CHAPTER VI

The Stratigraphy of the Upper Part of the Reydarfjordur Acid Volcanic Succession

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(i) Introduction

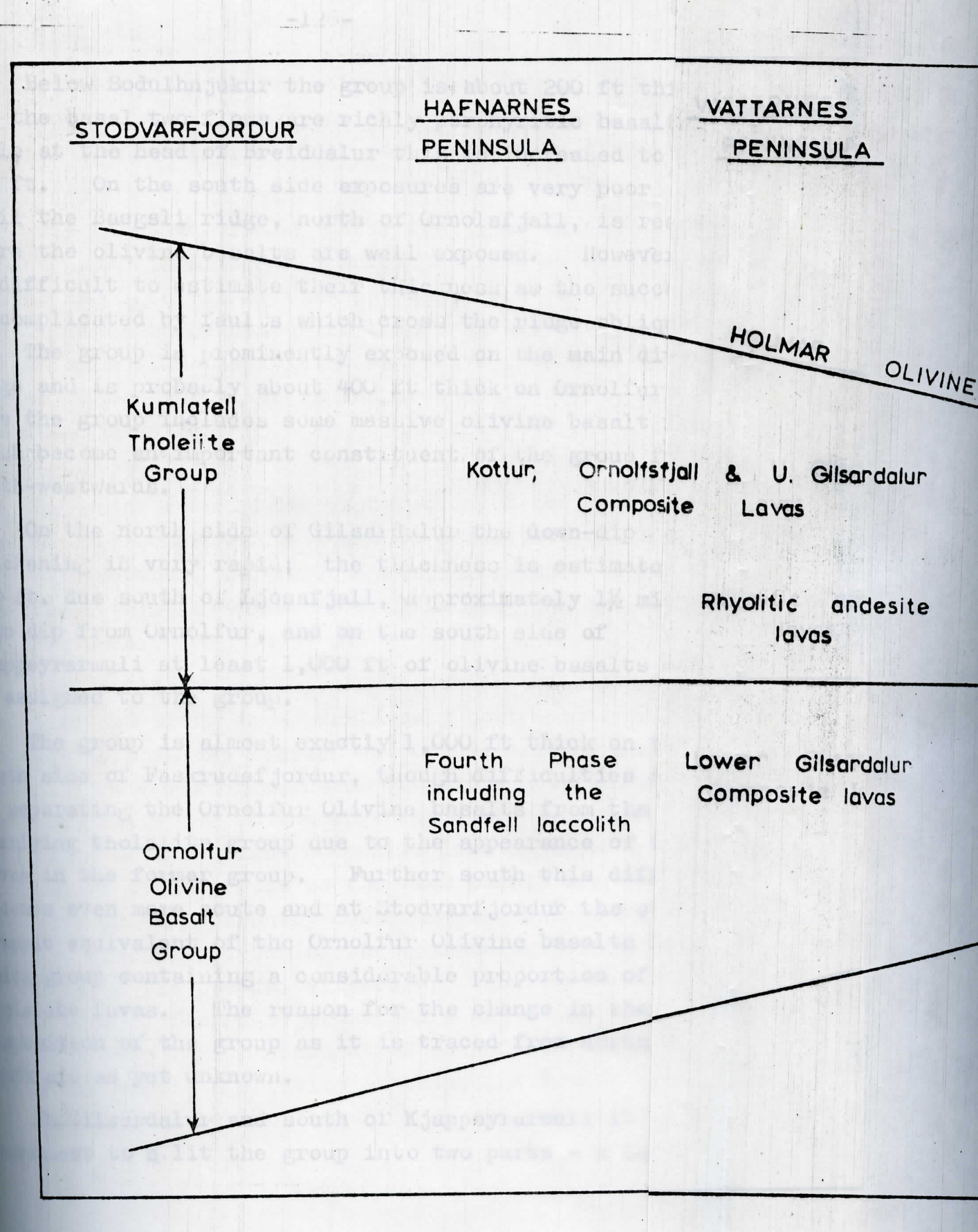
In order to facilitate the description of the upper part of the Acid Succession, the following stratigraphic table has been included to clarify the time relations of the various acid episodes. (fig.27)

Flood basalts were erupted over a wide area south of the Hafnarnes Peninsula and around Budir from the close of the Third Phase until the eruption of the Holmar Olivine Basalt Group. However, on the Hafnarnes Peninsula a local Fourth Phase interrupted this flood basalt volcanicity, while north of Reydarfjordur two further phases, the Fifth and Sixth, constitute the upper part of the Acid Succession. It was during the Fourth and Sixth Phases that the four distinctive composite lavas were erupted in the Faskrudsfjordur area.

(ii) Ornolfur Olivine Basalt Group

Although this group occurs within the limits of the Acid Succession as defined in Chapter II, it is unlike the rest of the acid group, being largely composed of olivine basalts. As will be seen there is every indication that this group and the over-lying Kumlafell tholeiite group are wedge-shaped masses of normal flood basalts, unrepresented north of Reydarfjordur.

The Olivine basalt group is widespread and can be traced from below Sodulhnukur, around Breiddalur and over the Faskrudsfjordur/Reydarfjordur watershed, into Gilsardalur and down to the shore of Faskrudsfjordur; thence south across the Hafnarnes peninsula as far as the Breiddalsvik/Stodvarfjordur watershed. It is very variable in thickness and in general thickens from north to south.


STODVARFJORDUR
HAFNARNES PENINSULA
VATTARNES PENINSULA
HOLMAR OLIVINE
Kumlafell Tholeiite Group
Kottur, Ornolfsfjall & U. Gilsardalur Composite Lavas
Rhyolitic andesite lavas
Fourth Phase including the Sandfell laccolith
Lower Gilsardalur Composite lavas
Ornolfur Olivine Basalt Group

RNES

INSULA

REYDARFJORDUR

SELDALUR

NORDFJORDUR

MAR OLIVINE BASALT GROUP

U. Gilsardalur
vas

ic andesite
avas

Sixth Phase
and Lakahnaus Porph. Crp.

Basaltic andesite lavas

Thin Tholelite lavas

Tholeiltes with a few Oliv. Bas.

Gilsardalur
site lavas

Fifth Phase

Seldalur Tuffs

THIRD PHASE

DIAGRAMMATIC STRATIGRAPHIC TABLE OF THE UPPER PART OF THE REYDARFJORDUR ACID VOLCANIC SUCCESSIO

Fig. 27

Below Sodulhnjukur the group is about 200 ft thick and the basal two flows are richly porphyritic basalts, while at the head of Breiddalur this is increased to 300 ft. On the south side exposures are very poor until the Baegsli ridge, north of Ornolsfjall, is reached, where the olivine basalts are well exposed. However, it is difficult to estimate their thickness as the succession is complicated by faults which cross the ridge obliquely.

The group is prominently exposed on the main dividing ridge and is probably about 400 ft thick on Ornolfur. Here the group includes some massive olivine basalt flows which become an important constituent of the group further south-westwards.

On the north side of Gilsardalur the down-dip thickening is very rapid; the thickness is estimated at 800 ft. due south of Ljosafjall, approximately 1½ miles down dip from Ornolfur, and on the south side of Kjappeyrarmuli at least 1,000 ft of olivine basalts can be assigned to the group.

The group is almost exactly 1,000 ft thick on the south side of Faskrudsfjordur, though difficulties arise in separating the Ornolfur Olivine basalts from the overlying tholeiite group due to the appearance of tholeiite lavas in the former group. Further south this difficulty becomes even more acute and at Stodvarfjordur the stratigraphic equivalent of the Ornolfur Olivine basalts is a thick group containing a considerable proportion of tholeiite lavas. The reason for the change in the composition of the group as it is traced from north to south are as yet unknown.

In Gilsardalur and south of Kjappeyrarmuli it is convenient to split the group into two parts - a lower

unit containing mainly massive olivine basalt flows (some over 100 ft thick) and an upper part, usually between 100 and 150 ft thick containing thin olivine basalt flows averaging perhaps 20 ft in thickness.

The plane separating these two types of olivine basalt lavas is of considerable importance as it was during the interval of time between these two that the first of the three composite lavas was extruded, while at the same time the initial explosive eruption of the fourth phase took place in the area south of Faskrusdfjordur.

Composite lavas.

In order to make the description of the composite bodies more comprehendable and to facilitate comparison one with another, the three dykes and related lavas are described together (Chapter VII) rather than in stratigraphic order.

The earliest composite dyke, which is quartz-bearing, was intruded along an approximately north-south line running through the western end of Gilsardalur and gave rise to the Lower Gilsardalur Composite Lava which can be found below and to the north of Kjappeyrarmuli. The extrusion of this first composite lava appears to have had little or no effect on the flood basalt eruptions in the area which apparently continued approximately as before, gradually drowning the upstanding acid and basic products of the composite fissure. However, on the south side of Faskrudsfjordur there was a sudden and probably very rapid accumulation of thin tholeiite lavas while the rhyolite activity of this, the Fourth Phase, is represented by the intrusion of the Sandfell Laccolith.

(iii) Fourth Phase - Introduction and Description of basal Rhyolitic Andesite Lavas

This Fourth phase, which appears to differ in several ways from the three earlier phases, will now be described, dealing with events in a stratigraphic order, before commenting on the points which distinguish this phase from its three predecessors.

Apparently the earliest lava which can be assigned to this phase of activity consists of a single pink rhyolitic andesite flow with good platy flow structure. The lava, which is in places over 100 ft. thick, is the topmost flow affected by the doming associated with the Sandfell Laccolith and forms a massive knob on the ridge joining Sandfell to Vindfell. The flow is also found west of the ridge, but is more prominent on the east side where the cliff marking the line of the flow is markedly displaced by the large fault which, to the north, downfaults the eastern part of the Sandfell by about 400 ft. What is probably the same flow can also be found on the north side of Stodvarfjordur.

Hawkes and Hawkes (1933) mention an acid tuff which rests on this rhyolitic andesite flow and outcrops on the Sandfell Vindfell ridge. In view of the position of the Sandfell tuff between the domed lavas and the overlying basalts, it must be approximately contemporaneous with the intrusion of the Laccolith (see fig. 28) and may even represent the break through of the acid magma to the surface.

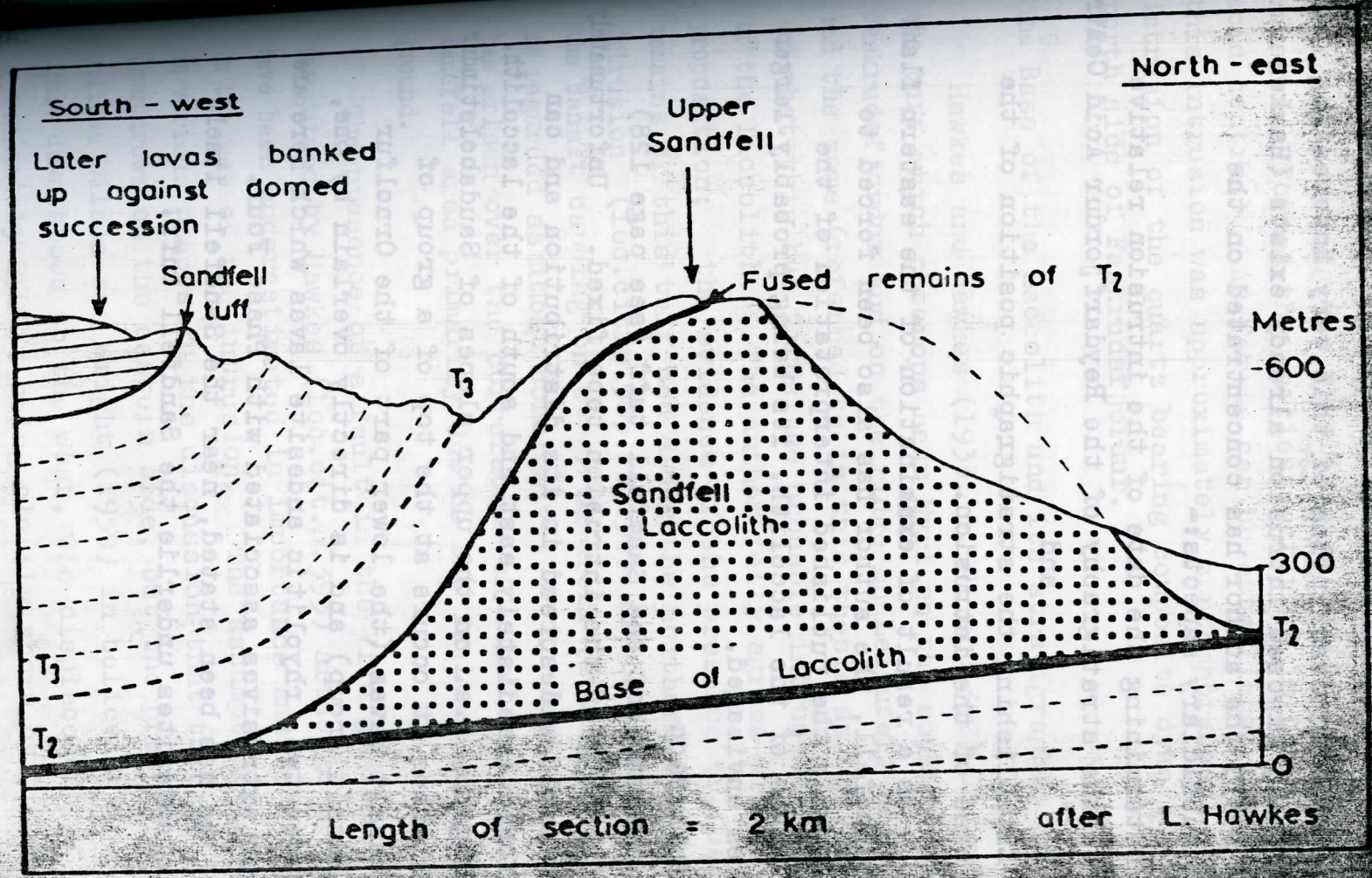

South - west
North - east
Later lavas banked up against domed succession
Upper Sandfell
Sandfell tuff
Fused remains of T_2
Metres
600
T_3
Sandfell Laccolith
300
T_2
T_3
Base of Laccolith
T_2
0
Length of section = 2 km
after L. Hawkes

Fig. 28

(iv) Fourth Phase - Sandfell Laccolith

As a detailed description of this very interesting and beautifully exposed intrusion already exists (Hawkes & Hawkes, 1933) the author has concentrated on the following subsidiary aspects:-

(a) Determining the date of the intrusion relative to the stratigraphy of the Reydarfjordur Acid Centre and

(b) Establishing the stratigraphic position of the base of the intrusion.

Partly as a result of examination of the eastern flank of Lower Sandfell, the author has also been forced to modify slightly the published interpretation of the original shape of the laccolith, its being probably larger than Hawkes envisaged.

Date of intrusion

The presence of the Sandfell tuff (see page 128) enables the date of the intrusion tobe fixed. Unfortunately the tuff is not widespread in its distribution and can only be found immediately east and south of the laccolith. In this region, i.e. on the upper slopes of Saudabolstindur and Hakarlshaus it occurs at the top of a group of olivine basalt lavas (the lower part of the Ornolfur Olivine Basalt Group) and is directly overlain by one, or in places two, rhyolitic andesite lavas which here are the lowest extrusives associated with Phase Four. However, as has been stated, near the Sandfell itself rhyolitic andesites underlie the Sandfell tuff.

It therefore seems fairly certain that the intrusion took place during the rhyolitic andesite eruptions which otherwise formed the earliest Fourth Phase activity in the Reydarfjordur Acid centre. As far as cen be established at present, this intrusion was approximately contemporaneous with the intrusion of the quartz bearing composite dyke on the north side of Faskrudsfjordur.

The Base of the Laccolith and its stratigraphic position.

Hawkes and Hawkes (1933, p.391 and 392) showed that the tuff which outcrops near Eyri on the south side of Faskrudsfjordur and on the ridge on Leirufell were one and the same (referred to in this thesis as the Tuff T_2) and that this bed forms the probable intrusive horizon of the laccolith. The author fully agrees with this proposition; the evidence of the presence of fused remains of this tuff bed along the northern margin of the intrusion (loc.cit.p.385 fig.3b) and on the underside of the basalt capping on Upper Sandfell (loc.cit.p.389, fig.7b) is regarded as almost conclusive. However some confusion has arisen over the correlation of other tuffs in the Sandfell area primarily due to the faulted nature of the ground.

The presence of a fault in the Vikurgerdisa was recognised by Hawkes (loc.cit.p.393) although it seems to have been underestimated in importance and is not shown on the map of the intrusion. The assumption is made in various places in the discussion that this fault downthrows on the eastern side, but the present author follows Wilson and Wright (1959) in believing that this fault downthrows to the west, the displacement of approximately 250 ft being clearly shown by the shift

of the Sandfell tuff in the cliffs on the north side of the main ridge between Saudabolstindur and Hakarlshaus. Thus the mass of rhyolite which forms the small hill of Rauduhnauser can no longer be interpreted as a down-faulted continuation of the Sandfell Laccolith, but is probably an entirely separate, but perhaps syngenetic, rhyolite sill.

The penetration of the tuff bed south of Rauduhnauser by rhyolite sills was cited by Hawkes as an example of the tendency for intruding magma to spread out along the thicker inter-basaltic horizons, but it can be shown that this invaded tuff is the same as the tuff on Leirufell and it seems likely that these small rhyolite sills south of Rauduhnauser are in fact the upfaulted continuation of the Sandfell Laccolith. The fusion of the tuff by the intrusive rhyolite is very similar to that described from the laccolith itself, while the rhyolites of sills and laccoliths are indistinguishable. Eastwards the sills thin and die out, while to the west exposures in the area adjacent to the line of the Vikurgerdisa fault become poor due to the excessive amount of drift.

Note on the Form of the Laccolith immediately following the intrusive Phase.

On the north, west and south faces of the Sandfell traces of the original cover of lavas still exist, or their former presence can be inferred with a reasonable amount of certainty. To the east, i.e. on the eastern slopes of Lower Sandfell, there is a large area of dolerite which Hawkes interpreted as a remnant of the basaltic cover (loc.cit.p.387), though he clearly had some doubts about this as he notes "there is no clear alternation of basalts and tuffs such as is shown in all the other bordering masses of country rocks". However,

the observed veining of the dolerite by acid rock apparently indicated that the dolerite was older and thus part of the cover rocks.

If one neglects the veining, all the available information points to this mass being a large dolerite intrusion. Over a large part of the body there is a strong, almost vertical, platy jointing and, as noted by Hawkes, dolerite/rhyolite contacts are similarly steeply inclined. The lower part of the body shows well developed columnar jointing very rarely developed in Icelandic Tertiary lavas, but common in dolerite intrusions; what Hawkes described as a "single basalt surrounded by Porphyry" (loc.cit.p.387,fig.5b) is almost certainly a dyke-like off-shoot of the intrusion and shows very marked columnar jointing at right angles to the contacts. Perhaps the most convincing evidence, however, is that the margins of the dolerite show distinct marginal chilling against the acid rock, marked by a slight reduction in grain size adjacent to the contact.

Finally, one must consider the veining of the dolerite by the rhyolite. This in fact is more widespread than Hawkes notes, and is especially common along the southern margin of the intrusion. However, the acid veins,which vary in size from several feet across down to a few inches, do not have rectilinear margins as one might expect if the rhyolite invaded solid dolerite. Instead,the margins are sinuous, while the rhyolite adjacent to the basalt contacts is a glassy variety not found elsewhere in the intrusion.

The present author suggests that the veins were developed while the dolerite was still liquid and that they were caused by the mobilisation of the rhyolite along the contact of what was a fairly large dolerite intrusion. The mobilised rhyolite then intruded the dolerite. Similar examples showing the melting of wall rocks adjacent to basic intrusions have been reported by several authors including Walker and Poldervaant (1942) who report rheomorphic veins of melted material intruding the dolerite.

The conclusion that this body is in fact a later dolerite intrusion considerably affects the interpretation of the general structure of the Sandfell Laccolith. The possibility is suggested, inview of the complete absence of domed rocks on the eastern side of the Sandfell, that the laccolith was originally larger than visualised by Hawkes and may in fact have extended well to the east of the Vikurgerdisa fault, all the domed rocks now having been removed by erosion.

(v) Fourth Phase - Thin Tholeiite Lavas

The rest of the activity associated with the Fourth Phase produced a thick and steeply dipping sequence of thin tholeiite lavas which form all the upper parts of Vindfell, Midfell, Hakarlshaus and Saudabolstindur, as well as a wedge of lavas in the flood basalt sequence on Kumlafell. These thin lavas are similar in every respect to the thin tholeiite lavas associated with the first three acid phases, being rubbley flows with a marked absence of red beds between the flows. All the lavas examined are fine grained and non-porphyritic, or only sparsely so, and the majority are believed to be tholeiites. However, there are indications from the

flow characteristics that some of the flows are more acid than normal tholeiites and are more correctly styled "basaltic andesites".

The lack of conspicuous detrital horizons make it difficult to decide whether one is dealing with individual flows or flow units, but whatever the case one is at once struck by their thinness and the consequent absence of marked "trap" topography. As an example one need only quote measurements from the eastern flank of Saudabolstindur where approximately ten flows (or flow units) total 120 ft.

It is obvious that now only a small erosional remnant of what was once a very much more extensive group of lavas can be seen and only below Kumlafell, where the group is sandwiched in a flood basalt succession, is its whole thickness preserved. However, even after present day erosion, the thickness of the group remains impressive, with 700 ft. of lavas on Vindfell. The dip is unusually high here, being about 22° to the south-west and this is thought to be partly a depositional dip. Westwards the thickness of the group and the dip both decrease until no trace of the thin lavas can be found west of the Eyrardalur on the south side of Faskrudsfjordur.

The high dips and the thinness of the lavas both suggest that originally the group formed a flat lying volcanic cone, probably centred near the Sandfell Laccolith, of which only a small segment now remains.

As was stated earlier, away from the Sandfell area flood basalt eruptions continued without any break and the flat-lying lavas of the Ornolfur Olivine Basalt division and the Kumlafell tholeiites are now banked up against the steeply dipping thin tholeiite lavas,

producing a pronounced discontinuity; this is particularly clear below Kumlafell, where the dip of the thin lavas is particularly steep. Here the discontinuity is marked by a thick red-bed, indicating a considerable time interval before the upstanding volcanic pile was drowned by the later flood basalts.

The fact that the relationship between the flood basalts and the Fourth Phase is one of banking up and not interfingering suggests that on a flood basalt time scale the extrusion of the Phase was extremely rapid - an hypothesis supported by the absence of detrital horizons between the thin tholeiite lavas.

(vi) Fourth Phase - Discussion

The Fourth Phase differed in several ways from the three earlier Phases, in particular:-

(a) There was no initial large scale pyroclastic eruption corresponding with that which produced First Phase Agglomerates.

(b) Acid magma was intruded as a laccolith instead of being extruded as lavas.

(c) Rhyolite and rhyolitic andesite activity during the Fourth Phase took place in the same area, unlike the first three phases when they often took place in separate areas.

However, the overall similarity of this group to the three earlier phases, in particular the presence of the three major magma types (rhyolite, rhyolitic andesite and tholeiite) in approximately the same proportions, make the description of this rather anomalous group of rocks, as a separate phase, acceptable

(vii) Kumlafell Tholeiite Group

In Faskrudsfjordur and Stodvarfjordur the Ornolfur Olivine Basalts are overlain in places by a thick group of massive tholeiite lavas, believed tobe flood basalts, which like the underlying olivine basalts are largely absent in Reydarfjordur and appear to have no equivalents in the area described by Walker (1959) on the north side of that fjord.

In Gilsadalur, directly underlying the massive Gilsadalur rhyolitic andesite lava, are two tholeiite lavas which are the most northerly members of the group. Exposures round Kjappeyramuli are poor but Walker (pers. comm.) has recorded 600 ft. of tholeiite lavas north-west of the town of Budir, all of which must be assigned to this group. On the south of Faskrudsfjordur the author has found similar thicknesses and north of Thverfell tholeiites occur between 680 and 1,440 ft. where they are overlain by the characteristic olivine basalts of the Holmar Group.

On Kumlafell there are about 1,000 ft. of mostly tholeiite lavas and especially noteworthy is the flow of basalt bearing quartz xenocrysts at the very top of the group, directly beneath the Holmar olivine basalts which form the summit knoll of the mountain.

In Stodverfjordur generally it is difficult to separate the Ornolfur and Kumlafell groups, but it should be emphasized that their combined thickness is considerable - about 3,500 ft. onthe south side of Stodvarfjordur - while both flood basalt divisions are unrepresented on the north side of Reydarfjordur.

(viii) Fifth Phase - Introduction.

The two closing phases associated with the Reydarfjordur Acid Volcanic Succession reach their maximum intensity north of Reydarfjordur; in fact no Fifth Phase lavas have been recognized south of the fjord.

The division of the top part of the acid succession into two phases is made onthe grounds that the rhyolite lavas overlying Phase Three fall naturally into two distinct groups, i.e. the rhyolites of the Holmanes and Eskifjordur area (Phase Five) and the slightly later Sellatratindur rhyolites (Phase Six)

The precise age relations between Phase Four, which is restricted to the Hafnarnes Peninsula, and Phase Five, are unknown, but they are probably approximately contemporaneous, both overlying Phase Three.

(ix) Fifth Phase - Agglomerates and rhyolite lavas

The Fifth resembles the first three Phases in that a group of rhyolite lavas rests on a mass of agglomerate, produced by an early explosive eruption. The majority of the Fifth Phase rhyolites, referred to as R_{5a}, R_{5b} etc., are exposed in the cliffs on the Holmanes Peninsula, at the eastern end of which there is a small exposure of the underlying agglomerate in a small cliffed bay. The base of the agglomerate is concealed below sea-leve, and a maximum thickness of 30 ft. is exposed in the lens-shaped exposure, some 180 ft. long.

Texturally the agglomerate closely resembles Ag_1 and contains fragments up to 2 ft. in diameter. It is overlain by a bedded acid tuff, some 6 ft. thick, which

appears to be welded in places. The welding is probably an original feature but may possibly be due to fusion by heat from the overlying rhyolite lava. After allowing for the effects of the regional tilt, the tuff had a residual dip in places exceeding 20°, probably an original dip due to deposition on the slopes of an agglomerate cone.

(R_{5a}) This lava rests directly on the tuff-veneered agglomerate cone. It is purple and has a very well developed platy flow structure which at the base is parallel to the underlying tuff layer.

At the eastern end of Eskifjordur are further extensive exposures of rhyolite, probably a continuation of the same flow. However, the flow characters are somewhat different as the rhyolite, which is sparsely porphyritic, is here pink and has less pronounced flow structure.

(R_{5b}) The flow forming the northern central part of the Holmanes peninsula is a greyish purple, vesicular, weakly porphyritic rhyolite with a black pitchstone at the top and base. It does not develop well marked platy flow structure. The relation of this flow to R_{5a} is obscure on the north side of the peninsula, but on the south side R_{5a} overlies R_{5b}, the two lavas being separated by the tuff overlying the agglomerate dome.

(R_{5c}) Probably the youngest of the three rhyolites outcrops on the north-western shore of the Holmanes Peninsula, opposite Eskifjordur. The flow is slightly porphyritic, platy and weathers to a pale pink or grey colour. Fragments derived from the outcrop along the shore tend to be slate-like, due to the strongly developed platy flow structure. The top of the flow is marked by a white weathering pitchstone.

Although it is thought that the Holmanes peninsula was the centre of acid eruptions during the fifth phase, the extrusion of rhyolite magma also appears to have taken place in areas further north-north-east, where three further lavas can be recognised on Sellatratindur, $R_{5d, e \& f.}$ Two of these three flows are cut by the Sellatur rhyolite plug (The vent feeder for at least one of the Sixth Phase lavas) and are exposed in the cliffs to the west of that mass.

(R_{5d}) Stratigraphically the lowest of these three lavas on Sellatratindur is the thyolite (R_{5d}), the base of which is not exposed; the rock is porphyritic and grey when fresh. The top of the flow, at 1,260 ft., is marked by a layer of green pitchstone which weathers white.

What is thought to be the same flow occurs in Sellatradalur between 830 and 920 ft. and again 800 yds further west in the stream west of Hognastadir between 520 and 560 ft. where the rhyolite is rather darker in colour and more flinty in texture.

(R_{5e}) Some 160 ft. above R_{5d}, adjacent to the Sellatur plug, is a further rhyolite which is here tentatively grouped with the other Third Phase rhyolite, though it may in fact be one of the earliest flows of the Sixth Phase.

The outstanding feature of the flow is that it is cut by two small cylindrical dolerite masses, one of which is about 100 ft. in diameter, which cut across the original platy flow structure without disturbing it in any way. The masses have a well developed columnar jointing.

(R_{5f}) The most easterly flow extruded during the Fifth Phase outcrops east of Sellatratindur, where it is the lowest of the massive flows exposed on the ridge rising westwards from the col between Nontindur and Lakahnaus. The flow, here some 80 ft. thick, shows well developed platy flow structure, which is horizontal at the flow base; while the rock is grey with markedly lath-shaped feldspar phenocrysts. The top of the lava is marked by a white-weathering pitchstone.

This flow can be traced northwards, where it appears to be banked up against the Glamsauga rhyolite, while to the south-west the flow forms a discontinuous line of cliffs below the eastern faces of Helgustadafell and Lakahnaus; it does not extend as far as the southern spur of Helgustadafell.

It should be noted that the rhyolites on the Holmanes Peninsula are not continuous with those on Sellatratindur as there are no Fifth Phase lavas above Sigmundarhus.

(x) Fifth Phase Flank Succession - Introduction and Seldalur tuffs.

The Fifth Flank succession is unusual in containing no rhyolitic andesite lavas; only tholeiites, basaltic andesites and rhyolites occur. Also unusual is the lack of a bedded tuff equivalent of the basal agglomerate. Two well defined acid tuff horizons (The Seldalur tuffs) do occur at the base of the phase, but evidence is presented later to show that these are probably not products of the Reydarfjordur centre.

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The more important and lower of the two thicker Seldalur tuffs directly overlies the Third Phase group of intermediate lavas where they outcrop in Seldalur. Data on the thickness of this tuff layer is given in fig. 29 and as can be seen the maximum thickness of 100 ft. is attained in the Fannerdalsa and the tuff thins to 20 ft. in the Sela.

Thickness variations in tuff layers may be interpreted in at least two ways - original depositional variation, or variation produced by erosion and subsequent re-deposition. In the present case both factors were probably operative. Where the tuff overlies groups of intermediate lavas, it is possible that these produced minor topographic features and that subsequent erosion was concentrated in these areas. This might account for the tuff apparently being entirely absent in the Sela. However, it would not account for the southward thinning of the tuff from the Fannerdalsa where the tuff rests on basalts, and this thinning is probably an original feature.

Studies of the size of the constituent fragments shows that they are conspicuously large on the north side of Holafjall and in the Fannerdalsa, but much smaller in the Sela. Significant quantitative measurements are difficult to make as the tuff is not uniform in grain size throughout its thickness.

Thus it can be seen that thickness and grain-size variations both suggest that the tuff was the product of an eruption which took place in a volcanic centre down-dip to the north-west and is not in fact a product of the Reydarfjordur Acid Volcanic Centre as thought by Walker (1959)

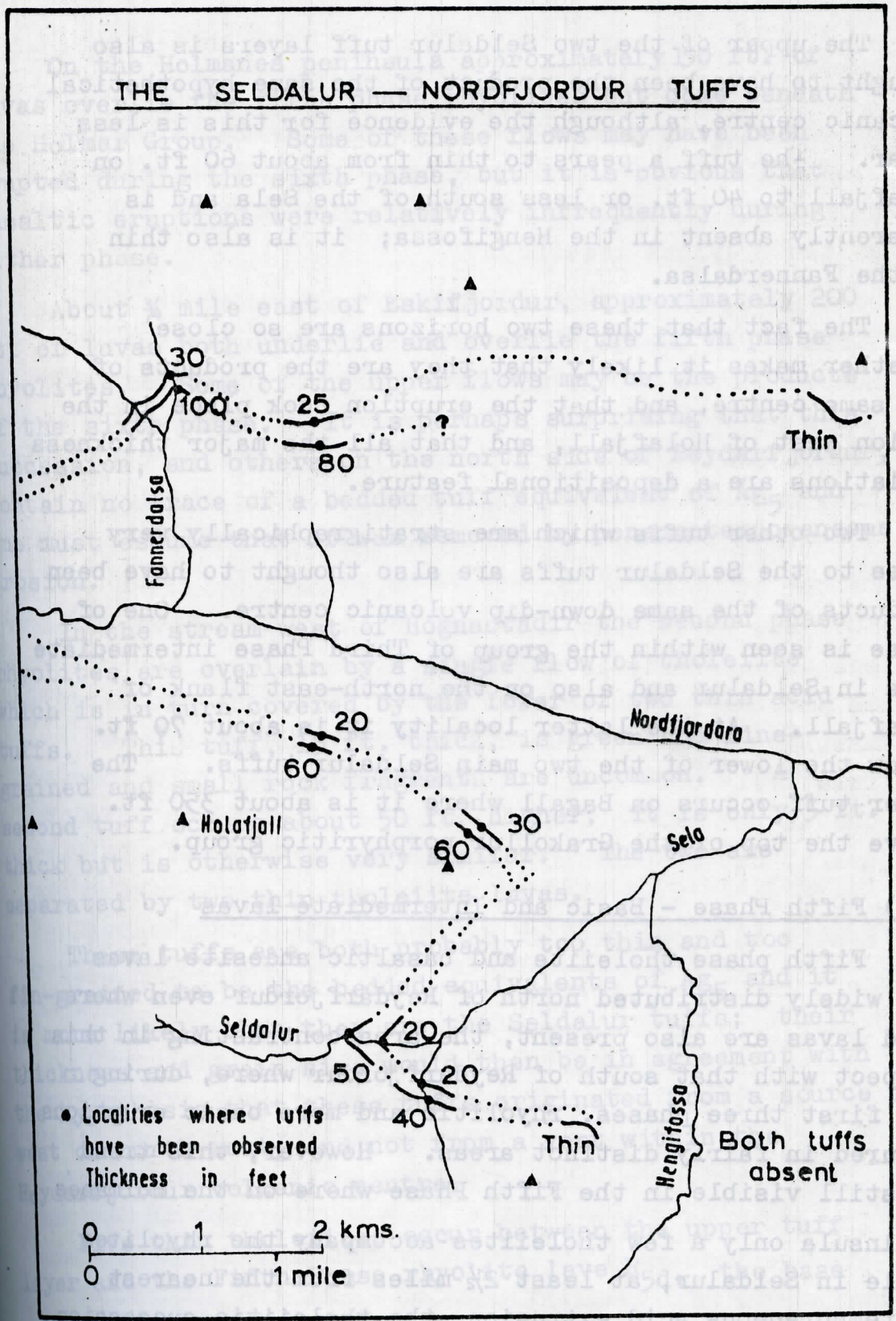

THE SELDALUR — NORDFJORDUR TUFFS
30
100
25
80
?
Thin
Fannerdalsa
Nordfjordara
20
60
Holafjall
30
60
Sela
Seldalur
20
50
20
40
Thin
Hengifossa
Both tuffs absent
• Localities where tuffs have been observed
Thickness in feet
0 1 2 kms.
0 1 mile

Fig 29

The upper of the two Seldalur tuff layers is also thought to have been the product of the same hypothetical volcanic centre, although the evidence for this is less clear. The tuff appears to thin from about 60 ft. on Holafjall to 40 ft. or less south of the Sela and is apparently absent in the Hengifossa; it is also thin in the Fannerdalsa.

The fact that these two horizons are so close together makes it likely that they are the products of the same centre, and that the eruption took place in the region west of Holafjall, and that all the major thickness variations are a depositional feature.

Two other tuffs which are stratigraphically very close to the Seldalur tuffs are also thought to have been products of the same down-dip volcanic centre. One of these is seen within the group of Third Phase intermediate lavas in Seldalur and also on the north-east flank of Holafjall. At the latter locality it is about 70 ft. below the lower of the two main Seldalur tuffs. The other tuff occurs on Bagall where it is about 350 ft. above the top of the Grakollur porphyritic group.

(xi) Fifth Phase - Basic and Intermediate lavas

Fifth phase tholeiite and basaltic andesite lavas are widely distributed north of Reydarfjordur even where acid lavas are also present, the area contrasting in this respect with that south of Reydarfjordur where, during the first three phases, rhyolitic and more basic eruptions occured in fairly distinct areas. However, this trend is still visible in the Fifth Phase where on the Holmanes peninsula only a few tholeiites accompany the rhyolites while in Seldalur, at least 2½ miles from the nearest contemporaneous acid extrusion, the tholeiitic succession has increased in thickness to 350 ft.

On the Holmanes peninsula approximately 150 ft. of lavas overlie the fifth phase rhyolites but come beneath the Holmar Group. Some of these flows may have been erupted during the sixth phase, but it is obvious that basaltic eruptions were relatively infrequently during either phase.

About ¾ mile east of Eskifjordur, approximately 200 ft. of lavas both underlie and overlie the fifth phase rhyolites. Some of the upper flows may be the products of the sixth phase. It is perhaps surprising that this succession, and others on the north side of Reydarfjordur, contain no trace of a bedded tuff equivalent of Ag_5 and one must assume that it was removed by penecontemporaneous erosion.

In the stream west of Hognastadir the second phase rhyolites are overlain by a single flow of tholeiite which is in turn covered by the lower of two thin acid tuffs. This tuff, 15 ft. thick, is green and fine-grained and small rock fragments are uncommon. A second tuff occurs about 50 ft. higher; it is only 5 ft. thick but is otherwise very similar. The two are separated by two thin tholeiite lavas.

These tuffs are both probably too thin and too fin-grained to be the bedded equivalents of Ag_5 and it is more likely that they are the Seldalur tuffs; their thickness and grain size would then be in agreement with the hypothesis that these tuffs originated from a source to west or north-west, and not from a vent within the Reydarfjordur volcanic centre.

Five thin tholeiites occur between the upper tuff layer and the Fifth Phase rhyolite lave R_{5d}, the base

of which occurs at 520 ft. This rhyolite is in turn overlain by approximately 400 ft of thin tholeiites, of which perhaps half belong to the Fifth Phase.

A similar succession is exposed in Sellatradalur except that only one of the tuff layers is present and this rests on the third phase rhyolites which are absent at the previous locality.

South of Sellatratindur the basic rocks of the Fifth Phase are usually obscured by rhyolite scree. However, west of the Sellatur plug, five tholeiite flows occur between the two fifth phase rhyolites, while above Sigmundarhus there is apparently a 700 ft. succession of thin basic flow overlying the Third Phase rhyolites. Again presumably some of the upper flows were erupted during the sixth phase.

The top of the Third Phase rhyolites above Sellatur and Sigmundarhus is marked by a conspicuous bench. This is probably produced both by the resistant nature of the massive rhyolite flows and by the presence of the relatively soft overlying tuff bed. This tuff, perhaps one of the two Seldalur tuffs, is usually concealed by drift, but an exposure is seen below Helgustadafell. The tuff is also exposed at Nontindur and at the above mentioned localities it is fine-grained.

In the nordfjordur area, the fifth phase and the lower part of the Sixth Phase consist of a thick succession of predominently basic flows which rest on the Seldalur tuffs. The characteristics of the group undergo a progressive change from south to north, there being a steady northward reduction in the thickness of the group as a whole and a gradual increase in the average thickness of the individual lavas. In Oddsdalur and on the flanks of Hautn the succession

consists of unusually thin flows; thirty-one lavas, of which a few are intermediate in composition, total 830 ft. In the Tandastadaa the succession is approximately 700 ft. thick, but consists of only sixteen lavas. On Bagall the thickness of rocks is still further reduced to 450 ft.

The shortness of the interval between the eruption of the lavas in the Oddadalur area is reflected in the absence of red-beds between the individual lavas, while on Bagall, where the interval was longer, detrital horizons and thick red-beds are quite common.

It should be noted that only the lower part of the basalt succession described above is referred tothe Fifth Phase. The upper lavas were probably erupted during the Sixth Phase.

(xii) Sixth Phase - Introduction

The final phase of eruptions from the Reydarfjordur centre was in many ways unusual. It included the extrusion of three spectacular composite lavas, a thin group of richly porphyritic basalts (the Lakahnaus Porphyritic group), the most extensive rhyolite flow in the Reydarfjordur area, a group of unusual anorthoclase bearing rhyolites, and two exceptionally massive rhyolitic andesite flows.

The distribution of the acid lavas is also unusual. The eruptive centre apparently lay north of Reydarfjordur for it is here that the greatest thickness of rhyolites occurs. However, the composite eruptions, which also resulted in the extrusion of a considerable volume of acid magma, occur further south.

In contrast to the preceding Phases, the Sixth Phase rhyolites do not rest on a basal agglomerate, nor has any

widespread tuff horizon been found at the base of the sixth phase in adjoining areas.

(xiii) Sixth Phase Lavas south of Reydarfjordur

Only five individual Sixth Phase lavas have been recognised south of Reydarfjordur. Two are massive rhyolitic andesite flows and the other three, which are later, are composite lavas. These five distinctive flows are sandwiched between the tholeiites of the Kumlafell Tholeiite Group, which here underlies the Holmar Olivine Basalts.

Together, the two rhyolitic andesite lavas, which were extruded approximately simultaneously, form an important stratigraphic horizon which can be found on both sides of Faskrudsfjordur, in Gilsardalur, in Breiddalur and below Sodulhnjukur. Although no more than one individual lava is seen in any vertical section, there are clear indications from the isopachyte map (fig. 30) that there are in fact two flows - one to the north and a larger thicker unit to the south. As can be seen, the maximum thickness of this southern portion is nearly 300 ft. while variations in the flow thickness are extremely rapid in places - perhaps a reflection of the original viscosity of the magma or undetected irregularities in the surface.

The most interesting feature of these rhyolitic andesite lavas is that they are the only flows of this type in the Reydarfjordur area not directly associated with thin tholeiite and basaltic andesite flows. Thick sequences of these thin lavas underlie thick Sixth Phase intermediate lavas in the Nordfjordur area, but do not appear south of Reydarfjordur.

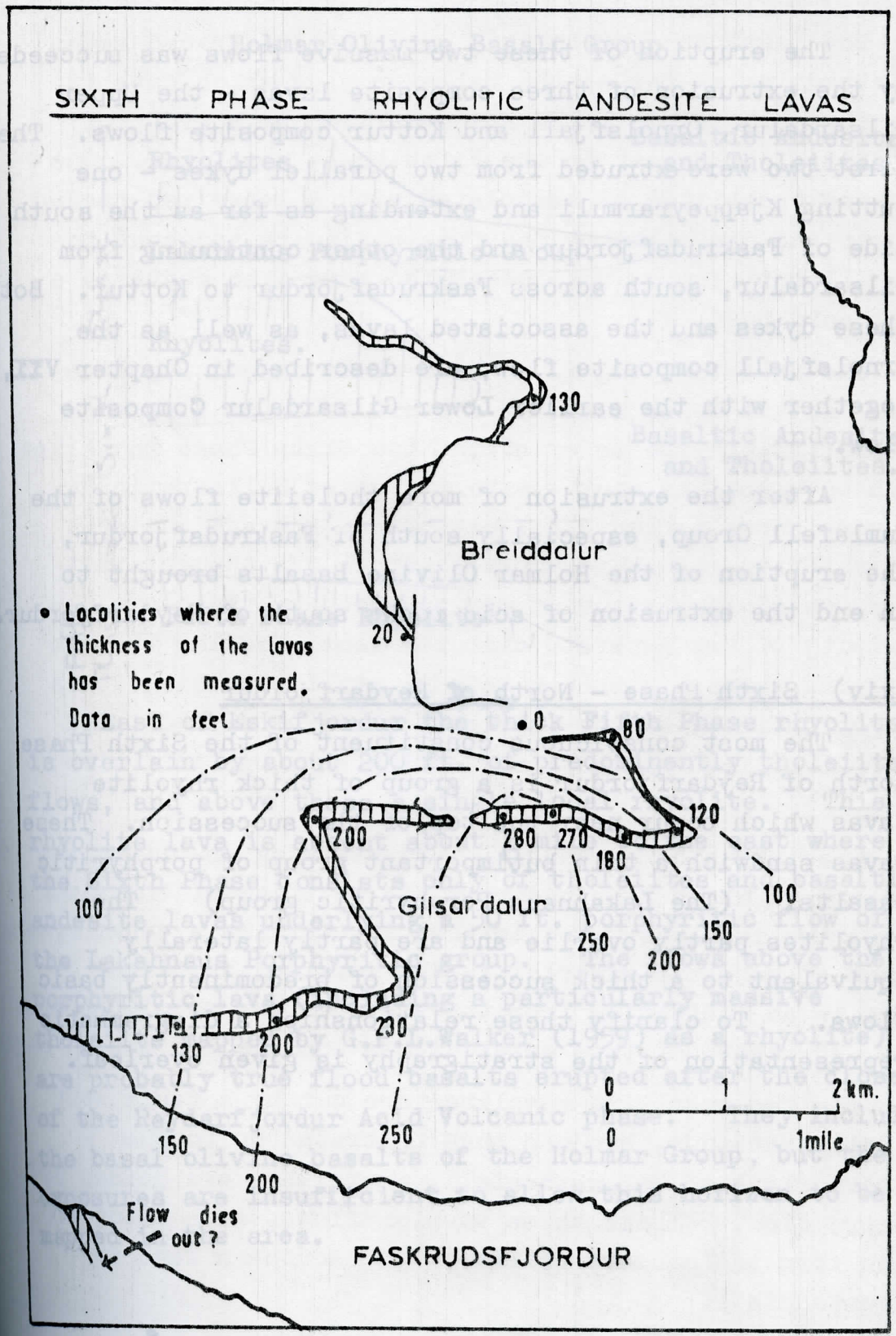

SIXTH PHASE RHYOLITIC ANDESITE LAVAS
130
Breiddalur
20
• Localities where the thickness of the lavas has been measured. Data in feet
0
80
120
200
280
270
180
100
100
Gilsardalur
250
150
200
230
130
200
150
200
250
0 1 2 km.
0 1mile
Flow dies out ?
FASKRUDSFJORDUR

Fig. 30.

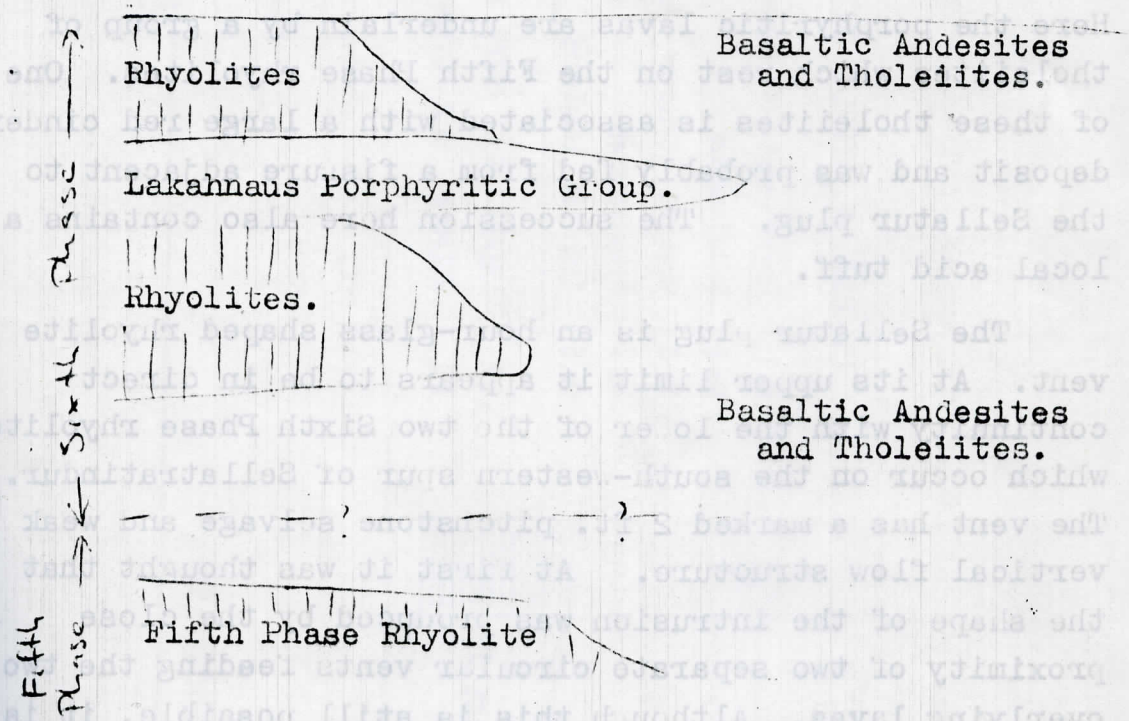
The eruption of these two massive flows was succeeded by the extrusion of three composite lavas - the Upper Gilsardalur, Ornolsfjall and Kottur composite flows. The first two were extruded from two parallel dykes - one cutting Kjappeyrarmuli and extending as far as the south side of Faskrudsfjordur and the other continuing from Gilsardalur, south across Faskrudsfjordur to Kottur. Both these dykes and the associated lavas, as well as the Ornolsfjall composite flow, are described in Chapter VII, together with the earlier Lower Gilsardalur Composite flow.

After the extrusion of more tholeiite flows of the Kumlafell Group, especially south of Faskrudsfjordur, the eruption of the Holmar Olivine Basalts brought to an end the extrusion of acid rocks south of Reydarfjordur.

(xiv) Sixth Phase - North of Reydarfjordur

The most conspicuous constituent of the Sixth Phase north of Reydarfjordur is a group of thick rhyolite lavas which occur near the top of the succession. These lavas sandwich a thin but important group of porphyritic basalts. (The Lakahnaus Porphyritic group) The rhyolites partly overlie and are partly laterally equivalent to a thick succession of predominently basic flows. To clarify these relationships a diagrammatic representation of the stratigraphy is given overleaf.

Holmar Olivine Basalt Group



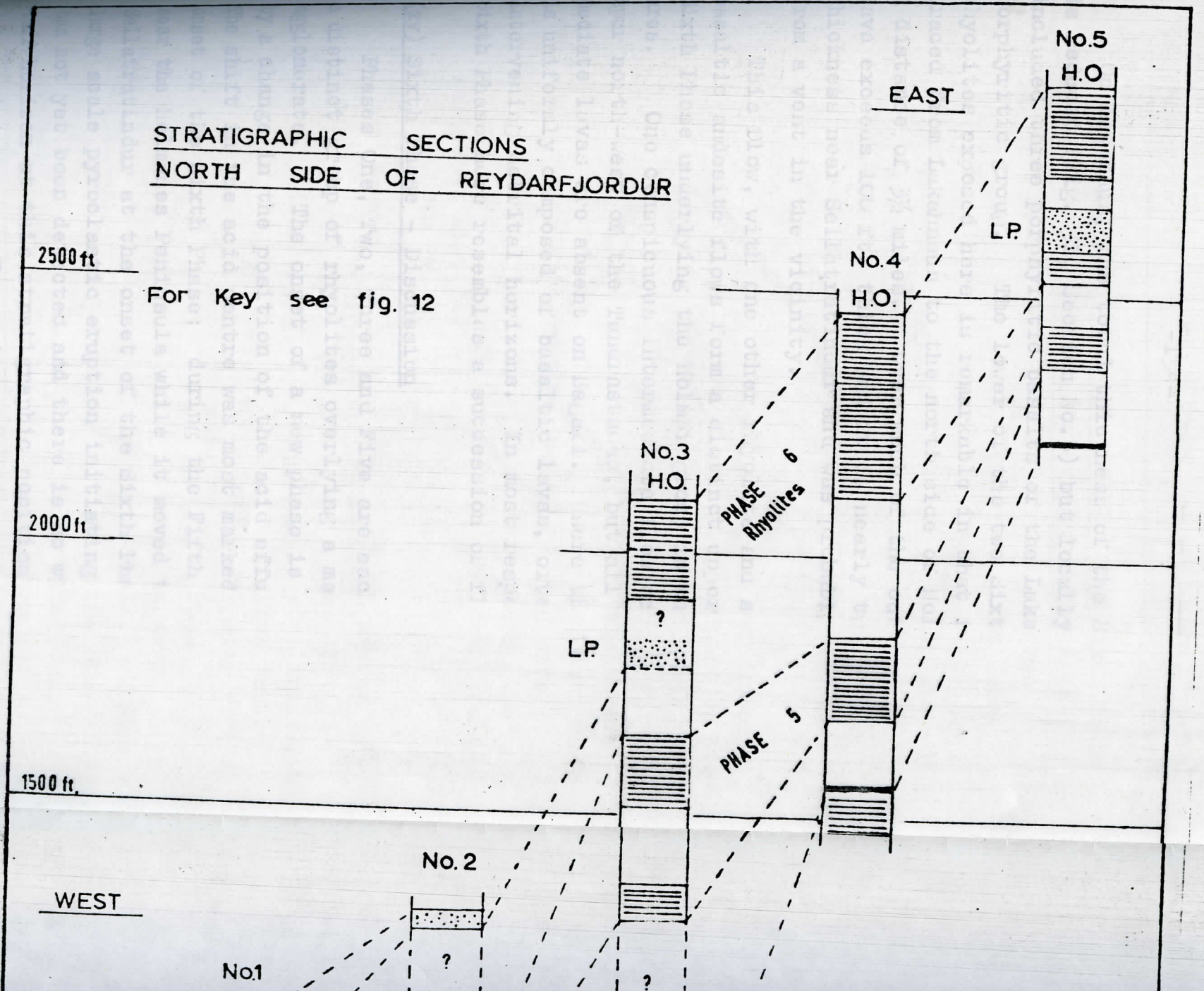
East of Eskifjordur the thick Fifth Phase rhyolite is overlain by about 200 ft. of predominently tholeiite flows, and above these a single local rhyolite. This rhyolite lava is absent about ½ mile to the east where the Sixth Phase consists only of tholeiites and basaltic andesite lavas underlying a 50 ft. porphyritic flow of the Lakahnaus Porphyritic group. The flows above the porphyritic lava (including a particularly massive tholeiite mapped by G.P.L.Walker (1959) as a rhyolite) are probably true flood basalts erupted after the close of the Reydarfjordur Acid Volcanic phase. They include the basal olivine basalts of the Holmar Group, but the exposures are insufficient to allow this horizon to be mapped in the area.

The Lakahnaus Porphyritic group can be traced round Sellatradalur as far as the Sellatur plug which cuts it. Here the porphyritic lavas are underlain by a group of tholeiites which rest on the Fifth Phase rhyolites. One of these tholeiites is associated with a large red cinder deposit and was probably fed from a fissure adjacent to the Sellatur plug. The succession here also contains a local acid tuff.

The Sellatur plug is an hour-glass shaped rhyolite vent. At its upper limit it appears to be in direct continuity with the lower of the two Sixth Phase rhyolites which occur on the south-western spur of Sellatratindur. The vent has a marked 2 ft. pitchstone selvage and weak vertical flow structure. At first it was thought that the shape of the intrusion was produced by the close proximity of two separate circular vents feeding the two overlying lavas. Although this is still possible, it is thought unlikely as the intrusion shows no well-defined internal chilled contacts suggesting only one intrusive phase.

The intrusion is unusual in containing an-orthoclase phenocrysts(which also occur in the majority of the sixth Phase rhyolite lavas,) and in that it contains a considerable amount of basaltic material in the marginal rhyolite; there is an indication from the shape of the xenoliths that some, at least, of this material was included as basalt magma.

The two overlying rhyolites are cut by a fault west of Sellatratindur, but can then be traced on to the western flank of Helgustadafell, where they are joined by a third flow. These three tabular flows, each about 100 ft. thick form the massive cliffs on the southern face of Helgustadafell.


STRATIGRAPHIC SECTIONS
NORTH SIDE OF REYDARFJORDUR
For Key see fig. 12
2500 ft
2000 ft
1500 ft.
WEST
EAST
No.1
No.2
No.3
H.O.
No.4
H.O.
No.5
H.O
L.P.
?
PHASE 6
Rhyolites
PHASE 5

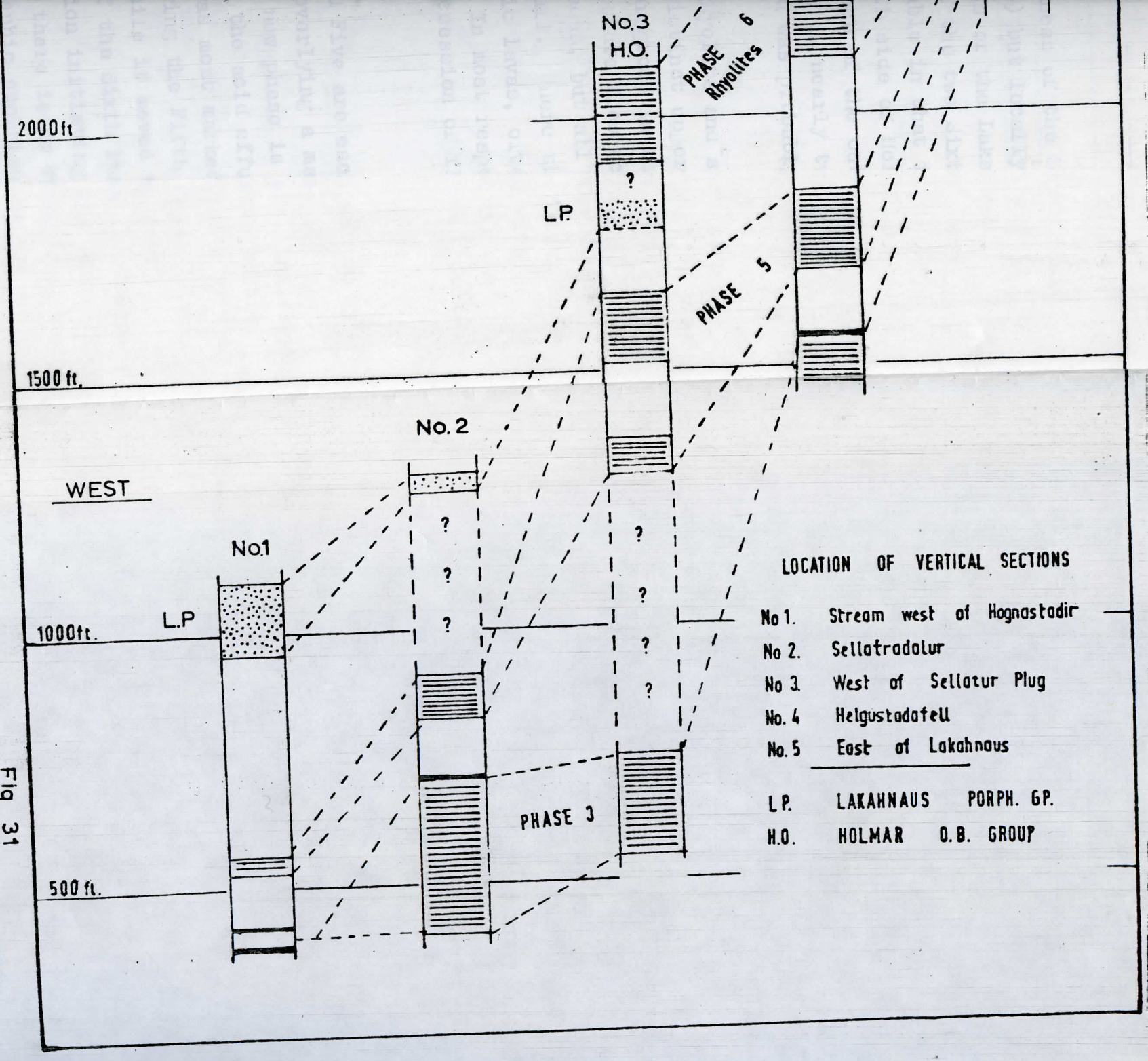

No.3
H.O.
PHASE 6
Rhyolites
2000 ft
?
L.P
PHASE 5
1500 ft.
No. 2
WEST
No.1
?
?
?
?
?
?
?
1000ft.
L.P
PHASE 3
500 ft.
LOCATION OF VERTICAL SECTIONS
No 1. Stream west of Hognastadir
No 2. Sellafradalur
No 3. West of Sellatur Plug
No. 4 Helgustadafell
No. 5 East of Lakahnaus
L.P. LAKAHNAUS PORPH. GP.
H.O. HOLMAR O.B. GROUP

Fig 31

On Lakanaus, the total thickness of the Sixth Phase is reduced (Fig. 31, Section No.5) but locally here is included three porphyritic basalts of the Lakanaus Porphyritic group. The lower of the two Sixth Phase rhyolites exposed here is remarkable in that it can be traced from Lakahnaus to the north side of Holafjall - a distance of 3½ miles. Over much of the outcrop the lava exceeds 100 ft. thick and it is nearly twice this thickness near Sellatratindur and was probably erupted from a vent in the vicinity.

This flow, with one other rhyolite and some massive basaltic andesite flows form a distinct upper part of the Sixth Phase underlying the Holmar group in the Nordfjordur area. One conspicuous intermediate flow occurs on the spur north-west of the Tandrastadaa, but all the intermediate lavas are absent on Bagaal. Here the Sixth Phase is uniformly composed of basaltic lavas, often with intervening detrital horizons. In most respects, the Sixth Phase here resembles a succession of flood basalts.

(xv) Sixth Phase - Discussion

Phases One, Two, Three and Five are each marked by a distinct group of rhyolites overlying a mass of agglomerate. The onset of a new phase is also indicated by a change in the position of the acid effusive centre. The shift in the acid centre was most marked prior to the onset of the Sixth Phase; during the Fifth Phase it was near the Holmanes Peninsula while it moved to near Sellatratindur at the onset of the Sixth Phase. However, large scale pyroclastic eruption initiating the Sixth Phase has not yet been detected and there is no widespread acid tuff horizon at this stratigraphic position in the surrounding area. For this reason it is thought that the

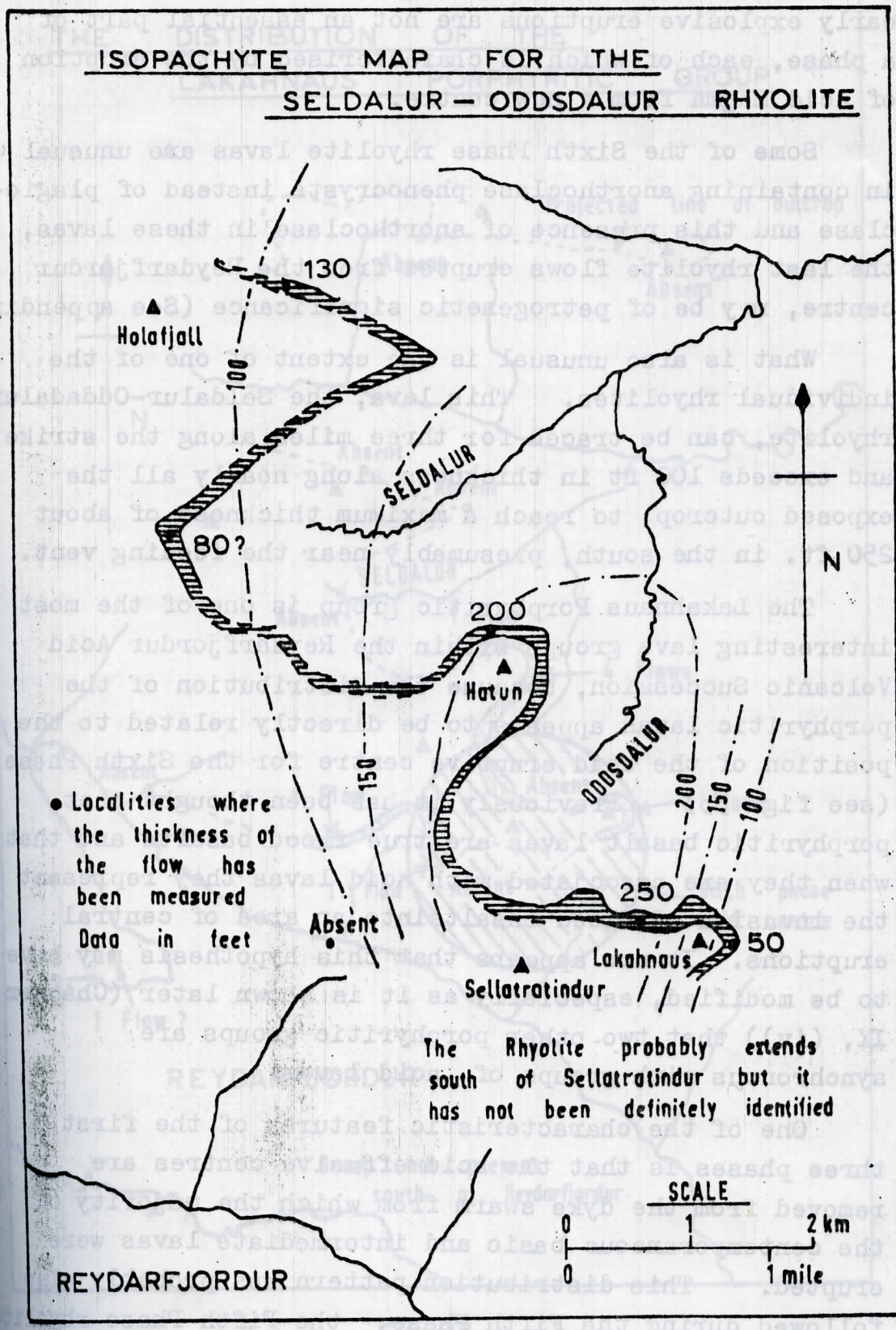

ISOPACHYTE MAP FOR THE
SELDALUR – ODDSDALUR RHYOLITE
130
Holafjall
100
SELDALUR
80?
200
Hatun
150
ODDSDALUR
200
150
100
N
250
50
Lakahnaus
Absent
Sellatratindur
• Localities where the thickness of the flow has been measured
Data in feet
The Rhyolite probably extends south of Sellatratindur but it has not been definitely identified
SCALE
0 1 2 km
0 1 mile
REYDARFJORDUR

Fig 32

early explosive eruptions are not an essential part of a phase, each of which is characterised by the eruption of acid magma from a new centre.

Some of the Sixth Phase rhyolite lavas are unusual in containing anorthoclase phenocrysts instead of plagioclase and this presence of anorthoclase in these lavas, the last rhyolite flows erupted from the Reydarfjordur centre, may be of petrogenetic significance (See appendix)

What is also unusual is the extent of one of the individual rhyolites. This lava, the Seldalur-Oddadalur rhyolite, can be traced for three miles along the strike and exceeds 100 ft in thickness along nearly all the exposed outcrop to reach a maximum thickness of about 250 ft. in the south, presumably near the feeding vent.

The Lakahnaus Porphyritic group is one of the most interesting lava groups within the Reydarfjordur Acid Volcanic Succession, because the distribution of the porphyritic lavas appears to be directly related to the position of the acid eruptive centre for the Sixth Phase. (see fig. 35) Previously it has been thought that porphyritic basalt lavas are true flood basalts and that when they are associated with acid lavas they represent the invasion of flood basaltsinto an area of central eruptions. It now appears that this hypothesis may have to be modified, especially as it is shown later (Chapter IX, (iv)) that two other porphyritic groups are synchronous with groups of acid lavas.

One of the characteristic features of the first three phases is that the acid effusive centres are removed from the dyke swarm from which the majority of the contemporaneous basic and intermediate lavas were erupted. This distribution pattern was probably also followed during the Fifth Phase; the Fifth Phase rhyolites

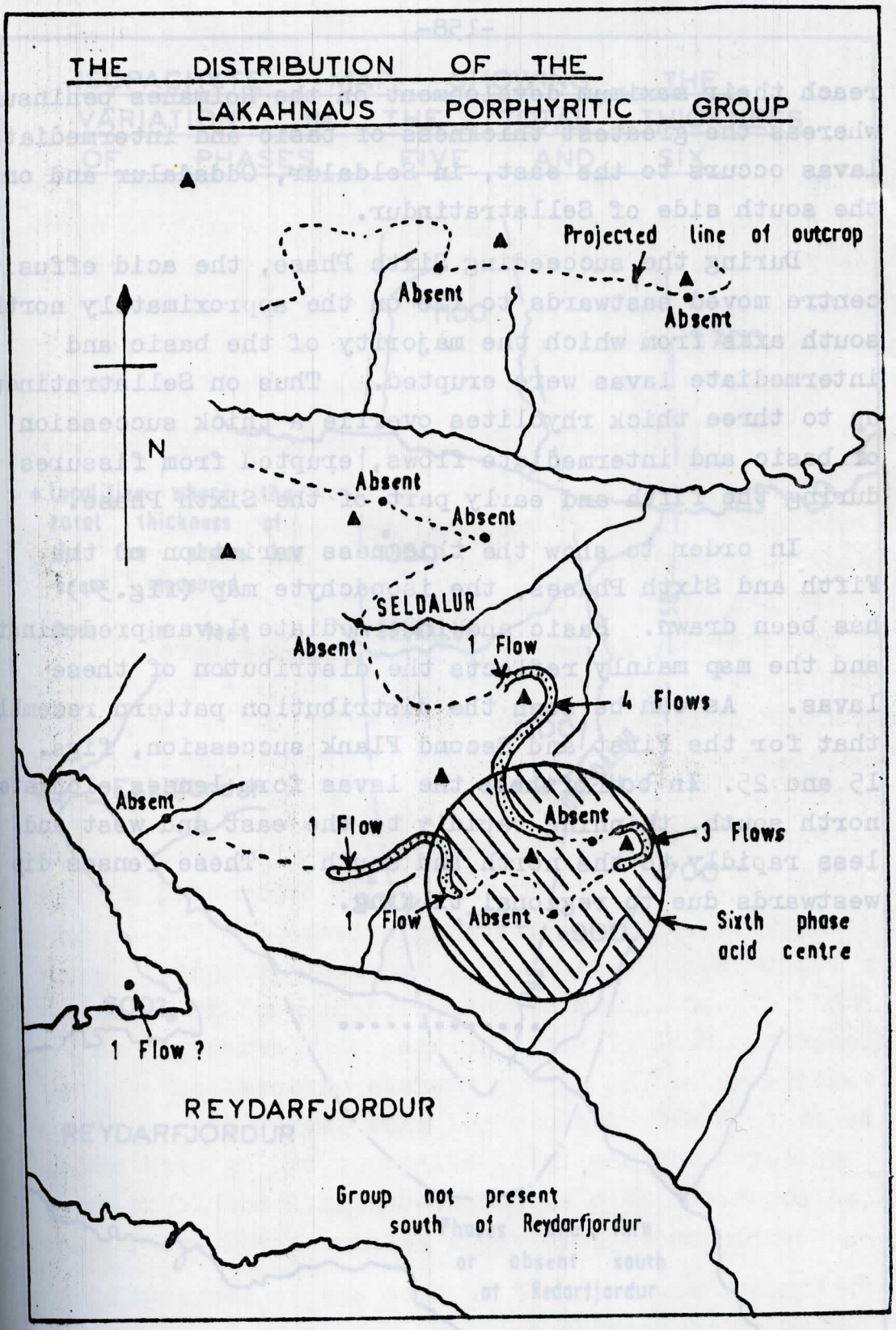

THE DISTRIBUTION OF THE
LAKAHNAUS PORPHYRITIC GROUP
Projected line of outcrop
Absent
Absent
N
Absent
Absent
SELDALUR
Absent
1 Flow
4 Flows
Absent
1 Flow
Absent
3 Flows
1 Flow
Absent
Sixth phase
acid centre
1 Flow ?
REYDARFJORDUR
Group not present
south of Reydarfjordur

Fig 33

reach their maximum development on the Holmanes peninsula, whereas the greatest thickness of basic and intermediate lavas occurs to the east, in Seldalur, Oddsdalur and on the south side of Sellatratindur.

During the succeeding Sixth Phase, the acid effusive centre moved eastwards to lie on the approximately north-south axis from which the majority of the basic and intermediate lavas were erupted. Thus on Sellatratindur up to three thick rhyolites overlie a thick succession of basic and intermediate flows, erupted from fissures during the fifth and early part of the Sixth Phase.

In order to show the thickness variation of the Fifth and Sixth Phases, the isopachyte map (fig.34) has been drawn. Basic and intermediate lavas predominate and the map mainly reflects the distribution of these lavas. As can be seen the distribution pattern resembles that for the First and Second Flank succession, figs. 15 and 25. In both of these the lavas form lenses elongated north south, thinning rapidly to the east and west and less rapidly to the north and south. These lenses dip westwards due to regional tilting.

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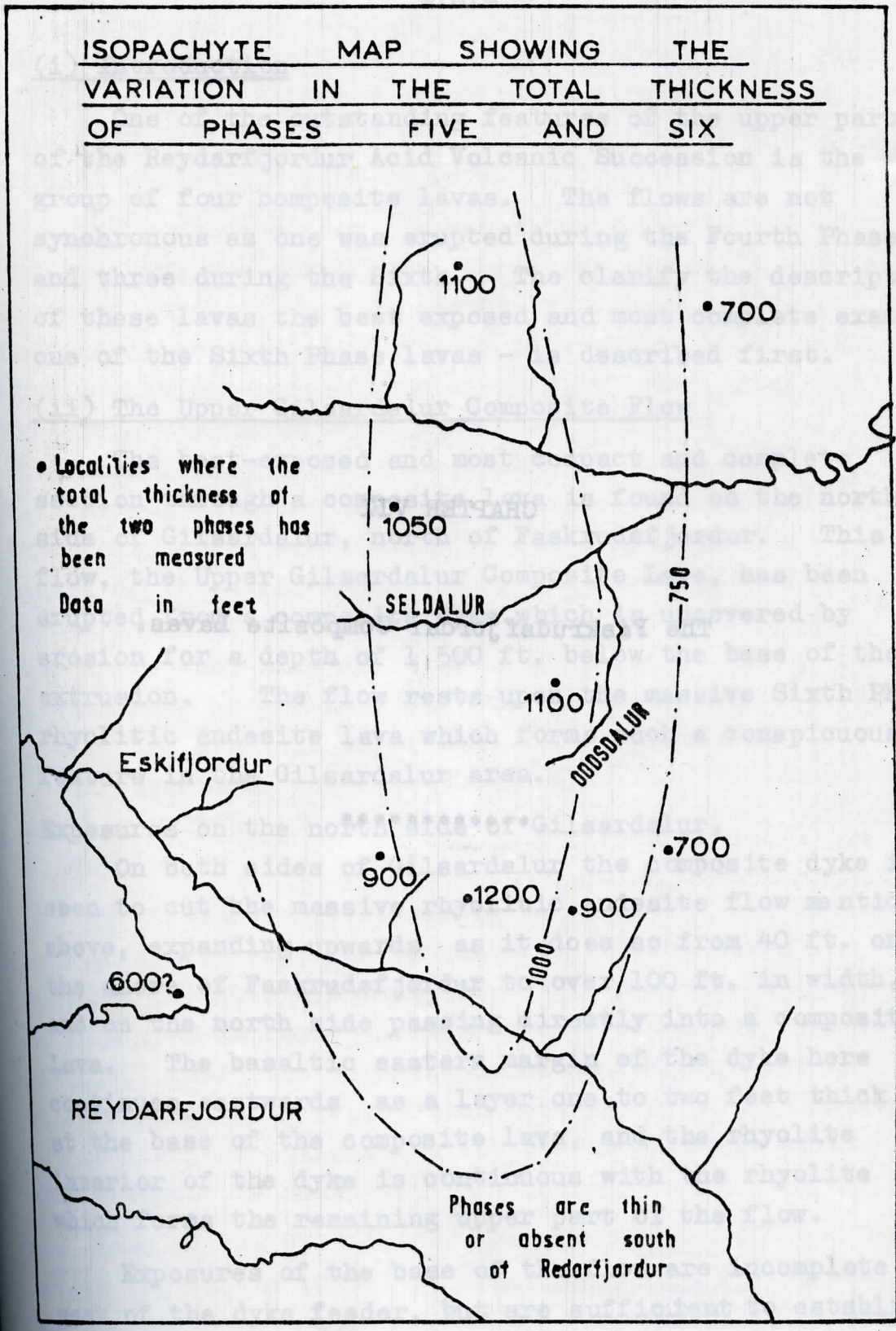
ISOPACHYTE MAP SHOWING THE VARIATION IN THE TOTAL THICKNESS OF PHASES FIVE AND SIX
1100
700
• Localities where the total thickness of the two phases has been measured
Data in feet
1050
SELDALUR
750
1100
ODDSDALUR
Eskifjordur
900
1200
900
700
1000
600?
REYDARFJORDUR
Phases are thin or absent south of Redarfjordur

Fig. 34