Karol Rotnicki
Poznań

PERIGLACIAL SLOPE PLANATIONS IN THE SOUTH-EASTERN PART OF THE OSTRZESZÓW HILLS

Abstract

Geomorphic investigations of some slope planations occurring in the south-eastern part of the Ostrzeszów hills (Graet Poland) have established their periglacial origin. These planations appear at two different levels, the upper of which is only partly preserved and dissected by valleys within which the lower level is developed. It is most likely that these planations were formed during the last (Baltic) glaciation.

INTRODUCTION

In the course of geomorphic research work in the Ostrzeszów hills in 1959, it was observed that a small depression called Parzynów basin (after the village situated within it) displays a highly unusual distribution of relief features. The investigations in question formed part of the research program of the Department of Physical Geography of the Poznań University, but were also intended to prepare the site for the VIth INQUA Congress.

The Ostrzeszów hills are a push-terminal moraine of the Warta stage, of the Middle Polish glaciation. Hence, it represents an area which after recession of the Warta ice-sheet was subjected to the same laws of relief formation as was the Łódź Upland (Dylik 1956). And, as has been demonstrated by J. Dylik (1953) the present-day landscape features of this Upland were chiefly produced by the operations of processes belonging to the periglacial morphogenetic cycle.

The features of this relatively small part of the south-eastern Ostrzeszów hill range, which will be described below, display all the characteristics of a denudation landscape, produced as a result of the activities of such a set of processes as are typical of periglacial environment.

MORPHOLOGY OF THE PARZYNÓW—RZETNIA REGION

The Ostrzeszów hill range begins east of the Syców gate, and extends over some 38 km, forming a crescent which runs first eastwards to turn farther to the north. The area investigated in the Parzynów—Rzetnia region lies some 5—6 km south of Ostrzeszów. Thus, it is situated in the south-eastern border, which at the same time forms the outward part of the Ostrzeszów hills, that run in this section NE—SW. In this section also appear the highest elevations of these hills, reaching some 250—284 m above sea level (Kobyla Góra — 284 m).

Conspicuous in the morphology of the Parzynów—Rzetnia region are two facts, which usually characterize a periglacial denudation landscape, i. e. (1) a predominance of concave forms, in the shape of vast valleys with elongate, gently sloping sides (3—7°) and (2) the presence of massive complexes of elevations, like for example the Kobyla Góra complex (pl. 1). If, however, these facts be contemplated on a broader hipsometric background, it becomes obvious, that each individual complex of elevations is, in reality, isolated and separated from the others by large valleys or passes, formed as a result of a junction between two valley heads. The highest elevations of the area in question are not incoherently scattered but form an amphitheater, enclosing the gentle depression of the Parzynów basin (fig. 1, 2) that opens to the south-east. The most slope gradients in the area described, reaching up to 10—14° and in the Kobyla Góra complex even to as much as 20°, occur within these elevations. The Parzynów—Rzetnia valley constitutes the axis of the Parzynów basin. In morphologic composition, this valley consists of several parts. Its head part has the appearance of a trough-like valley, without any visible breaks between sides and bottom. Farther away from the junction of the Parzynów—Rzetnia valley with the asymmetrical small Celinka valley on the north and the Zmyślona Parzynowska valley on the west, it takes the shape of a flat- and broad-floored valley, the bottom of which has as much as 300—400 m in width. Still farther, already beyond the Ostrzeszów hills, it extends south-eastwards until, near Kępno, it joins the Samica valley, which in turn, joins the Prosna valley lying east of the region discussed. Between the Ostrzeszów hills and the Samica valley, the Parzynów—Rzetnia valley becomes notably shallower. Its sides are much more gentle (1—2°). Numerous denudation small valleys occur within the hill- and valley-sides.

This brief outline of the morphology of the Parzynów—Rzetnia region would be, however, incomplete if it contained no reference to the intermediate features between its highest elevations and its valleys. The term *intermediate features* is here understood in a hipsometrical sense. In fact these forms seem to set the most interesting problem that arose during investigations of the south-esatern Ostrzeszów Hills.

Some, easily recognizable planations (fig. 1, 2) adjacent to the highest elevations of the Ostrzeszów hills were observed to occur within the Parzynów basin. The smallest, though extremely well-developed one appears on the north-facing slope of the Kobyla Góra (pl. 2). This planation has some 200 m in length, and 150 m in width (length was measured along the line of slope). Its gradient is scarcely 1,5—2°, while that of the above-rising slope of the Kobyla Góra hill is up to 12°. The slope break from where the planation begins is relatively sharp (pl. 2). In its lower part, the planation passes into a long, 7° inclined slope to the Zmyślona Parzynowska valley. A similar, though somewhat larger flat surface occurs 1 km south-west of Parzynów. It borders on the south-eastern hill massif, the highest summit of which rises 278 m above sea level. The summit surface of this elevation has a slightly convex profile that passes into a steep slope inclined 10—11°. At 252—255 m of altitude its gradient diminishes to 4°. At this point begins the planation that slopes gently south-eastwards.

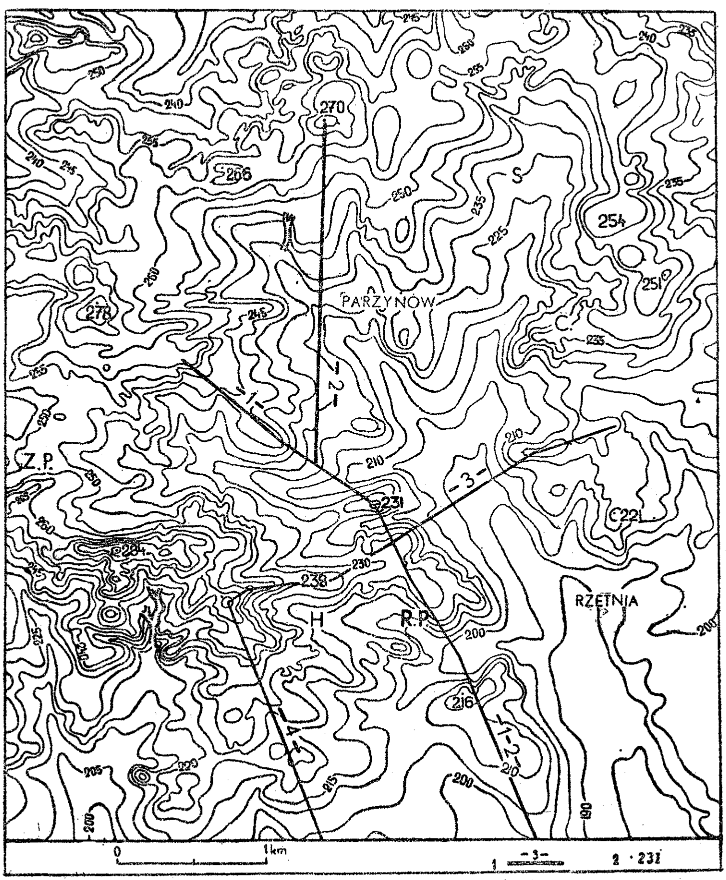


Fig. 1. Hipsometric map of the Parzynów—Rzetnia region

1. lines of morphologic profiles; 2. elevations above sea level in m; C — Celinka, H — Hurna hamlet, RP — Rzetnia Pustkowie, S — Sobolizna, ZP — Zmyślona Parzynowska; contour lines 5 m apart

Its lower part has a gradient of only 1 °. Somewhat farther in the same direction the planation merges into the Zmyślona Parzynowska valley-side of 5 ° inclination. This planation surface has some 700 m in length and up to 400 m in width (fig. 3, profile 1a). Two further planations occur in the immediate neighbourhood of Parzynów: a small one on the western outskirts of the village and the other north of the village. The latter does not differ in size from the one situated south-west of Parzynów. The gradient of the above-rising „steep" slope is, however, somewhat lesser (7—9 °), though the planation surface has here likewise a gradient of 1—3 °. Near Parzynów, it merges into the Parzynów—Rzetnia valley-side (fig. 3, profile 2b). Another planation occurring south-west of the Hurna hamlet

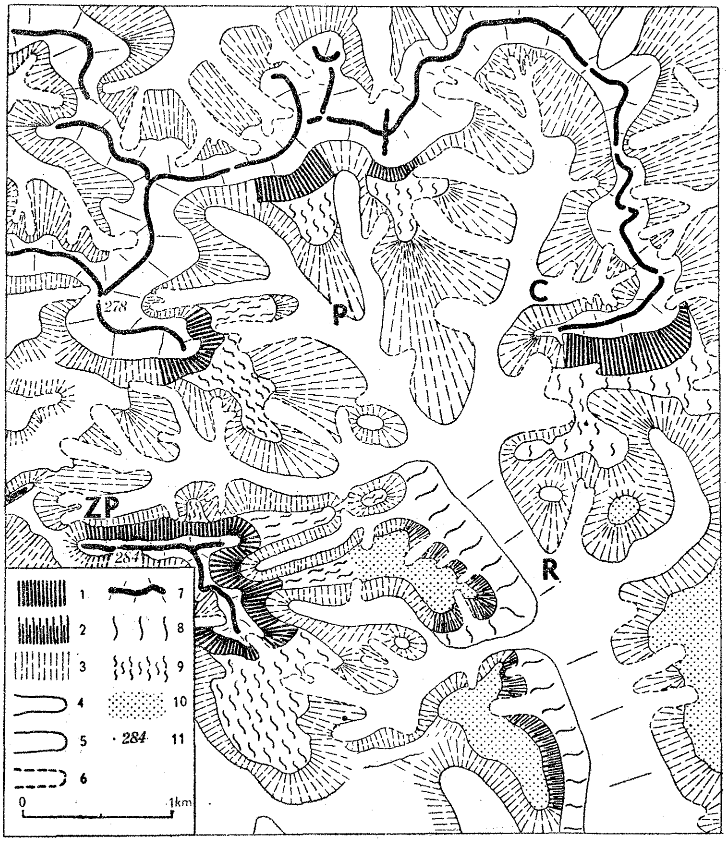


Fig. 2. Morphologic map of the Parzynów—Rzetnia region

1. „steep" slopes (9—13°) above the upper planation; 2. „steep" slopes (10—15°) above the lower planation; 3. other slopes; 4. trough-like periglacial valleys; 5. flat-bottomed periglacial valleys; 6. denudation troughs; 7. crest lines; 8. lower planation level; 9. upper planation level; 10. accumulation surfaces connected with upper planation level; 11. elevations above sea level (in m); C — Celinka, P — Parzynów, R — Rzetnia, ZP — Zmyślona Parzynowska

lies, already outside the Parzynów basin and borders from the south on the Kobyla Góra complex. In its south-eastern part, this complex has a slightly rounded surface which passes into a declivity sloping 8—9° towards the surface of planation. This surface has a mean gradient of 1—1,5° and as much as 800 m in length. On the north-west side of the road from Rzetnia to Mielęcin, the planation terminates with a slope, inclined 8° (fig. 3, profile 4).

All the planations occurring within the Parzynów basin display, apart from these common features described above, also two other typical characteristics. One of them is their situation at an almost equal absolute altitude: 250—255 m above sea level north of the Kobyla Góra, 247 and 235—250 m above sea level in the Parzynów region, and 240—250 m above sea level between Parzynów and Zmyślona Parzynowska. Secondly, all these planations lie some 15—20 m above the valley bottoms of Parzynów—Rzetnia and Zmyślona Parzynowska. All the planations are connected with the valley-bottoms through long slopes, grading 5—8°.

Within the Parzynów basin and partly also south-east of it, appear some highly peculiar elevations. One of them, rising 231 m above sea level appears in the continuation of the planation that narrows down to the east and is seen on the eastern side of the Kobyla Góra (fig. 1, 2, 3; in the profiles this elevation is marked as *d*). The hill in question is separated from the planation by a pass, formed as a result of a junction between the heads of two denudation troughs. From the south, the north and the east it is bordered by valleys. South of this hill that rises 231 m above sea level, on the opposite side of a narrow, 20 m deep valley, appears a flat plateau, somme 700 m in length and 250—300 m in width which is likewise bordered by valleys from the east and the south (fig. 1, 2, 3: profiles 1e, 2e). Its relative height is of 15—20 m. The surface of this plateau, situated west of Rzetnia lies at an altitude of 225—230 m, and slopes extremely gently to the south-east. From the west, towards the plateau, the part of the planation adjoining the east-facing hill-sides of the Kobyla Góra grades 3° (fig. 1, 3; profile 3). South-west of Rzetnia, on the opposite side of the valley that borders the plateau from the south, appears another elevated flat surface, 3 km in length and some 400 m in width. It is bordered from the east by the Parzynów—Rzetnia valley, and on the west by a broad valley that merges into that of the Samica. Absolute height of this surface attains in its northern part 215—216 m, sloping very gently to the south; near Przybyszów (3 km south of Rzetnia) its absolute height is no more than 185 m. The relative height of this surface also diminishes southwards. While near Rzetnia it reaches 25 m in relation to the Parzynów—Rzetnia valley, near Przybyszów it decreases to 10 m.

Considering the absolute height of the hill rising 231 m above sea level and that of the two plateaux which are separated by 20 m deep valleys, it becomes obvious that they all may be united into one surface sloping gently south-eastward (pl. 3). This surface lies partly within and partly without the Parzynów basin. Morphologic profiles derived from a topographic map on a scale of 1 : 25 000 (sheet Rogaszyce) show that this surface may be extended still farther, into the Parzynów basin (fig. 3; profiles 1, 2). From the mean gradient and the absolute height of this surface and from those of the Parzynów and Zmyślona Parzynowska planations, it may be inferred that this surface is somehow connected with these planations.

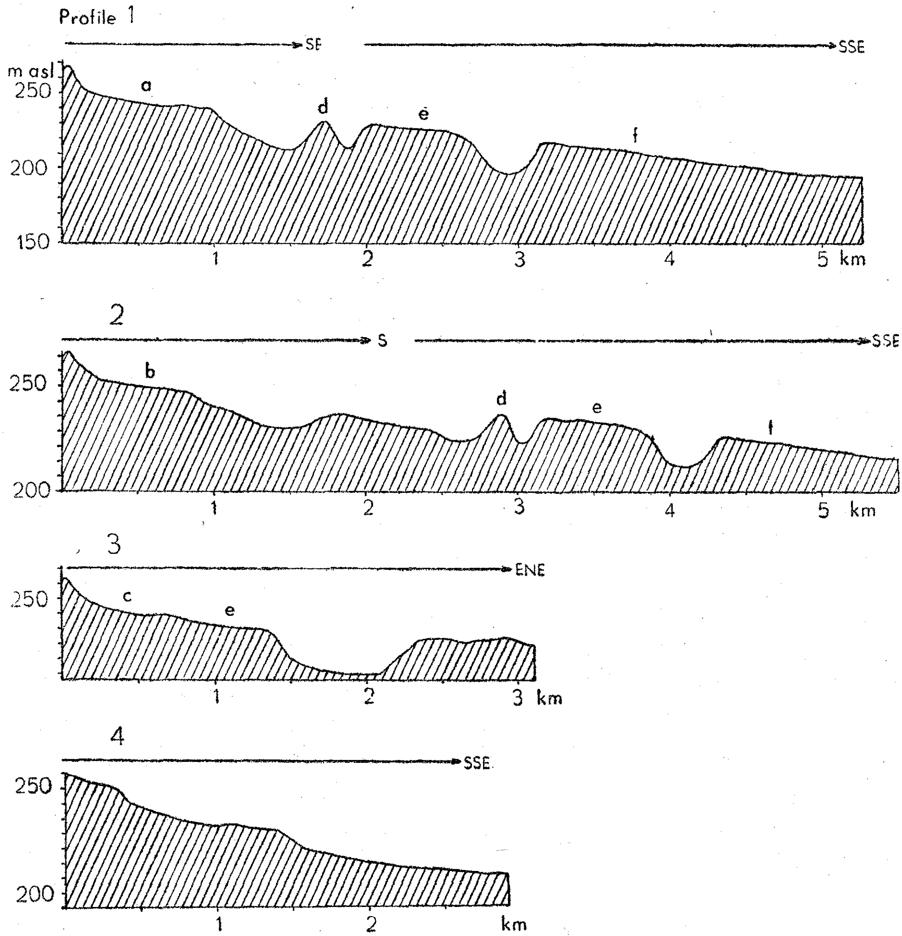


Fig. 3. Morphologic profiles from the Parzynów—Rzetnia region

The lines of profiles are marked in fig. 1

Analysis of the morphologic profiles (fig. 3, profiles 1, 2, 3) and the features occurring within the Parzynów basin suggest three conclusions, which are that: (1) the planations, the surface of both the plateaux and the summit of the hill rising 231 m above sea level may have formed one single, fairly vast fossil surface, s'oping gently south-eastwards and extending partly beyond the Parzynów basin; (2) this surface was later dissected by valleys 15—25 m in depth; (3) there is a conspicuous connexion of this surface and between the highest elevations, surrounding the Parzynów basin. Anyway, the upper parts of the individual surface fragments abut against the „steep" sides of the heighest elevations of the area in question. The intimate association of these planations with the above-rissing „steep" slopes allows of the assumption that this connexion is a genetic one. Evidence supporting this assumption will be discussed in a further section of the present paper.

The second, lower planation level occurs within two of the valleys that cut through the upper surface. These are: the valleys of the Parzynów—Rzetnia and one of its side-valleys that joins the main one west of Rzetnia. The south-western slope of the Parzynów—Rzetnia valley consists of three distinct segments: a convex upper one, an almost straight-line one at the middle and a concave one near the base. The central segment has a gradient of up to 15°. Although not sharp, the break between the steep slope segment and the concave basal one is very well-defined (pl. 4). The elongated concave surface of the lower slope part grades first 4°, while farther down its gradient is no more than 1—2°, until below a fairly well-marked break it finally merges into the flat valley-bottom (fig. 2, p. 8; fig. 3, profile 3; fig. 8). This conspicuous slope planation has some 250—300 m in length. The northern side of the western tributary of the Parzynów—Rzetnia valley, shows a similar shape (fig. 2). Particularly characteristic is the fact that in the Parzynów—Rzetnia valley, planations occur only within the segment in which it takes the shape of a flat-bottomed valley.

To summarize these statements it may be said that the topography in the Parzynów—Rzetnia area exhibits two slope-planation levels of a different age. The older level is dissected by valleys containing younger valley planations.

SUB-SURFICIAL GEOLOGIC COMPOSITION OF THE PARZYNÓW BASIN

The Ostrzeszów Hills are in fact an upridged end moraine composed of Tertiary clays and quartz sands and of glacifluvial material and glacial till. Abruptly dipping layers are almost the rule within these hills. Their dip varies 40 to 90° and is commonly towards the Odolanów depression. The contacts between individual scales strike conformly to the morphologic axis of the Ostrzeszów Hills (Rotnicki 1960).

Covers of periglacial formations are common throughout the Ostrzeszów Hills. Investigations have shown that the processes characteristic of periglacial environments were chiefly responsible for denudation in this area.

Exposures in the highest summit parts of the hills surrounding the Parzynów depression, show that the sands, gravels and clays disturbed by ice-pressure almost reach the surface (pl. 5) which truncates the abruptly dipping layers. Such a geologic structure is seen, for instance in the summit exposure of the hill rising 278 m above sea level, about 1 km of Parzynów. Glacifluvial sands and gravels dipping at an angle of 71° are here thinly veneered with a structureless layer the thickness of which varies 30 to 100 cm. In several places, the boundary between the stratified sands and gravels and that of structureless cover is obliterated. The structureless material is more sandy than that of the deposits disturbed by ice-pressure. In this exposure, the lower limit of the structureless layers shows in many places a clearly marked festoon-like outline. This pattern of the lower limit of the structureless layer is the more evident as the base of this zone is, in several places, thouroughly ferricreted. In view of all these characteristics of the structureless layer it may be defined as a weathering zone, which developed as a result of frost-caused weathering under periglacial conditions. The fact is further attested by the presence of ice wedges, occurring partly within the structureless layers and partly within the bedded sands (pl. 5). These wedges, some 70 cm in length are filled with structureless, strongly ferruginuous sands. Similar features were frequently pointed out by J. Dylik (1952, 1953) as indicative of periglacial weathering zones. The one here discussed, however, shows a complete absence of involutions and dusty material. This is probably due to the fact that the hill summit, containing this exposure is not flat but rounded. Consequently, the active layer of permafrost was subjected to congelifluction which must have been both vigorous and rapid, since no involutions had time to form within the weathering zone. Additional evidence of speedy removal of material from the active layer of the weathering zone is provided by the almost complete absence of dusty particles in this material. This shows that before removal it was not subjected to any prolonged congelifluction movements.

Periglacial covers on the tops of other hills around the Parzynów depression e.g. on the Kobyla Góra (284 m above sea level) or on the elevation 270 m above sea level, 1 km north of Parzynów, exhibit similar characteristics. They are all considerably reduced. The sands and gravels upridged by ice-pressure often outcrop to the surface. From this, it may be inferred that as soon as the material of the hill summits found itself within reach of the active layer, the base of which was gradually lowered by denudation, it was rapidly transported downslope. This explains why the material of the hill tops around the Parzynów depression is but slightly weathered.

The next features to be now discussed are the periglacial covers found on the „steep" hill-sides, sloping 9—14° towards the planations. Both exposures and excavations made at these sites show that on the „steep" hill-sides, even in their downslope parts, covering sediments have an insignificant thickness of 40 to 100 cm, exceptionally up to 140 cm. The cover of a hill-side, sloping at 11° towards a planation south-west of Parzynów, may be described as an example. Its thickness in the middle part of the slope is 50 to 90 cm (fig. 4). This cover consists of structureless sands with irregular agglomerations of gravels and small pebbles, whose

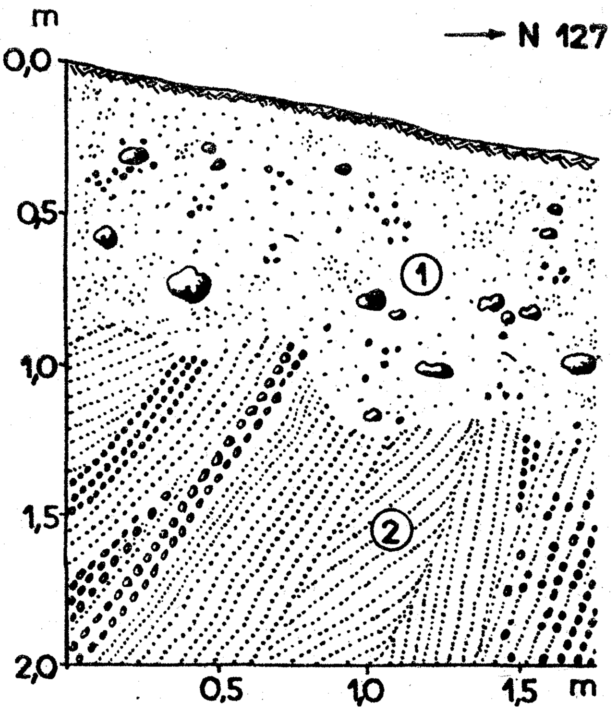


Fig. 4. Congelifluction cover on the „steep" slope, above the planation surface near Parzynów

1. sand with irregular agglomerations of gravel and pebbles; 2. bedded sands and gravels, disturbed by glacial tectonics

major axes are oriented conformly to the line of slope, indicating thereby that the material was shifted down the slope. Such evidence has been already invoked by J. Hövermann (1954), G. Lundqvist (1949) and L. Weinberger (1954). In the lower slope part, the thickness of the cover increases slightly (up to 1,4 m). All the hill-sides controlling the other planations were found to exhibit congelifluction covers of a like structure and negligible thickness. On the north-facing slope of the Kobyla Góra complex the cover has 0,4 m in thickness and on the east-facing slope — 0,5 m.

The periglacial covers occurring on the planations, are totally dissimilar in structure from those observed in the summit parts and the slopes rising above the planations. Diggings made on the planations showed that even at fairly considerable distances from the break between „steep" slope and planation, the cover is rather thin. For example, on the planation south-west of Parzynów, some 500 m from the „steep" slope the cover has scarcely 1,3—1,4 m in thickness. It consists of distinctly laminated silts, sand, and gravels. All the laminae seen in these excavations are discontinuous and faintly contorted (fig. 5 A). This indicates that they were deposited by diffused, unorganized streams. These laminae frequently contain intrusions of sand and gravel sometimes including wind-worn stones. Such sand-gravel intrusions with eologliptoliths indicate that material on the planations was partly transported by congelifluction. As a rule, however, the deposits occurring on the planations of the Parzynów—Rzetnia region were deposited by surficial downwash. Another common peculiarity of all the planation sediments is their allochtonous character. The component material of the covering sediments was found to be totally different from that of the underlying substratum. In the Parzynów planation, abruptly dipping Tertiary quartz sands are overlain by a ferruginous sand-gravel cover with an admixture of pebbles that was deposited partly by downwash and partly by congelifluction. Covering deposits are absent from some parts of the planations. Outcrops of the underlying material, consisting of glacitectonically disturbed sands, gravels and clays, appear at the surface (fig. 5 B). Slope sediments are, for example, completely absent from the small planation bordering from the north on the Kobyla Góra complex (pl. 2; fig. 5 B). Greenish-blue Pliocene clays and glacifluvial sands crop out here to the surface by which they are truncated. A similar phenomenon is observed on the planation east of the Kobyla Góra. The thickness of the planation cover increases slightly (up to 2,2 m) with distance from the „steep" slope. This increase, however, is not uniform. South of Parzynów some 250 m from the „steep" slope, the silty-sandy cover accumulated chiefly by downwash has some 2,1 m in thickness, while 500 m away from the slope it has no more than 1,4 m.

In drawing certain general conclusions regarding the geologic structure of the planations in the Parzynów basin it may be said that: (1) these surfaces show no relationship to either the structure or the lithology of their substratum, for they occur as well on sands and gravels as on clays; (2) the lithologic alterations of the substratum fail to be reflected by the morphology of the planations (fig. 5 B); (3) the planations do not represent any surfaces of accumulation, since their allochtonous cover is very thin; (4) they are truncated surfaces as a result of erosive processes operating on the slopes. Hence they may be defined as *slope planations*, according to the term proposed by J. Dylik (1954, 1957).

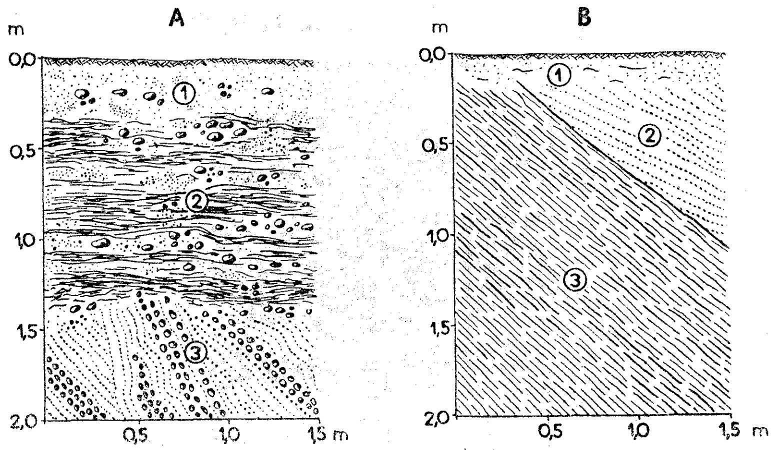


Fig. 5. Geologic structure of the upper planation level

A — downwash deposits on the planation near Parzynów: 1. structureless sands with gravels and pebbles; 2. fine- and medium grained laminated sands, incidentally silts with intrusions of structureless sands and gravels; 3. abruptly dipping sand- and gravel layers

B — structure of the planation north of Kobyla Góra: 1. structureless sandy-clayey material; 2 and 3. bedrock: Pliocene sands and clays

In the foregoing discussion it has been shown how these planation surfaces were initiated. It has been stressed that they are closely connected with the relatively steep slopes of the highest elevations around the Parzynów depression and that the summit of the 231 m high hill and the surface of the flat plateaux form their hipsometrical continuation (fig. 3, profiles 1 and 2). It appears, therefore, necessary to discuss in turn the geologic composition of both hill and plateaux which are separated from the planations by comparatively deep valleys.

On the summit of the hill rising 231 m above sea level west of Rzetnia (figs. 1, 2, 3, profiles 1 d and 2 d) there is a layer of slope deposits, 1,4 m in thickness (fig. 6). It consists of gravel and pebbles interbedded with two sand layers deposited by congelifluction. The pebble layer is in some places very compact and agglomerated by clays. The slope deposits are underlain by white quartz sands dipping 83°. At their contact with periglacial sediments, the layers of quartz sand are slightly bent southwards. This indicates transportation of a periglacial cover formed on the summit of this hill. Apart from the structure of this cover, its component material

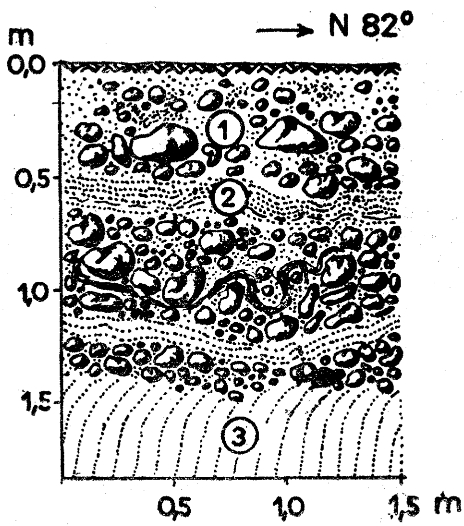


Fig. 6. Congelifluction deposits on the hill summit 231 m above sea level, 1 km north-west of Rzetnia

1. structureless gravels and stones, often agglomerated with clay; 2. discontinuous, contorted laminae of sand; 3. bedded, Tertiary quartz sands

which differs from that of the underlying bedrock, provides evidence of its allochtonous character. The presence of slope sediments on the summit of an isolated hill shows that this hill must have been once connected with a higher surface from where these deposits were removed by congelifluction and downwash. Such a geologic structure indicates that its summit surface must have been connected with the remnants of planation surfaces (fig. 3, profiles 1 ad, 2 bd). It was not until this higher planation level was formed that the hill was cut off from it by valleys.

A totally dissimilar geologic structure is that of the two flat plateaux, west and south-west of Rzetnia (fig. 3, profiles 1 ef and 2 ef). From the morphologic point of view the surfaces of these plateaux are continuations of remnants of the higher level and thus represent, on the whole, a fossil surface, gently sloping south-eastwards.

The geologic structure of the plateau west of Rzetnia (fig. 3, profiles 1e and 2e) will be discussed in the first place as it is known from 1 exposure and 8 dig holes. The exposure is situated in the northern part of the plateau by the road-cut. It shows a sedimentary series having a total thickness of 5 m. The base of the exposure lies some 13—14 m below the plateau surface. The whole series consists of periglacial sediments (fig. 7), bedded almost horizontally. A conspicuous characteristic of these deposits is the rhythmical alternation of gravel and sand deposits with bedded sands and sand-dust sediments. There are here as many as five consecutive gravel layers. None of the particular layers has more than 75 cm in thickness. These sediments contain a fairly large admixture of dusty particles. Sometimes, the gravels and pebbles form tough concretions due to the presence of clay. This material was found to include a few eologliptoliths. Three layers (fig. 7, points 3, 5, 9) exhibit some structures which seem to indicate that the pebble-gravel series was deposited by downwash. The sands and silts included are severely contorted and dislocated. In layer 9 they take the appearance of typical plications (fig. 7, point 9; pl. 6), while in other layers, the pebble-gravel material is quite structureless (p. 7). All these characteristics clearly indicate that these sediments were deposited by congelifluction.

In this exposure, all the gravels, sands and silts show a twofolded structure. Silty sands are here very thinly laminated (fig. 7, points 2, 10, 12); the laminae are discontinuous and faintly undulating. This indicates that they were deposited by sheet-wash waters. The sand and gravel sediments show an entirely different pattern (fig. 7, points 6, 7, 8). Laminae are here straight and continuous. Even in one case, a phase of dune sedimentation was noted within them. All this provides evidence of the rapidity of water flow by which these materials were deposited. According to J. Dylik (1953) „bedded sands, occurring between two well-defined periglacial horizons, should equally be regarded as periglacial", for both the top layer and the base horizon belong to the same periglacial period. A closer study of the alternating congelifluction and water-laid sediments, described above, suggests the same conclusion. The water-laid sands often pass gradually into the congelifluction series. At the contact of these two series appears a layer in which the congelifluction deposits encroach upon those deposited by water. Excavations made in the flat surface of the plateau and in its slopes show that it is wholly built of sediments accumulated by downwash and congelifluction (fig. 8, A, B). Dig holes on the sides of the plateau reveal the presence of two series of periglacial

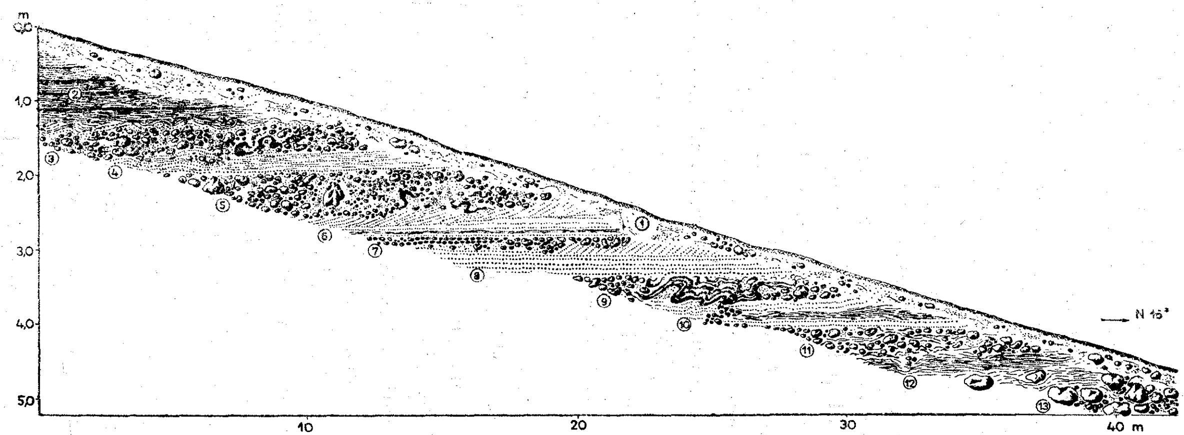


Fig. 7. Exposure, 1 km north-west of Rzetnia in the northern part of the plateau composed of periglacial sediments

1. structureless sands and gravels with pebbles; **2.** dusty sands, undulating, discontinuously laminated; **3.** gravels and stones with sands, deposited by congelifluction; **4.** fine- and medium grained sands, discontinuously laminated; **5.** gravels and stones with sands, deposited by congelifluction, though with a larger admixture of fines; **6.** and **8.** coarse-grained sand with gravels — continuous bedding; **7.** bedded gravel; **9.** sands and stones with plications in the sands, deposited by congelifluction; **10.** dusty sands — undulating, discontinuously laminated; **11.** gravels and stones with silts, deposited by congelifluction; **12.** dust sand, discontinuously laminated; **13.** stones including pebbles up to 20 cm in diameter formations. One of them consists of almost horizontally bedded sediments, deposited by either sheet-wash or congelifluction (fig. 8, pit B-2), while the second was wholly accumulated by congelifluction operating on the slope of the plateau (fig. 8, pit B-1). An ice-wedge found in the top part of this series, tends to confirm the assumption that the deposits composing this plateau — the joint thickness of which is more than 15 m — are all of periglacial origin.

The second plateau, lying south-east of the first (fig. 3, profiles 1f, 2f) shows a somewhat different geologic structure. It was found, that in its northern part, deposits disturbed by ice-pressure occur already at

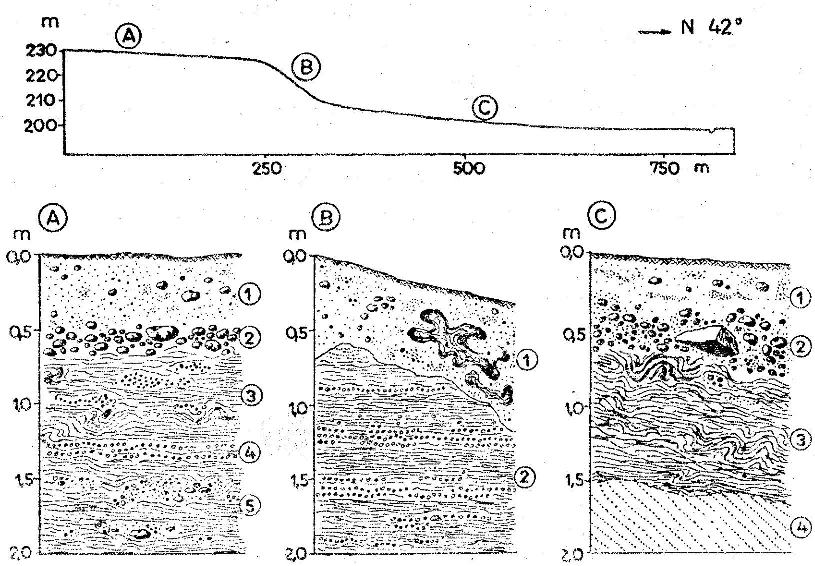


Fig. 8. Geologic structure of the lower planation level in the Parzynów—Rzetnia valley

A — Excavation on the flat surface of the plateau composed of periglacial sediments: 1. structureless sands with a few pebbles; 2. stone layer; 3. sand laminae, discontinuous, slightly contorted; 4. fine-grained bedded gravel; 5. incrusted structureless sand with pebbles

B — Excavation on the slope controlling the planation: 1. congelifluction sediment — sands with irregular conglomerates of gravel and clods of silt; 2. periglacial sediments of sand, composing the plateau

C — Excavation in the surface of planation: 1. structureless sand with single pebbles; 2. structureless gravel and stone layer with wind-worn stones; 3. silty sands and silts, deposited by sheet-wash, disturbed by congelifluction; 4. abruptly dipping bedrock sands

a depth of 4,5—5 m. Thus periglacial sediments have here no more than 5 m in thickness. In type, they rather resemble the deposits which form the top part of the first plateau i.e. sands laid by downwash and congelifluction containing faceted stones. As there are no exposures in the site and the excavations made here reached only a depth of 2,8 m and failed to penetrate beneath the slope cover it was so far impossible to ascertain whether towards the south the periglacial sediments increase in thickness.

All these data seem to suggest that both these plateaux, the surfaces of which lie within the continuation of the higher planation level, are not planations but (the first plateau, in particular) land-forms produced by accumulation. From the altitude attained by the base of the periglacial sediments within both the plateaux and the hill rising 231 m above sea level it may be inferred that in the primary glacial relief there existed a depression at the site of the first plateau (fig. 3, profiles 1e and 2e). Later, this depression was gradually filled with periglacial deposits. In the uppermost part of the 231 m hill, the top of the substratum reaches 229,5 m above sea level. 200 m farther south, near the northern edge of the plateau, at 210 m above sea level the periglacial deposits remained unbottomed. And 1 km farther south, the top of the underlying materials lies some 212 m above sea level (fig. 9).

Figure 8 illustrates the structure of the lower planation lying in the Parzynów—Rzetnia basin. In its north-eastern part, this valley planation

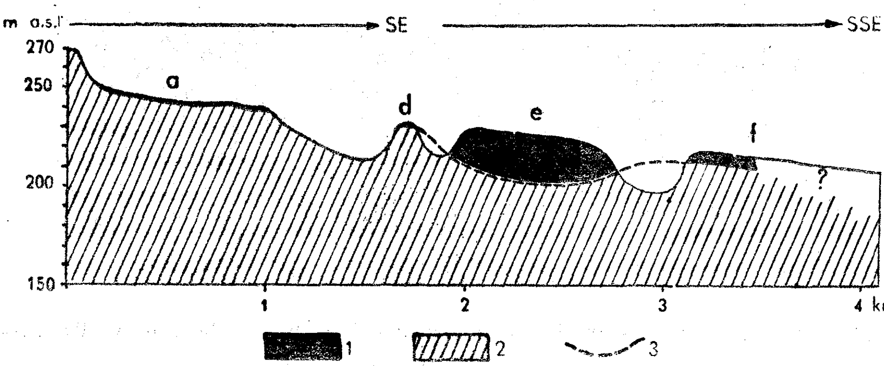


Fig. 9. Morpho-geologic profile of the upper planation level and of the associated zone of periglacial accumulations

1. periglacial sediments; 2. bedrock formations disturbed by glacial tectonics; 3. schematic profile of the bottom of the initial depression filled with periglacial deposits

borders on the plateau built of periglacial sediments. Excavations made on the „steep" side (11—13°) that slopes towards the planation have revealed the presence of two series of periglacial sediments (fig. 8 B): (1) the almost horizontally stratified deposits of which the plateau is composed and (2) a congelifluction layer, 0,5 m in thickness which is connected with the slope in question. Such a combination indicates that the upper planation level and the valley planation did not develop simultaneously.

Both the upper level and the connected plateau built of periglacial sediments were formed much earlier.

The valley planation is mantled with downwash deposits which were subsequently disturbed by congelifluction. These sediments have ca 1,5 m in thickness (fig. 8 C).

CONCLUSIONS

The totality of the geologic evidence discussed above indicates that the planation surfaces occurring in the Parzynów basin were formed under periglacial conditions. Periglacial planations are known from the area of the Polish Lowland since a few years ago they were first identified by J. Dylik (1953, 1956) who has shown lately (1957) that periglacial planations are of a pediment type and strikingly resemble pediments developed under the conditions of a semi-arid, warm climate. Later A. Dylikowa and H. Klatkowa (1956) have recognized some periglacial planations occurring in the forefield of the northern edge of the Łódź Upland. The slope planations of the Parzynów depression greatly resemble the pediment-like planations described by J. Dylik (1957). These surfaces with a gradient of no more than 1—4° abut in each of the examples studied against the relatively steep slopes of the highest elevations bordering the Parzynów depression. Separating the „steep" slope and the planation, there is a well-defined, though not all too sharp break, which may be better called a „zone of break" (fig. 3; pl. 2, 4). The planation surfaces are thinly veneered with allochtonous deposits, up to 2 m in thickness. Several places, however, are devoid of slope cover (fig. 5 b). Planation truncates the abruptly dipping glaciotectonic structure of the bedrock; this shows that these surfaces were produced by denudation. The structure of the cover that rests on them indicates that it was deposited by run-off waters and — though to a less-degree — by congelifluction. This proves that sheet-wash was the chief process operating on the planations in the south-eastern part of the Ostrzeszów Hills. All these facts indicating that sheet-wash was here the chief agent of planation, tend to confirm the views of J. Dylik (1954, 1957) who believes that congelifluction was not the only factor responsible for the formation of periglacial slope planations. According to J. Dylik (1954, 1957), under periglacial conditions sheet-wash must have largely contributed to the formation of pediments. As concerns the planations of the Parzynów basin, downwash may be even said to have played a preponderant part. The objections raised by A. Cailleux (1955) against the suggestion that periglacial planations may be regarded as analogues of pediments were, as well known, based on the assumption that periglacial planations are produced by congelifluction, whereas true pediments result from sheet-wash.

In the Parzynów basin run-off waters were flowing over the planation surfaces in widely diffused streams. The discontinuous, faintly undulating laminae occurring in the planations, are evidence of a laminar, non-turbulent flow. Streams of that kind had no erosive capacity. Such a type of downwash resembles closely those processes that operated on the pediments produced in semi-arid, warm climatic zones (King 1953) and on the periglacial pediments described by J. Dylik (1957).

Material from the „steep" slopes and the summits of the highest elevations around the Parzynów basin, was conveyed on to the higher planation level. In the case of the valley planation near Rzetnia, the material was removed from the slope of the flat plateau. On these slopes, periglacial sediment attains scarcely 0,5—0,9 m in thickness. It was deposited by congelifluction.

The summits and hillsides of the elevations around the Parzynów basin were the main sources supplying the material which was removed and deposited on the higher planation surface. A like source of the material found on the valley planation was the slope of the flat plateau, west of Rzetnia. It seems worth noting that there is no evidence indicating any prolonged wastage of this material by frost-weathering, before its removal. This may be partly attributed to the fact that the material accumulated on the planations was chiefly derived from the „steep" slope. Under periglacial conditions, in this area built of clastic rocks as soon as the frozen ground had thawed to a certain depth, the water-saturated slope cover was immediately subjected to congelifluction. Frost-weathering which is so potent a factor of denudation on hard rocks, was here of no greater importance (Büdel 1937, 1948; Troll 1948). Clastic materials invaded by permafrost behaved, no doubt, just in the same manner as hard rocks; but as soon as they were penetrated by the active layer they were ready for removal. Hence, the only effect of congelifraction was to speed up transportation. It was observed that in the upper periglacial level of the Parzynów basin, the percentage of fines and silty material increases slightly outside the planation, within the zone of accumulation. It is, however, difficult to say whether the fact is an effect of congelifraction during transportation onto the planation surface or rather that of the sorting action of the transferring agents.

As mentioned previously, the „steep" slopes controlling the planation surfaces of the Parzynów basin exhibit a thin congelifluction cover (0,5—0,8 m). This is not to say that no other processes operated on these slopes. J. Dylik (1954, 1957) and L. C. King (1953) believe that steep slopes (free face) rising above planation surfaces of the pediment type were subjected to a concentrated action of processes. L. C. King who studied such slopes during heavy rain-falls noticed a regular production of numerous small grooves, cut by turbulent downwash streams. According to L. C. King, the concentrated action of this process causes a parallel retreat of the free face. J. Dylik (1957) assumes that under periglacial conditions, the receding slope was subjected not only to rill-wash but also to concentrated congelifluction which resulted in the formation of denudation small-valleys. Under periglacial conditions, just in the same way as under semi-arid warm climatic conditions, the action of morphogenetic processes was generally seasonal, being most intensive at the time of spring floods.

Concentrated congelifluction and rill-wash were, no doubt, operating also on the „steep" slopes above the planation surfaces of the Parzynów basin. Evidence of the former is provided by the denudation small-valleys occurring on these slopes (pl. 4). However, the „steep" slope fails to exhibit any direct traces of concentrated water-action. If rill-wash operated on this part of the slope, its effects must have been chiefly erosive. The „steep" slope cannot, therefore, be expected to exhibit any traces of that process. The net result of denudation on the slope is rather a positive one and, therefore, displays only the deposits accumulated during the latest phase of its development, when the processes of the periglacial morphogenetic cycle had lost much of their former effectiveness.

Indirect evidence, however, reveals the action of rill-wash on the „steep" slope. Under periglacial conditions, sheet-flood was operating over the planation surfaces. But it seems hardly possible that water-action should have started on surfaces having so small a gradient. Waters which were largely derived from melting snow must have necessarily operated first on the „steep" slope above the break separating it from the planation. As emphasized by L. C. King (1953) and J. Dylik (1957) the break is a line separating the part of the slope, which is subjected to a concentrated action of processes, from the waning slope (pediment) where they operated in sheets. The accuracy of this statement is strengthened by the fact that L. C. King (1953) based it on direct observations of present-day processes. The presence on the planations of deposits testifying to sheet-flow may, therefore, be regarded as evidence of concentrated water-action on the „steep" slope.

In the Parzynów basin, the slope break is not linear but appears rather in the form of a narrow zone. This is an effect of the specific character of periglacial processes and also to a certain extent of the lithologic properties of the bedrock on which the planations were formed. According to L. C. King (1953) in unresistant rokcs the break is usually more gentle.

This view may also be invoked for the area in question. It seems, however, that in the case of the planation here described that gentle break may have resulted from still another, equally important cause. J. Dylik (1957) has established, that under different climatic conditions the various processes operating on the „steep" slope and on the pediment differ widely from one another in their effects. One of the most striking characteristics of the Parzynów depression is in the relatively insignificant difference between the gradient of the „steep" slope and that of the planation. From this it may be inferred that the difference between the processes operating on either of these slope parts was accordingly much lesser than between those, for example, known from semi-arid, warm climatic zones where free-face slopes have gradients of 50° and more (King 1953). Moreover, under periglacial conditions in addition to concentrated processes on slopes inclined 9—13°, surficial ones were certainly operating too. According to J. Büdel (1948) slopes with a gradient 2° to 15° afford the most suitable conditions for the development of congelifluction. All these circumstances have contributed to the production, in the Parzynów depression, of gentle breaks between „steep" slope and planation.

As regards the zone of deposition of the material derived from the receding „steep" slope connected with the upper planation level, large portions of this surface (300—800 m) failed to provide a base for accumulation, since they are only thinly veneered with periglacial sediments (whose thickness increases slightly in the distal part of the planation). The zone of accumulation, connected with the upper planation level lies as far away as on the northern extremity of the plateau, west of Rzetnia (fig. 2, 3, profiles 1e and 2e; fig. 9). A fossil depression occurring in this place is filled with periglacial sediments, more than 15 m in thickness. Farther south-eastwards outside the fossil depression, their thickness decreases to 4 m (fig. 9).

Such an areal situation of periglacial sediments in the Parzynów depression emphasises the transitional role of the upper planation level of which only a few single fragments have survived until to-day. This surface (fig. 3, profiles 1a, 2b, 3c) provided the tract over which materials supplied by destruction of the highest elevation around the Parzynów basin, were transported downslope. Thus, it developed at the expense of these elevations, as a result of a parallel retreat of the „steep" slopes. On the other hand, the planed surface facilitated denudation by providing a surface over which waste from the surrounding slopes was readily transferred and accumulated primarily within the depression west of Rzetnia which may have been left by some melted dead-ice body. After this hollow had been filled up with periglacial deposits (fig. 7, 9) the waste continuously supplied from the pediment was transported farther south-eastwards, beyond the fossil depression. As a result, this zone was progressively aggraded, until it finally attained the level of the upper planation of the Parzynów basin. Thus, the pediment and the aggradation zone coalesced to form one surface sloping gently to the south-east (fig. 3, profiles 1, 2; fig. 9).

Later, with increasing humidity of periglacial climate the joint surface of pediment and accumulation level was trenched by fairly deep valleys (15—25 m). Thus, a flat plateau, bordered by valleys arose at the site of the initial depression filled with periglacial deposits (fig. 2, 3, profiles 1e, 2e). In one of these valleys, namely the Parzynów—Rzetnia valley another planation was formed adjoining the plateau composed of periglacial sediments (fig. 8; pl. 4).

Finally, the writer wishes to emphasize the significance of the more than 15 m thick series of periglacial sediments composing the flat plateau west of Rzetnia whose surface forms a continuation of the upper planation level. Although it has been established that this surface is relatively thinly veneered with allochtonous periglacial deposits, there still may remain some doubts concerning the possibility of its having come into existence under some other morphogenetic cycle after extinction of which it was only remodeled by periglacial processes. In fact, the deposits found to-day on the planation record solely the final processes, to which it was subjected.

Leaving aside the fact — which might be regarded as a sort of indirect evidence — that no such planations could possibly be formed under the climatic conditions prevailing after the retreat of the ice-sheet of the Warta stage, it may be said that direct evidence showing that the planations of the Parzynów depression were developed under periglacial conditions alone is provided by this 15 m thick series of periglacial deposits (fig. 7; pl. 6, 7) which accumulated initially within the fossil depression. This fact may be regarded as most relevant, for it tends to confirm the assumption that the basal sediments of this series are synchronous with the initial phase of development of the upper planation level. Together with the retreat of the „steep" slope and the formation of a pediment, these deposits were steadily growing in thickness. The periglacial age of this series indicates that the surface of planation owes likewise its existence to periglacial denudation.

Both the planation levels discussed in this article have probably come into being during the Baltic glaciation. Further investigations of the connections between the Parzynów and Rzetnia valley — through the Samica-valley — and the terraces of the Prosna valley may prove helpful in determining more precisely the time in which the pediment-like periglacial planations of the Parzynów basin began to form.

Translation by T. Dmochowska

References cited

Büdel, J. 1937 — Eiszeitliche und rezente Verwitterung und Abtragung im ehemals nicht vereisten Teil Mitteleuropas. *Pet. Geogr. Mitt., Ergenzungsheft* 229.

Büdel, J. 1948 — Die klima-morphologischen Zonen dear Polarländer. *Erdkunde,* Bd. 2.

Cailleux, A. 1955 — Sur les conditions des aplanissements. *Czas. Geogr.,* t. 26.

Dylik, J. 1952 — Głazy rzeźbione przez wiatr i utwory podobne do lessu w środkowej Polsce (summary: Wind-worn stones and loess-like formations in Middle Poland). *Biul. Państw. Inst. Geol.* 67.

Dylik J. 1953 — O peryglacjalnym charakterze rzeźby środkowej Polski (résumé: Du caractère périglaciaire de la Pologne Centrale). *Acta Geogr. Univ. Lodz.,* nr 4.

Dylik, J. 1954 — Zagadnienie powierzchni zrównań i prawa rozwoju rzeźby subaeralnej (résumé: Le problème des surfaces d'aplanissement et les lois de développement du relief subaeral). *Czas. Geogr.,* t. 25.

Dylik, J. 1956 — Coup d'oeil sur la Pologne périglaciaire. *Biuletyn Peryglacjalny,* nr 4.

Dylik, J. 1957 — Próba porównania powierzchni zrównań w warunkach półsuchych klimatów gorących i zimnych (Tentative comparison of planation surfaces occurring under warm and under cold semi-arid climatic conditions). *Biuletyn Peryglacjalny,* nr 5.

Dylikowa, A., Klatkowa, H. 1956 — Exemple du modelé périglaciaire du Plateau de Łódź. *Biuletyn Peryglacjalny,* nr 4.

Hövermann, J. 1954 — Die Periglazial-Erscheinungen im Tegernseegebiet. *Gött. Geogr. Abhandl.,* H. 15.

Jahn, A. 1954 — Denudacyjny bilans stoku (résumé: Balance de denudation du versant). *Czas. Geogr.,* t. 25.

King, L. C. 1953 — Canons of landscape evolution. *Bull. Geol. Soc. Amer.,* vol. 64.

Lundqvist, G. 1949 — The orientation of the block material in certain species of flow earth. *Geogr. Annaler,* Årg. 31.

Rotnicki, K. 1960 — Uwagi o genezie wzgórz Ostrzeszowskich w świetle nowych danych geologicznych i geofizycznych (summary: The considerations on the genesis of the Ostrzeszów Hills, southern Great-Poland Lowland, the Warta Stadium, in the light of new geological and geophysical data). *Zeszyty Naukowe Uniw. A. Mickiewicza w Poznaniu, Geografia,* nr 3.

Troll, C. 1948 — Der subnivale oder periglaziale Zyklus der Denudation. *Erdkunde,* Bd. 2.

Weinberger, L. 1954 — Die Periglazial-Erscheinungen im österreichischen Teil des eiszeitlichen Salzach-Vorlandgletschers. *Gött. Geogr. Abhandl.,* H. 15.

Karol Rotnicki
Poznań

PERYGLACJALNE ZRÓWNANIA STOKOWE W POŁUDNIOWO-WSCHODNIEJ CZĘŚCI WZGÓRZ OSTRZESZOWSKICH

Streszczenie

Zarys treści

W południowo-wschodniej części Wzgórz Ostrzeszowskich zaobserwowano spłaszczenia stokowe. Badania geomorfologiczne wykazały, że są to zrównania peryglacjalne. Występują one w dwóch poziomach. Wyższy poziom, zachowany fragmentarycznie, jest rozcięty przez doliny, w których obrębie powstał niższy poziom. Najprawdopodobniej zrównania te powstały podczas zlodowacenia bałtyckiego.

W południowo-wschodniej części Wzgórz Ostrzeszowskich (wschodni odcinek Gór Kocich), stanowiących spiętrzoną morenę czołową stadium Warty, stwierdzono występowanie zrównań stokowych. Zrównania występują w dwóch poziomach. Wyższy poziom zachowany we fragmentach w postaci półek, które przylegają do najwyższych wzniesień Wzgórz Ostrzeszowskich, jest położony na wysokości 220—245 m n.p.m. Powierzchnie zachowanych fragmentów zrównań opadają nieznacznie pod kątem 1—4°, natomiast stoki wznoszące się ponad nimi są nachylone pod kątem 9—15°. Fragmenty wyższego poziomu zrównania są położone na wysokości 15—20 m ponad dnami dolin. Długość poszczególnych fragmentów wyższego poziomu zrównania wynosi od 150 do 700 m. W południowo-wschodniej części Wzgórz Ostrzeszowskich występują również pojedyncze pagórki oraz stoliwa, które łączą się z opisanymi fragmentami zrównania w jedną kopalną powierzchnię, później rozciętą (fig. 2 i 3). Niższy poziom zrównania występuje w niektórych dolinach i łączy się z ich dnami.

Badania geomorfologiczne wykazały, że zrównania powstały w rezultacie działania procesów charakterystycznych dla środowiska peryglacjalnego. Powierzchnie zrównań są dyskordantne w stosunku do glacitektonicznych struktur podłoża. Nie są one uwarunkowane litologią podłoża, gdyż występują zarówno na glacitektonicznie zaburzonych osadach piaszczysto-żwirowych jak i na trzeciorzędowych iłach. Powierzchnie zrównań pokryte są stosunkowo cienką pokrywą osadów peryglacjalnych; ich miąższość wynosi od 0 do 2,2 m. Są to osady pochodzące ze spłukiwania powierzchniowego oraz osady kongeliflukcyjne. Osady stokowe występują również i na szczytach pagórków i stoliw, których powierzchnie łączą się z wyższym poziomem zrównania. Ten fakt świadczy o tym, że wspomniane pagórki i stoliwa niegdyś musiały być połączone z wyższym poziomem zrównania (fig. 3 i 6).

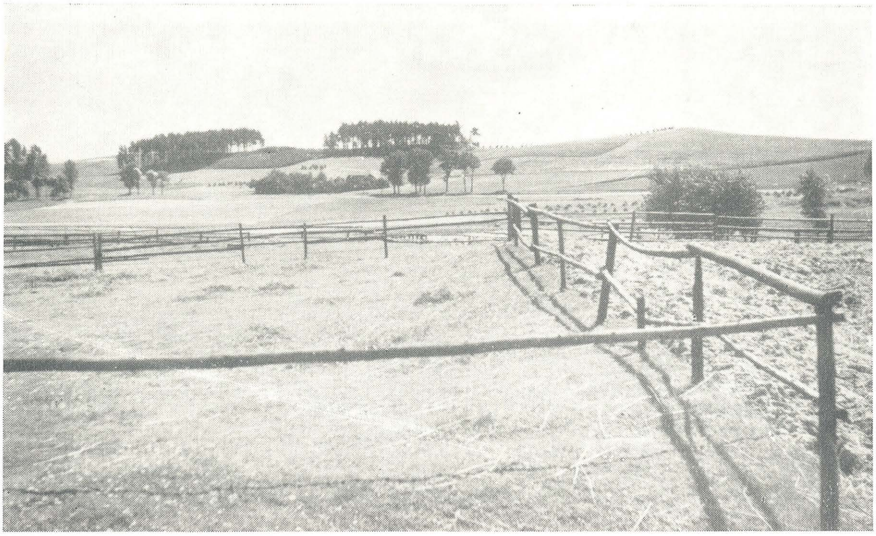
Stwierdzono, że w południowo-wschodniej części Wzgórz Ostrzeszowskich wyższy poziom zrównania przechodzi w powierzchnię akumulacji peryglacjalnej. Miąższość osadów peryglacjalnych występujących w tej strefie dochodzi do 20 m. Są to osady pochodzące ze spłukiwania, przewarstwiane osadami kongeliflukcyjnymi i należy je uznać za syngenetyczne z wyższym poziomem zrównania (fig. 9). W stropie tych osadów występują kliny zmarzlinowe. Wszystkie te fakty dowodzą, że zrównania występujące we Wzgórzach Ostrzeszowskich powstały w środowisku peryglacjalnym.

Cechy geologiczne oraz morfologiczne zrównań, a zwłaszcza ich pośrednia, przejściowa pozycja między strefą szczególnie silnej denudacji (grzbiety kulminacyjne i „strome" stoki opadające ku zrównaniom) a strefą akumulacji peryglacjalnej świadczą, że są to peryglacjalne zrównania stokowe typu pedymentów. Posiadają one wiele wspólnych cech ze zrównaniami tego typu opisanymi przez J. Dylika (1957). Zrównania występujące we Wzgórzach Ostrzeszowskich powstały najprawdopodobniej podczas ostatniego zlodowacenia.

Spis ilustracji

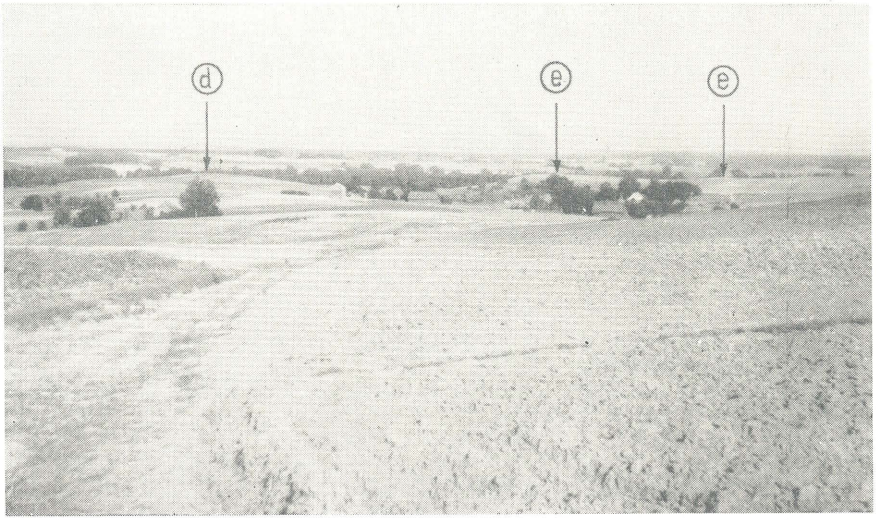
Rysunki

Fotografie

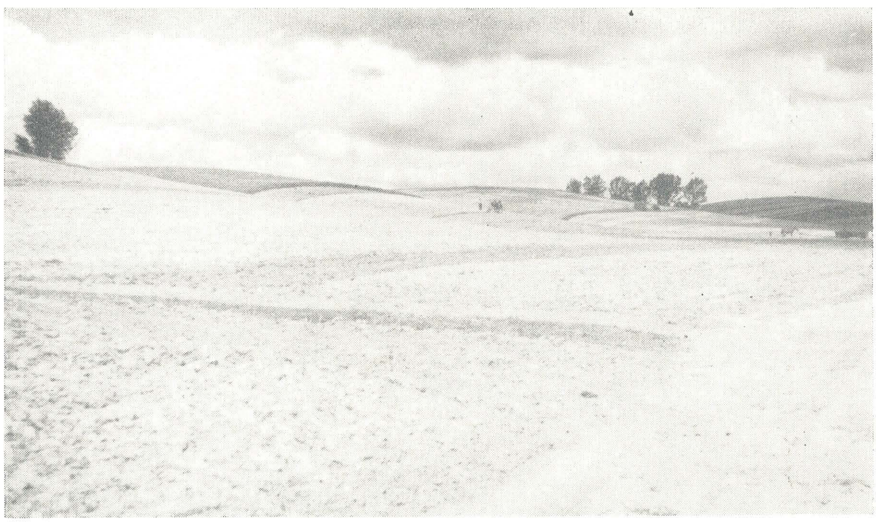


Pl. 1. Segment of the Kobyla Góra complex of hills (284 m above sea level) seen from the north

Pl. 2. Segment of the upper planation, north of the Kobyla Góra complex



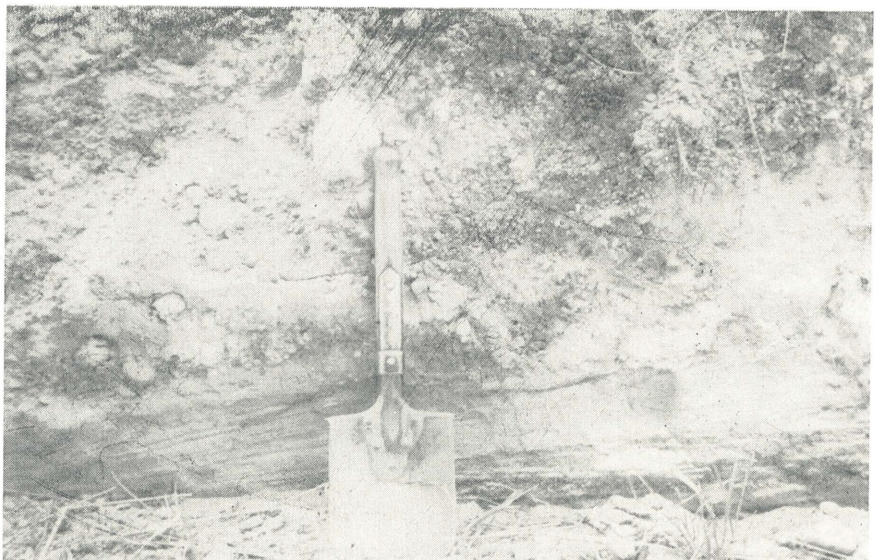
Pl. 3. Hill rising 231 m above sea level (d) and flat plateau (e) west of Rzetnia. View from the west



Pl. 4. „Steep" slope and part of the planation in the Parzynów—Rzetnia valley. On the right hand side — the 231 m high hill (shaded)

Pl. 5. Thin waste cover on the summit of the 278 m high hill 1 km west of Parzynów. On the right hand side — small ice-wedge

Pl. 6. Plications in the congelifluction sediments composing the plateau west of Rzetnia (fig. 7, p. 9)



Pl. 7. Congelifluction deposits overlying water-laid periglacial sediments (fig. 7, p. 5, 6