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PERIGLACIAL PHFNOMENA IN NORTHERN POLAND

Abstract

In northern Poland appear some traces of periglacial environment, which are connected with the decline of the last glaciation. On the area of the older substages of this glaciation nearly all periglacial phenomena are represented; the small elements of the periglacial relief pattern are also to be found. In Pomerania, however, the periglacial climatic conditions, associated with the period of the younger Dryas did not leave any morphological marks. It is only the particular periglacial structures, as ice wedges, free involutions and the slope deposits resulting from down-wash processes, that appear here.

Following some non infrequent opinions in the range of the last Pleistocene glaciation and in particular in the last substage of this glaciation there are no traces of the periglacial environment's influence. Also in Poland the North region extending on both sides of the lower Vistula is considered as beeing an area located formerly beyond the periglacial zone. The relief of this region presents forms of the glacial and fluvioglacial accumulation so distrinct and fresh, that it was used as the starting point in the glacial relief-forms srtucture research (*6, 8*). It was due to the accumulative landscape of this region that for a long time the area was a priori excluded from the periglacial terrain works.

During the field studies on periglacial phenomena led in different regions of Poland by the research-workers of the Institute of Physical Geography of the University of Łódź under the guidance of prof. J. Dylik have included the area of North Poland. Several departures to Pomerania in the years 1951, 1953 and 1954 enabled to collect the actual data. Suitable morphological and geological observations were made when looking for traces of the periglacial environment. It was noticed that in the meridional section following North the relief is more and more distinct, that individual landforms of the glacial accumulation are more and more „younger", as well as more typical and representable.

To the sphere of the occurring of the periglacial phenomena we may introduce also some generalisation. In the limits of the oldest, Brandenburg and Poznań substages of the glaciation Varsovien II we meet often the periglacial slope deposits with prevailing congeliflual structures. On the North and especially when we pass the marginal old glacial

valley of Toruń-Eberswald i. e. in Pomerania the slope deposits represent down-wash processes. The structures of free, unbound congelifluction are rather exceptional. We did not meet until now in Pomerania neither the structures of a bound congelifluction nor of bound involutions. It is also northward that the appearance of pulverulent formations, yet well distinct in the limits of the Poznań substage, is diminishing.

THE AREA IN THE RANGE OF THE BRANDENBURG AND POZNAŃ SUBSTAGE

The area is extending northward of the maximal range of Varsovien II i. e. from the line running in the West-East direction from Gubin on Nysa through Zielona Góra, terminal moraines of Leszno, Koło on the Warta, Płock, Mława, Kolno and Augustów. As the northern border of this region is accepted the marginal glacial valley of Toruń-Eberswald and on the east side of Vistula the southern limit of the Masovian Lake-Land. It is a zone of a breadth which diminishes strongly toward the East running nearly in the direction of a parallel. In the range of the both older substages of the youngest glaciation is laying then the Land of Lubusz, the Greater Poland, the Kujawy and the Northern Masovia [1].

Ice wedges. Generally they are not great reaching the average length of 1—1,5 m. Only few known exposures showed longer wedges as for instance in the culmination of the Moraska Góra in the Middle-Poznanian terminal moraine. The ice-wedges were found most often, however, in the fluvioglacial gravels. The smaller though better formed wedges occur in the boulder clay. The characteristic feature of all wedges which are known to us is their obtuse and often baggy ending at the bottom. It is not seldom that shapes were found coming at the bottom in a horizontal enlargement (fig. 1) or branching and penetrating the surrounding material. This type of ice-wedges is probably connected with the texture of material in which they were formed. They were but exclusively observed in the boulder clay. In gravels and sands the wedges have a straight or slightly undulating shape of walls and a mild ending (pl. 1).

The ice-wedges are usually filled with sand of various fineness (dust included) apart from material in which they were developed. Near the walls of the wedge the filling material is most often ferruginous

[1] See map 1 from the paper of J. Dylik: Coup d'oeil sur la Pologne périglaciaire in this No of the *Periglacial Bulletin*.

and coarser. In Pakosław the ice-wedge is piercing the clay and the sand filling the wedge is distinctly laminated on its border. At the times short and breaking off lamina are observed. It is not seldom noticed, that among individual stones as found in wedges appear eologlyptoliths. They present various stage of evolution — from faintly

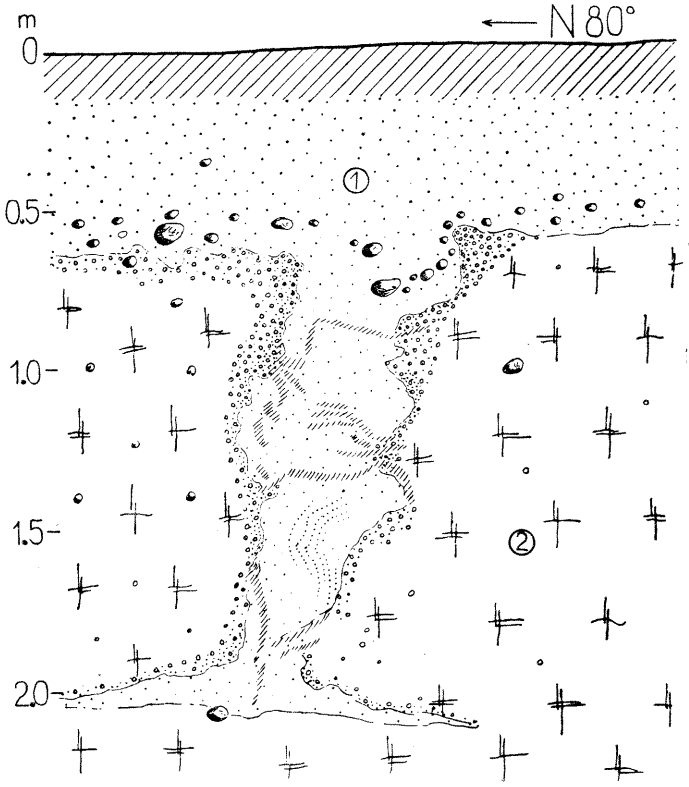

Fig. 1. Trojanowo near Poznań. Ice wedge

1. sand of differend grain-size with pebbles; 2. boulder clay, sandified and ferruginous at the margins of the wedge

eolised till beautifully formed faceted stones. The stones are often placed near the wedge's border with their longer axis vertical. The configuration was observed among others in Pakosław, where a perfect view of it was on the plan. The ice-wedge in horizontal projection is presented as a fissure 20—30 cm in breadth; the length of the wedge, however, was not stated as the digging was ended in the wall at 80 cm.

On the area under discussion on the 12 wedge localities there are no traces of squeezing or uplift of the sands along the walls of ice-

wedges. This characteristic feature of wedges from areas of older glaciations here was entirely absent. It is only in the exposure near Świebodzin in the Land of Lubusz that one could reckon with a slight uplift of sand layers. In all other localities as e. g. in the culmination of the Moraska Góra northward of Poznań, in Osieczna near Leszno or in Narty to the South of Szczytno, where the wedge's surrounding consist of stratified material, the layers were breaking off sharply close to or did not come to the wedge. The neighbouring layers were not bent downwards and were pushed upwards neither.

Unbound involutions. On plain surfaces or in the culimination of hills it was observed often the appearance of the festoon-like top of fluvioglacial sands and gravels. The stratification breaks off vidently and under the layer of covering material is found an assemblage of stones. There are formed then stone festoons as beeing cut in the fluvioglacial. In pocket-like cavities we find a fine and as a rule dusty sand. At times, however, it is even a coarse sand or gravel. We find also seldom individual stones and among them the faceted stones are frequent. In many cases the structures under discussion present well shaped free involutions. The segregation of the material is then visible: the coarser on the margin and the fine material in the centre of the structure. The size of the involution is different but not exceding 1 m in breadth and hardly ever deviating from the value of 0,5 m in depth. There are therefore small formes but occurring in company and hence fairly apparent.

Well formed involutions were observed independent from the mode of stratification of the material in which they have appeared. They are cases, however, when the connection between the shape of involution and the value of the dip of strata is obvious. At a greater gradient of the gravel layers asymetric structures come into view reminding in profile the tiny uninclinal valleys.

Expressivity of involution depends on the quantity of a stone assemblage. It is likely why structures formed in a coarse gravel containing a fairly portion of a stony material were more conspicuous. It seems likely that in these observations the structures formed in sand formations where stones are scarce are omitted. Then the fraction difference between the material of the subsoil and that of the involution filling calls no ones attention. On the other hand on account of the infiltration of water which is taking place the original involutional profile may be destroyed also at present.

Congeliflual deposits in the area represent chiefly the unbound type. It is marked by a peculiar structure of deposits, by the joint ap-

pearance of different grain-size material and as well by the absence of the characteristic for the bound congeliflual movement plications and the discontinuity of the bent layers. The congeliflual deposits are here of a scarce thickness exceeding exceptionally 1,5 m. As for the well formed congeliflual deposits they are rather sporadic and limited to short segments on the slopes. It is probably why the material collected during the investigations, limited to the knowledge of only few localities, is so scarce. We should emphasize, however, that exactly from this area come the first properly discerned periglacial disturbances described by Passendorfer as early as 1932 (*11*).

At present we know scarcely few localities of a congeliflual structure. In Barcin near Pakość, westward from Inowrocław, a congeliflual zone on the slope of a little dale passing to Noteć had distinct features of the free mass movement relative to the frozen subsoil. In the base lie stratified sands, here and there truncated and forming an uneven and irregular shape of top. On them is lying a 1—1,5 m thick cover of allochtoneous material. Clayey formation wrapping clods of bright sand of preserved lamination is prevailing. We notice streaks and gray loam fragments as also gravel concentrations, which are absent on the spot in the base. Proceeding upwards the predominace of sand is again marked (pl. 2).

Among other localities of discerned congeliflual deposits we can mention Trojanowo and Rosnówko in the neighbourhood of Poznań, Racięcice northward from Konin and eastward from Vistula — Białyszewo and Rajgród in the neighbourhood of Augustów. It is most often, however, that these deposits are structureless and consist of variously grained sands, which often proves to be alien for the subsoil base. Congeliflual displacement is also witnessed by faceted stones as met in these deposits, beeing most often at the bottom of this zone.

Pulverulent material. On plain or slightly inclined surfaces appear pulverulent sands and often loess-like material. They occur usually in the presence of the free involutions, to which they are closely bound as their filling. They occur also as independent from involutions in the top of residual weathering zones. The differences relative to pulverulent loess-like material occuring in the Middle-Poland (*3*, *5*) lie rather in their quantity that in quality. While to the South of the limit of the last glaciation loess-like deposits are so common as they cover vast areas with a nearly close coating, then in Greater-Poland and adjoining areas pulverulent sand occur as insular. Their average thickness is also smaller attaining exceptionally 1,5 m and fluctuating usually from 0,5 to 1 m.

Tundra-structures. It is of interest on the area under discussion the occurrence of tundra phenomena. We know for certain three localities of that kind of structures. We can here name bound involutions in Grębocin near Toruń (*10*) and in the neighbourhood of Poznań i. e. in Pakosław and Kotowo. In all of these three localities the above mentioned involutions were formed in varved clay. Of peculiar fine shape they are in Grębocin and Kotowo. However, they are not the surface structures representing the last periglacial stadium. Maybe they originated in the regression of the Poznanian substage or even earlier as e. g. in Pakosław the involutionally disturbed varved clay is covered with boulder clay with the above mentioned ice-wedge inserted. Similar stratigraphic situation represents Grębocin (*10*).

POMERANIA

Pómerania is a region where the activity of denudational processes could not contrive to destroy the accumulating glacial relief. A fairly amazing conformity of topographic surfaces with the internal structure of land-forms was here preserved. Hence in the landscape of Pomerania predominate powerful assemblies of terminal moraines. It is they which form with a whole system of isolated cavities this most diversified landscape. On the other hand the great areas of outwash plains present horizontal surfaces. They are cut with rivers flowing in distinct but narrów valleys. In opposition to the Middle Poland and the South Uplands the absence of long and extensive slopes is in Pomerania conspicuous.

Several data taken from field-works have proved, however, that also here the traces of periglacial environment must be considered. Some localities with ice-wedges and free involutions were here found and distinct traces of disintegration and thermal segregation were stated. At the bottom of slope deposits there are also stone pavements with boulders carved in eolian way.

The ice-wedges of Pomerania much differ from the well-developed structures of this kind as known in Middle and South Poland. They resemble however the above described wedges occurring on the area of the Poznanian and Brandenburg substages. Pomeranian wedges are fairly wide and short and distinctly rounded at bottom. All wedges which are known in Pomerania, are developed in fluvioglacial gravels (pl. 3) and one was found in a fine-grained, stratified sand (pl. 4).

The ice-wedges have a dark ferruginous margin. Their filling consists of gravel or sand similar to the surrounding material. It is only the original structure of the bedrock which is destroyed. Moreo-

ver, particularly in wedges formed in gravels, the process of disintegration and of segregation are registered. Weathered and shattered stones and an assemblage of greater particles placed rather near the

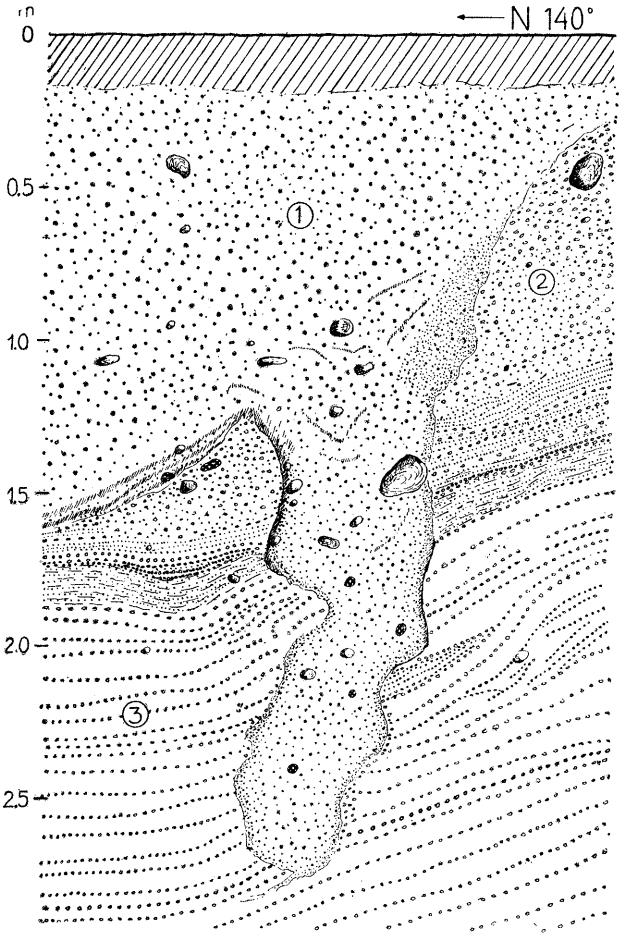

Fig. 2. Jutrzenka near Bytów. Ice wedge

1. structureless sand of different grain-size with frost split and weathered boulders; 2. unstratified gravel; 3. fluvioglacial

walls of the ice-wedge is frequent while in the centre prevails a smaller fraction (pl. 3). A slight diminution of the grain-size from the bottom upwards is also observed. It is why in the upper enlargement of the wedge or close beyond it the sand contains a fairly portion of pulverulent material.

Among ice wedges as found on the area under discussion a relatively long wedge from Jutrzenka near Bytów is to be distinguished. Its whole length can be estimated as surpassing 2 m although on its left it was probably later destroyed (fig. 2). An uneven shape of the wedge margin is also worth to be seen. The wedge has its straits and enlargements. The shape as if adjusted to the mode of stratification and the structure are. The wedge is inclined following the direction of the layer dipping. It is perhaps a sing that the processes active in the development of the wedge are only little advanced and it indicates its expansive origin.

Unbound involutions. The involutions which appear on the area considered belong to the free ones and their formation was strongly assisted by the weathering and thermal segregation processes. They present forms similar to the structural soils. On the rings they show concentrations of a coarser material, of a finness increasing towards the centre (pl. 6). In general however, the mechanical weathering was not much advanced on the area, as an exclusive appearance of only pulverulent material in involutions does not occur. This feature establishes a distinct peculiarity of Pomeranian unbound involutions in relation to the described above and to the involutions occurring in the Middle Poland (*3*, *4*).

Westward of Miastko unveils itself one of best developed involution-layers of Pomerania. In an exposure-wall of 9 m in length, the fragment of which is here shown (fig. 3), involutions were outlined in the top of a coarse stratified gravel. An assemblage of a coarser material on the sides and that of a fine material in the centre of pocket-like cavities was fairly visible. A great quantity of scattered stones was to be seen especially in the margins of the involution and in the material between them. In the centres of semi-circular outlined involutions a sand contained a little of pulverulent material. Upwards, in the sand covering the involution-layer, the predominance of a medium- and coarse-grained sand was prevailing. That part of material is likely to be interpreted as a congeliflual zone and the more so as its thickness was increasing down the slope.

The free, unbound involutions belong to frost-structures being fairly common throughout Pomerania as well westward as eastward of Vistula. Basing on the scanty indeed data it seems however that free involutions are frequent occurring in the main chain of Pomeranian moraines. On the areas of outwash plains, however, the appearance of a stony horizon under structureless covering sands is often to be found (pl. 5). The phenomenon is similar to *Steinsohle* as known from the German literature (*2*). However we find also here symptoms of

frost segregation as the horizon of stones shows a slightly festoonlike profile.

Slope deposits. Congeliflual structures are feebly developed and occur rather sporadic. They show usually characteristic features of a free mass movement down the slope. In the vicinity of Lidzbark on Łyna in the East Pomerania was observed a congeliflual zone of about 1 m in thickness. At the bottom of it there was found a stony horizon with frost splitting boulders. In congeliflual series takes part a bright and medium-grained sand appearing in greater clods as also the boulder clay lying in the subsoil. The allochtoneous origin of the material is witnessed not only by the structure of deposits, but also by the horizon of stones as occurs at its bottom, which can be considered as a stone pavement. Among these stones there are many frost split boulders. The stony horizon and the covering of congeliflual formations as well show an inclination of 8° according to the inclination of the slope and that of the present surface. Similar congeliflual deposits are found in Filipowo westward of Suwałki and in Pieniążkowo northward of Nowe on Vistula. Both localities at the bottom of the congeliflual zone have shown besides some traces of down-wash processes.

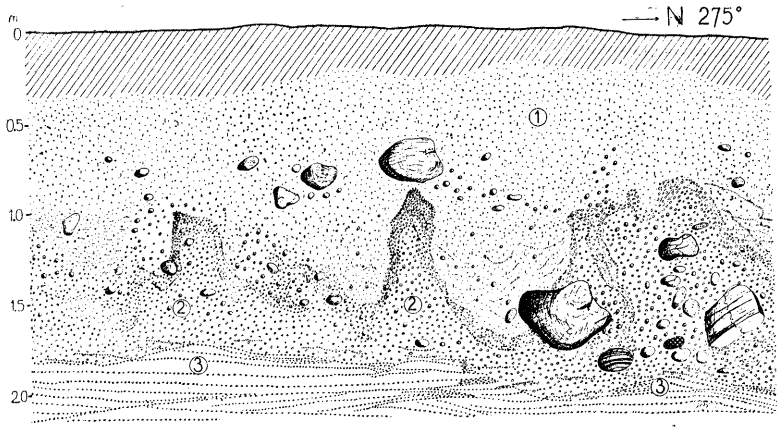

Fig. 3. Bobolice, westward of Miastko. The free involution layer
1. sand of various grain-size, pulverulent constituents interfered; 2. ferruginous gravel with frost weathered pebbles; 3. fluvioglacial

Slope deposits resulting from down-wash are fairly frequent in every part of Pomerania. They are well formed and reaching many a time beyond 2 m in thickness. Slope formations are to be found on rather slightly inclined surfaces and they are vanishing on the spot,

where the slope is falling under a great angle down the valleys and the lake-basins. At the foot of slopes in river valleys this kind of deposits was not occurring as yet.

The down-wash deposits differ from the free congeliflual formations as they show a particular texture and a grain-size composition of material apart from the bedrock, where they appear at present. The clayey and silty material with tiny striae of sand prevails. The deposits as a whole show a lamination according to the sloping of the surface.

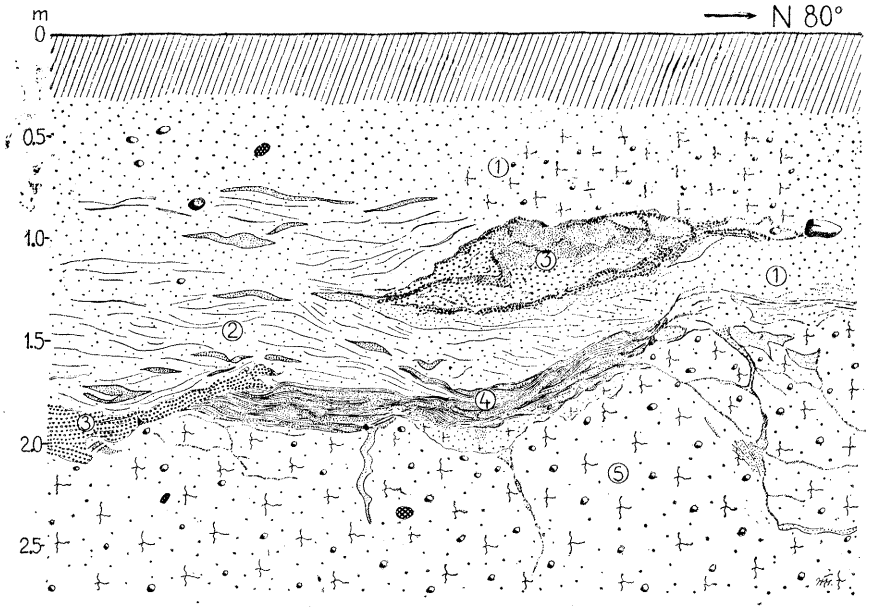

Fig. 4. Przyłęk near Dobiegniewo. Periglacial slope deposits of a down-wash character, upward pass into the free congelifluction

1. structureless sand and clay; 2. indistinctly laminated sand and sild; 3. ferruginous sand and gravel coarse; 4. sand, sild and clay of an uncontinuous lamination; 5. boulder clay in situ

The laminae are discontinuous, they break off and the small disconformity are frequently apparent (pl. 7). Proceeding upwards — as mentioned above — the share of water in deposits of distinct features of down-wash was diminishing to the increase of a free movement of individual particles of material (fig. 4).

There exist some indubitable differences between the frost-structures and periglacial formations of Northern Poland and these ones, which occur on the areas of older glaciations. The differences are not only of a quantitative nature but as well are concerning the formation of

particular phenomena. A prevailing and even exclusive structure origin under more severe periglacial climatic conditions is conspicuous on the area considered. Tundra structures are here rather sporadic and not so shapely developed as on areas situated to the last glaciation externally. The long and deep ice-wedges as also bound congeliflual formations so common in Middle Poland are here absent.

Northward the appearance of pulverulent formations and that of covering deposits in general is diminishing. The residual weathering zones on Pomerania are nearly absent and the stratified fluvioglacial formations or the boulder clay appear close under the soil. It is only in privileged localities that occur shallow ice wedges and free involutions and these more frequent than congeliflual formations. The activity of wind was not efficient neither, as in Pomerania faceted stones are to be found exceptionally and among wind-worn stones the ribbed eologlyptoliths prevail (pl. 8). Such features of periglacial phenomena on the area under discussion are resulting probably due to the feeble infleunce of frost processes and they explain the hardly perceptible traces of the morphogenetic periglacial cycle.

The North Poland was included by the periglacial climatic environment for a comparably short time i. e. only during the ice-sheet regression of the Baltic glaciation. The periglacial zone was shifting from the South and entered to the terrains immediately released by the glacier. It was a period of a swiftly proceeding tepe-faction of the climate. It was the decisive factor as to the question of the transient periglacial environment and that of limiting the particular process, in which the morphological efficiency did not fully appear.

In Pomerania first of all occur frost structures due to the disintegration, to the thermal segregation and to the regelation. The fissures appearing in winter and resulting from the split of soil initiated the shallow ice wedges (*7*). They are maybe the one-yaer wedges, as the sidewards formation and the good sorting of material inside the wedge was not to be found in them. The limited appearance of pulverulent material is here also peculiar. It indicates that the mechanical weathering, which could menage to infringe only the greater fragments observed at present in the form of frost split boulders, are but only little advanced.

Among periglacial phenomena of Pomerania the frost structures and congeliflual deposits poverty is conspicuous. There are different reasons which have hereto contributed. The best conditions for the congeliflual mass movement exist when the surfaces are inclined at angles from 2 to 15° (*1*). Meanwhile the fresh glacial relief-forms on

the area have in general not many surfaces of this kind. The short and strongly inclined slopes of the terminal moraines hills did not favour the formation of the congeliflual flowing on a broad front. On the other hand the extensive outwash plains were only slightly inclined. Moreover the intensity of congeliflual processes depends on the quantity of the fine and pulverulent material, rather scarce in the glacial deposits. However, the weathering, being not very efficient due to the limited in time periglacial environment, did not deliver it in a sufficient quantity.

The efficiency of periglacial processes on the area of Pomerania did not register itself in relief pattern. The periglacial structures are geological phenomena: they only change the original structure of deposits, in which they are developed, and do not contribute to the immediate morphologicial changes. The congelifluction, however, as the most powerful denudational factor was here clearly limited. Thence results not only the poverty of congeliflual deposits, but above all the proper relief-forms are here absent (*4*). The denudation did not contrive to confer on the landscape its own mark with the characteristic long, extensive and concave slopes. The periglacial morphogeny was in its initial and preparatory stage.

Translated by J. Rakowiecki

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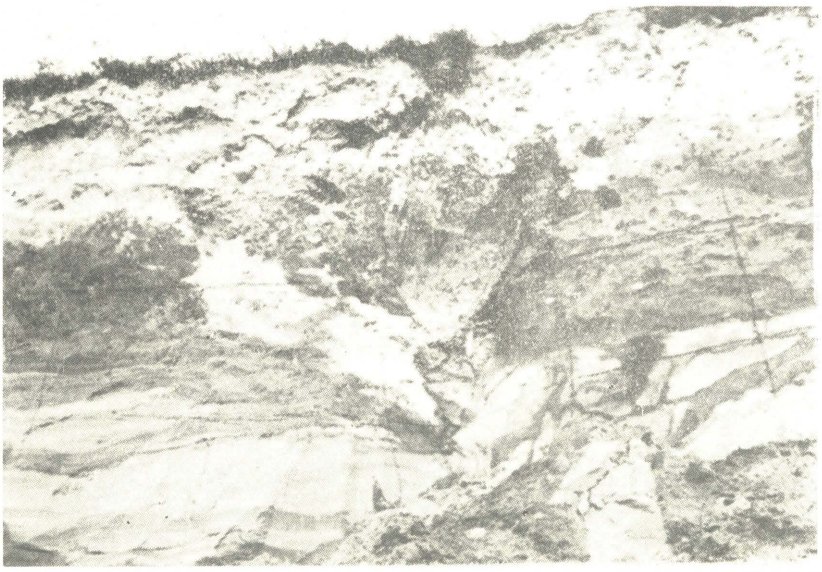
phot. J. Dylik, 1951

Pl. 1. Kurzętnik, the neighbourhood of Brodnica. Ice wedge



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Pl. 2. Barcin, the neighbourhood of Inowrocław. Congeliflual deposits

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Pl. 3. Bramka near Morąg. Ice wedge

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Pl. 4. Gołdap. Ice wedge

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Pl. 5. Bramka near Morąg. Covering sand with pebbles

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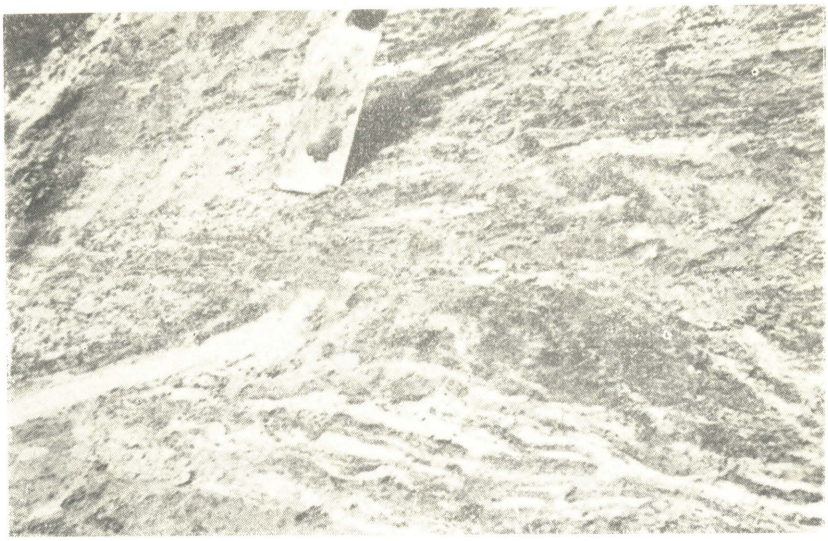
Pl. 6. Polanów, westward of Miastko. Free involution in fluvioglacial gravels



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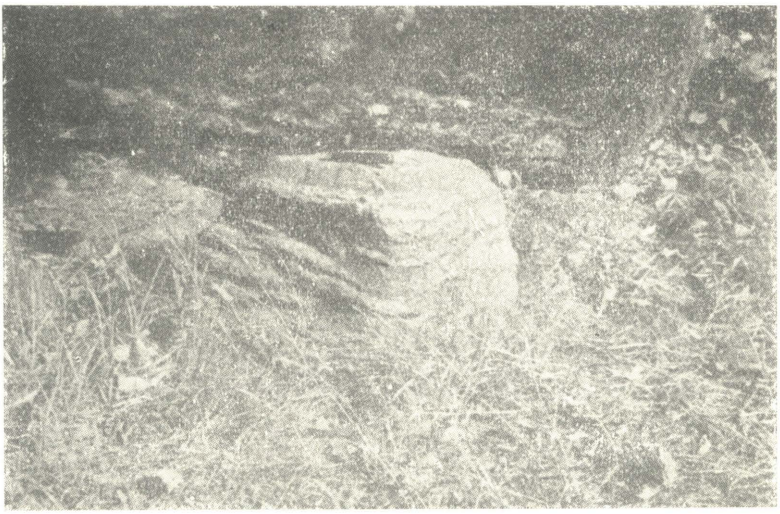
Pl. 7. Przyłęk near Dobiegniewo. The texture of periglacial slope deposits



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Pl. 8. Dylewo Hills. Ribbed cologlyptolith