Factors Influencing Morphology of Four Jointed Basalt Scarps in Southwest Iceland

Ayla Heinze Fry

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Project mentor:
Juliet Crider, University of Washington

Internship coordinator:
Juliet Crider

Reading committee:
Juliet Crider
Alison Duvall

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Abstract

This study focuses on detailed description and comparison of morphology and traits of fault scarps in jointed basaltic bedrock in Iceland. I predict that intact rock quality has a greater impact on scarp morphology than internal structure of stacked lava flows. I use geomorphic Rock Mass Rating (RMR) as a proxy for rock quality. I assess talus slopes in conjunction with internal structure of stacked lava flows in intact rock faces to assess how the internal structure impacts scarp evolution and morphology. This investigation is conducted in conjunction with research by Cassandra Brigham, University of Washington PhD student, to investigate the style and tempo of fault scarp growth and degradation in jointed bedrock.

We studied four scarps in two areas of Iceland, Þingvellir and the Reykjanes Peninsula. The areas both lie in the West Volcanic Zone (WVZ) of southwestern Iceland. We chose the scarps, formed within faulted intermediate and mafic basalt flows of different post-glacial ages, for their good exposure in a tectonically activity area.

I used engineering geology methods, such as discontinuity surveys, scanline surveys for block frequency, and RMR in my analysis. I also used detailed notes from site location to subdomain scale. Orthophoto analysis contributed greatly to the analysis of the rock.

The four scarps studied have highly variable along-strike scarp morphology over short distances, used to define domains. For example, walls of near-vertical intact rock faces spanning the height of the scarp are juxtaposed with extensive talus and grassy slopes spanning the height of the scarp, with other morphologies consisting of intact rock face, talus and grassy slope in varying patterns. Despite the highly variable scarp morphology, rock quality, measured by RMR values, are relatively consistent.

I also used qualitative observations of stacked lava flow structure and talus piles to assess why and how morphology of the scarps evolve. Flow structure strongly defines discontinuity distribution and properties within the rock, which provide sources of weakness that contribute to potential scarp failure. Where horizontally bound by through-going discontinuities, zones of fine joint-bounded blocks recess under coarse blocks in many locations. These zones may be a source of instability in the rock face, potentially contributing to the toppling of coarser blocks above them. Repeated upward fining sequences due to stacking of lava flows provide multiple locations where fine blocks can recess beneath coarse blocks. Although the impact of stacked lava flow structure on bedrock scarp morphology is qualitatively analyzed, it appears to play at least as significant a role in the morphology of the scarps where observed, if not more than RMR values.

Based on quantitative comparisons of different RMR to morphology types within a domain and qualitative analysis of structure of stacked lava flows compared to overall scarp morphology, neither factors individually or likely together completely explain the varied morphology of the scarps.

These are preliminary findings based on only four scarps. Many analyses are also limited by the accuracy of the orthophoto, which projects points as if the scarp were perfectly vertical, which is not the case in all locations. For this reason, this study best captures general patterns, not exact values of block and talus sizes, areas, or scarp heights.

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1 Introduction

Scarps are relatively vertical sections of slope separating much flatter areas of different elevations. They are typically remnants of erosion or vertical displacement of Earth's surface from faulting. Scarps can be present in sediment or rock. In both cases, morphology may retain information regarding relative age of a scarp, contributing factors to scarp formation and potentially magnitude of the events that cause them.

Wallace (1977) was one of the early researchers to describe unconsolidated sediment scarp degradation and morphology in relation to age of scarp formation. Debris slopes formed as the scarp degrades decrease in slope angle as the scarp ages (Wallace, 1977). The diffusion equation may be used as a means to describe how unconsolidated cohesionless sediment scarps evolve (Nash, 1980; Hanks, 1984). The diffusion equation states that the rate in change of elevation ($\partial y/\partial t$) at a given point location is proportional to the curvature of the slope ($\partial^2 y/\partial x^2$) at that point. This equation provides the basis for morphometric dating of scarps in unconsolidated sediment (Wallace, 1977; Nash, 1980). Most of these previous studies that date and describe diffusion of scarps in regolith do not address the additional processes involved in jointed bedrock scarp evolution (Hilley, et al., 2001).

Both relative and absolute dating of jointed bedrock scarps has proven challenging due to the variety of processes that cause the degradation of jointed bedrock scarps. Jointed bedrock results in blocks, which may be subject to stochastic processes. Bedrock scarp retreat has been studied with respect to waterfalls (e.g. Lamb and Dietrich, 2009), glacial headwalls (e.g. MacGregor et al., 2009), biogenic weathering (André, 1997), frost shattering (André, 1997) and post-glacial stress reduction (André, 1997). Not all of these processes apply to certain regions. Therefore, processing controlling bedrock scarp evolution vary and the ability to determine a uniform model for jointed bedrock scarp degradation is challenging. Jointed bedrock fault scarps may retain information pertinent to a region's recent tectonic history, such as timing and event magnitude; however, the processes involved with bedrock fault scarp retreat require more study.

Iceland is ideal for studying jointed-rock fault scarps due to its tectonic activity and well-exposed scarps in jointed basalt flows of different ages. For this study, we sought to identify an area with multiple bedrock scarps of different ages, influenced by similar environmental conditions and tectonic setting. We selected four fault scarps in southwest Iceland that cut basalt flows of varying ages. In Iceland, I observed heterogeneous scarp morphology along strike of a single bedrock scarp over short distances. For example, walls of near-vertical intact rock faces spanning the height of the scarp juxtaposed with extensive talus and grassy slopes spanning the height of the scarp, and morphologies in-between having a combination of intact rock face, talus and grassy slope in varying patterns. This variable morphology along strike of a scarp of known age indicates that the bedrock scarp morphology is not controlled by a uniformly continuous degradation of the scarp over time as is seen in sediment and alluvium scarps. The lack of uniform degradation observed in bedrock scarps inhibits clear patterns allowing morphological dating. The question then

becomes: What factors are influencing the variable morphology along the strike of jointed bedrock scarps?

I conducted this study in cooperation with UW PhD student Cassandra Brigham, in the context of her larger study on fault scarp degradation in jointed rock. My portion of the study focuses on detailed descriptions, and an engineering geology approach to compare morphology and traits pertaining to Rock Mass Rating (RMR) and structure within rock at the four target fault scarps, with the goal of assessing aspects impacting scarp morphology. I predict that intact rock quality has a greater impact on scarp morphology than internal structure of the stacked lava flows. I use geomorphic Rock Mass Rating (RMR) as a proxy for rock quality. I describe internal structure of the stacked lava flows as both the structure within individual lava flows, and the contact between the stacked flows. I look at talus slopes in conjunction with internal structure of stacked lava flows in intact rock faces to assess how the internal structure impacts scarp evolution and morphology.

2 Scope of Work

My objectives for this work included: 1) field description of the morphology and discontinuity distribution at portions of the four target scarps, 2) supplemental observations from examination of orthophotographs (hereafter "orthophotos") of the scarps, especially for areas inaccessible in the field, and 3) summary descriptions, analysis, and identification of patterns observed at the sites, with emphasis on calculated rock mass ratings (RMR) and intact rock structure to support or refute my hypothesis.

I conducted field work over three weeks in July and August 2017. My on-site work for the scope of this investigation included: assistance selecting sites within scarps for detailed description; distinguishing domains and subdomains of sites based on scarp morphology and rock characteristics; making general observations of scarp morphology patterns and structural patterns within intact rock faces; and conducting discontinuity surveys and making detailed observations about lichen and other vegetative presence, staining, and weathering in order to assess RMR.

In order to have all the information needed to calculate an RMR for all of the intact rock domains and subdomains, and to evaluate intact rock structures, post-field work included: analysis of orthophotos for additional descriptive details of staining related to water or weathering, supplementing joint orientation and opening where unreachable in the field; scanline surveys of number of joint-bounded block frequency (blocks/m); and plotting of strikes and dips on stereonets to help analyze intact rock structure.

To assess the impact of rock mass rating, I calculated rock mass rating for each subdomain, averaged it per domain, and compared it to the scarp morphology within domains and to overall scarp height. I also looked for repeated structures in intact rock, and intact rock characteristics where more erosion and potential for failure appeared present.

3 Background

3.1 Motivation and Location Choice

In addition to motivation to understanding the controls of morphologic evolution in bedrock fault scarps as a means of relative fault dating, this study may be applied to the analysis of other jointed rock faces, such as road cuts, to determine where their surface may evolve or fail in order to mitigate the hazard.

Iceland provides an excellent setting to study jointed-bedrock fault scarps due to its tectonic activity and well exposed, relatively young fault scarps in jointed-basalt flows of different ages. I worked on fault scarps within the West Volcanic Zone (WVZ) in the southwest portion of the island (Fig. 1) in two general areas, Þingvellir and the Reykjanes Peninsula. Þingvellir, the more northern area, provides the benefit of many lava flows, well characterized geology (Grant and Kattenhorn, 2004; Sinton, et al., 2005; Sonnette, et al., 2010), and relatively accessible scarps. We chose two scarps in Þingvellir: Hildargjá and Gildrulholtsagjá (Fig. 2). Reykjanes Peninsula, the more southern area, is overall younger (Grant and Kattenhorn, 2004) and more seismically active (Einarsson, 1991). We selected two scarps near Vogar: Nydri-Mosadalgjá and Stóra-Aragjá (Fig. 2). Many scarps exist within these areas. The selected scarps met criteria of being relatively young, accessible, and simple in structure with varied morphology.

3.2 Geologic Setting

Iceland is a volcanic hotspot island in the North Atlantic Ocean, cut by the Mid-Atlantic Ridge. The rifting from the Mid-Atlantic Ridge (Fig. 1) produces normal faults within basalt in the both the West Volcanic Zone (WVZ) and the East Volcanic Zone (EVZ) in the southern portion of the island. The fault scarps studied for this report are in the WVZ in the southwest quadrant of Iceland.

The WVZ and EVZ each take a portion of the plate boundary extension. As of 2005, the WVZ spread about 3-7 mm/yr, about 20-30% of the total spreading of 18-20 mm/yr (Sinton et al., 2005; Geirsson, et al., 2006; LaFemina et al., 2005). This indicates that the EVZ currently accounts for a greater amount spreading than the WVZ. Despite a shift of dominant rifting activity from the EVZ to the WVZ, the entire length of the WVZ had equal activity throughout the post-glacial period (Sinton et al., 2005).

The lava flows cut by the faults formed during rifting are of varying age, but all lava flows within the study area are younger than the last glaciation around 12,000 ybp (Grant and Kattenhorn, 2004). Flows are of mafic and intermediate composition (Jóhannesson, 2014). Hildargjá is in the 6,000 to 9,000 year old Skjaldbreidur I unit (Fig. 3) of the Skjaldbreidur complex of lava flows (Sonnette et al., 2010). An unknown vent structure generated the unit (Sinton, et al., 2005). Gildrulholtsagjá is located within the Gjábakkahraun unit (Fig. 3), which consists of lava flows ranging from 9,000 to 10,200 years old (Sonnette et al., 2010). The lava flows were generated by a small shield vent. Both Nydri-Mosadalgjá and Stóra-Aragjá are located within mafic and intermediate lavas of postglacial ages greater than 11,000 years old (Fig. 4).

Assuming continuous faulting during the Holocene, the age of a basalt flow can be used as an approximation of time of scarp formation (Sonnette, et al., 2010). Ongoing rifting causes multiple basaltic flows to be cut by the same faults and fissures, therefore, morphology characteristics of different-aged flows cut by the same fault provide snapshots in scarp evolution through time.

Processes controlling bedrock scarp retreat in this setting are poorly constrained. Possible processes of scarp retreat may include: biogenic weathering (André, 1997), frost shattering (e.g. Matsuoka, 2008), and seismically-induced toppling of joint-bounded blocks (e.g. Rood et al., 2015).

3.3 Engineering Geology Practices

Numerous engineering geology practices are used to describe vertical rock faces. Three used in this study are: rock mass rating (RMR), discontinuity surveys, and scanline surveys for joint frequency. The main engineering geology focus of this study, RMR, uses information from the discontinuity surveys and scanline surveys to determine its values.

The rock mass rating (RMR) is a semi-quantitative means by which to assign a rock face a value representing its strength and stability, based on numerous rock and discontinuity properties. Multiple versions of RMR tables exist in the engineering geology literature (e.g. Hoek, et al., 1995; Selby, 1980; ASTM D5878-08, 2008). I use the "geomorphic RMR" of Selby (1980, in Selby 1993). Table 1 outlines the geomorphic RMR. RMR is calculated based on weighted values given to rock strength, weathering, spacing of joints, joint orientations, joint widths, continuity of joints and outflow of groundwater (Selby, 1980). In place of an R value determined by Schmidt hammer, I use the equivalent uniaxial compressive strength estimated using a standard rock hammer (Table 2, Selby 1993). The R-scale rock strength determined using a rock hammer (Table 2), has seven categories, ranging from a high of R6 to a low of R0. The weathering classification I used for the RMR is presented in Table 3. RMR pertains to rock masses, which consist only of intact rock, therefore RMR evaluation does not apply to talus slopes or grassy slopes.

Discontinuity surveys (Appendix A, Fig. A.1) are used by entities such as the Washington State Department of Transportation (Eric Smith, 2016, personal correspondence) to evaluate road outcrops for stability analysis. Discontinuities are weak planes in the rock, such as faults and joints. Discontinuity surveys provide records of discontinuity set information, including: number of discontinuities, spacing, type, dip, dip direction, persistence, number of joint terminations visible within the surveyed rock face, joint aperture, presence and quality of infill, strength of wall rock, roughness of joint surfaces, joint shape, and joint roughness coefficient (JRC) (Appendix A, Fig A.1). These factors provide insight into the engineering properties of the surveyed rock mass (Bell, 2004).

Scanline surveys may be used for multiple purposes, including assessing fracture density on a relatively vertical rock face (e.g. Zeeb, et al., 2013; Watkins, et al., 2015). Linear scanlines are useful as a fast method of recording information about fractures noted at points along a tape at an outcrop (Watkins, et al., 2015). Scanline surveys are typically conducted perpendicular to the strike of fracture sets on a rock face to best represent the

fractures present (Watkins, et al., 2015). Although other methods assessing fracture density exist, such as areal sampling, rectangular window sampling, circular scanline sampling (Zeeb, et al., 2013; Watkins, et al., 2015), linear scanline method is best suited for this study due to its simplicity and ability to capture characteristics of different subdomains by use of separate scanlines.

4 Methods and Assumptions

4.1 Field work

4.1.1 Site Selection

Scarps were chosen because they are relatively accessible, cut basalt flows of different ages and have variable morphology along strike. Within each scarp, we studied a subsection, referred to as a "site" for brevity. We chose each site based on the site's ability to represent a variety of features interesting for studying jointed-rock scarp degradation. Some features we looked for included: multiple morphologies along the scarp, differing presences of talus, intact rock faces with forward and backset faces, presence of staining, evidence of recession.

4.1.2 Site Division

We divided each site into domains based on large-scale geomorphic patterns and overall intact rock structural patterns. For example, predominantly intact rock organized into distinct layers in a sub-vertical face, different proportions and mixtures of sub-vertical intact rock and rocky talus or grassy slope, complete lack of intact rock, or variation in intact-rock joint patterns compared to adjacent sections. Shorthand for domains is written as D, followed by the number of the domain. Within each domain are subdomains, distinguished based on structure, joint frequency and character of rock or talus. Shorthand for subdomains is written as SD, followed by the number of the subdomain. Shorthand for domain 1, subdomain 1 may therefore appear, for example, as D1 SD1.

4.1.3 Detailed Observations

I made detailed observations within domains and subdomains where the rock was readily visible or physically accessible. Detailed observations include anything from noting of grass or moss growing out of particular spots, water or weathering stains, vesicularity, and features addressed in discontinuity surveys. Discontinuity surveys provide a guide to collect information about discontinuities of intact rock faces. I used a slightly modified Washington State Department of Transportation Discontinuity sheet (Appendix A, Fig A.1) to conduct my surveys. I conducted surveys by filling in average or accessible information for all safely accessible subdomains at all four sites.

When accessible, I placed a flat notebook parallel to the surface of the rock and took strike and dip measurements on the notebook surface using a Brunton compass. When unable to be adjacent to an intact rock wall, I sometimes approximated strikes and dips via sighting with a Brunton Compass. When many faces within a joint set of a subdomain had variable strikes and dips, I recorded the range of strikes and a range of dips. If I could not put the

Brunton compass direction on the rock or on a field book or clipboard on the rock, I aligned a flat surface as best as possible to the joint surface and took an approximate strike and dip.

4.2 Post-field evaluation

4.2.1 Stereonets

Stereonets, a way to visualize orientations of lines and planes in 2D, are useful to evaluate joint orientation patterns. Joint orientation patterns can reveal if intersecting joints faces make rhomboids, rectangles, columnar sets, or other patterns. For each of the four sites, I plotted joint planes and poles to those planes on a stereonet using Stereonet v.9.9.6 software (Allmendinger, 2017). I additionally plotted the great circle plane of the strike of the outcrop, with an assumed dip of 90˚, in order to help visualize how discontinuities intersect the scarp face.

For those joints that showed a range in attitudes, I plotted each end-member strike with each end-member dip. Where I indicated a more representative strike or dip in addition to the range, I plotted another strike and dip pair including the more commonly represented measurement. For example, if dip ranged from 70˚ to 89˚, but was most commonly near 85˚, and strike ranged from 300˚ to 340˚, but was typically near 340˚, I would plot the pairs: (300,70), (300, 89), (340, 70), (340, 89), and (340,85). If only one measurement type had a more representative value, six points would represent the range instead of five, and points may be repeated for weighting purposes. Take the example above, but dip did not have a more common value listed: the range would be represented by: (300,70), (300, 89), (340, 70), (340, 89), (340,70) and (340,89). Where planes were close to vertical but had enough variation that precise measurements were not feasible, I recorded the dip as "~vt" to represent "approximately vertical". When plotted, 90˚ was used for a dip angle.

After plotting the poles to planes to represent the joint planes, I used Kamb contours provided in the software to contour the points. Kamb contours calculate the number of standard deviations points have from a uniform distribution in the circle (Cardozo and Allmendinger, 2013). Since number of strike and dip data points are limited at the Vogar sites due to accessibility, and their scarps strike approximately the same, I combined their data into one stereonet.

4.2.2 Photo analysis

Photogrammetry uses photos to measure distances between objects. Structure from Motion (SfM), a photogrammetric technique, uses matching features in overlapping, offset 2D photos to determine the location and orientation of the camera and determine the geometry of the scene captured by the photographs (Westoby, et al., 2012). From this, 3D orthorectified models are made that can be used to measure distances between objects and points. We took many overlapping and offset aerial field photos of different orientations using a small drone. From these drone photos, we created georeferenced 3D models and mosaicked, orthorectified orthomosaic photos (hereafter "orthophotos") of each scarp using Agisoft PhotoScan Pro (Appendix A). The modeled areas of the scarp are shown in Fig. 5. Orthophotos are perpendicular to the strike of the scarp. In locations where scarp

strike varied significantly between domains, we generated separate orthophotos, each perpendicular to its respective domain.

I used Inkscape, free open source drafting software, to analyze the orthophotos (Appendix A). Photo analysis includes: measuring domain area; mapping morphology into intact rock, rocky talus and grassy slopes; and measuring block sizes. Scarp morphology is broken into three simple categories: intact rock (shown in pink), rocky talus (shown in yellow) and grassy slope (shown in green). If a very small amount of one unit falls within another larger section of a different geomorphic unit, the smaller unit is included in the larger unit and mapped as such. I determined percent of each morphology type in a given domain using Fiji ImageJ software (Appendix A).

Block size analysis of intact rock is an average of number of blocks per meter, conducted in the form of a modified scanline survey. All but one of the scanlines run sub-horizontal, parallel to layers within my subdomains. I drew the edges of blocks visible in the orthophotos, measured a line perpendicular to the block edges from one end of a distinguishable series of blocks to another, then counted the number of blocks the line crossed. Where multiple areas of a subdomain show measurable block patterns, separated by areas without distinct patterns, I measured both sections. I then provide a range, and sometimes an average for the block frequency (blocks/m) measurement. This is modified from a scanline survey that marks every fracture. The choice to modify the scanline survey is relevant because visible block structure protrudes from the wall face, and therefore orientation can be better identified, and rock quality better represented by the size of the blocks, not the number of joints intersected along the line. Block size analysis of talus slopes relies on many measurements of block diameters.

5 Observations: Domain Descriptions

I surveyed a total of 15 geomorphic domains from the four scarps. Each of these domains is divided into subdomains, labeled from bottom to top of the scarp (unless otherwise indicated). Detailed descriptions of each domain and subdomain at the four scarps are included in Appendix B. Factors contributing to descriptions include: discontinuity surveys describing joint properties; orthophoto analysis; and descriptions of presence of water, moss, lichen cover and weathering. Electronic versions of the discontinuity surveys conducted in the fielded are presented in Appendix C. Tables generated during photo analysis are presented in Appendix D. Here I provide a summary of key similarities and differences among the scarps and their domains.

5.1 Geomorphic Mapping

Intact rock, mapped as pink (e.g. Figs. 6 – 9) consists of in-place rock that does not show signs of having moved from another location. Intact rock is most commonly a sub-vertical, continuous wall of rock cut by joints. The rock occasionally looks like disconnected talus in an orthophoto but is distinguishable as in-place in higher resolution photographs. Rocky talus, mapped as yellow, (e.g. Figs. 6 – 9) consists of individual blocks and pieces of unanchored rubble moved from an original location to a new position. Blocks, not connected to one another other than by friction between blocks, often form moderately

sloped fan shapes at the base, or occasionally in the upper portion top, of a scarp. In a few instances, rocky talus is located partway up the scarp. Rocky talus may be covered in moss or grass, but overall is dominated by rock, and many blocks are measurable. Grassy slope, mapped as green, (e.g. Figs. 6 – 9) consists of areas dominated by vegetation. There are few, if any, visible rocks, typically covered in grass or moss. Most of the time, if a rock is visible, only a small portion is exposed, and therefore not accurately measurable.

The geomorphic maps (Figs. 6 - 9) show that scarps are most dominated by intact rock and rocky talus. Of the four scarp sites observed, Hildargjá (Fig. 6) has the largest area and percent of area covered by grassy slope. Hildargjá is also the only scarp that has talus represented near the top of the scarp when intact rock is present. Gildrulholtsagjá is the tallest scarp, and consistently shows the largest piles of talus beneath its intact rock faces (Fig. 7). Nydri-Mosadalgjá is dominated by vertical intact rock faces, but one intact rock domain has a large section of talus beneath it (Fig. 8). Stóra-Aragjá domains have similar heights, but one is dominated by intact rock with a fissure at its base and no talus at the base, and a domain with no fissure, and talus along the entirety of the base (Fig. 9).

5.2 Domain Types

We divided each site into domains in the field based on overall scarp form. Each domain typically contains more than one geomorphic unit. For example, Stóra-Aragjá D1 is made about half of vertical intact rock, with mostly rocky talus and some grassy slope at its base. Other domains, such as Nydri-Mosadalgjá D2, are made entirely of one geomorphic unit. We selected sites that exhibited a variety of scarp forms in a short along-strike distance. Of the 15 domains across the four scarps, most are vertical intact rock or vertical intact rock with rocky talus slope at the base. Other less common domain types have inter-fingering of rocky talus or grassy slope between intact rock or rocky talus located as a horizontal layer between vertical intact rock layers. Hildargjá has some geomorphic patterns that stand out from the other scarps. As opposed to the other sites, where the main sections of non-vertical slope are talus piles at the base, the Hildargjá scarps commonly slope back in form of talus or grassy slope from the top of a vertical intact rock face to the top of the scarp. This morphology may be related to erosion, as the slopes are sometimes stepped, with sections of vertical intact rock faces separated by talus or grassy slope.

5.3 Block Size Observations

5.3.1 Intact Rock

Each domain with intact rock contains blocks of multiple sizes within the intact rock that vary by layer rather. Layers are typically sub-horizontal. The blocks can be divided into categories of fine, medium and coarse relative to one another. I observed both fine, medium and coarse block layers at bases of intact rock faces.

Other than at Gildrulholtsagjá's D2, where few patterns are identifiable, repetitive fining of blocks from bottom to top of a flow occurs in all other scarps and domains containing intact rock. These patterns are seen multiple times vertically within a single domain. Some are more obvious than others, with distinct coarse, medium and fine blocks and columns, where some others have medium-sized blocks similar in size to either the finer or coarser

blocks. D2 at Nydri-Mosadalgjá is a good example of similar sizing between coarse and medium sized blocks, and the coarser blocks are actually above the medium sized blocks. I do not consider this departure from the fining pattern significant due to the similarity in size of the medium and coarse blocks. From coarsely-spaced grading up to finely-spaced joints, vesicularity increases up towards the top of the finely spaced joint section (e.g. Fig. 10).

Where a section of fine blocks bound by horizontal joints are underneath coarse blocks, the finer blocks recess underneath coarser blocks. This is seen to severe degrees (approx. 0.5 to 1 m scale) at the base of Hildargjá D2 (Fig. 11) and Gildrulholtsagjá D1 (Fig. 12), under coarser blocks on the 2 m to 3 m scale. To a lesser extent, recession of centimeters to 0.3 m is seen in Gildrulholtsagjá, Nydri-Mosadalgjá, and Stóra-Aragjá (Fig. 13). These recession patterns are observed where horizontal joints divide the finer blocks from the medium and coarse blocks. The pattern is not typically seen where more finely-spaced joints develop out of medium-spaced or coarse-spaced joints below them. Lower subdomains are not visible at the base of Nydri-Mosadalgjá and Stóra-Aragjá D2 due to infill of large vertical fissures.

5.3.2 Talus

Talus block sizes vary, even within a single domain. Some talus sizes seem to lack a clear source material with similar dimensions and may be much smaller than any material viewed above it, such as at Hildargjá D6. Not all block sizes within intact rock appear represented by the visible talus.

5.4 Rock and Joint Characteristics

Rock characteristics are fairly uniform. The observed intact strength of rock in all subdomains is high: typically, R6, and occasionally R5 (reference Table 2). Weathering is typically absent or slight (reference Table 3). Gildrulholtsagjá D2 SD3 shows the most weathering: it is a talus section between competent rock that I categorized as moderately weathered. Within a set of layers progressing from coarse to fine blocks, vesicularity increases upwards (Fig. 14), indicating the direction of the flow top at the top of the fine layer. Some indication of the flow surface is typically indicated by discoloration (e.g. Fig. 15) or surficial patterns (e.g. Fig. 16).

Most joints I observed are tight and lacking fill, but some showed very wide apertures (up to 30 cm) with fallen rock infill. Apertures range between those two extremes, most commonly between 0.1 and 25 mm. Infill is typically absent, though some surfaces have staining, and fewer joints contain broken rock or some sort of vegetation growing out of them. Joints rarely have cohesionless fines within them. Frequently at the top of the most finely-spaced joint section, surficial features, and sometimes reddish or blueish coloration are present.

5.5 Water and Vegetation

From my observations during the summer, evidence of water coming out of rocks or joints in the rock is rare. A few locations show staining that suggests water presence at other

times (e.g. Fig. 17), and even fewer have visible traces of water (e.g. Fig. 18), though none is flowing. Lichen is less prevalent on fresh-looking rock faces. Moss or grass is present on tops of rock layers (Fig. 19), growing out of joints (e.g. Fig. 18), or even vesicles.

6 Analysis

6.1 Intact rock block size statistics

Intact rock block sizes are important factors for both RMR calculations and evaluation of intact rock structure. Table 4 summarizes results from analyses comparing the block frequency and average height of blocks for all subdomains mapped as intact rock at all scarps. Complete intact rock block size statistics for each subdomain are presented in Appendix F.

Blocks sizes are broken into size groups based on relative size compared to surrounding blocks. The groups consist of coarse-, medium-, and fine-sized blocks. Some blocks are in-between sizes, and could either be considered, for example, fine or medium, and may be considered on the border and presented as "mf". Categories are broken into coarse (c), coarse and medium to coarse (c + mc), medium and medium to coarse and medium to fine (m + mc + mf), medium (m), fine and fine to medium (f + mf), fine (f), and total.

Block height decreases as blocks fine. The average block frequency, and typically the standard deviation, increase as the block size fines. If all measurements of block frequency across all domains are combined, there are an average of 1.62 blocks/m, with a standard deviation of 1.13. Fine blocks (f) range from 0.96 to 5.13 blocks/m, with an average of 2.76 blocks/m (Table 4). Medium blocks (m) range from 0.55 to 2.73 blocks/m with an average of 1.09 blocks/m (Table 4). Coarse blocks (c) range from 0.33 to 1.45 with an average of 0.61 blocks/m (Table 4). Large and overlapping ranges exist in this analysis because I placed blocks in categories based on relative size to surrounding blocks. Although these are the average numbers between all scarps, they are only meant to provide a sense of scale for structure. Averages for each size bin vary at each subdomain, domain, and individual scarp. It is the number of blocks per meter at the subdomain and domain level that are relevant to RMR and intact rock structure analysis.

6.2 Geomorphic Rock Mass Rating (RMR)

I used Table 1 as a guide to calculate a geomorphic RMR for each subdomain mapped as intact rock face (Table 5), to help describe its resistance or susceptibility to modification or failure. Appendix E contains the full calculations for the 60 RMR-applicable subdomains. Calculated geomorphic RMRs range from 62 to 92. Nearly all subdomains fall under the category of "strong" rock. Only two subdomains are considered "moderate" quality: that consisting of recessed material leading into a fissure (Hildargjá D2 SD1) and the rocky talus slope between intact rock faces (Gildrulholtsagjá, D2 SD3). Although the RMR only applies to rock mass, I attempted to estimate an RMR value for Gildrulholtsagjá D2 SD3 talus area due to the appearance of the subdomain weathering out of the intact rock located between two intact rock faces high on a rock face. Only one subdomain is classified as "very strong."

Since the average domain RMRs did not vary much (only by 8), I looked at strongest and weakest RMR values within a domain to evaluate how RMR may control scarp morphology. I compared the highest and lowest RMR values in each domain against: the percent of the domain covered in talus, the percent of the domain presented as intact rock, the scarp height and the vertical percent of the scarp accounted for by talus (Fig. 20). Weakest RMR within a domain shows no trends when compared against percent domain made of intact rock and percent domain made of talus (Fig. 20a). Strongest RMR within a domain shows a positive trend when compared against percent domain made of intact rock, and a negative trend when compared against percent domain made of talus (Fig. 20b). R^2 values for these two trends are 0.27 and 0.42 respectively. Scarp height has no relation to the strongest or weakest RMR values within a domain (Fig. 20c). The vertical percentage of the scarp height made of talus also has no relation to the strongest or weakest RMR values within a domain (Fig. 20d).

6.3 Stereonets

Stereonets help describe the internal structure of a rock face by determining the type of jointing present at the scarps. Stereonets containing poles to planes and strike of the scarp face are presented in Figure 21. Kamb contouring of poles to planes reveals a bull's eye, and rough girdle or ring along the outside rim, with stronger trends roughly southeast-northwest. The presence of a partial girdle can indicate approximate columnar jointing, where one side of the jointing was not captured as clearly due to scarp orientation. The girdle indicates many orientations of steeply dipping planes intersecting the scarp face, and cut by roughly horizontal discontinuities, indicated by the "bulls-eye" on the stereonets. There is some indication of girdling at the Hildargjá site. Trends at the Gildrulholtsagjá site are not very clear because of varied scarp orientation limited measurements. Overall, Vogar sites are much more organized and represented by near horizontal and near vertical strikes and dips. The structure of joints can help determine distribution of joints and how a scarp degrades.

6.4 Talus

The statistics for talus size are presented in Table 6. Average talus size in a domain does not correspond with average block size within intact rock in the same domain and is frequently larger than the average intact rock block size (Fig. 22b). Talus at the base of scarps is frequently present in larger volumes where recessed sections of scarp exist, compared to adjacent forward sections. Talus represents a variation in morphology and is therefore used to analyze influences on morphology.

7 Discussion and Limitations

Nearly all rock in this study falls within the "strong" rock RMR classification (Table 5), indicating that the age, height, and individual aspects of the scarps have very little impact on the rock quality. Thus, RMR of intact rock does not explain the highly variable bedrock scarp morphology, of juxtaposed areas of vertical intact rock faces to talus and grassy slopes and morphologies in-between, along short distances of scarps. In this investigation, rock strength, weathering, joint continuity, and groundwater presence were all similar

enough across the scarps to result in little variation of the RMR value. Number of blocks per meter, joint orientation, and joint widths resulted in most of the variation of RMR values. Blocks per meter and joint orientation had rating spreads of 13 each, and joint widths had a rating spread of 5. The strongest RMR values in each domain is weakly correlated with the percent of the domain made of talus and intact rock (Fig. 20b). Talus percent in a domain decreased with higher values of the highest RMR, having an R^2 value of 0.42. Intact rock percent in a domain increased with higher values of the highest RMR, having an R^2 value of 0.27. Although RMR may be an appropriate method to determine differences between more variable bedrock, and the most competent rock in a domain has some association with morphologic differences, RMR cannot by itself account for all of the highly variable scarp morphology along short distances along strike.

The girdling and central cluster within all but the Gildrulholtsagjá stereonet may indicate columnar jointing broken by horizontal joints because it indicates sub-vertical joints of many orientations into the rock face and horizontal joints (Fig. 21). The columnar joints help understand the structure within a rock face, and therefore the joint frequency. The stereonets presented are of limited utility in understanding joint orientations, because data are limited and many joint orientations were approximated.

Þingvellir sites have less distinct structural patterns that deviate from sub-horizontal and sub-vertical joints in sub-horizontal layers. For example, Hildargjá D5 has two subdomains divided by a sub-vertical line and the blocks within those subdomains do not fall into the typical pattern of sub-horizontal layers broken by sub-vertical joints with upward-fining blocks. Vogar sites have overall clearer, more well-defined and uniformly shaped blocks and layers; sub-horizontal layers clearly present fining of blocks upwards within flows. Typically, talus is at the bottom of the scarp, although at Hildargjá, talus is more commonly near the top and in the middle of the scarp.

Increasing vesicle concentration upwards within a flow is consistent with cooling of low-viscosity flows. In low viscosity flows, air pockets, which later form vesicles, rise buoyantly, concentrating vesicles towards the top of the flow (Fig. 10 and Fig. 14; Lockwood and Hazlett, 2010). A repeating pattern of fining blocks upwards within a flow is consistent with changes in joint spacing with thermal gradient. Joints in younger flows often form during flow emplacement, such as columnar joints (Lockwood and Hazlett, 2010). Based on the girdling in the stereonets (Figure 21), I expect columnar jointing at the scarps studied. Columnar joints form perpendicular to the cooling surfaces (typically at the top and bottom of the flow) via contraction, propagating towards the center of the flow as lava cools (Lockwood and Hazlett, 2010). Emplacement-joint frequency is in part controlled by thermal gradients, where higher thermal gradients result in faster cooling and more finely-spaced joints (DeGraff and Aydin, 1993). In a lava flow, the largest thermal gradient is between the surface of the flow and air, and decreases towards the center of the flow. Thus the finely-spaced joints near the top of the flow, as observed, are consistent with the largest thermal gradient.

In many locations, especially at the bases of intact scarps, fine blocks constrained by through-cutting sub-horizontal joints are recessed compared to medium and coarse blocks around them, leaving coarse blocks overhanging (Figs. 11, 12 and 19). A thin section of fine

blocks between medium and large size boulders (e.g. Fig. 13) can results in a small recessed section between the medium and coarse blocks. The recession of the fine blocks implies that the fine blocks are a weakness within rock faces. Weaker fine-block subdomains may contribute towards the rock fall or topple of coarse and medium blocks above them given enough recession. This process may be one of the erosional processes occurring at the field sites. Areas where columnar joints develop out of the layer below without a through-cutting horizontal joints confining them do not show the same recession as those subdomains with finer blocks confined by through-cutting horizontal joints.

My data do not show any relations between scarp height and average talus diameter (Fig. 22a) or vertical percent degraded rock (talus and grassy slope) (Fig. 23). Although the small blocks may be a source of weakness within a rock face, as discussed earlier, average talus diameters are frequently larger than the average block size of the corresponding domain (Fig. 22b). The lack of correlation between average intact block size and average talus size is surprising, since one would expect the blocks at the base of a scarp to represent the block sizes within the face of a scarp. I propose three possible reasons why this relationship is not seen and average talus is skewed larger than the intact block size: 1) smaller talus is not as visible in orthophotos due to small size of the talus and orientation of the photo, 2) smaller talus falls through the openings between larger talus and is therefore not visible from the surface, and 3) smaller talus falls first as smaller intact blocks are eroded, causing undercutting of coarse- and medium-sized blocks that fall later, covering the smaller talus and thus skewing the size of the talus larger. Referring to possibility one, I saw smaller diameter talus near the base of the rock face at Gildrulholtsagjá D2, and larger talus further downslope. This is a limitation to the accuracy of talus size representation. More data and different orientations are needed to investigate these three proposed explanations.

The study and analyses are limited by number of scarps analyzed, and subsequently, number of data points. Many analyses are limited by the accuracy of the orthophoto, which projects points as if the scarp were perfectly vertical, which it is not in all locations. This may lead to some distortion. The closer items in the picture may also appear larger. For this reason, this study best captures general patterns, not exact values.

8 Findings and Recommendations

The four scarps studied have highly variable morphology over short distances along strike, but fairly consistent RMR values. Although RMR values are overall similar, a weak correlation exists between highest RMR in a domain and the percent of the domain represent by intact rock and rocky talus. The correlation with intact rock is positive (R^2 = 0.27). The correlation with talus is negative (R^2 = 0.42). The weak correlations indicate that there is some relation of highest RMR within a domain to scarp morphology, but that other factors also contribute significantly to variable scarp morphology.

In each flow, layered within intact faces, blocks fine and increase in vesicularity upwards. Where horizontally bound by persistent joints, subdomains of fine blocks recess at in large sections under coarse blocks to the base of where the scarp is visible, or recess slightly between medium and coarse blocks in many locations. This recession indicates that they

are a source of weakness in the rock face. The recession of fine-block horizons may be a contributor to the toppling of coarse- and medium-sized blocks above them. Although the small blocks may be a source of weakness within a rock face, the average talus diameters are larger than the small intact block sizes or the average size of intact blocks above the piles. Talus size analysis is likely skewed toward larger diameter boulders. To assess the three proposed reasons for skewing outlined in the discussion, I recommend closer observations of talus in the field to determine if smaller talus is seen beneath the larger talus blocks. If smaller talus is observed beneath larger talus, determining whether it appears that larger talus fell on top of smaller blocks, or it appears 'loose' between the larger talus boulders. This internal structure, the interaction of stacked lava flows, seems to have some influence on morphology. Although the role of internal structure is not quantitatively analyzed, it appears to play at least as significant a role in the morphology of the scarps where observed, if not more than RMR values.

Neither of these factors individually or together fully explain the varied along-strike scarp morphology observed.

These are preliminary findings based on limited field time and number of scarps. More scarp evaluations are required to identify robust relationships among rock attributes and scarp morphology. Many analyses are also limited by the accuracy of the orthophoto, which projects points as if the scarp were perfectly vertical, which it is not in all locations. I recommend an investigation into any distortion caused by the orthorectifying process. For this reason, this study best captures general patterns, not exact values. Further investigations are necessary to determine if and how age of a scarp influences scarp morphology, and whether it not being observed in this case is isolated. Further investigations are also necessary to pinpoint the influence of rock quality and internal structure of stacked lava flows on fault scarp morphology and expand the research area to determine if the factors are influential in other environments as well.

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10 Figures

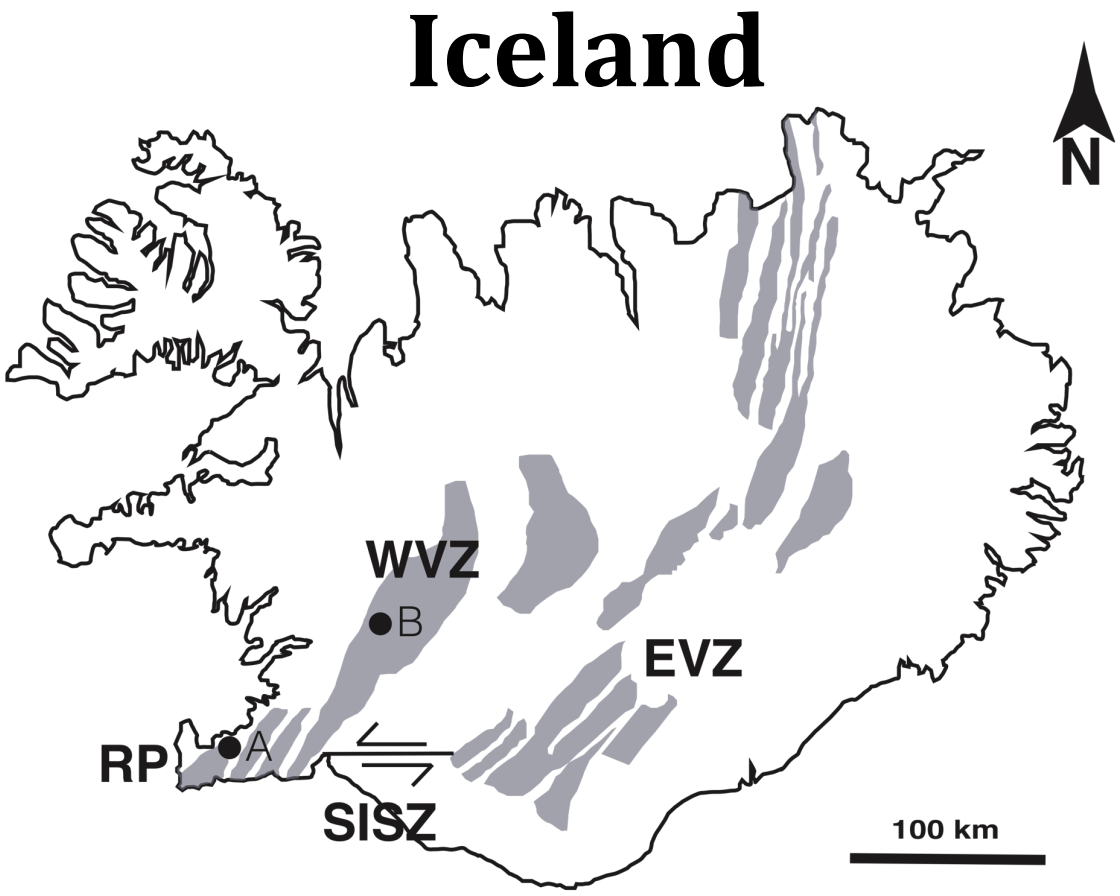


Figure 1. General location of study areas with respect to Iceland and the volcanic zones. Both field areas are within the Western Volcanic Zone (WVZ). Area A encompasses the sites near Vogar in the Reykjanes Peninsula (RP), and area B encompasses the Þingvellir sites. The South Island Seismic Zone (SISZ) separates the WVZ from the Eastern Volcanic Zone (EVZ). (Fig. by C. Brigham, modified Einarsson, 1991).



Figure 2. A southwest section of Iceland shows areas A and B from Figure 1. The locations of individual scarps are presented. Hildargjá and Gildrulholtsagjá are in the Þingvellir area in the northeast corner of the image. Stóra-Aragjá and Nydri-Mosadalgjá are in the Reykjanes Peninsula near the town of Vogar in the southwest corner of the image. Nydri-Mosadalgjá is further east. The inset better shows the locations of Stóra-Aragjá and Nydri-Mosadalgjá (Images from GoogleEarth, 12.30.16, compilation 4.21.15 and 7.9.17 inset).

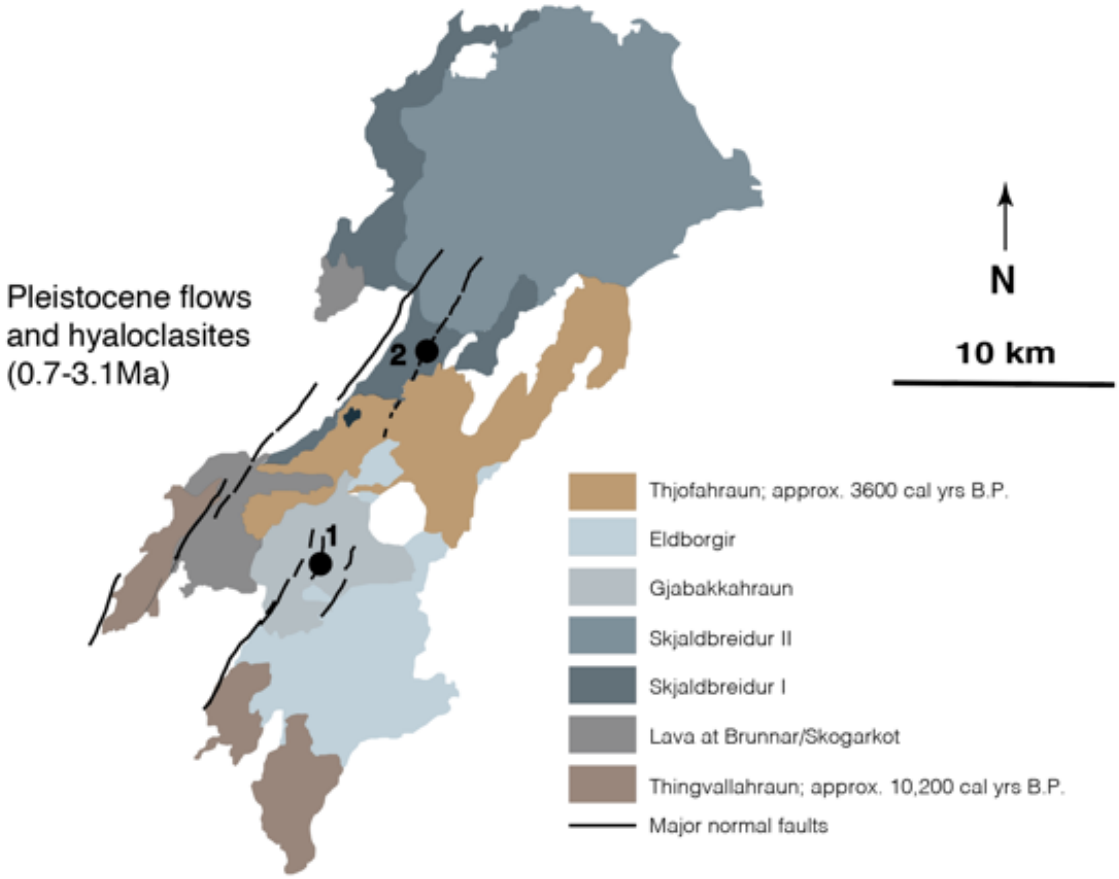


Figure 3. Map of the geologic units in the Þingvellir area with Gildrulholtsagjá (1) and Hildargjá (2) sites marked as points on the map. Black lines mark the traces of major normal faults within this area of the WVZ. (Fig. by C. Brigham, modified from Sinton, et al., 2005).

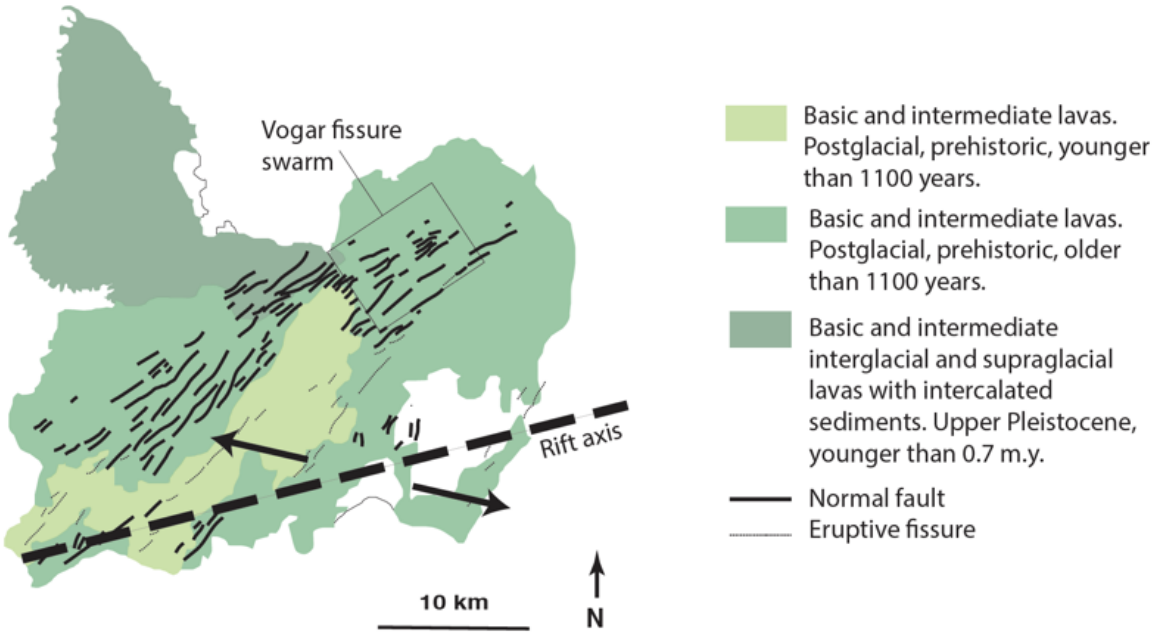


Figure 4. Map of geologic units in the Reykjanes Peninsula. Nydri-Mosadalgjá and Stóra-Aragjá lie within the Vogar fissure swarm in mafic and intermediate lavas that are post-glacial, prehistoric, and older than 11,000. Black lines mark the traces major normal faults. The large dashed line marks the rift axis, and the arrows indicate the direction of spreading from the rift axis. "Basic" refers to mafic rock (Fig. by C. Brigham, modified from Jóhannesson and Saemundsson, 1998).

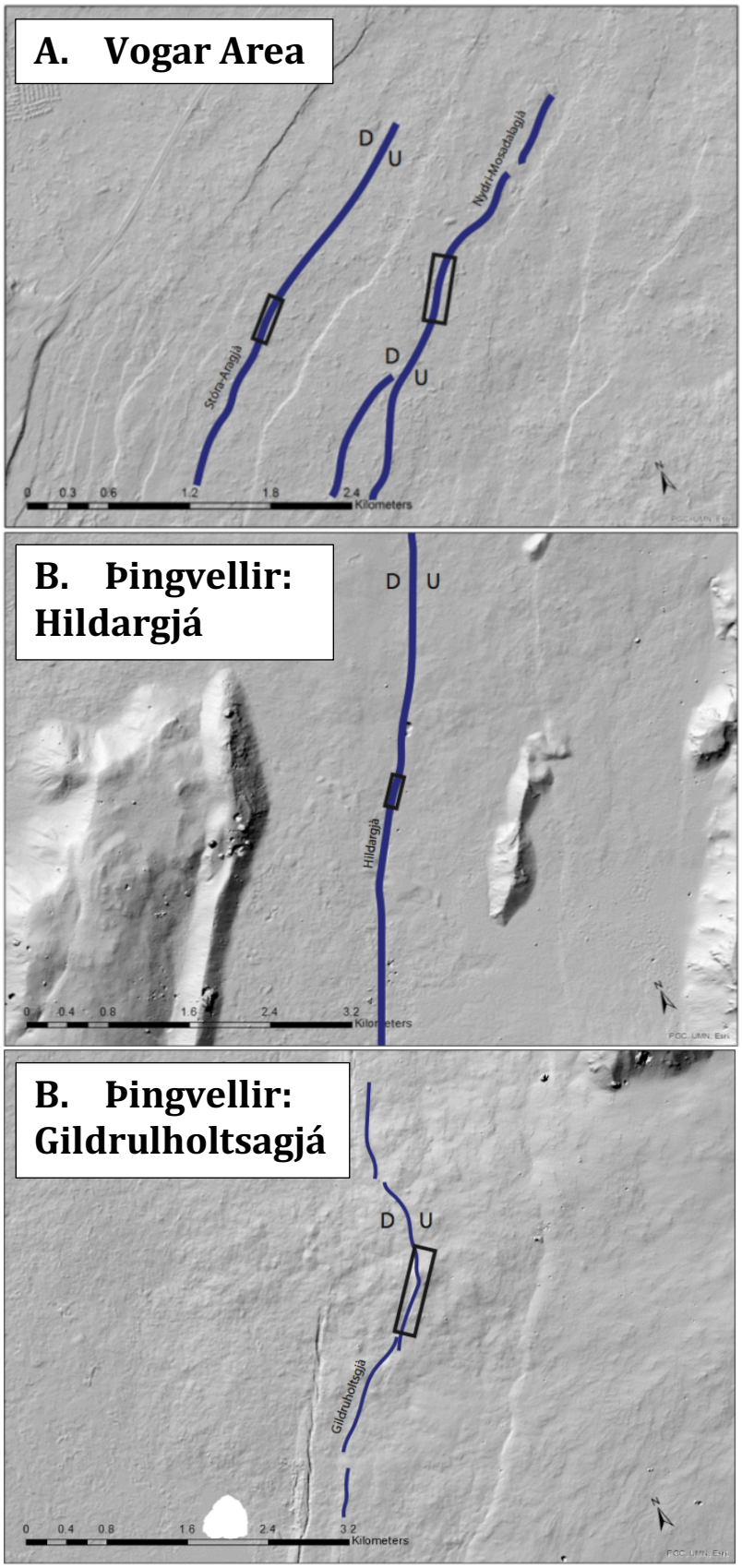


Figure 5 Digital Elevation Models (DEMs) for each of the four scarp locations. Scarps are denoted by blue lines. Areas of the scarp where SfM models conducted to make orthophotos are outlined in black boxes. "D" and "U" refer to the sides of the scarp that moved down and up respectively. Areas A and B refer to Fig. 1. Nydri-Mosadalgjá and Stóra-Aragjá in A; Stóra-Aragjá further to the west.

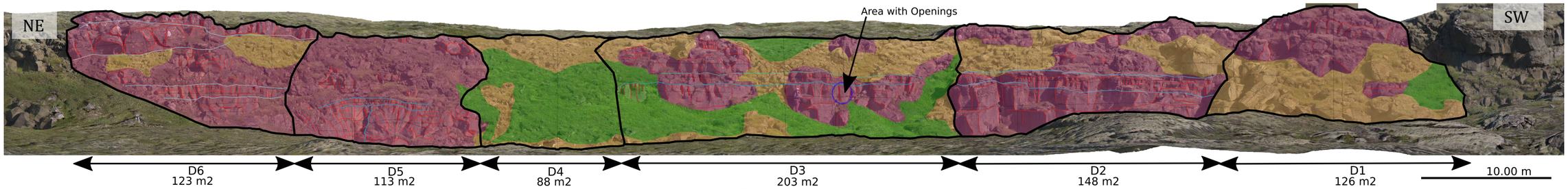


Figure 6. Geomorphic map of Hildargjá site: domains are outlined (black), red lines mark joint edges. The colors pink (intact rock), yellow (rocky talus) and green (grassy slope) indicate basic geomorphologies. Measurements are in black, and in meters.

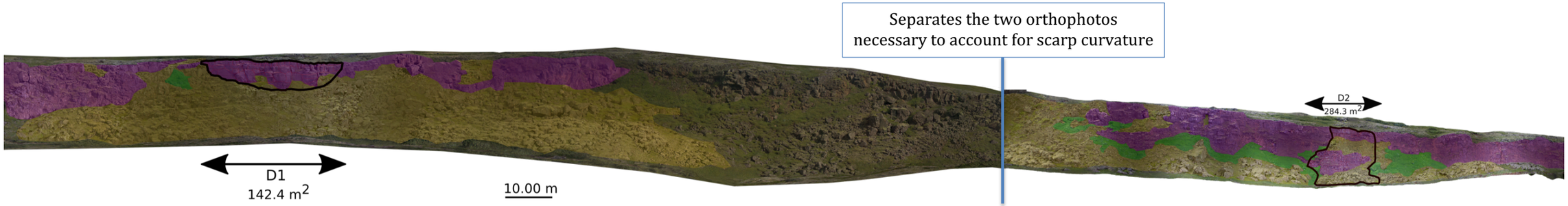


Figure 7. Geomorphic map of Gildrulholtsagjá, showing locations of the two domains by marking arrows. Domain 1 on the left side and domain 2 on the right side. Pink indicates intact rock, yellow indicates rocky talus, and green indicates grassy slope.

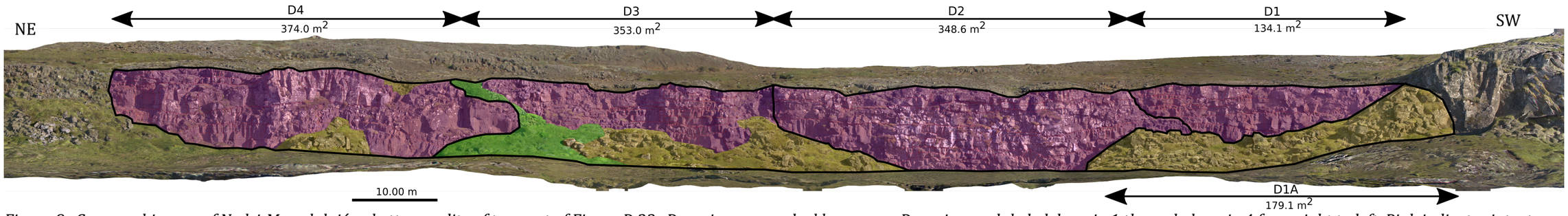


Figure 8. Geomorphic map of Nydri-Mosadalgjá; a better quality of top part of Figure D.23.. Domains are marked by arrows. Domains are labeled domain 1 through domain 4 from right to left. Pink indicates intact rock, yellow indicates rocky talus, and green indicates grassy slope. The image includes the orthophoto, geomorphology and block edges (red).

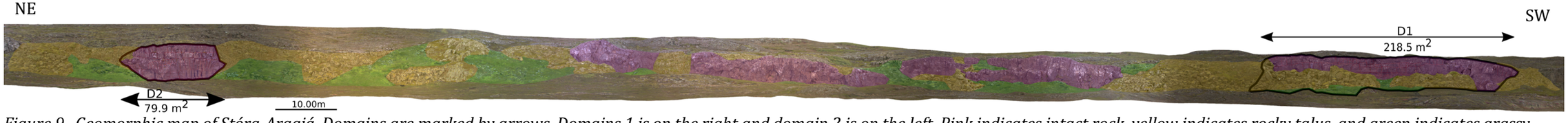


Figure 9. Geomorphic map of Stóra-Aragjá. Domains are marked by arrows. Domains 1 is on the right and domain 2 is on the left. Pink indicates intact rock, yellow indicates rocky talus, and green indicates grassy slope. The image includes the orthophoto, geomorphology and block edges (red).

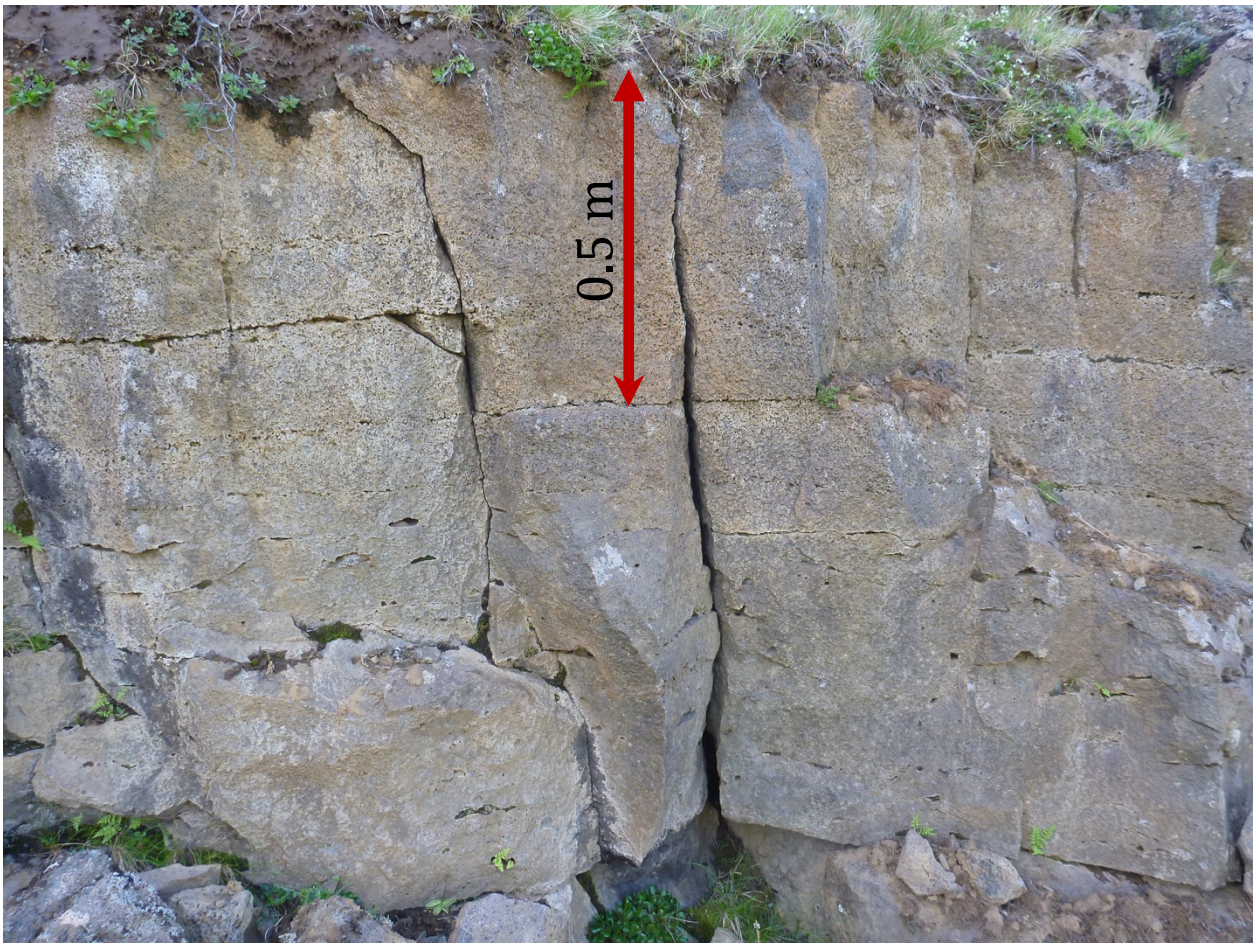


Figure 10. Vesicularity increases upwards towards as does block fining within Hildargjá D6.



Figure 11. Intersection of D2 SD1 and D2 SD2 of Hildargjá. SD1 is made of small blocks going down into a fissure with some reddish alterations. SD1 is recessed relative to SD2 (coarse blocks) above it.

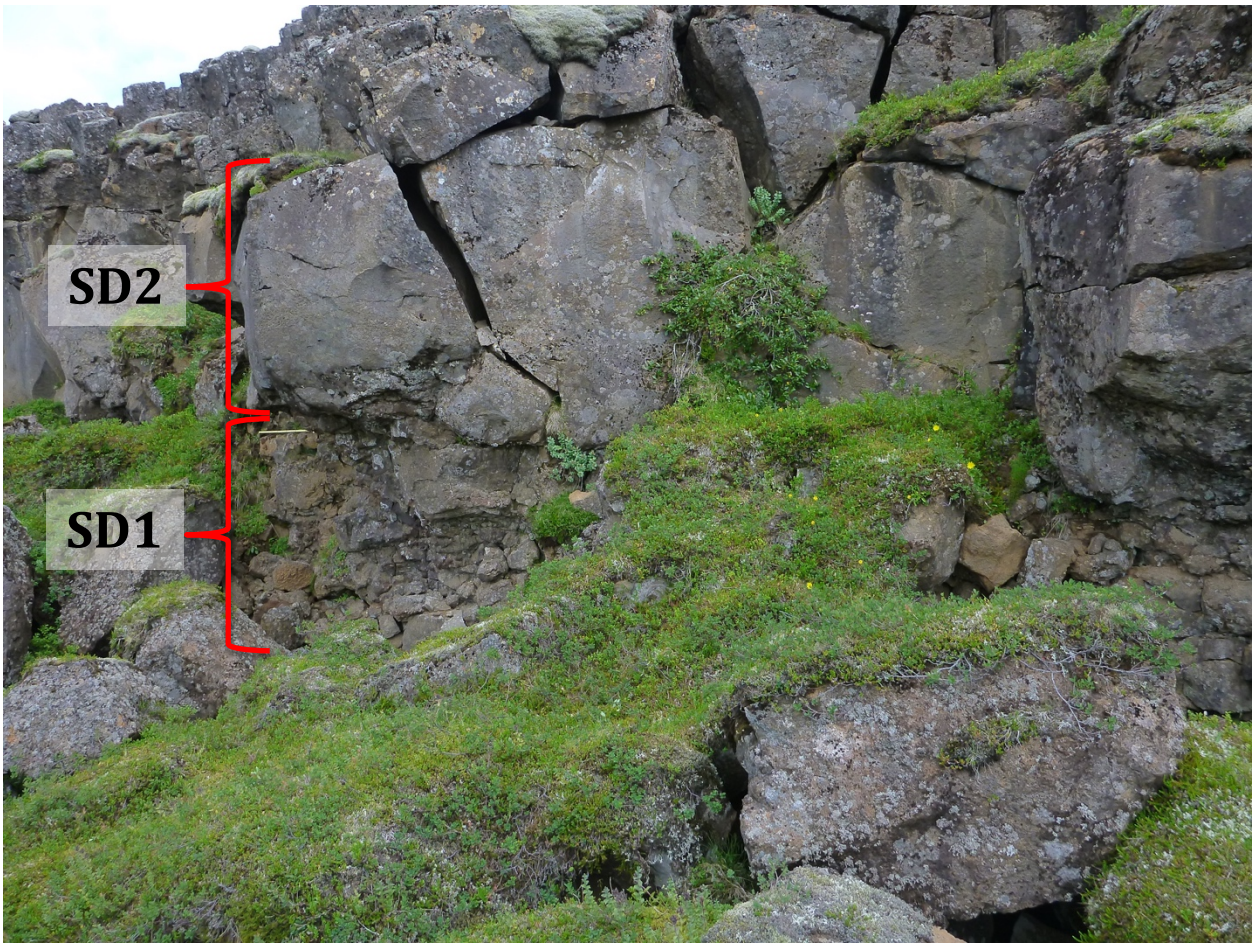


Figure 12. Looking obliquely northeast at the central section of Gildrulholtsagjá, D1. In this photo, open joints are visible between the large blocks of SD2. The block in SD2 separated from the rest of the face by the gaping joint is very poorly supported due to the significant recession of SD1 below.



Figure 13. Recession of fine blocks of Stóra-Aragjá D1, SD3 (middle) under coarse blocks of Stóra-Aragjá D1, SD4, and above medium block of Stóra-Aragjá D1, SD2. Red imprint of ropy features visible on the under-hang.



Figure 14. An example of increasing vesicularity upwards, from Gildrulholtsagjá D2 SD2.



Figure 15. A second close-up of Gildrulholtsagjá D1 SD1. The photo shows red to blue discoloration of the rock in small broken-up blocks without clean straight edges or continuous joints. Surficial features having ropy texture are present where red is seen in the photo.



Figure 16. Surficial feature imprint facing downwards on the southwest side of Gildrulholtsagjá D2 SD2.

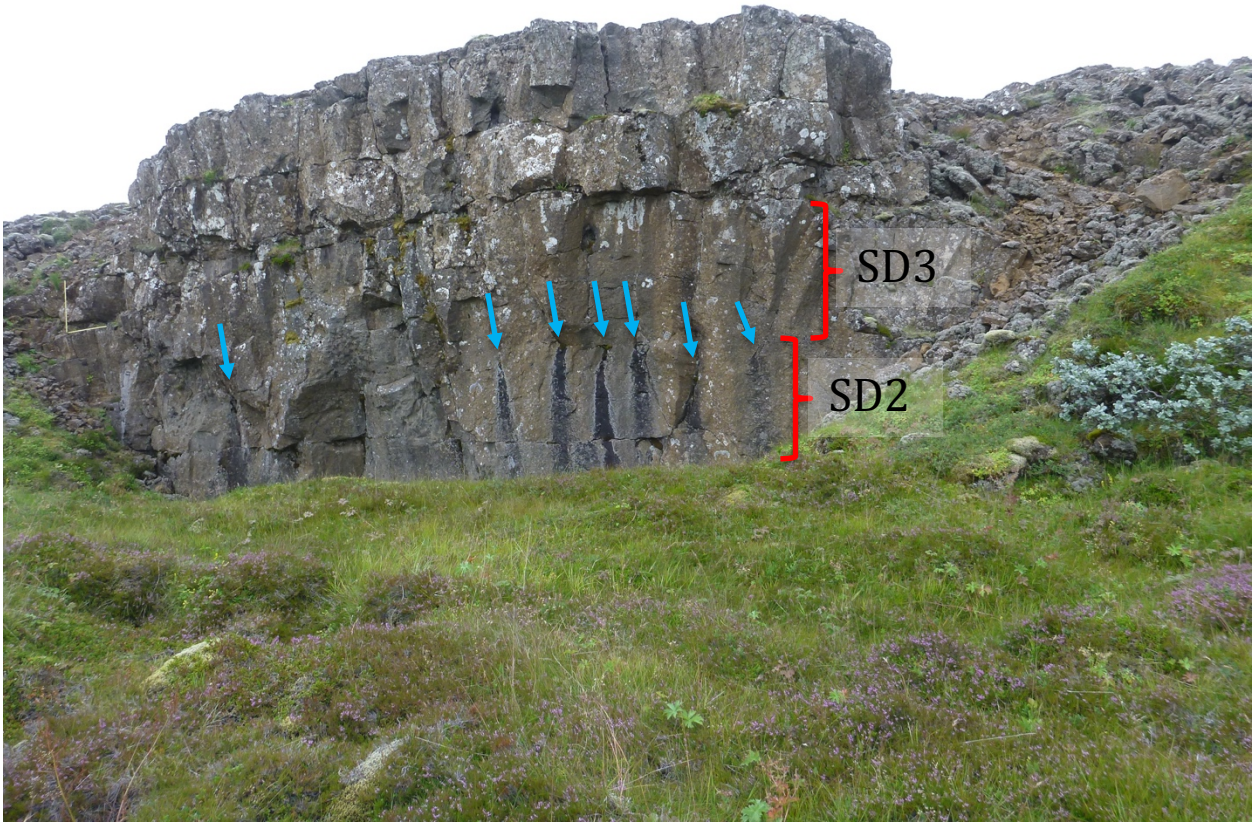


Figure 17. Seven water marks (pointed to by blue arrows) are visible in the lower half of Stóra-Aragjá D2: one on the northeast side and six in the central and southwest side of the domain at the intersection of SD2 and SD3.



Figure 18. At Stóra-Aragjá D2, moss grows out of the origin points of the water marks at the intersection of SD2 and SD3.

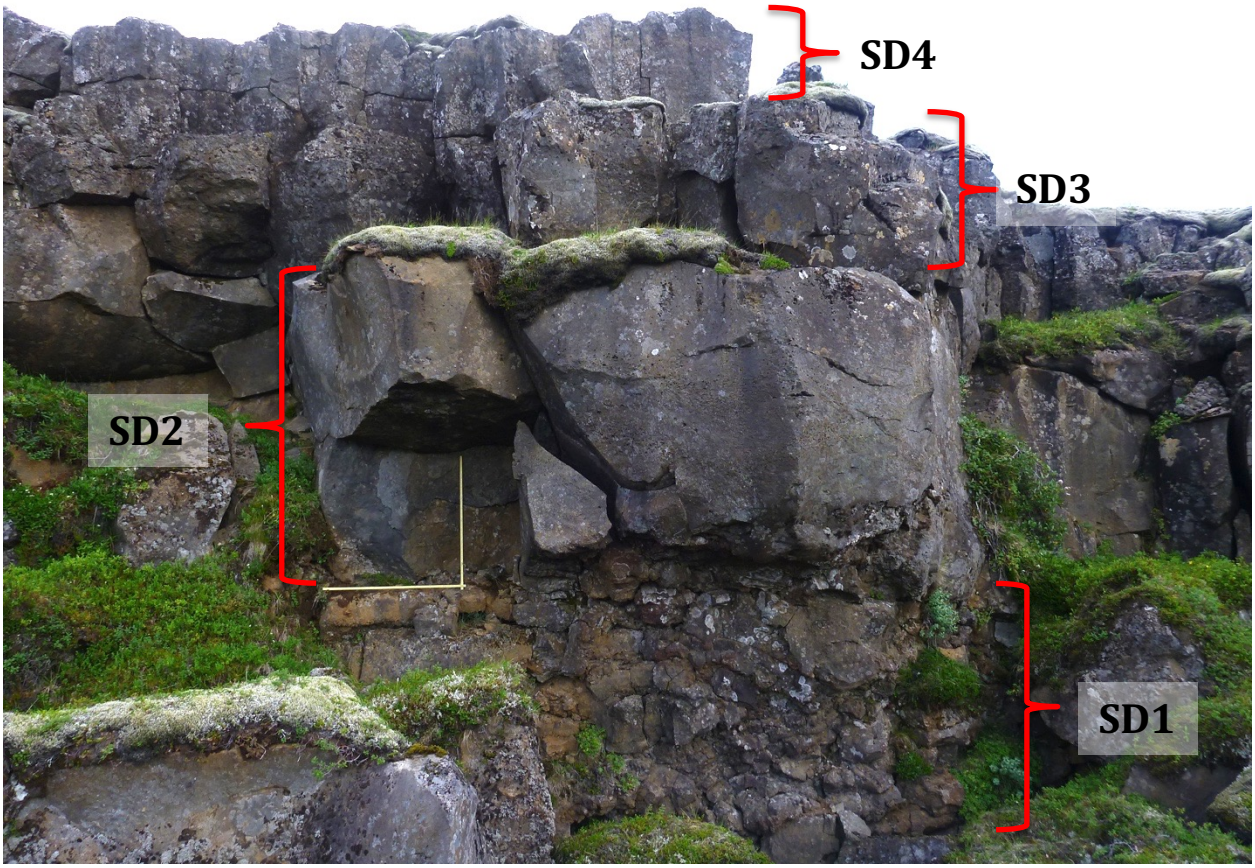


Figure 19. Close-up photo of Gildrulholtsagjá domain 1. SD1, composed of finer blocks, is recessed relative to the very large blocks of SD2. Some orange-weathering stains on the northeast side and dark alterations exist in SD1. SD2 consists of the very large blocks. SD3 consists of the medium sized blocks on top of SD2. SD4 consists of the fine columnar blocks at the top of the scarp. Some lichen is present in SD1. More lichen is visible in SD3 and SD4. The square ruler (yellow) is 94x94 cm.

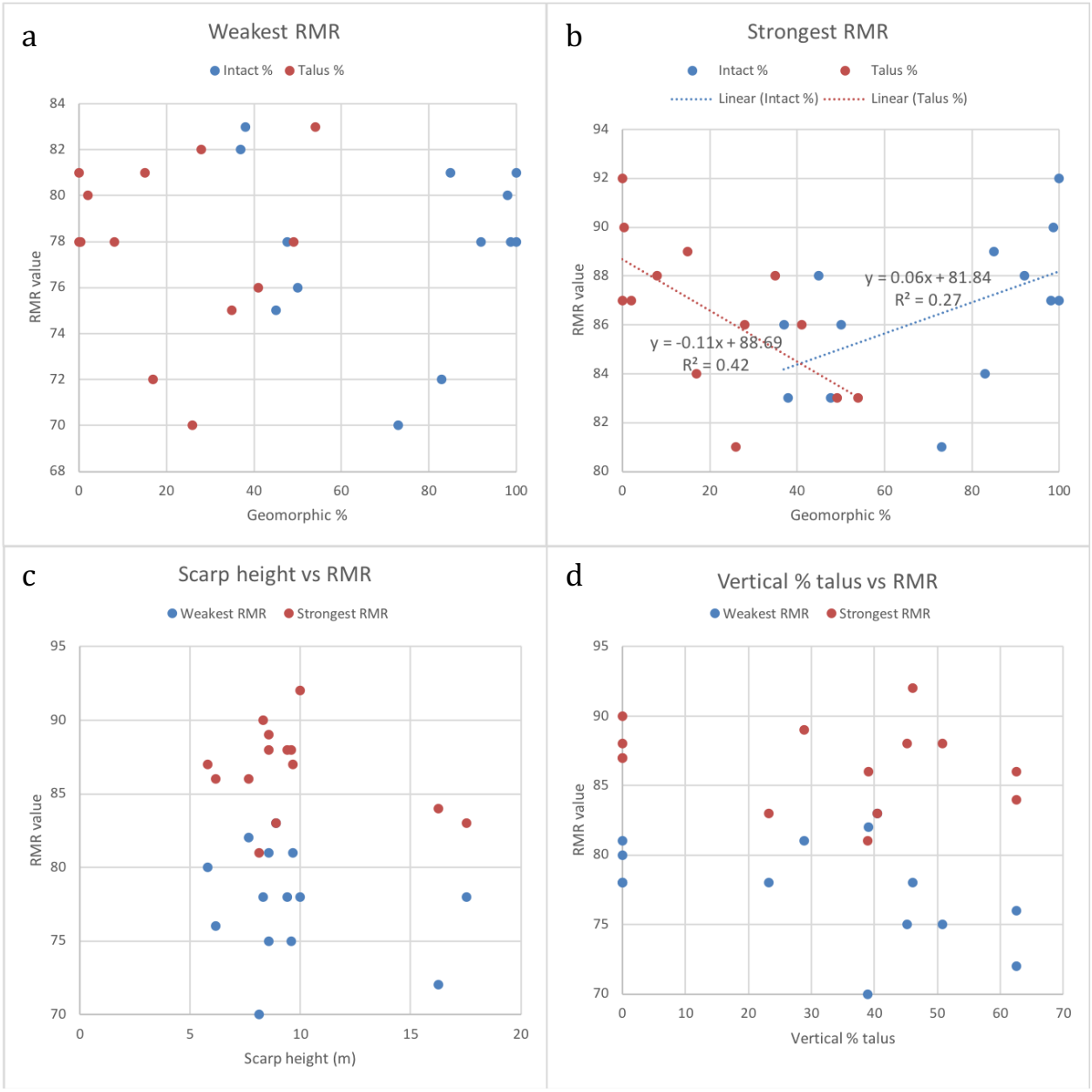


Figure 20. Analysis of rock mass rating (RMR), using the weakest and strongest RMR values in each domain. (a) Value of RMR for of the weakest subdomain in each domain compared to percent of the domain covered by intact rock and talus; (b) RMR of the strongest subdomain in each domain, compared to percent of the domain covered by intact rock and talus; (c) strongest and weakest RMR values are compared to scarp height; (d) and strongest and weakest RMR values are compared to the vertical percent of the scarp height accounted for by talus.

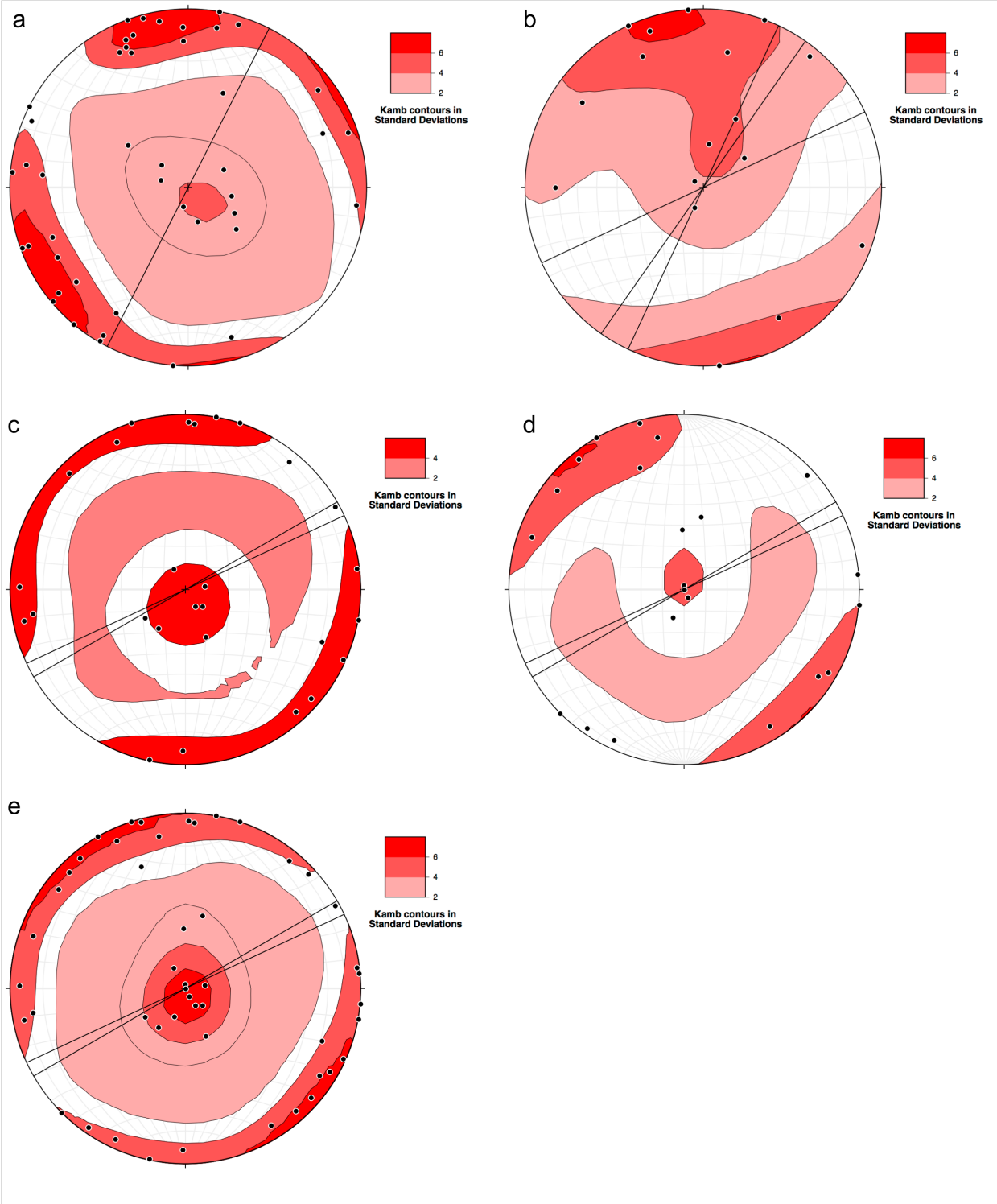


Figure 21. Stereonet plots of poles to planes (points) of each of the sites: a) Hildargjá, b) Gildrulholtsagjá, c) Nydri-Mosadalgjá, d) Stóra-Aragjá, e) Nydri-Mosadalgjá and Stóra-Aragjá Combined. Great circles (lines) represent the range of orientations of the scarp at each site. Kamb contours show standard deviation of plotted poles to planes from an even distribution.

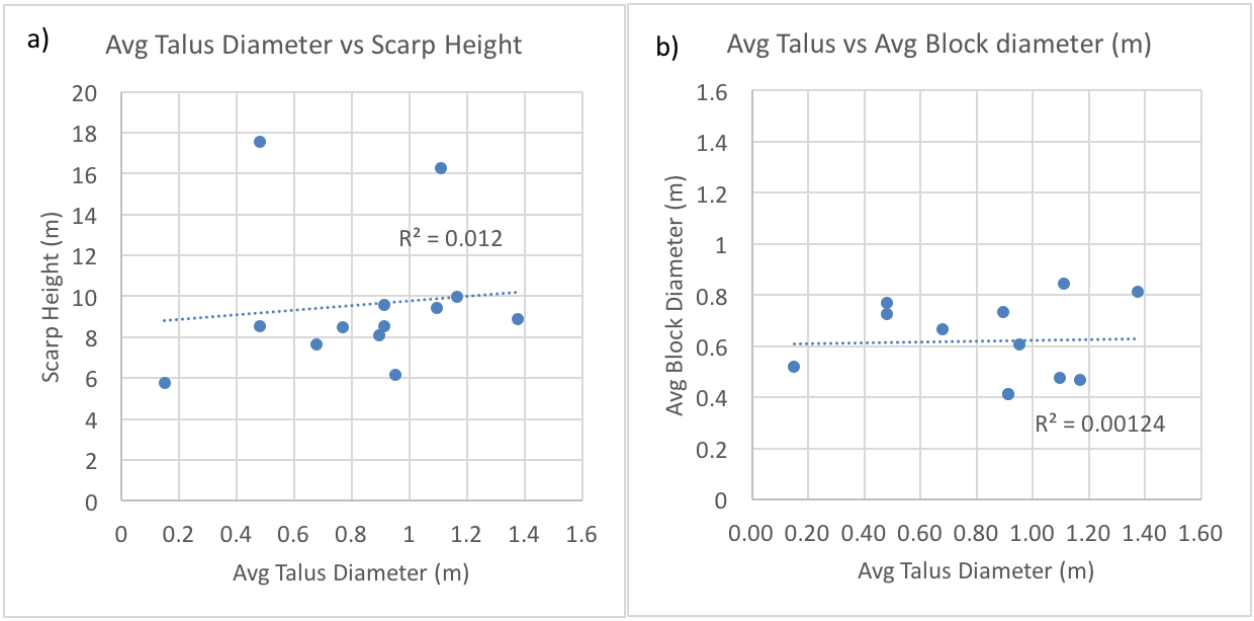


Figure 22. Talus diameter compared to a) scarp height or b) intact block diameter. There is no correlation for either comparison.

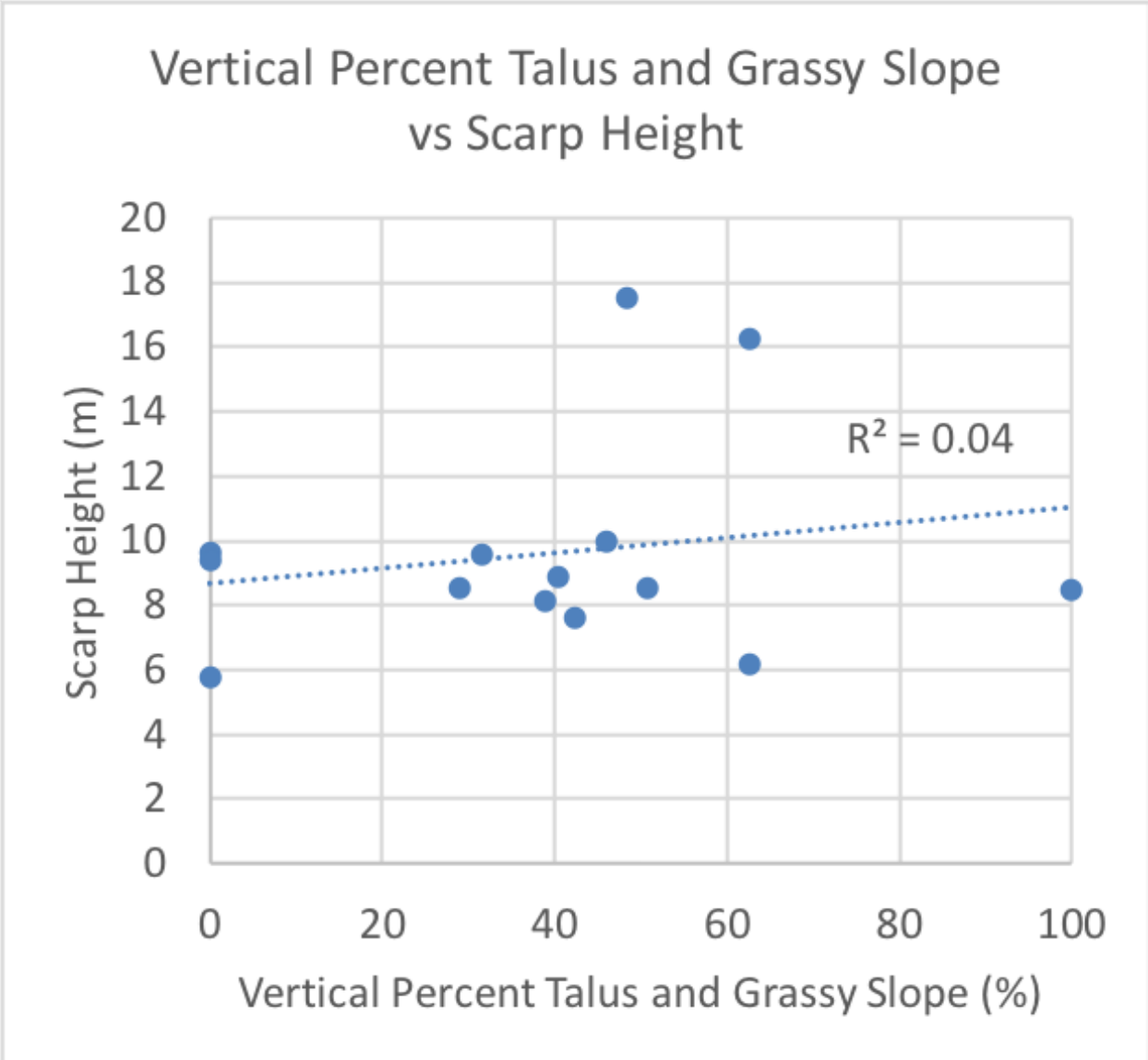


Figure 23. Vertical percent of the scarp covered by degraded rock (talus and grassy slope) compared to scarp height. There is no correlation between vertical percent degraded rock and scarp height.

11 Tables

Table 1. Geomorphic Rock Mass Strength Classification and Ratings

Table 1: Geomorphic rock mass strength classification and ratings					
Parameter	**(1) Very Strong**	**(2) Strong**	**(3) Moderate**	**(4) Weak**	**(5) Very Weak**
Intact rock strength (Uniaxial compressive strength)	>200 Mpa r: 20	100-200 MPa r: 18	50-100 Mpa r: 14	25-50 Mpa r: 10	1-25 MPa r: 5
Weathering	Unweathered r: 10	Slightly Weathered r: 9	Moderately Weathered r: 7	Highly Weathered r: 5	Completely Weathered r: 3
Spacing of Joints	>3 m r: 30	3-1 m r: 28	1-0.3 m r: 21	0.3-0.05 m r: 15	<0.05 m r: 8
Joint Orientations	Very favorable. Steep dips into slope, cross joints interlock r: 20	Favorable. Moderate dips into slope r: 18	Fair. Horizontal dips, or nearly vertical (hard rocks only) r: 14	Unfavorable. Moderate dips out of slope r: 9	Very unfavorable. Steep dips out of slope r: 5
Width of Joints	<0.1 mm (Very Tight) r:7	0.1-1 mm (Tight) r: 6	1-5 mm (Moderately Wide) r: 5	5-20 mm (Wide to Very Wide) r: 4	>2 mm (Very Wide) r: 2
Continuity of Joints	None continuous r:7	Few continuous r: 6	Continuous, no infill r: 5	Continuous, thin infill. r: 4	Continuous, thick infill r: 1
Outflow of Groundwater	None r: 6	Trace r: 5	Slight <25 l/min/10m^2 r: 4	Moderate 25-125 l/min/10m^2 r: 3	Great <125 l/min/10m^2 r: 1
Total Rating	100-91	90-71	70-51	50-26	<26

Source: Modified from Selby 1993 Table 7.5; Intact rock strength from Selby 1993 Table 6.3

Table 2. R scale strength classification of rock material

Table 2: Classification of rock material strengths			
Grade	**Description**	**Field Identification**	**Approximate compressive (Mpa)**
R6	Extremely strong rock	Specimen can only be chipped with geological hammer	>250
R5	Very strong rock	Specimen requires many blows of geologic hammer to fracture it	100-250
R4	Strong rock	Specimen requires more than one blow with a geologic hammer to fracture it	50-100
R3	Medium weak rock	Cannot be scraped or peeled with a pocket knife; specimen can be fractured with single firm blow of geologic hammer	25-50
R2	Weak rock	Can be peeled with a pocket knife; shallow indentations made by firm blow with point of geologic hammer	5-25
R1	Very weak rock	Crumbles under firm blow with point of geological hammer; can be peeled by a pocket knife	1-5
R0	Extremely weak rock	Indented by thumbnail	0.25-1

Source: Modified ISRM, 1978

Table 3. ISRM Weathering Classification

Table 3: Weathering Classification, ISRM (1978)		
Term	**ID**	**Description**
Fresh (100% rock)	I	No visible sign of rock material weathering; perhaps slight discoloration on major discontinuity surfaces.
Slightly Weathered (100% rock)	II	Discoloration indicates weathering of rock material and discontinuity surfaces. All the rock material may be discolored by weathering and may be somewhat weaker than its fresh condition.
Moderately Weathered (>50% rock)	III	Less than half of the rock material is decomposed and/or disintegrated to a soil. Fresh or discolored rock is present either as a discontinuous framework or as corestones.
Highly Weathered (<50% rock)	IV	More than half of the rock material is decomposed and/or disintegrated to a soil. Fresh or discolored rock is present either as a discontinuous framework or as corestones.
Completely Weathered (100% soil)	V	All rock material is decomposed and/or disintegrated to soil. The original mass structure is still largely intact.

Source: Modified ISRM, 1978

Table 4. Intact rock block frequency statistics per scarp and in total.

Intact Rock Block Frequency Statistics (blocks/m): Hildargja						
	Min	**Max**	**Avg**	**Count**	**St. Dev**	**Avg Block Ht (m)**
c	0.33	1.45	0.64	5	0.47	1.70
m	0.55	1.26	0.86	6	0.27	1.08
f	0.96	4.00	1.90	11	2.52	0.75
Total	**0.33**	**4.00**	**1.37**	**22**	**0.89**	**1.08**
Intact Rock Block Frequency Statistics (blocks/m): Gildrulholtsagja						
	Min	**Max**	**Avg**	**Count**	**St. Dev**	**Avg Block Ht (m)**
c	0.42	0.42	0.42	1	#DIV/0!	1.96
c + mc	0.42	1.30	0.86	2	0.62	1.81
m + mc	0.79	1.30	1.04	2	0.36	1.57
m	0.79	0.79	0.79	1	#DIV/0!	1.47
f	1.24	2.07	1.57	3	0.44	0.79
Total	**0.42**	**2.07**	**1.24**	**6**	**0.56**	**1.41**
Intact Rock Block Frequency Statistics (blocks/m): Nydri-Mosadalagia						
	Min	**Max**	**Avg**	**Count**	**St. Dev**	**Avg Block Ht (m)**
c	0.35	1.01	0.65	10	0.22	1.51
c + mc	0.69	0.96	0.79	1	0.22	0.97
m + mc + mf	0.79	1.92	1.34	12	0.36	0.71
m	0.73	1.97	1.31	16	0.32	0.83
f + mf	1.56	5.13	2.69	16	0.97	0.73
f	1.56	5.13	3.08	28	0.94	0.73
Total	**0.35**	**5.13**	**2.09**	**58**	**1.22**	**0.87**
Intact Rock Block Frequency Statistics (blocks/m): Stóra-Aragjá						
	Min	**Max**	**Avg**	**Count**	**St. Dev**	**Avg Block Ht (m)**
c	0.42	1.15	0.71	4	0.35	1.00
c +mc	0.42	1.64	0.91	9	0.37	1.02
m+ mc + mf	0.81	2.73	1.45	12	0.53	1.15
m	0.93	2.73	1.40	5	1.48	0.83
f + mf	1.55	3.92	2.62	5	1.18	1.31
f	2.77	4.19	3.69	4	0.71	0.59
Total	**0.42**	**4.19**	**1.78**	**20**	**0.05**	**1.00**
Intact Rock Block Frequency Statistics (blocks/m): All						
	Min	**Max**	**Avg**	**Count**	**St. Dev**	**Avg Block Ht (m)**
c	0.33	1.45	0.61	20	0.32	1.54
c +mc	0.42	1.64	0.85	12	0.37	1.27
m+ mc + mf	0.79	2.73	1.28	26	3.16	1.14
m	0.55	2.73	1.09	28	0.48	1.05
f + mf	1.55	5.13	2.65	21	1.03	1.02
f	0.96	5.13	2.76	46	1.04	0.74
Total	**0.33**	**5.13**	**1.62**	**106**	**1.13**	**1.09**

Table 5: Geomorphic rock mass rating summary table										
Domain	**Domain Avg**	**Sub-domain**	**RMR Value**	**Rock Strength**	**Weathering**	**Blocks/m**	**Joint Orientations**	**Joint Widths**	**Continuity of Joints**	**Ground-water**
Table 5A: Hildargjá										
Domain 1	83	**SD2**	83	R6 (>200 Mpa) [20]	II [9]	0.33-1 [28]	Fair - Unfavorable [12]	V. wide [2]	Few continuous [6]	None [6]
Domain 2	77	**SD1**	70	R6 (>200 Mpa) [20]	II [9]	3.33-20 [15]	Fair - Unfavorable [10]	Moderately wide [5]	Most continuous, occasional infill [5]	None [6]
		SD2	81	R6 (>200 Mpa) [20]	II [9]	0.33-1 [28]	Fair [12]	V. wide [2]	Continuous, no infill [5]	Trace [5]
		SD3	81	R6-R5 (>200 Mpa) [20]	II [9]	1-3.33 [21]	Fair [12]	V. tight [7]	Few continuous [6]	None [6]
Domain 3	84	**SD1**	86	R6-R5 (>200 Mpa) [20]	II [9]	0.33-1 [28]	Fair - Unfavorable [11]	V. tight [7]	Few continuous [6]	Trace [5]
		SD2	82	R6-R5 (>200 Mpa) [20]	II [9]	1-3.33 [21]	Fair [14]	Tight [6]	Few continuous [6]	None [6]
		SD3	83	R6-R5 (>200 Mpa) [20]	II [9]	0.33-3.33 [24]	Fair [14]	V. tight to v. wide [4]	Few continuous [6]	None [6]
Domain 5	83	**SD1**	78	R6 (>200 Mpa) [20]	II [9]	1-3.33 [21]	Fair [14]	Wide - v. wide [4]	Continuous, thin discontinuous infill [4]	None [6]
		SD2	88	R6 (>200 Mpa) [20]	I [10]	0.33-1 [28]	Fair [14]	Moderately wide [5]	Continuous, no infill [5]	None [6]
		SD3	78	R6 (>200 Mpa) [20]	I [10]	3.33-20 [15]	Fair [14]	V. tight [7]	Few continuous [6]	None [6]
		SD4	83	R6 (>200 Mpa) [20]	I [10]	1-3.33 [21]	Fair [14]	Tight [6]	Few continuous [6]	None [6]
		SD5	90	R6 (>200 Mpa) [20]	I [10]	0.33-1 [28]	Fair [14]	Moderately wide [5]	None continuous [7]	None [6]
Domain 6	84	**SD1**	82	R6 (>200 Mpa) [20]	II [9]	0.33-1 [28]	Fair - Unfavorable [11]	Wide - v. wide [4]	Continuous, no infill [5]	Trace [5]
		SD2	81	R6 (>200 Mpa) [20]	II [9]	1-3.33 [21]	Fair [14]	Tight [6]	Few continuous [6]	Trace [5]
		SD4	83	R6 (>200 Mpa) [20]	II [9]	0.33-1 [28]	Fair [13]	V. wide [2]	Continuous, no infill [5]	None [6]
		SD5	89	R6 (>200 Mpa) [20]	I [10]	0.33-1 [28]	Favorable [18]	V. wide [2]	Continuous, no infill [5]	None [6]

Table 5: Geomorphic rock mass rating summary table										
Domain	**Domain Avg**	**Sub-domain**	**RMR Value**	**Rock Strength**	**Weathering**	**Blocks/m**	**Joint Orientations**	**Joint Widths**	**Continuity of Joints**	**Ground-water**
Table 5B: Gildrulholtsagajá										
Domain 1	78	**SD1**	72	R5-R6 (>200 Mpa) [19]	II [8]	3.33-20 [15]	Fair [14]	Moderately wide [5]	Continuous, no infill [5]	None [6]
		SD2	79	R6 (>200 Mpa) [20]	II [9]	0.33-1 [28]	Unfavorable [9]	Wide - v. wide [3]	Continuous, no infill [5]	Trace [5]
		SD3	84	**R6 (>200 Mpa) [20]**	I [10]	0.33-1 [28]	Unfavorable [9]	Moderately wide [5]	Few continuous [6]	None [6]
		SD4	78	**R6 (>200 Mpa) [20]**	I [10]	1-3.33 [21]	Unfavorable [9]	Tight [6]	Few continuous [6]	None [6]
Domain 2	76	**SD2**	78	R6 (>200 Mpa) [20]	II [9]	avg 1-3.33 [21]	Fair [12]	Moderately wide [5]	Few continuous [6]	Trace [5]
		SD3[1]	62	**R5 (100-200 Mpa) [18]**	III [7]	3.33-20 [15]	Very unfavorable [5]	Moderately wide [5]	Few continuous [6]	None [6]
		SD4[2]	82	**R6 (>200 Mpa) [20]**	II [9]	1-3.33 [21]	Fair [14]	Tight [6]	Few continuous [6]	None [6]
		SD5	83	**R6 (>200 Mpa) [20]**	I [10]	1-3.33 [21]	Fair [14]	Tight [6]	Few continuous [6]	None [6]

Table 5C: Nydri-Mósadalgiá										
Domain 1	84	**SD1**	85	R6 (>200 Mpa) [20]	I [10]	1-3.33 [21]	Fair [14]	V. tight [7]	None continuous [7]	None [6]
		SD2	78	R6 (>200 Mpa) [20]	II [9]	3.33-20 [15]	Fair [14]	V. tight [7]	None continuous [7]	None [6]
		SD3	84	R6 (>200 Mpa) [20]	II [9]	1-3.33 [21]	Fair [14]	V. tight [7]	None continuous [7]	None [6]
		SD4	78	R6 (>200 Mpa) [20]	II [9]	3.33-20 [15]	Fair [14]	V. tight [7]	None continuous [7]	None [6]
		SD5	92	R6 (>200 Mpa) [20]	I [10]	0.33-1 [28]	Fair [14]	V. tight [7]	None continuous [7]	None [6]
		SD6	85	R6 (>200 Mpa) [20]	I [10]	1-3.33 [21]	Fair [14]	V. tight [7]	None continuous [7]	None [6]
Domain 2	84	**SD1**	82	R6 (>200 Mpa) [20]	I [10]	1-3.33 [21]	Fair [12]	V. tight [7]	Few continuous [6]	None [6]
		SD2	81	R6 (>200 Mpa) [20]	I [10]	1-3.33 [21]	Fair [12]	Tight [6]	Few continuous [6]	None [6]
		SD3	86	R6 (>200 Mpa) [20]	I [10]	1-3.33 [22]	Fair [14]	V. tight [7]	None continuous [7]	None [6]
		SD4	82	R6 (>200 Mpa) [20]	I [10]	1-3.33 [21]	Fair [14]	Tight [6]	Continuous, no infill [5]	None [6]
		SD5	87	R6 (>200 Mpa) [20]	I [10]	0.33-1 [28]	Fair [13]	Moderately wide [5]	Continuous, no infill [5]	None [6]

Table 5: Geomorphic rock mass rating summary table										
Domain	**Domain Avg**	**Sub-domain**	**RMR Value**	**Rock Strength**	**Weathering**	**Blocks/m**	**Joint Orientations**	**Joint Widths**	**Continuity of Joints**	**Ground-water**
Table 5C: Nydri-Mósadalgiá cont'd										
Domain 3	81	**SD0**	88	R6 (>200 Mpa) [20]	I [10]	0.33-1 [28]	Fair [14]	Moderately wide [5]	Continuous, no infill [5]	None [6]
		SD1	81	R6 (>200 Mpa) [20]	I [10]	1-3.33 [21]	Fair [12]	Tight [6]	Few continuous [6]	None [6]
		SD2	82	R6 (>200 Mpa) [20]	I [10]	1-3.33 [21]	Fair [14]	Tight [6]	Continuous, no infill [5]	None [6]
		SD3	75	R6 (>200 Mpa) [20]	I [10]	3.33-20 [15]	Fair [12]	Tight [6]	Few continuous [6]	None [6]
		SD4	79	R6 (>200 Mpa) [20]	I [10]	1-3.33 [21]	Fair [12]	Moderately wide [5]	Continuous, no infill [5]	None [6]
		SD5	81	R6 (>200 Mpa) [20]	I [10]	1-5 [19]	Fair [14]	Tight [6]	Few continuous [6]	None [6]
		SD6	82	R6 (>200 Mpa) [20]	I [10]	1-3.33 [21]	Fair [14]	Tight [6]	Continuous, no infill [5]	None [6]
		SD7	82	R6 (>200 Mpa) [20]	I [10]	1-3.33 [21]	Fair [13]	Tight [6]	Few continuous [6]	None [6]
Domain 4	82	**SD0A**	88	R6 (>200 Mpa) [20]	I [10]	0.33-1 [28]	Fair [14]	Moderately wide [5]	Continuous, no infill [5]	None [6]
		SD0B	84	R6 (>200 Mpa) [20]	I [10]	1-3.33 [21]	Fair [14]	V. tight [7]	Few continuous [6]	None [6]
		SD1	82	R6 (>200 Mpa) [20]	I [10]	1-3.33 [21]	Fair [14]	Tight [6]	Few continuous [6]	Trace [5]
		SD2	84	R6 (>200 Mpa) [20]	I [10]	1-3.33 [21]	Fair [14]	V. tight [7]	None continuous [7]	Trace [5]
		SD3	78	R6 (>200 Mpa) [20]	I [10]	1-5 [19]	Fair [12]	Moderately wide [5]	Few continuous [6]	None [6]
		SD4	82	R6 (>200 Mpa) [20]	I [10]	1-5 [19]	Fair [14]	V. tight [7]	Few continuous [6]	None [6]
		SD5	79	R6 (>200 Mpa) [20]	I [10]	1-5 [19]	Fair [14]	Moderately wide [5]	Continuous, no infill [5]	None [6]

Table 5: Geomorphic rock mass rating summary table										
Domain	**Domain Avg**	**Sub-domain**	**RMR Value**	**Rock Strength**	**Weathering**	**Blocks/m**	**Joint Orientations**	**Joint Widths**	**Continuity of Joints**	**Ground-water**
Table 5D: Stóra-Aragjá										
Domain 1	82	**SD1**	86	R6 (>200 Mpa) [20]	I [10]	1-3.33 [21]	Favorable [18]	Tight [6]	Continuous, no infill [5]	None [6]
		SD2	84	R6 (>200 Mpa) [20]	II [9]	1-3.33 [21]	Favorable - Fair [16]	V. tight [7]	Continuous, no infill [5]	None [6]
		SD3	76	R6 (>200 Mpa) [20]	II [9]	3.33-20 [15]	Fair [14]	V. tight [7]	Few continuous [6]	Trace [5]
		SD4	83	R6 (>200 Mpa) [20]	II [9]	0.74-3.33 [23]	Fair [14]	Tight [6]	Continuous, no infill [5]	None [6]
		SD5	81	R6 (>200 Mpa) [20]	I [10]	1-3.33 [21]	Fair [14]	Moderately wide [5]	Continuous, no infill [5]	None [6]
		SD6	82	R6 (>200 Mpa) [20]	I [10]	1-3.33 [21]	Fair [13]	Tight [6]	Few continuous [6]	None [6]
Domain 2	84	**SD2**	87	R6 (>200 Mpa) [20]	I [10]	0.33-1 [28]	Fair [14]	Moderately wide [5]	Continuous, no infill [5]	Trace [5]
		SD3	84	R6 (>200 Mpa) [20]	I [10]	1-3.33 [21]	Fair [14]	V. tight [7]	None continuous [7]	Trace [5]
		SD4[3]	80	R6 (>200 Mpa) [20]	II [9]	1-3.33 [21]	Fair [13]	Moderately wide [5]	Few continuous [6]	None [6]
		SD5	84	R6 (>200 Mpa) [20]	I [10]	0.77-1.11 [24]	Fair [14]	Moderately wide [5]	Continuous, no infill [5]	None [6]

[rating] rating value in brackets

[1] Talus face

[2] Disorganized

[3] No Patterns

RX Bold indicates rock strength inferred from surroundings

RMR values indicate rock strenght: 91-100 [very strong]; 71-90 [strong]; 51-70 [moderate]; 26-50 [weak]; <26 [very weak]

Table 6. Talus diameter statistics per domain, scarp, and in total.

Talus Diameter Statistics (m)																			
	Hildargjá						Gildrulholtsagjá			Nydri-Mósadalagjá				Stóra-Aragjá					Grand Total
	D1	D2	D3	D4	D6	Total	D1	D2	Total	D1A	D3	D4	Total	D1	D2 SD4	Sub-total	Outside Domains	Total	
Min	0.54	0.46	0.24	0.31	0.10	0.10	0.35	0.08	0.08	0.39	0.22	0.25	0.22	0.40	0.11	0.11	0.07	0.07	0.07
Max	2.34	2.89	2.04	2.20	1.42	2.89	2.74	2.56	2.74	2.81	1.89	2.73	2.81	1.88	0.35	1.88	1.71	1.88	2.89
Avg	1.38	0.90	0.68	0.77	0.48	0.76	1.11	0.48	0.71	1.17	0.91	1.10	1.08	0.95	0.15	0.73	0.45	0.50	0.72
Count	16	16	30	16	35	113	69	120	189	38	20	18	76	18	7	25	113	138	516
St Dev	0.60	0.62	0.38	0.46	0.30	0.53	0.57	0.48	0.59	0.68	0.39	0.86	0.67	0.44	0.09	0.53	0.32	0.38	0.57

12 Appendices

12.1 APPENDIX A – Methods

- 12.1 Figure A.1. Discontinuity Survey Data Sheet
- 12.1.1 Agisoft PhotoScan Pro, Making an orthophoto
- 12.1.2 Orthophoto Analysis
- 12.1.3 Fiji ImageJ Analysis, Geomorphology Percents

DISCONTINUITY SURVEY DATA SHEET

PROJECT: _____ DATE: _____

SURVEY LOCATION: _____ BY: _____

TRAVERSE DESCRIPTION: _____ SHEET ____ OF ____

LOCATION	QTY	SPACING	TYPE	DIP	DIP DIRECTION	PERSISTENCE	TERMINATION	APERTURE	INFILL	STRENGTH	ROUGH	SHAPE	JRC	COMMENTS

12.1.1 Agisoft PhotoScan Pro, Making an orthophoto

- Use Lightroom software to go through and select photos of the part of the scarp of interest
- Export
- Add Photos in Agisoft
- Add
- Batch Process
    - Build Dense Cloud
    - Build Mesh
    - Build Texture
    - Build Tiled Model
    - Build Orthomosaic (makes planform orthomosaic by default)
- Check "save project after each step"
- On 3D model, select and remove unwanted pieces: those outside of the area of interest that were not filtered out in the initial photo selection and/or points that cause erratic noise in the model
- Rotate the 3D model such that you are looking at it from the top and align the scarp top parallel to the top of the screen. Rotate the model down until you are looking perpendicular to the scarp. When exporting an additional orthophoto from this view perpendicular to the scarp (*File > Export Orthomosaic > Export JPEG/TIFF/PNG…*), do so using "current view."

12.1.2 Orthophoto Analysis

Orthophotos are perpendicular to the scarp orientation. Note: orthophotos "look" direction is perpendicular to scarp. At Gildrulholtsagjá (Gil), the scarp is curved. First provided image is perpendicular to domain 1.

- Import jpeg into Inkscape (can't be too large, or opens as black page; tiff seems to be too big – had to use photoshop to rotate and crop and save as jpeg on fast computers)
- Select image with pointer selection tool
- Edit > resize page to selection (to page size to match image)
- Use Pen Tool to outline domains (beyond what was used to take measurements
- Use Pen tool to outline geomorphic areas as intact rock (magenta), rocky talus (yellow), or grassy slope (green). Fill at 40% opacity, except 60% for yellow. Go beyond domains.
- Add new layer for scale. Make line along known measurement.
- Measure line: Extensions > Visualize Path > Measure Path (Length)
    - apply scale of 1 at first. hit apply with desired unit. Number appears on line. find scaling conversion to known measured length by dividing known measurement by computer measurement. Then apply the scaling by hitting the "apply" button for a measurement that should match your true measurement. Note that rounding will not always work because scaling can only be to the first decimal point (e.g. scaling for Gildrulholtsagjá is actually about 43.72, the closest of which rounds to 43.7. This approximated scaling makes the scale stick 93.8 cm on each side, when it should be 94 cm)
        - Hildargjá scaling = 29.7;
        - Gildrulholtsagjá D1 scaling = 43.7; D2 scaling = 38.7;
        - Nydri-Mosadalgjá scaling = 33.0;
        - Stóra-Aragjá scaling = 27.1.
- Get area of Domains: Extensions > Visualize Path > Measure Path (Area): keep scaling from length
- Save new SVG file for geomorphology manipulation
    - group together geomorphology
    - clip geomorphology by domain extents (select domain first, geomorphology second: Object > Clip > Set)
- Do fracture analysis (blocks/m) or measure block sizes

12.1.3 Fiji ImageJ Analysis, Geomorphology Percents

Image J Percent of Area for geomorphology of domains

- Open Fiji application (ImageJ)
- Open .png image saved from Inkscape of domain with clipped area
- Got to Analyze > Set Measurements: area, min and max value, mean gray value, display label, click OK
- Draw line on known distance. Analyze > Set Scale. fill in known distance and unit
- Go to Image > Adjust > Color Threshold
    - use sliders on Hue to isolate the colors
    - hit “select”
- Analyze > measure (gives measurements picked in step 3 for selected area)
- Repeat step 4&5: I do pink, green, yellow (intact, grassy, rocky), total
- Save table using “Save As”: e.g. Domain_results

TOTAL AREA: can be done in ImageJ using set scale, or by using outlines when scaling is set in Inkscape when whole mapped section is mapped domains (Hildargjá)

12.2 Appendix B – Observations – Field and Orthophoto

12.2.1 Þingvellir National Park Locations

Both scarps, Hildargjá and Gildrulholtsagjá, face west-northwest near the northeastern side of Lake Þingvallavatn.

12.2.1.1 Hildargjá (aka Gatfell)

Hildargjá is a remote site located along an F-class road type (recommended for all-terrain vehicles only) off of road 550 in Þingvellir National Park. The scarp is located about 13 km north-northeast of the northeast corner of Lake Þingvallavatn (See Fig. 2). The scarp strikes about 027˚-207˚ (northeast-southwest). Six domains compose the field site: D1 through D6, labeled southwest to northeast. The six domains total an area of approximately 801 m^2. Fig. 6 shows locations and boundaries of the six domains, geomorphic units, joints and measurements.

12.2.1.1.1 Hildargjá Domain 1

The face of domain 1 (D1) has an area of approximately 126 m^2 in the rough shape of a triangle (Fig. D.1.). D1 is dominated by large rocky talus, and some intact rock. About 54% of the domain is rocky talus, 38% is intact rock and 8% is grassy slope. The lower portion of the domain (subdomain 1, aka D1 SD1) consists predominantly of boulders that look representative of the blocks from the intact rock above them. The upper part of the domain (sub-domain 2, aka D1 SD2) is intact rock. Boulders are typically on the meter to multi-meter scale (mostly less than 3m), and poorly defined blocks are covered in moss and lichen.

Subdomain 1 (D1 SD1) consists of the rocky talus and grassy slope and a small section of intact rock. The intact rock is not expansive or consistent enough to determine an average number for blocks per meter (blocks/m). Boulders are typically on the meter to multi-meter scale, ranging from 1.38 m to 2.34 m diameter, and smaller blocks are on the half-meter scale (0.54 to 0.82 m). Blocks are poorly defined and covered in moss and lichen. The blocks are typically angular to sub-angular.

Subdomain 2 (D1 SD2) consists of intact rock. The intact rock faces retreat back towards the top of the scarp in a step-like fashion. Moss covers the flat surfaces of the benches. The intact rock face appears rubbly, and blocks are not well-defined by clean or perpendicular edges. Fractures of the larger blocks appear conchoidal. The blocks have sub-vertical joints and appear to be tilting out of the face. Photo-analysis of one layer of about 1 m thick unit of rocks that present a pattern reveals an average of 1.23 blocks/m.

12.2.1.1.2 Hildargjá Domain 2

Domain 2 (D2), roughly rectangular in shape (Fig. D.2.), has an area of approximately 148 m^2. Intact rocks with nearly vertical faces in the lower half of the domain (subdomains 1-3) and sloped, rubbly intact rock and rocky talus in the upper half of the domain (subdomain 4) dominate D2. Joints are sub-vertical and sub-horizontal within the vertical faces. About 73% of the domain is intact rock and 26% is rocky talus. D2 has much more well-defined cubic blocks than D1. Grass-covered slope and large blocks of rock fall are present at the base of the defined subdomains, but are not visible in the orthophoto. Boulders near the base of the scarp are covered in lichen and grass. Lighter lichen patches, and some dark

stripes of lichen are present of the westerly faces, although most rock is exposed. Moss is present on to of exposed horizontal surfaces within the subdomains.

Subdomain 1 (D2 SD1) is not visible in the orthophoto presented. The domain consists of closely spaced joints resulting in small blocks, 12" (0.3 m) by 8" (0.2 m) or smaller, going down into the fissure at the base of the scarp (Fig. 11) on the southwest side. Joint surfaces are rough, and 0-1" apertures are typically clean or filled with cohesionless fines. The sub-horizontal joints dip out of the scarp face, where the approximately 12" spaced sub-vertical joints cut into the scarp obliquely. Blocks are not neatly arranged in rows and columns. This domain undercuts the overlying rock, resulting in an overhang above a fissure. D1 SD1 appears more easily eroded than the above material.

Subdomain 2 (D2 SD2) consists of massive blocks (approximately 2.3m x 1.8m x 1.5m) with two horizontal layers and many vertical deviations, resulting in an approximately 3m thickness of the unit. The layers are about 1.5 m tall each. Persistence of the horizontal joints are high, and vertical joints are mostly continuous through the subdomain. Vertical joint sets make an approximately 66˚ intersection with each other. Photo-analysis reveals roughly 0.3 blocks/m, which is roughly on par with the reciprocal of vertical joint spacing. Vesicles and elongated air pockets are present at the top of the subdomain (Fig. D.3.). Rock face is mostly well-exposed, with some light lichen patches on western faces, and some stripes of dark lichen. Moss covers the top of flat, exposed surfaces. Some minor amounts of water, visible as dark stripes in Fig. D.3., seep from the vesicles and holes.

Subdomain 3 (D2 SD3) has closer-spaced sub-vertical joints than D2 SD2 that start to take the appearance of poorly-defined columns. D2 SD3 is one layer bound by two sub-horizontal joints that dip slightly into the scarp. Columns are about 0.7m to 1m tall. The two vertical joint sets have spacings of 0.3m and 0.45m. The vertical joint sets make an approximately 73˚ angle with each other. Photo-analysis reveals an average of 1.88 blocks/m. The accessible joint surfaces were not well exposed and undulating, therefore difficult to take strike and dip measurements upon. Strike and dip was taken upon the second leftmost crack (to the right of the scale) in the Figure D.4..

Subdomain 4 (D2 SD4) is dominated by rocky talus and irregularly-spaced, poorly-defined intact rock covered in moss and lichen. One piece of intact rock underneath the pahoehoe in the upper northeast corner of the subdomain is confined by a relatively horizontal surface dipping 34˚ back into the face. The base of the intact boulders also appears to tilt back into the face, although no measurements were possible. Subangular to angular intact and loose block sizes range in size, for example, 10x15x30 cm, 12x5x10 cm and ~1m scale boulders.

12.2.1.1.3 Hildargjá Domain 3

Of the 203 m^2, roughly rectangular domain 3 (D3), about 37% is intact rock, 34% grassy slope and 28% rocky talus (Fig. D.5.). The domain consists of relatively vertical rock faces with rocky talus on top, and grassy slopes mixed with rocky talus below and above, inter-fingering between the intact rock sections. Most of the grassy slopes and the rocky talus areas are not listed in subdomains below. The subdomains consist of intact vertical rock faces (subdomains 1 and 2), and a third subdomain as with irregular shapes of intact rock with no distinct patterns and rocky talus above the intact rock.

Subdomain 1 (D3 SD1) is similar to D2 SD2 with its massive blocks and elongated vesicles at the top of the subdomain. It does not, however, have the clearly defined, straighter-edged blocks of D2 SD2, or as consistent of a spacing (ranging from 0.4 to 2.7m) or strike and dip. One block in the middle section was 1.5m tall. Overall, one to two layers of the subdomain are visible, depending on which of the two sections of the vertical face is observed. At its thickest height, the domain is about 3.15 m thick, with horizontal joints occurring every 0.7 to 1.7 m. Photo-analysis reveals vertical joints resulting in 0.66 to 0.89 blocks/m. Vertical joints were not typically open and had low persistence. There are also open (0.12-0.28m) joints filled with rock that run parallel to the scarp (Fig. D.6.). Minor seepage was observed in a few locations, as well as some orange staining.

Subdomain 2 (D3 SD2), not accessible in the field, is set back from D3 SD1. It consists of one, defined.

Subdomain 3 (D3 SD3) is a mix of intact rock with no clearly distinct patterns, rocky talus, and a section of grassy slope. The intact rock has massive, conchoidal fracture surfaces, and smaller columnar and blocky sections. Photo-analyses in different sections reveal 0.55 large blocks/m and 3.08 small blocks/m. Within the rocky talus sloping back from the top of the intact rock, identifiable blocks are most commonly less than 0.7 m in diameter, with a few boulders about 0.9 m in diameter, and one about 1.53m in size. The rocky talus is covered with grass in some parts, and rock diameters are not clearly identifiable.

12.2.1.1.4 Hildargjá Domain 4

Domain 4 (D4) is roughly square-shaped (Fig. D.7.). Of its 88 m^2 area, about 67% is grassy slope, 33% rocky talus 1% intact rock. Rocky talus is mostly at the top and bottom of the domain. A 2.2 m boulder is at the base of the domain. In the upper section of the domain, boulder blocks typically range from 0.38 to 1.07m. The slope remains approximately linear from the base to the top of the scarp.

12.2.1.1.5 Hildargjá Domain 5

About 98.7% of roughly square (Fig. D.8.), 113 m^2, domain 5 (D5) is intact rock. The small remainder of D5 is about 0.5% grassy slope and 0.4% is rocky talus. The domain is divided into five subdomains, with a mixture of horizontal and vertically delineating lines. Two more finely jointed layers (subdomain 3 and 4) bound subdomains 1 and 2 vertically. A vertical line delineates subdomains 1 and 2. On either side of the delineating line of subdomains 1 and 2, rough columns splay to the southwest and northeast.

Subdomain 1 (D5 SD1), the northeastern-most subdomain, has relatively vertical joints in the southwest that then splay to the northeast. D5 SD1 is about 3.75 m wide and 2.65 m tall. This part of the flow is massive, resulting in large blocks. Joints runs approximately perpendicular and parallel to the rock face, the latter of which has more open aperture. Vertical columns are interrupted by some inconsistent horizontal fracturing. The vertical jointing results in approximately 1.4 blocks/meter. Overall, horizontal jointing is about 1.13 blocks/m.

Subdomain 2 (D5 SD2) has large, poorly structured columns that splay northeast and southwest from the center of the subdomain, with approximately 0.87 blocks/m. Fractures are more conchoidal. D5 SD2 is about 5.6 m wide and 3.15 m tall. The splayed columns go

nearly to the top of the domain without breakage. The base is confined by subdomain 3, a relatively horizontal layer.

Subdomain 3 (D5 SD3) is below D5 SD2 (Fig. D.9.), and not visible in the orthophoto. It is made of one layer of fine spaced, non-persistent 0.8 m tall columns. Blocks have a spacing of about 0.1-0.25 m. The joint faces are not typically through-cutting, that is, joints do not cut all the way through the rock (Fig. D.10.).

Subdomain 4 (D5 SD4) overlays subdomains 1 and 2. It was not accessible in the field. The finer joint spacing develops out of the top of the more massive columns below. The single layer of columns is about 0.6 m high, and has approximately 2.08 blocks/m.

Subdomain 5 (D5 SD5) consists of the remainder of the domain, including some area above the other subdomains, and some to the sides. It consists of overall intact, but rubbly looking rock with few consistencies. Grass and moss cover relatively horizontal surfaces. Some patches have well-defined joint planes, such as that above subdomain 1, which contains a spacing of 0.87 blocks/m.

12.2.1.1.6 Hildargjá Domain 6

About 85% of the wedge-shaped (Fig. D.11.), 123 m^2 domain 6 (D6) is intact rock and 15% is rocky talus. D6 has small, loose rubble by the base of the intact rock face. This domain returns to a more fine and uniform jointing as in D2 and D3, but with less clearly defined patterns progressing towards the top of the domain. Subdomains 3-5 were not accessible in the field.

Subdomain 1 (D6 SD1) at the base of the rock face has large blocks about 1-1.5 m in length. Photo-analysis reveals an average of 0.63 blocks/m. Joint spacing is not very consistent. The two horizontal layers have a thickness of about 0.65 m each. Joints are overall tight, but some are open, up to ¾". Joint surfaces have small undulations, and there is some evidence of minor amounts of water seepage (Fig. D.12.).

Subdomain 2 (D6 SD2), develops more columns above D6 SD1, but also has several non-persistent horizontal joints. Joint spacing for each side of a block was typically around 1m. Photo-analysis reveals about 1.63 blocks/m, with some additional development towards the top of the subdomain in places, resulting in 4 blocks/m. The whole unit is about 0.95 m thick, which are either continuous columns, or split by horizontal joints of 0.3 to 0.5 m spacing. The rock is vesicular, and strike and dips are variable.

Subdomain 3 (D6 SD3) has intact rock, as well as some fine rocky talus with some grass on top. Intact block sizes are variable, with some large on the scale of 1.57m, and others smaller, on the scale of 0.58m. Rocky talus is on the smaller side (0.2 to 0.4 m diameter). Overall, there is no consistent rock face or patterns. Intact rock appears more similar to rocky talus. The subdomain is about 3m thick.

Subdomain 4 (D6 SD4) is a nearly 2 m thick row of large blocks with conchoidal, non-vertical joints. There are about 0.43 blocks/m. The front faces are free of biological cover, except for some lichen growth. The subdomain is topped with some rubble and grassy-moss covering.

Subdomain 5 (D6 SD5) has one row of blocks smaller than D6 SD4 below it. The blocks are not well-defined. The unit, a maximum of 1 m tall, has about 0.95 blocks/m. These rocks are fairly free of grass and moss.

12.2.1.2 Gildrulholtsagjá (aka Gil)

Gildrulholtsagjá is a site located about a 45-minute hike from a spot of land above a house near Lake Þingvallavatn in Þingvellir National Park. The hike goes along a wide dirt path, and then off trail. The scarp is located about 2.7 km northeast of the northeast corner of the Lake Þingvallavatn (See Fig. 2). The scarp strikes about 065˚-245˚ (east northeast-west southwest) on the northeast side of the scarp and 035˚-215˚ (north northeast-south southwest) on the southwest side of the scarp. Two domains were analyzed, Domain 1 (Fig. D.13.) near the northeast side and Domain 2 (Fig. D.14.) near the southwest side. The two domains total an area of approximately 426.7 m^2.

12.2.1.2.1 Gildrulholtsagjá Domain 1

Domain 1 (D1), covering 142.4 m^2 on the northeast side of the scarp, consists of 83% intact rock and 17% rocky talus (Fig. D.15.). The domain is at the top of the scarp. The domain consists of four subdomains, divided by sub-horizontal joints, the first of which is only present in the center of the domain. The discontinuity focused on the central area of the domain, marked by the box in Figure D.16.. Beneath the domain is a tall section of talus slope covered in moss and grass. The talus slope makes up most of the height of the scarp (Fig. D.16.). Figure D.15. shows locations and boundaries of the domain, colored geomorphic units, block edges, and measurements.

Subdomain 1 (D1 SD1), located only in the center of the domain is section more finely fractured and weathered than the rest of the domain. It has a height of about 1.85 m underneath an overhang of the subdomain above it (Fig. 19). Blocks are not of uniform size, shape, or orientation. The edges of the blocks are not sharp and have a rounded appearance in many blocks. The rock has the appearance of being jumbled or forming in an altered state (Fig. D.17.). Height of blocks range from 0.1 to 0.55 m, and widths range from 0.1 to 0.7 m, both average tending towards the lower values. Orange weathering is persistent on the northeast side of D1 SD1 (Fig. 19). Surficial features, often red, ropey or bluish tinted features originally formed at the surface of a flow, are ropey and red-colored in Figure 16. The rock is typically very vesicular. Lichen is present at greatest concentration near the intersection with subdomain 2.

The shelf forming the overhang above D1 SD1 is made by the single massive layer of subdomain 2 (D1 SD2). The layer is 1.96 m thick and has about 0.42 blocks/m. Fractures are typically conchoidal (Fig. D.18. and Figure D.19.). The joint surfaces are smooth. The large block thicknesses are only broken by fractures occasionally. Where exposed, the top of the layer is covered in moss, however most of the rock faces have very little lichen or other growth. Some areas have darkened staining associated with potential water staining (e.g. Fig. 19 right side). Only minor amount of other orange staining is present. This layer has the most open joints (e.g. Fig. D.19. and Figure 12). There are very few vesicles in this unit. From approximation from afar, the top joint face appears to dip 2˚ to the northeast, and dips downslope.

Above the massive blocks of D1 SD2 are slightly smaller blocks (0.79 blocks/m) of domain 3 (D1 SD3). The unit, about 1.47 m thick, is typically made of one layer, though sub-horizontal fractures occasionally make the blocks two high. The blocks are slightly less organized than the subdomain below, and the joint dividing the two is not always horizontal. The sub-vertical joints are straighter, rather than conchoidal, though still conchoidal in places. Overall, the blocks are fairly cube-like. Lichen is more present in this subdomain than either of the two below it. This layer appears as if not much motion would be required to cause toppling or sliding blocks.

At the top of the scarp, subdomain 4 (D1 SD4) has columnar joints, making an average of 1.68 columns/m, with a thickness of about 1.02 m. Mostly columns reach the full thickness of the unit, but in locations such as Figure D.20., a horizontal joint divides the columns in about equal two. Lichen coverage is more than the rest of the subdomains of D1, however, it is still at a moderate level. No significant weathering was observed. To the northeast, just beyond the extent of the domain, the columns of D1 SD4 can be seen toppling away from the rock face (Fig. D.18.). This layer appears as if not much motion would be required to cause toppling or sliding blocks.

12.2.1.2.2 Gildrulholtsagjá Domain 2

Domain 2 (D2) is broken into five horizontally delineated subdomains, including the talus slope at the base of the scarp. The domain has an area of 284.3 m^2, 49.1% of which is rocky talus, 47.7% of which is intact rock, and 3.2% of which is grassy slope. This intact rock of the domain is rather chaotic, with few persistent patterns, joints or sizes of blocks. The orthophoto marking the domain, geomorphology, block edges are presented in Figure D.21..

Subdomain 1 (D2 SD2) is the large talus pile at the base of the intact rock face, built up higher on the southwest side. It consists of a gradation of boulder sizes, smaller near the rock face, and southwest side, and increasing in size downslope and to the northeast side (Fig. D.22.). Block sizes range from 0.09 m to 2.56 m with an average of 0.65 m based on 65 measurements from the orthophoto. Within the area closest to the rock face, the average block size is 0.21 m. Further downslope, the average block size is 0.99 m.

Above the rocky talus, subdomain 2 (D2 SD2) is a mostly vertical intact rock face, about 7.73 m tall at maximum height. Patterns are isolated and non-persistent. Block sizes are highly variable (Fig. D.22.), with heights ranging from 0.09 to 1.27 m and widths ranging from 0.12 to 2.09 m. Very few joints are persistent in the subdomain. Although most joints are sub-horizontal or sub-vertical regularly, a number aren't, and many do not connect. Many joints are surrounded by vesicular material (Fig. 14) and surficial features (Fig. 16). A section on the southwest side of the domain slopes from the top of the subdomain about 2/3 of the way down the slope. This section is rubbly and partially covered in grass. Orange stained weathered areas are present on this slope and a few other locations. The orange staining may be a coating due to falling rubble from the subdomain above.

Subdomain 3 (D2 SD3) slopes back from the top of subdomain 2 to the bottom of subdomain 4. The unit is about 4.40 m thick. It is covered in small, loose rubble with significant amounts of orange weathering staining. Rubble diameter ranges from 0.08 to 1.05 m, with an average of 0.28 m based on 55 measurements from the orthophoto. Some

rubble is covered by moss, and some areas are covered by small grass tufts and bare red-brown fines.

The next sub-vertical face, subdomain 4 (D2 SD4), like D2 SD2, lacks patterns, and is even less blocky than the subdomains below. A lava tube surrounded by alterations is present in the top center of the subdomain. The thickness of this unit is about 1.24 m except in the area of the lava tube, where it is about 2.11 m. A few large, but fractured, blocks are within the subdomain.

Subdomain 5 (D2 SD5), present above and to the northeast of the lava tube is the only consistently blocky or columnar subdomain within D2. There are approximately 1.30 blocks/m of about 1.66 m height. The joints appear planar to conchoidal.

12.2.2 Vogar Sites

Nydri-Mosadalgjá and Stóra-Aragjá sites are sections of scarps located southeast of the town of Vogar on the Reykjanes Peninsula (Fig. 1 and Figure 2). From the unpaved section of road 420, going southwest of Vogar, there is a small offshoot to the south of the road that has a small structure where we parked. The two sites, Nydri-Mosadalgjá and Stóra-Aragjá, face north-northwest.

12.2.2.1 Nydri-Mosadalgjá (aka Vogar A)

Stóra-Aragjá is about a 30-minute hike to the southeast from the parking location. The scarp is located about 4 km southeast of Vogar (Fig. 2). The scarp strikes an approximate 060-240. It consists of four domains, which mostly consist primarily of intact rock (Fig. D.23.). Figure 8 is a better-quality version of the part of Figure D.23. including the orthophoto.

12.2.2.1.1 Nydri-Mosadalgjá Domain 1

Domain 1 (D1) is a section of intact near-vertical rock face that is backset from the rest of the scarp. The 134.1 m^2 area visible in the orthophoto is 100% intact rock. There are frequent inconsistent appearances within the different subdomains and horizontal discontinuities of the subdomains. The subdomains, of which there are six, are distinguished by relatively horizontal divisions. Within the subdomains, joints are typically sub-vertical or sub-horizontal. The rock faces look relatively fresh, with very little lichen growth. Talus at the bottom of the domain, later described as domain 1A, is covered in moss and grass. I conducted a discontinuity survey at an approximately 3 m swath of the domain on the southwest side (Fig. D.24.)

The lowest subdomain, subdomain 1 (D1 SD1) consists of three relatively horizontal layers about 4.1m thick in total. The bottom layer of the subdomain, about 1.99 m thick, has about 1.56 blocks/m, which have a columnar appearance. The joints are not through-going. Vesicle density in this layer indicated the flow boundary direction as upwards, where surficial features were observed. Near the top of the bottom layer, the columns sometimes further divide into smaller columns of about 2.01 blocks/m. The middle layer, with an approximate average thickness of 2.08 m, is horizontally variable going from thin and fairly amorphous on the northeastern side of the domain to thick and more defined joint patterns on the southwestern side. On the southwestern side of the domain, finer joints develop out of top of the larger well-defined blocks resulting in the appearance of two layers in isolated

spots. The larger blocks have 0.58 blocks/m whereas the smaller ones are 2.94 blocks/m. The top layer is more uniformly massive, although has smaller blocks than the larger ones produced in the middle layer. Overall this subdomain is relatively massive in nature. The. The subdomain above has more finely spaced joints.

Above D1 SD1, subdomain 2 (D1 SD2) is one approximately 0.53 m thick layer of finely jointed columns resulting in 3.8 to 5.1 blocks/m. The layer is horizontally discontinuous, and not found on the southwestern side of the domain. Spacing of the joints is variable.

Subdomain 3 (D1 SD3) above D1 SD2 is one layer approximately 0.87 m tall. The subdomain is relatively amorphous without patterns, except for a semi-massive blocky section on the northeast side of the domain, where there are a few defined blocks with about 1.12 blocks/m.

Subdomain 4 (D1 SD4), like D1 SD2 is a short, finely jointed layer. It can be up to 0.51 m thick, although it has variable thickness, pinching out just southwest of where the discontinuity survey was conducted and then returning to a similar thickness further southwest, tracing subdomain 5. It has about 1.62 blocks/m on the northeast side, and about 3.43 blocks/m on the southwest side.

Subdomain 5 (D1 SD5) is a lens-shaped section, at the height of which D1 SD4 below it is pinched out temporarily. The maximum thickness is about 1.8 m. The patterns within the subdomain are overall massive, having about 0.35 blocks/m in middle, and smaller blocks of broken material, about 0.5 m in diameter, to either side of the more uniform section of the lens.

To the northeast of the D1 SD5 lens at the top of the scarp, horizontally oriented, relatively finely jointed columns about 1 m in thickness make up subdomain 6 (D1 SD6). There are 1.27-1.43 blocks/m.

12.2.2.1.2 Nydri-Mosadalgjá Domain 1A

The 179.1 m^2 area immediately below and in front of D1 is made of 100% rocky talus. The rock is covered by much grass and moss in some sections, and rockier in others. Of 38 diameter measurements of talus made from the orthophoto, 0.39 m is the minimum size, 2.81 m the largest size, and 1.17 m the average size.

12.2.2.1.3 Nydri-Mosadalgjá Domain 2

The tall, 348.6 m^2 area of domain 2 (D2) is made of 100% intact rock, divided by relatively horizontal layers with relatively vertical joint sets (Fig. D.25.). A large chasm is open behind D2 (Fig. D.26.), visible from near discontinuity survey of D1. An approximately 4 m wide discontinuity survey was conducted on the northeast side of the domain, adjacent to the fissure at the base of the rock face (Fig. D.25.). The free face, with no backset or talus, is covered in lichen. A large flow boundary that bends towards either edge of the domain slightly, appears to dip out of the face slightly to the east. That the flow boundary captures the downward trajectory on either side of the domain may indicate the domain captured a near-complete cross section of a lobe of a flow. Other sections are more pillowy and altered, especially near the lava tube. Some shallow cutting columnar joints sections are present. Looking into the fissure, the vertical rock face is undercut at the base (Fig. D.27.). Where the lower subdomains become discontinuous near the center of the domain is an area where surficial features, discoloration and alterations may be seen, which I think

potentially indicate presence of a lava tube, although it is not known and evidence for a lava tube is otherwise unclear.

The bottom most subdomain, subdomain 0 (D2 SD0) starts as amorphous, non-patterned and variably sized blocks, and continues to include anything going into the fissure at the base of the domain.

Subdomain 1 (D2 SD1) marks the lowest subdomain with clear patterns. There is one row of columns, of horizontally variable thickness, spacing and orientation, and discontinuous in the middle of the domain. The upper bounding flow boundary dips down along strike near the edges of each side of the domain. The columns, about 1.2 m tall, formed perpendicular to the top flow boundary. Columns are about 1.2 m tall. In the discontinuity survey area, there are 2.45 blocks/m. There are 2.00 and 2.49 blocks/m in two locations in the center and southwest sections of the domain.

Two similar rows of blocky-jointed rock of about equal thickness make up subdomain 2 (D2 SD2). The thickness of D2 SD2 is 1.3 m in total. The bottom row has 0.87 blocks/m, and the top row has 1.54 to 1.65 blocks/m. The joints are not particularly strong or through-going. The pattern of these layers is horizontally discontinuous. Locating the pattern on the southwest side of the domain is unsure. To the northeast side, a lava tube with its associated rock formations and alterations bounds D2 SD2.

Subdomain 3 (D2 SD3) consists of three relatively horizontal layers. The total thickness of D2 SD3 is about 2.5 m. The bottom layer, about 1 m thick, is separated from the middle layer by discontinuous horizontal jointing. The middle is differentiated from the top layer mostly by the change in character of the jointing, since differentiating horizontal jointing is absent in most areas of the boundary. Where the horizontal jointing between layers is regularly unclear, the boundary is represented by a dashed line on the orthophoto (Fig. D.25.). Both the middle and top layers have an average thickness of 0.78 m. Although the thickness measurements given above are the best average estimates, thicknesses of the layers vary, especially in the top two layers. In some areas, namely the middle of the domain and the far northeast side of the domain, it is difficult to trace each layer across the domain. The bottom and middle layers are much blockier, having about 0.69 blocks/m, and 0.79 blocks/meter in the northeast and 1.27 blocks/m in the southwest respectively. The top layer has finely spaced, non-through-cutting columnar joints with about 3.47 blocks/m on the northeast side and 2.91 blocks/m on the southwest side. In each layer, block sizes vary. These layers are heavily lichen-covered in the northeast, and fairly free of lichen in the southwest where the scarp face curves back towards D1 some.

Subdomain 4 (D2 SD4) is about 2.2 m thick in the discontinuity survey area, though thickness is highly variable, thickening to the southwest, having a maximum thickness of about 3.45 m. In the area of the discontinuity survey, the bottom of the subdomain has a horizontal blocky row with an average of about 1.82 blocks/m. Some other areas of the subdomain have small sections of uniform block spacing, but most of D2 SD4 does not fit in horizontal layers with clear blocks. Sizes of blocks or pieces of blocks are variable in size and shape. The subdomain is highly variable horizontally and vertically. The block sizes range from 0.16 to 0.83 m.

In subdomain 5 (D2 SD5), although not completely well arranged and organized, rocks are more orderly in layers with sub-vertical joints than in the subdomain below. D2 SD4 runs across the top of the domain, sometimes with one layer, and sometimes with two. In a couple of isolated locations, columnar jointing is present, having about 1.83 blocks/m. The more typical jointing results in about 0.74 to 0.96 blocks/m.

12.2.2.1.4 Nydri-Mosadalgjá Domain 3

The 353.0 m^2 area of domain 3 (D3), the most geomorphically diverse domain at Nydri-Mosadalgjá, is about 45% intact rock, 35% rocky talus, and 19% grassy slope. The intact rock has one protruding section and a relatively wedge-shaped section backset to the northeast (Fig. D.23.). The rocky talus and grassy slope lay beneath the intact rock. The discontinuity survey in this domain was conducted on the northeast side of the forward protrusion. On the southwestern side of the protrusion, large open gaps that look ready to fall are visible (Fig. D.28.). The sub-horizontal bed by the open gaps dips about 5˚ out of rock face. Rock surfaces in subdomains 0 through 4 are mostly clear of lichen, whereas subdomains 5 through 7 have moderate lichen coverage. Patterns from the protruding section are lost in some areas in the backset face. Within the subdomains, joints are typically sub-vertical or sub-horizontal.

Not included in the discontinuity survey, subdomain 0 (D3 SD0), is made of very large, poorly-defined blocks with some additional jointing within the blocks. There are 0.37 blocks/m, with a thickness of about 2.07 m. These blocks, at the base of the outcrop, are not well defined.

Subdomain 1 (D3 SD1) is made of a 1.07 m tall row of columnar joints that form about 2.25 columns/m. There is only a small amount of variation in the spacing of the columns. The columns develop out of the D3 SD0, with no horizontal joint set.

Subdomain 2 (D3 SD2) is composed of a lava tube and the area immediately surrounding it that experienced alterations and non-square blocks that orient themselves around the lava tube. Blocks are about 0.07 to 0.73 m big in diameter. There is no organization into columns or rows.

Only visible above the lava tube of D3 SD2, Subdomain 3 (D3 SD3) is composed of two short, equally thick rows of finely spaced columns. The subdomain is a total of about 0.43 m thick, with each row about 0.21 m tall. There are about 4.31 blocks/m. The unit pinches out to the southwest and is not visible in the backset wall to the northeast.

Above D3 SD3, Subdomain 4 (D3 SD4) two rows, about 1 m thick on bottom and 0.7 m on top, are blockier and less columnar than the surrounding subdomains. There are about 1.01 blocks/m in the bottom layer, of variable size, and 1.43 to 1.59 blocks/m in the top row. Blocks sizes are more variable in the top row. Joints are relatively planar, but more conchoidal in the lower row.

Subdomain 5 (D3 SD5), like D3 SD3 is made of short, fine columns. The single layer is about 0.51 m tall and has 4.66 blocks/m on the northeast side and of the domain and 3.07 blocks/m on the southwest side. This subdomain is the first subdomain in D3 to have any significant amount of lichen. The subdomain fades from visibility on the edges of the domain.

Although overall considered two layers, the layers of subdomain 6 (D3 SD6) are very different in character. Only the top layer has well-defined enough joints to measure. Those joints result in about 1.33 blocks/m of 0.96 m thickness. The bottom layer, about 0.8 m tall, does not have any clear, prominent jointing patterns. It has a more disjointed and broken-up appearance. This subdomain has the most lichen coverage of all the subdomains in domain 3.

Covering the very top of the outcrop in very select locations, columnar jointed rock of subdomain 7 (D3 SD7) is approximately 0.64 m tall. The northeast side has about 2.42 blocks/m and the southwest side has about 4.63 blocks/m. Most of the top of the scarp does not have clear patterns. Only some lichen covers the subdomain.

12.2.2.1.5 Nydri-Mosadalgjá Domain 4

Of the 374.0 m^2 area of domain 4 (D4), 92% is intact rock and 8% rocky talus. The domain is composed of a vertical free face of rock immediately west of a talus slope spanning the height of the scarp. The scarp face is relatively flat in this domain. The discontinuity survey was conducted on a slightly backset section on the northeast edge of the domain, and evaluated subdomains 1 through 5. Overall, subdomains 0A through subdomain 4 are three repeated sequences of small columnar blocks forming out of the top of more massive, large blocks. Some orange staining and tinting was observed in the discontinuity survey area. Near the top of the southwest section of the domain, near the intersection with domain 3, evidence of water seepage is present. Although very little lichen in the domain, some lichen is present, especially in the top central portion of the domain.

Subdomain 0A (D4 SD0A) was not included in the discontinuity survey, and therefore named after returning from the field. It is the lowest section, and very slightly southwest of where the discontinuity survey was conducted. Large blocky boulders fade into the subdomain above without horizontal joints. Within the 1.92 m tall layer of large boulders, there are about 0.74 blocks/m. The face is fairly free of lichen.

Also named after the return from the field, subdomain 0B (D4 SD0B) subdivides out of D4 SD0A below. It makes one layer of columns, with about 2.92 blocks/m of about 1.06 m thickness. In a few columns, the rock further divides into smaller columns near the top of the subdomain. Although not mostly through-cutting, joints are clear. The rock is very slightly tinged with orange, and only a very small amount of lichen is present.

The bottom-most subdomain evaluated in the discontinuity survey, subdomain 1 (D4 SD1) is made of one layer. The layer is blocky, although it becomes more columnar to the southwest. The more columnar section included in this subdomain spans the height of both D4 SD1 and subdomain 2, making it about 1.48 m tall, whereas the layer is only about 0.83 m tall under subdomain 2. The resulting average is 1.50 blocks/m, which would be lower were the columnar section not included. The columnar section is more covered in lichen than the adjacent shorter blocks to the northeast.

Subdomain 2 (D4 SD2) has more columnar structure and more frequent joints, resulting in 2.61 to 2.93 blocks/m. Column spacing is variable and the bottom confining layer has a wave to it, to which columns form perpendicular. The layer is an average of 0.65 m tall. The discontinuity area on the northeast side has an orange tinge and less lichen than the more forward face. The planar to conchoidal joints are not through-cutting.

Similar to D4 SD1, subdomain 3 (D4 SD3) blocks are massive. Two layers are present although there is not clear joint defining the line between them. The entire subdomain is about 2.29 m thick. The bottom layer is about 1.24 m thick, and the top about 1.02 m thick. The line dividing the layers is very faint and not persistent, however it is visible and interpretable in most locations, and characteristics are somewhat different between the two layers to assist in the distinguishing line. Although both massive, the top layer has more closely spaced joints (0.98 blocks/m), whereas the bottom has larger blocks (0.74 blocks/m). Block spacing is variable in both layers. The more forward section has much more lichen coverage. This subdomain continues at the top central area of the domain, although the influence of subdomain 4 above it is greater. Near the top central area of the domain, this subdomain has significant lichen cover. In the top central area, lower massive blocks occur 0.48 blocks/m and the upper layer 0.73 blocks/m.

Developing from the top of SD 3 without a clear and distinct joint defining the boundary, subdomain 4 (D4 SD4) is best defined by a change in joint frequency and appearance. This layer is about 0.5 m thick with columns having 2.40 to 4.29 blocks/m in very close proximity in the northeast section in the discontinuity survey area. This area has minor amounts of orange discoloration and lichen. This subdomain can be traced to the top of the central section of the domain, where columns are more prominent, consistent, and taller. In some areas, it is hard to distinguish the joints between D4 SD3 and D4 SD4. In this top central area, there are 2.55 to 2.83 blocks/m.

Subdomain 5 (D4 SD5) is complicated, with some sections having massive poorly defined blocks (northeast side), some sections that seem more rubbly (central), and some sections with well-defined blocks (southwest side). The domain is about 1.78 m tall and pinches out near the center of the domain, where D4 SD3 and D4 SD4 trace to the top of the domain. The blocks on the northeast side are about 0.71 m tall and may be as big as 2.71 m. Photo quality makes it difficult to determine the smallest size. The rubble in the center of the subdomain ranges from 0.25 to 0.75 m in diameter, with an average of 0.35m based on seven measurements. In the section with well-defined blocks, there are three layers of 0.71, 0.42 and 0.51 m thicknesses from bottom to top respectively. Jointing frequency increases from the bottom to top layer. The frequencies are 1.25, 2.62 and 4.04 blocks/m respectively. All of the blocks have some lichen.

12.2.2.2 Stóra-Aragjá (aka Vogar B)

Stóra-Aragjá is a section of scarp located southeast of the town of Vogar. From the unpaved section of road 420, going southwest of Vogar, there is a small offshoot to the south of the road that has a small structure where we parked. Stóra-Aragjá is about a 45- to 60-minute hike to the southeast from the parking location. The scarp is located about 3.15 km south-southeast of Vogar (Fig. 2). The scarp strikes approximately 060-240.

The area of scarp geomorphically analyzed, extending slightly beyond each domain, and all the area in-between is: 36% intact rock, 42% rocky talus and 22% grassy slope, covering approximately 1263 m^2 (Fig. D.29.). Domain 1, farthest southwest, has a clear vertical rock face, but is has rocky talus at its base and is surrounded by swaths of rocky talus covering the entire slope (chosen for this reason). Domain 2, furthest northeast, is almost entirely vertical rock face, chosen because of some water staining patterns and the fissure at the base of the rock face. The rocky talus has an approximate minimum size of 0.07 m, a

maximum of 1.88 m, and an average of 0.5 m based on 137 measurements across the scarp using the orthophoto (perpendicular to D2).

12.2.2.2.1 Stóra-Aragjá Domain 1

The scarp strikes approximately 060-240 in domain 1 (D1). This 218.5 m^2 domain is composed of 50% intact rock, 41%rocky talus and 9% grassy slope (Fig. D.30.). Intact rock goes from midway up the domain to the top of the scarp. Rocky talus, and some grassy slope are below the intact rock. Some construction materials (Styrofoam and wood with nails) were located in the small grassy section near the center of the domain. Rocky talus sections that cover the full height of the scarp surround the domain on both sides. The intact rock is broken into six relatively horizontal subdomains detailed below. Subdomains 1-3 are only visible in a small, central, part of the domain. Subdomain 5 is lateral discontinuous. The visible subdomains vary laterally, changing in thickness pinching out and reappearing, or seeming to change some in terms of patterns. Measurements were taken in the central section of the domain where subdomains 1-3 were visible.

Subdomain 1 (D1 SD1) is a single, relatively uniform and massive layer about 0.4 m tall. Only one block with a width of about 0.87 m is just barely identifiable. The bounding horizontal joint surfaces dip out of face obliquely. Vertical joint spacing is not consistent. The rock is vesicular.

Entering subdomain 2 (D1 SD2), vesicularity continues: vesicles are larger lower in the subdomain, but there are more vesicles covering greater area in the upper part of the domain. The subdomain has two layers, which help are the division where the vesicle trends are observed. The total height of D1 SD2 is about 0.4 m, of which the two layers are about equal in thickness (0.2 m each). Vertical jointing is more present tan in D1 SD1, although the joints are still not very persistent or clear and have variable strike and dip. The top layer has the most vertical jointing. The bottom layer has few vertical joints (which seem to be continuations of joints from the top layer) resulted in a spacing of 1.09 blocks/m. Although many of the top layer joints are still not clear, persistent or through-cutting, there are more joints, resulting in about 2.67 blocks/m based on photo analysis. The horizontal joints dip out of face by almost 30˚.

Subdomain 3 (D1 SD3) has many difference characteristics from the other subdomains of D1. It is the same thickness, 0.2 m, as each layer of D1 SD1; however, it has many more, and much closer spaced vertical joints that make more columnar joints. Based on photo analysis, it has about 4.19 blocks/m. The joints typically have a tight aperture. It is a single layer of a slightly more blue-gray color than the surrounding subdomains, with some additional orange staining that may in part be a coating of eroded fines. A few of the columns are split half way down their height, and have crushed rock, rubbly fines, and more of the orange coating on their surface (Fig. D.31.). This layer undercuts the overlying subdomain. The boundaries are sub-horizontal, the top of which is a flow boundary. On the under-hang of the top boundary, reddish imprints of the top of a flow are visible (Fig. 13). The flow boundary marks a clear division between the highly vesicular rock in D1 SD3 and the overlying rock.

Subdomain 4 (D1 SD4), much more massive than the subdomains below it, is one 0.9 m tall layer, with large blocks having a frequency of 0.74 to 1.12 blocks/m. To either side of the

central section of the domain, this subdomain and subdomain 6 absorb the height of the pinched-out subdomain 5. The sub-vertical fractures are conchoidal clean or surface-stained planes. The patterns of relative size are overall consistent, but due to the conchoidal joints angles are not, and the wedges formed can result in an inconsistent spacing recorded.

Subdomain 5 (D1 SD5) is locally present near the middle of D1. It consists of one layer, with not particularly consistent spacing, that is about 0.5 m tall. The layer only exists to either side of a rubbly concave bowl cutting back into the rock face and exposes a retreated section subdomain 6 at its back wall (Fig. D.32.). To the southwest of the concave bowl, there are about 1.68 blocks/m. To the northeast of the concave bowl, there are about 0.93 blocks/m. Strike and dip measurements were approximated by aligning clipboard with the joint plane. The joints have apertures of 0.1-1.5".

Subdomain 6 (D1 SD6) also takes on part of D1 D5's height when the lower subdomain becomes discontinuous. Near the center of the domain, D1 SD6 is about 1 m tall, but varies in height along its length. Sometimes the bocks encompass the entire height of the subdomain, but many are also cut by sub-horizontal joints resulting in two sections of rock to reach the top of the scarp, and may be 0.2 to 1.04 m in height. The "sub-horizontal" joints are not all actually horizontal, but more horizontal than vertical, and they are typically not very persistent. The blocks have varying degrees of through-cutting, some of which cut far into the rock, and others of which just define the shape of a column without actually cutting through the rock (e.g. Fig. D.10.). The blocks are taller than they are wide, giving them a columnar appearance. There are about 1.33 to 1.73 blocks/m. The columns splay to either side on the edges of the domain, with toppled rocks on the southwest side of the domain (Fig. D.33.). Both the ends of the domain and the areas where concave bowls are present appear prone to failure given any small amount of energy. The toppled rock and rubbly concave bowl, and other areas of retreat near the top of the domain may be evidence of past failures. One joint that spans the height of D1 SD4 and D1 SD6 is oblique to roughly parallel to the scarp face is filled with cobbles (Fig. D.34.). Vesicularity increases towards the top of the subdomain.

12.2.2.2.2 Stóra-Aragjá Domain 2

The scarp strikes approximately 065-245 in domain 2 (D2). The 79.9 m^2 domain is 98% intact rock and 2% rocky talus (Fig. D.35.). Intact rock goes down into a fissure below ground level, all the way to the top of the scarp. The fissure is filled with fallen rock, and some wood pieces were visible. The domain is broken into five subdomains. The rocky talus, located next to subdomains 4 and 5, is not included in the subdomains.

The first subdomain (D2 SD1), beneath the grass line of the orthophoto, extends down into fissure to an unknown depth. It is filled with fallen rock, and some pieces of wood (Fig. D.36.). The fallen rock is typically large, on the meter or greater scale in its largest dimension.

The second subdomain (D2 SD2) is about 2.6 m thick and consists of two relatively horizontal layers that appear to dip slightly back into the face. The bottom layer is 1.4 m thick and the top 1.2 m thick. The five sub-vertical joints, which have two approximately perpendicular strikes, result in massive blocks with a recurrence of 0.42 blocks/m. The

intersection of D2 SD2 with subdomain 3 defined by a change in jointing characteristics rather than a joint itself. The rock becomes increasingly vesicular from the top of the subdomain through to subdomain 3. From the intersection of D2 SD2 and subdomain 3, seven black watermarks (Fig. 17), five of which are very clear, stain the surface of the rock in conical fashion from their point of origin in small cracks or vesicles. Six of these watermarks are on the southwest side of the domain, where the columns of the above subdomain are well-developed. Moss is growing at the origin point of the water stains (Fig. 18).

Subdomain 3 (D2 SD3) varies laterally, but consists of more finely and regularly spaced vesicular columns, typically as one layer. There are a few locations were some sub-horizontal jointing or fracturing resulted in two layers on the northeast side of the domain. The columnar jointing develops out of the top of D2 SD2 without any defining boundary other than changed jointing characteristics. The top boundary is a well-defined, persistent flow boundary that is approximately horizontal, but dips slightly to either side when tracing way from the center of the domain (Fig. 17). That the flow boundary captures the downward trajectory on either side of the domain may indicate the domain captured a near-complete cross section of a lobe of a flow. The columns splay slightly to either side of the outcrop from the center of the domain, remaining approximately perpendicular to the top boundary. The columns are about 1m tall in the northeast, and about 1.8 m tall in the southwest. The larger columns have 1.55 to 1.95 blocks/m. Some additional jointing near the top of the subdomain in some locations results in in 2.77 to 3.92 blocks/m. Due to the splaying nature of the columns, strike and dip are particularly variable. The spacing of the joints are also variable. Mossy and grassy patches are growing out of cracks (Fig. D.37.). Rubble on either side of the domain makes the rock face difficult to access safely, especially on the southwest side.

Wedge-shaped, subdomain 4 (D2 SD4) protrudes between D2 SD3 and domain 5 midway up the rock face on the northeastern side of the domain. Blocks are small and “jumbled” compared to the rest of the domain. There are no distinct patterns. On average, the wedge is about 1.4 m thick.

Two layers of equal thickness make up the 2.2 m thick subdomain 5 (D2 SD5). This subdomain has the most structured and defined blocky horizontal and vertical jointing in the domain. The top layer has more jointing than the lower layer. Although it was unsafe to get directly to the face of the rock, sighting and approximation were used to collect strike and dip. On the side of the domain, sub-vertical joints parallel to the domain face occurred approximately ever 0.4 to 0.5 m. Horizontal layers appear to dip very slightly out of the face ($\sim 4^{\circ}$); From orthophoto analysis of the front of the domain, there are about 0.81 blocks/m in bottom half of the subdomain, and 1.03 blocks/m in top half (ignoring development of columnar joints in the upper part of two blocks).

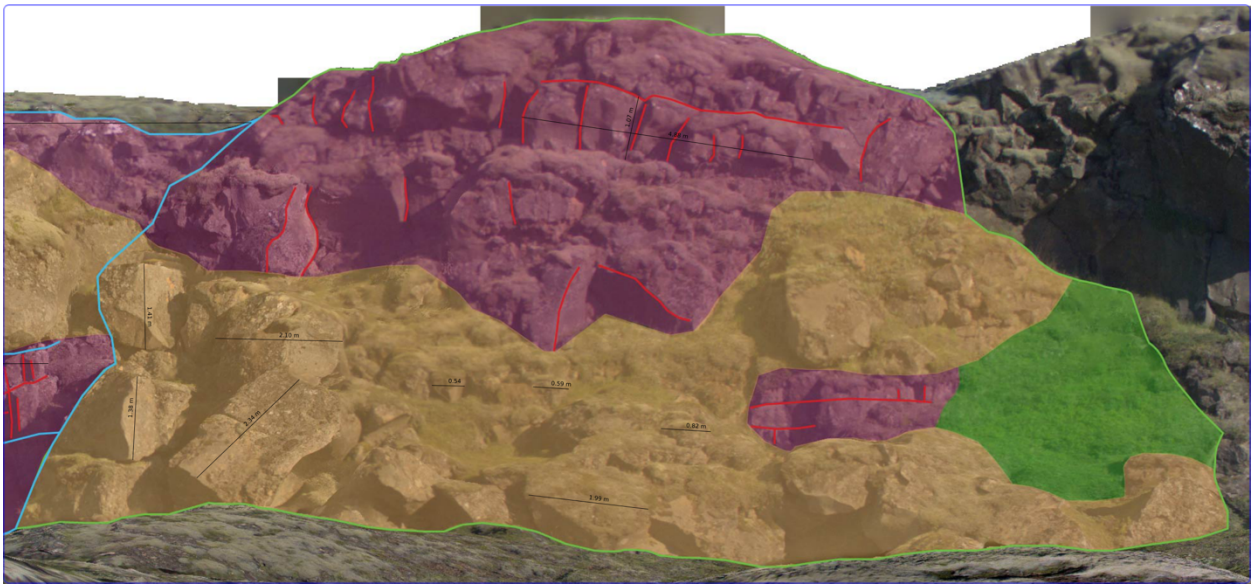


Figure D.1. Hildargjá D1 is divided into two subdomains, marked by the boundary between mostly yellow and mostly pink. Red lines mark joint edges. Black lines measure distances over many blocks (used to determine number of blocks per meter) and talus diameters.

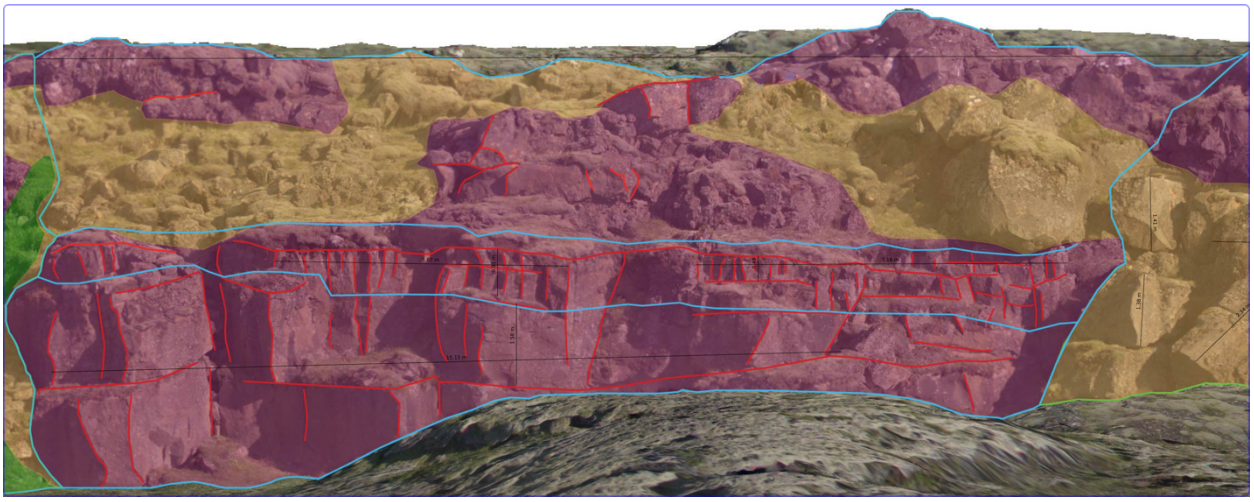


Figure D.2. Hildargjá D2 is broken into four subdomains, three of which can be seen in this image. SD1 is not visible in the image. The horizontal blue lines indicate the boundaries of the subdomains. Red lines mark joint edges. Black lines measure distances over many blocks (used to determine number of blocks per meter) and talus diameters.



Figure D.3. An overview of Hildargjá D2, clearly focusing and SD2 and SD3. Some black staining, visible in the center of the photo, suggests water presence at other times..



Figure D.4. Looking at Hildargjá D2 SD 3 from the southwest side, from the location on the far left at the top of intact rock in Figure D.3. Strike and dip were taken at the crack second from the left.

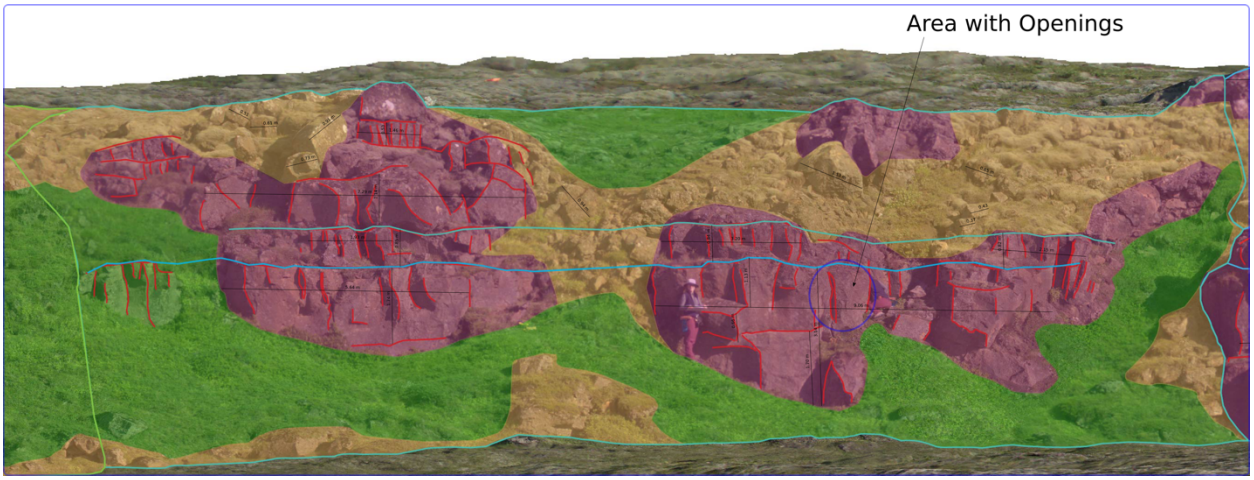


Figure D.5. Hildargjá D3 is broken into three subdomains, boundaries indicated by the horizontal blue lines. Red lines mark joint edges. Black lines measure distances over many blocks (used to determine number of blocks per meter) and talus diameters. This area has open joints parallel to the rock face in the area indicated above.



Figure D.6. Open joints filled with rock, parallel to the rock face in Hildargjá D3 SD1. Location is indicated by the blue circle in Figure D.5..

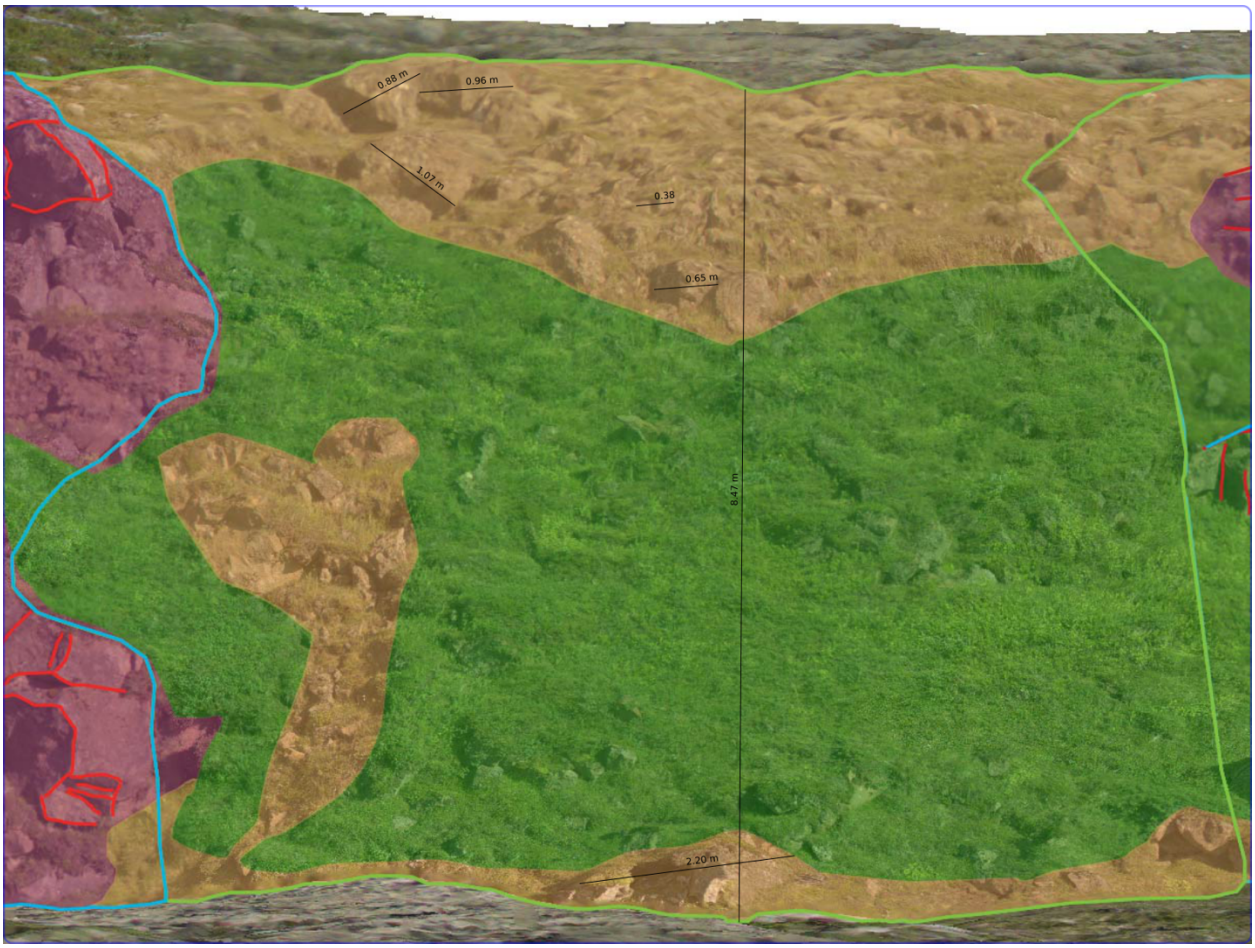


Figure D.7. Hildargjá D4 is covered mostly in grassy slope (green), and some rocky talus (yellow). Black lines measure height of the scarp and talus diameters.

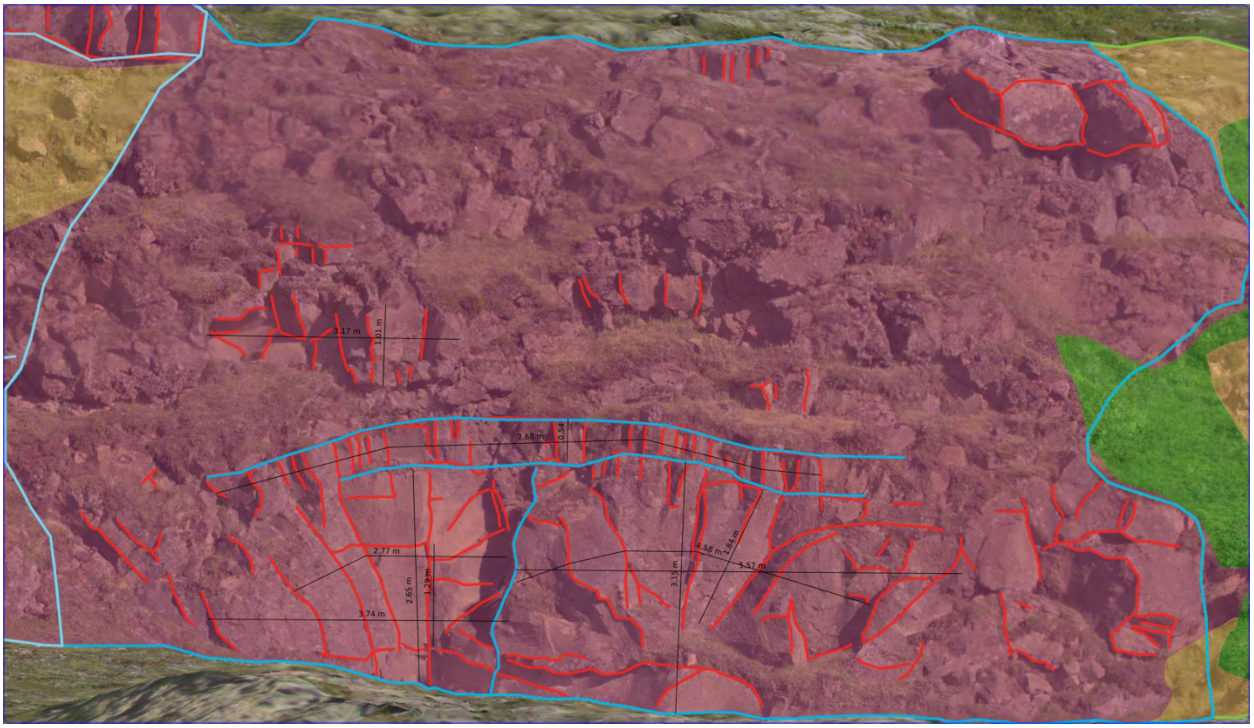


Figure D.8. Hildargjá D5 is broken into five subdomains, four of which are seen in this image. SD3 is below SD2 on the right side of the sub-vertical blue line. Blue lines indicated boundaries between subdomains. Red lines mark joint edges. Black lines measure distances over many blocks (used to determine number of blocks per meter).



Figure D.9. Central-southwest side of Hildargjá D5. The picture centers on the larger blocks of SD2. SD3 is formed by more columnar blocks underlying SD2. SD4 consists of finer blocks overlying SD1 and SD2.



Figure D.10. Close-up of Hildargjá D5 SD3. Column joints are non-persistent – they do not fully cut through the rock.

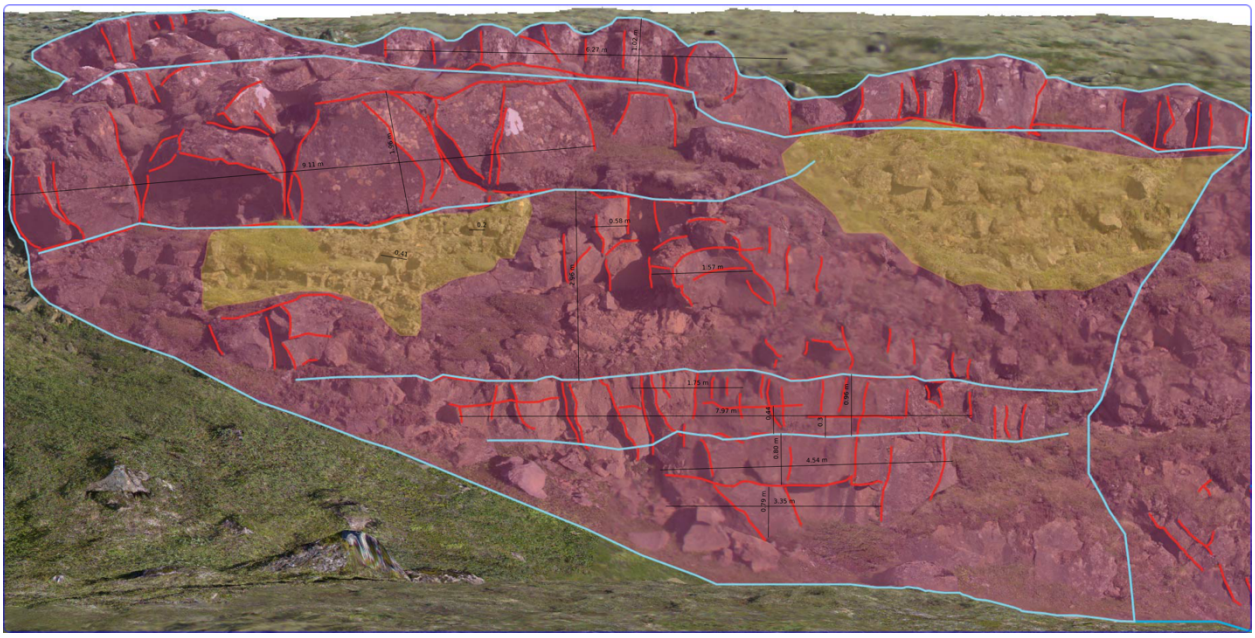


Figure D.11. Hildargjá D6 is broken into five subdomains, boundaries indicated by the horizontal blue lines. Red lines mark joint edges. Black lines measure distances over many blocks (used to determine number of blocks per meter), subdomain heights, and talus diameters. Talus is in the middle of the domain between intact rocks.



Figure D.12. Photo viewing the southwest side of Hildargjá D6 and the northeast side of D5. Black stains, indicating trace water, are visible on the bottom part of the rock face on the left side of the photo.

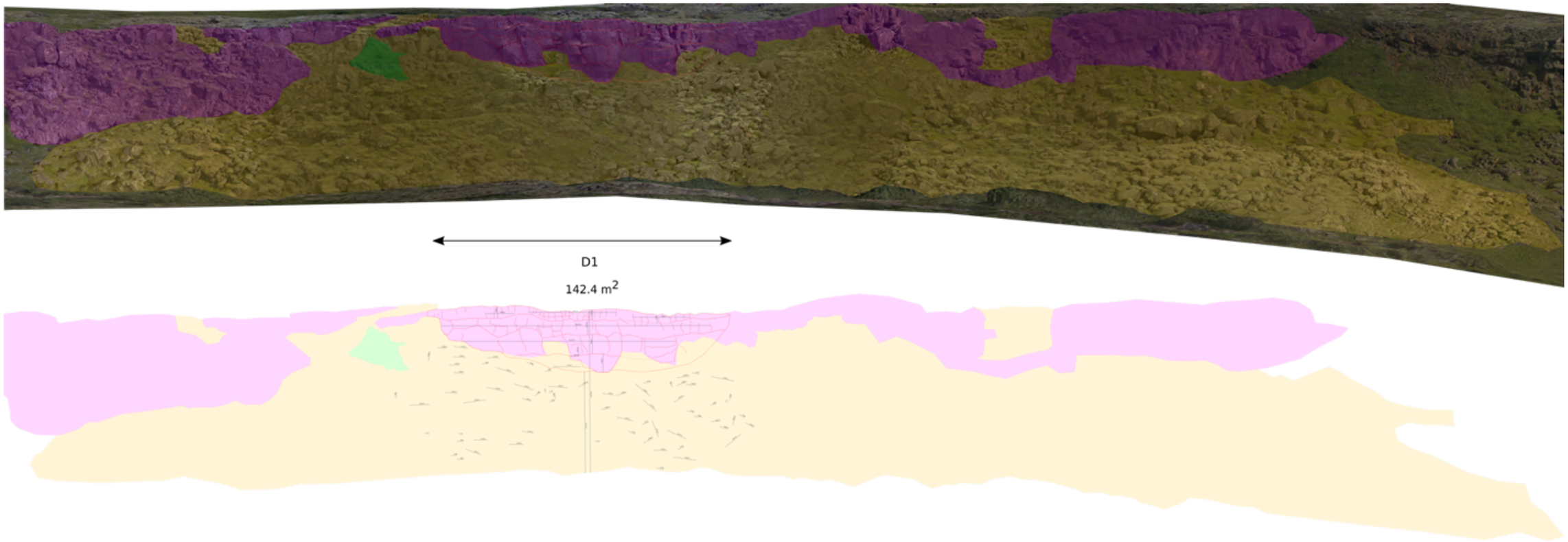


Figure D.13. Gildrulholtsagjá site, area around D1 near the northeast side of the scarp. The image includes the geomorphology mapping where intact rock is pink, rocky talus is yellow and grassy slope is green. Red lines mark block edges. Black lines measure distances over many blocks (used to determine number of blocks per meter), heights, and talus diameters. The top image has the orthophoto underneath the geomorphology and block edges. The bottom does not have the orthophoto to more clearly see measurements and block edges within D1. Measurements for talus were taken below D1.

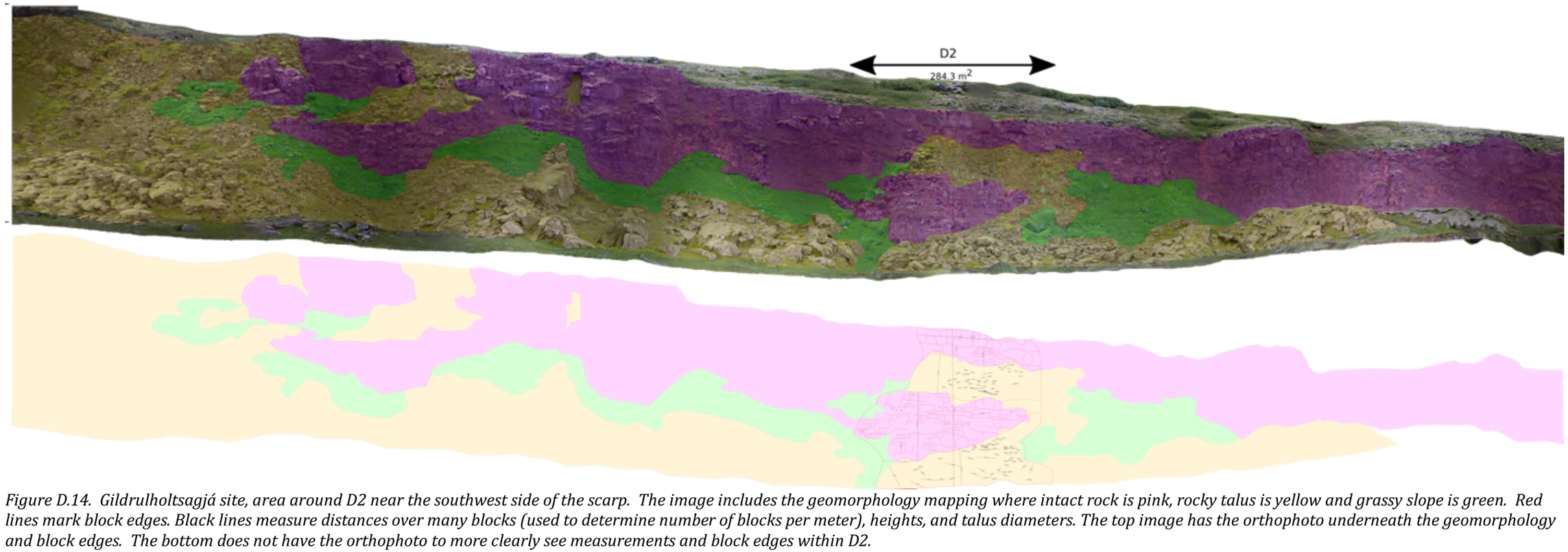


Figure D.14. Gildrulholtsagjá site, area around D2 near the southwest side of the scarp. The image includes the geomorphology mapping where intact rock is pink, rocky talus is yellow and grassy slope is green. Red lines mark block edges. Black lines measure distances over many blocks (used to determine number of blocks per meter), heights, and talus diameters. The top image has the orthophoto underneath the geomorphology and block edges. The bottom does not have the orthophoto to more clearly see measurements and block edges within D2.

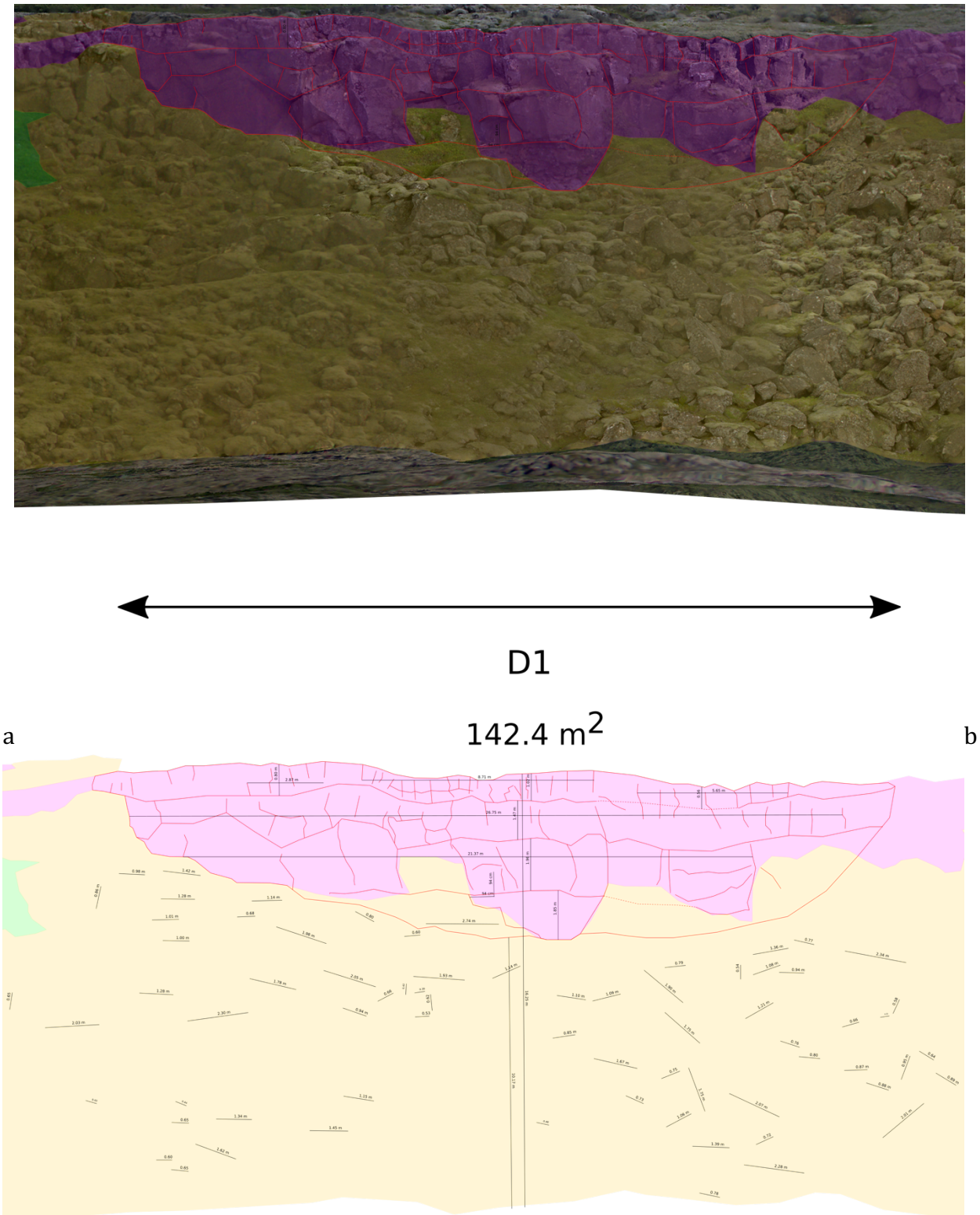


Figure D.15. Close-up of Gildrulholtsagjá D1 from Figure D.13.. More clearly visible are a) the orthophoto with the extent of the domain, and b) measurements marked in black, and red marking block edges.



Figure D.16. The photo shows the area used for the discontinuity survey of Gildrulholtsagjá D1 at the top of the scarp in the red box. Talus accounts for most of the height of the scarp.



Figure D.17. A close-up of Gildrulholtsagjá D1 SD1. The photo shows red to blue discoloration of the rock and small broken-up blocks without clean straight edges or continuous joints. The rock is vesicular. There are not uniform sizes.



Figure D.18. An oblique view looking northeast along Gildrulholtsagjá D1 shows conchoidal fractures at the intersection of the large blocks of SD2.



Figure D.19. A close-up of a conchoidal fracture in Gildrulholtsagjá D1 SD2.



Figure D.20. Photo of Gildrulholtsagjá D1 shows square blocks of SD3 above the large blocks of SD2, and taller and more slender columnar blocks of SD4. Blocks of SD4 are typically one layer thick, although a sub-horizontal joint divides the columns in half in this photo.

Figure D.21.a

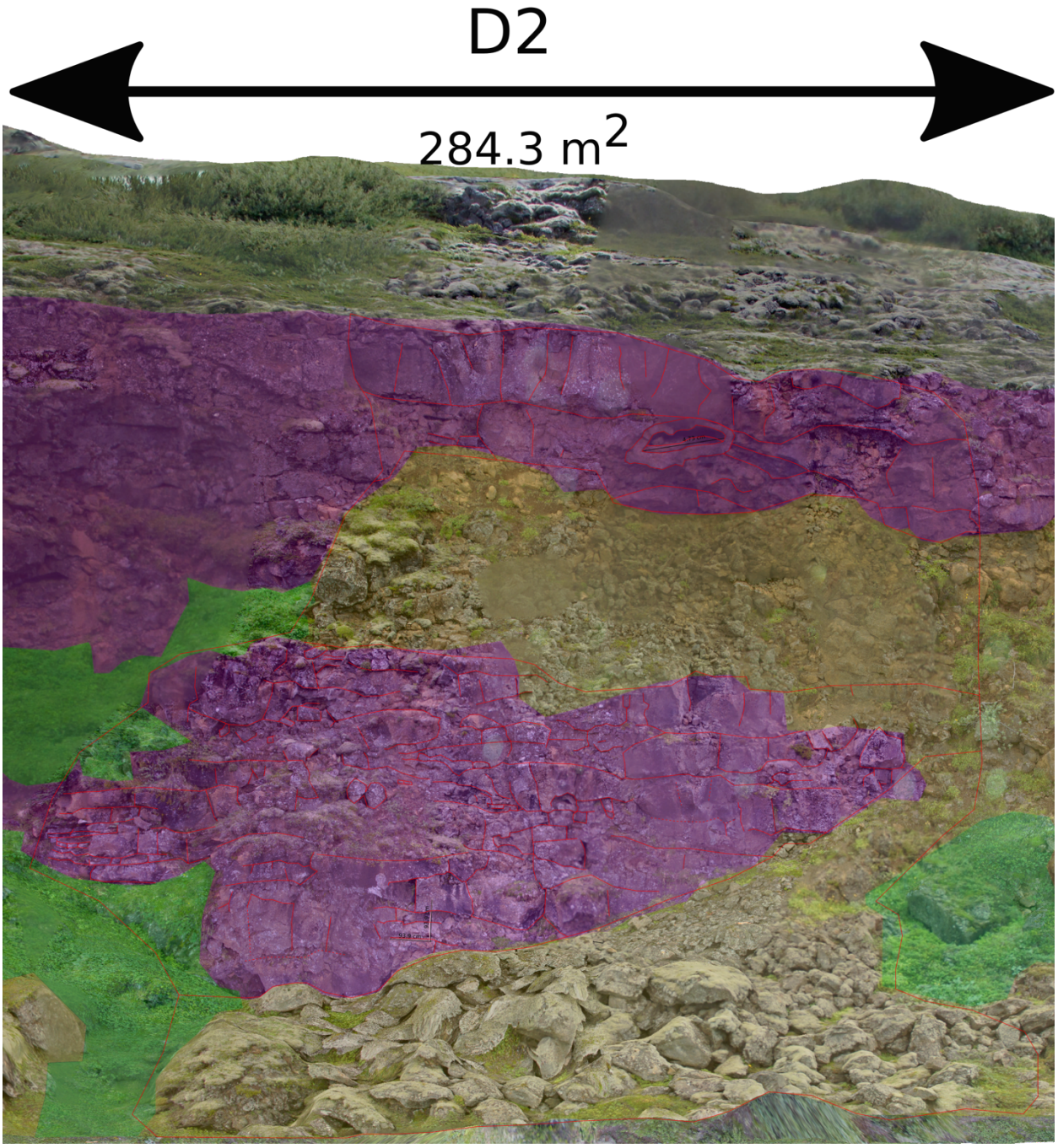


Figure D.21.b

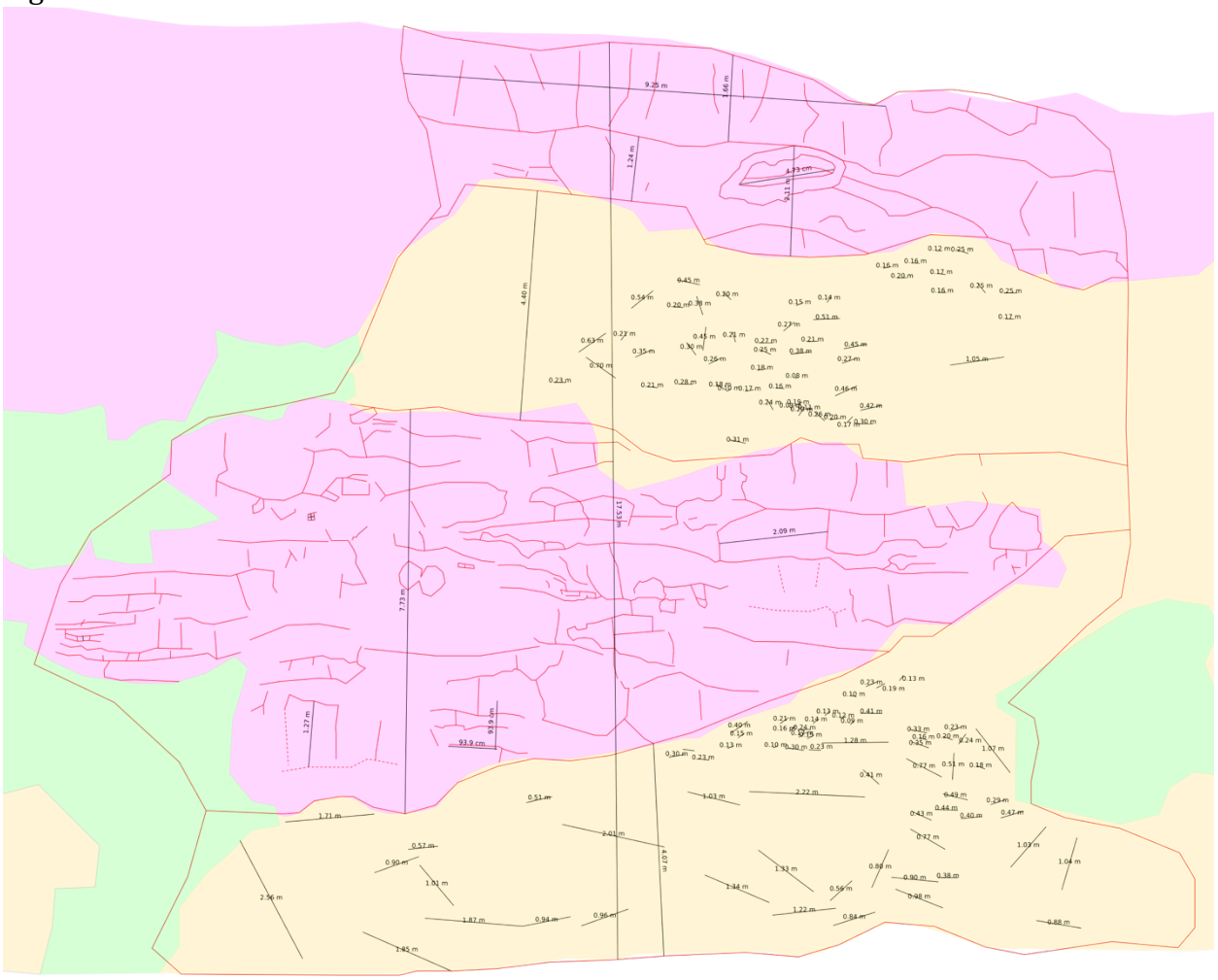


Figure D.21. A close-up of Gildrulholtsagjá D2 photo analysis process includes a) geomorphology, block edges, orthophoto and b) measurements overlaying block edges and geomorphology.



Figure D.22. The photo shows Gildrulholtsagjá D2. The talus diameter increases downslope and to the northeast. The intact blocks do not have clear patterns. A lava tube is near the top of the scarp. Underneath the lava tube is a section of slope covered in fine talus.

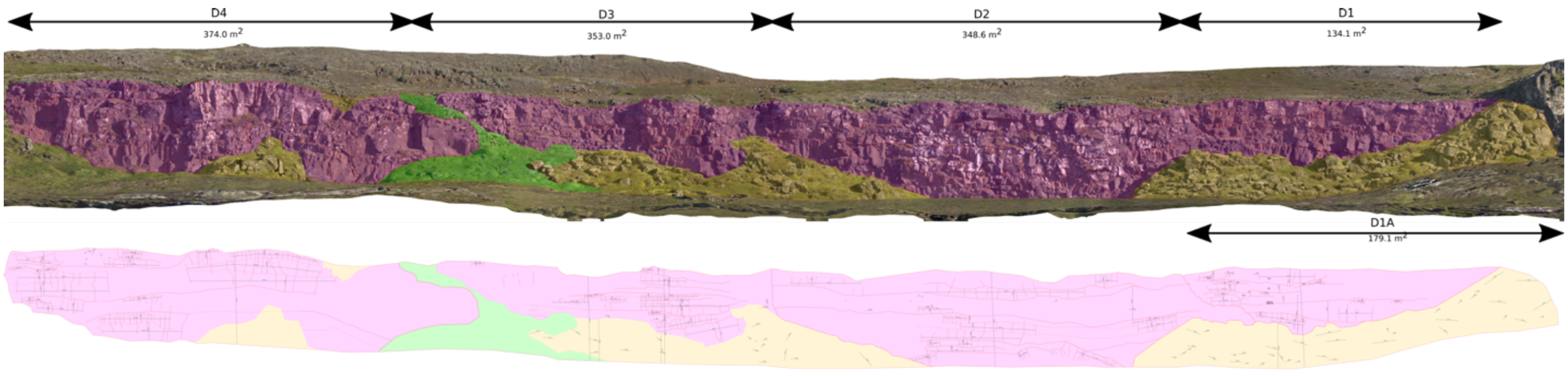


Figure D.23. Presentation of Nydri-Mosadalgjá orthophoto analysis. The image includes the geomorphology mapping where intact rock is pink, rocky talus is yellow and grassy slope is green. Red lines mark block edges. Black lines measure distances over many blocks (used to determine number of blocks per meter), heights, and talus diameters. The top image has the orthophoto underneath the geomorphology and block edges. The bottom does not have the orthophoto to more clearly see measurements and block edges.

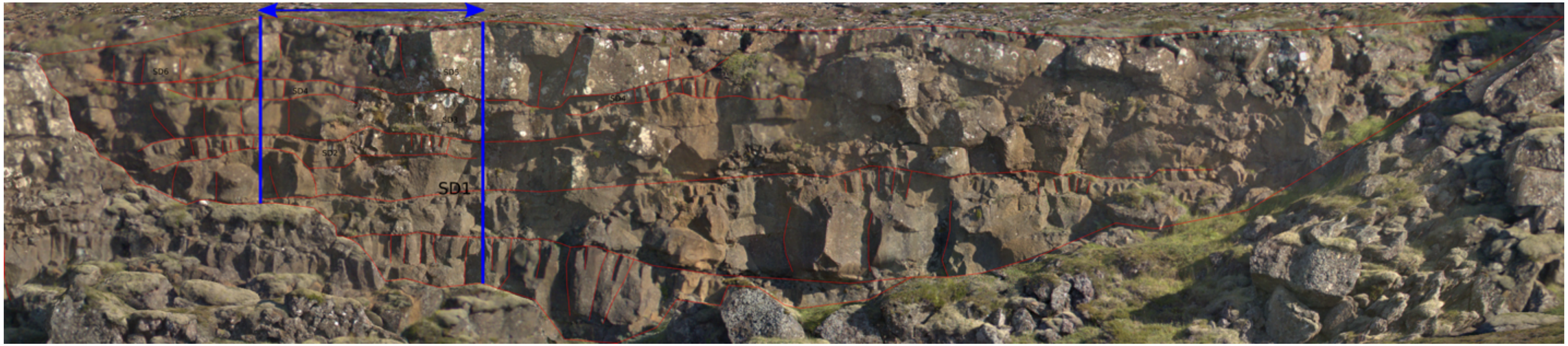


Figure D.24. Nydri-Mosadalgjá D1 figure with discontinuity survey swath bounded by blue lines. Block edges marked with red lines.

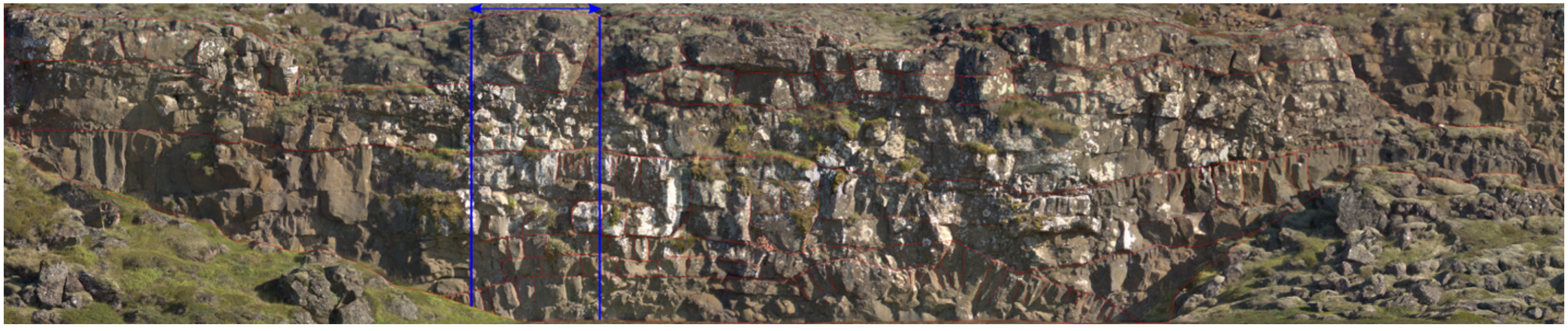


Figure D.25. Nydri-Mosadalgjá D2 with discontinuity survey swath bounded by blue lines. Block edges marked with red lines. In the middle, if zoomed in, can see horizontal dashed red lines.

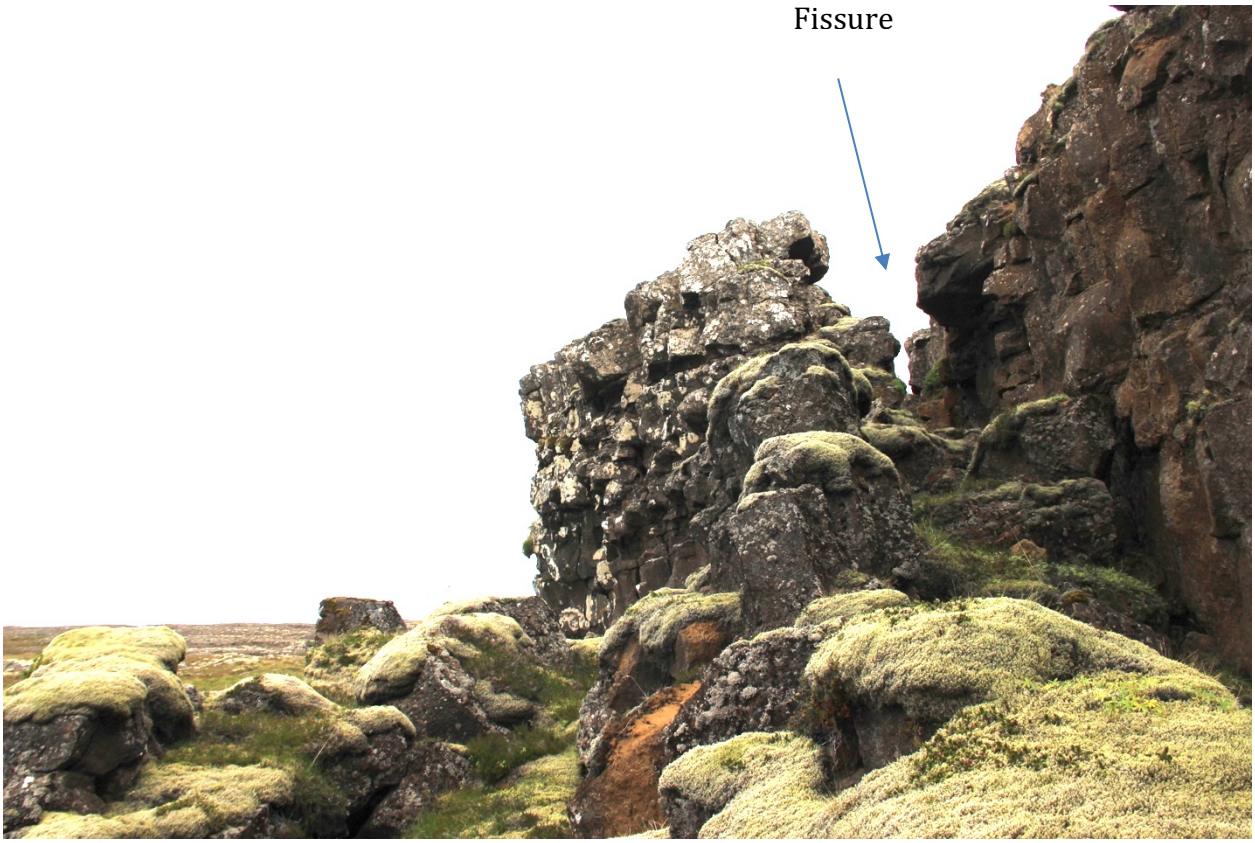


Figure D.26. Open fissure behind Nydri-Mosadalgjá D2 (left side of photo) viewed from D1 (right side of photo).

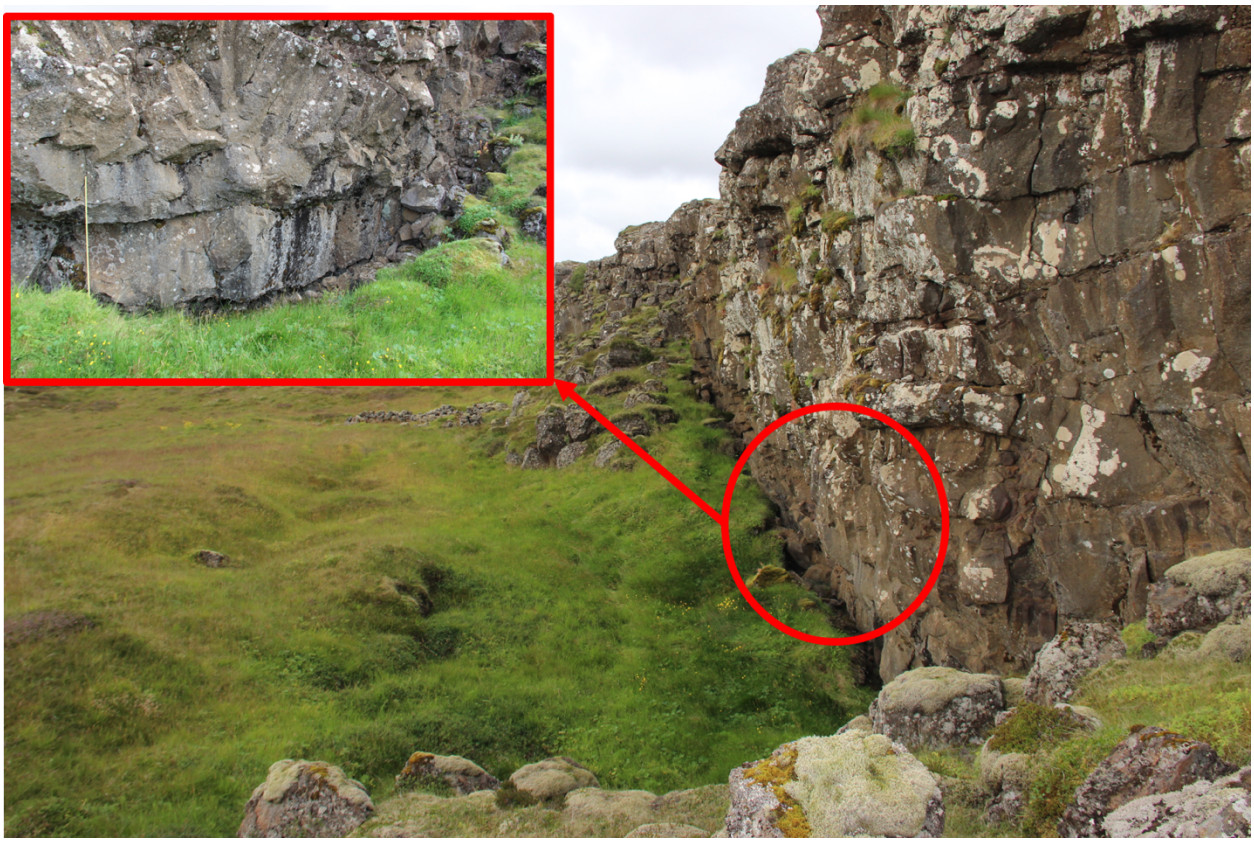


Figure D.27. Photo shows undercutting at the base of Nydri-Mosadalgjá D2. Large picture is view of D2 from the southwest side, clearly showing the fissure at the base. The inset image shows some undercutting at the base of the rock face.



Figure D.28. Open joint on the southwest side of Nydri-Mosadalgjá D3, that appears about ready to fall off the front of the rock face.

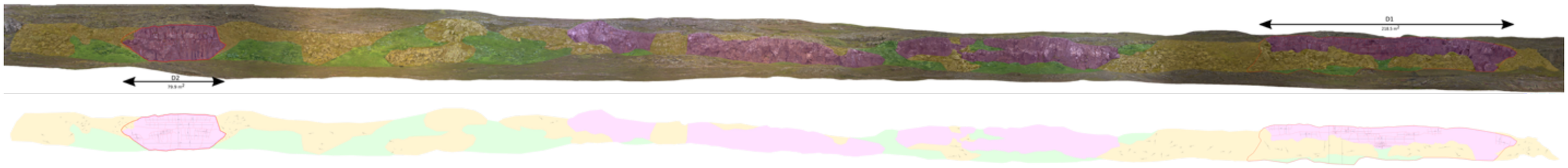
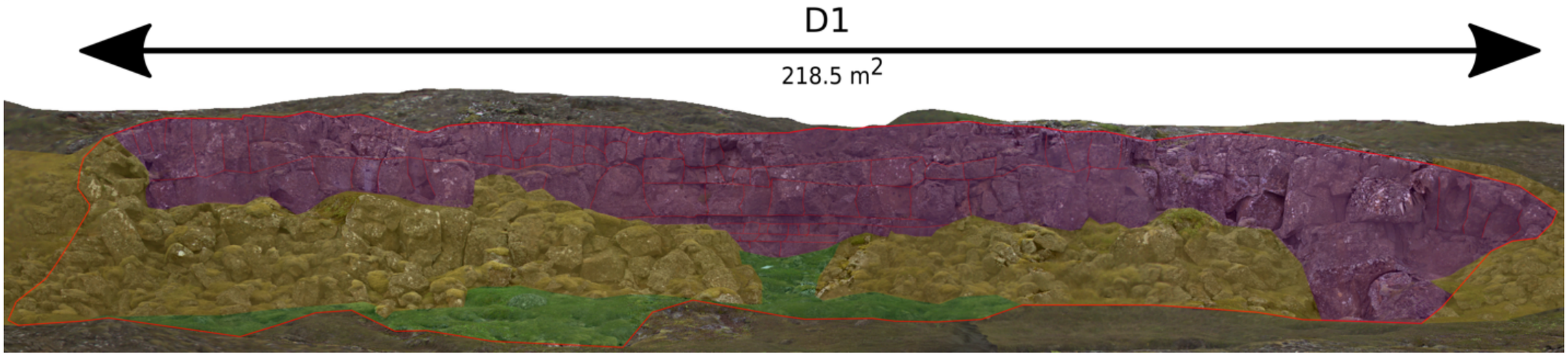


Figure D.29. Presentation of Stóra-Aragjá orthophoto analysis. The image includes the geomorphology mapping where intact rock is pink, rocky talus is yellow and grassy slope is green. Red lines mark block edges. Black lines measure distances over many blocks (used to determine number of blocks per meter), heights, and talus diameters. The top image has the orthophoto underneath the geomorphology and block edges. The bottom does not have the orthophoto to more clearly see measurements and block edges

a



b

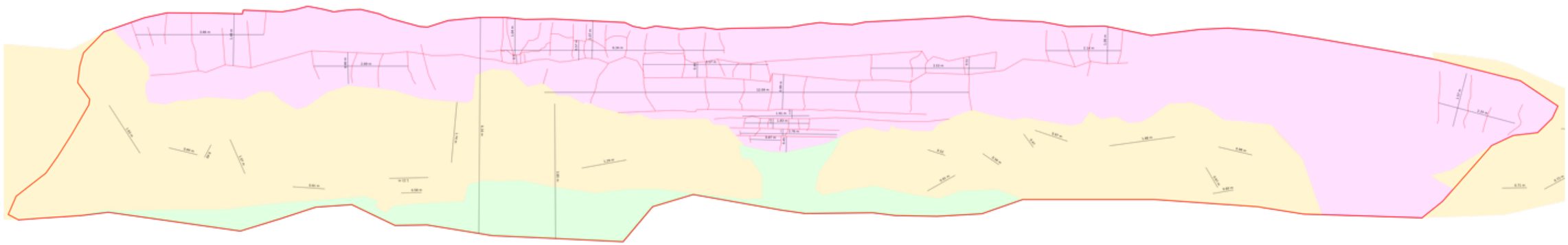


Figure D.30. A subsection of Stóra-Aragjá from Figure D.29., focused on D1 more clearly shows a) the orthophoto, geomorphology and block edges and b) the geomorphology, block edges and measurements.



Figure D.31. Rubbly area within the finely-jointed section of Stóra-Aragjá D1 SD3, at the bottom of the photo.



Figure D.32. A view of the central section of Stóra-Aragjá, D1. A concave of rubble cuts back into SD6 at the top of the scarp. This is the only area of the domain where SD1 – SD3 are visible.

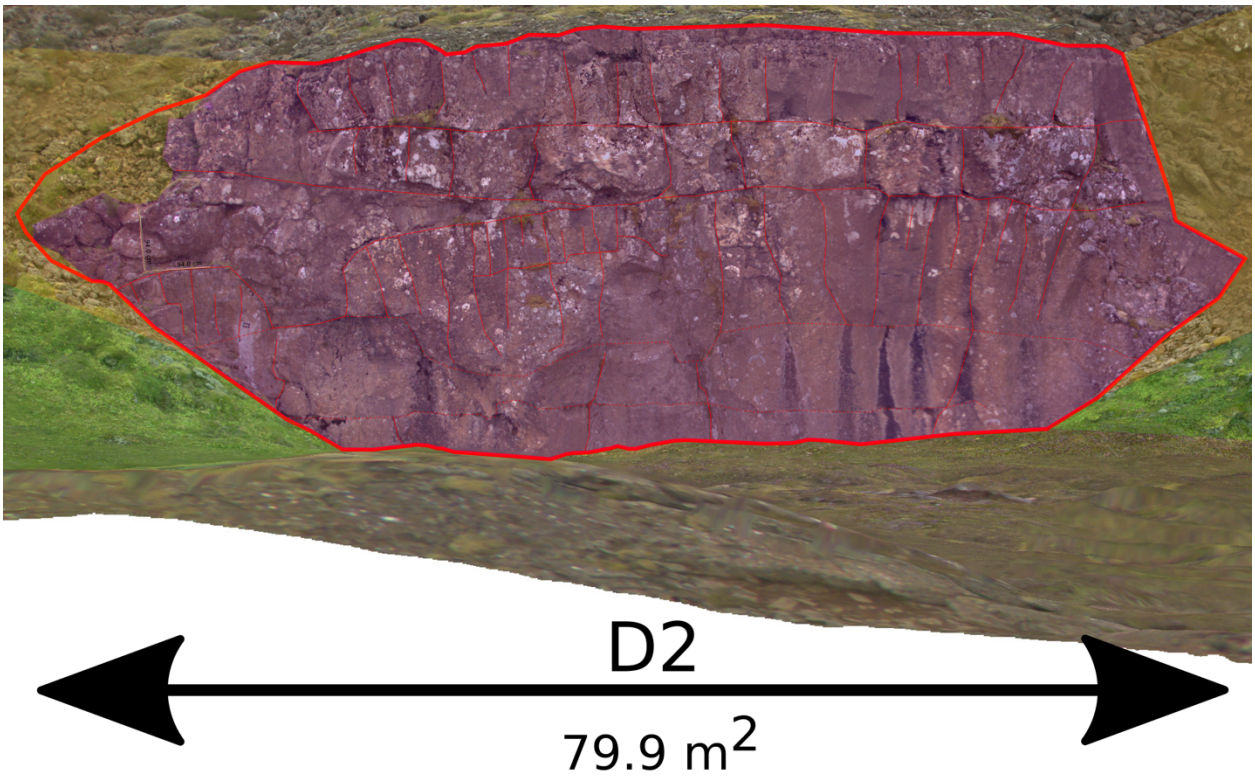


Figure D.33. Northeast side of Stóra-Aragjá D1. Blocks at the top of the domain on the far northeast side are toppling over.



Figure D.34. A joint spanning Stóra-Aragjá D1 SD4 and SD6 is parallel to the rock face and infilled with rock.

a



b

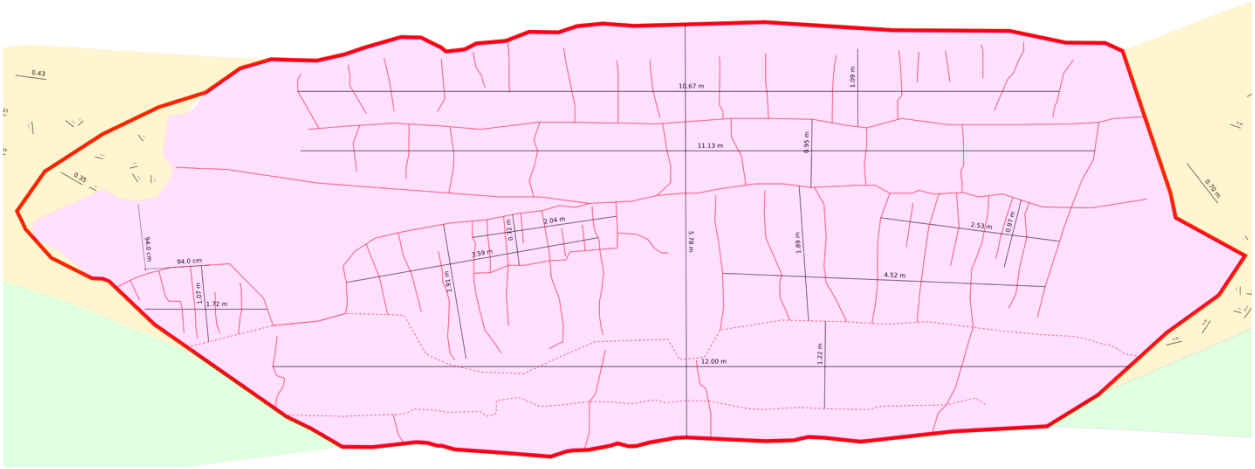


Figure D.35. A subsection of Stóra-Aragjá from Figure D.29., focused on D2 more clearly shows a) the orthophoto, geomorphology and block edges and b) the geomorphology, block edges and measurements.



Figure D.36. A view into the fissure and at SD1 at the base of Stóra-Aragjá, D2. SD1 slightly undercuts SD2 going into the fissure. A block within the fissure has pahoehoe features on top of it.



Figure D.37. In Stóra-Aragjá D2, grass grows out of the cracks in SD3 (the large, tall columnar area).

12.3 APPENDIX C – Discontinuity Surveys

Location	Gildrulholtsagjá (aka Gill)
Date(s)	7/28/2017, 7/30/2017

Location	Quantity	Spacing	Spacing Unit	Type	Dip	Strike	Persistence	Termination	Apeture	Infill	Strength	Roughness	Shape	JRC	Comments	Specific Location	Date
D1-SD1	~10	0.1-.055 typ 0.15	M	J,B	*v	*v	VL (<<3')	2	T-~1/4"	1,3,so.5	R5-R6	VR	U,I	18-20	**HORIZ SET** *see field notes for s&d, potential surface features	-	7/28/17
D1-SD1	>10	0.7-0.1	M	J	e.g.66 (*v)	e.g.100 (*v)	VL (<<3')	2	T-~1"	1	R5-R6	R-VR	P-I	12-14	**VT TRENDS**	-	
D1-SD1	>10	0.7-0.1	M	J	e.g.70 (*v)	e.g.065 (*v)	VL (<<3')	2	T-~1"	1	R5-R6	R-VR	P-I	12-14	variable s&d: picked 2 general trends	-	
D1-SD2	~6	MULT	-	J	~VT	~110	L	2	T-25 cm	1,5	R6	R-S	C	2-4	**VT TRENDS**	-	
D1-SD2	~3	MULT	-	J	~VT	65	L	2	T-25 cm	1,5	R6	R-S	C	2-4	Concoidal - use photes w/scale to estimate more	-	
D2-SD1															Talus Slope	-	
D2-SD2	>>10	*v, 4.5	IN	FB/J	23	144	VL-M in to 15'	2	T-3/4"	1,5	R6	R	P	8-10	**HORIZ SET** taken on flow boundary - N side D2	North Side	7/30/17
D2-SD2	>>10	6+, *v	IN	J	90	085-265	VL (<1')	2	T	NA	R6	R	P	8-10	**LEFT VT FACE SET**		
D2-SD2	>>10	6+, *v	IN	J	73	240	VL (<1')	2	T	NA	R6	R	P	8-10	**RIGHT VT FACE SET**		
D2-SD2		m-scale, *v	M	FB/J	20	097		1-2	T	1	R6	R	P-C	16-18	**HORIZ SET** Taken on flow boundary; S side D2	South Side	
D2-SD2		0.7, *v	M	J	84	129	L	1-2	T-1/8"	1	R6	R	C*	6-10	**RIGHT VT FACE SET** - CONCOIDAL		
D2-SD2		0.3, *v	M	J	82	71	L	1-2	T-1/8"	1	R6	R	C*	6-10	**LEFT VT FACE SET** - CONCOIDAL		
D2-SD3															Broken up elevated talus slope	-	
D2-SD4															Too inconsistent - deformed by lava tube/flow?	-	
D2-SD5	2				**05**	**035**	M	2	T-MW						**HORIZ SET** *apparent s&d from bottom of scarp		
D2-SD5	8+	~0.3-0.5	M	FB?/J	**72**	**000,035**	VL-L(~3')	2	T						**MOSTLY HORIZ SET**, splays in different directions, *apparent s&d		
D2-SD5	7+			J	**84**	**200**	VL-L(~3')	2	T						**VT SET**, variable splays, *apparent s&d		

* D2: HIGHLY VARIABLE DOMAIN - OVERALL NOT CONSISTENT IN SPACING AND ORIENTATION. SOME HORIZ AND VT TRENDS
* D1-SD1 (add from notes - curved horiz joints), D1-SD2&3&4 froom model - have estimated s&d for SD4

No Info
See Fig A.1. for explaination

*v = variable
italics = closer to average
bold s&d = approximate
FB = flow boundary

Location	Hildargjá (aka Gatfell)
Date(s)	7/26/2017- 7/27/2017

Location	Quantity	Spacing	Spacing Unit	Type	Dip	Strike	Persistence	Termination	Apeture	Infill	Strength	Roughness	Shape	JRC	Comments	Date
D1															Rockfall. Meter to multi-meter scale.	7/26/17
D2-SD1	11	1	FT	J	72	332	VL	1-2	0-1"	1	R6	R	U-I	12-14	RQD 90-100 **VT SET**	
D2-SD1	9	8	IN	J	29	221	VL-L	1-2	0-1/2"	1,3	R6	VR	I	18	**HORIZ SET**	
D2-SD2	7	2.3	M	J	83	321	L (~8FT)	0	5->12"	1,5	R6	R	P	8	**VT SET** Minor damp - water seeos from holes, not joints	
D2-SD2	3	1.3	M	J,B	13	015	VH	2	T	1,3	R6	R-VR	I	18	**HORIZ SET** RQD 100	
D2-SD2	1	1.8	M	J	**90**	027-207	NV*	1	V. WIDE	5	R6	R	P	NV	**VT SET** not very visible/measurable (NV)	
D2-SD3	6	0.3	M	J	85	23	VL-L	2	<1/4"	1,5,10	R5-R6	R	U	14-16	**VT SET** RQD 90-100 from 027 side	
D2-SD3	~23	0.45	M	J	**90**	**310**	VL	2	T	1	R5-R6	NV	NV	NV	**VT SET** chip small w/ 1 blow (vesicles) front face via sighting	
D2-SD4					34	035									Irrecgular sices 12 cm to 10x15x30 cm to 1m scale	
D3-SD1	2	1.5	M	J	20	191	H-VH		~1/4"	1,3	R5-R6	R	P-U	12-14	**HORIZ SET** Minor seeps in some places Chip w/ hammer	
D3-SD1	9	0.4-2.7	M	J	80-90	070-100	VL	2	Gen. 0"	NA	R5-R6	R	P-U	10-12	**LEFT VT FACE SET** Irregular s&d/spacing	
D3-SD1	11	0.5-1.8	M	J	70-89 (*~85*)	300-*340*	VL	2	0"	NA	R5-R6	R	P-U	12-14	**RIGHT VT FACE SET**	
D3-SD1	2	0.95	M	J, TC	76,90	254, 275	L	1	0.12, 0.28m	1,5	R5-R6	R	P-U	10-12	open cracks on 207 side section & face	
D4															Grassy Talus Slope	
D6-SD1	2	0.65	M	J	09	285	M-H	1	~1/8"	1,2?	R6	R	P-U	8-10	**HORIZ SET** small undulations; RQD ~100, some evidence minor H2O; taken from underhang on right	
D6-SD1	5	1-1.5	M	J	80	143	L	2	T-3/4"	1	R6	R	U	14-16	**VT SET** Not very consistent in style, not always straight; *cont to SPZ?* S&d from more straight and open joint	
D6-SD2	5-7	0.9-1	M	J	71-79	067-088	L	2-1	T	1	R6	R	P-U	8-10	**LEFT VT FACE SET** Vesicular, RQD~100, variable s&d	
D6-SD2	~7	~1-1.3	M	J	*71*-89	005-320	L	1-2	T-3/4"	1	R6	R	P-U	10-14	**RIGHT VT FACE SET** variable s&d	
D6-SD2	2	1.3	M	J, TC	71-79	067-088	L	2	VW (~1.5")	3,10	R6	R	U-P	14-16	**VT SET** - similar joint set to line 21	
D6-SD2	2-3	0.3-0.5	M	J	24	209	L-VL	1-2	T	1,10	R6	R	P-U	~10	**HORIZ SET** variable spacing - along vesicles s&d at 1 location	7/27/17
D6-SD3															Not intact face: boulders to cobbles Some intact material	
D5-SD1	7-8	0.3-1.1	M	J	**	**	L-M	1	T-7"	1,5,10	R6	R	U-P	4-6 14-16	see FB1, pg 19 sketch	
D5-SD1	~3	~0.9-1.1	M	J	**	**	VL-L	2	~1/8-1/4"	1,2	R6	R	U-P	10-12	see FB1, pg 19 sketch	
D5-SD3	8	0.1-0.25	M	J	84	186	VL	2	0-0.3"	1,3	R6	R	P-U	8-10	**VT SET**	

Location	Hildargjá (aka Gatfell)
Date(s)	7/26/2017- 7/27/2017

Location	Quantity	Spacing	Spacing Unit	Type	Dip	Strike	Persistence	Termination	Apeture	Infill	Strength	Roughness	Shape	JRC	Comments	Date
D5-SD3	10	0.12, *i	M	F?,J?	84	080	*V* L	2	0	1	R6	R	P(U)	8-10	**LEFT VT FACE SET** i = intermittant	
D5-SD3	9	0.05-0.08 *	M	F?,J?	81	008	*V* L	2	0	1	R6	R	P(U)	8-10	**RIGHT VT FACE SET** i - do not generally through-cut, but make angles	
D5-SD3	2	0.8	M	J	16	255	L-M	0	VW (1-3")	5,10	R6	R	P-U	12-14		

** see field notes

No Info

See Fig A.1. for explaination

italics = closer to average

bold s&d = approximate

NV = not visible

*10 = Biological material - moss, grass, etc

Location	Nydri-Mosadalgjá (aka Vogar A)
Date(s)	8/2/2017, 8/8/2017

Location	Quantity	Spacing	Spacing Unit	Type	Dip	Strike	Persistence	Termination	Apeture	Infill	Strength	Roughness	Shape	JRC	Comments	Date
D1-SD1	3	0.65, 0.9	M	J,FB	09	240	VH	0	T-0.2"	1,5	R6	R	P	8-10	**HORIZ SET** vesicles, flow boundary orientation	
D1-SD1	~5	0.6-0.75	M	J	82	065	VL-L	2-1	T	1	R6	R	~P,I	6-8	**LEFT VT FACE SET** not typically through-going	
D1-SD1	~5	0.6-0.75	M	J	84	001	VL	2-1	T	1	R6	R	~P,I	6-8	**RIGHT VT FACE SET** not typically through-going	
D1-*		0.1-0.2	M	J	89	282	VL	2	T	1	R6	R	~P	8-10	**LEFT VT FACE SET** Top SD1, parts SD2, similar to SD4, shallow	
D1-*		0.1-0.2	M	J	88	173	VL	2	T	1	R6	R	~P	~8	**RIGHT VT FACE SET** looks shallow, irregular s&d but similar	
D1-SD1/2	1	-	-	FB	11	225	VH	0	T	1	R6	R	P,C@ END	8-10 16-18	**ORIENTATION??** Some surficial features	
D1-SD3															Massive, Non-uniform joints	
D1-SD6	~5+	~0.35	M	J	~VT	190	VL	2	T	1	R6	R	P	8-10	**RIGHT VT FACE SET** *s&d from standing in line w/ face & estimated; horizonatal variability	
D1-SD6	~5+	~0.35	M	J	~VT	100	VL	2	T	1	R6	R	P	8-10	**LEFT VT FACE SET**	8/2/17
D2-SD1/2	1	-	-	FB	22	305	M	2	T-1/8"	1,2	R6	R	P-C	8-10	**HORIZ SET** curves towards east	
D2-SD1	~20	0.2	M	J	84	093	VL	2	T	1	R6	R	P	8-10	**LEFT VT FACE SET** splay some, shallow generally	
D2-SD1	~15	0.1	M	J	77	351	VL	2	T-1/4" usual	1,5,10	R6	R	P	8-10	**RIGHT VT FACE**	
D3-SD1	1	-	-	J	09	170	VH	0	MW	1,10	R6	R	P	6-8	**HORIZ SET**	
D3-SD1	12	0.15	M	J	83	228	VL	2	T	1	R6	R	P	4-6	**VT SET**	
D3-SD1	11	0.25	M	J	83	045	VL	2	T	1	R6	R	P	4-6	**VT SET**	
D3-SD2															lava tube - inconsistent patterns	
D3-SD3	3	0.6	M	J	24	247	H	2	T	1	R6	R	P-U	8-12	**HORIZ SET**	
D3-SD3	11	0.6	M	J	83	349	VL	2	T	1	R6	R	U	14-18	**VT SET**	
D3-SD3	10	0.8	M	J	90	072	VL	2	T	1	R6	R	U	14-18	**VT SET**	
D4-SD3	3	~1.1	M	J	23	325			T	1,10	R6	R	P-U	10		
D4-SD3		0.2	M	J	90	108		2	1/2"+		R6	R	P-C	10		
D4-SD3		1.35	M	J	87	151		2	1/8"		R6	R	P-C	10		
D3-SD4	5	~1.6	M	J	81	271	VL-L	2	0-MW	1,10	R6	R	P-C-I	10-12	**RIGHT VT FACE SET** irregularish shape, varies on lose fae	
D3-SD4	2	0.4	M	J	84	221	L-M	2-1	0"	1	R6	R	P-C	4-6	**LEFT VT FACE SET** facing surface	
D3-SD4	2-3	0.5-0.7	M	J	11	060	H	1	T-1/8"	1,10	R6	R	P-I	8-10	**HORIZ SET**	
D4-SD1															Massive, Non-uniform joints	8/8/17
D4-SD2	6	0.4-0.15	M	J	72	201	VL	2	T	1	R6	R	P-C	4-6	**LEFT VT FACE SET** - shallow	
D4-SD2	8	0.2	M	J	83	129	VL	2	T	1	R6	R	P-C	4-6	**RIGHT VT FACE SET** - shallow	
D4-SD5		0.6	M	J	09	170			T	1	R6	R	P-I	8-10	**HORIZ SET**	
D4-SD5		0.85	M	J	85	091		2	T	1	R6	R	P-U	8-10	**LEFT VT FACE SET**	
D4-SD5		0.7	M	J	88	204		2	T	1	R6	R	P-U	8-10	**RIGHT VT FACE SET**	

*where consistenty present
No Info
See Fig A.1. for explaination

italics = closer to average
bold s&d = approximate
FB = flow boundary

NV = not visible
*10 = Biological material - moss, grass, etc

Site Location	Stóra-Aragjá (aka Vogar B)
Date(s)	8/9/17

Location	Quantity	Spacing	Spacing Unit	Type	Dip	Strike	Persistence	Termination	Apeture	Infill	Strength	Roughness	Shape	JRC	Comments	Date
D1-SD1	2	0.4	M	J/FB	35	103	L-M visible	0	T	1,10	R6	VR	P-U	10-12	**HORIZ SET** none other (top and layer down) consistent	8/9/17
D1-SD2	3	0.2	M	J	28	088	L-M	0-2 middle less visible	T	1	R6	VR	P-(U)	10-12	**HORIZ SET** incl horiz from below layer; wavy	
D1-SD2	6	0.45-0.6	M	J	85	137	VL	2	T	1	R6	R-VR	P-C	6-8	**LEFT VT FACE SET** variable s&d - inconsistent, hard to see	
D1-SD2															**RIGHT VT FACE SET** nothing consistent	
D1-SD3	25	0.1-0.2	M	cJ	90	315	*V* L	2	T	1	R6	VR	P	4-6	**RIGHT VT FACE SET** part of columnar	
D1-SD3	3?	0.1-0.17	M	cJ	81	238	VL	2	T	1	R6	VR	P-(I)	4-6	**LEFT VT FACE SET** not consistent planes - representative	
D1-SD3	2	0.2	M	J/FB	02	084	H	0	T-1"	1,"5","8"	R6	VR	P-U	6-8	**HORIZ SET** top & bottom; dips slightly either way	
D1-SD4	7	0.6+	M	J	84	295	VL-L	2	~1/10"	1,2	R6	R	C-U	8-12	**LEFT VT FACE SET** consisten pattern, inconsistent angles - wedges; inconsistent spacing	
D1-SD4	~7	0.4+	M	J	81	038	VL-L	2		1,2	R6	R	C-U	8-10	**RIGHT VT FACE**	
D1-SD5	~7	~0.45	M	J	85	051	VL	2	0.1-1.5"	1	R6	R	P-U	4-6	**VT SET** approximate by allighning clipboard - variable	
D2-SD1															In Crevasse below grass line	
D2-SD2	3	~1.3	M	J/FB	14	292	L-M	1-2	1/16"	10	R6	R	P-U	10-12	**HORIZ SET**	
D2-SD2	3	~1.5, 3.5	M	J	**80**	**213**	L (4-10'?)	2	T-1/10"	1,10	R6	R (S?)	P-C	4-6	**RIGHT VT FACE SET** apparent dip/strike	
D2-SD2	2	~2.5, 4.5	M	J	86	305	L	2	1/8"?	1,10	R6	R	P-C	4-6	**LEFT VT FACE SET**	
D2-SD3		0.03-0.3	M	dJ	*v	*v	VL	2	T-0.25"	1,2,10	R6	R-VR	P-C	6-8	**RIGHT VT FACE SET** ENE side *v, variable - see field notes	
D2-SD3		0.08-0.2	M	cJ	*v	*v	VL	2	T	1,10	R6	R-VR	P-(C)	6-8	**LEFT VT FACE SET** see above field note	
D2-SD3	1	-	M	FB	~0	-	M-H (~30')	0	T-1/2"	1,5,(6?)	R6	VR	I	14-18	**HORIZ SET** Top - splays on either side	

No Info
See Fig A.1. for explaination

italics = closer to average
bold s&d = approximate
FB = flow boundary
cJ = columnar joint
*v = variable

NV = not visible

*10 = Biological material - moss, grass, etc

12.4 APPENDIX D – Photo Analysis Tables

Location	Domain	Area (m2)	%intact	% rocky talus	% grassy slope	subdomain	num blocks	dist	blocks/m	Block Height (m	OR block si	notes	f/m/c
Hildargja	D1	126	38	54	8	SD1					1.65		
Hildargja	D1										0.68		
Hildargja	D1										1.07		
Hildargja	D1										1.74		
Hildargja	D1										0.82		
Hildargja	D1										1.99		
Hildargja	D1										0.59		
Hildargja	D1										1.01		
Hildargja	D1										0.54		
Hildargja	D1										1.5		
Hildargja	D1										0.89		
Hildargja	D1										2.1		
Hildargja	D1										2.34		
Hildargja	D1										2.29		
Hildargja	D1										1.41		
Hildargja	D1										1.38		
Hildargja	D1					SD2	6	4.88	1.23	1.07			f
Hildargja	D2	148	73	26	0	SD1						inaccessible/not visible	
Hildargja	D2					SD2	5	15.15	0.33	1.58			c
Hildargja	D2					SD3	13	7.16	1.82	0.49			f
Hildargja	D2					SD3	11	5.67	1.94	0.91			f
Hildargja	D2					SD4					2.89		
Hildargja	D2										1.29		
Hildargja	D2										0.46		
Hildargja	D2										0.63		
Hildargja	D2										0.55		
Hildargja	D2										0.59		
Hildargja	D2										0.58		
Hildargja	D2										0.68		
Hildargja	D2										0.79		
Hildargja	D2										0.51		
Hildargja	D2										0.64		
Hildargja	D2										1.63		
Hildargja	D2										1.17		
Hildargja	D2										0.84		
Hildargja	D2										0.55		
Hildargja	D2										0.53		
Hildargja	D3	203	37	28	34	SD1	6	9.06	0.66	1.44			m
Hildargja	D3						5	5.64	0.89	1.74			m
Hildargja	D3					SD2	6	3.2	1.88	0.84			f
Hildargja	D3						3	2.15	1.40	0.82			f
Hildargja	D3						4	1.93	2.07	0.85			f
Hildargja	D3					SD3	4	7.29	0.55	1.14		large	m
Hildargja	D3						4.5	1.46	3.08	0.53		small	f
Hildargja	D3	88	1	33	67						0.36	most are in SD3	
Hildargja	D3										0.7		
Hildargja	D3										1.29		
Hildargja	D3										0.79		
Hildargja	D3										2.04		
Hildargja	D3										0.5		
Hildargja	D3										0.53		

Location	Domain	Area (m2)	%intact	% rocky talus	% grassy slope	subdomain	num blocks	dist	blocks/m	Block Height (m)	OR block size	notes	f/m/c
Hildargja	D3									0.36			
Hildargja	D3									0.65			
Hildargja	D3									0.43			
Hildargja	D3									0.37			
Hildargja	D3									0.5			
Hildargja	D3									0.41			
Hildargja	D3									1.53			
Hildargja	D3									0.57			
Hildargja	D3									0.65			
Hildargja	D3									0.5			
Hildargja	D3									0.72			
Hildargja	D3									0.72			
Hildargja	D3									0.77			
Hildargja	D3									0.34			
Hildargja	D3									0.52			
Hildargja	D3									0.94			
Hildargja	D3									0.24			
Hildargja	D3									0.34			
Hildargja	D3									0.91			
Hildargja	D3									0.73			
Hildargja	D3									0.61			
Hildargja	D3									0.51			
Hildargja	D3									0.8			
Hildargja	D4									0.7			
Hildargja	D4									2.2			
Hildargja	D4									0.58			
Hildargja	D4									0.65			
Hildargja	D4									0.38			
Hildargja	D4									0.92			
Hildargja	D4									0.96			
Hildargja	D4									1.07			
Hildargja	D4									0.88			
Hildargja	D4									0.61			
Hildargja	D4									0.52			
Hildargja	D4									0.42			
Hildargja	D4									0.34			
Hildargja	D4									0.31			
Hildargja	D4									1.08			
Hildargja	D4									0.68			
Hildargja	D5	113	98.7	0.4	0.5	SD1	4		2.76	1.45	1.29	horiz	c
Hildargja	D5						3		2.65	1.13		vt	c
Hildargja	D5					SD2	4		4.58	0.87	1.84		c
Hildargja	D5					SD3						inaccessible/not visible	
Hildargja	D5					SD4	16		7.68	2.08	0.54		f
Hildargja	D5					SD5	4		3.17	1.26	1.01		m
Hildargja	D6	123	85	15	0	SD1	3		4.54	0.66	0.80		m
Hildargja	D6						2		3.35	0.60	0.79		m
Hildargja	D6									1.42			
Hildargja	D6									0.96			
Hildargja	D6									1.05			
Hildargja	D6									0.59			

Location	Domain	Area (m2)	%intact	% rocky talus	% grassy slope	subdomain	num blocks	dist	blocks/m	Block Height (m	OR block si	notes	f/m/c
Hildargja	D6										0.39		
Hildargja	D6										0.65		
Hildargja	D6										0.31		
Hildargja	D6										0.3		
Hildargja	D6										0.44		
Hildargja	D6										0.92		
Hildargja	D6					SD2	13	7.97	1.63	0.44			f
Hildargja	D6						7	1.75	4.00	0.52		top of SD	f
Hildargja	D6					SD3					1.57	intact block size	
Hildargja	D6										0.58	intact block size	
Hildargja	D6										0.51		
Hildargja	D6										0.43		
Hildargja	D6										0.27		
Hildargja	D6										0.49		
Hildargja	D6										0.48		
Hildargja	D6										0.28		
Hildargja	D6										0.68		
Hildargja	D6										1.1		
Hildargja	D6										0.3		
Hildargja	D6										0.11		
Hildargja	D6										0.1		
Hildargja	D6										0.12		
Hildargja	D6										0.67		
Hildargja	D6										0.27		
Hildargja	D6										0.24		
Hildargja	D6										0.26		
Hildargja	D6										0.21		
Hildargja	D6										0.51		
Hildargja	D6										0.57		
Hildargja	D6										0.51		
Hildargja	D6										0.25		
Hildargja	D6										0.31		
Hildargja	D6										0.37		
Hildargja	D6										0.32		
Hildargja	D6										0.41		
Hildargja	D6					SD4	4	9.11	0.44	1.96			c
Hildargja	D6					SD5	6	6.27	0.96	1.02			f
Gildrulholtsagja	D1	142.4	83	17	0	SD2	9	21.37	0.42	1.96			c
Gildrulholtsagja	D1					SD3	21	26.75	0.79	1.47			m
Gildrulholtsagja	D1					SD4	7	5.65	1.24	0.56			f
Gildrulholtsagja	D1						18	8.71	2.07	1.02			f
Gildrulholtsagja	D1						4	2.87	1.39	0.80			f
Gildrulholtsagja	D1										0.65		
Gildrulholtsagja	D1										2.03		
Gildrulholtsagja	D1										0.86		
Gildrulholtsagja	D1										0.43		
Gildrulholtsagja	D1										0.98		
Gildrulholtsagja	D1										1.42		
Gildrulholtsagja	D1										1.28		
Gildrulholtsagja	D1										1.01		
Gildrulholtsagja	D1										1		

Location	Domain	Area (m2)	%intact	% rocky talus	% grassy slope	subdomain	num blocks	dist	blocks/m	Block Height (m	OR block si	notes	f/m/c
Gildrulholtsagja	D1										1.28		
Gildrulholtsagja	D1										0.44		
Gildrulholtsagja	D1										0.65		
Gildrulholtsagja	D1										0.6		
Gildrulholtsagja	D1										0.65		
Gildrulholtsagja	D1										1.62		
Gildrulholtsagja	D1										1.34		
Gildrulholtsagja	D1										2.3		
Gildrulholtsagja	D1										0.68		
Gildrulholtsagja	D1										1.14		
Gildrulholtsagja	D1										1.98		
Gildrulholtsagja	D1										1.78		
Gildrulholtsagja	D1										1.45		
Gildrulholtsagja	D1										1.15		
Gildrulholtsagja	D1										0.94		
Gildrulholtsagja	D1										2.05		
Gildrulholtsagja	D1										0.8		
Gildrulholtsagja	D1										0.66		
Gildrulholtsagja	D1										0.6		
Gildrulholtsagja	D1										0.42		
Gildrulholtsagja	D1										0.39		
Gildrulholtsagja	D1										0.53		
Gildrulholtsagja	D1										0.62		
Gildrulholtsagja	D1										1.93		
Gildrulholtsagja	D1										2.74		
Gildrulholtsagja	D1										1.14		
Gildrulholtsagja	D1										0.48		
Gildrulholtsagja	D1										0.85		
Gildrulholtsagja	D1										1.1		
Gildrulholtsagja	D1										1.09		
Gildrulholtsagja	D1										1.67		
Gildrulholtsagja	D1										0.73		
Gildrulholtsagja	D1										1.06		
Gildrulholtsagja	D1										0.75		
Gildrulholtsagja	D1										1.75		
Gildrulholtsagja	D1										1.9		
Gildrulholtsagja	D1										0.79		
Gildrulholtsagja	D1										1.39		
Gildrulholtsagja	D1										0.78		
Gildrulholtsagja	D1										2.28		
Gildrulholtsagja	D1										0.72		
Gildrulholtsagja	D1										2.07		
Gildrulholtsagja	D1										0.54		
Gildrulholtsagja	D1										1.21		
Gildrulholtsagja	D1										1.08		
Gildrulholtsagja	D1										1.36		
Gildrulholtsagja	D1										0.94		
Gildrulholtsagja	D1										0.77		
Gildrulholtsagja	D1										0.76		
Gildrulholtsagja	D1										0.8		
Gildrulholtsagja	D1										0.87		

Location	Domain	Area (m2)	%intact	% rocky talus	% grassy slope	subdomain	num blocks	dist	blocks/m	Block Height (m)	OR	block size	notes	f/m/c
Gildrulholtsagja	D1										0.66			
Gildrulholtsagja	D1										2.34			
Gildrulholtsagja	D1										0.58			
Gildrulholtsagja	D1										0.35			
Gildrulholtsagja	D1										0.88			
Gildrulholtsagja	D1										0.95			
Gildrulholtsagja	D1										2.01			
Gildrulholtsagja	D1										0.64			
Gildrulholtsagja	D1										0.89			
Gildrulholtsagja	D2	284.3	47.7	49.1	3.2	SD1					2.56			
Gildrulholtsagja	D2										1.71			
Gildrulholtsagja	D2										1.85			
Gildrulholtsagja	D2										0.9			
Gildrulholtsagja	D2										0.57			
Gildrulholtsagja	D2										1.01			
Gildrulholtsagja	D2										1.87			
Gildrulholtsagja	D2										0.94			
Gildrulholtsagja	D2										0.51			
Gildrulholtsagja	D2										2.01			
Gildrulholtsagja	D2										0.96			
Gildrulholtsagja	D2										1.03			
Gildrulholtsagja	D2										1.34			
Gildrulholtsagja	D2										2.22			
Gildrulholtsagja	D2										1.33			
Gildrulholtsagja	D2										1.22			
Gildrulholtsagja	D2										0.56			
Gildrulholtsagja	D2										0.84			
Gildrulholtsagja	D2										0.8			
Gildrulholtsagja	D2										0.41			
Gildrulholtsagja	D2										0.9			
Gildrulholtsagja	D2										0.98			
Gildrulholtsagja	D2										0.77			
Gildrulholtsagja	D2										0.43			
Gildrulholtsagja	D2										0.77			
Gildrulholtsagja	D2										1.28			
Gildrulholtsagja	D2										0.38			
Gildrulholtsagja	D2										0.44			
Gildrulholtsagja	D2										0.49			
Gildrulholtsagja	D2										0.51			
Gildrulholtsagja	D2										0.18			
Gildrulholtsagja	D2										1.07			
Gildrulholtsagja	D2										0.29			
Gildrulholtsagja	D2										0.47			
Gildrulholtsagja	D2										1.03			
Gildrulholtsagja	D2										0.88			
Gildrulholtsagja	D2										1.04		switch	
Gildrulholtsagja	D2										0.24			
Gildrulholtsagja	D2										0.2			
Gildrulholtsagja	D2										0.23			
Gildrulholtsagja	D2										0.35			
Gildrulholtsagja	D2										0.16			

Location	Domain	Area (m2)	%intact	% rocky talus	% grassy slope	subdomain	num blocks	dist	blocks/m	Block Height (m)	OR block size	notes	f/m/c
Gildrulholtsagja	D2									0.33			
Gildrulholtsagja	D2									0.13			
Gildrulholtsagja	D2									0.19			
Gildrulholtsagja	D2									0.23			
Gildrulholtsagja	D2									0.1			
Gildrulholtsagja	D2									0.41			
Gildrulholtsagja	D2									0.09			
Gildrulholtsagja	D2									0.12			
Gildrulholtsagja	D2									0.13			
Gildrulholtsagja	D2									0.14			
Gildrulholtsagja	D2									0.21			
Gildrulholtsagja	D2									0.16			
Gildrulholtsagja	D2									0.24			
Gildrulholtsagja	D2									0.17			
Gildrulholtsagja	D2									0.15			
Gildrulholtsagja	D2									0.23			
Gildrulholtsagja	D2									0.3			
Gildrulholtsagja	D2									0.1			
Gildrulholtsagja	D2									0.4			
Gildrulholtsagja	D2									0.15			
Gildrulholtsagja	D2									0.13			
Gildrulholtsagja	D2									0.23			
Gildrulholtsagja	D2									0.3			
Gildrulholtsagja	D2					SD2						height min 0.09 to 1.27 max	
Gildrulholtsagja	D2											width 0.12 min to 2.09 max	
Gildrulholtsagja	D2					SD3				0.25	min		
Gildrulholtsagja	D2									0.17	max		
Gildrulholtsagja	D2									1.05	avg		
Gildrulholtsagja	D2									0.25			
Gildrulholtsagja	D2									0.25			
Gildrulholtsagja	D2									0.12			
Gildrulholtsagja	D2									0.17			
Gildrulholtsagja	D2									0.16			
Gildrulholtsagja	D2									0.16			
Gildrulholtsagja	D2									0.2			
Gildrulholtsagja	D2									0.16			
Gildrulholtsagja	D2									0.14			
Gildrulholtsagja	D2									0.51			
Gildrulholtsagja	D2									0.45			
Gildrulholtsagja	D2									0.27			
Gildrulholtsagja	D2									0.46			
Gildrulholtsagja	D2									0.42			
Gildrulholtsagja	D2									0.3			
Gildrulholtsagja	D2									0.17			
Gildrulholtsagja	D2									0.2			
Gildrulholtsagja	D2									0.26			
Gildrulholtsagja	D2									0.11			
Gildrulholtsagja	D2									0.2			
Gildrulholtsagja	D2									0.19			
Gildrulholtsagja	D2									0.09			
Gildrulholtsagja	D2									0.24			

Location	Domain	Area (m2)	%intact	% rocky talus	% grassy slope	subdomain	num blocks	dist	blocks/m	Block Height (m	OR	block si	notes	f/m/c
Gildrulholtsagja	D2										0.16			
Gildrulholtsagja	D2										0.08			
Gildrulholtsagja	D2										0.38			
Gildrulholtsagja	D2										0.21			
Gildrulholtsagja	D2										0.15			
Gildrulholtsagja	D2										0.27			
Gildrulholtsagja	D2										0.27			
Gildrulholtsagja	D2										0.25			
Gildrulholtsagja	D2										0.18			
Gildrulholtsagja	D2										0.17			
Gildrulholtsagja	D2										0.1			
Gildrulholtsagja	D2										0.18			
Gildrulholtsagja	D2										0.26			
Gildrulholtsagja	D2										0.21			
Gildrulholtsagja	D2										0.2			
Gildrulholtsagja	D2										0.45			
Gildrulholtsagja	D2										0.38			
Gildrulholtsagja	D2										0.2			
Gildrulholtsagja	D2										0.45			
Gildrulholtsagja	D2										0.3			
Gildrulholtsagja	D2										0.28			
Gildrulholtsagja	D2										0.21			
Gildrulholtsagja	D2										0.35			
Gildrulholtsagja	D2										0.21			
Gildrulholtsagja	D2										0.54			
Gildrulholtsagja	D2										0.7			
Gildrulholtsagja	D2										0.63			
Gildrulholtsagja	D2										0.23			
Gildrulholtsagja	D2										0.31			
Gildrulholtsagja	D2					SD4								
Gildrulholtsagja	D2					SD5	12	9.25	1.30	1.66				m-c
Nydri-Mosadalgiá	D1	134.1	100	0	0	SD1	5	3.2	1.56	1.49			larger, lower blocks of bot	f
Nydri-Mosadalgiá	D1						10	4.97	2.01	0.65			top of bottom layer	f
Nydri-Mosadalgiá	D1						2	3.47	0.58	1.84			middle layer, SW side of	c
Nydri-Mosadalgiá	D1						4	1.36	2.94	0.54			middle layer, top SW side	f
Nydri-Mosadalgiá	D1						4	1.09	3.67	0.38			middle layer, top SW side	f
Nydri-Mosadalgiá	D1						3	2.98	1.01	1.12			top layer on NE side, whe	m
Nydri-Mosadalgiá	D1					SD2	5	1.29	3.88	0.53				f
Nydri-Mosadalgiá	D1						4	0.78	5.13	0.53				f
Nydri-Mosadalgiá	D1					SD3	3	2.67	1.12	0.76				m
Nydri-Mosadalgiá	D1					SD4	3	1.85	1.62	0.51			NE Side	f-m
Nydri-Mosadalgiá	D1						6	1.75	3.43	0.46			SW side	f
Nydri-Mosadalgiá	D1					SD5	2	5.66	0.35	1.81			center	c
Nydri-Mosadalgiá	D1					SD6	1	0.79	1.27	0.79				m
Nydri-Mosadalgiá	D1						2	1.4	1.43	0.52				m
Nydri-Mosadalgiá	D1A	179.1	0	100	0	SD1					0.39	SW side		
Nydri-Mosadalgiá	D1A										2.16			
Nydri-Mosadalgiá	D1A										2.3			
Nydri-Mosadalgiá	D1A										1.34			
Nydri-Mosadalgiá	D1A										0.62			
Nydri-Mosadalgiá	D1A										1.81			

Location	Domain	Area (m2)	%intact	% rocky talus	% grassy slope	subdomain	num blocks	dist	blocks/m	Block Height (m)	OR block si	notes	f/m/c
Nydri-Mosadalgiá	D1A									2.39			
Nydri-Mosadalgiá	D1A									0.6			
Nydri-Mosadalgiá	D1A									0.8			
Nydri-Mosadalgiá	D1A									0.58			
Nydri-Mosadalgiá	D1A									2.33			
Nydri-Mosadalgiá	D1A									1.22			
Nydri-Mosadalgiá	D1A									0.75			
Nydri-Mosadalgiá	D1A									0.48			
Nydri-Mosadalgiá	D1A									0.56			
Nydri-Mosadalgiá	D1A									2.45			
Nydri-Mosadalgiá	D1A									2.08			
Nydri-Mosadalgiá	D1A									2.81			
Nydri-Mosadalgiá	D1A									1.1			
Nydri-Mosadalgiá	D1A									1.27			
Nydri-Mosadalgiá	D1A									1.57			
Nydri-Mosadalgiá	D1A									0.6			
Nydri-Mosadalgiá	D1A									0.68			
Nydri-Mosadalgiá	D1A									1.08			
Nydri-Mosadalgiá	D1A									1.57			
Nydri-Mosadalgiá	D1A									0.74			
Nydri-Mosadalgiá	D1A									0.65			
Nydri-Mosadalgiá	D1A									0.51			
Nydri-Mosadalgiá	D1A									0.87			
Nydri-Mosadalgiá	D1A									1.24			
Nydri-Mosadalgiá	D1A									0.61			
Nydri-Mosadalgiá	D1A									0.98			
Nydri-Mosadalgiá	D1A									0.66			
Nydri-Mosadalgiá	D1A									1.62			
Nydri-Mosadalgiá	D1A									0.99			
Nydri-Mosadalgiá	D1A									0.61			
Nydri-Mosadalgiá	D1A									0.74			
Nydri-Mosadalgiá	D1A									0.59		NE Side	
Nydri-Mosadalgiá	D2	348.6	100	0	0	SD1	6	2.45	2.45	0.92		w/in discontinuity survey	f
Nydri-Mosadalgiá	D2						2	1	2.00	0.94			f
Nydri-Mosadalgiá	D2						10	4.01	2.49	1.21			f
Nydri-Mosadalgiá	D2					SD2	5	5.78	0.87	0.64			m
Nydri-Mosadalgiá	D2						2	1.21	1.65	0.71			m
Nydri-Mosadalgiá	D2						2	1.3	1.54	0.78			m
Nydri-Mosadalgiá	D2					SD3	7	10.17	0.69	0.99		NE side bottom	c
Nydri-Mosadalgiá	D2						6	7.58	0.79	0.77		NE side middle	m-c
Nydri-Mosadalgiá	D2						5	3.93	1.27	1.01		SW side middle	m
Nydri-Mosadalgiá	D2						9	2.59	3.47	0.79		NE side top	f
Nydri-Mosadalgiá	D2						13	4.46	2.91	0.47		SW side top	f
Nydri-Mosadalgiá	D2					SD4	6	3.48	1.72	0.50		bottom row	f-m
Nydri-Mosadalgiá	D2						3	1.56	1.92	0.39		just above bottom row	f-m
Nydri-Mosadalgiá	D2					SD5	12	16.32	0.74	1.13			c
Nydri-Mosadalgiá	D2						7	7.32	0.96	1.00			c
Nydri-Mosadalgiá	D2						4	2.18	1.83	1.38		SW columnar section	f
Nydri-Mosadalgiá	D3	353	45	35	19	SD0	2	5.42	0.37	2.07		bottom big blocks	c
Nydri-Mosadalgiá	D3					SD1	14	6.21	2.25	1.07			f
Nydri-Mosadalgiá	D3					SD2						area arounds lava tube	

Location	Domain	Area (m2)	%intact	% rocky talus	% grassy slope	subdomain	num blocks	dist	blocks/m	Block Height (m	OR block si	notes	f/m/c
Nydri-Mosadalgiá	D3					SD3	5	1.16	4.31	0.43			f
Nydri-Mosadalgiá	D3					SD4	9	8.92	1.01	1.01		bottom layer; variable siz	c
Nydri-Mosadalgiá	D3						7	4.88	1.43	0.70		top layer; SW side	m
Nydri-Mosadalgiá	D3						4	2.51	1.59	0.58		top layer; NE side	m
Nydri-Mosadalgiá	D3						7	3.56	1.97	0.48			m
Nydri-Mosadalgiá	D3					SD5	9	1.93	4.66	0.28		NE side	f
Nydri-Mosadalgiá	D3						18	5.86	3.07	0.51		SW side; some more simi	f
Nydri-Mosadalgiá	D3					SD6	6	4.5	1.33	0.96		where visible/definable	m
Nydri-Mosadalgiá	D3					SD7	5	1.08	4.63	0.65		SW side	f
Nydri-Mosadalgiá	D3						3	1.24	2.42	0.63		NE side	f
Nydri-Mosadalgiá	D3				boulders	boulders					1.89		
Nydri-Mosadalgiá	D3										0.85		
Nydri-Mosadalgiá	D3										1.32		
Nydri-Mosadalgiá	D3										1.16		
Nydri-Mosadalgiá	D3										0.78		
Nydri-Mosadalgiá	D3										0.54		
Nydri-Mosadalgiá	D3										0.5		
Nydri-Mosadalgiá	D3										0.99		
Nydri-Mosadalgiá	D3										0.22		
Nydri-Mosadalgiá	D3										0.51		
Nydri-Mosadalgiá	D3										0.65		
Nydri-Mosadalgiá	D3										0.7		
Nydri-Mosadalgiá	D3										0.74		
Nydri-Mosadalgiá	D3										1.06		
Nydri-Mosadalgiá	D3										0.53		
Nydri-Mosadalgiá	D3										0.97		
Nydri-Mosadalgiá	D3										1.16		
Nydri-Mosadalgiá	D3										1.22		
Nydri-Mosadalgiá	D3										1.11		
Nydri-Mosadalgiá	D3										1.37		
Nydri-Mosadalgiá	D4					Base					0.44		
Nydri-Mosadalgiá	D4										0.31		
Nydri-Mosadalgiá	D4										1.42		
Nydri-Mosadalgiá	D4										2		
Nydri-Mosadalgiá	D4										2.15		
Nydri-Mosadalgiá	D4										0.7		
Nydri-Mosadalgiá	D4										1.35		
Nydri-Mosadalgiá	D4										2.73		
Nydri-Mosadalgiá	D4										1.48		
Nydri-Mosadalgiá	D4	374	92	8	0	SD0A	6	8.1	0.74	1.92		central	c
Nydri-Mosadalgiá	D4					SD0B	21	7.19	2.92	1.06			f
Nydri-Mosadalgiá	D4					SD1	7	4.66	1.50	0.83	1.48		m
Nydri-Mosadalgiá	D4					SD2	9	3.07	2.93	0.68		more NE	f
Nydri-Mosadalgiá	D4						10	3.83	2.61	0.61			f
Nydri-Mosadalgiá	D4					SD3	7	9.44	0.74	1.24		bottom, NE	c
Nydri-Mosadalgiá	D4						9	9.21	0.98	1.02		top, NE	m
Nydri-Mosadalgiá	D4						7	14.67	0.48	1.73		bottom, central	c
Nydri-Mosadalgiá	D4						10	13.63	0.73	1.59		top, central	m
Nydri-Mosadalgiá	D4					SD4	4	1.67	2.40	0.50		NE most side	f
Nydri-Mosadalgiá	D4						9	2.1	4.29	0.50		NE	f
Nydri-Mosadalgiá	D4						23	9.03	2.55	0.86		SW central	f

Location	Domain	Area (m2)	%intact	% rocky talus	% grassy slope	subdomain	num blocks	dist	blocks/m	Block Height (m)	OR block size	notes	f/m/c
Nydri-Mosadalgiá	D4						6	2.12	2.83	1.45		central	f
Nydri-Mosadalgiá	D4					SD5					1.63	NE section	
Nydri-Mosadalgiá	D4										2.71	NE section	
Nydri-Mosadalgiá	D4										0.35	central	
Nydri-Mosadalgiá	D4										0.33	central	
Nydri-Mosadalgiá	D4										0.28	central	
Nydri-Mosadalgiá	D4										0.45	central	
Nydri-Mosadalgiá	D4										0.75	central	
Nydri-Mosadalgiá	D4										0.38	central	
Nydri-Mosadalgiá	D4										0.25	central	
Nydri-Mosadalgiá	D4						7	5.59	1.25	0.71		SW	m
Nydri-Mosadalgiá	D4						6	2.29	2.62	0.42			f
Nydri-Mosadalgiá	D4						8	1.98	4.04	0.51			f
Stóra-Aragjá	D1					SD1	1	0.87	1.15	0.45	0.87	horiz spacing	c
Stóra-Aragjá	D1					SD2	3	2.76	1.09	0.21		v. poorly jointed	m-c
Stóra-Aragjá	D1						5	1.83	2.73	0.29			m
Stóra-Aragjá	D1					SD3	8	1.91	4.19	0.25		identified from photos	f
Stóra-Aragjá	D1					SD4	9	12.09	0.74	0.99			c
Stóra-Aragjá	D1						3	2.69	1.12	0.90			c
Stóra-Aragjá	D1					SD5	6	3.57	1.68	0.44			m
Stóra-Aragjá	D1						3.3	3.53	0.93	0.51			m
Stóra-Aragjá	D1					SD6	3	2.25	1.33	1.57			m-c
Stóra-Aragjá	D1						3	2.14	1.40	1.06			m-c
Stóra-Aragjá	D1						6	3.66	1.64	1.49			m-c
Stóra-Aragjá	D1						11	6.34	1.74	1.07			m
Stóra-Aragjá	D2					SD1						inaccessible/not visible	
Stóra-Aragjá	D2					SD2	5	12	0.42	1.22			c
Stóra-Aragjá	D2					SD3	7	4.52	1.55	1.89		large blocks - central/SW	m-f
Stóra-Aragjá	D2						7	3.59	1.95	1.91		NE - larger	m-f
Stóra-Aragjá	D2						7	2.53	2.77	0.97		SW fine	f
Stóra-Aragjá	D2						5	1.72	2.91	1.07		far NE	f
Stóra-Aragjá	D2						8	2.04	3.92	0.72		NE fine	f
Stóra-Aragjá	D2					SD4							
Stóra-Aragjá	D2					SD5	9	11.13	0.81	0.95		bottom half	m-c
Stóra-Aragjá	D2						11	10.67	1.03	1.09		top half - big scale	m
Stóra-Aragjá	D2					talus - locations noted to right of notes					1.24		
Stóra-Aragjá	D2										0.52		
Stóra-Aragjá	D2										0.31		
Stóra-Aragjá	D2										0.33		
Stóra-Aragjá	D2										0.11		
Stóra-Aragjá	D2										0.85		
Stóra-Aragjá	D2										0.34		
Stóra-Aragjá	D2										0.52		
Stóra-Aragjá	D2										0.65		
Stóra-Aragjá	D2										0.26		
Stóra-Aragjá	D2										0.43		
Stóra-Aragjá	D2										0.35		
Stóra-Aragjá	D2										0.16		
Stóra-Aragjá	D2										0.16		
Stóra-Aragjá	D2										0.28		
Stóra-Aragjá	D2										0.45	further left of D2	

Location	Domain	Area (m2)	%intact	% rocky talus	% grassy slope	subdomain	num blocks	dist	blocks/m	Block Height (m	OR	block si	notes	f/m/c
Stóra-Aragjá	D2									0.2				
Stóra-Aragjá	D2									0.26				
Stóra-Aragjá	D2									0.26				
Stóra-Aragjá	D2									0.24				
Stóra-Aragjá	D2									0.23				
Stóra-Aragjá	D2									0.23			just left of D2	
Stóra-Aragjá	D2									0.17				
Stóra-Aragjá	D2									0.42				
Stóra-Aragjá	D2									0.15				
Stóra-Aragjá	D2									0.1				
Stóra-Aragjá	D2									0.35				
Stóra-Aragjá	D2									0.11				
Stóra-Aragjá	D2									0.12				
Stóra-Aragjá	D2									0.14			In D2	
Stóra-Aragjá	D2									0.11				
Stóra-Aragjá	D2									0.11				
Stóra-Aragjá	D2									0.11				
Stóra-Aragjá	D2									0.23				
Stóra-Aragjá	D2									0.2				
Stóra-Aragjá	D2									0.12				
Stóra-Aragjá	D2									0.11				
Stóra-Aragjá	D2									0.17				
Stóra-Aragjá	D2									0.11				
Stóra-Aragjá	D2									0.07				
Stóra-Aragjá	D2									0.1				
Stóra-Aragjá	D2									0.3				
Stóra-Aragjá	D2									0.07				
Stóra-Aragjá	D2									0.08				
Stóra-Aragjá	D2									0.13				
Stóra-Aragjá	D2									0.14				
Stóra-Aragjá	D2									0.18				
Stóra-Aragjá	D2									0.13				
Stóra-Aragjá	D2									0.29				
Stóra-Aragjá	D2									0.63				
Stóra-Aragjá	D2									0.7			Right of D2	
Stóra-Aragjá	D2									0.91				
Stóra-Aragjá	D2									0.16				
Stóra-Aragjá	D2									0.15				
Stóra-Aragjá	D2									0.13				
Stóra-Aragjá	D2									0.11				
Stóra-Aragjá	D2									0.28				
Stóra-Aragjá	D2									0.27				
Stóra-Aragjá	D2									0.17				
Stóra-Aragjá	D2									0.18				
Stóra-Aragjá	D2									0.52				
Stóra-Aragjá	D2									0.47				
Stóra-Aragjá	D2									0.25				
Stóra-Aragjá	D2									0.32				
Stóra-Aragjá	D2									0.68				
Stóra-Aragjá	D2									0.26				
Stóra-Aragjá	D2									0.23				

Location	Domain	Area (m2)	%intact	% rocky talus	% grassy slope	subdomain	num blocks	dist	blocks/m	Block Height (m	OR block si	notes	f/m/c
Stóra-Aragjá	D2									0.87			
Stóra-Aragjá	D2									0.38			
Stóra-Aragjá	D2									0.77			
Stóra-Aragjá	D2									0.71			
Stóra-Aragjá	D2									0.74			
Stóra-Aragjá	D2									0.84			
Stóra-Aragjá	D2									0.45			
Stóra-Aragjá	D2									0.2			
Stóra-Aragjá	D2									0.23			
Stóra-Aragjá	D2									0.74			
Stóra-Aragjá	D2									0.64			
Stóra-Aragjá	D2									0.32			
Stóra-Aragjá	D2									1.46			
Stóra-Aragjá	D2									0.59			
Stóra-Aragjá	D2									0.56			
Stóra-Aragjá	D2									0.9			
Stóra-Aragjá	D2									1.71			
Stóra-Aragjá	D2									0.4			
Stóra-Aragjá	D2									0.41			
Stóra-Aragjá	D2									0.47		Between D2 and D1	
Stóra-Aragjá	D2									0.52			
Stóra-Aragjá	D2									0.6			
Stóra-Aragjá	D2									0.37			
Stóra-Aragjá	D2									1.14			
Stóra-Aragjá	D2									0.75			
Stóra-Aragjá	D2									0.72			
Stóra-Aragjá	D2									0.9			
Stóra-Aragjá	D2									0.77			
Stóra-Aragjá	D2									0.44			
Stóra-Aragjá	D2									0.85			
Stóra-Aragjá	D2									0.7			
Stóra-Aragjá	D2									1.28			
Stóra-Aragjá	D2									0.58			
Stóra-Aragjá	D2									0.38			
Stóra-Aragjá	D2									0.4			
Stóra-Aragjá	D2									0.86			
Stóra-Aragjá	D2									1.18			
Stóra-Aragjá	D2									0.73			
Stóra-Aragjá	D2									0.52			
Stóra-Aragjá	D2									1.63			
Stóra-Aragjá	D2									0.84			
Stóra-Aragjá	D2									0.4			
Stóra-Aragjá	D2									1.07			
Stóra-Aragjá	D2									0.91			
Stóra-Aragjá	D2									1.11			
Stóra-Aragjá	D2									0.58			
Stóra-Aragjá	D2									1.74			
Stóra-Aragjá	D2									1.29			
Stóra-Aragjá	D2									0.91		In D1	
Stóra-Aragjá	D2									0.52			
Stóra-Aragjá	D2									0.56			

Location	Domain	Area (m2)	%intact	% rocky talus	% grassy slope	subdomain num blocks	dist	blocks/m	Block Height (m	OR block si	notes	f/m/c
Stóra-Aragjá	D2									0.47		
Stóra-Aragjá	D2									0.97		
Stóra-Aragjá	D2									1.88		
Stóra-Aragjá	D2									0.67		
Stóra-Aragjá	D2									0.6		
Stóra-Aragjá	D2									0.98		
Stóra-Aragjá	D2									0.71		
Stóra-Aragjá	D2									0.72		
Stóra-Aragjá	D2									0.34		
Stóra-Aragjá	D2									0.21		
Stóra-Aragjá	D2									0.34		
Stóra-Aragjá	D2									0.1		
Stóra-Aragjá	D2									0.66	Right of D1	
Stóra-Aragjá	D2									0.62		
Stóra-Aragjá	D2									0.27		
Stóra-Aragjá	D2									0.2		
Stóra-Aragjá	D2									0.18		
Stóra-Aragjá	D2									0.14		
Stóra-Aragjá	D2									0.41		
Stóra-Aragjá	D2									0.83		

12.5 APPENDIX E – RMR Analysis

	Hildargjá														
Location	**H D1SD2**	**H D2SD1**	**H D2SD2**	**H D2SD3**	**H D3SD1**	**H D3SD2**	**H D3SD3**	**H D5SD1**	**H D5SD2**	**H D5SD3**	**H D5SD4**	**H D5SD5**	**H D6SD1**	**H D6SD2**	**H D6SD4**
Classification	**(2)**	**(3)**	**(2)**	**(2)**	**(2)**	**(2)**	**(2)**	**(2)**	**(2)**	**(2)**	**(2)**	**(2)**	**(2)**	**(2)**	**(2)**
Parameter	**Strong**	**Moderate**	**Strong**	**Strong**	**Strong**	**Strong**	**Strong**	**Strong**	**Strong**	**Strong**	**Strong**	**Strong**	**Strong**	**Strong**	**Strong**
Intact rock strength (N-type Schmidt hammer 'R')	>200 MPa r: 20.00	>200 MPa r: 20.00	>200 MPa r: 20.00	>200 MPa r: 20.00	>200 MPa r: 20.00	>200 MPa r: 20.00	>200 MPa r: 20.00	>200 MPa r: 20.00	>200 MPa r: 20.00	>200 MPa r: 20.00	>200 MPa r: 20.00	>200 MPa r: 20.00	>200 MPa r: 20.00	>200 MPa r: 20.00	>200 MPa r: 20.00
Weathering	Slightly Weathered r: 9.00	Slightly Weathered r: 9.00	Slightly Weathered r: 9.00	Slightly Weathered r: 9.00	Slightly Weathered r: 9.00	Slightly Weathered r: 9.00	Slightly Weathered r: 9.00	Slightly Weathered r: 9.00	Unweathered r: 10.00	Unweathered r: 10.00	Unweathered r: 10.00	Unweathered r: 10.00	Slightly Weathered r: 9.00	Slightly Weathered r: 9.00	Slightly Weathered r: 9.00
Spacing of Joints	3-1 m r: 28.00	0.3-0.05 m r: 15.00	3-1 m r: 28.00	1-0.3 m r: 21.00	3-1 m r: 28.00	1-0.3 m r: 21.00	3-0.3 m r: 24.00	1-0.3 m r: 21.00	3-1 m r: 28.00	0.3-0.05 m r: 15.00	1-0.3 m r: 21.00	3-1 m r: 28.00	3-1 m r: 28.00	1-0.3 m r: 21.00	3-1 m r: 28.00
Joint Orientations	Fair - Unfavorable Horizontal to moderate dips, or nearly vertical (hard rocks only) r: 12.00	Fair - Unfavorable Horizontal to moderate dips, or nearly vertical (hard rocks only) r: 10.00	Fair Horizontal (~13°) dips, or nearly vertical (hard rocks only) r: 12.00	Fair Horizontal (~13°) dips, or nearly vertical (hard rocks only) r: 12.00	Fair - Unfavorable Horizontal dips (~20°), or nearly vertical (hard rocks only) r: 11.00	Fair Horizontal dips, or nearly vertical (hard rocks only) r: 14.00	Fair Horizontal dips, or nearly vertical (hard rocks only) r: 14.00	Fair Horizontal dips, or nearly vertical (hard rocks only) r: 14.00	Fair Horizontal dips, or nearly vertical (hard rocks only) r: 14.00	Fair Horizontal dips, or nearly vertical (hard rocks only) r: 14.00	Fair Horizontal dips, or nearly vertical (hard rocks only) r: 14.00	Fair Horizontal dips, or nearly vertical (hard rocks only) r: 14.00	Fair- Unfavorable Horizontal (~24°) dips, or nearly vertical (hard rocks only) r: 11.00	Fair Horizontal dips, or nearly vertical (hard rocks only) r: 14.00	Fair Horizontal dips, or nearly vertical (hard rocks only) r: 13.00
Width of Joints	>20 mm r: 2.00	1-5 mm r: 5.00	>20 mm r: 2.00	<0.1 mm r: 7.00	<0.1 mm r: 7.00	0.1-1 mm none to wide r: 6.00	<0.1 to >20 mm r: 4	5-20 mm r: 4	1-5 mm r: 5.00	<0.1 mm r: 7.00	0.1-1 mm r: 6.00	1-5 mm r: 5.00	5-20 mm r: 4	0.1-1 mm r: 6.00	>20 mm r: 2.00
Continuity of Joints	Few continuous r: 6.00	Not always Continuous, occasional infill r: 5.00	Continuous, no infill r: 5.00	Few continuous r: 6.00	Few continuous r: 6.00	Few continuous r: 6.00	Few continuous r: 6.00	Continuous, thin discontinuous infill. r: 4	Continuous, no infill r: 5.00	Few continuous r: 6.00	Few continuous r: 6.00	None continuous r: 7.00	Continuous, no infill r: 5.00	Few continuous r: 6.00	Continuous, no infill r: 5.00
Outflow of Groundwater	None r: 6.00	None r: 6.00	Trace r: 5.00	None r: 6.00	Trace r: 5.00	None r: 6.00	None r: 6.00	None r: 6.00	None r: 6.00	None r: 6.00	None r: 6.00	None r: 6.00	Trace r: 5.00	Trace r: 5.00	None r: 6.00
Total Rating	77.00	70.00	81.00	81.00	86.00	82.00	83.00	78.00	88.00	78.00	83.00	90.00	82.00	81.00	83.00
Notes															

Source: Modified Selby 1993 Table 6.5; Intact rock strength from Selby 1993 Table 5.3

Table 1: Geomorphic rock mass strength classification and ratings

	Hildargjá	Gildrulholtsagjá							Nydri-Mosadalgjá					
Location	**H D6SD5**	**G D1SD1**	**G D1SD2**	**G D1SD3**	**G D1SD4**	**G D2SD2**	**G D2SD3**	**G D2SD4**	**G D2SD5**	**NM D1SD1**	**NM D1SD2**	**NM D1SD3**	**NM D1SD4**	**NM D1SD5**	**NM D1SD6**
Classification	**(1)**	**(2)**	**(2)**	**(2)**	**(2)**	**(2)**	**(3)**	**(2)**	**(1)**	**(2)**	**(2)**	**(2)**	**(2)**	**(1)**	**(2)**
Parameter	**Very Strong**	**Strong**	**Strong**	**Strong**	**Strong**	**Strong**	**Moderate**	**Strong**	**Very Strong**	**Strong**	**Strong**	**Strong**	**Strong**	**Very Strong**	**Strong**
Intact rock strength (N-type Schmidt hammer 'R')	>200 MPa r: 20.00	R5-R6 >200 MPa r: 19.00	>200 MPa r: 20.00	>200 MPa r: 20.00	>200 MPa r: 20.00	>200 MPa r: 20.00	100-200 MPa r: 18.00	>200 MPa r: 20.00	>200 MPa r: 20.00	>200 MPa r: 20.00	>200 MPa r: 20.00	>200 MPa r: 20.00	>200 MPa r: 20.00	>200 MPa r: 20.00	>200 MPa r: 20.00
Weathering	Unweathered r: 10.00	Slightly Weathered r: 8.00	Slightly Weathered r: 9.00	Unweathered r: 10.00	Unweathered r: 10.00	Slightly Weathered r: 9.00	Moderately Weathered r: 7.00	Slightly Weathered r: 9.00	Unweathered r: 10.00	Unweathered r: 10.00	Slightly Weathered r: 9.00	Slightly Weathered r: 9.00	Slightly Weathered r: 9.00	Unweathered r: 10.00	Unweathered r: 10.00
Spacing of Joints	3-1 m r: 28.00	0.3-0.05 m r: 15.00	3-1 m r: 28.00	3-1 m r: 28.00	1-0.3 m r: 21.00	avg 1-0.3 m r: 21.00	0.3-0.05 m r: 15.00	1-0.3 m r: 21.00	1-0.3 m r: 21.00	1-0.3 m r: 21.00	0.3-0.05 m r: 15.00	1-0.3 m r: 21.00	0.3-0.05 m r: 15.00	3-1 m r: 28.00	1-0.3 m r: 21.00
Joint Orientations	Favorable Moderate dips into slope r: 18.00	Fair variable in, out horizontal dips, or nearly vertical (hard rocks r: 14.00	Unfavorable Moderate dips out of slope r: 9	Unfavorable Moderate dips out of slope r: 9	Unfavorable Moderate dips out of slope r: 9	Fair Horizontal dips, or nearly vertical (hard rocks only) r: 12.00	Very unfavorable Steep dips out of slope r: 5.00	Fair Horizontal dips, or nearly vertical (hard rocks only) r: 14.00	Fair Horizontal dips, or nearly vertical (hard rocks only) r: 14.00	Fair Horizontal dips, or nearly vertical (hard rocks only) r: 14.00	Fair Horizontal dips, or nearly vertical (hard rocks only) r: 14.00	Fair Horizontal dips, or nearly vertical (hard rocks only) r: 14.00	Fair Horizontal dips, or nearly vertical (hard rocks only) r: 14.00	Fair Horizontal dips, or nearly vertical (hard rocks only) r: 14.00	Fair Horizontal dips, or nearly vertical (hard rocks only) r: 14.00
Width of Joints	>20 mm r: 2.00	1-5 mm r: 5.00	5-20 and >20 mm r: 3	1-5 mm r: 5.00	0.1-1 mm r: 6.00	1-5 mm r: 5.00	1-5 mm r: 5.00	0.1-1 mm r: 6.00	0.1-1 mm r: 6.00	<0.1 mm r: 7.00	<0.1 mm r: 7.00	<0.1 mm r: 7.00	<0.1 mm r: 7.00	<0.1 mm r: 7.00	<0.1 mm r: 7.00
Continuity of Joints	Continuous, no infill r: 5.00	Continuous, no infill r: 5.00	Continuous, no infill r: 5.00	Few continuous r: 6.00	Few continuous r: 6.00	Few continuous r: 6.00	Few continuous r: 6.00	Few continuous r: 6.00	Few continuous r: 6.00	None continuous r: 7.00	None continuous r: 7.00	None continuous r: 7.00	None continuous r: 7.00	None continuous r: 7.00	None continuous r: 7.00
Outflow of Groundwater	None r: 6.00	None r: 6.00	Trace r: 5.00	None r: 6.00	None r: 6.00	Trace r: 5.00	None r: 6.00	None r: 6.00	None r: 6.00	None r: 6.00	None r: 6.00	None r: 6.00	None r: 6.00	None r: 6.00	None r: 6.00
Total Rating	89.00	72.00	79.00	84.00	78.00	78.00	62.00	82.00	83.00	85.00	78.00	84.00	78.00	92.00	85.00
Notes							*talus face	*disorganized							

Source: Modified

Table 1: Geomorphic rock mass strength classification and ratings

	Nydri-Mosadalgjá														
Location	**NM D2SD1**	**NM D2SD2**	**NM D2SD3**	**NM D2SD4**	**NM D2SD5**	**NM D3SD0**	**NM D3SD1**	**NM D3SD2**	**NM D3SD3**	**NM D3SD4**	**NM D3SD5**	**NM D3SD6**	**NM D3SD7**	**NM D4SD0A**	**NM D4SD0B**
Classification	**(2)**	**(2)**	**(2)**	**(2)**	**(2)**	**(2)**	**(2)**	**(2)**	**(2)**	**(2)**	**(2)**	**(2)**	**(2)**	**(2)**	**(2)**
Parameter	**Strong**	**Strong**	**Strong**	**Strong**	**Strong**	**Strong**	**Strong**	**Strong**	**Strong**	**Strong**	**Strong**	**Strong**	**Strong**	**Strong**	**Strong**
Intact rock strength (N-type Schmidt hammer 'R')	>200 MPa r: 20.00	>200 MPa r: 20.00	>200 MPa r: 20.00	>200 MPa r: 20.00	>200 MPa r: 20.00	>200 MPa r: 20.00	>200 MPa r: 20.00	>200 MPa r: 20.00	>200 MPa r: 20.00	>200 MPa r: 20.00	>200 MPa r: 20.00	>200 MPa r: 20.00	>200 MPa r: 20.00	>200 MPa r: 20.00	>200 MPa r: 20.00
Weathering	Unweathered r: 10.00	Unweathered r: 10.00	Unweathered r: 10.00	Unweathered r: 10.00	Unweathered r: 10.00	Unweathered r: 10.00	Unweathered r: 10.00	Unweathered r: 10.00	Unweathered r: 10.00	Unweathered r: 10.00	Unweathered r: 10.00	Unweathered r: 10.00	Unweathered r: 10.00	Unweathered r: 10.00	Unweathered r: 10.00
Spacing of Joints	1-0.3 m r: 21.00	1-0.3 m r: 21.00	1-0.3 m over r: 22.00	1-0.3 m r: 21.00	3-1 m r: 28.00	3-1 m r: 28.00	1-0.3 m r: 21.00	1-0.3 m r: 21.00	0.3-0.05 m r: 15.00	1-0.3 m r: 21.00	1-0.2 m r: 19.00	1-0.3 m r: 21.00	1-0.3 m r: 21.00	3-1 m r: 28.00	1-0.3 m r: 21.00
Joint Orientations	Fair Horizontal (~22°) dips, or nearly vertical (hard rocks only) r: 12.00	Fair Horizontal (~22°)dips, or nearly vertical (hard rocks only) r: 12.00	Fair Horizontal dips, or nearly vertical (hard rocks only) r: 14.00	Fair Horizontal dips, or nearly vertical (hard rocks only) r: 14.00	Fair Horizontal dips, or nearly vertical (hard rocks only) r: 13.00	Fair Horizontal dips, or nearly vertical (hard rocks only) r: 14.00	Fair Horizontal (~24°) dips, or nearly vertical (hard rocks only) r: 12.00	Fair Horizontal dips, or nearly vertical (hard rocks only) r: 14.00	Fair Horizontal (~24°) dips, or nearly vertical (hard rocks only) r: 12.00	Fair Horizontal dips (~23°), or nearly vertical (hard rocks only) r: 12.00	Fair Horizontal dips, or nearly vertical (hard rocks only) r: 14.00	Fair Horizontal dips, or nearly vertical (hard rocks only) r: 14.00	Fair Horizontal dips, or nearly vertical (hard rocks only) r: 13.00	Fair Horizontal dips, or nearly vertical (hard rocks only) r: 14.00	Fair Horizontal dips, or nearly vertical (hard rocks only) r: 14.00
Width of Joints	<0.1 mm r: 7.00	0.1-1 mm r: 6.00	<0.1 mm r: 7.00	0.1-1 mm r: 6.00	1-5 mm r: 5.00	1-5 mm r: 5.00	0.1-1 mm r: 6.00	0.1-1 mm r: 6.00	0.1-1 mm r: 6.00	1-5 mm r: 5.00	0.1-1 mm r: 6.00	0.1-1 mm r: 6.00	0.1-1 mm r: 6.00	1-5 mm r: 5.00	<0.1 mm r: 7.00
Continuity of Joints	Few continuous r: 6.00	Few continuous r: 6.00	None continuous r: 7.00	Continuous, no infill r: 5.00	Continuous, no infill r: 5.00	Continuous, no infill r: 5.00	Few continuous r: 6.00	Continuous, no infill r: 5.00	Few continuous r: 6.00	Continuous, no infill r: 5.00	Few continuous r: 6.00	Continuous, no infill r: 5.00	Few continuous r: 6.00	Continuous, no infill r: 5.00	Few continuous r: 6.00
Outflow of Groundwater	None r: 6.00	None r: 6.00	None r: 6.00	None r: 6.00	None r: 6.00	None r: 6.00	None r: 6.00	None r: 6.00	None r: 6.00	None r: 6.00	None r: 6.00	None r: 6.00	None r: 6.00	None r: 6.00	None r: 6.00
Total Rating	82.00	81.00	86.00	82.00	87.00	88.00	81.00	82.00	75.00	79.00	81.00	82.00	82.00	88.00	84.00
Notes															

Source: Modified

Table 1: Geomorphic rock mass strength classification and ratings

	Nydri-Mosadalgjá					Stóra-Aragjá									
Location	**NM D4SD1**	**NM D4SD2**	**NM D4SD3**	**NM D4SD4**	**NM D4SD5**	**SA D1SD1**	**SA D1SD2**	**SA D1SD3**	**SA D1SD4**	**SA D1SD5**	**SA D1SD6**	**SA D2SD2**	**SA D2SD3**	**SA D2SD4**	**SA D2SD5**
Classification	**(2)**	**(2)**	**(2)**	**(2)**	**(2)**	**(2)**	**(2)**	**(2)**	**(2)**	**(2)**	**(2)**	**(2)**	**(2)**	**(2)**	**(2)**
Parameter	**Strong**	**Strong**	**Strong**	**Strong**	**Strong**	**Strong**	**Strong**	**Strong**	**Strong**	**Strong**	**Strong**	**Strong**	**Strong**	**Strong**	**Strong**
Intact rock strength (N-type Schmidt hammer 'R')	>200 MPa r: 20.00	>200 MPa r: 20.00	>200 MPa r: 20.00	>200 MPa r: 20.00	>200 MPa r: 20.00	>200 MPa r: 20.00	>200 MPa r: 20.00	>200 MPa r: 20.00	>200 MPa r: 20.00	>200 MPa r: 20.00	>200 MPa r: 20.00	>200 MPa r: 20.00	>200 MPa r: 20.00	>200 MPa r: 20.00	>200 MPa r: 20.00
Weathering	Unweathered r: 10.00	Unweathered r: 10.00	Unweathered r: 10.00	Unweathered r: 10.00	Unweathered r: 10.00	Unweathered r: 10.00	Slightly Weathered r: 9.00	Slightly Weathered r: 9.00	Slightly Weathered r: 9.00	Unweathered r: 10.00	Unweathered r: 10.00	Unweathered r: 10.00	Unweathered r: 10.00	Slightly Weathered r: 9.00	Unweathered r: 10.00
Spacing of Joints	1-0.3 m r: 21.00	1-0.3 m r: 21.00	1-0.2 m r: 19.00	1-0.2 m r: 19.00	1-0.2 m r: 19.00	1-0.3 m r: 21.00	1-0.3 m r: 21.00	0.3-0.05 m r: 15.00	1.35-0.3 m r: 23.00	1-0.3 m r: 21.00	1-0.3 m r: 21.00	3-1 m r: 28.00	1-0.3 m r: 21.00	1-0.3 m r: 21.00	1.3-0.9 m r: 24.00
Joint Orientations	Fair Horizontal dips, or nearly vertical (hard rocks only) r: 14.00	Fair Horizontal dips, or nearly vertical (hard rocks only) r: 14.00	Fair Horizontal (~23°) dips, or nearly vertical (hard rocks only) r: 12.00	Fair Horizontal dips, or nearly vertical (hard rocks only) r: 14.00	Fair Horizontal dips, or nearly vertical (hard rocks only) r: 14.00	Favorable Moderate dips into slope r: 18.00	Favorable - Fair Horizontal (~28°) dips into slope, or nearly vertical (hard rocks only) r: 16.00	Fair Horizontal dips, or nearly vertical (hard rocks only) r: 14.00	Fair Horizontal dips, or nearly vertical (hard rocks only) r: 14.00	Fair Horizontal dips, or nearly vertical (hard rocks only) r: 14.00	Fair Horizontal dips, or nearly vertical (hard rocks only) r: 13.00	Fair Horizontal dips, or nearly vertical (hard rocks only) r: 14.00	Fair Horizontal dips, or nearly vertical (hard rocks only) r: 14.00	Fair Horizontal dips, or nearly vertical (hard rocks only) r: 13.00	Fair Horizontal dips, or nearly vertical (hard rocks only) r: 14.00
Width of Joints	0.1-1 mm r: 6.00	<0.1 mm r: 7.00	1-5 mm r: 5.00	<0.1 mm r: 7.00	1-5 mm r: 5.00	0.1-1 mm r: 6.00	<0.1 mm r: 7.00	<0.1 mm r: 7.00	0.1-1 mm r: 6.00	1-5 mm r: 5.00	0.1-1 mm r: 6.00	1-5 mm r: 5.00	<0.1 mm r: 7.00	1-5 mm r: 5.00	1-5 mm r: 5.00
Continuity of Joints	Few continuous r: 6.00	None continuous r: 7.00	Few continuous r: 6.00	Few continuous r: 6.00	Continuous, no infill r: 5.00	Continuous, no infill r: 5.00	Continuous, no infill r: 5.00	Few continuous r: 6.00	Continuous, no infill r: 5.00	Continuous, no infill r: 5.00	Few continuous r: 6.00	Continuous, no infill r: 5.00	None continuous r: 7.00	Few continuous r: 6.00	Continuous, no infill r: 5.00
Outflow of Groundwater	Trace r: 5.00	Trace r: 5.00	None r: 6.00	None r: 6.00	None r: 6.00	None r: 6.00	None r: 6.00	Trace r: 5.00	None r: 6.00	None r: 6.00	None r: 6.00	Trace r: 5.00	Trace r: 5.00	None r: 6.00	None r: 6.00
Total Rating	82.00	84.00	78.00	82.00	79.00	86.00	84.00	76.00	83.00	81.00	82.00	87.00	84.00	80.00	84.00
Notes														*no patterns	

Source: Modified

12.6 APPENDIX F – Intact Block Frequency Statistics, Talus Statistics

Intact Rock Block Frequency Statistics (blocks/m): Hildargja D1						
	Min	Max	Avg	Count	St. Dev	Avg Block Ht (m)
f	1.23	1.23	1.23	1	#DIV/0!	1.07
Total	1.23	1.23	1.23	1	#DIV/0!	1.07
Intact Rock Block Frequency Statistics (blocks/m): Hildargja D2						
	Min	Max	Avg	Count	St. Dev	Avg Block Ht (m)
c	0.33	0.33	0.33	1	#DIV/0!	1.58
f	1.82	1.94	1.88	2	0.09	0.70
Total	0.33	1.94	1.36	3	0.90	0.99
Intact Rock Block Frequency Statistics (blocks/m): Hildargja D3						
	Min	Max	Avg	Count	St. Dev	Avg Block Ht (m)
m	0.55	0.89	0.70	3	0.17	1.44
f	1.40	3.08	2.11	4	0.71	0.76
Total	0.55	3.08	1.50	7	0.91	1.05
Intact Rock Block Frequency Statistics (blocks/m): Hildargja D5						
	Min	Max	Avg	Count	St. Dev	Avg Block Ht (m)
c	0.87	1.45	1.15	3	0.29	1.57
m	1.26	1.26	1.26	1	#DIV/0!	1.01
f	2.08	2.08	2.08	1	#DIV/0!	0.54
Total	0.87	2.08	1.36	5	0.46	1.36
Intact Rock Block Frequency Statistics (blocks/m): Hildargja D6						
	Min	Max	Avg	Count	St. Dev	Avg Block Ht (m)
c	0.44	0.44	0.44	1	#DIV/0!	1.96
m	0.60	0.66	0.63	2	0.05	0.80
f	0.96	4.00	2.20	3	1.60	0.66
Total	0.44	4.00	1.38	6	1.35	0.92
Intact Rock Block Frequency Statistics (blocks/m): Hildargja						
	Min	Max	Avg	Count	St. Dev	Avg Block Ht (m)
c	0.33	1.45	0.64	5	0.47	1.70
m	0.55	1.26	0.86	6	0.27	1.08
f	0.96	4.00	1.90	11	2.52	0.75
Total	0.33	4.00	1.37	22	0.89	1.08

Intact Rock Block Frequency Statistics (blocks/m): Gildarholtsagja D1						
	Min	Max	Avg	Count	St. Dev	Avg Block Ht (m)
c	0.42	0.42	0.42	1	#DIV/0!	1.96
m	0.79	0.79	0.79	1	#DIV/0!	1.47
f	1.24	2.07	1.57	3	0.44	0.79
Total	0.42	2.07	1.18	5	0.63	1.16
Intact Rock Block Frequency Statistics (blocks/m): Gildarholtsagja D2						
	Min	Max	Avg	Count	St. Dev	Avg Block Ht (m)
m-c	1.30	1.30	1.30	1	#DIV/0!	1.66
Total	1.30	1.30	1.30	1	#DIV/0!	1.66
Intact Rock Block Frequency Statistics (blocks/m): Gildarholtsagja						
	Min	Max	Avg	Count	St. Dev	Avg Block Ht (m)
c	0.42	0.42	0.42	1	#DIV/0!	1.96
c+m-c	0.42	1.30	0.86	2	0.62	1.81
m+m-c	0.79	1.30	1.04	2	0.36	1.57
m	0.79	0.79	0.79	1	#DIV/0!	1.47
f	1.24	2.07	1.57	3	0.44	0.79
Total	0.42	2.07	1.24	6	0.56	1.41

Intact Rock Block Frequency Statistics (blocks/m): Nydri-Mosadalagia D1						
	Min	Max	Avg	Count	St. Dev	Avg Block Ht (m)
c	0.35	0.58	0.46	2	0.16	1.83
m+ m-f	1.01	1.62	1.29	5	0.24	0.74
m	1.01	1.43	1.21	4	0.18	0.80
f + f-m	1.56	5.13	3.03	8	1.25	0.64
f	1.56	5.13	3.23	7	1.20	0.65
Total	0.35	5.13	2.14	14	1.43	0.85
Intact Rock Block Frequency Statistics (blocks/m): Nydri-Mosadalagia D2						
	Min	Max	Avg	Count	St. Dev	Avg Block Ht (m)
c	0.69	0.96	0.79	3	0.14	1.04
c+m-c	0.69	0.96	0.79	4	0.12	0.97
m+ m-c + m-f	0.79	1.92	1.40	7	0.43	0.69
m	0.87	1.65	1.33	4	0.35	0.79
f + f-m	1.72	3.47	2.35	8	0.61	0.83
f	1.83	3.47	2.53	6	0.60	0.95
Total	0.69	3.47	1.71	16	0.83	0.85
Intact Rock Block Frequency Statistics (blocks/m): Nydri-Mosadalagia D3						
	Min	Max	Avg	Count	St. Dev	Avg Block Ht (m)
c	0.37	1.01	0.69	2	0.45	1.54
m	1.33	1.97	1.58	4	0.28	0.68
f	2.25	4.66	3.56	6	1.11	0.60
Total	0.37	4.66	2.42	12	1.45	0.78
Intact Rock Block Frequency Statistics (blocks/m): Nydri-Mosadalagia D4						
	Min	Max	Avg	Count	St. Dev	Avg Block Ht (m)
c	0.48	0.74	0.65	3	0.15	1.63
m	0.73	1.50	1.12	4	0.33	1.04
f	2.40	4.29	3.02	9	0.67	0.73
Total	0.48	4.29	2.10	16	1.21	0.98
Intact Rock Block Frequency Statistics (blocks/m): Nydri-Mosadalagia						
	Min	Max	Avg	Count	St. Dev	Avg Block Ht (m)
c	0.35	1.01	0.65	10	0.22	1.51
c+m-c	0.69	0.96	0.79	1	0.22	0.97
m+ m-c + m-f	0.79	1.92	1.34	12	0.36	0.71
m	0.73	1.97	1.31	16	0.32	0.83
f + f-m	1.56	5.13	2.69	16	0.97	0.73
f	1.56	5.13	3.08	28	0.94	0.73
Total	0.35	5.13	2.09	58	1.22	0.87

Intact Rock Block Frequency Statistics (blocks/m): Stóra-Aragjá D1						
	Min	Max	Avg	Count	St. Dev	Avg Block Ht (m)
c	0.74	1.15	1.00	3	0.22	0.78
c+m-c	0.74	1.64	1.21	7	0.28	0.95
m+ m-c	0.93	2.73	1.57	8	0.55	0.83
m	0.93	2.73	1.77	4	0.74	0.58
f	4.19	4.19	4.19	1	#DIV/0!	0.25
Total	0.74	4.19	1.65	12	0.95	0.77
Intact Rock Block Frequency Statistics (blocks/m): Stóra-Aragjá D2						
	Min	Max	Avg	Count	St. Dev	Avg Block Ht (m)
c	0.42	0.42	0.42	1	#DIV/0!	1.22
c+m-c	0.42	0.81	0.61	2	0.28	1.09
m+ m-c + m-f	0.81	1.95	1.33	4	0.51	1.46
m	1.03	1.03	1.03	1	#DIV/0!	1.09
f + f-m	1.55	3.92	2.62	5	0.92	1.31
f	2.77	3.92	3.20	3	0.63	0.92
Total	0.42	3.92	1.92	8	1.20	1.23
Intact Rock Block Frequency Statistics (blocks/m): Stóra-Aragjá						
	Min	Max	Avg	Count	St. Dev	Avg Block Ht (m)
c	0.42	1.15	0.71	4	0.35	1.00
c+m-c	0.42	1.64	0.91	9	0.37	1.02
m+ m-c + m-f	0.81	2.73	1.45	12	0.53	1.15
m	0.93	2.73	1.40	5	1.48	0.83
f + f-m	1.55	3.92	2.62	5	1.18	1.31
f	2.77	4.19	3.69	4	0.71	0.59
Total	0.42	4.19	1.78	20	0.05	1.00

Intact Rock Block Frequency Statistics (blocks/m)						
	Min	Max	Avg	Count	St. Dev	Avg Block Ht (m)
c	0.33	1.45	0.61	20	0.32	1.54
c+m-c	0.42	1.64	0.85	12.00	0.37	1.27
m+ m-c + m-f	0.79	2.73	1.28	26.00	3.16	1.14
m	0.55	2.73	1.09	28.00	0.48	1.05
f + f-m	1.55	5.13	2.65	21.00	1.03	1.02
f	0.96	5.13	2.56	46.00	1.04	0.71
Total	0.33	5.13	1.62	106.00	1.13	1.09

*f = fine blocks
*m = medium blocks
*c = coarse blocks