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Łódź

CONGELIFLUCTION LOBES ON THE SOUTHERN HORNSUND COAST IN SPITSBERGEN

Abstract

Congelifluction lobes belong to the most common periglacial forms in northern Sörkappland. They occur on surfaces sloping 3 to 20°. On the basis of the changes observed in congelifluction lobes and indicated by segment pegs and artificial stone stripes an attempt has been made to determine the annual value of displacement of the waste and the character of that displacement.

It is well-known that many investigators studying periglacial phenomena regard congelifluctional mass-movement as one of the prime morphogenetic processes in areas of cold climate and permafrost. The southern Hornsund coast affords ample evidence supporting this view. None of the periglacial structures is here as common and conspicuous as those due to congelifluctions. Congelifluctional mass-movement leads here to the production of structures referred to in the literature as solifluction tongues or lobes, small garland terraces, steeps, stone banked terraces.

Congelifluction lobes are very common in the northern Sörkapp. In its horizontal contour, their shape is that of tongues elongated in downslope direction. They have a more or less well-defined front, and side--ridges composed almost exclusively of angular debris. They occur as well on slightly inclines surfaces (3—5°) as on steeper slopes (15—20°) Sharp (1942) holds that a gradient of 5—15° is characteristic of such. formations. Below these values the lobes turn into elongated polygons, and above these values — into stone stripes. On the whole the values cited by Sharp are in accordance with the observations made in Sörkappland although lobes have been here encountered both below and above such slope gradients.

The congelifluction lobes occurring in the southern Hornsund coast may be roughly divided into 2 categories. The first comprises either poorly or entirely non-sorted formations, and the second — well-sorted lobes whose front and side-ridges consist of debris surrounding the earthy center of the lobe.

Forms belonging to the category of non-sorted lobes occur sporadically in places where a sufficient quantity of material of homogenous fraction is available and where the material tends in the direction of the finest particles. Such formations are most frequently found in moraines, in some of the steeper parts of the slope and, in a general way, in surfaces containing an abundance of fines. In the horizontal contour, these lobes have the shape of irregular tongues with uneven surfaces (pl. 1). Their sizes vary from 1—2 m in width and 3—5 m in length to ca 0,5 m in width and 1 m in length.

The category of lobes composed of sorted material exibits a series of structures differing from each other in both contour and size, though not in genetic character. The diversity in size and shape can here be attributed only to differences in topographic and morphologic situation and to the degree to which these formations are developed. On the basis of such characteristic, 3 types have been distinguished in the category of sorted structures.

Lobes that are largest but also least regular are encountered in the base part of talus cones. They approximately average 5—7 m in length, 4—5 m in width and the outward side of their front is often over 0,5 m in height. However, there are also larger forms e. g. those occurring on the slopes of Savitsjtopen. The arrangement of the material is in conformity with the contour of the lobe, that is to say that the largest particles lie in the border-zone of the structures forming their front and side-ridges, while towards the center, the particles become increasingly finer. Appreciable gradients up to about 14—16° and — if the debris is very coarse — even to 20°, are characteristic of that type of structures. Gravitative displacement of material largerly contributes to the formation and development of such lobes. This is principally due to the appreciable inclination of the surface on which they occur and to the availability of coarse material.

Such congelifluction lobes as those occurring in the upper part of a waning slope whose gradient decreases from 9—14° to about 6° belong to the second type of sorted forms. In the vertical section their shape is distinctly arcuate with both its wings curved in upslope direction (pl. 2). In length the forms vary from 1,5 m to 3 m and in width from 1 m to 1,5 m. The height of their front averages 5—10 cm on its inner side and 15—20 cm on its outer side. Both the front and the side ridges of the form are largely composed of coarse waste, whose shape is that of „dice" debris. The particles become increasingly finer towards the center until they change into mere fine dust with a random distribution of single larger rock fragments (fig. 1).

Structures of that type develop on surfaces where apart from angular debris, pulverulent fines are abundant. The shallow depth of permafrost in the spring (about 10—20 cm at the time of snow-melting highest degree of moisture) the material saturated with water to the limit of fluidity which is here very low (21—22%) as well as the cycle of alternate freeze and thaw create conditions promoting congeliflуctional displacement.

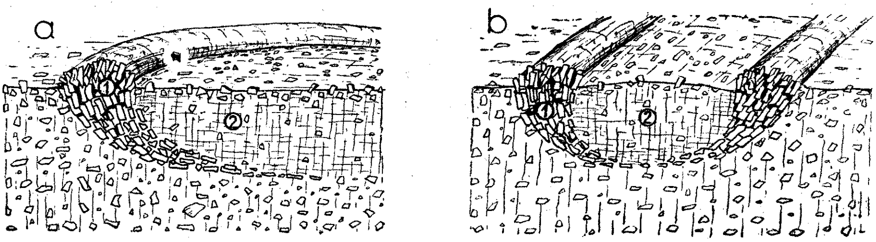

Fig. 1. Congelifluction lobe in the vertical (a) and the horizontal (b) cross section
1. angular debris; 2. earthy material with random distribution of angular debris

The third group of sorted congelifluction structures comprises such lobes as are characteristic of the downward part of wening slopes and of other more extensive, gently sloping surfaces where strongly comminuted material is sufficiently abundant. A typical feature of these forms is the considerable predominance of their longer over their horizontal axis, as well as less developed and less defined front and side-ridges. These structures have as much as 4—5 m in length and 0,5—1,5 m in width. Both front and side debris-ridges hardly ever exceed 5—7 cm. However in many forms of that type both front and side-ridges do not even rise above the level of the central part (pl. 3). Small gradient (not over 5°) and abundance of fine-grained waste are characteristic of such lobes.

In the vertical distribution, the forms described show a certain order. First appear large lobes that have formed on the base portion of talus cones. The upper part of the waning slope is the area of occurrence of lobes with well-defined debris ridges, while below, the downward part of the waning slope exhibits very elongated lobes belonging to the third type of sorted structures.

It should be emphasized that the formation of lobes is mainly controlled by such factors as: distance separating them from debris-slope, sharpness of limit between debris- and waning slope, quality of bedrock, conditions of moisture and density of the vegetal cover.

The nearer the debris-slope, the more well-defined and „lively" are the structures and the greater their distance from the debris slope the more they become increasingly flatter and the clear outline of the debris ridges and the earthy center become obliterated. Single lobes frequently encroach upon each other thus forming a number of storeyed small terraces. Such pattern has been observed in the slopes of Tsjebysjovfjellet, Sergeijevfjellet or Lidfjellet.

Both the size and the shape of the forms are clearly dependant on the character of the bedrock. Congelifluction lobes that form on slopes composed of schists entirely differ from those occurring on surfaces overlain by dolomite or sandstone waste. While the lobes that developed on schist bedrock are usually flat and relatively wide, the same forms occurring on dolomites are much higher and better differentiated into debris and earthy part.

An attempt has been made to evaluate the proportions and to determine the character of congelifluction movement on the basis of the changes occurring within the lobes. In 1957, several profiles of stakes have been installed within the lobes and in 1958 stone stripes have been extended across these forms. The profiles of stakes buried at various depth having become tilted out in downslope direction, subsurface movement of the waste must obviously be predominant. Also the segment pegs recorded differential creep of the material, as only 4 or 5 of the upper segments were tilted out of their vertical position. This shows that movement occurs only to a depth of ca 20—25 cm. These observations, would thus tend to confirm those made by Smith (1960) in Southern Georgia and by Jahn in Spitsbergen, since, according to these authors only 20—30 cm thick layer of waste is submitted to vigorous displacement. The value of horizontal displacement of waste may be inferred from the position of the segment pegs and from the distance to which the stone stripes were shifted. During the period from September 1958 to July 1959 the stone stripes became curved in downslope direction. The most appreciable displacement was about 10 cm, though such a high value was noted only in one lobe. In the majority of structures displacement attained scarcely 4—5 cm and in several it did not occur at all. The arcuate curvature of the stone stripes provides evidence of more rapid movement at the center of the lobe and slower movement at its margins (pl. 5).

All these observations reveal the preponderant role of congelifluctional mass-movement in the modelling of the surface. If the quantity of the material involved be taken into account, it becomes obvious why, inspite the negligible value of displacement, all the irregularities of the surface become rapidly levelled. To-day already, the surfaces of waning slopes are found to be perfectly smoothed as a result of several congelifluction lobes coalescing to form a large congelifluctional glacis (pl. 4), as are e. g. the glacis developed on the slope of the Wurmbrandegga in

Gåshamna, on the Höferpynten or on the valley side of the Ślakli, which also show smooth surfaces chiefly due to the downcreep of material.

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Pl. 1. Gåshamna. Non-sorted congelifluction lobe

Pl. 2. Gåshamna. Debris lobe in downward part of talus cone

Pl. 3. Gåshamna. Congelifluction lobes in waning slope

Pl. 4. Gåshamna. Congelifluctional glacis formed through coalescence of several lobes

Pl. 5. Gåshamna. Congelifluction lobe. Curvature of the stone stripe indicates value and differenciation of movement