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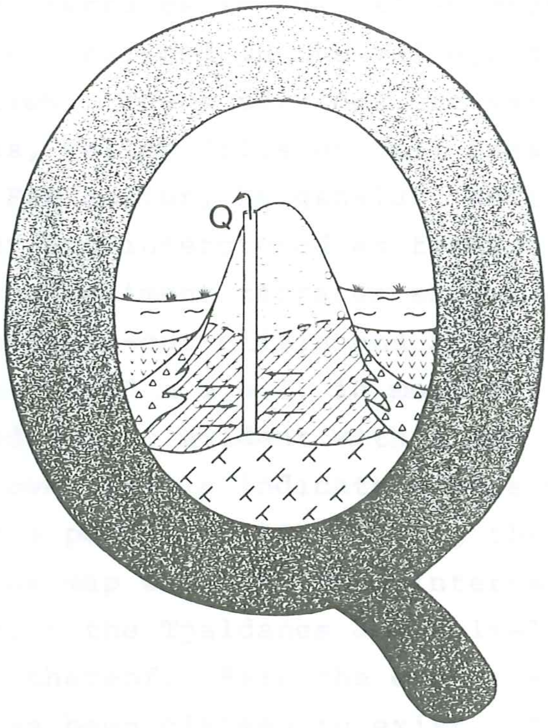

GLACIAL GEOMORPHOLOGY AND RAISED SHORELINES IN THE SKARDSSTRÖND-SAURBAER AREA WEST ICELAND

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ABSTRACT.

Glacial and marine geomorphological features have been studied and mapped on the south coast of Gilsfjördur West-Iceland. In this region the main Icelandic ice-sheet is supposed to have met with a separate Vestfirdir ice-cap. Fossiliferous sediments in the area are assumed to be of Late Weichselian age. Sediment terraces in the valley mouths indicate that smaller glaciers existed in the valleys along the coast during the deglaciation. These terraces are variously interpreted as sandar, deltas, valley fills or till areas. Part of the sediments in Fagridalur, Belgsdalur, Hvítidalur, Olafsdalur and Garpsdalur are interpreted as terminal moraines. The surfaces of the sediment terraces show signs of marine erosion in the form of wave-cut cliffs and beach ridges. The marine limit is about 75-80 m a.s.l. in most valleys. No E-W shoreline gradient is evident within the area. Strandline features at lower levels indicate a more or less constant sea-level for a period of time during the general regression. The part of the map which is most interesting is the Saurbaer area, especially the Tjaldanes and Holtaland terraces and the valleys south thereof. Here the evidence of two glacier stillstands has been claimed to exist. According to a single ^{14}C-dating of subfossil molluscs the Tjaldanes and Holtaland sediment terraces are from about 11.620 BP.

CONTENTS.

1 INTRODUCTION.

This report is the result of a reconnaissance study on the glacial geomorphology of an area located in West Iceland at the head of Breidafjördur south of Vestfirdir (Fig. 1). The field data was collected in Iceland at the Science Institute, University of Iceland. The preparing of the data and writing of this report was done at the Department of Quaternary Geology, University of Lund during the summer and autumn 1986.

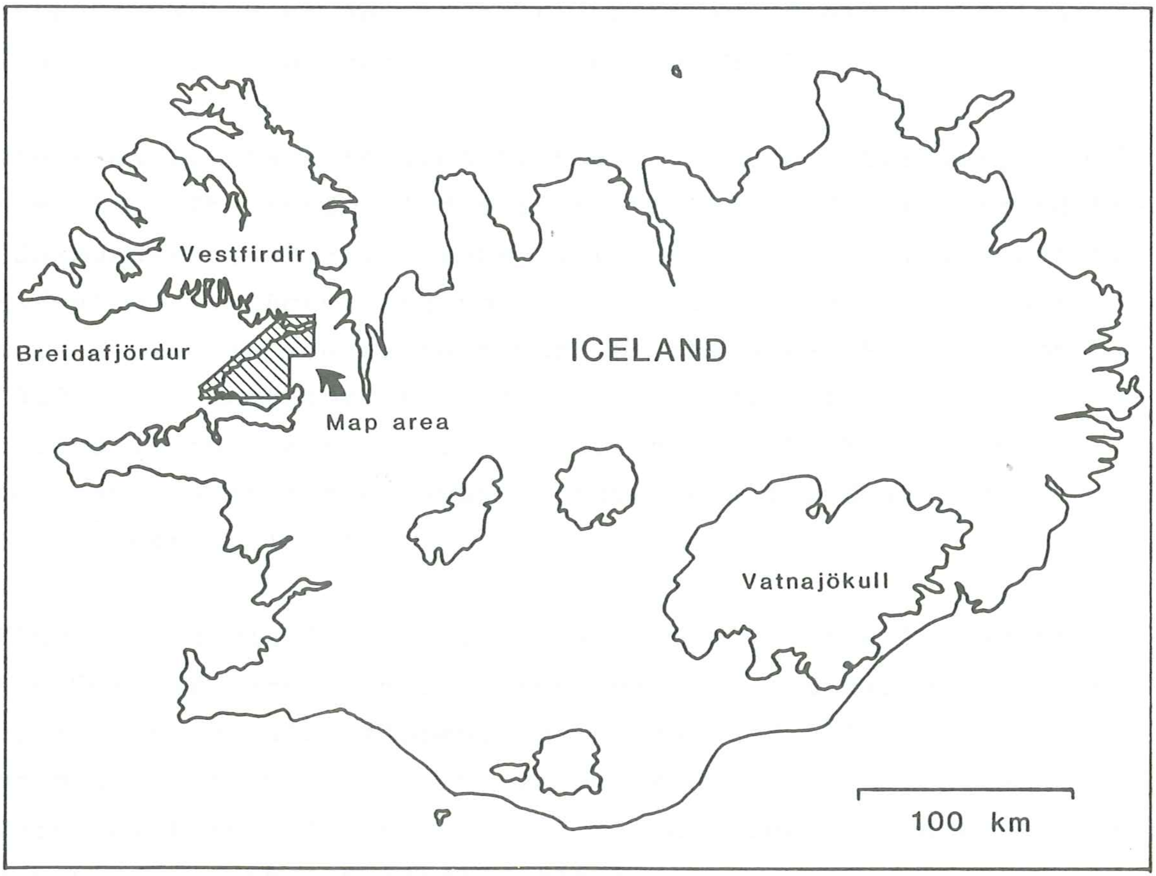

Fig. 1. Location map.

I worked mainly in the valleys and lowlands on the north side of the peninsula between Hvammsfjördur and Gilsfjördur. There were numerous reasons for selecting the present study area for investigating glacial morphology, sea-level changes and glacial history. It has been known for a long time for its fossiliferous sedimentary terraces and that includes the "type locality" for the Late Weichselian Saurbaer interstadial in

Iceland (Einarsson, 1978). In these parts of Iceland it is also most likely that the main ice-sheet met with an independant ice-cap in Northwest Iceland.

The main purpose of the study was to gather information on the glacial geomorphology and to search for suitable sites for further and more detailed studies of e.g. the lithostratigraphy and chronostratigraphy of the area. Strandline features were also mapped to get some idea of the sea-level changes in this region. By studying the available geological literature, interpretation of aerial photographs and field investigations, a geomorphlogical map has been produced.

The area is characterized by the 7-10 ma old tertiary flood basalts. The regional dip is to the SSE and dikes trend NE-SW (Saemundsson, 1979). Gabbro intrusions occur e.g. north of Hafratindur. According to the geological map, acid rocks are more common in the eastern part of the area (Kjartansson, 1969). An unconformity can be traced from Tindar on Skardsströnd in the SW to Kollafjördur in the NE. Fossiliferous sediments within the lavapile have been found at Tindar (Jőhannesson, 1980).

Fluvial and glacial erosion has sculptured the landscape since the Tertiary and formed fjords, valleys and cirques. Steep cliffs above talus slopes, rockslides and alluvial fans are common landforms along the valley sides and in coastal areas. Very few parts of the basaltic plateau seem to have been left untouched by the overriding glaciers.

The glaciers and glacial rivers have deposited glacial, glaciomarine and glaciofluvial sediments in almost every valley of the area. These are recognised as various terraces and as marginal landforms. The Late Weichselian transgression of the sea often caused cliffs and raised beaches to be eroded into these landforms. Such landforms are most prominent at Saurbaer and in Hvolsdalur and Stadarhőlsdalur. The top of the marine terraces of Tjaldanes and Holtaland is at about 45 m a.s.l.

2 PREVIOUS INVESTIGATIONS.

2.1 Glaciations.

Thoroddsen (1905) was of the opinion that Iceland was almost completely covered with ice at the time of the last glacial maximum, except for a few nunataks at the glacier margins. As for Vestfirdir, he thought it had a separate ice-cap, with outlet glaciers reaching into the sea and many nunataks along its fringes. He assumed the boundary between the two ice-caps to have run along Gilsfjördur (Fig. 1 and Plate 1).

Thórarinsson (1937) drew a simular picture of the glaciation in Northwest Iceland and compared it to the present situation at Southeast Vatnajökull. Einarsson (1968) suggested that most of Iceland was covered by ice, but that Vestfirdir and Snaefellsnes had independent ice-centers or ice-caps, seperated from the main ice-sheet.

Not much has been written as too the extent of glaciers in the Breidafjördur region during the Weichselian maximum glaciation. The adjoining areas, Vestfirdir in the northwest (Lárusson, 1975, Sigurvinsson, 1983, Hjort et al., 1985) and Borgarfjördur in the south (Ingólfsson, 1984, 1985), have recently been investigated regarding glacial history, deglaciation and sea-level changes during Late Weichselian time.

Kjartansson (1955) was of the opinion that glaciers had flowed into the Breidafjördur basin from Hvammsfjördur, towards northwest. A glacier flowing from northeast, that is from Gilsfjördur and the mountain area north of the fjord should then have forced the Hvammsfjördur glacier to change course towards west.

On the Icelandic shelf west of Breidafjördur Olafsdottir (1975) observed a morphological feature that has been interpreted as an end-moraine, representing the maximum extent of the Weichselian glaciation in this region.

Jóhannesson (1986) is of the opinion that ice free areas probably excisted in the study area during the Pleistocene, but he does not specify the time any further. Sigbjarnarson (1983) assumes that the main Icelandic ice-sheet confined several dynamic centra during the Pleistocene glacials and that there were ice-free areas, especially on promontories and slopes along the coast.

2.2 Marine terraces and sediments .

North of Gilsfjördur Thoroddsen (1891) found terraces, of marine origin, at 39 and 72 m a.s.l. He thought that the marine limit here (at 70-80 m) was of Late Glacial age. Along the south shore of Gilsfjördur, he found terraces at 30-50 m at Saurbaer and at 30-40 m a.s.l. at Tjaldaneshlíd, Fagridalur and Gröf. Further he mentioned localities with subfossil marine molluscs at Núpur (Nípur, Fridriksdóttir, 1978) and Saelingsdalsheidi (probably meaning Tverdalur, Bárdarson, 1921). A marine limit of 100 m between Skard and Stadarhóll was reported by Pjeturss (1910).

The most thorough investigation of the sediments at Saurbaer was made by Bárdarson (1921). He interpreted the terraces of Tjaldanes and Holtaland as Late Weichselian terminal moraines. He also assumed that later, when the glaciers retreated, the sea transgressed up to c. 80 m a.s.l. He mentioned geomorphological features at the mouth of the tributary valleys in the area which he thought were terminal moraines from a second glacier stillstand. The locations of marine terraces mentioned by Bárdarson are: Tverdalur, Tverfell, Belgsdalur, Hvítidalur, the head of Hvolsdalur, Máskelda, Efri-Brunná and Holtaland.

Through studying the mollusc fauna Bárdarson (1921) visualized the environment during sedimentation in Saurbaer. Among the molluscs he found was the high-arctic species Portlandia arctica. Subfossil localities mentioned are: Tjaldanes, Ekruhorn and Holtaland near the present shore and Belgsdalur and Gullmelur in the tributary valleys. Bárdarson was of the opinion that the fossiliferous sediments at Tjaldanes and Holtaland were deposited while the sea-level stood 40-45 m above the present one and that the sediments in the tributary valleys were deposited a little later and after a marine transgression up to c. 80 m a.s.l. He assumed that the glaciers terminated in the tributary valleys at this later stage. Bárdarson also investigated fossiliferous marine and littoral sediments which he thought had been deposited during the following regression of the sea in this area. ^{14}C-dating of a sample from the Ekruhorn sediments gave 11.620 $\pm$ 240 BP (Kjartansson, 1966).

A list and a map have been published of the localities in Iceland, where Late Weichselian and Early Flandrian subfossils molluscs are found (Fridriksdóttir, 1978). On this list there are 10 localities in the Saurbaer area and the Museum of Natural History stores samples from 8 of these localities.

3 METHODS.

3.1 Literature.

Considerable time was spent on studying literature concerning the investigated area and the Pleistocene geology of Iceland in general. This study took place both before and after the fieldwork was carried out. As evident from the foregoing chapter not much has been written of the glacial geology in these parts of Iceland. The main work on the subject is that of Bárdarson (1921).

3.2 Maps and aerial photographs.

The geological map of Iceland, sheet 2, West-central Iceland (Kjartansson, 1968) is not a very detailed map, but it indicates alluvial sediments in most valleys of the area and in the Saurbaer lowland. It also shows to what extent these areas are supposed to have been transgressed by the sea in

Late Weichselian time. Localities of observed fossils and glacial striae are marked on the map. Other maps used are topographical maps from the Icelandic Geodetic Institute (1974, 1984) and from the U.S. Army Map Service (1949-1951). Aerial photgraphs were used to map geomorphological features, locate sediment exposures, beach ridges, etc.

3.3 Field methods.

The field work was mainly performed in the lowlands and valleys. Overview photographing was attempted for the whole investigated area, and interesting sites were photographed in detail.

Locating and preliminary interpretation of geomorphological features was done with help of maps and aerial photographs. Altitudes of beach ridges, wave-cut cliffs, terraces and other features indicating former marine levels, were measured with an aneroid altimeter of the type Paulin. For correction all measurements were either linked to mean sea-level or localities of known altitude. Because of unstable weather conditions and continuous changes in atmospheric pressure, control measurements should have been performed at relatively short intervals. In the present investigation the interval of reliability is estimated to $\pm$ 5 m. The search for suitable sites for sedimentological studies was not very successful. Therefore little has yet been done to relate the morphology of the mapped sediments to their sedimentological and lithostratigraphical characteristics. Previously known locations of fossiliferous sediments were investigated and sampled for future ^{14}C-dating. The subfossil mollusc samples will be the subject of a separate study. Therefore only sample numbers are given in this report. Glacial striae were noted in a few places.

4 DESCRIPTION OF THE GEOMORPHOLOGICAL MAP.

After completion of the fieldwork the data was compiled, and a second stereographic interpretation of the aerial photographs performed - now with the aid of gathered field data and photographs. The result of this was then projected on to a map base, producing the geomorphological map in 1:100 000 (Plate 1). The base for it is the topographical map of Iceland in 1:100 000 (Landmaelingar Islands, 1974, 1984).

Primarily the map shows those sediments which in some way or other can be connected with former glaciations. Also strandlines and raised beaches have been mapped. Two areas, Saurbaer and Fagridalur, are presented in separate maps in 1:50 000 (Fig. 2 and Fig. 3).

The description of the geomorphological map treats different subareas, starting farthest west, with the islands Fremri-Langey and Efri-Langey at the mouth of Hvammsfjördur, from there travelling eastwards along the south shore of Gilsfjördur. The geomorphological features shown on the map are: 1) **Unclassified marine terraces.** 2) **Unclassified supramarine terraces.** When the lithology is complicated and poorly known and the certain origin of these formations therefore unknown, they are shown on the map as undefined terraces - marine or supramarine, depending on wether they are situated under or above the marine limit. 3) **Sandar and deltas.** This classification is morphological, but also based on scattered observations in exposures. 4) **Terminal moraines.** In a few places the innermost part of the terraces is defined as a terminal moraine, because of what is interpreted as an ice-contact slope in the valley. 5) **Till.** Areas of irregular topography are classified as till areas. The material is poorly sorted with angular boulders on the surface. 6) **Drainage channels.** Channels cut into sediments and bedrock, are interpreted as lateral, subglacial or overflow channels. 7) **Terrace edge/ Erosional scarp** and 8) **Beach ridges.** These are the evidence of a higher marine limit in Late Weichselian time. 9) **Levelled** surfaces. Important terrace surfaces, wave-cut cliffs and beach ridges. 10) Fossil localities. 11) Sediment exposures.

4.1 Langeyjarnes-Ballarárhlíd.

Islands and skerries nearly close the mouth of Hvammsfjördur, in the coastal area west of Klofningur. Almost all of them show evidence of marine erosion and some have a thin sediment cover. Slope activities beneath the mountain cliffs have destroyed nearly all sedimentological evidence of former glaciations, but morphological evidence does remain.

In this region it is of interrest to measure glacial striae because it is assumed that the two main glacier-flows on in Hvammsfjördur and the other in Gilsfjördur coalesced off the coast west of Klofningur. For the purpose of gathering data, Langeyjarnes and Ballarárfjall were visited. Only very few striated surfaces were discovered. They indicate a glacier mowing towards NW at Langeyjarnes and W on Ballarárfjall. Bedrock surfaces are heavily weathered and striation was only noted on recently uncovered surfaces. On Ballarárfjall there is a thin till cover with patterned ground.

Sedimentary terraces containing subfossil molluscs were observed at Melar. Other parts of this area are covered by peat, with occasional rocks penetrating the surface. The skerries off the coast might have assisted in preserving the sediments at Melar by preventing marine erosion. An exposure in the c. 12 m high beach cliff shows the following sequence (Plate 1 exposure (H)): At the bottom a c. 10 m thick unstratified, silty diamicton with outsized clasts and an increasing sand content upwards. Then a 1.5 m thick bed of stratified sand with lenses of gravel and on top a 0.5 m of gravel. The topmost two meters of the diamicton contain subfossil molluscs (sample: Ballará (1)).

Alluvial fans have developed below Ballarárdalur an Deildarár-gil. Raised beaches were not observed in this area. Most of the lowland must however have been inundated by the sea in Late Weichselian time.

4.2 Villingadalur.

Villingadalur is one of the longest valleys in this area, about 10 km. It is narrow with only two small tributary valleys in the south. The highest surrounding mountains reach 600 m. In front of the valley there is a fairly broad strandflat and steep cliffs with talus slopes, on either side of its mouth. A dominant feature is a number of extruding dikes, which are obviously more resistant to erosion than the surrounding bedrock.

It is easy to see that this valley was glaciated, but it is difficult to classify the sediments and the landforms. The sediments were accumulated behind a bedrock threshold. They may have been deposited at the snout of a glacier. An alluvial fan from Krossárdalur has been deposited on top of the sandur and delta in the valley. Approximatly 3.5 km inside the A farm the following sequence was noted (Plate 1 exposure (I)): In the river bed a c. 4 m thick silty, waguely stratified diamicton containing outsized clasts and layers of sandy gravel. On top of this bed are 2-3 m of gravel with rounded boulders.

The sediments of Villingadalur have been transgressed and the evidence are wave-cut cliffs and beach ridges up to 73 m. The most distinct cliff is that of 58 m a.s.l. All the farms in this area are situated on the strandflat in front of the valleys.

4.3 Skard.

Skard is a low passage to Búdardalur in the east, its highest point c. 120 m. Dikes are also prominent features here as in

Villingadalur e.g. Manheimatindar. In the westernmost parts of Skard, east of the farms, there is an accumulation of sediments behind a rock bar. In front of a small moraine ridge the sediments are interpreted as sandur and delta, later affected by marine erosion. It is suggested that a glacier has at some stage flowed over Skard from Búdardalur.

Parts of the rock bar at Skard forms a wave-cut cliff. Beach ridges on the terraces reach the level of 86 m. The farms are situated on a lower terrace at 66 m. Wave-cut cliffs exist at even lower levels. Below 30 m a.s.l. the area is characterized by bare cliffs, fens, small lakes, island and skerries.

4.4 Búdardalur.

The section between Skard and Búdardalur consists of a narrow coastland, with abraded cliffs and occasionally a thin sediment cover. Terraces are not found below the steep talus slopes. The same description can be applied to the coastal area east of Búdardalur, all the way to Nípur. At its mouth the valley is N-S oriented, but turns to E-W at Barmsgil. It is a long and deep valley, 600 m in its innermost parts. Some of the highest surrounding mountains reach 800 m and the mountain Svarthamar has a plateau surface. Dikes stick out on the surface in many places e.g. at Tindar. Dikes also form the feature called Steinboginn east of the Búdardalur farms. On aerial photographs Steinboginn looks very much like a small moraine ridge.

Large sediment terraces in the valley are the remnants of former sandar and deltas. Búdardalsá and the creeks in the valley have cut channels through the terraces. Evidence of transgression in this valley are wave-cut cliffs in the sediments at 46 m and beach ridges up to 67 m a.s.l.

4.5 Nípurdalur.

Nípurdalur has no lowland and little sediments within itself. South of Nípurdalur there is a large cirque with Svarthamar as the west and south rim and Sandfell as the east rim. Both mountains are more than 700 m high.

The reason for including this area in the present description is that in front of the valley, near the shore, there are sediment terraces, where small exposures of silty diamicton contain fragments of subfossil molluscs.

4.6 Fagridalur.

Fagridalur is a small valley (Fig. 2) with two tributary valleys on its east side, Geitadalur and Seljadalur. The highest mountains with Hafratindur reaching 923 m S and SE of Fagridalur. They are clearly sculptured by glacial erosion. Aretês, horns and cirques are common.

At the mouth of the main valley there are distinct terraces, a former sandur and delta, with wave-cut cliffs and beach ridges on their surfaces. Outside the valley area the sediment cover is thin and with the bedrock protruding through it. The innermost part of these terraces is interpreted as a terminal moraine and a till area.

All the sediments below the marine limit at 78 m a.s.l. have been affected by marine erosion. Wave-cut cliffs at lower levels in Fagridalur are found at 65, 46, 29 m a.s.l. The best sediment exposures are on both sides of the rivers Fagradalsá and Seljadalsá. On the west bank of Fagradalsá, the following sequence of sediments was observed in an exposure immediatly northeast of the terminal moraine (Fig. 2 exposure (J)): Resting upon striated bedrock, a c. 7 m thick unstratified, silty diamicton containing outsized clasts, then a 10-12 m thick bed of stratified sand with gravel lenses. On top there is a c. 4 m thick bed of horizontally stratified gravel with rounded boulders. The section is interpreted as a till overlain by glacifluvial sediments.

There are no terraces south of the till area in Fagridalur. The valley is characterized by steep valley sides, talus slopes and alluvial fans. On the north face of the mountain Torffjall, west of Tjaldanes, at Digrimúli, is a sediment terrace with beach ridges on its surface.

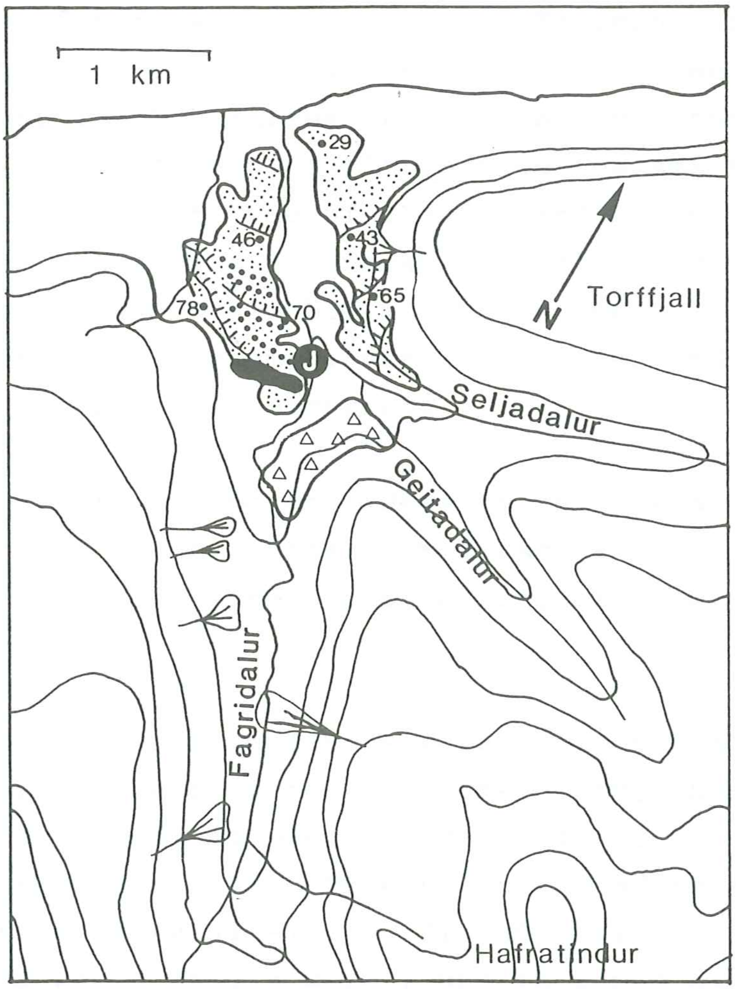

Fig. 2. Fagridalur subarea. For legend see plate 1.

4.7 Saurbaer.

Saurbaer is the name of the area including amongst others the valleys Stadarhólsdalur and Hvolsdalur (Fig. 3). In the present description this region is divided into three different sections: 1) Tjaldanes-Holtaland which is the foreland of the main valleys, its most prominent features being terraces 40-50 m a.s.l. 2) Stadarhólsdalur running towards the southwest and 3) Hvolsdalur towards southeast.

4.7.1 Tjaldanes-Holtaland.

As mentioned before the terraces of Tjaldanes and Holtaland are assumed to be terminal moraines of Late Weichselian age (Bárdarson, 1921). Marine erosion has sculptured these terraces and 30-40 m high cliffs face the sea to the west and northwest. The altitude of the lowland behind the terraces is only a few meters a.s.l. Because of slumping and solifluction few exposures are available in the sediments. The best localities are along small creeks, ditches and places where slumping has recently occurred.

Wave-cut cliffs and beach ridges on the terrace surface up to a level of 47 m and subfossil molluscs at 15-20 m a.s.l. show that the sediments were deposited in, or later transgressed by the sea.

Samples of subfossil molluscs were collected at three localities: 1) West of the Tjaldanes farm, where slumping had recently occurred (sample: Tjaldanes (1)). 2) East of the river at Ekruhorn. Also here slumping had recently occurred (samples: Ekruhorn (1)-(4)). 3) Djúpidalur northwest of Holtahyrna where shells were found in loose excavation masses along the power transmission line (sample: Holtaland (1)). The mollusc samples at Tjaldanes and Ekruhorn were collected from a dark-gray, unstratified, pebbly, silty diamicton containing outsized clasts and gravel lenses. The frequency of shells increased upwards in the bed. Shells were also collected from the slump masses.

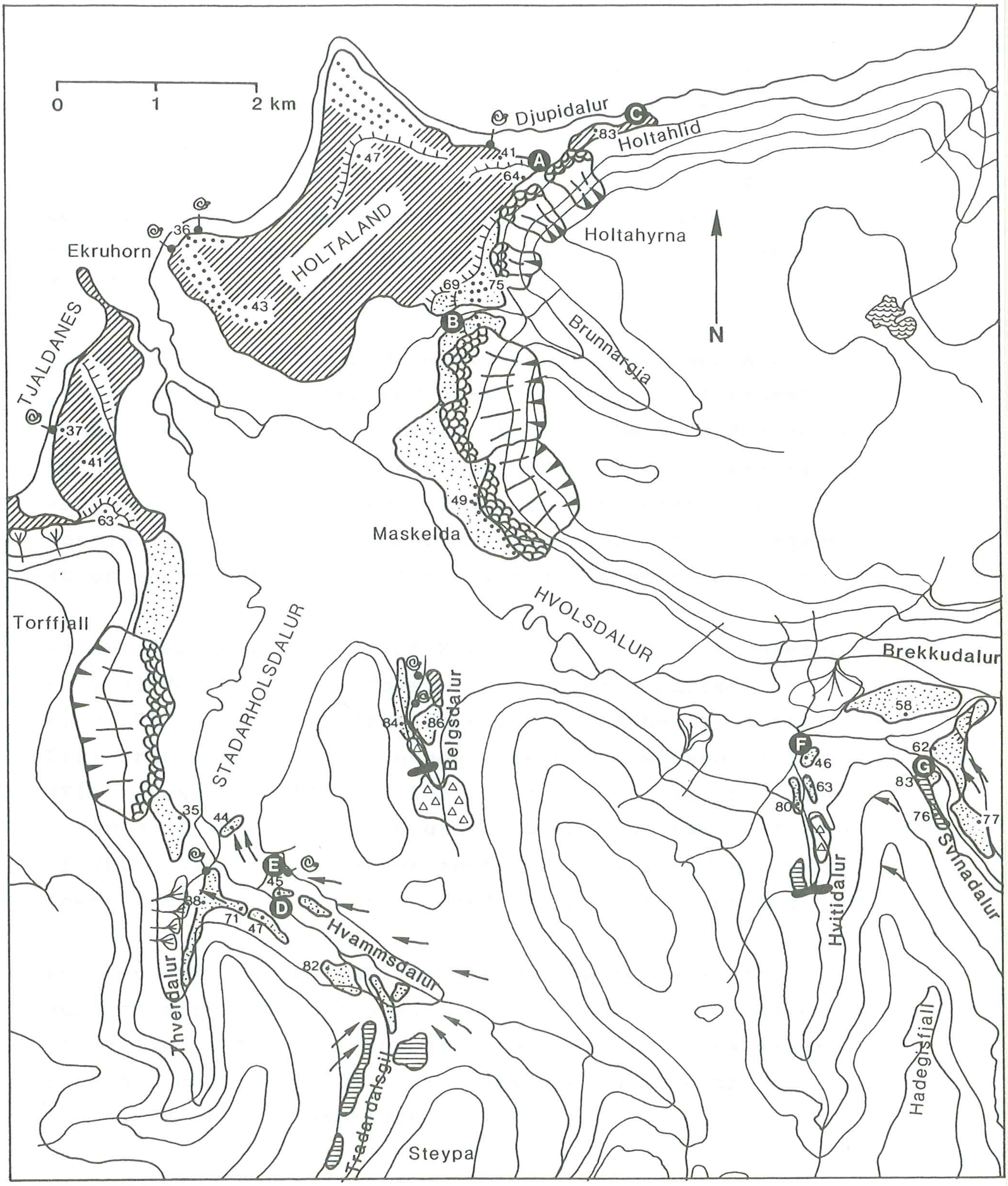

Fig. 3 Saurbaer subarea. For legend see plate 1.

In the eastern part of this area a few exposures in the upper part of the terraces were studied. In a gravel pit just west of Holtahyrna the following sequence was noted (Fig. 3 exposure(A)): At the bottom at least 1 m unstratified, silty diamicton. Then a c. 2 m thick bed of stratified sand, on top of which lies 4-6 m of horizontally stratified gravel and gravelly sand (in 10-20 cm thick layers). Large blocks, more than 1 m in diameter, originally part of the sediments are found in the gravel pit.

Here the above described sediments at Holtaland are interpreted as glaciomarine sediments overlain by littoral sediments. They indicate a former high sea-level and a regression in the area. Further investigations of the litostratigraphy and deformation of these sediments is necessary before concluding more about the glacial history of the region and about the exact origin of the Tjaldanes-Holtaland terraces.

An abraded terrace west of Brunnárgjá is partly covered by a rock-slide. Beach ridges on the terrace surface are noted up to c. 75 m. In a roadcut immediatly northeast of the farm Efri-Brunná the following sequence was observed from below (Fig. 3 exposure(B)): At least 2 m silty diamicton. Then c. 10 m of sand and sandy gravel with a westward dip, on top of which lies c. 1.5 m horizontally stratified sandy gravel. These sediments are interpreted as part of an eroded delta.

Further east, at Holtahlíd, there is a terrace with its surface altitude 83 m a.s.l. An exposure in a roadcut shows stratified sediments consisting of 2-20 cm thick layers of sand and cobbly gravel. The beds are faulted and dip 20^{o} to the north (Fig. 3 exposure(C)).

4.7.2 Stadarhólsdalur.

This description treats the area south of Tjaldanes. The main valley running north-south is Stadarhólsdalur, which further inland is divided into Hvammsdalur and Thverdalur.

Tradardalsgil is a tributary valley to Hvammsdalur. The altitude of the surrounding mountains is 300-400 m reaching 900 m in the south. A big rockslide has fallen from the east side of Torffjall.

Only small terraces are in the main valley north of the mouth of Thverdalur. The terrace "Gullmelur" rises above the valley floor where Thverdalur and Hvammsdalur meet. "Gullmelur" and the terraces in Hvammsdalur are interpreted as a delta and sandur. Rhythmic sediments were discovered in Hvammsdalur, half a kilometer northwest of the farm Kjarlaksvellir, immediately north of Hvammsdalså. Two exsposures were studied. One was situated just above the river bed and another one along a small stream, north of the Hvammsdalur road. Down by the river (Fig. 3 exposure(D)) the beds consist of 0.5-2 cm thick clayey, silty beds alternating with 2-4 mm thick silty, gravelly sand laminae. Below, in some places, there is an unstratified silty diamicton containing outsized clasts and sandy gravel lenses. The thickest section of rhythmic beds is 6 m. On top are beds of stratified sand and gravel. North of the road (Fig. 3 exposure(E)) the rhythmic sediments rest on WNW-striated bedrock - c. 2 m of clayey silt beds alternating with silty, gravelly sand laminae with an upwardly increasing content of coarse material. On top of the rhythmics is a c. 0.5 m bed of stratified gravel. In Hvamms-dalur there is a rock bar north of the mountain Steypa. West thereof and in Tradardalsgil are distinct terraces. Some of their sediments are assumed to be remnants of a valley fill and some to be part of a lateral terrace, but here they are mapped as unclassified supramarine terraces. A valley fill is behind the threshold in Hvammsdalur. These terraces are most likely of sandur and delta origin overlying till. The terrace of Tradardalsgil contains a great deal of unsorted material. Characteristic for both Hvammsdalur and Tradardalsgil are the great number of drainage channels, cut both into sediments and bedrock.

There are two generations of terraces at different altitudes in Tverdalur and Hvammsdalur, one at c. 80 m and another

c. 45 m a.s.l. Subfossil molluscs were discovered and collected at "Gullmelur" in Tverdalur, at 49 m a.s.l. This is probably the same locality mentioned by Bárdarson (1921). The shells could not be traced to a definite bed within the sediments, but seem to be concentrated to a silty, sandy bed and are mostly associated with black, scattered and porous boulders. Features that look like beach ridges on the terrace surface are most likely lateral drainage channels cut into the sediments.

It seems that the main glacier flow in this area was in Tradardalsgil. At some stage a glacial lake or shallow fjord occupied this area allowing the deposition of rhythmic sediments. It is however not possible to exactly define the position of the glacier front at that time.

4.7.3 Hvolsdalur.

This part treats the area from Tjaldanes and Holtaland into Brekkudalur and Svínadalur, including the tributary valleys Belgsdalur and Hvítidalur (Fig. 3). The surrounding mountains reach 500-600 m. The whole area is clearly glacially eroded, but glacial sediments are mainly found on the valley sides and at the mouth of the tributary valleys and not in Hvolsdalur.

At Máskelda, a former gravel pit is what is left of a terrace with a superimposed beach ridge at 49 m a.s.l. The terrace is assumed to have formed as a sandur or delta.

In Belgsdalur the altitude of terrace surfaces was determined to 86 m a.s.l., but no definite evidence of marine erosion exist here. Large blocks and boulders are though common on the surface of the eastern terrace where it extends into Hvolsdalur. A till covered area lies in the inner part of the valley. Subfossil molluscs were found in the sediments of the western terrace in two places at 56 and 44 m a.s.l. respectively . The stratigraphy could be studied in an exposure along a small stream. At the 44 m level fossils were found in a bed of gray, unstratified, gravelly, silty diamicton with occasional outsized clasts. On top of it lies a bed of stratified sand and gravel (sample: **Belgsdalur (3)** and **(4)**). At the 56 m level subfossils were gathered from the talus slope, c. 100 south of the small stream and it was unpossible to trace the exact origin of the shells (sample: **Belgsdalur (1)**).

Part of the sediments in Belgsdalur could just as well have been deposited by a Hvolsdalur-glacier as by a glacier in Belgsdalur, but the present data is not diagnostic in that matter. Terraces at lower lewels are situated at the farms Stóri-Múli and Litli-Múli.

Neither glacial deposits nor marine terraces are found between Belgsdalur and Hvítidalur. Well developed alluvial fans are west of the farm Hvítidalur and above the farm Fremri-Brekka.

Hvítidalur is a hanging valley to Hvolsdalur. Below its threshold are small terraces. In a gravel pit, east of the river Húsá (Fig. 3 exposure(F)), the sediments are foreset bedded and dip 26° to the north. The beds consist of 10-20 cm thick layers of poorly sorted, silty, sandy gravel and sandy gravel. Some layers are 1.0 m thick. 13.5 m of the beds are exposed and they are interpreted as the remnants of a delta.

Behind the threshold the deposits resemble a valley fill which further south in the valley is interpreted as a till area ending in a terminal moraine across the valley with an ice-contact, southward slope. The morphology is also influenced by the underlying bedrock. Drainage channels are observed on Hádegisfell, the mountain between Hvítidalur and Svínadalur.

The main terraces of Hvolsdalur are at the head of the valley, where Svínadalur meets Brekkudalur. They are interpreted as sandur and delta. Terraces west and southwest of the farm Bessatunga are at higher altitudes and are interpreted as lateral terraces. North of the farm the terrace edges are at

62 and 82 m a.s.l. They mark the highest sea-level in innermost Hvolsdalur.

Opposite the Bessatunga farm a gravel pit is cut in a lateral terrace (Fig. 3 exposure(G)). It exposes 20-40 cm thick beds of sand, with gravel lenses, alternating with boulder rich unstratified sandy diamicton, containing large angular blocks. The beds dip 10^{o} to the northeast and are interpreted as ice-contact sediments.

Definition of any icefront position is not possible on the basis of the present data on the sediments in Brekkudalur and Svínadalur. But the terraces at Máskelda and, opposite it at Belgsdalur may be the remnants of a marginal sediment accumulation. The drainage channels at Hádegisfell show that at some stage Svínadalur must have been occupied by a large glacier. The molluscs at Belgsdalur indicate a marine inundation to at least 56 m a.s.l.

4.8 Olafsdalur.

Olafsdalur east of Saurbaer is a short valley or an elongated cirque with very little lowland (Plate 1). The surrounding mountains reach between 400 and 750 m a.s.l.

The sediment terraces in Olafsdalur have clearly been formed in front of a glacier. Their innermost parts are interpreted as a terminal moraine, with a distinct ice-contact slope on its southern side. Rhythmic sediments are exposed behind the moraine (Plate 1 exposure(K)). These rhythmic sediments consist of 2 cm thick sandy silt beds with outsized clasts, alternating with laminae of 0.2-1 cm thick silty, sometimes gravelly sand. Some beds and laminae are draped over the clasts. Other sedimentary landforms in Olafsdalur are recent fluvial fans. At the mouth of the valley an alluvial fan has been built up from the west, by the river Lambadalsá.

Signs of high marine levels in the valley are beach ridges up to 74 m a.s.l. on the surface of the terraces. The altitude of the terrace east of the river is 40 m a.s.l.

4.9 Kleifar.

The bottom of Gilsfjördur is called Kleifar and there are only 3.5 km to the water-devide between Gilsfjördur an Bitrufjördur in the east (Plate 1). The mountains in the nearest surroundings seldom reach 500 m. On the west face of the mountain Bruni, lateral and owerflow channels, at about 400 m, show that a glacier has at some stage flowed towards the south in Brekkudalur.

At Kleifar and in Brekkudalur the terraces and their sediments are what is left of a sandur and a delta. The level of beach ridges and wave-cut cliffs is determined to 44 and 56 m a.s.l.

I suggest that a westwardly mowing glacier in Gilsfjördur may have supplied much of the sediments in the Holtaland terraces in Saurbaer.

4.10 Garpsdalur.

The mapping in Garpsdalur is mainly based on interpretation of aerial photographs and a short reconnaissance in the field. Here very distinct sediment terraces are interpreted as sandur and delta. The sediments were deposited in front of a glacier terminating in the outer part of the valley. The hollow left by the glacier inside the terminal moraine is now occupied by a lake.

Beach ridges on the terrace surface up to 90 m and a wave-cut cliff at 74 m a.s.l. are the evidence of high marine levels. This is the highest altitude of strandline features observed in the present study area.

5 SUMMARY AND CONCLUSIONS.

Most of the investigated area was covered by glaciers during the Weichselian maximum glaciation. During the deglaciation period, smaller glaciers must have existed in almost every valley along the coast, as indicated by the sediment terraces at the valley mouths. These terraces are variously interpreted as sandar, deltas, valley fills or till areas. The innermost parts of these features are interpreted as terminal moraines in Fagridalur, Belgsdalur, Hvítidalur, Olafsdalur and Garpsdalur .

The surfaces of the sediment terraces bear sign of marine erosion, in the form of wave-cut cliffs and beach ridges. During deglaciation the sea-level was high. The marine limit is around 75-80 m a.s.l. in most valleys. The highest measured strandline features are beach ridges in Garpsdalur at 90 m a.s.l.

No W-E shoreline gradient is evident within the area, but admitively my data is too scattered and undated to allow for any certain conclusion in this respect. However if further studies should prove that there really is no such gradient, then this is what would be expected in the region where the main Icelandic ice-sheet is supposed to have met with a separate Vestfirdir ice-cap. Terrace edges, wave-cut cliffs and beach ridges at lower levels indicate that during the general regression period sea-level may have remained more or less constant for an extended period of time during the formation of the Tjaldanes-Holtaland terraces. These terraces represent a sea-level at c. 45 m a.s.l. and according to a single ^{14}C-dating they are from around 11.620 BP.

The most interesting part of the map is that of Saurbaer, especially the Tjaldanes and Holtaland terraces and the valleys south thereof. Only here has evidence of two glacier stillstands been claimed to exist (Bárdarson, 1921), one across the valley foreland at Tjaldanes and Holtaland and a second one further inland at the mouth of the tributary valleys, Belgsdalur and Hvítidalur. But whether Bárdarson was right in drawing this conclusion can not be judged from the information now available. Detailed stratigraphical studies have not yet been carried out. During this study the main emphasis was placed on the glacial and marine geomorphological features and the geographical distribution of sediments. ^{14}C-analysis of the collected subfossil molluscs will at least enable these deposits to be more thoroughly dated and hopefully also throw more light on faunal changes during the Late Weichselian. One new fossil locality was discovered during the field-work.

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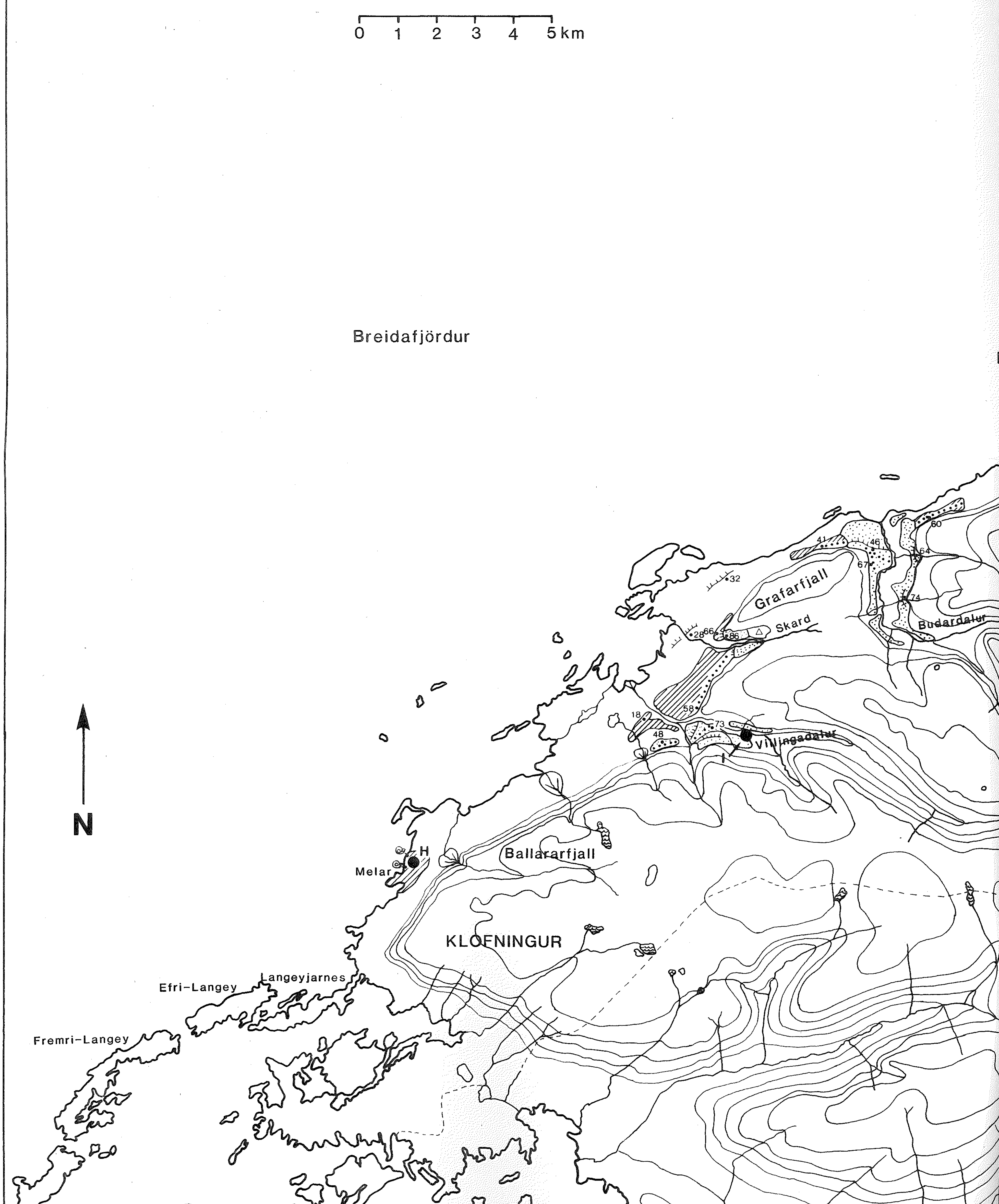
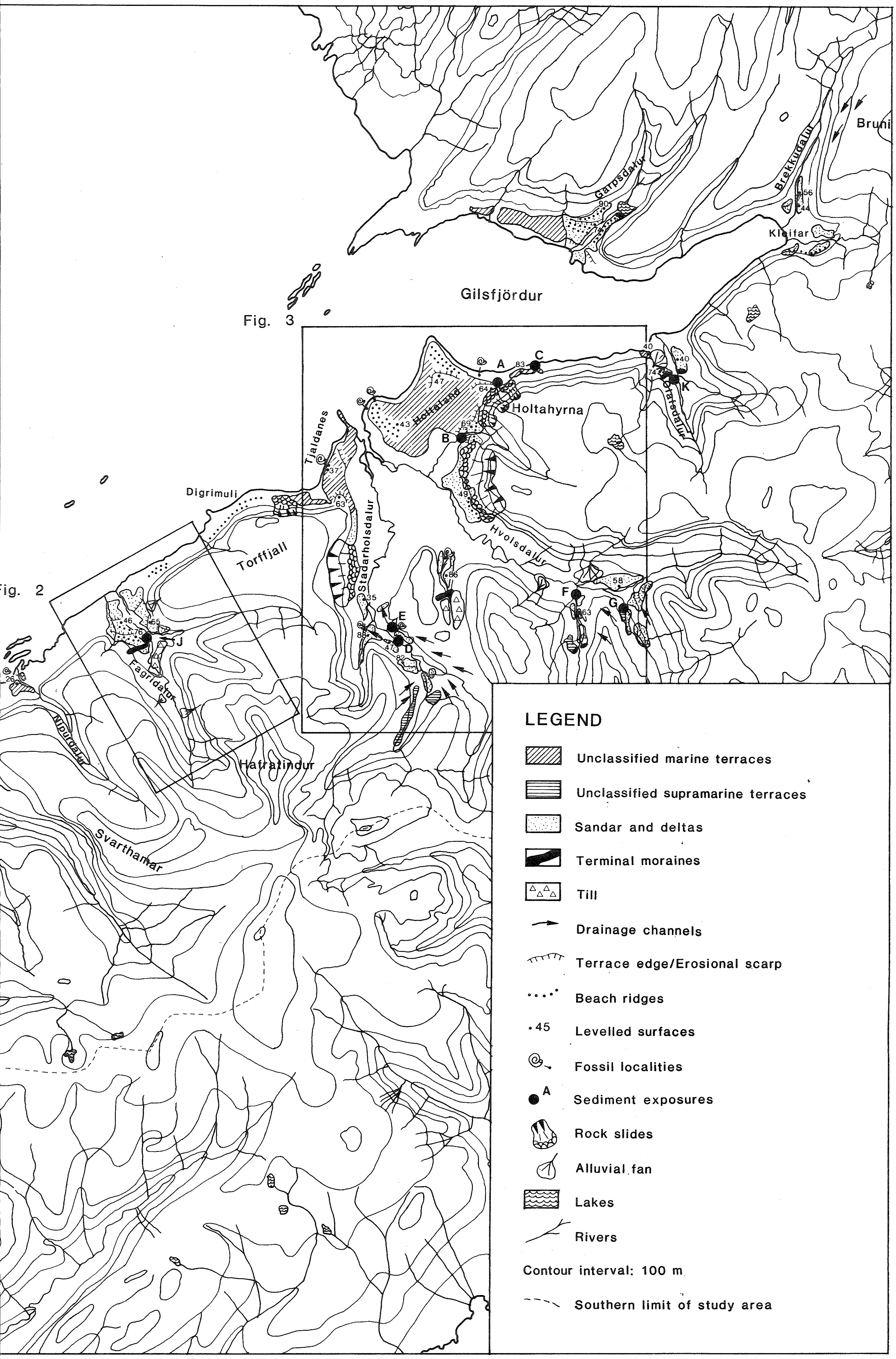
List of plates.

PLATE 1

GEOMORPHOLOGICAL MAP

SKARDSSTRÖND-SAURBAER





Gilsfjördur
Fig. 3
Fig. 2
Garpsdalur
Brekkudalur
Bruni
Kleifar
Tjaldanes
Digrimuli
Torffjall
Holtaland
Holtahyrna
Hvolsdalur
Stadarholsdalur
Fagridalur
Nipurdalur
Hafratindur
Svarthamar
A
B
C
D
E
F
G
J
K
LEGEND
Unclassified marine terraces
Unclassified supramarine terraces
Sandar and deltas
Terminal moraines
Till
Drainage channels
Terrace edge/Erosional scarp
Beach ridges
•45 Levelled surfaces
Fossil localities
Sediment exposures
Rock slides
Alluvial fan
Lakes
Rivers
Contour interval: 100 m
Southern limit of study area

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