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# TL AGES OF LOESSES FROM THE LAST TWO GLACIALS IN SE POLAND

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**Abstract:** Loesses cover a large area in SE Poland so their exploration is an important part of the palaeogeographical studies on Pleistocene. The research involves stratigraphic problems. At present, luminescence dating provides the greatest number of chronostratigraphic data concerning loesses. In this work we report TL ages of loesses from the last two glacial cycles in SE Poland, obtained in the TL Laboratory of the Department of Physical Geography and Palaeogeography, Maria Curie-Skłodowska University in Lublin after 1993. Samples for TL dating were collected in 11 loess profiles (2-9 samples in each site) in order to obtain additional information for stratigraphic interpretations deduced from paleopedological, lithological, structural, and other data. Basing on the comparison of 54 TL ages, we can determine age intervals, in which the dating results of similar values assemble, and then get general information about the periods of intensified Aeolian accumulation related to defined stratigraphic units. The TL ages of all samples were obtained using the total-bleach method (TB) for the determination of the equivalent dose.

**Keywords:** loess, paleosols, thermoluminescence, total-bleach method, Vistulian

## 1. INTRODUCTION

Silt deposits formed with considerable contribution of Aeolian factor are defined as typical/proper loesses (Maruszczak, 1986; 1990 and 2000). From among the Pleistocene deposits, loesses are those in which the record of events/phenomena of glacial-interglacial cycle is relatively best preserved. Beds of loess silt correspond to stadial periods of cooling, and intraloess soils were formed under the conditions of warmer and more humid climate; the degree of their development was conditioned by the intensity and duration of warm intervals. However, due to the occurrence of accumulation hiatuses and many phenomena destroying loess covers (erosion, denudation), the deposit sequences in loess profiles are usually incomplete (Frechen, 1999). Different types of hiatuses are better visible if they are represented by erosion and denudation surfaces, which truncate intraloess soils. If such surfaces are absent, the boundaries between loess beds of different ages are weakly or not visible (Maruszczak, 1986). Thus, the occurrence of stratigraphic hiatuses in loess profiles makes difficult a reliable correlation of loess sequences or layers examined in different sites. Such correlations can be made only when independent age control is provided (Frechen, 1999). Therefore, the use of absolute dating methods is necessary in the studies aimed at the reconstruction of climate changes recorded in loess sequences. Especially important role is played by luminescence methods (TL and OSL), which can be applied to commonly occurring mineral material (mainly quartz, feldspars), so they can be used when other dating methods (e.g. $^{14}C$, K/Ar, U/Th) are inapplicable.

In Poland typical/proper loesses occur in the southern part of the country, mostly in the South-Polish Uplands, i.e. in the Lublin, Sandomierz, and Cracow regions (compare Maruszczak, 1986 and 1991). They are also found in the forelands and foothills of the Carpathians and Sudetes. Typical loesses of different ages form rather continuous patches occurring usually between 200 and 350 m a.s.l. Both their areas and thickness increase eastwards. In the west they are about 10 m thick, and in the east they reach 40 m. From among loess beds those from the last glacial are dominant, and their thickness increases from almost 10 m in the west to over 20 m in the east. The loesses from the earlier glacials are usually of smaller extent, thinner, and covered by the Vistulian loess. Thus

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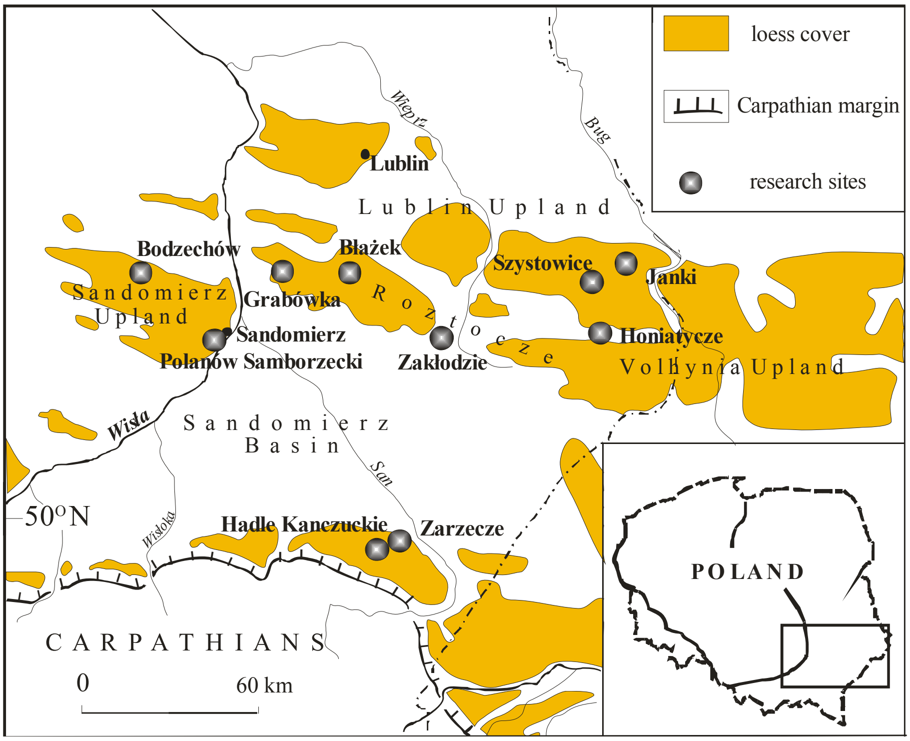


**Fig. 1.** *Location of the examined sections.*

loesses are better visible in the landscape of eastern Poland where their distribution resembles that of vast loess covers of SE Europe. Loesses in western Poland resemble irregularly distributed loess patches of W Europe. That is why the loesses occurring in SE Poland are something like transit land bridge between the loesses of Western and Eastern Europe, and are of great importance for stratigraphic and palaeogeographical studies.

Taking into account the scientific importance of loess deposits from SE Poland (Maruszczak, 1986 and 1991), in this work we discuss the results of thermoluminescence analyses for the profiles representing the South-Polish Uplands, i.e. the Lublin and Sandomierz regions, and also the forelands and foothills of the Carpathians (**Fig. 1**). Maruszczak (1991) describes the above-mentioned loess areas as follows. The Lublin Upland is situated between the Wisła and Bug rivers. Loesses of this region occur in the areas situated up to 350 m a.s.l., with relative heights from 30-40 m to 100-120 m. The Lublin region is the most extensive and compact loess area in Poland. It is distinguished by a large extent of typical loesses, the thickness of which is 30-40 m along high morphological scarps and the sides of rather big valleys. The Sandomierz Upland, situated between the Vistula River and Holly Cross Mountains, resembles the Lublin Upland but it is characterized by lower loess thickness, which exceeds 30 m in its eastern part only in places. In the foothills of the Holly Cross Mountains, loamy covers of slope deposits replace loesses at a height of 350-400 m. In the Carpathian Foreland loesses occur in a narrow zone near the Carpathian margin, at a height up to 400 m a.s.l. Typical, rather thick loesses occur only in lower-lying areas (200-300 m a.s.l.) of the Rzeszów Foreland, mainly between the San and Wisłok rivers.

## 2. LUMINESCENCE METHODS

As it was mentioned above, the age of Quaternary deposits, i.e. the time passed since their deposition, can by determined by luminescence methods with the use of their mineral components, i.e. quartz and feldspars. Crystal lattices of these minerals contain defects and impurities, which form traps. Free electrons, released by the radiation produced during decay of natural radioisotopes (mainly those of $^{235}$U, $^{238}$U, $^{232}$Th, and $^{40}$K series), migrate to these traps. When these minerals are heated or exposed to the light, electrons are released from the trap levels, and they recombine with luminescence centres. The emitted light, according to the stimulating factor (thermal or optical), is named thermoluminescence or optically stimulated luminescence, respectively. The dating methods (TL and OSL) using luminescence phenomena are based on an important assumption that before deposition the luminescence signal from mineral grains was bleached and reset to zero for OSL, or near zero, i.e. to the residual level for TL. With this assumption we can accept that after deposition the luminescence clock restarted, adequately to radioactivity in the sedimentary environment. As luminescence intensity is measurable, we can determine the value (named equivalent dose), which corresponds to the energy absorbed by mineral grains since the deposition time till the present. The time passed since a deposit was exposed to sunlight last time is given by the ratio of the equivalent dose to the dose rate. The dose rate is defined as the effective dose of radiation absorbed by a deposit in a year, and is calculated from the measurements of radioisotope concentrations.

Optically stimulated luminescence methods (OSL) are classified in respect of the used light wavelength. In the IRSL method, the luminescence of a sample is measured during the exposure to infrared light (880-960 nm) emitted by IR diodes; in GLSL method to light emitted by green (420-560 nm) diodes (Frechen *et al.*, 1999). Other classification of OSL methods into the additive dose and regeneration techniques is associated with the manner of equivalent dose determination. Within TL methods three techniques for determining the equivalent dose are used: additive dose, regeneration, and total-bleach. It is important to distinguish these modifications of TL and OSL methods because different techniques applied to the same sample can give different results (Van den Haute *et al.*, 2003). However, these differences are smaller when using OSL methods, as demonstrated by the scientists discussing the dating results obtained by IRSL and GLSL methods with different techniques of equivalent dose determination (Frechen, 1999; Frechen *et al.*, 1999).

On the contrary, the results of TL dating are strongly dependent on the conditions of sediment deposition and the technique of equivalent dose determination. The results obtained by additive dose method can be overestimated because this technique does not include the correction for unbleachable residual thermoluminescence, i.e. that which cannot be bleached even during long exposure to light. On the other hand, the results obtained by regeneration method can be underestimated, especially when the analysed loess deposits are older than 70-80 ka (Berger et al., 1992). This is caused by long bleaching by artificial light, which can change the sensitivity of mineral material. This phenomenon does not occur in every dated sample, however the obtained results should be verified using the total-bleach technique (Berger *et al.*, 1992; Frechen, 1992 and 1999; Frechen *et al.*, 1997 and 1999; Zhou and Wintle, 1994), which is free from the above-mentioned limitations.

However, the total-bleach method is strongly dependent on the conditions of loess deposition. The obtained dating results are consistent with geologic interpretation only if the exposure to sunlight has been sufficiently long to bleach the thermoluminescence accumulated in mineral grains during their earlier history to the residual level. The necessary exposure time is estimated at about 10-12 h (Frechen *et al.*, 1999).

Of course, it is difficult to judge if mineral grains composing loesses in Poland and in adjacent territories have been exposed to sunlight for such a long time. Loess material in Europe is considered to be of local origin so it was probably transported by surface winds from a short distance of up to several tens of kilometres (Dolecki and Łanczont, 1995; Maruszczak, 1986; Frechen *et al.*, 1999; Chlebowski *et al.*, 2003). Very extensive comparative studies on TL and IRSL methods applied to silt deposits from Hungary, Czech Republic, Germany, Belgium, and France (Frechen, 1992 and 1999; Frechen *et al.*, 1997, 1999, 2001 and 2003) reveal that the total-bleach method applied to those silts, which are defined in literature as reworked loess, slope wash deposit, deluvial and solifluction loess, gives overestimated results, adequately to insufficient bleaching of TL signal. However, the results of IRSL and TL dating of typical/proper loesses are usually consistent with geologic interpretation so it is confirmed that the total-bleach method can be used for dating of Aeolian silt deposits.

## 3. HISTORY OF THE TL LABORATORY IN LUBLIN

The period of activity of the TL laboratory in Lublin should be divided into three stages. The first stage lasted from 1980 to 1992 when Butrym run the laboratory. The second stage occurred in 1992/1993 when Fedorowicz (who currently runs the TL laboratory in Gdańsk University) made several age determinations. The third stage started at the end of 1993 when Kusiak succeeded took over the running of the laboratory. Each stage was characterized by different method of thermoluminescence dating.

In the first stage, the equivalent dose was determined by additive dose method, and the dose rate – with the use of the LiF dosimeters in 1-2 kg samples (Butrym, 1985). In the years 1980-1992 about 2500-2800 dating results were obtained (the exact number is impossible to determine now). Geographers and geologists accepted these results. However, the use of additive dose method for determination of equivalent dose could have given overestimated results (this technique does not include the correction for residual thermoluminescence). The use of the LiF dosimeters in small samples could have given underestimated results because the dosimeters obtained only a part of ionising radiation energy in comparison to that which they could have obtained in the soil. Due to the above-mentioned reasons, different researchers criticized this method of thermoluminescence dating (Fedorowicz and Olszak, 1988; Pazdur and Bluszcz, 1987a, 1987b; Wintle, 1987; Frechen, 1992; Frechen *et al.*, 1997). Butrym obtained many dating results for loess. He dated also some of the profiles described in this paper but the results seem to be incomparable with modern ones. The results of TL dating carried out in Lublin in the years 1980-1992 differ also from the results obtained for the same loess profiles in other TL laboratories (Butrym, 1987; Butrym and Maruszczak, 1984; Frechen *et al.*, 1997).

In 1984, a series of 14 samples taken from the exposure in the Odonów brickyard was dated in three TL Laboratories: Gliwice, Lublin, and Warsaw (Bluszcz, 1987; Butrym, 1987; Prószyńska-Bordas *et al.*, 1987). The TL ages obtained in Lublin were distinctly older than those determined in Warsaw and Gliwice (Madeyska, 1992). These differences can be interpreted as follows. The TL results obtained in Lublin with the use of additive dose method (two other laboratories used regeneration method) could have been overestimated because of several overlapping factors such as not included correction for unbleachable residual thermoluminescence and underestimated dose rate due to the use of dosimeters.

On the other hand, TL dating of the Hungarian loess made in Lublin in the 80's of the $20^{th}$ century gave considerably underestimated results in comparison with those obtained in Cheltenham (Frechen *et al.*, 1997). This underestimation probably resulted form the lack of preheating after irradiation in order to eliminate the induced in laboratory unstable part of TL signal (Berger *et al.*, 1992; Kusiak, 2002; Wintle, 1997).

The above-mentioned examples indicate that the TL dating results obtained in Lublin in the years 1980-1992 could have been overestimated or underestimated in comparison with those obtained in other laboratories. This fact raises doubts about the reliability of these results in the context of discussion on the possibility of TL dating of loess samples.

The second stage of activity of the TL Laboratory in Lublin occurred in 1992/1993. In this period about 100-300 dating results were obtained (the exact number is impossible to determine now). The equivalent dose was determined by regeneration method, and the dose rate – from the measured concentrations of natural radionuclides with use of gamma spectrometer (Fedorowicz and Olszak, 1985). None of the profiles described in this paper were dated then.

During the third stage, i.e. from the end of 1993 till now, about 1200 dating results were obtained for the Quaternary deposits of different origin. These results are marked by the symbol "Lub-" and numbered starting from 3001. The equivalent dose is determined by the total-bleach technique, and the dose rate – from the measured concentrations of natural radionuclides in deposit.

## 4. EXPERIMENTAL DETAILS

The TL age of deposit is given by the ratio of the equivalent dose to the dose rate. The equivalent dose (ED) for all the results of TL dating published in this paper are obtained for the 45-63 μm polymineral fraction, which is separated by wet sieving. Loesses contain 50-80% of the 2-63 μm fraction, so this grain size is predominant in them (Wintle, 1987). Therefore, grains from this range of diameters are commonly used for the TL dating. It is also estimated that in loess about 95% of the TL signal comes from feldspars, and only about 5% from quartz (Singhvi and Mejdahl, 1985). That is why no separation of the mineral components from silt fraction is usually performed. However, the polymineral fraction requires treatment with 10% HCl to remove carbonates and iron compounds, and with 30% $H_2O_2$ to remove organic material. After each phase of treatment, the processed sample is washed with distilled water several times. Then, the mineral material obtained from each sample is divided into portions (6-9). One subsample is left as natural. Second subsample is bleached, i.e. exposed to light simulating sunlight (from an ultraviolet lamp of OSRAM ULTRA-VITALUX type) for 12 hours, in order to determine the residual level of thermoluminescence. Several subsamples are irradiated with use of the $^{60}$Co γ source. Irradiation doses (from tens to several thousands Gy) are individually selected for each sample, according to its natural TL. Before the TL measurements all subsamples are preheated at 160°C for 3 hours.

The TL measurements are carried out using the RA'94 reader produced by Mikrolab Kraków. Each 4 mg portion is put on special platinum plate, and heated with a constant rate (10°C/sec.) up to 400°C. Heated minerals emit the light of characteristic wavelength range (Wintle, 1987). Optical filters are used in order to obtain narrower TL signal. The results presented in this paper are obtained using the BG-28 (380-500 nm) filter (Berger *et al.*, 1992). The emitted light is recorded with the EMI 9789 QA photomultiplier, and then presented as the plot of TL intensity versus temperature, i.e. a glow curve.

To determine the equivalent dose, the maximum heights of all obtained glow curves should be read and plotted as TL = f(D), where TL is thermoluminescence intensity, and D is irradiation dose for a given subsample. Linear or exponential function is fitted to the obtained points, and extrapolated to the dose axis. The intersection point shows the ED value with correction for residual thermoluminescence (**Fig. 2)**. The ED values for all presented TL ages are calculated with the FIT-SIM programme of Grün (1994), which is based on the simplex fitting procedures and analytical error calculation by Brumby (1992).

The dose rate is a sum of $d_\alpha$, $d_\beta$, $d_\gamma$, and $d_c$, i.e. dose rates from α, β, γ, and cosmic radiation, respectively. Dose rates $d_\alpha$, $d_\beta$, $d_\gamma$ are calculated from the measured concentrations of natural radionuclides ($^{40}$K, $^{226}$Ra, $^{228}$Th) occurring in a sample, with use of the MAZAR 95 spectrometer, on the basis of data published by Aitken (1983). According to the data published by Wintle (1987), if the equivalent dose is determined for mineral grains about 50 μm in diameter, these grains receive about 50% of the dose rate $d_\alpha$ accumulated in the same deposit by the grains ≤10 μm in diameter. Therefore, an adequate correction is made in calculation of the dose rate. Cosmic dose rate ($d_c$) is calculated on the basis of data published by Prescott and Hutton (1988), with regard to the depth of deposit occurrence. Correction for deposit moisture is taken after Berger (1988).

## 5. MAIN PERIODS OF LOESS ACCUMULATION IN EUROPE

In the recent years, many IRSL and TL age determinations were carried out for loess deposits from the last interglacial-glacial cycle in Western and Southern Europe. Luminescence age estimates of loess deposits correlated with OIS 5 (Eemian and Early Vistulian) are older than 70 ka in Germany (Frechen, 1999), older than 75 ka in Czech Republic (Frechen *et al.*, 1999), and from 70 to 120 ka (70-100 ka for humus horizons) in Belgium (Frechen *et al.*, 2001; Van den Haute *et al.*, 2003). Based

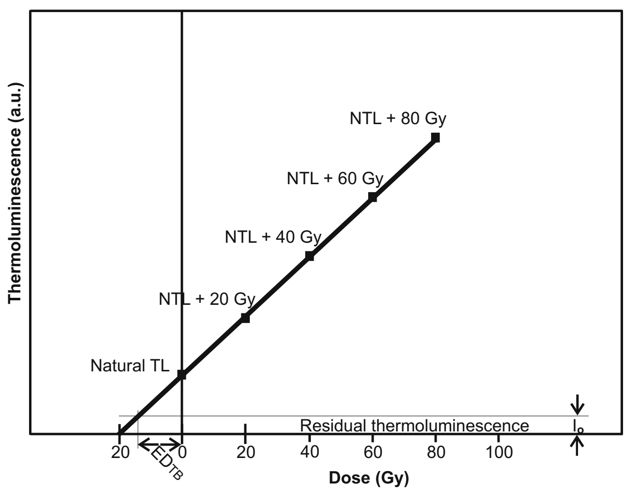


**Fig. 2.** *TL growth curve for total-bleach (TB) method.*

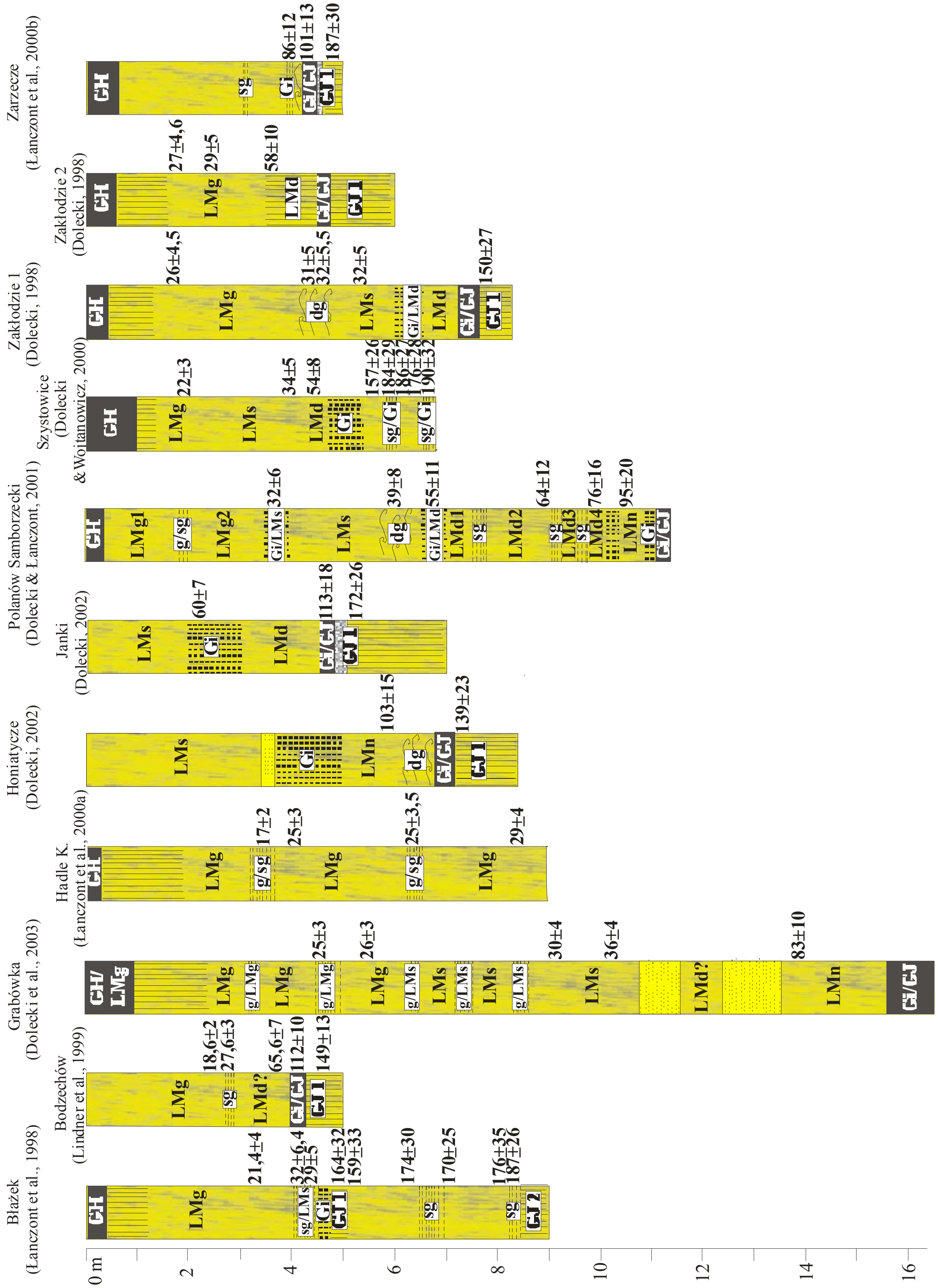


**Fig. 3.** *Sample collection points in the profiles.*

on the published results of luminescence dating for loess deposits correlated with Pleniglacial (OIS 4-2), several major periods of loess accumulation can be distinguished. In Belgium: 65-60 ka - OIS 4, 50-40 ka and 36-33 ka – OIS 3, 26-19 ka and 17-13 ka – OIS 2 (Frechen *et al.*, 2001 and 2003). In France: 73-65 ka – OIS 4, 65-35 ka – OIS 3, 25-20 ka and 18-13 ka – OIS 2 (Frechen *et al.*, 2003). In Germany: 59-40 ka (for the deposits partially preserved due to subsequent erosion) and 40-25 ka – OIS 3, 24-20 ka and 17-13 ka – OIS 2 (Frechen, 1999). In Czech Republic: 55-40 ka – OIS 3 and 25-15 ka – OIS 2 (Frechen *et al.*, 1999). In Hungary: 60-50 ka – OIS 4, 35-25 ka – OIS 3 and 20-13 ka – OIS 2 (Frechen *et al.*, 1997).

TL dating results (total-bleach technique) for the Vistulian loess deposits occurring in Eastern Europe (SE Ukraine) were also published, e.g. for 25 samples from the Rivne profile and 17 samples from the Torčyn profile (Nawrocki *et al.*, 2003). The loess correlated with the Early Glacial (OIS 5, substages 5d-5a) was dated at 119-85 ka. The deposits correlated with the Lower Pleniglacial (OIS 4) were dated at 70-61 ka. The deposits correlated with the Middle Pleniglacial were dated at 42-30 ka (OIS 3) and with Upper Pleniglacial (OIS 2) - 29-18 ka.

## 6. RESULTS AND DISCUSSION

In this paper the results of TL dating made in Lublin in the years 1993-2004 are presented (**Figs 3** and **4)**. We report the TL ages from the last two glacial cycles. All examined profiles occur within large patches of upland loess, but in different morphological positions, i.e. on loess plateaux (Błażek, Bodzechów, Honiatycze, Janki, Szystowice), in their marginal parts and on slopes (Zarzecze, Zakłodzie 1, Zakłodzie 2, Grabówka) or on the valleys' sides (Polanów Samborzecki, Hadle Kańczuckie).

The deposits correlated with the last glacial were sampled in all profiles mentioned above. The deposits from the penultimate glacial were sampled in seven profiles: Błażek, Bodzechów, Honiatycze, Janki, Szystowice, Zakłodzie 1, and Zarzecze. Samples were taken from the Bt horizon of the Eemian paleosol. The underlying loess was sampled only in two profiles: Błażek (5 samples), and Szystowice (5 samples).

Six TL ages obtained for the interglacial forest soil ($B_t$ horizon) are considerably scattered from 187±30 to 139±23 ka. The TL age estimates for loess underlying the Eemian soil (not transformed by pedogenesis) in the Błażek and Szystowice profiles (ten samples) are also very scattered from 190±32 to 157±26 ka (Dolecki and Wojtanowicz, 2000; Łanczont *et al.*, 1998). The authors of the papers in which these profiles were described in detail, divided LSg into the units of lower rank on the basis of paleopedological data. However, the obtained TL dating results do not allow defining precisely the corresponding age intervals because the measurement error is greater than the differences between the results.

A comparison of the results obtained for the Polish loess deposits from the penultimate glacial and for those from Belgium and Hungary shows some similarities. Loess underlying $B_t$ horizon of the Eemian soil in Belgium yielded age estimates about 120 ka (Van den Haute et al., 2003). In Hungary, the TL ages obtained for deposits correlated with OIS 6 range from 101±12 to 208±21 ka (Frechen *et al.*, 1997). The TL ages of loesses from the penultimate glacial in SE Poland are similar to those of Hungarian loesses, however, some results are higher than the TL ages of Belgium loesses. Therefore, a part of the TL dating results obtained for Polish loesses is probably overestimated because of weaker zeroing of the material before accumulation. It is also possible that in the examined sites the Eemian soil developed on older loess beds than those accumulated in the last part of the penultimate glacial.

Early Glacial, occurring between 116 and 75 ka (compare Mojski, 1999), was characterized by great complexity of processes associated with accumulation of loess deposits (Maruszczak, 1991). In our paper, this period is represented by only seven results of TL dating. Loess was dated at 86±12 ka, 83±10, 95±20, and 103±15 ka, chernozem soil at 101±13, 112±10 and 113±18 ka. These data are too few to be representative but they can be correlated with the upper part of OIS 5 (substages 5d-a), and are in good agreement with the data from adjacent regions. Similar results were also obtained in the TL Laboratory in Lublin for the following Ukrainian profiles: Mostys'ka, Rivne, Torčyn, Yezupil, Kolodiiv (Boguckyj *et al.*, 2000; Nawrocki *et al.*, 2003; Łanczont and Boguckyj, 2002; Łanczont and Madeyska, 2005). Comparable results were also published for the European regions lying westwards and southwards of Poland (Frechen, 1999; Frechen *et al.*, 1999 and 2001; Van den Haute *et al.*, 2003).

The next group of results obtained for Polish loess profiles is related to Lower Pleniglacial (OIS 4). Generally, loess from this period (lower younger loess LMd) is not common in the Vistulian profiles, often is not complete, contains stratigraphic hiatuses (Dolecki and Łanczont, 2001; Maruszczak, 1991). The TL dating of loess from Bodzechów and Polanów Samborzecki profiles yielded the following ages: 76±16 ka, 65.6±7 ka and

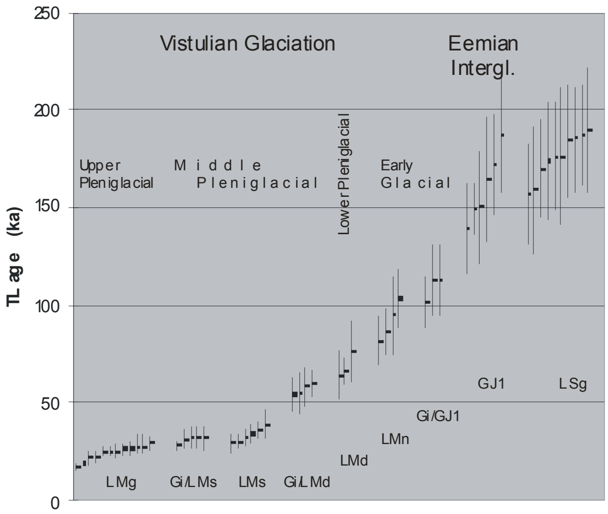


**Fig. 4.** *The results of TL dating of sediments from the last and penultimate glacial cycles.*

64±12 ka. The other TL results: 70±11 ka, 72±11 ka, 68±10 ka and 64±9 ka (Kusiak, unpublished data), obtained for Wąchock profile, are in agreement with the data from Bodzechów and Polanów Samborzecki profiles. For comparison, in Western Europe there are following periods of loess accumulation corresponding to OIS 4: 65-60 ka in Belgium and 73-65 ka in France (Frechen *et al.*, 2001 and 2003). In Hungary, loess accumulation correlated with OIS 4 occurred between 60 and 50 ka (Frechen *et al.*, 1997). These values are slightly younger then TL ages of Polish loess.

TL ages of deposits correlated with Middle Pleniglacial (OIS 3) range from 60 to 27 ka. The first group of the obtained TL data correspond to the beginning OIS 3. In Poland, it was a period of development of interstadial soil (Gi/LMd) proceeded by accumulation of LMd loess correlated with Lower Plenivistulian (Maruszczak, 1991). The results obtained for Gi/LMd soil (the gathered single data came from four profiles) range from 60 to 54 ka (60±7, 58±10, 55±11 and 54±8 ka). It is worthy to note that in NW Ukraine the Dubno 2 soil which is correlated with the beginning of the Middle Pleniglacial (Łanczont and Boguckyj, 2002), was TL dated in Torčyn and Rivne profiles at 61±7 ka and 70-67 ka, respectively (Nawrocki *et al.*, 2003). The first result is similar to those obtained for Gi/LMd, and the second – for LMd.

The second group of results obtained for Polish loess profiles is related to loess (middle younger loess LM) and interstadial soil (Gi/LMs) formed in the younger part of OIS 3. Five age estimates for loess range from 39 to 30 ka, and data (6 samples) obtained for interstadial soil (Gi/LMs) are from the interval 32-27.6 ka.

In Europe, the following periods of loess accumulation are correlated with OIS 3: 50-40 ka and 36-33 ka in Belgium, 65-35 ka in France, >40 ka and 40-25 ka in Germany, 55-40 ka in Czech Republic, 35-25 ka in Hungary (Frechen, 1999; Frechen *et al.*, 1997, 1999, 2001 and 2003). Similar results (42-28 ka) were also obtained for samples from NW Ukraine (Nawrocki *et al.*, 2003). Therefore, the results determined for loesses from SE Poland are in agreement with the data from other European regions.

The TL ages corresponding to Upper Pleniglacial, obtained in the TL Laboratory in Lublin, range from 30 to 17 ka. Eight from among twelve obtained results are from the interval 30-25 ka and four from 22 to 17 ka. If we accept that the Upper Pleniglacial lasted from 25 to 13 ka (compare Mojski, 1999), and typical TL ages of loess in Europe are from ~28 to 13 ka (Frechen *et al.*, 2003), we find that most of these results are slightly overestimated. The reasons can be different. Some of these results were obtained for the lower parts of the Upper Pleniglacial loess profiles, which often contain deluvial-solifluction material. Therefore, fresh mineral material could have been mixed with older one. We can also take into account the possibility that the mineral material was insufficiently bleached before deposition due to short distance transport. The results obtained for Polish loesses are almost identical with those from NW Ukraine, probably reflecting similar origin and transport distances of silt deposited in the discussed areas.

## 7. CONCLUSIONS

A compilation of dating results obtained in the years 1993-2004 in Lublin for loess deposits from SE Poland and a comparison with the results obtained by luminescence methods for other European loess areas allow us to find some regularities. The TL ages obtained for SE Poland are in agreement with the age intervals of loess accumulation in other loess areas of Central Europe. The results obtained for loess correlated with Upper Pleniglacial are partly overestimated but its stratigraphic position is rather unquestionable. On the other hand, these results probably confirm a near-surface reduction of the youngest part of loess cover by erosion processes at the end of Vistulian and the beginning of Holocene. The best correlation is found for the middle younger loess (LMs) deposits. The obtained results define the time of loess accumulation similar to that found for adjacent regions, i.e. between 39 and 28 ka – the upper part of the Middle Pleniglacial (Interpleniglacial). The comparison of older units is more difficult because of considerably lower number of obtained TL ages. Among other things, this fact results from poor accessibility of these deposits to examination.

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