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ON THE PLEISTOCENE DEVELOPMENT OF THE COASTAL GEOMORPHOLOGY IN ICELAND

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ABSTRACT

Comparative geomorphological studies of the coastal areas of South-eastern and Eastern Iceland to those in the North show the main topographical landforms eroded by alpine glaciation and marine abrasion. Those areas of Iceland which show predominantly alpine landscape are presented on a map as well as the largest ones of the coastal cliffs. Attention is drawn to the difference in the development of the coastal scenery in the northern and southern parts of Iceland especially the formation of strandflat in the South. This evaluation leads to that conclusion that the thickness of the Pleistocene glaciers has been much less in the coastal zone of the Southeastern Iceland than in the North, but there have always been some ice-free areas during the glacials following the alpine glaciation.

INTRODUCTION

The paper presented here is intended as a small contribution to the Quaternary geomorphology of Iceland. It is not a complete account, but rather considers and discusses two important aspects i.e. the importance of alpine glaciers and of marine erosion in the formation of the landscape. The work is particularly based on observations on the coastlines and coastal areas of southeastern and eastern Iceland although other areas are of course considered for comparision. In the light of these observations it is attempted to build up a picture of the thickness and extent of glaciers in previous glacial periods in these areas, and indeed for the country as a whole, although it is as yet imperfect.

GEOMORPHOLOGY OF ICELAND IN QUATERNARY TIME

Few earth scientists will doubt that many of the more important features in the Icelandic landscape bear witness to Quaternary glaciation, such as fjords, valleys, corries and serrated edges (arétes). Many authors have discussed or pointed at these in their work. Mention can be made of *Thorvaldur Thoroddsen* (1905-06, 1908-1911), *Helgi Pjetursson* (1905, 1906, 1908), *Trausti Einarsson* (1959, 1961, 1962, 1972, 1977), *Guðmundur Kjartansson* (1943, 1955, 1961, 1962, 1966), *Sigurdur Thórarinsson* (1937, 1951, 1956, 1960), *Thorleifur Einarsson* (1961, 1968, 1969, 1976), *Kristján Sæmundsson* (1979), and *Thórdís Ólafsdóttir* (1975), as well as various other papers by these authors not mentioned here. In addition a large number of other earth scientists both from Iceland and abroad have mentioned these features, it being sufficient to refer here to *Arthur Holmes* (1965), *Arne Noe-Nygård* (1962), *Gunnar Hoppe* (1968 and 1982) and *Hubertus Preusser* (1976). No discussion will here be made on the theories of individual authors or their separate topics but refererence is made to their work where relevant.

There are different opinions amongst these authors as regards the possible thickness and extent of glaciers during glacial periods and whether certain areas have been ice-free and even vegetated throughout the Quaternary Era. In the last few decades the opinion has become rapidly popular that Iceland has been covered by a very thick ice sheet, even 2000-3000 m, in previous glaciations and that it has calved off the edge of the continental shelf at depths of at least 200 m or more so that the country was completely covered by ice. This view is very similar to that held for the ice sheets of Scandinavia and Canada. According to this view the formation of the Icelandic landscape and its continental shelf should be foremost due to erosion by a thick ice sheet with an ice centre and main divide somewhere in the central highlands.

In my opinion many geomorphological and glaciological arguments are decidedly against this theory. In quite recent years some authors as *Ingvar Birgir Fridleifsson* (1985), *Halldór Pétursson* (1986) and *Ólafur Ingólfsson* (1987) have gained in their works very comparable results as present author has introduced in his papers (G. Sigbjarnarson 1982 and 1983), which shows to-day some revision is going on that topic. In the discussion that follows I shall try to assemble some of the most compelling factors to support this view.

Two types of landform have mainly aroused my interest in field trips to the coastal areas of the country. On the one hand there is the factor of how extensive areas exclusively or predominantly display characteristics of alpine glaciation. The highland of Tröllaskagi in the North, Snæfellsnes in the West and the eastern fjord mountains (Fig. 1) are clear examples of this. These landforms are widespread elsewhere if one looks closely for example in the western fjord mountains, in southeast Iceland and at the south margin of Vatnajökull. On the other hand there are highly developed wave-cut cliffs and promontories (Fig. 2) which not only extend seawards from various headlands, exposed to wave attack at the present sea level, but also for a considerable distance landwards, requiring a sea level 20-40 m higher than today for their formation, and even as high as 100-120 m a.s.l. Látrabjarg and Horn in the Western fjord are examples of promontories which extend seawards today, while Lómagnúpur and Esja in the South are examples of promontories having well developed strandflats beneath.

Fig. 3 is a map of Iceland showing promontories and definite wave-cut cliffs, which reach more than 60 to 80 m height above their present base, whether it is sea level, strandflat or sedimentary infill. On Fig. 3 are also shown all those areas where the glacial geomorphology shows predominantly alpine landscape characteristics. Various other areas should also be considered, where certain mountainous areas have a composite form. The map as a whole can neither be considered as complete nor exact. Time neither permits description of individual features of the map nor explanation of those features which appear doubtful but I have based it on various definitions of *Sugden and John* (1976) and *Krüger* (1974).

FORMATION OF THE ALPINE LANDSCAPE

The main characteristic of alpine glaciers is that their location depends almost exclusively on the mountain landscape which existed before their formation. Above the glaciation limit snow and ice collect on top of the mountain peaks and on their flanks, and collapse as avalanches and ice-falls to the corries and valleys, where the ice and snow are welded together as an homogeneous mass, which creeps downslope. The valley glaciers flow along the main valleys and are constantly added to by tributary glaciers and overfull corries in the valley sides continuing until ablation equilibrium is reached. If the ablation is insufficient to melt the ice before the snout has emerged from the valleys (fjords), it extends in all directions forming a piedmont glacier, and this rapidly increases the ablation area.

The geomorphology due to alpine glaciation (Fig. 1) is predominantly a sharpening and enlarging of the fluvially eroded landforms which preexisted at each glaciation, rather than the creation of a new landscape. It is characterised therefore by serrated ridges, horns, corries, throughs or fjords which are often excavated more deeply than the land or the ocean floor in front of them. The formation of a piedmont glacier has only a minor effect on this development, since the erosional capability of a glacier decreases very rapidly as it spreads outwards.

Those areas in Iceland, where alpine landforms are predominant, are shown in Fig. 3. Glacier formation there has thus been the result of the pre-glacial landscape. There is no reason to suppose that these areas have at any time been covered by very thick ice sheets, because they would be bound to have left very distinct erosional traces, since the erosional capability of glaciers increases very quickly with increasing ice thickness. Many of the alpine areas shown on Fig. 3 have been located inbetween two large valley glaciers flowing out of valleys or fjords on either side of them. *Sudgen and John* (1976) cite the promontories of the western fjords as being typical for this development (p. 207). It is likely that the proportion of alpine glacier areas has increased throughout Quaternary time, glacial periods have become more frequent and glacial erosion has increased.

According to Fig. 3 one quarter of the country, just over 26000 km^2, is eroded by alpine glaciers. Normally there are some ice free areas in alpine glaciers. They appear as horns, serrated ridges, steep slopes or promontories. Even so it cannot be discounted that some of these alpine areas shown on Fig. 3, have at times been completely covered by ice, and then as independent ice centres. On the other hand it is equally possible that there have always been some nunataks and ice free patches in large alpine glaciers, such as in the eastern fjords, southeast Iceland, Snæfellsnes peninsular on the west coast, the western fjords and Tröllaskagi in the central North.

Figure 4 is a map of Fáskrúdsfjördur and Stödvarfjördur on the central east coast of Iceland. They are taken as being typical of those landforms formed by alpine glaciers. The accumulation zones of the glaciers, hanging valleys, corries and depressions in the mountain slopes are specially indicated on the map as well as the direction of flow of the glaciers from them. There is no evidence in the landforms that glaciers from the central highland have at any time flowed in these fjords, so that they have been independent accumulation zones of alpine glaciers which have produced valley or fjord glaciers as shown in Fig. 4. It can be judged with some certainity, how far the accumulation glaciers flowed down the slopes, before they joined the main valley glacier. On this basis I have therefore estimated the mean thickness of the main valley glaciers, which have formed the fjords and the valleys inland of them, as well as showing their main direction of flow. It should be pointed out that by the estimated mean thickness I do not refer to any particular time, but rather the mean thickness of glaciers responsible for erosional forms. It is estimated by many factors, such as the erosional forms of the main fjords and valleys glacial cols the height of hanging valley and corries and the spurs between them.

With the formation of the fjords the mean thickness of the glaciers was 100 m above present sea level at their mouth and increased slightly inland up to 500-600 m a.s.l. farthest up the valleys. Observations on the level of corries farthest out on the fjords and promontories suggest that the glaciation limit has been 350-450 m a.s.l. facing the sun to the northern side of the fjords, but about 100 m lower in the shaded southern side of the fjords. The glaciation limit and therefore the corries level has then usually increased gradually inland, but here it is more difficult to estimate because of the added factor of the inreasing thickness of the main valley gacier.

Piedmont glaciers have spread out from the fjord mouths as the arrows in Fig. 4 indicate. It is difficult to estimate their size. The accuracy of marine charts is not sufficient to enable the determination of smaller landforms on the seafloor nor the knowledge of its material. The ablation zone of the glaciers extended fairly far up the fjords, and that together with their tickness make it possible to conclude that piedmont glaciers have never extended more than a few kilometers outwards from the fjord mouth on the continental shelf. The island Skrúdur (Fig 4), located about 3 km eastward from the promontory on the north side of Fáskrúdsfjördur is an eroisonal remnant of the spur between the fjords. It is about 150 m high and rather small rocky island with steep slopes against the sea. Its landward side is a bare rocky wall, while its seaward side facing the east is quite covered talus scree to the top. This difference is most likely due to the glaciers have never been capable to erode on its seaward side from it became independent island. This all suggests that there have always been some ice free areas on the spurs and farther out on the fjord slopes, as well as nunataks on steep slopes, serrated edges and horns above the firn limit. On Fig. 4 those areas are marked where it is very probable that there were always some ice free areas.

In comparison with the alpine landscape of the eastern fjords, Fig. 5 shows the glacial erosion by a thick ice sheet from the central highlands, showing an area of the central eastern Iceland only about 25 km inland from that on Fig. 4. The landscape forms are rather different from those shown on the former. The arrows show the main direction of flow of those glaciers responsible for the formation of the landscape. From them it can be seen that these glaciers have moved over an undulating surface and eroded it according to their direction of flow. On the other hand it can also be seen that the main direction of flow has adapted itself somewhat to the larger landforms such as the main valleys, Fljótsdalshérad and Jökuldalur where glacial erosion has been very active. The plateau there between, Fellaheidi displays considerably less of the characteristics of glacial erosion so that the glaciers tere have been considerably less active and in all probability it was an accumulation zone, so that it was completely ice covered, although it can be considered likely that the highest peaks, Rangárhnjúkur and Sigurdargerdisbjarg where nunataks for long periods of time (Fig. 5).

MARINE EROSION

As to be expected in an oceanic island the coast of Iceland is much eroded by the sea i.e wave-cut cliffs, sea crags and fjord promontories. The more outstanding examples of such formations are shown on the map of Iceland in Fig. 3. There it can be seen that they surround the land almost completely except in the geologically youngest parts and farthest inland in the fjords and inlets. Their development is at various stages, depending on situation and part of the country. It is noteworthy that highly developed marine erosion is associated with the alpine geomorphology in all headlands and fjord promontories, where coastal cliffs rising several hundred meters directly out of the sea area widespread or have a low coastal rim beneath them.

Relative to the present day strandline the strandflats appear to be higher in the south and west of the country than in the north. From Gerpir southwards and westwards as far as Látrabjarg there are strandflats in front of almost all headlands, but hardly at all underneath headlands in the western fjords, northern Iceland or the eastern fjords north of Gerpir. I have not seen or found any satisfactory explanation for this phenomenon, but the strandflat is of great importance to the road system. Where the marine terrace is available the moutnain roads are both few and low.

The Norwegian *H. Reusch* (1901) introduced the term *strandflat* in 1894, and he belived it to be the result of marine erosion. Since then various theories have been put forward as to its formation, for instance *F. Nansen* (1922) and *O. Holtedahl* (1960), the former rather favouring marine erosion with a mixture of glacial erosion, and the latter favouring nearly entirely glacial erosion. As regards strandflats in Iceland, I lean towards the opinion that marine erosion in collaboration with piedmont glaciers and sea ice are responsible for their formation. It is also advisable to keep in mind that when marine erosion at the coastline of an ice covered land, in the Quaternary Era, is compared to the coast of an ice free land then relative strandline changes are very unlike because of the interplay of land submergence caused by ice pressure and a fall of sea level due to glacier formation. Marine erosion has also been much more effective on a glacially eroded land, especially since erosion by fjord and piedmont glaciers helped to keep the coast open for attack by the sea at the end of each glaciation.

It is clear that most of the more important wavecut cliffs and promontories in the south and west of the country have been eroded and have acquired their present appearance at a higher strandline than that of today. Widespread erosional forms suggest a strandline 20-40 m higher and even higher, for instance in the inner part of Faxaflói, where marine erosional forms appear to extend upwards to over 100 m a.s.l. It is now known that the strandline in Iceland reached from 40 m and up to as high as 100 m in different areas, at the close of the last glaciation. On the other hand I consider it out of the question to attribute to such a sea level rise of short duration, the formation of wave-cut cliffs and promontories such as Látrabjarg, Horn, Gerpir, Lómagnúpur and Eyjafjöll, to name a few examples. In fact nearly all the coast of Iceland display evidence of severe marine erosion in Quaternary time (Fig. 3). In my opinion another explanation must be sought for this, rather than the short-term, relative rise in sea level, at the end of each glaciation.

Because of the storage of water in Pleistocene glaciers the surface of the world's oceans fell about 100-125 m during the last glaciation and even as much as 160 m when the ice age glaciers reached their greatest extent in the Quaternary Era (*E. Seibold* 1974), but in addition Iceland was submerged to some extent due to the weight of ice. Most authors have however tended to the opinion that the strandline in Iceland has been somewhat lower than today, even to the extent of several tens of meters. I don't believe there is any reason to question the fact that the strandline in Iceland has been somewhat lower than today in former glaciations. However I consider that there is no reason to assume a large fall in sea level, since it is farily certain that the Icelandic crust is so weak and flexible, that it isostatic sinking under ice pressure takes a very short time compared with the continents. It is even possible that at certain times isostatic sinking has been so much in certain areas, that the sea level has been higher than it is today. On the other hand it would hardly be likely, that the extensive marine erosion along the coast of the country has occurred during glacial periods themselves, except to a small degree.

It is considered well proven that sea level was considerably higher during interglacial periods of the Quaternary Era than it is today, and still more so towards the beginning of the Quaternary Era. *A. Holmes* (1965) belives sea level to have fallen nearly 200 m in the last 2 million years (p. 713), and *P. Woldstedt* (1961) reaches a similar conclusion (p. 374). He believes that sea level has been almost 20 m higher during the last interglacial and 30 m higher in the second last interglacial.

When it is borne in mind that the majority of promontories and wave-cut cliffs belong to the alpine landscape and that it is likely that glacial erosion at the coast was limited during the last glaciation, it seems obvious to conclude that the fjords promontories and wave-cut cliffs and the strandflats have been formed largely during the interglacial periods of the Quaternary Era.

GLACIAL EROSION AND FLUVIAL EROSION

By comparing Figs. 4 and 5 the enormous difference in the large scale landforms of the landscape formed by alpine glaciers on the one hand and by the ice sheet of the central highland on the other can be clearly seen. On closer examination this difference is not oly apparent in the large scale landforms but in the smaller ones too. A well developed roche-moutonnée landscape where erosion by a comparatively thick glacier has been very effective is very widespread in Scandinavia and Canada, but in Iceland it is only found in Fljótsdalshérad, in a small area in Borgarfjördur district in the west and a very few other areas. In the very same places very well developed large glacial grooves (flutations) are also found such as can be seen in Fig. 7 which shows glacial grooves in Fljótdalsérad. Here a sinuous groove can be seen, a socalled "cavetto", a feature believed represent "highly plastic" erosion (*J. Gjessing* 1965, 1966). This suggests that the erosive capability of glaciers has been most in these areas, since as well known it depends mainly on the glacier thickness and the rate of flow.

Widespread on the fjord promontories and mountain sides near the coast are to be found large, steep talus slopes, especially where characteristic features of marine erosion are dominant, as for example on Hvalnes (Fig. 6). Such screes are hardly found inland where glacial erosion features are dominant. Towards the top of the screes is a network of water eroded gullies, which are often tens of meters deep, so that the landscape there appears as a forest of pyramids (buttresses) uppermost in the mountain sides. (Figs. 6 and 8). A number of water eroded gullies can be seen in Fig. 8, which extend side by side downslope from the corrie landscape farthest up the mountain. The talus, gullies and pyramids bear witness to very active water erosion and frost weathering of long duration. The position of these strongly water eroded areas on peninsulas and farther out the fjords slopes decidedly suggest that they have been subjected to little or no glacial erosion during the last glaciation and possibly others, since their position agrees with probable ice free areas, as they are shown in Fig. 4.

Well developed glacial cols (Fig. 9) can be found widespread in the alpine landscape and they give an idea of the thickness of the valley or fjord glaciers at their time of formation. *H. Pjetursson* (1906) and *T. Einarsson* (1959) have treated them in their work and the latter has pointed out that in some places they are found at two more altitude levels.

A rather thicker weathering cover is widesprad above the main valley or fjord glaciation limits (Fig. 4) than below them, and all glacial erosional forms are considerably more subdued there. One of the clearest examples which I have seen of this is where the weathering cover thickness and glacially eroded forms become more subdued at 200-250 m a.s.l. at the Vatnsskard road at the lower end of Fljótsdalshérad valley.

THE SOUTHESTERN COAST FROM EYJAFJÖLL TO FLJÓTSDALSHÉRAD

On Fig. 3 it can be seen that the coastal mountains are almost everywhere formed by alpine glaciers and marine erosion is also well developed there. A survey of the glacially eroded landforms from Berufjördur to Eyjafjöll reveals that glacially eroded valleys and fjords are very poorly developed compared with Fljótsdalshérad and mid northern Iceland in spite of the fact that the coast there is directly connected to the central highlands. This feature is especially poorly developed west of Hornafjördur, where it is hardly possible to talk about well developed glacially eroded valleys, except where the present outlet glaciers, from Vatnajökull flow today. On the other hand marine eroded features, wave cut cliffs and promontories are very well developed and little eroded by encroaching glaciers. The age of strata does not seem to really matter, except for the very youngest. This points without doubt, to the fact that in previous glaciations the glaciers here have not attained great thickness or extent. The glaciation limits have hardly been lower than 400-600 m a.s.l. and glaciers have either melted on the slopes beneath the moutains or in the case of piedmont glaciers at the valley or fjord mouths, where calving could also have played a part in the ablation. The eastern fjords and southeastern Iceland have therefore not been unlike the glaciated coasts of Spitsbergen and many other arctic islands to-day. I consider that a greatly reduced precipitation from that of the present could be a satisfactory explanation for this.

Observations on the geomorphology of southeastern Iceland and the eastern fjords suggest decidedly that marine erosion as well as alpine glaciers are mainly responsible for the landscape which we find there today.

CLACIER THICKNESS AND ICE FREE AREAS

Glacier thickness may be estimated from the geomorphological forms left by the glacier, which again to some extent depend on the rate of flow of the ice.

The thickness of those glaciers which formed the alpine landforms, covering a quarter of the country, has been touched upon (Figs. 3 and 4). The landforms only give an estimation of the mean thickness of the glaciers which formed them, but I do not consider that there is any reason to conclude that those glaciers have ever been much thicker. It is possible that they have at some time reached a greater ice thickness, when conditions of glacier formation were at a maximum, but erosional features left by such glaciers should be found since erosive capability rapidly increases with ice thickness.

If one considers the distribution of alpine areas in Fig. 3, it can be seen that their position around the country suggests that glacier thickness in the central highlands has never been, at least in late Quaternary time, so great that the outflowing glaciers from there have buried these areas, but rather that the glacial valleys and fjords have always managed to transport the glacial ice away. It suggests further therefore that glacier flow from the central highlands has continually adapted to the landscape and this is true of the ice centres too as pointed out by *T. Einarsson* (1977). In other words, there have therefore continuously been many ice centres and ice ridges in the main highland areas and glacial flow has been from there in all directions or similar to what can be seen in the present glaciers.

The height of móberg mountains has been used as an indication of the minimum thickness of the glaciers (*G. Kjartansson* 1943, *K. Sæmundsson* 1979). I think it is likely that this gives not only an idea of minimum thickness but also the approximate maximum thickness. A superficial observation of the structure of móberg mountains in the southern highlands of the country south of the Tungnaá river and Thjórsá river show that nearly all these eruptions they formed in, reached above the glaciers, since they are first and foremost built of hyaloclastics, pillow lava formations being infrequent. On the other hand the proportion of pillows and cubic jointed basalts increases greatly, to the north of the Tungnaá river and elsewhere within the central highlands. This suggests a considerably smaller glacier thickness in the southern higlands than in the central ones.

One of the characteristics of alpine glaciers is that nunataks are usually associated with them as well as ice free slopes and spurs. It is thus likely that this has been the case in Iceland in previous glacial periods, and indeed this viewpoint agrees well with research by some botanists, as *S. Steindórsson* (1954, 1962) on those places where plants have held out and survived previous glacial periods, eventhough it is questioned by some others (*S. Friðriksson* 1962). It could be said that in all alpine areas it is possible to find some plants having a limited distribution. In addition the opposite could be said, that all plants having a limited distribution can be found associated with alpine areas. I belive all the evidence points towards there having been ice free areas on promontories and slopes along the coast, not only during the last glaciation but throughout all of the Quaternary Era.

The pleistocene age of the interglacial lavas in glacial eroded valleys of the tertiary basalts as in Vídidalur at Húnaflói (*L.E. Koerfer* 1972) and Quaternary formations in Lón and Hornafjördur (*H. Torfason* 1979) suggest that valley development has been well advanced at least a million years ago. I think this indicates that the main features of the landscape and possibly the continental shelf had already been formed early in the Quaternary or even to some extent before the end of the Pliocene period.

In glacial periods there would always heve been many ice centres in Iceland with the main ice divide between the north and south flowing glaciers close to the present water divide and glacier thickness would not have been much thicker than that of Vatnajökull today, generally 200-700 m (*H. Björnsson*, 1982) but possibly up to 1000 m in deep valleys. (*J. Eythórsson*, 1951).

Time does not permit discussion of the conditions of glacier formation in previous glacial periods. Examination of those weather maps most likely to compare with the prevailing climate in glacial periods (*H. H. Lamb* 1977), suggest that all precipitation was considerably less especially in southern and southeastern Iceland, where the prevailing precipitation direction was northeasterly to northerly.

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TEXT OF FIGURES

Fig. 1. Alpine landscape south of Reydarfjördur from Oddskard. The picture shows the mountain ridge between Reydarfjördur and Fáskrúdsfjördur with hanging valleys, serrated edges (arêtes) and spurs. Glacial cols can be seen at 350-400 m a.s.l. on valley spurs. cf. Fig. 9.
- Photo G. Sigbj.

Fig. 2. Finnurinn (foreground) and Hvannadalabjarg (distance) are typical fjord promontories as they occur in the western fjords, northern Iceland and eastern fjords north of Gerpir. The picture is taken from Ólafsfjardarmúli at the mouth of Eyjafjördur.
- Photo G. Sigbj.

Fig. 3. Alpine landscape and coastal cliffs in Iceland. 1. Cross hatched areas show the part of the country where erosional forms of alpine glaciers predominate, or approximately 26,000 km^2. 2. Marine eroded fjord promontories and wave cut cliffs higher than 60 to 80 m are shown with broad, hatched lines.

Fig. 4. Glacial geomorphology in Fáskrúdsfjördur and Stödvarfjördur. 1. Accumulation zone: mountain slopes, hanging valleys, corries and depressions are shown with broad broken lines, while 2. arrows show direction of flow of glaciers from them and along the fjords. 3. Contour lines show probable elevation of the main glacier. 4. In cross hatched areas it is likely that there have always been some ice free areas.

Fig. 5. Glacial geomorphology in Fljótsdalshérad and Jökudalur. Arrows show the main direction of flow of glaciers which produced the landforms. Fellaheidi has probably been a glacier accumulation area.

Fig. 6. Hvalsnesskridur are wave cut cliffs with a strandflat beneath such as is most common on costal promontories in western Iceland, southern Iceland and the eastern fjords south of Gerpir.
- Photo G. Sigbj.

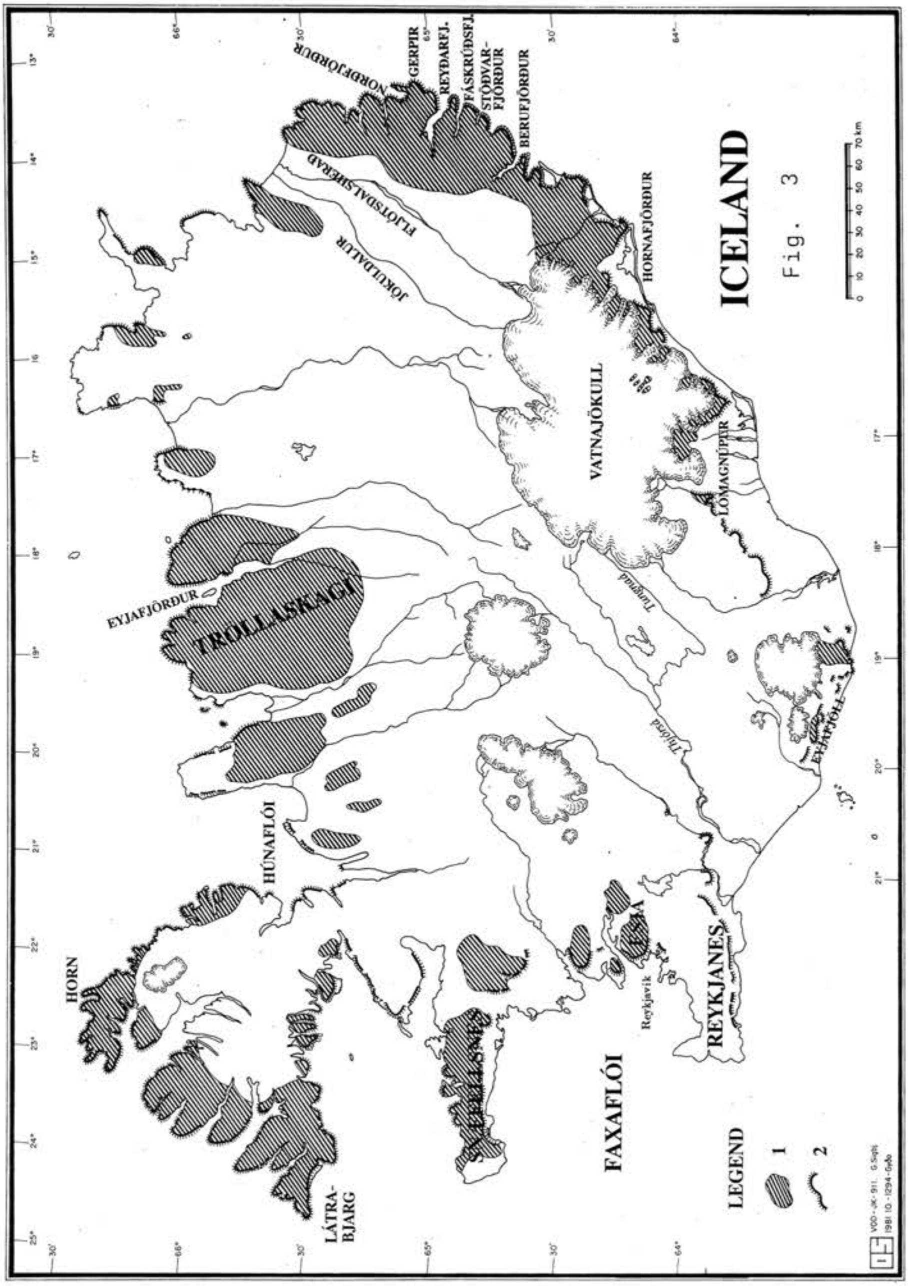
Fig. 7. Glacially grooved outcrop south of the farm Sledbrjótur in Fljótsdalshérad.
- Photo G. Sigbj.

Fig. 8. Northern slope of Nordfjördur eastern Iceland. At the top are horns, serrated edges and corries, which characterise the alpine landscape. Below is a greatly water eroded gully slope. It is likely that the gully walls were ice free during the last glaciation, but the thick till cover below them represents the glacial maximum. Smoke from capelin processing plant fills the valley floor.
-Photo G. Gigbj.

Fig. 9. Galcial cols at just over 400 m.a.s.l. in Reydarfjördur. (cf. Fig. 1).
- Photo G. Sigbj.

Fig. 1

Fig. 2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JÖKULDALUR
HORNAFJÖRÐUR
VATNAJÖKULL
LÓMAGNÚPUR
Tungnaá
Þjórsá
EYJAFJÖLL
EYJAFJÖRÐUR
TRÖLLASKAGI
HÚNAFLÓI
HORN
LÁTRA-BJARG
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Fig. 3

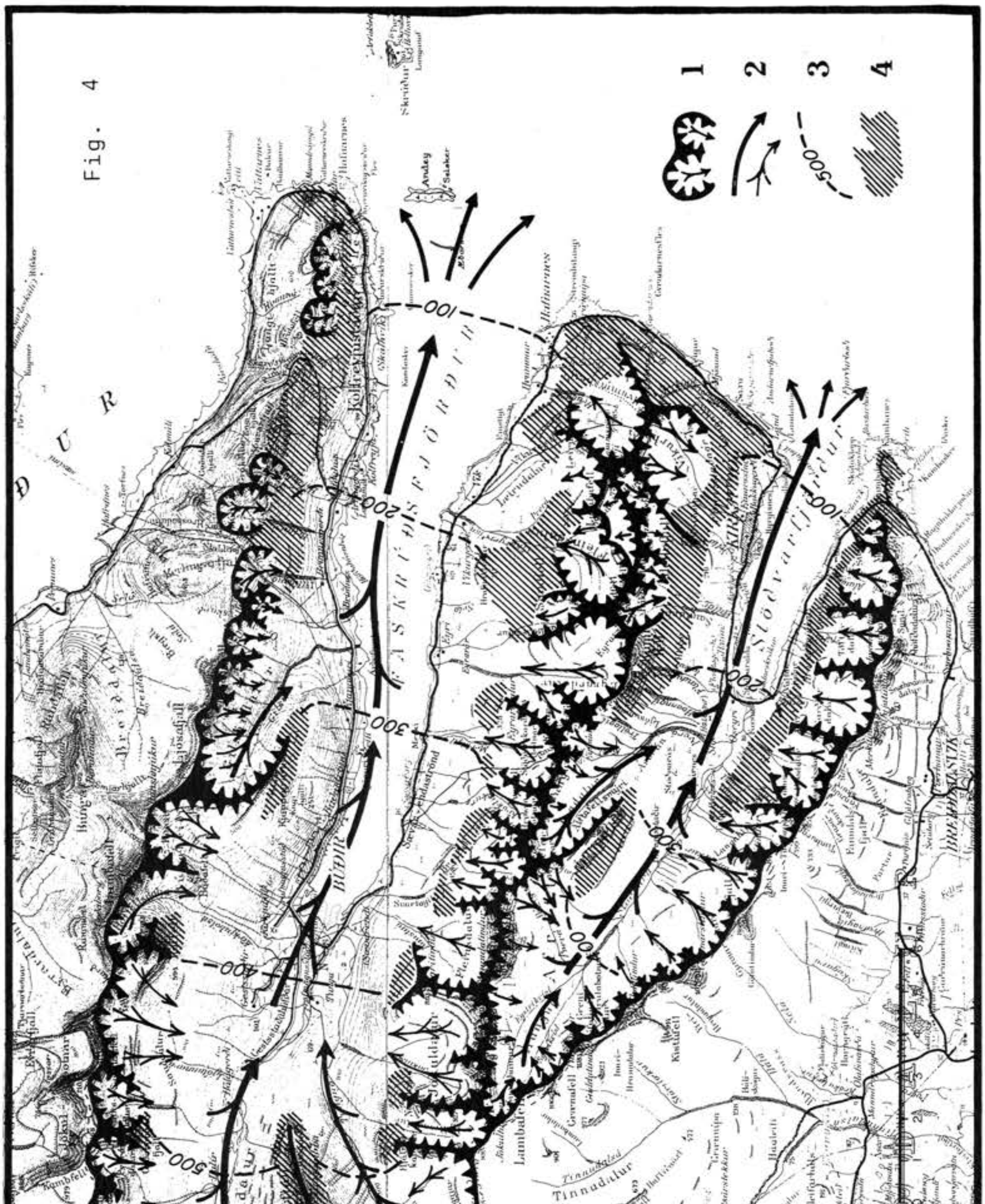
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Fig. 4

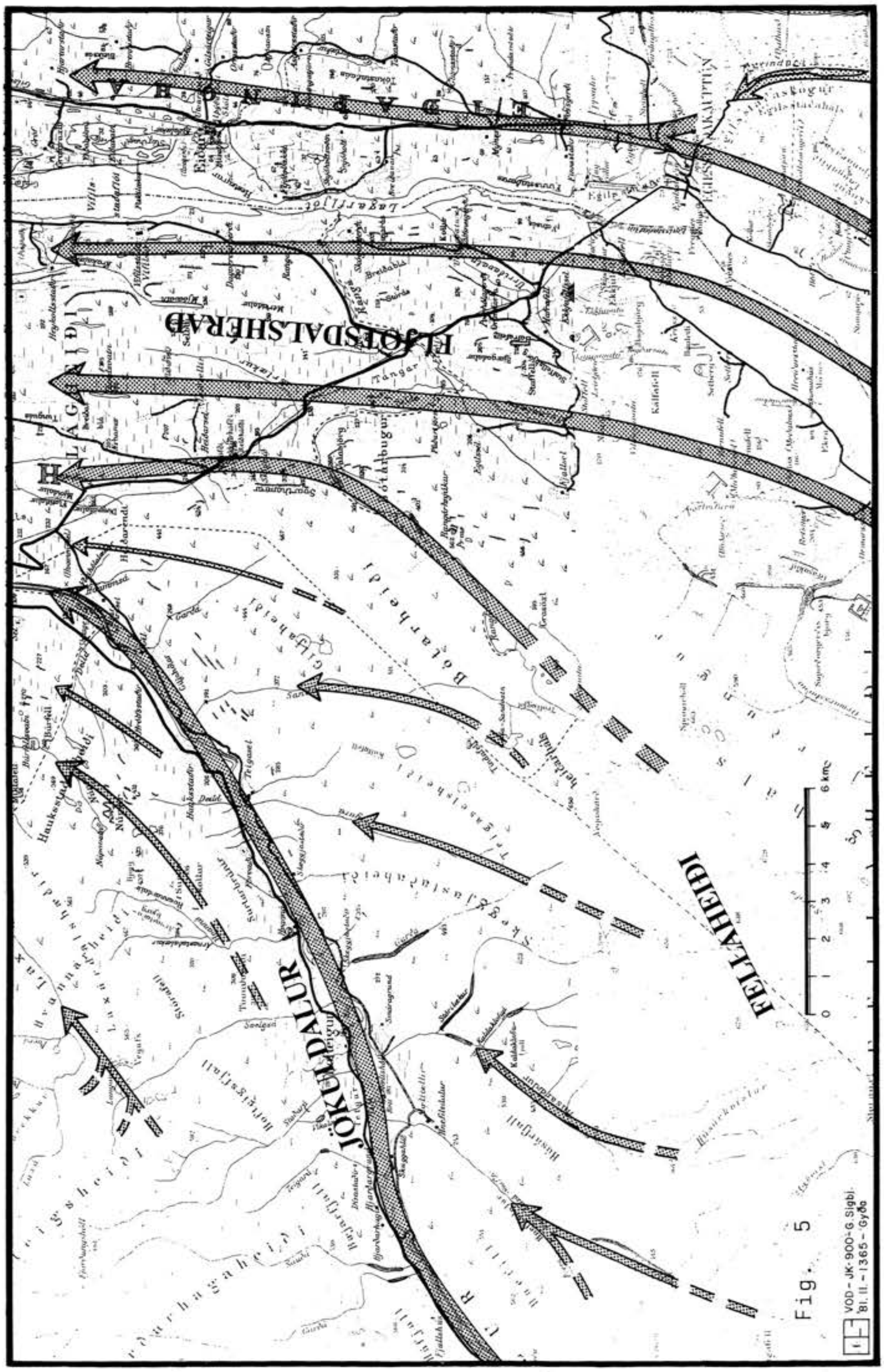
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Fig. 5

Fig. 6

Fig. 7

Fig. 8

Fig. 9