REPORT OF THE IMPERIAL COLLEGE EXPEDITION TO ICELAND, 1969

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IMPERIAL COLLEGE VOLCANOLOGICAL EXPEDITION TO ICELAND 1969

EXPEDITION AND GEOLOGICAL REPORT

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The idea for an expedition was conceived in November, 1968 by four first year geology undergraduates of the Royal School of Mines, Imperial College, London. After two months of discussion, a trip to Iceland was considered the most appropriate to facilitate our various interests and the excellent volcanology and mountaineering to be had on the volcano Oraefajokull in the south-east of Iceland seemed an ideal choice. The expedition lasted seven weeks from 13th July till 27th August.

PERSONNEL

Geoffrey Wadge, leader, aged 19 from Burnley, Lancs. Geoff looked after expedition equipment and acts as equipment officer for Imperial College Caving Club. An experienced climber and caver, Geoff is now studying structural geology in the third year.

Ian Boughton, aged 19 from Brighouse, Yorks. Ian took care of transport and food supplies. Also a climber and caver, Ian is now a third year Mining Geologist.

Stephen Sparks, aged 20 from Whaley Bridge, Derbyshire took charge of photography. Considerable climbing experience in Scotland and Wales and some caving. Stephen in 1969-70 acted as President of the Exploration Society and now studies structural geology in the third year.

Clive Newall, aged 19 from Penrith, Cumberland, has a very full mountaineering background. As a member of Keswick Mountain Rescue Team, Clive was the most experienced climber in the party. Now, Clive is studying mining geology in the third year.

TRANSPORT AND GENERAL SYNOPSIS

On Monday, 14th July we flew on a Boeing 727 of Icelandair from Abbots Insch to Keflavik, Iceland. The main bulk of our equipment had been shipped out on M. S. Gullfass a few days previously. We stayed at Reykjavik for two days at the local Salvation Army Hostel in order to arrange future travel arrangements and to reclaim our equipment from the customs.

That Wednesday we caught one of the infrequent but efficient buses which took us along the south coatt as faras the settlement of Kalfholt. Map 1. shows our various routes and camps. After our first night under canvas, we attempted to hitch inland to Hekla. With Icelandic roads renowned for their enterprising use of river beds, lava flows and the economical use of road metal, and also with traffic noticeable by its absence, hitching is not recommended as an expedient form of transport in central Iceland.

Eventually we arrived at Hekla and spent two days looking at the 1947 lave flows and the magnificent Hekla itself. On Saturday, 19th July, we again tried to hitch further inland to the hot-spring area of Landmannalaugar. This ended in two of us having to bribe a local to take us out there.

In all, we spent eight days at Landmannalaugar, which shows almost every conceivable feature of classical volcanology, and aesthetically, is one of the wonders of Iceland with its glory of mountain ridge, lava flow, sprinklings of ice and fierceness of colour. During our stay here, we were essentially camping light, taking the minimum of food and equipment and leaving the great bulk of it in Reykjavik. Our visit to Landmannalaugar was largely controlled by exceedingly poor weather, culminating in a 36-hour storm towards the end. However, we had an especially interesting visit to the Eldgja fissure in an Icelandic friend's vehicle. Also, bathing every evening in the pools, fed by hot-springs is an experience not to be missed even if as usual the rain is falling. The geology is most spectacular, notably the fumarolic activity and huge dacite lava flow which dominates the head of the valley.

On Sunday, 27th July, we took no risks and caught the weekly coach which takes tourists to and from Landmannalaugar. Due to the torrential rains the river had swollen to frightening proportions. The coach rescued an Icelandic family whose vehicle had literally been swept away at a ford. The lighter first two weeks of the expedition were over.

Back at Reykjavik we reinstalled in the Salvation Army hostel which appears to cater for Icelandic alcoholics and drug addicts as well as the occasional university expedition. The aforementioned establishment, however, is highly recommended for its hospitality, magnificent breakfasts, economy and colourful inmates.

On Wednesday, 30th July, having secured maps and arranged air transport for our equipment, we set sail for Hornafjordur on the south-east coast. The two-day journey via the Westmann Islands was in the 80-ton Herjolfur which authorities mysteriously considered seaworthy. The sea was exceedingly rough, and we suffered.

At Hornafjordur we successfully hitched a lift with a milk wagon to within 10 miles of our destination at Hog garmstead, under the shadow of Oraefajokull volcano (Map 2.). After the initial attentions of a very strong gale we spent two days building up our base-camp in the ruins of Grof Farm, destroyed in the eruption of 1362. Our equipment had arrived at Fagurholsmyri airstrip without mishap and the garage/supermarket here was the sole communications point for 50 miles or more around.

After settling into base-camp, we spent the rest of the time, some 18 days, mapping the south-west slopes of Oraefajokull above Hof. The weather again proved rather antagonistic and it was quite a struggle to cover a significant area. On August 27th we persuaded a local farmer to take our gear to the airstrip where we stayed the night. The next day we caught the local flight back to Reykjavik - a tremendous journey.

Again, taking advantage of the Salvation Army's hospitality, we loaded our equipment onto the Gullfoss, cleared up unfinished business with Reykjavik University and set sail on August 30th. The voyage on Gullfoss was a gastronomic bonanza and thanks to the calm weather we arrived at Leith smiling three days later.

EQUIPMENT

At Oraefi we used a large Andre Jamet frame-tent which we used for sleeping two and as an office and eating place. This type of tent is, despite its numerous merits, not recommended for this part of the world, as we noted a tendency for it to collapse under gale force conditions. We also used two Vango Force Ten mountain tents which certainly lived up to their reputation. Though on the heavy side (18 lbs.), their survival under the most provocative conditions was excellent.

For lighting and heating, we used "Gaz" butane equipment which proved good value and convenient. However, it should be noted that many airlines refuse to transport gas cylinders, and this nearly had us in difficulties. Fortunately, Icelandair's effeciency in bureaucratic matters is none too high.

We used Fairy 'Everest Mummy' sleeping-bags and they certainly lived up to their high reputation. Our Ian Clough cagoules were invaluable in such a wet climate but the overtrousers proved disappointingly weak on the inner leg. We took two rucksacks each: Don Whillans climbing sacks which were every bit as good as their reputation, and Karrimor Totem sacks. The Totem tends to be weak at one or two points, but on the whole it is a fair piece of equipment, which will no

LANDMANNALAUGAR

TRAVERSING JÖKULSA RIVER

DACITE LAVA FLOW

RHYOLITE PEAK

TOWARDS TORFAJÖKULL

doubt improve with time.

Before leaving equipment, we would advise similar expeditions to take an extra pair of climbing-boots for each member. In only taking one pair, albeit new, and going out each day, we found it impossible to clean or dry them adequately. Consequently the uppers suffered excessively and were in a state of disrepair towards the end.

FOOD

We took a large supply of food with us from England, mostly in the form of canned and dried foods. We took only dried foods with us to Landmannalaugar and this began to tell towards the end of our stay when the paucity of calories resulted in a weakness of both flesh and spirit. Food in Iceland, especially in remote parts such as Oraefi, is expensive apart from the odd local commodities such as fish and milk. It is worth ones while to import as much as possible by boat. Future expeditions are advised to take more than a tent pole and pin to fish with as Iceland's trout and salmon are surprisingly perceptive.

SUMMARY

In that the mapping was completed; in that we gained a very good insight into a very beautiful country: in that we gained invaluable experience in arranging it and combating and overcoming the unforeseen, the expedition was a great success. A number of miscellaneous points we feel might be of value to future parties are now mentioned:

Iceland, for the geologist, has had relatively little study and with its vital position in relation to earth structure it merits for more attention. Oraefajokull, the second largest volcano in Europe, has had virtually no large scale work done on it and this demonstrates the general neglect. We were lucky enough to be near an airstrip but in the main, no serious expedition to the interior or the remoter parts of the country can be without motor transport, indeed a landrover.

The weather we received was very poor, but we were reliably informed that it had been the worst summer for many years. Our frequent allusions to the weather should not be taken too seriously as a standard. The rocks of Iceland being almost totally young volcanics means that the standard of climbing and mountaineering is rather low. Scree slopes predominate and rock faces are often loose and rubbly; the older lava flows can make good, interesting walking routes but to venture onto the more recent ones such as the 1947 Hekla flow is virtually suicidal. Permission to study and venture onto the glaciers was not granted to us by the Icelandic authorities and anyone wishing to do so must bear in mind that evidence of considerable glacier experience is required for such a request to be granted.

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Mr. A. Stephenson for his guidance as head of the Exploration Board.

LAVA ROCK - BRIDGE

SUB - GLACIAL COLUMNAR BASALT

ORAEFI

RHYOLITE COMPLEX HRUTSFJALL

TEPHRA STREAM - SECTION

THE GEOLOGY OF SOUTH-WEST ORAEFAJOKULL

Oraefajokull volcano, on the southern flank of the Vatnajokull Ice Cap, is the largest volcano in Iceland that has been active in Post-Glacial times. It is estimated to be the second largest volcano in Europe by volume. The volcano is of the central type and rises from the low sondur plains to an ellipse-shaped crater with a total volume of 14 km^3. The crater rim rises to 2,119 mtrs. at the peak Huannadalshrukur, Icelands highest top. Considering its dimensions, very little is yet known about its structure and geology. The volcano's sides slope at an average 15^o and above 1300 metres the massif is covered by an ice-cap, part of the Vatnajokull, except for a few nunataks.

The regional setting of Oraefajokull appears to be that of an outlier of the broad neovolcanic zone that bisects Iceland from north to south. The oldest rocks appear to be late Tertiary basalts near Sumafelsjokull which show reverse magnetism. Glaciers radiate out to the south, east and west of the ice-cap and erosion by glaciers and meltwaters is extremely rapid and huge canyons have been eroded on the lower slopes. These canyons provide very good sections of the geology, quite often cutting deep into the succession.

The Godafjall and Hrutsfjall massifs consist of a large rhyolite complex, covered to the east by typical sub-glacial volcanic products and some later sub-aerial lava-flows and tephra-cones. The chemistry of the products is largely that of an olivine tholeiite, though some intermediate flows were found. In the following description we consider the geology of the area in three parts with a separate description of the petrology.

The Rhyolite

Covering 5 sq. kms., this huge complex of rhyolite forms the two prominent mountains of Hrutsfjall and Godafjall. The shape of its boundaries can be seen on Map 2.

From its eastern boundary we found perfect exposure of its relationship for surrounding rock types in the fossil sea-cliff of Hofsfjall which faces south-west. The rhyolite is overlain by the Hofsfjall formation of sub-aquatic basalt which will be described later. The contact between the rhyolite and the overlying formation is an erosional unconformity with a distinct ½ metre conglomerate marking the time break which dips to the south-east.

The north-western flank is nowhere so simple. In the Slage valley basaltic formations clearly underly the rhyolite and these basalts show noticeably different form to those that overly the rhyolite. Further up the valley, however, it is difficult to interpret whether the rhyolite overlies, underlies or is merely piled up against the other formations. On Slaga itself the indication is that the rhyolite is in fact younger than the rocks that make up the bulk of the Slaga.

Morphologically the rhyolite is a large dome-shaped mass and, if the bore is taken at the 100 metre contour, we can assume it to be at least 600 metres in maximum vertical thickness. The aspect ratio (ratio of thickness to width) cannot be much greater than 7 which is typical of acid extrusives with a high viscosity. The question of whether this represents an extrusion or intrusion arises but though there is little positive evidence extrusions seems the more tenable theory.

Flow-bonding is well developed throughout the mass, providing a very good parting. 30 dip readings on the rhyolite found that the western margin showed consistent strike and generally an inward dip. Further back in the massif, however, little consistency could be found and structures were very complicated including dome features and folding of the flow-bonding. In the valley south of Godafjall several successive flows could be seen. The flows dipped gently with the slope of the whole massif away from Oraefajokull. Godafjall from a distance shows structures which could represent a plug or vent. Unfortunately the summit cannot be reached to verify this. North-east of Hrutsfjall a prominent pinnacle shows a beautiful plug of rhyolite cutting through more basic members of the volcanics.

The rhyolite itself proved very variable in colour and texture. In the external parts variation could be found over only a few centimetres. North of Godafjall a mass of obsidion contained a core of pumice. Flow-bonded rock varied from a ubiquitous light coloured grey-pink variety through darked brown, finer types to black obsidious. In Grof gorge lens-like masses of flow-bonded spherulitic obsidion occurred. The spherulites were red and averaged about 2 mm. diameter. The flow-bonding itself often contained small-scale folds. One specimen, for example, had a fold wavelength of about 5 cm.

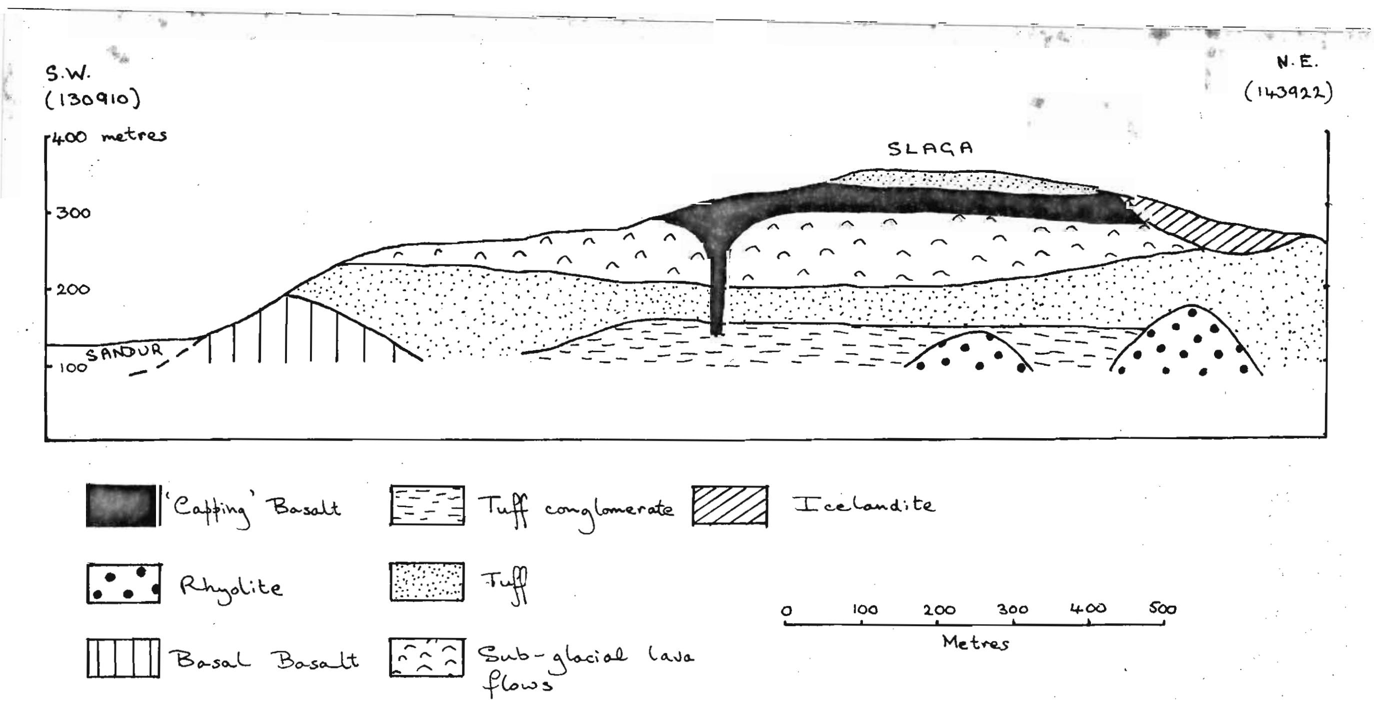
The scanty evidence points towards the rhyolite complex being extrusive with possible centres at Godafjall and Hrutsfjall. This acid phase appears to have advanced south-east over older volcanics aroung Slaga and was later covered by the younger series of the Hofsfjall plateau.

Finally, Thorarinsson mentions rhyolite found on the summit of Oraefajokull at the hunatak Hvannadalshnukur. As thick rhyolite extends under the ice-cap around the Rotarfjall glacier, a tentative correlation with the summit exposure may be suggested.

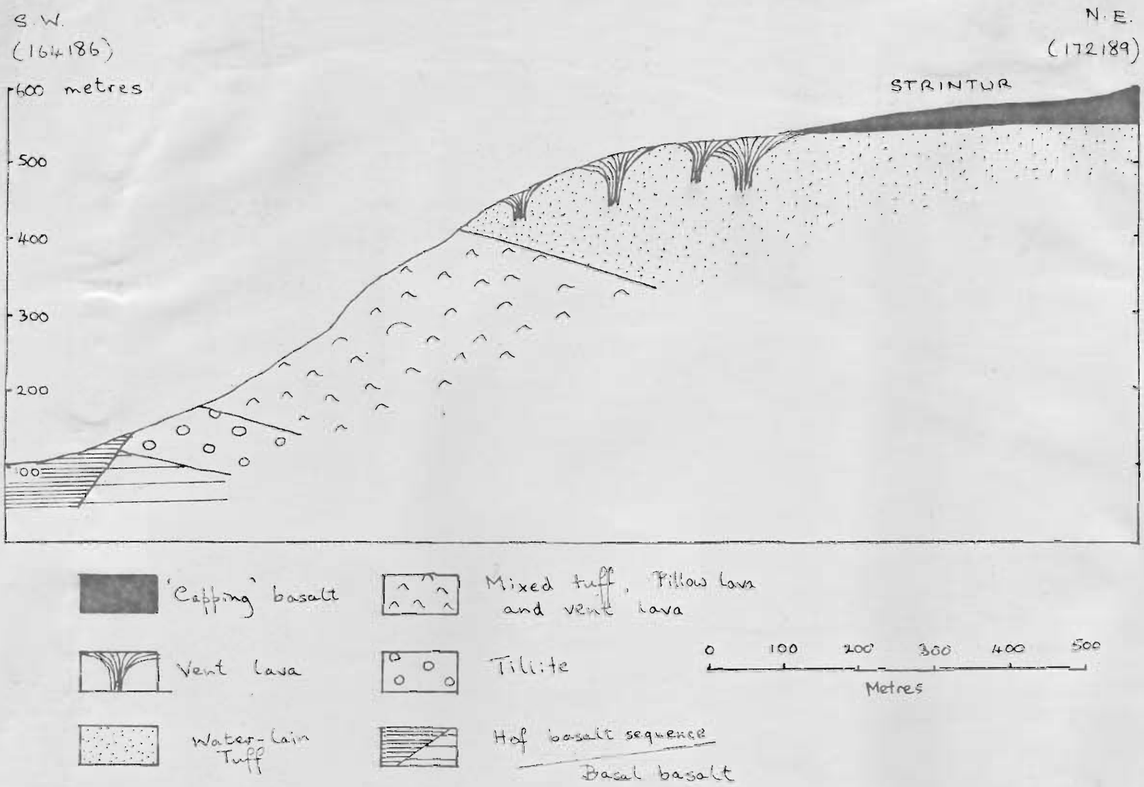
Slaga

To the north-west of the Godafjall-Hrutsfjall massif lies a complex of basalts, tuffs and tillites which appear to be older

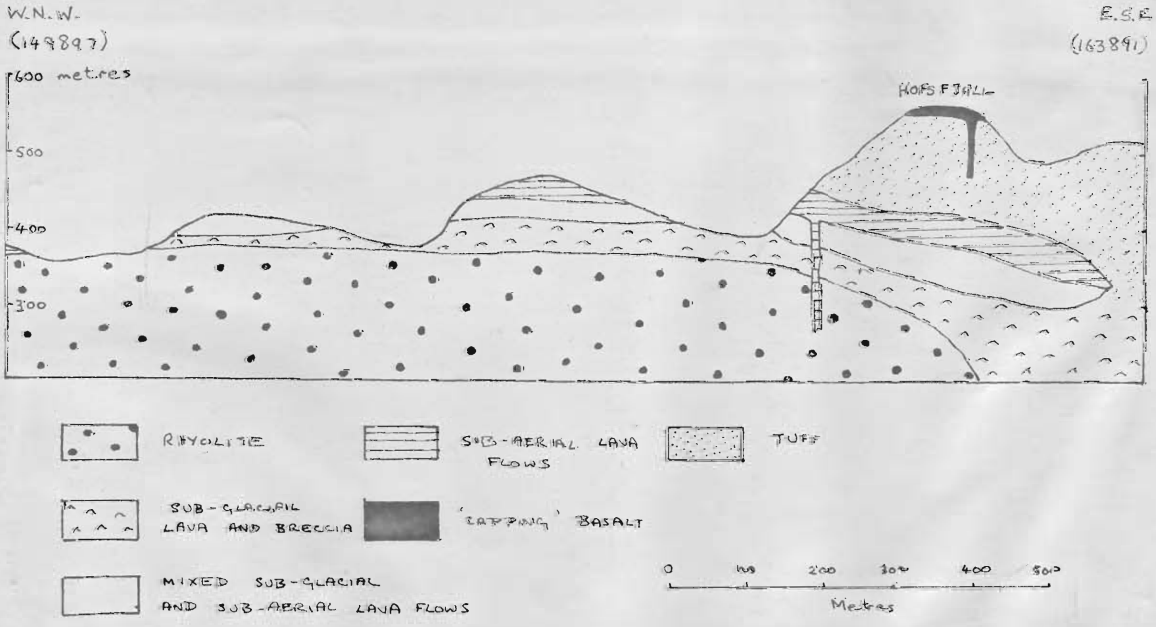
MAP 1



SECTION 1



SECTION 2



SECTION 3

than the rhyolite. At the entrance of the Rotarsjokull valley non-porphyritic basalt lavas dipping 10° S. W. apparently underly the rhyolite. The basalt is covered by a confused sequence of tillite and lava succeeded further upstream by porphyritic sub-glacial lavas and finally, black, fine tuffs. Immediately below the rhyolite on Hrutsfjall an introformational conglomerate suggests this sequence is pre-rhyolite.

On the Slage side of the valley we find little correlation with a thick series of tuff, pillow lava and pillow breccia capped by a sub-aerial flow and a tuff on both sides of the river (section 1.).

<u>The Hofsfjall-Fagurholsmyri Succession</u>

The volcanics to the south-east of the rhyolite are of a later phase. Study of the geology was concentrated mainly in the steep gorges cutting the massif. We feel it best to describe the complicated geology region by region building up a composite picture with reference to the sections.

From Hof southwards extends an old marine abrasion cliff, showing some 26 sub-aerial flow units of porphyritic basalt of very consistent composition. The average thickness of the flow units is 3 metres, though individual units are very variable in thickness along their length. Between each unit a red slaggy layer, averaging $\frac{1}{2}$ metre occurs. In hand-specimens there are large phenocrysts (1-5 mm.) of plagioclase in a dark basaltic groundmass with occasional olivine and pyroxene phenocrysts clearly visible.

The Gljufursa river cuts the plateau behind Fagurholsmyri and the Hof basalt type occurs in the lower section. This supports the idea that the lower part of the plateau is composed of the porphyritic Hof basalts. Stratigraphically underlying this sequence we find a thick flow of coarse grey porphyritic basalt which outcrops from Hofsnes farm past the airstrip at Fagurholsmyri as far as the Salthofdhi promontory. This is a single flow unit of 20-25 metres attaining a maximum thickness of 60 metres at Salthofdhi. Thorarinson correlates this with a similar flow on Ingolfshodhi.

To the south-east of Baejorgil a flat topped hill called Strintur occurs. Section 2. shows a closely studied profile of the south-west face which overshadows Hof. The Hof basalts end abruptly in a gully to the wouth-east of the settlement and begin again at the entrance of Baejorgil canyon. It is suggested that the Hof basalts are banked up against the succession of Strintur. This relation is seen also in Baejorgil where there is a vertical contact between the Hof basalts and tuffs to the north-east. The Strintur massif and Hofsfjall tuffs and pillow lavas formed a steep topography besides which the Hof basalts were banked up. Subsequent erosion has revealed this old topographical contact.

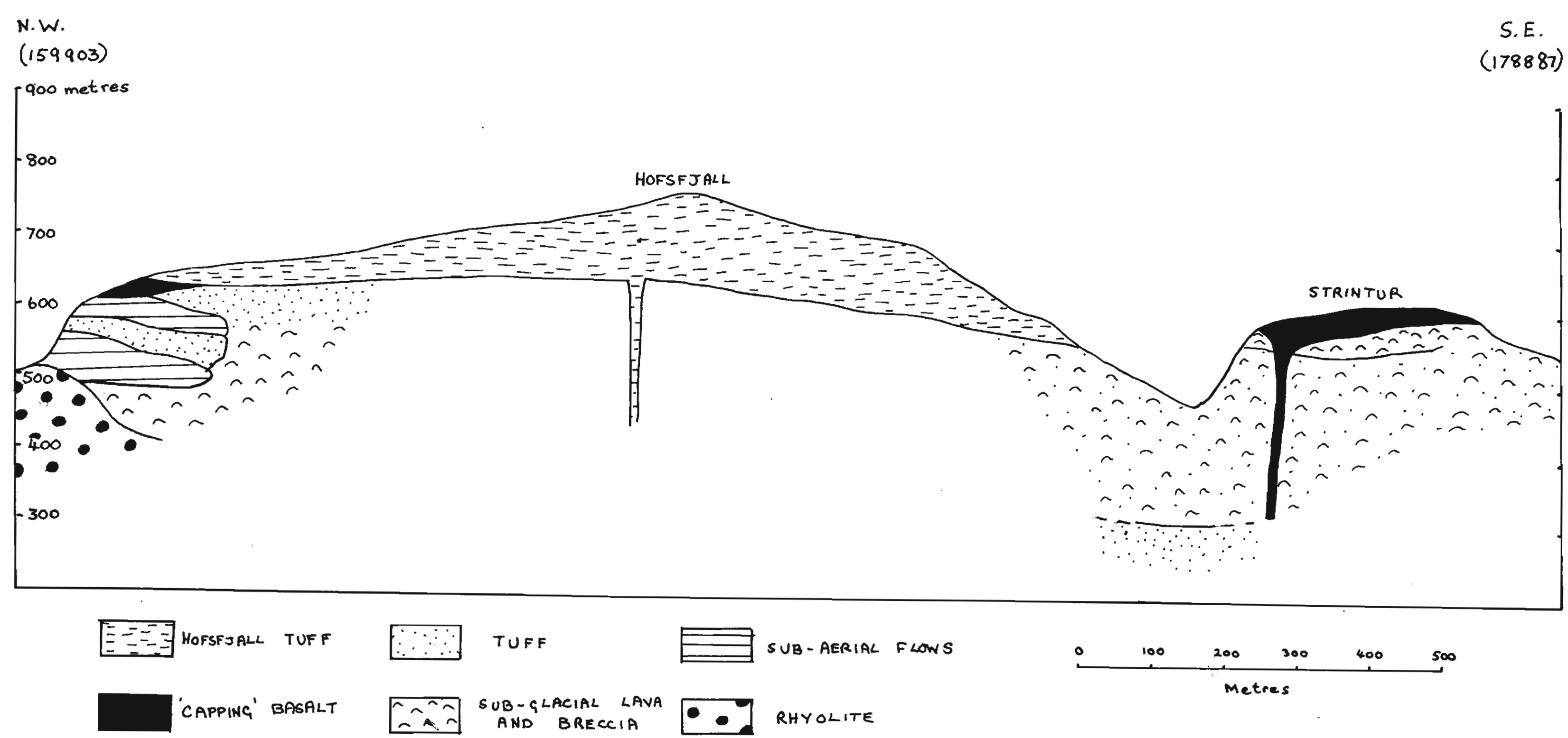
The Strintur sequence shows a 20-30 metre tillite bed overlying a black vesicular basal basalt. The tillite is overlain by the succession seen in section 2. We find first a thick series of palagonite tuff intercalated with sub-glacial lavas and irregular basalt masses. Further up black horizontally bedded tuffs occur giving way to light brown tuffs near the summit. Strong corss-bedding suggests a fluviatile or lacustrine environment. Cutting the whole series are the apparent cores of an old basaltic adventive crater row. Magnificent radial columnar jointing provides very striking land-forms and the vent basalts give out into thick flows intercalated with the water-lain tuff. Each flow-unit is composed of three sub-units. At the base regular pillows are formed in a 1-2 metre zone of regular columnar joints and finally a zone of irregular joints (termed kubbaberg in Iceland after Sigvaldeson). A sub-glacial environment can be envisaged easily enough in which such a lava could develop.

Strintur has reworked tuff paralleling the present slope. This deposit, which complicates the picture in many places is known as pseudo palagonite. The top of Strintur owes its table shape to a sub-aerial, moraine covered basalt flow of 35-40 metres thickness. Immense columns 2 metres in diameter and some 25-30 metres high occur around the flows feeder dyke and provide a highly spectacular feature. This flow is a grey oliving-feldspar porphyritic basalt. Strintur, to sum up, shows classic 'Moberg' formation sequence of lava extruding under ice.

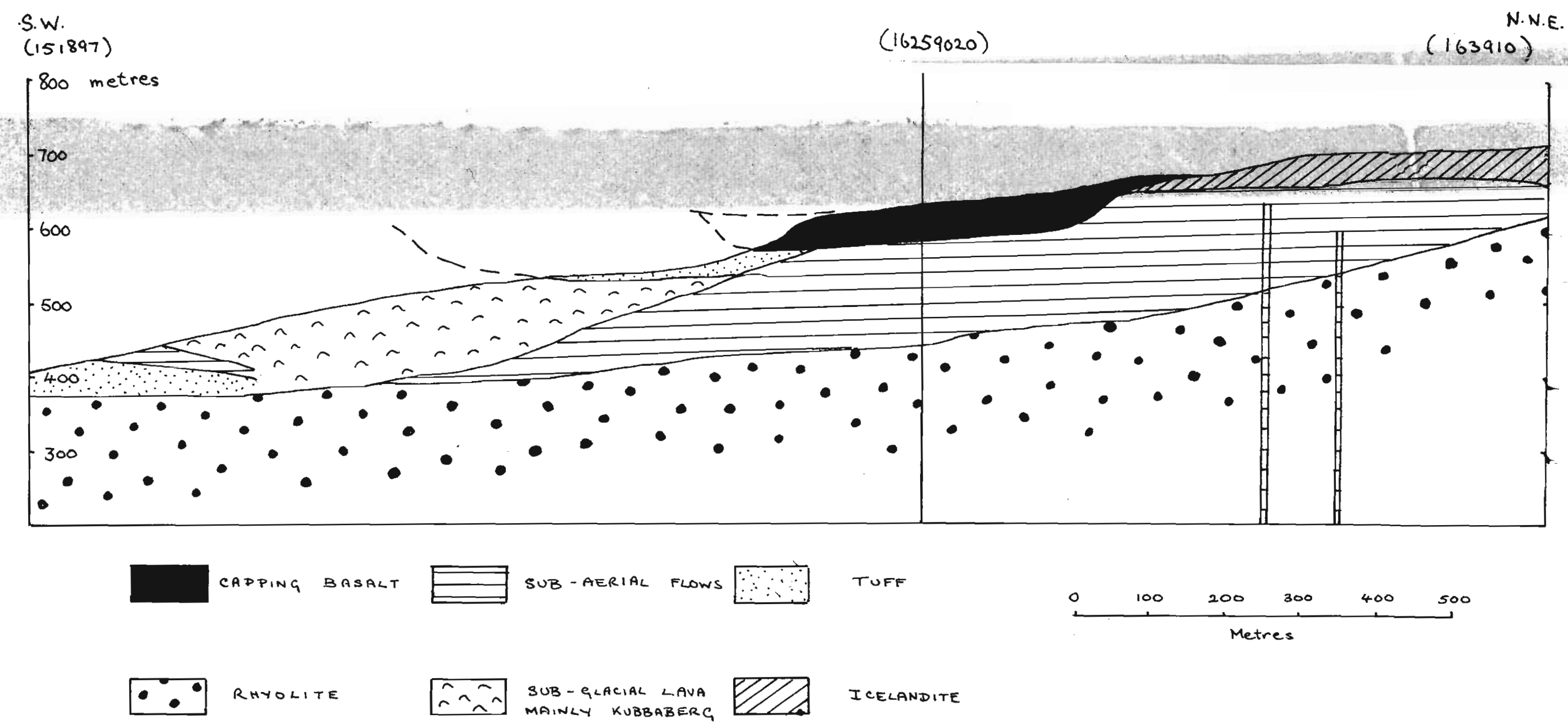
The Baejargil canyon sequence bears many resemblances to the Strintur formation though proportions of products differ and the succession is much thicker. At the base we see a well-bedded glassy tuff, overlain by a massive sequence of irregularly bedded kubbaberg basalt. Lying unconformably on this are pillow breccias and palagonite tuff. Over this we find a large thickness of brown water-lain tuff. Basic dykes cut through the whole sequence to feed sub-aerial flows at the top. We are away from the Strintur adventive centre so we find no equivalent of the old vents in the brown water-lain tuff.

Grof Gorge parallels Baejorgil further north and here conclusive evidence of the rhyolites age relation to the Hofsfjall-Fagurholsmyri formation occurs in an unconformity of the latter on the rhyolite. A 1 metre basal conglomerate demonstrates that this is not an igneous contact. Over the unconformity we find a thick sequence (section 3.) of pillow lavas and irregular kubbaberg basalts, cut by many basic dykes. Lying unconformably on this are pillow breccia and palagonite. Irregular thick, but not extensive laterally, lavas occur fed by well-marked dykes.

Between Hofsfjall and Godafjall lies a large well-exposed canyon. The N. E. cliff shows the extensions (section 4.) of the Hofsfjall tuff over the rhyolite. The unconformity here dips 10° to 50° to the south-east. The sequence west Hofsfjall is cut out by a massive and irregular body of porphyritic basalt. This shows kubbaberg jointing and radial structures similar to the Strintur vents. Section 5. shows the sequence up the valley and shows the characteristic thickening and thinning of the formations over incredibly short distances. This


N.W.
(159903)
S.E.
(178887)
900 metres
800
700
600
500
400
300
HOFSFJALL
STRINTUR
HOFSFJALL TUFF
TUFF
SUB-AERIAL FLOWS
'CAPPING' BASALT
SUB-GLACIAL LAVA AND BRECCIA
RHYOLITE
0
100
200
300
400
500
Metres

SECTION 4



S.W.
(151897)
(16259020)
N.N.E.
(163910)
800 metres
700
600
500
400
300
CAPPING BASALT
SUB-AERIAL FLOWS
TUFF
RHYOLITE
SUB-GLACIAL LAVA MAINLY KUBBABERG
ICELANDITE
0
100
200
300
400
500
Metres

SECTION 5

makes correlation from gorge to gorge difficult. The sub-aqueous products tend to give way to sub-aerial products to the N. E. An old valley at 16259020 has been spectacularly filled in by a thick 40 metre basalt. The icelandites seen in the extreme north-east consist of five flow units fed by non-porphyritic dykes cutting both the rhyolite and sub-aerial basalts trending E. -W. The flow units are 7-15 metres thick and show characteristic flow-bonding and fine-grained texture.

The other major area examined in any detail consisted of detailed examination of the upper sections of Gljufursa river and around Starhofdhi. The Hof basalt sequence is last seen at the 200 metre contour. Here a conglomerate gives way to intercalated tuff and pillow breccia. Upstream this is succeeded by a porphyritic sub-glacial basalt intercalated with tuff. At this point the valley splits into two main tributories and continues in steep gorges with large waterfalls. The waterfalls occur due to a thick grey porphyritic basalt which covers the Moberg formation beneath. The flows appear to parallel the present slope and the river repeatedly cuts through it in a waterfall.

The right-hand section consists of brown palagonite tuffs and large masses of a characteristic kubbaberg jointed basalt. Small feeder dykes for these are exposed at the confluence and again at 500 metres. In addition pillow breccias and thin sub-aerial flows occur. All this is covered by the grey porphyritic lava.

It is best to mention here the inherent difficulties associated with mapping the geology of slopes of Central-type volcanoes such as Oraefajokull. Due to extreme variability of the deposits and that the stream roughly parallels the slope of the volcano, one often has great difficulty in deciding whether the section goes up or down stratigraphically. The factor which decides this is the relation of the volcano slope to the gradient of the river. In a stream such as Gljufursa this factor is quite variable.

The left-hand branch of Gljufursa parallels the right only ½ km. away yet the sequence is very different. Here the grey porphyritic sub-aerial lavas are dominant and it appears that these lava types have thickened considerably towards Strintur. East of the right hand gorge the sub-aerial lavas also thicken towards Storhofdhi. Storhofdhi itself is a post-glacial parasitic cone which appears to have been the source of some of the grey porphyritic flows. Around Storhofdhi abundant fresh orange tuff and cinder at the summit testifies to fairly recent activity. Above Gljufursa and further west the whole plateau is capped by this lave type, so Storhofdhi is by no means the only source of a late and fairly voluminous volcanic phase.

Finally, recent eruptive activity is clearly demonstrated on the summit of Hofsfjall. The Hofsfjall Tuff is a very fresh, well stratified, brown tuff with ubiquitous boulder fragments of basalt increasing in size towards the summit. The largest fragments are about 15 cms. in diameter. The upper Baejargil canyon clearly shows that this parasitic cone was formed before the last glaciation and the thick grey porphyritic lava that caps Strintur is covered by moraine. This flow clearly rides over the Hofsfjall Tuff, baking it hard and also invades the tuff and has digested parts of it.

PETROLOGY

In the field the volcanics conveniently fell into four categories: rhyolite, sub-aerial basalt flows, sub-aquatic lava types and finally tuffs (mainly palagonite). The rhyolite, due to the large size of the Godafjall mass forms an unusually high proportion of the rock-types compared with the rest of Oraefajokull. Of the remaining rock types tuff composed 40% by volume and though it is difficult to estimate the relative importance of sub-aquatic and sub-aerial lavas the ratio must be about 50 : 50. The structures of sub-aquatic lavas were quite diverse with pillow lavas, pillow breccias, irregular glassy masses and the three-tier kubbaberg style of flow, but due to the fine-grained, often glassy nature of the rocks little could be deduced of their composition and origin.

The sub-aerial lavas were dominently olivine bearing tholeiite, frequently porphyritic ($>$10% phenocrysts). This type constitutes the Hof basalts, their north-west extension in Grof Gorge and those opposite Godafjall. They also form the 'capping' uppermost lavas seen on Strintur, S. W. Hofsfjall, Slaga and Storhofdhi and the Gljufursa plateau. These latter flows though petrologically similar, appear to develop larger phenocrysts, especially olivine and pyroxene and to be coarser grained than the Hof basalt type. In the field they form thicker flows, are a lighter grey and fall at a younger strati-graphical horizon.

The olivine tholeiites always contain three distinct phenocrysts of plagioclase (bytownite), titanaugite and olivine commonly developed in the ratio 60%, 30% and 10% respectively. The phenocrysts of plagioclase are generally An_{70-80}. Some are zoned with An_{50} the minimum recorded value of normally zoned crystals. The pyroxene is augite, often titanaugite. In one flow from Gljufursa hypersthene is found as quite abundent phenocrysts along with augite and olivine. Olivine forms large idiomorphic crystals of general composition Fo_{70-80}. The groundmass is of labradorite, augite, magnetite, ilmenite and subsidiary olivine.

The later 'capping' flows are in general much coarser and thicker than the Hof basalts and we can assume here that some lavas were partly crystalline on eruption, and this would lead to increasing viscosity and hence thickness of flow at Fagurholsmyri which although not strictly a 'capping' flow it is abnormally coarse (doleritic) and extremely thick. Its high viscosity on eruption was probably due to a crystal content of about 35%. The Fagurholsmyri lava in thin-section shows very interesting textural variations from fine to coarse away from the phenocrysts indicating that the liquidous phase may have been chilled against the crystals or that it was enriched in water and volatiles at crystallisation.

Distinct from these lavas, stratigraphically at least, are the basal basalts at the entrance of Slaga valley. These are dark, non-porphyritic and quite coarsely crystalline and look quite similar to some non-porphyritic dyke rocks of the olivine tholeiites. The rock is a very mafic-rock basalt containing 40% titanaugite and has an S. G. of 3.0. The plagioclase is of composition An_{65-75} and olivine crystals are present. Magnetite grains are large and abundant and some of the pyroxene has been altered to green amphibole.

In the upper sections of the Godafjall valley fine-grained intermediate flows occur. They are dark-grey, non-porphyritic rocks commonly showing flow-bonding. Small phenocrysts in thin section show labradorite of composition An_{55}. These are set in a micro-crystalline groundmass of plagioclase (often skeletal) and pyroxene. Interstitial magnetite occurs. These rocks are of andesite composition and best termed Icelandites (Carmichel 1964). These lavas are found scattered on the higher parts of the plateau north-west of Hofsfjall.

The foregoing descriptions are obviously generalised to a certain extent and probably intermediate types exist. There is certainly a very wide range of texture and phenocryst content. However, it is clearly evident that there are two main magma types present: the porphyritic olivine tholeiite type and the rhyolite. Rocks of intermediate composition, the Icelandites, are of minor volume, though their presence is significant as a possible hybrid. This situation reflects the general situation in Iceland of a bimodal compositional distribution of the volcanics and again poses the problem of the genesis of the Icelandic rocks.

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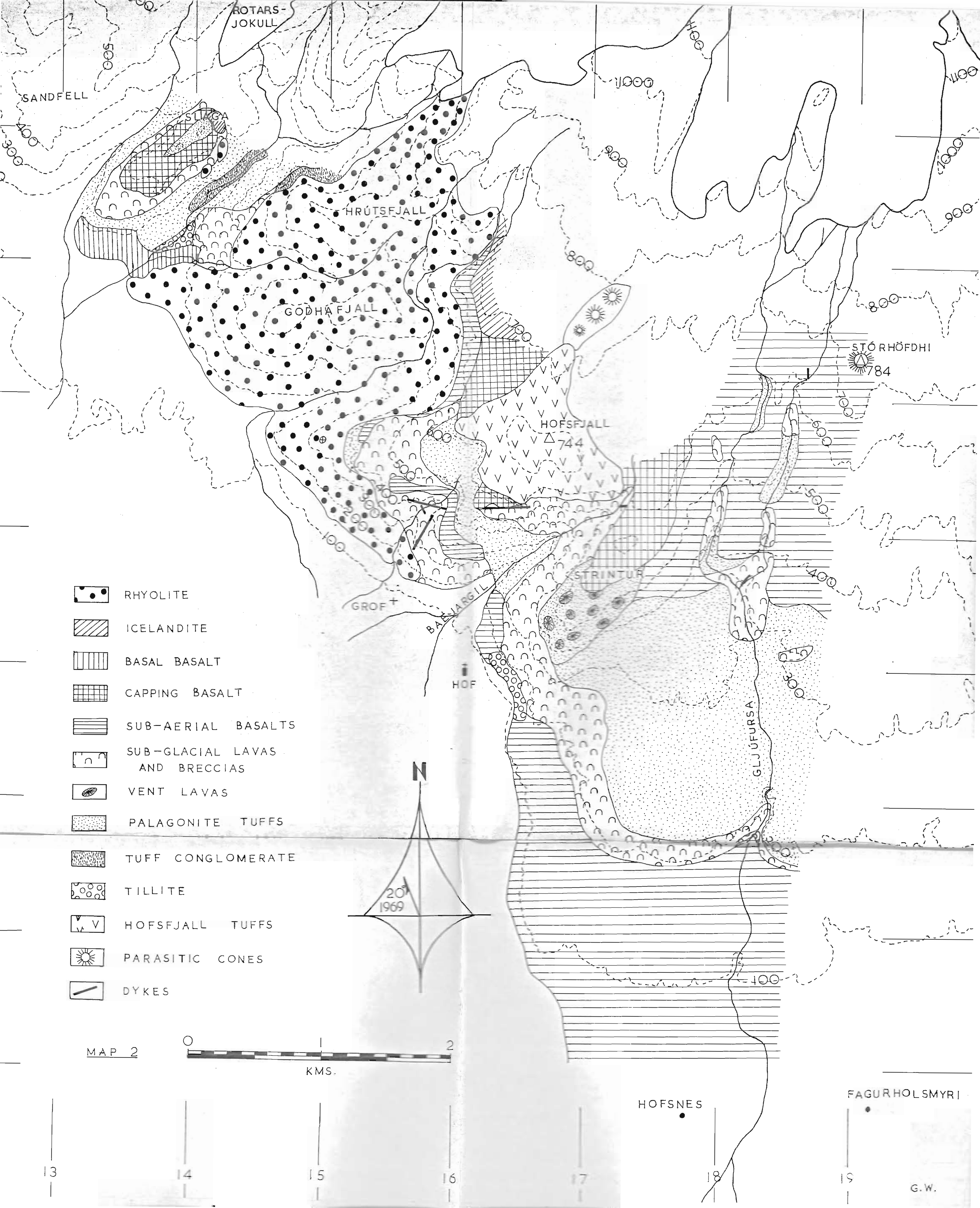
ROTARS-
JOKULL
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744
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784
STRINTUR
GROF
BAEJARGIL
HOF
GLJUFURSA
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FAGURHOLSMYRI
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ICELANDITE
BASAL BASALT
CAPPING BASALT
SUB-AERIAL BASALTS
SUB-GLACIAL LAVAS
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