GEOCHRONOMETRIA Vol. 23, pp 35-38, 2004 – *Journal on Methods and Applications of Absolute Chronology*

AGE OF THE VISTULA RIVER OVERBANK DEPOSITS IN TORUŃ

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Key words: LUMINESCENCE DATING, OVERBANK DEPOSITS, FLUVIAL PROCCESES, FLOOD PLANE

Abstract: **The paper presents luminescence dates of the overbank deposits accumulated on the Bazarowa Holm in Toruń. From these results we conclude that the flood deposits accumulation was started in this part of the Vistula river valley between 1000 and 2000 years ago. Deforestation and following increase of the floods' events intensity, which occurred in early Middle Ages, may be the possible reasons for the aggradation phase on the flood plane.**

1. INTRODUCTION

The chronology of the overbank alluvial accumulation in the Vistula river valley near Toruń isn't well known. The only indirect data derive from ^{14}C dating of the roof peat in paleochannels covered by the flood deposits. On this base Tomczak (1982, 1987) stated that the overbank deposits were accumulated in the Toruń Basin in a Sub-Atlantic period. The luminescence methods have not been used so far for mineral flood deposits dating in the Lower Vistula river valley. In the paper we present some preliminary results of the two methods of luminescence dating – Optically Stimulated Luminescence (OSL) and Thermoluminescence (TL), applied for the direct age determination of the overbank and channel deposits.

2. RESEARCH SITE

The research was done on the Bazarowa Holm situated in the Toruń Basin (**Fig.1**) opposite to the Toruń Old Town (**Fig. 2**). The reason for the site choice was its location in the narrowest part of the Vistula river flood plane in the Basin. The position of the Vistula river channel is almost stable in this place since the beginning of Holocen (**Fig. 2a-d**)

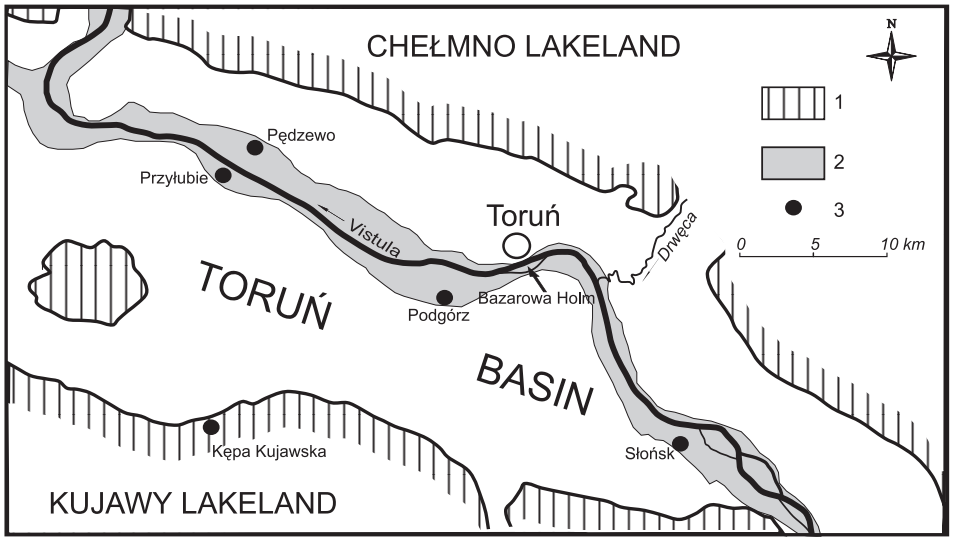

Fig. 1. *Sketch of the Toruń Basin (based on Tomczak, 1987). 1 – moraine plateau, 2 – flood plan, 3 – ^{14}C methods dated sites*

(Tomczak, 1971). That is why dating of the overbank deposits accumulated here is very important for the designation of the beginning of the flood events in the Basin.

The investigation site is located on the oldest and the highest part of the Bazarowa Holm. The thickness of the deposits in a vertical profile is 4.4 m (**Fig. 3**). Geological structure of the flood plane is typical for overbank deposits in the whole Vistula river valley (Myślińska *et al*., 1982; Tomczak, 1971; Kalicki, 1996). In upper part of the deposit series there is the "young - sandy mada" consisting of sand and silty-sand different lithofacies: massive sand, massive silty sand, massive sandy silt, ripple cross-laminated sand and wavy laminated silty sand. This series was probably accumulated after a deforestation of the Vistula flood plane. In the lower part there are horizontally laminated silt and clay - the "old - clayey mada". It was accumulated before deforestation of the flood plane but after deforestation of the Vistula valley overflood

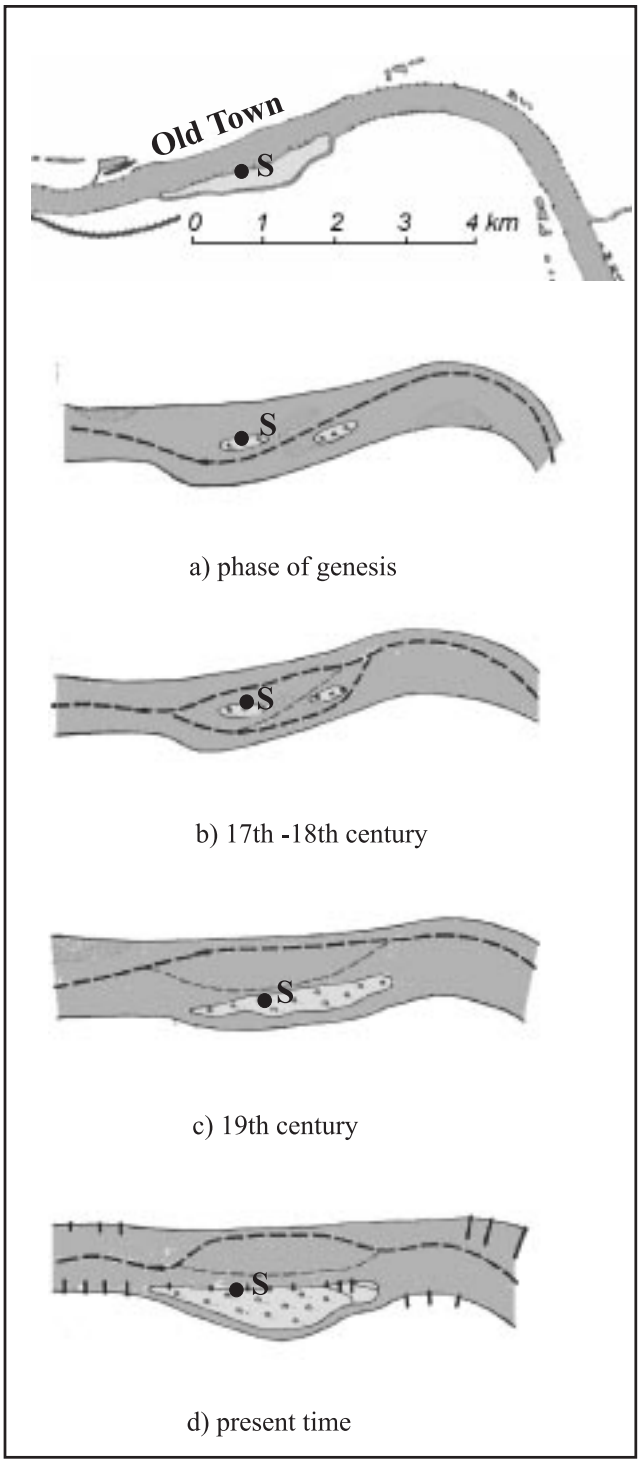

Fig. 2. *Sketch of the Vistula channel configuration in Toruń (upper figure) and (a-d) phases of Bazarowa Holm evolution (based on Tomczak, 1971). S – research site on the Bazarowa Holm*

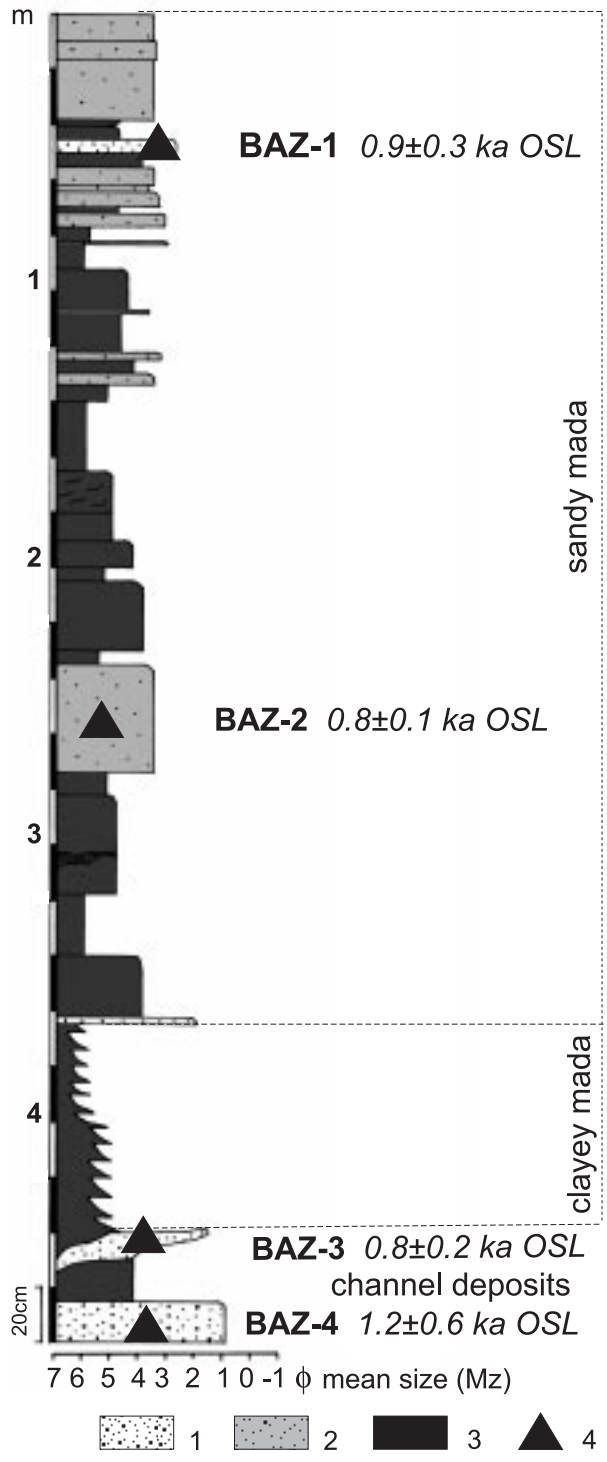

Fig. 3*. Lithofacial section of the Vistula overbank deposits and OSL data of the samples taken from the research site on the Bazarowa Holm in Toruń.1 – sand, 2 – silty sand, 3 – silt or clay, 4 – points of taking samples for luminescence dating*

terraces in the Toruń Basin and Kujawy Lakeland moraine plateau. This fact can be connected with the early medieval paleosoil level in a dune located in Kępa Kujawska (**Fig. 1**). This soil level was dated by ^{14}C method to 1.3±0.6 ka (Oczkowski *et al.*, 2000).

Two samples of the overbank deposits (Baz-1 – 0.5 m, Baz-2 – 2.5 m) and two samples of the channel deposits (Baz-3 – 4.4 m, Baz-4 – 4,8 m) were collected from this profile (**Fig. 3**). These samples represent deposits of massive sandy and sand-silty lithofacies. It is assumed that a luminescence signal in the channel and in overbank deposits was bleached in similar transport conditions.

3. LUMINESCENCE DATING

The both dating techniques, TL as well as OSL, are based on luminescence signal accumulated in natural dosimeters (e.g. quartz or feldspar grains) during burial period. The determined age refers to the moment when previously accumulated luminescence was erased for the last time. In case of alluvial deposits such a removal of luminescence signal can be caused by daylight opperation during transport and deposition of the material. However, the extent of this reset depends on local conditions (main parameters are: the insolation, the transport environment and duration of the daylight exposure) and is hardly ever complete (Wallinga, 2002). Partial bleaching of luminescence signal results in so called residual luminescence and leads to age overestimation. Although the OSL signal can be much easier bleached by sunlight than the TL signal it still suffers from lack of standard procedure for detecting partial bleaching. Anyway OSL method minimises the danger of over-aging and because of that we decided to base our study on OSL results. On the other hand it would be interesting to compare both TL and OSL ages of alluvial sands and for that reason we present also set of TL dates.

The quartz inclusion technique was applied for grains extracted in the size range from 0.1 to 0.3 mm. The annual doses (*DR*) were calculated on the base of gamma spectrometry measurements (Oczkowski *et al.*, 2000).

The equivalent dose (*ED*) values were estimated by OSL additive dose method and TL regeneration method. The Riso TL-OSL system model DA-12 was used. Prior to the luminescence measurement the preheat at 200°C for 20 s was performed. For OSL measurement the green light was used (at 30°C for 100 s). In TL method bleaching was conducted in a daylight simulator (Oczkowski and Przegiętka, 1998) prior to the regeneration and the readout sequences. The heating rate was 4°C/s.

As it can be noticed there is an inconsistency between TL and OSL dating results (**Table 1**). In general, TL ages suggest that the samples are ca. 10 times older than it derives from the OSL dating. Moreover, the TL dates seem to be reversed (the deeper samples seem to be younger). The OSL ages are rather consistent in the range of their uncertainties.

We concluded that the bleaching of TL signal in these samples during transport and deposition was not sufficient and much less effective in a comparison to our laboratory daylight simulator. However, the OSL results exhibit quite large uncertainties (relative uncertainty varies from 17% up to 50%) what can suggest uneven level of OSL reset in quartz grains. Anyway, the OSL ages seem to be reliable (right order of the OSL age sequence) and acceptable from the geological point of view. Centrary to the TL dates, the OSL ages are in accordance with the current concept of river sediments' chronology in the Toruń Basin (Tomczak, 1987).

We expect the next measurements with Single Aliquot Regenerative OSL protocol should improve the accuracy of determined age. We also should try to use the TL plateau method for verifying the assumption of the appropriate bleaching, which method seemed to work properly in case of eolian sediments (Chruścińska *et al.*, 2004).

4. CONCLUSIONS

The OSL dating of the overbank deposits shows that the sediments that built the Bazarowa Holm have been accumulated for a thousand years. Moreover, Tomczak (1987) refers to the four ^{14}C dates of the samples taken from the roof of peat in the paleochannels which are covered by flood deposits. As presented in a **Fig. 1** they come from Podgórz (705±45 BP), Słońsk (1440±50 BP), Przyłubie (1875±70 BP) and Pędzewo (1925±65 BP). The first two correlate with our OSL data but two others are older. Basing on these dates we suggest that probably the process of flood deposits accumulation started in the whole Toruń Basin between two and one thousand years ago. A possible reason for that process was a deforestation of the Vistula river flood plain that took place between 10th and 11th century. Hence in early Middle Age the danger of a flood emerged and the aggradation phase of the overbank sediments was initiated.

Table 1. *The annual dose (DR) and equivalent dose (ED) values and luminescence dates. The uncertainty of DR values is so small (less than 0.2%) that it was omitted in the final age calculations*

Sample	Depth (m)	DR (Gy/ka)	Method	ED (Gy)	Age (ka)
Baz-1	0.5	1.630	OSL	1.5 ± 0.5	0.9 ± 0.3
			TL	20 ± 4	12.0 ± 2.5
Baz-2	2.5	1.570	OSL	1.2 ± 0.2	0.8 ± 0.1
			TL	18 ± 5	11.5 ± 3.2
Baz-3	4.4	1.950	OSL	1.6 ± 0.4	0.8 ± 0.2
			TL	20 ± 3	10.3 ± 1.5
Baz-4	4.8	0.820	OSL	1.0 ± 0.5	1.2 ± 0.6
			TL	7 ± 3	8.5 ± 3.7

REFERENCES

Chruścińska A., Lankauf K.R., Luc M., Oczkowski H.L., Przegiętka K.R. and Szmańda J.B., 2004: Evolution of St. Laurent Mountain near Chełmno based on luminescence dating. *Geochronometria (this volume)*.

Kalicki T., 1996: Overbank deposits as indicators of the change in discharges and supply of sediments in the upper Vistula valley. In: Starkel L. and Kalicki T., eds., *Ewolution of Vistula river valley during the last 15,000 years* 6, *Geographical Studies Special Iss*ue 9: 43-61.

Myślińska E., Hoffman E., and Kulesza-Wiewióra K., 1982: Zróżnicowanie geologiczne mad w wybranych odcinkach doliny Wisły, (Geological differentiation of mada in selected fragments of the Lower Vistula valley). *Przegląd Geologiczny* 9: 474-479 (in Polish).

Oczkowski H.L. and Przegiętka K.R., 1998: TL Dating of Young Aeolian Deposits from Kępa Kujawska. *Radiation Measurements* 29: 435-439.

Oczkowski H.L., Przegiętka K.R., Lankauf K.R. and Szmańda J.B., 2000: Gamma spectrometry in thermoluminescence dating. *Geochronometria 18*: 57-66.

Tomczak A., 1971: Kępa Bazarowa na Wiśle w Toruniu w świetle badań geomorfologicznych oraz archiwalnych materiałów kartograficznych (Kępa Bazarowa in Toruń, in the light of geomorphological research and archival cartographical materials). *Studia Societatis Scientiarum Torunensis* 7 (6): 1-111. (in Polish).

Tomczak A., 1982: The evolution of the Vistula river valley between Toruń and Solec Kujawski during the Late Glacial and Holocene. In: Starkel L., ed., *Evolution of the Vistula river valley during the last 15 000 years. Geographical Studies Special Iss*ue1: 108-129.

Tomczak A., 1987: Evolution of the Vistula valley in the Toruń Basin in the Late Glacial and Holocene, In: Starkel L. ed., *Evolution of the Vistula river valley during the last 15 000 years. Geographical Studies Special Iss*ue 4: 207-232.

Wallinga J., 2002: Detection of OSL age overestimation using single-aliquot techniques. *Geochronometria 21*: 17-26.