Paleomagnetic stratigraphy of the Mosfellssveit area, SW-Iceland : a pilot study

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ABSTRACT

A pilot stratigraphical study has been carried out of the basalt lava and hyaloclastite pile between Gufunes and Hafrahlíð in the Mosfellssveit area, Southwest Iceland, using paleomagnetic remanence polarities for correlation. About 200 units, mostly lavas, were sampled and measured for this purpose. Due to inadequate outcrops and to tectonic disturbances, the results are not entirely satisfactory, especially as regards the usefulness of the remanence data for geomagnetic secular variation studies. We provide descriptions and maps of the sampling profiles used in constructing a tentative polarity column for the area, which is predominantly of reverse polarity corresponding to the Matuyama geomagnetic chron. Two normal-polarity intervals in the lava pile are correlated with similar zones in the nearby Mt. Esja. There is evidence of at least eight glaciations in the area.

INTRODUCTION

A large number of paleomagnetic projects have been undertaken in Iceland in the last thirty years, mostly in conjunction with stratigraphic mapping efforts. Among these is the study of Kristjánsson et al. (1980) in the Esja-Akrafjall area of SW-Iceland, where K-Ar dating substantiated earlier suggestions that the Esja volcanism is of Lower to Middle Matuyama age. Further confirmation of the age estimates of Kristjánsson et al. (1980) has recently been provided by K-Ar dates quoted by Geirsdóttir (1991). The presence of two normal geomagnetic polarity zones in the Esja succession was also confirmed, the older one of which is the "N3" of Einarsson (1957). Kristjánsson et al. (1980) were, however, unable to determine whether it should be correlated with the Olduvai or the Reunion subchron but they favoured the latter.

Knowledge of the Quaternary geology of the region from Reykjavík to Esja is potentially of some economic importance, since aquifers at 1–2 km depth in the region provide geothermal heating for a population of approx. 130,000. A map of its surface geology has been available (Tryggvason and Jónsson 1958) but it is indeed remarkable that no stratigraphic work has been published up to now. Paleomagnetic polarity determinations on lava samples in outcrops and geothermal drill cores were made by the late Th. Sigurgeirsson around 1954 according to his notebooks in our possession, but the results were not written up in detail. Some parts of the region were mapped by geology students (e.g. theses by Torfason 1974, Theodórsdóttir 1972, Thors 1969,1974).

The present paleomagnetic project was initiated in 1972 by sampling in profile UL and was gradually

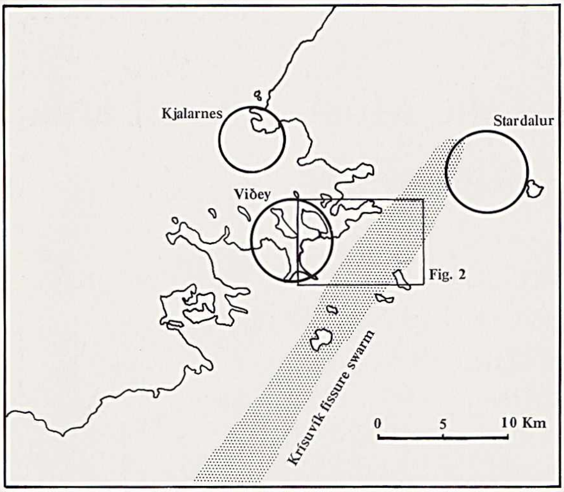

Fig. 1. Geological setting of the Mosfellssveit region. Circles are extinct central volcanoes and the dotted zone represents the active Krísuvík fissure swarm. – *Megindrættir í jarðfræði Mosfellssveitar.*

extended, in an attempt to construct a composite section from the Gufunes peninsula to the Hafrahlíð hill and to correlate the area with the above-mentioned study in Mt. Esja. Uncertainties in the mapping during its initial stages have resulted in considerable stratigraphic overlap between some of the profile segments we sampled.

GEOLOGICAL SETTING

The Mosfellssveit area (approx. position 64.15°N, 21.7°W) south of Mt. Esja is adjacent to the Reykjanes-Langjökull active rift zone. The geology of the area is dominated by three extinct central volcanoes of Gauss to Lower Matuyama (i.e. about 3.0–1.8 M.y.) age. They are named Kjalarnes, Viðey and Stardalur volcanoes (Fig.1). The Kjalarnes and Stardalur volcanoes have been described by Friðleifsson (1973, 1985) and the Viðey volcano by Jóhannesson (1985). Each of these was associated with a NE-SW trending swarm of dykes, faults and fissures.

The succession consists predominantly of series of interglacial lava flows and subglacial hyaloclastites, intercalated with minor tillites and detrital beds. The lavas are generally thin, of the order of 5 m as compared with an average of 12 m in older parts of Iceland (Walker 1959). This may reflect the proximity of the Mosfellssveit area to the source volcanoes.

The lava pile has been tilted towards the southeast, i.e. towards the present volcanic zone. The amount of dip is quite variable, from a few degrees up to about 30. Superimposed on this old tectonics is a more recent tectonic activity associated with the Krísuvík fissure swarm (Fig. 1) which stretches towards NE from the active Krísuvík volcanic system. The trend of the recent faults and fissures is more or less the same as that of the older faults.

The most common secondary mineral in the succession is chabazite, but analcime also occurs along with chalcedony, opal, calcite and clay minerals. Scolecite was not found during our field work.

The original pile has been heavily eroded by later glaciations, which have left a landscape of wide valleys and low (< 300 m) hills. Parts of the area are largely covered by interglacial lava flows of Late Brunhes age, which were not studied here, and by postglacial detritus. Continuous profiles are accessible only in sections along the coast, in streams and in cliffs. The poor exposures and the large number of normal faults make detailed correlations difficult.

THE MAPPED SUCCESSION AND ITS CORRELATION WITH MT. ESJA

Twelve profiles were mapped and sampled for this study (Figs. 2, 3). Their cumulative thickness between the Gufunes promontory and the top of the Hafrahlíð hill is about 800 m.

The lava flows were classified according to Walker´s (1959) classification system into four types, i.e. olivine basalt, porphyric basalt, tholeiite and compound flows. It should be noted that this system is based only on field observations of lava lithology : petrographic or geochemical analyses were not made in the present study. No units of acidic or intermediate composition were noted in our profiles, but boulders of rhyolite in unit UA 19 in Úlfarsfell are thought to be derived from the subglacial rhyolites erupted on both the northern and southern rim of the

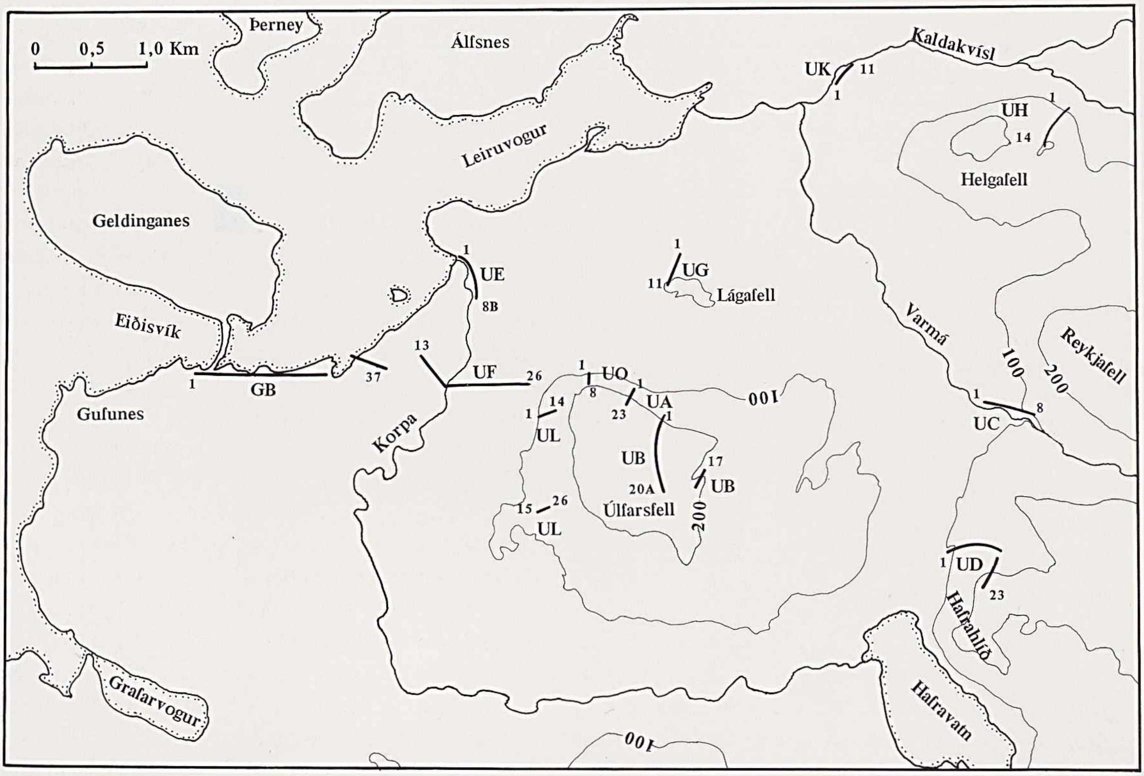

Fig. 2. Location of stratigraphic/paleomagnetic profiles in Mosfellssveit. – *Staðsetning sniða vegna kortlagningar og sýnatöku.*

nearby Stardalur caldera (Friðleifsson 1985). The flows are often intercalated with sedimentary beds, most commonly thin red partings but thicker sediments are also found, tillites as well as tuffaceous and silt beds.

In this paper the succession is divided into 8 series (Fig. 4), four predominantly of basalt lavas and four of hyaloclastite and sediments. The division is based on the paleomagnetic polarity of the volcanics as well as on their lithology. It should be noted that the paleomagnetic polarities of hyaloclastites, given below, are only based on measurements in the field.

a) The Gufunes hyaloclastite is the lowermost exposed series in the area. It is found in Gufunes, in a borehole at the Korpa river (Smárason et al. 1985) and north of the Kaldakvísl river. It is presumably reversely magnetized. Its thickness is uncertain, but it is at least 250 m thick in a borehole in Gufunes (see Tómasson et al. 1977) and the thickness of corresponding series in Esja ranges from 5 to 300 m (Unit 18 of Friðleifsson 1973). Jóhannesson (1985) suggested that the Gufunes hyaloclastite was a part of the caldera filling of the Viðey volcano.

b) The Eiðsvík basalt series consists predominantly of coarse-grained compound lava flows at least 20 m thick and normally magnetized. It is exposed at the head of Eiðsvík as well as at the south coast of Leiruvogur and along the southern bank of the Kaldakvísl river. In Esja, this series ranges in thickness from 10 to 200 m (Unit 19 of Friðleifsson 1973).

c) The Korpúlfsstaðir basalt series is reversely magnetized, and its cumulative thickness is about 350 m. It consists predominantly of tholeiitic lava flows but includes a pronounced unit of compound lava flows which ranges in thickness from 30 m in the western part of the area up to 80 m in Helgafell in the

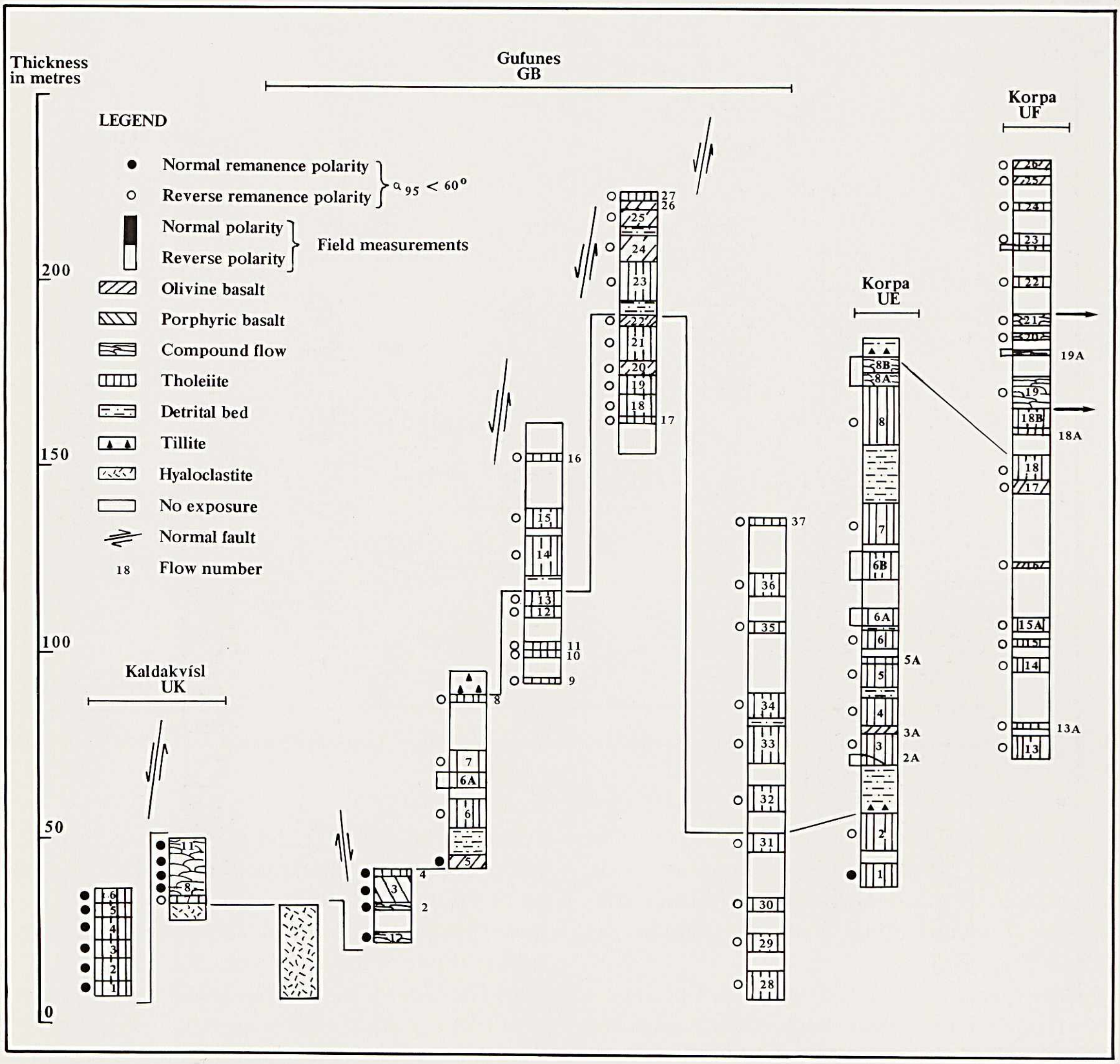

Fig. 3a. Stratigraphy of sampled section of the Mosfellssveit region including correlations and paleomagnetic polarity. – *Jarðlagasnið sem sýnum var safnað úr í Mosfellssveit.*

eastern part. A unit of thin tholeiite flows in the uppermost part of the series presumably represents the flank succession of the Stardalur volcano. This series corresponds to Units 22 and 24 in Esja (Friðleifsson 1973).

d) The Lágafell hyaloclastite which occurs within the Korpúlfsstaðir series, is reversely magnetized. It is about 40–50 m thick in Lágafell and along the Varmá river but truncates towards west and north. It is found to be 15–20 m thick in a borehole east of Borgarholt (Tulinius et al. 1986). It is probably the same as Unit 23 in Esja.

e) The Úlfarsfell basalt series is normally magnetized and about 120 m thick. It is composed of

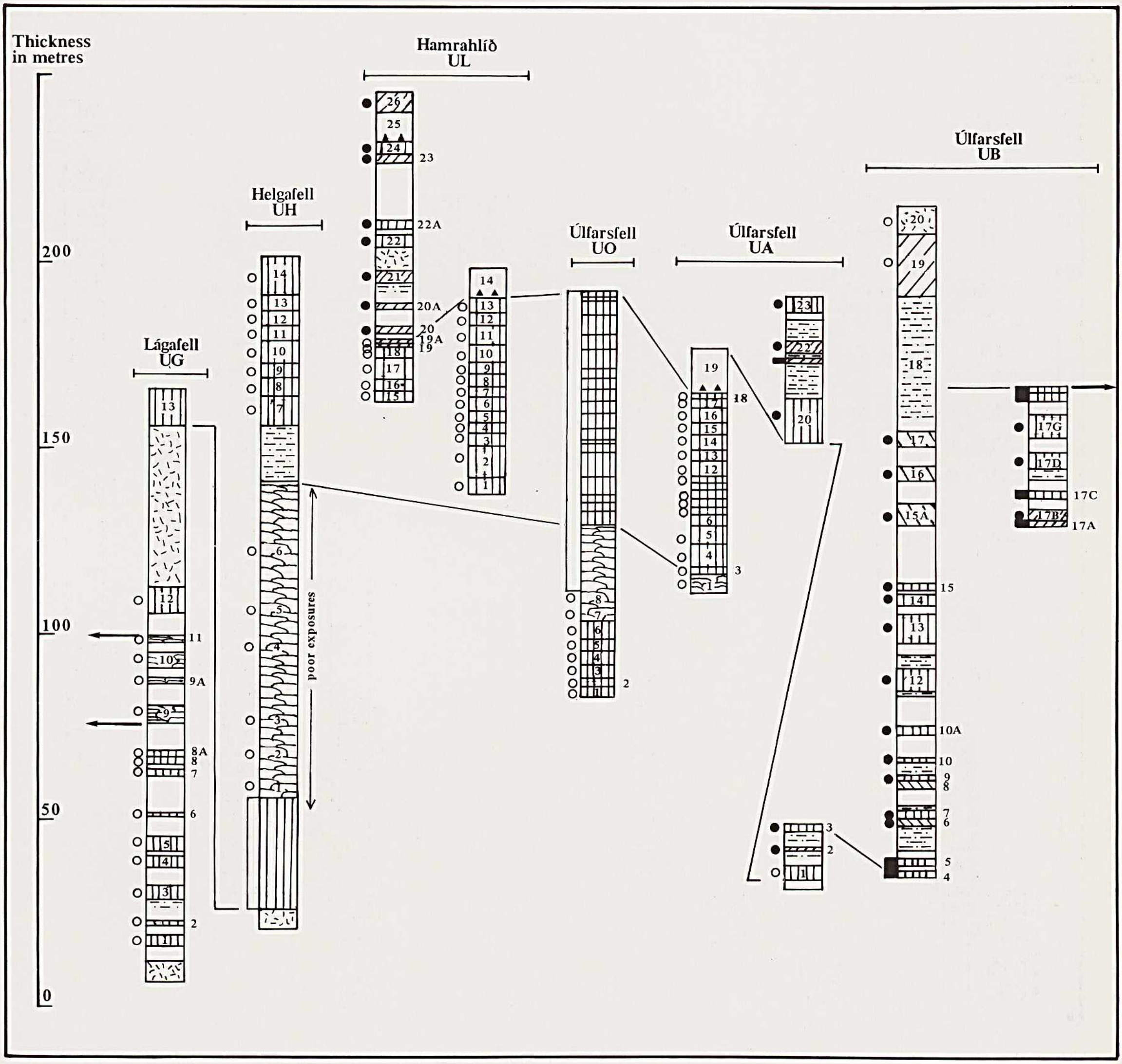

Fig. 3b.

tholeiitic and porphyric flows and the lower part of the series is intercalated with a few relatively thick tuffaceous sedimentary beds. This series corresponds in age to Units 25 and 26 in the Esja region.

f) The Stórihnúkur hyaloclastite seems to be mostly reversely magnetized. Its thickness is at least 60 m. The lower part is dominated by well stratified silt and sandstones but the upper part comprises irregular columnar jointed flows and hyaloclastites. We consider this series as well as the two that follow, to be stratigraphically above the Esja succession described by Friðleifsson (1973) and Kristjánsson et al. (1980).

g) The Borgardalur basalt series is reversely magnetized and is about 130–140 m thick. Its lower part

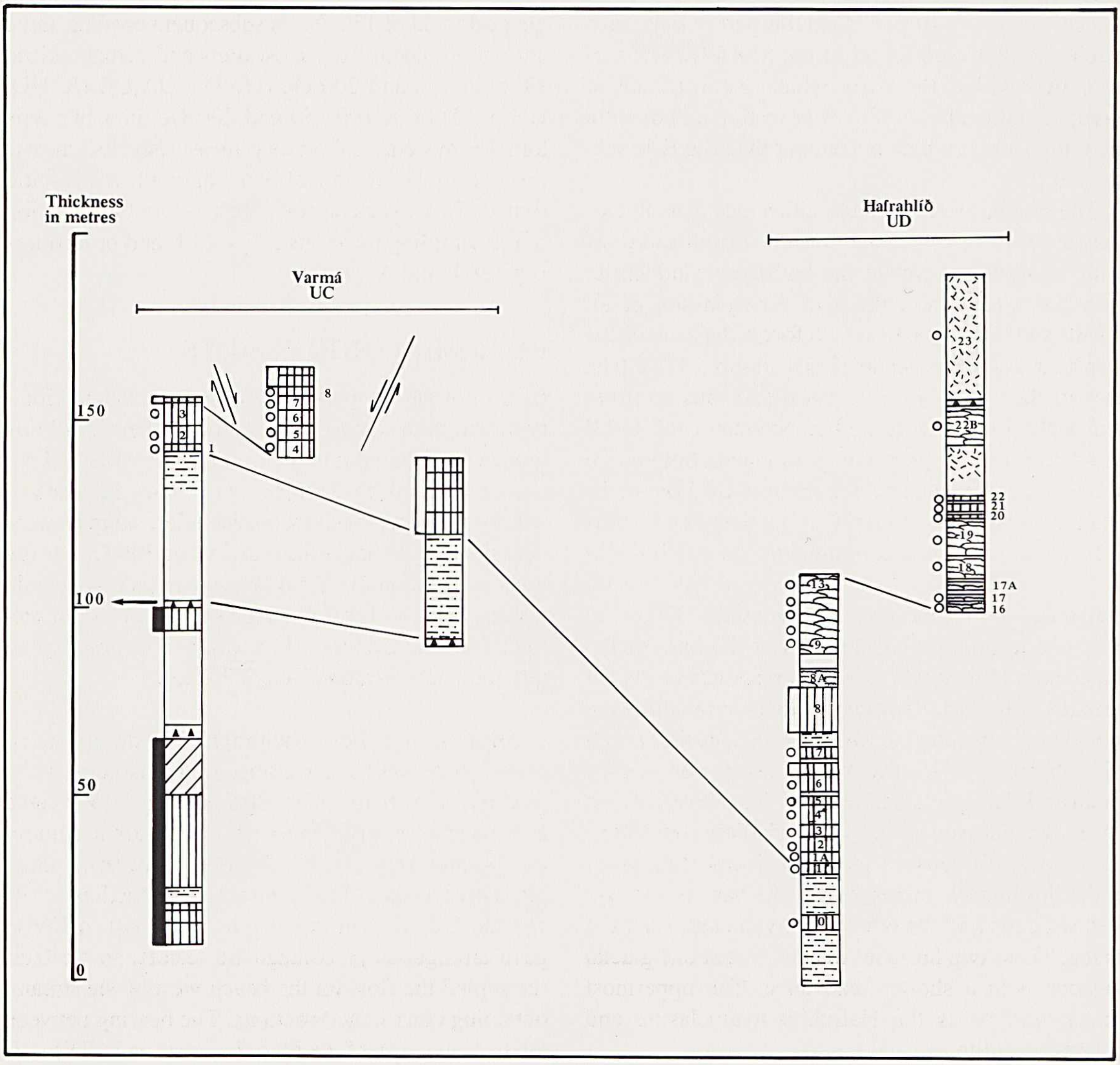

Fig. 3c.

consists of relatively thin tholeiite flows but its upper part of coarse-grained compound lavas.

h) The Hafrahlíð hyaloclastite is at least 35 m and is reversely magnetized.

Several minor gaps and other stratigraphical uncertainties may still remain in this composite section. We have not mapped in detail or sampled some parts of the Mosfellssveit-Reykjavík area including Viðey, Æsustaðafjall, Reykjafell and Grímmannsfell.

GLACIATIONS

In the composite Esja/Eyrarfjall section of Kristjánsson et al. (1980), we consider the part above flow SB

22 to correlate with the lower and middle parts of our Mosfellssveit section. There are indications of three glaciations (no. 9, 10 and 11) in this part of Esja. Five glacial horizons are found in the Mosfellssveit section, two within the parts which we correlate to Kristjánsson et al.´s (1980) Esja section and three in the topmost part which is younger than the Esja succession.

The glacial horizons may either occur as hyaloclastite series of subglacial volcanic origin and/or as tillite beds. We correlate the Gufunes hyaloclastite with the glacial horizon 9 of Kristjánsson et al. (1980) and Esja Unit 18 which forms the base of the Stardalur central volcano (Friðleifsson 1973). The base of the series is not exposed and thus no tillite bed is observed. The tillite bed between lavas GB 8 and 9 corresponds presumably to glacial horizon 10 in Esja. The tillite bed resting on flow UE 8B and the Lágafell hyaloclastite seems to have no counterpart in Esja other than two conglomerate beds (SB 46/49 and SB 61/62) which Kristjánsson et al. (1980) suggested may represent separate glaciations. The tillite bed seen in profiles UL and UA at the base of the upper normal magnetic event corresponds to glacial horizon 11 in Esja. Rhyolite boulders in the tillite are thought to correspond to rhyolite hyaloclastites erupted subglacially in Móskarðshnúkar and Grímmannsfell during glaciation 11 of Esja (Friðleifsson 1973, Kristjánsson et al. 1980, Friðleifsson 1985). Two apparently separate glacial horizons occur within the Stórihnúkur series, one at the base of the layered silt beds and the other as a hyaloclastite unit at its top. These two horizons may represent one glacial advance with a shorter readvance. The uppermost glacial horizon is the Hafrahlíð hyaloclastite and underlying tillite.

PALEOMAGNETIC METHODS

2.5-cm core samples were collected using portable drills and oriented as described by Kristjánsson et al. (1980). All profiles are numbered upwards from the base; the suffixes A, B etc. indicate outcrops which were located after the initial mapping and which may represent separate units. Some thin, inaccessible, poorly exposed, or crumbly flows were not sampled. In the first profile (UL), two cores were generally taken from each unit and AF-demagnetized at a single peak field of 150 Oe. In subsequent profiles, three cores were taken from most units and demagnetized either at 100 and 200 Oe (profiles UA,UB,UC,UD, UH 6–15) or at 100,150 and 200 Oe, in a two-axis tumbler system. Laboratory measurements, mostly done at the University of Iceland, employed a static four-probe fluxgate arrangement. A brief description of the sampling locations (Figs. 2, 3) and procedures is given in the Appendix.

PALEOMAGNETIC RESULTS

In most of the samples it was easy to isolate a primary direction of remanence; the mean intensity of this remanence is similar to the averages for other collections published by Kristjánsson (1984). In cases of within-unit directional inconsistencies, samples were occasionally demagnetized at 250 or 300 Oe, or the units were resampled. All lava-mean paleomagnetic results, listed in Table 1, have been corrected for tectonic tilt. The amount of tilt which is assumed to be due southeast, is also given in Table 1.

Stratigraphy. For stratigraphic work, the most useful paleomagnetic parameter in this case is the polarity, shown for each flow in Fig. 3. We have attempted to set up a composite stratigraphic column for the area (Figs. 4, 5). An N to R reversal takes place near the bottom of the composite section, at GB 5/6 and UE 1/2. The outcrop of UE 1 east of Korpa gave ambiguous paleomagnetic results, so we later resampled the flow on the beach west of the stream, obtaining consistent directions. The bearing between the two outcrops of the N to R transition is ENE (cf. Fig. 4) rather than NE, suggesting the presence of complications such as an unconformity or a set of large faults.

We propose that the normal-polarity lavas correlate with Einarsson´s (1957) N3 zone which is of variable thickness in the Hvalfjörður area, but Einarsson gives a mean thickness of 50 m. In the Kistufell profile SB of Kristjánsson et al. (1980) flows no. 24–36 belong to this zone. The flow UK 7, which has a transitional magnetic direction (Table 1),

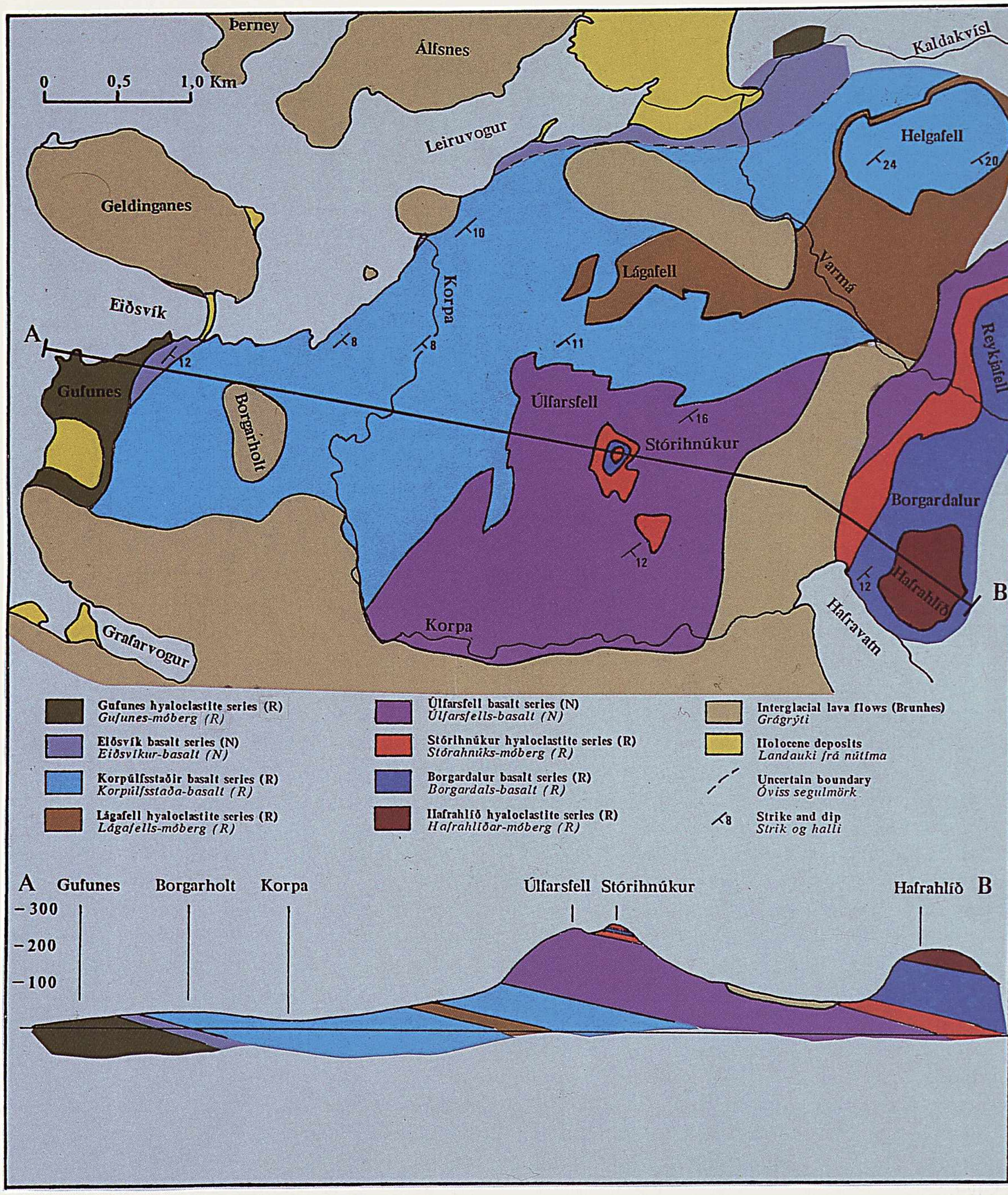

Fig. 4. Simplified paleomagnetic and geological map of the Mosfellssveit region along with a transection of the mapped lava pile. – *Einfaldað jarðfræðikort af Mosfellssveit, ásamt þversniði af jarðlögum.*

may be at the bottom of the normal zone in the Mosfellssveit area, but this direction does not fit the pole path found by Sigurgeirsson (1957 ; Kristjánsson and Sigurgeirsson 1992) for the R3-N3 transition in lavas in Hvalfjörður. It is therefore possible e.g. that UK 7 belongs to a geomagnetic excursion within N3.

The lowermost zone of normal-polarity lavas is followed by the relatively thick reverse lava series in the remainder of GB and UE as well as in UF. Continuous outcrops in this series end at the foot of Úlfarsfell due to scree, but we consider that profile UH covers the stratigraphic gap below the cliff profile UO in Úlfarsfell.

Most of the upper part (UB) of Úlfarsfell is of normal magnetization, which may correspond to the Olduvai subchron or possibly the elusive Gilsá subchron of approx. 1.6 M.y. age. We correlate this zone with the youngest normal zone in Esja, occurring in intrusions and hyaloclastites in the Svínaskarð (Móskarðshnúkar) profile SC of Kristjánsson et al. (1980) and in other late products of the Stardalur central volcano (Friðleifsson 1973, 1985).

The very top of Úlfarsfell (Stórihnúkur peak), as well as profile UD, is reversely magnetized. The pattern of easterly declinations of remanence in UC 2 – 8 is remarkably similar to that in UD 1 – 5 (or 7) , and the inference that they are contemporaneous agrees well with the geological strike. In a more detailed survey of the Úlfarsfell area, it may become possible to correlate other small groups of lavas, or even individual lava units, over some distance with the aid of their paleomagnetic directions and other characteristics, for example between the profiles UL and UA/UB.

Secular variation. Despite generally close within-unit directional agreement (95% confidence angles < 10° in Table 1), the lavas described here are much less satisfactory material for paleomagnetic secular variation studies than are other lava sequences described so far from Iceland. The reasons for this are mostly geological :

a) Tectonic tilt is quite large, with a correspondingly large uncertainty.

b) Outcrops are not very good, possibly causing repeated sampling of the same flow in some instances, such as in the flat-lying Gufunes profile GB.

c) Undetected faults, and lack of traceable horizons (such as extensive tuffs or petrographically distinct lavas) may have caused duplicate sampling of a few lavas in adjacent profiles or even within the same profile: thus, the similar remanence directions in lavas GB 8, 12/13, 21 and 32/33 indicate that there are repeated segments (see Fig. 3). Similarly, the sites UB 13,14,15 and UB 15A,16,17 may actually represent the same three (or two) flows.

d) Relatively close grouping of directions in two to several successive lavas is common; it does not appear to be due to secondary regional remagnetization. Examples include UC 2–8 as pointed out above, UF 13–16, UD 10–20 and even UH 3–14. This serial correlation indicates that each such group of lavas was erupted in a short episode compared to secular variation time scales.

For these reasons, we feel it is not appropriate at this stage to state any mean paleomagnetic directions or between-lava angular statistics for our collection.

CONCLUSIONS AND DISCUSSION

We have mapped a composite 800 m thick section along a stretch of approximately 8 km from Gufunes to Hafrahlíð in the Mosfellssveit area. The section is mostly of reverse magnetization and most probably of Lower Matuyama age, somewhere in the range 1.6 to 2.2 million years. A normally magnetized zone of a few tens of m thickness overlies hyaloclastite at the base of the profile, and another normally magnetized zone of over 100 m thickness is found in the upper part of Úlfarsfell. We correlate (Fig. 5) the lower normal zone with Einarsson´s N3 zone in Kistufell and other locations farther east, and the upper zone with the final phase of the Stardalur volcano. These may correspond in time respectively to the Reunion and Olduvai subchrons, but additional radiometric dates in the area are needed to test this suggestion.

The publication of the present pilot study is intended to stimulate further interest in the mapping of stratigraphy and structure in the Kjós-Mosfellssveit-Reykjavík region. This mapping can be done

LAVA	N	D	I	LON	LAT	ALF	J100	POL
UO	N-ULFARSFELL							
UO 1	4	244	-80	205	-66	4	3.0	R
UO 2	3	159	-76	77	-81	5	3.1	R
UO 3	4	168	-73	33	-83	5	3.1	R
UO 4	3	160	-69	29	-74	8	4.2	R
UO 5	3	166	-72	30	-80	11	2.6	R
UO 6	3	163	-65	14	-70	8	2.7	R
UO 7	3	171	-69	6	-78	8	1.6	R
UO 8	3	169	-68	8	-76	8	6.7	R
UA	N-ULFARSFELL							
UA 1	4	132	-59	50	-53	9	2.5	R
UA 3	3	130	-59	53	-52	10	1.1	R
UA 4	3	129	-64	60	-57	7	1.2	R
UA 5	3	128	-74	84	-66	6	0.7	R
UA 8	5	173	-75	46	-87	5	0.9	R
UA 9	3	147	-81	121	-75	3	1.4	R
UA 11	3	175	-80	142	-84	6	0.8	R
UA 12	3	169	-75	49	-84	7	1.4	R
UA 13	3	173	-78	116	-85	5	1.1	R
UA 14	3	150	-74	64	-75	6	1.0	R
UA 15	3	148	-76	79	-76	10	1.5	R
UA 16	3	181	-77	177	-88	6	2.8	R
UA 17	4	161	-79	111	-81	4	1.4	R
UA 18A	3	172	-81	139	-82	6	1.3	R
UA 20	3	60	+83	10	+68	3	4.0	N
UA 22	3	299	+76	274	+64	4	0.8	N
UA 23	4	301	+80	289	+67	7	3.8	N
UB	ULFARSFELL , UPPER PART							
UB 1	3	163	-75	53	-82	4	2.4	R
UB 2	3	318	+80	289	+73	6	1.7	N
UB 3	3	318	+80	290	+73	5	4.2	N
UB 6	3	297	+69	259	+57	9	1.4	N
UB 7	3	298	+71	263	+60	8	1.7	N
UB 9	4	321	+77	269	+73	10	4.3	N
UB 10	3	297	+71	262	+59	5	3.2	N
UB 11	4	299	+73	265	+61	5	2.9	N
UB 12	3	326	+77	269	+76	4	6.2	N
UB 13	5	334	+80	293	+78	4	1.0	N
UB 14	4	142	+81	355	+49	8	0.9	N
UB 15	3	129	+70	12	+35	6	1.3	NT
UB 15A	5	348	+80	307	+82	2	6.7	N
UB 16	3	132	+70	10	+34	5	0.9	NT
UB 17	3	134	+64	12	+26	3	0.6	NT
UB 17B	5	275	+81	299	+60	14	2.8	N
UB 17D	5	297	+68	256	+55	5	3.4	N
UB 17G	4	337	+72	224	+76	6	4.8	N
UB 19	4	186	-70	317	-79	4	0.8	R
UB 20	5	193	-61	314	-66	3	12.5	R
UB 20A	2	324	-46	190	-06	(10)	8.5	E
UC	VARMA							
UC 1	4	182	-68	333	-78	4	2.8	R
UC 2	4	77	-77	119	-51	2	3.8	R
UC 3	3	85	-79	119	-56	6	3.0	R
UC 4	3	92	-75	106	-53	2	6.0	R
UC 5	3	68	-77	123	-49	5	5.0	R
UC 6	5	25	-82	148	-49	9	3.6	R
UC 7	3	52	-76	129	-43	7	4.0	R
UC 8	3	44	-83	142	-53	5	3.1	R
UD	HAFRAHLID							
UD 0	3	156	-58	20	-61	9	2.2	R
UD 1	3	64	-78	126	-47	9	6.0	R
UD 1A	3	70	-81	128	-54	8	3.0	R
UD 2	4	56	-77	129	-46	9	5.7	R
UD 3	4	57	-80	132	-50	5	5.7	R
UD 4	3	48	-77	133	-45	7	6.5	R
UD 5	4	39	-72	134	-35	4	4.7	RT
UD 6	3	22	-80	148	-46	5	3.0	R
UD 7	4	15	-83	152	-50	8	7.2	R
UD 8	5	PILLOWS				>60	9.9	(R?)
UD 9	4	126	-78	98	-68	3	7.6	R
UD 10	3	93	-77	110	-56	4	2.8	R
UD 11	3	73	-74	115	-46	3	2.4	R
UD 12	3	91	-82	124	-60	4	3.0	R
UD 13	3	98	-82	124	-62	3	6.9	R
UD 14	4	83	-81	124	-57	9	4.7	R
UD 15	3	89	-80	120	-58	7	3.2	R
UD 16	3	94	-79	115	-58	5	3.0	R
UD 17	4	75	-84	136	-59	4	2.2	R
UD 18	3	95	-78	111	-57	7	2.3	R
UD 19	4	95	-79	115	-59	4	2.2	R
UD 20	3	102	-79	112	-60	4	1.6	R
UD 21	3	128	-61	57	-53	3	1.4	R
UD 22	3	130	-64	59	-57	8	1.3	R
UD 23	4	204	-70	277	-74	5	3.6	R

LAVA	N	D	I	LON	LAT	ALF	J100	POL
GB	GUFUNES							
GB 1	3	325	+67	226	+66	3	0.7	N
GB 2	3	336	+67	211	+71	5	2.2	N
GB 3	3	327	+64	219	+64	11	0.4	N
GB 4	3	328	+67	224	+68	5	2.2	N
GB 5	3	329	+68	224	+69	5	1.1	N
GB 6	3	202	-71	275	-76	9	4.3	R
GB 7	4	206	-75	251	-78	10	2.6	R
GB 8	3	129	-66	62	-59	3	1.3	R
GB 9	3	178	-75	3	-87	8	6.3	R
GB 10	4	182	-76	308	-88	3	3.2	R
GB 11	3	129	-77	95	-69	10	4.3	R
GB 12	4	116	-61	68	-48	3	3.4	R
GB 13	3	116	-62	70	-50	4	4.7	R
GB 14	3	162	-67	21	-72	9	2.3	R
GB 15	4	160	-66	22	-70	9	1.6	R
GB 16	3	214	-69	265	-69	5	3.1	R
GB 17	4	220	-72	251	-69	7	3.6	R
GB 18	3	204	-73	266	-77	5	2.4	R
GB 19	3	121	-80	110	-67	4	4.0	R
GB 20	3	133	-77	93	-70	3	7.8	R
GB 21	3	120	-70	77	-59	2	2.3	R
GB 22	4	155	-79	107	-79	5	6.6	R
GB 23	3	185	-74	302	-86	3	17.0	R
GB 24	3	171	-68	3	-76	4	2.7	R
GB 25	4	146	-73	64	-73	3	3.6	R
GB 27	3	162	-73	44	-80	6	6.2	R
GB 28	3	187	-66	322	-73	8	1.5	R
GB 29	3	188	-73	300	-83	5	3.8	R
GB 30	3	176	-71	353	-82	7	4.3	R
GB 31	3	115	-65	73	-51	6	19.4	R
GB 32	3	138	-67	55	-63	4	2.2	R
GB 33	3	156	-73	51	-77	5	2.1	R
GB 34	3	148	-66	41	-67	5	1.8	R
GB 35	3	156	-70	39	-74	5	2.6	R
GB 36	3	146	-64	40	-64	8	1.2	R
GB 37	3	151	-65	35	-67	5	1.5	R
UE	KORPA							
UE 1	5	32	+67	95	+67	3	4.8	N
UE 2	3	149	-52	25	-53	9	2.0	R
UE 3	4	165	-75	61	-83	4	2.5	R
UE 4	3	146	-69	49	-69	3	4.2	R
UE 5	3	156	-69	37	-73	4	2.6	R
UE 6	3	154	-62	26	-65	5	3.2	R
UE 7	3	168	-71	20	-80	3	2.1	R
UE 8	3	156	-69	35	-73	2	6.3	R
UE 15	3	197	-67	297	-73	3	0.9	R
UF	KORPA							
UF 13	3	153	-65	31	-67	8	2.5	R
UF 13A	3	153	-65	31	-67	7	2.2	R
UF 14	4	151	-68	42	-70	6	3.7	R
UF 15	3	153	-60	25	-62	3	4.0	R
UF 15A	4	155	-65	29	-68	4	6.0	R
UF 16	4	152	-62	29	-64	2	2.5	R
UF 17	4	176	-73	357	-83	7	8.0	R
UF 18	4	167	-72	26	-81	5	3.4	R
UF 19	4	168	-66	7	-72	3	15.9	R
UF 20	3	193	-64	311	-70	4	19.7	R
UF 21	3	181	-71	335	-81	6	11.9	R
UF 22	3	182	-78	178	-88	6	5.5	R
UF 23	3	187	-70	317	-79	4	2.1	R
UF 24	3	187	-68	319	-77	4	1.9	R
UF 25	4	177	-69	347	-79	4	2.6	R
UF 26	3	175	-69	354	-78	4	11.6	R
UF 27	3	160	-71	37	-77	8	4.1	R
UF 28	3	161	-69	26	-75	4	3.1	R
UF 29	3	147	-68	47	-69	2	2.5	R
UF 30	4	237	-83	190	-69	3	2.8	R
UF 30X	2	157	-70	36	-75	(14)	4.2	R
UG	LAGAFELL							
UG 1	3	161	-67	22	-72	3	2.7	R
UG 2	3	166	-69	16	-76	8	3.6	R
UG 2A	3	158	-72	46	-77	3	3.1	R
UG 3	3	217	-80	209	-75	6	6.3	R
UG 4	3	183	-82	163	-80	1	7.3	R
UG 5	3	167	-82	140	-79	1	9.6	R
UG 6	3	177	-78	131	-87	4	14.7	R
UG 7	4	195	-72	286	-80	5	9.0	R
UG 8	4	184	-72	321	-82	5	3.8	R
UG 8A	4	194	-68	301	-75	4	24.6	R
UG 9	4	194	-73	281	-82	5	12.3	R
UG 10	3	201	-67	292	-72	6	7.2	R
UG 11	4	175	-67	351	-75	5	5.4	R

	UK	KALDAKVISL							
UK	1	3	358	+70	166	+80	6	1.5	N
UK	2	3	11	+72	117	+81	23	1.0	N
UK	3	4	351	+73	201	+83	7	0.9	N
UK	4	3	3	+67	152	+76	5	3.6	N
UK	5	3	9	+69	130	+78	5	1.4	N
UK	6	3	49	+65	77	+59	6	1.6	N
UK	7	4	135	-40	36	-39	7	1.3	RT
UK	8	3	42	+76	50	+72	6	2.0	N
UK	9	3	28	+73	80	+75	6	1.9	N
UK	10	3	37	+74	65	+72	8	1.5	N
UK	11	4	35	+75	60	+74	3	0.6	N
	UH	HELGAFELL							
UH	1	3	NEAR INTRUSIONS						(?)
UH	2	3	NEAR INTRUSIONS						(?)
UH	3	3	177	-77	126	-88	11	6.1	R
UH	4	3	200	-79	206	-81	11	4.9	R
UH	5	4	233	-70	245	-62	3	1.5	R
UH	6	3	227	-70	249	-65	13	19.3	R
UH	7	3	212	-72	259	-72	10	0.2	R
UH	8	3	198	-73	277	-79	3	5.3	R
UH	9	4	192	-74	276	-83	5	5.2	R
UH	10	3	202	-74	261	-79	10	4.8	R
UH	11	3	186	-75	285	-86	8	1.1	R
UH	12	3	176	-75	23	-87	6	4.8	R
UH	13	3	192	-74	274	-84	4	3.9	R
UH	14	4	199	-73	272	-79	3	5.2	R
UH	15	4	VIGHOLL THREE N, ONE R CORE						(N?)

TILT CORRECTIONS (ALL WITH DOWN-DIP = 135'ETN)
GB 1-27,UA,UB,UL,UC,UD 12 DEG.
GB 28-37,UE,UF,UG 8 DEG UK 18 DEG UH 20 DEG

	UL	NW-ULFARSFELL (HAMRAHLID) 1972							
UL	1	2	139	-50	35	-48	(16)	0.7	R
UL	2	2	106	-49	68	-34	(30)	0.9	RT*
UL	3	2	125	-61	59	-52	(14)	1.1	R
UL	4	3	148	-68	44	-69	13	1.1	R
UL	5	2	158	-74	57	-79	(4)	0.8	R
UL	6	2	159	-77	79	-81	(11)	1.0	R
UL	7	2	139	-77	90	-73	(7)	1.1	R
UL	8	2	154	-76	74	-78	(5)	1.2	R
UL	9	2	132	-79	101	-71	(7)	0.8	R
UL	10	2	162	-75	62	-82	(3)	1.1	R
UL	11	3	174	-79	130	-85	3	1.4	R
UL	12	3	134	-84	131	-71	9	1.2	R
UL	13	3	161	-77	86	-82	6	0.8	R
UL	14	4	TILLITE				>60	1.4	(?)
UL	15	4	154	-79	106	-79	10	1.8	R
UL	16	3	165	-76	66	-83	8	1.2	R
UL	17	3	105	-85	133	-65	13	0.8	R
UL	18	3	179	-78	147	-88	15	0.9	R
UL	19	2	157	-75	62	-79	(25)	1.0	R*
UL	19A	3	26	-70	141	-30	12	3.3	RT
UL	20	4	204	+80	327	+46	6	3.5	N
UL	21	2	179	+62	339	+17	(7)	1.2	NT
UL	22	3	296	+74	270	+61	7	3.3	N
UL	23	3	255	+84	316	+59	6	2.9	N
UL	24	3	287	+77	285	+61	6	2.8	N
UL	25	4	TILLITE				>60	2.0	(N?)
UL	26	3	315	+75	262	+70	4	3.0	N

Table 1. Results of paleomagnetic direction measurements in the Mosfellssveit area profiles of Fig. 3. – Niðurstöður segulstefnumælinga á hraunlögum í Mosfellssveit.

N: number of samples used in computing average remanence directions.

D,I: declination and inclination of best mean remanence direction.

LON, LAT: longitude and latitude of virtual geomagnetic pole.

ALF: 95% confidence angle for mean direction (in brackets if N=2).

J100: arithmetic mean remanence intensity after 100 Oe AF treatment, A/m. In profile UL, this is replaced by the mean natural remanence.

POL: polarity (T= low-latitude pole).

both through surface geological observations, by research on material from the many deep geothermal drill holes in the region, and by the interpretation of geophysical measurements such as aeromagnetic surveys.

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APPENDIX : DESCRIPTION OF SAMPLING LOCALITIES

GB : Gufunes promontory. Starts at sea level west of the Eiðsgrandi gravel bar and follows the coast to no. 30. Ends above the old rock quarry near the Korpúlfsstaðir buildings.

UE : Korpa river. Starts at sea level east of the stream, the first eight units being sampled on the east bank. Lavas UE 9–15 were mapped at scattered locations around the Blikastaðir farm, but only no. 15 was sampled.

UF : Korpa. Sampling started at flow no. 13 ca. 100 m west of the Korpúlfsstaðir road. The section then crosses the Korpa stream, and a few outcrops are

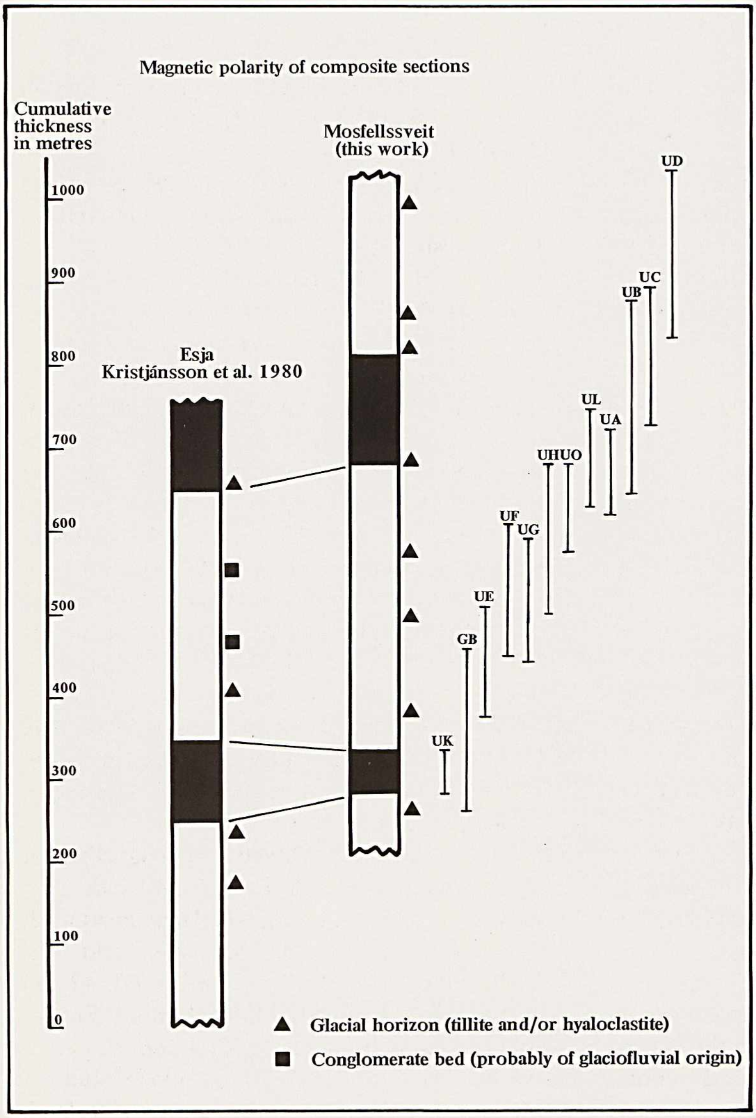

Fig. 5. Polarity column of the mapped section and proposed correlations with the uppermost part of the Esja section of Kristjánsson et al. (1980). Dark is normal magnetization. Glacial horizons and glaciofluvial conglomerate beds are also indicated. – *Samsett jarðlagasúla , er sýnir þykktir rétt og öfugt segulmagnaðra myndana í Mosfellssveit. Kuldaskeiðslög og tengingar við Esju einnig sýnd.*

found in the fields towards Úlfarsfell. The top 4–5 units are not included in Fig. 3: flow 29 is just below the main road and 30, 30X are near the old geothermal pipeline.

UG : Lágafell hill. Starts at the Hamraborg residence, lavas 1–5 were sampled below the main road and the others on the western slope of the Lágafell hill.

UK : Kaldakvísl river. Starts at the ruins of a small hydroelectric power station and continues upstream. UK 7 was collected underneath the bridge and the remainder in the south river bank immediately east of the bridge. Note that the presence of a fault makes flow 7 the oldest one in this profile. There are no exposures immediately above UK, but we attempted sampling outcrops of four lavas just east of the Highway 36 turnoff and two in the north river bank; their paleomagnetic directions are mostly normal but the stratigraphy is irregular and some of our results were of poor consistency, so detailed data from these are not included in Table 1.

UL : W- Úlfarsfell. The lower part is in the small but conspicuous gully above the main road around Hamrahlíð, ending in the tillite bed UL 14 at ca. 160 m. The upper part starts at the end of a track off road no. 430 at about 120 m altitude.

UO : NW- Úlfarsfell. Short profile segment sampled at the base of the cliffs, stratigraphically lower than UA.

UA: N- Úlfarsfell. Beginning at the base of the cliffs at an elevation of about 155 m. Thin flows, difficult to drill, so that several were omitted. Reversal from R to N occurs at a tillite horizon above UA 18.

UB : Upper Úlfarsfell. Continuation of UA with some overlap, beginning at about 180 m altitude. The units numbered UB 4 and 8 could not be found during sampling. UB 17 B,D,G are thin flows cored on a ridge running east from the top of the mountain (named Stórihnúkur). UB 20 is a thin vein at the peak of Stórihnúkur and 20A is nearby pillows or blobs in the tuff.

UC : Varmá stream. Short segment sampled, starting above Efrihvoll where the stream leaves a steep gully. The lower part of the segment includes some hard irregularly jointed lavas, presumably subglacial.

UD : Hafrahlíð hill. UD 0–15 are in the brook of Uxalækur in the Borgardalur valley, starting at about 100 m altitude. UD 0 is an isolated intrusive or lava flow displaying irregular columnar jointing within the tuffaceous sediment. After an unexposed gap of a few tens of m above UD 15 the profile continues up the peak south of Borgardalur. UD 23 are isolated basalt pillows in tuff.

UH : Helgafell hill, from base of the compound flow at an elevation of about 80 m to no. 14 at the top of the hill. Sites UH 1 and 2 were close to small intrusives and gave very inconsistent remanence results, so that data from these lavas have been discarded. UH 15 is the intrusive plug Víghóll, east of Helgafell. Two production wells of Hitaveita Reykjavíkur are in the vicinity, about 40 m below sampling site UH 1 in altitude. Well MG 19 (1513 m deep) is about 350 m east of site UH 1 and well MG 37 (2000 m deep) is about 350 m northwest of site UH 1. There is a fault with downthrow to the west between well MG 37 and site UH 1.

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Ágrip

SEGULSTEFNUMÆLINGAR Á HRAUNLÖGUM Í MOSFELLSSVEIT – FRUMKÖNNUN

Mjög lítið hefur birst á prenti um jarðfræði hinna eldri myndana í Mosfellssveit og Reykjavík, og er þessi grein tilraun til þess að bæta nokkuð úr því. Við höfum kortlagt myndanir frá Gufunesi inn að Hafrahlíð, eftir því sem ófullkomnar opnur og fjöldi misgengja á þessu svæði leyfðu. Við höfum einnig stuðst við prófritgerðir jarðfræðistúdenta, borholuskýrslur og óbirtar upplýsingar sem starfsmenn Orkustofnunar létu okkur vinsamlega í té. Tekin voru sýni úr um 200 hraunum til segulstefnumælinga, og hafa segulstefnurnar einkum verið lagðar til grundvallar við tengingar milli sniða.

Segulmögnun hraunanna á Mosfellssveitarsvæðinu er yfirleitt „öfug“, og er reiknað með að þau hafi runnið fyrir eða um miðbik svokallaðs Matuyama-segulskeiðs sem náði yfir tímabilið fyrir 2.4–0.7 millj. ára. Þunn „rétt“ segulmögnuð syrpa sem kemur fyrir ofan á móbergi í Eiðsvík og víðar, gæti þá verið frá hinu stutta Reunion-skeiði, og jafngömul syrpu sem m.a. kemur fyrir í miðjum hlíðum í Kistufelli. Önnur rétt segulmögnuð syrpa og nokkru þykkri, ofan til í Úlfarsfelli, gæti þá samsvarað Móskarðshnúkum í aldri. Ummerki sjást um að minnsta kosti átta jökulskeið í þessum stafla, og falla þau nokkuð vel að þeim fjölda sem finnst í samsvarandi sniðum í Esjunni.