# Moraine Systems in the Faroe Islands: Glaciological and Climatological Implications

**Ole Humlum, Hanne H. Christiansen, Harald Svensson & Lis E. Mortensen**

**Abstract**

*Geomorphological investigations on the Faroe Islands have shown the existence of small, but distinct moraine systems, indicating the former occurrence of glaciers. At least two glacial events may be distinguished: an older characterised by valley glaciers 2-4 km long, and a younger characterised by small cirque glaciers. Dating ($^{14}C$) indicates that the youngest moraines are older than 5,200 yr. BP. During the two glacial events the largest glaciers were located in cirques facing NE, while the smallest were located in cirques facing SW. During the two glacial events equilibrium line altitude was at 200-350 m a.s.l. and 300-450 m a.s.l., respectively. Glaciers of intermediate size were found in cirques facing NW and SE. This pattern is interpreted as being caused by strong snow drift from SW and W. The temperature and precipitation values during the glacial events are discussed with reference to measured meteorological conditions at modern glaciers.*

**Keywords**

*Faroe Islands, North Atlantic, Late Weichselian glaciation, North Atlantic Drift, cirque, moraine systems, palaeoclimate.*

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The Faroe Islands are situated in a sensitive region of the Atlantic Ocean for registering climatic changes. In warm periods, with generally strong, or northward-displaced, circulation features in the atmosphere and ocean, these islands lie continually in the main arm of the North Atlantic Drift (the Gulf Stream). In colder periods, when the North Atlantic Drift weakens or its main arms take a more southerly position, a tongue of polar water from the East Iceland branch of the East Greenland Current approaches the Faroe Islands from the north. When this happens, polar ice may partly surround the islands, as happened several times during the Little Ice Age (last time 1888 AD; see Lamb 1977). By this, the Faroe Island region is so placed as to register large amplitude shifts of the water current boundary in the North Atlantic, which generally are thought to fluctuate with the overall climate in the northern hemisphere (Ruddiman & McIntyre 1981; Bard et al. 1987).

During the Quaternary the Faroe Islands were several times covered by a local ice cap (Jørgensen & Rasmussen 1986). No foreign erratics have been found and the glacial striae radiate out in all directions from the larger islands. Geomorphic imprints of the Quaternary glaciations are largely in the form of erosional features, such as striae, roches moutonnées and U-shaped valleys, while depositional landforms are sparse (Jørgensen & Rasmussen 1986).

The present study intends, by means of a geomorphological analysis, to extract palaeoclimatic information from this part of the North Atlantic region. Air photo interpretation (1:10.000) of the Faroes with special respect to geomorphological indications of Late Weichselian or Holocene glaciation in high-lying cirques was initiated already in 1987 by two of the authors. Several promising localities were found and during 1994 and 95 field work were carried out in selected areas. Moraine systems were found at several localities, some of which are described in the present paper. The ages of the moraines are discussed, as is the character of the climate that produced the associated glaciers.

## Study Area: Topography and Climate

The Faroe Islands (Fig. 1) have a total area of about 1,400

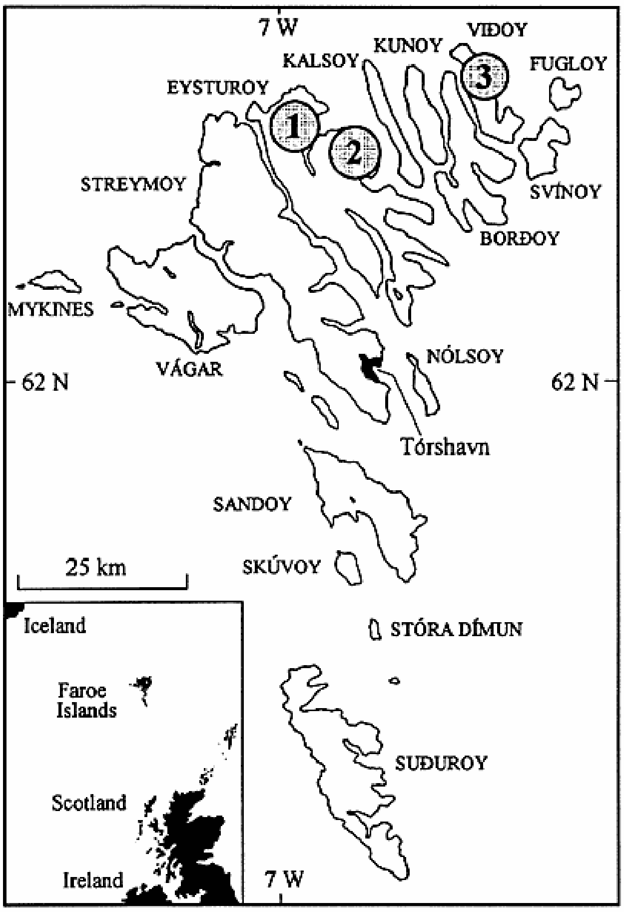


*Figure 1: Map showing the Faroe Islands and the study areas. 1: The study area at Slættaratindur, N Eysturoy. 2: The study area at Oyndarfjørður, NE Eysturoy. 3: The study area SE of Viðareiði, N Viðoy. The small inset map shows the general position of the Faroe Islands in the North Atlantic.*

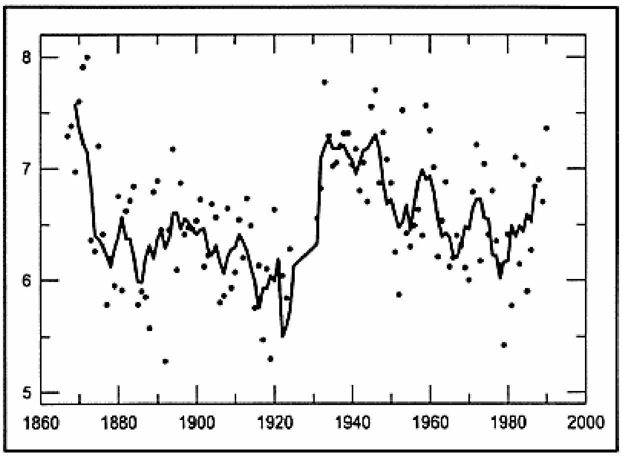


*Figure 2: Running 5-year mean air temperature (°C) in Tórshavn 1867-1990. Black dots indicate measured values for the individual years. Source: Danish Meteorological Institute (DMI), Copenhagen.*

$km^2$ and are situated between 61°20'N - 62°24'N and 6°15'W and 7°41'W. The distance from the southernmost to the northernmost point is about 113 km and the corresponding east-west distance is about 75 km.

The bedrock is Tertiary plateau basalts, with a total thickness of at least 5,200 m (Rasmussen & Noe-Nygaard 1970, Berthelsen et al. 1984). The landscape is a plateau basalt landscape with typical glacial imprints such as cirque carved lava plateaus and U-shaped valleys and fjords. The upper land surface rises gradually from about 600 m a.s.l. in the southwestern part of the islands to more than 800 m a.s.l. in the northeastern part. The highest mountain, Slættaratindur, reaches 882 m a.s.l. (Fig. 1).

The present climate of the Faroe Islands is strongly maritime in character, reflecting proximity to the sea and the moderating influence of the North Atlantic Drift. Summers are cool and winters mild. In general the present climate can be characterised as windy, changeable and humid. In Tórshavn the present mean annual air temperature is 6.5°C (1961-1990), with year-to-year variations of 0.5-1.5°C (Fig. 2). August is the warmest month with 10.5°C and the coldest is January with 3.2°C. The yearly mean precipitation is around 850 mm w.e. (water equivalent) in the west (Mykines) and increases to about 2,750 mm w.e. (Klaksvík) in the mountainous northern and eastern part of the islands. Mean cloud cover is about 80% in all seasons. The dominant wind direction is from the N, W and SE, while especially winds from E and NE are less frequent. During the winter, storms with very strong winds from the N are frequent (Hansen 1990).

Since 1867, when meteorological observations were initiated in Tórshavn, the mean air temperature has undergone significant variations (Fig. 2). During the 1920s and early 1930s the mean air temperature rose about 1.8°C, but afterwards a cooling trend has dominated until recent years. These variations probably reflect variations in temperature and intensity of the North Atlantic Drift. In the absence of the North Atlantic Drift winter temperatures would be 5-6°C lower than at present (Søgaard in press). The geographical position within a climatic sensitive region is emphasised by the 1.8°C mean air temperature rise in Tórshavn during the 1920-33 period, when the Earth mean surface air temperature rose just 0.1°C (Lamb 1989).

The knowledge of the regional climate of the Faroe highlands is poor. On mountain plateaus above 500 m a.s.l. the widespread occurrence of periglacial features, such as small sorted circles, stone stripes, deflation surfaces and -terraces, solifluction sheets and -lobes (Christiansen 1988), suggests a mountain climate characterised by extreme humidity and strong winds rather than extreme cold. Adopting a normal vertical lapse rate, the mean winter air temperatures in the high mountains probably lie between -0.3°C - 0°C, with yearly mean temperatures of 1°C to 4°C (Hansen 1990). Permafrost is absent, though annual ground freezing on high ground occasionally may be expected to reach depths of 0.5 m or more. Thus, the high Faroe mountains can be classified as a maritime periglacial region.

## Previous Work

The first to describe striae and roches moutonnées from the Faroe Islands as glacial phenomena was the British author Chalmers (1856), who stayed on the islands for a short period in 1855. He visited a locality at the settlement Eiði in the north of Eysturoy (Fig. 1), already described by Allan (1814), and concluded that the erosional phenomena were caused by ice flow from the north and that the Faroe Islands had been covered by an arctic ice sheet (Chalmers 1856). The work by Helland (1879) and Geikie (1880), however, showed, that the Faroes only have had a local glaciation. Geikie (1880) also described a possible interglacial deposit, near the town Klaksvík, a locality which was later studied by Rasmussen (1972).

During the Weichselian a local ice cap accumulated in the Faroes, covering the terrain up to at least 700 m a.s.l., and extending far beyond the present coastline out on the shelf (Jørgensen & Rasmussen 1986). Almost nothing is known about the Late Weichselian deglaciation on the Faroe Islands. No recessional or readvance moraine systems have been described, and only some dead-ice features and ancient medial moraine accumulations have been mentioned from a few major valleys on Streymoy (Sugden & John 1976 (p. 241), Jørgensen & Rasmussen 1986). It is thus not known when the islands became ice-free. The oldest relevant $^{14}C$ date is obtained from a lake bottom core at Hoydalar and gives an age of 9,660±150 yr. BP (Jóhansen 1975, 1985), indicating that glacier ice may have been present in the large valleys up to the beginning of the Holocene.

The question of short episodes of Holocene glaciation in the Faroes has not been addressed in the literature, but the possibility should, however, not entirely be ruled out. This issue will be further discussed later in the present paper. The work by Jóhansen (1985) on the vegetational history indicates that the early Holocene (Preboreal 10,000-9,000 yr. BP) climate on the Faroe Islands was arctic-subarctic with arrival of *Betula nana*. In Boreal times (9,000-8,000 yr. BP) the climate changed towards more oceanic conditions, with disappearance of *Betula nana*. Following the introduction of a rather warm and wet climate species such as *Juniperus* and *Salix* expanded, covering the lowlands, together with tall-herb vegetation and grass heaths. The Atlantic period (8,000-5,000 yr. BP) was wet, with evidence of strong leaching of soils. Peat began to accumulate, especially on high grounds. From the onset of the Subboreal (5,000-2,500 yr. BP), climate became cooler and wetter leading to widespread peat formation and decreasing amounts of *Juniperus* and *Salix*. Subatlantic time (2,500-0 BP) brought the arrival of man in two landnam phases, 600-700 yr. AD (monks from Ireland) and 800-900 yr. AD (the Vikings), and was punctuated by the Little Ice Age (1,400-1,900 yr. AD).

## Field Observations

The Faroe cirques and main glacial valleys are well developed (Fig. 3), but at first glance very few depositional glacial forms appear. No raised coastal deposits were

***Figure 3:*** *Glacial trough valley (Viðvík) with adjoining cirques in southeastern Viðoy, area 3 in Figure 1. The highest mountain (Sneis) reaches 634 m a.s.l. Seen towards SSE. May 1995.*

found. Except for the steep headwalls and exposed mountain plateaus, the terrain is usually mantled by Holocene blanket peat deposits, 0.5-1.5 m thick (Fig. 4). Interbedded within the individual peat layers several 0.5-2 mm thick grey fine-grained layers were observed in several localities. They represent Holocene ash layers, probably derived from Icelandic eruptions (Thorarinsson 1981), as has been described by Waagstein & Jóhansen (1968) and Mangerud et al. (1968) from deposits cored in lake Saksunarvatn, northern Streymoy. Holocene ash layers of probable Icelandic origin have also been described from Iceland (Björck et al. 1992), Ireland (Pilcher & Hall 1992), Scotland (Blackford et al. 1992) and Germany (Merkt et al. 1993).

The widespread blanket peat at even high altitudes is important in that the peat not only insulates the underlying regolith from freeze-thaw cycles, thus preventing the development of periglacial forms, but also obscures many relict features that developed during the Late Weichselian period.

Detailed geomorphological mapping demonstrated the presence of distinct moraine systems in several cirques and trough valleys. Most of these moraine ridges are small-scale features, less than 1-5 m high, but in certain valleys they are prominent, 10-15 m high, and may even be observed in air photos (Fig. 5).

Distinct moraine systems were found in the upper part of valleys in NE Eysturoy, SE and N of Oyndarfjørður and around the highest mountain Slættaratindur (882 m a.s.l), and in N Viðoy (Fig. 1). Moraines are also found elsewhere but, in general, the moraines appear to be especially frequent and well developed in NE Faroe Islands. Three of the localities will shortly be described below.

The moraines at Viðoy are especially found along the northern and southern valley side of a large NE-exposed cirque, 5 km SE of the village Viðareiði (Fig. 6). The moraine ridges are 1-7 m high and consist of coarse talus-like material with very large (1-2 m) boulders scattered on the surface. Some of the protruding boulders are polished by winds from S and SE. The wind direction may be controlled by the local topography. The northernmost moraine ridge is covered by talus deposits at its upper end (Fig. 6), thereby probably indicating an age higher than Late Holocene. The upper end of the moraine ridges indicate a former equilibrium line altitude (ELA) of about 280-300 m a.s.l. The moraines together show the outline of

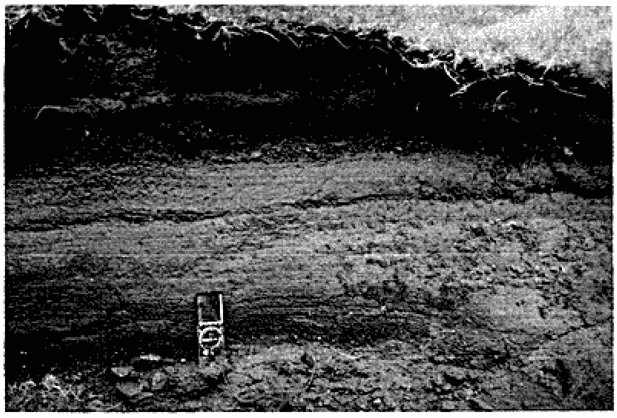

***Figure 4:*** *Holocene peat covering Late Weichselian or Holocene sediments (below the compass) in the upper part of a cirque NE of Slættaratindur, Eysturoy. A sample (AAR-2103) obtained from the lowermost peat layer was dated to 2,985±55 yr. BP. The profile is about 0.6 m high. August 1994.*

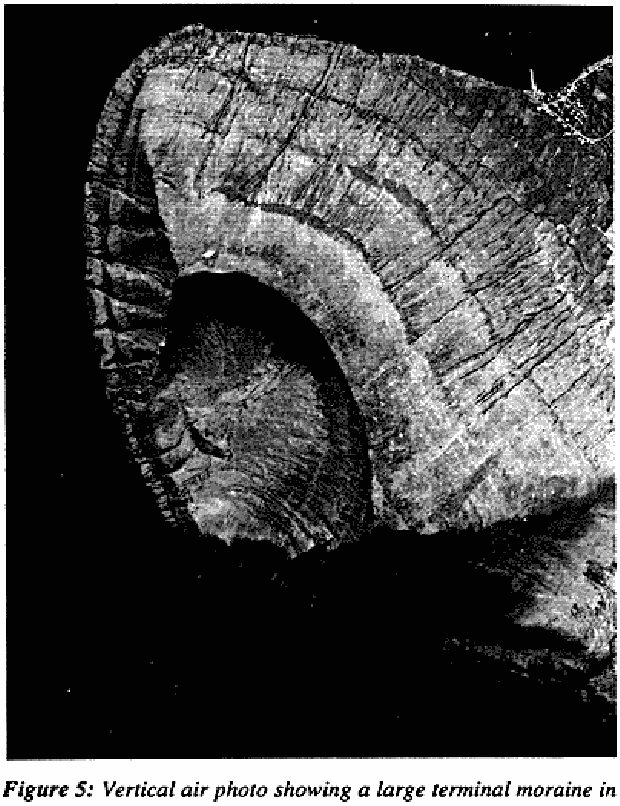

***Figure 5:*** *Vertical air photo showing a large terminal moraine in Trølldalur, N of Oyndarfjørður, area 2 in Figure 1. The ridge, which seen shortly above the cirque mouth, is 10-15 m high and indicates the former existence of a small cirque glacier with ELA at about 270 m a.s.l. The valley mouth measures about 750 m across. North is towards the bottom of the photograph. May 1970.*

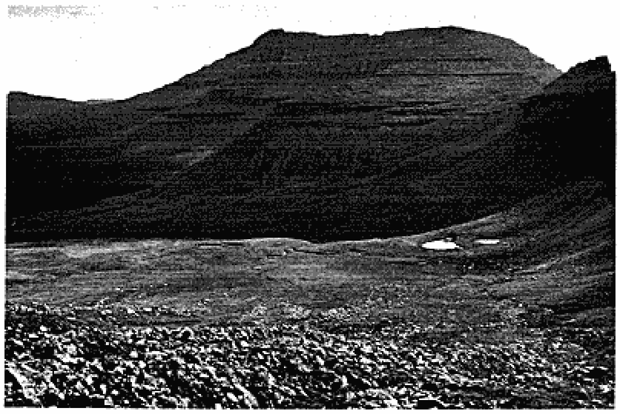

*Figure 6: Large NE-exposed cirques with left lateral moraine ridge, SE of Viðareiði, N Viðoy, area 3 in Figure 1. The moraine ridge starts at ca. 290 m a.s.l. (at the two lakes) and indicates a contemporary ELA at this altitude. Accumulation of peat inside the moraine ridge started 2,680±70 yr. BP (AAR-2105). Seen towards SE. August 1994.*

*Figure 8: Terminal moraine ridges (white arrows) terminating at 385 m a.s.l. in N-exposed cirque, Svínabotnur, northern Eysturoy, area 1 in Figure 1. This well-defined moraine ridge can be followed up to about 440 m a.s.l. (position of former ELA). Accumulation of peat inside the moraine ridge started 5,150±90 yr. BP (AAR-2104). Seen towards SW. May 1995.*

*Figure 7: Remnants of left lateral moraines deposited by a valley glacier flowing towards north (right) in Dalurin, northern Eysturoy, area 1 in Figure 1. The uppermost occurrence of this moraine system indicates a former ELA at about 270 m a.s.l. The visible part of the valley side is about 150 m high. Seen towards W. May 1995.*

a 1.5 km long valley glacier with terminus at 60 m a.s.l., with smaller cirque glaciers to the N and S. Accumulation of peat inside the moraine ridge started 2,680±70 yr. BP (AAR-2105).

In the Dalurin valley, N Eysturoy, remnants of lateral moraines were found along the western valley side (Fig. 7). These moraine ridges are 2-6 m high and indicate the former existence of a 2 km long valley glacier flowing towards N. Several systems (5-6) of ridges are deposited below each other during minor advances during a general retreat following deposition of the outermost moraines. The moraine ridges have later been truncated by Holocene streams flowing down the valley side and are also modified by solifluction. The upper end of this moraine system points towards a former ELA of about 270 m a.s.l. Farther down the Dalurin valley, at the village Gjógv, remnants of an older and even more subdued moraine system are found, deposited by a 3.5 km long valley glacier flowing towards N and NE. During the period where this older system was deposited, again judging from the uppermost occurrence of the moraine ridges, the ELA was about 180 m a.s.l.

In the uppermost part of the Svínabotnur, N Eysturoy, a terminal moraine system consisting of two ridges was found (Fig. 8). The system indicates the former existence of a small cirque glacier, about 350 m long and flowing towards N. Compared to the above mentioned moraine systems these moraines have a more fresh appearance with steep slopes and many angular blocks protruding from the surface and may indicate a limited readvance or reglaciation. The moraine ridges are 1-5 m high and consist of talus-like material derived from the prominent headwall above (Fig. 8). The moraines can be followed up to 440 m a.s.l., which probably indicate the local ELA then. Accumulation of peat inside the moraine ridges started 5,150±90 yr. BP (AAR-2104). Farther down the valley, remnants of other moraine systems were found, but with a much more subdued appearance.

## Discussion

The moraines ridges observed indicate the extent of glaciers during at least two glacial stages. The uppermost, such as the moraine system in Svínabotnur has a much more fresh-looking appearance than e.g. the moraines at Gjógv, which are more subdued due to solifluction and fluvial activity. In general, the older moraine systems were deposited during at least two glacial stages characterised by 1-4 km long valley glaciers, while the younger moraines correspond to a (third ?) stage with smaller cirque glaciers, only 0.3-0.5 km long (Fig. 9b). It is not yet completely clear if the small cirque glaciers are contemporary with the younger of the two valley glacier stages, or represent an individual third glacial stage. This remains to be investigated by future investigations. However, all moraine systems observed indicate that the former glaciers were especially large in cirques and valleys facing NE, and smaller in cirques facing SW. In cirques and valleys facing NW or SE the glaciers were of intermediate size. Judging from the uppermost part of the individual moraine ridges, the mean ELA for the two stages can be estimated to around 200-350 m a.s.l. and 300-450 m a.s.l., respectively (Fig. 9b).

In most cases the younger of these two moraine systems are surprisingly fresh looking, with many protruding angular blocks (Fig. 8). The frequent component of talus-like debris points towards the importance of rockfalls from the free rock faces above the glaciers. The older sets of moraines (Fig. 7) have been much more modified by subsequent solifluction and fluvial dissection. Protruding angular blocks are also less frequent. The general appearance and topographical position of the youngest moraine ridges (Fig. 9b) signal a readvance or renewed glaciation period, while the older moraine ridges may have been deposited during a previous, general deglaciation period.

To obtain information on the age of the observed moraine systems, samples from the lowermost 2-3 cm of the basal peat layer, inside certain moraine ridges, were collected for $^{14}C$ dating (Table 1). Ages are all within a range of about 2,500-5,200 yr. BP, and all the observed moraine systems are therefore older than the Little Ice Age. The Little Ice Age hypothesis of a Late Holocene (Sub Atlantic) glaciation on the Faroe Islands can thus be rejected.

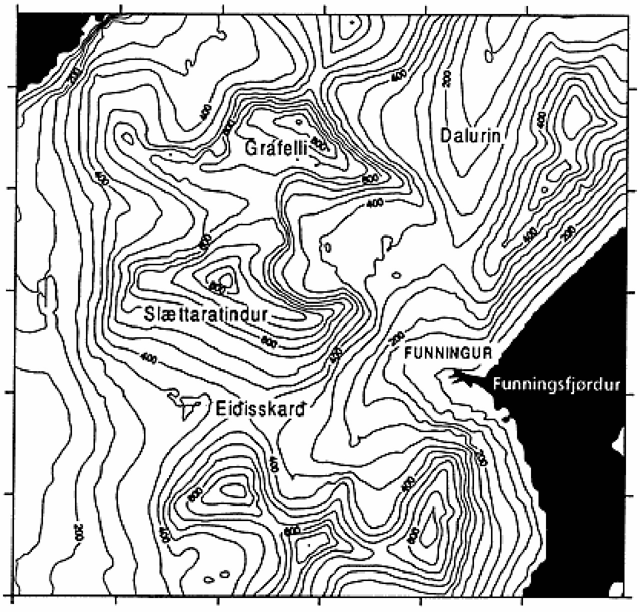


*Figure 9a: Topographic map showing the Slættaratindur (882 m a.s.l.) massive, northern part of Eysturoy, area 1 in Figure 1. Contour equividistance 50 m. Water is shown in grey. North is towards the top. Distance between border tick marks is 1000 m.*


*Figure 9b: Computer generated shaded relief map of figure 9a (light source in NW), showing moraine systems (black lines) and outline of reconstructed glaciers (white-grey and white). ELA in metres above present sea level. Values for ELA are positioned at the associated glacier outline. Subglacial longitudinal ridges (D) shown in dark grey. Question marks indicate cirques without visible moraine systems.*

*Table 1:* $^{14}C$ *dates (AMS) from the present study, reported in conventional radiocarbon years BP (before present = 1950). Samples were taken from the lowermost 2-3 cm of the peat layer.*

| *Sample* | *Collection site* | $^{14}$*C Age (BP)* |
|---|---|---|
| AAR-2103 | Basal layer in peat accumulation in cirque NE of Slættaratindur, N Eysturoy, 0.5 m below surface, 425 m a.s.l. | 2985 ±55 |
| AAR-2104 | Basal layer in peat accumulation inside moraine ridge in Svínabotnur, N Eysturoy, 0.4 below surface, 490 m a.s.l. | 5150 ±90 |
| AAR-2105 | Basal layer in peat accumulation inside moraine ridge in NW Dallying, N Viðoy, 0.3 m below surface, 260 m a.s.l. | 2680 ±79 |
| AAR-2106 | Basal layer in peat accumulation on Miðhagi mountain plateau, SE of Klaksvík, S Bordoy, 0.6 m below surface, 350 m a.s.l. | 2460 ±120 |
| AAR-2435 | Basal layer in peat accumulation above glaciofluvial sediments, S of Fjallavatn, Vagar, 1.8 m below surface, 110 m a.s.l. | 8110 ±160 |

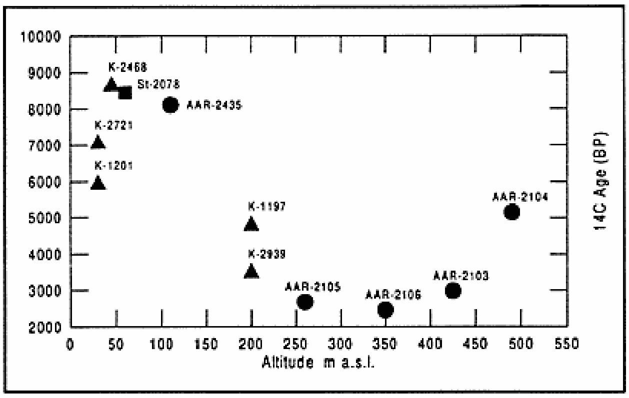


***Figure 10:*** *Altitude-age relationship of basal peat layer datings (*$^{14}C$*) from the Faroe Islands. Datings from Jóhansen 1985 (triangles), Persson 1971 (square) and the present study (circles). AAR-2103 is from the innermost part of the cirque NE of Slættaratindur (Fig. 4 and 9), AAR-2104 is from Svínabotnur (Fig. 8 and 9), AAR-2105 is from a cirque SE of Viðareiði, N Viðoy (Fig. 6 and 1). The sample AAR-2106 is from a mountain plateau with evidence of a former ice cap on southern Bordoy (Fig. 1). AAA-2435 is from a locality north of Fjallavatn, Vagar. All other samples (Persson 1971, Jóhansen 1985) are from bog localities in trough valleys on Vagar and Eysturoy, respectively, and were collected without special reference to moraine systems.*

In Figure 10 all known dates from the Faroe Islands on the initiation of peat accumulation are shown in an altitude-age diagram. Jóhansen (1985) suggested from five $^{14}C$ datings (K-1197, K-1201, K-2468, K-2721, K-2939) that peat formation started in low-lying areas around 7,100-8,700 yr. BP and extended upwards later in the Holocene. This hypothesis is further substantiated by the inclusion of the date St-2078 (Persson, 1977) and the five new dates from the present study (AAR-2103, AAR-2104, AAR-2105, AAR-2106 and AAR-2435). The date AAR-2104 (490 m a.s.l.), however, does not fit entirely within the general pattern. Peat accumulation may apparently have been initiated before 5,000 yr. BP even at rather high altitudes. The North Atlantic Holocene peat accumulation history has been investigated in Britain, where blanket peat formation was initiated in western uplands as early as 7,000 yr. BP (Pears 1975, Birks 1977), and peat accumulation on the Faroe Islands may have followed this general evolution, being situated only 300 km NNW of Scotland. The date AAR-2104 was obtained inside the youngest moraine system observed (Fig.8) and the corresponding glacial stage is thus more than about 5,200 yr. BP old. From this, a Mid Holocene (Atlantic) age can probably be ruled out for the last glaciation on the Faroe Islands.

The Early Holocene (Boreal) period before 7,000 yr. BP was characterised by warmer conditions than at present in Britain. In Late Boreal and Early Atlantic times mean annual air temperatures in England and Wales were 1.3-1.6°C higher than at present (Lamb et al. 1966), suggesting a Mid- or Early Holocene glaciation in the Faroe Islands to be unlikely.

From the above, the observed moraines derived from the youngest cirque-glacier episode (Fig. 9b) are tentatively ascribed a pre-Holocene age. The majority of reconstructed ELA are at about 300-450 m a.s.l., which is close to what would be expected by extrapolation of Younger Dryas ELA reconstructed in England, Scotland and Iceland (250-450 m a.s.l ; Sissons 1979 and 1980, Cornish 1981, Gray 1982, Ballantyne 1989, Ingólfsson 1985, 1987, 1988 and 1991). A proper dating of the moraines observed on the Faroe Islands has, however, not yet been possible. The geometry of the youngest moraine systems observed on the

Faroe Islands signals a readvance or renewed glaciation. The asymmetrical spatial glaciation pattern with especially large glaciers facing N, NE and E (Fig. 9b) suggests significant winter snow drift by winds from SW and W at that time.

The moraine ridges associated the previous glacial stage with valley glaciers (Fig. 7 and 9b) were perhaps probably deposited during a period of general retreat. The spatial pattern of glacier evolution was probably caused by snow drift from SW and W.

The altitude of the upper end of the observed moraines enables an estimate of the contemporary ELA, and from this, a reconstruction of certain aspects of the stadial palaeoclimate can be performed. The reconstructed ELA for the period with valley glaciers is about 200-350 m a.s.l., while it is about 300-450 m a.s.l. during the last glaciation episode with small cirque glaciers (Fig. 9b).

From a geomorphological point of view, glacier equilibrium lines are very important because they represent the lowest boundary of climatic glaciation. The climate that prevails at glacier equilibrium lines is considered to be just sufficient to maintain the existence of glaciers (Ohmura et al. 1992). Analysing the climatic control on ELA, it is usually considered appropriate to use at least two variables, precipitation and temperature, which represent the effects of accumulation and ablation, respectively. The climate at the ELA is known accurately on about 70 modern glaciers world-wide, where annual mass-balance measurements and meteorological observations have been carried out for a sufficiently long period. Figure 11 shows this as a plot of the mean yearly precipitation versus summer mean air temperature observed at these glacier equilibrium lines. From this empirical plot it clearly stands out, that as summer mean temperatures get higher, accumulation (precipitation) must increase to compensate the increased ablation.

Using modern meteorological observations from the Faroe Islands, where August is the warmest month with 10.5°C at sea level, and assuming a mean vertical lapse rate of 0.0065°Cm$^{-1}$, a modern mean summer air temperature of about 6.5-8.0°C can be estimated for the cirque valley bottoms (about 300-450 m a.s.l.), where moraine systems have been observed. As mentioned earlier, there are at present no data available on the mountain climate of the Faroes. However, adopting the above estimate, and using measured precipitation values, the higher part of the present Faroe valleys plots in Figure 11 as the shaded ellipse in the diagram. It correctly appears that the modern

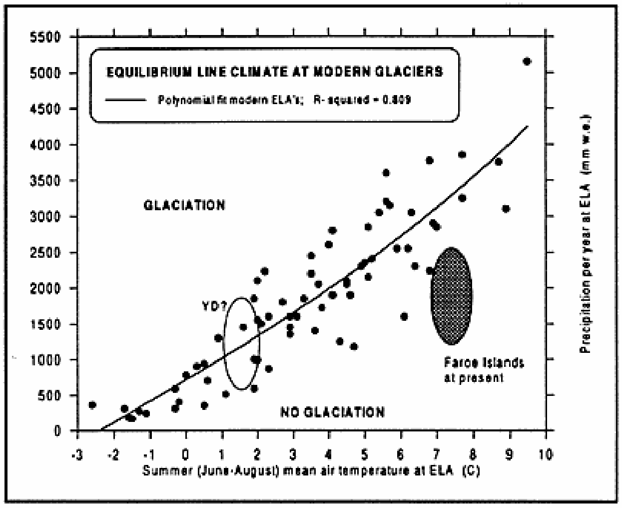


***Figure 11:*** *Annual total precipitation (winter mass balance plus summer precipitation) and the mean summer air temperature measured at the ELAs for 70 modern glaciers, using raw data from Ohmura et al. (1992). The solid line indicates a polynomial fit, yielding a coefficient of determination (R-squared) of 0.809 (N=70). The polynomium takes the form:* $Y = 713.098 + 300.597*X + 2.35328*X^2 + 0.540662*X^3$. *The hatched ellipse indicates the present position of mountains and cirques in the Faroe Islands. The open ellipse 'YD?' indicates the inferred position during Younger Dryas.*

Faroe Island cirques plots in the no-glaciation part of the diagram, although some of the highest mountains with maximum precipitation (northern and northeastern part of the islands) must be rather close to incipient glaciation. The higher part of the mountains (500-882 m a.s.l.) today is in a periglacial nival zone with widespread nivation features such as nivation hollows, fluvial snowmelt scars and niveo-eolian deposits, and some small perennial snowpatches. A lasting summer air temperature decrease of rather few degrees, say 3-4°C, would probably initiate small glaciers in several cirques in these mountains, even with a small decrease in precipitation.

In both England and Scotland (300 km SSE of the Faroe Islands), a Younger Dryas glacier readvance is both well documented and widespread. The limits of this readvance (the Loch Lomond Stadial) are usually defined by remarkable fresh glacial features such as moraines, drift limits and periglacial trimlines that mark the upslope transition from glacial drift and ice-scoured bedrock to terrain that bears the imprint of contemporaneous frost action (Gray and Coxdon 1991). These features have enabled geomorphologists to reconstruct equilibrium line

altitudes (ELA) during the Younger Dryas, and from this, to reconstruct aspects of the stadial palaeoclimate. In Scotland, average 'regional' reconstructed ELA rise gradually southwards from 495 m a.s.l. for the western Southern Uplands of Scotland to 540 m a.s.l. for the English Lake District and 600 m a.s.l. for northern Wales (Sissons & Southerland 1976, Sissons 1980, Cornish 1981, Gray 1982, Ballantyne 1989). Across the Scottish Highlands and Inner Hebrides, the ELA rise from around 300 m a.s.l. in the west to 1000 m a.s.l. in eastern Scotland (the Cairngorms). Sissons (1979, 1980) interpreted the spatial pattern of the Loch Lomond readvance to be controlled by southerly snow-bearing winds associated with eastward passage of warm or occluded fronts across northern Britain, with depressions following more southerly tracks than at present.

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