THE DEVELOPMENTAL STAGES OF AN ACCUMULATIVE CONE OF DRY VALLEY AS AN INDICATION OF CHANGE IN NATURAL ENVIRONMENT CONDITIONS (WESTERN POMERANIA)

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ABSTRACT. The aim of this paper is to present the stages of development of an alluvial cone as an indication of change in natural environment conditions. a detailed research was conducted within the upland regions of Drawsko Lakeland. At the valley mouth of one of the erosional-denudational valleys an alluvial cone in question splays out. The imparity between the capacity of the erosional-denudational valley and the capacity of the alluvial cone indicates that the main stage of erosion had taken place before the cone's deposition. During the beginning stage the material acquired from the dissection was most likely delivered directly to the channel of Dębnica river and was incorporated in the fluvial transport. The cone was formed during the later stage. The results of the radiocarbon analyses reveal that the formation of the alluvial cone and the valley associated with the cone took place during the Subatlantic. It was also estimated that the cone aggraded with the rate of approximately 3,9 mm per year.

KEYWORDS: erosional-denudation valley, alluvial cone, Drawsko Lakeland, West Pomerania

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1. Introduction

Frequently the lithologic structure of cones reflects all depositional happenings connected with the development of these forms. The alluvial cones occurring in lake edge zones present the most complete and rich record of geological happenings (Sinkiewicz 1994) draws attention to it. As the cited author states, the interfingering of the cones' deposits with the lacustrine formations makes it a lot easier to determine the stratigraphy of the cones. During fieldwork concerning the issue of upland edge transformation in the region of Piaski Pomorskie (Western Pomerania) at the mouth of one of the erosional-denudational valleys there was an accumulative cone identified, whose deposits interfinger with peat deposits. The sampled organic material subjected to ^{14}C dating was used to estimate the age of the cone and the age of the dry valley associated with the cone.

2. Study area

The study area was located in Southbaltic Lakeland region (subprovince 314 according to J. Kondracki's regional division 2000) in West Pomerania Lakeland macroregion (314.4), mesoregion Drawskie Lakeland (314.45) (Fig. 1). The south border of Drawskie Lakeland (Lake Lubie – Czaplinek – Szczecinek) is mapped out by the zone of marginal forms of_Pomeranian phase of wisła glaciations. This targeted area is characterized by rich landform, surrounded by many lakes of Drawskie Lakeland. The arrangement of the biggest lakes together with the surrounding string of morainic hills creates a characteristic arch of 120 km length, whose radius is outlined by Parsęta valley. The area is about 20 km wide. There is a vast area of outwash plains of river basins of Drawa, Piława and Gwda in the foreland of the study area, while in the back of the study area there is a dish-shaped low-lying area of Białogardzka Plain, which is drained by upper Parsęta and its tributaries. The Parsęta river basin, where the research was conducted, embraces three different morphogenetic zones (Sylwestrzak 1978, Karczewski 1998). In the south and south-east part of the Parsęta river basin there is a zone of marginal forms of Pomeranian phase of wisła glaciations. The sets of kame forms and the kettle holes reflect the areal deglatiation, which took place on the study area. North from marginal forms of Pomeranian phase the morainic upland slopes down towards Baltic Sea creating seven morainic levels diversified litofacially and in terms of formation of river system (Karczewski 1989, 1998). The study area is located in a highest, VII upland level. The morainic upland levels are rich in accumulative hills of frontal and dead-ice moraine, the sets of kame forms and kettle holes. In the center and in the north part of the area in question the valleys and erosional-accumulative plains of fluvioglacial waters spread out. The exact recognition of the alluvial cone's deposits was carried out within the edge zone of Piaski Pomorskie. In the east part of the upland edge there is an accumulative cone, asso-

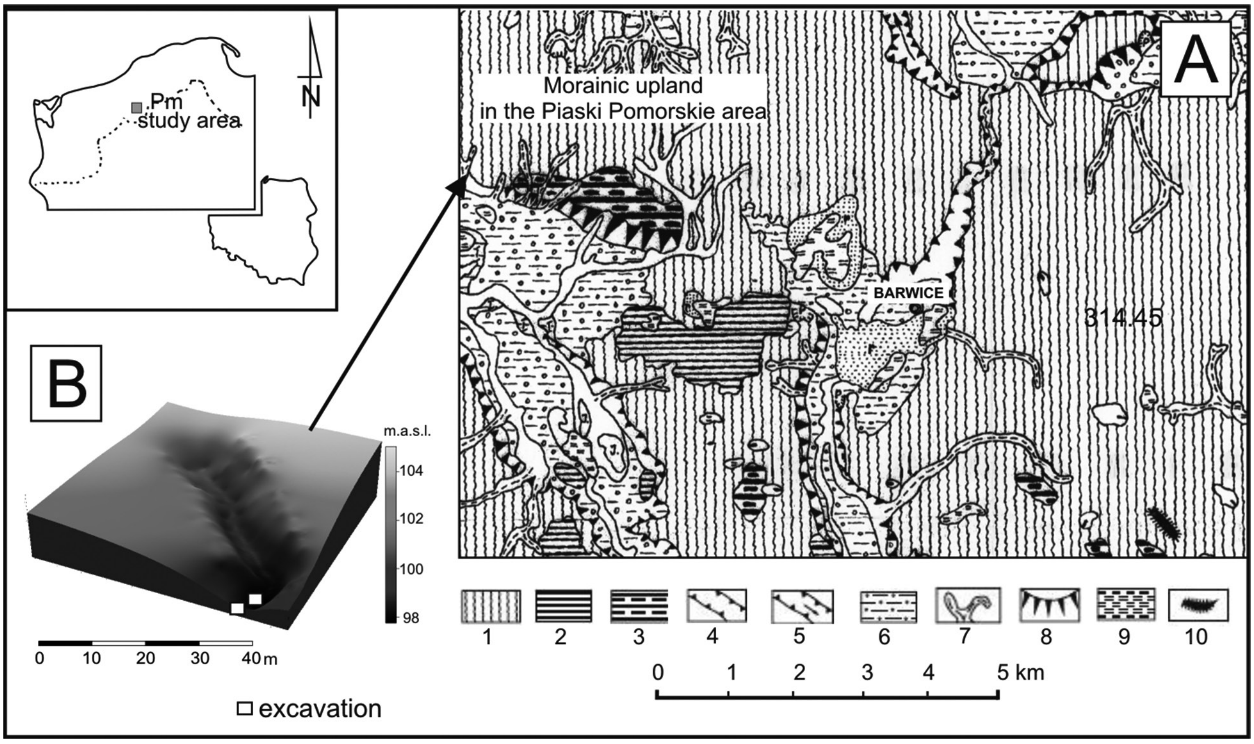

Fig. 1. Location of study area.
A – Morainic upland in the Piaski Pomorskie area (after Popielski 2005).
1 – undulating morainic plateau, 2 – moraines leading storage, 3 – dead ice moraines, 4 – subglacial trough, 5 – melt water valley, 6 – erosion and accumulation plains snowmelt water, 7 – valleys, ravines, young slit erosion, 8 – long slopes, 9 – plain peat, 10 – eskers, forms of peat accumulation
B – study area, erosional – denudation valley.

ciated with one of the valleys, which spreads out near to a moory depression (ordinates between 85-82.5 m asl; 53°45'44.11"φ N, 16°14'30.17"). This is the studied cone (Fig. 1). The drainage area of erosional-denudational valley covers little more than 3 hectares. The valley is 110.5 m long and its cubature is 1215 m^3. It should be noted that the alluvial cone hardly marks in landform. The cone may reach its maximum width of 20 m and the length of 16 m. The cone's deposits lie directly on fluvioglacial sands and gravels (Popielski 2005).

3. Material and method

In order to establish the stages of the alluvial cone's development there were many scientific methods used. There was fieldwork done in a targeted sites and laboratory examination with the use of geological and geomorphological methods. The fieldwork included the excavation in the distal and the proximal parts of the cone to about 2 m depth. There were samples collected from the excavation pits and the structural measurements of the layers were performed according to recommendations of Gołąb (1951) and Stankowski (1961). Furthermore, the deposits on the whole surface of the cone were recognized with the use of hand drilling to about 5 m depth.

The laboratory examination and the accompanying results processing consisted of the following stages:

- an analysis of the mechanical composition of deposits using Cassagrande's areometric-sieve method modified by Prószyński (Racinowski 1973, Płochniewski 1986);
- determination of the calcium carbonate ($CaCO_3$) content using Scheibler's apparatus;
- an analysis of the abrasion grade of quartz grains using Krygowski's mechanical graniformametry method (1964);
- an examination of landform age (dating of organic deposits – ^{14}C analysis (Poznan Radiocarbon Laboratory); and
- determining of organic matter content using calcination method (550°).

4. Results

The graining analyses of deposits obtained from the alluvial cone reveal – the longitudinal section as well as vertical section – considerable diversity. The cone is mainly composed of fine-grained and silt deposits; coarse-grained and middle-grained deposits are in minority. In its proximal part a significant proportion of matter consists of middle- and coarse-grained sand

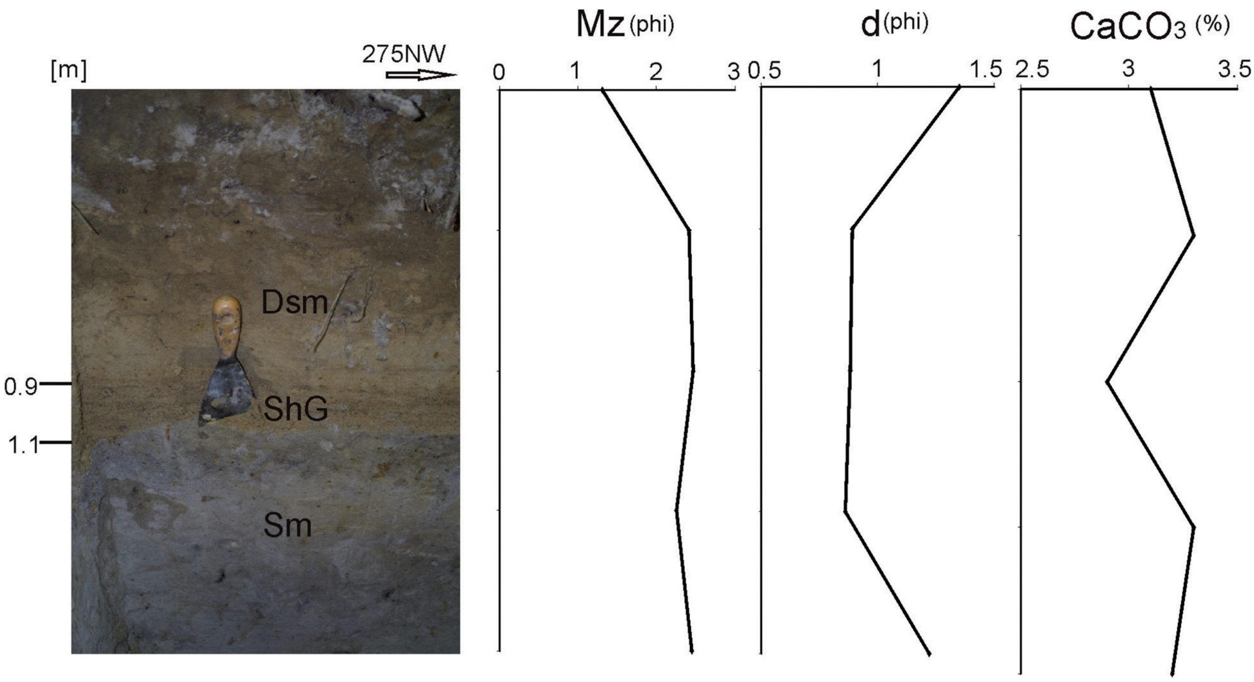

Fig. 2. Geological profile of the proximal part of alluvial cone with its grain-size distribution values and $CaCO_3$ content.

fractions, while in a distal part of the cone there is abundance of fine-grained and silt fraction. In general the deposits have poor sorting (sorting indices δ – 0.75–1.34 phi); The deposits become finer and better sorted in a distal part of the studied form (Fig. 2).

It was ascertained that the most dominant type of deposits, that the cone is composed of, are fine sands. In the distal part, under a layer of sands, at a 1 m depth, there was a layer of peat discovered, which in a top part interfinger with grey fine sand bends. The obtained organic matter was dated using the ^{14}C method. Three samples were analyzed. The bottom of the peat deposits was dated[1] at 2100±30 BP (Poz-22990, calibrated to 198BC–46BC, 95.4%), the central part, to 1965±35 BP (Poz-22991, 44BC-122AD, 95.4%), and the top, to 1835±35 BP (Poz-22992, 81AD-253AD, 95.4%). The content of organic matter in the samples exceeded 80%. In order to determine the age of the alluvial cone and the valley associated with the cone more accurately, the samples of mineral deposits seperating peat deposits were analyzed using OSL method (Fig. 3).

The analyzed samples were also examined in order to determine the percentage of calcium carbonate. a small amount of $CaCO_3$ was discovered (2–3.5%).

The examination of the abrasion grade of quartz grains within range 1.40–1.0 mm and 1.0–0.8 mm shows a marked bimodality if the distribution. The bimodality shows in a great proportion of angular material (type α, up to 60%) and intermediate one (type β, up to about 40%).

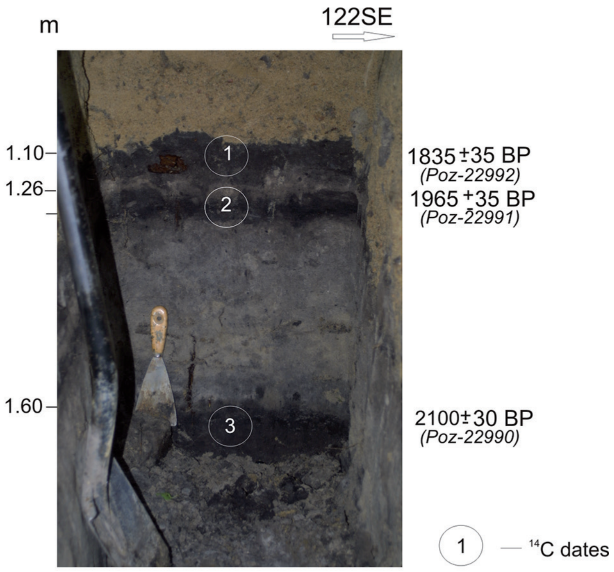

Fig. 3. Geological profile of the distal part of alluvial cone.

[1] Using the OxCal program.

5. Discussion

The noticed grain tendency to become fine in the longitudinal section mirrors transportation ability of running waters that change in time and space. Nowaczyk (1991) observed a similar situation in an alluvial cone in Szabliski in the west part of Warsaw-Berlin ice-marginal valley. The measurements of laminas motion and dips indicate that the waters forming the cone flowed in the SE and NW direction.

An attempt to assess the conditions for the development of the cone and the dry valley associated with the cone can be made on the basis of the analysis of peat deposits in the distal part of the studied form. As far as climatic conditions are concerned, the peat deposits formed in three layers in the cone, show that there were mild temperatures and abundant rainfall. Mineral interbedding in organic deposits results from increased erosion in the dry valley as well as from progressive denudation process. Radiocarbon analyses provide evidence that the formation of the alluvial cone and the valley associated with the cone occurred in Subatlantic. The Subatlantic is the period of strong anthropopressure. As Starkel (1991) states, the Holocene's distinguishing feature is that in the Neolithic a settled man – a farmer and a breeder – appeared, who has intensively influenced natural environment for about 6500 years. The Neolithic people settled in areas of river valleys. The area in question (Central Pomerania) was then under Wielbark/Pomeranian culture influence (Machajewski 2006). Machajewski (2006) points out that the Wielbark settlements were located on broad and long terraces of river bays, around the valleys by edges of larger watershed divide, exceptionally on islands situated on upland areas. The central Pomerania settlements were characterized by distinct dynamics of change. The findings of research conducted by Majewski (2008) within erosional-denudational valleys located on the east shore channel of Lake Jasień (Polanów Plateau; West

Pomeranian Lakeland) imply that the first stage of the valley development took place during the Oldest Dryas. According to the quoted author, the slope processes were initiated in Subatlantic as a result of human economic performance (slash-and-burn farming, land cultivation). The radiocarbon dating of the peat top created an opportunity to determine the rate of the cone's development at 3.9 cm per year. The data proves that the cone accumulated at a very fast rate. Smolska (2005) found out the same with regard to Suwalski Lakeland, pointing out that the rate of accumulation of the Neoholocene's cones was a few times faster than the rate of accumulation of deluvial covers.

6. Conclusions

The observed dynamics of deposition processes with regard to the targeted cone may indicate anthropogenic as well as climatic factor. The research conducted by Rotnicki (1966, 1991), Churska (1989), Sinkiewicz (1989), Borówka (1994), and Majewski (2008) prove low efficiency of Holocene slope processes in the development of young glacial landform. The young glacial landform areas are unique in their majority of short slopes (several dozen meters in length, rarely over 100 meters) as well as the occurrence of abundant local denudation base levels. Currently conducted researches indicate that the morphogenesis of slopes is predominantly conditioned by slopewash, and to a lesser degree by mass movements or gully erosion (Stach 1991, Smolska 2005, Szpikowski 2003, Szpikowski *et al*. 2008). Much bigger dimensions of the erosional-denudational valley in relation to the capacity of the slope washes that the cone is built of, indicate that the valley already existed in Pleistocene. The waters coming from the thalweg formed the stream, which transported matter from the slopes. The waters flowing down the valley bottom made it deeper and eroded towards the sides. The erosional pavement resting on the erosional-denudational valley's bottom is the evidence of erosion. The loaded stream flowed into the valley's foreland where, as a result of decrease in its transportation ability, the accumulation of the alluvial cone took place. The imparity between the capacity of a dissection and the capacity of the alluvial cone indicates that the main stage of erosion had taken place before the cone's deposition. During the beginning stage the material acquired from the dissection was most likely delivered directly to the channel of Dębnica River and was incorporated in the fluvial transport. Later, the cone was formed. The studied alluvial cone was formed under the influence of changing climatic conditions. Due to lack of adequate evidence for climatic changes it can be assumed that the development of the cone and of the dry valley may have been determined by anthropopressure. The thickness of the deluvial matter deposited in the proximal part of the cone is about 1.2 m.

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