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THE ÖRÆFAJÖKULL ERUPTION OF 1362

BY

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WITH 1 PLATE
AND 31 FIGURES IN THE TEXT

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CONTENTS

INTRODUCTORY

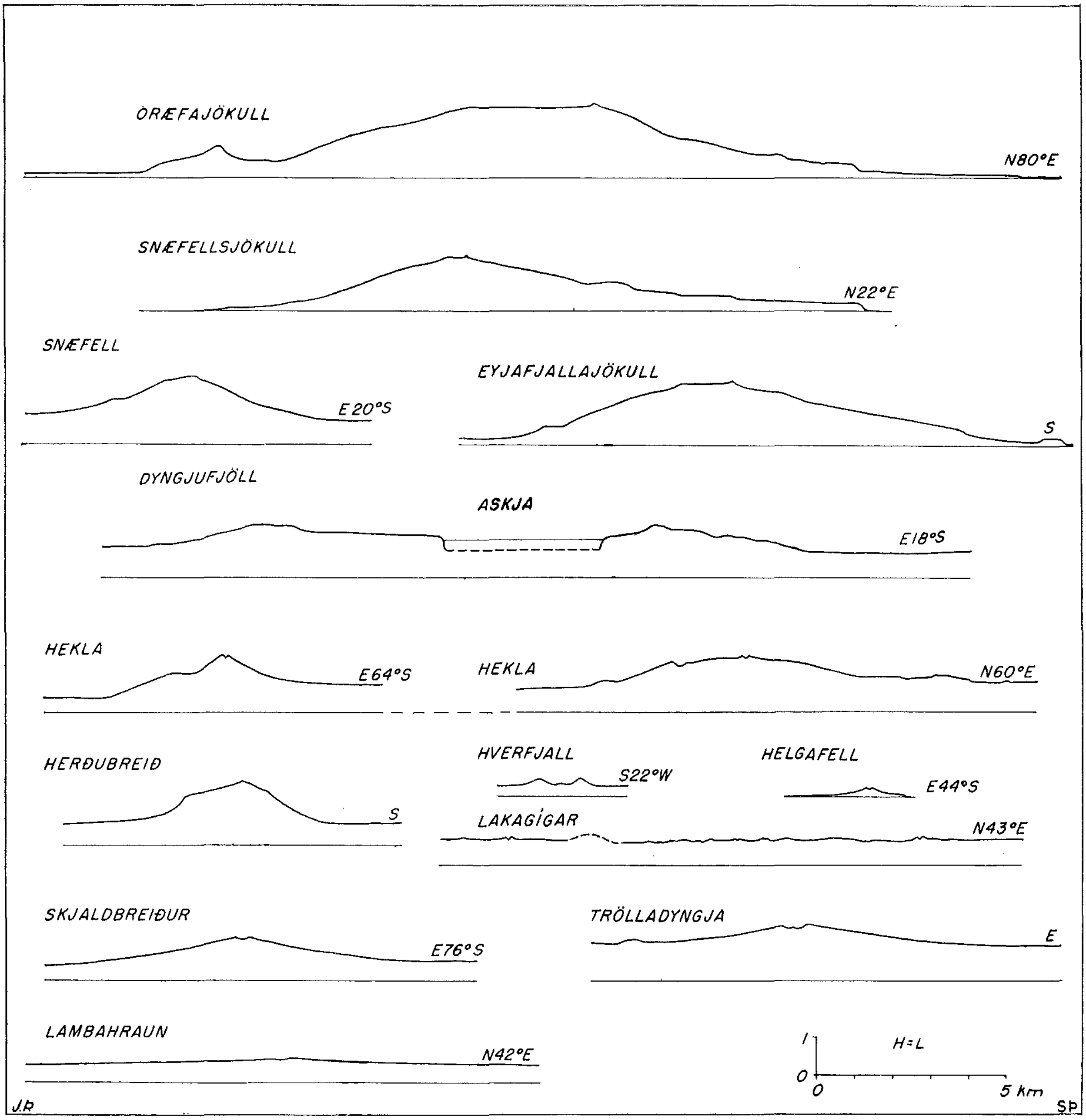
The Landnámabók tells us that when Ingólfur Arnarson, "the first settler" in Iceland, went to that country for the second time, in 874 A.D., with a view to making his abode there, he threw overboard his high seat pillars for luck, and vowed that wherever he might find them washed ashore, he would make his home. He himself landed at the place ever since called Ingólfshöfdi. It is nowhere specifically mentioned where he made his quarters during the first winter, but we may assume that it was somewhere in that vicinity.

Landnámabók further states that when three years later Ingólfur permanently settled where his thralls, Karli and Vífill, had found the high seat pillars washed ashore, the former said: "It was an ill fate that we crossed fertile districts if we are to settle in this exposed ness" (Landnámabók, 1900, pp. 7—8).

First impressions are apt to persist long, and it is not improbable that Karli, or the sagaman who reports this saying, was thinking of the luxuriant lands first encountered by Ingólfur and his train upon their arrival in Iceland, the birchwood slopes and the grassy plains sheltered by the ice-capped mountain which towers above all others in Iceland. It is not probable that many spots in the country looked more productive at that time, and we may assume that the ridges around Reykjavík seemed a less tempting habitation. Karli could have had no premonition that eleven centuries later almost half the population of Iceland would have their abode on these very ridges. Neither could he have divined what fate Ingólfur was averting from his descendants by submitting to the will of the Gods and leaving the rich slopes and plains at the foot of the great ice-crowned mountain, *Öræfajökull.*

ÖRÆFAJÖKULL. SHAPE AND SIZE

Öræfajökull in SE Iceland is the giant among Icelandic volcanoes. Both its hight and volume exceed that of any other volcano that has been active in the country in Postglacial Time. The only pleistocene Icelandic volcano that



ÖRÆFAJÖKULL
N80°E
SNÆFELLSJÖKULL
N22°E
SNÆFELL
E20°S
EYJAFJALLAJÖKULL
S
DYNGJUFJÖLL
ASKJA
E18°S
HEKLA
E64°S
HEKLA
N60°E
HERÐUBREIÐ
S
HVERFJALL
S22°W
HELGAFELL
E44°S
LAKAGÍGAR
N43°E
SKJALDBREIÐUR
E76°S
TRÖLLADYNGJA
E
LAMBAHRAUN
N42°E
1
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may have been built up to a comparable size is Dyngjufjöll ytri (cf. Fig. 1), presupposing that this massif as it now is can be regarded as the remains of a single cone volcano, the centre of which has collapsed and formed the big Askja caldera. Fig. 1 shows the size of Öræfajökull compared with some other well-known Icelandic volcanoes of different types. Öræfajökull is a cone volcano. From the low sandur plains in S and W it rises, with an average angle of inclination ab. 15°, to a crater rim with an average height of 1850 m, bordering a huge summit crater (Fig. 2). This crater is ellipse-shaped. Its. max. diam. (N—S) is 5 km, diam. W—E is 3 km, its area nearly 14 km^2. Above the rim rise some peaks. Above the S rim rise Rótarfjallshnúkur (1848 m) and the two Hnappar (Knobs), 1851 and 1758 m (Figs. 2 and 9), from which the volcano in all probability got its first name, Knappafell, soon changed to Knappafellsjökull (cf. Snæfell and Snæfellsjökull), and much later to Öræfajökull. On the E rim are two nameless hills, 1927 and 2044 m, and above the NW rim rises Iceland's highest peak, Hvannadalshnúkur, 2119 m (Fig. 3). The absolute hight of the volcano is nearly the same as the relative one. Only two volcanoes in Europe, Etna and Beerenberg, are higher and only Etna has a greater volume.

Öræfajökull is the most magnificent glacier area in Iceland. From the ice-capped upper part of the cone a number of glaciers thrust in ragged falls down the slopes towards SE, S and W, having eroded steepsided valleys in the mountain socle. Most of them reach down to the lowland plain at the foot of the massif. On many of these glacier tongues remarkably beautiful and regular ogives, both annual and multiple ones, are formed (Thorarinsson 1952, 1953, Ives and King 1954, 1955, Elliston 1957). The ogives on Hrútárjökull viewed by Doctor Sveinn Pálsson from the crater rim of Öræfajökull on Aug. 11th 1794, led this keen observer to the conclusion that glaciers should be regarded as a tough viscous substance, something like bitumen. More than any other glacier area in Iceland Öræfajökull may be said to be a classical ground of glacier research.

Fig. 1. The outlines of Öræfajökull and some other Icelandic volcanoes of different types. The outlines are constructed (without any corrections) from topographical maps with 20 m equidistance of contour lines. The outlines of Hekla are constructed from the Danish Geodetic Inst. Map, Scale 1:100 000, revised by Á. Bödvarsson after the eruption 1947/48. The rest is constructed from the U. S. Army Map Service photogrammetric maps, scale 1:50 000. The outlines of the Laki crater row constructed in this way are inaccurate, and not all the row is shown.

The height scale is the same as the length scale. The horizontal line beneath each volcano marks the sea level.

Fig. 2. Öræfajökull. Aerial view from S. In the foreground Kvíárjökull with ogives and entonnoirs. On the crater rim are visible the Hnappar peaks and (in the background) Hvannadalshnúkur. — *Photo P. Hannesson, May 28th 1938.*

THE GEOLOGY OF ÖRÆFAJÖKULL

Öræfajökull is situated at the E border of the young volcanic belt that stretches through Iceland from SW to NNE. Topographically the volcano forms an offshoot of the Vatnajökull massif towards S. The lowest part of the connecting ridge is 1352 m high.

The base of Öræfajökull is built up mainly of rocks typical of the Icelandic palagonite formation: palagonite tuffs and breccias, basalt lava layers, beds of tillites, and fluvial and glacifluvial sediments.

The south facing abrasion cliff between Hnappavellir and Hofsnes consists of rather thick basalt lava layers of felspar porphyritic texture. Thoroddsen marks these layers as dolerite on his geological map but they are not quite as coarse-grained as typical dolerites. These basalts are also found in the promontory Ingólfshöfdi, where they dip eastwards. In the westernmost part of Ingólfshöfdi they rest on tuff breccias, and in the boundary zone is some pillow lava and a breccia layer that may possibly be tillite.

Fig. 3. Hvannadalshnúkur, Iceland's highest peak (2119 m). Aerial view from SE. — *Photo S. Thorarinsson, Aug. 27th 1955.*

The west-facing cliff that extends from Bæjargil just NE of Hof to Fátækramannahóll is built up of series of rather thin felspar porphyritic basalt layers; these layers are also found in the canyon of Gljúfurá. These layers are somewhat younger than the Ingólfshöfdi — Fagurhólsmýri layers and belong probably to the last interglacial. Higher up on the E rim of Bæjargil are some peculiar rock formations, Strintur (Fig. 7), in all probability the cores of old adventive craters. The famous Hljódaklettar in the canyon of Jökulsá á Fjöllum in Northern Iceland are a similar formation. Medial moraines, originating on the NE side of Öræfajökull, contain many blocks of gabbro. Pebbles of gabbro are also found in front of Skaftafellsjökull. In the moraines in front of Hrútárjökull occur boulders of basalt with unusually big plagioclase phenocrysts (up to 6 cm^2). Rhyolite (liparite) also occurs at different places. The biggest rhyolite area within the massif proper is in the SW. The pyramide shaped Godafjall, 3 km NW of the farm Hof, consists mainly of rhyolite and a considerable area round that mountain, including i.a. the later mentioned rock hill Slaga, is more or less rhyolitic or metamorphosed by acid intrusions. Rhyolite also occurs in Bleikafjall E of Stigárjökull and on a smaller scale in Stadarfjall and Vatnafjall on both sides of Kvíárjökull. At a hight of about 950 m on Vatnafjall Flosi Björnsson, of Kvísker, one of the many Kvísker brothers, who are known as skilful amateur naturalists, found two miniature rhyolite cumulo domes that seem to be of late glacial age. The low hill Bæjarsker, at the SE foot of Breidamerkurfjall, consists of granophyre. As the upper part of the volcano is ice covered, only little is known about the rock. Samples collected by the 1954 Vatnajökull expedition on the big nunatak peak Thurídartindur (1741 m) on the NE slope of the volcano, prove that this peak is built up of rhyolite.

According to Thoroddsen (1895, p. 44) the peak Hnappur vestri consists mainly of rhyolite. A sample from Rótarfjallshnúkur, collected by G. Jónasson, was basalt.

The 250 m high, nearly vertical SE face of Hvannadalshnúkur (Fig. 3) is built up thoroughly of flow-banded rhyolite. The upper part of the rock wall is more light coloured (pale grey), overlaying a darker, pink grey rock, the junction marked by a somewhat undulating line. A dark dyke cuts vertically through the rock wall.[1])

THE GEOLOGICAL STRUCTURE AND STRATIGRAPHY OF THE ÖRÆFAJÖKULL MASSIF

The geology and stratigraphy of the Öræfajökull massif are far from baving been studied thoroughly enough to establish a reliable stratigraphy and chronology of the different part of the massif. Acc. to Henson (1955, cf. also Noe-Nygaard 1956) the lower part of Skaftafellsfjöll, short NW of the Öræfa-

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[1]) When I visited Hvannadalshnúkur, on June 1st 1956, it was impossible to collect rock samples from the SE face because of the risk of snow avalanches. Shortly later however, G. Jónasson, leader and co-leader of many recent Vatnajökull expeditions, at my request collected some samples there. So did also the same summer the American mountaineer, K. A. Henderson (Henderson 1957). At my request professor A. Noe-Nygaard, of the University of Copenhagen, who has formerly made a thorough petrographic study of some rhyolite occurrences within the Vatnajökull area (Noe-Nygaard 1952), has kindly undertaken a study of the rock samples from Hvannadalshnúkur. From a preliminary report (in a letter to the author) I quote the analysis No. 16 in Table 1 and the following comment:

"The chemical composition is very similar to that of the liparites from Pálsfjall and Geirvörtur (Noe-Nygaard, 1952, p. 49). I have examined your rock samples jökull massif, is of Tertiary age. Noe-Nygaard (1953, p. 224) has found tillites at Raudhellar in Morsárdalur, 150 m above the plain. Studies of Nielsen and Noe-Nygaard (op. cit. and Nielsen–Noe-Nygaard 1936) indicate that the visible socle of Öræfajökull is mostly pleistocene. All rocks examined by the author last summer at the foot of the Öræfajökull massif, from Kvísker in the SE to Svínafellsfjall in the W, including rocks from the promontory Ingólfshöfdi, show a normal magnetization. The lowermost basalt layer visible in Lambhagi, just S of the Svínafell farm, shows a faint reverse magnetization and a sample collected at my request from a basalt-layer at the foot of Skaftafellsheidi, just N of Skaftafell (coll. by Sigurdur Björnsson of Kvísker) also showed a rather faint but unmistakable reverse magnetization. A sample collected by Björnsson in Jökulfell, W of Bæjarstadarskógur, was distinctly reversely magnetized. The normally magnetized rocks in the Öræfajökull massif should all be pleistocene and probably younger than the Günz-Mindel Interglacial (Hospers 1953, Einarsson 1957). In early June 1957 the youngest of the Kvísker brothers, Helgi Björnsson, made a discovery, which will probably lead to a better knowledge of the age of the Öræfajökull massif. In the scree of Snidagil, a ravine in the southernmost part of Svínafellsfjall, he found a small fragment of petrified wood. Soon after his brother, Sigurdur Björnsson, visited the place and found some leaf impressions. Later a more systematic and thorough collection of leaf impressions was carried out with Björnsson's help by the author, who also studied the stratigraphy of the fossil-bearing formation, which forms the base of nearly the entire W face of Svínafellsfjall, up to a height of approx. 120 m above the plain and 250 m above sea level. The most abundant leaf impressions are those of *Alnus viridis* L., which is in accordance with preliminary pollenanlytic studies of the sediment. The formation is covered by a thick layer of tillite, previously described by Noe-Nygaard (1953), and underlain by basalt layers that are normally magnetized down to a layer about 100 m below the base of the sediment at Lambhagi. In the reversely magnetized layer some of the "bubbles" are partly filled with cryptocrystalline quartz and the layer on the whole looks older than the layers immediately underlying the fossil bearing sediment, so that possibly there is here a hiatus in the lava series. The examination of the collected material is far from finished and the same is the case with my stratigraphic studies, but the preliminary results suggest that this very interesting formation belongs to the Mindel-Riss Interglacial. A stratified sedi-

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under the microscope and can inform you that the Hvannadalshnúkur liparite (rhyolite) is closely related to the liparite occurrences in Vatnajökull previously described by me and also to the rock samples you sent from the nunataks Thórdarhyrna and Thurídartindur."

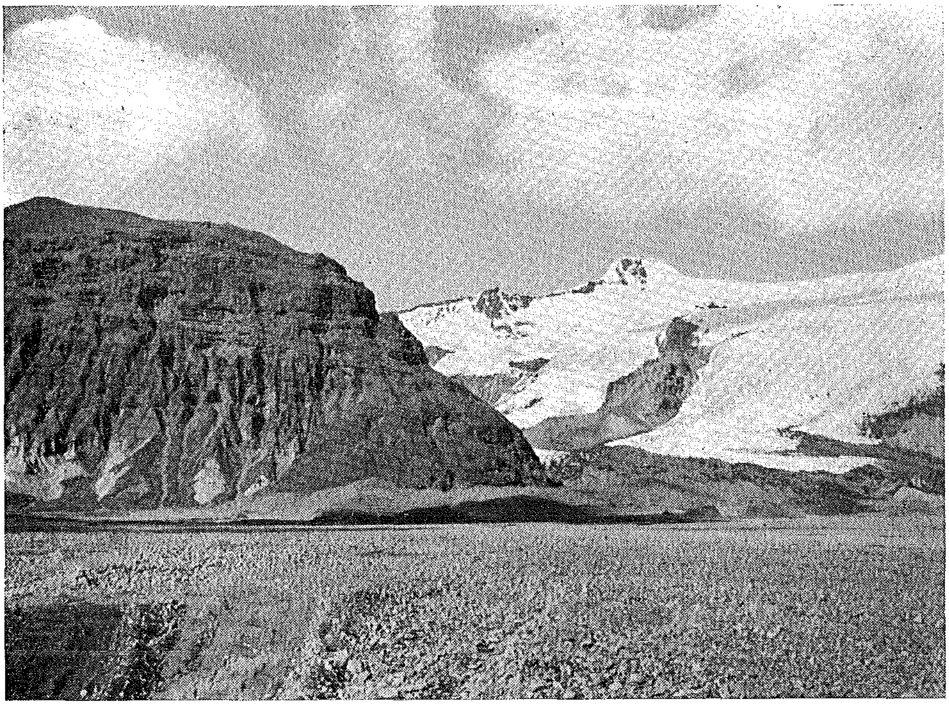

Fig. 4. Svínafellsfjall and Falljökull. The light coloured plant bearing Svínafell formation is visible at the base of the mountain. The formation reaches upwards to the lowermost horizontal line running along the mountain slope. Flosahellir (Flosi's Cave), mentioned on p. 27, is visible beneath the vertical cliff high up on the mountain to the farthest right. The ridge dividing Falljökull is Raudikambur. The highest peak is Hvannadalshnúkur. — *Photo S. Thorarinsson, July 5th 1957.*

ment of similar type, about 30 m thick, is found on Breidamerkurfjall, but S. Björnsson has so far in vain looked for leaf impressions in that sediment.

The age relation between the Svínafell formation and the Fátækramannahóll — Hof basalts has not yet been established with certainty because of the great disturbance in the area between Hof and Sandfell due to the rhyolitic intrusions.

As to the age of the upper part of the Öræfajökull massif, i. e. the present volcanic cone proper, it is in my opinion certainly younger than the Riss Glacial. On the other hand my tephrochronological studies in the area (cf. later in this paper) point against the cone being built up more than a little in Postglacial Time. We may safely assume that all summit eruptions of the volcano in Postglacial Time have been either purely explosive or mixed, with considerable production of tephra, and the tephra layers from most of these eruptions ought to be found in soil profiles around the volcano.

In a profile in Bæjarstadarskógur (Fig. 16:9), about 18 km NW of the summit crater of the volcano, dating back at least 8000 years from present, 26 tephra layers are found, of which 16 are earlier than 1362 A.D., and in a profile at Kvísker (De 32) SE of the volcano, 24 layers, of which 14 are earlier than 1362, were found. Some of these layers are undoubtedly from volcanoes other than Öræfajökull; others can more or less certainly be ascribed to that volcano. Among them are two rhyolitic layers ($Ö_2$ and $Ö_3$ in my profiles, cf. Figs. 16, 17, 21). Even if we take into consideration that during some eruptions the bulk of the tephra may have been carried towards the NNE and not have left a tephra layer S and W of the volcano, we may, from comparison with soil profiles near other volcanoes such as Katla (cf. Fig. 16:1 b) and Hekla (Thorarinsson 1954), conclude that Öræfajökull has not been very active in Postglacial Time.

Fig. 5. Stórugrjót, a sandur plain W of Kvíárjökull covered by jökulhlaup sediment. In the background to the right is seen the front of a lava flow coming from the breach between Stadarfjall and Kvíármýrarkambur. — *Photo S. Thorarinsson, July 10th 1957.*

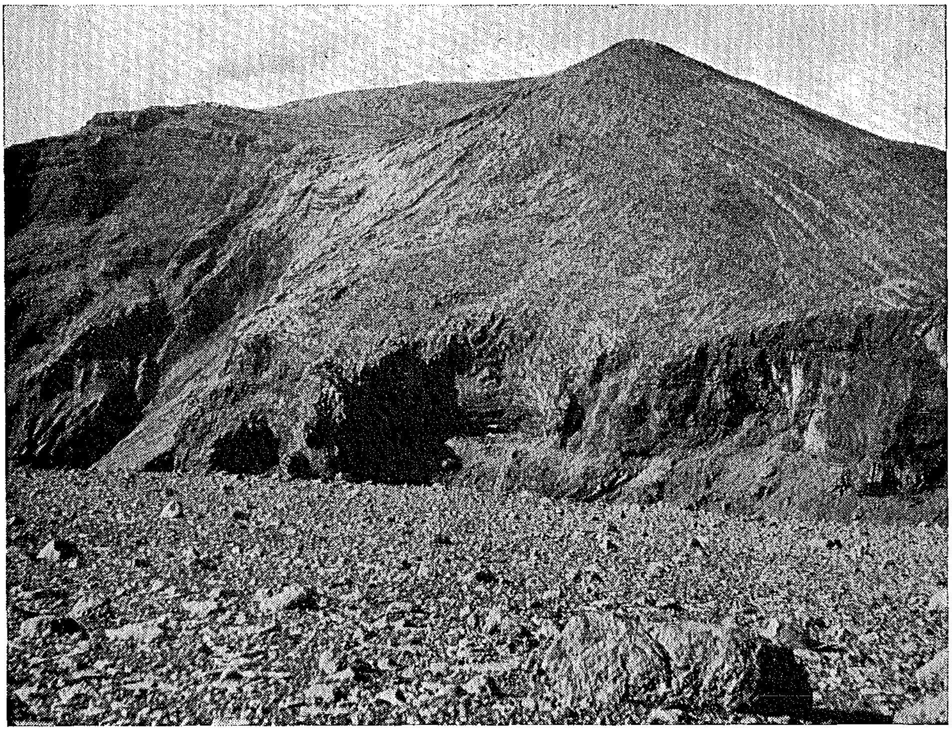

Fig. 6. Hofsfjall (744 m), a tuff cone on the SSW slope of Öræfajökull. Note the very regular stratification. View from S over Bæjargil. — *Photo S. Thorarinsson, Sept. 13th 1955.*

Besides the tephra producing eruptions, which most likely were summit eruptions, some small flank eruptions have also taken place in Postglacial Time. NE of Hofsfjall is a row of small basaltic parasite cones (bocche), the lowest one at a height of about 800 m. Stórhöfdi (784 m) N of Fagurhólsmýri is also a postglacial parasite cone. A small postglacial lava flow, the easternmost one in Southern Iceland, has its source in a short crater row on Vatnafjall at a height of about 600 m (cf. Pl. I). The craters are situated at the very edge of the precipituous W slope of Vatnafjall and they are now nearly eroded away by the lateral erosion of Kvíárjökull. This suggests that the eruption took place many thousand years ago. The lava is basaltic, felspar porphyritic. A small tongue of it reaches the lowland in the mouth of the canyon Stóralækjargljúfur, and disappears under Kambsmýrarkambur, the E marginal moraine of Kvíárjökull.

A small postglacial lava flow is also found on the W side of Kvíárjökull, where it emerges from under the northernmost part of the marginal moraine Kvíár-

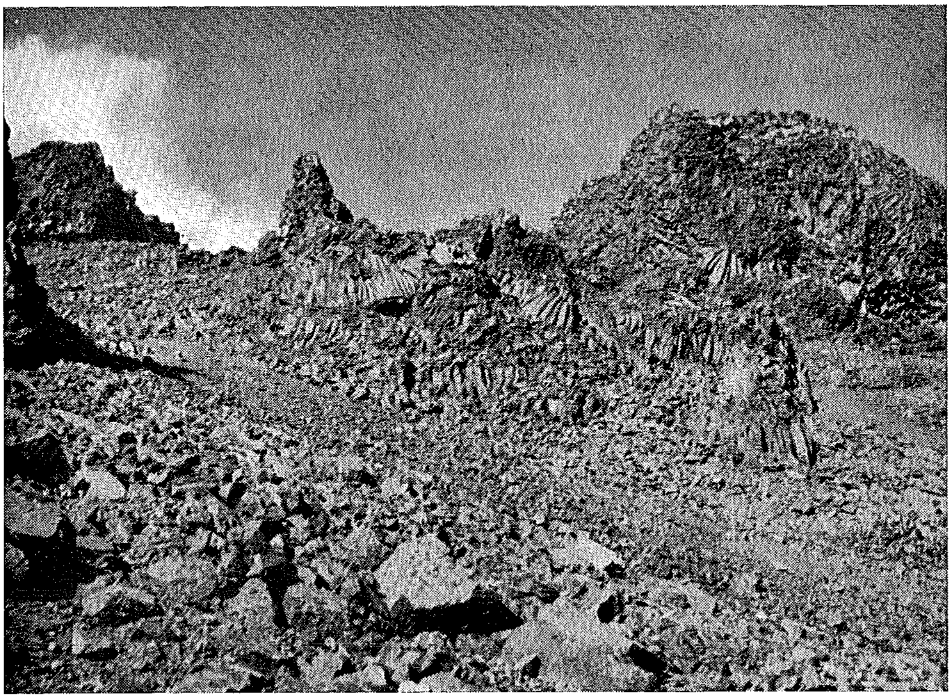

Fig. 7. Strintur, peculiar peaks rising against the sky NE of Hof, Öræfi. They are the cores of an old, basaltic adventive crater row. Note the radial columnar structure. — *Photo S. Thorarinsson, Sept. 13th 1955.*

mýrarkambur, and is also seen in the breach between this moraine and Stadarfjall (Fig. 5). This lava is greyish black with small felspar phenocrysts, and rather dense, compared with the lava E of Kvíárjökull. The northern edge of the flow is rather steep and up to 25 m high. The SiO_2 content of this lava is 48.55% (Analyst. Ó. Bjarnason). Obviously this flow is not a continuation of the flow on the E side of Kvíárjökull. It may have a separate source under the present Kvíárjökull, but more likely it comes from the same crater row as the eastern flow but has taken its course towards SW at a time when in all probability Kvíárjökull was much less extensive than now, which in its turn indicates that this lava was extruded during the Postglacial Warm Period.

The somewhat problematic formation of the promontory Salthöfdi, E of Fagurhólsmýri, is in my opinion most likely the result of a fissure eruption that took place shortly after the ice had receded from the area but while the sea still reached the cliff between Fagurhólsmýri and Hnappavellir.

The summit of Hofsfjall, N of Hof, is really a very regularly stratified tuff cone (Fig. 6) dissected by the canyon Bæjargil. Judging from its well preserved shape it should be very young, but at the E foot of the cone the tuff layers are covered by a moraine covered lava so that the cone is not younger than late glacial and may possibly be from the last interglacial.

To sum up the above, we conclude that the postglacial activity of Öræfajökull has not added much either to the height or to the volume of the volcano and the cone must thus be older in the main.

When discussing the building up of regular volcanic cones such as Öræfajökull, Eyjafjallajökull and Snæfellsjökull to a height above the present firn limit we have to realise that the ice-covered volcanoes that have been active in historical time in Iceland have, as far as we know, been mainly explosive and not produced any considerable amount of lava. And the tephra produced has not added much to the volume of the ice-covered upper parts of these volcanoes, as the tephra that has fallen on the firn and ice has been carried away. The condition prior to the building up of these volcanic edifices under present climatic conditions must therefore be that these volcanoes were so active during long periods that no thick ice cap could be formed on them between the eruptions. It should also be taken into consideration that during the Postglacial Warm Period and also during the warmest part of the preceding interglacials the height of the firn line was considerably greater than now. These considerations do not solve the problem of the age of these volcanoes. Judging however from their well preserved conical shape I find it most likely that the upper parts of their cones were mainly built up during the latter half of the Würm Glaciation, and during periods of activity when the eruptions occurred with intervals short enough not to allow the formation of thick ice cover on the volcanoes.

In this connection I want to point out that these three big cone volcanoes are all situated very near to the coast. During the last glaciation they were therefore situated in the marginal area of the Icelandic inland ice. The outwards moving inland ice streams must have been rather thin in the marginal area and partly consisted of shelf ice where bordering these volcanoes. Their situation was therefore similar to that of Mt. Erebus in the Antarctic. These volcanoes have risen high above the surface of the surrounding ice cover — especially their seafacing sides — whereas the table mountains were built up within more central parts of the inland ice where the ice cover was much thicker, so that they had to be built up to a considerable height before they could be capped by subaerial lava flows.

Of the three cone volcanoes mentioned Öræfajökull is probably the oldest, whereas Snæfellsjökull is nearly certainly the youngest and may even have increased considerably in size in Postglacial Time.

THE SETTLEMENT AT THE FOOT OF ÖRÆFAJÖKULL

Let us now briefly survey the settlement at present found along the foot of Öræfajökull. Both from physical and human geographical point of view it is one of the most interesting of the inhabited parts of Iceland. Until the advent of aviation it was the most isolated one. In front the waves of the open Atlantic break upon a sandy and harbourless coast, where only the promontory of Ingólfshöfdi affords some shelter, while in the rear there extends the earth's largest glacier field between the two polar circles. On either side are the country's most extensive sandur deserts Breidamerkursandur (formerly Breidársandur) to the E, and Skeidarársandur (formerly Lómagnúpssandur) to the W, and the two glacier rivers considered the most formidable in the country, Skeidará in the W, and Jökulsá in the E (Fig. 8). It is symbolic of the isolation of this settlement that it is believed to be one of the few on the surface of the globe where mice are not found. There is an old tradition that it is of no use bringing cats into the settlement, as they will perish of utter boredom.

For a long time past there have been eight farms in Öræfi. Counted from west to east they are: Skaftafell, Svínafell, Sandfell and Hof, there being churches at these two latter ones; Hofsnes, Fagurhólsmýri, Hnappavellir, and Kvísker. The Hof, Hofsnes, Fagurhólsmýri and Hnappavellir farms are on a continuous grassy stretch, but the other farms are separated from these four and from each other by torrential glacier rivers, confined to no stable channels, but shifting from one side to another on outwash fans devoid of vegetation. The most elevated farm, Skaftafell, is now some 200 m above sea-level, the lowest one, Kvísker, about 20 m. By Icelandic standards Öræfi has a favourable climate. The average annual temperature at Fagurhólsmýri (1901—1930) is 4.1° C, or 0.2° C lower than in Reykjavík. But if temperature were measured at Svínafell or Skaftafell, it would probably be found to be higher than anywhere else in Iceland. This is due to the great föhn effect of Öræfajökull when the wind is from SE. The annual precipitation at Fagurhólsmýri is 1820 mm, the second highest measured at any coastal station in Iceland (Vík in Mýrdalur having 2390 mm). On the southern slopes of Öræfajökull the annual precipitation is probably not less than 4000 mm. At Skaftafell and Svínafell it is considerably lower than at Fagurhólsmýri. My belief is that no farm in Iceland enjoys more pleasant weather than these two, and indeed the vegetation testifies to this. Nowhere in Iceland is it more luxuriant than in the NW part of Öræfi.

It is peculiar to Öræfi that for a long time past several farmers have simultaneously been occupying the same farm. Thus Hnappavellir (Fig. 10) in 1940 had five separate farmhouses, occupied by seven farmers, and so it was with Hof

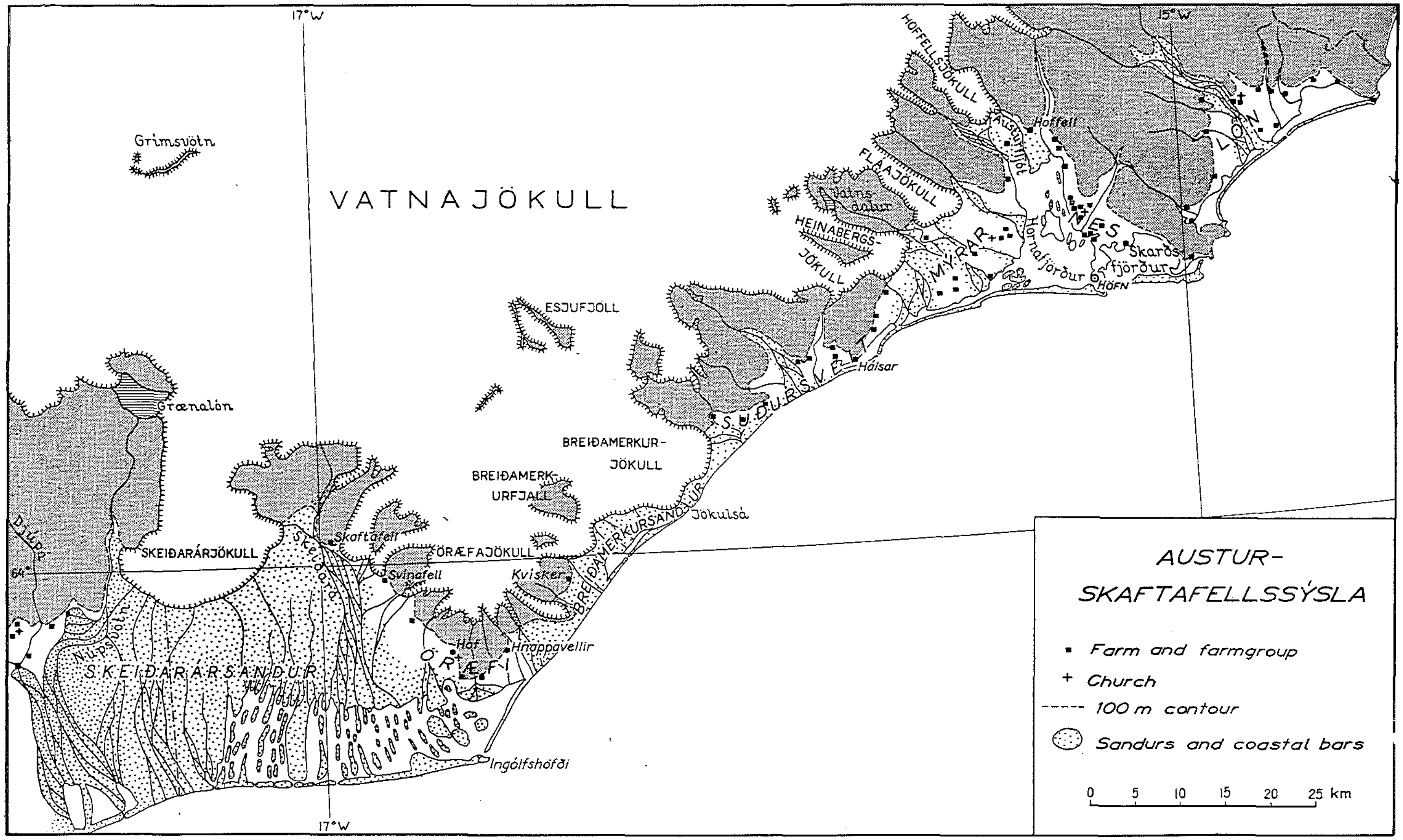

Fig. 8. The province Austur-Skaftafellssýsla. Ice free areas above 100 m are shaded. — *After Thorarinsson 1956.*

(Fig. 11) also. Five farmers occupied Svínafell and three Skaftafell. Actually the farmsteads are therefore hamlets, otherwise rarely met with in Iceland, where as a rule each farm is held by a single farmer.

In 1940 the total population of Öræfi was 199 persons.

One need no long study the old records to find that much has changed in this locality since the first settlers came there about 900 A.D. Landnámabók says that Thórdur Illugi, one of the early settlers, was shipwrecked on the coast of Breidársandur, and made his abode "below Fell", i. e. at the farm later called Fjall, at the foot of Breidamerkurfjall (cf. the map Fig. 12). Somewhat farther east was a farm called Breidá, where, according to Njál's Saga, lived Kári Sölmundarson, the valiant avenger of the sons of Njáll. Even if we regard Njál's Saga as primarily a work of fiction, it is a romance of the kind that the master who wrote it in the thirteenth century would never have placed Kári at Breidá unless he knew that it was, or had been, a good farm. Recently both these farms, Fjall and Breidá, have emerged from underneath the ice because of the rapid glacier recession of the last few decades, after having been covered by the glacier of Breidamerkurjökull for more than two centuries (cf. Thorarinsson 1956). In Commonwealth times Svínafell was a major farm, particularly in the early part of the thirteenth century. At that time it presented a view different from that now to be seen there, when Svínafellsjökull has pushed a high frontal of moraines to within a distance of a few hundred metres from the farm buildings and glacier rivers have spread their sediments quite close to the cultivated field surrounding the farmstead.

It is obvious that glaciers have advanced and harassed this settlement since it first became a human habitation. This, however, has had no decisive effect upon the fate of the settlement, least of all in the earlier centuries. Other forces were more fateful. But let us first consider this ancient habitation a little further.

The most informative sources on this settlement in the olden times are the chartularies (icel. *máldagar*). These are rich in valuable information, especially as regards the Roman Catholic period, but have not yet been sufficiently studied for local history. The Old Ecclesiastical Laws of 1123 A.D. decree that the wardens of churches are to keep inventories of all property belonging to these churches, be it lands, stock, chattel or tithes. The oldest preserved chartulary of what was then the district between Breidársandur and Lómagnúpssandur is believed to date from 1179 and reads as follows.

"To the Church of St. Mary at *Raudilækur*[1]) belongs the entire glebe land as well as *Hladnaholt, Langanes,* and *Bakki* farms, with scot and lot, and all the

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1) Italics mine. S. Th.

Fig. 9. Fagurhólsmýri and Öræfajökull. The peaks on the crater rim are Rótarfjallshnúkur (to the left) and Hnappur vestri. Stórhöfdi, an old parasite cone, rises against the white slope a little to the right on the picture. — *Photo S. Thorarinsson, July 21st 1954.*

river plains formerly belonging to *Hólar* farm, and three parts of Ingólfshöfdi, while two parts belong to the occupant of *Eyrarhorn* farm. Half the fowling belongs to the church. It owns meadow land at Gegnishólar, and shall be entitled to grazing for 30 horses from Raudilækur in the land of *Krossholt* both in winter and summer, 15 old oxen in the land of Hólar, 160 wethers in the land of *Fjall.* A third grazing land is at Kvíármýri. [To it belong] all woods west of Saudabólsskógur to the wood belonging to *Skammstadir.* One patch of wood is in a valley in Jökulsfell. Cheese tax is due to Raudilækur from the whole district between Breidársandur and Lómagnúpssandur. The church owns 15 cows and barren cattle to the value of 5 cows, ninety ewes and barren sheep to the value of five cows, 12 'hundreds' worth of prize stock, 50 'hundreds' worth of vestments all told. The parishes between Grafbrekka and Jökulsá as well as church tithes, except from *Sandfell,* belong to Raudilækur Church. Seashore belonging to the Church is not [here] specified because there is only such as has already been declared in court. To this is added such as belongs to Langanes. Against this property it is incumbent to maintain two priests and one deacon. Mass shall be sung

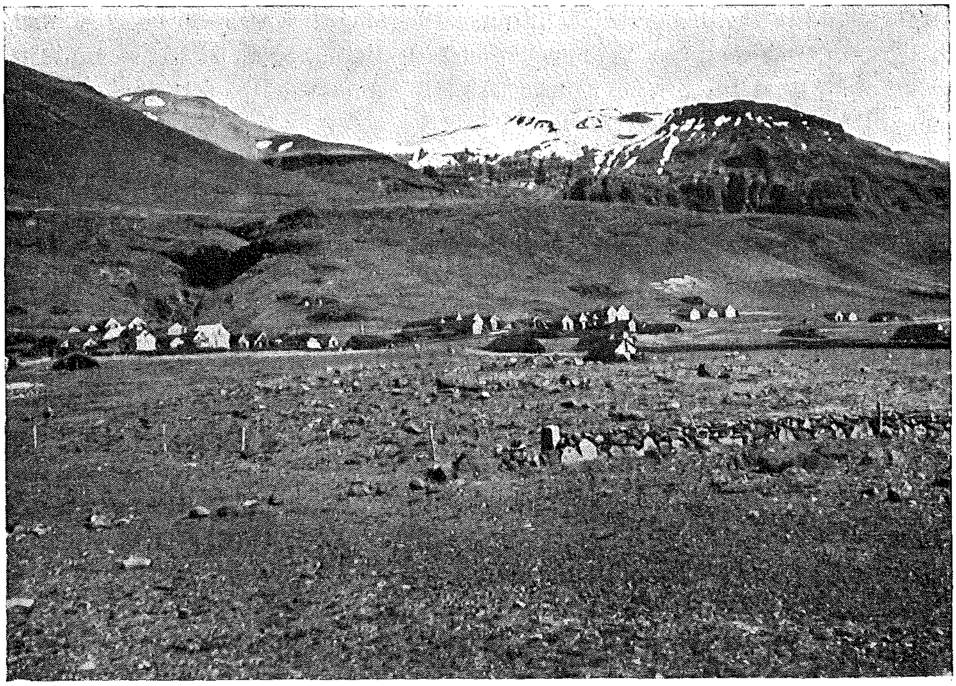

Fig. 10. The farm group Hnappavellir. — *Photo S. Thorarinsson, 1938.*

there not less than twice weekly and all vigil days and ember days and every day during Lent and every other day during Advent. To the Church belongs the seashore between Kvíá and Hamraendar, in equal share with those who occupy Sandfell. To it alone belongs the seashore south of Kvíá as far as Einangrar; a third share it owns off Eyrarhorn, two parts against the occupants of Sandfell of all jetsam washed ashore, and prior to division one-eighth of all eatables washed ashore" (D I i, pp. 248—249).

Even this chartulary alone tells us a good deal. It names ten farms (their names are here italicized), but only one of these farm-steads, Sandfell, is now to be seen, and has been deserted. We learn here of a church, Raudilækur Church, possessing great wealth in lands and chattel. Of this church not a trace is left, but we can guess approximately where it stood. Together with Raudilækur farmstead it must have stood on the sandur a good distance west of Sandfell. The parish is called *Hérad,* but that was a name given only to extensive and important parishes. As long as Raudilækur existed the parish bore this name, or *Hérad milli Sanda* (*Hérad* between the Sands). But in the records of the See of Skálholt it gradually comes to be called *Litlahérad* (Small Hérad), in contradistinction to a larger *hérad* in the bishopric, viz .Fljótsdalshérad (cf. E. Ó. Sveinsson 1948, p. 186). In later centuries the appellation Litla Hérad gave rise to the tradition maintaining that the present Öræfi formerly comprised two settlements, Stóra and Litla (Big and Small) Hérad.

Altogether the chartulary of 1179 shows a wealthy district. Yet we can see by it that the woodlands are somewhat deteriorating, and it also points to some limitation of pasture — long characteristic of Austur-Skaftafellssýsla. The church has succeeded in usurping much of the seashore rights. These were much coveted because of the drift-wood, extremely valuable in a country with nothing but birch woods. Seal-catching must also have been of no small account on these shores, and still remains so on some of them.

The most comprehensive picture of the settlement is preserved for us from the earlier half of the fourteenth century, as the chartularies of all the churches at that time in Hérad are extant from about 1343 (DI ii, pp. 772—777). These churches were: St. Mary's Churches at Breidá, Hnappavellir and Raudilækur, and St. Clement at Hof. For some unknown reason the church at Svínafell had by then been abandoned, though with certainty we know of its existence in 1241 (Sturlunga saga ii, p. 109), and that it probably lasted somewhat into the fourteenth century. It is beyond the scope of this paper to deal in a thorough manner with those documents; we must content ourselves with touching upon points that serve to convey an idea of the size of the settlement about 1340.

According to the said chartularies the Breidá Church owns in addition, of course, to the glebe land, the lands of Hólar and of Hellir eystri (Eastern Hellir). Two chapels belong to the church. At Breidá there is one priest. Hnappavellir Church owns one-fourth of Hnappavellir farm. To it four farms are liable for all dues, and there are three chapels, but only one priest. Hof Church owns the farm land and half the farms Svínafell, Skaftafell, Sandhöfdi and Svínanes. Two farms are liable for tithes to Hof Church and each has a chapel. A priest and a deacon are to reside there. In addition to the glebe land Raudilækur Church still owns the three farms, Hladnaholt, Langanes and Bakki. Further, ten farms are liable to it for tithes, and to it belong two annex churches, at Sandfell and Jökulfell. Chapels are three, and a fourth just pulled down. There are two priests. Altogether we have here seventeen houses of worship enumerated, of which four are main churches, i. e. churches incumbent to maintain a priest; two annex churches and eleven chapels. Inclusive of the other farms that pay tithes or are owned by the churches, partly or wholly, the total number of farms according to these chartularies is thirty.

Altogether we know from the chartularies the names of some 22—24 farms before the middle of the fourteenth century. Alphabetically arranged these names

Fig. 11. Hof in Öræfi. View towards N. The arrow points to the farmruin Gröf. Behind Gröf is the outwash fan of Kotá. The black and more distant part of that fan is Svartijökull. — *Photo S. Thorarinsson, Sept. 13th 1955.*

are as follows: Bakki, Breidá, Eyrarhorn, Fjall, Hellir eystri, Hladnaholt, Hnappavellir, Hof, Hólar, Jökulfell, Krossholt, Kvísker, Langanes (Nes)[1], Raudilækur, Sandfell, Sandhöfdi, Skaftafell, Skammstadir, (Skard)[1], Steinsholt, Svínafell, Svínanes, Vindás. In the name of a certain seashore is preserved one farm name, Freysnes, and possibly also in the name of Salthöfdi. The name of Eastern Hellir suggests that there was also a Western Hellir. Tradition says that north of Hof

[1]) Not certainly a farm name.

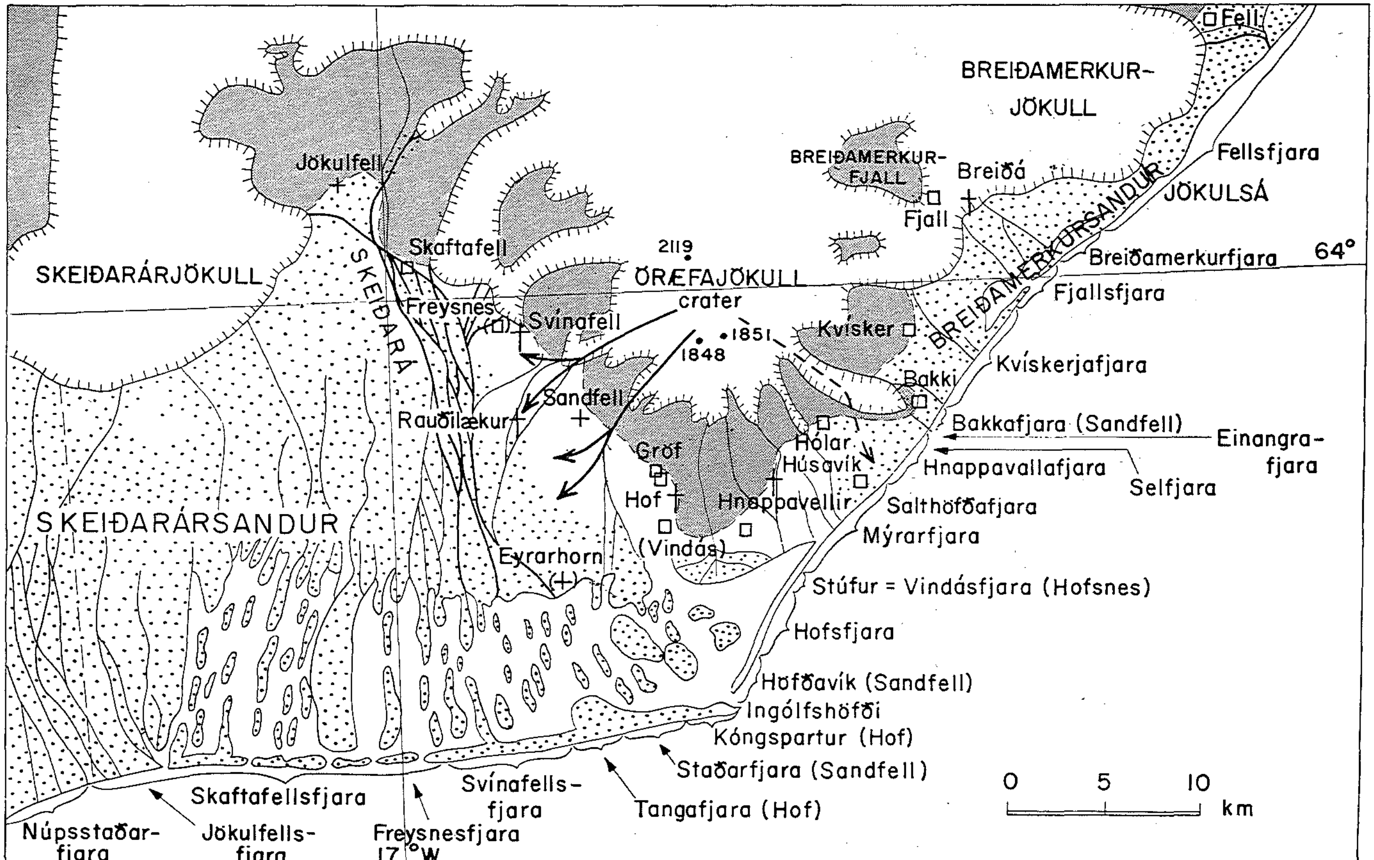

Fig. 12. Litlahérad in the 14th century. Topography according to the 1904 map. Icefree areas above 100 m are shaded. The courses of the 1362-jökulhlaup and the jökulhlaup from Kvíárjökull are shown very schematically. Long crosses: Main churches. Short crosses: Annex churches. The map also shows the present division of the shore.

were two farms, Gröf and Gröf eystri. One of these, Gröf, has recently been excavated (see below, p. 87 ff.), and it had certainly been occupied about 1350. So was possibly also Húsavík farm, the ruins of which are mentioned by Ísleifur Einarsson 1783 (Blanda, vol. 1., p. 48), and maybe even the present Hofsnes farm. Also on this authority it may be shown that then were at least about thirty farms in Öræfi, and the number may have been somewhat higher. The statement of Biskupa-annálar (cf. p. 27) that the farms numbered forty is not far off. According to the census of 1703 the average household per farmstead was 7.3, and there is no reason to suppose that the number was below that about the middle of the fourteenth century. On that estimate the population of Hérad in the mid-fourteenth century should have been some 220, and more probable that it was above that figure.

The map Fig. 12 shows the position of such farmsteads and ruins of old which can be placed either exactly or with relative certainty. The most doubtful locations are bracketed. Main churches are indicated b.y a large cross, annex churches by a small one. This map should give some idea of the settlement about the middle of the fourteenth century. On the map I have indicated the seashore stretches in accordance with particulars supplied by farmer Ragnar Stefánsson of Skaftafell, the late Ari Hálfdanarson of Fagurhólsmýri, and the Kvísker brothers. The seashore stretches reflect fairly the old settlement. The longest stretches belong to the ancient manor farms, Skaftafell and Svínafell. The westernmost part of the Skaftafell shore is the ancient Jökulfell shore, while its easternmost part is Freysnes shore. To the east of the Svínafell shore is one that probably belonged to Eyrarhorn. Stadarfjara (Rectory shore) is presumably that of Raudilækur, where the main church was. Thus one could continue, but let it suffice to point out that the eastern boundary of Breidamörk shore indicates that formerly the channel of Jökulsá was a good deal farther west than at present. The shoreline has altered, the rivers shifted, farms disappeared, but the demarcations of the shore stretches have remained little changed through the course of the centuries.

THE GREAT ERUPTION

For ages the magnificent ice-capped volcano had towered behind Hérad between the Sands affording shelter to the habitations of men, when all of a sudden its role was reversed. In an annalistic fragment, from the See of Skálholt, that is believed to have been written in the north of the country (in the monastery at Mödruvellir; cf. Isl. Ann., p. xx) approximately contemporaneously with the events it relates, preserved in the original draft (AM. 423 a 4to), we read of the year 1362: "Volcanic eruption in three places in the South and kept burning from flitting days until the autumn with such monstrous fury as to lay waste the whole of Litlahérad as well as a great deal of Hornafjördur and Lónshverfi districts, causing desolation for a distance of some 100 miles. At the same time there was a glacier burst from Knappafellsjökull into the sea carrying such quantities of rocks, gravel and mud as to form a sandur plain where there had previously been thirty fathoms of water. Two parishes, those of Hof and Raudilækur, were entirely wiped out. On even ground one sank in the sand up to the middle of the leg, and winds swept it into such drifts that buildings were almost obliterated. Ash was carried over the northern country to such a degree that foot-prints became visible on it. As an accompaniment to this pumice might be seen floating off the West Coast in such masses that ships could hardly make their way through it" (Isl. Ann., p. 226).[1])

Gottskálksannáll, which exists in a sixteenth century transcript, but is believed to have been copied from a fourteenth century original written in the North of the country and is on the whole a trustworthy source on events from the middle of that century, says of the year 1362: "Volcanic eruptions in six places in Iceland. In the East Knappafellsjökull burst and rushed over Lómagnúpssandur, cutting off all roads. A river called Úlfarsá[2]) in the East Country shifted from its channel and flooded the rectory called Raudilækur, wasting away all buildings except the church" (Isl. Ann., p. 359).

The annals contained in Flatey Book written in Vestur-Húnavatnssýsla in the North during the last decades of the fourteenth century, comment thus upon the year 1350: "Volcanic eruption in Knappafellsjökull with darkness so intense that roads could not be seen at midday, and the entire Litlahérad was devastated" *("aleyddist allt Litlahérad")* (Isl. Ann., p. 404). Lögmannsannáll merely remarks: "Volcanic eruption in Litlahérad devastating the whole settlement" (Isl. Ann., p. 279). This is believed to have been written in the North, about 1380, but the eruption is here dated 1367.

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1) "Elldr uppi i iij stodum fyrir sunnan ok hellz þat fra fardogum til hauz med sua myklum bysnum at eyddi allt Litla herad ok mikid af Hornafirdi ok Lons huerfi sua at eyddi .V. þingmanna leidir her med hliop Knappa fellz iokull fram i sio þar sem uar XXX diup med griotfalli aur ok saur at þar urdu sidan slettir sanndar. tok ok af ij. kirkiu soknir med ollu at Hofi ok Rauda læk. Sanndrin tok i midian legg a slettu en rak saman i skafla sua at uarla sa husin. oskufall bar nordr um land sua at sporrækt uar þat fylgdi ok þersu at uikrinn saz reka hronnum fyrir Uestfiordum at uarla mattu skip ganga fyrir."

2) Probably the same river as the present Virkisá.

That exhausts our almost contemporary, or little later than contemporary, records of this eruption. Our next source is fully two centuries younger. Oddverjaannáll, believed to have been compiled about 1580 (Isl. Ann., p. xxxix), adds the following clause to the statement of Lögmannsannáll: "Previously there had been here seventy farms. No living creature survived except one old woman and a mare" (Isl. Ann., p. 489).

Qualiscunque descriptio Islandiae, formerly ascribed to Schoolmaster Sigurdur Stefánsson, but now believed to be the work of Bishop Oddur Einarsson, but in any case dating from about 1590 (Benediktsson 1956) says: "Anno etiam 1362. ruptus est alter quidam mons, cui nomen Knappafellsjokull, ex quo præter fordes et cineres tanta copia pumicum et combustorum lapidum in mare egesta est, ut refluxa oceani omnia uicina littora his implerentur" (op. cit. p. 10).

A little later, or in 1605, the Rev. Jón Egilsson wrote his Biskupa-annálar (Bishops Annals) at Skálholt, and in these he says: "It has been the current tradition that during the time of these last seven bishops (viz. between 1216 and 1348) it so happened that the glacier in Öræfi burst with a flood and swept away on a single morning and by a single flood forty farms, while eight remained, those that now are there, not a soul escaping except the priest and the deacon at Raudilækur, which is now a deserted farm W of Sandfell; and the church remained standing throughout the flood, although it was made of wood only. It has now been transferred to Sandfell and people have said that traces of many farmsteads are still to be seen, both rocks and slabs" (S. t. s. Ísl. i, p. 32). Bishop Gísli Oddsson also touches upon this eruption in his work De mirabilibus, written in 1638, where he says (p. 37): "Hnappafellsjökull, alpes sunt, a rotunda monticuli cujusdam singulari figura ad imaginem globuli hnappur sic appellati, Anno 1362 dicuntur erupisse et fortasse eodem tempore integram provinciam, fere 50 prædiola, secum una abstulisse et in oceanum magnum deportasse."

We must further refer to the traditional stories written down by district sheriff *(sýslumadur)* Ísleifur Einarsson as told to him by the people of Öræfi during the first decade of the eighteenth century. Amongst other things he tells us that "once when the Svínafell shepherd, Hallur by name, had gathered home the ewes for milking, and the maids had started milking, they heard a loud report in the Öræfajökull, at which they were astonished. Shortly afterwards there came a second report. Whereupon the shepherd said that they would be well advised not to wait for a third one. He then went into Flosi's Cave *(Flosahellir)* which is situated up in the mountain side east of Svínafell (cf. Fig. 4), and when he was there a third report was heard in the aforesaid jökull, causing it to burst, emitting so much water and rocks that this flowed down every gully, destroying all people and all animals throughout the Öræfi settlement, except the said shepherd and one horse with a blazed face. And in the summer, when those from the Eastern Districts were going to attend the Althing, they found this horse standing on a certain rock to the east of Fagurhólsmýri. When they were going to catch him, he jumped off that rock, since when it is called Blaze's Rock *(Blesaklettur)*, which name it bears even today" (Blanda i, p. 51).

Now, what deductions can we draw from these sources? Let us first of all look at the chronology. Here the annals are not in agreement, and indeed one of them, Gottskálksannáll, mentions two eruptions in Knappafellsjökull in the fourteenth century, the first of these in 1332. In accordance with this Thoroddsen in his Geschichte der isländischen Vulkane (p. 105) says that Öræfajökull was twice active in the fourteenth century, and J. Thorkelsson believes that Svínafell was destroyed by a jökulhlaup caused by an eruption in Öræfajökull in 1332 or 1341, and that this accounts for there being no church here in 1343 (Thorkelsson 1920/21, p. 267). But examination of tephra layers, later to be referred to, seems definitely to indicate that the 1362-eruption was an initial one, and such eruptions generally come after long intervals of quiescence, as did the Hekla eruption of 1104 that destroyed the settlement of Thjórsárdalur, and the Monte Somma eruption of 79 A.D. Neither can I see from the annals that there was an eruption in Öræfajökull earlier in the century. Gottskálksannáll records at the date of 1332 that "a fire was seen burning in the east from nearly all over Iceland, and seemed to be in the same direction from whatever human habitation it was viewed, and is believed to have been in Knappafellsjökull" (Isl. Ann., p. 348). The Flatey Book Annals and Skálholt Annals also refer to fire in the east, visible from nearly all over Iceland, but mention no eruption, and the Annal fragment from Skálholt says on this subject: "Fire burning and sandfall in Sída in the South. At the same time lights were seen far out on the sea both to the south and the north of the land" (Isl. Ann., pp. 207, 220, 398). It seems to me obvious that the light seen was not caused by an eruption, but must have been some phenomenon in the sky, probably a meteor, and the eruption which at the same time took place was in all probability in a volcanic area in the western part of Vatnajökull. Nor is any value to be attached to the statement of the Skálholt Annals that simultaneously with the Hekla eruption of 1341 there were eruptions in "Hnappar vallar iokli" (i. e. in Knappafellsjökull) and Herdubreid (Isl. Ann., p. 209). No other of the ancient Annals mentions this Öræfajökull eruption, while Gísli Oddsson says in his annal that there was an eruption in Lómagnúpur simultaneously with that of Hekla (Ann. in Isl. farrago, p. 2).

I think we may regard it as certain that during the fourteenth century Öræfajökull was active only once and by that one eruption laid waste Litlahérad. And this eruption may be dated with a fair exactness. The time limit *post quem* is supplied to us by Lögmannsannáll, which has been preserved in the writer's, the Rev. Einar Haflidason's, own handwriting towards the end of 1361. True, the Annal does not say a great deal about the major phenomena of nature, except Hekla's activity, in which the author had special reasons for taking interest, but even so it is incredible that he would have passed over the destruction of Litlahérad if it had taken place before he laid down his pen. Time limit *ante quem* is the death of Thórarinn Sigurdsson, Bishop of Skálholt. In the Vilchins chartulary of the Church of Stafafell in Lón we read: "Further there were transferred to it from Hnappavellir Church by the order of Biskop Thórarinn six cow values and horses to the value of a cow, two "hundreds" worth in chattel, a large crucifix, a chalice and such vestments as there are to be found, two bells from Breidá, and a crucifix" (DI iv, pp. 201—202). In an unprinted essay on the trustworthiness of the chartularies relating to Litlahérad, kindly written at my request by Professor M. Már Lárusson, evidence is adduced to show that Bishop Thórarinn Sigurdsson probably died towards the end of 1364 and that he officially visited Stafafell in the summer of either 1364 or 1363, but it could hardly have been in the same summer as the Öræfajökull eruption took place. Thus it is unlikely that the eruption occurred later than in 1363. Accordingly there is no ground for suspecting the annals most circumstantially describing the eruption when they state that it took place in 1362, especially as Lögmannsannáll puts it at 1367; for in that Annal occurrences after 1361 are frequently five years old. Annals are, moreover, in agreement that Bishop Thórarinn died two years after the eruption. Since the statements of the annal fragment from Skálholt appear to be accurate on many other points, as we shall have occasion to note further on, there is no reason either to doubt that the eruption began at flitting days, i. e. in the early days of June, which would mean about the middle of June by our style of computing time. Our conclusion is therefore that *the eruption that destroyed Litlahérad began about the middle of June in 1362.*

THE JÖKULHLAUPS OF 1362

From what has been said above it may be seen that as early as about 1600 it had become an established belief that tremendous floods were the chief cause of the destruction of Litlahérad, these having literally swept away the farmsteads. And this was Thoroddsen's opinion. His conclusion is that much of the hlaup went south from the summit crater and that it flowed from underneath Kvíárjökull. This opinion he bases on the fact that there is an indisputable jökulhlaup sediment south of Stadarfjall, the so-called Stórugrjót (Fig. 5). That formation extends all the way down to the sea over a wide expanse over which Hólá and Stigá have later been shifting, and the volume of water that here rushed forth has obviously been very great. Thoroddsen's conclusion that the Annal fragment from Skálholt refers to this hlaup is therefore entirely reasonable, for it says there that Knappafellsjökul disgorged into the sea, forming plain sandurs where there had formerly been thirty fathoms water (Thoroddsen 1895, pp. 58, 59; 1925, pp. 101, 108). I have not been able with definite certainty to decide whether on this point Thoroddsen is right or not, but from what I have seen it appears to me most probable that Stórugrjót is older than Kvíármýrarkambur, the western marginal moraine of Kvíárjökull; but this big moraine is certainly prehistoric; most likely it was formed during an advance of Kvíárjökull ab. 500 B.C. (Thorarinsson 1956 b). S. Björnsson of Kvísker, who has studied this problem more thoroughly than I, regards it as certain that Stórugrjót are prehistoric; (pers. inform.). What is certain is that the jökulhlaup producing Stórugrjót occurred after the extrusion of the previously mentioned lava flow W of Kvíárjökull, for this jökulhlaup has washed big boulders up on the fringe of that flow.

Immediately to the west of the Hnappavellir farm group there is a small area called Grjót covered by sediment of similar type as Stórugrjót. Some people in Öræfi believe that in 1362 a hlaup went south from the jökull rushing down the channel of Gljúfurá river and causing a flood around Fagurhólsmýri. Traces may be seen showing that the deep and narrow gully of Gljúfurá had in some places been filled to the brim and pumice been left on its edges, and a short distance north-west of Fagurhólsmýri there are thick layers of light-coloured pumice. But when we look more closely we find that under this pumice is a thick layer of humus soil (Fig. 23). The tephra layers in this soil show indubitably that the upper part of the soil has been formed in historical times, and so it is certain that the pumice derives from the eruption of 1362. In this place a considerable volume of water has rushed forth, but apparently it has not come from underneath the jökull, as is the case with jökulhlaups strictly speaking, but has been formed by melting on its surface under hot pumice bombs that have fallen on the southern slope of the glacier cap. In this way was formed some of the hlaup that accompanied the beginning of the latest Hekla eruption (Kjartansson 1957). The jökulhlaup proper which accompanied the 1362 eruption has very largely flowed to the west of the jökull and rushed forth from underneath the two southernmost glaciers, i. e. Rótarfjallsjökull and Falljökull (Virkisjökull), and indeed Gottskálksannáll plainly says that Knappafellsjökull "rushed over Lómagnúpssandur (i. e. Skeidarársandur) cutting off all roads".

Guided by an eye-witness's description of the jökulhlaups accompanying the eruption of Öræfajökull in 1727, we can form an approximate idea of the manner of the hlaups of 1362. The eye-witness is the Rev. Jón Thorláksson, then rector of Sandfell and living at Hof. This description he wrote half a century after the eruption, at the request of O. Olavius. It runs as follows: 1)

"In the year 1727, on the 7th of August, which was the tenth Sunday after Trinity, after the commencement of divine service in the church of Sandfell, as I stood before the altar, I was conscious of a gentle concussion under my feet, which I did not mind at first; but during the delivery of the sermon, the rocking continued to increase so as to alarm the whole congregation; yet they remarked that the like had often happened before. One of them, a very aged man, went to a spring, a little below the house, where he prostrated himself on the ground, and was laughed at by the rest for his pains; but, on his return, I asked him what it was he wished to ascertain, to which he replied: "Be on your guard, Sir; the earth is on fire!" Turning at the same time towards the church-door, it appeared to me, and all who were present, as if the house contracted and drew itself together. I now left the church, necessarily ruminating on what the old man had said; and as I came opposite to Mount Flaga,2) and looked up towards its summit, it appeared alternately to expand and be heaved up and fall again to its former state. Nor was I mistaken in this, as the event shewed; for on the morning of Monday the 8th, we not only felt frequent and frightful earthquakes, but also heard dreadful reports, in no respect inferior to thunder. Everything that was standing in the houses was thrown down by these shocks; and there was every reason to apprehend, that mountains as well as houses would be overturned in the catastrophe. However the houses did not fall over. What most augmented the terror of the people was, that nobody could divine in what place the diaster would originate, or where it would end.

After 9 o'clock, three particularly loud reports were heard, which were almost instantaneously followed by several floods of water that gushed out, the last of which was the greatest, and completely carried away the horses and other animals that it overtook in its course. When these floods were over the glacier itself slid forwards over the plane ground, just like melted metal poured out of a crucible, and so settling was of such a height, that I could not discover more of the well known mountain Lómagnúpur, than about the size of a bird. The water now rushed down on the earth side without intermission, and destroyed what little of the pasture grounds remained. It was a most pitiable sight to behold the females agony, and my neighbours destitute both of counsel and courage; however as I observed that the current directed its course towards my house, I removed my family up to the top of a high rock, on the side of the mountain, called Dalskardstorfa, where I caused a tent to be pitched, and all the church utensils, together with our food, clothes and other things that were most necessary, to be conveyed thither; drawing the conclusion that should the eruption break forth at

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1) With some corrections I use here E. Hendersons translation of Thorláksson report (Henderson 1818, pp. 256—261).

2) Here is meant the Mount Slaga in front of Rótarfjallsjökull and the glacier behind it, as viewed by the minister on his way between Sandfell and Hof.

some other place, this height would escape the longest, if it were the will of God, to whom we committed ourselves, and remained there. Things now assumed quite a different appearance. The glacier itself burst and many icebergs were run down quite to the sea, but the thickest remained on the plain at a short distance from the foot of the mountain. The noise and reports continuing, the atmosphere was so completely filled with fire and ashes, that the day could scarcely be distinguished from night, by reason of the darkness which followed, and which was only lighted up by the glowing of the fire that had broken through five or six fissures in the mountain. In this manner the parish of Öræfi was tormented for three days together, by fire, water and falling ashes; yet it is not easy to describe the disaster as it was in reality; for the surface of the ground was entirely covered with pitchblack pumice-sand and it was impossible to go out in the open air with safety, on account of the red hot stones that fell from the atmosphere, and many who ventured out covered their heads with buckets and other such utensils. On the 11th it cleared up a little in the neighbourhood, but the ice-mountains still continued to send forth smoke and flames. The same day I rode, in company with three others, to see how matters stood with the parsonage, as it was most exposed; but we could only proceed with the utmost danger, as there was no other way except between the ice-mountain and the glacier that had slid forwards over the plain, where the water was so hot that the horses almost got immanageable; and just as we entertained the hope of getting through by this passage, I happened to look behind me, when I descried a fresh deluge of hot water descending from above, which, had it reached us, must inevitably have swept us before it. Contriving, of a sudden, to get on the ice I called to my companions to make the utmost expedition in following me; and be those means we reached *Sandfell* in safety. The whole of the farm, together with the cottages of two tenants, had been destroyed; only the dwelling houses remained, and a few spots of the *túns*. The people stood crying in the church. The cows which, contrary to all expectation, both here and elsewhere, had escaped the disaster, were lowing besides a few hay-stacks that had been damaged. At the time the jökulhlaup broke forth the half of the people belonging to the parsonage, were in four newly-constructed sheep cots belonging to the chalet, where two women and a boy took refuge on roof of the highest; but they had hardly reached it, when, being unable to resist the force of mud that was forced against it, it was carried away by the deluge of water, and as far as the eye could reach, the three unfortunate persons were seen clinging to the roof. One of the women was afterwards found among the mud of the jökulhlaup, but burnt, and as it were parboild; her body was so damaged and tender but it could scarcely be touched.

Everything was in the most deplorable condition. The sheep were lost; some of which were washed up dead from the sea in the third parish from *Öræfi*. The hay that was saved was found insufficient for the cows, so that only a fifth part of them could be fed. The mountain continued to burn night and day, from the 8th of August, as already mentioned, till the beginning of spring, in the month of April the following year, at which time the stones were still so hot, that they could not be touched; and it did not cease to emit smoke till the near end of the summer. Some of them had been completely burnt and calcined; some were black and full of holes; and others were so loose in their contexture that one could blow through them. The most of the horses, which had not been swept into the ocean, were afterwards found completely mangled. On the first day of summer 1728, I went with a person of quality to examine the rifts in the mountain, along which it was for the most part possible to creep. I found here a quantity of salpetre, and could have collected it, but did not choose to stay long in the excessive heat. At one place a heavy outburnt stone lay across a large fissure; and as it rested on a small basis we easily dislodged it into the chasm, but could not observe the least signs of its having reached the bottom. These are the more remarkable particulars that have occurred to me with respect to this mountain; however I must add that one tenant told me that he had, before the fire broke out, heard a sound in the mountain like a moan or chatter, but trying to hear it more clearly it disappeared. I took notice of this, being not less curious about it, and I can not deny that I observed the same. This is also said to have happened in connection with other eruptions of this kind.

Thus God hath led me, through fire and water, through much trouble and adversity, to my eightieth year. To him be the honour, the praise and the glory for ever" (Olavius, 1780, pp. 603—607).

The enormous dead ice masses resulting from such a jökulhlaup can remain for decades or even centuries before being thoroughly melted. When Ólafsson and Pálsson travelled through Öræfi in early September 1756 they describe the dead ice between Hof and Sandfell as "a terrible area covered by iceblocks and rocks, pumice and ash, half a mile[1]) broad and two miles in length. It was very difficult to travel over this area as one had not only to cross steep banks and troublesome parallel-running ridges but also had to be very careful to avoid both man and horse falling down into fissures or pits, abundant everywhere between the iceblocks. This ice-covered area is like the front of Skeidarárjökull, only much lower" (Ólafsson 1772, p. 783). The eastern part of this area still has the name Svartijökull (Black Glacier, cf. Fig. 11), and further southwest there are three "glaciers", Forarjökull, Midjökull and Grasjökull (Morass Glacier, Middle Glacier and Grass-Covered Glacier).

The three last named dead ice areas may, at least partly, be remnants of the 1362-jökulhlaup from Rótarfjallsjökull, which presumable took about the same course as in 1727, emerging from under the glacier snout on both sides of the Slaga Mountain. On closer examination one occasionally finds within the 1727 dead ice area spots of the 1362-jökulhlaup sediment which is more clayish than that of the 1727-hlaup (the s. c. Hnaus, E of Kotá, is such a spot), but mostly it is covered by the 1727-sediment, and as a whole the jökulhlaup from Rótarfjallsjökull in 1362 may have been of about the same size as in 1727.

[1]) Danish miles. One D. m. about four English miles.

Fig. 13. Jökulhlaup sediment from 1362 about 1 km S of Svínafell. Wiew towards S. — *Photo S. Thorarinsson, July 5th 1957.*

As to the jökulhlaups from Falljökull the 1362-hlaup was probably much bigger than in 1727, as its sediments are spread over much greater area, especially towards NW and W, where they are not covered by the 1727-hlaup-sediment. This area stretches westwards from Svínafellsfjall to Skeidará and the easternmost part is called Langafellsjökull. Fig. 13 shows a typical surface of an area covered by jökulhlaup sediment, ab. 1 km S of the Svínafell farm. Further westwards on the plain, up to 4 km from the present snout of Falljökull one finds very big angular blocks of tuff-breccia, some scattered, others in groups, f. ex. at Selhóll (Fig. 14). The biggest blocks rise 4—5 m above the present gravel plain and the area of the base of the biggest block I have measured near Selhóll was more than 50 m². How deep these blocks rest in the gravel is not known, but the biggest blocks certainly weigh more than 500 tons. These blocks were undoubtedly transported from the glacier by the 1362-hlaup. The so-called Smjörsteinn (Butter Stone) on Háuaurar SE of Svínafell is also from the 1362-hlaup.

Fig. 14. Selhóll 2.5 km SSW of Svínafell, Öræfi. The big blocks are from the jökulhlaup of 1362. The Svínafell farm is seen at the foot of the hills in the background. — *Photo S. Thorarinsson, July 7th 1957.*

Presumably most of these enormous watermasses came from the summit area of Öræfajökull and forced their way beneath the ice cover of the northern, spoon-shaped part of the intake area of Falljökull. This intake area cuts deeper into the summit crater than any other intake area of the outlet glaciers of Öræfajökull. Both here and at Rótarfjallsjökull some relatively small amount of the flood water was probably caused by the falling of hot bombs on the firn area. The jökulhlaup from Falljökull flooded most of the area between Svínafell and the present Falljökulskvísl, but how far westward it extended we cannot tell, as the western part of the area has been covered by recent sandur sediments deposited by the Skeidará river. The great relative height of Öræfajökull suggests that its hlaups are of the same type as the hlaup caused by the Katla volcano in Mýrdalsjökull, i. e. that the discharge rises very rapidly to an euphemeral maximum, at which the discharge is very great compared with the total volume of hlaup-water (cf. Thorarinsson 1957 b). This is supported by Thorláksson's description quoted above. The hlaup was probably discharged in less than one day, and it is not an unreasonable estimate that the combined discharge of the hlaups from Falljökull and Rótarfjallsjökull at their euphemeral maximum was at least 100 000 m^3/sec. or about that of the river Amazon. It may even have been considerably greater. Certainly there is no exaggeration in Gottskálksannál's statement that Knappafellsjökull "rushed over Lómagnúpssandur cutting off all roads". There is not necessarily any great exaggeration in the statement of the Annal fragment from Skálholt, that plain sands were formed where there were previously thirty fathoms water. The material carried by the hlaup from underneath Falljökull and Rótarfjallsjökull must have been tremendous. The material carried by the jökulhlaup that accompanied the Katla eruption in October 1918 formed a promontory extending about one kilometer into the sea, though by now tidal currents have largely worn away that promontory. We may assume that the 1362 hlaups extended farther out the coastline on both sides of Ingólfshöfdi.

It deserves to be mentioned, in connection with the jökulhlaup from Falljökull, that the highest part of the mountain ridge that divides the two branches of that glacier has the name Raudikambur (Fig. 4). Maybe this partly explains why the Rev. Jón Egilsson in his Bishops' Annals says that Thjórsárdalur was laid waste by an eruption in Raudukambar in that same valley in the times of the same seven bishops (cf. p. 27) where Öræfi was laid waste. There has never been an eruption in Raudukambar in Thjórsárdalur in Postglacial Time but from its appearance a layman might justifiably conclude that there had been. And seeing that a mountain bearing the same name is connected with the Öræfajökull eruption of 1362, these two factors might suffice for giving rise to Jón Egilsson's erroneous assumption when writing his Annals two and a half century later.

But dreadful as the jökulhlaups of 1362 undoubtedly were, washing away a number of farmsteads in that part of the settlement which apparently was most thickly populated in the fourteenth century, viz. the section between Hof and Svínafell farms, the belief that these hlaups destroyed all habitation in Öræfi must be far from accurate. Possibly a minor hlaup came from Svínafellsjökull, caused by surface melting in the intake area of that glacier — and it is not unlikely that surface melting due to the falling of bombs, may have resulted in some hlaup water flowing down nearly every gully in Öræfi, as tradition has it — but certainly no big flood has come from Svínafellsjökull, and no traces of it are to be found. Farms to the north of Svínafell can thus hardly have been deserted on account of hlaups. And I believe that few, if any, of the farms to the east of Hof were deserted for that reason, even if hlaups played their part in the desertion of farms in the neighbourhood of Fagurhólsmýri.

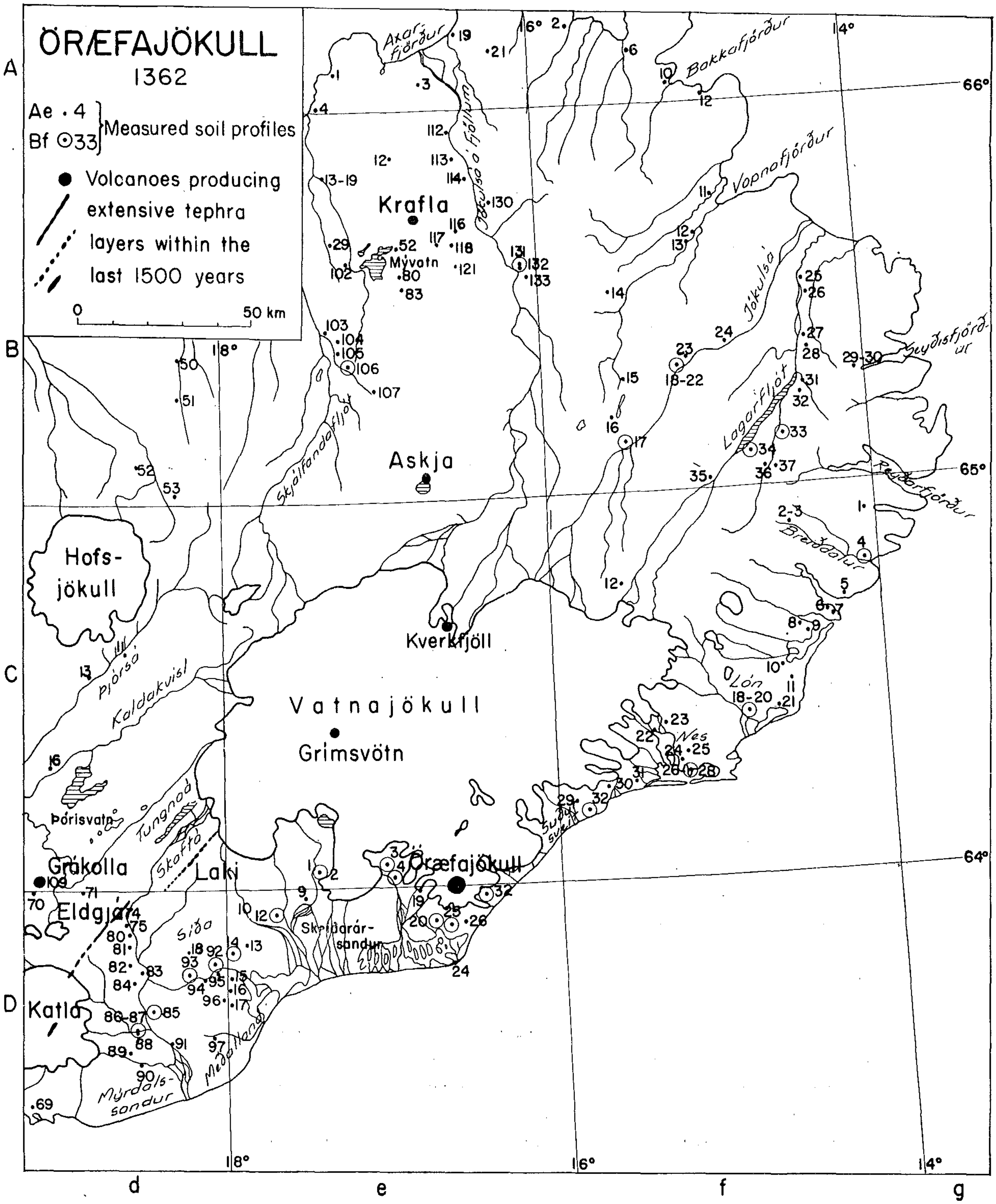
I can see no reason for doubting the statement of Gottskálksannáll and the

Annals of Jón Egilsson that Raudilækur Church withstood the hlaup, in spite of the fact that it was out on the lowland plain somewhere west of Sandfell, though probably it stood on some minor hill or eminence. No doubt many farms in Litlahérad had a better defence against water floods than Raudilækur.

Contrary to Thoroddsen I am of the opinion that although many farms were destroyed by the hlaups of 1362, especially in Raudilækur Parish, yet it was the tephra fall that took by far the heaviest toll. For this opinion I find some support in contemporary records, particularly the Annal fragment from Skálholt. The sand is formed into such drifts by the wind that buildings are almost blotted out from view, and the sea is so packed with drifting pumice off the West Coast that sailings are made almost impossible. This indicates no little fall of tephra. And if the annals are correct in stating that the greater part of Hornafjördur and Lón were laid waste, nothing but tephra could have been the cause of this. And we are now in a position to test the accuracy of the ancient and laconic records by means of tephrochronology. So let us now leave Öræfi for a while and see what soil profiles in E Iceland and their tephra layers have to tell.

THE EVIDENCE OF THE TEPHRA LAYERS

One of the aims of tephrochronological studies in Iceland has been to supplement and correct the information available in written sources about volcanic eruptions in historical times. One of the first tephra layers that awoke H. Bjarnason's interest and mine when we started the study of tephra layers in the early 1930's was a light layer found occurring in the soils in SE Iceland. Independently of each other we had measured some profiles in Austur-Skaftafellssýsla in 1933 (Bjarnason) and 1936 (Thorarinsson) and together we measured some profiles in E Iceland in Aug. 1937. However we had only studied this light layer in about 20 profiles when we in a paper of 1940 published a map showing its approximate distribution (Bjarnason & Thorarinsson 1940, Fig. 5). As stated in that paper the profiles studied were too few to allow any exact mapping of the extension of the layer or estimation of the volume of the tephra. Because of a misinterpretation of a passage in the Reverend E. Hálfdánarson's contemporary description of the eruption in Öræfajökull 1727 where he mentions "white and porous pumice" (*"vikur, hvítur og póróttur"* Blanda i, p. 58) we concluded in the above mentioned paper that the light tephra layer spread over SE Iceland was "in all probability" produced by the eruption of Öræfajökull 1727 (op. cit. p. 13). Having returned to Iceland in 1945 after a five years stay in Sweden during the second world war, I started a more thorough and systematic study of the tephra layers


ÖRÆFAJÖKULL
1362
Ae · 4
Bf ⊙33
Measured soil profiles
Volcanoes producing extensive tephra layers within the last 1500 years
0
50 km
Axarfjörður
Bakkafjörður
Vopnafjörður
Krafla
Mývatn
Jökulsá
Seyðisfjörður
Lagarfljót
Skjálfandafljót
Askja
Reyðarfjörður
Breiðdalur
Hofsjökull
Kverkfjöll
Þjórsá
Kaldakvísl
Vatnajökull
Grímsvötn
Lón
Nes
Þórisvatn
Tungnaá
Skaftá
Laki
Suðursveit
Grákolla
Öræfajökull
Eldgjá
Skeiðarársandur
Síða
Katla
Meðalland
Mýrdalssandur
66°
65°
64°
18°
16°
14°
A
B
C
D
d
e
f
g

all over the country. That summer I travelled through Skaftafellssýslur and measured many new profiles, and remeasured more carefully those previously measured. It became then quite clear that the above-mentioned light layer was from the eruption of Öræfajökull 1362 (Thorarinsson 1946).[1] Since 1945 I have nearly every summer travelled through some parts of E Iceland and measured soil profiles, as may be seen from Table 3. Some of the profiles previously measured in E Iceland were remeasured and many new ones added. Some of my travels, especially through the interior, have mainly been done for the purpose of measuring soil profiles, and I have then been able to measure them with satisfying accuracy. But during some other trips I have sometimes had to do the measurements rather hastily as time for such measurings has not then always been available; and they are, in fact, rather time-consuming.

For registrations of soil profiles measured all over Iceland — they are now nearly eight hundred — it has been necessary to divide the map of the country into areas. The areas used are delimited by the meridians and latitude circles and each area is designated by two letters, like the squares in a chess table, as shown on the maps Figs. 15 and 28. On these maps are plotted all profiles where the layer Ö 1362 has been found. These profiles are listed in Table 3. Within the 0.1 isopachyte (cf. the map Fig. 28) most of the profiles where Ö 1362 was not found, are also plotted, on the maps outside that isopachyte only some of the profiles measured. Encircled in the map Fig. 15 are the profiles shown on Figs. 16—18. Before dealing especially with the layer Ö 1362 something must be said about the profiles in general and some tephra layers in particular.

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1) It should in this connection be mentioned that Thoroddsen observed white pumice in the soil in Öræfi on his travels through that district in 1894 and regards it as likely that it was produced by the 1362-eruption (Thoroddsen 1895, p. 58). E. Ólafsson writes that on his and B. Pálsson's journey between Hof and Hnappavellir in early September 1756 "we had a pit dug one ell deep in the soil that was rather compact everywhere in this area, we found a 1½ feet thick layer of white pumice, partly in big pieces, partly finely ground" (Ólafsson, 1772, p. 783).

Fig. 15. Map showing the location of soil profiles. Encircled are profiles drawn on Figs. 16—18. (Obs. Dd 18 on the map should be Dd 78.)

TABLE 1

Chemical analyses of tephra layers

%	1 Ö 1362	2 Ö 1362	3 Hvannadals-hnúkur	4 Ö 1727	5 K 1918	6 K 1755	7 K 1755	8 K 1625
SiO_2	68.56	70.14	74.12	56.05	47.68	47.02	48.63	46.93
TiO_2	0.29	0.32	0.36	1.47	5.01	4.77	—	—
Al_2O_3	14.45	13.28	12.97	14.17	12.54	13.59	—	—
Fe_2O_3	1.45	3.98[1])	1.41	3.37	3.44	3.55	—	—
FeO	2.47	—	0.91	10.27	12.34	11.94	—	—
MnO	0.10	0.11	0.05	0.36	n. d.	0.24	—	—
MgO	0.05	0.02	nil	1.41	5.25	5.38	—	—
CaO	1.55	1.26	0.98	5.41	9.58	8.88	—	—
Na_2O	5.01	5.83	4.96	4.20	2.43	2.37	—	—
K_2O	3.40	3.38	3.90	1.48	0.88	1.12	—	—
P_2O_5	0.05	0.02	0.14	0.61	0.23	—	—	—
S	—	—	—	—	—	—	—	—
H_2O^+	2.63	1.89	0.23	0.90	0.44	1.48	—	—
H_2O^+	—	0.24	0.02	—	0.15	0.68	—	—
Sum	100.01	100.47	100.05	99.70	99.97	101.02	—	—

1) FeO + Fe_2O_3 calculated as Fe_2O_3.

Notes on Table 1.

1. Greyish white pumice (max. particle diam. 5 cm) from the 1362 eruption of Öræfajökull. Collected by S. Thorarinsson 16/8 1945 in the homefield of Svínafell in Öræfi (profile Dc 19). Registered A 1945:72 (Mus. Nat. Hist. Reykjavík). Analyst. Bruun.
2. Greyish white pumice from the 1362-eruption. Collected by J. Jónsson at Sandfell in Öræfi. Analyst. Central Analytical Laboratory, Uppsala. (Cited from Jónsson 1957, p. 177.)
3. Light grey rhyolite from the E face of Hvannadalshnúkur. Collected by G. Jónasson June 6th 1956. Registered A 1956:24. Analyst. M. Mouritzen. (Cited from an unpublished paper of A. Noe-Nygaard.)
4. Brownish black pumice (max. particle diam. 1 cm) from the eruption of Öræfajökull 1727. Collected by S. Thorarinsson 16/8 1945 at Skaftafell in Öræfi (profile Cc 4, Fig. 17:10). Registered A 1945:73. Analyst. Bruun.
5. Glassy basalt scoria from the eruption of Katla 1918. Analyst. Raoult. (Cited from Lacroix 1923.)
6. Black pumiceous tephra (max. particle diam. 0.4 cm) from the eruption of Katla

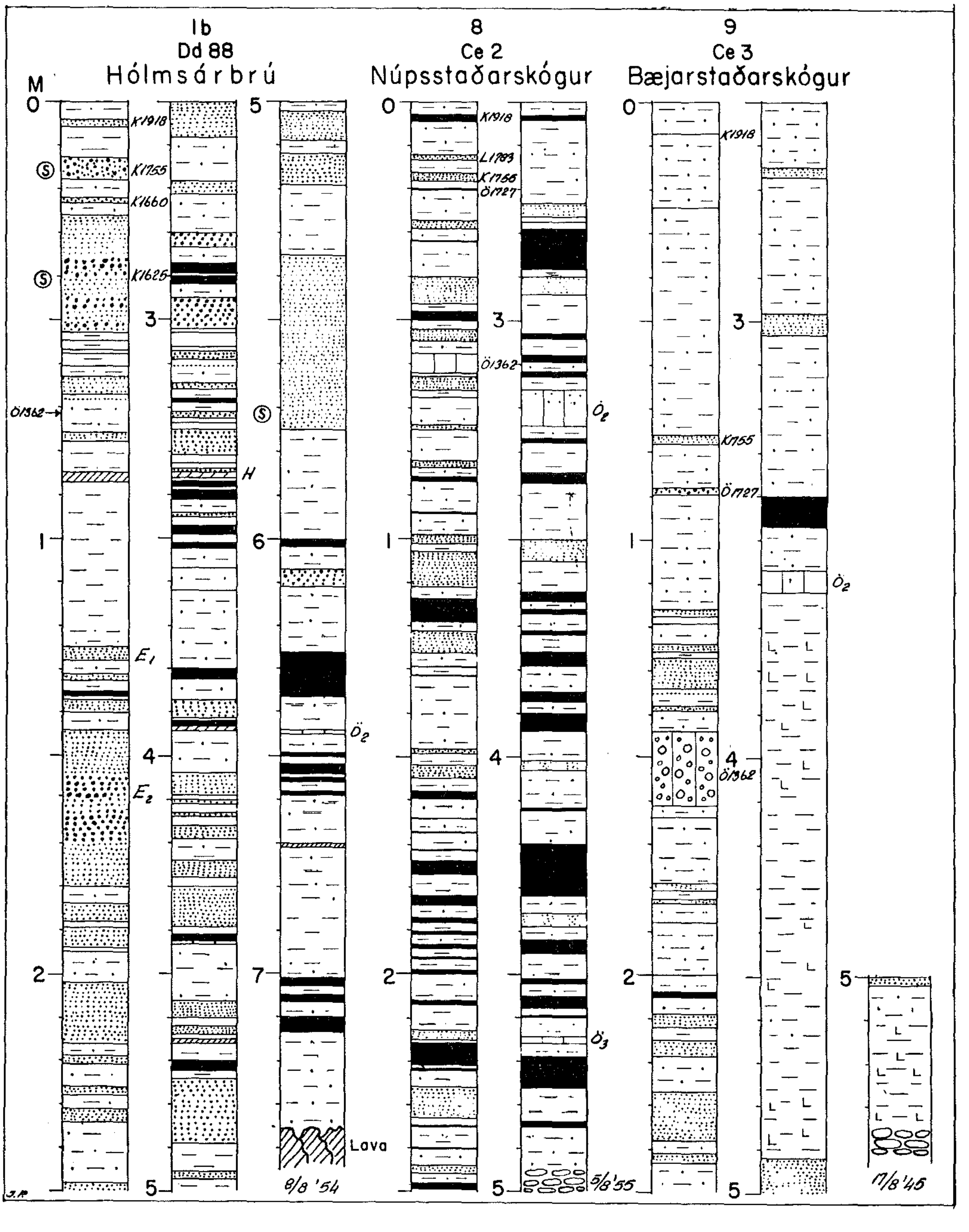
TABLE 1

found in soil profiles in E Iceland.

9 E_1	10 H 1845	11 H 1845	12 L 1783	13 Gr 1903	14 H_3	15 H_4	16 A 1875	17 H_1
47.17	59.20	59.90	50.38	49.61	68.99	71.27	70.50	66.84
4.69	—	—	2.11	2.94	0.24	—	0.75	0.30
13.23	15.20	—	14.16	11.49	13.36	—	12.70	14.75
5.35	9.60	—	4.17	4.66	0.42	—	2.20	1.75
10.76	—	—	9.25	11.33	3.29	—	2.70	3.88
0.22	—	—	0.23	0.26	0.15	—	—	0.20
5.84	0.60	—	6.58	5.55	1.04	—	1.02	0.96
10.05	4.82	—	11.42	9.66	2.62	—	3.02	3.24
2.49	} 6.74	—	2.01	2.45	3.22	—	3.56	2.84
0.91		—	0.53	0.33	2.15	—	2.12	3.13
—	—	—	—	0.32	1.93	—	—	0.38
—	—	—	—	0.13	—	—	—	—
0.00	—	—	0.33	1.00	2.59	—	0.78	1.48
0.00	3.03	—	0.00	0.18	—	—	0.11	0.14
100.71	99.19	—	101.17	99.91	100.00	—	99.46	99.89

1755. Collected by S. Thorarinsson 6/8 1955 in profile Dd 88 on the N bank of the river Hólmsá just W of the bridge. Sample taken from lower part of the tephra layer. Registered A 1955:66. Analyst. H. Jónsson.

7. Black, silty tephra (cf. Fig. 27) from the eruption of Katla 1755. Collected by G. Kjartansson 4/8 1944 at the river Thverá in Fljótshverfi (profile De 10 a and Fig. 20). Registered A 1945:83. Analyst. H. Jónsson.
8. Black, pumiceous tephra (max. particle diam. 1.0 cm) from the eruption of Katla 1625. Collected by S. Thorarinsson 6/8 1955 in profile Dd 88 (cf. analysis nr. 6). Registered A 1955:67. Analyst. H. Jónsson.
9. Black, scoriaceous tephra (max. particle diam. 3.0 cm) from an eruption in the N part of Eldgjá. Minim. age 2000 years (cf. Jónsson 1958). Collected by S. Thorarinsson 3/8 1955 in profile Dd 74 (cf. the map Fig. 15), ab. 2.5 km SE of the outflow of Strangakvísl from Eldgjá. Registered A 1955:64. Analyst. H. Jónsson.
10. Silty tephra from the eruption of Hekla 1845. Collected on Orkney, Orkney Islands, 1845. Analyst. A. Connell. (Cited from Edinb. New Phil. Journ. 1846, p. 218.)
11. Bomb fragment from the 1845 eruption fallen in the neighbourhood of Hekla and collected by Schythe 1846 and preserved in the Min. and Geol. Mus., Copenhagen. Analyst. Me Mouritzen.



Ib
Dd 88
Hólmsárbrú
8
Ce 2
Núpsstaðarskógur
9
Ce 3
Bæjarstaðarskógur
M
K1918
K1755
K1660
K1625
Ö1362
H
E1
E2
Ö2
Lava
8/8 '54
L1783
K1756
Ö1727
Ö1362
Ö3
5/8 '55
17/8 '45

12. Brownish black tephra (pumice, max. particle diam. 5 cm) from the eruption of the Laki crater row 1783. Collected by G. Gestsson 21/9 1952 in a cave on the W bank of the river Tungná, ab. 23 km WNW of Laki (cf. Gestsson 1954). Registered A 1952:16. Analyst. H. Jónsson.
13. Black finegrained tephra ("ash") from the eruption of Grímsvötn 1922, collected on a ship off Cape Langanes 29/5 1903 at 12 o'clock noon. In the Min. Mus. Coll., Copenhagen. Analyst. Me Mouritzen. (Cited from Mouritzen and Noe-Nygaard 1950, p. 583.)
14. Light silty tephra from Hekla. Age ab. 2700 years (cf. p. 49), collected by S. Thorarinsson 1937 in a soil profile at Lögmannshlíd in Eyjafjördur, 210 km N 20° E of Hekla. Analyst. N. Sahlbom. (Cited from Thorarinsson 1944, p. 81.)
15. Light pumice from Hekla. Age ab. 4000 years (cf. p. 49). Collected by S. Thorarinsson 6/7 1949 in a profile E of Búrfellsháls, Thjórsárdalur. Registered A 1949:17. Analyst. Jóh. Jakobsson. (Cited from Thorarinsson 1954, p. 36.)
16. Light yellowish pumice from the eruption of Askja 1875. Collected by M. Trautz 1910 in Askja. Analyst. Hoppe. (Cited from Hoppe 1934, p. 471.)
17. Greyish white pumice from the eruption of Hekla 1104. Collected by S. Thorarinsson 1939 in a soil profile at the farmruin Stöng, Thjórsárdalur, 18 km NNW of Hekla. Analyst. N. Sahlbom. (Cited from Thorarinsson 1944, p. 81.)

Layers from Katla.

Fig. 16 shows three profiles, all of which were measured down to the bottom of the soil cover. The great number of tephra layers (77 in all) in profile Dd 88 is in all probability mainly due to the vicinity of the subglacial volcano Katla, situated ab. 25 km west from the profile. This volcano seems to have been very active through the whole Postglacial Time. Four of the historical tephra layers from Katla have been identified with certainty in the profile (cf. also Fig. 17). The youngest of these layers, K 1918, is found in nearly all soil profiles in Vestur-Skaftafellssýsla and Öræfi. During the eruption, that lasted from Oct. 12th to Nov. 4th, the tephra was mainly carried towards NE and N, and it caused considerable damage, especially in the district Skaftártunga (Jóhannsson 1919, Sveinsson 1919) and so much ash fell two times in Öræfi as almost to prevent all grazing (pers. inform. of farmers in Öræfi).

The 1918-layer is now found in considerable depth in the soil profiles, an indication of rapid deposition of wind-born material from areas where the soil erosion is going on, or from the sandur areas.

Fig. 16. Soil profiles from Skaftártunga, Fljótshverfi and Öræfi.
Location on the map Fig. 16. Legend on Fig. 18.

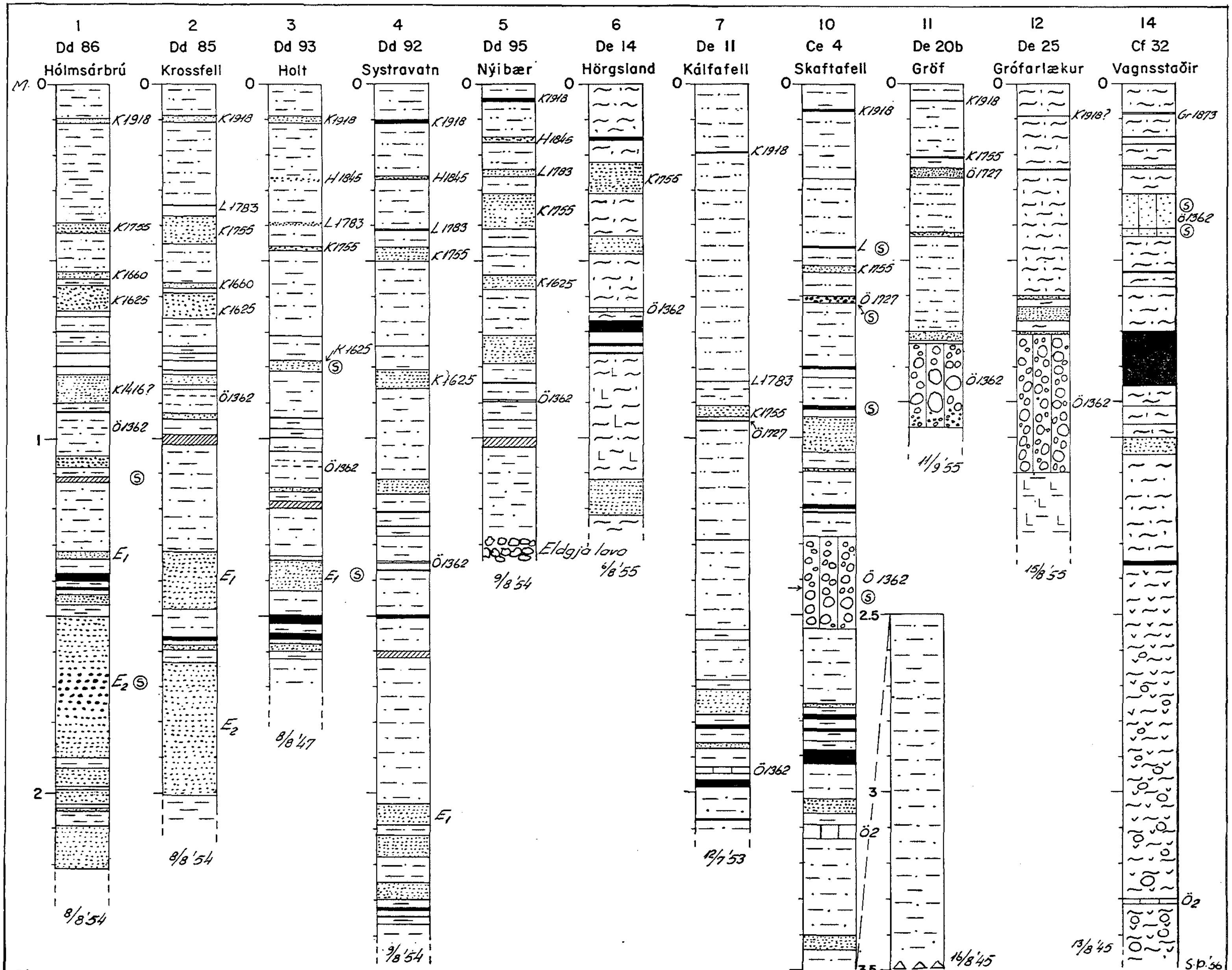


Fig. 17. Soil profiles with Ö 1362.

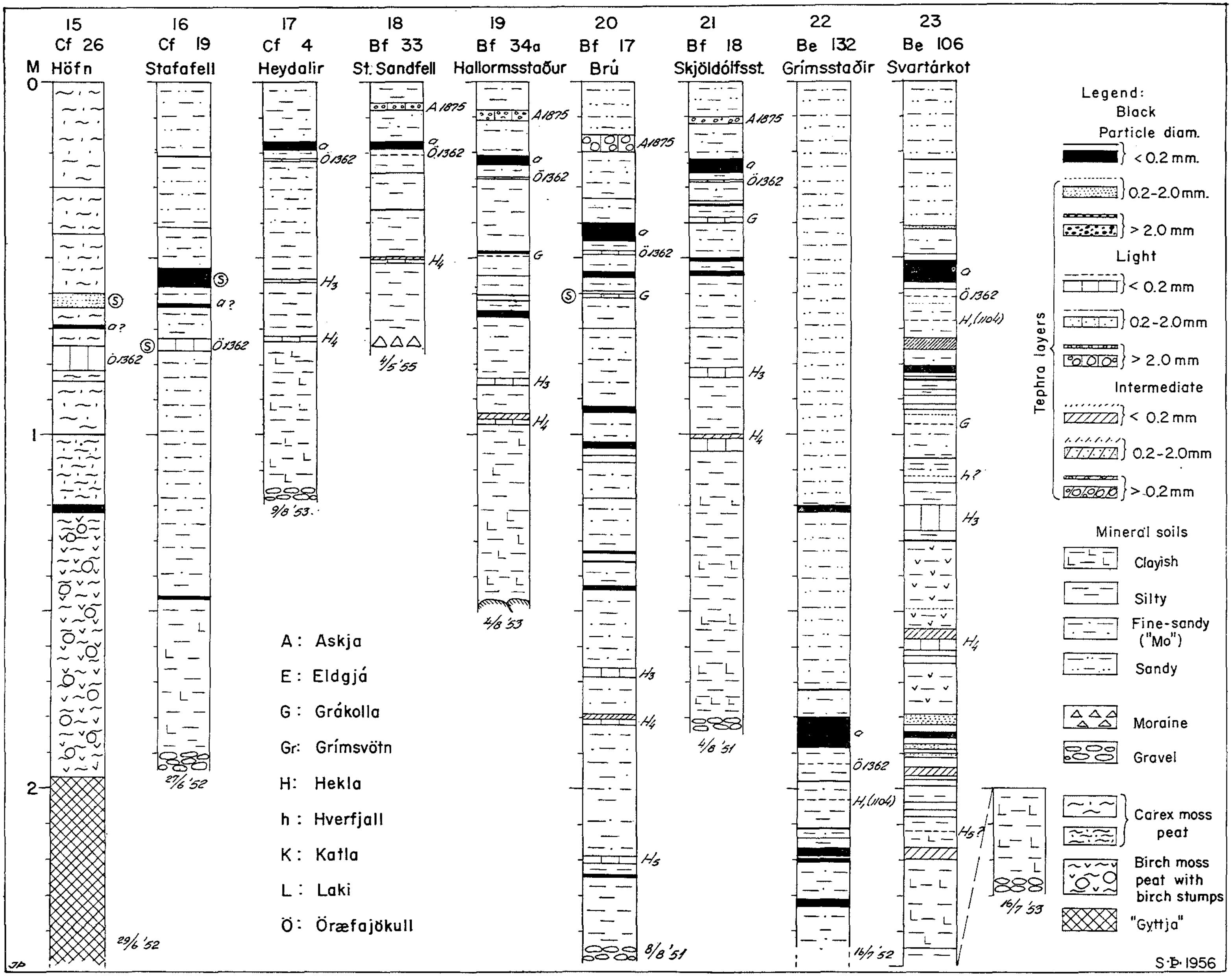


Fig. 18. Soil profiles with Ö 1362.

K 1755 — This layer was produced by one of the most disastrous eruptions of Katla in historical time. During the first phase of this eruption, that started on Oct. 17th, an enormous amount of tephra was whirled out and carried eastwards, and the effect of the tephra fall on the districts Skaftártunga, Álftaver and the western part of Sída was catastrophic. According to contemporary records (Safn t. s. Îsl. IV, pp. 235—251), the thickness of the tephra layer when freshly fallen was "half an ell" (ab. 30 cm) on level ground E of Mýrdalssandur, and when Ólafsson and Pálsson visited Skaftártunga in Aug. the following summer only one farm was inhabited in that district (Ólafsson 1772, pp. 772—775). As a matter of fact, the areas most seriously affected had hardly recovered when hit by the still more disastrous catastrophe of 1783.

According to Ólafsson and Pálsson the pumice from the 1755 eruption was carried to the E part of Sída. In Öræfi so much ash fell that the grassland became quite black (op. cit., p. 782).

The 1755-layer is upon the whole the thickest layer from historical time found in Vestur Skaftafellssýsla E of Mýrdalsjökull. On the E bank of the river Thverá (Vatnid) opposite the old site of the Thverá farm (Dd 11) a black tephra layer 10—20 cm thick is covered by the 1783-lava without any humus soil between (Fig. 20). G. Kjartansson, who kindly pointed out this place to me in 1945, was of the opinion that this layer was that of the Laki eruption 1783 (pers. inform.) and that was also my opinion until last summer hen I made a more detailed study of this profile, and compared it with profiles in the vicinity. It then became clear that the black layer (cf. further about this layer p. 80) was really that of Katla 1755.

K 1660 and 1625 — During the 1721 eruption of Katla the tephra was mainly carried towards N and NW (Thorarinsson 1955). During the eruptions 1660 and 1625 that started on respectively Nov. 3rd and Sept. 2nd the tephra was mainly carried towards E and both layers have been identified in soil profiles. Acc. to contemporary records (Safn t. s. Îsl. iv, pp. 218—219 and 210—215), which may be regarded as satisfactorily reliable, the amount of tephra produced by the 1660 eruption has been relatively small, although causing some damage, especially in Skaftártunga, whereas the tephrafall 1625 seems to have been nearly as great as that of 1755. It affected most seriously the districts Skaftártunga, Sída, Landbrot and the northern part of Medalland. Nearly all farms in Skaftártunga were temporarily abandoned.

The written information available about the eruption of Katla before 1625 is scanty and no layer has as yet been identified with absolute certainty. It seems however probable that the layer designated K 1416? is from the eruption of Katla known to have occurred in that year (Isl. Ann. p. 292).

Table 1 shows the chemical composition of the 1918 and 1755 layers and the SiO_2 per cent of the 1625 layer. It may be added that the SiO_2 per cent of the 1721 tephra from Katla is 46.63 (analyst. H. Jónsson). The chemical composition of the Katla tephra evidently changes very little from one eruption to another.

The Eldgjá Layers.

Not all of the black layers in profile D 88 come from Katla. At least two thick layers come from the famous fissure system Eldgjá. Layer E_1 I have followed via the profiles Dd 74—75 and 81—85, from its source, the northernmost part of Eldgjá proper, between Gjátindur and Móraudavatnshnjúkar (Thorarinsson 1955 b). Whether other parts of Eldgjá took part in the production of this layer is not known. E_2 comes probably from the southern part of Eldgjá and is more than 100 years older than E_1. In the southern bank of Hólmsá, at the bridge, E_2 is covered by a lava flow from Eldgjá without any soil between. E_1 is in all probability prehistoric and of the same age as the Eldgjá lava E of Kúdafljót, and its age is at least 2000 years.

In an unpublished monograph on Eldgjá and its lavaflows, kindly put at my disposal, G. Robson has stressed the similarity in chemical composition between the eruption products of Eldgjá and Katla. Robson points out that Katla is situated on the continuation of the Eldgjá system towards SW and he suggests, "that Katla and Eldgjá comprise a single volcanic system". The analysis of Eldgjá tephra presented in Table 1 shows a chemical composition very similar to that of the Katla tephra. It should be pointed out, however, that even the Grímsvötn tephra has nearly the same chemical composition, without being regarded by Robson as belonging to the same volcanic system.

Hekla 1845.

One of the tephra layers identified in soil profiles in Vestur-Skaftafellssýsla is that of Hekla's next but last eruption, which began on Sept. 2nd 1845. During the initial phase of this eruption the tephra was carried towards SE and the axis of max. thickness of the layer runs through northern Skaftártunga and central Sída where the layer is said to have been "1—1½ inch thick" as freshly fallen in some places (Schythe 1847, p. 52). Schythe also states that the tephra fall which in Sída started at about 11 o'clock on Sept. 2nd consisted of greyish yellow scoria of the size of buck-shot. This scoria fall lasted about one hour and was succeeded by the falling of black sand and still later by fine black "ash" (op. cit., p. 52). The analyses 10 and 11 in Table 1 correspond mainly to the tephra that fell during the first hour. The fine-grained ash that fell afterwards in Skaftártunga was certainly more basic (cf. Thorarinsson 1954 a).

In southern Skaftártunga I have not found any layer from the 1845 eruption. In central Sída the thickness of the 1845-layer in soil profiles is 0.5—1.5 cm, and the grain size is mainly coarse sandy.

Layers from Grímsvötn.

The profile Ce 2, from Núpsstadarskógur, shows nearly as great a number of tephra layers (73 in all) as the profiles in Skaftártunga. In Sída there are not so many layers in the profiles and this shows that many of the layers in Núpsstadarskógur must have other sources than the layers found in Skaftártunga. Most likely many of these layers come from eruption centres in Vatnajökull, especially from the Grímsvötn area. It is somewhat astonishing on the other hand that the layers in Ce 2 are so much more numerous than in profile Ce 3 from Bæjarstadarskógur, 20 km farther east. This might however be partly explained by volcanic activity in centres in SW Vatnajökull, especially within the Thórdarhyrna – Geirvörtur area, situated farther south and south west than Grímsvötn, and thus nearer to Núpsstadarskógur than Bæjarstadarskógur. But a lot of layers in profile Ce 2 are undoubtedly from Grímsvötn. I have not as yet made any attempt to identify Grímsvötn layers except the layer from the 1873 eruption. This layer is found in profiles in Sudursveit and Mýrar (Fig. 17:14) where there was a heavy tephrafall from Grímsvötn on Jan. 10th 1873, so heavy that the farmers had to clear the homefields from the tephra layer the following spring (cf. the newspaper Nordanfari Aug. 9th 1873, p. 109). The total tephra production of the 1873 eruption may be estimated to about 0.3 km^3 when freshly fallen, which is much more than the normal for Grímsvötn eruptions during the last two centuries.

An analysis of Grímsvötn tephra is given in Table 1. The chemical composition of Grímsvötn tephra from the eruptions in 1922 and 1934 is nearly identical with that of the 1903 eruption (Áskelsson 1936, Barth 1937, Mouritzen and Noe-Nygaard 1950, Noe-Nygaard 1951).

The light Hekla Layers.

It is beyond the scope of this paper to deal with the light Hekla layers H_1 (1104), H_3, H_4 and H_5. They will be dealt with in a later paper, as their extension and thickness distribution may now be mapped rather exactly with the help of the many measured soil profiles where they occur. They have all been spread mainly towards N and NE. Layers H_3, H_4 and H_5 have now all been dated with the C^{14} method and these dates are well in accordance with previous tephrochronological estimates (cf. Thorarinsson 1954). The C^{14} dates are as follows:

H_3	(Y - 85)	2720 ± 130	years
H_4	(K–140)	4000 ± 150	„
		3650 ± 150	„
	Av.	3830 ± 120	years
H_5	(K–141)	6320 ± 190	„
		6510 ± 250	„
	Av.	6410 ± 170	years

The age measurements of H_3 were done by the Geochronometric Laboratory in Yale, those of H_4 and H_5 by the Carbon-14 Dating Laboratory in Copenhagen.

As to layer H_5, I want to mention that, when discussing its age in my paper on Laxárgljúfur, I had not found that layer on the older Thjórsárlava in the "Land" district and therefore thought it most likely that it was older than this enormous lava flow. Later I have found the layer on that lava flow and the flow is thus definitely somewhat older than 6500 years.

Askja 1875.

The tephra layer produced by the great explosive eruption in Askja 1875 is the youngest of the light rhyolitic layers found in Icelandic soils.

The stratigraphy of the tephra as revealed in the steep northern bank of lake Öskjuvatn indicates that the production of rhyolitic tephra probably started in Askja already at the beginning of the eruptive activity at the turn of the year 1874/1875. It is certain, however, that no tephra was carried to the inhabited districts in E Iceland until during the great paroxysm on 28—29 March 1875. In 1944 I drew an isopachyte map of the tephra layer, based on contemporary information about the thickness and extension of the tephra layer (Thorarinsson 1944, p. 98). When comparing this map with the occurrence of layer A 1875 in the soil profiles we find that the thickness of the layer as measured now in the profiles is on the whole 2—3 times less than according to the isopachyte map, which shows the layer when freshly fallen. Within the 5 cm isopachyte of that map the thickness is now about four times less. In Table 1 is included one analysis of Askja tephra. It is possible that the pumice analysed was produced before March 28th as analyses of the tephra from the big paroxysm show a little lower silica content. Average of three analyses of tephra that fell in Scandinavia is 68.73% SiO_2 (v. Wolff 1929, p. 950).

Layer G.

When measuring soil profiles in the Thjórsárdalur walley in 1939 in connection with excavation of farm ruins from the Settlement period I found in all these profiles a light pumice layer (designated VII b), 1—3 cm thick. This layer was found a few cm beneath the settlement niveau that could be fairly exactly determined, as it was marked in soil profiles near the farm ruins by a thin charcoal layer, resulting from clearance of woodland in connection with the settlement. The settlement niveau was also determined with the aid of pollen diagrams (Thorarinsson 1944). From its relation to the settlement niveau the age of layer VII b can be estimated to about 1200 years. Later I have followed this layer all over SW Iceland. Its source is obviously not very far from Hekla and I think it is almost certain that this source is a rhyolitic volcano (tephra ring) that I discovered in 1952 just NE of lake Frostastadavatn. This volcano I gave the name Grákolla.

In soil profiles in NE Iceland there occurs a light layer that must be of approximately the same age as my layer VII b. The westernmost place where I have found this layer in NE Iceland is at Vídikeŕ (Be 104), the southernmost in E Iceland is at Hallormsstadur (Bf 34, cf. 19—23, Fig. 18). The layer is thickest, 1—2 cm, in Jökuldalur, the grain size in this area is about that of the Öræfajökull and Hekla layers which points to a source about as far away. It seems probable, although not yet definitely proved, that this is the same layer as VII b, and thus coming from Grákolla. It is therefore designated with the letter G in my soil profiles.

Layer "a".

Layer "a" is a greyish black tephra layer occurring in nearly all soil sections that I have measured in NE and E Iceland. I first noticed this layer when working in the Mývatn area and I have denoted it with the letter "a" in profiles published from that area (Thorarinsson 1951, Fig. 27; 1952, Fig. 18; 1953 b, Fig. 14). When the layer "a" is found together with the layer Ö 1362 there is usually no layer between these two and they are separated by a layer of soil that is only a few cm thick. Layer "a" is thickest in the inland districts of Thingeyjarsýslur and Nordur-Múlasýsla and it is upon the whole by far the biggest tephra layer that has fallen in NE Iceland in historical time. A comparison with the layer produced by the Askja eruption 1875 shows clearly how big a layer "a" really is. In most places it is thicker than A 1875 and it is spread over much greater area. In fact it ranks among the 10 biggest tephra layers produced in Iceland in historical times. W of Vadlaheidi the layer thins out rapidly and in Eyjafjördur its thickness is 1 cm or less. Its western limit has not been determined. In the Lón district or the southernmost part of E Iceland two black layers are found a little above Ö 1362 in the profiles (16, Fig. 18) and it is not yet determined with certainty which of these is "a", but most likely it is the lower one. The same is the case in the district Nes (Cf. 26). How far westwards S of Vatnajökull the layer is spread I cannot tell yet but I do not think it will be found W of Breidamerkursandur. In most lowland districts the thickness of "a" is very uniform from place to place which points to its having fallen on snow-free ground. The grain size is nearly the same, fine to medium sandy, over the whole area covered by the layer. This indicates that the eruption centre is not situated near to any soil covered area bordering Ódádahraun which points against its being in Dyngjufjöll (Askja). On the other hand the thickness of the layer in NE Iceland is so great that it can hardly have been erupted by any volcano in southern Iceland. Consequently it seems most probable that the source of this layer is in Vatnajökull, within the Kverkfjöll or Grímsvötn areas.

As to the age of layer "a" it is certainly somewhat younger than Ö 1362 and it is also certainly considerably older than layer M in profiles in the Mývatn district (cf. the before mentioned profiles from that area), that was produced by the "Mývatn Fires" 1724—1729. A closer approximation of the age of "a" can be reached by the study of soil profiles. One must be very careful when extrapolating the rate of soil thickening from one part of a soil profile to another, especially when it is a question of soil formed during the last few centuries, during which the rate of thickening has on the whole increased rapidly and un-

TABLE 2

Calculation of the age of layer "a".

Profile	Thickness of soil H_1 — Ö 1362 258 years cm	Thickness of soil Ö 1362 — "a" X years cm	Length of X years	Layer "a" deposited Anno
Be 104	5.5	4.3	202	1564
Be 106	6.5	3.0	119	1481
Be 107	3.0	1.5	129	1491
Be 131	9.2	3.0	84	1446
Be 132	9.5	5.0	135	1497
Average	6.7	3.4	134	1496

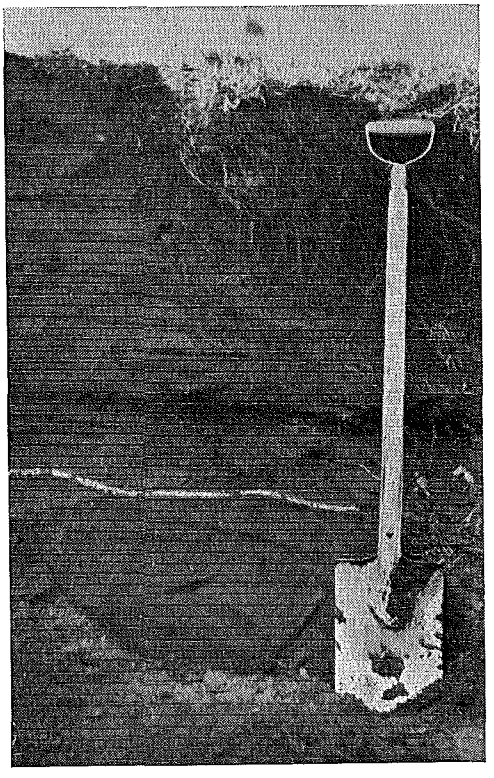


Fig. 19. Ö 1362 in a profile at the motor-road short NE of Dverghamrar, Sída (Table 3:20). Length of spade 107 cm. — *Photo S. Thorarinsson, Aug. 4th 1955.*

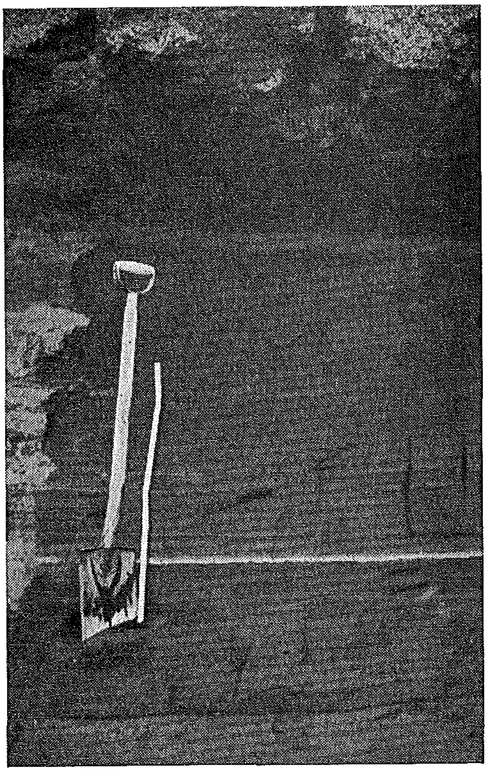


Fig. 20. Ö 1362 in a bank beneath the 1783-lava E of Thverá, Sída (Table 3:21). Length of spade 107 cm. — *Photo S. Thorarinsson, July 29th 1957.*

evenly because of increased soil erosion, but further down in the profiles such an extrapolation may often be done with satisfactory results.

In five profiles, two of which are shown on Fig. 18 (Be 132 and Be 106) both the 1362 layer and the layer H_1, produced by the initial eruption of Hekla 1104, are found. In these profiles which were carefully measured the grain size of the soil formed between 1104 and 1362 is about the same as between the 1362-layer and layer "a". The grain size is that of fine "mo", typical for the loessial soil. This indicates that the rate of soil thickening did not change much during this period. In this case we are justified in trying to calculate the age of layer "a" by comparing the thickness of the soil layers (tephra layers extracted) H_1 – Ö 1362 and Ö 1362 – "a". The result is shown in Table 2.

As it is more likely that the rate of soil thickening increases upward than

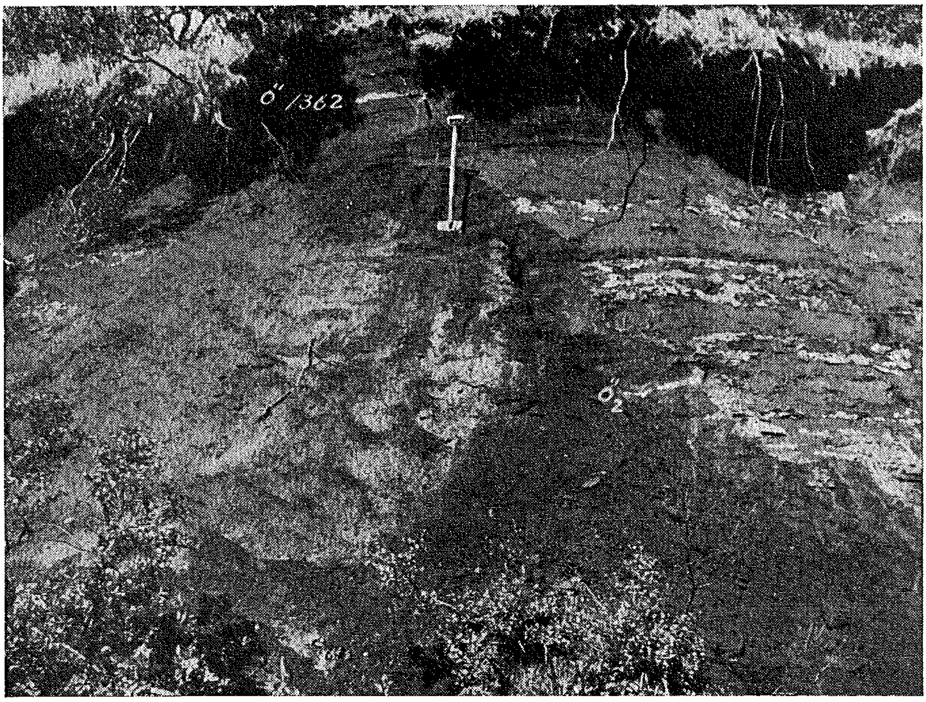


Fig. 21. Ö 1362 and $Ö_2$ in a rofbard in Núpsstadarskógur, Fljótshverfi (Table 3:27; Fig. 16). — *Photo S. Thorarinsson, Aug. 5th 1955.*

downward in the parts of the soil profiles used for the calculation the figures for X most likely represent maximum figures.

I find it allowable to conclude that layer "a" was in all probability neither deposited before 1420 nor after 1570 and I find it most likely that it was deposited during the latter half of the 15th century.

In preserved documentary records there are mentioned only two eruptions which possibly could have produced layer "a". In a votive letter written at Grund in Eyjafjördur (20 km N of point Bd 50 on the map Fig. 15), dated March 11, 1477, we read among other things: „Gathered were there clerks and laymen from between Vardgjá and Glerá, and they spoke of those wonders, singular occurrences and menaces which then were current in the forms of fires, the falling of sand and darkness caused by ash and terrifying thunderings. Owing to these wonders animals were deprived of their sustenance although there was no snow on the ground (DI vi, pp. 103—107).

Ólafur Jónsson thinks it probable that this refers to eruption in Dyngjufjöll, though he considers it conceivable that it was in the northern edge of Vatnajökull

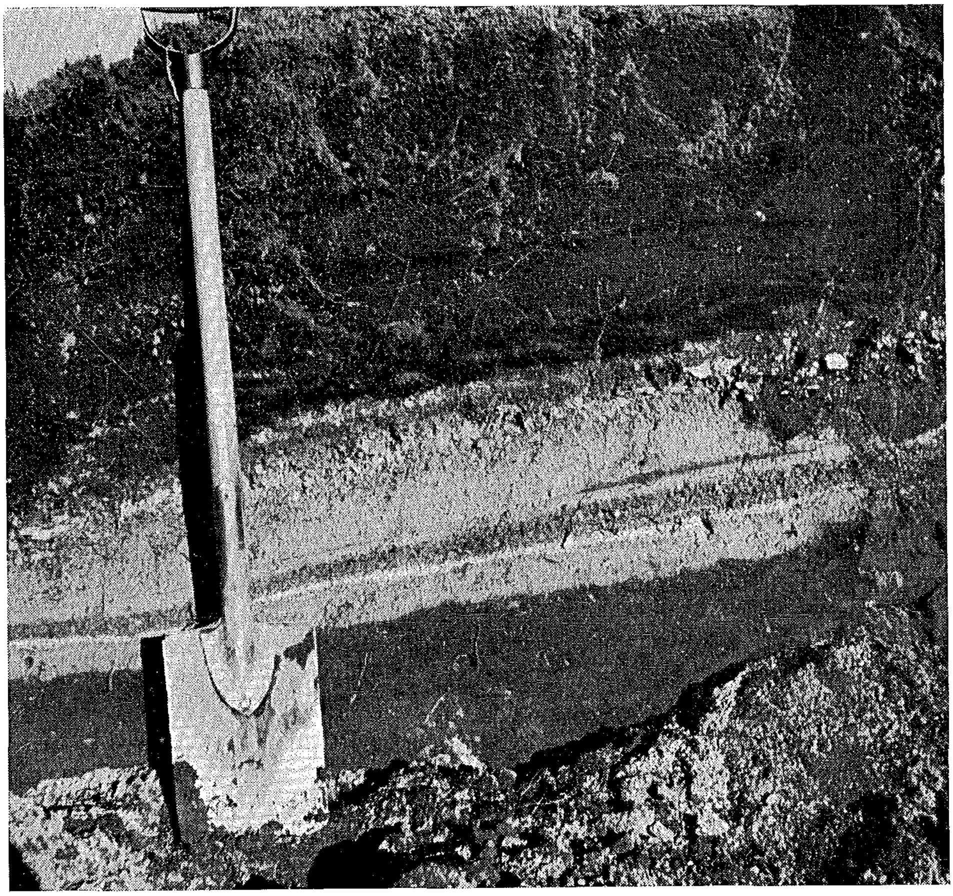


Fig. 22. Ö 1362, N bank of Grafarlækur, near Gröf, Öræfi (Table 3:34). Length of spade 107 cm. — *Photo S. Thorarinsson, Sept. 11th 1955.*

(Jónsson 1945, ii, p. 213). No inference to this effect can, however, be drawn on the strength of the above source, and other sources referred to by Jónsson are worthless. Neither is there any authority for his assertion that the consequences of this eruption seem to be entirely confined to the middle of the northern part of the country. The assumption that this is the eruption that formed layer "a" is not contradicted, however, by the thinness of that layer in the Eyjafjördur district, as apparently in that locality there are no other layers thicker dating from historical times, except H_1 in places. And seeing that the time accords well with such conclusions as may be deduced from investigation of tephra layers, it is not inconceivable that the eruption referred to in the above votive letter is the one that formed layer "a".

In his Bishops Annals Jón Egilsson mentions with reference to the Hekla eruption that began in July 1510 that "there was then simultaneously a fire burning in Trölladyngja [i. e. Dyngjufjöll] and Herdibreid" (Safn t. s. Ísl. I, p. 44). Also that eruption might conceivably come into consideration as having produced layer "a", though this appears to me definitely more unlikely on the grounds previously adduced against that layer's having originated in Dyngjufjöll.

Thus we reach the following conclusion with regard to layer "a":

Sometime between anno 1420 and 1570 A.D. — probably during the latter half of the 15th century — there occurred in Iceland a volcanic eruption that, with regard to the amount of tephra produced, ranks among the ten biggest in Iceland in historical time. The eruption centre was most likely in Vatnajökull (Grímsvötn or Kverkfjöll), and the tephra was mainly carried towards N and NE. In the lowland the tephra probably fell on snowfree ground and the tephrafall

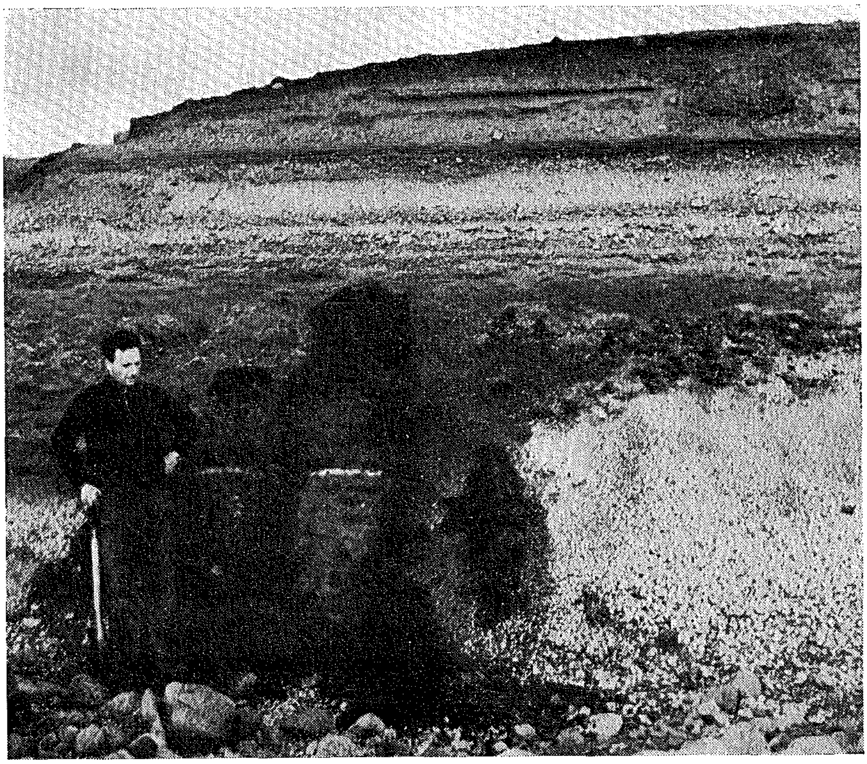


Fig. 23. Ö 1362 deposited by water above loessial soil on the E bank of Gljúfurá, 1 km NW of Fagurhólsmýri, Öræfi. $Ö_2$ is seen in the soil profile to the right of the left hand of the man. — *Photo S. Thorarinsson, July 21st 1954.*

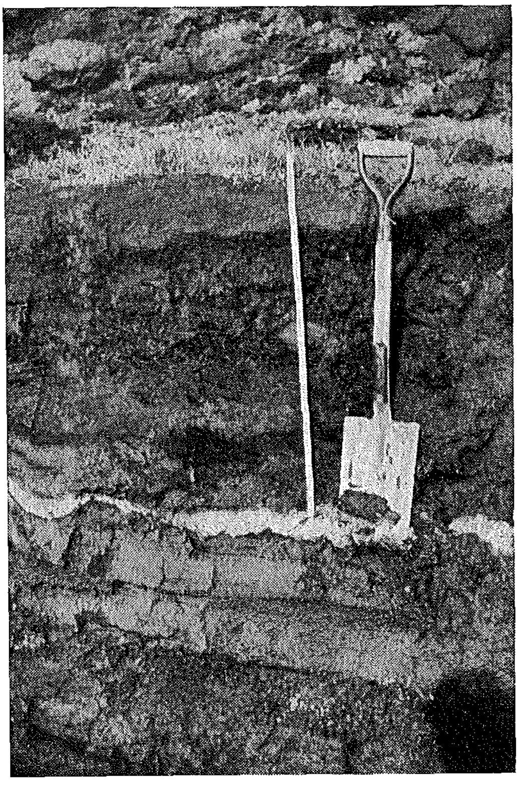


Fig. 24. Ö 1362 in bog profile NE of water-tower at Höfn, Nes (Table 3:51). Length of rule 1 m. — *Photo S. Thorarinsson, June 29th 1952.*

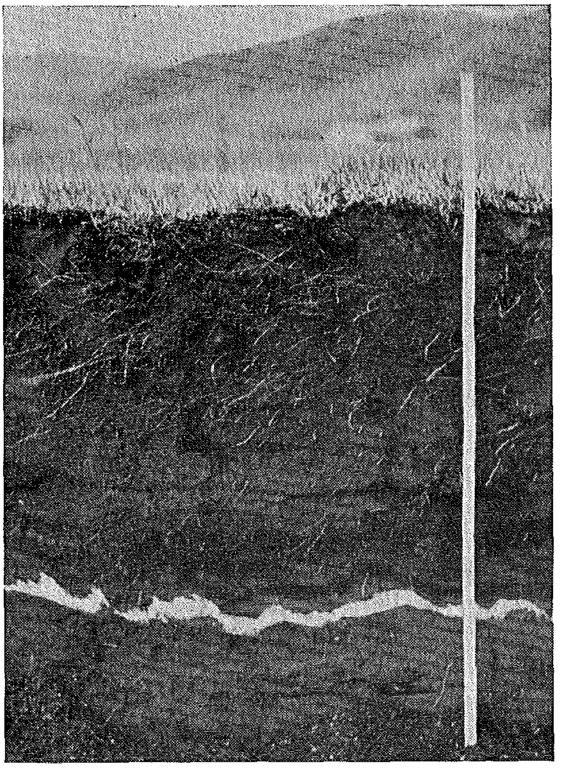


Fig. 25. Ö 1362 in a rofbard short SE of Stafafell, Lón (Table 3:58). Length of rule 1 m. — *Photo S. Thorarinsson, June 27th 1952.*

must have caused very serious damage on grassland in Thingeyjarsýslur and Múlasýslur and was probably catastrophic for some districts.

This eruption might possibly be the one that is known to have happened in March 1477, also, although less likely, it could be an eruption that probably took place in the southern part of Ódádahraun or in Kverkfjöll in the summer of 1510. But it may equally well have taken place without being mentioned in any preserved written record. In that case the only source of further knowledge about this very big eruption is a closer study of the tephra layer which this eruption has left in the soils of NE and E Iceland.

Ö 1362

In Table 3 are listed all the profiles where I have found the layer produced by the 1362 eruption in Öræfajökull, designated in the profiles as Ö 1362. All these profiles are situated within the 0.1 isopachyte on the map Fig. 27. Within that isopachyte there are also some profiles where Ö 1362 has not been found. Quite naturally there will be a border zone of such a layer where the layer is very thin and is found in some profiles and not in others and within that zone it may easily be overlooked in some profiles. This may, for instance, be the case with some of the profiles Dd 74, 75 and 80—84, which were measured rather hastily during a travel by bus from Eldgjá to Skaftártunga on Aug. 3rd 1955. In these profiles the layer would hardly be more than 1—2 mm thick. In profile Dd 88 (cf. Fig. 16) at the Hólmsá bridge I looked carefully for the layer but did not find it, although it was found in profile Dd 86 200 m farther north. On Fig. 16 I have indicated with an arrow where Ö 1362 ought to be found in profile Dd 88.

Even in areas where the tephra layers on the whole are relatively thick one

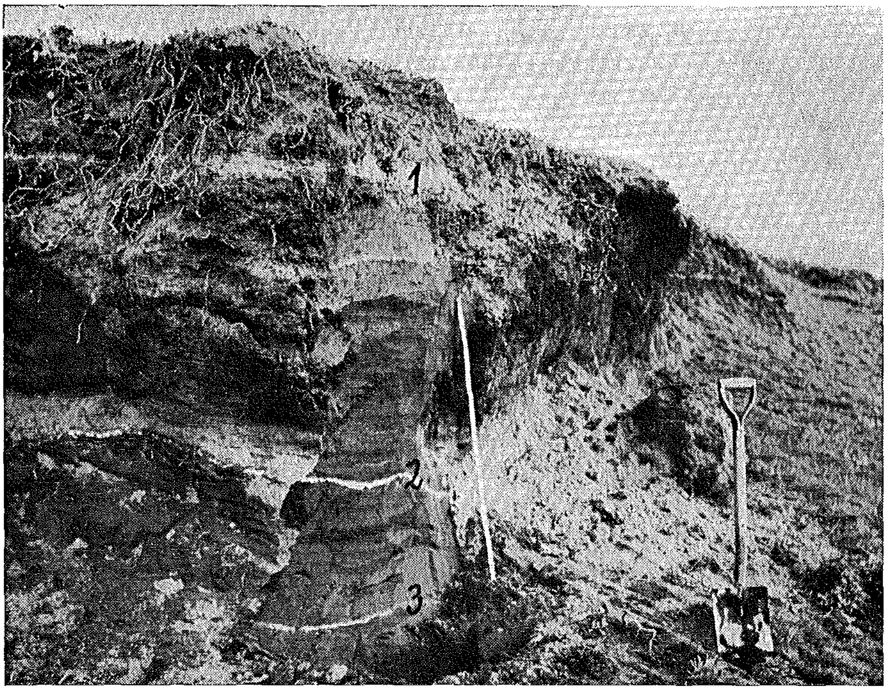


Fig. 26. Rofbard SW of Heidarsel, Jökuldalsheidi (Table 3:88). 1: A 1875, 2: Ö 1362, 3: G. Length of rule 1 m. — *Photo S. Thorarinsson, Aug. 6th 1951.*

must expect that they will not be found in all profiles, as they may have been swept away by wind or water. This is especially the case when the layers have fallen on snow cover. The fact that Ö 1362 is found in nearly all profiles where one would expect to find it makes it probable that at least the lowland areas were snowfree when it fell.

As already mentioned, there occur in NE Iceland, within the areas Be and Bf on the map Fig. 15, two light layers, H_1 and G, that do not differ very much in age from Ö 1362. They may therefore be expected to occur in about the same depth in the soil profiles. Moreover, in these areas they are of about the same grain size and thickness as Ö 1362. When all these three layers are found in the same profile, such as is the case at Vídiker, Svartárkot and Sudurárbotnar (Be 104, 106, 107), it is easy to state the youngest one is Ö 1362, but when they do not all occur it may be difficult to tell which one is missing. In profile Be 121 on the W slope of Skógarmannafjöll eystri only one light layer occurs. Certainly it is either Ö 1362 or H_1, and as it is only 5 cm below layer "a" and the soil is fine sandy, indicating a rather fast thickening, it seems very likely that the light layer here is Ö 1362. In the Hólsfjöll area two of the light layers occur (cf. Fig. 18) and I regard it as almost certain that these layers are H_1 and Ö 1362. Within the area Bf, i. e. in Vopnafjördur, Jökuldalsheidi, Jökuldalur and Fljótsdalshérad, two layers also occur, viz. Ö 1362 and layer G (cf. profiles on Fig. 18), but here it is also the case that when one of them is missing it may be difficult to tell which of them it is. In profiles De 25 and De 26, measured in loessial soil on the gravel plain east of river Lagarfljót between the farms Dratthalastadir and Ekra, one light layer is found 9.5 resp. 16.5 cm beneath layer "a" and separated from that layer even by two thin basaltic layers. The thickness of the light layer is 1.5 resp. 1.0 cm. In these cases there is little doubt that the layer is G. In Vopnafjördur (profiles Bf 11—13) the problem is more difficult. Only one light layer is found in two of the profiles and in the third none was found. From its relation to layer "a" I concluded that in profile Bf 15, 0.5 km E of Teigur farm, the light layer was G, as it was separated from "a" by 18 cm of silty loessial soil with two thin black layers, whereas in profile Bf 12, 1.3 km E of Hof farm, the light layer found in the same type of soil was only 7 cm beneath layer "a" and no black layers between them. In this profile the light layer most likely is Ö 1362. Possibly this could be determined definitely by careful microscopic or spectroscopic studies, but no samples were taken when these profiles were measured.

Notes on Table 3.

From lack of an adequate term I use in Table 3 the Icelandic term *rofbard* for an earth bank of a special type very common in Iceland (cf. Fig. 26) and resulting from winderosion in areas covered by a thick layer of loessial soil. These rofbards border the soil covered areas against the areas where the wind-erosion has swept away the soil cover and in these rofbards the wind-erosion is mainly at work. The thickening of the loessial soil cover in Iceland is mostly due to deposition of windborn material that is bound by the vegetation, and the rate of thickening is thus an indicator of the intensity of the soil erosion, but it must be remembered that a profile with tephra layers measured in a rofbard gives an exaggerated picture of the accelerated soil thickening since the arrival of man in Iceland, as the deposition of the windborn material is more rapid on the top of the rofbards than farther away from the zone where the wind-erosion is going on. Small soil patches left isolated in a wind-eroded area are sometimes some metres thicker than the soil cover was on an average when the wind-erosion started in the area.

The soil profiles are measured only down to the parent soil, viz. down to the ground moraine and fluvial gravel etc., but where a parent soil does not exist, down to the underlying rock. *Total thickness* in the Table thus means the thickness of the soil above the ground moraine etc.

The *coarseness* of the tephra, when expressed in figures in Table 3 refers to the particle diam. as roughly measured in the field.

In the Table I have discriminated between only two main types of soil, *peat soil* (P) and *loessial soil* (L). Because of the wind drift the Icelandic peat soil usually contains much minerogenic (loessial) material, especially in the upper part of the soil profiles, and the loessial soil, which in its typical form is silty or very fine sandy, is often more coarse-grained (fine sandy — medium sandy) in the upper parts of the profiles, especially in the rofbards.

TABLE 3

The thickness and depth of the

Nr.	Date of Measurement	Locality	Nr. on Index-map
1	8/8 '54	250 m NW of Hólmsábridge, Skaftártunga	Dd 86
2	11/8 '47	S shore of river Skálm, Mýrdalssandur, 2.6 km W of bridge	Dd 90
3	10/8 '47	Edge of Eldgjá lava at Leidvöllur, Medalland	Dd 91
4	8/8 '54	At motorroad through Stéttur, Skaftártunga, N of Krossfell	Dd 85
5	24/7 '57	Short E of Selá, 1.5 km S of Eintúnaháls, Skaftártunga ...	Dd 78
6	„	0.5 km NE of Heidarsel, Skaftártunga	Dd 79
7	8/8 '47	0.5 km W of Holt, Sída	Dd 93
8	„	0.4 km SW of Holt, Sída	Dd 93 b
9	„	Just W of homefield of Ytri-Dalbær, Landbrot	Dd 94
10	23/7 '57	Kirkjubæjarheidi, Sída, 2.5 km NNW of Systravatn	Dd 92 c
11	„	Just NE of Systravatn	Dd 92 b
12	9/8 '54	At Systravatn, just E of outlet	Dd 92
13	„	Just S of motor-road, 0.3 km E of Nýibær, Landbrot	Dd 95
14	9/8 '47	At roadside just N of Ytra Hraun, Landbrot	Dd 96
15	„	Hnausar, Medalland, near the farm	Dd 97
16	6/8 '55	1.2 km W of Arnardrangi, Landbrot	De 17
17	20/8 '45	Just W of Seglbúdir, Landbrot	De 16
18	„	1 km W of Eystri Dalbær, Landbrot	De 15
19	6/8 '55	At motor-road S of Hörgsland, Sída	De 14

TABLE 3

ephra layer Ö 1362 at different places.

Soil	Total thickness cm	Ö 1362 Depth cm	Ö 1362 Thickness cm	Ö 1362 Coarse-ness	Remarks	Nr.
L	> 250	97	0.1	Silty	Rofbard, Fig. 17:1	1
L	165	106	0.2	„	Bottom of pseudocrater	2
L	74	58	0.5	„		3
L	> 210	88	0.2	„	Ditch at roadside, Fig. 17:2	4
L	> 170	134	0.5	„	Bank of a brook	5
L	> 200	129	0.4	„	Rofbard	6
L	> 100	108	0.3	„	„ Fig. 17:3	7
L	> 170	67	0.3	„		8
L	105	44	0.3	„		9
P	> 150	54	0.8	Coarse silty		10
L	> 200	62	1.0	„	„	11
L	> 250		0.5	„	„ Fig. 17:4	12
L	128	89	0.3	„	Bottom of pseudocrater, Fig. 17:5	13
L	> 90	67	1.5	„	Ditch at roadside	14
L		67	0.8	„	Average of diff. measurements	15
L	232	200	1.3	„	Rofbard	16
L	> 160	160	1.0	„	„	17
L	66	42	1.2	„	On Eldgjá lava	18
P	> 130	63	1.3	„	Ditch at roadside, Fig. 17:6	19

Nr.	Date of Measurement	Locality	Nr. on Index-map
20	4/8 '55	At motor-road NE of Dverghamrar, Sída	De 14
21	23/7 '57	E bank of river Thverá, Sída, opposite the old Thverá farm ..	De 10 a
22	„	Slope above the old Thverá farm	De 10 b
23	12/7 '53	0.4 km SW of Kálfafell, Fljótshverfi, N bank of river Laxá ..	De 12
24	22/7 '57	0.1 km N of motor-road, 0.4 km W of Djúpá bridge, Fljótshverfi	De 12 b
25	6/8 '55	1.5 km E of Núpsstadur, Fljótshverfi, at motor-road	De 9
26	5/8 '55	Above Festarklettur, Núpsstadarskógur, Fljótshverfi	Ce 1
27	„	Núpsstadarskógur, just SE of hut	Ce 2
28	17/8 '45	Bæjarstadarskógur, Öræfi, northernmost part	Ce 3
29	16/8 '45	Skaftafell, Öræfi, just N of Hædir	Ce 4
30	„	Skaftafell, just SW of Bölti	Ce 4 b
31	14/9 '55	End moraine Stóralda, in front of Svínafellsjökull, Öræfi ..	De 18 b
32	16/8 '45	Svínafell, Öræfi, homefield	De 19 a
33	6/7 '57	Svínafell, short S of Stekkjartún	De 19 b
34	11/9 '55	Gröf, Öræfi, N bank of Grafarlækur in Skógartunga	De 20 a
35	„	Gröf, S bank of Grafarlækur near farm ruin	De 20 b
36	„	Gröf, 0.3 km N of farm ruin	De 20 c
37	15/9 '55	Ingólfshöfdi, Öræfi, ENE of lighthouse	De 24 a
38	„	Ingólfshöfdi, N of lighthouse	De 24 b
39	„	Ingólfshöfdi, W of lighthouse	De 24 c

Soil	Total thickness cm	Ö 1362 Depth cm	Ö 1362 Thickness cm	Ö 1362 Coarse-ness	Remarks	Nr.
L	> 130	86	1.5	Coarse silty	Cut at roadside. Photo Fig. 19	20
L	> 250	129	1.5	„	Beneath 1783-lava, Photo Fig. 20	21
L	> 250	63	1.5	„		22
L	> 500	193	1.8	„	Rofbard, Fig. 17:7	23
L	378	185	2.0	„	„	24
L	96	63	2.0	Sandy-silty	„	25
L			4.5	„		26
L	485	57	4.5	„	„ Photo Fig. 21 Fig. 16:8	27
L	535	144	17	≦ 2 cm	„ Fig. 16:9	28
L	350	128	26	≦ 5 „	„ Fig. 17:10	29
L	190	58	7	„	Ditch at roadside	30
L	105	31	70	Gravelly	Accumulated by wind	31
L	> 100	46	50	≦ 5 cm		32
L	232	42	38	≦20 „	Scattered fragments up to 20 cm in diam.	33
L	> 100	47	30	≦ 5 „	Photo Fig. 22 „	34
L	> 100	73	25	≦10 „	Fig. 17:11. Diam. of biggest pumice fragment at farm-ruin 60 cm.	35
L	> 150	78	15	≦ 5 „	Rofbard	36
L	84	39	8	≦ 3 „		37
P	∾ 100	48	10	„		38
L			15	„	Rofbard	39

Nr.	Date of Measurement	Locality	Nr. on Index-map
40	15/8 '45	W bank of Grófarlækur, Öræfi, just S of motor-road	De 25
41	16/9 '55	Ab. 1 km SW of Hnappavellir, Öræfi	De 26
42	15/8 '45	Hellugilstorfa, 0.6 km W of Kvísker, Öræfi	De 32
43	13/7 '57	Stadardalur, Sudursveit, E of river, 2.5 km NE of Brunnar	Cf 29
44	13/8 '45	Vagnsstadir, Sudursveit, W bank of Blanda	Cf 32
45	„	Skálafell, Sudursveit, ditch near farm	Cf 30
46	'57	Flatey, Mýrar, ditch near farm	Cf 31
47	20/6 '52	Svínafell, Nes, short N of Valagil	Cf 22
48	23/6 '52	Hoffell, Nes, ditch just S of homefield	Cf 23
49	12/8 '45	Borgir, Nes, ditch 0.3 km N of farm	Cf 24
50	11/8 '45	Akurnes, Nes, ditch in homefield	Cf 25
51	29/6 '52	Höfn, Nes, ditch short NE of watertower	Cf 26
52	„	Höfn, ditches W of watertower	Cf 26 b
53	30/9 '49	Höfn, walls of swimming pool	Cf 27
54	16/7 '51	Höfn, Ósland, northern shore short E of road	Cf 28
55	„	Bogs E of Mt. Snæfell	Cf 12
56	27/6 '52	Stafafell, Lón, gravel terrace 0.8 km SE of homefield	Cf 18
57	„	Ab. 0.2 km N of Cf 18	Cf 19
58	„	Near Cf 19	Cf 20
59	24/6 '52	At motor-road about 1 km E of Svínhólar, Lón	Cf 21

Soil	Total thickness cm	Ö 1362 Depth cm	Ö 1362 Thickness cm	Ö 1362 Coarse-ness	Remarks	Nr.
P	> 150	70	40	≦ 6 cm	Fig. 17:12	40
P	> 200	90	25		Birch trunks 50 cm below Ö 1362	41
L	414	66	12	≦ 5 „	Rofbard	42
P	∾ 150	83	6	Fine-sandy		43
P	> 240	31	11	„	Fig. 17:14. Thickness nearly 7 cm	44
P			12		Inform. from farmers	45
P		180	10		Information from Th. Gudmundsson, Reynivellir	46
L	> 100	60	3.5	Coarse silty		47
P	> 100	40	5	„		48
P	> 200	80	3	„	Horse bones found at 1.6 m depth	49
P	> 150	49	6	„		50
P	> 270	75	7.0	„	Fig. 18:15. Photo Fig. 24.	51
P			7.0	„	Aver. of measurements at 7 places	52
P	> 200	65	6.5	„		53
P	∾ 160	70	> 3	„	Ö 1362 10 cm below low-water level	54
			+		Light layer mentioned by Sveinn Pálsson	55
L	∾ 200	79	1.0	„	Rofbard	56
L	190	73	3.5	„	„ Fig. 18:16	57
L	> 100	60	2.5	„	„ Photo Fig. 25	58
L			2.5	„	„	59

Nr.	Date of Measurement	Locality	Nr. on Index-map
60	6/8 '53	At Selá, Lónsheidi, N of motor-road	Cf 11
61	27/6 '52	1 km E of Flugustadir, Álftafjördur, near motor-road	Cf 10
62	„	Northern Melrakkanes, at motor-road	Cf 9
63	„	Just E of Bragdavellir, Hamarsfjördur, at motor-road	Cf 8
64	25/6 '52	At motor-road 2 km E of Teigarhorn, Berufjördur	Cf 7
65	„	1.5 km SW of Teigarhorn	Cf 6
66	9/8 '53	Berunes, Berufjördur, homefield N of farmhouse	Cf 5
67	„	0.8 km S of Heydalir, Breiddalur, near motor-road	Cf 4
68	5/8 '53	2.5 km W of Thorgrímsstadir, Sudurdalur, near motor-road	Cf 3
69	„	E bank of brook from Thröng, Sudurdalur, near Nr. 68	Cf 2
70	9/8 '33	At Tunga, Fáskrúdsfjördur	Cf 1
71	27/7 '33	Near Valthjófsstadur, Fljótsdalur	Bf 35
72	10/8 '49	Thingmúli, Skriddalur, homefield	Bf 36
73	„	0.3 km S of Arnhólsstadir, Skriddalur, W of motor-road	Bf 37
74	31/7 '37	Near Búdareyri, Reydarfjördur	
75	4/8 '53	Hallormsstadur, Fljótsdalur, S bank of brook just NE of schoolhouse	Bf 34 a
76	„	At motor-road, not far from Nr. 75	Bf 34 b
77	4/5 '55	1.3 km N of St. Sandfell, Skriddalur, just W of motor-road	Bf 33
78	„	Ditch just S of Egilsstadir	Bf 32
79	1/8 '37	Eidar, Hjaltastadarthinghá, just S of homefield	Bf 27

Soil	Total thickness cm	Ö 1362 Depth cm	Ö 1362 Thickness cm	Ö 1362 Coarseness	Remarks	Nr.
L	172	74	2.5	Coarse silty	Rofbard	60
L	> 100	31	2.0	„		61
			1.5			62
			2.0			63
L		37	1.8	„		64
P	> 150	25	2.5			65
P	> 100	53	1.5	„		66
L	115	22	0.5	„	Fig. 18:17	67
L	56	12	1.0	„		68
L	150	15	1.5	„		69
P	370	18	∾ 1.0	„	Measured by H. Bjarnason	70
L	> 280	20	1.5	„	Measured by H. Bjarnason	71
L		30	0.5	„	Ö 1362 covers here presumed ruins of booths	72
L	90	32	1.5	„		73
			1.0	„	Index Nr. omitted on Fig. 15	74
L	147	27	0.5	„	Fig. 18:19	75
L	> 80	20	0.5	„		76
L	72	21	0.2	„	Fig. 18:18	77
P	132	30	0.4	„		78
P	162	18	0.5	„	Measured by H. Bjarnason	79

Nr.	Date of Measurement	Locality	Nr. on Index-map
80	4/8 ''51	2 km E of Hofteigur, Jökuldalur, at motor-road	Bf 24
81	3/8 '53	Between Rjúkandi rivers, Jökuldalur, just N of motor-road ..	Bf 23
82	4/8 '51	Skjöldólfsstadir, Jökuldalur, profile cut at roadside, near farmhouse	Bf 18
83	1/8 '37	About 0.5 km N of Skjöldólfsstadir	Bf 19
84	„	Near 83	Bf 20
85	„	0.5 km W of Skjöldólfsstadir	Bf 21
86	„	Just N of Skjöldólfsstadir	Bf 22
87	6/8 '51	Brú, Jökuldalur, bank of river just W of homefield	Bf 17
88	„	Heidarsel, Jökuldalsheidi, N bank of brook 1.2 km SSW of farm	Bf 16
89	1/8 '37	Rangalón, Jökuldalsheidi, near farm ruin	Bf 15
90	6/8 '51	Just N of road Vopnafjördur—Mödrudalur, S of Súlendur ..	Bf 14
91	7/8 '51	1.5 km N of Hof, Vopnafjördur, just W of motor-road	Bf 12
92	8/8 '51	0.5 km S of Gömlu Grímsstadir, Hólsfjöll	Be 132
93	16/7 '52	Gömlu Grímsstadir, beneath stonewall of farm ruin	Be 131
94	2/8 '57	Austari Skógarmannafjöll, W slope of northernmost ridge ..	Be 121
95	2 17/7 '53	Sudurárbotnar, Ódádahraun, just E of hut	Be 107
96	16/7 '53	Svartárkot, Bárdardalur, SW bank of lake, at outlet	Be 106
97	2/8 '52	0.3 km WNW of Vídiker, Bárdardalur	Be 104

Soil	Total thickness cm	Ö 1362 Depth cm	Ö 1362 Thickness cm	Ö 1362 Coarseness	Remarks	Nr.
L	> 150	85	0.5	Coarse silty	Rofbard	80
L	> 220	102	0.5	„	„	81
L	180	28	0.5	„	Fig. 18:21	82
L	195	22	0.5	„		83
L	120	19	0.5	„		84
P	150	35	0.5	„		85
L	150	38	0.4	„	Rofbard	86
L	245	49	1.0	„	Fig. 18:20	87
L	> 270	141	1.5	„	Rofbard. Photo Fig. 26	88
L		43	0.8	„	„	89
L	222	158	0.7	„	„	90
L	∾ 100	57	0.3	Fine-silty	„	91
L	410	265	0.2	„	„ Fig. 18:22	92
L	165	30	0.2	„		93
L	> 200	84	0.2	„	„	94
L	283	84	0.2	„	„ on lava. Fig. 18:23	95
L	275	61	0.2	„		96
L	> 160	105	0.2	„	„	97

The Depth of Ö 1362.

A whole paper could be — and later will be — written concerning the information that can be gained from Icelandic soil profiles about soil formation and soil erosion in Iceland. Here this problem will only be briefly touched upon. From Table 3 we find that the average depth of Ö 1362 in peat profiles is 50 cm, in loessial soil profiles (except rofbards) 45 cm, and in rofbards 107 cm. This illustrates what was said before about the local thickening of the soil in the rofbards. We also find that on the whole the soil thickening is more rapid in Skaftafellssýslur than in Múlasýslur. The average depth of Ö 1362 in the loessial profiles in Múlasýslur, rofbards not included, is only 25 cm. The wind drift from the extensive sandur areas in Skaftafellssýslur and the much more frequent tephrafalls, especially W of Breidamerkursandur, are the chief reasons for this difference. Table 4 is based on the loessial profiles, rofbards excluded, where both A 1875 and Ö 1362 are found. Here we can compare the rate of soil thickening since 1875 and between 1362 and 1875. The thickness of the tephra layers found between the above-mentioned layers is of course subtracted from the soil thickness. Although it should be taken into consideration that the older soil may be some-

TABLE 4

The rate of thickening of loessial soil in E Iceland at different periods.

No. Table 3	Depth of A 1875 cm	Thickening per year 1875—1950 mm	A 1875 — Ö 1362 (513 years) cm	Thickening per year 1362—1845 mm	H_3 — H_4 Ab. 750—1850 B.C. (1100 years) cm	Thickening per year H_3 — H_4 mm
71	5	0.67	10	0.19		
72	9	1.20	18	0.35		
73	12	1.60	13	0.25	10	0.09
75	8	1.07	13.5	0.26	8	0.07
76	6	0.80	10	0.19		
77	6	0.80	11	0.20		
82	10	1.33	12.5	0.24	16.5	0.15
83	5.5	0.73	15	0.30	15	0.14
84	6.5	0.87	10	0.19	17	0.15
87	15	2.00	23	0.45	10.5	0.10
Average	8.3	1.11	13.6	0.27	12.8	0.12

what more compressed than the layers above A 1875, the table shows that without doubt the soil thickening, which is an indicator of the soil erosion, has been much more rapid since 1875 than it was on the average 1362—1875. It is also of interest to compare the thickness of the soil layer between the tephra layers H_3 and H_4, the age of which has been determined by the radio carbon method (cf. p. 49). We find that during the about 1100 years that passed between the deposition of these two layers the thickening of the loessial soil has been more than twice as slow as between 1362 and 1875. It may be added that practically everywhere in the country — except in the very neighbourhood of Hekla — where layers H_3 and H_4 are found in loessial soil, the thickness of soil between them is about the same, 10—15 cm, even in rofbards. This means, that during this period of soil formation which covers the greater part of the Scandinavian Bronze Age and forms the latter part of the Postglacial Warm Period, the deposition of loessial dust was on the whole very slow in Iceland compared with recent times.

This in its turn indicates that considerably more of the country was covered by vegetation towards the end of the Postglacial Warm Period than after the middle of the 14th century, both in the lowland areas and — not least — in the interior.

The Chemical Composition and other Properties of the 1362-tephra.

Table 1 shows the chemical composition of the 1362-tephra. According to Rittmann's nomenclature of volcanic rocks (Rittmann 1952) the tephra is a soda rhyolite on the limit to quartz-latite. The refringence of the glass lies between 1.495 and 1.500 (determ. by Stud. geol. G. Sigvaldason, The University of Göttingen). Roughly estimated the mineral content is less than 1%. The minerals are sanidine (automorph twin crystals, common size 0.1×0.05 mm), acid plagioclase and pyroxene. The colour of the pumice in a fresh fracture is light silver grey. In the bigger pumice fragments the pumice is very porous, and has obviously been expelled from the magma reservoir in a liquid state. With regard to porosity the pumice is very like the Hekla pumice of 1104 and other rhyolitic pumice from that volcano. The fine-grained tephra ("ash") looks practically white in the soil profiles.

There is hardly any difference in colour between the nethernmost and uppermost parts of the 1362 tephra layer, nor does there seem to be any noticeable difference between the colour of tephra of similar grain size in different parts of the tephra sector. We may therefore assume that there has been very slight chemical differentiation of the tephra during the eruption.

THE TYPE OF ERUPTION AND THE ERUPTION CYCLE

It has been shown in a previous paper (Thorarinsson 1954 a) that Hekla has in Postglacial Time had 5 cycles of activity, each one probably starting with a rather basic mixed eruption and ending with a violent and purely explosive acid eruption, or, to put it differently, Hekla has had 5 periods of activity, each one starting with an acid and violently explosive eruption occurring after a long interval of quiescence. The interval preceding Hekla's eruption in 1104 was more than 250 years. The resemblance to the Krakatau activity was pointed out.

The 1362 eruption of Öræfajökull was also preceded by an interval of quiescence, lasting at least 500 years. This eruption was purely explosive and certainly a very violent one, thus of the type of initial eruptions that Rittmann (1944, p. 74) classifies as "eruzioni iniziale di ceneri e pomice". It is of interest to note that the next eruption in Öræfajökull, in 1727, produced tephra that was much more basic than that of 1362 (cf. Table 1:4) or a pigeonite-andesite according to Rittmann's nomenclature, with a SiO_2 content only 56%.

It was previously stated that Öræfajökull has in all probability produced two highly acid tephra layers in prehistoric postglacial times. Thus the volcano seems to have a cycle of activity of a similar type as the Hekla cycle.

The inital eruption of Askja in 1875 was previously mentioned (p. 49). It was purely explosive and produced only highly acid tephra (cf. Table 1:16) or rhyodacitic, acc. to Rittmann's nomenclature. But the next eruption in Askja in 1922 produced only lava. The lavaflow Bátshraun was issued from craters about 0.6 km from the 1875 crater. According to an unpublished analysis, carried out at the University Research Laboratory (analyst. H. Jónsson) the SiO_2 content of this lava is 57.02% and the lava is andesite basalt (acc. to Rittm. nomencl.).

The big cone volcano Snæfellsjökull (cf. Fig. 1) has produced two rhyolitic tephra layers in prehistoric Postglacial Time (Thorarinsson 1953).

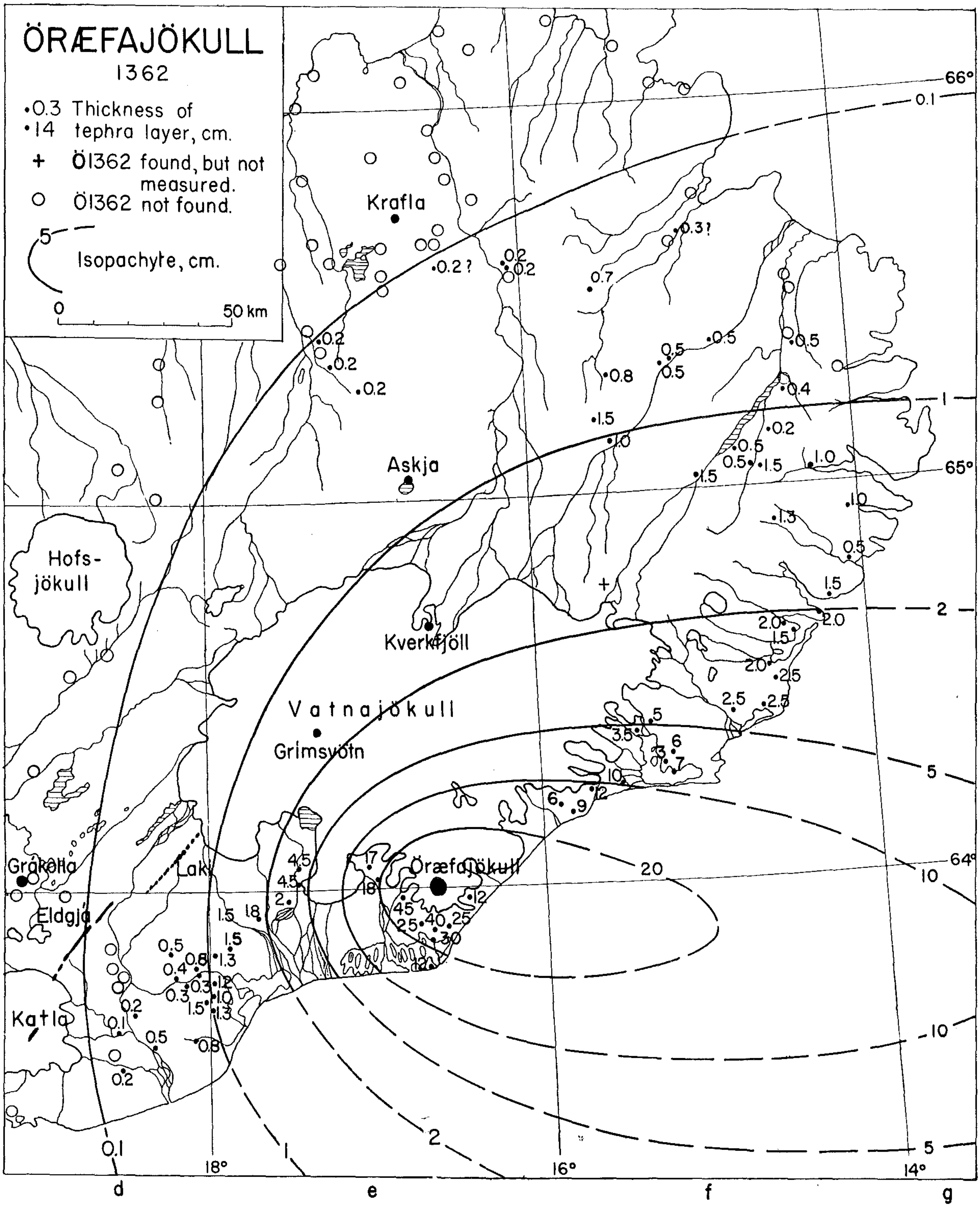
On the southern slopes of Eyjafjallajökull I have found pieces of rhyolitic pumice so big that their source is probably in that volcano.

Thus all the big cone volcanoes that have been active in Iceland in Postglacial Time have it in common that once or more during the last 8000 years or so they have had acid explosive outbursts, but most of their eruptions have been more or less basic. This suggests that all these cone volcanoes are fed by individual isolated magma pockets at a rather shallow depth in the crust, and that in these pockets differentiation takes place during the intervals of quiescence (cf. Einarsson 1950, pp. 29—30; van Bemmelen and Rutten 1955, p. 15), whereas the lava mass producing fissures and shield volcanoes are fed directly by a more regional and considerably deeper lying primary magma, that also was the source of the isolated magma pockets. From this primary magma were also directly fed the table mountains and tuff ridges during the Würm Glacial. These volcanoes correspond directly to respectively shield volcanoes and lava producing fissures in the Postglacial.

Many summers' field work in the Mývatn - Jökulsá area in N Iceland has led me to the same conclusion regarding the genesis of the subglacial palagonite tuff ridges as has earlier been reached by other geologists such as P. Hannesson in the 1930's (pers. inform., cf. also Hannesson 1951) and G. Kjartansson (1944), viz. that these ridges correspond directly to the fissures that have produced lava in Postglacial Time. As to the building up of the table mountains I quite accept in principle the opinion first suggested by Kjartansson (1944) and later detailed independently by Mathews (1947) and van Bemmelen and Rutten (1955). These authors regard the table mountains as results of central eruptions that have built up their volcanic edifices subglacially until they had become high enough to produce subaerial lava flows that now cap the tuff socles. These authors seem however, not to have discussed whether the table mountains correspond to the shield volcanoes or to mixed central volcanoes such as Öræfajökull. In my opinion the table mountains correspond to the shield volcanoes and have been fed from a deeper lying, more uniform magma than the mixed volcanoes of the Öræfajökull type. The rather uniform chemical composition of the tuffs, breccias and lavas building up the table mountains is on line with the chemical uniformity of the shield volcano lavas and in contrast with the differentiation of the products of cone volcanoes fed by local magma chambers. Furthermore the table mountains are geographically situated among the shield volcanoes and in areas where postglacial shield volcanoes are lacking, such as in the Langisjór area (Kjartansson 1957 b) table mountains are lacking too.

I have previously shown (Thorarinsson 1951), that in N Iceland the shield volcano activity probably came to an end ca. 3500 years ago, and that the shield volcanoes were mainly active there during the first millenia of the Postglacial. Thus the shield volcano activity in this area has been a direct continuation of the activity that built up the table mountains during the later part of the Würm Glacial. It may also be pointed out in this connection that the postglacial shield volcanoes have reached nearly the same — although not quite the same — height as the table mountains from the late Würm Glacial. The height, rather limited, to which the magma table could be raised did thus change rather little during a long period. Why the shield volcano activity ceased while the fissures continued to pour out lava is still an open question.

The main reason why the tuff ridges never were built up to a height comparable to the height of the highest table mountains seems to be simply that one and the same fissure very seldom erupts more than once. (This does not mean



ÖRÆFAJÖKULL
1362
•0.3 •14 Thickness of tephra layer, cm.
+ Ö1362 found, but not measured.
○ Ö1362 not found.
Isopachyte, cm.
0
50 km
Krafla
Askja
Hofs-jökull
Kverkfjöll
Vatnajökull
Grímsvötn
Öræfajökull
Grákolla
Laki
Eldgjá
Katla
66°
65°
64°
18°
16°
14°
A
B
C
D
d
e
f
g

that a long fissure always was formed in its entire length during a single eruption, but that each part of the fissure has erupted only once. Hekla is the most famous exception.) In N Iceland I have not found a single fissure that has certainly erupted more than once, but some of the subglacial ridges have been built up by two or more parallel running fissures that have not erupted at the same time (e. g. Námafjall). Other subglacial ridges are clearly built over a single fissure (e. g. the ridges in Kverkfjallarani, Austari Skógarmannafjöll, the ridges between Mödrudalur and Vídidalur).

THE THICKNESS AND EXTENSION OF Ö 1362. THE ISOPACHYTE MAP

On the map Fig. 27 I have plotted the thickness of Ö 1362 in the profiles measured and drawn isopachytes based on these thickness figures. It must be stressed, that in areas where this tephra layer in very thick and consists mainly of coarse pumice, such as in Öræfi, the thickness values based on measurements in isolated spread soil profiles cannot be expected to give very reliable values of the original average thickness of the layer within the area. Most of the pumice has been carried away by water and wind and in some places the pumice has "swept into drifts", as described in the annal fragment from Skálholt. The thickness of the layer is most even where it has fallen on woodland or flat marshy ground and I have, where possible, tried to select such places for my profiles. Thus, for instance, the sections at Skaftafell and in Bæjarstadarskógur are in woodland. In 1362 A.D. woodland was considerably more extensive in Iceland than nowadays, so that many of the measured "rofbards" were woodland at that time.

No profiles have been measured in the western part of the district Sudursveit, but the layer seems to be on the whole thinner there than farther eastwards in that district. For some reason or other, more of it may have been swept away from this area, as it is rather unlikely that its original thickness, when freshly fallen, was less there than farther east. Farther away from Öræfi, both to the W (W of Skeidarársandur) and to the E (E of Sudursveit), the thickness of the layer diminishes very regularly, and in nearby profiles the thickness does not vary much. This is characteristic for layers that have fallen on snow-free ground and after the grass had begun to grow. As a whole the thickness distribution of Ö 1362 on land is very regular, which points to the main tephra-producing phase

Fig. 27. Isopachyte map of the tephra layer Ö 1362. Thickness in cm.

of the eruption being of relatively short duration, probably not much more than a day or so. This phase was in all probability similar, although presumably somewhat larger and of a longer duration, than the main phase of the eruptions in Askja in March 29th—30th 1875 or the initial phase of the Hekla eruption in March 29th 1947 (Thorarinsson 1944, 1954). According to the Annal fragment, the eruption lasted the whole summer of 1362 and there is no reason to doubt that, but judging from the isopachyte map it seems most likely that after the initial phase the tephra was not spread to any great amount outside the immediate vicinity of the volcano. In soil section in western Öræfi the 1362 tephra is more or less clearly stratified (cf. Figs. 22 and 28), and this stratification seems to be primary, due to changes in intensity of the volcanic paroxysms. At the bottom is a layer of fine-grained (silty) tephra. This tephra forms a hardened crust, on the average 2—3 cm thick, on the stone pavement in front of the excavated farm ruins at Gröf and also on the stones of the front wall of the farm (cf. Fig. 28). It seems that this tephra was damp when it fell, and presumably the air through which it fell was moist, without heavy rain however, as that would have washed the ash from the stones. In the farmhouses, which were more or less filled with pumice, no such crust was found. A comparison with the big rhyolitic eruption in Askja March 29th 1875 is here of interest.

At Eiríksstadir in Jökuldalur, 60 km E of Askja, the tephra fall started with an ash fall. The ash was "greyish-white, very fine grained and so sticky that it could be knead like dough" (Thoroddsen 1925, p. 205). The ash fall lasted two hours, forming a layer some few cm thick on the ground and then, after a short interval, began the pumice fall with gradually increasing size of the pumice fragments until they had reached the size of a clenched fist and within four hours the layer had reached 20 cm thickness. The parallelism with the tephra fall 1362 as revealed in the sections at Hof, is striking.

Above this hardened crust fine gravelish and coarse gravelish layers of pumice alternate in the tephra layer and here and there fragments of big bombs are found. The biggest fragment measured close to the farmhouses was 60 cm in length. Pieces of head size were common. The stratification of the tephra layer not far from Gröf is shown on the photo Fig. 22. South of Svínafell I have found pieces of pumice up to 20 cm in diam., and about the same size between Fagurhólsmýri and Hnappavellir. High up on Bleikafjall there are banks of very coarse grained pumice, some metres high, along the brooks. The pumice layer is also very thick high up on Stadarfjall (pers. inform. of Flosi Björnsson, Kvísker). From Table 3 we can conclude that outside Öræfi the grainsize of the tephra diminishes very regularly with increasing distance from the volcano. Outside Öræfi the thickness of the layer on the whole diminishes very regularly as an ex-

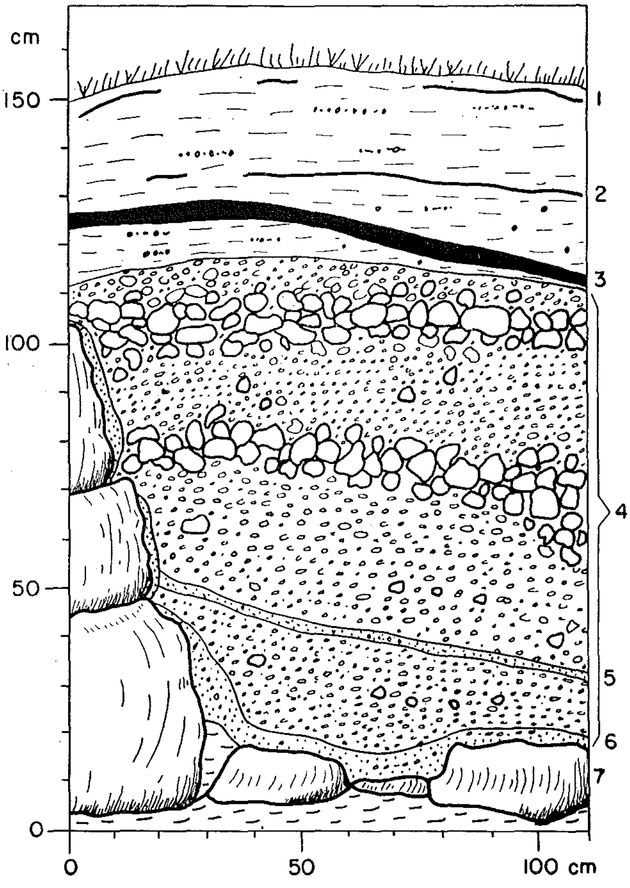


Fig. 28. Section measured at the farmruin Gröf, in front of the "Skáli", 4 m to the right of the main entrance. Drawn by the author, somewhat schematized, in Sept. 1955. 1: K 1918. 2 and 3: Black tephra layers. 4: Ö 1362 (5: A fine sandy layer, 6: The silty bottom crust of Ö 1362). 7: Stone pavement. Above Ö 1362 and beneath the stone pavement is loessial soil.

ponential function of the increasing distance from the volcano. The thickness and area on land are shown in Table 5.

The total area on land covered by the 1362-tephra within the 0.1 cm isopachyte is 38000 km².

The average thickness of the tephra fallen on land is ∾ 3 cm and the total volume 1.2 km³. It is obvious, however, when one regards the isopachytes on land

TABLE 5

The area and thickness distribution of Ö 1362 on land.

Thickness cm	Area km²	Average thickness cm	Volume km³	Thickness cm	Area km²	Volume km³
> 40	300	∾ 100	0.300	> 40	300	∾ 0.300
40 — 20	700	29	0.203	> 20	1000	0.503
20 — 10	1330	14..6	0.194	> 10	2330	0.697
10 — 5	1970	7.4	0.146	> 5	4300	0.843
5 — 2	4100	3.2	0.131	> 2	8400	0.974
2 — 1	10600	1.5	0.155	> 1	19000	1.129
1 — 0.1	19000	0.4	0.076	> 0.1	38000	1.205

that the greater part of the tephra has fallen on the sea. And as the isopachytes on land are very regular I have attempted a rough calculation of this amount based on extrapolation of the isopachytes as shown on the map with dotted lines. By the extrapolation I have assumed that on the sea the thinning of the tephra has been exponential in the same way as on land and that the isopachytes are as regular. The comprehensive measurements of the tepra-fall from Hekla on March 29th 1947 have been taken into consideration (Thorarinsson 1954 a).

According to this calculation,[1]) which must of course be regarded as rough, the max. distance of the 10 cm isopachyte from the volcano is ∾ 170 km, that of the 1 cm isopachyte ∾ 460 km and that of the 0.1 cm isopachyte ∾ 750 km, and the total areas within these isopachytes ∾ 12 000, ∾ 100 000 and ∾ 280 000 km² respectively. Whether by calculating the average thickness from a hypsographic curve or by exponential integration the result is about the same, that the total volume was about 6 km³ within the 0.1 cm isopachyte. A lot of tephra has fallen outside the 0.1 cm isopachyte but hardly more than 5% of the total volume, and that of course is inside the limit of error in the calculation of the tephra volume as a whole.

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[1]) For help in this calculation I am indebted to Mr. Glúmur Björnsson, The State Electricity Authority, Reykjavík.

THE THICKNESS AND VOLUME OF THE TEPHRA LAYER WHEN FRESHLY FALLEN

The calculations of the thickness and volume of the tephra on land are based on measurements of the thickness of the tephra layer in its present, compressed state in the soil profiles, and so are the extrapolations of the isopachytes and calculations of the tephra volume as a whole.

In order to get an idea of the thickness and volume of the tephra when freshly fallen I have tried to compare the vol. weight of the compressed tephra with that of freshly fallen. A sample of the 1362 tephra was cut out of a profile near Cf 23 (Table 3:48) at Hoffell in Hornafjördur. The thickness of the layer where cut out was 3 to 4 cm. Distance from the summit crater of Öræfajökull is 75 km. The SiO_2 content of this tephra is certainly nearly the same as that of sample 1, Table 1, or ab. 69%. The vol. weight of this sample was 0.9.

The size composition of this tephra, measured by Dr. B. Jóhannesson, at the University Research Institute, Reykjavík, is shown on Fig. 29.

In order to find out the vol. weight of this tephra when freshly fallen, Jóhannesson carried out, at my request, the following measurements. The tephra was made to fall lightly down to the bottom of a glass measure (250 cm^3 diam.

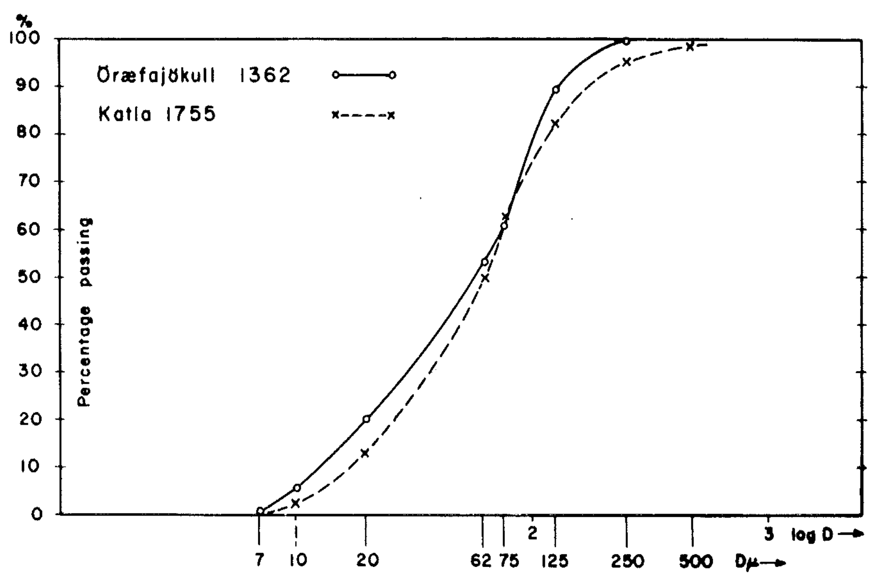

Fig. 29. Size composition of samples from the tephra layers Ö 1362 (whole drawn line) and K 1755 (broken line).

34 mm). The height of fall was 30.5 cm. When the layer on the bottom had reached a thickness of 3 cm the vol. weight was measured. This gave the following result:

	g/cm^3
Sample not sieved	0.56
Grain size 250 — 125 μ	0.46
„ „ 125 — 75 μ	0.56
„ „ 75 — 62 μ	0.59
„ „ <62 μ	0.60

Determination of the spec. weight gave:

	g/cm^3
Grain size 250 — 125 μ	2.34
„ „ 125 — 72 μ	2.42
„ „ 72 — 62 μ	2.40
„ „ <62 μ	2.41

For comparison exactly the same measurements were made on a sample of the Katla tephra of 1755, taken in profile Dc 10 a (Table 3:21) at Thverá, at 65 km distance from Katla. SiO_2 content of this sample was 48.63 (Table 1:7). The measurements gave the following results:

	g/cm^3
Sample not sieved	1.05
Grain size 250 — 125 μ	0.97
„ „ 125 — 75 μ	1.10
„ „ 75 — 62 μ	1.03
„ „ <62 μ	1.05

Determination of spec. weight:

	g/cm^3
Grain size 250 — 125 μ	2.94
„ „ 125 — 75 μ	2.95
„ „ 75 — 62 μ	2.95
„ „ <62 μ	2.96

These measurements agree on the whole well with measurements of the Hekla tephra of 1947 (Thorarinsson 1954 a).

The reduction in volume (due to compression) of the non-assorted sample from Hoffell was 38%. I have previously mentioned that the thickness on the rhyolitic layer A 1875 is on the average at least 2—3 times less according to my measurements in soil profiles than according to information on the thickness of the layer when freshly fallen. The same is the case when contemporary information on the thickness of the Hekla layers of 1693 and 1766 is compared with measurements of these layers in the soil profiles. It should be borne in mind that the thickness figures found in contemporary records on big tephra falls are on the whole maximum figures, it being a tendency rather to exaggerate than reduce the thickness when it is not exactly measured. However I think we may conclude that the 38% reduction in volume certainly is a minimum value of the real volume reduction of the 1362 layer when freshly fallen when calculated from the isopachyte map. *Thus the total volume on the 1362 tephra freshly fallen on land has been at least 2 km^3 and the total volume fallen on land and sea at least 10 km^3. Given an average vol. weight of 0.55 which is a figure not far from right, this corresponds to ∾ 2 km^3 of solid rhyolitic rock with a spec. weight of 2.7.*

As far as the production of tephra is concerned, the eruption in Öræfajökull in 1362 is the biggest one in Iceland in historical time, probably the third biggest in the Postglacial and the biggest one in Europe since Monte Somma erupted Anno 79 A.D.

THE PROBABLE WEATHER SITUATION DURING THE TEPHRA FALL

The isopachyte map is based entirely on the measurement of the thickness of the tephra layer without taking into consideration the possible or probable weather situation at the time of the tephra fall. The question is then whether the distribution of the tephra according to the isopachyte map can be explained by any weather situation likely to occur in Southern Iceland. One of the meteorologists of the Icelandic Weather Bureau *(Vedurstofan)*, Mr. Jónas Jakobsson, has kindly undertaken to try to answer this question and his answer is the following:

At Dr. Thorarinsson's request I have considered what is the most likely weather situation to cause a dispersion of tephra indicated in his chart of the 1362 Öræfajökull eruption. In the following the assumption will be made that the outrush lasted 24 to 36 hours and that the tephra was mainly dispersed within the troposphere.

According to the chart the main bulk of the tephra has been carried away with a wind direction of approximately 280 degrees (W, 10 degrees N). Comparison to the 1947 Hekla eruption (Thorarinsson 1954 a) leads one immediately to the conclusion that this must have been the wind direction in the middle and upper troposphere at the beginning of the eruption, since at that stage the rate of tephra production is at its maximum.

A likely surface weather situation at the time of such an upper air condition is an increasing SE-wind caused by the approach of a low pressure center from the SW with accompanying fronts and precipitation. At that time the wind below the middle of the troposphere is from the W, lower SW, then S and finally SE in the lowest layers. Twelve hours later the low has come closer and is a short distance to the SE of the volcano. In the middle troposphere the wind is southerly and from there down to the surface it backs through SE to E and NE-winds. At this time the rain area covers most of eastern Iceland. Still another 12 hours later the low is to the E or NE of the crater; the surface wind is from the N and backs with increasing hight to the NW and remains from that direction up through the tropopause. It is of importance that the wind in the upper troposphere never flows from the east quadrant with this weather cycle. It explains the limited extent of tephra to the west of Öræfajökull. The easterly wind which is of longest duration in the lowest layers never reaches great hights during the eruption, and therefore the tephra cannot be carried a great distance to the west.

When movement of lows is rapid in easterly or northeasterly direction, it is quite possible to get similar tephra chart even though the surface wind is from the N at the beginning of the eruption. The winds backs to the WNW with increasing hight, and as the low center approaches the wind turns to E at the surface, SE and S at higher levels.

The discussion above is based on personal experience gained in connection with weather forecasting, but is not founded on any special research program.

Therefore, it was necessary to investigate whether a situation similar to the

TABLE 6

Winds aloft at Keflavík airport 18th to 20th of May, 1957, in degrees true and knots. Heights are in kilometers.

Height	*I.M.T. 23*	*05*	*11*	*17*	*23*	*05*
0.9	calm	050/04	030/06	?	130/08	120/04
1.3	calm	040/04	030/04	260/08	090/11	110/05
2.1	calm	040/06	340/10	020/08	070/12	070/08
3.2	calm	030/06	320/04	190/07	090/08	310/04
4.3	010/06	360/08	270/12	020/04	070/08	080/03
5.7	020/12	350/10	250/06	060/07	090/08	110/06
7.3	350/12	310/14	250/14	170/10	310/08	220/03
9.2	340/15	300/10	270/42	180/05	270/14	300/10
10.7	300/20	270/26	280/31	350/04	250/13	230/14
11.8	320/19	290/10	270/26	120/10	270/12	240/10
14.3	310/08	250/09	250/09	250/08	200/12	210/08
16.4	calm	240/07	230/14	250/06	220/08	200/08

TABLE 7

Winds aloft at Keflavík airport 8th and 9th of September, 1957, in degrees true and knots. Heights are in kilometers.

Height	*I.M.T.* *11*	*17*	*23*	*05*	*11*	*17*
0.9	010/25	020/18	070/16	070/16	130/13	110/11
1.3	340/18	020/12	070/21	070/13	120/10	090/10
2.1	340/14	360/18	080/15	070/10	110/13	110/10
2.8	320/16	350/06	080/07	130/10	130/17	130/11
4.3	320/19	330/20	320/04	150/06	170/10	160/18
5.4	290/41	290/29	270/16	230/19	190/19	190/16
7.0	280/58	290/49	270/32	230/28	160/28	180/27
9.0	280/66	300/59	270/37	230/29	160/37	160/44
10.7	260/61	280/52	270/36	250/39	180/43	170/37
11.6	260/29	280/37	260/23	230/22	210/16	220/18
14.6	260/23	270/18	250/23	240/20	220/16	240/21
16.6	250/23	230/18	250/19	240/15	240/19	240/14

one just described appears in the spring or summer of a particular year. I chose the year 1957, and on the surface weather map for the months March, through September I found over twenty situations which seemed possible.

Examination of upper wind observations made four times a day at Keflavík airport showed, however, that most of these cases were improbable due to the absence of some particular wind direction, mainly southerly winds. Only three of the wind profiles seem likely to effect the dispersion of tephra depicted in the chart. These profiles are from the months March, May and September, and two the last are listed below. In both cases the height of the tropopause was close to 10 kilometers. In the September cycle no rain fell at either Keflavík or Vestmannaeyjar. On the 19th of May, however, 1—2 mm of precipitation was measured at Keflavík for the period 5 to 17 hours I.M.T., but none 12 hours before or after. At Vestmannaeyjar, total amount of rainfall was 1.6 mm fairly evenly distributed over the 39 hours period from 5 o'clock p. m. on the 18th of May to 8 o'clock a. m. on the 20th.

If an eruption like the one of Öræfajökull in the year 1362 had started at Keflavík in the early morning of the 19th of May, 1957, or the afternoon of September 8 the same year, and lasted for some 24 hours, the tephra would have spread all around the crater and possibly formed a pattern similar to the one on the chart depending in details on the starting time and other particulars of the eruption.

Of course, this does not prove that the wind situation during the Öræfajökull eruption was the same as either of these two. *But the fact remains that here has been pointed out an actual wind cycle able to bring about the main features of this particular dispersion pattern.*

THE EFFECT OF THE 1362 ERUPTION ON THE SHAPE OF ÖRÆFAJÖKULL

What was the shape of Öræfajökull before this tremendous eruption, and how did the eruption affect it? Did the enormous summit crater exist before the eruption? If not, was the topmost part of a pre-existing cone, with a summit crater much smaller than the present one, blown up in 1362, or is the present crater mainly a caldera? An attempt will be made to answer these questions at least partly. As to the first part of the last question the answer in my opinion is no. If a great amount of the presumably mainly basaltic rock of the highest part of the cone had been blown up one would expect to find a lot of accessory tephra, viz. lithic fragments, basaltic and rhyolitic, mixed with the essential rhyolitic tephra. I have found no such fragments.

In my opinion the present summit crater is mainly an "explosion-collapse", caldera (cf. Williams 1941), but the name of the volcano before 1362, Knappafell or Knappafellsjökull, is in all probability derived from the same peaks that still rise from the part of the crater rim that falls south. Two of these peaks are still called Knappar or Hnappar. This suggests that the caldera did exist already before 1362, but most likely it was deepened and widened (especially towards the N) as a result of the 1362 eruption. The eruption certainly took place within the area occupied by the present caldera, and probably from a single vent, which need not have been very wide. The bulk of the rhyolitic tephra produced by the eruption in Askja 1875 was whirled up in less than 12 hours through a single vent about 100 m in diam. at the previous surface. Whether the vent in Öræfajökull was situated near the centre of the present caldera or peripheric, like the Víti crater in Askja, cannot now be decided. What we know about the hlaups however rather points to its having been situated in the northern part of the present caldera.

COMPARISON WITH THE ANNALS

The conclusions we have reached in the preceding chapters regarding the explosive eruption of Öræfajökull in 1362, and the thickness and extension of its tephra layer, as shown on the isopachyte map, are in surprisingly good accordance with the description of the eruption quoted from the Annal fragment from Skálholt. An experiment carried out by the present writer during the last Hekla eruption showed that on grass-covered ground footprints became traceable when a fine-grained ash had formed a layer 0.35 mm thick (Thorarinsson 1955 a, Fig. 2). From the thickness of the layer in southernmost Bárdardalur and at Sudurárbotnar we can conclude with certainty that so much ash fell in some districts in Northern Iceland that "footprints were traceable" as stated in the annal.

The isopachyte map also shows that besides the pumice transported to the sea south of Iceland by the rivers, tremendous amounts have been transported to the sea through the air. This pumice was very porous and light and thus capable of floating long. As a branch of the North Atlantic Drift — a continuation of the Gulfstream — is deflected westwards by the submarine ridge between Iceland and Scotland and flows along the south and west coast of Iceland until it meets the Polar Current off the northernmost part of the west coast, it certainly is very natural that "this pumice might be seen floating off the West Coast in such masses that ships could hardly make their way through".[1)]

The Annal fragment further states that the eruption in 1362 laid waste "a great deal of Hornafjördur and Lónshverfi" viz. the districts Sudursveit, Mýrar, Nes and Lón. This is also in very good agreement with what may be concluded from the isopachyte map. We shall bear in mind that the eruption started near the middle of June, which was nearly at the worst time of the year from the point of view of farmers, the subsistence of which is mainly based on haymaking and the summer grazing of their live stock. From experience from other eruptions in Iceland it may be regarded as likely that, where thickness of the 1362 layer when freshly fallen was 12 cm or more, the farmers had to abandon their farms temporarily and this includes nearly all Hornafjördur in its old sense, viz. the districts Sudursveit, Mýrar and Nes. It is also very likely, with regard to the isopachyte map, that some farms in the Lón district were temporarily abandoned, as the thickness of the tephra layer in SW Lón may have been up to about 10 cm as freshly fallen. As pointed out to me by M. M. Lárusson, Bishop Thórarinn's decision to dispose of the property of the churches of Hnappavellir and Breidá

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1) In view of the fact that pumice, probably of Icelandic origin, has been found on raised beaches both in Spitsbergen, Norway, Denmark and W. Greenland (Undås 1934, 1942, Noe-Nygaard 1951, Thorarinsson 1951, Donner & West 1957), one could expect to find pumice also on raised beaches in Iceland. This is, however, as far as I know, not the case. Probably the explanation is simply that the postglacial uplift in Iceland was so rapid that the coastline was at its lowest before explosive postglacial volcanic activity in Iceland began on a big scale (cf. Thorarinsson 1956).

and as far as Stafafell seems to indicate that the Bishop regarded as doubtful that the district west of Lónshverfi would again become habitable. As to Litlahérad itself, I do not think it is a rash estimate that here the pumice layer was in few places and perhaps nowhere of less than 30—40 cm thickness immediately after it was formed and around some of the farms it was probably thicker. *Even if the floods had not done their share the fate of the settlement situated at the foot of the great volcano in June, 1362, would undoubtedly have been correctly described by the laconic statement of the Flatey Book annal (cf. p. 26): "Aleyddist allt Litlahérad" (Litlahérad entirely devastated).*

ON THE FATE OF THE INHABITANTS OF HÉRAD

Inevitably one asks what was the fate of the people who lived in Hérad at the time when the place was overwhelmed by these horrors. On this question contemporary records leave us actually in the dark. Such statements as "two parishes entirely wiped out" and "Litlahérad entirely devastated" only tell us that the settlement ceased to exist, but nothing about the actual loss of life. The oldest record of this is the beforesaid interpolation of Oddaverjaannáll, "no living creature survived except an aged woman and a mare". This statement, made more than two hundred years after the event, calls to mind the story of the horse, Blaze, put into writing by Ísleifur Einarsson a hundred years later. Both stories are closely akin to popular fables. I cannot refrain from pointing out the fact that in Icelandic traditional stories of cataclysmic upheavals of natural forces one person in most cases escapes, and as a rule this is no prominent personage, but on the contrary a shepherd, a servant maid or a labourer. It is as though in their inner hearts the people will not admit that natural forces can come out entirely triumphant in their onslaught on human life. And interwoven with this seems to be the experienced fact that in such convulsions the overlord has no better prospect of surviving than the small man, and maybe just the reverse. In the traditional stories the labouring man is in closer touch with nature and more inclined to hearken to her warning voice. Seeing that Raudilækur Church withstood the flood, Jón Egilsson's statement that the priest and the deacon escaped is in no wise improbable. But what about those others who lived in Hérad? We may endeavour to speculate as to what could have brought about their death in consequence of the eruption. In doing so we have some guidance in the accounts of other great explosive eruptions all along from the description of the Monte Somma eruption of 79 A.D. in the letters of Pliny the younger down to such eruptions as have taken place in the present century such as the one in St. Maria in Guatemala in 1902, that of Vesuvius in 1906, and the Katmai eruption of 1912.

Let us first consider the jökulhlaups. We may regard as certain that they swept away some farmsteads, especially in the vicinity of Raudilækur and Sandfell. It is probable that these great deluges came on very suddenly, similarly to the 1727 eruption, of which there are descriptions by eye-witnesses (cf. p. 31). In the 1727 hlaup three persons were drowned while others had narrow escapes. There is no lack of indications that the jökulhlaups of 1362 were considerably greater, at any rate the hlaup from underneath Falljökull, and seeing that they submerged a much more thickly populated area, there seems no reason to doubt that a number of people were drowned. It should not be overlooked that in the 1727 hlaup some of the water was hot, and in 1362 this might also have been the case and augmented the loss of life. But it is equally certain that many farmsteads were so situated that the flood could not reach them. The Stafafell Church chartulary shows that the floods did not sweep away the churches at Breidá and Hnappavellir.

The commencement of the 1727 eruption was accompanied by earthquake shocks that terrified the people, but there is no mention of these shocks having caused any damage. It seems probable that more severe shocks preceded the 1362 eruption. The excavation of the farm-buildings at Gröf indicates that pumice penetrated into these practically in the beginning (G. Gestsson, personal information), and this might have been caused by the buildings being damaged by earthquakes, or even that they partly fell in. However, in view of what we know of the severest earthquakes in Iceland in recent centuries (Thoroddsen 1924), it seems very unlikely that a number of people in Hérad lost their life in that manner. What is more probable is that the tephra fall itself caused some deaths. A number of horses were knocked dead by falling pumice in 1727, though the tephra fall was then of small account in comparison with the overwhelming terror of 1362. It seems probable that both people and animals who were then out in the open and not in close proximity to the shelter afforded by buildings may have been knocked dead by the pumice that rained over them. The previously mentioned bomb fragment, 60 cm in diam. on the pavement in front of the Gröf farmhouse conveys some idea as to what it was like to be out in the open while the tephra fall was at its wildest. If the bombs were hot, as may have been the case, that did not improve matters. The pumice that fell on the inner part of Jökuldalur, ca. 60 km from Askja, on March 29th 1875, is said to have been burning hot (Gunnarsson 1875, p. 59). It should, however, be said that the bombs from the 1362 eruption did not set the buildings at Gröf on fire. Neither were the churches at Hnappavellir and at Raudilækur destroyed by fire.

There is still the possibility, that there came so much volcanic dust as to cause some people to suffocate. Nuées ardentes could also possibly have occurred, but no traces of such have been found. Altogether it is not impossible that the statement of Oddaverja-annáll, "no living creature survived except one aged woman and a mare", may be not far from the truth. On the other hand, it must be deemed more probable that quite a number of the inhabitants survived the first onslaught, and almost certainly all who were then capable of doing so endeavoured to save themselves by flight at the earliest possible moment. But this was easier said than done. Presumably few horses were available, and it was a tricky question in which direction to attempt the flight — westward across the wide expanses of Lómagnúpssandur over the almost impassable courses of the jökulhlaups, or eastward across Breidársandur, where the nearest habitation was somewhat less distant. The dreariest of these two journeys was, however probably that of those who took the latter option, for they could not have seen a blade of grass until they arrived in Lón, a hundred kilometres east of Öræfi, or even farther. Yet we may assume that there was one mitigating circumstance, namely that in this early part of the summer the glacier rivers had not begun to swell appreciably.

It is to be expected that people from other districts who first ventured into Hérad after the cataclysmic revolt began to abate found few living things there; still it may be that they found then one old woman who somehow escaped and survived, and also a horse, and that there may thus be a grain of truth in the traditional story of later countries. All this is more or less probable guesses. Nevertheless, I believe it is pretty certain that since the dawn of Icelandic history no volcanic eruption has directly caused so much loss of life as the Knappafellsjökull (Öræfajökull) eruption of 1362.

FOR HOW LONG DID THE SETTLEMENT REMAIN ABANDONED?

It is difficult to decide conclusively the question as to the length of time the settlement between Skeidarársandur and Breidamerkursandur remained uninhabited subsequent to the eruption of 1362. We will briefly survey here the chief indications that may help to throw some light on the subject.

The fact that a great deal of Hérad was deserted because of pumice fall, and not because of jökulhlaups, tends to indicate that some of the area may have become habitable relatively soon, maybe after approximately a decade. Experience from other eruptions, such as the Katla eruptions of 1612 and 1755, the Hekla eruptions of 1693 and 1766, and the Askja eruption of 1875, shows that areas deserted because of pumice fall may revive remarkably soon and then be inhabited again. Wind and water are effective in clearing away the pumice. On the other hand it is a fact that the Icelandic settlement which of all suffered in this manner to a degree nearest in comparison to that of Hérad in 1362, namely the upper reaches of Thjórsárdalur, never was inhabited again after the Hekla eruption of 1104.

Farmer Sigurdur Björnsson of Kvísker has pointed out to me that in the homefield of Hof farm stretching down from the farmstead of Kot, heaps are to be seen of unassorted pumice dating from the 1362 eruption, that seem to have been raked together. Similar pumice heaps dating from the Hekla eruption of 1693 I have noticed in the homefield of Tungufell farm in the Hreppar district, and these were definitely put together by human action (Thorarinsson 1946). If the same applied to the pumice heaps at Hof, it certainly suggests that the farm did not long remain deserted.

I am told by Gísli Gestsson that no definite inferences can be drawn from the excavation at Gröf as to when people visited the farm again after it had been deserted. That farm was never inhabited again. Apparently some household articles were carried away from the farm, and this may have been done, partly at any rate, at the time the people fled from the eruption, though the articles may have been fetched later. Maybe also that some timbers were salvaged, but that could have been done much later. The Icelandic people have always had to be careful not to waste any timber, and it is possible that the farm-buildings might in part have been standing for decades.

The map of the present seashore, which as said above indicates what the settlement was like in the days before 1362, rather supports the hypothesis that the settlement was not for any great length of time entirely deserted; for in that case the ancient division of the seashore would have become somewhat confused. It is, however, possible that exact knowledge on this point was preserved through chartularies and other written documents.

In regard to the chartularies it should be noted that Hítardalsbók (DI iii) mentions none between Reynivellir in Fellshverfi (Sudursveit) and Kálfafell in Fljótshverfi. Yet it is clear (from M. M. Lárusson's above-cited essay) that Bishop Oddgeir (1366—1381) officially visited Kálfafell in Fellshverfi, and may thus be supposed to have crossed Hérad. It is further a notable fact that Vilchinsbók (DI iv), which preserves chartularies of the churches of Skálholt Bishopric drawn up during Bishop Vilchin's visitation of these in 1397, contains none relating to those between Reynivellir and Kálfafell. Indeed the only written source mentioning habitation within this area in the latter part of the fourteenth century is the chartulary of Hof Church from Bishop Mikael's collection of chartularies believed to date from 1387 (DI iv, p. 401). But in the aforesaid essay

Fig. 30. The farmruin of Gröf is being cleared of the pumice of 1362. In foreground the "skáli". Heaps of pumice from the excavation on the walls. — *Photo G. Gestsson, 1957.*

M. M. Lárusson cogently agrees that this chartulary is highly dubious and "undoubtedly spurious in the form preserved". Thus it cannot be regarded as an unchallengeable proof that Öræfi was inhabited in the ninth decade of the fourteenth century. The oldest reliable documentary authority for human habitation between Breidamerkursandur and Skeidarársandur after 1362 dates from 1482 (DI vii, pp. 431—433).

This, however, is no proof that the district between these sandur plains remained uninhabited during the first half of the fifteenth century, for we have on the whole so very few sources on habitation in Iceland during that period. It seems unlikely that habitation did not revive in this locality already in the early decades of the fifteenth century, and we must regard as possible if not probable that the revival came sooner.

There is still one thing which throws some light on the story of Hérad, and that is its passant name, Öræfi. As far as known this name first occurs in Lögmannsannáll under the date of 1412 (E. Ó. Sveinsson 1948, p. 187). This chronicle tells us of some English sailors "who lost contact with their fellows and came ashore from a boat near Horn in the east and signified that they wished to buy victuals and said that they had been sitting in the boat for several days. These five Englishmen remained in this country during the winter, for the boat had disappeared from them when they came back and as many [men] as there were in it. One of them was taken in at Thykkvibær in Ver, another at Kirkjubær, three to the east of Öræfi" (Isl. Ann., p. 290). The meaning of the word *öræfi* or *óræfi* (also spelt *órhæfi*) where it first occurs in Icelandic records, seems to be open coastland without harbour or shelter, so for instance in Landnámabók when speaking of the south coast of Iceland (Landnámabók 1900, p. 103). E. O. Sveinsson (op. cit.) writes that in the passage in Lögmannsannáll just quoted the name is used for the former Hérad and that the place was thus named by seafaring people because of its lack of a harbour. I do not think this is altogether right. The district may be said to have been without a harbour both before and after the eruption of 1362, and it is hardly a mere chance that this name of it is never found before the eruption, and that it should occur in the earliest record referring to the same area after the same eruption, that is to say when we discount the chartulary of 1387. It is in itself only what is to be expected that such documents as chartularies, based on older ones of the same kind, should retain the old name of the place. In a chartulary the name Öræfi first occurs about 1500 (*"Hof j Öræfum"*, DI vii, p. 37), while a Sandfell Church chartulary "of the same age", is assigned to *"Sandfell j Litla hierade"* (DI vii, p. 37).

It is further to be observed that already quite a long time before 1400 *öræfi* acquired a meaning akin to what it has now, i. e. uninhabited area, *anœcumen*. In a translation of *Vitæ patrum* in Heilagra manna sögur *eremi vasta secreta* is rendered *"auræfe (ok) obygdar eydemerkr"* (Heilagra manna sögur ii, p. 489), and in Jóns saga helga, written in the thirteenth century and extant in a fourteenth century vellum, *öræfi* is used in the sense of wilderness (Biskupasögur i, p. 200). It seems to me very unlikely that the records *"firir austan auræfi"* in Lögmannsannáll refer to an inhabited area between Skeidarársandur and Breidamerkursandur for it is contrary to usage to indicate an inhabited district east of an extensive sandur area by naming it in a juxtaposition with a district west of it. No one would say that Sudursveit is east of Öræfi, but that it is east of Breidamerkursandur, just as we would not speak of Álftaver as being east of Mýrdalur, but east of Mýrdalssandur. To me it seems by far the most likely that *"auræfi"* here refers to the entire area between Fljótshverfi and Sudursveit, which became one continuous desert — the longest one to be crossed anywhere in the country —

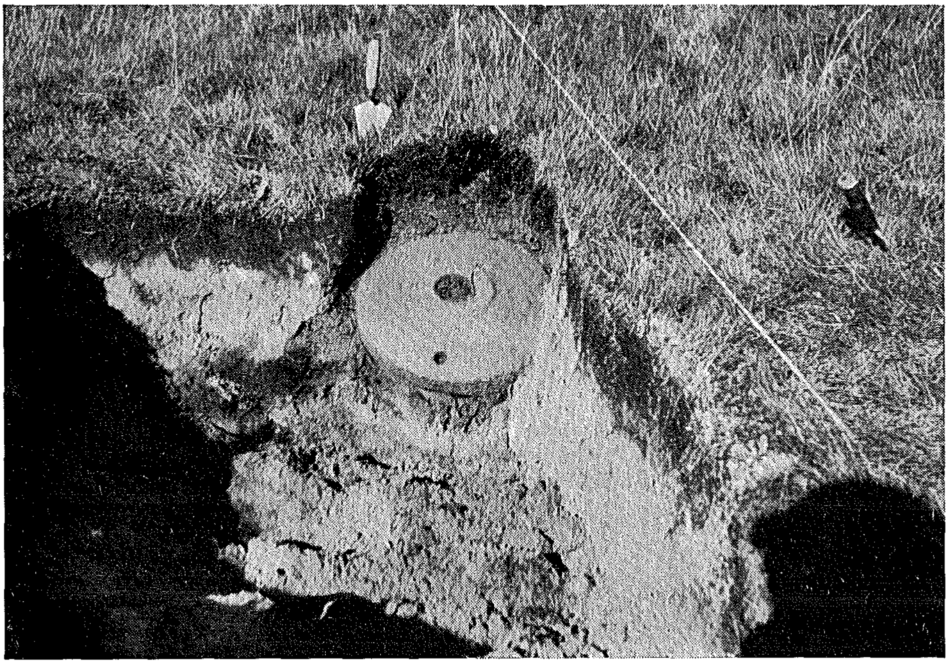

Fig. 31. Millstone (hewn from flow-banded rhyolite) in the ruin of the farmhouse in Gröf, Öræfi. — *Photo S. Thorarinsson, Sept. 13th 1955.*

after the eruption of 1362, and that just because of the devastation caused by this eruption this area acquired the new name, which remained and was applied to the new settlement that in due course arose in these wastes, and that at the beginning the name *Öræfi* was used equally of the settlement and the area as a whole.

In the autumn of 1955 I spent a few days working on the excavation of ruins of the Gröf farm-stead under the supervision of Gísli Gestsson, assistant keeper of antiquities. The last day I was digging I happened to dig up a finely wrought quern stone in the ruins of the farm-house. Not unlikely that stone had in its time ground corn grown in Iceland. Certain it is that Raudilækur Church was entitled to "a sieve of seeded corn" when its last inventory was drawn up, and thus the growing of corn had not been given up in that parish at the time of the Knappafellsjökull eruption in 1362. Since that day this well-cut quern stone remains to me a symbol of that flourishing settlement, Hérad between the Sands, which came to an abrupt end in the year of our Lord 1362. When it rose again it no longer bore the name of Hérad, not even Litlahérad. It was called Öræfi. This singularly paradoxical name of a human habitation *Öræfi,* wilderness, *anœcumen,* is the initial word in a new and a long story, and at the same time the last word in the story of *Hérad milli Sanda.*

SUMMARY

Öræfajökull (former Knappafellsjökull) is by far the biggest active volcano in Iceland (Fig. 1). Only one volcano in Europe, Etna, has a greater volume. The socle of Öræfajökull is built up during the Pleistocene, mainly of basaltic lavas and tuff-breccias belonging to the Palagonite formation. Rhyolitic intrusive and extrusive rocks occur at different places within the massif. So does the highest peak of the volcano (Hvannadalshnúkur 2119 m) consist of rhyolite. In Svínafellsfjall an interesting fossil bearing sedimentary formation (plant remnants) was discovered in 1957 and a preliminary suggestion is that this formation belongs to the Mindel-Riss Interglacial. The cone proper of the volcano was probably built up mainly during the Würm Glacial.

According to Thoroddsen four eruptions of Öræfajökull have been recorded in historical time. In reality they are only two, in 1362 and 1727. With the aid of tephrochronology and by studies of the tracks of jökulhlaups in Öræfi it has proved possible to supplement considerably the scanty informations on the 1362 eruption that are found in contemporary annals.

The 1362 eruption is shown to have been a typical initial eruption, purely explosive, and producing enormous amount of rhyolitic tephra. Measurements of the thickness of this tephra layer (Ö 1362) in numerous soil profiles all over E Iceland (Figs. 15—18) have resulted in an isopachyte map (Fig. 27) that may be regarded as satisfactorily reliable. From this map the author has calculated that the total volume of the tephra layer Ö 1362 when freshly fallen on land and sea has been at least 10 km^3, corresponding to about 2 km^3 of solid rhyolitic rock. With regard to the production of tephra the eruption is the biggest one in Iceland in historical time, probably the third biggest in the Postglacial and certainly the biggest one in Europe since the eruption of Monte Somma 79 A.D. Along the foot of the Öræfajökull massif the thickness of Ö 1362 as freshly fallen has been on average at least 40 cm. In the southern part of the district Nes, nearly 80 km

ENE of Öræfajökull, the thickness has been about 12 cm. According to a rough estimate the total area within the 0.1 cm isopachyte has been nearly 300 000 km².

In the soil profiles that have been measured in order to determine the extension and thickness of Ö 1362, numerous other tephra layers occur, some of which have been identified and dated more or less exactly. Among them are six rhyolitic layers, four of which are prehistoric, and a dark, basaltic layer, designated "a" in the profiles. This layer is somewhat younger than Ö 1362 and was probably deposited during the latter half of the 15th century. From its thickness and extension it is evident that the eruption producing it ranks among the ten biggest eruptions in Iceland in historical time with the regard to the amount of tephra produced. Nevertheless no written records that can with certainty be connected with this great eruption have been preserved.

From the depth of Ö 1362 and other dated tephra layers in the soil profiles it is concluded that the soil erosion in E Iceland has on the whole been much more rapid since 1875 than it was on average 1362—1875. It is also stated that during the Postglacial Warm Period the thickening of the loessial soil cover and accordingly also the soil erosion, was very slow in Iceland compared with recent time.

Chartularies and other contemporary written records together with place names and farm ruins reveal that near the middle of the 14th century about 30 farms were situated along the foot of Öræfajökull. The district was called Hérad, a name given only to extensive and important parishes. We still know the name of some 22—24 farms and the position of many farmsteads (Fig. 12). In the chartularies from the 14th century seventeen houses of worship are mentioned, whereof four were main churches, two annex churches and eleven chapels. The principal church was that of Raudilækur, situated W of Öræfajökull.

The whole settlement was completely destroyed by the 1362 eruption, that began near the middle of June. Since about 1600 it has been an established belief that the tremendous floods (jökulhlaups) accompanying the eruption were the chief cause of the destruction of Hérad, having literally swept away the farmsteads. On closer study one finds, however, that only some of the farms can have been destroyed in that way. Contrary to Thoroddsen's opinion it may be regarded as nearly certain that no large floods did then rush southwards from Öræfajökull. The jökulhlaups mainly flowed to the west, from underneath the glaciers Rótarfjallsjökull and Falljökull (Pl. I). Presumably most of the enormous water masses came from the summit area of Öræfajökull. (For comparison an eyewitness account of the 1727 eruption and jökulhlaups is quoted in extenso.) The present writer is of the opinion that although some farms undoubtedly were destroyed by the floods, especially in the Raudilækur parish, yet it was the tephra fall that took the heaviest toll. For this opinion he finds some support in the contem-

porary annals, but mainly in the extension and thickness of the tephra layer. The tephra fall did not only destroy those farms in Hérad that were not swept away by the floods. The districts Sudursveit, Mýrar and Nes east of Öræfajökull were also abandoned for some years. The present writer regards it as pretty certain that since the dawn of Icelandic history no volcanic eruption has directly caused so much loss of life as the 1362-eruption. As to the settlement along the foot of Öræfajökull it is difficult to decide conclusively how long it remained abandoned. It seems unlikely however that habitation did not revive there already in the early decades of the 15th century and it is possible if not probable that the revival came sooner. But when that revival came the former so prosperous settlement had lost its old name Hérad and got a new name and a significative one, a paradoxical name of a human habitation. That name was Ö r æ f i, waste land.

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Except for the list of references and the place names on the maps the Icelandic letters *ð* and *þ* are in this paper written as *d* and *th* respectively.

PLATE I

Öræfajökull. Map compiled by S. Thorarinsson 1958. Scale 1: 100 000. The topography is according to the U. S. Army Map Service photogrammetric maps, scale 1: 50 000, based on aerial photography Aug. 1945.

Addenda:

Having visited Öræfi again in August 1958 when the present paper was already in print, the author wants to add the following remarks on the map Pl. I:

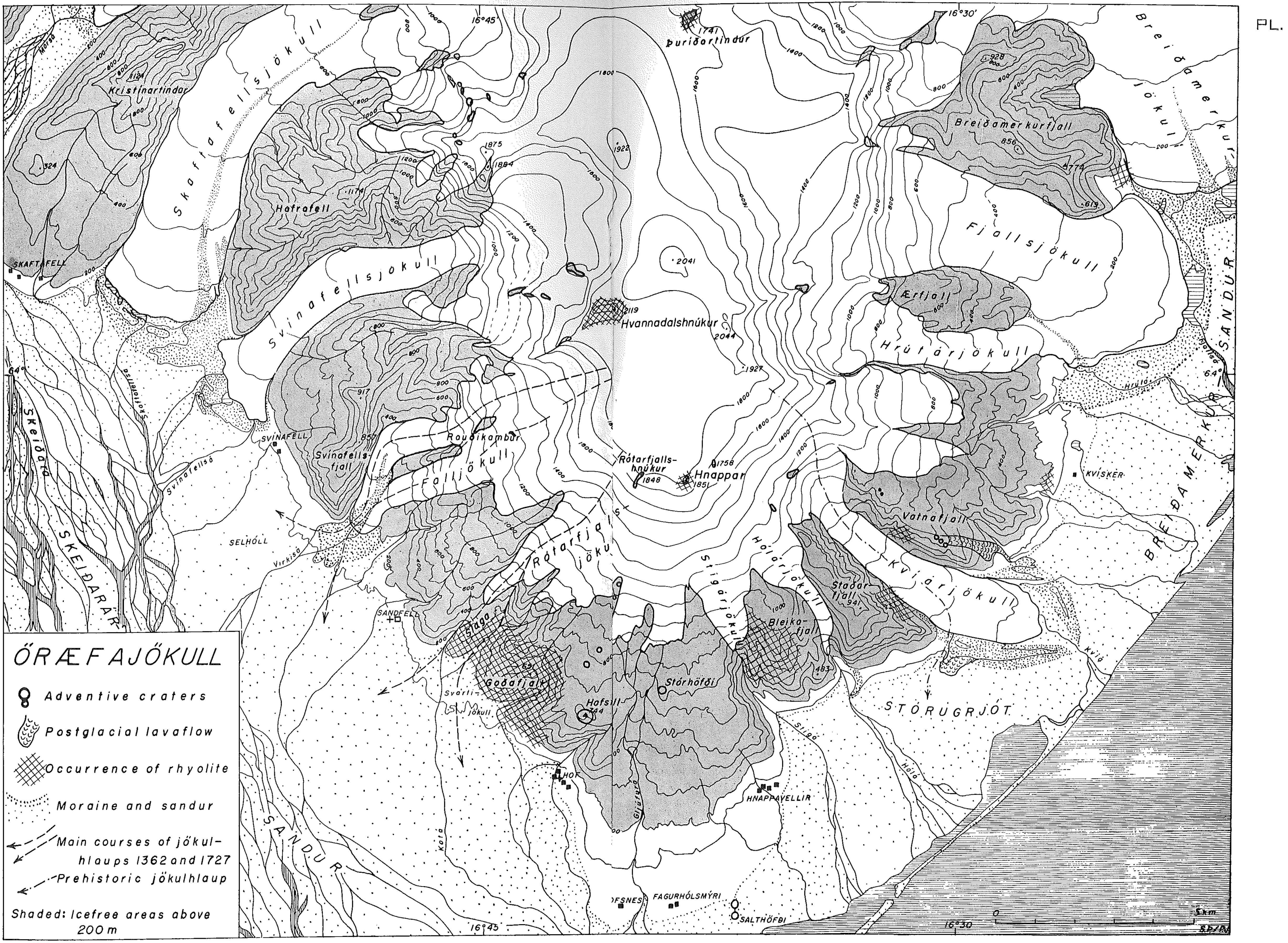
The rhyolite area at Godafjall does not extend so far northwards as shown on the map. It occurs only in the SE-most part of the mountain Slaga.

Small occurrences of rhyolite were observed on the southern slope of Hrútsfjall, N of the icefall of Svínafellsjökull.

The rhyolite at Kvísker extends a little farther westwards than shown on the map.

In the mouth of the valley between Sandfellsheidi and Slaga there are small remnants of a postglacial lava flow.

PL. I


ÖRÆFAJÖKULL
Adventive craters
Postglacial lavaflow
Occurrence of rhyolite
Moraine and sandur
Main courses of jökulhlaups 1362 and 1727
Prehistoric jökulhlaup
Shaded: Icefree areas above 200 m
16°45'
16°30'
64°
Skaftafellsjökull
Kristinartindar
Hafrafell
SKAFTAFELL
Svínafellsjökull
Svínafell
SVÍNAFELL
Svínafellsfjall
Rauðikambur
Falljökull
Hvannadalshnúkur
2119
2041
1922
1875
1884
Þuríðartindur
1741
Breiðamerkurjökull
Breiðamerkurfjall
Fjallsjökull
Ærfjall
Hrútárjökull
Rótarfjallshnúkur
1848
Hnappar
1851
1756
Rótarfjallsjökull
Stígárjökull
Hólárjökull
Kvíárjökull
Vatnafjall
KVÍSKER
Staðarfjall
941
Bleikafjall
483
Stórhöfði
Hofsfell
744
Goðafjall
Slaga
SANDFELL
SELHÓLL
Virkisá
Svínafellsá
Skaftafellsá
Skeiðará
SKEIÐARÁRSANDUR
SANDUR
BREIÐAMERKURSANDUR
STÓRUGRJÓT
Kvíá
Hólá
Stigá
Gljúfurá
Kotá
Svartijökull
HOF
HNAPPAVELLIR
FAGURHÓLSMÝRI
SALTHÖFÐI
5 km