

33 IGC Excursion No. 6, August 15 – 22, 2008



33 IGC, The Nordic Countries



The Volcanic and Sedimentary Evolution of the Faroe Islands Basalt Group

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Puffins on Mykineshólmur. Photo courtesy of Thomas Varming.

Abstract

This post 33 International Geological Congress field excursion to the Faroe Islands shall visit up to 70 localities over the course of 6 days examining some of the key aspects of the Faroe Islands Basalt Group (FIBG). The FIBG is a Palaeogene lava field associated with the opening of the North Atlantic Ocean and is part of the North Atlantic Igneous Province. Over the 6 days the field excursion shall compare and contrast the different lava facies of the three main Beinivørð, Malinstindur and Enni formations. The differences in lava facies shall be explained by different emplacement mechanisms and evidence shall be given to show that the majority of the lava flows on the Faroe Islands are pahoehoe in character and emplaced through the inflation (endogenous) process. The field excursion shall also visit a variety of interlava lithologies that punctuate the overwhelming lava-dominated volcanic pile. Evidence shall be shown that clearly demonstrates that sedimentary processes were an important aspect to the development of the FIBG. This includes the observation that key interlava lithologies typically occur where the lava flows exhibit changes in morphology, petrology and geochemistry. These changes will be observed at the following principal sedimentary-dominated Prestfjall, Hvannahagi and Sneis formations but also at the Kvívík and Argir beds. A visit to the Faroe Islands would not be complete without examining the three major saucer-shaped sills that represent the youngest phase of igneous activity on the islands.



View NE towards Vágur from Sornfelli, Streymoy.

Logistics

Dates and Location

Timing:	Friday, 15 – Friday, 22 August 2008
Start Location:	Rendezvous at the meeting point in the departure hall at Oslo Airport, Norway no later than 04:30
End Location:	Vágar Airport, Faroe Islands at 06:30

Travel Arrangements

Friday, 15 August 2008

The group will rendezvous with the excursion leader, Simon Passey, at the meeting point (between check-in desks C and D) in Oslo Airport (www.osl.no) no later than 04:30 to check-in for the 06:15 Scandinavian Airlines flight (SK1461) to Copenhagen, Denmark. The group will then transfer to the 08:35 Atlantic Airways flight (RC451) to the Faroe Islands. Upon arrival at 10:00 at Vágur Airport, Faroe Islands the group will be transferred by bus to Hotel Hafnia. The bus journey will take ~45-60 minutes.

Friday, 22 August 2008

The group shall spend the night of Thursday, 21 August at the 62°N airport hotel (Hotel Vágur), which is ~300 m away from the airport terminal. Therefore, it is a short walk from the hotel the following morning to check-in by 06:30 to catch the 07:30 Atlantic Airways flight (RC450) to Copenhagen, Denmark. The flight is due to arrive in Copenhagen at 10:45 and members of the group travelling onto Oslo shall transfer for the 14:15 Scandinavian Airlines flight (SK460) that is expected to arrive in Oslo at 15:25.

Accommodation

The majority of the excursion shall be spent at Hotel Hafnia in the capital Tórshavn, which is near the harbour and is only a few minutes walk from the town centre. During the excursion the group shall also stay two nights at Hotel Øravík on the southernmost island of Suðuroy and a night at Hotel Klaksvíkar Sjómansheim in the second largest town of Klaksvík on the NE island of Borðoy. The last night shall be spent at the 62°N airport hotel, also known as Hotel Vágur, which is situated to the SE of Sørvágur on the western island of Vágur.

Field Logistics

Most of the excursion shall be spent visiting road side localities with a limited amount of walking. However, a day shall be spent visiting the secluded Hvannhagi valley on Suðuroy, which requires a 1 hour return hike over rugged, sometimes boggy, terrain from the drop-off location. The route is well worn but is steep in places, so those that suffer with vertigo should inform the excursion leader. The weather can also be quite changeable and therefore, it is essential to have good walking boots, field clothes and adequate waterproof clothing (including over-trousers). A trekking pole is also an advisable piece of equipment for crossing small, often slippery, streams and for walking up, but especially down, the slippery slopes. Other than travelling around the islands using a small chartered bus the group shall also use

the public ferry service between Tórshavn and Suðuroy. This is a 2 hour ferry journey one-way and a good pair of binoculars is advisable. In addition, two chartered boat trips are planned and sea-sickness tablets may be advisable if you suffer from the condition.



Fieldwork on the Faroe Islands requires warm and waterproof clothing, Ytripartur, SE of Skálabotnur, Eysturoy. Photo courtesy of David W. Jolley.

General Introduction

The Faroe Islands (Føroyar in Faroese) are located 62°N, 7°W in the NE Atlantic Ocean, ~280 km NW of Scotland and ~400 km SE of Iceland (Fig. 1). The capital is Tórshavn, which literally means ‘Thor’s harbour’ and is located on the SE side of Streymoy. The archipelago is made up of ~779 islands and skerries that cover a land area of ~1396 km². However, there are only 18 main islands (0.84-374.17 km²), 17 of which are inhabited. The greatest distances from N-S and E-W are ~113 km and ~75 km, respectively. There is ~1290 km of coastline and no location is more than 5 km away from the ocean. The landscape of the Faroe Islands has been sculpted by glacial action during the Quaternary, producing a dissected mountainous terrain. Consequently, the islands have an average height of 300 m and the highest mountain is Slættaratindur on Eysturoy at 882 m above sea level (asl).

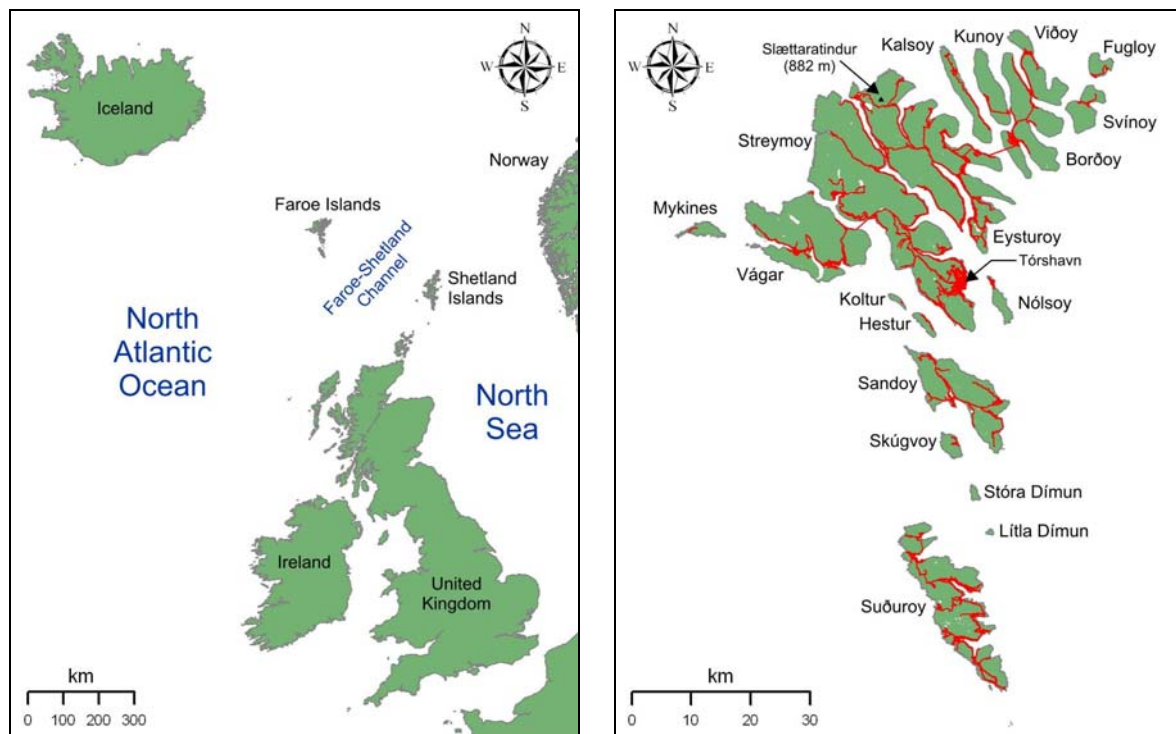


Fig. 1. Location map showing the position of the Faroe Islands within the North Atlantic.

The maritime climate of the islands is greatly influenced by the warm North Atlantic Drift and therefore, is humid, unsettled and windy, with mild winters and cool summers (Cappelen & Laursen 1998). There are typically between 200 and 300 days of precipitation (≥ 0.1 mm) with a mean annual precipitation value for Tórshavn of ~1280 mm. This increases to >3000 mm for the more mountainous northern regions. Mean temperatures range from ~4° in the winter to ~11° in the summer and wind speeds for the islands are generally quite high averaging 16-22 km/h in the summer and 23-36 km/h in the winter. In the summertime, fog can be a problem, causing delays to flights, but also making hill walking very treacherous as it can descend quite quickly. On average, Tórshavn has only 2 clear days per year, where cloud cover is <20%.

The islands are well known for the diversity of bird life, but especially the colourful and comical puffins that breed here during the summer. The national bird is the oystercatcher (*tjaldur*), a distinctive black and white wader with a long orange-red bill, which quickly draws attention to itself by its piping call (Fig. 2a). The arrival of the oystercatcher is celebrated every year on the 12 March and signifies the beginning of spring and lengthening days. The

islands are also known for their breeding colonies, notably those of the gannet on the islets off Mykineshólmur and also the world's (self-acclaimed) largest storm petrel colony situated on the E side of Nólsoy.

There are only three established land mammals on the islands: mountain hare, brown rat and the house mouse. All of them were introduced by man. The mountain hare was introduced to the islands from Norway in 1854 and are now widespread. Initially, the hares turned white in winter but because of the milder winters compared to Norway they are tending to stay brown throughout the year. Marine mammals are common around the islands, especially grey seals (Fig. 2b) and various cetacean species (whales, dolphins and porpoises), but particularly the pilot whale.

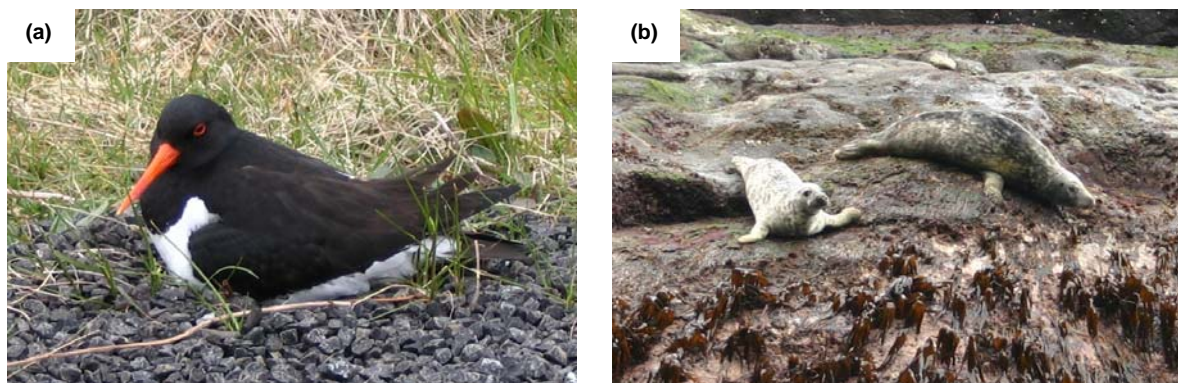


Fig. 2. Faroese wildlife. (a) Oystercatcher, Syðradalur, Streymoy. Photo courtesy of Thomas Varming. (b) Grey seals, Kalsoy.

As of the 1 January 2008 the population of the islands was ~48,430, where ~40% live within the Tórshavn municipality (Hagstova Føroya 2008). The islands have their own parliament (Fig. 3), *Løgting*, and are a self-governing overseas administrative division of the Kingdom of Denmark, but unlike Denmark they are not part of the European Union. The national language is Faroese, which is based on Old Norse, with Danish as a second language, although English is widely spoken. The economy of the islands is based primarily on fishing and fish processing which accounts for about >90% of the export volume and ~15% of the work force in 2007.



Fig. 3. View of Tinganes, the 'assembly peninsula' and the oldest part of Tórshavn, Streymoy.

Fieldwork on the islands generally involves cross-country walking over rough, sometimes boggy, terrain. As most roads are close to sea-level climbing to heights above 300 m is common and slopes are extremely steep, typically grass covered and slippery. It can also be difficult to climb due to some of the lava flows forming thick walls or benches (*hamar*) that need to be negotiated. Route planning is essential before setting off and topographic maps at

the 1:20,000 scale can be purchased from book shops in Tórshavn. The islands are also criss-crossed by steep-sided ravines (*gjógv*) that become dangerous obstacles in foggy weather and in the past people have been killed or seriously injured falling down them. As mentioned above, the weather is quite changeable and rain and strong winds are common. It is therefore, essential to have good walking boots and adequate waterproof clothing. A trekking pole is an advisable piece of equipment crossing the small very slippery streams, walking up, but especially down the slippery slopes and also crossing loose scree in higher terrain.



*The excursion leader, Simon R. Passey, making notes, Hvanndalsá, Suðuroy.
Photo courtesy of David W. Jolley.*

Regional Geology

The Faroe Islands and its insular shelf (to water depths of ~150-200 m) form the Faroe Platform, which has a roughly triangular geometry and is part of the North Atlantic margin, a passive continental margin that extends from the western Barents Sea to offshore W of Ireland (Doré *et al.* 1999). The margin is characterised by numerous sedimentary basins formed by extensional episodes during the Devonian to the Early Eocene (Doré *et al.* 1999). The arrival of the putative proto-Iceland plume beneath Greenland led to widespread volcanic activity during the Palaeocene and Early Eocene (62-54 Ma; Saunders *et al.* 1997; Ritchie *et al.* 1999; Jolley & Bell 2002). The manifestation of this volcanic activity is referred to as the North Atlantic Igneous Province (Fig. 4; Saunders *et al.* 1997) and the Faroe Islands are an exposed remnant of a predominantly subaerial, continental flood basalt domain, the Faroe Islands Basalt Group (FIBG), of this province (Waagstein 1988; Ellis *et al.* 2002; Passey & Bell 2007). On the Faroe Islands, the FIBG has a gross stratigraphic thickness of at least 6.6 km and is dominated by tholeiitic basalt lava flows, subdivided into seven formations based primarily on lithology (Figs. 5 & 6; Rasmussen & Noe-Nygaard 1969; 1970; Passey & Bell 2007), but also on geochemistry (Waagstein 1988). The FIBG extends from the Faroe Islands into the Faroe-Shetland Basin for at least 200 km to the E and SE (Naylor *et al.* 1999; Ritchie *et al.* 1999; Ellis *et al.* 2002).

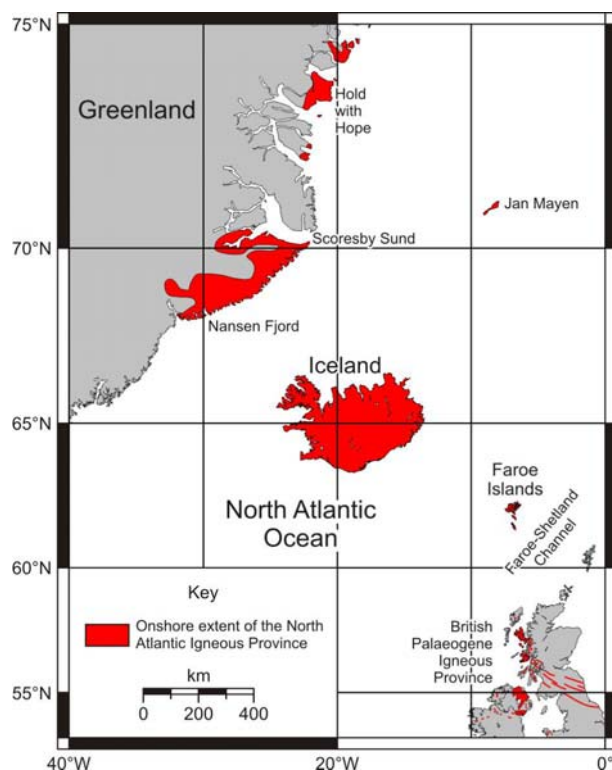


Fig. 4. Location map showing the position of the Faroe Islands Basalt Group within part of the North Atlantic Igneous Province.

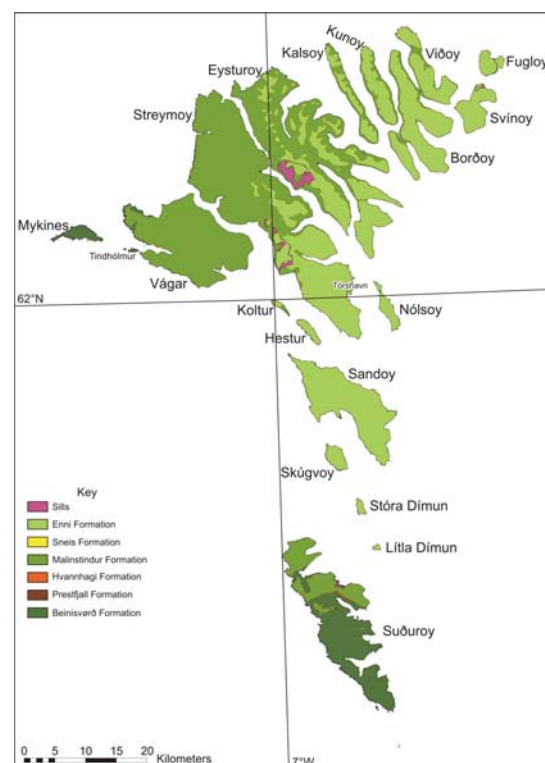


Fig. 5. Simplified geological map of the Faroe Islands. Modified after Rasmussen & Noe-Nygaard (1969; 1970)

Prior to the commencement of volcanic activity, the Faroe Islands and East Greenland were <120 km apart based on likely plate reconstitutions (Larsen *et al.* 1999). It is inferred from geochemistry (Gariépy *et al.* 1983; Hald & Waagstein 1983; Holm *et al.* 2001) and geophysics (Casten 1973; Bott *et al.* 1974; Richardson *et al.* 1998; Richardson *et al.* 1999) that the FIBG on the Faroe Islands overlies continental, Precambrian metamorphic basement. The oldest phase of volcanism recorded in the vicinity of the Faroe Islands is the ~1075 m

thick Lopra Formation which has only been encountered in the Lopra-1/1A borehole on Suðuroy (Ellis *et al.* 2002; Waagstein 2006). The formation consists of various volcanoclastic lithologies, the majority of which are described as lapilli-tuffs and are interpreted as a sequence of hyaloclastites (Waagstein 2006).

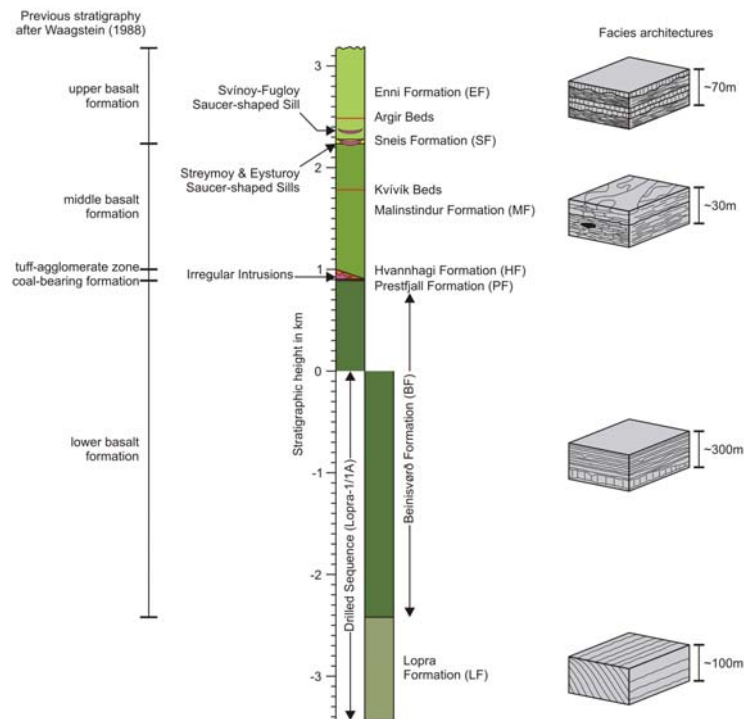


Fig. 6. Simplified lithostratigraphic column for the Faroe Islands Basalt Group, Faroe Islands. Modified after Passey & Bell (2007).

The Lopra Formation passes upwards into the Beinivørð Formation that is ~3,250 m thick, ~890 m of which are exposed on the Faroe Islands and ~2,360 m have been proven in the onshore borehole Lopra-1/1A (Rasmussen & Noe-Nygaard 1969; 1970; Hald & Waagstein 1984; Waagstein 1988; Ellis *et al.* 2002; Waagstein 2006; Passey & Bell 2007). The formation is dominated by subaerial pahoehoe sheet lobes (flow lobes that have widths significantly greater than their thicknesses), which have an average thickness of ~20 m and an observed maximum thickness of ~70 m (Fig. 7; Passey & Bell 2007). The sheet lobes predominantly exhibit poorly-developed columnar jointing although well-developed columnar jointing becomes more common within the upper 100-200 m of the formation. The majority of the lava flows are aphyric, finely crystalline basalts with an intergranular texture (Hald & Waagstein 1984). The lava flows are commonly separated by saprolitic boles but within the upper 100-200 m of the formation the flows are interbedded with coals and volcanoclastic claystones through to conglomerates. These lithologies were deposited in swamp, fluvial and lacustrine environments (Ellis *et al.* 2002). The Beinivørð Formation has been geochemically correlated to the Nansen Fjord Formation of East Greenland and have been suggested to represent a pre-break-up succession covering an estimated area of ~70,000 km² and having an estimated volume of ~120,000 km³ (Larsen *et al.* 1999).

The exposed section of the Beinivørð Formation has a normal-reversed-normal-reversed polarity, which Waagstein (1988) correlated to magnetochrons C26N, C25R, C25N and C24R (Thanetian-Ypresian). This is supported in part by preliminary radiometric age determinations for the exposed and drilled sections of the Beinivørð Formation (Waagstein *et al.* 2002).

However, this is currently at odds with palynological age determinations that imply that the exposed section of the Beinisevørð Formation post-dates the Palaeocene-Eocene Thermal Maximum (Jolley & Bell 2002; Jolley *et al.* 2002) that, according to Gradstein *et al.* (2004), occurs at 55.8 Ma (i.e. within C24R; Ypresian). Jolley & Bell (2002) interpret the normal polarity sequences as cryptochrons within C24R.



Fig. 7. Four simple lava flows (syn. sheet lobes) of the Beinisevørð Formation, Heygsmúli, Suðuroy. The cliff is ~90 m high.

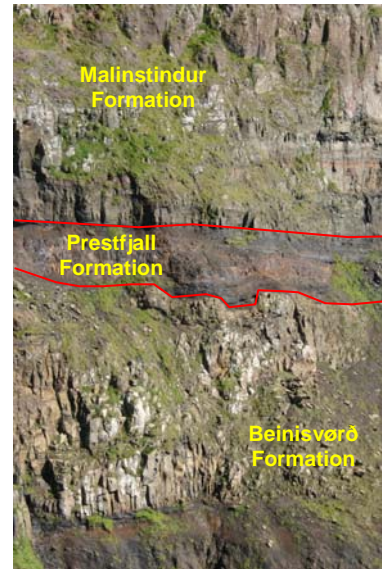


Fig. 8. Coals and claystones of the Prestfjall Formation, which is ~8 m thick in this section at Suðuri undir Hæli, Suðuroy.

A volcanic hiatus followed the emplacement of the Beinisevørð Formation during which erosion down to the second highest lava flow occurred. It is on to this highly eroded surface that the 3-15 m thick inter-eruption facies of the Prestfjall Formation was deposited (Fig. 8; Rasmussen & Noe-Nygaard 1969; 1970). The formation crops out on the islands of Suðuroy, Tindhólmur and western Vágur and is poorly exposed except for a few localities and therefore, the formation is characterised on observations made from the coal mines on Suðuroy (Rasmussen & Noe-Nygaard 1969; 1970). An idealised section through the formation consists of a basal underclay which is overlain by the lower and upper coal seams separated by the middle clay. The coal seams have an average combined thickness of ~70 cm. The top of the formation is typically represented by a roof clay, which is occasionally replaced or overlain by basaltic sandstones and conglomerates. The sedimentary units were deposited in swamp, lacustrine and fluvial environments which have a palynofloral assemblage characteristic of the base of the T45 sequence seen offshore in the Faroe-Shetland Basin (Jolley & Bell 2002; Jolley *et al.* 2002).

Volcanism resumed with widespread ash fall deposits that were contemporaneous with sedimentation and this syn-eruption facies is represented by the Hvannahagi Formation (Fig. 9). The Hvannahagi Formation crops out on the islands of Tindhólmur, Vágur and Suðuroy and is locally restricted to palaeo-lows on the volcanic land surface (Rasmussen & Noe-Nygaard 1969; 1970; Passey 2004). The formation has been intruded by numerous irregular dolerite sills and consequently it is unclear exactly how thick the formation is, but it is at least 40-50 m thick (Rasmussen & Noe-Nygaard 1969; 1970; Passey 2004). The formation consists of two sequences each composed of basal tuffs overlain by volcanoclastic mudstones-conglomerates (Passey 2004). Each of these sequences began with pyroclastic activity which blanketed the volcanic terrain with basaltic tephra. This tephra was subsequently reworked and deposited from mass flow/sheet flood events under hyperconcentrated and debris flow

processes. The top of the formation sometimes alternates with the first lava flow lobes of the Malinstindur Formation.

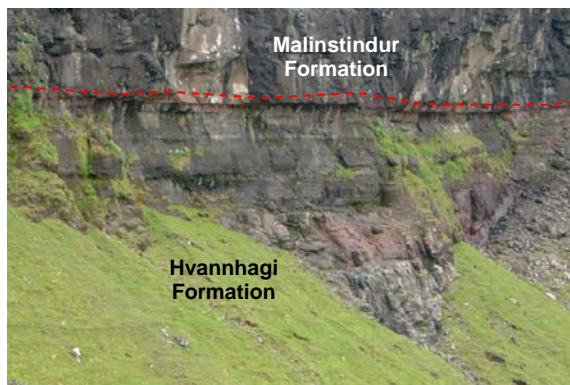


Fig. 9. A ~30 m thick section through the Hvannhagi Formation, Uttariþartur, Hvannhagi, Suðuroy.

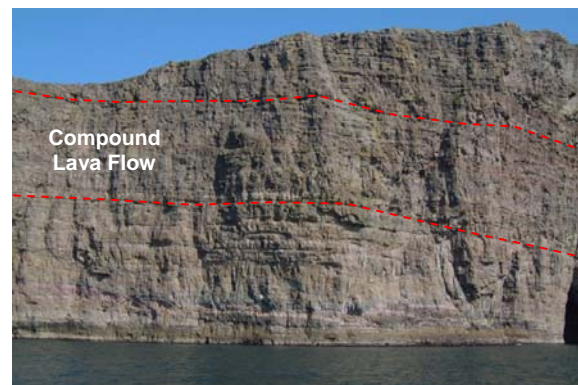


Fig. 10. A ~150-160 m thick section through compound lava flows of the Malinstindur Formation, Eyguni, Vágur.

Irregular intrusions associated with the onset of the Malinstindur Formation volcanism have disrupted the base of the Hvannhagi Formation and locally exceed ~100 m in thickness (Waagstein 1988; Hald & Waagstein 1991). The Malinstindur Formation is ~1200-1400 m thick in the N of the Faroe Islands (Rasmussen & Noe-Nygaard 1969; 1970; Waagstein 1988; Ellis *et al.* 2002; Passey & Bell 2007). The formation is composed almost exclusively of subaerial, compound lava flows (Fig. 10). The lava flows have an average thickness of ~20 m and are made up of smaller anastomosing flow lobes that range from tens of centimetres up to ~4 m in thickness. The flow lobes are typically of the P-type pahoehoe variety, consisting of a basal crust with pipe amygdales, a massive core and an upper amygdaloidal crust (Passey & Bell 2007). Many of the flow lobes exhibit well-preserved ropy surfaces. The flows progress up-section from olivine-phyric to plagioclase-phyric varieties which is reflected by decreasing Fe and Mg contents (Waagstein 1988). Approximately, two-thirds above the base of the formation a distinct sequence of brown weathering, olivine-phyric compound flows occur that are characterised by having a low-TiO₂, MORB-like composition (Waagstein 1988). Ubiquitous throughout the formation are filled lava tubes ranging in size from small distributary tubes up to master lava tubes (Passey & Bell 2007). The lava flows are separated by weathered surfaces and towards the top of the formation volcanoclastic sandstones through to conglomerates become more prevalent. These volcanoclastic lithologies were mainly deposited in fluvial and lacustrine environments.

The upper surface of the Malinstindur Formation is generally highly reddened due to subaerial weathering and is interpreted to represent a disconformity surface on to which the sedimentary units of the Sneis Formation were deposited (Fig. 11). The Sneis Formation is highly variable in thickness ranging from ~1 m in the central Faroe Islands to ~30 m in the N. The formation is typically composed of a basal, <1 m thick, volcanoclastic sandstone, the Sund Bed, which is overlain by greyish volcanoclastic conglomerate. The conglomerate can be separated into two sequences by a reddened weathered surface in the W. Moving to the S the formation thins and fines and is represented by volcanoclastic sandstones and mudstones. The Sneis Formation, like the Hvannhagi Formation, has been subsequently intruded by shallow invasive sheets. This syn-eruption facies represents an unconstrained sheet flood from which deposition took place under debris, hyperconcentrated and 'normal' streamflow processes.

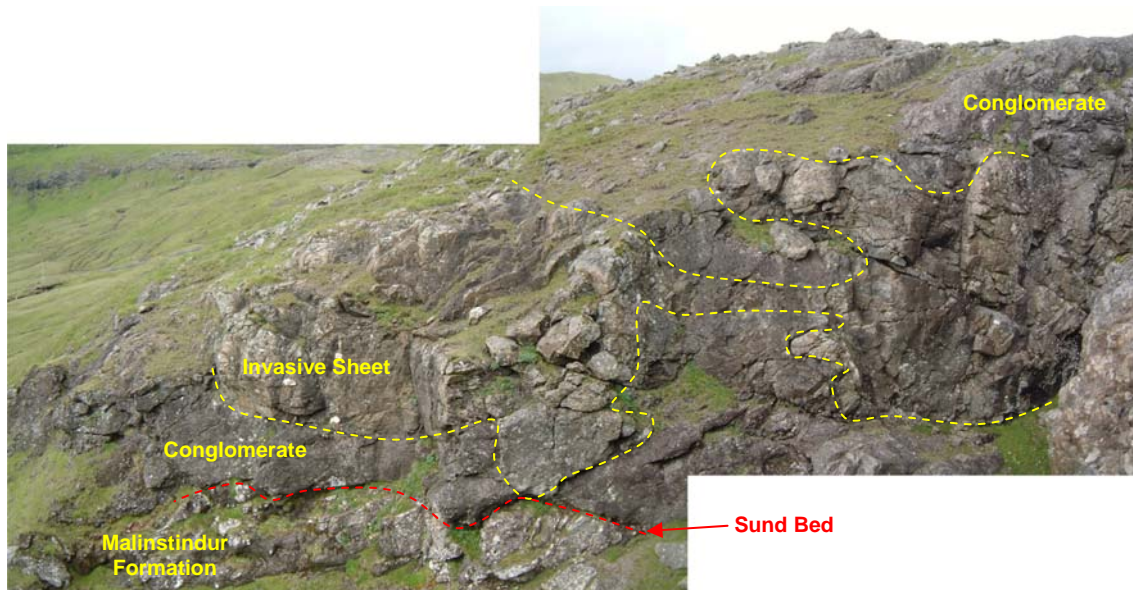


Fig. 11. A ~20 m thick section through the Sneis Formation, Dalagjógv, Norðradalur, Streymoy.

The Sneis Formation is overlain by the >900 m thick Enni Formation (Fig. 12; Rasmussen & Noe-Nygaard 1969; 1970; Waagstein 1988; Ellis *et al.* 2002; Passey & Bell 2007). The basal ~250 m of the Enni Formation is dominantly composed of compound lava flows similar in character to those of the preceding Malinstindur Formation (Passey & Bell 2007). This basal sequence is overlain by the widespread <1-6 m thick Argir Beds, a volcanoclastic sequence deposited in a complex fluviatile-floodplain environment. Above the Argir Beds the Enni Formation is composed of a mixture of compound lava flows and sheet lobes. Both flow types also vary between brown weathering, aphyric to olivine-phyric basalt to pale weathering, aphyric to plagioclase-phyric basalt. The appearance of the olivine-phyric basalts at this level maybe intrinsically linked with the shallow intrusion of the Sneis Formation by widespread flow banded olivine-phyric invasive sheets (sills). Both the shallow intrusions of the Sneis Formation and the brown weathering, olivine-phyric lava flows have a low-TiO₂, MORB-like composition (Waagstein 1988). The lava flows are typically separated by volcanoclastic mudstones through to conglomerates, which were deposited in fluviatile, lacustrine and estuarine environments (Ellis *et al.* 2002).



Fig. 12. A ~150 m thick section through the Enni Formation, Lítladalur, Kunoy. The formation is composed of a mixture of compound and simple (sheet lobe) lava flows.

The Malinstindur and Enni formations have a reversed polarity which has been attributed to magnetochron C24R (Waagstein 1988). The two formations have also been geochemically correlated to the Milne Land Formation of East Greenland and together are suggested to form a syn-break-up succession covering an estimated area of ~220,000 km² and having an

estimated volume of $\sim 250,000 \text{ km}^3$ (Larsen *et al.* 1999). It has been estimated that at least a few hundred metres have been eroded away from the top of the volcanic pile on the Faroe Islands (Waagstein *et al.* 2002; Jørgensen 2006). The FIBG was subsequently intruded by dykes and the following saucer-shaped sills: Streymoy Sill (Fig. 13), Eysturoy Sill and the Svínøy-Fugloy Sill. The Streymoy and Eysturoy sills have intruded the sequence spanning the Sneis Formation, whereas the Svínøy-Fugloy Sill occurs within a few hundred metres of the Sneis Formation at the base of the Enni Formation.



Fig. 13. View of the western side of the Streymoy saucer-shaped sill, Sátan mountain ($\sim 621 \text{ m asl}$), E of Leynar, Streymoy.

The volcanic activity associated with the North Atlantic Igneous Province resulted in the eventual continental break-up between Greenland and Eurasia, culminating with the onset of seafloor spreading in magnetochron C24R times (55-54 Ma; Saunders *et al.* 1997; Ritchie *et al.* 1999; Jolley & Bell 2002). To the W and N of the Faroe Islands, seaward dipping reflector sequences (SDRS) mark the transitional zone between the attenuated continental Faroe Platform and oceanic crust of the Iceland and Norway basins (Smythe 1983; Parson & the ODP Leg 104 Scientific Party 1988; Ritchie *et al.* 1999). It has been suggested that subsequent Cenozoic compression along the Faroe-Iceland Ridge led to the present elevation of the Faroe Islands (Andersen 1988; Doré & Lundin 1996; Doré *et al.* 1999).

Terminology

Lava Flows Morphologies

For simplicity the terminology proposed by Self *et al.* (1997) has been adopted when describing lava flow morphologies. A *flow lobe* is used to describe an individual package of lava surrounded by a chilled crust and a *lava flow* is the product of a single, more or less continuous outpouring of lava that can be composed of one or more flow lobes. Individual lava flows are typically separated by weathering surfaces and/or clastic lithologies. If a lava flow consists of a single flow lobe it is referred to as a simple lava flow and conversely, a compound lava flow is made up of two or more flow lobes of any geometry or size (Walker 1970). Flow lobes that have a sheet-like or tabular geometry and are significantly wider than they are thick are referred to as sheet lobes. A flow field is the aggregate product of a single eruption or vent and is built up of one or more lava flows and is usually identified on the basis of the geochemistry of the constituent flows.

Passey & Bell (2007) have demonstrated that both the flow lobes of the simple and compound lava flows of the Faroe Islands exhibit similar morphological characteristics even though they

vary greatly in areal extent and thickness. Therefore, unless otherwise stated, the flow lobes described in this guide should be considered as pahoehoe emplaced through the inflation (endogenous) mechanism (Fig. 14) and that the term sheet lobes should be considered as synonymous with simple lava flows.

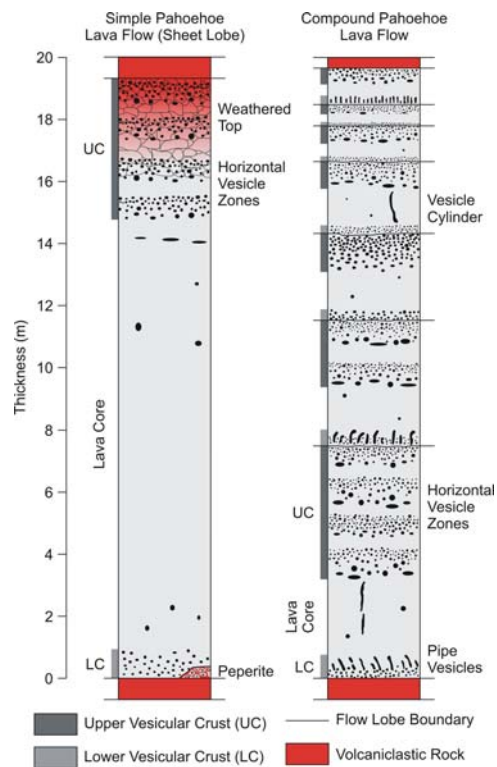


Fig. 14. Simplified vertical section through typical simple (sheet lobes) and compound lava flows of the Faroe islands. Modified after Waagstein (1998) and incorporating data from Passey & Bell (2007).

Volcaniclastics

A volcaniclastic rock is a general term for a clastic rock composed of >60% volcanic debris (Shipboard Scientific Party 2002). Volcaniclastic rocks are classified based on their overall grain size and the degree of grain roundness. Volcaniclastic rocks can be formed by a range of sedimentary or igneous processes and the resulting descriptive name (e.g. volcaniclastic sandstone) does not imply any debris forming mechanism, transportation process, or depositional setting (Fisher 1961; 1966; Fisher & Smith 1991).

Excursion Route

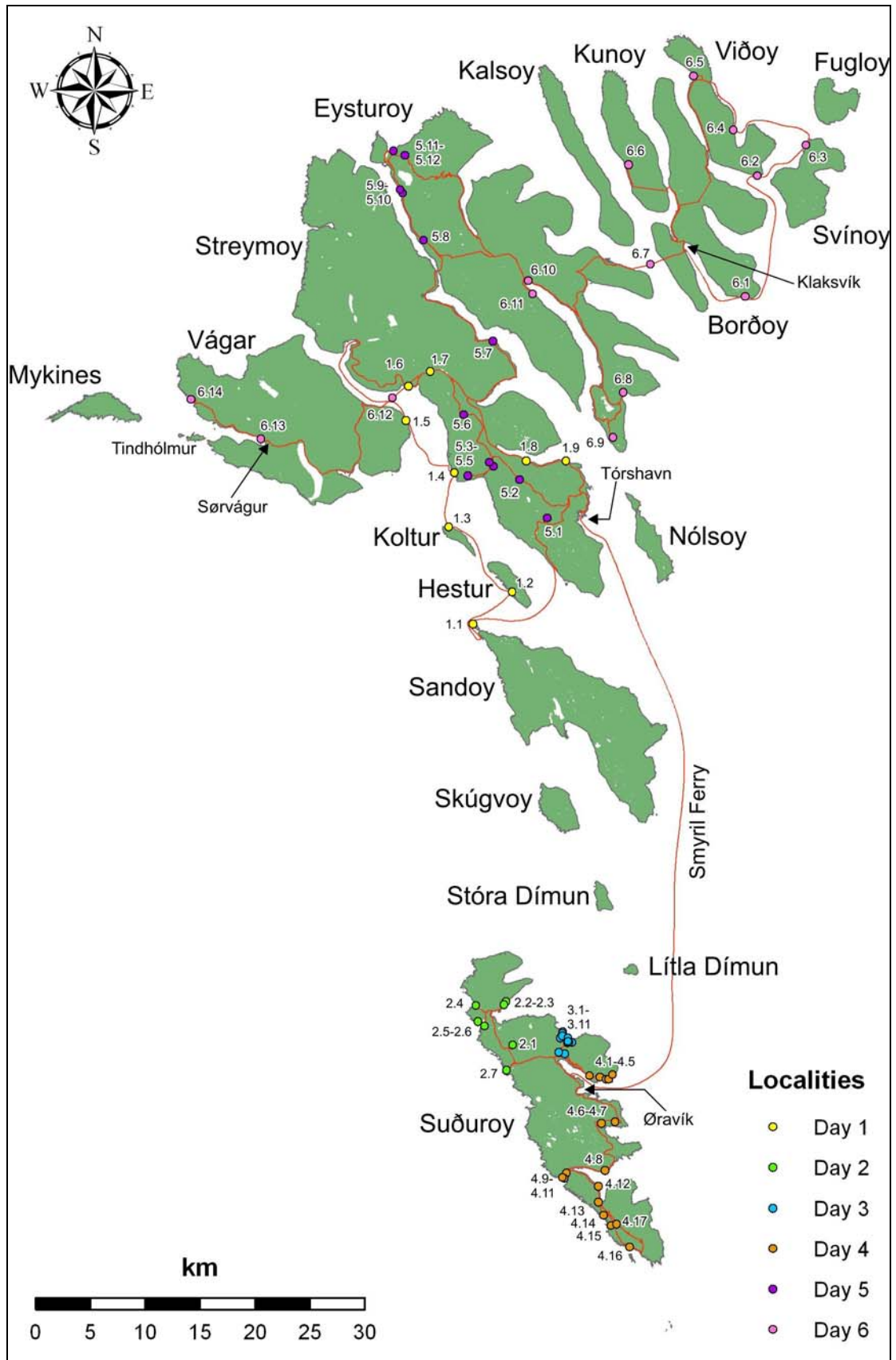


Fig. 15. Route map for the excursion. The group shall spend nights in Tórshavn, Øravík, Klaksvík and Sørvágur during the excursion.

Day 1 – Saturday, 16 August 2008

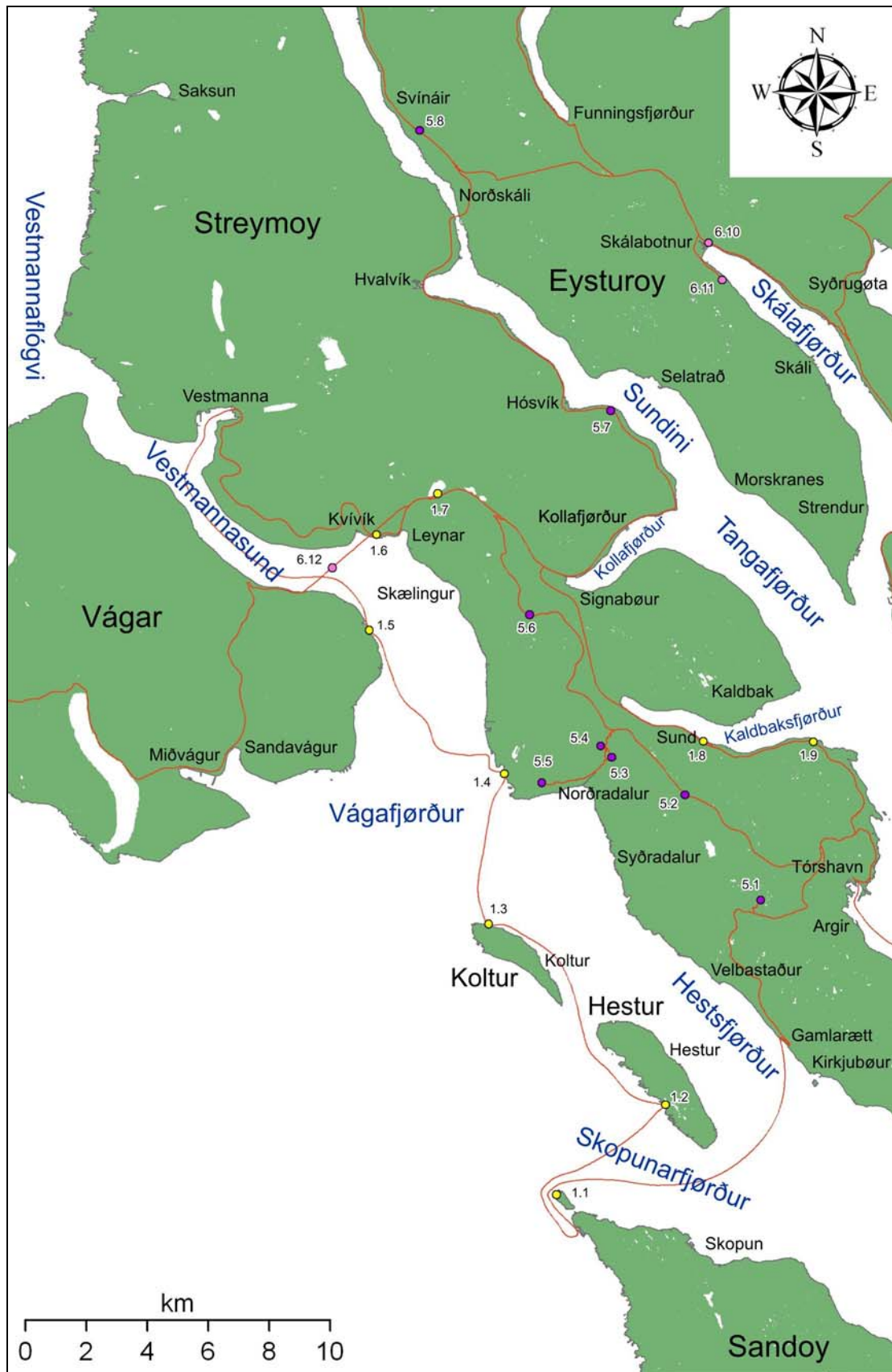


Fig. 17. Excursion route map for Day 1 – Stops 1.1 to 1.9.

Introduction

The group shall rendezvous with the excursion leader outside Hotel Hafnia for 08:30 where a bus shall be waiting to take us to the small harbour at Gamlarætt, western Streymoy (Fig. 17). The bus journey shall take ~20 minutes. The group shall then transfer to the boat, Vanir, where the majority of the day shall be spent and therefore, it is important to bring **warm clothes**, **waterproofs** and your **packed lunch**. The boat shall sail out into Hestsfjørður, passing Hestur on the starboard side before heading out along Skopunarfjørður to the small island of Trøllhøvdi, NW Sandoy (Fig. 17). From here, the boat shall head N towards Vestmanna taking in the geology and scenic views of Vágafjørður and Vestmannasund. The geology viewed during the boat trip shall include the upper few hundred metres of the Malinstindur Formation, including the Kvívík Beds, through to the Høvdhamarin Flow of the Enni Formation. This also includes the so-called vents of Rasmussen & Noe-Nygaard (1969; 1970), which shall be discussed as to their mode of formation. Time permitting, a few road side localities shall be visited on the bus journey back to Hotel Hafnia (Fig. 17). These stops will allow for close-up views of some of the inland exposures of features observed during the boat trip. The night shall be spent at Hotel Hafnia and participants are expected to arrange their own evening meal.

Gamlarætt to Vestmanna Boat Trip

Stop 1.1: Trøllhøvdi, Sandoy



Fig. 18. View of the N end of the Trøllhøvdi Lava Tube, Boðabergstangi, Trøllhøvdi, NW Sandoy.



Fig. 19. View of the Trøllhøvdi Lava Tube across Høvdasund, Trøllhøvdi, NW Sandoy.

Location

Trøllhøvdi Island [PJ 0711 6709; ~160 m asl], ~4 km WNW of Skopun, Sandoy (Fig. 17).

Introduction

This locality, at the top of the Malinstindur Formation, allows for the examination of a >1.4 km long lava tube within the inflated pahoehoe flow lobes of a compound lava flow.

Description

A more than 1.4 km long lava tube can be observed at four different localities along its length. The lava tube, the Trøllhøvdi Lava Tube, is generally elliptical in cross-section and forms a stand-alone feature compared to the inflated pahoehoe flow lobes that encase it (Passey & Bell 2007). The first exposure is at the NW end of Trøllhøvdi at Boðabergstangi, where it occurs ~35 m asl and ~20 m below the base of the Sneis Formation (Fig. 18). The lava tube at

Boðabergstangi has a cross-sectional area of $\sim 45 \text{ m}^2$. From this location the lava tube is assumed to travel $\sim 800 \text{ m}$ to the SE where it emerges close to sea level at the SE end of Trøllhøvdi (Fig. 19). The change in elevation is accounted for by the regional dip in this area. Although, the lava tube has been eroded to the S of Trøllhøvdi its trend can be traced across Høvdasund where it forms the prominent spit of land, known as Hvalsryggur (whales back), NW Sandoy (Fig. 19). Hvalsryggur is $\sim 90 \text{ m}$ long by $\sim 30 \text{ m}$ wide and initially trends NW-SE before changing to a more N-S direction. At Hvalsryggur, the lava tube has a cross-sectional area $> 140 \text{ m}^2$ (Passey & Bell 2007). The final exposure of the lava tube occurs $\sim 330 \text{ m}$ to the S in the vicinity of Raðinskor, NW Sandoy. The lava tube would have been a thermally efficient method of transporting lava across the lava field before it emerged at the flow front. It is unclear from the exposures as to the general direction in which the lava was travelling, but was either to the N or to the S. Lava tubes on the Faroe Islands have only been observed within the compound lava flow sequences of the Malinstindur and Enni formations (Passey & Bell 2007).

Stop 1.2: Loftið, Hestur

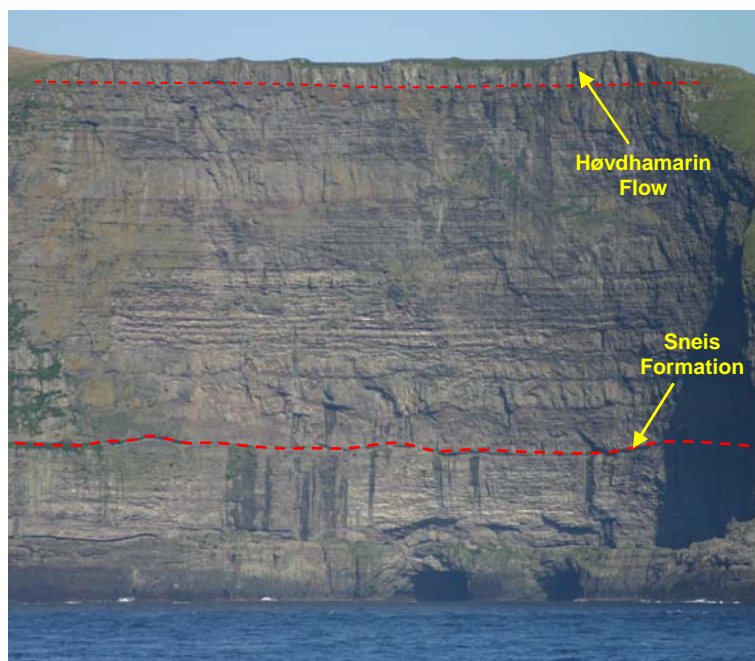


Fig. 20. View of the Loftið cliff section, Hestur.

Location

Loftið cliff section [PJ 1068 7004; 0-240 m asl], $\sim 1.3 \text{ km}$ SSW of Hestur village, Hestur (Fig. 17).

Introduction

The Loftið cliff section affords excellent views of the stratigraphy from the upper Malinstindur Formation and the base of the Enni Formation, including the Høvdhamarin Flow.

Description

The cliff section is $\sim 240 \text{ m}$ high and $\sim 170 \text{ m}$ long and strikes $N146^\circ E$ (Fig. 20). The base of the cliff section comprises two compound lava flows of the Malinstindur Formation, ~ 25 and

~40 m thick, respectively. The flows are composed of thinner flow lobes picked out by the in-weathering of the sub-horizontal upper vesicular crusts, often highlighted by guano. The upper compound lava flow is overlain by a volcanoclastic sandstone sequence attributed to the Sneis Formation from correlations on the E side of Hestur. The Sneis Formation is overlain by the lower ~175 m of the Enni Formation, which is composed predominantly of compound lava flows similar to those of the preceding Malinstindur Formation. However, this interval is punctuated by at least four sheet lobes, which are classified as such because they have widths significantly greater than their thicknesses. Two of these sheet lobes occur together ~20 m above the Sneis Formation and are 12 and 10 m thick, respectively. The third sheet lobe occurs ~72 m above the second sheet lobe and is ~15 m thick. This sheet lobe appears to wedge out against compound lava flow lobes towards the SSE-SE of the cliff section (i.e. towards the right as we look at it). This sheet lobe is overlain by an additional ~32 m of compound lava, which is in turn overlain by the fourth sheet lobe that occurs at the top of the cliff section. This sheet lobe is at least 14 m thick and forms a stratigraphic marker unit, the Høvdhamarin Flow, which is exposed across western Sandoy and southern Streymoy.

The displacement of the structural contours of this unit and those for the Sneis Formation and the Argir Beds from Hestur and Streymoy to Sandoy suggests the presence of an ESE-trending fault, parallel to the bathymetry low in Skopunarfjørður to the S of this locality. The displacement is either the result of dextral strike-slip faulting in the order of 6-7 km or normal faulting to the S in the region of 200-300 m, although the former is more likely (Passey 2008).

Stop 1.3: Keksagil, Koltur

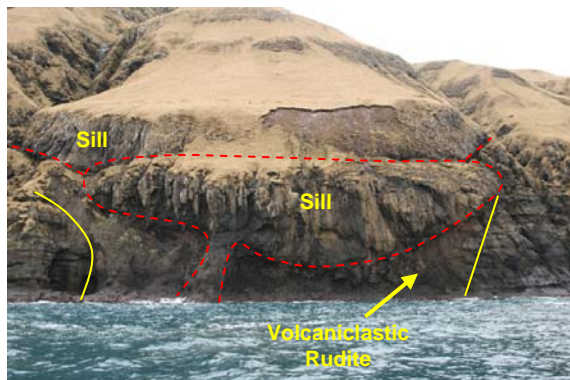


Fig. 21. View of Stop 1.3, WNW of Keksagil, Koltur.

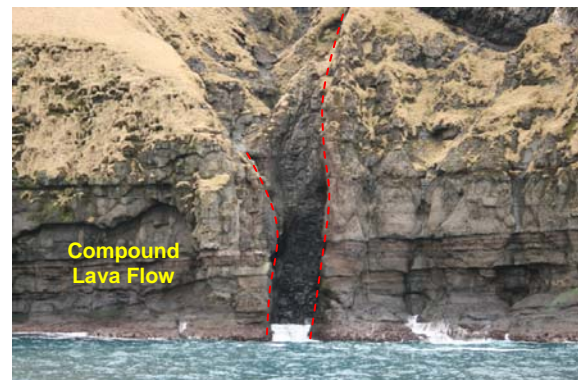


Fig. 22. View of the ~3-4 m wide dyke in the Keksagil stream, Koltur.

Location

Coastal section [PJ 0489 7598; 0-50 m asl], WNW of Keksagil, Koltur (Fig. 17).

Introduction

This stop visits and discusses one of the Malinstindur Formation “vent” localities of Rasmussen & Noe-Nygaard (1969; 1970).

Description

The locality is limited to a ~160 m wide section of coastline bounded by two dyke filled streams (Fig. 21). The stream at the ESE end of the locality is known as Keksagil (i.e. to the left of the section as we look at it). The locality is composed predominantly of Malinstindur Formation compound lava flows made up of thinner flow lobes. However, between the two

streams a section of flow lobes has been removed and subsequently infilled by a volcanoclastic rudite. The term, volcanoclastic rudite, is used in a descriptive sense because it is unclear whether the material is of pyroclastic or sedimentary origin. The infilled hollow has sharp, inward dipping to vertical contacts and is ~75 m wide at sea level, but widens up section to ~115 m at the extent of the exposure. The sequence has been interpreted as an infilled volcanic neck by Rasmussen & Noe-Nygaard (1969; 1970). This is partially supported by the section being the focus of intrusive activity. Firstly, the section is bounded by the two parallel, NNE-SSW trending, aphyric dykes that can also be seen on the W side of Koltur. The dyke in Keksagil is ~3-4 m wide (Fig. 22), whereas the dyke at the WNW end of the locality consists of at least two anastomosing parts up to 3 and 2 m wide, respectively. Secondly, the volcanoclastic rudite has been intruded by a bowl-shaped sill up to ~85 m wide by up to ~23 m thick. The feeder dyke for the sill can be seen towards the bottom left and is up to ~6 m wide by ~12 m long. The feeder dyke forms a standalone feature that has resisted erosion unlike the volcanoclastic rudite surrounding it. Lastly, a second sill occurs immediately above the bowl-shaped sill, which is at least 20 m thick, weakly columnar jointed and forms a more or less tabular body between the two dyke filled streams, suggesting it was fed by these dykes.

Stop 1.4: Nípubarmur, Streymoy

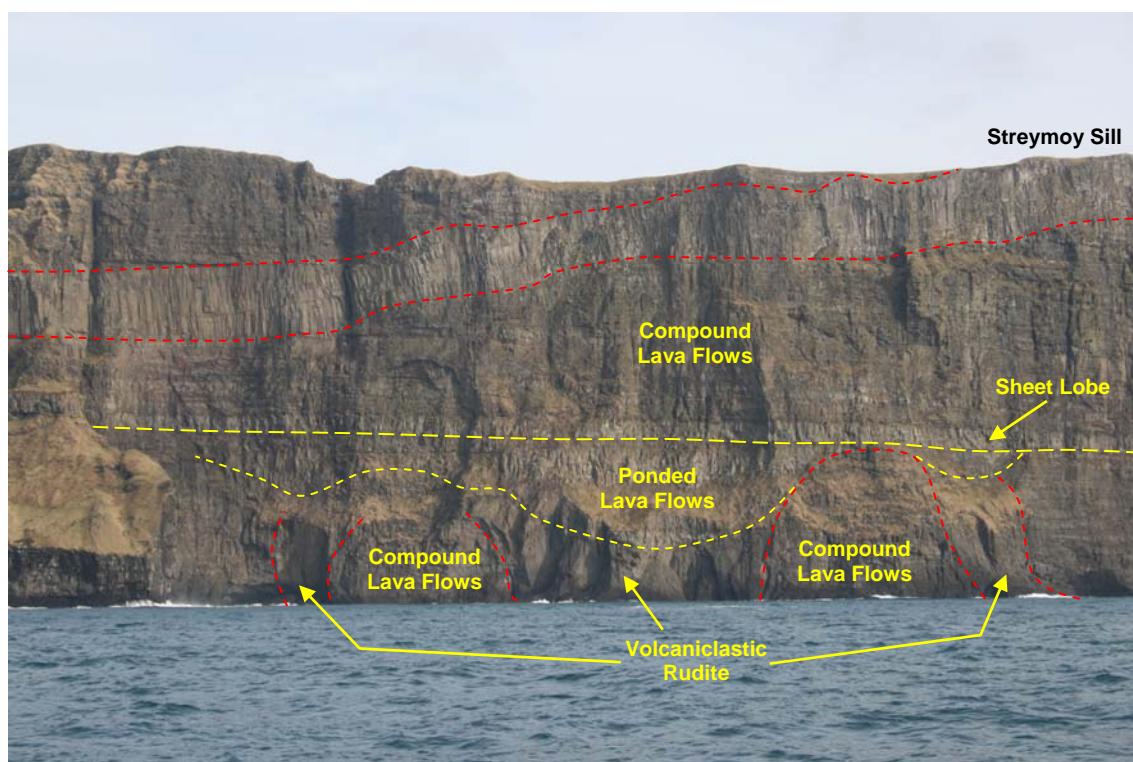


Fig. 23. View of the Streymoy Sill along the ~310 m high Nípubarmur cliff section, Streymoy.

Location

Nípubarmur cliff section [PJ 0541 8091; 0-310 m asl] between Grótsteyrur and Reipaskorargjógv, ~3 km W of Norðradalur, Streymoy (Fig. 17).

Introduction

This stop allows for the examination of a number of volcanoclastic rudites from the Malinstindur Formation, interpreted to be agglomerates within a series of small volcanic

necks (Geikie 1896) or alternative, within a single fissure (Rasmussen & Noe-Nygaard 1969; 1970). In addition, the stop affords excellent views of the Streymoy Sill.

Description

The cliff section strikes N152°E (i.e. NNW-SSE) and is on average 310 m high, reaching a maximum height of ~341 m at Dalsnípa, at the SSE end (Fig. 23). The cliffs are dominated by compound lava flows of the Malinstindur Formation, which are made up of thinner flow lobes. The lava flows have however, been intruded by the ~50 m thick columnar jointed Streymoy Sill towards the top of the cliffs. The sill is transgressive along this section of the coastline and climbs upwards by ~90 m with angles of up to 12° towards Dalsnípa (Fig. 23).

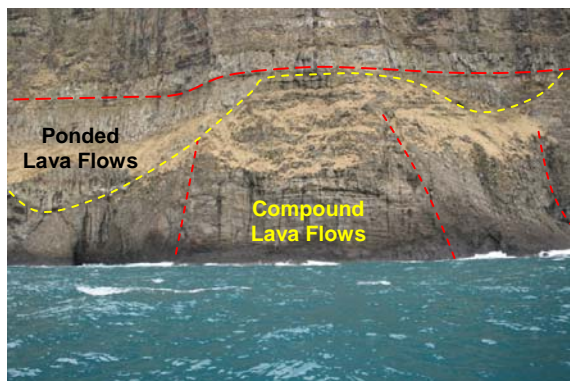


Fig. 24. View of a compound lava flow “high” draped by volcaniclastic rudite on either side, Nípubarmur, Streymoy.

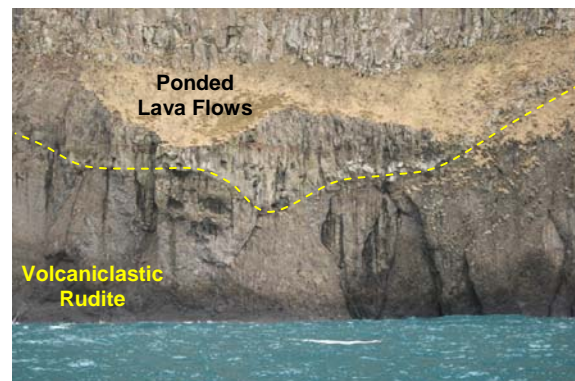


Fig. 25. Ponded lava flow within a depression in volcaniclastic rudite, Nípubarmur, Streymoy.

Towards the base of the cliff section the compound lava sequence is punctuated by a noticeable sheet lobe that occurs ~105-115 m asl (Fig. 23 & 24). The sheet lobe is ~12-15 m thick and the base of the flow forms a relatively flat-lying reference plane that can be traced along the coastline. Below this sheet lobe the compound lava flows have been removed in at least four places along this section of the Nípubarmur coastline. These hollows between the compound lava flow “highs” have subsequently been infilled by volcaniclastic rudites and ponded flow lobes (Fig. 24). The volcaniclastic rudites are clearly bedded where the beds dip steeply inwards towards the centres of the hollows (Fig. 25). This is clearly seen in the hollow ~230 m to the S of the fracture at the NNW end of the cliff section (i.e. to the left as we look at it). Here, the hollow is ~190 m wide at sea level, which increases to ~250 m below the base of the prominent sheet lobe (Fig. 25). The volcaniclastic rudite is at least 35 m thick at the centre of the hollow and has diffuse, near vertical contacts with the bounding compound lava flows. The remaining ~80 m of the hollow is infilled by ponded flow lobes. The basal flow lobe is ~17 m thick and has a sharp, planar upper contact that is clearly reddened (Fig. 25). This is overlain by a second ponded flow lobe up to ~58 m thick. The base of this second flow lobe is columnar jointed, where the joints are aligned perpendicular to the inclined NNW margin of the hollow. The second flow lobe is also observed to thin to a few metres over the “high” to the SSE before thickening to ~20 m in a hollow on the other side. In the prominent hollow the second ponded flow lobe is overlain by a ~5 m thick compound flow, which thickens to the NNW and pinches out to the SSE. The sequence is then overlain by the prominent sheet lobe that can be traced along the coastline, implying that a regionally planar surface was restored following the infilling of the hollows. The volcaniclastic rudite in the hollow at the far NNW-end can be clearly seen to be bounded by compound lava behind, suggesting a contact running parallel to the cliff section.

An additional hollow can be observed on the SSW side of the ESE-trending Reipaskorargjógv fracture and on the N side of the Reipaskor headland (Fig. 26). Here, the volcanoclastic rudite infills a hollow ~75 m wide at sea level which increases to ~110 m at the top of the exposure. The rudite is bounded by sharp, inward and steeply dipping contacts. The SSW contact is coincidental with a SSE-trending dyke. The top surface of the rudite is convex-down and has been infilled by a ponded flow lobe up to 60 m thick. The basal ~30 m consists of curvy-columnar joints that are generally aligned perpendicular to the basal contact. These narrowly spaced joints appear to pass upwards into a more massive ~30 m thick upper section of the flow lobe, which is crudely columnar jointed and where the spacing between joints has increased. The curvy-columnar columns may be the result of water ingressing along joints and modifying the internal isotherms during solidification (cf. Passey & Bell 2007). The top of the flow lobe is generally planar and is overlain by ~12 m of compound lava, which is in turn, overlain by the prominent sheet lobe observed along the Nípubarmur coastline to the S.

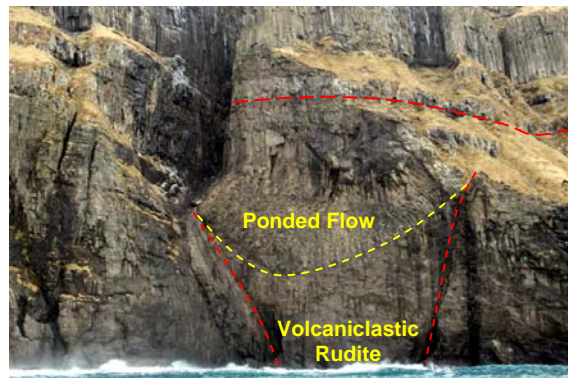


Fig. 26. Volcanoclastic rudite and ponded lava flow, Reipaskorargjógv, Streymoy.

Initial interpretations of this section of the coastline by Geikie (1896) suggested that the hollows represented separate volcanic necks infilled by agglomerate. Later, Rasmussen & Noe-Nygaard (1969; 1970) suggested that the volcanoclastic rudites are connected and infill a ~1.5 km long fissure bounded to the ENE by the cliffs and on the WSW side by a N152°E trending dyke. However, since these interpretations were made our understanding of the processes that occur in volcanic settings have developed, particularly the role of sedimentation. Therefore, an alternative explanation could be the erosion of the compound lava flows and subsequent deposition of bedded volcanoclastic rudites in a fluvial environment. This is partially supported by the overall lack of any significant pyroclastic material deposited on the palaeo-landscape, particularly if these were indeed vents. An observation first pointed out by Geikie (1896). Unfortunately, the bases of the hollows are not observed to categorically identify them as channels or bottomless vents. Future petrographic investigations of the volcanoclastic rudites may help to resolve this issue.

Stop 1.5: Marragjógv, Vágar

Location

Coastline section between two streams [PJ 0098 8563; 0-20 m asl], ~300 m SSE of Marragjógv, Vágar (Fig. 17).

Introduction

This stop visits and discusses one of the “vent” localities of Rasmussen & Noe-Nygaard (1969; 1970) immediately below the Kvívík Beds, Malinstindur Formation.

Description

This section of the coastline consists of compound lava flows composed of thin anastomosing flow lobes situated immediately below the ~1 m thick, bedded, volcanoclastic sandstone sequence belonging to the Kvívík Beds (formerly the B-horizon). The Kvívík Beds form a stratigraphic marker unit that crops out across SE Vágar, northern Streymoy and north-western Eysturoy. The flow lobes immediately overlying the Kvívík Beds, ~400 m SSE of Marragjógv, contain abundantly obvious tree moulds.

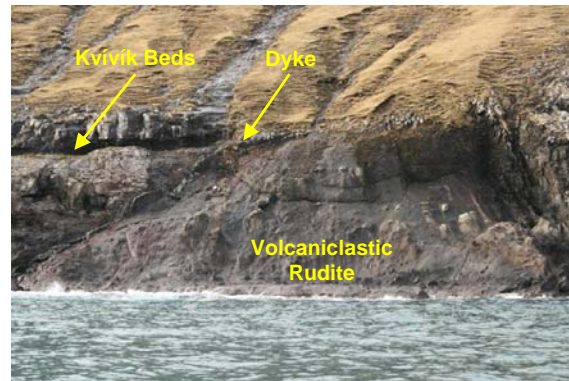


Fig. 27. View of the volcanoclastic rudite at Stop 1.5, Marragjógv, Vágar.

Along a ~75-85 m long section of the coastline, more or less between two streams, SSE of Marragjógv the compound lava flow lobes have been removed and replaced by a ~20 m thick volcanoclastic rudite that is clearly sub-horizontally bedded (Fig. 27). The rudite is very poorly sorted, containing clasts up to 1 m across, although most clasts are typically the size of large cobbles. The SSE contact of the rudite dips steeply outwards giving the rudite the appearance of forming a small mound. The rudite is overstepped by flow lobes of a compound lava flow, which in turn are overlain by the Kvívík Beds. The SSE contact has subsequently been intruded by a NW-SE trending dyke that can clearly be traced up the mountainside. The contact on the NNW side of the volcanoclastic rudite is less clear because it appears that apophyses from the aforementioned dyke extend out laterally over the top of the rudite and downwards into the rudite at the NNW end. Consequently, the intrusions disrupt the section at this end.

The volcanoclastic rudite has been interpreted by Rasmussen & Noe-Nygaard (1969; 1970) as material infilling a volcanic neck, although no reasoning is given for their interpretation. On hindsight, the mound-like and bedded nature of the volcanoclastic rudite, may suggest that the clastic material was deposited from a mass flow event, similar to other units observed from this level.

Vestmanna to Tórshavn Road Side Localities

Stop 1.6: Byrgisgjógv Road Cut, Streymoy

Location

Passing the turning down to the village of Kvívík turn left onto a small tarmacked road and park in the wide area at the T-junction. A short walk along the track brings you to Stop 1.6 [PJ 0122 8876; ~65 m asl], ~170 m WNW of Byrgisgjógv, Stykkið, Streymoy (Fig. 17).

Introduction

This stop allows for the examination of a multiple dyke that cuts through the compound lava flows lobes of the Malinstindur Formation.



Fig. 28. View of the multiple dyke at Stop 1.6, Stykkið, Streymoy.

Description

This locality consists of a multiple dyke with a breadth of ~5 m (Fig. 28). The dyke is composed of large plagioclase feldspar phenocrysts which are typically aligned parallel to the sides of the dyke (Rasmussen & Noe-Nygaard 1969; 1970). On either side of the dyke is a 1-2 m wide fracture zone, the surfaces of which are lined with various clay minerals. On some of these surfaces slickensides can be seen, implying some lateral movement. This suggests that the dyke exploited and intruded a pre-existing fracture zone. Looking to the ESE the dyke can be inferred to travel across the fjord from Byrgisgjógv to Vaðsteinagjógv, a distance of ~1 km. In this part of the fjord, the Vágar sub-sea tunnel (*Váगतunnilin*) had to traverse the dyke and the associated fracture zone at right-angles to reduce the risk of water seepage or structural weaknesses associated with them. Rasmussen & Noe-Nygaard (1969; 1970) have traced the sporadic exposures of the dyke over a distance of at least 10 km. The dyke is observed to terminate at Trantur, ~600 m NNW of Skælingur, where, over a height of ~140 m, the breadth of the dyke is seen to decrease from ~4 m to ~1 m. At a height of ~560 m the dyke tapers out as thin, irregular apophyses within the Enni Formation. Associated with the tapering out of the dyke is an overall decrease in both the size and abundance of the plagioclase feldspar phenocrysts (Rasmussen & Noe-Nygaard 1969; 1970). The NE termination is not exposed because the dyke enters Vestmannaund along the coastline to the SSE of Egilsnes.

Stop 1.7: Klivarnar Road Cut, Streymoy

Location

Before the 760 m long Leynar Tunnel (*Leynatunnilin*) take the turning to the left and park in the lay-by. From here, walk along the old road for ~200 m taking in the views to the N across Leynavatn Lake (Fig. 17). At the bend in the road is the Klivarnar section [PJ 0321 9012; ~70 m asl].

Introduction

This stop allows for the examination of a small fluvial channel that has cut down into the compound lava flow lobes from the Malinstindur Formation.



Fig. 29. Fluvial channel at Stop 1.7, Klivarnar, Streymoy.

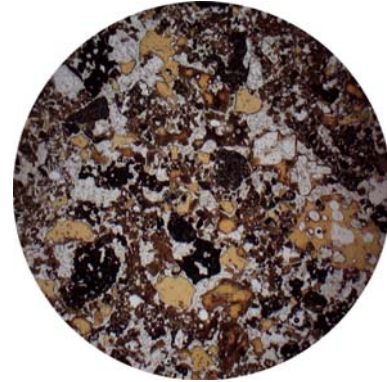


Fig. 30. Photomicrograph of the volcaniclastic sandstone from Stop 1.7. Field of view ~ 3mm.

Description

The Klivarnar section consists of an erosional channel infilled by reddish brown, cross-bedded volcaniclastic sandstones (Fig. 29). The sandstone is >1 m thick in the centre of the channel and rapidly thins away from the structure. The sandstone is poorly sorted, clast supported and is dominated by sub-angular to sub-rounded opaque to hydrated basaltic glass clasts (Fig. 30). The largest glass clasts are typically vesiculated and sometimes exhibit cusped margins. The sandstone also contains minor amounts of equigranular to plagioclase-phryic, sub-rounded basalt lava flow clasts. These sediments contain occurrences of the freshwater chlorophycean algae, *Botryococcus braunii*, suggesting a fluvial and/or lacustrine environment (Ellis *et al.* 2002). Notice how the overlying compound flow lobes also appear to be infilling the channel. The flow lobes can be clearly subdivided into a basal crust, massive core and upper crust. The basal crust is typically characterised by pipe amygdaloids and the upper crust commonly exhibits horizontal vesicle zones. The massive cores also typically exhibit vertical vesicle cylinders. Consequently, these flow lobes can be characterised as P-type (pipe-bearing) pahoehoe and were emplaced through the inflation (endogenous) process (Passey & Bell 2007).

Stop 1.8: Sund Quarry, Streymoy

Location

Park in the disused Sund Quarry [PJ 1194 8198; ~10 m asl] at the end of a small track off the main road into Tórshavn, Streymoy (Fig. 17).

Introduction

This stop allows for the examination of the Sund Bed the ubiquitous stratigraphic marker unit from the base of the Sneis Formation.

Description

The basal Sund Bed of the Sneis Formation is well exposed along the terrace at the back of the Sund Quarry. The Sund Bed is <1 m thick and is crudely graded as well as finely laminated in places. This reddened volcaniclastic sandstone is generally medium grained and poorly sorted. The unit is dominated by sub-rounded to rounded clasts of reworked palagonitised basaltic glass, although larger clasts still preserve vesicles and cusped margins. A characteristic feature of the Sund Bed and which is clearly evident at this locality is the preservation of creamish, charcoalified branchwood fragments that have a classic ‘boxwork’

structure (Fig. 31). These fragments are typically found in a layer approximately two-thirds above the base of the bed. This surface is well exposed on fallen blocks where branchwood fragments up to 4 m in length can be seen. The Sund Bed is overlain by a volcanoclastic conglomerate sequence that has been intruded by a thick basaltic sill which forms the quarry face. Thin ‘pockets’ of the conglomerate can be seen directly overlying the Sund Bed in the quarry but the conglomerate is more clearly seen above the sill in sections above the main road to the N of this location. The Sund Bed and the overlying volcanoclastic conglomerate are interpreted to have been deposited from hyperconcentrated and debris flow regimes, respectively.

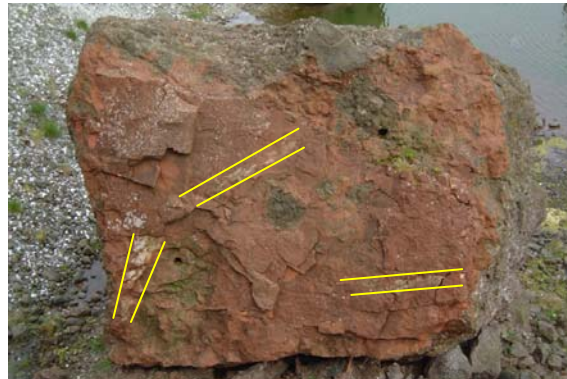


Fig. 31. Plant fragments from the Sund Bed, Sund Quarry, Streymoy. The block is ~4 m wide.

Stop 1.9: Sandvíkatangi, Streymoy

Location

Park in the lay-by on the left side of the road at Sandvíkatangi [PJ 1554 8196; ~15 m asl], ~2 km NW of Hoyvík, Streymoy (Fig. 17).

Introduction

This stop gives the opportunity to view the Høvdhamarin Flow that occurs within the basal ~200 m of the Enni Formation.

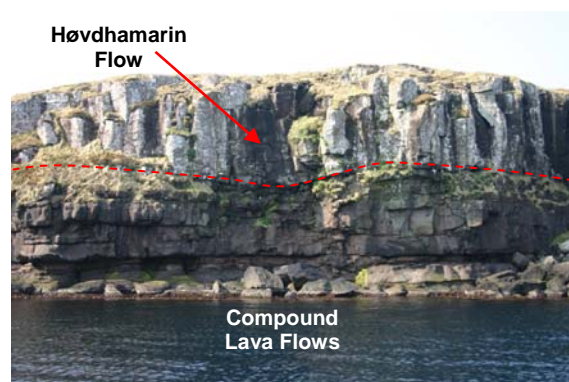


Fig. 32. View of the Høvdhamarin Flow, Enni Formation, ESE of Stop 1.9, Sandvíkatangi, Streymoy.

Description

Heading into Tórshavn from Sund a prominent whitish grey bench (*hamar*) can be seen on the right side of the road overlying a weathered compound lava flow (Fig. 32). From this lay-by a prominent bench can be seen ~300 m to the SE. This bench is the Høvdhamarin Flow, a sheet

lobe that occurs ~140-180 m above the base of the Sneis Formation and forms the basal unit of a ~40-80 m thick package of sheet lobes commonly intercalated with thinner compound lava flows (Passey 2008). The Høvdhamarin Flow is between 10 and 15 m thick and can be traced over a distance of at least ~25-30 km across southern Streymoy, Hestur and Sandoy. The flow commonly exhibits weakly-developed columnar jointing, the surfaces of which typically display chisel markings. The Høvdhamarin Flow is a plagioclase-phyric basalt which contains <10 to ~20 vol.% plagioclase feldspar laths that range in size from <0.5 to 1 cm in length. The smaller laths typically form glomerocrysts in the finely crystalline groundmass. The lower ~2 m of the Høvdhamarin Flow is distinctly vesicular compared to the overlying non-vesicular core and the basal contact is usually sharp and planar. The upper surface of the Høvdhamarin Flow is generally poorly exposed due to weathering of a more vesicular upper crust.



Tórshavn viewed from Argir, Streymoy.

Day 2 – Sunday, 17 August 2008

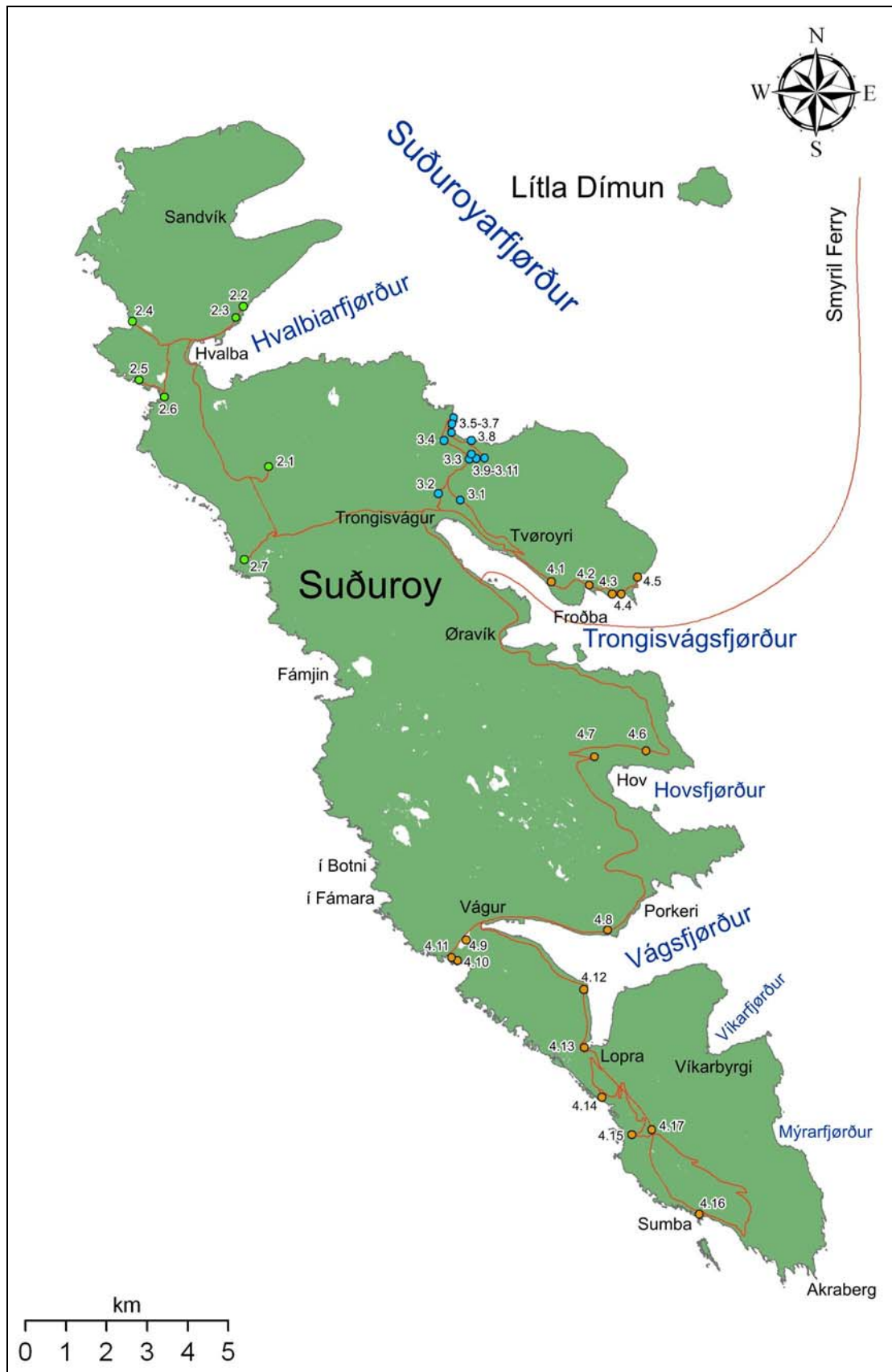


Fig. 33. Excursion route map for Day 2 – Stops 2.1 to 2.7.

Introduction

The first part of the day shall be spent onboard the Smyril ferry sailing from Tórshavn to Suðuroy where two nights shall be spent at Hotel Øravík (Fig. 15). The group shall rendezvous with the excursion leader outside Hotel Hafnia for 08:30 with their luggage. From the hotel it is <500 m to walk to the ferry terminal. The group shall then make our way up the stairs or lift and via the gangplank (*landgongd*) board the Smyril car ferry, which is named after the only falcon found on the islands (*Falco columbarius* - merlin). This brings us onto deck 5 in front of Stairwell B. Luggage can then be left in one of the luggage storage rooms (*Baggaga*) on the starboard (*right*) side of deck 5. We shall congregate in the room (*móttøka*) on the portside (*left*) of the ferry, which is the room immediately to the left as you board the ferry. Once the ferry begins to sail we shall head to the sun deck (*sóldekk*) towards the stern. If the weather is good enough, we shall head up to deck 7, where **gloves** and a **warm hat** are advisable. This vantage point will give good views of Tórshavn and the following principal islands during the sailing: southern Streymoy, Nólsoy, Sandoy and Lítla Dímun. The journey takes ~2 hours depending on weather conditions and currents.

The ferry journey takes in the scenic geology from the youngest to oldest formations exposed on the islands. By the time we reach Suðuroy we shall have observed the mixed facies architectures of the Enni Formation composed of both sheet lobes and compound lava flows, the compound flow dominated Malinstindur Formation of northern Suðuroy and eventually the Beinিসvørð Formation made up extensively of laterally expansive sheet lobes. After arriving in Suðuroy we shall check-in to Hotel Øravík before visiting the coal mine at Rókhagi and then a number of road side localities shall be examined from the Beinিসvørð Formation through to the Malinstindur Formation (Fig. 33).

Suðuroy (South Island) is the fourth largest island with an area of ~165 km² and is ~32 km long by ~10-12 km wide. The island is orientated with a pronounced NNW-SSE trend and is characterised by steep cliffs on the western side and deep fjords on the eastern side. The highest mountain is Gluggarnir at 610 m which is situated to the SW of Trongisvágur. In January 2008, the population of the island was 4915, that is ~10% of the total population and the island is the fourth most populous (Hagstova Føroya 2008). The population live in small fishing villages connected by winding roads and tunnels. The two largest municipalities are those of Tvøroyri in the N and Vágur in the S. The night shall be spent at Hotel Øravík where an evening meal will be provided.

Tórshavn to Suðuroy Ferry Journey

Nólsoyarfjørður

After leaving the harbour the ferry heads out into Nólsoyarfjørður (Fig. 15), the strait between the E side of southern Streymoy (starboard) and the island of Nólsoy (portside). Both southern Streymoy (Stream Island) and Nólsoy (Narrow Island) are composed of basalt lava flows and volcanoclastics of the Enni Formation, the youngest formation of the Faroe Islands Basalt Group. Following the coastline W from Tórshavn you will see the Sandagerði beach, which is a popular site on warm sunny days. On the W side of the beach is the Sandá river which separates Tórshavn from the small village of Argir. To the S of the village the <6 m thick Argir Beds, a sequence of reddened fluvial-floodplain facies volcanoclastic sandstones, can be observed dipping down towards sea level (Fig. 34). In this area, the Argir Beds have a dip of ~2.1° to the ESE and occur ~250 m above the base of the Enni Formation. The Argir Beds overlie a sequence of plagioclase-phyric compound flows and are overlain by a

sequence dominated by plagioclase-phyric simple flows. Just after the Argir Beds disappear below sea level the small Bergsendi quarry is observed at the coastline. It was on top of the quarry face that the deep (~700 m) Glyvursnes-1 borehole was drilled in 2002 as part of the SeiFaBa (seismic and petrophysical properties of Faroes basalt, 2002-2005) project (Japsen *et al.* 2005). In this borehole, the Argir Beds are ~5 m thick and consist of a coarsening and thickening upwards sequence of volcanoclastic sandstones. The Bergsendi quarry and landing area were built to transport the boulders extracted from the Glyvursnes quarry, which can be seen ~60 m asl. The rock boulders were used to construct the harbour in Tórshavn.

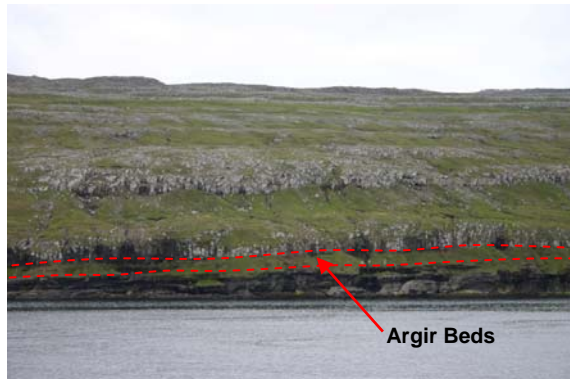


Fig. 34. The ~5 m thick Argir Beds overlain mainly by sheet lobes, Enni Formation, ~200 m SE of Altarshella, Streymoy.



Fig. 35. A >15 m thick section through the Høsmøl Beds, Enni Formation, Høsmøl, Nólsoy.

Nólsoy is composed of some of the youngest lava flows of the Faroe Islands Basalt Group. A waning of the volcanic activity is clearly observed on Nólsoy through the abundance of tree moulds contained along the bases of the lava flows and through the development of thick volcanoclastic sandstone sequences, for example, the >15 m thick sandstone sequence at Høsmøl, halfway along the island (Fig. 35). The Høsmøl Beds, which occur ~200-250 m above the base of the Argir Beds, can easily be observed through a pair of binoculars. Notice how the sedimentary units are intercalated with thin flow lobes from a compound lava flow sequence. The Høsmøl Beds were quarried and exported from the late 1930s until the mid-1950s as they had properties suitable to soften hard water. Nólsoy covers an area of ~10 km² and ~260 people live in the only village at the N end of the island.

Sandoy

After ~15-20 minutes the ferry passes the southern tip of Streymoy and if the weather is good the island of Hestur maybe seen to the N (Fig. 15). Hestur has a pronounced NW-SE elongation and is located between Streymoy and Sandoy, which is now on the starboard side of the ferry. Hestur which literally means “horse” in Faroese is ~5 km long by ~1-2 km wide and has an area of ~6 km². Approximately, 40 people live in the only village on the E side. The island is composed of the upper ~80-100 m of the Malinstindur Formation, <1.5 m thick Sneis Formation and the lower 350 m of the Enni Formation, including the ~4 m thick Argir Beds at the northern end (Passey 2008).

Sandoy (Sand Island) is the fifth largest island with an area of ~112 km² and has a population of ~1400 people. Plans are under consideration to construct a ~12 km long sub-sea road tunnel between Gamlarætt, Streymoy and the Skopun area, NE Sandoy. Sandoy is composed almost exclusively of the Enni Formation except for the far NW end where the upper ~20 m of the Malinstindur Formation and the <1 m thick Sneis Formation are exposed (Passey 2008). Sailing along the E side of Sandoy the Enni Formation can be seen to be composed of

a mixture of compound lava flows and sheet lobes. The sheet lobes form prominent benches (*hamar*) in the landscape which contrasts with the poorly exposed grass covered compound flows.

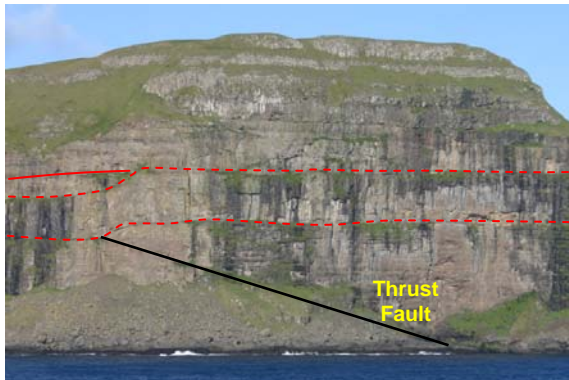


Fig. 36. A thrust fault in the Enni Formation can be seen at the base of the ~200 m high Skálhøvdi headland, Sandoy.

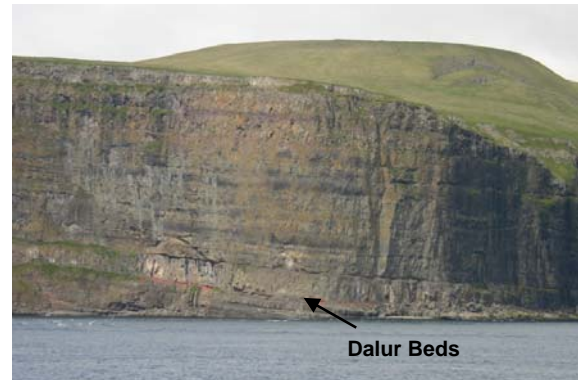


Fig. 37. The ~200 m high Nøsin cliffs composed of lava flows from the Enni Formation, S of Dalur, Sandoy.

After ~30-40 minutes the village of Skálavík can be seen, which is followed by a change in the dominant orientation of coastline from NW-SE to N-S (Fig. 15). The Skálhøvdi headland to the E of Skálavík is ~200 m high and is composed mainly of compound flows that have infilled topographic lows (Fig. 36). Towards the base of the cliffs at the southern end there is a small thrust fault that dies out with height. The fault has resulted in the doming of the overlying flow and associated sediments producing a positive relief that has been infilled by subsequent flows. Consequently, the timing of the fault can be constrained to the emplacement of the Enni Formation. The cliff section is ~600-800 m above the base of the Argir Beds, which across southern Sandoy dip to the ENE by ~3.3° (Passey 2008). The ferry now passes the villages of Húsavík and Dalur and this stretch of coastline from Skálhøvdi to Skorin, the southern tip of Sandoy, can be seen to be mainly composed of thinly bedded compound flows intercalated with more persistent sheet lobes. At the base of the ~200 m high Nøsin cliff section a thick reddened volcanoclastic sandstone sequence crops out, which was extracted just S of the village of Dalur, ~2.5 km to the N, as it was used to soften hard water similar to the Høsmøl Beds from Nólsoy (Fig. 37). The Nøsin cliffs are ~400-600 m above the base of the Argir Beds (Passey 2008).

Skúgvoy, Stóra Dímun and Lítla Dímun

After ~1 hour at sea Smyril will pass the southern point of Sandoy and sail on by the islands of Stóra Dímun and Lítla Dímun (Fig. 15), which literally mean the big and little rocks, respectively. Looking N however, the island of Skúgvoy may be seen to the W of Sandoy. Skúgvoy is named after the great and Arctic skua sea birds that breed on the island. These birds are aggressive and will readily dive bomb humans if they walk into their breeding territories. The island covers an area of ~10 km² and has a population of ~50 people. Skúgvoy is composed predominantly of basalt lava flows spanning the Argir Beds, ~120 m below and ~250 m above (Passey 2008).

Stóra Dímun covers an area of ~2.6 km² and ~10 people live on the island. This compares to Lítla Dímun, which is the only uninhabited main island and has an area of ~0.84 km². Based on the extrapolation of the structural contours of the Argir Beds from Skúgvoy and Sandoy the two islands should be composed exclusively of units from the Enni Formation above the Argir Beds (Passey 2008). Excellent views of the E side of Lítla Dímun (Fig. 38), which has a

height of ~414 m, show how the island is made up of a mixture of compound lava flows and sheet lobes separated by reddened volcanoclastic lithologies.



Fig. 38. View of the E side of Lítla Dímun, composed of a mixture of compound flows and sheet lobes.

Northern Suðuroy

Northern Suðuroy (Figs. 15, 33 & 39) is composed of the basal compound lava flows of the Malinstindur Formation, which have a thinly bedded appearance and are generally poorly exposed and grass covered. If the weather is clear, the secluded Hvannahagi valley maybe seen, where Day 3 shall be spent examining the sedimentary and pyroclastic lithologies of the Prestfjall and Hvannahagi formations. After about 90 minutes into the journey the basal contact of the Malinstindur Formation comes into view at the Holið í Helli section. This section which consists of a ~14 m thick sequence from the Prestfjall Formation shall be examined in detail on Day 4. The ferry now turns into Trongisvágsfjørður and heads NW to the newly built harbour at Krambatangin. On the starboard side, the uppermost sheet lobes of the Beinivørð Formation can be seen and contrasted with the poorly exposed compound flows of the Malinstindur Formation that forms the high ground. The sheet lobes in this area typically have well-developed columnar jointing and the famous fan-shaped section at Kulagjógv can be examined through a pair of binoculars. A number of localities along this coastline shall be visited on Day 4.



Smyril Car Ferry, Trongisvágsfjørður, Suðuroy.

Northern Suðuroy Road Side Localities



Fig. 39. Simplified geological map of Suðuroy with excursion stops indicated. Modified after Rasmussen & Noe-Nygaard (1969; 1970).

Stop 2.1: Rókhagi Coal Mine, Suðuroy



Fig. 40. View of the Rókhagi coal mine, SE of Hvalba, Suðuroy.

Location

The Rókhagi coal mine [PJ 1074 2881; ~165 m asl] is ~3.2 km SE of Hvalba, Suðuroy (Figs. 33 & 39).

Introduction

The Rókhagi coal mine (Fig. 40) has been in operation for ~20 years and extends ~200 m into the mountainside. The earliest recorded document pertaining to an interest in the coal on the islands dates back to 1626. Since then there has been a number of investigations into the economic potential of the coal. The coal-bearing Prestfjall Formation on Suðuroy covers an area of ~23 km² and is subdivided into 4 coal fields: Grímsfjall, Northern (includes the Rókhagi coal mine), Southern and Kolheyggjur-Hovstúgva. Rasmussen & Noe-Nyggard (1969; 1970) estimated, based on average total coal seam thicknesses, that the amount of extractable coal in 1954 was ~13.9 million tons, of which, ~2 million tons had already been mined. The miners shall take small parties into the mine to see the coal face. **THE MINE IS QUITE CLAUSTROPHOBIC, DARK AND VERY LOW, SO PLEASE MIND YOUR HEADS!**

Description

The base of the Prestfjall Formation is composed of a whitish-grey underclay (*bankin*) that commonly has a maximum thickness of ~1 m (Fig. 41). The underclay, which has also been referred to as an argillite, from the Rókhagi coal mine is composed primarily of beidellite, a smectite group clay mineral, derived, most likely, from the argillisation of volcanoclastic material (Parra *et al.* 1987). This is commonly overlain by the lower coal seam (*stabbín*) that has an average thickness of between 38 and 45 cm and a maximum thickness that rarely exceeds 1 m (Fig. 41). The coal is usually of the dull striped variety, where there are alternating layers of dull (durain) and bright (vitrain) coal.

A dark shale or middle clay (*rannin*) frequently containing streaks and lenses of bright (vitrain) coal, overlies the lower coal seam and has an average thickness of ~24 cm (Fig. 41). The middle clay has also been shown to contain predominantly beidellite but also a minor amount (~15%) of metahalloysite, a dehydrated form of halloysite, a kaolinite group clay mineral (Parra *et al.* 1987). The shale is overlain by the upper coal seam (*kolbandið*) that has a maximum thickness of ~80 cm (average ~38 cm) and is commonly composed of bright,

vitrain coal (Fig. 41). The combined (lower and upper) coal seam thickness rarely exceeds 1 m and has an average thickness of between 70 and 80 cm, although an exceptional thickness of ~1.7 m has been reported from the Rókhagi mine (Lund 1989). Both coal seams, from the Rókhagi mine, have an average vitrinite reflectance of 0.5 (range 0.40-0.57), implying they have the rank of sub-bituminous coal (Laier *et al.* 1997).

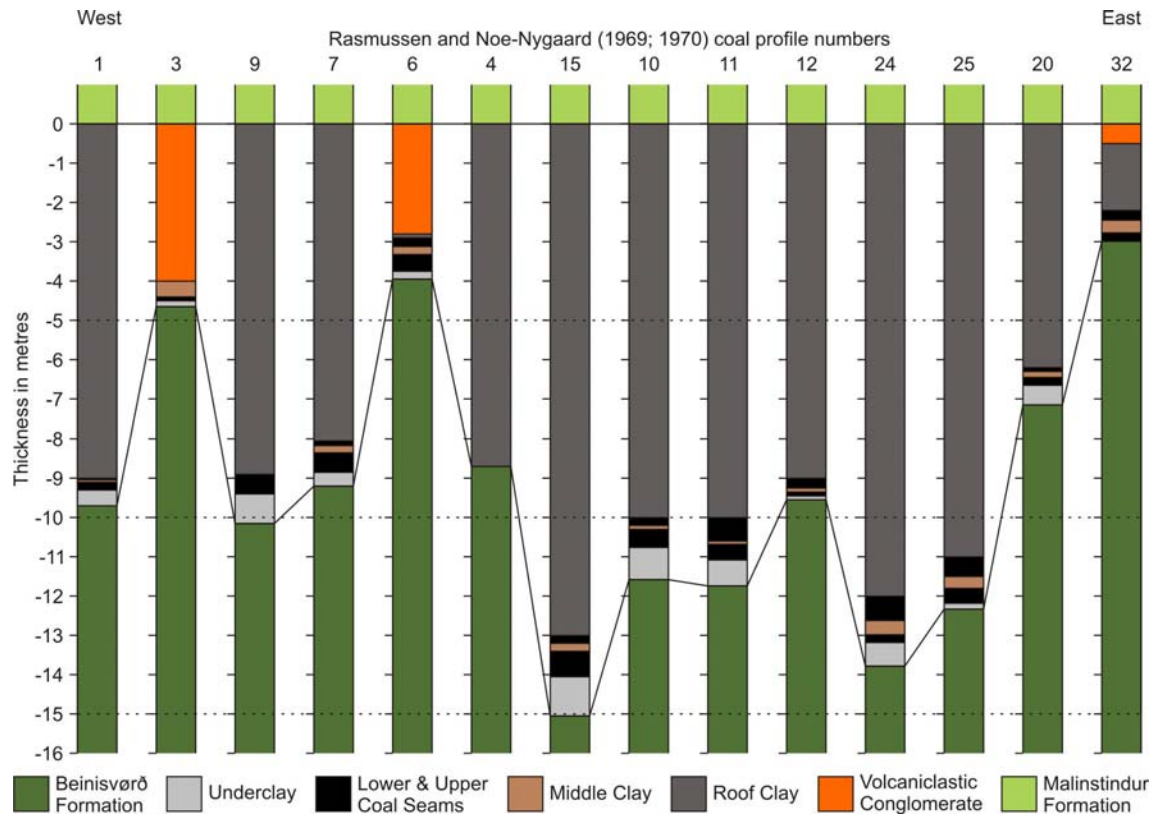


Fig. 41. Fourteen complete profiles through the Prestfjall Formation, Suðuroy. Modified after Rasmussen & Noe-Nygaard (1969; 1970).

The upper coal seam is generally overlain by a roof clay that reaches a maximum observed thickness of ~13 m and has an average thickness in the order of ~4.3 m (Fig. 41). The basal section of the roof clay (*fúrstin*) commonly contains small streaks or lenses of coal and the presence of clay ironstone and other concretionary material have been alluded to but unfortunately, no further details are given (Rasmussen & Noe-Nygaard 1969; 1970). The upper part of the roof clay is locally referred to as *takleir*. The roof clay from the Rókhagi mine has been characterised as being composed almost completely of metahalloysite with minor amounts of allophane, an amorphous, hydrous aluminium silicate, most likely, derived from the alteration of volcanic ash (Parra *et al.* 1987). Occasionally, particularly in western Suðuroy, the roof clay is overlain, or replaced, by a sequence of greenish-brown volcaniclastic sandstones and granule-grade conglomerates that have an observed maximum thickness of ~4 m (Fig. 41). The sandstones are composed predominantly of palagonitised basaltic glass, but also a large proportion, particularly in the conglomerates, of finely crystalline basalt clasts of various compositions and textures, assumed to be derived from the surrounding lava flows of the Beinissvørð Formation.

The Prestfjall Formation yields a palynofloral assemblage (Lund 1983; 1989; Jolley 1997; Ellis *et al.* 2002) characteristically found offshore in the Faroe-Shetland Basin at the base of Unit 2 of the Flett Formation (Jolley 1997; Jolley *et al.* 2002).

Stop 2.2: Sandvík Tunnel, Suðuroy

Location

Park on the small grass covered terrace on the E side of the southern entrance to the Sandvík Tunnel [PJ 1011 3276; ~75 m asl], 1.5 km ENE of Hvalba, Suðuroy (Figs. 33 & 39).

Introduction

This locality, from the base of the Malinstindur Formation, has good examples of individual pahoehoe flow lobes and their structures.

Description

The Sandvík Tunnel (*Sandvíkartunnilin*) opened in 1969 and is ~1.5 km long and climbs ~30 m, exiting ~1 km S of Sandvík village. At the back of the terrace is a small man-made cave cut into pahoehoe flow lobes of a compound lava flow of the Malinstindur Formation. On the roof, at the front of the cave, there is an impression of a ropy surface from the overlying flow lobe. At the base of the cave on the E side there is a ~1.4 m thick aphyric to olivine-microporphyritic flow lobe that overlies a ~80-90 cm thick amygdaloidal upper crust of the underlying flow lobe. The upper crust of this basal flow lobe consists of amygdale zones, alternating between amygdale-rich and non-amygdaloidal divisions. The top of the lobe is slightly broken up and has a reddened glassy skin with a weakly developed ropy surface.

The overlying flow lobe can be subdivided into three sections based on amygdale distribution patterns and can be classified as a P-type (pipe-bearing) pahoehoe flow lobe. There is a <20 cm thick basal crust, which contains pipe amygdales that start ~5 cm above the base of the flow lobe. The pipe amygdales are <10 cm long and some are curved in the assumed flow direction. The basal crust is overlain by a massive core that contains <5 vol.% amygdales. The core is overlain by a ~75 cm thick upper crust that is highly amygdaloidal. The amygdales appear to increase in size downwards, on average from <2 mm to ~5 mm. At the base of the upper crust there are a number of mega-amygdales up to 6 cm across. The upper crust has a reddened glassy skin and is overlain by another P-type flow lobe that contains pipe-amygdales along its base. Taking the upper crust thickness of the main flow lobe above and applying it to the empirical equation of Hon *et al.* (1994) it is suggested that this flow lobe ceased inflating within ~4 days. If the timings of all the flow lobes within this single compound lava flow could be calculated, a minimum emplacement duration for the flow itself could be inferred.

Walking to the edge of the terrace and climbing over the fence the reddened tuffs and lapillistones of the Hvannhagi Formation maybe observed at the base of the cliff. Looking W towards Hvalba some of the dolerite sills that invade the Hvannhagi Formation can be seen forming the prominent headlands.

Stop 2.3: Áin í Lágamúla Culvert, Suðuroy

Location

On the road back to Hvalba park in a lay-by on the N side of the road just before the bridge that crosses the Áin í Lágamúla stream. The location is in the small culvert in the Áin í Lágamúla stream [PJ 0994 3248; ~50 m asl], ~1.2 km ENE of Hvalba, Suðuroy (Figs. 33 & 39).

Introduction

This stop allows for the examination of the typically inaccessible tuffs of the Hvannhagi Formation and the contact with the overlying Malinstindur Formation.



Fig. 42. View of the contact between the Hvannhagi and Malinstindur formations, Áin í Lágamúla, Suðuroy.

Description

There is a small waterfall which is ~10-15 m high and consists of bedded, reddened olivine-phyric coarse tuffs. The tuffs are distinctive due to the presence of 1-2 mm long needles of altered olivine crystals. The tuff units are thickest in this area, locally >40 m thick, and are intercalated with beds of lapillistone. A number of beds typically fine upwards from lapillistones to tuffs. Walking back up the road for ~40 m the contact between the tuffs and the overlying compound lava flow lobes of the Malinstindur Formation can be observed (Fig. 42). The tuffs in this area are similar to the basal tuff units that will be examined in Hvannhagi valley on Day 3, but this section appears to lack the overlying sedimentary facies observed in Hvannhagi.

Stop 2.4: Kolaratangi, Suðuroy

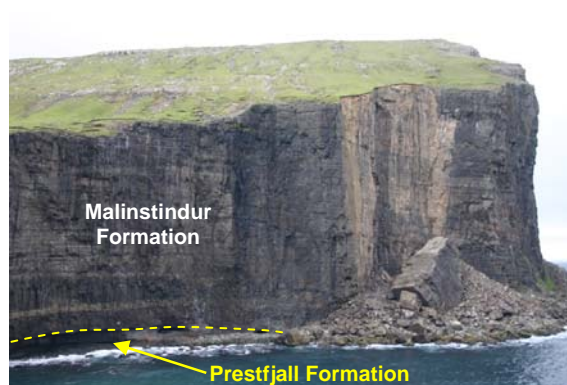


Fig. 43. View of the Prestfjall and Malinstindur formations, N side of Grímsfjall headland, Suðuroy.

Location

Park at the end of the track which leads to the old rubbish chute at Kolaratangi [PJ 0739 3239; ~35 m asl], ~1.5 km W of Hvalba, Suðuroy (Figs. 33 & 39).

Introduction

A general view of the sedimentary units of the Prestfjall Formation and the overlying compound lava flows of the Malinstindur Formation.

Description

This locality affords the view, to the S, of the headland known as Grímsfjall (Fig. 43). The cliffs are ~160-180 m high and the prominent cliff fall occurred within the last 10 years. The base of the cliffs are composed of sedimentary units belonging to the Prestfjall Formation that have been intruded by columnar jointed sills. The Prestfjall Formation is overlain by the compound lava flows of the Malinstindur Formation. Notice how the compound flows are composed of thinner anastomosing flow lobes less than a few metres in thickness. Immediately to the S of the rubbish chute the individual nature of the flow lobes can be examined. It can be seen that the majority are of inflated P-type (pipe-bearing) pahoehoe, consisting of a basal crust, a core and an upper crust. The basal crusts are commonly characterised by containing pipe-amygdales and the upper crust typically exhibits horizontal amygdale zones. These features and some weakly developed ropy surfaces can be examined in the area to the S of the rubbish chute. **PLEASE DO NOT GO TOO CLOSE TO THE EDGE OF THE CLIFFS!**

Stop 2.5: Grímsfjall, Suðuroy

Location

Grímsfjall cliff section [PJ 0755 3094; ~65 m asl], ~850 m WSW of Hvalba, Suðuroy (Figs. 33 & 39).

Introduction

This locality allows for a close-up view of the entire section through the Prestfjall Formation and the sill that has intruded the sedimentary units.

Description

From the car park at the end of the track at Hvalbiareiði head W along the coastline with the lake of Heygsvatn on your right. Climb over the fence and continue until you come to a small stone building. Turn towards the lava flow and there you will find a footpath that will take you on to the top. Continue along the coastline until you come to a small stone wall where you will find a well worn sheep path climbing diagonally upwards. Stay on this path for a couple of minutes until it brings you to a small stone sheep hut. **PLEASE DO NOT LEAVE THE PATH AS THE GRASS CAN BE VERY SLIPPERY AND THERE IS NOTHING TO STOP YOU GOING OVER THE EDGE OF THE CLIFFS!** The walk takes ~30 minutes.

A complete section through the Prestfjall Formation is observed on the W side of the inaccessible bay (Fig. 44). The base of the cliffs consists of the three uppermost sheet lobes of the Beinivørð Formation; the basal flow forms the upper flow at Stop 2.6. The flows are ~15, ~25, and ~12 m thick (including associated interlava units), respectively. The flows are characterised by sharp planar bases and weakly developed columnar jointing. The middle flow correlates to the flow that is exposed in the quarry to the E, although between this location and the quarry the flow appears to be composed of at least two large flow lobes and therefore, maybe compound in morphology. The highest flow is extremely weathered and only relict columnar jointing is observed. This weathered flow terminates against the underlying flow in the vicinity of the stone wall to the E and the flow is missing from the section observed in the next bay to the W (not seen from this location). Therefore, the uppermost flow appears to be laterally confined to this section.

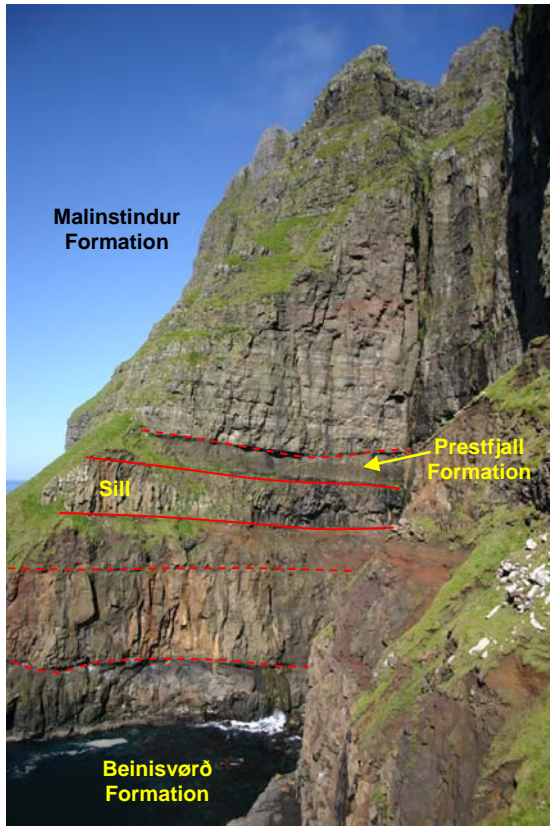


Fig. 44. The Grímsfjall cliff section composed of the Beinivørð, Prestfjall and Malinstindur Formations, Suðuroy.



Fig. 45. Bedded volcaniclastic sandstones at Stop 2.5, Grímsfjall, Suðuroy.



Fig. 46. Cross-bedded volcaniclastic sandstones at Stop 2.5, Grímsfjall, Suðuroy.

The reddened soil profile overlying the uppermost flow is overlain by brownish sandstones and black coals of the Prestfjall Formation. The sandstones can be clearly seen on the E side of the bay. A prominent coal seam of the Prestfjall Formation is intruded by a ~15 m thick sill with well-developed columnar jointing. The sill is overlain by a ~8 m thick sequence through the Prestfjall Formation (Rasmussen & Noe-Nygaard 1969; 1970). With the aid of binoculars the base of the upper section of the Prestfjall Formation can be seen to be composed of ~1 m thick sequence of coals and claystones. This is overlain by a generally olive grey sequence up to ~7 m thick consisting of basaltic sandstones and conglomerates (Passey 2004). Some of these fluvial sandstones are partially exposed on the E side of the bay (this locality). These sandstones are thinly to medium bedded and contacts between beds are commonly sharp and planar (Fig. 45). Cross-bedding is common in some beds (Fig. 46). The partial exposure comprises fine to medium grained sandstones, although some beds contain well rounded coarse sand to granule grade clasts. Elongate grains are typically aligned parallel to bedding. The sandstones are generally composed of palagonitised basaltic glass, but also contain small amounts of eroded lava flow clasts and discernable organic material. The coarser units are similar in composition but consist of a much higher percentage of material derived from the erosion of basalt lava flows, assumed to be sourced from the Beinivørð Formation. The basalt lava clasts differ in texture suggesting a number of different flows were being eroded. The change between fine and coarse beds may reflect seasonal variations or flooding events.

The Prestfjall Formation is overlain by the compound lava flows of the Malinstindur Formation. Notice how the flows are composed of thinner flow lobes typically <5 m thick. Notice the lack of interlava intervals in this basal sequence suggesting that eruptions were fairly continuous with on minor pauses marked by reddened weathering surfaces.

Stop 2.6: Hvalbiareiði, Suðuroy



Fig. 47. View of the volcaniclastic sandstone and saprolitic bole between two sheet lobes of the Beinisvørð Formation, Hvalbiareiði, Suðuroy.

Location

Hvalbiareiði Harbour [PJ 0817 3053; ~10 m asl], ~900 m S of Hvalba, Suðuroy (Figs. 33 & 39).

Introduction

This locality allows for the close examination of soil profile from a sheet lobe of the Beinisvørð Formation.

Description

From the car park follow the winding path down to the harbour taking care on the often slippery tarmac. The landing is composed of a basal 10-12 m thick aphyric to moderately plagioclase-phyric sheet lobe of the Beinisvørð Formation and is the third/fourth highest simple flow in this area (Fig. 47). The top of the flow is marked by a rubbly top that forms part of a saprolitic bole (palaeosol) sequence (Passey & Bell 2007). The overlying sandstone and soil is ~1.5 m thick which grades downwards from highly altered basaltic material into fresh basalt of the flow beneath. At the base of the reddened sandstone and soil profile are abundant basalt corestones liberated during the weathering process.

The sandstone and soil profile are overlain by a ~15 m thick aphyric sheet lobe known as the Hvalbiareiði Flow (Passey & Bell 2007). The flow has poorly developed columnar jointing and is characterised by having a sharp planar base. However, along some sections the base of the flow contains hyaloclastite pockets that have formed when the lava flow quenched and brecciated in contact with small localised pools of surface water. The base of the flow can also be seen to have passively bulldozed into the underlying soil producing an M-shaped structure. New research has suggested that the sheet lobes of the Beinisvørð Formation were emplaced as inflated pahoehoe lava flows (Passey & Bell 2007) rather than the previously interpreted 'a'a mode of emplacement. This is supported by the absence of extensive basal clinkery layers, the lack of disruption to underlying sediments, amygdale distribution patterns and the so-called rubbly flow tops are predominantly part of extensive soil sequences rather than having formed through autobrecciation.

Stop 2.7: Soyðistangi Viewpoint, Suðuroy

Location

Soyðistangi Viewpoint [PJ 1014 2652; ~278 m asl], ~4.5 km WSW of Trongisvágur, Suðuroy (Figs. 33 & 39).

Introduction

This spectacular locality allows for the comparison between the simple flows of the Beinivørð Formation and the compound flows of the Malinstindur Formation. On the way to the locality a normal fault shall be examined cutting the simple flows of the Beinivørð Formation.

Description

From the main road, follow the red and yellow way markers over boggy but flat ground for ~1.1 km to the viewpoint with a permanent telescope. About 200 m along the walk stop and look to the S towards the N side of Galvurin mountain (~568 m asl). Towards the W side of the mountain a NW-SE trending normal fault can be observed cutting the sheet lobes of the Beinivørð Formation with a downthrow of ~10 m to the SW (Fig. 48; Rasmussen & Noe-Nygaard 1969; 1970). The fault dies out with height where the coal-bearing strata of the Prestfjall Formation is inferred to be flexed over the fault and in the Malinstindur Formation the fault occurs as a lineament with no discernable movement (i.e. a fracture; Rasmussen & Noe-Nygaard 1969; 1970). The fault can be seen again on the SE side of the mountain where the displacement is in the order of ~11 m. Turning around and looking to the N, the fault can be seen to the W of the Hvalba Tunnel. The fault is believed to extend to Hvalbiareiði (Stop 2.6) where the displacement is ~1 m to the SW (Rasmussen & Noe-Nygaard 1969; 1970). The trace of this fault on the E side of Prestfjall (opposite the Rókhagi coal mine) has caused problems mining the coal in this area. These problems consist of water leakage into the mine, but also the coal seams occurring at a lower level on the SW side of the fault. Exploration boreholes have been drilled to locate the coal seams on the downthrown side of the fault.

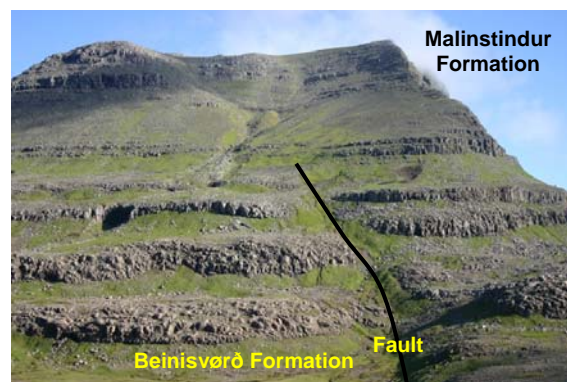


Fig. 48. View of a normal fault with the downthrown side to the W (i.e. to the right), N side of Galvurin, Suðuroy.

Continue along the path for a further ~900 m to the viewpoint with a permanent telescope. **DO NOT GO BEYOND THE FENCE FOR YOUR OWN SAFETY!** Looking to the NW, you can see the cliff face of Hæddin mountain, the summit of which is 471 m asl (Fig. 49). The cliff can clearly be separated into two sequences composed of different lava flow morphologies. The basal ~260 m of the cliff consists of 8 simple lava flows of the Beinivørð Formation. The simple lava flows may also be classified as sheet lobes as their widths are

significantly greater than their thicknesses (cf. tabular flows). The 8 simple flows can be distinguished by the in-weathering of soil profiles and/or interlava sedimentary units as well as by their sharp planar bases. Excluding the basal and upper sheet lobes (minimum thicknesses due to lack of exposure and erosion), the intervening 6 sheet lobes range in thickness (including associated interbeds) between 28 and 53 m and have an average thickness of ~37 m. The Beinisevørð Formation is overlain by the ~14 m thick, poorly exposed, Prestfjall Formation, consisting of coals, claystones and sandstones of swamp, lacustrine and fluvial environments. The Prestfjall Formation is overlain in this section by a ~200 m thick sequence of compound lava flows of the Malinstindur Formation. The boundaries between the compound lava flows are difficult to identify. The compound flows are made up of numerous thinner, anastomosing and meandering lava flow lobes <10 m thick, but typically <2 m thick. It has been suggested that the simple flows were erupted from fissure systems as opposed to the compound flows erupted in a piecemeal manner from point-sourced volcanoes (Passey & Bell 2007). The vents have not been identified, but the compound flows were, most likely, erupted locally, whereas the sheet lobes were most probably sourced from a westerly direction (Waagstein 1988; Passey & Bell 2007).

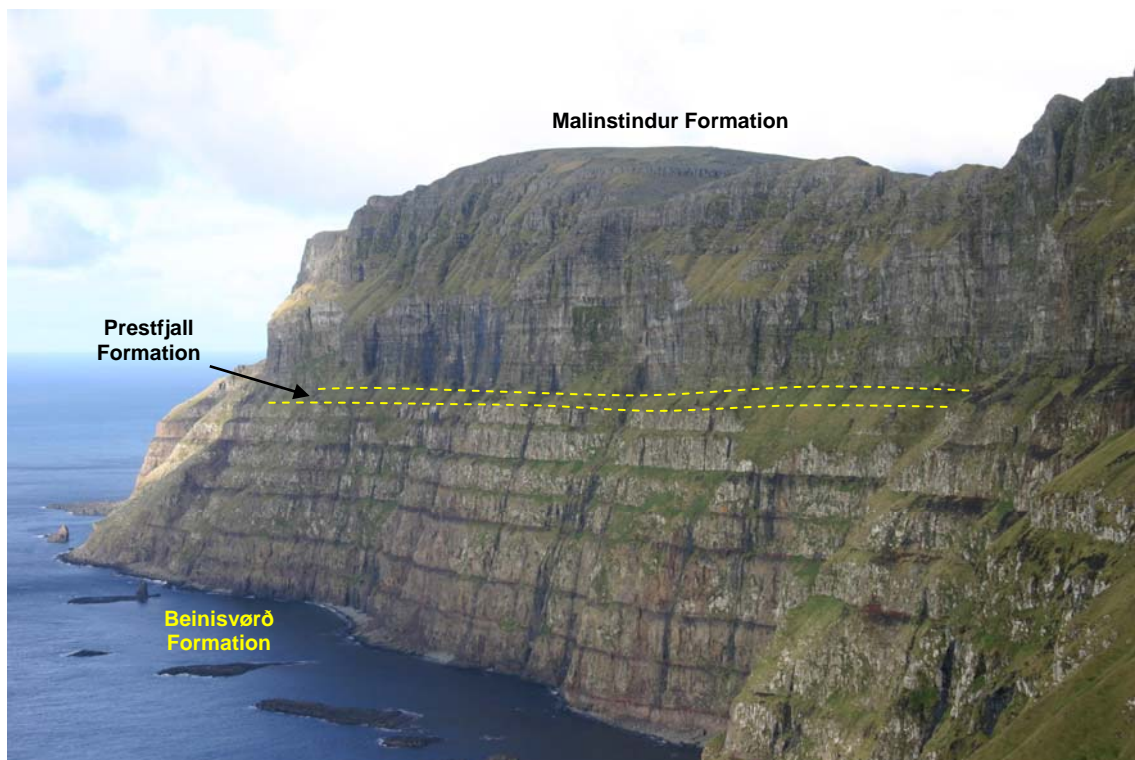


Fig. 49. View of the ~460 m high cliffs to the N of Soyðistangi, Suðuroy. The cliffs are composed of lava flows of the Beinisevørð and Malinstindur formations and the sedimentary units of the intervening Prestfjall Formation.

Day 3 – Monday, 18 August 2008



Fig. 50. Excursion route map for Day 3 – Stops 3.1 to 3.11.

Introduction

The group shall rendezvous with the excursion leader outside Hotel Øravík for 08:45. A ~15 minute bus journey shall take the group to the start location N of Trongisvágur. From here, the group will walk for ~1 hour into the secluded and idyllic valley of Hvannhagi situated along the northern coastline of Suðuroy (Figs. 33, 39 & 50). The whole day shall be spent in the valley and therefore, you will need to bring with you your **lunch**, **warm clothing**, and **waterproofs**. In addition, make sure you have sturdy footwear, preferably **walking boots**. Safety is paramount as some of the terrain maybe rough in places and slippery in wet weather. If the fog comes down please stick together as a group and watch out for one another. In the unlikely event that there is an emergency the local emergency phone number is 112. Guides shall be positioned at the front and rear of the group for safety. The valley consists of good exposures from the Beinisdvørd, Prestfjall, Hvannhagi and Malinstindur formations as well as the numerous irregular intrusions that have disrupted this interval. The night shall be spent at Hotel Øravík where an evening meal will be provided.

Hvannhagi Hiking Trip

Start Location 3.1: Marknagarðurin, Suðuroy

Location

End of the track at Marknagarðurin [PJ 1546 2798; ~115 m asl], ~600 m NE of Trongisvágur, Suðuroy (Figs. 50 & 51).

Introduction

From the end of the track it is a ~1.3 km walk to the top of the pass into Hvannhagi. Leaving the track head through gate sign posted 'Hvannhagi' and follow the worn track up around the side of the hill, making sure you do not go above the craggy rock exposures. Coming round the side of the hill head towards the N, staying on the E side of the Svalbarðaá stream, this can be seen to your left. Climb up onto the mountain pass (*Eiðið*) that has a height of ~206 m. From here, descend onto the other side of the pass to Stop 3.3, following the cairns and/or the fence line, which is to the E (i.e. on your right). Stop at the gate to the left of the wooden sheep pen, this is Stop 3.3.

Start Location 3.2: Hválurin, Suðuroy

Location

Water tanks [PJ 1492 2815; ~90 m asl], Hválurin, ~400 m N of Trongisvágur, Suðuroy (Figs. 50 & 51).

Introduction

From the water tanks head N following the Svalbarðaá stream which is on your right (i.e. to the E). There is a fence that runs along the E side of the stream and when this turns sharply to the E (i.e. to your right) cross the stream using the stepping stones. From here head up to the top of the valley following the worn sheep track, keeping the stream on your left. This is the mountain pass of *Eiðið* at a height of ~206 m. From here, descend onto the other side of the pass following the cairns and/or the fence line, which is to the E (i.e. on your right). Stop at

the gate to the left of the wooden sheep pen, this is Stop 3.3. The distance from the water tanks to Stop 3.3 is ~1.2 km.

Stop 3.3: Grindin, Suðuroy

Location

Grindin [PJ 1568 2900; ~170 m asl], ~1.5 km NE of Trongisvágur, Suðuroy (Figs. 50 & 51).

Introduction

Stop 3.3 is situated at the top of the path that descends down into Hvannahagi valley. This locality gives a general overview of the valley where lithologies from the Beinissvørð, Prestfjall, Hvannahagi and Malinstindur formations can all be examined (Fig. 51).

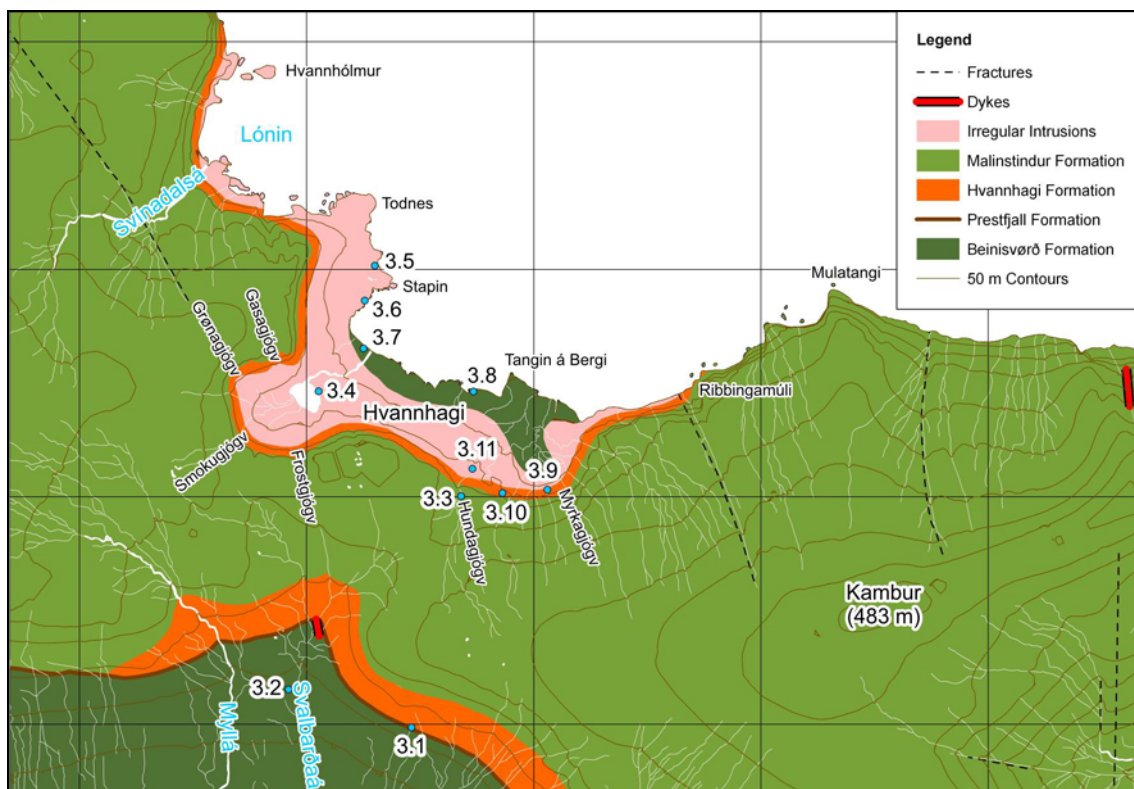


Fig. 51. Simplified geological map of Hvannahagi, N of Trongisvágur, Suðuroy. Stops 3.1 to 3.11 are indicated. Modified after Rasmussen & Noe-Nygaard (1969; 1970).

Description

The valley covers an area of ~0.78 km² and is ~1.3 km long by 300-700 m wide. Hvannahagi can be separated into two halves, each represented by small cirques. The eastern cirque is called Uttaripartur and the western one Norðaripartur, which also contains the picturesque lake of Hvannavatn (Fig. 50). The Norðaripartur cirque can not be seen from this location, but the crescent bay S of Stapin can clearly be seen (Fig. 52).

The wave-cut platform to the S of Stapin is composed of lapillistone-agglomerate and is named the Stapin Vent (Stop 3.6). The vent belongs to the Beinissvørð Formation as it is overlain by the Prestfjall Formation consisting of conglomerates, shales and carbonaceous shales >2 m thick (Stop 3.7). Simple lava flows of the Beinissvørð Formation form the coastline along the E side of the valley (Stop 3.8). The majority of the valley is composed of

irregular intrusions >60 m thick that appear to have been intruded at the basal contact or within the base of the Hvannhagi Formation. The uppermost ~25 m of the Hvannhagi Formation is well exposed along the back of the Uttariartur cirque valley (Stops 3.9 & 3.10) and is directly overlain by the compound lava flows of the Malinstindur Formation. The units above the irregular intrusions have been domed upwards in the Hvannhagi area and this is clearly seen through the contact between the Hvannhagi and Malinstindur formations dipping steeply down towards sea level to the E of Uttariartur. The opposite side of the dome can be seen along the western coastline of Lónin bay to the W of Hvannhagi. The Malinstindur Formation forms the steep valley walls.

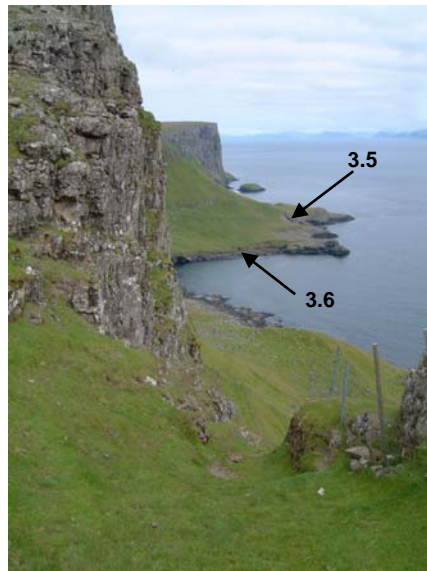


Fig. 52. View from Stop 3.3 into Hvannhagi valley, Suðuroy.

The Hvannhagi Formation is restricted to WNW-ESE trending exposures across Suðuroy, but more generally NW-SE when taking in consideration the exposures on the island of Vágur (Fig. 5). On the W side of Suðuroy the Hvannhagi Formation is either extremely poorly developed, intercalated with the basal flows of the Malinstindur Formation, or is missing. The Hvannhagi Formation is composed of 2 sequences, both represented by a basal airfall tuff overlain by sedimentary deposits, mainly debris and hyperconcentrated flow units, but also overbank floodplain facies. The basal airfall tuff is >12 m thick in Hvannhagi and for such a thick deposit not to be preserved to the W implies that this was potentially higher ground and the ash was eroded and transported to the depocentres in the Hvannhagi area. The airfall tuffs are mainly olivine-phyric and are presumed to be the precursors to the eruption of the Malinstindur Formation compound lava flows that are also olivine-phyric. The Hvannhagi Formation represents a syn-eruption facies, where sedimentation and volcanism occurred contemporaneously.

Stop 3.4: Hvannavatn Lake, Suðuroy

Location

Pass through the gate at Stop 3.3 and head down along the path, taking care over the initially rough terrain. The path heads westwards and is easy going. About 400 m along the path a fence is crossed using the stile. This fence separates Hvannhagi into two areas so that the differently owned sheep can be kept apart. Eventually the path will bring you to the NE end of Hvannavatn lake [PJ 1505 2946; ~90 m asl], Hvannhagi, Suðuroy (Fig. 50).

Introduction

This locality looks at the glacial lake of Hvannavatn.

Description

Hvannavatn lake is ~140 by ~100 m across and has an area of ~12,000 m². The lake is categorised as a cirque lake (cf. tarn) which are normally characterised by being small, circular and typically deep. The lakes do not have a prominent inlet and are fed by runoff from high relief upslope giving them a large watershed. The lakes are also commonly dammed by a lip of bedrock, as is the case for Hvannavatn, or by small glacial moraine. The lip of bedrock at the NE end of the lake is made up of columnar jointed dolerite belonging to the irregular intrusions that have invaded the Hvannhagi Formation. The contact between the Hvannhagi Formation and the overlying Malinstindur Formation is poorly exposed at the back of the cirque, but can be identified by the reddening of the upper units of the Hvannhagi Formation. An alternative route out of the valley is a scramble up along NNW-SSE trending fracture of Frostgjógv at the SE corner of the cirque.

Stop 3.5: Todnes, Suðuroy



Fig. 53. Rafted xenolith in the irregular dolerite intrusions at Stop 3.5, S of Todnes, Suðuroy.

Location

From the lake head down the slope for ~600 m to the S side of Todnes peninsula [PJ 1530 3001; ~8 m asl], ~80 m NW of Stapin, Hvannhagi, Suðuroy (Figs. 50 & 51).

Introduction

A rafted sedimentary sequence enclosed in a dolerite intrusion can be clearly examined at this location.

Description

At this location a large, ~20-30 m long by ~5-10 m wide rafted sedimentary sequence is contained within the irregular intrusions that have invaded the Prestfjall and Hvannhagi formations (Fig. 53). The way up direction of the raft is to the N (i.e. towards the coastline).

The raft consists of a basal shale unit that is overlain by thinly to thickly bedded volcanoclastic sandstones. The base of the sandstone section consists of channel-like features containing angular clasts derived from the underlying shale unit. Fine scale sedimentary faulting is observed in some of the sandstone beds. The sandstones are highly altered, but consist primarily of sub-rounded grains of basaltic glass at various stages of palagonitisation. Typically the clasts are vesicular with laths of plagioclase feldspar. Overlying the bedded sandstones is a ~3 m thick sequence of volcanoclastic breccia, which is poorly sorted. The irregular intrusions have similar geochemistries to the olivine-phyric to aphyric basalt compound lava flows of the Malinstindur Formation and are therefore interpreted to represent shallow feeders for these flows (Waagstein 1988; Hald & Waagstein 1991).

Stop 3.6: í Støð, Suðuroy

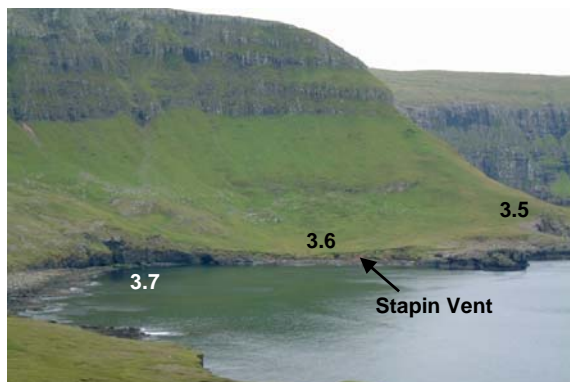


Fig. 54. View of the í Støð wave-cut platform composed of pyroclastic units from the Stapin Vent, Suðuroy.



Fig. 55. Cow-dung bomb from the Stapin Vent pyroclastic deposits, í Støð, Suðuroy. The hammer is ~40 cm long.

Location

Heading S from Stop 3.5 make your way down onto the í Støð wave-cut platform [PJ 1525 2986; ~1 m asl] from the northern end, ~120 m SW of Stapin, Hvannhagi, Suðuroy (Figs. 50 & 51).

Introduction

This locality examines one of the best vent deposits exposed on the Faroe Islands.

Description

The platform is composed exclusively of a mass of lapillistone-agglomerate that has a domed and annular outcrop pattern and forms the Stapin Vent (Fig. 54; Rasmussen & Noe-Nygaard 1969; 1970; Passey 2004). The vent is ~10 m thick and is at least 150 m wide (i.e. length of the bay). The unit has the appearance of being thinly bedded and is composed entirely of basaltic fragments. The unit is very poorly sorted, although there maybe some grading and maximum fragment sizes are up to ~70 cm across. Cow-dung and breadcrust bombs are observed within the exposure (Fig. 55). Some of the bombs exhibit vesicle-poor cores whilst having highly vesicular margins. The fragments in thin section are typically glassy with tiny, infrequent laths of plagioclase feldspar. The vent was most likely a localised eruption site during the waning stages of the emplacement of the Beinisdvørð Formation. The margins of the vent are clearly overlain by sedimentary units interpreted to be from the Prestfjall Formation (Stop 3.7). At the northern end of the bay the agglomerate is overlain by at least 1.8 m thick sequence of shales that have been intruded by dolerite sills.

Stop 3.7: Leirbakki, Suðuroy

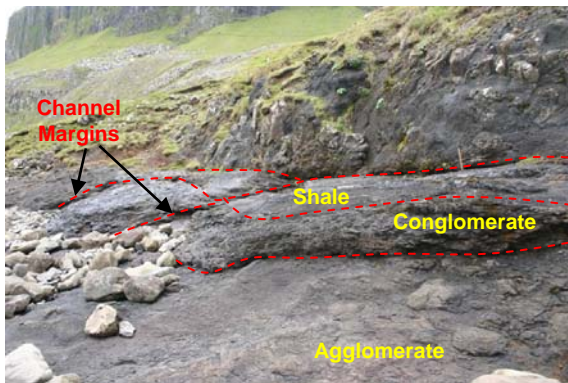


Fig. 56. Channelised conglomerates and coaly shales of the Prestfjall Formation overlying pyroclastic deposits from the Stapin Vent, Leirbakki, Suðuroy.



Fig. 57. Woody fragments from the discontinuous coaly shale from the Prestfjall Formation, Leirbakki, Suðuroy.

Location

From Stop 3.6 head up and over the headland at the southern end of the í Støð wave-cut platform crossing over the two streams from Hvannavatn lake. Make your way down onto the wave-cut platform to the W of the outlet of the second stream that was crossed. This is Leirbakki wave-cut platform [PJ 1525 2965; ~5 m asl], ~330 m S of Stapin, Hvannahagi, Suðuroy (Figs. 50 & 51).

Introduction

Sedimentary units from the Prestfjall Formation can be examined that overlie deposits from the Stapin Vent.

Description

At this location the foreshore is composed of a continuation of the vent deposit from the last location. This is overlain by a maximum 1.5 m thick channelised conglomeratic sequence (Fig. 56). Three channels up to 10 m wide can be observed cutting downwards to the E. The middle channelised sequence appears to fine upwards. The conglomerates are poorly sorted and maximum clast sizes are typically large cobble grade. The clasts are generally sub-rounded and elongated clasts are weakly imbricated. The majority of clasts are massive basalt, although some are vesicular and are contained in a muddy matrix. The conglomerates are overlain by a medium to dark grey shale that is locally up to 1 m thick in lows and <50 cm thick on highs. The shale is very finely laminated and has an iridescent sheen most likely due to manganese staining. The shale is overlain by discontinuous coaly shale up to 8 cm thick. The unit contains discernable woody fragments several centimetres in length that are most likely allochthonous (Fig. 57). The coaly unit is overlain by a second shale up to 20 cm thick similar to the underlying shaly unit. This sequence is overlain by a thick conglomerate sequence up to 10 m thick that has been heavily disrupted through the intrusion of apophyses from the overlying dolerite sill complex.

The Stapin Vent deposits were initially assigned to the so-called tuff-agglomerate zone (now the Hvannahagi Formation) of Rasmussen & Noe-Nygaard (1969; 1970). However, palynological analysis of the shales and the coaly unit at this locality suggests that they are Prestfjall Formation in age as they have a distinctive assemblage when compared to the interlava lithologies associated with the Beinisevørð Formation (D.W. Jolley pers. comm).

2004). Consequently, as these units overlies the vent deposit it implies that the vent is at least late Beinissvørð Formation or early Prestfjall Formation age, the former being more likely. Nevertheless, the Stapin Vent is older than the previously assigned Hvannhagi Formation (i.e. formerly the tuff-agglomerate zone) age of Rasmussen & Noe-Nygaard (1969; 1970).

Stop 3.8: Tangin á Bergi, Suðuroy

Location

From Stop 3.7 walk back up onto the grassy bank and then proceed along the coastline to the E following the bench of Gráhamar (grey bench), which is composed of columnar jointed dolerite sill. About 200 m along the coastline a small dry wall needs to be carefully climbed over. The stone ruins in this area are former boat houses. Continue for a further ~350 m passing the gully called Gjógv Óla Vang to the base of a prominent weakly columnar jointed basalt lava flow. This locality is the wave-cut platform [PJ 1573 2946; ~5 m asl], ~170 m SW of Tangin á Bergi, Hvannhagi, Suðuroy (Figs. 50 & 51).

Introduction

This stop consists of the uppermost flow of the Beinissvørð Formation where internal structures can be examined as well as the underlying sedimentary sequence.

Description

The wave-cut platform is composed of the upper ~3 m of a vesicular upper crust to an aphyric simple lava flow of the Beinissvørð Formation. This is irregularly overlain by a 2.5-4.0 m thick volcanoclastic shaly mudstone to conglomerate sequence. The upper contact undulates with a relief of less than a few metres and is overlain by a second aphyric simple lava flow. This flow is, most likely, the uppermost flow of the Beinissvørð Formation in the Hvannhagi valley. The flow has a sharp planar contact and the basal crust consists of pipe amygdales 5-12 cm in length that start ~10 cm above the base of the flow and are curved in the assumed flow direction. The flow is weakly columnar jointed where the basal 1.0-1.5 m consists of columns ~40-50 cm wide. Above this height the column widths increase to 1.2-2.0 m. The marked change in column widths, most likely, represents the median parting between the two cooling fronts from the top and bottom of the flow. Chisel marks, band-like markings, up to ~10 cm thick have developed on some of the vertical surfaces of the columns, which represent cycles of stress build-up and stress release.

Stop 3.9: East Uttaripartur, Suðuroy

Location

From Stop 3.8 head to the SW towards the first stream to the W of the major gully, Myrkagjógv, at the back of the Uttaripartur cirque valley. The base of the stream exposure occurs at a height of ~55 m and consists of a walk of ~600 m over initially boggy ground before the terrain steepens considerably. Please take care walking up this often slippery slope. Stop 3.9 occurs at the base of cliffs [PJ 1606 2903; ~65 m asl] in the first stream ~80 m W of Myrkagjógv, Hvannhagi, Suðuroy (Figs. 50 & 51).

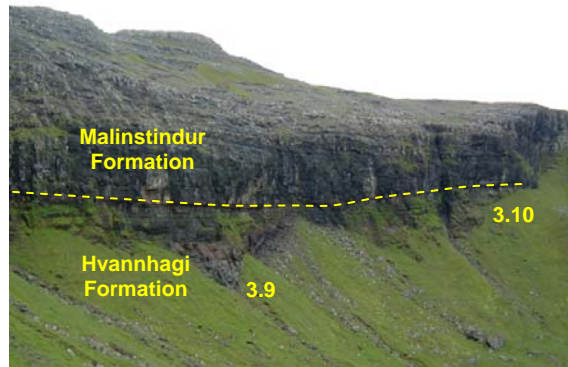


Fig. 58. View of the Hvannahagi Formation in Uttaripartur, Suðuroy.

Introduction

This locality allows for the close examination of the basal 20 m of the Hvannahagi Formation tuffs and overbank floodplain deposits.

Description

This ~30 m thick section consists of units of the Hvannahagi Formation and forms the thickest exposed section in the valley (Fig. 58; Passey 2004). However, only the basal 20 m can be examined safely. The basal 4 m comprises greyish dolerite sills that commonly contain xenoliths of tuffaceous material several tens of centimetres across. The upper contact is typically sharp and undulating. The sills are overlain by ~12 m of thickly to very thickly bedded olivine-phyric coarse tuff. The basal ~4 m is light olive grey which contrasts with the upper ~8 m that is reddened due to surface oxidation. The unit is very poorly sorted and has an average fragment size of medium sand (i.e. coarse ash), although lapilli sized fragments are common. The tuff is dominated by devitrified basaltic glass fragments which are typically vesicular and exhibit cusped margins. The tuff is distinctive in hand specimen due to the abundance of blackish green, 1-2 mm long, needles. These are altered euhedral and skeletal phenocrysts of olivine.



Fig. 59. Heterolithic sequence from the Hvannahagi Formation, Stop 3.9, Suðuroy.

Staying on the left side of the stream the coarse tuff is seen to be overlain by a ~5.5 m thick heterolithic sequence consisting of sharp-based sandstones and mudstones (Fig. 59). The

sandstone beds range in thickness from 8 cm up to 2 m, although the thickest sandstones are found at the base and top of the sequence. The mudstones occur in a section ~1.5 m thick that occurs ~3 m above the base of the heterolithic sequence. In this section, the sandstone beds have a maximum thickness of ~20 cm, whereas the mudstone beds range in thickness from 1 to 13 cm. The greenish black sandstone beds are massive, poorly sorted and consist of sub-angular to sub-rounded highly palagonitised basaltic glass clasts with an average grain size of medium sand. The very dusky red mudstones are moderately sorted and comprise sub-rounded highly altered basaltic glassy material. The alternating and sharp-based nature of the sequence implies that the units were deposited in a floodplain environment during catastrophic overbank flooding events. This sequence is laterally confined to this section suggesting that this area was a palaeo-low during the deposition of the Hvannhagi Formation.

The upper 8-10 m of the Hvannhagi Formation is difficult to examine at this location but consists primarily of volcanoclastic conglomerates and sandstones as well as a second tuff bed. These units shall be examined at Stop 3.8. The Hvannhagi Formation is overlain with a sharp planar contact by the compound lava flows of the Malinstindur Formation.

Stop 3.10: West Uttaripartur, Suðuroy

Location

Walk back to the bottom of the stream section at Stop 3.9 and head W along the base of the cliffs and up past a small stream that runs down through a dyke filled fracture. Stop 3.10 occurs at the base of cliffs [PJ 1586 2901; ~125 m asl], ~300 m W of Myrkagjógv, Hvannhagi, Suðuroy (Figs. 50 & 51).

Introduction

This stop consists of the upper units of the Hvannhagi Formation consisting of a welded tuff and mass flow deposits.

Description

The section to the W of the dyke filled fracture consists of the upper ~11 m of the Hvannhagi Formation (Fig. 58; Passey 2004). The base of the sequence consists of the light olive grey olivine-phyric coarse tuff seen at the base of the previous section. This is overlain by ~3.5 m of thickly bedded conglomerates and sandstones (Fig. 60). The conglomerates are very poorly sorted with the largest clasts being typically pebble or cobble grade. The clasts are generally sub-angular to sub-rounded and are composed of coal, mudstone, basalt lava, coarse tuff and smaller material being composed of palagonitised basaltic glass. The conglomerates are commonly overlain by thickly laminated sandstone beds that tend to be fine to medium grained. The environmental setting, lateral extensiveness and bedding structures of the conglomerates and sandstones suggest they were, most likely, deposited under debris and hyperconcentrated flow conditions during unconfined sheet floods (mass flows). This sequence overlies the heterolithic sandstone and mudstone sequence observed in Stop 3.9, suggesting the palaeo-low inferred at Stop 3.9 is situated to the E of this location.



Fig. 60. Debris and hyperconcentrated flow conglomerates and sandstones from the Hvannahagi Formation, Uttariþartur, Suðuroy.



Fig. 61. Welded olivine-phyric coarse tuff with fiamme-like fragments forming a eutaxitic texture, Hvannahagi Formation, Uttariþartur, Suðuroy.

The conglomerate and sandstone sequence is overlain by a >2 m thick olivine-phyric coarse tuff similar in composition to the tuff from the base of the Hvannahagi Formation in this area (Fig. 61). However, this tuff exhibits fiamme-like fragments that define a sub-horizontal planar foliation or eutaxitic texture. The fiamme typically have short axis : long axis ratios between 0.3 and 0.5. The tuff is dominated by orange cusped glass shards sintered together, with an average size of medium sand (i.e. coarse tuff), although shards up to 1 mm are noted. These large shards commonly contain highly altered euhedral to subhedral phenocrysts of olivine. The shards are also highly vesicular and generally contain small (<100 μm) laths of plagioclase feldspar. The fiamme are morphologically similar to the orangey “host” tuff except that the glass shards are dark brown to near opaque. The boundaries between the “host” tuff and the fiamme are sharp and lobate. The formation of the fiamme is not fully understood at this locality but is, most likely, formed in response to compaction. The tuff can be traced between sections over a distance of at least ~2 km.

Stop 3.11: Dysjarnar, Suðuroy

Location

Walk out onto the prominent hillock ~100 m to the NW of the Stop 3.10, this is Dysjarnar [PJ 1573 2912; ~118 m asl], Hvannahagi, Suðuroy (Fig. 50).

Introduction

This last locality examines a substantial landslide in the valley.

Description

Dysjarnar is a sizeable landslide that is ~200 m wide from E to W and is ~100-110 m at the thickest point (Jørgensen 1978). The landslide consists of 8-10 ridges that are typically low, <1 to 2 m high. The edge of the landslide thins outwards like a fan. Lubrication of the mechanically weaker rock units of the Prestfjall Formation at the base of the landslide, most likely, through the retreat of the glaciers during or shortly after the last ice age, removed the support for the overlying Hvannahagi Formation and associated sills and the basalt lava flows

of the Malinstindur Formation (Fig. 62). Movement took place on a vertical or inclined surface in the basalt but assumed a listric form in the underlying highly plastic claystones and coals of the Prestfjall Formation. This movement resulted in a rotation of the rock body and therefore, this type of rock slide is referred to as a slump. The height difference at Dysjarnar between the top of the slump and the cliff top, where the basalt is believed to have originated, is in the order of ~50-70 m.

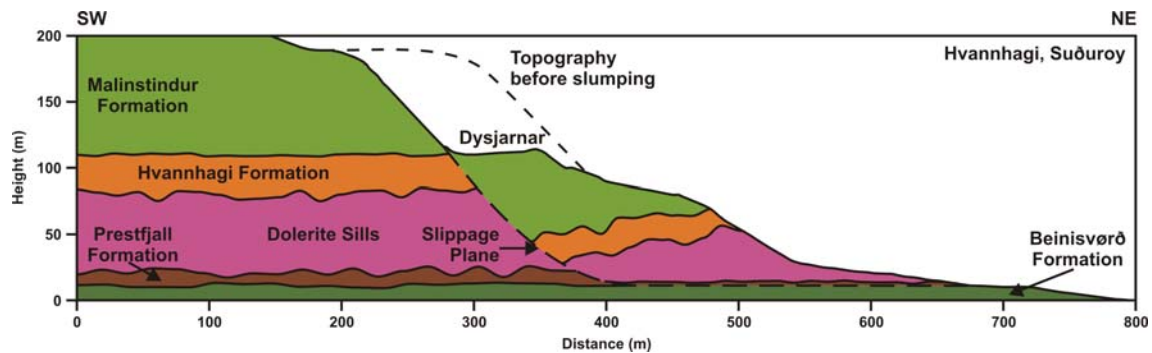


Fig. 62. Generalised cross-section through the Dysjarnar landslip, Suðuroy.

Return to the Bus

From Dysjarnar head westwards up the steep slope to the gate along the path we originally came down on. Before leaving, could the last person please make sure the gate is securely closed and fastened. A short walk back up the path brings you to the wooden sheep pen. From here, just head back the same way as we came in the morning (Fig. 50).

Day 4 – Tuesday, 19 August 2008

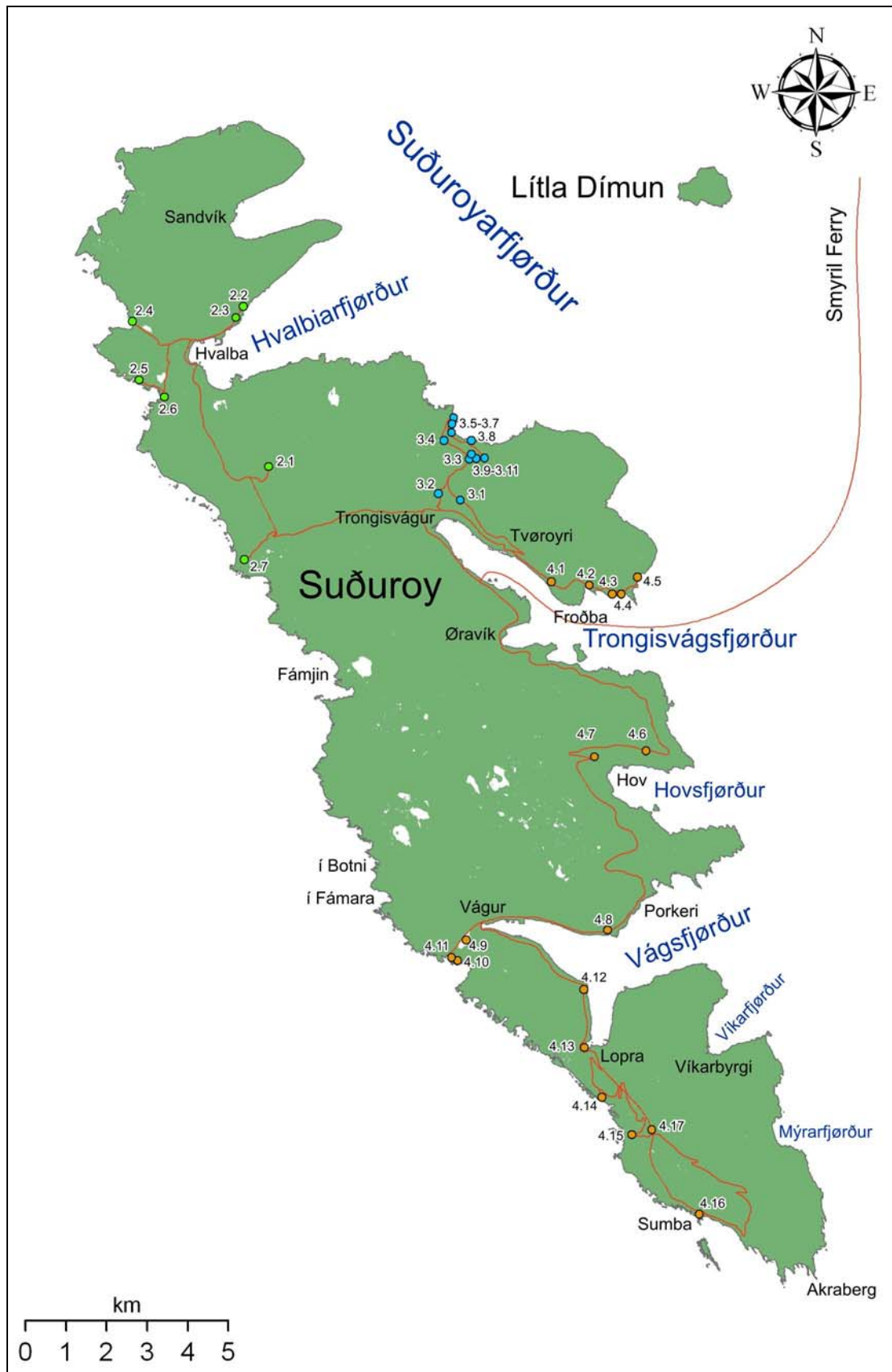


Fig. 63. Excursion route map for Day 4 – Stops 4.1 to 4.17.

Introduction

The group shall rendezvous with the excursion leader outside Hotel Øravík at 08:30 with their entire luggage as we shall not be returning to the hotel. Today shall be spent travelling around central and southern Suðuroy visiting a number of road side localities before catching the 15:30 ferry back to Tórshavn. The road side stops shall allow the group to examine various facets (e.g. lava morphologies, interlava units, faults) of the Beinisvørð Formation (Fig. 39). The night shall be spent at Hotel Hafnia and participants are expected to arrange their own evening meal.

Suðuroy Road Side Localities

Stop 4.1: Cemetery Quarry, Froðba, Suðuroy

Location

Park in the disused quarry [PJ 1770 2598; ~30 m asl] opposite the cemetery in Froðba, Suðuroy (Figs. 39 & 63).

Introduction

This stop looks at the irregular columnar jointing of a simple flow from the Beinisvørð Formation.

Description

The sheet lobe at the back of the quarry is ~9 m thick and is characterised by very poorly developed (irregular) columnar jointing (Fig. 64). The base of the flow can be seen on the E side of the quarry. The basal contact is sharp and planar and overlies an extremely weathered flow top of the underlying flow. The poorly developed nature of the columns has been attributed to cooling of flows in a relatively dry environment, whereas well-developed columnar jointed flows are typically associated with ponding in generally wetter environments.



Fig. 64. Lava flow with poorly-developed columnar jointing, Beinisvørð Formation, Froðba, Suðuroy.

Stop 4.2: Mølin Road Cut, Suðuroy

Location

Park in the lay-by [PJ 1864 2588; ~30 m asl] ~200 m W of Molin bay on the N side of the road, Froðba, Suðuroy (Figs. 39 & 63).

Introduction

In contrast to the last stop this locality looks at a sheet lobe from the Beinisdvørð Formation that is characterised by well-developed columnar jointing.

Description

At this locality the third uppermost sheet lobe of the Beinisdvørð Formation is exposed for ~200-300 m along the roadside (Fig. 65). The flow is ~25 m thick, where the basal ~10 m is well exposed. The flow is characterised by well-developed columnar jointing with an average spacing of ~1 m. The near-planar surfaces of the joint faces exhibit chisel marks, which alternate from smooth to rough portions over a distance of 8-10 cm. This alternation is considered to indicate the direction in which the column surface propagated and is the product of cycles of stress build-up and release, which produced the fractures that define the columns. This flow is, most likely, the inland continuation of the Kulagjógv Flow observed at Stop 4.3.



Fig. 65. Lava flow with well-developed columnar jointing, Beinisdvørð Formation, Froðba, Suðuroy.



Fig. 66. Ponded Kulagjógv Flow with fan-shaped columnar jointing, Froðba, Suðuroy.

Stop 4.3: Kulagjógv, Suðuroy

Location

From the road cross over the crash barrier and head down towards the Rættartangi headland [PJ 1920 2568; ~5 m asl] taking care to climb over the fence. This locality affords a view to the E of the Kulagjógv section, ~1.2 km E of Froðba, Suðuroy (Figs. 39 & 63).

Introduction

This spectacular locality looks at the famous fan-shaped columns of a Beinisdvørð Formation sheet lobe.

Description

Looking along the coastline to the E you can see the Kulagjógv Flow which is characterised by well-developed columnar jointing and is the third uppermost sheet lobe of the Beinisdvørð

Formation in this area. The thickness of the flow varies along its length, but is on average ~20 m thick. At Kulagjógv, the flow displays superb fanning arrays of columns due to the ponding of the lobe within a channel, which can be used to recognise relief of ~20 m on the underlying palaeo-land surface (Fig. 66; Passey & Bell 2007). The underlying, apparently unbedded, volcanoclastic breccia is composed of clasts of amygdaloidal and non-amygdaloidal basalt, which has been differentially eroded and subsequently inundated by the Kulagjógv Flow.

Stop 4.4: Nasin Beach, Suðuroy



Fig. 67. Skarvatangi Flow and underlying fluvial sedimentary units, Beinissvørð Formation, Nasin, Suðuroy.

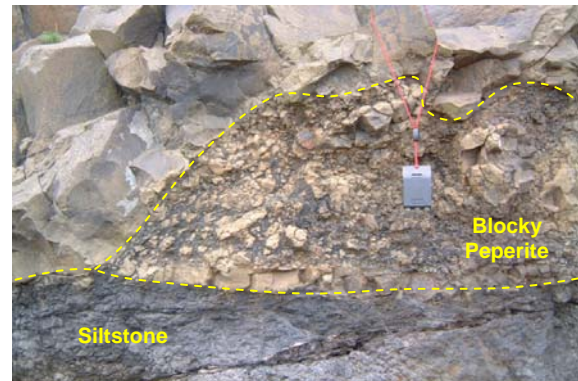


Fig. 68. Blocky peperite at the base of the Skarvatangi Flow, Beinissvørð Formation, Nasin, Suðuroy.

Location

From Stop 4.3 head up and over the Kulagjógv flow taking care to cross the fence and then head E until you reach Nasin beach [PJ 1942 2568; ~15 m asl], ~1.4 km E of Froðba, Suðuroy (Figs. 39 & 63).

Introduction

This exposure looks at a well developed sedimentary sequence and the interaction with the overlying sheet lobe of the Beinissvørð Formation.

Description

At this locality a ~6-7 m thick fluvial sedimentary sequence occurs between the second and third uppermost sheet lobes of the Beinissvørð Formation in this area (Fig. 67; Passey & Bell 2007). The base of the sedimentary sequence is composed of a ~4-5 m thick volcanoclastic conglomerate. The conglomerate is composed of a variety of crystalline basalt lava clasts that have undergone varying degrees of alteration. Some of the clasts are extremely altered having a greenish yellow coloration, tentatively implying that they have undergone chloritisation. Other clasts consist of reddish brown mudstone/bole. The unit is poorly sorted with clasts ranging in size up to cobble grade. The clasts are generally well rounded and elongated clasts are commonly aligned parallel to bedding. The conglomerate is overlain by a very dusky red to greyish brown volcanoclastic sandstone up to 2 m in thickness.

The siltstone is overlain by a ~17 m thick weakly columnar jointed basalt sheet lobe, known as the Skarvatangi Flow (Passey & Bell 2007). The basal contact is sharp and planar. The width of the columns in the basal 2-3 m is ~60 cm whereas the remainder of the flow the width increases to ~2 m. The change in width size between the columns, most likely, represents the median parting where the cooling fronts from the top and the bottom of the lobe

met. The base of the lobe also contains isolated pockets of blocky peperite consisting of angular basalt clasts derived from the flow mixed with material from the underlying sedimentary sequence (Fig. 68). One such pocket can be observed at the far eastern end of the beach. The peperite is ~6 m wide by ~60 cm thick and consists of clasts that have a more or less jigsaw-fit configuration. The peperite has formed through the flow quenching and brecciating in contact with localised water-saturated sediment (Passey & Bell 2007).

Stop 4.5: Holið í Helli, Suðuroy

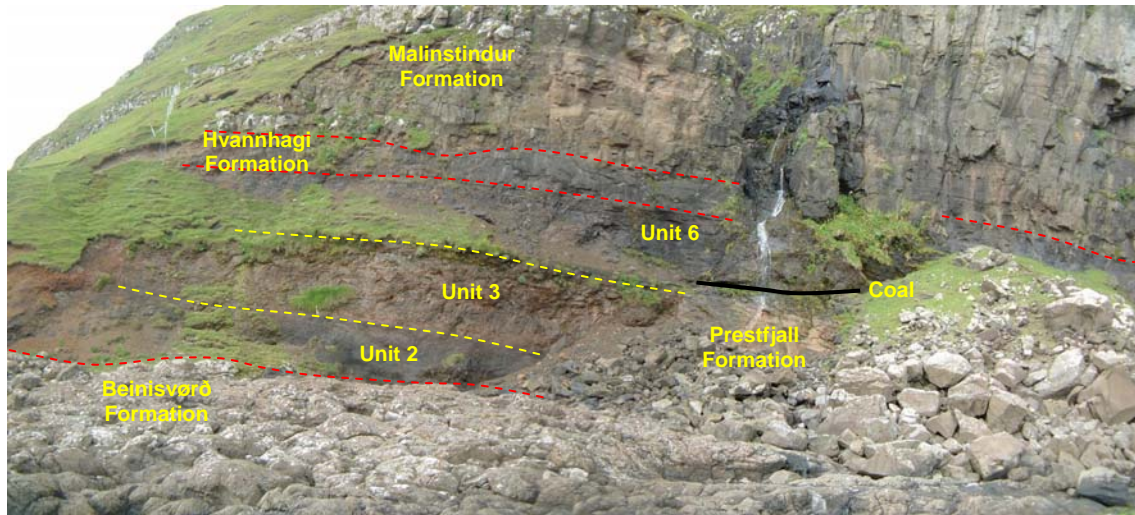


Fig. 69. A ~17 m thick section through the Prestfjall and Hvannahagi formations, Holið í Helli, Suðuroy.

Location

From the old rubbish chute head N through the gate and along the coastline for ~250 m until you reach the stream in Hálskjógv. This locality consists of the Holið í Helli Section [PJ 1982 2609; ~5 m asl], ~250 m N of Ulingatangi, Suðuroy (Figs. 39 & 63).

Introduction

At this locality the group will be able to examine an atypical section through the Prestfjall and Hvannahagi formations, including clay ironstones.

Description

At this locality the section consists of a completely exposed sequence through the Prestfjall and Hvannahagi formations inbetween the basalt lava flow sequences of the Beinivørð and Malinstindur formations (Fig. 69). This is one of the only complete and accessible exposures through the Prestfjall and Hvannahagi formations. At this locality, the Prestfjall Formation is ~14 m thick and can be subdivided into at least six units, but the typical subdivision of the formation by Rasmussen & Noe-Nygaard (1969; 1970) cannot be applied here due to the lack of the two commonly occurring lower and upper coal seams. Therefore, this locality should be regarded as an atypical sequence through the Prestfjall Formation (Passey 2004). The Prestfjall formation at this locality represents the margin to the palaeo-lake that developed during this time (Passey 2004). The depocentre of the lake was most likely situated to the W in the area of the Rókhagi coal mine where the most substantial amount of coal developed.

0.0-5.0 m: The coastline is composed of the uppermost sheet lobe of the Beinisvörð Formation. The upper surface is highly irregular most likely due to erosion during the volcanic hiatus that followed the emplacement of the Beinisvörð Formation.

5.0-5.8 m: Unit 1 of the Prestfjall Formation is a medium bluish grey, poorly sorted, granule-grade volcanoclastic conglomerate, that is ~0.8 m thick. The conglomerate is matrix supported and consists of sub-rounded basalt clasts. The average clast size of the conglomerate is ~3 x 3 mm with maximum sizes of 5 x 2 cm. The long axes of the clasts are commonly aligned parallel to bedding.

5.8-8.8 m: Unit 2 is a brownish black, mottled, coarse grained volcanoclastic sandstone, which is ~3 m thick. The sandstone is blocky and thinly to thickly laminated. In thin section, the sandstone comprises near-opaque clasts, average size ~1 mm, with the slightest hint of dark red under plane-polarised light. Tentatively, this suggests enrichment in iron and therefore, the clasts are, most likely, iron oxides or oxyhydrates. Some of the clasts consist of highly altered glassy basalt, with a maximum size of ~4 mm and some of these contain lath-shaped crystals, <100 µm in size, that have been pseudomorphed by a yellowish brown mineral, these are most likely remnants of plagioclase feldspar crystals replaced by secondary minerals. Fractures between the clasts have been filled by a yellowish brown siderite cement which reacts sluggishly with 10% hydrochloric acid. Also contained within the fractures and commonly enclosed with the cement are rare colourless siderite spherules with an average size of ~200 µm and which occasionally reach exceptional sizes in the order of ~2 mm. Under cross-polarised light the siderite spherules exhibit a characteristic Maltese Cross extinction pattern. The siderite cement enclosing the spherules is typically in optical continuity with the spherules. One large, partially preserved, spherule consists of three concentric growth zones each with an oxidised rim or zone. This zonation is interpreted to represent periods when the sandstone was water-logged (siderite growth) and periods when it was well drained (oxidisation), most likely, reflecting seasonal variations.

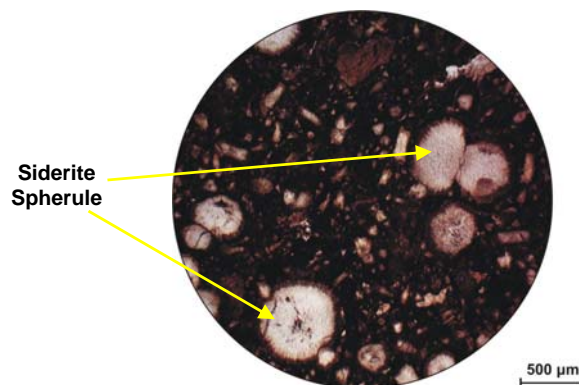


Fig. 70. Photomicrograph of the clay ironstone containing siderite spherules from Unit 3, Prestfjall Formation, Holið í Helli, Suðuroy.

8.8-13.3 m: Unit 3 is a massive, dense, light olive grey clay ironstone that contains 30-40 vol.% siderite spherules (Fig. 70). The clay ironstone is ~4.5 m thick and the basal 1.5 m contains discoidal coal fragments with a maximum size of ~15 x 2 cm. In thin section, the unit consists of a clay-rich matrix that has been significantly compacted around larger grains, particularly the siderite spherules. Irregular, sometimes cusped to platy, lithic fragments occur throughout the unit. These fragments are <1 mm in size and consist of palagonitised and chloritised basaltic glass. The siderite spherules have maximum diameters of ~1 mm and exhibit a range of morphologies including small, irregular, sub-rectangular crystals, split crystals and almost perfect spheres (sphaerosiderites). The abundance of split crystals far out

weighs the number of sphaerosiderites by ~9 to 1. The siderite spherules exhibit a distinctive Maltese Cross extinction pattern under cross-polarised light. Under the SEM, trigonal siderite crystals are commonly observed growing on the margins of pre-existing siderite spherules or forming stand-alone Christmas tree-like clusters. Where spherule-to-spherule contacts are observed the smaller of the two spherules are commonly shattered into small irregular pieces, suggesting the spherules formed prior to compaction. Geochemical investigations of the siderite spherules imply that the sequence was deposited in a freshwater environment. This is supported by the lack of pyrite in the sequence. The geochemical signature observed for the siderite spherules in this section differ significantly from those from the Rókhagi coal mine suggesting that they were deposited under different environmental settings (Passey 2004).

13.3-14.8 m: Unit 4 is a thin, ~1.5 m thick, brownish black volcanoclastic claystone, similar in character to the matrix from the underlying unit. The claystone contains light olive grey nodules with a well-developed spheroidal weathering characteristic. The nodules are elliptical in shape and have an apparent higher density than the claystone host. The nodules are all aligned parallel to bedding and range in size from 8 x 2 cm up to 25 x 9 cm and they are normally thinly laminated. The nodules contain iron stained spherical aggregates up to 7 mm in diameter within a clayey matrix. In thin section, these aggregates consist of irregular, sub-rectangular crystals of siderite <200 µm in size, with rare, ~5-10 vol.%, siderite crystals with a pseudo-spherulitic shape up to 2 mm in size. These pseudo-spherulitic crystals commonly have a brown oxidised rim. Sharp boundaries between the aggregates and the clayey matrix define the spherical shape, which is heightened by the clayey matrix having been compacted around the aggregates. The nodularity and the concentration of siderite fragments in the spherical aggregates may be the result of bioturbation.

14.8-19.0 m: Units 5 and 6 are poorly exposed and difficult to access due to their location in the near-vertical stream section. Unit 5 is a thin, ~0.7 m thick discontinuous coal seam, which is overlain by Unit 6, a ~3.5 m thick dark grey organic-rich claystone containing numerous coal streaks aligned parallel to bedding.

19.0-22 m: Unit 6 is overlain by the ~3 m thick Hvannahagi Formation composed here, of three extensively weathered, devitrified basaltic tuff beds, 0.6, 1.2 and 1.2 m thick, respectively. The tuffs have an iridescent sheen, most likely, due to manganese leaching. The base of the middle tuff contains abundant charcoalfied wood fragments aligned parallel to bedding.

>22 m: Pahoehoe flow lobes of a compound lava flow of the Malinstindur Formation. The basal flow lobe has a sharp and planar contact.

Stop 4.6: Ryskihjalli Road Cut, Hov, Suðuroy

Location

Park in the lay-by [PJ 2003 2182; ~175 m asl] opposite the water storage tower, from here proceed up the road along the Ryskihjalli road cut for ~350 m (Figs. 39 & 63).

Introduction

This locality affords the opportunity to examine the only documented example of a multi-tiered lava flow from the Beinisevørð Formation.

Description

The occurrence of multi-tiered flow lobes is extremely rare within the Faroe Islands Basalt Group, but this sheet lobe from the Beinisdvørð Formation can quite clearly be divided into colonnade and entablature tiers (Fig. 71; Passey & Bell 2007). The base and top of the Hov Flow are not observed, but the sheet lobe is at least 20 m thick. The colonnade tier comprises the lower 8-10 m of the exposed section and is composed of well-developed columns that have a uniform width of ~1.8 m. There is a sharp and planar contact between the colonnade and the overlying 8-10 m thick entablature tier. The entablature consists of 20-30 cm wide, wavy or curvi-columnar (hackly) columns. It is unclear, due to lack of exposure, whether the entablature is overlain by an upper colonnade, comparable to the multi-tiered flow lobes of the Columbia River Basalt Group (Long & Wood 1986).

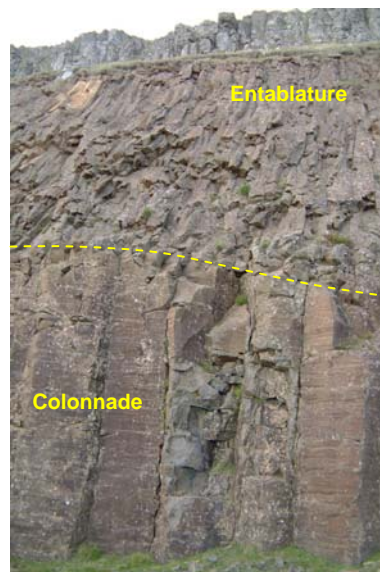


Fig. 71. Multi-tiered Hov Flow that can be separated into colonnade and entablature tiers, Beinisdvørð Formation, Hov, Suðuroy.

Stop 4.7: Við Garð Road Cut, Hov, Suðuroy

Location

Park in the lay-by next to the bus shelter, which is in front of the Við Garð road cut section [PJ 1876 2165; ~75 m asl], Hov, Suðuroy (Figs. 39 & 63).

Introduction

This locality examines a sedimentary volcanoclastic conglomerate intercalated between two sheet lobes from the Beinisdvørð Formation.

Description

The base of the section consists of a >5 m thick basal volcanoclastic conglomerate (Fig. 72). The base of the brownish black conglomerate is not observed. The conglomerate may consist of two units separated by a thin, <50 cm thick reddened weathering profile towards the middle of the exposure. The bedded conglomerate is very poorly sorted with an average clast size of pebble grade (Fig. 73). The clasts are sub-angular to sub-rounded with the degree of rounding appearing to increase as clast size decreases. The largest clasts tend to occur at the base of the unit, where one mega-clast is ~2 m across and is composed of massive basalt. Clast

lithologies consist of variable types of basalt lava from those that are vesicular/amygdaloidal to more non-vesicular clasts. Some of the beds, which are typically <1.5 m thick, exhibit weak normal grading. The conglomerate is juxtaposed against and appears to be infilling a palaeo-low developed along the surface of the underlying lava flow, suggesting it is sedimentary in origin. The conglomerate becomes more clay-rich towards the top and is overlain by a 0.5-2 m thick rubified claystone unit (Fig. 72), consisting primarily of smectite (beidellite) and kaolinite (metahalloysite) group minerals with haematite and goethite (Parra *et al.* 1987). The claystone, most likely, represents a palaeosol sequence formed through the weathering of the underlying conglomeratic unit under hot climatic conditions and alternating moist and dry seasons (Parra *et al.* 1987). The sequence is overlain by a columnar jointed sheet lobe which generally has a sharp and planar base although some sections are brecciated as a result of quenching in contact with surface water (Fig. 72).

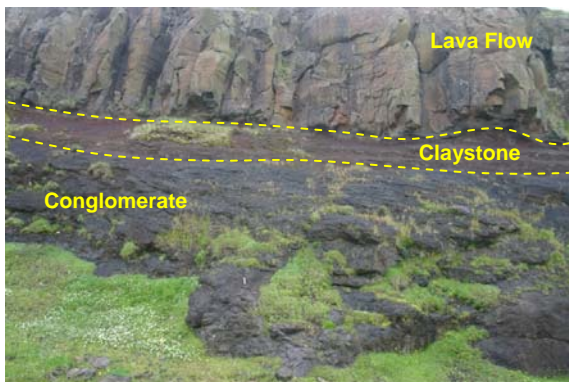


Fig. 72. Volcaniclastic sedimentary units, Beinísvoð Formation, Hov, Suðuroy.



Fig. 73. Volcaniclastic conglomerate, Beinísvoð Formation, Hov, Suðuroy.

Stop 4.8: Nes Quarry, Suðuroy

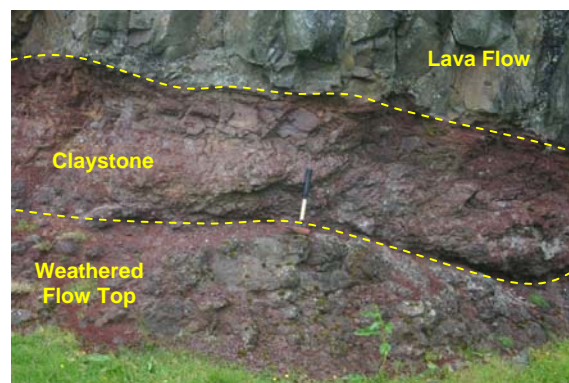


Fig. 74. Saprolitic Bole, Beinísvoð Formation, Nes, Suðuroy.

Location

Park in the lay-by in front of the disused quarry [PJ 1908 1739; ~35 m asl] to the SW of Nes village, Suðuroy (Figs. 39 & 63).

Introduction

This stop looks at the weathering products of a volcanic ash and the top of a sheet lobe from the Beinísvoð Formation.

Description

The base of the sheet lobe that forms the back of the quarry can be observed at the western entrance. Here, a ~90 cm thick rubbly weathered flow top consisting of sub-angular basalt corestones is exposed (Fig. 74). The corestones vary greatly in size up to ~50 cm across. The corestones are contained within fine grained clay-rich material. The weathered top is overlain, with a sharp contact, by a rubified and fissile claystone unit. The claystone is composed of beidellite (smectite group clay mineral) and haematite, which Parra *et al.* (1987) suggested formed through the argillisation of volcanic ash and therefore, represents a soil profile. The claystone is overlain by weakly columnar jointed sheet lobe that is at least 6 m thick. The flow has an apparent dip of ~10° towards the back of the quarry (i.e. to the NE). The basal contact is sharp and planar, except for minor brecciated zones due to quenching. The columns at the base of the flow have an average spacing of ~40 cm.

Stop 4.9: Vatnið Lake, Suðuroy

Location

Vatnið lake [PJ 1560 1715; ~4 m asl] is situated ~500 m SW of Vágur village, Suðuroy (Fig. 63).

Introduction

This locality describes the deposits contained within the Vatnið lake that were deposited from tsunamis generated by the Storegga Slide.

Description

Vatnið lake occurs ~4 m asl and is located in a NE-SW trending valley to the SW of Vágur. The lake is ~1-3 m deep, covers an area of ~0.125 km² and is ~400 m long by ~200 m wide. The base of the lake consists of a tsunami sequence deposited from two large waves, the first more powerful than the second, that inundated the area (Grauert *et al.* 2001). Each deposit consists of a layer of sand overlain by organic conglomerates. The deposits contain marine shell fragments and rip-clasts of lake mud along with foraminifera. The tsunami sequence also contains 5-8% fully marine polyhalobous diatom species which contrasts with only 1-2% in the overlying normal lacustrine mud sequence. The two large waves are associated with the tsunami generated by the Storegga Slide (Grauert *et al.* 2001). The first wave was so powerful that it eroded away the pre-existing lake deposits. The height of the tsunami run-up along Vágsfjørður is estimated to have been between 10 and 20 m above the contemporaneous sea level (Grauert *et al.* 2001; Bondevik *et al.* 2005). The Storegga Slide occurred off the Norwegian coastline ~8100±250 calendar years BP, affected an area of ~95000 km² and displaced 2400-3200 km³ of sediment (Haflidason *et al.* 2005).

Stop 4.10: Skarðsgjógv, Suðuroy

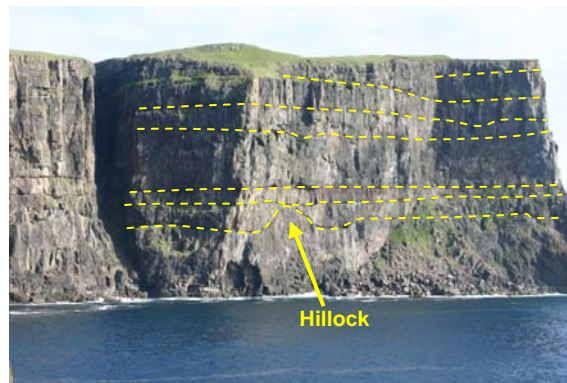


Fig. 75. View of Beinisevørð Formation lava flows, Vágseiði, Suðuroy.

Location

From the Vágseiði car park follow the track to the SE until you reach the rubbish chute at Skarðsgjógv [PJ 1540 1664; ~15 m asl], ~1.1 km SW of Vágur, Suðuroy (Figs. 39 & 63).

Introduction

This location gives an opportunity to examine the interaction between topography and the emplacement of the sheet lobes of the Beinisevørð Formation.

Description

The cliffs opposite the rubbish chute are ~160 m high at the western end and consist of 8 sheet lobes, which are identified by reddened weathering surfaces or interlava units (Fig. 75). The flows range in thickness from 8 to 55 m and have an average thickness of ~20 m. The flows are relatively massive with indistinct columnar jointing. The upper surface of the basal flow has been eroded resulting in a highly irregular relief, which includes a noticeable hillock, ~45 m wide by ~15-16 m high. The overlying flow has infilled and levelled off the irregular topography. The infilling flow is on average ~12 m thick, which decreases to ~1 m on top of the hillock, but increases to ~17-18 m in a ~40 m wide low immediately to the W of the hillock (i.e. a depression ~5-6 m deep).

At the eastern end of the cliffs there is a NW-SE trending normal fault (Skúvisgjógv) with a displacement of up to 10 m to the SW. It is unclear, but the fault most probably continues along Skarðsgjógv. Looking either side of the rubbish chute it can be clearly seen that the basal volcanoclastic conglomerate unit, which is overlain by a reddened siltstone, has been downthrown by up to 12 m on the western side.

Stop 4.11: Vágseiði, Suðuroy



Fig. 76. A N-S trending fracture zone cutting through units of the Beinisvørð Formation, Vágseiði, Suðuroy.

Location

From the Vágseiði car park, ~1.1 km SW of Vágur, Suðuroy take the boat ramp down to the base of the upper flow, then turn to your left and walk out onto the top of the underlying flow [PJ 1524 1672; ~5 m asl], which incidentally overlies the volcanoclastic conglomerate observed at Stop 4.10 (Figs. 39 & 63).

Introduction

At this stop two fracture zones with minor displacement can be examined cutting through the Beinisvørð Formation lava flows.

Description

The rubbly weathered top to the basal flow is overlain by a maximum ~60 cm thick reddened saprolitic bole that grades downwards into the flow. The saprolitic bole is overlain by a sheet lobe that is at least ~6 m thick. The basal contact of this upper flow is sharp and planar and contains pipe amygdales that are exposed along the eastern wall. In this area, there are two ~4 m wide near vertical fracture zones ~15 and ~35 m E of the boat ramp, respectively (Fig. 76; Waagstein 1998). The more or less N-S trending fracture zones can be examined in detail along the N face of the upper flow. Displacement is minimal along these fractures, typically <20 cm with the downthrown side to the W (Waagstein 1998).

Stop 4.12: Núpur Road Cut, Suðuroy

Location

Park in the lay-by next to the cattle grid alongside the Núpur road cut [PJ 1850 1593; 65 m asl], ~1.4 km N of Lopra, Suðuroy. The cattle grid is electrified so please use the gate to pass over it (Figs. 39 & 63).

Introduction

This location examines a sequence through two thin sheet lobes of the Beinisvørð Formation and their associated weathering profiles.



Fig. 77. Weathering profile along the upper surface of a Beinisvørð Formation lava flow, Núpur, Suðuroy.

Description

The base of the section consists of a ~1.2 m thick rubified saprolitic bole containing basalt corestones from the underlying lava flow. This is overlain with a sharp and planar, although undulating, contact by a ~5 m thick simple pahoehoe lava flow that consists of a ~30 cm thick basal amygdaloidal crust, a ~1.7 m thick non-vesicular massive core and a ~3 m thick upper amygdaloidal crust (Waagstein 1998). The amygdales in the upper crust increase in size downwards to maximum diameters in the order of ~10 cm (Waagstein 1998). The top of the flow consists of a ~20 cm thick reddened weathered flow top which is overlain by a <10 cm thick reddened volcanoclastic mudstone. This is overlain by a second simple pahoehoe lava flow that is ~6 m thick, which can also be separated into three tiers based on amygdale distribution patterns (Waagstein 1998). The upper amygdaloidal crust is ~3 m thick and consists of a reddened weathering profile ~0.6-1.0 m thick (Fig. 77). The weathering profile grades downwards from a ~10-30 cm thick mudstone into a rubbly zone dominated by basalt corestones liberated from the underlying flow. This soil profile is overlain by a >5 m thick simple pahoehoe lava flow with a sharp and planar basal contact. The flow is characterised by weakly developed columnar jointing, the surfaces of which display chisel markings. Using the upper crust thicknesses (~3 m each) for the two flows and applying them to the empirical equation of Hon *et al.* (1994) it would suggest that in this section they both ceased inflating within ~62 days. Therefore, the two flows at this location have a minimum emplacement duration of ~125 days, but this does not include the time required for the development of the intervening soil profile, which is, most likely, hundreds if not thousands of years.

Stop 4.13: Lopra-1/1A Borehole, Suðuroy

Location

Park in the tarmac area on the right of the road as you head into Lopra village, Suðuroy (Figs. 39 & 63). The Lopra-1/1A borehole site is marked by a large cemented hole [PJ 1851 1450; ~8 m asl].

Introduction

This stop briefly describes the drilling of the deep, ~3.5 km, Lopra-1/1A borehole through the Beinisvørð and Lopra formations.

Description

Between 2 July and 5 November 1981 the deep borehole Lopra-1 was drilled on this site (Berthelsen *et al.* 1984). The aim of the borehole was to drill beyond the base of the volcanic

sequence and establish the nature of the underlying geology. The borehole reached a depth of 2178 m and did not succeed in penetrating the base of the volcanics. The borehole primarily encountered simple lava flows and minor interlava lithologies and was therefore, interpreted as a continuation of the Beinisdvörð Formation (Hald & Waagstein 1984). The lava flows have an average thickness of ~20 m and a gamma ray response commonly below 20 API units, whereas the interlava lithologies, including boles, produce pronounced peaks as high as 80 API units. The borehole also encountered at least two dolerite intrusions 96 and 108 m thick, respectively. These were later interpreted as steeply inclined (85°) dykes with true thicknesses of ~9 m (Hald & Waagstein 1984).



Fig. 78. Drilling rig for the deepening of the Lopra-1 borehole in 1996. Photo courtesy of Turid Madsen.

The Lopra-1 borehole was deepened between 13 July and 3 November 1996 to a total depth of 3565 m (Fig. 78), which is an additional thickness of 1387 m (Chalmers & Waagstein 2006). The borehole also included a sidetrack referred to as Lopra-1A, but the borehole still did not penetrate below the base of the volcanic pile. The borehole extended the thickness of the Beinisdvörð Formation by a further ~312 m (Ellis *et al.* 2002). The Beinisdvörð Formation directly overlies the ~1075 m thick Lopra Formation which is composed almost exclusively of volcanoclastic lithologies (Ellis *et al.* 2002; Waagstein 2006). The basal ~665 m has a highly variable gamma ray response of between 10 and 40 API units and is attributed to the volcanoclastic lithologies having been intruded by sills and/or invasive lavas (Ellis *et al.* 2002; Waagstein 2006). This basal section is overlain by a ~350 m thick volcanoclastic sequence that has regular gamma ray response of between 15 and 30 API units (Ellis *et al.* 2002; Waagstein 2006). This is in turn, overlain by a ~60 m thick volcanoclastic sandstone section that passes up into the overlying subaerial lava flows of the Beinisdvörð Formation, which also has a similar gamma ray response as the lava flows (i.e. <20 API units; Ellis *et al.* 2002; Waagstein 2006). The bulk of the volcanoclastics have been interpreted as hyaloclastites (Waagstein 2006), most likely, forming a prograding lava-fed delta and forms a contiguous volcanic phase with the overlying Beinisdvörð Formation.

Stop 4.14: Spreingisbrekka Viewpoint, Suðuroy

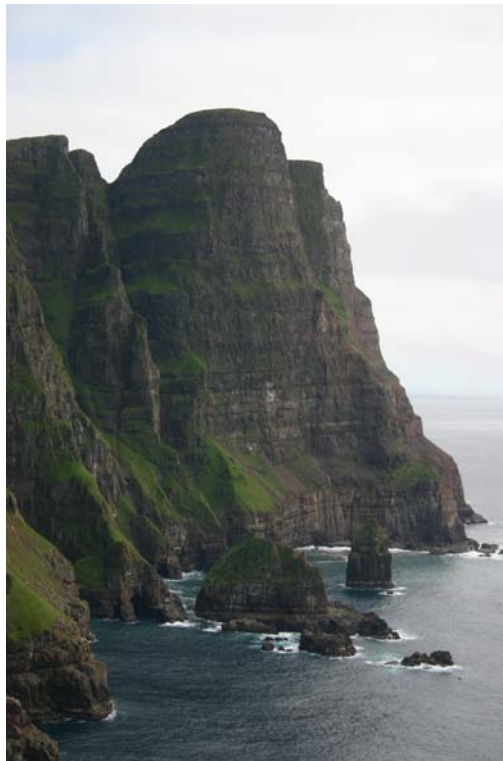


Fig. 79. View of the lava flows of the Beinivørð Formation, Beinivørð cliff section, Suðuroy.

Location

Park in the long lay-by on the SW side of the road [PJ 1879 1356] and walk up ~70 m to the top of the cliffs following the small red and yellow way markers at the top. This locality is situated at an elevation of ~200 m asl and is known as the Spreingisbrekka viewpoint [PJ 1894 1328], ~1.2 km S of Lopra, Suðuroy (Figs. 39 & 63). **DO NOT STAND TOO CLOSE TO THE EDGE OF THE CLIFFS AS THEY ARE UNSTABLE!**

Introduction

This vantage point affords views of the Beinivørð cliff section composed almost entirely of sheet lobes of the Beinivørð Formation.

Description

From this vantage point look to the SE and the Beinivørð cliff section (~470 m) can be seen ~1.5 km away (Fig. 79). The cliff appears to be composed almost entirely of simple lava flows composed of single sheet lobes. These are the oldest lava flows exposed on the Faroe Islands. The sheet lobes are identified by their reddened weathered tops or by the in-weathering of reddened volcanoclastic units and their sharp planar bases. The cliff is composed of at least 21 flows; this is a minimum figure due to the ~95 m thick poorly exposed section that occurs ~50 m above sea level. The number of flows, however, most likely does not exceed 26 in total. The flows range in thickness from ~10 to ~40 m and have an average thickness of ~19 m (these figures include any overlying interlava units). These figures are based on new photogrammetrical analysis and consequently, differ slightly from those published by Passey & Bell (2007). The simple flows are characterised by having sharp planar bases and generally having poorly defined columnar jointing.

Also look out for some of the last puffins to visit the island this summer. There is a breeding colony on the island of Tindastakkur at the bottom of the cliffs. The number of puffins, and other sea birds, has been decreasing drastically over the past few years. This is partly due to a lack of sandeels in the NE Atlantic Ocean, which is a major food source for the puffins and the other sea birds.

Stop 4.15: Tindaland Viewpoint, Suðuroy



Fig. 80. View of the Beinivørð Formation lava flows at the top of the Beinivørð cliff section, Suðuroy.

Location

Park in the small lay-by on the sharp bend in the road and then walk out to the edge of the cliffs via the small footbridge. This locality is situated at an elevation of ~370 m asl and is known as the Tindaland viewpoint [PJ 1968 1235], ~2 km SSE of Lopra, Suðuroy (Figs. 39 & 63). **DO NOT STAND TOO CLOSE TO THE EDGE OF THE CLIFFS AS THEY ARE UNSTABLE!**

Introduction

This viewpoint allows the uppermost sheet lobes of the Beinivørð cliff section to be examined as well as NW-SE trending dyke that cuts through them.

Description

From this vantage point the uppermost sheet lobes of the Beinivørð cliff section (~470 m) can be examined, which is ~430 m to the S (Fig. 80). These sheet lobes are on average 19 m thick and are separated from the other flows by weathering profiles and/or by thin reddened volcaniclastic units. The flows are characterised by sharp planar bases and indistinct columnar jointing. The lava flows are cut by a number of NW-SE fractures with negligible vertical displacement. One of the fractures, Hestgjógv, has been intruded by a near-vertical dyke that is horizontally jointed (Fig. 80).

Stop 4.16: Pollurin Harbour, Sumba, Suðuroy

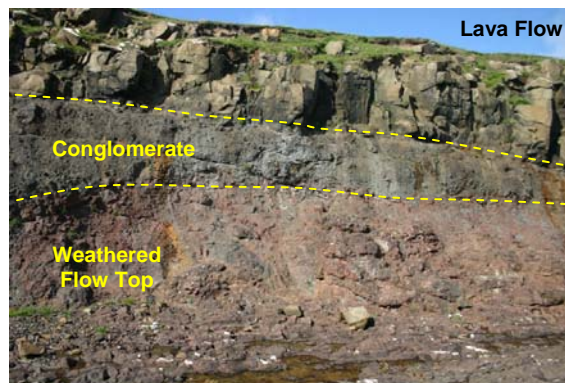


Fig. 81. Weathering profile, volcanoclastic conglomerate and lava flow, Beinivørð Formation, Sumba, Suðuroy.

Location

Park in Pollurin harbour (Figs. 39 & 63) and then walk towards the boats and climb over the wall on to the wave-cut platform [PJ 2134 1040; ~15 m asl].

Introduction

This stop allows the group to examine a volcanoclastic conglomerate intercalated between two sheet lobes of the Beinivørð Formation. In addition, one of the largest dykes on the Faroe Islands can also be observed.

Description

The wave-cut platform consists of an aphyric sheet lobe that has a ~3-4 m thick reddened weathered flow top consisting of corestones (Fig. 81). The weathered top is overlain by a <10 cm thick reddened volcanoclastic siltstone which is in turn overlain by a volcanoclastic conglomerate with a maximum thickness of ~2-3 m. The conglomerate consists of thin, poorly sorted, beds that tend to fine upwards and appear to form small channel-like structures. The beds comprise vesicular/amygdaloidal to non-vesicular basalt lava clasts that are sub-angular to sub-rounded and are generally pebble to cobble grade. The conglomerate is, most likely, a channelised fluvialite or a small debris flow deposit. The conglomerate is overlain by a >3 m thick sheet lobe with a sharp and planar basal contact, although, apophyses from the flow extend downwards into the conglomerate. Towards the eastern end of the exposure the conglomerate thins to a few tens of centimetres and the overlying flow infills a low which is defined by crude columnar jointing that has formed at right-angles to the channel margin.

About 100 m to the W, a NW-SE trending dyke is exposed and is one of the thickest dykes observed on the Faroe Islands and the following is based on the description given by Waagstein (1998). The dyke is ~18 m wide and clearly shows an increase in grain size from the margins to the centre. The dyke is sparsely plagioclase-phyric consisting of clusters of phenocrysts up to 5 mm long. The phenocrysts are most abundant in the central part of the dyke and first metre of the western contact. The dyke also contains amygdales up to 10 mm across that are concentrated in planes parallel to the dyke margins at a spacing of 10-20 cm.

Stop 4.17: Sumba Tunnel, Suðuroy

Location

The Sumba Tunnel (*Sumbiartunnilin*; Fig. 63) connects the two villages of Lopra and Sumba, southern Suðuroy [PJ 1908 1383; ~70 m asl to PJ 2046 1116; ~120 m asl].

Introduction

This locality describes the harnessing of groundwater from a fracture that cuts through the sheet lobes of the Beinisvørð Formation.

Description

The Sumba Tunnel (*Sumbiartunnilin*) is a two laned tunnel that was opened in 1997 and is 3240 m long by 6 m wide by 4.6 m high. The tunnel avoids having to take the high mountain road and reduces the journey length between Lopra and Sumba by ~4 km. The company Lisberg Water was established to harness the groundwater that seeps down through a large fracture that runs along a section of the tunnel. The total water leakage from the tunnel is ~30 litres/second (~2600 m³/day) and only in longer dry periods does it drop to ~20 litres/second (T. Varming pers. comm. 2006). Generally, Faroese groundwater is enriched in iron, aluminium and manganese which are leached from the surrounding bedrock, however, the Sumba Tunnel water does not show such increased levels. This implies that the water passes through the fracture before it can interact with the basalt geology (T. Varming pers. comm. 2006).



Akraberg Lighthouse, Suðuroy. This is the most southerly point of the Faroe Islands, except for the Sumbiarsteinur skerry, ~6 km to the S. The name Akraberg literally means “the mountain with pasture fields”. The lighthouse and associated buildings were built in 1909. The next land to the south is Scotland, ~320 km away.

Day 5 – Wednesday, 20 August 2008



Fig. 82. Excursion route map for Day 5 – Stops 5.1 to 5.12.

Introduction

The group shall rendezvous with the excursion leader, with their entire luggage, outside Hotel Hafnia for 08:30. The day shall spend the day visiting a number of road side localities between Tórshavn and Klaksvík, Borðoy (Fig. 15). The bus will take a convoluted route via the high mountain road between Tórshavn and Kollfjarðardalur before heading to Eysturoy and taking the road around the northern end of island (Fig. 82). The journey will examine the geology from the upper Malinstindur Formation, the Sneis Formation and the Enni Formation, including the Argir Beds (Figs. 5 & 6). During the day the group will be able to compare and contrast the different lava flow morphologies and their emplacement mechanisms. Consideration will also be given to the variety of volcanoclastic lithologies that punctuate the stratigraphy and mark hiatuses in the volcanic activity. There will also be an opportunity to compare and contrast the Streymoy and Eysturoy sills. The night shall be spent at Hotel Klaksvíkar Sjómansheim where an evening meal will be provided.

Tórshavn to Klaksvík Road Side Localities

Stop 5.1: Horse Stables, Norðastahorn, Streymoy



Fig. 83. The ~6 m thick Argir Beds, Enni Formation, Norðastahorn, Streymoy.

Location

Park behind the horse stables [PJ 1382 7676; ~170 m asl] in Norðastahorn, W of Tórshavn, Streymoy (Fig. 82).

Introduction

This stop shall examine the volcanoclastic lithologies of the Argir Beds that mark a clearly obvious change in the style of lava volcanism at this level in the Enni Formation.

Description

This locality is composed of a >50 m long exposure of the Argir Beds, which have a thickness of up to 6 m at the western end of the outcrop (Fig. 83). The Argir Beds range in thickness from 2 m up to 6 m and consist of volcanoclastic mudstones through to granule-rich sandstones. The units are dominated by reworked, highly palagonitised, basaltic glass fragments. Lithic clasts of reworked volcanoclastic mudstone and basaltic lava flow clasts occur in the coarser units. Occasionally, branch fragments have been recovered. Long shallow sand channels can be seen on the W side of the small stream towards the base of the section. At this locality the overall coarsening upwards of the Argir Beds suggest that they were

deposited in a widespread and complex fluvial, lacustrine and floodplain environment. The Argir Beds are overlain by an aphyric basalt simple lava flow. The base of overlying flow is generally sharp and planar and occasionally, small cylindrical structures, interpreted as tree moulds, are observed.

Looking W from the stables towards Fjallmannaheggjur (~417 m), the Argir Beds occur within the grass covered terrain between the lower, poorly exposed sequence of compound lava flows and an upper, prominent, sheet lobe. This marks a volcanic hiatus in this area and a change in the eruptive style of the Enni Formation lava flows, which, with future mapping, may require a further stratigraphic subdivision of the formation at this level.

Stop 5.2: Sundshálsur, Streymoy

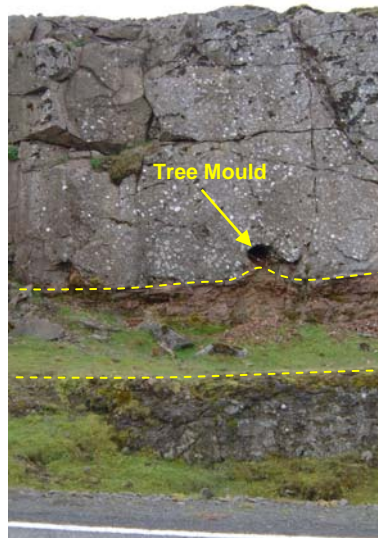


Fig. 84. A ~30 cm wide tree mould at the base of an Enni Formation lava flow, Sundshálsur, Streymoy.

Location

Park in the lay-by on the left side of the road just before a prominent road cut [PJ 1133 8022; ~310 m asl], ~900 m WNW of Sundshálsur, Streymoy (Fig. 82).

Introduction

This stop examines a volcanoclastic sandstone sequence overlain by a sheet lobe that contains a number of tree moulds, Enni Formation.

Description

The section consists of a ~1.2 m thick volcanoclastic sequence comprising weakly cross-laminated fluvial sandstones and siltstones (Ellis *et al.* 2002). The sequence has a mottled appearance due to the formation of ferruginous rhizoconcretions (precipitation of haematite) due to the effect of root networks on the substrate, implying a vegetated surface (Ellis *et al.* 2002). This is supported by a number of cylindrical structures, interpreted as tree moulds, preserved at the base of the overlying simple lava flow. The prominent tree mould has a diameter of ~30 cm and extends ~75 cm into the flow (Fig. 84). Elsewhere in the Enni Formation, well preserved foliage of *Metasequoia occidentalis* have been recovered suggesting this was the dominant tree taxon on the vegetated lava flow tops (Ellis *et al.* 2002).

Looking E across the road towards the side of the valley, a prominent, well exposed, simple lava flow is observed. The flow has a thickness significantly wider than it is thick and therefore, can be classified as a sheet lobe. Underneath this sheet lobe, green to red fragments can be seen forming a distinct scree horizon. Closer examination has shown this represents a volcanoclastic sequence up to 5 m thick and is a continuation of the Argir Beds observed at Stop 5.1.

Stop 5.3: Dalagjógv, Streymoy

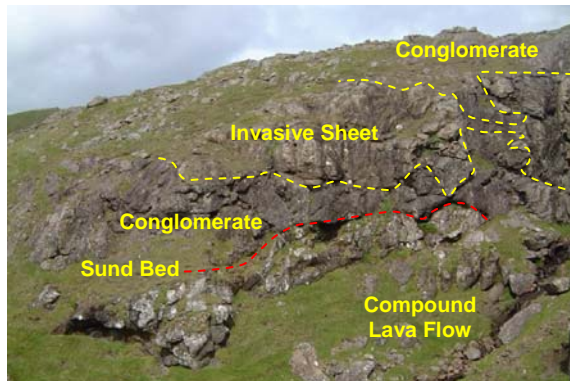


Fig. 85. View of the intruded Sneis Formation, Dalagjógv, N of Norðradalur, Streymoy.



Fig. 86. The Sneis Formation volcanoclastic conglomerate, Langareyn, N of Norðradalur, Streymoy.

Location

From the lay-by head SSE over the flat-lying plateau of Langareyn for ~400 m to the top of Dalagjógv. From here walk down the gjógv to the base of the crag line [PJ 0893 8146; ~170 m asl], ~950 m NNE of Norðradalur, Streymoy (Fig. 82).

Introduction

This stop affords the opportunity to examine a vertical section through the Sneis Formation sandstones and conglomerates as well as the basalts that intrude them.

Description

Dalagjógv (gjógv = gully) is the eroded remnant of a NE-SW trending dyke which has resulted in the exposure of a vertical section (~170-190 m) through the Sneis Formation (Fig. 85). The dyke (Str.17) is a ~6-7 m wide aphyric basalt which has a MORB-like composition being depleted in TiO_2 (1.02 wt.%), K_2O (0.08 wt.%) and P_2O_5 (0.08 wt.%; Hald & Waagstein 1991). Occasionally, horizontal jointing can be seen in the dyke as well as small skins of the dyke attached to the sides of the gjógv. The base of the sequence consists of compound basalt lava flows of the Malinstindur Formation. The upper surface of the Malinstindur Formation is generally highly weathered and is overlain by the ubiquitous Sund Bed of the Sneis Formation. This reddened volcanoclastic sandstone is composed almost entirely of basaltic glass at various stages of palagonitisation. The basaltic glass exhibits a high degree of rounding, although larger clasts preserve cusped margins and vesicles. Typically, the sandstone contains abundant creamish charcoalified branchwood fragments with a ‘boxwork’ structure, which is a distinctive feature of this unit (see Stop 1.8). The Sund Bed at this locality has a maximum thickness of 0.5 m and has an undulating geometry. This is overlain by a sequence composed of volcanoclastic conglomerate up to ~11 m thick, which has been intruded by a ~9 m thick basaltic sill. The conglomerate consists of thin anatomising

beds, some of which, appear to be reversely graded. The conglomerate is poorly sorted, clast supported and has an average clast size of very large pebbles to small cobbles (Fig. 86). The clasts are composed of rounded, very finely to finely crystalline basalt clasts, typically with conspicuous laths of plagioclase feldspar. The top of the Sneis Formation is not exposed but is overlain by a brecciated, sheet-like, plagioclase-phyric lava flow, which is at least 5 m thick. Due to the distinctive small broken basalt fragments of this flow, which are believed to resemble candy sugar, these types of basalt flows are locally referred to as kandisgrót (candy rock).

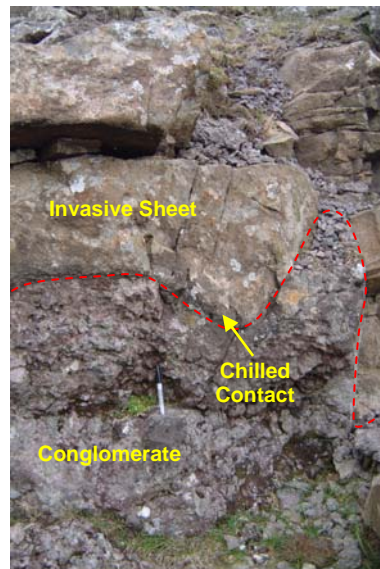


Fig. 87. Contact between the Sneis Formation conglomerate and the invasive sheets that have intruded this interval, Langareyn, N of Norðradalur, Streymoy.

The sill is a massive, aphyric basalt which has a characteristic, brown weathering colouration (lacks light-coloured lichen colonisation) and has a foliation which is interpreted as flow banding of plagioclase microlites. Internal intrusive contacts within the sill can be observed on the NW face of the gjógv. Usually, the basal contact of the sill occurs along the interface between the Sund Bed and the overlying conglomeratic sequence or within a few metres of this interface. The basal contact is typically planar and regular whereas the upper contact is irregular and apophyses can, with careful examination, be identified extending into the volcanoclastic conglomerate sequence. Bifurcation of the conglomeratic material by intruding magma can clearly be seen in vertical sections along the NNW-trending bench of Langareyn, between Dalagjógv and the road (Fig. 87).

Stop 5.4: Takhamar, Streymoy

Location

This locality is ~500 m NW from Stop 5.3 and is along a stream that cuts through the Takhamar bench [PJ 0857 8182; ~205 m asl], ~1.2 km N of Norðradalur, Streymoy (Fig. 82).

Introduction

This stop looks at the leading edge of the basalts that have intruded the Sneis Formation.

Description

This locality shows the leading edge of the sill (see Stop 5.3) intruding the volcanoclastic conglomerate sequence as thin lobes/fingers (apophyses) before terminating (Fig. 88). This section clearly demonstrates the intrusive nature of these low-TiO₂ basalts. Tracing the sill, which forms a prominent bench, away from the last locality in either direction, it is evidently seen that the sill terminates within the mountainside forming a crescent-moon outcrop pattern. The sill in this area has a length of ~2 km. Mapping across southern Streymoy to NW Sandoy has demonstrated that these brown weathering, low-TiO₂, stratiform sill(s) are restricted to sections of the Sneis Formation which consist of thick sequences of volcanoclastic conglomerate.

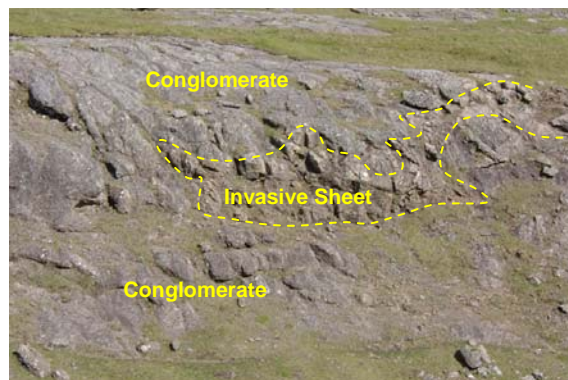


Fig. 88. View of the leading edge of the invasive sheets that have intruded the Sneis Formation conglomerate, Takhamar, Streymoy.

Stop 5.5: Kolaryggur, Streymoy



Fig. 89. View of the S end of the Streymoy saucer-shaped sill, Kolaryggur, W of Norðradalur, Streymoy.

Location

Park in the lay-by just before the fish laboratories at the end of the road [PJ 0663 8061; ~105 m asl], ~2.5 km W of Norðradalur, Streymoy (Fig. 82).

Introduction

A scenic locality to take in the view of the Streymoy Sill that has intruded the uppermost part of the Malinstindur Formation, the Sneis Formation and the Enni Formation.

Description

From the viewpoint look W towards Dalsnípa and turn clockwise until the summit of Núgván (~667 m) to the NE. This view shows the southern extent of the large Streymoy Sill intruding strata of the Malinstindur, Sneis and Enni formations (Fig. 89). The NNW-SSE trending

Streymoy Sill is ~9 km long and varies between 1-2 and 2-3 km in width (Rasmussen & Noe-Nygaard 1969; 1970). The thickness of the sill varies between 5 and 50 m and typically displays well-developed columnar jointing. The sill has a more or less saucer-shaped geometry and this can quite clearly be seen from this locality, whereby the sill can be subdivided into the flat-lying inner sill and the transgressive inclined sheet sections. The inclined sheet defines the irregular ring-shaped rim to the saucer (Fig. 90). To the N, the eastern extent of the sill is highly transgressive with the inclined sheet having dips in excess of 75° (Rasmussen & Noe-Nygaard 1969; 1970).



Fig. 90. View of the S end of the Streymoy saucer-shaped sill from Eggin, W of Norðradalur, Streymoy.

The inner sill section at this locality has intruded the volcanoclastic strata of the Sneis Formation. This relationship between the flat-lying sections of the Streymoy Sill intruding the Sneis Formation is also seen ~7 km to the N on the SE side of Sátan. This suggests there is a relationship between the rigidity of the host material and the intrusiveness of the sill, where the sill spreads laterally into the Sneis Formation because it has a rigidity that is, most likely, less than the encasing basalt lava flows. The Streymoy Sill has a MORB-like composition (Hald & Waagstein 1991).

Stop 5.6: Hundsarabotnur Quarry, Streymoy

Location

Park in the lay-by opposite the Hundsarabotnur Quarry [PJ 0622 8615; ~320 m asl], Streymoy (Fig. 82).

Introduction

This stop allows for the group to take in the views across the valley and observe the gross characteristics of the Malinstindur, Sneis and Enni formations. The stop also allows for a close examination of the volcanoclastic conglomerate of the Sneis Formation.

Description

From this viewpoint look N towards the summit of Árnadalstindur (~718 m) ~4.8 km away (Fig. 91). The base of the mountainside is composed of the poorly exposed compound lava flows of the Malinstindur Formation. Approximately, halfway up the mountainside there is an area of flat terrain marking a significant break-in-slope. This can be traced ~3 km NW to Gívrufjall (~649 m) before the plateau disappears out-of-sight behind the mountain. This break-in-slope is represented by the Sneis Formation and from the view point it can be seen to consist of a prominent, sporadically exposed, tabular basalt, which is the low-TiO₂ sill(s) that has intruded the volcanoclastic strata of the formation. The area forming the flat terrain has, if

the lighting is right, a mauve-reddish colouration and consists of the volcanoclastic conglomerate of the Sneis Formation, which has a thickness of ~25 m in this area. The general dip of the Sneis Formation is ~2° to the SE in the region of Árnadalstindur. The Sneis Formation is overlain by compound and simple lava flows of the Enni Formation.

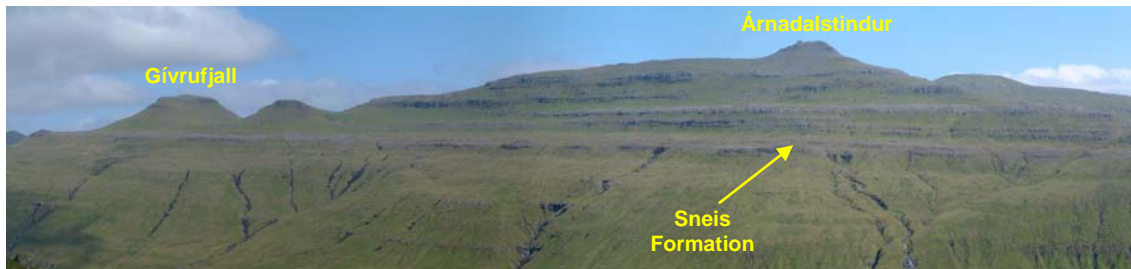


Fig. 91. View of the W side of Árnadalstindur, Streymoy.

This view point is situated on the volcanoclastic conglomerate of the Sneis Formation which is clearly exposed on the flat terrain to the E of this location (Fig. 92). In this area the conglomerate is clearly bedded with a general flow direction to the S. Sub-rounded to well-rounded, boulder sized clasts (20-40 cm in diameter) are common towards the top of the very poorly sorted conglomerate. The conglomerate has been intruded by a distinctive brown weathering flow-banded aphyric invasive sheet that can be seen to climb-up across the road to the NW where it directly overlies the reddened, volcanoclastic sandstone of the Sund Bed. A sequence straddling the Sneis Formation is extracted from the Hundsarabotnur Quarry. The Streymoy Sill is observed transgressing down to the quarry where apophyses are observed extending into the quarried sequence.



Fig. 92. View of the Sneis Formation conglomerate, Hundsarabotnur, Streymoy. The Hammer is ~40 cm long.

Stop 5.7: Torkilsá Road Cut, Streymoy

Location

Park in a small lay-by on the right side of the road which immediately follows the more prominent picnic lay-by. This is the Torkilsá road cut [PJ 0889 9284; ~70 m asl], ~1 km NW of í Bugum, Streymoy (Fig. 82). **PLEASE BE CAREFUL CROSSING THE BUSY ROAD!**

Introduction

This locality allows the group to search for Equisetum fragments contained within a volcanoclastic sandstone sequence from the Malinstindur Formation.

Description

The exposure consists of a ~1.5 m thick fluvialite volcanoclastic sequence consisting of trough crossed bedded sandstones which cut down into laminated, finer sandstones (Fig. 93). The sandstones are poorly to moderately sorted and have an average grain size of fine sand, although granules are common (Fig. 94). The sandstones are dominated by clasts of basaltic glass at various stages of palagonitisation, which are typically vesiculated and have cusped margins. Some of the more opaque glass clasts contain phenocrysts of plagioclase feldspar. The sandstones also contain minor amounts of sub-rounded basalt lava clasts, comprising laths of plagioclase feldspar, clinopyroxene and Fe-Ti oxides.



Fig. 93. View of the ~1.5 m thick section of fluvialite volcanoclastic sandstones, Malinstindur Formation, Torkilsá, Streymoy.

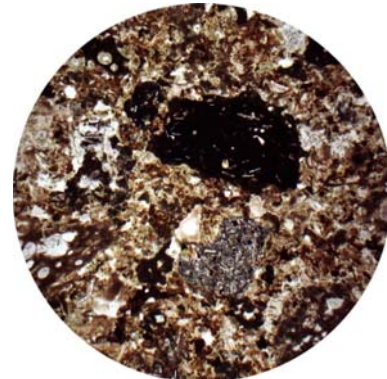


Fig. 94. Photomicrograph of a Malinstindur Formation volcanoclastic sandstone from Torkilsá, Streymoy. Field of view is ~1.5 mm.

At ~1-1.2 m above the base of the sequence abundant macrofossil fragments of *Equisetum* are found (Fig. 95). *Equisetum* consists of jointed stems that can be subdivided into internodes and nodes. It is at the nodes that aerial stems, leaves and roots can develop. *Equisetum* can reproduce asexually and consequently, is a very invasive plant that spreads laterally through rhizome (horizontal underground stem) networks that can be as much as 4 m below the surface, which means they can survive environmental disturbances such as fire, rapid burial and drought. This is particularly prevalent in volcanic areas where *Equisetum* is one of the first colonisers after an eruption. Modern examples of *Equisetum* are semi-aquatic to aquatic and are typically found growing within or along the banks of fluvialite systems.

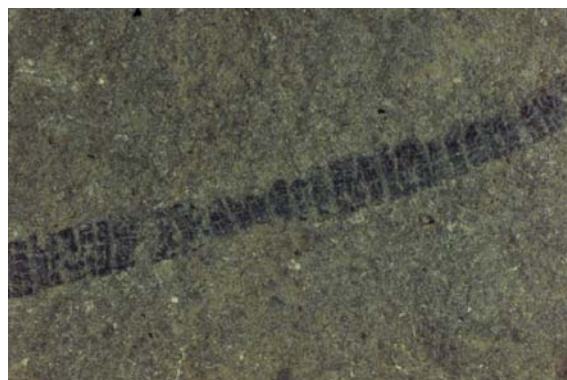


Fig. 95. *Equisetum* fragment, Malinstindur Formation sandstone, Torkilsá, Streymoy. Field of view is ~4 cm.

From the lay-by look to the NE and you will see the upper surface of the saucer-shaped Eysturoy Sill (Fig. 96). The sill is aligned NW-SE and is ~6.5 km long by ~2.0-3.5 km wide and covers an area of ~16 km² (Rasmussen & Noe-Nygaard 1969; 1970). The sill transgressively climbs upwards to the E, forming the prominent pinnacle of Reyðafelstindur

(~764 m) at the SE end. From Veðranes to Oyri along the eastern coastline of Sundini the sill forms a more or less unbroken bench characterised by extremely well-developed columnar jointing. The thickness of the sill varies from <10 to ~55 m (Rasmussen & Noe-Nygaard 1969; 1970). The sill has intruded the upper ~150 m of the Malinstindur Formation and transgresses up through the Sneis Formation and the lower ~400 m of the Enni Formation. The Eysturoy Sill differs from the Streymoy Sill, which is MORB-like, by having a high-TiO₂ content (Hald & Waagstein 1991). The eastern bench of the Eysturoy Sill can be seen from Stop 6.10.

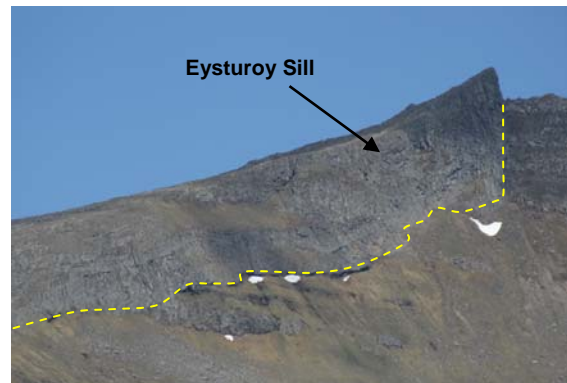


Fig. 96. View of the SW side of the Eysturoy saucer-shaped sill, Reyðafelstindur, Eysturoy.

Stop 5.8: Stórá, Svínáir, Eysturoy

Location

Park along the side of the road just before the small bridge that crosses the Stórá stream [PK 0263 0203; ~55 m asl] at the N end of Svínáir village, Eysturoy (Fig. 82). **PLEASE BE CAREFUL WALKING ALONG THE SIDE OF THE ROAD AND ALSO CROSSING THE CRASH BARRIER AND FENCE DOWN TO THE BASE OF THE SMALL WATERFALL!**

Introduction

This locality allows for the Kvívík Beds and associated volcanic hiatus of the Malinstindur Formation to be examined.

Description

The base of the section consists of pale (grey) weathering plagioclase-phyric flow lobes of a compound lava flow. The flow is exposed under the bridge where it contains as much as 20 vol.% laths of plagioclase feldspar up to 5 mm in length. The upper crust of the uppermost flow lobe is, however, aphyric suggesting a cumulate texture. The top of the flow lobe is not particularly reddened due to weathering. The plagioclase-phyric compound flow is overlain by a maximum ~1.2 m thick volcanoclastic sandstone sequence (Fig. 97). The sandstone infills fractures in the underlying flow and the basal ~35 cm is greenish brown whereas the upper ~85 cm is reddened due to subaerial weathering. The unit consists of bedded medium to very coarse, poorly sorted, sandstones. Some of the beds, however, have a weak normal grading. The sandstone consists of sub-rounded clasts of basaltic glass at various stages of alteration ranging from those that are near opaque to those that are yellowish to orange in colour. Some of the clasts are distinctly vesicular as well. Along the base of the section there are casts of assumed tree bark between the underlying flow and the sandstone (Fig. 98).



Fig. 97. View of the ~ 1.2 m thick Kvívík Beds, Malinstindur Formation, Svínáir, Eysturoy.



Fig. 98. View of a tree bark cast at the base of the Kvívík Beds, Malinstindur Formation, Svínáir, Eysturoy.

The sandstone sequence is overlain by distinctly brown weathering, aphyric, although olivine-bearing, compound lava flow lobes (Fig. 99). The basal contact is sharp and planar without having significantly disrupted the underlying sandstones. The flow lobes can be classified as P-type pahoehoe as they consist of a basal crust, massive core and an upper crust. The basal crusts typically contain pipe amygdales that start a few centimetres off the base of the flow and are commonly curved in the assumed flow direction. The massive cores are generally non-vesicular although they commonly contain vesicle cylinders, represented by whitish veins consisting of segregated vesicular material. The upper crusts are typically characterised by horizontal vesicle zones, which tend to differentially weather out. Good exposures of the internal structure of the flow lobes can be seen above the waterfall. Walk to the right of the waterfall and then up the slope, cross over the stream and then walk down the other side examining the flow lobes as you go. On the way you shall pass a very good example of ropy lava consisting on centimetre-scale ropes curved in the assumed direction of flow (Fig. 100).

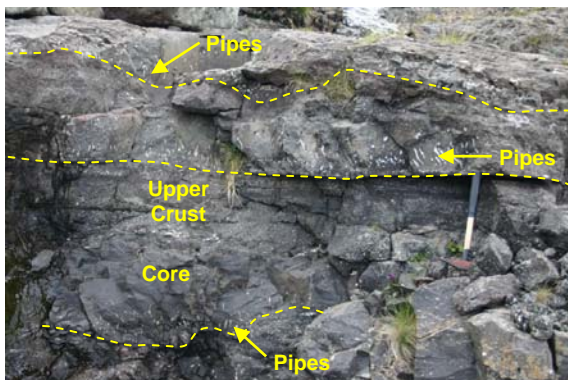


Fig. 99. View of P-type inflated pahoehoe flow lobes, Malinstindur Formation, Svínáir, Eysturoy. The hammer is ~ 40 cm long.



Fig. 100. View of ropy lava, Malinstindur Formation, Svínáir, Eysturoy. The hammer is ~ 40 cm long.

Provisional mapping has been able to correlate the sequence as far W as Saksun, Streymoy and as far SW as Vestmanna and Kvívík, Streymoy. This sandstone sequence has been named as the Kvívík Beds and marks a volcanic hiatus approximately two thirds above the base of the Malinstindur Formation. The volcanic hiatus is also associated with the appearance of brown weathering, olivine-bearing compound lava flows with a MORB-like composition (Rasmussen & Noe-Nygaard 1969; 1970; Waagstein 1988). The occurrence of these flows has been previously mapped as the B-horizon (Rasmussen & Noe-Nygaard 1969; 1970).

Stop 5.9: Hellisá, Ljósá, Eysturoy



Fig. 101. Tree mould within a compound lava flow, Malinstindur Formation, Hellisá, Eysturoy.

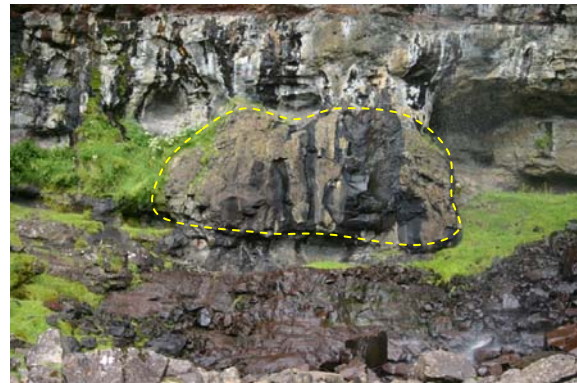


Fig. 102. View of an assumed lava tube, Malinstindur Formation compound lava flow, Hellisá, Eysturoy.

Location

Park on the right side of the road on the S side of the bridge that crosses the Hellisá stream [PK 0072 0633; ~40 m asl], ~500 m N of Ljósá, Eysturoy and then walk along the disused road to the old bridge (Fig. 82).

Introduction

This locality consists of a pseudo-lava tube within a compound lava flow from the Malinstindur Formation.

Description

Look upstream to the overhanging waterfall. The waterfall is composed of a compound lava flow sequence consisting of brown weathering, aphyric flow lobes that range in thickness from tens of centimetres to a few metres in thickness. Throughout the section a number of cylindrical structures can be seen, which are interpreted as tree moulds (Fig. 101). At the base of the waterfall is a more resistant elliptical mass of basalt that is interpreted to be a lava tube (Fig. 102). The tube is ~4.5 m high by ~9.5 m wide and has a cross-sectional area of ~34 m². Lava tubes would have been a thermally efficient method of transporting lava significant distances from the localised point-sourced shield volcanoes that erupted the compound lava flows of the Faroe Islands (Passey & Bell 2007).

Stop 5.10: Road Cut, Ljósá, Eysturoy

Location

Park in the rough lay-by just past the road excavation [PK 0046 0666; ~65 m asl], ~900 m N of Ljósá, Eysturoy and walk back along the road to view the fresh rock exposure (Fig. 82). **PLEASE TAKE CARE WALKING ALONG ROAD AS THE CARS TEND TO DRIVE VERY FAST IN THIS AREA!**

Introduction

This stop examines the structure of a number of inflated pahoehoe flow lobes from a compound lava flow of the Malinstindur Formation.

Description

Towards the NW end of the road cut the basal ~11 m thick section through a compound lava flow can be observed overlying a reddened surface of the preceding compound lava flow (Fig. 103). The upper compound flow consists of at least 4 flow lobes that are, from lowest to highest, ~1.1, ~2.2, ~2.3 and ~5.4 m thick (measured using photogrammetrical software). Each lobe can be subdivided into a basal crust, a massive core and an upper crust based on amygdale distribution patterns. Therefore, the lobes can be characterised as P-type (pipe-bearing) pahoehoe and indeed some of the basal crusts exhibit well formed pipe amygdales. The basal crusts are overlain by massive cores that are essentially non-vesicular except for the presence of vesicle cylinders represented by near vertical segregation veins. Occasionally at the top of these segregation veins there are large mega-amygdales with their major-axes aligned parallel to the upper contact. The core is overlain by an upper amygdaloidal crust, which in the thicker lobes shows clear alternations between amygdale-rich and massive bands, commonly referred to as horizontal vesicle zones, each representing an injection of fresh lava. Taking the upper crust thicknesses of the four lobes (~0.6, ~1.0, ~1.0 and ~1.9 m, respectively) and using them in the empirical inflation duration equation of Hon *et al.* (1994), it returns durations of ~2.5, ~6.9, ~6.9 and ~24.8 days, respectively. This gives a minimum emplacement duration for the 11 m thick section of ~41 days. This assumes that the flow lobes were emplaced continuously, but the lack of reddened weathered surfaces between the lobes would imply the time gap between lobes was minimal.

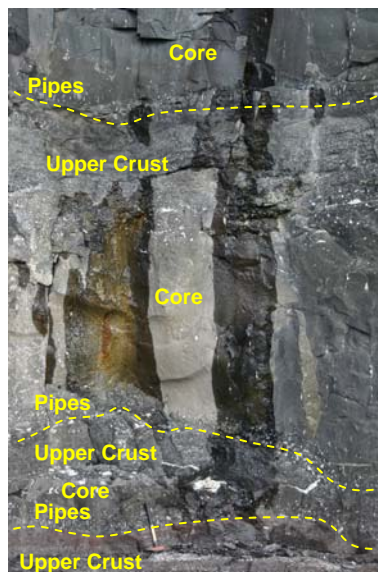


Fig. 103. View of part of a Malinstindur Formation compound lava flow composed of thinner P-type inflated pahoehoe flow lobes, Ljósá, Eysturoy.

Stop 5.11: Krúp, Eysturoy

Location

From the car park at the N end of the football pitch in Eiði walk along the coastline for ~250 m staying on top of the flow and do not climb above the next lava bench until you reach the wave-cut platform known as Krúp [NK 9988 1015; ~10 m asl], ~1.2 km NE of Eiði, Eysturoy (Fig. 82).

Introduction

This locality examines another exposure of the Kvívík Beds of the Malinstindur Formation as well as a small fault that cuts through the unit.

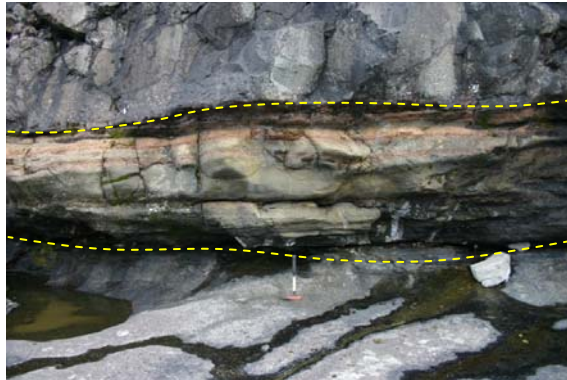


Fig. 104. View of the ~1.5 m thick Kvívík Beds, Malinstindur Formation, Eiði, Eysturoy.

Description

From the car park you initially walk over a prominent brown weathering aphyric compound lava flow before the sequence is dominated by plagioclase-phyric compound lava flow lobes. This compound lava flow sequence, which is not particularly weathered, is overlain by a maximum ~1.5 m thick volcaniclastic sandstone sequence (Fig. 104). The mottled greenish-red sequence is bedded and comprises medium grained to granule-rich sandstones. The sandstones are overlain with a sharp planar contact by brown weathering aphyric, although olivine-bearing, compound flow lobes. The basal crusts commonly contain pipe amygdales and small cylindrical structures interpreted to be tree moulds.

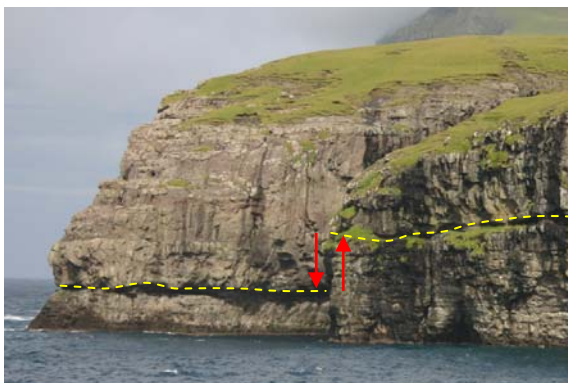


Fig. 105. Normal fault S of Trøllshøvdi headland, Malinstindur Formation, Eysturoy.

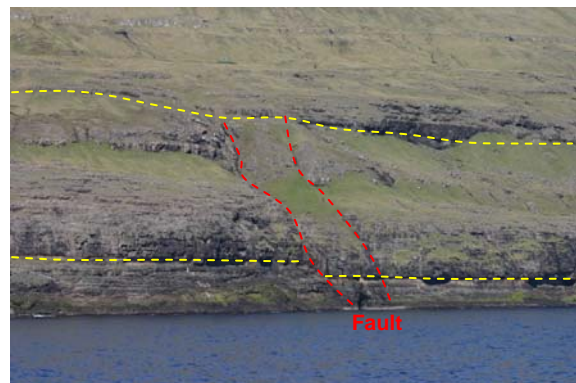


Fig. 106. Normal fault in Heimastagjógv, Malinstindur Formation, Eysturoy.

Following the sandstone sequence around the coastline you will see a small ENE-WSW trending fault with the downthrow of ~1 m to the SSE. The fault zone is <1 m wide and consists of a fault breccia. Looking along the coastline another fault can be seen in the E-W trending gjógv at the southern end of the Trøllshøvdi headland (Fig. 105). At this fault the compound flow sequence has been downthrown to the N by up to ~10 m. The fault can be traced to the W, although curving slightly, across to the Eiðiskollur peninsula where the fault occurs in Heimastagjógv (Fig. 106). It appears that the fault dies out with height having little appreciable affect on the uppermost compound lava flows of the peninsula. These E-W normal faults have been associated with a N-S extensional stress regime during the emplacement of the Malinstindur and Enni Formations (Geoffroy *et al.* 1994).

Stop 5.12: á Svannisbrekku Viewpoint, Eysturoy

Location

Park in the lay-by on the left side of the road with the permanent telescope. This is the á Svannisbrekku viewpoint [PK 0087 0977; ~145 m asl], ~1.9 km ENE of Eiði, Eysturoy (Fig. 8.2).

Introduction

This last stop of the day takes in the scenic views of the sea stacks Risin og Kellingin and the highest mountain of Slættaratindur.

Description

This locality affords a view to the NW of the Kollur peninsula to the N of the village of Eiði and in particular the sea stacks of Risin (~71 m asl) og Kellingin (~69 m asl), which translates into “the Giant and the Witch” (Fig. 107). Risin is to the N (i.e. to the right as we look at it). The story goes that the Icelandic giant wished to drag the Faroe Islands back home to Iceland. So one night, the giant and his wife, the witch, tied a heavy rope around the rock of Eiðiskollur (~352 m asl) and began pull as hard as they could. However, as much as they tried the islands would not move. In their unrelenting efforts they lost track of time and before they could react the sun came up and turned them to stone. The peninsula is composed entirely of compound lava flows of the Malinstindur Formation.



Fig. 107. View of Risin og Kellingin (the Giant and the Witch). Risin is to the right of the view, N Eysturoy.



Fig. 108. View of Slættaratindur (in the background), Eysturoy, the highest mountain on the Faroe Islands at ~882 m asl.

Looking to the ESE, the highest mountain of the Faroe Islands can be seen, unless it is shrouded in fog. This is Slættaratindur and is ~882 m asl (Fig. 108). The upper ~320 m of the mountain is composed of lava flows of the Enni Formation and the Argir Beds are exposed ~30 m below the summit. The Sneis Formation is easy to identify because it has been intruded by the distinctive brown weathering, basaltic sheets that stand out against the other grey weathering basalts.

Day 6 – Thursday, 21 August 2008

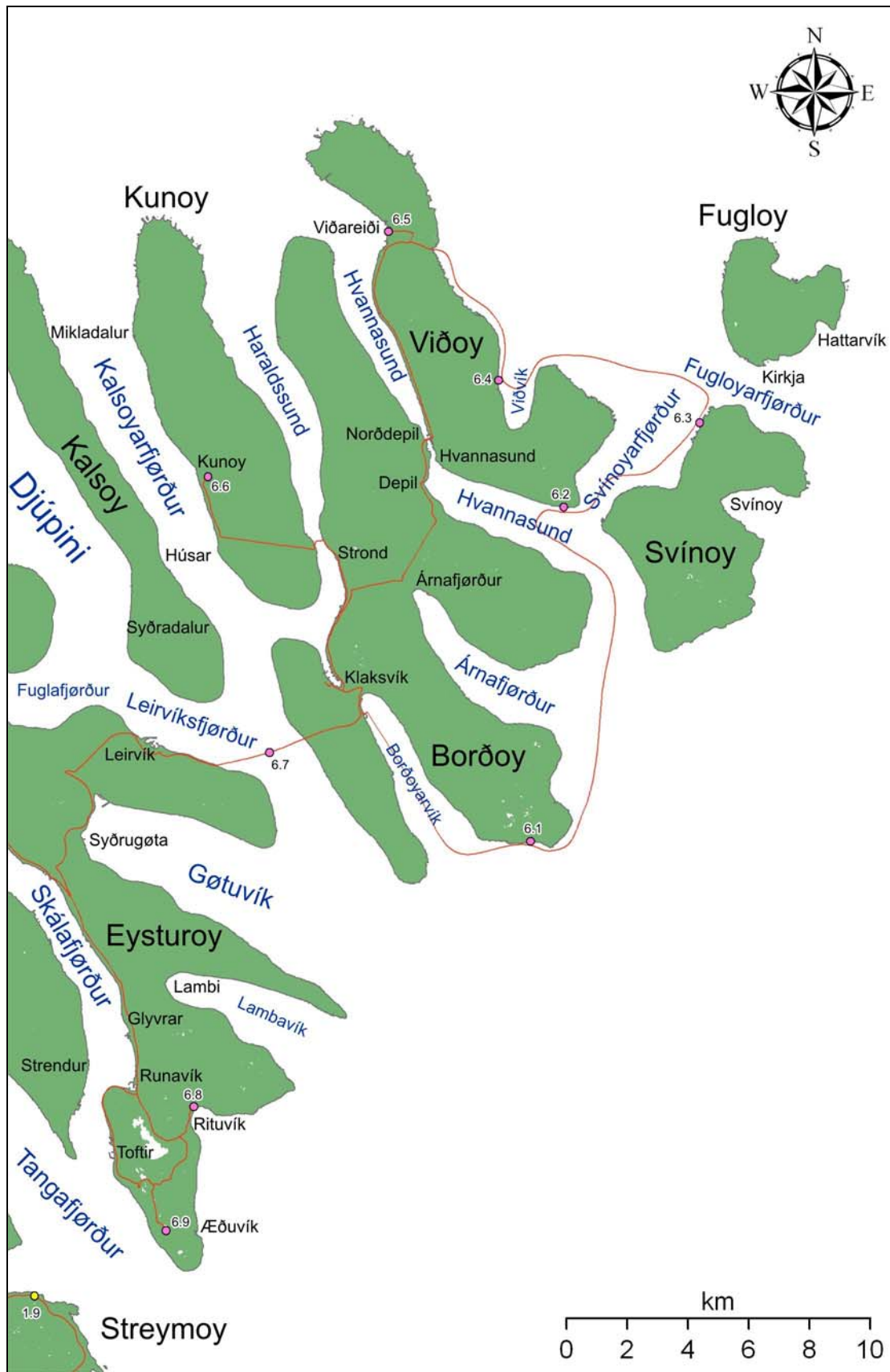


Fig. 109. Excursion route map for Day 6 – Stops 6.1 to 6.9 (Stops 6.10 to 6.14 can be seen in Figs. 15 & 82).

Introduction

The group shall rendezvous with the excursion leader and your entire luggage outside Hotel Klaksvíkar Sjómansheim for 08:30. The bus will then take us to the small pier on the SE side of Klaksvík where we will transfer to the small boat, Vanir. The luggage will stay with the bus. The morning shall be spent on the boat and therefore, it is important to bring **warm clothes**, **waterproofs** and your **packed lunch**. The boat will head SE along Borðoyarvík before turning to the E and following the southern coastline of Bjargamansdalur (Fig. 109). The boat will then head N to the southern end of Viðoy passing between the E side of Borðoy and western Svínoy. The boat will then sail along Svínoyarfjørður before turning to the N and sailing along the eastern coastline of Viðoy before arriving at the small fishing village of Viðareiði at the N end of the island. The boat will stop at a number of localities to examine some so-called vents of the uppermost Malinstindur and Sneis formations and to also look at the contrasting lava flow morphologies of the Enni Formation. In addition, there will be an opportunity to examine the Svínoy-Fugloy Sill. At Viðareiði, the group shall rendezvous with the bus which will take a convoluted journey, via southern Eysturoy, to the 62°N airport hotel on Vágar (Figs. 15, 82 & 109). A number of road side localities shall be visited that mainly focus on lava flow morphologies and emplacement mechanisms of the compound flows of the Malinstindur Formation. The night shall be spent at the 62°N airport hotel (Hotel Vágar) and participants are expected to arrange their own evening meal.

Klaksvík to Viðareiði Boat Trip

Stop 6.1: Skoramunni, Borðoy

Location

Skoramunni cliff section [PJ 3184 9690; ~0-130 m asl], ~150 m W of Gjógvin í Djúpi and ~7.4 km SE of Klaksvík, Borðoy (Fig. 109).

Introduction

This stop shall examine a small thrust fault that cuts through a section of sheet lobes of the Enni Formation.

Description

The cliffs are ~130 m high and are more or less aligned E-W. The cliffs are composed of lava flows separated by reddened volcanoclastic units of the Enni Formation. The base of the cliffs consists of a reddened volcanoclastic unit that overlies flow lobes of a compound lava flow, which disappear below sea level at the eastern side of the locality (i.e. to the right as we look at it). The volcanoclastic unit is overlain by a ~63 m thick compound lava flow made up of thinner flow lobes. The compound lava flow is overlain by a ~46 m thick sequence composed of sheet lobes separated by reddened volcanoclastic sandstones. The sheet lobes, from base to top, are ~16, ~14 and ~13 m thick respectively. The basal sheet lobe is underlain and overlain by sandstones that are ~1.8 and ~1.4 m thick, respectively. This sheet lobe dominated interval is overlain by a compound lava flow ~16 m thick which is overlain by a volcanoclastic sandstone and another sheet lobe that is at least 15 m thick.

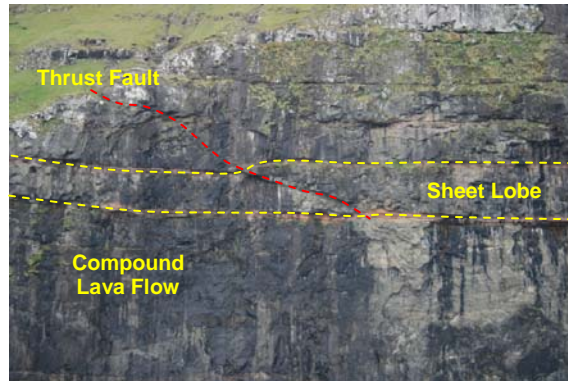


Fig. 110. View of a small reverse slip fault within lava flows of the Enni Formation, Skoramunni, Borðoy.

The interval dominated by sheet lobes has been visibly affected by a dip-slip reverse fault (Fig. 110). This can clearly be seen within the basal sheet lobe towards the W side of the cliffs (i.e. to the left as we look at it). The E side of the basal sheet lobe has been faulted upwards by ~4 m and ~10 m to the W. The reverse fault obviously affects the overlying sandstone. The reverse fault dips by ~20° within the basal sheet lobe and can be seen to climb up through the two overlying sheet lobes. The fault plane extends down into the underlying volcanoclastic sandstone but does not appear to affect the underlying compound lava flow and therefore, the reverse fault, most likely, propagates along the boundary between the sandstone and the compound lava flow. Geoffroy *et al.* (1994) suggest that the reverse faults observed on the Faroe Islands are linked to an ENE-WSW orientated compressional event.

Stop 6.2: Bugurin á Torvstíggj, Viðoy

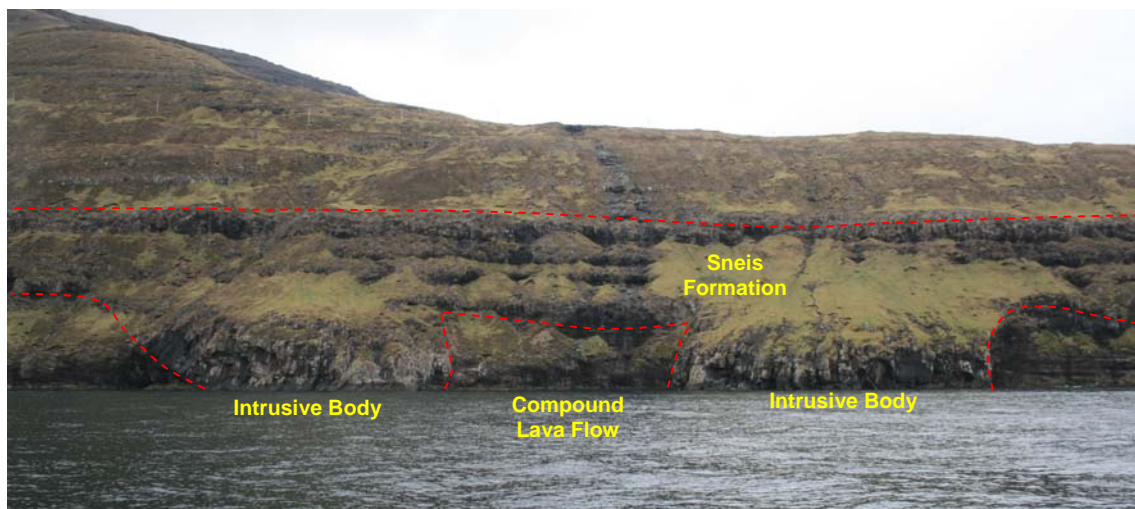


Fig. 111. View of two intrusive basaltic bodies disrupting the Sneis Formation, Bugurin á Torvstíggj, Viðoy.

Location

Bugurin á Torvstíggj coastline section [PK 3295 0791; 0-70 m asl], ~4 km ESE of Hvannasund, Viðoy (Fig. 109).

Introduction

This stop allows the group to examine a section of coastline previously interpreted as a vent from the very top of the Malinstindur Formation.

Description

The small ~75 m wide bay of Bugurin á Torvstíggj is composed of a ~35 m thick compound lava flow of the uppermost Malinstindur Formation (Fig. 111). The top surface of the compound lava flow is weathered and overlain by a noticeably reddened volcanoclastic sandstone up to 1 m thick. The sandstone correlates to the Sund Bed from the base of the Sneis Formation. The conglomerates commonly associated with the Sneis Formation can clearly be seen on the E side of the Bergið headland, ~500 m to the E. The sandstone and conglomerates of the Sneis Formation obviously contain a series of brown weathering, tabular basalts, assumed to be the invasive sheets that are commonly observed invading the Sneis Formation elsewhere on the islands (see Stop 5.3).

On either side of the Bugurin á Torvstíggj bay the uppermost compound lava flow of the Malinstindur Formation has been removed and replaced by two massive, crudely columnar jointed basaltic bodies (Fig. 111). The two basaltic bodies are both ~110 m wide and both form small headlands that have resisted erosion unlike the compound lava that occurs around them. The compound flow lobes between the two basaltic bodies have been visibly crumpled (folded) suggesting that they have been compressed between the two basaltic bodies.

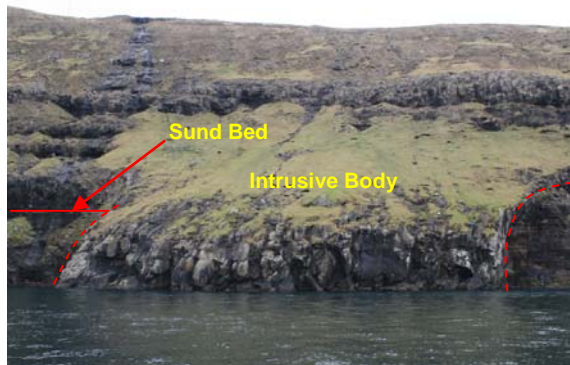


Fig. 112. Basaltic intrusive body forming the Skáp Gretu headland on the E side of Bugurin á Torvstíggj, Viðoy.

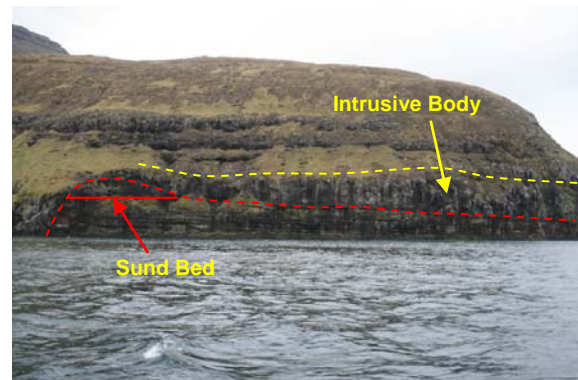


Fig. 113. The intrusive body on the E side of Bugurin á Torvstíggj can be observed to climb up and extend into the Sneis Formation, S side of Bergið, Viðoy.

The basaltic body forming the easternmost headland, known as Skáp Gretu, has sharp vertical contacts and the eastern contact is clearly seen to climb up through the Sund Bed and into the Sneis Formation where it flattens out and extends eastwards along the coastline (Figs. 112 & 113). The basaltic body noticeably thickens away from the Skáp Gretu headland and on the E side of Bergið the upper contact can be seen to be diffuse and overlain by conglomerates of the Sneis Formation. The compound lava flows at the eastern contact of Skáp Gretu have a several metre wide, visibly reddened, thermally altered zone.

The western basaltic body also has sharp contacts against the uppermost compound lava flow of the Malinstindur Formation (Fig. 114). The eastern contact is vertical and the contact zone within the basaltic body is characterised by sub-horizontally jointed columns that have cooled perpendicularly to the contact. This is also seen along the western contact, but this contact is inclined by ~30° and climbs upwards towards the W (Fig. 115). The basaltic body climbs upwards and extends to the W-WNW within the Sneis Formation. The basaltic body and a number of the overlying brown weathering, tabular basalts of the Sneis Formation are observed to continue to climb upwards and finally pinch out against the uppermost brown weathering, tabular basalt of the Sneis Formation.



Fig. 114. Basaltic intrusive body forming headland on the W side of Bugurin á Torvstíggj, Viðoy.

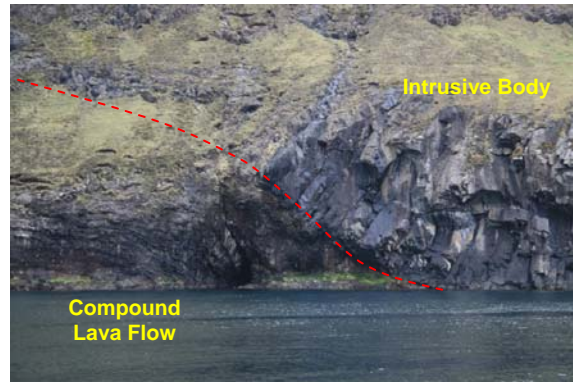


Fig. 115. Basal contact of the western intrusion, notice the down-warping of the adjacent compound lava flows of the Malinstindur Formation, Bugurin á Torvstíggj, Viðoy.

Initially, this section was interpreted by Walker & Davidson (1936) as a vent, where the basalts forming the two headlands fed, what they believed to be, the overlying lava flow. Subsequently, Rasmussen & Noe-Nygaard (1969; 1970) suggested that there is a clear connection between the basalt filling the voids and the overlying basalt, but they favoured the idea that the overlying basalt was a lava flow that infilled the depressions. However, the confinement of the basaltic bodies to the Sneis Formation, as observed from the pinching out to the WNW, the crumpling of the compound flow lobes between the basaltic bodies and the vertical contacts suggest that the bodies are invasive and that they, most likely, fed the invasive sheets of the Sneis Formation in this area.

Stop 6.3: Coastline between Keldufjall and Selnes, Svínøy

Location

Coastline section between Keldufjall [PK 3760 1013; ~463 m asl] and Selnes [PK 3777 1123; 0 m asl], ~2.5 km N of Svínøy village, Svínøy (Fig. 109).

Introduction

This section of the coastline affords views of the Svínøy-Fugloy Sill which transgresses through lava flows of the Enni Formation.

Description

The coastline between Keldufjall and Selnes is relatively straight, trending N27°E and is composed of compound lava flows and sheet lobes of the Enni Formation. Along this section of the coastline the lava flows have been intruded by the SSW inclined sheet of the Svínøy-Fugloy saucer-shaped sill (Fig. 116). The sill can be seen to climb upwards from Selnes to the summit of Keldufjall over a vertical thickness of ~400 m and a lateral distance of ~1 km. the sill is ~30 m thick in this area and appears to be composed of multiple phases of intrusion. The sill exhibits well-developed columnar jointing (Fig. 117). This side of the saucer comes down to sea level at Kallanes, northern Svínøy where it is then assumed to extend across Fugloyarfjørður to Fugloy where it reappears to the E of Skorin and then climbs up behind the village of Hattarvík before descending once again to Eiðsvík bay. The sill trends more or less NNE-SSW and has a overall length of ~6 km (Keldufjall to Eiðsvík) and width of ~1.5 km (Rasmussen & Noe-Nygaard 1969; 1970). The Svínøy-Fugloy sill has an areal extent of >2.25

km² and the thickness of the sill varies between 15 and 40 m (Rasmussen & Noe-Nygaard 1969; 1970).

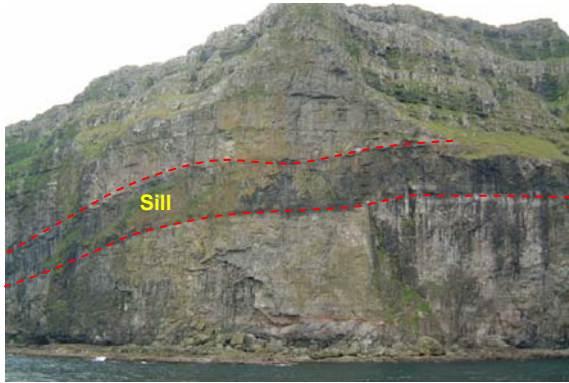


Fig. 116. View of the ~30 m thick Svínøy-Fugloy Sill, Selnes, Svínøy.



Fig. 117. The Svínøy-Fugloy Sill is columnar jointed and intruded lava flows of the Enni Formation, Selnes, Svínøy.

Stop 6.4: Husið millum Gjáir, Viðoy

Location

Husið millum Gjáir coastline section [PK 3079 1209; 0-20 m asl] between Gjógvin Lítla and Gjógvin Stóra, W side of Viðvík bay, Viðoy (Fig. 109).

Introduction

This stop examines a vent locality from the Malinstindur Formation of Rasmussen & Noe-Nygaard (1969; 1970).



Fig. 118. View of the southern vertical contact between compound lava flows and an intruded volcaniclastic breccia, Malinstindur Formation, Husið millum Gjáir section, Viðoy.



Fig. 119. View of the volcaniclastic breccia in the Husið millum Gjáir section, Viðoy.

Description

This section of the coastline trends N-S and is composed of compound lava flows of the Malinstindur Formation. The top of the Malinstindur Formation occurs ~80-90 m asl. Along a ~150 m long section of the coastline however, the compound lava flows have been removed and are bounded N and S by sharp vertical contacts to a height of ~20 m (Fig. 118; Rasmussen & Noe-Nygaard 1969; 1970). The void has subsequently been infilled by a volcanoclastic breccia composed of a variety of angular fragments consistent with having been derived from the compound lava flows of the Malinstindur Formation (Fig. 119). The breccia is also interrupted by a small, ~30 m wide, depression that has subsequently been infilled by flow lobes from a compound lava flow. The breccia has also been disrupted by numerous near vertical dykes that tend to taper out within the breccia and have distinctive glassy contacts.

Viðareiði to Sörvágur Road Side Localities

Stop 6.5: Viðareiði, Viðoy

Location

Park in the car park on the N side of the picturesque church in the village of Viðareiði, Viðoy (Fig. 109). From the car park head to the small bridge and then walk down the N (right) side of the stream until you reach the wave-cut platform [PK 2717 1697; ~10 m asl].

Introduction

This locality allows for the examination of the morphologies and emplacement mechanisms of inflated pahoehoe flow lobes of the Malinstindur Formation.

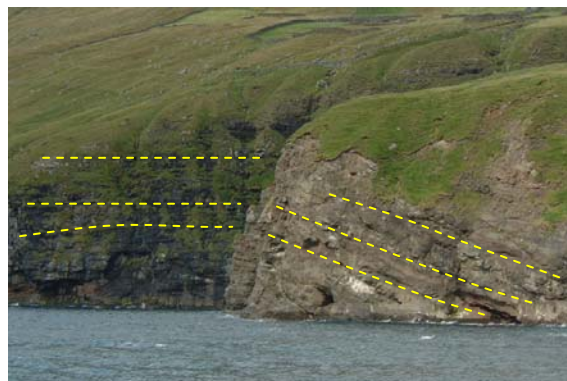


Fig. 120. View of the channel margin N of Viðareiði where compound lava flows of the Malinstindur Formation mantle the topography, Viðoy.

Description

At this locality flow lobes of a Malinstindur Formation compound lava flow are observed infilling a small channel. Looking along the coastline to the NNW the flow lobes are observed mantling the channel margin with angles between 20 and 30°, representing the pre-existing topography (Fig. 120; Passey & Bell 2007). Within the channel the flow lobes have been suggested to invade a ~1.2 m thick volcanoclastic sequence resulting in the bifurcation of the strata (Fig. 121). The volcanoclastic sequence is composed of poorly lithified and highly friable mudstones through to conglomerates (Fig. 122). These units have a very heterogeneous clast population ranging from reworked palagonitised basaltic glass to various basalt lava clasts, which exhibit variations in petrology (including vesicularity) and texture

(rounding, grain size, etc.). The finer lobes are generally thinly to very thickly laminated. Some of the bedded volcanoclastics have been gently folded and parallel the basal contact of the overlying flow lobe, implying that volcanoclastics have been affected by loading. The preservation of these delicate structures and the poorly lithified nature of the volcanoclastics suggests that the flow lobes have invaded, at least some of the sequence passively and also protected them from lithification through encasement (Passey & Bell 2007).

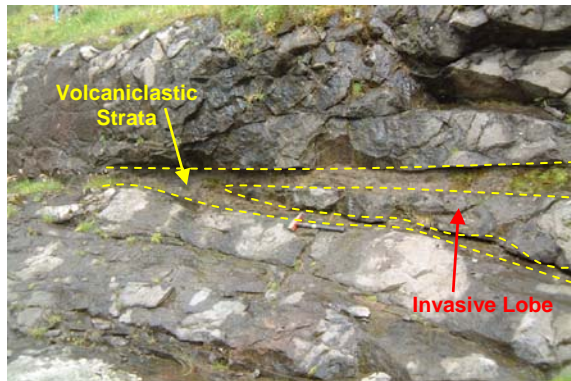


Fig. 121. Bifurcation of the volcaniclastic strata by a flow lobe, Malinstindur Formation, Viðareiði, Viðoy.



Fig. 122. Volcaniclastic conglomerates to mudstones, Malinstindur Formation, Viðareiði, Viðoy.

The flow lobes range from <0.5 to >2 m in thickness and exhibit features consistent with being inflated, pipe-bearing (P-type) pahoehoe lava. The surfaces of many of the P-type flow lobes display ropy structures that vary in scale from 40×40 cm to 3×2 m (Fig. 123). Within the compound lava flow sequence to the S of the stream small ($\sim 0.14 \text{ m}^2$) distributary lava tubes can be seen, implying that lava tube networks were an efficient mechanism in the emplacement the lava flows (Passey & Bell 2007). Within this sequence a ~ 1.6 m thick P-type flow lobe can be subdivided into a lower crust, a core and an upper crust. The 10 cm thick lower crust is characterised by pipe amygdales with a maximum length of ~ 8 cm that start a few centimetres off the base of the flow lobe (Fig. 124). Many of these pipe amygdales are curved, defining the localised flow direction of the lobe. The core is a compact, massive zone with irregular jointing and generally lacks amygdale cylinders. The upper crust is on average ~ 25 cm thick and is dominated by elliptical amygdales that have a maximum diameter of ~ 2 cm. By using this upper crust thickness and the emplacement duration equation of Hon *et al.* (1994) it implies that this flow lobe was active for ~ 10.3 hours (Passey & Bell 2007).



Fig. 123. Ropy lava on the surface of a pahoehoe flow lobe, Malinstindur Formation, Viðareiði, Viðoy.

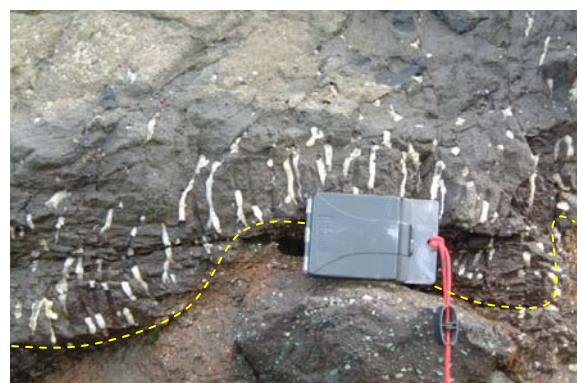


Fig. 124. Pipe amygdales in the lower crust of an inflated P-type pahoehoe flow lobe, Malinstindur Formation, Viðareiði, Viðoy.

Stop 6.6: Kunoy Village, Kunoy

Location

After emerging from the Kunoy Tunnel (*Kunoyartunnilin*) take the first turning to the right next to a small quarry and park at the end of the road, this is Stop 6.6 [PK 2125 0891; ~85 m asl], ~500 m SE of Kunoy village, Kunoy (Fig. 109).

Introduction

This stop contrasts the different morphologies and petrologies of the Enni Formation lava flows.

Description

Looking to the NE from the viewpoint to the back of the Lítladalur valley the differing lava flow morphologies of the Enni Formation can be clearly distinguished (Fig. 125). The lava flow sequences have been subdivided into those composed of compound and simple (sheet lobe) lava flows, respectively. Compound lava flows are made up of numerous lava flow lobes which contrasts to the simple flows consisting of a single flow lobe that have widths greater than they are thick (i.e. sheet lobes). The compound flows and simple flows generally have comparable thicknesses but the flow lobes comprising the compound flow vary greatly in thickness from tens of centimetres to a few metres. The difference between the simple and compound flows is, most likely, linked to the manner in which the lava was supplied during the eruption and the eruptive style of the volcanic system. The sheet lobes were erupted over laterally extensive areas from fissure systems which had a continuous supply of lava, which contrasts with the tube-fed compound flows which were erupted in a gradual, piecemeal manner from point-sourced, low shield volcanoes with limited areal extents (Passey & Bell 2007).

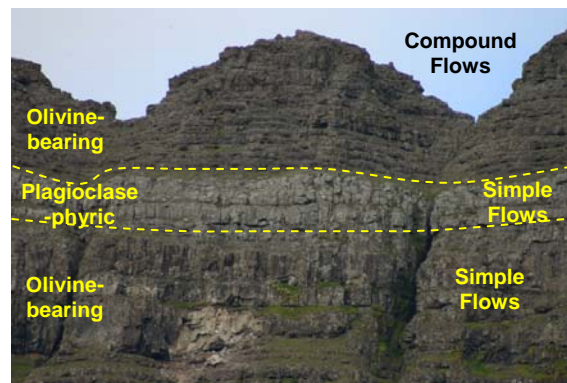


Fig. 125. View of contrasting lava flow facies of the Enni Formation. Simple vs. compound flows and grey weathering (plagioclase-phyric) vs. brown weathering (olivine-rich) flows. Ridge line SE of Middagsfjall, Kunoy.

Further subdivision of the flows is based on their gross macroscopic petrographies into aphyric, plagioclase porphyritic and olivine (micro-) porphyritic basalt. Some of the flows also exhibit distinctive lichen colonisation coloration, principally those with a pale (grey) or brown coloration, often referred to as a weathering coloration (Fig. 125). Light-coloured lichen tends to grow on the plagioclase-phyric basalts, hence giving them a pale (grey) weathering attribute. This differs from the brown coloured flows that are typically enriched with olivine and is not favoured by the lichens. The colonisation of the different flows is most

likely linked to their geochemistries. This featurings can be seen at a height of ~700 m in the mountain side and these distinctive lava packages can be traced across to Borðoy and Viðoy.

Stop 6.7: Norðoyar Sub-Sea Tunnel, Leirvíksfjørður

Location

The Norðoyar Tunnel (*Norðoyatunnilin*) between Klaksvík, Borðoy and Leirvík, Eysturoy (Fig. 109).

Introduction

As the bus passes through the sub-sea Norðoyar Tunnel some general information shall be given about the tunnel.

Description

The Norðoyar Tunnel (*Norðoyatunnilin*) was the second sub-sea tunnel on the Faroe Islands and was opened on 29 April 2006 and connects the islands of Eysturoy and Borðoy. The tunnel is located primarily within the compound lava flows of the Malinstindur Formation (Fig. 126). The two-lane road tunnel is ~6.3 km long and ~10 m wide. Tunnel work commenced on the Eysturoy side on 18 December 2003 and on the Borðoy side on 27 April 2004 and cost DKK 398 million (~£36.3 million). The tunnel has a maximum slope of ~6% and at the lowest point, the tunnel is ~150 m below sea level. The minimum thickness of bedrock above the tunnel is <50 m. The tunnel extracted, through blasting, ~630,000 m³ of rock and 1100 t of cement was used for fractures alone, most of which, were located along the section beneath Borðoy. Water leakage into the tunnel is ~180 l/min/km, which is below the allowed rate of 300 l/min/km.



Fig. 126. Inflation cleft in the top of a compound lava flow lobe has been infilled by a greenish volcaniclastic sandstone, Malinstindur Formation, Norðoyar Tunnel, Leirvíksfjørður.

The tunnel replaces the ferry service between Leirvík, Eysturoy and Klaksvík, Borðoy. The journey time between Klaksvík and Leirvík is now ~5 minutes where it previously took ~30 minutes by ferry plus the time spent waiting between departures. The opening of the tunnel has connected six islands or ~86% of the population directly through the road network and in 2006, an average of 1544 vehicles passed through the tunnel a day. To make the drive through the tunnel less monotonous and thereby reducing the chance of accidents in the tunnel, Tróndur Patursson, a famous Faroese artist has created a light show along ~200 m of the deepest part of the tunnel.

Stop 6.8: Rituvík, Eysturoy



Fig. 127. Rituvík Lava Tube within compound lava flows of the Enni Formation, Rituvík, Eysturoy.

Location

As you enter the village of Rituvík stop opposite a small gate on the right side of the road, just past the first few houses. Go through the gate, walk down the right side of the small stream to the wave-cut platform and finally, cross over the slippery stream this is Stop 6.8 [PJ 2077 8819; ~10 m asl] at the western end of Kósin Bay, ~300 m SW of Rituvík, Eysturoy (Fig. 109).

Introduction

This stop will examine the Rituvík Lava Tube within a compound lava flow of the Enni Formation.

Description

At this locality the Rituvík Lava Tube is exposed (Fig. 127). The lava tube has a sinuous geometry and an elliptical cross-section ~3.2 m wide by ~1.1 m high. Therefore, the tube has a cross-sectional area of ~2.8 m² and as the exposed length of the tube is ~15-20 m that gives it a minimum volume of between 41 and 55 m³ (Passey & Bell 2007). The lava tube is concentrically jointed and has a massive appearance consisting of <5 vol.% plagioclase feldspar glomerocrysts up to 5 mm across. The tube is contained within a pale (grey) weathering compound lava flow, where the flow lobes are a mixture of plagioclase-phyric and aphyric basalt. Apophyses from the lava tube can be seen to extend into the lava flow and at the contact the lava tube has thermally affected the surrounding flow lobes. The filled nature of the lava tube implies that it was emplaced on relatively flat terrain which inhibited the tube from draining. Numerous filled lava tubes are observed throughout the Malinstindur and Enni formations, although they are restricted to compound lava flow sequences (Passey & Bell 2007).

Stop 6.9: Neshagi, Eysturoy



Fig. 128. View of the wind turbines built on lava flows of the Enni Formation, Neshagi, Eysturoy.

Location

Park at the end of the road that leads to the three large wind turbines at Neshagi [PJ 1986 8411; ~140 m asl], Eysturoy (Fig. 109).

Introduction

This stop affords scenic views to the NE, S and SW and gives information about the wind turbines at this location.

Description

This locality affords a view to the S of Nólsoy, to the SW of the Tórshavn municipality and to the NE of eastern Eysturoy and the NE islands. The three wind turbines were erected by SEV in June 2005 and were operational by the end of the month (Fig. 128). The wind turbines have an average output of ~165 MWh per month, which compares to an average monthly output of ~46 MWh for the smaller wind turbine that can be seen to the N. This smaller turbine was the first one built on the islands in 1993. Wind power accounts for ~4% of the total electricity production on the islands and combined with hydropower this increases to ~39%.

The wind turbines are constructed on the plagioclase-phyric sheet lobes immediately overlying the Argir Beds (Fig. 128). The Argir Beds are at least ~5 m thick in this area and are intercalated with a brown weathering, aphyric compound lava flow. This can be seen between the heights of ~68 and ~82 m in the small stream that leads from the Nesvatn Lake to the S. The Argir Beds have a ubiquitous association with one or two brown weathering aphyric lava flows from Eysturoy to the NE islands implying that the sediments and the lava flows were emplaced contemporaneously.

Stop 6.10: Gulisteinur, Eysturoy

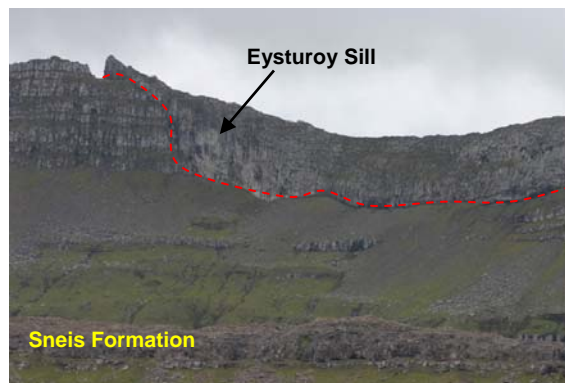


Fig. 129. View of the E side of the Eysturoy Sill that cuts through the lava flows of the Enni Formation. The pinnacle is Reyðafelstindur, SW of Skálabotnur, Eysturoy.

Location

Park in the lay-by [PJ 1211 9834; ~10 m asl] on the right side of the road overlooking Gulisteinur, ~400 m SE of Skálabotnur petrol station, Eysturoy (Fig. 82).

Introduction

This stop discusses the E side of the Eysturoy Sill that intrudes the lava flows of the Enni Formation.

Description

Looking to the W from the viewpoint affords the view of the eastern bench of the saucer-shaped Eysturoy Sill (Fig. 129). The SE end of the sill forms the pinnacle of Reyðafelstindur (~766 m) and moving to the NW the sill cuts steeply down through a ~120 m thick sequence of pale (grey) weathering plagioclase-phyric sheet lobes before levelling out at the approximate level of the Argir Beds. The sill continues to transgress at this level before cutting down into the top of the underlying ~270 m thick sequence dominated by plagioclase-phyric compound flows. The sill continues at this level and can be seen to comprise multiple intrusions that generally have well-developed columnar jointing.

Up to the level of the sill the mountainside is primarily composed of grey (pale) weathering compound lava flows. The exception is the occurrence of at least two, possibly three, brown weathering aphyric, although olivine-bearing, basalts. The uppermost and thickest of these has invaded the volcanoclastic conglomerates of the Sneis Formation. On the E side of Reyðafelstindur the conglomerates form a flat-lying plateau and are locally up to ~25 m thick. The conglomerates typically consist of beds <5 m thick with anastomosing and meandering lobe-like geometries. The conglomerate lobes have a dominant flow direction to the S and are interpreted to represent deposits from a mass flow event under debris flow processes. The conglomerates have been invaded by at least three separate sheets with a combined thickness approaching 40 m.

The second brown weathering sheet occurs ~50 m below the base of the Sneis Formation and is <10 m thick and has intruded a similar volcanoclastic conglomerate sequence up to ~5 m thick. This unit has been mapped to the SW across Eysturoy, but does not occur at a similar stratigraphic level on Streymoy suggesting it is locally constrained to the eastern side of Tangafjørður, the fjord that separates Streymoy from Eysturoy. This volcanoclastic

conglomerate sequence and associated invasive sheet has a general dip in this area of between 2.1° and 2.9° to the SE.

Stop 6.11: Hvítusteinar Quarry, Eysturoy

Location

Park outside on the left side of the entrance to the Hvítusteinar Quarry [PJ 1255 9713; ~20 m asl], ~1.3 km SE of Skálabotnur, Eysturoy (Fig. 82). Walk into the quarry and head along the track on the left and then head up the bank on your left to get a view of the quarry face. **PLEASE BE CAREFUL AS THIS IS STILL AN ACTIVE QUARRY!**

Introduction

This stop examines the compound flow lobes and associated volcanoclastic lithologies from the Malinstindur Formation.

Description

The quarry face is ~25 m high by ~100 m long and consists of a basal compound lava flow at least ~12 m thick. The flow consists of at least 3, dominantly aphyric, flow lobes. The uppermost flow lobe is clearly of the P-type pahoehoe variety containing a basal crust with pipe amygdales and an upper crust with weakly defined horizontal vesicle zones. The upper contact of the flow lobe is sharp and planar except at the NW (right) end of the quarry where it undulates slightly. This is overlain by a ~1.5 m thick reddened volcanoclastic sandstone. The sandstone is thinly bedded and consists of medium to coarse sand. Some of the beds contain discernable creamish charcoaled plant fragments. Some fallen blocks can be examined in the quarry. The sandstone is overlain by a second compound lava flow at least ~12 m thick. The flow lobe immediately overlying the sandstone is also P-type pahoehoe, containing pipe amygdales and an upper crust with clearly visible horizontal vesicle zones.

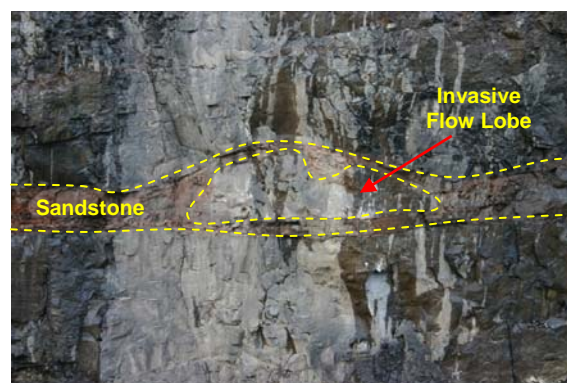


Fig. 130. View of the volcanoclastic sandstone that has been invaded by an inflated pahoehoe flow lobe, Malinstindur Formation, Hvítusteinar Quarry, Eysturoy.

The sandstone has been invaded by what is assumed to be an invasive flow lobe ~0.5 m above the base of the sandstone (Fig. 130). The basal contact of this plagioclase-phyric basalt is sharp and planar and parallels the underlying bedding plane. The upper contact has a pronounced undulation that has resulted in the doming of the upper sandstone beds, although at the NW end of the quarry the upper contact is sharp and planar. The prominent invasive dome at the back of the quarry wall is ~8-9 m wide by ~2.0-2.5 m thick. The orientation of the horizontal vesicle zones in the upper crust of the overlying flow lobe imply that this lobe has also been domed over the invasive pod of lava. However, the subsequent flow lobes do not

appear to be affected suggesting that the invasive flow lobe was emplaced after the first flow lobe was emplaced on top of the sandstone sequence. The invasive lobe thickens to the N along the quarry wall to ~3-4 m in thickness before thinning again at the far end of the quarry.

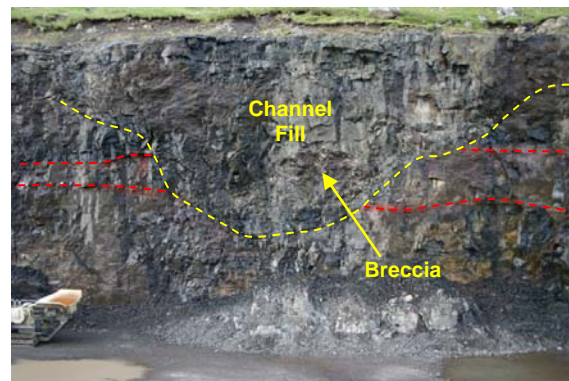


Fig. 131. View of an infilled channel that has cut down through the compound lava flows of the Malinstindur Formation, Hvítusteinar, Eysturoy.

Along the central section of the quarry face and ~7 m above the floor a channel is observed (Fig. 131). The channel is ~40 m wide and ~13 m deep and has cut down into ~5 m of the upper compound lava flow, the ~5 m thick section consisting of the sandstone and the invasive flow lobe and the uppermost ~3 m of the underlying compound lava flow. The channel has been infilled by flow lobes from the overlying compound lava flow, although the NW (right) side of the channel is composed of a breccia that is highly zeolitised. This breccia may have formed through the quenching and brecciation of the flow lobes as they infilled the water filled channel.

Stop 6.12: Vágur Sub-Sea Tunnel, Vestmannastrandir

Location

The Vágur Tunnel (*Váгатunnilin*) between Leynar, Streymoy and Stórabrúgv, Vágur (Fig. 82).

Introduction

Some general information shall be given about the Vágur sub-sea tunnel.

Description

The Vágur Tunnel (*Váгатunnilin*) was the first sub-sea tunnel on the Faroe Islands and was opened on 10 December 2002 and connects the islands of Vágur and Streymoy. The two-lane road tunnel is ~4.9 km long and ~10 m wide. Work commenced on the Streymoy side on 28 September 2000 and on the Vágur side on 27 February 2001 and cost DKK 302 million (~£27.6 million). An estimated total of 490,000 m³ of rock was blasted during the construction of the tunnel and ~1000 t of cement was used for fractures alone, where 800 t was used between the Streymoy entrance and the Stykkið dyke (Stop 1.6). The tunnel is primarily within the compound lava flows below the Kvívík Beds, Malinstindur Formation. The maximum slope in the tunnel is ~7% and at the lowest point the tunnel is ~105 m below sea level and the minimum thickness of bedrock above the tunnel is ~30 m. An emergency reservoir tank ~50 m long is situated at the base of the tunnel and can hold all the water that enters the tunnel for a period of 48 hours if the pumps should break down. The tunnel leaks ~100 l/min/km which is a third of the allowable leakage rate. The tunnel replaces the ferry

service between Oyrargjógv, Vágur and Vestmanna, Streymoy. The journey time between the airport and Tórshavn is now ~45 minutes where it previously took over 2 hours using the ferry and the total distance has been reduced by ~10 km.

Stop 6.13: Sørvágur Quarry, Vágur

Location

Sørvágur Quarry [NJ 8781 8396; ~10 m asl], ~700 m WNW of Sørvágur, Vágur (Fig. 15).

Introduction

This locality examines the internal structure of an inflated pahoehoe flow lobe from the Malinstindur Formation.

Description

Along the road leading from the quarry a ~4.12 m thick flow lobe forming part of a much larger, but poorly exposed, compound lava flow can be examined (Passey & Bell 2007). The flow lobe occurs inbetween two poorly exposed flow lobes and can be subdivided into three parts based on amygdale (infilled vesicle) distribution patterns. The basal ~12 cm can be defined as the lower crust containing ellipsoidal vesicles, which is overlain by a ~2.2 m thick, massive, irregularly jointed core that noticeably lacks vesicles. Occasionally, crude vertical amygdale cylinders can be observed. The core is overlain by a ~1.8 m thick upper crust that is amygdaloidal overall, but exhibits horizontal amygdale zones that range in size from a few centimetres to several tens of centimetres thick (Fig. 132). These amygdale zones comprise upper amygdale-rich and lower non-amygdaloidal divisions. Similar amygdale zones can be observed in the upper crust of the underlying flow lobe. At the entrance to the quarry the lower crust of the overlying flow lobe can be seen to comprise good examples of pipe amygdales that are up to 10 cm and curved in the assumed (localised) flow direction (Fig. 133).

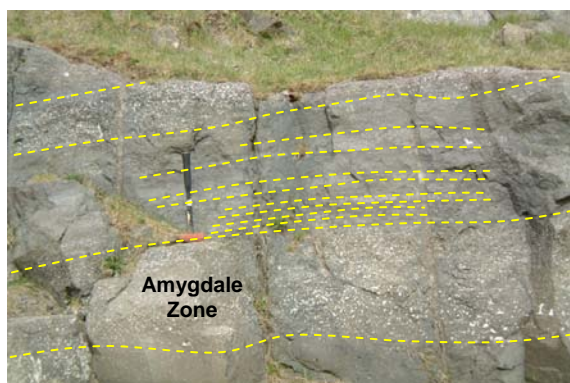


Fig. 132. View of the upper crust with amygdale zones from a ~4.2 m thick inflated flow lobe, Malinstindur Formation, Sørvágur Quarry, Vágur.

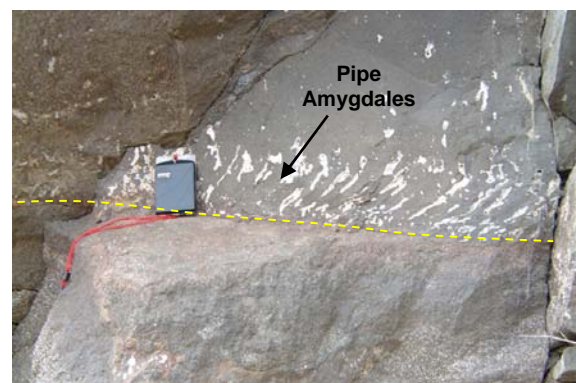


Fig. 133. View of pipe amygdales within the lower crust of an inflated flow lobe, Malinstindur Formation, Sørvágur Quarry, Vágur.

The subdivision of the flow lobe into three parts based on the amygdale distribution patterns and the presence of pipe amygdales along the bases of some flow lobes means that the flow lobes can be classified as pipe-bearing (P-type) pahoehoe. The amygdale distribution pattern also implies that the flow lobe was emplaced through the inflation mechanism and taking the upper crust thickness of ~1.8 m and applying it in the empirical equation of Hon *et al.* (1994), suggests that the flow lobe would have been active for ~22.2 days (Passey & Bell 2007).

Stop 6.14: Gásadalur, Vágur

Location

Cliff top [NJ 8141 8757; ~90 m asl], ~150 m SW of Gásadalur village, Vágur (Fig. 15).

Introduction

This last stop of the field excursions ends with the scenic views of Mykines, Gáshólmur and Tindhólmur islands.

Description

Gásadalur village is located on the top of the Beinissvørð Formation and the valley to the E of the village is within the claystone units of the Prestfjall Formation with the mountains behind composed of the compound lava flows of the Malinstindur Formation. The sheet lobes of the Beinissvørð Formation can clearly be seen along the coastline to the W of the village where they are commonly separated by extensive coaly claystone units, the precursors to the units of the Prestfjall Formation. The Prestfjall Formation is locally overlain by the Hvannahagi Formation, both of which, have been extensively intruded by irregular sills. This can be seen along the Bíggjarskor cliffs to the SE of the village. Looking to the W, across Mykinesfjørður, the island of Mykines can be seen ~4-5 km away (Fig. 134). The ~560 m high island is composed exclusively of the Beinissvørð Formation and the sheet lobes of the formation can be observed to dip steeply down to the SE. The island covers an area of ~10 km² and in January 2008, ~18 people lived in the only village at the western end of the island (Hagstova Føroya 2008). Gáshólmur and the western side of Tindhólmur can also be seen to the S of Gásadalur (Fig. 134). Gáshólmur is ~61 m high and is composed entirely of sheet lobes of the Beinissvørð Formation. Tindhólmur is ~262 m high and is composed dominantly of compound lava flows of the Malinstindur Formation overlying the intruded units of the Prestfjall Formation and uppermost sheet lobes of the Beinissvørð Formation.



Fig. 134. View of the S side of Mykines, Gáshólmur and Tindhólmur islands from Kvívíksskoranøva, Vágur.

Day 7 – Friday, 22 August 2008

Introduction

The previous evening, Thursday, 21 August the group will have stayed at the 62°N airport hotel (Hotel Vágar), which is ~300 m away from the airport terminal. Therefore, it is a short walk from the hotel this morning to check-in by 06:30 to catch the 07:30 Atlantic Airways flight (RC450) to Copenhagen, Denmark. The flight is due to arrive in Copenhagen at 10:45 and members of the group travelling onto Oslo shall transfer for the 14:15 Scandinavian Airlines flight (SK460) that is expected to arrive in Oslo at 15:25.



Atlantic Airways helicopter in front of Malinstindur Formation compound lava flows, Nakkur, Suðuroy.

Acknowledgements

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StatoilHydro Faroes A/S offices, Tinganes, Tórshavn, Streymoy.

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Winter sunrise over Nólsoy.