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# NEW RESULTS OF TL DATING OF THE LOESS PROFILE AT POLANÓW SAMBORZECKI WITH USE OF THE OPTICAL FILTERS BG-28 AND UG-11

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**Abstract**. Termoluminescence (TL) ages have been obtained for the samples collected at Polanów Samborzecki near Sandomierz from the loess profile. The TL glow curves were recorded with use of optical filters UG-11 (300-380 nm). Different values of equivalent dose (ED) and TL age have been obtained using the UG-11 filter are about 20% lower than the BG-28 results. TL ages determined with use of the BG-28 filter confirm entirely the preliminary stratigraphic interpretation of the profile at Polanów Samborzecki based on geological and paleopedological criteria. Use of the UG-11 filter results in distinctly underestimated TL age.

## 1. INTRODUCTION

Thermoluminescence (TL) ages were determined for the loess samples collected at Polanów Samborzecki near Sandomierz (Dolecki and Łanczont, 1997a). It was a part of the methodical work, carried out in the TL laboratory in Lublin, on a dependence of the TL age upon the TL spectrum band selected to determine the equivalent dose (Kusiak, 1997). The examined loess exposure is situated in the Vistula valley side at 165 m a.s.l., about 20 m above the present valley bottom.

This profile has been generating interest for a long time because of a considerable thickness (10 m) and great stratigraphic differentiation of the younger loesses, i.e. these representing the Vistula Glaciation, overlying a very well developed pedocomplex correlated with the Eemian Interglacial and with the earliest part of the last glaciation. Many scientists studied the stratigraphy and chronostratigraphy of these loesses (Buraczyński, 1995; Grygierczyk and Waga, 1993; Konecka-Betley, 1996). However, the obtained results were different due to varied minuteness of the investigations but also because they were based on the TL ages determined in different laboratories. That is why we again studied this profile in detail. On the basis of paleopedological and lithological differentiation the younger loesses from Polanów were divided into units of lower rank by Dolecki and Łanczont (1997a, **Fig. 1**).

## 2. TL DATING

The examined loesses were TL dated by the standard method which is used in the Lublin Laboratory (Kusiak, 1997). Deposit age was calculated as a quotient of the equivalent dose (ED) and the annual dose (Dr). The annual dose was calculated from the formula:

$$Dr = k\,a\,d_{\alpha} + d_{\beta} + d_{\gamma} + d_{c} \qquad (1)$$

where:
$k = 0.14$ – α-efficiency factor;
$a = 0.5$ – a correction resulting from the fact that the grains about 50 mm in diameter can obtain only 50% of the radiation dose received by the grains 10 mm in diameter and smaller in the same deposit (Wintle 1987);
$d_{\alpha}$, $d_{\beta}$, $d_{\gamma}$, $d_{c}$ – doses coming from the α, β, γ and cosmic radiation, respectively.

Doses $d_{\alpha}$,$d_{\beta}$,$d_{\gamma}$ were calculated on the basis of concentration measurements of the natural radionuclides: $^{40}K$, $^{226}Ra$, $^{228}Th$, with use of the three-channel g spectrometer of AZAR-82 type, assuming equilibrium in the decay chains. Radionuclide concentrations (in Bq/kg) were converted to α, β, γ dose rates (in Gy/ka) on the basis of data published by Aitken (1983). Cosmic dose rate was determined on the basis of data published by Prescott and Hutton (1988). Corrections for deposit moisture were taken after Prószyńska-Bordas and Prószyński (1983).

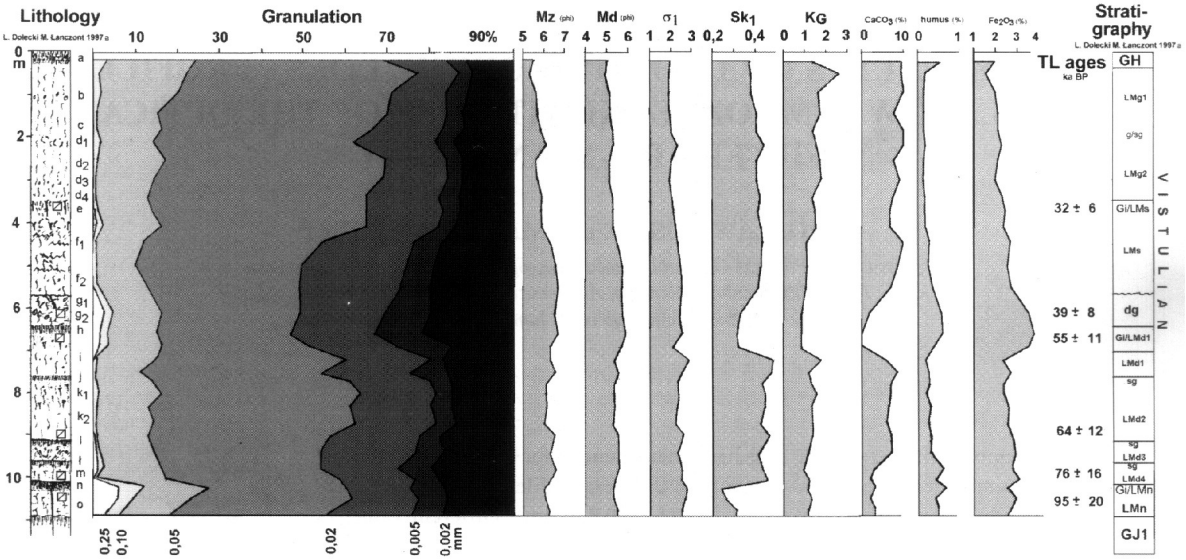


***Fig.1.*** *Profile of younger loesses at Polanów Samborzecki (after Dolecki and Łanczont, 1997). Mz – mean grain diameter, Md – median, $\sigma_1$ – standard deviation, $Sk_1$ – skewness, $K_G$ – kurtosis.*

| | | |
|---|---|---|
| **a** | **0.0-0.27 m** | Grey-yellowish humus horizon, carbonate, distinctly denuded in the upper part. |
| **b-$d_3$** | **0.27-3.20 m** | Loess, dark-yellow in the upper part, lighter in the bottom part, carbonate, with gley spots in places. Layers c and $d_1$ constitute the horizon in which the stratigraphic boundary dividing LMg probably occurs. |
| **$d_4$** | **3.20-3.47 m** | Dark-yellow loess, carbonate, with manganese concretions. |
| **e** | **3.47-4.17 m** | Well developed interstadial gley soil, grey, grey-yellowish, yellow-rusty-coloured, spotted. |
| **$f_1$-$f_2$** | **4.17-5.70 m** | Yellow-brown and greyish-yellowish loess, rather consistent, carbonate, HCl+ weakly in the bottom part. |
| **$g_1$- $g_2$** | **5.70-6. 65 m** | Denudation products translocated on the burried slope, consistent dark-yellow loamy deposit with greyish tint, layered-streaked, with numerous forms of secondary carbonates (concretions, crusts), rather distinct border in line with the decalcification border. |
| **h** | **6.65-7.00 m** | Brown horizon of the interstadial soil, with iron-manganese concretions 1-3 mm in diameter. |
| **i** | **7.00-7.60 m** | Very consistent loess, greyish-yellowish, carbonate, with small iron-manganese concretions. |
| **j** | **7.60-7.75 m** | Gley horizon, silty-clayey loess with marbled structure, with numerous concretions. |
| **$k_1$-$k_2$** | **7.75-9.10 m** | Light greyish-yellowish loess, carbonate, very consistent, with numerous iron-manganese concretions. In the layer $k_2$ indistinct traces of stratification with the blurred outlines. |
| **l** | **9.10-9.60 m** | Silty layer, brown with greyish tint, distinguishable by great agglomeration of small manganese-iron concretions. Numerous filamentous carbonate *pseudomycelia,* and lighter gley spots in places. This layer confirms development of weak pedogenesis, probably of interphase rank. |
| **ł** | **9.60-9.82 m** | Humus horizon, disturbed by slope processes, with small manganese concretions, layered structure, indistinct borders. HCl+ weakly. |
| **m** | **9.82-10.10 m** | Dark-yellow loess, carbonate, with small manganese concretions and spots. |
| **n** | **10.10-10.25 m** | Humus horizon of interstadial soil, dark-grey and brown, structureless. This horizon is cut by fissures (filled by lighter loess) reaching in places the interglacial soil complex. |
| **o** | **10.25-10.90 m** | Dark-yellow-brown loess, slightly spotted, with scattered small manganese-iron concretions, distinctly horizontally streaked. |

The equivalent dose (ED) was determined by the total-bleach technique. From each sample the polymineral fraction (45-63 mm) was separated and then etched with 10% HCl and 30% $H_2O_2$. The treated mineral grains were irradiated by ionising radiation from $^{60}Co$ source. An unstable thermoluminescence introduced into the artificially irradiated samples causes underestimation of the obtained TL ages, so the irradiated samples must be heated before readout of the TL glow curves. Various heat treatments (75°C, 90°C, 140°C and 160°C) were tested for effectiveness of this process. Examples of the TL glow curves obtained for the sample Lub-3279 were plotted in **Fig. 2.** The TL glow curves were recorded with use of the RA'94 TL reader-analyser, the EMI 9789 QA photomultiplier and the optical filters UG-11 (300-380 mm) and BG-28 (380-500 mm), in argon atmosphere, using a heating rate of 5°C/s. Plateau test was carried out for each sample and the results are shown in **Table 1**, and for the sample Lub-3279 also in **Fig. 4.** Debenham and Walton used the UG-11 filter (ultraviolet) in order to separate the thermoluminescence typical of feldspars from the whole TL spectrum obtained for polymineral samples (Mycielska-Dowgiałło and Prószyńska-Bordas, 1989). Use of the ultraviolet TL resulted in age underestimation what was reported by Debenham (1985), Dijkmans *et al.* (1988), Grün *et al.* (1989). However, the UG-11 filter has been still used in many laboratories. Therefore, we decided to test this filter using the samples of loesses from Sandomierz environs.

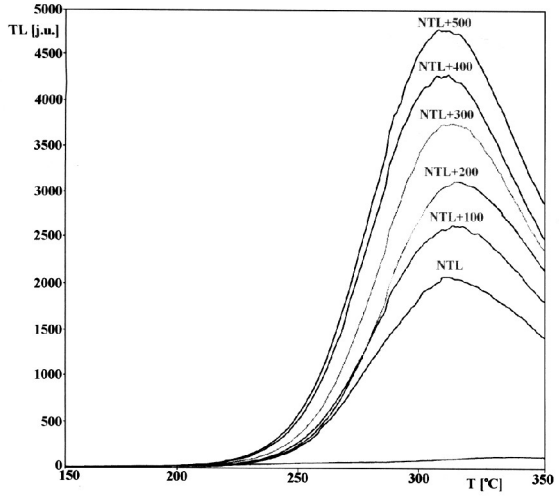


*Fig. 2. TL glow curves obtained for sample Lub-3279. TL emission was recorded through filter BG-28. The samples have been preheated for 4 hr at 160°C prior to glowing. NTL-natural TL. Numbers indicate values of additive γ doses in Gy.*

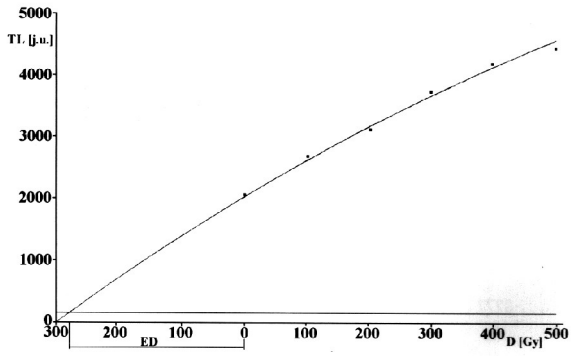


*Fig. 3. TL growth curves obtained for sample Lub-3279. TL emission was recorded through filter BG-28. Each point is mean value of ten measurements. An exponential function has been fitted to the points. ED-equivalent dose.*

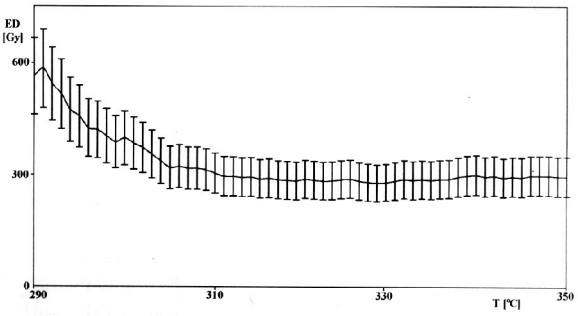


*Fig. 4. Results of plateau test for sample Lub-3279. TL emission was recorded through filter BG-28.*

## 3. DATING RESULTS

The TL ages obtained with use of the BG-28 filter (blue-green) were accepted as reference data. The BG-28 filter was chosen for regular use in our laboratory on the basis of the results published by Balescu *et al.* (1992), Balescu and Lamothe (1992), Berger (1988), Berger *et al.*, 1992), Mycielska-Dowgiałło and Prószyńska-Bordas (1989) and our own studies (Kusiak, 1997). These results show that the blue TL can give TL ages well corresponding with geological interpretation of deposits, even those which are several hundred thousand years old.

The results given in **Table 1**, **Table 2** and **Figs 2-4** indicate that different values of the equivalent dose and TL age were obtained according to kind of the optical filter used during readout of the TL glow curves. In all samples the ED values and TL ages obtained with use of the UG-11 filter are about 20% lower than the BG-28 results.

## 4. DISCUSSION

The age of the four units of the stadial/interstadial rank was determined. Within the lower younger loess (LMd), representing the lower Wisła Pleniglacial, the four units of the phase/interphase rank were distinguished. Their age was determined between 55 and 76 ka BP. The obtained results can be important when discussing a question of the Vistula stage division into small stratigraphic units (vide Mojski, 1997a, b). The accumulation period of the LMd loess corresponds to stage 4 of the oxygen isotope timescale. The subarctic brown paleosol developed on the $LMd_1$ layers can be correlated with substage 3.3 of the $\delta^{18}O$ curve, as in the chronostratigraphic scheme of the Polish loesses by Maruszczak (1991).

***Table. 1.*** *Annual doses.*

| Lab. No. Lub- | $d_\alpha$ [Gy/ka] | $d_\beta$ [Gy/ka] | $d_\gamma$ [Gy/ka] | $d_c$ [Gy/ka]] | Annual dose Dr [Gy/ka] |
|---|---|---|---|---|---|
| 3274 | 0.478 | 1.639 | 0.948 | 0.12 | 3.185±0.25 |
| 3275 | 0.459 | 1.517 | 0.931 | 0.08 | 2.987±0.27 |
| 3276 | 0.445 | 1.471 | 0.879 | 0.07 | 2.865±0.23 |
| 3277 | 0.436 | 1.561 | 0.892 | 0.05 | 2.939±0.26 |
| 3278 | 0.489 | 1.572 | 0.943 | 0.05 | 3.054±0.27 |
| 3279 | 0.471 | 1.535 | 0.904 | 0.04 | 2.950±0.27 |

***Table 2.*** *TL ages.*

| Lab. No. Lub- | Depth [m] | Stratigraphy | Filter | Plateau [°C] | Equivalent dose ED [Gy] | TL Age [ka] |
|---|---|---|---|---|---|---|
| 3274 | 3.5-3.55 | Gi/LMs | UG-11 | 215-280 | 81±13 | 25±5 |
| | | | BG-28 | 305-350 | 101±16 | 32±6 |
| 3275 | 6.0-6.05 | LMs | UG-11 | 220-280 | 102±18 | 34±7 |
| | | | BG-28 | 310-350 | 117±20 | 39±8 |
| 3276 | 6.7-6.75 | $Gi/LMd_1$ | UG-11 | 230-300 | 112±18 | 39±7 |
| | | | BG-28 | 305-350 | 157±28 | 55±11 |
| 3277 | 8.9-8.95 | $LMd_2$ | UG-11 | 220-280 | 156±25 | 53±10 |
| | | | BG-28 | 310-340 | 188±31 | 64±12 |
| 3278 | 9.9-9.95 | $LMd_4$ | UG-11 | 220-250 | 194±33 | 63±12 |
| | | | BG-28 | 310-340 | 233±42 | 76±16 |
| 3279 | 10.3-10.35 | LMn | UG-11 | 220-280 | 218±35 | 74±14 |
| | | | BG-28 | 310-350 | 280±53 | 95±20 |

## 5. CONCLUSIONS

The TL ages determined with use of the BG-28 filter confirm entirely the stratigraphic intepretation (based on the geological and paleopedological criteria) of the profile at Polanów Samborzecki (Dolecki, Łanczont 1997a, b).We note that the TL ages obtained with the use of the UG-11 filter are considerably underestimated what is confirmed by the geological situation of loesses in the Polanów Samborzecki profile and in the other profiles of SE Poland (Dolecki and Łanczont, 1997b).

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