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GEOLOGICAL REPORT

ON

THE AREA OF SOUTH WESTERN ICELAND

CONTAINING THE PROPOSED DAM SITES

ON THE HVITA, THJORSA AND TUNGNA

RIVERS

BY

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1947

C O N T E N T S.

Geology of the Dam Sites.

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Geological map of the area

Geological Sections	I. Klofaey
	II. Urridafoss
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THE GEOLOGY OF THE DAM SITES.

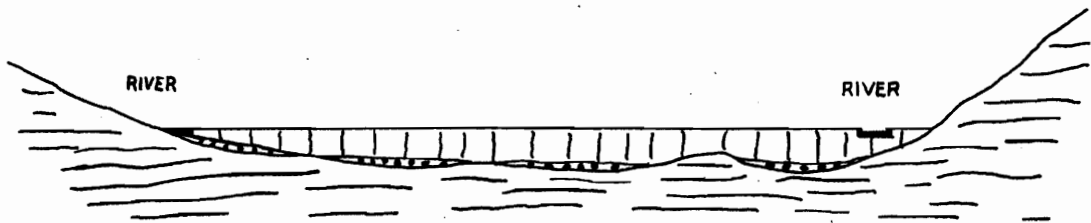
General.

The older rocks of the region consist of an approximately horizontal layered series of basalts and consolidated fragmental deposits which latter vary from fine ashes (tuffs) to coarse deposits of angular basalt fragments (breccias). Some of the basalt layers, known as "pillow lavas" are an agglomeration of tightly fitting rounded masses averaging 3 - 6 feet across. The upper and lower parts of the basalt sheets are commonly crowded with holes (vesicular structure) - the middle part is massive and often shows a rude vertical columnar structure. Some of the fragmental deposits contain scratched boulders and cobbles - these are old glacial moraines.

The topography of the country of these old rocks was an irregular one of hill masses, many steep-sided, with wide stretches of valley lowlands. Then, perhaps several thousands of years ago, a vast outpouring of lava occurred in the Fiskivötn (Veiðivötn) region. This lava descended to the West submerging the valleys and lowlands like a water flood and finally reached the sea. It is known as the Thjorsa lava and is perhaps the most extensive one in the world. The Hekla lavas were poured out after the extrusion of the Thjorsa lava for in many places they can be seen to overlie it.

The Thjorsa lava is present at all the dam sites - in what follows it will be referred to as "the lava". This lava can readily be distinguished from all other rocks at the dam sites. It is light grey, and the distinctive feature is that any piece broken off will show on the fresh surface a sprinkling of white felspar crystals $\frac{1}{2}$ to 1 cm. across. The upper and lower layers are vesicular, the middle layer is massive and often roughly columnar. After the outpouring of this lava the great rivers commonly followed courses along the

boundary of the lava to the slopes of the older rocks, and this is the situation at all the dam sites, save that of Klofaey, so that one end of each dam will abut against the older rocks and the other end against the lava. At Klofaey the river course is wholly in the lava, but not far from its boundary. In generalised section the situation is :-



Older basalts and tuffs



The Thjorsa lava



Loose valley deposits; sands, gravels, peat etc.
(pre lava)

The lava thins towards the boundary. We saw its base in the Urridafoss gorge only, where it is about 15 ft. thick - and this is very close to the original boundary. Away from the boundary it must be much thicker. Beneath the lava loose deposits of the pre-lava valley flow may be expected to occur in places - they are seen in the Urridafoss gorge - but they may be absent. We do not anticipate that such loose deposits are of any considerable thickness at the dam sites - had they been so the fast flowing currents would have cut deeper channels.

Klofaey.

We examined both banks of the river but had no opportunity to land on the island. The banks are of the lava

and we have no doubt that the island is of lava also. Mr. Barrie reported that the river had an even depth of about 3 feet with hard bottom throughout. The whole channel must lie in the lava. The older rock of the western slopes to the lava is compact grey basalt. The line of junction of the lava and the older rocks is obscured by loose blown sands here, but there is probably only a small thickness of loose deposits, if indeed any at all, between the base of the lava and the solid basalt of the old valley floor. Section I gives a general picture of the probable situation here.

It appears that the projected spillway channel to the south would run along the boundary of the lava. Unless lined one would expect considerable seepage through the vesicular lava and through any loose deposits which may be present below the lava. In the section the surface of the lava is depicted as a general flat one, but in detail it is irregular and clinkery with slight depressions. Such depressions may be filled with blown sand. - They are easily seen and their size can be quickly found by digging.

Urridafoss.

The gorge to the east of Thjorsa bridge lies between lava on the north and basalt on the south. Between the bridge and the falls for a short distance both sides of the gorge are of basalt. We saw the base of the lava in two places (1) immediately west of the bridge where the lava rests on a layer of peat 20 cms. thick, and (2) to the east of the bridge where a layer of conglomerate and sands 2 ft. thick occurs beneath the lava down to water level. Just before the entrance to the gorge the rocks of the southern bank are seen to consist of two compact and firm basalts with a slaggy lava layer 2 - 3 ft. thick between them.

The dam site is we understand just within the

entrance to the gorge where an island is seen nearer to the southern than the northern bank of the river. The island is of basaltic rock, but it was impossible to approach it and we cannot be absolutely certain which particular rock it is without examining a specimen. We think it most probable that it is the basalt and not the lava. Section II is based on this interpretation. Thus the whole of the river bed is probably in firm compact basalt.

Hestvatn.

We understand there is a possibility of constructing a dam on the Hvita, East of Hestfjall, near Gislataðir. There the general situation is similar to that at Urridafoss gorge, but with two differences :-

(1) The older rocks are fragmental deposits of tuffs and consolidated moraine, instead of basalts

(2) Part of the river bed is probably lava. The farmer at Arhraun reports that at very low water level in winter time he has seen lava rock in the river bed.

Section III gives a reasonable view of the situation here.

Tungnaa.

We visited the site indicated to us by the surveyors on their map - it is marked with an "S" on our map.

Here there is a broad valley (about 2 km. across) of lava with the Tungnaa river flowing along its northern boundary to the higher ground of the older rocks. See Section IV. The older rocks here are pillow lavas and tuffs. The higher parts of this area are waterless - which indicates clearly the high porosity of the tuffs. The surface of the lava at "S" is only about 3 - 4 m. above the river level. There is no gorge to take a dam of 25 metres such as had been suggested to us - nor is there any such gorge in the neighbourhood.

The Hekla eruptions.

This volcano is an irregular elongate accumulation of lavas and ashes trending N.E. - S.W. and eruptions have occurred at many places along the ridge - which evidently overlies a deepseated fissure, and also from near-by parallel fissures. In later historic times eruptions have occurred as follows :-

1766-8

1845

1878 small

1913 small

1947 Began on March 29th and still continues (Aug. 1st)

The extent of these flows can be seen from the map which also shows the lava of 1389-90, and the various pre-historic lavas. Klofaey is the only dam site which might possibly be reached by a Hekla lava. Klofaey is 10 km. from the ends of the nearest historic lava flows - 1766 and 1878 - and is $2\frac{1}{2}$ km. from the end of the nearest pre-historic flow, which was poured out more than 1000 years ago. Thus no Hekla lava has ever reached Klofaey and although absolute prediction is impossible it is reasonable to hope that it will not be reached in the future, and that the courses of the Thjorsa and Tungnaa rivers will not be disturbed either.

The only way in which Hekla eruptions might be expected to affect the site is that with the wind in the suitable direction there might be a considerable fall of rock fragments. This year (1947) the wind was northerly during the great eruption of ash, and pieces of pumice up to 50 cms. in diameter and weighing 25 kilos. fell at a distance of 5 km. from the crater. Even at a distance of 15 km. (which is also the distance to Klofaey) blocks the size of a man's head fell in great numbers. From early Hekla eruptions there are reports of falling stones which killed men and animals as far

away from the volcano at 45 km.

Earthquakes.

In historic times the low plain of S.W. Iceland through which the great rivers, Hvita, Olfusa, Thjorsa and Markarfljot flow has suffered more from severe earthquakes than any other part of the country. There is abundant geological evidence of the incidence of earthquakes in this region in pre-historic times and it may be fully expected that this activity will continue. At the same time it is to be noted that the severe earthquakes are infrequent - the last two occurred in 1784 and 1896.

Icelandic earthquakes may be divided into two classes:-

- (1) Volcanic - associated with eruptions of ash and lava.
- (2) Tectonic - due to the release of major strains in the earth's crust.

(1) Volcanic. These are the less destructive and if severe are only so in the immediate neighbourhood of the erupting volcano. In May 1912 earthquakes destroyed some farms close to Hekla - but these earthquakes were not destructive at the distance of the Thjorsa river. During the present eruption (1947) which is a very considerable one slight tremors only have been felt in the Hekla vicinity and there has been no damage to farms. It is not to be expected that future Hekla earthquakes will be any menace at any of the projected dam sites - they are too far from the volcano.

(2) Tectonic. These affect large areas and the dam sites may be considered to be equally exposed to them. Of previous earthquakes of this type there are reliable reports of the last one (1896) only. At that time no investigation was made at the level of present-day scientific study, and the area was a sparsely populated one. The following notes extracted from the accounts given at the time will help to indicate the

severity of the earthquake.

The destruction of farm buildings was considerable, about 20% of the houses were totally destroyed, but at that time the buildings were of poor construction the walls being of uncemented stones and often containing layers of turf. The suspension bridge across the Olfusa at Selfoss, built in 1891, was severely damaged. The earthquake wave came from the north west and the northern end of the bridge collapsed. Fissures up to 4 cm. wide were formed in the concrete cable anchor-blocks and the cables snapped. The base of the suspension tower which was made of poorly cemented stones overturned. The Thjorsa suspension bridge, a later and better construction built by Dorman Long in 1895, suffered slight damage only.

A notable feature of severe Icelandic earthquakes is the formation of fissures in the ground. In 1896 long cracks developed in the Skeid and Holt areas both in the Thjorsa lava and in the older basalt and tuff country - some of the cracks were open fissures, and at one "some" differential vertical displacement was reported. The trend of the majority of the fissures was N.E. - S.W. - some were N - S and some E - W. The common direction of such fissures of an earlier age is also N.E. - S.W. - and the fissure from which the Hekla lavas have been extruded has this trend. The longest crack formed in 1896 extended for 10 km. and for a distance of 3 km. it gaped from two to three feet. There is no reason to suspect that the dam sites are particularly liable to be the location of future fissures. The location of such fissures cannot be predicted.

Another feature in 1896 was the avalanching of rocks from steep slopes - e.g. from the sides of Hestfjall and Vordufell with small falls of rock at the sides of river gorges.

This might occur at the dam sites at Urridafoss and at the Hvita (east of Hestfjall) but it can be of no vital

importance.

Hlaups.

Hlaups are sudden rushes of water which may descend Icelandic rivers. They originate in two ways :-

1. By the bursting of lakes dammed up by glaciers.

There are now no such lakes feeding the Hvita, Thjorsa, and Tungnaa rivers. It is possible that in the future with advance or retreat of the western Vatnajokull glacier such lakes might come into being but it is not to be anticipated that any hlaups from them would have serious consequences at the dam sites. Formerly a small ice-dammed lake, Hagavatn, existed at the source of a tributary of the Hvita. This no longer exists and if it were to re-form it would be no danger. In the neighbourhood of Hestfjall previous hlaups from Hagavatn were no greater than normal winter floods on the Hvita.

II. By melting of ice due to volcanic eruptions.

No such hlaups have occurred on the Thjorsa, Hvita, or Tungnaa rivers in historic times. Hlaups due to eruptions under the western Vatnajokull have always been restricted to the rivers flowing from the southern border of the glacier.

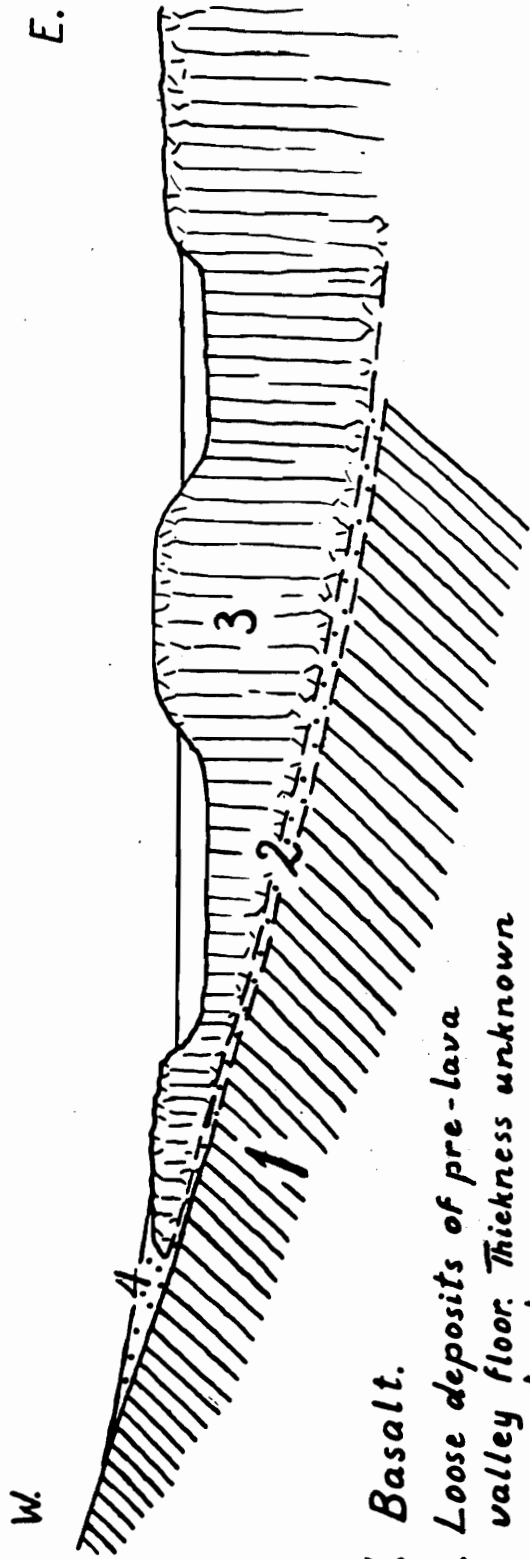
Thus hlaups are not to be considered any menace to the dams.

(Signed) Leonard Hawkes

(Signed) Gudmundur Kjartansson

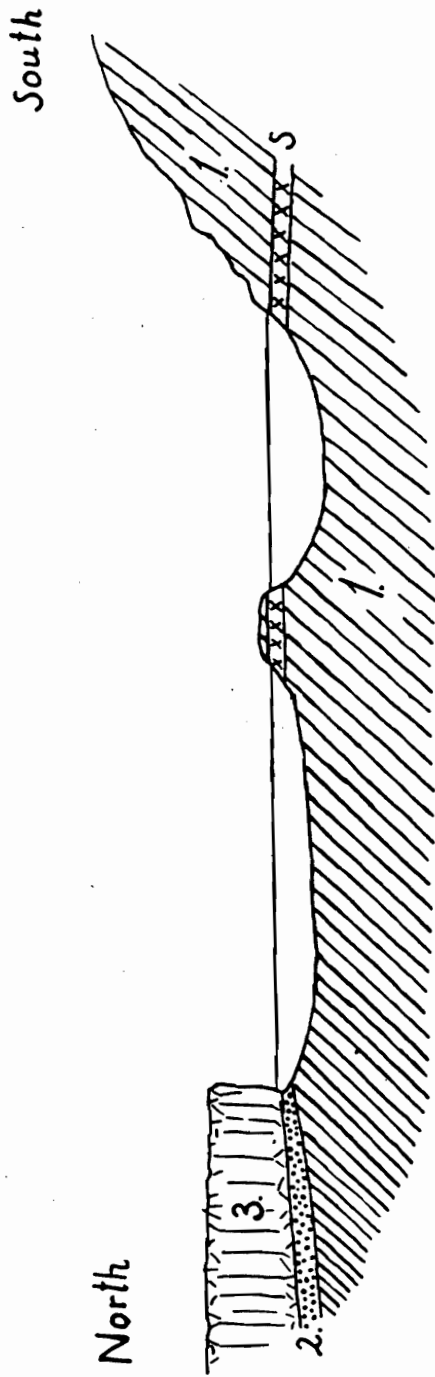
August 6th 1947.

Section I. - Klofaey



1. Basalt.
2. Loose deposits of pre-lava valley floor. Thickness unknown - may be absent.
3. Þjórsá lava.
4. Wind-blown sand.

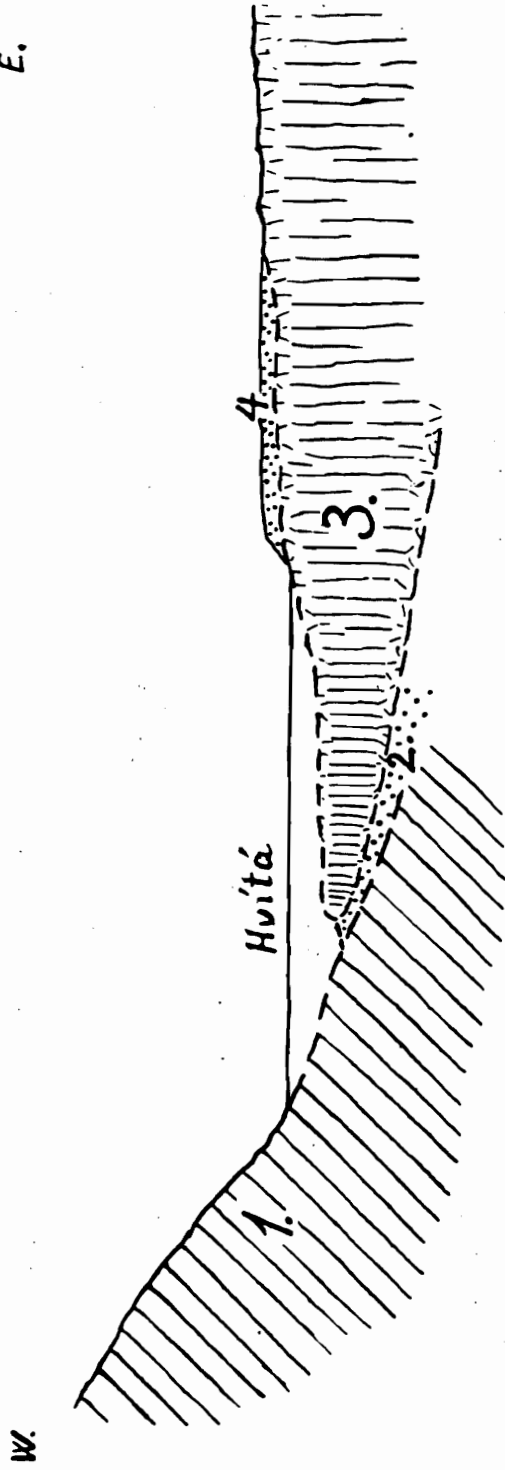
Section II - Urriðafoss gorge



1. Basalts with a slaggy layer (S).
2. Loose deposits.
3. Þjórsá lava.

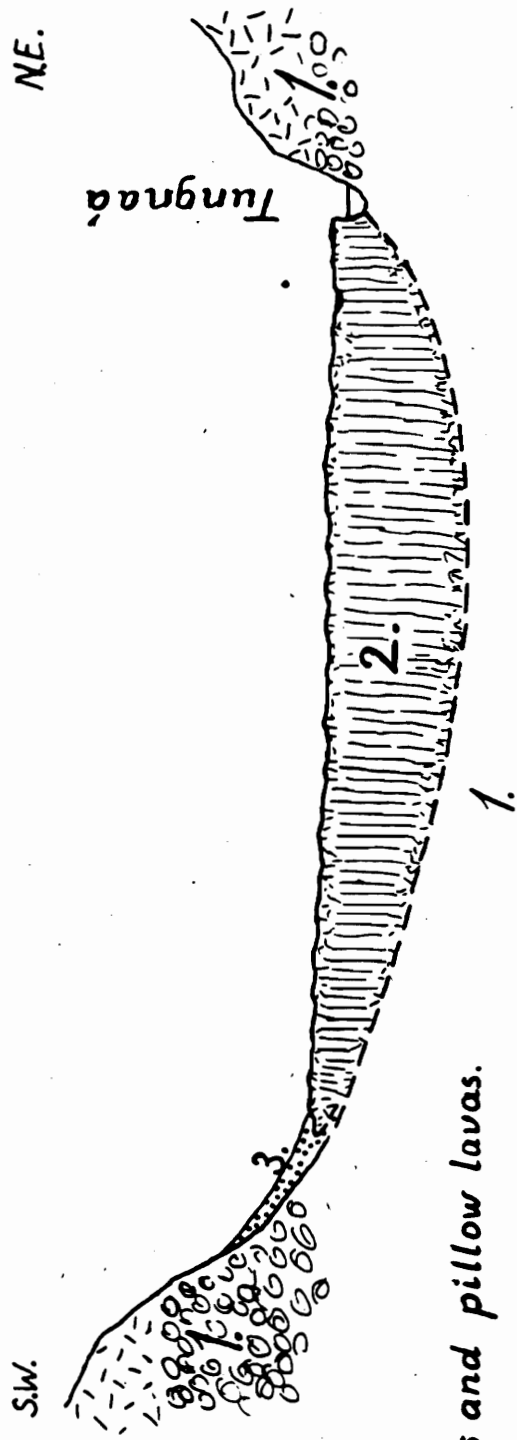
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Section III. - Hvítá at Hestfjall



1. Tuffs, breccias, and hard moraine.
2. Possible loose deposits of pre-lava valley floor.
3. Þjórsá lava.
4. Soil.

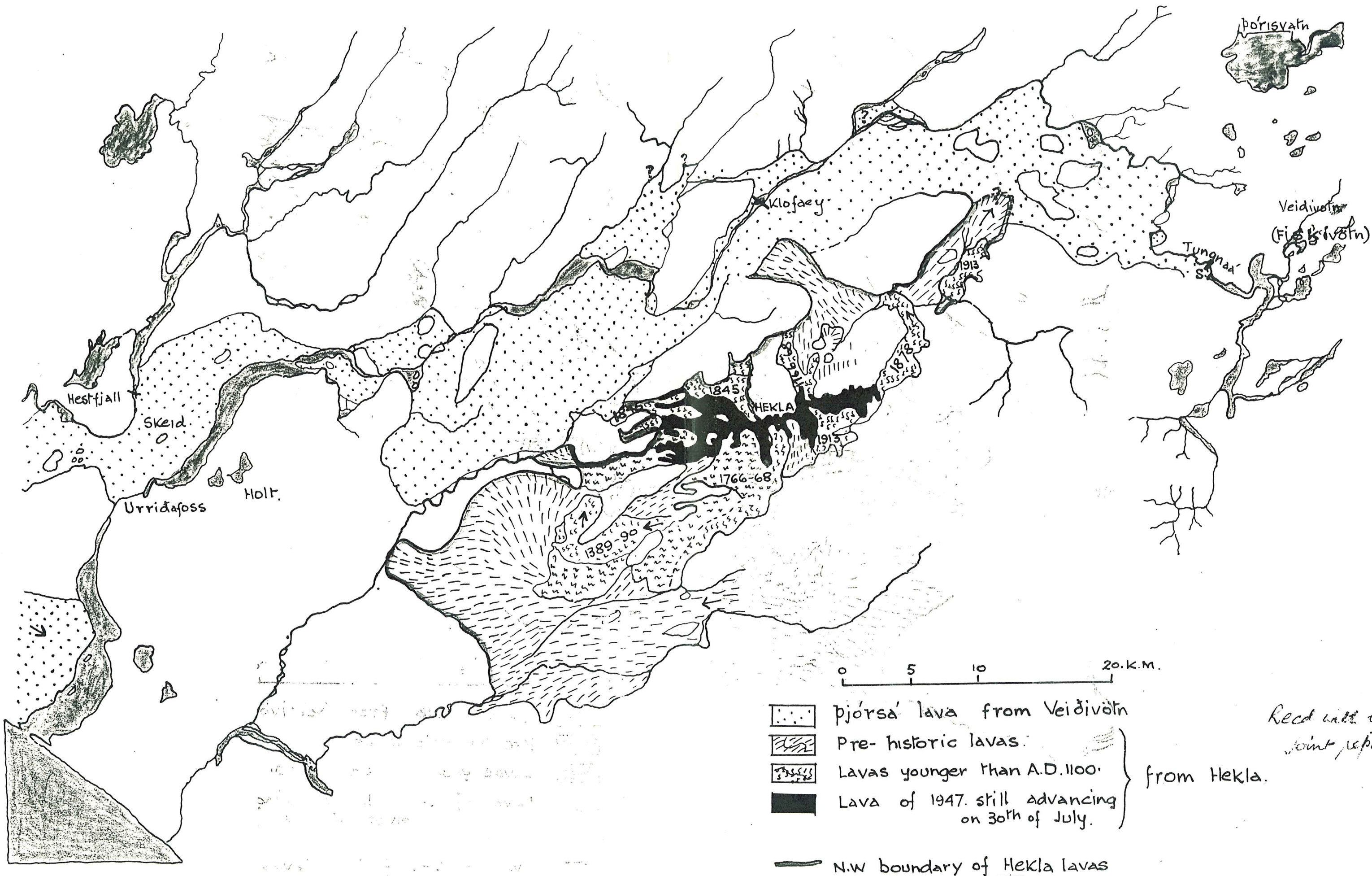
Section IV. - Tungnaá valley below the Fiskivötn lakes








1. Tuffs and pillow lavas.

2. Þjórsá lava.

3. Loose scree.



-  Pjórsa' lava from Veidivötn
-  Pre-historic lavas.
-  Lavas younger than A.D. 1100.
-  Lava of 1947. still advancing on 30th of July.
-  N.W boundary of Hekla lavas

Recd with joint report from Hekla.