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LAND SLIDE FORMS ON POŁOMA MOUNTAIN IN THE SINE WIRY NATURE RESERVE, WEST BIESZCZADY

FORMY OSUWISKOWE GÓRY POŁOMA W REZERWACIE PRZYRODY SINE WIRY W BIESZCZADACH ZACHODNICH

Włodzimierz Margielewski: Land slide forms on Połoma mountain in the Sine Wiry nature reserve, West Bieszczady. Streszczenie. *Ochr. Przyr.* Ann. 49: 23 – 29, 1991, Kraków.

Abstract. There are slide forms of different age in the nature reserve on the southern slope of the Połoma mountain in the West Bieszczady. An attempt has been undertaken to determine their genesis and succession, on the basis of geodesic and dendrogeomorphological measurements. An old insequent slide from before 1810 and within its colluvium a young consequent form dating from 1980 were discriminated. When it comes to the latter a course of its evolution was reconstructed.

Key words: slide forms, genesis, succession, age, nature reserve, West Bieszczady, Poland

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Treść. W rezerwacie przyrody na południowym stoku góry Połoma w Bieszczadach Zachodnich występują różnowiekowe formy osuwiskowe. Na podstawie pomiarów geodezyjnych i dendrochronologicznych podjęto próbę określenia ich genezy i sukcesji. Wyróżniono stare osuwisko insekwentne z okresu sprzed 1810 roku, a w obrębie jego koluwium młodą formę konsekwentną datującą się z 1980 roku. Zrekonstruowano przebieg rozwoju tej ostatniej.

I. INTRODUCTION

Among the modelling processes of the outher Carpathians mountain ridges surface rock mass movements play an important role. These lead to rapid remodelling of large slope fragments and occasionally of ridge-crest zones. (Alexandrowicz, Alexandrowicz 1988, Baumgart-Kotarba 1974, Flis 1959, Gerlach 1976, Kotarba 1986, Nemćok 1982). Those processes are genetically related to ground geologic structure as well as other factors such as slope inclination, climate erosion etc. (Bober 1984, Kleczkowski 1955, Oszczypko 1971, Starkel 1965). Mountain ridges built from a series of alternating thick sandstone and thin shales layers are especially prone to slope failure. Such geologic structure is characteristic for Śląska nappe in the area of Szczycisko and Połoma in the Bieszczady (Gucik, Ślączka, Żytko 1973). There steep seated Otryt sandstone deposits intercalated with shales have undergone fluvial preparation. That gave rise to narrow, subsequent valley subsides, some of which have tectonic genesis. They separate the compact, wide, resistant, parallel mountain ridges (Baumgart-Kotarba 1974, Starkel 1969). The steep and high valley walls are favourable for landsliding. Such processes are initiated mainly during river swelling resulting in flooding, while more active side erosion upsets slope dynamic balance. Their effects are traceable on the northern slopes of the

subsequent, occasionaly gap-like, Wetlina valley in the Bieszczady, over a distance of 4 km, between the contemporary non-existent Łuh settlement and the Wetlina mouth in Solinka. The formed here landsliding zone comprising varied, widespread forms of different age is due to the strong undercutting of the southern slopes of hills Połoma and Szczycisko. The most intensive landsliding processes have taken place on the northern slope of Połoma mountain which is the highest peak in this region (776 m above sea level.)

Połoma mountain has been formed in steep seated (60°) Otryt sandstone layers belonging to Krosno deposits of lower Korbań fold (Koszarski, Żytko 1961). These formations are visible in the bottom surface of the Wetlina river bed. Those are medium-bedded (0.3–0.5 m), polimictic, medium and coarsegrained sandstones, with shales intercalations. The Wetlina river incising a subsequent valley in those, has numerously undercut the southern slope of the mountain causing movements of large slope fragments a result of which has been formation of a large landsliding zone about 14 ha in area stretching at an elevation of 660 to 510 m above sea level. Because of instability of the slope it's been numerously rejuvenated. The youngest movements of this kind took place in 1980. A tongue of then born secondary slide blocked the Wetlina river bed leading to water swelling and formation of a dam-lake about 0.5 ha in area, called "The Emerald Lake" (Alexandrowicz 1991, Cabaj, Pelc 1991, Michalik, Mazur 1991). The created forms were subjected to conservation in 1988. The created there the Sine Wiry nature reserve 450.19 ha in area comprised the southern slopes of Połoma and Szczycisko mountains. Its aim is to protect the Witlina river section of water-gaps between Łuh settlement and the Wetlina river mouth in the Solinka along with the surrounding wood complex (Kurzyński, Mazur 1988, Michalik, Mazur 1991). The landsliding zone of Połoma mountain within the nature reserve constitutes 3% of its area.

Połoma rock slide form was first investigated by Dziuban (1983), who didn't go beyond a schematic draft and interpretation of the youngest slide in this research. The old slide form was only partially and not thoroughly recognized.

The detailed land research has been carried out with the aim of determination of evolution stages of the slide form on the southern slopes of Połoma mountain included in the nature reserve. A geomorphological map of landsliding zone on a scale of 1 : 2000 was the basis of this analysis. It was charted by tachymeter survey method basing on polygonal traverse. Additionally observations have been made and dendrogeomorphological samples taken with Pressler increment borer in order to determinate the forms succession.

II. SLIDE FORMS ON THE SOUTHERN SLOPES OF POŁOMA MOUNTAIN

Slide forms on the southern slopes of Połoma mountain exhibit several formation stages (Fig. 1.). The most wide-spread is the oldest slide. It has been renewed by several generations of secondary movements. The older ones were locally forming a colluvial surface of an initial slide and eventually produced a system of secondary niches and colluvial banks. The youngest movements in 1980 gave rise to a slide whose tongue blocked the Wetlina river (Fig. 1, 2).

1. The old initial slide

A detailed tacheometric measurement taken in the area of the southern slopes of Połoma, along with morphologic structure analysis have showed the existence of an old wide-spread slide 13.3 ha in area. The old slide possesses a semicircular niche with distinct, often steep escarps. In its central part, below the main niche with escarps 20–30 m high an underniche flattening 0.3 ha big got preserved (in its present day shape). A system of lenghwise banks separated with trenches formed below — most of them got damaged by the new slide. The assymetry of escarp development is characteristic for the old form. In its eastern part they constitute a steep (50°) soliflucted, stabilized slope 50 m high nowadays. The western part is sliced by steep (70°), numerously rejuvenated by secondary movements escarps. A 10–15 deep crack trench stretching along the whole escarp got formed at their foot. It was the basis for two rather small secondary niches. The upper got cut by the bigger and lower, younger one of an amphitheatre contour (Fig. 1.).

As a result of landsliding processes in the area of a brook spring — the Wetlina side stream, the ridge above the major niche of the old slide was cut by an escarp system sloping northward. Eventually, a narrow (30–40 m) crest sloping arch-like from Połoma south-westward was formed.

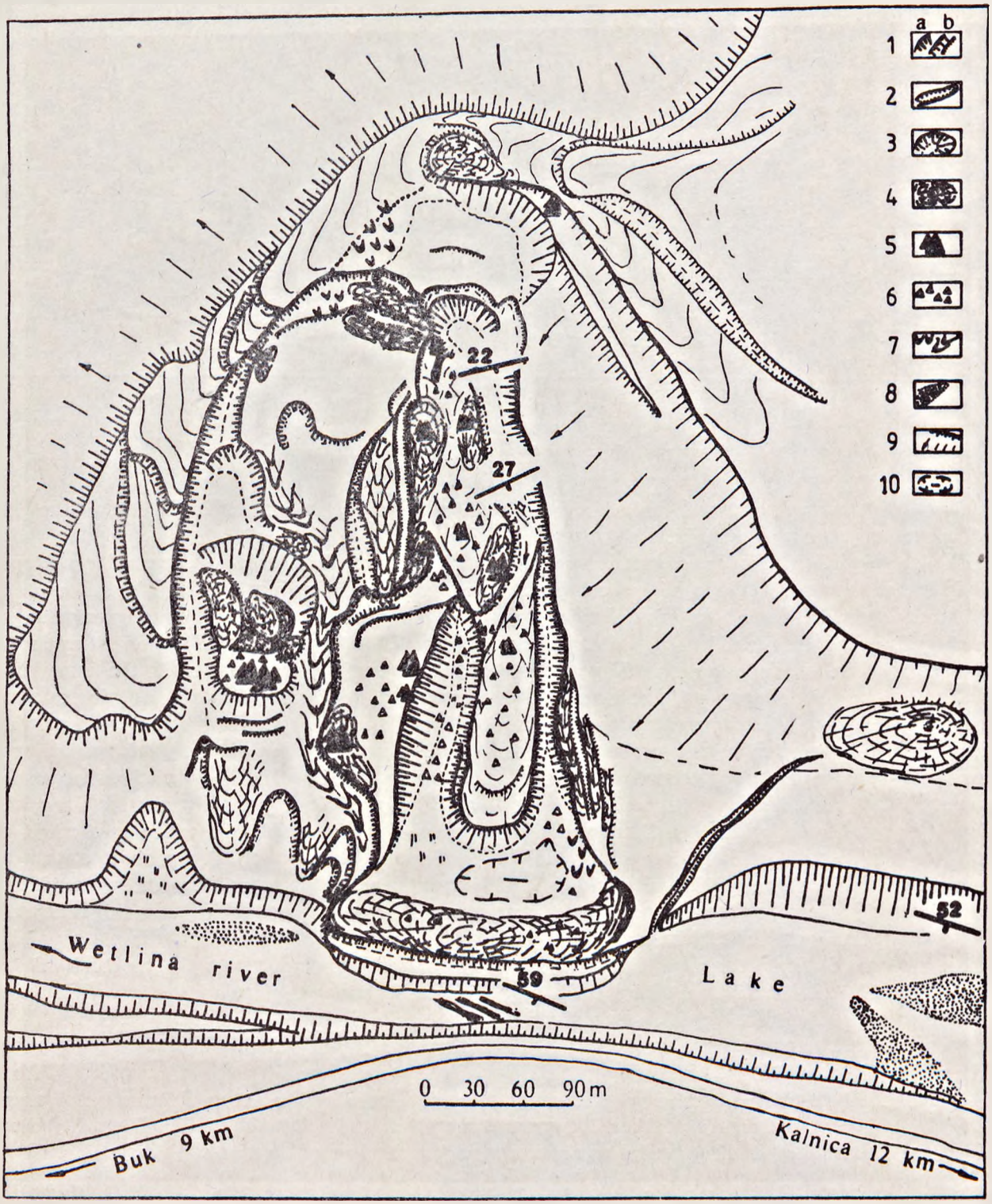

Fig. 1. Geomorphological map of the slide on Połoma mountain: 1 — escarps (a-rock, b-band), 2 — crack trenches, 3 — niches and rock escarps, 4 — colluvial swell, 5 — rock packets, 6 — rock rubble, 7 — creeps, 8 — sand bed, 9 — steep slope, 10 — soaked hollow

Ryc. 1. Plan geomorfologiczny osuwiska na górze Połoma: 1 — skarpy (a — skaliste, b — ziemne), 2 — rowy rozpadlinowe, 3 — nisze i skarpy skaliste, 4 — nabrzmienia koluwialne, 5 — pakiety skalne, 6 — rumosz skalny, 7 — złaziska, 8 — łachy piaszczyste, 9 — stromy stok, 10 — podmokłe zagłębienia

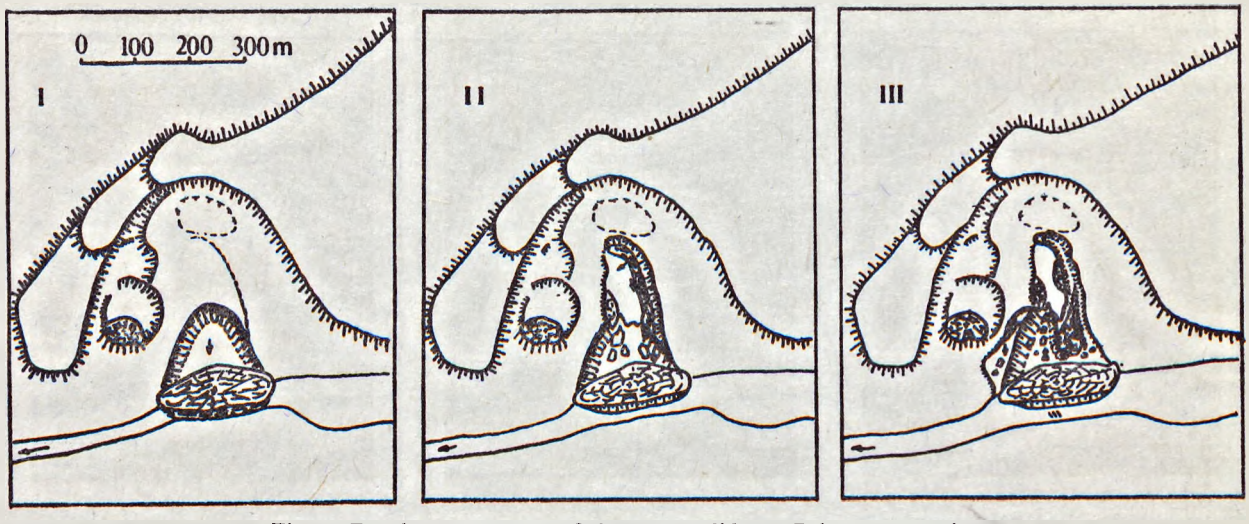

Fig. 2. Development stages of the young slide on Połoma mountain.
Legend: see Fig. 1

Ryc. 2. Etapy rozwoju młodego osuwiska na górze Połoma. Objaśnienia sygnatur na ryc. 1.

It forms a system of steps and flanks the landsliding zone from north-west (Fig. 1.).

The samples from the trees growing in the crack trench below the major niche and within the secondary niches have been taken for dendrogeomorphological analysis. The received data show that the age of these forms exceeds 92 years. On the area of the older slide parts, that is on banks, escarps of the major niche and escarps slicing the culmination crest from the north there are heavily rotten trees of a trunk section corresponding to that of 150 years. Taking into account a decay time it is possible to estimate the formation time of the old slide form of Połoma at before 1810. According to Dziubaṇ (1983) the old slides on Połoma might have got created at the same time as the slide in Duszatyń which crept from the southern slope of Chryszczata mountain in the Bieszczady in 1907. It blocked the Osława tributary forming the peculiar "Duszatyńskie Lake" which is protected as a nature reserve named "Zwiezło" (Alexandrowicz, Drzał, Kozłowski 1975). In the light of dendrogeomorphological data the old initial slide of Połoma is at least 100 years older than the slide of Chryszczata mountain.

2. The young slide form

The youngest slide on the surveyed area crept from the southern slope of Połoma mountain in July 1980 (Dziuban 1983). This form was cut out in the central part of the old colluvium and constitutes 40% of its area. Its culmination at an elevation of 639 m above sea level is about 80 m away from the main niche of the old form.

The increased rainfall twice exceeding the average perennial for July i.e. 287/135 mm initiated landsliding movements. It led to oversaturation of forms, mainly of the shales horizon which is the slide surface, with water. At the same time slope dynamic balance got disturbed, due to a rapid swelling of the Wetlina river and undercutting of the northern valley slopes. Rock masses over a distance of 179 m and an area of 5.4 ha got sliced off, partially rotationally shifted along the slope and sled towards the valley as a result of these processes (Fig. 1.). A form got created of a complex structure and genesis. Genetically, this is a slope slide, delapsive, in which rock masses were gradually shifted upwards reaching higher and higher slope parts. On the basis of well preserved forms three evolution stages of this slide can be discriminated (Fig. 2.).

I. As a result of the intensive undercutting of the steep slope (40°) by the swollen Wetlina decolbment of rock masses and formation of a primary slide took place (Fig. 2(I)). It reached more or less the half of the whole slide zone i.e. 580 m above sea level. Eventually, a semicircular, deep (30 m) niche, whose west escarp can be seen nowadays, was formed. The torn off rock masses 35 thousand m^3 in cubature were consequently shifted along the slope causing a lake formation. The lake front leant against the opposite valley bank, swelled and broke up. At its back 3–5 m deep hollow without water-outlet was formed.

The colluvium front blocked the Wetlina flow causing swelling of river waters and creation of a dam-lake 0.5 ha in area. The Wetlina stripping away the peripheral elements of the lake front, cut in and formed a new river bed, shifted 12 m southwards in relation to the old one, and reached the bed-rock. During slicing of colluvium the river cut in it a narrow terrace 2–3 m wide.

II. Formation of the primary slide, whose niche cut deeply into the slope, led to disturbance of slope dynamic balance and initiated another generation of movements. These were marked as a linear decolbment of rock masses over a distance of 150 m along the surface of crosswise cracks (165–200°) (Fig. 2(II)). A N–S edge was formed. It curved westward at its culmination part at an elevation of 639 m forming quasi main niche, in effect the whole escarp is a niche. The torn off rock packet 0.8 ha in surface rotated south-westward thrusting with its front over the niche of the slide below. Its fragment 2 thousand m^3 in cubature fell off the niche and partially scattered building rubble blocks at its foot. As a result of an overfold of the western edge of the packet onto the folded area, an accumulation trench 2 m deep, 80 m long was formed. During the overfolding the tree trunks growing over the bed-rock were buried up to 1–1.5 m.

III. After the decolbment and rotation a part of the packet at the main decolbment edge scattered linear-like and the formed colluvium 5 thousand m^3 in cubature slid consequently along the shales layer grooving a trough 120 m long and 20–30 m wide (Fig. 2 (III)). Its eastern steep escarp 10–25 m high, which is the main decolbment surface, is higher than the west one (6–10 m). This assymetry indicates that there are two formation stages of the through i.e. insequent pack decolbment and consequent slide of its scattered fragment along the trough. At the trough outlet the transported material was thrown off forming a tongue widening at the bottom. The tongue front slid over the primary slide burying the eastern and central part of its niche. At the swell contract with the main decolbment edge a crack trench 2 m deep was formed. At the lower part of escarp, above the decolbment edge a bank system with crack trenches formed, due to friction of the transported material against the decolbment edge. Shifting of the main packet and by that generated ground vibrations caused "a crump" of the area adjacent to the western edge of the slide. At the same time it got shifted along about 5 m down the slope in a shape of a compact, but morphologically varied packet. The area of tearing off with an outline of a 1–1.5 m high escarp in its northern part as well as the swelling and overfolding of its bottom part onto the bed-rock give evidence for the stated above. A few preserved, deformed trees building a so-called "groggy woods" suggest the compactness of packets during their short-way transportation.

III. INTERPRETATION

The measurement of deposition parameters of bed-rock have provided essential information concerning the genetic relationship of the surveyed forms. The strike of Otryt sandstone layers measured in outcrops within the Wetlina and Solina beds and in basset at the road to Łopienka and Terka amounts to 135–145°, at a steep angle of dip (55–65°) in SW direction. Similar measurements taken in forms in situ uncovered in the escarp of the slide created in 1980 amount to 70/ /22/SW. The data show the significant differences in deposition of layers at the valley bottom and on the slope. Such distribution may suggest local remodelling within the slope, especially that the uncovered layers are on the colluvial area of the old form. It may suggest as well a deep or even tectonic genesis of the old slide, in which dislocation and rotation of the compact packets occurred resulting in the change of layer deposition and decrease in their angle of dip. The deep decolbment may have taken place along the two or several surfaces of non-continuity leading to creation of insequent slip of a wedge-like type (Embleton, Thornes 1985). The form from 1980 was cut out within the forms building the colluvium of the old slide, of already changed deposition parameters (Fig. 3). The differences in development of the main forms of the two slides give the evidence for the above. The oldest initial slide has a distinct main niche with steep high escarps and typical underniche flattenings. Their fragments got locally preserved in a form of a few steps within the escarp but the main flattening 0.3 ha big is at the foot of the main niche of the old slide (Fig. 1.) Occurrence of crack trenches within its area is also characteristic. Such structure appears often in insequent slides. The youngest slide doesn't have a distinct niche. There's no underniche flattening, either. There

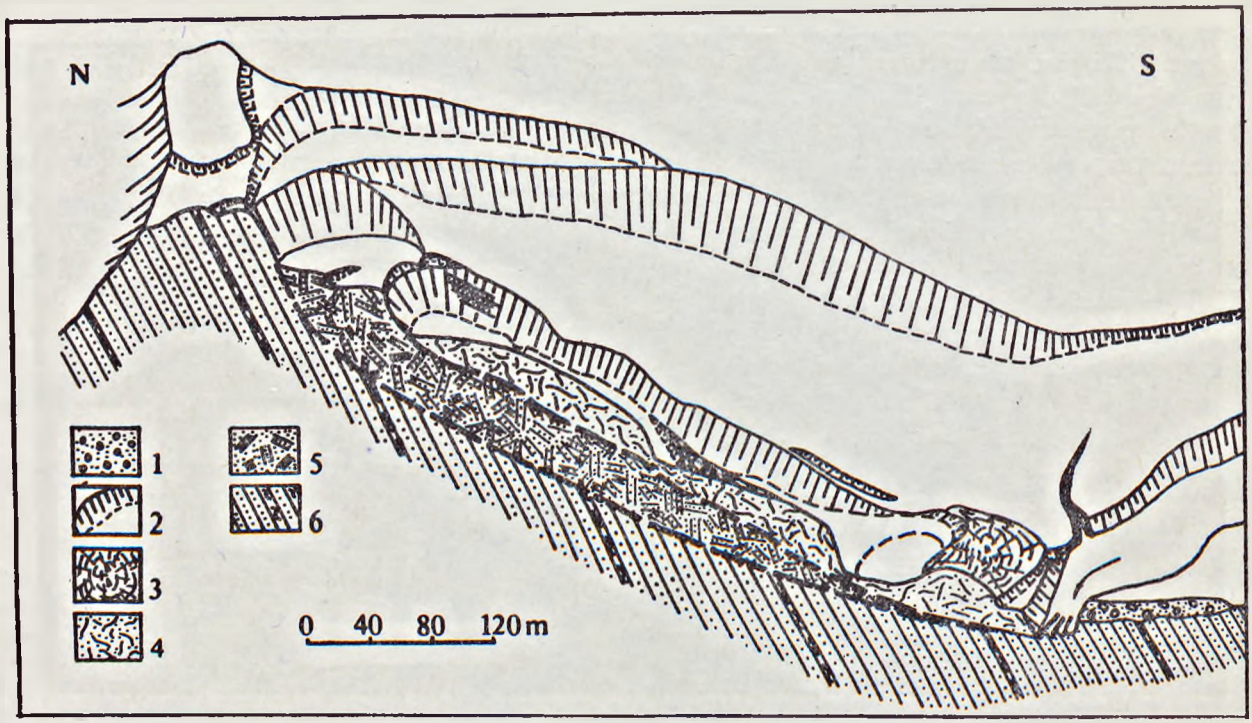

Fig. 3. Schematic section showing distribution of different generations of slides on Połoma mountain: 1 — gravel building the Wetlina terrace, 2 — escarps, 3 — slide swell, 4 — colluvium of the young slide, 5 — colluvium of the old slide, 6 — bedrock sandstones with shales intercalations

Ryc. 3. Schematyczny przekrój obrazujący układ występowania różnych generacji form osuwiskowych na górze Połoma: 1 — żwiry budujące terasę Wetliny, 2 — skarpy, 3 — nabrzmienia osuwiskowe, 4 — koluwium osuwiska młodego, 5 — koluwium starej formy osuwiskowej, 6 — skały podłoża — piaskowce z cienkimi wkładkami łupków

is a slide trough with a distinct slide surface and pushed apart compact packets with preserved flora. These are typical of a consequent slide of packet-rubble characteristic. A change of parameters of layer deposition within the area of the old slide is likely, as suggested above, to have taken place. This had a significant influence on formation and shape of the youngest slide. Lack of outcrops on slopes beyond the sliding zone doesn't allow for measurements of course and dip of bed and for unambiguos confirmation of the suggested hypothesis.

Influence of neotectonic on initiation of rock mass movement can not be excluded. Location of the surveyed area in the vicinity of the central Carpathian depression with Dukielskie fold zone (Gucik, Ślączka, Żytko 1973, Rączkowski, Wójcik, Zuchiewicz 1985) implies such a possibility. The old generation of surface rock mass movements on Połoma might have been initiated by tectonic quakes. Rather big decolbment depth, spreading of forms and compact shifting of the colluvium may support such hypothesis. But the youngest, shallow slide was initiated by oversaturation of rock masses with rain water and upsetting of slope balance by the river side erosion. It was formed as a result of slope tendency to regain the dynamic balance disturbed by undercutting. The morphology of the colluvium of the old slide influenced its final shape and the way of sliding. At present, relative stabilization of the remodelled southern slope of Połoma has taken place. There are no distinct dilative cracks above the escarps and rather small land slumps above the culmination of the escarp — the "niche" of the youngest slide are the only signs of "rejuvenation" of the relief. Because of the occurrence of shale layers within the trough, local remodelling of packet may take place during the heavy rainfall.

Translated into English by Anna Foret

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STRESZCZENIE

Północne zbocza doliny rzeki Wetliny (Wetlinki) w Bieszczadach Zachodnich charakteryzują się występowaniem licznych, rozległych form osuwiskowych. Najmłodsze z nich zeszło w 1980 roku z południowego stoku góry Połoma, zaś jego jęzor zatamował koryto Wetliny, powodując powstanie jeziora zaporowego.

Wykonane na południowym stoku Połomy szczegółowe zdjęcie tachimetryczne oraz analiza form morfologicznych wykazały istnienie w jego obrębie kilku różnowiekowych form osuwiskowych (ryc. 1). Najstarsze osuwisko, o powierzchni 13,3 ha, posiada wyraźnie wykształconą amfiteatralną niszę, oraz zachowane fragmenty wypłaszczeń podniszowych. Kształt i budowa formy wskazują na głębokie odkłucie mas skalnych wzdłuż kilku płaszczyzn, które nastąpiło w stromo nachylonych (60°) warstwach piaskowców otryckich, z których jest zbudowana góra Połoma. Ruchy te prawdopodobnie zostały zainicjowane wstrząsami tektonicznymi, wywołanymi neotektonicznymi przeobrażeniami w obrębie pobliskiej strefy kontaktu centralnej depresji karpackiej z fałdami dukielskimi. Analiza dendrochronologiczna pozwoliła na określenie wieku formy na ponad 180 lat. W obrębie osuwiska zachodziły liczne ruchy potomne, prowadzące do powstania niewielkich drugorzędnych nisz w obrębie skarp.

W 1980 roku ulewne deszcze spowodowały przesycenie wodą materiału skalnego na zboczu, zaś wezbrana Wetlina głęboko podcięła południowy stok Połomy. W wyniku dążenia stoku do osiągnięcia stanu równowagi dynamicznej, oraz przeciążenia wodą utworów budujących zbocze, nastąpiło płytkie (do 25 m) odkłucie mas skalnych na długości 179 m. W pierwszym etapie powstało osuwisko „pierwotne" o wyraźnej, półkolistej niszy (ryc. 2/I), zaś jego koluwium zjechało w formie jęzora w koryto Wetliny, powodując spiętrzenie wód. Osuwisko to naruszyło równowagę zbocza, co spowodowało odkłucie mas skalnych wzdłuż jednolitej krawędzi do wysokości 639 m n.p.m. (ryc. 2/II). Odkłuty pakiet skalny zrotował w kierunku SW nasuwając się na podłoże. W miejscu jego kontaktu ze starymi formami morfologicznymi zbocza powstały unikalne rowy o charakterze akumulacyjnym. Znaczny fragment pakietu przy głównej krawędzi odkłucia rozsypał się linijnie i żłobiąc rynnę został zrzucony u jej wylotu w formie jęzora (ryc. 2/III). Wykształcone ponad główną krawędzią odkłucia wały brzegowe powstały w wyniku tarcia materiału przemieszczanego rynną, o jej wschodnią skarpę.

Analiza elementów zalegania warstw wykazała różnice pomiędzy kierunkiem i kątem zapadania utworów podłoża (w korycie Wetliny), a skał odsłoniętych w skarpie najmłodszego osuwiska. Taki układ sugeruje, iż w obrębie starego osuwiska, na ograniczonym obszarze nastąpiło zgodne przemodelowanie elementów zalegania warstw zaznaczające się zmniejszeniem kąta upadu (z 60–25°) i zmianą kierunku zapadania (z SW na SE). Osuwisko najmłodsze zostało wycięte w centralnej części strej formy (stanowi 40% jego powierzchni), a więc w obrębie utworów o zmienionych w stosunku do podłoża elementach zalegania warstw (ryc. 3). Na tego typu relację wskazują również wyraźne różnice w sposobie wykształcenia form. Stare osuwisko posiada elementy charakterystyczne dla głębokiego, insekwentnego odkłucia, zaś rozkład koluwium formy najmłodszej wskazuje na jego konsekwentny charakter.

W 1988 roku osuwiska na górze Połoma oraz jeziorko zaporowe zostały objęte ochroną rezerwatową. Ich powierzchnia stanowi 3% obszaru utworzonego na tym terenie rezerwatu przyrody Sine Wiry, którego celem jest ochrona przełomowego odcinka rzeki Wetliny, wraz z otaczającym go kompleksem leśnym.