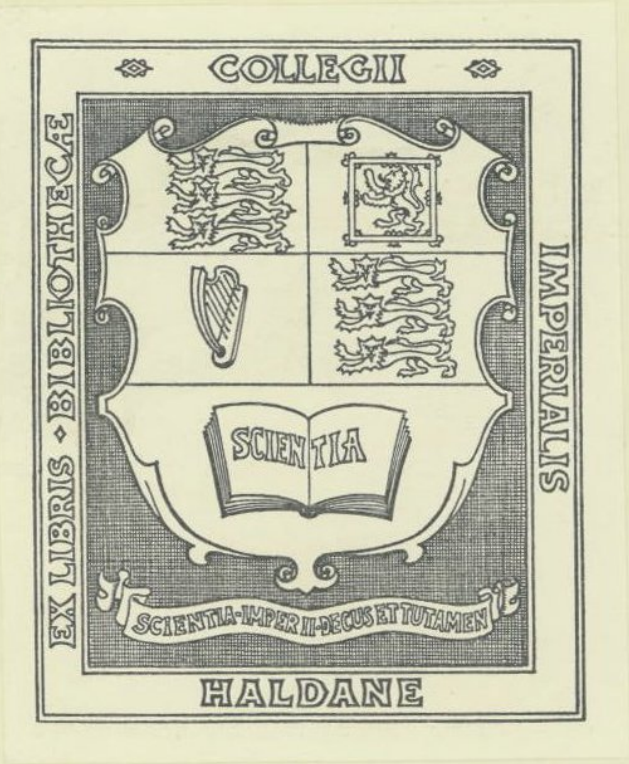
IMPERIAL COLLEGE

OF SCIENCE & TECHNOLOGY

ICELAND

1956

THE EXPLORATION BOARD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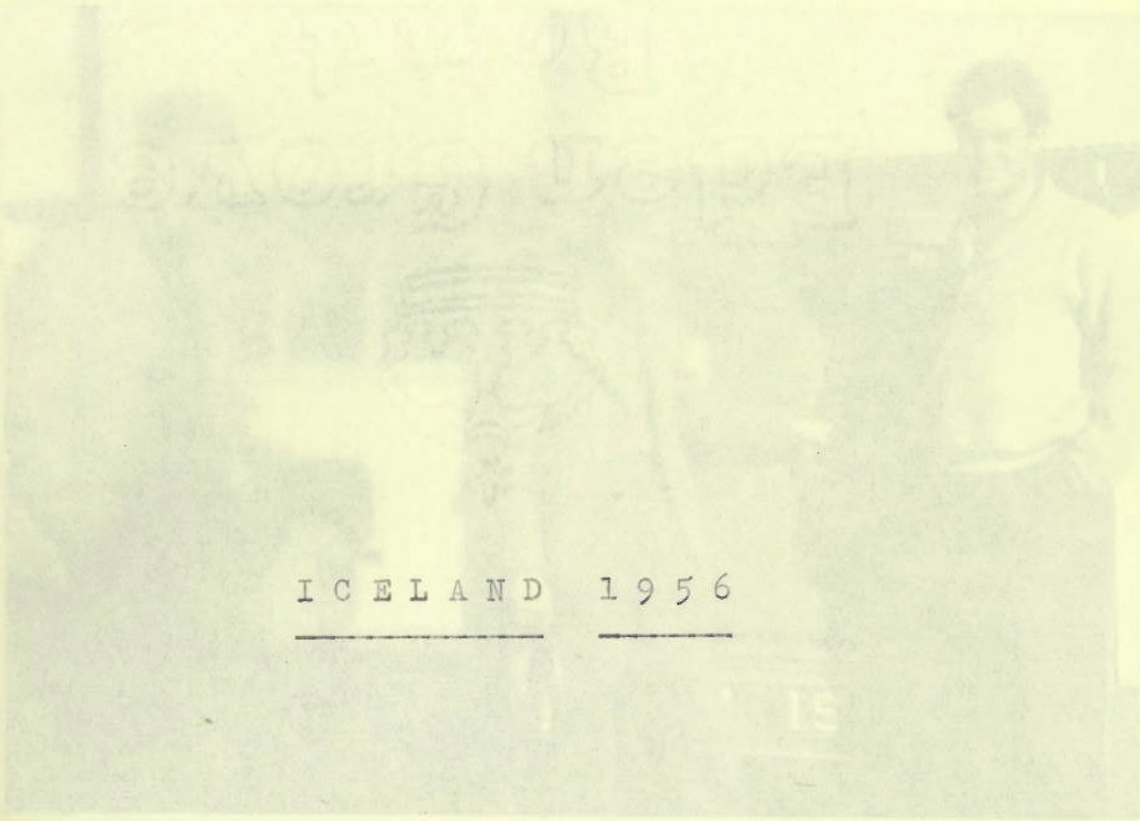

I C E L A N D 1 9 5 6

Members :

P. Ibbotson - 2nd Year, Geology

M.D.McQueen - 2nd Year, Geology

Frontispiece. (Left to right) Peter Ibbotson, Malcolm McQueen and Ian Carmichael, in Iceland, with car PZ.19.

A C K N O W L E D G M E N T S

We should like to record our gratitude to :-

The ICELANDIC FARMERS, for their hospitality and friendliness.

DR. THORBJORN SIGURGEIRSSON, for help in E. Iceland.

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The IMPERIAL COLLEGE EXPLORATION BOARD, for their financial help and advice in the compilation of this report.

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PART I.

THE EXPEDITION

1. OBJECTS OF THE EXPEDITION.

As the two members were 2nd Year Geologists the objects of this expedition were primarily of a geological nature. The first object was to see as much of the geology of Iceland as possible and, in particular, that of the newer volcanic areas. The second was to apply the experience gained to the study of a particular area on the south coast of Reydarfjordur in the eastern Tertiary volcanic area.

2. ACCOUNT OF THE EXPEDITION.

a. Timetable of Journey.

We left Leith harbour in the M.V.Gullfoss on 2nd July and arrived in Reykjavik, the capital city of Iceland, on 5th July.

1st Camp	Hveradalir	5th -6th July
2nd "	Hekla	6th -7th "
3rd "	Solheima	8th -9th "
4th "	Thingvellir	10th-11th "
5th "	Reykjavik	12th-13th "
6th "	Akureyri	14th "
7th "	Myvatn	15th-16th-17th "
8th "	Asbyrgi	17th July
9th "	Raufarhöfn	18th "
10th "	Desert between Jokullsa-a-Fjollum and Jokullsa-a-Bru	19th July
11th "	Reydarfjordur, nr. Therunes Farm	20th July-17th Aug.
12th "	Faskrudsfjordur, nr. Hofduhus Farm	17th-22nd Aug.
13th "	Reydarfjordur, nr. Berunes Farm	22nd-24th Aug.
14th "	Thingmuli	24th-28th Aug.

Camp site, Hveradalir.

We left Thingmuli on the 28th August and flew to Reykjavik, where arrangements were made for us by the Skjaldbreid Hotel to stay in a private house.

We left Reykjavik, on the Gullfoss, on the 1st September and arrived in Leith on the 4th September. We parted company at Edinburgh and the practical field work of the Expedition was considered completed.

b. Journey Out.

The journey to Leith was by car - an Austin Countryman owned by Dr. George Walker, of the Geology Department. This station wagon was taken with us to Iceland. The Icelandic Steamship Company (Eimskipafjelag) Motor Vessel Gullfoss took the Expedition from Leith to Reykjavik. This is a small vessel of 3,500 tons and is the only regular passenger boat sailing from Great Britain to Iceland. It runs a fortnightly service in the summer months. We travelled out second class in a four-berth cabin, which was most comfortable. The cuisine on board was mainly Scandinavian and of very good quality.

On arrival in Iceland there were few customs formalities, though an Immigration Officer asked "How long are you staying ?" "Where are you going ?" "What are you going to do ?" The Chief Customs Officer was kind enough to allow us to keep our luggage in the customs shed while the car was being unloaded.

c. The First Fortnight.

The Gullfoss reached Reykjavik early on 5th July and disembarkation started about 10 a.m. By the time all the luggage and the van had been unloaded, and customs and other formalities attended to, it was lunch-time, and so before setting out for the interior we had lunch. The most experienced of the party said that Skyr - an Icelandic dish - made a good meal. It must be regretted and duly noted that Skyr had a very mixed reception !

After lunch and a little shopping we set off on the road to the south-west. Our destination was Hekla - a volcano which erupts periodically and which last did so in 1947. We drove over a weird and barren landscape of lava flows and lava fields, which we later came to expect and understand as being typical of Iceland. It was along this road that we saw curious mounds of lava and cinder, which were identified as Hornitos.

A little further on we saw our first unpretentious little hot-spring. That night we camped by the road-side.

The following day, we continued on the journey to Hekla across ash, the day being distinguished only by two things :-

1. We missed the recommended route to Hekla, which delayed us by several hours.

2. When we did find the road, it proved unsuitable for anything but a lorry and in consequence of this we witnessed a fight between a stone in the road and the drainage plug of the petrol tank of the van. The stone won, and the plug was ripped off. A repair was effected at a nearby farm. We selected a different route and camped ten miles from the foot of Hekla.

Early next morning we began the ascent by crossing a very cold stream and then climbing over the foot of the lava flows. The going was very hard and after several hours climbing we had only reached a ridge 1,100 feet high. Hekla was still four miles away, and 3,000 feet more up to the summit, and so, reluctantly, we gave up the attempt.

Sunday, July 8th, saw us on our way to one of the Ice-Caps - Myrdalsjokuk in the south. It took us a day to get there and then we spent a day climbing up on to the Cap and looking at Solheimajökull - a very good example of a valley glacier. Then we turned back westwards to see the great Glacial Gorge below the waterfall at Gullfoss and across to Geysir 'The Home of Hot Springs.' Great Geysir - being somewhat old - only erupts now when 1 cwt. of soap is applied down the vent. This calamity was unforeseen and as the Expedition was not in the habit of carrying this amount of soap with it Great Geysir remained peaceful. (Is this 'stop work' attitude of Geysir's, we wonder, the result of nationalisation ?) However, the smaller geysirs gave an excellent display.

On we travelled to Thingvellir - the site of the original Icelandic Parliament - a small area by a lake, which afforded many features typical of Icelandic geology. Here we saw several shield volcanoes, fissure eruptions, gjas and tumuli. (The significance of these will be discussed in a later section.)

Approaching Hekla.

Front of the 1947 flow from Hekla. Two lobes of the flow almost meet on the downstream side of the hill.

Front of the 1947 lava flow from Hekla, showing extreme roughness of surface.

The waterfall Skogafoss in southern Iceland.

Camp near Solheimajokull.

Solheimajokull, here nearly a mile wide.

Edge of Solheimajokull.

Explosion crater, Kerid near Selfoss in S.W. Iceland.

Hot spring at Geysir.

After spending a day at Thingvellir, we took the road west to Reykjavik, and camped, in pouring rain, just outside the capital. Friday, the 13th, was spent in Reykjavik shopping and then we set out along the road that leads to the north, and finally to the east, of Iceland.

After two days' journey, we arrived at Akureyri, the northern capital. This town is, by Icelandic standards, very large, but by English standards, only a village. It is a fishing port and a transport centre, since the only road between east and west passes through it. We camped by a lake a few kilometres beyond the town and the following day moved on to Myvatn. This is one of Iceland's most famous beauty spots and full, also, of geological phenomena - cinder craters, gjas, fissure eruptions, lava tubes and Dimmuborgir - a rift in the lava, the significance of which is not yet fully understood. There are also many hot springs.

We spent two or three days there, looking at these things, and then on Tuesday, July 17th, we left Myvatn and started moving towards the east coast. Later that day, on arrival at the Grimsstadir crossroads, after a fifteen--minute conference, we decided on a change of plans. We decided to go north to the northernmost tip of Iceland, instead of straight on to the east coast. It was late when we camped near a very beautiful spectacular feature called Asbyrgi. This is a very steep-sided valley, nearly a mile across, and is the abandoned channel of an old glacial river. The bottom of the valley is now preserved as a sort of national camping ground and football pitch.

After some investigation round Asbyrgi, the following day we continued north to Kopasker, where we had dinner, and then, after a twenty-mile drive, got out of the car at 10.15 p.m. We walked across the lava fields, to a lighthouse on the northernmost tip of Iceland, where we were just within the Arctic Circle.

Later, we moved to Raufarhöfn, where the herring harvest was going on at 2 a.m. As this was the end of the road, we had to return the way we came. At Dettifoss we stayed a few hours to look at a postglacial fissure eruption, which was cut by a striking gorge 600 feet deep, and at the wonderful display of columnar basalts. We continued south and camped at the edge of the desert, which next day we crossed after a small argument with the van. So it was, that on Friday, July 20th, we arrived at Reydarfjordur - the area of mapping. Before commencing work we paid a short visit to the famous Iceland Spar Mine.

Hornito at Myvatu.

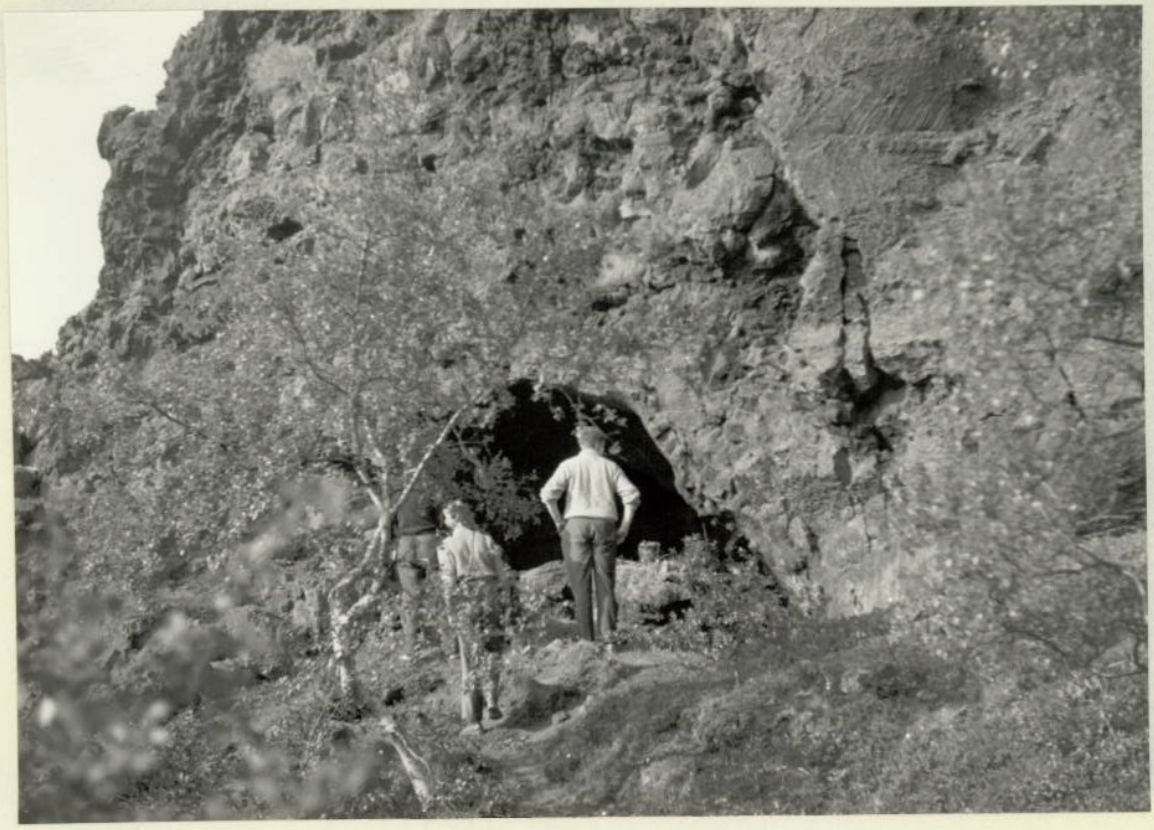
Roof of lava cave, Myvatu.

Camp in lava drainage channel, on the shore of Myvatu.

Myvatu camp.

Packing up, Myvatu camp.

In lava drainage channel leading from Dimmuborgir.



In the collapsed drained-out lava of Dimmuborgir.

Gja (a non-eruptive fissure), near Myvatu.

Pressure ridge on top of lava flow, Myvatu.

Approaching the fumarole field of Nimaskard, Myvatu.

Boiling mud-pot, Manaskard, Myvatu.

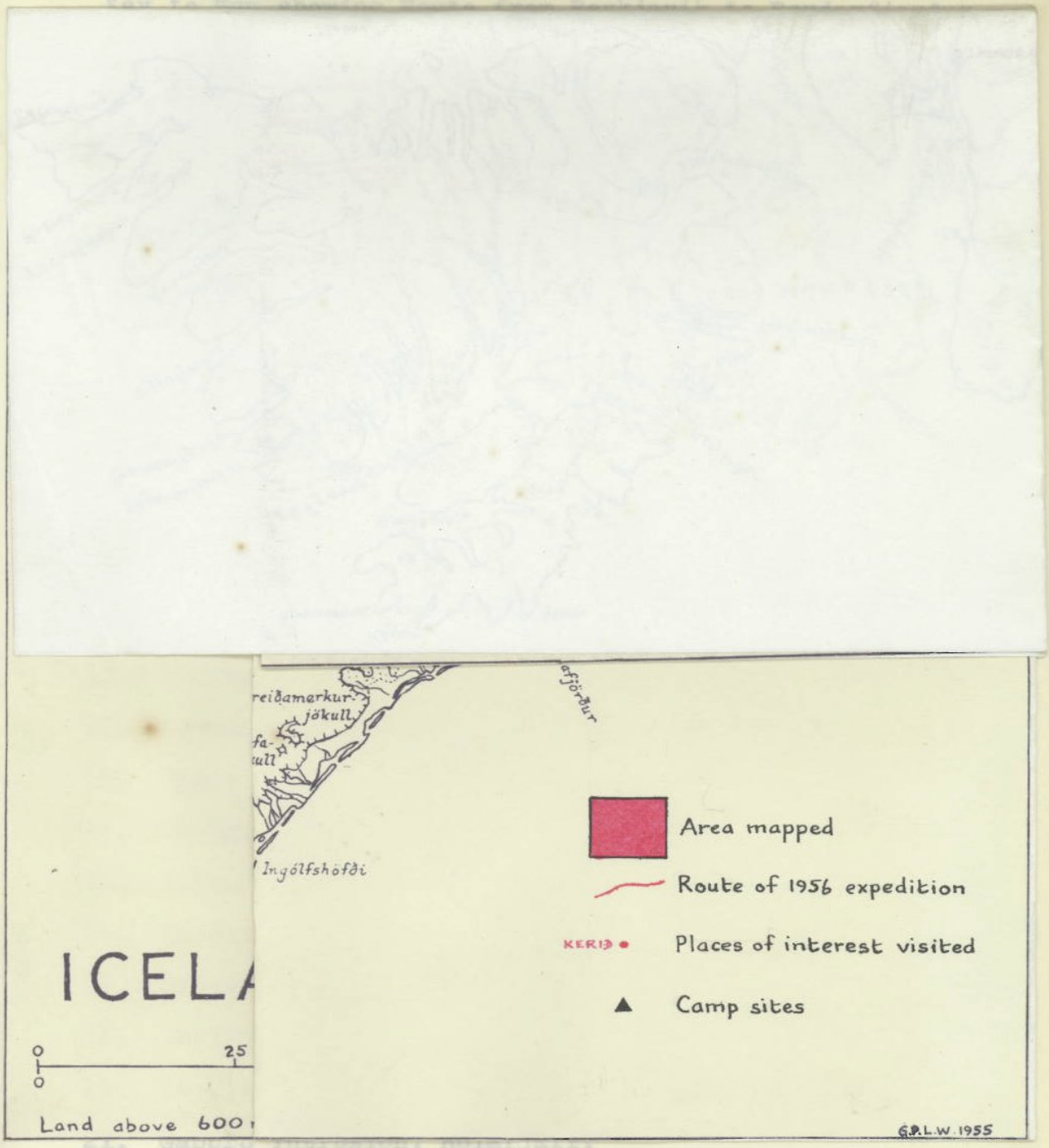
Vertical wall of Asbyrgi.

At Raufarhofn, northernmost town in Iceland.

Cinder cones on postglacial eruptive fissure, near Dettifoss.

Crossing desert E. of Myvatu.

Camp at Modvudalur, near Geldingafjoll ridge.



Map of Iceland showing route of the expedition, camp-sites, points of interest, and the area mapped.


ICELAND
0 25 50 MILES
0 50 100 KM.
Land above 600 m (1970 ft) stippled
Area mapped
Route of 1956 expedition
KERIÐ Places of interest visited
Camp sites
Húnaflói
Breiðifjörður
Faxaflói
Hofsjökull
Langjökull
Vatnajökull
Mýrdalsjökull
Skagafjörður
Eyjafjörður
Skjálfandi
Axarfjörður
Þistilfjörður
Bakkaflói
Vopnafjörður
Héraðsflói
Langanes
Reyðarfjörður
Fáskrúðsfjörður
Berufjörður
Hornafjörður
Hvalfjörður
Borgarfjörður
Hvammsfjörður
Snæfellsnes
Reykjanes
Vestmannaeyjar
Dyrhólaey
Vík
Mýrdalssandur
Skeiðarársandur
Ingólfshöfði
Reykjavík
Hekla
Askja
Mývatn
Snæfell
Jökulsá á Fjöllum
Jökulsá á Brú
Lagarfljót
Blanda
Þjórsá
Hvítá
Þingvallavatn
KÓPASKER
ÁSBYRGI
DETTIFOSS
STORAGJA & 1740 LAVA
NÁMASKARD
DIMMUBORGIR, LUDENT, THRENGLABORGIR
SKUTASTAÐIR
GOÐAFOSS
BAKKI
HÖLAFJALL
KOTAGIL
THINGEYRAR
GELDINGAFJALL
ICELAND SPAR MINE
GRÁBROKKAHRAUN
THYRILL
SKJALDBREIÐUR
GEYSIR
GULLFOSS
THINGVELLIR
HAGAVIKURHRAUN
KERIÐ
HOLMSHRAUN
KOLVIÐARHOLT
HVERAGERÐI
INGÓLFSFJALL
HEKLA
SOLHEIMAJÖKULL

Key to Map showing Route from Reykjavik to Reydarfjordur with Camp Sites and Points of Interest.

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1. Hornitos in Holmshraun.
2. Fumaroles and pillow lavas at Kolvidarholt.
3. Hot Springs and Fumaroles at Hveragerdi.
4. Zeolites in palagonite on Ingjolfsfjall.
5. Selfoss.
6. Hekla with 1947 lava.
7. Seylandsfoss.
8. Skogafoss.
9. Myrdalsjokull and Solheimajokull.
10. Kerid Crater.
11. Gulfoss.
12. Geysir.
13. Hagavikurhraun fissure eruption.
14. Thingvellir lavas and gjas.
15. Skjaldbreidur.
16. Rhyolite, Thyrill.
17. Grassokkahraun lava.
18. Inclined sheets and rhyolite - Thingeyrar.
19. Zeolites in Gulley; Kotagil.
21. Gabbro intrusion, Holafjall.
22. Intrusion at Bakki.

23. Godafoss.

24. Skustustadir crater group.

25. Dimmuborgir.

26. Hverfjall tuff-crater.

27. Ludent andesite and Hraunbunga crater.

28. Threngslaborgir fissure eruption.

29. Storagja and 1740 lava, Reykjahlid.

30. Namarskard fumaroles.

31. Hrafutinnuhryggur Obsidian.

32. Dettifoss with preglacial lavas and fissure eruption.

33. Asbyrgi.

34. Porphyritic basalt. Kopasker.

35. Geldingsfjall fissure.

36. Iceland Spar Mine.

d. The Mapping.

The geological mapping carried out by the Expedition was completed in an area of E. Iceland of 20 - 25 square miles. The area lay on the peninsular separating Reydarfjordur and Faksrudsfjordur, and between the farmsteads of Eyri and Kolmuli on the north side and between Brimnes and Kolfreyjustadur on the south side.

The work was centred on three camp sites, the main one being at Therunes from which the major part of the mapping was carried out. The camp site gave ready access to the large corrie behind it, but mapping to the south and west of this was carried out from two subsidiary camps at Hofduhus and Berunes respectively. At each of these two camps about four days were spent, whilst at Therunes the time was a month.

Exposures, on the whole, are very good, but stream sections, of course, provided the most complete successions. There are several inaccessible cliffs, and some of the mountains can only be ascended from the south side. Coastal exposures are very good. The country is very rugged, with the mountains rising to 3,500 feet.

Large scale topographic maps of the area (e.g. 6 inches - 1 mile) were not obtainable, the largest scale available being approximately 2 inches to 1 mile. This is the 1 : 100,000 map produced by the Danish Survey and this was subsequently found to be incorrect in some of its detail. It was not suitable for mapping and so a map on the scale of 1 : 33,000 based on the published map, but with topography modified from aerial photographs, was obtained from the Air Ministry, London. It was found inadvisable to increase the size of this completed map.

No detailed geological map of the eastern part of Iceland is published, the only available geological map being that by Thoroddsen, 1901, on which the area mapped is shown vaguely as Tertiary Basalts.

The major part of the mapping was done by both writers working together as a team, but certain parts, notably some coast sections, were mapped individually.

PART II.

GEOLOGICAL RESULTS

1. NOTES ON THE GEOLOGY OF ICELAND.

Iceland is a completely volcanic island situated 500 miles west of Norway, 200 miles east of Greenland, and its northernmost point touches the Arctic Circle. The island is composed predominantly of basaltic lavas erupted from Tertiary times up to the present day.

The two main types of eruptions are the fissure type and the central shield volcano type. Sub-aerial fissure eruptions, such as the Threngslaborgir-Ludentborgir eruption east of Myvatn, show rows of spatter cones along the line of the fissure. Sub-glacial fissure eruptions give rise to palagorite ridges. Palagorite is a hydrated basaltic gel. There are several central shield volcanoes in Iceland, the classic example being Skjaldbreid, which is north of Thingvellir. The glacial equivalents of central eruptions are the flat-topped, steep-sided, table mountains, of which Herdubreid is an example.

There are numerous non-eruptive fissures, called gjas. The most famous of these is the Almannagja at Thingvellir, which is two kilometres long.

Iceland shows many classic features, apart from those already mentioned. The most famous of all is Geysir. Geysir (from which all other geysers are named) is situated in an area of intense thermal and fumarole activity in Hankdalur. Myvatn is the classic area exhibiting the greatest variety of volcanic features. Here is situated the Threngslaborgir-Ludentborgir fissure eruption, Hverfjall and Lident, which are two tephra cones each of the order of 1 kilometre in diameter and with rims about 150 metres high.

Skustustadir, south of Myvatn, is a group of explosion cones on the Laxahraun, the lava flow from the Threngslaborgir fissure. The Laxahraun also shows the remnants of what is believed to have been a lava lake called Dimmuborgir. Dimmuborgir means "the dark castles." It is a weird place, because the lava has assumed many queer forms, which the guide books describe as "congealed pandemonium."

2. SUMMARY OF GEOLOGY OF REYDARFJORDUR AREA.

This area is essentially one of Tertiary Lavas, basic in composition and with a constant dip of 6° - 8° in a south west direction. Into these basalts have been intruded four rhyolitic flows. Minor intrusions, such as dykes and sills and sheets, are also present in great abundance.

The lava flows, though, do not constitute the whole of the story, since there must have been long periods between extrusion of flows, when no volcanic activity was taking place. Thus, we find between the flows other beds such as tuffs, ash--bands and agglomerates. Sometimes these contain abundant fossil plants. These constitute up to nine-tenths Geological Time, but are often poorly exposed.

The lavas are often of massive structure, though some do show poor jointing, but two flows in particular show columnar jointing. One of these is situated on the summit of Baesgli and the other is on the side of Randafell. The tops of the flows fall into two forms :-

(i) Brecciated Top - where the top is broken up and often discoloured red.

(ii) Vesicular Top - formed by the escape of gases during cooling. The vesicles are now often infilled by agate, platy calcite, quartz and zeolites.

Xenoliths are often included in flows :

A series of successions given, shows the stratigraphy of the area.

Two small faults are seen in the area. The first of these is a relatively insignificant fault cutting through sections of the Eyrira. It has a trend of about 310° and hades steeply to the north west. The other fault occurs in the Heljasa on the north side of Faskrudsfjordur. This is associated with a 10 ft. wide quartz zone and fault breccia. The displacement of the fault is unknown, but the rocks on the downthrow side appear to have been dragged up.

The basalts have been said to be Tertiary or Quaternary in age, but the only way of dating them is seemingly on palaeontological grounds. The included fossils in these rocks are, however, all floral, and Palaeontologists will go no further than to say that the rocks are post-Mesozoic in age. Geomagnetic and radioactivity methods may, in the future, have some bearing on the subject.

In this area of Iceland. no economic minerals were found. The only mineral so far mined in eastern Iceland has been Iceland Spar, which was found in basalt on the north side of Reydarfjordur. However other minerals are found in cavities and vesicles in the rocks:-

(i). Calcite - Platy calcite was found to be very common south of Reydarfjordur. It is possible that platy calcite is distributed in an aureole round a rhyolite intrusion, but evidence for this is very slight.

(ii). Agate - A few vesicles were found to contain agates, but the beaches in the area contained many of them.

(iii). Quartz and chalcedony - These are rarely found in vesicles, although the Heljasa fault contains an 8-ft. wide quartz vein. Chalcedony is rare.

(iv). Jasper - Red jasper is common, particularly, it seems, in connection with rhyolite flows.

(v). Zeolites - In Iceland are some of the type localities for minerals of the zeolite group. There are common infillings in vesicular tops of olivine-basalt flows where they often occur in association with calcite. Celadonite and chlorophaeite are also found.

Raised beaches and deltas and lagoons in the area indicate a rising land surface (or falling sea level), and there is also a well-marked summit level peneplain at approximately 3,000 feet.

The main geomorphological action has been that of glaciation. Morainic deposits and stone polygons are well developed, although these latter may be due to present-day frost action. Roches moutonées and ice-striated outcrops give a good idea of the movement of the ice. This must have been in a S.E. direction along both the north and south sides of the fjord. Small valley and corrie glaciers can also be recognised, with morainic deposits.

It seems obvious, therefore, that in this particular area topography has been influenced by three factors : geology, uplift and glaciation. This has produced a very rugged relief, noted for its step-like appearance (due to successive flows of basalt) and to the numerous waterfalls due to streams tumbling over them.

Intrusions.

The following intrusions have been noted in the area mapped :-

(a). Ljosafjall

This intrusion lies below the mountain Nontindur, south of Thernunes. In shape it is a large rectangular body, half a mile square. There is no direct evidence that this is, in fact, an intrusion, due to masking of the contacts by screes. The west end of the body has the characteristics of a typical intrusion, but towards the eastern end the rhyolite takes on a flow structure.

(b). Breiddalsa.

This intrusion, of hourglass shape, is situated in the corrie S.W. of Sodulhnjukur. It contains a lens of olivine-basalt. The margin of the intrusion is, in places, well exposed, and is chilled and finer in grain than the rest of the rock. This intrusion differs from the others in that it does not stand up above the surrounding country, but lies flush with the corrie sides.

(c). Hrafnarkambur.

This intrusion has an elongated outcrop and is about half a mile long and a quarter of a mile wide. Its longest axis is N.N.E.-S.S.W. and it outcrops one mile north-west of Thernunes. Here, once again, the contact is obscured by scree slopes, and flow-banding is extremely well developed. This intrusion, with the one that follows, has been responsible for dragging up the basalts to the north.

(d). Raudafjall.

Circular in plan, this intrusion lies half a

Tertiary basalt scenery, Reydarfjordur.

Ljosarfjoll, showing Tertiary basalts resting on rhyolite.

Ljosarfjoll, showing Tertiary basalts and rhyolite underneath.

Rhyolite intrusion in Breiddalur.

west of Hrafnakambar, but once again the contacts are obscured by scree. The porphyritic basalt lavas which are seen to have been uplifted by the Hrafnakambar intrusion, is seen here 'plastered' on the side of the Raudafjall intrusion. Beneath it lies an exposure of pitchstone.

(e). Berunes.

This intrusion, seen as scattered outcrops on the coast near Berunes, is of very speculative nature, but field evidence suggests that it is a large sill of rhyolitic composition.

(f). The dyke swarm.

Everywhere is a dyke swarm, which has been measured over four known distances, giving a dyke percentage stretch of 5.5. The largest dyke seen is 140 ft. wide, of porphyritic basalt.

Many sills and sheets are seen in the area, and many of them are of porphyritic basalt. Most important are the acid sheets, some of which may be cone-sheets, and certainly 50 % of those mapped are tangential to the Breiddalsa intrusion

3. SUMMARY OF PETROGRAPHY.

In the area there are four main types of rock : olivine-basalt, porphyritic basalt, tholeiite and rhyolite. Of these, two were studied in detail by each author with the aid of the petrographic microscope. A summary of the characteristics of the four types follows.

Other rock-types found included both basic and acid agglomerates, and andesites. These were present only to a minor extent.

About forty-five specimens were brought back, and a list of these is appended.

(i) Olivine Basalt.

The most important Olivine Basalts in the area are those forming the mountain peaks. A specimen representative of that series is described here :

P 16 - Sodulhnjukur -

In hand specimen this is rather a coarse dark grey rock with large greenish glassy areas of feldspar. Patches of a yellow amorphous mineral are seen. These are all in a fine grained groundmass. The rock is rather brittle.

In thin section large porphyritic feldspars are seen. They are albite twinned-zoned idiomorphic crystals of Plagioclase. They are up to $1\frac{1}{2}$ mm. in size and have the composition of labradorite. There are also a few crystals of angite.

The fine grained groundmass is made up mainly of lath shaped crystals of plagioclase (andesine) with a few small pyroxene crystals. Also present in the groundmass is some olivine, much of which is now altered to red-brown iddingsite - a small amount of which occurs at the edge of the olivine crystal, but in many cases the olivines are completely pseudomorphed. Iron ores are also present as small skeletal crystals.

This summarized rock description is typical of many of the Olivine Basalt, except that some of them tend to become more doleritic in texture.

(ii) Rhyolites.

A study, from a mineralogical and textural point of view, of the rhyolites indicates that they are nearly all identical. They all, almost without exception, contain complex twinned porphyritic plagioclase, which is often zoned. Ferromagnesian minerals are present in very small proportions. They are all extremely acidic, many having free quartz grains.

It seems perfectly clear that these rhyolites, many of which are intensive, must all be connected with the same period of volcanic activity.

Flow banding in the rhyolites is extremely well-developed and frequently forms large overfold structures. The similarity of the rhyolites has been noted from intrusions along the length of the east coast and it has, in fact, been suggested that they all belong to the same period of volcanicity.

The pitchstone near Raudafell shows very fine perlitic structure and contains clusters of oligoclase, with some hedenbergite, fayalite and iron ore.

(iii) Porphyritic Basalts.

Porphyritic Basalts occur as dykes and flows. The feldspar phenocrysts are Bytownite with from 70 % - 80% Anorthite. The groundmass contains pyroxene, plagioclase - which is richer in Albrite than the phenocrysts - iron ore, some 1% - 2% Apatite and some-times a little glass dusted with iron ore granules.

(iv) Tholeiites.

The Tholeiites are basalts which are distinguished from Olivine Basalts by the absence of olivine. They are extremely fine-grained rocks with pyroxene, plagioclase feldspar (Bytownite), ore and glass. The pyroxene seems to be of two types - pigeonite ($2V = 12^{\circ} - 15^{\circ}$) and augite ($2V = 35^{\circ} - 50^{\circ}$).

SPECIMENS

P 1. Tholeiite, C.R. North of Therunes.

P 2. Rhyolite dyke cutting P 5.

P 3. P.B. 12" sill, seaward end of Landamotsa.

P 4. Altered P.B., same location.

P 5. Intrusive Rhyolite, same location.

P 6. Tholeiite, C.R. north of Therunes 1 mile.

P 7. Tholeiite, Landamotsa ¼ mile from sea.

P 8. Breiddalsa Rhyolite Intrusion.

P 9. Banded Tholeiite, coast between Therunes and Hafranes.

P 10. Breiddalsa Rhyolite Intrusion.

P 11. Therunes P.B. by bridge.

P 12. Agglomerate, ¼ mile above confluence of main streams in Corrie.

P 13. Therunes P.B. on coast.

P 14. Tholeiite, ½ mile S.W. of Therunes.

P 15. Tholeiite, Gulley below Sodulhnjukur.

P 16. O.B. Sodulhnjukur.

P 17. Tholeiite, confluence of main streams in Corrie.

P 18. O.B. dyke, ½ mile N.E. of Therunes.

P 19. O.B. dyke just west of Hafranes.

P 20. Rhyolite, Breiddalsa ¼ mile from sea.

P 21. Intrusive P.B., Ridge ¾ mile N.E. of Ornolfsfjall.

P 22. Andesite sill, ¼ mile N. of Ornolfsfjall.

P 23. Sand or Ash, road between Therunes and Berunes.

P 24. Tholeiite and Sulphide, where Berunesa enters sea (2).

P 25. Tholeiite and Sulphide, where Berunesa enters sea.

P 26. Basalt and Zeolites, coast one mile E. of Berunes.

P 27. P.B., road ¾ mile E. of Berunes.

P 28. PVERFELL. P.B. over Tuff.

P 29. " Tuff.

P 30. " Sediment from Lignite Bed.

P 31. " Lignite.

P 32. Acid Sheet, Landamotsa ½ mile from sea.

P 33. Acid Intrusion, confluence of Storadalsa and Berunesa.

P 34. Pitchstone, foot of Raudafell.

P 35a. Rhyolite, ½ mile N.W. of Muli.

P 35b. Acid Sheet, ½ mile N. of N. end of Hrafnakambar.

P 36. Pitchy Rhyolite, ⅛ mile upstream from P 35b.

P 37. Columnar P.B., Raudafell Intrusion.

P 38. Rhyolite dyke in upper reaches of Landamotsa.

P 39a. P.B. Kolmuli Ridge.

P 39b. Tholeiite half-way up Hafranesfell.

P 40a. P.B. east of Kolmuli.

P 40b. P.B. below summit of Hafranesfell.

P 41a. 140 ft. P.B. dyke.

P 41b. P.B. Kolfreyjustadur.

P 42. Rhyolite ½ mile due west of Muli.

P 43. O.B., confluence of Storadalsa and Berunesa.

P 44. O.B. ½ mile North of Berunes Nontindur.

P 45. Glass on Flows, Hafranesfell.

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Peter Ibbotson (standing left) and Malcolm McQueen (standing right) with Ian Carmichael at Thingmuli at the finish of the expedition.

APPENDICES

A. FOOD taken to Iceland.

Tinned Meat	15 (12 oz.) tins
Cheese	7 lbs.
Powdered Soups	30 packets
Jam	14 lbs.
Marmalade	7 lbs.
Honey	7 lbs.
Horlicks (tablets	6 doz. tins tablets
and powder)	1 doz. 1 lb. tins.
Tea	½ lb.
Coffee (Nescafé)	2 (4 oz.) tins
Chocolate	6 doz. 8 oz. bars
Mint Cake	50 bars
Tinned Fruit	4 (1 lb. 14 oz.) tins
Dried Vegetables	8 packets

B. CAMPING AND FIELD EQUIPMENT.

Black's Arctic Guinea tent with flysheet.
Sea-esta air beds.
Black's Pal-o'-mine sleeping bags.
Primus Stove.
Canteen of Cooking Utensils.
Laurie's boots with Tricounies and heel plates.
Black's Anaraks.
Geological hammers.
Prismatic compasses.

C. NOTES ON THE EQUIPMENT.

The tent was good, though on the small side for two untidy people. We had to be reasonably tidy in a tent of this size. The flysheet was essential as some of our gear was kept under it, for there was not enough room in the tent.

Air beds were very good - one was accidentally punctured, so a tube of rubber cement is an essential accessory.

Sleeping bags were warm when care was taken to close up the strings around the top.

Primus stove - must be taken care of. We pricked it and the wire of the pricker broke in the nozzle, which caused words as hot as the uneven flame that was produced.

We cannot blame our cooking utensils for the cooking.

Laurie's boots, properly nailed, are, we consider, essential for geological work. They should be broken in beforehand to avoid blisters.

D. LOCAL CONDITIONS.

Iceland is extremely hospitable towards the tourist or traveller, and below are enumerated some of the aspects of Icelandic life to be considered before going there :

(i) Climate.

Enough has been said about the climate of Iceland to deter even the hardiest of men, but experience shows that it has been grossly exaggerated. The summer days are long (it does not get dark in June or July) and when the sun is shining the days are very warm. The island sometimes has a wet summer, but it is a useful generalisation that if it is dry in the east, it is wet in the west, and vice versa. During a two-week tour of the island and six weeks stay in the east, we had only five wet days.

But even in summer, when the days have a pleasant warmth about them, the nights have been known to be bitterly cold. Therefore, for those who would camp, a warm sleeping bag is absolutely essential. Mists, which are very dense and cold, are common. We experienced a mist down to sea level which persisted for three days, during which time it was impossible to work on the mountains.

As winter approaches the days become shorter and snow begins to creep down the mountains. We first saw it at the end of July and by the beginning of September it had crept down to 2,000 feet. This is a sign for tourists to get away before the roads become impassable. Often in winter, farms are isolated for weeks, and certainly winter there is not the time for geological work.

(ii) Roads.

Roads are very bad in Iceland. They are unmetalled and made usually of volcanic ash and rock débris. In some parts the tyre marks of a Jeep crossing the desert are the only indication of a road. In Reykjavik the roads are metalled, but beware, it is a maze of one-way streets. An Icelandic map may show quite a network of roads, but on close scrutiny 50% of these may turn out to be no more than a bridle-path.

There is no road through the centre of the island and no complete road joining the east and west along the south coast. The only east-west road is around the north, passing through Akureyri, and often this is no more than a farm track with almost impossible zig-zags rising to 2,000 feet. The type of vehicle recommended for use is either a Land Rover or a Jeep.

(iii) Public Transport.

There are three ways of travelling in Iceland :

(a) By Sea - There is a service, not very regular or reliable, which links Reykjavik and other parts of the island. Vessels sail clockwise and anti-clockwise round the island, calling at the main fjords. This no doubt provides good views of inaccessible parts of the island, but it is rather time-consuming and expensive.

(b) By Air - There is a very good air network on the island. It is very quick and as cheap as other means of transport, except when excess baggage is checked. Ours wasn't.

(c) By Bus - Icelandic long-distance buses are very comfortable, but the journeys are rather tedious. To travel from Reykjavik to Egillstaddir takes two days - two stages of twelve hours each.

Due to the exchange rate (45.55 kr. equals £1; 1 kr. equals approximately 5d; 100 aurar equal 1 kr. - which means that 10/- of goods in the U.K. will cost £1 in Iceland) everything is expensive.

The air fare from Egillstaddir to Reykjavik is £10 single and the cost of bus travel between the same two points is £8.10.0d (500 miles). The sea fare is about £3.10.0d, but on top of this food for two days has to be bought on board, and this probably costs £3.

Hitch-hiking about the island is a possibility.

(iv) Cost of Living.

Again due to the exchange rate, food is extremely expensive. A few examples are given :-

Milk - according to where you buy it - 1/3d - 1/9d a litre.
Bread - 1/3d per loaf (white - brown - soda - and rye bread .)
Tomatoes - 4/6d half-a-kilo.
Oranges - about 2/- each (Blueberries may be gathered in August.)
Cereals - 3/- per packet.
Eggs - 5d each.

The cheapest food is fish.

Paraffin for a primus - about 5d for two pints.

Note - There is no scarcity of food, but bread is hard to obtain except in the larger towns; milk can be bought at any farm.

At the cheapest restaurants in Reykjavik, soup, and a half-portion of the fish dish, will cost 8/- to 9/-. Coffee is extra. In the remoter parts of the island, hotel feeding is slightly more expensive.

Coffee and cakes will cost 5/- per person, and drinks, such as the ubiquitous Coco-Cola, will cost 1/3d per bottle in Reykjavik and up to 4/- in the east.

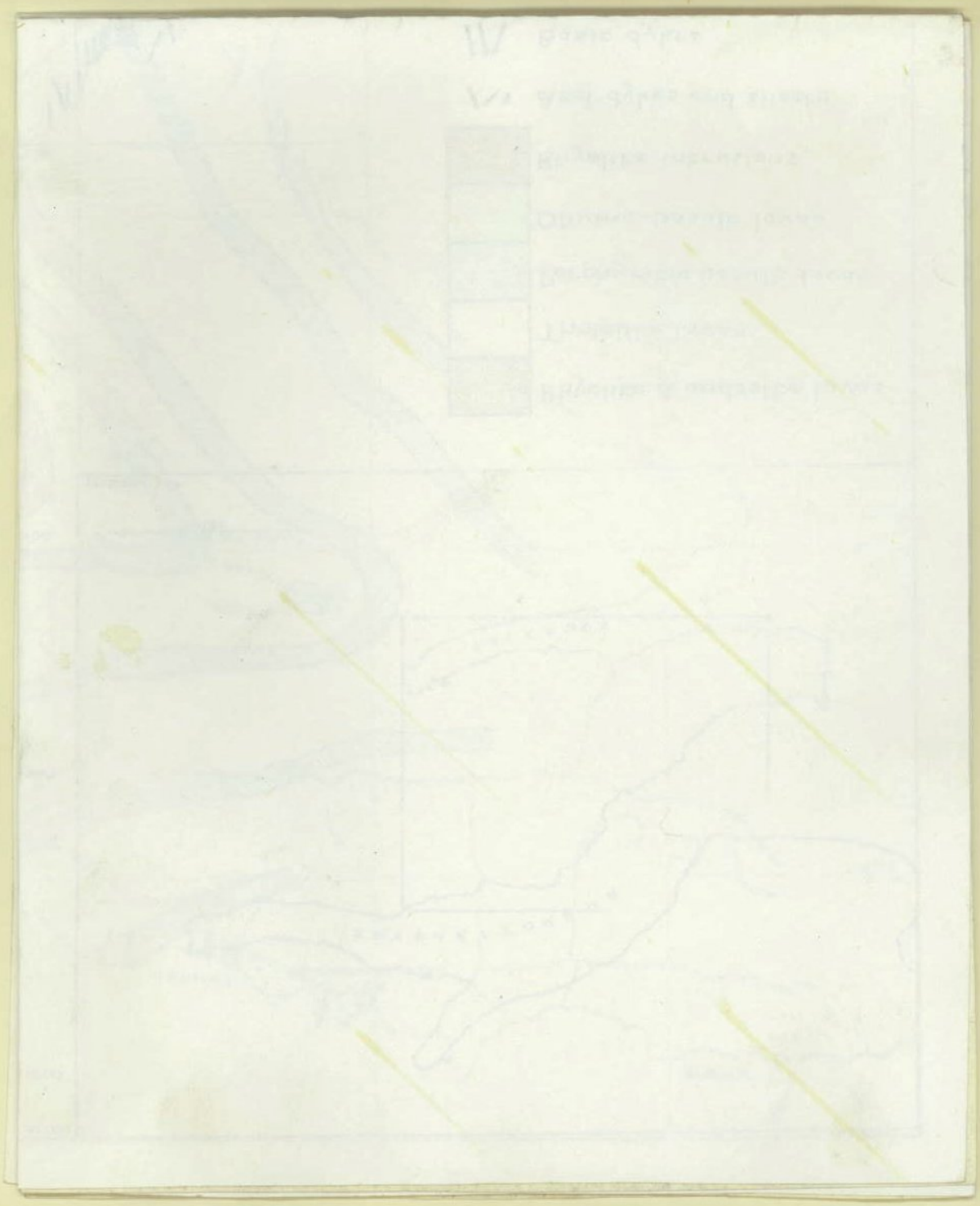
(v) Accommodation.

The Icelandic farmer is extremely hospitable, but is not often in a position to offer accommodation. Camping is by far the cheapest means, but near Reykjavik there are very few good camping sites. In other parts of Iceland, hotels are very few and far between and it is often difficult to obtain accommodation at them. The cheapest accommodation in Reykjavik is in private houses and suitable ones will probably be found for visitors by the Hotel Skaldbreid. A double room provided in a private house, cost £7 for four nights - this did not include food, which has to be bought out.

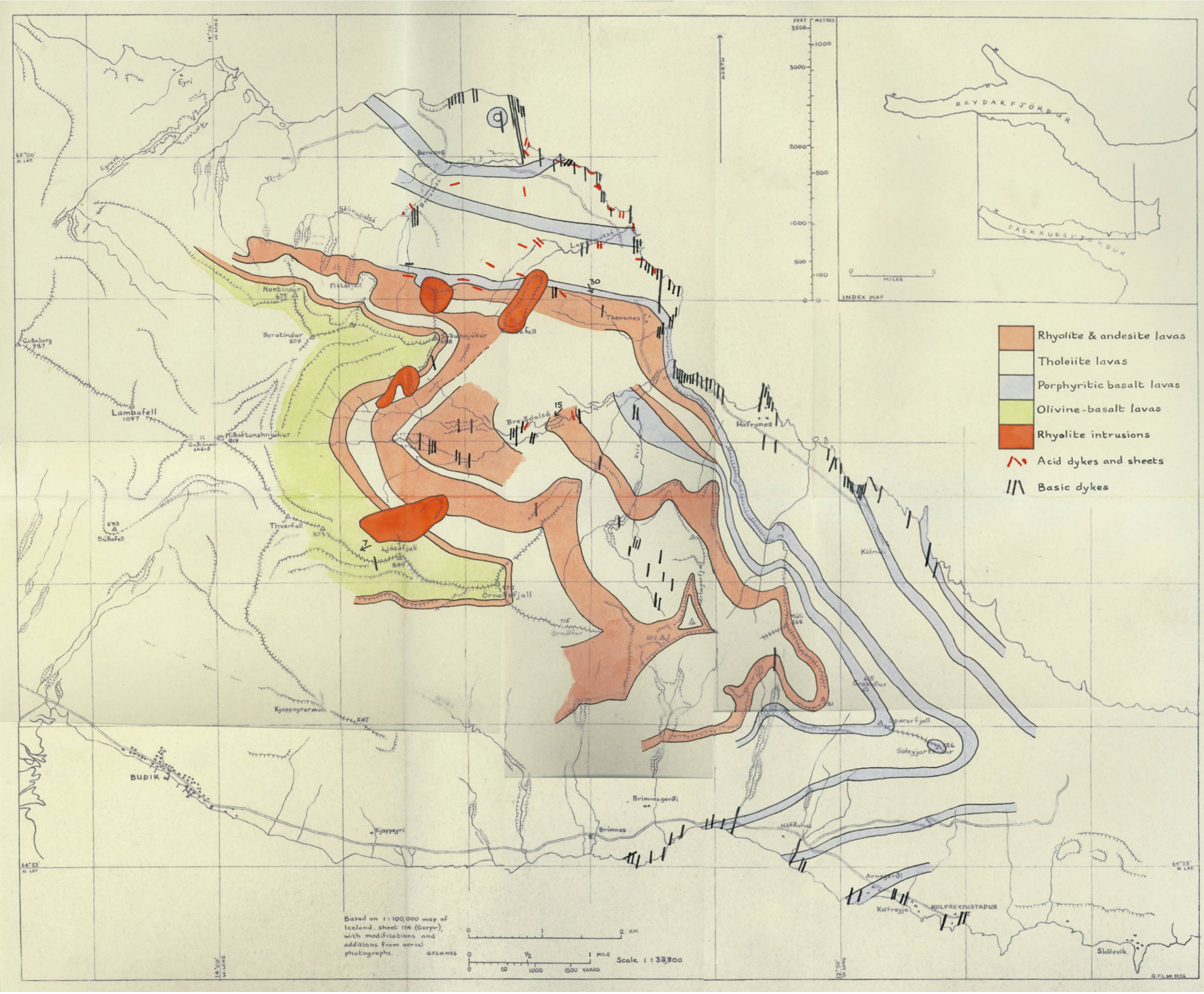
E. FINANCES.

Fares :		
Boat Fares, Leith-Reykjavik return	£50. 0. 0	
Leith - Manchester	2. 0. 0	
Leith - London	3. 3. 0	
Local Bus Fares in Iceland (120 kr.)	2.14. 0	
Air (Egillstaddir-Reykjavik) (950 kr.)	19. 0. 0	
Contribution to car running	30. 0. 0	
	£106.17. 0	£106.17.
Field Equipment :		
Clothing (socks, anarak, rucsac, waterproof)	£19. 0. 0	
Boots	15. 0. 0	
Photographic film	9. 1. 0	
Maps of E.Iceland (38 kr.)	17. 0	
Sundries (cutlery, torch, batteries, candles, paraffin, meta fuel etc.)	3. 0. 0	
	£46.18. 0	£46.18.
C/F		£153.15.

B/F			£153.15. 0
Food :			
(i) Purchased in Britain: (tinned food, mint cake, chocolate, dried soup and vegetables)	£11.14. 8		
(ii) Purchased in Iceland :			
During first two weeks	6.10. 0		
During following six weeks	19.12. 0		
	£37.16. 8	£37.16. 8	
Restaurant and Hotel Accommodation :			
Edinburgh Restaurant meals	£2.15. 0		
Iceland (150 kr.) Hotel accommodation	6.14. 0		
Reykjavik - return journey	7. 0. 0		
	£16. 9. 0	£16. 9. 0	
Total cost for two			£208. 0. 8
Grant from Imperial College Exploration Board			£162. 0. 0



Geological map of part of the country south of Reydarfjordur, eastern Iceland, mapped in 1956.



Rhyolite & andesite lavas
Tholeiite lavas
Porphyritic basalt lavas
Olivine-basalt lavas
Rhyolite intrusions
Acid dykes and sheets
Basic dykes
INDEX MAP
REYDARFJÖRDUR
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Berutindur 809
Gobaberg 987
Lambafell 1097
Thverfell
Búdafell
Ljósafjall
Ornolfsfjall
Theranes
Hafranes
Kolmúli
Kjappeyrarmúli
BUÐIR
Kjappeyri
Brimnes
Brimnesgerði
Arnagerði
Kolfreyja
KOLFREYJUSTADUR
Skálavik
Based on 1:100,000 map of Iceland, sheet 114 (Gerpir), with modifications and additions from aerial photographs.
G.P.L.W. 1956
Scale 1 : 33,300