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Stone tool analysis and context of a new late Middle Paleolithic site in western central Europe – Pouch-Terrassenpfeiler, Ldkr. Anhalt-Bitterfeld, Germany

Eine neue spätmittelpaläolithische Fundstelle im westlichen Mitteleuropa – Pouch-Terrassenpfeiler, Ldkr. Anhalt-Bitterfeld, Deutschland. Steinartefaktanalyse und mitteldeutscher Kontext

Marcel Weiss*

Max-Planck-Institut für Evolutionäre Anthropologie, Deutscher Platz 6, D-04103 Leipzig

Abstract - In central Germany, the late Middle Paleolithic is characterized by the abundant use of prepared core techniques and a high variability in retouched pieces. Typical stone tools, like backed bifacial knives, leaf-shaped bifacial tools, bifacial scrapers, handaxes and various scraper forms are part of the assemblages of well-known sites like Königsaue and Neumark-Nord 2/0 (Saxony-Anhalt), Gamsenberg/Oppurg (Thuringia), Salzgitter-Lebenstedt and Lichtenberg (Lower Saxony). These late Middle Paleolithic sites are grouped together whether as Prądnik Culture (PC), Keilmessergruppen (KMG) or as Mousterian with Micoquian Option (MMO).

In this study, a new site fitting to this context is presented from central German. The site Pouch/„Terrassenpfeiler", situated in the former brown coal quarry Tagebau Goitzsche - Baufeld Rösa-Sausedlitz, east of Bitterfeld (Saxony-Anhalt) yielded 371 flint artifacts, including 58 complete tools. They consist of scrapers, flakes with use-wear, backed knives, backed bifacial knives and leaf-shaped scrapers. Blank production is dominated by uni- and bidirectional prepared core methods. The OSL ages for the find layer of 46.2 ± 2.5 ka and 47.1 ± 2.7 ka as well as radiocarbon dates on sediment between 40 000 and 44 000 calBP (2-σ) place the site in early Marine Isotope Stage (MIS) 3. In addition to this assemblage, 1 017 complete survey finds, collected between 1991 and 2002 in the former quarry by volunteer archaeologists, were analyzed. With respect to the retouched tools, these finds belong also to these groups. The artifacts come from the base of the Weichselian Lower Terrace of the Mulde river, the same geological context as the excavated site Pouch/„Terrassenpfeiler".

The analysis of the artifacts revealed strong affinities to the assemblages of Königsaue, Salzgitter-Lebenstedt and Lichtenberg: the dominance of prepared core methods, bifacial tools like backed bifacial knives, handaxes, bifacial scrapers and leaf-shaped scrapers as well as the presence of backed knives. The variable application of creating a back on simple flake tools, unifaces and bifaces is also a characteristic of these sites. Related to that, the concept of a back opposite a sharp cutting edge in relation to a retouched tip (Keilmesser-concept) was carried out flexibly on simple flake tools, unifacial tools and bifacial tools and explains part of the observed variability.

Zusammenfassung - *In Mitteldeutschland ist das späte Mittelpaläolithikum charakterisiert durch die Anwendung von präparierten Kerntechniken in der Grundformenproduktion, sowie einer großen Vielfalt in der Ausprägung der Steingeräte. Typische Geräteformen der bekannten Fundstellen Königsaue und Neumark-Nord 2/0 (Sachsen-Anhalt), Gamsenberg/Oppurg (Thüringen), sowie Salzgitter-Lebenstedt und Lichtenberg (Niedersachsen) sind Keilmesser, Faustkeile, blattförmige bifaziale Geräte, bifaziale Schaber und verschiedene Schaberformen. Diese spätmittelpaläolithischen Artefaktinventare werden mit den Begriffen Prądnik Kultur (PC), Keilmessergruppen (KMG) oder Moustérien mit Micoque-Option (MMO) zusammengefasst.*

In dem vorliegenden Artikel wird in diesem Zusammenhang eine neue mitteldeutsche Fundstelle vorgestellt. Die Fundstelle Pouch/„Terrassenpfeiler" befand sich im ehemaligen Braunkohlentagbau Goitzsche - Baufeld Rösa-Sausedlitz. Unter den 371 Feuersteinartefakten befinden sich 58 komplette Geräte: Schaber, Messer mit gestumpftem Rücken, Abschläge mit makroskopischen Gebrauchsspuren, Keilmesser und blattförmige Schaber. Die Grundformenproduktion ist geprägt durch uni- und bidirektionale, präparierte Kernkonzepte. Die OSL Alter der Fundschicht von 46.2 ± 2.5 ka und 47.1 ± 2.7 ka, wie auch zusätzliche Radiokohlenstoffalter an Sediment zwischen 40 000 und 44 000 calBP (2-σ), datieren die Funde in das frühe Marine Sauerstoff-Isotopenstadium (MIS) 3. Zusätzlich zu diesem Inventar wurden 1 017 komplette Artefakte, aus Begehungen des Tagebaus durch ehrenamtliche Bodendenkmalpfleger zwischen 1991 und 2002, analysiert. Bezüglich der retuschierten Stücke sind diese Funde ebenfalls den zuzuordnen. Beide Inventare stammen aus derselben geologischen Position von der Basis der weichselzeitlichen Niederterrasse der Mulde. Nach geologischen Gesichtspunkten ist die Entstehung der Terrassenbasis im frühen MIS 3 anzusetzen.

*marcel_weiss@eva.mpg.de

Die hier vorgestellten Steinartefakte zeigen starke Affinitäten zu den Inventaren von Königsaue, Salzgitter-Lebenstedt und Lichtenberg: präparierte Kerntechniken in der Grundformenproduktion, bifaziale Geräte, wie Keilmesser, Faustkeile, bifaziale Schaber und blattförmige Schaber, sowie das Vorhandensein von Messern mit gestumpften Rücken. Ein weiteres Charakteristikum ist die Schaffung verschiedener Varianten einer Rückenpartie an einfachen Abschlaggeräten, unifazialen und bifazialen Geräten. In diesem Zusammenhang ist das Konzept eines Rückens gegenüber einer retuschierten Arbeitskante in Verbindung mit einer retuschierten, distalen Spitzenpartie zu sehen, welches flexibel bei einfachen Abschlaggeräten, unifazialen und bifazialen Geräten angewandt wurde.

Keywords - Prądnik Culture, Keilmessergruppen, M.M.O., Micoquian, stone tools, refits
Prądnik Kultur, Keilmessergruppen, M.M.O., Micoquien, Steinartefakte, Zusammenpassungen

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Introduction

In central Germany, late Middle Paleolithic stone tool assemblages, dated between Marine Isotopic Stage (MIS)5a/c to early MIS 3, are characterized by the abundant use of prepared core techniques and a high variability in retouched pieces. Typical are bifacial backed knives, leaf-shaped bifacial tools, bifacial scrapers, handaxes and various scraper forms. The assemblages of the well-known sites (Fig. 1) Salzgitter-Lebenstedt (Pastoors 2001, 2009; Tode 1982), Lichtenberg (Veil et al. 1994), Königsaue (Mania 2002a; Mania & Toepfer 1973) and Neumark-Nord 2/0 (Laurat & Brühl 2006) are grouped together typo-technologically as Prądnik Culture (Burdukiewicz 2000; Krukowski 1939), Keilmessergruppen (Jöris 2001, 2004, 2006; Mania 1990; Ruebens 2012; Veil et al. 1994) or Mousterian with Micoquian option (Richter 1997, 2002, 2012).

The Prądnik Culture (PC) was defined by Krukowski (1939). The term refers to Middle Paleolithic artifact assemblages in Poland, containing handaxes and bifacial tools. The most important bifacial implement are the Prądniks: asymmetric or arch-shaped tools, today mostly called bifacial backed knives. Krukowskis (1939, Burdukiewicz 2000) Prądnik Cycle refers not only to bifacial tools. He views the Prądniks as dynamic: a continuum from simple and unifacial knife-like tools ("Prądnikshaks", Krukowski 1939) to bifacial tools and remnant pieces. Some of the bifacial tools were resharpened by a strike on the tip parallel to the edge, which is referred to as the Prądnik or para-burin technique (Jöris 2001).

The term Keilmessergruppen (KMG) was first introduced by Mania (1990) and was further refined by Veil et al. (1994), replacing the formerly used term Micoquian (Bosinski 1967, 1968; Günther 1964). It denominated last glacial assemblages with bifacial tools in central and eastern Europe, referring to the stone artifacts of La Micoque/France (Bosinski 1967). Veil et al. (1994) criticize the geological context of the assemblage of La Micoque layer N (6) and the under-representation of bifacial backed knives. They state that the inventory cannot be regarded as typical for assemblages found in central and eastern Europe and thus the term is unsuitable for these regions. At present, the new term KMG is defined for last glacial bifacial Middle Paleolithic assemblages of central and eastern Europe containing bifacial backed knives and leaf-shaped bifacial tools (leaf-shaped scrapers, leaf-shaped handaxes).

Jöris (2004, 2006) subdivided the KMG into three chronological-typological units: KMG-A, KMG-B and KMG-C. As the chronometric dates for some of the sites are regarded as problematic, Jöris analyzed additionally the stratigraphic sequences and used typological aspects of the stone artifacts to define these groups. The oldest unit, KMG-A, is placed in MIS 5a to early MIS 4 and is assigned to some of the assemblages in focus here: Königsaue, Salzgitter-Lebenstedt and Lichtenberg. KMG-A is characterized by frequent Levallois concepts, handaxes, leaf-shaped scrapers and bifacial backed knives with convex cutting edges. Typical for the early MIS 4, KMG-B inventories include bifacial backed knives with recti-linear cutting edges and the frequent application of the Prądnik or para-burin technique. Levallois concepts are supposed to be rare (Jöris 2006). Two of the key sites are Buhlen/Hessen (Jöris 2001), Germany, and the Ciemna Cave, Poland (see also Valde-Nowak et al. 2014). Finally, KMG-C assemblages show bifacial backed knives with rectilinear cutting edges and frequent Levallois concepts. Handaxes are frequently absent. The KMG-C assemblages are placed in early MIS 3 with typical assemblages like the G-layer complex of the Sesselfelsgrotte, Bavaria (Richter 1997), and Kulna Cave (CZ) layer 7a (Valoch et al. 1988).

Richter (1997, 2000, 2002, 2012) suggested the term "Mousterian with Micoquian Option" (MMO) for central and eastern European late Middle Paleolithic assemblages. Based on his research in the Sesselfels-grotte, he developed the concept of an initial Mousterian assemblage with the potential of the presence of large amounts of bifacial tools in direct dependence of site occupation length. He defined two groups: an earlier MMO-A with Quina type blank production and a later MMO-B with Levallois blank production. The central German sites Königsaue,

Fig. 1. Map of the central German LMP sites mentioned in the text (lower left inset), the profile at the southern rim, 200 m west of the "Hilfsdrehpunkt"/ Sausedlitz, in 1993 (upper right inset) and the find spots in the former brown coal quarry "Tagebau Goitzsche" east of Bitterfeld. (1) area "Hilfsdrehpunkt"/ Sausedlitz, (2) southern slope, areal west of the area "Hilfsdrehpunkt"/ Sausedlitz, (3) southern slope, areal east of the area "Hilfsdrehpunkt" / Sausedlitz-Weinberg, (4) eastern part of the southern slope/ Sausedlitz, (5) single finds, eastern slope/ Sausedlitz, Löbnitz, (6) single finds, northern slope/ Löbnitz, Pouch, (7) area of the northwestern slope/ Pouch, (8) area of the western slope/ Pouch, (9) area "Terrassenpfeiler" - a promontory extending into the quarry/ Pouch, (10) Lower Terrace gravel dump within the quarry, (11) different find spots in the areal "Bärenhof" or "Bärenholz" (western slope, eastern slope and "Montageplatz")/ Pouch, (12) the excavated site of Pouch-"Terrassenpfeiler". Redrawn from sketches by A. Rudolph, Leipzig. Graphic: M. Weiß/MPI-EVA.

Abb. 1. *Karte der im Text erwähnten spätmittelpaläolithischen Fundstellen Mitteldeutschlands (kleine Karte links unten), die Profilsituation am südlichen Rand des Tagebaus, 200 m westlich des „Hilfsdrehpunktes", 1993 (rechts oben), sowie die Fundstellen im ehemaligen Braunkohletagebau Goitzsche, östlich von Bitterfeld und. (1) Areal am sogenannten „Hilfsdrehpunkt"/ Sausedlitz, (2) Areal westlich des „Hilfsdrehpunktes"/ Sausedlitz, (3) Areal östlich des „Hilfsdrehpunkts"/ Sausedlitz-Weinberg, (4) östlicher Abschnitt der südlichen Böschung/ Sausedlitz, (5) einzelne Funde entlang der östlichen Böschung/ Sausedlitz, Löbnitz, (6) einzelne Funde an der nördlichen Böschung/ Löbnitz, Pouch, (7) Areal an der nordwestlichen Böschung/ Pouch, (8) Areal an der westlichen Böschung/ Pouch, (9) Areal „Terrassenpfeiler", eine Landzunge, die sich in das Baufeld erstreckt/ Pouch, (10) aufgeschüttete Niederterrassenschotter auf der Innenfläche des Tagebaues, (11) verschiedene Fundpunkte im Areal „Bärenhof" oder „Bärenholz" (westliche Böschung, östliche Böschung und „Montageplatz")/ Pouch, (12) die ausgegrabene Fundstelle Pouch-"Terrassenpfeiler". Umgezeichnet nach Skizzen von A. Rudolph, Leipzig. Grafik: M. Weiß/MPI-EVA.*

Lichtenberg and Salzgitter-Lebenstedt thus would belong to the unit MMO-B. In contrast to Jöris's model, Richter proposes a short-chronology and states that the earliest probable occurrence of the MMO was shortly before the first glacial maximum in MIS 4. More likely, it could have started in early MIS 3 and ended around 45 000 BP (Richter 2002).

The Prądnik Culture/Keilmessergruppen/ Mousterian with Micoquian Option (PC/KMG/MMO) are seen as a distinct contemporary eastern and central European entity to the Mousterian of Acheulean Tradition (MTA) of southwestern France and Britain, as well as the Mousterian with Bifacial Tools (MBT) found in Belgium and the Netherlands (Ruebens 2012, 2013). Whereas the PC/KMG/MMO is characterized by bifacial backed knives, leaf shaped bifacial tools, as well as the application of the para-burin technique, MTA assemblages are dominated by classic handaxes. The MBT inventories display a mix of assemblage attributes of the MTA of western and the KMG of central Europe. Ruebens (2012, 2013) interprets this three-fold typo-technological pattern as the result of larger-scale regionalized behavioral trends among late Neanderthal groups.

To understand the macro-regional pattern in the late Middle Paleolithic of Europe it is important to study regional assemblages in more detail. This study focusses on central Germany and a new site with two separate assemblages is presented here: the excavated and collected artifacts of Pouch-Terrassenpfeiler (Pouch/TPf), discovered in the former open-cast brown coal quarry "Tagebau-Goitzsche – Baufeld Rösa-Sausedlitz", east of Bitterfeld, Saxony-Anhalt and a survey collection (Goitzsche Collection – GC) found in the entire former quarry between 1991 and 2002. A detailed analysis of the cores, flakes and especially tools reveals certain tool types and technological concepts that are characteristic for the central German late Middle Paleolithic. Optical stimulated luminescence as well as radiocarbon dating place the assemblage of Pouch/TPf in early MIS 3.

The material will be discussed in relation to the central German late Middle Paleolithic sites of Salzgitter-Lebenstedt, Lichtenberg, Königsaue, Neumark-Nord 2/0 and Gamsenberg/Oppurg. Despite similarities and differences at the assemblage level, like raw material, blank production and tool types, two morphological features of stone tool variability among these sites are presented here: the presence of backing in various forms and the flexible application of the Keilmesser-concept on several stone tool types.

Material, Geology and Chronology

Discovery and Geology of the Goitzsche Collection (GC)

From 1949 to 1993 coal mining took place in the southeast of Bitterfeld, Saxony-Anhalt, at the open-cast mine "Tagebau Goitzsche" and "Tagebau Goitzsche - Baufeld Rösa-Sausedlitz" (Rudolph & Bernhardt 1997). The lignite was covered by last glacial fluvial sediments (Lower Terrace) of the river Mulde (Wimmer 1997), where the first artifact (Appendix, Plate 1: 1), a bifacial point, was found in 1984 by P. and M. Müller during a geological survey. From 1991 to 2002, artifacts were systematically collected by the volunteer archaeologists and geologists A. Rudolph, W. Bernhardt, D. Runck and R. Wimmer and collaborators, who documented the geological context of the finds as much as was possible. The major part of the artifacts came from the base of the gravel-sand-silt accumulations of the Lower Terrace. They were collected in different locations within the former quarry area (Fig. 1), mostly in the quarry field "Rösa-Sausedlitz". There, the main part of the artifacts was found in the area of the western promontory extending into the quarry (district Pouch) and the southern slope (district Sausedlitz). The Lower Terrace in this area is represented by an 8 to 10 m thick and 4 to 5 km wide accumulation of gravels and sands, with, often cryoturbated, silt/gyttja/peat deposits at four different levels of the sequence (Wimmer 1997). In central and northwestern Europe, the last glacial river terraces formed most probably in early MIS 3, as riverine sediment accumulation followed a major erosion in MIS 4 (Mol 1995, 1997, Mol et al. 2000, van Huissteden et al. 2001). Two of the silt/gyttja/peat deposits in the lower third of the terrace of the Mulde river, called "Löbnitzer Horizonte" (Hiller et al. 1991), were dated by radiocarbon on pinewood and peat at the beginning of the 1990s. Although these age measurements should be taken with caution as they are old (non-AMS) ^{14}C dates, they support a MIS 3 formation of the terrace (Mol et al. 2000, van Huissteden et al. 2001). Their radiocarbon ages (Fig. 2.) range from ~26 500 calBP to 38 000 cal BP (1-σ) for the upper horizon and ~31 000 calBP to ~40 000 cal BP (1-σ) for the lower horizon (Hiller et al. 1991).

In total, 1 225 stone artifacts (GC) were collected from about four different levels at the base of the Lower Terrace (Fig. 1.). Additionally, animal bones were recovered. Identified species are *Mammuthus primigenius*, *Elephas antiquus* or *Mammuthus primigenius*, *Coelodonta antiquitatis* or *Stephanorhinus kirchbergensis*, *Equus* sp., *Megaloceros giganteus* and *Bos primigenius* or *Bison priscus* (Rudolph & Bernhardt 1997).

Discovery and Geology of the site Pouch/TPf

In the western part of the quarry field "Tagebau-Goitzsche – Baufeld Rösa-Sausedlitz" a promontory extended into the mine but was omitted from mining. Under a modern infill on top of it, the base of the Lower Terrace was preserved. Since the 1990s, many artifacts were collected in this area. During refilling of the pit with water to create a lake, waves eroded the bank and artifacts from Pleistocene deposits were exposed (Seiler & Runck 2003). Subsequently the State Museum of Prehistory Saxony-Anhalt/Halle (Saale) conducted a rescue excavation in July and August 2002. The site was constantly affected by erosion through wave action from the artificial lake which fills the coal mine pit. Since this was a rescue excavation, fieldwork alternated with observation and recovery of artifacts that had fallen from the profile. Consequently, the assemblage is mixed in the reliability of its contextual information. However, since there are only two horizontal artifact concentrations (Fig. 3) any fallen artifacts originate from one of them. Unfortunately, a flood by the Mulde river raised the lake level above site elevation making the site no longer accessible. In total, 371 artifacts made of erratic flint were recovered by excavation and additional recovery (Pouch/TPf). Only one bone fragment was found and radiocarbon dating was attempted on this bone. Furthermore, sediment samples from different layers were collected for radiocarbon and optical-stimulated luminescence dating (OSL) prior to the destruction of the site.

The find layers of the site Pouch/TPf were located about 1 m above the base of the Lower Terrace (Fig. 3). The late Pleistocene sediments in this area are partially situated directly on Miocene sands. A sequence of coarse and fine gravels alternating with

Lab No.	layer	Material	$\delta^{13}C$ (AMS)	carbon yield (mg)	Uncalibrated	Calibrated (BP), 1-Sigma		Calibrated (BP), 2-Sigma		Refe-rence
						from	to	from	to	
Quarry Goitzsche										
LZ-GOI 53	upper „Löbnitzer Horizont“	pinewood			26 230 ± 1 400	31 700	28 760	33 790	27 860	Hiller et al. 1991
LZ-GOI 20	upper „Löbnitzer Horizont“	sediment			26 110 ± 4 000	37 900	26 570	48 030	25 280	
LZ-GOI 26	lower „Löbnitzer Horizont“	sediment			29 550 ± 1 560	35 180	31 720	38 170	30 990	
LZ-GOI 28	lower „Löbnitzer Horizont“	sediment			29 380 ± 2 400	36 730	31 040	42 090	29 430	
LZ-GOI 29	lower „Löbnitzer Horizont“	sediment			32 320 ± 2 260	39 500	34 330	43 570	32 510	
Pouch/TPF										
KN-5541	Layer 3	sediment			41 300±1 600 BP	46 340	43 330	48 740	42 610	
KN-5542	Layer 4 (above layer 7)	sediment			>40 000					
KN-5543	Layer 4 (above layer 5)	sediment			32 700±530 BP	37 580	36 110	38 360	35 660	
KN-5544	Layer 5 (find layer)	sediment			37 400±1 300 BP	42 880	40 680	44 400	39 550	
KN-5545	Layer 5 (find layer)	sediment			28 530±940 BP	33 480	31 570	34 510	31 020	
KIA-21132	Layer 12 (find layer)	bone (Inv.-Nr.: 6305:12:142)	-43 ‰ (1st run) and -36.3 ‰ (2nd run)	1st run collagen: 0.1; 2nd run colla-gen: 0.06	14 000 BP and >20 700 BP					
KN-5546	0.3 m east of Layer 5	pinewood			>43 000					
Salzgitter-Lebenstedt										
KIA-34481	o.B. („upper turbated layer“	bone		collagen: 3.2	33 970 + 360/-340	38 910	38 010	39 390	37 310	Pastoors 2009
KIA-34482	o.B. („upper turbated layer“	bone		collagen: 3.9	37 950 + 540/-500	42 580	41 850	42 980	41 470	
KIA-34483	o.B. („upper turbated layer“	bone		collagen: 3.7	45 280 + 1 270/-1 090	49 810	47 700	out of calib-ration range	46 560	
KIA-34484	o.B. („upper turbated layer“	bone		collagen: 3.5	43 110 + 1010/- 900	47 490	45 410	48 960	44 750	
Königsaue										
OxA-7124	Königsaue A	birch tar			43 800 ± 2 100	49 000	45 640	out of calib-ration range	44 620	Hedges et al. 1998
OxA-7125	Königsaue B	birch tar			48 400 ± 3 700	date out of the range	44 680	out of calib-ration range	43 220	

Fig. 2. Radiocarbon dates for the peat layers of the Lower Terrace sequence ("Löbnitzer Horizonte"), Salzgitter-Lebenstedt and Königsaue. The radiocarbon dates are calibrated with OxCal 4.2, calibration curve IntCal 13.

Abb. 2. *Radiokohlenstoffdatierung der Löbnitzer Horizonte innerhalb der Niederterrasse der Mulde, Salzgitter-Lebenstedt und Königsaue. Die Radiokohlenstoffdaten wurden mit OxCal 4.2, Kalibrationskurve IntCal 13, kalibriert.*

cross-bedded sand and silt followed above the base. River channels incised these and were later filled with cross-bedded sand/gravel and silt. These kinds of sediments are typical for early MIS 3 riverine deposits in the European lowlands (Mol et al. 2000; van Huissteden et al. 2001). The top of the sequence was cut by a modern infill.

Two artifact concentrations were observed and excavated in one square meter each (Fig. 3). The major part of artifacts with reliable context, 96 objects, were found in layer 5. This layer was a silty clay with an intrusion of middle sand (layer 6), probably due to cryoturbation, on top of the eastern channel infill (Fig. 3). The recorded profile locations of the finds (n=255) not recovered by formal excavation (Runck & Seiler 2003) indicate that most of these originate from layer 5 as well. Because of their documented vertical position, these artifacts are included in the analysis. Based on their unrolled, fresh edges, the artifacts appear to be in a primary context, although the whole sediment package was probably affected by small scale cryoturbation. The second concentration of artifacts (n=20) with reliable context was found in layer 12, located in the upper part of the western channel infill, about 5 m west of layer 5 (Fig. 3). This find layer was a sandy intrusion in a clay/silt aggradation (Layer 3) and affected by cryogenic processes as well.

The two artifact concentrations are stratigraphically not connected (Fig. 3). However, they are treated as a single analytical unit as the sediment of layer 12 is reported by the excavators to be similar to layer 5 and that it was probably effected by the same small scale cryoturbatic process. Although layer 5 is disturbed by a sand intrusion, the artifacts are assumed to be the result of one occupational event, because the sediment is reported by the excavators as being identical in both parts of the layer and the OSL ages for the two parts of the deposit are highly consistent (see below). Furthermore, 7 refit sequences are consistent with the assemblage being manufactured in a very short period of time.

OSL-dating of the site Pouch/TPf

Luminescence dating determines the time elapsed since sediments were last exposed to sunlight (Aitken 1985, 1998) and thus by interference the deposition of artefacts is dated. OSL dating of the sediments was undertaken in 2003 by M. Krbetschek† (University of Freiberg). Until now, the results have only been presented in a poster presentation (Clasen 2004) and therefore detailed information on parameters which would be essential for interpretation are lacking.

The following descriptions, as well as the tables, were taken from the detailed OSL report (Krbetschek 2003) on file at the State Office for Heritage Management and Archaeology - State Museum of Prehistory Saxony-Anhalt/Halle (Saale). OSL dating at the site was undertaken on sand-sized quartz. The OSL samples were collected from the upper western (sample R514-1: Fig. 3; Fig. 4) and the lower eastern (sample R515-2: Fig. 3; Fig. 4) part of the find layer 5. Two additional samples were obtained from layer 15, a silty channel infill (samples R316-r and R316-l: Fig. 3; Fig. 4) to test the integrity of the geological sequence.

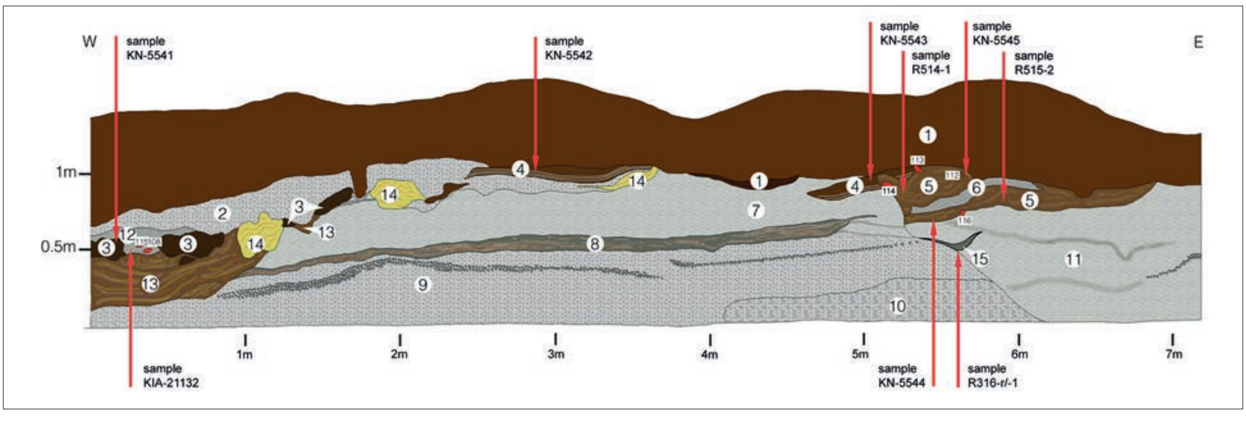

Fig. 3. East-West profile of the site Pouch ("Terrassenpfeiler"). Numbers in rectangles and related red spots represent main artifacts occurrences. (1) modern infill, (2) sandy gravel, (3) clay, silty, homogenous, ~46 000 to 43 000 calBP (1-σ), (4) clayey silt, fine sand, fine layered (+lignite), >40 000 BP and ~37 500 to 36 000 calBP (1-σ), (5) silty clay, artifacts, dated to 46.2 ± 2.5 ka and 47.1 ± 2.7 ka (OSL), ~43 000 to 41 000 calBP (1-σ) and ~37 500 to 36 000 calBP (1-σ), (6) middle sand, (7) sand with gravel, cross-bedded, (8) silt, (9) sand, gravel, (10) coarse gravel, gravel, sand, (11) fine to middle sand with gravel lenses, cross-bedded, (12) sandy intrusion in 3, artifacts, (13) silty clay, sand, (14) silty clay, (15) silt, OSL dated to 56.5 ± 4.4 ka and 56.2 ± 5.1 ka. Redrawn from the profile drawing of H. Heilmann, LDA Sachsen-Anhalt. Graphic: Marcel Weiß/MPI-EVA.

Abb. 3. *Ost-West Profil der Fundstelle Pouch („Terrassenpfeiler"). Die Nummern in den Rechtecken bezeichnen Artefakte. (1) moderne Aufschüttung, (2) sandiger Kies, (3) Ton, schluffig, ~46 000 bis 43 000. calBP (1-σ), (4) toniger Schluff, Feinsand, fein geschichtet (+Braunkohle), >40 000 BP und ~37 500 bis 36 000 calBP (1-σ), (5) schluffiger Ton, Artefakte, 46.2 ± 2.5 ka and 47.1 ± 2.7 ka (OSL), ~43 000 bis 41 000 calBP (1-σ) und ~37 500 bis 36 000 calBP (1-σ), (6) Mittelsand, (7) Sand, kiesig, schräg geschichtet, (8) Schluff, (9) Sande und Kiese, (10) Grobkies, Feinkies, Sand, (11) Fein- Mittelsand, Kieseinlagerungen, schräg geschichtet, (12) Sandinjektion in 3, Artefakte, (13) schluffiger Ton, Sand, (14) schluffiger Ton, (15) Schluff OSL-datiert: 56.5 ± 4.4 ka and 56.2 ± 5.1 ka, Umgezeichnet nach der Profilzeichnung von H. Heilmann, LDA Sachsen-Anhalt. Grafik: Marcel Weiß/MPI-EVA.*

sample No.	moisture content in %	radionuclide content			cosmic ray component D_K / in µGy/a	dose rate D/ in µGy/a	equivalent dose D_E/ in Gy	OSL-age t/ in ka
		^{238}U / in ppm	^{232}Th / in ppm	^{40}K / in %				
R316-r	14.0	2.53 ± 0.06	6.13 ± 0.27	1.65 ± 0.03	170	2453 ± 108	143.69 ± 9.45	56.5 ± 4.4
R316-l	12.8	2.70 ± 0.06	6.79 ± 0.31	1.75 ± 0.03	170	2591 ± 106	145.69 ± 11.67	56.2 ± 5.1
R514-1	15.1	3.59 ± 0.08	11.72 ± 0.42	1.85 ± 0.03	170	3062 ± 71	141.39 ± 6.96	46.2 ± 2.5
R515-2	11.9	3.04 ± 0.07	9.60 ± 0.35	1.83 ± 0.03	170	2929 ± 64	138.02 ± 7.37	47.1 ± 2.7

Fig. 4. Table of the OSL parameters for dating and results: moisture content in %, radionuclide content, cosmic ray component D_K / in µGy/a, total dose rate D/ in µGy/a, equivalent dose D_E/ in Gy, OSL-age t/ in ka (1-σ).

Abb. 4. *Tabelle der OSL Parameter und Alter: Wassergehalt in %, Radionuklidgehalt, kosmische Dosisleistung D_K / in µGy/a, Gesamtdosisleistung D/ in µGy/a, Äquivalenzdosis DE/ in Gy, OSL-Alter t/ in ka (1-σ).*

The samples were collected in light-tight rectangular sediment containers driven horizontally into the cleaned profile. Sediment from either end of these containers was used for laboratory analysis of environmental radiation dose rates. The sediment from the unexposed center was processed under low intensity red light in the laboratory. The samples were treated to isolate pure sand-sized quartz (90-160 µm) according to published methods (Rhodes 1988). Equivalent dose (DE) measurements were performed with an automated Risø TL-DA-15 reader equipped with blue light-emitting diodes for stimulation of the sand grains, and a Hoya U340 filter for quartz luminescence signal detection (Botter-Jensen 1997). Irradiation was provided by a calibrated 90Sr/90Y β-source (Botter-Jensen et al. 2000). The DE was measured using the single-aliquot regenerative-dose (SAR) protocol of Murray and Wintle (2000). This protocol was applied to 10 aliquots from each of samples R316-r and R-316-l, and to 9 aliquots of R514-1 and R515-2, using preheat temperatures of 260°C and maximum applied laboratory dose of 224 Gy. The beta and gamma components of the dose rates were determined from measurements of radionuclide activities using low level gamma spectrometry. Attenuation of sediment dose rates was accounted for according to the in situ and saturation moisture contents measured in the laboratory on the bulk sample from the containers. The cosmic ray component of the dose rate was estimated based on published equations (Prescott & Hutton 1988; Prescott & Stephan 1982). The total dose rate was calculated after Aitken (1985; Fig. 4).

The ages calculated for the find layer 5 (Fig. 4) are 46.2 ± 2.5 ka (R514-1) and 47.1 ± 2.7 ka (R515-2) at 1-σ uncertainty. The silt channel infill (layer 15), which is stratigraphically situated below yielded 1-σ OSL ages of 56.5 ± 4.4 ka (R316-r) and 56.2 ± 5.1 ka (R316-l). Nominally, these age estimates are statistically indistinguishable.

Radiocarbon dating of the site Pouch/TPf

In addition to the OSL-dating, some sediment samples, one bone and one piece of pinewood were radiocarbon dated (Fig. 2). The sediment samples were watered and manually cleaned from fresh roots during the course of two weeks by repeated suspension, pretreated with HCL, bi-destilled watering, NaOH, neutralized, HCL, neutralized for a few days, followed by burning in O of a large amount of material. The resulting CO2 was cleaned and any contact to other chemicals was avoided. Insoluble fractions, containing possible contaminations, were filtered out with a 0.45 µm silver filter. The resulting carbon yield and δ13C-values (Fig. 2) do not allow a reliable result (dating report P.M. Grootes for sample KIA-21132) and these results are therefore rejected from the analysis of the site. According to the laboratory report the pretreatment of the compact bone sample (< 0.5 mm) follows the Longin (1971) method. The radiocarbon results were calibrated with OxCal 4.2, calibration curve IntCal 13.

KN-5541 dated carbon from the homogenous clay/silt layer 3, which contains a sandy lens with artifacts (layer 12). The radiocarbon age is ~46 000 to 43 000 calBP (1-σ) (Fig. 2). Associated with layer 4 is another homogenous clay/silt aggradation, which, according to the excavators, is preserved in two separated parts: one is situated directly above the sand with gravel accumulation layer 7 and the other one is overlying the find layer 5 (Fig. 3). The sediment sample KN-5542, taken from the part of the layer above layer 7, yielded an infinite ^{14}C-age of >40 000 BP (Fig. 2). Additionally, KN-5543 dated the clayey silt layer 4 directly above the find layer 5 to an age of ~37 500 to 36 000 calBP (1-σ) (Fig. 2). The carbon from the sediment of find layer 5 was radiocarbon dated to ~43'000 to 41 000 calBP (1-σ) (KN-5544) and ~33 500 to 32 000 (1-σ) (KN-5545) (Fig. 2). The additional piece of pinewood (KN-5546), found stratigraphically at the elevation of the find layer 5 but not in the same sediment, has an infinite age of >43 000 BP (Fig. 2).

The bone result (KIA-21132) is rejected on methodological grounds (Fig. 2), and it appears likely that the young ages for KN-5543 & KN-5545 were obtained on samples contaminated with younger humic acids and therefore should be regarded as minimum ages. The intrusion of younger humic acids into the Pleistocene sediments could also explain the significant younger ages of KN-5543 & KN-5545. The pinewood sample KN-5546, where contamination with humic acid might have had less influence compared to bulk sediment, probably gives a better age estimate than the age estimates on sediment. Its infinite age, therefore, suggests that the carbon from the site is out of the range of the method and/or laboratory procedures, which is in accordance with the OSL age results.

The radiocarbon dating results KN-5541, KN-5542, KN-5544, KN-5546 are fully compatible on the calibrated time scale (where appropriate) with the OSL ages at 2-σ (Fig. 2, Fig. 4), and it is only on this time scale that interpretation and comparison is possible (Richter et al. 2009).

Methodology of lithic analysis

The stone artifacts presented here are stored in the collections of the State Office for Heritage Management and Archaeology - State Museum of Prehistory Saxony-Anhalt/Halle(Saale) and the Archaeological Heritage Office Saxony/Dresden. Quantitative and qualitative attributes of cores, flakes and tools were recorded using the attribute analysis developed by Schäfer and Weber (Schäfer 1993; Weber 1986), using some modifications following Ertmer (2012). Only complete artifacts were used in the analysis. Nevertheless, all the attributes and measurements available were recorded for the broken pieces as well.

Two assemblages were analyzed in this study: the excavated finds of the site Pouch/TPf (including the ones recovered from the profile) and the survey collection artifacts GC. Despite the fact that the artifacts of the latter represent single finds from different surveys at various locations, they are treated as one analytical unit for the following reasons: their stratigraphic position was recorded and the major part of this collection can be traced to the same geological context, the base of the Weichselian Lower Terrace (Wimmer 1997), which existed in the southern and western rim of the quarry (where also the excavated site Pouch/TPf was situated). Furthermore, the sample sizes from the various find locations are too small to provide meaningful results.

To test the integrity of GC, however, two groups based on the artifact preservation state were defined. The rolled, heavily rolled and heavily damaged pieces most probably are from secondary contexts, while sharp-edged and slightly damaged artifacts from the Weichselian Lower Terrace sequence presumably have an early MIS 3 age (see above). The two groups of "fresh" and "rolled" were analyzed separately in order to falsify the hypothesis that they represent the same technocomplex. Sharp-edged artifacts are defined by lacking macroscopically visible damage or abrasion of the edges and dorsal ridges. They form the group "fresh" together with artifacts labeled as "slightly edge damaged" which include occasional marginal, and sometimes recent, damage. "Heavily edge damaged" pieces showed frequent damage on all edges and "rolled" artifacts have slightly rounded dorsal ridges and edges. When the ridges and edges, as well as the surfaces, were damaged and strongly rounded, they were assigned to the attribute "heavily rolled". These latter categories were grouped as "rolled".

Furthermore, the radiocarbon and OSL dating results place the sequence of Pouch/TPf clearly in early MIS 3. A Middle Pleniglacial age for the lower sequence of the Mulde Lower Terrace - as already indicated by the radiocarbon ages of the "Löbnitzer Horizonte"- is thus confirmed. Consequently, all sharp edged and slightly rolled survey collection artifacts (GC) found near or at the base of the Lower Terrace are likely of an early MIS 3 age as well.

For the cores (Appendix, Tab. 1; SI 1, Fig. 1), the quantitative aspects maximum length, width, thickness (Schäfer 1993; Weber 1986) and weight, as well as striking angles (Schäfer 1993; Weber 1986) were measured. In cases of multiple striking platforms, minimum and maximum angles were recorded. Where possible, the length and the width of the last flake scar was measured to compare the results to the dimensions of the flakes in the respective inventory. If multiple flake scars were present, the largest one was chosen. The edge conditions of the cores (Appendix, Tab. 2; SI 1, Fig. 4) were employed to subdivide the collected artifacts into an assemblage of sharp edged, fresh pieces on the one hand and rolled/damaged objects on the other hand (see above). If possible, the blank type of each core was determined (Schäfer 1993; Weber 1986). Attributes like the shape of the core, the number of flake detachment surfaces, the flaking directions, the number of "predetermined" flake scars (Schäfer 1993; Weber 1986), the longitudinal shape and the cross section of the flake detachment surfaces, as well as the number of prepared or flaked core margins (Schäfer 1993; Weber 1986) were recorded for typo- and technological classification. If a core has Levallois like features sensu stricto, the Levallois-classification was noted (see Pastoors 2001). It should be mentioned that not every core with prepared margins or striking platforms is a typical Levallois core regarding the stringent classification provided by some authors (Boëda et al. 1990; Pastoors 2001). As there are still some problems in the definition and interpretation of Levallois and its variability, these concepts are treated here as a special case within a wider range of prepared core techniques (Debénath & Dibble 1994; Dibble & Bar-Yosef 1995). To learn more about the discard behavior, the stage within the reduction sequence of each core was subjectively estimated as follows. Nodules or natural flint pieces are classified as a tested nodule if their natural shape is retained, flake removals are non-extensive and core margins are not prepared. A blank with a few flake removals that seem to prepare the shape of the core and/ or the striking platform(s) is called a prepared core blank (Baumann & Mania 1983). A complete core has one or more prepared striking platforms, a prepared flake detachment surface but no visible removal of a central ("predetermined") flake (Baumann & Mania 1983). A flaking core shows most of the before mentioned features, but the most important characteristic are central flake removals (Baumann & Mania 1983). When a core is classified as an exhausted core, it is mostly very flat and reduced, the striking angles are low and no productive flaking seems possible anymore (Baumann & Mania 1983).

Like the cores, flakes were classified in two groups (rolled and fresh) based on edge conditions (Appendix, Tab. 3; SI 1, Fig. 5). Recorded quantitative attributes of the flakes are (Appendix, Tab. 1; SI 1, Fig. 2) maximum length in flaking direction, maximum width, maximum thickness (Schäfer 1993; Weber 1986) and weight, maximum platform width and maximum platform thickness (Schäfer 1993; Weber 1986), as well as interior (IPA) and exterior platform angle (EPA) (Dibble & Whittaker 1981). The IPA was measured including the bulb, as proposed by Weber and Schäfer (Schäfer 1993; Weber 1986). Both angles are strongly related, with the difference of EPA being influenced by the knapper directly, e.g. through platform preparation and core trimming. The IPA depends on the EPA but is also influenced by the force applied, the hammer used or the angle of blow (regarding EPA and hammer type see: (Magnani et al. 2014)). Additional attributes were calculated: the length-width-index (LWI), the relative-thickness index (RTI) and the width-thickness-index (WTI) of the platform (Schäfer 1993; Weber 1995, 2007). The Length/Width (LWI) is an expression for the elongation of the flake: the higher the LWI the more elongated is the flake. The relative thickness of a flake is calculated 200*(Thickness/(Length+Width)) (Weber 1995). Thinner flakes (relative to their length and width) have a lower RTI. Thinner flakes have also a lower platform depth (Schäfer 1993). This is resulting in long and narrow platforms, expressed by a high WTI (Platform Width/Platform Thickness). The state of the platform, e.g. plain, faceted and cortical, as well as the amount of platform retouch were recorded to draw conclusions about the preparation of the former striking platform and the technical concept underlying the core reduction. Furthermore, the shape of each platform was noted to see if the applied core reduction strategy resulted in certain platform appearances. According to Ertmer (2012), the platform shapes were classified as irregular, oval, half-oval, rectangular, wedge-shaped, triangular, winged, ribbon-like and chapeau de gendarme. The presence or absence of core trimming (Schäfer 1993; Weber 1986) was recorded to draw conclusions about the investment in flaking surface preparation and the maintenance of the striking angle (see Dibble & Whittaker 1981; Magnani et al. 2014). To investigate the stage of core reduction at which each flake was struck, the state of the dorsal surface, e.g. cortical, flake scars or flake scars and cortex, was recorded and the amount of dorsal surface retouch was estimated in steps of 10 % (Schäfer 1993; Weber 1986). The number of directions and the specific directions of the dorsal flake scars were noted (Schäfer 1993; Weber 1986) to compare to the flaking directions of the cores. Attributes like the shape of the flake or remnants of the core margin ("éclat débordant", e.g. cortex, fine or coarse preparation) reveal if certain flake types were preferentially produced.

The retouched tools (Appendix, Tab. 1 & 4; SI 1, Fig. 3 & Fig. 6) were not categorized regarding their preservation state. Firstly, the comparison of the analytical results of the fresh and rolled cores and flakes justified treating them as one unit (see below). Secondly, the quantity would be too low to get meaningful results. They were instead grouped as simple edge retouched tools, such as scrapers, unifacial tools and bifacial tools. With this approach, differences and similarities in the dimensions and other attributes between the tool classes could be investigated. Furthermore, the retouched tools were classified as flake tools and core tools (Schäfer 1993; Weber 1986) to see which blanks were preferably used. Regarding the flake tools, the state of the platform (e.g. faceted) was analyzed to get an indication of the core technology used to produce the blank. The maximum dimensions (length, width, thickness and weight) of the stone tools were recorded. One of the goals of this study was the morphology and the placement of cutting or working edges. Mostly, retouch was used to define the cutting edge (Pastoors 2001). If no retouch was present, the working edge was defined by the frequent occurrence of macroscopic edge damage or its position opposite a prepared back. Unmodified flakes with a natural back opposite a sharp edge were not included in the analysis of cutting edges. A further study of the frequency and placement of edge damage is in progress. The minimum and maximum edge angle of the supposed cutting edge was quantified with an accuracy of 5° (Schäfer 1993; Weber 1986) to investigate reduction intensity and obtain information which might be related to function. The position (dorsal, ventral, alternating), the intensity (coarse and/ or fine, with coarse being bigger and fine being smaller than 5 mm (Schäfer 1993; Weber 1986) in length) and the morphology (simple/scalar and/or stepped) of the retouch (Schäfer 1993; Weber 1986) was recorded to study retouching techniques. To investigate the extension of the retouch, its length was measured using a caliper. The shape of the retouched edges and the presence or absence of a back was recorded. Backs were classified as: cortical backs, backs with cortex and retouch ("massive backs" after Pastoors 2001), retouched ("backed") backs (Pastoors 2001), steep dorsal flake scar or the remnants of a core edge, platforms that served as backs (Pastoors 2001) and thinned backs.

for unifaces and bifaces it was considered to be more subjective to divide the surfaces into ventral and dorsal analysis of the surface retouch. the flake morphology was used for uni- or bifacial flake tools to determine these surfaces. Otherwise, the more convex surface was considered as the dorsal and the other as ventral (see Jöris 2001). Attributes like the amount, the directions and the scar morphology (shallow or deep flake scars) of the surface retouch were recorded (Schäfer 1993; Weber 1986). Tool cross sections were recorded because they vary in spatial and cultural classification systems for late Neanderthal groups in Europe and between distinct tool classes (Ruebens 2012).

The recorded data was analyzed using the statistical software R (R Core Team 2015). The quantitative results presented in the Appendix Table 1 and the Supplementary information 1 figures 1 to 3 are given in their quartiles, median and mean. The median is favored in this analysis because its value is robust against outliers. An exception is the presentation of the morphological flake indices in the text. Here the mean is favored to allow comparison of results with published data from the literature. However, the median, the mean and the quartiles are all presented in the tables. Not every attribute could be clearly identified or characterized on each individual artifact, which causes the total number of artifacts analyzed to differ.

In the assemblage of Pouch/TPf, seven refits were identified. These artifacts were CT-scanned with a BIR Actis 225/300 scanner with resolutions of 36 to 69 µm and refitted using the software AVIZO. The individual refits could be analyzed without damaging the artifacts and without gluing them together with the help of the resulting 3D model. Figures of these models can be found in the online Supplementary Information 2, while online Supplementary Information 3 contains 3D PDFs of some artifacts.

Results

Lithic analysis Pouch/TPf

Including fragments, a total of 371 artifacts were recovered by formal excavation and additional recovery from the profile in 2002. All the artifacts are made of baltic flint. 99 % of the pieces are patinated, and one angular fragment is crazed due to thermal alteration. The majority of artifacts has a brown (40 %) or yellowish brown (22 %) patina. A blueish-white patina (sometimes light) was observed on 16 % of the artifacts. Other patination colors are olive, rust-colored, black and different kinds of grey. Three artifacts show a gloss. On 40 artifacts (11 %), thermal alterations, in the form of cracks and pot-lid fractures, were observed. This could be an indication of the use of fire but frost alteration cannot be excluded without physical examinations like thermoluminescence. For the analysis, the fragmented artifacts and the 15 angular fragments (4 %) were excluded and therefore 297 pieces were analyzed, comprising 9 cores (3 %), 215 flakes (72 %) and 58 tools (20 %).

Cores

In total, 24 cores were found in the assemblage of Pouch/TPf. Nine specimens (38 %) are completely preserved and were analyzed (Appendix, Tab. 1 & 2; SI 1, Figs. 1 & 4), while two are heavily damaged (8 %), two are frost cracked (8 %), one core is longitudinal broken (4 %) and 10 cores (42 %) are indeterminate broken chunks or shattered cores. The nine complete cores were made mostly on natural pieces (78 %) and two on cobbles (22 %). One core is a tested nodule (11 %) and one could be determined as a flaking core (11 %). Seven cores are exhausted (78 %). Although the majority of cores is exhausted, different stages of core reduction are present.

The median length is 71 mm, the width$_{median}$ 66 mm and the thickness$_{median}$ 28 mm (Appendix, Tab. 1; SI 1, Fig. 1). 110.8 g is the median weight.

The dimensions of the last flake scars (Appendix, Tab. 1; SI 1, Fig. 1) indicate that the cores were discarded when their flake dimensions reached a minimum size$_{median}$ of about 40 x 40 mm.

The median minimum striking angle is 72.5 degrees (Appendix, Tab. 1; SI 1, Fig. 1), while the maximum striking angle$_{median}$ has a value of 77.5 degrees.

The complete cores of the site Pouch/TPf are mostly oval in shape (67 %) and have prepared core margins (88 %) (Appendix, Tab. 2; SI 1, Fig. 4). On a single (100 %), mostly convex (convex cross section: 56 %) flake detachment surface, predominantly unidirectional (55 %) flaking concepts were applied. Bidirectional methods, including divergent flaking, are also common (33 %). Five cores (56 %) are classified as Levallois (Appendix, Plate 4: 1) sensu stricto. Two of them are exploited unipolar recurrent (40 %), one bipolar préférentiel (20 %) and two divergent préférentiel (40 %).

Flakes

215 complete flakes were analyzed (Appendix, Tab. 1 & 3; SI 1, Figs. 2 & 5). They have a median length of 50 mm, a width$_{median}$ of 37 mm and a thickness$_{median}$ of 9 mm (Appendix, Tab. 1; SI 1, Fig. 2). The median weight is 13.4 g. Most of the flakes were produced on prepared cores through unidirectional and bidirectional flaking. Two thirds of the platforms are faceted (Appendix, Plate 4: 2-3) and the dorsal flake scars are mostly bidirectional (44.9 %) or unidirectional (35.8 %). Multiple directions are less common (19.3 %) (Appendix, Tab. 3; SI 1, Fig. 5). The IPA$_{median}$ is 100 degrees and the EPA$_{median}$ 90 degrees. Core trimming to maintain the striking angle was rarely observed (85 %) (Appendix, Tab. 3; SI 1, Fig. 5). As for the

Typology	Goitzsche Collection		Pouch/TPf	
	n	Figures	n	Figures
all tools	57		58	
partial edge retouch	9 % (5)		5 % (3)	
scraper	25 % (14)	Plate 1:3	52 % (30)	Plate 7; Plate 8; Plate 9: 3 & 5, SI 3 PDFs. 3 & 4
naturally backed knife	5 % (3)		2 % (1)	
backed knife	2 % (1)		10 % (6)	Plate 9: 1-2 & 4
bifacial scraper	5 % (3)	Plate 3:1	0	
leaf-shaped scraper	11 % (6)	Plate 2:1	3 % (2)	Plate 6
leaf-shaped handaxe (Faustkeilblatt)	5 % (3)	Plate 2:2	0	
bifacial backed knife (Keilmesser)	7 % (4)	Plates 1:2 & 3:2; SI 3 PDF 1	5 % (3)	Plate 5
handaxe	7 % (4)	Plate 1:4, SI 3 PDF 2	0	
partial biface (Halbkeil)	2 % (1)		0	
point	4 % (2)	Plate 1:1	0	
indeterminate biface	14 % (8)		2 % (1)	
indeterminate tools	5 % (3)		0	
truncated-faceted piece	0		3 % (2)	
flakes with macroscopic edge damage (use-wear ?)	0		17 % (10)	

Fig. 5. Table of the typological classification of the tools from (Goitzsche Collection) GC and Pouch/TPf.
Abb. 5. *Tabelle der typologischen Klassifizierung der Geräte von GC und Pouch/TPf.*

collected artifacts, platform shapes show no real trend, the most common forms are irregular (26 %), wedge-shaped (13 %), oval (12 %), half-oval (8 %), winged (10 %), triangular (8 %) and ribbon-like platforms (6 %) (Appendix, Tab. 3; SI 1, Fig. 5). Different core reduction stages are observable among the flakes: about one half of the dorsal surfaces (47 %) is completely covered with flake scars (Appendix, Plate 4: 2) and the other half (47.9 %) with cortex and flake scars (Appendix, Tab. 3; SI 1, Fig. 5). Flakes with divergent lateral edges are the most frequent in the assemblage (30 %) (Appendix, Tab. 3; SI 1, Fig. 5). Flakes with divergent-convergent (19 %) and with parallel edges (19 %) are the second most common types, followed by round flakes (16 %). Convergent (8 %) and irregular flakes (9 %) are rather rare. Core edged flakes (Appendix, Plate 4: 3) were produced. They are visible with a share of one third in the record. With a mean LWI of 1.43 the flakes show a tendency to be elongated. Regarding their mean RTI of 21.37, they are relatively thin. The high mean WTI for the platforms of 3.64 results from the prevalence of long and narrow platforms (Appendix, Tab. 1; SI 1, Fig. 2).

Tools

The 58 tools (Appendix, Tab. 1 & 4; SI 1, Figs. 3 & 6), which are all preserved in a very good condition with sharp edges, are differentiated into 40 simple edge retouched tools (69 %), 12 unifaces (21 %) and six bifaces (10 %). Using the typological approach, the tools can be described as listed in Figure 5. Scrapers (Appendix, Plate 7; Appendix, Plate 8; Appendix, Plate 9: 3 & 5, SI 3, PDFs. 3 & 4) are the most common tool type. Among other types (Fig. 5) are backed knives (Appendix, Plate 9: 1-2 & 4), leaf-shaped scrapers (Appendix, Plate 6) and bifacial backed knives (Appendix, Plate 5). Regarding the classificatory framework provided by Ruebens (2012), the presence of leaf-shaped bifacial tools and bifacial backed knives places this assemblage within the KMG/MMO of central Europe. Among the scrapers, two interesting features have to be emphasized. First, some scrapers are backed like the backed knives (Appendix, Plate 9: 3 & 5). Secondly, there are five unifacial scrapers (Appendix, Plate 7; Appendix, Plate 8: 3, SI 3, PDFs 4 & 5) which look like bifacial backed knives: they have a cortical and/ or a cortical and retouched back opposite a convex cutting edge, a retouched tip and a wedge-shaped cross section. Bifacial backed knives or Keilmesser are defined as: "(...) bifacially worked core tools possessing a single sharp working edge, which is formed by bifacial retouch from one side after the other, opposed by an unworked or roughly worked (in rare cases more carefully worked) back (...) In the terminal part of the tool the back often changes to a second, quite sharp edge, which converges with the distal end of the working edge to form a more or less pointed tip (...)." (Jöris 2006: 292). Another feature is a wedge-shaped and plano-convex cross section resulting from a thick back and a flat "ventral" and a more convex retouched "dorsal" surface. The described scrapers possess all of these features with only the ventral parts of the working edges as well as the ventral surfaces not retouched. In addition, 6 simple flake tools show some features of this concept as well: despite the absence of surface retouch, they have a cortical back opposite to a sharp retouched cutting edge and (except one case) a retouched distal tip (Appendix, Plate 8: 1 & 4).

The resharpening of bifacial backed knives using the para-burin or Prądnik technique was not observed. The only evidence of this technique is a possible resharpening flake or para-burin spall (Fig. 6).

All of the 40 simple retouched tools and the 12 unifacial tools are flake tools (Appendix, Tab. 4; SI 1, Fig. 6). Half of the bifacial tools are flake tools (Appendix, Plate 5: 1 & 3), two are core tools (Appendix, Plate 5: 2; Appendix, Plate 6: 2) and one leaf-shaped scraper was manufactured on an exhausted centripetal Levallois core (Appendix, Plate 6: 1).

More than two thirds of the platforms of the flake tools are faceted (56 %) or partly faceted (20 %). The rest of the platforms are removed through modification (19 %) or broken (6 %). In the assemblage of Pouch/TPf, flakes from prepared cores have been used as the main blank for the production of flake tools.

The median lengths for the three tool classes vary between 84 mm and 104 mm (Appendix, Tab. 1; SI 1, Fig. 3). The simple flake tools (median dimensions: L= 86.5 mm, W= 57.5 mm, T= 12 mm) and the bifaces (median dimensions: L= 84 mm, W= 58.5 mm, T= 16 mm) are almost of similar average size, but the unifaces (median dimensions: L= 104 mm, W= 67.5 mm, T= 17 mm) are the largest tool class.

The median extension of the retouch on the simple tool edges is 77 mm which is 33 % of an edge

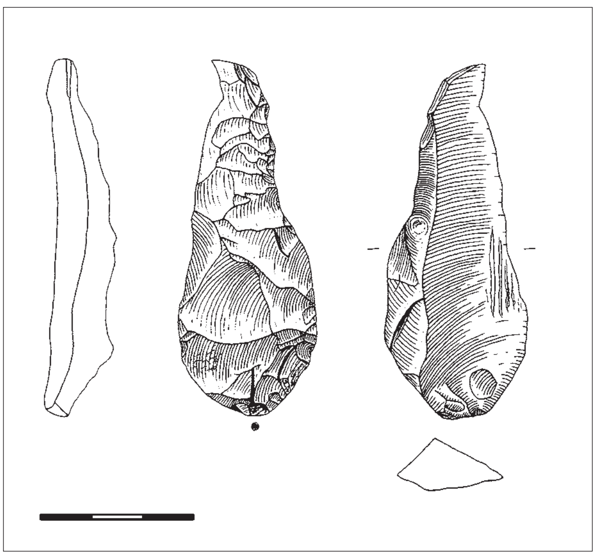

Fig. 6. Resharpening flake or para-burin spall (2004:8680,76). ⅔ natural size; drawing: M. Weiß.

Abb. 6. *Nachschärfungsabschlag oder Schneidenschlag (2004:8680,76). ⅔ natürliche Größe; Zeichnung: M. Weiß.*

$length_{median}$ of 234 mm (Appendix, Tab. 4; SI 1, Fig. 6). On the tool edges of the unifaces, the median retouch extension is 60 % (159 mm of 265 mm). The highest median value for the extension of the edge retouch is on bifaces: 74 % of the edges are retouched (168 mm of 227 mm).

Although alternate (14 %) and ventral edge retouch (6 %) occurs, the majority of the simple flake tools is retouched on the dorsal side (80 %) (Appendix, Tab. 4; SI 1, Fig. 6). The unifaces show almost an equilibrium between dorsal (44 %) and alternate edge retouch (41 %). The bifaces are dominated by alternate edge retouch (77 %).

The simple flake tools show mostly a fine (55 %) or a combination of fine and coarse (39 %) edge retouch (Appendix, Tab. 4; SI 1, Fig. 6). The edges of the unifaces are mostly retouched with a combination of fine and coarse flake scar (85 %). Coarse (7 %) or fine edge retouch (7 %) only is rare on the unifaces. The bifaces show mostly a fine edge retouch (46 %) or the combination of fine and coarse (46 %). The fine and slightly retouched edges of the simple tools indicate that they were probably not reduced intensively and were perhaps not extensively used.

This argument is reinforced by the occurrence of mostly simple/flat/scalar retouch (86 %) on the edges of the simple flake tools. Unifaces still have a considerable amount of simple/flat/scalar retouch (44 %), but the combination of simple with stepped retouch scars is more frequent (56 %) than in simple flake tools (14 %). The same is observable for the bifaces: 31 % of the edges show simple/flat/scalar retouch and 69 % show additionally stepped retouched parts. One leaf-shaped scraper (Appendix, Plate 6: 2) has a Quina-like retouch, probably due to intense reduction.

The simple tools show various shapes of the retouched edges (Appendix, Tab. 4; SI 1, Fig. 6), although the most common edge shape is convex (50 %), followed by straight-convex (18 %) and straight (17 %). The convex edge shape mostly refers to the working edge (21 of 33 convex edges). Some edges have a straight-concave (6 %), a convex-concave (5 %), a concave (3 %) or an angled (2 %) shape. Most of the irregular edge shapes are caused by only slightly retouche and the edge contours are predominantly influenced by the original edge shapes of the flakes. Convex edge shapes are as well the most common type of edge outline among the unifacial (70 %) and the bifacial tools (69 %), mostly referring to the working edge (unifaces: 10 convex edges out of 19, bifaces: three convex edges out of nine). Straight (unifaces: 22 %, bifaces: 15 %) and straight-convex edges (unifaces: 4 %, bifaces: 15 %) are also quite frequent.

The cutting edge was mostly identified (see methods section) on one of the lateral edges, sometimes on the distal end (Appendix, Tab. 4; SI 1, Fig. 6). The longest and thinnest edge of the blank was preferentially selected. The median minimum functional edge angle of the simple flake tools is 20 degrees with a maximum of 30 degrees (Appendix, Tab. 1; SI 1, Fig. 3). The unifaces have a slightly higher minimum functional edge angle$_{median}$ with 25 degrees. Their maximum functional edge angle$_{median}$ is 40 degrees. The bifaces have median functional edge angles ranging from 25 to 35 degrees. On average, the edge angles in this assemblage are very low.

An interesting, characteristic aspect of the tool morphology at Pouch/TPf is the presence of backs: 34 of the 40 simple flake tools (85 %) possess a back of some kind, all of the unifacial tools do and five of the six bifaces (83 %) possess a back as well. But within the category "back" exists a great amount of variability - there were different ways to achieve the same goal. The most common back on simple tools is a natural or cortical back, present in 11 (28 %) artifacts (Appendix, Plate 8: 4). A retouched back (backing) was observed in seven cases (18 %) and the combination of retouch and cortex in four cases (10 %). Four times (10 %) a steep dorsal flake scar or the remains of a core edge served as a back, twice (5 %) combined with retouch (Appendix, Plate 9: 1). Six times (15 %), the platform opposite a sharp or retouched edge was used as a back in the case of transversal tools (Appendix, Plate 8: 2). The combination of a cortical back and retouch was found five times (42 %) on the unifacial tools (Appendix, Plate 7: 1-2) and a cortical back three times (25 %) (Appendix, Plate 8: 3). In one case (8 %), a steep dorsal flake scar or core edge and retouch served as a back and three times (25 %) a steep dorsal flake scar without modification served as a back. In four cases (67 %), the backs of the bifaces consist of cortex plus retouch (Appendix, Plate 5; Appendix, Plate 6: 1) and in one case (17 %) the back is completely retouched (Appendix, Plate 6: 2).

The intensity of the surface retouch on the unifacial tools is relatively low (Appendix, Tab. 4; SI 1, Fig. 6). The unifaces of Pouch/TPf show a preference for two and three flaking directions for the shaping of a surface (Appendix, Tab. 4; SI 1, Fig. 6). The same aspect was observed on the bifaces. In both tool classes, the surface retouch scars are shallow (unifaces: 50 %, bifaces: 42 %) or show a combination of shallow and deep shapes (unifaces: 50 %, bifaces: 50 %). One biface (8 %) is covered only by deep shaped flake scars.

In most cases the cross sections of the simple flake tools are plano-convex (88 %), due to the flake morphology. Biplane (3 %) and irregular cross sections (10 %) are rare. The unifaces have mostly a plano-convex (92 %) with only one (8 %) biconvex cross section. Half of the bifacial tools are also plano-convex. The other half has irregular cross sections.

Refits

In the assemblage of Pouch/TPf, seven refit sequences have been found so far. Raw material similarities suggest the presence of additional potential refits. The first refit (Fig. 7; SI 2, Video) consists of two core fragments and two flakes. The second refit is a small cortical flake refitted to a flint slab (2004:8680,3; 2004:8680,4). A third refit complex (SI 2 Figs. 1a & 1b) is a scraper that could be attached to a transversal broken flake (SI 2, Figs. 1a & 1b). In two cases, two flakes detached from prepared cores could be attached to one another (SI 2, Figs. 2a & 2b; SI 3, PDF 6). Another refit (SI 2, Fig. 3) is represented by indeterminate, maybe unfinished, bifacial tool that could be attached to a core. The last refit is a flake attached to a slightly rolled exhausted Levallois core (divergent préférentiel) with gloss on the flake detachment-surface (SI 3, PDF 7). This core was recovered fallen from the profile between the days of excavation. A flake, found during the excavation in layer 5 could be refitted to the surface opposite the flake detachment surface.

Lithic analysis GC

In this chapter a summary of the GC analysis is presented. More detailed information is provided in the Supplementary Information 1.

Including fragments, a total of 1 225 artifacts were collected from about 1991 to 2002 in the entire former quarry "Tagebau Goitzsche - Baufeld Rösa-Sausedlitz". One artifact could not be analyzed because it is on display at the museum "Staatliches Museum für Archäologie Chemnitz". All pieces are made of baltic flint, except two on fine quartzite. For the analysis, broken artifacts and 9 angular fragments were excluded. Thus a total of 1 017 complete pieces

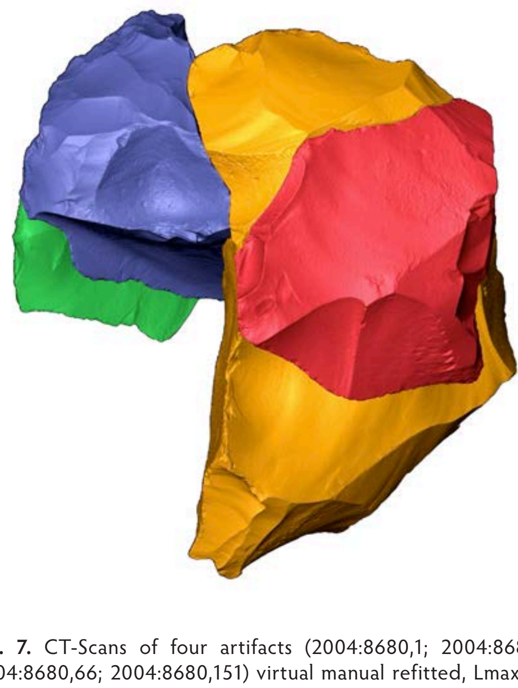

Fig. 7. CT-Scans of four artifacts (2004:8680,1; 2004:8680,2; 2004:8680,66; 2004:8680,151) virtual manual refitted, Lmax= 92 mm, Wmax= 109 mm, Tmax= 42 mm Graphic: M. Weiß.

Abb. 7. *CT-Scans der virtuell-manuell zu einem Kern zusammengepassten Artfakte (2004:8680,1; 2004:8680,2; 2004:8680,66; 2004:8680,151) als , Lmax= 92 mm, Bmax= 109 mm, Dmax= 42 mm. Grafik: M. Weiß.*

(83 %) were analyzed comprised of 207 cores (20 %), 744 flakes (73 %), and 57 tools (6 %).

The results given in the supplementary information 1 figures 1, 2, 4 and 5 indicate that there is no difference between the fresh and the rolled artifacts. The cores show no distinction regarding their dimensions and striking angles, the blanks used, the shape, the reduction strategies and techniques and their degree of reduction when discarded. For the flakes the same is true with no obvious difference between rolled and fresh artifacts. This forms, together with the geological situation, the basis for the assumption that the rolled and the fresh assemblages of GC belong to the same techno-complex from a given time frame in prehistory. As the freshly preserved artifacts from the base of the Weichselian Lower Terrace have most probably an early MIS 3 age, the same can be reasonably assumed for the rolled artifacts. The river system of that period is described as ephemeral anastomosing, with large discharge fluctuations typically occurring in both channel and overbank environments (Mol et al. 2000; Mol 1997; van Huissteden et al. 2001). That means that the river channels were frequently changing and reworking sediment and therefore abrasion and damage of artifacts was highly possible during that time. In the following, the fresh and the rolled artifacts are treated as a single analytical unit.

The GC artifacts: cores, flakes and tools

The most common blank type for the 207 cores were natural pieces (73 %). Cobbles (12 %), found in the river deposits and flakes (10 %) were used to a lesser extent. Regarding their state of exploitation, flaking cores (41 %) and exhausted cores (40 %) are the most common. Their median dimensions are: L=96 mm, W= 86 mm and T= 45 mm, with a $\text{weight}_{\text{median}}$ of 360.8 g (SI 1, Fig. 1). The mostly oval or rounded shaped cores (51 %) are dominated by prepared, unidirectional (66 %) techniques with one flaking surface (80 %). Bidirectional methods (26 %, including divergent) and two flaking surfaces (14 %) are quite common as well. Levallois cores sensu stricto are present (33 %), with predominantly unipolar recurrent (26 %) and unipolar préférentiel (36 %) flaking methods. Bidirectional methods, like bipolar recurrent 10 %), bipolar préférentiel (6 %) and divergent préférentiel, (13 %) are also quite common (SI 1, Fig. 4). The centripetal method was less frequently applied (9 %). The cores have a median minimum striking angle of 75 degrees and a median maximum striking angle of 80 degrees (SI 1, Fig. 1).

744 flakes were analyzed (SI 1, Fig. 2, SI 1, Fig. 5). They have a median length of 64 mm, a $\text{width}_{\text{median}}$ of 50 mm and a $\text{thickness}_{\text{median}}$ of 16 mm. Their median weight is 42.6 g. The majority of the flakes were detached from prepared cores or cores with prepared striking platforms respectively, as 40 % of the platforms are faceted and 16 % are partly faceted (SI 1, Fig. 5). Cortical, plain and damaged platforms are present as well. The $\text{IPA}_{\text{median}}$ is 110 degrees, the $\text{EPA}_{\text{median}}$ is 85 degrees (SI 1, Fig. 2). Platform shapes show no real trend. The most common forms are irregular (19 %), wedge-shaped (18 %), oval (9 %), half-oval (7 %), winged (9 %), triangular (8 %) and ribbon-like (8 %) platforms (SI 1, Fig. 5). The directions of the dorsal flake scars are predominantly uni- (41 %, including opposed and lateral) and bidirectional (35 %, including divergent). This reinforces the result obtained from the analysis of the cores that uni- and bidirectional flaking methods are characteristic for this assemblage.

Round flakes (25 %) or broad flakes with divergent lateral edges (34 %) were the most produced specimens (SI 1, Fig. 5). Blade-like flakes (13 %) and flakes with divergent-convergent edges (14 %) played a minor role in flake production. Core edged flakes (29 %) were not preferably produced. The mean of the elongation expressed in the LWI, is 1.32 (SI 1, Fig. 2) (here the mean is used for comparison to the data presented in the literature (Schäfer 1993)), shows that the flakes are rather broad. The mean calculated RTI has a value of 27.73. With a mean WTI for the platforms of 3.02, the platforms are rather long and narrow.

The 57 complete tools (SI 1, Figs. 3 & 6) consists of 13 simple tools (23 %), 14 unifacial retouched tools (25 %) and 30 bifacial tools (53 %) and are typological classified as listed in Figure 5 and Supplementary Information Figure 6. Among other tool types occur scrapers (Appendix, Plate 1: 3), bifacial scrapers (Appendix, Plate 3: 1), leaf-shaped scrapers (Appendix, Plate 2: 1), leaf-shaped handaxes or Faustkeilblätter (Appendix, Plate 2: 2), bifacial backed knives or Keilmesser (Appendix, Plate 1:2; Appendix, Plate 3: 2; SI 3, PDF 1), handaxes (2 unfinished, 1 classical (?) and one leaf-shaped) (Appendix, Plate 1:4, SI 3, PDF 2), and points (Appendix, Plate 1:1). Following Rueben´s (2012, 2013) approach, the GC bifacial (and unifacial) tools can be grouped together as leaf-shaped bifacial tools, bifacial backed tools, bifacial scrapers and partial bifaces. A broader way of classification is the differentiation of the tools based on blank type (Schäfer 1993; Weber 1986) (SI 1, Fig. 6). The 13 simple tools are all flake tools, while 93 % (13) of the 14 unifacial tools are flake tools as well. One artifact was made of a frost-fractured piece. Only 30 % (9) of the 30 bifacial tools are flake tools, more commonly (70 %) they were produced through shaping. Width median length measurements between 80.5 mm to 92 mm for all tool classes (SI 1, Fig. 3) show that the stone tools are relatively large. The edge retouched flake tools are on average longer (median 85 mm) and broader (median 57 mm) than the unifaces (median L= 80.5 mm, median W= 53.5 mm) but shorter and narrower than the bifaces (median measurements: L= 92 mm, W= 61 mm). The unifacial tools (median T= 22 mm) and the bifaces (median T= 23 mm) are on average thicker than the simple flake tools (median T= 14 mm) and are more than twice as heavy (SI 1, Fig. 3). The simple tools have predominantly (61 %) dorsal edge retouch (SI 1, Fig. 6). Ventral retouch is less common (26 %), and alternate retouch is rare (13 %). The unifaces are as well dominated by dorsal edge retouch (56 %), but alternate retouch is also common (38 %). Regarding the bifacial tools, the relationship between dorsal and alternate retouch is reversed. Most common here is alternate edge retouch (54 %), followed by less frequent retouch on the dorsal part of the edge (30 %). Ventral edge retouch is rare among the unifaces (6 %) and the bifaces (16 %). Convex edges are the most common type in all tool classes (SI 1, Fig. 6) (simple: 36 %, uniface: 50 %, biface: 49 %), followed by straight edges (simple: 32 %, uniface: 21 %, biface 19 %). Straight-convex edges are still quite frequent (simple: 18 %, uniface: 18 %, biface 8 %). Concave, straight-concave and convex-concave edges are rare in all tool classes. Angled retouched edges are not found in unifacial and simple tools, but they are found quite frequently among the bifaces (16 %). In most of the cases the angled edge forms a back opposite to the cutting edge (Appendix, Plate 1: 2; Appendix, Plate 2: 2, Appendix, Plate 3: 1). The median for the minimum functional edge angle is 35 degrees for the simple retouched tools and the unifaces and 40 degrees for the bifaces (SI 1, Fig. 3). The maximum functional edge angle$_{median}$ is 45 degrees for the simple tools, 50 degrees for the unifaces and 60 degrees for the bifaces.

Besides the working edge, backs appear to be the second most important morphological feature of the GC late Middle Paleolithic stone tools. More than half of the simple tools (54 %) and the unifaces (56 %) as well as almost two thirds of the bifacial tools (59 %) have a back. The following back types occur in the record (SI 1, Fig. 6): a cortical back (simple tools: 15 %, unifaces: 14 %, bifaces: 13 %), a cortical back with retouch (unifaces: 7 %, bifaces: 10 %), retouched backs (simple tools: 8 %, unifaces: 21 %, bifaces: 13 %), a steep dorsal flake scar or a core edge forming a back (simple tools: 15 %, unifaces: 7 %, bifaces: 3 %), a platform that served as back (simple tools: 8 %) and a thinned back (simple tools: 8 %, unifaces: 7 %, bifaces: 20 %).

The last attribute presented in this study is the cross section of the tools (SI 1, Fig. 6). The simple tools are dominated by plano-convex cross sections (92 %). A plane/convex-plane/convex cross section was observed in one case (8 %). Among the unifaces, plano-convex cross sections are also the most common (64 %). Biconvex cross sections are present but rare (14 %). Unifaces also show sometimes irregular cross sections in the form of plane/convex-plane/convex (7 %) and convex-plane/convex (14 %) cross sections. Bifacial tools have often a biconvex cross section (47 %) but plano-convex tools are also quite common (30 %). Irregular cross sections are present less frequently (24 %).

Discussion

Comparison of the assemblages GC and Pouch/TPf

The analysis of the collected assemblage GC has provided good arguments for the assumption that the rolled and the fresh artifacts are likely to be of the same age, as cores and flakes almost always provided very similar results for individual attributes. This conclusion is reinforced by the refit of a slightly rolled and glossy core with a sharp edged flake (SI 3, PDF 7), both recovered from the site Pouch/TPf. The analyses of the two assemblages, the collected survey finds GC and the excavated assemblage Pouch/TPf, have shown that they are typo-technologically closely related: unidirectional and bidirectional flaking concepts dominate the blank production; bifaces were sometimes made on flakes; dorsal retouch dominates the simple tools, dorsal and alternate retouch the unifaces and the bifaces; the retouched edges are dominated by convex and straight shapes and the morphological concept of a back and its variability is found in both assemblages. Therefore, as the site of Pouch/TPf was OSL- and radiocarbon dated to early MIS 3, the technological relatedness of the cores and the flakes to the collected artifacts reinforces the proposed MIS 3 attribution of the collected assemblage based on the geological evidence and previous chronometric dating of the peat layers (Fig. 2).

However, some differences between the two assemblages were observed as well. The dimensions of the Pouch/TPf cores are much smaller compared to the GC cores. This could be due to collection bias in the GC assemblage on the one hand and due to the fact that most of the cores are exhausted in Pouch/TPf on the other hand. The Pouch/TPf cores were discarded with a median minimum last flake scar size of 40 x 40 mm, which is much smaller than the observation for GC with about 60 x 54 mm (SI 1, Fig. 1). That means that the Pouch/TPf cores were mostly discarded in a later stage as the ones from the GC finds, because the median dimensions, especially the median lengths, of their last flake scars are about one third bigger. The striking angles observed on the Pouch/Tpf cores are smaller than those for the GC cores. Possibly, the smaller striking angles of the cores from Pouch/TPf resulted from the dominance of exhausted cores in the record.

Another difference is the dimension of the flakes. The flakes of Pouch/TPf are smaller in their median dimensions (50 x 37 x 9 mm) than those from GC (64 x 50 x 16 mm), partly due to the fact that in Pouch/TPf a proportion of the bigger flakes was shaped into tools (see flake tools and their dimensions). Although no sediment screening was done during the excavation, the smaller fraction is also more numerous in the excavated Pouch/TPf finds and bifacial retouch debris is preserved as well (Appendix, Plate 4: 4-7). There are also some differences in platform angles. The median IPA of Pouch/TPf is 100 degrees or about 10 degrees smaller than in the GC assemblage, whereas the median EPA of 90 degrees is about 5 degrees steeper. The results for the morphological flake indices are also slightly different. With a mean LWI of 1.43, the flakes of Pouch/TPf are more elongated as those from the GC assemblage (LWI=1.32). The latter are also relatively thicker with a mean RTI of 27.73 compared to a mean RTI of 21.37 for the Pouch/TPf flakes. This could be due to the fact that smaller and thinner flakes are present in the Pouch/TPf assemblage (see above).

Regarding the tools, the proportion of bifacial tools is higher in the GC assemblage than in the Pouch/TPf assemblage. In contrast, simple flake tools are more numerous in Pouch/TPf than in GC. First of all, the GC assemblage is the result of many surveys in different locations thus representing samples from several assemblages. Secondly, bifaces are more easy to spot, even for well trained collectors. On the other hand, Pouch/TPf was excavated and the finds were embedded in a fine grained sediment. Their edges seem to be in a very fresh condition. Therefore, also pieces with a marginal or partial retouch were recorded as tools. The embedding and the post-depositional processes that affected the edges of the tools in the GC assemblage are unknown. Therefore, it can not be ruled out that some marginal retouch should be considered as edge damage and those pieces were not recorded as tools. Furthermore, the angles of the collected tools are much steeper in the GC assemblage. This could be the result of reworking and fluvial transport on the one hand, as 44 % of the collected tools are rolled or heavily damaged. On the other hand, bifaces tend to have larger edge angles than simple flake tools, due to the process of reduction (see Iovita 2014). As GC has more bifaces in relation to simple flake tools and unifaces than Pouch/TPf, this could raise the median edge angle value for the GC tools.

Despite their differences, the GC and Pouch/TPf stone tools clearly belong to the late Middle Paleolithic group PC/KMG/MMO. Edge retouched flake tools, unifacial tools and bifaces are present. Flake tools tend to be produced on flakes detached from prepared cores. Among the unifaces and bifaces are leaf-shaped bifacial tools, bifacial backed tools, bifacial scrapers and partial bifaces. Plano-convex, biconvex and irregular cross sections of the tools are as well characteristic for this central European late Middle Paleolithic group (Ruebens 2012). It can be concluded that most of the tools from Pouch/TPf have not been intensively resharpened or recycled and, therefore, were probably only used for a short period of time: the edge retouch on the simple tools is in general not very extensive, in some cases only marginal. The unifaces are not reduced to a large extent either. They represent the tool class with the largest dimensions (made on the largest flakes) and the surface is predominantly only partially covered by retouch. Additionally, the edges of almost all artifacts are in an exceptionally fresh condition. Nevertheless, resharpening and recycling, which indicates a longer use-life, is visible in three bifacial (Appendix, Plate 5: 1-2; Appendix, Plate 6) and one or possibly two unifacial tools (Appendix, Plate 7): the surface form shaping (about 100 %) and the edge retouch are more intense, one of the leaf-shaped scrapers has even a Quina-scraper edge indicating strong reduction (Appendix, Plate 6: 2). Recycling was observed in the case of another leaf-shaped scraper (Appendix, Plate 6: 1), which was produced on an exhausted Levallois-core. It is possible that these more reduced and recycled implements were brought to the site, because also their raw material differs from the dominant brown or yellowish brown colored flint varieties: a unifacial scraper (Appendix, Plate 7: 2) and a leaf-shaped scraper (Appendix, Plate 6: 1) are rust-colored, while a bifacial backed knife (Appendix, Plate 5: 2) and another leaf-shaped scraper (Appendix, Plate 6: 2) are rather black. To summarize, it appears by the presence of exhausted cores, flakes of different size classes and the refits of cores and flakes that most of the tools were produced on-site and used for a short time period, whereas some tools were probably brought to the site and experienced a longer use life.

With reference to Middle Paleolithic typologies (e.g. Debénath & Dibble 1994), it was observed that the tools are very variable in their morphologies. Middle Paleolithic stone tool variability can partly be explained either by resharpening (Dibble 1995; Hiscock & Clarkson 2008; Iovita & McPherron 2011; Jöris 2006), maintaining the angle of the cutting edge (Iovita 2014) or the presence of distinct cultural entities (e.g. Bosinski 1967; Bordes 1961; Guibert et al. 2008; Ruebens 2012, 2013, 2014; Soressi 2002). This study indicates/suggests that the frequent application of two related morphological features in stone tool manufacture could explain certain aspects of variability. This relates to the concept of a back, which was applied on simple flake tools, unifaces and bifaces, is very variable, as different kinds of backs were observed: cortical backs, retouched backs (backing), the combination of cortex and retouch, steep dorsal flake scars at one lateral edge or platforms that served as a back. In some cases, the back was thinned. The possible relation to hafting was not investigated here as it is part of study currently in progress. These examples of backs shows how flexible Neanderthals were in the application of their technical concepts to create, probably, some sort of handle on their implements resulting in a huge variability in the appearance of their stone tools. Backing on flakes (backed knives) and on simple scrapers is of special interest for this study. Backed knives are characteristic for the contemporary MTA in France (Ruebens et al. 2015; Soressi 2002) and they are supposed to be rare in the late Middle Paleolithic of central Europe (Ruebens et al. 2015). Therefore, their presence in central Germany has to be emphasized.

The second, though related, morphological characteristic of the Pouch/TPf stone tools is the strong evidence that the Keilmesser-concept (bifacial backed knife – concept) was applied to unifacial and to a more limited extent to simple flake tools as well. Except for the bifacial retouch, the Keilmesser-like unifaces have a thick cortical or a cortical and retouched back, a retouched tip on the distal end, a sharp and retouched convex cutting edge and a wedge shaped cross section. The simple flake tools assigned to this concept additionally lack unifacial retouch. They are also characterized, however, by a thick cortical back, a convex or slightly convex, retouched functional edge, a retouched tip and a wedge shaped cross section. Although the two morphological features – backs in general and the variable Keilmesser-concept – are studied separately from one another, it is possible that their application represents certain morphological aspects that lie on a continuum: flakes with a natural back were transformed into simple scrapers showing Keilmesser-features, then transformed into bifacial backed-like unifacial tools and finally to bifacial backed knives. It seems that some stages of this reduction sequence are visible in the assemblage of Pouch/TPf. Such a broader interpretation of the Keilmesser-concept was already suggested by Krukowski (1939) in his definition of the Prądnik Culture or the Prądnik Cycle.

Contextualizing Pouch/TPf through comparison to other central German late Middle Paleolithic sites

In the following the presented observations on the assemblage level are further explored. To contextualize the assemblage of Pouch/TPf within the central German late Middle Paleolithic, it is compared to four sites from that region (Fig. 8) using the available literature. For the comparison, the sites Salzgitter-Lebenstedt (Pastoors 2001, 2009; Tode 1982), Lichtenberg (Veil et al. 1994), Königsaue (Mania 2002a; Mania & Toepfer 1973) and Neumark-Nord 2/0 (Laurat & Brühl 2006) were chosen, because they are all situated relatively close to each other at the margins or/and within the central-northern German plain. Furthermore, they represent excavated assemblages and their chronometric dates (OSL, TL, ^{14}C) place them all in the Weichselian late Middle Paleolithic. The main points of interest for this study are the chronology of each site, the type of blank production, the flake indices (LWI, RTI, WTI), the bifacial tool classes and the presence of backing as well as the occurrence of the Keilmesser-concept in different tool types. The survey collection finds of Tagebau Goitzsche are excluded from this comparison, as they are biased through fluvial post-depositional processes and collection- or survey strategies. Nevertheless, it should be kept in mind that the analysis revealed strong relations between the two assemblages.

Lichtenberg

In the open-air site Lichtenberg (Fig. 1), Lower Saxony (Veil et al. 1994), the artifacts were found in a sandy, cryoturbated slope sediment with intrusions of silt and fine gravels. The TL-ages for the find layer and the associated layer below are 66.2 ± 14.6 ka (Li 50/46.5F) and 52.0 ± 6.8 ka (Li 55/47F) as well as 71.2 ± 42 ka (Li 50/46.5U) and 54.2 ± 11.8 ka (Li 55/47U) (Veil at al. 1994). The calculated average age of 57 ± 6 ka places the site most likely in early MIS 3 or MIS 4 (Jöris 2004; Veil et al. 1994).

In Lichtenberg, bifacial backed knives, leaf-shaped scrapers, handaxes and leaf-shaped handaxes were often produced on frost fractured materials or natural cobbles that had already the shape of the desired tool and required less form shaping (Veil et al. 1994). Veil et al. (1994) state that the most common and most important feature of the Lichtenberg bifacial and unifacial tools is a convex cutting edge opposite a blunt edge or back. The same concept is characteristic of the assemblage of Pouch/TPf. The raw material characteristics of Lichtenberg and Pouch/TPf are distinct, frost fractured pieces and cobbles versus abundant large blocks of flint respectively. Therefore, the concept of a back in relation to a sharp convex cutting edge and a tip was carried out differently in response to these specific local circumstances. This led, for instance in the case of Pouch/TPf, to the production of large flakes which were used as blanks for tools, therefore resulting in a higher proportion of flake tools in the assemblage. Some of the tool types found in Lichtenberg, like handaxes or leaf-shaped handaxes, are not present in the record of Pouch/TPf, but the contemporary presence of such tools in the area is evidenced by the assemblage of the collected artifacts. However, a second important aspect connecting Pouch/TPf and Lichtenberg is the occurrence of backed knives and backed scrapers in both assemblages. Regarding the blank production, Levallois concepts are visible in Lichtenberg, although most flakes in this assemblage seem to be the result of retouch or bifacial knapping. As the low mean RTI of 16.5 (pers. conv. Th. Weber) for Lichtenberg indicates rather thin flakes. This could also be due to the fact that most flakes result from bifacial shaping. The mean LWI is 1.17 and the mean WTI is 3.97 (pers. conv. Th. Weber) for the Lichtenberg flakes. These Lichtenberg values differ to that of Pouch/TPf (Fig. 8), as the flakes in the latter tend to be more elongated and relatively thicker.

Salzgitter-Lebenstedt

Salzgitter-Lebenstedt is situated about 12 km southwest of Brunswick, Lower Saxony (Fig. 1). All stone artifacts have sharp edges and bones were found in anatomical connection in different geological layers suggesting low energy fluvial deposition with the finds not exposed to strong post-depositional processes (Pastoors, 2009). Because the artifacts show a strong typological conformity, the material of Salzgitter-Lebenstedt was treated as one sample by most of the researchers (Gaudzinski 1998; Pastoors 2001, 2009; Schäfer 1993; Tode 1982), despite having been recovered from 19 geological layers (Pastoors 2009). Recent radiocarbon dates on worked animal bone (Fig. 2) range from 1σ ~45 000 calBP to ~50,000 calBP (Pastoors 2009) and confirm the MIS 3 age obtained from prior dating efforts (Pastoors 2001). The ages of the samples KIA-34481 and KIA-34482 presented in (Fig. 2) were considered by Pastoors (2009) as too young due to contamination. It should be noted that Jöris (2003, 2006) proposes an older age for the site, around Greenland Interstadial (GI)-20 (Rasmussen et al. 2014) or late MIS 5. He attributes the cryoturbated cover sands of the find layer to the peak of MIS 4.

The site is best known for its worked mammoth ribs (Gaudzinski 1998, 1999) and human remains attributed to Neanderthals (Gaudzinski 1998; Hublin 1984). The assemblage of Salzgitter-Lebenstedt (Pastoors 2001) includes unidirectional, divergent and other bidirectional concepts of the prepared cores as well as the presence of non-Levallois cores. The mean values of the morphometric flake indices LWI (1.22), RTI (23) and WTI (3.8) (Schäfer 1993) are closer to those of Pouch/TPf (Fig. 8) as compared to Lichtenberg, indicating a similar flake production in Salzgitter-Lebenstedt and Pouch/TPf. Tools on blanks detached from prepared cores are quite frequent in Salzgitter-Lebenstedt. The site is well known for its handaxes, but bifacial tools include also leaf-shaped bifacial tools, bifacial backed knives and bifacial scrapers. The concept of a back opposite a sharp functional edge is also frequent in Salzgitter-Lebenstedt. Pastoors (2001) lists zig-zag-shaped backs, massive backs and platforms that serve as backs. Scrapers with retouched tips, sometimes in combinations with a natural back, are common in the assemblage as well (Tode 1982). And, like in Lichtenberg and Pouch/TPf, backed scrapers (6) and backed knives (4) are present.

Neumark-Nord 2/0

The open-air site Neumark-Nord 2/0 (NN 2/0), Saxony-Anhalt (Fig. 1) is situated in shore sediments of a former lake in which the artifacts and animal bones were embedded, consisting of fine sand with fine gravel components (Hesse & Kindler 2014; Laurat & Brühl, 2006). The OSL ages obtained on quartz from the sediment are in perfect agreement from two independent studies, giving 88 ± 8 ka (Strahl et al. 2010) and 93 ± 7 ka (Richter & Krbetschek 2014). As the sediment deposition represents a maximum age for the artifacts, the archaeological remains have to be placed in MIS 5c or 5a (Richter & Krbetschek 2014). This is in agreement with the Eemian age of the underlying layer Neumark-Nord 2/2 (Sier et al. 2011; Strahl et al. 2010; Richter & Krbetschek 2014).

Prepared core techniques are very rare in NN 2/0 (Laurat & Brühl 2006). Most of the cores are opportunistically flaked chunks (Laurat & Brühl 2006). Bifacial backed knives, leaf-shaped scrapers and bifacial scrapers are present in the record, but their dimensions are quite small with lengths mostly between 3 to 5 cm (Laurat & Brühl 2006). Backs do not seem to play an important role in the assemblage, although some knives with natural and thinned backs were reported (Laurat & Brühl 2006). Backed knives are not present in the assemblage of NN 2/0. In contrast to the above mentioned two sites, the assemblage of NN 2/0 has only a two characteristics in common with Pouch/TPf, which are the presences of bifacial backed knives and leaf-shaped scrapers.

Königsaue

Situated in the northern Harz foreland of Saxony-Anhalt (Fig. 1), the open-air site Königsaue (Mania 2002a; Mania & Toepfer 1973) was discovered in 1963. The Middle Paleolithic artifacts were found in peaty sediments in the lower part of a geological profile, which gained importance because it covers, according to Mania (1973, 2002a), a time period from the Eemian up to the Holocene. This interpretation is based on the assumptions that the layers at the bottom of the sequence belong to the Eemian and that every transgression-regression cycle of the lake, visible in peat accumulations in turn with sand/silt sediments, represents interstadials and stadials respectively. Either 11 (Mania & Toepfer 1973) or 15 sediment cycles (Mania 2002a) are visible in the profile. Embedded in the peat sediments intermixed with sand accumulations of the sedimentation cycle Ib, three archaeological layers, Königsaue A, B and C, were excavated. Five ^{14}C-dates of the Middle Paleolithic layers are available. The first three are on bulk sediment from the geological unit Ib (Mania 2002a; Mania & Toepfer 1973): >55 800 BP (GrN-5698), >45 000 BP (B 626) and 60 000 + 1 400/-1 200 BP (GrN-7001). All these dates have to be treated with caution, as they were done with older non-AMS dating techniques. Two of them are also infinite ages and GrN-7001 is out of range for the calibration curve. Therefore, they were not calibrated and mentioned in Figure 2. Two additional radiocarbon dates were made in 1998 (Hedges et al. 1998) on two birch tar pieces, one bearing artifact and wood imprints. The latter, found in Königsaue A, revealed an age of 1σ: ~46 000 calBP to 49 000 calBP (Fig. 2), the radiocarbon results for the second piece from Königsaue B are out of range for the calibration curve (Fig. 2). Nevertheless, these dates should be regarded with caution, as they are at the limit of the radiometric dating method and significant improvements were made for other materials, which might apply for tar as well and which revealed many reported finite ages to be in fact infinite after more rigorous approaches (Higham 2011; Talamo & Richards 2011; Wood et al. 2012). Mania

(2002a) also disagrees with these dates based on the geology, which places the artifacts clearly in MIS 5a (Odderade). Whether or not this is the case was highly debated recently (Jöris 2004; Mania 2002a; Richter 2002) and the problem is not yet resolved. Königsaue could be placed either in early MIS 3 or MIS 5a.

Three artifact concentrations were identified and assigned to three different cultural groups (Mania 2002a; Mania & Toepfer 1973): Königsaue A (Kö A) represents Micoquian (sensu Bosinski 1967), Königsaue B (Kö B) is assigned to a Mousterian material culture and Königsaue C (Kö C) is thought to be Micoquian again (Mania 2002a; Mania & Toepfer 1973). Following Mania (2002a) the assemblage of Königsaue A is characterized by a Levallois like flake production and a high amount of bifacial tools. The flakes have a mean LWI of 1.24, a mean RTI of 19.4 and a mean WTI of 3.7 (Schäfer 1993). 25 of 102 tools are bifacially shaped. Among them are bifacial backed knives (11), leaf-shaped handaxes (Faustkeilblätter) (6), leaf points (2), a bifacial point, a bifacial scraper and four fragments (Mania 2002a). Some of the 45, in some cases unifacial, scrapers have a convex cutting edge in combination with a retouched tip. Five naturally backed knives with use-wear and 4 backed knives are also present in the assemblage. The rest of the tools are Levallois points, denticulates and choppers.

The composition of the assemblage of Kö B is described by Mania (2002a) as being also characterized by a Levallois like flake production on oval cores. The mean flake indices are: LWI=1.21, RTI=24.1 and WTI=3.8 (Schäfer 1993). In contrast to Kö A, the proportion of bifacial tools is quite low with one handaxe and two unfinished handaxes among 135 tools. 38 tools are scrapers on flakes with predominantly dorsal retouched edges. Another category are 38 flakes with use wear, among them 13 naturally backed knives and one backed knife. Additional tool forms are notches and denticulates, borers, end scrapers and choppers.

Kö C has also a blank production on prepared cores (Mania 2002a). The mean LWI of the flakes is 1.21, the mean RTI is 23.3 and the mean WTI is 3.9. The proportion of tools, 8 % of the assemblage, is very low (n=24). 14 tools are classified as bifaces, among them bifacial backed knives, leaf-shaped handaxes, leaf points and bifacial scrapers. Eight of the bifacial scrapers have a Quina-like edge retouch. The remaining tools consist of scrapers, end scrapers, denticulates, flakes with use-wear and a naturally backed knife (Mania 2002a).

In light of the presented analysis of Pouch/TPf the techno-typological differentiation can be questioned. First of all, prepared core techniques on oval cores dominate the blank production in all three assemblages. The morphometric flake indices (Fig. 8) are very similar for Kö A, B and C (Schäfer 1993). Furthermore, their LWI, RTI and WTI are closely related to those at Pouch/TPf and Salzgitter-Lebenstedt (Schäfer 1993). The relation of these indices to Lichtenberg is not quite clear, because in Lichtenberg flakes were produced during bifacial shaping. The simple scrapers, detached from prepared cores and a dominance of dorsal edge retouch, found in Kö B are present in Pouch/TPf as well. Naturally backed knives with use wear (Kö A – C) and backed knives (Kö A and B) are present in the Pouch/TPf record. The flexibly applied Keilmesser-concept observed in Pouch/TPf is found mostly in Kö A and C: besides bifacial backed knives in both assemblages, unifacial scrapers with a retouched tip are additionally found in Kö A. One leaf-shaped scraper with a Quina-like edge retouch was observed in Pouch/TPf and is also present in Kö C. Bifacial tools were found in all three Königsaue levels: mostly bifacial backed knives and leaf-shaped bifacial tools in Kö A and Kö C and handaxes in Kö B. The former types are present in Pouch/TPf as well. Based on these aspects it is concluded that there is no technological or morphological difference between the three levels found in Königsaue and that they show striking affinities to Pouch/TPf.

Concluding comparison of the sites

Comparing the morphometric flake indices to the data from other Lower and Middle Paleolithic sites from Schäfer (1993), all the presented sites are technologically related (Fig. 8). Their indices fall all in the range for the Weichselian Middle Paleolithic described by Schäfer (1993). Pouch/TPf differs slightly concerning its higher mean value for the LWI, meaning that the flakes at this site are more elongated. Lichtenberg has a low RTI, indicating that the flakes are very thin. This could be the result of producing flakes during bifacial form shaping. Regarding typological-morphological aspects of variability presented in this study, together with similarities in the blank production (Fig. 8) the sites Pouch/TPf, Salzgitter-Lebenstedt, Lichtenberg and Königsaue appear to share certain characteristics regarding their stone tool inventories, whereas NN 2/0 is different in terms of a blank production that is rather opportunistic and tools that are rather small. Bifacial tools, like bifacial backed knives are present within this assemblage, but morphological concepts like backing and a variety of backs, as well as the concept of a back in relation to a cutting edge and a tip (Keilmesser-concept) are only visible in bifacial tools. In contrast, the two morphological concepts that are part of stone tool variability at the site of Pouch/TPf (the occurrence of backs and backing and the flexible application of the Keilmesser-concept) are found in all the the other three sites. To summarize, the Neanderthals producing these late Middle Paleolithic assemblages seemed to share a common technological package, like prepared core techniques, a certain concept of knives, including a back, a sharp edge and a tip (Keilmesser-concept), a variable concept of a back, including backing, as well as a

site	raw material	dominant blank production	morphological flake indices	bifacial tools	backing	Keilmesser-concept	age estimation	reference
Neumark-Nord 2/0	local baltic flint (moraine deposits) and others	opportunistic	not available	bifacial backed tools, leaf-shaped scrapers, bifacial scrapers	no	yes (only bifacial tools)	MIS 5c or MIS 5a (OSL)	Laurat & Brühl 2006; Strahl et al. 2010; Richter & Krbetschek 2014
Pouch/Tpf	local baltic flint, abundant in the river gravels (reworked moraine deposits)	unidrectional and bidirectional methods on prepared cores and non-Levallois	LWI=1.43 RTI=21.37 WTI=3.64	bifacial backed tools, leaf-shaped bifacial tools	yes	yes	early MIS 3 (OSL)	this paper
Salzgitter-Lebenstedt	local baltic flint (moraine deposits), flinty slate	unidrectional and bidirectional methods on prepared cores and non-Levallois	LWI=1.22 RTI=23 WTI=3.8	bifacial backed tools, leaf-shaped bifacial tools, bifacial scrapers, handaxes	yes	yes	early MIS 3 (C14)	Schäfer 1993; Tode 1982; Pastors 2001,2009
Lichtenberg	mostly local frost fractured baltic flint pieces (moraine deposits)	bifacial form shaping, prepared core techniques possible	LWI= 1.17 RTI= 16.5 WTI= 3.97	bifacial backed tools, leaf-shaped bifacial tools, handaxes	yes	yes	late MIS 4 to early MIS 3 (TL)	Veil et al. 1994, pers. conv. Th. Weber
Königsaue A	local baltic flint (moraine deposits)	prepared cores	LWI=1.24 RTI=19.4 WTI=3.7	bifacial backed tools, leaf-shaped bifacial tools, bifacial scraper (1)	yes	yes	MIS 5a or early MIS 3 (C14)	Mania & Toepfer 1973, Mania 2002, Schäfer 1993
Königsaue B		prepared cores	LWI=1.21 RTI=24.1 WTI=3.8	handaxes	yes	no		
Königsaue C		prepared cores	LWI=1.21 RTI=23.3 WTI=3.8	bifacial backed tools, leaf-shaped bifacial tools, bifacial scrapers	no	yes (only bifacial tools)		

Fig. 8. Comparison table of the sites mentioned in the text with respect to the raw material used, the dominant blank production method, the morphometric flake indices, the types of bifacial tools, the occurrence of backing and the Keilmesser-concept with age estimations for the sites.

Abb. 8. *Vergleichstabelle der im Text behandelten Fundstellen bezüglich des genutzten Rohmaterials, der dominierenden Grundformenproduktion, der morphometrischen Abschlagindices, der bifazialen Gerätetypen, das Auftreten von Rückenstumpfung sowie dem Keilmesser-Konzept und die Alterseinschätzung für die Fundstelle.*

common pool of bifacial tool varieties, like bifacial backed tools, leaf shaped bifacial tools or handaxes. All these concepts, from blank production on prepared cores to tool shaping, were applied flexibly and adapted to the local circumstances, e.g. raw material availability, raw material quality, size or shape. A study to explore these morphological concepts more in depth and to look how different morphological features like back, cutting-edge and tip are related to one another is in progress.

The chronology of the late Middle Paleolithic in central Germany

The chronology of the late Middle Paleolithic in central Germany is ambiguous at the moment. The OSL-dates and some of the radiocarbon dates of Pouch/TPf show an early MIS 3 age for the site (Fig. 2). Salzgitter-Lebenstedt, as suggested by the recent radiocarbon dates (Fig. 2), can most probably be attributed to early MIS 3 as well. The OSL-ages for Neumark-Nord are quite solid, as two independent measurements (Strahl et al. 2010; Richter & Krbetschek 2014) obtained identical results placing the occupation of NN 2/0 in the range of MIS 5c or MIS 5a, which is consistent with the geology and dating results as well as palynology for underlying layers (Sier et al. 2011; Strahl et al. 2010, Richter & Krbetschek 2014). For Lichtenberg, the situation is more complicated. The geology suggests an age younger than MIS 5 (Veil et al. 1994), consistent with the TL-ages placing it in an age range between MIS 4 or early MIS 3. Königsaue can be attributed either to MIS 5a or to early MIS 3 based on geology and debatable radiocarbon dates respectively. While NN2/0 is clearly attributable to MIS 5 all the other sites with undisputed chronometric age determination which are all also techno-typologically different are placed in MIS 3.

Conclusions

In the present study, the late Middle Paleolithic stone artifacts of the excavated site Pouch/TPf and of the collected assemblage, all situated in the former quarry Tagebau Goitzsche, were analyzed. It was shown that both assemblages are closely related in terms of flaking technologies and stone tool morphologies. OSL-dates for Pouch/TPf place the site – and based on the artifact similarity the related GC finds from the same geological context – in early MIS 3. The artifacts of the excavated site Pouch/TPf show a close relationship to four late Middle Paleolithic central German sites in their morphological flake indices. However, in terms of dominant blank production and tool morphology, one of them, Neumark-Nord 2/0, is distinct from the assemblage of Pouch/TPf and all others: its blank production is rather opportunistic, the Keilmesser-concept is only visible in the bifacial tools and backing does not seem not to play an important role in the tool morphology. NN 2/0 is OSL-dated to an age within MIS 5c or MIS 5a.

On the other hand, the sites Lichtenberg, Salzgitter-Lebenstedt and Königsaue A-C share certain features with the assemblage of Pouch/TPf:

1. A variety of prepared core techniques, including Levallois sensu stricto, represent the major mode of blank production, dominated by uni- and bidirectional flaking methods.
2. Common bifacial tool concepts occur in distinct frequencies at the individual sites: bifacial backed knives, leaf-shaped bifacial tools (including leaf-shaped scrapers and Faustkeilblätter), bifacial scrapers, partial bifaces and handaxes.
3. The majority of the functional edges on tools are convex, but straight-convex and straight edge shapes occur as well.
4. The tool concept of a blunt edge or back opposite a sharp cutting edge and in some cases the shaping of a tip at the distal end of the tool (Keilmesser-concept), is applied on bifacial, unifacial and simple flake tools as well as on different blank types and causes, therefore, a great amount of variability in tool appearances.
5. The concept of a back is variable in its application: thick cortical backs, cortical backs and retouch, retouch (backing), steep dorsal flake scars or remains of a former core margin on a flake or a thick platform that was used as a back.
6. Backed knives, although in a low quantity, and backed scrapers occur in all of the assemblages (except Kö C). It has to be emphasized that backed knives are understood as a characteristic of the contemporary MTA in France (Ruebens et al. 2015; Soressi 2002) and that they are supposed to be rare in central Europe (Ruebens et al. 2015).

Pouch/TPf and Salzgitter-Lebenstedt date most probably in early MIS 3, while the ages of Königsaue and Lichtenberg are considered as not well established and it is therefore not clear if these sites are contemporaneous. The OSL-dates of Pouch/TPf and the similarity of the assemblage to Salzgitter-Lebenstedt, Lichtenberg and Königsaue are in line with the chronology of the MMO proposed by Richter (1997, 2002). However, more chronometric data, whether relative or chronometric, and the study of broader European context of these regional entities is required.

An important result of this study is the flexibility of the Keilmesser-concept and how it was applied on different tool classes in some central German sites. In the case of Pouch/TPf, it appears that simple- and unifacial tools, which show features of bifacial backed knives, as well as bifacial backed knives themselves, represent different stages of transformations of a single concept. This idea supports the interpretation Krukowski (1939) made for the Polish LMP assemblages, when he defined the Prądnik Culture or the Prądnik Cycle at the beginning of the last century.

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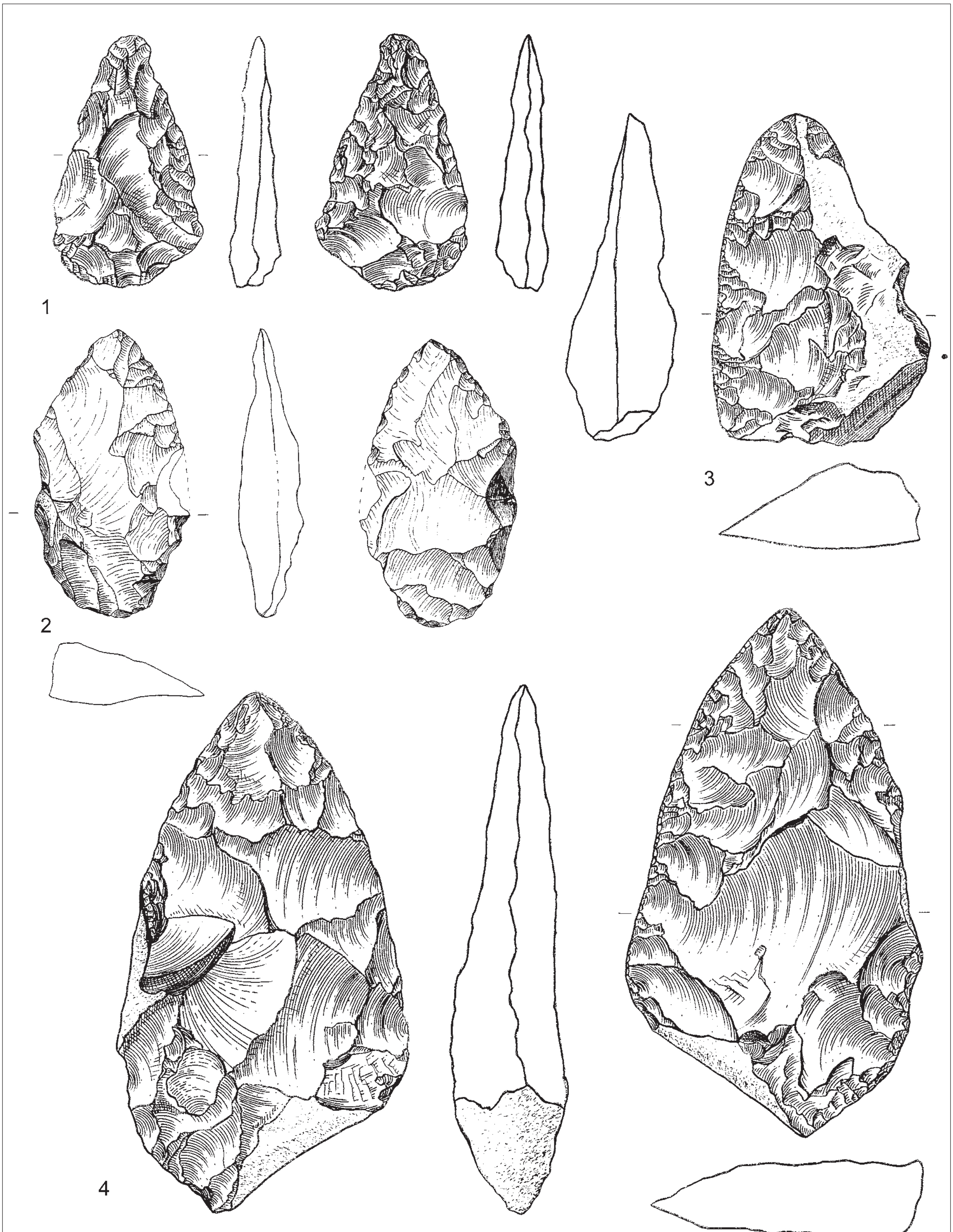
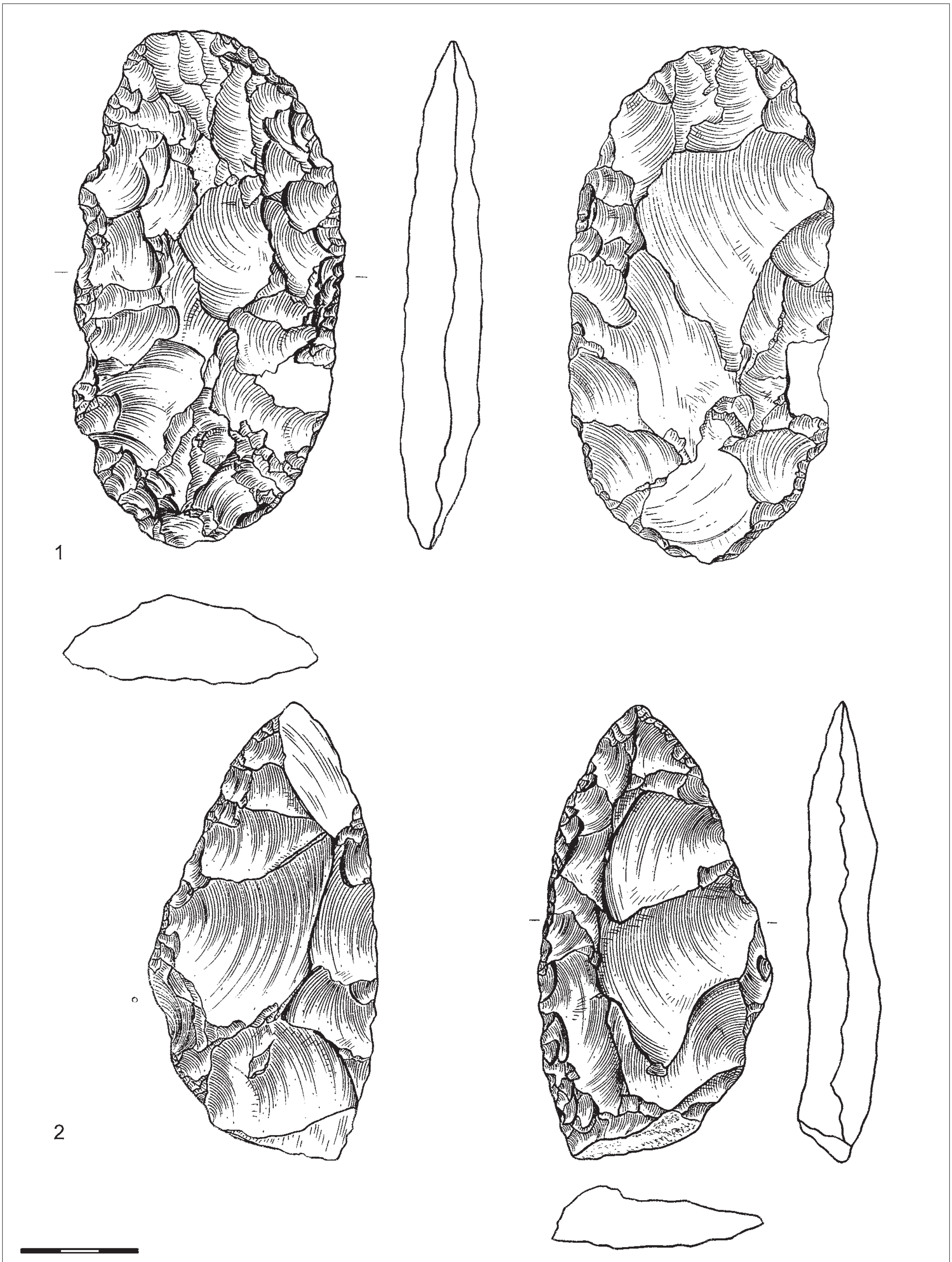


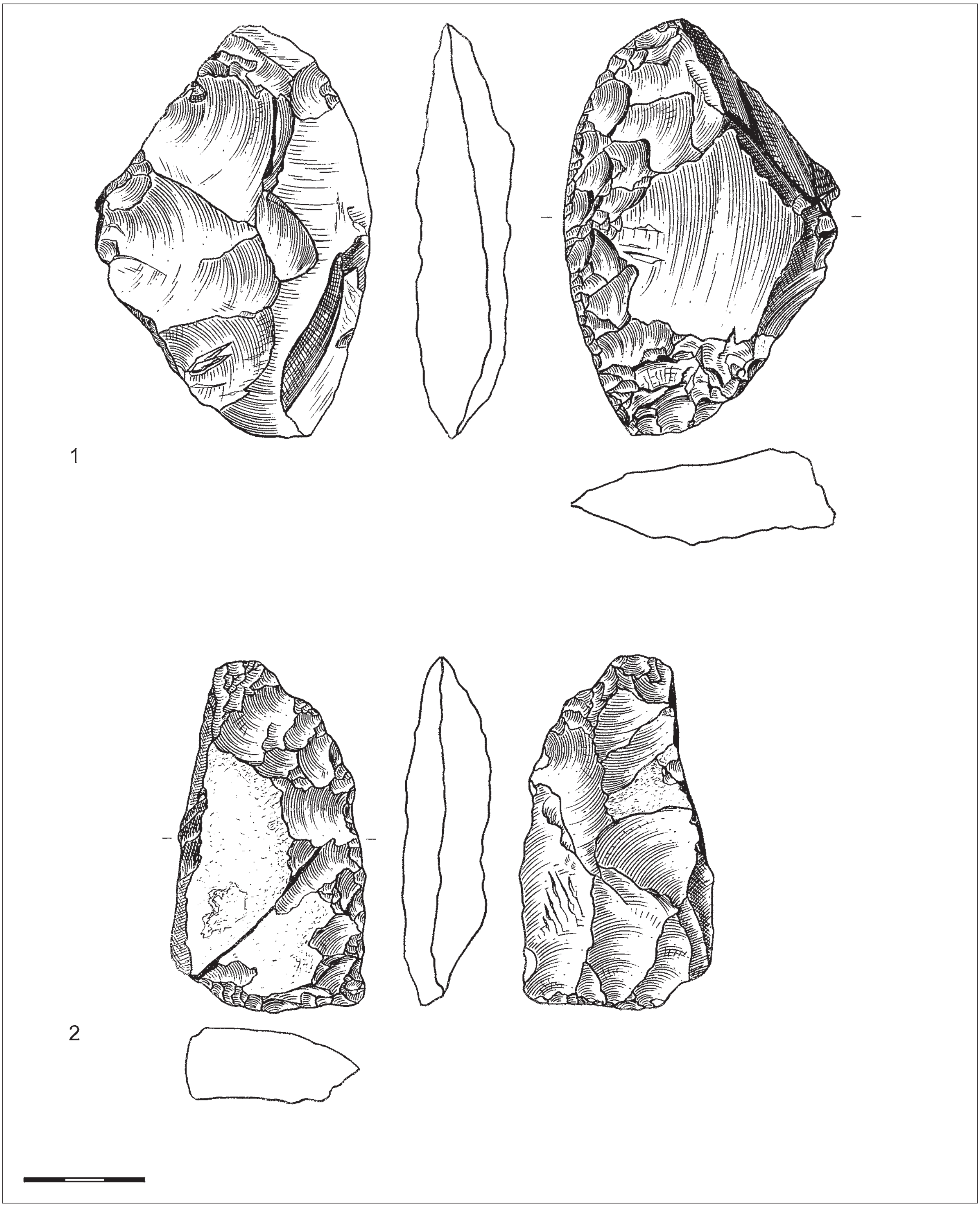
Appendix, Plate 1. Collected artifacts in the former brown coal quarry „Tagebau Goitzsche - Baufeld Rösa-Sausedlitz" (GC). (1) bifacial point (2004:25473), Lower Terrace gravel dump north of the quarry, (2) bifacial backed knife (SSZ-7/1/98), "Weinberg", Sausedlitz, (3) unifacial scraper with natural back (SSZ-16/1/324), „Hilfsdrehpunkt", Sausedlitz, (4) (leaf-shaped -) handaxe (SSZ-16/1/306), Lower Terrace gravel dump, Pouch. ⅔ natural size; drawings: 1, 3-4: W. Bernhardt, 2: M. Weiß.

Appendix, Tafel 1. *Sammelfunde aus dem ehemaligen Braunkohletagebau „Tagebau Goitzsche - Baufeld Rösa-Sausedlitz" (GC), (1) bifaziale Spitze (2004:25473), aufgeschüttete Niederterrassenschotter nördlich des Baufelds, (2) Keilmesser (SSZ-7/1/98), „Weinberg", Sausedlitz, (3) unifazialer Schaber mit natürlichem Rücken (SSZ-16/1/324), „Hilfsdrehpunkt", Sausedlitz, (4) (blattförmiger-) Faustkeil (SSZ-16/1/306), durch den Tagebaubetrieb umgelagerte Niederterrassenschotter, Pouch. ⅔ natürliche Größe; Zeichnungen: 1, 3-4: W. Bernhardt, 2: M. Weiß.*



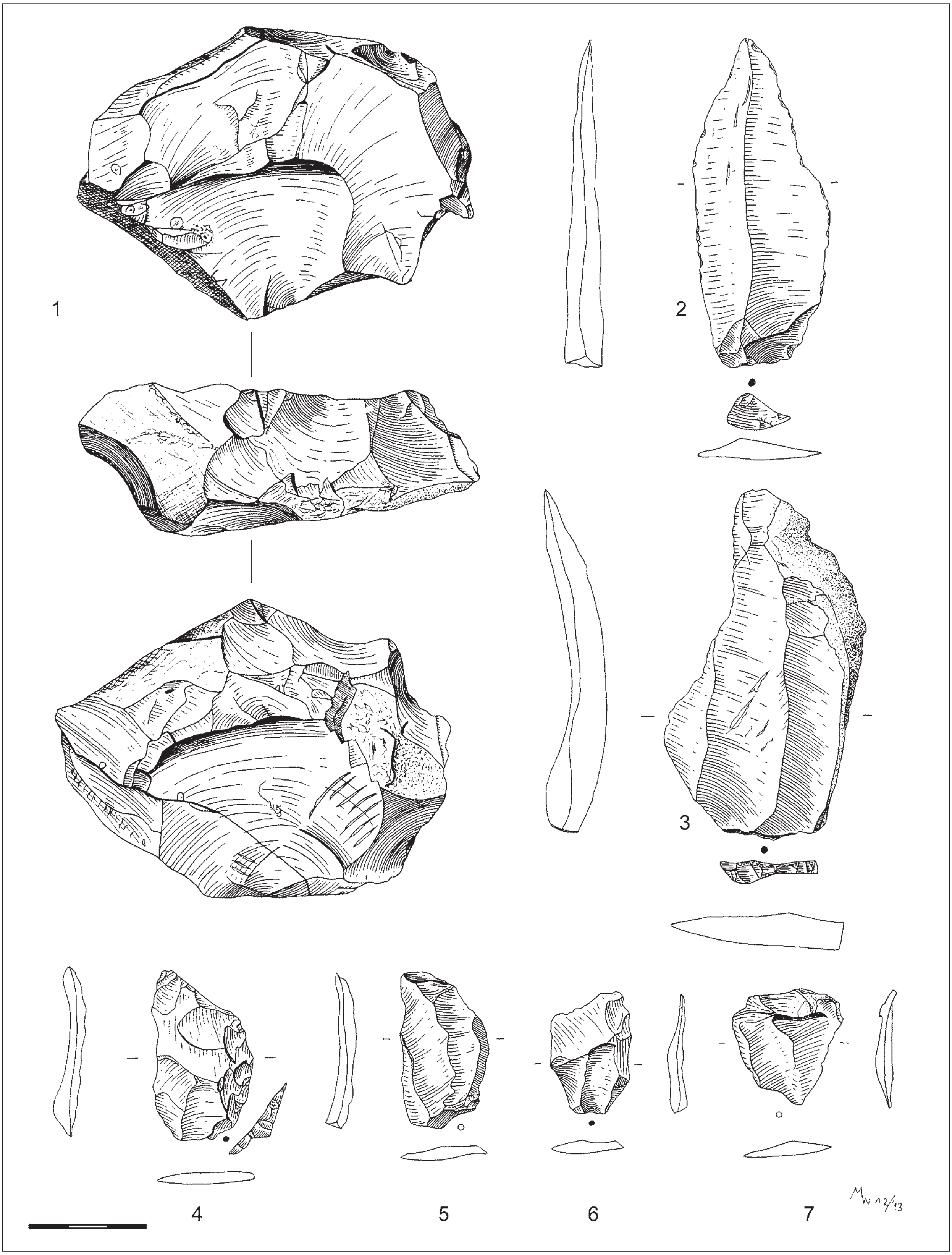
Appendix, Plate 2. Collected artifacts in the former brown coal quarry "Tagebau Goitzsche - Baufeld Rösa-Sausedlitz" (GC). (1) leaf-shaped scraper (2001:2020), Bärenhof-Montageplatz, Pouch, (2) leaf-shaped handaxe with thinned back (9852:1:1), western slope, Pouch. ⅔ natural size; drawings: W. Bernhardt.

Appendix, Tafel 2. *Sammelfunde aus dem ehemaligen Braunkohletagebau "Tagebau Goitzsche - Baufeld Rösa-Sausedlitz" (GC). (1) blattförmiger Schaber (2001:2020), Bärenhof-Montageplatz, Pouch, (2) Faustkeilblatt mit verdünntem Rücken (9852:1:1), westliche Böschung, Pouch. ⅔ natürliche Größe; Zeichnungen: W. Bernhardt.*



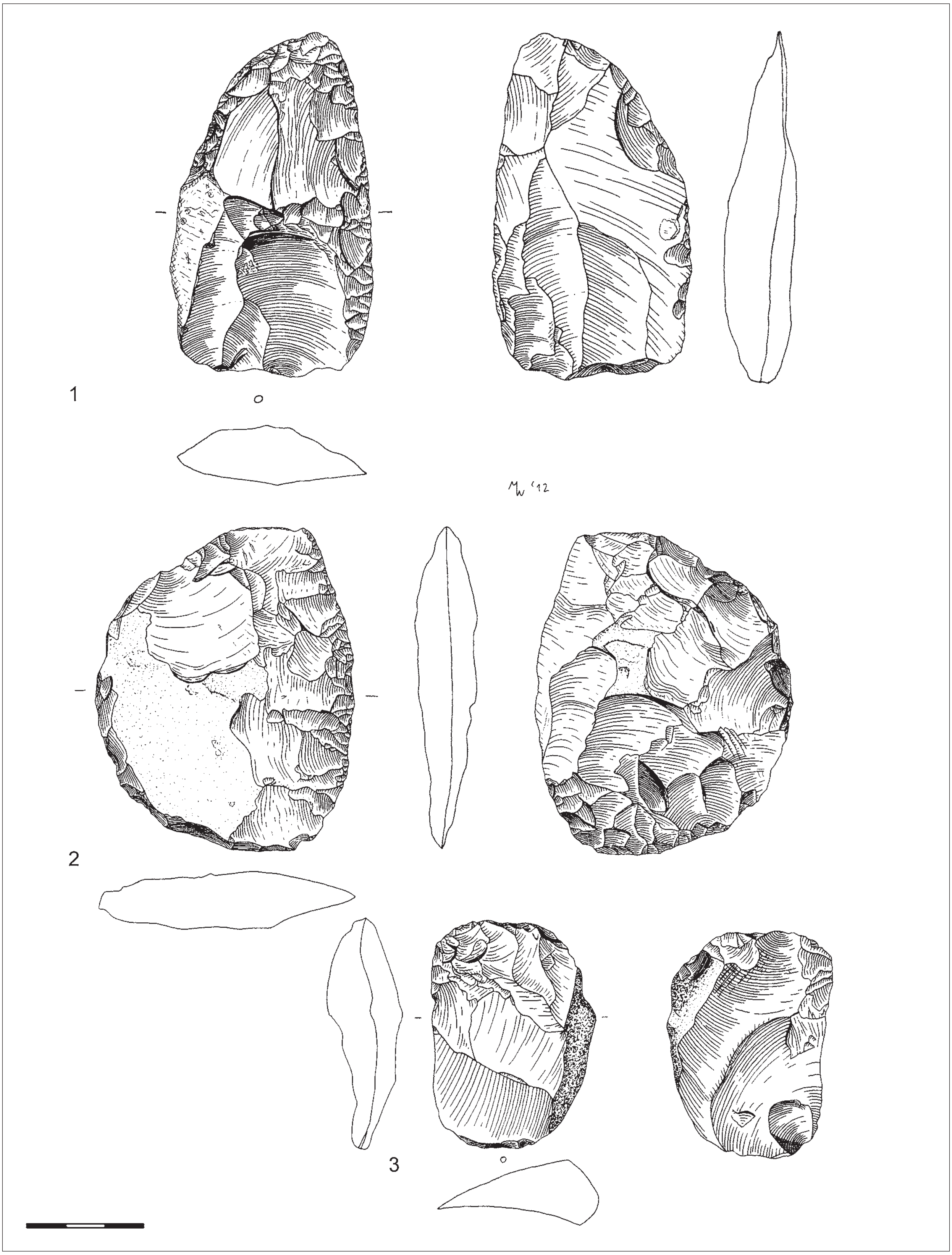
Appendix, Plate 3. Collected artifacts in the former brown coal quarry "Tagebau Goitzsche - Baufeld Rösa-Sausedlitz" (GC). (1) bifacial scraper (SSZ-16/1/270), eastern part of the southern slope, Sausedlitz, (2) bifacial backed knife (SSZ-16/1/35), "Hilfsdrehpunkt", Sausedlitz. ⅔ natural size; drawings: W. Bernhardt.

Appendix, Tafel 3. *Sammelfunde aus dem ehemaligen Braunkohletagebau „Tagebau Goitzsche - Baufeld Rösa-Sausedlitz" (GC), (1) bifazialer Schaber (SSZ-16/1/270), östliches Areal der südlichen Böschung, Sausedlitz, (2) Keilmesser (SSZ-16/1/25), „Hilfsdrehpunkt", Sausedlitz. ⅔ natürliche Größe; Zeichnungen: W. Bernhardt.*



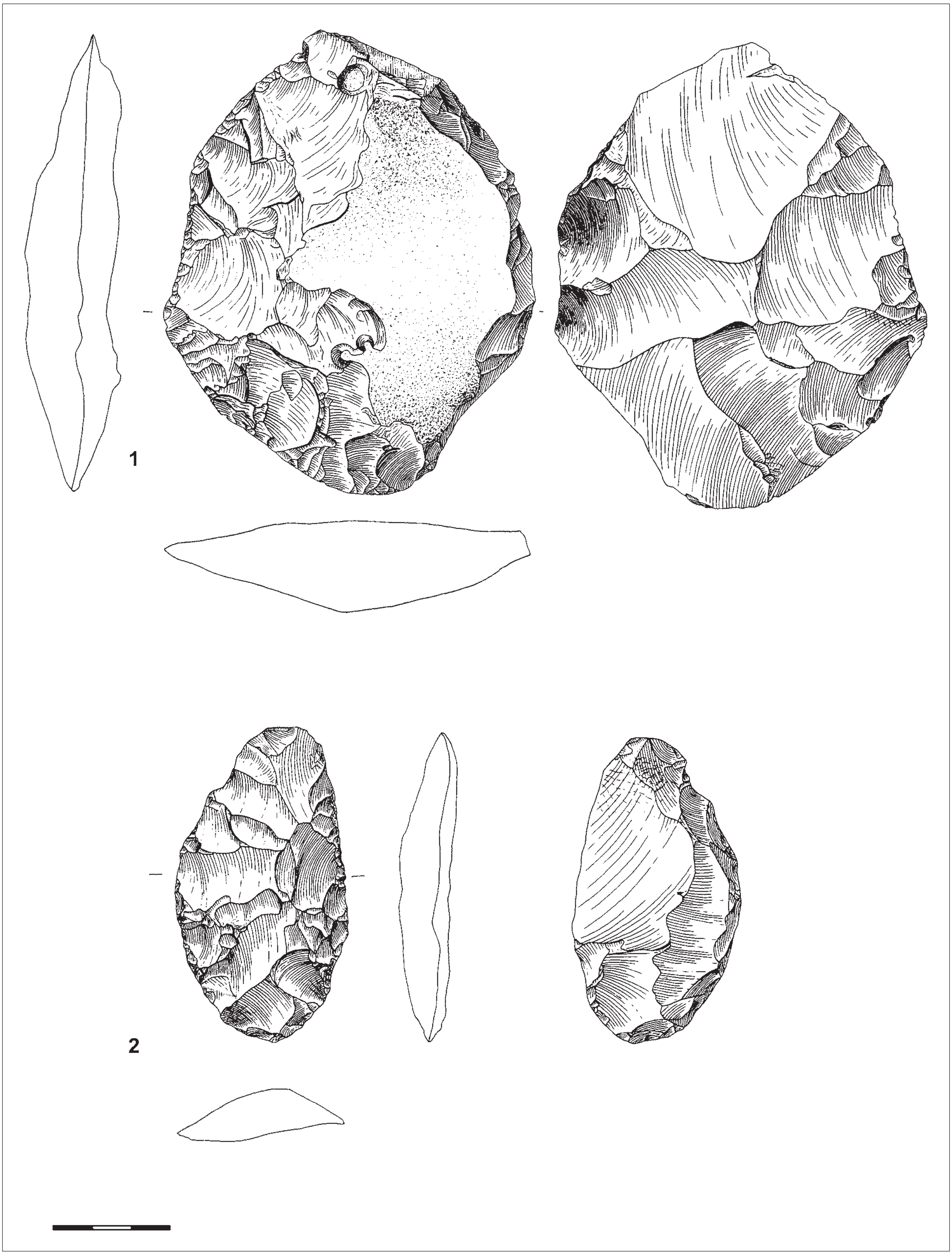
Appendix, Plate 4. Core and flakes, site Pouch/TPf. (1) core, unidirectional recurrent with prepared core edges (2004:8680,135), (2) flake, blade (2004:8680, 60), (3) flake, éclat débordant (2004:8680, 61), (4) – (7) retouch debris (2004:8680, 91; 2004:8680,85; 2004:8680,89; 2004:8680,88). ⅔ natural size; drawings: M. Weiß.

Appendix, Tafel 4. *Kern und Abschläge, Fundstelle Pouch/TPf. (1) unipolar zyklischer Kernstein mit präparierten Kernkanten (2004:8680,135), (2) Abschlag, Klinge (2004:8680, 60), (3) Kernkantenabschlag (2004:8680, 61), (4) – (7) Retuschierabfälle (2004:8680, 91; 2004:8680,85; 2004:8680,89; 2004:8680,88). ⅔ natürliche Größe; Zeichnungen: M. Weiß.*



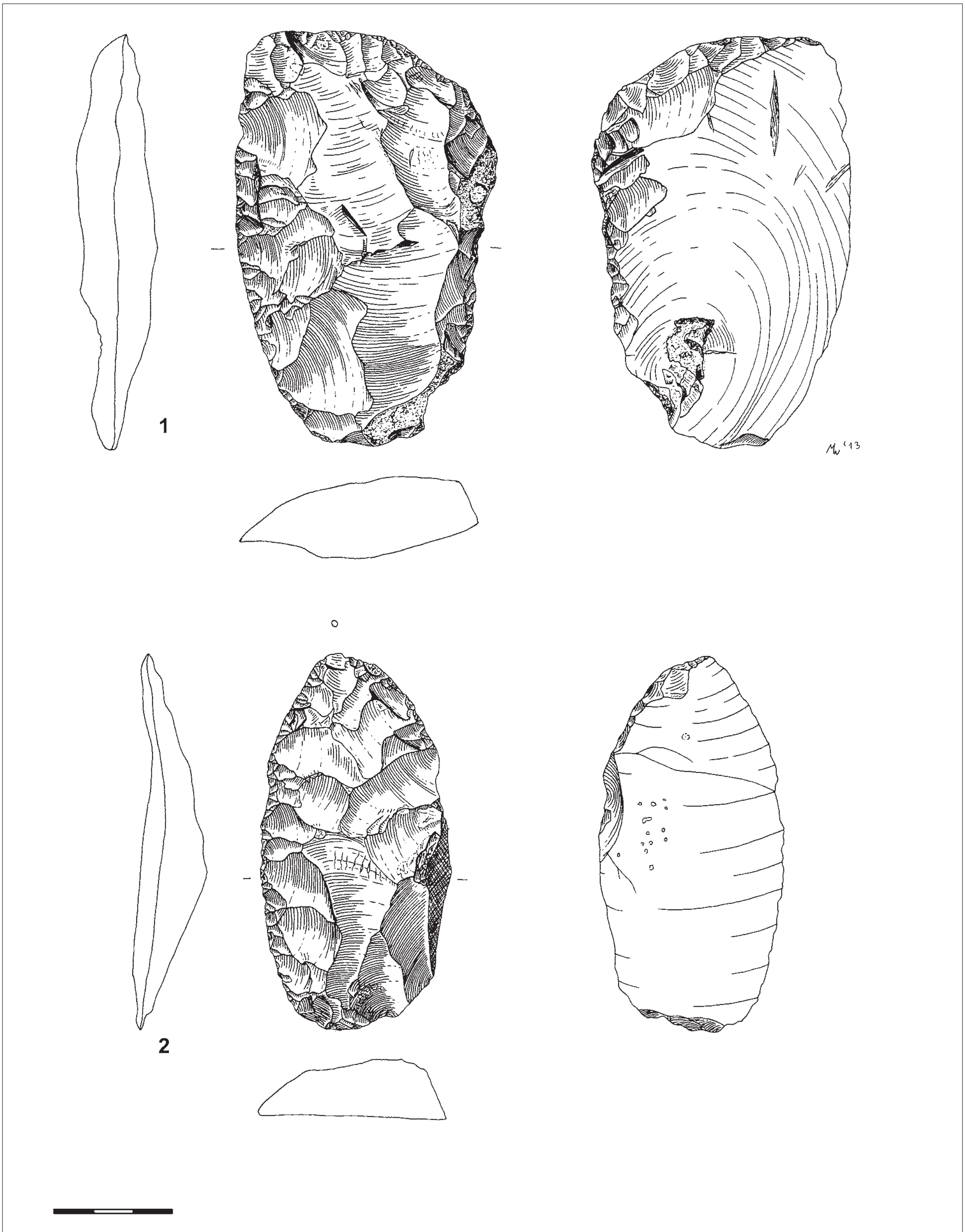
Appendix, Plate 5. Bifacial tools, site Pouch/TPf. (1) bifacial backed knife, made of a flake (2004:8679,2), (2) bifacial backed knife (2004:8679,55), (3) bifacial backed knife, made of a flake (2004:8679,46). ⅔ natural size; drawings: M. Weiß.

Appendix, Tafel 5. *Bifaziale Geräte, Fundstelle Pouch/TPf. (1) Keilmesser aus Abschlag (2004:8679,2), (2) Keilmesser (2004:8679,55), (3) Keilmesser aus Abschlag (2004:8679,46). ⅔ natürliche Größe; Zeichnungen: M. Weiß.*



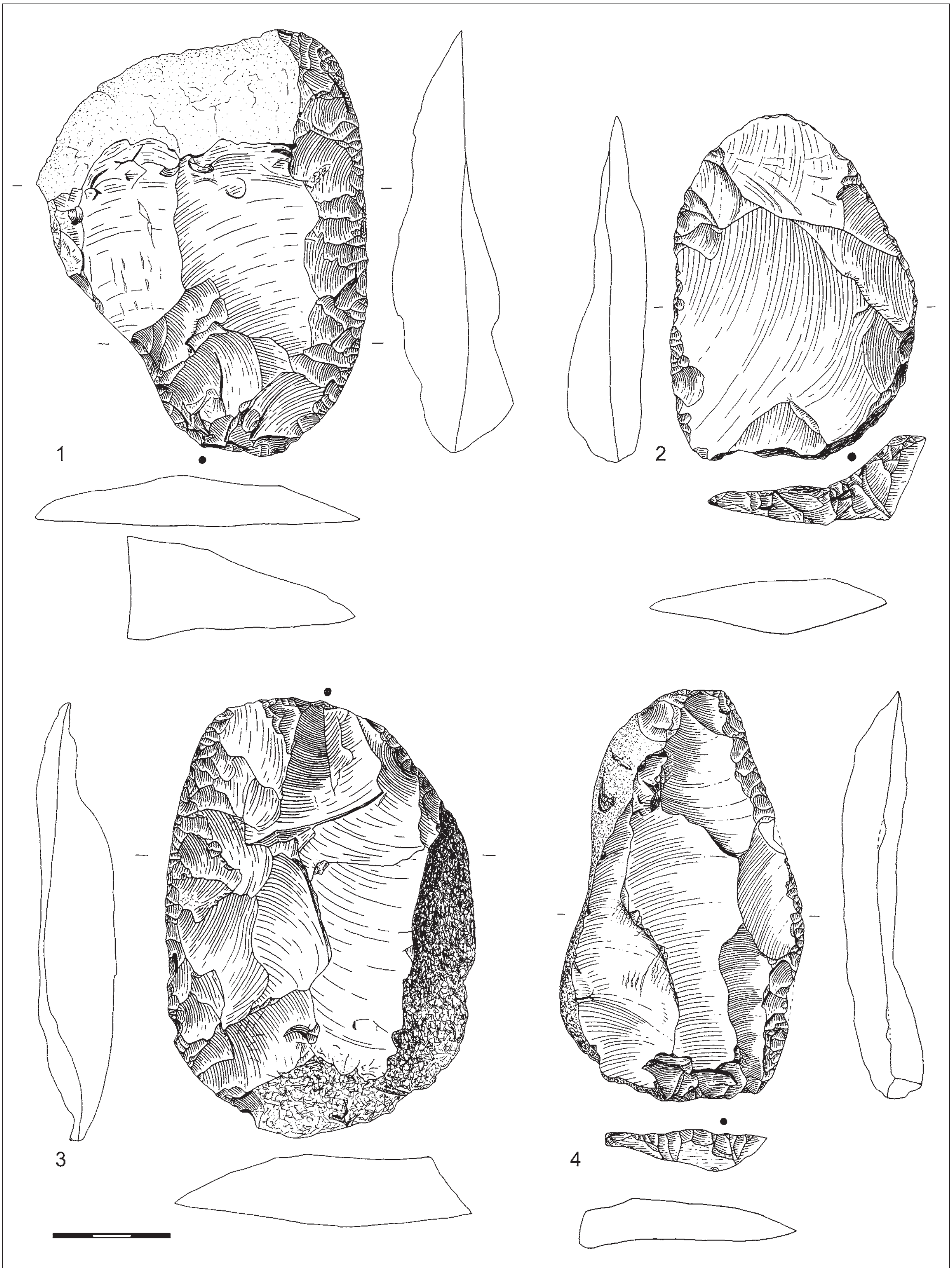
Appendix, Plate 6. Bifacial tools, site Pouch/TPf. (1) leaf-shaped scraper made of an exhausted centripetal core (2004:8679,42), (2) leaf-shaped scraper (2004:8679,4). ⅔ natural size; drawings: M. Weiß.

Appendix, Tafel 6. *Bifaziale Geräte, Fundstelle Pouch/TPf. (1) blattförmiger Schaber aus einem zentripetalen Restkern (2004:8679,42), (2) blattförmiger Schaber (2004:8679,4). ⅔ natürliche Größe; Zeichnungen: M. Weiß.*



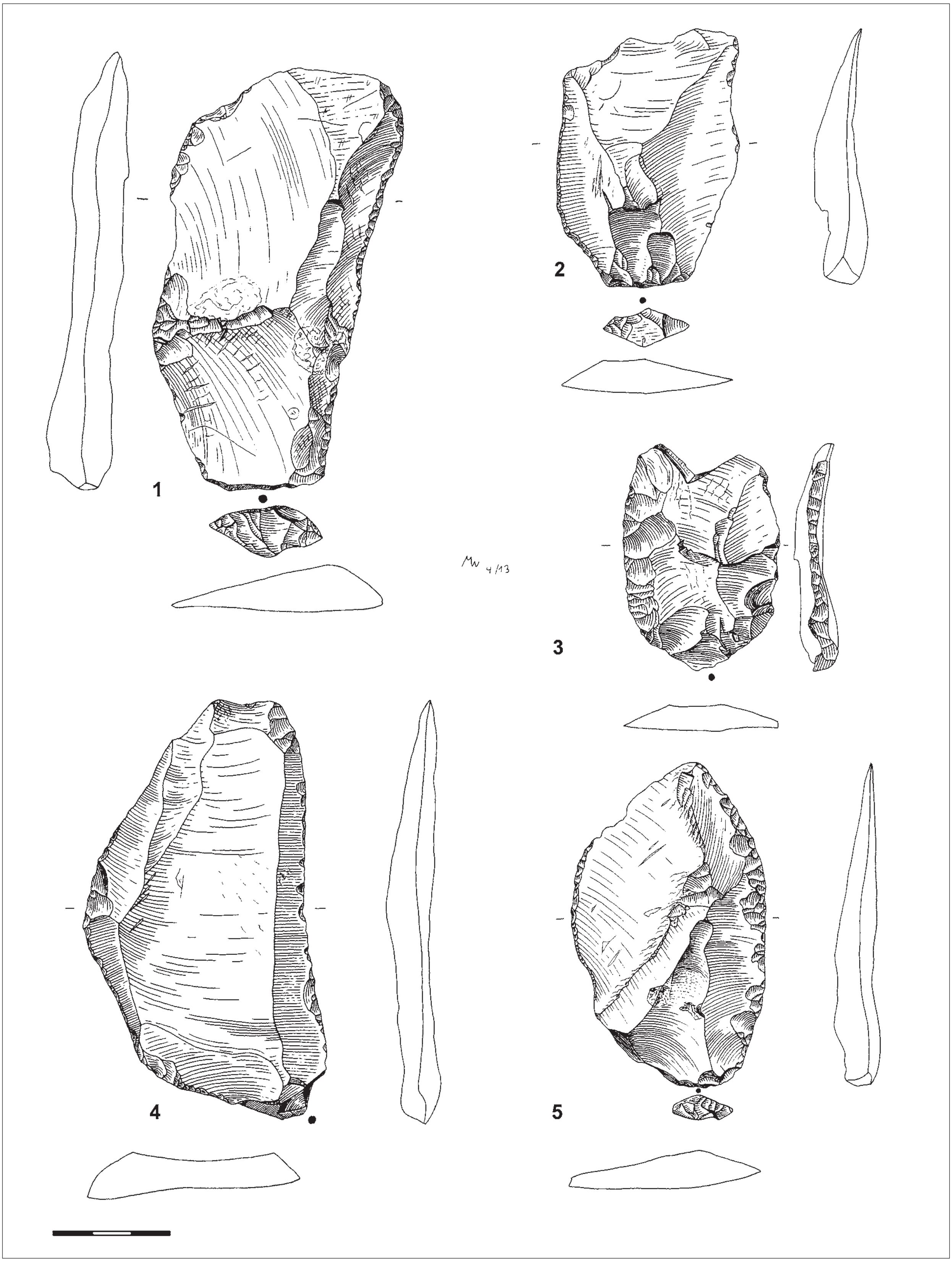
Appendix, Plate 7. Unifacial scrapers, site Pouch/TPf, (1) unifacial scraper with cortex back and backing (2004:8679,5), (2) unifacial scraper with cortex back and backing (2004:8679,6). ⅔ natural size; drawings: M. Weiß.

Appendix, Tafel 7. *Unifaziale Schaber, Fundstelle Pouch/TPf, (1) unifazialer Schaber mit natürlichem und gestumpftem Rücken (2004:8679,5), (2) unifazialer Schaber mit natürlichem und gestumpftem Rücken (2004:8679,6). ⅔ natürliche Größe; Zeichnungen: M. Weiß.*



Appendix, Plate 8. Scrapers, site Pouch/TPf. (1) scraper with natural back (2004:8679,53), (2) scraper with platform as back and slight backing (2004:8679,20), (3) unifacial scraper with natural back (2004:8679,52), (4) scraper with natural back (2004:8679,9). ⅔ natural size; drawings: M. Weiß.

Appendix, Tafel 8. *Schaber, Fundstelle Pouch/TPf. (1) Schaber mit natürlichem Rücken (2004:8679,53), (2) Schaber mit Schlagflächenrest und leichter Stumpfung als Rücken (2004:8679,20), (3) unifazialer Schaber mit natürlichem Rücken (2004:8679,52), (4) Schaber mit natürlichem Rücken (2004:8679,9). ⅔ natürliche Größe; Zeichnungen: M. Weiß.*



Appendix, Plate 9. Backed tools, site Pouch/TPf. (1) backed knife (2004:8679,18), (2) backed knife (2004:8679,60), (3) backed scraper (2004:8679,51), (4) backed knife (2004:8680,27), (5) backed scraper (2004:8679,29). ⅔ natural size; drawings: M. Weiß.

Appendix, Tafel 9. *Rückengestumpfte Geräte, Fundstelle Pouch/TPf, (1) Messer mit gestumpftem Rücken (2004:8679,18), (2) Messer mit gestumpftem Rücken (2004:8679,60), (3) Schaber mit gestumpftem Rücken (2004:8679,51), (4) Messer mit gestumpftem Rücken (2004:8680,27), (5) Schaber mit gestumpftem Rücken (2004:8679,29). ⅔ natürliche Größe; Zeichnungen: M. Weiß.*

Quantitative attributes cores, Pouch/TPf (Excavation 2002)							
Type	**Min.**	**1st Qu.**	**Median**	**Mean**	**3rd Qu.**	**Max**	**n**
Cores	*Length (in mm)*						
	40	52	71	84	105	155	9
	Width (in mm)						
	27	44	66	67	78	120	9
	Thickness (in mm)						
	12	21	28	32	40	71	9
	Weight (in g)						
	13,2	45	111	231	339,9	850	9
	Length of the last flake scar						
	26	37	40	52	77	83	8
	Width of the last flake scar						
	25	35	44	49	57	89	8
	Minimum striking angle						
	45	60	73	69	80	85	8
	Maximum striking angle						
	60	68	78	74	81	85	8
Quantitative attributes flakes, Pouch/TPf (Excavation 2002)							
Type	**Min.**	**1st Qu.**	**Median**	**Mean**	**3rd Qu.**	**Max**	**n**
Flakes	*Length (in mm)*						
	6	37	50	53	68	170	215
	Width (in mm)						
	8	26	37	40	48	119	215
	Thickness (in mm)						
	1	6	9	10	13	37	215
	Weight (in g)						
	< 0	5	13	29	28	304	215
	Platform Width (in mm)						
	1	11	16	19	26	55	197
	Platform Thickness (in mm)						
	1	4	6	6	8	27	196
	Interior Platform Angle						
	80	95	100	103	110	130	214
	Exterior Platform Angle						
	50	80	90	87	95	120	207
	Elongation (Length-Width-Index)						
	0,33	1,04	1,37	1,43	1,79	2,96	215
	Relative-Thickness-Index						
	5,88	15,3	20,14	21,37	25,88	47,83	215
	Platform elongation (Width-Thickness-Index)						
	0,64	2,33	3	3,64	4,36	14	196

Appendix, Tab. 1. continued next page.

Appendix, Tab. 1. *Fortsetzung nächste Seite.*

Quantitative attributes tools, Pouch/TPf (Excavation 2002)							
Classification	**Min.**	**1st Qu.**	**Median**	**Mean**	**3rd Qu.**	**Max**	**n**
			Length (in mm)				
simple tools	49	67	87	85	100	141	40
unifaces	55	89	104	100	115	128	12
bifaces	57	81	84	86	87	120	6
			Width (in mm)				
simple tools	37	49	58	59	69	88	40
unifaces	43	60	68	66	78	85	12
bifaces	41	44	59	61	68	96	6
			Thickness (in mm)				
simple tools	6	10	12	13	15	26	40
unifaces	14	16	17	18	18	25	12
bifaces	11	15	16	18	22	29	6
			Weight (in g)				
simple tools	10	34	64	68	83	195	40
unifaces	47	88	119	127	170	218	12
bifaces	35	49	78	106	145	236	6
			Edge length (in mm)				
simple tools	134	196	234	229	258	370	40
unifaces	189	221	265	263	306	322	12
bifaces	161	200	227	227	232	324	6
			Retouch length (in mm)				
simple tools	22	53	77 (33 %)	89 (39 %)	120	200	40
unifaces	0	97	159 (60 %)	143 (54 %)	190	239	12
bifaces	46	81	168 (74 %)	158 (69 %)	208	291	6
			Minimum edge angle (cutting edge)				
simple tools	10	15	20	20	25	35	40
unifaces	15	24	25	26	30	35	12
bifaces	20	25	25	27	30	35	5
			Maximum edge angle (cutting edge)				
simple tools	15	25	30	33	40	50	40
unifaces	30	40	40	41,7	41	65	12
bifaces	30	35	35	38	40	50	5

Appendix, Tab. 1. Table of quantitative attributes of cores, flakes and tools for the excavated artifacts of Pouch/TPf 2002.

Appendix, Tab. 1. *Tabelle der quantitativen Merkmale der Kerne, Abschläge und Geräte für die gegrabenen Artefakte von Pouch/TPf 2002.*

All cores, preservation											
n	**complete**	**lightly damaged core**	**heavy damaged core**	**frostcrack**	**indeterminate broken (chunks)**	**longitudinal broken**					
24	38 % (9)	0	8 % (2)	8 % (2)	42 % (10)	4 % (1)					
Complete cores, edge condition											
n	**sharp edges**	**slightly damaged edges**	**heavily damaged edges**	**rolled**	**heavily rolled**						
9	100 % (9)										
Complete cores, blank											
n	**indetermined**	**natural piece**	**cobble**	**flake**							
9	0	78 % (7)	22 % (2)	0							
Cores, shape											
n	**natural shape**	**irregular**	**globular**	**prismatic**	**conical, triangular**	**biconical**	**discoid**	**rounded, oval, discoidal**			
9	11 % (1)	11 % (1)	0	11 % (1)	0	0	0	67 % (6)			
Number of flake detachment surfaces											
n	**0**	**1**	**2**	**3**	**4**						
9	0	100 % (9)	0	0	0						
Flake detachment surfaces, directions											
n (surfaces)	**unidirectional**	**unidirectional cyclic**	**unidirectional lateral („divergent")**	**unidirectional bilateral**	**bidirectional**	**bidirectional cyclic**	**bidirectional lateral**	**bidirectional bilateral**	**opportunistic**	**centripetal**	**indeterminate**
9	33 % (3)	22 % (2)	22 % (2)	0	11 % (1)	0	0	0	0	0	11 % (1)
Classification Levallois											
n	**unipolar récurrent**	**unipolar préférentiel**	**bipolar récurrent**	**bipolar préférentiel**	**divergent préférentiel**	**centripète**					
5	40 % (2)	0	0	20 % (1)	40 % (2)	0					
Number of („predetermined") flake scars											
n	**0**	**1**	**2 - 4**	**5 - 7**	**8 - 12**						
8	0	38 % (3)	62 % (5)	0	0						
Number of prepared core margins											
n	**0**	**1**	**2**	**3**	**4**						
9	11 % (1)	33 % (3)	11 % (1)	33 % (3)	11 % (1)						
Longitudinal shape, flake detachment surface											
n (surfaces)	**convex**	**concave**	**plane**	**irregular**							
9	44 % (4)	44 % (4)	11 % (1)	0							
Cross section, flake detachment surface											
n (surfaces)	**convex**	**concave**	**plane**	**irregular**							
9	56 % (5)	22 % (2)	22 % (2)	0							
State of exploitation											
n	**tested blank**	**blank with preparation**	**complete core**	**flaking core**	**exhausted core**	**indeterminate**					
9	11 % (1)	0	0	11 % (1)	78 % (7)	0					

Appendix, Tab. 2. Table of qualitative attributes of cores the excavated artifacts of Pouch/TPf 2002.

Appendix, Tab. 2. *Tabelle der qualitativen Merkmale der Kerne für die gegrabenen Artefakte von Pouch/TPf 2002.*

All flakes, preservation													
n	**complete**	**lightly damaged**	**proximal**	**distal**	**medial**	**longitudinal broken**	**frostcrack**	**indeterminate broken**					
265	80 % (213)	1 % (2)	6 % (16)	9 % (24)	2 % (5)	1 % (3)	0	1 % (2)					
Complete flakes, edge condition													
n	**uncertain**	**sharp edges**	**slightly damaged edges**	**heavily damaged edges**	**rolled**	**heavily rolled**							
215	0	99 % (212)	1 % (2)	0	<1 % (1)	0							
Platform													
n	**plain**	**cortex**	**cortex + facetted**	**facetted**	**with prepared core margin**	**cortex + prepared core margin**	**facetted + prepared core margin**	**cortex + facetted + prepared core margin**	**broken**	**cortex + broken**	**remo-ved**		
215	12 % (25)	10 % (21)	7 % (16)	61 % (132)	0 %	0 %	1 % (2)	0 %	9 % (19)	0 %	0 %		
Platform, amount of retouch													
n	**0 %**	**10 - 30 %**	**40 - 60 %**	**70 - 90 %**	**100 %**								
172	12 % (21)	2 % (3)	4 % (7)	3 % (6)	78 % (135)								
Platform, shape													
n	**not preserved/ no platform**	**punctiform**	**linear**	**oval**	**half-oval**	**triangular**	**rectangular**	**ribbonlike**	**wedge-shaped**	**irregular**	**winged**	**chapeau de gendarme**	**trapezoid**
208	3 % (6)	4 % (9)	8 % (16)	12 % (24)	8 % (17)	8 % (16)	<1 % (1)	6 % (13)	13 % (28)	26 % (54)	10 % (20)	0	2 % (4)
Dorsal surface													
n	**uncertain**	**cortex**	**flake scars**	**cortex + flake scars**	**cortex? + flake scars**	**cortex + flake scars?**							
215	<1 % (1)	3 % (7)	47 % (101)	48 % (103)	1 % (3)	0							
Dorsal surface, amount of secondary surface (flake scars)													
n	**0 %**	**10 - 30 %**	**40 - 60 %**	**70 - 90 %**	**100 %**								
213	3 % (7)	5 % (11)	17 % (36)	27 % (57)	48 % (102)								
Dorsal flake scars, number of directions													
n	**1**	**2**	**3**	**4**									
207	36 % (74)	45 % (93)	15 % (31)	4 % (9)									

Appendix, Tab. 3. continued next page.

Appendix, Tab. 3. *Fortsetzung nächste Seite.*

Dorsal flake scars, directions													
n	indeterminate	aligned (ventral)	opposed (ventral)	bidirectional	aligned (ventral) + lateral („divergent“)	aligned (ventral) + bilateral	opposed (ventral) + lateral	opposed (ventral) + bilateral	bidirectional + lateral	bidirectional + bilateral	lateral	bilateral	concentric
207	1 % (2)	28 % (58)	2 % (5)	11 % (23)	26 % (53)	7 % (14)	4 % (9)	2 % (5)	6 % (13)	4 % (8)	4 % (9)	3 % (7)	<1 % (1)
Dorsal surface, core trimming													
n	yes	no											
214	15 % (32)	85 % (182)											
Complete flakes, remnants of core margins													
n	none	coarse prepared	fine prepared	coarse + fine prepared	cortical								
215	68 % (146)	8 % (17)	1 % (3)	2 % (5)	20 % (44)								
Complete flakes, shape													
n	indeterminate	parallel edges	divergent edges	convergent edges	irregular	round	divergent-convergent edges						
215	0 %	19 % (40)	30 % (64)	8 % (17)	9 % (19)	16 % (34)	19 % (41)						

Appendix, Tab. 3. Table of qualitative attributes of flakes for the excavated artifacts of Pouch/TPf 2002.

Appendix, Tab. 3. *Tabelle der qualitativen Merkmale der Abschläge für die gegrabenen Artefakte von Pouch/TPf 2002.*

All tools, preservation									
Classification	**n**	**complete**	**lightly damaged**	**proximal**	**distal**	**medial**	**frostcrack**	**indetermina-te broken**	
all tools	66	80 % (53)	3 % (5)	9 % (6)	3 % (2)	0	0	0	
Complete tools, edge condition									
Classification	**n**	**sharp edges**	**slightly damaged**	**heavily damaged**	**rolled**	**heavily rolled**			
all tools	58	100 % (58)	0	0	0	0			
Complete tools, coarse classification									
Classification	**n**	**simple tools**	**uniface**	**biface**					
all tools	58	69 % (40)	21 % (12)	10 % (6)					
Complete tools, „blank - classification“									
Classification	**n**	**flake tools**	**core tools**	**modified core**					
simple tools	40	100 % (40)	0	0					
unifaces	12	100 % (12)	0	0					
bifaces	6	50 % (3)	33 % (2)	17 % (1)					
Position retouch, all edges									
Classification	**n (re-touched edges)**	**dorsal**	**ventral**	**alternate**					
simple tools	66	80 % (53)	6 % (4)	14 % (9)					
unifaces	27	44 % (12)	15 % (4)	41 % (11)					
bifaces	13	23 % (3)	0	77 % (10)					
Intensity of retouch									
Classification	**n (re-touched edges)**	**coarse**	**fine**	**fine and coarse**					
simple tools	66	6 % (4)	55 % (36)	39 % (26)					
unifaces	27	7 % (2)	7 % (2)	85 % (23)					
bifaces	13	8 % (1)	46 % (6)	46 % (6)					
Retouch morphology									
Classification	**n (re-touched edges)**	**simple/ flat/ scalar**	**stepped**	**simple + stepped**					
simple tools	66	86 % (57)	0	14 % (9)					
unifaces	27	44 % (12)	0	56 % (15)					
bifaces	13	31 % (4)	0	69 % (9)					
Shape of the retouched edges									
Classification	**n (re-touched edges)**	**straight**	**convex**	**concave**	**straight-convex**	**straight-concave**	**convex-concave**	**angled**	
simple tools	66	17 % (11)	50 % (33)	3 % (2)	18 % (12)	6 % (4)	5 % (3)	2 % (1)	
unifaces	27	22 % (6)	70 % (19)	4 % (1)	4 % (1)	0	0	0	
bifaces	13	15 % (2)	69 % (9)	0	15 % (2)	0	0	0	
Working edge									
Classification	**n**	**left edge**	**right edge**	**proximal end**	**distal end**	**two**	**indetermi-nate**		
simple tools	40	33 % (13)	43 % (17)	0	18 % (7)	8 % (3)	0		
unifaces	12	33 % (4)	50 % (6)	0	17 % (2)	0	0		
bifaces	6	33 % (2)	50 % (3)	0	0	0	17 % (1)		

Appendix, Tab. 4. continued next page.

Appendix, Tab. 4. *Fortsetzung nächste Seite.*

Type of back									
Classification	**n**	**none**	**cortex**	**cortex + retouch**	**retouch (backed)**	**breakage**	**steep dorsal flake scar or core edge**	**steep dorsal flake scar or core edge + retouch**	**platform**
simple tools	40	15 % (6)	28 % (11)	10 % (4)	18 % (7)	0	10 % (4)	5 % (2)	15 % (6)
unifaces	12	0	25 % (3)	42 % (5)	0	0	25 % (3)	8 % (1)	0
bifaces	6	17 % (1)	0	67 % (4)	17 % (1)	0	0	0	0
Amount of surface retouch									
Classification	**n (surfaces)**	**10 - 30 %**	**40-60 %**	**70 - 90 %**	**100 %**				
unifaces	12	17 % (2)	50 % (6)	17 % (2)	17 % (2)				
bifaces	12	8 % (1)	25 % (3)	42 % (5)	25 % (3)				
Directions of the surface retouch									
Classification	**n (surfaces)**	**1**	**2**	**3**	**4**				
unifaces	12	17 % (2)	50 % (6)	25 % (3)	8 % (1)				
bifaces	12	17 % (2)	42 % (5)	42 % (5)	0				
Morphology of the surface retouch scars									
Classification	**n**	**shallow**	**deep**	**shallow + deep**					
unifaces	12	50 % (6)	0	50 % (6)					
bifaces	12	42 % (5)	8 % (1)	50 % (6)					
Complete Tools, cross section									
Classification	**n**	**biconvex**	**biplane**	**plano-convex**	**plane/convex - plan/convex**	**convex-plane/ convex**			
simple tools	40	0	3 % (1)	88 % (35)	5 % (2)	5 % (2)			
unifaces	12	8 % (1)	0	92 % (11)	0	0			
bifaces	6	0	0	50 % (3)	17 % (1)	33 % (2)			
Complete Flake tools, platform state									
Classification	**n**	**plain**	**cortex**	**cortex + retouch**	**retouch**	**removed**	**destroyed**		
flake tools	54	0	0	20 % (11)	56 % (30)	19 % (10)	6 % (3)		

Appendix, Tab. 4. Table of qualitative attributes of tools for the excavated artifacts of Pouch/TPf 2002.

Appendix, Tab. 4. *Tabelle der qualitativen Merkmale der Geräte für die gegrabenen Artefakte von Pouch/TPf 2002.*

Literature cited

Aitken, M. J. (1985). *Thermoluminescence Dating*. Academic Press, London.

Aitken, M. J. (1998). *An introduction to optical dating: The dating of Quaternary sediments by the use of Photon-Stimulated Luminescence.* Oxford University Press, New York.

Baumann, W. & Mania, D. (1983). *Die paläolithischen Neufunde von Markkleeberg bei Leipzig.* Veröffentlichungen des Landesmuseums für Vorgeschichte Dresden 16, VEB Deutscher Verlag der Wissenschaften, Berlin.

Boëda, E., Geneste, J.-M. & Meignen L. (1990). Identification de chaînes opératoires lithiques du Paléolithique ancien et moyen, *Paléo* 2 (1): 43–80.

Bordes, F. (1961). *Typologie du Paléolithique ancien et moyen (Cahiers du Quaternaire 1).* Éditions du CNRS, Paris.

Bosinski, G. (1967). *Die Mittelpaläolithischen Funde Im Westlichen Mitteleuropa*. Fundamenta A/4. Böhlau-Verlag, Köln, Graz.

Bosinski, G. (1968). Zum Verhältnis von Jungacheuleen und Micoquien in Mitteleuropa. In: J. Piveteau (Ed.) *La Préhistoire : Problèmes et Tendances.* Éditions du CNRS, Paris, 77–86.

Botter-Jensen, L. (1997). Luminescence techniques: instrumentation and methods, *Radiation Measurements* 27: 749–68.

Botter-Jensen, L., Bulur, E., Duller, G. A. T. & Murray, A. S. (2000). Advances in luminescense instrument systems, *Radiation Measurements* 32: 523–28.

Burdukiewicz, J. M. (2000). The backed biface assemblages of East Central Europe. In: A. Ronen & M. Weinstein-Evron (Eds.) Toward Modern Humans: *Yabrudian and Micoquian, 400–50 K-Years Ago*. Proceedings of a Congress Held at the University of Haifa November 3–9, 1996, British Archaeological Reports, Oxford, 155–65.

Clasen, S. (2004). Wie gewonnen – so zeronnen: Die paläolithische Fundstelle im ehemaligen Tagebau Rösa, Lkr. Bitterfeld. In: *Tagungsband und Exkursionsführer: 71. Tagung der Arbeitsgemeinschaft Norddeutscher Geologen, 01. bis 04. Juni in Frankfurt (Oder),* 59.

Debénath, A. & Dibble, H. L. (1994). *Handbook of Paleolithic Typology: Lower and Middle Paleolithic of Europe.* UPenn Museum of Archaeology.

Dibble, H. L. & Bar-Yosef, O. (Eds.), (1995). *The Definition and Interpretation of Levallois Technology.* Prehistory Press, Madison.

Ertmer, S. (2012). *Fundkomplexe aus saalezeitlichen Schottern und die Möglichkeiten ihrer Auswertung.* PhD dissertation, Eberhard Karls Universität, Tübingen.

Gaudzinski, S. (1998). Knochen und Knochengeräte der mittelpaläolithischen Fundstelle Salzgitter-Lebenstedt (Deutschland). *Jahrbuch des Römisch-Germanischen Zentralmuseums Mainz* 45: 163–220.

Gaudzinski, S. (1999). Middle Palaeolithic bone tools from the open-air site Salzgitter-Lebenstedt (Germany). *Journal of Archaeological Science* 26 (2): 125–41.

Guibert, P., Bechtel, F., Bourguignon, L., Brenet, M., Couchoud, I., Delagnes, A., Delpech, F., Detrain, L., Duttine, M., Folgado, M., Jaubert, J., Lahaye, Ch., Lenoir, M., Maureille, B., Texier, J.-P., Turq, A., Vieillevigne, E., Villeneuve, G. (2008). Une base de données pour la chronologie du Paléolithique moyen dans le Sud-ouest de la France. In: J. Jaubert, J.-G. Bordes, I. Ortega (Eds.) *Les sociétés du Paléolithique dans un Grand Sud-Ouest de la France: nouveaux gisements, nouveaux résultats, nouvelles méthodes*, Mémoire XLVII de la Société préhistorique française, 19–40.

Günther, K. (1964). *Die Altsteinzeitlichen Funde der Balver Höhle.* Bodenaltertümer Westfalens 8, Münster.

Hedges, R. E. M., Pettitt, P. B., Ramsey, C. B. & Klinken, G. J. V. (1998). Radiocarbon Dates from the Oxford Ams System: Archaeometry Datelist 25. *Archaeometry* 40 (1): 227–39.

Hesse, N. & Kindler, L. (2014). Geologie und Genese der quartären Beckenfüllung Neumark-Nord 2 und deren Ausgrabung. Geology and development of the quaternary basin infill Neumark-Nord 2 and its excavation. In: S. Gaudzinski-Windheuser & W. Roebroeks (Eds.) *Multidisziplinary Studies of the Middle Palaeolithic Record from Neumark-Nord (Germany), Volume 1.* Veröffentlichungen des Landesamtes für Archäologie Sachsen-Anhalt - Landesmuseum für Vorgeschichte, Halle(Saale), 13–37.

Higham, T. (2011). European Middle and Upper Palaeolithic radiocarbon dates are often older than they look: problems with previous dates and some remedies. *Antiquity* 85 (327): 235–49.

Hiller, A., Litt, T. & Eissmann, L. (1991). Zur Entwicklung der jungquartären Tieflandstäler im Saale-Elbe-Raum unter besonderer Berücksichtigung von ^{14}C-Daten. *Eiszeitalter & Gegenwart* 41: 26–46.

Hiscock, P. & Clarkson, C. (2008). The Construction of Morphological Diversity: A Study of Mousterian Implement Retouching at Combe Grenal. In: W. Andrefsky (Ed.) *Lithic Technology.* Cambridge University Press, Cambridge.

Hublin, J.-J. (1984). The fossil man from Salzgitter-Lebenstedt (FRG) and its place in human evolution during the Pleistocene in Europe. *Zeitschrift für Morphologie und Anthropologie* 75: 45–56.

Hülle, W. M. (1977). *Die Ilsenhöhle unter Burg Ranis/Thüringen. Eine paläolithische Jägerstation*. Verlag Gustav Fischer, Stuttgart.

Iovita, R. (2014). The role of edge angle maintenance in explaining technological variation in the production of Late Middle Paleolithic bifacial and unifacial tools. *Quaternary International* 350: 105–15.

Iovita, R. & McPherron, S. P. P. (2011). The handaxe reloaded: A morphometric reassessment of Acheulian and Middle Paleolithic handaxes. *Journal of Human Evolution* 61 (1): 61–74.

Jöris, O. (2001). *Der Spätmittelpaläolithische Fundplatz Buhlen (Grabungen 1966-69). Stratigraphie, Steinartefakte und Fauna des oberen Fundplatzes.* Universitätsforschungen zur Prähistorischen Archäologie, Bonn.

Jöris, O. (2004). Zur chronostratigraphischen Stellung der spätmittelpaläolithischen Keilmessergruppen: Der Versuch einer kulturgeographischen Abgrenzung einer mittelpaläolithischen Formengruppe in ihrem europäischen Kontext. *Bericht der Römisch- Germanischen Kommission* 8: 49–153.

Jöris, O. (2006). Bifacially backed knives (Keilmesser) in the central European Middle Palaeolithic. *In:* N. Goren-Inbar & G. Sharon (Eds.) *Axe Age: Acheulian Tool-Making from Quarry to Discard.* Equinox Publishing Ltd, London, 287–310.

Krbetschek, M. (2003). *Ergebnisbericht der OSL-Datierung* Landesamt für Denkmalpflege und Archäologie Sachsen-Anhalt.

Krukowski, S. (1939). Paleolit. *In:* S. Krukowski, J. Kostrzewski & R. Jakimowicz (Eds.) *Prehistoria Ziem Polskich, Encyklopedia Polska* 4. Polska Akademia Umiejętnośsci, Kraków, 1-117.

Longin, R. (1971). New Method of Collagen Extraction for Radiocarbon Dating. *Nature* 230: 241-242.

Laurat, T. & Brühl, E. (2006). Zum Stand der archäologischen Untersuchungen im Tagebau Neumark-Nord, Ldkr. Merseburg-Querfurt (Sachsen-Anhalt) - Vorbericht zu den Ausgrabungen 2003-2005. *Jahresschrift für mitteldeutsche Vorgeschichte* 90: 9–69.

Magnani, M., Rezek, Z., Lin, S. C., Chan, A. & Dibble, H. L. (2014). Flake variation in relation to the application of force, *Journal of Archaeological Science* 46: 37–49.

Mania, D. (1990). *Auf den Spuren des Urmenschen: Die Funde aus der Steinrinne von Bilzingsleben*. Deutscher Verlag der Wissenschaften, Berlin.

Mania, D. (2002a). Der mittelpaläolithische Lagerplatz am Ascherslebener See bei Königsaue (Nordharzvorland). *Praehistoria Thuringica* 8: 16–75.

Mania, D. (2002b). Die 'Harzreste' aus der mittelpalöolithischen Ufersiedlung am Ascherslebener See bei Königsaue. *Praehistoria Thuringica* 8: 76–81.

Mania, D. & Toepfer, V. (1973). *Königsaue: Gliederung, Oekologie und Mittelpaläolithische Funde der letzten Eiszeit*. Veröffentlichungen des Landesmuseums für Vorgeschichte in Halle 26, Deutscher Verlag der Wissenschaften, Berlin.

Mol, J. (1995). Weichselian and Holocene river dynamics in relation to climate change in the Halle-Leipziger Tieflandsbucht (Germany). *Eiszeitalter & Gegenwart* 45: 32–41.

Mol, J. (1997). Fluvial response to Weichselian climate changes in the Niederlausitz (Germany). *Journal of Quaternary Science* 12 (1): 43–60.

Mol, J., Vandenberghe, J. & Kasse, C. (2000). River response to variations of periglacial climate in mid-latitude Europe. *Geomorphology* 33 (3–4): 131–48.

Murray, A.S. &. Wintle, A.G (2000). Luminescence dating of quartz using an improved single-aliquot regenerative-dose protocol. *Radiation Measurements* 32: 57–73.

Neruda, P. & Nerudová, Z. (2014). New radiocarbon data from Micoquian layers of the Kůlna Cave (Czech Republic). *Quaternary International* 326–327: 157–67.

Pastoors, A. (2001). *Die Mittelpaläolithische Freilandstation von Salzgitter-Lebenstedt: Genese der Fundstelle und Systematik der Steinbearbeitung*. Archiv der Stadt Salzgitter, Salzgitter.

Pastoors, A. (2009). Blades? – Thanks, no interest! – Neanderthals in Salzgitter-Lebenstedt. *Quartär* 56: 105–18.

Prescott, J. R. & Hutton, J. T. (1988). Cosmic ray and gamma ray spectrometry for Thermoluminescence and ESR. *Nuclear Tracks and Radiation Measurements* 14: 223–27.

Prescott, J. R. & Stephan, L. G. (1982). The contribution of cosmic radiation to the environmental dose for thermoluminescense dating: Latitude, altitude and depth dependences. *Pact* 6: 16–25.

Rasmussen, S. O., Bigler, M., Blockley, S. P., Blunier, T., Buchardt, S. L., Clausen, H. B., Cvijanovic, I., Dahl-Jensen, D., Johnsen, S. J., Fischer, H., Vasileios G., Guillevic, M., Hoek, W. Z., Lowe, J., Pedro, J. B., Popp, T., Seierstad, I. K., Steffensen, J. P., Svensson, A. M., Vallelonga, P., Vinther, B. M., Walker, M. J. C., Wheatley, J. J. & Winstrup, M. (2014). A stratigraphic framework for abrupt climatic changes during the Last Glacial period based on three synchronized Greenland ice-core records: refining and extending the INTIMATE event stratigraphy. *Quaternary Science Reviews* 106: 14–28.

R Core Team (2015). *R: A Language and Environment for Statistical Computing*. R Foundation for Statistical Computing, Wien.

Rhodes, E. J. (1988). Methodological considerations in the optical dating of quartz. *Quaternary Science Reviews* 7: 395–400.

Richter, D., Tostevin, G., Škrdla, P. & Davies, W. (2009). New radiometric ages for the Early Upper Palaeolithic type locality of Brno-Bohunice (Czech Republik): comparison of OSL, IRSL, TL and ^{14}C dating results. *Journal of Archaeologica Science* 36: 708-720.

Richter, D. & Krbetschek, M. (2014). Preliminary luminescence dating results for two Middle Palaeolithic occupations at Neumark-Nord 2. *In:* S. Gaudzinski-Windheuser & W. Roebroeks (Eds.) *Multidisziplinary Studies of the Middle Palaeolithic Record from Neumark-Nord (Germany). Volume 1.* Veröffentlichungen des Landesamtes für Archäologie Sachsen-Anhalt - Landesmuseum für Vorgeschichte, Halle(Saale), 131–36.

Richter, J. (1997). *Sesselfelsgrotte III. Der G-Schichten-Komplex der Sesselfelsgrotte. Zum Verständnis des Micoquien.* Quartär Bibliothek 7, Saarbrücker Druckerei und Verlag, Saarbrücken.

Richter, J. (2000). Social memory among late Neanderthals. *In:* J. Orschiedt & G.-C. Weniger (Eds.) *Neanderthals and Modern Humans – Discussing the Transition. Central and Eastern Europe from 50.000 – 30.000 B.P.* Neanderthal Museum, Mettmann, 123–32.

Richter, J. (2002). Die ^{14}C-Daten aus der Sesselfelsgrotte und die Zeitstellung des Micoquien/M.M.O. *Germania* 80 (1): 1–22.

Richter, J. (2012). Moustérien und Micoquien. *In:* H. Floss (Ed.) *Steinartefakte vom Altpaläolithikum bis in die Neuzeit*. Tübingen Publications in Prehistory, Tübingen, 227–36.

Rudolph, A. & Bernhardt, W. (1997). Altsteinzeitliche Fundstellen bei Bitterfeld und Löbnitz, *Leipziger Geowissenschaften* 5, 167–73.

Ruebens, K. (2012). *From Keilmesser to Bout Coupé Handaxes: Macro-Regional variability among Western European late Middle Palaeolithic bifacial tools.* Ph.D, dissertation, University of Southampton, Southampton.

Ruebens, K. (2013). Regional behaviour among late Neanderthal groups in Western Europe: A comparative assessment of late Middle Palaeolithic bifacial tool variability. *Journal of Human Evolution* 65 (4): 341–62.

Ruebens, K. (2014). Late Middle Palaeolithic bifacial technologies across northwest Europe: Typo-technological variability and trends. *Quaternary International* 350: 130–46.

Ruebens, K., McPherron, S. P. & Hublin, J.-J. (2015). On the local Mousterian origin of the Châtelperronian: Integrating typo-technological, chronostratigraphic and contextual data. *Journal of Human Evolution* 86: 55-91.

Schäfer, D. (1993). Grundzüge der technologischen Entwicklung und Klassifikation vor-jungpaläolithischer Steinartefakte in Mitteleuropa. *Bericht der Römisch-Germanischen Kommission* 74: 51–193.

Seiler, M. & Runck, D. (2003). Ein neuer mittelpaläolithischer Fundplatz in den Basiskiesen der Mulde-Niederterrasse bei Bitterfeld (Sachsen-Anhalt) - erste Auswertungsergebnisse. *In:* J. M. Burdukiewicz, L. Fiedler, W.-D. Heinrich, A. Justus & E. Brühl (Eds.) *Erkenntnisjäger. Kultur und Umwelt des frühen Menschen. Festschrift für Dietrich Mania.* Veröffentlichungen des Landesamtes für Archäologie Sachsen-Anhalt - Landesmuseum für Vorgeschichte, Halle (Saale), 541-558.

Sier, M. J., Roebrooks, W., Bakels, C. C., Dekkers, M. J., Brühl, E., De Loecker, D., Gaudzinski-Windheuser, S., Hesse, N., Jagich, A., Kindler, L., Kuijper, W. J., Laurat, T., Mücher, H. J., Penkmann, K. E. H., Richter, D. & Van Hinsbergen, D. J. J. (2011). Direct terrestrial-marine correlation demonstrates surprisingly late onset of the last interglacial in central Europe. *Quaternary Research* 75: 213-218.

Soressi, M. (2002). *Le Moustérien de Tradition Acheuléenne du Sud-Ouest de la France. Discussion sur la signification du faciès à partir de l'étude comparée de quatre sites: Pech-de-l'Azé I, Le Moustier, La Rochette et La Grotte XVI.* PhD dissertation, Université Bordeaux I, Bordeaux.

Strahl, J., Krbetschek, M. R., Luckert, J., Machalett, B., Meng, S., Oches, E. A., Rappsilber, I., Wansa, S. & Zöller, L. (2010). Geologie, Paläontologie und Geochronologie des Eem-Beckens Neumark-Nord 2 und Vergleich mit dem Becken Neumark-Nord 1 (Geiseltal, Sachsen-Anhalt). *E&G Quaternary Science Journal* 59: 120–67.

Talamo, S. & Richards, M. (2011). A comparison of bone pretreatment methods for AMS dating of samples >30,000 BP. *Radiocarbon* 53 (3): 443–49.

Tode, A. (1982). *Der Altsteinzeitliche Fundplatz Salzgitter-Lebenstedt. Teil I, Archäologischer Teil.* Böhlau-Verlag, Köln, Wien.

Valde-Nowak, P., Alex, B., Ginter, B., Krajcarz, M. T., Madeyska, T., Miękina, B., Sobczyk, K., Stefański, D., Wojtal, P., Zając, M. & Zarzecka-Szubińska, K. (2014). Middle Paleolithic sequences of the Ciemna Cave (Prądnik valley, Poland): The problem of synchronization. *Quaternary International* 326–327, 125–45.

Valoch, K., Latzmann, M. & Najmrová, L. (1988). *Die Erforschung Der Kŭlna-Höhle 1961-1976.* Moravské muzeum, Brno.

Van Huissteden, J., Gibbard, P. L. & Briant R. M. (2001). Periglacial fluvial systems in northwest Europe during marine isotope stages 4 and 3. *Quaternary International* 79 (1): 75–88.

Veil, S., Breest, K.,. Höfle, H.-C, Meyer, H.-H., Plisson, H., Urban-Küttel, B., Wagner, G. A. & Zöller L. (1994). Ein mittelpaläolithischer Fundplatz aus der Weichsel-Kaltzeit bei Lichtenberg, Lkr. Lüchow-Dannenberg. *Germania* 72 (1): 1–66.

Weber, T. (1986). Die Steinartefakte des Homo erectus von Bilzingsleben. *In:* D. Mania & Th. Weber (Eds.) *Bilzingsleben III*. Veröffentlichungen des Landesmuseums für Vorgeschichte in Halle 39, Berlin, 65–231.

Weber, T. (1995). Multivariate methods for the classification of Lower and Middle Palaeolithic stone inventories. *BAR Inernational Series* 600: 105–105.

Weber, T. (2007). Paläolithische Artefaktinventare Analytisch betrachtet: Fallbeispiele Clacton und Hoxne. *In:* E. Speitel (Ed.) *Terra Praehistorica. Festschrift für Klaus-Dieter Jäger zum 70. Geburtstag*. Beiträge zur Ur- und Frühgeschichte Mitteleuropas 48, Kommissionsverlag Beier & Beran - Archäologische Fachliteratur, Langenweißbach, 147–55.

Wimmer, R. (1997). Zur Geologie der Paläolithfundstellen bei Bitterfeld und Löbnitz. *Leipziger Geowissenschaften* 5: 175–81.

Wood, R. E., Douka, K., Boscato, P., Haesaerts, P., Sinitsyn, A. & Higham, T. F. G. (2012). Testing the ABOx-SC method: dating known-age charcoals associated with the Campanian Ignimbrite. *Quaternary Geochronology* 9: 16–26.