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BLOCK FIELDS IN THE KHIBINY MTS.

Vast upland- and mountainous areas in the Khibiny are covered with a thick mantle of coarse angular rock fragments. These debris accumulations form various types of block fields, which differ in their morphology but are of similar structure and genesis. On the surface the block covers are composed of angular blocks 20 cm—2 m in diameter, derived from the local rocks. These accumulations of thick rock fragments formed the following types of block covers: block fields situated on the high plateaux, festoon-like block fields and block streams on the mountain-sides, and block covers on steep rock faces and at the slope foot.

Block fields usually occur in the central, slightly sloping parts of plateaux in the altitudes of 1000—1200 m (Pl. 1). At the edge of plateaux the block fields sometimes become terrace-like but more often they appear as stripes composed of large blocks or as colluvial (deluvial) covers interrupted by crystalline bedrock. Here, like in other mountainous areas, the distribution of block fields is dependent on the outcrops of rocks more resistant to weathering, for instance on the Rasvumchorr plateau the block fields occur in the zone of fine crystalline rischorites but they are lacking where the nepheline-apatite rocks outcrop to the surface and the waste particles are of sand size.

The block fields are dead forms, they do not display traces of any movement. Rock fragments are covered with the same waste as outcroping rocks. The position of blocks is stable, tufts of mosses and lichens are not deformed either torn along the block contact lines. Fine debris between the blocks provides further evidence that the block fields arose *in situ*, i. e. they are stagnant features. Many earthy islands scattered among the blocks are overgrown with turf.

Characteristic of the block field is a horizon of fine waste occurring between the rock debris and crystalline bedrock surface. The

blocks of the surficial horizon of the block fields are sometimes arranged parallelly and oriented corcondantly to the line of slope; often they are vertically oriented and fit tightly to each other. All these features as well as the transition of block fields into old polygon nets and stone stripes bear witness to the activity of processes in the formation of block fields.

Festoon-like block fields occur on the upper steep slope segments, sometimes descending to the birch zone. In plan they are crescent- or sickle-like and its convex front part is turned downslope. Near the upper nick point of slope, over which there is a plateau, the festoon-like block fields sometimes form uninterrupted chains or garlands stretched parallelly to the line of slope. Individual block fields of that type look like festoons or chain links.

Well developed festoon-like block fields were studied on the 30—40° slopes of the Yukspor, Fersman and Lyavochorr Mts. of meridian orientation. The largest parts of block fields reach up to 10—30 m in width. In the cross profile there can be seen in the frontal part a threshold 0.5—1.5 m high (e. g. when the slope gradient is 40° the block field surface slopes down at 25°). The threshold is best developed in the central part, whereas at the ends of the arch it is not detectable. The outline of the inward block field border is unconspicuous but it shows the sketch of an arch whose convexity is turned downslope.

The crescent-like block fields are composed in their surface horizon of rock debris 20—40 cm, and of blocks 1—2 m in size. The largest blocks are concentrated along the front which most often shows traces of degradation. When the block fields enter into the shrub zone some old birches can be seen just in front of the rubbles. In the back part of the block field, where large blocks are less numerous on the surface, sometimes small earthy islands overgrown with vegetation occur (in one of such islands there live ants just under the turf).

On the Yukspor Mt. side sloping 32° and of 500 m in altitude, the arch-shaped block field is composed of:

Horizon 1 (0—30 cm) — large, angular blocks of bedrock with an admixture of erratic pebbles

Horizon 2 (30—60 cm) — debris detached from bedrock with an admixture of alien gravels and small pebbles

Horizon 3 (60—80 cm) — fossil peat-humus soil horizon, dark brown in colour

Horizon 4 (80—130 cm) — coarse grained sand with an admixture of debris, strongly consolidated; brown in colour, lighter downwards (illuvial horizon of fossil soil)

Horizon 5 (130—138 cm) — coarse sand with an admixture of gravels, dark-grey in colour

Horizon 6 (138—150 cm, visible) — top of crystalline bedrock.

The presence of a thick layer of the fossil soil underlying block mantle proves that these block fields are of allochtonous type. The relict earthy islands are the evidence of upheaving processes causing the displacement of debris. The concentration of large blocks on the surface resulted mainly from the washing away of fine waste. Thus, the festoon-like block fields present the relict solifluxion phenomena, relatively stagnant under the present-day conditions in the mountainous tundra of the Khibiny, because of mechanic weathering which is rather insignificant as well as of the vegetation cover due to melt- and rain-water activity.

Block streams consist of coarse debris arranged in belts and stripes oriented parallelly to the slope. It may be the result of a smooth and poorly dissected relief of the bedrock surface which occasionally appears bare on the slope segments between erosional gullies. Block streams usually fill up the elongated depressions in the middle parts of slopes. Below one of such streams is presented:

On the northern side of the Vydyarchorr Mt., in the tundra zone there is a well developed block stream. This belt-like stream 8 m in width and 50 m long is composed of coarse debris. The blocks on the belt surface are from 20—30 cm to 100 cm in size. The block stream has the same gradient as the slope surface, i. e. 33—35°. The morphologic appearance of the debris stream speaks for its stagnancy; the blocks are covered with waste and show no traces of any movement.

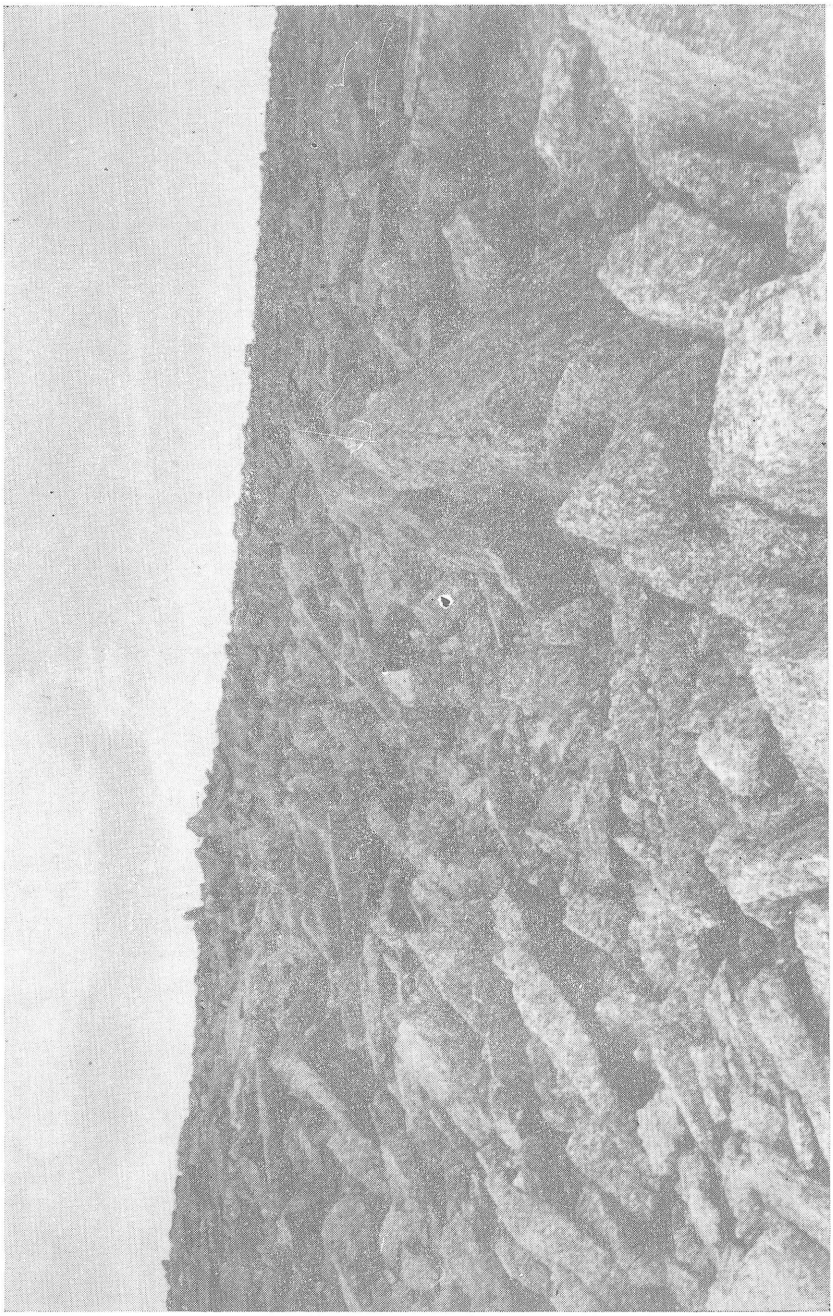
To estimate the rate of movement, some blocks were marked in the middle part of the stream. After one year of observations no movement of the whole block field either of individual blocks was recorded.

Thus, the morphologic features as well as the field observations prove that the block streams in the Khibiny are the dead relict forms. Some relatively fresh faces of blocks are due to the thermal cracking and insignificant displacement of waste caused by winter frost and snow pressure.

Block covers at the nick-lines and at the foot of slopes are characteristic of the tundra in the upper parts of valleys. Such an accumulation of debris usually occur in the contact zone between the slope and the valley bottom. The analogous forms, however, occur also on the higher slope portions where the block cover "lean" against a rock projection. Some of such block fields are spread over the area of several hundreds of meters. At the slope foot the outline of block covers is almost indistinct but their lower edge often has the form of an arch whose convex front is turned downwards. The turf covered front 0.5—1.0 m high, is a peculiar element of the block covers occurring at slope bases. The cross-section through one of such fronts showed that it is composed mainly of the organic-mineral mass, brown-grey in colour, with humus lenses in the bottom part. It seems probable that vegetation stoped the movement of blocks though the main hampering factor was a very sudden change of inclination in places where the block field passes from slope to the valley bottom. A sudden slumping of many blocks at digging the excavation proves that such block covers are not stabile forms. The instability is a feature acquired in time of the accumulation of rock blocks along the slope foot and at break-lines. Under the present-day conditions the block covers show distinct traces of gradual overgrowing with vegetation.

Geologic structure as well as the lack of any motion in all types of the block fields in the Khibiny Mts. nowadays, allow to regard them as relict forms. The widespread distribution of the overgrown block fields at valley bottoms gives evidence for the existence of frost heaved blocks and rock debris relatively not old; frost caused origin and relict character of block covers is very distinct (Perov, 1965). In the Lutnermajok river valley under a 50 cm thick layer of gravels and blocks there is a dome-like frozen fine waste bed deprived of larger rock fragments. The size of these mounds and their heights are similar to those of the earthy islands and stone polygons occurring near the block fields.

Besides the block fields in damp places, there can be seen in the valley bottoms some others entirely overgrown by the forest or tundra vegetation. Their relict character is doubtless and their structure clearly shows the traces of upfreezing of rock fragments. Below, there is a profile of section in the bottom of Poachyok valley at the foot of the Techtarporr Mt. in the tundra zone (the surface is overgrown with a dense cover of tundra bushes):



Pl. 1. Block field on the Lyavochorr plateau

Pl. 2. Structure of the debris-pebble cover on the slope of glacifluvial terrace in the Kukisjok river valley

1 (0—30 cm) — blocks and debris, void spaces are filled with peaty humus. Numerous rock fragments bear traces of "pitted" (atmospheric) weathering

2 (30—45 cm) — debris, gravel and sand, brown in colour, strongly compact

3 (45—105 cm) — dusty sand with an admixture of debris; tiny-scale structure, greenish in colour, brown in upper part (beneath the illuvial horizon)

4 (105—195 cm) — dusty-sandy material with debris and stones. Strongly compact moraine. Visible traces of tiny-scale structure in places of concentration of fine-grained material.

There are three conspicuous horizons: (a) non-sorted moraine deposits — horizon 4, (b) frozen fine waste partly changed by soil processes — horizon 2 and 3, (c) coarse rock fragments on the surface. The void spaces between the blocks were later on filled with peat. It is one more evidence of frost origin of the horizon deprived of stones as well as of the block cover itself which arose due to upfreezing of stones from the horizon of loose moraine deposits. The genesis of block covers is confirmed by analogous present-day debris- and pebble-covers which occur on the innundation terraces, on lake shores and more seldom on the convex segments of valley bottoms. The top, 5—10 cm thick, bed is mostly composed of debris or pebbles below which there is a horizon of fine waste 15—30 cm in thickness overlying non-sorted substratum deposits (Pl. 2). Under the present-day climatic conditions prevailing in the Khibiny Mts. the up-freezing of large rock fragments occurs almost only on high plateaux.

A short review of the main types of block fields in the Khibiny permits to present their general characteristics.

All the block covers are relict forms and show various stages of degradation and overgrowth by vegetation. Under the present-day conditions even the most dynamic slope block covers, i.e. stone streams, do not display any traces of movement; only debris- and pebble-covers are still in progress.

Most of the block fields are situated on slopes. They developed as the result of movement of the debris. Morphology and structure of the slope block covers attest their solifluxion origin. The variety of these covers results from the relief pattern. On the gently sloping surfaces of the plateaux, the terrace-like block fields were

formed whereas the festoon-like terraced covers developed on steep slopes with colluvial material; on steep rocky slopes the stone streams occurred, and along the slope foot at bases of rocky thresholds there were formed the block fields of the slope-base type with distinct frontal parts at their lower edges.

The thick peaty soils overlain by blocks give evidence of the downslope movement of the rock fragments after a long period of soil forming processes, i.e. after the period of insignificant slope processes. However, the simultaneity of old solifluxion and upfreezing of stones is not responsible for the same degree of preservation of the block fields under present-day conditions. The appearance of a block field depends on its position in one of the altitudinal physiographic zones, on the relief as well as on type of the block field itself. Some of block covers are completely overgrown by vegetation but many of them are well visible and undergo a slow overgrowth; however, there are also some which still display a slight movement, those are in equilibrium limit resulting from the angle of rest of the rock material.

The study on the block fields situated in the northern Ural in zone of the present-day glaciation allow to make some comparison. Stone streams are the most characteristic of the mountain sides which is connected with an intensive relief. One can readily observe the transition from block fields on the plateau to stone streams on slopes and from the latter to block covers at the slope foot. Like in the Khibiny, also here all types of block covers have features of the frost origin and are stable. Only some of them, which are composed of small blocks and are situated in the zone of activity of meltwaters derived from slope glaciers and from large snow patches, exhibit traces of vivid formation and movement of the material.

The genesis of block fields was referred by many workers mainly to weathering under the severe climatic conditions as well as to mass movements (K a p l i n a, 1965). The present writer agrees with the opinion of A. H a m b e r g, L. D., B e l o k r y l o v and others that frost-heaving was the principal agent in the origin of block fields (*cf.* Osnovy geokiologii, 1959). The results of the investigations in the Khibiny and in the northern Ural authorize to regard most of the block fields as the r e l i c t f o r m s of the H o l o c e n e l a n d - f o r m s.

Translated by Z. Apanańska

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