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Pleistocene periglacial and periglacial-soil structures in the western part of the Holy Cross Mts

ABSTRACT: Rubble festoons developed on tectonically loosened Liassic sandstones are reported from the western part of the Holy Cross Mts, Central Poland. These structures, as well as ice-wedge casts and funnel-shaped structures occurring in Quaternary deposits, originated under the periglacial conditions of Pleistocene patchy tundra.

INTRODUCTION

The paper reports on the occurrence of Pleistocene periglacial and periglacial-soil structures in the western part of the Holy Cross Mts in Central Poland (*cf.* Lindner 1971, 1977). These structures include frost deformations developed within the belt of Jurassic outcrops, as well as frost-ground deformations developed in Quaternary deposits.

PERIGLACIAL FORMS

North of Brody village, 4 km SW of Końskie, there are exposed Liassic sandstones (strike 70°—80°; dip smaller than 10°), the splitting of which markedly increases towards the top parts of small quarries (Pl. 1, Figs 1—2). The sandstones are covered by a thin layer of sands with silts and Scandinavian boulders and angular fragments of local rocks; this layer represents a residuum of Mid-Polish Glaciation tills (Lindner 1971).

Quarry walls show strong splitting and loosening as well as a marked uplift of sandstone layers at 0.5—1.5 m below the ground surface (Pl. 1, Figs 1—2). These disturbances gave origin to a system of festoons typical of the periglacial climate (*cf.* Washburn 1956, Dylik 1956, Różycki 1957, Laskowska 1961, Jahn 1975). The forms studied are characterized by coincidence of the zone of maximum uplift of individual sandstone beds and the course of their joint fractures (Pl. 1, Fig. 1). The fractures are arranged in two directions almost perpendicular to one another (35—45° and 110—130°), at the dips up to 70—80° in various directions.

The joint loosening of the sandstones was the factor facilitating development of festoon forms when the climate turned to periglacial (*vide* Fig. 1). In those times vegetational cover was lacking and water accumulating and freezing in fissures contributed to the manifestation of bedding in subsurface parts of the sandstones (Fig. 1*A*). The origin of permafrost

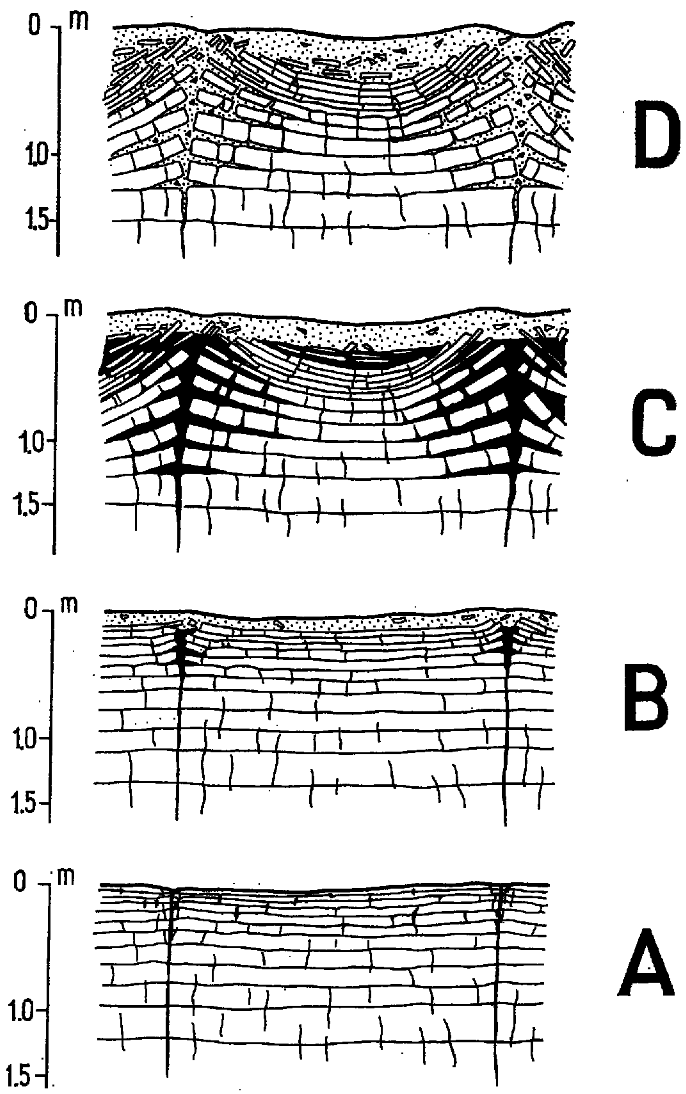


Fig. 1. Successive stages (*A*—*D*) of development of the rubble festoons in the exposures of Liassic sandstones at Brody near Końskie (*cf.* Pl. 1, Figs 1—2)
Marked black is ground ice; detailed explanation in the text

led to an increase of ground-ice volume within joint fractures and interbedding surfaces, and to the uplift of individual layers (Fig. 1*B*). Short-lasting partial melting of ground-ice facilitated deposition of sand, and repeated freezing and thawing led to further widening of fractures (Fig. 1*C*), and their preservation to the present time (Fig. 1*D*).

PERIGLACIAL-SOIL FORMS

EXPOSURES AT SIEROSŁAWICE

In SW part of Sierosławice village, 3 km of Końskie, there occurs a hill made up of sandy-gravel deposits encapping a culmination of Liassic sandstones covered with tills. The hill represents a fragment of the

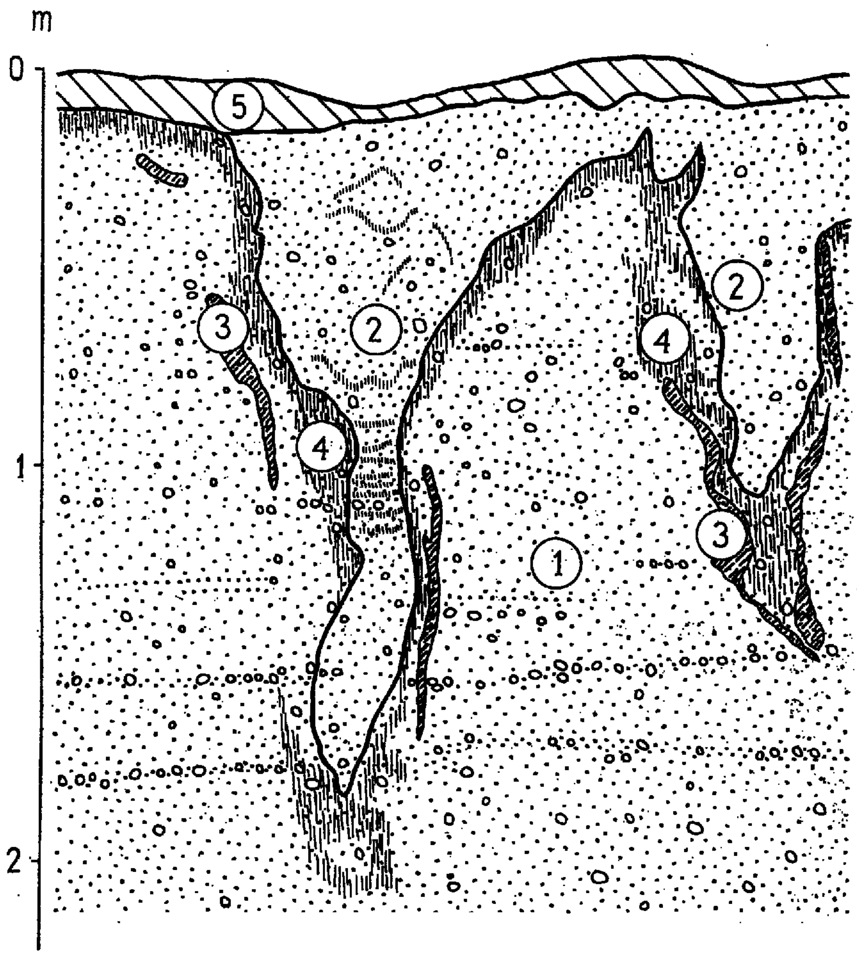


Fig. 2. Funnel-shaped structures in gravelous sands at Sierosławice near Końskie
1 gravelous sand, containing calcium carbonate; *2* decalcified sand with streaks of iron compounds; *3* cementations of calcium carbonate; *4* streaks of iron compounds; *5* soil

basal part of a sander-cone end; along with neighbouring forms of glacial origin it marks the zone of recessional stop of the front of the Mid-Polish Icesheet (Lindner 1971). The sand-pit situated in the uppermost part of the hill displays numerous wedge- and funnel-shaped forms developed in subsurface part of the sandy-gravel deposits (Text-figs 2—3 and Pl. 2, Fig. 1).

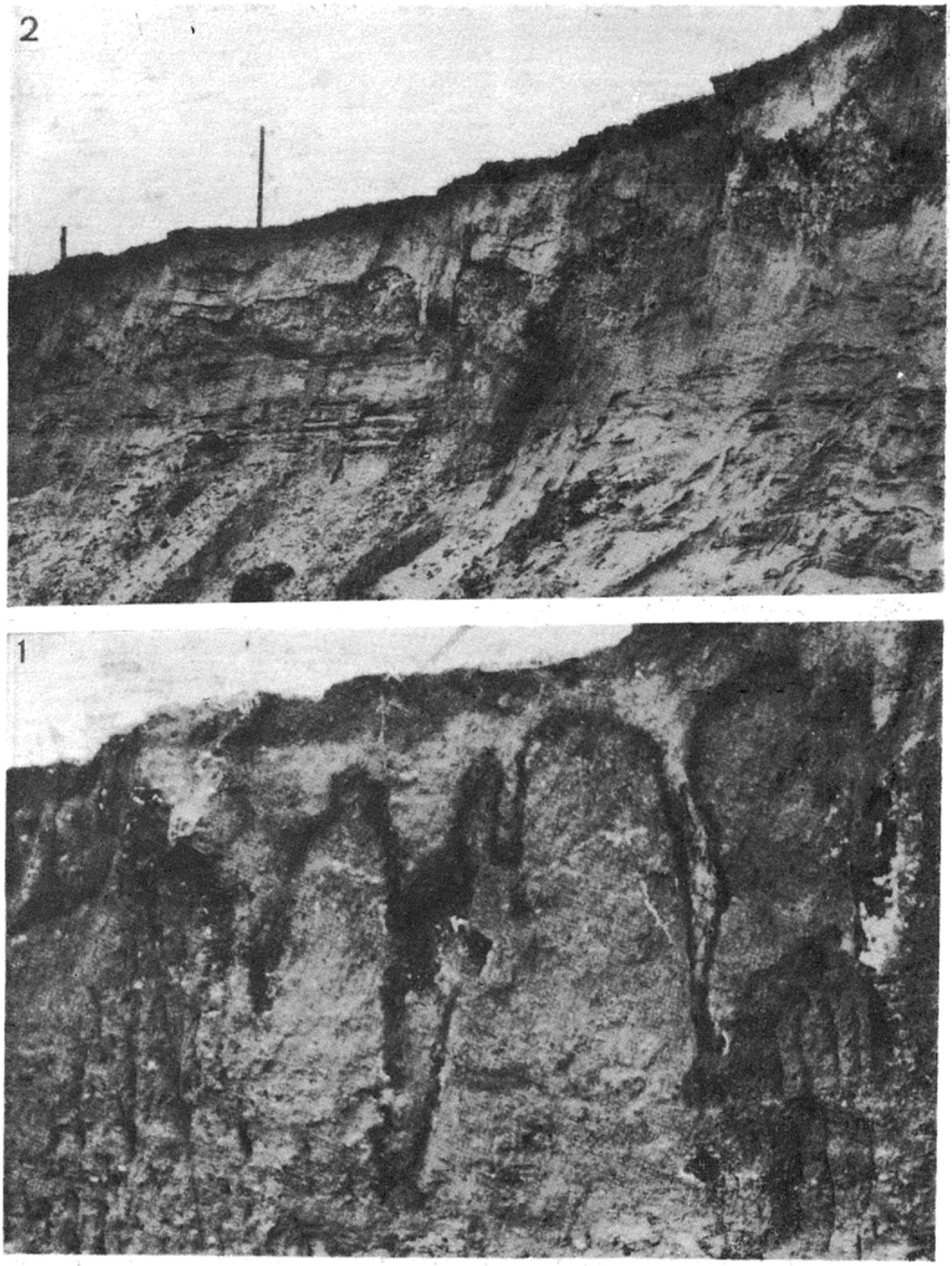
The funnel-shaped forms (Pl. 2, Fig. 1) are more common than the wedge-shaped ones, and more differentiated in dimensions, extending to the depths varying from 0.5 to 4 m. Their central parts are made up of the same sandy-gravel material as the deposit in which they occur; and they even display sometimes the same type of sedimentary rhythms as the deposit forming the sandy-gravel substrate. The funnel-shaped forms are distinguished taking primarily into account their decalcified interior (*2* in Fig. 2), and precipitation of ferruginous (*4* in Fig. 2) and carbonate solutions (*3* in Fig. 2) washed out of them in the zone of their contact with the substrate (*1* in Fig. 2); whereas, the differences in lithological composition in respect to the substrate are considered of secondary importance.

The funnel-shaped forms do not continue in the horizontal direction, as a rule being represented by vertical or almost vertical structures narrowing along with depth.

The funnel-shaped forms are slightly similar to the structures reported from the northern and north-eastern parts of the USSR (*e.g.* Suslov 1954, Tyrtikov 1956, Krejda 1958) and Scandinavia (Johnsson 1959). Analogous forms recorded in Poland were interpreted as structures typical of the periglacial conditions of patchy tundra (*e.g.* Maruszczak 1959, 1960; Uggla & Przedwojski 1973). Funnel-like mode of migration of ferruginous and carbonate solutions under the conditions of patchy tundra is determined by wavy shape of the top surface of permafrost. Deeper infiltration of the solutions was limited to the areas devoid of vegetational cover and thus subjected to more intense and deeper thawing; the infiltration, in turn, was shallower in areas with vegetational cover and, consequently, shallower thawing.

The ice-wedge casts developing above the substrate thawing each year (*cf.* Pissart 1970, Romanovskij 1970) predominate among wedge--shaped forms at Sierosławice. In Poland, such forms were usually described as fissures with secondary infilling (*cf.* Goździk 1973). One of such casts is characterized by a marked, symmetric widening of the upper part (Fig. 3) which may be interpreted as being a result of permafrost degradation by solar radiation (*cf.* Péwé & al. 1969, Jahn 1975). The wedge casts extend to the depth of 1.5—2 m, and their spatial distribution indicates that they presumably represent fragments of polygons about 20—30 m in diameter. The wedges are usually infilled with unsorted sand with silt

1–2 Rubble festoons at Brody near Końskie (*cf.* Text-fig. 1).



1—2 Funnel-shaped structures attributable to patchy tundra, exposed (1) at Sierosławice near Końskie (cf. Text-fig. 2), and (2) at Leśnica near Małogoszcz.

and streaks of secondary ferrugineous precipitation (*2* in Fig. 3). Their shape is always accentuated by a distinct coating of ferrugineous precipitate (*4* in Fig. 3) and, at some distance, by concentrations of calcium carbonate (*3* in Fig. 3).

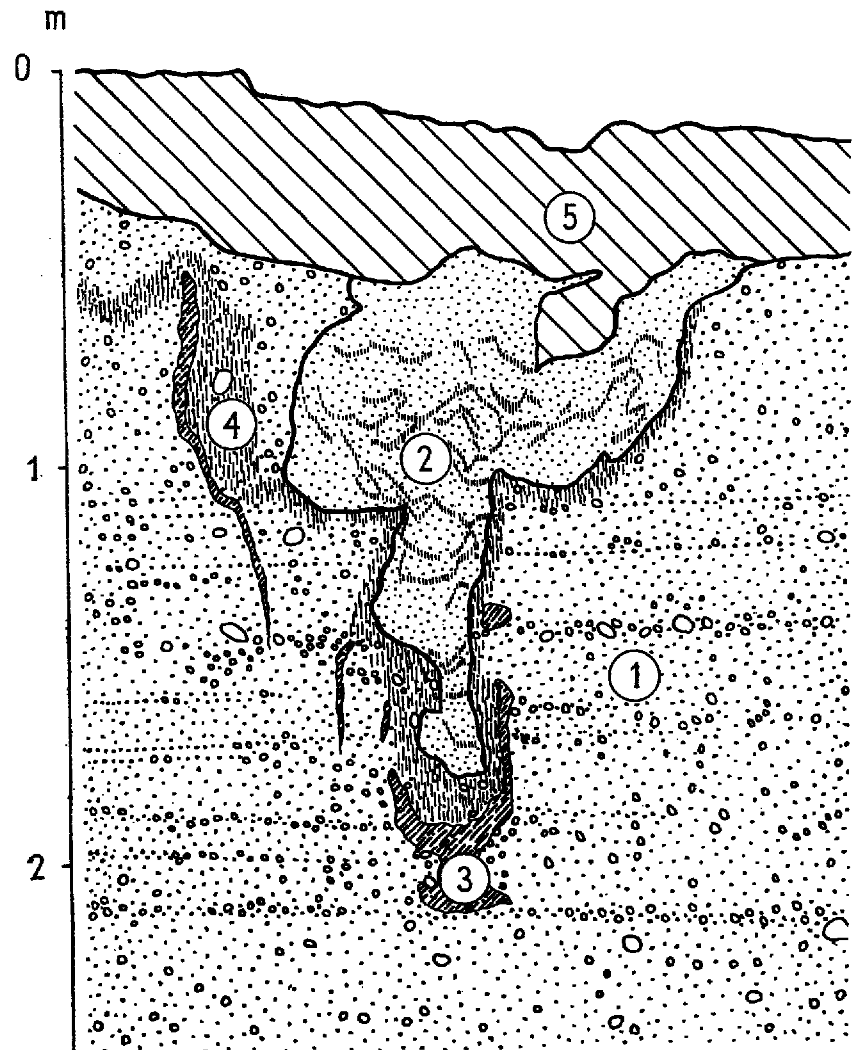


Fig. 3. Ice-wedge with secondary infilling at Sierosławice near Końskie
1 gravelous sand, containing calcium carbonate; *2* silty sand with streaks of iron compounds; *3* cementations of calcium carbonate; *4* streaks of iron compounds; *5* soil

EXPOSURE AT LEŚNICA

One of the exposures from Leśnica near Małogoszcz displays sands and silts with horizontal bedding covered by a layer of debris of Upper Jurassic limestones, almost a meter thick. The upper surface of this layer is featured by several funnel-shaped forms (Pl. 2, Fig. 2) resembling those from Sierosławice. The funnel-shaped structures are filled with sandy material with marked admixture of silt. Ferruginous-carbonate precipitates accentuating these forms, and concentrated at their boundaries, form a kind of illuvial horizon which should also be recognized as developed under the conditions of patchy tundra.

FINAL REMARKS

The presented examples of periglacial and periglacial-soil structures allow to conclude that the rubble festoons originated in result of overlapping of a process of frost seggregation and an already existing pattern of joint, that is, they are periglacial forms with location, shape and size determined by microtectonic features of the bedrock-forming Liassic sandstones.

The presence of ferruginous and carbonate precipitates at the contact of wedge-shaped and funnel-shaped structures and of sandy-gravel deposits indicates that origin of both these structures was connected with the existence of permafrost processes during the Pleistocene glaciations.

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PLEJSTOCEŃSKIE STRUKTURY PERYGLACJALNE I PERYGLACJALNO--GLEBOWE W ZACHODNIEJ CZĘŚCI GÓR ŚWIĘTOKRZYSKICH

(Streszczenie)

Przedmiotem pracy są struktury peryglacjalne i peryglacjalno-glebowe występujące w zachodniej części Gór Świętokrzyskich (por. Lindner 1971, 1977). Wśród struktur tych wyróżniono: (1) peryglacjalne festony gruzowe rozwinięte w strefie przypowierzchniowej ciosowo spękanych piaskowców liasowych (fig. 1 oraz pl. 1), oraz (2) kliny zmarzlinowe i specyficzne formy lejkowe (fig. 2–3 oraz pl. 2), rozwinięte w osadach czwartorzędowych, które uznać należy za powstałe w warunkach plejstoceńskiej tundry plamistej.
