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Landscape history since the Saalian Drenthe stadial in the Widawa Catchment Area in Silesia, Poland: A case study on long-term landscape changes

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ABSTRACT

With the pre-Roman Iron Age, approximately in the 2nd century BCE, a cluster of iron smelting sites began to develop in the catchment area of the Widawa River, located in the Old Drift landscape of northeastern Silesia, Poland. Before this area became an important local center for early iron smelting during the late pre-Roman Iron Age to the Roman period, its landscape had undergone distinct changes since it was covered for the last time by ice sheets during the Saalian Drenthe stadial. Besides climate driven environmental and landscape changes during the late Pleistocene and Holocene the area is influenced by a settlement history since the Mesolithic.

In order to understand the holistic development of this pre-Roman Iron Age iron smelting cluster this paper investigates the late Pleistocene landscape history of the southeastern part of the Widawa catchment with a focus on study sites in the context of early human impacts. Therefore a multi-proxy approach was applied, integrating geomorphological mappings and sedimentological analyses (lithology, particle grain size, bulk parameters, total inorganic and organic carbon) of selected drilling transects, dated by AMS radiocarbon with archaeological records, geological and topographical data.

The study area developed its present shape in six main phases: Subsequently to the last ice coverage (A), which extensively accumulated Saalian glacial till, the Widawa valley initially developed its present directionality (B). The subsequent valley formation is characterized by a succession of accumulation phases of glaciofluvial deposits of the Drenthe (C) and Warthe stadial (D) and fluvial deposits of the Weichselian glacial period (E) and the Holocene (F), which each were followed by a subsequent incision of the Widawa valley. First human impacts on the sediment budget are represented by alluvial fan deposits, which accumulated at the end of the 4th millennium BP. This alluvial fan, situated in the context of three prehistoric slag sites, shows a complex sedimentological succession of charcoal dated fan sediments that indicate a human impact on the landscape development during the pre-Roman Iron Age and the Roman period, pointing to a temporal and spatial context of early iron smelting.

1. Introduction

From the pre-Roman Iron Age (PRIA) northeastern Silesia, Poland, was inhabited by the Przeworsk culture (Godłowski, 1985). Their settlement and smelting sites were frequently situated at the floodplain margins of the Oder River and its tributaries (Orzechowski, 2002). According to the database of the Archaeological Record Poland (AZP, since 1978), a very particular cluster of early iron smelting sites of this culture, representing the investigated study area, is located in the vicinity of the modern town of Namysłów, along the floodplain of the Widawa River. The material culture of these sites comprises remarkable findings: artefacts like bog iron ore fragments, iron slags and furnace remains point to an early smelting and processing of iron (Thelemann et al., 2016). As Joosten et al. (1998) documented for the Netherlands, early iron production from the 2nd century CE resulted in an increasing demand for charcoal and – depending on the magnitude of the smelting activities – this led to largely deforested areas. Depending on the intensity of deforestation, mining induced erosional and depositional events, which might have influenced the landscape development (James et al., 2013). On the regional scale of

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Silesia those increased human impacts without iron smelting context are shown for the Bronze Age and the Iron Age (Zygmunt, 2009; Pawłowski et al., 2014).

Using a geoarchaeological approach, selected sediment archives located in the vicinity of pre-Roman Iron Age sites were investigated in order to analyze whether the introduction of iron smelting was associated with additional pressure on the landscape. To understand the holistic long-term landscape development dynamics of the study area this geoarchaeological approach also focuses on investigations of landscape development as a whole since the last direct ice coverage during the Saalian Drenthe stadial to the late-Holocene (Table 1). Although this region has been geologically, palynologically and historically investigated (Bartczak, 1997; Bykowski, 1997; Cincio, 1997; Kuszell et al., 2007), there has been no such comprehensive study of the landscape history. The paper thus deals with the following research questions: (i) When and how did the Widawa valley develop and establish its present shape and (ii) are there early human impacts detectable in the sediment archives of the study area and can these be set in the context of early iron smelting?

with hillslopes mostly below 1°, particularly rarely exceeding 5° inclination. Steeper natural slopes only occur at former undercut banks at the margins of the Widawa floodplain, but never exceed 20°. The majority of slopes are exposed towards south and north (CODGiK, 2013). On topographic maps from the late 19th century, the upper reaches of the Widawa are represented by an anastomosing river system, and the lower reaches are characterized by alternating meandering and anastomosing sections. Some parts of the Widawa show straight courses and have been subject to hydraulic engineering measures (TK25, 1886–1938). Today the river course is almost entirely regulated.

In the European context the climate of the study area is characterized by a rather cold temperate, all-year humid continental climate with warm summers (Przybylak et al., 2010; Köppen, 1931 after; Kuttler, 2009; Climate-data.org, 1982–2012). Monthly temperatures average between −2 and 18 °C and annual precipitation totals between 500 and 600 mm (Pelzer, 1991; Rössner, 1998; Climate-data.org, 1982–2012).

Geologically, the Widawa catchment area belongs to the Pleistocene Old Drift landscape (Liedtke, 1981) with Quaternary de-

Table 1
Pleistocene and Holocene North West European and Polish chronology.

Series	Stages and periods		Marine isotope stages [MIS]	approx. age [in ka BP]
	North West European nomenclature	Polish nomenclature		
Holocene [Blytt-Sernander Sequence][e]	Subatlantic[d]	Subatlantyk[d]	1[c]	2.5–0.0[d]
	Subboreal[d]	Subboreał[d]	1[c]	5.0–2.5[d]
	Atlantic[d]	Atlantyk[d]	1[c]	8.0–5.0[d]
	Boreal[d]	Boreał[d]	1[c]	9.0–8.0[d]
	Preboreal[d]	Preboreał[d]	1[c]	11.7–9.0[d]
Pleistocene	Weichselian glaciation[a]	Zlodowacenie Wisły [Vistulian glaciation/northern Polish glaciation][b]	5d-1[c]	110–11.7[c]
	Eemian interglacial[a]	Interglacjał eemski [Eemian interglacial][b]	5e[a]	130–110[c]
	Warthe stadial, Saalian complex[a]	Zlodowacenie Warty [Warty stadial, middle Polish glaciation][b]	6[a]	220–170[a]
	Seyda interval[a]	Kamienna-interstadial[a]	6[a]	220[a]
	Drenthe stadial, Saalian complex[a]	Zlodowacenie Odry [Oder stadial, middle Polish glaciation][b]	6[a]	290–220[a]
	Holsteinian interglacial[a]	Interglacjał mazowiecki [Mazovian interglacial][b]	11[a]	360[a]
	Elsterian glaciation[a]	Zlodowacenie Sanu [Sanian glaciation/southern Polish glaciation][b]	12[a]	510–470[a]

[a] Cohen and Gibbard (2011); Gozhik et al. (2012); Börner (2007).
[b] Bartczak (1997); Cincio (1997); Börner (2007); Lindner and Marks (2008).
[c] Marks et al. (in press); Engels et al. (2010).
[d] Borówka et al. (2005); Walanus and Nalepka (2005).
[e] Starkel (1995).

2. Regional setting

The study area is situated in the Oleśnica Plain in the catchment area of the Widawa River, a tributary of the Oder River in north-eastern Silesia, Poland (Fig. 1A). To the north (Fig. 1B) the catchment area is delimited by the Trzebnica Ridge (Wał Trzebnicki; Winnicki, 1997; Rössner, 1998; Kuszell et al., 2007), a terminal moraine of the Warthe stadial deposited during the Saalian complex (Table 1; Rössner, 1998; Liedtke, 1981; Litt et al., 2007). The Oder glacial valley of the Warthe stadial forms the southern boundary of the catchment area (Fig. 1B).

Our focus is on a cluster of prehistoric slag sites recorded by the archaeological records (AZP, since 1978). These sites are situated along the Widawa floodplain and concentrate around the Michalice Reservoir (Fig. 2), which was dammed in 2001 (Wiatkowski et al., 2010). The topography of the study area varies between 137 and 187 m above sea level (a.s.l.) and is characterized by flat landforms

posits reaching a thickness of up to 90 m (Bartczak, 1997). The oldest geological surface deposits are represented by glacial till of the Elsterian glacial period (Table 1), exposed especially along the Widawa floodplain in the lower parts in the south but also in the north and east of the study area (Fig. 2). These Elsterian glacial tills reach a thickness of up to 35 m in the northwestern plateaus (Bartczak, 1997). Most of the plateaus are covered by glacial till, sand and gravel of eskers deposited during the Drenthe stadial of the Saalian complex and reaching up to 13 m thickness (Fig. 2). The upper slopes are formed in glaciofluvial sand and gravel of the Drenthe stadial, while the lower slopes are often covered by glaciofluvial deposits of the Warthe stadial, followed by fluvial and lateral slope-wash deposits (translated according to Kittel et al. (2014) from the Polish term '*deluvial*') accumulated during the Weichselian glacial period (Table 1). The lowlands of the Widawa floodplain and its tributaries are covered by Holocene fluvial deposits (Fig. 2).

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