VEGAGERÐIN

Siglufjörður - Ólafsfjörður

Veggöng um Héðinsfjörð

Yfirlit yfir jarðfræði Tröllaskaga og aðstæður til jarðgangagerðar

Jarðfræðistofan Ehf
JFS Geological services Ltd

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Road tunnel through Héðinsfjörður

Geological report

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1 Jarðfræði Miðnorðurlands og Tröllaskaga

1.1 Yfirlit yfir berggrunn Íslands

Ísland er staðsett á Mið-Atlantshafshryggnum sem liggur á mörkum landreksplatna Evrasíu og Norður-Ameríku. Jafnóðum og plöturnar rifna í sundur fyllist í gliðnunarrifuna á milli þeirra með eldkviku í formi innskota og gosbergs. Landreksgliðnunin kvíslast yfir Ísland, frá Reykjanesskaga (og Mið-Suðurlandi) í suðvestri til Skjálfandaflóa og Melrakkasléttu í norðaustri. Elsta berg landsins er að finna hvað lengst frá rekásnum, neðst í ystu múlum á norðanverðum Vestfjörðum (liðlega 15 milljón ára), á ystu annesjum á Austfjörðum (nærri 13 milljón ára), á staðbundnu svæði í kringum Borgarnes (12 m. ára) og svo yst við mynni Eyjafjarðar (liðlega 11 milljón ára).

Miklar breytingar urðu á upphleðslu jarðlagastaflans fyrir um 3 milljón árum vegna kólnandi loftslags og myndunar jökla. Venja hefur skapast hérlendis að kalla þann hluta berggrunnsins sem er eldri en 3 milljón ára tertíert berg og það sem yngra er kvartert .

Tertíeri berggrunnurinn er úr miklum bunka af basaltlögum og millilögum úr setbergi og hallar bunkanum inn til landsins. Setbergslögin eru ýmist þunn lög (nokkrir cm eða fáeinir tugir cm) úr fornum fokjarðvegi og þunnri gjósku og svo aftur þykkari setmyndanir myndaðar við stórkostlegt öskufall, eða tiltölulega staðbundnar þykkar setmyndanir myndaðar við rof og setmyndun samfara því.

Ekki er þó tertíeri berggrunnurinn ein samofin basalthella heldur finnast dreifðar í henni yfir 80 svokallaðar megineldstöðvar og er meginþorri þeirra löngu útkulnaður. Lætur nærri að hátt í helming af jarðskorpu Íslands megi rekja til eldvirkni í slíkum eldstöðvum. Jarðfræðibygging megineldstöðvanna er öllu flóknari en plötubasaltstaflans umhverfis þær.

1.2 Landafræði Tröllaskaga

Milli Skagafjarðar og Eyjafjarðar gengur fram einn tröllslegasti fjallgarður Íslands og hin síðari ár hefur hann verið nefndur eftir því Tröllaskagi. Hann er afar víðfeðmur, um 35 km breiður frá austri til vesturs og um 80 km langur frá norðri til suðurs, hálendur en sundurskorinn af djúpum dölum með hrikalegar hamrabrúnir. Að sunnan tengist fjallendi hans miðhálendi Íslands en fer þó lækkandi þangað, úr um 1200 m hæð á Nýjabæjarfjalli, niður í um 800 - 900 m á norðanverðum Sprengisandi.

Nyrðri hluti skagans, norðan Öxnadalsheiðar einkennist öðru fremur af tiltölulega heildstæðri fjallahæð sem hefur gjarnan í svipaðri hæð flatmyndaða kolla, eða fjallaspildur með bröttum fjallabrúnum, víða með skálum og skörðum. Fjöllin rísa þar hæst í fjallgarðinum milli Skíðadals og Hörgárdals þar sem tindar ná upp í 1456 m hæð í Dýjafjallshnjúki. Næst Hörgárdal og Skíðadal eru flestir tindar hvassbrýndir en til vesturs og norðvesturs ber sífellt meira á flötum fjallatoppum, jafnframt því sem fjöllin lækka í stórum dráttum til NNV og svipuð fjallahæð verður beggja vegna einstakra dala.

Öxnadalsheiði og Hörgárdalsheiði mynda djúp skörð þvert í gegnum skagann þar sem þær tengja saman Norðurárdal í Skagafirði og Hörgárdal og Öxnadal í Eyjafirði. Sunnan þeirra rís fjallgarðurinn enn hærra upp, í 1536 m hæð y.s. í fjallinu Kerlingu við austurbrún skagans innan við Akureyri. Þaðan og inn fyrir Torfufell eru háfjöll skagans í austurjaðrinum en öldótt háslétta fer lækkandi vestur að brúnum Austurdals í Skagafirði.

1.3 Berggrunnur Tröllaskaga

Berggrunnur Tröllaskaga hlóðst að mestu leyti upp á tímabilinu frá um 12 til 4 milljóna ára. Upphleðslan markast í stórum dráttum af legu gosbeltisins um Ísland. Fyrir meira en 6-7 milljónum ára, lá aðal gosbeltið að vestanverðu við Tröllaskaga, þar sem nú eru Húnavatnssýslur. Berglögum í meginhluta skagans hallar til vesturs og suðvesturs í átt að þessu forna gosbelti. Fyrir 6-7 milljónum ára fluttist gosbeltið til austurs, yfir basaltplötuna á Mið-Norðurlandi og tóku þá að hlaðast upp berglög ættuð frá austri og suðaustri. Í suðausturhluta skagans hallar lögunum til suðurs og suðausturs í átt að núverandi gosbelti. Hallastefnur eru sýndar á einfölduðu berggrunnskorti af Tröllaskaga á teikningu 1.

Í sneið sem liggur skáhallt til suðvesturs undan jarðlagahallanum gegnum fjallgarðinn, frá Ólafsfirði um Sólheimafjall og áfram inn Austurdal í Skagafirði er samtals um 5 km þykkur jarðlagastafli sem hlóðst upp á tímabilinu frá liðlega 12 til tæplega 8 milljónum ára. Til viðbótar er 2-3 km þykkur jarðlagastafli í suðaustanverðum skaganum (innanverðum Eyjafjarðardölum) sem hlóðst að mestu upp frá um 7 til tæplega 4 milljóna ára. Þannig má rekja sig gegnum 7-8 km þykkan jarðlagastafla í Tröllaskaga.

Jarðlagastaflinn er víðast reglulegur, með undantekningum í grennd við fornar megineldstöðvar, eins og síðar verður vikið að. Hraunlögin eru yfirleitt 5-15 m þykk. Einstök hraunlög aðgreinast venjulega með lagmótakarga en algengt er að þunn, rauð millilög, úr fornum þurrlendisjarðvegi séu milli hraunlaga. Í grennd megineldstöðvanna eru þykk, súr gjóskulög og mikil staðbundin óregla í jarðlagaskipan. Á stöku stað eru setbergslög úr vatnsfluttu seti, svo sem sandsteinn og völuberg.

1.3.1 Jarðlagasyrpur, halli berglaga og ummyndun

Nokkrar jarðlagasyrpur með tiltekin séreinkenni hafa verið kortlagðar með umtalsverða útbreiðslu í berggrunni Tröllaskaga. Á samsettu jarðlagasniði gegnum skagann frá Ólafsfjarðarmúla suðvestur í Sólheimafjall í Blönduhlíð er farið gegnum liðlega 4 km þykkan bergstafla með um 300 basaltlögum og er meðalþykkt laganna 13-15 m að meðtöldum lagmótakarga. Liðlega 7% bergsins eru úr setlögum en flest eru þau þunn, eða minna en metri á þykkt.

Hallastefna jarðlaga á Tröllaskaga er ekki regluleg, heldur breytist hún frá einu svæði til annars. Norðan Hringvegar er meginhallinn til suðvesturs. Sunnan Hringvegar er megin hallastefnan til suðurs og SSA er kemur suður um Eyjafjarðarsveit. Víða er jarðlagahalli 3-4° við sjávarmál og í dalbotnum en fer upp í 7° í rótum Ólafsfjarðarmúla (sjá örvar er sýna hallastefnu berglaga á teikningu 1). Jarðlagahallinn minnkar jafnan upp á við á hverjum stað og gjarnan nemur hallabreytingin 1-1,5° fyrir hverja 200 m hækkun en allvíða er breytingin þó minni. Mesti jarðlagahallinn er þó ekki norðaustast í elsta berginu við ströndina, eins og búast hefði mátt við, heldur á þröngu snörunarbelti er liggur á milli Fljóta og Siglufjarðar. Þar er að finna allt að 30° halla til vesturs í afmörkuðum snöruðum spildum.

Basaltstafli sem hleðst upp og grefst sífellt dýpra undir nýjum hraunlögum, tekur að ummyndast vegna aukins hita og þrýstings. Ummyndunarstig bergsins kemur fram í holu- og sprungufyllingum, sem urðu til við útfellingar úr jarðvatni sem lék um bergið. Útfellingarnar kristallast í svokallaðar síðmyndaðar steindir og eru ummyndunarstig í basalti kennd við nokkrar tegundir þeirra svo koma nöfn geislasteina fyrir í nöfnum sumra ummyndunarbeltanna.

Yfirleitt er berggrunnur Tröllaskaga þéttur og því mettaður vatni, nema e.t.v. í efstu 200-300 metrunum í fjallarindum. Hátt til fjalla ofan kabasít- tomsonít ummyndunarbeltisins eru berglög nokkuð jafnlek og vatn kemur víða fram í lindum í tiltekinni hæð þar sem ummyndunar fer að gæta eða þar sem þétt setlög liggja í berginu. Þessi þétting með tilheyrandi lidnarennsli verður víða í 500-900 m hæð y.s. (Glögg skil í vatnsleiðni verða t.d. stundum á efra borði ummyndaðs ólivínbasalts auk þéttiskila á yfirborði setbergslaga).

Niðri í kabasít- tomsonít ummyndunarbeltinu og neðar í jarðlagastafla er vatnstreymi í berginu nær eingöngu bundið við sprungur, misgengi og brotaberg á jöðrum bergganga. Jarðvatnsstaða og lindasvæði eru talin auka frostveðrun við lágt hitastig, þannig að rofflötur (og jafnvel breiður stallur) geti myndast í fjallshlíð nærri jarðvatnsborði. Þetta má víða sjá þar sem lindalínur koma fram í hliðstæðri hæð og skálabotnar í fjöllum.

1.3.2 Misgengi, gangar og brotalínur

Í Tröllaskaga er aðalstefna bergganga NNA-SSV (Kristján Sæmundsson og fl. 1980). Gangarnir eru víðast 2-8 m þykkir en einstaka gangar eru allt að 20 m. Gangar eru líkt og misgengin nær lóðréttir í upphafi, en hallast venjulega með jarðlagastaflanum. Þeir eru ýmist aðfærsluæðar hraunlaga, eða enda uppi í jarðlagastaflanum án þess að bergkvikan hafi náð yfirborði. Gangarnir, eins og misgengin endurspegla togspennu í skorpunni þar sem bráðin bergkvika þrýstir sér upp um togsprungu.

1.4 Mótun landslagsins

Síðla á tertíertíma lá Tröllaskagi austan við gosbelti rekássins um Ísland. Ætla má, að þá hafi megineldstöðvarnar risið nokkur hundruð metra (og jafnvel mörg hundruð metra) yfir hásléttuna frá NNA-SSV. Fyrir um 6-7 milljónum varð upplausn og hliðrun í gosbeltinu og reif það sig upp austan Tröllaskaga og Flateyjardalsskaga og hefur haldist þar síðan. Hliðrun gosbeltisins olli miklum umbrotum í bergskorpunni, einkum við norðurströndina þar sem þverbrotabelti myndaðist frá gamla rekhryggnum austur í hið nýja gosbelti um Ísland (milli Mið-Suðurlands og Skjálfandaflóa - Öxarfjarðar). Umbrotin hafa vafalítið stuðlað að myndun sigstalla og dælda í berghleif Mið-Norðurlands sem síðar urðu dalir og loks firðir.

Þegar loftslag fór kólnandi undir lok tertíer, tóku jöklar að myndast, fyrst á megineldstöðvunum sem hæst risu. Ein megineldstöðin trónaði stök austan núverandi Eyjafjarðar og má leiða líkur að slakki hafi verið milli hennar og eldstöðvanna í Fljótum og Öxnadal. Hliðstætt fjalllendi kann einnig að hafa verið vestan Skagafjarðar því megineldstöðvar eru einnig í Laxárdalsfjöllum, milli Skagafjarðar og Húnavatnssýslu.

Frá austurhlíðum hásléttu Tröllaskaga skriðu jöklar og þræddu norður til strandar eftir farvegum sem myndast höfðu með ýmsu móti, e.t.v. mest af brotahreyfingum í berggrunni og rennandi vatni. Samsvarandi aðstæður mynduðust að vestanverðu, þar sem dalir í Skagafirði beindu skriðjöklum norður til hafs. Í fjalllendinu milli Eyjafjarðar og Skagafjarðar varð til svonefnt Alpalandslag, þar sem jökulstreymið átti greiða leið til flestra átta (nema síst inn til landsins). Landið einkennist af djúpum dölum og fjörðum með stuttar skálar hátt uppi á milli hvassbrýndra fjalla. Eftir því sem Eyjafjörður og Skagafjörður dýpkuðu, hafa skriðjöklar safnast í þá í miklum meginstraumi sem þokaðist til norðurs. Yfirborð skriðjöklanna var líklega að jafnaði miklu lægra en meginfjöll Tröllaskaga.

Ummerki um þetta forna rof og dalamyndun má sjá víða í Skagafirði. Frá miðhluta ísaldar eru miklar gosmyndanir í utanverðum Skagafirði (svo sem Þórðarhöfði, Drangey, Ketubjörg og víðar) og í innri hluta Skagafjarðarhéraðs eru setlög sem líklega eru frá mið- eða síðari hluta ísaldar (svo sem í Hellisási milli Svartár og Héraðsvatna). Jarðmyndanir frá þessum tíma finnast auk áðurnefndra staða í liðlega 500 m hæð y.s. við Kotagil í Norðurárdal og í tæplega 400 m hæð y.s. í Heiðarsporði innar í Norðurárdal.

Í Eyjafirði sjálfum er ekki að finna slíkar gamlar hraunfyllur í dölum, nema í utanverðum Fnjóskadal og í Helguhóli (framundan Dalsmynni) utan við Laufás. Þetta eru vísbendingar um að Eyjafjörður og Skagafjörður hafi verið komnir í núverandi dýpt fyrir milljónum ára.

Á norðvestanverðum Tröllaskaga, utan Öxnadalsheiðar, eru tiltölulega jafnhá fjöll, sem fara lækkandi norður að Sléttuhlíð og Fljótum. Mynda þau eins og slitrótta kúpulaga háslettu sem nú er sundurskorin af dölum og skálum. Austur til Eyjafjarðar hækkar þessi slitrótta háslétta og hverfur í hvassbrýndum tindum frá Siglufirði, suður um Svarfaðardal og Hörgárdal. Einmitt þar eru merki um fornar megineldstöðvar sem líklega trónuðu yfir umhverfi sitt á tertíer og höfðu afgerandi áhrif á vatns- og jökulrof í nágrenni sínu.

1.5 Laus jarðlög

Fjallað er um laus jarðlög að nokkru leyti í aldursröð þar sem byrjað er á þeim elstu. Staðir sem nefndir eru í texta eru flestir sýndir á teiknngum 1 og 2.

Jökulruðningur. Jökulruðningur er víða í dalbotnum, dalsmynnum og stundum inni í miðjum dölum. Mestur er jökulruðningurinn í innhluta Skagafjarðar og Eyjafjarðar. Hvergi eru miklar jökulruðningsmyndanir í utanverðu meginhéraði Skagafjarðar né í miðhluta þess. Í Eyjafirði eru víða jökulruðningshólar í þverdölum og við mynni þeirra.

Í Siglufirði, Héðinsfirði og Ólafsfirði, má sjá endastig jökla í miðjum dölum og miklar jökulurðir eru í sumum þverdölum utarlega í fjörðunum.

Malarhjallar. Við lok síðasta jökulskeiðs reis sjávarborð í kjölfar bráðnunar jökla. Hæst sjást sjávarmörk í framanverðum Skagafirði í 43-48 m hæð y.s. í miklum malarhjöllum, Vindheimamelum, í fornum óseyrum Svartár við norðurenda Reykjatungu. Hliðstæðir hjallar eru slitrótt út vestanverðan Skagafjörð, um Reynisstað til Sauðárkróks. Fornu hjallarnir lækka til norðurs svo að norðan við Fell í Sléttuhlíð eru efstu hjallar í um 30 m hæð y.s. Í Eyjafirði eru Melgerðismelar í um 35 m hæð y.s., við neðanverða Hörgá eru hjallar nærri 20 m hæð y.s. auk þess sem malarhjallar finnast á sjávarbotni framan við Ós Hörgár. Einnig eru slitróttir hjallabútar við utanverðan Svarfaðardal og í Ólafsfirði.

Frostveðraðar urðir. Á utanverðum Tröllaskaga og háfjöllum, allt inn á Nýjabæjarfjall eru útbreiddar frostveðraðar urðarþekjur. Norðan Norðurárdals, um Sólheima- og Akrafjall og áfram norður um Hjaltadal, Deildardal og Unadal eru öll háfjöll þakin frostveðraðri urð úr köntuðu grjóti. Þykkt frostveðruðu urðarflákanna virðist vera í hámarki í Sléttuhlíð, Fljótum, Siglufirði, Héðinsfirði, Ólafsfirði og utanverðum Svarfaðardal. Þessar urðarþekjur eru minni og þynnri inn til dala en þekja þó gjarnan efri fjallakraga dalanna.

Algengt er að finna þykka urðarbingi neðan skörðóttra skála undan fjallabrúnum og á afmörkuðum stöðum hafa frostveðraðar urðarþekjur sigið undan halla og myndað þykka urðarbingi. Urðarbingir eru mestir og tíðastir norðantil á Tröllaskaga svo sem í Fljótum, Siglufirði, Héðinsfirði og Ólafsfirði og má ætla að flestir slíkir bingir eigi uppruna í fornum urðarjöklum.

Á Siglufjarðarleið um Almenning í Austur-Fljótum hefur Vegagerðin lagt út mælinet til að fylgjast með hreyfingum á veginum. Þar nemur heildarfærsla yfir liðlega 20 ára tímabil 2,2-3,1 m eða um 0,10-0,15 m á ári. Afmarkaðar spildur norðarlega á Almenningi skríða hraðar eða um 0,50 m á ári en þar nær mælitímabilið aðeins yfir 2-3 ár. Þessar hreyfingar eru fyllilega sambærilegar við það sem mælt hefur verið í virkum urðarjöklum. Undir urðarbingjunum við Almenningsnöf þar sem sjór brýtur frambrún þeirra, hafa fundist 43 þúsund ára gömul skeljabrot í gömlum fjörusandi.

Í Héðinsfirði eru ummerki um tiltölulega afmarkaða og stutta jökla eftir því sem lesið verður í ummerki frá síðjökultíma og aftur á síðasta jökulskeið. Mjög áberandi jökulurðir mynda þykkan lagskiptan setbunka fram úr Víkurdal við utanverðan fjörðinn að austan. Þær eru svo miklar að líklegt er að þær hafi myndast á löngum tíma. Ljóst má vera að á þeim tíma hefur jökull ekki gengið langt fram megindal Héðinsfjarðar. Óljós ummerki jaðarurða jökuls má greina á tveimur hallandi beltum í austurhlíðinni ofan og utan við Vatnsenda. Þessar hallandi urðarrendur benda til að ysta greinanlega jökultungan hafi endað utantil við Héðinsfjarðarvatn. Staðir sem nefndir eru hér í texta eru flestir sýndir á teikningu 2.

Sumarið 2000 fundust skeljaleifar undir urðar- eða skálar-jökulsseti í vatnsbakkanum innan við Hestskarðseyri við vestanvert vatnið. Skeljarnar voru aldursgreindar og reyndust vera 12.720 ± 90 BP ára samkvæmt geislakolstímatali sem ekki hefur verið leiðrétt fyrir aldri sjávar. (Með leiðréttingu fyrir aldri sjávar er aldurinn er 12.330 ± 90 BP). Jökulruðningur yfir skeljunum er innan jaðargarða eftir tungu skálarjökuls er lá ofan úr skálinni ofan Hestskarðseyrar og má ætla að sá jökull hafi gengið fram á Yngra Dryas tíma sem kallað hefur verið Búðastig sunnanlands.

Við Grundarkot innar í Héðinsfirði er lagleg hólaþyrping í dalbotninum. Ætla má að þar séu jökulruðningshólar, sennilega endastig jökla í Héðinsfjarðardal á Búðaskeiði (Yngra-Dryas) fyrir liðlega 10.000 árum. Þessi umfjöllun um takmarkaða stærð jökla í Héðinsfirði síðla á síðasta jökulskeiði er til skýringar á því að frostveðraðar og sífreramyndaðar setmyndanir setja mjög svip á landslag í Héðinsfirði (ásamt Siglufirði og utanverðum Ólafsfirði). Sífreramynduð þykk urðartunga ofan við Grundarkot lokar fyrir annars landfræðilega heppilegan munna jarðganga til Ólafsfjarðar. Hliðstæðar urðartungur í Siglufirði takmarka einnig mögulegt val á staðsetningu jarðgangamunna.

1.6 Jöklar og urðarjöklar á nútíma

Jöklunarmörk (hæðin sem jöklar taka að myndast við) liggja nokkru lægra á norðanverðum skaganum en sunnantil. Norðan við Ólafsfjörð myndast jöklar í um 900-1000 m háum fjöllum en sunnan Öxnadalsheiðar því aðeins að fjöll séu yfir 1200-1300 m að hæð. Hjarnmörk eru talin vera í um 1100 m hæð y.s. á miðhluta skagans en lækka lítilsháttar nyrst.

Á Tröllaskaga eru fjölmargir virkir urðarjöklar og hafa liðlega 160 verið greindir með aðstoð loftmynda og vettvangskönnun og skráðir á kort. Margir urðarjöklanna eru samsettir úr fleiri en einum urðarstraumi, bæði liggja straumarnir samhliða og stundum gengur hver urðartungan yfir aðra.

2 Jarðgangaleiðir á norðanverðum Tröllaskaga um Héðinsfjörð

Fyrirhuguð samgönguleið milli Siglufjarðar og Ólafsfjarðar liggur um Héðinsfjörð og verða á henni tvenn aðskilin jarðgöng gegnum fjallgarðana beggja vegna Héðinsfjarðar. Jarðlagahallinn á þessu svæði er til suðvesturs þannig að báðir fjallgarðarnir eru byggðir upp úr því sem næst sömu bergsyrpunum. Bergið er í elsta hluta basalthellu Miðnorðurlands og liggur litlu hærra í jarðlagastaflanum en jarðgöngin í Ólafsfjarðarmúla. Kristján Sæmundsson jarðfræðingur hefur kortlagt ýtarlega berg nærri fyrirhuguðum jarðgangaleiðum og byggja þessi skrif að verulegu leyti á niðurstöðum hans. Staðsetning jarðlagasniða sem Kristján hefur lýst ásamt yfirliti yfir bergsyrpur og brotavirkni er sýnd á teikningu 2.

2.1 Almennt um jarðfræðilegar aðstæður

Jarðlög milli Siglufjarðar og Ólafsfjarðar eru nær eingöngu basalthraunlög með óverulegum millilögum. Ekki gætir þar upphleðslu frá megineldstöðvum en fyrir koma strjál súr túff og flikrubergslög. Efst í fjallskollum báðum megin Héðinsfjarðar eru lög úr dílabasalti, þá tekur við mikil syrpa úr þóleiítbasalti sem nær niður í miðjar hlíðar en þó hvergi niður á fyrirhugaðar jarðgangaleiðir. Í lághlíðum er þykk syrpa af ólivínbasalti sem víða er með hátt hlutfall plagíóklasdíla og flokkast þá sem dílabasalt. Lega helstu bergsyrpa eru sýndar á teiknigu 2 til 4.

Jarðlagahalli. Berglögum milli Siglufjarðar og Ólafsfjarðar hallar í stórum dráttum 5-8° til suðvesturs í neðstu 200 m ofan sjávarmáls en hærra til fjalla er hallinn minni. Nokkru norðar og vestan við gangaleiðina eru allbreiðar bergspildur sem snarast hafa til á milli misgengja og halla mun meir.

Brotalamir (misgengi, gangar og meginsprungur) greinast að miklu leyti í tvö brotakerfi. Annað, og það eldra markast af ríkjandi N-S berggöngum og misgengjum sem mynduðust líklega samhliða upphleðslunni þegar gosbeltið lá vestan Tröllaskaga. Yfirlit yfir kortlagða ganga og misgengi er sýnt á teikningu 2.

Berggangar eru yfirleitt í þessu kerfi og koma gjarnan fyrir í knippum en eru mun strjálli milli knippanna. Tíðni bergganga lækkar jafnan með vaxandi hæð yfir sjávarmáli. Meginstefna bergganga er er nálægt 10°austan við norður og er því meginstefna jarðganganna tiltölulega þvert á berggangana. Á fyrirhuguðum jarðgangaleiðum er hlutfall bergganga í berginu breytileg á bilinu frá 2% og upp í 7% þar sem gangaskarar liggja um. Þykkt einstakra ganga hefur mælst frá 1-14 m og meginstefna ganga er á bilinu 5-15°. Halli bergganga er yfirleitt um 85° með bratta til austurs og virðist vera að meginþorri þeirra hafi snarast til suðvesturs með halla jarðlagastaflans.

Misgengi. Misgengi á norðanverðum Tröllaskaga eru alla jafnan gömul og koma ekki fram sem stallar í landslaginu. Ríkjandi stefna misgengja er samsíða ofangreindri stefnu bergganga (5-15°). Stærð misgengja (lóðrétt sig) hefur mælst frá 1 m og upp í liðlega 100 m. Nær einhlítt er að misgengisfletinum halli niður undir signu spilduna. Halli misgengisflata hefur mælst 75-85°. Flestum hallar þó yfir 80° og virðist halli jarðlagastaflans ekki breyta þar miklu. Stærstu misgengjum fylgir jafnan misgengisbreksía, lítil sem engin í misgengjum með undir 10 m færslu en 2-5 m þykk í þeim stærri. Misgengisbreksían er byggð upp úr köntuðum steinum sem steyptir eru í fínkorna mulning, leifar setlaga, útfellingar úr geislasteinu, leir og ópal.

Annað brotakerfi með NV-SA sprungum (og einnig N-S sprungum) er yngra og tengist svokölluðu Tjörnes brotabelti sem gengur frá Tjörnesi og til VNV skammt norðan Tröllaskaga og hefur verið virkt síðastliðin 6-7 milljón ár.

Jarðskjálftar. Harðir jarðskjálftar hafa átt upptök á norðanverðum Tröllaskaga og á landgrunninu þar fyrir utan. Þeir tengjast Tjörnes brotabeltinu sem líta má á sem hliðstæðu brotabeltisins á Suðurlandi sem veldur sögulegum skjálftum þar. Jarðskjálftar á þessum slóðum eiga líka mikinn þátt í að viðhalda jarðhitakerfum á norðanverðum skaganum þar sem höggbylgjur skjálftanna brjóta öðru hvoru upp útfellingar úr jarðhitavatni sem leitast við að setjast í sprungur sem heitt vatn leikur um. Jarðskjálftar eru tiltölulega tíðir á belti sem liggur frá Dalvík norðvestur í Fljót.

Jarðskjálftar. Harðir jarðskjálftar hafa átt upptök á norðanverðum Tröllaskaga og á landgrunninu þar fyrir utan. Þeir tengjast Tjörnesbrotabeltinu sem líta má á sem hliðstæðu brotabeltisins á Suðurlandi sem veldur sögulegum skjálftum þar. Jarðskjálftar eru tiltölulega tíðir á belti sem liggur frá Dalvík norðvestur í Fljót. og eiga þeir líka mikinn þátt í að hrista upp í eldri sprungum og viðhalda jarðhitakerfum á norðanverðum skaganum.

Jarðvatn. Efstu fjallarindar eru gerðir úr fersku lítt holufylltu bergi og því tiltölulega vel vatnsleiðandi. Vatnið hríslast þar um lagmótakarga og innra sprungunet basaltlaganna. Neðan 450-550 m hæðar y.s. er almennt mjög lítil lekt í berginu svo sem greina má á dýjaveitum og stökum lindum hátt í fjöllum þar sem vatnið sem síast hefur inn í efsta hluta fjallanna kemur fram. Í neðri hluta fjalla er lektin að mestu bundin við sprungur og bergganga.

Ummyndun í berginu á jarðgangaleiðum beggja vegna Héðinsfjarðar tilheyrir líklegast neðsta hluta mesólít- skólesít beltisins. Ólivínbasalt og dílabasalt er hér almennt vel holufyllt og verður bergið að teljast heppilega mikið ummyndað með tilliti til jarðgangagerðar.

Jarðhiti. Á norðanverðum Tröllaskaga er mikill náttúrulegur jarðhiti á yfirborði í Fljótum og í Ólafsfirði. Einnig eru jarðhitasvæði í Skútudal í Siglufirði og volgrur í Héðinsfirði. Jarðskjálftar viðhalda jarðhitakerfum þar sem höggbylgjur skjálftanna brjóta öðru hvoru upp útfellingar sem sest hafa til í berggöngum og gömlum misgengjum sem heitt vatn leikur um. Þrjú þekkt jarðhitasvæði eru á fyrirhuguðum jarðgangaleiðum, það mesta í Ólafsfirði en minni kerfi nærri Grundarkoti í Héðinsfirði (í landi Vatnsenda) og innantil í Skútudal í Siglufirði.

2.2 Jarðlagasnið og kjarnaboranir

Við undirbúningsrannsóknir vegna jarðganganna á árunum 1994 til 2000 hefur Kristján Sæmundsson á Orkustofnun lýst allmörgum jarðlagasniðum til að leggja grunn að jarðlagalíkani sem notað er fyrir jarðgangaleiðir milli Siglufjarðar og Ólafsfjarðar. Niðurstöður rannsóknanna eru gefin út í nokkrum skýrslum Orkustofnunar (sjá heimildir). Flest sniðin liggja upp lækjarfarvegi í fjallahlíðum þar sem vatnið hefur hreinsað laust efni ofan af berginu. Staðsetning jarðlagasniða er sýnd á teikningu 2.

Rannsóknarboranir vegna jarðgangaleiðanna fóru fram í ágúst til desember 2000. Boranir í Héðinsfirði fóru fram síðla í ágúst og í september, í Siglufirði í nóvember og í Ólafsfirði í lok nóvember og fyrri hluta desember. Staðsetning kjarnaborhola er sýnd á teikningum 2, 5 og 6.

Í Siglufirði var boruð ein 330 m djúp kjarnahola (SG-1) nærri fyrirhuguðum gangamunna í Skútudal, auk 15 hola sem boraðar voru með loftbor til kanna dýpi á fast berg.

Í vesturbrekkum Héðinsfjarðar var boruð 220 m djúp kjarnahola (HG-2) auk grunnrar holu (HG-3) nærri mögulegum munna um 0,5 til 1 km innan við Héðinsfjarðarvatn. Að auki var fjöldi grunnra hola boraður með loftbor til að þreifa eftir dýpi á klöpp.

Í austurbrekkum Héðinsfjarðar var boruð 350 m djúp kjarnahola ofan við Grundarkot auk tveggja grynnri hola við mögulega munna til beggja hliða. Til viðbótar var boraður fjöldi hola með loftbor til könnunar á þykkt lausra jarðlaga. Laus jarðlög takmarka val á mögulegum jarðgangamunna í hlíðinni nærri Grundarkoti.

Í Ólafsfirði var boruð 150 m djúp kjarnahola uppi undir fjallsrótum ofan við Ósbrekku og tvær 50 og 60 m djúpar holur neðarlega í brekkunum ofan við flugvöllinn. Að auki voru boraðar með loftbor nokkrar grunnar holur við mögulega gangamunna. Helstu upplýsingar um kjarnaborun árið 2000 vegna áformaðra jarðganga í norðanverðum Tröllaskaga eru sýndar í meðfylgjandi töflu.

Summary of drilled holes at Héðinsfjörður Tunnel Project in the year 2000

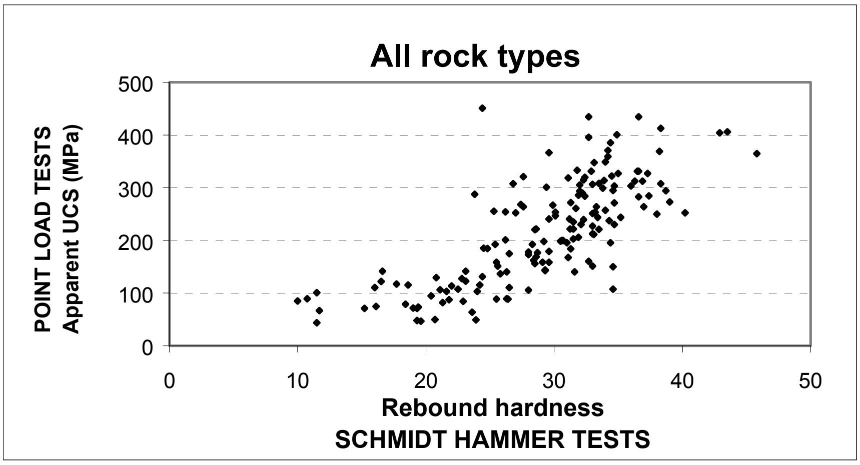
Name	Drill. (year/ week)	X-Coord	Y-Coord	Elev. (m a.s.l.)	Incl.° fr.ve	Depth (m)	Core %	RQD >0,1m %	Point load tests	Sch. ham. tests	Perm tests	GWT (depth) m
Siglufjörður												
SG-1	00/46	505070	625870	131,38		330,7	99,2	94,0	71	57	15	5,1
Héðinsfj.												
HG-1	00/35	508608	622466	192,47		350,2	96,5	89,6	54	46	13	37,5
HG-2	00/36	507695	622950	163,47		219,6	99,8	82,1	27	21	11	2,0
HG-3	00/37	507924	623325	117,39		42,5	99,4	65,9	4	4	3	11,8
HG-4	00/38	508241	622183	118,25		51,6	99,6	80,9	7	4	3	13,5
HG-5	00/39	508836	623008	150,77		78,6	94,1	80,6	12	9	5	18,8
Subotal:						**742,5**	**96,0**	**84,6**	**104**	84	**34**	
Ólafsfj.												
ÓG-1	00/48	514647	619673	42,269		63,6	97,2	69,0	13	8	5	3,0
ÓG-2	00/48	514142	619860	123,38		150,6	98,6	81,7	32	24	9	3,8
ÓG-3	00/49	514816	620186	39,634	30°	50,7	96,5	69,1	8	7	3	3,5
Subotal:						**264,9**	**97,9**	**76,3**	**53**	**39**	**17**	

Total						**1338**	**97,2**	**85,5**	**228**	**180**	**66**	

Almennt má segja að kjarnaholur sýni að berg á jarðgangaleiðum sé tiltölulega heillegt og vel samlímt og því álitlegt til jarðgangagerðar. Borkjarnanum var lýst eftir hefðbundnum aðferðum (sem notaðar hafa verið til undirbúnings jarðganga á Íslandi í yfir tvo áratugi) og sýndarstyrkur (apparent uniaxial breaking strength) mismunandi berggerða mældur með punktálagstæki (point load).

Í stuttu máli sýna niðurstöður að basalt hefur einása sýndarbrotstyrk 100-350 MPa, kargaberg hefur einása brotstyrk 50-150 MPa og setberg hefur einása brotstyrk 50-100 MPa með nokkrum lægri gildum. Áréttað skal að ekki hafa verið gerðar brotprófanir á samsvarandi sýnum í rannsóknarstofu til kvörðunar á punktálagsprófunum, svo mögulegt er að einása brotstyrkur bergsins sé í raun mun lægri en uppreiknaður sýndarstyrkur sem birtur er hér.

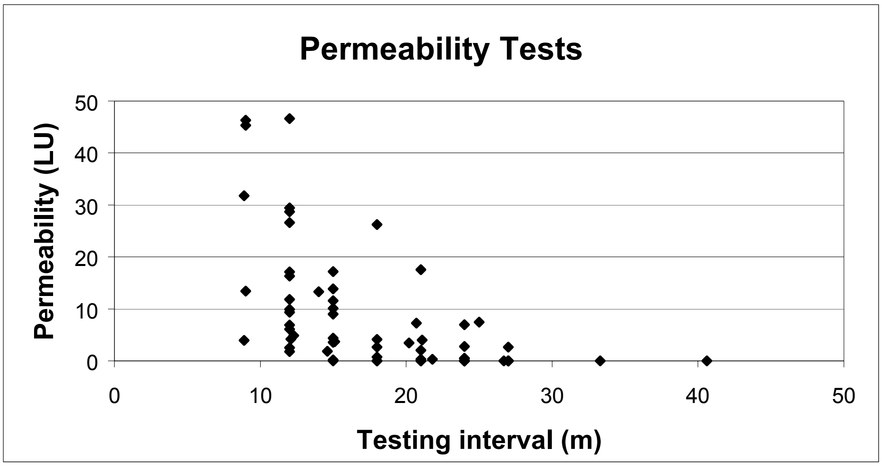
Auk punktálags var mæld harka bergsins (rebound hardness) með Schmidt hammer tæki. Meðfylgjandi er dreifirit sem sýnir hvernig sýndarstyrkur og harka bergsins dreifist, eins og þessir þættir voru prófaðir í kjölfar borana árið 2000.



Mynd 1. Samband sýndarstyrks og hörku bergs milli Siglufjarðar og Ólafsfjarðar.

Lekt bergsins var prófuð í öllum kjarnaholum og þær dýpri í mörgum þrepum þar sem pakkari var settur í holuna og vatni þrýst niður með miklum þrýstingi. Niðurstöður þessara lektarprófana benda til þess að þar sem bergið er tiltölulega heilt utan misgengja og bergganga sé það tiltölulega vatnsþétt. Þegar prófað var í misgengjum og berggöngum lak bergið mikið.

Á mynd 2 eru sýnd tengsl lektar og lengdar prófunarbila í borholum. Þar sést að lengd prófunarbila var á bilinu 9-27 m og að lengd prófunarbila virðist ekki hafa farið fram yfir afkastagetu mælitækjanna (hvað varðar rennslismagn og þrýstifall).



Mynd 2. Samband á milli lektar og lengdar prófunarbila í borholum.

Á mynd 3 á næstu síðu er sýnt á skematískan hátt hvernig basaltstaflinn er byggður upp úr mismunandi lögum og eru sýnd helstu tölugildi sem vænta má í mismunandi lögum og einnig innan einstakra laga. Teikningin verður að skoðast sem lýsing almenns eðlis og geta verið frávik frá því sem sýnt er þar bæði varðandi samsetningu einstakra lag og mældra þátta varðandi bergstyrk og annað.

Typical sequence of rock units in Tertiary basaltic successions in Tröllaskagi northern Iceland

General technical properties of the rock

Typical Uniaxial Compressive Strength (UCS) [MPa]
Mainly based on Point load tests

Typical Q values

Based on tests from the Siglufjörður - Ólafsfjörður tunnel project

Main results for reddish sandstone
20-60 MPa Q = 0.2-4

In upper part of scoria
50-120 MPa
Q = 7-15

In lower part of scoria
120-200 MPa
Q = 10-20

Main results for crystalline basalt
100-400 MPa
most frequent
200-300 MPa
Q = 5-20

Tholeiite basalt 300-400 MPa

Olivine basalt
100-200 MPa for the compound flow,
250-350 MPa for single lava flows

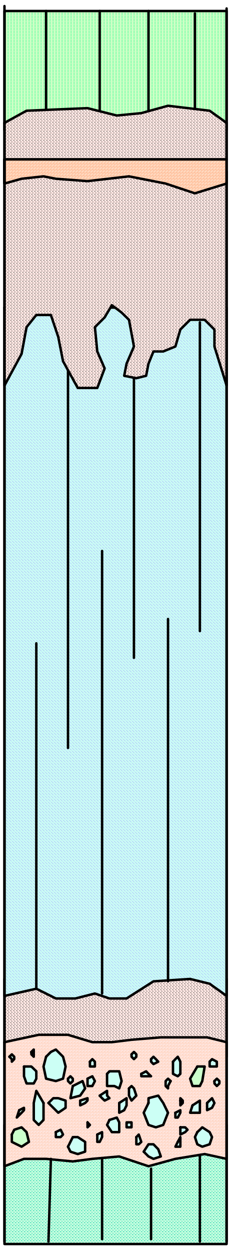
Porphyritic basalt 250-350 MPa

Bottom scoria
Main results 50-2-100 MPa
Q = 5-15

Main results for conglomerate
50-100 MPa
Q = 2-4

Basalt lava with eroded surface
Q = 5-15

Fault breccias and dykes
show lower rock quality



Description of rock

Crystalline basalt

Bottom scoria often 0,3-1 m

Sedimentary interbed, normally basic tuff
Typical thickness 0.1-1 m

Scoria. In upper part, often containing sedimentary fillings, infiltrated from overlying sedimentary layer

Irregular top of crystalline basalt

Crystalline basalt, often vesicular in upper part and frequently filled with secondary minerals in the lower Tröllaskagi strata.

Crystalline part of a basalt layer, 70-80% of a tholeiite lava but it is generally over 80% in olivine tholeiite and porphyritic lavas
Typical thickness of crystalline part 4-12 m

Often containing columnar jointing (diameter 1-2.5 m)

Micropores are common and flow banding in micropores, leading to a platy cleavage is often found, especially in tholeiite rock

Bottom scoria, often 3-8 % of the lava
Typical thickness 0.3-1 m

Conglomerate interbed. Typical thickness 0.5-10 m
Typical grain size ranging from sandy and silty matrix, containing boulders exceeding 1,5 m in diameter. Conglomerate is rare in the lower Tröllaskagi strata
Eroded surface of underlying crystalline basalt.
Eroded surfaces are rare in the lower Tröllaskagi strata.

Jarðfræðistofan Ehf
JFS Geological services Ltd

VEGAGERÐIN

Mynd 3. Einfölduð skýringarmynd yfir helstu tæknilega þætti berglaga.

3 Jarðgangaleið milli Siglufjarðar og Héðinsfjarðar

Jarðlögunum hallar til suðvesturs um 5-8° en jarðgangaleiðin stefnir VSV-ASA þannig að nálægt 30°horn er milli strikstefnu jarðlaga og stefnu ganganna. Því er halli berglaga nálægt 3-4°til vesturs eftir gangaleiðinni.

Jarðlagasnið í Héðinsfirði og Siglufirði sýna að rekja má syrpu af þóleiítbasalti gegnum efri hluta fjallanna og aðra syrpu af ólivínbasalti sem er í neðri hlíðum í Héðinsfirði innan við Héðinsfjarðarvatn má sjá ganga niður í botn Skútudals í Siglufirði (sjá yfirlit yfir jarðlagasyrpur á teikningu 3 og nákvæmara snið á teikningu 7). Frekari lýsingar á jarðlagaskipan og tenginu bergsyrpa milli Héðinsfjarðar og Siglufjarðar er að finna í skýrslum Orkustofnunar um jarðfræði svæðisins (Kristján Sæmundsson 1996-2000).

Við kjarnaboranir fannst eitt dílótt basaltlag djúpt í holu SG-1 í Skútudal sem virðist falla vel að lagi ofarlega í holu HG-2 í Héðinsfirði (sjá teikningu 7). Ekki er talið að þekkja megi önnur lög á milli hola enda er bergið beggja vegna fjallsins mjög svipað. Berglögunum hallar til suðvesturs eða skáhallt eftir jarðgangaleiðinni frá Héðinsfirði niður til Skútudals. Samkvæmt þessu munu liðlega 3 km löng jarðgöng skera liðlega 200 m þykkan nær samfelldan stafla af ólivínbasalti með tiltölulega þunnum millilögum. Ekki er að sjá að nein sérstök jarðlög í berginu takmarki legu jarðganga, hvorki varðandi hæðarlegu þeirra né stefnu.

Auk basaltlaga eru nær lóðréttir berggangar og misgengi sem liggja tiltölulega þvert á jarðgangaleiðina. Berggangarnir finnast í flokkum eða skörum í jarðlagastaflanum og skáru allar kjarnaholurnar við báða gangaenda slíka bergganga. Langflestir gangar sem fundust við kortlagningu svæðisins eru 1-4 m þykkir en fáeinir 5-8 m hafa fundist.

Á teikningu 7 er sýnt hvar búist er við að berggangar og misgengi skeri gangaleiðina. Fullvíst má telja að brot og berggangar verði mun fleiri á gangaleiðinni en sýnt er á teikningu 7 en ætla má að stefnur ganga og brotalína sem síðar finnast, verði flestar samsíða þeim sem þekktar eru. Tíðnirósin fyrir sprungudreifingu stefnir mjög eindregið N-S eða skáhallt á gangaleiðina og er stefna brotanna hagstæð með tilliti til jarðgangagerðar.

Fyrirsjáanlegt er að jarðgöngin munu skera sprungur og ganga er tengjast jarðhitasvæðinu innantil í Skútudal. Ekki er ljóst hversu mikil áhrif göngin munu hafa á rekstur jarðhitasvæðisins en þau verða vafalítið einhver þrátt fyrir fyrirhugaða þéttingu bergsins.

3.1 Munni jarðganga í Skútudal í Siglufirði

Áformuðum munna jarðganga í Skútudal í Siglufirði hefur verið valinn staður undir fremur brattri liðlega 200 m hárri hlíð, neðan við alldjúpar skálar sem hærra liggja í fjallinu. Fram úr skálunum liggur 5-10 m þykk kápa úr grófgerðum jökulruðningi. Uppruni urðarinnar er í urðarþekju á framhluta skálarjökuls eða urðarjökuls er lá þar á síðasta jökulskeiði. Efnisgerðin er fremur grófgerð köntuð eða lítið núin bergmylsna í sand og siltkenndum grunni. Vegna bratta hefur urðin sigið niður hlíðina, án þess þó að mynda sérstaklega þykka hauga í hlíðarfætinum.

Skammt innan við munnasvæðið sér í klöpp í læk og aftur um 150 m innar með hlíðinni í farvegi Hestskarðsár. Annars sér ekki í klöpp utar í dalnum að austan. Á teikningu 9 er kort af fyrirhuguð munnasvæði í Skútudal.

Kjarnahola SG-1 er staðsett í 131 m hæð y.s. í um 300 m fjarlægð utan og ofan við áformaðan gangamunna (sjá teikningu 9). Staðsetning holunnar var valin með tilliti til aðgengis upp hlíðina og að holan færi gegnum jarðlög á gangaleiðinni. Lögum sem fram koma í holunni hallar liðlega 5° niður að munna og er að sjá að þykk massíf basaltlög verði í munnanum. Berggangar með N-S stefnu eru tíðir í hlíðinni og gæti þurft að hnika skeringum við munna til með tilliti til þeirra.

Nokkrir grafningar liggja samsíða niður hlíðina á munnasvæðinu án þess að þar sjáist í klöpp. Hæðarmunur á grafningum og bökkum við þá er víða 2-4 m. Á teikningu 9 sýndar eru staðsetningar borana ásamt súlum er túlka jarðgerð og dýpi á fast. Neðan og innan við kjarnaholuna voru boraðar 15 holur með loftbor til að kanna dýpi á fast. Reyndist það vera mjög breytilegt, frá liðlega 3 m upp í tæplega 10 m. Nánari lýsingar á loftborun er í viðauka (Appendix IV).

Næst fyrirhuguðum munna í holum SL-12, SL-14 og SL-15 reyndist dýpi á fast vera a.m.k. 5-8 m. Næst yfirborði er um 3 m þykk jarðvegsþekja en undir er 3-5 m þykkur jökulruðningur. Hola SL-14 er næstum í veglínunni skammt frá stöð 2340 en aðrar holur eru utar og ofar í brekkunni (sjá teikningu 9). Í holu SL-14 reyndist vera mikil og hörð fyrirstaða á tæplega 5 m dýpi sem túlkuð er sem klöpp en í ljósi annarra hola í nágrenninu getur verið að þar sé grafið stórt bjarg á yfirborði klapparinnar. Á langsniði jarðlaga eftir fyrirhugaðri veglínu við gangamunna á teikningu 11 er þremur syðstu loftborsholunum varpað inn í sniðið.

Vegna þess að loftborsholum var fremur valinn staður í dældum en á kollum má telja að þykkt lausefna geti að meðaltali verið um 2-3 m meiri en boranir sýna. Því er nær að telja að þykkt lausefna við fyrirhugaðan munna í Skútudal sé um 8-9 m ±2 m. Þar sem veglínan fer skáhallt samsíða hlíðinni inn í göngin verða fláar brekkumegin að skála nokkuð háir.

3.2 Munni jarðganga gegnt Víðinesi í Héðinsfirði

Áformaður munni jarðganga utan við Björnsneshjalla gegnt Víðinesi í Héðinsfirði er undir hárri og brattri hlíð Fílaskálahnjúks (Sjá staðsetningu á teikningu 2 og 5.. Fýlaskál innri er lítil skál, ofan við 500 m hæð í hnjúknum en lítið efni úr henni situr eftir í hlíðinni svo sem glöggt má sjá í grunnum lækjarfarvegum þar sem klöppin myndar fossaþrep. Í hlíðarfætinum er skriðukeila sem virðist vera að miklu leyti lagskipt á þann veg að aurhlaup úr lækjarfarvegum hafa margsinnis farið yfir þunnan jarðveg í hallamýri.

Upplýsingar um berg nærri munna má lesa úr kjarnaholu HG-3 sem er í 50 m hæð y.s tæplega 200 m sunnan við áformaðan gangamunna (sjá teikningu 10). Þykk og massíf lög úr ólivínbasalti virðast lenda í munnanum og er ekki fyrirsjáanlegt að nein vandkvæði verði með loft við gangamunna nema ef berggangar lenda nákvæmlega í munnanum. Þá gæti þurft að hnika munnanum nokkra metra innar í hlíðina.

Könnun var gerð á þykkt lausra jarðlaga í hlíðarfætinum þar sem heita Björnsneshjallar nokkru sunnan við áformaðan gangamunna, sjá teikningu 10 og nánari lýsingu á loftborsholum í viðauka (Appendix IV). Könnunin beindist að liðlega 300 m löngu belti en næstu holurnar eru í um 100 m fjarlægð frá munnanum. Talið er að yfirfæra megi aðstæður frá nyrstu holunum yfir á aðstæður við munnann og er það gert á langskurðarteikningu jarðlaga í gangalínu á teikningu 11. Þar er jarðvegur aðeins 3-5 m þykkur þegar komið er upp fyrir 30 m hæð í brekkunni en neðar þykknar jarðvegurinn hratt. Í 15-25 m hæð y.s. mælist jarðvegsþykkt 6-9 m. Rétt þykir þó að búast við að jarðvegur geti verið um 2 m þykkari við gangamunna en fram kemur í borholunum. Langsnið jarðlaga á teikningu 11 tekur mark af því og er búist við að um 5-9 m dýpi verði á klöpp við munnann.

Borað var með loftbor á strjálingi meðfram Héðinsfjarðará til að kanna lágmarksdýpi á fast (sjá staðsetningar og túlkun jarðgerðar á teikningum 12 og 13. Hvergi var borað niður á fast berg en í öllum tilvikum var farið niður á 15 m dýpi og hætt að bora þar í lausu mjúku efni, enda var þá komið niður fyrir hugsanlegt hönnunardýpi fyrir niðurrekna staura undir brúarstólpa. Næst yfirborði var í flestum holum farið í gegnum 2-4 m þykkan jarðveg en undir er set með fremur litla fyrirstöðu, líklega fínsandur.

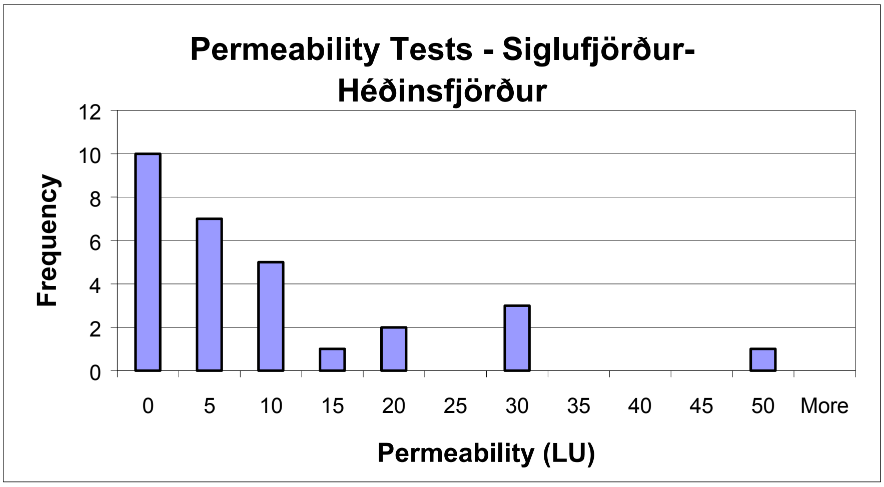
3.3 Tæknilegir eiginleikar bergs milli Siglufjarðar og Héðinsfjarðar

Kjarnahola SG-1 í Skútudal og kjarnaholur HG-2 og HG-3 í Héðinsfirði veita upplýsingar um bergið. Bergið í holu SG-1 er mjög heillegt, RQD gildi að mjög miklu leyti yfir 90% og Q- gildi er almennt á bilinu 7-30 sem vísar til mjög heillegs bergs. Engin teljandi setlög fundust í holunni og af 16 lektarprófunum sýndu aðeins tvær lektargildi yfir 10 LU og 9 prófanir sýndu engan leka. Yfirlitslýsing á holunni er á teikningu 16 og nákvæm lýsing á berginu í viðauka I. Þrýsti og rennslisferlar lektarmælinga eru í viðauka II.

Í Héðinsfirði eru holur HG-2 og HG-3 og í þeim skiptast á basaltlög úr dílabasalti og ólivínbasalti og berggangar. Engin teljandi setbergslög eru í holunum. Basaltið er heillegt með RQD yfir 80% og Q- gildi 7-20. Berggangarnir eru smásprungnir með Q- gildi 1-5 og þar gætti nokkurrar eyðingar á kjarnanum. Af 14 lektarprófunum í holunum tveimur sýndu 3 mælingar lekt yfir 20 LU. Þar af sýndi ein mæling á lekt í bergöngum ofarlega í holu HG-3 mimkla lekt (43 LU) lekt sem bendir til að mikils leka megi vænta er göngin skera suma bergganga.

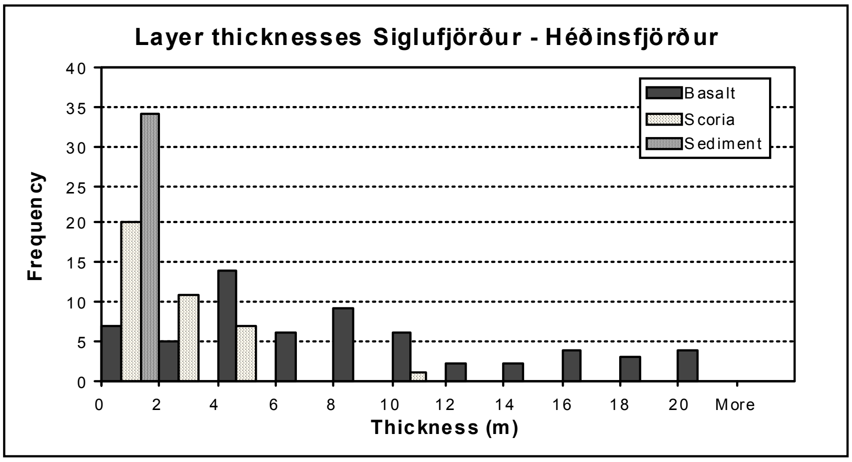
7 mælingar í holum HG-2 og HG-3 sýndu 5-15 LU lekt og 4 mælingar litla sem enga lekt. Yfirlitslýsing á holunum er á teikningum 17 og 18 og nákvæm lýsing á berginu í viðauka I. Þrýsti og rennslisferlar lektarmælinga eru í viðauka (Appendix II).

Lekt berglaga í þremur borholum (SG-1, HG-2 og HG-3) er skera berg á jarðgangaleiðinni milli Siglufjarðar og Héðinsfjarðar er sýnd á meðfylgjandi tíðniriti. Þar kemur skýrt fram að flestar mælingar sýndu litla lekt. Ýtarlegri upplýsingar um lektarprófanir eru í töflum og á línuritum í viðauka (Appendix II).



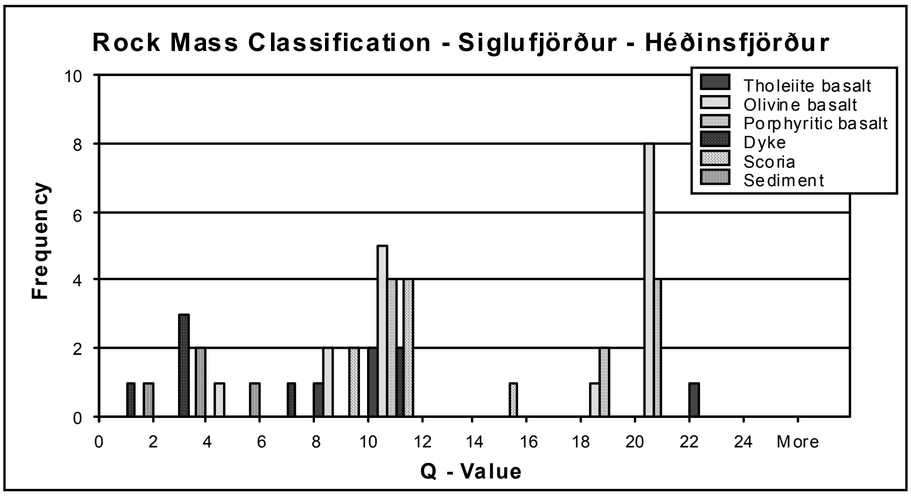
Mynd 4. Lekt berglaga milli Siglufjarðar og Héðinsfjarðar samkvæmt lektarprófunum.

Þykkt berglaganna milli Siglufjarðar og Héðinsfjarðar skiptist á eftirfarandi hátt miðað við kjarnaborholur og jarðlagasnið í nágrenni gangaleiðarinnar: Meginþorri basaltlaga er 2-12 m þykkur en algengust eru þó 4-6 m þykk lög. Stök lög eru yfir 15 m þykk. Lagmótakargi á yfirborði basaltlaga mælist yfirleitt 1-5 m þykkur. Botnkargi laganna er mjög víða 0,2-0,5 m þykkur. Setbergslög eru flest 0,2-0,4 m þykk og aðeins 4 lög mældust 1,5-2 m þykk. Þykktardreifing laga mismunandi berggerða er sýnd á tíðniriti á mynd 5 en frekari sundurgreining er á tíðniritum í viðauka (Appendix 3).



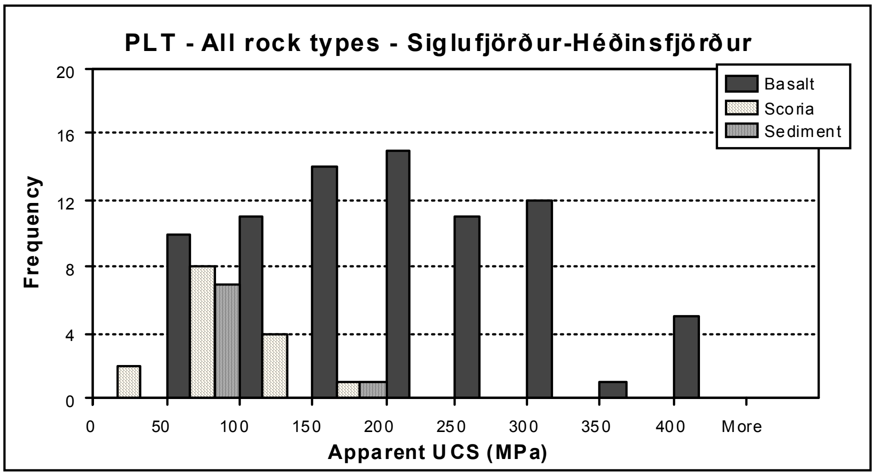
Mynd 5. Yfirlit yfir þykktardreifingu laga milli Siglufjarðar og Héðinsfjarðar.

Bergið í borholum við leiðina milli Siglufjarðar og Héðinsfjarðar er yfirleitt sterklegt og heillegt og því álitlegt til jarðgangagerðar. Berggangar sýna þó yfirleitt mun lakari berggæði en basaltið. Yfirlit yfir niðurstöðu berggæðamats (Rock mass classification), á borkjarna úr holum SG-1, HG-2 og HG-3 er sýnt á meðfylgjandi tíðniriti á mynd 6. Við matið eins og það er birt á kjarnaloggum eru gefin upp neðri og efri mörk berggæða fyrir einstök lög. Tíðniritið hér að aftan sýnir meðaltalsgildi einstakra mælinga. Nánar má lesa einstaka þætti berggæðamatsins á borholuloggum í viðauka.



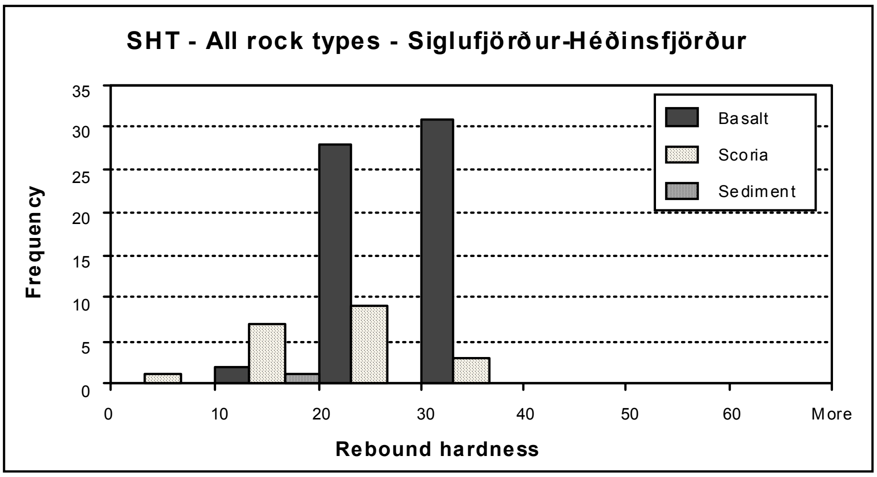
Mynd 6. Berggæðamat meðaltals Q- gildi berglaga á jarðgangaleið milli Siglufjarðar og Héðinsfjarðar.

Brotprófanir á borkjarna með "Point load" punktálagstæki sýndu að einása "sýndar" brotstyrkur basalts tekur yfir breitt bil, frá 50 til 300 MPa (sjá mynd 7). Fáeinar prófanir sýndu hærra brotþol eða yfir 350 MPa. Kargi basaltsins brotnar við UCS 60-180 MPa og þunn slitrótt setlög brotna aðallega við 60-90 MPa með fáum undantekningum. Nánari upplýsingar um brotprófanir og sýndarstyrk berglaga er að finna í viðauka (Appendix III). Áréttað skal að ekki hafa verið gerðar brotprófanir á samsvarandi sýnum í rannsóknarstofu til kvörðunar á punktálagsprófunum.



Mynd 7. Yfirlit yfir sýndarstyrk (apparent uniaxial strength) mismunandi bergs á jarðgangaleið milli Siglufjarðar og Héðinsfjarðar.

Harka bergsins var mæld á borkjarna með Schmidt hammer tæki. Tíðnirit á mynd 8 sýnir yfirlit yfir hörku bergs á jarðgangaleiðinni. Nánar má sjá dreifingu hörku fyrir mismunandi bergtegundir í viðauka (Appendix III).



Mynd 8. Yfirlit yfir hörku (rebound hardness) mismunandi bergs á jarðgangaleið milli Siglufjarðar og Héðinsfjarðar.

4 Jarðgangaleið milli Héðinsfjarðar og Ólafsfjarðar

Á teikningu 6 er lega jarðgangaleiðarinnar milli Héðinsfjarðar og Ólafsfjarðar sýnd ásamt staðsetningu jarðlagasniða, kjarnaborhola og helstu jarðfræðilegra drátta sem kortlagðir hafa verið. Jarðlögunum hallar til suðvesturs um 5-8° en jarðgangaleiðin stefnir VSV-ASA þannig að nálægt 30° horn er milli strikstefnu jarðlaga og stefnu ganganna. Jarðlögum hallar því um 3-4° til vesturs eftir gangaleiðinni.

Langsnið jarðlaga á teikningum 4 og 8 sýna að rekja má í grófum dráttum skil á milli jarðlagasyrpa milli Ólafsfjarðar og Héðinsfjarðar þótt einstök lög þekkist ekki á báðum stöðum. Ofantil í hlíðum í Ólafsfirði er syrpa af þóleítbasalti sem hvílir á syrpu sem aðallega er úr dílóttu ólivínbasalti. Skilin milli syrpanna eru í um 400 m hæð y.s. í Ósbrekkufjalli nærri áformaðri jarðgangaleið og lækka niður í átt að munna í Héðinsfirði og eru þar í um 200 m hæð y.s. Þessi hæðarmunur væri samt liðlega 100 m meiri ef ekki kæmu til stór misgengi sem skera jarðgangaleiðina undir Syðraárdal og lækka jarðlög austast á gangaleiðinni sem því nemur.

Áætlað er að göngin verði tæplega 7 km löng og að þau skeri um 300-400 m þykkan jarðlagastafla. Kjarnahola HG-1 ofan við Grundarkot í austurhlíð Héðinsfjarðar sker meginhluta staflans, vestanfrá og kjarnahola OG-2 undir Ósbrekkufjalli í Ólafsfirði sker berg á austustu 1-2 km. Langsnið jarðlaga á teikningu 8 sýnir afstöðu borhola og jarðlagasniða og hvernig bergsyrpur liggja eftir jarðgangaleiðinni. Þar eru einnig sýndir yfirlitsþættir yfir heilleika bergsins (RQD), berggæðastuðul eða Q- gildi þess og "sýndar" einása brotstyrkur.

Að auki er sýnt á teikningu 8 hvar búist er við að berggangar og misgengi skeri gangaleiðina. Fullvíst má telja að brot og berggangar verði mun fleiri á gangaleiðinni en sýnt er á teikningu 8 en ætla má að stefnur viðbótar brotalína verði samsíða þeim sem þekktar eru. Við kortlagningu bergsins kom í ljós að flestir gangar eru 2-6 m þykkir og allmargir gangar eru 7-14 m þykkir. Vafalítið munu fleiri brot og berggangar finnast á gangaleiðinni en sýnt er á teikningu 7 en ætla má að þau verði samsíða þeim sem þekkt eru. Tíðnirósin fyrir sprungudreifingu stefnir mjög eindregið N-S eða skáhallt á gangaleiðina og er stefna brotanna hagstæð með tilliti til jarðgangagerðar.

Í brekkunum ofan við flatlendið í Ólafsfirði er mikill jarðhiti í landi Ósbrekku og byggir hitaveita Ólafsfirðinga að miklu leyti á vatni þaðan. Göngin munu skera þetta jarðhitasvæði litlu innan við munnann og komu áhrif jarðhitans skýrt fram í kjarnaholu ÓF-1. Búast má við að hitastig vatnsins verði 50-60 °C. Ekki er ljóst hversu mikil áhrif göngin munu hafa á rekstur jarðhitasvæðisins en þau verða vafalítið einhver þrátt fyrir fyrirhugaða þéttingu bergsins. Búast má við að göngin skeri fleiri sprungur er leiða jarðhitavatn innar á gangaleiðinni. Til dæmis er mögulegt að jarðhiti tengist stórum misgengjum undir Syðraárdal. Fyrirsjáanlegt er að jarðgöngin munu skera sprungur og ganga er tengjast jarðhita sem finnst ofan við Vatnsenda í Héðinsfirði en hitastig á yfirborði þar er milli 20-30 °C.

4.1 Munni jarðganga utan Grundarkots Héðinsfirði

Munni jarðganga úr Héðinsfirði til Ólafsfjarðar er áformaður sunnan við Merkjalæk utan við rústir Grundarkots. Staðurinn er í hvammi, skammt utan við þykka hjalla úr urðarjökulsseti sem sigið hefur fram úr skál hærra í fjallinu niður í hlíðarfótinn. Landfræðilega hefði þótti æskilegt að hafa munna við Grundarkot en boranir leiddu í ljós að þykkt urðarinnar ofan Grundarkots er 15-25 m og því ekki fýsilegt að fara þar með göng inn í fjallið.

Í hvamminum utan við urðartunguna eru nokkrar loftborsholur er sýna að í um 35 m hæð y.s. er um 7 m dýpi á klöpp og virðast laus jarðlög haldast svipuð að þykkt ofar í brekkunni (sjá staðsetningu loftborshola á teikningu 12). Langsnið jarðlaga við munna er á teikningu 15. Sniðið byggir á nokkrum loftborsholum er sýna dýpi á klöpp.

Berg við munna er metið með hliðsjón af borkjarna úr holu HG-1 sem er staðsett í um 120 m hæð um 250 m sunnan við stöð 7150 og kjarna úr holu HG-5 sem er staðsett í 85 m hæð y.s um 350 m NA við gangamunnann. Bergið er að jafnaði mjög heillegt en lagamót með setbergi munu verða mjög nærri áformuðum munna og gætu leitt til þess að bergþekja yfir munnanum yrði höfð dálítið þykkari en annars væri.

4.2 Munni jarðganga við Ósbrekku í Ólafsfirði

Fyrirhugaður munni jarðganga í Ólafsfirði er í hlíðarfætinum utan og neðan við rústir bæjarins Ósbrekku og um 200 m frá hesthúsaþyrpingu Ólafsfirðinga. Veglína að munna verður yfir núverandi flugbraut. Berglög nærri munna koma fram í kjarnaholu ÓG-1 sem staðsett er í 40 m hæð y.s. um 50 m vestan við gangalínuna. Bergið í holunni reyndist vera mikið brotið og með útfellingar sem fylgja jarðhitavatni. Jarðhitakerfi fylgja sprungu og gangakerfi sem liggur samsíða hlíðinni. Að líkindum munu göngin skera gegnum nokkur slík kerfi. Önnur kjarnaborhola, OG-2 er í tæplega 125 m hæð y.s. og um 100 m vestan við gangalínuna á móts við stöð 13200 og sýnir hún tiltölulega þykk sterkleg basaltlög með þunnum millilögum úr sandsteini.

Þétt net hola var borað með loftbor nærri áformuðum munna nærri stöðvum 13800 - 13900 í gangalengd (sjá staðsetningu á teikningu 14). Allstaðar reyndist vera grunnt á klöppina eða aðeins um 3 m. Jarðvegurinn er að mestu mold í lítt framræstri hallamýri. Langskurður jarðlaga við munna er sýndur á teikningu 15. Ekki er talið að lagamót setji þakhæð eða þekju í munna neinar skorður en berggangar eða sprungur eru líklegar til að hafa einhver áhrif á hversu djúpt inn þurfi að fara með gryfju fyrir vegskála.

Auk könnunar á hlíðinni neðan við eyðibýlið Ósbrekku sem nefnd er hér að framan ver einnig athugað svæði um 0,5 km norðar með hlíðarfætinum. Þar var boruð hallandi kjarnahola ÓG-3 auk borunar tveggja grunnra holameð loftbor (sjá staðsetningar á teikningu 14. Þar sést klöpp úr samfelldum basaltlagastafla fáeinum metrum norðan við holu ÓG-3 og í tveimur loftborsholum er klöppin á 2-3 m dýpi. Litlu sunnar með hlíðinni sér í basaltlag á yfirborði. Þarna eru taldar hagstæðar aðstæður fyrir munna jarðganga.

4.3 Tæknilegir eiginleikar bergs milli Héðinsfjarðar og Ólafsfjarðar

Kjarnahola HG-1 ofan Grundarkots sker meginhluta staflans á áformaðri jarðgangaleið (talið frá vesturenda) og kjarnahola OG-2 undir Ósbrekkufjalli í Ólafsfirði fer gegnum berg sem vænta má að verði á austustu 1-2 km gangaleiðarinnar. Staðsetningar holanna og áformaðra mannvirkja er sýnd á teikningu 6.

Héðinsfjörður. HG-1 er 350 m djúp og sker bergsyrpu með plagíóklas dílótt ólivínbasalt með talsvert áberandi beltum úr lagmótakarga og strjálum þunnum millilögum úr vaxkenndum ummynduðum sand- siltsteini. Basaltið og karginn eru afar heillegt berg, kjarnaheimta nærri 100%, algengast er að RQD borkjarnans sé 90-100% og sjaldnast niður í 80%. Q- gildi basalts og karga er víðast 5-15 í efri hluta holunnar en 10-30 í neðri hlutanum. Yfirlitslýsing holu HG-1 er á teikningu 17 og nákvæm lýsing í viðauka (Appendix I). Töflur yfir brotlolspróf á berginu eru í viðauka (Appendix 3).

Basaltlögin eru yfirleitt 10-20 m þykk og kargalögin 2-5 m. Strjál setbergslög, 0,3-3 m þykk eru aðallega úr ummynduðum glerríkum (túffríkum) sandsteini. Af 13 lektarprófunum í holunni sýndi aðeins efsta prófunarbilið talsverða lekt eða um 30 LU. Þrjár prófanir sýndu 2,6-7,3 LU og níu prófanir sýndu engan leka, enda mátti ráða af holufyllingum í berginu að vatn þar væri ekki á teljandi hreyfingu. Rennslis og Þrýstingsferlar lektarprófana í holunni er í viðauka (Appendix I).

Hola HG-5 í Héðinsfirði er 78 m djúp og veitir einnig upplýsingar um bergið næst munna í Héðinsfirði milli Grundarkots og Vatnsenda og er yfirlitslýsing á holunni á teikningu 20 og nákvæm lýsing í viðauka (sama á við um holu HG-4). Í holu HG-5 eru dílabasaltslög og ólivínbasalt með strjálum þunnum setlögum. Bergið þar er mjög heillegt, kjarnaheimta tæplega 100%, RQD gildi að mjög miklu leyti 80-90% og Q- gildi er almennt á bilinu 5-15 sem bendir til heillegs bergs. Aðeins fundust 3 setlög í holunni og 6 lektarprófanir sýndu allar nema ein lektargildi á bilinu 5-15 LU en ein prófun næst yfirborði sýndi hærri lekt (45 LU).

Hola HG-4 er liðlega 50 m djúp og staðsett í hlíðinni nokkru innan við Grundarkot. Þessi hola var boruð vegna mögulegrar gangaleiðar milli Möðruvallaskálar og Skeggjabrekkudals en áhugi á þeirri leið er ekki lengur til staðar. Bergið í holu HG-4 er heillegt og samfellt basalt með lagskipt kargalög. Engin setbergslög fundust. Fjórar lektarmælingar sýndu lektargildi 4-17 LU.

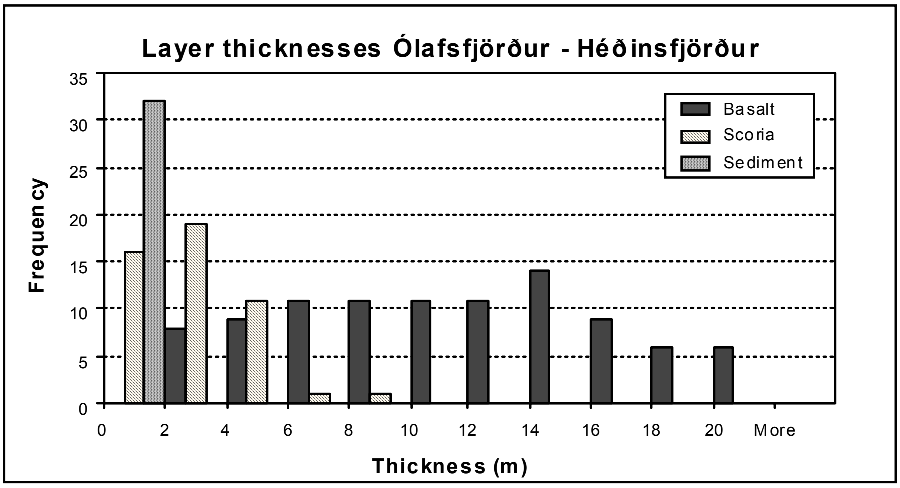
Ólafsfjörður. Kjarnahola ÓG-2 er 150 m djúp og staðsett nærri gangaleiðinni í 123 m hæð y.s. undir Ósbrekkufjalli, sjá yfirlits borholusnið á teikningu 22 og ýtarlega lýsingu í viðauka (Appendix 1). Á teikningu 6 er lega ganganna sýnd á þessu svæði. Talið er að holan gefi upplýsingar um berg á liðlega 1,5 km kafla austast á gangaleiðinni eins og sýnt er á teikningu 8. Frá yfirborði niður undir 90 m dýpi er dílótt ólivínbasalt með tveimur örþunnum millilögum úr sandsteini. Kjarnaheimta er nærri 100%, RQD 55-80% og Q- gildi 3-15. Neðri hluti holunnar sker þóleiítbasalt í bland við dílabasalt og ólivínbasalt og er heilleiki bergsins og berggæði hliðstæð því sem er ofar. Lekt í holunni mældist 30-50 LU á 10-28 m dýpi en þaðan og niður í botn mældist lektin aðeins 2-6 LU. Áberandi sprungur með útfellingum úr ópal og fleiri steindum er fylgja jarðhitavatni finnast á nokkrum stöðum í borkjarnanum.

Kjarnahola ÓG-1 er staðsett í 42 m hæð y.s. nærri rústum eyðibýlisins Ósbrekku, ofan við Flugbrautina í Ólafsfirði. Holan er nærri fyrirhuguðum gangamunna og liðlega 60 m djúp og er yfirlitslýsing af holunni á teikningu 21 en nákvæm lýsing í viðauka. Holan sker samfelldan stafla af ólivínbasalti með fáeinum örþunnum millilögum úr sandsteini og vaxkenndu ummynduðu túffi.

Berglögin sem slík eru heilleg, kjarnaheimta víðast um 100% og RQD 70-80%. Lögin eru mjög vel holufyllt, með geislasteinum. Kjarninn er þó mjög áberandi brotinn á nokkrum stöðum á 30-40 m dýpi og virðist vera að holan hafi skorið misgengi. Auk þess eru þar tvær þunnar gangæðar úr smástuðluðu og brotnu bergi. Mjög skammt frá holunni eru holur sem boraðar voru til að kanna útbreiðslu á heitu vatni enda er mikill jarðhiti í næsta nágrenni. Fullvíst er talið að við gangagerðina muni mikið heitt vatn renna inn í göngin skammt innan við munna í Ólafsfirði og að umtalsvert þurfi að þétta bergið á gangaleið undir hlíðum Ósbrekkufjalls.

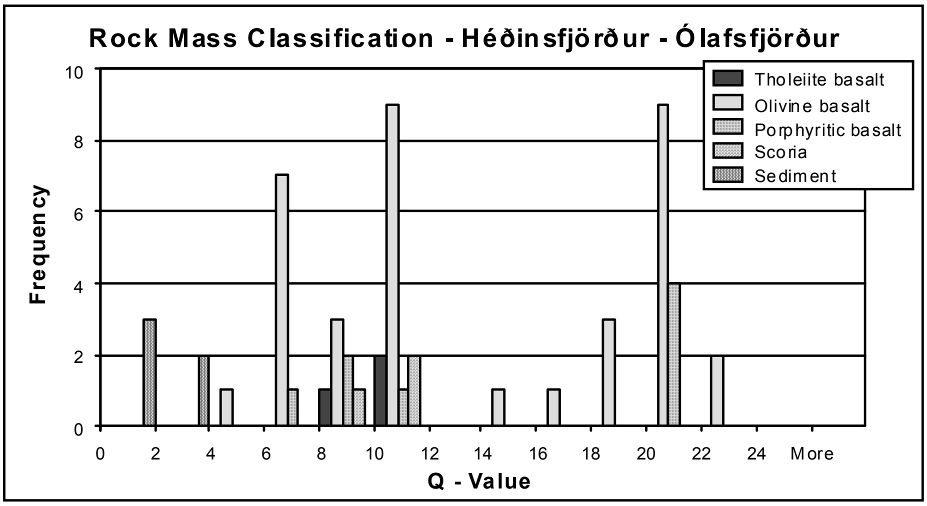
Kjarnahola ÓG-3 var boruð í 40 m hæð y.s. utan og ofan við hesthúsin hjá flugvellinum í Ólafsfirði. Bergið í holunni er blandað basalt með tveim þunnum millilögum og er yfirlitslýsing á teikningu 21. RQD er á bilinu 30-70 og Q- gildi 4-25. Þarna eru tæknilega góðar aðstæður fyrir munna jarðganga en þykja landfræðilega ekki jafn heppilegar og við holu HG-1.

Á mynd 9 er sýnt hvernig þykkt berglaganna skiptist miðað við kjarnaborholur og jarðlagasnið í nágrenni gangaleiðarinnar. Meginþorri basaltlaga er 2-12 m þykkur en algengust eru þó 4-6 m þykk lög. Stök lög eru yfir 15 m þykk. Lagmótakargi á efra borði laga er yfirleitt 2-5 m þykkur en kargi á neðra borði víða 0,2-0,5 m þykkur. Flest setbergslög eru innan við 1 m þykk en fáein eru 1,6-2 m. Frekari upplýsingar um þykktardreifingu mismunandi berggerða er í viðauka (Appendix III).



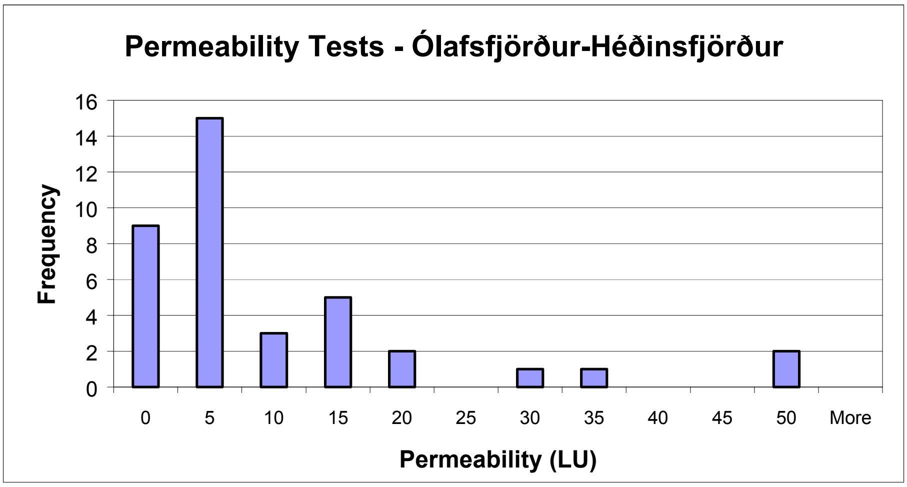
Mynd 9. Yfirlit yfir þykktardreifingu laga á jarðgangaleið milli Héðinsfjarðar og Ólafsfjarðar.

Niðurstaða berggæðamats á borkjarna úr holum HG-1, HG-4 og HG-5 í Héðinsfirði ásamt holum ÓG-1 til ÓG-3 í Ólafsfirði er sýnt á tíðniriti á mynd 10. Við matið eins og það er birt á kjarnaloggum eru gefin upp neðri og efri mörk berggæða fyrir einstök lög. Tíðniritið hér að aftan sýnir meðaltalsgildi einstakra mælinga. Nánar má lesa einstaka þætti berggæðamatsins á borholuloggum í viðauka (Appendix III).



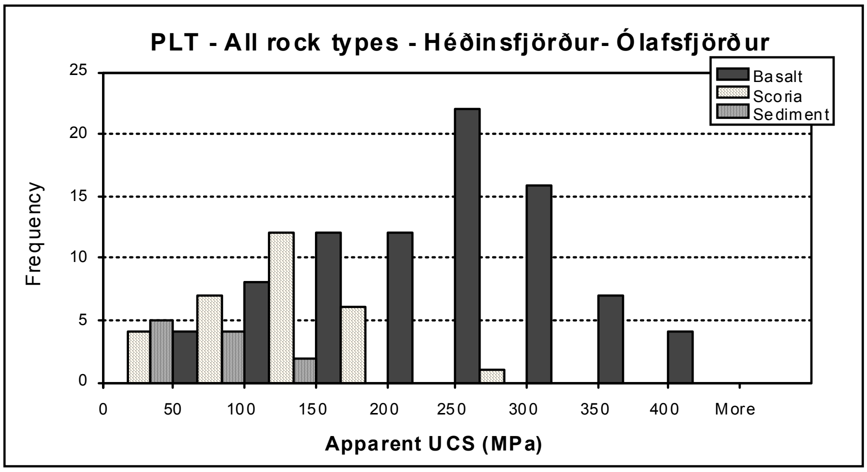
Mynd 10. Berggæðamat, Meðaltals Q- gildi berglaga á jarðgangaleið milli Héðinsfjarðar og Ólafsfjarðar.

Lekt berglaga í sex borholum er skera berg á jarðgangaleiðinni milli Siglufjarðar og Héðinsfjarðar er sýnd á meðfylgjandi tíðniriti á mynd 11. Þar kemur fram að flestar mælingar sýndu litla lekt en þó sýnist bergið talsvert lekara en á vestari gangaleiðinni. Ýtarlegri upplýsingar um lektarprófanir eru í töflum og á línuritum í viðauka.



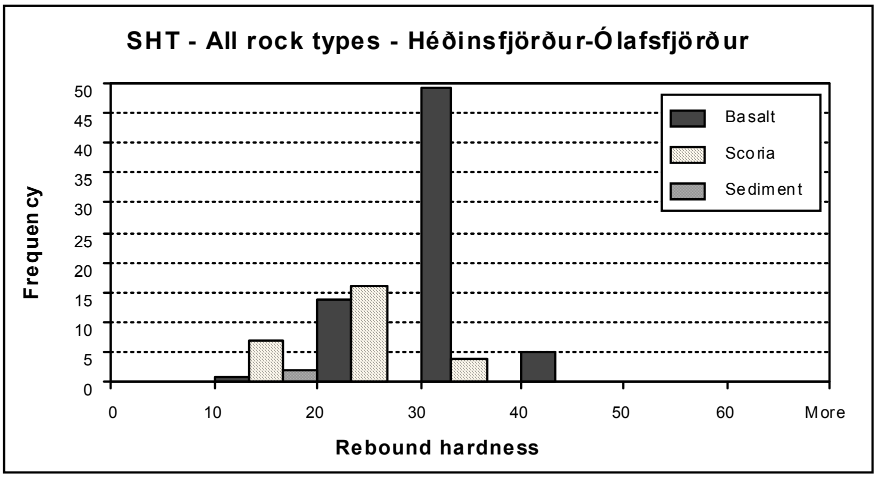
Mynd 11. Lekt berglaga milli Héðinsfjarðar og Ólafsfjarðar samkvæmt lektarprófunum.

Brotprófanir á borkjarna með point load punktálagsmæli sýndu að einása sýndar brotstyrkur basaltsins tekur yfir þrengra bil en á vestari gangaleiðinni eða frá 150 til 300 MPa (sjá tíðnirit á mynd 12). Fáeinar prófanir sýndu bæði lægra og hærra brotþol (hæstu 4 gildi yfir 400 MPa). Kargi basaltsins brotnar við mjög breytilegt álag eða UCS 40-180 MPa og þunn slitrótt setlög brotna aðallega við 60-90 MPa með fáum undantekningum. Nánari upplýsingar um sýndarstyrk berglaga er að finna í viðauka. Áréttað skal að ekki hafa verið gerðar brotprófanir á samsvarandi sýnum í rannsóknarstofu til kvörðunar á punktálagsprófunum.



Mynd 12. Yfirlit yfir sýndarstyrk (apparent uniaxial strength) mismunandi bergs á jarðgangaleið milli Héðinsfjarðar og Ólafsfjarðar.

Harka bergsins var mældur á borkjarna með Schmidt hammer tæki. Meðfylgjandi tíðnirit sýnir hvernig harka bergs mældist í berglögum á jarðgangaleiðinni. Nánar má sjá dreifingu hörku fyrir mismunandi bergtegundir í viðauka.



Mynd 13. Yfirlit yfir hörku (rebound hardness) mismunandi bergs á jarðgangaleið milli Héðinsfjarðar og Ólafsfjarðar.

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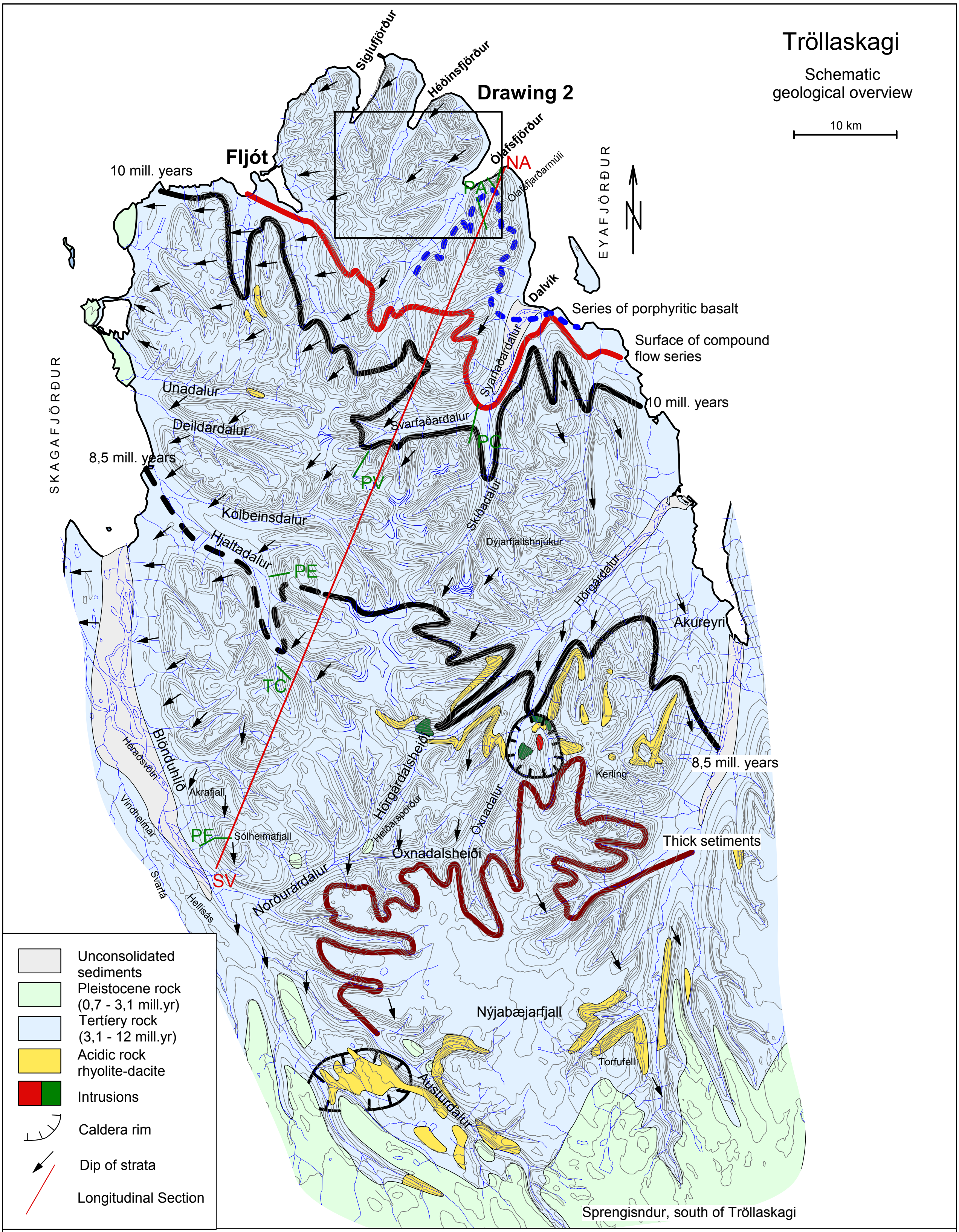
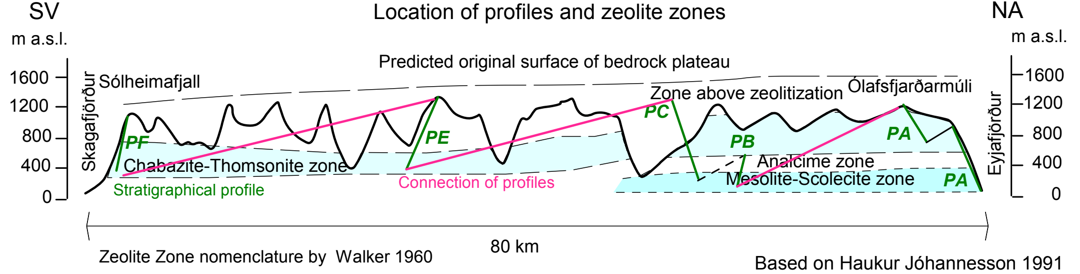
Loftmyndir (Aerial photographs) frá Landmælingum Íslands frá mismunandi tímum.

Landlíkan í mismunandi mælikvörðum frá Loftmyndum ehf og Vegagerðinni 2001.



Schematic section across Tröllaskagi
Location of profiles and zeolite zones



Zeolite Zone nomenclature by Walker 1960

Based on Haukur Jóhannesson 1991

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Scale

Design	KS/ÁgG
Drawn	ÁgG/HH
Chk.	
Appr.	

Héðinsfjörður Road Tunnel

Tröllaskagi North Iceland
Schematic geology

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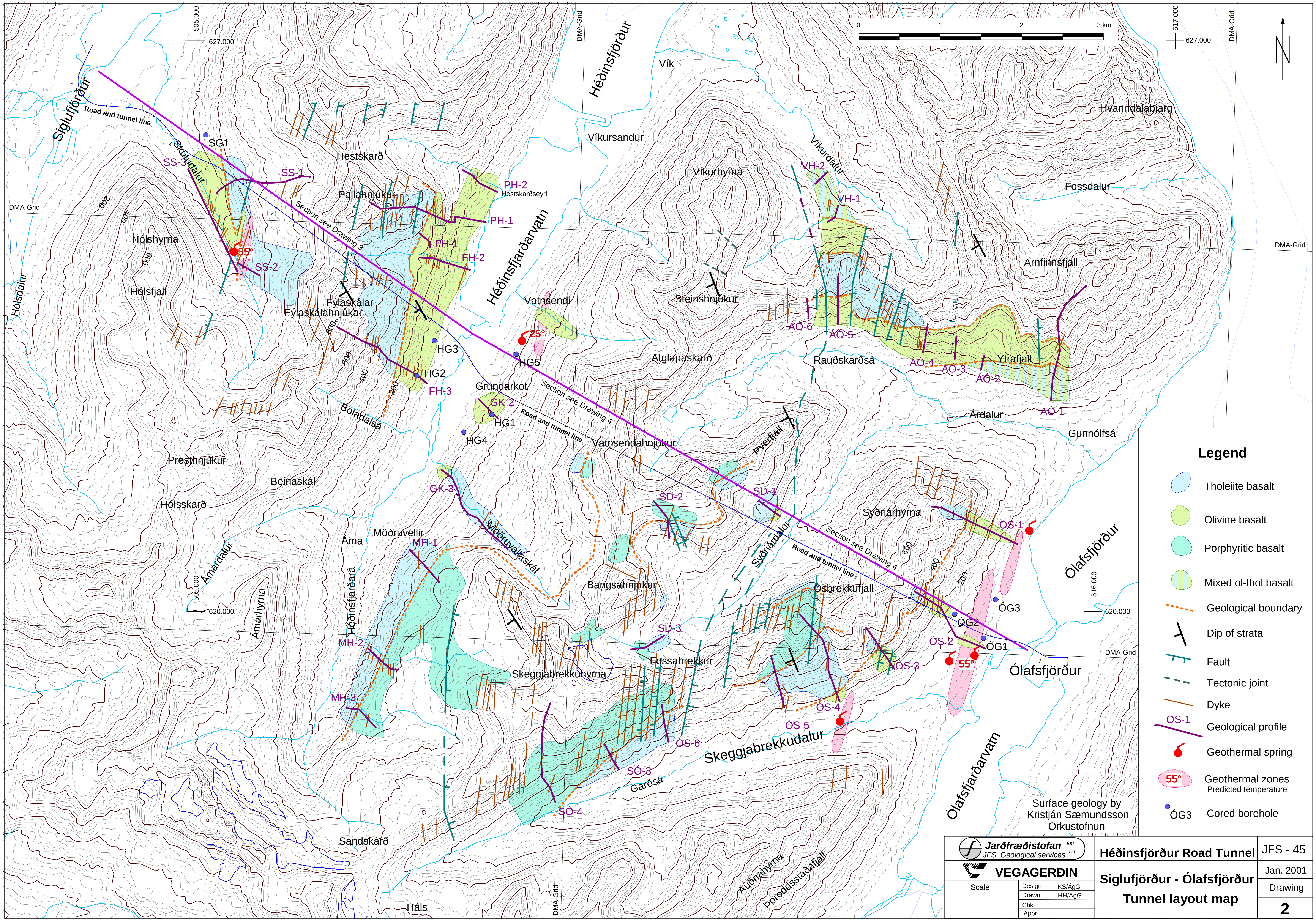
Jan. 2001

Drawing

1



Surface geology by
Kristján Sæmundsson
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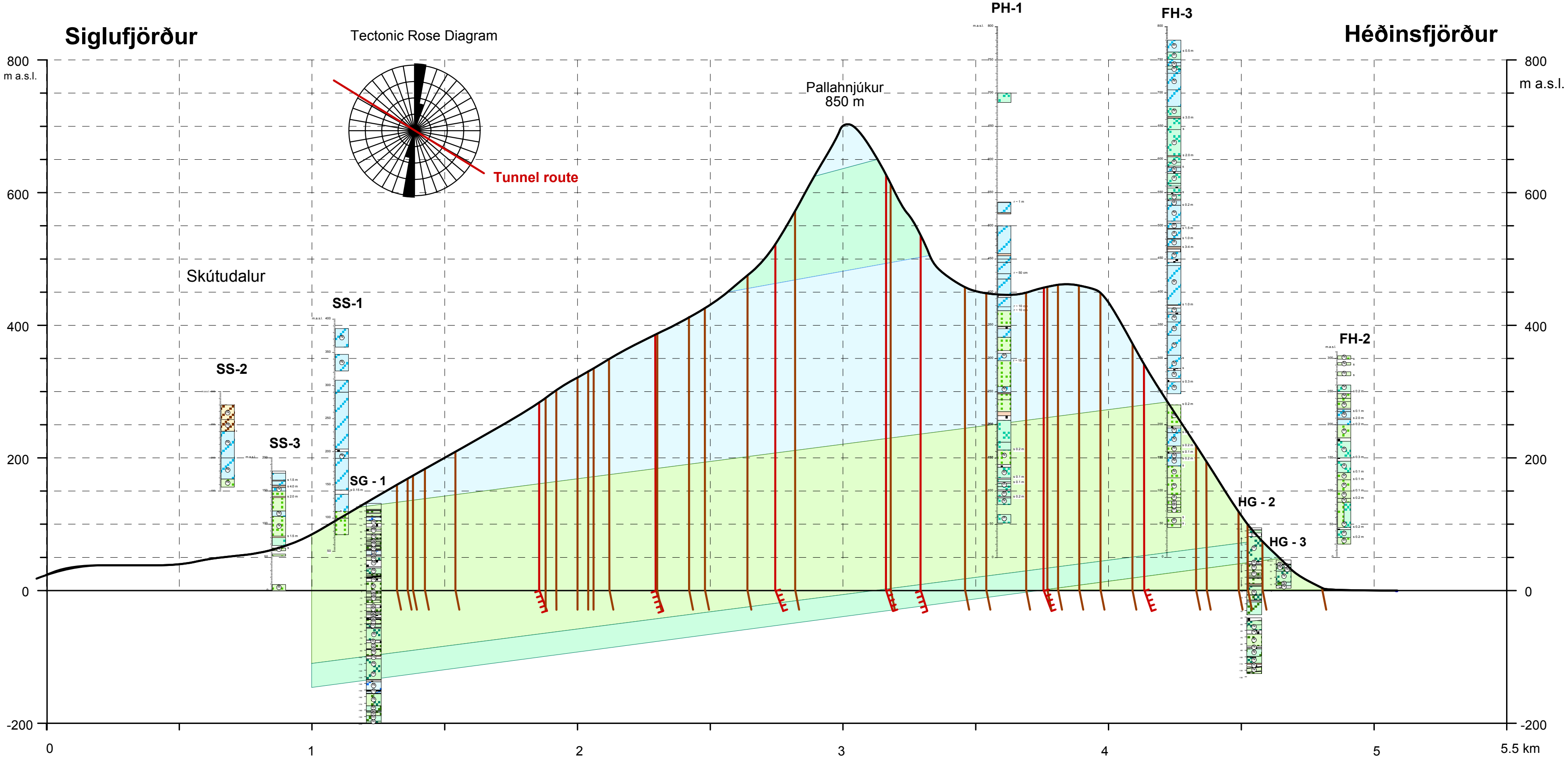
VEGAGERÐIN			**Siglufjörður - Ólafsfjörður** **Tunnel layout map**	Jan. 2001
Scale	Design	KS/ÁgG		Drawing
	Drawn	HH/ÁgG		**2**
	Chk.			
	Appr.			

Siglufjörður - Héðinsfjörður



Legend

🟦 Tholeiite basalt

🟩 Olivine basalt

🟩 Porphyritic basalt

🟨 Andesite

🟧 Sediment

▨ Scoria

Fault

Downtrow

Dyke

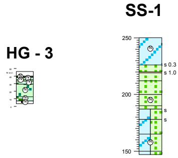
Ⓝ Normal polarity

Ⓡ Reverse polarity

Ⓐ Anomalous polarity

Cored borhole

Geological profile



Jarðfræðistofan Ehf
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Scale

Design	ÁgG
Drawn	ÁgG/CAD
Chk.	
Appr.	

Héðinsfjörður Road Tunnel

Siglufjörður - Héðinsfjörður

Geological section

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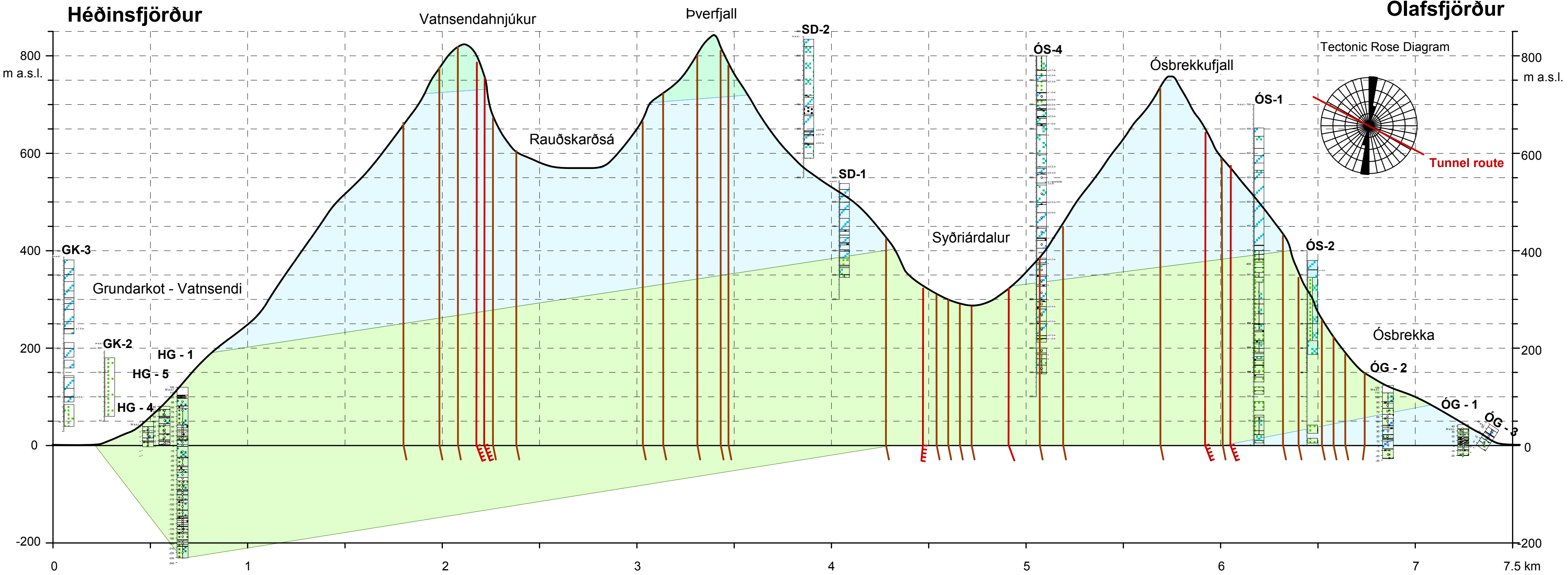
Jan. 2001

Drawing

3

Héðinsfjörður - Ólafsfjörður



Legend

🟦	Tholeiite basalt	🟨	Andesite
🟩	Olivine basalt	🟧	Sediment
🟩	Porphyritic basalt	▨	Scoria

Downtrow — Fault

Dyke

Ⓝ Normal polarity

Ⓡ Reverse polarity

Ⓐ Anomalous polarity

ÓG - 1 Cored borhole

SS-1 Geological profile

Jarðfræðistofan Ehf
JFS Geological services Ltd

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Scale	Design	ÁgG
	Drawn	ÁgG/CAD
	Chk.	
	Appr.	

Héðinsfjörður Road Tunnel

Héðinsfjörður - Ólafsfjörður
Geological section

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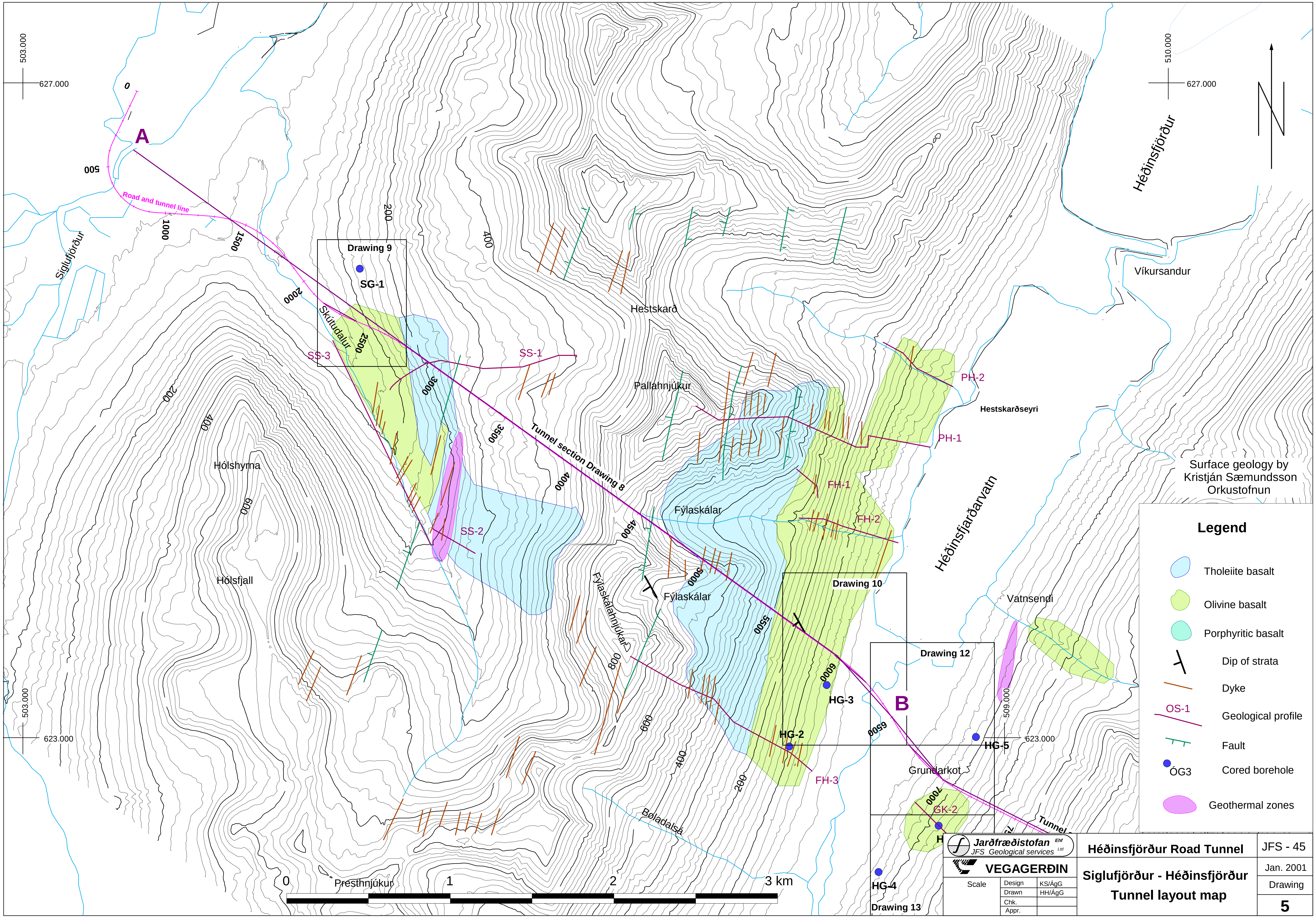
Jan. 2001

Drawing

4



Jarðfræðistofan Ehf
JFS Geological services Ltd

VEGAGERÐIN

Scale	Design	KS/ÁgG
	Drawn	HH/ÁgG
	Chk.	
	Appr.	

Héðinsfjörður Road Tunnel

Siglufjörður - Héðinsfjörður
Tunnel layout map

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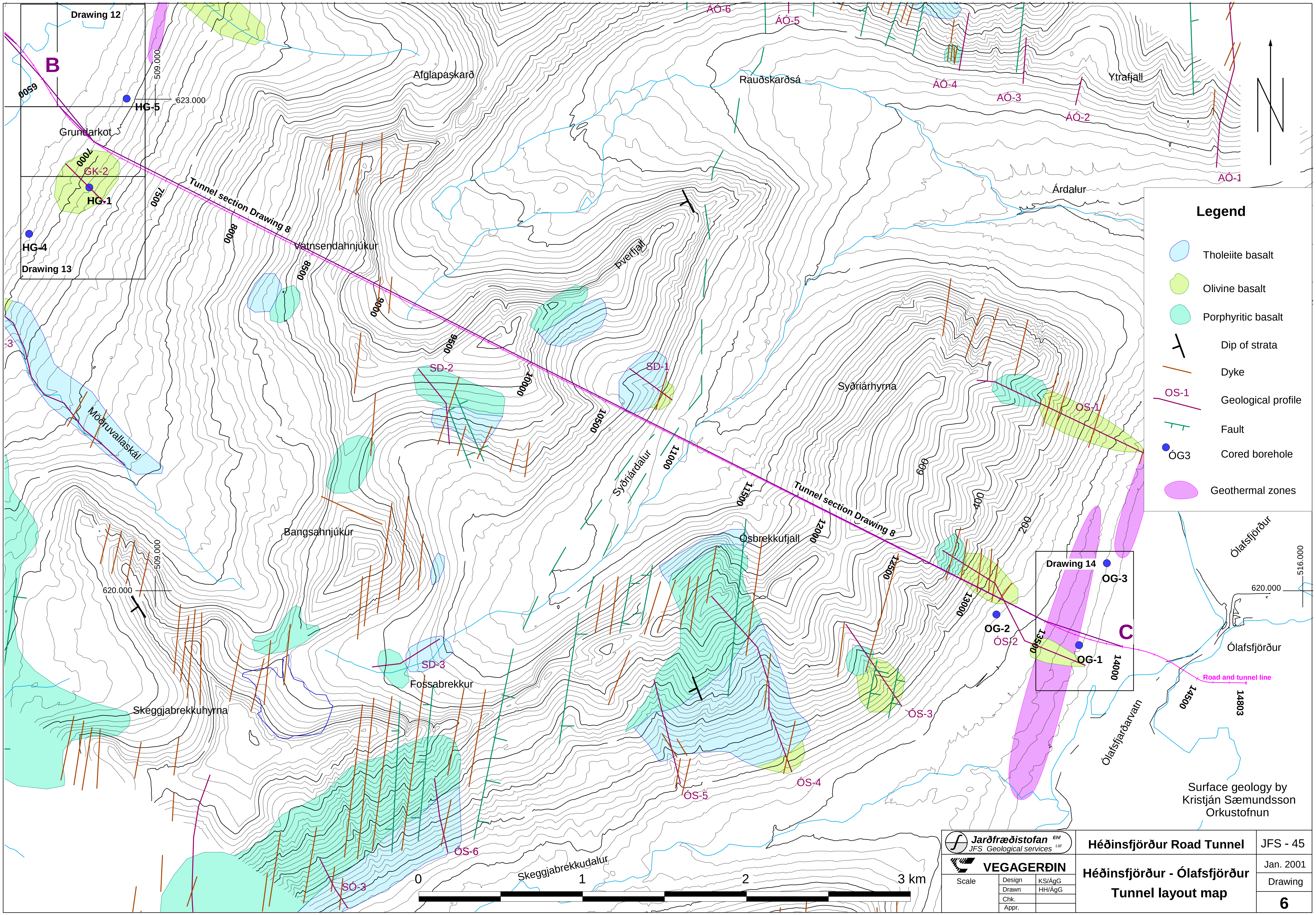
Drawing

5



Surface geology by
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Jarðfræðistofan Ehf
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Scale	Design	KS/ÁgG
	Drawn	HH/ÁgG
	Chk.	
	Appr.	

Héðinsfjörður Road Tunnel

Héðinsfjörður - Ólafsfjörður
Tunnel layout map

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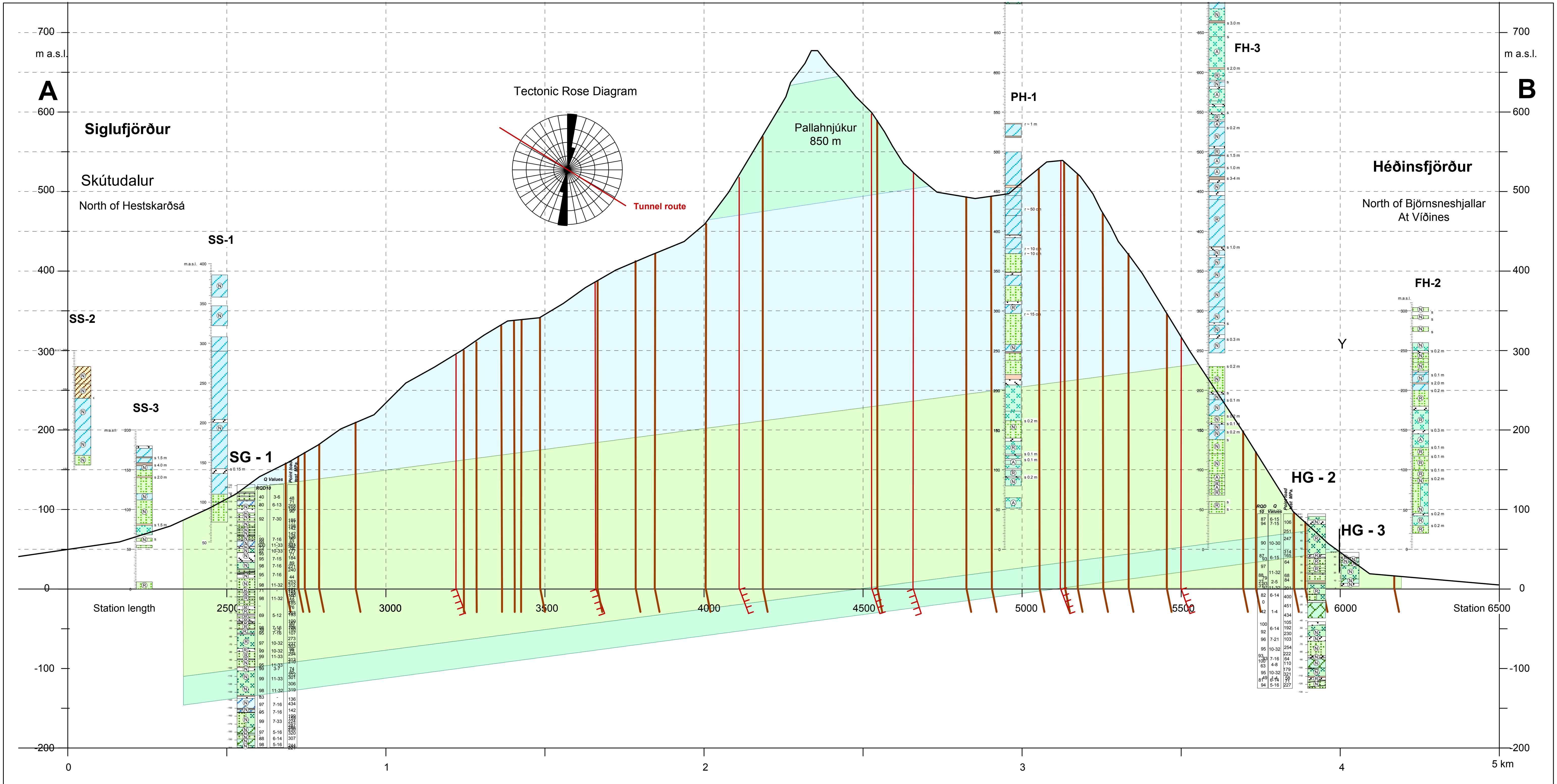
Jan. 2001

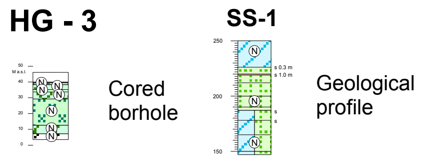
Drawing

6



Legend

- 🟦 Tholeiite basalt
- 🟩 Olivine basalt
- 🟩 Porphyritic basalt
- 🟨 Andesite
- 🟧 Sediment
- ▨ Scoria
- Fault
- Downtrow
- Dyke
- Ⓝ Normal polarity
- Ⓡ Reverse polarity
- Ⓐ Anomalous polarity



Jarðfræðistofan Ehf
JFS Geological services Ltd

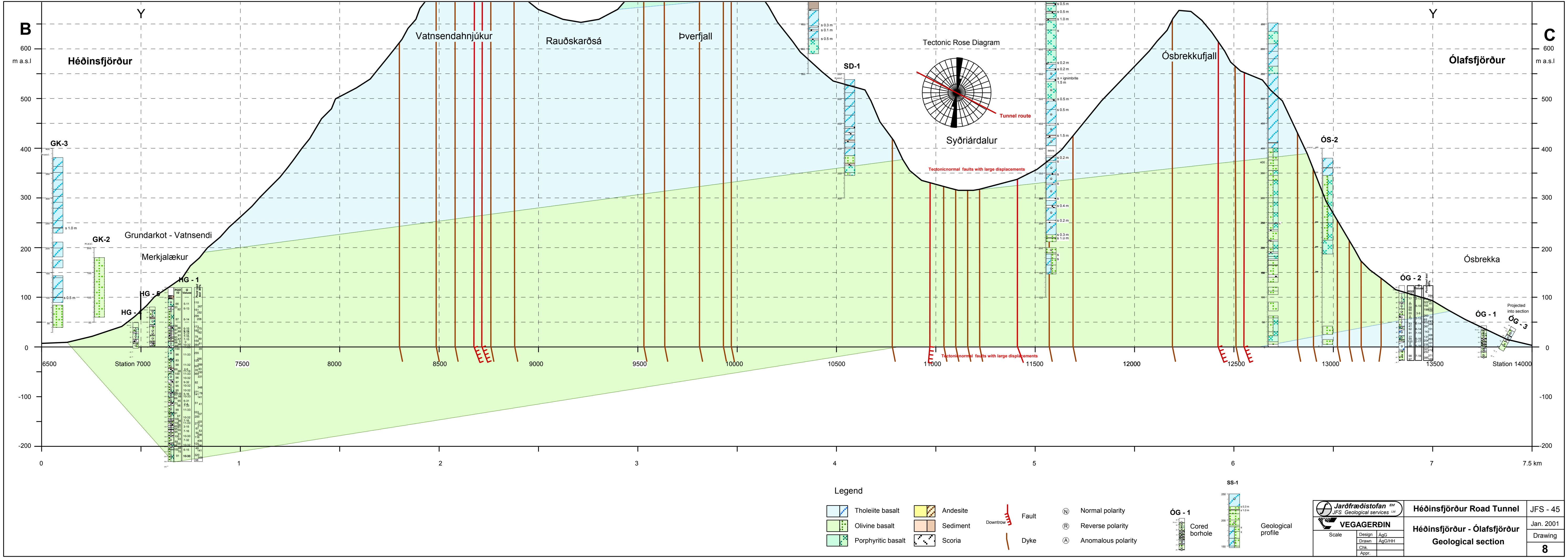
VEGAGERÐIN

Héðinsfjörður Road Tunnel

Siglufjörður - Héðinsfjörður
Geological section

JFS - 45
Jan. 2001
Drawing
7

Scale	Design	ÁgG
	Drawn	ÁgG/HH/WaF
	Chk.	
	Appr.	



Jarðfræðistofan Ehf
JFS Geological services Ltd

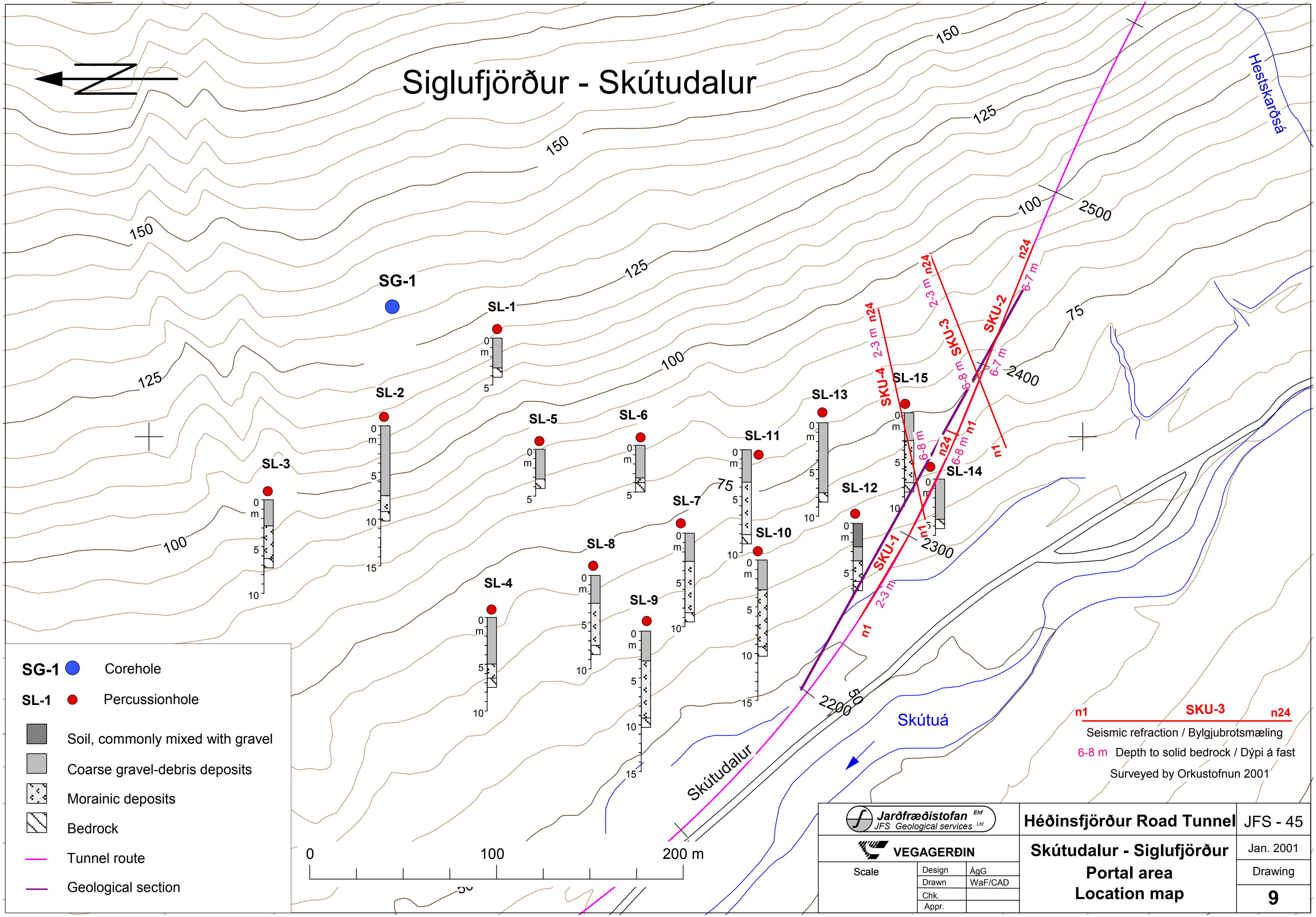
VEGAGERÐIN

Scale	Design	ÁgG	
	Drawn	ÁgG/HH	
	Chk.		
	Appr.		

Héðinsfjörður Road Tunnel

Héðinsfjörður - Ólafsfjörður
Geological section

JFS - 45
Jan. 2001
Drawing
8



Jarðfræðistofan Ehf
JFS Geological services Ltd

VEGAGERÐIN

Scale	Design	ÁgG	
	Drawn	WaF/CAD	
	Chk.		
	Appr.		

Héðinsfjörður Road Tunnel

Skútudalur - Siglufjörður

Portal area
Location map

JFS - 45

Jan. 2001

Drawing

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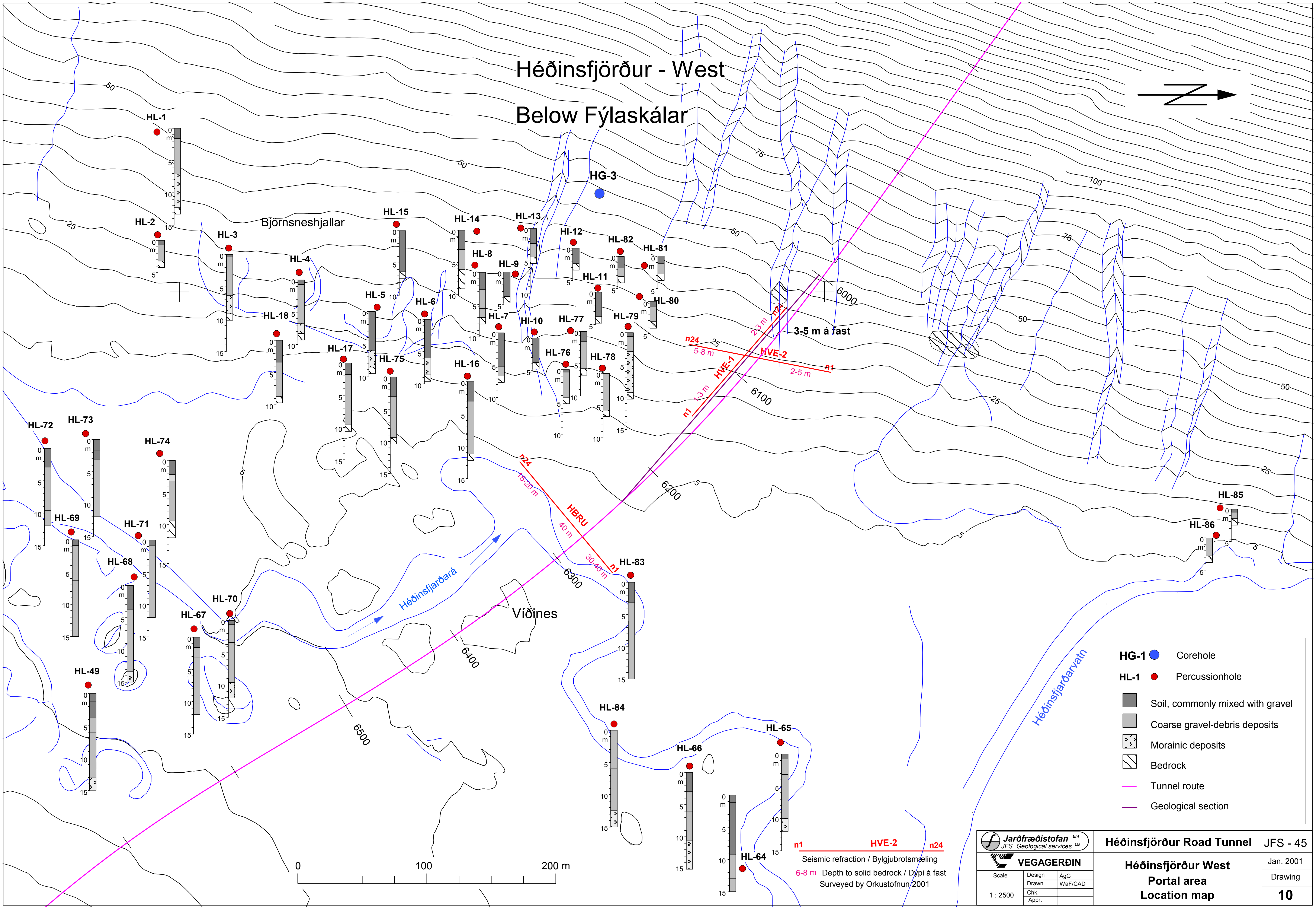

Jarðfræðistofan Ehf
JFS Geological services Ltd

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Scale 1 : 2500

Design ÁgG
Drawn WaF/CAD
Chk.
Appr.

Héðinsfjörður Road Tunnel

Héðinsfjörður West
Portal area
Location map

JFS - 45
Jan. 2001
Drawing
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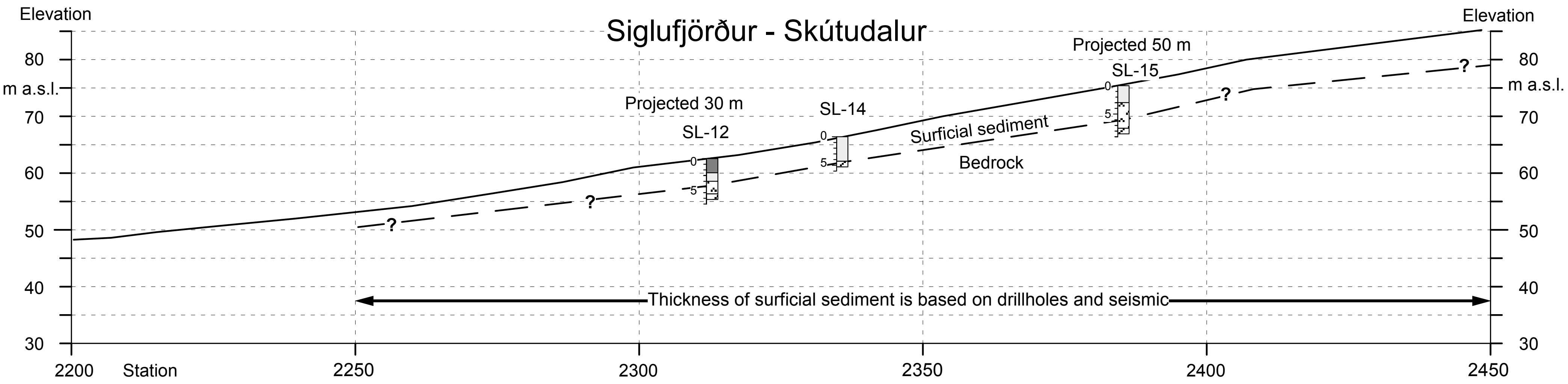
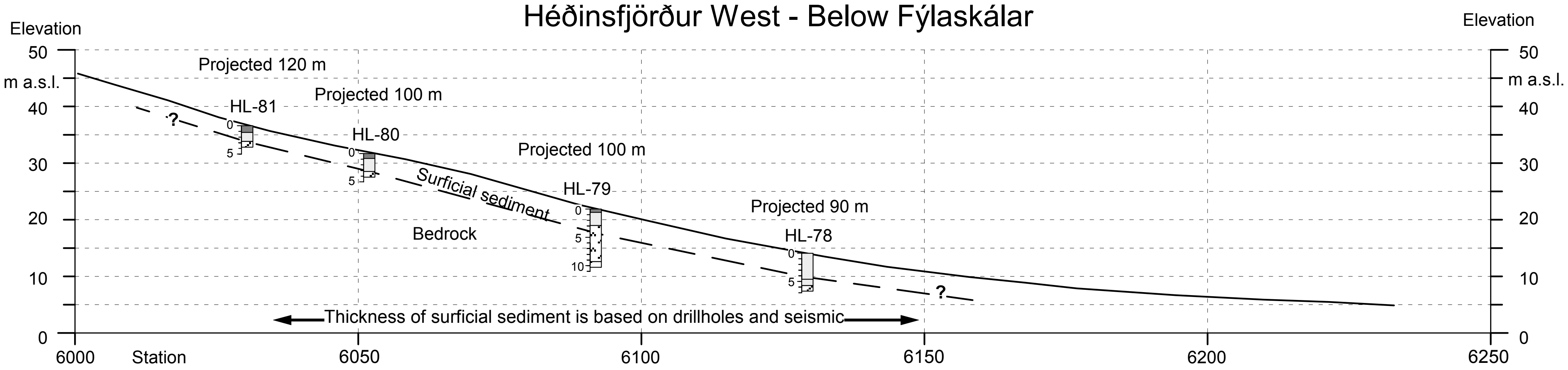
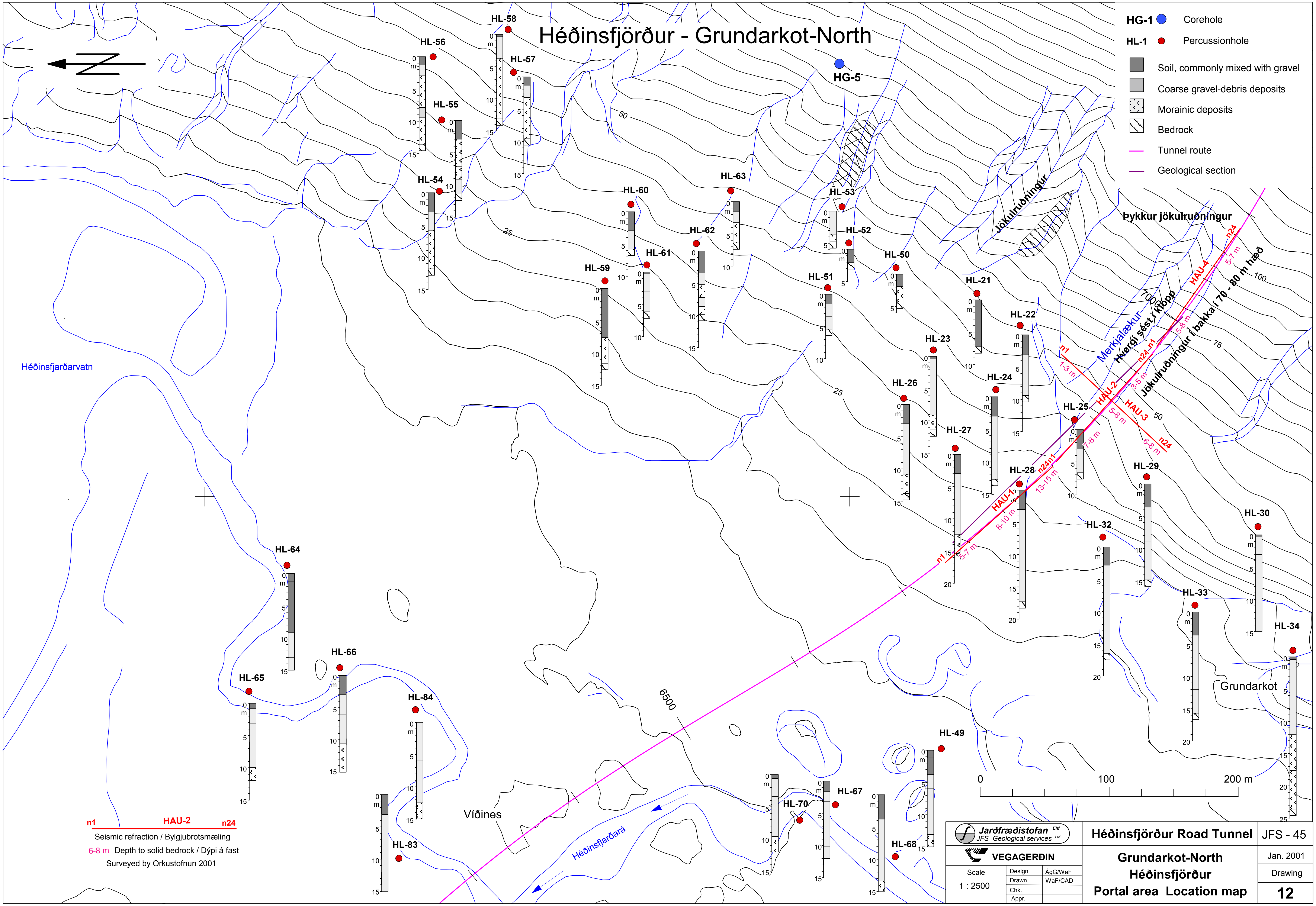
Siglufjörður - Héðinsfjörður





Jarðfræðistofan Ehf *JFS Geological services* Ltd			**Héðinsfjörður Road Tunnel**	JFS - 45
VEGAGERÐIN			**Siglufjörður - Héðinsfjörður** **Portal areas** **Geological Sections**	Jan. 2001
Scale 1 : 1250	Design	ÁgG		Drawing
	Drawn	WaF/CAD		**11**
	Chk.			
	Appr.			

Héðinsfjörður - Grundarkot-North



HG-1 ● Corehole

HL-1 ● Percussionhole

▩ Soil, commonly mixed with gravel

▨ Coarse gravel-debris deposits

▨ Morainic deposits

▨ Bedrock

— Tunnel route

— Geological section

n1 HAU-2 n24

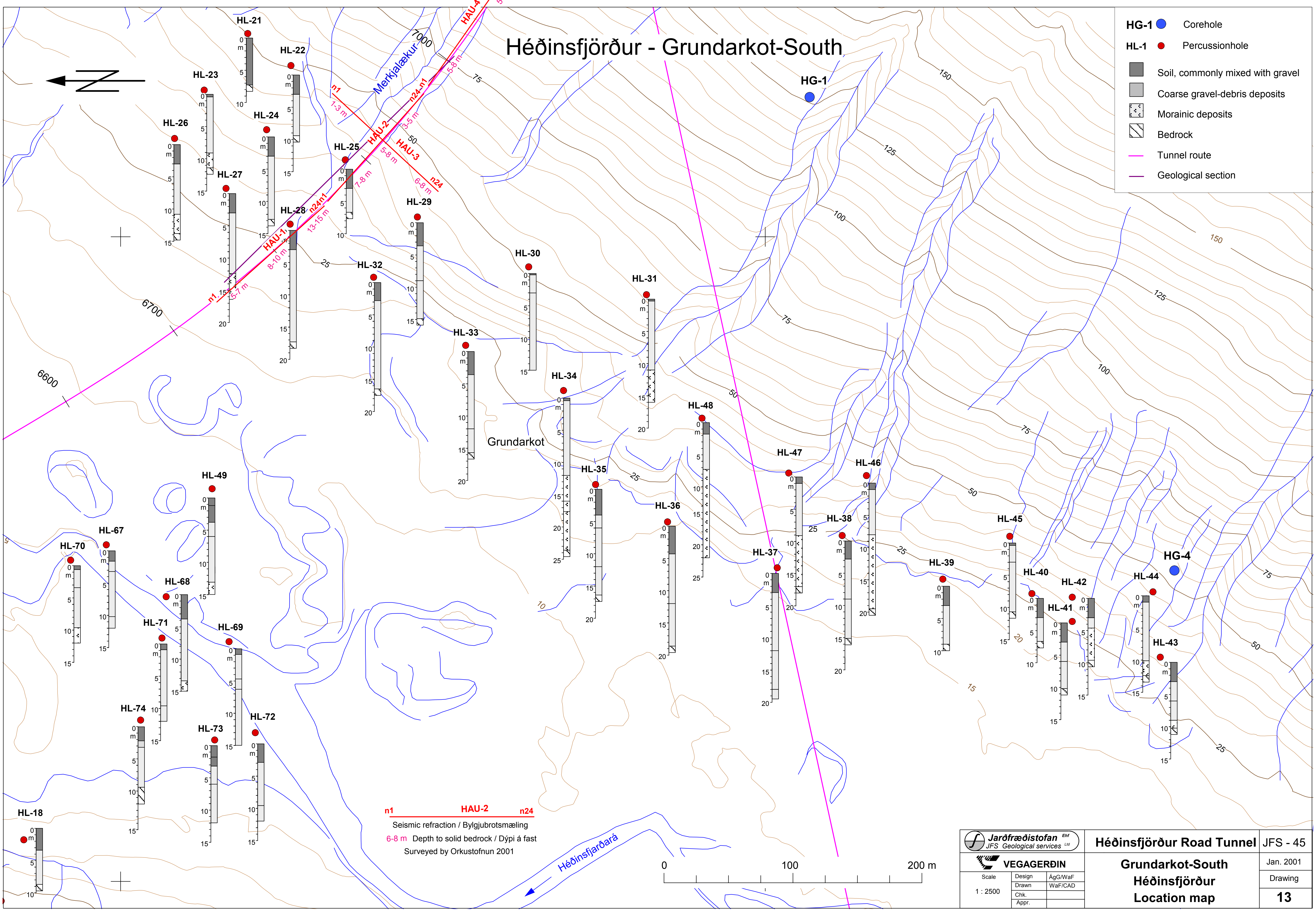
Seismic refraction / Bylgjubrotsmæling

6-8 m Depth to solid bedrock / Dýpi á fast

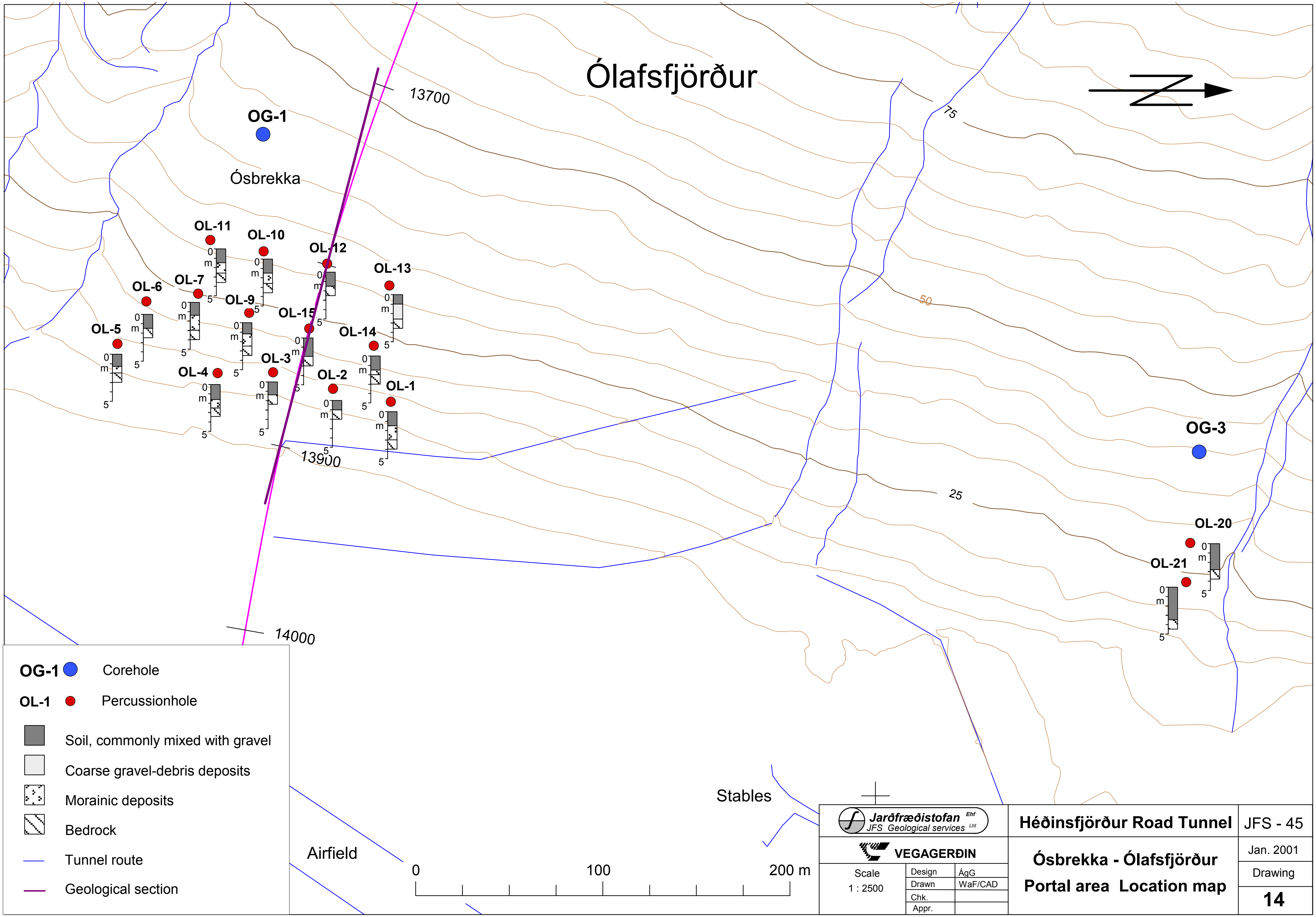
Surveyed by Orkustofnun 2001

Jarðfræðistofan Ehf JFS Geological services Ltd		Héðinsfjörður Road Tunnel	JFS - 45
VEGAGERÐIN		Grundarkot-North Héðinsfjörður Portal area Location map	Jan. 2001
Scale 1 : 2500	Design ÁgG/WaF Drawn WaF/CAD Chk. Appr.		Drawing 12

Héðinsfjörður - Grundarkot-South



Jarðfræðistofan Ehf JFS Geological services Ltd	Héðinsfjörður Road Tunnel	JFS - 45
VEGAGERÐIN	Grundarkot-South Héðinsfjörður Location map	Jan. 2001
Scale 1 : 2500	Design ÁgG/WaF Drawn WaF/CAD Chk. Appr.	Drawing 13



Jarðfræðistofan Ehf
JFS Geological services Ltd

VEGAGERÐIN

Scale	Design	ÁgG
1 : 2500	Drawn	WaF/CAD
	Chk.	
	Appr.	

Héðinsfjörður Road Tunnel

Ósbrekka - Ólafsfjörður
Portal area Location map

JFS - 45

Jan. 2001

Drawing

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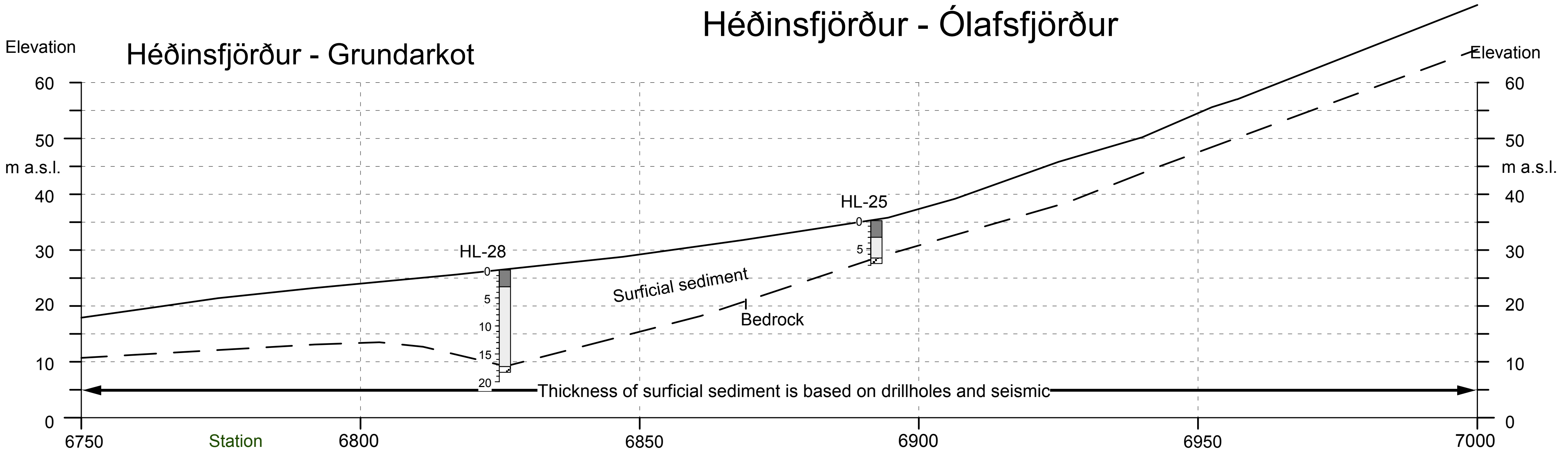
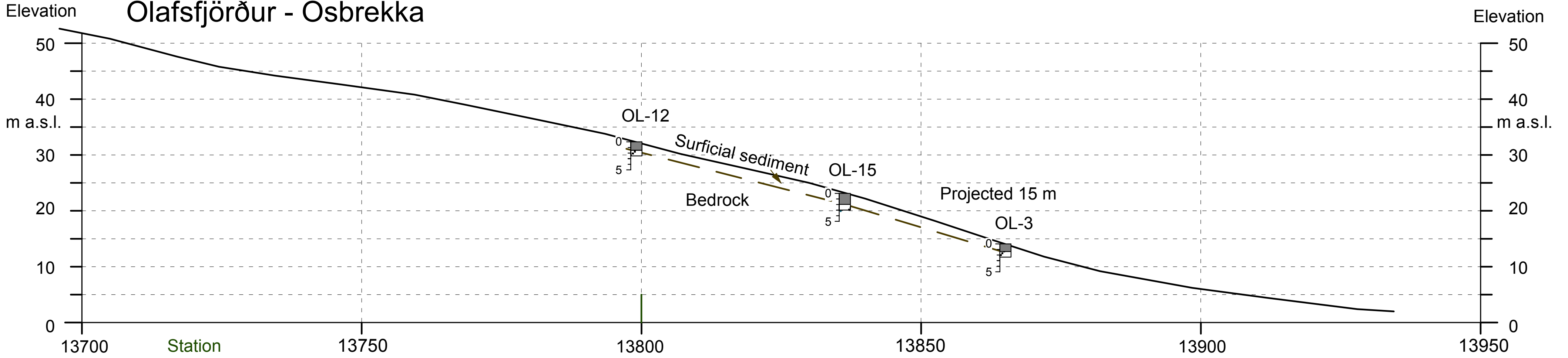
Héðinsfjörður - Ólafsfjörður

Héðinsfjörður - Grundarkot



Ólafsfjörður - Ósbrekka



Jarðfræðistofan Ehf
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VEGAGERÐIN

Scale	Design	ÁgG
	Drawn	WaF/CAD
	Chk.	
	Appr.	

Héðinsfjörður Road Tunnel

Héðinsfjörður-Ólafsfjörður
Portal areas
Geological Sections

JFS - 45

Jan. 2001

Drawing

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Jarðfræðistofan Ehf
JFS Geological services Ltd

VEGAGERÐIN

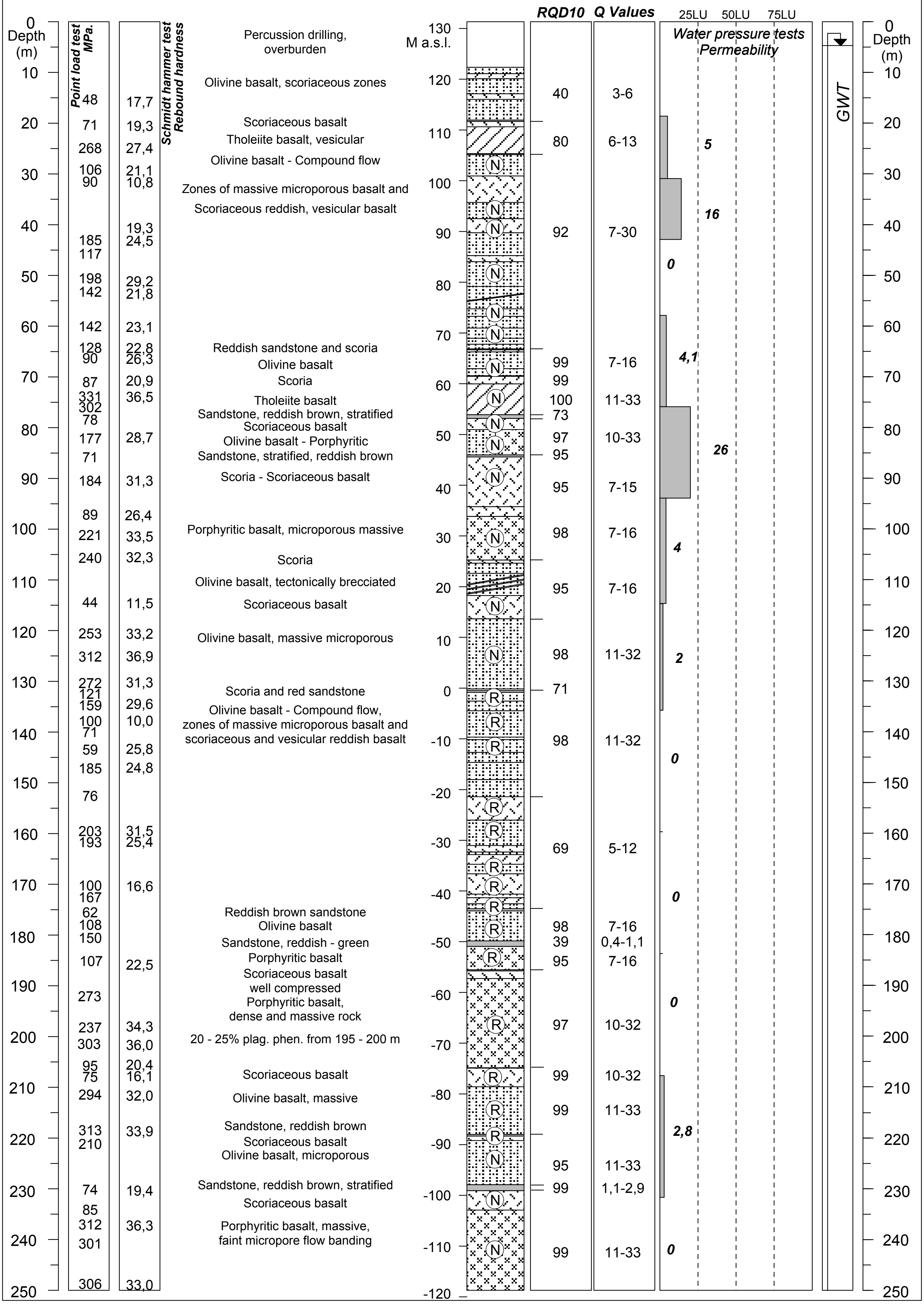
Empl.:

Héðinsfjörður Road Tunnel
Siglufjörður
Overview Corehole SG - 1 0 - 250 m

Coord.: X: 625.869,726 **Y:** 505.069,561 **Elev:** 131,37

JFS-45 | **SG1a** | **Drwg.** **16**

Drilling contr.: RFS **Time drilled:** Nov. 2000
Drilling rods: NQ rods with triple tube
Diam. of hole: 75,5 mm **Diam. of core:** 44,8 mm
Depth: 330,7 m **Casing:** Approx. 9 m



Jarðfræðistofan Ehf
JFS Geological services Ltd

VEGAGERÐIN

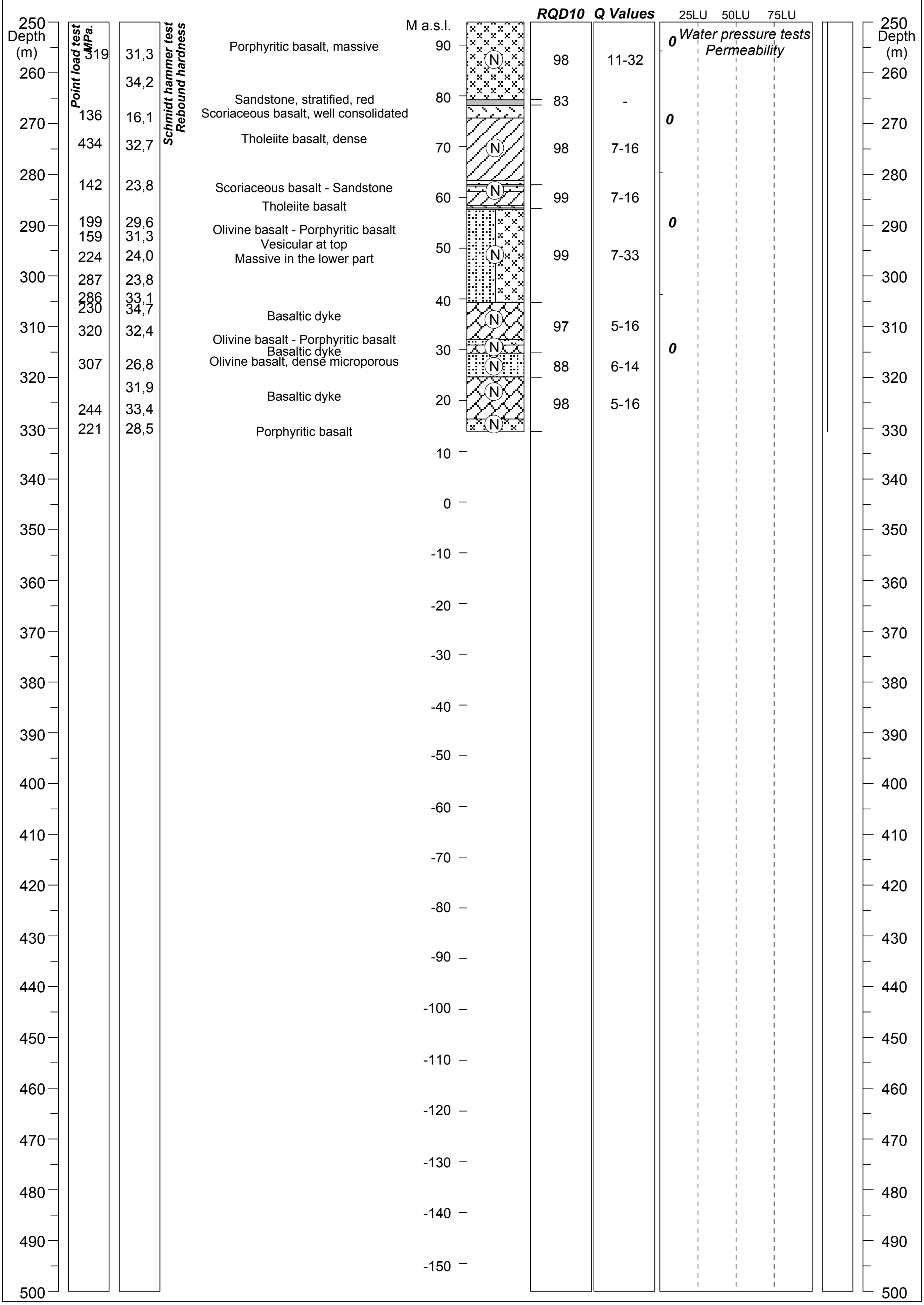
Empl.:

Héðinsfjörður Road Tunnel
Siglufjörður
Overview Corehole SG - 1 250 - 330,7

Coord.: X: 625.869,726 **Y:** 505.069,561 **Elev:** 131,37

JFS-45 **SG1b** **Drwg.** **16A**

Drilling contr.: RFS **Time drilled:** Nov. 2000
Drilling rods: NQ rods with triple tube
Diam. of hole: 75,5 mm **Diam. of core:** 44,8 mm
Depth: 330,7 m **Casing:** Approx. 9 m



Jarðfræðistofan Ehf
JFS Geological services Ltd

VEGAGERÐIN

Empl.:

Héðinsfjörður Road Tunnel
Héðinsfjörður
Overview Corehole HG - 1 0 - 250 m

Coord.: X: 622.465,59 **Y:** 508.608,38 **Elev:** 119,5

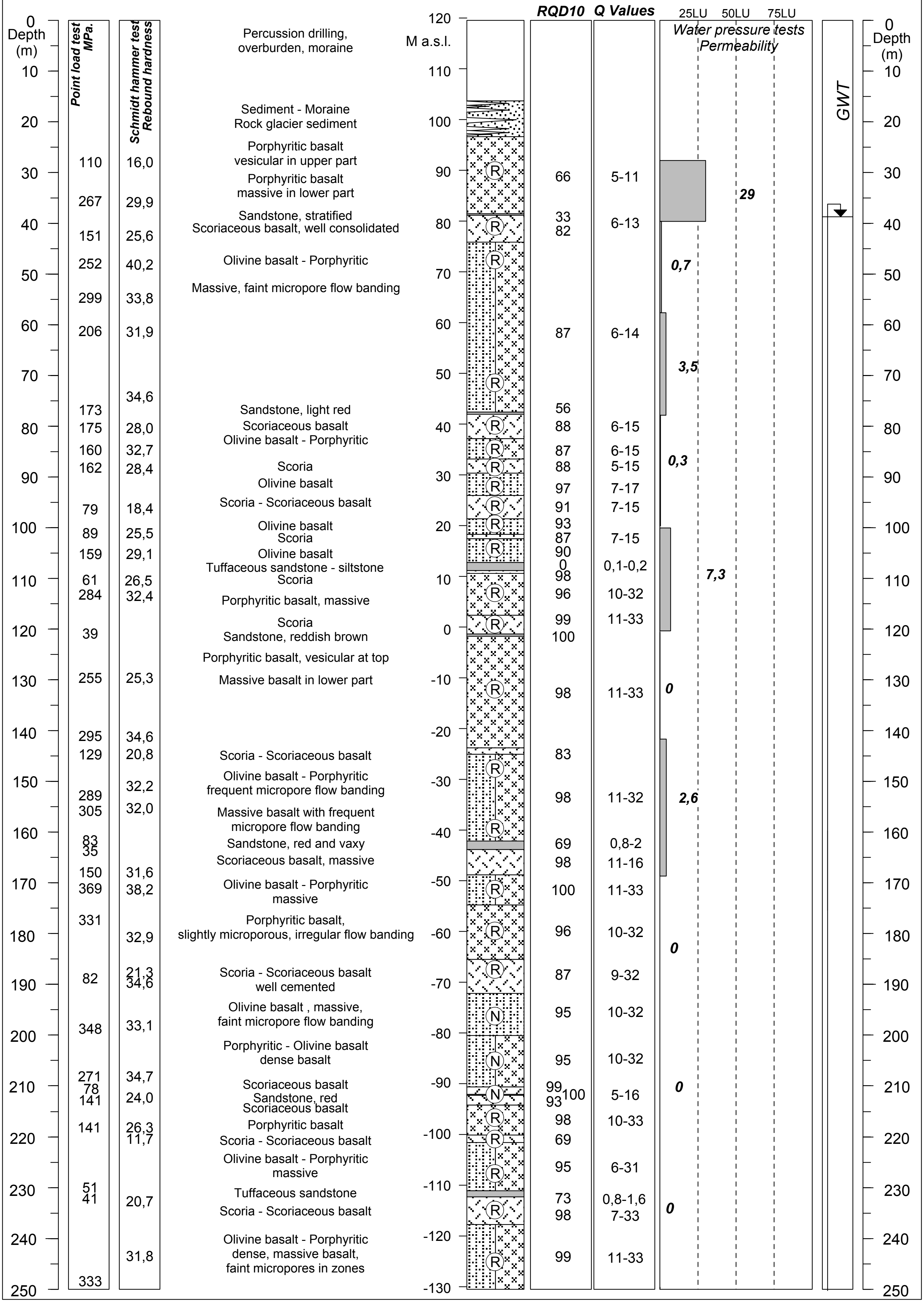
JFS-45 | **HG1a** | **Drwg.** 17

Drilling contr.: RFS **Time drilled:** Aug. 2000

Drilling rods: NQ rods with triple tube

Diam. of hole: 75,5 mm **Diam. of core:** 44,8 mm

Depth: 350,2 m **Casing:** Approx. 16 m



Jarðfræðistofan Ehf
JFS Geological services Ltd

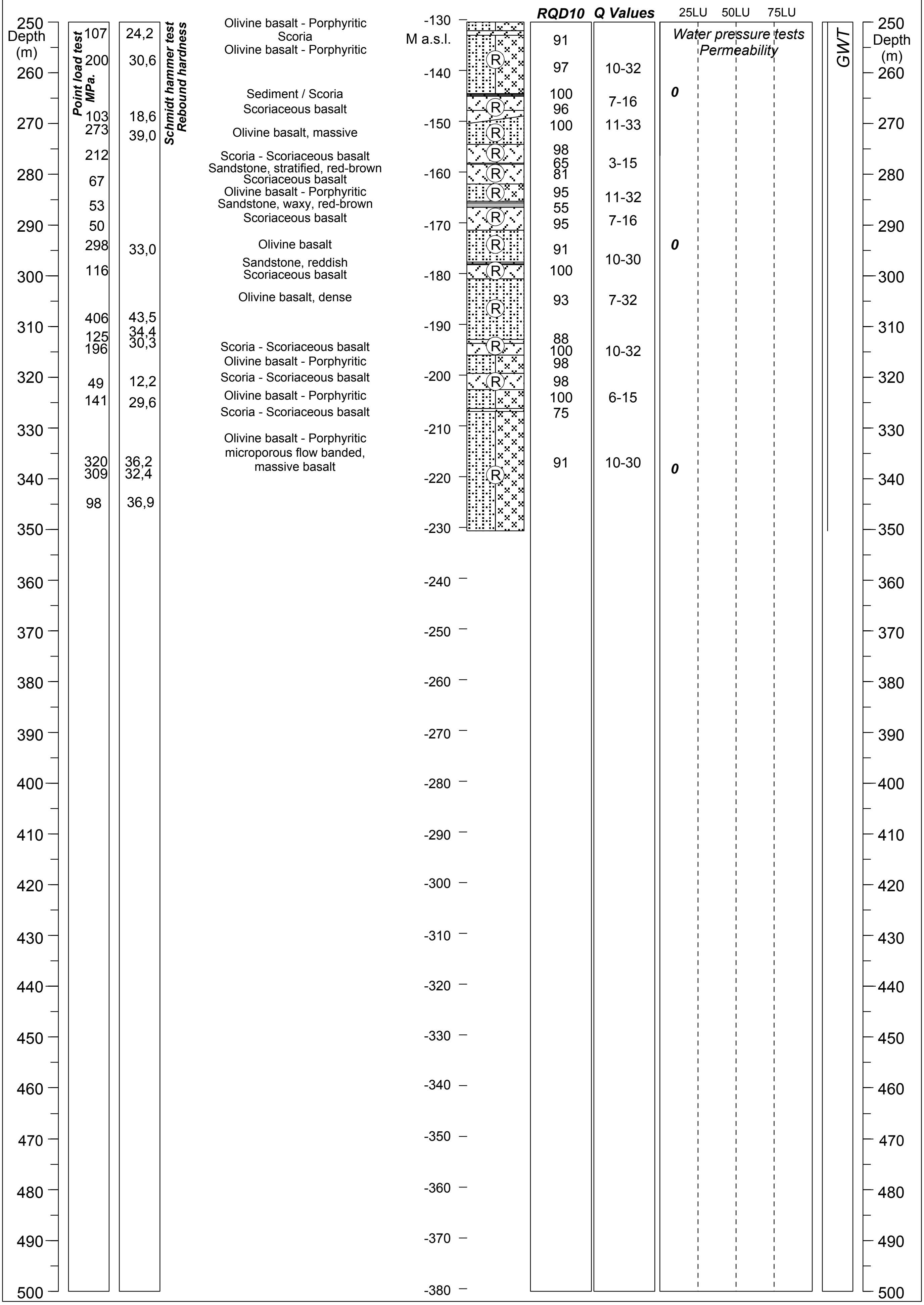
VEGAGERÐIN

Empl.:

Héðinsfjörður Road Tunnel
Héðinsfjörður
Overview Corehole HG - 1 250 - 350,2 m

Coord.: X: 622.465,59 **Y:** 508.608,38 **Elev:** 119,5

JFS-45 **HG1a** ***Drwg.*** **17A**
Drilling contr.: RFS ***Time drilled:*** Aug. 2000
Drilling rods: NQ rods with triple tube
Diam. of hole: 75,5 mm ***Diam. of core:*** 44,8 mm
Depth: 350,2 m ***Casing:*** Approx. 16 m



Jarðfræðistofan Ehf
JFS Geological services Ltd

VEGAGERÐIN

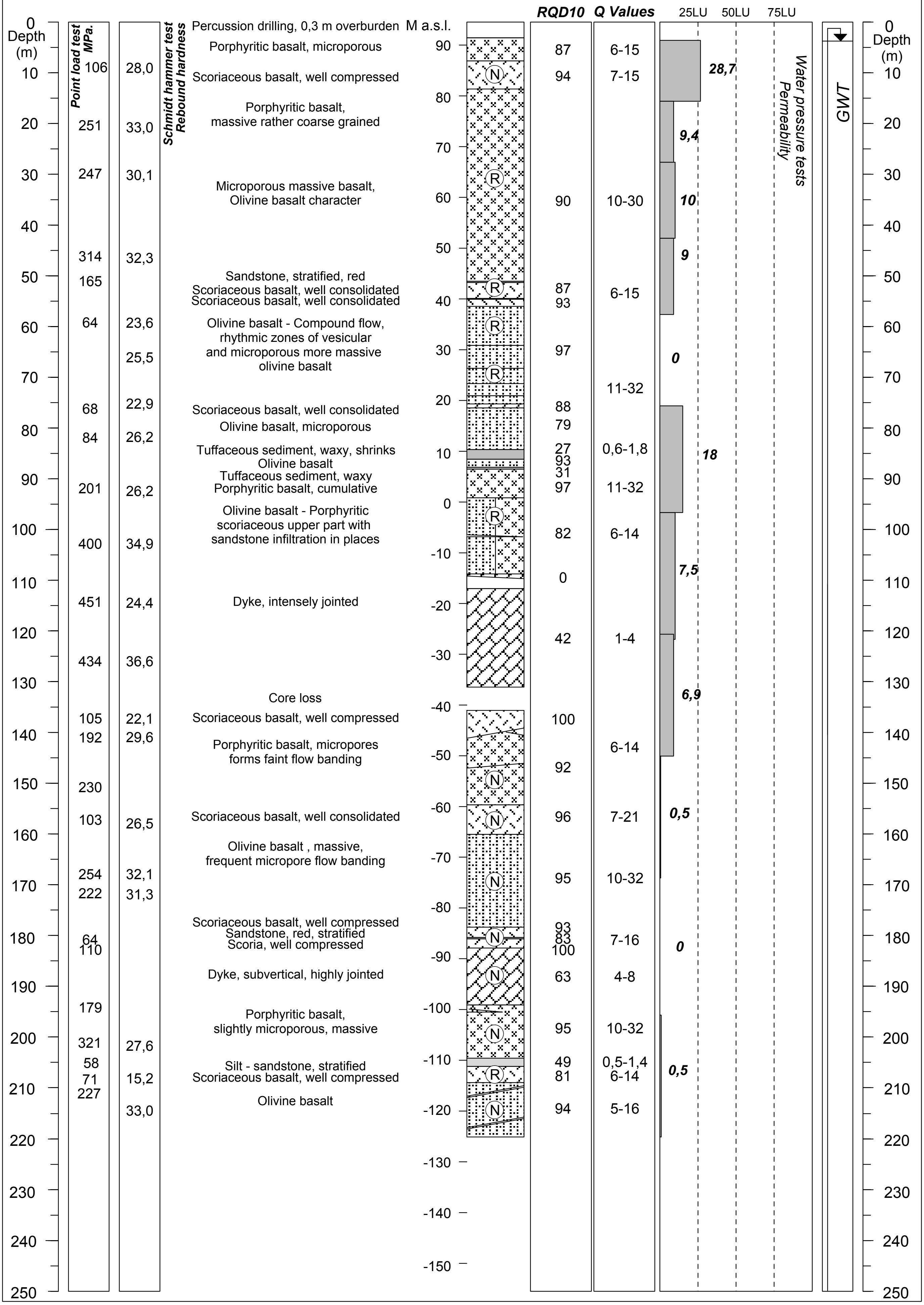
Empl.:

Héðinsfjörður Road Tunnel
Héðinsfjörður
Overview Corehole HG - 2 0 - 219,6

Coord.: X: 622.895,58 **Y:** 508.115,36 **Elev:** 94,5

JFS-45	**HG2a**	***Drwg.* 18**

Drilling contr.: RFS ***Time drilled:*** Sept. 2000
Drilling rods: NQ rods with triple tube
Diam. of hole: 75,5 mm ***Diam. of core:*** 44,8 mm
Depth: 219,6 m ***Casing:*** Approx. 3,12 m



Jarðfræðistofan Ehf
JFS Geological services Ltd

VEGAGERÐIN

Empl.:

Héðinsfjörður Road Tunnel
Héðinsfjörður
Overview Corehole HG - 3 0 - 42,5 m

Coord.: X: 623.325,49 **Y:** 507.923,75 **Elev:** 46,0

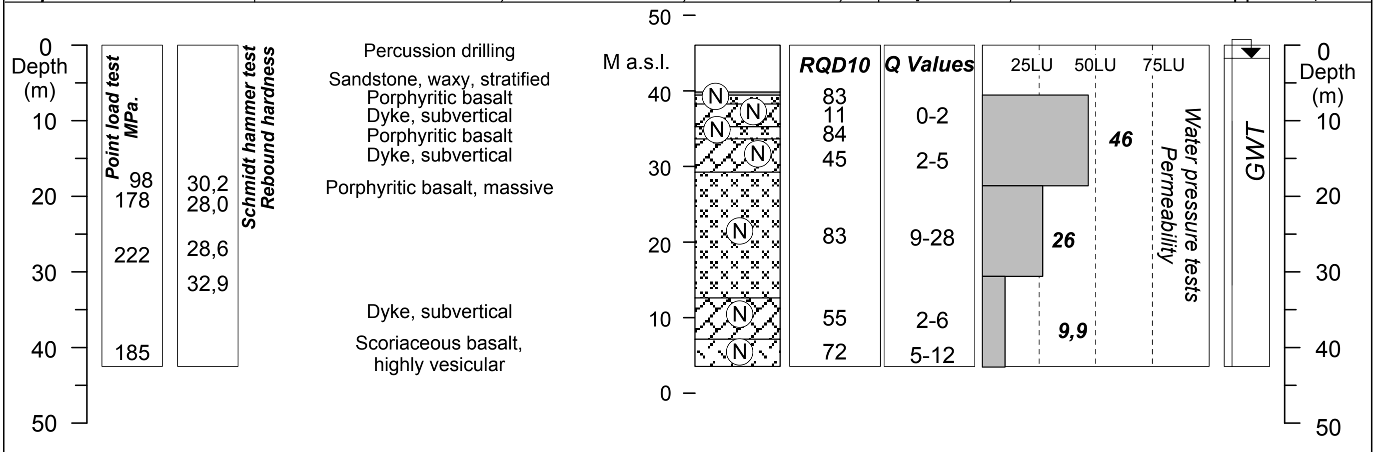
JFS-45 | **HG3a** | ***Drwg.*** **19**

Drilling contr.: RFS ***Time drilled:*** Aug. 2000

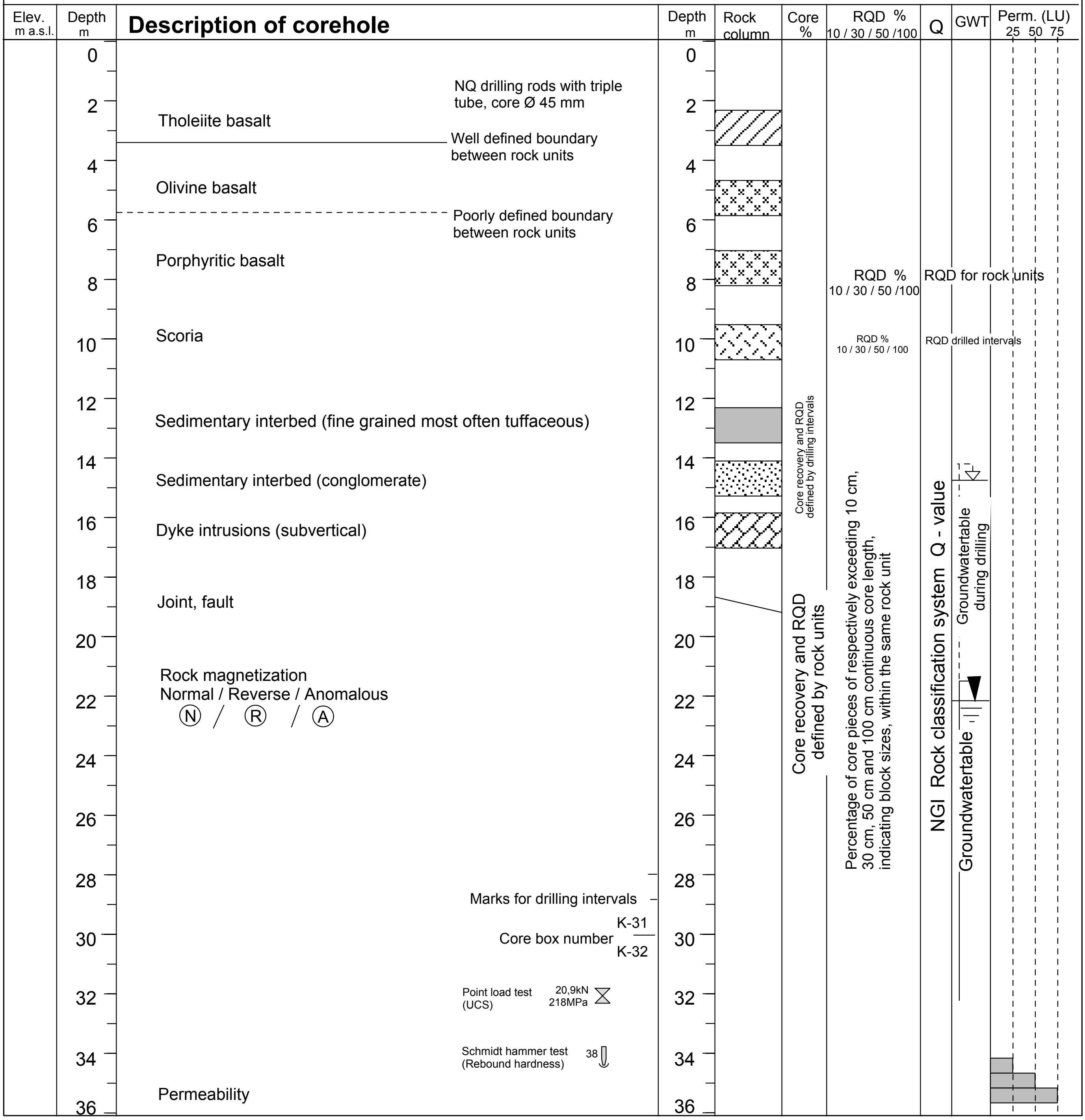
Drilling rods: NQ rods with triple tube

Diam. of hole: 75,5 mm ***Diam. of core:*** 44,8 mm

Depth: 42,5 m ***Casing:*** Approx. 6,2 m



LEGEND



Jarðfræðistofan Ehf
JFS Geological services Ltd

VEGAGERÐIN

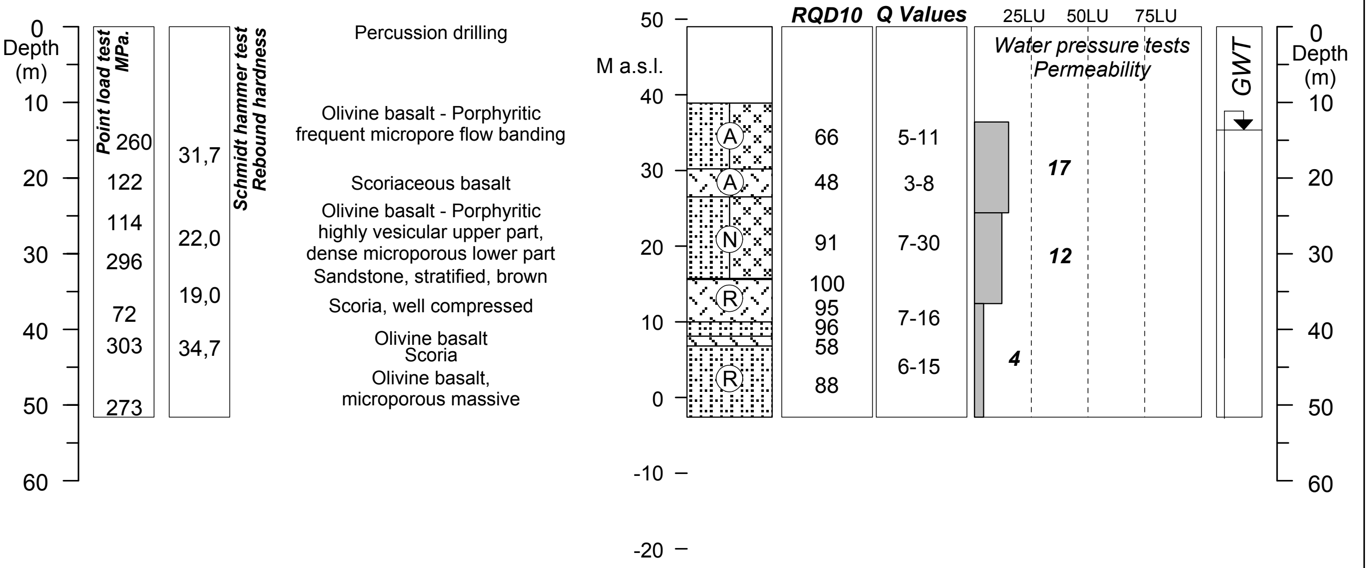
Empl.:

Héðinsfjörður Road Tunnel
Héðinsfjörður
Overview Corehole HG - 4 0 - 51,6 m

Coord.: X: 622.182,66 **Y:** 508.241,19 **Elev:** 49,0

JFS-45 | **HG4a** | ***Drwg.*** **20**

Drilling contr.: RFS ***Time drilled:*** Sept. 2000
Drilling rods: NQ rods with triple tube
Diam. of hole: 75,5 mm ***Diam. of core:*** 44,8 mm
Depth: 30,38 m ***Casing:*** Approx. 10.1 m



Jarðfræðistofan Ehf
JFS Geological services Ltd

VEGAGERÐIN

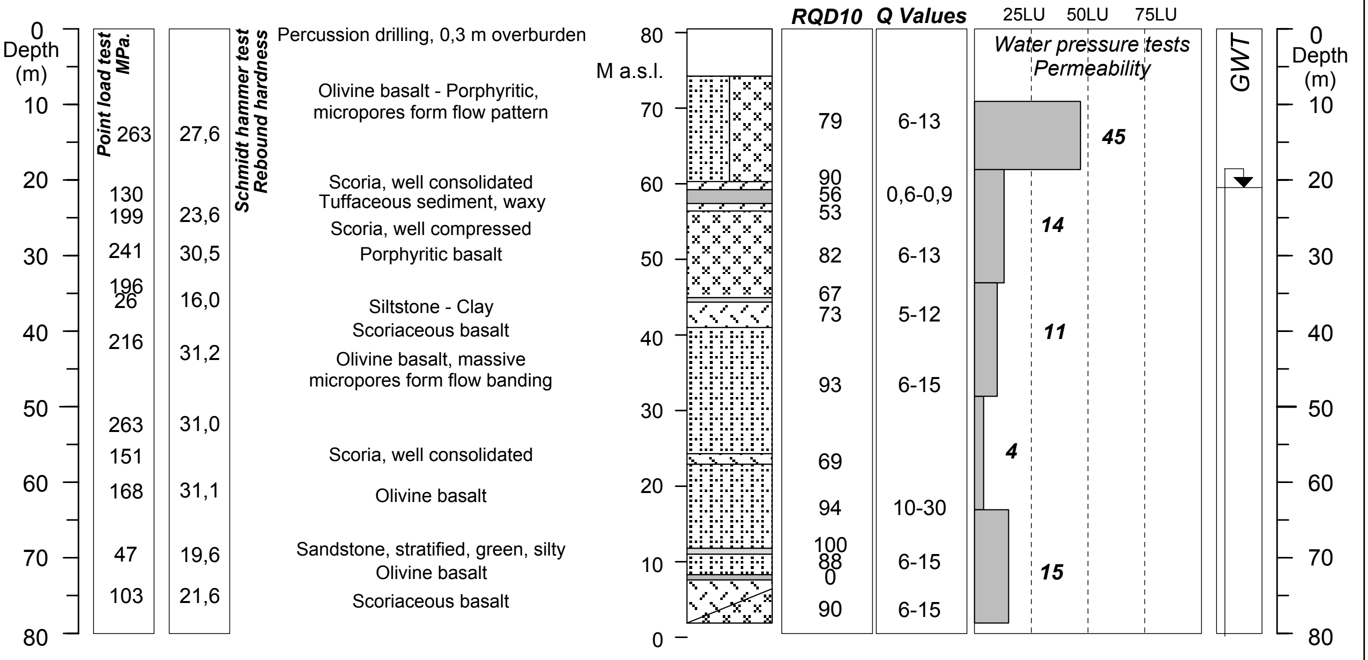
Empl.:

Héðinsfjörður Road Tunnel
Héðinsfjörður
Overview Corehole HG - 5 0 - 78,6

Coord.: X: 623.008,04 **Y:** 508.835,73 **Elev:** 80,5

JFS-45 | **HG5a** | ***Drwg.*** **20**

Drilling contr.: RFS ***Time drilled:*** Sept. 2000
Drilling rods: NQ rods with triple tube
Diam. of hole: 75,5 mm ***Diam. of core:*** 44,8 mm
Depth: 78,6 m ***Casing:*** Approx. 6,25 m



Jarðfræðistofan Ehf
JFS Geological services Ltd

VEGAGERÐIN

Empl.:

Héðinsfjörður Road Tunnel
Ólafsfjörður
Overview Corehole ÓG - 1 0 - 63,6 m

Coord.: X: 619.672,834 **Y:** 514.646,618 **Elev:** 42,27

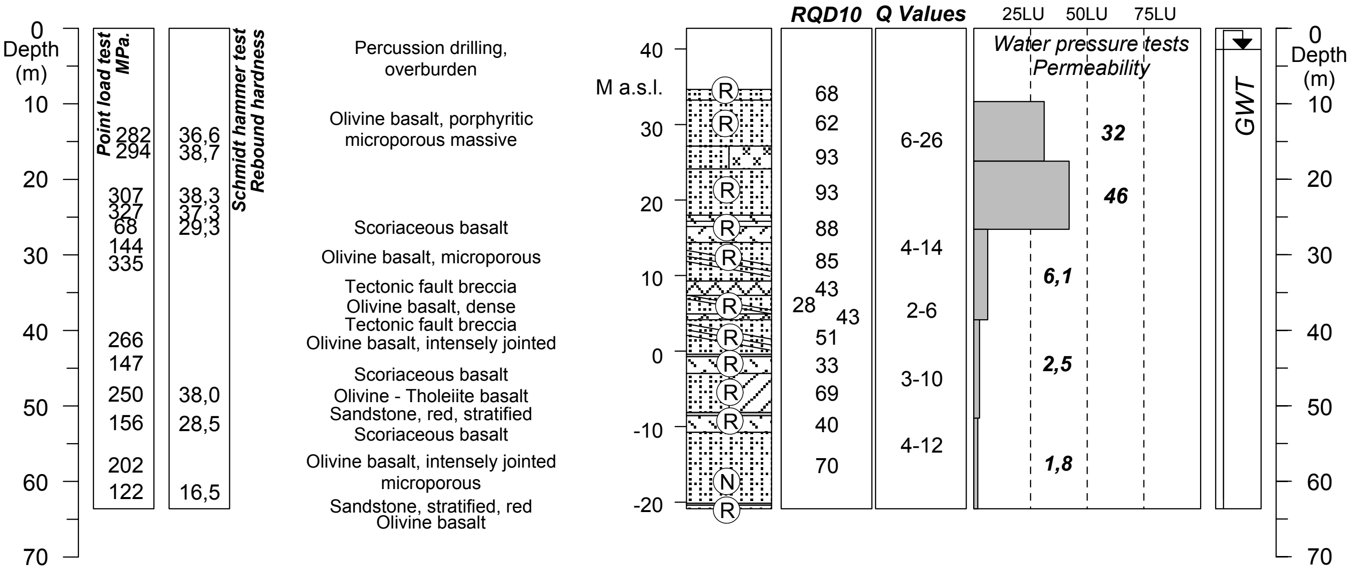
JFS-45 **ÓG1a** ***Drwg.*** **21**

Drilling contr.: RFS ***Time drilled:*** Nov. 2000

Drilling rods: NQ rods with triple tube

Diam. of hole: 75,5 mm ***Diam. of core:*** 44,8 mm

Depth: 63,6 m ***Casing:*** Approx. 8,1 m



Jarðfræðistofan Ehf
JFS Geological services Ltd

VEGAGERÐIN

Empl.:

Héðinsfjörður Road tunnel
Ólafsfjörður
Overview Corehole ÓG - 3 0 - 50,7 m

Coord.: X: 620.186,2 **Y:** 514.816,225 **Elev:** 39,63

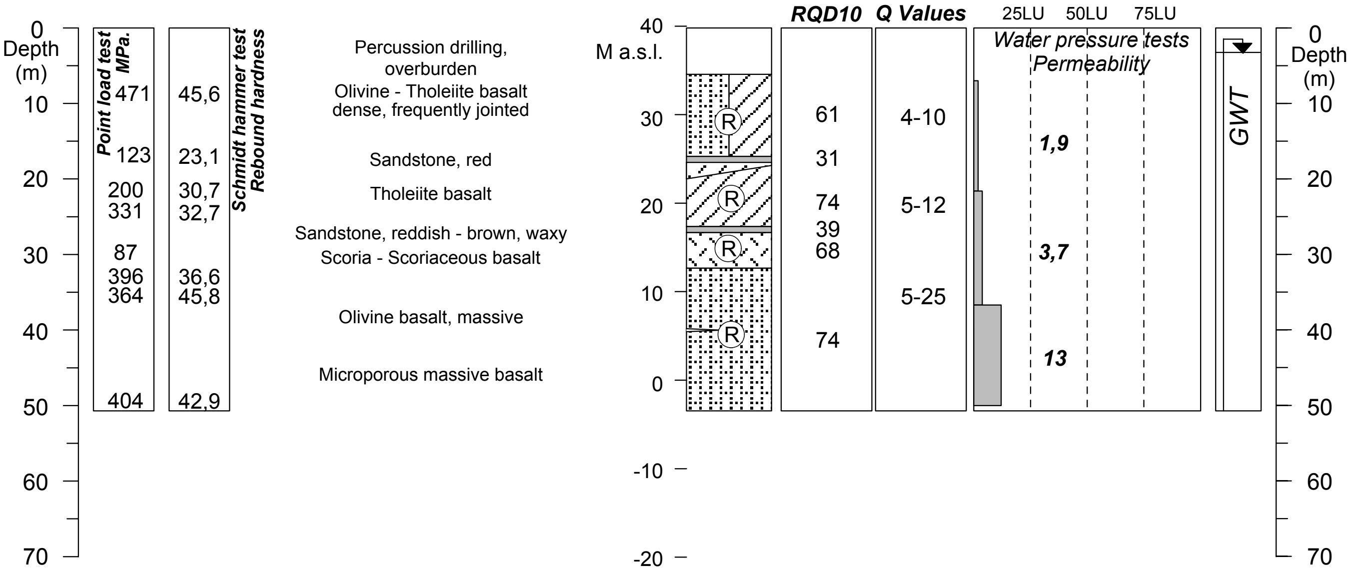
JFS-45 **ÓG3a** ***Drwg.*** **21**

Drilling contr.: RFS ***Time drilled:*** Dec. 2000

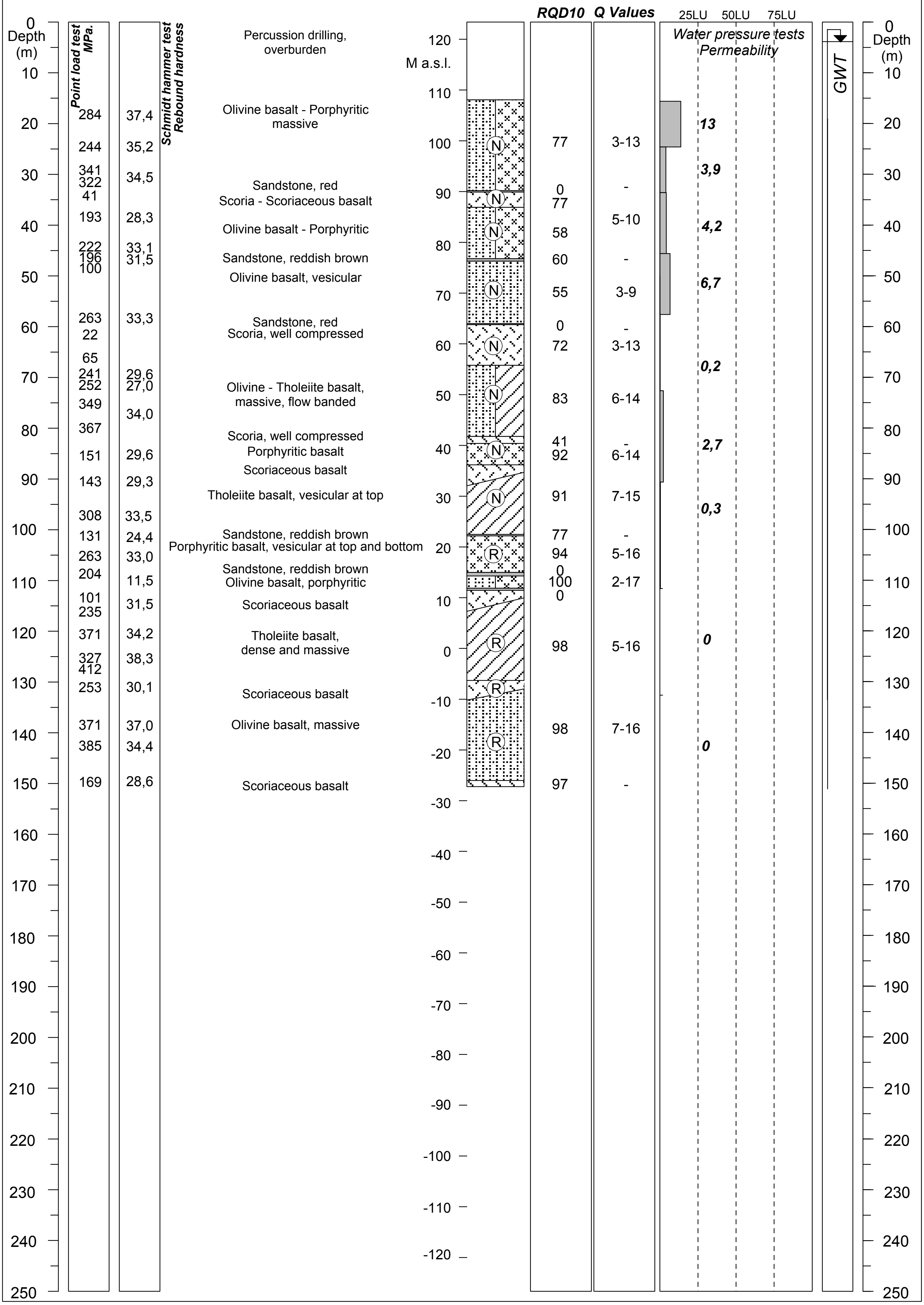
Drilling rods: NQ rods with triple tube

Diam. of hole: 75,5 mm ***Diam. of core:*** 44,8 mm

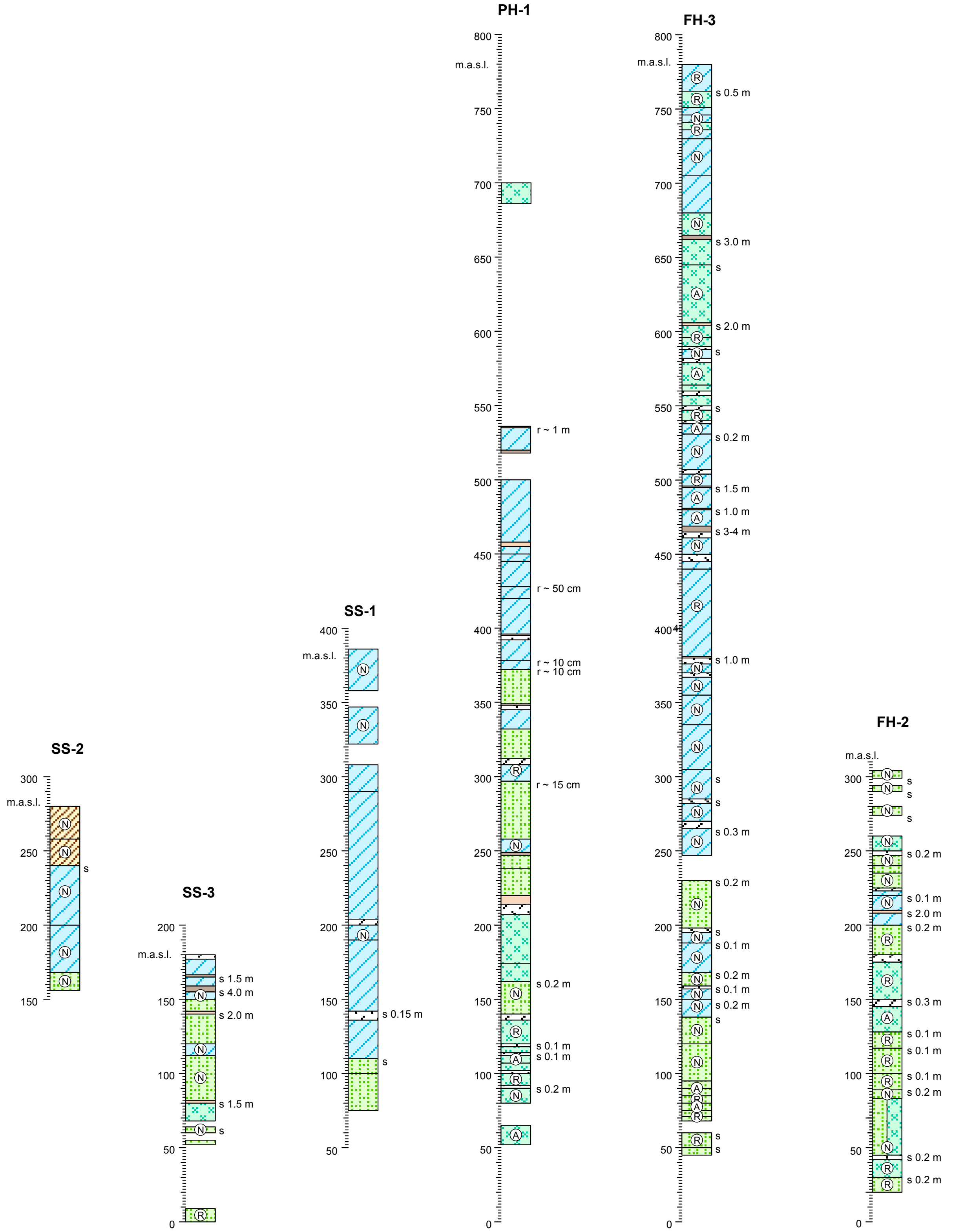
Depth: 50,7 m ***Casing:*** Appr. 6,15 m. Incl. 30°W



Jarðfræðistofan Ehf JFS Geological services Ltd	Héðinsfjörður Road Tunnel Ólafsfjörður	JFS-45	ÓG2a	Drwg. 22
		Drilling contr.: RFS	Time drilled: Dec. 2000	
VEGAGERÐIN	Overview Corehole ÓG - 2 0 - 250 m	Drilling rods: NQ rods with triple tube		
		Diam. of hole: 75,5 mm	Diam. of core: 44,8 mm	
Empl.:	Coord.: X: 619.860,016 Y: 514.142,369 Elev: 123,38	Depth: 150,6 m	Casing: Approx. 15,3 m	



Siglufjörður - Héðinsfjörður
Geological profiles



Profiles by Kristján Sæmundsson

Location see drawing 2

Jarðfræðistofan Ehf
JFS Geological services Ltd

VEGAGERÐIN

Scale

Design	ÁgG
Drawn	WaF/HH
Chk.	
Appr.	

Héðinsfjörður Road Tunnel

Geological profiles
Siglufjörður -
Héðinsfjörður

JFS - 45

Jan. 2001

Drawing

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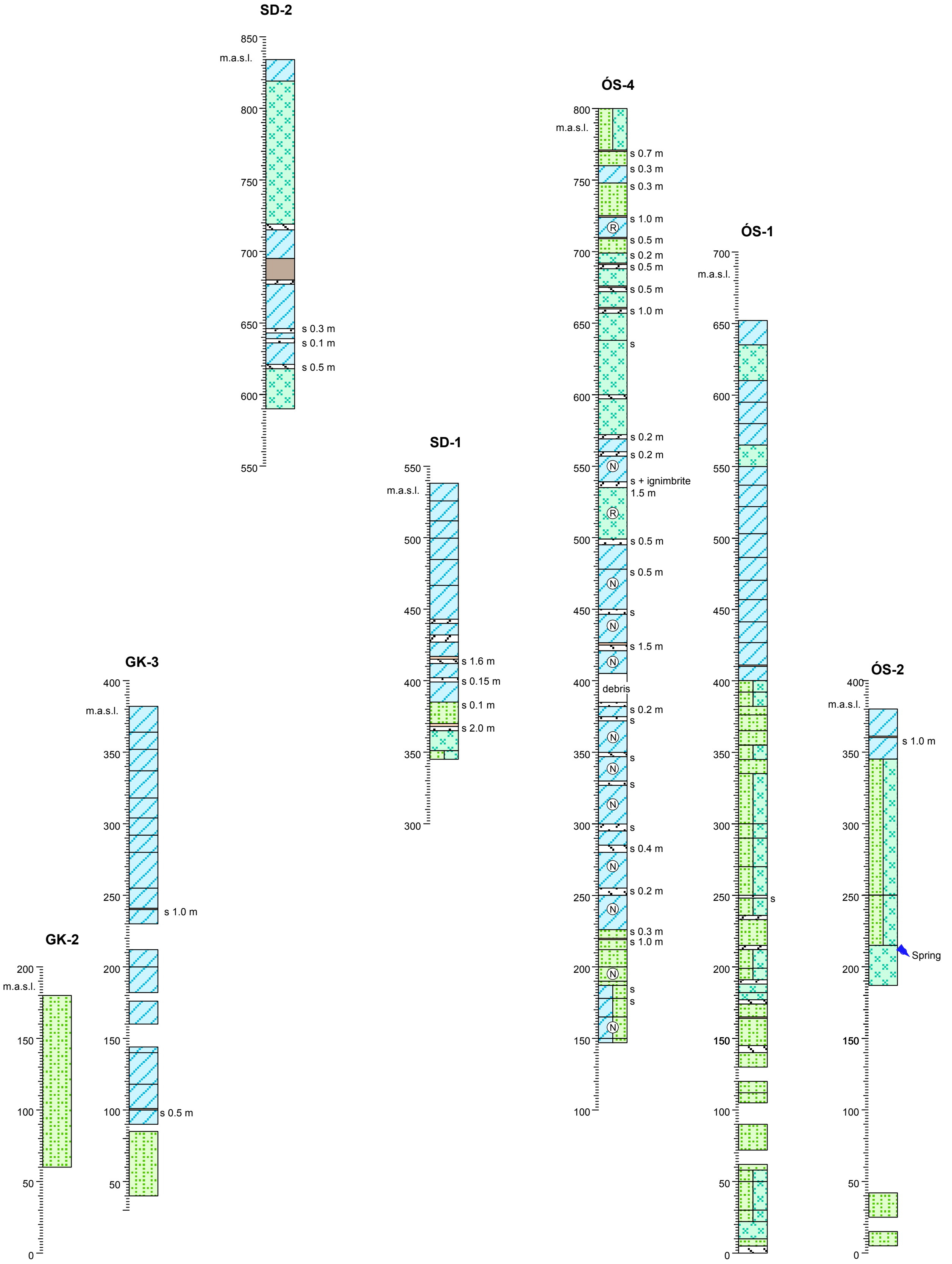
Héðinsfjörður - Ólafsfjörður
Geological profiles



Profiles by Kristján Sæmundsson

Location see drawing 2

Jarðfræðistofan Ehf Ltd
JFS Geological services

VEGAGERÐIN

Scale	Design	ÁgG	Héðinsfjörður Road Tunnel	JFS - 45
	Drawn	WaF/HH	Geological profiles Héðinsfjörður - Ólafsfjörður	Jan. 2001
	Chk.			Drawing
	Appr.			24

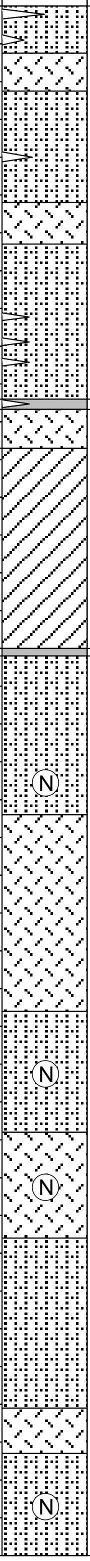
Appendix I Detailed core logs

Holes SG-1, HG-1 through HG-5, OG-1 through OG-3

Jarðfræðistofan Ehf JFS Geological services Ltd	**Héðinsfjörður Road Tunnel** **Siglufjörður** **Corehole SG - 1 0 - 50 m**	JFS-45 Date Nov. 2000 Design WaF/ÁgG	Drwg. SG-1 Page **1** of **7** Drawn WaF/DB
Empl. **VEGAGERÐIN**	Coord. X: 625869.726 Y: 505069.561 Elev.: 131.37	Driller RFS	Drilled Nov. 2000

Description of corehole SG - 1

Elev. m a.s.l.	Depth m	Description of corehole SG - 1
131.37	0	Overburden
	2	NQ drilling rods, triple tube
	4	Surficial sediments with scattered angular stones in silty / sandy matrix.
	5	Percussion drilling down to 9,0 m. 4" steel casing.
	8	Surface of bedrock
122.4		**Olivine basalt**
	10	Intensely jointed. Only small angular fragments of basalt above 10.8 m. Slightly scoriaceous.
	12	Dark grey, vesicular basalt. Core stumps up tp 0,3 m Mainly intensely jointed and crushed rock. Joints < 5 mm wide, filled with black clay.
	14	Scoriaceous olivine basalt. Better core recovery than above. 17,7 4,6kN 48MPa
	16	Vesicular and porous olivine basalt. Intensely jointed. Joints up to 4 mm wide,rough and undulating, filled with black clay.
	18	K-1 K-2
		Dark, intensely jointed olivine basalt
111.8		Sediment — Sandstone, waxy, weak rock.
	20	Scoriaceous basalt. Well compressed and cemented. Massive core. 6,8kN 71MPa
110.7		**Tholeiite basalt** 19,3
	22	Fresh grey, vesicular basalt. Elongated vesicles up to 50 mm, coated with 2-3 mm thick zeolitic crusts. Smaller vesicles completely filled with zeolites. Joints rough and undulating, coated with black clay and zeolites. 25,7kN 268MPa Fine microporous flow banding 27,4
		Scoria. Well compressed and cemented.
105.3	26	Sediment — 0,2 m reddish-brown, waxy sandstone.
		Olivine basalt - Compound flow K-2
	28	Dark microporous, massive rock. 21,1 K-3 Few inclined joints,rough and undulating, healed with zeolites. Two 3 cm wide joints filled with sandstone. Dark colour due to black clay fillings in micropores. 10,2kN 106MPa
	31	Reddish,vesicular slightly scoriaceous zone. 10,8 8,6kN 90MPa Vesicles up to 20%, 5-20 mm in diameter, filled with zeolites. Few inclined joints, healed with zeolites.
	36	Massive, microporous zone. K-3 Dark grey basalt due to black clay fillings in micropores. K-4
	39	Vesicular and scoriaceous zone. Reddish brown colour. Approx. 15-20 % vesicles up to 20 mm in diameter, well filled with zeolites. 19,3
	42	Microporous, very massive zone, almost continuous core. 24,5 Scattered vertical pipes, filled with zeolites. 17,8kN 185MPa 11,3kN 117MPa
	46	Reddish-brown vesicular, slightly scoriaceous zone. Approx. 15-20 % vesicles up to 20 mm in diameter, well filled with zeolites. K-4 K-5
	48	Very massive, dark grey microporous olivine basalt. Scattered large vesicles (<1%), well filled with zeolites.
81.4	50	



Core %	RQD % 10 / 30 / 50 /100	Q
62	0/0/0/0	
93	0/0/0/0	
100	29/0/0/0	
100	69/0/0/0	
100	20/0/0/0	
80	80/0/0/0	
100	24/0/0/0	$Q=\frac{40}{9}x\frac{2-3}{2-3}x\frac{1}{1}$
		Q = 2.9 - 6.6
100	98/74/52/0	
95	**40/12/6/0**	
100	53/20/0/0	
75	0/0/0/0	
98	11/0/0/0	
87	37/0/0/0	
100	33/0/0/0	
78	**0/0/0/0**	
100	77/0/0/0	
100	**90/33/0/0**	
100	92/37/0/0	
100	100/44/0/0	
100	72/13/0/0	
100	**78/22/0/0**	$Q=\frac{80}{9}x\frac{2-3}{2-3}x\frac{1}{1}$
		Q = 5.9 - 13.3
100	75/28/0/0	
100	**0/0/0/0**	
100	74/43/0/0	
100	88/60/21/0	$Q=\frac{92}{9}x\frac{2-3}{1-3}x\frac{1}{1}$
		Q = 6.8 - 30.6
100	95/64/29/0	
100	95/51/20/0	
100	**92/67/32/0**	
100	91/61/39/0	
100	100/79/34/0	
100	89/71/44/0	
100	96/64/56/0	
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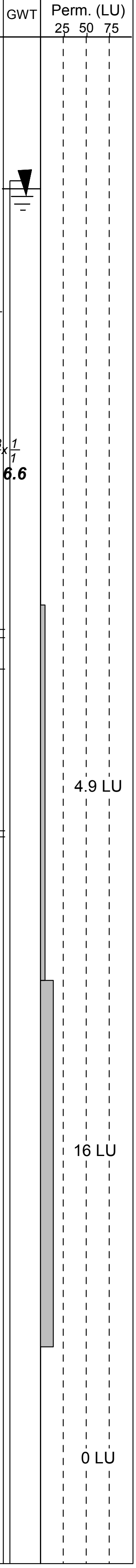


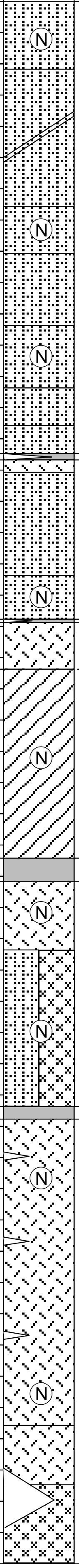
Jarðfræðistofan Ehf
JFS Geological services Ltd

Héðinsfjörður Road Tunnel
Siglufjörður
Corehole SG - 1 50 - 100 m

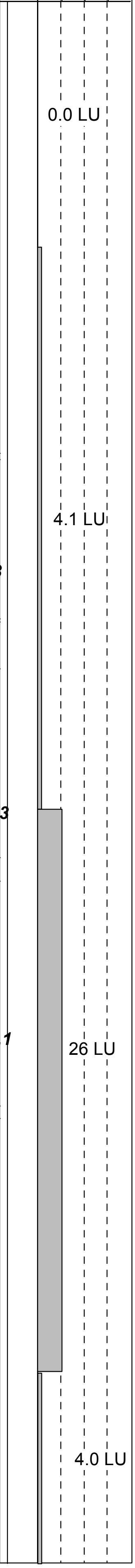
JFS-45 | Drwg. SG1b
Date Nov. 2000 | Page 2 of 7
Design ÁgG/WaF | Drawn WaF/DB
Empl. VEGAGERÐIN | Coord. X: 625869.726 Y: 505069.561 | Elev.: 131.7
Driller RFS | Drilled Nov. 2000

Elev. m a.s.l.	Depth m	Description of corehole SG - 1		Core %	RQD % 10 / 30 / 50 /100	Q
81.4	50	**Olivine basalt - Compound flow** Massive microporous olivine basalt, scattered fine joints healed with zeolites	19,0kN 198MPa	100	95/74/24/0	
	52		13,6kN 142MPa 29,2			
		Vesicular reddish-brown basalt, vesicles ~10-15%, < 20 mm, most often filled with zeolites	21,8	100	94/88/37/0	
	54			**100**	**92/67/32/0**	
	56	Inclined joints healed with zeolites, probably fault zone, fault zone 0,3 m wide, consisting of well cemented brecciated rock	K-5 K-6	100	92/65/29/0	
		Microporous massive zone, very dark colour				$Q=\frac{92}{9}x\frac{2-3}{1-3}x\frac{1}{1}$
	58					***Q = 6.8 - 30.6***
	60	Vesicular zone, vesicles ~15%, up to 20 mm in diameter, vesicles well filled with zeolites	13,6kN 142MPa 23,1	100	86/58/22/0	
	62	Microporous massive zone, dark grey olivine basalt, continuous core		100	98/79/39/0	
		Vesicular zone	12,3kN 128MPa 22,8			
	64	Microporous massive zone, dark colour		100	92/92/92/0	
66.9		**Sediment** dark, reddish-brown sandstone		**45**	**0/0/0/0**	
	66	**Olivine basalt** Vesicular, grey olivine basalt, slightly scoriaceous, all vugs well filled with zeolites, inclined joints, rough and undulating, healed with zeolites	8,6kN 90MPa K-6 26,3 K-7	100 **100**	97/70/23/0 **99/65/24/0**	$Q=\frac{99}{9}x\frac{2-3}{2-3}x\frac{1}{1}$
	68	Above 64,6 m scoriaceous				***Q = 7.3 - 16.3***
		Massive olivine basalt		100	100/62/24/0	
61.6	70	**Sediment** brown sandstone		**80**	**0/0/0/0**	
		Scoria Well compressed and consolidated, brown sandstone infiltrations	20,9 8,4kN 87MPa	**100**	**99/73/73/73**	
60.0	72	**Tholeiite basalt**		100	100/85/63/0	
	74	Light grey, very fine grained, microporous basalt, Scattered large vesicles well filled with zeolites, Micropores form distinct flow banding Hard and brittle rock	31,8kN 331MPa 36,5 29,0kN 302MPa K-7 K-8	100 **100**	100/85/43/43 **100/89/62/21**	$Q=\frac{100}{9}x\frac{2-3}{1-2}x\frac{1}{1}$
	76					***Q = 11.1 - 33.3***
		Scoriaceous in lowermost 0,2 m	7,5kN 78MPa	100	100/100/100/0	
53.9		**Sediment** Sandstone, dark, reddish-brown, stratified, waxy		**100**	**73/73/73/0**	
53.3	78	**Scoriaceous basalt**		100	90/90/90/0	
	80	Scoriaceous basalt, vesicular, vesicles ~15%, well filled with zeolites		100	96/87/73/43	
		Olivine basalt - porphyritic		**100**	**97/88/78/49**	
	82	Microporous massive basalt, plag. phen. ~ 5-7%, < 4 mm, Nearly continuous core,	17,0kN 177MPa 28,7			$Q=\frac{97}{9}x\frac{2-3}{1-2}x\frac{1}{1}$
						Q = 10.7 - 32.1
	84	Sharp boundary	K-8 K-9	100 100	99/87/76/76 100/100/100/0	
48.5		**Sediment** Sandstone, dark, reddisch-brown, stratified	6,8kN 71MPa	**100**	**95/95/0/0**	
	86	**Scoria - scoriaceous basalt**		94	77/68/54/54	
	88	Scoria with sandstone infiltrations at top, below vesicular, scoriaceous basalt				
		Very massive rock due to zeolitic recementing, nearly continuous core				
	90	Dispersed joint pattern, joints healed with zeolites	31,3	96	93/70/58/41	
		Vesicles ~ 15%, < 20 mm in diameter, partly filled - filled with zeolites	17,7kN 184MPa	**99**	**95/83/74/58**	
	92	All vugs well filled with zeolites		99	96/90/90/90	$Q=\frac{92}{9}x\frac{2-3}{2-3}x\frac{1}{1}$
			K-9			***Q = 6.8 - 15.3***
	94		K-10	100	100/87/73/73	
	96	**Scoriaceous basalt** Very well compressed and consolidated, continuous core	8,5kN 89MPa 26,4			
	98	**Porphyritic basalt**		50	49/42/42/0	
31.4	100	Microporous, slightly flow banded basalt, 7-8% plag. phen. < 4 mm Vesicles ~3-5%, <20 mm, elongated, filled with zeolite		100	99/82/57/39	

Depth m | Rock column



GWT | Perm. (LU) 25 50 75



Jarðfræðistofan Ehf
JFS Geological services Ltd

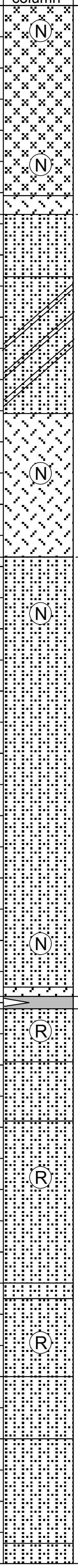
Héðinsfjörður Road Tunnel
Siglufjörður
Corehole SG - 1 100 - 150 m

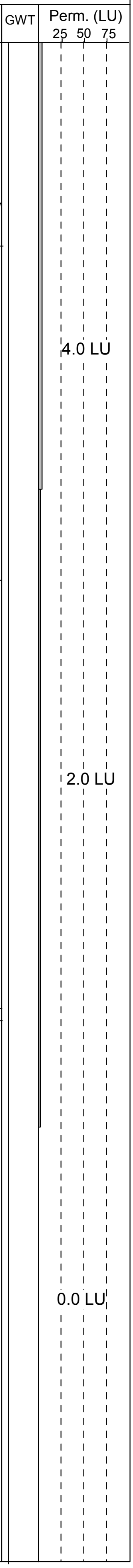
JFS-45 | Drwg. SG1c
Date Nov. 2000 | Page 3 of 7
Design ÁgG/WaF | Drawn WaF

Empl. **VEGAGERÐIN** | Coord. X: 6255869.726 Y: 505069.561 | Elev.: 131.37 | Driller RFS | Drilled Nov. 2000

Description of corehole SG - 1

Elev. m a.s.l.	Depth m	Description of corehole SG - 1		Core %	RQD % 10 / 30 / 50 /100 Q
31.37	100	Porphyritic basalt		100	99/82/57/39
	102	Massive porphyritic basalt Vesicles ~2%, 30-40 mm, elongated, well filled with zeolites	21,3kN 221MPa 33,5 K-10	**98**	**98/82/73/40** $Q=\frac{98}{9}x\frac{2\text{-}3}{2\text{-}3}x\frac{1}{1}$
	104		K-11		***Q = 7.3 - 16.3***
	106		32,3 23,0kN 240MPa	100	99/82/82/82
		Faint scoriaceous zone in sound basalt		100	95/90/81/81
	108	Olivine basalt Vesicular, slightly scoriaceous on top		**100**	**95/86/78/66** $Q=\frac{95}{9}x\frac{2\text{-}3}{2\text{-}3}x\frac{1}{1}$
	110	Olivine basalt Olivine basalt with distinct marks of tectonic activity, tectonically brecciated rock			***Q = 7.0 - 15.8***
	112	Fragments of basalt well cemented in black clay, yielding continuous core Large scattered vugs, partly filled and filled with zeolites Dark, black veine pattern, joints filled with zeolites	K-11	100 100	97/72/59/41 85/85/61/0
	114	Scoriaceous basalt Well compressed and consolidated scoriaceous basalt	11,5 K-12 4,2kN 44MPa	100	99/99/99/99
	116	Fragments well cemented in zeolites All vugs well filled with zeolites Continuous, massive core, only mechanical breaks		100	97/91/91/91
13.7	118	Olivine basalt			
	120	Massive microporous, sligthly flow banded basalt	24,3kN 253MPa	100	100/100/100/71
		Scattered large pores, coated and filled with black clay and partly zeolites	33,2	100	100/100/100/57
	122	Approx. 3-4% plag. phen. < 4 mm	K-12 K-13	**100**	**98/92/78/48** $Q=\frac{98}{9}x\frac{2\text{-}3}{1\text{-}2}x\frac{1}{1}$
	124	Scattered, steeply inclined and vertical joints, rough and undulating, healed with black clay			***Q = 10.8 - 32.4***
			36,9	100	95/95/39/0
	126		30,0kN 312MPa	100	90/45/0/0
	128			100	99/99/99/99
	130		26,1kN 272MPa 31,3	100	96/76/60/0
		Scoriaceous in lowermost part	K-13		
-1.0	132	Sediment red, fine grained sandst., well consolidated, cont. core	K-14	**91**	**71/0/0/0**
		Olivine basalt - Compound flow Vesicular but well cemented zone, reddish-grey colour	11,6kN 121MPa	100	100/100/100/0
	134	Massive dark grey, microporous zone, continuous core	29,6	100	100/100/100/100
	136	Reddish-brown vesicular zone Vesicles and vugs ~20%, well filled with zeolites Continuous core			
	138		9,6kN 100MPa 10,0	100	100/100/100/100
	140		K-14	100 **100**	92/83/83/46 **98/92/86/61**
		Microporous zone faint flow boundary	K-15		
	142	Vesicular zone, scoriaceous	25,8 5,7kN 59MPa		$Q=\frac{98}{9}x\frac{2\text{-}3}{1\text{-}2}x\frac{1}{1}$ ***Q = 10.8 - 32.4***
	144	faint flow boundary Vesicular zone, scoriaceous		100	95/86/70/55
	146	Massive, microporous zone	24,8 17,8kN 185MPa	100	98/91/91/91
	148	Vesicular zone		100	99/99/99/80
-18.6	150	Massive, microporous zone			



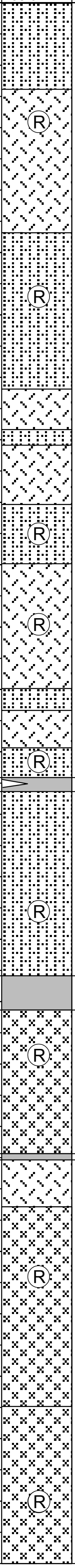


Jarðfræðistofan Ehf
JFS Geological services Ltd

Héðinsfjörður Road Tunnel
Siglufjörður
Corehole SG - 1 150 - 200 m

JFS-45	Drwg. SG1d
Date Nov. 2000	Page 4 of 7
Design ÁgG/WaF	Drawn WaF/DB
Driller RFS	Drilled Nov. 2000

Empl. **VEGAGERÐIN** Coord. X: 625869.726 Y: 505069.561 Elev.: 131.37



Elev. m a.s.l.	Depth m	Description of corehole SG - 1		Core %	RQD % 10 / 30 / 50 /100	Q	GWT	Perm. (LU) 25 50 75
-18.6	150	Vesicular zone	K-15 / K-16					
		Microporous zone						
	152	Vesicular zone, vugs well filled with zeolites		100	97/90/90/42			
-21.3		Faint flow boundary						
		Olivine basalt - Compound flow	7,3kN 76MPa					
	154	Vesicular scoriaceous basalt, ~20% vesicles, up to 30 mm Vugs well filled with zeolites		100	97/97/85/46			0.0 LU
	156							
	158	Massive microporous zone Scattered white veins of joints healed with zeolites Continuous core		100	100/100/100/77			
			31,5 19,5kN 203MPa K-16 / K-17	**100**	**69/35/23/0**			
	160			100	98/84/84/84			
	162		25,4 18,5kN 193MPa			$Q=\frac{69}{9}x\frac{2-3}{2-3}x\frac{1}{1}$		
		Vesicular, reddish-brown zone Vugs filled with zeolites				***Q = 5.1 - 11.5***		
	164	Massive microporous zone						
		Vesicular reddish-brown scoriaceous zone Vesicles well filled with zeolites		100	100/92/92/67			
	166	Massive microporous zone		100	98/98/98/68			
	168	Vesicular - scoriaceous zone Reddish-brown to dark grey vesicular basalt, vugs filled with zeolites Solid core, jointing due to drilling	K-17 / K-18	100	98/89/49/0			0.0 LU
	172	Massive microporous zone	16,6 9,6kN 100MPa					
		Vesicular zone Reddish-brown, vugs well filled with zeolites	16,0kN 167MPa	100	100/93/82/82			
	174	Massive microporous zone		100	100/0/0/0			
-43.7		Sediment Sandstone, reddish-brown to grey, solid core		**93**	**78/78/0/0**			
	176	Olivine basalt Vesicular zone, vugs well filled with zeolites		100	100/91/91/73			
		Massive microporous zone. White veins of joints healed with zeolites, partly brecciated between 74-77 m depth		**100**	**98/89/81/29**			
	178	Vesicular zone Vugs up to 30 mm, well filed with zeolites	10,4kN 108MPa K-18 / K-19			$Q=\frac{98}{9}x\frac{2-3}{2-3}x\frac{1}{1}$ ***Q = 7.3 - 16.3***		
		Massive microporous zone						
	180	Few inclined joints, rough and undulating, healed with zeolites	14,4kN 150MPa	100	96/85/69/0			
-49.7				100	100/100/100/0			
		Sediment Sandstone/siltstone, waxy sediment of low strength Redd.-brown in upper part, green and tuffaceous in lower part		**100**	**39/0/0/0**	$Q=\frac{39}{9}x\frac{1-2}{3-4}x\frac{1}{2,5}$ ***Q = 0,4 - 1,1***		
-50.8	182	Porphyritic basalt		100	99/99/99/99			
	184	Cumulative plagioclase crystals, 20-30%, < 5 mm Vesicles ~10%, in the uppermost part filled with zeolites Continuous core	10,3kN 107MPa	**100**	**95/95/95/95**	$Q=\frac{95}{9}x\frac{2-3}{2-3}x\frac{1}{1}$ ***Q = 7.0 - 15.8***		
	186	Sediment Sandstone, reddish-green	22,5	100 100	99/99/99/99 0/0/0/0			
-55.6		Scoriaceous basalt		**100**	**0/0/0/0**			
	188	Well compressed and consolidated, massive core	K-19 / K-20	100	89/81/81/47			
		Porphyritic basalt						
	190	Bright grey, dense and massive rock Plag. phen. ~20%, < 5 mm		**99** 100	**97/94/90/74** 99/99/85/85			
	192	Few scattered joints, rough and undulating, healed with zeolites, partly thin black clay coatings Slightly porous, ~3-4%, pores filled with zeolites	26,2kN 273MPa			$Q=\frac{97}{9}x\frac{2-3}{1-2}x\frac{1}{1}$		0.0 LU
	194					***Q = 10.7 - 32.1***		
		Cumulative plagioclase crystals 20-25% between 195 - 200 m depth		100	100/100/100/100			
	196							
				100	95/84/73/49			
	198		34,3 22,8kN 237MPa K-20 / K-21					
-68.6	200			100	100/100/100/100			

Jarðfræðistofan Ehf
JFS Geological services Ltd

Héðinsfjörður Road Tunnel
Siglufjörður
Corehole SG - 1   200 - 250 m

JFS-45	Drwg. SG1e
Date Nov. 2000	Page 5 of 7
Design ÁgG/WaF	Drawn WaF/DB

Empl. **VEGAGERÐIN** | Coord. X: 625869.726 Y: 505069.561 | Elev.: 131.37 | Driller RFS | Drilled Nov. 2000

Description of corehole SG - 1

Elev. m a.s.l. | Depth m

-68.6 | 200

Porphyritic basalt

Grey, dark spottet massive basalt, continuous core
Approx. 3-4% small vesicles, filled with black clay
Faint microporous flow banding

36,0 | 29,1kN 303MPa

-74.8 | 206

Sediment Sandstone, red, solid core Sharp contact / distinct boundary

Scoriaceous basalt

20,4 | 9,1kN 95MPa

K-21

Well compressed and consolidated
Vugs filled with zeolites
Well cemented continuous core

K-22

16,1 | 7,2kN 75MPa

-78.5 | 210

Olivine basalt

32,0 | 28,2kN 294MPa

Bright grey dense and massive rock
Approx. 2-3% plagioclase phenocrysts

- - - - - - - - - - - -

Massive olivine basalt
Approx. 5-7% plag. phenocrysts
Few joints, rough and undulating
High breaking strength

K-22
K-23

30,1kN 313MPa
33,9

-88.1 | 219

Sediment Sandstone, redd.-brown, waxy at base
Vesicular, redd.-brown zone, sligthly scoriaceous, vesicles well filled with zeolites

- - - - - - - - - - - -

Olivine basalt

20,2kN 210MPa

Dark grey, fine-medium grained microporous olivine basalt
Micropores form distinct flow banding
Scattered small vesicles filled with zeolites
Very sound rock of high breaking strength
Continuous core

-97.8

Sediment Sandstone, redd.-brown,stratified, small basalt fragments in lenses, green waxy siltstone at base

19,4 | 7,1kN 74MPa

-111.1 | 230

Scoriaceous basalt

Well compressed and consolidated scoriaceous basalt
Vugs well filled with zeolites
Well cemented rock yielding continuous core

- - - - - - - - - - - -

8,2kN 85MPa

Porphyritic basalt

Grey, medium grained basalt with plagioclase porphyroblasts
Approx. 5-7% plagioclase phenocrysts < 4 mm
Faint microporous flow banding
Massive continuous core

36,3 | 30,0kN 312MPa

- - - - - - - - - - - -

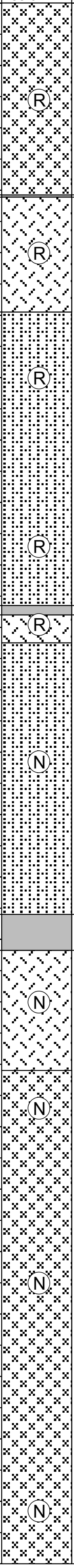
28,9kN 301MPa

Increasing ratio of porphyroblasts
Approx. 7-10% plagioclase phenocrysts < 5mm
Faint microporous flow banding
Massive continuous core

K-25
K-26

33,0 | 29,4kN 306MPa

-118.6 | 250



Core %	RQD % 10 / 30 / 50 /100
100	100/100/100/100
100	**97/94/90/74**
	$Q=\frac{97}{9}x\frac{2\text{-}3}{1\text{-}2}x\frac{1}{1}$
	Q = 10.7 - 32.1
100	98/98/98/98
100	100/100/100/0
100	**100/0/0/0**
100	98/98/98/98
100	**99/97/97/97**
100	100/96/96/96
100	100/100/100/0
100	99/99/99/33
	$Q=\frac{99}{9}x\frac{2\text{-}3}{1\text{-}2}x\frac{1}{1}$
	Q = 11 - 33
100	98/93/78/38
100	**99/95/91/42**
100	100/93/93/68
100	**83/0/0/0**
100	100/0/0/0
100	99/99/99/56
100	**95/89/80/53**
	$Q=\frac{99}{9}x\frac{2\text{-}3}{1\text{-}2}x\frac{1}{1}$
	Q = 11 - 33
100	100/94/94/94
100	100/95/95/41
100	100/100/100/0
100	**99/77/50/0**
	Q = 1,1 - 2,9
100	98/98/98/98
100	95/95/81/46
100	100/88/65/0
100	**99/90/87/58**
100	97/97/97/97
	$Q=\frac{99}{9}x\frac{2\text{-}3}{1\text{-}2}x\frac{1}{1}$
	Q = 11 - 33
100	100/98/98/98
100	100/100/100/100
100	100/100/100/100
100	100/100/100/100

GWT

Perm. (LU) 25 50 75

0.0 LU

2.8 LU

0.0 LU

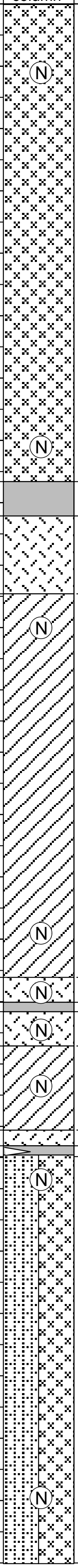
Jarðfræðistofan Ehf
JFS Geological services Ltd

Héðinsfjörður Road Tunnel
Siglufjörður
Corehole SG - 1 250 - 300 m

JFS-45 | Drwg. SG1f
Date Nov. 2000 | Page 6 of 7
Design ÁgG/WaF | Drawn WaF

Empl. VEGAGERÐIN
Coord. X: 625869.726 Y: 505069.561 Elev.: 131.37
Driller RFS | Drilled Nov. 2000

Elev. m a.s.l. | Depth m | **Description of corehole SG - 1** | Depth m | Rock column | Core % | RQD % 10 / 30 / 50 /100 | Q | GWT | Perm. (LU) 25 50 75



-118.6 250

Porphyritic basalt

Grey, very massive porphyritic basalt
Approx. 7-10% plag. phen, < 5 mm

30,6kN 319MPa

Massive continuous core

K-26
K-27

31,1

Grey, very massive porphyritic basalt
Approx. 5-8% plag. phen
Distinct microporous flow banding
Very weak N magnetisation

34,2

K-27

Well compressed and consolidated scoria in lowermost 0,2 m

K-28

-133.9

Sediment

Sandstone, dark red-brown, stratified, not waxy
Flat inclusions of scoria fragments

-135.0

Scoriaceous basalt

16,1

Well compressed and consolidated scoriaceous basalt
Vugs well filled with zeolites, continuous core

13,1kN 136MPa

-137.5

Tholeiite basalt

Very fine grained dense grey basalt
Irregular flow pattern comparable to basalt-andesite
Hard and brittle rock of high breaking strength

32,7 41,7kN 434MPa

K-28
K-29

Distinct microporous flow banding
Scattered small pores (~2%)
Pores empty or partly coated with black clay

-149.9

Scoriaceous basalt

13,6kN 142MPa

-150.8

Well compressed and consolidated, in between 0,24 m of sand / siltstone mixed with scoria, most probably layer boundary

23,8

-152.0

Tholeiite basalt

K-29
K-30

Fresh grey, fine grained tholeiitic basalt
Scattered large vesicles filled with zeolites

-154.7 286 Scoria Well compressed and consolidated scoria

-155.4 Sediment Sandstone

Uppermost part highly vesicular (~20%), vesicles well filled with zeolites

Olivine basalt - porphyritic

29,6 19,1kN 199MPa

Dark grey slightly porphyritic olivine basalt
Between 288-292 m frequent large vesicles up to 30 mm in diameter, well filled with zeolites

31,3 15,3kN 159MPa

More massive microporous basalt, large vesicles disappear
Few inclined white veins of rough joints healed with zeolites
Scattered dark veins of rough and undulating joints healed with black clay

K-30
K-31

21,5kN 224MPa

24,0

-168.6 300

Core %	RQD % 10 / 30 / 50 /100	Q
100	98/98/98/98	
100	99/82/82/36	
100	**98/95/92/79**	
100	96/92/92/92	
		$Q=\frac{98}{9}x\frac{2-3}{1-2}x\frac{1}{1}$
		Q = 10.8 - 32.4
100	95/85/85/85	
100	96/96/96/78	
100	98/98/98/0	
100	**83/50/50/0**	
100	100/88/88/88	
100	**96/90/90/45**	
100	92/92/92/0	
100	89/79/79/0	
100	**98/93/90/79**	
100	100/100/100/100	
		$Q=\frac{97}{9}x\frac{2-3}{2-3}x\frac{1}{1}$
		Q = 7.2 - 16.2
100	100/86/74/74	
100	99/99/99/99	
100	100/100/100/100	
100	**100/100/100/0**	
100	**100/100/100/0**	
100	**98/98/98/0**	
100	100/100/100/100	
100	**100/100/85/85**	
		Q = 7.0 - 15.8
100	100/100/0/0	
100	**100/100/100/0**	
93	**52/0/0/0**	
100	99/99/99/99	
100	100/100/100/75	
100	**99/93/90/77**	
100	99/99/99/99	
		$Q=\frac{99}{9}x\frac{2-3}{1-3}x\frac{1}{1}$
		Q = 7.3 - 33.0
100	99/91/91/91	
100	97/69/57/57	

Perm. (LU): 0.0 LU; 0.0 LU; 0.0 LU

Jarðfræðistofan Ehf *JFS Geological services* Ltd	**Héðinsfjörður Road Tunnel** **Siglufjörður** **Corehole SG - 1 300 - 350 m**	JFS-45 Date Nov. 2000 Design ÁgG/WaF	Drwg. SG-1g Page **7** of **7** Drawn WaF/DB
Empl. **VEGAGERÐIN**	Coord. X: 625869.726 Y: 505069 Elev.: 131.37	Driller RFS	Drilled Nov. 2000

Elev. m a.s.l.	Depth m	**Description of corehole SG - 1**	Depth m	Rock column	Core %	RQD % 10 / 30 / 50 /100 Q	GWT	Perm. (LU) 25 50 75
-168.6	300	**Olivine basalt - porphyritic** 23,8 27,6kN 287MPa	300		100	100/100/90/90		
					100	**99/93/90/77**		0.0 LU
	302	Very massive microporous rock Scattered thin and rough veins of narrow joints healed with zeolites K-31	302	Ⓝ		$Q=\frac{99}{9}x\frac{2-3}{1-3}x\frac{1}{1}$		
		K-32				***Q = 7.3 - 33.0***		
	304	33,1 27,5kN 286MPa	304		100	100/100/100/0		
-173.9		Sharp boundary (core breaks at contact)						
	306	**Basaltic dyke** 34,7 22,1kN 230MPa	306	Ⓝ	100	100/100/100/0		
		Dense fine grained basalt, grey in colour			**100**	**97/91/86/17**		
	308	Few thin joints, rough and undulating Scattered thin white veins < 1 mm of rough and undulating Joints healed with zeolites	308		100	93/93/93/41		
						$Q=\frac{97}{9-12}x\frac{2-3}{2-3}x\frac{1}{1}$		
	310	Core shows boundary between dyke and surrounding olivine basalt over one meter 30,7kN 320MPa Contact is welded but subvertical 32,4 Joints along the contact are filled/healed with zeolites	310			***Q = 5.3 - 16.1***		
	312	K-32	312	Ⓝ	100	100/83/71/0		
-181.1		**Olivine basalt - porphyritic** Medium grey, microporous basalt Welded contact to dyke K-33			100 **100** 100	100/0/0/0 **100/76/0/0** 100/92/0/0		
-182.2	314	**Basaltic dyke** Dark grey very finegrained basalt Thin white veins of healed joints	314	Ⓝ	**100**	**86/47/0/0**		
-183.8		**Olivine basalt** 26,8			100	82/0/0/0		0.0 LU
	316		316		100	89/35/0/0		
		Dense microporous olivine basalt 29,5kN 307MPa Scattered thin black veins of joints healed with black clay		Ⓝ	**100**	**88/36/14/0**		
	318	Scattered plagioclase phenocrysts Few vesicles < 10 mm, well filled with zeolites	318			$Q=\frac{86}{9}x\frac{2-3}{2-3}x\frac{1}{1}$ ***Q = 6.3 - 14.3***		
		Welded contact			100	88/54/54/0		
-188.5	320	**Basaltic dyke**	320		100	92/74/54/0		
	322	Dark grey fine grained rock mass 31,9 Scattered thin black veins of joints healed with black clay Solid continuous core	322	Ⓝ	**100**	**97/93/89/78**		
					100	100/100/100/100		
	324		324			$Q=\frac{97}{9-12}x\frac{2-3}{2-3}x\frac{1}{1}$		
		33,4				***Q = 5.3 - 16.1***		
	326	23,4kN 244MPa	326	Ⓝ	100	99/99/99/99		
-196.8	328	Welded boundary	328		100	90/90/90/90		
		Porphyritic basalt						
		Medium grey medium grained basalt with porphyroblasts 28,5 21,2kN 221MPa		Ⓝ	**100**	**99/48/29/0**		
-199.3	330	Approx. 10-15% plagioclase phenocrysts	330					
		Bottom of Hole at 330,7 m						
	332		332					
	334		334					
	336		336					
	338		338					
	340		340					
	342		342					
	344		344					
	346		346					
	348		348					
	350		350					

Jarðfræðistofan Ehf
JFS Geological services Ltd

Héðinsfjörður Road Tunnel
Héðinsfjörður
Corehole HG - 1 0 - 50 m

JFS-45	Drwg. HG1a		
Date Sept. 2000	Page 1 of 7		
Design ÁgG/WaF	Drawn DB/WaF		
Driller RFS	Drilled August 2000		

Empl. VEGAGERÐIN | Coord. X: 622465.59 Y: 508608.38 | Elev.: 126.27

Elev. m a.s.l. | Depth m

Description of corehole HG - 1

126.27 — 0

Overburden

Steep slope with debris at surface. Angular and subrounded stones in a sandy - silty matrix (debris)

Percussion drilling down to 15,85 m
No core recovery

NQ drilling rods, triple tube

Debris, in the lower part (down from approx. 7 m) morainic material with high content of silt and clay

Glacial - subglacial moraine, visible in nearby outcrops, > 8 m thickness
Basaltic pebbles angular to subrounded in shape in sandy / silty matrix (percussion drilling)

Below 15,85 m short stumps of well cut basaltic pebbles (app. 0,1 m in length) in addition smaller eroded basaltic stones
Low core recovery. Stones of different basaltic rocks

110.0 — 16

Moraine - Rock glacier sediment

Well cut stumps, up to 0,15 m long, mainly dense basalt

Up to 0,3 m well cut stones, consolidated till
Eroded basaltic stones of redd., slightly scoriaceous porphyritic basalt

102.9

Porphyritic basalt

Reddish-brown, rather large vesicles 10 - 15 %, mainly filled with chalcedony and some calcite

16,0
10,6kN
110MPa

Continuous vesicular basalt, reddish-brown colour

Decreasing vesicles in grey porphyritic basalt
5 - 7 % vesicles, filled with chalcedony

K-1
K-2

Massive porphyritic basalt, vesicles almost absent
Plagioclase phenocrysts approx. 12 - 15 %, < 3 - 4 mm
Scattered inclined joints, rough and undulating, coated with black clay

29,9 25,6kN 267MPa

Weak R-magnetization

87.9 — 38

Sediment Reddish, strat. Sdst. ~ 0,1 m with scoria-fragments, low strength

Scoriaceous basalt

K-2
K-3

Well consolidated, reddish-brown rock mass
Slight infiltrations of brownish sandstone in topmost 0,2 m
Vugs well filled with zeolites

Group of inclined joints, rough and undulating, very thin black clay coatings,
0,2 m Scoria at bottom, breaks due to low strength

25,6 14,5kN 151MPa

82.5 — 44

Olivine basalt - porphyritic

Massive basalt with faint micropore flow banding

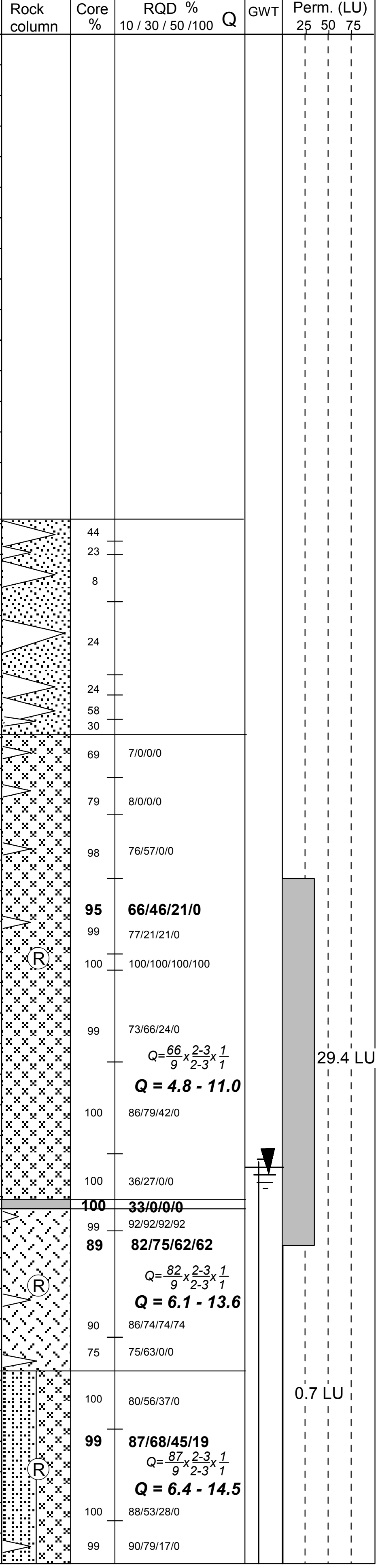
Approx. 10 % plagioclase phenocrysts < 3 - 4 mm
Scattered inclined joints, rough and undulating, coated with black clay

Very uniform microporous basalt

40,2
24,2kN
252MPa

K-3
K-4

76.2 — 50



Jarðfræðistofan Ehf JFS Geological services Ltd	**Héðinsfjörður Road Tunnel** **Héðinsfjörður** **Corehole HG - 1 50 - 100 m**	JFS-45	Drwg. HG1b
		Date Sept. 2000	Page 2 of 7
		Design ÁgG/WaF	Drawn DB/WaF
Empl. VEGAGERÐIN	Coord. X: 622465.59 Y: 508608.38 Elev.: 126.27	Driller RFS	Drilled August 2000

Description of corehole HG - 1

Elev. m a.s.l. 76.2 — Depth 50 m

Olivine basalt - porphyritic

Microporous, faint micropore flow banding in a continuous very solid rock mass
Few inclined joints, rough and undulating

33,8 — 28,7kN 299MPa

Plagioclase phenocrysts varying between 5 - 10 %, < 4 mm
Small pyroxene inclusions

K-4 / K-5

Few, very thin veins of joints healed with thin black clay and zeolites

31,9 — 19,8kN 206MPa

Olivine basalt with evenly, distributed plagioclase phenocrysts < 5 - 7 %

Few thin black veins of healed joints

K-5 / K-6

Some thin black and white veins of healed joint pattern
Some of the joints opens during drilling

34,6

Increasing vesicles up to 3 - 5 % in the lower part
Scoriaceous material in the lowest 0,2 m

48.8 — **Sandstone** Light red, uniform sandstone, not waxy — 16,6kN 173MPa — K-6 / K-7

Scoriaceous basalt

Very few joints, well consolidated, almost continous rock mass
Small vesicles approx. 10 - 15 %, half filled and filled with zeolites and dark green clay

16,8kN 175MPa
28,0

43.8 — **Olivine basalt - porphyritic**

32,7 — 15,4kN 160MPa

Approx. 5 - 10 % plagioclase phenocrysts < 5 mm
Few inclined joints, rough and undulating, filled with zeolites
Thin irregular vein pattern of rough healed joints, healed with black clay

39.8 — **Scoria**

K-7 / K-8

28,4 — 15,6kN 162MPa

Reddish- brown, well compressed and consolidated
Continuous core of moderate strength
Vesicular, all vesicles filled with zeolites

37.0 — **Olivine basalt**

5 - 7 % small plagioclase phenocrysts, subvertical joint pattern, healed with black clay cementing the core over 0,4 m
Below only scattered thin black vein pattern

Black joint pattern disappearing below 92,8 m

32.6 — **Scoria - scoriaceous basalt**

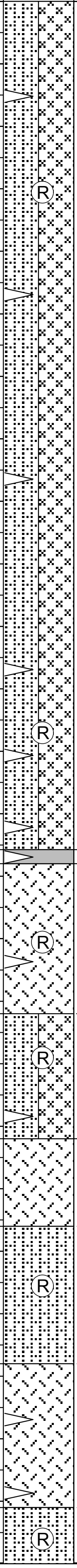
18,4

Well compressed and consolidated
All former vugs filled with white secundary minerals (zeolites)
Very massive scoriaceous basalt

K-8 / K-9 — 7,6kN 79MPa

28.0 — **Olivine basalt** Coarse grained, dark compound flows
Vesicles at top, well filled with black and green clay and zeolites

26.2 — Depth 100 m



Core %	RQD % 10 / 30 / 50 /100	Q
99	90/79/17/0	
99	93/78/78/49	
100	99/90//81/81	
		$Q=\frac{87}{9}x\frac{2-3}{2-3}x\frac{1}{1}$
		Q = 6.4 - 14.5
99	90/72/64/0	
99	**87/68/45/19**	
100	96/71/41/0	
98	92/54/41/0	
100	100/96/83/0	
98	73/66/22/0	
98	77/54/18/0	
98	52/20/0/0	
78	**56/0/0/0**	
100	91/37/0/0	
99	**88/74/50/26**	
		$Q=\frac{88}{9}x\frac{2-3}{2-3}x\frac{1}{1}$
		Q = 6.5 - 14.6
98	87/87/60/41	
100	86/73/73/0	
100	87/37/37/0	
97	**87/55/43/0**	
		$Q=\frac{87}{9}x\frac{2-3}{2-3}x\frac{1}{1}$
		Q = 6.4 - 14.5
94	87/78/51/0	
100	100/75/45/0	
		Q = 4.8 - 14.5
100	**88/64/19/0**	
100	79/56/0/0	
100	94/58/36/0	
		$Q=\frac{97}{9}x\frac{2-3}{2-3}x\frac{1}{1}$
		Q = 7.2 - 16.6
100	**97/59/41/0**	
100	98/59/44/0	
99	93/85/85/0	
		$Q=\frac{91}{9}x\frac{2-3}{2-3}x\frac{1}{1}$
		Q = 6.7 - 15.2
96	**91/85/67/0**	
91	86/86/34/0	
100	94/56/56/0	
100	**93/56/43/0**	
100	92/55/31/0	

GWT

Perm. (LU) 25 50 75

0.7 LU

3.5 LU

0.3 LU

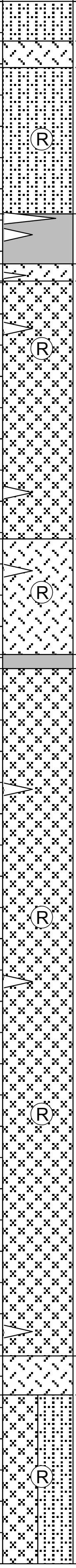
Jarðfræðistofan Ehf
JFS Geological services Ltd

Héðinsfjörður Road Tunnel
Héðinsfjörður
Corehole HG - 1 100 - 150 m

JFS-45
Drwg. HG1c
Date Sept. 2000
Page 3 of 7
Design ÁgG/WaF
Drawn WaF/DB

Empl. VEGAGERÐIN
Coord. X: 622465.59 Y: 508608.38
Elev.: 126.27
Driller RFS
Drilled August 2000

Description of corehole HG - 1



Elev. m a.s.l.	Depth m	Description of corehole HG - 1	Core %	RQD % 10 / 30 / 50 /100	Q	Perm. (LU) 25 50 75
26.2	100	**Olivine basalt** Mikroporous, massive basalt, micropores filled with black clay.	100	92/55/31/0		
24.9		-8,5kN 89MPa				
		Scoria Vesicul., well cons., all vesic. fill. with black clay and zeolites.	**100**	**87/66/0/0**		
24.1	102	25,5				
		Olivine basalt	100	67/0/0/0		
		Dark grey, massive rock.	100	95/80/48/0	$Q=\frac{90}{9}x\frac{2-3}{2-3}x\frac{1}{1}$	
	104	Micropores filled with black clay. 29,1			***Q = 6.6 - 15.0***	
		Few larger vesicles filled with zeolites. 15,3kN 159MPa K- 9	**100**	**90/53/32/0**		
	106	K-10	100	88/0/0/0		
19.4			49	0/0/0/0	$Q=\frac{10}{12}x\frac{1-1.5}{3-4}x\frac{1}{2,5}$	
		Sediment Dark green, silty sandstone. Waxy surface of tuffaceous sediment, apparently of low breaking strength	**74**	**0/0/0/0**		
			84	0/0/0/0		
	108		100	0/0/0/0	***Q = 0,1 - 0,2***	
17.8			**98**	**98/98/98/98**		
17.2		**Porphyritic basalt** 26,5 -5,9kN 61MPa	96	96/83/46/0		
	110		**97**	**96/85/58/23**		7.3 LU
		Massive porphyritic basalt Approx. 15-20% plagioclase phenocrysts, < 5 mm				
	112	Few vesicles (1%), empty Continuous core 32,4 27,3kN 284MPa			$Q=\frac{96}{9}x\frac{2-3}{1-2}x\frac{1}{1}$	
	114				***Q = 10.6 - 32.0***	
		K-10	99	96/87/78/61		
	116	K-11				
9.0			98	98/90/70/0		
	118	**Scoriaceous basalt** Few large vugs, well filled with zeolites	**99**	**99/92/59/0**	$Q=\frac{99}{9}x\frac{2-3}{1-2}x\frac{1}{1}$	
	120				***Q = 11.0 - 33.0***	
			100	100/100/0/0		
5.0		**Sediment** Reddish-brown sandstone, not waxy 3,7kN 39MPa	**100**	**73/73/0/0**		
	122	Mix of scoria and sandstone 0,2 m	100	99/59/25/0		
		Porphyritic basalt				
	124	Vesicular in the upper part, down to 125 m Scattered vesicles are empty, but most are filled with zeolites				
		K-11 K-12	98	95/95/83/64		
	126	Decreasing vesicles				
		Massive porphyritic basalt				
	128	Approx. 15 - 20 % plagioclase phenocrysts < 5 mm Very massive rock yielding, continuous core	100	94/90/81/33		
		24,5kN 25,3 255MPa	**100**	**98/93/78/57**		
	130	Only few scattered inclined joints, rough and undulating, coated with dark green clay and zeolites	99	99/99/83/83		
	132				$Q=\frac{98}{9}x\frac{2-3}{1-2}x\frac{1}{1}$	0.0 LU
	134	Very massive rock yielding continuous core			***Q = 10.8 - 32.6***	
		K-12 K-13	100	100/100/100/78		
	136					
			100	100/100/85/85		
	138	- - - - - - - - - - -				
		Plagioclase phenocrysts decrease seriously in a massive dark grey basalt Very few original joints, rough and undulating, coated with black clay				
	140		100	100/100/75/75		
		28,3kN 34,6 295MPa				
	142		99	97/97/79/0		
		Increasing amount of plagioclase phenocrysts at base				
-17.2		20,8 12,4kN 129MPa				
	144	**Scoria** Reddish-brown sandstone 5 cm Well consolidated scoriaceous basalt K-13	**100**	**83/66/40/0**		
-18.4		**Olivine basalt** K-14				
	146	Scattered plagioclase phenocrysts ~5 %	100	99/75/64/45		2.6 LU
		Few inclined joints, rough and undulating, thin fillings, some of them form thin white veins	**100**	**98/84/72/47**		
	148	Frequent micropore flowbanding	100	97/71/42/0		
-23.7	150					

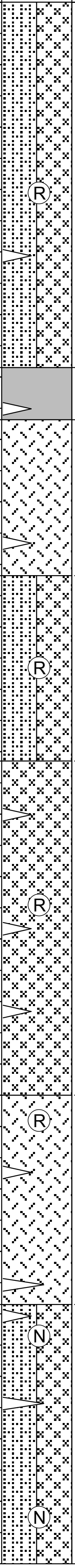
Jarðfræðistofan Ehf
JFS Geological services Ltd

Héðinsfjörður Road Tunnel
Héðinsfjörður
Corehole HG - 1 150 - 200 m

JFS-45 | Drwg. HG1d
Date Sept. 2000 | Page 4 of 7
Design ÁgG/WaF | Drawn DB/WaF

Empl. VEGAGERÐIN | Coord. X: 622465.59 Y: 508608.38 | Elev.: 126.27 | Driller RFS | Drilled August 2000

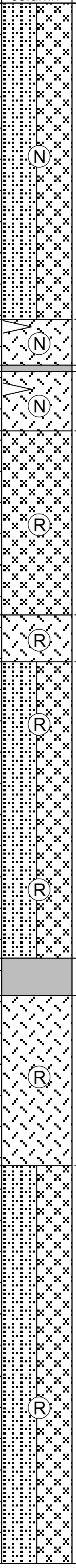
Description of corehole HG - 1



Elev. m a.s.l.	Depth m	Description of corehole HG - 1		Core %	RQD % 10 / 30 / 50 /100	Q	Perm. (LU) 25 50 75
-23.7	150	**Olivine basalt - porphyritic**	32,2				
	152	3 - 5 % plagioclase phenocrysts < 5 mm.	27,8kN 289MPa	100	94/92/70/40		
		Intense micropore flowbanding, but no breakage at micropore bands	K-14 K-15				
	154			100	100/100/90/41		
			32,0	**100**	**98/84/72/47**		
	156		29,3kN 305MPa			$Q=\frac{96}{9}x\frac{2-3}{1-2}x\frac{1}{1}$	
						Q = 10.6 - 32.0	
	158	Very massive basalt with frequent micropore flow banding, medium grey rock		98	98/91/91/91		2.6 LU
	160			100	100/73/73/73		
-35.5			8kN 83MPa				
	162	**Sandstone**		100	80/58/38/0	$Q=\frac{69}{9}x\frac{1-2}{3-4}x\frac{1}{2,5}$	
		Red waxy sandstone with small basalt fragments at 162,0 m.	3,4kN 35MPa	**96**	**69/35/23/0**		
-37.2			K-15	92	35/0/0/0	***Q = 0,8 - 2***	
	164	**Scoriaceous basalt**	K-16	100	98/88/42/0		
		Very massive continuous rock yielding continuous core		**98**	**98/93/86/75**		
	166	All vugs filled with zeolites				$Q=\frac{98}{9}x\frac{2-3}{2}x\frac{1}{1}$	
						Q = 10.8 - 16.3	
-42.2	168		31,6 14,4kN 150MPa	97	97/97/97/97		
		Olivine basalt - porphyritic		100	100/100/86/86		
	170	Grey, few scattered large vesicles well filled with zeolites		**100**	**100/100/93/93**		
		Small plagioclase phenocrysts ~ 3 - 5 %				$Q=\frac{100}{9}x\frac{2-3}{1-2}x\frac{1}{1}$	
		Very few original joints	38,2 35,4kN 369MPa				
	172					***Q = 11.1 - 33.3***	
		Massive, porphyritic basalt Plagioclase phenocrysts ~ 10 % < 5 mm		100	100/100/100/100		
-48.1	174		K-16 K-17				
		Sudden increase in plagioclase crystals					
		Porphyritic basalt					
	176			98	98/98/98/72		
		10 - 15 % plagioclase phenocrysts < 4 - 5 mm Slightly microporous, micropores form irregular flowbanding	31,8kN 331MPa				
	178	Very few joints, inclined as well as horizontal, planes rough and undulating, coated with black clay		99	97/90/78/0		
		Small vesicles filled with black clay and zeolites, no open vugs		**97**	**96/90/82/35**		
	180	Occasional white veins of thin joints, healed with zeolites	32,9			$Q=\frac{96}{9}x\frac{2-3}{1-2}x\frac{1}{1}$	
						Q = 10.6 - 32.0	
	182		K-17	92	92/75/62/0		0.0 LU
			K-18				
	184			100	100/100/100/100		
-58.8		**Scoria**					
	186			100	100/100/100/100		
		Massive scoriaceous basalt, well compressed and consolidated		93	93/93/93/92		
		Vugs filled with zeolites, few open vesicles coated with green-blue clay		**87**	**87/87/87/87**		
	188	Most probably lower boundary	21,3			$Q=\frac{87}{9}x\frac{2-3}{1-2}x\frac{1}{1}$	
		Sandstone infiltrations in the scoria	7,9kN 82MPa				
	190	Well cemented and consolidated scoriaceous basalt				***Q = 9.6 - 32.0***	
		Continuous core	34,6	70	70/70/70/70		
		Almost all vesicles and vugs are filled with zeolites					
-68.5	192	**Olivine basalt - porphyritic**		96	96/96/96/96		
			K-18	100	100/100/100/100		
	194	Scattered plagioclase phenocrysts	K-19				
		Rather fine grained basalt, dispersed micropores filled with black clay		65	59/59/59/59		
		Additional scattered pores filled with zeolites				$Q=\frac{95}{9}x\frac{2-3}{1-2}x\frac{1}{1}$	
	196	Amount of plagioclase phenocrysts ~ 3 - 5 %, < 5 mm				***Q = 10.5 - 31.6***	
		Faint microporous flow banding					
		Very few joints - massive basalt yielding almost continuous core	33,1	**97**	**95/88/82/56**		0.0 LU
	198	Scattered vesicles filled with zeolites	33,4kN 348MPa	100	100/100/100/100		
-73.8	200			100	100/100/100/100		

Jarðfræðistofan Ehf JFS Geological services Ltd	**Héðinsfjörður Road Tunnel** **Héðinsfjörður** **Corehole HG - 1 200 - 250 m**	JFS-45	Drwg. HG1e
		Date Sept. 2000	Page **5** of **7**
		Design ÁgG/WaF	Drawn DB/WaF
Empl. **VEGAGERÐIN**	Coord. X: 622465.59 Y: 508608.38 Elev.: 126.27	Driller RFS	Drilled August 2000

Description of corehole HG - 1



Elev. m a.s.l.	Depth m	Description of corehole HG - 1	Core %	RQD % 10 / 30 / 50 /100	Q	GWT	Perm. (LU) 25 50 75
-73.8	200	**Olivine basalt - porphyritic** Plagioclase phenocrysts varying between 3 - 10 % K-19 / K-20 Faint micropore flow banding Dense basalt of rather high specific weight Scattered inclined joints, rough and undulating, coated with black clay Also inclined thin veins of joints healed with black clay and zeolites 34,7 26kN 271MPa	100 100 **97** 100 100	100/100/100/100 100/96/84/37 **95/88/82/56** 100/95/69/0 85/50/23/0	$Q=\frac{95}{9}x\frac{2-3}{1-2}x\frac{1}{1}$ ***Q = 10.5 - 31.6***		0.0 LU
-83.9	210	**Scoriaceous basalt** Well consolidated, continuous core All vugs filled with zeolites 7,5kN 78MPa	96 **99** 100	96/96/0/0 **99/99/68/0** 100/100/100/0			
-85.5		**Sediment** Red sandstone, not waxy K-20	**100**	**100/0/0/0**	$Q=\frac{96}{9}x\frac{2-3}{2-4}x\frac{1}{1}$ ***Q = 5.3 - 16.0***		
	212	**Scoriaceous basalt** 24,0 13,5kN 141MPa K-21 Massive, well consolidated rock yielding continuous core. No clear markline	**93**	**93/93/93/93**			
-87.5	214	**Porphyritic basalt** 15 - 20 % plagioclase phenocrysts < 4 mm Small vesicles filled with black clay and zeolites Dispersed inclined vein pattern of healed joints indicating stress zone Healed joints, joint surfaces rough and undulating, coated and cemented with black clay 26,3 13,5kN 141MPa Vugs well filled	100 **100** 100	100/81/73/54 **98/81/62/26** 97/81/51/0	$Q=\frac{98}{9}x\frac{2-3}{1-2}x\frac{1}{1}$ ***Q = 10.8 - 32.6***		
-93.9	220	**Scoria - Scoriaceous basalt** Well consolidated, massive core in lower part. Breaks up in the uppermost 0,6 m due to low strength 11,7	**100**	**69/52/52/0**			
-94.9	222	**Olivine basalt - porphyritic** K-21 / K-22 Massive basalt with few scattered joints Approx. 5 - 7 % plagioclase phenocrysts < 4 mm Thin black vein pattern of dispersed joints Small pores 2 - 4 %, filled with black clay Subvertical vein 2 - 3 mm wide, healed with zeolites at 229,0 m Scoriaceous basalt in the lowest 0,3 m 4,9kN 51MPa	100 100 **100** 100 100	81/57/0/0 100/100/100/75 **95/89/80/53** 99/99/99/50 93/85/80/63	$Q=\frac{92}{9}x\frac{2-3}{1-3}x\frac{1}{1}$ ***Q = 6.8 - 30.6***		
-104.4	230	**Sediment** Sandstone, tuff., reddish-brown to greenish-brown, waxy K-22 Disintegrates partly during drilling 3,9kN 41MPa K-23	100 **100** 100	100/100/100/0 **73/42/42/0** 54/0/0/0	$Q=\frac{73}{9}x\frac{1-1.5}{3-4}x\frac{1}{2,5}$ ***Q = 0,8 - 1,6***		
-105.6	232	**Scoria - Scoriaceous basalt** 20,7 Very well compressed and consolidated mix of scoriaceous zones and basalt Continuous massive uniform core All vugs filled with zeolites and very well cemented	100 **100** 100	96/96/96/96 **98/97/97/44** 100/97/97/0	$Q=\frac{98}{9}x\frac{2-3}{1-3}x\frac{1}{1}$ ***Q = 7.2 - 32.6***		0.0 LU
-111.1	238	**Olivine basalt - porphyritic** Scattered plagioclase phenocrysts 3 - 6 % < 4 mm Scattered vesicles filled with zeolites Micropore flow banding, but no cleavage at micropore bands Dense massive basalt of rather high specific weight K-23 / K-24 Frequent but faint micropores in zones 31,8 32kN 333MPa	100 100 100 **100** 100 100 100	100/0/0/0 96/95/82/0 100/94/94/70 **99/90/87/58** 100/86/86/59 97/85/85/85 100/93/93/93	$Q=\frac{99}{9}x\frac{2-3}{1-2}x\frac{1}{1}$ ***Q = 11.0 - 33.0***		
-123.8	250						

Jarðfræðistofan Ehf
JFS Geological services Ltd

Héðinsfjörður Road Tunnel
Héðinsfjörður
Corehole HG - 1 250 - 300 m

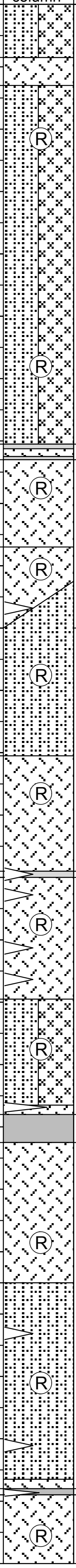
JFS-45 | Drwg. HG1f
Date Sept. 2000 | Page 6 of 7
Design ÁgG/WaF | Drawn WaF

Empl. **VEGAGERÐIN** | Coord. X: 622465.59 Y: 508608.38 | Elev.: 126.27 | Driller RFS | Drilled August 2000

Description of corehole HG - 1

Elev. m a.s.l.	Depth m	Description of corehole HG - 1		Core %	RQD % 10 / 30 / 50 /100	Q	GWT	Perm. (LU) 25 50 75
-123.8	250	Olivine basalt- porphyritic Large vesicles coated with crystals of stilbite and small tomsonite	K-24 K-25 24,2	100	100/93/93/93			
-125.5	252	Scoria Well compressed and consolidated, with waxy sandst.-infiltr.	10,3kN 107MPa	**100**	**91/78/0/0**			
-126.4	254	Olivine basalt - porphyritic Massive microporous basalt, medium grained Scattered vesicles, 2 - 5%, in zones Vesicles filled or coated with dark green and black clay or zeolites Many large vesicles filled with mordenite Scattered inclined joints, filled and healed with brown tuffaceous sandst. and hardened dark clay Massive and microporous Olivine basalt with varying amount of plagioclase phenocrysts, 2 - 5 %	30,6 19,2kN 200MPa K-25 K-26	100 100 **100** 100 100	97/97/72/72 100/100/83/0 **97/93/89/67** 100/97/70/70 98/98/98/98	$Q=\frac{96}{9}x\frac{2-3}{1-2}x\frac{1}{1}$ ***Q = 10.6 - 31.8***		0.0 LU
-138.1	264	Sediment Sediment mixed with scoria, green clay in sediment		**100**	**100/76/0/0**			
	266	Scoriaceous basalt Well compressed and consolidated scoriaceous basalt		100 **100** 100	100/100/100/100 **96/91/85/85** 100/79/9/79			
-141.2	268	Scoria - scoriaceous basalt Vesicular scoriac. basalt, most vesicles filled with zeolites and milky calcite Healed inclined joints forming rock of sufficient strength	9,9kN 18,6 103MPa K-26	94	91/91/77/77	$Q=\frac{96}{9}x\frac{2-3}{2-3}x\frac{1}{1}$ ***Q = 7.1 - 16.0***		
-143.8	270	Olivine basalt Massive olivine basalt, sligthly flow banded and vesicular in upper part Vesicles in the upper part > 5 - 7 mm, filled with zeolites Scattered joints, rough and undulating Very homogenous and dense rock in the lower part, yielding continuous core	K-27 26,2kN 273MPa 39,0	100 **100** 100 100	100/100/100/0 **100/100/100/85** 100/100/100/100 100/100/100/100	$Q=\frac{100}{9}x\frac{2-3}{1-2}x\frac{1}{1}$ ***Q = 11.1 - 33.3***		
-147.9	274	Scoria - scoriaceous basalt Well consolidated, vesicles coated and some filled with calcite Some large open vesicles	20,4kN 212MPa	100 **100** 100	98/87/87/0 **98/75/75/0** 98/52/52/0	$Q=\frac{89}{9}x\frac{1-3}{2-3}x\frac{1}{1}$		
-152.2	278	Sediment 0,2 m of stratified red-brown sandstone		**80**	**65/0/0/0**			
		Scoriaceous basalt Well consolidated scoriaceous basalt with green sandstone infiltrations Vesicles up to 10 mm, filled with zeolites, some open vesicles Highly porous scoria, pores filled with zeolites	K-27 K-28 6,4kN 67MPa	84 **90** 98 89	79/79/31/0 **81/81/47/0** 84/84/64/0 80/80/52/0	***Q = 3.3 - 14.8***		
-155.7	282	Olivine basalt - porphyritic Scattered plagioclase phenocrysts (2 - 3 %) < 3 mm Up to 20 mm large vesicles filled with zeolites in the central part between 282,5 and 283,0 m. Massive rock, scoriaceous at bottom		100 **99** 100 70	100/100/100/0 **95/95/95/76** 97/97/97/97 0/0/0/0	$Q=\frac{95}{9}x\frac{2-3}{1-2}x\frac{1}{1}$ ***Q = 11 - 32***		
-159.4	286	Sediment Red-brown waxy sandstone with green infiltrations Breaks during drilling in the lower part	5,1kN 53MPa	**100**	**55/55/0/0**			0.0 LU
-160.3	288	Scoriaceous basalt 5 - 7 % vesicles < 3 - 4 mm filled with zeolites Scattered plagioclase phenocrysts < 2 - 3 mm Massive rock yielding continuous core Fragments of porphyritic basalt up to 0,25 m large Vesicles and pores filled with zeolites, massive rock	K-28 K-29 4,8kN 50MPa	100 **100** 100 100	98/98/98/98 **95/95/85/46** 99/99/99/0 89/89/58/0	$Q=\frac{95}{9}x\frac{2-3}{1-3}x\frac{1}{1}$ ***Q = 7.0 - 15.8***		
-164.8	292	Olivine basalt Porphyritic basalt with scattered plagioclase phenocrysts < 2 - 3 mm Large vesicles up to 20 mm filled with zeolites Scattered smaller vesicles filled with black clay Few, scattered inclined joints Scoriaceous in the lowest 0,3 m	28,6kN 298MPa 33,0	100 99 **98** 97	100/100/100/0 93/93/93/93 **91/91/84/42** 87/87/71/0	$Q=\frac{91}{9}x\frac{2-3}{1-2}x\frac{1}{1}$ ***Q = 10.1 - 30.3***		
-171.5	298	Sediment Reddish, not waxy sandstone		**85**	**85/0/0/0**			
		Scoriaceous basalt Well consolidated, red, dense scoria with zeolite fillings (< 5 mm) in pores. Continuous massive core	11,1kN 116MPa K-29 K-30	**100**	**100/100/100/84**			
-173.8	300							

Rock column



Jarðfræðistofan Ehf JFS Geological services Ltd	**Héðinsfjörður Road Tunnel** **Héðinsfjörður** **Corehole HG - 1 300 - 350 m**	JFS-45 Date Sept. 2000 Design ÁgG/WaF	Drwg. HG1g Page 7 of 7 Drawn WaF
Empl. **VEGAGERÐIN**	Coord. X: 622465.59 Y: 508608.38 Elev.: 126.27	Driller RFS	Drilled August 2000

Elev. m a.s.l. | Depth m | Rock column | Core % | RQD % 10 / 30 / 50 /100 Q | GWT | Perm. (LU) 25 50 75

Description of corehole HG - 1

-173.8 — 300 — Scoriaceous basalt with plag. phen. (3 - 5 %) and zeolites in lowermost part

-174.4

Olivine basalt - porphyritic

302 — Solid, dense basalt forming rock of high strength
Approx. 5 - 7 % plagioclase phenocrysts < 2 - 3 mm in upper part
Large vesicles (< 15 mm) filled with zeolites (mordenite)
304 — Scattered inclined and horizontal joints, rough and undulating

Dense basalt of high specific weight
306 — Dispersed faint micropore spots

43,5
39kN 406MPa K-30 K-31
308 — Increasing amount of plagioclase phenocrysts in the lower part

Increasing amount of inclined, mostly closed joints healed with zeolites
310 — Open joints, rough and undulating, empty (fresh)
Scattered few vesicles filled with zeolites — 34,4
Micropores form distinct flow banding

312 — 12kN 125MPa

-186.9 — **Scoria** Well consolidated, pores well filled with zeolites — 30,3

-187.1 — 40 mm of red sandstone, boundary between units

314 — **Scoria - scoriaceous basalt** Red-brown, ~ 10 - 15 % — 18,8kN 196MPa
vesicles < 10 mm, well filled with zeolites and partly with clay

-189.4 — 316 — **Olivine basalt - porphyritic**
Approx. 3 - 5 % plagioclase phenocrysts < 3 - 4 mm
Scattered inclined joints, rough and undulating, — K-31
318 — partly healed with zeolites — K-32
Micropores form distinct flow banding in lowermost part

-193.0 — **Scoriaceous basalt** Ves. filled with zeolites, scattered inclined joints

-193.6 — 320 — **Scoriaceous basalt** 1 - 2 cm red sandstone — 12,2 — 4,7kN 49MPa
Reddish brown, well compressed and consolidated.
Vesicles and pores well filled with zeolites.
322 — Scattered joints in upper 0,5 m.

-196.2 — **Olivine basalt - porphyritic**
324 — Approx. 3 - 5 % plagioclase phenocrysts < 2 - 3 mm — 13,5kN
Vesicles 5 - 10 % filled with black clay and zeolites — 29,6 141MPa
Scattered few horizontal and inclined joints, healed with black clay
326 — Scoriaceous in lowermost 0,5 m

-200.1 — **Scoria** Grey-red-brown, well compr. and cons., large vugs, filled with zeolites

Olivine basalt - porphyritic — K-32 K-33
328 — Porous-vesicular basalt with approx. 2 - 3% plagioclase phenocrysts < 2 mm
Few small vesicles (< 3 - 5 mm), filled with zeolites
330 — Scattered inclined and horizontal joints, rough and undulating, empty
Scattered thin white veins of joints, healed with zeolites

332

334 — Inclined joints healed with zeolite and/or calcite
Open joints rough and undulating, empty (fresh)

336 — 36,2 — 30,8kN 320MPa — K-33 K-34
Microporous olivine basalt, micropore flow banding

338 — 32,4 — 29,7kN 309MPa

Overall very massive basalt
340 — Yielding almost continuous rock with thin white veins of healed joints

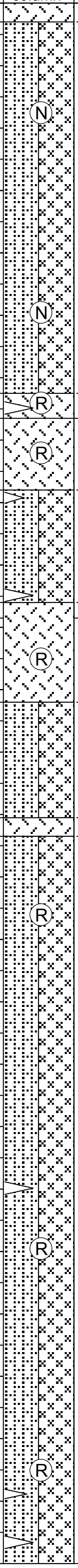
342

344

346 — 36,9 — 9,4kN 98MPa — K-34 K-35

348

Dense joint pattern
-223.8 — 350 — Bottom at 350,2 m



Core %	RQD % 10 / 30 / 50 /100	Q
100	**100/100/100/84**	
100	96/79/69/41	
100	99/99/99/99	
100	**93/87/67/55**	$Q=\frac{95}{9}x\frac{2-3}{1-3}x\frac{1}{1}$ ***Q = 7.0 - 31.6***
100	92/90/78/78	
100	87/81/19/0	
88	**88/75/75/0**	
100	**100/100/85/47**	$Q=\frac{97}{9}x\frac{2-3}{1-2}x\frac{1}{1}$ ***Q = 10.7 - 32.3***
99	99/72/72/0	
98	**98/76/76/0**	
95	95/95/95/0	
100	**30/0/0/0**	
100	98/77/77/0	
100	**98/83/83/0**	
100	99/99/99/0	
		$Q=\frac{93}{9}x\frac{2-3}{2-3}x\frac{1}{1}$ ***Q = 6.8 - 15.5***
100	100/100/82/0	
100	**100/100/89/41**	
100	100/100/100/100	
100	**75/0/0/0**	
100	100/100/100/0	
100	99/99/99/99	
100	100/100/100/84	
100	90/75/49/0	
99	**91/82/64/43**	
96	77/57/0/0	
		$Q=\frac{91}{9}x\frac{2-3}{1-2}x\frac{1}{1}$ ***Q = 10.1 - 30.3***
100	96/64/51/0	
100	98/98/98/98	
98	91/91/77/56	
91	64/51/0/0	

Perm. (LU): 0.0 LU (306 m); 0.0 LU (328 m)

Jarðfræðistofan Ehf
JFS Geological services Ltd

Héðinsfjörður Road Tunnel
Héðinsfjörður
Corehole HG - 2 0 - 50 m

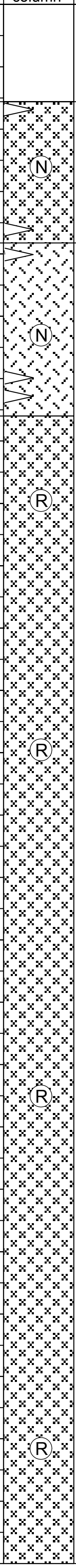
JFS-45		Drwg.	HG2a
Date	Sept. 2000	Page **1** of **5**	
Design	ÁgG/WaF	Drawn	WaF/DB
Driller	RFS	Drilled	Sept. 2000

Empl. **VEGAGERÐIN** Coord. X: 622895.58 Y: 508115.36 Elev.: 99.04

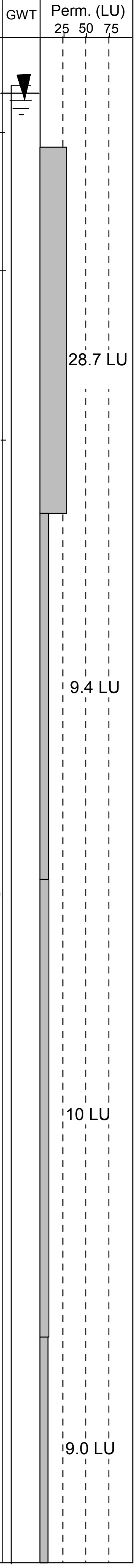
Description of corehole HG - 2

Elev. m a.s.l.	Depth m	Description
99.04	0	Overburden NQ drilling rods, triple tube
		Percussion drilling down to 3,12 m; no core recovery
	2	Uppermost 0,3 m debris, below bedrock
		Hole cemented and 4" steel casing down to 3,12 m
95.9		Porphyritic basalt
	4	Approx. 7-10% plagioclase phenocrysts < 2 - 3 mm,
		Microporous with scattered flow banding
		Large vesicles filled with zeolite (10 mm dm) at 3,5 m depth and
	6	(40 mm dm) at 4,5 m depth. Massive basalt
		Inclined joints, rough and undulating, coated with black clay
		Lower boundary formed by 3 cm of reddish-grey stratified sandstone
91.4	8	Scoria
		Well compressed and consolidated red scoria (10,2kN 106MPa)
		yielding continuous core with large (0,1m) compressed (28,0)
	10	basalt fragments in the uppermost part
		Pores and vugs filled with zeolites
		Scoriaceous basalt, vugs filled with zeolites, well cemented joints
	12	K-1
		Well consolidated and compressed scoria, pores filled with zeolites K-2
85.8		
	14	Porphyritic basalt
		Rather coarse grained massive basalt of olivine basalt character
		Approx. 7 - 10 % plagioclase phenocrysts < 2 - 4 mm
	16	Scattered horizontal and inclined joints
		rough and undulating, coated with clay and zeolites
		Plag. phen. increase to 10 - 15% below 16 m,
	28	more obvious porphyritic basalt
		Micropores form distinct flow banding
		Hard and brittle rock (33,0 24,1kN 251MPa)
	20	
		Very massive, microporous basalt
		K-2
	22	K-3
	24	Very massive basalt, approx. 7 - 10 % plagioclase phenocrysts < 2-4 mm
		Scattered horizontal and inclined joints, rough and undulating,
		coated with clay and zeolites;
	26	Massive, microporous rock of high breaking strength
	28	
	30	(30,1 23,7kN 247MPa)
		K-3
	32	K-4
		Inclined joint, rough and undulating, filled/healed with zeolites, breaks during handling
	34	Elsewhere the core is very massive and continuous
	36	(24,7kN 257MPa)
		Increasing amount of plagioclase phenocrysts (>10%)
		including small pyroxene crystalls
	38	
	40	
		K-4
	42	K-5
		Vertical joints, rough and undulating, coated with thin black clay or
	44	partly healed with zeolites
		Scattered joints in the lower part of the basalt,
		subvertical and steeply inclined
	46	The joints are rough, undulating, coated with thin grey
		and brownish clay (32,3 30,2kN 314MPa)
	48	Scattered inclined and vertical joints, rough and undulating, empty
49.0	50	

Rock column

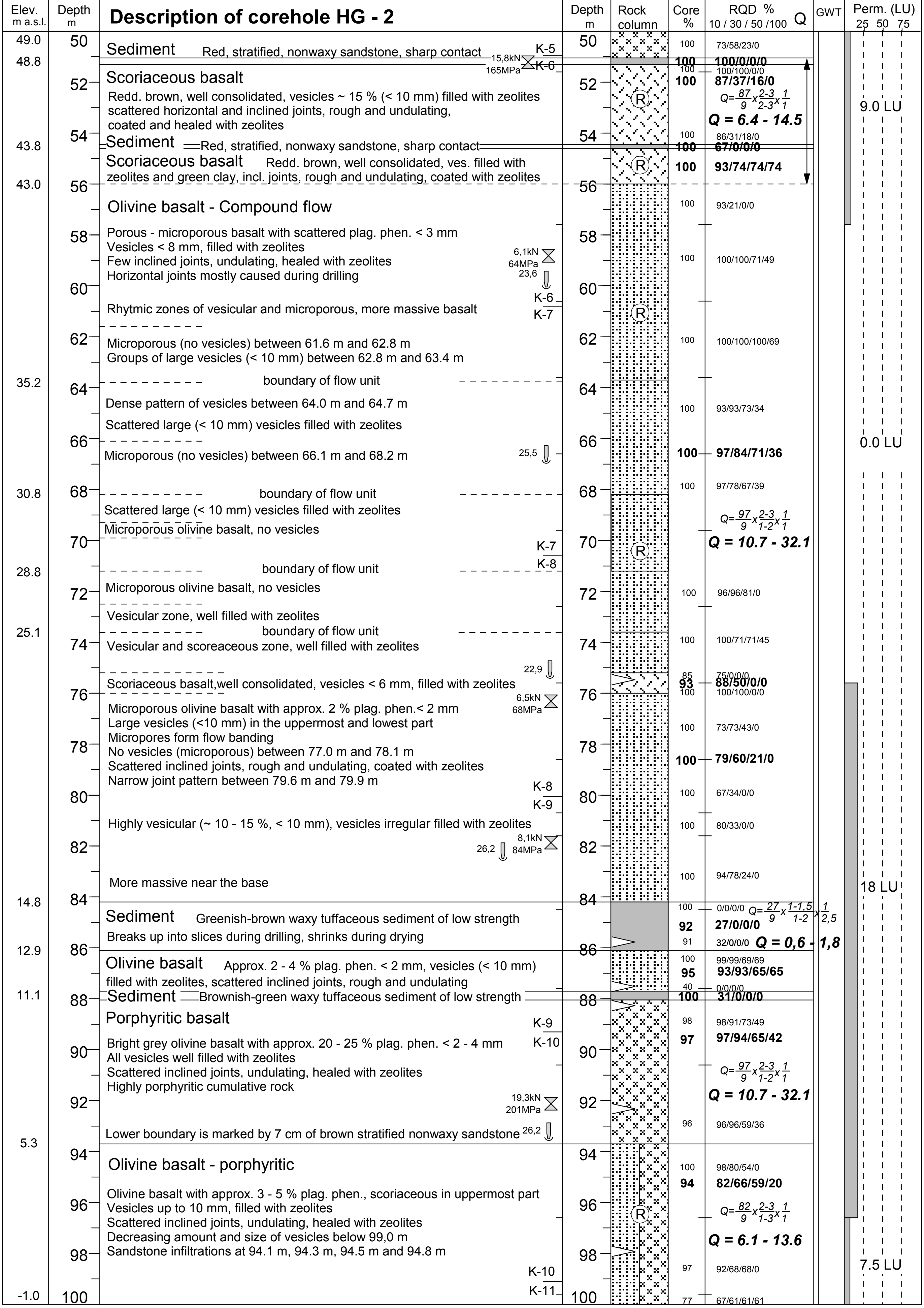


Core %	RQD % 10 / 30 / 50 /100	Q
96	96/67/0/0	
98	**87/41/0/0**	$Q=\frac{87}{9}x\frac{2\text{-}3}{2\text{-}3}x\frac{1}{1}$ ***Q = 6.4 - 14.5***
100	94/41/0/0	
95	61/30/0/0	
99	92/67/52/52	$Q=\frac{94}{9}x\frac{2\text{-}3}{1\text{-}3}x\frac{1}{1}$ ***Q = 6.9 - 15.6***
100	100/100/41/0	
98	**94/81/38/18**	
97	90/75/48/0	
92	92/92/0/0	
97	92/92/0/0	
100	100/75/65/47	
100	92/92/92/92	
100	92/60/19/0	
100	90/55/24/0	
100	94/65/65/0	$Q=\frac{90}{9}x\frac{2\text{-}3}{1\text{-}2}x\frac{1}{1}$ ***Q = 10.0 - 30.0***
100	100/100/100/61	
100	87/76/76/50	
100	**90/77/65/39**	
100	99/99/83/66	
100	100/100/100/100	
100	66/66/66/47	
100	80/80/52/34	
100	93/74/74/0	
100	73/58/23/0	



Jarðfræðistofan Ehf Ltd JFS Geological services	**Héðinsfjörður Road Tunnel** **Héðinsfjörður** **Corehole HG - 2 50 - 100 m**	JFS-45 Date Sept. 2000 Design ÁgG/WaF	Drwg. HG2b Page **2** of **5** Drawn WaF/DB
Empl. **VEGAGERÐIN**	Coord. X: 622895.58 Y: 508115.36 Elev.: 99.04	Driller RFS	Drilled Sept. 2000

Description of corehole HG - 2



Elev. m a.s.l.	Depth m	Description
49.0	50	**Sediment** Red, stratified, nonwaxy sandstone, sharp contact — K-5
48.8		15,8kN 165MPa — K-6
	52	**Scoriaceous basalt** Redd. brown, well consolidated, vesicles ~ 15 % (< 10 mm) filled with zeolites scattered horizontal and inclined joints, rough and undulating, coated and healed with zeolites
43.8	54	**Sediment** Red, stratified, nonwaxy sandstone, sharp contact
		Scoriaceous basalt Redd. brown, well consolidated, ves. filled with zeolites and green clay, incl. joints, rough and undulating, coated with zeolites
43.0	56	**Olivine basalt - Compound flow**
	58	Porous - microporous basalt with scattered plag. phen. < 3 mm Vesicles < 8 mm, filled with zeolites Few inclined joints, undulating, healed with zeolites — 6,1kN 64MPa Horizontal joints mostly caused during drilling — 23,6
	60	K-6 / K-7 Rhytmic zones of vesicular and microporous, more massive basalt
	62	Microporous (no vesicles) between 61.6 m and 62.8 m Groups of large vesicles (< 10 mm) between 62.8 m and 63.4 m
35.2	64	boundary of flow unit Dense pattern of vesicles between 64.0 m and 64.7 m Scattered large (< 10 mm) vesicles filled with zeolites
	66	Microporous (no vesicles) between 66.1 m and 68.2 m — 25,5
30.8	68	boundary of flow unit Scattered large (< 10 mm) vesicles filled with zeolites Microporous olivine basalt, no vesicles
	70	K-7 / K-8
28.8		boundary of flow unit
	72	Microporous olivine basalt, no vesicles Vesicular zone, well filled with zeolites
25.1		boundary of flow unit
	74	Vesicular and scoreaceous zone, well filled with zeolites — 22,9
		Scoriaceous basalt,well consolidated, vesicles < 6 mm, filled with zeolites
	76	Microporous olivine basalt with approx. 2 % plag. phen.< 2 mm — 6,5kN 68MPa Large vesicles (<10 mm) in the uppermost and lowest part Micropores form flow banding
	78	No vesicles (microporous) between 77.0 m and 78.1 m Scattered inclined joints, rough and undulating, coated with zeolites Narrow joint pattern between 79.6 m and 79.9 m
	80	K-8 / K-9 Highly vesicular (~ 10 - 15 %, < 10 mm), vesicles irregular filled with zeolites — 8,1kN 84MPa
	82	26,2
		More massive near the base
14.8	84	**Sediment** Greenish-brown waxy tuffaceous sediment of low strength Breaks up into slices during drilling, shrinks during drying
12.9	86	**Olivine basalt** Approx. 2 - 4 % plag. phen. < 2 mm, vesicles (< 10 mm) filled with zeolites, scattered inclined joints, rough and undulating
11.1	88	**Sediment** Brownish-green waxy tuffaceous sediment of low strength
		Porphyritic basalt — K-9 / K-10
	90	Bright grey olivine basalt with approx. 20 - 25 % plag. phen. < 2 - 4 mm All vesicles well filled with zeolites Scattered inclined joints, undulating, healed with zeolites Highly porphyritic cumulative rock
	92	19,3kN 201MPa Lower boundary is marked by 7 cm of brown stratified nonwaxy sandstone — 26,2
5.3	94	**Olivine basalt - porphyritic**
	96	Olivine basalt with approx. 3 - 5 % plag. phen., scoriaceous in uppermost part Vesicles up to 10 mm, filled with zeolites Scattered inclined joints, undulating, healed with zeolites Decreasing amount and size of vesicles below 99,0 m
	98	Sandstone infiltrations at 94.1 m, 94.3 m, 94.5 m and 94.8 m K-10 / K-11
-1.0	100	

Core %	RQD % 10 / 30 / 50 /100	Q
100	73/58/23/0	
100	**100/0/0/0**	
100	100/100/0/0	
100	**87/37/16/0**	$Q=\frac{87}{9}x\frac{2-3}{2-3}x\frac{1}{1}$
		Q = 6.4 - 14.5
100	86/31/18/0	
100	**67/0/0/0**	
100	**93/74/74/74**	
100	93/21/0/0	
100	100/100/71/49	
100	100/100/100/69	
100	93/93/73/34	
100	**97/84/71/36**	
100	97/78/67/39	
		$Q=\frac{97}{9}x\frac{2-3}{1-2}x\frac{1}{1}$
		Q = 10.7 - 32.1
100	96/96/81/0	
100	100/71/71/45	
85	75/0/0/0	
93	**88/50/0/0**	
100	100/100/0/0	
100	73/73/43/0	
100	**79/60/21/0**	
100	67/34/0/0	
100	80/33/0/0	
100	94/78/24/0	
100	0/0/0/0	$Q=\frac{27}{9}x\frac{1-1,5}{1-2}x\frac{1}{2,5}$
92	**27/0/0/0**	
91	32/0/0/0	***Q = 0,6 - 1,8***
100	99/99/69/69	
95	**93/93/65/65**	
40	0/0/0/0	
100	**31/0/0/0**	
98	98/91/73/49	
97	**97/94/65/42**	
		$Q=\frac{97}{9}x\frac{2-3}{1-2}x\frac{1}{1}$
		Q = 10.7 - 32.1
96	96/96/59/36	
100	98/80/54/0	
94	**82/66/59/20**	
		$Q=\frac{82}{9}x\frac{2-3}{1-3}x\frac{1}{1}$
		Q = 6.1 - 13.6
97	92/68/68/0	
77	67/61/61/61	

Jarðfræðistofan Ehf
JFS Geological services Ltd

Héðinsfjörður Road Tunnel
Héðinsfjörður
Corehole HG - 2 100 - 150 m

JFS-45 | Drwg. HG2c
Date Sept. 2000 | Page **3** of **5**
Design ÁgG/WaF | Drawn WaF/DB
Empl. VEGAGERÐIN | Coord. X: 622895.58 Y: 508115.36 Elev.: 99.04
Driller RFS | Drilled Sept. 2000

Description of corehole HG - 2

Elev. m a.s.l. -1.0 — Depth 100 m

Olivine basalt - porphyritic

Porphyritic basalt with 7 - 10 % plagioclase phen. < 2 mm — Core loss 0,6 m
Scattered inclined joints, partly healed with zeolites
Horizontal joints mainly due to drilling — 34,9
Open fracture filled with zeolites, reddish-brown oxidated surface — 38,5kN 400MPa
Vesicles in lower part partly filled with dark clay.
Clay also on joint surfaces
Distinct vertical joints at 107,0 m, rough and undulating, coated with zeolites.

Elev. -9.7

Subvertical dyke

Very dark and chilled margin — Core loss 2,3 m
Probably 3 m wide fracture zone, filled with basalt breccia in clayous matrix
Fragments < 40 mm, sharp and angular
Steeply inclined joint filled with zeolites and clay — K-11

Elev. -12.6

Subvertical dyke

K-12
Dark grey, fine grained basalt
Intensely jointed, frequently healed with black clay and zeolites — 43,3kN 451MPa
Hard and brittle cubes — 24,4
Crushed rock, partly cemented in black clay.
resulting in thin black network of veins
Scattered plagioclase phenocrysts < 2 mm (~ 2 - 3 %)
Open, inclined joints partly coated with zeolites, rough and undulating
Closed joints healed with zeolites and / or filled with black clay
Fragment of porphyritic basalt inclusions.
Intensely jointed, frequent thin black pattern of healed joints
K-12 / K-13
Frequency of joints decreasing between 121,6 - 129,2 m
41,7kN 434MPa — 36,6
More massive part of the dyke, decreasing joint pattern
K-13 / K-14
Scattered plagioclase phenocrysts ~2 - 3 % , < 3 mm
Dyke becomes intensely jointed around 130 m depth
Core loss at the boundary of the dyke
Core loss 4,6 m

Elev. -36.6

Scoriaceous basalt

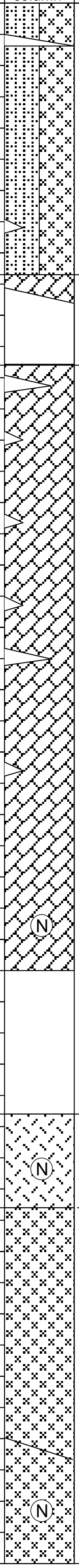
Well compressed and consolidated
All vugs filled with zeolites — 22,1 — 10,1kN 105MPa

Elev. -39.6

Porphyritic basalt

Slightly scoriaceous porphyritic basalt — 18,4kN 192MPa
Plagioclase phenocrysts ~ 10 - 15 %, < 3 - 4 mm — 29,6
Below 135,6 m continuous core
Approx. 15 % plagioclase phenocrysts — K-14 / K-15
Decreasing amount of vesicles downwards
Micropores form distinct flow banding
Scattered inclined joints partly healed with zeolites and black clay
Vertical joint filled with zeolites and basalt fragments in clayey matrix
Surface rough and undulating
Inclined joint filled with rock fragments in reddish oxidated clayey matrix, rough and undulating
Approx. 0,1 m wide vein from a dyke, filled with black, chilled basalt, surface rough and undulating
The margins are cemented with zeolites

Elev. -51.0 — Depth 150 m



Core %	RQD % 10 / 30 / 50 /100	Q
77	67/61/61/61	
94	**82/66/59/20**	
100	97/85/85/38	
		$Q=\frac{82}{9}x\frac{2-3}{1-3}x\frac{1}{1}$ **Q = 6.1 - 13.6**
95	50/38/38/0	
100	67/37/0/0	
0	**0/0/0/0**	
67	34/0/0/0	
97	28/0/0/0	
97	64/29/19/0	
		$Q=\frac{35}{15}x\frac{2-3}{2-3}x\frac{1}{1}$ **Q = 1.5 - 3.5**
95	28/0/0/0	
56	48/27/0/0	
100	90/36/36/0	
76	**42/15/9/0**	
99	60/18/18/0	
100	69/43/18/0	
100	39/0/0/0	
93	0/0/0/0	
0	0/0/0/0	
5	0/0/0/0	
0	0/0/0/0	
100	**100/100/74/37**	
100	100/100/74/37	
		$Q=\frac{92}{9}x\frac{2-3}{1-2}x\frac{1}{1}$ **Q = 6.9 - 15.6**
100	100/77/77/0	
100	**92/76/55/14**	
100	95/86/71/0	
100	77/56/43/0	
100	100/100/0/0	

GWT

Perm. (LU) 25 50 75
7.5 LU
6.9 LU
0.5 LU

Jarðfræðistofan Ehf
JFS Geological services Ltd

Héðinsfjörður Road Tunnel
Héðinsfjörður
Corehole HG - 2 150 - 200 m

JFS-45		Drwg.	HG2d
Date	Sept. 2000	Page	4 of 5
Design	ÁgG/WaF	Drawn	WaF/DB
Driller	RFS	Drilled	Sept. 2000

Empl. VEGAGERÐIN | Coord. X: 622895.58 Y: 508115.36 | Elev.: 99.04

Description of corehole HG - 2

Elev. m a.s.l. -51.0 — Depth 150 m

Porphyritic basalt 10 - 15 % plagioclase phen. < 3 - 4 mm
Vesicles up to 10 mm, filled with zeol., and black clay
Scattered inclined joints, rough and undulating, partly coated with dark clay or healed with zeolites. Vertical joint, ~ 5 mm wide, filled with reddish oxidated clay. Surface coated with zeolites, rough and undulating.
Micropores form faint flow banding
Scoriaceous porphyritic - olivine basalt in the lower most part

22,1kN 230MPa (150 m); K-15, K-16 (152 m)

-55.2 — 154

Scoriaceous basalt
Reddish-brown, well consolidated scoria
Approx. 10 % vesicles > 10 mm, filled with zeolites
Scattered inclined joints, rough and undulating, coated with yellow-red clay or healed by zeolites

26,5 (155.5 m); 9,9kN 103MPa (157.3 m)

-61.0 — 160

Olivine basalt
Scattered plagioclase phenocrysts 3 - 5 %, > 2 mm
Vesicles < 5 mm, filled with zeolites
Scattered conjugated inclined joints and extensional cracks, filled with zeolites
Horizontal joints due to drilling
Large vesicles < 15 mm filled with zeolites between 165,0 - 169,5 m
Obvious dense rock, but low strength

Higher ratio of plagioclase phenocrysts at 166, 0 - 170,0 m depth

K-16, K-17 (161.5 m); 32,1 — 24,4kN 254MPa (168 m); K-17, K-18 (171.3 m); 31,3 — 21,3kN 222MPa (172 m)

Massive olivine basalt with frequent micropore flow banding
Scattered larger vesicles filled with zeolites

-79.3 — 178

Scoriaceous basalt
Well compressed and consolidated, yielding continuous core
Inclined 50 - 100 mm thick veins of chilled basalt of a dyke part

-81.5 — 180

Sediment Red sandst., fine grained, stratif. with large scoria fragm. K-18

Scoria Well compressed and consolidated
Vesicular, all vugs filled with white secondary minerals
Veins of a dark grey fine grained basalt form a dyke

6,1kN 64MPa K-19 (181 m); 10,6kN 110MPa (182 m)

-83.4 — 182

Subvertical Dyke
Dark grey, fine grained, scattered plag. phen. ~ 1 - 2 %, < 3 - 4 mm
The dyke is highly jointed, mainly due to tectonic stress
Fragments frequently 10 - 30 mm between usually healed joints, forming thin black and white vein pattern
The vein pattern consists of frequent parallel inclined slices, often cut into smaller fragments by other joint systems.

K-19, K-20 (189.5 m)

Rather fine grained, medium dark grey rock
Intensely jointed and crushed due to tectonic stress,
Majority of the joints is healed with black clay and often zeolites

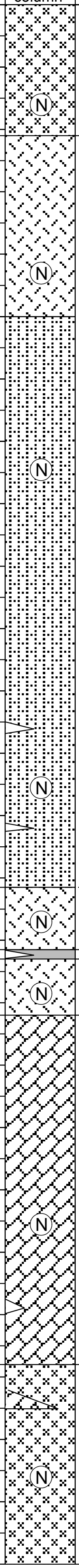
Narrow joint pattern, inclined joints partly healed with black clay or zeolites.

-94.6 — 194

Porphyritic basalt
15 % plagioclase phenocrysts < 3 - 4 mm
At 194,4 m depth part of a subvertical dyke (0,45 m)
Vesicles > 3 mm, filled with black clay
Larger vesicles < 10 mm filled with zeolites
Inclined joints healed with zeolites
Massive, slightly microporous porphyritic basalt
All small pores filled with black clay

17,2kN 179MPa (195 m); K-20, K-21 (199.5 m)

-101.0 — 200



Core %	RQD % 10 / 30 / 50 /100	Q
100	75/0/0/0	
100	91/68/34/34	
100	**92/76/55/14**	
100	75/50/0/0	
100	98/67/54/0	
100	**96/83/71/48**	$Q=\frac{96}{9}x\frac{2-3}{1-3}x\frac{1}{1}$ ***Q = 7.1 - 21.3***
100	93/93/93/93	
100	100/100/0/0	
100	100/100/100/100	
100	99/87/76/76	
100	100/95/95/48	$Q=\frac{95}{9}x\frac{2-3}{1-2}x\frac{1}{1}$ ***Q = 10.5 - 31.5***
100	100/99/88/88	
99	**95/87/77/60**	
94	85/85/85/73	
99	99/81/42/0	
100	46/0/0/0	
100	**93/74/43/0**	$Q=\frac{95}{9}x\frac{2-3}{2-3}x\frac{1}{1}$
83	**83/0/0/0**	
100	**100/100/30/0**	***Q = 7.0 - 15.8***
100	47/35/0/0	
100	29/0/0/0	
99	**63/28/0/0**	
100	79/46/0/0	$Q=\frac{63}{15}x\frac{3-4}{2-3}x\frac{1}{1}$ ***Q = 4.2 - 8.4***
97	86/45/0/0	
100	68/0/0/0	
100	92/81/65/0	
100	**95/79/63/20**	$Q=\frac{95}{9}x\frac{2-3}{1-2}x\frac{1}{1}$ ***Q = 10.5 - 31.5***
100	96/57/46/0	
100	92/92/69/69	

GWT

Perm. (LU) 25 50 75
0.5 LU
0 LU
0.5 LU

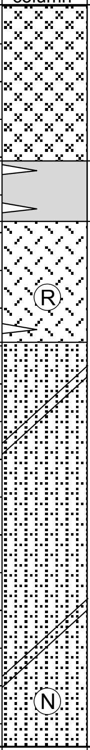
Jarðfræðistofan Ehf
JFS Geological services Ltd

Héðinsfjörður Road Tunnel
Héðinsfjörður
Corehole HG - 2 200 - 250 m

JFS-45	Drwg. HG2e	Date Sept. 2000	Page 5 of 5
Design ÁgG/WaF	Drawn DB/WaF	Driller RFS	Drilled Sept. 2000

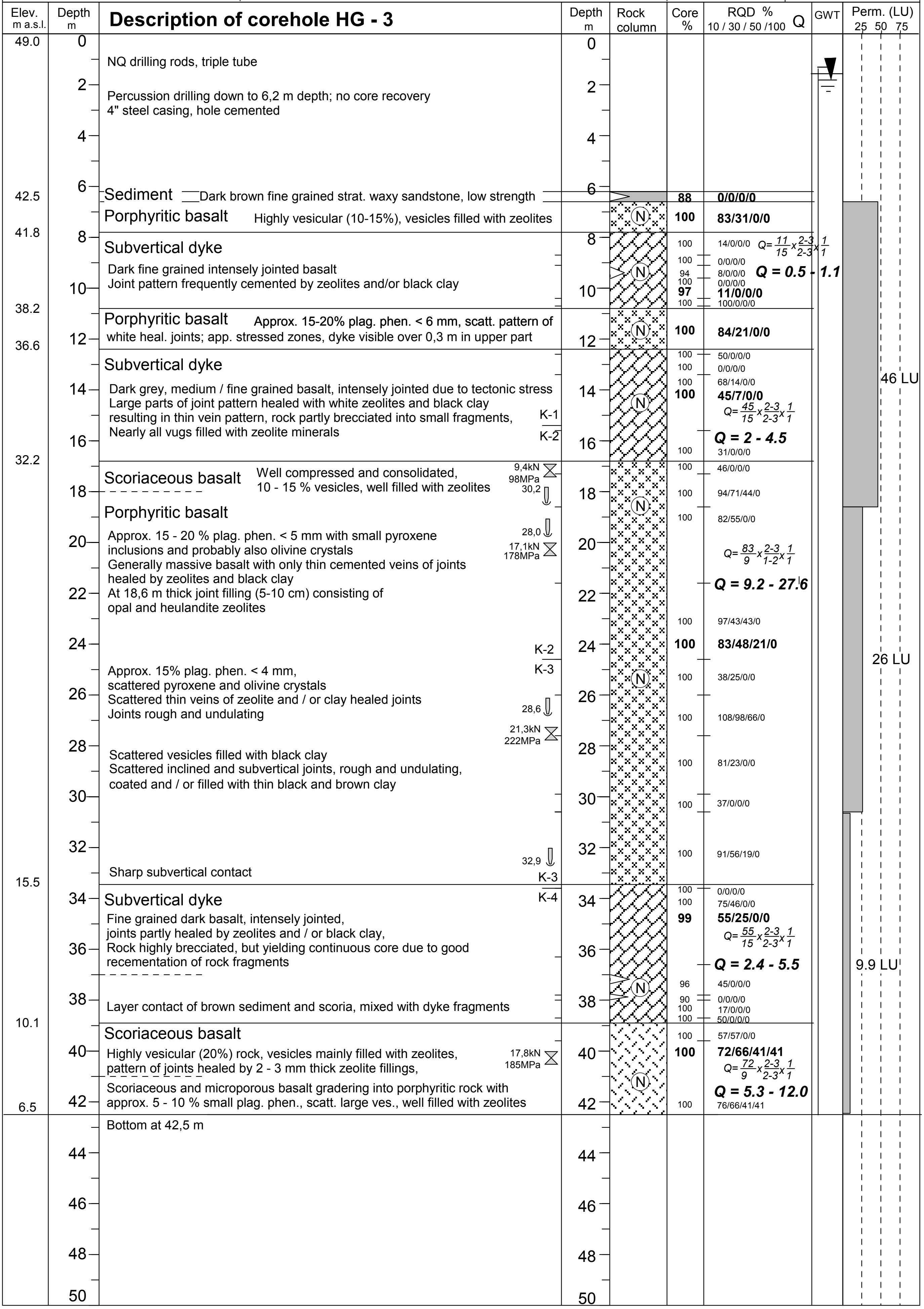
Empl. **VEGAGERÐIN** Coord. X: 622895.58 Y: 508115.36 Elev.: 99.04

Description of corehole HG - 2



Elev. m a.s.l.	Depth m	Description of corehole HG - 2	Core %	RQD % 10 / 30 / 50 /100	Q	Perm. (LU)
-101.0	200	Porphyritic basalt 30,8kN 321MPa Approx. 15 % plagioclase phen. < 4 mm, with pyroxene porphyroblasts Very sound basalt with dispersed small pores < 2 mm, filled with black clay Scattered inclined joints coated and healed with zeolites 27,6	100 100	92/92/69/69 99/87/75/0		
-105.1	204	Sediment Reddish-brown, stratified silt-sandstone, waxy in central part Coarse fragments of scoriaceous basalt in the lower part 5,6kN 58MPa	80 **83** 85	30/0/0/0 **49/39/0/0** 57/57/0/0	$Q=\frac{49}{9}x\frac{1-2}{3-4}x\frac{1}{2,5}$ ***Q = 0,5 - 1,4***	
-106.7	206	Scoriaceous basalt 6,8kN 71MPa Well compressed and consolidated 15,2 Pores and vesicles filled with zeolites K-21 Inclined joints, rough and undulating, healed and coated with zeolites K-22 Scoria breaks partly during drilling and handling	100 **96** 92	81/76/35/0 **81/40/19/0** 80/0/0/0	$Q=\frac{81}{9}x\frac{2-3}{2-3}x\frac{1}{1}$ ***Q = 6.0 - 13.5***	
-109.9	210	Olivine basalt Approx. 3 - 5 % very small plagioclase phenocrysts < 2 mm 21,8kN 227MPa Large vesicles (~ 10 mm diameter) ~ 2 %, filled with zeolites Scattered inclined joints, healed with zeolites Tectonic zone at 211,0 - 212,0 m, narrow white veins healed with zeolites Large partly open joints, rough and undulating, filled / healed with zeolites and rock fragments 33,0 Tectonical joint zone 0,2 m of crushed rock at 215,4 m K-22 cemented in white zeolites, forming white vein pattern K-23 Olivine basalt, medium grained, grey rock, microporuous flow banding Frequent steeply inclined tectonical joints, healed with zeolites, with some open canals, small vesicles coated with black clay and zeolites	100 100 **100** 100 100	86/79/0/0 100/100/100/100 **94/84/63/37** 89/77/60/0 98/80/64/34	$Q=\frac{94}{9-12}x\frac{2-3}{2-3}x\frac{1}{1}$ ***Q = 5.2 - 15.6***	0.5 LU
-120.6	220	Bottom at 219,6 m				

Jarðfræðistofan Ehf JFS Geological services Ltd	**Héðinsfjörður Road Tunnel** **Héðinsfjörður** **Corehole HG - 3 0 - 50 m**	JFS-45 Date Sept. 2000 Design ÁgG/WaF	Drwg. HG3a Page **1** of **1** Drawn WaF/DB
Empl. **VEGAGERÐIN**	Coord. X: 623325.49 Y: 507923.75 Elev.: 49.01	Driller RFS	Drilled August 2000



Description of corehole HG - 3

Elev. m a.s.l.	Depth m	Description
49.0	0	NQ drilling rods, triple tube Percussion drilling down to 6,2 m depth; no core recovery 4" steel casing, hole cemented
42.5	6	**Sediment** Dark brown fine grained strat. waxy sandstone, low strength
		Porphyritic basalt Highly vesicular (10-15%), vesicles filled with zeolites
41.8	8	**Subvertical dyke** Dark fine grained intensely jointed basalt Joint pattern frequently cemented by zeolites and/or black clay
38.2		**Porphyritic basalt** Approx. 15-20% plag. phen. < 6 mm, scatt. pattern of white heal. joints; app. stressed zones, dyke visible over 0,3 m in upper part
36.6	12	**Subvertical dyke** Dark grey, medium / fine grained basalt, intensely jointed due to tectonic stress Large parts of joint pattern healed with white zeolites and black clay resulting in thin vein pattern, rock partly brecciated into small fragments, Nearly all vugs filled with zeolite minerals K-1 / K-2
32.2		**Scoriaceous basalt** Well compressed and consolidated, 10 - 15 % vesicles, well filled with zeolites 9,4kN 98MPa 30,2
	18	**Porphyritic basalt** Approx. 15 - 20 % plag. phen. < 5 mm with small pyroxene inclusions and probably also olivine crystals Generally massive basalt with only thin cemented veins of joints healed by zeolites and black clay At 18,6 m thick joint filling (5-10 cm) consisting of opal and heulandite zeolites 28,0 17,1kN 178MPa K-2 / K-3 Approx. 15% plag. phen. < 4 mm, scattered pyroxene and olivine crystals Scattered thin veins of zeolite and / or clay healed joints Joints rough and undulating 28,6 21,3kN 222MPa Scattered vesicles filled with black clay Scattered inclined and subvertical joints, rough and undulating, coated and / or filled with thin black and brown clay 32,9 Sharp subvertical contact K-3
15.5	34	**Subvertical dyke** K-4 Fine grained dark basalt, intensely jointed, joints partly healed by zeolites and / or black clay, Rock highly brecciated, but yielding continuous core due to good recementation of rock fragments Layer contact of brown sediment and scoria, mixed with dyke fragments
10.1		**Scoriaceous basalt** Highly vesicular (20%) rock, vesicles mainly filled with zeolites, pattern of joints healed by 2 - 3 mm thick zeolite fillings, 17,8kN 185MPa Scoriaceous and microporous basalt gradering into porphyritic rock with approx. 5 - 10 % small plag. phen., scatt. large ves., well filled with zeolites
6.5	42	Bottom at 42,5 m

Core %	RQD % 10 / 30 / 50 /100	Q
88	**0/0/0/0**	
100	**83/31/0/0**	
100	14/0/0/0	$Q=\frac{11}{15}x\frac{2-3}{2-3}x\frac{1}{1}$
100	0/0/0/0	
94	8/0/0/0	**$Q = 0.5 - 1.1$**
100	0/0/0/0	
97	**11/0/0/0**	
100	100/0/0/0	
100	**84/21/0/0**	
100	50/0/0/0	
100	0/0/0/0	
100	68/14/0/0	
100	**45/7/0/0**	$Q=\frac{45}{15}x\frac{2-3}{2-3}x\frac{1}{1}$ **$Q = 2 - 4.5$**
100	31/0/0/0	
100	46/0/0/0	
100	94/71/44/0	
100	82/55/0/0	$Q=\frac{83}{9}x\frac{2-3}{1-2}x\frac{1}{1}$ **$Q = 9.2 - 27.6$**
100	97/43/43/0	
100	**83/48/21/0**	
100	38/25/0/0	
100	108/98/66/0	
100	81/23/0/0	
100	37/0/0/0	
100	91/56/19/0	
100	0/0/0/0	
100	75/46/0/0	
99	**55/25/0/0**	$Q=\frac{55}{15}x\frac{2-3}{2-3}x\frac{1}{1}$ **$Q = 2.4 - 5.5$**
96	45/0/0/0	
90	0/0/0/0	
100	17/0/0/0	
100	50/0/0/0	
100	57/57/0/0	
100	**72/66/41/41**	$Q=\frac{72}{9}x\frac{2-3}{2-3}x\frac{1}{1}$ **$Q = 5.3 - 12.0$**
100	76/66/41/41	

Jarðfræðistofan Ehf
JFS Geological services Ltd

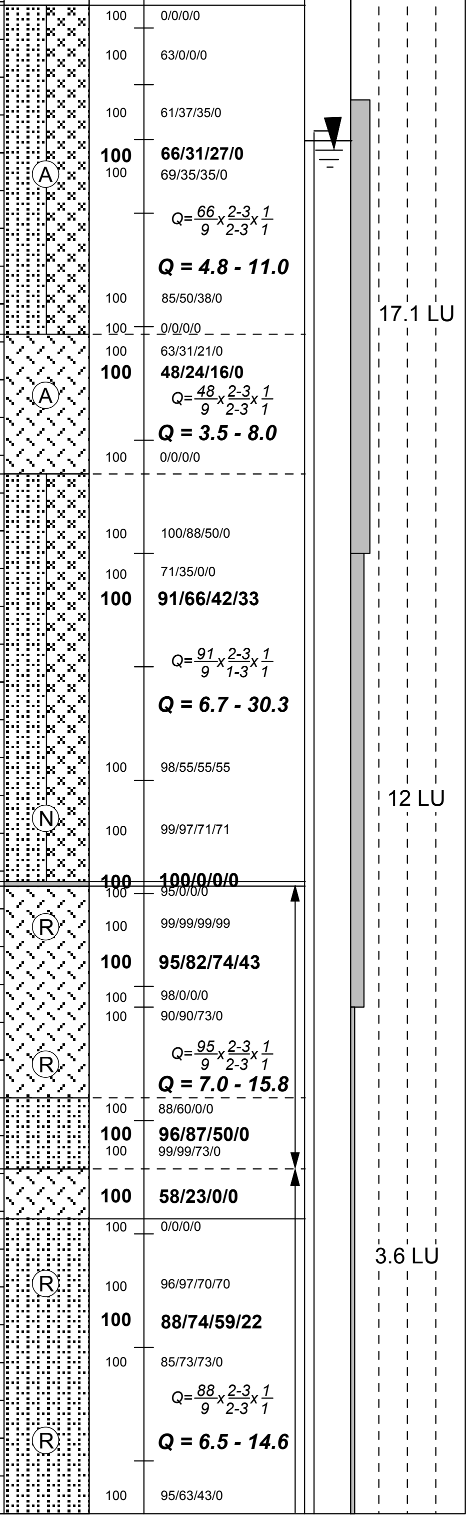
Héðinsfjörður Road Tunnel
Héðinsfjörður
Corehole HG - 4   0 - 50 m

JFS-45	Drwg. HG4a
Date Sept. 2000	Page 1 of 2
Design ÁgG/WaF	Drawn WaF/DB
Driller RFS	Drilled Sept. 2000

Empl. VEGAGERÐIN | Coord. X: 622182.66 Y: 508241.19 Elev.: 53.45

Description of corehole HG - 4

Elev. m a.s.l.	Depth m	Description of corehole HG - 4	Core %	RQD % 10 / 30 / 50 /100 Q
53.45	0	NQ drilling rods, triple tube 4" steel casing approx. 10,1 m. Loose gravely overburden, approx. 3 m thick soil mixed with gravel and large boulders. below blocky debris and well consolidated material (moraine).		
42.3	10	**Olivine basalt - porphyritic** 5 - 10 % small plagioclase phenocrysts < 2 - 3 mm Frequent microporous flow banding Scattered inclined joints, rough and undulating, partly coated with dark and green clay Set of conjugated inclined pale-pink joints, rough and undulating, surface coated with reddish oxidated clay 25kN 260MPa Distributed vesicles 3 - 4 %, ~ 5 - 6 mm diameters, filled with black clay and sometimes zeolites Very weak R-magnetization 31,7 Vesicles filled with zeolites and green clay K-1	100 100 100 **100** 100 100 100	0/0/0/0 63/0/0/0 61/37/35/0 **66/31/27/0** 69/35/35/0 $Q=\frac{66}{9}x\frac{2-3}{2-3}x\frac{1}{1}$ ***Q = 4.8 - 11.0*** 85/50/38/0 0/0/0/0
34.6		K-2 **Scoriacious basalt** Vesicles 5 - 10 %, all well filled with zeolites and black clay. 11,7kN 122MPa Frequent joints, rough and undulating, coated and filled with pale-pink clay and zeolites.	100 **100** 100	63/31/21/0 **48/24/16/0** $Q=\frac{48}{9}x\frac{2-3}{2-3}x\frac{1}{1}$ ***Q = 3.5 - 8.0*** 0/0/0/0
31.0	22	**Olivine basalt - porphyritic** Vertical joints, rough and undulating, healed with zeolites Highly vesicular 15 - 20 %, <= 10 mm diameter Most vesicles filled with zeolites, few coated 10,9kN 114MPa 22,0 K-2 Some empty vesicles at 28,1 m K-3 Vesicles disappear Dense olivine basalt, small plagioclase phenocrysts < 2 mm diameter ~ 3 % Micropores form distinct flow banding 28,4kN 296MPa Joints rough and undulating, healed with zeolites Few horizontal joints due to drilling Dense pattern of zeolite filled vesicles < 7 mm diameter in the lowest 0,4 m **Sediment** Brown stratified sandstone, not waxy, 0,1 m	100 100 **100** 100 100 **100**	100/88/50/0 71/35/0/0 **91/66/42/33** $Q=\frac{91}{9}x\frac{2-3}{1-3}x\frac{1}{1}$ ***Q = 6.7 - 30.3*** 98/55/55/55 99/97/71/71 **100/0/0/0**
20.0	34	**Scoriaceous basalt** Well compressed and consolidated reddish-brown scoria 19,0 All vugs are well filled with zeolites forming strongly scoriaceous basalt Few horizontal joints due to drilling and handling 6,9kN 72MPa K-3 Very weak R-magnetization K-4	100 100 **100** 100 100	95/0/0/0 99/99/99/99 **95/82/74/43** 98/0/0/0 90/90/73/0 $Q=\frac{95}{9}x\frac{2-3}{2-3}x\frac{1}{1}$ ***Q = 7.0 - 15.8***
14.4	40	**Olivine basalt** Approx 3 - 5 % plag. phen. < 2 - 3 mm Scattered inclined and vertical joints, mainly healed with zeolites	100 **100** 100	88/60/0/0 **96/87/50/0** 99/99/73/0
12.5		**Scoria** Well compressed and consolidated, reddish-brown scoria More zeolites < 20 mm in lower part, all vugs filled with zeolites	**100**	**58/23/0/0**
11.2	42	**Olivine basalt** 29,1kN 303MPa Microporous, massive, grey basalt, faint microporous flow banding Crushed olivine basalt fragments at 42,0 - 42,6 m 34,7 Scattered small plagioclase phenocrysts (~3 - 5 %, < 2 mm), more porphyritic in character in topmost 2 m (5-7% plag. phen.) Very few inclined and subhorizontal joints, rough and undulating, coated with brownish and greenish opal and jaspis K-4 Overall uniform rock K-5	100 100 **100** 100 100	0/0/0/0 96/97/70/70 **88/74/59/22** 85/73/73/0 $Q=\frac{88}{9}x\frac{2-3}{2-3}x\frac{1}{1}$ ***Q = 6.5 - 14.6*** 95/63/43/0
3.4	50			



Jarðfræðistofan Ehf
JFS Geological services Ltd

Héðinsfjörður Road Tunnel
Héðinsfjörður
Corehole HG - 4 50 - 51,6 m

JFS-45
Drwg. HG4b
Date Sept. 2000
Page **2** of **2**
Design ÁgG/WaF
Drawn WaF/DB

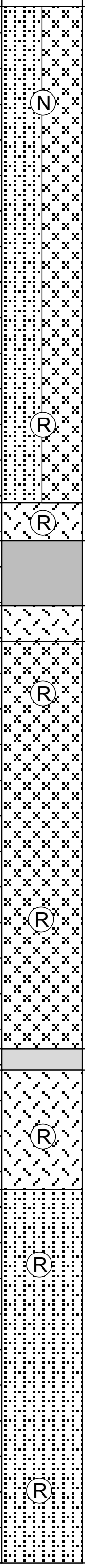
Empl. **VEGAGERÐIN**
Coord. X: 622182.66 Y: 508241.19 Elev.: 53.45
Driller RFS
Drilled Sept. 2000

Elev. m a.s.l.	Depth m	**Description of corehole HG - 4**	Depth m	Rock column	Core %	RQD % 10 / 30 / 50 /100	Q	GWT	Perm. (LU) 25 50 75
3.4 1.8	50	Olivine basalt 26,2kN 273MPa ⧖ Density of plagioclase phenocrysts increasing to ~ 5 - 10 % in lower part	50		100	95/63/43/0			4 LU
	52	Bottom at 51,6 m	52						
	54		54						
	56		56						
	58		58						
	60		60						
	62		62						
	64		64						
	66		66						
	68		68						
	70		70						
	72		72						
	74		74						
	76		76						
	78		78						
	80		80						
	82		82						
	84		84						
	86		86						
	88		88						
	90		90						
	92		92						
	94		94						
	96		96						
	98		98						
	100		100						

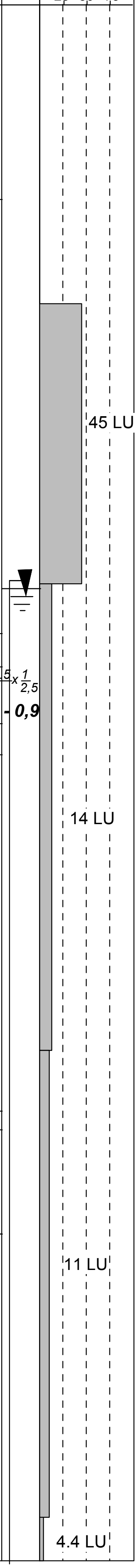
Jarðfræðistofan Ehf JFS Geological services Ltd	**Héðinsfjörður Road Tunnel** **Héðinsfjörður** **Corehole HG - 5 0 - 50 m**	JFS-45 Date Sept. 2000 Design ÁgG/WaF	Drwg. HG5a Page 1 of 2 Drawn WaF/DB
Empl. **VEGAGERÐIN**	Coord. X: 623008.04 Y: 508835.73 Elev.: 84.73	Driller RFS	Drilled Sept. 2000

Description of corehole HG - 5

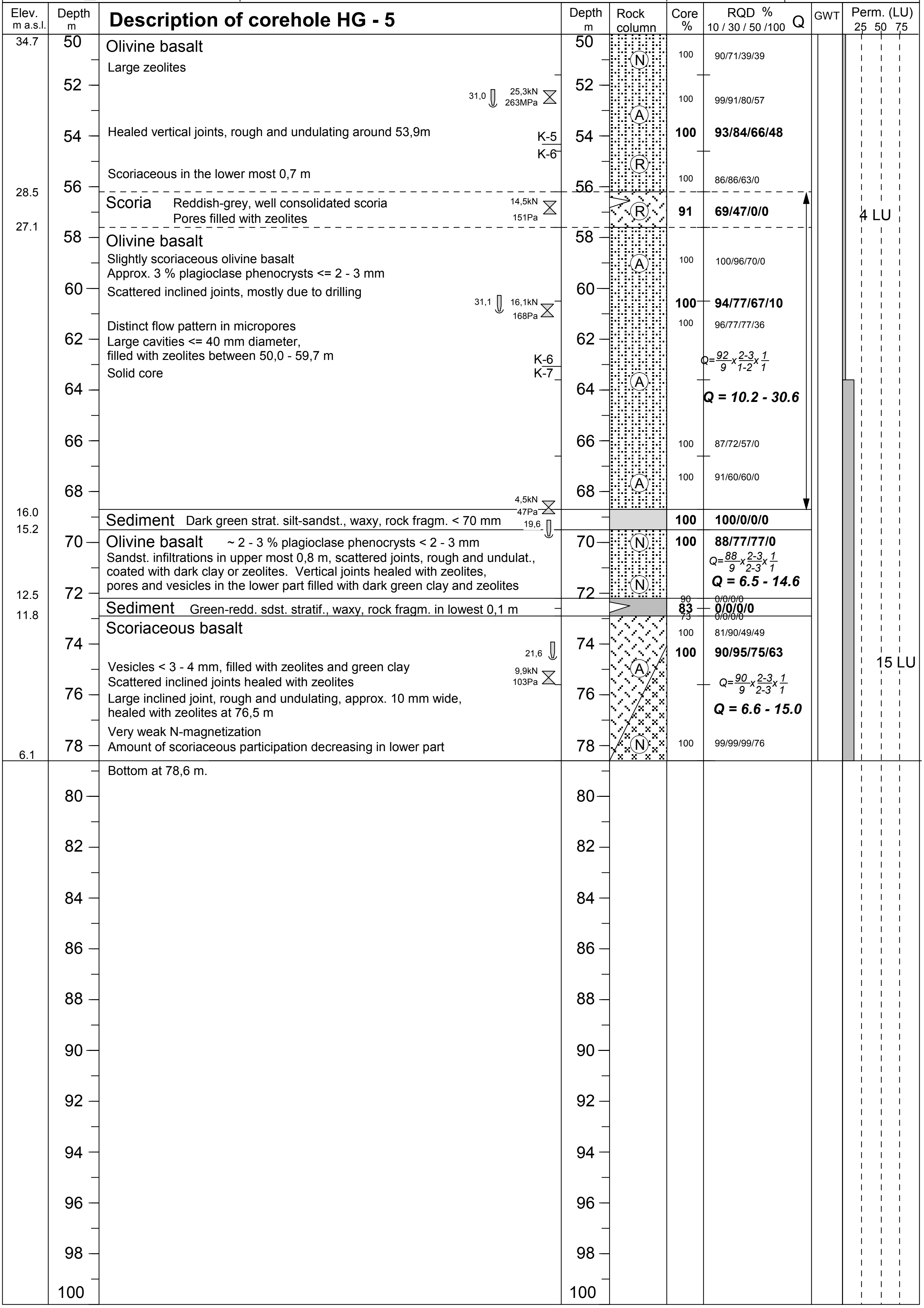
Elev. m a.s.l.	Depth m	Description
84.73	0	**Overburden** NQ drilling rods, triple tube Loose overburden with debris and probably moraine deposits Percussion drilling down to 6.25 m depth 4" steel casing, hole cemented
78.4	6	**Olivine basalt - porphyritic** Approx. 3 - 5 % plagioclase phenocrysts <= 2 mm Scattered inclined joints, rough and undulating, coated with clay and / or healed by zeolites Micropores form distinct flow pattern Pores partly filled with dark green-black clay Vesicles in lower part appear in groups / spots of 4 - 5 mm diameter, mainly filled with dark-black clay or zeolites Layered flow drag in rhythmic porous and dense zones 27,6 25,3kN 263MPa K-1 / K-2 Vertical joints rough and undulating, coated with zeolites and clay in between Joint pattern is more frequent than in upper part Some joints are healed with zeolites or open
64.5	20	**Scoria** Well compress. and consolidat., reddish-grey scoria - scor. basalt Scatt. joints, rough and undulat., coated with zeolites, pores filled with zeolites
63.2		**Sediment** Red stratif. silt-sandstone, waxy in the lower part 12,5kN 130MPa Single layers of coarse grained < 4 mm rock fragments Scatt. horizont. joints prob. due to drill., vert. joints in upper part heal. w. zeolit.
61.6		**Scoria** Redd.-grey, well compressed, pores filled with zeolites Sandstone-infiltrations in upper most 0,2 m
60.6	24	**Porphyritic basalt** 23,6 19,1kN 199MPa K-2 / K-3 Approx. 7-10% plag. phen. < 3-4 mm Scattered horizontal and vertical joints, rough and undulating, coated with clay Size and amount of vesicles decreasing below 26,1 m Larger inclined to vertical joints around 27,5 m, rough and undulating, partly coated with light brown clay 23,1kN 241MPa Approx. 15 - 20 % vesicles <= 4 mm, filled with zeolites 30,5 Below 30 m large scattered vesicles up to 9 mm diameter, filled with zeolites Between 33,2 - 33,9 m vertical joints approx. 10 mm wide, rough and undulating Pores and vesicles below 33,9 m are healed with zeolites and dark green clay 18,8kN 196MPa K-3 / K-4 Slightly scoriaceous in the lower most 0,5 m 2,5kN 26MPa
48.9	36	**Sediment** Red clay-silt, not waxy, vert. and inclin. joints heal. with zeolites
		Scoria - scoriaceous basalt 16,0 Grey - dark grey scoriaceous basalt Scatt. inclined joints, rough and undulating, healed with zeolites around 38,3 m Joint zone filled with breccia in sandy matrix, well cemented partly healed with zeolites ~10 mm wide
45.2	40	**Olivine basalt** Micropores form distinct flow banding 20,7kN 216MPa Large joint between 40,0 - 40,6 m, fill. with green.-br. breccia in sandy matrix, joints approx. 20 mm wide, up to 10 mm thick zeolites coating on both sides 31,2 Below 41,0 m scattered large vesicles < 10 mm diameter, open, coated and filled with zeolites Large cavities filled with zeolites around 43,6 m, < 50 mm diameter Approx. 3 - 5 % Plagioclase phenocrysts < 2 mm K-4 / K-5 Very massive basalt Scattered inclined and vertical joints, rough and undulating, coated and healed with zeolites Very solid core of massive basalt between 42,6 - 54,6 m
34.7	50	



Core %	RQD % 10 / 30 / 50 /100	Q
100	76/70/37/0	
100	85/69/69/49	
99	**79/62/34/11**	$Q=\frac{80}{9}x\frac{2\text{-}3}{2\text{-}3}x\frac{1}{1}$ ***Q = 5.9 - 13.3***
96	87/84/16/0	
98	83/59/30/0	
100	50/0/0/0	
96	**90/74/74/0**	
97	97/97/0/0	$Q=\frac{56}{9}x\frac{1\text{-}1.5}{4}x\frac{1}{2,5}$
92	**56/17/0/0**	***Q = 0,6 - 0,9***
91	47/0/0/0	
97	**53/40/0/0**	
100	90/59/18/0	
100	58/23/23/0	
99	**82/59/43/10**	$Q=\frac{80}{9}x\frac{2\text{-}3}{2\text{-}3}x\frac{1}{1}$ ***Q = 5.9 - 13.3***
98	91/78/59/0	
100	91/80/80/51	
100	**67/0/0/0**	
73	100/0/0/0	
95	**73/48/36/0**	$Q=\frac{73}{9}x\frac{2\text{-}3}{2\text{-}3}x\frac{1}{1}$ ***Q = 5.4 - 12.2***
96	71/50/38/0	
97	979/69/35/35	
100	100/90/81/33	
99	**93/84/66/48**	$Q=\frac{93}{9}x\frac{2\text{-}3}{2\text{-}3}x\frac{1}{1}$ ***Q = 6.8- 15.5***
100	100/100/100/100	
99	90/71/39/39	

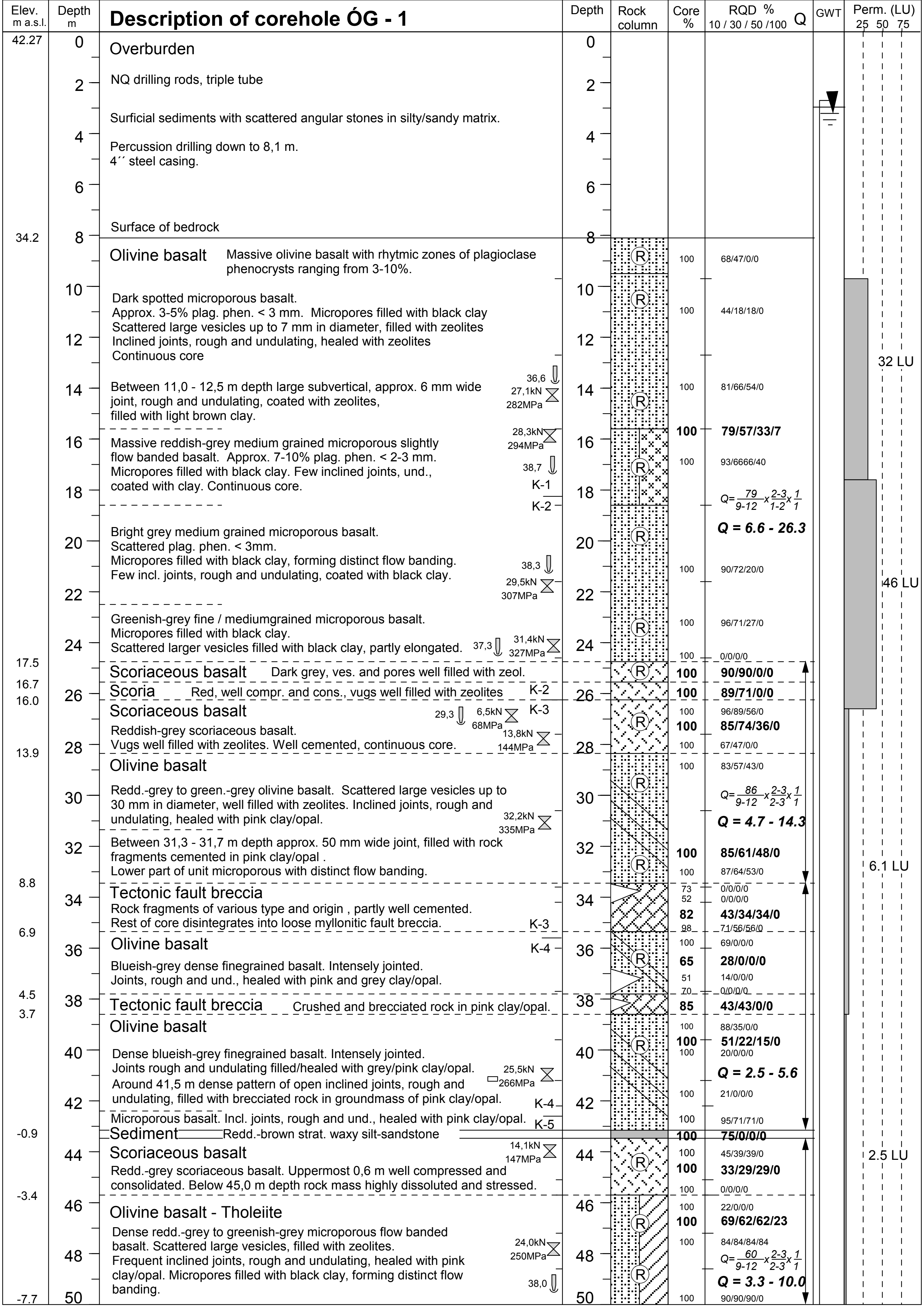


Jarðfræðistofan Ehf Ltd JFS Geological services	**Héðinsfjörður Road Tunnel** **Heðinsfjörður** **Corehole HG - 5 50.0 - 78.6 m**	JFS-45 Date Sept. 2000 Design ÁgG/WaF	Drwg. HG5b Page **2** of **2** Drawn WaF/DB
Empl. **VEGAGERÐIN**	Coord. X: 623008.04 Y: 508835.73 Elev.: 84.73	Driller RFS	Drilled Sept. 2000



Elev. m a.s.l.	Depth m	Description of corehole HG - 5	Core %	RQD % 10 / 30 / 50 /100	Q
34.7	50	**Olivine basalt** Large zeolites	100	90/71/39/39	
	52	31,0 25,3kN 263MPa	100	99/91/80/57	
	54	Healed vertical joints, rough and undulating around 53,9m K-5 K-6	**100**	**93/84/66/48**	
	56	Scoriaceous in the lower most 0,7 m	100	86/86/63/0	
28.5		**Scoria** Reddish-grey, well consolidated scoria Pores filled with zeolites 14,5kN 151Pa	**91**	**69/47/0/0**	
27.1	58	**Olivine basalt** Slightly scoriaceous olivine basalt Approx. 3 % plagioclase phenocrysts <= 2 - 3 mm	100	100/96/70/0	
	60	Scattered inclined joints, mostly due to drilling 31,1 16,1kN 168Pa	**100**	**94/77/67/10**	
		Distinct flow pattern in micropores	100	96/77/77/36	
	62	Large cavities <= 40 mm diameter, filled with zeolites between 50,0 - 59,7 m Solid core K-6 K-7			$Q=\frac{92}{9}x\frac{2-3}{1-2}x\frac{1}{1}$ ***Q = 10.2 - 30.6***
	66		100	87/72/57/0	
	68	4,5kN 47Pa	100	91/60/60/0	
16.0		**Sediment** Dark green strat. silt-sandst., waxy, rock fragm. < 70 mm 19,6	**100**	**100/0/0/0**	
15.2	70	**Olivine basalt** ~ 2 - 3 % plagioclase phenocrysts < 2 - 3 mm Sandst. infiltrations in upper most 0,8 m, scattered joints, rough and undulat., coated with dark clay or zeolites. Vertical joints healed with zeolites, pores and vesicles in the lower part filled with dark green clay and zeolites	**100**	**88/77/77/0**	$Q=\frac{88}{9}x\frac{2-3}{2-3}x\frac{1}{1}$ ***Q = 6.5 - 14.6***
12.5	72	**Sediment** Green-redd. sdst. stratif., waxy, rock fragm. in lowest 0,1 m	90 **83** 73	0/0/0/0 **0/0/0/0** 0/0/0/0	
11.8		**Scoriaceous basalt**	100	81/90/49/49	
	74	21,6	**100**	**90/95/75/63**	
	76	Vesicles < 3 - 4 mm, filled with zeolites and green clay Scattered inclined joints healed with zeolites Large inclined joint, rough and undulating, approx. 10 mm wide, healed with zeolites at 76,5 m 9,9kN 103Pa			$Q=\frac{90}{9}x\frac{2-3}{2-3}x\frac{1}{1}$ ***Q = 6.6 - 15.0***
6.1	78	Very weak N-magnetization Amount of scoriaceous participation decreasing in lower part	100	99/99/99/76	
		Bottom at 78,6 m.			
	80				
	82				
	84				
	86				
	88				
	90				
	92				
	94				
	96				
	98				
	100				

Jarðfræðistofan Ehf JFS Geological services Ltd	Héðinsfjörður Road Tunnel Ólafsfjörður Corehole ÓG - 1 0 - 50 m	JFS-45	Drwg. ÓG1a
		Date Dec. 2000	Page 1 of 2
		Design WaF/ÁgG	Drawn WaF
Empl. VEGAGERÐIN	Coord. X: 619672.834 Y: 514646.618 Elev.: 42.27	Driller RFS	Drilled Nov. 2000



Description of corehole ÓG - 1

Overburden

NQ drilling rods, triple tube

Surficial sediments with scattered angular stones in silty/sandy matrix.

Percussion drilling down to 8,1 m.
4´´ steel casing.

Surface of bedrock

Olivine basalt Massive olivine basalt with rhytmic zones of plagioclase phenocrysts ranging from 3-10%.

Dark spotted microporous basalt.
Approx. 3-5% plag. phen. < 3 mm. Micropores filled with black clay
Scattered large vesicles up to 7 mm in diameter, filled with zeolites
Inclined joints, rough and undulating, healed with zeolites
Continuous core

Between 11,0 - 12,5 m depth large subvertical, approx. 6 mm wide joint, rough and undulating, coated with zeolites, filled with light brown clay.

36,6
27,1kN 282MPa

Massive reddish-grey medium grained microporous slightly flow banded basalt. Approx. 7-10% plag. phen. < 2-3 mm. Micropores filled with black clay. Few inclined joints, und., coated with clay. Continuous core.

28,3kN 294MPa
38,7
K-1
K-2

Bright grey medium grained microporous basalt.
Scattered plag. phen. < 3mm.
Micropores filled with black clay, forming distinct flow banding.
Few incl. joints, rough and undulating, coated with black clay.

38,3
29,5kN 307MPa

Greenish-grey fine / mediumgrained microporous basalt.
Micropores filled with black clay.
Scattered larger vesicles filled with black clay, partly elongated.

37,3
31,4kN 327MPa

Scoriaceous basalt Dark grey, ves. and pores well filled with zeol.

Scoria Red, well compr. and cons., vugs well filled with zeolites K-2

Scoriaceous basalt K-3

29,3
6,5kN 68MPa
13,8kN 144MPa

Reddish-grey scoriaceous basalt.
Vugs well filled with zeolites. Well cemented, continuous core.

Olivine basalt

Redd.-grey to green.-grey olivine basalt. Scattered large vesicles up to 30 mm in diameter, well filled with zeolites. Inclined joints, rough and undulating, healed with pink clay/opal.

32,2kN 335MPa

Between 31,3 - 31,7 m depth approx. 50 mm wide joint, filled with rock fragments cemented in pink clay/opal .
Lower part of unit microporous with distinct flow banding.

Tectonic fault breccia
Rock fragments of various type and origin , partly well cemented.
Rest of core disintegrates into loose myllonitic fault breccia. K-3

Olivine basalt K-4
Blueish-grey dense finegrained basalt. Intensely jointed.
Joints, rough and und., healed with pink and grey clay/opal.

Tectonic fault breccia Crushed and brecciated rock in pink clay/opal.

Olivine basalt

Dense blueish-grey finegrained basalt. Intensely jointed.
Joints rough and undulating filled/healed with grey/pink clay/opal.
Around 41,5 m dense pattern of open inclined joints, rough and undulating, filled with brecciated rock in groundmass of pink clay/opal.

25,5kN 266MPa
K-4

Microporous basalt. Incl. joints, rough and und., healed with pink clay/opal. K-5

Sediment Redd.-brown strat. waxy silt-sandstone

14,1kN 147MPa

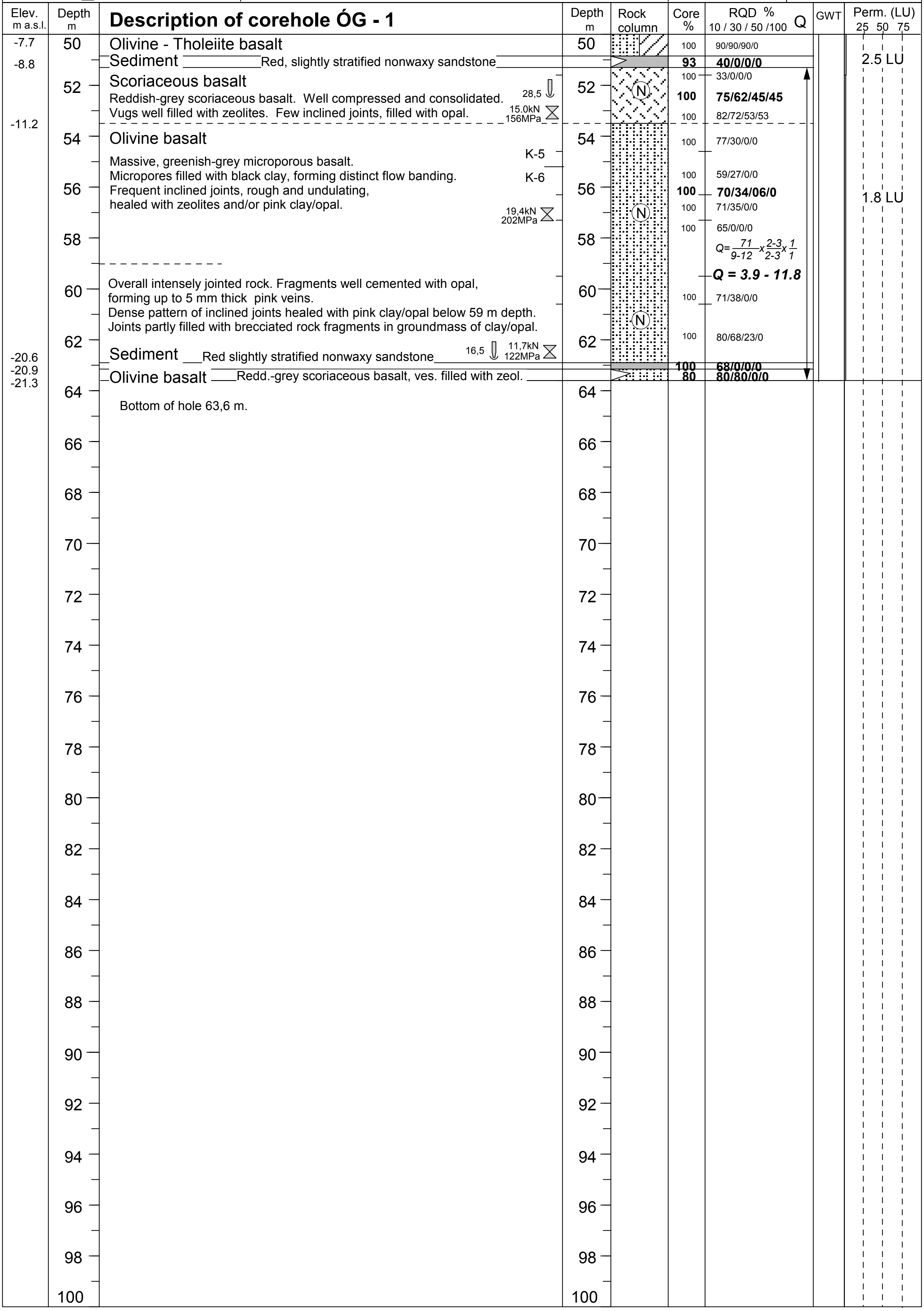
Scoriaceous basalt
Redd.-grey scoriaceous basalt. Uppermost 0,6 m well compressed and consolidated. Below 45,0 m depth rock mass highly dissoluted and stressed.

Olivine basalt - Tholeiite
Dense redd.-grey to greenish-grey microporous flow banded basalt. Scattered large vesicles, filled with zeolites.
Frequent inclined joints, rough and undulating, healed with pink clay/opal. Micropores filled with black clay, forming distinct flow banding.

24,0kN 250MPa
38,0

Core %	RQD % 10 / 30 / 50 /100
100	68/47/0/0
100	44/18/18/0
100	81/66/54/0
100	**79/57/33/7**
100	93/6666/40
	$Q=\frac{79}{9\text{-}12}x\frac{2\text{-}3}{1\text{-}2}x\frac{1}{1}$
	Q = 6.6 - 26.3
100	90/72/20/0
100	96/71/27/0
100	0/0/0/0
100	**90/90/0/0**
100	**89/71/0/0**
100	96/89/56/0
100	**85/74/36/0**
100	67/47/0/0
100	83/57/43/0
	$Q=\frac{86}{9\text{-}12}x\frac{2\text{-}3}{2\text{-}3}x\frac{1}{1}$
	Q = 4.7 - 14.3
100	**85/61/48/0**
100	87/64/53/0
73	0/0/0/0
52	0/0/0/0
82	**43/34/34/0**
98	71/56/56/0
100	69/0/0/0
65	**28/0/0/0**
51	14/0/0/0
70	0/0/0/0
85	**43/43/0/0**
100	88/35/0/0
100	**51/22/15/0**
100	20/0/0/0
	Q = 2.5 - 5.6
100	21/0/0/0
100	95/71/71/0
100	**75/0/0/0**
100	45/39/39/0
100	**33/29/29/0**
100	0/0/0/0
100	22/0/0/0
100	**69/62/62/23**
100	84/84/84/84
	$Q=\frac{60}{9\text{-}12}x\frac{2\text{-}3}{2\text{-}3}x\frac{1}{1}$
	Q = 3.3 - 10.0
100	90/90/90/0

Jarðfræðistofan Ehf JFS Geological services Ltd	**Héðinsfjörður Road Tunnel** **Ólafsfjörður** **Corehole ÓG - 1 50 - 100 m**	JFS-45 Date Dec. 2000 Design ÁgG/WaF	Drwg. ÓG1b Page **2** of **2** Drawn WaF
Empl. **VEGAGERÐIN**	Coord. X: 619672.834 Y: 514646.618 Elev.: 42.27	Driller RFS	Drilled Nov. 2000



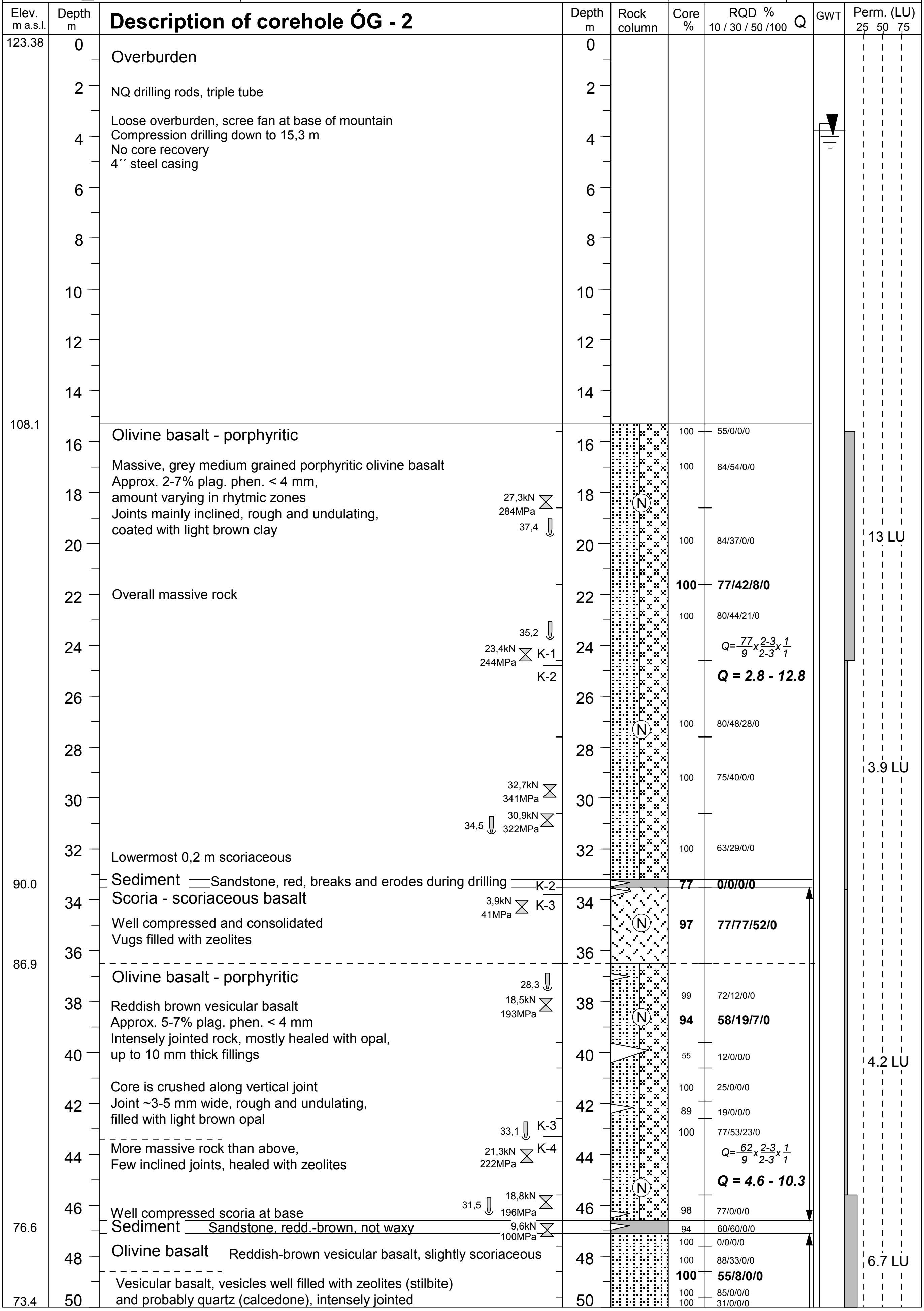
Description of corehole ÓG - 1

Elev. m a.s.l.	Depth m	Description
-7.7	50	Olivine - Tholeiite basalt
-8.8		Sediment — Red, slightly stratified nonwaxy sandstone
	52	Scoriaceous basalt Reddish-grey scoriaceous basalt. Well compressed and consolidated. Vugs well filled with zeolites. Few inclined joints, filled with opal.
-11.2	54	Olivine basalt Massive, greenish-grey microporous basalt. Micropores filled with black clay, forming distinct flow banding. Frequent inclined joints, rough and undulating, healed with zeolites and/or pink clay/opal.
	60	Overall intensely jointed rock. Fragments well cemented with opal, forming up to 5 mm thick pink veins. Dense pattern of inclined joints healed with pink clay/opal below 59 m depth. Joints partly filled with brecciated rock fragments in groundmass of clay/opal.
-20.6	62	Sediment — Red slightly stratified nonwaxy sandstone
-20.9		Olivine basalt — Redd.-grey scoriaceous basalt, ves. filled with zeol.
-21.3	64	Bottom of hole 63,6 m.

Core %	RQD % 10 / 30 / 50 /100	Q
100	90/90/90/0	
93	**40/0/0/0**	
100	33/0/0/0	
100	**75/62/45/45**	
100	82/72/53/53	
100	77/30/0/0	
100	59/27/0/0	
100	**70/34/06/0**	
100	71/35/0/0	
100	65/0/0/0	
		$Q=\frac{71}{9-12}x\frac{2-3}{2-3}x\frac{1}{1}$
		Q = 3.9 - 11.8
100	71/38/0/0	
100	80/68/23/0	
100	**68/0/0/0**	
80	**80/80/0/0**	

Jarðfræðistofan Ehf JFS Geological services Ltd	**Héðinsfjörður Road Tunnel** **Ólafsfjörður** **Corehole ÓG - 2 0 - 50 m**	JFS-45	Drwg. ÓG2a
		Date Dec. 2000	Page **1** of **3**
		Design WaF/ÁgG	Drawn WaF/DB
Empl. **VEGAGERÐIN**	Coord. X: 619860.016 Y: 514142.369 Elev.: 123.38	Driller RFS	Drilled Dec. 2000

Description of corehole ÓG - 2



Overburden

NQ drilling rods, triple tube

Loose overburden, scree fan at base of mountain
Compression drilling down to 15,3 m
No core recovery
4´´ steel casing

Olivine basalt - porphyritic

Massive, grey medium grained porphyritic olivine basalt
Approx. 2-7% plag. phen. < 4 mm,
amount varying in rhytmic zones
Joints mainly inclined, rough and undulating,
coated with light brown clay

Overall massive rock

Lowermost 0,2 m scoriaceous

Sediment Sandstone, red, breaks and erodes during drilling

Scoria - scoriaceous basalt

Well compressed and consolidated
Vugs filled with zeolites

Olivine basalt - porphyritic

Reddish brown vesicular basalt
Approx. 5-7% plag. phen. < 4 mm
Intensely jointed rock, mostly healed with opal,
up to 10 mm thick fillings

Core is crushed along vertical joint
Joint ~3-5 mm wide, rough and undulating,
filled with light brown opal

More massive rock than above,
Few inclined joints, healed with zeolites

Well compressed scoria at base

Sediment Sandstone, redd.-brown, not waxy

Olivine basalt Reddish-brown vesicular basalt, slightly scoriaceous

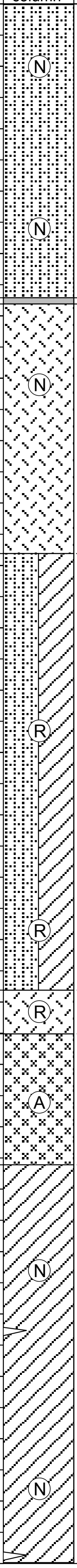
Vesicular basalt, vesicles well filled with zeolites (stilbite)
and probably quartz (calcedone), intensely jointed

Core %	RQD % 10 / 30 / 50 /100
100	55/0/0/0
100	84/54/0/0
100	84/37/0/0
100	**77/42/8/0**
100	80/44/21/0
	$Q=\frac{77}{9}x\frac{2-3}{2-3}x\frac{1}{1}$
	Q = 2.8 - 12.8
100	80/48/28/0
100	75/40/0/0
100	63/29/0/0
77	**0/0/0/0**
97	**77/77/52/0**
99	72/12/0/0
94	**58/19/7/0**
55	12/0/0/0
100	25/0/0/0
89	19/0/0/0
100	77/53/23/0
	$Q=\frac{62}{9}x\frac{2-3}{2-3}x\frac{1}{1}$
	Q = 4.6 - 10.3
98	77/0/0/0
94	60/60/0/0
100	0/0/0/0
100	88/33/0/0
100	**55/8/0/0**
100	85/0/0/0
100	31/0/0/0

Jarðfræðistofan Ehf JFS Geological services Ltd	**Héðinsfjörður Road Tunnel** **Ólafsfjörður** **Corehole ÓG - 2 50 - 100 m**	JFS-45	Drwg. ÓG2b
		Date Dec. 2000	Page **2** of **3**
		Design ÁgG/WaF	Drawn WaF/DB
Empl. **VEGAGERÐIN**	Coord. X: 619860.016 Y: 514142.369 Elev.: 123.38	Driller RFS	Drilled Dec. 2000

Description of corehole ÓG - 2

Elev. m a.s.l.	Depth m	Description	Samples / tests
73.4	50	**Olivine basalt**	
	52	Vesicular olivine basalt (10-15%) Intensely jointed rock, Joints rough and undulating, filled and partly healed with yellowish brown opal	K-4 K-5
	54	Lower part more massive and microporous Micropores form distinct flow banding	
	57		33,3
	58	Lowermost 0,2 m scoriaceous	25,3,3kN 263MPa
63.9	59.5	**Sediment** Sandstone, red, breaks during drilling	
	60	**Scoria**	K-5
	61	Well compressed and consolidated scoria Vugs filled with zeolites	2,1kN 22MPa K-6
	62	Rock seems to be more or less continuous, but core breaks up and erods slightly during drilling	
	65	More massive crystalline basaltic zone	6,2kN 65MPa
	66	Well cemented, compact zone Vugs well filled with zeolites	
55.8	68	**Olivine basalt - Tholeiite**	29,6 23,1kN 241MPa K-6
	69–72	Intermediate basalt classification Massive light grey dense fine grained flow banded basalt Inclined joints, rough and undulating, healed / filled with opal Scattered large vesicles filled with zeolites and / or black clay Zoned microporous flow banding Core partly breaks into slices during drilling and handling due to flow banding	K-7 27,0 24,2kN 252MPa
	74		33,5kN 349MPa
	77–80		34,0 K-7 K-8 35,2kN 367MPa
41.8	82	**Scoria** Well compressed but weak scoria (low breaking strength) Vugs well filled with zeolites	
40.4	83	**Porphyritic basalt** Coarse grained, microporous basalt Approx 7-8% plag. phen. < 4 mm	29,6 14,5kN 151MPa
36.2	87	**Tholeiite basalt** Scoriaceous in topmost 2-3 m	K-8 K-9
	90	Vesicular between 90 - 94 m depth Large vesicles, well filled with zeolites	29,3 13,7kN 143MPa
	94	Massive tholeiite basalt Frequent microporous flow banding Vesicles elongated / plated, well filled with zeolites and black clay	33,5 29,6kN 308MPa K-9 K-10
23.4	100	Scoriaceous at base	



Core %	RQD % 10 / 30 / 50 /100
100	31/0/0/0
100	59/0/0/0
100	**55/8/0/0**
100	70/0/0/0
100	41/11/0/0
100	67/17/0/0
100	**0/0/0/0**
100	92/92/92/0
100	66/21/21/0
100	**72/40/32/13**
100	80/45/35/35
100	47/28/0/0
100	81/46/0/0
100	84/60/39/0
100	**83/46/21/0**
100	90/74/42/0
100	87/26/17/0
100	73/23/0/0
100	**41/25/0/0**
100	91/91/91/91
100	**92/92/86/86**
100	92/92/82/82
100	100/100/100/0
100	95/87/87/39
98	**91/75/63/23**
96	75/23/0/0
100	99/99/99/67
100	94/87/69/0
92	92/80/45/0

Q (50–59.5 m): $Q=\frac{55}{9-12}x\frac{2-3}{2-3}x\frac{1}{1}$ **Q = 3.0 - 9.2**

Q (60–67.5 m): $Q=\frac{77}{9}x\frac{2-3}{2-3}x\frac{1}{1}$ **Q = 5.7 - 12.8**

Q (67.5–81.5 m): $Q=\frac{83}{9}x\frac{2-3}{2-3}x\frac{1}{1}$ **Q = 6.1 - 13.8**

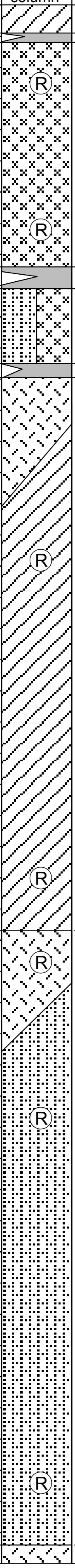
Q (81.5–87 m): $Q=\frac{82}{9}x\frac{2-3}{2-3}x\frac{1}{1}$ **Q = 6.1 - 13.6**

Q (87–100 m): $Q=\frac{91}{9}x\frac{2-3}{2-3}x\frac{1}{1}$ **Q = 6.7 - 15.2**

GWT

Perm. (LU) 25 50 75: 6.7 LU; 0.2 LU; 2.7 LU; 0.3 LU

Jarðfræðistofan Ehf JFS Geological services Ltd	**Héðinsfjörður Road Tunnel** **Ólafsfjörður** **Corehole ÓG - 2 100 - 150 m**	JFS-45 Date Dec. 2000 Design ÁgG/WaF	Drwg. ÓG2c Page **3** of **3** Drawn WaF/DB
Empl. **VEGAGERÐIN**	Coord. X: 619860.016 Y: 514142.369 Elev.: 123.38	Driller RFS	Drilled Dec. 2000



Elev. m a.s.l.	Depth m	**Description of corehole ÓG - 2**		Core %	RQD % 10 / 30 / 50 /100	Q	GWT	Perm. (LU) 25 50 75
23.4	100	Tholeiite basalt Massive basalt, scoriaceous in lowermost 0,25 m		92	92/80/45/0			
22.3				**93**	**77/0/0/0**			
		Sediment Sandstone, redd.-brown, not waxy, compedent	24,4					
	102		12,6kN 131MPa	100	102/0/0/0			
		Porphyritic basalt		100	85/77/77/77			
	104	Massive basalt with few narrow white veins of healed joints Approx. 7-10% plag. phen. < 4 mm Small vesicles filled with black clay	33,0 25,3kN 263MPa	**100**	**94/91/80/71**	$Q=\frac{94}{9-12}x\frac{2-3}{2-3}x\frac{1}{1}$		0.3 LU
	106	Vesicular in topmost and lowermost part (10-15%) Vesicles well filled with zeolites	K-10 K-11			***Q = 5.2 - 15.6***		
15.0	108		19,6kN 204MPa	100	100/100/100/100			
14.3		Sediment Sdst., red-brown, waxy in lower part, low strength	11,5	**64**	**0/0/0/0**			
	110	Olivine basalt - porphyritic Medium coarse grained, ves. basalt, ~ 15% vesicles, filled with zeolites		**100**	**100/86/86/86**	***Q = 1.9 - 17.5***		
11.6		Sediment Sandstone, red waxy, low breaking strength		**93**	**0/0/0/0**			
	112	Scoriaceous basalt Vesicular basalt with scoriaceous zones Large vugs, well filled with zeolites Well cemented continuous core	9,7kN 101MPa	100	100/93/78/56			
	114		31,5					
		Tholeiite basalt	22,6kN 235MPa K-11					
	116		K-12	100	97/97/97/97			
		Fine grained, massive basalt, irregular flow banding Inclined joints, healed with calcite and calcedone Scattered small vesicles (~1-3%), filled with black clay Scattered thin vein pattern of calcite healed joints Horizontal microporous flow banding Dense basalt with xenolites of granophyr						
	118			**100**	**98/95/89/69**			
				100	95/95/95/95			
	120		34,2 35,6kN 371MPa			$Q=\frac{98}{9-12}x\frac{2-3}{2-3}x\frac{1}{1}$		0.0 LU
	122					***Q = 5.4 - 16.3***		
				100	98/98/87/87			
	124							
				100	100/100/88/46			
	126		31,4kN 327MPa 38,3 K-12 K-13					
			39,6kN 412MPa					
	128			100	97/88/88/33			
-6.3	130	Scoriaceous basalt Massive scoriaceous basalt, scattered vesicles filled with zeolites, calcite and green clay. 1-3 cm thick red sandstone infiltration at top	30,1 24,3kN 253MPa	100	97/83/57/0			
	132	Olivine basalt						
	134	Homogeneous, massive basalt Small plagioclase phenocrysts (3-7%, < 4 mm) Scattered pores and micropores, filled with black clay Few inclined joints, partly healed with zeolites	K-13	100	100/93/77/77			
	136		K-14	**100**	**98/89/81/57**			
		Few thin white veins of parallel joints healed with zeolites at 145 m depth		100	100/100/100/100			
	138		37,0 35,6kN 371MPa			$Q=\frac{98}{9}x\frac{2-3}{1-3}x\frac{1}{1}$		
	140					***Q = 7.2 - 16.3***		
				100	97/86/74/74			0.0 LU
	142		34,4 37,0kN 385MPa					
				100	93/86/86/62			
	144		K-14 K-15					
	146			100	98/87/87/64			
	148		28,6	100	100/86/86/0			
-26.0		Bottom of Hole at 150,6 m depth	16,2kN 169MPa					
-26.6	150	Scoriaceous basalt Very well compressed and consolidated		**100**	**97/97/97/97**			

Jarðfræðistofan Ehf JFS Geological services Ltd	**Héðinsfjörður Road Tunnel** **Ólafsfjörður** **Corehole ÓG - 3 0 - 50 m**	JFS-45 Date Dec. 2000 Design WaF/ÁgG	Drwg. ÓG3a Page **1** of **1** Drawn WaF
Empl. **VEGAGERÐIN**	Coord. X: 620186.2 Y: 514816.225 Elev.: 39.63	Driller RFS	Drilled Dec. 2000

Description of corehole ÓG - 3

Elev. m a.s.l. / Depth m

39.63 — 0

Overburden

NQ drilling rods, triple tube
Thin cover of loose soily debris
Percussion drilling down to 6.15 m
Depth to bedrock 4,5 m
No core recovery
Hole inclined 30° West
4" steel casing

34.3 — 6

Olivine basalt - Tholeiite

Massive medium grey fine grained intermediate basalt
Scattered vesicles < 1% up to 3 mm in diameter, filled with zeolites
Frequent inclined joints, rough and undulating, coated with brown clay
Some joints healed with zeolites

Massive but highly jointed rock mass

Vesicles in lowermost 0,5 m filled with black clay
Few large vesicles up to 20 mm in diameter in lowermost 0,2 m

Scoriaceous in lowermost 0,1 m, sharp contact

24.9

Sediment

Sandstone, red, layers with fragments of scoria
5 cm thick lense of light brown clayeous volcanic tephra

24.2

Scoria

Redd.-brown scoria, well compressed and consolidated

Tholeiite basalt

Redd.-brown vesicular basalt. Large vesicles filled with zeolites, smaller vesicles empty

Fresh grey more massive microporous basalt
Scattered vesicles filled with zeolites
Long joint splitting the core, rough and undulating
Joints rough and undulating, coated with thin brown clay

16.9

Sediment

Sandstone, red.-brown, waxy, breaks during drilling

16.2

Scoria - scoriaceous basalt

Well compressed and consolidated scoriaceous basalt
Vugs filled with zeolites
Compedent rock, breaks up with few joints during drilling

12.0 — 32

Olivine basalt

Massive fine grained olivine basalt
Scattered small vesicles filled with zeolites
Frequent inclined joints, rough and undulating,
coated with clay and/or zeolites up to 2-3 mm

Subvertical joint
Massive zone
Core breaks at subvertical joint

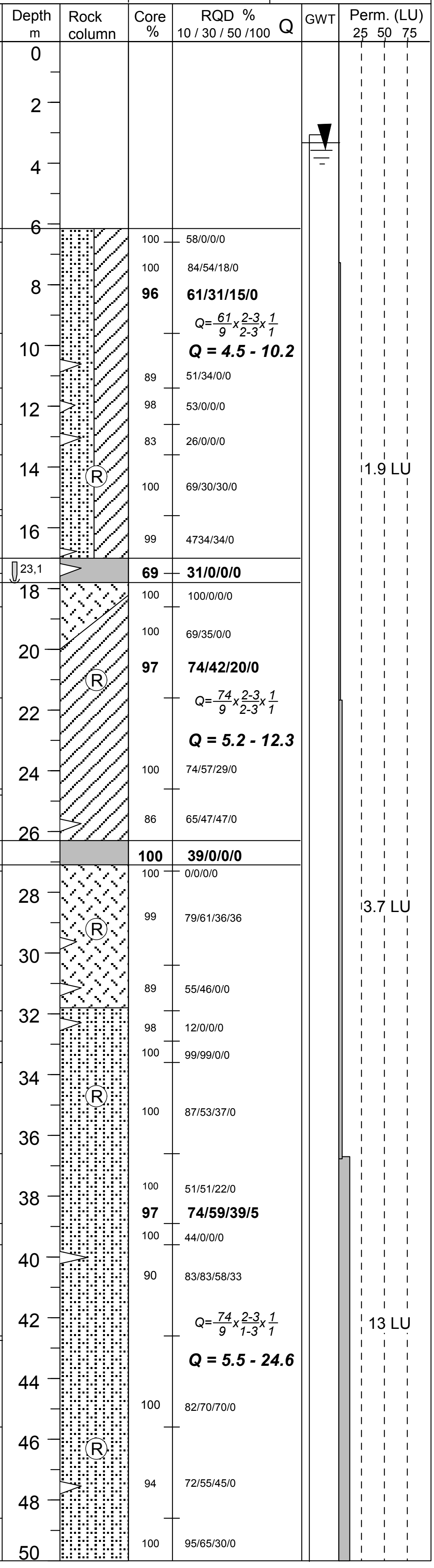
Massive fine grained microporous olivine basalt
Irregular microporous flow pattern
Approx. 3-4% small plagioclase phenocrysts
Few inclined joints, rough and undulating

Inclined joints, rough and undulating, thin blueish clay coating

-4.3 — 50

Bottom of hole at 50.7 m

Point load tests and samples: 45,2kN 471MPa; 45,6; K-1; K-2; 11,8kN 123MPa; 23,1; 19,2kN 200MPa; 30,7; 31,8kN 331MPa; 32,7; K-2; K-3; 8,4kN 87MPa; 38,0kN 396MPa; 36,6; K-3; K-4; 35,0kN 364MPa; 45,8; K-4; K-5; 38,8kN 404MPa; 42,9



Jarðfræðistofan Ehf JFS Geological services Ltd	**Legend for coreholes**	JFS-39	Drwg.
		Date	Page 1 of 1
		Design ÁgG	Drawn ÁgG/DB
Empl. **Landsvirkjun**	Coord. X: Y: Elev.:	Driller RFS	Drilled August 2000

Elev. m a.s.l.	Depth m	Description of corehole	Depth m	Rock column	Core %	RQD % 10 / 30 / 50 /100	Q	GWT	Perm. (LU) 25 50 75

Depth m: 0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40 42 44 46 48 50

LEGEND

NQ drilling rods with triple tube, core Ø 45 mm

Tholeiite basalt	▨
Well defined boundary between rock units	──
Olivine basalt	▦
Poorly defined boundary between rock units	- - -
Porphyritic basalt	▩
Scoria	▨
MÓBERG: Tuff breccia	░
MÓBERG: Pillow breccia	▒
MÓBERG: Cube jointed basalt	▒
Sedimentary interbed (fine grained most often tuffaceous)	■
Sedimentary interbed (coarse grained sand and pumice)	░
Sedimentary interbed (conglomerate / diamictite and tillite)	◩
Dyke intrusions (subvertical)	▩
Joint, fault	╲

Marks for drilling intervals –

Core box number K-31 / K-32

Rock magnetization
Normal / Reverse / Anomalous
Ⓝ / Ⓡ / Ⓐ

Point load test (UCS) 20,9kN 218MPa ⧖

Schmidt hammer test (Rebound hardness) 38

Permeability

Core recovery and RQD defined by drilling intervals

Core recovery and RQD defined by rock units

RQD % 10 / 30 / 50 /100 — RQD for rock units

RQD %/DI 10 / 30 / 50 / 100 — RQD drilled intervals

Percentage of core pieces of respectively exceeding 10 cm, 30 cm, 50 cm and 100 cm continuous core length, indicating block sizes, within the same rock unit

NGI Rock classification system Q - value

Groundwatertable during drilling

Groundwatertable

Appendix II Permeability tests

Holes SG-1, HG-1 through HG-5, OG-1 through OG-3

Borhole SG-1 - Permeability tests overview

Tested intervals					Permeability LU-value				Perm. K-value		Maximum values		
Test	**Depth**			**Interval**	**Low range**		**High range**		**Low range**	**High range**	**Max. flow**	**Max. press**	**Opening threshold**
Nr.	**from** *(m)*		**to** *(m)*	*(m)*	**Perm.** *(LU)*	**Press.** *(bar)*	**Perm.** *(LU)*	**Press.** *(bar)*	**Perm.** *(K)*	**Perm.** *(K)*	*(l/min)*	*(bar)*	*(bar)*
1	18,6	-	30,9	12,3	0,0	4,0	4,9	8,0	1,00E-06	1,28E-06	62	14	6
2	30,9	-	42,9	12,0	0,0	4,0	16,3	10,3	1,00E-06	2,26E-06	202	12,7	6
3	42,9	-	57,9	15,0	0,0	16,1	0,0	16,1	1,00E-06	1,00E-06	0	16,09	does not open
4	57,9	-	75,9	18,0	2,0	10,0	4,1	13,7	1,11E-06	1,23E-06	108	15,8	is open
5	75,9	-	93,9	18,0	10,8	10,3	26,3	5,5	1,72E-06	3,72E-06	350	12,6	is open
6	93,6	-	114,7	21,1	0,1	6,0	4,0	2,0	1,00E-06	1,22E-06	99	17,75	decreasing perm.
7	114,7	-	135,7	21,0	1,6	6,6	2,0	20,3	1,08E-06	1,11E-06	86,5	20,25	opens very little
8	135,7	-	159,7	24,0	0,0	24,6	0,0	24,6	1,00E-06	1,00E-06	0	24,6	does not open
9	159,7	-	183,7	24,0	0,0	20,0	0,0	20,0	1,00E-06	1,00E-06	0	20	does not open
10	183,7	-	207,7	24,0	0,0	20,0	0,0	20,0	1,00E-06	1,00E-06	0	20	does not open
11	207,7	-	231,7	24,0	0,0	13,5	2,8	7,5	1,00E-06	1,15E-06	80	23,95	14,9
12	231,7	-	255,7	24,0	0,0	20,0	0,0	20,0	1,00E-06	1,00E-06	0	20	does not open
13	255,7	-	279,7	24,0	0,0	24,1	0,0	24,1	1,00E-06	1,00E-06	0	24,1	does not open
14	279,7	-	303,7	24,0	0,0	24,5	0,0	24,5	1,00E-06	1,00E-06	0	24,45	does not open
15	303,7	-	330,7	27,0	0,0	22,0	0,0	22,0	1,00E-06	1,00E-06	0	22	does not open

Borehole HG-1 - Permeability tests overview

Tested intervals					**Permeability LU-value**				**Perm. K-value**		**Maximum values**		
Test	**Depth**			**Interval**	**Low range**		**High range**		**Low range**	**High range**	**Max. flow**	**Max. press**	**Opening threshold**
Nr.	**from**		**to**		**Perm.**	**Press.**	**Perm.**	**Press.**	**Perm.**	**Perm.**			
	(m)		***(m)***	***(m)***	***(LU)***	***(bar)***	***(LU)***	***(bar)***	***(K)***	***(K)***	***(l/min)***	***(bar)***	***(bar)***
1	27,6	-	39,6	12,0	0,6	10,2	29,4	4,4	1,03E-06	4,35E-06	225	11	11
2	39,6	-	57,6	18,0	0,0	7,9	0,7	12,9	1,00E-06	1,04E-06	16,7	14,8	8,85
3	57,6	-	77,8	20,2	0,5	4,9	3,5	13,9	1,03E-06	1,19E-06	103	14,82	opens very little
4	77,8	-	99,6	21,8	0,0	11,0	0,3	17,0	1,00E-06	1,02E-06	12,4	17	12 very little
5	99,6	-	120,3	20,7	0,1	10,0	7,3	10,5	1,01E-06	1,44E-06	157	11,9	opens very little
6	120,6	-	141,6	21,0	0,0	15,0	0,0	15,0	1,00E-06	1,00E-06	0	15	does not open
7	141,6	-	168,6	27,0	0,7	2,3	2,6	9,7	1,04E-06	1,14E-06	84	14,59	opens very little at 3.4
8	168,6	-	195,6	27,0	0,0	15,2	0,0	15,2	1,00E-06	1,00E-06	0	15,21	does not open
9	195,6	-	222,6	27,0	0,0	22,3	0,0	22,3	1,00E-06	1,00E-06	0	22,25	does not open
10	222,6	-	249,6	27,0	0,0	25,6	0,0	25,6	1,00E-06	1,00E-06	0	25,6	does not open
11	249,6	-	276,3	26,7	0,0	20,3	0,0	20,3	1,00E-06	1,00E-06	0	20,32	does not open
12	276,3	-	309,6	33,3	0,0	20,5	0,0	20,5	1,00E-06	1,00E-06	0	20,47	does not open
13	309,6	-	350,2	40,6	0,0	20,5	0,0	20,5	1,00E-06	1,00E-06	0	20,46	does not open

Borehole HG-2 - Permeability tests overview

Tested intervals					**Permeability LU-value**				**Perm. K-value**		**Maximum values**		
Test	**Depth**			**Interval**	**Low range**		**High range**		**Low range**	**High range**	**Max. flow**	**Max. press**	**Opening threshold**
Nr.	**from**		**to**		**Perm.**	**Press.**	**Perm.**	**Press.**	**Perm.**	**Perm.**			
	(m)		***(m)***	***(m)***	***(LU)***	***(bar)***	***(LU)***	***(bar)***	***(K)***	***(K)***	***(l/min)***	***(bar)***	***(bar)***
1	3,6	-	15,6	12,0	0,0	3,4	28,7	4,5	1,00E-06	4,20E-06	155	8,25	4,35
2	15,6	-	27,6	12,0	0,0	2,4	9,4	11,0	1,00E-06	1,60E-06	123	13,25	3,4
3	27,6	-	42,6	15,0	0,4	2,4	10,1	12,3	1,02E-06	1,66E-06	217	14,88	3,4
4	42,6	-	57,6	15,0	1,8	3,0	9,0	13,9	1,10E-06	1,57E-06	188	14,75	4 very little
5	57,6	-	75,6	18,0	0,0	16,0	0,0	16,0	1,00E-06	1,00E-06	0	16	does not open
6	75,6	-	96,6	21,0	2,7	2,0	17,6	6,4	1,15E-06	2,41E-06	236	6,7	3
7	96,6	-	121,6	25,0	4,5	12,5	7,5	7,4	1,25E-06	1,45E-06	173	14,1	perm decreases
8	120,6	-	144,6	24,0	1,4	3,0	6,9	2,1	1,07E-06	1,43E-06	127	15,55	perm decreases
9	144,6	-	168,6	24,0	0,0	2,0	0,5	20,0	1,00E-06	1,03E-06	28,6	20	4 very little
10	168,6	-	195,6	27,0	0,0	24,0	0,0	24,0	1,00E-06	1,00E-06	0	24	does not open
11	195,6	-	219,6	24,0	0,1	2,0	0,5	4,0	1,01E-06	1,02E-06	11,2	20	does not open

Borehole HG-3 - Permeability tests overview

Tested intervals					Permeability LU-value				Perm. K-value		Maximum values		
Test	Depth			Interval	Low range		High range		Low range	High range	Max. flow	Max. press	Opening threshold
Nr.	from		to		Perm.	Press.	Perm.	Press.	Perm.	Perm.			
	(m)		*(m)*	*(m)*	*(LU)*	*(bar)*	*(LU)*	*(bar)*	*(K)*	*(K)*	*(l/min)*	*(bar)*	*(bar)*
1	6,6	-	18,6	12,0	4,3	8,0	46,6	4,9	1,24E-06	1,03E-05	274	11,6	9,9
2	18,6	-	30,6	12,0	0,0	10,0	26,6	10,8	1,00E-06	3,79E-06	345	11,95	12
3	30,6	-	42,6	12,0	3,2	6,0	9,9	16,2	1,17E-06	1,64E-06	192	17,6	opens very little

Borehole HG-4 - Permeability tests overview

Tested intervals					Permeability LU-value				Perm. K-value		Maximum values		
Test	Depth			Interval	Low range		High range		Low range	High range	Max. flow	Max. press	Opening threshold
Nr.	from		to		Perm.	Press.	Perm.	Press.	Perm.	Perm.			
	(m)		*(m)*	*(m)*	*(LU)*	*(bar)*	*(LU)*	*(bar)*	*(K)*	*(K)*	*(l/min)*	*(bar)*	*(bar)*
1	12,6	-	24,6	12,0	0,0	4,0	17,1	3,9	1,00E-06	2,35E-06	133	9,45	6
2	24,6	-	36,6	12,0	0,0	4,0	11,9	6,8	1,00E-06	1,81E-06	96	7,85	6
3	36,6	-	51,6	15,0	0,0	10,0	3,6	17,8	1,00E-06	1,20E-06	95	19,2	12,25

Borehole HG-5 - Permeability tests overview

Tested intervals					Permeability LU-value				Perm. K-value		Maximum values		
Test	Depth			Interval	Low range		High range		Low range	High range	Max. flow	Max. press	Opening threshold
Nr.	from		to		Perm.	Press.	Perm.	Press.	Perm.	Perm.			
	(m)		*(m)*	*(m)*	*(LU)*	*(bar)*	*(LU)*	*(bar)*	*(K)*	*(K)*	*(l/min)*	*(bar)*	*(bar)*
1	9,6	-	18,6	9,0	0,0	12,0	45,3	1,3	1,00E-06	9,63E-06	204	13,1	13,1
2	18,6	-	33,6	15,0	2,9	2,0	13,9	12,2	1,15E-06	2,00E-06	253	12,15	3
3	33,6	-	48,6	15,0	0,0	4,0	11,6	14,2	1,00E-06	1,79E-06	246	16,65	6
4	48,6	-	63,6	15,0	0,0	4,0	4,4	19,5	1,00E-06	1,25E-06	128	19,8	6
5	63,6	-	78,6	15,0	0,0	2,0	17,2	9,3	1,00E-06	2,36E-06	238	11,95	3,25

Borehole ÓG-1 - Permeability tests overview

Tested intervals					Permeability LU-value				Perm. K-value		Maximum values		
Test	Depth			Interval	Low range		High range		Low range	High range	Max. flow	Max. press	Opening threshold
Nr.	from		to		Perm.	Press.	Perm.	Press.	Perm.	Perm.			
	(m)		*(m)*	*(m)*	*(LU)*	*(bar)*	*(LU)*	*(bar)*	*(K)*	*(K)*	*(l/min)*	*(bar)*	*(bar)*
1	9,7	-	18,6	8,9	0,0	2,4	31,8	7,1	1,00E-06	4,91E-06	204	13,77	4,37
2	18,6	-	27,6	9,0	0,0	4,2	46,3	2,7	1,00E-06	1,01E-05	226	16,51	6,16
3	27,6	-	39,6	12,0	0,0	3,3	6,1	15,3	1,00E-06	1,35E-06	111	16,62	5,27
4	39,6	-	51,6	12,0	1,4	2,2	2,5	17,4	1,07E-06	1,13E-06	51	17,68	opens very little
5	51,6	-	63,6	12,0	1,4	2,8	1,8	4,3	1,07E-06	1,09E-06	35	17,36	opens very little

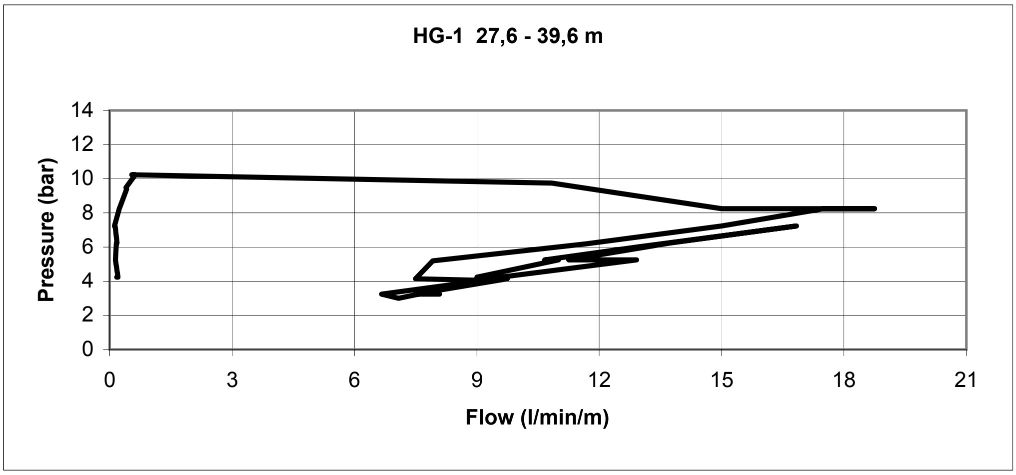
Borehole ÓG-2 - Permeability tests overview

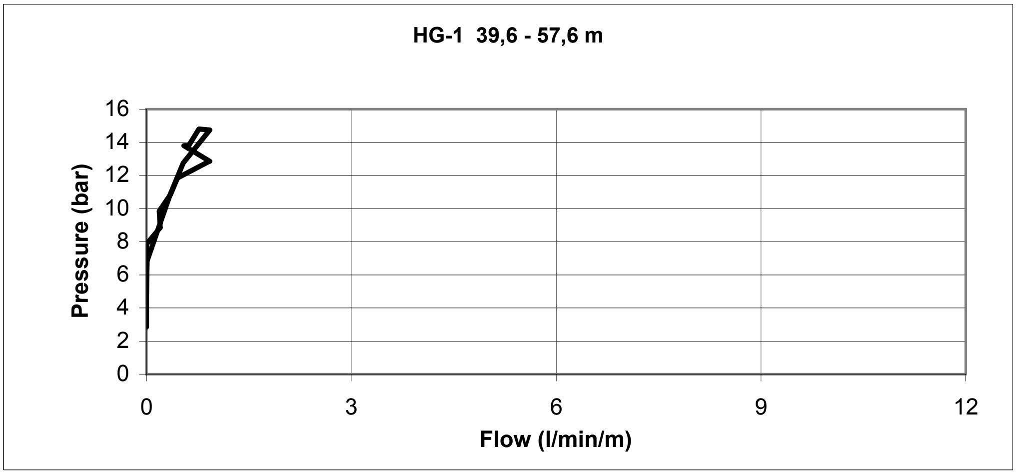
Tested intervals					Permeability LU-value				Perm. K-value		Maximum values		
Test	Depth			Interval	Low range		High range		Low range	High range	Max. flow	Max. press	Opening threshold
Nr.	from		to		Perm.	Press.	Perm.	Press.	Perm.	Perm.			
	(m)		*(m)*	*(m)*	*(LU)*	*(bar)*	*(LU)*	*(bar)*	*(K)*	*(K)*	*(l/min)*	*(bar)*	*(bar)*
1	15,6	-	24,6	9,0	0,0	4,4	13,4	11,8	1,00E-06	1,96E-06	143	13,62	6,32
2	24,6	-	33,5	8,9	0,0	2,7	3,9	18,5	1,00E-06	1,22E-06	65	18,53	4,28
3	33,5	-	45,6	12,1	1,8	12,6	4,2	2,6	1,09E-06	1,23E-06	56	18,55	opens very little
4	45,6	-	57,6	12,0	2,0	6,3	6,9	15,8	1,10E-06	1,41E-06	131	15,89	is open at beginning
5	57,6	-	72,6	15,0	0,0	3,2	0,2	8,4	1,00E-06	1,01E-06	3,7	18,89	opens very little at 4.4
6	72,6	-	90,6	18,0	1,2	14,1	2,7	3,4	1,06E-06	1,14E-06	48	19,39	is very little open
7	90,6	-	111,6	21,0	0,1	9,2	0,3	3,3	1,01E-06	1,02E-06	8,2	19,3	does not open
8	111,6	-	132,6	21,0	0,0	19,1	0,0	19,1	1,00E-06	1,00E-06	0	19,1	does not open
9	132,6	-	150,6	18,0	0,0	19,4	0,0	19,4	1,00E-06	1,00E-06	0	19,38	does not open

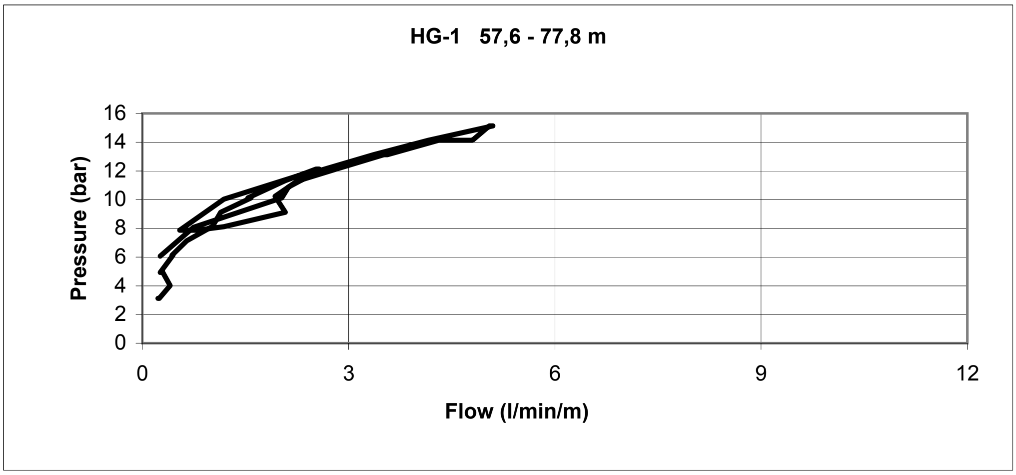
Borehole ÓG-3 - Permeability tests overview

Tested intervals					Permeability LU-value				Perm. K-value		Maximum values		
Test	Depth			Interval	Low range		High range		Low range	High range	Max. flow	Max. press	Opening threshold
Nr.	from		to		Perm.	Press.	Perm.	Press.	Perm.	Perm.			
	(m)		*(m)*	*(m)*	*(LU)*	*(bar)*	*(LU)*	*(bar)*	*(K)*	*(K)*	*(l/min)*	*(bar)*	*(bar)*
1	7,0	-	21,6	14,6	0,7	2,8	1,9	7,0	1,04E-06	1,10E-06	19	7	does not open
2	21,6	-	36,7	15,1	0,0	2,6	3,7	12,6	1,00E-06	1,20E-06	70	12,7	4.3 very little
3	36,7	-	50,7	14,0	2,6	2,8	13,3	10,2	1,14E-06	1,95E-06	190	10,2	is open

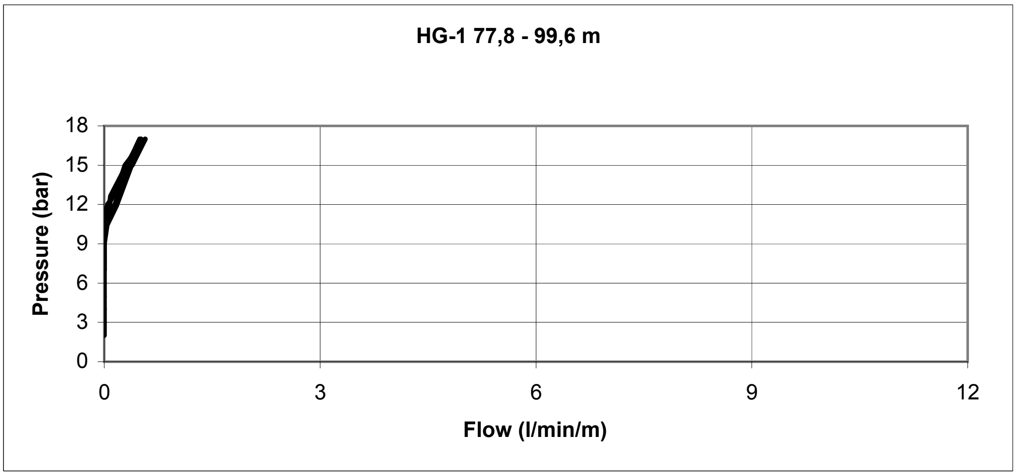
Permeability tests in Siglufjörður, Héðinsfjörður and Ólafsfjörður

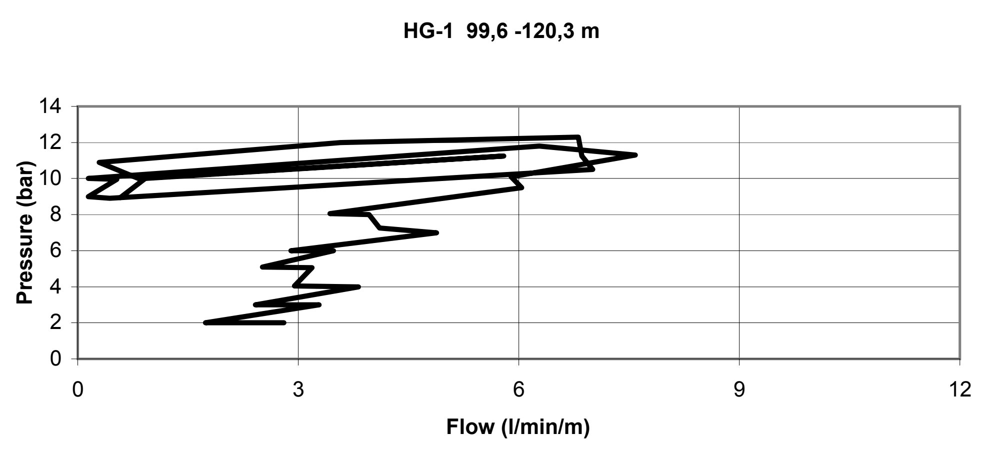


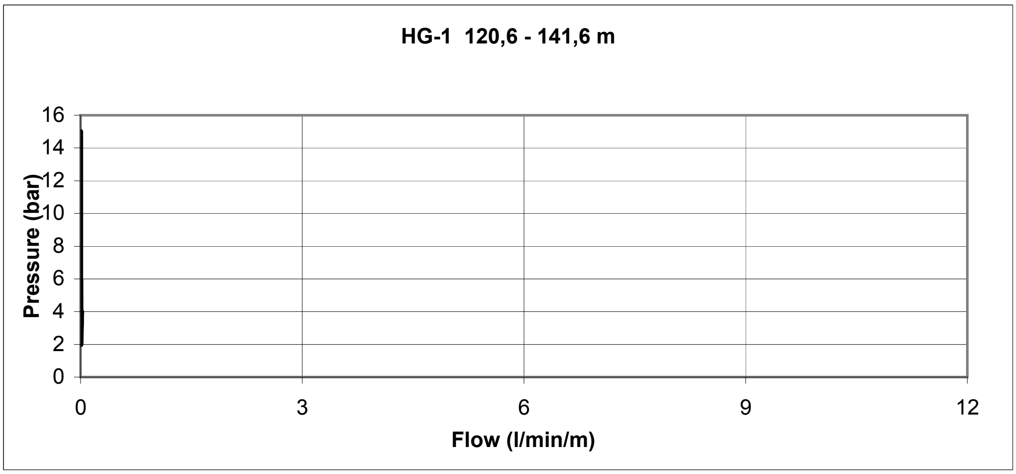




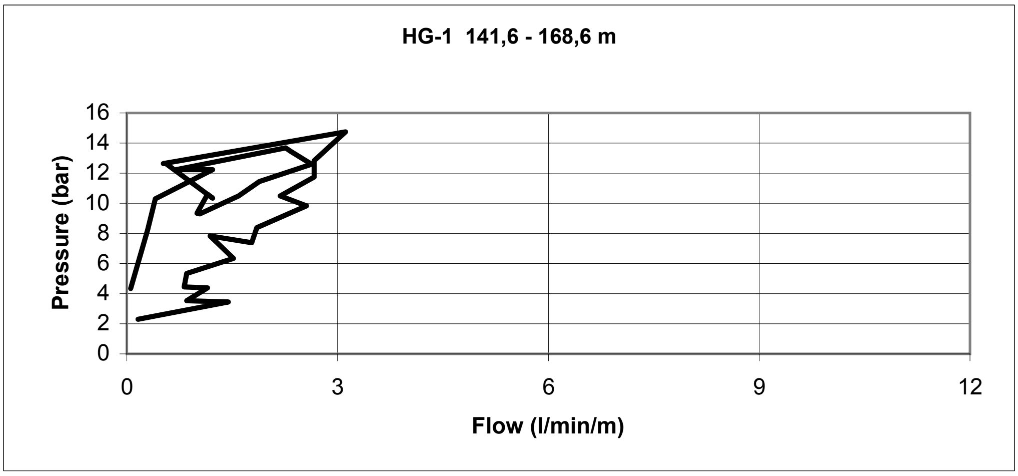
Permeability tests in Siglufjörður, Héðinsfjörður and Ólafsfjörður

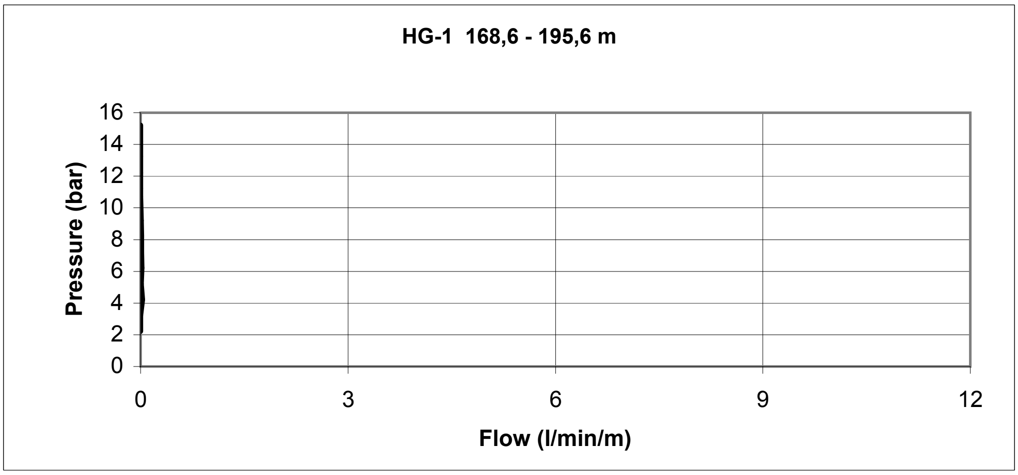


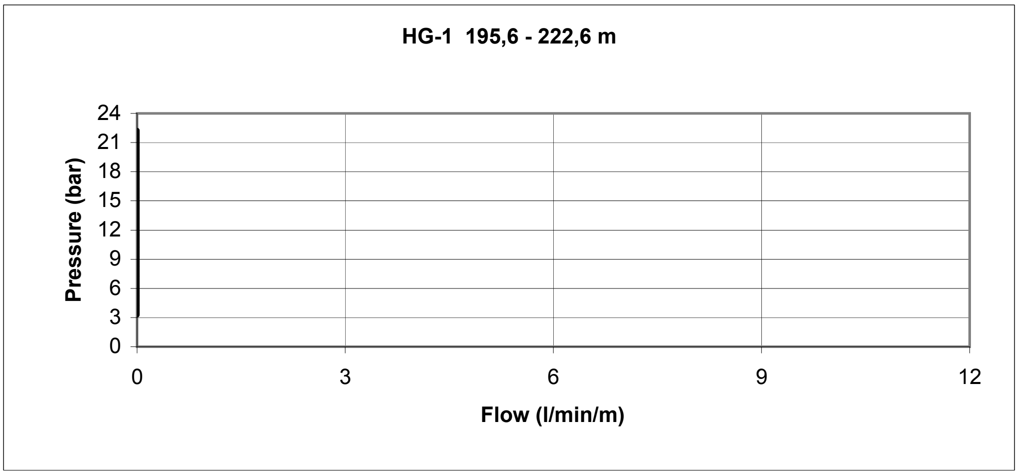


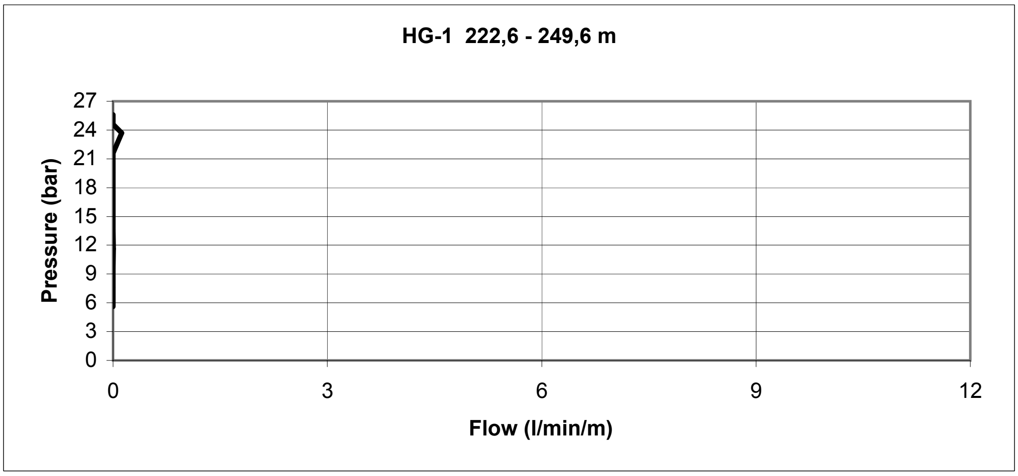


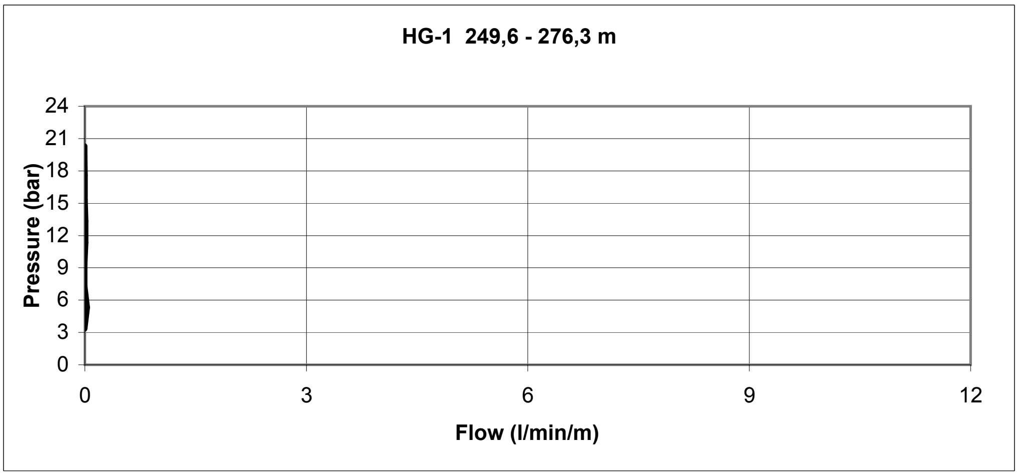
Permeability tests in Siglufjörður, Héðinsfjörður and Ólafsfjörður

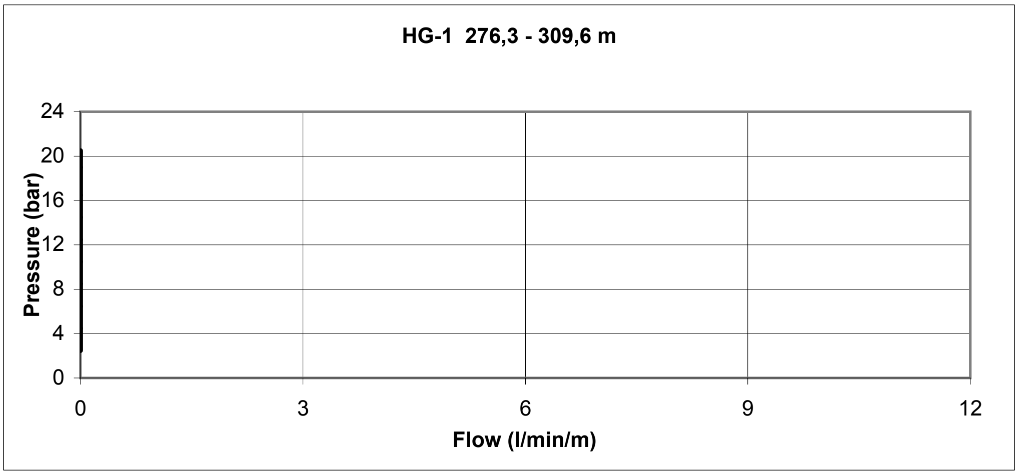




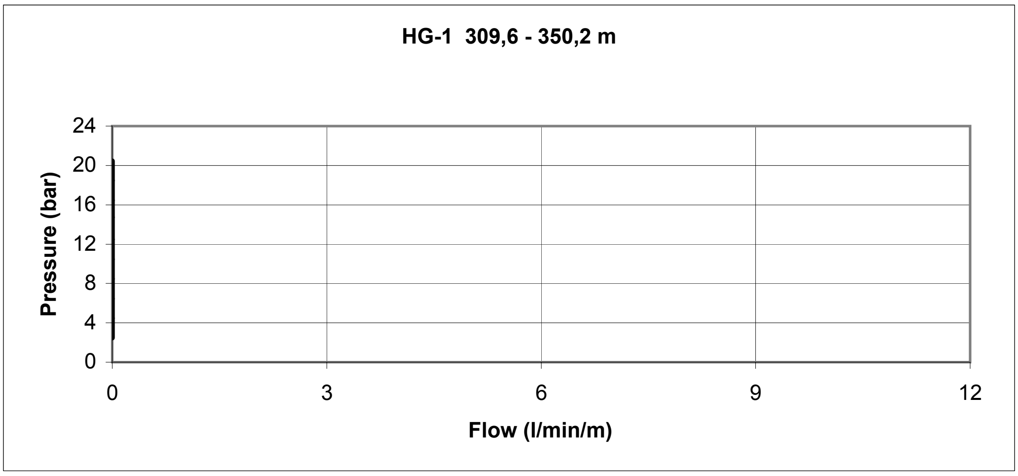


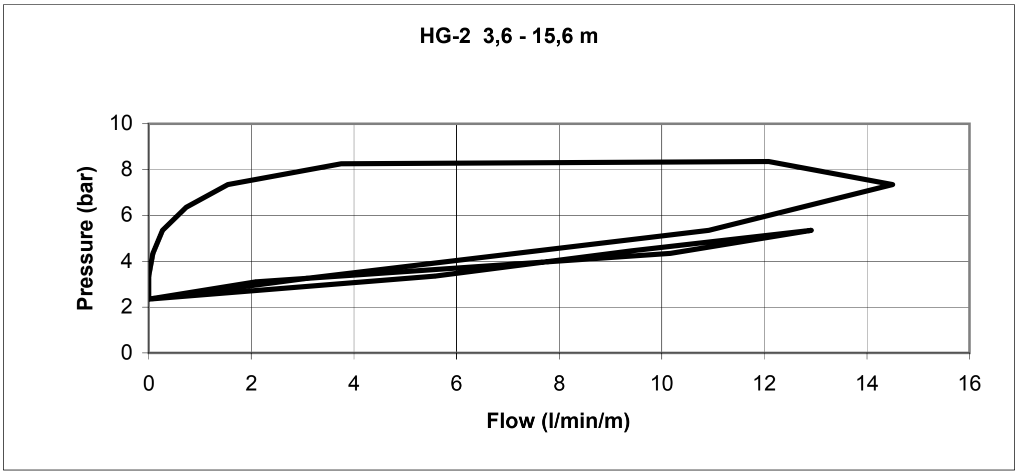

HG-1 222,6 - 249,6 m
Pressure (bar)
27
24
21
18
15
12
9
6
3
0
0
3
6
9
12
Flow (l/min/m)

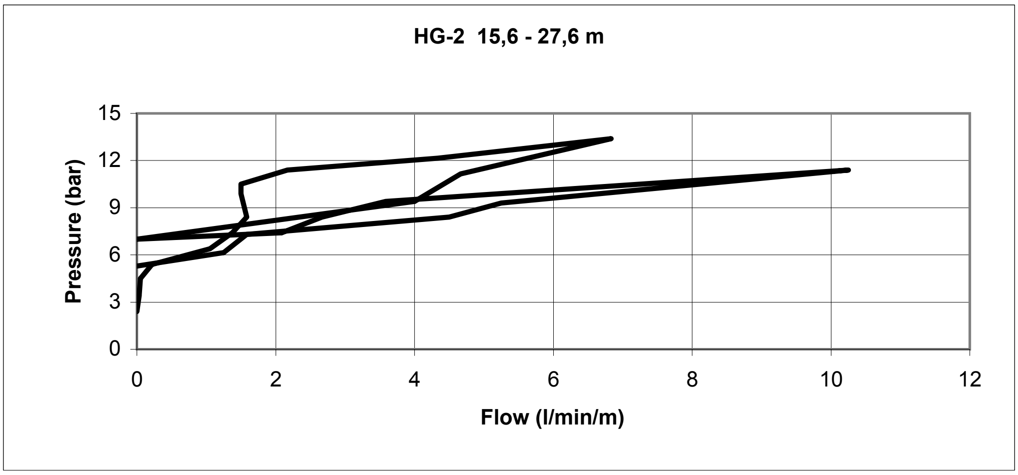

HG-1 249,6 - 276,3 m
Pressure (bar)
24
21
18
15
12
9
6
3
0
0
3
6
9
12
Flow (l/min/m)


HG-1 276,3 - 309,6 m
Pressure (bar)
24
20
16
12
8
4
0
0
3
6
9
12
Flow (l/min/m)

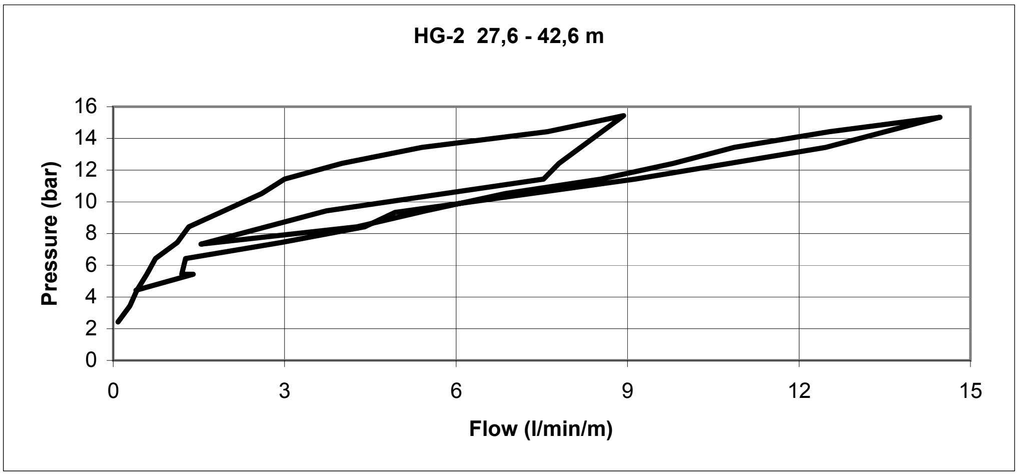
Permeability tests in Siglufjörður, Héðinsfjörður and Ólafsfjörður

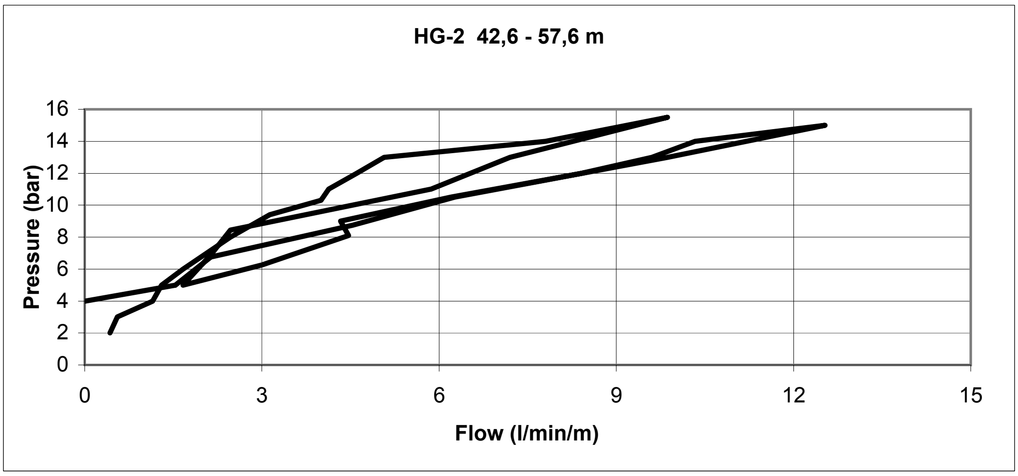


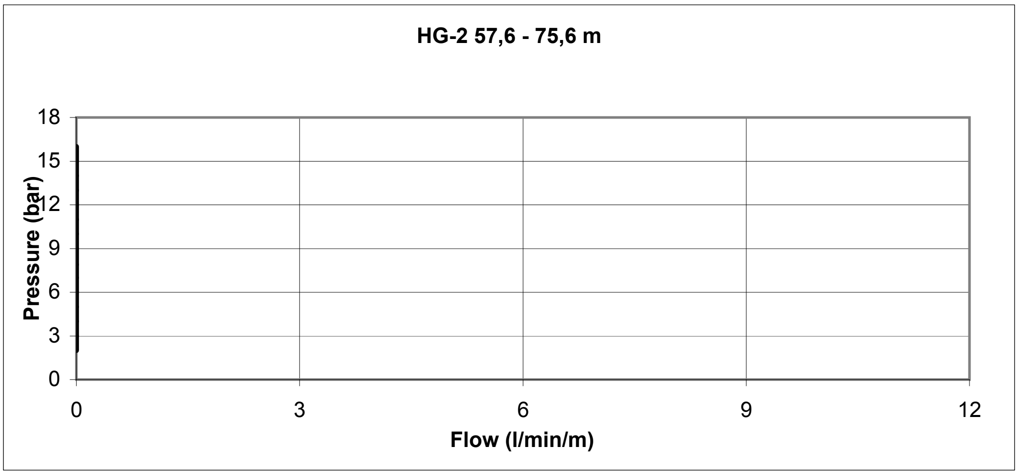




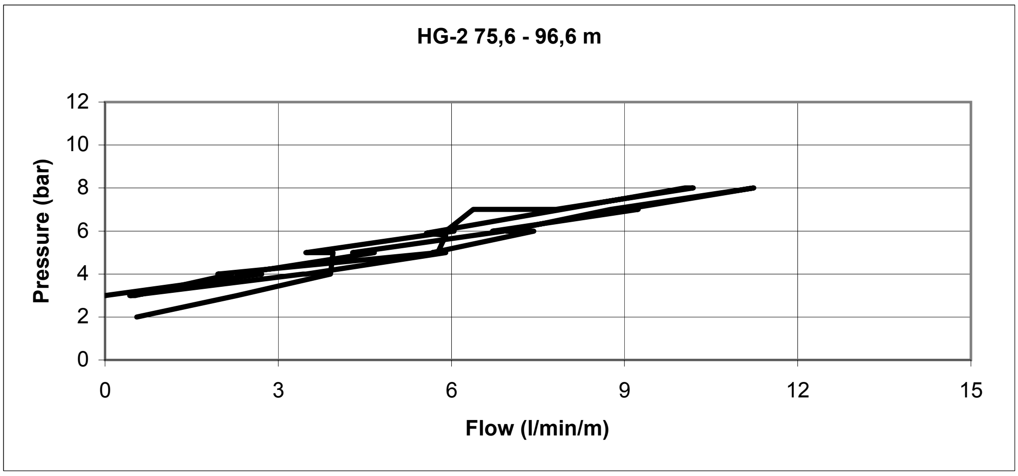
Permeability tests in Siglufjörður, Héðinsfjörður and Ólafsfjörður

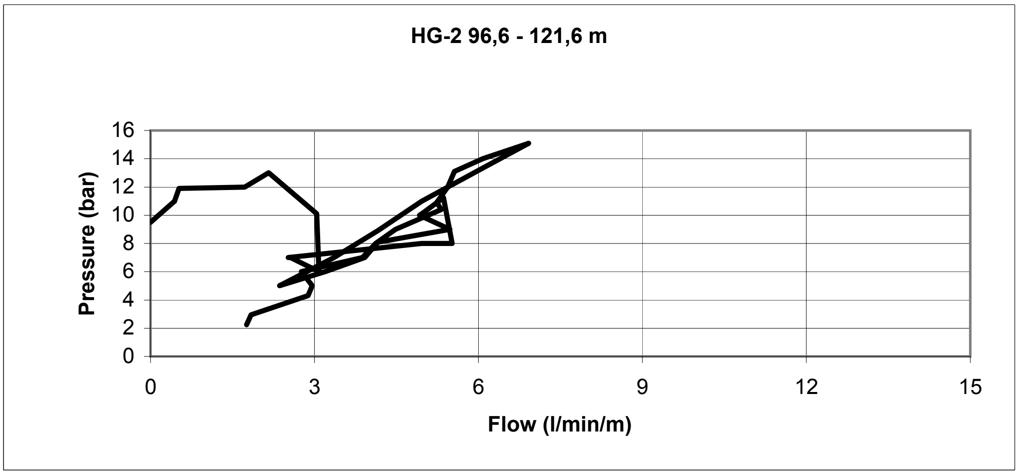


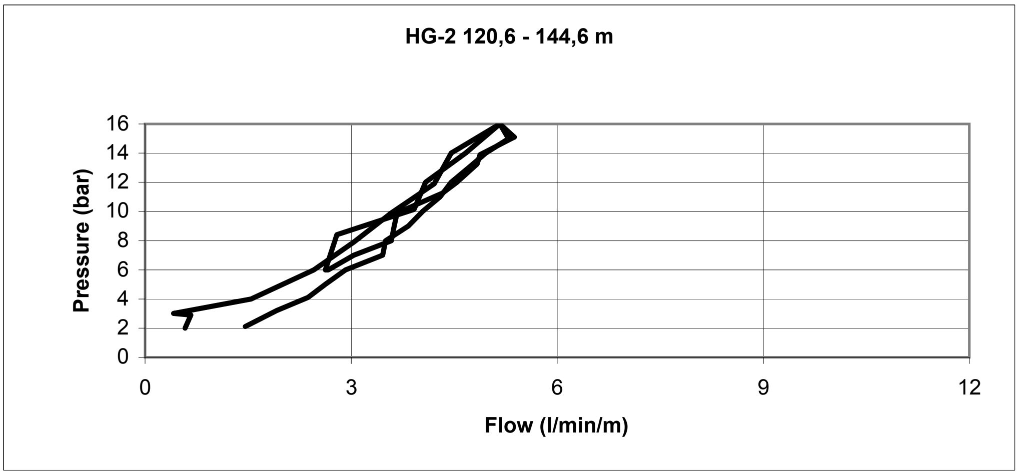




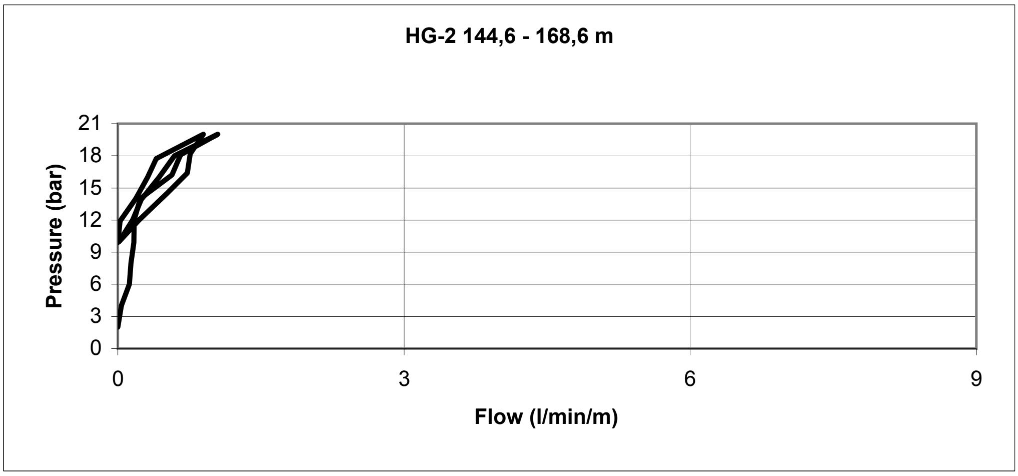
Permeability tests in Siglufjörður, Héðinsfjörður and Ólafsfjörður

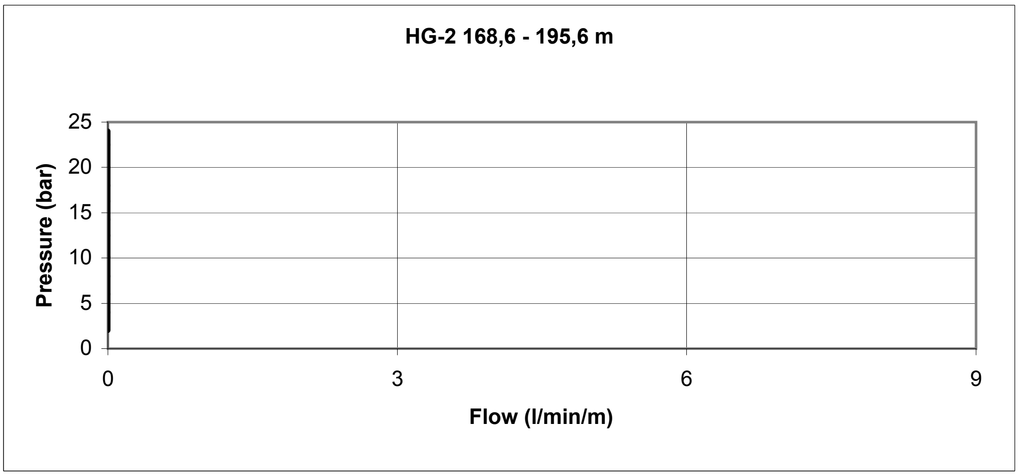


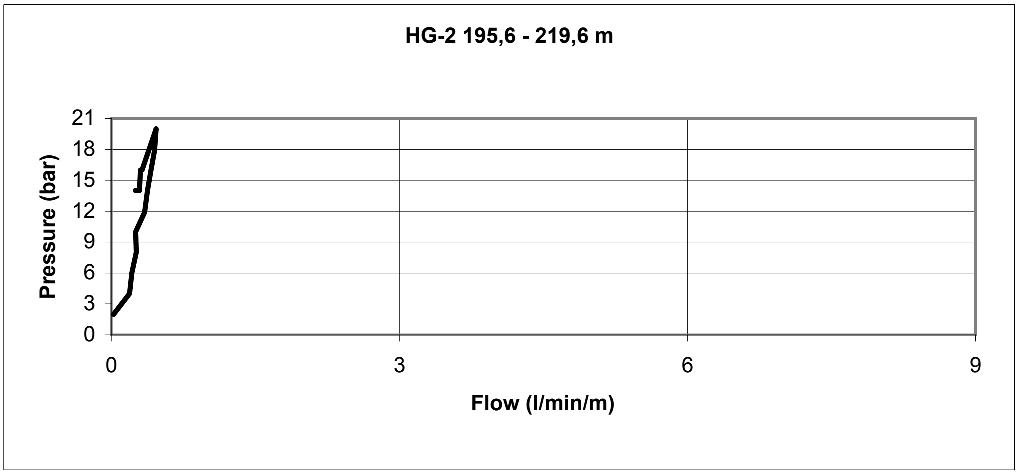




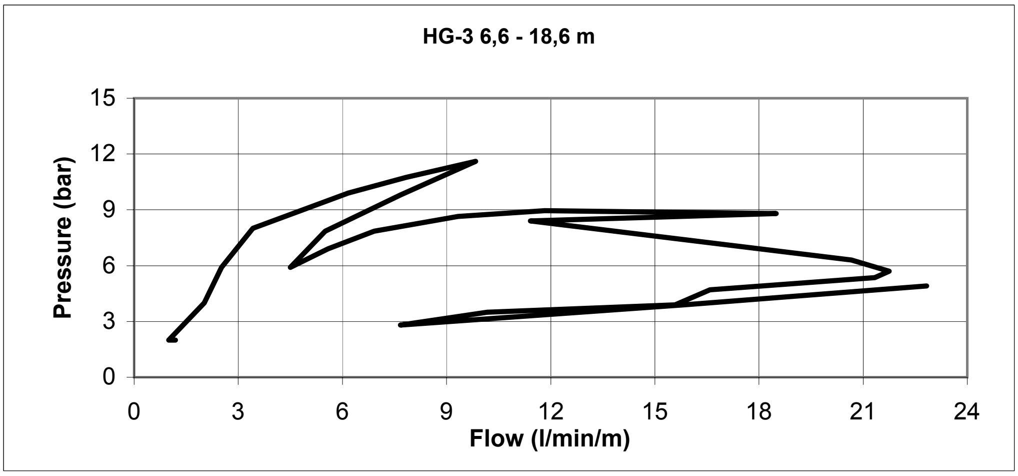
Permeability tests in Siglufjörður, Héðinsfjörður and Ólafsfjörður

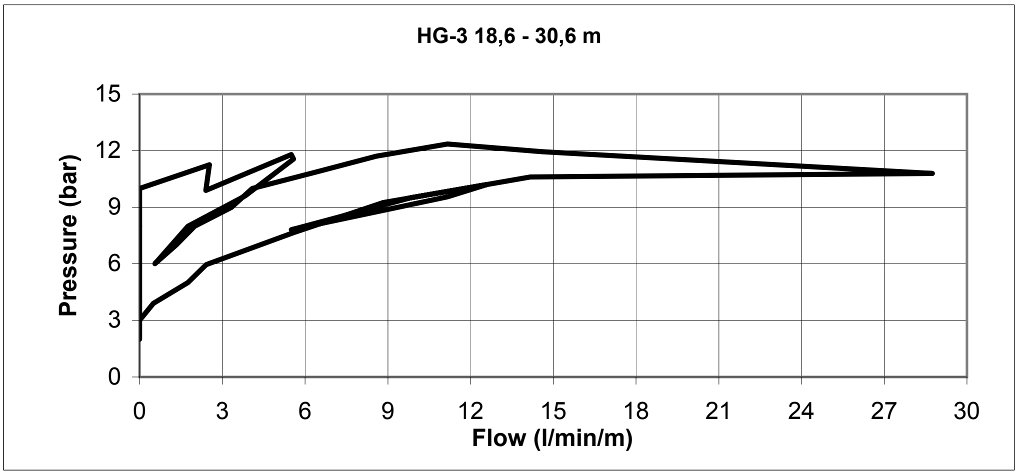


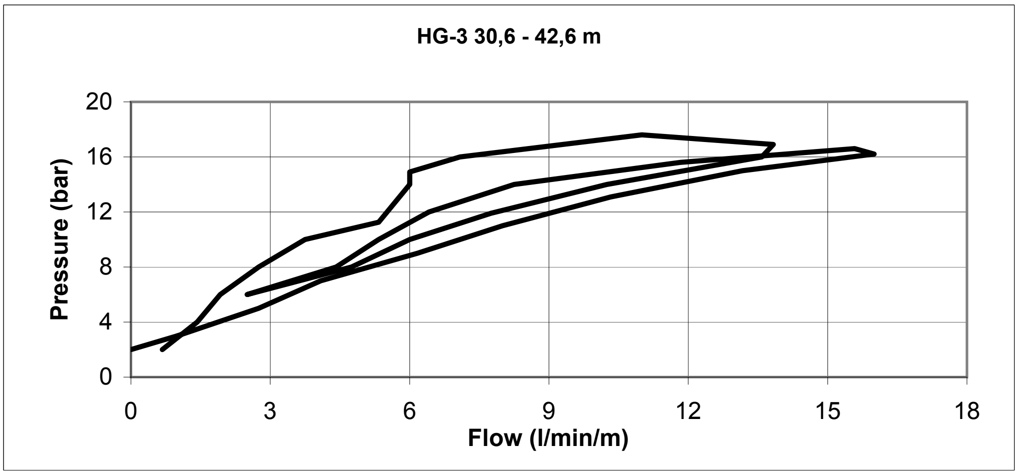




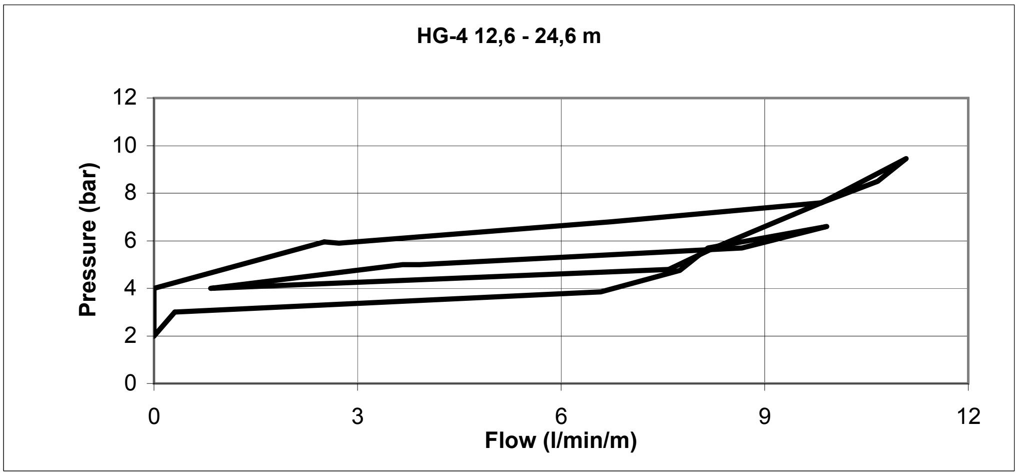
Permeability tests in Siglufjörður, Héðinsfjörður and Ólafsfjörður

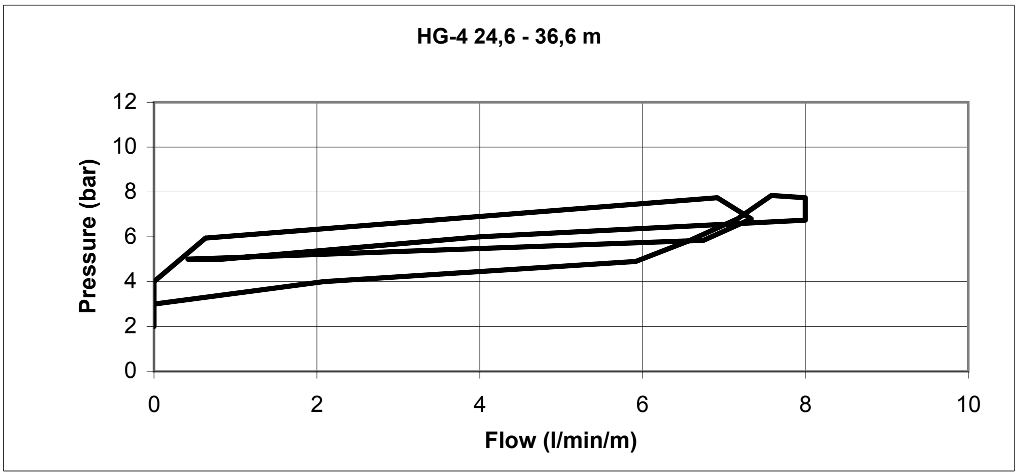


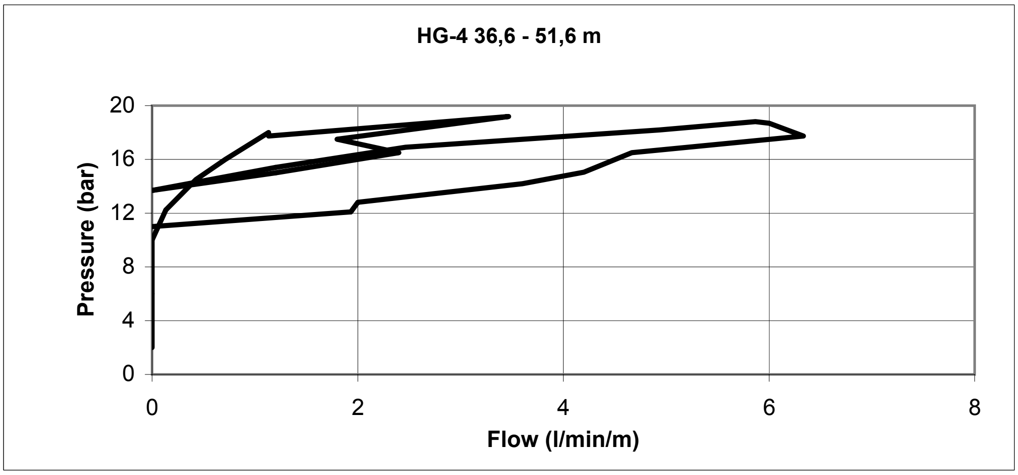


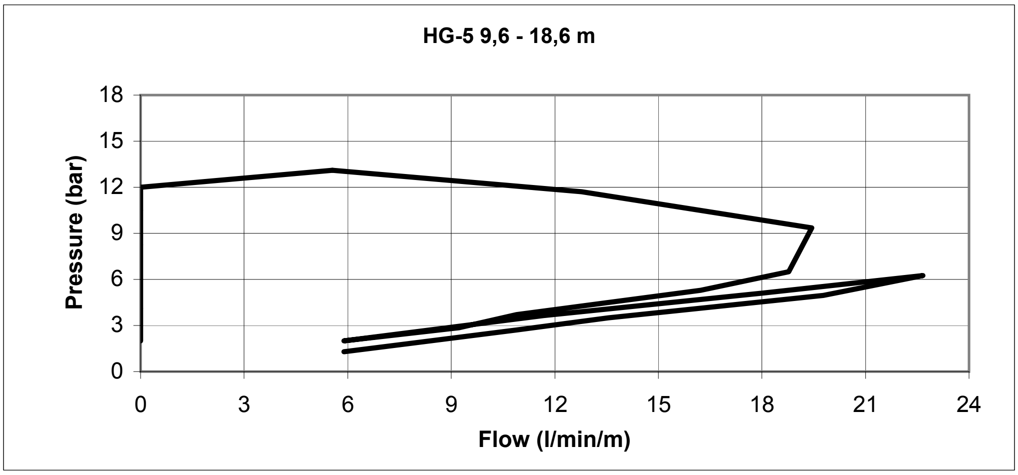


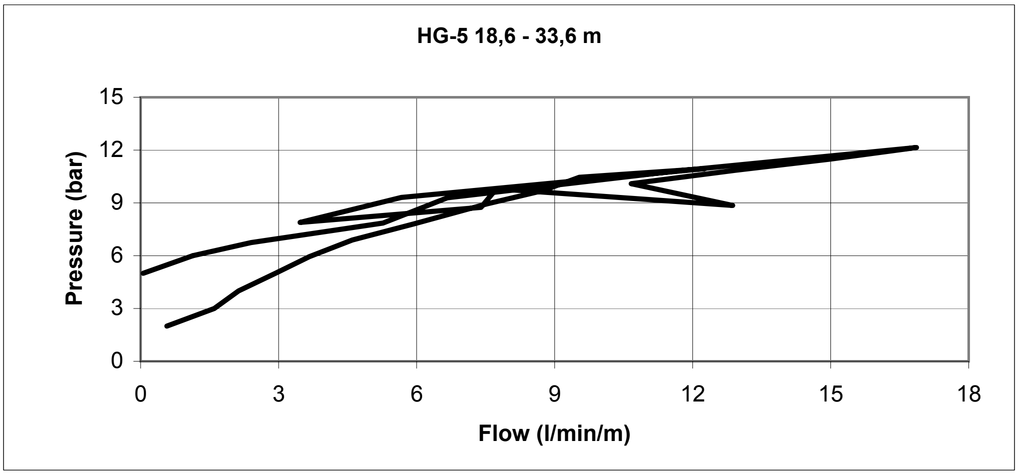
Permeability tests in Siglufjörður, Héðinsfjörður and Ólafsfjörður

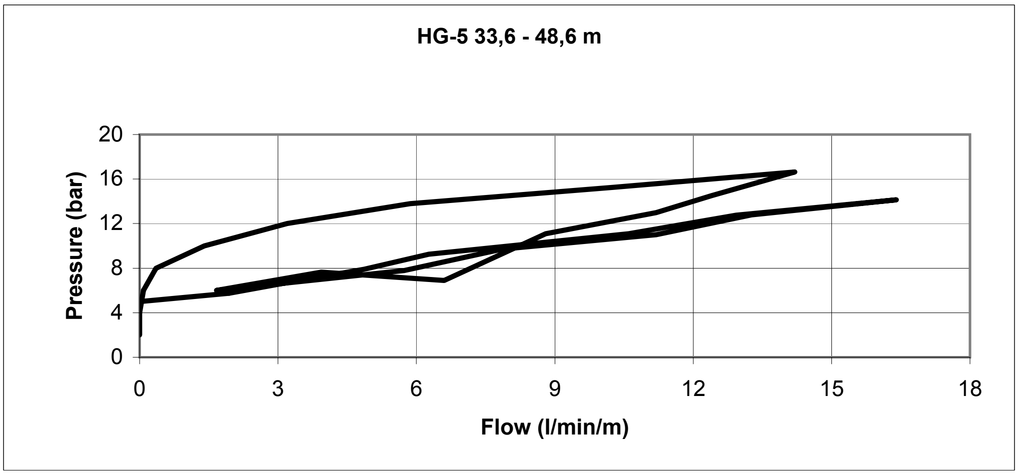




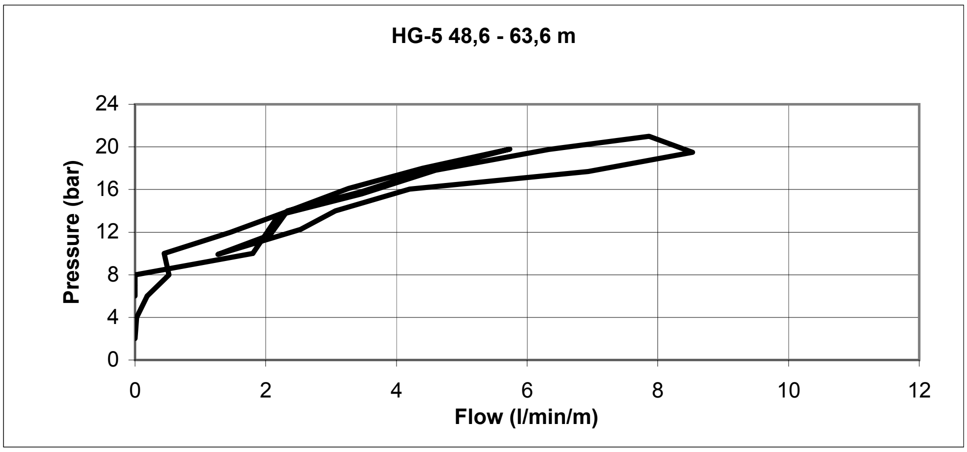


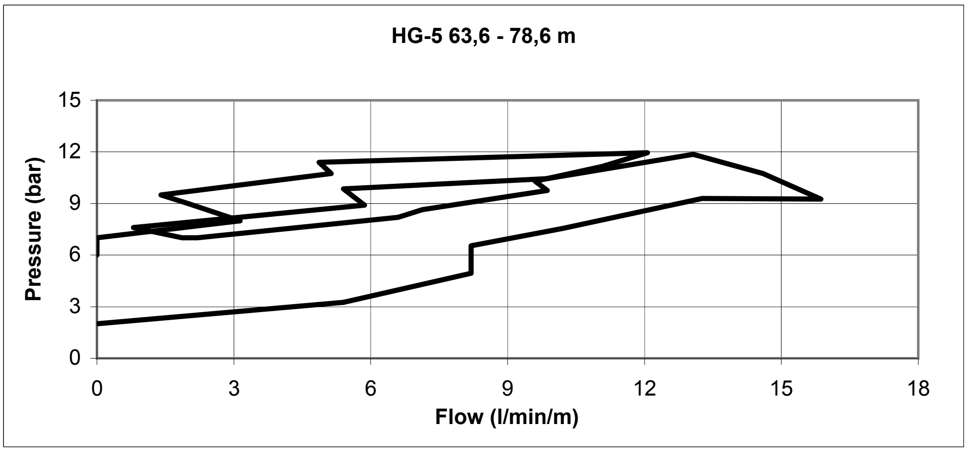

HG-5 9,6 - 18,6 m
Pressure (bar)
18
15
12
9
6
3
0
0
3
6
9
12
15
18
21
24
Flow (l/min/m)

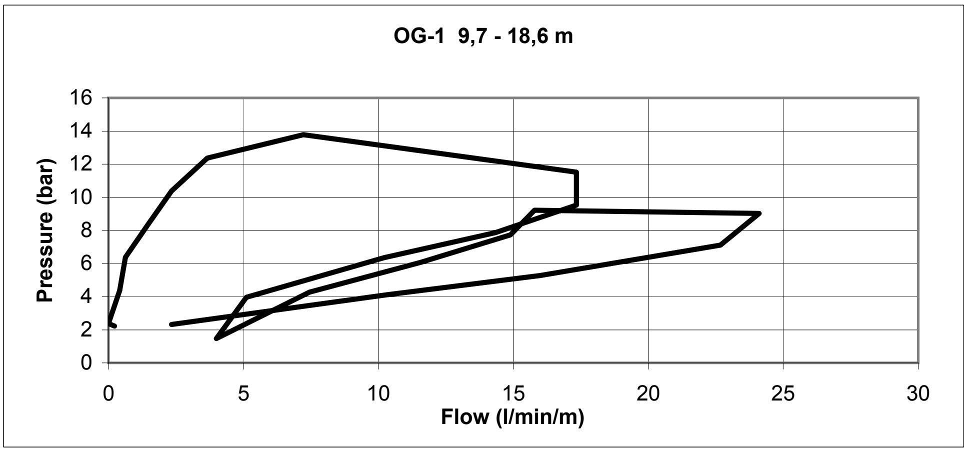

HG-5 18,6 - 33,6 m
Pressure (bar)
15
12
9
6
3
0
0
3
6
9
12
15
18
Flow (l/min/m)

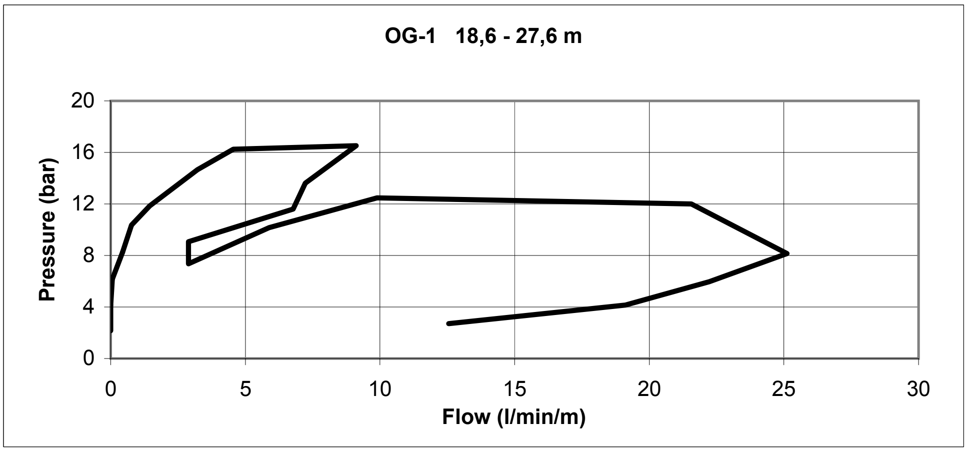

HG-5 33,6 - 48,6 m
Pressure (bar)
20
16
12
8
4
0
0
3
6
9
12
15
18
Flow (l/min/m)

Permeability tests in Siglufjörður, Héðinsfjörður and Ólafsfjörður

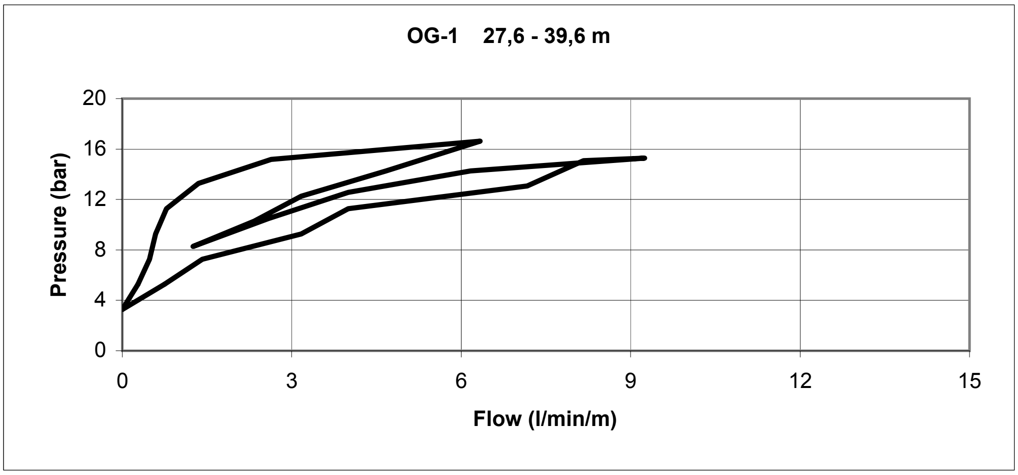


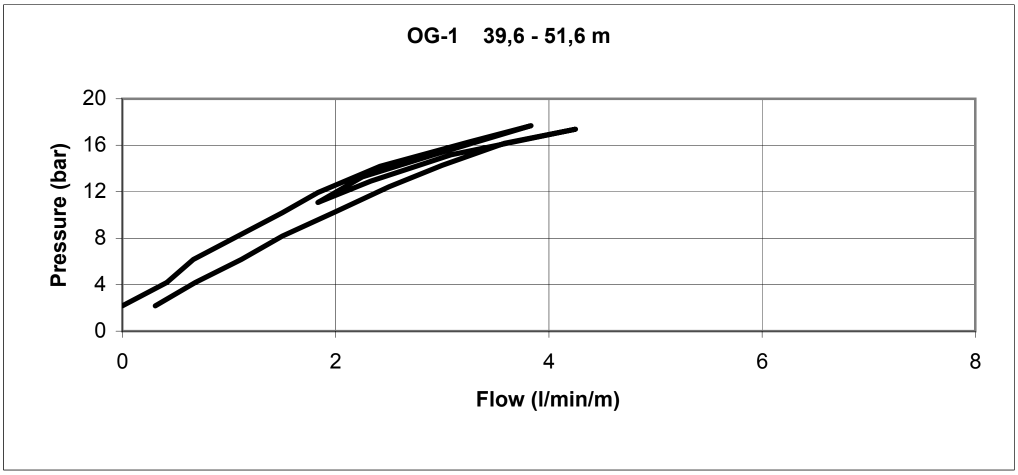


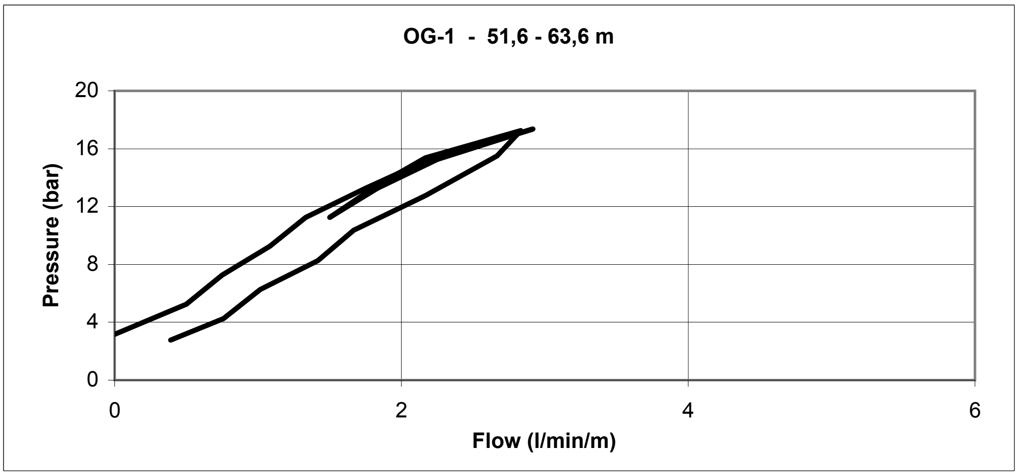




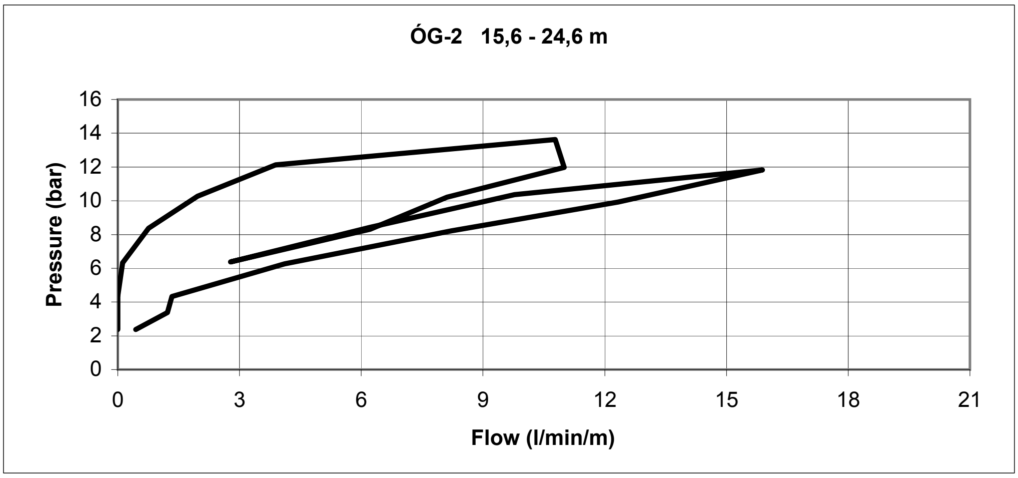
Permeability tests in Siglufjörður, Héðinsfjörður and Ólafsfjörður

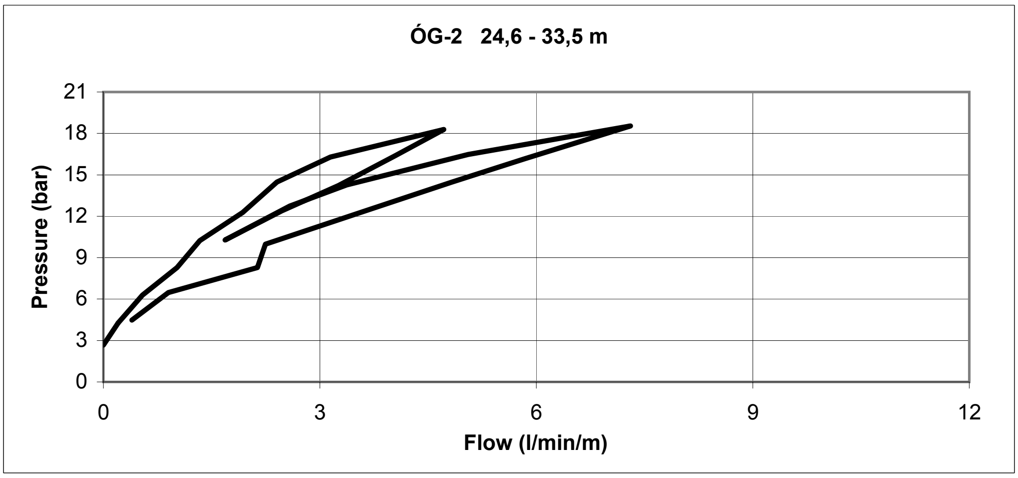


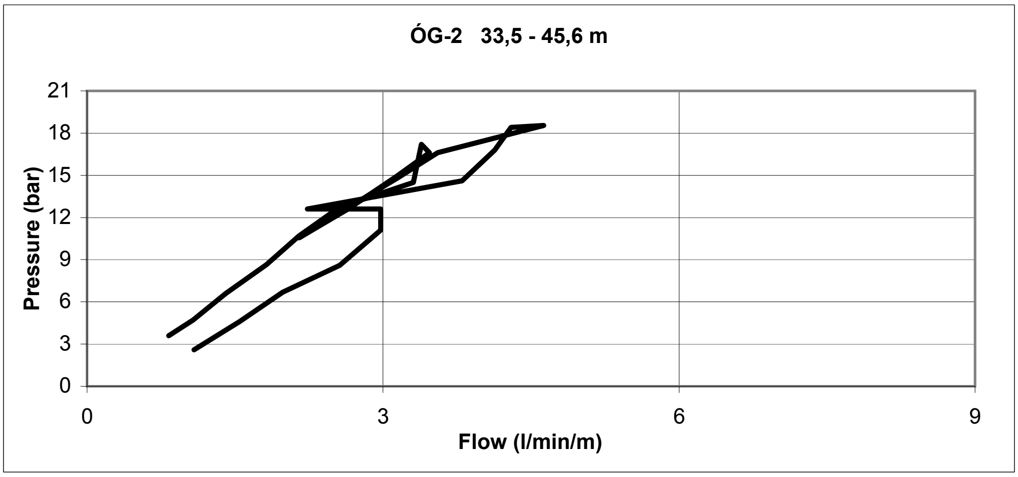




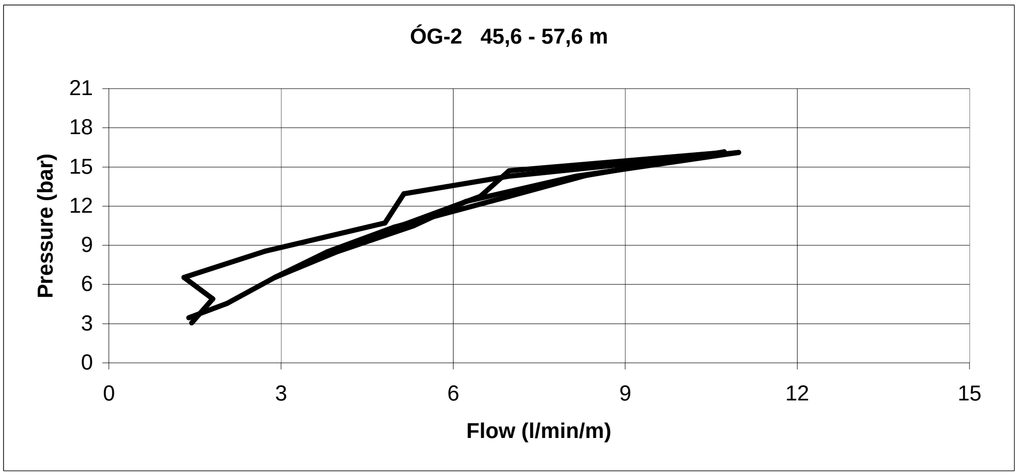
Permeability tests in Siglufjörður, Héðinsfjörður and Ólafsfjörður

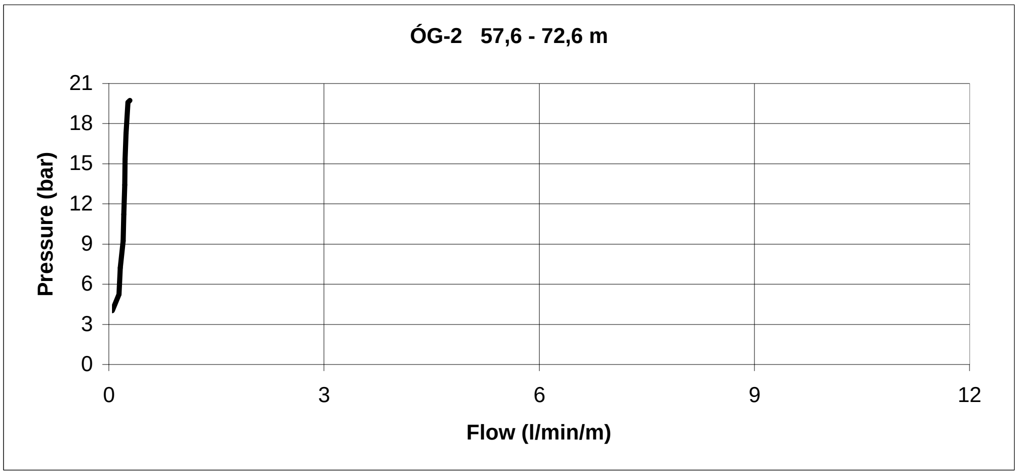


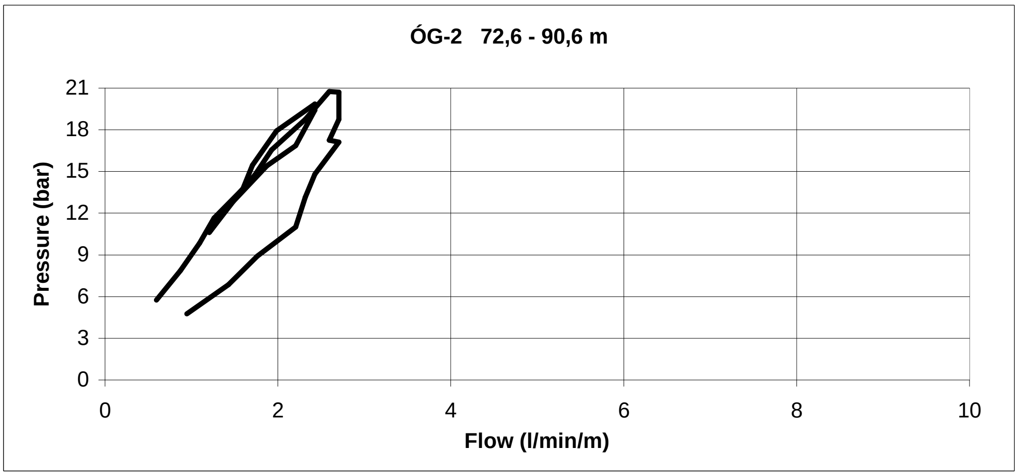




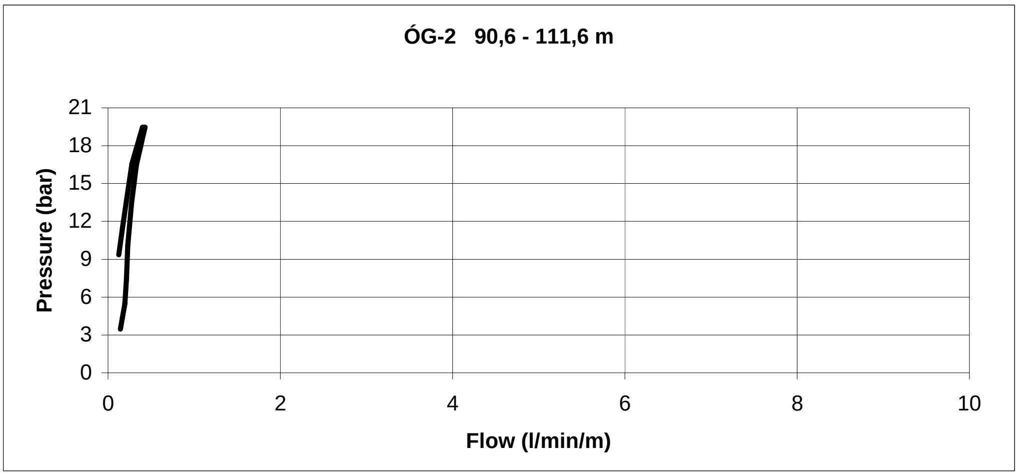
Permeability tests in Siglufjörður, Héðinsfjörður and Ólafsfjörður

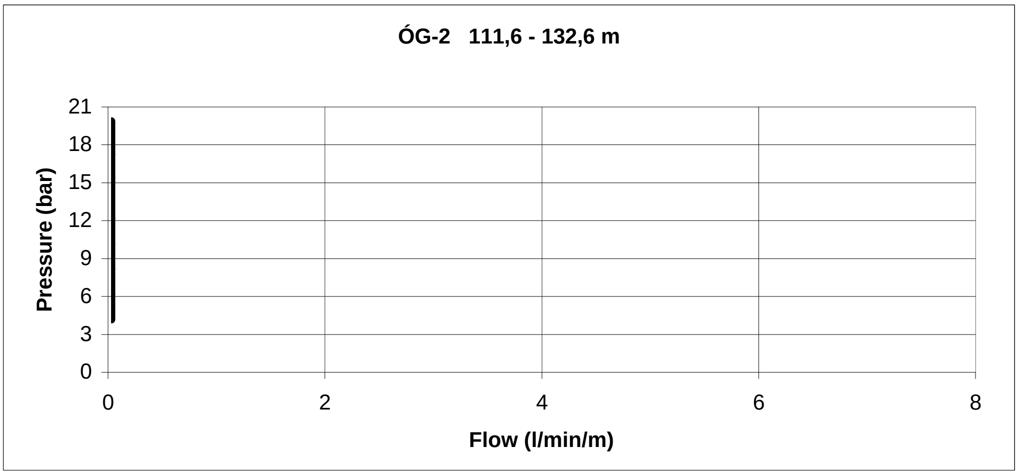


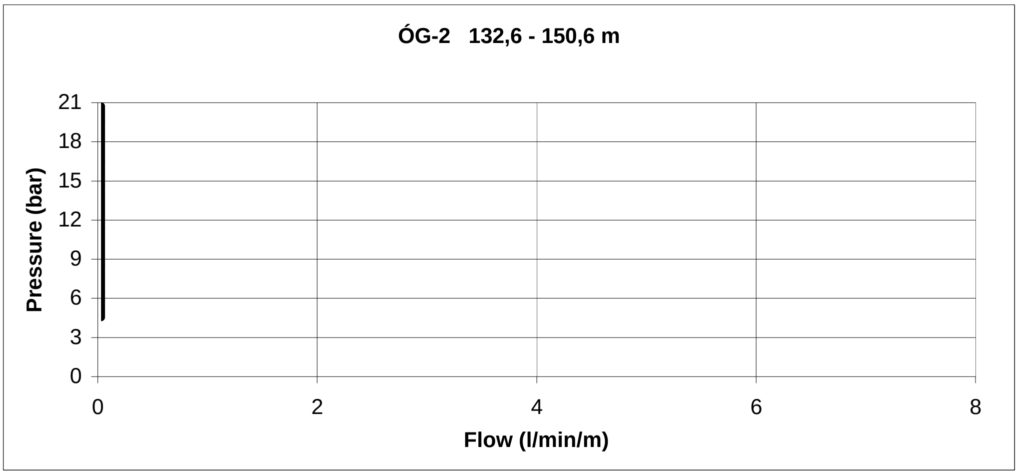


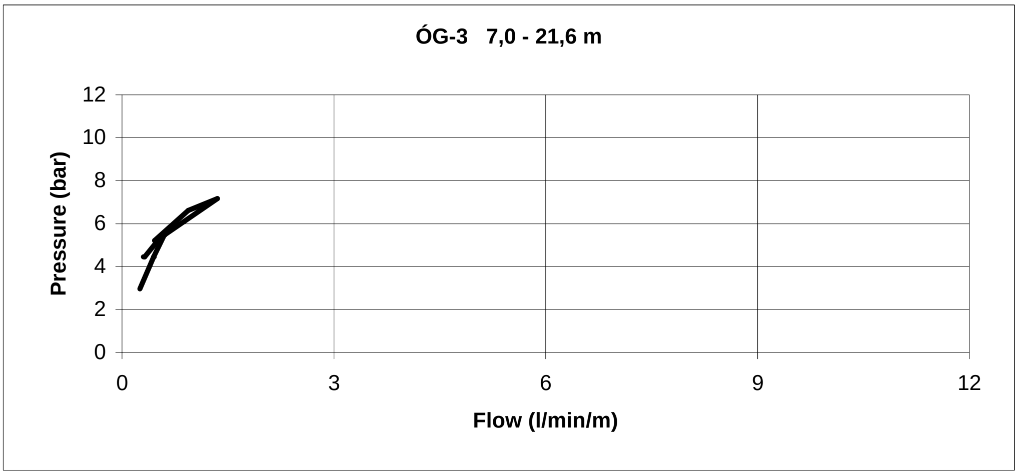


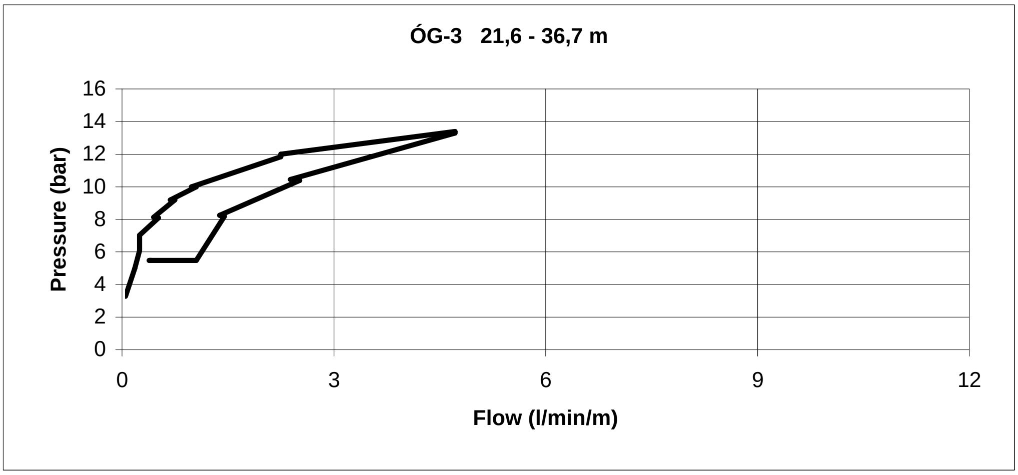
Permeability tests in Siglufjörður, Héðinsfjörður and Ólafsfjörður

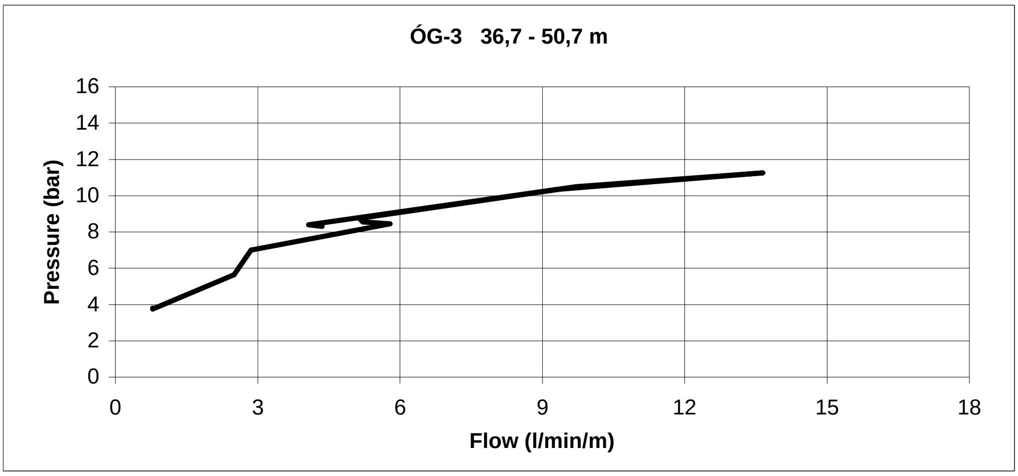




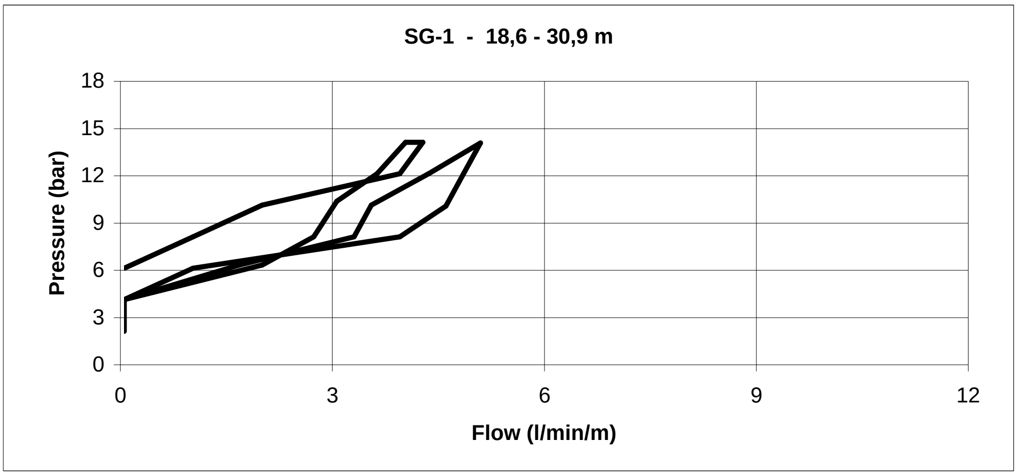


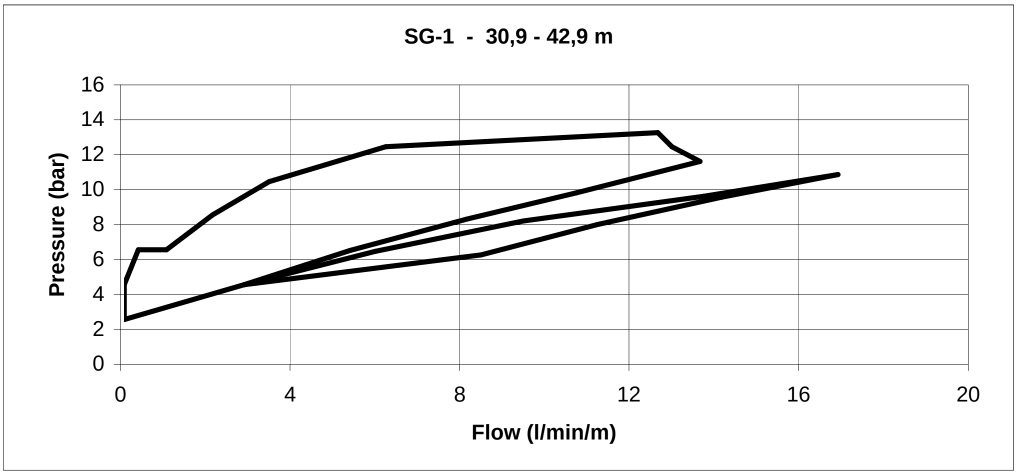

ÓG-3 7,0 - 21,6 m
Pressure (bar)
0
2
4
6
8
10
12
0
3
6
9
12
Flow (l/min/m)

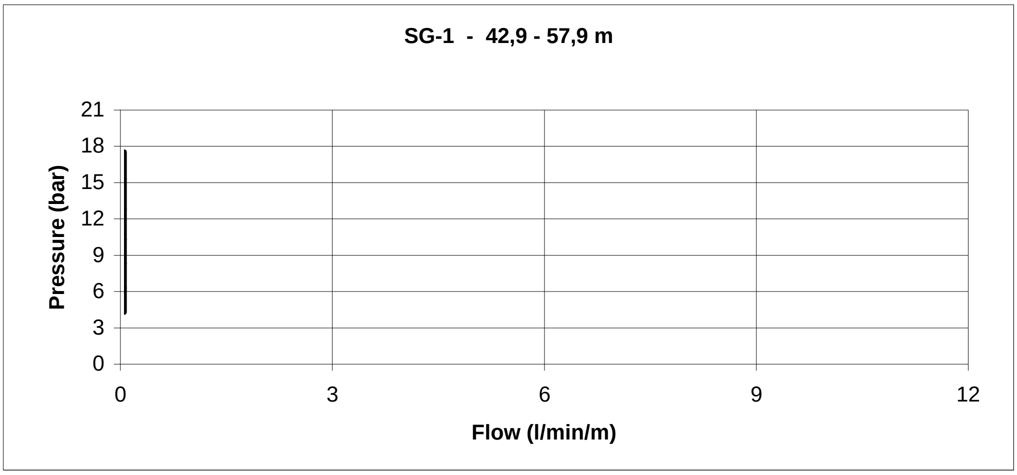

ÓG-3 21,6 - 36,7 m
Pressure (bar)
0
2
4
6
8
10
12
14
16
0
3
6
9
12
Flow (l/min/m)


ÓG-3 36,7 - 50,7 m
Pressure (bar)
0
2
4
6
8
10
12
14
16
0
3
6
9
12
15
18
Flow (l/min/m)

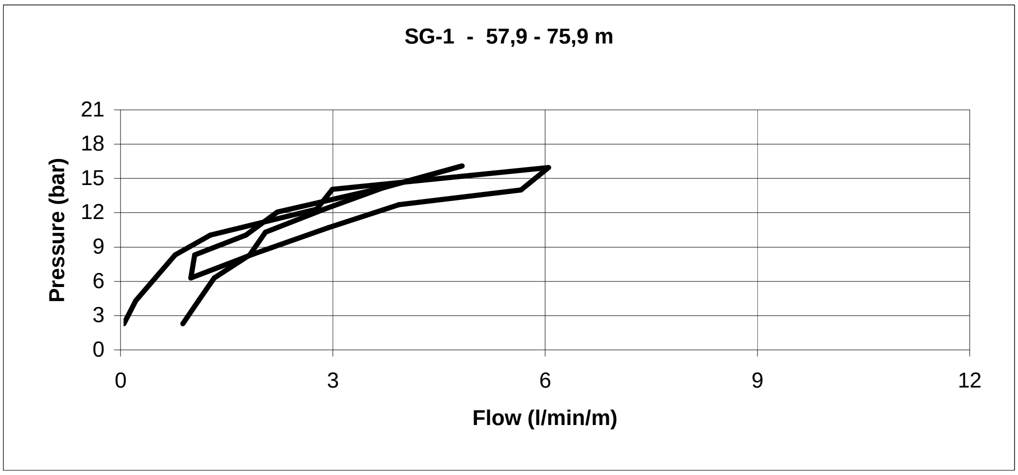
Permeability tests in Siglufjörður, Héðinsfjörður and Ólafsfjörður

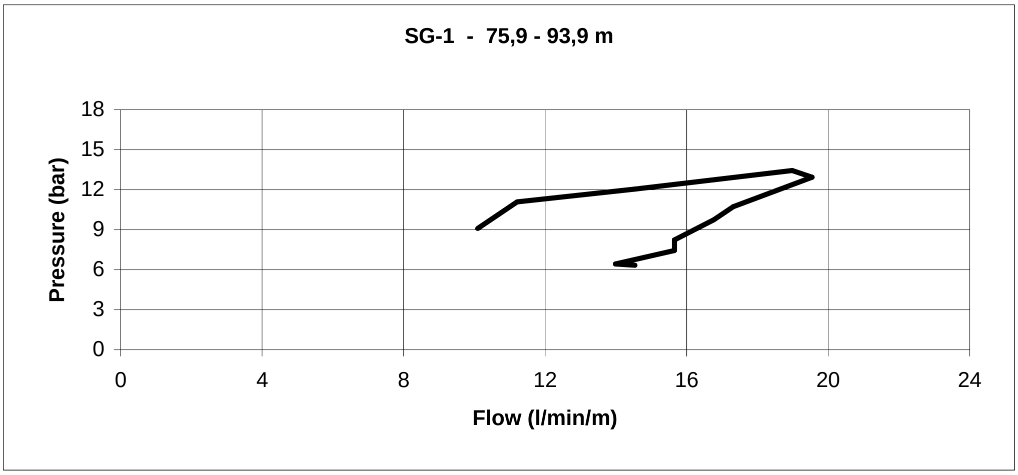


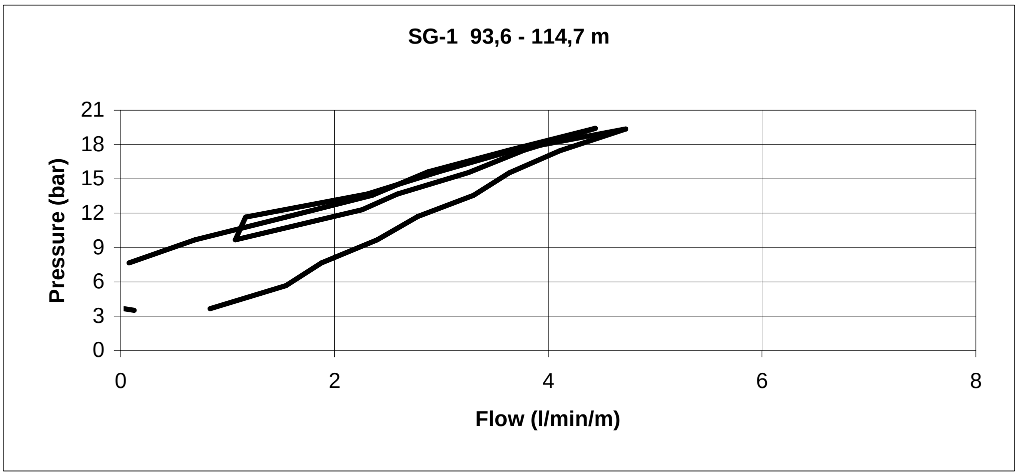




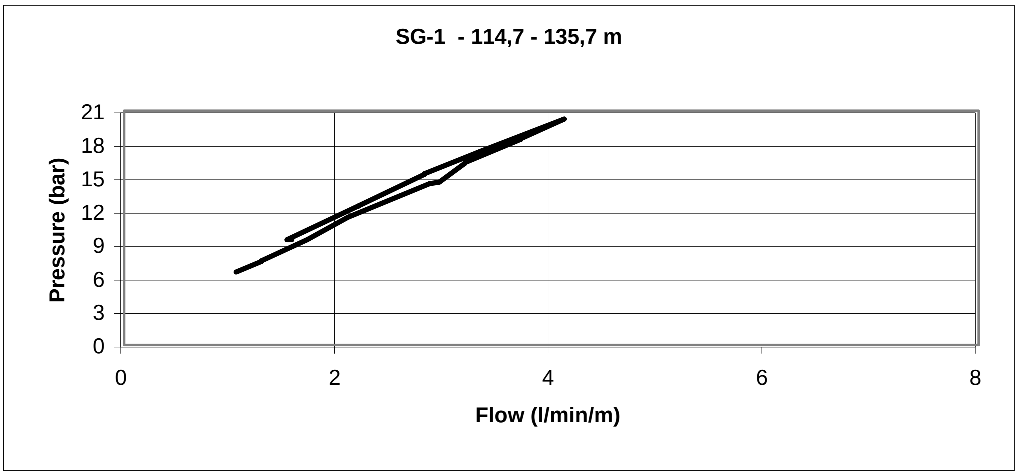
Permeability tests in Siglufjörður, Héðinsfjörður and Ólafsfjörður

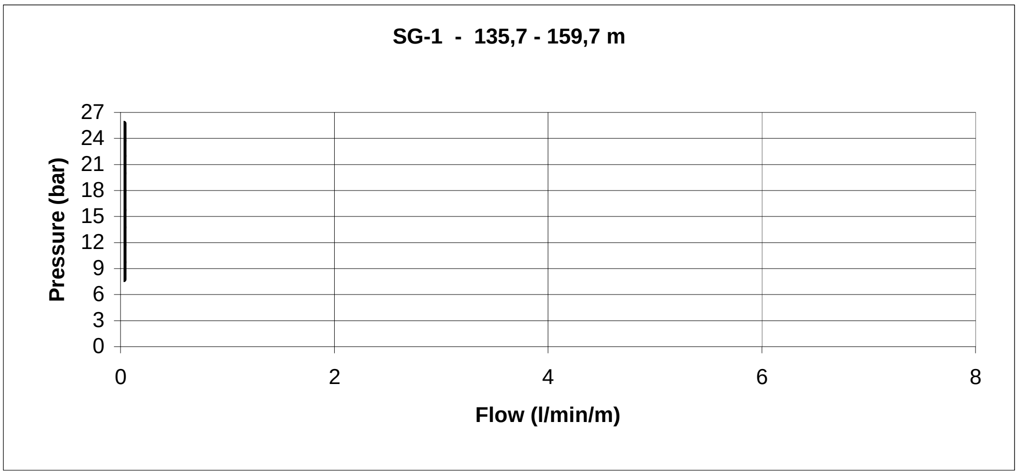


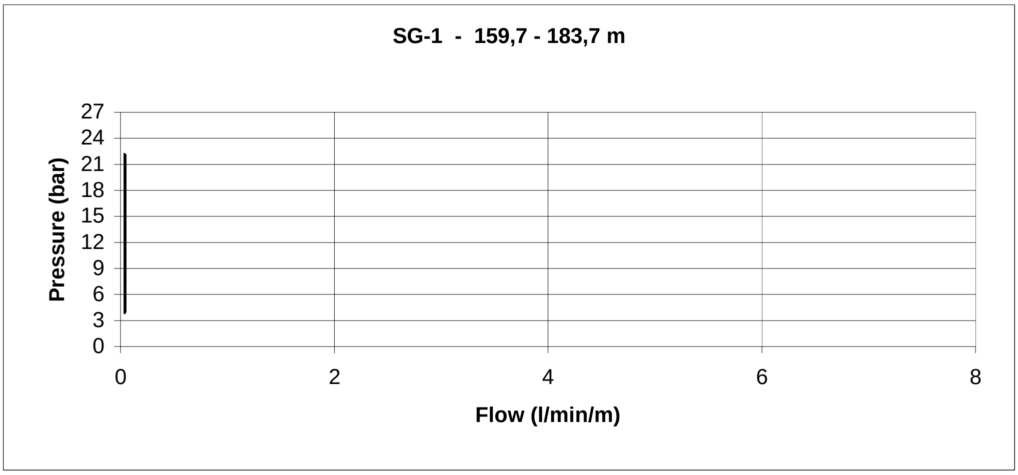




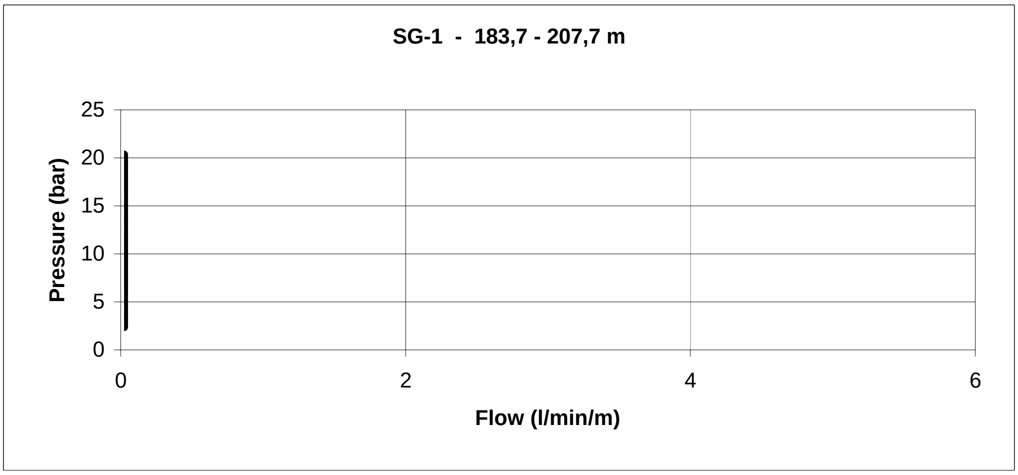
Permeability tests in Siglufjörður, Héðinsfjörður and Ólafsfjörður

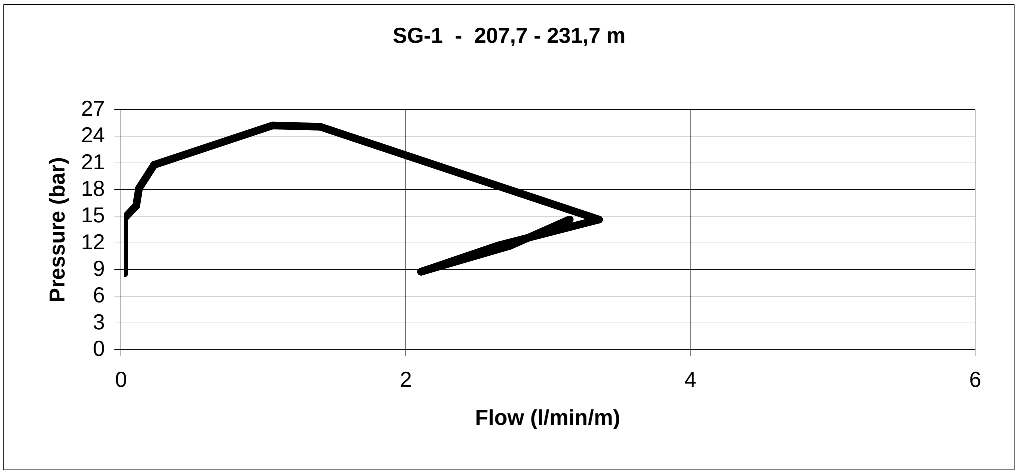


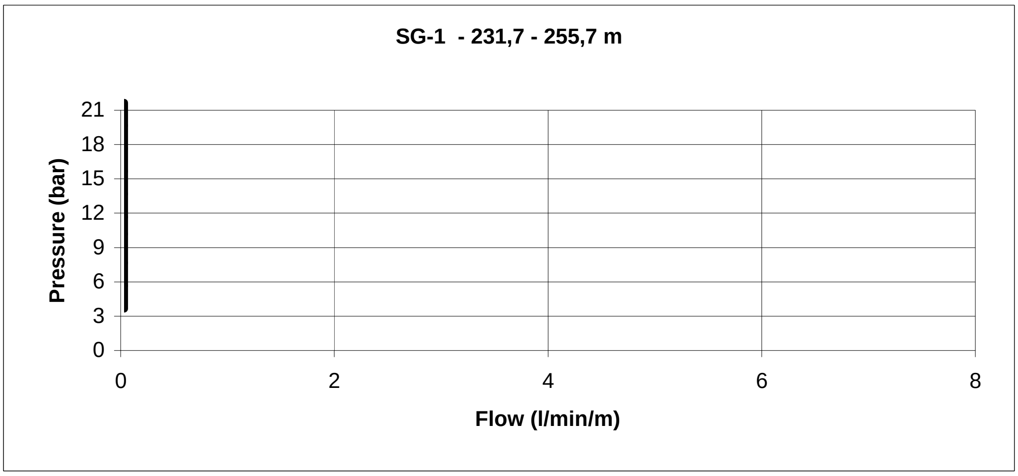




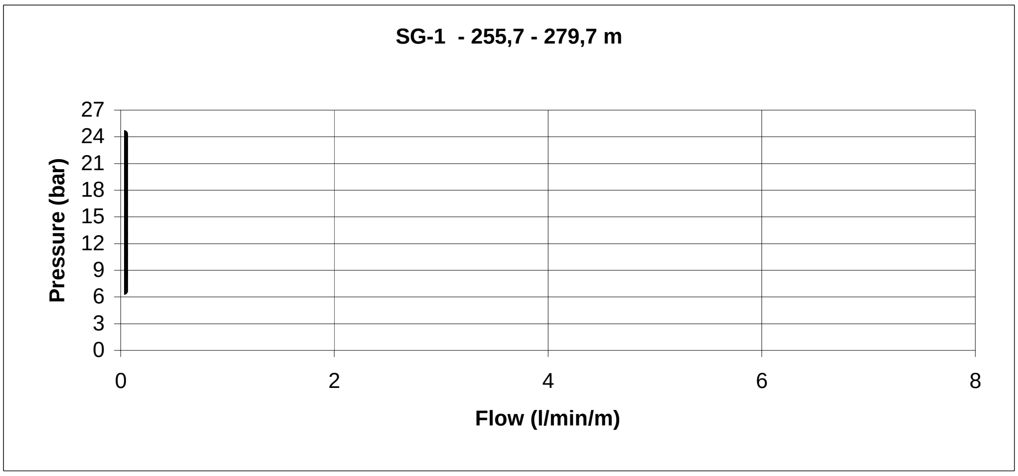
Permeability tests in Siglufjörður, Héðinsfjörður and Ólafsfjörður

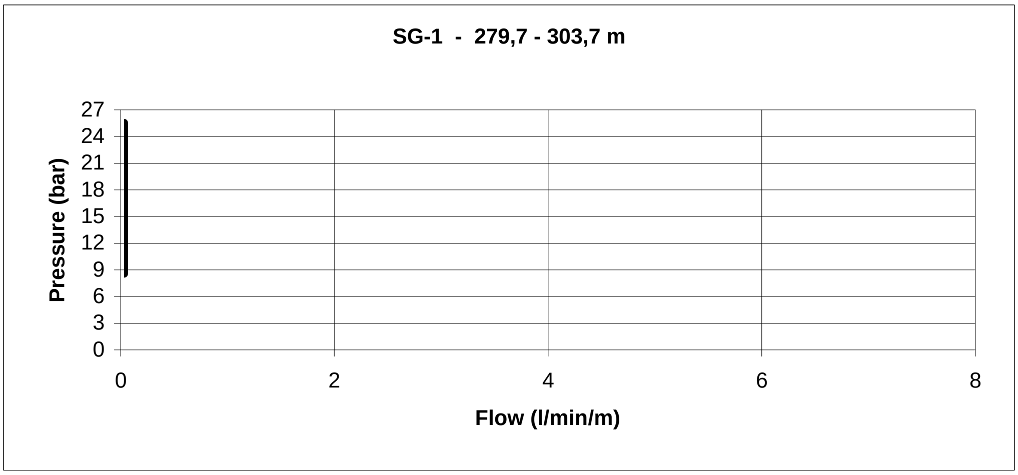


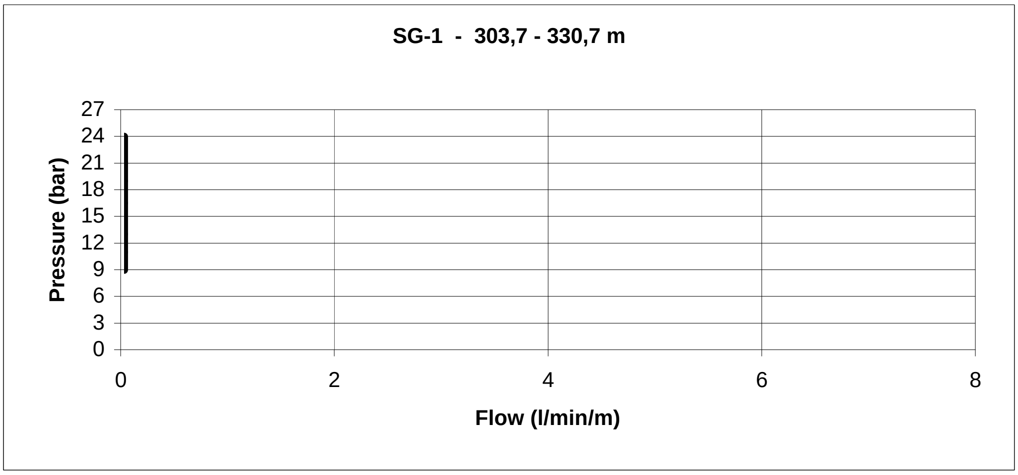




Permeability tests in Siglufjörður, Héðinsfjörður and Ólafsfjörður







Appendix III Field tests on core

Holes SG-1, HG-1 through HG-5, OG-1 through OG-3

Depth (m) From	Depth (m) To	Hole - SG-1 Point Load Test Rocktype	Number of tests	P (kN)	Is (50) (MPa)	Apparent UCS (MPa)
15,0	15,3	Scoriaceous basalt	5	4,6	2	48
20,2	20,5	Scoriaceous basalt	6	6,8	3	71
23,8	24,0	Tholeiite basalt	4	25,7	12	268
28,9	29,3	Olivine basalt	5	10,2	5	106
31,3	31,6	Olivine basalt	5	8,6	4	90
42,9	43,3	Olivine basalt	7	17,8	8	185
45,3	46,7	Olivine basalt	8	11,3	5	117
51,4	51,7	Olivine basalt	5	19,0	9	198
52,5	52,8	Olivine basalt	6	13,6	6	142
59,3	59,6	Olivine basalt	6	13,6	6	142
63,4	63,9	Olivine basalt	8	12,3	6	128
65,9	66,3	Olivine basalt	6	8,6	4	90
71,0	71,3	Scoria	5	8,4	4	87
73,7	74,2	Tholeiite basalt	5	31,8	15	331
75,1	75,5	Tholeiite basalt	5	29,0	14	302
77,5	77,9	Sandstone	9	7,5	4	78
82,2	82,6	Olivine basalt	8	17,0	8	177
85,4	85,8	Sandstone	5	6,8	3	71
90,7	90,9	Porphyritic basalt	4	17,7	8	184
96,8	97,1	Scoriaceous basalt	8	8,5	4	89
101,6	102,0	Porphyritic basalt	4	21,3	10	221
105,4	105,7	Porphyritic basalt	5	23,0	11	240
114,4	114,7	Scoriaceous basalt	5	4,2	2	44
120,7	121,1	Olivine basalt	6	24,3	12	253
125,3	125,7	Olivine basalt	4	30,0	14	312
129,7	130,2	Olivine basalt	9	26,1	12	272
133,2	134,0	Olivine basalt	10	11,6	5	121
134,9	135,4	Olivine basalt	12	15,3	7	159
137,4	137,9	Olivine basalt	12	9,6	5	100
138,9	139,4	Olivine basalt	13	6,8	3	71
143,6	144,0	Olivine basalt	11	5,7	3	59
147,4	147,7	Olivine basalt	4	17,8	8	185
153,3	153,7	Olivine basalt	10	7,3	3	76
159,3	159,7	Olivine basalt	9	19,5	9	203
161,7	162,1	Olivine basalt	7	18,5	9	193
171,1	172,2	Olivine basalt	12	9,6	5	100
172,2	172,6	Olivine basalt	9	16,0	8	167
175,0	175,4	Sandstone	7	6,0	3	62
177,7	177,9	Olivine basalt	5	10,4	5	108
180,4	180,7	Olivine basalt	7	14,4	7	150
184,5	185,0	Porphyritic basalt	12	10,3	5	107
192,1	192,4	Porphyritic basalt	10	26,2	12	273
198,0	198,4	Porphyritic basalt	8	22,8	11	237
201,2	201,5	Porphyritic basalt	7	29,1	14	303
206,6	207,1	Scoriaceous basalt	11	9,1	4	95
207,7	208,2	Scoriaceous basalt	12	7,2	3	75
211,4	211,8	Olivine basalt	9	28,2	13	294
217,4	218,4	Olivine basalt	11	30,1	14	313
220,5	221,0	Olivine basalt	10	20,2	10	210
229,2	229,8	Sandstone	12	7,1	3	74
234,3	234,7	Scoriaceous basalt	11	8,2	4	85
237,1	237,6	Porphyritic basalt	10	30,0	14	312
240,1	240,7	Porphyritic basalt	12	28,9	14	301
249,3	249,7	Porphyritic basalt	10	29,4	14	306

Depth (m) From	Depth (m) To	Hole - SG-1 Point Load Test Rocktype	Number of tests	P (kN)	Is (50) (MPa)	Apparent UCS (MPa)
254,9	255,4	Porphyritic basalt	11	30,6	14	319
261,7	262,0	Porphyritic basalt	7	34,5	16	359
265,4	265,8	Sandstone	10	8,3	4	86
267,7	268,2	Scoriaceous basalt	10	13,1	6	136
273,7	274,2	Tholeiite basalt	8	41,7	20	434
281,9	282,4	Scoriaceous basalt	12	13,6	6	142
288,3	288,7	Olivine basalt	10	19,1	9	199
291,7	292,2	Olivine basalt	13	15,3	7	159
295,9	296,3	Olivine basalt	10	21,5	10	224
300,7	301,0	Olivine basalt - porphyritic	8	27,6	13	287
304,6	305,2	Basaltic dyke	15	27,5	13	286
306,1	306,7	Basaltic dyke	15	22,1	10	230
309,9	310,5	Basaltic dyke	10	30,7	15	320
317,0	317,5	Olivine basalt	6	29,5	14	307
320,9	321,4	Basaltic dyke	7	27,4	13	285
326,0	326,5	Basaltic dyke	7	23,4	11	244
329,4	329,9	Porphyritic basalt	10	21,2	10	221

Depth (m) From	Depth (m) To	Hole - HG-1 Point Load Test Rocktype	Number of tests	P (kN)	Is (50) (MPa)	Apparent UCS (MPa)
27,1	27,6	Porphyritic basalt	9	10,6	5	110
35,4	35,7	Porphyritic basalt	8	25,6	12	267
42,6	43,0	Scoriaceous basalt	10	14,5	7	151
46,9	47,4	Olivine basalt - porphyritic	10	24,2	11	252
54,9	55,2	Olivine basalt - porphyritic	7	28,7	14	299
61,0	61,2	Olivine basalt - porphyritic	7	19,8	9	206
77,1	77,4	Scoriaceous basalt	6	16,6	8	173
79,6	80,1	Scoriaceous basalt	10	16,8	8	175
83,5	83,7	Olivine basalt - porphyritic	5	15,4	7	160
87,2	87,6	Scoria	9	15,6	7	162
94,6	94,9	Scoria	10	7,6	4	79
101,4	101,8	Olivine basalt	10	8,5	4	89
104,9	105,2	Olivine basalt	4	15,3	7	159
109,0	109,2	Porphyritic basalt	7	5,9	3	61
112,7	113,0	Porphyritic basalt	8	27,3	13	284
121,0	121,4	Sandstone	8	3,7	2	39
129,6	130,0	Porphyritic basalt	11	24,5	12	255
140,9	141,2	Porphyritic basalt	6	28,3	13	295
143,6	144,0	Scoriaceous basalt	10	12,4	6	129
153,3	153,6	Olivine basalt	9	27,8	13	289
156,0	156,4	Olivine basalt	8	29,3	14	305
162,0	162,3	Sandstone	7	8,0	4	83
162,9	163,3	Sandstone	6	3,4	2	35
167,6	168,0	Olivine basalt - porphyritic	13	14,4	7	150
171,2	171,5	Olivine basalt - porphyritic	7	35,4	17	369
177,4	177,8	Porphyritic basalt	8	31,8	15	331
189,6	190,0	Scoria	12	7,9	4	82
198,1	198,5	Olivine basalt - porphyritic	8	33,4	16	348
208,2	208,4	Olivine basalt - porphyritic	8	26,0	12	271
211,6	211,8	Sandstone	6	7,5	4	78
212,0	212,4	Scoriaceous basalt	12	13,5	6	141
218,5	218,7	Porphyritic basalt	4	13,5	6	141
230,8	231,1	Sandstone	8	4,9	2	51
231,2	231,5	Sandstone	8	3,9	2	41
249,6	250,0	Olivine basalt - porphyritic	7	32,0	15	333
252,1	252,5	Scoria	9	10,3	5	107
257,0	257,4	Olivine basalt - porphyritic	9	19,2	9	200
267,6	267,9	Scoriaceous basalt	12	9,9	5	103
270,6	271,0	Olivine basalt	11	26,2	12	273
275,5	275,9	Olivine basalt	8	20,4	10	212
281,5	281,9	Scoria	4	6,4	3	67
285,6	286,0	Olivine basalt - porphyritic	10	5,1	2	53
290,2	290,6	Scoriaceous basalt	7	4,8	2	50
294,6	295,0	Porphyritic basalt	8	28,6	14	298
298,2	298,6	Scoria	10	11,1	5	116
298,5	298,9	Scoria	11	11,1	5	116
308,0	308,3	Olivine basalt - porphyritic	6	39,0	18	406
312,1	312,4	Olivine basalt - porphyritic	6	12,0	6	125
313,8	314,2	Olivine basalt	9	18,8	9	196
320,3	320,7	Scoria	9	4,7	2	49
324,6	324,9	Porphyritic basalt	10	13,5	6	141
336,7	337,2	Olivine basalt - porphyritic	12	30,8	15	320
338,2	338,6	Olivine basalt - porphyritic	9	29,7	14	309
345,1	345,4	Olivine basalt - porphyritic	8	9,4	4	98

Depth (m) From	Depth (m) To	Hole - HG-2 Point Load Test Rocktype	Number of tests	P (kN)	Is (50) (MPa)	Apparent UCS (MPa)
8,8	9,2	Scoria	11	10,2	5	106
19,7	20,1	Porphyritic basalt	8	24,1	11	251
30,3	30,6	Porphyritic basalt	8	23,7	11	247
36,1	36,6	Porphyritic basalt	13	24,7	12	257
46,9	47,3	Porphyritic basalt	8	30,2	14	314
51,1	51,3	Sandstone	5	15,8	7	165
58,8	59,1	Olivine basalt	11	6,1	3	64
62,1	62,6	Olivine basalt	9	15,2	7	158
75,9	76,2	Scoria	6	6,5	3	68
81,8	82,1	Olivine basalt	9	8,1	4	84
92,1	92,5	Porphyritic basalt	8	19,3	9	201
103,3	103,7	Olivine basalt - porphyritic	11	38,5	18	400
113,7	114,0	Basaltic dyke	3	43,3	20	451
126,1	126,5	Basaltic dyke	4	41,7	20	434
136,7	137,1	Basaltic dyke	12	10,1	5	105
140,0	140,4	Olivine basalt - porphyritic	10	18,4	9	192
150,6	151,0	Olivine basalt - porphyritic	10	22,1	10	230
157,1	157,5	Olivine basalt	12	9,9	5	103
168,0	168,4	Olivine basalt	7	24,4	12	254
171,9	172,2	Olivine basalt	8	21,3	10	222
180,3	180,6	Sandstone	6	6,1	3	64
182,0	182,3	Scoria	11	10,6	5	110
194,8	195,2	Porphyritic basalt	8	17,2	8	179
201,3	201,6	Porphyritic basalt	5	30,8	15	321
205,1	205,4	Sandstone	10	5,6	3	58
207,1	207,4	Scoriaceous basalt	8	6,8	3	71
210,5	210,9	Olivine basalt	10	21,8	10	227

Depth (m) From	Depth (m) To	Hole - HG-3 Point Load Test Rocktype	Number of tests	P (kN)	Is (50) (MPa)	Apparent UCS (MPa)
17,4	17,7	Basaltic dyke	10	9,4	4	98
20,1	20,5	Porphyritic basalt	10	17,1	8	178
27,7	28,0	Porphyritic basalt	6	21,3	10	222
40,0	40,3	Scoriaceous basalt	11	17,8	8	185

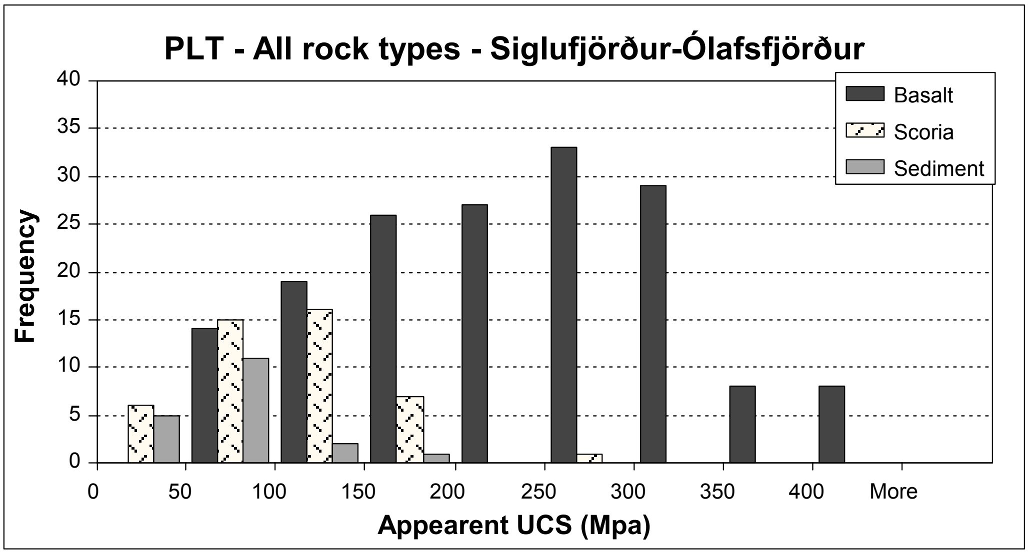
Depth (m) From	Depth (m) To	Hole - HG-4 Point Load Test Rocktype	Number of tests	P (kN)	Is (50) (MPa)	Apparent UCS (MPa)
15,2	15,5	Olivine basalt	7	25,0	12	260
20,0	20,2	Scoriaceous basalt	7	11,7	6	122
26,0	26,5	Olivine basalt	11	10,9	5	114
30,6	31,0	Olivine basalt	7	28,4	13	296
37,5	38,0	Scoria	10	6,9	3	72
42,6	43,0	Olivine basalt	8	29,1	14	303
50,1	50,5	Olivine basalt	10	26,2	12	273

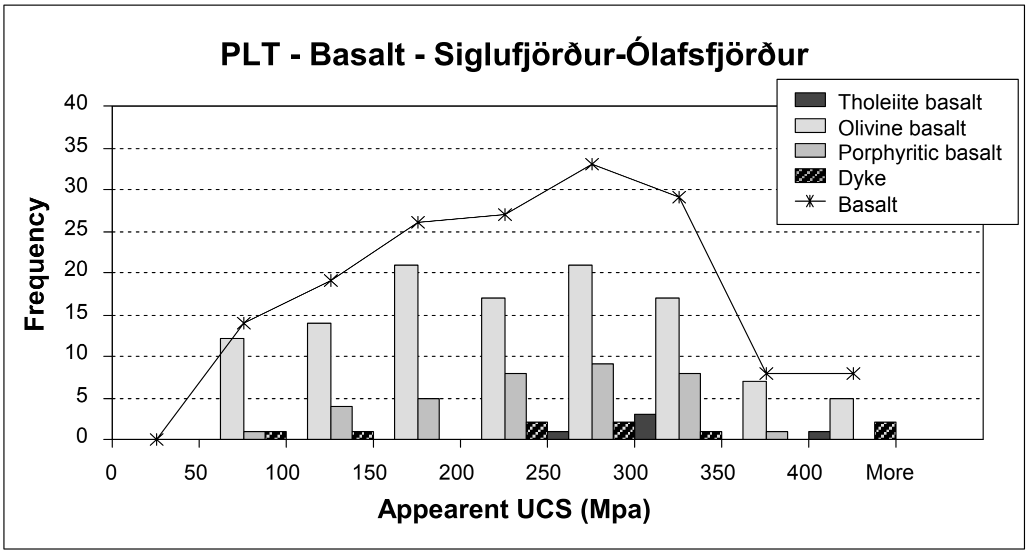
Depth (m) From	Depth (m) To	Hole - HG-5 Point Load Test Rocktype	Number of tests	P (kN)	Is (50) (MPa)	Apparent UCS (MPa)
13,8	14,1	Olivine basalt	8	25,3	12	263
21,3	21,6	Sandstone	7	12,5	6	130
24,5	24,9	Porphyritic basalt	7	19,1	9	199
28,9	29,1	Porphyritic basalt	7	23,1	11	241
34,4	34,8	Porphyritic basalt	8	18,8	9	196
35,8	35,9	Sandstone	4	2,5	1	26
40,6	41,0	Olivine basalt	8	20,7	10	216
52,3	52,6	Olivine basalt	11	25,3	12	263
55,7	56,1	Olivine basalt	12	14,5	7	151
60,8	61,1	Olivine basalt	9	16,1	8	168
68,7	69,0	Sandstone	7	4,5	2	47
75,1	75,5	Scoriaceous basalt	10	9,9	5	103

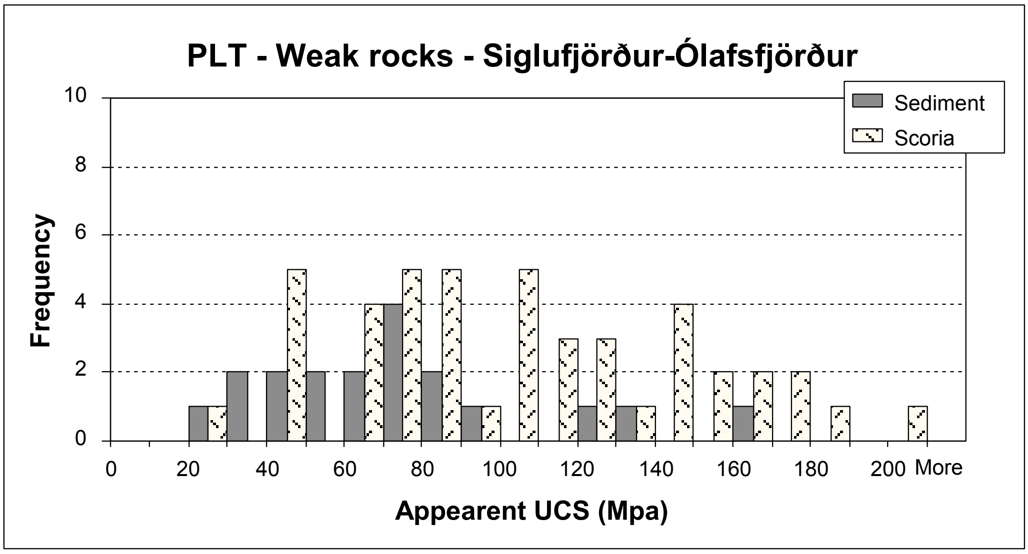
Depth (m) From	Depth (m) To	Hole - ÓG-1 Point Load Test Rocktype	Number of tests	P (kN)	Is (50) (MPa)	Apparent UCS (MPa)
14,1	14,5	Olivine basalt - porphyritic	7	27,1	13	282
16,4	16,8	Porphyritic basalt	8	28,3	13	294
21,6	22,0	Olivine basalt - porphyritic	8	29,5	14	307
23,9	24,3	Olivine basalt	7	31,4	15	327
25,7	26,3	Scoria	10	6,5	3	68
26,8	27,2	Scoriaceous basalt	12	13,8	7	144
29,6	30,0	Olivine basalt	5	32,2	15	335
42,4	42,7	Olivine basalt	4	25,5	12	266
43,7	44,0	Scoriaceous basalt	10	14,1	7	147
47,8	48,4	Olivine basalt	9	24,0	11	250
52,8	53,2	Scoriaceous basalt	7	15,0	7	156
56,8	57,2	Olivine basalt	5	19,4	9	202
61,4	61,8	Breccia	4	11,7	6	122

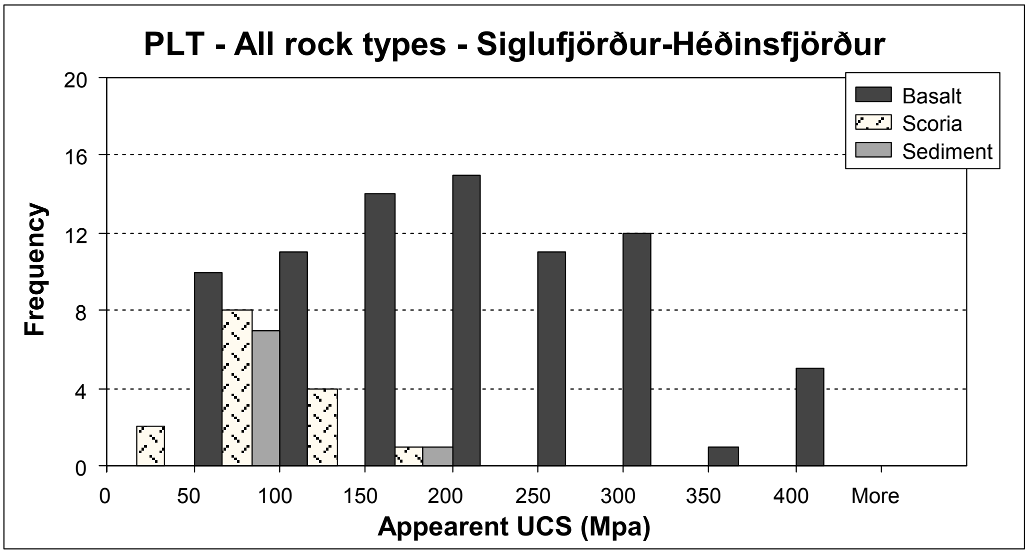
Depth (m) From	Depth (m) To	Hole - ÓG-3 Point Load Test Rocktype	Number of tests	P (kN)	Is (50) (MPa)	Apparent UCS (MPa)
7,7	8,2	Olivine basalt	5	45,2	21	471
17,8	18,1	Scoriaceous basalt	7	11,8	6	123
19,7	20,1	Olivine basalt	7	19,2	9	200
23,5	24,0	Tholeiite	9	31,8	15	331
29,7	30,0	Scoriaceous basalt	7	8,4	4	87
32,8	33,2	Olivine basalt	6	38,0	18	396
34,3	34,7	Olivine basalt	4	35,0	17	364
48,7	49,1	Olivine basalt	6	38,8	18	404

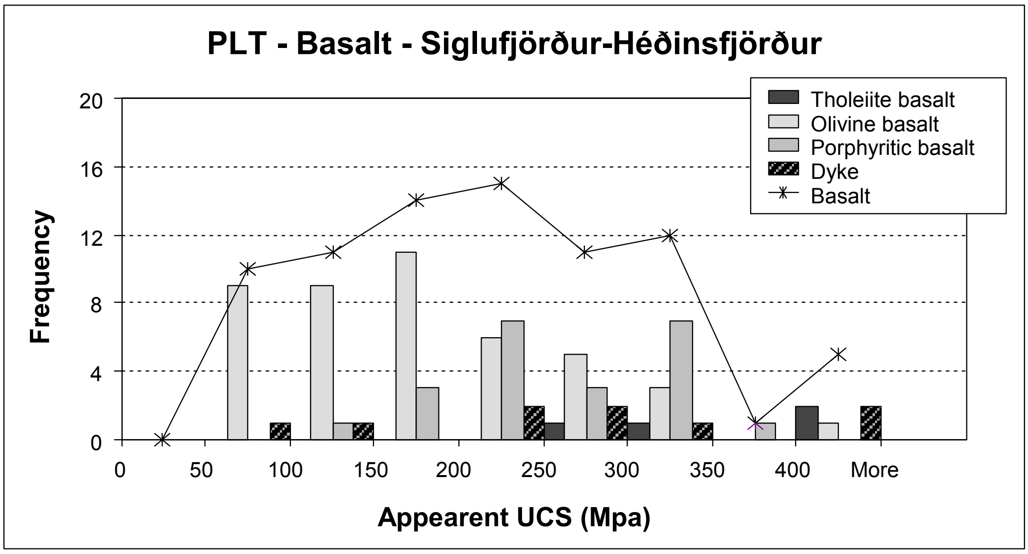
Depth (m) From	Depth (m) To	Hole - ÓG-2 Point Load Test Rocktype	Number of tests	P (kN)	Is (50) (MPa)	Apparent UCS (MPa)
17,7	18,2	Olivine basalt - porphyritic	7	27,3	13	284
24,2	24,5	Olivine basalt - porphyritic	5	23,4	11	244
29,3	29,8	Olivine basalt	9	32,7	15	341
30,6	31,0	Olivine basalt	10	30,9	15	322
34,4	34,8	Scoria	8	3,9	2	41
38,0	38,3	Olivine basalt	4	18,5	9	193
43,8	44,2	Olivine basalt - porphyritic	7	21,3	10	222
46,0	46,3	Olivine basalt - porphyritic	5	18,8	9	196
46,6	46,9	Sandstone	6	9,6	5	100
55,8	69,1	Olivine basalt	8	20,3	10	211
57,8	58,1	Olivine basalt	7	25,3	12	263
61,1	61,4	Scoria	6	2,1	1	22
65,2	65,6	Scoriaceous basalt	11	6,2	3	65
68,6	69,0	Olivine basalt	8	23,1	11	241
71,1	71,6	Olivine basalt	12	24,2	11	252
74,4	74,8	Olivine basalt	8	33,5	16	349
79,6	80,0	Olivine basalt	9	35,2	17	367
84,6	85,0	Olivine basalt - porphyritic	13	14,5	7	151
90,3	90,6	Olivine basalt	10	13,7	6	143
96,3	96,6	Olivine basalt	7	29,6	14	308
101,5	101,8	Olivine basalt	9	12,6	6	131
104,9	105,4	Olivine basalt - porphyritic	15	25,3	12	263
108,2	108,5	Olivine basalt	8	19,6	9	204
112,7	113,1	Scoriaceous basalt	11	9,7	5	101
114,9	115,4	Olivine basalt	8	22,6	11	235
120,6	120,9	Olivine basalt	5	35,6	17	371
125,6	126,0	Olivine basalt	5	31,4	15	327
126,2	126,6	Olivine basalt	5	39,6	19	412
130,3	130,8	Scoriaceous basalt	9	24,3	12	253
238,2	138,6	Olivine basalt	9	35,6	17	371
141,6	142,0	Olivine basalt - porphyritic	9	37,0	18	385
149,6	150,1	Scoriaceous basalt	9	16,2	8	169

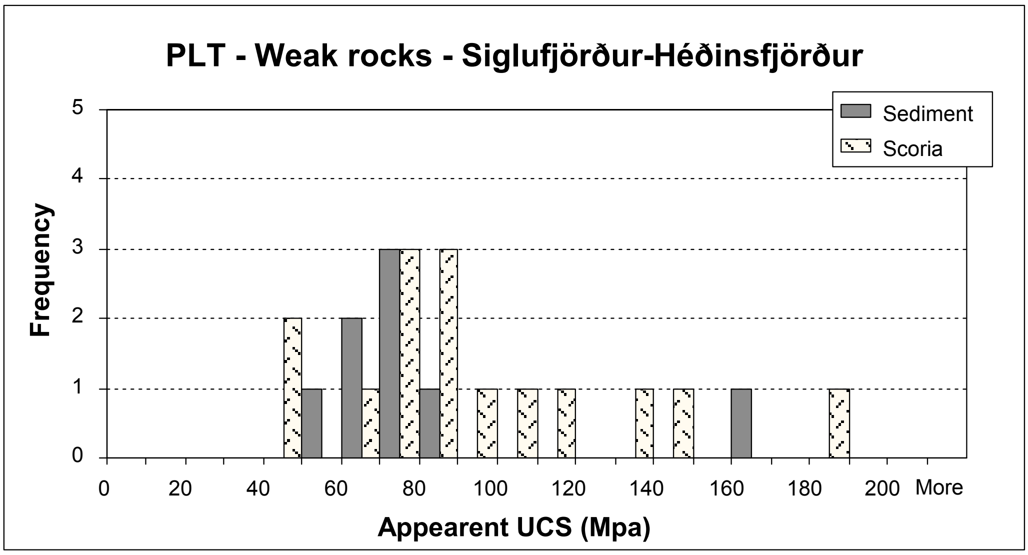

PLT - All rock types - Siglufjörður-Ólafsfjörður
Frequency
Appearent UCS (Mpa)
0
5
10
15
20
25
30
35
40
0
50
100
150
200
250
300
350
400
More
Basalt
Scoria
Sediment

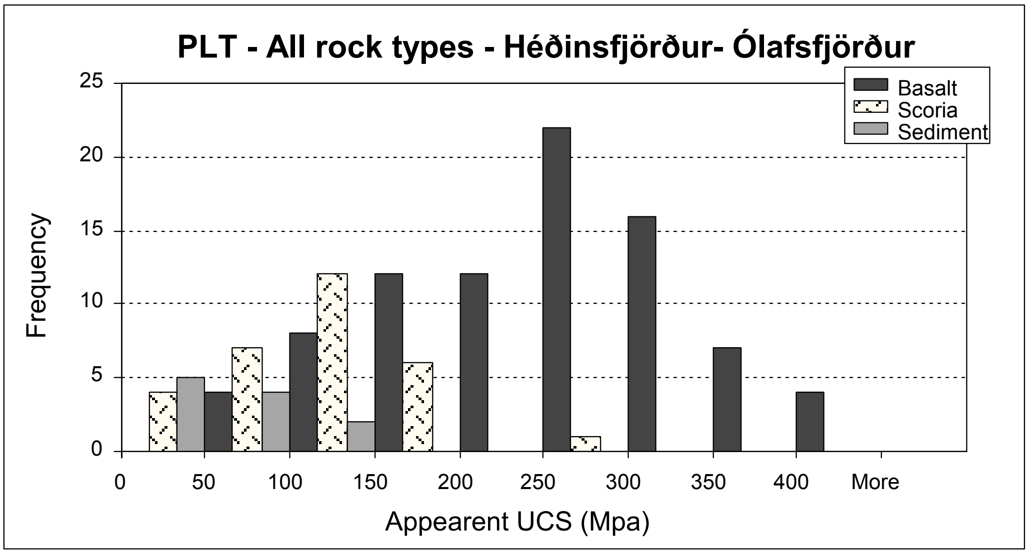

PLT - Basalt - Siglufjörður-Ólafsfjörður
Frequency
Appearent UCS (Mpa)
0
5
10
15
20
25
30
35
40
0
50
100
150
200
250
300
350
400
More
Tholeiite basalt
Olivine basalt
Porphyritic basalt
Dyke
Basalt

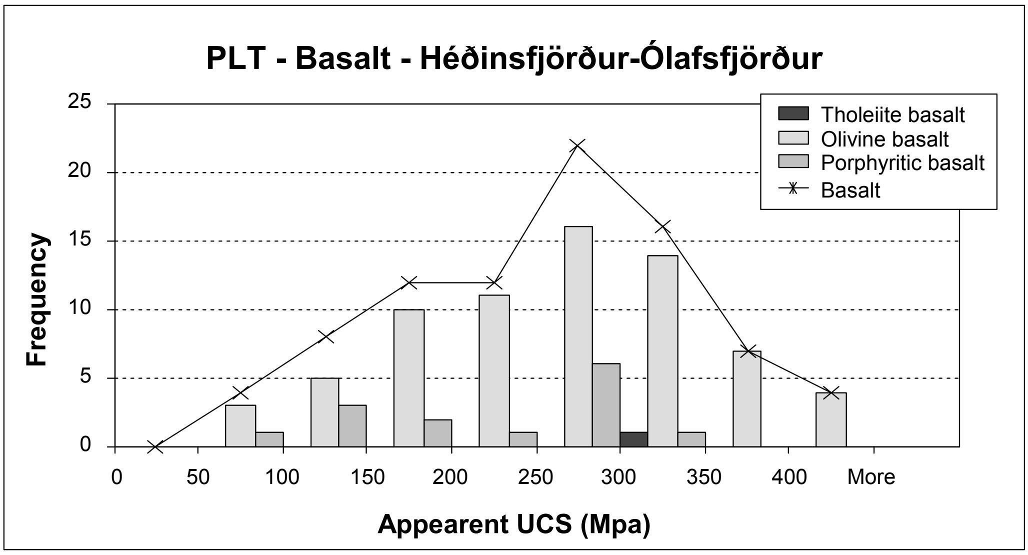

PLT - Weak rocks - Siglufjörður-Ólafsfjörður
Frequency
Appearent UCS (Mpa)
0
2
4
6
8
10
0
20
40
60
80
100
120
140
160
180
200
More
Sediment
Scoria

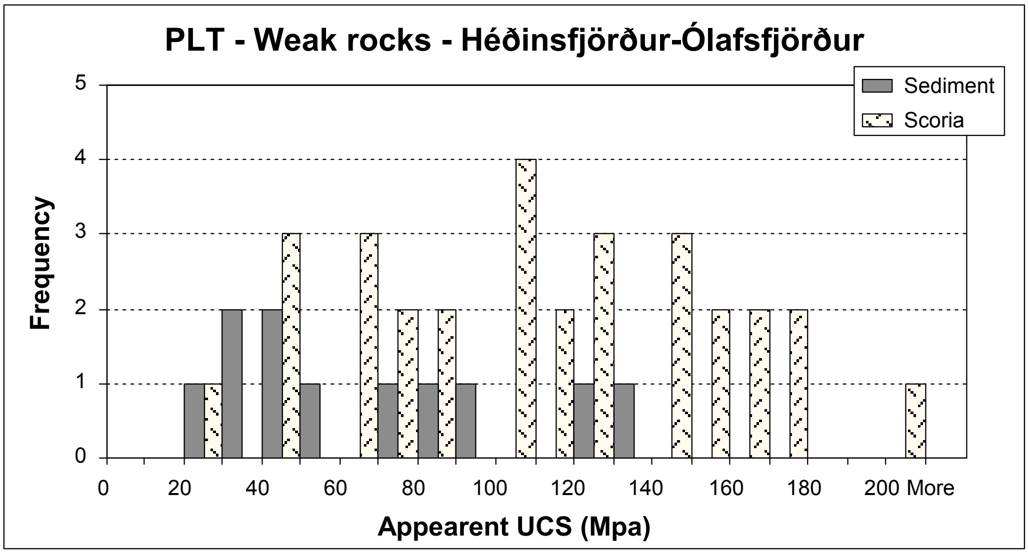

PLT - All rock types - Siglufjörður-Héðinsfjörður
Basalt
Scoria
Sediment
Frequency
0
4
8
12
16
20
0
50
100
150
200
250
300
350
400
More
Appearent UCS (Mpa)


PLT - Basalt - Siglufjörður-Héðinsfjörður
Tholeiite basalt
Olivine basalt
Porphyritic basalt
Dyke
Basalt
Frequency
0
4
8
12
16
20
0
50
100
150
200
250
300
350
400
More
Appearent UCS (Mpa)


PLT - Weak rocks - Siglufjörður-Héðinsfjörður
Sediment
Scoria
Frequency
0
1
2
3
4
5
0
20
40
60
80
100
120
140
160
180
200
More
Appearent UCS (Mpa)


PLT - All rock types - Héðinsfjörður- Ólafsfjörður
Frequency
25
20
15
10
5
0
0
50
100
150
200
250
300
350
400
More
Appearent UCS (Mpa)
Basalt
Scoria
Sediment


PLT - Basalt - Héðinsfjörður-Ólafsfjörður
Frequency
25
20
15
10
5
0
0
50
100
150
200
250
300
350
400
More
Appearent UCS (Mpa)
Tholeiite basalt
Olivine basalt
Porphyritic basalt
Basalt


PLT - Weak rocks - Héðinsfjörður-Ólafsfjörður
Frequency
5
4
3
2
1
0
0
20
40
60
80
100
120
140
160
180
200
More
Appearent UCS (Mpa)
Sediment
Scoria

Hole - SG -1 Schmidt Hammer Test				
Depth (m)	**Rock type**	**D mm**	**Number of blows**	**Rebound Hardness**
15,32	Olivine basalt	44,8	8	17,7
20,5	Scoriaceous basalt	44,8	10	19,3
24,1	Tholeiite basalt	44,8	7	27,4
28,8	Olivine basalt	44,8	9	21,1
31,2	Olivine basalt	44,8	8	10,8
40,9	Scoriaceous basalt	44,8	10	19,3
42,3	Olivine basalt	44,8	10	24,5
51,8	Olivine basalt	44,8	10	29,2
53,4	Scoria	44,8	10	21,8
59,1	Olivine basalt	44,8	10	23,1
63,3	Olivine basalt	44,8	10	22,8
66,4	Olivine basalt	44,8	10	26,3
70,8	Scoriaceous basalt	44,8	10	20,9
82,1	Olivine basalt	44,8	10	28,7
90,2	Scoriaceous basalt	44,8	10	31,3
73,4	Tholeiite basalt	44,8	10	36,5
97,2	Scoriaceous basalt	44,8	10	26,4
102,1	Porphyritic basalt	44,8	10	33,5
105,3	Porphyritic basalt	44,8	10	32,3
113,3	Scoriaceous basalt	44,8	10	11,5
121,2	Olivine basalt	44,8	10	33,2
125,2	Olivine basalt	44,8	10	36,9
130,4	Olivine basalt	44,8	10	31,3
135,6	Olivine basalt	44,8	10	29,6
138,8	Scoriaceous basalt	44,8	10	10,0
143,5	Scoriaceous basalt	44,8	10	25,8
146,2	Olivine basalt	44,8	10	24,8
159,2	Olivine basalt	44,8	10	31,5
162,4	Olivine basalt	44,8	12	25,4
171,4	Scoriaceous basalt	44,8	10	16,6
186,8	Porphyritic basalt	44,8	10	22,5
197,8	Porphyritic basalt	44,8	10	34,3
201,6	Porphyritic basalt	44,8	10	36,0
206,4	Scoriaceous basalt	44,8	10	20,4
208,3	Scoriaceous basalt	44,8	10	16,1
211,9	Olivine basalt	44,8	10	32,0
218,5	Olivine basalt	44,8	10	33,9
229,9	Sandstone	44,8	10	19,4
236,8	Porphyritic basalt	44,8	11	36,3
240	Porphyritic basalt	44,8	8	29,4
249,2	Porphyritic basalt	44,8	10	33,0
255,5	Porphyritic basalt	44,8	10	31,1
261,6	Porphyritic basalt	44,8	10	34,2
267,6	Scoriaceous basalt	44,8	10	16,1
274,3	Tholeiite basalt	44,8	10	32,7
282,5	Scoria	44,8	10	23,8
288,1	Olivine basalt porphyritic	44,8	10	29,6
292,5	Olivine basalt porphyritic	44,8	10	31,3
296,4	Olivine basalt porphyritic	44,8	10	24,0
300,6	Olivine basalt porphyritic	44,8	10	23,8
304,5	Olivine basalt porphyritic	44,8	10	33,1
305,9	Dyke	44,8	10	34,7
310,5	Dyke	44,8	10	32,4

Hole - SG -1 Schmidt Hammer Test				
Depth (m)	**Rock type**	**D mm**	**Number of blows**	**Rebound Hardness**
316,9	Olivine basalt	44,8	8	26,8
321,5	Dyke	44,8	12	31,9
325,8	Dyke	44,8	10	33,4
329,3	Porphyritic basalt	44,8	10	28,5

Hole - HG-1 Schmidt Hammer Test				
Depth (m)	**Rock type**	**D mm**	**Number of blows**	**Rebound Hardness**
27	Porphyritic basalt	44,8	8	16,0
35,9	Porphyritic basalt	44,8	10	29,9
43,1	Scoriaceous basalt	44,8	10	25,6
46,7	Olivine basalt porphyritic	44,8	10	40,2
55,2	Olivine basalt porphyritic	44,8	10	33,8
60,9	Olivine basalt porphyritic	44,8	10	31,9
74,2	Olivine basalt porphyritic	44,8	10	34,6
80,1	Scoriaceous basalt	44,8	10	28,0
83,8	Olivine basalt porphyritic	44,8	10	32,7
87,1	Scoria	44,8	10	28,4
95,1	Scoria	44,8	10	18,4
101,8	Olivine basalt	44,8	10	25,5
104,8	Olivine basalt	44,8	10	29,1
109,3	Scoriaceous basalt	44,8	10	26,5
112,5	Porphyritic basalt	44,8	10	32,4
129,9	Porphyritic basalt	44,8	10	25,3
141,4	Porphyritic basalt	44,8	10	34,6
143,3	Scoriaceous basalt	44,8	10	20,8
150,7	Olivine basalt	44,8	10	32,2
154,8	Olivine basalt	44,8	10	32,0
168,1	Scoriaceous basalt	44,8	10	31,6
171,6	Olivine basalt porphyritic	44,8	10	38,2
180,6	Porphyritic basalt	44,8	10	32,9
189,5	Scoria	44,8	10	21,3
190,5	Scoria	44,8	10	34,6
198,5	Olivine basalt porphyritic	44,8	8	33,1
208,1	Olivine basalt porphyritic	44,8	10	34,7
212,5	Scoriaceous basalt	44,8	10	24,0
218,8	Porphyritic basalt	44,8	10	26,3
220,3	Scoria	44,8	10	11,7
233	Scoriaceous basalt	44,8	10	20,7
243	Olivine basalt porphyritic	44,8	10	31,8
252,1	Scoria	44,8	10	24,2
257,4	Olivine basalt porphyritic	44,8	10	30,6
268,1	Scoria	44,8	10	18,6
272,4	Olivine basalt	44,8	10	39,0
295,1	Olivine basalt	44,8	10	33,0
298,9	Scoria	44,8	10	23,9
307,9	Olivine basalt porphyritic	44,8	10	43,5
310,6	Olivine basalt	44,8	9	34,4
313,9	Scoriaceous basalt	44,8	10	30,3
320,4	Scoriaceous basalt	44,8	10	12,2
324,9	Olivine basalt	44,8	10	29,6
336,7	Olivine basalt	44,8	10	36,2
338,1	Olivine basalt	44,8	10	32,4
345,5	Olivine basalt	44,8	10	36,9

Hole - HG-2 Schmidt Hammer Test				
Depth (m)	**Rock type**	**D mm**	**Number of blows**	**Rebound Hardness**
9,4	Scoria	44,8	10	28,0
19,6	Porphyritic basalt	44,8	10	33,0
30,1	Porphyritic basalt	44,8	10	30,1
35,9	Porphyritic basalt	44,8	10	34,0
46,7	Porphyritic basalt	44,8	10	32,3
59,3	Olivine basalt	44,8	10	23,6
66,7	Olivine basalt	44,8	10	25,5
75,7	Olivine basalt	44,8	10	22,9
82,2	Olivine basalt	44,8	9	26,2
93,1	Porphyritic basalt	44,8	10	26,2
103,1	Olivine basalt porphyritic	44,8	10	34,9
114,1	Dyke	44,8	5	24,4
126,8	Dyke	44,8	8	36,6
137,3	Scoriaceous basalt	44,8	10	22,1
140,6	Porphyritic basalt	44,8	10	29,6
155,9	Scoria	44,8	10	26,5
168,4	Olivine basalt porphyritic	44,8	10	32,1
172,5	Olivine basalt	44,8	8	31,3
202,6	Porphyritic basalt	44,8	10	27,6
207	Scoriaceous basalt	44,8	10	15,2
215,2	Olivine basalt	44,8	10	33,0

Hole - HG-3 Schmidt Hammer Test				
Depth (m)	**Rock type**	**D mm**	**Number of blows**	**Rebound Hardness**
17,72	Scoria	44,8	10	30,2
19,9	Porphyritic basalt	44,8	10	28,0
26,6	Porphyritic basalt	44,8	10	28,6
40,4	Scoria	44,8	10	32,9

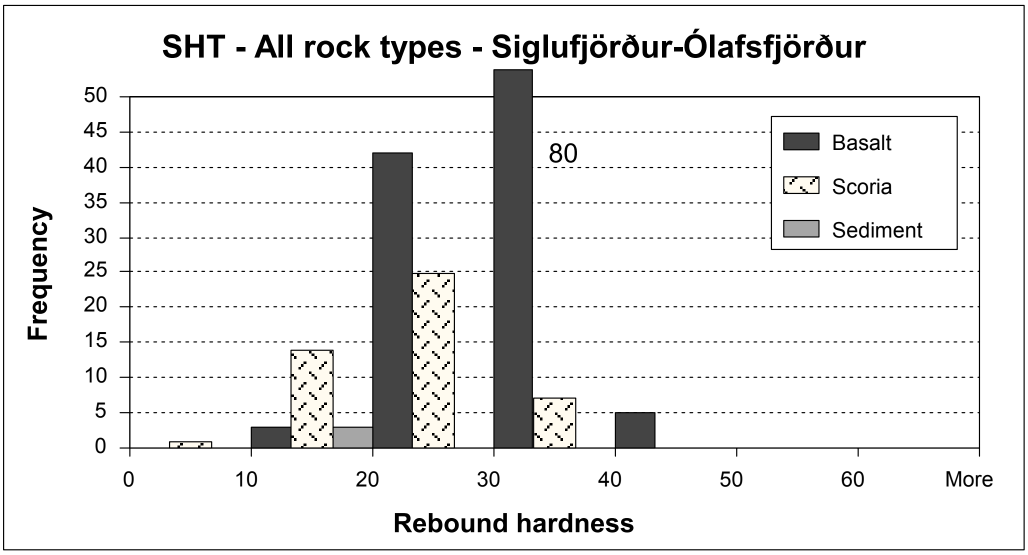
Hole - HG-4 Schmidt Hammer Test				
Depth (m)	**Rock type**	**D mm**	**Number of blows**	**Rebound Hardness**
17,3	Olivine basalt	44,8	10	31,7
27,4	Olivine basalt	44,8	10	22,0
35	Scoria	44,8	10	19,0
43,2	Olivine basalt	44,8	10	34,7

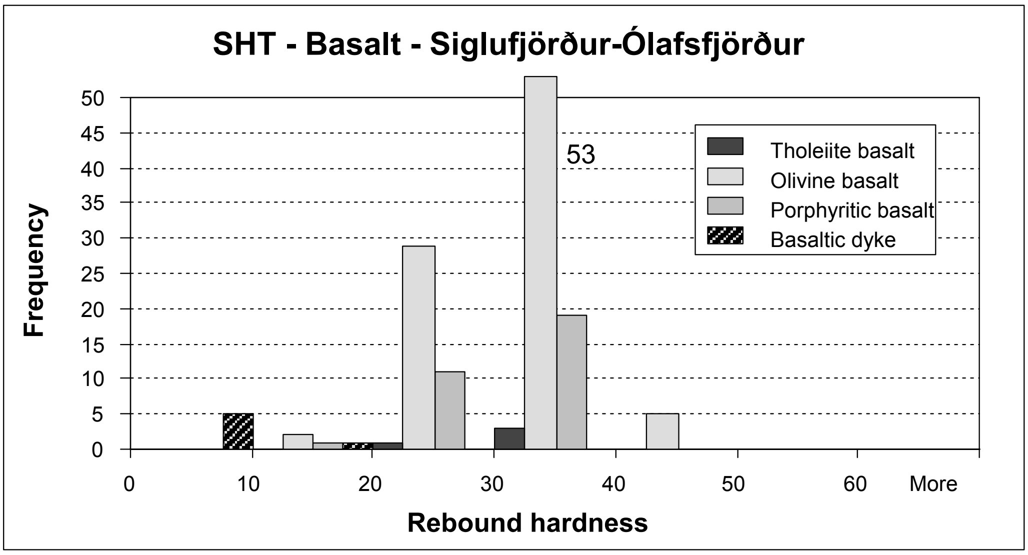
Hole - HG-5 Schmidt Hammer Test				
Depth (m)	**Rock type**	**D mm**	**Number of blows**	**Rebound Hardness**
14,2	Olivine basalt	44,8	12	27,6
24,9	Scoria	44,8	10	23,6
29,3	Porphyritic basalt	44,8	10	30,5
36,2	Scoria	44,8	10	16,0
42,5	Porphyritic basalt	44,8	10	31,2
52,7	Porphyritic basalt	44,8	10	31,0
60,6	Olivine basalt	44,8	10	31,1
69,2	Sandstone	44,8	10	19,6
74,7	Scoriaceous basalt	44,8	10	21,6

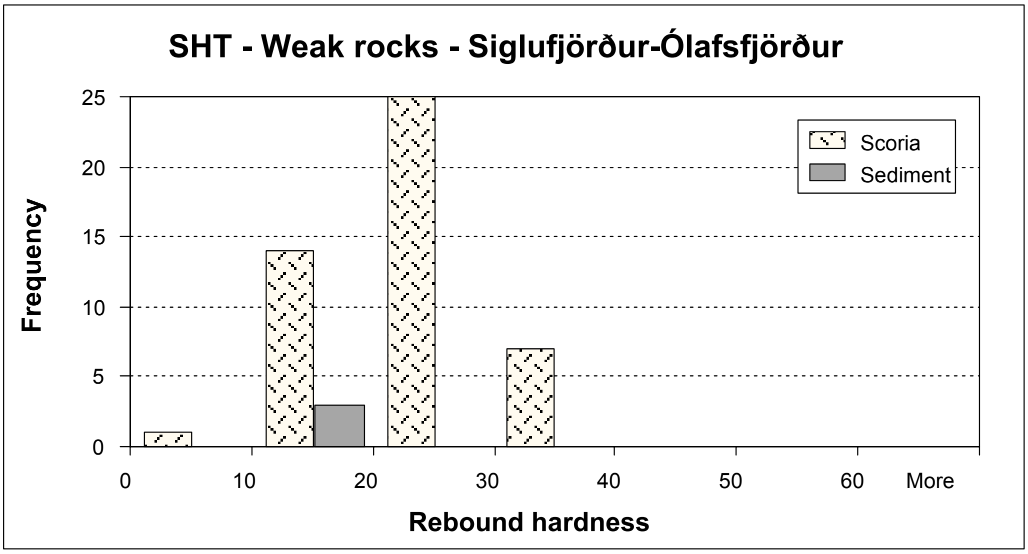
Hole - ÓG-1 Schmidt Hammer Test				
Depth m	**Rock type**	**D mm**	**Number of blows**	**Rebound Hardness**
13,9	Olivine basalt-porph.	44,8	12	36,6
16,9	Porphyritic basalt	44,8	14	38,7
21,5	Olivine basalt-porph.	44,8	12	38,3
24,4	Olivine basalt	44,8	14	37,3
26,7	Scoriaceous basalt	44,8	14	29,3
48,5	Olivine basalt	44,8	12	38,0
52,5	Scoriaceous basalt	44,8	15	28,5
61,9	Breccia	44,8	11	16,5

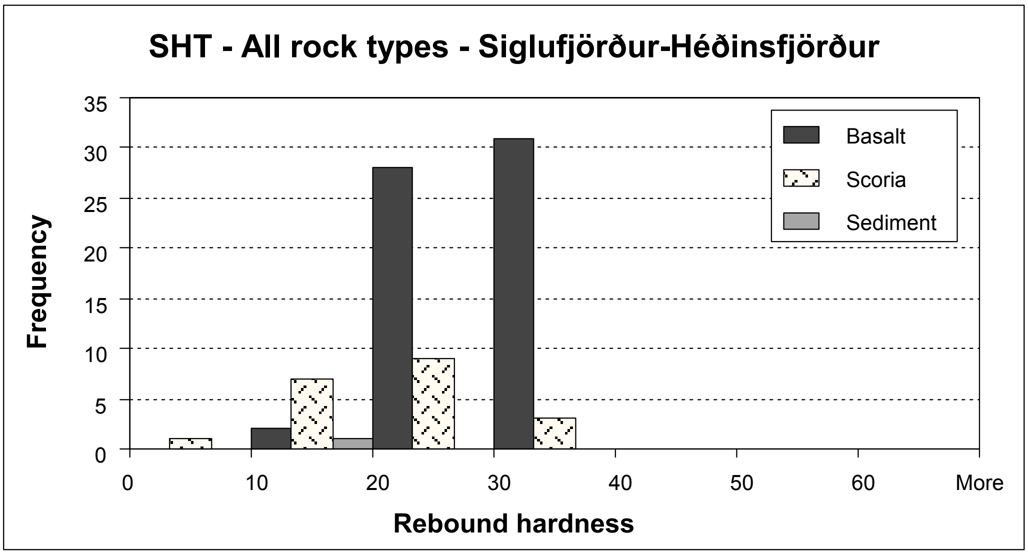
Hole - ÓG-2 Schmidt Hammer Test				
Depth m	**Rock type**	**D mm**	**Number of blows**	**Rebound Hardness**
18,3	Olivine basalt-porph.	44,8	12	37,4
23,9	Olivine basalt-porph.	44,8	11	35,2
31,4	Olivine basalt	44,8	12	34,5
37,9	Olivine basalt	44,8	11	28,3
43,6	Olivine basalt	44,8	16	33,1
45,9	Olivine basalt-porph.	44,8	11	31,5
57,7	Olivine basalt	44,8	12	33,3
68,6	Olivine basalt	44,8	12	29,6
70,9	Olivine basalt	44,8	9	27,0
77,6	Olivine basalt	44,8	10	34,0
84,4	Olivine basalt	44,8	12	29,6
89,9	Olivine basalt	44,8	12	29,3
96,8	Olivine basalt	44,8	12	33,5
101,4	Olivine basalt	44,8	12	24,4
105,5	Olivine basalt-porph.	44,8	12	33,0
109,2	Scoriaceous basalt	44,8	14	11,5
114,8	Olivine basalt	44,8	14	31,5
120,5	Olivine basalt	44,8	13	34,2
123,4	Olivine basalt	44,8	14	35,0
126,1	Olivine basalt	44,8	12	38,3
130,2	Scoriaceous basalt	44,8	12	30,1
138,1	Olivine basalt-porph.	44,8	12	37,0
142,1	Olivine basalt-porph.	44,8	14	34,4
150,3	Scoriaceous basalt	44,8	16	28,6

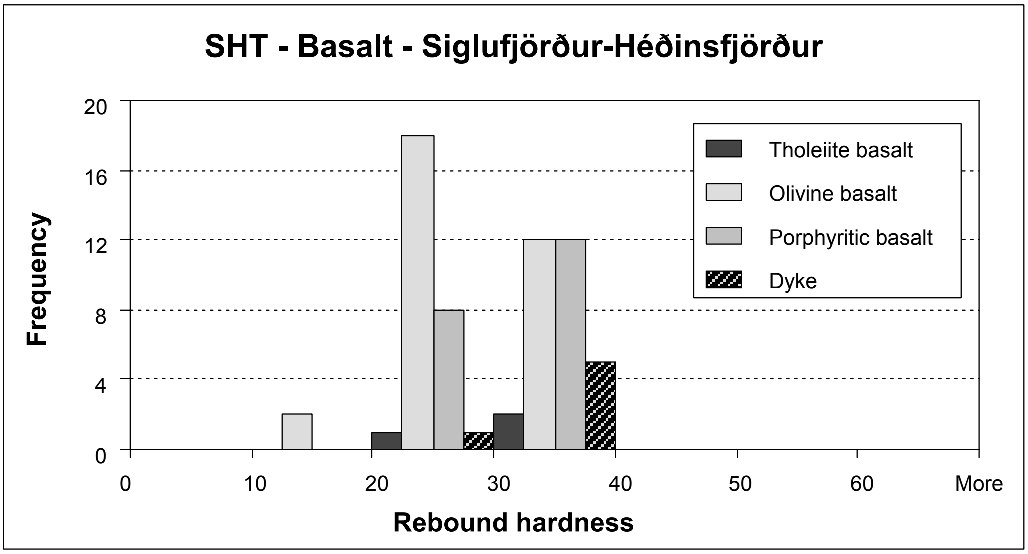
Hole - ÓG-3 Schmidt Hammer Test				
Depth m	**Rock type**	**D mm**	**Number of blows**	**Rebound Hardness**
8,6	Olivine basalt-Tholeiite	44,8	18	45,6
18,2	Scoriaceous basalt	44,8	18	23,1
20,3	Olivine basalt	44,8	18	30,7
24,5	Olivine basalt	44,8	18	32,7
33,5	Tholeiite	44,8	18	36,6
34,8	Olivine basalt	44,8	15	45,8
50,6	Olivine basalt	44,8	18	42,9

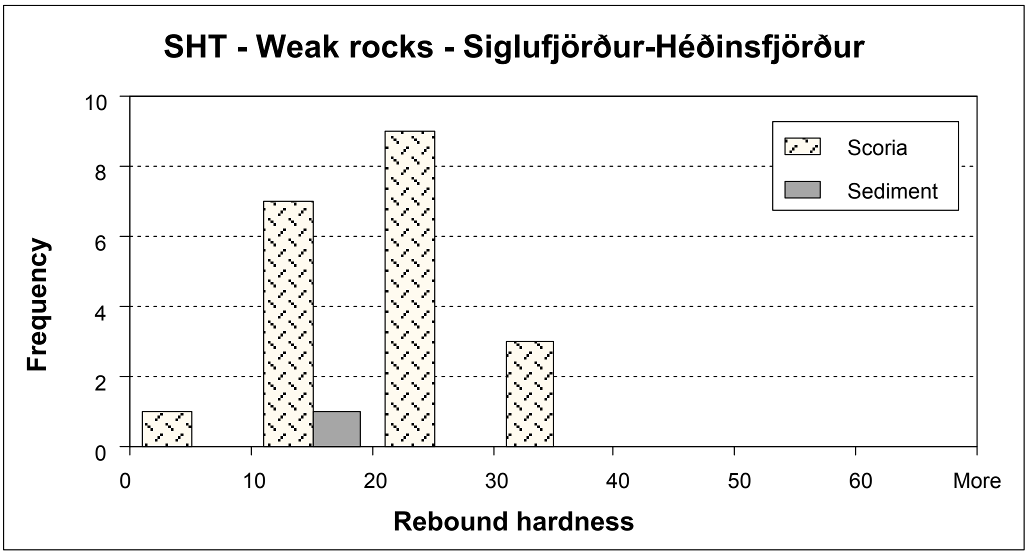

SHT - All rock types - Siglufjörður-Ólafsfjörður
Frequency
Rebound hardness
0
5
10
15
20
25
30
35
40
45
50
0
10
20
30
40
50
60
More
80
Basalt
Scoria
Sediment

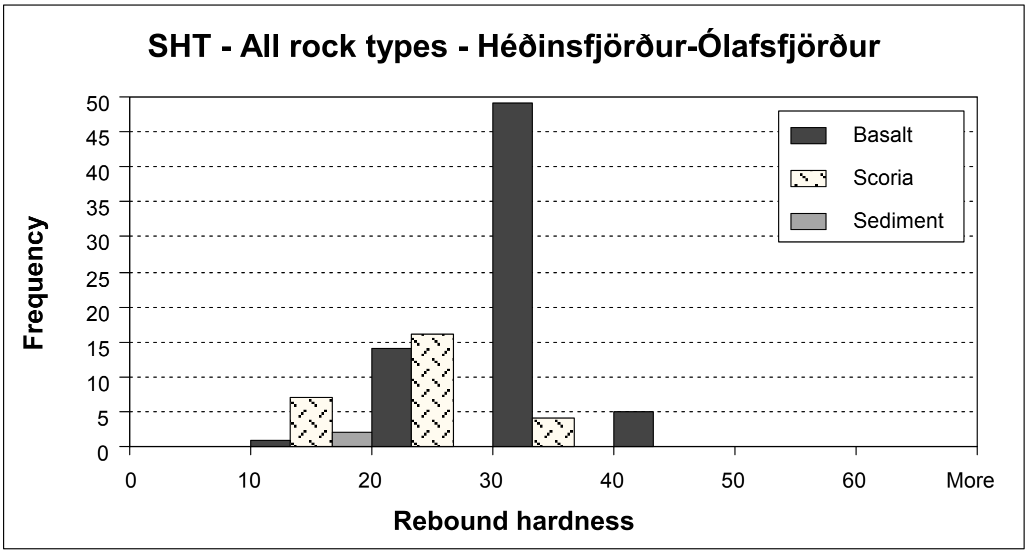

SHT - Basalt - Siglufjörður-Ólafsfjörður
Frequency
Rebound hardness
0
5
10
15
20
25
30
35
40
45
50
0
10
20
30
40
50
60
More
53
Tholeiite basalt
Olivine basalt
Porphyritic basalt
Basaltic dyke

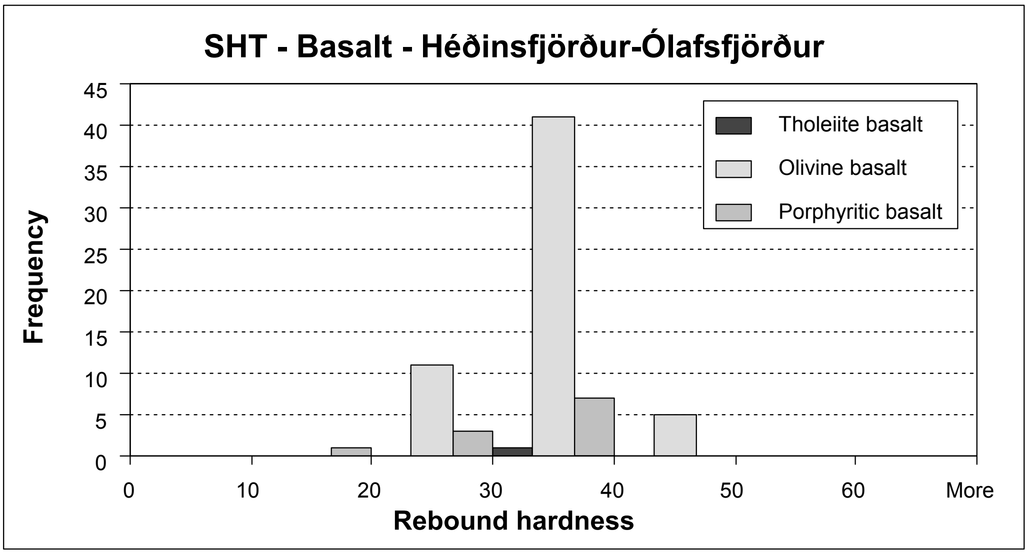

SHT - Weak rocks - Siglufjörður-Ólafsfjörður
Frequency
Rebound hardness
0
5
10
15
20
25
0
10
20
30
40
50
60
More
Scoria
Sediment

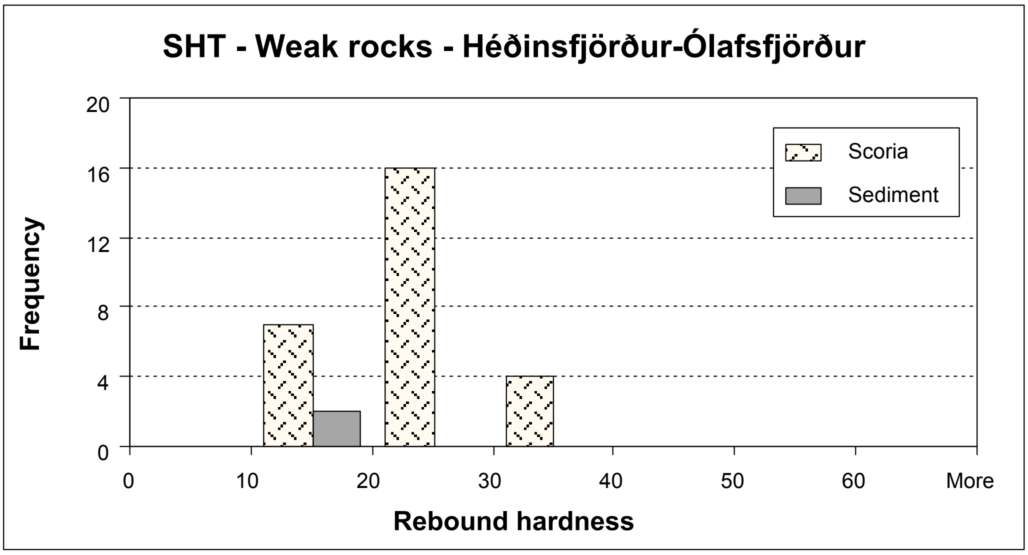

SHT - All rock types - Siglufjörður-Héðinsfjörður
Frequency
35
30
25
20
15
10
5
0
0
10
20
30
40
50
60
More
Rebound hardness
Basalt
Scoria
Sediment


SHT - Basalt - Siglufjörður-Héðinsfjörður
Frequency
20
16
12
8
4
0
0
10
20
30
40
50
60
More
Rebound hardness
Tholeiite basalt
Olivine basalt
Porphyritic basalt
Dyke


SHT - Weak rocks - Siglufjörður-Héðinsfjörður
Frequency
10
8
6
4
2
0
0
10
20
30
40
50
60
More
Rebound hardness
Scoria
Sediment


SHT - All rock types - Héðinsfjörður-Ólafsfjörður
Frequency
50
45
40
35
30
25
20
15
10
5
0
0
10
20
30
40
50
60
More
Rebound hardness
Basalt
Scoria
Sediment


SHT - Basalt - Héðinsfjörður-Ólafsfjörður
Frequency
45
40
35
30
25
20
15
10
5
0
0
10
20
30
40
50
60
More
Rebound hardness
Tholeiite basalt
Olivine basalt
Porphyritic basalt


SHT - Weak rocks - Héðinsfjörður-Ólafsfjörður
Frequency
20
16
12
8
4
0
0
10
20
30
40
50
60
More
Rebound hardness
Scoria
Sediment

Appendix IV Percussion drilling at portal areas

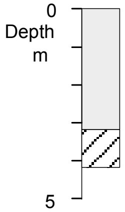
Héðinsfjörður Road Tunnel

Siglufjörður / Skútudalur - percussion drilling

SL-1

X: 505057.59
Y: 625813.57

121.1 m a.s.l.



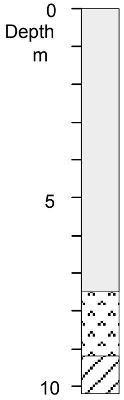
Coarse debris deposits mixed with soil; Moderate resistance;

Bedrock at 3.2 m;

SL-2

X: 505010.64
Y: 625874.14

112.1 m a.s.l.



Coarse debris deposits mixed with soil; Moderate/high resistance;

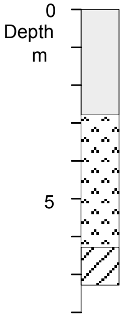
High Resistance in homogeneous material; either highly consolidated moreainic deposits, or soft, weathered bedrock;

Bedrock at 9.2 m;

SL-3

X: 504970.81
Y: 625936.37

99.2 m a.s.l.



Coarse debris deposits mixed with soil; Low/moderate resistance;

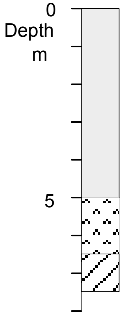
Homogenuous, well consolidated morainic deposits; High/very High resistance;

Bedrock at 6.3 m;

SL-4

X: 504907.51
Y: 625816.57

72.0 m a.s.l.



Debris mixed with soil; Moderate/high resistance;

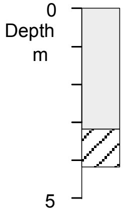
Well consolidated morainic deposits; High/very high resistance;

Bedrock at 6.5 m;

SL-5

X: 504997.66
Y: 625790.95

92.5 m a.s.l.



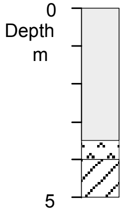
Coarse debris deposits mixed with soil; Moderate resistance;

Bedrock at 3.2 m;

SL-6

X: 504999.65
Y: 625736.76

87.6 m a.s.l.



Coarse debris deposits mixed with soil; Moderate resistance;

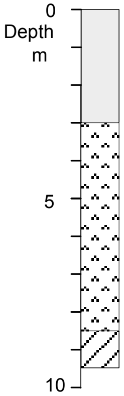
Moraine; high resistance;

Bedrock at 4.0 m;

SL-7

X: 504953.61
Y: 625715.19

74.9 m a.s.l.



Coarse debris deposits mixed with soil; Low/moderate resistance;

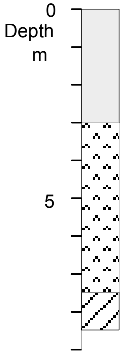
Homogenuous, well consolidated morainic deposits; High/very High resistance;

Bedrock at 8.5 m;

SL-8

X: 504930.91
Y: 625762.15

73.4 m a.s.l.



Debris mixed with soil; Moderate/high resistance;

Well compacted and consolidated morainic deposits; High/very high resistance;

Bedrock at 7.5 m;

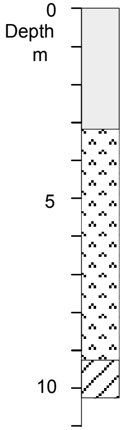
Héðinsfjörður Road Tunnel

Siglufjörður / Skútudalur - percussion drilling

SL-9

X: 504901.35
Y: 625733.48

63.4 m a.s.l.



Coarse debris deposits mixed with soil; Moderate resistance;

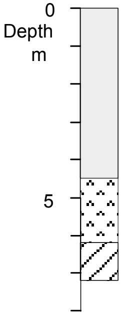
Well compacted and consolidated morainic deposits; High/very high resistance;

Bedrock at 9.3 m;

SL-10

X: 504938.70
Y: 625673.94

65.8 m a.s.l.



Coarse debris deposits mixed with soil; Moderate resistance;

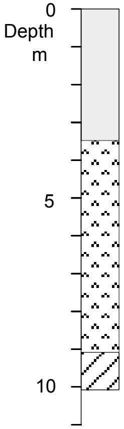
Well consolidated morainic deposits; High resistance;

Bedrock at 6.2 m;

SL-11

X: 504989.98
Y: 625673.52

80.9 m a.s.l.



Coarse debris deposits mixed with soil; Low/moderate resistance;

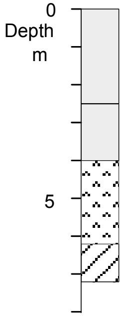
Homogenuous, well consolidated morainic deposits; High/very High resistance;

Bedrock at 9.1 m;

SL-12

X: 504958.76
Y: 625621.85

63.5 m a.s.l.



Debris mixed with soil; Moderate/high resistance;

Coarse debris deposits; Moderate/high resistance;

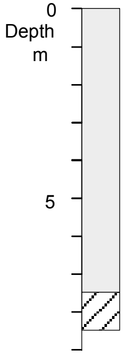
Well compacted and consolidated morainic deposits; High/very high resistance;

Bedrock at 6.2 m;

SL-13

X: 505013.16
Y: 625639.40

80.9 m a.s.l.



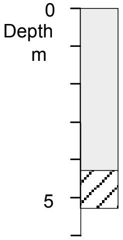
Coarse debris deposits mixed with soil, partly large stones and boulders; Moderate/high resistance;

Bedrock at 7.5 m;

SL-14

X: 504983.87
Y: 625581.60

66.0 m a.s.l.



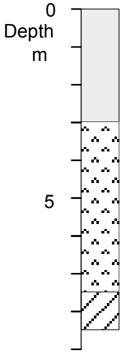
Coarse debris deposits mixed with soil; Moderate resistance;

Bedrock at 6.2 m;

SL-15

X: 505017.59
Y: 625595.05

75.8 m a.s.l.



Coarse debris deposits mixed with soil; Low/moderate resistance;

Well compacted and consolidated morainic deposits; High/very High resistance;

Bedrock at 7.5 m;

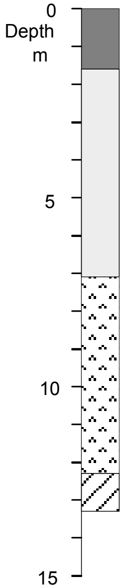
Héðinsfjörður Road Tunnel

Héðinsfjörður - percussion drilling

HL-1

X: 507955.70
Y: 622953.91

93.0 m a.s.l.



Soil mixed with gravel;
Low resistance;

Gravel deposits, mixed
with stones/boulders;
Moderate/high resistance;

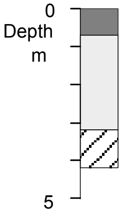
Homogenuous,partly
stony, well consolidated
material high resistivity
(morainec deposits);

Bedrock;
Bottom at 13,3 m;

HL-2

X: 507876.08
Y: 622982.42

109.6 m a.s.l.



Soil, sandy, partly gravel;
Low resistance;

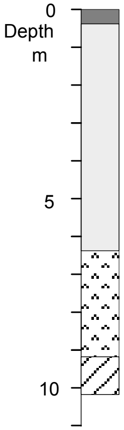
Sandy,soily gravel
deposits;
moderate/high resistance;

Bedrock at 3,2 m;

HL-3

X: 507965.95
Y:623038.04

96.7 m a.s.l.



Soil mixed with gravel;
Low resistance;

Coarse, gravelly debris
deposits;
Moderate/high resistance;

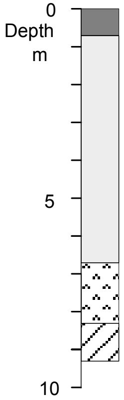
Homogenuous material of
high resistance, partly
stones (morainic
deposits);

Bedrock; bottom at 9,2 m;

HL-4

X: 507984.83
Y: 623092.64

94.5 m a.s.l.



Soil mixed with gravel;
Low/mod. resistance;

Soily/sandy gravel
deposits (debris);
Moderate resistance;

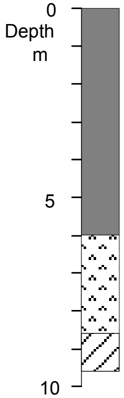
Homogeneous, well
consolidated material;
High resistance;

Bedrock; bottom at 9.3 m;

HL-5

X: 508011.79
Y: 623153.07

89.0 m a.s.l.



Soil mixed with gravel and
stones;
Low/moderate resistance
in upper part, moderate
/high resistance in lower
part;

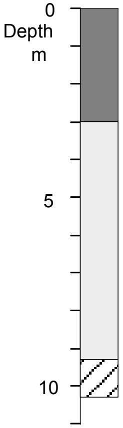
Homogenuous deposits of
high/very high resistance
(well consolidated
moraine, or soft,
weathered bedrock);

Bedrock at 8,6 m;

HL-6

X: 508017.01
Y: 623189.86

88.4 m a.s.l.



Soil mixed with gravel,
partly stones/boulders;
Low/moderate resistance;

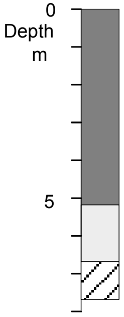
Sandy,soily gravel
deposits;
Moderate resistance;

Bedrock at 9,3 m;

HL-7

X: 508026.92
Y: 623247.31

88.7 m a.s.l.



Soil mixed with gravel and
stones;
Low/moderate resistance;

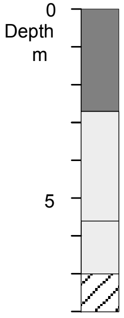
Coarsegrained debris
deposits;
Moderate/high resistance;

Bedrock at 6,7 m;

HL-8

X: 507979.20
Y: 623228.86

98.34 m a.s.l.



Soil mixed with gravel and
stones;
Low/mod. resistance;

Soily/sandy gravel
deposits (debris);
Moderate resistance;

Debris deposits, well
consolidated;
Moderate/high resistance;

Bedrock at 7,0 m;

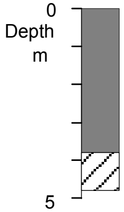
Héðinsfjörður Road Tunnel

Héðinsfjörður - percussion drilling

HL-9

X: 507986.05
Y: 623260.20

97.0 m a.s.l.



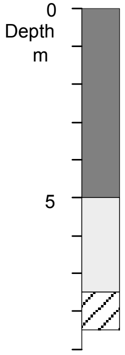
Soil mixed with gravel and stones;
Moderate/high resistance;

Bedrock at 3,8 m;

HL-10

X: 508031.01
Y: 623274.86

88.2 m a.s.l.



Soil mixed with gravel, partly stones/boulders;
Low/moderate resistance;

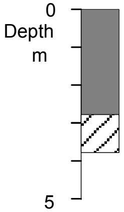
Gravelly debris in sandy matrix;
Moderate/high resistance;

Bedrock at 7,5 m;

HL-11

X: 507997.00
Y: 623324.13

96.4 m a.s.l.



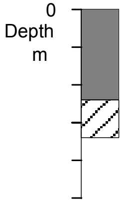
Soil mixed with gravel;
Low/moderate resistance;

Bedrock at 2,8 m;

HL-12

X: 507961.54
Y: 623305.19

104.3 m a.s.l.



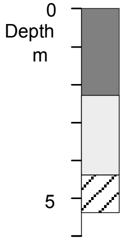
Soil mixed with gravel and stones;
Low/mod. resistance;

Bedrock at 2,4 m;

HL-13

X: 507950.48
Y: 623264.38

105.6 m.a.s.l.



Soil mixed with gravel;
Low/moderate resistance;

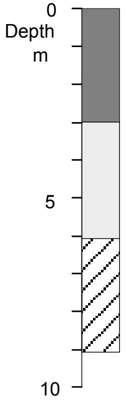
Coarse debris deposits;
Moderate resistance;

Bedrock at 4,4 m;

HL-14

X: 507952.9
Y: 623230.36

104.6 m a.s.l.



Soil mixed with graveland stones;
Low/moderate resistance;

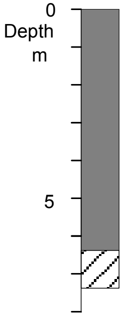
Coarse debris deposits;
Moderate resistance;

High Resistance in homogeneous material; either highly consolidated moreainic deposits, or soft, weathered bedrock;

HL-15

X: 507970.53
Y: 623167.96

96.2 m a.s.l.



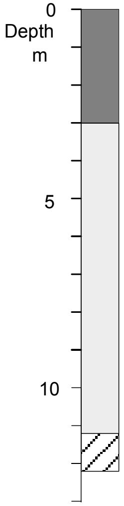
Soil mixed with gravel and stones;
Low/moderate resistance;

Bedrock at 6,4 m;

HL-16

X: 508065.19
Y: 623223.06

76.7 m a.s.l.



Soil mixed with gravel and stones;
Low/mod. resistance;

Gravelly deposits, partly large stones/boulders;
Moderate resistance;

Bedrock at 11,2 m;

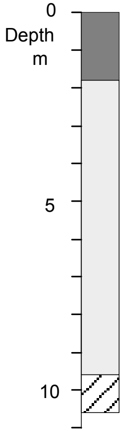
Héðinsfjörður Road Tunnel

Héðinsfjörður - percussion drilling

HL-17

X: 508052
Y: 623126.96

74.71 m a.s.l.



Soil mixed with gravel;
Low resistance;

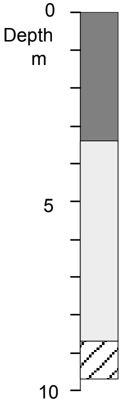
Coarsegrained debris
deposits;
Moderate resistance;

Bedrock at 9,6 m;

HL-18

X: 508032.29
Y: 623075.10

78.0 m a.s.l.



Soil mixed with gravel;
Low resistance;

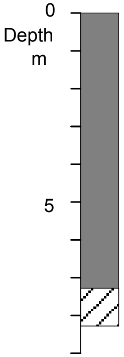
Coarse debris deposits;
Moderate resistance;

Bedrock at 8,7 m;

HL-21

X: 508657.43
Y: 622901.43

116.5 m a.s.l.



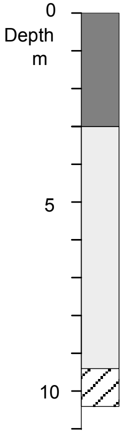
Gravel soil and debris;
Low/moderate resistance;

Bedrock at 7,3 m;

HL-22

X: 508632.81
Y: 622867.91

117.4 m a.s.l.



Soil mixed with gravel and
stones;
Low/mod. resistance;

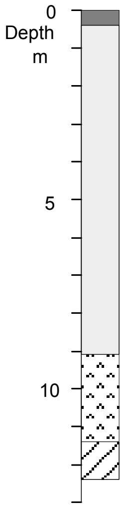
Coarse debris deposits,
partly large
stones/boulders;
Moderate resistance;

Bedrock at 9,4 m;

HL-23

X: 508613.77
Y: 622935.20

103.5 m a.s.l.



Soil

Coarse debris deposits;
Moderate resistance;

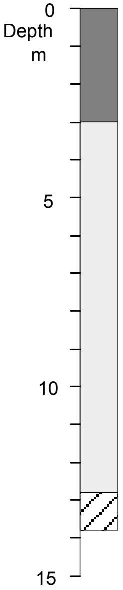
Homogenuous, medium
grained, well consolidated
deposit (moraine);
High resistance;

Bedrock at 11,4 m;

HL-24

X: 508583.07
Y: 622886.76

105.15 m a.s.l.



Soil mixed with gravel;
Low/moderate resistance;

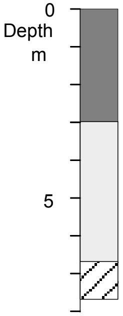
Coarse debris deposits
with sandy matrix;
Moderate resistance;

Bedrock at 12,8 m;

HL-25

X: 508559.71
Y: 622825.78

101.6 m a.s.l.



Soil mixed with gravel;
Low/moderate resistance;

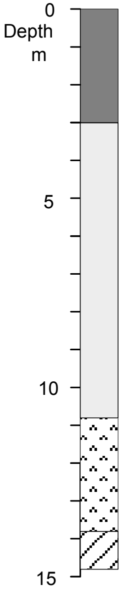
Coarse, gravelly debris
deposits;
Moderate resistance;

Bedrock at 6,7 m;

HL-26

X: 508576.28
Y: 622958.18

96.41 m a.s.l.



Soil mixed with gravel;
Low/mod. resistance;

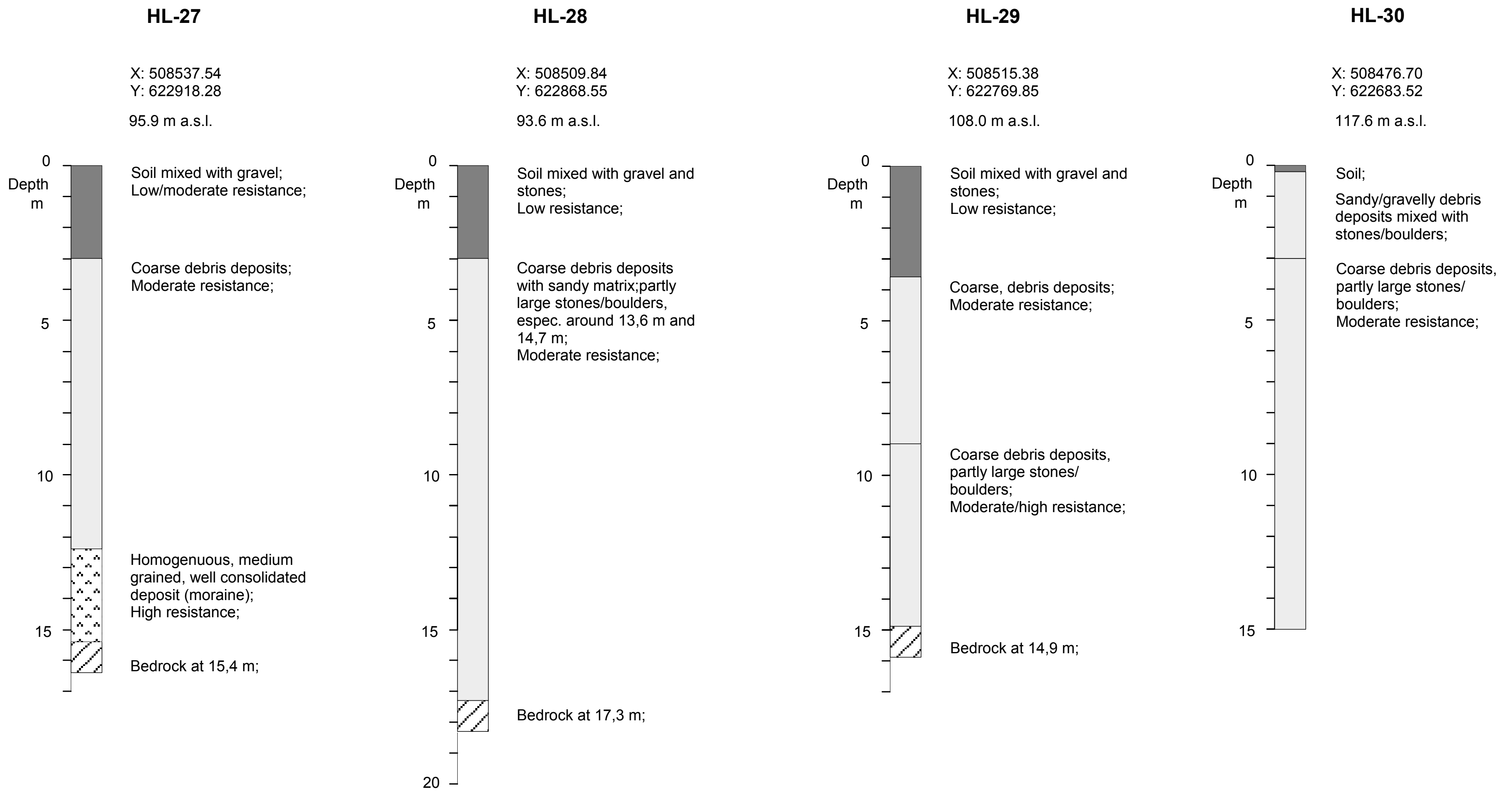
Coarse debris deposits,
partly large stones/
boulders;
Moderate resistance;

Homogenuous medium
grained deposits;
partly stones, well
consolidated (moraine)
High resistance;

Bedrock at 13,8 m;

Héðinsfjörður Road Tunnel

Héðinsfjörður - percussion drilling



HL-27

X: 508537.54
Y: 622918.28

95.9 m a.s.l.

Soil mixed with gravel;
Low/moderate resistance;

Coarse debris deposits;
Moderate resistance;

Homogenuous, medium grained, well consolidated deposit (moraine);
High resistance;

Bedrock at 15,4 m;

HL-28

X: 508509.84
Y: 622868.55

93.6 m a.s.l.

Soil mixed with gravel and stones;
Low resistance;

Coarse debris deposits with sandy matrix;partly large stones/boulders, espec. around 13,6 m and 14,7 m;
Moderate resistance;

Bedrock at 17,3 m;

HL-29

X: 508515.38
Y: 622769.85

108.0 m a.s.l.

Soil mixed with gravel and stones;
Low resistance;

Coarse, debris deposits;
Moderate resistance;

Coarse debris deposits, partly large stones/ boulders;
Moderate/high resistance;

Bedrock at 14,9 m;

HL-30

X: 508476.70
Y: 622683.52

117.6 m a.s.l.

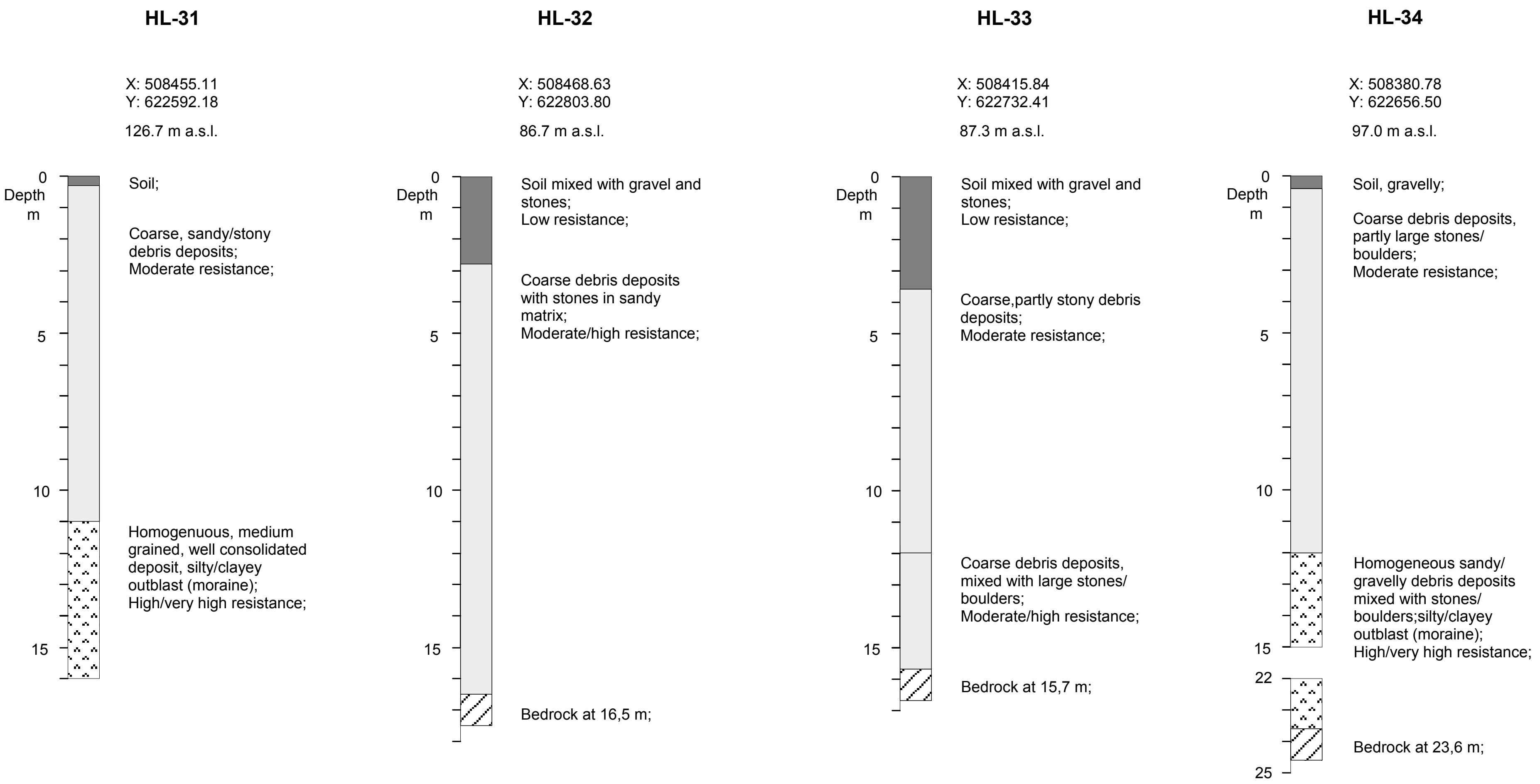
Soil;

Sandy/gravelly debris deposits mixed with stones/boulders;

Coarse debris deposits, partly large stones/ boulders;
Moderate resistance;

Héðinsfjörður Road Tunnel

Héðinsfjörður - percussion drilling



HL-31

X: 508455.11
Y: 622592.18

126.7 m a.s.l.

Soil;

Coarse, sandy/stony debris deposits; Moderate resistance;

Homogenuous, medium grained, well consolidated deposit, silty/clayey outblast (moraine); High/very high resistance;

HL-32

X: 508468.63
Y: 622803.80

86.7 m a.s.l.

Soil mixed with gravel and stones; Low resistance;

Coarse debris deposits with stones in sandy matrix; Moderate/high resistance;

Bedrock at 16,5 m;

HL-33

X: 508415.84
Y: 622732.41

87.3 m a.s.l.

Soil mixed with gravel and stones; Low resistance;

Coarse,partly stony debris deposits; Moderate resistance;

Coarse debris deposits, mixed with large stones/ boulders; Moderate/high resistance;

Bedrock at 15,7 m;

HL-34

X: 508380.78
Y: 622656.50

97.0 m a.s.l.

Soil, gravelly;

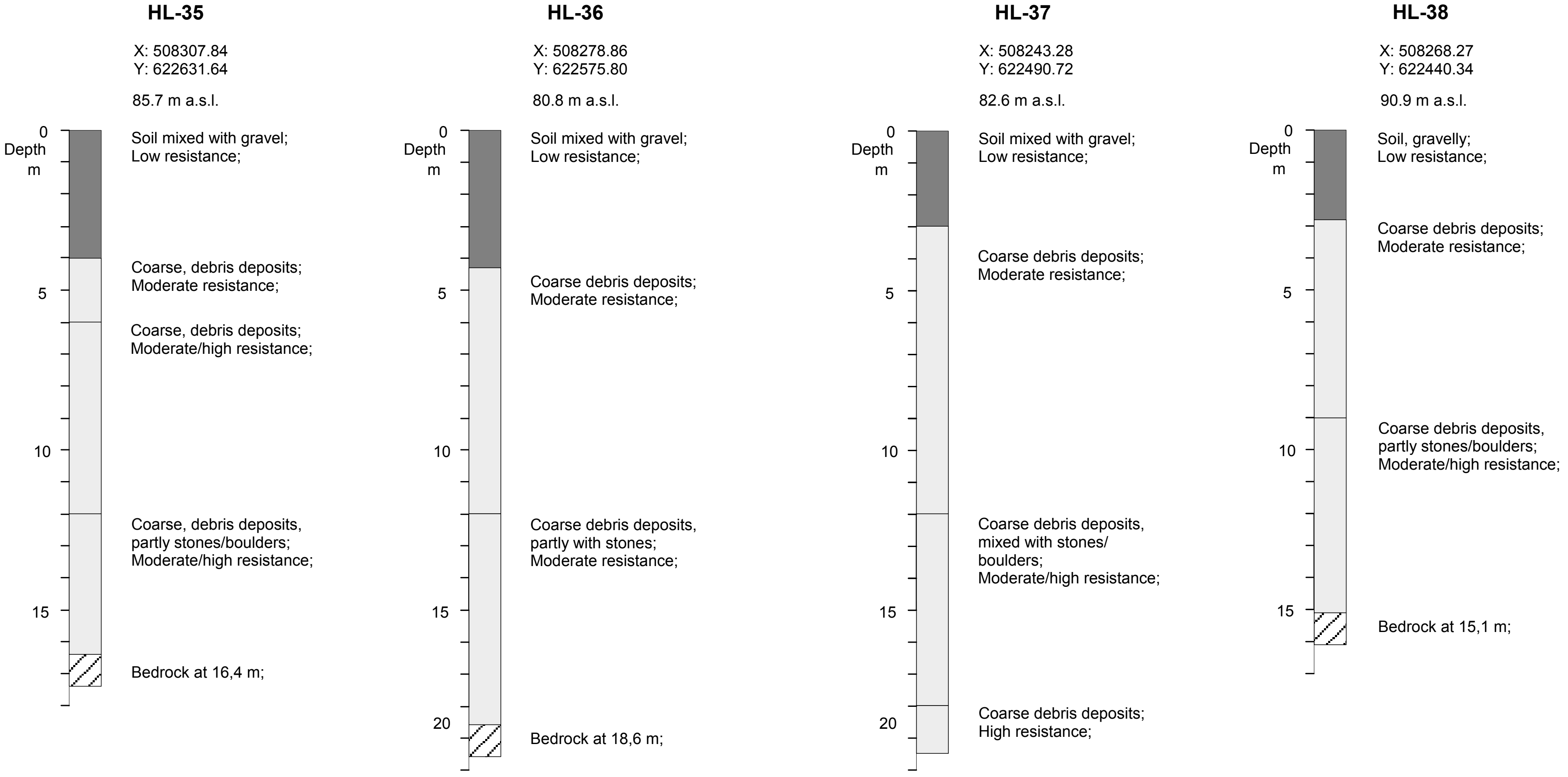
Coarse debris deposits, partly large stones/ boulders; Moderate resistance;

Homogeneous sandy/ gravelly debris deposits mixed with stones/ boulders;silty/clayey outblast (moraine); High/very high resistance;

Bedrock at 23,6 m;

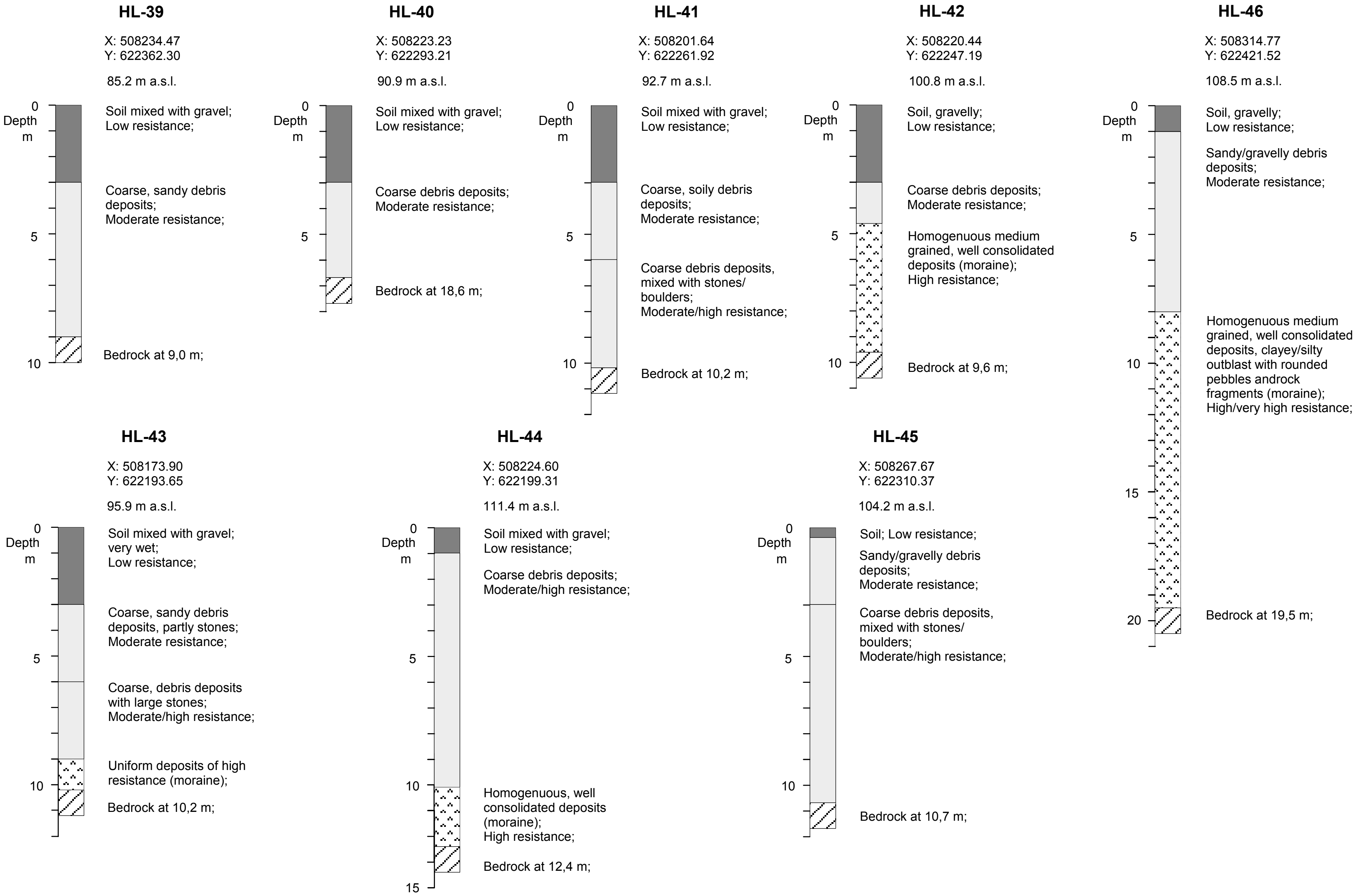
Héðinsfjörður Road Tunnel

Héðinsfjörður - percussion drilling



Héðinsfjörður Road Tunnel

Héðinsfjörður - percussion drilling



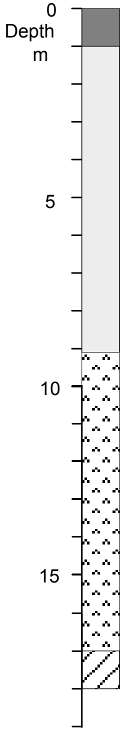
Héðinsfjörður Road Tunnel

Héðinsfjörður - percussion drilling

HL-47

X: 508316.71
Y: 622481.78

100.2 m a.s.l.



Soil mixed with gravel;
Low resistance;

Coarse, sandy/gravelly
debris deposits;
Moderate resistance;

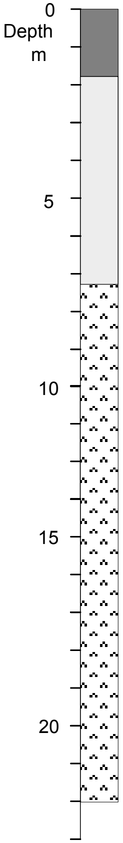
Well consolidated
homogenuous deposits;
clayey/silty outblow mixed
with rock fragments and
pebbles (moraine);
High resistance;

Bedrock at 17,0 m;

HL-48

X: 508359.31
Y: 622549.06

102.1 m a.s.l.



Soil mixed with gravel;
Low resistance;

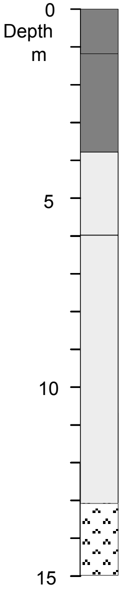
Sandy/gravelly debris
deposits;
Moderate resistance;

Homogenuous, well
compacted and
consolidated deposits;
clayey/silty outblast with
pebbles and rock
fragments (moraine);
High/very high resistance;

HL-49

X: 508304.58
Y: 622929.06

75.8 m a.s.l.



Soil, Peat;

Soily, sandy, gravelly
deposits;
Low resistance

Soft soily gravel deposits;
Moderate resistance;

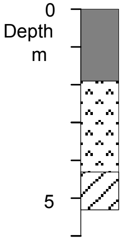
Coarse gravel deposits in
silty/sandy groundmass,
partly stones;
Moderate/high resistance;

Well consolidated
deposits with thin
silty/sandy layers/lenses
(moraine);
High resistance;

HL-50

X: 508677.57
Y:622964.16

109.4 m a.s.l.



Soil mixed with gravel;
Low resistance;

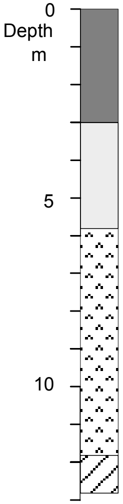
Well consolidated
morainic deposits with
clayey/silty outblow;
High resistance;

Bedrock at 4,3 m;

HL-54

X: 508736.86
Y: 623318.14

92.4 m a.s.l.



Soil mixed with gravel;
Low/moderate resistance;

Well compacted and
consolidated deposits,
partly stones;
Moderate/high resistance;

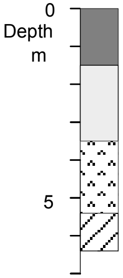
Well compacted and
consolidated deposits,
homogenuous, partly
stones (moraine);
High resistance;

Bedrock at 11,8 m;

HL-51

X: 508662.10
Y: 623017.07

101.1 m a.s.l.



Soil;

Soily gravel;
Low resistance;

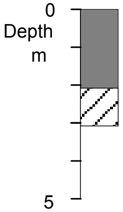
Coarse, debris deposits;
Moderate resistance;

Bedrock at 5,4 m;

HL-52

X: 508696.82
Y: 623000.73

107.8 m a.s.l.



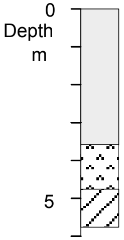
Soil mixed with gravel;
Low resistance;

Bedrock at 2,1 m;

HL-53

X: 508724.84
Y: 623006.00

116.5 m a.s.l.



Sandy/gravelly debris
deposits with large
stones/boulders;
Moderate/high resistance;

Well consolidated
deposits (moraine);

Bedrock at 4,8 m;

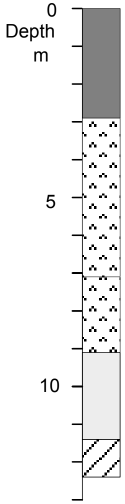
Héðinsfjörður Road Tunnel

Héðinsfjörður - percussion drilling

HL-55

X: 508792.19
Y: 623316.36

102.9 m a.s.l.



Soil mixed with gravel;
Low resistance;

Well consolidated rather homogenuous deposits, probably moraine;
High resistance;

Well consolidated morainic material, partly larger stones;
High resistance;

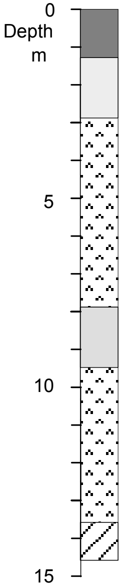
Blocky material of moderate resistance;

Bedrock at 11,4 m;

HL-56

X: 508841.15
Y:623323.03

109.5 m a.s.l.



Soil mixed with gravel;
Low resistance;

Coarse debris deposits;
Moderate resistance;

Homogenuous deposits, well compressed and consolidated, with thin layers/lenses of soft, clayey/sandy material (moraine);
High resistance

Soft soily/sandy deposits;
Low/moderate resistance;

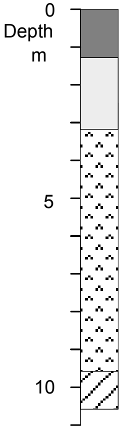
Very well consolidated clayey/silty deposits (moraine);
High/very high resistance;

Bedrock at 13,6 m;

HL-57

X: 508829.08
Y: 623260.70

116.7 m a.s.l.



Soil mixed with gravel;
Low resistance;

Coarse deposits in sandy matrix, partly stones;
Moderate resistance;

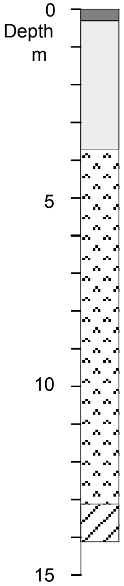
Homogenuous deposit; medium grained, well consolidated (moraine);
High resistance;

Bedrock at 9,6 m;

HL-58

X: 508862.29
Y: 623264.86

121.6 m a.s.l.



Soil mixed with gravel;

Coarse grained gravelly deposits, well rounded pebbles;
Moderate resistance;

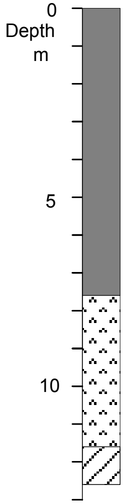
Well consolidated homogenuous deposits, partly stones (moraine);
High resistance;

Bedrock at 13,1 m;

HL-59

X: 508667.86
Y: 623008.04

88.8 m a.s.l.



Soil mixed with gravel and large stones/boulders up to 0,7 m diameter;
Low resistance;

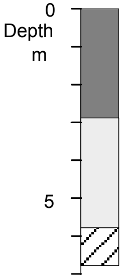
Homogenuous deposits of medium to coarse grained well consolidated morainic material, partly stones (moraine);
High resistance;

Bedrock at 11,6 m;

HL-60

X: 508726.74
Y: 623169.71

99.5 m a.s.l.



Soil mixed with gravel;
Low resistance;

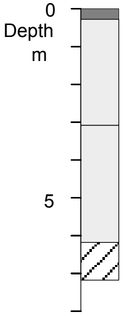
Coarse gravelly deposits;
Moderate/high resistance;

Bedrock at 13,6 m;

HL-61

X: 508679.73
Y: 623157.35

91.1 m a.s.l.



Soil mixed with gravel;
Low resistance;

Coarse debris deposits
Low/moderate resistance;

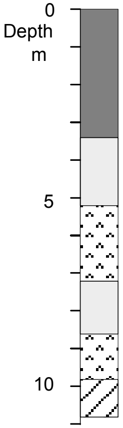
Homogenuous deposit; medium grained, well consolidated, partly stones in silty/sandy matrix (moraine);
High resistance;

Bedrock at 6,2 m;

HL-62

X: 508696.36
Y: 623118.95

99.1 m a.s.l.



Soil mixed with gravel;
Low resistance;

Coarse grained gravelly deposits,partly stones;
Moderate resistance;

Homogenuous silty/sandy deposits, partly stones (moraine);
High resistance;

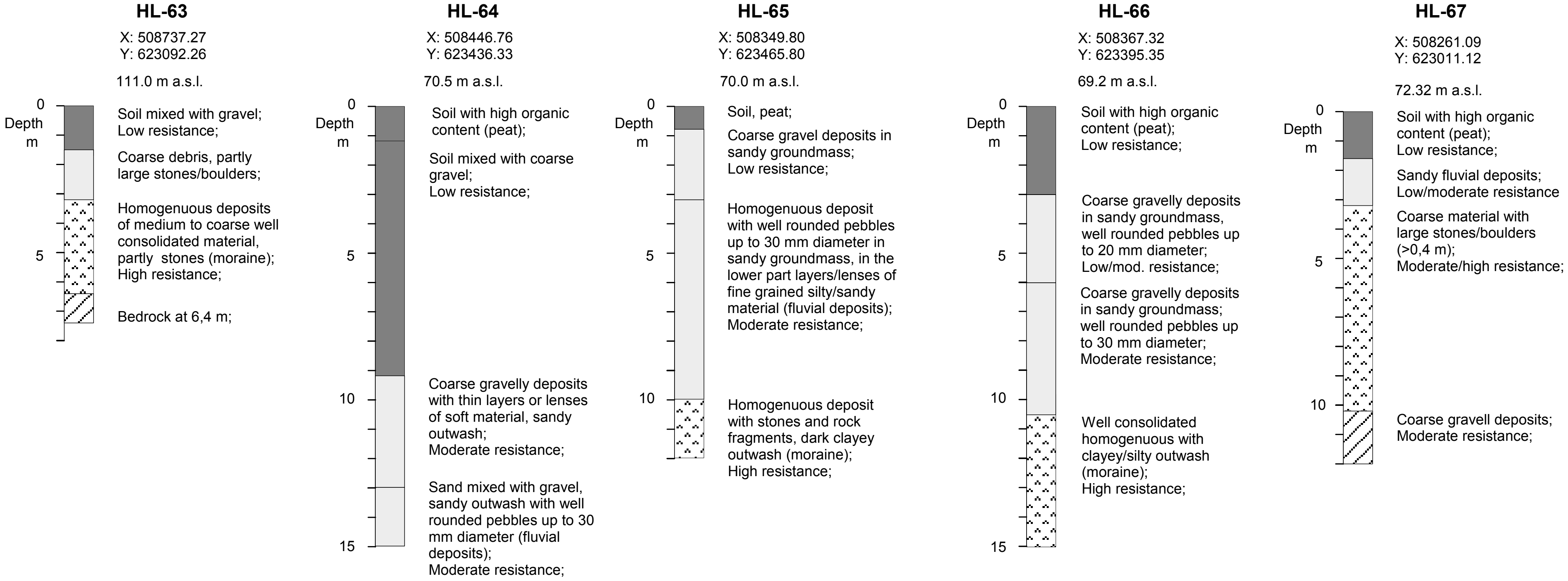
Coarse debris deposits;
Moderate resistance;

Moraine;
High resistance;

Bedrock at 9,8 m;

Héðinsfjörður Road Tunnel

Héðinsfjörður - percussion drilling



HL-63

X: 508737.27
Y: 623092.26

111.0 m a.s.l.

Soil mixed with gravel; Low resistance;

Coarse debris, partly large stones/boulders;

Homogenuous deposits of medium to coarse well consolidated material, partly stones (moraine); High resistance;

Bedrock at 6,4 m;

HL-64

X: 508446.76
Y: 623436.33

70.5 m a.s.l.

Soil with high organic content (peat);

Soil mixed with coarse gravel; Low resistance;

Coarse gravelly deposits with thin layers or lenses of soft material, sandy outwash; Moderate resistance;

Sand mixed with gravel, sandy outwash with well rounded pebbles up to 30 mm diameter (fluvial deposits); Moderate resistance;

HL-65

X: 508349.80
Y: 623465.80

70.0 m a.s.l.

Soil, peat;

Coarse gravel deposits in sandy groundmass; Low resistance;

Homogenuous deposit with well rounded pebbles up to 30 mm diameter in sandy groundmass, in the lower part layers/lenses of fine grained silty/sandy material (fluvial deposits); Moderate resistance;

Homogenuous deposit with stones and rock fragments, dark clayey outwash (moraine); High resistance;

HL-66

X: 508367.32
Y: 623395.35

69.2 m a.s.l.

Soil with high organic content (peat); Low resistance;

Coarse gravelly deposits in sandy groundmass, well rounded pebbles up to 20 mm diameter; Low/mod. resistance;

Coarse gravelly deposits in sandy groundmass; well rounded pebbles up to 30 mm diameter; Moderate resistance;

Well consolidated homogenuous with clayey/silty outwash (moraine); High resistance;

HL-67

X: 508261.09
Y: 623011.12

72.32 m a.s.l.

Soil with high organic content (peat); Low resistance;

Sandy fluvial deposits; Low/moderate resistance

Coarse material with large stones/boulders (>0,4 m); Moderate/high resistance;

Coarse gravell deposits; Moderate resistance;

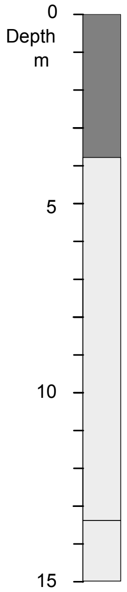
Héðinsfjörður Road Tunnel

Héðinsfjörður - percussion drilling

HL-68

X: 508220.83
Y: 622964.69

72.8 m a.s.l.



Soil mixed with gravel;
Low resistance;

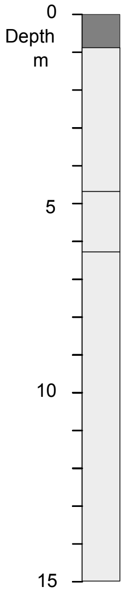
Coarse fluvial deposits
with well rounded pebbles
in sandy groundmass;
Moderate/high resistance;

Coarse, well consolidated
material;
High resistance;

HL-69

X: 508185.98
Y: 629915.91

73.7 m a.s.l.



Soil;

Coarse fluvial deposits in
sandy groundmass;
Low/moderate resistance;

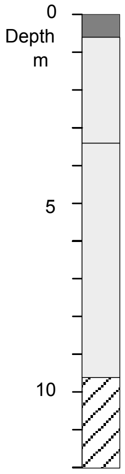
Large stones/boulders in
sandy groundmass;

Homogenuous coarse
grained deposit partly
large stones/boulders;
Moderate/high resistance;

HL-70

X: 508249.14
Y: 623038.79

72.3 m a.s.l.



Soil;

Coarse gravelly deposits,
very high content of soil;
Low resistance;

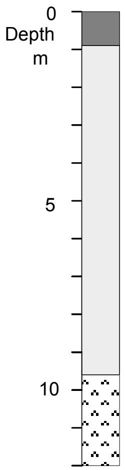
Coarse fluvial deposits in
sandy groundmass, well
rounded pebbles, partly
large stones/boulders;
Moderate resistance;

Well consolidated
homogenuous material
with clayey/silty outwash
(moraine);
High resistance;

HL-71

X: 508188.78
Y: 622967.94

73.2 m a.s.l.



Soil mixed with gravel;
Low resistance;

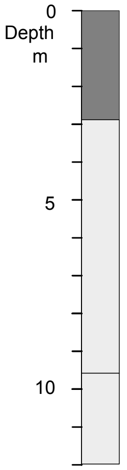
Sandy fluvial deposits
with well rounded
pebbles;
Low/moderate resistance;

Coarse gravelly deposits
with stones/boulders in
sandy groundmass;
High resistance;

HL-72

X: 508115.36
Y: 622895.58

94.5 m a.s.l.



Soil mixed with gravel;
Low resistance;

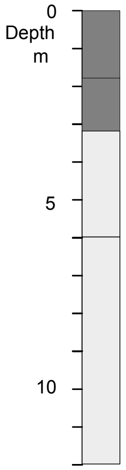
Coarse fluvial deposits
with sandy groundmass
and well rounded pebbles;
Sandy layers/lenses
between 9,3 m-9,7 m;
Low/moderate resistance;

Very coarse grained
deposits, partly stones/
blocks;
High resistance;

HL-73

X: 508109.70
Y: 622927.07

73.9 m a.s.l.



Soil with high organic
content (peat);

Soil mixed with gravel;
Low resistance;

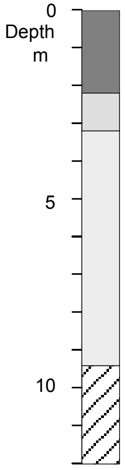
Coarse fluvial deposits
with well rounded pebbles;
Low/moderate resistance;

Coarse grained deposit,
partly stones/boulders;
High resistance;

HL-74

X: 508125.13
Y: 622984.53

73.3 m a.s.l.



Soil;

Soily/sandy deposits;
Low resistance;

Coarse gravelly deposits
with sandy outwash,
partly large stones/
boulders;
Soft layers/lenses
between 7,6m -8,3m;
Moderate/high resistance;

Homogenuous coarse
grained deposit, partly
stones;
Moderate resistance;

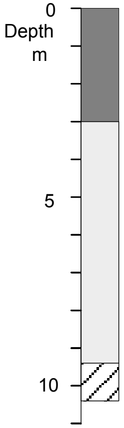
Héðinsfjörður Road Tunnel

Héðinsfjörður - percussion drilling

HL-75

X: 508061.33
Y: 623263.77

81.7 m a.s.l.



Soil mixed with gravel;
Low resistance;

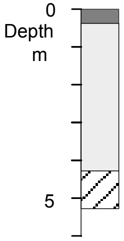
Coarse debris deposits,
sandy groundmass;
Moderate/high resistance;

Bedrock at 9,4 m;

HL-76

X: 508055.97
Y: 623299.28

81.3 m a.s.l.



Soil;

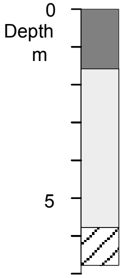
Coarse debris deposits
with soily/sandy matrix,
partly stones/boulders;
Moderate resistance;

Bedrock at 4,9 m;

HL-77

X: 508030.02
Y: 623303.02

85.9 m a.s.l.



Soil mixed with gravel;
Low resistance;

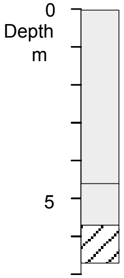
Coarse, sandy/gravelly
deposits, partly stones;
Moderate/high resistance;

Bedrock at 5,8 m;

HL-78

X: 508059.03
Y: 623327.68

80.8 m a.s.l.



Coarse debris deposits
mixed with soil, partly
stones/boulders;
Low/moderate resistance;

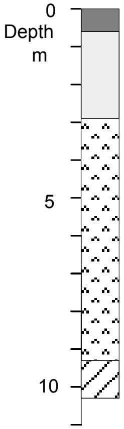
Very coarse debris;
High resistance;

Bedrock at 5,7 m;

HL-79

X: 508026.76
Y: 623347.61

89.6 m a.s.l.



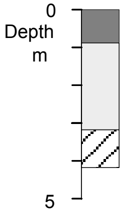
Soil;
Coarse, very soily gravel
deposits, partly
stones/boulders;
Low resistance;
Homogenuous, well
consolidated deposit
(moraine);
High resistance;

Bedrock at 9,3 m;

HL-80

X: 508003.51
Y: 623356.39

96.0 m a.s.l.



Soil;

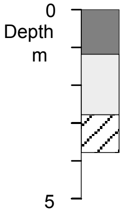
Coarse gravelly deposit
mixed with soil and sand;
Low resistance;

Bedrock at 3,2 m;

HL-81

X: 507979.61
Y: 623360.57

104.4 m a.s.l.



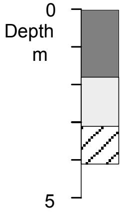
Soil mixed with gravel;
Low resistance;
Coarse, sandy/gravelly
debris deposits;
Moderate resistance;

Bedrock at 2,8 m;

HL-82

X: 507968.52
Y: 623341.53

104.5 m a.s.l.



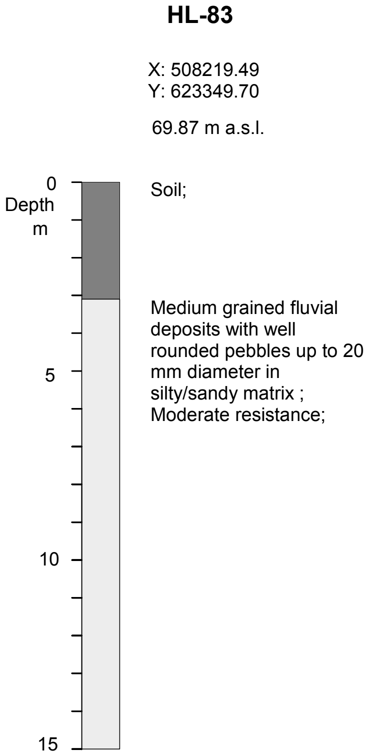
Soil mixed with gravel;
Low resistance;

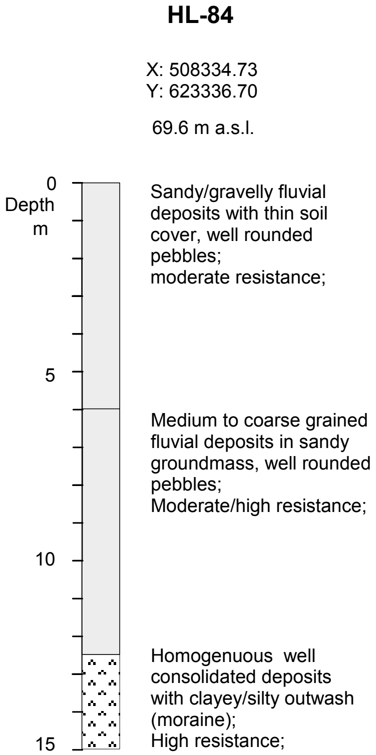
Coarse debris deposits, partly
stones; Low/mod. resistance;

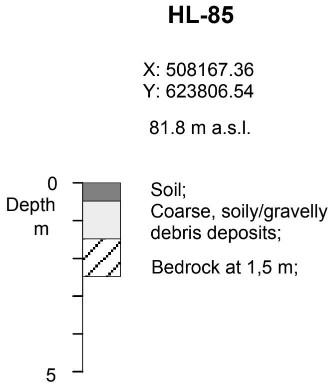
Bedrock at 3,1 m;

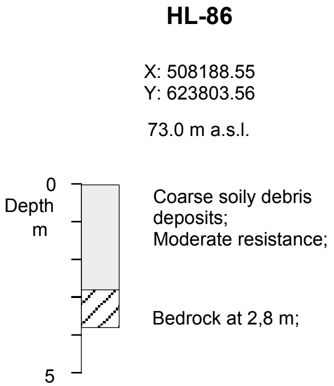
Héðinsfjörður Road Tunnel

Héðinsfjörður - percussion drilling









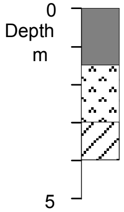
Héðinsfjörður Road Tunnel

Ólafsfjörður - percussion drilling

OL-1

X: 514789.46
Y: 619714.06

13.8 m a.s.l.



Soil;

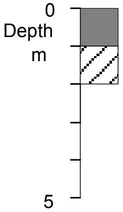
High resistance in homogeneous material; either highly consolidated morainic deposits, or soft, weathered bedrock;

Bedrock at 3.0 m;

OL-2

X: 514782.56
Y: 619714.06

13.7 m a.s.l.



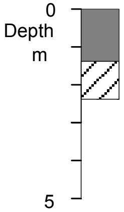
Soil, partly stones;

Bedrock at 1.0 m;

OL-3

X: 514773.75
Y: 619678.17

14.4 m a.s.l.



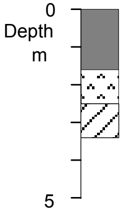
Soil, partly stones;

Bedrock at 1.7 m;

OL-4

X: 514774.16
Y: 619648.55

12.1 m a.s.l.



Soil, partly stones;

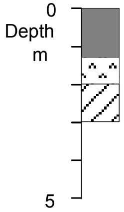
High resistance in homogeneous material; either highly consolidated morainic deposits, or soft, weathered bedrock;

Bedrock at 2.6 m;

OL-5

X: 514758.53
Y: 619595.05

13.2 m a.s.l.



Soil;

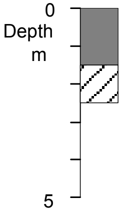
High resistance in homogeneous material; either highly consolidated morainic deposits, or soft, weathered bedrock;

Bedrock at 2.0 m;

OL-6

X: 514735.88
Y: 619610.48

19.2 m a.s.l.



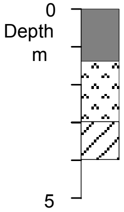
Soil, partly stones;

Bedrock at 1.0 m;

OL-7

X: 514731.76
Y: 619638.16

23.9 m a.s.l.



Soil, partly stones;

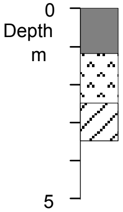
High resistance in homogeneous material; either highly consolidated morainic deposits, or soft, weathered bedrock;

Bedrock at 3.0 m;

OL-9

X: 514741.95
Y: 619665.43

22.4 m a.s.l.



Soil, partly stones;

Consolidated coarse deposits (moraine); High resistance;

Bedrock at 2.5 m;

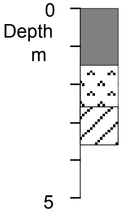
Héðinsfjörður Road Tunnel

Ólafsfjörður - percussion drilling

OL-10

X: 514709.15
Y: 619673.11

30.3 m a.s.l.



Soil, partly stones;

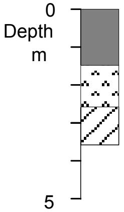
High Resistance in homogeneous material; either highly consolidated morainic deposits, or soft, weathered bedrock;

Bedrock at 2.6 m;

OL-11

X: 514703.12
Y: 619644.64

30.2 m a.s.l.



Soil, partly stones;

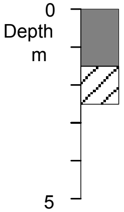
High Resistance in homogeneous material; either highly consolidated morainic deposits, or soft, weathered bedrock;

Bedrock at 2.6 m;

OL-12

X: 514714.72
Y: 619707.07

29.9 m a.s.l.



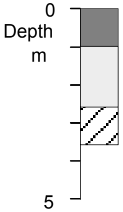
Soil, partly stones;

Bedrock at 1.5 m;

OL-13

X: 514727.39
Y: 619740.30

30.2 m a.s.l.



Soil;

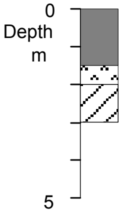
Coarse, still soily deposits, partly stones;
Mod./high resistance;

Bedrock at 2.6 m;

OL-14

X: 514759.55
Y: 619731.96

23.2 m a.s.l.



Soil, partly stones;

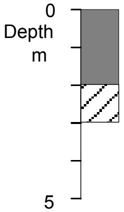
High Resistance in homogeneous material; either highly consolidated morainic deposits, or soft, weathered bedrock;

Bedrock at 2.6 m;

OL-15

X: 514750.37
Y: 619697.47

22.8 m a.s.l.



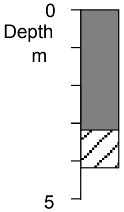
Soil, partly stones;

Bedrock at 2.6 m;

OL-20

X: 514864.95
Y: 620168.14

26.8 m a.s.l.



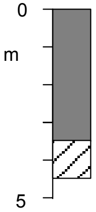
Soil, mixed with stones and gravel stones;
Low/moderate resistance;

Bedrock at 3.2 m;

OL-21

X: 514885.85
Y: 620165.96

22.7 m a.s.l.



Soil, mixed with stones and gravel stones;
Low/moderate resistance;

Bedrock at 3.6 m;