CHAPTER IV

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REYDARFJORDUR ACID VOLCANIC SUCCESSION

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Stratigraphy

Second Acid Phase

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(a) CENTRAL AREA

(i) Introduction

The second major division of acid rocks on the south side of Reydarfjordur consists of a group of rhyolite lavas and agglomerates, closely comparable with the rocks produced in the central area during the First phase. Everywhere the rocks of the second phase rest directly on those of phase one; however, due to a slight displacement of the centre of acid activity, some of the 2nd phase rhyolite lavas and agglomerates rest on part of the First flank succession. Also, in contrast with the first period of activity, local updoming took place during the second phase.

(ii) Agglomerates

Directly comparable with the First Phase agglomerates is a group of predominately acid agglomerates which mark the onset of the Second major phase of activity. Unfortunately they are very poorly exposed and only visible in the stream section in the Breiddalsa. Here they rest directly on the rhyolitic andesites of the First flank succession, while they are cut by several large irregular basic intrusions, as well as by some thin inclined basic sheets. The basal part is very coarse and acid in composition with large angular fragments of several types of rhyolite, some over 1 ft. in diameter, set in a pumiceous matrix. Upwards the agglomerate becomes finer in grain and at 580 ft in the southern branch of the Breiddalsa the colour changes from green to light brown. Above this point acid material is less common and it seems possible

that the change in colour is due to a change in the character of the eruption from acid to basic. Relationships are similar to those in the First phase agglomerates except that this later mass is capped by an undoubted basic cinder deposit.

The agglomerates must be very local in extent for similar deposits have been found nowhere else at this horizon in the Breiddalur area. However, bedded tuff deposits, probably equivalent to the second phase Agglomerates, are found locally on the Baegsli ridge above the rhyolitic andesites of the First phase and again on the south eastern flanks of Sodulhnukur where there is a considerable thickness of bedded tuffs. In common with the underlying lavas these dip at about 15° to the south east, the steep dip and aberrant direction being due to the disturbance associated with the Thernanes Uplift. In the flank succession ~~on~~ the agglomerates of Phase two, are represented by the thickest bedded tuff deposit in the area - Tuff T_2 - which in places reaches 100 ft. in thickness.

(iii) Rhyolite lavas south of Reydarfjordur

Most of the second phase rhyolite lavas were extruded soon after the eruption of agglomerates and rest on them, although one thin acid lava is found interbedded in the agglomerate mass. The thicker lavas are well exposed in the Breiddalsa where three flows are found (R_{2a}, R_{2b}, and R_{2c}) One can be traced to the Baegsli ridge, although all the flows die out before reaching Kerlingarfjall

(R_{2a}) This is stratigraphically the lowest and most important flow in the second acid phase. Perhaps its most outstanding character is the relatively large proportion of phenocrysts of sodic plagioclase which are white to pale yellow and constitute perhaps 10% of the rock. The groundmass is pale grey with some iron staining, and weathered surfaces are pink. R_{2a} outcrops in three localities - in the northern and southern branches of the Breiddalsa, and on the Baegsli ridge where it is 120 ft. thick, and outcrops between 770 ft and 890 ft.

(R_{2b}) The two other lavas of this unit have only been examined in the northern part of the Breiddalsa where they are excellently exposed in a deep gorge. R_{2b} can be clearly seen to rest on R_{2a} and the well developed platy flow structure is parallel to the flow base in this lower part of the flow. When fresh the rock is black and porphyritic and most of the flow is vesicular. Alteration seems to have been most intense round vesicles and has resulted in the formation of a white, chalky, amorphous rock. It is impossible to estimate the exact thickness of this flow as it is cut out by a rhyolite vent (Feeder for one of the phase 3 Rhyolites) but it must be at least 50 ft.thick.

(R_{2c}) At the western side of the vent a different rhyolite (R_{2c}) is exposed and this is assumed to overlie R_{2b}, although this cannot be established. The flow is unusual in that it is composed of two distinct parts or flow units, of essentially identical composition and presumably erupted one after the other with only a brief time interval. Well developed linear structures are present throughout almost the entire thickness of

the lower unit and these are thought to be axial lineations related to the conspicuous large folds in the platy flow structure. The junction between the two units, which occurs near the top of a large waterfall, shows white weathering, while the fresher rhyolite above this, constituting the upper unit, is a pinkish purple colour and platy flow structure is conspicuously developed on both a large and a microscopic scale. Apparently identical plagioclase feldspar phenocrysts are abundant throughout both flow units. The top of the upper flow unit is obscured by drift and it is difficult to estimate its total thickness, or the thickness of the flow as a whole, although it is certainly the thickest second phase rhyolite.

(iv) Rhyolite lavas north of Reydarfjordur

In the area near Sellatur are three tabular rhyolite lavas which can with reasonable certainty be ascribed to the Second Acid Phase. Stratigraphically the lowest, as well as the thickest of these flows outcrops on the shore directly below the farm of Sellatur and can thence be traced up-dip to the southern slopes of Helgustadafell where the flow is about 250 ft thick. Dip measurements on the top of the flow are as high as 12^{o} to the south-west. The rhyolite R_{2d} is pink or brown on weathered surfaces and grey when fresh. Platy flow structure is well developed and its attitude suggests that the flow was fed from a vent further south.

(R_{2e}) About 100 yds west of Hognostadir, stream exposures reveal two rhyolite lavas directly overlying

R_{2d} which here outcrops between sea level and 100 ft. The lower of these two flows (R_{2e}) outcrops between 100 and 200 ft and is a black porphyritic rhyolite which weathers to a dull brown colour. The top of the flow is rubbly and brecciated without pitchstone. Further east this and the underlying flow become separated by a thin tholeiite lava.

(R_{2f}) The base of the upper most flow is marked by a layer of pale coloured pitchstone, although the main part of the flow is black when fresh and porphyritic. Platy flow structure is irregular but well developed and apparently approximately horizontal near the flow base. The top of the flow is very irregular with many large hollows and depressions. This flow does not extend more than 100 yds or so eastwards as it is not present in the adjacent stream gully. Probably all three flows extend further west and the long gap in the rock exposures on the coast south-west of Hognastadir is probably due to rapid erosion of these rhyolites.

It is seen that on the north side of Reydarfjordur phase two rhyolites are more abundant as the group is traced westwards, reaching a maximum of three flows near sea-level. This pattern is repeated south of the fjord, where the phase two rhyolites are thickest in the Breiddalsa.

While rhyolitic eruptions were proceeding in the Breiddalur area and north of Reydarfjordur, without any noticeable disturbance of the underlying strata, in the area west of Thernunes the intrusion of three rhyolitic plugs took place simultaneously with large-scale updoming of the surrounding lavas. These three rhyolite bodies and possibly one other rhyolite lava are the only remaining acid representatives of the Second phase.

(v) Rhyolite Vents

The rhyolites and agglomerates of the first phase are cut by three large rhyolite vents:-

(a) Hrafnakambar
(b) Raudafell.
(c) A small rhyolite mass about ½ mile south west of Hrafnakambar summit.

Hrafnakambar.

The conspicuous ridge which bears the name "Hrafnakambar" is made almost entirely of a rhyolite intrusion, the general shape of which is dyke-like. It is approximately 1,000 yds long and 150 yds wide, with the long axis trending at 20°, i.e. approximately parallel to the regional dyke swarm. It is convenient to divide the mass into two parts, the summit knoll and the lower part of the ridge further to the north. Although these two parts are separated by a broad apron of scree derived from the summit knoll, it is almost certain that they are contiguous and they are petrographically indistinguishable.

The principal features of the dyke-like portion of the intrusion are summarised below:-

(a) Although the actual contacts are not exposed, an examination of the rocks very close to the contacts suggest that the western one is straight and vertical or steeply inclined, while the eastern one dips at about 60° inwards, or to the west, and is straight except for one step in it.

(b) The intrusion appears to terminate abruptly southwards (although the actual contacts are again obscured by scree) and it is not continuous with an acid dyke of more normal proportions.

(c) Columnar jointing is well developed and the attitude of the columns is shown diagramatically in Fig. 18. As can be seen the jointing is normal to both the eastern and western contacts.

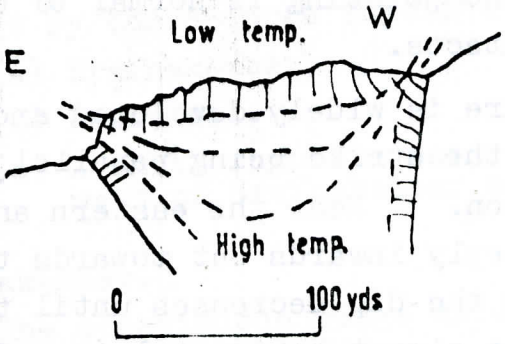
(d) Platy flow structure is widely developed and follows a regular pattern, the strike being parallel to the sides of the intrusion. Near the eastern and western margins it dips steeply inwards but towards the centre of the rhyolite body the dip decreases until the platy flow structure becomes almost horizontal (see fig.18)

(e) Near the eastern and western margins the rhyolite shows a strong lineation parallel to the axes of minor folds and the rock often takes on a rodded appearance. From the published description it would appear that this is very similar to the rodding in Trachyte and Felsite dykes from Skye (Harker 1904) In particular see p.393, fig. 78, but note difference in scale. Elsewhere, where it is only weakly developed, the lineation is visible as a preferred orientation of plagioclase feldspar laths and a slight streaking out of the rock. The linear structure is apparently not developed in the centre of the intrusion.

The plunge of this linear structure was measured at intervals along the western margin of the intrusion and it was found to vary in a regular manner, being vertical at 1,000 ft. but gradually decreasing in dip until at 760 ft. the dip was 10° towards 20° and at 650 ft. it was horizontal, striking along 20°. Below this altitude it is irregular and difficult to see.

In contrast the summit knoll shows irregular and weakly developed platy flow structure and no columnar jointing.

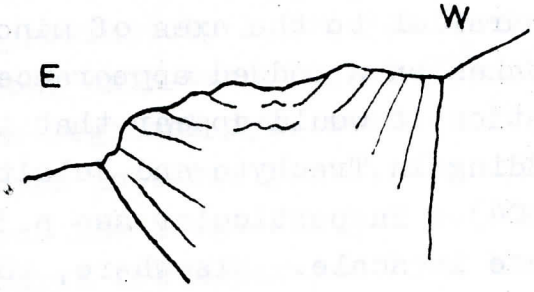
THE HRAFNAKAMBAR RHYOLITE



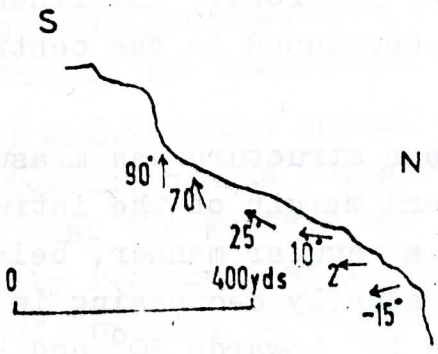
Diagrammatic cross-section drawn at 500 ft above sea level on the north side.

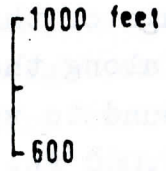
Columnar jointing — full lines

Conjectural isotherms — broken lines



As above but showing the attitude of the platy flow structure





Section along western margin. Arrows show the orientation of feldspar laths, the angle being measured in the plane of the platy flow structure which is almost vertical.

Fig. 18

The marginal lineation in the dyke-like portion was presumably produced by viscous flow and its gradual steepening towards the southern end of the intrusion suggests that here the rhyolite attained the surface. The summit knoll may represent a remnant of a rhyolite flow fed from the intrusive mass below, while it is possible that most of the dyke-like portion was roofed. Only this lower portion shows columnar jointing and in all this context it is interesting to note that Williams (1929) in hispaper on volcanic domes states that"Jointing is best developed in those protrusions which consolodated almost wholly under the cover of other rocks".

Thus the intrusion may be likened to a foot, the ankle being the vent which fed the overlying flow and the lower part of the foot being the headed dyke-like portion of the intrusion, there being a gradual transition from one to the other.

Overlying the Raudafell Rhyolite flow is another thin rhyolite lava which is poorly exposed on the southern upper slopes of Raudafell. The rhyolite is non-porphyritic, grey or pink, and markedly streaky, though the different coloured layers do not apparently represent marked compositional differences. The most spectacular feature of this lava is the amazingly complicated pattern of flow-folding which is developed along the flow base. A preliminary survey suggests that the orientation and type of folds are extremly variable and that they probably developed at different stages during the cooling of the flow.

This lava is included here on account of its proximity to the Raudafell rhyolite which it clearly post-dates. It is tentatively grouped with the rhyolites of phase two,

although it is possible that it was extruded during the early part of phase three.

Raudafell.

The pink rhyolitic hill of Raudafell on the south side of Reydarfjordur consists of a rhyolite flow and its plug-feeder which cuts through the earlier agglomerates and rhyolite lavas of phase one.

The intrusive portion occupies most of the lower northern and north-eastern parts of the hill where, through gaps in the extensive scree, one can make out the chilled pitchstone margin of the plug, particularly around the northern side. Here, 600 ft. above sea level, the rhyolite can be seen cutting through the first phase agglomerates. The conspicuously thick pitchstone margin shows pronounced columnar jointing, with small pitchstone columns varying in diameter from 4" to 1". Poor exposures do not allow one to examine the actual contact, but the platy flow structure and the attitude of the pitchstone columns suggest that it is not vertical but inclined inwards at about 40° to the south-south-west. Poor exposures on the eastern side of the hill again show columnar pitchstone which indicates that the contact here dips at 30° to the west. Unfortunately the lack of any regular internal structure in the pitchstone on the north-western side of the intrusion makes it impossible to estimate the attitude of the contact here, but a general view suggests that the intrusion is funnel-shaped. On the eastern side it can be seen that with increasing altitude the contact flattens until it is horizontal, so that all the upper part of the hill must be regarded as extrusive, the rhyolite flowing out on the old land surface.

The extent to which columnar jointing is developed probably provides the best guide as to which part of the

body was extrusive and which occupies the vent. All the lower part of the Raudafell mass shows, in a similar fashion to the Hrafnakambar rhyolite, very pronounced massive columnar jointing and this is taken as indicating a considerable depth of burial with slow uniform cooling. However, the upper part of the hill shows irregular jointing and well marked platy flow structure - features typical of rhyolite lavas.

The extrusive portion of the body does not appear to have been very extensive, particularly on the western side of the vent. Here the Raudafell rhyolite flow directly overlies R_{ib} but is only about 50 ft thick, while the platy flow structure in the pitchstone margin dips at 40° to the south west suggesting that the extrusion is steeply dipping at this point. The flow does not extend westwards past the conspicuous gully which separates the rhyolitic hills of Raudafell and Flatafjall. On the eastern side of the intrusion the transition from transgressive intrusion to a flat-lying extrusion is well seen at the head of the group of gullies between Raudafell and Hrafnakambar.

In the two branches of the westernmost gully, what is presumably the vent margin is seen transgressing the lavas of phase 1 (see fig.8) Here the Raudafell rhyolite overlies agglomerate - probably dating from an early explosive phase when the crater was formed. No sign of this agglomerate has been found elsewhere though it may be contemporaneous with the upper part of the second phase Agglomerates. Again the dip of this vent agglomerate and the overlying rhyolite is very steep at about 45° to the west-south-west. As one traces the rhyolite westwards the dip becomes less steep and the agglomerates wedge out until 300 yds to the west the rhyolite rests on the

uppermost flank lavas of phase 1 with no intervening agglomerate deposit and no marked discontinuity.

Small rhyolite mass about half mile south-west of Hrafnakambar Summit.

This small rhyolite body is petrographically very similar to the intrusions of Hrafnakambar and Raudafell and for this reason is thought tobe approximately contemporaneous. The outcrop is approximately circular and about 400 yds in diameter. Topographically it forms a small knoll on the poorly exposed south-eastern slopes of Sodulhnukur. The margin of the intrusion is exposed only in the gully which drains the ground south of Hrafnakambar. Here the rhyolite is seen cutting the domed basalts of the 1st flank succession and also, along the northern edge of the intrusion, the bedded tuffs, doubtfully referred to the beginning of the Second acid phase. Like the other two intrusions the rhyolite is slightly porphyritic, grey or pink in colour and shows well developed platy flow structure. Near the margin the rhyolite shows "rodding" similar to that on Hrafnakambar, but this has an irregular orientation.

This intrusion is taken to represent a cross-section through a rhyolite vent exposed at a fairly high level although it is not visibly connected to any extrusion.

(vi) The Thernunes uplift and associated propylitisation and minor intrusions

The lavas and tuffs show aberrant dips over a wide area between Eyri and Thernunes on the south side of Reydarfjordur. In a volcanic area such as Eastern Iceland one is faced with four possible explanations -

either the dips are depositional, or else they are due to tilting of the strata by (a) folding, (b) updoming by intrusions, (c) downsagging or collapse.

For reasons stated earlier it seems possible that the First Phase Agglomerates formed an agglomerate cone and it follows that any of the overlying lavas extruded from the flanks or top of this cone would show depositional dips; this may account for some of the high dips in the rhyolite lavas in the higher reaches of the Storadalsa and Ytria, but for the following reasons it is not thought to account for all the abberant readings.

If the lavas had been erupted on to the flanks of the cone, they would now show radial dips about the present outcrop of the agglomerate mass. As can be seen from figure 19. this is not the case, and the anticlinal axis in the lavas is not continuous with the long axis of the agglomerate outcrop. This strongly suggests that the more northerly anticlinal axis, north of the Landamotsa, is unrelated to the agglomerate cone and, in fact, due to updoming.

The mapping of the outcrop of the Grakollur porphyritic group provides additional evidence for this updoming. (Subsequently referred to as the Thernunes Uplift). The critical section from Muli to Hafranesfell and across the Sela to Hrafnakambar is shown in Fig.20. As can be seen this suggests that the lavas in the Hrafnakambar area have been updomed by over 1,000 ft; the only possible alternative is that the lavas were erupted down the flanks of a cone and then flowed out over the flat basalt plain. Inthe latter case one would expect the lavas to be thin on the cone flanks and thicker on the flat plain. Not only

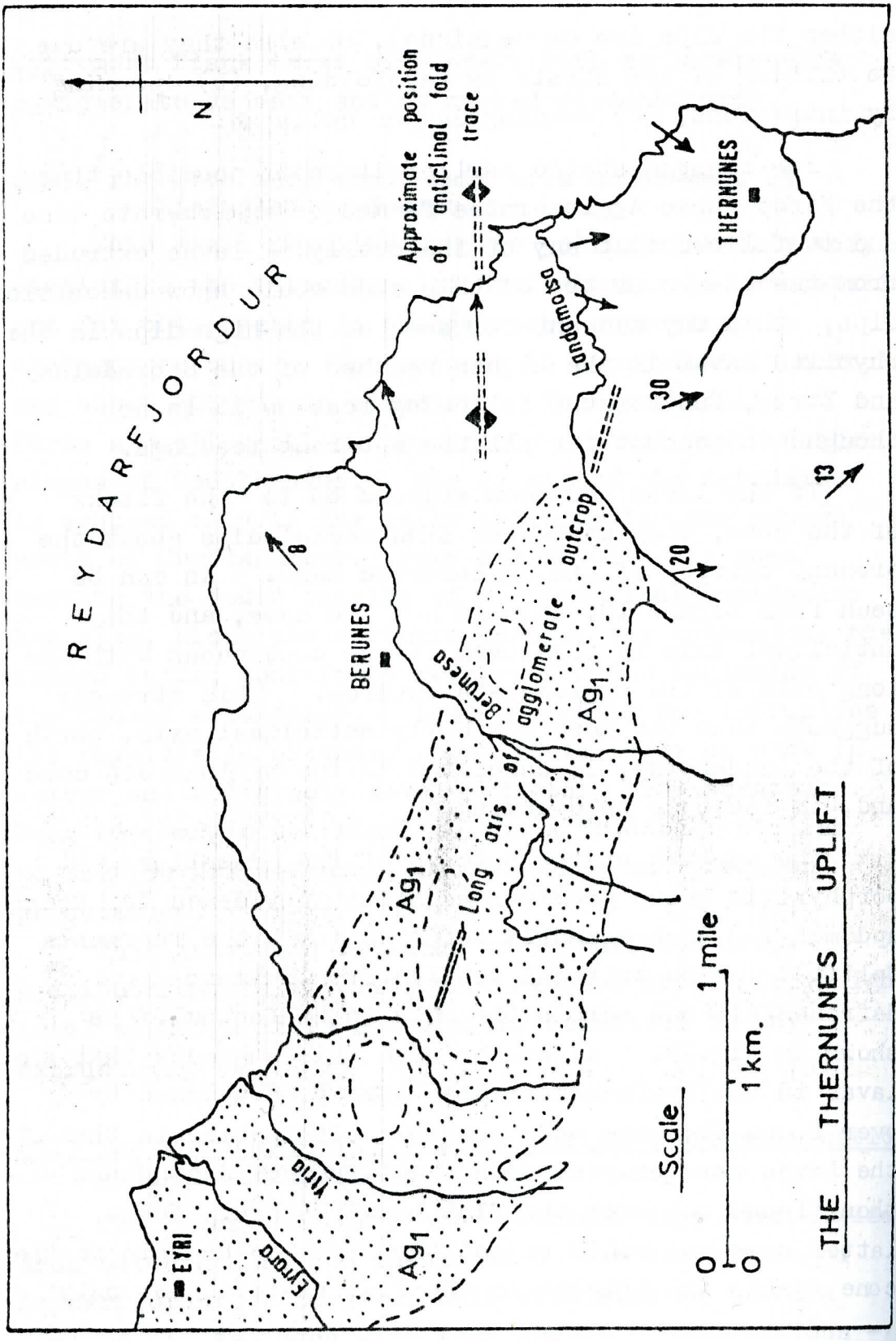

N
REYDARFJORDUR
Approximate position of anticlinal fold
trace
THERNUNES
Landamosa
30
13
20
8
BERUNES
Berunesa
agglomerate
outcrop
Ag1
Long axis of
Ag1
Ag1
Virio
Eyrore
EYRI
Scale
1 mile
1 km.
0
0
THE THERNUNES UPLIFT

Fig. 19

MAP AND SECTION SHOWING THE UP-DOMING OF THE GRAKOLLUR PORPHYRITIC GROUP (Gr.P.) ON THE SOUTH SIDE OF REYDARFJORDUR

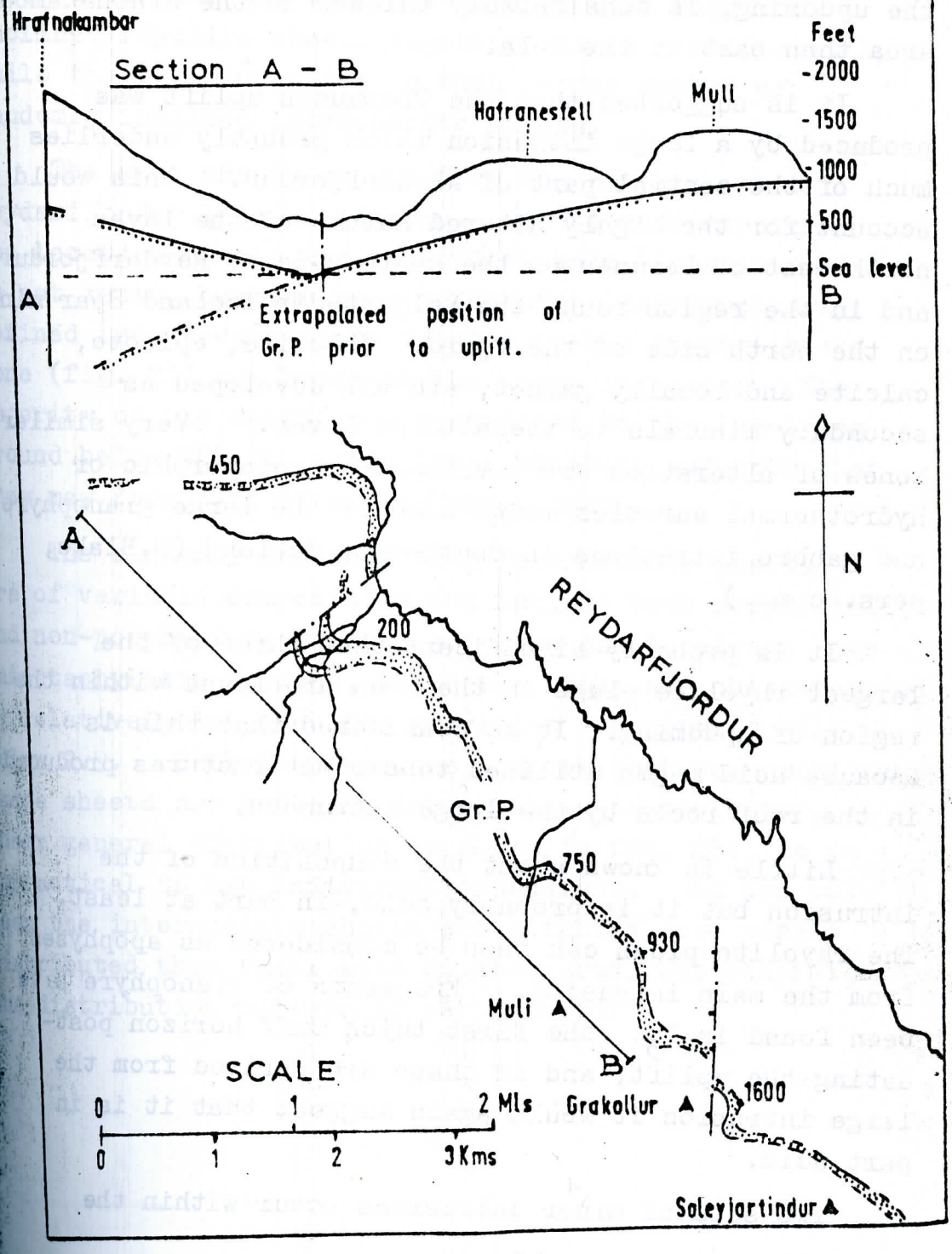


Fig. 20

has such a relationship not been observed, but there is every indication that the rhyolite lava, intercalated in the Grakollur porphyritic group and also involved in the updoming, is considerably thicker in the Hrafnakambar area than east of the Sela.

It is suggested that the Thernunes uplift was produced by a large intrusion which probably underlies much of the central part of Reydarfjordur. This would account for the highly altered nature of the lavas north-east of Berunes on the south side of Reydarfjordur and in the region round the Helgustadir Iceland Spar mine on the north side of the fjord. Chlorite, epidote, calcite and locally garnet, are all developed as secondary minerals in the altered lavas. Very similar zones of alteration are developed as metamorphic or hydrothermal aureoles round some of the large granophyre and gabbro intrusions in South-east Iceland (D.Blake, pers. comm.)

It is probably significant that three of the largest rhyolite plugs in the area are found within the region of updoming. It is considered that this is because acid magma utilised tensional fractures produced in the roof rocks by the large intrusion.

Little is known about the composition of the intrusion but it is probably acid, in part at least. The rhyolite plugs can then be considered as apophyses from the main intrusion. Fragments of granophyre have been found in T_3, the first thick tuff horizon post-dating the uplift, and if these are derived from the large intrusion it would again suggest that it is in part acid.

Two sets of minor intrusions occur within the

area of updoming, both of which were probably injected at approximately the same time as the larger major intrusion. One set consists of a group of regularly inclined rhyolite sheets together with a rhyolite sill, while the other comprises a much larger number of randomly inclined intermediate sheets.

The acid sheets extend from the north short of Reydarfjordur into Breiddalur. Due to poor exposure the location of all the individual acid minor intrusions is not known, but the area affected is fairly clearly defined and appears to be related to the prophylitized zone (fig. 21) and hence to the major intrusion. The majority of the sheets are restricted to the low-lying ground below 750 ft. while their attitude suggests that they may form part of a cone sheet swarm.

The randomly inclined thin intermediate sheets are of variable composition and include both porphyritic and non-porphyritic varieties. The sheets always have thin tachylitic margins, while the rocks are characterised by relatively low specific gravities - generally well below 2.9. Both these points suggest that compositionally these sheets are probably intermediate in character. Their general distribution is shown in fig. 22; it is impractical to map individual intrusions. As can be seen the intermediate sheets are slightly more widely distributed than their acid counterparts, but otherwise the distribution pattern is very similar

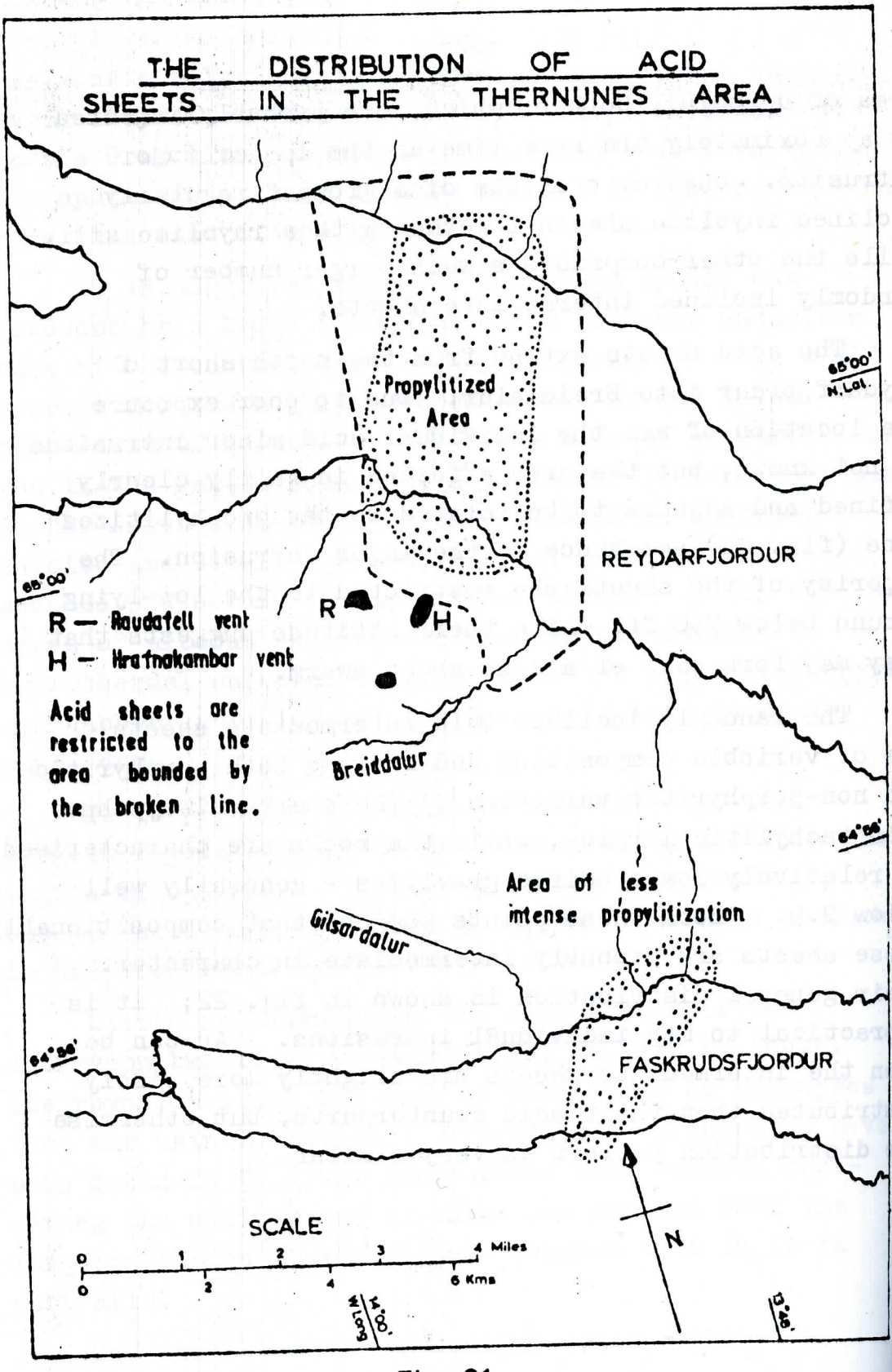

THE DISTRIBUTION OF ACID SHEETS IN THE THERNUNES AREA
Propylitized Area
REYDARFJORDUR
65°00' N.Lat.
65°00'
R — Raudafell vent
H — Hrafnakambar vent
Acid sheets are restricted to the area bounded by the broken line.
R
H
Breiddalur
64°56'
Area of less intense propylitization
Gilsardalur
64°50'
FASKRUDSFJORDUR
SCALE
0 1 2 3 4 Miles
0 2 4 6 Kms
N
13°30' W.
13°30'

Fig. 21

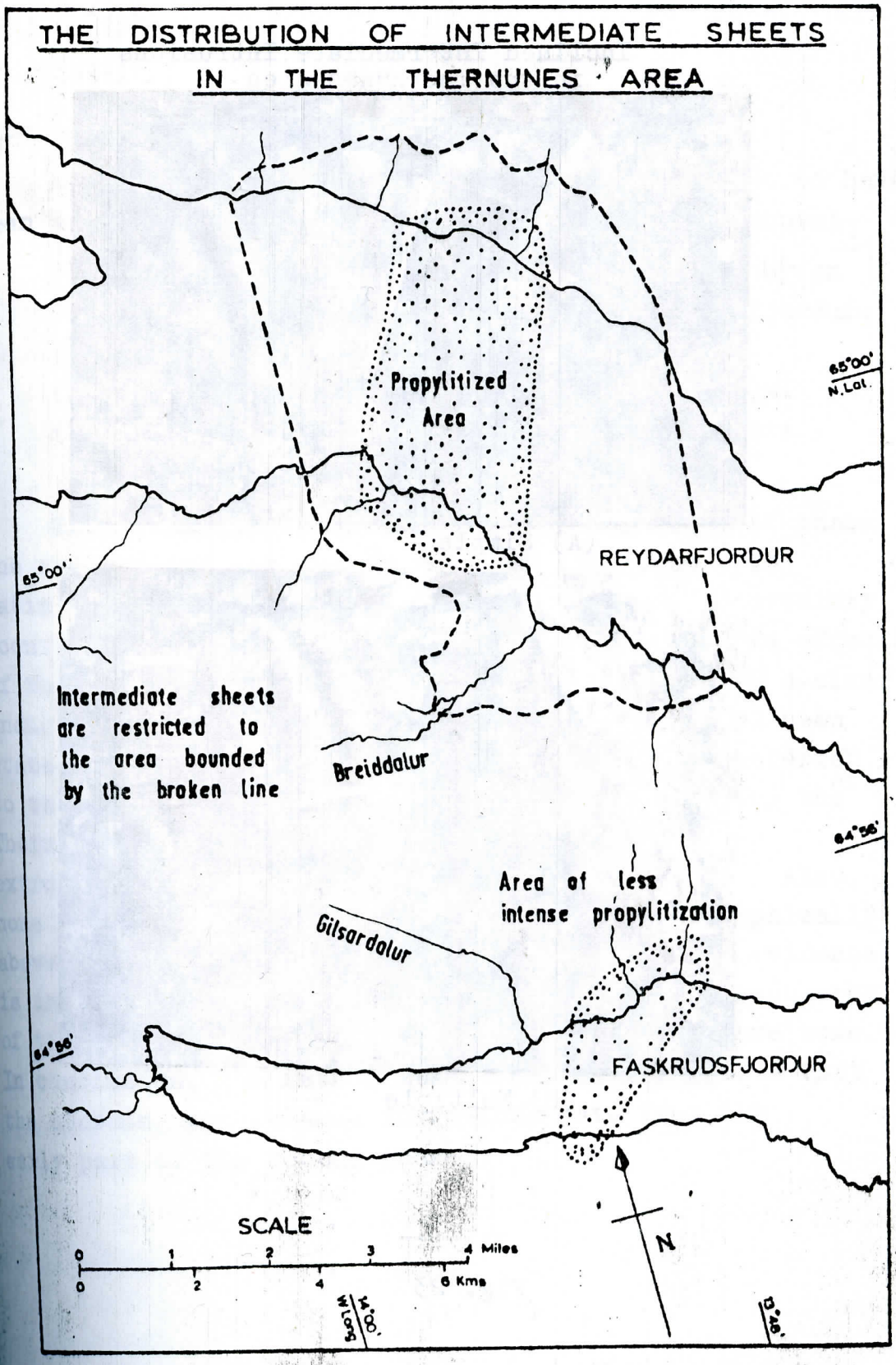

THE DISTRIBUTION OF INTERMEDIATE SHEETS
IN THE THERNUNES AREA
Propylitized Area
65°00' N.Lat.
65°00'
REYDARFJORDUR
Intermediate sheets are restricted to the area bounded by the broken line
Breiddalur
64°56'
Area of less intense propylitization
Gilsardalur
64°56'
FASKRUDSFJORDUR
SCALE
0 1 2 3 4 Miles
0 2 4 6 Kms
N
14°00' W.Lon.
13°48'

Fig. 22

Inclined Intermediate Intrusions
in the Thernunes Area

(A) Simple

(B) Multiple

Fig. 23

Date of the Uplift

As has been stated, the following are thought to have been approximately contemporaneous and related events:-

(a) The production of a metamorphic aureole by an intrusion in the central area of Reydarfjordur.
(b) The formation of the Thernunes Uplift.
(c) The intrusion of the three rhyolite plugs.
(d) The intrusion of the acid and intermediate sheets.

The metamorphic aureole affects only rocks of phase one and earlier and therefore is of little help in dating the uplift which as will be seen almost certainly occurred at some stage during the 2nd phase. The effects of the uplift are however wide-spread and give us a clear indication of the date of the intrusion. As has been stated, south-east of Sodulhnukur bedded tuffs referred to the beginning of the 2nd phase are disturbed by the Thernunes uplift, while they are overlain by the extrusive portion of the Hrafnakambar rhyolite. Also, none of the inclined sheets cuts rocks stratigraphically above the Phase Two agglomerates; however this evidence is inconclusive for this may be due to present exposures of the overlying rocks lying outside the intrusive zone. In conclusion, the rather meagre evidence suggests that the updoming and related intrusions date from the early part of the second phase.

(b) FLANK SUCCESSION

(i) Introduction

South of Faskrudsfjordur it is often difficult to separate the second and third flank successions due to the limited occurrence of the bedded tuff equivalent to the Third Phase Agglomerates. However, the top of the Third Phase is clearly defined by a group of flood basalts.

(ii) Kambanes Peninsula

The second flank succession is very thin south of Faskrudsfjordur and no lavas of this phase have been found on the Kambanes Peninsula. The tuff horizon, T_2, is also absent or very thin.

(iii) Hafnarnes Peninsula

On the north side of Stodvarfjordur, the first exposures on the shore west of Kirkjubol are of a thick acid tuff (T_2). Above this is an apparently closely related group of acid and basic tuffs and porphyritic basalts, most of which are included in the Third Phase.

The following section is exposed:-

North side of Stodvar-fjordur	Third phase	2 Tholeiite flows	
		Basic tuff } Porphyritic Basalt }	Large phen.type
		Acid tuff	T_3
	Second phase	Porphyritic Basalt	Large phen.type
		Thick Acid tuff	T_2
	First Phase.	Exposure gap	

Although considerable doubt exists about the interpretation of this succession, it is clearly established that here the second flank succession is very thin.

No exposures of the tuff T_2 have been found in the area north of Kirkjubol but both T_2 and T_3 occur near the summit of the flat-topped ridge Thriklakkar.

North-westwards on Leirufell T_2 forms a very conspicuous green scar near the top of the mountain and is over 100 ft thick. It is separated from the overlying tuff T_3 by three thin tholeiite flows which constitute the whole of the second flank succession, here only 60 ft thick.

The intrusion of the Sandfell laccolith into the basalts on the south side of Faskrudsfjordur makes stratigraphic studies more difficult. The laccolith was intruded along the tuff layer T_2 and as the intrusion post-dates the deposition of T_3 some of the lavas domed by the laccolith are those of the Second Flank Succession. Hawkes and Hawkes (1933) studied the succession of domed rocks on the Sandfell-Vindfell ridge and measured the thickness of the lavas from the intrusive level of the laccolith to the first conspicuous tuff horizon (i.e. the thickness from T_2 to T_3) This 280 ft of lavas here constitutes the second flank succession and includes some flows which show definite intermediate affinities which may be outliers of the rhyolitic andesite group which forms an important part of the succession on the Vattarnes peninsula.

Further north east the basal tuff T_2 is exposed on the coast near Eyri on the south side of Faskrudsfjordur. The tuff, here at least 100 ft thick and split by a single

tholeiite flow, is overlain by perhaps 150 ft. of thin tholeiite lavas of the Second Phase - the exact figure is uncertain owing to the absence of T_3.

(iv) Vattarnes Peninsula

The second flank succession reaches its maximum thickness of 450 ft on the Vattarnes peninsula, where the presence of both T_2 and T_3 allow its thickness to be established in most areas.

The basal tuff T_2 outcrops on the shore about ¾ of a mile west of the mouth of the Gilsa where it is about 100 ft thick (Tryggvason & White, 1955) In the Gilsa to the north east, the tuff is reduced in thickness to 20 ft. and the uneven top here must indicate penecontemporaneous erosion. The deposit is very coarse with some blocks up to 6" in diameter and although the matrix is acid, the majority of the fragments are basaltic. Very poor exposures of what is probably the same bed occur in the small stream which enters the sea near the farm of Brimnes, and the tuff can be followed from just east of the Heljara to nearly as far as the Grakollur fault, east of which it outcrops continuously at about 2,100 ft. onSoleyjartindur.

The correlation of the tuff exposures on the north side of Faskrudsfjordur is open to doubt because of poor exposure and the large number of faults which are known to cut the area (the most intensely faulted yet mapped in Iceland) The correlation of the tuff horizon on Soleyjartindur with that on the shore west of the Gilsa is particularly suspect.

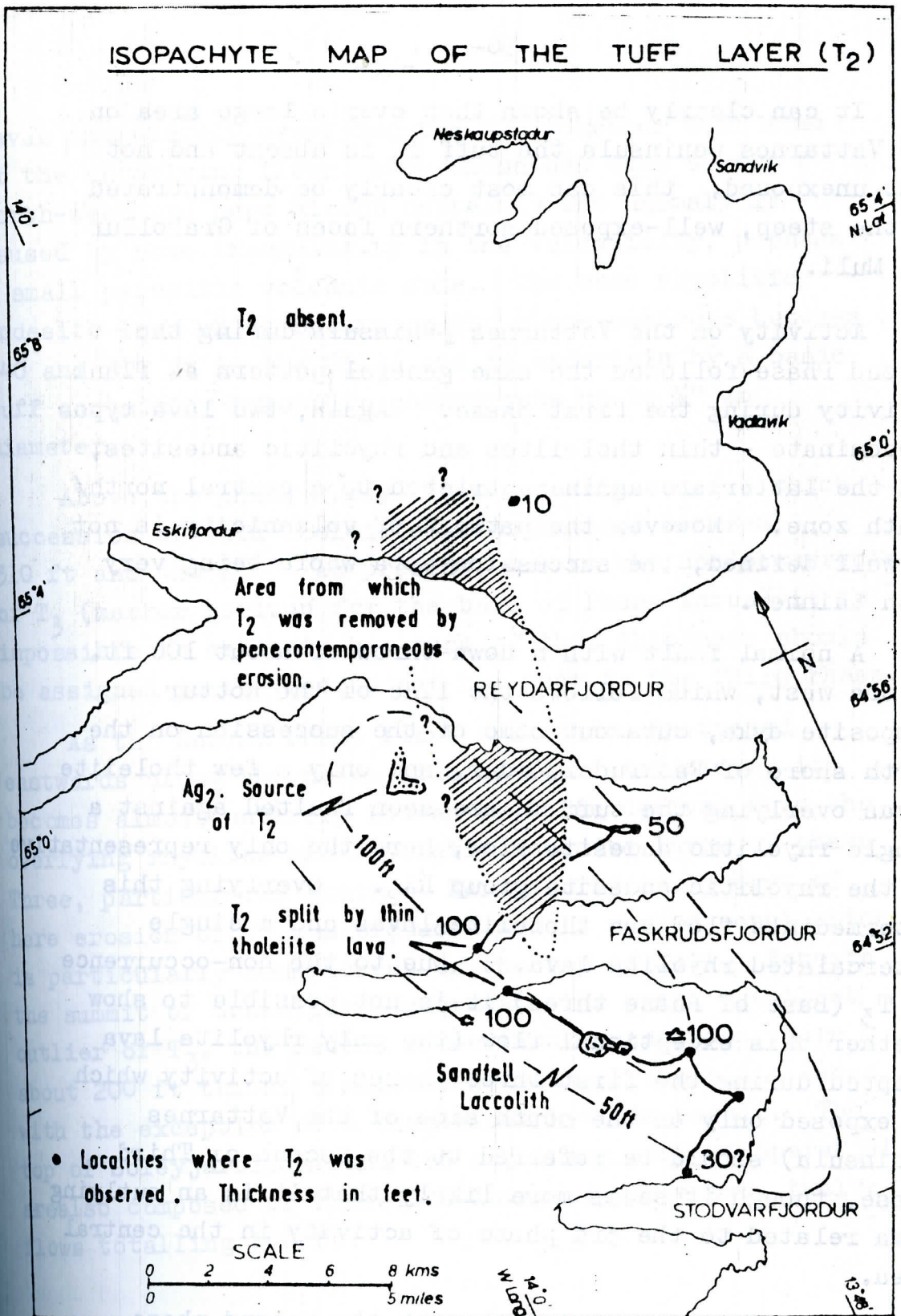

ISOPACHYTE MAP OF THE TUFF LAYER (T_2)
Neskaupstadur
Sandvik
65°4' N.Lat
14°0'
65°8'
T_2 absent.
Kadlavik
65°0'
?
?
?
?
10
Eskifjordur
65°4'
Area from which T_2 was removed by penecontemporaneous erosion.
REYDARFJORDUR
N
64°56'
Ag_2. Source of T_2
100ft
50
65°0'
T_2 split by thin tholeiite lava.
100
FASKRUDSFJORDUR
64°52'
100
100
Sandfell Laccolith
50ft
30?
• Localities where T_2 was observed. Thickness in feet.
STODVARFJORDUR
SCALE
0 2 4 6 8 kms
0 5 miles
W Long
14°0'
13°48'

Fig. 24

It can clearly be shown that over a large area on the Vattarnes peninsula the tuff T_2 is absent and not just unexposed; this can most clearly be demonstrated on the steep, well-exposed northern faces of Grakollur and Muli.

Activity on the Vattarnes peninsula during the Second Phase followed the same general pattern as flank activity during the first phase. Again, two lava types predominate - thin tholeiites and rhyolitic andesites, and the latter are again restricted to a central north/south zone. However the pattern of volcanicity is not so well defined, the succession as a whole being very much thinner.

A normal fault with a down-throw of about 100 ft. to the west, which follows the line of the Kottur composite dyke, cuts out some of the succession on the north shore of Faskrudsfjordur, and only a few tholeiite lavas overlying the tuff T_2 are seen faulted against a single rhyolitic andesite flow, here the only representative of the rhyolitic andesite group RA_2. Overlying this intermediate flow are tholeiite lavas and a single intercalated rhyolite lava. Due to the non-occurrence of T_3 (Base of Phase three) it is not possible to show whether this exceptional flow (the only rhyolite lava erupted during the first three phases of activity which is exposed only on the south side of the Vattarnes Peninsula) should be referred to the Second or Third phase, though it seems more likely that it is an outlying lava related to the 3rd phase of activity in the central area.

A complete succession through the Second phase flank lavas is exposed in the Gilsa. Here the tholeiite

lavas immediately overlying the T_2, together with some of the underlying flows, show anomalous dips to the north-west and here almost certainly the anomaly is caused by some irregularity in the volcanicity, perhaps a small parasitic volcanic cone. The same rhyolitic andesite lava which occurs on the shore outcrops between 240 and 310 ft in the Gilsa and is underlain by a basic tuff containing bytownite phenocrysts up to ¾" in diameter.

Above the phase 2 rhyolitic andesite comes a thick succession of thin tholeiite lavas exposed between 310 ft and 420 ft. At present, due to the non-occurrence of T_3 (marker horizon for the base of Phase Three) it is impossible to estimate how much of this thickness should be assigned to the Second and how much to the Third Phase.

As the Second Phase flank succession is traced eastwards along the north side of Faskrudsfjordur, it becomes almost entirely hidden by scree derived from the overlying rhyolite and rhyolitic andesite lavas of phase Three, particularly south of Kerlingarfjall. East of here erosion of T_3 has produced a well marked bench which is particularly conspicuous on the top of Muli. Beneath the summit of Grakollur, underneath the small but thick outlier of T_3, the Second Phase flank succession, here about 200 ft thick, consists entirely of tholeiite lavas, with the exception of a single porphyritic basalt. The top of Soleyjartindur and the adjoining peak of Sparafjall are also composed of tholeiite lavas of phase two, twelve flows totalling 140 ft.

The bedded equivalent of the Phase Two agglomerates, T_2, has been found on the south side of Reydarfjordur only, on Soleyjartindur, so difficulties in separating the First and Second phases of activity become considerable on the south side of Breiddalur, on Hafranesfell and on Muli,

The top of the north-west ridge of the latter mountain is composed of at least 16 thin tholeiite flows which total about 350 ft. and rest directly on the rhyolitic andesites of Phase One and were probably all erupted during the second acid phase. As this group is traced westwards down dip two acid intermediate lavas come in, these outcropping on the upper flanks of Hafranessfell, while the total thickness of the group remains approximately constant at about 350 ft. Although these two lavas do not show all the typical features of rhyolitic andesites, they are probably similar in composition to the rhyolitic andesites of Phase One, and as can be seen they occur in a stratigraphic position analogous to that of the first phase rhyolitic andesites.

The ground above the headwaters of the Sela is poorly exposed but contains one feature of note - a reworked basic tuff which outcrops at about 1,250 ft. and contains bytownite phenocrysts.

Westwards on the Baegsli ridge interfingering between the predominently basic flank succession and the acid lavas of the central area is again seen.

The following succession is recorded from the west side of the ridge.

Thickness		Lava Group
100 ft.	Rhyolite R_{3c}.	Third Phase
200 ft.	Basaltic Andesite " " (thin) " " " " Scree (Tuffs?)	Second Flank Succession
100 ft.plus.	Rhyolite R_{2a}	Second Phase

These are the most westerly exposures of the flank succession in Breiddalur and as far as is known no flank rocks of the Second Phase exist in the ground north and west of the Breiddalsa.

(v) North side of Reydarfjordur

Due to the absence of one or both of the tuffs T_2 and T_3 it is impossible to define exactly the extent of the Second Flank Succession north of Reydarfjordur. However, second phase rhyolites have been identified and in the area near Sellatur these can be used as a marker horizon. No second phase rhyolitic andesite lavas occur north of Reydarfjordur and there is every indication that the succession as a whole is thin.

Near Sellatur and Sigmundarhus the rhyolites of the Second Phase overlie thin tholeiite lavas which cannot be separated from underlying similar flows of the First Phase. A further group of thin tholeiites totalling about 200 ft. overlies the rhyolites and

approximately half this succession is referred tothe second phase.

Second Phase tholeiites are only poorly exposed on the southern slopes of Lakahnaus and Nontindur and the succession is complicated by faulting. Further west outliers of Phase Two flank succession lavas form the summits of Grakollur and Vindhals. On Grakollur there are ten tholeiite lavas totalling 200 ft, some of which should perhaps be referred to the third phase. On Vindhals only two porphyritic tholeiite lavas are preserved. In both cases the lavas overlie the T_2, here fine-grained, rich in pumice and less than 10 ft. thick. In the Nordfjordur area the succession is entirely composed of tholeiite lavas, but it is never possible to differentiate between second phase lavas and those of the preceding phases. These flows have been examined on the northern slopes of Glamsauga, in Oddsdalur and Seldalur and on Bagall and the scanty evidence available suggests that the group is thinnest at the last of these localities. Here it is composed of flows which more closely resemble flood basalts in contrast to the thin tholeiites of the Reydarfjordur area.

(vi) Conclusion

It has already been noted that the tuff layer T_2 is absent from certain areas on the Vattarnes peninsula, and probably also from much of the area round Sellatur and above Helgustadir. As these areas are so close to the feeding vent in Breiddalur, and as the tuff is present in other localities further from the source, it is assumed that the absence of the tuff is due to

penecontemporaneous erosion before the deposition of the overlying basalts.

Although there is only a limited amount of data it is possible to reconstruct the original thickness variations produced during the deposition of the tuff bed. In doing this, readings from the zone of penecontemporaneous erosion have been ignored. The resulting isopachyte map (fig..24) closely resembles that for the tuff layer T_1, especially in that the isopachytes are drawn out towards the south-east, presumably due to a strong north-westerly wind prevailing at the time of deposition. The map also shows that over part of the area affected by penecontemporaneous erosion the tuff, when originally deposited, was over 100 ft thick.

The erosion of this particular portion of the tuff layer may be attributed to a topographic feature produced by the first phase rhyolitic andesites. This group of lavas forms a lens within the First Flank succession and it is thought that at times it stood up as a topographic ridge. There is a close relationship between the areas from which the tuff has been eroded and the area of maximum thickness of the rhyolitic andesite lens, which suggests that the tuff was stripped from the ridge by erosion soon after its deposition.

Although neither T_2 nor T_3 persist far north of Reydarfjordur, it is possible by means of extrapolation to construct an isopachyte map for the stratigraphic

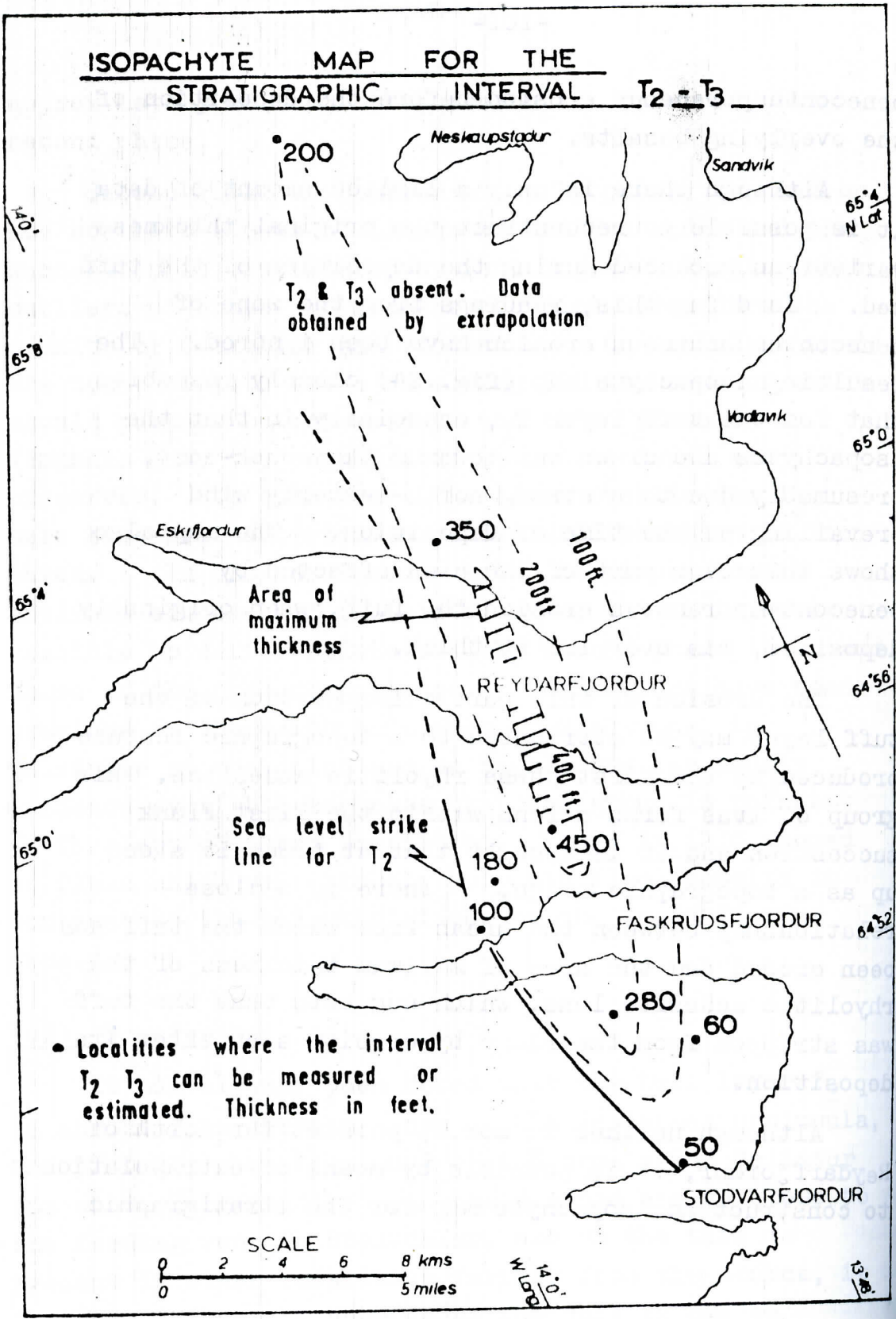

ISOPACHYTE MAP FOR THE STRATIGRAPHIC INTERVAL $T_2 - T_3$
Neskaupstadur
Sandvik
Vadlavik
Eskifjordur
200
350
450
180
100
280
60
50
T_2 & T_3 absent. Data obtained by extrapolation
200ft
100ft
400 ft.
Area of maximum thickness
Sea level strike line for T_2
REYDARFJORDUR
FASKRUDSFJORDUR
STODVARFJORDUR
• Localities where the interval T_2 T_3 can be measured or estimated. Thickness in feet.
SCALE
0 2 4 6 8 kms
0 5 miles
65°4' N Lat
65°0'
64°56'
64°52'
14°0' W Long
13°48'

Fig. 25

interval T_2 - T_3, covering the area from Nordfjordur south to Stodvarfjordur (fig. 25) This shows the thickness variation for the second flank succession as a whole. As can be seen the succession forms an elongate lens of lavas with a maximum thickness of 450 ft. thinning rapidly up and down dip and less rapidly to the north and south. This depositional pattern is strikingly similar to that recorded for the first flank succession. As T_2 and T_3 both represent time-bedding planes, it is deduced that there was preferential eruption of lavas along the axis of the lens and a corresponding amount of subsidence.

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