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ARCHAEOLOGICAL AND RADIOCARBON DATING OF ALLUVIAL FANS AS AN INDICATOR OF PREHISTORIC COLONISATION OF THE GŁUBCZYCE PLATEAU (SOUTHWESTERN POLAND)

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Abstract: **The development of agriculture accelerated soil erosion processes and the deposition of erosion products in the form of alluvial fans at the mouths of dry or temporarily drained valleys. The age of the alluvial fan in Borucin, in the Psina basin, has been established and the stages of its formation have been reconstructed with the use of radiocarbon dating of the roof of peat underlying the mineral sediment of the fan. The fan started to form in the second part of Suboreal period (3650 ± 70 BP). Maximum fan progradation occurred at the end of the Period of Roman Influence when the area was settled by the agricultural Przeworsk culture(1670 ± 70 BP). In the Early Middle Ages, silty clays eroded from cultivated slopes no longer reached the outer fan zone, which points to a lower population density/less intensive agriculture in the area. The period of formation of the second fan under examination, located at the mouth of a side valley of the Odra, has been preliminarily determined on the basis of archaeological research. The progradation of this fan is probably related to the agricultural activity of the Lusitian Culture and forest clearances linked to the construction of a stronghold (9th-7th century BC).**

1. INTRODUCTION

Areas covered by loess exhibit specific relief features. Dry or temporarily drained valleys are features that always accompany loess landscapes. The permeability of loess and the usually thick loess layers found in valley bottoms usually deprive valley systems formed on loess of alimentation from ground water, so these systems are largely modelled by slope processes and the erosion caused by episodic water (Śnieszko, 1995). In such conditions, a change in one element of the natural environment (e.g., forest clearance) within the catchment results in a relatively rapid increase in sheet flow, especially during periods of heavy rains and the snow-melt season.

The close proximity to the Moravian Gate, which was used by Neolithic cultures moving north from the Pannonia Basin, favoured the colonisation of the Głubczyce Plateau. This area, where an economic model based on agriculture and breeding prevailed, was settled from the Neolithic Age onwards (with varying population density). This was a result of the exceptionally favourable climate and soil conditions in the region. The transition to a settled lifestyle and the introduction of agriculture as well as the related forest clearances were the primary causes of the activation of soil erosion processes and sediment transfer between hillslopes and valley floors (Klimek *et al*., 2001; Klimek, 2002). The intensified erosion of loess slopes caused the progradation of alluvial fans deposited at valley mouths and the build-up of alluvial plains. Thus the sediments within alluvial fans hold the records of prehistoric and historic agricultural colonisation of the Głubczyce Plateau.

The questions concerning the impact of human (farmers' and breeders') presence on the transformation of natural landscape and the problems related to the introduction of Neolithic agriculture were discussed, inter alia, by Ballantyne (1991), Niewiarowski e*t al.* (1995), Pøesen *et al.* (1996), Klimek (2002 and 2003), Heine and Niller (2003), Prøsh – Danielsen and Sandgren (2003), and Robinson (2003). The influence of anthropogenic changes on the loess highlands of southern Poland was also described by Śnieszko (1995) and Kruk *et al.* (1996).

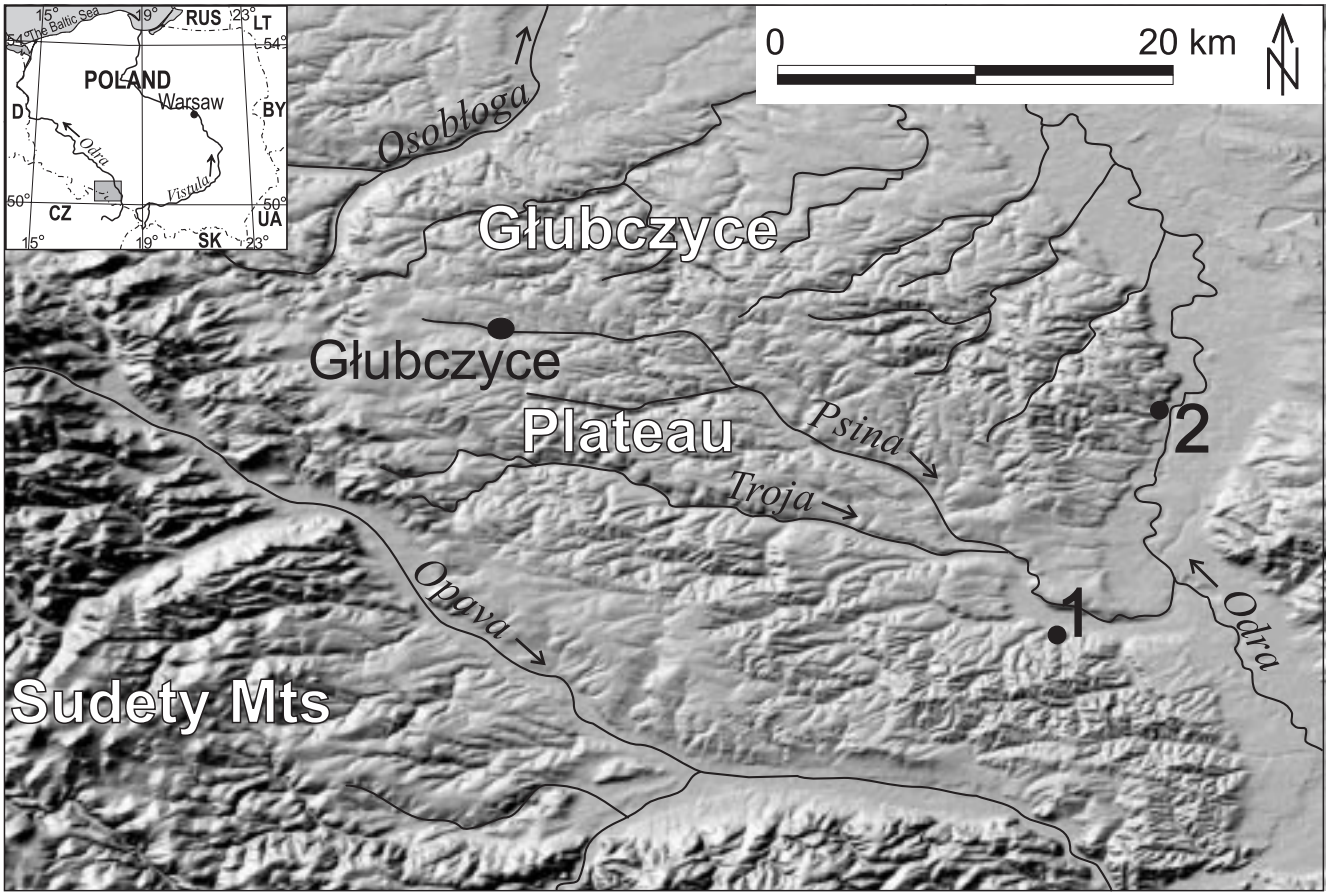

Fig. 1. *Location map of the study areas (1– Borucin, 2 – Łubowice) and the relief of the Głubczyce Plateau*

The aim of this paper is to present the transformations in the relief of the foot of the slopes and the structure of alluvial fans caused by prehistoric and historic changes in the utilisation of the basins of a small side valley of the Odra, and the Psina – a left bank tributary of the Upper Odra. The development stages of alluvial fans have been established on the basis of determined ^{14}C dates and the sedimentological analyses conducted. The results of archaeological research have also been used.

2. CHARACTERISTICS OF THE STUDY AREA

The research has been conducted within the area of the Głubczyce loess Plateau in the Upper Odra Basin in south-western Poland **(Fig. 1)**. This region is delimited to the south and west by the Eastern Sudety Mountains and the Carpathians. In the east and the north, it borders on the Silesian Upland. The undulating Plateau gently falls towards the north-east, finally descending to 250 m a. s. l. A major part of the Plateau is covered by a layer of loess, up to 9 metres thick dating from the Vistulian Glaciation. This layer rests on older clay and gravel sediments from the Pleistocene and the Tertiary Period (Jersak, 1991). Lower terraces and the bottoms of river valleys do not exhibit a loess cover. The surface of the Plateau is dissected by numerous permanent or intermittent watercourses at the mouths of which alluvial fans have formed **(Fig. 2)**. The alluvial fan deposited at the mouth of a side valley of the Psina near Borucin has been examined **(Fig. 2A)**. Pilot research has also been conducted on an alluvial fan formed at the mouth of a side valley of the Odra near Łubowice **(Fig. 2B)**.

3. MORPHOMETRIC AND GRANULOMETRIC FEATURES OF ALLUVIAL FANS

At the mouth of a dry valley near Borucin over 2.5 kilometres long and with a gradient of 10.5 metres per kilometre, an alluvial fan is situated, the morphological features of which make it clearly visible **(Fig. 3A)**. The area of the valley catchment is 0.45 km^2 and the area of the fan is around 0.13 km^2 **(Fig. 2A)**. The fan is asymmetrical, indicating a variable direction of its progradation, which had progressed in several phases **(Fig. 3A)**. This is also indicated by flattened areas visible along the longitudinal profile of the fan **(Fig. 4)**. The thickness of sediments at the base of the fan reaches up to 2.5 metres. The fan prograded onto organic sediments filling the bottom of the Psina valley. The sediments/deluvia forming the fan are only 40–80 centimetres thick at a distance of around 450 metres from the valley slope. Despite the fact that the loess layer was the source of the alluvial fan, grain size analysis has indicated that the sediments forming the fan are of two types **(Fig. 4)**. The bottom part of the fan is formed by clayey silts, sometimes of organic origin, which indicates the long range of the silty material eroded from the valley, probably due to the gradual forest clearance of the latter. The silty clays covering the former layer were

probably deposited during a period when the valley catchment was utilised in a less intensive way and the forest cover partly regenerated. The differences in sediments forming the fan are probably due both to climate changes that occurred during the Holocene and to changes in land cultivation, particularly the degree of deforestation.

The alluvial fan in Łubowice, with an area of 0.21 km^2, was deposited at the mouth of a small valley with a gradient of metres per kilometre **(Fig. 2B, 3B)**. The area of the catchment within which the fan examined was found is 5.39 km^2. The fan prograded onto the sediments filling the Odra palaeomeander and it exhibits an oblong shape in the north-western direction, parallel to the gradient of the Odra valley. Preliminary grain size analysis shows that it consists of silty clays eroded from the loess valley slopes.

4. ANALYSIS OF ARCHAEOLOGICAL DATES

Archaeological research indicates that in the past, the loess areas of Poland were particularly preferred when people from Neolithic cultures founded their settlements (Łanczont *et al*., 2003). The oldest population in the area of the Głubczyce Plateau, which engaged in primitive agriculture, is represented by the Band Pottery Culture

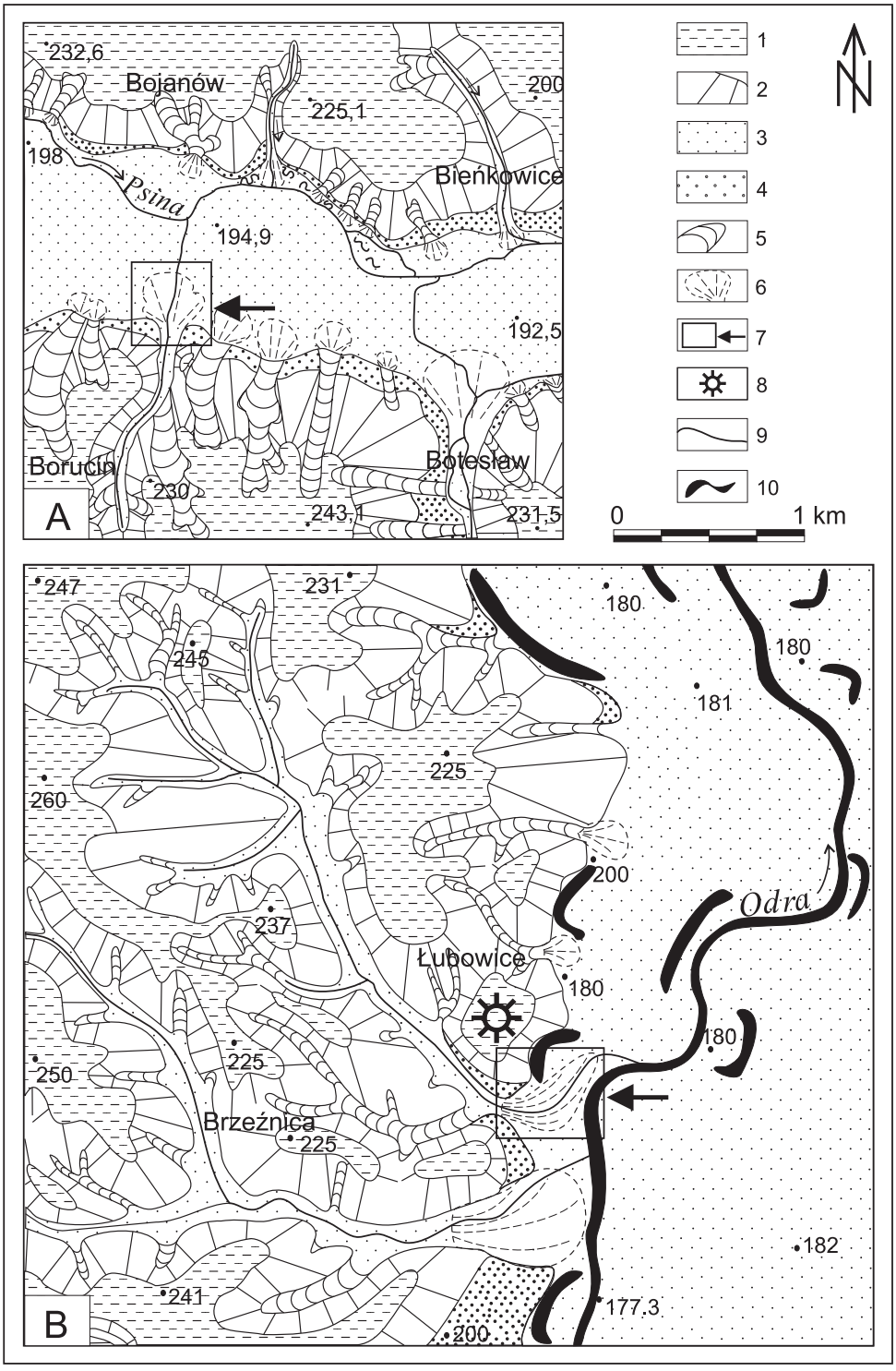

Fig. 2. *Geomorphic sketch maps showing the location of study areas (A – Borucin, B – Łubowice)*
1 – loess plateau, 2 – slopes, 3 – holocene valley floors, 4 – Last Glacial (Vistulian) terraces, 5 – dry valleys, 6 – alluvial fans, 7 – study areas, 8 – stronghold, 9 – rivers, 10 – palaeochannels

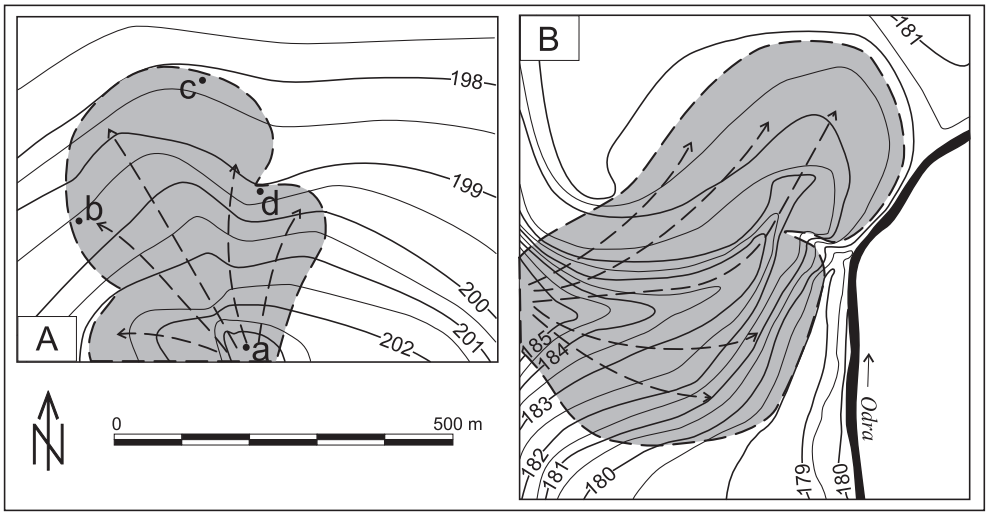

Fig. 3. *The range of alluvial fan sediments (A – Borucin, B – Łubowice)*

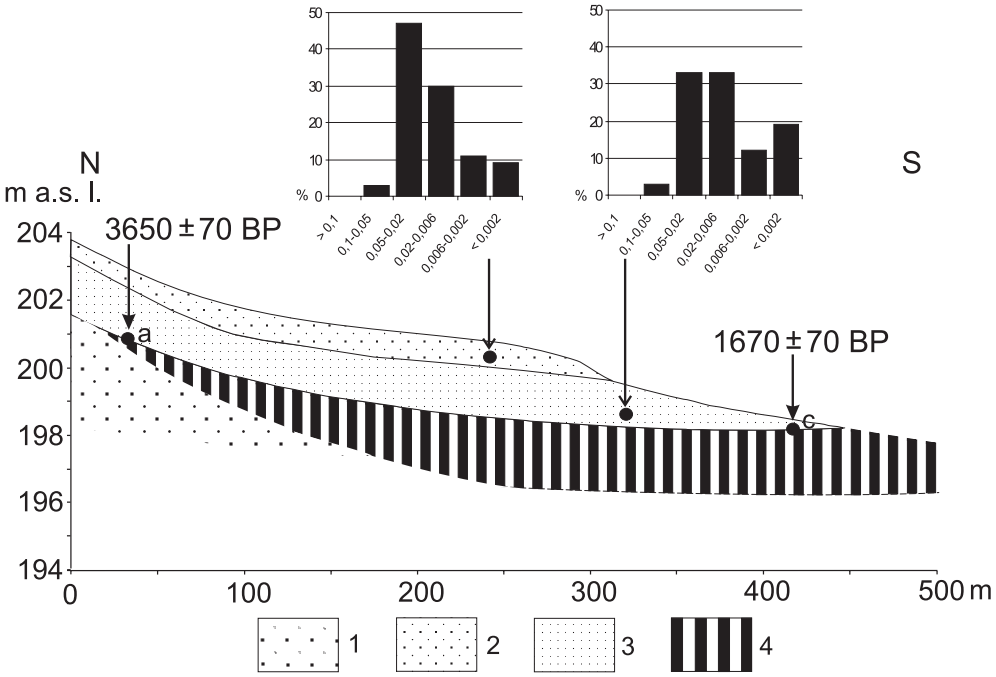

Fig. 4. *Cross section through the alluvial fan in Borucin. 1-silt, 2- silty clay, 3- clayey silt, 4- peat*

(Kaczanowski and Kozłowski, 1998; Fig. 5). This group had already arrived in the area around the middle of the 6th millennium BC from the Pannonia Basin, most probably via the Moravian Gate. It founded settlements on the edge of the loess area, in places located near waterways, sheltered from wind and secure from flooding. Such areas were also often populated in later periods **(Fig. 5)**. Neolithic sites/settlements of this culture were found, inter alia, on the southern slope of the Psina valley in Bolesław, near Borucin (Kuźniar-Niedźwiecka *et al*., 1967). The excavations uncovered dugout dwellings as well as refuse and storage pits containing bits of clay vessels with a characteristic band ornament. Other types of pottery as well as querns and milling stones were also found at the site, unequivocally indicating the agricultural character of the population. It may be surmised that during the Band Pottery settlement period, one settlement caused the forest clearance of around 10–50 hectares of land because the settlements founded at that time numbered from 20 to 100 people and 0.4–0.5 hectares of wheat were required to feed one person during a year (Kaczanowski and Kozłowski, 1998). Therefore it may be supposed that the people belonging to this culture were the first to cause considerable deforestation on the Głubczyce Plateau, which significantly accelerated soil erosion processes.

From around 1300 BC, the Lusatian Culture started to develop in the Odra basin **(Fig. 5)**. The most important features of this culture were an economy based on agriculture and breeding, wooden houses, certain settlement structures, pottery and bronze artefacts. Agriculture was still primitive in this period and was primarily based on various types of digging implements and, to a lesser extent, on coulters pulled by humans and cattle (Szydłowska, 1989). Fields were cleared through cutting and burning forests and thus the economic activities of those peoples certainly had an important impact on the erosion of soil on deforested slopes. The massive removal of forest cover was also linked to the demand for wood, which was used in the construction of houses, settlements

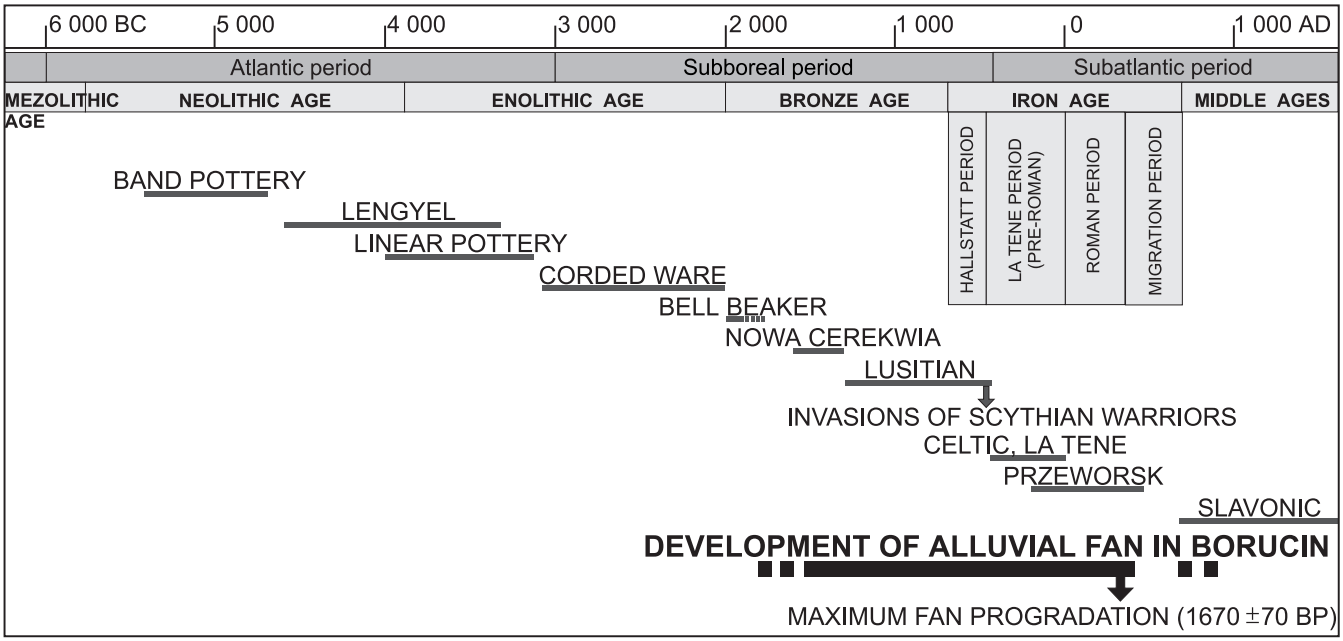

Fig. 5. *Alluvial fan progradation (in Borucin) on the background of the occupation of the Głubczyce Plateau by agricultural groups*

and strongholds or simply for burning. The clearly visible traces of one-and-a-half kilometre long embankments of a former stronghold in Łubowice dating back to the 8th–9th century BC (Chochorowski – oral communication), with an area of around 20 hectares, give an indirect impression of the massive deforestation of this period **(Fig. 2B)**. The construction of this structure also attests to the considerable population density. My current knowledge about the second fan under examination, which is situated at the foot of this stronghold, and especially the lack of ^{14}C dating, does not allow me to accurately determine the time when it was formed. However a review of archaeological data collected to date pertaining to the stages and the intensity of settlement in the Upper Odra Basin, and especially in the Łubowice area, allows me to state that the maximum progradation of the alluvial fan was probably linked to the intensive agriculture of the Lusitian Culture, which entered a period of renaissance in this area between the 9th and the 7th century BC. The end of the Lusitian Culture was caused by the invasions of Scythian nomads in the 6th century BC (Kaczanowski and Kozłowski, 1998).

Archaeological research indicates that population density in the Psina basin rose markedly during the Roman Period (Godłowski, 1969 and 1980). The people of the Przeworsk Culture penetrated the Głubczyce Plateau and settled in new, formerly uninhabited areas. This process reached its peak during the later stages of the Late Roman Period, *i.e.* in the second half of the 3rd century and the 4th century AD. Archaeological research shows that there was a decrease in settlement during the period after the decline of the Przeworsk Culture, *i.e.* in the 5th and 6th centuries AD – during the Migration Period (Gedl, 1997; Kaczanowski and Kozłowski, 1998). The next stage of settlement only came with the advent of the Slavonic culture, which began in the 6th century AD **(Fig. 5)**. This is confirmed by the presence of an early medieval settlement in Borucin dating back to the beginning of the 11th century (Panic, 1992).

5. RADIOCARBON DATING RESULTS

All the dates came from Kyiv Radiocarbon Laboratory. The radiocarbon dates of the roof of peat filling the bottom of the Psina valley and underlying the alluvial fan sediments indicate that the process of fan formation varied with time. The fan expanded gradually and covered organic sediments in various periods. The variability of its progradation results from the mechanisms of water flow and sedimentation within the fan. The dates determined have made it possible to reconstruct the stages of formation of the fan **(Fig. 6)**. The oldest dated stage of its development dates back to 3650 ± 70 BP **(Fig. 6a)**. The fan originally developed in a north-westerly direction (1980 ± 80 BP; **Fig. 6b**) and then prograded more to the north – parallel to the axis of the dry valley – reaching its maximum size (1670 ± 70 BP; **Fig. 6c**). Due to the increase in the level of deposition in the axis zone, the fan started to prograde in a north-easterly direction (1510 ± 60 BP; **Fig. 6d**). The dust which contributed to the build-up of the upper part of the fan was probably deposited during the reactivation of the valley catchment caused by the Slavs' intensified agricultural activities in the Early Middle Ages **(Fig. 6e)**. These sediments, however, did not reach the outer fan, but only the mid fan zone, which is indicated by the convex longitudinal profile of the fan **(Fig. 4)**. Another proof of the less intensive settlement process in the Psina basin in this period is the small number of archaeological sites/artefacts from this period in relation to earlier periods (Foltyn, 1998). As the sediment which contributed to the build-up of the fan did not cover the peats filling the bottom of the Psina valley, it has not been possible to date this stage of fan development using the radiocarbon method.

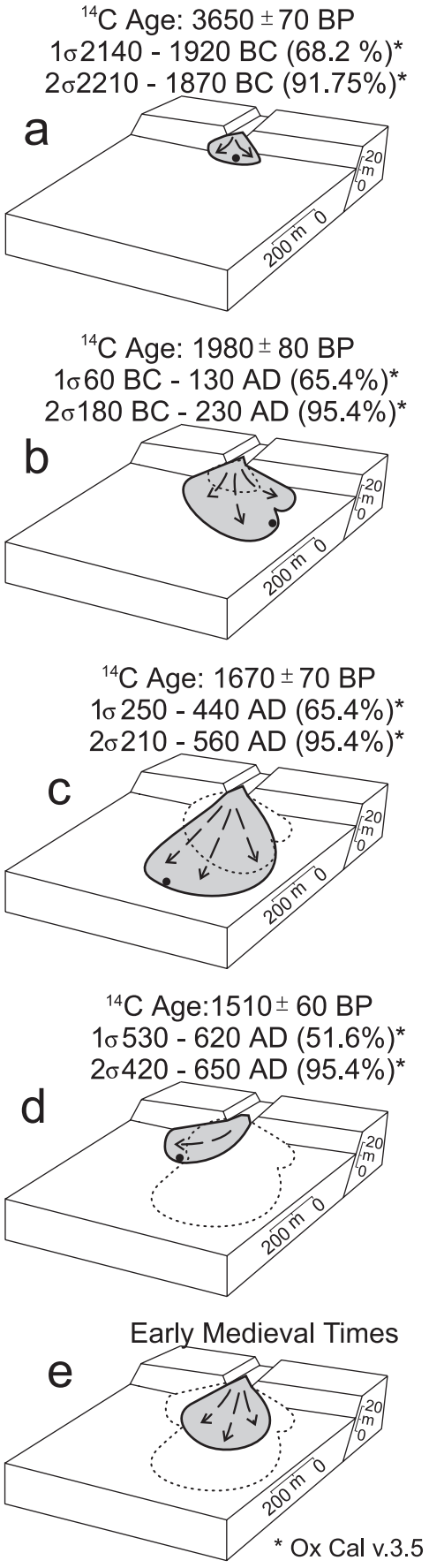

Fig. 6. *Blockdiagrams illustrating stages of alluvial fan progradation in Borucin*

6. CONCLUSIONS

The results of palaeogeographical research, based on geomorphological and sedimentological analyses and supported by radiocarbon dating, confirm the results of archaeological research conducted to date. The alluvial fan in Borucin started to form at the second part of the Subboreal period during the Early Bronze Age at the latest and the maximum progradation of the fan is linked to the most intensive settlement in this area during the Late Roman Period. This coincides with intensive agricultural activity during the period of the Przeworsk Culture. The next stage of fan progradation occurred in the Early Middle Ages (after the "settlement depression" during the Migration Period, which lasted for two hundred years). The much lower number of Slavs in the area and thus the decreased agricultural activity prevented the silty clays washed from valley slopes from reaching the outer fan zone, which is indicated by its convex longitudinal profile.

The most rapid development of the Łubowice fan is in turn probably linked to intensive agricultural activity and forest clearances conducted by the Lusatian Culture in the final stages of the Bronze Age and at the beginning of the Iron Age.

Research results show that the deforestation of the slopes of side valleys on the loess Głubczyce Plateau significantly influenced the changes in slope processes, resulting e.g. in the washing of the soil cover formed on the loess bedrock and the formation of alluvial fans. The phenomenon of the movement of erodable loess as a result of the destruction of the plant cover through human agricultural activity is also typical for other loess-covered areas in Poland (Śnieszko, 1995; Kruk *et al*., 1996; Klimek *et al*., 2001).

Therefore, it may be stated that from the Neolithic Age onwards, humans have become a force shaping the slope and valley systems on the loess Głubczyce Plateau. Their influence on erosion processes was larger than that of climate conditions. Climate, and especially humid periods, may only modify processes caused by (deliberate or involuntary) human activity.

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