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Eemian and Vistulian (Weichselian) development of the meltout depression on the watershed between the Mroga and Mrożyca Rivers (Central Poland) based on lithological and pollen analysis

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ABSTRACT

The lithological and palaeobotanical research conducted in a closed-drainage depression located in the watershed zone between the Mroga and Mrożyca Rivers (Central Poland) allowed for the reconstruction of its palaeogeography in the period subsequent to the retreat of the last ice sheet (Wartanian Stage of the Odranian Glaciation). The purpose of this article is to gather and synthesise the obtained results, as well as to reconstruct the processes of development and filling in the studied depression over the last 135,000 years. The post-glacial evolution of the relief was recorded in the mineral and biogenic sediments deposited on glacial formations. The modern closed-drainage depression is a trace of a fossil extensive glacial meltout depression. The post-glacial development of the land relief within the depression involved three stages, dominated by different types of morphogenesis, i.e. the deglaciation stage during the Wartanian Stage of the Odranian Glaciation, the Eemian Interglacial-Early Vistulian aggradation stage, and the Vistulian aggradation-denudation stage. High thickness of the identified biogenic sediments suggests considerable transformations of the relief of the watershed during the two cycles of temperate climate – the Eemian Interglacial and the Holocene. The thickness of the mineral sediments suggest low dynamics of the environment during the Last Glacial Maximum (LGM), and undermine the hypotheses on the determining effect of periglacial conditions on the character of the relief of Central Poland. The obtained results constitute an inspiration and starting point for another research project concerning the reconstruction of the watersheds in Central Poland.

1. Introduction

The catchment of the Mroga River is located in the Wartanian zone, outside of the range of the Vistulian ice sheet (LGM – Last Glacial Maximum). It is an area that has been thoroughly investigated in terms of the palaeogeography of the Upper Pleistocene, with particular regard to the scope of the periglacial slope processes (Dylik, 1961, 1967) and fluvial processes (Turkowska, 1975, 1976, 1988, 1997). Towards the end of the Middle Pleistocene, during the Wartanian Stadial of the Odranian Glaciation the area of Central Poland was covered by the ice sheet for the last time. This cold stage corresponds to the Marine Oxygen Isotope Substage MIS 6, named Saalian Glaciation in Western Europe (Huissteden et al., 2003; Fig. 1). Upper Pleistocene consisted of the Eemian Interglacial corresponding to MIS 5e and the last glacial stage in Poland named the Vistulian (Weichselian), subdivided into two first-rank cold intervals (the Lower and Upper Plenivistulian, corresponding to MIS 4 and 2), preceded by the Early Vistulian (MIS 5d-a) and separated by the Middle Plenivistulian (MIS 3). The youngest part of the Vistulian was named the Late Vistulian or the Late Glacial (Fig. 1).

The research conducted in Central Poland over the last 50 years has been particularly focused on river valleys, with close attention to their terraces and slopes. Less attention was paid to research of plateau areas (Wieczorkowska, 1975). Sites documented in the course of such studies provided the basis for the development of an opinion on the dominant role of the periglacial morphogenesis in the development of the relief of the Łódź Plateau. A number of

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			Western Europe		Poland		MIS
PLEISTOCENE	UPPER		HOLOCENE		HOLOCENE		1
		VISTULIAN (WEICHSELIAN)	Late Pleniglacial [4]	Late Glacial	Late Vistulian/Late Glacial		
				Mecklenburg	Upper Plenivistulian	Gardno	2
				Pomeranian		Pomeranian	
				Frankfurt		Poznań	
				Brandenburg		Leszno	
			Middle Pleniglacial	Denekamp [3]	Middle Plenivistulian	VS4	3
				Hengelo [3]			
				Moershoofd [3]			
				Glinde [2]			
				Ebersdorf [2]			
				Oerel [2]			
			Early Pleniglacial [2]	Schalkholz	Lower Plenivistulian	VS3	4
			Early Glacial [1]	Odderade	Early Vistulian	Rudunki	5a
				Rederstall		VS2	5b
				Brörup		Brörup	5c
				cooling			
				Amersfoort			
				Herning		VS1	5d
			EEMIAN		EEMIAN		5e
	MIDDLE		SAALIAN (Drenthe+Warthe)		ODRANIAN (Odranian+Wartanian)		6

Fig. 1. Stratigraphy of the Upper Pleistocene in Poland and its correlation to the Western Europe. [1] after Menke and Tynni (1984), [2] after Behre and Lade (1986), [3] after Hammen (1995), [4] after Mojski (2005) and Marks et al. (2015).

sequences with the Eemian and Early Vistulian pollen spectra has also been documented in Central Poland (Klatkowa, 1997), mostly located in uplands in the upper sections of denudation valleys but only a few are preserved in modern water divides, still existing as separate catchments. Eemian and Early Vistulian biogenic sediments fill the meltout depressions exited after blocks of dead ice formed in the Wartanian Stage of the Odranian Glaciation. The article presents the results of lithological and palaeobotanical research conducted over the last decade in the closed-drainage depression on the watershed between the Mroga and Mrożyca Rivers. The study first focused on the northern part of the depression, in the vicinity of a small peatbog – Żabieniec (Lamentowicz et al., 2009; Twardy et al., 2010), and then it was continued in the southern part of the depression, and in the neighbouring denudation valley (Majecka, 2012a, b, 2014). The objective of this article is to collect and compile the obtained results, and consequently to perform a reconstruction of the development and filling of the studied depression based on the properties of the documented sediments and their thickness levels. Due to the emphasised role of the Vistulian periglacial morphogenesis in the development of the relief of Central Poland, particularly supported by the results of the research conducted in valleys, it was also attempted to assess its importance for the development of the relief of watersheds.

2. Study site

According to geomorphological subdivision of Poland the study area is located in Central Poland, on the Łódź Plateau (Gilewska, 1986), approximately 25 km north-east of Łódź, on the watershed between the Mroga River and its left-bank tributary – the Mrożyca River. It occupies an area of approximately 4.5 km^2, and covers an oval closed-drainage depression with the diameter of 1.8 km and the upper section of a denudation valley with the length of approximately 1.2 km. The area is located in the zone of the Wartanian relief, not covered by the Vistulian Glaciation (Last Glacial Maximum LGM). Biogenic sediments are deposited on the glacial sediments of the Saalian Glaciation, and the uppermost series are composed of organic and mineral sediments from the Vistulian (Weichselian) (Fig. 2A, B). At present the area is used for agriculture.

The geological mapping to SMGP 1:50,000 evidenced that the analysed depression is of meltout genesis, and developed as a result of the melting of lumps of dead ice in the phase of retreat of the Wartanian ice sheet (Nowacki, 1990, 1993). It occupies an area of approximately 136.0 ha (Twardy et al., 2010). It is surrounded by glacial landforms: the northern boundary is composed of a series of moraine hills, the western and eastern boundaries are composed of

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