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THE NIVATIONAL LANDFORMS AND THE RECONSTRUCTED SNOWLINE OF SLAETTARATINDUR, FAEROE ISLANDS

The fact that snow and its effects may lead to the formation of distinctive landforms has been recognized for many years. This paper, based on fieldwork undertaken during the summer of 1963 by a member of the University College of Wales Study Group in the Faeroes, attempts to show how nivational landforms occur around Slaettaratindur and the bearing that they have on reconstructing the snowline for that part of the North Atlantic.

In 1894 the Irish geologist, Kinahan, wrote of blocky moraines and boulder littered slopes that result from the movement of scree and similar material down over a snow-patch. Such moraines and bouldery slopes were so common in Ireland that, according to Kinahan, the stones composing these features were known as *cloghsnatty* (*snow stones*) in Irish. In the United States geologists were also interested in landforms produced by nivational processes. Matthes (1899—1900) wrote of features developed in the Big Horn Mountains of Wyoming and Russell (1933) described features which he believed to be formed by material accumulating at the foot of snow-patches after sliding over the surface of the snow-patch. Behre (1933) described similar landforms in Colorado, terming them *nivation ridges* (p. 630). W. V. Lewis (1939) wrote of the action that occurs under and in front of snow-patches, frost shattering near the headwall and solifluction elsewhere. McCabe (1939) described essentially the same processes from his studies of snow-patches in Spitsbergen. More recently Botch (1946) has discussed snow-patches and the associated comminution and transportation of debris associated with them in the Urals. Watson (1964) postulates and describes drift platforms formed underneath snow-patches, referring particularly to landforms which exist in Mid-Wales. From these and similar researches it would appear that nivational landforms in mountain areas may include nivation ridges and platforms of debris.

Slaettaratindur (882 metres) is the highest mountain in the Faeroe Islands, being situated at 62°17′N, 7°W at the northern end of the island

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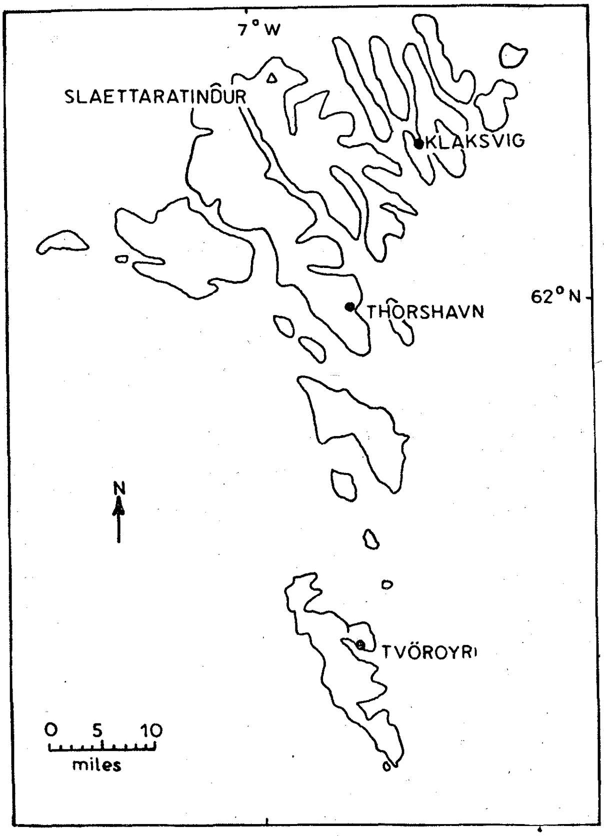

Fig. 1. Faeroe Islands. Location map

of Eysturoy. The solid geology of the area, as of most of the Faeroes, is essentially simple, consisting of a series of basalts and tuffs which dip to the south at 4°—8°. Lomas (1899) whilst describing the neighbouring island of Stremoy, wrote: ..."the lavas everywhere dip south-east at a gentle angle (3°)" (p. 513). Arising from the low angles of dip is one of the major features of Faeroes scenery, described by Grossman (1896) as "the straight horizontal outline of the mountain-tops" (p. 2). Glaciation has worked on this southerly dipping plateau to sharpen the landscape, leading to the formation of Alpine scenery with steep cliffs, *arêtes* and hanging valleys, features which dominate the scenery of the whole archipelago. Although little detailed work has yet been done on the glaciation of the area, it is patently obvious that, as Sømme (1960) says "... the Faeroes were principally a central erosion area". The present writer believes that periglaciation, too, was an important factor in shaping the landscape to its present form, a process which is still continuing (Lewis and Lass 1965).

The Faeroe Islands are also of interest in determining the height of the snowline, a feature which Manley (1949) has reconstructed for the eastern sector of the North Atlantic. Manley believes that the highest peaks in the Faeroes verge on the snowline, stating that "...among rather cloudy wet mountain groups in which snowdrifts may just survive, but not glaciers, we may include the northern Faeroe Islands. I have been informed that small snowbeds commonly survive near the summit of Slaettaratindur (882 m.) where the mean temperature for June—September should be about 5 °C." (p. 185). Since some workers believe that snowline reconstruction in mountainous areas may provide a means of comparative dating it is essential that accurate information should be obtained. Unfortunately, in recent years snowbeds do not exist throughout the year on Slaettaratindur, although local inhabitants state that it is often snow-covered from November onwards, with some snow-patches remaining until late June or July. The topographical evidence suggests that Manley placed the snowline at too low an altitude over the Faeroes and that the nivational landforms are largely fossil features, entirely cloaked with vegetation, and not actively developing as they should be were the snowline at a lower altitude.

THE NIVATIONAL LANDFORMS

The least common of the nivational landforms are the rock-cut benches, which occur in three valleys as shown on Table I.

Table I

The rock benches of nivational origin in Slaettaratindur

Valley	Altitude at the top of backwall	Altitude at the leading edge of bench	Axis	Angle of elevation from the leading edge of the bench to the top of the backwall
	Altitudes in feet			
Svinabotnur	1680	1460	283°	17°
	2190	1470	154°	
Givrarbotnur	2600	2100	248°	33°
Fremra Dalsa	1350	1160	SE	

Each bench (plate 2) takes the form of a ledge cut into the mountain--side. The ledges vary in width from a few feet to 45—50 feet and slope at angles of from 5° to 16°. Although it is likely that each bench originated on a break of slope due to differential rates of weathering of the bedrock, the benches transgress the bedding and must, therefore, have been accentuated by a major agent of erosion. Ekblaw (1918) has described the great benches that are formed by erosion behind and under lateral snow-patches in North Greenland, snow-patches which may have originated on minor ledges due to the local lithology. The benches of Slaettaratindur, due to their position in an ascending sequence of moraines, drift platforms and benches, and because of their morphology are believed to have originated by erosion behind and perhaps under relatively small snow-patches. These snow-patches may have originated on pre-existing minor breaks of slope which they have greatly accentuated. The benches are covered with loose boulders of varying size and shape. Vegetation, often no more than lichens and moss, grows on and between the boulders.

Table II

The snow-patch platforms of Slaettaratindur

Valley	Height at top of backwall	Bottom of platform	Facing	Angle of elevation from the leading edge of the platform to the top of the backwall
	Altitudes in feet			
Djupidalur	2300	600	W	30°—34°
Svinabotnur	2480	1320	103°	34°
	1910	1580	266°	33°
	1910	1630	242°	36°
Ambadalur	2200	1080	223°	31°—28°
	1850	1300	212°	25°
Gardadalur	2500	970	300°	18°—32°
Fremra Dalsa	1920	1350	E	38°

The snow-patch platforms were probably formed by the forward movement of material under the snow from a backwall towards the front of a snow-patch, possibly by the process of solifluction, in a way which has been suggested by Botch (1946). The resultant landform is a drift platform, often lobate and terraced, which nurtures a noticeably different vegetation from that of surrouding areas. The platform is sometimes built-up a few feet above the surrounding terrain (plate 3).

Eight examples of such drift platforms exist within the valleys surrounding Slaettaratindur (Table II, pl. 2). The leading edge of each platform is markedly lobate and well defined terraces occur on some of them (plate 3). The surfaces of the platforms are littered with many loose boulders which have, presumably been dislodged from the cliff above.

The third type of landform described, the nivation ridges, is essentially the same feature that Russell (1933) and other American workers have described on numerous occasions. These landforms appear to result from the accumulation of debris that slides down over the surface of a snow--patch to gather, often as a crescentic arc, at its base, as described by Behre (1933) and Sharp (1942) who described the features as an "accumulation of boulders which have rolled or slid across a snowbank at the foot of a slope" (p. 496). The form of the ridges is best seen from Plate 4 and from fig. 2. They are low accumulations of debris which seldom exceed

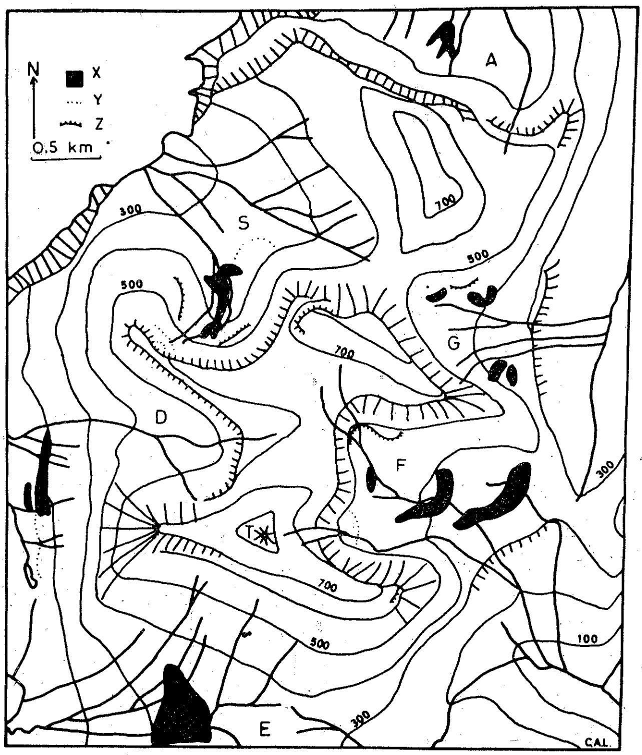

Fig. 2. The nivational landforms of Slaettaratindur, Faeroe Islands

A — Ambadalur; 2 — Djupidalur; E — Eidisskard; F — Fremra Dalsa; G — Gardadalur; S — Svinabotnur; X — nivation ridge; Y — snow-patch platform; Z — leading edge of rock bench of nivational origin; Contours every 100 metres; T — Slaettaratindur

10 or 12 feet in height and are often much less. They appear on the ground as low crescentic ramparts, grass covered and often with boulders lying on their surface. On the inner side of the ridge a boggy patch, or even a small pond, may exist. Unfortunately time did not allow for any detailed cross sections of these features to be surveyed.

Table III

The nivational ridges of Slaettaratindur (Altitudes in feet)

Valley	Altitude at the top of the backwall (in feet)	Altitude of the lowest nivational ridge (in feet)	Axis of ridge	Angle of elevation from the top of the ridge to the top of the backwall
Djupidalur	2300	700	118°	30°
	2300	780	123°	28°
Svinabotnur	2210	1230	155°—175°	28°
	2140	1350	222°	39°
	1680	1290	280°	15°
Ambadalur	2400	1080	223°	31°—28°
Gardadalur	2060	1070	268°	35°
	1540	1240	350°	$26^1/_2$°
	1540	1010	347°	26°
Fremra Dalsa	2000	1290	270°	23°—25°
	2000	1240	332°	14°
	2040	1150	353°	23°
Eidisskard	?	1060	108°	?

Table III clearly indicates that in the climatic conditions which have prevailed on Slaettaratindur the area suited for nivation ridge development has been between 700 and 1350 feet, a range of 650 feet. The angle of elevation between the top of the nivation ridge and the top of the backwall ranges from 14° to 35°. Unfortunately, only three valleys contain more than two such ridges so that it is difficult to establish a nivational chronology, except to say that the oldest ridge is that at the lowest altitude. The range in altitude within each series varies from 120 feet in Svinabotnur to 230 feet in Gardadalur.

Table II shows how snow-patch platforms cover a far greater range of altitude than do the nivation ridges or even the rock benches, covering a range of 1030 feet, from 600 to 1630 feet. Rock benches (Tabl. I) range over

940 feet reaching a maximum of 2100 feet. The conclusion drawn from these figures is that rock benches occupy the highest position and are thus likely to be the last stage in the process of nivational erosion. Platforms and nivation ridges, the latter being related to the former as field observations showed, are an earlier stage in the ascent of the snowline up the mountain.

Manley (1949) has laid considerable emphasis on the position of the lowest permanent snow-bed as being a clue to the present height of the snowline. Where there are no permanent snow-beds it might still be possible to determine the former height of the snowline that existed when the nivational landforms originated by using the information derived from these landforms.

The evidence afforded by Slaettaratindur suggests that climatic amelioration in the Faeroes proceeded gradually since all three landform-stages, namely nivation ridges, platforms and rock benches, are reasonably well developed around the mountain. The least well developed of these landforms are the nivation ridges, which are insignificant when compared with those of, for example, the Brecon Beacons of South Wales.

The snowline has been reconstructed from the nivation ridges evidence using Manley's formula (Manley 1949)[1] and Table IV shows its level at the time when the most recent nivation ridges were formed.

Table IV

The Reconstructed Snowline

Orientation	Altitude (in feet above sea-level)
West face	2207
North face	2547
East face	2526
South face	No reconstruction possible

Manley states that the snowline should be about 450 metres above the lowest altitude at which snowbeds survive in "exceptionally sheltered localities" (p. 186). The writer has taken the uppermost nivation ridge in each series to be indicative of the lowest snowbed altitudinally, and although the figures given in Table IV may be only approximate, it is almost certain that they reflect correctly the oscillations of the snowline from one side of the mountain to another. Thus the snowline would have been lowest on the west-facing slopes, even though they are the sunny slopes,

[1] See also Manley (1951).

and highest on the shaded north and east slopes. This pattern is in accord with the findings of Seddon (1957) for the whole of Snowdonia and Nussbaum and Gygax (1952) in Cantabria, although both articles deal with a mountain massif, rather than with a single peak like Slaettaratindur. Around single peaks in Snowdonia, however, Seddon actually found the moraines, or nivation ridges, to be lowest in the north-east facing quadrant. Charlesworth (1937) at least in his earlier works, believed that the snowline would be lowest on northern and eastern slopes, those which receive least insolation. This view is not supported by the evidence afforded by Slaettaratindur or by the evidence found in Snowdonia and Cantabria by the above workers. Neither does the extensive work of Ahlmann (1948) in areas around the North Atlantic support Charlesworth's views. The snowline evidence strongly suggests that when Faeroes' nivation ridges were formed, the prevailing snow-carrying winds came from the west, bringing heavy precipitation to the windward west-facing slopes.

The reconstruction of the snow-line, assuming that the figures given are accurate, also shows that the snowline lay below the summit of Slaettaratindur when the nivation ridges were formed but had risen above it by the time the rock benches were eroded. The importance of this fact cannot be shown without reference to areas outside the Faeroes. In the Brecon Beacons, the latest nivation ridges were formed when the snowline, derived by the method described above, lay above the summit of the mountains. One is tempted to suggest that the differences between the position of the snowline in these two areas was due to differences in precipitation, the snowline being depressed in areas of heavier precipitation.

The apparent absence of glacial moraines within the area of Slaettaratindur is most noticeable. At fjord level and below, there are magnificent cirque basins and many of the smaller islands, such as Koltur, Hestur and others, appear to be little more than the backwalls of massive cirques. Surrounding Slaettaratindur is a plateau at 700 feet above sea level, which bears all the traces of northward flowing ice of uncertain age, with rock--basin lakes and well defined striae. Above 450 metres the depositional features that exist appear to be due to periglacial rather than glacial processes.

CONCLUSION

Slaettaratindur possesses three main types of nivational land-forms, namely snow-patch platforms, nivation ridges and rock-benches. From the evidence provided by the reconstructed snowline it appears that these landforms were produced only when the snowline lay below the summit of the mountain and that from morphological and vegetational evidence, they are not now being significantly accentuated. The plateau surrounding the mountain bears witness to a period of intense glaciation. There are no permanent snowbeds on the mountain at the present time.

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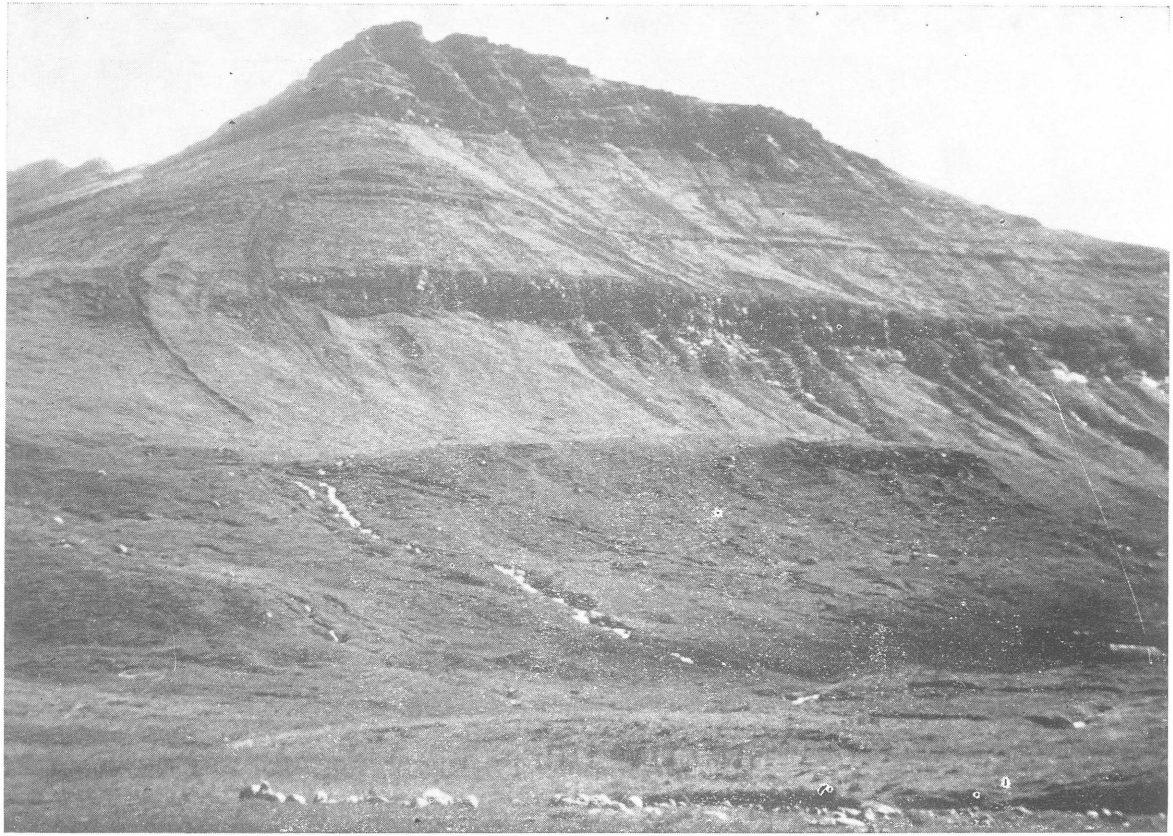

Pl. 1. The West Face of Slaettaratindur (882 metres), the highest point in the Faeroe Islands. The cliff is 500 metres high

Pl. 2. The rock-cut bench on the backwall above the nivational ridges in Svinabotnur. The leading edge of the bench is emphasised by the dark vegetation along the rills as they pass over the leading edge

Pl. 3. The snow-patch platform under the West Face of Slaettaratindur. The lobate terraces on the platform and the way in which the rills are cutting into the drift are very noticeable

Pl. 4. The nivational ridges of Svinabotnur. The snow-patch platform indicated on Fig. 2 appears in the top centre of the photograph, partly covered with large boulders