Quaternary International 388 (2015) 119–141

Contents lists available at ScienceDirect

Quaternary International

journal homepage: www.elsevier.com/locate/quaint

Fluvial history of the Sub-Carpathian Basins (Poland) during the last cold stage (60–8 cal ka BP)

Piotr Gębica [a, *], Danuta J. Michczyńska [b], Leszek Starkel [c]

[a] University of Information Technology and Management in Rzeszów, Department of Geography, Sucharskiego 2, 35-225 Rzeszów, Poland
[b] Silesian University of Technology, Institute of Physics – CSE, GADAM Centre of Excellence, Krzywoustego 2, 44-100 Gliwice, Poland
[c] Institute of Geography and Spatial Organization, Department of Geomorphology and Hydrology of Mountains and Uplands, PAS, Św. Jana 22, 31-018 Krakow, Poland

ARTICLE INFO

Article history:
Available online 29 June 2015

Keywords:
River terraces
Alluvial fans
Chronostratigraphy
Vistulian
Sub-Carpathian Basins

ABSTRACT

The fluvial landforms of the last cold stage are represented in the Sub-Carpathian Basins by a system of 2–3 terraces, which grade into alluvial fans of a height of 15–20, 8–12 and 6–8 m above the present riverbeds in the mountain foreland. In the Vistula River valley the 15–20 m high terrace, covered with loess, extends along the western margin of the Sandomierz Basin and northern margin of the Carpathians. Away from the mountain margin, it passes into the sandy terrace plain with dunes. It is formed of at least two Interpleniglacial alluvial fills: the older one dated at 48–36 ka BP (over 50–40.6 ka cal BP) and the younger one dated 30–25 ka BP (34.1–29.0 ka cal BP) thus pertaining to the Upper Pleniglacial. This latter forms a terrace 15 m high. In general, accumulation of fluvial sediments interrupted with erosion phases dominated in the mountain foreland during the period 60–25 ka BP (over 60–29 ka cal BP). The most significant erosion phase took place before the maximum extension of the Vistulian (Weichselian, Wisconsinian) ice sheet (i.e. before 25–20 ka BP = 29–24 ka cal BP) and was connected with a change from an oceanic to a more continental climate. The next alluvial fill of terrace 8–12 m high (with remnants of braided river channels) was formed at the end of the Upper Plenivistulian. The incision of the river channels below the present channel level was followed by aggradation in the Late Vistulian (15–13 ka BP = 18.2–15.6 ka cal BP) accompanied by a change in river channel system from braided to meandering. In the Wisłoka and San River valleys alluvial plains extending by lateral erosion of large meanders were abandoned by rivers mainly in the Younger Dryas and the Preboreal. The Late Vistulian large palaeomeanders are missing along lower Soła and lower Dunajec. These rivers, fed from higher mountains, had still tendency to braiding. The climate cooling of the Younger Dryas brought an increase in the delivery of bedload to the river channels and a tendency to braiding in Vistula valley (Drwinka depression). The expansion of forest in the Early Holocene reduced the water discharge and the size of meanders. As a result, their width fallen by 3–5 times. Alluvial data showed also a distinct humid climatic phase ca. 9.5–8.5 ka cal BP.

1. Introduction

The Sub-Carpathian Basins represent a depositional basin gathering the sediments of rivers flowing from the Carpathians. The Vistulian (Weichselian, Wisconsinian) was a stage which saw the intensive accumulation of alluvia in this area. During Last Glacial Period extensive alluvial fans in the outlet of Carpathian valleys to the mountain foreland were formed. Alluvial fans were dissected by river incision and in the widened trough covers of younger alluvial fans were inserted. This resulted in the formation of alluvial terraces. The best recorded depositional sequence represents the Middle and the Upper Plenivistulian, correlated with a large part of MIS 3 and MIS 2 (Dansgaard et al., 1993). Owing to the widespread use of the radiocarbon method and luminescence methods (TL and OSL), the stratigraphic–palaeogeographic evolution of the Sub-Carpathian Basins during the period 60–8 cal ka BP, studied as part of the scientific project INTIMATE (COST Action ES0907, Blockley et al., 2012), is among the best recorded in Europe. Using these dating methods allows a reconstruction of changes in fluvial deposition along the valleys situated in the

* Corresponding author.
E-mail addresses: piotrgebica@wp.pl (P. Gębica), danuta.michczynska@polsl.pl (D.J. Michczyńska), starkel@zg.pan.krakow.pl (L. Starkel).

http://dx.doi.org/10.1016/j.quaint.2015.06.012
1040-6182/

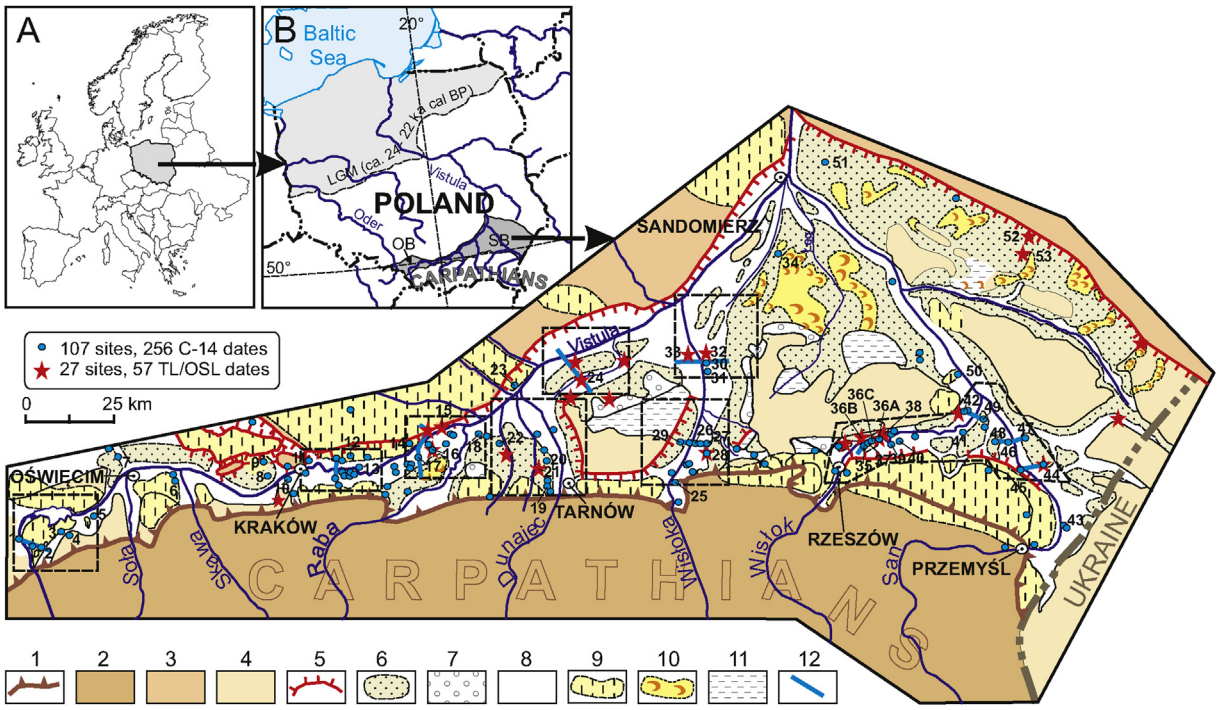

Fig. 1. A geomorphological map of the Fore-Carpathian Basins and the distribution of the most important sites of fluvial deposits dated by the radiocarbon and thermoluminescence (TL, OSL) methods (after Starkel, 1980; Gębica, 2004, partly modified). 1 – margin of the Carpathians, 2 – Carpathian foothills, 3 – Uplands, 4 – Fore-Carpathian plateaus, 5 – main escarpments, 6 – Vistulian terraces and alluvial fans, 7 – older (than Vistulian) river terraces, 8 – Holocene valley floors (floodplains), 9 – loess cover on the terraces and plateaus, 10 – fields of drift-sand and dunes (inactive), 11 – slope-wash plains and cones, 12 – geological cross-sections. The most important sites are numbered (1–53). Sites dated by radiocarbon method are marked with circles, and by luminescence method with stars. Locations of valley sections described in the text and presented in Figs. 2–10 are marked by dashed rectangles. List of the most important sites (mentioned in the text): 1 – Drogomyśl, 2 – Pierściec, 3 – Chybie, 4 – Bronów, 5 – Kaniów, 6 – Zator, 7 – Bieruń Nowy, 8 – Ściejowice, 9 – Kryspinów, 10 – Ludwinów, 11 – Prądnik alluvial fan in Kraków, 12 – Nowa Huta, 13 – Pleszów, 14 – Brzesko Nowe, 15 – Śmiłowice, 16 – Trawniki, 17 – Drwinka–Grobla Forest, 18 – Gróbka, 19 – Dębina Łętowska, 20 – Szujec, 21 – Niwka near Radłów, 22 – Włoszyn, 23 – Opatowiec, 24 – Zabrnie-Czaplówka, 25 – Podgrodzie, 26 – Brzeźnica B, 27 – Brzeźnica A–C, 28 – Pustynia, 29 – Wola Żyrakowska, 30 – Mielec-Trześń Mała, 31 – Mielec-Wojsławskie depression, 32 – Chorzelów, 33 – Trzciana, 34 – Kobylarnia, 35 – Łąka, 36 – Łukawiec I–IV, 37 – Łukawiec V, 38 – Czarna-Podbór, 39 – Wola Mała 1, 40 – Wola Mała 2, 41 – Gniewczyna Łańcucka, 42 – Grodzisko Nowe, 43 – Stubno, 44 – Bobrówka-Wietlin, 45 – Jarosław, 46 – Manasterz-Nielepkowice, 47 – Kostków, 48 – Wólka Pełkińska, 49 – Wólka Ogryzkowa, 50 – Leżajsk, 51 – Łążek, 52 – Kąty, 53 – Korytków.

periglacial zone (Fig. 1) (Rotnicki, 1987; Harasimiuk, 1991; Starkel, 1991, 1994, 1995b; Starkel and Gębica, 1995, Turkowska, 1995; Superson, 1996; Gębica, 2004; Starkel et al., 2007; Gębica, 2013; Starkel et al., 2015).

The aim of this paper is a reconstruction of the chronostratigraphy of alluvia and a determination of the age of the Vistulian alluvial terraces on the base of large data-set. A leading point is the timing of the phases of alluvial deposition and valley incision in response to changing environmental conditions in the river catchments. The authors also attempted to correlate the terrace surfaces, differentiated in structure and morphology, along the longitudinal transects of valleys. This review paper presents all collected dating results published originally mainly in local literature, or in press (Tables 1 and 2).

Table 1
Summary of dating results for the most important 71 sites (marked by numbers (53) and numbers with letters for sub-localities) from the Sub-Carpathian Basins. All radiocarbon dates were calibrated using OxCal 4.2 programme (Bronk Ramsey, 2009) and IntCal13 calibration curve (Reimer et al., 2013). Results of calibration were rounded by 100 yrs. Sites are organized along particular river valleys. Sites from Vistula valley are interrupted by sites from its tributaries (from W to E). For location of sites see Fig. 1. Dates for samples from alluvial fans, used for analysis presented in Fig. 11 are marked by "*". Dates for samples from palaeochannels, used for analysis presented in. Fig. 13 are marked by "**".

Name Altitude and coordinates	No. at the map	River Valley	Terrace level	Dated material	Lab. Co.	Dating method	Date	Error	Calibrated age cal BP (68.2% conf. Int.)	References
Drogomyśl	1	Vistula	IV	peat	Lv-1074	C-14	9020	120	10300–9900	Niedziałkowska et al. (1985)
262 m a.s.l.				peat	Gd-1393	C-14	9490	100	11100–10500	
18.75 E, 49.867 N				peat	Lv-966	C-14	11220	100	13300–12900	
				peat	Lv-965**	C-14	11250	110	13300–13000	
				organic clay	Gd-1395**	C-14	31100	1100	36300–34000	
				organic silt	Gd-913	C-14	30000	+5000 −3000	42300–31100	
Pierściec I	2	Vistula	I	peat	Gd-6362	C-14	29200	1000	34300–32000	Niedziałkowska and Szczepanek (1993–1994)
270–280 m a.s.l.				organic silt	Gd-5784	C-14	29500	800	34500–32700	
18.816 E, 49.835 N				peat	Gd-6364**	C-14	30700	1300	36400–33500	
				organic silt	Gd-6246**	C-14	35800	2500	43100–37600	
Chybie I	3A	Vistula	I	peat	Gd-948	C-14	>41000		>44500	Niedziałkowska et al. (1985)
260 m a.s.l.				peat	Gd-1460	C-14	>45000		>48400	
18.828 E, 49.902 N										