CHAPTER 6

The Envelope of the Volcano

The lavas on the flanks of a volcano can usually be distinguished fromenveloping lavas by their residual outward dips away from the core of the volcano. In the Austurhorn area the envelope of the Alftafjordur volcano is represented by lavas which are the lateral equivalent of the uppermost flank lavas and by lavas which come stratigraphically above the volcano. These lavas include many thin tholeiitic lavas of central volcano type as well as a number of typical flood basalts, but acid and intermediate lavas and thick pyroclastic deposits are almost completely lacking. The lowest undoubted enveloping lavas exposed here are flood basalts belonging to the Fossarvik group. In the north and west this group marks the approximate upper limit of the Alftafjordur volcano but in the south-west, where the lavas have been tectonically tilted, apparent flank lavas - andesites and very thin tholeittes - occur above the Fossarvik group. Here the uppermost flank lavas are capped by a higher group of flood basalts, the Vikurfjall group.

The Fossarvik Porphyritic Group

This group of porphyritic basalt lavas forms a marker horizon extending from the south-west shore of Alftafjordur in the north to the col at the head of Lonsheidi in the south. Outside the Austurhorn area this same group can be traced from the north of Alftafjordur to the north side of Berufjordur, where it thins out against the southern flank of the Breiddalur central volcano (Walker, 1963,p.38). The group is so named after Fossarvik, on the south-west side of Berufjordur, where it is over 250m thick.

The thickness of the Fossarvik group varies considerably within the Austurhorn area. On the southern shore of Alftafjordur the group consists of four lavas and an interbedded agglomeratic tuff, with a total thickness of 30m. To the south-west, along the base of Kjolfjall, the group thins to one or two flows first overlying thin tholeiitic lavas and bedded sub-aerial tuffs on the flanks of

the Alftafjordur volcano, and then interdigitating with similar bedded tuffs on the south-west side of this mountain. The group thickens again in Starmyrardalur but thins out eastwards against steeper dipping flank lavas on the north-western slopes of Snjotindur (fig.10a). At Thingbrekka four porphyritic flows with two interbedded tholeiite lavas are present, and six porphyritic flows, 50m thick, occur to the south in Rjupnadalur. The Fossarvik group thickens to 100m on the north side of Ljosardalstindur, and then thins out rapidly both south-east along Ljoshamrar and north-east on the south side of Snjotindur, the group again being banked up against and interfingering with the products of the Alftafjordur volcano.

The Fossarvik group consists predominantly of massive porphyritic olivine-basalt lavas in which the content of phenocrysts (mainly plagioclase) varies from less than 5% to more than 25% of the rock. Outside the hydrothermal aureole of the Alftafjordur volcano these lavas are usually very rich in zeolites, but inside the aureole zeolites are absent, the amygdales instead containing quartz and calcite. Some non-porphyritic tholeiite lavas and interbedded detrital beds are often included within the group.

The lavas of the Fossarvik group are typical flood basalts, as shown by their wide geographical extent, their relatively uniform thickness and their constant westerly dip of around 7°, and they are probably unrelated to the activity of the Alftafjordur volcano.

The Succession above the Fossarvik Group

Thin tholeiitic lavas dominate the succession above the Fossarvik group, although porphyritic basalts, olivine-basalts, andesites and acid lavas, as well as tuffs and water-lain sediments, also occur. It has not been found possible to correlate any of these lavas with lavas outside the Austurhorn area.

Succeeding the Fossarvik group on the north-east side of

Kjolfjall come tholeiite lavas, while on the south-east side come thin olivine-basalt lavas interdigitating with the bedded tuffs which occur on the flank of the Alftafjordur volcano. Many of the higher flows in the lower 60m. of the succession on Kjolfjall are comparatively coarse-grained, and are probably intermediate in type between olivine-basalt and tholeiite. Thin tholeiites predominate above, with occasional porphyritic flows.

The same general sequence of thin tholeiites occurs on the west side of Lonsheidi, but on Snjotindur to the east there are also some flood basalts. On the west side of this mountain two tholeiite lavas separate the Fossarvik porphyritic group from an overlying group, 45m. thick, of four olivine-basalt flows. These flows lose their distinctive character on the north and east sides of Snjotindur, as here they come within the hydrothermal aureole of the Alftafjordur volcano.

On Ljoshamrar the Fossarvik group is both overlain and underlain by very thin and highly amygdaloidal basaltic lavas which have an average thickness of less than 4m. Above these very thin lavas come a group of andesites which outcrop on top of Ljosardalstindur and on the dip slope to the south-west.

The succession on Vikurfjall, which comes stratigraphically above that of Ljoshamrar, is more variable and includes water-lain sediments, acid lavas and a group of porphyritic olivine-basalts - the Vikurfjall group - as well as tholeiitic, andesitic and dacitic lavas. A water-lain sediment is exposed at 360m. on the north-west side of Vikurfjall, where it can be traced for 300m. The deposit, which is 40m thick, consists mainly of poorly sorted acid pumice fragments and is generally well bedded, with fine and coarse (sometimes conglomeratic) layers. Thin carbonaceous layers are common and often contain plant remains; these are mainly twig fragments but leaf impressions also occur. The Vikurfjall group overlies the sedimentary horizon, and reaches its maximum thickness of some 300m immediately over the plant bed. Most of the lavas in

the group, which includes some non-porphyritic olivine-basalts and tholeiites, are rudely columnar. To the north-west the lower lavas of the Vikurfjall group thin against andesite lavas on the northern slopes of Geithamarstindur (the same andesites as those on Ljosardalstindur).

On the west side of Vikurfjall south of Geithamarstindur the upper lavas of the Vikurfjall Group overlie six acid lavas, below which come the tholeiitic lavas forming cliffs on the south-west side of Vikurfjall. The acid lavas, which are weakly porphyritic and possess a prominent flow-banding, appear dacitic rather than rhyolitic, and they form flat-lying tabular flows with an average thickness of only 17m. Acid tuffs are interbedded with the dacites and also with the olivine-basalts immediately above. These pyroclastic layers contain rhyolitic bombs, indicating a near-by source of eruption, and it seems likely that the acid lavas and associated pyroclastics have been erupted from the pipe-like vent exposed in the cliffs north-west of Vik (fig 10c). This pipe, 120m. in diameter, is infilled with an acid agglomerate which contains large boulders of flow-banded dacite similar to that of the lavas above. The pipe is bounded by a zone of brecciated basalt a metre or so thick, and it passes upwards, through a zone of brecciated dacite, into the dacite lavas themselves.

Below the tholeiite lavas forming the cliffs on the south-west side of Vikurfjall, there is a water-lain sedimentary deposit interbedded with basaltic lavas. This sediment outcrops along the shore east of Vik farm and also on the west side of the Vikura river. It is generally unbedded and conglomeratic, consisting of unsorted, rounded and sub-angular basalt pebbles lying in a matrix of basaltic sand. Though quite extensive, the congolmerate is very variable in thickness, and is probably a river deposit.

The derivation of the lavas above the Fossarvik group is somewhat uncertain. Some of them, such as those of the olivine-basalt group on Snjotindur and of the Vikurfjall group, are interpreted as true flood basalts, unrelated to central volcanic activity. The very thin tholeiitic lavas, on the other hand, were most likely emitted from central volcanoes, and the problem is, which volcano? Besides the Alftafjordur volcano, a large volcanic centre is known to occur west of the area mapped (fig 1), while another ancient volcano may lie beneath the sea south of the Austurhorn, the northern limit of which could be represented by the vent on Vikurfjall. The Lon volcano probably commenced its activity when the Alftafjordur volcano had been active for some time, and most of the thin lavas of the "envelope" to the west of the Austurhorn area may well be the products of the Lon volcano. The andesites on Ljosardalstindur are probably derived from the Alftafjordur volcano while most of the more northerly lavas above the Fossarvik group are most likely the products of some other volcano the centre of which may be concealed down dip.

CHAPTER 7

Minor Intrusions
(Other than those associated with the Austurhorn Intrusion)

These include dykes, sills, sheets, laccoliths, irregular "pods" and plug-like bodies. Certain of the minor intrusions show points of special interest, and are described separately. These are the columnar-jointed tholeiite intrusions, the two Krossanesfjall gabbro masses, and the "differentiated sheets" south of Vikurfjall. The great majority of the minor intrusions are associated with the activity of Alftafjordur volcano.

Dykes

Both basic and acid dykes are found in the Austurhorn area, and probably all gradations occur between olivine-basalt and rhyolite, though no dykes of intermediate composition have been recognised in the field. Many of the dykes are probably feeders for the extrusive lava flows which have a similar range in composition (Walker, 1959b). Besides single dykes, composite and multiple dykes also occur. Few dykes can be traced for any great distance along their strike.

(a) Basic Dykes (fig. 11)

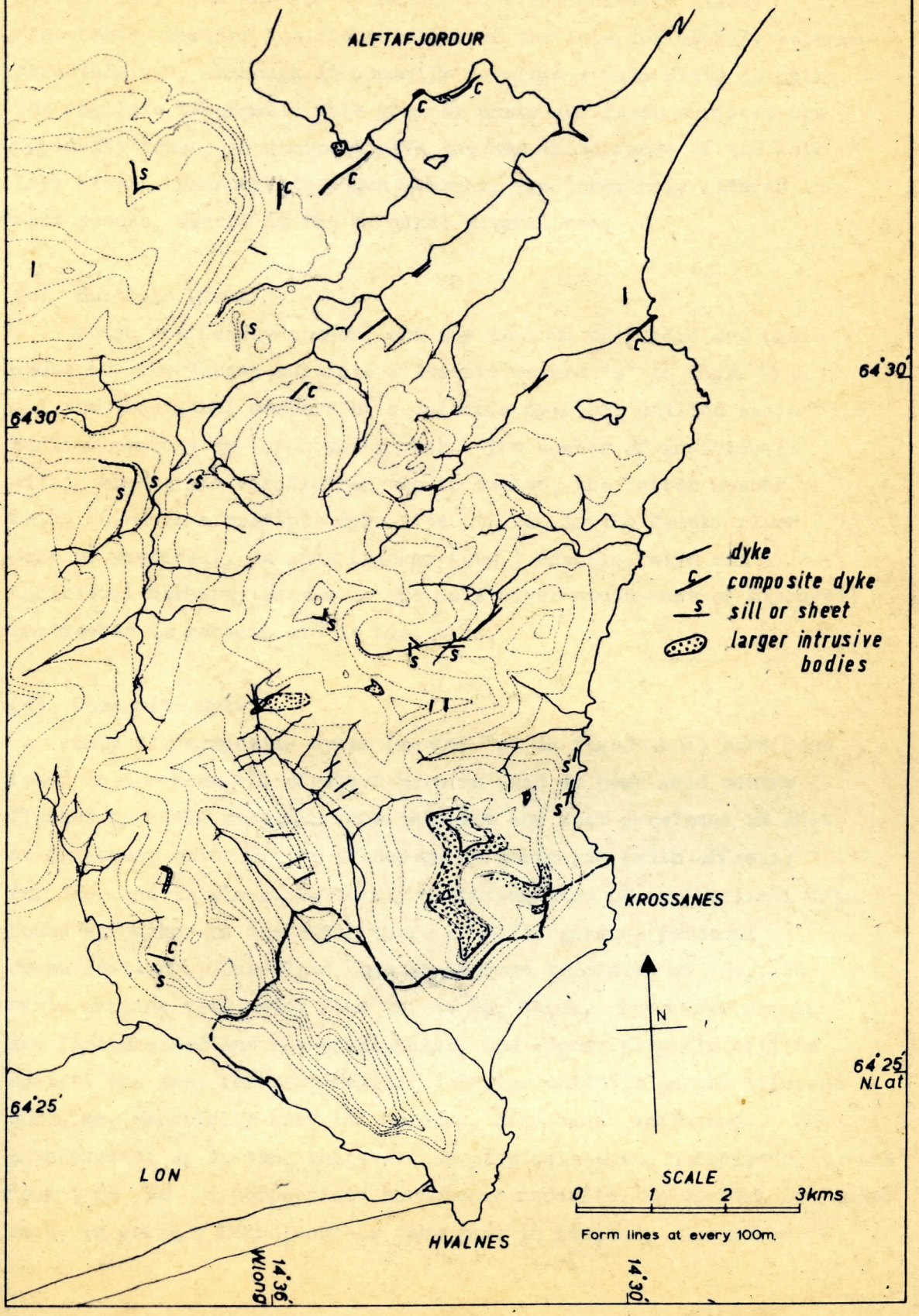
These are by far the most common. They range from olivine-basalt to tholeiite and include porphyritic and non-porphyritic types. The basic dykes vary in thickness from 0.3m. to 40m., with an average of about 1m., comparable with the average thickness of basic dykes in the Thingmuli area, but rather less than the average for most of eastern Iceland and the British Tertiary (Carmichael, 1962).

(b) Acid Dykes

Acid dykes are much subordinate to the basic dykes (fig. 12). They range in thickness from less than 1m. to 6m., with an average of 2m. The thinnest acid dykes are usually formed entirely of flow-banded green pitchstone, which may be completely altered to a pale greyish

Fig11. Distribution of Basic Dykes

Fig. 12 Acid Minor Intrusions



rotten rock. The thicker dykes may have recognisably glassy flow-banded margins but the rhyolite of the interior usually appears structureless, although it commonly develops a rude platy jointing. The rhyolite is usually pale grey or white and fresh surfaces are typically rough, in contrast with the smooth surfaces of the acid lava flows. Phenocrysts, when present, are invariably altered to rust specks, except in the marginal pitchstones.

(c) Multiple Dykes

These are fairly common, and may include both acid and basic members. The larger multiple dykes are marked "m" in figs. 11 & 12 All the individual members of a multiple dyke are chilled against the earlier members or the country rock. The number of individuals within such dykes varies from two to twelve, the latter number being found in a multiple dyke, 13m. thick, in the Fauska river west of Maelifell. A much thicker (60m.) example, with six individual members, occurs in the Sela river south-east of Starmyri: one member is gabboic and is 40m. wide.

(d) Composite Dykes

Only six composite dykes (marked "c" in figs. 11 & 12) have been found in the area, all of which have an acid or near acid centre flanked by basic margins. The thickest and most prominent is that at Skipsnes, which can be traced south-westwards (with offsets) for 3Km. and is almost certainly a continuation of an identical dyke found by Walker on the north shore of Alftafjordur (personal communication). This dyke has an average thickness of 20m., the basic margins each being from 1m. to 2m. thick. The basic margins are fine-grained and non-porphyritic, and appear slightly chilled against the grey acid "andesitic" interior which is porphyritic and contains, especially near its borders, many basic inclusions. The phenocrysts, up to 1cm. long, are of plagioclase and hornblende, and the rock type is a porphyritic hornblende-andesite, an unusual Icelandic rock, as primary hornblende is very rare in Iceland. The other

composite dykes are thinner and cannot be traced for any great distance. That on Ljoshamrar, for instance, is less than one metre thick and was only seen in a single stream exposure.

(e) Dyke Distribution

The distribution of the dykes is shown in figs. 11 & 12, in which almost every dyke found has been plotted. The dykes appear to belong to two main swarms, one with a general north-easterly trend and the other with a general easterly trend, although, as can be seen, many dykes diverge from these two swarms. Most of the dykes of the north-eastern swarm are probably associated with the activity of the Alftafjordur volcano, as also are many of the aberrant dykes, especially those in the core region of the volcano. The majority of the dykes further north in eastern Iceland, including those of the Alftafjordur swarm on the north side of the volcano, have a north-north-easterly trend (Walker 1959, 1963); this general trend veers to the more easterly direction in the Austurhorn area. The east-west swarm, which affects all parts of the area but is most prominent in the south-west, appears to be mainly later than the Alftafjordur swarm, and is possibly related to another volcanic centre, such as that of Lon, further east (fig. 1).

Because of the lack of suitable exposures, few dyke counts could be made in the area. The maximum measured intensity was that just north of Hauksjorn, where twenty-two dykes, with a total thickness of 25m., occur in a 1Km. section, giving a percentage stretch of 2.5%. Here and elsewhere, however, exposures are not complete, and no reliable percentage dilation figures are available for the Austurhorn area.

Sills

Sills are not very common, except where they are associated with intrusive sheets, as on the east side of Krossanesfjall (figs. 14 & 15b). A prominent basic sill 7m. thick, occurs at around 700m. on Snjotindur and other, thinner, sills occur on the south-west side of Vikurfjall

and on Ljorhamrar. Some acid sills (fig. 12) occur in the west; one porphyritic pitchstone sheet (specimen H270, Carmichael 1963), less than 1m. thick, outcrops at 490m. on the south-west side of Vikurfjall, and a thicker acid sill (4m.) outcrops on Gjaartungur and in Skerpugil. In fig.13 sills are not differentiated from sheet intrusions.

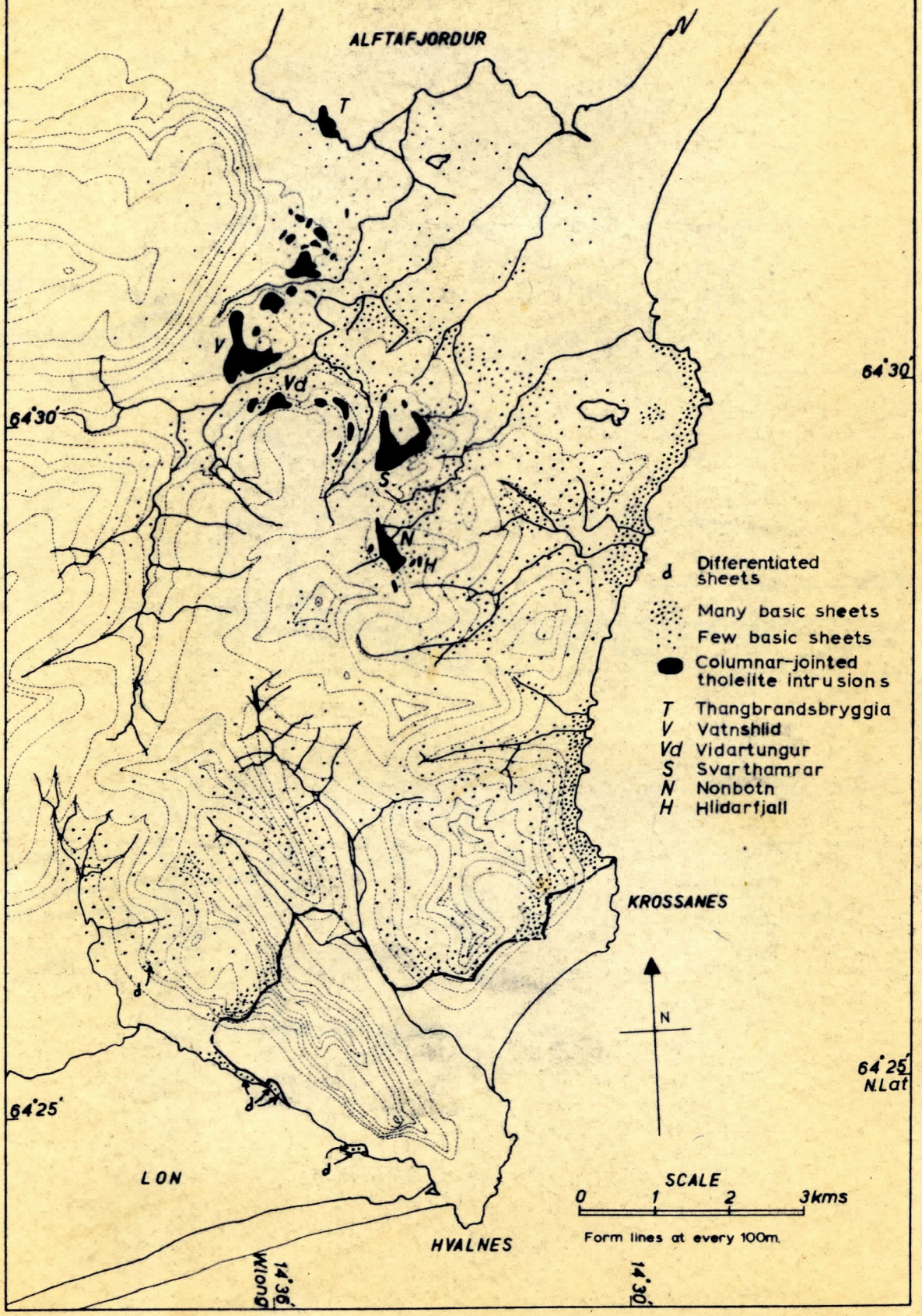
Thin Intrusive Sheets

These include all intrusive discordant sheets which have an average dip of less than 60°. Their general distribution is shown in fig. 13 . Sheets are found almost everywhere where exposures are good, being particularly abundant in and around the core region of the Alftafjordur volcano. They appear to be quite randomly oriented, are often highly irregular, cutting across each other (figs. 14 & 15a) and are not, apparently, centrally inclined. The great majority of the sheets are basic in composition, and many are porphyritic. The best exposures of sheets are found along the coast between Kirkjusandur and Krossanes, especially on the east side of Krossanesfjall (fig.15b) At the latter locality sheets make up about 15% of the sea cliffs, though they diminish in number upwards.

Other Acid Minor Intrusions

At least one small intrusive dome of rhyolite occurs within the core region of the Alftafjordur volcano (page 26), and further acid intrusive bodies occur on Krossanesfjall, Seltindur, Geithamarstindur, and at the head of Hvaldalur (fig. 12). Three or more laccoliths, possibly connected to each other in cedar-tree fashion, occur near the top of Krossanesfjall and are separated from each other by andesite and basalt lavas (fig. 12): a similar intrusion also occurs on the north-east side of the mountain. These intrusions, which are cut by many basic sheets and, above Hvalnesskridur, by apophyses of granophyre, are made up of porphyritic and non-porphyritic rhyolite. The lavas on the east side of Krossanesfjall summit have been updomed by the uppermost intrusion (cf. Sandfell laccolith - Hawkes and Hawkes, 1933), where the marginal intrusive rock is an altered

Fig.13 Distribution of Basic Sheets & the Columnar-jointed Tholeiite Intrusions



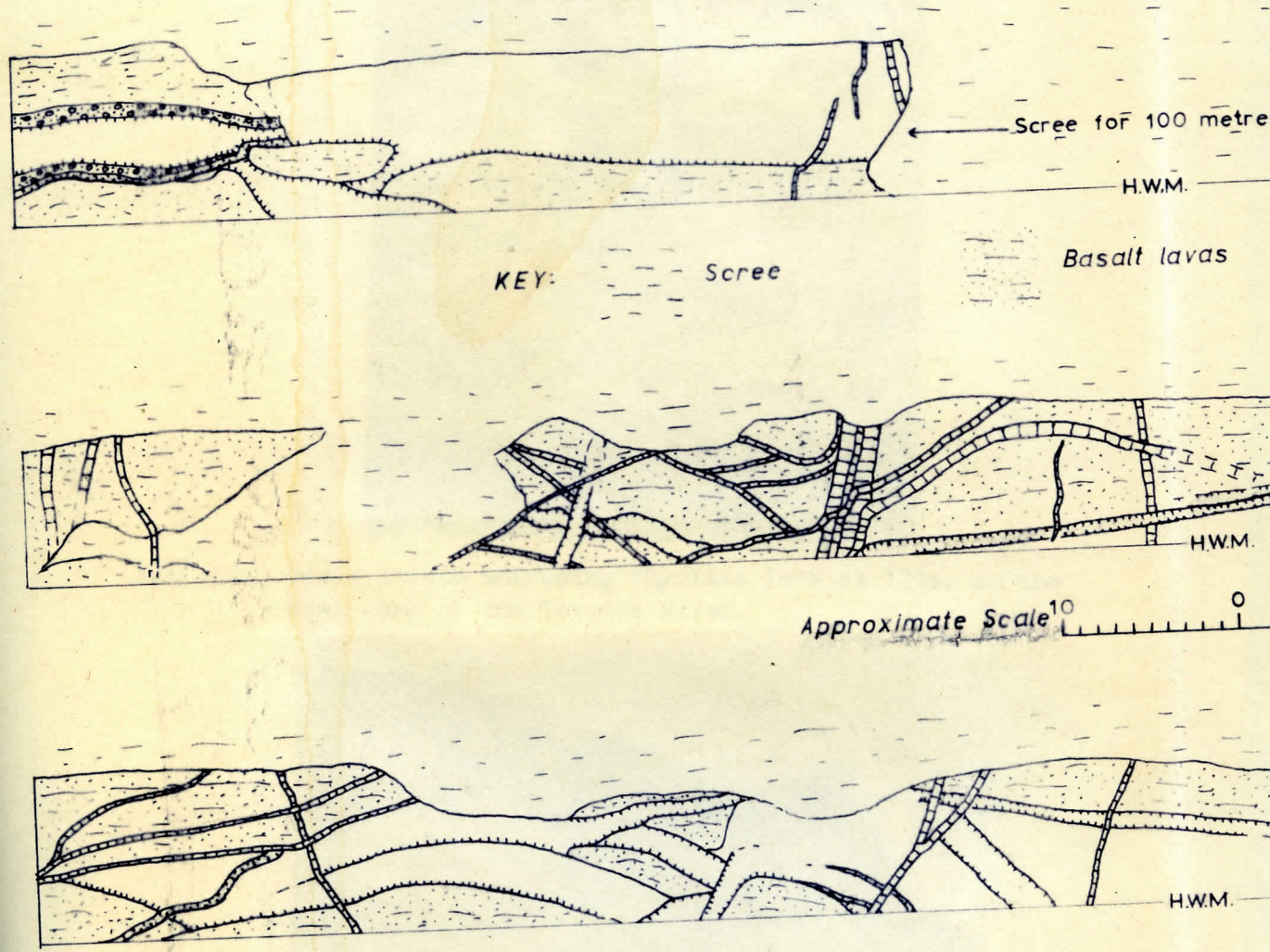
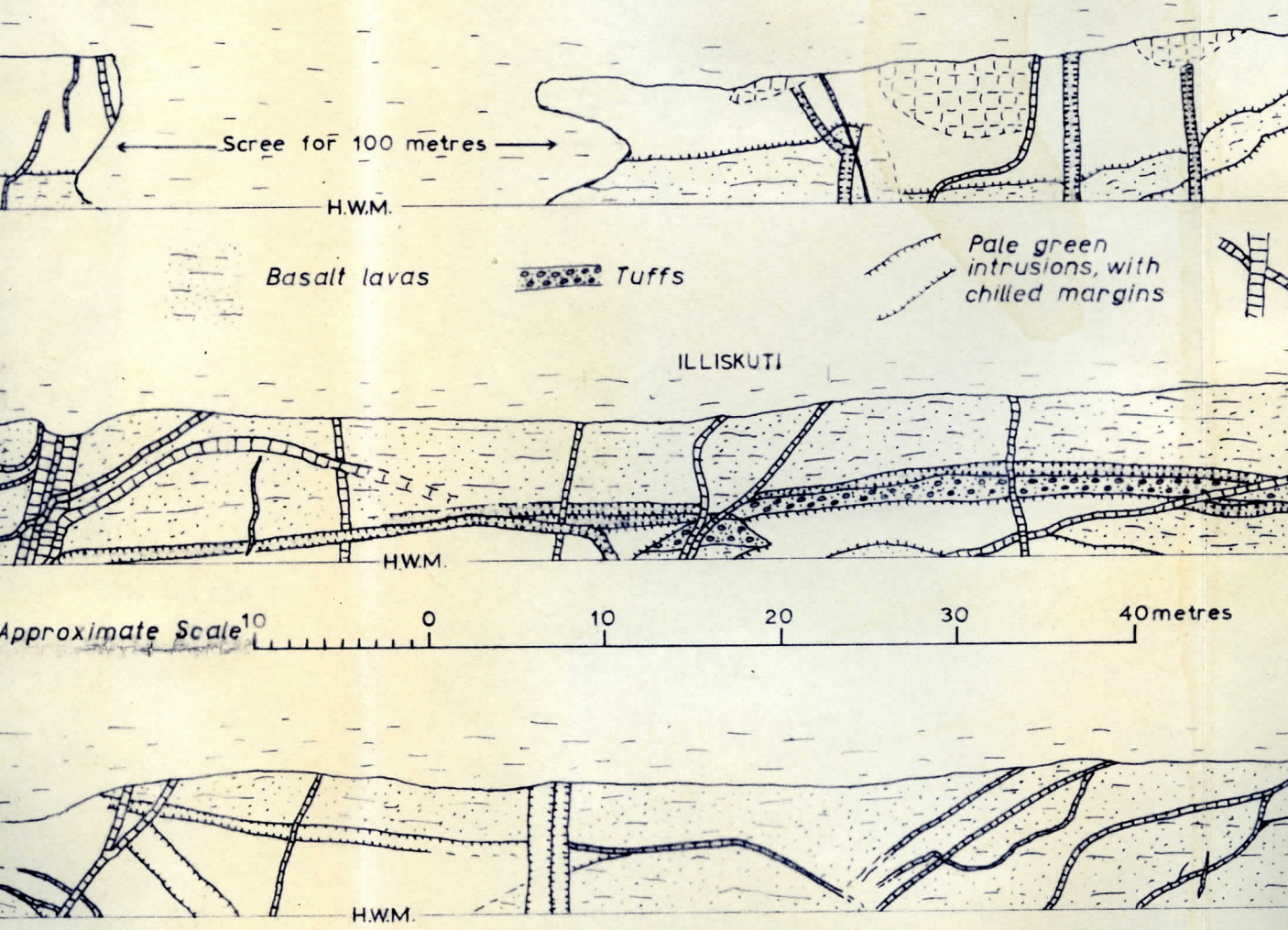
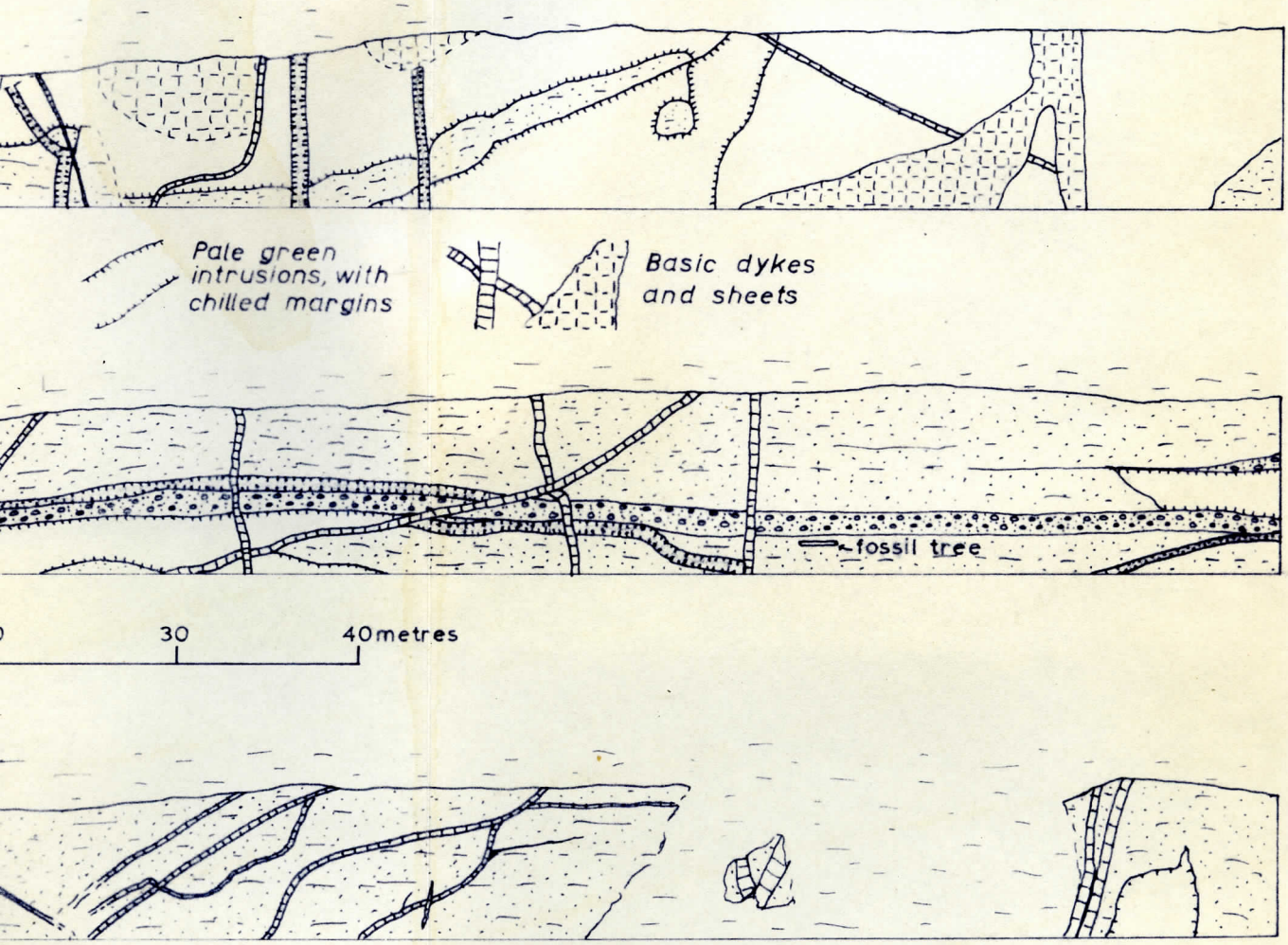


Fig.14 Part of the cliff section along the east coast between K



along the east coast between Krossanes and Maelifellsdalur, showing the many minor intrusi



alur, showing the many minor intrusions cutting basalt lavas.

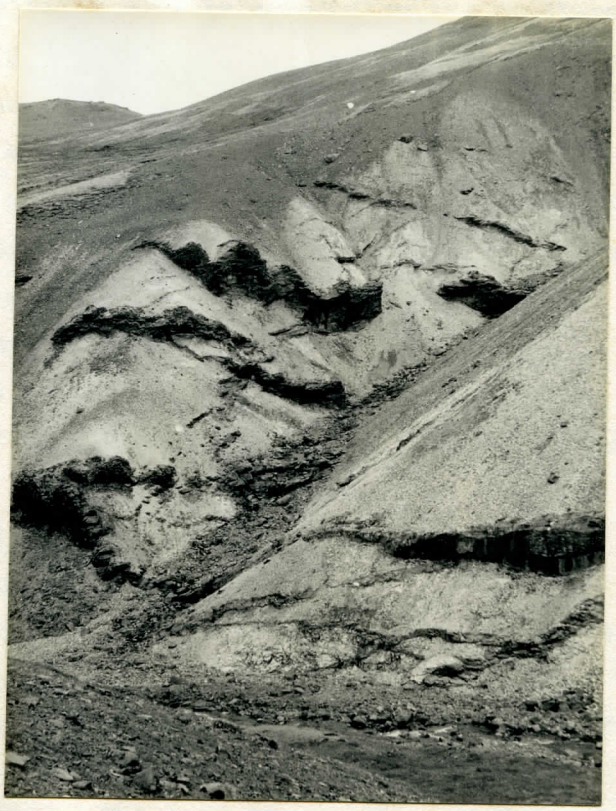


Fig 15a. Basic sheets intruding rhyolite lava at 176m. on the east bank of the Thvotta River.

Fig. 15b. Basalt lavas (B) and intrusive sheets (S) at Illiskuti, on the east coast. The cliff here is about 10m. high.

rhyolitic pitchstone with flow-banding developed parallel to the contact; a similar rock is seen below the south-western peak of Krossanesfjall. Elsewhere, except above Hvalnesskridur, the contacts of these acid intrusions are not exposed, as all are concealed under scree. The rhyolite on the west side of Seltindur appears to be a remnant of another laccolith, though its intrusive nature is open to some doubt. At the head of Hvaldalur a mass of rhyolite, with an altered pitchstone margin, forms an irregular sheet-like intrusion, some 12m. thick, cutting basalt lavas. On the west side of Geithamarstindur a near vertical, possibly pipelike body of rhyolite, some 15m. in diameter, intrudes the lavas.

Columnar-jointed Tholeiite Intrusions

(a) Introduction

In the northern part of the Austurhorn area there are a number of irregular tholeiite intrusions which have a prominent columnar jointing. Their distribution is shown in fig. 13; the larger intrusions are those of Nonbotn, Svarthamrar, Vidartungur, Vatnshlid and Thangbrandsbryggia. The intrusions occur at different levels within the lavas and pyroclastics forming the Alftafjordur volcano, and they are cut by later basic and acid dykes. Being more resistant to erosion than the surrounding rocks, the larger intrusions form prominent positive topographical features, and only rarely are capping rocks found.

Though the size and shape of the intrusions vary considerably, they can be described in general terms as irregular pod-like masses possessing smooth, undulating and rounded surfaces. Often, as on Hlidarfjall, Svarthamrar and south and west of Starmyri, thin, undulating, columnar-jointed sheets also occur, some of which join separate intrusive "pods".

The tholeiite of the intrusions is typically very fine-grained and non-porphyritic, though occasional feldspar phenocrysts occur and may locally make up to 1% of the rock; rare vesicles and veins contain calcite, quartz and chalcedony. The margins of the intrusions

are chilled though not glassy and, unlike the main part of the intrusions, they are not normally columnar-jointed. The adjacent basic lavas show little sign of contact metamorphism, but pyroclastics usually appear baked at the intrusion contacts. Nowhere are the country rocks seen to be structurally disturbed by the intrusions.

The columnar jointing is perpendicular to the intrusion contacts and, because of the irregular shapes of the intrusions, is typically very variable in attitude. The individual columns vary from 15cm. to 1m. in diameter, and they are not equally well developed in all the separate intrusions.

(b) The Intrusions.

Two columnar-jointed intrusions occur on Hlidarfjall, forming prominent knobs some 10m. high. The two intrusions are exposed over a vertical height of 30m. and are connected to each other by irregular sheets. The country rocks are unbedded pyroclastics, with some thin basalt lavas. The intrusive tholeiite itself, which is similar to that of the other intrusions south-east of the Sela river, is very fine-grained with only rare phenocrysts.

West of Hlidarfjall is the large Nonbotn intrusion, forming a 25m. cliff over which flows the Thvotta river. The intrusion rises towards Hlidarfjall to the south-east, but remains level and thins rapidly to the north-west. The country rocks north, east and south are basic lavas with interbedded tuffs, while to the west the intrusion is capped by andesite lavas. These andesites are cut by thin columnar-jointed sheets in the immediate vicinity of the main intrusion. This Nonbotn intrusion is one of the few such intrusions seen in contact with lava flows.

The group of connected intrusions on Svarthamrar (fig.16a) consist of an upper thick sheet capping the hill and two lower tongue-like intrusions projecting to the north which form steep-sided ridges on either side of a hollow in which is exposed agglomeratic tuff: associated with these larger intrusions are some