# MATERIAL

To examine the process of change in human behaviour and how this process is motored by climatic and environmental change the present study is based on three types of archives: the climate, the environment, and the archaeology which comprises the remains of human behaviour.

In archaeological analyses, climate and environmental change were often taken as synonymous (Fort/Pujol/Cavalli-Sforza 2004; Gamble et al. 2004; Blockley et al. 2006; Riede/Edinborough/Thomas 2009), although high-resolution multi-proxy studies demonstrated that climate and environmental change were sometimes neither contemporaneous nor straightforwardly connected. Besides climatic parameters such as atmospheric and hydrological data, the environmental development is also dependent on factors such as geomorphological setting, pedogenesis, and/or migration rates of biotic populations (Lotter et al. 1992, 198; Hoek 2001; Hoek/Bohncke 2001, 1258. 1262; Litt et al. 2001, 1244; Jones et al. 2002; Price 2003). Therefore, an explicit difference is made between climate[1] as seen by proxies for temperature, moisture, or wind activity and environment[2] such as soil development, plant growth, or fauna presence. By this distinction, changes in human behaviour can be related more precisely in a chronological scale to specific exogenous forces.

## CLIMATE AND CHRONOSTRATIGRAPHIC ARCHIVES

The climate archives (**fig. 2**) represent one of the three main types of archives in the present study combined with the environmental and the archaeological records. However, the climate is assumed as the main motor for environmental changes and, therefore, the process of climate change is used as basic chronostratigraphy in the present study.

The climate of north-western Europe is strongly governed by the North Atlantic and this climate regime is well recorded in the isotopic record of the Greenland ice-cores. Thus, the eventstratigraphy based on oxygen isotopes received from Greenland ice-cores (Björck et al. 1998; Walker et al. 1999; Jöris/Weninger 2000) is chosen as the basic chronostratigraphic terminology in the present study. Due to the rapid hemispheric ventilation in the atmosphere and, therefore, the relatively constant ratio of atmospheric oxygen isotopes across the hemisphere, the atmospheric oxygen isotopic record is well suited as a tool for correlating distant areas and various biospheres in a common chronostratigraphic framework. In contrast, the correlation and use of litho- and biostratigraphic nomenclature as chronostratigraphic units led to some confusion in the Late Weichselian terminology (see p. 41-45; cf. de Klerk 2004) and is therefore avoided in the present study.

1 According to the Intergovernmental Panel on Climate Change (IPCC), which was established by the United Nations Environment Programme (UNEP) and the World Meteorological Organization (WMO): »›Climate‹ refers to the average weather in terms of the mean and its variability over a certain time-span and a certain area.« (Baede et al. 2001, 87), whereas the weather »is the fluctuating state of the atmosphere around us, characterised by the temperature, wind, precipitation, clouds and other weather elements.« (Baede et al. 2001, 87). Hence, atmospheric values on temperature, precipitation, and wind activity are gathered to allow for statements on the change of Lateglacial climate.

2 By the term environment the natural environment defined as »all living and non-living things that occur naturally on Earth« (see http://en.wikipedia.org/wiki/Natural_environment [1/8/2011]) is meant and furthermore, the central concept of Frans Klijn and Helias A. Udo de Haes is followed regarding the environment »... as an ecosystem in order to incorporate all relevant interactions in the physical [i.e. natural] environment.« (Klijn/de Haes 1994, 90).

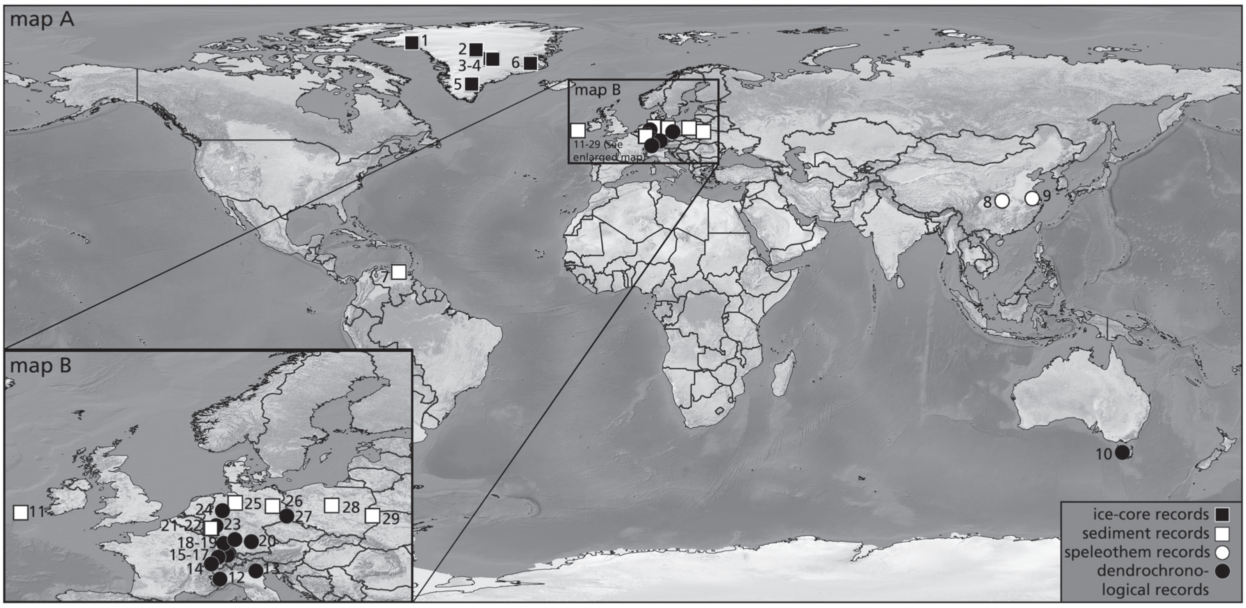



**Fig. 2** **A** World map and **B** map of north-western Europe with sites yielding climate and chronostratigraphic relevant data. **1** Camp Century; **2** NGRIP; **3** GISP2; **4** GRIP; **5** DYE-3; **6** Renland; **7** Cariaco basin; **8** Qingtian cave; **9** Hulu cave; **10** Tasmania (Huon pines); **11** MD01-2461; **12** Avigliana; **13** Revine; **14** Ollon; **15** Avenches; **16** Zürich area (Landikon, Gänziloh, Birmensdorf, & Zürich-Wiedikon); **17** Dättnau; **18** Upper Rhine material; **19** Main material; **20** Danube, Isar, Iller, & Günz; **21** Meerfelder Maar; **22** Holzmaar; **23** Kruft; **24** Warendorf; **25** Hämelsee; **26** Rehwiese; **27** Lausitz (Cottbus, Reichwalde, Lohsa, Scheibe); **28** Lake Gościąż; **29** Lake Perespilno. – For references and further details see text.

However, terrestrial sequences with oxygen isotope records are limited and not present at any archaeological site. Therefore, further chronostratigraphic systems such as varve counting, correlation of marker horizons, and/or radiocarbon dating are necessary additions to build a solid chronostratigraphic sequence of the Weichselian Lateglacial in north-western Europe. However, radiocarbon dates require a calibration to solar years. The necessary data for this calibration curve were achieved from deep sea and terrestrial records which are also introduced and evaluated in the following. Usually, these records also produced climate data and, thus, by the use of these records, a direct correlation of climate with the radiocarbon calibration data is possible. This correlation facilitates the assembling of the different chronostratigraphic systems in a common time frame.

To create a common timescale for these different chronostratigraphic systems two points of reference are distinct in the present study: The year 2000 A.D. (b2k)[3] introduced by the construction of ice-core chronostratigraphy (Rasmussen et al. 2006) and the year 1950 A.D. (BP) used in the context of radiocarbon dating (Godwin 1962). The still very common use of the BP scale outside radiocarbon dating led to some confusion due to the incongruence of radiocarbon years with solar years (cf. van der Plicht/Hogg 2006). Thus, the convention of using an additional cal. (calendar, Stuiver/Kra 1986, Pearson 1987) set before the reference point is now commonly used to separate $^{14}C$ ages from calendar ages (including calibrated $^{14}C$ ages). In

3 The year 2000 A.D. (b2k, Vinther et al. 2006; Rasmussen et al. 2006) is preferred as a reference point in the current project when correlating stratigraphic sequences and, in addition, the point is applied to the calibrated $^{14}C$ ages instead of the recommended »cal. BC« because of easier comparability of the stratigraphic sequences. This reference year is chosen because the dating of many discussed sequences and assemblages neither originated from radiometric measurements as should be concluded from the use of the BP scale nor representing exact prehistorical dates as might be concluded when referring to the historic timescale (BC/A.D.). Instead, the dating of the episodes introduced in the present study represent correlations and scientific interpretations of various chronostratigraphic approaches.

the present work, $^{14}C$ and other radiometric measurements will be marked additionally ($^{14}C$-BP; TL-BP) to prevent any further misreading.
The studied time window comprises a period of approximately 3,500 calendar years (or 2,800 $^{14}C$ years) between the time characterised by the cold steppe horse hunters of the Late Magdalenian and the time of the FMG-assemblages originating from forest red deer hunters in the Central Rhineland (cf. Street/Terberger 2004, 294 f.). The studied time period belongs completely to the Weichselian and, more precisely, to the Late Weichselian or Weichselian Lateglacial. The specification of the terms referring to the Weichselian period is therefore not further used in the following since it is regarded as unnecessary precision. The term Lateglacial is used in the present work according to Walker et al. 1999 and refers in the Greenland eventstratigraphy to the time from the onset of GS-2[4] to the onset of the Holocene (GH). In general, the Lateglacial can be subdivided into three main periods: The Upper/Late Pleniglacial (GS-2, furtheron: Late Pleniglacial), the Lateglacial Interstadial (GI-1, furtheron: the Lateglacial Interstadial) and the Lateglacial Stadial (GS-1, furtheron the Lateglacial Stadial).

### Greenland ice-core records

The Greenland oxygen isotope eventstratigraphy (Björck et al. 1998) is well established as a reflection of climate on the North Atlantic seaboard. Therefore, this eventstratigraphy is frequently used as the basis for chronostratigraphic frameworks for north-western Europe. In this study, the Greenland oxygen isotope eventstratigraphy is used as the baseline to which the other climate and chronostratigraphic relevant records from the deep sea and terrestrial sites are correlated.
Thus far, several ice-core sequences from Greenland have been published (**fig. 2**; e.g. Johnsen et al. 2001). The European Greenland ice-core project (GRIP) drilled an ice-core (Dansgaard et al. 1993) at the summit of the Greenland ice sheet. This ice-core record was proposed as the stratotype for the eventstratigraphy (Björck et al. 1998; Walker et al. 1999). This proposal has been widely accepted and adopted due to the reliable, high-resolution chronostratigraphy related to the ice-core records. At the time of the proposal as stratotype, an age model (ss09) was preferred which was based mainly on the rate of surface snow accumulation. This age model was established by the correlation of the GRIP sequence with a further three Greenland ice-core records (DYE-3, Renland, and Camp Century). The correlation was based on reference horizons in the Holocene section, a multi-parameter identification of the annual layers in the Lateglacial and early Holocene part, and calculation with an ice flow model for the part beyond c. 14,550 years cal. b2k (Johnsen et al. 1992; Dansgaard et al. 1993).
However, instead of the GRIP record the ice-core records of the US-American Greenland ice-sheet project two (GISP2; Grootes et al. 1993) and the multi-national North Greenland ice-core project (NGRIP; Dahl-Jensen et al. 2002; Andersen et al. 2004) were occasionally used as comparatives (Hughen et al. 1998a; Wang et al. 2001; Sirocko et al. 2005). The GISP2 sequence was drilled 28 km west of the GRIP ice-core.

4 Following the eventstratigraphy based on oxygen isotopes as displayed in the Greenland ice-cores, the stadial (GS-2) following after the LGM (GS-3) was divided into three parts, of which the youngest/upper most part (GS-2a) referred to a severe cold (Björck et al. 1998, 288) and dry phase (Moreno et al. 2010). However, in a more recent correlation of various Greenland ice-core records the limit between GS-2a and GS-2b became blurred and could not be securely detected (Lowe et al. 2008). This boundary remained also indistinct in most of the preserved litho- and biostratigraphies except for the ELSA record (Sirocko et al. 2005). Stratigraphically a period requires detectable limits and, therefore, the whole GS-2 is considered in the present work as belonging to the Lateglacial, although the study focuses only on the unclear GS-2a which is regarded as arisen in research history (van der Hammen 1957; Mangerud et al. 1974; Björck et al. 1998) and is used in the present study according to the limit given in **fig. 3A**.

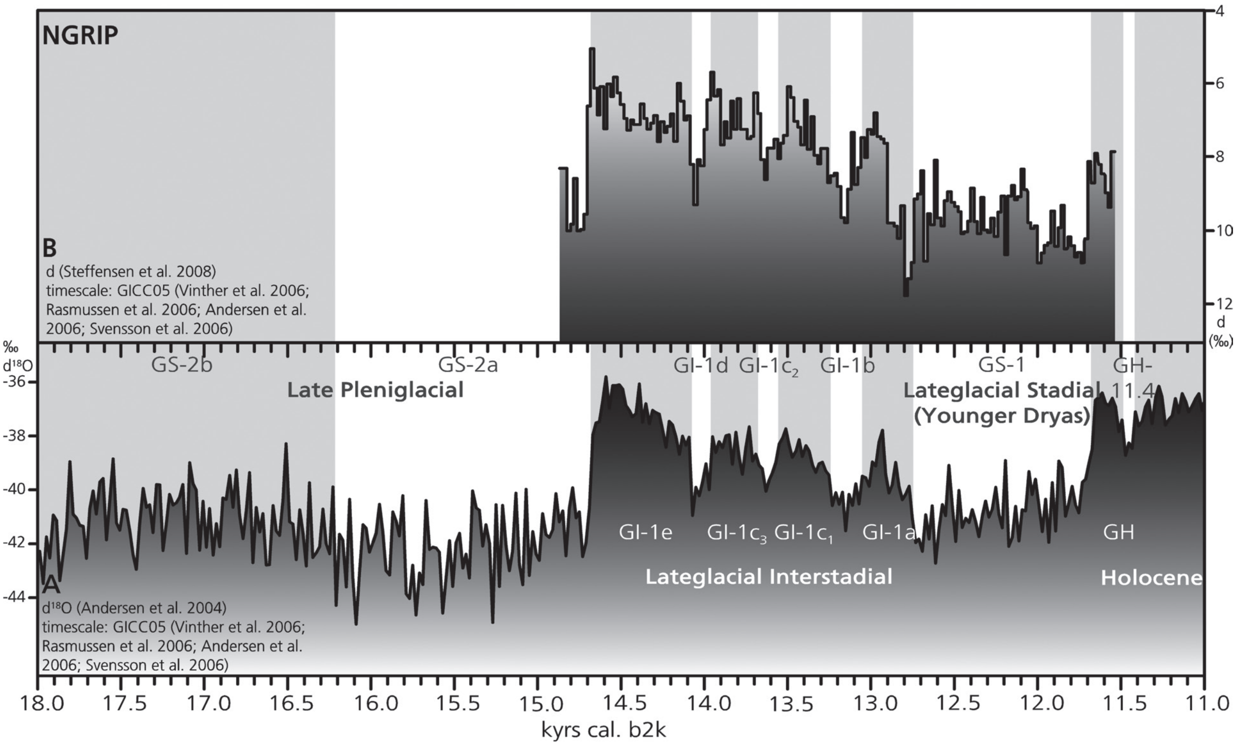



**Fig. 3** Lateglacial isotope records from NGRIP in GICC05 (Vinther et al. 2006; Rasmussen et al. 2006; Andersen et al. 2006; Svensson et al. 2006; Rasmussen et al. 2008; Svensson et al. 2008). **A** oxygen isotope record (Andersen et al. 2004). Grey shaded areas represent periods of more interstadial oxygen isotope values than the surrounding values (for instance, the values in GS-2b are more interstadial than in GS-2a but still these values are as stadial as the values in GS-1). – **B** deuterium excess record (Steffensen et al. 2008). – For further details see text.

Visible layers from this record were counted in the Pleistocene part (Alley et al. 1997; Meese et al. 1997) and contributed regularly to the establishment of precise, high-resolution ice-core chronologies. The NGRIP ice-core came from a drilling north of the two summit ice-cores (Andersen et al. 2004).

Comparison to the GISP2 and NGRIP record and a correction of the isotope accumulation model with seawater-corrected isotope values led to an updated version of the generally preferred age model to the ss09sea age model (Johnsen et al. 2001). Although some incongruences existed in the details (Southon 2002), the Greenland ice-core sequences were usually used in this ss09sea age model until the presentation of the so-called Greenland ice-core Chronology 2005 (GICC05).

In 2006 this new chronology was presented (Vinther et al. 2006; Rasmussen et al. 2006; Andersen et al. 2006; Svensson et al. 2006). In general, this chronology was based on the detection and counting of annual layers in the records from GRIP, NGRIP, and DYE-3 (*c.* 65° northern latitude; Vinther et al. 2006). The annual layers were defined by a visible stratigraphy (greyscale refraction) and by the cyclic development of chemical parameters such as ammonium ($NH_4^+$) and calcium ($Ca^{2+}$) which were obtained in a continuous flow analysis (CFA; Rasmussen et al. 2006). The resolution of the single parameters differed between three and 50 years (Rasmussen et al. 2006, X-3 tab. 1). The three sequences were correlated by volcanic marker horizons such as documented in the electrical conductivity measurement (ECM) records of the ice-cores in the Holocene period. Below the Holocene/Pleistocene transition only data from the NGRIP record was used to construct the chronology (Rasmussen et al. 2006; Andersen et al. 2006). Below the beginning of the Lateglacial Interstadial, the sequence of NGRIP was synchronised with those of GRIP and GISP2 again by the ECM record and, furthermore, the $NH_4^+$ record (Rasmussen et al. 2008). Based on these correlations and the detection of annual layers, the chronology was counted back 60,200 years (Svensson et al. 2008).

| onset of main isotope events | GICC05 (NGRIP) | | | | | | |
|---|---|---|---|---|---|---|---|
| GH | 11,703 ± 99 (d) | 11,703 ± 99 (d) | 11,681 ± 111 ($^{18}O$) | 11,703 ± 101 (d) | 11,686 ± 101 (dust) | 11,691 ± 102 ($Ca^{2+}$) | 11,695 ± 102 (λ) |
| GS-1 | 12,896 ± 138 (d) | 12,896 ± 138 (d) | 12,819 ± 202 ($^{18}O$) | 12,897 ± 140 (d) | 12,805 ± 144 (dust) | 12,804 ± 142 ($Ca^{2+}$) | 12,863 ± 160 (λ) |
| GI-1a | × | 13,099 ± 143 (GRIP) | × | × | × | × | × |
| GI-1b | × | 13,311 ± 149 (GRIP) | × | × | × | × | × |
| GI-1c | × | 13,954 ± 165 (GRIP) | × | × | × | × | × |
| GI-1d | 14,075 ± 169 (d) | 14,075 ± 169 (d) | × | × | × | × | × |
| GI-1e | 14,692 ± 186 (d); 14,680 ± 93 ($^{18}O$)* | 14,692 ± 186 (d) | 14,687 ± 187 ($^{18}O$) | 14,693 ± 188 (d) | 14,684 ± 188 (dust) | 14,681 ± 188 ($Ca^{2+}$) | 14,683 ± 193 (λ) |
| GS-2a | ×* | not clear | × | × | × | × | × |
| ref. | Rasmussen et al. 2006, tab. 4 | Lowe et al. 2008, tab. 1; cf. Blockley et al. 2012, tab. 1 | Steffensen et al. 2008, 683 tab. 1 (ramp points ± standard error of ramp fitting results, added with general counting error) | | | | |

**Tab. 1** Comparison of dates (all given in years cal. b2k) for the onset of the main isotope events in the NGRIP ice-core. Parameters: **d** deuterium excess; **$^{18}$O** oxygen isotopes; **GRIP** onsets for $\delta^{18}O$ events and episodes in GRIP, depths given by Björck et al. 1998 and transferred to NGRIP depths using the volcanic markers of Rasmussen et al. 2006; **dust** dust content; **$Ca^{2+}$** calcium concentration; λ annual layer thickness. * date given in Andersen et al. 2006, 3254 tab. 1.

In addition, the ss09sea age model (Johnsen et al. 2001) was correlated to the GICC05 at 60,000 years and applied to the NGRIP record further back to 123,000 years (Wolff et al. 2010). Even though the counting error in the GICC05 approach was in general relatively low due to the cross-checking and the use of various parameters (Rasmussen et al. 2008, X-4), the error accumulated and increased with time depth. In the studied time period the counting error reached *c.* 130-230 years.

Nevertheless, depending on the publication date, some data correlated to the ice-core records as for example the ELSA sequence (Sirocko et al. 2005) are also set in an old age model and require an updated correlation if applied with records of the new chronology.

Due to the significance of the NGRIP data for the Lateglacial part of the GICC05, the NGRIP sequence was chosen as stratotype of the oxygen isotope eventstratigraphy in the present work (fig. 3A; tab. 1; cf. Lowe et al. 2008). More precisely, the Lateglacial data records originate generally from the NGRIP2 ice-core. The $\delta^{18}O$ record is given in a 20 year mean resolution (Rasmussen et al. 2006, X-14). The oxygen isotopes are considered in the ice-core records as proxy for the air temperature at the coring site and, thus, seasonal cycles (summer– winter) can be distinguished at sufficient high-resolution sampling. Furthermore, the oxygen isotope ratio is measured in relation to a standard of ocean water (Dansgaard et al. 1993) because the carrier substance originated from these ocean waters and, thus, the oxygen isotope ratio is also strongly dependent on the hydrological cycle (e.g. Keeling 1995; Johnsen et al. 2001; Landais et al. 2010). In Greenland the water cycle is mainly governed by the circulations of the North Atlantic which is the major factor of north-western European climate as well. Therefore, oxygen isotope records from limnic archives in north-western Europe which are also governed by the North Atlantic circulation were frequently correlated to the Greenland oxygen isotope record (e.g. Lotter et al. 1992; Grafenstein et al. 1999; Hoek/Bohncke 2001).

However, the deuterium excess was used to define the limits of stadial and interstadial conditions in the Greenland eventstratigraphy (see **tab. 1**) most recently due to an early and sharp reaction to changes in the North Atlantic circulation (Steffensen et al. 2008). The deuterium excess is an index calculated from oxygen and deuterium isotopes ($d = \delta^2H - (8x\delta^{18}O)$) and, therefore, a second-order parameter which is usually given in a 20 year mean resolution in the ice-core records (**fig. 3B**). In contrast to the oxygen isotopes, the deuterium excess is considered to reflect the ocean surface temperature in the region where the Greenland precipitation originated from (i.e. source region of moisture) or the seasonality of snow precipitation (Masson-Delmotte et al. 2005). However, changes in this parameter were assumed to precede changes in temperature or vegetation recorded in other archives (Lowe et al. 2008, 10 tab. 1). Therefore, the deuterium excess is not a suitable proxy for correlations with terrestrial archives from north-western Europe. In consequence, the limits of the eventstratigraphy have to be partially redefined in the present study according to the oxygen isotope sequence (see p. 245-247) to allow a correlation with the terrestrial archives. Yet, the simultaneity of the Greenland oxygen isotope records with deep sea or terrestrial records was discussed recurrently (Goślar/Arnold/Pazdur 1995; Blaauw et al. 2010). Nevertheless, some of the thereby described offsets were perhaps due to reaction time of the different proxies and/or the identification of the precise trigger (for example temperature or precipitation) causing changes in these proxy data. Moreover, correlations of the Greenland eventstratigraphy based on isotope records with other, also non-isotopic records from the deep sea (e.g. Koç/Jansen/Haflídason 1993) as well as from terrestrial archives (e.g. Wastegård 2005) can be accomplished by ECM records, visible volcanic ashes, and sulphate records. A detailed Lateglacial tephrostratigraphy from the NGRIP record was previously published (Mortensen et al. 2005). This analysis included the microscopically detected ash shards, the chemical composition of ashes, and the gypsum ($Ca^{2+}$) corrected sulphate content (or excess sulphate, cf. De Angelis et al. 2003) which is considered a good proxy for mainly volcanic sulphate input into the atmosphere. Nevertheless, this data set was presented in a previous age model and, thus, needs to be shifted to the GICC05 (see p. 247 f.) before using this indicator as a correlation factor.
Another mean of comparison is the record of beryllium isotopes ($^{10}Be$). These isotopes can be measured from the aerosols in Greenland ice. The production of these beryllium isotopes in the atmosphere is governed by the interaction with cosmic radiation comparable to the production of atmospheric radiocarbon isotopes. Thus, the beryllium record represents a tool for connecting the Greenland ice-cores to the $^{14}C$ calibration curve (Muscheler et al. 2000; Muscheler et al. 2008). However, a detailed beryllium record is thus far not available for the NGRIP sequence but is available for GRIP and GISP2 (Muscheler et al. 2005).

### Deep sea records

In addition to the ice-core records, various records such as sediment or coral cores from the deep sea exist. Often these deep sea archives produced isotopic profiles (e.g. $^{14}C$, $^{10}Be$, $^{18}O$), temperature curves, and/or sea-level sequences from foraminifera, diatoms, or corals (Fairbanks 1989; Bond et al. 1992; Koç/Jansen/Haflídason 1993; Hughen et al. 1998a; Dokken/Jansen 1999; Bard et al. 2000; Björck/Koç/Skog 2003; McManus et al. 2004). However, these sequences also provided insights in the development of the sea ice cover as well as the ice sheets in the adjacent lands, in particular on the northern Atlantic by layers of ice-rafted debris (IRD, Heinrich 1988; Bond et al. 1999; Dokken/Jansen 1999; McCabe/Clark/Clark 2005; Peck et al. 2007; Bigg et al. 2010; Stanford et al. 2011b). Some of the deep sea archives were dated by a series of radiometric measurements but generally the chronologies are only floating and were correlated with comparable proxy records from other archives, in particular from the Greenland ice-cores (McManus et al. 2004; Peck et al. 2007). The connection to a continuous chronostratigraphy is problematic as some of the atmospheric isotopes became deposited in the deep ocean with considerable time lags due to the global ocean-atmosphere exchange system (Dokken/Jansen 1999; Muscheler et al. 2000; Ikeda/Tajika 2002; Schrag et al. 2002; Fairbanks et al. 2005). Especially for the carbon cycle, these »lags« (reservoirs) are known to be inconsistent in time and space and, in fact, to vary considerably (Muscheler et al. 2000; Björck/Koç/Skog 2003; cf. Lowe/Walker 2000, 57 f.; Schaub et al. 2008b, 77). Consequently, the time lags of the carbon isotope records from the deep sea needed to be estimated per time slice and per sequence. This estimate was usually also accomplished by correlation with other chronostratigraphies such as tephrochronology (Koç/Jansen/Haflídason 1993), ice-core chronologies (Bond et al. 1999), or partially dendrochronology (Hughen et al. 2004c) based on the assumption that isotopic events should correlate. Furthermore, for some sequences such as corals paired dating series ($^{14}C$ and $^{230}Th/^{234}U$) with an additional stratigraphic control were another possibility (Fairbanks et al. 2005). In summary, these deep sea records can produce a supplementary confirmation of the established climatic developments but need to be evaluated with some caution.

## Cariaco basin, Venezuela

Chronostratigraphies which are based on counts of annually laminated sediment couplets from the deep sea such as the floating varve chronology from the Cariaco basin, offshore Venezuela are very rare (**fig. 2**; Hughen et al. 1996b; cf. Ojala et al. 2012). In the Cariaco basin, several piston cores and additional ODP cores were drilled in the basin with four piston cores, in particular PL07-58PC and PL07-56PC, and one ODP core producing most of the results (Hughen et al. 2004c; Hughen et al. 2006). For instance, the PL07-58PC core provided a record of well preserved lipids (**fig. 4B**) which are considered as plant biomarkers distinguishing between arid and humid terrestrial plant communities (Hughen et al. 2004b). The varve chronology comprises *c.* 5,500 annual couplets spanning the period from the Holocene/Pleistocene transition to the transition from the Late Pleniglacial into the Lateglacial Interstadial (Hughen et al. 1998a; Hughen et al. 2000; Hughen et al. 2004c; Hughen et al. 2006). The lamination of the sediment were assumed to result from a generally bi-sected climatic cycle in the basin: The dry, windy season with coastal upwelling produced light-coloured, organic-rich plankton layers, whereas dark-coloured mineral grains from local river runoff formed the layers of the non-windy, rainy season (Hughen et al. 1996a; Hughen et al. 2000, 1951). Furthermore, almost 400 reliable $^{14}C$ dates were meanwhile made on samples for which the position in this laminated sequence is known with a 10-15 years exact precision (Hughen et al. 2000; Hughen et al. 2006). However, since the Cariaco basin sequence (**fig. 4**) is a floating chronology it also needs to be correlated, which can be accomplished by the $^{14}C$ record (Hughen et al. 2000) as well as by climatic changes which are displayed in the grey scale (relative reflectance) of the Cariaco basin sediment cores (Hughen et al. 1998a; Hughen et al. 2004a). The grey scale in combination with the laminae thicknesses are assumed to reflect the intensity of the local up-welling and the trade winds (Hughen et al. 2004b). These intensities are dependent on the position of the Inter-Tropical Convergence Zone (ITCZ) and, thus, the northern Atlantic thermohaline cycle. Hence, this record can also be used as confirmation for other records reflecting shifts in this oceanic exchange system such as the Central European dendrochronology (CEDC, Friedrich et al. 2004; see p. 25-30) to which the Cariaco basin record was wiggle-matched by the use of the $\Delta^{14}C$ variations (Hughen et al. 2000). The $\Delta^{14}C$ records of the CEDC and the Cariaco basin overlap currently in a 1,900 year long section between approximately 10,550 to 12,460 years cal. b2k. $\Delta^{14}C$ refers to the level of radiocarbon in the atmosphere (Stuiver/Polach 1977) which can be due to the global carbon cycle and

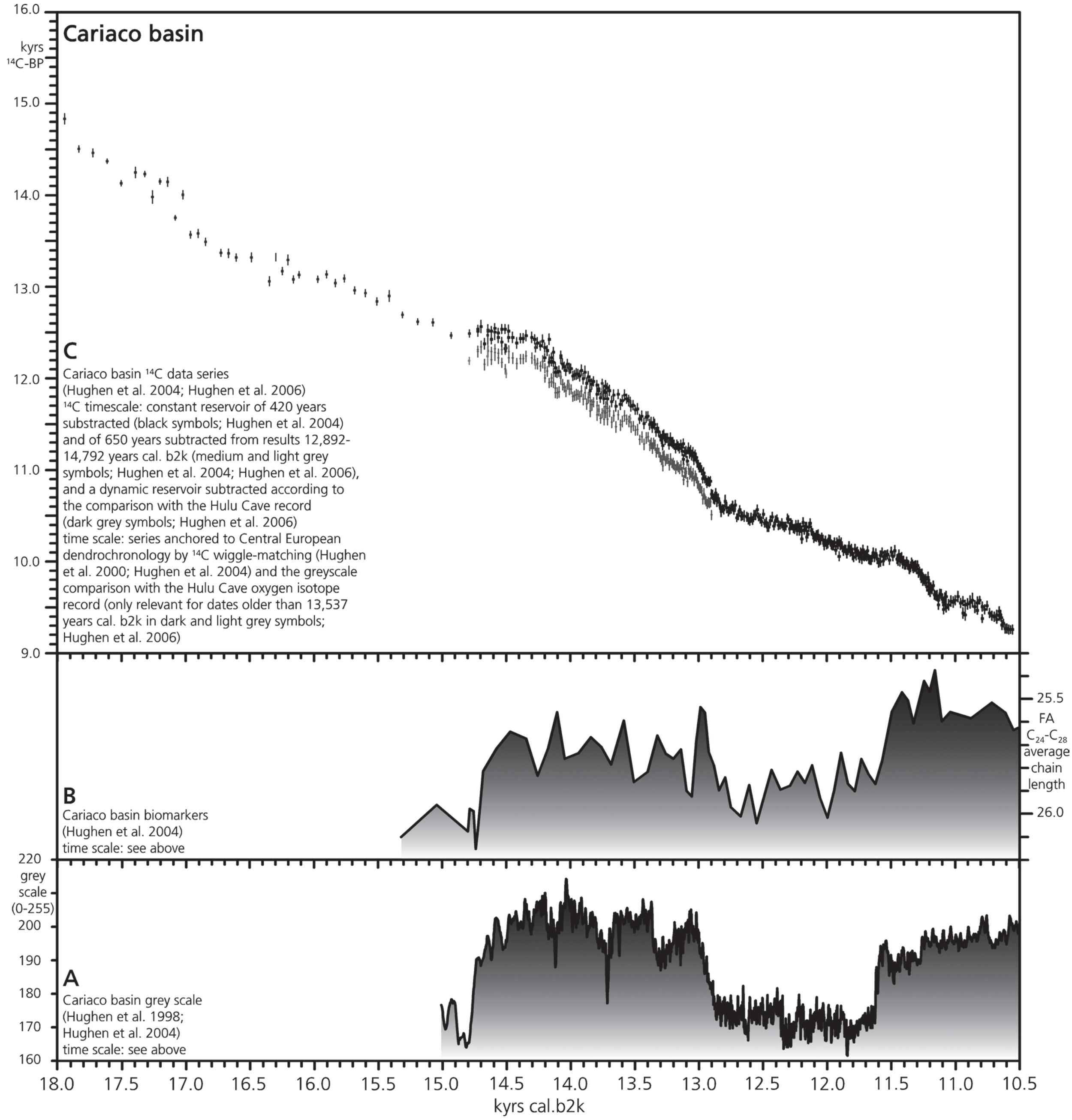



**Fig. 4** Lateglacial records from the Cariaco basin with the varve timescale wiggle-matched to the Central European dendrochronology (Hughen et al. 2000, Hughen et al. 2004c) and correlated to the Hulu Cave record (Hughen et al. 2006). Timescale shifted from cal. BP to cal. b2k. **A** greyscale record (Hughen et al. 1998a; Hughen et al. 2004a). Grey shaded areas represent periods of more interstadial values than the surrounding values. – **B** average chain length index of $C_{24}$-$C_{28}$ *n*-alkanoic homologs from the fatty acids (FA) of leaf waxes (Hughen et al. 2004b). – **C** series of $^{14}C$ dates in three different versions: one with constant reservoir of 420 years subtracted (black symbols); one with 650 years subtracted from the results between 12,892 and 14,792 years cal. b2k (medium and light grey symbols; Hughen et al. 2004a; Hughen et al. 2004c; Hughen et al. 2006), and one with a dynamic reservoir subtraction according to the correlation with the Hulu Cave record (for results older than 13,537 years cal. b2k; Hughen et al. 2006). – For further details see text.

the exchange of carbon isotopes between the atmosphere, the biosphere, and the oceans (Hughen et al. 2004a; Muscheler et al. 2004; Schuur et al. 2009) or due to the production rate of carbon isotopes in the atmosphere. The production rate of cosmogenic radionuclides such as $^{14}C$ or the beryllium-10 isotope ($^{10}Be$) in the atmosphere is motored by solar radiation, the geomagnetic field, and/or interstellar galactic cosmic ray flux (Laj et al. 2002; Muscheler et al. 2004; Hughen et al. 2004a; Muscheler et al. 2005). Since these

different reasons are globally effective, the changes should occur globally in a relatively short time period. However, due to the origin from the deep sea the $^{14}C$ dates from the Cariaco basin incorporated a reservoir effect (see p. 13) which is considered relatively constant at the Cariaco basin during the Lateglacial and the early Holocene (Hughen et al. 2000, 1951). Thus, 420 years were assigned to the marine reservoir effect and subtracted from the measurement results (Hughen et al. 2004c, 1183). Nevertheless, comparison with the floating German Lateglacial pine chronology (GLPC, Kromer et al. 2004; see p. 25-30) indicated a change in the reservoir ages from 420 years in the Holocene and the Lateglacial Stadial to 650 years in the Lateglacial Interstadial (**fig. 4C**; Hughen et al. 2004c, 1184 f.; Kromer et al. 2004, 1205-1207). The GLPC is also still a floating chronology and at least two positions to anchor this chronology to the Cariaco basin record are plausible, therefore, a change in reservoir ages remains a preliminary assumption (Hughen et al. 2006, 3217). The Weichselian sequence of the Cariaco basin was again correlated to the archive from the Hulu Cave (see p. 17 f.) also by wiggle-matching of the $\Delta^{14}C$ records (Hughen et al. 2006). This comparison indicated significant anomalies in the observed $\Delta^{14}C$ record between 15,050 and 45,050 years cal. b2k and based on simulation models were suggested to result from fluctuations in the reservoirs. Recently, the Cariaco basin sequence was fine-tuned to the oxygen isotope record of NGRIP using the variation of total reflectance or lightness of the sediment (Deplazes et al. 2013). This tuning was published too recently to be further integrated into the current project.
However, the chronology of this deep sea record was further described and evaluated in detail elsewhere because, in particular, the Cariaco basin record was frequently used in the construction of calibration curves passing beyond the current limit of dendrochronology because it bridges the Lateglacial Interstadial/Lateglacial Stadial transition (Lowe/Walker 2000; Reimer et al. 2004; Fairbanks et al. 2005; Weninger/Jöris 2008).

## MD01-2461, offshore Ireland

MD01-2461 is a sediment core drilled on the north-western flank of the Porcupine Seabight, offshore south-west of Ireland (**fig. 2**; Peck et al. 2007). At this location, the sediment was subject to significant detrital carbonate-rich IRD (ice-rafted debris) deposition due to a route of iceberg drift which originated from the circum-North Atlantic ice sheets. Thus, the concentration of IRD is considered as a proxy for iceberg delivery to the site. Significant increase of this concentration reflects massive destabilisations of the contributing ice sheets and revealed periods of so-called Heinrich events (Heinrich 1988; Bond et al. 1992). During these events the formation of North Atlantic Deep Water is hindered and, thus, the transport of warm surface waters northwards is curtailed resulting in an exceptionally cold and dry climate in the northern Atlantic seaboard (Rahmstorf 2002; Stanford et al. 2011b). Based on a synchronised sea sediment stratigraphy, these Heinrich events were counted from top down beginning with Heinrich 0 which is related to the Younger Dryas (Rahmstorf 2002). Due to this connection with Heinrich events, the IRD records are as a proxy also of some relevance for the development of the north-western European climate. Furthermore, the end of Heinrich 1 occurred in the Late Pleniglacial and was related to the oldest part of the studied time period (cf. Stanford et al. 2011b).
The IRD concentration as well as its composition was analysed in a high-resolution approach on this sediment core (Peck et al. 2007). Furthermore, oxygen isotopes based on benthic foraminifera, magnetic susceptibility, the sea surface temperature (SST) based on the different presence of species in the planktonic assemblage, and some chemical parameters were also measured (**fig. 5**).
The chronostratigraphy of this record was formed by correlation of the SST record from the core to the GISP2 oxygen isotope record, $^{14}C$ dates, and the testing on the tephrostratigraphy (Peck et al. 2007).

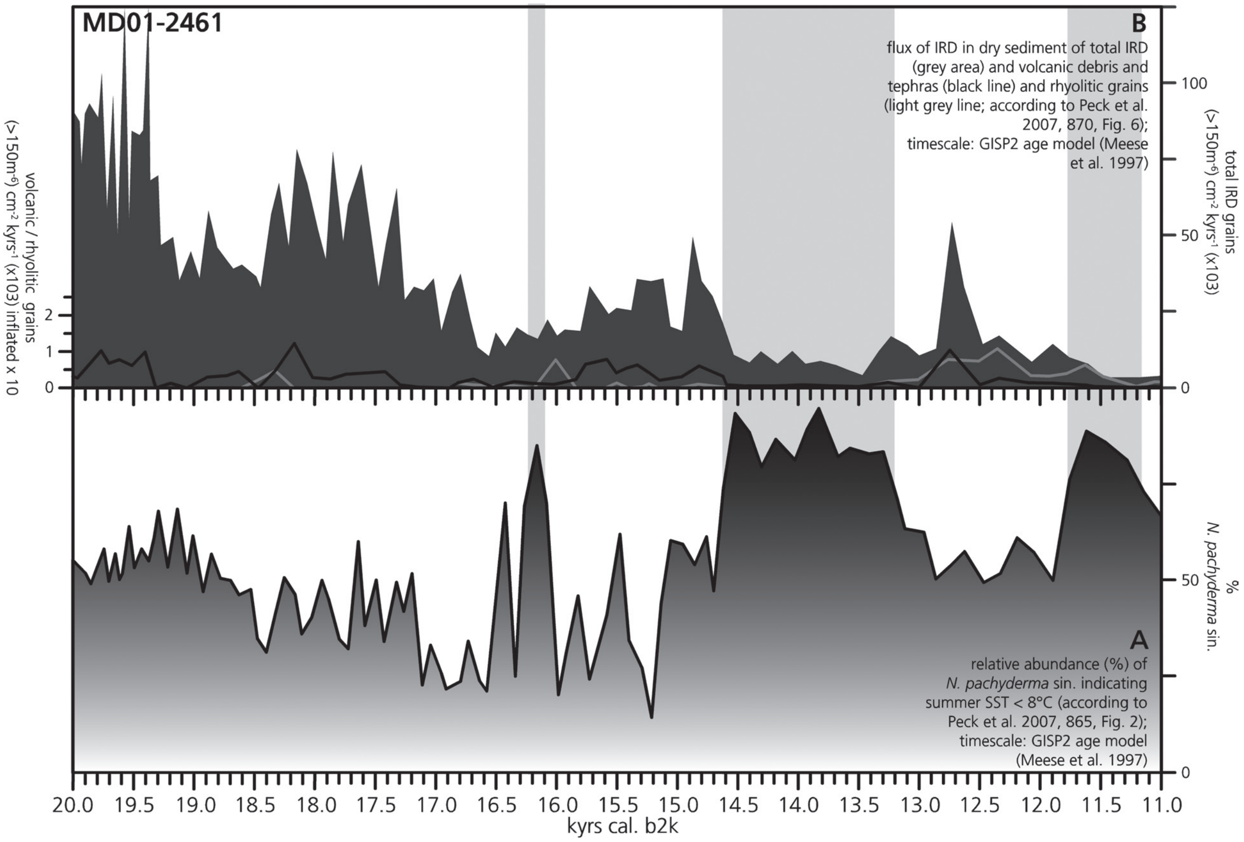



**Fig. 5** Lateglacial records from the MD01-2461 with timescale according to GISP2 age model (Peck et al. 2007). Timescale shifted from cal. BP to cal. b2k. **A** relative abundance (%) of *Neogloboquadrina pachyderma* sinistral, an indicator for polar waters and dominant in planktonic assemblages in waters of summer SST < 8°C. Grey shaded areas represent periods of more interstadial values than the surrounding values. – **B** concentration of total IRD (grey shaded area) and volcanic debris and tephra (grey and black lines) in dry sediment. – For further details see text.

According to these correlations, the sediment core contained a sequence from approximately 10,050 to 60,050 years cal. b2k. However, due to the correlation with the GISP2 record in a previous age model this relative stratigraphy has to be correlated to the new GICC05.

### Terrestrial records

Besides the sequences from Greenland and the deep sea, terrestrial records produced important information on the general climate development and, in particular, on the local impacts of these climatic regimes perceivable by Lateglacial hunter-gatherers. Some of these terrestrial records are as detailed as the glacial and oceanic archives. In contrast to deep sea records, an offset in the atmospheric values is either not as high or non-existent in continental sequences (including limnic ones). Therefore, these records are particularly important for the refinement of a Lateglacial chronostratigraphy. Furthermore, it is possible to directly connect the isotope events with the biotic stratigraphies in these records which help with describing the Lateglacial environment as well as relating these environmental developments to the global climate record. Additionally, the chronostratigraphy of these records can often be tested by radiometric dating as for instance in the Hulu cave speleothems (Wang et al. 2001) or the varve sequence of Holzmaar (Hajdas/Bonani/Zolitschka 2000).

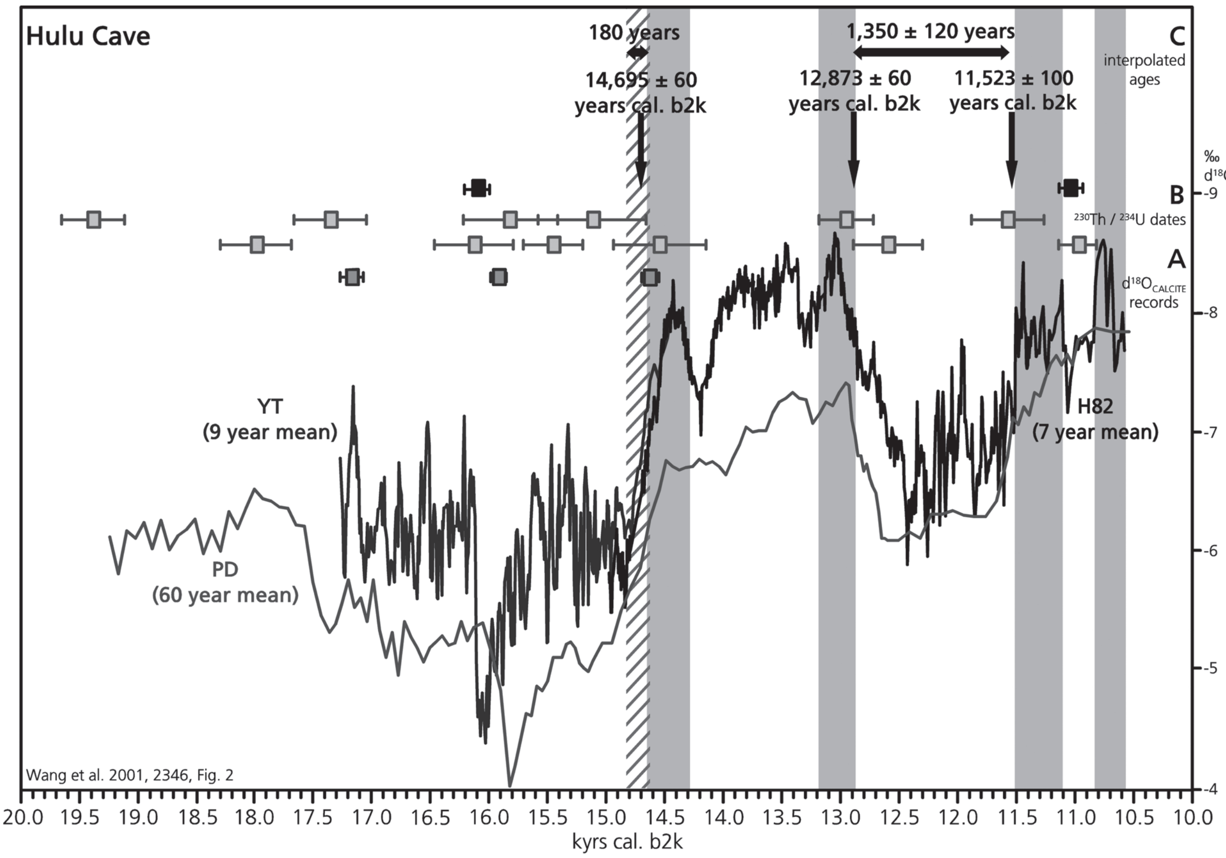



**Fig. 6** Lateglacial records from the Hulu Cave stalagmites (reproduced fig. 2, Wang et al. 2001, 2346 but timescale shifted from cal. BP to cal. b2k). **A** oxygen isotope records from three colour coded stalagmites. – **B** $^{230}$Th/$^{234}$U dates colour coded according to stalagmites in A. – **C** interpolated ages based on A, B, and laminae counting. Grey shaded areas represent more intense summer East Asian monsoon according to the oxygen isotope values. Hatched area represents the Late Pleniglacial to Lateglacial Interstadial transition. Duration for this transition and the Lateglacial Stadial are given on top. – For further details see text.

## Speleothems

Continuously grown speleothems which cover large parts of the Lateglacial period are rare and only few are known from Europe (Wurth et al. 2000; Kempe et al. 2002; Moreno et al. 2010). The advantage of speleothems are possible seasonal bandings, a reliable output of $^{230}$Th/$^{234}$U dates, and the combination with oxygen as well as carbon isotope records (Wang et al. 2001; Spötl/Mangini/Richards 2006).

### Hulu Cave, China

The Hulu cave lies 28 km east of Nanjing, China (**fig. 2**). Calcite samples for $\delta^{18}$O analysis and a series of 59 $^{230}$Th/$^{234}$U dates were taken along the growth axes of five speleothems from 35 m deep inside the cave (Wang et al. 2001). A few TIMS-$^{230}$Th/$^{234}$U dates in the late Pleistocene part of the oxygen isotope curve yielded standard deviations of ± 60-100 years (**fig. 6**; Wang et al. 2001, supplemental tab. 1). The origin of the isotope record from calcite might cause some offset though and it was therefore questioned (e.g. Hughen et al. 2006, 3221). However, the $\delta^{18}$O record was supposed to mainly reflect the summer/winter precipitation ratio, which is influenced by the intensity of the Asian monsoon, and a close connection to the Greenland air temperatures could be identified (Wang et al. 2001, 2347). This assumption was also questioned recently suggesting that instead changes in the moisture source were reflected by the $\delta^{18}$O record of the stalagmites (Maher/Thompson 2012). Nevertheless, the same study considered precessional forcing of inter-hemispheric temperature gradients as possible drivers of the $\delta^{18}O$ variations in Chinese stalagmites. Yet, this forcing is again a global phenomenon and should affect climatic archives in a comparable manner and at comparable times. However, this forcing was assumed to change the position and intensity of the subtropical pressure cells which then resulted in the differences within the speleothem records. Thus, in this case, differences in the reaction time and the impact on the record are possible. For the construction of the Hulu Cave speleothem chronology the $\delta^{18}O$ curves of three speleothems were correlated (**fig. 6**) and the bands in the continuously grown speleothems were counted between 11,050 and 11,850 years cal. b2k (Holocene to GS-1) and between 13,050 and 14,650 years cal. b2k (GI-1 to GS-2a; Wang et al. 2001, 2346). These bands were assumed to represent annual cycles due to the congruency of the number of counted layer couplets with the results of the radiometric dating.

The high-resolution calcite $\delta^{18}O$ curve in combination with the low standard deviations of the $^{230}Th/^{234}U$ dates and the additional band counting made the Hulu sequence (**fig. 6**) a good terrestrial control stratigraphy in the Pleistocene chronology of the northern hemisphere and it was therefore used several times to adjust other sequences (Hughen et al. 2006; Weninger/Jöris 2008). An atmospheric $^{14}C$ record based on a Hulu Cave stalagmite (Southon et al. 2012) was published too recently to be integrate in the current project.

Qingtian Cave, China

The limestone cave is located in central China (**fig. 2**), near the southern edge of the Chinese Loess Plateau where the cave is strongly influenced by the seasonal cycle of the Asian monsoon (Liu et al. 2008). A stalagmite was recovered from 40 m inside the cave and produced a mostly undisturbed laminated section of 1,498 ± 21 couplets which were placed by seven $^{230}Th/^{234}U$ dates (**fig. 7**) to the time interval between 12,130 ± 80 years cal. b2k to 13,530 ± 90 years cal. b2k. Hence, this record covers the period from the mid-Lateglacial Stadial (GS-1) to the mid-Lateglacial Interstadial (GI-1$c_2$). Besides an oxygen isotope record, the $^{13}C$ isotopes and the layer thickness of the couplets were recorded for the laminated section. The layer thickness was assumed to reflect the meteorological changes outside the cave. Problems and restrictions of the record are comparable to the data from Hulu cave (see p. 17 f.). Nevertheless, the Qingtian record provided a detailed climate history for the mid-Lateglacial and the transitions therein.

## Varve chronology

Seasonally laminated sediments occur not only in the deep sea but also in small and deep lakes which form sediment traps (Brauer et al. 1994). Some of these archives can reach an annual resolution which can only be disturbed by various errors concerning the counting of the couplets, taphonomic development, or changes in the deposition regime.

The currently longest counted sequence comes from the approximately 34 m deep Lake Suigetsu (Japan) where a floating chronology was established encompassing 29,100 couplets and was dated by correlation of the more than 330 $^{14}C$ dates on macrofossils from the lake with the CEDC to 8,880-37,980 years cal. b2k (Kitagawa/van der Plicht 1998). The sequence below this age was estimated to date down to *c.* 45,000 years due to the calculation of the sedimentation rate. However, the correlation with the calibration data indicated that parts of the sequence were miscounted or affected by hiatus (van der Plicht et al. 2004). These results warrant the exclusion of this dataset. Meanwhile, a new drilling program in the lake yielded more precise varve data and further radiocarbon dates which helped refining the age-depth-model of the sequence (Kossler et al. 2011; Bronk Ramsey et al. 2012). In the future, this new material promises to fill

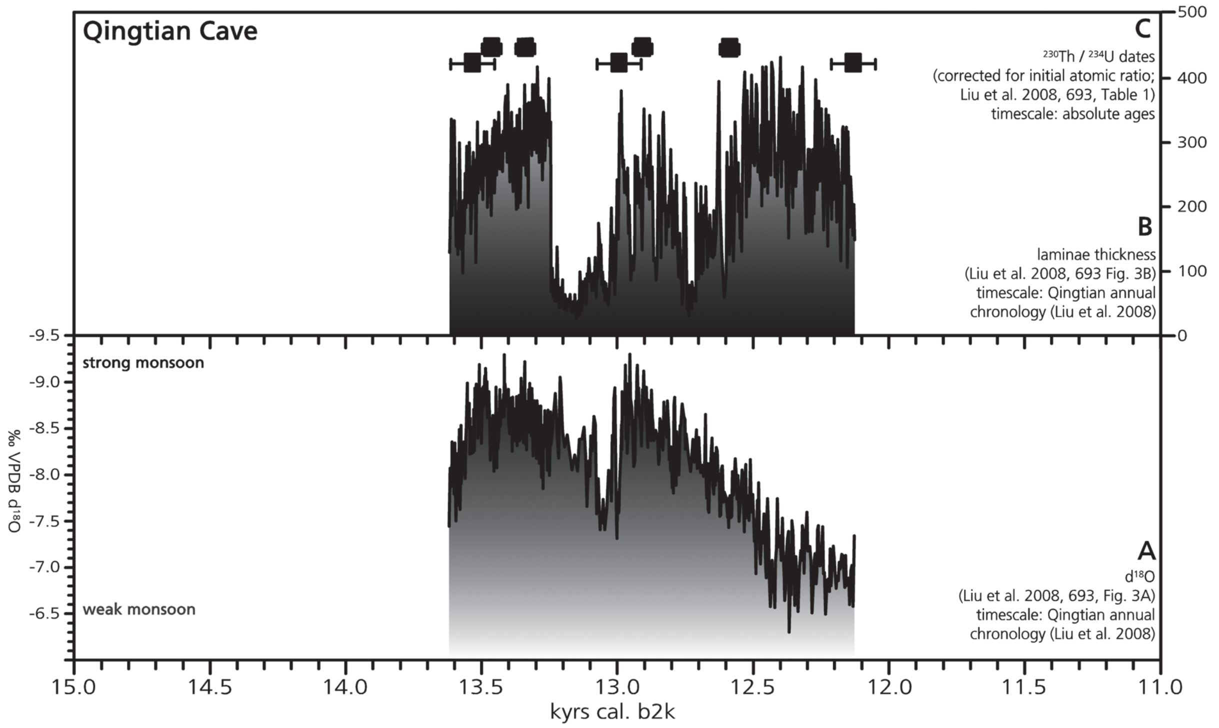



**Fig. 7** Lateglacial records from the Qingtian Cave stalagmites in the Qingtian annually resolved chronology (Liu et al. 2008). Timescale is shifted from cal. BP to cal. b2k. **A** oxygen isotope record. – **B** layer thickness. – **C** corrected $^{230}Th/^{234}U$ dates. Grey shaded areas represent periods of strong monsoon according to the oxygen isotope values. – For further details see text.

some gaps and produced new insights in the Lateglacial chronology but the results are too recent for the incorporation in the present approach.

Another prominent Lateglacial varve sequence comes from the south-eastern Turkish Lake Van which covers the time period from the present day back to 13,750 ± 356 varve years cal. b2k (Landmann et al. 1996; Wick/Lemcke/Sturm 2003). Although the lake sequence yielded various additional analyses, no series of $^{14}C$ dates was published as an additional chronostratigraphic parameter. Thus, the evaluation of the chronostratigraphic reliability on the scale of the northern hemisphere was not possible. Therefore, this sequence was not further incorporated in the present study.

Holzmaar and Meerfelder Maar, Germany

In the middle-range mountains west to north-west of the Central Rhineland, lakes have formed in several volcanic maar depressions in the Quaternary Eifel volcanic field. These volcano lakes form natural sediment traps and laminated sediments were recovered from some of these locations such as Meerfelder Maar, Holzmaar, or Schalkenmehrener Maar (Brauer et al. 1994; Sirocko et al. 2005). Lamination, colour, and thickness of the couplets in these lakes are influenced by various climatic parameters controlling the water and sediment catchments of the lake as well as the developments of diatom population (Vos et al. 1997; Brauer/Endres/Negendank 1999; Zolitschka et al. 2000). The numerous sediment cores link laminated sediments to detailed geochemical analyses (Brauer et al. 2008; Sirocko et al. 2005; Lücke et al. 2003), pollen profiles (Litt/Stebich 1999), macrofossils (Hajdas et al. 1995), and diatom sequences (Brauer et al. 1999). Furthermore, ash layers from the surrounding Quaternary volcanoes served for chronostratigraphic correction and/or correlation of the various sequences (Zolitschka et al. 2000).

In a project on these Eifel Laminated Sediment Archives (ELSA), four of these sequences (Hoher List, Oberwinkler Maar, Dehner Maar, and Schalkenmehrener Maar) were correlated to form the »ELSA greyscale stack 2005« (ELSA greyscale) which can be considered as indicator for the organic carbon content and the introduction of silt (dust; Sirocko et al. 2005). Thus, in warm periods the record is mainly governed by the organic production of the lake catchment area and in cold periods by aeolian activity (Seelos/Sirocko/Dietrich 2009). Wind systems were reconstructed based on the geo-topography of the lakes and an analysis of the lithological composition of the introduced dust (Seelos/Sirocko/Dietrich 2009; Dietrich/Seelos 2009). The Lateglacial part of this greyscale was received from the Schalkenmehrener Maar where the Lateglacial Stadial section was not preserved sufficiently in the sediment cores drilled until 2005 and, therefore, data for this period is lacking in the record (cf. Sirocko et al. 2005, supplementary material). The chronostratigraphy is based on the varve chronologies of the sequences combined with radiometric age control (luminescence and $^{14}C$ dates) as well as the tuning of the ELSA greyscale to the NGRIP oxygen isotope record in the ss-09sea chronology (Sirocko et al. 2005; cf. Andersen et al. 2004). Consequently, if this record is applied it also requires tuning to the GICC05.

The most prominent lakes with laminated sequences spanning the Lateglacial are the Meerfelder Maar (MFM) and the Holzmaar (**fig. 2**), situated approximately 10 km farther to the east than the former. In both sequences the stratigraphic marker horizons of the Lateglacial LST and the early Holocene Ulmener Maar Tephra (Zolitschka/Negendank/Lottermoser 1995) are present, allowing for a good correlation of the cores from the two localities (**fig. 8**). Additionally, a series of 41 $^{14}C$ dates was taken on terrestrial macrofossils from Holzmaar (Hajdas et al. 1995; Zolitschka et al. 2000) and from the MFM a further 51 samples were $^{14}C$-dated (Brauer et al. 2000b) to allow further comparison with the $^{14}C$ calibration curves.

The Holzmaar sequence was laminated back from the present day and contained some 23,220 ± 810 couplets (Zolitschka et al. 2000). The upper *c.* 13,840 of these are of organic composition (Vos et al. 1997; Leroy et al. 2000), whereas the lower 9,380 couplets are clastic sediments. The latter are demonstrated to represent annual cycles by a sedimentation model and by comparison with solar cycles (Brauer et al. 1994; Vos et al. 1997). Missing or poorly developed varves in the Holocene part were detected by correlation with the $^{14}C$ dates of the CEDC record and the correction of 346 years between 3,550-4,550 years cal. b2k in the record was confirmed as correct by comparison with the same sequence in the MFM record (Zolitschka et al. 2000). However, due to this clear gap, the Lateglacial chronology has to be regarded as floating. The comparison with the MFM also indicated a hiatus of approximately 320 years within the Younger Dryas (**fig. 8**; Zolitschka et al. 2000) which had first been identified in the pollen record (Leroy et al. 2000).

In the MFM record the upper 1-2 m (i. e. the last *c.* 1,500-2,000 years) were not analysed due to poor varve preservation (Brauer et al. 2008, supplementary information) but from there on 12,000 couplets were counted (Brauer/Endres/Negendank 1999, 19). This floating chronology was correlated with the Holzmaar record by the use of the Ulmener Maar Tephra (dated to 11,050 ± 215 varve years cal. b2k; Zolitschka 1998; Brauer/Endres/Negendank 1999). Above this correlation point some offsets might occur but the correlation of the Ulmener Maar Tephra at 11,050 years cal. b2k seemed reliable, based on comparison with both the $^{14}C$ record as well as the Holocene increase in tree-ring width of the CEDC (Brauer et al. 2000b), and therefore the offsets on top of this tephra are of no further interest here. Below this correlation layer some 3,020 couplets were counted in the MFM record (**fig. 8**) including the LST (Brauer/Endres/Negendank 1999) which occurred 1,880 couplets below the Ulmener Maar Tephra. In contrast, the Holzmaar record yielded only 1,560 varves between these two marker horizons. At the Holocene/Pleistocene transition the lamination in the MFM was weak and, thus, over 4 cm (some 50 varve years) the exact counting becomes uncertain (Brauer/Endres/Negendank 1999). If these 50 varves were included, the hiatus in the Holzmaar record during the Lateglacial Stadial would also need to increase to 370 years and the onset of the Younger Dryas as well as the dating of the LST would also be pushed some 50 years older. Thus, this uncertainty was considered with the error estimate and not counted on top of the varve years. In the lower part of

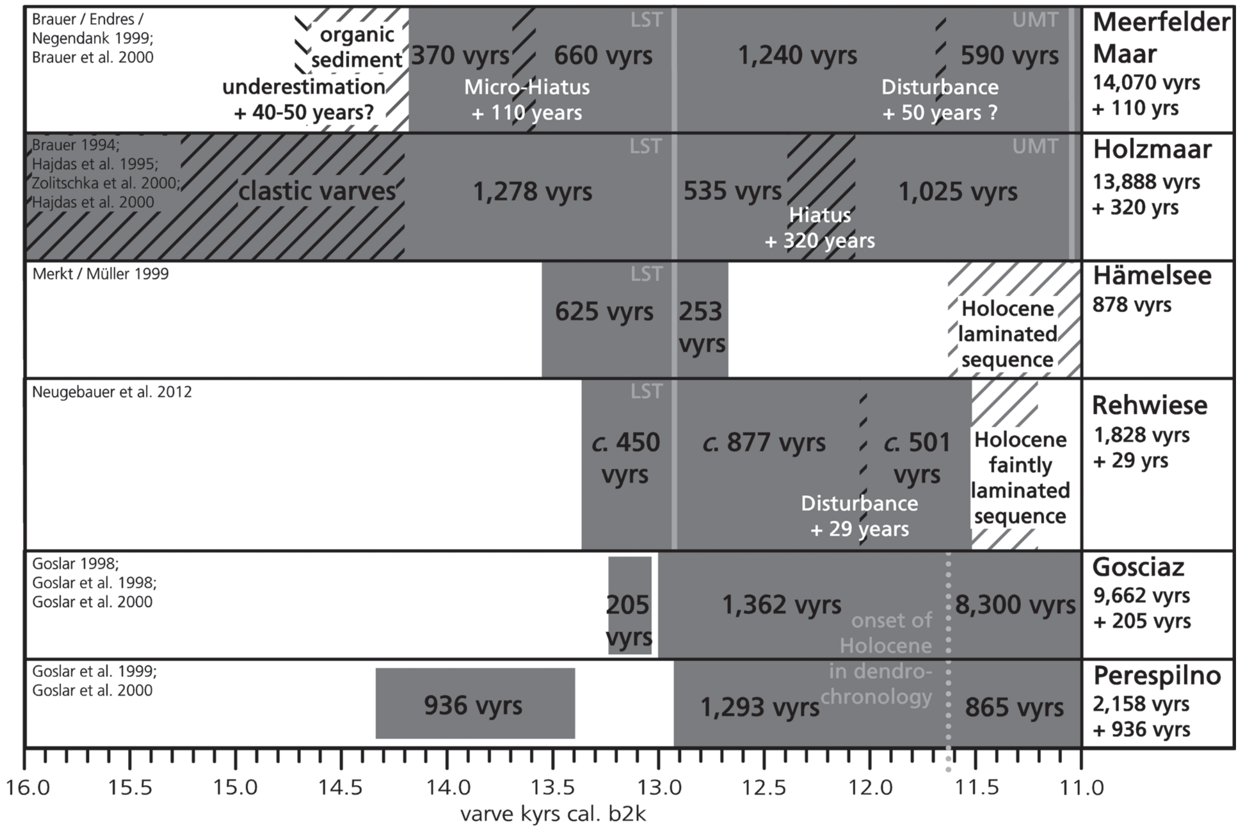



**Fig. 8** Comparison of Lateglacial varve chronologies from Northern Europe. Timescales according to the varve chronologies and shifted from cal. BP to cal. b2k. Dotted lines: onset of the Holocene in oxygen isotope records. – Dashed line: sedimentological onset of the Holocene. – Solid line: tephra layer. – **LST** Laacher See Tephra; **UMT** Ulmener Maar Tephra. – For further details see text.

the laminated section, another c. 4 cm thick, disturbed section occurred which was estimated by correlation with the pollen zones in northern Germany to represent approximately 110 missing couplets (Brauer et al. 2000a, 231). However, if this part was compared to the Holzmaar record (Leroy et al. 2000) the most plausible correlation (psz 3-4/5) represented 340-380 couplets, i. e. 210-250 years more than were counted in MFM. According to the calculation of the sedimentation rate in this section of the MFM, 60-80 couplets could be missing (Brauer/Endres/Negendank 1999, 21). Thus, in the present study the »conservative« 110 varve counts were added. Additionally, the lowest 75 cm of the more organic sediment in the MFM sequence were not laminated. This section was estimated by extrapolation of depth and varve frequency in the 200 couplets following the onset of lamination (Brauer/Endres/Negendank 1999, 20) to have begun some 430 years earlier. However, an underestimation of up to 10 %, i. e. 40-50 couplets seemed possible (Brauer/Endres/Negendank 1999).
In combination, the two Eifel Maar records form a solid chronostratigraphy of the Lateglacial which can be connected to other records by the use of stratigraphic marker horizons as well as comparison of the carbon isotope record.

Hämelsee, Germany
The Hämelsee lies centrally on the southern North European Plain, near the transition towards the middle-range mountains (**fig. 2**). The lake presumably represents a sinkhole over Permian salt (Merkt/Müller 1999). Here partially laminated sediment formed as in several other lakes from northern Germany such as Lake Belau (Dörfler et al. 2012) and Lake Wollingst (Merkt/Kleinmann 1998; Müller/Kleinmann 1998).

These lakes were correlated using the Holocene event of the elm decline and various stratigraphic marker horizons such as the LST (**fig. 8**; Merkt/Müller 1999). For the Holocene the Saksunarvatn Ash was chosen as the correlation point. Sediments reaching back to the LST were found in the Lake Belau and the Hämelsee. Although the Holocene sequence of the Hämelsee reached back to the onset of the Holocene, the Preboreal section was not counted as being as reliable as the same sequence in the Plußsee (Merkt/Müller 1999, 44 fig. 3). On top of the Preboreal *c.* 1,600 couplets were counted in the Hämelsee, describing the Holocene sequence. Below the Preboreal a gap of inconsistent varve formation followed encompassing most parts of the Lateglacial Stadial. However, 253 laminated couplets were deposited on top of the LST. 625 couplets were counted below the LST. The unlaminated or poorly laminated sequences were correlated with well established chronostratigraphies from elsewhere (e. g. Lake Gościąż, MFM) because in northern Germany almost all lake sediments displayed a hiatus in sedimentation during the Lateglacial Stadial and sequences too short for the earlier parts of the Lateglacial Interstadial (Litt et al. 2001, 1239). However, the direct comparison of some parts of the MFM records with the segmented northern German records displayed some differences, for instance, in the duration of some events (Merkt/Müller 1999, 45) and led to the recalculation of some disturbed layers in the MFM (see p. 20; Brauer et al. 2000a). Nevertheless, these correlations need to be seen with some caution due to the uncertain difference in reaction time and the various positions in the succession of biozones. Microfacies analysis of the sediment revealed that a multitude of parameters had influenced the sedimentation in Hämelsee and that different processes led to the onset of the Allerød than those that led to the onset of the Younger Dryas (Merkt 1994, 60; Merkt/Müller 1999, 48).

Thus, the Hämelsee only provided a Holocene and a Lateglacial floating varve chronology which was partially confirmed and added by other northern German sequences such as the one from the Lake Belau, the Plußsee, the Lake Muggesfeld, and the Lake Wollingst. These floating northern German varve sequences can be correlated to other chronostratigraphies by stratigraphic marker horizons such as the LST or the Holocene Saksunarvatn Ash. In the Hämelsee record this chronostratigraphy is additionally combined with sedimentological, geochemical, pollen, spores, and rotifer analyses, as well as a series of some 15 $^{14}$C dates on macrofossils. Therefore, the Hämelsee sequence can be used as a comparative record in the mid-Lateglacial.

Rehwiese, Germany

The palaeolake Rehwiese lies in the south-west of the Greater Berlin area within the North European Plain (**fig. 2**). The lake was part of a glacially formed water gap (*Grunewaldrinne*) which connected the Havel with the Spree and developed during the Weichselian maximum stage of the Scandinavian ice sheet in the area of modern Berlin.

The palaeolake Rehwiese consisted of three basins which were silted up by the mid-Holocene, some 6,000 years ago, and form part of a modern grassland park at the city limits of Berlin (Neugebauer et al. 2012). Four sediment cores were drilled at two locations in the centre of the still visible depression of the central basin of the palaeolake. At each location the two cores were drilled parallel with some overlap to produce two composite sequences (A/B and C/D) of laminated sediments and approximately 3.65 m thickness encompassing a period from the younger part of the Lateglacial Interstadial to the Early Holocene. The laminated sediments were formed by mainly calcite varves. Below the laminated sediments a silty layer was deposited on top of partially layered sands. On top of the Early Holocene varves a deposit with considerably poorer lamination followed which was overlain by some 6 m of a homogeneous calcareous gyttja. Finally, an approximately 1 m thick deposit of peat covered the lacustrine stratigraphy. Therefore, this laminated sequence represents another floating chronology.

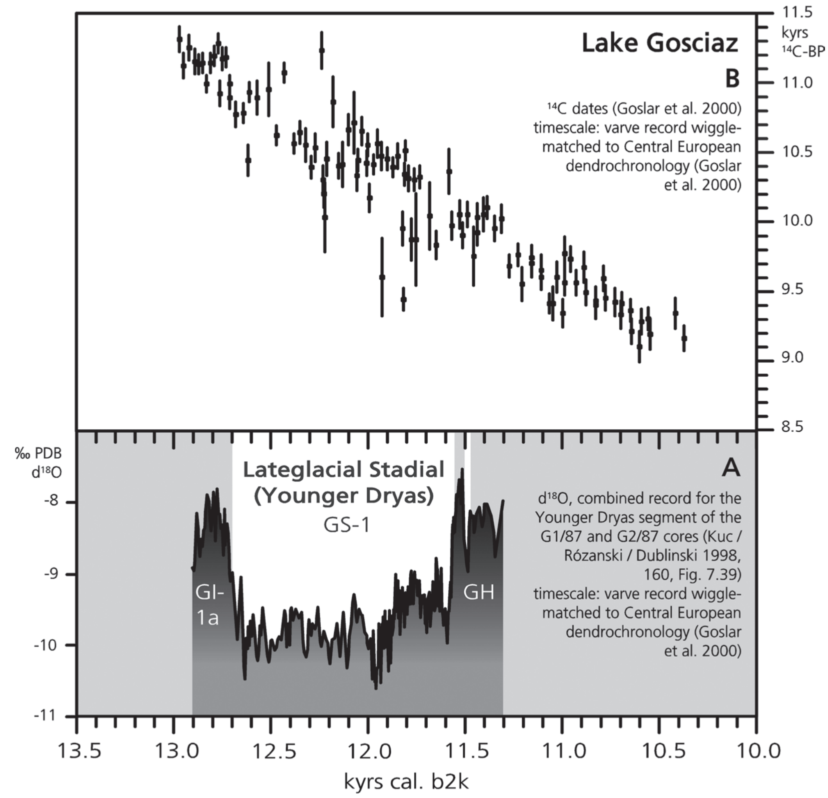



**Fig. 9** Lateglacial record from Lake Gościąż in varve chronology wiggle-matched by $^{14}C$ isotopes to Central European dendrochronology (Goslar et al. 2000). Timescale is shifted from cal. BP to cal. b2k. **A** oxygen isotope record (Kuc / Różański / Dubliński 1998). Grey shaded areas represent periods of more interstadial oxygen isotope values than the surrounding values. – **B** series of $^{14}C$ dates (Goslar et al. 2000). – For further details see text.

However, in the lower part of the sequences the LST was found and used as the anchor point to connect the Rehwiese to the MFM record (**fig. 8**). On top of the LST 1,378 couplets and below some 450 couplets were counted with the confidence of *c.* 1 % counting error (Neugebauer et al. 2012). A disturbance of 7.4 cm in both composite sequences was interpolated by sedimentation rate to 29 couplets within the Younger Dryas section, around 12,040 years cal. b2k (Neugebauer et al. 2012). However, this profile represents the thus far most complete section of the Younger Dryas in the European varve records.

The material below the LST is not yet published. In addition to a detailed micro-facies analysis of the sediments from the LST upwards, geochemical analyses were performed and palynological results from a previously taken profile were correlated with a few high-precision pollen counts in short sub-sections (Neugebauer et al. 2012) and yielded one of the most reliable records for the Younger Dryas in northern Germany.

Lakes Gościąż and Perespilno, Poland

In the Polish part of the North European Plain two important Lateglacial stratigraphies with laminated sediments are from Lake Gościąż and Lake Perespilno (**fig. 8**). While Lake Gościąż is situated approximately in the centre of northern Poland, Lake Perespilno lies near the eastern border of the country and near the transition towards the middle-range mountains (**fig. 2**).

Lake Gościąż is one of the north-western lakes of the Gostynińskie Lake District, which is formed by over 60 lakes and is situated in the Płock Basin at the lower Vistula valley, north-west of Warsaw. The basin lies just inside the limits of the maximum extent of the Scandinavian ice sheet during the LGM. The lakes formed after the retreat of the periglacial conditions and the down cutting of the Vistula (Churski 1998). Similar to Gościąż, Lake Perespilno is located in the western part of a lake district with 67 lakes, which formed in a depression with restricted water runoff (Bałaga / Goslar / Kuc 1998). Some 300 km south of the maximum extent of the ice sheet the lakes were presumably formed due to karst and thermokarst processes in the underlying marl and chalk bedrock.

Laminated sediments from several cores taken at Gościąż cover a period from the Late Pleniglacial to the present day and produced intensively studied lithological and environmental sequences (Ralska-Jasiewiczowa et al. 1998). These were studied with geochemical and mineralogical analyses (Łącka/Starnawska/Kuźniarski 1998) and investigations of pollen (Ralska-Jasiewiczowa/Demske/van Geel 1998), diatoms (Marciniak 1998), cladocera (Szeroczyńska 1998), and isotopes ($^{13}C$, $^{18}O$; Kuc/Różański/Dubliński 1998). Moreover, the cores provided samples for a series of 47 $^{14}C$ dates (**fig. 9**; Goslar/Arnold/Pazdur 1998; Goslar et al. 2000). In the seven cores from Perespilno, 51 $^{14}C$ dates were taken on macrofossils (Goslar et al. 2000); furthermore, isotopes ($^{13}C$, $^{18}O$), geochemistry, and pollen were analysed (Bałaga/Goslar/Kuc 1998; Goslar et al. 1999).

In the upper part of the Gościąż stratigraphy, the poor development of the lamination prevented a reliable counting of couplets. Consequently, the 9,662 ± 90 couplets were not continuous to the present day and, hence, formed a floating chronology (Goslar 1998b). The organic sediments represent seasonal cycles and, thus, can be counted as varves. Significant gaps and uncertainties in the correlation generally occurred in the Holocene portion (8,300 ± 50 couplets). However, in the lower, Lateglacial part (1,362 ± 42 couplets + 205 uncorrelated couplets) some uncertainties arose at the onset of the Younger Dryas where a sand layer eroded some parts of the main counted cores. However, this gap was bridged by cores from the western and northern parts of the lake and, consequently, the gap was estimated to only represent 4 +6 / -2 varve years (Goslar 1998c). Generally, the cores were recovered in 1-2 m long segments and the correlation of these segments also provided a potential cause of miscounting. This problem applied in particular to the deepest segment of the deepest core which could not be correlated with certainty to the Lateglacial sequence.

These 205 couplets (**fig. 8**; Goslar 1998c) formed yet another independent floating, unconnected chronology and will not be used in the present study. Based on the lithological, palynological, and isotope studies, the Younger Dryas was clearly identified. Thus, the continuous counting reached back 222 ± 2 couplets beyond the onset of the isotopically determined Younger Dryas into the Lateglacial Interstadial. In the Younger Dryas section 1,140 ± 40 couplets were counted. In a monographic publication the Gościąż sequence was intentionally not compared to other records on a regional or global scale (Goslar et al. 1998b, 171-173), but wiggle-matching of $^{14}C$ dates on macrofossils with the CEDC record then in use allowed a fixation of the Holocene/Pleistocene limit and, furthermore, demonstrated the coincidental rise of the oxygen isotope record in Gościąż and the tree-ring width in the Central European pines (Goslar et al. 2000). Nevertheless, the shift of the CEDC since (Friedrich et al. 2004) implicated a comparable shift of the Gościąż record. The $^{14}C$ dates displayed a wide wiggling in the Lateglacial part. The $\delta^{18}O$ record in Gościąż was comparable to the tree-ring width mainly controlled by climatic parameters, in particular, the hydrological regime of the lake and the air temperature (Kuc/Różański/Dubliński 1998, 158). The varve thickness in Lake Gościąż seemed to be controlled by the organic productivity of lacustrine biota (Goslar 1998d, 105) and temperature during the flowering period (Goslar 1998d, 107).

At Perespilno only the lower 3 m of sediment was laminated (Bałaga/Goslar/Kuc 1998). The sequence comprises 3,105 ± 120 couplets (**fig. 8**; Goslar et al. 1999) which were not confirmed as representing annual cycles, but comparison with the Gościąż record suggested this assumption to be plausible (Bałaga/Goslar/Kuc 1998). The record was correlated mainly with Gościąż and comprised a period from the early Holocene to the mid-Lateglacial Interstadial (Goslar et al. 1999). Originally, two major gaps occurred within the sequence, one of which was due to coring and could be bridged by additional cores (cf. Bałaga/Goslar/Kuc 1998 and Goslar et al. 1999). The other one was a 10.8 cm long section of unlaminated sediment from the later part of the Allerød. According to the sedimentation rate in the surrounding sediments this part was first estimated to encompass 145 ± 20 couplets (Bałaga/Goslar/Kuc 1998) but later recalculated to 80 ± 60 couplets (Goslar et al. 1999). This gap bisected the core record into a part encompassing 2,158 ±

100 couplets, in which the transition from the Holocene to the Lateglacial Stadial and the transition to the Lateglacial Interstadial were present, and an older part containing 936 ± 35 couplets (Goslar et al. 2000). In the longer, younger section 168 ± 10 couplets represented the end of the Lateglacial Interstadial, 865 ± 20 years were assigned to the Holocene, and the remaining 1,125 ± 70 couplets were deposited during the Lateglacial Stadial. The older section was wiggle-matched to coral $^{14}C$ calibration data and, thus, dated to a period between 13,750 and 14,500 years cal. b2k (Goslar et al. 2000). However, calibration data sets spanning the early Lateglacial were refined since (e. g. Weninger/Jöris 2008) and the correlation should be reviewed in light of these new curves. No other isotopic measurements of the older part of the Perespilno sequence were published for more reliable comparison and so, for the moment, it needs to be considered as unconnected to the calendar age timescale and thus will not be used in the present study. Analyses of geochemistry and isotopes were connected with the upper part of the record as well as a palynological study and measurements of magnetic susceptibility (Goslar et al. 1999), which reflected the ratio of induced magnetisation to the magnetic field and could be used to identify volcanic activity in sediment records (Peters et al. 2010). However, a precondition for the latter analysis is a constant content of magnetic minerals in the sediment which seemed not to be the case in the record from Lake Gościąż (Nilsson 2006).
The main significance of the Polish records is the generally undisturbed lamination during the Younger Dryas as well as the extensive additional analyses. From Lake Gościąż so far the only continental high-resolution oxygen isotope record in combination with varve counting, a record of varve thickness, and a series of $^{14}C$ dates is known. The record could thus be correlated to the Greenland ice-cores by the use of the $\delta^{18}O$ data (Goslar/Arnold/Pazdur 1998) and also to the CEDC by wiggle-matching the carbon isotope series (Goslar et al. 2000) as well as comparing the varve thickness record (Goslar 1998a) which in addition allowed a correlation with other laminated sequences (Litt et al. 2001).

### Dendrochronology

Tree-ring chronologies, with their annual resolution and content of carbon, provide a strong tool for constructing radiocarbon calibration curves (Stuiver 1982; Friedrich et al. 2004). Based on the assumption of comparable production rates of cosmogenic radionuclides due to the common dependence on solar radiation and geomagnetic field, the $\Delta^{14}C$ record can be correlated to the Beryllium ($^{10}Be$ flux) record in Greenland ice-cores (Muscheler et al. 2008). Furthermore, by the means of tree-growth rate this terrestrial environmental record can partially be compared to the isotope eventstratigraphy (Friedrich et al. 2001b; Schaub et al. 2008a) because tree-ring width is controlled by the climatic conditions prevailing during the growth season and, thus, changes in the hydrological regime, in particular, can be inferred from this record (Friedrich et al. 1999). Additionally, the tree-rings were also sampled for further isotopes such as $^{2}H$ (deuterium) and $^{13}C$, which in this record mainly reflect humidity and temperature during the summer months (Friedrich et al. 1999).
Unlike many other records, the CEDC extends back from modern times continuously (**fig. 10**). In general, the $^{14}C$-dated samples comprised approximately 10 tree-rings and yielded ages with standard deviations of 15 to 35 radiocarbon years (Reimer et al. 2004). The previously described data sets showed clearly the significance of the CEDC for most of the other chronostratigraphic records. Besides representing the correlative sequence for various floating varve chronologies, the dendrochronological data set was also accepted by the major calibration curves as the most reliable $^{14}C$ calibration record (Fairbanks et al. 2005; Weninger/Jöris 2008; Reimer et al. 2009) and, consequently, the calibration results for dates from the time period covered by this data set are generally similar. However, if corrections are made to the tree-

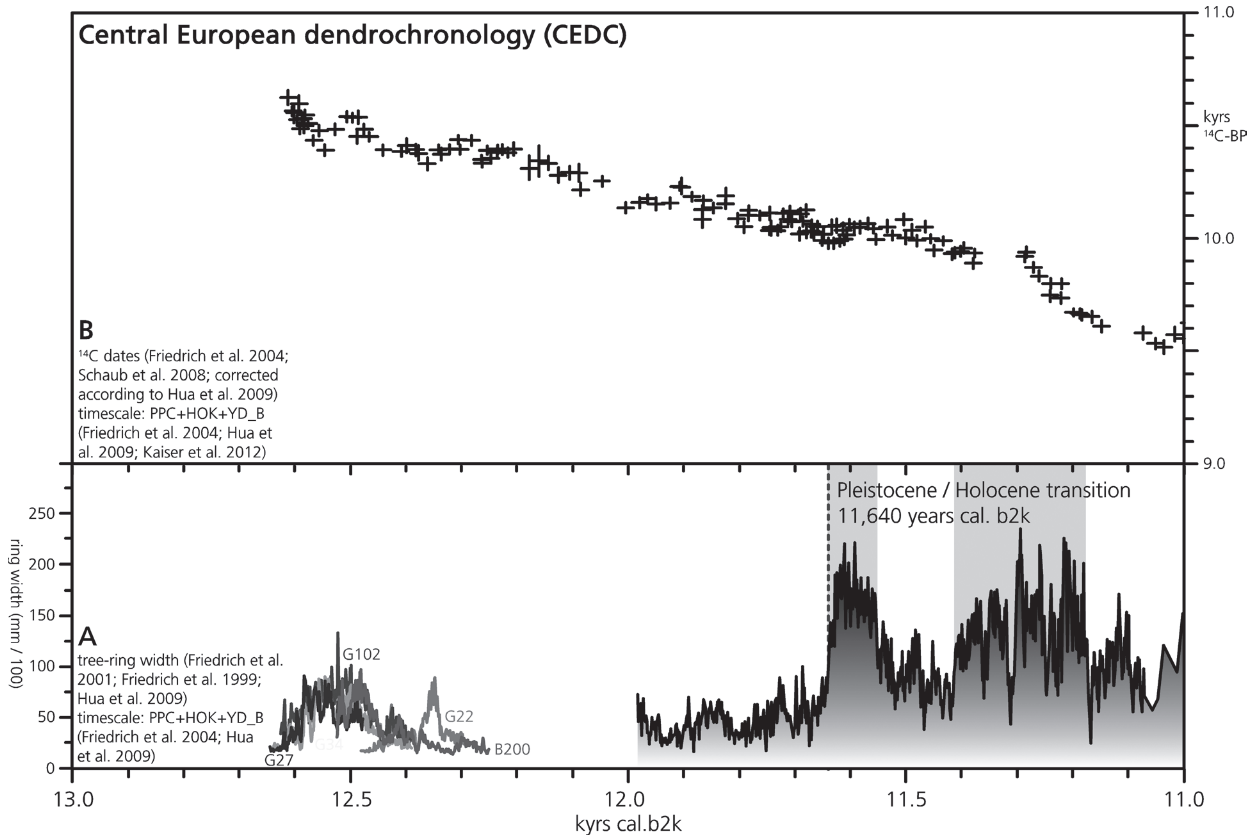



**Fig. 10** Central European dendrochronology (CEDC; Friedrich et al. 2004; Schaub et al. 2008b). Timescale is shifted from cal. BP to cal. b2k. **A** tree-ring width record (Friedrich et al. 1999; Friedrich et al. 2001b) supplemented with tree-ring widths of five trees forming the YD_B chronology (Hua et al. 2009, 2983 fig. 1; scale is only approximated according to comparison with Schaub et al. 2008b, 79 f. figs 4B and 5B). Grey shaded areas represent periods of intense tree-ring growth. – **B** series of $^{14}C$ dates (Friedrich et al. 2004; Schaub et al. 2008b). – For further details see **tab. 2** and text.

| tree-ring sequences | sites of contributing sequences | ref. |
|---|---|---|
| CEDC | Upper Rhine, Main, Danube, & Lausitz material (HOC); Upper Rhine, Danube, Isar, Iller, & Günz material (PPC); Avenches & Ollon (PPC extension); Cottbus (YDPC); Birmensdorf (ZHW); Gänziloh & Birmensdorf (YD_B) | Friedrich et al. 1999; Friedrich et al. 2004; Schaub et al. 2008b |
| GLPC | Dättnau; Danube, Isar, Iller, & Günz material; Reichwalde; (the Kruft poplars were correlated to the GLPC but formed no part of it) | Kromer et al. 2004 |
| LG pine ring widths | Avigliana; Revine; Dättnau; Danube & Isar material; Reichwalde, Lohsa, & Scheibe material; Warendorf | Friedrich et al. 2001b |
| CELM | Dättnau (Daeboech, Daeboeal, Daealch1-4); Landikon (Landboeal); Gänziloh (Gaenalch); Danube, Isar, & Günz material (Danube LG 2 & 3) | Schaub et al. 2008b; Kaiser et al. 2012 |
| Huon pines | Stanley river/Tasmania | Hua et al. 2009 |
| YD_A | Gänziloh | Schaub et al. 2008b |

**Tab. 2** Various tree-ring sequences and the sites yielding samples for these sequences (see **fig. 2**; cf. Kaiser et al. 2012). Abbreviations: **CEDC** Central European dendrochronology; **HOC** Hohenheim oak chronology; **PPC** Preboreal pine chronology; **YDPC** Younger Dryas pine chronology; **ZHW** Zürich-Wiedikon; **YD_B** Younger Dryas B sequence; **GLPC** German Lateglacial pine chronology; **LG** Lateglacial; **CELM** Central European Lateglacial master chronology; **YD_A** Younger Dryas A sequence.

ring data set (**tab. 2**), the chronologies in several other archives are also affected. In the Lateglacial this was especially apparent at the common correlation point of the Holocene/Pleistocene transition which was identified by a significant increase in the width of the tree-rings. This transition was last shifted from 11,620 years cal. b2k (Friedrich et al. 1999) to 11,640 years cal. b2k because of mis-correlation due to

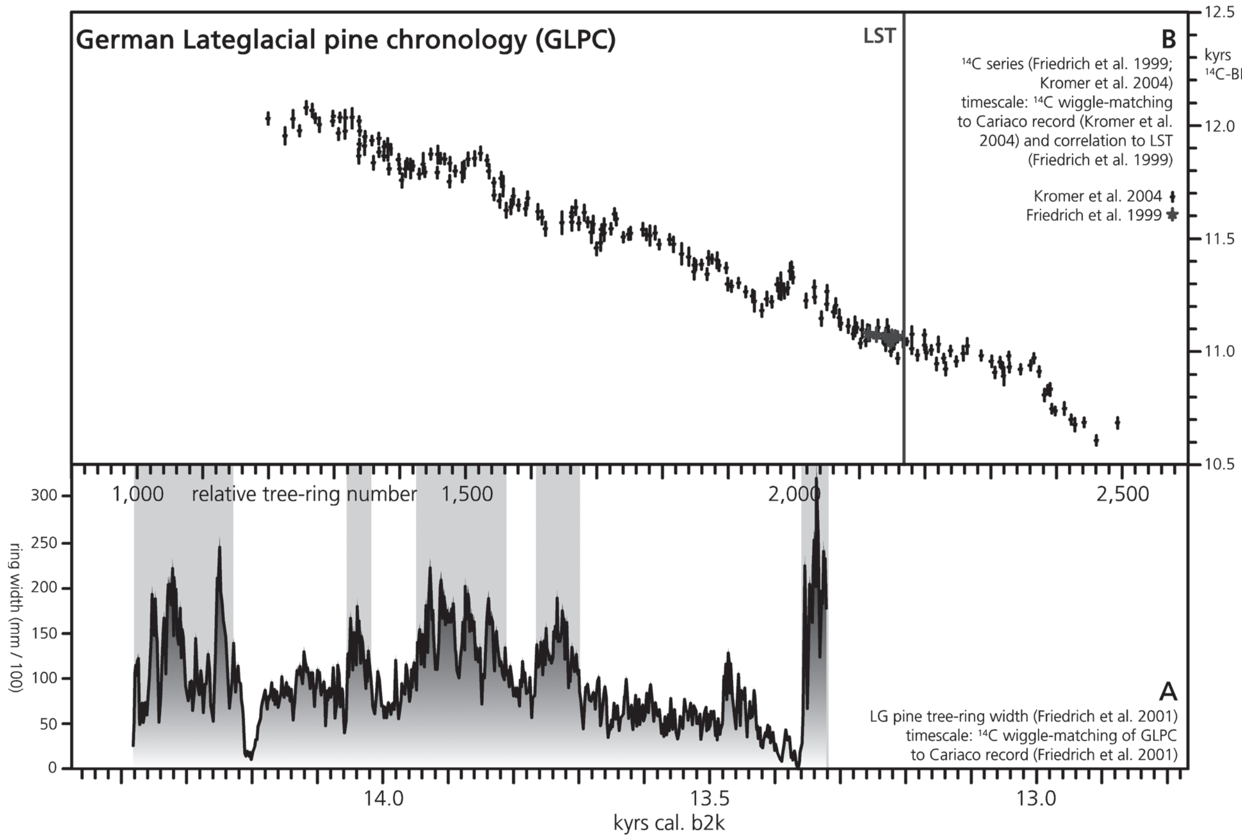



**Fig. 11** German Lateglacial pine chronology (GLPC; Friedrich et al. 1999; Kromer et al. 2004) and Lateglacial (LG) pine tree-ring width sequence (Friedrich et al. 2001b). Timescale is shifted from cal. BP to cal. b2k. **A** tree-ring width record of LG pines (Friedrich et al. 2001b). Grey shaded areas represent periods of intense tree-ring growth. – **B** series of $^{14}C$ dates of GLPC (Friedrich et al. 1999; Kromer et al. 2004). – For further details see **tab. 2** and text.

cockchafer predation (Friedrich et al. 2004, 1120). Thus, correlations made with the dendrochronological record prior to this publication needed to be shifted accordingly. For a while the dendrochronological record extended reliably only into mid-GS-1 (12,460 years cal. b2k; Friedrich et al. 2004) but new data were presented lately pushing the CEDC further back into the early Lateglacial Stadial (12,644 years cal. b2k; Schaub et al. 2008b; cf. Hua et al. 2009; Reimer et al. 2009). Thus far, no detailed record of the tree-ring growth patterns including the extensions has been published (Schaub et al. 2008b) but the tree-ring growth sequences of the single trees forming the last extension (YD_B) were published in relation to each other (Hua et al. 2009, 2983 fig. 1). These sub-sections are used in the present study (**fig. 10**). However, even with this extension the continuous dendrochronology could not yet be connected unambiguously to the floating GLPC (**fig. 11**) or to the more recently developed Central European Lateglacial Master chronology (CELM; **fig. 12**). The former comprised a series of 1,382 tree-rings from 517 tree-ring sections (**tab. 2**). Furthermore, this set provided data about tree growth (Friedrich et al. 2001b) and produced also a series of 106 high-precision $^{14}C$ dates taken usually on samples encompassing ten tree-rings and giving ages with a standard deviation of 20 to 50 radiocarbon years (Kromer et al. 2004) and was thus used for calibration (e. g. Weninger/Jöris 2008). In addition to trees found in southern German gravel pits, Swiss loam pits, and eastern German bogs, trees buried in the deposits of the LSE contributed to this record (Friedrich et al. 1999, 36-38; Kromer et al. 2004, 1205). Approximately 1,040 rings were counted before and some 340 rings after the LSE. By this marker the GLPC set became correlative to other sequences which contained the LST.

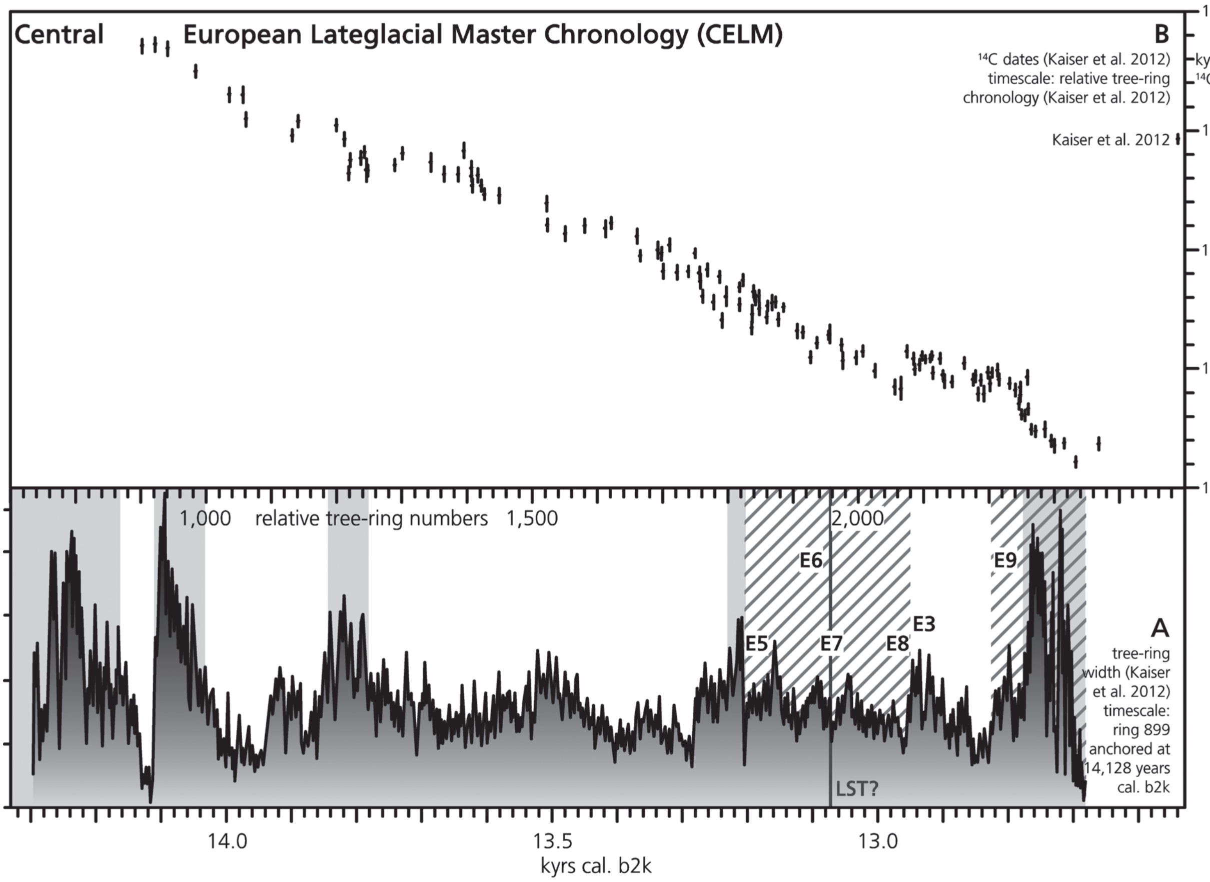



**Fig. 12** Central European Lateglacial Master chronology (CELM; Kaiser et al. 2012). Timescale is shifted from cal. BP to cal. b2k. **A** tree-ring width record (Kaiser et al. 2012). Dark grey hatched areas events E6 and E9 according to Kaiser et al. 2012, 85 f. fig. 5, where also the short-term events E5, E7 and E8 are given. E3 is set according to Schaub et al. 2008a, 36-38. Grey shaded areas represent periods of intense tree-ring growth. – **B** series of $^{14}$C dates (Schaub et al. 2008b; Kaiser et al. 2012; cf. Kromer et al. 2004). – For further details see **tab. 2** and text.

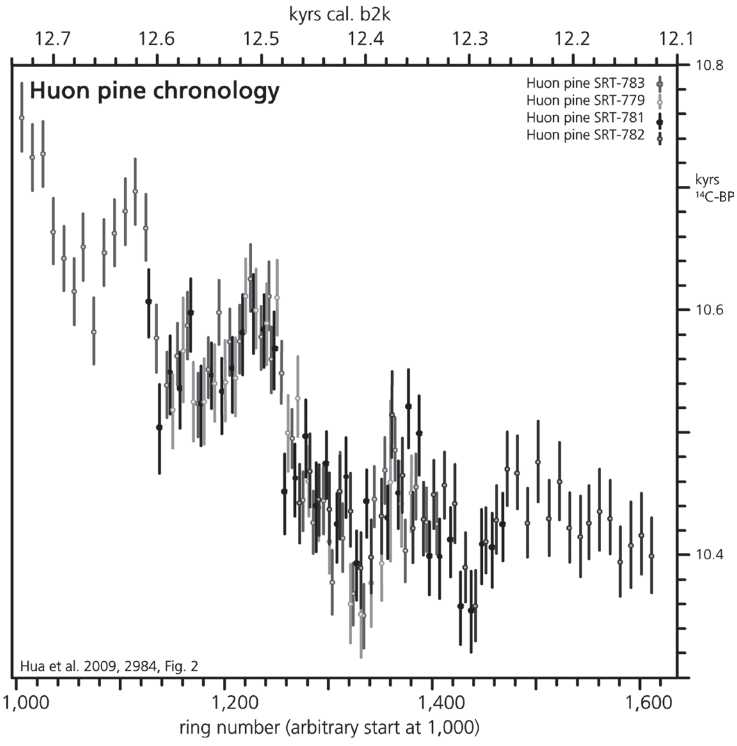



**Fig. 13** $^{14}$C dates from Huon pine record with relative tree-ring timescale (bottom) and results of wiggle matching with CEDC (top; Hua et al. 2009). Timescale is shifted from cal. BP to cal. b2k. – For further details see **tab. 2** and text.

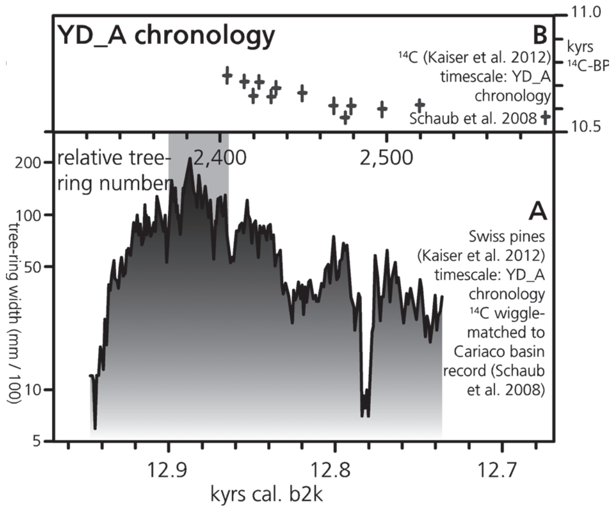



**Fig. 14** Younger Dryas A chronology (YD_A). Relative tree-ring timescale wiggle matched with Cariaco basin and results of correlation to absolute timescale. Timescale is shifted from cal. BP to cal. b2k. **A** tree-ring width (Schaub et al. 2008b; Kaiser et al. 2012). Grey shaded area represents period of intense tree-ring growth. – **B** $^{14}$C dates (Schaub et al. 2008b; Kaiser et al. 2012). – For further details see **tab. 2** and text.

In general, the CELM record comprises the same tree-ring sections but was further extended with younger sections and encompasses 1,606 tree-rings (Kaiser et al. 2012). In addition, a further 131 decadal samples produced $^{14}$C ages for the Swiss material.

Two attempts to make the connection between the CEDC and the tree-ring data set from the Lateglacial Interstadial already exist:

One of these attempts connected the CEDC with the GLPC set by the aid of tree-ring sequences from Tasmanian Huon pines covering 617 years during GS-1 (Hua et al. 2009; **fig. 13**). The tree-ring width of these pines was measured couple-wise (i. e. annually) and samples for $^{14}$C dating were taken in four to ten year intervals. However, due to the origin from Tasmania, i. e. on the southern hemisphere, an average hemispheric offset had to be subtracted. This offset was estimated to 40 years (Hua et al. 2009, 2985). Then the $^{14}$C record was wiggle-matched to the revised extension of the CEDC and the GLPC. This data set was chosen for the construction of the IntCal09 calibration curve. However, in the light of small intra-hemispheric offsets in the $^{14}$C content (Kromer et al. 2001) and inconstant inter-hemispheric offsets of uncertain dimension (Barbetti et al. 2004), a correlation of dendrochronologies from different hemispheres, in particular, remains problematic (cf. Hua et al. 2009, 2985).

In the other attempt, tree-ring data from the Swiss Gänziloh site were correlated to a 212-year long subset in the early Younger Dryas period (YD_A) combining tree-ring widths with $^{14}$C dates (**fig. 14**). $^{14}$C-dated samples from this subset covered usually ten tree-rings, although sometimes larger sections were necessary for ensuring reliable measuring results (Schaub et al. 2005, 13). The ten pines of the YD_A chronology set were used as an extension of the CEDC into the early Lateglacial Interstadial but the cross-dating process with the generally accepted dendrochronology was complicated by the generally short sectioned tree-ring sequences from the early Lateglacial Stadial (Kaiser et al. 2012). Therefore, the connection was established by wiggle-matching of the $^{14}$C record with the Cariaco basin record (in the version of Hughen et al. 2000) resulting in a small and, thus, still insecure overlap of approximately ten tree-rings (Schaub et al. 2008b, 77. 82) and a more clear overlap of *c.* 50 tree-rings to the floating Zürich Lateglacial chronology 1 (ZH LG_1; (Schaub et al. 2008b, 82), i. e. the CELM data (cf. Kaiser et al. 2012, 83). A later revision of the Cariaco basin chronology resulted in a general shift 14 years older due to the revised onset of the Holocene in the CEDC (Hughen et al. 2004c, 1164) which should result in a gap of *c.* four years between the CEDC and the YD_A chronology. Moreover, the 14 years have to be added on the results given in Schaub et al. 2008b and Kaiser et al. 2012. In contrast, based on a correlation with the IntCal09 and, thus, the Australian Huon pine data, the YD_A chronology either overlaps almost entirely with the end of the CELM or should overlap

more clearly with the end of the CEDC record. At least 40-50 years overlap on both sides were assumed (Kaiser et al. 2012, 83) but neither has yet been confirmed dendrochronologically (cf. Schaub et al. 2008b, 79 fig. 4; 80 fig. 5; Kaiser et al. 2012, 82 fig. 3K-h). Short-term events recorded in the younger part of the CELM (**fig. 12**; cf. Schaub et al. 2008a, 36-38; Kaiser et al. 2012, 85f.) can be particularly useful in this comparison.
Nevertheless, in a numerical comparison the results of the two attempts are relatively similar. Although these results differed only by a few decades, this offset is of special significance for the high-resolution calibration curve of this period (pers. comm. Olaf Jöris, Neuwied) due to a strong increase in atmospheric $^{14}C$ isotopes at the transition to the Lateglacial Stadial. Therefore, the correlations are discussed in more detail elsewhere (p. 250-253 and p. 358-364).

Consequently, two major independent resources with annual resolution from modern times to the Pleistocene are available for the purpose of Lateglacial chronostratigraphy at the moment: the ice-core records from Greenland and the CEDC. Other records with annual resolution are correlated to these records and can help to further confirm the annual chronostratigraphy.
The CEDC has a higher resolution and, in addition, forms an essential part of the radiocarbon calibration curve. This correlation is important because of the connection of the climatic records to one another. However, as long as the connection across the early Lateglacial Stadial is not ascertained this record cannot be used for the Lateglacial Interstadial. Nevertheless, if the LST can be reliably attributed it can function as a solid correlation point.
The Greenland ice-core sequences are in contrast continuous records across the Lateglacial. The records are presented in the GICC05 based on NGRIP in the Lateglacial which is therefore used in the present study as a chronostratigraphic baseline to which the other records are related. The tephrochronological analysis excluded the presence of the LST particles in the ice-cores (Mortensen et al. 2005) and, thus, this important marker cannot be directly correlated. However, based on the ice-core depths the records can be transferred to the GICC05 chronology. This way it is possible to create a detailed insight into the climate development and precise chronological development. In particular, the correlation of the calibration records shall then be further used to relate the environmental as well as archaeological record (see Material-Databases, p. 49-53) to this chronostratigraphy.

## ENVIRONMENTAL ARCHIVES

A fundamental presupposition of the present study is that the environmental change is of greater importance for the Lateglacial hunter-gatherers than climate change. This assumption is based on the fact that the natural environment provides the basic resources for the survival of hunter-gatherers such as food and raw material for clothing, equipment, or building shelters. These resources originate from geological deposits (minerals, fossils, stones, and lithic raw materials), the vegetation, and animals. Therefore, changes in the existence and/or accessibility of these natural resources have to have effects on the human activities in which these materials were involved. Moreover, the procurement strategies for raw materials influence the human mobility patterns and the supply of vital resources affects the human demography. Thus, the natural environment as providing the basic source for the daily life of hunter-gatherers also sets the framework in which humans can act.

Thus, in addition to the climate development and the changes of human behaviour, the natural environment is modelled by the use of different archives. In the present study, the landscapes form a fundamental archive on which the vegetation record is set. Landscapes refer to the physical geography of the studied areas, in particular, their geomorphological appearance, the geological and pedological deposits as well as the waterways. In general, changes in geomorphology and geology occur too gradually to be effective in the studied time period. Therefore, these factors are introduced in the following and assumed as mainly stable during the studied period. Nevertheless, the accessibility of resources could have been hindered by different natural circumstances such as pedological processes or changes in the water regime and/or the vegetation. Archives for the changes of water regimes are scarce in western Central Europe and fluctuations in lake levels which are frequently reconstructed elsewhere (Bohncke/Wijmstra 1988; Renssen/Isarin 2001; Magny 2001; Magny/Bégeot 2004) are particularly rare in the studied regions. Indications for the changes in the water regimes originate mostly from river bed constructions with a relatively low temporal resolution (Gibbard 1988; Antoine 1997; Pastre et al. 2003; Kasse et al. 2005). Thus, these general reconstructions are introduced in the following and adopted in the result chapter. For the reconstruction of the vegetation, pollen archives are used because these records deliver a general impression of a wider catchment area and, therefore, give a general cross-section of the available vegetation patches in the studied areas. Additionally, directly dated macro-fossils deliver information of the vegetation available near the findspots. The presence of selected fauna species can also be read from directly dated samples.

In the last decade, various genetic considerations were also introduced to the discussion about vegetation development (Hewitt 2000; Willis/van Andel 2004; Michalczyk et al. 2010; Habel/Assmann 2010). However, comparable to other genetic studies the chronological precision of these studies remained below the necessities of the present approach and, consequently, these studies are only mentioned anecdotally.

However, the reasons for changes in the above mentioned parts of the natural environment and the tempo of these changes are very heterogeneous.

### Landscapes

The landscapes in Europe have changed significantly since the Lateglacial. To visualise some of these changes maps were made within the present study (see p. 253-259) based on modern satellite data. These data resulted from the shuttle radar topography mission (SRTM) mainly accomplished by the US-based National Geospatial-Intelligence Agency (NGA) and the National Aeronautics and Space Administration (NASA). The mission aimed to obtain elevation data on a near-global scale to generate a high-resolution digital topographic database of the planet. The mission was accomplished during eleven days in February 2000 with a specially modified radar system which flew on board of the Space Shuttle Endeavour. The resulting raw data (version 1) were reviewed by the NGA (version 2.1). These reviewed elevation data were made available online for public use (Farr et al. 2007; downloadable at http://dds.cr.usgs.gov/srtm/version2_1/SRTM30/). The SRTM 3×3 (arc-seconds) tiles reach an approximate 90 m resolution (cf. Smith/Sandwell 2003), whereas the SRTM30 data are of *c.* 900 m resolution (30×30 arc-seconds, cf. documentation file at http://dds.cr.usgs.gov/srtm/version2_1/SRTM30/) which is sufficient for the overview of north-western Europe. Furthermore, the data of the lower resolution were supplemented with measured and estimated bathymetric data (SRTM30_plus; Sandwell/Becker 2009) and published in 40 degree latitudinal by 50 degree longitudinal tiles. These tiles are used in the present study (downloaded as SRTM30_plus, version 6.0, at ftp://topex.ucsd.edu/pub/srtm30_plus/). Thus, the basis of the maps created for the present study are

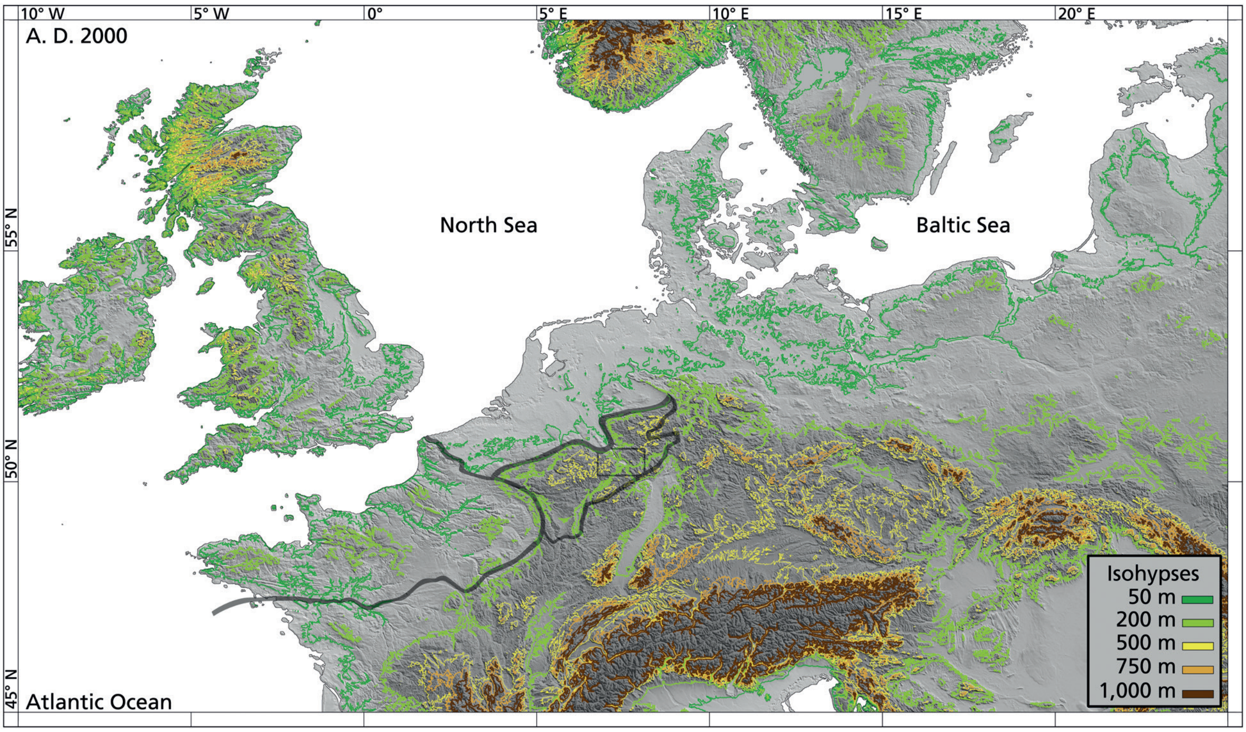



**Fig. 15** Modern north-western Europe with selected modern isohypses (50 m – green, 200 m – green-yellow, 500 m – yellow, 750 m – orange-brown, 1,000 m – brown, all in m a.s.l.) and the sub-areas of the study (grey) indicated (see **fig. 1**). – For further details see text.

modern topographic data which in detail differ from the Lateglacial setting, for instance, due to isostasy, aeolian deposition, pedogenesis, and modern gravel pit quarrying.

However, some main geomorphological settings such as the presence of karst formations and geological deposits remained generally unaltered. These features are of interest because they can be assumed to have also influenced the perception of the landscape by the Lateglacial hunter-gatherers (cf. Rockman 2003a). In particular, for Lateglacial communities these features were presumably important criteria because they yielded natural shelter, micro-habitats, and/or lithic and mineral resources. In addition, the fresh water supply was certainly another substantial point. Besides the choice of the Lateglacial communities, the various geographical developments after the Lateglacial occupation further influenced the preservation of archaeological material in these areas. Therefore, evaluations of these large scale factors are necessary in large scale analyses to incorporate the bias factor.

In the following, the sub-areas delivering the archaeological material (i.e. the Central Rhineland and the western upland zone, northern France including the Paris Basin) are used to characterise the various landscapes within which Lateglacial humans had to adapt their way of life. This study area (**fig. 15**) is limited in the north by the North European Plain. However, to the south-west the Plain gradually passes into northern France. In the present study, the 50 m above sea level (a.s.l.) isohypse in combination with modern watershed limits (**fig. 16**) serves as an approximate distinction between the western North European Plain and northern France. The watersheds still belonging to the lowland region are the Scheldt and Aa which drain into the North Sea and on the northern French side the Liane, the Authie, and the Somme flow into the English Channel. Moreover, in the gradually rising southern part of the western North European Plain, the limit between the lowlands and northern France as well as the western uplands is chosen following the geology (**fig. 17**) with the Devonian uplands which frequently rise above 500 m a.s.l. and are also known as the Rhenish Slate Mountains or the Rhenish Shield marking the boundary. Still, the transition between the

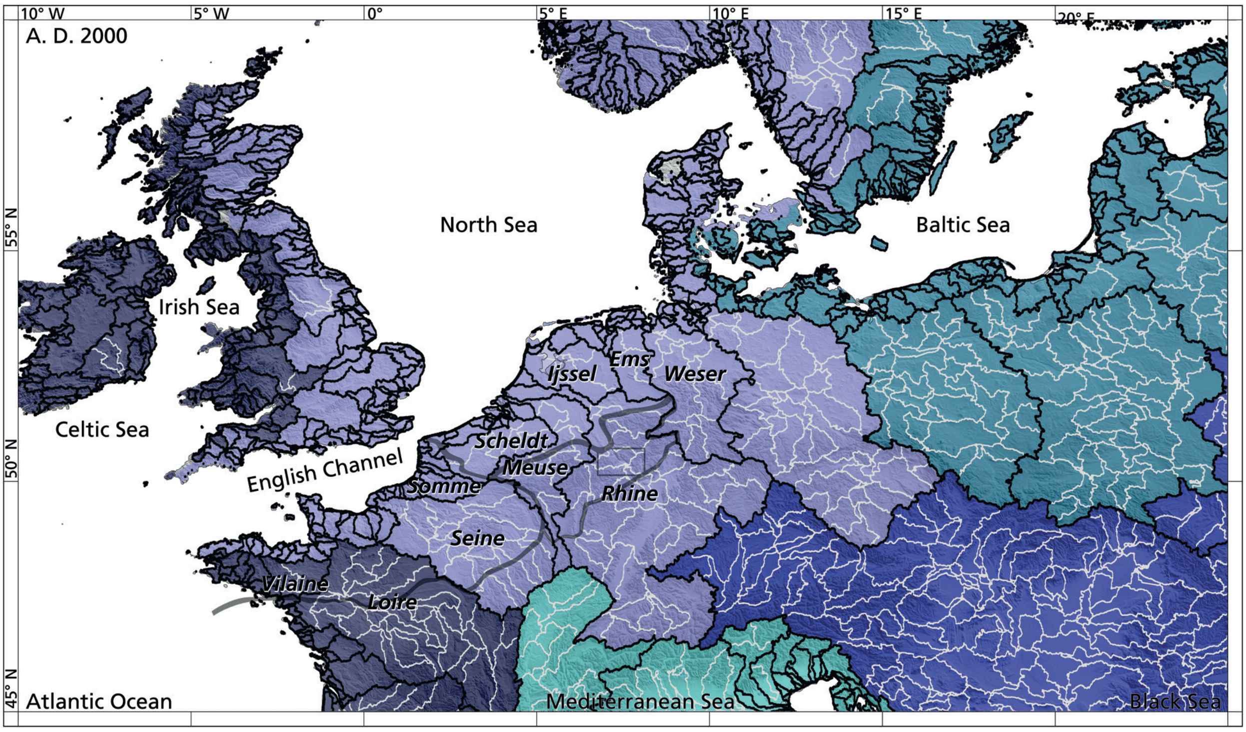



**Fig. 16** Modern north-western European watersheds (data source: European Commission/Eurostat 2002; SADL [Spatial Applications Division Leuven] 2005; freely available for non-commercial use); major water catchment areas in the study area are named. Dark blue shaded: Atlantic draining systems; light blue shaded: North Sea draining systems; turquoise shaded: Baltic Sea draining systems; royal blue shaded: Black Sea draining systems; light turquoise shaded: Mediterranean Sea draining systems.

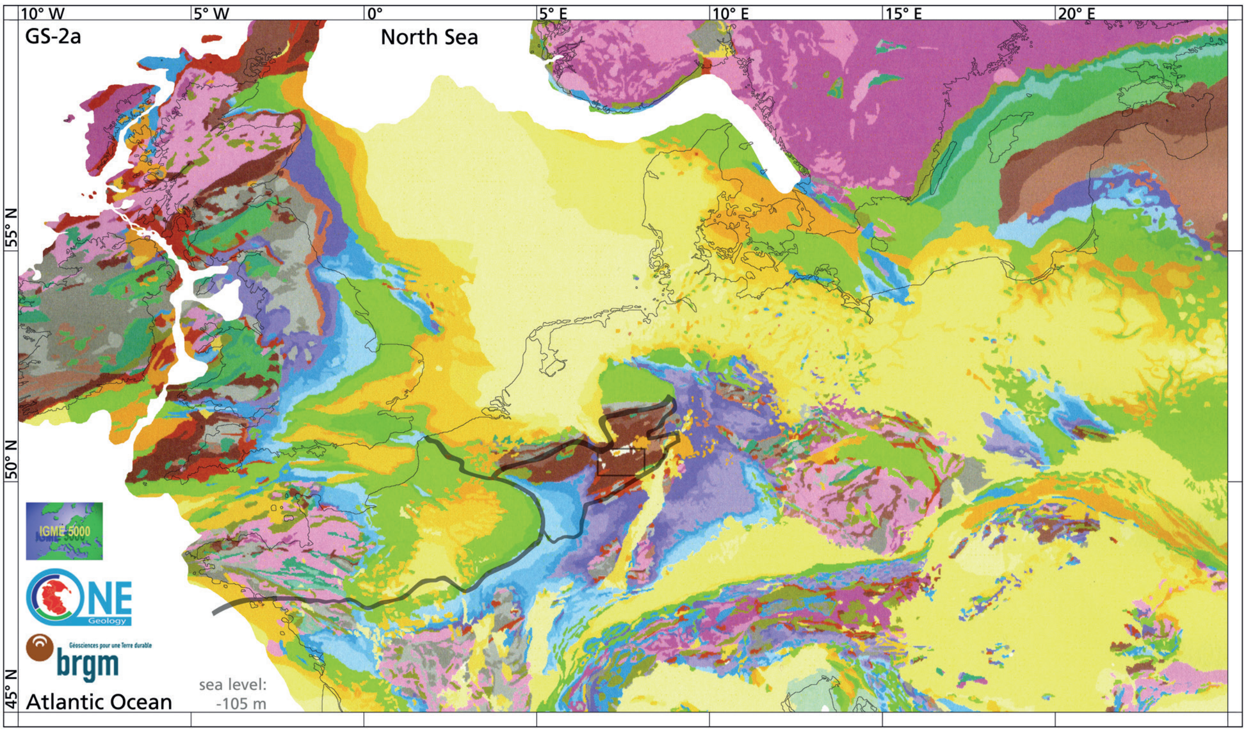
North European Plain and the adjacent uplands remains in some parts diffuse, hence, in this work a limit is chosen marked by a regular altitude of the modern terrain exceeding 200 m a. s. l. This isohypse is also taken as approximate limit between northern France and the western uplands.

To evaluate developments in the upland regions immediately adjacent to the North European Plain it is not necessary to consider the higher uplands farther to the south in this study. Indeed, in these southern regions the highly variable micro-climate and hence micro-ecotopes, which are probably due to the various effects of heterogeneous altitudes on regional climate and ecosystems (e. g. Bridault/Fontana 2003; Körner 2007), might obliterate some general developments within the Lateglacial environment which led to the changes observed in north-western Europe. The southern limit of north-western Europe is therefore determined at about 47° of northern latitude and/or at a recurrent altitude of the terrain above 750 m a. s. l. (**fig. 15**).

In the west the Atlantic Ocean forms a natural limit to the area.

The eastern limit of the study area is also partially defined on geomorphology but in part also due to geology. In particular, the Weser catchment area which generally consists of the Triassic Weser hills is chosen as the limitation. The western uplands are dominated by the Devonian Rhenish Shield which also contained the Central Rhineland region (**fig. 17**). This shield is surrounded by small Jurassic and Triassic formations and tends to reach higher altitudes than do the uplands adjacent to the east.

Plotting environmental data over the thus defined large areas cannot deliver a differentiated picture of each ecotope in this region (cf. Metzger et al. 2005) and for a more precise picture of the mosaic Lateglacial landscapes a more detailed analysis than is possible in a large scale meta-analysis such as the present study is necessary. Ideally, a detailed analysis would focus on only one of the sub-areas or on parts of it. However, a more general picture allows for a search for more universally valid patterns. The use of this type of approach




- Quaternary
- Pliocene
- Pliocene - Pleistocene
- Pliocene - Quaternary
- Miocene
- Neogene
- Neogene - Quaternary
- Oligocene
- Oligocene - Miocene
- Eocene
- Eocene - Oligocene
- Eocene - Miocene
- Eocene - Pliocene
- Palaeocene
- Palaeocene - Eocene
- Palaeogene
- Palaeogene - Neogene
- Cenozoic
- Late Cretaceous
- Late Cretaceous - Palaeocene
- Late Cretaceous - Eocene
- Late Cretaceous - Palaeogene
- Late Cretaceous - Neogene
- Early Cretaceous
- Cretaceous
- Cretaceous - Eocene
- Cretaceous - Miocene
- Cretaceous - Neogene
- Late Jurassic
- Late Jurassic - Early Cretaceous
- Late Jurassic - Cretaceous
- Middle Jurassic
- Middle Jurassic - Late Jurassic
- Early Jurassic
- Early Jurassic - Late Jurassic
- Jurassic
- Jurassic - Cretaceous
- Alpine
- Late Triassic
- Late Triassic - Jurassic
- Middle Triassic - Late Triassic
- Early Triassic
- Early Triassic - Middle Triassic
- Triassic
- Triassic - Middle Jurassic
- Triassic - Jurassic
- Triassic - Early Cretaceous
- Mesozoic
- Mesozoic - Neogene
- Late Permian
- Late Permian - Early Triassic
- Late Permian - Middle Triassic
- Early Permian - Middle Permian
- Permian
- Permian - Triassic
- Permian - Cretaceous
- Late Carboniferous
- Late Carboniferous - Middle Permian
- Late Carboniferous - Permian
- Early Carboniferous
- Carboniferous
- Carboniferous - Middle Permian
- Carboniferous - Permian
- Late Devonian
- Late Devonian - Early Carboniferous
- Late Devonian - Carboniferous
- Variscan
- Middle Devonian
- Middle Devonian - Late Devonian
- Early Devonian
- Early Devonian - Middle Devonian
- Devonian
- Devonian - Carboniferous
- Devonian - Permian
- Late Silurian
- Late Silurian - Devonian
- Wenlock - Early Devonian
- Early Silurian
- Silurian
- Silurian - Early Devonian
- Silurian - Devonian
- Late Ordovician
- Middle Ordovician
- Middle Ordovician - Late Ordovician
- Early Ordocvician
- Early Ordovician - Middle Ordovician
- Ordovician
- Ordovician - Silurian
- Ordovician - Devonian
- Late Cambrian - Early Ordovician
- Late Cambrian - Middle Ordovician
- Middle Cambrian - Late Cambrian
- Early Cambrian
- Cambrian
- Cambrian - Ordovician
- Cambrian - Silurian
- Palaeozoic
- Palaeozoic - Triassic
- Cadomian
- Caledonian
- Proterozoic III
- Proterozoic III - Middle Cambrian
- Proterozoic III - Cambrian
- Proterozoic III - Silurian
- Proterozoic III - Devonian
- Proterozoic III - Palaeozoic
- Proterozoic II
- Proterozoic II - Proterozoic III
- Proterozoic I
- Proterozoic I - Proterozoic II
- Proterozoic
- Proterozoic I - Proterozoic III
- Proterozoic - Ordovician
- Archean
- Archean - Proterozoic I
- Precambrian
- Archaen - Cambrian
- Precambrian - Palaeozoic
- Precambrian - Cenozoic
- undifferentiated
- unknown

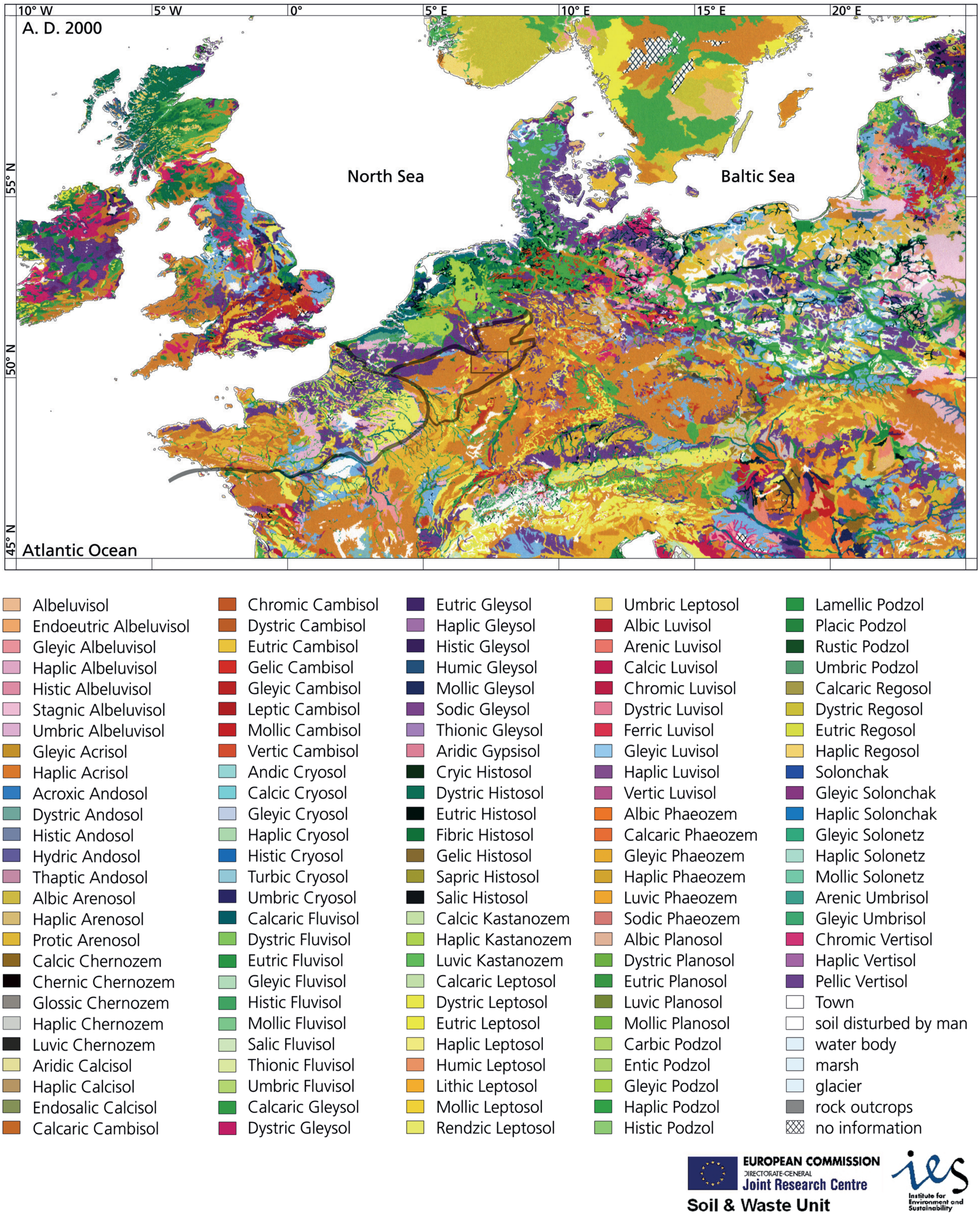



**Fig. 18** Distribution of soils in modern north-western Europe with the sub-areas of the present study (WRB full soil code, data source: Soil Map Internet Server (SOMIS), version 2.0, van Liedekerke / Jones / Panagos 2006; http://eusoils.jrc.it/ESDB_Archive/ESDBv2/index.htm; cf. Jones / Montanarella / Jones 2005).

←

**Fig. 17** Geology of north-western Europe with sea-level c. 105 m below modern sea level, the sub-areas of the present study, and modern coastlines indicated (data source for off- and onshore geology: IGME5000, (c) BGR Hannover, 2007; cf. Gradstein / Ogg / Smith 2004; with the permission of One Geology).

was shown to be of some value on the example of Lateglacial Britain (Rockman 2003a). North-western Europe is characterised today by various biomes but can be assigned in general to a northern European environment based on main climatic influences (Metzger et al. 2005).

Nevertheless, the varied preservation patterns of environmental data, especially on archaeological sites, leads to different scales of detailed information on the surrounding environment. Consequently, archaeological results can often only be compared on a very general level to the very detailed reconstructions of past environments. In particular, the deposition history and, thus, the temporal development were relatively well known for the environmental sites, whereas for the archaeological sites the gaps and over-representation of the environmentally defined parts of the stratigraphy were often difficult to estimate. The chronostratigraphic comparability of the two types of archives is therefore regularly restricted to a very general correlation.

Besides influencing the physical appearance of the landscapes, the geological units[5] (**fig. 17**) are also of further importance since they determine the possible existence of natural (rock) shelters as well as the availability of lithic raw materials for prehistoric hunter-gatherers. Formations from the Mesozoic era in particular can contain rich resources of fine-grained lithic raw materials and also various fossil materials such as amber or jet which were of some interest for Lateglacial hunter-gatherers. Hence, in some regions the rich variety of raw materials can explain decisions made by the prehistoric people. Other regions such as the Devonian uplands of the Rhenish Shield are poor in high quality lithic raw materials. In these regions especially studies of the origin of used lithic raw materials can often deliver precise patterns of spatial behaviour of the Lateglacial hunter-gatherers.

Besides the choice of Lateglacial humans, their archaeological visibility also depends on modern developments. For instance, the study area today comprises several countries and regions (**fig. 1**) with different policies of cultural heritage management and research strategies. These factors can also lead to divergent distribution patterns of Lateglacial sites, depending upon surveying, excavating, and reporting practices. In addition, various language areas are covered by this study.

Moreover, the Lateglacial archaeological horizons often immediately underlie the modern top soils[6] (**fig. 18**) or are even found incorporated within these soils. The soils and/or their development may therefore also have a considerable impact on the taphonomy of the archaeological assemblages. For example, in acidic environments the preservation of bone material is less probable (e.g. Nielsen-Marsh et al. 2006, 447; Turner-Walker 2008, 12), whereas pollen grains seem to be better preserved in these environments (e.g. Marshall 2007, 126). In addition to the development of the different soil types, water drainage appears also to play a major role in the preservation of organic material.

Besides the role in organic preservation, drainage systems have also contributed to the modelling of routes which were possibly taken by Lateglacial hunter-gatherers in their expansion into northern Europe assuming that river valleys indeed served as guiding influences for the mobility of Palaeolithic hunter-gatherers (e.g. Kobusiewicz 1999, 190f.; Conard/Bolus 2003, 333; Steele 2010, 2018). In general, north-western Europe is part of the north-western European water drainage system (**fig. 16**; cf. UNEP/DEWA~Europe 2004) meaning that the major river systems end in the Atlantic Ocean, partially, following a detour through the English Channel, the Celtic, the Irish, the North, or the Baltic Sea. Even though the geography of Europe was very different in the past, the mainland water catchment areas were presumably generally comparable. However,

5 Due to technical practicability, relatively detailed data for the geology as well as for the soils (see **fig. 18**) are presented in the maps of the present study even though only a sub-set of this data is needed for the description of the sub-areas.

6 In the following, terms and distribution are according to Jones/Montanarella/Jones 2005, 28-33. However, in the archaeological part the main stratigraphic description of the sites is followed.

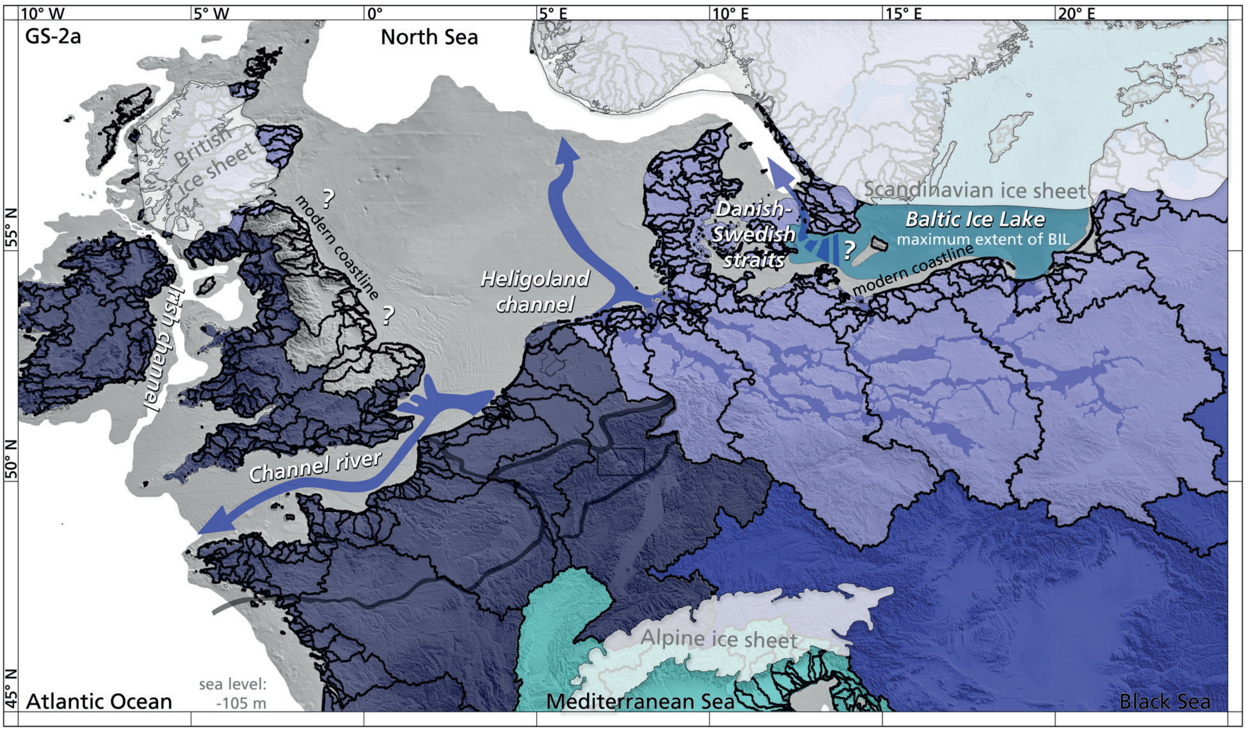



**Fig. 19** North-western Europe at c. 16,000 years cal. b2k with major modern watersheds (data source: European Commission/Eurostat 2002; SADL [Spatial Applications Division Leuven] 2005; freely available for non-commercial use). Dark blue shaded: eastern Atlantic Ocean draining systems; light blue shaded: North Sea/northern Atlantic Ocean draining systems; light turquoise shaded: Mediterranean Sea draining systems; royal blue shaded: Black Sea draining systems; for most eastern British rivers the drainage remains uncertain thus far and therefore these areas are not shaded. Major large river systems in today submerged areas are indicated (cf. Björck 1995a; Konradi 2000; Streif 2004; Antoine et al. 2003a; Bourillet et al. 2003). Furthermore, the glacial valleys and water gaps are displayed in a medium blue shade in the North Sea draining system according to Wolstedt 1956, pl. I. – For further details see text.

during the Lateglacial the North Sea and English Channel system in particular were bisected more distinctly (**fig. 19**). Which rivers contributed to the northern and which to the Channel system depended not only on the existing topography of the landscape (Coles 1998) but also on the rising sea-level, i. e. water flowing into the northern North Sea basin from the North Atlantic Ocean and into the English Channel from the eastern Atlantic Ocean. With the inflowing water from the north a considerable area of land surface first became salt water marshes and was subsequently submerged in the salt water of the North Sea. This process was not accomplished before the early Holocene (e. g. Weninger et al. 2008). The water from the eastern Atlantic breaking through the English Channel also only reached the North Sea Basin in the Holocene and, subsequently, did not confluence with the waters coming from the northern Atlantic previously (cf. Uehara et al. 2006, 7; Shennan et al. 2000, 309 f.). Thus, during the studied period a land bridge connected the British Isles with continental Europe. Consequently, a considerable number of Lateglacial sites must be considered as lost due to the changed sea-level. Nevertheless, according to 3D seismic analyses in some sample areas a network of rivers, wetlands, and tunnel valleys existed on most parts of the North Sea basin during the Lateglacial (cf. Praeg 2003, Fitch/Thomson/Gaffney 2005, Lonergan/Maidment/Collier 2006, Gaffney/Thomson/Fitch 2007). Thus, how, from where, and when this landbridge was accessible and traversable depended presumably on the seasonality and the precipitation feeding the large river channels as well as the wetland networks.

Western upland zone

The western uplands form the higher elevated sub-area with altitudes regularly above 400 m a.s.l. and occasional altitudes as high as 750 m a.s.l. in the central part (**fig. 15**). This sub-area has not changed much geomorphologically since the Pleistocene. Only in some parts the appearance of the landscape changed moderately due to Late Pleistocene and early Holocene volcanic activity.

The main drainage systems (**fig. 16**) are Meuse, Moselle, and Rhine. The Weser which is oriented strictly northwards forms the limit to the east. The Rhine flows to the north-west and its tributaries, the Moselle and the Lahn, dissect the central part of the sub-area with their south-west to north-east directed valleys. However, most of the smaller river valleys are directed north to north-west and also the Moselle, in its upper reaches, flows from south to north along the German-Luxembourg border. In addition to this valley, the Meuse cuts a wide, south-east to north-west directed valley in the western limit towards northern France. The valleys of the Saar, the upper Moselle, and the Meuse approach each other south of Luxembourg (**fig. 1**) and traverse a wide north-south oriented depression. In this sub-area the drainage has not much changed since the Pleistocene with the only difference that then the rivers flowed into the large English channel river system instead of the North Sea (**fig. 19**).

Geologically, the south-western part is formed in general by the Jurassic uplands (**fig. 17**; cf. Asch 2005). Chert was occasionally found in a band of Triassic formations at the eastern limit of this part of the sub-area (Floss 1994). The Rhenish Shield which covers the north-eastern zone of the sub-area is a predominantly Devonian formation. This zone is rich in quartz and various types of quartzite as well as related metamorphic rocks (Floss 1994). The quartzite varieties are sometimes very fine-grained and homogeneous such as several varieties of Tertiary quartzite. Furthermore, chalcedony deposits were found in some places. However, this eastern part of the sub-area is generally poor in fine-grained siliceous raw materials compared to northern France and other adjacent regions. Hence, these fine-grained siliceous lithic resources were usually considered as imports. In consequence, the eastern part of this sub-area is particularly suited for the analysis of raw material origins and procurement distances, and/or the adaptation to less homogeneous raw materials. In addition, due to the major river valleys the area is a geographical pivot. In this context, the sub-area is also particularly interesting in the expansion process onto the North European Plain.

In fact, the initial area of the present study is located in the eastern part of this sub-area at the junction of the Rhine valley and its west-east running tributaries. Therefore, the archaeology from the Central Rhineland and its position within the pattern of north-western European Lateglacial developments is also of particular interest for the adjacent areas and their distant relations.

In contrast to the scarcity of fine-grained siliceous raw materials, haematite deposits are commonly known in the eastern part and occasionally in the western part of this sub-area. Pieces of this mineral can sometimes also be found in various river gravels in the eastern part. Jet, or at least cannel coal, deposits are possibly also present in the eastern sub-area but have not yet been unambiguously identified in the Rhineland (Allason-Jones/Jones 2001). Shell deposits (cf. Alvarez Fernández 2001, 548) were also possible but not yet localised in the Central Rhineland. However, Miocene shell deposits are well known from the southward adjacent Mainz Basin. Probably these deposits were also visited by Late Pleniglacial groups from the southern uplands (e.g. Pasda 1994) where rich chert and some jet deposits are known. Perhaps, investigations of sites from this area (Loew 2006; Serangeli/Terberger 2006) will help in the future to further analyse these north-south connections. However, raw materials originating from southern Central Europe farther south than the Mainz Basin were not common in the study area and a stable (exchange) connection farther to the south can in consequence not be established.

Soil formation is comparatively uniform with cambisols generally dominating the pedogenesis (**fig. 18**). This type is a young soil which developed under various environmental conditions (Jones/Montanarella/Jones 2005, 29). Preservation of organic material is relatively variable and in this region often influenced by the site type (preservation is generally good in caves; Terberger 1993) and/or cover by volcanic material (e.g. Baales et al. 2002).
Even though this sub-area is the highest elevated region with numerous river valleys and many caves, Lateglacial material most commonly originated from open air sites (see p. 52 f.) which, as in the Paris Basin, are predominantly associated with river valleys. The good and extensive preservation of material below the LST indicated that this impression is partially biased by preservation. For example, in the Eifel region, well above the river valleys, single hearths survived in the Lateglacial Interstadial soil. However, the distribution of sites also revealed that the position in the river valleys reflected generally a topographic choice because the major sites were found only in the river valleys or on adjacent promontories. In southern Belgium the assemblages were recovered almost exclusively from rock shelters and caves (Dewez 1987; Otte 2000). In Luxembourg and the adjacent eastern French regions archaeological sites are rare and material was often found during surface surveys (Huet et al. 1995; Guillot/Guillot/Thévenin 2000; Spier 2000). However, most of the sites from this zone have a considerably recent research history.

### Northern France

In the northern French sub-area, the relatively level terrain generally ranges between 50 and 150 m a.s.l. and only in the western part are altitudes above 250 m a.s.l. occasionally reached, and ones up to 400 m a.s.l. are rare (**fig. 15**). In addition, large river systems characterise this sub-area (**fig. 16**). The south-east to north-west drainage direction of the river systems bisects northern France: In the west the Loire and the Vilaine system flow westwards into the eastern Atlantic Ocean and in the east the Seine and the Somme drain northwards into the English Channel. During the Pleistocene the tidal waters from the eastern Atlantic Ocean were not present due to the lower sea-level and the northern French rivers at that time formed tributaries to the large Channel river system draining into the eastern Atlantic Ocean (**fig. 19**). This system was further supplied by rivers in southern and eastern England along with Belgian, Dutch, and north-western German rivers. In contrast to the wide glacial valleys on the North European Plain, the northward draining rivers in northern France flow in comparably narrow meandering valleys more comparable to the western upland zone.
The region of the Seine, the Oise, and the Marne valleys is dominated by Palaeogene deposits (**fig. 17**; cf. Asch 2005) which are replaced towards the south by mainly Miocene formations. Geologically this sub-area is relatively uniform with a core region, which formed in the Cenozoic era, surrounded by Cretaceous deposits, which are again enclosed to the west and east by a band of Jurassic formations. In the east this band forms already a part of the western upland zone. Considerable amounts of fine grained lithic raw material (Senonian and Turonian flint) can also be found in the various river terraces of the core region (Valentin/Julien/Bodu 2002). In addition, some rare Tertiary, in particular Bartonian, chalcedonies occur in the archaeological inventories which, perhaps, originated from the Loire near Orléans or a no longer existing source on the plateau east of the Seine (Valentin 1995, 143. 165. 246. 350; Lang 1998, 91). The western part of the sub-area, in particular Brittany, was mainly formed by igneous (Palaeozoic and Proterozoic volcanic rocks) and metamorphic rocks (mainly Precambrian formations) which delivered lithic raw materials of considerably lower quality and, furthermore, restricted the organic preservation (Naudinot 2008). In consequence, lithic material analyses and technological studies in this part revealing import distances and adaptation to

less suited materials contrast the technological studies performed in the central Paris Basin where rich high-quality lithic raw materials where accessible almost everywhere in the river gravels.
In contrast to the geology, the soils in the western part are more homogeneous than in the rest of this sub-area. Cambisols clearly dominate the western part of this sub-area, whereas in the eastern part various soil formations (gleysols, luvisols, albeluvisols, leptosols, fluvisols) are common (**fig. 18**; cf. Jones/Montanarella/Jones 2005).
In the large river valleys of the Seine and the Somme some very rich and well excavated open air sites were extensively studied since the late 1960s (e. g. Fagnart 1997; Valentin 2008a). Rock shelter and cave sites are rare (see p. 52 f.) and were often originally excavated at an early period in research history (e. g. Barois-Basquin/Charier/Lécolle 1996; Martin 2007a; Pigeaud et al. 2010). Numerous Lateglacial assemblages were identified comparatively recently in the west of this sub-area (Marchand et al. 2004; Naudinot 2008), however, the majority of these are surface collections. Furthermore, organic material was only recovered occasionally from any of the excavated sites there. Therefore, the making of a chronology in this part of the sub-area is mainly dependent on techno-typological analogies and the stratigraphy which again is often disturbed. Thus, in a study focusing on well dated and excavated archaeological assemblages the impression of human absence during the Lateglacial could arise, even though the material presented so far clearly demonstrated the opposite (Naudinot 2010).

Thus, the landscapes of the study area deliver rich resources which are distributed variously. Probably, this uneven distribution influenced the land-use strategies of mobile hunter-gatherer groups (cf. Butzer 1982, 211-278). For instance, the larger rivers in northern France provided not only water, food (fish), and orientation but delivered in their gravels also an important lithic raw material resource. In contrast, this resource needed to be imported to the Central Rhineland.
Furthermore, these landscapes form the premises upon which the living environment develops and, thus, influences the tempo and mode of this development.

### Pollen stratigraphies

Along with the landscape, the vegetation needs to be considered as an important resource for the Lateglacial hunter-gatherer groups (cf. Gaudzinski-Windheuser/Jöris 2006, 46-50) if environmental factors are assumed to have affect human behaviour. Moreover, the vegetation forms as the primary producer of energy also the basic trophic level for the food chain. In addition, the presence of shrub and/or forest patches also changes the appearance of a landscape and the visibility of e. g. landmarks or prey therein. Pollen profiles are considered as important environmental archives in the present study because they give a general overview of these factors. Furthermore, the local presence of specific plants can be attested by directly dated macro-remains.
Preservation of biotic indicators is in general difficult and often leads to the preservation in specific surroundings such as aquatic environments or in assemblages biased by humans (e. g. burnt materials). However, burnt materials such as charcoal can also be preserved in small size classes, i. e. micro-charcoal and then human interference is not necessary causal to these preserved remains. Moreover, a quantitative analysis of non-human induced micro-charcoal, especially in stratigraphic sequences, can help deducing local as well as global fire regimes (Power et al. 2008). These regimes depend again very much on the local climatic conditions (Niemann/Behling 2008). For the studied area, visible charcoal analyses on a broad scale were partially recorded for the final part of the studied period in the so-called Usselo-soil (van der Hammen/van Geel 2008). However, systematic micro-charcoal analyses on a larger scale are not yet accomplished.

In fact, most of the well dated Lateglacial vegetation records were preserved in water-logged environments. Presumably, this overbalance of littoral and/or riparian communities influenced the picture of the Lateglacial landscapes significantly. For instance, the conditions at waterholes or in river valleys are in general more favourable for plants which is why littoral and/or riparian ecotopes are considered to respond quicker to climatic changes than their surrounding (Bennike/Seppänen 2004). Furthermore, vegetation communities with good water availability are usually more productive (Gouveia et al. 2008) and in sheltered areas such as river valleys vegetation is also more probable to develop steadily than in exposed areas (van Leeuwaarden/Janssen 1987).

However, in addition to hydrological conditions, in particular, water availability (Rodriguez-Iturbe 2000; Whittaker/Nogués-Bravo/Araújo 2007; Gouveia et al. 2008), vegetation development depends on multiple factors which range from extra-local to very local such as solar radiation (Whittaker/Nogués-Bravo/Araújo 2007), temperature (Hollister/Webber/Bay 2005), the development of the soil (Bennike/Seppänen 2004), or the distance to a refuge of plants (Whittington/Fallick/Edwards 1996). Moreover, these factors influence the gradual and migratory process (biome succession) after natural hazards and/or ice ages. For instance, Hartmut Usinger pointed out that the general succession of vegetation in the early Lateglacial sequences of northern Germany is very similar beginning with an initial maximum of *Hippophaë* sp., followed by subsequent maxima of *Helianthemum* sp. and *Juniperus* sp. (Usinger 1985, 10). The first increase of tree birches (*Betula pubescens*) is usually connected with the latter maximum. However, some studies on the distribution of tree pollen in the Lateglacial and early Holocene indicated that the development of deciduous forests (i. e. their refuge) is rather a western phenomenon, whereas in the east and the mountainous areas in the south the coniferous elements had a stronger influence (Cheddadi/Bar-Hen 2009, 375 fig. 5; 377). Thus, due to the migration distance of the various taxa the reforestation process and biotic succession is also not inevitably corresponding across Europe.

Moreover, preservation influences particularly the reliability of many quantitative analyses, such as pollen analysis, which are based on proportions and statistics and, hence, are in need of a sufficient amount of preserved material to deliver reliable results (Heiri/Lotter 2001). These quantitative pollen analyses were used for decades to date Lateglacial geological horizons within which archaeological remains were found (Schütrumpf 1937; Iversen 1942; Stampfuss/Schütrumpf 1970; Kaiser/de Klerk/Terberger 1999).

The general concept of pollen analysis is that pollen grains are counted per stratigraphic unit. These stratigraphic units represent usually a relative chronological sequence which in the best case can be on an annual resolution (see p. 18-25). The presentation of the counted pollen grains is made by calculating the pollen sums to a total of 100 %. This way a proportional development of the vegetation is combined with a relative chronostratigraphy.

However, the calculation of the pollen sums depends on the identification of the various pollen as well as the consideration about which pollen are incorporated in the calculation. The latter is connected to assumptions on which pollen are unrepresentative because they may be redeposited (Iversen 1942, 133 f.) or originate from an extra-local source and/or from species producing a particularly large number of pollen such as forest species as for instance *Pinus* sp. (Faegri/Iversen 1950). All these factors influence a percentage calculation of the pollen sums and, thus, the presentation in a pollen diagram. To manage some of these problems, some specific types of pollen are usually excluded from the pollen analysis. However, this extraction relies occasionally on assumptions that some studies have shown to be false for various reasons (e. g. Heikkilä/Fontana/Seppa 2009; Willis/van Andel 2004). Furthermore, for some of the chosen taxa presupposition on the presence in the Lateglacial based on the environmental development can be problematic due to the wide environmental variety of single species within a genus such as *Poaceae* (formerly: *Gramineae)*, *Cyperaceae*, or *Betula* sp. Besides different preferences concerning their

| pollen zone according to | Jessen 1935 | Iversen 1942 | Usinger 1985 | Hoek 1997 | van Geel/Coope/van der Hammen 1989 | Pastre et al. 2000, added by Pastre et al. 2003 | Litt/Stebich 1999 | Goslar et al. 1999 |
|---|---|---|---|---|---|---|---|---|
| Younger Dryas | Late Dryas (Zone III): Dryas flora; maximum of fir (*Pinus*) and willow (*Salix*) pollen | Younger Dryas (Zone III): tundra to light forests with occasional stands of birch (*Betula*) and spreading crowberry (*Empetrum*) heaths | Dryas-3 (DR-3): *Betula nana-Betula pubescens*-PAZ, *Empetrum* is typical, main expansion of *Pinus*, increasing values of *Betula nana* | Late Dryas (Zone 3): NAP-*Empetrum* PAZ, increasing NAP, decrease of *Pinus* and *Betula* (Zone 3a), increasing values of *Empetrum* (Zone 3b) | Late Dryas (Zone III): decline of *Pinus* and increase in *Betula* and NAP, e. g. *Artemisia*, *Helianthemum* but also *Empetrum*-type | Youngest Dryas (Zone 3): *Pinus* and *Artemisia* pollen zone, decreasing though still dominant *Pinus*, strongly increasing *Artemisia*, small increases of *Betula*, *Juniperus* and NAP | Younger Dryas biozone (III): NAP maximum between LST and UMT, increase also in *Salix* and *Juniperus* | Younger Dryas (zone c): *Artemisia*-Chenopodiaceae PAZ, increase of NAP especially *Artemisia* and Chenopodiaceae, but also *Ephedra distachya*, *Helianthemum*, *Pleurospermum austriacum*, *Gypsophila fastigiata* and *Juniperus* |
| Allerød | Allerød (Zone II): maximum of birch (*Betula*) pollen | Allerød oscillation (Zone II): forest with birch (*Betula*; zone IIa) and intruding pine (*Pinus*; zone IIb) | Alleröd (AL): *Juniperus-Betula nana-Betula pubescens*-PAZ, dominated by birch (*Betula pubescens* and *Betula nana*) and *Juniperus*; *Empetrum-Betula pubescens*-PAZ, cold episode within tree birch (*Betula pubescens*) forests with high values of *Empetrum*, increasing values of *Juniperus*, *Populus* and *Filipendula*; *Populus-Betula pubescens*-PAZ I and II: intermediate part (AL-b) with low birch, but high *Juniperus* and *Salix* pollen values, and a double *Populus* peak; intersected by *Artemisia-Betula pubescens*-PAZ with tree birch and *Artemisia* maxima; *Pinus-Betula pubescens*-PAZ, last part dominated by *Pinus* or tree birch depending of topography | Allerød (Zone 2): *Betula-Pinus* PAZ, increase in AP, *Betula* in particular, decrease of *Salix* (Zone 2a1), intruding *Pinus* with decreasing values of *Betula* and *Juniperus* (Zone 2a2), strong increase in *Pinus* (Zone 2b) | Allerød (Zones II) with *Betula* and *Pinus* phase, increase of *Filipendula*, whereas other NAP decrease | Allerød (Zone 2): *Betula* and *Pinus* pollen zone, sub-zone 2a: *Betula* increase with high values also of *Juniperus* and *Salix*, still high NAP values, especially of *Artemisia*, sub-zone 2b: *Pinus* increase and dominance over *Betula* and *Salix*, decrease of NAP, sporadic occurence of *Quercus* and *Corylus*, intermediate cold period with opening of vegetation by decrease in *Pinus* and *Betula,* an increase in *Juniperus*, *Artemisia*, Poaceae and Cyperaceae | Allerød biozone (II): 2nd Lateglacial tree birch (*Betula pubescens*) maximum in combination with the increase of pine (*Pinus*) and *Filipendula* | Alleröd (zone b): *Pinus-Betula* PAZ, *Pinus* and *Betula* dominant, *Artemisia*, *Thalictrum*, Chenopodiaceae regular, second part increase of *Populus* and *Filipendula*, decrease of *Thalictrum*, *Potentilla* and *Juniperus* |
| Older Dryas | Early Dryas (Zone I): maximum of fir (*Pinus*) and willow (*Salix*) pollen | Older Dryas (Zone Ic): tundra period, herb tundra with herbaceous plants and *Salix* pollen, decrease of *Betula* | Dryas-2 (DR-2): *Helianthemum-Betula nana*-PAZ, NAP dominant, *Betula nana* still dominant over increasing *Betula pubescens*, *Helinathemum* frequent, *Filipendula* occasionally | Early Dryas *sensu lato*, Earlier Dryas (Zone 1c): *Betula-Salix* PAZ, increase of *Salix*, *Juniperus* and NAP, decrease of *Betula* | Earlier Dryas (Zone Ic): *Artemisia* and *Helianthemum* maintain, whereas *Betula* and *Juniperus* decrease | Intermediate Dryas (sub-zone 1b): *Juniperus* and *Betula* pollen zone, increase in NAP | Older Dryas biozone (Ic): NAP maximum between Bølling and Allerød with *Artemisia* and Poaceae; *Betula* decreases | Older Dryas (zone a): *Betula-Salix* PAZ, NAP dominant, especially *Artemisia*, *Thalictrum*, Poaceae, Chenopodiaceae, Rubiaceae, high values of *Salix* and *Betula* |

**Tab. 3** Selected definitions of some main Lateglacial pollen zones. Abbreviations: **AP** arboreal pollen; **NAP** non-arboreal pollen; **PAZ** pollen assemblage zone.

| pollen zone according to | Jessen 1935 | Iversen 1942 | Usinger 1985 | Hoek 1997 | van Geel/Coope/van der Hammen 1989 | Pastre et al. 2000, added by Pastre et al. 2003 | Litt/Stebich 1999 | Goslar et al. 1999 |
|---|---|---|---|---|---|---|---|---|
| **Bølling** | × | Bølling oscillation (Zone Ib): shrub tundra with pollen of Poaceae, Cyperaceae, *Artemisia*, *Salix* sp., and dwarf birch (*Betula nana*) pollen | Bölling (BÖ): first part of Alleröd | Early Dryas *sensu lato*, Bølling (Zone 1b): *Betula-Salix* PAZ, increase in AP, *Betula* in particular | Bølling *sensu lato*, Bølling *sensu stricto* (Zone Ib): increase *Betula* (*nana* and *pubescens*), *Juniperus*, *Hippophaë rhamnoides* regular | Bølling: first part with extending steppic formation with increasing values of Poaceae, *Artemisia* and *Juniperus*; second part is subzone 1a: *Juniperus* and *Betula* pollen zone, *Juniperus* and *Betula* dominant before *Salix*, high NAP with significant values of *Helianthemum*, *Thalictrum* and *Sanguisorba minor* | Bølling biozone (Ib): 1st remarkable *Betula* maximum attributed to tree birch (*Betula pubescens*) | × |
| **Oldest Dryas** | × | Oldest Dryas (Zone Ia): tundra period, treeless tundra with pollen of Poaceae, Cyperaceae, and *Salix* | × | Early Dryas *sensu lato*, Earliest Dryas (Zone 1a): *Betula-Salix* PAZ, rise of *Artemisia*, increase of species-rich herbaceous plant communities and dwarf bushes | Bølling *sensu lato*, Earliest Dryas (Zone Ia): Poaceae, Cyperaceae, *Artemisia* and *Salix*, *Helianthemum* and *Armeria* regular | × | Oldest Dryas biozone (Ia): declines in *Betula* and *Salix*; NAP maximum between Meiendorf and Bølling and before the expansion of tree birches (*Betula pubescens*) | × |
| **Meiendorf** | × | × | »Meiendorf-Intervall« (according to Menke 1968 and 1980; better not used): *Hippophaë-Betula nana*-PAZ, NAP dominant, *Betula nana*, *Hippophaë* and *Juniperus* numerous, increased *Helianthemum* values | × | × | × | Meiendorf biozone: weak *Betula* maximum with dwarf birch (*Betula nana*); decline in *Pinus* (redeposited), and increases in *Betula*, *Salix*, and *Juniperus;* first warming after the Pleniglacial | × |
| **Late Pleniglacial** | × | × | × (*Artemisia*-Poaceae-PAZ) | Zone Late Pleniglacial (LP): NAP PAZ, Poaceae, Cyperaceae, and some dwarf bushes | Upper Pleniglacial | Pleniglacial: open environments with sparse vegetation cover | Pleniglacial biozone: open, tree less vegetation with many grasses and sedges with a high amount of *Helianthemum* and the continuous occurrence of *Artemisia*, *Armeria*, *Ephedra*, and other heliophilous taxa | × |

**Tab. 3** (continued)

habitat, the different species within a genus have also different reaction times to climatic amelioration advising again to not use these general vegetation diagrams as correlatives with, for instance, the Greenland climate record.

Yet, since Johannes Iversen has introduced the calculation of a »total« pollen sum (Iversen 1942; Iversen 1947; de Klerk 2004, 270), it was generally applied to pollen records. He combined the tree pollen sum with non-arboreal pollen sums in an attempt to develop a method for describing specifically past habitats between forest and tundra environments so that the resulting periodisation could be used for chronostratigraphic considerations (Iversen 1942). In this total pollen sum the differentiation of arboreal pollen (AP) and non-arboreal pollen (NAP) is supposed to reflect the varying openness of the landscape (i. e. forest and tundra landscape; Iversen 1942, 139). However, the »openess« of the surrounding is not directly reflected by the distinction between AP and NAP because among the AP values not only trees are compiled but also shrub species such as *Juniperus communis* and dwarf shrub varieties such as *Salix polaris* or *Betula nana*. Therefore, macro-fossil analyses are of particular interest to distinguish, for instance, the rises of *Betula* sp. pollen due to *Betula nana*, a dwarf shrub of approximately 1 m height, from the ones due to *Betula pubescens*, a deciduous tree of usually 20 m height.

Prior to the introduction of Iversen's total pollen sum, other calculations (e. g. »tree pollen sum«) were used and in the last decade again other calculations were presented such as the upland pollen sum (de Klerk 2004). This latter calculation assumed that bogs were not present on the North European Plain during the early Lateglacial and, thus, wetland taxa were excluded from the calculation (de Klerk 2004, 277). Nevertheless, the differences resulting from the various calculation procedures and the implied assumptions reveal that also the mentioning of percentages of specific pollen to distinguish various sections of the vegetation development as displayed by pollen profiles (Usinger 1985; Bock et al. 1985) need careful consideration. In the present work only general tendencies such as the presence, absence, maxima and minima of some relevant taxa are therefore mentioned.

The definitions of the generally applied vegetation zones which are mainly based on pollen diagrams for Lateglacial north-western Europe are inconsistent and occasionally even conflicting (**tab. 3**). In addition, these pollen zones were sometimes used as chronostratigraphic markers based on the assumption of contemporary developments in north-western Europe (Firbas 1939). With increasingly high temporal resolutions of the pollen profiles the offsets of biome successions became visible in different areas and the various definitions then led to some confusion (**tab. 4**; cf. de Klerk 2004).

Meanwhile, the pollen zones are often replaced by pollen assemblage zones (PAZ) which describe the vegetation community more carefully without using arbitrary terms connected to chronostratigraphy (Usinger 1985, 15 f.). However, these pollen zones describe comparable communities (e. g. pine-birch forests) which represent pure definitions of vegetation community types and should not be regarded as temporally equivalent across wide areas of north-western Europe.

To allow a general comparison and reveal the various developments of the Lateglacial environments across north-western Europe, the pollen profiles of the two sub-areas need to display the same types of pollen classes even though specific taxa may not play an important role in both sub-areas. Based on the classic environmental sequencing of Lateglacial north-western Europe (**tab. 3**; cf. Hoek 1997; Litt / Stebich 1999; Litt et al. 2001) some genera are chosen in the present work for comparison. These groups are among the AP birch (*Betula* sp.), pine (*Pinus* sp.), willow (*Salix* sp.), and juniper (*Juniperus* sp.) and among the NAP sage (*Artemisia* sp.) and the family of true grasses (*Poaceae*). Usually, filipendula (*Filipendula* sp.) and sunrose (*Helianthemum* sp.) would also be of interest but these species were not always recorded. As a pioneer species sea buckthorn (*Hippophaë* sp.) plays an important role in the recolonisation of northern (Usinger 1998) and higher mountainous habitats (Magny et al. 2006) where ice sheets shifted previous soils (including seeds

| events | names given for correlative bio-, geo- and/or chronozones |
|---|---|
| GH | Holocene: Litt/Schmincke/Kromer 2003<br>Flandrian: Mangerud et al. 1974 |
| GS-1 | Younger Dryas: Mangerud et al. 1974; Lotter et al. 1992; Litt/Stebich 1999; Goslar et al. 1999<br>Late Dryas: Walker 1995; Hoek et al. 1999<br>Dryas 3: Lotter et al. 1992<br>Loch Lomond Stadial: Jones et al. 2002 |
| GI-1a | Dryas 3: Lotter et al. 1992<br>Younger Allerød: Litt/Schmincke/Kromer 2003<br>Allerød c: Bokelmann/Heinrich/Menke 1983; Usinger 1981<br>Allerød: Mangerud et al. 1974; Litt/Stebich 1999; Hoek et al. 1999; Goslar et al. 1999 |
| GI-1b | Allerød: Mangerud et al. 1974; Litt/Stebich 1999; Hoek et al. 1999; Goslar et al. 1999<br>Allerød b: Bokelmann/Heinrich/Menke 1983<br>Allerød c: Usinger 1981<br>Gerzensee fluctuation/oscillation: Lotter et al. 1992; Litt/Schmincke/Kromer 2003 |
| GI-1$c_1$ | Allerød: Mangerud et al. 1974; Lotter et al. 1992; Litt/Stebich 1999; Hoek et al. 1999; Goslar et al. 1999<br>Allerød a: Bokelmann/Heinrich/Menke 1983<br>Allerød c: Usinger 1981<br>Older Allerød: Litt/Schmincke/Kromer 2003 |
| GI-1$c_2$ | Older Dryas: Litt/Stebich 1999<br>Intermediate Dryas: Bokelmann/Heinrich/Menke 1983; Bock et al. 1985<br>Allerød b: Usinger 1981<br>Allerød: Mangerud et al. 1974; Lotter et al. 1992; Hoek et al. 1999; Goslar et al. 1999 |
| GI-1$c_3$ | Allerød: Lotter et al. 1992; Usinger 1998; Hoek et al. 1999<br>Allerød a: Usinger 1981<br>Older Dryas: Mangerud et al. 1974; Goslar et al. 1999<br>Bølling: Bokelmann/Heinrich/Menke 1983; Litt/Stebich 1999 |
| GI-1d | Older Dryas: Bokelmann/Heinrich/Menke 1983; Clausen 1998<br>Earlier Dryas: Walker 1995; Hoek 1997; Hoek et al. 1999<br>Aegelsee fluctuation/oscillation: Lotter et al. 1992; Ammann et al. 1994<br>Oldest Dryas: Litt/Stebich 1999<br>Intermediate Dryas: Limondin-Lozouet et al. 2002<br>Dryas 2: Leroyer 1994<br>Bølling: Mangerud et al. 1974; Lotter et al. 1992 |
| GI-1e | Meiendorf: Bokelmann/Heinrich/Menke 1983; Usinger 1998; Litt/Stebich 1999<br>Bølling: Mangerud et al. 1974; Lotter et al. 1992; Hoek et al. 1999<br>Old Dryas: Leroyer 1994<br>*Hippophaë* phase: de Klerk 2008 |
| GS-2a | Bølling: Mangerud et al. 1974<br>Dryas 1: Lotter et al. 1992; Ammann et al. 1994; Leroyer 1994<br>earliest Dryas: van Geel/Coope/van der Hammen 1989; Hoek et al. 1999<br>Oldest Dryas: Magny et al. 2006; Clausen 1998<br>End Devensian: Jones et al. 2002<br>(Late) Pleniglacial: Hoek et al. 1999; Litt/Stebich 1999 |

**Tab. 4** Selected nomenclature applied to the isotopic events in north-western Europe. Correlation to the Greenland eventstratigraphy was made by the use of oxygen isotope curves (Lotter et al. 1992; Hoek et al. 1999; Goslar et al. 1999; Jones et al. 2002; Magny et al. 2006), by varve counts (Goslar et al. 1999; Litt/Stebich 1999), by radiocarbon dating (Mangerud et al. 1974), or by analogies of the climatostratigraphy (van Geel/Coope/van der Hammen 1989; Bokelmann/Heinrich/Menke 1983; Leroyer 1994; Usinger 1998). However, the limits of these zones are not necessarily identical to the limits of the isotopic events (see p. 245-250).

and roots) away and left barren gravel moraines behind. Nevertheless, in the areas with a constant pedogenesis this pioneer is of minor importance and, therefore, not recorded in the present study.

As representatives for the complete sub-area, general pollen diagrams are chosen from each sub-area. Nevertheless, these general pollen diagrams were formed very differently. For the western upland zone the maar lake sequences are chosen (Litt/Stebich 1999) due to their reliable chronostratigraphy as well as their central position in the sub-area (**fig. 20**). In contrast, from northern France no comparably complete, high-resolution archive is known. Therefore many sequences which were spread across the sub-area (**fig. 20**) contributed to a synchronised pollenstratigraphy of northern France (Pastre et al. 2003).

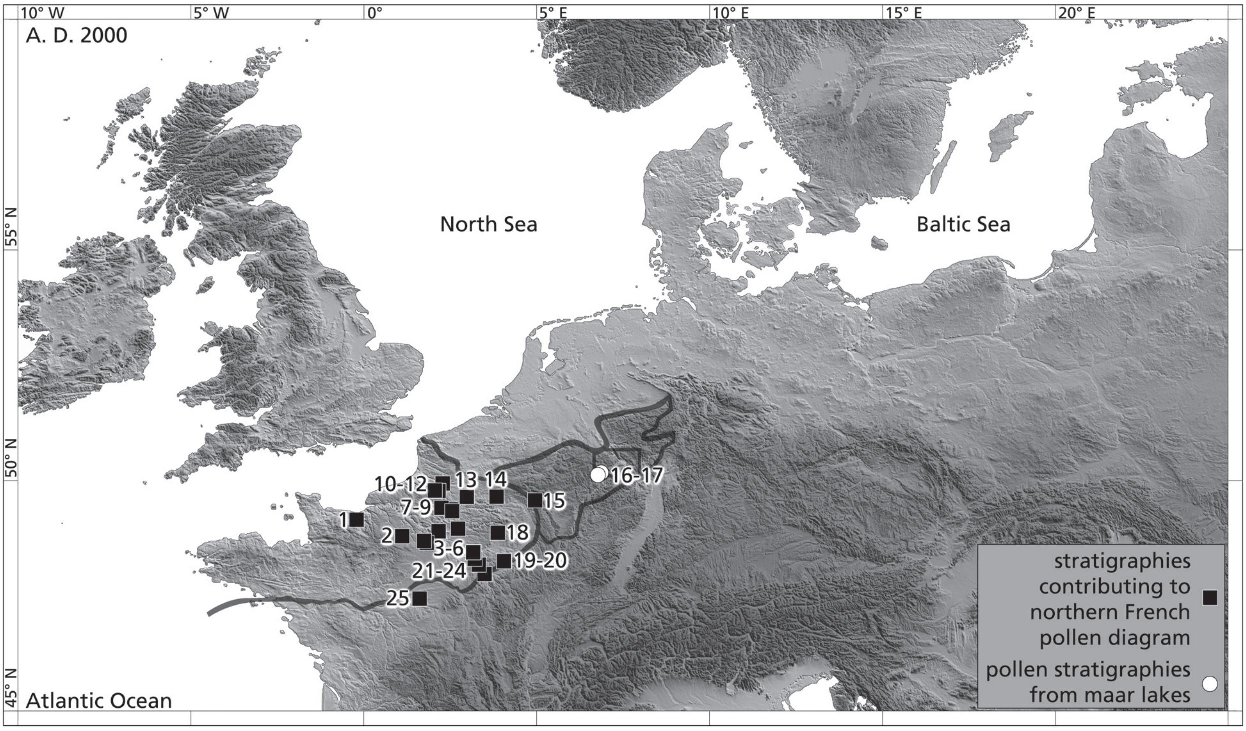
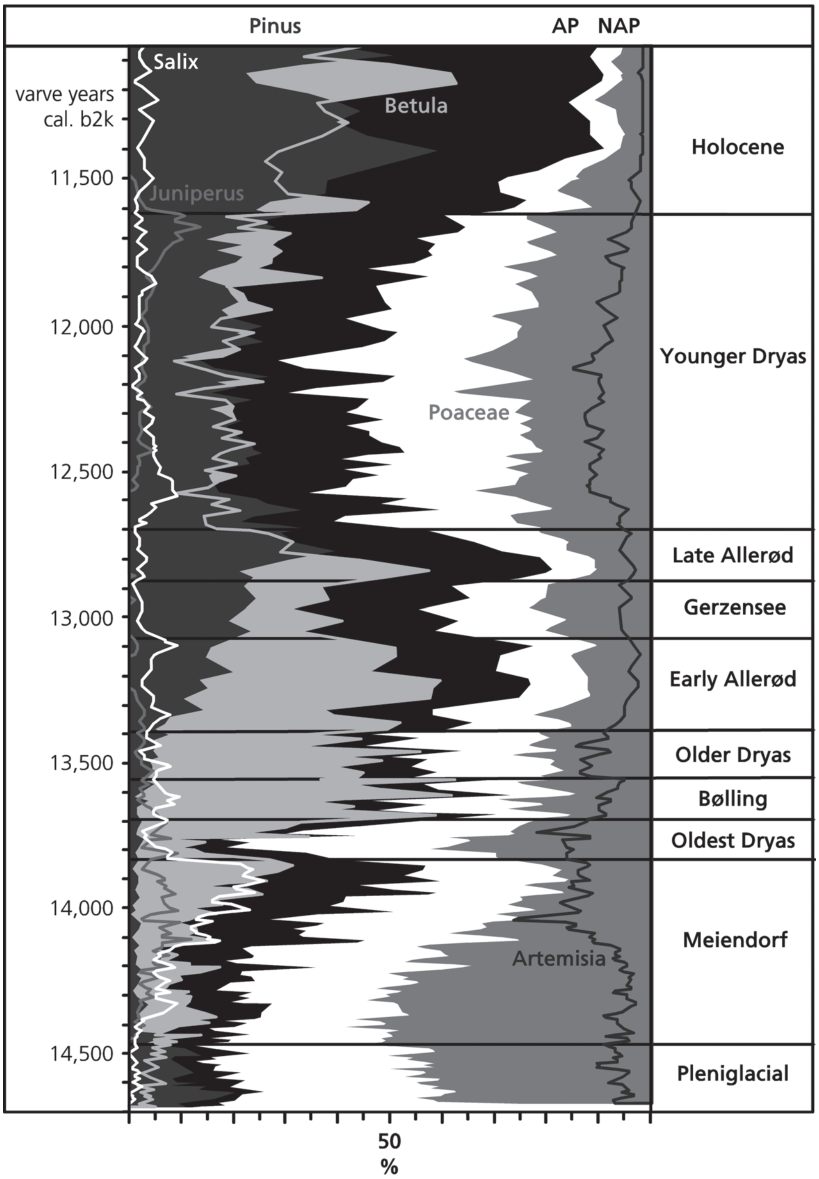



**Fig. 20** Map of sites contributing stratigraphies to the main pollen diagrams used per sub-area. **1** Bellengreville (Leroyer 1994); **2** Acon (Limondin-Lozouet et al. 2002); **3** Angennes (Leroyer 1994); **4** L'Archet (Leroyer 1994); **5** Le Closeau (Pastre et al. 2000); **6** Fresnes-sur-Marne (Pastre et al. 2000); **7** Bresles (Leroyer 1994); **8** Sacy (Pastre et al. 2000); **9** Houdancourt (Ponel et al. 2005); **10** Famechon (Leroyer 1994); **11** Conty (Limondin-Lozouet et al. 2002); **12** Etouvie (Limondin-Lozouet et al. 2002); **13** Beaurains-lès-Noyons (Pastre et al. 2000); **14** Chivres (Leroyer 1994); **15** La Bar (Leroyer 1994); **16** Holzmaar (Litt/Stebich 1999; Leroy et al. 2000); **17** Meerfelder Maar (Litt/Stebich 1999); **18** Coizard-Joches I & II (Leroyer 1994); **19** Saint Pouange (Pastre et al. 2000); **20** Saint Lèger (Pastre et al. 2000); **21** Bazoches-lès-Brays (Pastre et al. 2000); **22** Pont-sur-Yonne (Pastre et al. 2000); **23** Étigny (Pastre et al. 2000); **24** Migennes (Limondin-Lozouet et al. 2002); **25** Mur-de-Solonge (Leroyer 1994).

## Meerfelder Maar, Germany

The varved lake sediments in the western upland region delivered a precise sedimentologic stratigraphy (see p. 19-21; cf. Schettler/Rein/Negendank 1999; Lücke/Brauer 2004; Brauer et al. 2008) as well as a detailed Lateglacial pollen sequence for this area (Litt/Stebich 1999). Three cores from the Meerfelder Maar (MFM) were correlated to the MFM 6 sequence and used for the pollenstratigraphy as well as for the varve counting (Litt/Stebich 1999). Pollen zonation was made according to a cluster analysis which was based on a pollen calculation relying on a minimum of 500 grains per sample and excluding aquatic plants and pteridophytes (Litt/Stebich 1999, 7). Due to the correlation with the varve counting, exact onsets and ends for the clusters, i.e. biozones were given. For the studied time period six biozones were given (**fig. 21**): Pleniglacial, Meiendorf, Oldest Dryas, Bølling, Older Dryas, and Allerød. The latter is further sub-divided in Early, Middle (Gerzensee, cf. Lotter et al. 1992), and Late Allerød. The varve formation in the Meerfelder Maar began during the Meiendorf biozone and, thus, only for the four latter zones precise durations and dates for the onset can be given. The use of the classic palynological terms is combined with relatively precise definitions of how these terms are understood (cf. Litt/Stebich 1999, 10-14). However, these terms remain confusing and are therefore only used to refer to the described biozones (see **tab. 3**).

Fig. 21 Simplified Lateglacial pollen stratigraphy from Meerfelder Maar, MFM 6 (Litt et al. 2001, 1238 fig. 3). Timescale is according to varve chronology, i.e. interpolated below 14,070 years cal. b2k (see p. 20f.) and is shifted from cal. BP to cal b2k. – For further details see text.




## Pollenstratigraphy of northern France

In northern France no single comprehensive pollen record covering the Lateglacial sequence was found. Sequences comparable to the Meerfelder Maar were found only in the higher mountain regions of eastern France, for instance Grande Pile (Vosges; Beaulieu/Reille 1992; Guiter et al. 2003) and Lake Lautrey (Jura; Magny et al. 2006). However, for the former no detailed Lateglacial sequence is published yet and the latter, situated in the Jura mountains, is clearly too far away to be relevant for the Paris Basin or the Picardy.
Nevertheless, palaeoenvironmental analyses frequently accompanied the archaeological investigations of the last two decades in northern France (Leroyer 1994; Pastre et al. 1997; Limondin-Lozouet et al. 2002). Boreholes from some twenty sites scattered across the complete sub-area (**fig. 20**) provided material suitable for pollen analysis (Limondin-Lozouet et al. 2002). In general, palynological samples were taken every 5 cm from sequences containing organic and fine grained, slowly deposited sediments (Pastre et al. 2003, 2178). From the counted pollen the hygrophil species were excluded (cf. Leroyer/Allenet Ribemont 2011).

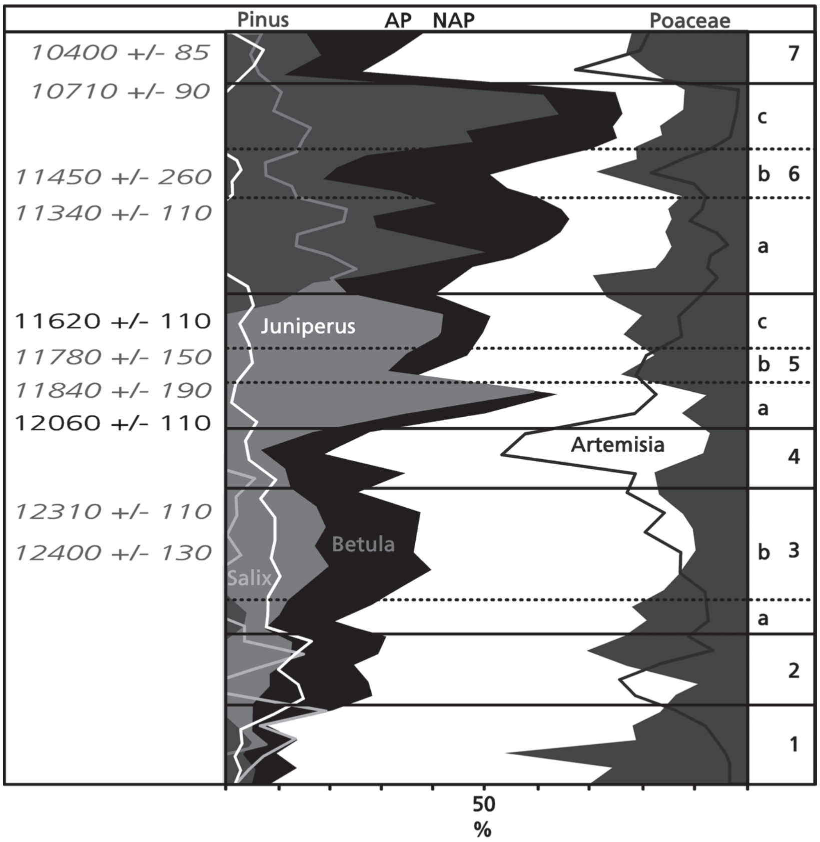



**Fig. 22** Synchronised pollen stratigraphy of northern France (Pastre et al. 2003, fig. 3; cf. Ponel et al. 2005, fig. 5). Dates are $^{14}C$ ages in $^{14}C$-BP. The ones set in grey and italic are made on sediment samples and the one set in black and italic is made on peat (cf. Limondin-Lozouet et al. 2002, tab. 1; Pastre et al. 2003, tab. 1). – For further details see text.

Frequently, these sequences covered only short sections of the Lateglacial and non-representative layers were also excluded (Limondin-Lozouet et al. 2002, 48). In addition, some $^{14}C$ dates were taken from these sequences but several of the samples were bulked sediment samples (Limondin-Lozouet et al. 2002, tab. 1; Pastre et al. 2003, tab. 1) which are not a reliable type of datable material (cf. Hiller et al. 2003). Thus, in contrast to the maar lakes from the western uplands, the temporal resolution of these sequences is less precise. Moreover, the sequences originated from different regions but usually from comparable limnic habitats. However, they were synthesised to deliver a standard pollenstratigraphy for northern France containing seven sub-zones which are numbered from bottom to top (**fig. 22**; Limondin-Lozouet et al. 2002; Pastre et al. 2003). Even though this compound sequence is based on the presuppositions of an instant and comparable vegetation development across the complete area, the constant stratigraphic evaluation should secure that only little gaps occurred in this succession. Furthermore, the wide distribution of the contributing sites sustains that the displayed developments affected most of the sub-area. Therefore, this record delivers a sufficiently precise record of the general vegetation development in northern France. In addition, this pollen stratigraphy was occasionally correlated directly with archaeological sites such as Conty (Limondin-Lozouet et al. 2002, 48; cf. Ponel et al. 2005).

Besides the pollen profiles, directly dated macro-fossils are useful material for reconstructing the local vegetation, and directly dated faunal remains also help to reconstruct the Lateglacial environment. However, this type of resource is presented in the next chapter because the evaluation of $^{14}C$ dates requires stratigraphic as well as chronostratigraphic considerations. Furthermore, the databases formed by the $^{14}C$ dates contribute in addition to information on the environment, also information on the dating of archaeological assemblages. Therefore, this material type is presented separately.

## DATABASES

In general, the present study is structured according to the three main lines of research: climate, environment, and human behaviour. However, the databases are separated in this material presentation because this type of data is related to all three parts of the study. For example, the content of radiocarbon databases can be used to model faunal presence or to date single archaeological sites. In addition, a reliable radiocarbon calibration curve is largely dependent on climate archives (see p. 250-253).
The values in databases represent single episodes which are self-explanatory. Thus, single values can also be taken out of the database and be interpreted independently. In contrast, values in stratigraphies such as pollen profiles are only meaningful in relation to each other and, thus, the changes between and within the single values are significant. However, the single episodes recorded in the databases can also be compiled to firm up an event by overlapping results or create a sequence of accumulation and scarcity of dates. In the latter case, the independent data points are transferred into an eventstratigraphy.

### Radiocarbon database

Since the introduction of radiocarbon measurements as an independent dating instrument in the late 1940s/early 1950s (Libby 1952), this method was used to date archaeological sites also in north-western Europe (e.g. Münnich 1957). Thus, a large corpus of $^{14}C$ dates from Lateglacial sites in north-western Europe has accumulated over the last 50-60 years. Besides the necessity of reviewing some of these results qualitatively (cf. Pettitt et al. 2003; Grimm/Weber 2008), the idea arose to use this increasing set of dates as a quantitatively analysable data set. This dates-as-data approach was introduced in the analysis of regional occupation patterns (Rick 1987). The main assumption was that an increase in human presence in a region also resulted in more activity and, thus, an increased production, deposition, and conservation of carbon material related to the human presence. Moreover, in a following step the results from adjacent regions were compared to indicate palaeodemographic movements (Housley et al. 1997; Gamble et al. 2005; Shennan/Edinborough 2007).
However, to make this quantitative approach possible a dataset consisting of as many reliable dates as possible is necessary. For the present study a database of almost 1,500 single radiocarbon dates (n = 1,486) associated with the Lateglacial of north-western Europe was collected and reviewed (see p. 259-263 and p. 265-269). 322 of these dates originated from northern France and the western uplands including the Central Rhineland (**tab. 5**). Only some 240 of these dates fall into the relevant time slice from 13,200 to 10,800 years $^{14}C$-BP.
The fundament for this database was formed by a large database of radiocarbon dates from Pleistocene and Holocene archaeological sites which was assembled at MONREPOS mainly by Martin Street and Olaf Jöris during the last decades and contained in mid-2009 some 8,600 single dates[7]. This fundament was supplemented by further sources (**tab. 6**).
For instance, a large database of radiocarbon dates (n = 9,356) from Palaeolithic sites in western Europe was published online by the INQUA (PI: Pierre Vermeersch; http://ees.kuleuven.be/geography/projects/14c-palaeolithic). Julia Fahlke used this database, in particular, and collected further results in regard to the Lateglacial faunal succession in Central Europe creating another set of radiocarbon dates (n = 934; Fahlke 2009).

7 Meanwhile the number has increased to some 12,000 single datasets (written comm., Martin Street).

| attributes | number of $^{14}C$ dates in data-base | number of $^{14}C$ dates from the Central Rhineland | number of $^{14}C$ dates from the western uplands* | number of $^{14}C$ dates from north-ern France |
|---|---|---|---|---|
| all dates | 1,489 | 123 | 185 | 137 |
| dates from relevant time slice | 894 | 101 | 136 | 101 |
| dates on bone | 769 | 85 | 142 | 79 |
| dates on teeth | 95 | 5 | 5 | 12 |
| dates on antler | 119 | 2 | 3 | 3 |
| dates on charcoal | 239 | 6 | 6 | 28 |
| dates on wood | 85 | 20 | 20 | 0 |
| dates on reindeer (*Rangifer tarandus*) | 208 | 5 | 20 | 14 |
| dates on horse (*Equus* sp.) | 195 | 24 | 40 | 21 |
| dates on red deer (*Cervus elaphus*) | 51 | 13 | 15 | 2 |
| dates on elk (*Alces alces*) | 26 | 6 | 6 | 0 |
| dates on large bovids (Bos / Bison; *Bos primigenius; Bison priscus*) | 55 | 3 | 3 | 13 |
| dates on birch (*Betula* sp.) | 19 | 4 | 4 | 0 |
| dates on pine (*Pinus* sp.) | 37 | 1 | 1 | 3 |
| AMS dates | 1,015 | 98 | 137 | 89 |
| conventional dates | 457 | 25 | 48 | 48 |

**Tab. 5** Number of $^{14}C$ dates with selected attributes in present database. Note that these numbers are unaudited (cf. p. 259-263 and p. 265-269). Relevant time slice is 13,200-10,800 years $^{14}C$-BP. ***** included are also the sites from the Central Rhineland database.

In addition, numerous radiocarbon dates (n = 6,019) were published as PACEA geo-referenced database (d'Errico et al. 2011) which was mainly filled by southern European sites. In the supplemental databases the $^{14}C$ dates were given without comments on the technical and/or contextual reliability of these dates. In contrast, in the MONREPOS database some comments on a technical and/or contextual evaluation were already given (cf. Pettitt et al. 2003; Grimm/Weber 2008). A comparable evaluation of $^{14}C$ dates was accomplished for Lateglacial samples from the Netherlands and adjacent regions available in the mid-1990s (Lanting/van der Plicht 1996) and provided some useful information of some 106 dates incorporated in the present study.
Moreover, additional dates were searched from several datelists of various laboratories published in the journals Radiocarbon, Science, and Archaeometry. Unfortunately, with the commercialisation of the laboratories they often lost the right of publishing dates and, therefore, these truly helpful compilations of dates from a single laboratory were rarely published after the 1980s except for the Oxford laboratory (Archaeometry). Revisions of available dates for specific regions or periods partially fill up this gap (e. g. Street/Baales/Weninger 1994; Lanting/van der Plicht 1996; Bodu et al. 2009b; Jacobi/Higham 2009). Many such revisions were also consulted. Further information was looked up in the online accessible database of the Oxford radiocarbon accelerator unit (ORAU; online database requires registration, http://c14.arch.ox.ac.uk/embed.php?File=). Another group of dates on the Hamburgian settlement were made accessible by the Cologne laboratory (n = 4), Jørgen Holm (n = 9), and the Kiel laboratory (n = 3). However, these dates were previously published (Grimm/Weber 2008). A further two dates from northern Germany were also discussed in a previous publication (Riede et al. 2010). A single date from Boppard made on a metapodial of red deer (*Cervus elaphus*; KIA-2644: 11,095 ± 55 years $^{14}C$-BP; $\delta^{13}C$ = -25.1; see p. 161 f.) was kindly provided by Stefan Wenzel (VAT, RGZM/Mayen) and not published previously.
For each date the laboratory number and the standard deviation as well as the site location including name, region, country, latitude, longitude, and the approximate altitude were recorded to enable a geo-referencing of the location from which the date originated and the use of the dates in GIS programs. Moreover, the

| database | MONREPOS 2009 | INQUA | Fahlke dissertation | PACEA | present database |
|---|---|---|---|---|---|
| ref. | unpublished | webpage | Fahlke 2009, appendix 1.A | d'Errico et al. 2011 | present study |
| n all $^{14}$C dates | 8,630 | 9,356 | 934 | 6,019 | 1,489 |
| n $^{14}$C dates attributed to relevant period | 1,654 | 2,232 | 569 | 1,917 | 1,288 |
| n $^{14}$C dates from the relevant time slice | 1,214 | 1,484 | 496 | 1,388 | 894 |
| n $^{14}$C dates from study area | 500 | 599 | 218 | 282 | 322 |
| n $^{14}$C dates from relevant time slice & study area* | 197 | 223 | 153 | 222 | 231 |

**Tab. 6** Number of $^{14}$C dates in main databases contributing to the present database. ***** Information from all these dates contributed to the present database but note that there is a significant overlap in dates and, therefore, an addition of these dates does not result in the number of dates in the database of the present study. Abbreviations: **Ref.** reference; **n** number of; **webpage** http://ees.kuleuven.be/geography/projects/14c-palaeolithic accessed 20th August 2007; **relevant period** Late Magdalenian to *Federmesser-Gruppen* and/or Late Pleniglacial to end of Lateglacial Interstadial. – Relevant time slice is 13,200-10,800 years $^{14}$C-BP. – Study area see **fig. 1**.

position of the sample on the site in the horizontal as well as vertical stratigraphy was further specified if possible to evaluate the relation of the sample to the other material. Additional information from the site such as results of pollen analyses of the source layers were also recorded. Furthermore, the archaeological affiliation of the material from which the sample originated was noted to make a selection of dates for specific archaeological groups possible. Other contexts were described as palaeontological, palaeobotanical, or stratigraphic affiliation. In addition, the sample was described by its general type of material such as bone, antler, or charcoal (**tab. 5**) which was further defined by a more detailed description such as »phalanx, sin., cut-marks« or »bulked sample, calcined pieces«. Furthermore, if the species was determined this information was also recorded. As far as published data, further indicators of the composition of the sample were noted such as the gelatin yield, the percentage of modern carbon (pmC), the $\delta^{13}$C value, the $\delta^{15}$N value, and the C/N ratio. All Oxford dates (n = 653) were checked for these values and, in general, the pretreatment procedure was also documented in the online database. Moreover, the dating method was distinct between counting of carbon ions by accelerator mass spectrometry (AMS; e.g. Fifield 1999) and the classic counting of radioactivity (β-counting or conventional dating; Libby 1952). As far as possible, a citation for the original publication was given. Otherwise, publications in which the date was used or which yielded further information on the sample were also recorded.

The pretreatment procedure as well as the additional information on the composition for the sample were used in a technical audit clarifying whether the given date produced a reliable age for the sample (see p. 259-263). The archaeological audit in contrast aims for the significance of the date for the age of the archaeological material (see p. 265-269). For example, a radiocarbon date can result in a reliable estimate for the death of an animal (»dated event«) such as a hare but the death of the hare might not have been related to the archaeological episode that was wished to be dated (»target event«, Dean 1978). In a pure archaeological audit the example date would be rejected, even though the date represents reliable evidence for the presence of the animal in this area. Thus, the distinction between technical and archaeological reliability is made to use the dates as indicators for the chronostratigraphic position of an archaeological assemblage as well as for the presence of vegetation or a fauna species in the area. The latter can help to model the environment and, in particular, indicate the availability of the specific resources in the studied region.

| attributes | number of sites in database | number of sites from the Central Rhineland | number of sites from the western uplands* | number of sites from northern France |
|---|---|---|---|---|
| sites with selected directly data faunal material | 135 | 9 | 21 | 11 |
| sites with selected directly data plant remains | 35 | 4 | 5 | 0 |
| sites with pollenstratigraphies | 94 | 1 | 9 | 22 |
| sites with climate and calibration data | 26 | 1 | 3 | 0 |

**Tab. 7** Number of sites in the database of sites with climatic and environmental data. * included are also the sites from the Central Rhineland.

## Database of Lateglacial sites from north-western Europe

In addition to the collection of radiocarbon dates, two geographic databases of locations of material associated with the Lateglacial of north-western Europe were created for the mapping of the material.

One set of databases consisted of findspots of climatic and / or environmental material (**tab. 7**). In the other one, archaeological sites and occasionally single concentrations on these sites (n = 1,188) were compiled (**tab. 8**). In both types of databases, the locations were given by a specific name such as Gönnersdorf I or Miesenheim 4 and a region, a country, and their geographic coordinates (latitude, longitude, altitude) were assigned to this name. The coordniates are necessary to use information connected to these sites such as radiocarbon dates in GIS programs. The coordinates of each site / concentration were cross-checked using published maps of the sites and Google-Earth™. The coordinates are given in decimal degrees and the altitude in m a.s.l. However, depending on the resolution of the primary site information a precision code for the coordinates was given (0 – approximate area; 1 – the same parcel; 2 – findspot). Additionally, a regional code for the present study was created to facilitate the analysis of sub-sets across modern political borders. The environmental databases were distinct between sites yielding directly dated samples of selected faunal species (n = 135) or plant species (n = 35), sites yielding stratigraphic sequences (n = 94), and sites yielding climate and calibration data (n = 26). To be able to plot the sites on the relevant maps, the events were recorded for which these sites yielded data. Furthermore, in the table of the stratigraphies the type of material which was analysed as well as the type of dating and the type of correlation was noted. In the databases with directly dated material, the results of the technical evaluation were taken into account by the indication if temporal distributions might be false.

In the database of archaeological sites, for all concentrations the archaeological classification was recorded in three scales: The first scale was the epoch (i.e. A – Palaeolithic, B – Mesolithic, C – Neolithic etc.), second scale was a sub-period (A – Early / Lower, B – Middle / Intermediate, C – Late / Upper, D – Final / Top), and thirdly an archaeological group was given such as Late Magdalenian or FMG. Finally, a reference was given where the sites were presented and / or mentioned. However, some concentrations were introduced partially or only mentioned in publications thus far and, therefore, the following attributes were not always recordable for all concentrations. For instance, a code for the integrity of the archaeological material was currently given to only 769 concentrations. By this code problems such as stratigraphical disturbances, archaeological classification uncertainties, or both are identified. This distinction is of particular importance when studying assemblages from a transition period to distinguish possible palimpsests from assemblages with mixed characteristics of the two poles of the transition. However, to be able to judge this integrity, precise excavation standards are required. Therefore, the excavation standards were also considered (0 – collection, no excavation; 1 – collection with more detailed information on stratigraphy; 2 – excavations with rough excavation technique and / or imprecise documentation; 3 – modern standard excavation, i.e. with careful excavation techniques and good documentation including 3D-data for single artefacts).

| attributes | number of sites in database | number of sites from the Central Rhineland | number of sites from the Western Uplands* | number of sites from northern France |
|---|---|---|---|---|
| all sites | 1,188 | 53 | 133 | 237 |
| all collections (with further information) | 282 (57) | 5 (2) | 25 (10) | 12 (3) |
| all excavated concentrations (modern standards) | 602 (416) | 47 (41) | 79 (57) | 145 (134) |
| material disturbed stratigraphically | 37 | 3 | 5 | 0 |
| archaeological attribution uncertain | 301 | 4 | 35 | 27 |
| material is archaeologically uncertain and stratigraphically disturbed | 66 | 2 | 7 | 3 |
| sites of Magdalenian-affiliation | 100 | 11 | 27 | 16 |
| sites of FMG-affiliation | 158 | 32 | 34 | 49 |
| sites of uncertain FMG- / Magdalenian-affiliation | 86 | 2 | 14 | 18 |
| open air sites | 919 | 45 | 60 | 170 |
| rock shelter sites | 27 | 0 | 4 | 2 |
| cave sites | 112 | 4 | 35 | 3 |
| sites with botanic material | 142 | 23 | 30 | 37 |
| sites with faunal material | 260 | 46 | 65 | 69 |
| sites with lithic material | 572 | 42 | 74 | 139 |
| sites with structures (evident) | 106 (78) | 13 (10) | 19 (14) | 24 (23) |

**Tab. 8** Number of concentrations for which selected attributes are recorded in the database of archaeological sites. ***** included are also the sites from the Central Rhineland.

Additionally, the site type was recorded for 1,061 concentrations to date indicating whether the concentration was found in a cave, a rock shelter, or in the open air. Moreover, the presence or absence of botanic evidence (n = 503), of faunal material (n = 631), of lithic material (n = 622), and of settlement structures (n = 367) from the sites was recorded. However, the number of sites where such material was present diverged considerably (**tab. 8**). For instance, even though some 260 concentrations out of 631 recordings yielded faunal material, this material was often poorly preserved and just represented by a few indeterminable bone fragments or only a malacological analysis was made. In addition, the lithic material was recorded in several sub-units such as number of cores, tools, or backed pieces. However, only the sites relevant to the present study are presented in more detail.

## ARCHAEOLOGICAL SITES

Along with climate and environmental archives, archaeological assemblages form the fundament of the present study. The archaeological record yields the mainstay for the interpretation of changes in human behaviour because this record was created by human behaviour. The lithic artefacts were produced by humans in a usually conscious and largely intentional technical process. The faunal remains reflect a subsistence choice and / or hunting ability of the past humans. Besides those finds, the spatial organisation of these humanly created remains forms the archaeological record.

However, selection or modification by agents other than humans such as taphonomic processes have to be excluded from this record to extract the patterns created by past human groups. To prevent misinterpretation due to naturally formed patterns, the archaeological record has to be evaluated in regard to the site formation process. Furthermore, admixture of diachronic archaeological material needs to be reduced as far as possible to prevent mixing of unrelated behavioural expressions to a common development.

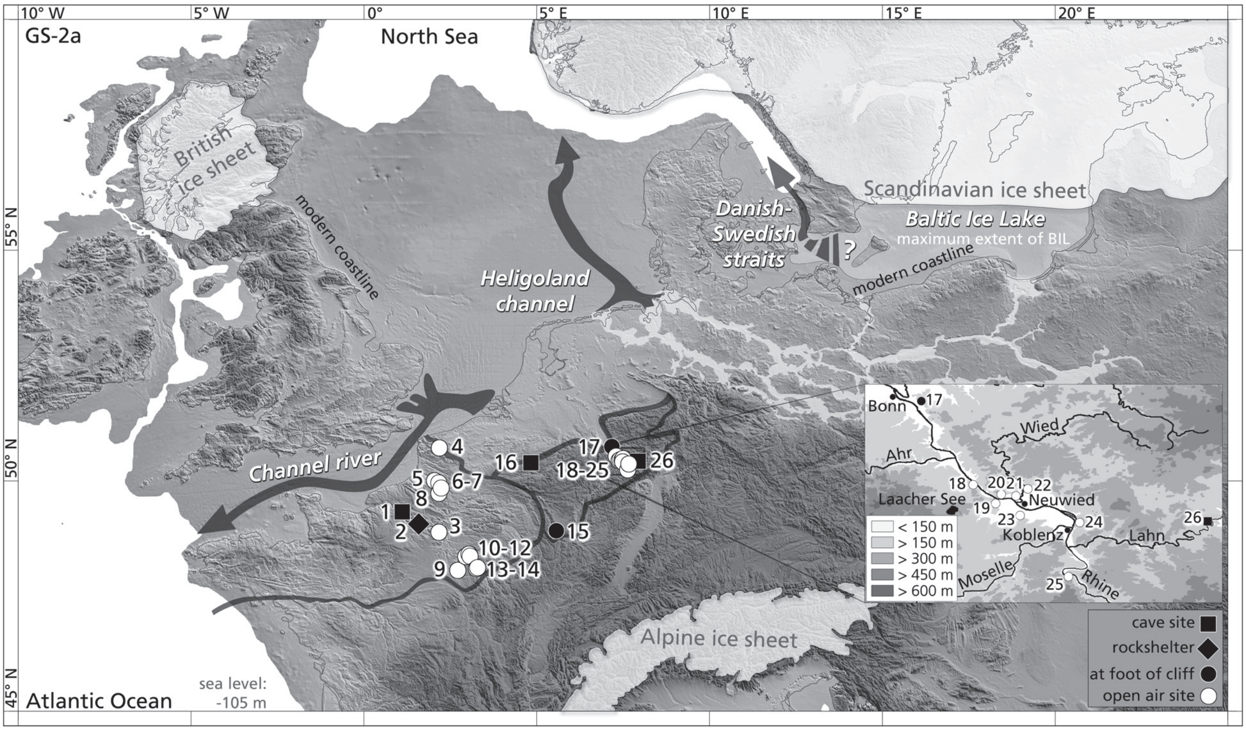



**Fig. 23** Map of archaeological sites used in the present study. **1** Grotte de Gouy; **2** Bonnières-sur-Seine; **3** Le Closeau; **4** Hallines; **5** Hangest-sur-Somme; **6** Belloy-sur-Somme; **7** Saleux; **8** Conty; **9** Cepoy; **10** Pincevent; **11** Le Tureau des Gardes; **12** Le Grand Canton; **13** Étigny; **14** Marsangy; **15** Saint Mihiel; **16** Bois Laiterie; **17** Bonn-Oberkassel; **18** Bad Breisig; **19** Andernach-Martinsberg; **20** Gönnersdorf; **21** Irlich; **22** Niederbieber; **23** Kettig; **24** Urbar; **25** Boppard; **26** Wildweiberlei.

If uniform patterns in the choice of the material as well as their spatial deposition are observed in this reviewed record, a social agreement on the behaviour creating the patterns must have existed. Thus, these established patterns emerged from a social discourse and a communal decision-making process. Furthermore, a change of the social agreement meant to abandon the previously stipulated behaviour and to prefer an alternative behaviour which created a divergent pattern from the previously stipulated one in the archaeological record. In a diachronic comparison of archaeological assemblages, the establishment of alternative behaviours as new stipulated ones can be observed. Consequently, changes in the archaeological material and/or the position of this material in the spatial organisation reflect changes in human behaviour.

However, since humans are imperfect in the repetition of a specific behaviour (Eerkens 2000; Hamilton/Buchanan 2009), a general pattern usually consists of a range of socially acceptable variation. Moreover, the creation of the material also depends on availabilities and characteristics of resources such as lithic or organic raw materials. These conditions shape the variation additionally. Thus, the patterns as well as the typical tolerance ranges have to be identified to describe the stable states of behaviour reflected by the archaeological material. Furthermore, to specify the changes between a previous and a new state of agreement, these patterns and tolerance ranges have to be described for both states. In the example of Lateglacial north-western Europe, these two stable states are the Late Magdalenian and the FMG.

In the Central Rhineland, the archaeological remains of these two stable states are particularly well preserved due to the protective cover by the LST. This good preservation allowed for a relatively precise chronostratigraphic attribution of the assemblages as well as detailed spatial analyses of sometimes single concentrations of human activities. However, only a few assemblages were attributed to the transitional period between the Late Magdalenian and the FMG. The most important sites from the Lateglacial in Central Rhineland are introduced in the following (see Material-Archaeology-Central Rhineland, p. 75-170) to describe the stable states and, thereby, specify the differences between them. In addition, the sparse information of the intermittent transition known from the Central Rhineland is outlined. Moreover, to fill this incomplete record of the transitional period, archaeological sites from northern France (see Material-Archaeology-Northern France, p. 182-244) comprising the Paris Basin and the Somme region as well as from the western upland zone (see Material-Archaeology-Western upland zone, p. 170-182) located between the Central Rhineland and northern France are included in the present study. These areas are chosen as supplements to the Central Rhineland because they were presumably inhabited by a closely related social network during the Late Magdalenian (Floss/Terberger 2002, 138; cf. Arts/Deeben 1987) and, probably, still in the period of the FMG (Bodu/Valentin 1997; De Bie/Vermeersch 1998; Bodu 2000a; De Bie/Van Gils 2006). In particular, the distribution of Late Magdalenian material in north-western Europe was assumed to indicate a large-scale common information network (cf. Schwendler 2012; Clarke 1968, 88-101). Thus, the progress of change from the Late Magdalenian to the FMG was probably influenced by the exchange of information within this network and/or by the possible secession from this network. In this case, archaeological assemblages dating to the transition period reflect individual decisions made in a large-scale social discourse on how to behave. Therefore, the social process of change from the Late Magdalenian to the FMG can be described more precisely by the use of reliable assemblages which consolidate the spatio-temporal web of observable decisions made in the process of changes. In addition, based on the similarities in the archaeological material from the Central Rhineland, northern France, and the western uplands during the Late Magdalenian and the FMG, a comparable process leading to the changes observable in the archaeological material between these two periods can be assumed for these three regions.

Since the archaeological assemblages form the mainstay for human behaviour, they are presented in detail (**fig. 23**). In particular, the research history, the setting, the stratigraphy, the archaeological material, the spatial patterns, and the chronology[8] of the archaeological sites are described in the following. Yet, a general description of the Late Magdalenian and the FMG is given previously to introduce the differences and commonalities between these two archaeologically defined groups.

## Archaeological groups

The archaeological material found underneath the LST in Central Rhineland was generally attributed to two major Lateglacial groups: the Late Magdalenian and the FMG.

8 According to the Oxford Dictionary »chronology« refers to »the arrangement of events or dates in the order of their occurrence« (»chronology« Oxford Dictionaries, April 2010, Oxford University Press. Online accessed: 27 August 2012 <http://oxforddictionaries.com/definition/english/chronology>). Thus, the chronology of a site refers to the general chronostratigraphic setting of the site as well as to the relation of the different activities and processes forming the site. Therefore, considerations about the chronology should address the relation of different occupation episodes on the site to each other (internal chronology), the influence of natural processes other than humans (site formation process), and the relation of the dated material to the human activity (chronological evaluation). The latter is necessary to clarify the chronostratigraphic position of the human activities which shall be dated (target event) in contrast to the material which is dated (dated event, Dean 1978). For example, if a site is dated by the pollen spectrum of an overlaying deposit, the dated event represents only a *terminus ante quem* with an unknown gap to the time in which the archaeological assemblage was deposited. Equally, if an ivory point is $^{14}C$-dated, the dated event is the death of the elephantidae with an unknown gap to the target event which could be the carving of the point as well as its use or its discard. For the Pleistocene, these gaps of the radiometric dated events to the target events were usually considered as attributable to the standard deviation and/or the calibration interval. However, the clarification of the relation of dated and target events becomes necessary with the increasing precision of radiocarbon dates as well as of the calibration curve because the gaps may no longer be covered by the methodological error margins. Furthermore, for the Lateglacial, this assumption is already challenged by the knowledge of the durability of some materials (Pétillon et al. 2011) and the probable use of fossil materials (Street et al. 2006).

These two entities reflected two chronologically successive sets of behaviour. Differences in some parts of these sets resulted probably from the adaptation to different surroundings. The different surroundings were formed by the variation of the climate regime and of the available resources such as vegetation and game. From these different surroundings, various necessities arose for the fulfilment of the physiological needs of humans (cf. Maslow 1943; Pittman/Zeigler 2007) such as protection against cold or moisture and repletion by vegetal and/or faunal resources. Thus, human groups had to adapt their behaviour to their surroundings to ensure their survival. How and when the Lateglacial groups adapted is the subject of the present study. Moreover, whether the adaptation occurred as a caesura or as a transformation period will be a result of this study. However, an assessment of the transition was often made -presumably in parts sub-consciously- when ambiguous assemblages from the transition period were attributed to one of the archaeological groups, to further sub-groups such as the Final Magdalenian or the Early Azilian, or to transitional industries. Hence, across Western Europe several archaeological assemblages were attributed to the Late Magdalenian, the FMG, and/or the transitional period between them. Although these previous attributions of the material are going to be mentioned in the presentation of the archaeological material, they are not considered as final assessments. However, to specify the similarity of the studied assemblages to the Late Magdalenian and/or the FMG, the general definitions and the main defining elements of the two archaeological groups are introduced in the following. Furthermore, these two entities set the beginning and the end point of the transition under study. Hence, the differences between the two groups are specifically emphasised. These differences allow for a description of the assemblages of the transitional period in terms of nearness to the one or the other archaeological group and focusing particularly on distinctive behaviours. Subsequently, a chronological order of these descriptions enables the reconstruction of the progress of changes in the Lateglacial revealing continuous and/or rapid developments.

### The Late Magdalenian

The archaeological remains recovered from the lower or older horizon found in the loess deposit underneath the LST in the Central Rhineland were classified as Late Magdalenian. The Magdalenian forms one of the major archaeological entities in the European Upper Palaeolithic. This entity was named by Gabriel de de Mortillet based on the lithic and organic material from the site La Madeleine in the Vézère valley (de Mortillet 1869; de Mortillet 1872). He proposed the Magdalenian to cover the second part of the Late Quaternary.

The eponymous rock shelter, La Madeleine, was first excavated from 1863 to 1865 by Édouard Lartet and Henry Christy. The excavators published the material successively in the following decade (Lartet/Christy 1875). In the 19th century and the early 20th century, further excavations were conducted by Elie Massénat, Paul Girod, Émile Rivière, and Denis Peyrony (Capitan/Peyrony 1928). Finally, Jean-Marc Bouvier (Bouvier 1977) excavated with modern standards in this rock shelter. Successively, the archaeological record from the site comprised a rich inventory of organic artefacts and more than 12,000 lithic artefacts. Furthermore, a burial of an infant with presumably richly decorated clothes was found by Denis Peyrony in 1926 and $^{14}C$-dated to the Younger Dryas period (Gambier et al. 2000). Besides La Madeleine, Denis Peyrony conducted further excavations in the western neighbouring rock shelter Villepin to receive a stratigraphic succession from the Magdalenian to the succeeding so-called Azilian (see p. 65-74; Peyrony 1936). Furthermore, the stratigraphic sequence from La Madeleine was combined with basically the stratigraphy from Le Placard by the abbot Henri Breuil in 1912 to construct what he considered a successive chronological development of the Magdalenian (Breuil 1913; cf. Breuil 1954).

Meanwhile, sites attributed to the Magdalenian were dated as early as approximately 17,500 years $^{14}$C-BP (Ducasse 2012). However, the Badegoulian had been occasionally considered as the earliest stage of the Magdalenian or a Proto-Magdalenian (cf. Ducasse/Langlais 2007; Ducasse 2012, 151 fig. 1) and the earliest Badegoulian sites were dated to *c.* 19,000 years $^{14}$C-BP. The upper temporal limit of the Magdalenian also depended on the definition of the Magdalenian and on its distinction from the Azilian (cf. Delporte 1966; Cheynier 1966). In consequence, this limit also ranged over a considerable period from approximately 12,800 to 11,500 years $^{14}$C-BP (Straus/Leesch/Terberger 2012).

Independent of the precise definition, a continuous development of the Magdalenian was only established for a south-western European refuge thus far (Straus/Leesch/Terberger 2012). The Magdalenian was consequently considered a strictly south-western European innovation. It reached most parts of north-western Europe after the LGM in a demic expansion process which possibly included several waves (cf. Verpoorte 2009). This spread of people from a south-western refuge across the upland zones of north-western Europe during the Late Pleniglacial was further sustained by mtDNA evidence (Torroni et al. 1998; Pereira et al. 2005). Archaeological evidence for single incursions into northern France and the north-western European uplands were found for almost all periods of the Magdalenian (Terberger/Street 2002; Bodu/Chehmana/Debout 2007). However, these incursions became more frequent during a middle period of the Magdalenian and an established settlement of these areas was only associated with a late period of the Magdalenian (Housley et al. 1997; Verpoorte 2004; Gamble et al. 2005; Miller 2012; Połtowicz-Bobak 2012). Hence, the Magdalenian in general and the Late Magdalenian in particular were considered as the »ancestral« tradition to the succeeding Lateglacial archaeological groups of north-western Europe, both in a behavioural and a biological sense (cf. Schwabedissen 1954; Weber 2012; Pettitt/Rockman/Chenery 2012).

In general, the Magdalenian was bisected by Henri Breuil into a lower part and an upper part based on the stratigraphic occurrence of organic artefacts and pieces of art at Le Placard and at La Madeleine (Breuil 1913, 40-56). The lower, early part was mainly based on the sequence in Le Placard. In this part, bevelled points but no barbed points occurred and the art which mainly decorated the organic material was described as ornamental. In contrast, the organic inventory of the upper, late part was supplemented by barbed points and the art became figurative. The successive development of this part was found at La Madeleine. Breuil differentiated a further three sub-units within the two parts: the Magdalenian 1-3 for the Lower/Early Magdalenian and Magdalenian 4-6 for the Upper/Late Magdalenian. For the Upper/Late Magdalenian the distinction of the sub-groups was based on the development of the barbed points at the eponymous site of La Madeleine beginning with rudimentary barbed points (4), followed by barbed points with one row of barbs (5), and barbed points with two rows of barbs, i.e. harpoons (6). A final stage of this development was later also recovered at the neighbouring site Villepin in the succeeding Azilian horizons where some flat harpoons were found that were made of red deer (*Cervus elaphus*) antler and that were perforated at their base (Peyrony 1936). Comparable specimens were already known from the eponymous site of the Azilian, Mas d'Azil (Piette 1895). Although the general succession of the organic implements persisted, overlap led to occasional co-occurrence of some types (Langlais et al. 2012). Furthermore, barbed point types were meanwhile confirmed for an early period of the Magdalenian and, thus, these implements were only absent during an intermediate part of the Magdalenian, although some discussed proto-types also existed in this period (Pétillon 2008b). Furthermore, the variety of the barbed points was demonstrated to be related rather to function and use than chronostratigraphy (Julien 1982; Weniger 2000; Pétillon 2008b). The continuous co-existence of various types of barbed points into the Final Palaeolithic and Mesolithic (Smith/Bonsall 1991; Cziesla/Pettitt 2003; Cziesla 2007a; Cziesla 2007b) further sustained the use-oriented interpretation of the observed variability. In consequence, the classification of barbed points developed by Henri Breuil could not be confirmed as chronostratigraphically precise and, thus, relevant distinction.

Besides the classification according to organic types, Henri Breuil mentioned changes occurring in the lithic inventory between his stage Magdalenian 5 and 6 (Breuil 1913). In the Magdalenian 5, burins on truncations and small curve-backed points were widely spread, whereas the abbot observed a clear regionalisation of the assemblages in the Magdalenian 6. Nevertheless, in this latter stage the *bec-du-perroquet* (cf. Sonneville-Bordes 1960, 332 f.) and the generally curved and »hooked« burins were considered as a still common element. Based on his excavations at Laugerie-Haute, Denis Peyrony sustained three groups of lithic inventories in the Early Magdalenian (Peyrony/Peyrony 1938) but in contrast to Breuil he regarded the lithic material of the Late Magdalenian as extremely uniform (Capitan/Peyrony 1928; Peyrony 1936). According to Peyrony, several types of burins were usually dominant and, particularly, dihedral ones and those on truncation were frequent in all horizons of the Late Magdalenian. Furthermore, borers, end-scrapers on blades, and numerous composite tools occurred in all horizons of La Madeleine (Capitan/Peyrony 1928). Among the backed implements or laterally modified pieces (LMP)[9], backed bladelets and blades were the dominant type but also large *couteaux à dos* were found. Backed points occurred occasionally in Late Magdalenian assemblages but no uniform type of these points was observable. The numbers of points increased throughout the stratigraphic succession and a regular appearance of these implements marked the onset of the Azilianisation process. Thus, the lithic inventories used by Breuil to define the Magdalenian 5 and 6 were either assemblages which already fell into the transition to the Azilian or were results of admixtures. Consequently, the distinction of sub-groups by Henri Breuil based on the lithic inventories is obsolete. In contrast, the concept of a general uniformity of Late Magdalenian lithic inventories as observed by Denis Peyrony proved valid, in particular, in regard to the large distances of the distribution of Late Magdalenian assemblages.

Many further sub-divisions of the Magdalenian and the Late Magdalenian exist (e. g. Capitan/Peyrony 1928; Sonneville-Bordes 1960; Schmider 1982; Bosselin/Djindjian 1988; Le Tensorer 1998). In fact, the distinctions of various sub-groups were often similar to the system of Breuil and/or meant to refine or define this system more precisely. For instance, based on the refinement of typologies, a Middle Magdalenian comprising Breuil's sub-units 3 and 4 was distinct (e. g. Allain et al. 1985; Onoratini/Defleur/Joris 1996). The Middle Magdalenian was interpreted as the emergence of the typical Late Magdalenian (Langlais 2007). However, the lithic inventory of a Middle Magdalenian comprised also scalene triangles and microburins (Langlais 2007) which were distinctive for the Early Magdalenian sub-unit 2 (Onoratini/Defleur/Joris 1996). Comparably, the Magdalenian 1 was meanwhile renamed Badegoulian and considered an independent stage from the Magdalenian (Ducasse 2012). Furthermore, in northern Europe little or no organic tools were preserved in inventories with lithic material comparable to the Late Magdalenian. These assemblages usually comprised no backed bladelets but numerous backed points and, therefore, were attributed to a Final Magdalenian (Garrod 1926; Schwantes 1933) that was correlated to Breuil's sub-units Magdalenian 5

9 In the following the term »laterally modified pieces« (LMP; Caspar/De Bie 1996) refers to laminar pieces with abrupt modification along at least one lateral edge (cf. Jacobi 2004, 34-45). They are mainly assumed to represent lithic projectile implements (Rust 1943, 191; Allain 1979, 100-103; Leroi-Gourhan 1983; Moss 1986; Bratlund 1996b; Rots/Stapert/Johansen 2002; Holm 2003; Sano 2009) but micro-wear analysis also suggested that at least the larger pieces were used as cutting tools (»knives«; Rots/Stapert/Johansen 2002). Thus, under this term almost all Upper and Final Palaeolithic projectile implements and various »knives« as well as their fragments are subsumed. This collection in a single group allows the establishment of a main morphological class comparable to end-scapers and burins. By the use of this term, an easier general comparison of various stages within the process of change based on retouched artefact classes can be established. Moreover, the distinction between classic types of LMP is sometimes difficult (Grimm/Jensen/Weber 2012) and distinction in fragmented material during the Lateglacial is often impossible. The attribution especially of transitional types usually follows the find context (Jacobi 2004). This attribution practice also applies to fragments of LMP. Pointed distal fragments are often counted as points, whereas medial and basal fragments are often counted within the group of the backed blades and bladelets, although this attribution might be false. To prevent these presuppositions, these pieces are subsumed under the neutral term LMP and only complete or nearly complete types are further distinguished (see p. 275-282).

and 6 (see above). If these additional sub-divisions were considered and given a chronological meaning, the Magdalenian development would proceed from the Badegoulian to the Middle Magdalenian to the Final Magdalenian. Consequently, the question would arise what was meant with an Early and a Late Magdalenian. This exaggerated excursus in nomenclature, correlations, and sub-divisions is meant to indicate the ambiguity of this variously defined and used taxonomic system based on Breuil (Breuil 1913; cf. Breuil 1954) and partially mixed with Peyrony's distinction (Capitan/Peyrony 1928; Peyrony 1936) and other sub-divisions of the Magdalenian (Bordes 1958; Sonneville-Bordes 1966; cf. Ducasse 2012). In general, these early francophone approaches of using typologies were meant to establish chronologically relevant sub-divisions of the Magdalenian.

In contrast to the francophone approaches, early German archaeologists often followed the concepts of Gustaf Kossina (Kossinna 1911) and tried to distinguish mainly geographic sub-groups which were assumed to represent different ethnic sub-units (Schwabedissen 1954, 71-76). Perhaps, this focus on spatially distinct but potentially contemporaneous groups was also due to the presence of dominantly Late Magdalenian type inventories in the German upland areas. Moreover, the chronological control of these assemblages was often poor because many of them were surface collections. To increase the chronological control, archaeological assemblages were combined with analyses of the natural sciences such as pollen analysis to help construct the environments and allow some chronological differentiations to be made (e. g. Rust 1958). Therefore, excavated sites where a stratigraphic control was possible were increasingly preferred. Accordingly, Rudolf Feustel defined some groups within the Late Magdalenian (Lausnitz, Feustel/Teichert/Unger 1963; Oelknitz, Feustel 1956, 25) based on mainly excavated assemblages from the Thuringian Basin. Particularly in the Oelknitz group, the lithic assemblage was dominated by a variety of backed bladelets. These implements could be truncated on one or both ends, denticulated, or as well be retouched laterally. Yet, several pieces appear to be broken intentionally, perhaps, to be fitted in composite projectiles (cf. Leroi-Gourhan 1983). Furthermore, among the frequent burins the examples on truncation dominated. In the Oelknitz group, these truncations were often long and concave (*Lacan* type) and the borers were also rather elongated and sometimes with solidly retouched edges (i. e. *bec* type). In the following years, Feustel's Oelknitz group comprised most of the reliable Magdalenian assemblages in north-western Europe and, thus, could be taken as synonymous with the Late Magdalenian of Denis Peyrony (see above). Subsequently, Feustel further distinguished five variants: Oelknitz, Nebra, Moosseedorf, Ahlendorf, and Kniegrotte (Feustel 1979). These variants were particularly based on their lithic assemblages. In the Nebra group, the variety of backed bladelets was considerably smaller than in the other groups, with no denticulated or laterally retouched backed pieces at the eponymous site. However, except for this difference, the inventories of the Oelknitz group were basically identical to the Nebra group. In both groups, burins were made on truncations which were generally oblique. In the Mooseedorf and the Ahlendorf group of Feustel, the burins were also made on truncations but in contrast to the Nebra and Oelknitz group these truncations were mainly straight. The difference to the Kniegrotte was the presence of triangles in the Kniegrotte assemblage (cf. Höck 2000). Occasionally, these groupings are still used. For instance, Thomas Terberger discussed the attribution of the Central Rhineland Magdalenian to the *Nebraer Gruppe* (Nebra group, i. e. variant) based on the retouched lithic artefact inventory of Andernach as well as of Gönnersdorf (Floss/Terberger 2002, 135-138). He noted further similarities among the sites of the Nebra group in the presence of female figurines and spatial structures, in particular, in the evident structures such as pits and pavements (Floss/Terberger 2002, 135-138). Feustel had already suggested this relation of Nebra to the Gönnersdorf material due to the presence of reindeer among the faunal remains, the presence of *baguette demi-rondes* made of ivory, and the presence of female figurines (Feustel 1979). Except for the *baguette demi-rondes*, these characteristics also applied to the Oelknitz material

(Feustel 1979; cf. Gaudzinski-Windheuser 2011). Thus, a differentiation of the Oelknitz and the Nebra variant remained vague.

Besides organic and/or lithic typology, Rudolf Feustel considered prey choice to distinguish sub-groups in the Late Magdalenian. However, the exploitation of horse (*Equus* sp.) in contrast to reindeer (*Rangifer tarandus*) was meanwhile shown to be partially underestimated on Late Magdalenian sites (Bridault/Bignon/Bemilli 2003; cf. Gaudzinski/Street 2003). Furthermore, the preference for one of these species was probably seasonally influenced (Bridault/Bignon/Bemilli 2003; Bignon 2006; Bodu et al. 2006b). In consequence, sub-groups based on the faunal assemblages could represent environmentally and/or seasonally distinct but possibly contemporaneous groups with partially similar archaeological material and behavioural patterns (Gaudzinski-Windheuser 2012).

In northern France, the fundamental publications of André Leroi-Gourhan (Leroi-Gourhan 1964; Leroi-Gourhan 1965) introduced the concept of the *chaîne opératoire* (Leroi-Gourhan 1943; Leroi-Gourhan 1945; Leroi-Gourhan 1964; Leroi-Gourhan 1965) to the analysis of archaeological assemblages. This concept was first applied in the study of Pincevent (Leroi-Gourhan/Brézillon 1966; Leroi-Gourhan/Brézillon 1972). The *chaîne opératoire* sets the retouched artefacts into a sequence of technical decisions beginning with the choice of material and ending at the discard of the artefacts. In particular, this concept supplemented the archaeological analysis with technological studies and archaeological assemblages were hence studied in their entirety. This more complete collection of data made possible the definition of taxonomic groups of artefact combinations and their formation. For the Late Magdalenian, these techno-typological studies revealed a complex technical system aimed to produce blades and bladelets (Bodu 1993). A standardised preparation process preceded the production of these final products. Various knapping instruments were used during this process but organic hammers were assumed to be used particularly in the main production of the final products (Pelegrin 2000). With the additional refitting of the studied materials and the spatial analysis of their distribution, the studies became agent-based and in some cases suggested the instruction of apprentices by skilled master flintknappers (Pigeot 1990; Audouze/Cattin 2011).

In addition, the techno-typological and spatial analyses were further supplemented by analyses of the natural environment and the topographic setting of the sites comparable to the early German tradition. In this combination of the environmental context and the setting of the archaeological evidence into a regional context, the taxonomic groups could be tested on their emergence due to chronological successions, various environmental adaptations, different functions, and/or ethnic interactions. Based on these combined information, settlement systems could be identified in the archaeological record (cf. Binford 1980). Furthermore, considerations about a Lateglacial palaeoethnography were formulated (Schmider 1982; Pigeot 1987; Valentin 2008a).

Accordingly, Gerd-Christian Weniger established two regional sub-groups within the Middle/Late Magdalenian of the German and Swiss upland areas: a south-western and a northern group (Weniger 1989; cf. Eriksen 1991). His sub-division was based on a multi-characteristic approach including subsistence strategies, mobile special goods, and settlement patterns. The sites of the south-western group were located in southern Germany and northern Switzerland. For instance, the Lateglacial hunter-gatherers in this sub-group seemed to aggregate in larger sites in the lowlands during the autumn-winter season to hunt reindeer. During the summer season, these groups dispersed to smaller sites in the uplands and hunted mainly horse and ibex. The northern group included the sites from the Thuringian Basin and the Central Rhineland and, thus, the attribution of assemblages to a common sub-group equated the assemblages of the Nebra variant. For these assemblages, the seasonal data were scarce but in the Central Rhineland a reversed situation to the south-western group seemed possible with large autumn-winter sites focused on horse and small

spring-summer sites focused on reindeer. However, in the Thuringian Basin no assemblages with significant proportions of reindeer were found.
Comparably, Terberger deduced from the presence of numerous evident structures on sites of the Nebra variant that the settlements should be interpreted as base camps (cf. Binford 1980). Based on this assumption, Terberger argued that the Nebra group was rather a chronological entity. Moreover, based on the raw material transports and ethnographic analogies, he considered an ethnic entity as possible in which Gönnersdorf and Andernach represented central places of local sub-groups which were presumably provided from camps such as Kanne or Orp located at the limits to the North European Plain. Together these sites formed part of an extended Nebra group (Floss/Terberger 2002, 138). Terberger further pointed out similarities with camp sites in the Paris Basin and set this extended Nebra group in the context of the Lateglacial expansion.
Furthermore, with the introduction of independent age measurements such as $^{14}$C dating, the taxonomic groups could be tested for their chronological relevance (Ducasse/Langlais 2007; Langlais 2007; Langlais et al. 2012). Micro-wear analyses helped in addition to produce precise interpretations on the use of artefacts (Plisson 1985; Moss 1986; Rots 2005; Pétillon et al. 2011; Sano 2012b). These studies made testing of the typologies possible for differences in the functions of the assemblages.
In general, the distinction between an Early Magdalenian and a Late Magdalenian (*sensu lato*) remained. However, the Early Magdalenian developed in south-western France from the Badegoulian after or at the end of the LGM (Ducasse/Langlais 2007; Ducasse 2012). The adaptive flexibility of the Early Magdalenian is replaced by the increasing technical rigidity of the Middle Magdalenian during the Heinrich 1 event (Langlais 2007; Langlais 2011). In the sub-division based primarily on excavated sites in the Thuringian Basin, this Middle Magdalenian would equate to Rudolf Feustel's Kniegrotte variant (Feustel 1979; cf. Höck 2000) of his Oelknitz group (Feustel 1956, 25). Middle Magdalenian assemblages with narrow triangles disappeared presumably between approximately 13,200 and 13,100 years $^{14}$C-BP (Thévenin 2000; Höck 2000; Ginter et al. 2005; Langlais et al. 2012). This period was paralleled by the end of the Heinrich 1 event and in this period the need to react on short-term needs was answered by some simplifications (Langlais 2008; Langlais et al. 2012). These changes resulted in highly standardised technical processes (Bodu 1993; Audouze/Cattin 2011) during the Late Magdalenian (*sensu stricto*) reflecting presumably a social system of strict conformism. This Late Magdalenian (*sensu stricto*) correlated to the other variants of Feustel's Oelknitz group (Feustel 1956; Feustel 1979). Moreover, the technology of this Late Magdalenian (*sensu stricto*), in particular, the lithic assemblage, »was greatly inspired by the Middle Magdalenian« (Langlais 2008, 231; cf. Langlais et al. 2012) which reflect the observation of Denis Peyrony that the Late Magdalenian (*sensu lato*) lithic assemblages are very similar (Capitan/Peyrony 1928). In Northern Europe, the independent character of the Final Magdalenian inventories was subsequently emphasised in terms such as Creswello-Hamburgian or shouldered point technocomplexes (e.g. Burdukiewicz 1981; Desbrosse/Kozłowski 1989). Furthermore, based on a correspondence analysis of retouched artefacts from various Lateglacial inventories, Bruno Bosselin and François Dijndijan clearly distinguish the Hamburgian and Creswellian from the Magdalenian by the absence of backed bladelets in the inventory (Bosselin/Djindjian 1988). Considering the reoccupation of Northern Europe as a social process sustained by comparative technological studies led to a reuse of the term Final Magdalenian for these northern inventories (Barton et al. 2003; Pettitt/Rockman/Chenery 2012; Weber 2012). Furthermore, comparable inventories were meanwhile found in the Paris Basin and attributed to a special variety of a Late or Final Magdalenian (*sensu lato*) named »*faciès Cepoy-Marsangy*« (Schmider 1982; Valentin 2008a). These similar developments in Northern Europe and northern France suggested some kind of connection between these regions and a related development (cf. Valentin 2008a; Weber 2012). Moreover, the presence of this sub-group in the Paris Basin makes a clear differentiation of the Final Magdalenian assemblages from the Late Magdalenian assemblages such as those from the unit IV

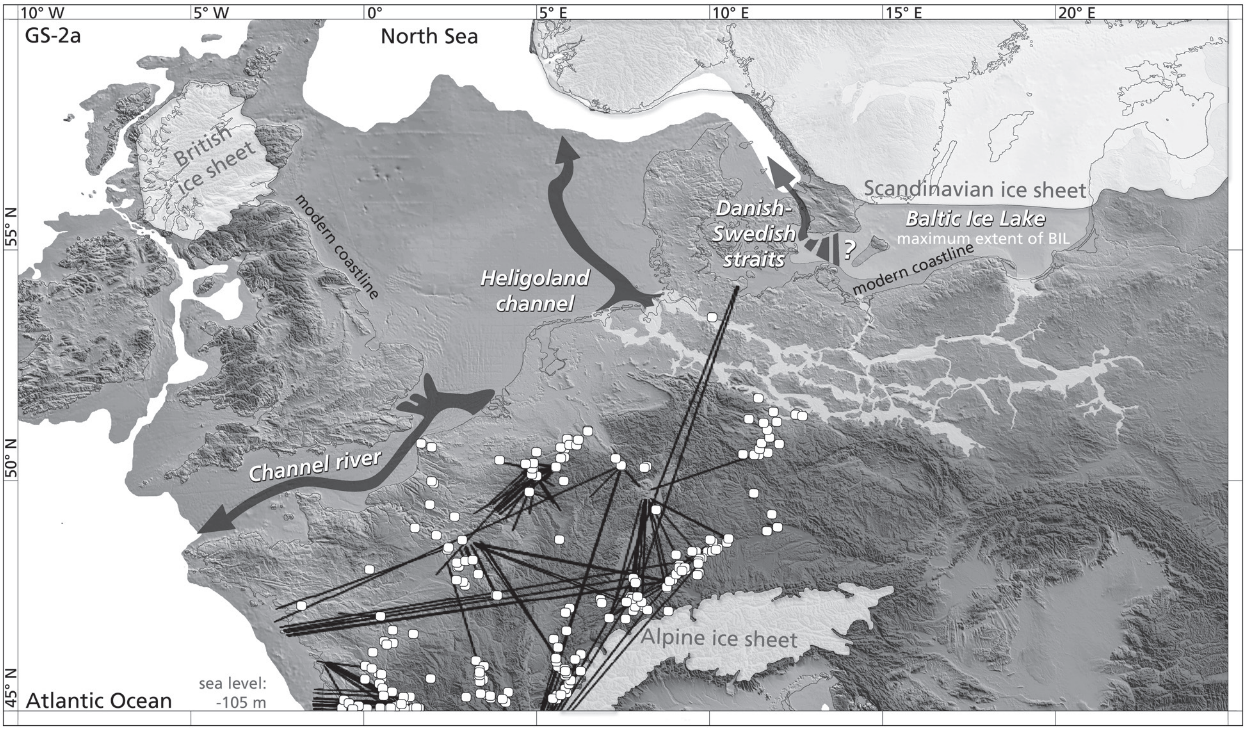



**Fig. 24** Connections between Late Magdalenian (*sensu lato*) sites and source areas of raw material for personal ornamentation according to Schwendler 2012, 340 fig. 6 (cf. Weniger 1989, 361 fig. 8; Połtowicz 2007, 24 fig. 2; Widlok et al. 2012, fig. 8).

in Pincevent or several units in Étiolles possible (Pigeot 1987;Bodu 1993; Valentin 1995; Valentin/Pigeot 2000). However, the Northern European inventories were clearly dated to the transition period analysed in the present study (Barton et al. 2003; Grimm/Weber 2008) with some possible dates as early as 12,700 years $^{14}$C-BP (Jacobi/Higham 2009). Consequently, the comparable inventories from northern France are incorporated in the present study (see p. 189-196, p. 204-210, and p. 220-226) and the Final Magdalenian is considered one of the earliest stages of the Azilianisation in the present study.

Thus, the Late Magdalenian as understood in the present study, is a Late Magdalenian *sensu stricto*. Sites of this Late Magdalenian are common in north-western Europe south of the English Channel and of the North European Plain suggesting this phase as a first phase of a permanent expansion into northern territories (cf. Housley et al. 1997; Gamble et al. 2005; Miller 2012). The connections of some raw materials discarded at these sites to the original source areas suggested that this large scale expansion process maintained a large network across north-western Europe (**fig. 24**; cf. Schwendler 2012). Independent of the interpretation of these materials as direct import or as trade goods, these long distance connections displayed information routes. In combination with the similarity of the archaeological material and behavioural patterns reflected by the settlement systems, these information routes indicated a shared social superstructure. Sites of this social network were found concentrated on the upland zones of north-western Europe and larger clusters of sites occurred particularly in relation to large river systems such as the Seine, the Meuse, the Rhine, the Rhône, the Danube, the Saale-Elbe, and the Vistula. However, watersheds (see **fig. 19**) were crossed to expand across the wide geographic distances from the Atlantic to eastern Poland (Połtowicz-Bobak 2009; Schwendler 2012). This Late Magdalenian occurred in a period of approximately 13,200 to 12,700 years $^{14}$C-BP (cf. Street/Jöris/Turner 2012). These assemblages were related to the Late Pleniglacial cold and dry grass steppe. Late Magdalenian sites from the Paris Basin and Poland occurred clearly in the same type of

environment but the sampled material produced several younger $^{14}C$ dates (Débout et al. 2012; Połtowicz-Bobak 2012).
Some young dates from the Paris Basin (and Poland?) indicate perhaps that the dated material should be reviewed concerning its attribution to a Late Magdalenian *sensu stricto* or a later development. However, many of the young dates were probably unreliable due to various technical and contextual reasons. For instance, contaminations due to technical causes during the AMS dating procedure (e.g. Wohlfarth et al. 1998; Higham/Jacobi/Bronk Ramsey 2006) or due to contextual admixture such as bulked samples are common reasons for unreliable dates. A rigid evaluation of the existing databases is necessary to clear the record from these unreliable results (cf. Street/Terberger 2004; Grimm/Weber 2008; Jacobi/Higham/Lord 2009). Reviewed databases yielded increasingly precise and, hence, solid patterns of past developments (e.g. Charles 1996; Housley et al. 1997; Barton et al. 2003; Verpoorte 2004; Gamble et al. 2005; Grimm/Weber 2008; Jacobi/Higham 2009; Verpoorte/Šída 2009; Jacobi/Higham 2010).
Among the archaeological material, lithic inventories were the most commonly preserved pieces of evidence. Likewise the observations in south-western Europe, the assemblages attributed to the Late Magdalenian (*sensu stricto*) in north-western Europe were comparable concerning their inventories and their technical systems. In general, the lithic inventories were based on blades and bladelets as blanks. Technological analyses of Late Magdalenian sites in the Paris Basin demonstrated that a careful preparation procedure was an essential part of the blank production (Bodu 1993). This process was very standardised (Pigeot 1990; Audouze/Cattin 2011). Even though these standards were adapted to the material present in areas with fewer raw materials and/or material of poorer quality, the normative process was still detectable (Floss/Terberger 2002; Audouze/Cattin 2011).
As observed already by Denis Peyrony (Capitan/Peyrony 1928), Late Magdalenian inventories comprised various types of standardised tool types such as dihedral burins, burins on truncation, backed bladelets, end-scrapers on blades, borers, and composite tools. In general, the LMP class dominated among the retouched artefacts corresponding to the observation of Rudolf Feustel concerning the Oelknitz group (Feustel 1956; Feustel 1979). Some special sub-types such as *Lacan* type burins or elongated borers could indicate further possible sub-groups (or variants as Feustel termed them), perhaps, with some chronological relevance (cf. Street/Jöris/Turner 2012).
In general, the backed bladelets as well as the various organic points (bevelled points, barbed points) were assumed to represent projectile implements, even though no direct evidence for the use of projectiles in the Late Magdalenian was found. However, finds from the Late Magdalenian site Pincevent indicated a composite use of these implements (Leroi-Gourhan 1983). These composite projectiles were considered too heavy for the use as arrow heads (Pétillon et al. 2011). In addition, the use of spears and spear-throwers (atlatl) was also assumed for the Late Magdalenian due to comparable finds of organic and lithic projectile implements in Lower Magdalenian assemblages which also contained spear-throwers (Pétillon et al. 2011). Moreover, a spear-thrower from the south-western French site Isturitz was dated to the early Lateglacial Interstadial (Szmidt et al. 2009) suggesting at least the further occurrence of this technology in this area. Furthermore, no unambiguous evidence for bow-and-arrow technology has been found thus far dating to the time before the end of the Lateglacial Stadial. A pine fragment from Mannheim-Vogelstang was discussed as a fragment of a children's bow and dated to approximately the Middle Magdalenian/early Late Magdalenian (GrA-precise lab. no. not given: 14,680 ± 70 years $^{14}C$-BP; Rosendahl et al. 2006). However, the classification as bow as well as the dating (stratigraphy; preservatives) are questionable and the use of old wood in later periods such as indicated by a pine shaft in Grieben (cf. Grünberg 2006) cannot be excluded. Nevertheless, the appearance of shaft smoothers was also considered as indirect evidence for the presence of arrows (Farmer 1994). These pieces were assumed to be used for straightening and smoothing wooden

shafts of projectiles (Rozoy 1978; Riede/Kristensen 2010) mainly based on ethnographic observations (Flenniken/Ozbun 1988). Even though the regular occurrence of these tools was noticed on sites in north-western Europe from the early Lateglacial Interstadial onwards (e.g. Luttenberg, Stapert 2005; Niederbieber, Loftus 1982; Le Closeau, *locus* R, Bodu 1998), first specimens were associated with early assemblages of the Late Magdalenian such as a fragment from the Polish site Dzierżysław 35 (Ginter/Połtowicz 2007). Moreover, this site was typologically attributed to the earlier phase of the Late Magdalenian or a Middle Magdalenian due to small triangles comparable to the pieces from the Kniegrotte. This typological attribution was further sustained chronologically by some radiocarbon results (Ginter et al. 2005; Wojtal 2007). In regard to the previous considerations, these microlithic triangles were possibly used as arrowheads. Perhaps, these rare evidences indicated that the knowledge about bow-and-arrow technology was present along with the concept of atlatl technology during the Late Magdalenian expansion.

On sites with a good preservation, organic tools or remains of their production were frequently found in Magdalenian assemblages. Therefore, these organic implements were also chosen as one of the first distinctive elements of Late Magdalenian assemblages. Commonly, organic remains in Late Magdalenian contexts comprised various types of hunting equipment such as barbed points, bevelled rods/points, baguettes demi-ronds as well as working tools such as awls, needles, or bâtons (Tinnes 1994; Lompré 2003; Pétillon 2006).

Major game species recovered at Late Magdalenian sites were horse (*Equus* sp.) and reindeer (*Rangifer tarandus*), often in large quantities on residential sites (Bridault/Bignon/Bemilli 2003; Bignon 2006; Street et al. 2006; Street/Turner 2013). These clearly dominant prey species were supplemented occasionally by bovids, mainly *Bison priscus*, and rarely saiga antelopes (*Saïga tatarica*) as well as mountainous species such as *Capra ibex* or *Marmota marmota* and, in addition, red deer (*Cervus elaphus*) in the southern regions. In northern regions red deer was usually only identified by teeth which probably reached the sites as ornamental items. Equally, mammoth (*Mammuthus primigenius*) and woolly rhinoceros (*Coelodonta antiquitatis*) remains often seemed to be collected and/or exchanged fossil items, but rarely could they also be attested as alimentary resource such as on the Polish site Wilczyze (Bratlund 2002). Additionally, the game frequently also included arctic hare (*Lepus timidus*), various fish species such as grayling (*Thymallus thymallus*), burbot (*Lota lota*), or salmon (*Salmo trutta/Salmo salar*), and birds, in particular, from the genera *Lagopus*, *Cygnus*, and *Anser*. Furthermore, carnivores were commonly identified in the Late Magdalenian assemblages, dominant among them is arctic fox (*Alopex lagopus*) but also canides (*Canis lupus* and/or *Canis familiaris*), bears (*Ursus spelaeus* and/or *Ursus arctos*) and sometimes hyena (*Crocuta* sp.).

Thus, a clear preference of prey and orientation on animals which occur in large herds in open landscapes such as horse and reindeer were observable. However, numerous supplemental fauna species revealed that the Late Magdalenian economy did not represent a specialised hunting community but in contrast showed generalised and flexible subsistence patterns (cf. Gaudzinski/Street 2003). Furthermore, some species were probably trapped specifically for further resources such as fur or jewellery (Álvarez Fernández 1999; Street/Turner 2013).

These flexible subsistence patterns and the considerations of Thomas Terberger about the sites of the extended Nebra group (Floss/Terberger 2002, 138) suggested that a single specific type of site alone cannot be attributed to the Late Magdalenian. Instead, various types of sites maintained a subsistence and settlement system. Moreover, the different functions of the single sites resulted in the absence of some settlement patterns such as pavements on various sites as well as to the absence of some categories of material such as art. For instance, portable art was lacking almost completely on the large French open air sites. At Étiolles, an engraved limestone was recovered as part of a stone ring around a hearth and represented rare evidence of Late Magdalenian art on open air sites of the Paris Basin. Other figuratively engraved stones such as the pieces from Pincevent or Cepoy (see p. 221 and p. 235) were clearly attributed to the Lateglacial Interstadial and archaeological assemblages which were distinct from the typical Late Magdalenian. By contrast, in the Central Rhineland, figurines and rich figurative art on schist plates were found on the Late Magdalenian sites (see p. 89 and p. 110f.). However, as mentioned, these sites were considered as base camps, whereas in the Paris Basin this simple model of base and special task camp was questioned (Bodu et al. 2011; Fougère 2011). Nevertheless, the large camp sites such as Pincevent or Étiolles were assumed to be regularly visited camps which were used flexibly for hunting as well as living (Julien/Karlin/Bodu 1987; Olive 2004; Bodu et al. 2009a; Fougère 2011). Based on Swiss Late Magdalenian sites, comparable suggestions were made that residential camps were moved to places of successful hunting episodes (Müller et al. 2006). However, the time spent at these sites appeared shorter than at the typical base camps. Nevertheless, combined techno-spatial analyses demonstrated the presence of skilled and unskilled, probably apprentice flintknappers on sites in the Paris Basin (Pigeot 1987; Bodu 1993; Valentin/Pigeot 2000) and suggested the accomplishment of further tasks such as transmitting flintknapping skills besides the hunting episode. Furthermore, pieces interpreted as jewellery were also found on these sites and indicated, as with the typical base camp sites, the particular long distance relations such as molluscs from the Atlantic in the Paris Basin (Alvarez Fernández 2001; Bodu et al. 2006b, 36), fossil molluscs from the Paris Basin in the Belgian Late Magdalenian sites (Dewez 1987; Álvarez Fernández 2009), Mediterranean molluscs in the Central Rhineland (Álvarez Fernández 2009), or Baltic amber pieces in Swiss assemblages (Schwab 1985; Leesch 1997; cf. Eriksen 2002). However, personal ornaments such as perforated animal teeth or molluscs and colourants are frequently present in considerable quantities, often of good quality, and also in large variety at Late Magdalenian sites (Álvarez Fernández 2009).

In conclusion, the Late Magdalenian (*sensu stricto*) can be distinguished by its comparable lithic inventory based on blade blanks and comprising various types of standardised tool types. Furthermore, organic material was used for various artefacts which again were formed in specific types such as bâtons, needles, or points. These generally very strictly defined types seem to reflect a very conformist behaviour. The procurement distances of raw materials as well as the varied degree of evident structures on sites suggested a complex settlement system. The origin of the various raw materials mark the Late Magdalenian as having a well connected social system.

### The *Federmesser-Gruppen*

In the Central Rhineland, the material from the upper or younger horizon found directly underneath the LST was classified as *Federmesser-Gruppen* (FMG). At present the term FMG is often used to describe an agglomeration of archaeological groups in the European Final or Late Palaeolithic.

Originally, the FMG were defined by Hermann Schwabedissen based particularly on the material from several concentrations around Rissen near Hamburg (Schwabedissen 1939, 143) and Prandinge in the Dutch province of Friesland (Schwabedissen 1944b). Successively, he added some 40 lithic assemblages, mainly from the western part of the North European Plain, to the FMG (Schwabedissen 1944a) and published this group in a monographic volume (Schwabedissen 1954). According to him, these inventories were characterised by (Micro-) Gravette points and/or *Federmesser* (Schwabedissen 1944a, 116-119), burins of diverse but often crude types (Schwabedissen 1954, 61), and numerous end-scrapers that usually occurred as varied types and regularly as double end-scrapers (Schwabedissen 1944b, 51). Even though Hermann Schwabedissen thought the FMG were a regional sub-group of the Final Magdalenian and connected with the Magdalenian expansion into Central and Northern Europe (Schwabedissen 1944b), organic implements such as

| name of archaeological group | eponymous/defining site | main reference(s) | defining elements |
|---|---|---|---|
| Azilian | Mas d'Azil (Ariège); Abri Villepin (Dordogne) | Piette 1889; Piette 1895; Peyrony 1936 | lithic industry of Magdalenian habit but different tool composition: Azilian points, short & round end-scrapers and few burins; organic tools made of red deer antler, in particular, flat & perforated harpoons (i. e. points with two rows of barbs); painted or engraved gravels with geometric signs |
| Tjonger Group (previously: Kuinder culture) | sites alongside the Tjonger (Friesland) such as Prandinge, Donkerbroek, and Makkinga | Popping/Beijerinck 1933; Bohmers 1947; Bohmers 1961 | various types of backed pieces with different dimensions; numerous end-scrapers, particularly short ones; various types of burins, often on truncation; flakes were the commonly used blank type |
| *Federmesser-Gruppen* | Rissen (Hamburg); Prandinge (Friesland); Wehlen (Niedersachsen) | Schwabedissen 1939; Schwabedissen 1944b; Schwabedissen 1954 | Magdalenian-like lithic industry; numerous Gravette points, *Federmesser*, and backed blades; numerous end-scrapers on blades, often double end-scrapers but also short end-scrapers; many various types of burins |
| Tarnowian (including the Ostroměř group) | Tarnowa (Województwo wielkopolskie); Ostroměř (Hradec Králové) | Krukowski 1939; Vencl 1970a; Kozłowski/Kozłowski 1996, 83 f. | Magdalenian tradition; rare backed pieces of various types; numerous small end-scrapers; rare burins of small dimension & various types made on thick blanks; blades and elongated flakes were preferred blanks |
| Witowian | Witów (Województwo łódzkie) | Chmielewska/Chmielewski 1960; Chmielewska 1961; Chmielewski 1961; Kozłowski/Kozłowski 1996, 81-83 | Epigravettian-like lithic industry; very small and variable backed pieces incl. bipointes in particular of a compact shape (Taucha type); small end-scrapers predominate; burins of various types usually made on thick blanks; flakes were the commonly used blanks |
| Penknife point phase | Mother Grundy's Parlour (Derbyshire); Robin Hood's Cave (Derbyshire) | Campbell 1977; Jacobi 1988; Barton/Roberts 1997; Barton/Dumont 2000 | Creswellian tradition; more numerous but smaller assemblages than Creswellian; great variability of backed pieces but penknife points are characteristic; short end-scrapers, some round thumb-nail end-scrapers; burins on truncation; preferred blanks were small blades; soft hammerstone mode of percussion; varying overall standards and quality of lithic raw materials |
| Hengistbury Head type industries | Hengistbury Head (Dorset) | Barton 1992; Conneller/Ellis 2007; Barton et al. 2009; Pettitt/White 2012 | straight-backed blades & bladelets; angle-backed points, shouldered points, and large tanged points; numerous end-scrapers which were often short; burins on truncations made on thick blanks; blades are preferred blanks; use of varied percussion instruments but dominantly soft hammerstone |

**Tab. 9** Characterisation for some selected FMG sub-groups.

bone or antler tools which were characteristic for the Magdalenian (Breuil 1913) were not considered in his definition due to the scarce preservation of such items in northern Germany, the Netherlands, and northern Belgium. However, several decades before Schwabedissen's publication, other groups of archaeological material which post-dated the Late Magdalenian were published. For instance, the Azilian was already defined in the late 19th century based on south-western French material (Piette 1889; Piette 1895; Peyrony 1936). The Azilian was regarded by Schwabedissen as another regional sub-group of the Final Magdalenian. According to Schwabedissen, the Azilian was distinct from the FMG by the presence of flat and perforated organic harpoons (i. e. biserially barbed points) and painted gravels (Schwabedissen 1954, 79).
The painted gravels are still unknown from unambiguous FMG contexts in north-western Europe. However, some painted stones and stone fragments were found in relation with Magdalenian horizons in southern Germany but several of these pieces represent presumable frost fragments of parietal art (Conard/Floss 1999; Conard/Malina 2011). In addition, although some single organic finds from the North European Plain and the adjacent uplands were meanwhile attributed chronostratigraphically to the FMG period (Veil et al. 1991; Terberger 1996; Clausen 2004; Grünberg 2006; Cziesla/Masojć 2007), organic artefacts are

thus far generally lacking from unambiguous FMG assemblages in Northern Europe. Only the sites in the Central Rhineland yielded organic artefacts which were clearly associated with FMG lithic assemblages. The organic items found in Northern Europe as well as in the Central Rhineland were very diverse but, in general, barbed points were found more frequently than other types. In contrast to the south-western French Azilian harpoons, the barbed points from north-western Europe were usually not perforated and of a greater variety. This variety referred to the general shape with uni- and biserially barbed points as well as to the morphology with denticulated barbs and finely carved barbs (cf. Baales 2002, 274-281; Tinnes in Baales 2002, 271-273; Cziesla/Pettitt 2003; Cziesla 2007b). Nevertheless, since barbed points were also a defining element for the Azilian, these implements can be regarded as one type of organic tool which was used across north-western Europe in the Lateglacial Interstadial and, thus, as one of the commonalities of these hunter-gatherer groups.

However, in contrast to the Late Magdalenian, the FMG material displayed a greater individuality and less standardisation in the shaping of these tools. This weakened conformism applied also to the lithic material, in particular, to the backed points. Perhaps, this decreased conformism after the highly standardised behaviour of the Late Magdalenian explains why the classification of the FMG/Azilian is still a matter of debate (Bodu/Valentin 1997; Baales 2002, 56-58; Heinen 2005, 102-109; Kegler 2007, 297-299).

Moreover, the observation of a decreased conformism among the FMG could also explain why so many regional and/or chronological sub-groups were defined, even though the general pattern of the archaeological material was similar (**tab. 9**). These various groups of Lateglacial assemblages were mainly defined during the late 19$^{th}$ and early 20$^{th}$ century when the influence of European nationalisms was high. In contrast, during the last decades of a unified Europe, the uniting aspects were more emphasised, also in archaeology, resulting in most of the assemblages from France to Poland and Bohemia (Vencl 1970b; Barton/Roberts 1996; Bodu/Valentin 1997; Kabaciński/Sobkowiak-Tabaka 2010; Riede/Laursen/Hertz 2011) and occasionally even to western Russia (Zhilin 1996) being attributed to the FMG as a common meta-group. Thus, the refusal or adoption of the term FMG across a wide geographical range was probably further influenced by tendencies of contemporary scientific policies to weight separating or uniting attributes in the various taxonomical classifications. The continuation of modern traditional preferences in the scientific community still finds its expression in the choice of using further names for the meta-group such as Azilian (Piette 1889; Piette 1895; Peyrony 1936; Kegler 2007; Valentin 2008a), Rückenspitzen-Kreis (Ikinger 1998), Arch-backed point technocomplex[10] (Schild 1984; Schild 1996), or Curve-Backed Point (CBP) groups (Kozłowski 1987).

Certainly, this wide adoption of a common term signalised an advanced expansion into Northern Europe in contrast to the Late Magdalenian. In addition to the areas occupied by the Late Magdalenian, territories settled by the meta-group in the Lateglacial Interstadial encompassed also central and southern Britain as well as the North European Plain. In general, these human groups were assumed to descend from a Magdalenian tradition which adapted to various landscapes during the Lateglacial expansion into north-western Europe and/or to a changing environment during the Lateglacial amelioration (cf. Schwabedissen 1954; Bodu/Valentin 1997; Coudret/Fagnart 1997; Baales 2002). In most of these groups an increasing importance of end-scrapers and the use of flexible knapping techniques on local materials were observed accompanied by a decreasing importance of burins and an elaborated blank production process. However, the definitions of the sub-groups greatly varied concerning the details used to define the group due to the material avail-

10 Arch-Backed Point Technocomplex were abbreviated as ABP (Schild 1984). This abbreviation could be easily confused with the term angle-backed points which refers to the Creswell and Cheddar type backed points. These angle-backed points were usually attributed to an older context (Creswellian, Barton et al. 2003; Jacobi 2004) and set in relation to the classic phase of the Hamburgian (shouldered point complex, Burdukiewicz 1986).

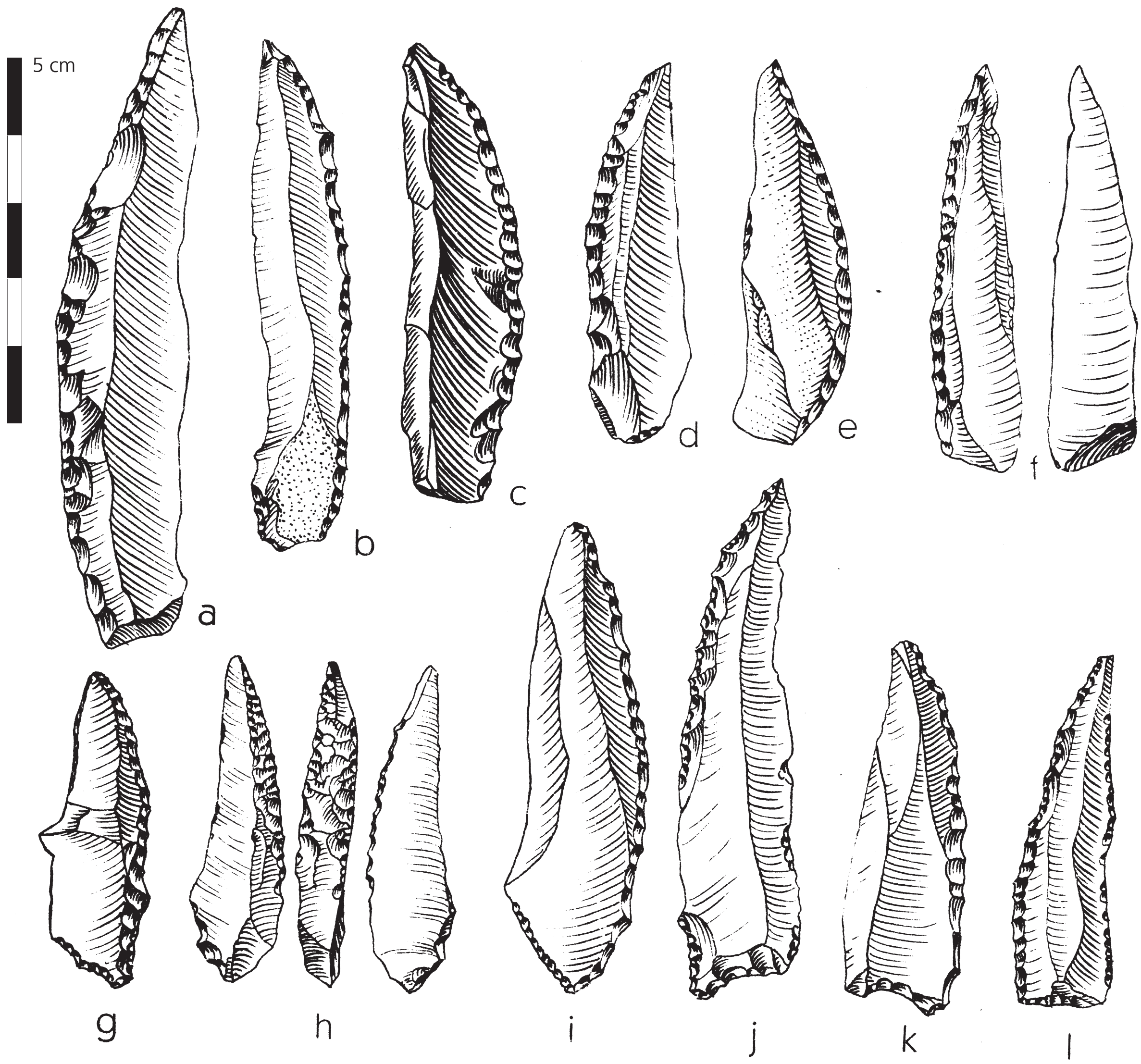



**Fig. 25** *Federmesser* according to Hermann Schwabedissen (Schwabedissen 1954, 23 Abb. 11). **a** large backed blade (*couteau à dos*); **b**, **d**, **g-j** penknife point (*pointe à base rétrécie*); **c**, **f** *Federmesser* (*pointe à dos courbe et sans aménagement de la base*); **k-l** Malaurie point (*pointe à base tronquée*). – Point e displays a basal impact fracture and is therefore not classified. Perhaps, the same problem affects the points a-d and, thus, the classification of the pieces b-d remains provisional. However, the specimen a is clearly larger than usual and the attribution as a *couteau à dos* is clear. The point j falls in the transition from penknife point to Malaurie point.

able for classification and the focuses of research during the time when the definitions were formulated. In general, the distinction was based on the projectile implements assuming that these objects were subject to quicker changes due to fashionable reasons and the dependence on the changing Lateglacial environment. These assumed quicker changes would make a finer chronological and/or environmental distinction possible. Thus, precise and applicable definitions of sub-groups should be based on chronostratigraphically reliable material from a known environmental range.

The majority of the lithic assemblages used by Schwabedissen were surface collections which he regarded as reliable due to his expertise in lithic artefacts (cf. Schwabedissen 1955). However, these sites provided little or no environmental or chronostratigraphic information. In addition, the few excavated assemblages (n = 14) in his monograph were documented according to the standards of the time that, at least in the case of Andernach-Martinsberg, were proven to be insufficient by later works (Bosinski/Hahn 1972; Veil 1982). Particularly, these insufficient documentations usually prohibited a spatial analysis of the sites, including the testing of palimpsest situations. However, this testing would be necessary, in particular, for the many sites which were found in sands because modern studies of analogous sites often showed the admixtures of various natural and anthropogenic events (cf. De Bie/Van Gils 2006). Thus, by modern standards the material from the standard volume about the FMG has to be rejected completely as a source of reliable comparisons. To define the FMG, other assemblages such as those sites from the Central Rhineland are required.

Furthermore, Hermann Schwabedissen yielded only a meagre catalogue of attributes to identify the FMG among which the *Federmesser* was the most distinctive one. However, his definition of the term *Federmesser* referred to any curve-backed monopoint (**fig. 25**; Schwabedissen 1954, 8. 23 Abb. 11; cf. Schwabedissen 1944a, 118f.). Schwabedissen adopted the term from Robert Rudolf Schmidt who had introduced the term *Federmesser* as a piece with one steeply retouched, arched formed edge (Schmidt 1912, 114) which is comparable to Gravette points but smaller than these mid-Upper Palaeolithic implements (Schmidt 1912, 136). However, Schwabedissen emphasised that the tip of the *Federmesser* in difference to a Gravette point was rather aligned with the (unretouched) lateral edge (Schwabedissen 1954, 8). Furthermore, the retouched edge should not contain an angle or a shoulder. Generally, these bladelets with curved lateral retouch had no basal modification even though various types of basal retouch even to the form of pointed tangs were acceptable for Schwabedissen (Schwabedissen 1954, 8).

Thus, many point types such as small Châtelperron or Micro-Gravette points (cf. Bohmers 1961, 23), Malaurie points, penknife points (cf. Fischer 1991, 102), as well as some special pieces of shouldered points (»tapered points«; Johansen/Stapert 2004, 35) were subsumable in the category *Federmesser sensu* Schwabedissen. He only differentiated the »*Halbmondmesser*« as a special type of *Federmesser*. These implements were equivalent to segments or bipoints.

Comparably, the Azilian point was previously very vaguely defined (Peyrony 1936; Bohmers 1956, 11; Sonneville-Bordes/Perrot 1956, 556) leading to the same uncertainty as the term *Federmesser.* Moreover, based on the finds from the rock shelter Villepin, bipoints were also included in the spectrum of the term Azilian point (Peyrony 1936). Therefore, the Azilian point also became widely synonymous with curve-backed point. Moreover, in south-western France a continuous development from the Magdalenian to the Mesolithic was assumed with the Azilian representing the Pleistocene part of this development (Breuil 1913). To distinguish the different stages of this development, various phases of the Azilian were described such as the *Azilien ancien*, *Azilien moyen*, *Azilien supérieur*, *Azilien récent*, *Azilien tardif, Azilien final*. However, mainly based on the stratigraphic results from eastern France (Girard/Bintz/Bocquet 1981; Pion 1990), a general bisection was suggested for the French Azilian with an older phase (*Azilien ancien*) dominated by bipoints and a younger phase dominated by monopoints (*Azilien récent*). In western Germany, Michael Baales comparably suggested to distinguish between the FMG and the Azilian by the definition of the two different types of points with the Azilian comprising the inventories with bipoints and the FMG the inventories with *Federmesser* (Baales 2002, 56-58). In contrast, Jan Kegler argued that in the eponymous inventory from Mas d'Azil no typical bipoints occurred (Kegler 2007, 298f.) and, consequently, the terms FMG and Azilian in a strict sense describe, in fact, the same type of inventories.

Furthermore, based on results from the Somme valley, Paule Coudret and Jean-Pierre Fagnart distinguished three phases within the FMG which they described as an initial phase with diverse armatures and two further phases with *Federmesser* dominant among the backed points (Coudret/Fagnart 1997). However, these *Federmesser* resembled again the definition of Schwabedissen containing also Malaurie points and *couteaux à dos*. Their intermediate phase was comparable to the former but the monopoints established as the more dominant LMP. Sites such as Saleux La vierge Catherine were attributed to the last phase of this FMG succession (Coudret/Fagnart 1997). In this phase assemblages yielded very comparable material to the FMG defined by Michael Baales based on the Central Rhineland sites (Baales 2002).

However, based on the stratigraphic sequence from the cave Bois Ragot at Gouex (Vienne) and the rock shelter Pont d'Ambon (Dordogne), a succession from the Late Magdalenian, the *Azilien ancien*, the *Azilien récent* to the Laborian characterised by Malaurie points was shown (Célérier/Chollet/Hantaï 1997). Moreover, in the sequence from Pont d'Ambon, the *Azilien récent* phases were characterised mainly by penknife points (*pointes à base rétrécie*; model 7) and the common Azilian point (model 1) which was described as »curve-backed without modification of the base«[11] (Célérier/Nisole/Beaune 1993, 89). Furthermore, the frequency distribution of points in Pont d'Ambon demonstrated the almost constant presence of this common Azilian point type or *Federmesser sensu stricto* from the Final Magdalenian to the Laborian (**fig. 26**; Célérier/Nisole/Beaune 1993).

This constant presence of *Federmesser s. s.* sustained on the one part the subsumption of the complete Lateglacial traditions with backed points as FMG[12]. However, on the other part this constant presence revealed that this type of implement was a poor choice as distinctive element in a chronological sequence. Moreover, as the wide geographical adoption of the term FMG had shown, this implement is also not well suited to identify geographic sub-groups (cf. Ikinger 1998, 45-54. 196-218).

The Pont d'Ambon sequence showed that for the classification of various backed points the number of pointed ends (mono- or bipoint) and the morphology of the basal part were particularly distinctive factors, besides the forming of the blunting lateral retouch (curve-, angle-, or straight-backed; see p. 275-282; cf. Brézillon 1968; Célérier/Nisole/Beaune 1993, 89-98; Ikinger 1998). In the context of projectile technology and hafting of projectile implements, these distinctions are of technical importance (Valentin 2008a, 144-160; cf. Grimm/Jensen/Weber 2012). Moreover, assuming that the breakage of the most valuable part was to be avoided, a validation of the various components of the projectile can be read from the various shapes of the lithic projectile implements and their potential predetermined breaking points.

However, the more precise distinction of curve-backed points (Célérier 1979; Célérier/Nisole/Beaune 1993, 89-92) and their stratigraphic significance (Célérier/Chollet/Hantaï 1997) could also explain the variously formulated impression that assemblages attributed to the FMG were relatively variable. In particular, the morphology of backed points, their frequency, and the proportion of backed bladelets were considered as variable factors (Taute 1963, 103-107; Barton et al. 2009). These factors were previously suggested to be functional, chronological, and/or traditional. For instance, Stefan Karol Kozłowski pointed out that smaller backed point types were more numerous in the mountain ranges of eastern Germany, the Czech Republic, and Poland, whereas larger specimens were predominant on the eastern German and Polish part of the North European Plain (Kozłowski 1987). Accordingly, the microlithic varieties of backed points on the distribution maps of Eva-Maria Ikinger were generally more frequent in the southern and mountainous areas than in the northern lowlands (cf. Ikinger 1998). Besides traditional preferences and/or environmental adaptations, the availability of high-quality lithic raw material and the applied blank production process could, in this case, have provoked the different proportions.

Thus, in addition to the composition of lithic tool inventories and particularly the LMP variety, the applied blank production process and the techniques used therein became a focus of studies examining the changes in the Lateglacial. For instance, characteristics found on cores and blanks were assumed to result from different knapping instruments and reflect various knapping concepts (cf. Bodu 1993, 43-49; Madsen 1996; Pelegrin 2000; Valentin 2000). In contrast to the shaping of projectile implements, these fundamental concepts

11 The original reads: »dos courbe sans aménagement de la base« and was translated by the present author.

12 Clearly, since the terms *Federmesser* and (common) Azilian point refer to the same implements, the same argumentation can be used to subsume the Lateglacial assemblages under the term Azilian.

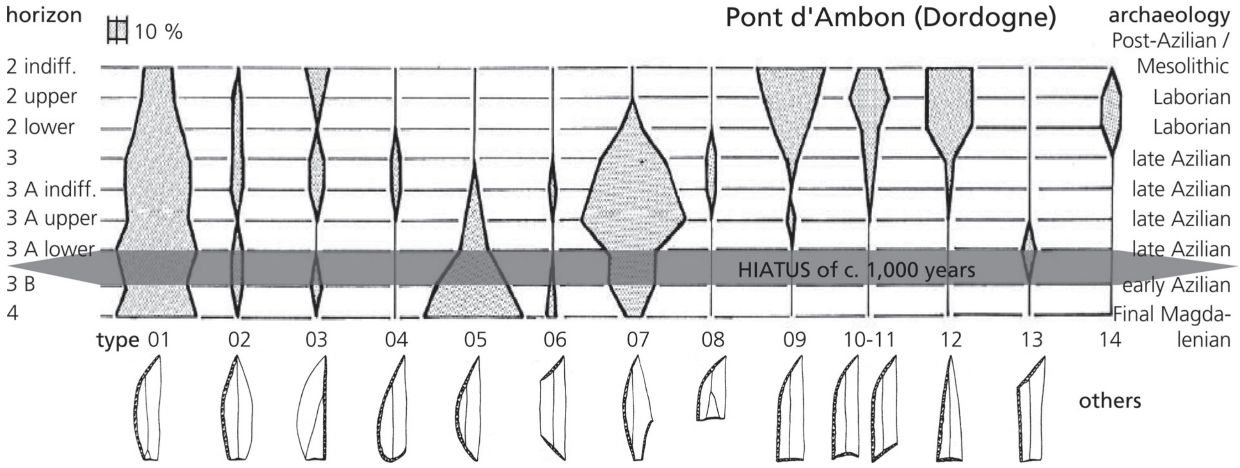



**Fig. 26** Frequency distribution of various point types at the rock shelter Pont d'Ambon (Dordogne; modified after Célérier/Nisole/Beaune 1993, 92 fig. 32 and Célérier 1979, 461 fig. 1). Point types (*modèles*) are: **1** common Azilian point which is curve-backed without modification of the base; **2** symmetric point which has a curve-backed retouch symmetrical to the opposite, unretouched edge; **3** bulbous point which is a straight-backed point with a convex, opposite edge; **4** point with rounded base is a curve-backed point with a retouch forming a rounded or ogival base; **5** segment or bipoint which is formed by a regularly curved retouch affecting tip and base; **6** double-truncated point with a usually unretouched edge between the two oblique truncations; **7** point with narrowed base which is a curve-backed point with an oblique retouch on the base causing an almost tang-like impression; **8** short point is the shortened variant of type 1 meaning the length-width proportions of the point are <2:1; **9** typical Malaurie point with an almost straight-backed curved retouch and straight basal retouch; **10** Malaurie point with concave basal retouch; **11** Malaurie point with oblique basal retouch; **12** straight-backed point with various basal modifications (comparable to a Gravette point); **13** angle-backed point; **14** others.

were assumed as a generally more stable part of the *chaîne opératoire*[13], within a single archaeological group (Valentin/Pigeot 2000, 132) as well as in a diachronic perspective (Karlin/Julien 1994; Valentin 1995, 19-47). For the Paris Basin, Boris Valentin demonstrated a change of knapping instruments in the phase of producing the preferred blanks from the Late Magdalenian towards the Late Azilian by the variation of characteristics (Valentin 2008a, 128). This development began with stigmatas on the blanks and cores suggesting the use of mainly organic hammers in the Late Magdalenian (Valentin 2008a, 48), followed by an increasing number of artefacts displaying characteristics of a soft hammerstone (Valentin 2008a, 123-130) such as flint nodules with a calcareous cortex or various types of argilites, and the almost exclusive occurrence of indications for the use of soft hammerstones during the *Azilien récent* (Valentin 2008a, 48-51). This change led to an increased flexibility in the blank production process that resulted in a lower productivity of standardised blanks which were commonly selected for the projectile implements, whereas for the other categories of retouched artefacts also unstandardised by-products of the blank production were used (Valentin/Julien/Bodu 2002).

The uniformity of the various FMG sub-groups and, thus, of the FMG meta-group becomes apparent on a more abstract comparison with the Late Magdalenian. The quality of the lithic raw materials were of minor importance and the frequency of locally available raw materials increased (Coudret/Fagnart 1997;

13 The *chaîne opèratoire* (Leroi-Gourhan 1943; Leroi-Gourhan 1945; Leroi-Gourhan 1964; Leroi-Gourhan 1965; Audouze/Leroi-Gourhan 1981; Pigeot 1987; Audouze 1999) was translated variously into English as »action sequences or ›chains‹« (Leroi-Gourhan 1993, 233), »operational process« (Leroi-Gourhan 1993, 233), »operational sequence« (Lemonnier 1986, 181; White 1993, xviii), or »chain of technical operations« (Dobres/Hoffman 1994, 237). However, since the French term was variously described and was widely applied, no translation is used in the present study. The *chaîne opératoire* referred to the complete process of the material exploitation by humans beginning at the procurement of the raw material and ending with the discard of the used artefact. Moreover, the single stages of this process and the techniques used therein reflected normative behavioural patterns (Pigeot 1987) which were adapted to a specific economy (Bodu 1993, 38) and thereby to a specific environment. In this sense, the *chaîne opératoire* reflected complex cognitive constructs which were supposedly transmitted as a recipe-like concept (Pelegrin 2009; cf. Mesoudi/O'Brien 2008b).

Floss 2002; Conneller 2007). In general, the dimensions of the lithic artefacts tend to decrease towards the younger period. Based on characteristics on cores and blanks (cf. Bodu 1993, 43-49; Madsen 1996; Pelegrin 2000), mineral materials such as stones seemed to be preferred as knapping instruments, in particular, soft hammerstones (Valentin 2008a, 48-51). However, seen in a more complex relation of raw material and applied knapping techniques, the difference between the Late Magdalenian and the FMG can be described as follows: The Late Magdalenians chose their raw materials according to their technological concept, whereas the FMG adopted the technological concept to the available raw materials. Thus, the conforming to standards of the *chaîne opératoire* appeared higher during the Late Magdalenian period and more flexible strategies were applied during the period of the FMG.

Moreover, the inventories of retouched lithic artefacts in the FMG were clearly dominated by end-scrapers, burins, and backed implements. Among the LMP point types prevailed and, in general, *Federmesser s. s.* or common Azilian points were frequent. The end-scrapers were generally more numerous than the burins and occasionally more numerous than the LMP. Small thumb-nail end-scrapers were common. Further retouched pieces such as truncations, borers, or composite tools occurred in these assemblages but were infrequent. The organic material was rarely preserved and though a general idea was recognised, the single implement followed no standardised shape. Assuming that the equipment of the Lateglacial hunter-gatherers developed as adaptation to various environments and the available resources, the larger variety of material in the FMG than in the Late Magdalenian could reflect the increasingly diverse landscapes of north-western Europe.

In the spatial organisation, little evidence for constructions was found on FMG sites. However, the few constructions were neither as massive nor as frequent as in the Late Magdalenian. Regularly, these structures were related to hearths. Some evident hearths were identified by the concentration of charcoal and / or the alteration of the sediment. Moreover, latent hearths were frequently indicated by accumulations of burnt materials such as stones but also burnt bones or lithic artefacts. In contrast to the Late Magdalenian assemblages, these burnt materials occurred regularly on FMG sites, perhaps due to an increased focus of activities around open fires. Furthermore, no spatial distinction of skilled and apprentice flintknappers was observed in relation to these hearths, in contrast to the Late Magdalenian evidence from the Paris Basin (Pigeot 1987; Valentin / Pigeot 2000).

In addition, the distinction of various functions of sites such as was possible for the Late Magdalenian (hunting camp, residential site, procurement place) became less clear for the FMG. In north-western Europe, assemblages of the FMG meta-group were usually found in open air sites and, rarely, in caves or in rock shelters. Generally, the concentrations contained the complete set of the lithic *chaîne opératoire* with cores, blanks, and retouched artefacts. Furthermore, the common retouched artefact classes were usually present at all sites. Moreover, at sites with sufficient preservation faunal material was normally found, often in the form of calcined bones. Thus, the lines of evidence for interpreting the function of the sites were generally similar on the FMG sites.

Most sites in Northern Europe attributed to the FMG, the sites attributed to the Azilian in Western Europe, and the sites attributed to the penknife point phase as well as, probably, the sites attributed to the Hengistbury Head type industries in Britain belong to the FMG meta-group. However, the distinction of some of these assemblages to the so-called Final Magdalenian such as the Creswellian, the classic Hamburgian, or the Magdalenian faciès Cepoy-Marsangy (MfCM) remained partially unclear. Thus, this meta-group enclosed assemblages which formed part of the transition studied in the present work. Therefore, the use of FMG as a term for the meta-group would lead to misunderstandings. To prevent these misunderstandings in the present study, the term FMG is not further used for the meta-group but according to the French terminology Azilian is chosen as the term for the meta-group (cf. Valentin 2008a, 47 f.). This meta-group also enclosed younger developments such as the so-called Laborian (Le Tensorer 1981) and was contrasted by the Magdalenian. Moreover, by the use of this terminology, Azilianisation becomes the appropriate term for the transition from the Late Magdalenian to the type of assemblages found immediately below the LST in the Central Rhineland. However, the process of changes did not stop with the eruption of the Laacher See volcano but continued into the Mesolithic.

Nevertheless, the term FMG is used furtheron for a sub-group comparable to the proposals of Michael Baales (Baales 2002), the final phase of FMG proposed for the Somme valley (Coudret/Fagnart 1997), and/or the *Azilien récent* in the Paris Basin (Valentin 2008a). This sub-group was related by a common set of behaviours.

In the lithic *chaîne opératoire* not much attention was paid to raw material procurement. The material was of varying quality. The blank production appeared very flexible and was adapted to the varying quality of the raw material as well as to the anticipated results. Few regular blanks were selected for the transformation to projectile implements, whereas for the other tool classes no apparent blank selection was detectable. Sometimes, even decortication or preparation flakes were chosen as blanks for end-scrapers or burins. Usually, the dominant classes of retouched artefacts were LMP and end-scrapers. Among the LMP, backed bladelets were rare or absent. The point types were clearly dominated by *Federmesser s. s.* or the common Azilian point, although straight-backed points without further modifications were also common. The end-scrapers were usually small and regularly of the thumb-nail shape. The burins were usually on truncations but, in general, no standardised types of burins were observable. Truncations and borers were also unstandardised and occurred irregularly. Composite tools were rare and if present usually a combination of burins and end-scrapers. The preserved faunal material was often calcined. Due to generally poor preservation, butchering marks were infrequently evidenced, but the often highly fragmented state in combination with the traces of heating suggested a boiling and burning of some of the bones. Moreover, the spatial distribution often indicated a relation of the lithic and the faunal material. However, the majority of the faunal material remained undetermined due to the state of preservation. Among the determinable remains red deer (*Cervus elaphus*) usually dominated. Furthermore, beaver (*Castor fiber*), large bovids, usually determined as aurochs (*Bos primigenius*), and single horses (*Equus* sp.) were common. These species were infrequently supplemented by elk (*Alces alces*), wild boar (*Sus scrofa*), roe deer (*Capreolus capreolus*), caprids such as ibex (*Capra ibex*) or chamois (*Rupicapra rupicapra*), badger (*Meles meles*), and fish, in particular, northern pike (*Esox lucius*). In total, the fauna represented the community of light forest with sufficient open waters and meadows. Organic tools were rarely preserved, and those which were preserved were often made of antler. Pieces of art or ornament were also rare. Nevertheless, abstract engravings on a slate plate in Niederbieber or on a shaft smoother from the same site emphasised that this lack of ornaments was not only due to a poor organic preservation. In general, haematite was also absent from these FMG sites. Furthermore, evident structures were scarce. Evident hearths were sometimes identified by the concentration of charcoal and/or the alteration of the sediment. Besides these evident structures, latent hearths were often identified by frequently occurring burnt materials such as calcined bones or heat-altered flints. Perhaps, a focus on the works performed arround the fire led to the increased burning of the archaeological material. In general, the hearths were surrounded by a dense cluster of mostly unburnt lithic artefacts. The analysis of the concentrations at Niederbieber showed that these concentration were generally structured in two opposing clusters of high artefact density (Gelhausen 2010; Gelhausen 2011a). However, these two clusters were not functionally distinct in general, for instance, between blank production and transformation into tools or between skilled and apprentice flintknappers (cf. Pigeot 1987). Furthermore, except for the clusters around a central hearth, hardly any other type of spatial organisation were found on FMG sites. Separated workshops for stone knapping or concentrations with special functions were rarely identified (De

Bie/Caspar 2000). Although some zones or clusters with blank production debris or specific tools were found, these accumulations only formed part of a larger concentration. Usually, the sites were formed by one or several of these typical concentrations focused on a central hearth and located on a small plateau. Furthermore, the sites with several concentrations could be formed by repetitive visits of a single small group as well as a single visit of several comparably behaving groups. Moreover, no assemblage attributed unambiguously to this sub-group was found in a rock shelter or a cave. In consequence, the distinction of various functions of sites became almost impossible for these FMG. According to Lewis R. Binford's classic differentiation of settlement behaviours among hunter-gatherer groups (Binford 1980), the differentiated sites of the Late Magdalenian seemed to represent the logistical system of collectors, whereas the evidence of these FMG sites appeared as a reflection of the general foraging system. Presumably, the Lateglacial reality was more complex than the model (cf. De Bie/Caspar 2000; Müller et al. 2006; Bodu 2010; Fougère 2011; Bodu et al. 2011; Gelhausen 2011b) but a change in the spatial organisations on the individual sites as well as in the variety of sites with different spatial organisations from the Late Magdalenian to the FMG is apparent. In the Central Rhineland, remains of this sub-group were recovered from the upper horizon of Andernach-Martinsberg, Urbar, Kettig, Niederbieber, Boppard, and Bad Breisig (see p. 93-101 and p. 143-168). The examples from the northern French sub-area were very similar and are therefore not further introduced in the present study. In the Somme Valley these sites include Saleux *La Vierge Catherine*, Saleux *Les Baquets* 234, the intermediate horizon at Conty, Hangest-sur-Somme I.3, the upper horizons of Hangest-sur-Somme III.1 as well as Belloy-sur-Somme (Coudret/Fagnart 1997; Fagnart 1997; Coudret/Fagnart 2006). In the Paris Basin the upper horizons of Le Closeau were attributed to this sub-group (Bodu 1998). Furthermore, the *locus* 33 at Le Cornet and in the Pays de la Loire some *loci* at Chaloignes represented this behavioural sub-group in the Haute-Normandie (Valentin/Fosse/Billard 2004; Marchand et al. 2008). In the western upland zone, no modern excavated site was unambiguously attributable to this sub-group. However, in the adjacent western part of the North European Plain several sites of this sub-group were recorded such as Meer (De Bie/Van Gils 2006), Rekem (De Bie/Caspar 2000), or Lommel (De Bie/Van Gils/Deforce 2009). Perhaps, comparable to the Paris Basin, the ephemeral character of the concentrations prevented a recognition of further *in situ* sites. Another reason for the lack of sites could be the choice of topographic settings that perhaps, resulted in a more severe destruction by down-slope erosion or wash outs. Nevertheless, this set of behaviours leading to the specific concentrations and assemblages described above as FMG was found on further sites on the western North European Plain such as Doetinchem (Niekus/Stapert/Johansen 1998; Johansen et al. 2000) and, perhaps, Horn-Haelen (Rensink 2002). Many other sites in this area such as the sites around Wierden (Deeben et al. 2006), Milheeze (Arts 2012), or Geldrop (Deeben 1988) as well as the classic site Usselo (Stapert/Veenstra 1988) clearly belonged to the Azilian tradition as well but their precise position in the Azilianisation process remains to be ascertained. Farther to the east, single concentrations such as Alt Duvenstedt 120a (Clausen 1999) and, possibly, Großlieskow and Kleinlieskow 120 (Pasda 2001; Pasda 2002) could also be attributed to this sub-group. This large geographical distribution and the relatively long chronostratigraphic occurrence of this sub-group made these FMG sub-group an equivalent to the Late Magdalenian. However, further assemblages or possibly groups of assemblages such as the MfCM, the Creswellian, the Early Azilian (*Azilien ancien*) bipoint phase, the Hengistbury Head industries, or the penknife point phase were found chronologically between and, perhaps, besides the Late Magdalenian and this FMG stage. The role of some of these assemblages and groups in the transition process remains to be clarified in the present study.

## The Central Rhineland

Patterns of Late Magdalenian as well as FMG behaviour were well preserved in the archaeological record from the Central Rhineland. The major sites are introduced in the following. However, material attributed to the reorganisation period between these two entities was rarely found and, therefore, this record is supplemented by northern French sites and sites from the intermittent western upland zone.

### Andernach, Rhineland-Palatinate

#### Research history

Herman Schaaffhausen was the first to conduct excavations on the Martinsberg in Andernach in 1883 (later named Andernach 1). In the context of the discovery of the site at Gönnersdorf, Gerhard Bosinski and Joachim Hahn re-analysed the material recovered by Schaaffhausen and stored in the Andernach Museum (partially with false labelling). The results of the re-analysis induced a test pit survey to find the excavation area of Schaaffhausen on the Martinsberg. This survey was organised by Stephan Veil in 1977 (Veil 1982, 394 f.). These works revealed the existence of two archaeological horizons explaining the FMG component in Schaaffhausen's Late Magdalenian material as admixture. However, by chance, the area excavated by Schaaffhausen was recovered in the course of a house construction in 1979, and a small rescue excavation was conducted under the supervision of Stephan Veil. From 1981 to 1983 Veil, accompanied by Martin Street, continued the excavation of the site (Andernach 2, *c.* 104 m²) that was attached south-westwards of the area examined by Schaaffhausen (Bolus / Street 1985). In total, three concentrations (I-III) of paved areas attributed to the Late Magdalenian were identified in these excavations as well as concentrations of FMG material (Andernach 2-FMG) around approximately three hearths. From 1994 to 1996 another area of the site (Andernach 3) some 15 m south-west of Andernach 2 was excavated with modern standards (81 m²) by Sylvie Bergmann, Jörg Holzkämper, and Jan Kegler. This area yielded a fourth concentration (IV) of large stone plates and pits from the Late Magdalenian (Holzkämper 2006) as well as another scatter of the FMG material (Andernach 3-FMG; Gelhausen / Kegler / Wenzel 2004). Due to time pressure inflicted by planned construction work, the southern area (32 m²) of Andernach 3 was only dug up in 12.5 cm × 12.5 cm × 5 cm blocks that were wet-sieved (Bergmann / Holzkämper 2002, 471). In total, some 245 m² (without some 130 m² uncovered by Schaaffhausen) were archaeologically investigated on the Martinsberg in Andernach.

#### Topography

Andernach is located at the north-western edge of the Neuwied Basin. The open air site is set at an altitude of *c.* 80 m a. s. l. on the south-eastward facing slope of the Martinsberg (**tab. 10**). The Martinsberg was formed by a Quaternary basalt lava stream alongside the Rhine which flows today approximately 1 km northwards of the site. During the Late Pleniglacial and Lateglacial Interstadial the Rhine bed was higher elevated and additionally braided. Thus, the river banks were closer to the site (*c.* 300 m; Veil 1982, 395-397). Northwards of the Martinsberg the hills forming the »Andernacher Pforte« (Andernach Gate) rise steeply forming a protective barrier for the settled area against northern winds. From this barrier to the south side of the Martinsberg only the gradually rising hills of the Eifel massif surround the slope. Southwards to north-eastwards of the site lies the wide Neuwied Basin. Thus, most times of a day the site is exposed to direct sunlight. Moreover, the brittle basalt underground induced erosive processes towards the lower lying floor of the Neuwied Basin. In fact, erosion channels disturbed the archaeological deposits in both areas and con-

| site | approximate / average distance to water | type of water body | morphographic setting | site type | direction of cave opening / exposure |
|---|---|---|---|---|---|
| Andernach | close / near | stream / river | slope | open air | × |
| Gönnersdorf | close / near | stream / river | slope | open air | × |
| Wildweiberlei | near | river | slope | cave | W |
| Oberkassel | distant | river | valley bottom | *open air* | *SW* |
| Irlich | close / near | river | valley bottom | open air | × |
| Kettig | near | river | slope | open air | × |
| Urbar | close | spring | slope | open air | × |
| Niederbieber | close / near | stream / river | slope | open air | × |
| Boppard | close | river | valley bottom | open air | × |
| Bad Breisig | immediate / close | river | valley bottom | open air | × |

**Tab. 10** Topographic characteristics of sites from the Central Rhineland. **immediate** 0-29 m; **close** 30-149 m; **near** 150-500 m; **distant** 500> m; **×** not restricted; **N** north; **S** south; **W** west; **E** east. Uncertain characteristics are set in italics. – For a discussion concerning the site type of Bonn-Oberkassel and for further details see text.

tained Late Magdalenian as well as FMG material. North-westwards and south-eastwards of Andernach 2 depressions isolated a »plateau« on which the settlement was set (Veil 1982). Presumably, this position further contributed to the erosive process. In addition, the erosion was possibly intensified by a small stream passing the site at a maximum distance of 100 m westwards (Holzkämper 2006, 5).

Stratigraphy

During the Andernach 2 excavations, a three-parted profile was recorded (Veil 1982, 397 f.) with the rutted basalt and its scree at the base overlain by a loess deposit and sealed by some 4 m of pumice of the LSE. The intermediate loess deposit was infiltrated by various fractions of basalt rubble depending on the proximity to the base but loess also filled in fissures in the basalt. In this lower part, the loess was light brown and calcareous, whereas in the upper half the loess was transformed into a brown loess loam with humus, iron, and manganese patches. The topmost centimetres are formed by a light brown loess loam. The general stratigraphic succession was confirmed by the excavations of Andernach 3 with the specification that the loess loam was in fact a stagnosol (»Pseudogley«) that was formed by waterlogging from a greyish brown loess (Kegler 2002, 501).

In this loess loam, two stratigraphically distinct archaeological horizons were observed (Veil 1982; Bergmann / Holzkämper 2002). The material of the lower horizon formed a continuous layer, whereas the archaeological remains of the upper horizon were scattered ephemerally mainly in the upper part of the loess loam, immediately underlying the LST. Based on the archaeological material, the lower horizon was attributed to a Late Magdalenian settlement and the upper horizon to a FMG occupation.

Charcoal was frequently found in small accumulations and attributed to this upper horizon. In Andernach 2, the pieces of charcoal were identified most commonly as willow (*Salix* sp.; 65.8 %) followed by pine (*Pinus* sp.), birch (*Betula* sp.), and a few pieces of elder (*Sambucus* sp.; Veil 1982, 400). In Andernach 3, birch and poplar (*Populus* sp.) as well as willow and Saliceae pieces, which were not further determinable, and singular specimens of *Prunus* sp., Maloideae (previously Pomoideae), and *Daphne* sp. were identified (Kegler 1999, 14). These determinations were consistent with an attribution to a Lateglacial Interstadial environment.

However, due to erosion the thickness of the loess deposit varies from a maximum of 50 cm to only 15 cm on the central part of the »plateau« (Veil 1982, 397). In addition, the archaeological material moved due to bio- and cryoturbation within the sediment. Moreover, in both modern excavation areas larger fissures in the basalt running NE-SW (Andernach 2) to N-S (Andernach 3) led to the formation of channels in the

| site | excavated m² | total ≥ 10 mm (all) | cores and core fragments | retouched artefacts | % of burnt artefacts to total ≥ 10 mm (all) | ref. |
|---|---|---|---|---|---|---|
| Andernach, lower horizon | *c.* 245 | 6,518 (43,832) | 55 | 1,831 | 0.5 (0.1) | 1-4 |
| Andernach I | *c.* 78 | ? (16,296) | 30 | 530 | × | 1-3 |
| Andernach II | *c.* 17 | ? (5,790) | 3 | 503 | × | 1-3 |
| Andernach III | *c.* 19 | ? (1,116) | 5 | 181 | × | 1-3 |
| Andernach IV | 113 | 1,194 (19,817) | 9 | 275 | 0.4 (0.0) | 1; 4 |
| Andernach, upper horizon | *c.* 245 | 3,794 (19,925) | 66> | 280 | × | 5-8 |
| Andernach 2-FMG | 104 | 1,377 (2,894) | 25 | 156 | 2.25 | 5-6 |
| Andernach 3-FMG | 113 | 2,417 (17,031>) | 41> | 124 | × | 7-8 |
| Gönnersdorf | 687 | 33,000 (81,786) | 309 / 311 | 4,855 / 4,320 | < 1.0 | 5; 9-12 |
| Gönnersdorf I | 96 | × | *c.* 35 | 1,657 | × | 9 |
| Gönnersdorf II | 215.5 | ? (29,742) | 28 | 1,550 | × | 5; 9 |
| Gönnersdorf III | *c.* 130 | × | *c.* 145 | 928 | × | 9 |
| Gönnersdorf IV | 126 | 854 (2,758) | 28 | 182 | 0.7 | 5; 10-11 |
| Gönnersdorf SW | 114.5 | 2,251 (2,804) | 6 | 148 | × | 12 |
| Wildweiberlei | *c.* 24 | 580 (662) | 28 | 99 | 2.6 (2.3) | 13 |
| Oberkassel | × | 1 | 0 | 0 | 0.0 | 14 |
| Irlich | × | 2 | 0 | 1 | 0.0 | 15 |
| Kettig | 242 | 3,834 (24,098) | 61 | 352 | 8.1 | 15 |
| Urbar | *c.* 17 | 516 (1,641) | 8 | 120 | 10.8 | 16 |
| Niederbieber | 1,032.5 | 19,306 (119,954) | 267 | 1,729 | 14.7 (2.4) | 17-23 |
| Niederbieber 1 | 48 | 2,583 (7,986) | 33 | 272 | 31.1 | 17 |
| Niederbieber 3 | 28 | 258 (1,402) | 1 | 9 | 81.2 | 17 |
| Niederbieber 4+17a | 74 | 2,119 (17,201) | 29 | 260 | 32.0 | 17-19 |
| Niederbieber 5 | 40 | 1,572 (~7,361) | 23 | 105 | 2.7 | 20 |
| Niederbieber 6+10a | 45 | 1,835 (12,941) | 14 | 104 | ~30.1 | 18-19; 21 |
| Niederbieber 7 | 36 | 1,040 (2,257) | 16 | 125 | 4.6 | 22 |
| Niederbieber 8 | 75 | 537 (11,336) | 5 | 37 | 3.4 | 18-19 |
| Niederbieber 9 | 123 | 2,088 (4,897) | 31 | 174 | 4.4 | 18-19 |
| Niederbieber 10 | 23 | 811 (2,314) | 11 | 58 | 10.0 | 18-19 |
| Niederbieber 11 | 56 | 499 (4,731) | 11 | 66 | 3.6 | 18-19 |
| Niederbieber 12 | 46 | 1,106 (6,804) | 21 | 65 | 5.1 | 18-19 |
| Niederbieber 13 | 39 | 697 (6,928) | 9 | 50 | 8.6 | 18-19 |
| Niederbieber 14 | 42 | 751 (6,595) | 22 | 89 | 5.2 | 18-19 |
| Niederbieber 15 | 30 | 284 (553) | 7 | 9 | 9.6 | 18-19 |
| Niederbieber 16 | 37 | 418 (5,383) | 7 | 42 | 5.5 | 18-19 |
| Niederbieber 17 | 51 | 162 (2,059) | 2 | 31 | 6.3 | 18-19 |
| Niederbieber 18 | 38 | 715 (13,991) | 1 | 10 | 0.6 | 23 |
| Niederbieber 19 | 28 | 159 (287) | 7 | 9 | 2.5 | 23 |
| Niederbieber 20 | 60 | 983 (3,404) | 10 | 45 | 3.2 | 23 |
| Bad Breisig | 50 | 5,956 (45,480) | 184 | 296 | 16.27 (2.15) | 24 |

**Tab. 11** Numbers of lithic artefacts recovered at sites from the Central Rhineland. Sub-assemblages are shaded grey. For Boppard these numbers are not available yet. – For further details see text. – References (ref.): **1** Bergmann/Holzkämper 2002; **2** Floss/Terberger 1987; **3** Floss/Terberger 2002; **4** Holzkämper 2006; **5** Floss 1994; **6** Bolus 1984; **7** Kegler 2002; **8** Gelhausen/Kegler/Wenzel 2004; **9** Franken/Veil 1983; **10** Sensburg/Moseler 2008; **11** Terberger 1997; **12** Buschkämper 1993; **13** Terberger 1993; **14** Schmitz/Thissen 1997; **15** Baales 2002; **16** Baales/Mewis/Street 1998; **17** Bolus 1992; **18** Gelhausen 2011a; **19** Gelhausen 2010; **20** Husmann 1989; **21** Thomas 1990; **22** Freericks 1989; **23** Gelhausen 2011c; **24** Grimm 2004.

sediment disturbing the archaeological deposits. In Andernach 2, such channels are particularly found in the eastern half. In Andernach 3, the channels cut through the centre of the excavation area. Partially, FMG material was found in these fissures.

| site | distance classes of raw material exposure from the site | | | | | ref. |
|---|---|---|---|---|---|---|
| | 0-5 km | 6-15 km | 16-60 km | 61-250 km | 251 km > | |
| Andernach, lower horizon | ***Tertiary quartzite***; indurated slate (single); *local flint (single);* Devonian quartzite; quartz; (quartzitic) slate; (indurated) sandstone; basalt; *haematite; jet;* brown coal | ***Tertiary quartzite*** (5 km > W) | ***Tertiary quarzite*** *(20-50 km NNW); chalcedony (35-50 km NNW); local flint (single, NW); haematite (c. 20 km NW)* | *Triassic chert (single, 65 km > SW or 160 km > N);* **Western European flint** (95 km > NW); *Mesozoic quartzite (100 km > W);* Baltic flint (100 km > N); *Tertiary quartzite, type Ratingen (95 km > E or 105 km > N);* chalcedony (110 km > SEE); molluscs (70 km > SE) | *jet (255 km > SE)*; Mediterranean molluscs (min. 680 km S, 800 km > SSW); Mediterranean/Atlantic whale bone (single, 800 km SSW, 900 km > SW) | 1-5 |
| Andernach, upper horizon | ***Tertiary quartzite***; indurated slate (single); silicified limestone; Devonian quartzite; quartz | *Tertiary quartzite* (5 km > W) | **chalcedony** (30-35 km NNW); Eifel local gravel flints (15-50 km > W) | silicified limestone (60 km > S-SE); siliceous oolite (70 km > SE); Western European flint (95 km > NW); Baltic flint (100 km > N-NE) | | 1; 6-7 |
| Gönnersdorf | indurated slate; rock crystal; *Jurassic chert*; slate; quartzitic slate; Devonian quartzite; quartz; *haematite*; *jet* | ***Tertiary quartzite*** *(12 km > SE)*; basalt | ***Tertiary quartzite*** *(16 km > SEE)*; Eifel local gravel flints (50 km > W); *haematite (c. 25 km > NW); opal (25 km > N)* | chalcedony (75 km > SE); siliceous oolite (75 km > SE); opal (75 km > SE); fossil curiosities (75 km > SE, 105-150 km W-SW, or 195 km > S); *Tertiary quartzite, type Ratingen (85 km > N);* **Baltic flint** (105 km > N); **Western European flint** (110 km > NW); *Palaeozoic quartzite (110 km > NW); fossil molluscs (110 km > NW)* | *jet (255 km > SE)*; jasper of Kleinkems type (305 km > S); Mediterranean molluscs (min. 680 km S, 800 km > SSW); *Atlantic molluscs (800 km > WSW)* | 1; 8-9 |
| Gönnersdorf SW | indurated slate (lydite); slate; quartzitic slate; Devonian quartzite; greywacke; Eisenschwarte; sandstone; quartz; haematite | Tertiary quartzite (12 km > SE); basalt | haematite (c. 20 km > NW) | chalcedony (75 km > SE); siliceous oolite (single; 75 km > SE); Tertiary quartzite, type Ratingen (85 km > N); **Baltic flint** (105 km > N); **Western European flint** (110 km > NW); Palaeozoic quartzite (single; 110 km > NW) | jasper of Kleinkems type (single; 305 km > S) | 1; 10 |
| Wildweiberlei | **indurated slate (lydite)**; basalt; slate; haematite | Tertiary quartzite (6 km > NE) | | Baltic flint (120 km > N); *Western European flint (85 km > NW)* | | 1; 11 |

**Tab. 12** Approximate distance classes of raw materials recovered at sites from the Central Rhineland. The most numerous lithic raw material(s) is/are set in bold. Raw materials of which only single artefacts were found are marked as (single). Sub-assemblages are shaded grey. Resources for which several places of origin are discussed are set in italics. For Gönnersdorf SW all materials found in the area are given, although several do probably not relate to the early Lateglacial Interstadial assemblage. – For further details see text. – References (ref.): **1** Floss 1994; **2** Floss/Terberger 2002; **3** Holzkämper 2006; **4** Alvarez Fernández 2001; **5** Langley/Street 2013; **6** Bolus 1984; **7** Kegler 2002; **8** Franken/Veil 1983; **9** Bosinski 1979; **10** Buschkämper 1993; **11** Terberger 1993; **12** Schmitz/Thissen 1997; **13** Baales 2002; **14** Baales/Mewis/Street 1998; **15** Gelhausen 2011a; **16** Wenzel 2004; **17** Grimm 2004.

| site | distance classes of raw material exposure from the site | | | | | ref. |
|---|---|---|---|---|---|---|
| | 0-5 km | 6-15 km | 16-60 km | 61-250 km | 251 km > | |
| Oberkassel | haematite | | haematite (*c.* 20 km SW) | **flint** (Western European 35 km > NW; Baltic 80 km > N) | | 12 |
| Irlich | haematite | | **chalcedony** (30 km > NNW); haematite (*c.* 25 km NW) | | | 13 |
| Kettig | ***Tertiary quartzite***; indurated slate; limonite; agate (single); indurated claystone (single); carnelian (single); quartz; Devonian quartzite; porphyry; quartzitic sandstone; argillaceous shale | Tertiary quartzite (8 km > W) | chalcedony (40 km > NW); Eifel local gravel flints (single; 55 km > W) | **Western European flint** (65 km > NW); *Tétange flint (90 km > SW);* Agate/Jasper of Weiselberg type (single; 95 km > SW); indurated claystone of Schaumberg type (115 km > SW); *Baltic flint (125 km > N)* | | 13 |
| Urbar | **Tertiary quartzite**; indurated slate; Devonian quartzite; quartz; argillaceous shale; *quartzitic sandstone; haematite* | | haematite (*c.* 35 km > NW) | Western European flint (single, 120 km > NW) | | 14 |
| Niederbieber | ***Tertiary quartzite***; indurated slate; Devonian quartzite; indurated limestone (single); quartzitic slate; basalt; argillaceous shale; *haematite* | **Tertiary quartzite** (8 km > SE) | **chalcedony** (35 km > NW); *haematite (c. 25 km NW)* | Western European flint (85 km > NW); Baltic flint (115 km > N); Triassic chert (170 km > SW); indurated claystone of Schaumberg type (115 km > SW) | | 1; 15 |
| Boppard | indurated slate; quartz; Devonian quartzite; jet | **Tertiary quartzite** (10 km > SW or 20 km > N-NW) | chalcedony (35 km > NW or 45 km > SW); Eifel local gravel flints (55 km > NWW) | Western European flint (80 km > NW) | | 16 |
| Bad Breisig | ***Tertiary quartzite***; indurated slate; argillaceous shale (single); Devonian quartzite; sandstone; brown coal | **Tertiary quartzite** (7 km > S or 9 km > N) | chalcedony (single, 15 km > NNW); Eifel local gravel flints (45 km > W) | Triassic chert (single; 80 km > SW); Western European flint (85 km > NW) | | 17 |

**Tab. 12** (continued)

Thus, in some parts of the excavated area the archaeological horizons are stratigraphically indistinguishable and the attribution of material to either the lower or the upper horizon became difficult. In consequence, the archaeological material was differentiated in these areas by tendencies in the choice of raw materials, techno-typological aspects, and varied horizontal distributions (Veil 1982, 398f.; Bergmann/Holzkämper 2002, 473; cf. Kegler 2002, 501-502). However, admixture of some pieces in the chronologically distinct archaeological material cannot be completely excluded. Hence, this constrain should be kept in mind when numbers are mentioned for this site because, in detail, they represent assumed attributions.
Nevertheless, in the following the material is presented according to the two distinct horizons.

Archaeological material of the lower horizon
In the lower horizon, a continuous band of settlement remains was observed (Veil 1982, 403). It produced in total 43,863 lithic artefacts (**tab. 11**) weighing *c.* 30kg that were attributed to the Late Magdalenian occupation (Floss/Terberger 2002, 3; Holzkämper 2006, 89). However, if the splinters are excluded only some 6,500 larger pieces were recovered at this site. Nevertheless, due to the only partial excavation and the occasional desilification of Tertiary quartzite, Harald Floss supposed that the amount of material which reached the site was at least some 30kg in addition combining for a total weight of approximately 60kg (Floss/Terberger 2002, 7).
The main raw materials were Tertiary quartzite (*c.* 20kg, n = 16,987) and Western European flint (max. 8kg, n = 23,635). The latter occurred in some varieties at the site such as Rijckholt type or Simpelveld type, and clearly belongs to the distant raw material class with the nearest occurrences some 100km to the north-west (**tab. 12**). In contrast, Tertiary quartzite is of local to regional origin but the exact source remained unidentified. Possible sources are situated at distances of 4km south-westwards to some 30-40km eastwards or north-westwards (Floss/Terberger 2002, 5-7; Holzkämper 2006, 95). The main type of Tertiary quartzite is a fine-grained material with occasional quartz inclusions of usually grey but also yellowish, greenish, or blackish colour. Besides these varieties, a piece of brownish colour with signs of river transport and 19 pieces of the coarse-grained Ratingen type occurred. The latter appeared to originate from a distant source some 100km either northwards or eastwards (Floss/Terberger 2002, 17). Near the possible north-western regional source of Tertiary quartzite several outcrops of chalcedony are known (Floss/Terberger 2002, 8). This raw material was present in a small quantity in the Late Magdalenian assemblages of Andernach (n = 1,066) but originated possibly from sources in the Main region some 120km to the south-east of the Martinsberg (Floss/Terberger 2002, 8f.). However, the characteristic cortex with wind abrasion was preserved only on some pieces, and also the number of pieces which were microscopically and chemically analysed was limited. Moreover, several pieces were patinated and, hence, Harald Floss could not exclude the region north-north-westwards as a possible origin of the Late Magdalenian chalcedonies (Floss/Terberger 2002, 9). Another distant source of lithic raw material was attested for the Baltic erratic flint (n = 1,291) that originated at a minimum of 100km north to north-eastwards. The fifth raw material yielding more numerous artefacts was a Mesozoic quartzite (n ~ 880) which often was also referred to as Palaeozoic quartzite or Ardennes quartzite (Floss/Terberger 2002, 14-16). However, the exact source is thus far unknown but a proximity to the Western European flint was assumed (Floss/Terberger 2002, 14). Very low numbers of artefacts or single pieces (Floss/Terberger 2002, 19-22; Holzkämper 2006, 98) were found of local indurated slate/lydite (n > 6), Devonian quartzite (n = 1), a local flint (n = 1), and a blade of Triassic chert that might originate from some 65km to the south-west or from 160km north-eastwards (Floss/Terberger 2002, 21).
In addition to the lithic raw materials, several rock materials were brought to the site, some of them in considerable quantities and/or volumes. For instance, *c.* 414kg of rocks were recovered only in Andernach IV (Holzkämper 2006, 57). These raw materials are basalt, quartz, some varieties of sandstone, various types of

| site | blank production | cores total | 1 platform | 2 platforms, 1 preferred | 2 platforms | 3 and more platforms | others (e.g. fragments) | ref. |
|---|---|---|---|---|---|---|---|---|
| Andernach, lower horizon | blades | 55 | **15>** | 8> | 8> | × | 9> | 1-2 |
| Andernach I | blades | 38 | **13** | 8 | 8 | 0 | 9 | 1 |
| Andernach IV | blades/bladelets | 9 | 2 | × | × | × | × | 2 |
| Andernach, upper horizon | flakes/bladelets | 66> | × | × | × | × | × | 3-4 |
| Andernach 2-FMG | flakes/bladelets | 26 | 6 | 1 | 9 | 4 | 6 | 3 |
| Gönnersdorf | bladelets | 309 | **118** | ? 2> | 76 | 67 | 48 | 5 |
| Gönnersdorf SW | bladelets | 6> | **1** | **1** | × | × | × | 6 |
| Wildweiberlei | blades/bladelets | 28 | 7 | 6 | **11** | 0 | 4 | 7 |
| Kettig | flakes/short blades | 60 | **7** | 5 | 5 | 5 | 1 | 8 |
| Urbar | flakes/bladelets | 8 | 1 | × | × | **2** | **5** | 9-10 |
| Niederbieber | flakes/bladelets | 267 | 11 | **20** | **20** | 14 | 3 | 11-13 |
| Niederbieber 1 | flakes/bladelets | 33 | 1 | **4** | 3 | 3 | × | 13 |
| Niederbieber 4 | flakes/bladelets | 29 | 2 | 7 | **8** | 4 | | 13 |
| Bad Breisig | bladelets/flakes | 184 | **50** | <46 | 32> | 13 | 43 | 14 |

**Tab. 13** General concept of blank production and core types recovered at sites from the Central Rhineland. For Boppard these numbers are not available yet. In Irlich no cores were found. Sub-assemblages are shaded grey. The most numerous class is set in bold. On some sites not all cores and core fragments were classified according to the number of platforms. In these cases the pieces displayed in the figures were classified. **×** this type is not mentioned or displayed in a publication. – For further details see text. – References (ref.): **1** Floss/Terberger 2002; **2** Holzkämper 2006; **3** Bolus 1984; **4** Kegler 2002; **5** Franken/Veil 1983, 83-148; **6** Buschkämper 1993; **7** Terberger 1993; **8** Baales 2002; **9** Mewis 1993; **10** Baales/Mewis/Street 1998; **11** Gelhausen 2011c; **12** Gelhausen 2011a; **13** Bolus 1992; **14** Grimm 2003.

quartzite, in particular, Devonian quartzite, and various slate types. These materials can be assumed as originating from local, nearby sources such as the basalt stream, the Rhine gravels, or primary slate resources such as the Krahnenberg at an approximate distance of 1 km north-westwards of the site (Holzkämper 2006, 57).

Among the lithic material, 55 cores were found in the modern excavations (**tab. 13**) of which 43 were made of Tertiary quartzite, five of Baltic erratic flint, four of Western European flint, two of chalcedony, and one of Mesozoic quartzite. Five Tertiary quartzite specimens can be classified as freshly prepared, i.e. complete cores of segmented shape measuring 10.7 to 15.7 cm (Floss/Terberger 2002, 26 f.). Further completely prepared cores were found in the Schaaffhausen material exceeding the pieces from the modern excavations by almost 5 cm in size (Floss/Terberger 2002, 26 f.). The cores of foreign materials are usually very small and exploited almost exhaustively. In general, the cores for blade and bladelet production clearly dominated. These cores frequently contained two prepared platforms but often only one was preferred. Hence, the cores were usually reduced from only one platform. The platforms were often additionally prepared and worked from only one knapping face (Floss/Terberger 2002, 33-37). Only approximately 8 % of the blanks from Andernach 2 wore traces of cortex, most frequently the cortex was on Mesozoic quartzite (22 %) and least frequently on Tertiary quartzite (5.4 %) suggesting that this raw material reached the site in a prepared shape (Floss/Terberger 2002, 47). In Andernach 3, the numbers in all raw materials were considerably lower with only a total of 78 specimens covered with cortex on some parts. In Andernach 2, almost a fifth to a quarter of the preserved butts of Tertiary quartzite and Western European flint blades and over a third of the Mesozoic quartzite blanks were made with a »talons en éperon«, whereas on the Baltic erratic flint and chalcedony blanks less than 5 % wore this spur (Floss/Terberger 2002, 40-60). In Andernach 3, this preparation was observed on some 4 % of the blanks (Holzkämper 2006, 101 f.).

1,831 retouched artefacts were attributed to the Late Magdalenian inventory in Andernach (**tab. 14**). The laterally retouched specimens are clearly the largest group (n = 607) but also a very heterogeneous group

| site | total | LMP | end-scrapers | trun-cations | borers | burins | compos-ite tools | others | ref. |
|---|---|---|---|---|---|---|---|---|---|
| Andernach, lower horizon | 1,831 | **367** | 251 | 70 | 98 | **395** | 41 | **613** | 1-3 |
| Andernach I | 530 | **122** | **186** | 26 | 42 | 106 | ? | ? | 1-2 |
| Andernach II | 503 | **151** | 20 | 20 | 50 | **191** | ? | ? | 1-2 |
| Andernach III | 181 | **56** | 41 | 11 | 9 | **51** | ? | ? | 1-2 |
| Andernach IV | 275 | **37** | 23 | 9 | 10 | **123** | 6 | **67** | 3 |
| Andernach, upper horizon | 280 | **128** | **41** | 20 | 0 | **41** | 3 | **49** | 4-5 |
| Andernach 2-FMG | 156 | **66** | **25** | 11 | 0 | 22 | 1 | **31** | 4 |
| Andernach 3-FMG | 124 | **62** | 16 | 9 | 0 | **19** | 2 | 16 | 5 |
| Gönnersdorf | 4,855 | **1,927** | 229 | 98 | 480 | **1,003** | 260 | 858 | 6 |
| Gönnersdorf I | 1,657 | **548** | 71 | 40 | 180 | **524** | 121 | 173 | 6 |
| Gönnersdorf II | 1,550 | **691** | 139 | 92 | 168 | **206** | 25 | **229** | 7-8 |
| Gönnersdorf III | 931 | **380** | 46 | 17 | 152 | **172** | 23 | 138 | 9 |
| Gönnersdorf IV | 182 | **86** | 5 | 6 | 5 | **22** | 3 | 7 | 8 |
| Gönnersdorf SW | 148 | **58** | 7 | 2 | 12 | **34** | 3> | <30 | 10 |
| Wildweiberlei | 99 | **20** | 6 | 5 | 9 | **12** | 3 | **44** | 11 |
| Irlich | 1 | **1** | 0 | 0 | 0 | 0 | 0 | 0 | 12 |
| Kettig | 352 | **100** | **117** | 21 | 5 | 36 | 3 | 70 | 12 |
| Urbar | 120 | **13** | **98** | 2 | 0 | 2 | 0 | 5 | 13 |
| Niederbieber | 1,729 | **551** | **279** | 158 | 37 | 236 | 2> | **427** | 14-15 |
| Niederbieber 1 | 272 | **69** | **58** | 23 | 5 | 49 | 0 | **68** | 14 |
| Niederbieber 3 | 9 | **5** | 0 | 0 | 0 | **3** | 0 | 1 | 14 |
| Niederbieber 4+17a | 260 | **80** | **75** | 25 | 2 | 34 | 0 | 44 | 14 |
| Niederbieber 5 | 105 | **34** | 6 | **9** | 2 | 7 | ? | **39** | 14 |
| Niederbieber 6+10a | 104 | **53** | 3 | **9** | 1 | 3 | 0 | **30** | 14 |
| Niederbieber 7 | 125 | 23 | 14 | **24** | 5 | **35** | 1 | **30** | 14 |
| Niederbieber 8 | 37 | **12** | 3 | 2 | 0 | **13** | ? | 7 | 14 |
| Niederbieber 9 | 174 | **65** | **32** | 15 | 4 | 14 | ? | **44** | 14 |
| Niederbieber 10 | 58 | **25** | **10** | 6 | 1 | 5 | ? | **11** | 14 |
| Niederbieber 11 | 66 | **27** | **16** | 5 | 1 | 7 | 1 | 10 | 14 |
| Niederbieber 12 | 65 | **26** | 5 | 2 | 0 | **13** | ? | **19** | 14 |
| Niederbieber 13 | 50 | **20** | **12** | 1 | 1 | 4 | ? | **12** | 14 |
| Niederbieber 14 | 89 | **25** | **21** | 8 | 5 | 15 | ? | 15 | 14 |
| Niederbieber 15 | 9 | **11** | **11** | 5 | 0 | 4 | ? | **11** | 14 |
| Niederbieber 16 | 42 | **19** | 1 | 3 | 1 | **4** | ? | 3 | 14 |
| Niederbieber 17 | 31 | **22** | 7 | **13** | 0 | 12 | ? | 9 | 14 |
| Niederbieber 18 | 10 | **6** | **3** | 0 | 0 | 1 | ? | 0 | 15 |
| Niederbieber 19 | 9 | **6** | 1 | 1 | 0 | 1 | ? | 0 | 15 |
| Niederbieber 20 | 45 | **23** | **10** | 1 | 3 | 6 | ? | 2 | 15 |
| Bad Breisig | 296 | **114** | **98** | 31 | 0 | 25 | 1 | 27 | 16 |

**Tab. 14** Numbers of retouched lithic artefacts recovered at sites from the Central Rhineland. For Boppard reliable numbers are not available yet. Sub-assemblages are shaded grey. The two most numerous classes are set in bold (except for the »others« class which can result from various types is involved, then the three most numerous groups are given). * include double counting of working edges on composite tools but lack splintered and laterally retouched pieces. – For further details see text. – References (ref.): **1** Floss/Terberger 2002; **2** Floss/Terberger 1987; **3** Holzkämper 2006; **4** Bolus 1984; **5** Kegler 2002; **6** Franken/Veil 1983, tab. 18; **7** Sensburg 2007; **8** Sensburg/Moseler 2008; **9** Terberger 1997, Tabelle 12; **10** Buschkämper 1993; **11** Terberger 1993; **12** Baales 2002; **13** Baales/Mewis/Street 1998; **14** Gelhausen 2011a; **15** Gelhausen 2011c; **16** Grimm 2004.

and the retouch could occasionally result from use rather than intentional retouch (Floss/Terberger 2002, 128f.). Yet, in combination with the micro-wear analyses (Plisson 2002; Vaughan 2002), this group indicates intensive use of the lithic inventory. However, among the typical tool classes, burins (n = 395) dominated the inventory followed by 367 LMP. On one dihedral specimen a basal thinning of the so called Kostienki end type was observed (Holzkämper 2006, 106). Among the burins, the ones on truncations are with 299 examples the most frequent type and 15.7 % were produced in the Lacan style (cf. Brézillon 1968, 179f.).

Dihedreal burins (n = 87) and burins on natural edges or negatives (n = 90[14]) occurred considerably less frequently. Based on the preserved lengths of some blanks, in particular of the broken specimens, Jörg Holzkämper considered the use of such burins in a hafted form (Holzkämper 2006, 107). Burin spalls were frequently used in the Andernach Magdalenian inventory as blanks for the preparation of borers or backed bladelets (Holzkämper 2006, 105). This efficient use hinted additionally at the intensive exploitation of the raw materials. Among the LMP, simple backed bladelets (n = 281) are most common, although many were fragmented and, thus, a possible attribution to other types could not be excluded entirely. Sometimes the backed bladelets were also retouched on the opposite edge (n = 88) and rarely a truncation (n = 3) was added or the backed bladelet was supplemented with a truncation and a retouched opposite edge (n = 2). No indication of a serial production such as notched ends were observed (Holzkämper 2006, 116). However, this absence was perhaps connected to the size of suitable raw material blanks and, thus, in combination with the frequent use of burin spalls, points to an alternative recipe for serial backed bladelet production in regions with poor supply of large nodules of fine grained, glassy raw materials. The 251 end-scrapers were generally made on blades and approximately 50 % were also laterally retouched and in one case basally thinned by a Kostienki end. 13 double end-scrapers were counted originating only from the excavations at Andernach 2. Among the 98 borers was one piece thinned with a Kostienki end. In Andernach 2 were seven double and one twin borer found. In general, these can be attributed to the perforator group but a few pieces (n = 11) fell rather into the *Zinken* group (»Grobbohrer«, Floss / Terberger 2002, 116). The truncations form a small group (n = 70). In Andernach 2, only one double truncation was found. Usually the truncations were straight (n = 36), rarely concave (n = 24), convex (n = 11), or irregular (n = 3; Floss / Terberger 2002, 119; Holzkämper 2006, 115 f.). The intentionally retouched lithics were occasionally made with more than one edge and in 41 cases in a combination of various tool classes (combinations with lateral retouches [n = 338] were excluded). Among these composite tools, the burin-end-scrapers formed the most numerous group (n = 19). Further combinations were frequently with burins (n = 10) but also the borer-backed bladelets (n = 8) occurred often. In addition, on five artefacts the Kostienki end thinning was the only performed retouch and a presumably Middle Palaeolithic side-scraper was perhaps reused during the Magdalenian (Floss / Terberger 2002, 129). 62 of the retouched artefacts were subsequently used as some type of chisel resulting in a characteristic splintering (i. e. splintered pieces). In addition to these retouched specimens, a further 175 artefacts were transformed by use into such splintered pieces that are not considered among the retouched pieces in the present study since the defining »retouch« was not an intentional decision of the flintknapper on a normative shape or functional possibilities but resulted from chance during the use of the piece.

In Andernach 2, micro-wear analyses were conducted mainly on the Tertiary quartzite artefacts from concentrations I and III by Hugues Plisson (Plisson 2002) and on mainly flint artefacts of concentration II by Patrick C. Vaughan (Vaughan 2002). Both analyses pointed to a rather specialised use of end-scrapers on which occasionally haematite adhesives for hide and leather working were found (Plisson 2002, 152; Vaughan 2002, 169. 171). In contrast, burins were used more variedly. In general, they appeared to be resharpened and often combined with an edge that was used otherwise, for instance for cutting leather (Plisson 2002, 148; Vaughan 2002, 167-169). Several pieces show long-term and / or intensive use-wear patterns suggesting either an intensive work episode or the reuse of preferred pieces. The smaller LMP were presumably used glued onto a shaft of a projectile (Vaughan 2002, 169).

14 Here the »special types« are included but the combinations with backed bladelets (n = 2) and borer (n = 1) are excluded (Floss / Terberger 2002, 94).

| site | *Coleodonta antiquitatis* | *Mammuthus primigenius* | *Rangifer tarandus* | *Equus* sp. | *Alces alces* | *Cervus elaphus* | *Capreolus capreolus* | *Capra ibex* | *Rupicapra rupicapra* | *Saiga tatarica* | *Bison* sp. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Andernach, lower horizon | | + (ivory) | + | ++ | | + (teeth) | | | | | ? |
| Andernach, upper horizon | | | | (+) | + | ++ | (+) | | + | | |
| Gönnersdorf | + | + | + | ++ | | + (teeth) | | | + | + | + |
| Gönnersdorf SW | (+) | (+) | (+) | ++ | + | + | | | | | |
| Wildweiberlei | + | | + | + | | | | + | | | |
| Oberkassel | | | | | | + | (?) | | | | |
| Irlich | | | | | | + (tooth) | | | | | |
| Kettig | | | | + | | ++ | + | | + (tooth) | | |
| Urbar | | | | ? | | ++ | | | | | |
| Niederbieber | | | | + | + | ++ | (+) | + | | | |
| Niederbieber 1 | | | | (+) | ++ | ++ | ? | | | | |
| Niederbieber 3 | | | | + | + | | | | | | |
| Niederbieber 4+17a | | | | (+) | | ++ | (+) | + | | | |
| Niederbieber 5 | | | | | + | ++ | | | | | |
| Niederbieber 7 | | | | | | + | | | | | |
| Niederbieber 10 | | | | | | + | | | | | |
| Niederbieber 14 | | | | (+) | | ++ (teeth) | | | | | |
| Niederbieber 15 | | | | | | ++ (teeth) | | | | | |
| Niederbieber 18 | | | | + | ++ | + | | | | | |
| Niederbieber 19 | | | | + | ++ | + | | | | | |
| Niederbieber 20 | | | | | ++ | + | | | | | |
| Boppard | | | | | | + | | | | | |
| Bad Breisig | | | | + (tooth) | | ++ | + | | | | |

**Tab. 15** Mammal species recovered at sites from the Central Rhineland. Sub-assemblages are shaded grey. Symbols are: **+** present; **( )** association is unclear; **?** classification/determination is uncertain; **++** major species making up more than 30 % of the faunal assemblage.– For further details see text. – References (ref.): **1** Street et al. 2006; **2** Street 1993; **3** Poplin 1976; **4** Poplin 1978; **5** Terberger 1993, 183 f.; **6** Street 2002; **7** Baales 2002; **8** Baales/Mewis/Street 1998; **9** Bolus 1992; **10** Gelhausen 2011a; **11** Husmann 1989; **12** Freericks 1989; **13** Gelhausen 2011c; **14** written comm. Stefan Wenzel, Mayen; **15** Grimm 2004.

In addition to the lithic inventory, at least 40 hammerstones and/or retoucheurs were recovered from the two excavation areas (Schulte-Dornberg 2002; Bolus 2002). Generally, these specimens were made of Devonian quartzite but in Andernach 2, three pieces were made of indurated sandstone and a single piece each made of quartzitic slate and of quartz were found. In all the concentrations, some 100 kg of mainly fragmented quartz were found. This material was presumably fractured and occasionally reddened and/or blackened by the use as heating stones (Eickhoff-Cziesla 1992, 129-134; Holzkämper 2006, 59). Gisela Schulte-Dornberg assumed in her Master thesis, in which she analysed 117 rock nodules and fragments from Andernach 2 and a further 206 pieces from Andernach 3, that the quartz fragments from the site

| *Bos primigenius* | *large bovid* | *Sus scrofa* | *Canis lupus / familiaris* | *Alopex lagopus* | *Vulpes vulpes* | *Ursus arctos / speleaus* | *further carnivores* | *Lepus timidus* | *Lepus* sp. | *Castor fiber* | Aves | Pisces | ref. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | + | + | | | | + | | | + | + | 1 |
| ? | | | | | | | | | | + | | + | 1-2 |
| | | | + | ++ | + | | | + | | | + | + | 1; 3-4 |
| | (+) | | | (+) | | | | | | | | | 1 |
| | | | | + | | (+) | | + | | | + | | 5 |
| | + | | ++ | | | + | | | | | | | 6 |
| | | | | | | | | | | | | | 7 |
| | + | | (?) | | (+) | (?) | (?) (*Martes martes*; *Mustela nivalis*) | | | + | | (+) | 1; 7 |
| | + | | | | | | | | | | | | 8 |
| + | | + | | | (+) (tooth) | | (+) (*Meles meles*) | | | + | | + | 1; 9-13 |
| | | ? | | | (+) (tooth) | | (+) (*Meles meles*) | | | | | + | 1; 9 |
| | | | | | | | | | | ++ | | | 9 |
| (+) | | | | | | | | | | | | | 1; 9; 10 |
| + | | | | | | | | | | | | | 11 |
| | | + (teeth) | | | | | | | | + (teeth) | | | 12 |
| | | + (teeth) | | | | | | | | ++ (teeth) | | | 10 |
| | | | | | | | | | | | | | 10 |
| | | | | | | | | | | | | | 10 |
| | | | | | | | | | | | | | 13 |
| | | | | | | | | | | | | | 13 |
| | | | | | | | | | | + (teeth) | | | 13 |
| | | + | | | | | | | | | | ++ | 14 |
| | | | (?) | | (+) | | (?) (*Meles meles*) | | (?) | | (?) | (+) | 15 |

**Tab. 15** (continued)

could only be attributed to heating stones (Schulte-Dornberg 2000, 19). By contrast, Michael Bolus, who analysed 26 specimens from Andernach 2, thought that more pieces of quartz were used as hammerstones but that these pieces served possibly as heating stones afterwards and were thereby splintered, i. e. lost for analysis (Bolus 2002, 175). By comparison with ethonographic analogies and experimental studies, Schulte-Dornberg showed that the rock materials were probably used for a wide variety of activities such as anvil, grinding stones or weights for squeezing, perhaps, of vegetation material (Schulte-Dornberg 2000, 147 f.). Faunal remains were relatively well preserved in the lower horizon at Andernach (**tab. 15**), in particular in the sheltering pits (Street 1993; Holzkämper 2006, 144 f.; Street et al. 2006). Dominant among the fauna remains was horse (*Equus* sp.) with a minimum of twelve individuals at Andernach 2 (Street et al. 2006, 762) and three individuals at Andernach 3 (Holzkämper 2006, 147). On-going reanalysis (Martin Street, in prep.) will perhaps reveal whether these numbers are additive or integrative. Nevertheless, the partially

| site | season | indicator | ref. |
|---|---|---|---|
| Andernach, lower horizon | autumn/winter; spring/summer | eruptive stages of horse and reindeer teeth; salmon and geese migration | 1-2 |
| Andernach, upper horizon | late spring/summer? | eruptive stages of red deer and bovine teeth; absence of antler | 1-2 |
| Gönnersdorf | autumn/winter; spring/summer | foetal bones of horses; size of arctic fox teeth; only shed reindeer antler; foal hooves | 1; 3-4 |
| Wildweiberlei | late summer – early winter | high number of young animals; hunting of arctic fox for its pelt | 5 |
| Kettig | late summer/autumn | eruptive stages of red deer and roe deer teeth; red deer teeth cementum analysis | 6 |
| Urbar | late autumn/early winter | red deer teeth cementum analysis; red deer antler | 7 |
| Niederbieber | late autumn – spring | eruptive stages of red deer and horse teeth; red deer and elk antler; age of red deer | 8-9 |
| Bad Breisig | autumn? | size of red deer teeth | 10 |

**Tab. 16** Seasonality of sites from the Central Rhineland as indicated by faunal material. – References (ref.): **1** Street et al. 2006; **2** Street 1993; **3** Poplin 1976; **4** Poplin 1978; **5** Terberger 1993, 183 f.; **6** Baales 2002; **7** Baales/Mewis/Street 1998; **8** Gelhausen 2011c; **9** Bolus 1992; **10** Grimm 2004, 16 f.

fragmented character of the assemblage clearly indicated the intensive processing of these bones including the obtaining of grease or the use of bone spalls as raw material for needles, awls, and, perhaps, bone points. The horse material also formed part of stable isotope analyses (oxygen, carbon, nitrogen) to establish this material as climate and environmental proxy (Stephan 1999; Stevens/Hedges 2004) and, subsequently, to use the variations for chronological argumentation (Stevens et al. 2009b). Antler, teeth, and bones of reindeer (*Rangifer tarandus*) were also common, although many pieces had presumably reached the site as either ornament (cut incisors, cf. Álvarez Fernández 2009, 48 f.) or as gathered raw material (shed antlers). Nevertheless, the bone material (Andernach 2 MNI = 3; Andernach 3 MNI ≥ 1) indicated also the processing as alimentary resource of this prey species. The eruptive stages of the reindeer and horse teeth suggested a hunting season of autumn/winter (**tab. 16**). Moreover, reindeer material was also sampled for carbon and nitrogen studies (Stevens et al. 2009b). A large bovid, probably bison (cf. *Bison* sp.), was represented by ten bones without observable modification, one molar or premolar, and eight incisors of which at least three were probably used as ornaments (Street et al. 2006, 762; Holzkämper 2006, 149). Material of large bovids was analysed for carbon and nitrogen isotopes and assumed to be attributable to the upper horizon (Stevens et al. 2009b). However, the results displayed two clearly distinct clusters, perhaps, suggesting an older and a younger phase that were attributed to two phases in the upper horizon (Stevens et al. 2009b, 144). According to the state of preservation and to the spatial distribution, one of the groups was related to a bovid bone that produced a relatively young date (OxA-998). Nevertheless, the two groups of stable isotope values among the large bovid samples from Andernach were also found in the bovid material from Gönnersdorf but with significantly lower nitrogen values. Generally, the material of the two sites showed high similarities and, therefore, Rhiannon Stevens and her colleagues considered this difference as a sign for the older age of the Gönnersdorf material (Stevens et al. 2009b, 144). However, then the question arises why the two distinct groups were also present at Gönnersdorf. Consequently, a possible association of some of the bovid material from Andernach to the Late Magdalenian occupation must not be neglected before further samples are directly $^{14}$C-dated. The remains of at least two arctic hares (*Lepus timidus*) and five or seven arctic foxes (*Alopex lagopus*) were also found. The fauna was further supplemented by swans (*Cygnus* sp.) and geese (*Anser* sp.) as well as at least two individuals each of grouse (*Lagopus* sp.) and common raven (*Corvus corax*). Moreover, salmon (*Salmo* sp.) was frequently identified and one bone each of grayling (*Thymallus thymallus*) and of European perch (*Perca fluviatilis*) were found. The former as migratory fish indicated a fishing period during the spring/summer period (**tab. 16**; Street et al. 2006, 763). Moreover, the

| site | points | | | | fish hook | sewing instru-ments | | knives | bâtons | axes | ham-mers | oth-ers | ref. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | bev-elled | barbed, single row | barbed, double row | others (incl. tip frag-ments) | | needles | awls | | | | | | |
| Andernach, lower horizon | + (a+i) | + (a) | + (a) | + (i) | | + (b) | + (b) | | + (a) | | + (a) | + (b) | 1-5 |
| Andernach, upper horizon | | | | + (b) | | | | | | | | | 6 |
| Gönnersdorf | + (a+i) | ? | | + (i) | + (b+a) | + (b+a+i) | + (b+a) | | + (a) | | | + (b) | 5 |
| Wildweiberlei | + (a) | | | | | | | | | | | | 7 |
| Oberkassel | | | | | | | | | | | | + (b) | 8 |
| Irlich | | | | ? (b) | | | | | | | | | 9 |
| Kettig | | + (a) | | | | | | | | | + (a) | | 9 |
| Urbar | | | | | | | | | | | | ? (b) | 10 |
| Niederbieber | | | | + (b) | | | | | | | | | 9; 11 |
| Boppard | | | | | | | | | | | | + (b) | 12-13 |

**Tab. 17** Modified organic material from sites from the Central Rhineland. For symbols see **tab. 15**. Material abbreviations are: **(b)** bone; **(a)** antler; **(i)** ivory. – Within the brackets: **/** or; **+** and. – For further details see text. – References (ref.): **1** Veil 1982; **2** Street 1993; **3** Street et al. 2006; **4** Holzkämper 2006; **5** Tinnes 1994; **6** Baales/Street 1996; **7** Terberger 1993, 182; **8** Mollison 1928; **9** Baales 2002; **10** Baales/Mewis/Street 1998; **11** Bolus 1992; **12** Wenzel/Álvarez Fernández 2004; **13** Wenzel 2004.

remains of a carnivore represent probably a large canid, perhaps a small wolf (*Canis lupus*) or a dog (*Canis familiaris*, Holzkämper 2006, 150). In the upper horizon of Andernach (see p. 93-101) the presence of dogs was suggested by tooth marks on bones (pers. comm. Martin Street, Neuwied) but thus far the oldest direct evidence of dogs in Central Rhineland were the early Lateglacial remains from Bonn-Oberkassel (see p. 140) that were dated approximately 850 years (550 $^{14}$C years) younger than the Late Magdalenian concentrations of Andernach. However, the few remains (seven postcranial fragments and a tooth) must be regarded as not further determinable than a large canid without further examination such as molecular analyses because morphologically significant regions were not preserved and the discussion of dog domestication remains highly controversial (e.g. Musil 2000; Raisor 2004; Germonpré et al. 2009; Napierala/Uerpmann 2010; Ardalan et al. 2011; Ovdov et al. 2011; Germonpré/Lázničková-Galetová/Sablin 2012).
In total, 253 organic artefacts made of 268 fragments were recovered at Andernach (**tab. 17**; Tinnes 1994, 5f.). The majority was made of antler (n = 163) followed by ivory (n = 64) and bone (n = 49). Besides the previously mentioned hammerstones, an organic hammer made of the proximal part of a reindeer antler was recovered at Andernach 2 (Tinnes 2002). Furthermore, ten bone retouchers were identified (Tinnes 1994, 118-122). Moreover, antler served as raw material for spalls (Veil 1982, 412; Holzkämper 2006, 154). Comparably, ivory and bone were also worked in such a manner at the site, producing spalls of various sizes (Veil 1982, 412-415; Tinnes 1994, 101; Holzkämper 2006, 154). However, the single and double bevelled rods found in Andernach were, in fact, made only of antler and ivory (Veil 1982, 415; Holzkämper 2006, 155). The two fragments of baguette demi-ronde were also made of ivory and the ten fragments of barbed points were made of antler (Tinnes 1994, 172). One of the latter might be a fragment with two rows of barbs. The only certain bone point was made of a cetacean bone, probably whale that was otherwise not identified in Andernach (Langley/Street 2013). These animals were hunted in Mediterranean Sea or the Atlantic Ocean and, thus far, comparable implements are only known from south-western France at a distance of approximately 1,000 km from Andernach (Langley/Street 2013). In addition, several needle and awl fragments made of bone as well as actual »needle cores« (Holzkämper 2006, 154) were found. Furthermore, two cut bone fragments showed polish on one end and, perhaps, belong into the context of hide-working

| site | figurines | engravings | | | colour | | | | jewellery | | | | | ref. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | »cut« cortex | figures / symbols on portables | figures / symbols on walls | spots | paintings on gravels | paintings on walls | colourants / powder | molluscs | amber / jet | drilled teeth | incised teeth | pen-dants | |
| Andernach, lower horizon | + (i+b+s) | + | + (s) | | + | | | + | + | + (j) | + (h+c) | | ? (j) | 1-5 |
| Andernach, upper horizon | | | | | | | | | | | | + (h) | | 6 |
| Gönnersdorf | + (i+a+s) | + | + (s) | | | | | + | + | + (j) | + (h+c) | + (h) | ? (s+b) | 3-5; 7 |
| Gönnersdorf SW | | | + (s) | | | | | + | | (+ (j)) | | | ? (s) | 8 |
| Wildweiberlei | | + | ? (s) | | | | | + | | | | | | 9 |
| Oberkassel | + (b+a?) | | | | | | | + | | | | + (h) | | 10 |
| Irlich | | | | | | | | + | | | + (h) | + (h) | | 11 |
| Urbar | | | | | | | | (+) | | | | | | 12 |
| Niederbieber | | | + (s) | | | | | + | | | | | | 13 |
| Boppard | | | + (b) | | | | | | | (+ (j)) | | | | 14 |

**Tab. 18** »Special« goods recovered at sites from the Central Rhineland. Sub-assemblages are shaded grey. For symbols see **tab. 15**. Material abbreviations are: **(s)** stone material; **(l)** lithic material; **(am)** amber; **(j)** jet; **(b)** bone; **(a)** antler; **(i)** ivory; **(h)** herbivore; **(c)** carnivore. – Within the brackets: **/** or; **+** and. – For further details see text. – References (ref.): **1** Veil 1982; **2** Holzkämper 2006; **3** Höck 1995; **4** Álvarez Fernández 1999; **5** Tinnes 1994; **6** Baales/Street 1996; **7** Bosinski 1987; **8** Buschkämper 1993; **9** Terberger 1993, 158. 165 f.; **10** Henke/Schmitz/Street 2006; **11** Baales 2002; **12** Baales/Mewis/Street 1998; **13** Bolus 1992; **14** Wenzel 2004.

implements (Veil 1982, 416; Holzkämper 2006, 155). Moreover, in Andernach 2 a complete bâton percé made of antler and a further four fragmented antler specimens were recovered (Tinnes 1994, 143-145).

Along with the mammoth (*Mammuthus primigenius*) which is only represented by possible fossil ivory, red deer (*Cervus elaphus*) could be identified only by two perforated canine (Street et al. 2006, 762) which arrived presumably as ornaments at the site (**tab. 18**). Moreover, several animal teeth were perforated or cut and, thus, probably used as personal ornaments. Esteban Álvarez-Fernández (Álvarez Fernández 2009, 48) emphasised particularly the modified arctic fox premolars resembling female figurines of the so-called *Gönnersdorf* type that was focused on the presentation of a female torso (see below).

In Andernach, 22 of these female figurines were found. Two of these items were uncovered at Andernach 3 (Bergmann / Holzkämper 2002) and the other 20 originated from the areas Andernach 1 and 2 (Höck 1995, 268-277). These abstract figures were basically formed by a long shaft from which a wide bulge representing the bottom and sometimes a smaller bulge on the opposite side representing the breasts were carved out (cf. Bosinski / Fischer 1974; Bosinski / d'Errico / Schiller 2001). Thus, the *Gönnersdorf* type represented the torso of a woman with secondary sex characteristics and the indication of limbs but no feet, hands, heads, or ornaments were shaped. These figurines were generally made of ivory (n = 20), one was possibly made of bone, and another one of quartzitic slate (Holzkämper 2006, 160 f.). Three were fragmented under the pressure of the overlying sediment. Two pieces were probably unfinished (Höck 1995, 288) and one in the process of being reshaped (Höck 1995, 289). Moreover, in the material from the Schaaffhausen excavation a reindeer pedicle was found, that presumably was the waste of antler exploitation, but it was transformed by a few manipulations into a bird figurine (Bosinski / Hahn 1972).

Along with figurines, the slate was formed into small round plates with a central perforation and occasional engraved ornaments. The function of these pieces is unclear (e. g. Gaudzinski-Windheuser / Jöris 2006, 54; Álvarez Fernández 2009, 51).

Comparable to Gönnersdorf, the slate plates of Andernach were often engraved with detailed drawings of the Pleistocene fauna, in particular horses, as well as schematic humans such as the abstract female shapes of the *Gönnersdorf* type (Bosinski 1996).

Furthermore, various exotic items were found at Andernach such as molluscs from fossil deposits in the Mainz basin (approximately 70 km south-eastwards) and from the Mediterranean Sea (at least some 800 km in the south-west; Alvarez Fernández 2001; Holzkämper 2006, 159). Some pieces of a tabular brown coal and jet were also recovered from the site. The origin for both materials might be found in the local Rhine gravels (Holzkämper 2006, 158). However, the use of the materials, in particular of brown coal, remains uncertain (Álvarez Fernández 1999, 84; Holzkämper 2006, 158), but the transformation of jet into beads was attested at Gönnersdorf (Álvarez Fernández 1999) and, perhaps, the material was used comparably at Andernach.

In sheltered areas such as underneath the stone plates and inside pits, the horizon was still coloured by haematite that was also found in the form of some hundred smaller pieces at the site. The use as well as the origin of this material were discussed controversially (Holzkämper 2006, 86-88). Probably, the mineral used at Andernach came from the local gravels or a regional source based on the chemical similarity to material found some 20 km north-westwards (Bosinski 1979, 138).

### Spatial organisation of lower horizon

During the excavations several evident structures were documented (**tab. 19**; Eickhoff-Cziesla 1992) including almost 60 pits and a partially thick cover of slate, sandstone, quartzite, and basalt plates which could reach over 50 cm in diameter (Veil 1982, 403; Holzkämper 2006, 64-85). These structures were used to define three large concentrations (I-III) in Andernach 2 and another one (IV) in Andernach 3.

| site | evident structures | | | | | latent structures | | grave | further | ref. |
|---|---|---|---|---|---|---|---|---|---|---|
| | pave-ment | stone set-ting | pit | hearth, stone packed | hearth, sediment alteration | hearth, latent | dwelling | | | |
| Andernach, lower horizon | + | | + | | | + | + | | ? (cache?) | 1-3 |
| Andernach I | + | | + | | | | | | ? (cache?) | 1-2 |
| Andernach II | | + | + | | | | | | | 1-2 |
| Andernach III | + (?) | | + | | | | | | | 1-2 |
| Andernach IV | | + | + | | | + | + | | | 3 |
| Andernach, upper horizon | | | ? | | + | + | + | | | 4-5 |
| Andernach 2-FMG | | | | | | + | + | | | 4 |
| Andernach 3-FMG | | | ? | | + | | + | | | 5 |
| Gönnersdorf | + | + | + | + | + | + | + | | | 6-10 |
| Gönnersdorf I | + | + | + | | + | ? | + | | | 6-7 |
| Gönnersdorf II | + | + | + | | | + | + | | | 8-9 |
| Gönnersdorf III | + | | + | | | + | ? | | | 10 |
| Gönnersdorf IV | | + | | + | ? | + | + | | | 9-10 |
| Gönnersdorf V | | + | | + | | + | ? | | | 7 |
| Wildweiberlei | + | ? | + | | + | | ? | | | 11 |
| Oberkassel | | | | | | | | + | | 12-13 |
| Irlich | | | | | | | | + | | 14 |
| Kettig | | | ? | | | + | | | | 14 |
| Urbar | | | | ? | | + | | | | 15 |
| Niederbieber | | | + | | + | + | + | | ? (cache?) | 5; 16-19 |
| Niederbieber 1 | | | | | + | | + | | | 5; 16-17 |
| Niederbieber 3 | | | | | | ? | | | | 16 |
| Niederbieber 4+17a | | | | | + | | + | | | 5; 16-17 |
| Niederbieber 5 | | | | | | + | | | | 17 |
| Niederbieber 6+10a | | | | | | + | | | | 17 |
| Niederbieber 7 | | | | | | + | | | | 17 |
| Niederbieber 8 | | | | | | ? | | | | 17 |
| Niederbieber 9 | | | | | | + | | | | 17 |
| Niederbieber 10 | | | | | | + | | | | 17 |
| Niederbieber 11 | | | | | | + | | | | 17 |
| Niederbieber 12 | | | | | | + | + | | | 17 |
| Niederbieber 13 | | | | | | + | + | | | 17 |
| Niederbieber 14 | | | | | | + | | | | 17 |
| Niederbieber 15 | | | | | | + | | | ? (cache?) | 17; 18 |
| Niederbieber 17 | | | | | | + | + | | | 17 |
| Niederbieber 19 | | | | | + | | | | | 19 |
| Niederbieber 20 | | | + | | + | | | | | 19 |
| Boppard | | | | | | + | | | | 20 |
| Bad Breisig | | | | | + | | ? | | | 21 |

**Tab. 19** Structures on sites from the Central Rhineland. Sub-assemblages are shaded grey. For symbols see **tab. 15**; except **?** means possible but anthropogenic formation or relation to the archaeology is uncertain. – For further details see text. – References (ref.): **1** Eickhoff-Cziesla 1992; **2** Floss/Terberger 2002; **3** Holzkämper 2006; **4** Stapert/Street 1997; **5** Gelhausen/Kegler/Wenzel 2004; **6** Bosinski 1979; **7** Buschkämper 1993; **8** Sensburg 2007; **9** Sensburg/Moseler 2008; **10** Terberger 1997; **11** Terberger 1993, 161-166; **12** Verworn/Bonnet/Steinmann 1919; **13** Schmitz 2009; **14** Baales 2002; **15** Baales/Mewis/Street 1998; **16** Bolus 1992; **17** Gelhausen 2011a; **18** Baales 2003b; **19** Gelhausen 2011c; **20** Wenzel 2004; **21** Grimm 2004.

The plates used for the pavement were occasionally knapped to size and/or subsequently slurred by trampling (Veil 1982, 408). Between and below these plates the lithic and organic material was found that presumably fell through gaps and/or were deposited during an earlier occupation episode or phase. The fact that various occupation phases or even episodes formed the concentrations at Andernach was assumed from the various fillings of the pits that were also sealed occasionally by larger plates (Bergmann/Holzkämper 2002, 481-484). However, the time period passed between the various deposits in the pits is difficult to estimate and, thus, the concentrations might have been settled recurrently during specific seasons or for one longer time period.

The density of the stone pavement varied and only concentration I appeared almost completely paved. However, at least for concentration III this scarcity can be partially explained by the incomplete documentation because the larger part of this accumulation lay in the excavation area dug by Schaaffhausen in the 19th century. Moreover, only five pits were attributed to this concentration, whereas in the other concentrations between 13 and 22 pits were recovered. The pits clustered in sub-zones within the stone plate scatters. In these pit zones, the highest density of artefacts were recorded. In parts, this fact was surely due to the good preservation within the pits as a consequence of rapid deposition combined with reduced erosion. Presumably, the pits were dug into the ground for various reasons such as postholes, boiling pits, or refuse pits. Perhaps, some pits were used successively for various tasks. The pits were also considered as hearth pits, but no evidence of this type of use such as coloured and bricked sediment or charcoal deposits was observed. In particular, many exotic items were preserved in the pits and occasionally the accumulated material seemed as a deposition and storage for later use (cache) of these materials (Eickhoff-Cziesla 1992).

Although no evident hearth was detected in Andernach (Veil 1982, 408; Holzkämper 2006, 159), Jörg Holzkämper demonstrated the presence of a central hearth in the concentration IV as well as another hearth at the southern fringe of this concentration by the distribution patterns of various fire indicators such as charcoal or burnt quartz. However, charcoal was only preserved in sheltered areas of concentration IV. In contrast, no charcoal was associated with the lower layer in Andernach 2. Furthermore, burnt quartzes were found in the pits of concentration I and II (Eickhoff-Cziesla 1992, 135. 374) but assumed to rather point to a use of these structures as boiling or refuse pits than representing actual hearths. Some pieces of charcoal from concentration IV were identified as pine (*Pinus* sp., n = 8), willow or poplar (Salicaceae, n = 2), and daphne (*Daphne* sp., n = 2).

Since the well excavated areas were subdivided by the extent of the pit zones and the concentration of stone plates, the majority of lithic artefacts was attributed to the almost completely excavated concentrations I and IV. Baltic flint cores were found exclusively in concentration I and the patinated side-scraper that was also made of Baltic flint was recovered in this concentration. Since the patinated surface was capped by some more recent negatives, Thomas Terberger assumed that the piece was gathered with the other raw material nodules of Baltic erratic flint at the source region (Floss/Terberger 2002, 129), i.e. the piece was probably taken for its suitable shape and raw material, not as a curiosity. However, the distribution of this generally dominant raw materials was varied. The Baltic erratic flint was found scattered across all of the site in varying quantities. In concentration II only some residual cores made of Tertiary quartzite that occurred generally in all concentrations were found in the periphery. The chalcedony cores were associated with concentration III (Floss/Terberger 2002, 26 Abb. 26), whereas the Western European flint cores only occurred in concentration IV. Furthermore, the number of cores associated with the concentrations also differs significantly (**tab. 13**) with a clear accumulation of cores in concentration I (n = 38). The hammerstones were also most frequently connected to the pit area in concentration I, whereas retouchers were basically found in the periphery of concentration I. Moreover, further hammerstones were recovered in the remaining modern excavated pit zone of concentration III, but in concentration II few indications of these rock tools were found. This observation is concomitant with the rarity of cores from this area (n = 3) and, thus, the assumption that blank production played no significant role in this concentration. A comparable picture was recovered in concentration IV where some hammerstones and further indications of an *in situ* blank production process were found but remained meagre (Holzkämper 2006, 100f. 140). Among the five occurrences where material from concentration II was fitted to material from concentration IV (Holzkämper 2006, 138) was one example of a serial blade production including a single preparation flake indicating that perhaps some blank production was performed in the south-western concentration IV, whereas in the north-eastern concentration II the blanks were further retouched (Holzkämper 2006, 101). In Andernach 2, the refitted material (n = 5,334) connected concentration I and III (i. e. E-W orientation) but left out concentration II. The lines running in the direction of concentration II from any of the other concentrations of Andernach 2 were generally associated with the fissures. Besides such inter-concentration connections, intra-concentration clusters were identified by spatial analysis. For example, in Andernach IV a second accumulation of material was found south of the pit zone and was interpreted in combination with the hearth at the fringe and an entrance situation of a suggested dwelling structure (Holzkämper 2006, 21. 32 f.).

However, in all concentrations all types of retouched artefacts occurred, although sometimes in small numbers. Nevertheless, this presence implies that comparable activities were performed in all concentrations but in different intensity. In particular, the LMP, truncations, and borers were distributed relative evenly across the concentrations. In particular, no significant cluster of the LMP that could be identified as an accumulation, for instance, near a hearth was observed thus far in Andernach 2 and in Andernach 3. Although the LMP were generally associated with the suggested hearths, they also accumulated between these centres (Holzkämper 2006, 119f.). The end-scrapers were clearly concentrated in concentration I indicating some type of hide scraping in this area. The burins in concentration III were again mainly associated with the disturbance, and possibly originated from concentration II where the majority of burins (n = 154) was found (Floss/Terberger 2002, 98). In particular, the Lacan type burins occurred with a single exception in concentration II and suggested cutting activities.

The contradictory seasonal indications of the faunal remains can be explained by the spatial distribution of the indicative material: The reindeer and horse teeth suggesting the autumn/winter season were associated with the concentrations I and III, whereas the salmon remains were mainly found in concentration II. The carbon and nitrogen isotope analysis of the material from Andernach 2 could not establish significant differences between the three concentrations (Stevens et al. 2009b). The Andernach IV material provided no samples for isotope analyses nor were seasonal indications recognised yet.

The haematite colouring was not very intensive in Andernach and appeared concentrated in some locations where perhaps haematite lumps were ground to red powder (cf. Holzkämper 2006, 87f.). Whether these areas can be associated with the tanning of animal skins remains unclear, but the adhesive haematite on some end-scrapers, the micro-wear analysis of this type of lithic tools, and the generally congruent distribution of haematite and end-scraper concentrations suggests the use in a common process.

In the eastern part of Andernach 2, the figurines and organic artefacts were found associated with the disturbed channel (Höck 1995, 277-279) and further pieces came from concentration I, often from pits. Since at least the bird figurine originated from the excavation area of Schaaffhausen some art was connected with concentration III. Equally, the two pieces from Andernach 3 originated from such sheltered situations (Holzkämper 2006, 160).

The Magdalenian concentrations at Andernach were considered as habitation sites with (paved) dwelling constructions (Holzkämper 2006, 14-28). In the Central Rhineland the discussion of Magdalenian dwelling constructions and structuring of habitation sites was mainly based on the Gönnersdorf site but applied equally to the lower horizon of Andernach (Eickhoff-Cziesla 1992). However, this discussion is presented in more detail in the presentation of Gönnersdorf (see p. 116-122).

In general, the concentrations in Andernach were considered to represent a base camp due to the large variety of material, the often high number of single specimens within the various material groups, and the massive constructions. The recovered constructions seemed to be made for a longer duration, and for the creation of these structures, a group of people was needed.

Chronology of the lower horizon

Meanwhile, Andernach with its 35 $^{14}C$ dates is one of the most frequently $^{14}C$-dated sites of the Lateglacial record in north-western Europe (**tab. 20**). However, several dates have to be rejected due to various reasons and some other dates referred to younger occupation events at the same site (see p. 265-269). Thus far, Late Magdalenian samples were only received from the concentrations I, II, and III. A temporal distinction of the dates from the various concentrations was not possible. They covered a period of 13,450-12,690 years $^{14}C$-BP. After calibration this period fell completely into the Late Pleniglacial (16,920-15,000 years cal. b2k; see p. 466-470).

The stratigraphic position in a loess deposit as well as the presence of a fauna preferring cold and open habitat sustained the radiometric attribution.

Nevertheless, for the lower horizon at Andernach more considerations concerning the spatial structuring and, perhaps, chronological development can be further probed after the accomplishment of a currently prepared synthesis of the site that focuses particularly on the spatial patterns of this major Late Magdalenian site (pers. comm. Martin Street, Neuwied). This analysis will also help reveal the settlement dynamics between the concentrations by outlining various working areas as well as defining their precise temporal development.

However, according to the thus far known evidence, at least two quasi-contemporary occupation events (concentration I/III and concentration II/IV) were distinguished in the chronology of the lower horizon of Andernach. The temporal distinction of these events is beyond the possible resolution of radiocarbon dating. Furthermore, each occupation event was related to two concentrations that were formed by several occupation phases if not distinct episodes.

Archaeological material of the upper horizon

As explained previously, the 3,794 lithic artefacts mentioned in the various analyses for the upper horizon (**tab. 11**; Bolus 1984; Gelhausen/Kegler/Wenzel 2004) represent an approximate value. Besides the occasionally uncertain attribution of individual specimens, Michael Bolus did not specify whether his number of 2,894 lithic artefacts for Andernach 2 included splinters i. e. the value might be too high for artefacts ≥ 1 cm (Bolus 1984). However, Harald Floss mentioned only some 101 lithic artefacts less but clearly stated that only 1,377 pieces were larger than 1 cm (Floss 1994, 272). Yet, the size distribution of the additional 100 items remains unclear. Furthermore, Jan Kegler included only the chalcedony artefacts (Gelhausen/Kegler/Wenzel 2004, 71; cf. Kegler 2002, 501 f.), probably due to the problems of distinguishing pieces made of other raw materials from the Late Magdalenian artefacts i. e. the value for Andernach 3 might be too low. Moreover, refitted material proved that, in the material excavated by Schaaffhausen in 1883, further remains of the FMG could be found (Bolus/Street 1985). Thus, a reanalysis and/or a more comprehensive publication of the Andernach material with special reference to the lithic artefacts would be particularly appreciable for the FMG component. A technological reanalysis of the FMG material from Andernach by Ludovic Mevel is on-going. Preliminary observations by him indicated that, in general, the reduction of the materials was comparable for the FMG material in the two modern areas of Andernach, but that some raw material types were treated differently in two notable cases. In one case the difference is perhaps due to the quality of the raw material (Tertiary quartzite), and in the other case (Western European flint, type 11) a Late Magdalenian intrusion was considered possible (written comm. Ludovic Mevel, Nanterre).

| site | lab. no. | years $^{14}$C-BP | ± years | material | species | comment | years cal. b2k | ref. |
|---|---|---|---|---|---|---|---|---|
| Andernach, lower horizon III (?) | *OxA-10492*** | *13,500* | *90* | rib | *Equus* sp. | cut-marks; REJECT: redating available | × | 1-4 |
| Andernach, lower horizon III (?) | OxA-10651** | 13,270 | 180 | phalanx | *Equus* sp. | | 17,100-15,500 | 1-4 |
| Andernach, lower horizon II | OxA-1128 | 13,200 | 140 | rib | *Equus* sp. | sample from pit | 16,920-15,520 | 3-5 |
| Andernach, lower horizon III (?) | OxA-10493** | 13,185 | 80 | rib | *Equus* sp. | cut-marks | 16,720-15,640 | 1-4 |
| Andernach, lower horizon I / upper horizon 2 | GrA-16986 | 13,180 | 70 | shaft fragment | *Cervus elaphus* | impact scar | 16,670-15,670 | 6 |
| Andernach, lower horizon I | OxA-V-2216-43 | 13,135 | 55 | humerus | *Equus* sp. | | 16,540-15,620 | 4 |
| Andernach, lower horizon I / upper horizon 2 | GrA-16985 | 13,110 | 80 | shaft fragment | *Cervus elaphus*? | | 16,550-15,550 | 6 |
| Andernach, lower horizon II | OxA-V-2218-40 | 13,110 | 50 | humerus | *Equus* sp. | | 16,390-15,630 | 4 |
| Andernach, lower horizon II | OxA-1129 | 13,090 | 130 | fragments | *Equus* sp. | sample from pit | 16,680-15,400 | 3-5 |
| Andernach, lower horizon III (?) | OxA-18409** | 13,025 | 50 | rib | *Equus* sp. | cut-marks; redating of OxA-10492 | 16,220-15,500 | 4; 7 |
| Andernach, lower horizon I | OxA-V-2218-38 | 13,015 | 50 | metatarsus | *Equus* sp. | | 16,210-15,490 | 4 |
| Andernach, lower horizon III | OxA-1130 | 12,950 | 140 | bone fragments | *Equus* sp. | sample from pit | 16,410-15,170 | 3-5 |
| Andernach, lower horizon I | OxA-1125 | 12,930 | 180 | bone fragments | *Equus* sp. | sample from pit | 16,530-15,010 | 3-5 |
| Andernach, lower horizon I | OxA-1126 | 12,890 | 140 | rib | *Equus* sp. | sample from pit | 16,270-15,070 | 3-5 |
| Andernach, lower horizon II | OxA-1127 | 12,820 | 130 | bone fragments | *Equus* sp. | sample from pit | 15,920-15,000 | 3-5 |
| Andernach, lower horizon III | OxA-V-2223-37 | 12,675 | 55 | humerus | *Equus* sp. | sample from pit | 15,440-15,000 | 4 |
| Andernach, upper horizon 2 | *OxA-999* | *12,500* | *500* | shaft fragments | *Cervus elaphus* | REJECT: redating available | × | 3-4; 8 |
| Andernach, upper horizon 2 | OxA-985 | 12,300 | 200 | bone | *Rupicapra rupicapra*? | PROBLEMATIC: large standard deviation | 15,340-13,620 | 3-4; 8 |
| Andernach, upper horizon 2 | OxA-V-2218-39 | 12,270 | 50 | femur | *Equus* sp. | | 14,560-13,960 | 4 |
| Andernach, upper horizon 2 | GrA-16987 | 12,050 | 70 | scapula fragments | *Castor fiber* | | 14,100-13,700 | 4; 6 |

**Tab. 20** $^{14}$C dates from sites from the Central Rhineland. If the sub-assemblage is known from which the sample originated, the sub-assemblage is given behind the site name. ***** dates which were pretreated by the use of ion-exchanged gelatin (Lab.code: AI) in the Oxford series (cf. Jacobi/Higham 2009, 1896); ****** dates which might be contaminated due to the use of a method leaving traces of a humectant in the collagen (Lab.code: AF*) in the Oxford series (cf. Higham et al. 2007, S55 & S2). Doubtful dates are shaded grey. Rejected dates are shaded grey and set in italics and, in addition, the main reason for rejection is given in comment. For further details see p. 265-269 and text. The dates were calibrated with the calibration curve of the present study (see p. 358-364) and the calibration program CalPal (Weninger/Jöris/Danzeglocke 2007). The result range of 95 % confidence is given for the calibrated ages (years cal. b2k). – References (ref.): **1** Bronk Ramsey et al. 2002; **2** Stevens/Hedges 2004; **3** Street/Terberger 2004; **4** Stevens et al. 2009b; **5** Hedges et al. 1987; **6** Kegler 2002; **7** Higham et al. 2011; **8** Gowlett et al. 1987; **9** Street 1993; **10** Münnich 1957; **11** Schwabedissen 1957; **12** Higham et al. 2007; **13** Hedges et al. 1998b; **14** Brunnacker 1978d; **15** Evin/Marien/Pachiaudi 1975; **16** Evin/Marien/Pachiaudi 1978; **17** Street/Baales/Weninger 1994; **18** Baales/Street 1998; **19** Baales 2002, 11 f. 40-45; **20** Baales/Mewis/Street 1998; **21** Lanting/Niekus/Stapert 2002; **22** kind permission of Stefan Wenzel; **23** Baales/Jöris 2001.

| site | lab. no. | years $^{14}$C-BP | ± years | material | species | comment | years cal. b2k | ref. |
|---|---|---|---|---|---|---|---|---|
| Andernach, upper horizon 2 | GrA-16991 | 12,040 | 70 | shaft fragment | *Bos* sp./*Bison* sp. | | 14,090-13,690 | 4; 6 |
| Andernach, upper horizon 2 | GrA-16989 | 11,960 | 70 | metatarsal fragment | *Cervus elaphus* | | 13,980-13,660 | 4; 6 |
| Andernach, upper horizon 2 | OxA-984 | 11,950 | 250 | shaft fragments | *Cervus elaphus* | re-dating of OxA-999 | 14,670-13,190 | 3-4; 8 |
| Andernach, upper horizon 2 | OxA-1924 | 11,890 | 120 | bone | *Cervus elaphus* | | 14,030-13,430 | 3-4; 9 |
| Andernach, upper horizon 2 | GrA-16990 | 11,820 | 70 | bone | artiodactyl | | 13,800-13,480 | 4; 6 |
| Andernach, upper horizon 2 | OxA-997 | 11,800 | 160 | bone | *Cervus elaphus* | | 13,980-13,300 | 3-4; 8 |
| Andernach, upper horizon 3 | GrA-16993 | 11,590 | 80 | bone | | northern concentration | 13,590-13,230 | 4; 6 |
| Andernach, upper horizon 2 | OxA-998 | 11,370 | 160 | bone | *Bos* sp./ *Bison* sp. | | 13,550-12,910 | 3-4; 8 |
| Andernach, upper horizon 1 | *H-85/91* | *11,300* | *220* | antler protein | Cervidae | REJECT: pretreatment, protein, material, uncertain association | × | 4; 10-11 |
| Andernach, upper horizon 3 | GrA-16994 | 11,160 | 70 | bone | | southern concentration | 13,190-12,870 | 4; 6 |
| Andernach, upper horizon 2 | *GrA-16521* | *10,970* | *60* | calcined bone | | REJECT: calcined bone | × | 4; 6 |
| Andernach, upper horizon 2 | *GrA-16613* | *9,490* | *45* | calcined bone | | REJECT: calcined bone | × | 4; 6 |
| Andernach, upper horizon 3 | *GrA-16618* | *7,550* | *40* | calcined bone | | REJECT: calcined bone | × | 4; 6 |
| Andernach, upper horizon 2 | *GrA-16616* | *7,360* | *40* | calcined bone | | REJECT: calcined bone | × | 4; 6 |
| Andernach, upper horizon 3 | *GrA-16621* | *5,775* | *40* | calcined bone | | REJECT: calcined bone | × | 4; 6 |
| Andernach, upper horizon 1? | *H193-178* | *4,330* | *360* | bone | | REJECT: carbonate fraction | × | 4; 10 |
| Gönnersdorf II | *OxA-10199*** | *14,570* | *90* | ivory | *Mammuthus primigenius* | worked; REJECT: probably fossil material | 18,030-17,590 | 3-4 |
| Gönnersdorf I | *OxA-10239* | *14,380* | *100* | femur | *Mammuthus primigenius* | REJECT: probably fossil material | 17,990-17,190 | 3-4 |
| Gönnersdorf II | *OxA-10200*** | *13,810* | *90* | molar fragment | *Coelodonta antiquitatis* | REJECT: probably fossil material | 17,150-16,950 | 3-4 |
| Gönnersdorf II | *OxA-10201*** | *13,610* | *80* | molar fragment | *Coelodonta antiquitatis* | REJECT: probably fossil material | 17,070-16,790 | 3-4 |
| Gönnersdorf I | OxA-V-2223-39 | 13,270 | 55 | metatarsal | *Equus* sp. | | 16,810-16,090 | 4 |
| Gönnersdorf II | OxA-V-2223-40 | 13,165 | 55 | metatarsal | *Equus* sp. | | 16,600-15,680 | 4 |
| Gönnersdorf II | OxA-V-2223-41 | 13,095 | 55 | scapula | *Bison* sp. | | 16,360-15,600 | 4 |
| Gönnersdorf III | OxA-V-2223-43 | 13,075 | 55 | metapodial | *Rangifer tarandus* | | 16,330-15,570 | 4 |
| Gönnersdorf III | OxA-15295 | 13,060 | 60 | metapodial | *Rangifer tarandus* | marrow fractured | 16,310-15,550 | 4; 12 |
| Gönnersdorf II | OxA-V-2223-31 | 13,010 | 55 | metatarsal | *Rangifer tarandus* | | 16,220-15,460 | 4 |
| Gönnersdorf I | OxA-V-2223-42 | 12,990 | 55 | metatarsal | *Rangifer tarandus* | | 16,180-15,420 | 4 |

**Tab. 20** (continued)

| site | lab. no. | years $^{14}$C-BP | ± years | material | species | comment | years cal. b2k | ref. |
|---|---|---|---|---|---|---|---|---|
| Gönnersdorf I | OxA-5729* | 12,910 | 130 | rib fragments | *Equus* sp. | | 16,290-15,130 | 3-4; 13 |
| Gönnersdorf | *KN-1980* | *12,910* | *105* | mollusc shell | | REJECT: no association | × | 4; 14 |
| Gönnersdorf I | OxA-5730* | 12,790 | 120 | rib fragments | *Equus* sp. | | 15,810-14,970 | 3-4; 13 |
| Gönnersdorf I | OxA-5728* | 12,730 | 130 | rib fragments | *Equus* sp. | | 15,760-14,720 | 3-4; 13 |
| Gönnersdorf | Ly-1172 | 12,660 | 370 | rib fragments | *Equus* sp.? | PROBLEMATIC: bulked sample | 16,680-13,600 | 4; 15 |
| Gönnersdorf | Ly-768 | 12,380 | 230 | bones | | PROBLEMATIC: bulked sample | 15,520-13,680 | 4; 16 |
| Gönnersdorf II | *OxA-2069* | *11,830* | *110* | ivory | *Mammuthus primigenius* | worked; REJECT: post-LST date | × | 4; 17 |
| Gönnersdorf | *Ly-1173* | *11,100* | *650* | rib fragments | *Equus* sp.? | REJECT: bulked sample; post-LST date | × | 4; 16 |
| Gönnersdorf | *KN-1979* | *10,540* | *210* | mollusc shell | | REJECT: no association; post-LST date | × | 4; 14 |
| Gönnersdorf V | OxA-15296 | 12,385 | 65 | radius | *Alces alces* | PROBLEMATIC: uncertain association | 15,010-14,050 | 12 |
| Wildweiberlei | OxA-18410** | 12,835 | 55 | modified antler | *Rangifer tarandus* | (dated after recognition of possible contamination) | 15,660-15,300 | 7 |
| Oberkassel | OxA-4793* | 12,270 | 100 | ulna | *Canis familiaris* | | 14,820-13,820 | 3; 13; 18 |
| Oberkassel | KIA-4162 | 12,210 | 60 | humerus | *Canis familiaris* | | 14,300-13,900 | 18 |
| Oberkassel | OxA-4792* | 12,180 | 100 | humerus | *Homo sapiens* | female | 14,470-13,750 | 3; 13; 18 |
| Oberkassel | KIA-4161 | 12,110 | 45 | maxilla, I2, I3 | *Canis familiaris* | | 14,140-13,780 | 18 |
| Oberkassel | OxA-4791* | 11,780 | 90 | os penis | *Ursus spelaeus* (?) | | 13,780-13,430 | 3; 13; 18 |
| Oberkassel | KIA-4163 | 11,620 | 60 | ulna | *Canis familiaris* | | 13,600-13,280 | 18 |
| Oberkassel | OxA-4790* | 11,570 | 100 | humerus | *Homo sapiens* | male | 13,600-13,200 | 3; 13; 18 |
| Irlich | OxA-9736** | 12,310 | 120 | rib | *Homo sapiens* | adult; PROBLEMATIC: brownish bone | 15,030-13,830 | 1; 19 |
| Irlich | UtC-9221 | 12,110 | 90 | long bone | *Homo sapiens* | red coloured; neonate | 14,220-13,700 | 1; 19 |
| Irlich | OxA-9848** | 11,965 | 65 | rib | *Homo sapiens* | neonate | 13,980-13,660 | 1; 19 |
| Irlich | OxA-9847** | 11,910 | 70 | femur | *Homo sapiens* | red coloured; adult | 13,930-13,570 | 1; 19 |
| Irlich | *OxA-9876*** | *2,660* | *40* | skull cap | *Homo sapiens* | adult; REJECT: brownish bone; Holocene age | × | 1; 19 |
| Kettig | *GrA-12396* | *11,960* | *90* | bone | | REJECT: calcined bone | × | 1 |
| Kettig | *GrA-14171* | *11,720* | *60* | bone | | REJECT: calcined bone | × | 19 |

**Tab. 20** (continued)

| site | lab. no. | years $^{14}$C-BP | ± years | material | species | comment | years cal. b2k | ref. |
|---|---|---|---|---|---|---|---|---|
| Kettig | *GrA-13389* | *11,710* | *50* | bone | | REJECT: calcined bone | × | 19 |
| Kettig | Hd-18123 | 11,314 | 50 | bones | cf. *Cervus elaphus* | PROBLEMATIC: bulked material | 13,280-13,040 | 19 |
| Kettig | *GrA-14762* | *11,210* | *60* | metacarpal | *Capreolus capreolus* | REJECT: calcined bone | × | 19 |
| Urbar | OxA-1137 | 11,350 | 120 | bone | *Cervus elaphus* | | 13,440-12,960 | 3; 19-20 |
| Niederbieber 9 | *GrA-16622* | *11,290* | *40* | bone | | REJECT: calcined bone | × | 21 |
| Niederbieber 3 | OxA-1135 | 11,130 | 130 | astralagus | *Equus* sp. | PROBLEMATIC: uncertain association | 13,260-12,700 | 3; 19 |
| Niederbieber 2 (19) | OxA-2066 | 11,110 | 110 | bone | *Alces alces* | | 13,210-12,690 | 3; 19 |
| Niederbieber 1 | *OxA-1132* | *10,700* | *130* | bone | *Cervus elaphus* | REJECT: post-LSE date | × | 3; 19 |
| Niederbieber 4 | *OxA-1136* | *10,480* | *130* | shaft fragment | *Cervus elaphus* | REJECT: post-LSE date | × | 3; 19 |
| Niederbieber 17 | *GrA-18672* | *10,420* | *110* | bone | | REJECT: poor carbon quality; post-LSE date | × | 21 |
| Niederbieber 7 | *OxA-2067* | *10,390* | *100* | bone | *Cervus elaphus?* | REJECT: post-LSE date | × | 3; 19 |
| Niederbieber 17 | *GrA-18881* | *10,390* | *80* | bone | | REJECT: poor carbon quality; post-LSE date | × | 21 |
| Niederbieber 2 (19) | *OxA-1133* | *9,750* | *240* | bone | *Alces alces*? | REJECT: post-LSE date | × | 3; 19 |
| Niederbieber 2 (19) | *OxA-1134* | *6,250* | *130* | tooth | *Equus* sp. | REJECT: post-LSE date | × | 3; 19 |
| Boppard | KIA-26644 | 11,095 | 55 | metapodial | *Cervus elaphus* | | 13,110-12,750 | 22 |
| Bad Breisig | GrA-17493 | 10,840 | 60 | charcoal | *Pinus* sp. | | 12,820-12,660 | 23 |
| Bad Breisig | *GrA-17642* | *10,480* | *80* | charcoal | | REJECT: uncertain association | × | 23 |
| Bad Breisig | *GrA-17716* | *10,220* | *60* | calcined bone | | REJECT: calcined bone | × | 23 |

**Tab. 20** (continued)

In addition to the chalcedonies, which probably originated from Bonn-Muffendorf some 30 km north-northwestwards of Andernach (**tab. 12**), several pieces of various Western European flint varieties and Baltic erratic flint (cf. Floss 1994, 271-283) were singled out from the Late Magdalenian assemblage and attributed to the FMG inventory due to the lack of patination (Veil 1982, 400) and/or their typological classification (cf. Kegler 2002, 502). Furthermore, due to the latter reason, pieces of Tertiary quartzite and indurated slate were also attributed to the upper horizon of Andernach 3. Both materials occurred also in Andernach 2 where Tertiary quartzite was, in fact, the dominant raw material. Additionally, in Andernach 2 siliceous oolite was recorded as well as the silicified limestone. The former raw material originated presumably from the Mainz Basin, at least 70 km to the south-east, or possibly from the Rhine gravels. The silicified limestone was probably picked up from gravels, possibly local or farther upstream or from the Nahe, some 60 km south-east of Andernach. In total, approximately 20 nodules of 13 different varieties were assumed to have been brought to the site (Stapert/Street 1997, 179). The amount of pieces with cortex indicated the transport of small, unprepared nodules of the foreign raw materials to the site (Veil 1982, 400). Hence, the lithic raw material attributed to Andernach 2-FMG is very heterogeneous.

At least 66 core and core fragments were recovered during the two modern excavations (**tab. 13**). In Andernach 2 the blank production was described as an opportunistic strategy which produced particularly flakes (Bolus 1984, 60; Stapert/Street 1997, 179). However, this picture can already be revised by the preliminary observations of Ludovic Mevel: The various blanks indicated the flexible use of a soft hammerstone to receive various blank types depending, presumably, on the quality and, perhaps, on the exploitation stadium of the raw material (written comm. Ludovic Mevel, Nanterre; Mevel/Grimm 2019). The cores which were worked from two platforms were frequently not in a polar but transversal or angular orientation to one another (Bolus 1984, 49-54). Michael Bolus recognised a relatively large number of blanks with cortex and he suggested therefore the introduction of the material in raw nodules (Bolus 1984, 58 f.). Thus far, only the retouched artefacts were analysed in Andernach 3 (Kegler 2002). Hence, the technology can only be partially read from the blanks chosen for further retouch which was mainly performed on bladelets for the LMP and dominantly flakes for the other tools, although blades and bladelets were also used (Kegler 1999). Consequently, the Andernach 3 material was presumably produced with a strategy similar to Andernach 2. This assumption was also supported by Ludovic Mevel's preliminary observations (written comm. Ludovic Mevel, Nanterre).

In total, 280 intentionally retouched pieces were found in the upper horizon (**tab. 14**). Furthermore, almost 200 pieces of tool production wastes such as end-scraper caps (n = 134) and burin spalls (n ≥ 63) were identified. These specimens indicated the production and/or resharpening of the tools on the site. Thus far, no wastes of the LMP production were found, although the LMP (n = 128) dominated clearly among the retouched artefacts. Almost 70 of these pieces were unambiguous points and according to Michael Bolus and Jan Kegler over 50 were *Federmesser*. Yet, the pieces displayed by Jan Kegler appear more variable in their morphology (Kegler 2002, 505 Abb. 5). Among the 39 backed blades and bladelets only one with two truncations and one laterally retouched piece occurred, all the others were simple ones. Four specimens from Andernach 2 were classified as pieces which were distally pointed by lateral retouch, but at least one of these specimens was used as a perforator (Bolus 1984; Plisson 1985). The truncations (n = 20) were in fact dominantly oblique (n = 15). End-scrapers and burins occurred in equal numbers (n = 41). The former were dominantly of the small, thumb-nail variant on flakes (n = 22). The latter group was diverse with those specimens on broken or natural edges (n = 14) being most numerous followed by dihedral types (n = 10) and burins on truncation (n = 8). The three composite tools were all combinations of burin and end-scraper. Some 35 pieces were laterally retouched. A further six artefacts were identified as splintered pieces.

259 pieces were examined for micro-wear traces and on at least 65 traces of use were recognised. Besides the backed pieces, ten unmodified artefacts showed traces of use as parts of projectiles (Plisson 1985) and one backed piece yielded residues interpreted as hafting glue (Kegler 1999, 42).

In the upper horizon of each excavation area a retoucher was found (Bolus 1984; Kegler 2002). Moreover, hammerstones were probably associated with the upper horizon in Andernach 3 but these specimens were not further analysed thus far (Kegler 2002, 508).

Comparable to the other material, the fauna of the upper horizon from Andernach 2 (**tab. 15**; Street 1993; Street et al. 2006) was difficult to distinguish from the material of the lower horizon. However, 407 remains were determinable and clearly dominated by red deer (*Cervus elaphus*, n = 209, MNI = 5). Further large game species were present such as two large cattle (*Bos* sp., n = 54), presumably aurochs (cf. *Bos primigenius*), and an elk (*Alces alces*, n = 36). Furthermore, the remains of at least two chamois (*Rupicapra rupicapra*, n = 26) and two beavers (*Castor fiber*, n = 44) were identified. In addition, some 320 fish bones were found and attributed generally to fish of the Cyprinidae (n = 89) family, usually Eurasian dace (*Leuciscus* sp.), in particular,

European chub (*Leuciscus cephalus*, n = 177). Moreover, remains of pike (*Esox lucius*, n = 47) were also frequent. Common minnow (*Phoxinus phoxinus*, n = 5) and European perch (*Perca fluviatilis*, n = 1) were rarely determined. The European bullhead (*Cottus gobio*, n = 1) is a small and bony fish which in the upper horizon of Andernach was probably a natural intrusion. The association of the few bones of horse (*Equus* sp., n = 4) and of the remains of roe deer (*Capreolus capreolus*, n = 5) with the upper horizon were also uncertain. Meanwhile a humerus of horse was dated slightly younger than the Late Magdalenian phase and a group of $^{14}C$ dates on horse, red deer, beaver, and bovid remains formed an intermediate period (see p. 468-470; Stevens et al. 2009b). A milk tooth of red deer and unworn teeth of large bovids as well as the absence of antlers could indicate a hunting season in late spring to summer (Street 1993, 135). Several of the bones displayed cut-marks and the spatial distribution suggested butchering, the extraction of marrow as well as discard activities on the site (Street 1993; Street et al. 2006, 776). A further 535 faunal remains larger than 3 cm were found in the upper horizon of Andernach 3 (Gelhausen / Kegler / Wenzel 2004, 71). The presence of red deer was also suggested for this concentration by a provisional analysis but the material was poorly preserved and a final analysis is not yet available (Street et al. 2006, 765).
Among the organic material of Andernach 2, a tooth of red deer was found which wore parallel incisions at its root (**tab. 18**). This piece is one of the rare items identified as special goods within the FMG inventories.

Spatial organisation of the upper horizon
FMG material was found in each modern area and was also present in the Schaaffhausen area according to the material from this collection (Veil 1982; Gelhausen / Kegler / Wenzel 2004; Street et al. 2006). Thus, a widespread scatter of FMG material on the Martinsberg is evident.
The distribution of burnt bone, quartz, burnt lithic material, and charcoal indicated the presence of three latent hearths in Andernach 2 and further supported the observation of two hearths in Andernach 3 (**tab. 19**). In Andernach 2, one hearth was situated in the eastern part near the infilled fissure lacking charcoal but surrounded by a lithic concentration. A second hearth dominated by charcoal of willow and situated in approximately the centre of the excavation area was associated with beaver remains (Stapert / Street 1997, 180). The third hearth of Andernach 2 was set only some metres westwards of the second, and contained birch, willow, and perhaps pine charcoal. It was associated with red deer and fish remains. The latter two hearths were located in the main lithic concentration of the upper horizon at Andernach 2. Moreover, the remains appeared directly overlaying the Late Magdalenian material, suggesting either a short time elapsed between these occupation phases, or a hearth which was dug in the sediment or the existence of structural post-holes (Stapert / Street 1997, 180) in which the material was transferred vertically within the stratigraphy. In fact, the faunal remains associated with the two hearths were generally dated to an early FMG period (Stevens et al. 2009b). The surroundings of these hearths were connected by refittings of lithic material and the faunal remains were conjoined across the complete excavated area (Stapert / Street 1997, 184). Density analysis with Dick Stapert's »ring and sector« method (Stapert 1992, cf. Wenzel 2009, 19) demonstrated some type of wall effect around these hearths (Stapert / Street 1997, 180-192). Yet, the analysis was based only on a small area with some overlap and generally few artefacts (Stapert / Street 1997, 180 f.). However, this analysis suggested areas of increased density (cf. Gelhausen 2010) for both hearths on the eastern side of the hearths and Dick Stapert and Martin Street assumed that the opposing distribution of various raw materials in this area indicated the presence of two flintknappers (Stapert / Street 1997, 190-192). Additionally, the western part of the Andernach 2 area was less disturbed, and the various raw material nodules showed some concentrated accumulations indicating varying knapping events (Stapert / Street 1997, 179). In the north-western area of Andernach 2, material of a black variety of a Western European flint (n = 146) was found which was of good quality and wore a fresh limestone cortex. This raw material

yielded some relatively long flakes (l = 6.4 cm) and could not be associated with any of the hearths of Andernach 2. Thus, this material might originate from an event which can be singled out (Stapert / Street 1997, 182-184; pers. comm. Martin Street, Neuwied). The chalcedonies occurred mainly in a southern concentration of Andernach 2. Perhaps this accumulation was associated with the Andernach 3 concentrations or another, unexcavated concentration. Material refitting might help prove an actual connection of the varied concentrations. In Andernach 2, two further concentrations were singled out east and west of the eastern fissure (Bolus 1984; Bolus 1991).

The two hearths of Andernach 3 were surrounded by archaeological material and also observable during the excavation by reddish and bricked sediment (Gelhausen / Kegler / Wenzel 2004, 71 f.). In contrast to the Andernach 2, the highest density around the hearths from Andernach 3 occurred on the western to southern side of the hearth. Again, the backed implements were tendentially closer to the hearths then the other tool types. Due to density distributions of the isopach type (e. g. Gelhausen / Kegler / Wenzel 2004, 70; Gelhausen / Kegler / Wenzel 2005, 2-4; Wenzel 2009, 19 f.) and the spread of refittings, Jan Kegler assumed the southern hearth to be encircled by some type of wall, probably a dwelling structure (Gelhausen / Kegler / Wenzel 2004). On the northern periphery of the southern accumulation, some pieces of charcoal, lithic debris, a bone fragment, and a small quartzitic slate plate were found in a 20 cm deep pit of 10 cm in diameter (Gelhausen / Kegler / Wenzel 2004, 72). However, this feature was located within one of the disturbing fissures as well as only some centimetres from the basalt distribution of the Magdalenian concentration and in addition only 1 m west of the westernmost Magdalenian pit (cf. Gelhausen / Kegler / Wenzel 2004, 74 fig. 3 d with Bergmann / Holzkämper 2002, 473 Abb. 2 and Holzkämper 2006, Abb. 3. 7). Thus, an association with the Magdalenian occupation and successive infilling also with younger material cannot be completely excluded. Nonetheless, Jan Kegler assumed the pit to represent a post-hole in the entrance area of the potential dwelling (Gelhausen / Kegler / Wenzel 2004, 74). The cores were dominantly recovered outside this supposed structure, several scattered clearly eastwards of the general artefact concentration but could partially be refitted to pieces in the southern concentration. Furthermore, Kegler considered the northern accumulation to represent an associated outside working area. Yet, the refittings from both areas were exclusive, but the densities appeared amalgamating in parts and the northern concentration was poor in cores and retouched specimens.

Chronology of the upper horizon

From the upper horizon in Andernach, 22 samples were taken for $^{14}C$ dating. Only two of these samples originated from Andernach 3 and further two were taken from the Schaaffhausen collection. The latter produced no reliable dates. The majority of dates (n = 16) refers to Andernach 2 and a group of these dates (n = 7) made in two different laboratories resulted in a consistent set (12,120-11,640 years $^{14}C$-BP; 14,100-13,300 years cal. b2k) which dates the occupation to the mid-Lateglacial Interstadial (GI-$1c_3$; see p. 468-470). However, two dates (GrA-16986 and GrA-16985) produced Late Pleniglacial ages, although the preservation condition of the material and the determination suggested an attribution to the FMG assemblage (pers. comm. Martin Street, Neuwied). Another older date (OxA-985) made on chamois remains was not redated and could not be excluded. A more recently dated horse femur yielded a comparable age (OxA-V-2218-39) and indicated the possibility of an early Lateglacial phase at the site (cf. Stevens et al. 2009b). One date (OxA-998) was made on a bone from a large bovid and was considerably younger than the main group of dates from Andernach 2. Besides the possibility of contamination, the bone was found in the south of Andernach 2 related to a possibly younger chalcedony concentration. Furthermore, one set of calcined bones from Andernach 2 (n = 3) and Andernach 3 (n = 2) was part of a pilot study revealing the problems inflicted with calcined bones in the Lateglacial (Lanting / Aerts-Bijma / van der Plicht

2001; Lanting/Niekus/Stapert 2002) and, therefore, could be rejected. One sample with a relatively old result (OxA-999) was redated and produced a younger date (OxA-984). In Andernach 3, an older $^{14}C$ date (GrA-16993) was made on a bone recovered west of the northern hearth and a younger date (GrA-16994) was also made on a bone sample that was recovered from the material south-west of the southern hearth (Kegler 2002, 511-514). The two reliable dates are clearly younger than the main set of dates from Andernach 2 (**tab. 20**) and surround the younger bovid date of Andernach 2. In general, the latent hearths in the centre of the excavation area 2 were already considered as stratigraphically lower (Stapert/Street 1997, 180), and thus concomitant with an interpretation of a younger occupation in the southern concentration. However, the accumulations in Andernach 2 were formed dominantly by Tertiary quartzite and Western European flint and no other peculiarities for FMG assemblages concerning the technical, subsistence related, or spatial behaviour were observed thus far in this area. Nevertheless, the underlying basalt fissures and erosive process resulted in some disturbances of the site which can only be resolved in parts by a comprehensive spatial analysis which is currently accomplished by Martin Street (Neuwied, pers. comm.). Possibly, this examination allows further assumptions on the connections of the varied lithic and faunal material in the different episodes to be made. Clearly, an evaluation of the many $^{14}C$ dates from the upper horizon (see p. 265-269) can help to shape the hypothesis of the chronological development of the site in Andernach.

Chronology of the Andernach site

In general, the archaeological material was attributed to either the lower or the upper horizon thus far. However, the serial $^{14}C$ dating of faunal remains (**tab. 20**) revealed more than two clusters of reliable dates suggesting a possible intermediate event as well as a later event at the site.

In particular, two $^{14}C$ dates point to an early Lateglacial Interstadial dating. One date was on a sample of horse (*Equus* sp.; OxA-V-2218-39) and another one on bones of probably chamois (*Rupicapra rupicapra*; OxA-985). The possible chamois bones were dated early in the times of applying the AMS-procedure and, thus, the date encountered a relatively large standard deviation. Since another sample from the same series (OxA-999) resulted in a demonstrably too old date, the date for the chamois sample could also be questioned.

Nevertheless, the horse femur was dated and analysed very recently. This single piece of evidence was found in the south-western part of the central Andernach 2-FMG concentration and immediately outside the pit area of the Late Magdalenian Andernach I. Thus, either an unknown problem caused an erroneous dating of the horse bone or the date is correct. However, if the date is correct, the equivalent archaeological material is questionable. Perhaps, a good quality black flint could be associated with the more recent date because tools of the black variety were, in fact, found in the vicinity of the dated material (cf. Stapert/Street 1997, 183f.; Stevens et al. 2009b). If this association was correct, the evidence would hint to a transitional complex which technically and according to the dated fauna (horse) was still close to the Late Magdalenian but according to the stratigraphy and the tool types was already changing towards the FMG.

A later event at the site was suggested by three younger dates and appeared to be associated with the use of chalcedonies in the south of Andernach 2 and in Andernach 3.

Presumably, the spatial reanalysis that is currently in progress, supplemented by the on-going comprehensive technological studies of the material by Ludovic Mevel, can reveal the varied settlement dynamics forming the documented pattern and, thus, help associate the sample with lithic materials and/or spatial structures. Clearly, the results help to further evaluate the significance of the single date.

However, the various clusters of $^{14}C$ dates from the Late Magdalenian to the FMG showed perhaps that the Martinsberg in Andernach continued to represent a favourable settlement place from the Late Pleniglacial through the onset of the Lateglacial Interstadial into its younger part.

## Gönnersdorf, Neuwied, Rhineland-Palatinate

### Research history

In 1968 slate plates and bones were observed during a house construction which included a deep pit for a cellar at Gönnersdorf (Bosinski 1979, 14f.), a part of the village Feldkirchen that meanwhile became a district of the town Neuwied/Rhine. A small rescue excavation under the supervision of Gerhard Bosinski provided a profile and a first impression of the significance of this open-air site because along with lithic artefacts and a slate pavement, figurines, jet beads, drilled animal teeth, engraved plaquettes, and well preserved organic material was also recovered from haematite stained sediment. From 1970 to 1976 several field seasons uncovered 687 m² in an area of some 30 m (E-W) by 50 m (N-S) and in the north-east of this main area an additional 36 test pits of 1 m × 0.5 m width reached approximately 15 m farther to the north and almost 20 m farther to the east to locate the end of the site. These test pits yielded some higher densities of lithic remains immediately adjacent to the north-eastern corner of the main excavation area but the density ceased farther to the north and east. However, beyond this test pit area, north-east- and eastwards there was further space for settlement structures on the plateau, but existing development prohibited further investigations and, possibly, had destroyed evidence prior to the discovery in 1968. In the west of the central area a rescue excavation became necessary in 1970 due to the unplanned construction of a swimming pool (Sensburg/Moseler 2008, 2-4). According to the material yielded by the excavated ditches, further evident structures were destroyed in this area by the pool construction. Therefore, the excavated area of Gönnersdorf can be considered as a section of a possibly larger site.

The excavated square-metres were numbered consecutively according to the time of excavation. Based on previous excavation techniques applied in Russia and, moreover, the excavation techniques used in Pincevent (see p. 231 f.), the excavation of Gönnersdorf was based on the documentation and recovery of the archaeological material per square-metre which was further sub-divided into equal quarters. These quarter square-metres were uncovered in artificial strata down to the main archaeological horizon with the 2D documentation of finds and wet sieving of the loess sediment. Furthermore, in the main archaeological horizons several horizontal plana were prepared and photographed per square-metre (Bosinski 1979, 50-53). Moreover, below the main horizon the pits became visible and were numbered consecutively and documented in a horizontal as well as a profile drawing if possible. However, often the filling of these pits prohibited such a procedure and these structures were documented by multiple horizontal photos following the process of careful preparation of the single items filled into the pit (Bosinski 1979, 54f.). This combined documentation of artificial layers and horizontal photos allowed for the attribution of a third dimension to several of the finds. In addition, the general horizontal documentation of the site was supplemented by several N-S and E-W oriented profiles in the excavation area. The archaeological material was analysed frequently by researches with different research focuses, resulting in a large bundle of publications of varying detail and extent, complicating a compilation of the material in a common frame (Jöris/Street/Turner 2011, 66). For instance, occasionally the numbers given for a specific material group from the same part of the site were in detail divergent (e.g. Sensburg/Moseler 2008, 64 and Franken/Veil 1983, 83-148). Some basic numbers such as the total number of lithic artefacts from concentration III have not yet been collected or published enabling a separate description of this sub-set. However, syntheses of the Gönnersdorf material are in preparation (Jöris/Street/Turner 2011) or in the process of publication (Street/Turner 2013).

Topography

The Lateglacial site of Gönnersdorf is located at the northern end of the Neuwied Basin and lies -as the crow flies- approximately 2 km north-east of the Late Magdalenian site of Andernach-Martinsberg. The Gönnersdorf site is set on a promontory-like slope on the northern side of the Rhine, some 250 m northwards of the modern river (**tab. 10**). However, the modern Rhine flows at approximately 60 m a. s. l., whereas the site was located at an altitude of 100-105 m a. s. l. The terrain on the site sloped gradually down southwards but in the south-western area the inclination became slightly steeper. From the edge of the excavation area, the terrain slopes gradually southwards for almost 200 m before a steeper step of some 20 m cuts downwards to the river banks. In the east the terrain remains on approximately the same altitude as at the site and, thus, was elevated on average 30-40 m above the river valley. This plateau extends over an approximately 2 km × 2 km area which is limited by the Rhine and the Neuwied Basin in the south as well as the valley of the Wied in the east. However, 45 m to the west of the excavated area a small valley sloping downwards to the river was observed which levelled the steps towards the Rhine but also intensified the impression of a promontory-situation of the site. Perhaps, this small valley contained a small stream before the eruption of the Laacher See Volcano (Bosinski 1979, 29). Farther to the west the site is protected by the hills forming the Andernach gate which rise steeply some 80 m upwards and in the north the continuation of these ridges ascends more gradually to the Westerwald.

The massive evident structures on the site were one of the reasons for its discovery. Large slate plates formed pavements, partially multi-layered and often densely packed, and / or stone settings. In general, these structures led to the sub-division of the excavation area in five sub-areas. Two large accumulations of the dense pavements were recorded in the excavation area: one in the south-east (concentration I; Bosinski 1979) and another one some metres to the north-west, in the southern central part (concentration II; Sensburg 2007; Sensburg / Moseler 2008). To the north of the latter a smaller, but comparably dense accumulation was observed (concentration III; Terberger 1997) which almost merges into the northern part of concentration II. In the north-north-east of concentration III and separated by several metres without a structure, a large almost quadratic stone setting with a densely packed area of stones in its centre as well as another stone-filled structure to its north was named concentration IV (Terberger 1997; Jöris / Terberger 2001; Sensburg / Moseler 2008). In the excavated area south of concentration II and west of concentration I another area with an ephemeral distribution of smaller stone plates was recorded as concentration V (Buschkämper 1993). The latter was attributed to a chronologically younger phase due to stratigraphic, techno-typological, and radiometric reasons and, therefore, is discussed in greater detail elsewhere (see p. 127-133). However, the eastern part of this sub-area was clearly attributable to the large concentration I (Buschkämper 1993, 23) and, furthermore, the scatter from the northern part of the south-western sub-area originated probably from the large concentration II (Buschkämper 1993, 34; Franken / Veil 1983, 216-233).

Stratigraphy

In the south-eastern corner of the northern part of Gönnersdorf (concentration IV), a 7 m deep profile was taken. At this depth the bedrock was not reached but a reddish brown soil of presumably Eemian age. On top followed an over 1 m thick deposit of greyish brown, loamy loess. An early Weichselian age was proposed due to the presence of the so-called Metternich tuff which consisted of a 20 cm thick pumice deposit in the lower third of the loamy loess (Bosinski 1979, 29). The sediment within this greyish brown deposit was not homogeneous but interspersed with krotovinas and lime concretions. The upper part of this loess was capped by the up to 3 m thick deposit of the eruptive material called »Eltville tuff« which originated from an eruption in the East Eifel volcanic field dated to approximately 20,000 years b2k

(Pouclet/Juvigné 2009). This material contained several alternating layers of dark basaltic pumice and light fine-grained material which was deposited in a gully according to the different profiles of the pit. On top of this volcanic material several centimetres of another greyish loess deposit followed. In this loess deposit and spreading into the upper part of the basalt tuff deposit some bone and ivory fragments as well as lydite artefacts were found, suggesting the presence of an older settlement on the plateau near the Late Pleniglacial site (Bosinski 1979, 29). This possible previous use of this setting sustains the impression of a favourable topography of Gönnersdorf for hunter-gatherer occupations. Next in the stratigraphic column followed an approximately 1 m thick, yellowish, calcareous loess in the upper part of which the Late Magdalenian horizon was situated (Bosinski 1979, 27. 47). The top 10-12 cm were transformed during the Lateglacial Interstadial into a dark, humic loam which appeared so fatty that wet-sieving seemed impossible (Bosinski 1979, 47). This dark loam was correlated with an Allerød soil. In some areas of the site this fat sediment reached almost to the Late Magdalenian horizon, whereas in other areas some 20 cm of loess were between the first planum of the Late Magdalenian horizon and the base of this Lateglacial Interstadial soil. In the south-western area of the excavation, some archaeological material was scattered in this intermediate, untransformed loess and, possibly represented a separated archaeological horizon (see below; Buschkämper 1993, 22). Finally, the dark loam was overlain by the LST which was stripped along with the topsoil before the excavations.

Thomas Buschkämper suggested the younger horizon in the south-western part of the excavation due to several indications:

The material of the eastward adjacent concentration I was deposited on approximately the same level of the terrain as the remains in the south-western area. Thus, both sub-areas were probably affected comparably by erosion and erosive processes played presumably no role between these two areas. Erosion could consequently not explain stratigraphic differences between these areas. The intermediate, untransformed loess was on average 10 cm thick in the south-western area (Buschkämper 1993, 11) and the archaeological material of concentration V was found mainly in this untransformed loess, the upper archaeological planum, and punctually even at the base of the dark loam (Buschkämper 1993, 7. 17). The archaeological material of the eastern concentration I was found dominantly in the Late Magdalenian horizon in the loess. The evident structures from the western part of the south-western area which were attributed to concentration I were also on average some 15 cm deeper in the loess than the structures attributed to concentration V (Buschkämper 1993, 23). Thus, a second phase of deposition seemed indicated by the stratigraphic distribution. Furthermore, among the archaeological material, some fragments of possible backed points as well as some remains of an elk were found suggesting also a younger development. As an additional argument for a younger phase, Buschkämper pointed out that frost cracks were observed in the lithic material attributed to the Late Magdalenian but not in the lithic material attributed to concentration V (Buschkämper 1993, 16). Even though he noted that the identification of frost cracks is problematic, this difference in preservation could indicate that severe cold episodes had affected the Late Magdalenian material but not the material from the centre of the south-western area deposited stratigraphically higher. In consequence, the latter material was possibly deposited in a climatically ameliorated episode.

Thus, the material from the centre of the south-western part of the excavation area separated by Thomas Buschkämper represented presumably a distinct episode in the occupation history of the site. Therefore, the material from the south-western area (concentration V) is presented separately from the main concentrations of Gönnersdorf attributed to the Late Magdalenian (concentrations I-IV) in the following sub-chapters.

In addition to further geological analyses of the stratigraphy of Gönnersdorf (Brunnacker 1978b; Brunnacker 1978c), various scientific studies were performed to confirm the chronostratigraphic setting (Brunnacker 1978d; Kuči 1978; Leroi-Gourhan 1978) as well as to model the natural environment during the time of occupation (Schweingruber 1978; Poplin 1978). However, the pollen analysis was based on only a few preserved specimens that were probably redeposited by the various ground movements such as bioturbation, sediment flows, or hydrological infiltration. This assumption also explained the difference to the malacological analysis suggesting covered ground vegetation with rare mesophile elements and only singular indications of semi-forested, hygrophile, or steppique species (Puisségur 1978). Along with the pollen, the occurrence of some small mammals (Malec 1978) such as the various Microtinae and mole (*Talpa europaea*) should be regarded critically concerning the possible intrusion in later periods.

Charcoal was frequently found at Gönnersdorf. In total, 612 samples were analysed and the majority were identified as fossil materials (flaky brown coal, n = 240; Tertiary wood i. e. jet, n = 174). This flaky brown coal was attested on other sites from the Central Rhineland as well and, perhaps, represented a source to feed the hearths. In addition, typical cold environment species such as pine (*Pinus* sp., n = 106), willow (*Salix* sp., n = 58), and, probably, juniper (cf. *Juniperus* sp., n = 34) were found. However, only in one case Scots pine (*Pinus sylvestris*) was identified (Schweingruber 1978, 83).

Archaeological material attributed to the Late Magdalenian

In Gönnersdorf a large amount of material, judging by the weight as well as the numbers were deposited. The assumed distances from where the material was brought to this particular topographic position marked the site as a special and more permanent construction.

In total, 81,786 lithic artefacts (Floss 1994, 219) were uncovered and, although splinters and flakes smaller than 2 cm were dominant (n = 48,786; **tab. 11**; Franken/Veil 1983, 93. 106. 124-126. 143-145; cf. Floss 1994, 224-235), the material weighted over 76 kg (Floss 1994, 219; cf. Franken/Veil 1983, 3. 6 Abb. 1).

The dominant raw materials were foreign flints (26.5 kg, n = 49,321; Floss 1994, 219) which made up more than half of the assemblage (*c.* 57 %; Franken/Veil 1983; 60 %, Floss 1994, 219). 63 % of the flints could be attributed to the Western European flints (15.5 kg, n = 31,024) that originated from sources of at least 110 km distance in the north-west and 18 % of the artefacts were made of Baltic erratic flint (~6 kg, n = 9,093) originating from a minimum of 105 km northwards (**tab. 12**). The remaining 19 % were patinated pieces which could not be classified precisely. Furthermore, the local raw materials, lydite (28 kg, n = 12,035) and Tertiary quartzite (19.5 kg, n = 15,181), occurred frequently. Besides the local variety of the latter, the Ratingen type that possibly was gathered at a distant source some 85 km either northwards or eastwards (Floss/Terberger 2002, 17) was recovered rarely (n = 212). Almost 3,000 artefacts were made of chalcedony which presumably did not originate from a local source but could possibly be associated with a source near Frankfurt some 75 km south-east of the site due to wind abrasion (Floss 1994, 224-226; cf. Franken/Veil 1983, 22). In addition, some 2,000 artefacts were made of siliceous oolite that probably originated from the same region as the chalcedony. Furthermore, Palaeozoic quartzite (n = 146), Jurassic chert (n = 30), rock crystal (n = 23), opal (n = 8), and a southern German jasper type (n = 3) were found in small quantities. The latter raw material was found exclusively in the south-western part of the excavation area and, perhaps, was associated with a younger occupation event (see p. 127-133). The source of the jasper was presumably in the Freiburg region, some 300 km to the south. The opal could have originated from the same region as the chalcedonies but also possibly from the Siebengebirge approximately 25 km and more to the north. Even though the few pieces were clearly distinguishable from the chalcedony, Harald Floss considered them to probably originate from the same region as the chalcedonies which were found accumulated in the same part of the excavation area (Floss 1994, 234). The rock crystal pieces showed abrasions of river transport and were probably taken from the Rhine gravels near the site. According to the remaining cortex, the chert artefacts formed a single nodule which, perhaps, was also collected along the banks of the Rhine (Floss 1994, 231). The few pieces of Palaeozoic quartzite, that was also referred to as

Ardennes quartzite, were comparable to the same material from Andernach (Floss 1994, 232; see p. 80) and was identified as a Mesozoic quartzite which, possibly, originated from the same region as the Western European flint (Floss/Terberger 2002, 14-16).

Eduard Franken mentioned 309 cores (Floss mentions at least 311 specimens) from the site. These were dominantly made of lydite (n = 224) but also pieces of Tertiary quartzite (n = 47) and Western European flint (n = 28) were recovered (**tab. 13**; Franken/Veil 1983, 83-87. 112-116. 130-134; Floss 1994, 224-235). The remaining cores were frequently of small dimension. The lydite pieces were predominantly exploited from one platform (n = 106) and for the 32 pieces exploited from two platforms Franken mentioned several pieces where one platform was used dominantly (Franken/Veil 1983, 85). However, among the Tertiary quartzite cores the exploitation from two platforms was most frequent (n = 22 to n = 11) and among the flint cores this pattern was even clearer (n = 24 to n = 1). Some cores had three or more platforms and these pieces frequently were of an almost global shape and a small dimension suggesting that these raw material units were exhaustively used. Only four such cores were made of Tertiary quartzite, 13 of flint, and 50 of lydite. On some cores, crested preparations were still observable (e. g. Franken/Veil 1983, Taf. 7.3; 13.3), and some crested blades and bladelets made for example of Tertiary quartzite were found (Franken/Veil 1983, 123. 126). The remaining material with this preparation points to a blank production focused on lamellar blanks and, in particular, bladelets. The presence of butts of the »*en éperon*« type was not analysed but some cores displayed preparation which could have formed the necessary spur (e. g. Franken/Veil 1983, Taf. 14.2). In the Gönnersdorf assemblage the absence of cores and blank production debris was considered as significant concerning the way in which the raw material reached the site. For instance, the Tertiary quartzite of the Ratingen type seems to have reached the site only as ready made blanks (Floss 1994, 224) and, perhaps, the Palaeozoic quartzite as well (Floss 1994, 232 f.). The jasper and the opal items were presumably brought to the site as retouched artefacts (Floss 1994, 233 f.).

The reddened quartzite analysed by Eduard Franken was coloured by haematite, not heating, and in contrast to the denser lithic raw materials this red powder infiltrated into the more porous Tertiary quartzite material (Franken/Veil 1983, 53-55). However, Stephan Veil mentioned that only 0.9 % of the retouched artefacts and 0.02 % of the debris material of the retouching process showed traces of heating and noted that in concentration II the numbers were the lowest with only 0.5 % in contrast to around 1 % in the other areas (**tab. 12**; Franken/Veil 1983, 272. 296). In fact, Thomas Terberger counted only 20 artefacts with traces of heating in the northern area (Terberger 1997, 49-54), and a further 189 burnt pieces in the adjacent central area (Terberger 1997, 188). Based on observations of Hartwig Löhr and referring to the material of concentration IIa, Martina Sensburg emphasised the scarcity of burnt lithic material (Sensburg/Moseler 2008, 22). Finally, in his dissertation focused on the use of fire at Gönnersdorf, Frank Moseler found only few indications for burning in the lithic assemblage of Gönnersdorf based on comparisons with experimental heating of several stone varieties (pers. comm. Frank Moseler, Neuwied).

Stephan Veil found 4,855 pieces with 5,261 retouched working edges (Franken/Veil 1983, 259). This number was partially revised by later recounting (Terberger 1997; Sensburg/Moseler 2008, 64 tab. 3) resulting in some 4,320 identified retouched artefacts (**tab. 14**).

Among the LMP, the simple backed bladelets clearly dominated (Franken/Veil 1983, 288). Occasionally pieces with two retouched edges occurred, and truncated pieces were rarely found. Very scarce were pieces with notched backs. Refitted pieces revealed the production of small segments by intentional breakage of long ready retouched bladelets (Franken/Veil 1983, Taf. 33.12-13) and the metrics showed a dense clustering of the broken backed bladelets suggesting a high standardisation for these tools (Franken/Veil 1983, 290 f.).

In the northern most part of the south-western excavation area, three LMP made of southern German jasper were found which probably represented part of a basic equipment exchanged at the site (Floss 1994, 234). One piece was considered as a backed point (Floss 1994, 234) that was later questioned (Buschkämper 1993, 51). In the present study, the piece is attributed to the backed bladelets with partial lateral retouch of the opposite edge because in regard to the middle axis of the implement the »apex« is set on the same side as the straight-backed edge. Moreover, the vertical position in the level above the first planum as well as the horizontal position in the distributed material between the two major Late Magdalenian concentrations (Buschkämper 1993, 50-52) suggested a connection with the main, Late Magdalenian settlement event of the site.

The majority of the burins was made on truncation followed by dihedral burins and pieces on breaks (Franken/Veil 1983, 284). Burins of Lacan type occurred frequently among the pieces on truncation and occasionally transversal burins were recorded (Franken/Veil 1983, 286). The end-scrapers were usually made on blades and splintering of the edges was observable on several specimens (e.g. Franken/Veil 1983, Taf. 20.12 and 16; Taf. 21.9, 15-18 and 20). Truncations were commonly oblique but straight, concave, and convex truncations occurred also in notable quantities (Franken/Veil 1983, 286). The borers were frequently made on burin spalls. Perforators were the common type, some with an elongating retouch and some even with a *Zinken*-like design (Franken/Veil 1983, Taf. 19.22 and 27) but the Gönnersdorf pieces were never as massive as typical *bec* or *Zinken* and the small negative signaling the *Zinken* could originate from damages during the use of the pieces. Sometimes artefacts, particularly retouched ones were thinned by the so-called Kostienki ends.

A traceological analysis of 203 artefacts of Western European flint revealed the use of these implements on various materials as well as for various motions (Sano 2012b). The use-wear confirmed the proposed uses for backed bladelets as parts of projectiles, for perforators as drilling instruments, and for end-scrapers as generally hide-working tools. Moreover, the study also showed the heterogeneous and sometimes intensive use of burins, splintered pieces, or further artefacts which were not formally retouched. The variety of activities indicated by the different patterns were assumed to emphasise the function of Gönnersdorf as a residential occupation in contrast to short-lived settlements such as the »quarry site« Eyserheide or the »hunting camp« at Bois Laiterie (Sano 2012b).

Along with the lithic material, several hundred kilograms of stone material were brought to the site accumulating already in the barely structured northern part to more than 660 kg of various types of slate, quartzite, basalt, sandstone, and prophyr with an additional *c.* 41 kg of quartz (concentration IV, Terberger 1997, 69-102) and mounting to 1,551 kg of slate varieties, quartzite, and basalt with additional 252 kg of quartz in the northern central area of the excavation (concentration III, Terberger 1997, 273-296). These stones probably originated from the Rhine gravels and the arising cliff west of the site suggesting transport distances of 50-200 m (Bosinski 1979, 92-134). They were occasionally laid out as multi-layered pavement on the ground, as cover on pits, as enclosure of possible hearths, and, perhaps, as ballast stones for shelter covers on the ground. In contrast to the lithic material, these stones showed frequent indications of heating and probable contact to fire (pers. comm. Frank Moseler, Neuwied).

Moreover, some chopping tools (Bosinski 1979, 115-120; Terberger 1997, 76-79. 275-277) as well as several retouchers, usually of elongated shape (Bosinski 1979, 120-123. 136 f.; Terberger 1997, 275-278. 298 f.), were made of these materials.

The faunal analysis (Poplin 1976; Poplin 1978; Street/Turner 2013) determined more than a dozen species in the organic material (**tab. 15**). However, these were present in very different quantities and presumably brought to the site for various reasons.

The most common species were horse (*Equus* sp., MNI ≈ 55), arctic fox (*Alopex lagopus*, MNI ≈ 35), reindeer (*Rangifer tarandus*, MNI ≈ 5), and mountain hare (*Lepus timidus*, MNI > 7; Street et al. 2006; cf. Jöris/Street/Turner 2011; Street/Turner 2013). Of these four species all body parts were found at the site, proving the introduction of complete animals to the site. The remains of arctic fox showed cut-marks suggesting that these animals were also completely exploited and not only hunted for their pelt (Street/Turner 2013). Based on the size of the teeth, François Poplin identified arctic fox along with a few individuals of red fox (*Vulpes vulpes*; Poplin 1976, 46). According to the foetal bones of the horses, the size of the teeth of the arctic fox, and the exclusive presence of shed reindeer antler, most parts of the site were attributed to an autumn/winter occupations, whereas the southern central area (concentration IIa) produced larger foetal bones of horse and even some foal hooves suggesting an occupation during the spring and early summer months (**tab. 16**; Poplin 1976, 149; Terberger 1997, 160; Sensburg 2007, 155 f.; Street/Turner 2013). Thus, the large numbers of animals, in particular, horses were probably accumulated by several hunting episodes which occurred over a period of several months, perhaps, several years.
Besides direct evidence from the faunal remains, Gönnersdorf also yielded indirect evidence by naturalistic engravings of different animals on the slate plates (**tab. 18**) providing detailed knowledge about these animals. Among the engravings, the proportion of horse to reindeer were comparable to the faunal material with numerous identified horses (Bosinski/Fischer 1980; Bosinski 2008, 17-22) in contrast to only occasionally observed reindeer images (Bosinski 2008, 49-55). However, the canon of engravings was not a one-to-one image of the faunal resource environment; further impressions and ideals governed the choice of motives. For example, foxes were not identified among the slate engravings. In the context of arctic fox clearly playing an important role in the faunal assemblage of Gönnersdorf, its absence in the canon of engraved animals is surprising. Hare was probably absent as well (cf. Bosinski 2008, 140; Jöris/Street/Turner 2011). In contrast, images of larger carnivores such as wolf (*Canis lupus*), bear (*Ursus* sp.), and lion (*Panthera* sp.) were found (Bosinski 2008, 105-113), although only the wolf was also present in the faunal assemblage. The presence of the latter was determined mainly by paw and cranial parts suggesting that some remains arrived in the form of a pelt at the site, whereas in other places such a pelt was perhaps made (Street et al. 2006, 761).
The megaherbivores of the classic mammoth steppe fauna were also identified at Gönnersdorf. Mammoth (*Mammuthus primigenius*) was determined by some pieces of ivory, some teeth fragments, a femur, and some ribs (Poplin 1976, 50). AMS-dating of the bones revealed that these pieces were some 1,000 $^{14}$C years older than the Late Magdalenian occupation at Gönnersdorf (Stevens et al. 2009b). In particular, the femur was found in a position suggesting its use as a construction element (Bosinski 1979, 65). Thus, the mammoth material was presumably collected as raw material for construction and the production of artefacts. However, the existence of detailed knowledge about these animals was proven by the numerous engravings of mammoths on the slate plates (Bosinski/Fischer 1980).
Woolly rhinoceros (*Coelodonta antiquitatis*) was also only detected with a few teeth and remains of a mandible (Poplin 1978, 99; Street et al. 2006). Samples from these remains were dated to an age comparabe to the mammoth material (Stevens et al. 2009b). Again, on the slate plates detailed engravings of these animals were found (Bosinski 2008, 39-48). Nevertheless, both megaherbivores were probably not contributing to the alimentary provision, but their remains represented raw materials for the inhabitants of Gönnersdorf.
Large bovids were only rarely identified in the faunal assemblage and originated presumably from bison (*Bison priscus*), although the attribution to aurochs (*Bos primigenius*) could not be entirely excluded. According to the different habitats of these species and the indications of a grass steppe landscape in the surrounding of the site during the Late Magdalenian occupation, the attribution to bison was preferred. However, on the

engravings attributed to large bovids the aurochs was clearly identified, whereas the bison was only partially observed (Bosinski 2008, 63-67 Taf. 77. 90-91). The two single ribs recovered from the south-eastern part were considered as tools for digging due to their smoothed ends (Poplin 1976, 53) and, hence, probably were also not hunting remains. Post-cranial remains of two large bovids (an adult and a young one) were found in the north of the site in a higher stratigraphic position and displayed marks of carnivore gnawing (Street et al. 2006, 762). Presumably, these individuals were remains of a carnivore attack some time after the abandonment of the site. However, in the central area a few post-cranial bones of a large bovid were recovered that perhaps represented prey remains but due to the small number these pieces were possibly introduced to the site as provision.

Saiga antelope (*Saiga tatarica*) had a presence comparable to the megaherbivores among the fauna remains with two bone fragments. Although these remains were extremely scarce, again this species occurred among the engravings (Bosinski 2008, 77-79). The occurrence of this dry desert inhabitant was of significance for the environmental reconstruction of the area during the Late Magdalenian period. However, the very scarce evidence could indicate that the hunting episode took place somewhere else and only the single remains reached the site as provision or for curiosity.

The mountainous species chamois (*Rupicapra rupicapra*) was only identified by teeth and mandible fragments. This sparse presence could also indicate the introduction in the form of a trophy or provision. On the slate plates this species was not observed but the related and equally mountainous ibex (*Capra ibex*) was engraved (Bosinski 2008, 71-75).

Red deer (*Cervus elaphus*) was only determined by some teeth which were usually drilled and, thus, probably arrived at the site in the form of adornments. On the slate plates some rare examples of red deer were identified (Bosinski 2008, 49-55). The post-cranial bones of at least two individuals were found in the south-western area and were presumably associated with a later occupation event (Street et al. 2006, 762).

Besides these major species, several bird species were determined: Mute swan (*Cygnus olor*), geese (*Anser* sp.), grouse (*Lagopus* sp.), probably rock ptarmigan (*Lagopus mutus*), snowy owl (*Nyctea scandiaca*), common raven (*Corvus corax*), and, perhaps, gulls (*Larus* sp.). This assemblage is almost identical with the evidences from Andernach. Various birds were also engraved on the slate plates at Gönnersdorf (Bosinski 2008, 115-128).

In contrast to Andernach, only few remains of fish were preserved (Poplin 1976, 63). However, the identified remains were with brown trout (*Salmo trutta*) and members of the Cyprinidae family comparable to the Andernach material but Gönnersdorf yielded additionally remains of burbot (*Lota lota*). Some engravings of fish were found (Bosinski 2008, 129-131).

In an attempt to explain the faunal co-occurrence of the various animals, François Poplin suggested five principal explanations (Poplin 1978, 101 f.): 1. the animals changed their behaviour, 2. the assemblage was formed over a considerable period of time, 3. the local topography allowed the co-existence of varied habitats, 4. the modern behaviour observed in the animals reflects only a range limited by the expansion of man, 5. the animals were present in the area at various seasons of the year. Certainly, all of these explanations as well as combinations of these are possible. However, excluding the probably fossil material (mammoth, woolly rhinoceros, bison?) and the pieces introduced as curiosity or, perhaps, from a distant source (bison?, saiga antelope?, red deer) the environment of Gönnersdorf was relatively similar to modern arctic or high mountain regions such as the Siberian tundra or the Carpathians and did not represent a typical Late Weichselian mammoth steppe habitat. Nevertheless, varied seasonality was suggested by the development of horse foetus bones, but the presence of varied habitats, in particular between the moist, protected valleys and the dry, exposed plateaus in the upland regions were variously sustained and, moreover, the vast amount of material at Gönnersdorf indicated the presence over a considerable period of time.

François Poplin found among the organic remains also at least five fragments of teeth which he distinguished from reindeer teeth and identified as human teeth (Poplin 1976, 3). In addition to a deciduous tooth, coronary fragments of adults with various stages of abrasion were found indicating the presence of at least three people (Poplin 1976, 68) of various age classes at the site. Presumably, these pieces were intra-vitam losses (Poplin 1976, 5).

Johann Tinnes described some 359 artefacts made of 368 fragments of bone (n = 91), antler (n = 222), and ivory (n = 46) from Gönnersdorf (**tab. 17**; Tinnes 1994, 2). This rich organic inventory comprised debris such as cut pieces (n = 7) or cores (n = 31) as well as tools and some pieces of art. The majority of cores were made of antler (n = 24), and only seven pieces were made of bone. The complete exploitation cycle of these raw materials was observable at Gönnersdorf (Tinnes 1994, 76) producing spalls of various sizes (Tinnes 1994, 80. 96. 98). However, the larger spalls were made of antler (n = 39) and ivory (n = 5), whereas the smaller needle blanks were made only of bone (n = 5). Accordingly, the 71 needle and two awl fragments were generally made of bone (n = 56) and less frequently of antler (n = 13) and ivory (n = 2; Tinnes 1994, 179). The two complete points and a further 41 fragments of single as well as double bevelled points (rods) were made only of antler (n = 40) and ivory (n = 3; Tinnes 1994, 146-153). Two fragments of baguette demi-rondes were also engraved with at least two identifiable animal heads (Tinnes 1994, 169 f.). In addition, two fragments of fish hooks made of bone and antler were found (Tinnes 1994, 176 f.). In contrast to Andernach, barbed points were not recovered except for a single barb (Tinnes 1994, 171 f.) and no hammer instrument was found but also ten bone retouchers were identified (Tinnes 1994, 115 f.). A single antler fragment of a bâton percé was found in the south-east of the excavation (Tinnes 1994, 142). Only two coin blanks were made of organic material (one of ivory, one of antler, Tinnes 1994, 188) in contrast to numerous specimens and fragments made of slate (Bosinski 1977; Terberger 1997, 93 f. 292-295).

The previously mentioned engravings (**tab. 18**) encompassed not all hunted animals but instead yielded also species clearly not present at the site such as bears, lions, or seals (Hansen 2006; Bosinski 2008, 87-95). The details of many engravings sustained the assumption of comprehensive knowledge of these animals and, furthermore, the consideration that to gain this knowledge the engravers must have seen those animals. In contrast, images of humans (women, phantoms) were very poor in detail and almost abstract (Bosinski / Fischer 1974). Phantoms were assumed as frontal views of an abstract human portrait. These portraits indicate an upper body with shoulders a neck and an oval head with eyes and mouths depicted by circles. Often the oval forming the head ends in a jelly bag cap-like end giving the whole figure a ghost-shape outline. In contrast, the female silhouette displayed a profile from approximately the knees to the neck with accentuated breasts and bottoms and only occasional signs of arms. These images were so numerous and peculiar that they formed a specific type for which Gönnersdorf became eponymous (see p. 89; Bosinski 1992; Bosinski / d'Errico / Schiller 2001).

Moreover, 19 female figurines and figurine fragments were made in the same abstract style (Tinnes 1994, 195; Höck 1995, 256-266). The raw materials used to carve these specimens were ivory (n = 10), antler (n = 3), and Devonian slate (n = 6). One of the antler pieces was classified as unfinished (Höck 1995, 288) suggesting that figurines were made at the site.

Among the faunal fragments were some teeth with drilling observed that fall into the category of jewellery. 38 examples of drilled arctic fox teeth were recorded and reached on average lengths of 1 cm. Esteban Álvarez-Fernández outlined that only nine of the 48 possible types of fox teeth (maxilla: I2, I3, C, P1, P2, P3; mandible: C, P2, P4) were chosen for this type of modification (Álvarez Fernández 1999, 88). Furthermore, he emphasised that the premolars (P2-P4) were often not completely preserved, which he assumed to be intentional to result in a similar, though smaller, shape to the female figurines (Álvarez Fernández 1999, 90-92). Besides fox teeth, six perforated canines of red deer were found (Álvarez Fernández 1999) as well as three fragments of sawed incisors of the same species (Street et al. 2006, 761. 772). Also, reindeer teeth which were sawn from the maxilla were considered as pendants according to experimental examples (Alvarez Fernández 2001; Álvarez Fernández 2009).

58 jet beads were documented in Gönnersdorf of which 49 were finished and a further nine examples were of various finishing stages attesting the fabrication of these items on the site (Álvarez Fernández 1999). Among the generally very small (*c.* 1 cm long) finished beads, the discoid (n = 19) and the biconical types (n = 18) were most common. The origin of the raw material remains unknown. A famous modern source of jet is located some 250 km south-eastwards near Holzmaden (Wuerttemberg). However, during the Roman period a centre of jet carving independent from the British jet fabrication was located north of the Central Rhineland in the Bonn and Cologne area (Allason-Jones / Jones 2001) suggesting that these craftsmen had also access to a possibly local resource which is no longer known. Perhaps, the suggestion of the local Rhine gravels serving as a source for the jet (Álvarez Fernández 2009) that was also considered for the lower layer in Andernach (Holzkämper 2006, 158) could be a good explanation. Nevertheless, without chemical analysis of the objects, the origin of the jet cannot be further determined.

Along with these pieces of art and jewellery, some molluscs which were occasionally perforated were found and determined as *Dentalium (Antalis) vulgare* (n = 17), *Dentalium (Antalis) inaeqicostatum* (n = 5), and *Homalopoma sanguineum* (n = 5; (Strauch / Tembrock 1978; Alvarez Fernández 2001). Although some of these molluscs could originate from fossil sources in the southern Netherlands and Belgium (Strauch / Tembrock 1978), the latter two species were of no fossil origin and originated probably from the Mediterranean region (Alvarez Fernández 2001, 548) that, as the crow flies, lies 680 km to the south. However, the straight connection from Gönnersdorf to the Mediterranean would require connections across the Alpine ice sheet and, therefore, the Rhine-Rhône axis appeared a more probable route along which the molluscs had come with a minimum distance of 800 km. In addition, the *Dentalium vulgare* could originate from the Mediterranean, but this species was also known from the Atlantic coast (Alvarez Fernández 2001, 550).

Furthermore, fossil curiosities such as a Tertiary shark tooth which was presumably collected from fossil deposits in the Mainz Basin or a dinosaur vertebra from Luxembourg or Lothringia were brought to the site (Floss 1994, 244. 256 Abb. 159).

Haematite was used intensively in some parts of the site. Besides the red powder which coloured the sediment at some of the central areas, several lumps and pieces of haematite were discovered on the site. According to the chemical comparison, these pieces originated from the same source as material found some 25 km north-westwards of the site (Bosinski 1979, 138). Probably, the origin of the material was nearby this north-western occurrence.

### Spatial organisation of the material attributed to the Late Magdalenian

The massive evident structures (**tab. 19**) on the site were one of the reasons for its discovery and allowed the sub-division of the excavation into five sub-areas (I-V). These large structures included pavements formed by stone settings and / or slate plates which were partially multi-layered and often densely packed.

Concentration I was significantly disturbed by the building of the house leading to the discovery of the site. The remaining structures were analysed by Gerhard Bosinski in the 1970s (Bosinski 1979) and supplemented by the work of Thomas Buschkämper (Buschkämper 1993, 23). They revealed some circular stone settings within the main pavement. Moreover, the stone settings in the south-western sub-area associated with the Late Magdalenian concentration I formed partially dense pavements (Buschkämper 1993, 23). Meanwhile, modern analytical tools require a combined reanalysis of these sub-areas to allow further interpretations of the position of the various parts in the formation of this south-eastern concentration as well as in the complete settlement process at the site. In the context of a comprehensive study of the complete site, this kind of reanalysis of the material from Gönnersdorf I is in progress but, thus far, the analysis was only partially accomplished (cf. Jöris/Street/Turner 2011; Street/Turner 2013). In constrast, concentration II was preserved almost completely. Only in the north-western part some imprecision of the excavation occurred due to a swimming pool construction (Sensburg/Moseler 2008, 3 f.). The western part of concentration III was possibly also affected by this intrusion. The concentration IV appeared largely undisturbed.

Along with the large accumulations of material, denser groups of pits were observed. These structures were generally located in the central area of the large stone pavements. In concentration I 35 pits were identified (Bosinski 1979, 142-154) of which several were suggested to represent postholes (Bosinski 1979, 150). In concentration II two groups of pits were observed and justified another subdivision (Eickhoff 1989) into a concentration IIa where 21 pits were installed (Sensburg/Moseler 2008, 30) and a north-westward adjacent concentration IIb where a further nine pits were still preserved (Sensburg/Moseler 2008, 13-21). Spatial analysis of the lithic material further sustained the two distinct zones in concentration II (Sensburg 2007; Sensburg/Moseler 2008). Concentration IIa was the most completely preserved, whereas concentration IIb was significantly affected by the limits of the excavation area and the construction of the swimming pool (Sensburg/Moseler 2008, 51). Moreover, in the south-eastern part of the large stone pavement a circular structure was identified as IIc (Eickhoff 1988, 39). With this area, no pits were associated. In fact, Dick Stapert assumed that this part represented an intensively used entrance area to the other parts of the concentration II (Stapert 2003). Furthermore, in concentration III 21 depressions were documented of which Thomas Terberger described 17 structures as pits (Terberger 1997, 197-233). Spatial analysis of the lithic material revealed a minimum of three distinguishable clusters in concentration III with two distinct accumulations (zone B and C) between the centre of concentration III (A) and the limits of concentration IIa (Terberger 1997; Sensburg 2007). Moreover, Thomas Terberger considered another activity area in the east of concentration III. In concentration IV, as well as in the south-western area, no pits were recorded.

However, this distribution of pits could explain other spatial patterns such as the presence of molluscs or female figurines or other pieces of jewellery or art, because the preservation of fragile and organic specimens appeared to be associated with the pits and the intensive cover of stone plates (cf. Álvarez Fernández 1999, 96). Similarly, the intensity of red coloured sediment was mainly connected to these centres of the concentrations where also the original sediment and its additions were more protected against post-depositional outwash. Such post-depositional processes presumably affected further light elements such as lithic splinters or charcoal.

However, in concentration I a single and in concentration IV two hearths were observed during the excavation (Bosinski 1979, 64-68; Terberger 1997, 25-32; Sensburg/Moseler 2008, 39). In concentration I the hearth was dug into the ground and associated with a femur of a mammoth that was interpreted as part of a construction element around the hearth (Bosinski 1979, 65). Probably, the depression protected small material against down slope movements. In concentration IV one hearth which was set some metres to the north-east of the almost quadratic stone setting was filled with stones, and identified by darkened sediment (Sensburg/Moseler 2008, 68-70). The two dense accumulations of Gönnersdorf IV were connected by refitting, The connection lines between these hearths were oriented in NE-SW direction. These structures corresponded most closely to the hearth constructions known from the Late Magdalenian in the Paris Basin (Bodu et al. 2006b, 89-108) or northern Switzerland (Müller et al. 2006). However, charcoal material spread south-eastwards from the hearth, which was probably due to clearing out (Sensburg/Moseler 2008, 69) either by humans or by post-depositional horizontal movements or both. Nevertheless, the larger materials remained *in situ* after the human abandonment of the site. The stones were mainly fragments of quartzite, quartzitic slate, and sandstone but also quartz pieces occurred in this accumulation. Due to the latter and their attribution as cooking stones, the function of this hearth was associated with the preparation of food (Sensburg/Moseler 2008, 70). Based on the spatial distribution of different materials and indicators for hearths, Frank Moseler assumed repetitive clearing of material from the hearth (Sensburg/Moseler 2008, 69) which is consistent with Thomas Terberger's suggestion of several rearrangements of the material forming this structure (Terberger 1997, 29). Thus, for this comparatively small structure several episodes of use that were not performed quasi-simultaneously were reconstructed. A second hearth was observed in the centre of the almost quadratic stone setting of concentration IV and was also layed out with partially burnt stone material (Sensburg/Moseler 2008, 70). However, in contrast to the northern hearth, quartzes were rare, but near the hearth a large and heavy (15.5 kg) basalt block was found based on which Frank Moseler assumed that the function of this hearth was basically to produce light and warmth (Sensburg/Moseler 2008, 71).

Further hearths were located by spatial analyses. In these analyses, lithic artefacts with traces of heating were excluded as a potential indicator for hearths because these specimens were considered, for example, by Martina Sensburg in reference to an observation made by Hartwig Löhr, as too sparsely present on Magdalenian sites to result in significant accumulations (Sensburg/Moseler 2008, 22; cf. Sensburg 2007, 49). However, the scarce pieces were mainly found around stone rings reinforcing the suggestion that these settings represented limits of hearths. In contrast to the lithic material, charcoal and burnt quartz fragments were chosen as good indicators (Terberger 1997, 235-238; Sensburg/Moseler 2008, 25. 68).

By the mapping of these materials, Thomas Buschkämper located two hearths (F2 and F3) in the partially dense stone pavements found in the south-western sub-area and associated with the concentration I (Buschkämper 1993, 23). The suggested, short-lived hearth F2 was situated within the southern limit of a circular structure of 2-2.5 m in diameter (Buschkämper 1993, 7). The other hearth was situated farther to the south and surrounded by a ring of stones and dumps from cleaning of this hearth in the surrounding (Buschkämper 1993, 7). Both suggested hearths were not dug into the ground. Also based on the distribution of the hearth indicators, Martina Sensburg proposed the presence of five hearths in concentration IIa (Sensburg 2007), and a further three hearths in concentration IIb (Sensburg/Moseler 2008). In addition, Thomas Terberger reconstructed in the centre of concentration III a large hearth that was open and, perhaps, dug into the ground and later covered by the stone plates (Terberger 1997). A second possible hearth which was situated in the north of the central concentration III was assumed in a considerably smaller circular structure. Additionally, two smaller accumulations associated with hearths (zones B and C) were located south of the main concentration III merging almost into concentration II. Another area associated with fire was identified by Terberger in the eastern part of the sub-area but appeared more ephemeral (Terberger 1997, 239-247).

In his revision of the indications for the use of fire and their spatial distribution at the site, Frank Moseler considered the indications for *in situ* hearths in contrast to dumped or redeposited material more critically, and concluded that only six reliable hearths can be identified by various fire indicators such as charcoal and burnt bone at Gönnersdorf (pers. comm. Frank Moseler, Neuwied; Moseler 2014). In addition to the three structures already observed during the excavations, further spots were noticed in the central part of concentration II and one or two spots in the centre of concentration III (Moseler 2014). In concentration IIb the determined pieces of charcoal were spread without an identifiable concentration but clearly outside the hearths suggested by Martina Sensburg (Jöris/Street/Turner 2011, fig. 6B; Sensburg/Moseler 2008, 22), and therefore Frank Moseler could not locate an unambiguous hearth in this concentration (pers. comm. Frank Moseler, Neuwied). Based on the determination of the recorded charcoal pieces in concentration IIb as possible juniper (cf. *Junipers* sp.) wood charcoal and the further occurrence of such specimens in the centre of concentration IIa, the charcoal fragments in concentration IIb could represent a clearing of the hearth in concentration IIa and, thus, reflect at least two successive episodes in the use of the complex concentration II. However, the charcoal in concentration IIb could also be the remains of an undetected/not excavated hearth. Perhaps, another concentration of determined pieces of charcoal in concentration II reflected a dump area or a destroyed hearth associated with the stone circle IIc.

The distribution of lithic raw materials was, in general, helpful to distinguish various episodes in the settlement process and their position in the chronological development of the site (Terberger 1997, 166. 258-273; Sensburg 2007, 86-117. 142-150) as well as suggesting the presence of further structures such as dwelling structures (Sensburg 2007, 18-21. 26f.).

In Gönnersdorf, methods to analyse the spatial distribution of materials were tested particularly because the massive evident structures were considered as architectural elements (Jöris/Street/Turner 2011) and, therefore, as good indicators for the reliability of the latent spatial analysis. For example, Dick Stapert performed a ring-and-sector analysis on all Late Magdalenian concentrations of Gönnersdorf (Stapert 1990; Stapert 1991; Stapert/Terberger 1991; Boekschoten/Stapert 1993; Stapert 2003).

Thomas Buschkämper performed another ring-and-sector analysis for the two suggested hearths in the eastern part of the south-western sub-area (Buschkämper 1993, 106-110. 118-122): He concluded that a dwelling structure in the northern part, measuring approximately 2.5m in diameter, existed with an opening oriented towards the south, and the northern hearth was located in this opening (Buschkämper 1993, 123). However, to prevent overlapping results, only eight 25cm wide rings were chosen per structure i.e. in total 2m around the assumed centre were examined. Nevertheless, some overlapping between the distribution around the southern hearth and the distribution within the circular structure were still observed (Buschkämper 1993, 108). Moreover, since Buschkämper did not choose a hearth as the centre of the rings, he assumed an unimodal frequency distribution to reveal the suggested barrier.

Clearly, this example showed the limits of the ring and sector method, but modern analytical tools such as density frequencies displayed in isolines (Gelhausen/Kegler/Wenzel 2004, 70; Wenzel 2009, 19f.) could help revealing overlapping areas. Moreover, the advantage of the latter method is the lower number of presuppositions such as the presence of a central hearth or a predefined barrier structure. In contrast, the fundamental calculations were more complex and, occasionally, led to misleading interpolations of the data (Wenzel 2009, 20). However, this problem affected, in particular, areas with low find densities which in Gönnersdorf were rather rare. Nevertheless, in the find rich areas, the analyst has to choose which lines are of significance (optimal isolines, Zimmermann et al. 2004; Zimmermann et al. 2009; cf. Holst 2014). Further distribution patterns such as refitting lines need to accompany these analyses to sustain the interpretations. Yet, the evidence of such refitting lines suggesting direct moves between two points should be considered critically due to possible transient stations (Sensburg 2007, 193f.).

Besides the circular structures identified by the ring and sector method (Stapert 1991; Stapert 1992; Buschkämper 1993), Gerhard Bosinski reconstructed a large and oval wall construction in Gönnersdorf I with a reverse lying main entrance towards the south-east based on the location of the evident structures such as postholes and large stone plates as well as the distribution of haematite stained sediment (Bosinski 1979). The circular wall structure reconstructed by Dick Stapert was set 1-2m east of this entrance (Stapert 1991; Jöris/Street/Turner 2011), whereas the circular structure reconstructed by Thomas Buschkämper was located 1-2m west of the back of the main structure (Buschkämper 1993; Jöris/Street/Turner 2011). Based on ethnographic analogies from the Inuit of Greenland, Dick Stapert and Lykke Johansen suggested that the main structure of concentration I served as a habitation place for a whole group, and that at some point a smaller group, perhaps mainly older people, stayed behind and moved into a smaller structure (Stapert/Johansen 1997, 60). In such a scenario, the chronology of this concentration would comprise at least two phases during a single occupation event.

Whether the smaller circular stone settings considered as dwelling structures by the ring and sector analyses were in fact teepee-like tents or other types of shelters cannot be ascertained, but future spatial analyses could sustain the presence of barriers. Thus far, these structures were neither observed to be intensively haematite stained, nor associated with depressions or pits, nor related to significant concentrations of the mainly processed animals (Street et al. 2006, fig. 12). However, ivory and mammoth molars were connected to the eastern-most circular structure in concentration I (Street et al. 2006, fig. 11a), suggesting the presence of a possible workshop. Moreover, these structures contained accumulations of mainly anorganic material and, therefore, represented intensely used zones of activities, probably lithic and other manufacturing. For concentration II, an oval shaped dwelling structure with an approximate 6 m extension in NW-SE direction and some 5 m in SW-NE direction was suggested by Dick Stapert with an intensively used and therefore also paved main entrance towards the south-east (Stapert 2003). This reconstruction incorporated the sub-concentrations IIa and IIb which were attributed to a dwelling of two families. This suggestion was based on the sector analysis and a classic gender attribution with men associated with the projectiles and stone knapping and women with »fine« tools such as borers (Stapert 2003, 11). In contrast, the spatial analyses of material densities performed by Martina Sensburg revealed a distinction of the two sub-concentrations IIa and IIb (Sensburg 2007; Sensburg / Moseler 2008). This distinction was already proposed by Sabine Eickhoff who, furthermore, distinguished the intensively used entrance in Dick Stapert's model as a circular structure (concentration IIc) in the south-east of the concentration (Eickhoff 1988, 39). In addition, Martina Sensburg reconstructed a heptagonal wall structure enclosing an approximately 40 m² large area with maximum extensions of 8 m × 7 m in concentration IIa (Sensburg 2007, 13-29), whereas the concentration IIb was considered as unlimited (Sensburg / Moseler 2008, 51). Due to the restrictions of the excavation area, Martina Sensburg concluded that the latter result had to remain hypothetical. Moreover, a red colouration of the sediment that was present in concentration I was observed only punctually in protected areas of concentration II (Sensburg 2007, 17 f.). Nevertheless, the occasional observation and the presence of the haematite powder in the pits attested to the intense use of this material also for concentration II. Comparable to the assumption of the ring analysis, a central zone of c. 3.5 m in diameter with a dense material concentration and a stone pavement surrounded by an approximately 1 m wide zone with poor finds was reconstructed in concentration IIa (Sensburg 2007, 7-11). All the pits were located within these zones. Around the find poor ring, an outer circle of lithic accumulations with an average width of 2 m was recorded that was also concomitant with the outer limits of the stone plate setting. Towards the south, a gap within the outer circle occurred which, perhaps, represented a frequently used passage and, thus, the main entrance to the supposed heptagonal structure (Sensburg 2007, 194). In the north-west, the find densities were partially blurred by the accumulations of concentration IIb (cf. Sensburg 2007, 8 Abb. 4; Sensburg / Moseler 2008, 26 Abb.18; 29 Abb. 19). The distributions from concentration IIa seemed to superimpose and, thus, influence the patterns connected with concentration IIb. In consequence, the two accumulations either developed contemporaneously, or the material of concentration IIb was cleared by the later activities in concentration IIa. Towards the north-east, this outer circle was no longer present, probably due to the disturbances by the southern zones of concentration III. In the south-east, the outer ring was at least 1 m wider due to the adjacent activity area IIc. The adjacent concentration IIc was characterised by a large accumulation of faunal remains including cut red deer incisors, stone plates, charcoal, and burnt stones. Although the latter two could indicate a dump area, the former two materials suggested a workshop comparable to the eastern circular structure in concentration I, and the composition of the associated lithic inventory further sustained this interpretation (cf. Eickhoff 1988, 39; Sensburg 2007, 116 f.). This activity zone was probably separated from the main concentration IIa (Eickhoff 1988, 39) and a respect of the limits could indicate quasi-contemporary processes (cf. Sensburg 2007, 147-150).

In concentration III, the problem of various phases which disturbed the previous distributions became most apparent (Stapert/Terberger 1991; Terberger 1997). However, for the main concentration IIIa an oval to circular enclosure with an exit towards the south-east and activity areas in the south and east were suggested (Terberger 1997). Again, the reddening of the sediment by haematite powder was only documented in protected areas such as underneath stone plates and inside pits. Moreover, according to the various distributions and the filling of the pits, Thomas Terberger suggested two, possibly three phases in which concentration III was occupied (Terberger 1997, 313-315). Such a suggestion also implied that the large structures in Gönnersdorf were more permanent installations that, once constructed, were used again in following visits to the site. Thus far, for the scarce areas east and south, no spatial analysis was made focused on the questions of barriers or dwelling structures. These areas were rather considered as open air workshops or, perhaps, dump areas.

According to Dick Stapert's spatial analysis, the remains of the main concentration of Gönnersdorf IV represented an enclosed area of approximately 5 m in diameter with an exit towards the south-west (Stapert 1990). In general, this result was approved by following studies, only the shape of the structure was assumed to be rather trapezoid to almost quadratic (Jöris/Terberger 2001; Sensburg/Moseler 2008, 98). A detailed spatial analysis provided again indications for a previous use of the terrain and the cleaning of these previous remains by the constructors of the possible dwelling structure (Sensburg/Moseler 2008, 72-74). However, all analyses indicated that the north-eastern hearth was an installation in the open air and by some refitted material connected to the main concentration of Gönnersdorf IV.

The discussion on where to locate dwelling structures, either outside the main material concentrations or around these accumulations, as well as on the shape of these structures -round, polygonal, or trapezoid- is too broad a topic to be discussed in the present study (cf. Leesch/Bullinger 2012; Gaudzinski-Windheuser et al. 2011b). However, in the proposed large structures, static problems could have occurred (pers. comm. Olaf Jöris, Neuwied), in particular, if the presence of forests and, thus, the availability of sufficient building wood was limited. Therefore, the proposed latent barriers could have also resulted from other measures such as setting up of windbreakers or cleaning or partial outwash outside the paved areas. Whether the pavements were installed to prevent tripping into sharp material, to protect against the partially perhaps frozen floor, and/or functioned as a type of floor heating is also not thematised here. Nevertheless, these questions become important when considering the procurement of resources such as the immense amounts of slate plates and the substitute of these resources by, perhaps, brushwood or bark (Janes 1989; Grøn 1990). Certainly, the concentrations were places of intense and very heterogeneous activities.

Detailed studies of the single concentrations and the succession of the activities performed in these concentrations are numerous for Gönnersdorf (Poplin 1976; Bosinski 1979; Terberger 1997; Sensburg 2007; Sensburg/Moseler 2008). Coupled with analyses of the material from the complete site (Franken/Veil 1983; Tinnes 1994; Höck 1995; Álvarez Fernández 1999; Street/Turner 2013), the impression of an important base camp arose, where most types of activities in hunter-gatherer lives were performed. Hence, from the dressing of the game to consumption and curing as well as further processing into garment, tools, or art and final discard were evident at the site. The use of further resources was also proven such as lithic raw materials that were knapped and retouched for the use as tools on the site or as projectiles or blanks elsewhere, or haematite which was ground for the use as powder. Furthermore, the import of relatively numerous pieces described as jewellery and the manufacturing of jewellery (jet beads, animal teeth) as well as art (figurines, engravings) attested the satisfaction of growth needs (Maslow 1943) and suggested the performance and participation of the inhabitants in more complex social actions. In the following discussion, some main activities are mentioned for the general site to highlight the differences and similarities between the concentrations.

The numerous lithic raw materials were generally scattered across the complete site but with varying centres. Western European flint was clearly associated with concentration II, but in concentration III and concentration I also notable numbers were found (Franken/Veil 1983, 64-71 Abb. 43-49). However, Baltic flint, that occurred infrequently in concentration II, was more commonly used in the other two areas. The Tertiary quartzite was clearly dominant in concentration I but occurred regularly also in concentration III (Franken/Veil 1983, 33 Abb. 22). In particular, the haematite stained specimens were accumulated in these areas (Franken/Veil 1983, 54-55 Abb. 39-40). Lydite was massively concentrated in concentration III spreading into concentration IV and the northern part of concentration II (Franken/Veil 1983, 9 Abb. 2). In general, chalcedony was ephemerally scattered but with a slightly increased number in concentration III and IV (Franken/Veil 1983, 24 Abb. 14). The raw materials with small numbers such as opal or rock crystal were generally found in concentration III with some outliers in concentration IV and concentration II (Franken/Veil 1983, 57 Abb. 41). However, this short overview already suggested that concentration III represented the most diverse raw material composition, whereas concentration II was least diverse.
Cores of the common lithic raw materials occurred in all areas of the site and also crested blades and bladelets were found scattered across the site (Franken/Veil 1983). These distributions suggested some type of knapping and blank production was associated with all concentrations, only the processed raw materials varied. However, only concentration IV yielded low numbers of debris material of the blank production and, therefore, Thomas Terberger suggested that the blanks used there were taken from concentration III (Terberger 1997, 160). The introduction of blanks into concentration IV from elsewhere on the site was indicative for quasi-contemporary and interwoven activities on the site. However, the occurrence of various knapping spots on the site could be interpreted either as quasi-contemporary episodes within a single occupation event with, perhaps, different actors, or as different occupation events with the recurrent performance of the blank production. In addition, the different distributions of the lithic raw materials suggested the differentiated use of resources on the site.
However, Stephan Veil pointed out that various lithic raw materials were used for the production of various tool types in Gönnersdorf and, consequently, the different distribution of tool classes partially depended on the distribution of the raw materials (Franken/Veil 1983, 262-266). However, all tool classes occurred in all concentrations of the site suggesting that in general similar activities were performed in all concentrations of the site, only with different intensity and/or with materials of different quality for the task. In detail, LMP which on average made up some 40-45 % of the retouched artefacts were the most numerous retouched artefacts in all concentrations, only in concentration IV the values were the greatest. A traceological analysis made on some 200 flints from concentration II showed that the LMP were clearly associated with the use as projectile implements (Sano 2012b). Thus, their concentration could indicate places of repair of hunting equipment. According to the numbers of single pieces in the artefact class, burins, splintered pieces, and sometimes borers followed on the distribution proportion of LMP. Truncations, end-scrapers, and composite tools were also usually present but in significantly lower numbers. The traceological analysis of some Western European flint artefacts suggested a diverse use of these tools and emphasised the large spectrum of activities performed with these pieces.
Comparable to the various areas where blank production and tool modification occurred, the presence of various spots on the site where the same tools were used and/or discarded could not reveal whether these tasks were performed by the same actors in a relatively short succession, or by various actors quasi-contemporary within a longer occupation event or whether these patterns resulted from several successive occupation events.
However, the presence of all stages of the lithic production as well as all types of tools in the three large units of Gönnersdorf marked these centres as possible independent structures where at least the part of the

livelihood of a hunter-gatherer group reflected by these implements was assured. Nevertheless, in concentration IV this assurance was not as completely evident as in the other concentrations due to the scarcity of evidence for the early preparation processes.
Similar to the lithic artefacts, horse was present in all concentrations, though in different numbers. Nevertheless, consumption of horse occurred probably in all concentrations, whereas the processing of the carcass was performed at various stations and with different intensities (Street/Turner 2013). For example, in concentration IV only two horses were securely determined, whereas concentration I produced indications for 14 and concentration II even for 28 individuals.
Considering that a modern adult Przewalski horse weighs a few hundred kilograms and assuming that prehistoric wild horses were of comparable or even larger size (Groves 1994), the transport of some 50 individuals to the site represented a considerable logistic effort. Several persons and possible transport equipment had to be involved in this effort, particularly, if the kill site was located at some distance to the site as was suggested for Late Magdalenian sites in Switzerland based on the analogy of a long fleeing distance of modern horses (Müller et al. 2006).
Along with horse, reindeer, arctic hare, fragments of mammoth, and various bird species were commonly spread species on the site, although they were not found in the scarce faunal assemblage from the northern concentration IV. In contrast, the remains of woolly rhino were only accumulated in concentration II, in particular IIb, and concentration III. Equally, the remains of bovids and caprids were mainly focused on these two central concentrations. In general, the fauna from concentration II and concentration III were comparable with the latter only containing less material and, thus, a connection of these main concentrations was suggested (Street et al. 2006, 761 f.). In this case the general organisation of the concentrations II and III with a large construction in the south-west and a smaller activity zone in the north-east were similar to the small ensemble in the area IV. However, the scarce seasonal evidence indicated a possibly successive use of the two large central concentrations. Moreover, the spatial analyses suggested several episodes on the two concentrations which, perhaps, were interrelated in a longer occupation event. Wolf remains were recovered in concentration I and II with the remains from concentration I representing perhaps a pelt (Street et al. 2006), whereas in concentration II rather the remains of producing a pelt were deposited. Arctic fox was dominantly associated with concentration I (MNI = 29), whereas on the other parts of the site only single specimens, in particular in the form of teeth pendants, were determined (Street et al. 2006; Street/Turner 2013). This focus on a single concentration and the high number of individuals in combination with the assumption of various hunting episodes forming the evidence would imply that the massive construction of this sub-area was perhaps occupied over a considerable period or recurrent visits. Furthermore, snowy owl and the majority of mammoth remains were very focused on concentration I.
Organic artefacts and debris of their production were unevenly distributed on the site and mainly associated with the large accumulations which can be due to preservation issues (Tinnes 1994). The most intense concentration of organic artefacts was with 181 fragments in concentration I followed by concentration II with 113 specimens (Tinnes 1994, 2). In concentration III and IV no organic artefacts were recovered.
The organic figurines were also mainly preserved underneath stone plates and in particular in pits. Consequently, the distribution of these pieces followed also the presence of these protective covers. The majority of female figurines made of organic raw materials were recovered from the northern part of concentration I, whereas the specimens made of slate were generally associated with concentration II (Höck 1995, 266 f.).
The production of pendants made of fox teeth was suggested for concentration I (Álvarez Fernández 1999) where also the main accumulation of this species was found. However, arctic fox teeth were also found in concentration II and III. In the former, the pieces without perforation were more common. Moreover, per-

forated red deer canines were also concentrated in concentration I (Álvarez Fernández 1999), whereas the red deer incisors were accumulated in concentration II (Street et al. 2006).

The molluscs were also mainly found in concentration I, in particular *Homalopoma sanguineum* was only recovered from this area. However, some *Denatlia* were found in all the three main areas (Alvarez Fernández 2001).

In the eastern part of concentration I some unfinished jet beads were found suggesting the location of a workshop in this part of the site, whereas in concentration II and III only single unfinished specimens occurred (Álvarez Fernández 1999). Additionally, many finished pieces were spread in the main concentrations, often found in pits suggesting loss or depot of these items (Álvarez Fernández 2009).

Engraved plates were found across the site but self-evident only in association with plate occurrences. Thus, the majority of engravings originated from the concentrations I and II, less frequently from concentration III, and only some examples were recovered in concentration IV and the south-western area. However, the number of single engraved individuals was significantly higher in concentration I (n = 377) than in concentration II (n = 178). For the most commonly represented types (females, n = 331; horses, n = 79; mammoths, n = 76), the distributions were very different (Bosinski / d'Errico / Schiller 2001, 291-298; Bosinski 2008): The engravings of horses were spread randomly on the site with single specimens found even in concentration IV and the south-western area. In contrast, female (n = 227) and mammoth engravings (n = 66) were significantly accumulated in concentration I where also most of the woolly rhino images (n = 13 out of n = 17) were found. The bird engravings (n = 22) were more frequent in concentration II (n = 15). Most of the less common motives were distributed evenly.

The resources used as firing material were different in the central concentrations[15]: In the western part of the centre of concentration III wood charcoal of willow (*Salix* sp.) was concentrated, whereas wood charcoal in the centre of concentration IIa was particularly determined as pine (*Pinus* sp.; cf. Street 2012). Occasional pieces of juniper (*Juniperus* sp.) were also found in this concentration, but these pieces were mainly scattered across concentration IIb. In all concentrations some type of brown coal supplemented presumably wood as fuel material (Schweingruber 1978). Equally, Tertiary wood was frequently used as supplementary in concentration III and was also found commonly in the eastern part of concentration IIa, only occasional pieces spread to concentration IV.

For concentration I the spatial analysis was thus far the least detailed one, but varied activities were still evidenced by the material from the concentration. In addition to fileting for possible alimentary use of horse and arctic fox, the preparation of pelts was suggested by the remains of arctic foxes and a wolf. Perhaps, the snowy owl remains were also indicative for the use of the feathers. In addition, the majority of organic artefacts were recovered from this area proving the particularly good preservation and also suggesting workshops for processing bone and dental material as well as reindeer antler. In this concentration many expressions and semifinished products of jewellery and art were found revealing the importance of artistic occupations in this area. Many pieces were found in pits and, particularly, one pit contained the probable remains of a complete necklace (Álvarez Fernández 2009, 53). The seasonal indicators attributed at least some of these activities to the cold and dark season where in the seasonal cycles of modern hunter-gatherers in arctic environments a reduction of the protein resources was observed (Halperin 1980) that could be matched by stored food and decreased caloric intake leading to more trapping instead of active hunting and the performance of other tasks inside a dwelling structure. In some arctic peoples such as the Copper Eskimo, aggregation camps were observed in this period of the year (Halperin 1980). The reanalysis of the

15 In concentration IV only a few pieces were determinable, whereas in concentration I the exact location remained unclear (cf. Peters 1969).

faunal material found also indications for the occupation during spring and early summer suggesting a longer period of use of this large structure (Street/Turner 2013).
In contrast, the activities of concentration II were usually considered to relate to the warmer period (Poplin 1978). These indications originated particularly from concentration IIa that influenced the distributions from concentration IIb. In a detailed spatial analysis of the large concentration IIa, Martina Sensburg distinguished various working areas based on the distribution of the various raw materials and the various classes of artefacts (Sensburg 2007, 112-117. 142-150). For example, she distinguished between inside and outside a proposed dwelling structure and emphasised the high amount of debris material outside the structure (Sensburg 2007, 60). In particular, in concentration IIc and in the scarce cluster south-east of this stone ring, cores of Western European flint were prepared and blanks were modified. Crested blades and bladelets made of this flint were also found basically in this south-eastern part where various raw materials were scattered. However, the main activity zone was located inside the supposed structure and organised around the central stone setting where all lithic raw materials were present and in addition preserved in almost all stages of exploitation. Nevertheless, Martina Sensburg emphasised that activities producing much debris or requiring a lot of space such as preparing of hides were performed outside the stone plate structure (Sensburg/Moseler 2008, 5). Moreover, according to the filling in the pits, she reconstructed an activity cycle within the centre of the structure beginning with a phase in which burins and backed bladelets were involved, perhaps accompanied by activities that made use of borers (Sensburg 2007, 142-145). In the next probable stage, blank production was one of the performed activities along with an intense production of burins and further renewal of backed bladelets. In this stage, activities were performed in which end-scrapers were used. Nevertheless, Sensburg recognised no substantial clearing in the distributions of the lithic material, leading her to assume a single occupation event (Sensburg/Moseler 2008, 5) according to a model of material diversification and the variability of spatial organisations established by Hartwig Löhr (Löhr 1979).
Besides the lithic production, processing of faunal material was also proven. All stages of processing of horses as well as arctic hare and reindeer were attested in this concentration. However, the reanalysis of the material showed that arctic hare was more dominant in concentration IIb than in concentration IIa which was clearly dominated by horse (Street/Turner 2013). Moreover, the spatial distribution of the faunal material yielded the south-eastern structure (IIc) as a third independent centre in this concentration. In contrast to concentration I, arctic fox played no important role. Perhaps, the absence was due to the warmer season when the pelt of the modern species is usually not as dense as in the colder season. Birds were comparably common as in concentration I, only snow owl was not determined among the species (Street/Turner 2013). However, rhino remains were more numerous, particularly in concentration IIb and the north-western part of concentration IIa but therefore mammoth was not as frequent as in concentration I.
Organic artefacts were frequent in this concentration (n = 113) with almost a third of the pieces (n = 40) originating from concentration IIb (Tinnes 1994). In contrast, the animal teeth interpreted as pendants (arctic fox and red deer incisors) were all found in the centre of concentration IIa and in concentration IIc where also a single unfinished jet bead was recovered (Álvarez Fernández 1999). Further, pieces of jewellery such as molluscs were found in this area (Alvarez Fernández 2001). Nevertheless, the indications for the production of these ornamental items were not as evident as in concentration I. Loss and discard seemed better explanations for the material in this area. In contrast to concentration I, the female figurines were usually made of slate in this concentration and the choice of engraved motives appeared reduced in comparison with concentration I. However, both activities were attested in the concentration. In general, the activities performed in concentration II were similar to the activities in concentration I, although often the numbers were smaller and the activities appeared not as intense as in concentration I. However, in this large

concentration a more detailed study of the faunal material supplementing Martina Sensburg's analyses could perhaps help to further differentiate various episodes and the development of this concentration, in particular in regard to the succession of the concentrations IIa, IIb, IIc, and in addition the influence of concentrations IIIb and IIIc on the spatial pattern.

Although almost all lithic raw materials were found dispersed across concentration III, the actually dominant raw material was different for each activity zone of this area: In the central area Tertiary quartzite dominated, whereas in the smaller northern part chalcedony was slightly more frequent, and in the eastern zone Baltic flint and Tertiary quartzite were slightly more common. In the zone IIIb, lydite artefacts were most numerous and in zone IIIc, the Western European flint occurred most frequently. However, the northern part of IIIa, the eastern zone, and the zone IIIc contained less artefacts than the central area IIIa and the adjacent zone IIIb. Since Western European flint and lydite were rarely found in the pits, they were considered as remains of a later phase (Terberger 1997, 235-248). Terberger suggested that the blanks found in concentration IV were taken from concentration III because of the low numbers of debris material of the blank production found in concentration IV (Terberger 1997, 160). Equally, he assumed concentration II and III to be interconnected in this way, whereas concentration I appeared rather unconnected according to the refitted material with concentration III, although the main raw materials from both concentrations were comparable. For instance, some crested blades of Tertiary quartzite that were common in concentration I were also found in concentration III and some cores of the same material were also found. In particular, in concentration IIIc a cluster of cores was found suggesting a working area there. In addition to the common raw materials, almost all exotic materials such as rock crystal were worked in this part of the site. In addition, fossil curiosities such as a shark tooth, a dinosaur vertebra, and a rhino bone were recovered here (Floss 1994, Abb. 159). Moreover, some finished and a few unfinished jet beads as well as a few perforated and not perforated arctic fox teeth were recovered from the central area III. Several pieces of each of these items as well as several more organic and anorganic artefacts including a perforated piece of lava were found together in a single pit in the south-west of the pit cluster (Álvarez Fernández 2009, 52 f.). Perhaps, these pieces represented the depot of a workshop. In summary, concentration III was the accumulation with the most heterogeneous spectrum of raw materials resulting from several activities mainly connected to lithic production. However, based on the technical, faunal, and ornamental remains the activities were again similar to those performed in concentration I and II but with the production of even less material than in concentration II.

In comparison with the other Late Magdalenian concentrations in Gönnersdorf, concentration IV yielded particularly small numbers of material. Nevertheless, according to the distribution of raw materials, Frank Moseler suggested that the majority of lydite artefacts were mainly cleared out before the main structure was set up (Sensburg/Moseler 2008, 99). However, the lydite distribution did not spread from the main centre in the southward located concentration III but originated from the north-west indicating further settlement activities west of the excavated area. The very scarce indications of a blank production attested that a significant amount of the blanks was prepared elsewhere. Also, the retouched tool inventory was very small. However, dependent on the analyst, half to almost two third of the retouched artefacts were LMP. Thus, these pieces were present more frequently than in other concentrations. Nevertheless, the other tool classes, in particular, burins, splintered pieces, and borers were comparably common as in other areas. Only some remains of horse were found in association with this concentration and, possibly, represent consumption debris. No organic artefacts, figurines, or jewellery were recovered from this area. This scarcity of organic material in general was partially attributed to the lack of pits and protecting stone pavement and, therefore, preservation could be an explanation for the rare finds. However, the presence of burnt quartzes led Frank Moseler to suggest boiling as activity around the north-eastern hearth (Sensburg/Moseler 2008,

99). Perhaps, this process further intensified the decomposition of the organic material used there. Nevertheless, the comparably small amount of lithic material, in particular knapping debris, indicated that some activities such as manufacturing processes were not performed intensively in this area. In regard to the refitted material, the evidence from the lithic inventory, and the general scarcity of faunal remains, concentration IV was probably a dependent concentration that was supplied from other areas of the site. However, some activities were performed around the north-eastern hearth and could have supplied, along with the main concentration, also other areas of the site.
Consequently, although some activities occurred at least once in all concentrations, some centres of for example blank production or horse exploitation appeared to have supplied other areas where for instance the blanks were used or horse was consumed. Further activities such as the manufacturing of mammoth ivory or jet appeared focused on only a few areas which, perhaps, reflected the lower necessity of such activities within the daily routine of hunter-gatherers. However, these focuses displayed a strict spatial distinction for some activities on the site.
This spatial organisation could result from either a single event in which different activities were performed quasi-contemporaneously in distinct spaces and possibly by different persons or from several temporally distinct events if these activities were for example performed in specific seasons such as perhaps the manufacturing of pendants from arctic fox teeth.
Although only a section of an even larger site was excavated in Gönnersdorf, a rich corpus of very diverse material, exceeding many Late Magdalenian sites, was uncovered within the remnants of massive structures. Comparable to other Late Magdalenian and, in particular, some cave sites, the material was spread by complex spatial dynamics within limited areas. In contrast to some other Late Magdalenian sites, these patterns resulted from numerous, diverse activities. In addition, the human material from the site suggested the presence of several age classes among the settlers of the site. Thus, Gönnersdorf represented one of the unambiguous examples of a base camp. Furthermore, the intense presence and, in particular, production of art, if understood as an expression of a growth motivation (Maslow 1955), could indicate a more important social component and support the conclusion that, perhaps, the site functioned as an aggregation camp. Nevertheless, to sustain this hypothesis the quasi-contemporary presence of different groups has to be proven in the chronological development of the site.

## Chronology of the Late Magdalenian

Based on the Late Magdalenian material from Champrèyves and Monruz, the very complex spatial patterns of Late Magdalenian sites were recently highlighted by Clemens Pasda (Pasda 2012). Thereby, he illustrated the thesis that only repetitive visits of specific locations formed sites which become visible (and interpretable) in the archaeological record because only a considerable amount of material makes possible the recognition of the (secondary) activities performed at the site (Pasda 2012, 5-8). In fact, the complex settlement dynamics of Gönnersdorf have been prompting this discussion for some decades (cf. Jöris/Street/Turner 2011). The different possibilities were that the site was settled in one long-lasting occupation event by a single family group or by an aggregation of family groups or that the site was occupied several times by a traditionally successive group or even by several independent groups as a favourable location. Following from this discussion were questions such as how permanent the Late Magdalenian settlements were and how far the Late Magdalenians could be described as semi-sedentary hunter-gatherers.
Indications for answering this question with the help of spatial analysis were found on two levels of the site: On an upper level was the relation of the main concentrations to each other and on a lower level the relation of various episodes within the main concentrations. The latter is only mentioned occasionally in the following discussion because more detailed studies of some concentrations of the site were already

published (Sensburg 2007; Sensburg/Moseler 2008) and further studies are still necessary for the other concentrations.
On the upper level, Thomas Buschkämper observed in the south-western area that the distribution of material attributed to concentration II ignored the structures attributed to concentration I and concluded that these two main concentrations resulted from two non-contemporary events (Buschkämper 1993, 23. 33f.). However, as suggested in relation to the north-eastern hearth in concentration IV, down-slope erosion could have affected the lighter materials. Thus, if the remains of concentration I and II were deposited at the same time, erosion could have moved lighter material from concentration II downwards on top of the material from concentration I. Therefore, a detailed analysis of this part of the site including profile drawings could help resolve the stratigraphic relation of these two major concentrations.
Moreover, in the north-eastern part of concentration IIa the distributions were probably disturbed by material from the southern part of concentration III, i. e. concentrations IIIb and particularly IIIc, suggesting at least a successive use of these concentrations. In addition, the distribution of material from concentration IIb appeared limited or pushed aside by the construction of concentration IIa.
Thus, according to the disturbances of the material distributions, the western structures of concentration I existed perhaps previously to the southern extension of concentration II which probably was connected to the activities of concentration IIa. Although Martina Sensburg assessed the respecting of limits and the existing material exchange in concentration II as probable indicator for a quasi-contemporary existence (Sensburg/Moseler 2008, 50), she could not rule out that these patterns resulted from concentration IIa succeeding concentration IIb and, thus, clearing out the material. Moreover, the disturbances in the north-east of concentration IIa suggested that the latter was preceding at least concentration IIIc and, perhaps, also concentration IIIb. However, whether these disturbances occurred in a clearing within a single, long-term occupation event or in different occupation events remained unclear. Yet, according to the complex interconnections a relatively short period for the development of this part of the site was probable (Sensburg/Moseler 2008, 49f.).
The different distribution of the lithic raw materials was applied as a reflection of the number of events or phases forming the site based on the assumption that these materials which originated from various, partially very distant, regions were introduced to the site either from different groups or at different times. Therefore, the interpretation of the raw material distributions was also coupled with the discussion of whether the site represented a revisited base camp or an aggregation camp. Another possibility for the presence of the diverse raw materials was the exchange of raw materials by some groups previous to the visit. In this case, the different raw materials could have been collected or otherwise received by a single group during a yearly round and then used and/or discarded in Gönnersdorf. Consequently, very diverse raw materials were perhaps used during a single occupation event. The least frequent material was, in this scenario, the material possibly collected early in the round and, therefore, reached the site only in small quantities, or a very distant material which was received in small quantities from another group. However, very frequent materials were conversely accessed shortly before the occupation of Gönnersdorf and/or easily accessible (and transportable) during the occupation. The Western European flint that dominated in concentration II came from a very distant source and, consequently, pointed to a long-distant movement comparable to the chalcedony in the concentration IV. If these distant materials were accumulated in such large quantities, transport must have been an issue resulting in the hypothesis of repetitive visits contributing to large quantity accumulation (Terberger 1997, 166). In contrast, the Tertiary quartzite reflected a regional movement prior to the settling of concentration I and the lydite from concentration III suggested very local moves. Thus, the latter could have been set up after the installation of one of the other concentrations and then supplied with the local material. In addition, the frequency of the deposited raw materials in the pits was used by

Thomas Terberger to distinguish two phases of raw material use: In one phase the pits were filled with four of the main raw materials, whereas two (Western European flint and lydite) were only found infrequently inside the pits and, thus resulted from another phase (Terberger 1997, 166). However, which of these phases occurred previously could not clearly be distinguished.

Moreover, assumptions based on the *chaîne opératoire* that required detailed analyses on the lower level to reveal various stages such as the scarcity of blank production debris in concentration IV was used as an indicator for temporal succession. In particular, some scarcer materials made possible detailed analyses on the succession of raw material use on the site (Sensburg 2007). However, following this line of evidence for the upper level of the complete site will become possible when all concentrations are presented in sufficient detail (cf. Jöris/Street/Turner 2011). For the two central, large units, this type of analysis was accomplished and revealed closely interwoven distributions of raw materials and possibly stages of production but the results led to very different interpretations: Thomas Terberger suggested at least two, possibly three distinct occupation phases, perhaps even occupation events in concentration III that were related to the possibly two-phased occupation of concentration II (Terberger 1997, 313-315), whereas Martina Sensburg considered a single occupation event for concentration II with various episodes (Sensburg 2007, 150-154. 202-204).

This discussion is of interest concerning the permanency of the Late Magdalenian settlement in Gönnersdorf and already arose from the massive structures and amounts of material found at the site as well as the assumption that such immense weights of stones accumulated successively. Nevertheless, whether this succession occurred during one very long or many stays could not be clarified.

Besides the distribution and overlapping of material, refitting lines were used as indications for spatial dynamics and, in particular, quasi-contemporaneity since the earliest analyses of Gönnersdorf (Bosinski 1979). However, Erwin Cziesla illustrated the general uncertainty of contemporaneity based on refitted material (Cziesla 1990, 184) and, in detail, Martina Sensburg clarified the uncertainty of stations traversed by the refitted material (Sensburg/Moseler 2008, 46-49). Nevertheless, frequent connections of material reflect a shared use of resources, and if such refits appear as directed mutually an exchange is a probable explanation and, in consequence, quasi-contemporaneous activities are a probable assumption. However, if these connections are only unidirectional one end served presumably as resource depot or dump but in consequence the distinction of such directions is based on the qualification of the refitted archaeological material (cf. Terberger 1997, 116-146). Moreover, besides relative synchronous activities a time lag between use and discard or deposition and reuse is possible, although in periods of strong aeolian activity the cover of the material limits its visibility and, thus, potential reuse.

Many refits were found between the western centre of concentration I and the south-western area (Franken/Veil 1983). Possibly, these represented flint workshops outside the centre of concentration I. Also from the south of this concentration, material was connected to the south-western area (Terberger 1997, 124) but in this case the former served perhaps as procurement area for the significantly younger concentration V. Single material from the peripheries of concentration I was refitted to material in the northern concentrations. In particular, refitted stone material connected the southern area with the centre of concentration III and concentration IV as well as the south-eastern part of concentration IIa. Along with the peripheries of concentration I, concentration IIa was also connected occasionally to the south-western area, but in these cases the south-western material appeared rather as dump remains. Moreover, a few refits to concentration IIb as well as to the concentrations IIIb and IV were found (Sensburg 2007). In contrast, the connections to the centre of concentration III and concentration IIIc as well as concentration IIc were numerous, displaying intensive exchange. Refitted material connected concentration IIb to all areas of the site except for concentration I (Sensburg/Moseler 2008, 46-51). In particular, the relations to concentration IIc and

IV were very frequent with concentration IIb serving as source for concentration IV. Some connections with the south-western area could also be interpreted as depot or dump. From the centre of concentration III some refits to concentration IIb were found and from concentration IIIb some pieces were connected to IIb, whereas from concentration IIIc only a single refit to concentration IIb was found. This pattern contrasted the intense connections between the areas in concentration III and concentration IIa. Hence, concentration III was frequently connected to some parts of concentration II. In particular, material from the centre of concentration III was frequently refitted to concentration IIa (Sensburg 2007) and to the northern transition between concentration IIa and IIb but only single items from the centre were refitted to concentration IIb (Sensburg/Moseler 2008) and very few to the accumulations in the adjacent areas IIIb and IIIc (Terberger 1997). Frequent refits of material from the centre were also achieved with the north-eastern hearth of concentration IV, whereas few connections to the main structure or from concentration IIIb and IIIc were found. Refits from concentration III to concentration I were very singular and made an accidental impression often connecting peripheral areas. Concentration IIIb was occasionally connected to concentration IIb, IIa, and IIIc. A few refits were achieved with the material from the eastern periphery between concentration III and IV. Material from concentration IIIb was rarely connected to other concentrations. In contrast, concentration IIIc was regularly connected to concentration IIa and IIc but only singularly to concentration IIb. In addition, some rare refits were found with the main structure of concentration IV and the south-eastern limit of the excavated area of concentration III. In concentration IV, the refitted material proved strong connections between the hearth in the north-east and the main structure. Moreover, both areas were frequently connected by quartzes, quartzite and slate plates as well as lithic implements to the various areas of concentration II. In contrast, the centre of concentration III served mainly as a source for the north-eastern hearth and was only rarely connected to the main structure. Furthermore, only single refits were made with concentration I (Terberger 1997, 109-160). The directions of all refits were suggested dominantly uni-directional connections supporting a hypothesis that the other concentrations served as sources for concentration IV. However, this pattern can be interpreted as quasi-synchronous concentrations »feeding« the northern most accumulation or as this northern concentration representing the latest occupation event exploiting the still visible remains from the previous events.

Certainly, frequent exchange of lithic materials occurred between the central concentrations suggesting an intense exchange of material among these accumulations. Many refitted pieces seemed to have served finally in the northern concentration IV. In contrast, the south-eastern concentration I was only connected by single refits of lithic and occasional refits of stone material. In particular, the relatively scarce examples to the centre of concentration I are explicable by unintentional movement of light material or use of still visible remains as a source or settling on no longer visible dumps. However, some connections to the southern, western, and eastern limits of concentration I could also indicate that the accumulation in the south-east was formed by several smaller and, perhaps, temporally distinct structures.

In a synopsis based on the seasonal indicators of the fauna, the filling of the pits, and the refitted material, in particular the Devonian quartzites, Thomas Terberger considered the first phase of concentration III, concentration IV, and possibly concentration I to have formed a winter settlement of a single group (Terberger 1997, 160). According to the refitted material, he further suggested that the concentration II existed previously to the second phase (Western European flint phase, perhaps, later or concomitant with lydite phase) of concentration III and concentration IV (Terberger 1997, 248) because he assumed that the blank production from concentration II had served as source for concentration IV (Terberger 1997, 160). However, the comparable raw material composition and the refitted material could also suggest that the blanks used in concentration IV were made in concentration III (Terberger 1997, 160). Nevertheless, the reanalysis of the distribution patterns in concentration IV by Frank Moseler suggested that the lydite phase was an early stage in concentration IV and the debris from this phase was partially moved aside by the later construction of the large stone structure (Sensburg/Moseler 2008, 99). Thus, if concentration II served as source depot for concentration IV, the lydite remains either represented a separated phase, or the main phase of concentration III occurred after the Western European flint and lydite phase.

Along with the general temporal distinction of the lithic raw material, faunal remains helped to refine the chronology of the site. In particular, the foetal and foal remains of horse were previously assumed as indicative for a seasonal difference in the use of concentration I and concentration II. According to this assumption, concentration I reflected one or several winter episodes (December – February). This seasonal classification was further sustained by the tooth development of reindeer and the significant amount of pelt production, in particular of arctic fox. Concentration II pointed rather to spring-summer hunting episodes (April – June; Poplin 1978; Street et al. 2006; Street/Turner 2013). However, the occupations could have been inhabited alternately but then the last stay would have been in the warm season, disturbing the winter material. In contrast, the very similar faunal composition of concentration II and III led Martin Street and his colleagues to consider these concentrations as interrelated (Street et al. 2006). The more recent reanalysis of the faunal material and its spatial distribution supplemented the previous seasonal indicators from the three main concentrations (Street/Turner 2013). Besides indicators for an occupation from January to April, horse remains indicative for June and September kills were also found in concentration I. The horse remains from concentration II yielded indications for hunting episodes during the whole year except for August, October, and December. Concentration III provided a very comparable pattern of horse kills as concentration I, only that there were indications for an October instead of a September hunting episode. Based on these results, an almost continuous settlement of all concentrations of Gönnersdorf appeared possible. The evidence from the faunal material was only scarce for the hottest summer months and the period of the longest day light which Martin Street and Elaine Turner suggested as a good point during the year for long range travels (Street/Turner 2013).

In contrast to the disturbances of the material distribution, the spatial distribution of reliable $^{14}C$ dates of samples determined to species revealed that a set of dates around 13,050 years $^{14}C$-BP from the central excavation area, particularly concentrations IIb and III, were tendentially older than the $^{14}C$ results from the western centre of concentration I that ranged at 12,810 years $^{14}C$-BP (Jöris/Street/Turner 2011, fig. 7a). However, single specimens in the south-east of concentration II and the eastern centre of concentration I produced older results. Another date obtained from an elk bone found in the south-western area resulted in a significantly younger age and, therefore, is discussed elsewhere (see p. 133). Moreover, a distinction between the episodes forming the central concentrations is thus far not possible based on the reliable $^{14}C$ dates. However, the long interval reflected by the reliable radiocarbon measurements (**tab. 20**; 13,325-12,600 years $^{14}C$-BP) sustained the assumption of Gönnersdorf as a traditional occupation site that was settled repetitively over a considerable period but, equally, that some parts were possibly settled quasi-contemporaneously.

In summary, the evidences from the upper level of spatial analysis clearly suggested numerous occupation episodes at Gönnersdorf that reflected diverse activities and distinguished the site as a base camp. Although a relative succession of some of these episodes was possible, the attribution to various occupation events was not unambiguously possible due to the complex interrelations and the contrasting interpretations which were possible based on these connections. The impossibility to resolve the temporal relations also prohibits the assessment of Gönnersdorf as an aggregation camp thus far because the accumulations could also result from successive moves of a single group on the site and the various materials collected or received by exchange during a yearly round. In particular, this problem applied to the northern concentrations which formed a densely connected area and, perhaps, was also related to the peripheries of concentration I. In this connection of areas some activities were multiply observable such as the production of burins or the exploitation of horse, whereas other activities such as the manufacturing of jet beads or female figurines appeared focused to specific spaces. Nevertheless, the indications from stratigraphic observations, refitting, and some seasonal determinations suggested that the centre of concentration I with its strong focus on arctic fox could represent an independent event.

Archaeological material of the south-western area

Thomas Buschkämper counted 2,804 lithic artefacts among this younger assemblage (**tab. 11**; Buschkämper 1993, 30. 53). Due to the horizontally intermediate position between the two major Late Magdalenian concentrations and the additional bio- and cryoturbation processes in the sediment, the distinction of this small inventory from spoilt Late Magdalenian material was not unambiguously possible (Buschkämper 1993, 22). Moreover, the majority of artefacts were made of flint (n = 1,943). In general, the Western European flint (n = 1,040) from approximately 110 km to the north-west (**tab. 12**) dominated the south-western assemblage as well as the concentration II. In fact, the majority of Western European flint was found in the northern part of the south-western area and was connected to the concentration II by several material refits (Buschkämper 1993, Plan 12-13). The majority of Western European flints were primary Jurassic flints, only eleven pieces were identified as gravel flints, and one burin as Simpleveld variety. A further 752 pieces were made of Baltic flint which originated from a distance of at least 105 km northwards and were mainly distributed in the eastern part (Buschkämper 1993, Plan 14), partially associated with the part attributed to concentration I. In addition, local Tertiary quartzite (n = 386) as well as the foreign Tertiary quartzite of the Ratingen type that originated from some 85 km either northwards or eastwards (Floss/Terberger 2002, 17) were found in the south-western area. These materials were also common raw materials in the adjacent concentration I and, in fact, the majority of artefacts made of these raw materials were associated with the eastern most part which was attributed to concentration I (Buschkämper 1993, 48 Plan 19). Furthermore, the local lydite (n = 417) in different varieties including five pieces of radiolarite were probably brought to the site from the Rhine gravels in complete pebbles (Buschkämper 1993, 53). Chalcedony (n = 37), siliceous oolite (n = 8), Jasper (n = 3), and Palaeozoic quartzite (n = 1) were identified in small numbers. The latter originated from the north-west as well as the dominant Western European flint and was considered as intrusion from concentration II (Buschkämper 1993, 50). The jasper originated probably from the southern German Freiburg region, approximately 300 km to the south (Floss 1994, 233). The chalcedony and the siliceous oolite were probably collected from sources some 75 km south-eastwards in the Mainz Basin.

Generally, Thomas Buschkämper excluded the Western European flint material from concentration V because he regarded the raw material as scattered across the complete area, presumably from the northern concentration II (Buschkämper 1993, 33 f.). However, he also stated that some artefacts were possibly reused in concentration V (Buschkämper 1993, 110 f.). Based on this assumption, Buschkämper gave only few details on this raw material.

Thus, in addition to the six cores recorded by him for this area, further cores from Western European flint were not considered (**tab. 13**). Four cores were made of Tertiary quartzite and three of them were found in the structured area attributed to concentration I. The fourth core was found 1 m northwards of a residual core made of Baltic flint (Buschkämper 1993, 35) in the area westwards adjacent to the structures attributed to concentration I. The Tertiary quartzite was partially affected by desilification (Buschkämper 1993, 44-47) that also destroyed some surfaces on a Tertiary quartzite core (Buschkämper 1993, Taf. 2.1). However, the remaining negatives indicated a core with two platforms of which one was mainly used to exploit the piece. Another core was made of lydite and found in the north-western corner of the area, but the main lydite accumulation was in the vicinity of the other two cores. Furthermore, several pebbles with (n = 98) or with-

out single blows (n = 22) as well as shattered pieces (n = 212) of lydite were recovered from the sub-area. The unambiguous lydite core was exploited unidirectional along one lateral edge (Buschkämper 1993, 53 f. Abb. 7) presumably aiming at elongated blanks, although the final knapping attempts ended in hinges. The majority of recovered blanks were bladelets as well as blades and burin spalls, indicating a blank production process focused on small elongated blanks.
Among the 148 retouched pieces recovered in the south-western area, LMP were most numerous with 58 specimens (**tab. 14**). The majority of the LMP was very fragmented but probably represented remains of backed bladelets (Buschkämper 1993, Abb. 6 Taf. 2-3) and resulted perhaps from a production of these implements by intentional breakage as suggested by refitted material on the other areas of Gönnersdorf (see p. 106). Moreover, some of the retouched material, in particular the LMP were associated with the structures attributed to the Late Magdalenian occupation (Buschkämper 1993, 33 f. 48). An unambiguous classification was difficult due to the very fragmented preservation but five LMP were discussed as backed points or backed point fragments.
The proposed backed point specimens were diversely made. The single jasper point was questioned by Thomas Buschkämper (Buschkämper 1993, 51) because the small bladelet displayed a straight retouched back that was very comparable to the backed bladelets, whereas the pointed shape was due to the shape of the blank. Furthermore, an only partial, width reducing retouch was performed on the opposite lateral edge. Thus, this LMP is considered as laterally retouched backed bladelet in the present study. This piece was also recorded in the Late Magdalenian assemblage (see p. 107). In addition to this piece, two further backed bladelet fragments made of jasper were found in the northern part of the south-western area where the material was associated with scatters of the main Late Magdalenian concentrations, in particular concentration II (Buschkämper 1993, 50-52 Plan 11). Therefore, the jasper artefacts were probably not associated with concentration V. In addition, a point of siliceous oolite was mentioned but not further described (Floss 1994, 227) and, clearly, was not found in the concentration in the south-west (Buschkämper 1993, 49 f.).
Consequently, only the four pieces made of Baltic flint are considered as possible points from the south-western area in the present study. The most complete backed point (1003/352) was already recognised by Stephan Veil (Franken/Veil 1983, 435 Taf. 29.4; Buschkämper 1993, 39). Another refitted specimen (a medial and a proximal piece) was also almost completely preserved and found approximately 4 m north-westwards of the former artefact. A further two fragments were a proximal and a distal fragment. The two almost complete specimens fall in the range of curve-backed points, although the most complete specimen had no continuous lateral retouch leaving a little unretouched edge. Both pieces were retouched additionally on their proximal edges and along the basal part of the opposite edge. Moreover, two fragments were found, a proximal and a distal piece. The latter represented a retouched tip and yielded a shoulder angle. This piece was found near the two refitted fragments in the centre of the south-western area. Interestingly, a notch was set on the unretouched edge opposite to the tip part of this fragment. Such notches were variously observed in northern curve-backed fragments (Schwabedissen 1954, 64). However, whether this damage was intentional such as for fastening some hafting material or was due to use and represented, perhaps, a specific impact pattern remained unclear. A notch-like damage was observed on the retouched basal part of the most complete specimen and there clearly indicating an impact damage. The proximal fragment was pointedly shaped by two lateral retouches. Nevertheless, comparisons with prepared backed bladelets with a retouched opposite edge that were not broken into smaller fragments (e. g. Franken/Veil 1983, Taf. 33.8-11. 14 .19) advise to be cautious when judging broken pieces. Furthermore, two sided, pointed retouches could also represent transitions towards borers. Therefore, the possible pointed base fragment which was found in the south-eastern part of the area in the planum I of the Late Magdalenian

(Buschkämper 1993, 40) could also represent a worn out borer[16]. In contrast, the occasional mention of composite tools of backed bladelets and borers or broken borers in the Gönnersdorf assemblage could perhaps include further possible backed points or fragments of those (Franken/Veil 1983, 435 Taf. 29.9). In addition, the many medial fragments classified as backed bladelets could refit to tips and/or pointed bases and, thus, also represent backed points (Buschkämper 1993, 39). However, the complete specimen with the possible impact fracture on its base clearly prove the presence of backed points in the material of the south-western area.

Besides the LMP, burins (n=34) were most frequently recovered. These tools were dominantly made on a truncation and were often shaped as the Lacan type. However, the latter were generally associated with the Late Magdalenian assemblage, in particular, with the eastern part of the south-western sub-area and, thus, concentration I. Furthermore, the dominance of Baltic flint and Tertiary quartzite among the burins reproduced the dominant raw materials of concentration I. Rarely dihedral pieces or burins on natural edges or fracture surfaces occurred. One such burin was made of Simpelveld flint that is a variety of Western European flint originating from the southern Netherlands and was found near the jasper pieces. Two further retouched artefacts of the Simpelveld flint were found in the northern concentrations III and IV (Buschkämper 1993, 32 f.). As with the jasper specimens, these three flint tools were considered as basic equipment. Nevertheless, this set of basic equipment was probably connected to the northern Late Magdalenian concentrations, not to concentration V. The seven end-scrapers were very worn out and the blanks were often broken. The remaining parts of the blanks were generally classifiable as wide blades. They were mainly concentrated in the eastern part of the south-western area. The twelve borers were clearly dominated by Baltic flint pieces (n=11) which were occasionally made on burin spalls. Generally, they were piercers which were made often by two concave retouches from alternating surfaces. These specimens were found in the central area and the south-eastern corner representing the tool class that was most apparently connected to concentration V. Although this connection might further sustain the doubts about the classification of the backed point fragments, the morphometrics as well as the shaping of the different groups were significantly different with the suggested backed points being wider and thicker and retouched only from the ventral side. The two straight truncations of which one was also laterally retouched were made of Baltic flint (Buschkämper 1993, 155 Taf. 6.5 and .8). The three mentioned composite tools were all made of Baltic flint and all were combinations with burins; in two cases the burins were combined with end-scrapers and once with a borer (Buschkämper 1993, 37). They were generally found in or in close vicinity of the area attributed to concentration I. At least seven splintered pieces were identified in this area.

Besides lithic material, also rock stone material was recovered in the area. More than 225 kg of slate, Devonian quartzite, a singular basalt, and a few specimens of sandstone of different varieties (including a piece of greywacke and some pieces with a high iron ore content, so- called *Eisenschwarte*) as well as more than 40 kg of quartz were recovered from the south-western area. Many quartz pebbles and fragments (n=312) were considered as cooking stones and hammerstones (Buschkämper 1993, 91-93). Some pebbles of Devonian quartzite were prepared as some type of chopping tool (n=3) and a further seven pieces were probably used as some type of hammerstones or retouchers according to the fields of scratches on their cortex (Buschkämper 1993, 87-90). Moreover, two pieces of a coarser, almost sandstone-like variety showed signs of abrasion along one edge (Buschkämper 1993, 89 f.). The largest amount of stone material was introduced to the south-western area in the form of plates. The majority of the slate plates were

16 The complete backed point was found in the same square-metre, but a borer made of Baltic flint was also found in this quarter of the square-metre. Thus, the horizontal position does not favour any of those classifications. However, the measurements of the piece and the forming of the retouches as well as their direction were rather indicative for a backed implement (see p. 275-282).

modified along the edges, although the distinction between artificial retouch and depositional damage was not possible in all cases (Buschkämper 1993, 71). However, some plates wore unambiguous hitting marks indicating attempts of splitting or dividing larger plates into smaller ones (Buschkämper 1993, 64) or they wore notches of various sizes along their edges (Buschkämper 1993, 72). These pieces sustained an intentional shaping of these plates by the Pleistocene inhabitants. In addition, several of the many recovered plates, also those made of Devonian quartzite, showed traces of use such as heating by fire (Buschkämper 1993, 67-69. 85-87) or cut-marks (Buschkämper 1993, 77) or depressions that could indicate the use of these pieces as lamps (cf. Buschkämper 1993, 94-96). These used pieces accumulated in the part attributed to concentration I (Buschkämper 1993, 78) but the heated plates were also frequently found in the central part (Buschkämper 1993, 68 f.). Moreover, 13 of the slate plates were intentionally engraved with mainly female shapes and mammoths (**tab. 18**). Occasionally, phantoms and horses were displayed and, furthermore, single examples of woolly rhino, and a possible seal were identified (Buschkämper 1993, 79). Nine of the engraved plates were associated with the remains of the Late Magdalenian concentration I in the east. However, four plates were recovered from the central part and displayed also females and a mammoth profile (Buschkämper 1993, 81 f.).

14 coin blank pieces made of slate were also found in the south-western area but only one in the central part, whereas nine specimens were found in the areas attributed to the Late Magdalenian. Whether these items were considered as pendants or button-like tools or were used differently remains a matter of debate (cf. Bosinski 1977).

Furthermore, some 50 pieces of haematite were recovered from this sub-area with the majority (n = 35) originating from the part attributed to concentration I (Buschkämper 1993, 26 f.). In contrast to the large Late Magdalenian concentrations, red colouring of larger patches of the sediment were not observed in the south-western area.

The presence of four pieces of jet was discovered in the anthracological analysis and, probably, was not connected to bead production (Buschkämper 1993, 29). In addition to Tertiary wood, the charcoal pieces from the south-western area were, in fact, mainly identified as flaky brown coal that was concentrated in the area attributed to concentration II. In addition, five samples were determined as pine (*Pinus* sp.) and were scattered across the area but two pieces were found in the central part.

Comparable to the other archaeological materials, several pieces among the faunal material resulted probably from Late Magdalenian activities. For instance, only five bones of arctic fox (*Alopex lagopus*) were found scattered across the south-western area (**tab. 15**; Buschkämper 1993, 100) and, presumably, resulted from sprawl of concentration I (Street et al. 2006, 762). Reindeer (*Rangifer tarandus*) was also only present with a few bone and antler remains which were attributed to concentration I (Street et al. 2006, 762). Hare (*Lepus* sp.) was only determined in a single piece (Buschkämper 1993). Furthermore, a tooth of woolly rhino (*Coelodonta antiquitatis*) and ivory pieces of mammoth (*Mammuthus primigenius*) were probably also remains of the Late Magdalenian activities (Buschkämper 1993, 100; Street et al. 2006, 762).

Two bone fragments of bovids were identified in the south-western area. One was recovered in the eastern part of the site belonging to concentration I and the other one in the central part. The latter was not found in the more recent reanalysis of the faunal material (Street/Turner 2013). Four remains of two bovids (an adult and a young one) were found in a higher stratigraphic position in the northern part of Gönnersdorf (concentration IV, Bosinski 1979, 26) but carnivore gnawing indicated that those animals were probably killed by animal predators not humans (Street et al. 2006, 762; Street/Turner 2013). Further remains of large bovids were recovered from the concentrations I, II, and III (Street et al. 2006, 761). In concentration III, the piece was associated with a possibly disturbed structure (Buschkämper 1993, 100). Hence, the position of these bovid elements remains uncertain in the site context.

However, as in all areas of Gönnersdorf, the dominant species among the preserved faunal remains was horse (*Equus* sp., Buschkämper 1993, 99) of which at least 150 pieces were identified in this sub-area (Street et al. 2006, 762). The bones and teeth scattered across the complete area and refitted pieces suggested connections to the Late Magdalenian concentrations in the north and east. However, an accumulation was also observed in the central area (Buschkämper 1993, 99). The remains of at least five horses were deposited in this area (Street et al. 2006, 762).
Remains of elk (*Alces alces*) and red deer (*Cervus elaphus*) were found in a tendentially higher stratigraphic position (Buschkämper 1993, 102 f.). In contrast to the Late Magdalenian concentrations, the ten red deer elements of the south-western area were dominantly bone material and, probably, attributable to three individuals of which one was a calf that was younger than a year (Buschkämper 1993, 102; Street/Turner 2013). The two elk bones from the south-western area and the single carpal from the south-western part of concentration II were the only evidence of this animal in Gönnersdorf. A radius fragment was found in the central area of the south-western area, whereas the diaphyse fragment of the radius was found in the western corner of the area (Buschkämper 1993, 214 Plan 46).

Spatial organisation of the south-western area
The preserved structures in this part of Gönnersdorf contained neither a continuous, multi-layered pavement nor pits or postholes (Buschkämper 1993, 7). However, stone settings that partially formed dense pavements were observed, particularly in the eastern part, but these structures were associated with the Late Magdalenian concentration I (Buschkämper 1993, 23). Due to the presence of Baltic flint and Tertiary quartzite the south-western area was generally considered as an extension of concentration I during the excavation (Buschkämper 1993, 9). In addition, based on his analysis of all the retouched lithic artefacts from Gönnersdorf, Stephan Veil suggested that the south-western part belonged mainly to the larger area of concentration I according to the distances of refitted material and he recognised two partially overlapping activity areas (I. D and E) within the south-western area (Franken/Veil 1983, 216-233). However, in the northern part of the south-western area he assumed the influence of two activity areas (II. A and D) from concentration II. Hence, the episodes forming these large concentrations spread also on the south-western sub-area and blurred the picture of the spatial patterns in this area. Thomas Buschkämper observed a comparable pattern with remains attributable to concentration I in the east (Buschkämper 1993, 23) and material of concentration II in the north (Buschkämper 1993, 33 f.). Furthermore, he stated that the material from the northern concentration disturbed the eastern as well as the central scatter and, therefore, assumed that the northern concentration represented a non quasi-simultaneous event (Buschkämper 1993, 34), although the distribution in the central part were possibly formed by reuse of the material from the other concentrations (Buschkämper 1993, 111). However, due to the probable connection of the eastern as well as the northern parts of the south-western area to the Late Magdalenian, these structures were previously described (see p. 111-114).
Even though no continuous pavement except for the eastern part was observed, a light scatter of plates and plate fragments was documented across the south-western area but only in the central part another concentration occurred (**tab. 19**). This concentration formed a semi-circular ring of approximately 2 m in diameter and was found shortly underneath the pumice (Buschkämper 1993, 7 f. 17-19). At the south-western end of this structure another cluster of slate plates was considered as remains of a hearth which could not be related unambiguously to the stone circle, although the distinction of plates to the one or the other structure was often impossible at the contact zone (Buschkämper 1993, 8. 18). The two evident structures were surrounded by spaces with sparse scatters of stone fragments and were defined as concentration V. The plates forming concentration V were in general smaller than the plates from the Late Magda-

lenian pavement and in contrast to these dense scatters open spaces extended between groups of stones. A comparable structure was the almost quadrangular stone setting with a central hearth in concentration IV. However, this structure was more clearly defined and considerably larger than the small semi-circle.
Thomas Buschkämper performed a ring and sector analysis of the semi-circular structure setting the centre not to the hearth but in the centre of the semi-circle (Buschkämper 1993, 106-118. 216 Plan 48). From this analysis Buschkämper assumed an enclosed area due to the distribution of the lithic remains (Buschkämper 1993, 116) which were in general scarce inside the structure. According to ethnographic examples, he considered this area to represent the remains of a ridge tent of 2 m in diameter (Buschkämper 1993, 130). However, due to the overlapping of several structures and the given stone setting he did not include areas over 2 m from the geometric centre of the semi-circle. Thus, a reanalysis of this possible dwelling structure with modern spatial interpolations and in the context of the surrounding material would be of some interest. Inside the semi-circular structure three possible backed point fragments were found and immediately »outside« of this area the elk radius was deposited. However, the most complete backed point was found in the south-eastern corner of the sub-area where the cluster of plates from concentration I became sparser. All these pieces were made of Baltic flint which therefore was most clearly related to a typologically younger episode. However, this raw material was also applied in the Late Magdalenian concentration I. The Baltic flint and a Tertiary quartzite core from the south-western area were recovered in close vicinity outside the main Late Magdalenian scatter with small debris in the surrounding suggesting this assemblage does not represent the dumps of concentration I but rather an independent knapping episode. Thomas Buschkämper revealed, by mapping the Baltic flint material according to the various levels, that two distinct scatters were observable (Buschkämper 1993, 36 f.). However, since the upper scatter mainly fills the gaps in the lower scatter (cf. Buschkämper 1993, 184 f. Plan 16 f.) this distinction reflected possibly stratigraphical movements and inaccuracies in the excavation and documentation process (Buschkämper 1993, 10-15. 17-22).
Nevertheless, refitted material connected the semi-circular structure particularly with the northern Late Magdalenian concentrations, not the eastern one. Thomas Buschkämper suggested that the concentrations II and III were exploited by the inhabitants of concentration V and, therefore, he concluded that the semi-circular structure represented a later occupation phase than any of the other episodes from Gönnersdorf (Buschkämper 1993, 141 f.).
The indications for the possible hearth were the fragmentation of plates of a fine-grained slate variant, heat alteration of the quartzitic slate plates, and the presence of charcoal pieces (Buschkämper 1993, 134) as well as the occurrence of fragmented quartzes of which some were coloured by fire (Buschkämper 1993, 211 Plan 43). Probably, the structure was severely disturbed, but Thomas Buchkämper assumed the use for cooking and proposed the structure to represent a satellite hearth (Buschkämper 1993, 135). Moreover, he considered this hearth to have served as plate quarry for the semi-circular structure and concluded that these structures reflected two distinct occupation episodes (Buschkämper 1993, 135). In fact, neither faunal remains nor significant numbers of lithic material were found in the vicinity of this structure which could be due to cleaning out of the material or suggest another type of use of this concentration such as a dump zone.
Some of the plates from the circle as well as from the possible hearth were engraved with lines as well as mammoths and female outlines. Even though these engravings were comparable to the motifs in concentration I, only quartzites and no slate plates were refitted between these concentrations. Some refits were possible between the semi-circular structure and the possible hearth but the hearth was also not connected to concentration I but equally to the northern concentrations. Moreover, one of the female engravings found in the stone circle was depicted with special emphasis and, thus, was probably not brought to this

part without recognition but, perhaps, chosen for curiosity (Buschkämper 1993, 81). Nevertheless, the manufacture of these engravings by the creators of the stone circle cannot be excluded.
Contrary to the assumed hearth, a small cluster of mainly quartzitic slate plates at the other end of the semi-circle yielded many fire heated plates (Buschkämper 1993, 195 Plan 27). Partially, this difference could be due to the materials forming the clusters (Buschkämper 1993, 67). However, only a single pine charcoal was found in the vicinity and no observable accumulation of burnt quartzes was detected in this area. Nevertheless, faunal remains as well as lithic material, in particular the lydite and Baltic flint artefacts, appeared focused to this concentration in detail and the space between the semi-circular structure and the pavement of concentration I in general.

### Chronology of the south-western area

The materials in the south-western area of Gönnersdorf were only partially distinguishable from the scatters between the main concentrations of the Late Magdalenian, and in particular from concentration I. In consequence, the numbers given here according to Thomas Buschkämper referred generally to the south-western area which was formed by various, probably non-simultaneous occupation episodes and only a very small sub-sample of these numbers was connected to concentration V.
The elk radius from the central area produced a considerably younger AMS date (Street in Higham et al. 2007, 16f.) than other reliable dates from Gönnersdorf (**tab. 20**) sustaining the stratigraphic tendency of a higher position in the sediment column. Thus, if the elk radius was related to the semi-circular structure of concentration V, these remains represented a presumably younger occupation episode. The presence of lithic point fragments in combination with elk and red deer bones resulted, perhaps, from a later occupation episode at Gönnersorf which was the last Pleistocene visit to the site according to the present evidence.

### Chronology of the Gönnersdorf site

In summary, the chronological development of the site of Gönnersdorf comprised at least two different occupation events. A Late Magdalenian occupation and a significantly younger event with a thus far unknown impact in the south-western area which was presumably infrequently used during the Late Magdalenian. Furthermore, the Late Magdalenian occupation was clearly formed by various phases and episodes, perhaps, even two or more distinct occupation events. However, the distinction of these events was beyond the sensitivity of radiometric dating, and only a faint stratigraphic evidence suggested a chronological succession. Nevertheless, two Late Magdalenian occupation events would still suggest a semi-permanent settlement. Even though the Late Magdalenian settlement comprised a possible duration of some hundred years, the patterns of the material and its use remain relatively stable. Only in the south-western area were changes in the material and its distribution observed and, in fact, dated to a younger age.

## Wildweiberlei, Diez, Rhineland-Palatinate

### Research history

The Wildweiberlei was a small double cave within a limestone outcrop which was destroyed during the early 20th century quarrying along the Lahn river (Terberger 1993, 1). Some scarce remains of a prehistoric occupation in the Wildweiberlei cave were first revealed by a small excavation of Carl Rademacher in 1917 and led to further investigation in the cave conducted by him in 1919 (Terberger 1993, 150f.). Finally, in 1920 some 24 m² in six test areas (A-F) were excavated inside and outside the cave under the supervision of H. Heck and F. Kutsch due to the approaching lime quarry (Terberger 1993, 148f.). The financial and temporal pressure of these works as well as trouble with and among the participants caused imprecisions in the excavation and documentation process (Terberger 1993, 149-151. 154 f.). In general, the position of the finds was recorded per 10 cm deposit and the horizontal position was oriented to a fixed point. Refitting demonstrated that even artefacts from the topsoil were connected to the Late Magdalenian horizon and, thus, confirmed the material to represent a presumably single assemblage (Terberger 1993, 159). The main distribution of the archaeological material was recovered in the entrance area of the northern cave (area D) and the adjacent ledge leading north-westwards to the plateau (area F) and south-eastwards to the second entrance (area E). In this southern entrance (area B) as well as inside the cave (area C) only a few bones and lithic artefacts were found (Terberger 1993, 153). Perhaps this scarcity was due to the only thin remains of the loess deposit in this part of the cave system. Equally, at the back of the northern cave (area A), only 30 cm of humic soil were excavated on top of the bedrock and only small bones, a mollusc, and some stones which were not considered as lithic artefacts were found. Nevertheless, refitted material connected the finds from the southern entrance with those of the northern cave suggesting that both galleries were used quasi-contemporaneously (Terberger 1993, 159 f.).

Topography

The cliff in which the small Wildweiberlei double cave was located formed a promontory at the transition from a bottleneck situation to a widened part of the Lahn valley. The cave system was situated approximately 15 m above the valley bottom and only accessible from the plateau (**tab. 10**; Terberger 1993, 148). The two main entrances of the cave were approximately 2.5 m high and situated some 7 m apart from one another. The two galleries were located in a west-east direction, thus opening towards the west where the valley widened. The ceiling became lower towards the eastern end where the caves were only some 1 m high. A small passage connected the two approximately 9-10 m long galleries. Further arms of the system ended in front of rubble fields.

Stratigraphy

Profiles recorded in the area of the northern cave were usually around 2 m high but could also reach a height of up to 3.5 m (area F), whereas the profiles in the southern cave did not exceed 1 m. In those reduced stratigraphies the bedrock scree was overlain by only 15-35 cm of loess on top of which some 30 cm of topsoil followed (Terberger 1993,153). The archaeological remains were recovered from the complete stratigraphy. In the northern profiles the brownish bedrock scree gradually transformed to a dark or greyish brown layer in an approximately 30 cm thick deposit (Terberger 1993, 155). Only in the entrance area D this layer was overlain by 7 cm of small pebbles. On top of this alluvial deposit, 20 cm of greyish brown sediment followed which were overlain by 15-20 cm of a reddish yellow loessic deposit with some limestone scree. The greyish loess layer on top was found again in all northern profiles. This layer was approximately 20-25 cm thick and contained in area D some limestone scree. The greyish loess was overlain by some 40-50 cm of greyish yellow loess which in area D contained a significant amount of limestone scree. The archaeological material was generally associated with the upper part of this deposit. However, some artefacts spread vertically from the centre of this deposit up into the lower topsoil. Inside the cave, the loess was observed to be intensely to lightly red coloured by haematite powder at the transition to the next layer (Terberger 1993, 165). This layer consisted of some 20-30 cm of light yellow loess which was at least partially transformed into a loess loam (Terberger 1993, 156). This loess loam was overlain by a burnt layer of supposed Latène Age on top of which the topsoil and finally limestone scree followed.

Archaeological material

In total, 662 lithic artefacts were recovered among which 82 pieces were classified as splinters (**tab. 11**; Terberger 1993, 167). Clearly, this number is too low especially in contrast to 28 cores, but probably this number reflects the variable quality of the excavation. Harald Floss observed that in contrast to the typical Late Magdalenian sites in the Neuwied Basin the lithic raw material of the Wildweiberlei yielded a more local character with lydite in four different varieties dominating the small inventory (Floss 1994, 263). Rolled pieces of this material occurred in the gravels of the Lahn and cores with still remaining gravel cortex were recorded in the Wildweiberlei assemblage (**tab. 12**). A fine-grained variety of Tertiary quartzite was also used and, according to a piece with cortex, this material was possibly collected in the Lahn gravels (Terberger 1993, 167). However, one end-scraper was made on a blade of a coarse-grained variety (Floss 1994, 263). Perhaps, this material originated from the Dornburg-Weilburg region which is located at a distance of at least some 15 km to the north-east (Floss 1994, 21-31). Furthermore, the locally available basalt was also exploited comparably to other lithic raw materials from a core (Terberger 1993, 167). Additionally, the LMP were generally made of Baltic flint which could be recovered in occurrences of at least 115 km northwards. Harald Floss assumed that besides Baltic flint also European flint was used (Floss 1994, 263). Yet, a verification of the used raw materials might, in particular for these foreign materials, be of interest concerning the social embedding of this site. However, cores (n = 2) and further debris of the flint material prove the introduction also of this foreign material in almost complete nodules.

Nevertheless, 23 of the 28 cores were made of the local lydite, a further two pieces were made of the local Tertiary quartzite, and another core was made of the local basalt. Furthermore, two basalt nodules and 16 lydite nodules display singular blank negatives indicating testing and rejection. In general, the cores were of small dimensions with a maximum length of 16 cm among the ready prepared but not exploited cores (n = 4, all lydite; Terberger 1993, 168). The 24 exploited cores were tendentially smaller than 6.5 cm and were formed in various shapes (**tab. 13**). Usually the cores were little prepared and yielded considerable amounts of cortex which regularly was found on the natural butt of the recovered blanks. However, 19 crested blades which were made of lydite except for two examples made of flint display some preparation on the cores. Nevertheless, only a single example was prepared completely and from both sites and a further two specimens partially from two sides. The majority were prepared from only one side (n = 13) and three blades were secondary crested blades (Terberger 1993, 171). The resulting blanks were, according to the negatives as well as the recovered material, rather blades than bladelets, but the bladelets were used more frequently as blanks for retouched tools (Terberger 1993, 170). Comparably to the majority of the cores, these blades surpassed lengths of 7 cm only occasionally (cf. Terberger 1993, 172 Abb. 58). Karin Terberger mentioned at least 15 burnt lithic artefacts (Terberger 1993, 161).

113 artefacts were identified as intentionally retouched pieces of which 20 were classified as LMP (**tab. 14**). Among the LMP only backed blades and bladelets were found but generally these tools were recovered in a fragmented state. One piece was completed by refitting (Terberger 1993, Taf. 72.6) and displayed that the modifying retouch did not extend along the entire lateral edge. Furthermore, the unretouched part was probably broken off intentionally from a shallow notch on the opposite edge. Few LMP had straight truncations (n = 5), of which one was additionally retouched on the opposite lateral edge. The burins (n = 12) were dominantly made on blades and of the dihedral type (n = 7). Only two burins were knapped from a truncation and only five oblique truncations without burin blow were found. In addition, nine borers were identified which were rather of the *Zinken* category with a blunt end but without massive retouches. The six end-scrapers were made on blades which were partially very long and also retouched along the lateral edges. Furthermore, the three composite tools were all combinations with end-scrapers, in two cases with a burin and in one case with a borer. The majority of retouched pieces were somehow laterally retouched

artefacts without further retouched working edges (n = 44). Only one specimen was retouched continuously on both edges forming a pointed blade (Terberger 1993, Taf. 71.7), whereas the most common was a partial unilateral retouch (n = 27) which was also the most common supplementary retouch to artefacts with other working edges (n = 9; Terberger 1993, 179). Splintered pieces were not found among the inventory of the Wildweiberlei.

A block fragment of basalt revealed a roughly picked area forming a bowl-shaped depression in the small block. According to its position inside the northern cave and the settlement area as well as in comparison with the Gönnersdorf material the use as lamp was suggested (Terberger 1993, 183).

During the excavation limestone and slate plates were observed, of which some pieces were some 5 cm thick (Terberger 1993, 165). Some of the plates were described as quartzitic slate with edges which were trimmed and, thus, appear very comparable to the remains from Gönnersdorf. However, only 75 fragments of the slate plates were recovered (Terberger 1993, 158) and apparently no engravings were recognised on these pieces. Furthermore, quartzite and quartz pebbles which were black coloured, supposedly by heating, were documented (Terberger 1993, 164) but only two quartzite pieces were collected (Terberger 1993, 158). One was a hammerstone with a clearly defined field of scars (Terberger 1993, 166). Additionally, a quartzitic sandstone plate with modifications along the edges and traces of scraping was recovered from the ledge area (Terberger 1993, 166). Nevertheless, the rock material from the Wildweiberlei cannot be quantified anymore but according to the descriptions, at least comparable weights to those from Gönnersdorf IV can be expected.

Among the faunal remains, approximately two horses (*Equus* sp.) and two reindeer (*Rangifer tarandus*) were identified with an adult and a young animal in each species (**tab. 15**; Terberger 1993, 183). Moreover, five individuals of willow grouse (*Lagopus lagopus*), three of arctic hare (*Lepus timidus*), and one of arctic fox (*Alopex lagopus*) supplement the classic Late Pleniglacial cold steppe fauna (Terberger 1993, 184). The arctic fox was determined by four molars, a mandible, and a caudal vertebra. The presence of ibex (*Capra ibex*) was probably accounted for the mountainous surrounding, whereas the remains of a young cave bear (*Ursus spelaeus*) were perhaps part of the fossil deposit of the cave (Terberger 1993, 183 f.). The presence of material from a young woolly rhino (*Coleodonta antiquitatis*) could also represent fossil remains which were possibly collected to serve in the structuring of the cave. Yet, only $^{14}C$ dating could reveal whether some bones were actually fossil material.

In general, the seasonal indicators were scarce but Karin Terberger suggested a use of the cave in the summer and / or autumn months due to the high number of young animals, but she also considered that if arctic fox was hunted for its pelt the presence of this species would indicate a winter prey (**tab. 16**; Terberger 1993, 184). However, the fur of modern arctic foxes changes in October and again in April but can remain the same colour throughout the year in areas of stable climate (Nowak 2005, 80). Moreover, the evidence from Gönnersdorf suggested that the teeth of the animals were particularly chosen for jewellery production (Álvarez Fernández 1999) and, furthermore, that the animals were completely exploited (Street / Turner 2013). Thus, the pelt was not necessarily the most important reason for hunting this species. Nevertheless, if the Wildweiberlei was occupied for some weeks in autumn to early winter the various seasonal indicators were perhaps evidence of different episodes within a single occupation event at the cave.

A fragment of a possibly double bevelled point made of antler was recovered at the site (**tab. 17**; Terberger 1993, 182). The basal part was not well preserved and the second bevelled surface remained uncertain (Terberger 1993, 182). However, two prepared ridges were observed and had possibly an ornamental character (**tab. 18**). Moreover, two pieces of antler showed the fabrication of antler spalls by the application of groove technique. Both items were broken relatively recently and, therefore, could no longer be identified as whether they were representing shed or adjacent antler specimens.

Spatial organisation

During the excavation in 1920 a hearth was recognised by darkened sediment infiltrated with charcoal and burnt bone fragments in the northern cave (**tab. 19**). The presumable hearth was located near the northern wall in the entrance area of the cave. The hearth was 0.6 m × 0.7 m wide and deepened 30 cm into the sediment (Terberger 1993, 161). Furthermore, based on the diary of the excavators, Karin Terberger reconstructed four pits inside the cave floor (Terberger 1993, 161-165). These structures were on average 30 cm wide and 20 cm deep but in detail their shapes and measures were probably very different. A small pit was assumed south of the hearth. Probably it was filled with fragments of slate plates, lithic debris including cores, and hammerstones. East of this pit a limestone plate with several small depressions which was possibly used as an anvil was recorded. A further two pits were located east of the hearth towards the inside of the cave. The pit near the hearth was of an intermediate dimension and eastwards followed by the largest pit. The western pit was completely covered and the eastern pit was partially covered by a construction of three large stone plates including a limestone plate. Charcoal, haematite, fragments of slate plates, bone fragments, and lithic artefacts including cores and blanks were deposited inside the pits. In the pit closer to the hearth the upper 20 cm were filled by ashes which, in combination with the limestone plate, might have served as some type of heating, roasting, or drying construction (Terberger 1993, 163). A fourth pit of intermediate size was set at some distance from the hearth near the southern cave wall. Besides ashes and haematite, only blackened stones (presumably burnt quartzes and quartzites) were recovered in this pit. Moreover, at least some parts of the interior cave were probably paved with slate plates (Terberger 1993, 163-165). Additionally, the sediment within this structure was coloured to various intensities by haematite powder. Thus, according to the descriptions of the excavators, comparable efforts to those measures undertaken at Gönnersdorf and Andernach were invested to produce the evident structures at the Wildweiberlei. In the south-western part of the cave entrance, the intensity of the reddened sediment weakened and this approximately 2-3 m² wide area yielded relatively few archaeological remains. This area was considered as some type of dwelling structure and/or compartment partitioning for the living and sleeping area of a small group (Terberger 1993, 165).

Refitting of material indicated the connection of material from the two galleries and the forecourt. South of the hearth, the anvil and the inventory of the pit suggested a knapping place which was further sustained by the refittings. A comparable activity zone was described in area F where the cave transformed into a rock shelter with a sandstone plate with scratches and a quartzite hammerstone within some lithic artefacts. Based on the amount of material and the settlement patterns, Karin Terberger considered the Wildweiberlei assemblage as remains of a habitation site of a single small group of people which, in several working episodes, spread material in various activity areas across the cave system during a single occupation event of a few weeks (Terberger 1993, 166).

Chronology

According to the results of Karin Terberger, the activities in the Wildweiberlei can be assumed as quasi-contemporaneous. Three samples of humanly modified horse (*Equus* sp.) bones and reindeer (*Rangifer tarandus*) antler from the Wildweiberlei were submitted to the Oxford radiocarbon laboratory but first failed to produce reliably datable material (Street/Terberger 2004, 295). However, refinement of the dating procedure allowed the modified antler to be dated to 12,835 ± 50 years $^{14}$C-BP (OxA-18410; **tab. 20**). Thus, by this date, the antler is placed to the younger end of the Neuwied Basin Late Magdalenian sites but still within the range of this classic Late Magdalenian period (Street in Higham et al. 2011, 1074). However, the collection and the use of the antler raw material could not be estimated precisely and, thus, in a general chronology of the Late Magdalenian in the Central Rhineland the occupation of the Wildweiberlei could be slightly younger than the Late Magdalenian occupations in the Neuwied Basin as considered previously (Terberger 1993, 180-182; cf. Street 1998b, 51). However, the behavioural patterns reflected by the material from the cave and its distribution within the cave system were still very comparable to the Late Magdalenian of the Neuwied Basin, only the more intense use of local materials and the setting inside a cave were distinct from Gönnersdorf and Andernach. The amount and diversity of the material were also smaller than in the two Neuwied Basin sites but this could be explained by the overall smaller size of the site.

## Oberkassel, Bonn, North Rhine-Westphalia

### Research history

In February 1914 track works within a basalt quarry revealed human remains in a sand deposit which was originally situated at the foot of a cliff which was facing south-westwards and already destroyed by the time of the discovery. Since the track workers collected the majority of bones the exact positions of the human material remained unknown. However, an inspection of the site by Max Verworn, Robert Bonnet, and Franz Heiderich a few days after the recovery in 1914 found an area of remaining red coloured sediment and occasional small bones where the workers had uncovered the human remains. Another two days later Gustav Steinmann, Charles Edgar Stehn, Hans Dragendorff, and Hans Lehner recorded a geological profile at the find spot and conducted a test pit survey in which they found human foot bones *in situ*. Furthermore, this survey revealed no finds outside the red stained sediments except for a small, patinated flint bladelet recovered from a sediment sample taken approximately 1 m away of the find area. Moreover, this focus on the limited red coloured area and the typological classification of the recovered artefacts led to the assumption of the remains representing a Late Magdalenian double burial. The Oberkassel evidence became particularly noticed because it was the only full-body double burial attributed to the Late Magdalenian (Schmitz / Thissen 1997, 202; Wüller 1999). The main results of the examinations in 1914 were published in 1919 by Verworn, Bonnet, and Steinmann in a monograph which for the time was very modern and comprehensive (Henke / Schmitz / Street 2006). According to the participants, the material was distributed to two collections (Rheinisches Landesmuseum and Geologisch-Paläontologisches Institut) and, perhaps, due to the high standard of the 1919 publication not further analysed until 1977. In this year Gerhard Bosinski initiated a unification of the material stored in the two archives (Street 2002). A redetermination of bones attributed to wolf (*Canis lupus*) as remains of a dog (*Canis familiaris*) by Erwin Cziesla, one of Bosinski's students at the time, resulted in several reanalyses of the whole assemblage (Henke 1986; Nobis 1986; Wüller 1993; Street 2002). Nevertheless, the site was considered lost to the basalt quarry until Ralf-W. Schmitz and Jürgen Thissen in cooperation with Renate Gerlach rediscovered the findspot by a field survey and geological test pit program in 1994 (Schmitz / Thissen 1997). Presumably, these reinvestigations at the site also led to the decision to propose organic remains from this site when the Oxford laboratory requested Upper Palaeolithic material from Germany for AMS dating. In the 2000s a prominent exhibition of important hominin remains in the context of the 150th anniversary of the discovery of the Neandertal human remains was held at the museum in Bonn where also the Oberkassel remains were stored (Rheinisches Landesmuseum Bonn 2006). The impulse from this project initiated again reinvestigations of the Oberkassel assemblage (Ralf W. Schmitz in Rheinisches Landesmuseum Bonn 2006, 350). Results of the reanalysis combined with modern methods such as molecular and stable isotope analyses are going to be presented in the context of the 100th anniversary of the recovery of the site in 2014 (Schmitz 2009).

| site | sample | years IRSL-BP | ± years | material | comment |
|---|---|---|---|---|---|
| Oberkassel | OD 1 | 11,870 | 1,030 | sandy loess/sand | upper loess (*c.* find horizon) |
| Oberkassel | OD 2 | 11,420 | 1,240 | sandy loess/sand | upper loess (below horizon) |
| Oberkassel | OD 3 | 12,180 | 1,750 | sandy loess/sand | upper loess (below horizon) |
| Oberkassel | OD 4 | 11,780 | 1,910 | sandy loess/sand | upper loess (below horizon) |
| Oberkassel | OD 5 | 11,170 | 1,780 | sandy loess/sand | upper loess (below horizon) |
| Oberkassel | OD 6 | 11,380 | 920 | sandy loess/sand | upper loess (below horizon) |
| Oberkassel | OD 7 | 11,210 | 1,400 | sandy loess/sand | upper loess (below horizon) |
| Oberkassel | OD 8 | 11,430 | 1,540 | sandy loess/sand | upper loess (below horizon) |
| Oberkassel | OD X | 12,090 | 2,744 | sand | upper loess (*c.* find horizon) |

**Tab. 21** IRSL dates from the stratigraphy at Oberkassel. Reference: Schmitz/Thissen 1997.

Topography

The site was set in the 19th century at the north-eastern foot of a basalt cliff at an altitude of 99 m a.s.l. (Verworn/Bonnet/Steinmann 1919, 6). Before the basalt quarry, the cliff rose steeply *c.* 90 m upwards east of the site. Nearby a small valley ascended gradually into the mountain ridges (**tab. 10**). The modern Rhine bed is located less than 1 km to the west and approximately 40 m lower than the site. On the opposite, western bank the river had widened the valley to some 5 km extend.

Stratigraphy

The stratigraphy recorded by Gustav Steinmann was generally confirmed by the 1994 reinvestigations (Schmitz/Thissen 1997). In general, the human remains were found at the bottom of some 6 m of basalt scree which was mingled with quartz gravels which originated from the terrace of the Rhine on top of the basalt cliff. Perhaps, the human bones were partially within 10 cm thick of sandy loam which were underlying the basalt scree and on top of a 4 m thick greyish yellow sand deposit which overlay the basalt bedrock (Verworn/Bonnet/Steinmann 1919, 6 f.). The quarry workers reported that the skeletons were buried under larger flat basalt boulders supplemented by smaller and larger basalt gravels (Verworn/Bonnet/Steinmann 1919, 3. 191). Due to the good preservation of the skeletons Max Verworn assumed that these boulders were positioned intentionally and protected the human material subsequently. However, if the skeletons were embedded in intensely red coloured loam (Verworn/Bonnet/Steinmann 1919, 3) or sandy loams as considered possible by Gustav Steinmann (Verworn/Bonnet/Steinmann 1919, 6 f.) the overlaying basalt boulders could represent a roof of shallow cave or rockshelter formed at the adjacent cliff and collapsed some time after the deposition of the dead (**tab. 10**). The hypothesis of a previously existing roof is further sustained by Max Verworn's description of the basalt scree in the immediate vicinity of the findspot stating that the deposits could only be moved by some effort including machines and strong man power (Verworn/Bonnet/Steinmann 1919, 4). Furthermore, Verworn considered the existence of a roof on the nearby cliff but he assumed this rockshelter as possible habitation site (Verworn/Bonnet/Steinmann 1919, 192). In this case the burial site of Oberkassel would equate the other evidences of intentional depositions of the dead from the early Lateglacial which were usually placed in caves or rockshelters (cf. Pettitt 2011, 226-231). Originally, Steinmann considered the lower sand deposit as an alluvial accumulation, precisely an upper terrace of the Rhine, whereas the modern reanalysis attributed the sands to an aeolian process. Of this loess no particles were found in the basalt scree but layers of basalt and/or quartz scree were found occasionally within the sands. The upper parts of the sands were dated by the infrared stimulated luminescence (IRSL) method (**tab. 21**) which belongs to the luminescence methods and is mainly applied to potassium feldspar-rich material (Wintle/Lancastert/Edwards 1994). This dating resulted in Lateglacial Interstadial to Early Holocene ages for the deposition of the sands and, thus, led to questioning of the typological attribution to the Late Pleniglacial (Schmitz/Thissen 1997, 201). However, meanwhile a tendency of IRSL ages to significantly underestimate the depositional age was considered (Kars/Wallinga/Cohen 2008) and the use of additional pretreatment (infrared stimulation) was suggested as producing more reliable results (Thomsen et al. 2008). Thus, these dates should be assumed as underestimates.

Archaeological material

The human remains represented two almost complete adult skeletons which were generally well preserved. The smaller one was determined as a young adult female, whereas the other remains originated from a mature-senile adult man who was estimated to have been at least older than 50 years. In the monograph from 1919 the remains were analysed morphologically in a comprehensive description (Henke/Schmitz/Street 2006, 244). This description stated that the bones were not manipulated post-mortem but coloured red with varying intensity sustaining the assumption of a burial of bodies and no secondary burial (Verworn/Bonnet/Steinmann 1919; Schmitz/Thissen 1997, 198). Generally, the female skeleton was more intensely covered by haematite than the male bones. The red stained body parts were also different: The female skeleton was particularly red coloured around the head, whereas the male skeleton was most intensely red coloured in the pelvis area. Nevertheless, both crania were damaged mainly on the right side and partially in the frontal part (Henke 1986). Some of these damages were presumably due to the recovery by the quarry workers (Verworn/Bonnet/Steinmann 1919, 2). Moreover, on the male skeleton fractures were observed on an elbow, a collar bone, and the cranium (Schmitz 2009) but the cause of these damages remained unmentioned. Possible causes include an accident, perhaps even a fatal one, during the lifetime of the man, as well as taphonomic processes such as sediment pressure or the fall of basalt boulders on the human remains. In the original publication the loss of several teeth was identified as *intra-vitam* process (Henke 1986).

Besides the human material, the red ochred sediment, and the single flint bladelet of uncertain association (**tab. 11**), almost 80 fauna remains were recovered at the site (**tab. 15**; Henke/Schmitz/Street 2006, 250 Tab. 1). Particularly, the presence of a possibly complete dog skeleton was frequently emphasised (Nobis 1986; Street 2002; Schmitz 2009). The importance of the Oberkassel dog was due to the conjecture as one of the earliest evidences of this domesticated animal for some time but meanwhile much older examples were attested in northern Eurasia (Germonpré et al. 2009; Germonpré/Lázničková-Galetová/Sablin 2012). Nevertheless, in the context of the consideration about local extinctions of dogs or the abandonment of the behaviour to keep dogs during the LGM and related to the Lateglacial expansion process into northern Europe the Oberkassel specimen retained a prominent position. In particular, the well documented morphological and chronological position of this specimen retained its position as important benchmark in the debate on use of dogs. Furthermore, the close connection to human behaviour in general and, in particular, the possible incorporation into ritual behaviour emphasised the importance of the Oberkassel dog. Among the 13 teeth and approximately 25 bones of dog no duplicates occurred and, furthermore, the morphological sizes were comparable suggesting the presence of a single, not fully grown individual (Street 2002, 275 f.).

In addition, brown bear (*Ursus arctos*), red deer (*Cervus elaphus*), and a bovid (*Bos primigenius*/*Bison priscus*) were determined by single teeth and bones (Street 2002). However, the red deer remains originated perhaps from another site (Henke/Schmitz/Street 2006, 251). Furthermore, a lumbar vertebra was considered as possible evidence of roe deer (*Capreolus capreolus*) and several bone fragments, in particular, those smaller than 1 cm could not be determined to species level.

A penis bone of bear which was $^{14}C$-dated to the Lateglacial displayed cut-marks along one edge on which a thick adherence of haematite was observed and the root of an ochre stained red deer incisive was cut (**tab. 18**; Henke/Schmitz/Street 2006).

The immediately recognised organic artefacts led to the original attribution of the assemblage to the mid-Magdalenian. In particular, the flat figurine made of a long bone (or possibly antler) was often referred to as »contour découpé« comparable to examples from the Magdalenian IV (e. g. Bosinski 1989). However, a material, metric, and stylistic reexamination of the Oberkassel piece invalidated this hypothesis (Baales/Street 1998). The missing head prohibited an exact recognition of the modelled species but generally a larger cervid (roe deer, red deer, or elk, *Alces alces*) was perceived (Mollison 1928; Bosinski 1989). This interpretation as well as the piece itself showed clear parallels to the amber figurine of an elk from Weitsche (Heuschen et al. 2006, 25; Henke/Schmitz/Street 2006, 253 f.; Schmitz 2009; Veil/Terberger 2009, 349 f.).
The other artefact was also made of a long bone and resembles modern bone folders (Mollison 1928) and was attributed to the French Palaeolithic lissoirs (**tab. 17**; Verworn/Bonnet/Steinmann 1919, 186). Another comparison was a spatula such as the piece found at Boppard (Wenzel/Álvarez Fernández 2004) but in contrast to the Boppard piece the cross-section of the Oberkassel piece is rectangular with rounded edges (Verworn/Bonnet/Steinmann 1919, 186). The blunt edges were cut by angular lines. One end was pointed, polished, and yielded fields of scratches on both sides, whereas on the other end a schematic animal head was carved which according to Max Verworn represented possibly a rodent or marten. Another possible perception for the head is a female roe deer head. Perhaps, the piece was used as a hair pin (Mollison 1928) which was assumed from the observation of the workers who recovered the item underneath one of the skulls (Verworn/Bonnet/Steinmann 1919, 186). However, an application in activities comparable to the interpretations of spatulas is also possible (Wenzel/Álvarez Fernández 2004, 148).
Martin Street concluded that the fauna assemblage did not resemble the typical prey of a hunting episode because the remains served mainly no alimentary supply but could be classified as ornamental pieces (Street 2002, 285 f.; Henke/Schmitz/Street 2006, 252).

Spatial organisation

According to the interrogated quarry workers the two skeletons were recovered in a not fully stretched position but not oriented in the same direction (Verworn/Bonnet/Steinmann 1919, 191). Furthermore, the previously mentioned stone settings as possible protection for the dead would be a unique observation for the Lateglacial in north-western Europe. However, since Irlich is also considered as burial at an open air site, this factor appeared not uncommon for the Central Rhineland, although generally the position in caves or rockshelters or on the forecourts of caves appeared the most common behavioural pattern in the Lateglacial (cf. Pettitt 2011, 226-231). In combination, these two unusual occurrences led the present author to consider a taphonomic explanation (e. g. roof collapse; see p. 139) for the formation of the Oberkassel evidence as probable. In this case, damages on mainly the right side of the faces and limbs of particularly the male remains suggested that the bodies were positioned on the left side and, therefore, the fall of the basalt boulders hit the right side first and harder. This part could probably be tested by the reanalysis of the human remains.
Nevertheless, the reported limited area of red ochre, the general presence of this material as well as of the special goods interpretable as items given into a grave or representing ornaments of special garments sustained the hypothesis of a double burial of an old man with a young woman and a dog.

Chronology

Seven subsequently taken $^{14}C$ dates (**tab. 20**) on the remains fall into the first part of the Lateglacial Interstadial. In contrast to the conclusion of the spatial arrangements, these dates are statistically not consistent with the hypothesis of a single event. Therefore, these dates have to be evaluated in greater detail elsewhere (see p. 265-269 and p. 470 f.).

In summary, the Oberkassel evidence suggested that two people and a dog were buried in a possible rock-shelter, presumably in a crouched or semi-stretched position on their left side. Due to the lack of spatial documentation of the buried remains, the chronology has to rely on the radiocarbon dating which requires further evaluation.

## Irlich, Neuwied, Rhineland-Palatinate

### Research history

In 1957 some human remains with a few archaeological remains were discovered in sands which were used in a house construction. These sands were assumed to be transported there from a sand pit in Irlich, today part of Neuwied/Rhine (Baales 2002, 11). In late 1963 they were recorded in the district museum of Neuwied where they were forgotten in a box until 1998 when the Archaeological State Service overtook the box. In addition to the human bones, four artefacts and a note were stored in the box. The note written on December, 25th 1963 suggested the necessity to reinvestigate the site and, moreover, described that the sands at the site were in some places red coloured. However, if the remains were only discovered from a sand heap and, furthermore, recorded in the museum approximately six years later the question arises how the writer of the note received this information. Moreover, the human bones were after their rediscovery in 1998 AMS-dated to a Lateglacial age and, therefore, are mentioned here. Detailed anthropological and pathological studies of the material led by Jörg Orschiedt are on-going (pers. comm. Jörg Orschiedt, Mannheim).

### Topography

Irlich is situated at the confluence of the rivers Wied and Rhine (**tab. 10**). The sand pit from which the human remains perhaps originated was situated *c.* 1 km west of this confluence at an approximate altitude of 60 m a.s.l. (Baales 2002, 11). On the other side of the Rhine and southwards of the site the Neuwied Basin spreads in a wide plain. The surrounding hills leave only a small bank before rising gradually some 35 m upwards to an almost 2 km wide plateau exposed to the south and protected towards the north by another hill step of more than 200 m altitudinal difference. On the north-western corner of this plateau the Late Magdalenian site of Gönnersdorf (see p. 103) was located.

### Stratigraphy

The sand pits from the mid-20th century in the Neuwied Basin were known to be covered by the LST (Baales 2002, 11). In 2001, Michael Baales confirmed by a sequence from a small test pit in a wall of the former sand pit of Irlich that the pumice of the LSE had fallen on top of a sand deposit (written comm. Michael Baales, Olpe). Therefore, if these remains were shovelled from these sands they should predate the LSE.

### Archaeological material

The human remains comprised some bone and teeth fragments including a completely preserved femur. Originally, some of the bones were identified as belonging to an adult individual and some to a juvenile child (neonate; Bronk Ramsey et al. 2002, 10 f.; Baales 2002, 11). All children bones and several bones of the adult were red colour stained, whereas other specimens were uncoloured. Along with the possibility of indicating the presence of three individuals (Baales 2002, 11), the differently coloured bones were possibly caused by only partial cover of the humans by the reddening material (cf. Schmitz/Thissen 1997, 198).
However, in a first assessment of the on-going reanalysis Jörg Orschiedt and his colleagues described all bones as red colour stained (Orschiedt/Berg/Flohr 2011). Moreover, the bones were regrouped with the

left femur and a further five bones (from the left arm, cranial fragments and a lumbar vertebra) originating from one adult individual, presumably, a young adult female which according to porotic bone appositions suffered perhaps from a haemorrhagic disease, possibly scurvy (Orschiedt/Berg/Flohr 2011). The remaining bones were identified as three possible children of different ages: the youngest child was about 6-12 months old (cranial fragments, tooth fragment, rib fragments), one was approximately 4-8 years old (single fragment of left parietal), and another one was 5-10 years old (single right ischium).
The archaeological material stored with the human bones in the box comprised a LMP fragment (**tabs 11. 14**), a burin spall, an organic point or awl fragment (**tab. 17**), and a perforated and incised red deer incisor (**tab. 18**). The two lithic artefacts were made of a yellowish homogeneous raw material, perhaps a chalcedony variant (Baales 2002, 10 f.) which could originate from the 30 km north-westwards located Bonn-Muffendorf or the Siebengebirge, east of Bonn (**tab. 12**). The tooth fragment was perforated at the end of the root and the root was incised with parallel lines. Furthermore, the grooves were slightly red coloured. The haematite i.e. red colouring material can be found in various resources within a distance of 50 km around Irlich. A not sufficiently large amount of collagen remained in the pointed artefact to date the piece reliably (Baales 2002, 12). Such singular artefacts and, in particular, the red colour appeared typically in funerary situations in the Upper and Final Palaeolithic as well as the Mesolithic. Therefore, the co-occurrence of these partially red coloured items with the red coloured human bones were considered as evidence of a possible burial situation (**tab. 19**; Baales 2002, 11).
All these pieces appeared typical for late Upper and/or Final Palaeolithic assemblages, although the pointed bone/antler fragment and the red colour rather indicated an association with the Late Magdalenian but the reliable $^{14}C$ dates are closer to the range of the main group of dates from the upper horizon of Andernach and, thus, a FMG context.

### Chronology

Five AMS dates were taken on the human material but produced slightly heterogeneous results (**tab. 20**; cf. Bronk Ramsey et al. 2002) which require a more precise evaluation (see p. 265-269 and p. 471 f.). However, an uncoloured, adult skull fragment (OxA-9876) resulting in an age of the Hallstatt period either did not belong to the assemblage or was more severely contaminated. The other dates scatter in the first part of the Lateglacial Interstadial. Whether these remains were deposited in one or several events can only be clarified by an evaluation of the dates since further stratigraphic observations are lacking. However, the assemblage attributed to the sand pit of Irlich seemed to reflect the deposition of a young woman who probably died of a disease and three young children. These people were buried in a typical Upper Palaeolithic tradition with some grave goods and covered by red coloured material. Moreover, the $^{14}C$ dates of the human remains, the probable topographic position, the red colouration as well as the potential grave goods appeared also closely parallel to the finds of Bonn-Oberkassel which by $^{14}C$ dates was equally attributed to the first part of the Lateglacial Interstadial.

## Kettig, Rhineland-Palatinate

### Research history

After the removal of the pumice of the LSE in 1992 and the subsequent mechanical levelling of the uneven Allerød soil, bone splinters and a pre-core made of Tertiary quartzite were collected from a field east of the town Kettig (Baales 2002, 60). These finds led to the excavation of the site in 1993 under the supervision of Michael Baales. In total, an area of 242 m² including eight test pits and an approximately 20 m long test trench reaching several metres south-westwards from the site were uncovered during this campaign. However, some parts of the site were severely affected by the mechanical levelling because the Allerød soil was in these parts removed and refilled in other parts by this action. At least some 30 m² were totally capped and a further 30 m² were almost disturbed (cf. Baales 2002, 87 Abb. 40). Due to time pressure and the generally compact impression of the vertical find distribution (10-20 cm spread) the exact height of the artefacts was only taken in a small test area. This test revealed that the heights were relatively arbitrary and the artefacts originated presumably from a single horizon. Thus, the single artefacts in Kettig were only recorded two dimensionally, although an approximate height can be given due to the recorded altitudes of the excavated square-metre and the recording of artefacts laying considerably deeper than 20 cm underneath the surface (Baales 2002, 60-63). Furthermore, the sediment from the quarter-square-metres was sieved and the material was sorted out microscopically.

Topography

The Lateglacial open-air site on the eastern limit of the town Kettig is located some 1.6 km south of the modern banks of the river Rhine. In the Lateglacial, a branch of the river passed the site in a distance of only some 200 m in the north (**tab. 10**; Baales 2002, 65-69). Approximately 400 m westwards of the site the Kettig creek flowed into the Rhine branch during the Lateglacial forming a sediment fan which silted up the banks of the Rhine branch. The site is located almost in an angle formed by the Rhine branch and the sediment fan. Approximately 1.5 km eastwards another small stream (Lützelbach) ended in the Rhine branch in the Lateglacial. Furthermore, on the eastern limit of the site the terrain steeply falls some 2 m and in several steps over the next 20 m the terrain slopes down a further 4 m. This step was also observed at the northern limit. By these steps in the Allerød terrain a kind of small terrace was exposed above the floodplain of the Rhine and on this terrace the site was located. Some 300 m south of the site the terrain slopes upwards gradually over 20 m before the Kärlich hill rises steeply *c.* 100 m upwards. Presumably, the terrace was formed by erosion fans of this adjacent hill. In the south-west of the site the hill levels off into the valley of the Kettig creek. The hill continues in south-eastern direction for approximately 1.5 km.

Stratigraphy

In general, the stratigraphy was only recorded until 5 cm underneath the last finds. However, the main profile taken on the eastern limit of the site began with a 25 cm thick grey calcareous clay of Tertiary age (Ikinger in Baales 2002, 70). In a drilling, these Tertiary deposits were recorded over a thickness of *c.* 3.7 m containing up to 20 cm thick layers of brown coal (Baales 2002, 73). On top followed some 1.75 m of loam containing in the upper part the Lateglacial artefacts. The 25 cm of loam on top of the grey Tertiary clay was greyish, calcareous, and silty to sandy followed by 65 cm of less sandy loam which comprised single loesskindel. In the lower part of the overlaying deposit these loesskindel reached diameters of 2 cm. This deposit was 50 cm thick and greyish with light red flecks. The sandy component increased again. In the 15 cm on top the flecks were yellowish red and light greyish. The 20 cm on top were separated by a band of fine gravels. The loam was grey to blackish grey with a sandy component and slate component in the size fraction of sand. Partially humus formation was observable. In the upper half charcoal flitter and bands of iron oxide and manganese oxide were spread. Clearly, this part was affected by the Holocene pedogenesis. In this part of the profile the archaeological material was deposited with the heavier pieces laying in general deeper and the lighter pieces were presumably due to mechanisms moving these pieces upwards in the soil (Baales 2002, 63). This stratigraphic position several centimetres below the Allerød surface suggested a dating some time prior to the LSE. On top of the dark loam some 4 m of pumice from the LSE followed. One long West-East profile in the test trench eastward adjacent to the site recorded a first depression east of the site followed by gradual down slope to a gravel deposited dispersed with brown coal pieces. In the first depression a geological drilling was made which produced the three samples for macro-botanical analysis and the six samples for the pollen analysis. The palynological samples were taken from a depth of 6 to 28 cm below the surface but the pollen were relatively poorly preserved. In general, the pollen diagram was dominated by pine (*Pinus* sp.) pollen which could partially be due to the dominance of pine pollen during the Allerød or due to the introduction of foreign or redeposited pollen (Bittmann in Baales 2002, 74 f.). The redeposition of Tertiary pollen was observed occasionally in all samples. Birch (*Betula* sp.) pollen played a more important role in the upper samples. Possibly, the stratigraphy comprised the Late Pleniglacial to the end of the Lateglacial Interstadial. However, the chronostratigraphic attribution remained uncertain, although the upper part was presumably attributable to an interstadial period in the mid- to younger Lateglacial Interstadial. Comparable to the pollen, the few preserved macro-botanical remains were dominated by birch and Salicaceae. In addition to the pollen and macro-botanical samples, the determined pieces of charcoal (n = 20) were dominantly from poplar (*Populus* sp.; n = 15) or more generally Salicaceae (n = 1). In addition, two pieces were from a leave tree which could not be further determined. Furthermore, also presumably unburnt roots of poplar (n = 2) and Salicaceae (n = 1) were found. Only one piece of charcoal was attributed to birch (*Betlua* sp.). Thus, the determined macro-remains and pieces of charcoal indicated an alluvial forest environment. The mollusc samples which were taken on various spots on the site also suggested a light birch-pine forest environment (Mania in Baales 2002, 78-83). This light forested landscape with nearby open areas which were, perhaps, located in the upper parts of the adjacent hills were further sustained by the micro-faunal remains recovered from the sieved samples (Baales 2002, 83-86).

Archaeological material

The archaeological material from Kettig contained almost 4,000 lithic artefacts larger than 1 cm and including splinters some 24,000 pieces were recovered (**tab. 11**). In relation to the amount of material found at the site, only relatively few refits were found (n = 67; Baales 2002, 171-174). Furthermore, also the considerable stone material yielded only 164 refit lines of which many were related to thermally altered material (Baales 2002, 180 f. 183-185). Among the total number of lithic artefacts were some 1,952 burnt artefacts also indicating some intense contact to fire.

The raw material spectrum was very diverse on this site (**tab. 12**). The two most common raw materials making up some 38 % each were the local Tertiary quartzite and the Western European flint. According to the cortex, the Tertiary quartzite originated mainly from primary deposits and less frequently from river gravels (Baales 2002, 105 f.). Harald Floss recorded several deposits around the Laacher See at a distance of 8 km and more westwards of the site (Floss 1994, 21-33). Among the Western European flint, 15 varieties were observed and, in addition, three artefacts were attributed to the local Eifel variety which can for instance be found near Blankenheim in the Eifel. Some of the Western European flint varieties could be found already in some 60 km distance to the north-west in the gravels of the Rur and occasionally of the Erft (Floss 1994, 94-97). However, the majority of this raw material originated from Meuse gravels or primary deposits in at least 80 to 100 km north-westward direction (Baales 2002, 108-110). Along with these two main raw materials, indurated slate (18.9 %), Baltic erratic flint or flint of the Tétange type (3.6 %), and chalcedony (1.4 %) provided significant numbers of artefacts. The various types of indurated slate including a glassy, green variety originated probably from the Rhine gravel which were accessible near the site. The chalcedonies originated according to their colour spectrum and the inclusions from the Bonn-Muffendorf deposit (Baales 2002, 111). The use of glassy flint with bryozoa inclusions from the Baltic erratic moraines which were located at a minimum distance of 125 km northwards of Kettig could not be attested unambiguously due to the lack of the characteristic cortex. However, on other sites from the Central Rhineland this raw material was clearly attested. Nevertheless, the comparable Tétange type flint which can be found in the vicinity of Trier and in Luxembourg as well as in the gravels of the Moselle was considered as alternative classification. A further eight raw materials (indurated claystone of the Schaumberg type; limonite; reddish agate/jasper of the Weiselberg type; agate; greenish jasper; indurated claystone; carnelian; quartz) were represented by few or single pieces. In particular, the Schaumberg and Weiselberg type artefacts as well as the greenish jasper are of interest in the discussion concerning the origin of the glassy flint with bryozoa inclusions because these rare materials originated also from the area south to south-east of Trier. Thus, these raw materials came from some 100 km south-west of Kettig and, perhaps, flints of the Tétange type reached the site by the same connection. The limonite, agate, indurated claystone, carnelian, and quartz could be found in the gravels in the immediate vicinity (Baales 2002, 110).

The proportion of pieces with cortex was generally low suggesting that the raw material pieces were brought to the site in a partially prepared state. However, some of the foreign materials encompassed higher proportions of pieces with cortex indicating that these were brought merely tested to the site. In total, most of the materials seemed to be introduced to the site as raw material units and not as ready prepared blanks or retouched pieces (cf. Baales 2002, 107 Abb. 53). Nevertheless, some pieces were singled out as having reached the site as ready prepared tools which were discarded on the site (Baales 2002, 114-119). Based on the raw materials three end-scrapers, a burin, a *Federmesser,* and a blade were attributed to this primary working set on the site. In total, 60 core and core fragments were recovered in Kettig (**tab. 13**). The majority were made of Tertiary quartzite (n = 25) followed by indurated slate (n = 17), Western European flint (n = 13), chalcedony (n = 4), and Baltic/Tétange flint (n = 1). In general the cores were of very small dimensions. Some of these pieces were exploited exhaustively which was possible in a flexible exploitation strategy aiming not necessarily for blades or bladelets. Of the 22 cores and core fragments displayed by Michael Baales some specimens were exploited from platforms which were not opposing each other but which were located at an approximately right angle to one another. Although the general concept appeared very flexible, elongated blanks and in some examples blade sequences were observed (Baales 2002, 138; cf. Baales 1999). In particular, some short blades were identified among the greenish indurated slate material (Baales 2002, 138). A more detailed technological analysis of the assemblage from Kettig by Ludovic Mevel will be of particular interest concerning the differences of the applied concept depending on the raw materials. Furthermore, besides two claystone retouchers and a minimum of five hammerstones, a used hammer made of red deer antler (see p. 148) was found attesting the use of an organic knapping instrument on the site of Kettig.

The inventory of retouched artefacts comprised 350 pieces (**tab. 14**). End-scrapers were the most numerous class (n = 117) followed by LMP (n = 100). The end-scraper were generally small and some were very small. Micro-wear analysis revealed that these pieces wore only few alterations due to use or hafting but indicated resharpening (Pawlik in Baales 2002, 263-265). Five end-scrapers were double end-scrapers. Among the LMP four broken pieces were refitted and, in consequence, 98 single LMP were present at the site. However, these specimens were in general heavily fractured. However, many pieces were tip fragments allowing for the attribution to the backed point group. The blunting lateral retouches were generally shaped as a curved or straight edge. In addition, the blunting retouches were occasionally discontinuous and only partially applied to the blank. For instance, some microlithic points were found on which only the tip part was retouched in a type of an oblique truncation. Principally, these fall in the range of Zonhoven points but were made on significantly smaller bladelets than typical Zonhoven points. Including these implements, only twelve pieces can be considered as complete or almost complete LMP yielding a considerable variety of LMP types. Micro-wear analysis of five points (including two microliths) identified remains of some sort of impure birch resin on these implements (Pawlik in Baales 2002, 261-263; Baales 2002, 265-267). Based on these results, the small microliths were, in fact, glued with their basal part to the shaft indicating a use as a head of a projectile. In contrast, the larger *Federmesser* and straight-backed points were glued with their blunted lateral edge to the shaft comparable to evidences with backed bladelets (Allain 1979, 100-103; Leroi-Gourhan 1983). However, in difference to the regular backed bladelets, the wider part of a point would have protrude of the projectile in a barb-like way. Besides the LMP, four *Krukowski* micro-burins were found representing remains of the production of LMP on the site. The 36 burins were with few exceptions made on retouches and in one case classified as Lacan type. Only three dihedral pieces were identified. The size of the blanks as well as the forming of the retouch and the setting of the burin blow vary considerably. On five pieces a lateral retouch was added to the blank. Comparable to the end-scrapers the burins were often resharpened. A minimum of 35 burin spalls sustained this impression and indicated the preparation of these pieces on the site. The 21 truncations were in contrast to the burins made in general on regular blades or bladelets. Two pieces were double truncated. Five borers were also recorded. Two were made of Tertiary quartzite and only the blank was broken shortly underneath the working end. The other three borers were made of Western European flint. One of these was also only a fragment. The three fragments were heavily worn out and, perhaps, due to this intense use morphologically classifiable as Zinken. The two almost complete specimens were rather attributable to the piercer group. The three composite tools were all combinations with burins: twice with truncation and once with an end-scraper. In addition to these tools, 48 artefacts with lateral retouch were identified as well as a further ten pieces with lateral splinters and 22 splintered pieces.

Several gravels and quartzes were recovered from the site but some were possibly deposited naturally at the site. Five pieces showed indications of use, perhaps, as hammerstones (Baales 2002, 176) and two retouchers as well as a retoucher fragment made of argillaceous shale. A further 175 gravels or fragments of Devonian quartzite, quartzitic sandstone, and prophyry were recovered from the site weighing some 20.6 kg of which some 7 % were thermally altered. Some pieces were intentionally split to receive plates. In addition, 72 quartz pebbles and fragments were also found in the excavation area. Several of these specimens were reddened or fragmented, possibly due to the use as cooking stones.

In addition to the stone material, more than 57,000 fragments of bone were preserved at the site. The majority of this organic material (75.9 %) was burnt (Baales 2002, 97). In general the surface was not well preserved. Nevertheless, some cut-marks were observed on the 278 fragments of red deer (*Cervus elaphus*; **tab. 15**; Baales 2002, 202-206). The development of the teeth of the lower jaw as well as a teeth cementum analysis of the material suggested a hunting period from late summer to late autumn (**tab. 16**; Baales 2002, 226 f.). All body parts of this species were found and attributed to approximately eight individuals of red deer. More than 100 fish remains were detected and among them were pike (*Esox lucius*) and Cyprinidae identified (Krey in Baales 2002, 222-224). 34 remains were determined as beaver (*Castor fiber*). These were often burnt (Baales 2002, 219). A further 30 elements were attributed to approximately three roe deer (*Capreolus capreolus*). The eruptive and abrasive stages of teeth of this species suggested a hunting episode in the mid-summer to mid-autumn period, although a winter to autumn was also indicated by a not completely closed epiphyse. Probably, three horses (*Equus* sp.) were represented by 27 remains. Heavy butchering marks and fracturing for the probable marrow extraction were observable on these pieces. 25 fragments were attributed to two large bovids (*Bos* sp./*Bison* sp.), presumably aurochs (*Bos primigenius*). Chopping marks indicated the opening of some bones, probably to receive the marrow (Baales 2002, 211). Approximately 18 remains of presumably fox (*Vulpes vulpes*) were discovered. Some teeth fragments were possibly attributable to chamois (*Rupicapra rupicapra*). Five pieces each were determined as brown bear (*Usrus arctos*) and marten (*Martes* sp.). A further two were determined as wolf (*Canis lupus*). The three latter species were attributed by the excavator to the background fauna (Baales 2002, 224). Further remains which presumably belong to the background fauna such as small rodents were also recorded at the site.

Besides the comparatively rich faunal remains, some pieces of organic artefacts were found (Baales 2002). One was a fragment of an antler spall (**tab. 17**). Furthermore, five pieces of an antler point with barbs along one row were uncovered. Three pieces were refitted to a small single barbed point. In addition, a basal piece of an antler was used as an organic hammer.

Spatial organisation

During the excavation no evident structures were observed but in the subsequent analysis a possible pit was detected by a small quartzite gravel broken in four pieces which lay in close vicinity considerably deeper than the other artefacts (**tab. 19**; Baales 2002, 86 f.). However, sediment changes were not observed and, therefore, this position could have been caused by natural processes as well. Generally, horizontal moving due to natural processes such as erosion seemed negligible (Baales 2002, 86). Nevertheless, in the north-eastern corner of the excavation area the disturbances by mechanical levelling presumably affected the extend of the archaeological material. More importantly, the northern concentration associated with the indurated slate artefacts was located in a severely disturbed area.

The stone material was also partially affected by the moving of the sediment (Baales 2002, 179). Even though some accumulations of these materials were recorded, no structures created by these items were observed.

A light scatter of burnt lithics with smaller accumulations was observed on almost the complete site. However, a significant concentration was found in the north-eastern corner. In this area also the quartz, porphyry, Devonian quartzite, and burnt bone material accumulated and suggested the presence of a hearth. The burnt animal remains and the Devoninan quartzite formed a second accumulation approximately 2 m south-west of the possible hearth. Perhaps, an intense activity area was located there. The refitting of various materials suggested connections between the hearth and the southern activity zone. Moreover, another concentration in the south of the excavation area was also connected by refits and suggested as dump site by the excavator (Baales 2002). However, a small accumulation of quartz and Devonian quartzite was present in the northern area where also a light concentration of lithic artefacts, in particular, the greenish glassy lydite was observed. Single pieces of this type of indurated slate, Devonian quartzite, and quartz were also found in the concentration south-west of the hearth. This small northern accumulation was not connected by refits to the activity and hearth area. Furthermore, the tool as well as the raw material spectrum of the activity zone was much more diverse. Thus, if the northern concentration represented a dump area from this working area the dump would presumably have been brought at an early stage of use of the working area to the north when the material was less diverse also in the working area. Alternatively, the northern concentration represented a second, less intensely used knapping spot (cf. Baales 2001, 132). The latter interpretation is favoured by the excavator due to the presence of cores in the margins of the concentration. Furthermore, the almost exclusive occurrence of the few limonite pieces and the artefacts of indurated claystone of the Schaumburg type in this concentration sustained an independent use of this area. Perhaps, also the roe deer tooth which yielded another seasonal indication can be associated with this area. Clearly, the site would profit from a spatial analysis based on modern standards.

Chronology

The $^{14}C$ dates were generally unreliable (**tab. 20**). A more reliable date produced an age comparable to Urbar. This chronostratigraphic setting is in accordance with the stratigraphic and environmental indications. Based on the blank production process as well as the variety and the use of lithic tools two phases with several episodes were distinguished on the site (Baales 2002, 128 f.). However, whether these phases were within a single occupation event, or in two distinct ones remains a matter of debate. Clearly, redating of this important material is necessary in general regarding its position in the transition process and in particular for clarifying the settlement history of the site.

## Urbar, Rhineland-Palatinate

### Research history

In Urbar, faunal and lithic material was first uncovered underneath the LST in 1966 by the teacher Günther Pausch who was constructing a sandbox in his private garden (Baales/Mewis/Street 1998). In this context 4.1 m² were dug without sufficient documentation. In 1972, a further 4.1 m² were excavated under the supervision of Hartwig Löhr. These square-meters were located adjacent to the north-east of the previous area and produced in particular a stratigraphic sequence as well as palaeoenvironmental samples. The sedimentological analysis provided a detailed stratigraphic sequence. Strongly burnt pieces could be determined by the anthracological analysis as some typical Lateglacial tree species (*Salix* sp., *Betula* sp., *Pinus* sp.) but neither the pollen nor the mollusc sample produced relevant results (Baales/Mewis/Street 1998). In 1979, further works in the garden added an uncovered area of 1.2 m² observed by the owner and in a test pit of 5.8 m² which was excavated east of the thus far known area in 1980 the limits of the archaeological concentration were reached. Finally, 7.2 m² were excavated in 1981 under the supervision of Hermann-Josef Fruth revealing the probable end of the find density towards the north. Due to partial overlapping of the campaigns, at Urbar a total of 16.7 m² was excavated with very heterogeneous documentation but often at least 2-dimensional recording of the finds (Baales/Mewis/Street 1998). However, the recovery of FMG material in Urbar started a number of further excavations related to the Lateglacial Interstadial in the Neuwied Basin.

### Topography

The site in Urbar is set on a plateau on the eastern bank of the Rhine (**tab. 10**). Some 2 km south-west of the site is the confluence of the Moselle into the Rhine located which in the Lateglacial represented a large water delta. Towards the north-west of this confluence the large Neuwied Basin extends. The Rhine flows some 550 m west of the Urbar site and some 180 m west of the site the plateau falls steeply some 80 m to the valley floor. Towards the south and east the terrain of the plateau rises gradually a further 30 m upwards. Northwards the plateau gradually slopes 50 m over a distance of more than 1.1 km ending in a promontory position which is formed by the Rhine in the west and a deep valley of a small tributary (*Mallendarer Bach*). This small stream comes from the east and turns northwards approximately 600 m east of the site and flows around the promontory. On the plateau, some 40 m northwards of the site Hartwig Löhr registered a possible spring from which a light depression runs north-westwards towards the Rhine.

### Stratigraphy

After the first observation in 1966 that the material was found underneath the pumice of the LSE, a stratigraphy was recorded and analysed in 1972 by Karl Brunnacker (Baales/Mewis/Street 1998). A drilling core made it possible to establish a 7.4 m deep sequence of which the lower *c.* 5.30 m were formed by varied loess deposits. These were intersected by layers of waterlogged material. The lower part was of sandier material which decreased towards the top. The upper 30 cm of the deposit were formed by a decalcified, loamy loess. It was overlain by a 20-25 cm thick deposit of yellowish to greyish brown loess loam which appeared mottled due to waterlogging processes. Intense bioturbation was observed in the form of many animal burrows which were partially filled with pumice from the deposits above. In the upper third of this layer, the majority of artefacts were found. However, they spread vertically over 20 cm in this layer, perhaps, due to the bioturbation (Brunnacker 1978e). On top followed a blackish brown loam layer of 15-25 cm thickness. This loam was considered as the upper part of the Allerød soil and was rutted with desiccation cracks of up to 5 mm width. This layer was sealed by a 45-90 cm thick deposit of pumice which was attributed to the LSE and which filled in the desiccation cracks of the underlying loam. The pumice deposit was bisected in a lower part of 35-70 cm of primary deposited material and an upper part of 10-20 cm formed by a secondarily deposited, greyish light brown pumice. Within the lower part some ferric precipitation was observed and this part was capped by an ash layer. On top of the pumice deposit, some 30 cm of greyish yellow weathered loam followed which were overlain by 15-25 cm of blackish brown topsoil.

Archaeological material

The lithic material comprised 1,641 pieces of which 516 were smaller than 1 cm (**tab. 11**). At least 15 refits were possible and further material was assumed to be clearly connected but could not be refitted. Some 10.8 % of the lithic artefacts wore traced of heating and, in particular, retouched pieces (22.5 %) were affected. Perhaps, this was due to the use near an open fire towards which unusable pieces were discarded.
The majority of lithic artefacts was made of Tertiary quartzite ($n_{all} = 1,463$; $n_{\geq 1\,cm} = 979$). In addition to these specimens, 146 attributed to five different varieties of indurated slate and a single retouch splinter of presumably Western European flint were found. Furthermore, 31 pieces made of Devonian quartzite were also considered as a part of lithic assemblage. Except for the flint, all raw materials occur locally. The Devonian quartzite and the indurated slate could be taken from the gravels of the Rhine (**tab. 12**). Known resources of Tertiary quartzite were recorded by Harald Floss 2-3 km north-north-east and some 4.5 km north-east of the site. Perhaps, the flint originated from some 120 km north-west.
Eleven pieces were identified as cores and core fragments (**tab. 13**). Ten of these were made of Tertiary quartzite and one of Devonian quartzite. The lack of cores made of indurated slate was considered by Harald Floss as result of the small excavation area because the origin in the near vicinity and the presence of cortex on some of the blanks clearly sustained knapping of this material on the site (Floss 1994, 270). In contrast, cortex was only partially present on pieces of Tertiary quartzite (Floss 1994, 268). Furthermore, the dimensions of the Tertiary quartzite cores were extremely small and the knapping directions were no longer identifiable on several negatives due to the too small size (Mewis 1993, 13). On the pieces with negatives indicating the knapping direction several platforms appeared to be used during the exploitation process. In addition, three of the fragments were assumed to represent a single core, although the pieces could not be refitted. Thus, the material was assumed to have been brought to the site in a final stage of exploitation (Floss 1994, 268). The core of Devonian quartzite was still partially covered by cortex and made of a thick flake. However, the ventral side was prepared and some blanks were knapped from a single platform. The lithic blanks showed indications for the use of various knapping instruments such as the forming of a lip (soft or indirect) as well as clearly distinct bulbs (hard direct).
The end-scrapers (n = 98) dominated clearly the 120 formally retouched artefacts (**tab. 14**). These end-scrapers were generally made on flakes, although some displayed regular ridges on their dorsal surface suggesting the origin of the blank from a series of regular, elongated blanks. However, many specimens were preserved only as fragments with an end-scraper cap. Furthermore, several end-scrapers were made on small blanks including several classic thumb-nail end-scrapers. Susanne Mewis performed a precise metrical analysis of the numerous end-scrapers revealing an almost static proportion of the pieces (Baales / Mewis / Street 1998, 256). The high number for the small area in combination with the observation of the low number of use-wear or resharpening of the pieces further sustained a short operating time for this tool class (Baales / Mewis / Street 1998, 260). Of the 13 LMP, seven were made of Tertiary quartzite and the remaining five of indurated slate. One complete backed point of Tertiary quartzite and three of indurated slate

were found. A further four pieces of Tertiary quartzite were refitted to two complete backed points and the fourth backed point of indurated slate was only slightly damaged. The back of these LMP were usually retouched continuously. The blunting retouch was shaped curved or straight and exceptionally in a s-shape. Of the complete and almost complete specimens only one wears a basal retouch made from the ventral side. Only two burins were found. These tools were made on truncations which were set on small flakes of Tertiary quartzite. Furthermore, two truncations, four laterally retouched artefacts, and a splintered piece were found in the assemblage of Urbar.

Besides the lithic material, three retouchers with multiple scar fields were also recovered in the small area. These specimens were all made of argillaceous shale which can be collected from the various gravels of the Rhine. Furthermore, flat plates of Devonian quartzite and few pieces of slate were recovered from the site. In addition, some gravels of indurated slate, Devonian quartzite, and quartzitic sandstone were also recovered from the small area. In how far these pieces served as hammerstones or in the structuring of the settlement remained unclear due to a sometimes uncertain position on the site and more often due to the lack of unambiguous modification. Nevertheless, some Devonian quartzite plates wore impact points and cut-marks (Baales/Mewis/Street 1998, 266f.). Moreover, burnt quartzes were also found. All these materials were accessible in the nearby gravels of the Rhine.

In addition, few pieces of a coarse-crystalline haematite were excavated. However, these reveal no traces of use (Baales/Mewis/Street 1998, 267). Nevertheless, if the haematite originated from the same source as suggested for Gönnersdorf it was brought to the site from approximately 40km in the north-west. Although in regard to the much coarser structure, the material could also be recovered from the Rhine gravel.

Besides mineral material, some organic remains (n=505) were preserved at the site (**tab. 15**). 298 pieces were attributed to red deer (*Cervus elaphus*) including two pieces of antler and 96 teeth fragments (Baales/Mewis/Street 1998, 268). According to the teeth fragments a minimum number of seven individuals was suggested (Baales/Mewis/Street 1998, 274). Some pieces yielded clear cut-marks or chopping marks indicating the butchering of the animals on the site. One, possibly two bone fragments were heavier and determined as large bovid (*Bos* sp./*Bison* sp.), presumably aurochs (*Bos primigenius*). In addition, a rib fragment was attributed due to its dimensions to horse (*Equus* sp.). On this piece fine cut-marks were observed. Mainly based on the singularity of the material of horse and bovid the import as tool to the site was considered (Baales/Mewis/Street 1998, 276).

Spatial organisation

Due to the limited excavation area and the incomplete documentation, the spatial organisation was only partially reconstructible. Clearly, no evident structure was observed during the various campaigns (**tab. 19**). However, the numerous gravels and stone plates in the centre were perhaps remains of a stone packed hearth and a particularly large plate was considered as heating stone or working surface (Baales/Mewis/Street 1998, 266f.). The distribution of burnt quartzes and lithic implements suggested that a latent hearth was located in the area excavated in 1966. Thus, the hearth would have been situated in the main activity centre and in the surrounding various activities were performed such as the use of end-scrapers for possibly hide-working. In contrast, the organic remains were mainly found in the south-eastern corner a bit offside the main zone around the hearth. This observation is further sustained by the fact that no bone was mentioned to be burnt.

Chronology

According to the stratigraphy, the site at Urbar was not deposited immediately before the LSE but some time previously allowing several centimetres of soil to develop on top of the archaeological material. The only $^{14}C$ date made on a red deer sample sustained this chronostraigraphic position (**tab. 20**). The anthracological analysis was partially questioned by Michael Baales and his colleagues (Baales/Mewis/Street 1998) due to the preservation status. However, the determined species were well documented in the Central Rhineland during the Lateglacial and the suggested alternative species (*Populus* sp.) was also recurrently documented underneath the LST. Nevertheless, the connection with the archaeological record remained uncertain and, thus, the proportion could reflect human choice as well as natural processes. Yet, a chronostratigraphic setting in the mid- to younger part of the Lateglacial Interstadial seems probable for the Urbar assemblage.

Furthermore, the small excavated area with the well defined concentration make a single occupation plausible, although the lack of heights, partial documentation, and the restricted area could also misguide the interpretation. The number of seven red deer appeared relatively high for a short occupation duration. However, the presence of stone material, in particular, assumed cooking quartzes and multiple tools suggested for hide-working could indicate an intensively used activity area, perhaps, in a longer period of occupation in a possible autumn/early winter camp. The relatively uniform inventory of retouched artefacts could be explained by a spatial organisation of working areas and the restricted excavation area not capturing all workspaces.

## Niederbieber, Neuwied, Rhineland-Palatinate

### Research history

The site Niederbieber was comparable to other sites such as Kettig discovered when in autumn 1980 the pumice of the LSE was removed for industrial purposes (Baales 2003a). The Allerød surface became partially disturbed or even capped (Baales 1998, 342). However, the exposed surface yielded first lithic artefacts, faunal remains, and charcoal accumulations which led to the first excavations. From 1981 to 1988 several areas (areas 1-7[17]) were excavated in general according to modern standards with 3D recording of the single finds, sieving of the sediment, and recording of the profiles. However, in some occasions time pressure prevented a 3D recording (Gelhausen 2011c, 5). The areas 1 and 4-7 were set in a near vicinity to each other on the plateau where the site was located. The area 2[18] was set some 30 m north-east of this main area and the area 3 was recovered some 90 m south-west of this main area in the valley below the plateau. Since 1982 a test pit programme setting two square-metre wide test pits every 10 m on the plateau had been conducted parallel to the excavation aiming for the stratigraphic and topographic development of the plateau (Bolus 1992, 4). Subsequently, the material from all areas on the plateau was presented in several M.A. theses of the University of Cologne. Moreover, Michael Bolus conducted in his dissertation a spatial analysis of two main concentrations recovered at the site (areas 1 and 4) as well as of the outlying area which probably represented a special task workshop (area 3) and the test pit programme (Bolus 1992). Equally, another M.A. thesis revised the material of the plateau concerning the presence of raw material units and hearths (Korn 1993). In a research priority programme of the German Research Foundation, the site was reinvestigated from 1995-1999 due to the prospect of good organic preservation and the almost undisturbed spatial patterns allowing more detailed information on settlement behaviour of this time period

17 Previously these concentrations were numbered with Roman numbers (I-VII) but the present study follows a suggestion to use the Roman numbers for the Late Magdalenian concentrations and Arabic numbers for FMG concentrations in the Central Rhineland (cf. Street et al. 2006).

18 This area 2 was meanwhile subdivided by Frank Gelhausen into the sub-areas 18, 19, and 20 (Gelhausen 2011c).

to be collected (Baales 1998; Baales 2003b). The archaeological material of these campaigns produced a further ten concentrations of lithic material. This material as well as the previously excavated areas from the main area of Niederbieber were analysed in a comprehensive spatial analysis of the site by Frank Gelhausen (Gelhausen 2010; Gelhausen 2011a; Gelhausen 2011b). Furthermore, he also reanalysed the material of area 2 with the same methods (Gelhausen 2011c). In total, some 1,020 m² were examined at Niederbieber of which almost 820 m² were located in the main area (areas 1, 4-17, test pits between 10 N / -5 W-E and 55 N / 61 W-E).

Topography

The site of Niederbieber is situated on a small promontory *c.* 25 m above the Wied valley (**tab. 10**). The river Wied passes the promontory 200-300 m in the north and west. Towards the north where the Wied valley narrows considerably the slopes are relatively steep, whereas in the west to south-west where the Wied widened the valley with a small meander the inclination becomes more gradual. The Wied flows a further 4 km from the site in south-south-west direction and then mouths into the Rhine. The Neuwied Basin extends south from this confluence. During the Allerød a small stream (*Herschbach*) ran down to the Wied valley some 30 metres westwards of the site forming the promontory position. In the *Herschbach* valley on the slopes to the Wied the excavation area 3 was located. However, the archaeological remains were mainly recovered from a small plateau with relatively little inclination and an extend of some 200 m in W-E direction and 100 m N-S. Some 10,000 m² of this spacious plateau were set under protection and partially excavated. Towards the north-east of the plateau hills rise up gradually to the low mountain ridges of the Westerwald. Eastwards the terrain rises gradually some 20 m above the site to a ridge which slopes farther to the east and south down to the wide valley of another small stream (*Aubach*). From this ridge the Neuwied Basin is partially visible today but this view is mainly possible due to the lack of tree cover. Approximately 1 km south of the site the Aubach flows into the Wied. At this confluence the valley is also widened and only some 2.2 km south-west of the site the Wied valley is again narrowed by hill flanks (*Heddesdorfer Berg*, Irlich) for approximately 1 km before the valley opens into the Neuwied Basin.

Stratigraphy

In general the stratigraphy of the plateau in Niederbieber was relatively simple. On top of the Wied gravels a loess loam had formed (Ikinger / Ikinger 1998). In the upper part of this loess loam the finds were recovered. However, in the south-western part of the promontory the stratigraphy was in some parts completely capped, perhaps, because the Allerød sediment was already reduced in the western parts due to erosive processes (Baales 1998, 342). Eastwards onto the plateau and, thus, the main excavation area the sediment deposit increased and reached 30-50 cm. In some parts with a thicker loess loam deposit the presence of two horizons was considered but refitting indicated that the artefacts belonged to one horizon (Gelhausen 2011c). However, the material was moved considerably by bioturbation and soil movement in the vertical axis. Nevertheless, the spatial analysis of Frank Gelhausen suggested that the movements did not substantially affect the horizontal position on most parts of the site (cf. Gelhausen 2010). Occasionally, small erosive channels and depressions affected the horizontal distribution of material (Baales 1998, 342; Gelhausen 2011c, 5). On top of the loess loam, approximately 1 m of pumice from the LSE was deposited and sealed the Allerød landscape. With the mechanical removal of this protective cover the preservation of the organic material was severely affected. In the first campaigns of areas 1 and 2 several faunal elements were still recovered, whereas in the late 1990s excavations occasionally only colour alterations in the sediment indicated the former presence of organic material. On top of the pumice, the Holocene topsoil had formed.

Archaeological material

The site yielded the largest FMG inventory in the Central Rhineland with over 19,000 lithic artefacts (> 1 cm) and in total almost 120,000 specimens (**tab. 11**). These remains originated from almost 20 distinct accumulations. 245 refit lines were detected on the site of which 29 connected distinct concentrations (Gelhausen 2011c; Gelhausen 2011a, 52-59). The proportion of burnt material varied considerably on the site. However, on average a sixth of the material showed traces of heat alteration.

The dominant raw materials varied between the concentrations (Street et al. 2006; Gelhausen 2011a, 14) and some previous classifications were meanwhile revised (cf. Husmann 1988; Floss 1994, 283-303; Gelhausen 2011a, 13-15). However, the majority of concentrations was dominated by the local Tertiary quartzite and the regional chalcedony (**tab. 12**; cf. Floss 1994, 283-303). Since rich Tertiary quartzite deposits exist at the upper Wied, this raw material can be found in the gravels of this river. However, some 7-8 km south-east of the site Harald Floss recorded a quartzite bank (Floss 1994, 21-26). According to inclusions the chalcedony originated probably from the deposit in Bonn-Muffendorf some 40 km north-west of the site. These main materials were accompanied by the equally local indurated slate, Baltic erratic flint, and regularly Western European flint. The Baltic erratic flint originated from the Baltic moraines some 115 km to the north of the site. The Western European flint was present in several varieties which were accessible at a distance of 85 km and more north-westwards. In addition to these common raw materials, some less frequent materials were found, some of which were attributed variously throughout the research history such as the indurated claystone of the Schaumberg type (cf. Gelhausen 2011a, 20 f.). This material originated from the area south to south-east of Trier and, thus, at least 115 km towards the south-west of the site. The Triassic chert which was found occasionally on the site also originated presumably from a south-western area. Deposits of this material were found in the southern Eifel region and around Trier at a distance of some 95 km from the site but the type present at Niederbieber originated presumably from the region of the French-German border *c.* 170 km in the south-west (Baales 2003b). In singular cases the local quartz was also observed to be retouched.

267 artefacts were identified as cores or core fragments (**tab. 13**). Many of the pieces appeared exhaustively exploited based on their small dimensions. Although often a single preferred platform was observable, most pieces were exploited from two or more platforms which were often set angular to one another. Although the majority of blanks discarded on the site were flakes, several sequences of bladelet production as well as some elaborately prepared crested bladelets were found (Gelhausen 2011a, 25-27. 30). These finds evidenced that a complex blank production process was possible at Niederbieber and, in addition, that all stages of this process seemed to be present at the site. The 18 retouchers and five hammerstones which were recovered from the site (Gelhausen 2011a, 30-33; Gelhausen 2011c) further sustain the differentiated use of instruments in the *chaîne opératoire*. The high number of retouchers is significant but was partially due to a depot of five retouchers in area 3 (Bosinski et al. 1982). However, the intense use of these tools was sustained in area 4 where nine retouchers and retoucher fragments were found (Bolus 1992). These specimens were usually made of a local argillaceous shale and, thus, very soft stones in contrast to the hammerstones made of harder quartzite and quartzitic sandstone. More details on the various stages of the *chaîne opératoire* and the relation of these stages to the raw materials will probably be yielded by the on-going technological analysis of Ludovic Mevel.

The retouched artefacts (n = 1,671) were clearly dominated by LMP (n = 571; **tab. 14**). Some specimens were preserved relatively complete but many pieces were very fragmented. In general, the blunting retouch was continuously along one side. Besides curve-backed pieces, many backs were shaped straightly. Nevertheless, among the backed points the *Federmesser* is the most common type (Gelhausen 2011a, 36). Nevertheless, some specimens with basal retouch, representing formally Malaurie points, were also found (cf. Bolus

1992, 12 Abb. 9.4; Bolus 1992, 13 Abb. 10.1; 10.4; Bolus 1992, 108 Abb. 91.14). However, these often short specimen give the impression of broken of tips which were recycled by the additional basal modification. Some of the 279 end-scrapers were also occasionally recovered in a fragmented state. Usually these fragments seemed to be made on regular blades but refitting showed these to be either short blades or regular flakes (e.g. Bolus 1992, 54 Abb. 39.39; 39.43). However, the majority of end-scrapers were made on small flakes and several pieces were retouched on more than one edge forming the typical thumbnail end-scrapers (Gelhausen 2011a, 37). The burins formed a very heterogeneous group of varying dimensions and morphology. More commonly, the burin blows were set on a retouch; frequently a truncation but also breakage surfaces and natural surfaces as well as former burin blows were used as platform. The latter type (dihedral burins) were not very frequent. Nevertheless, often more than one burin blow was observable on the same artefact indicating resharpening activities (e.g. Bolus 1992, 57 Abb. 43.34-35; 43.44). In some cases the distinction towards bladelet cores was diffuse (Gelhausen 2011a, 38; cf. Bolus 1992, 61 Abb. 47.24-26). In Niederbieber, the truncations were comparably heterogeneous as the burins in their dimensions and morphology. In addition to some double truncated pieces, few truncations were retouched from the dorsal instead of the more common ventral face. In addition, over 30 borers were identified on the site. Even though these specimens were also variedly made, no examples of *bec* or *Zinken* types occurred. Composite tools were usually not mentioned in the presentation of the Niederbieber material but at least two pieces, a burin and end-scraper combination (Freericks 1989) and a possible combination of end-scraper and a truncation (Gelhausen 2011a, Taf. 15.9), were found. Furthermore, many laterally retouched (n = 237), partially retouched or unclassifiable pieces (n = 86) were found as well as splintered pieces (n = 34; Gelhausen 2011a, 40 f.).

Some 235 lithic artefacts from the areas 1, 4, and 5 were analysed for micro-wear patterns (Plisson 1985; Husmann 1988; Bolus 1992). Of the approximately 45 artefacts analysed in area 1 twelve wore traces of use in general on the unmodified edge and often this trace appeared related to cutting meat or hide. Furthermore, 52 pieces of the 160 analysed artefacts from area 4 wore traces of use. These use-wear patterns were also found most often on unmodified edges which were used for very short intervals and mainly on animal resources. Moreover, 13 artefacts of 28 analysed pieces from area 5 were also used frequently for cutting meat or for works on hides. Most of these implements were not exhaustively used which, perhaps, explains the occasionally large amounts of lithic artefacts for the processing of the mainly faunal material.

In addition to the previously described retouchers and hammerstones, numerous flat quartzitic slate pebbles were recovered of which some were split intentionally (Baales 1998, 353 f.). In area 15, heavy and large plates (2.2-4.5 kg) appeared deposited at the periphery of the lithic accumulation (Gelhausen 2011a, 31-33). Comparably, in area 2, concentration 19, broken slate plates were found near a hearth and considered as a type of anvil, perhaps for the smashing of animal bones (Gelhausen 2011c). However, this material can also be found in the gravels of the Wied and, thus, occurred also naturally at the site. Nevertheless, Frank Gelhausen doubted the origin of heavier items found within the loess loam deposit from the underlying gravels and, in particular, assumed pieces found within the artefact concentrations as a result of human activity (Gelhausen 2011a, 31). In addition to the quartzitic slate, Devonian quartzite and a type of basaltic lava was occasionally recorded. These materials were perhaps also present in the Wied gravels but certainly available in the region, for instance, in the Rhine gravels and the volcanic field of the Eifel (Bolus 1992, 76). Single stones wore scar fields or scratches sustaining their interpretation as anvils or supports (Baales 1998, 353 f.; Gelhausen 2011a, 31-33; cf. Schulte-Dornberg 2000). However, burnt quartz was only found in very small quantities (n = 14) in some test pits (Bolus 1992) and in area 2 (n > 18; Gelhausen 2011c). At both locations several of these pieces were refitted. Moreover, some pebbles wore traces of fire but did not appear to be used as cooking stones (Freericks 1989, 33).

Furthermore, in area 7 a small slate plate which was broken, perhaps, along two possible drill holes was found and displayed engraved crosshatch lines on both sides (Baales/Street 1996).
A comparable special find was a shaft smoother made of a relatively coarse, reddish sandstone found in area 2 (periphery of concentration 18; Gelhausen 2011c). The complete end of the lathy fragment (71 mm × 34 mm × 22 mm) was rounded and two surfaces were flattened naturally. One was the working surface which displayed a central groove. On one of the rounded lateral edges ten linear incisions were set transverse to the groove direction. These incisions were almost parallel and ran onto the unworked flattened surface where five lines ended in a triangular extension. These engravings were interpreted as female silhouettes of an even further abstracted *Gönnersdorf* type (Loftus 1982; Gelhausen 2011c). The use of this particular composition of abstract females silhouettes set in a row on the slate plates in the lower horizons of Gönnersdorf and Andernach as well as on the shaft smoother from the FMG site at Niederbieber was considered as evidence for a continuous tradition between the inhabitants of these sites. An alternative interpretation as use-wear was based on ethnographic observations of the pairwise use of shaft smoothers (Flenniken/Ozbun 1988) and consideration about a fixation of these pairs by entwining cords (pers. comm. Olaf Jöris, Neuwied). However, to create this type of use-wear in the hard sandstone considerable force or duration must be assumed which probably would affect all the corded areas not only some parts. Furthermore, if the grooves were incised for the better fixation of the cords the question remains why these had to have triangular extensions. Thus, in the case of the Niederbieber specimen an intentional engraving appeared more plausible.
The numerous red haematite pieces recorded in areas 1, 3, 4, 6, and 7 (Freericks 1989; Bolus 1992; pers. comm. Frank Gelhausen, Engelskirchen) could represent natural infiltration from the underlying Wied gravels. However, on one piece of haematite from area 1 rubbing marks were found (Bolus 1992, 79).
Among the approximately 817 determinable faunal elements, beaver (*Castor fiber*) was clearly dominant with 584 pieces. However, these pieces comprised 577 teeth fragments from the areas 2, 7, and 10 but only seven bone fragments from area 3. Furthermore, almost 500 fragments were found in a single square-metre and a further 73 within the same concentration (area 10; Gelhausen 2011a, 42). Thus, the many remains originated presumably from very few individuals. The second most numerous species was red deer (*Cervus elaphus)* to which some 164 pieces were attributed in the main area (Gelhausen 2011a, 40-43) and, in addition, a few bones were recovered in area 2 (Gelhausen 2011c). Again, of the specimens from the main area 92 elements were teeth fragments. According to the still determinable body parts that had reached the area 1, Michael Bolus considered complete carcasses being brought to the site (Bolus 1992, 180). Elk (*Alces alces*) was identified on 42 fragments of which one originated from area 3 (Gelhausen 2011a, 40) and 38 attributed to at least two animals were found in area 2 and the adjacent test pit from 1990 (Gelhausen 2011c). Thus, only three remains of elk were found in the main area of the site (areas 1 and 5). Furthermore, large bovids, probably, aurochs (*Bos primigenius*) were identified on four examples found singularly in areas 5, 13, 17, and 17a and a further two specimens per area were recovered in the areas 11 and 12 (Gelhausen 2011a, 40-42). Horse (*Equus* sp.) remains were also found rarely (n = 14) across the site in the areas 1, 2, 10a, 14, 17, and 17a. Comparable to beaver, wild boar (*Sus scrofa*) was mainly identified by teeth fragments (n = 25) of which 22 were found in area 7 (Freericks 1989) and three from area 10 (Gelhausen 2011a, 42 f.). A metapodial from area 1 was not unambiguously identifiable but could be from wild boar or roe deer (*Capreolus capreolus*; Bolus 1992) which was only once more determined on a bone from area 17a (Gelhausen 2011a, 41 f.). Only in area 4 were several elements of the ibex (*Capra ibex*) recovered (Bolus 1992). In addition, in area 1 a mandible and tooth attributed to badger (*Meles meles*) and a tooth of a fox (*Vulpes vulpes*) were found. Their association with the archaeological record remained uncertain. However, a tooth of a pike (*Esox* sp.) was also found in area 1. Even though no manipulation was found, the presence

of fish remains in this elevated position suggested the introduction by other agents, presumably, the Lateglacial human inhabitants.

In area 2, teeth of a young horse were found including milk incisors and premolars but the molars were not erupted. Assuming the last milk incisor breaking through at approximately 6-9 months of age in modern horses and the first molar between 9-12 months of age, the individual was approximately 6-12 months old. If the foal was born around April/May according to the modern most typical mating period occurring in June these faunal remains would indicate a time of death in the cold period (**tab. 16**). The absence of antler among the elk material could also indicate the cold period but therefore the presence of a male individual had to be proven and, moreover, the selection observable from the recovered material in this area suggested only partial transport to the site (Gelhausen 2011c, 14). Hence, these seasonal indicators are very vague because they incorporate many assumptions. Comparably, the indications from area 4 which were based on the remains of red deer encompassed a time window from November to April with the most probable phase between January and April (Bolus 1992, 134). This attribution was due to the eruptive stages of the molars and premolars on four mandible fragments and the presence of an antler fragment adjacent to the skull. The eruptive stages observed on two mandible fragments of red deer from area 17a suggested an age of 9-11 years and of 40 months (Gelhausen 2011a, 42). Assuming a birth period of early May to mid-June as is common for modern red deer in Central Europe, the age of the latter animal would also indicate autumn as the time of death.

Concerning the minimal number of individuals for red deer, a maximum of four individuals was assumed in area 4 and three individuals were recorded at area 1 (Bolus 1992). In addition, in area 17a which is considered a previously unexcavated part of area 4 and in area 2 a minimum of two individuals was assumed (Gelhausen 2011a, 42; Gelhausen 2011c). Furthermore, according to the remains at least one individual was found in the areas 5, 6, 7, 10, 10a, 11, 13, 14, and 15. Whether these remains attested 20 different animals or some parts from different areas were attributable to the same animals could only be answered by a comprehensive analysis of the faunal remains encompassing all areas of the site. However, this analysis was not yet accomplished for Niederbieber. As shown elsewhere (Street/Turner 2013; Leduc 2014a) such reanalyses of complete sites contribute to the understanding of the spatial organisation on the sites. In particular, differentiated functions of working spaces as well as the relation between those working places can be assumed. However, the generally restricted preservation favoured a selected preservation of durable parts such as teeth or mandibles clearly limiting the results of an analysis of the organic *chaîne opératoire*. In fact, the majority of still determinable fauna was found in the western part of the plateau where the pumice cover was thicker (Gelhausen 2011a, 41). Furthermore, the surfaces of the bones were often poorly preserved hindering the inspection for butchering marks. Nevertheless, on a few specimens in the areas 2, 4, 5, 10a, 11, and 13 cut-marks and/or intentional impact marks were observed (Gelhausen 2011a, 42). These manipulation were found on bones of red deer, elk, horse, and the large bovids indicating the processing of various species at the site. Furthermore, the majority of the faunal material was very fragmented and many bones were only preserved as very small, calcined pieces suggesting exhaustive exploitation of the material, perhaps, for marrow extraction (Bolus 1992, 180).

Nevertheless, the modified bovid bone from area 5 was also considered as a possible, roughly hewed tool (Baales 2002, 186). Moreover, two bone point fragments were recovered from the areas 1 and 4 (Bolus 1992, 75) clearly indicating the former presence of organic tools on the site.

A brachiopod and a trilobite fossil were found in a test pit without archaeological context (Bolus 1992, 16) and a third fossil was found in area 5 (Husmann 1988). Although these fossils were known from the Wied gravels and could perhaps be introduced to the site naturally, a human collection of these finds could not be excluded completely (Bolus 1992, 16).

Spatial organisation

Evident structures in Niederbieber were only confirmed in the form of hearths (Gelhausen 2011a, 44-48; Gelhausen 2011c, 5-11). These structures were identified by coloured and bricked sediment. This evidence was observed only in the areas 1, 2, and 4. In the areas 1 and 4 one hearth was found within the centre of the artefact accumulation. In area 4, the heat altered sediment surrounded by further burnt material was found 12 cm below the loess surface suggesting this as the archaeological horizon. The differentiated spatial distribution of charcoal determined as *Betula* sp. and as *Salix* sp. was suggested as indication for two firing episodes and the calcined bones were assumed as representing, perhaps, a third phase (Bolus 1992, 139). In area 2, John Loftus identified four structures with burnt material of which two were possible hearths (J2 in sub-area 19 and J4 in sub-area 20), whereas one accumulation (J1) located in sub-area 18 was assumed as a possible dump and the other one (J3) which was located in sub-area 20 was considered as a burnt wooden structure or multiple hearths (Gelhausen 2011c). Alternatively, the irregular structure could also represent a burnt tree. The burnt sediment of the two hearths reached some 5-10 cm below the surface. Within the southern hearth J4 a smaller structures was observed and another small structure was set less than a metre aside the hearth and was considered as a possible posthole with a stone plate at the bottom (Gelhausen 2011c). Furthermore, in area 2 five depressions were observed which were partially attributed to animal burrows or erosion but human interference could not be excluded completely (Gelhausen 2011c).

Furthermore, Frank Gelhausen identified further 14 latent hearths and a possible hearth in the main area (Gelhausen 2010, 54-58). He assumed the accumulation of burnt material such as lithic artefacts, calcined bones, and charcoal as well as the concentration of LMP as reliable indicators for hearths (Gelhausen 2011a; cf. Gelhausen/Kegler/Wenzel 2004). Only the areas 16, 17a, and, perhaps, 8 yielded no indication for a hearth. However, area 17a was assumed as extension of area 4 and in area 8 a hearth was considered probable due to the comparable pattern of the material concentrations (Gelhausen 2011c, 48). Hence, only area 16 was not associated with indications of fire. This area contained only ephemerally scattered material. Furthermore, in the areas 9 and 13 the existence of a second hearth was proposed. In addition, a possible hearth existed in the outlying area 3 (Bolus 1992). In combination with the limited inventory, this area was assumed to represent a workshop for hafting and retooling (Bolus 1992, 158-160. 183).

In area 15, Michael Baales identified a possible cache of two partially prepared, large flakes of chalcedony (Baales 2003b, 193-196). In combination with the depot of retouchers (Bosinski et al. 1982), these depositions suggested an intention to return to this site.

In total, Niederbieber yielded 19 distinct concentrations of lithic artefacts and mainly burnt bones (Gelhausen 2011a; Gelhausen 2011c). Frank Gelhausen demonstrated the highly similar organisation of the concentrations from the main area as well as the southern part of area 20 with usually two clusters of relatively high artefact density set opposed to each other with a hearth in the centre (Gelhausen 2011a, 48; Gelhausen 2011c, 33-36). In the areas 1, 4, 5, and 17 the pattern was observed that larger organic material, in particular, if unburnt was usually found in the periphery of the concentrations comparable to the cores (Gelhausen 2011a, 43). This distribution of larger pieces at the periphery of a concentration was suggested as possible indication for a barrier effect. A ring and sector analysis conducted for the concentration in the areas 1 and 4 was not indicative for a barrier effect (Bolus 1992, 181). However, based on density distributions of various find classes such as small lithic debris, LMP, or total retouched artefacts as well as larger pieces such as cores and, furthermore, the intra-concentration refits for some of these concentrations the presence of a dwelling structure was made probable (Gelhausen/Kegler/Wenzel 2004). These structures were proposed for the concentrations in the areas 1, 4, 12, 13, and 17 (Gelhausen/Kegler/Wenzel 2005; Gelhausen 2011a, 151-154. 169. 232-235).

In total, only 26 refitting complexes could connect different parts of the main excavation area (Gelhausen 2011a, 52-59. 257-261). Nine complexes were related to area 9, eight complexes were related to area 1, and six complexes to area 4. However, these areas also yielded dense artefacts clusters (see **tab. 11**). Areas 1 and 4 were in particular closely connected suggesting that perhaps these areas were used contemporaneously. Refits to the areas 2 and 3 were not attempted. However, within area 2 several pieces were refitted (Gelhausen 2011c). Moreover, based on the stratigraphic position of the majority of the material, Frank Gelhausen considered two phases possible in the concentration 20, an older phase with Baltic flint and a later one with Western European flint (Gelhausen 2011c). The chalcedony formed a discrete concentration in this area but the artefacts scattered as intensely as the Baltic flint material. The little vertical distribution of the Western European flints were assumed as indication for a deposition shortly before the LSE. However, the horizontal distribution was not much affected. This more diffuse spatial organisation, perhaps, more complex evident structures, and a deeper temporal use was only observed in area 2 not on the main area (Gelhausen 2011c). On the main area the undisturbed appearance of the horizontal distribution in combination with the highly similar organisation and comparable lithic inventories was assumed as indicative for little settlement dynamics and a short-termed creation of these discrete scatters on which recurrently the same activities were performed but which could not be further resolved temporally (Gelhausen 2011a, 248f. 261-266; Gelhausen 2011b).

In contrast, the analysis of Michael Bolus on details also of the faunal remains from the areas 1 and 4 suggested the introduction of complete carcasses to the site and assigned the lack of some body parts to the poor preservation and the high fragmentation rate which resulted presumably from intentional breakage for the extraction of marrow (Bolus 1992, 180). Thus, at least the butchering and exploitation process of the prey seemed to be accomplished at the site. Furthermore, the numerous end-scrapers which were frequently attributed to hide-working activity as well as the use-wear analyses sustain an interpretation of a comprehensive exploitation of the animals at the site. In addition, in the areas where faunal remains were preserved the spectrum appeared usually diverse which in a site of post-processing of a single hunting episode would be expected to be more specialised. Nevertheless, since the numbers were small, this impression could be blurred by the introduction of elements from a provision. Additionally, besides the lithic inventories which were comparably diverse as at other FMG sites in the single concentrations at Niederbieber, some organic tools were found as well as numerous stone tools which indicated intensive preparation works at the site. Furthermore, also some rare indication of lost personal ornaments were found. In summary, these various indications of differentiated activities at the site contradict the interpretation as simple, short hunting stops. According to a specialising index, that was proposed by Jürgen Richter (Richter 1990) who assumed longer occupation durations to produce more diverse retouched artefact assemblages, the calculated occupation time yielded relatively long occupation periods also for concentrations which appeared of short-lived, undisturbed character to Frank Gelhausen (Gelhausen 2011a, 251-254). He suggested that either the diversity calculation did not apply to the assemblage of Niederbieber or that the considered occupation time of the areas was false, although he assumed these to be more reliable as based on the archaeological record.

### Chronology

The general, chronostratigraphic position of Niederbieber was attributed to the Lateglacial Interstadial due to the deposition of the finds in a loess loam covered by the pumice of the LSE. Moreover, the recovery of most artefacts in the 10cm immediately below the pumice and the preservation of most remains in a horizontally unaltered position suggested a deposition of these remains shortly before the LSE. In addition, the environmental indicators such as red deer and elk further sustained the attribution to the forested period in the Lateglacial Interstadial. A TL date from the site sustained this attribution in general (**tab. 22**;

| site | lab. no. | years TL-BP | ± years |
|---|---|---|---|
| Niederbieber | QTL51B | 13,000 | 1,100 |

**Tab. 22** TL date from Niederbieber. Reference: Bolus 1992, 19.

Bolus 1992). Furthermore, two technically reliable $^{14}C$ dates (OxA-2066 and OxA-1135) from the site (**tab. 20**) produced almost identical results from the 100-200 years before the LSE. However, the samples for these dates originated from area 2 (OxA-2066) and a test pit several metres west of area 3 (OxA-1135; Baales 2002, 41 f.; cf. Bolus 1992). Besides this spatial gap, the latter was also found in a stratigraphically higher position than the remains from the workshop in area 3. Thus, the relation of the sample for OxA-1135 to the archaeological material remained uncertain. The $^{14}C$ dates from the main excavation area produced unreliable results (see p. 265-269). The vague seasonal indications from area 2 as well as the areas 4 and 17a attributed the occupation of these concentrations very generally to a period from autumn to spring, more probable in the second half of the cold period. However, this comparable seasonal indications could sustain an actual co-existence of the concentrations as well as recurrent visits during more or less the same period of the year in a yearly round. This possibility of contrasting interpretations further sustained Frank Gelhausen's considerations that the connection of various episodes at Niederbieber to a common occupation event was almost impossible to prove by radiometric or stratigraphic analyses (Gelhausen 2011a, 254-257). Alternatively, he considered the various episodes at the site as quasi-contemporaneous and assumed that the episodes occurred within a relatively short period which allowed no further distinction between them. Furthermore, low settlement dynamics and/or respect of existing and still visible artefact heaps were suggested due to the little horizontal disturbance of the material combined with the few inter-concentration refits. The only exception were the more complex distributions in area 2 where different scatters appeared as a disturbance to other ones and the stratigraphic position showed different tendencies (Gelhausen 2011c). In addition, the two identified material depositions (Bosinski et al. 1982; Baales 2003b) suggested that further visits to the site were planned, perhaps, because Niederbieber was a habitually visited site in the seasonal cycle of these hunter-gatherers.

Thus, for the discussion of settlement behaviour on FMG sites, Niederbieber was particularly important due to the comparably good preservation. However, the major question was whether the concentrations, in particular of the main area, were created as diverse episodes during a single occupation event or created in successive, temporally distinct occupation events. Consequently, was Niederbieber an aggregation camp, a large base camp, or a recurrently visited place?

Comparable to Niederbieber, the Belgian FMG-sites Rekem (De Bie/Caspar 2000) and Lommel-Maatheide (De Bie/Van Gils/Deforce 2009) yielded several distinct concentrations of lithic artefacts and occasionally burnt bones. However, the FMG site at Niederbieber was in many characteristics distinct from the Belgian sites such as the topographic position on a promontory some 30 m above the river, whereas Rekem is situated on a sand bank in the Meuse valley and Lommel on the sand dune on the northern bank of a Lateglacial lake. This distinction may be due to the different geographic setting in the upland zone with steep valley walls in contrast to the south-western part of the North European Plain where the wide river plains or valleys with shallow water bodies are traversed by low sand dunes. Moreover, Rekem was considered as a large occupation site which developed by various episodes of workshops within one large occupation event (De Bie/Caspar 2000). The few undisturbed FMG concentrations at Lommel-Maatheide were accompanied by many Mesolithic accumulations and in contrast to Rekem assumed as settlement site which recurrently attracted Lateglacial and early Holocene hunter-gatherers. Frank Gelhausen also considered the similar patterns of the distinct concentrations at Niederbieber as a result from multiple, short episodes of hunting groups which prepared for a hunting episode and/or prepared the hunted prey for further transport (Gelhausen 2011b). Nevertheless, the refits as well as the diversity of the archaeological material marked the more complex nature of Niederbieber. Perhaps, the very different indications show the limits of classic distinctions of sites as hunting, base, or aggregation camps and suggest the presence of more flexible movements of residential camps, possibly, to nearby successful hunting grounds (cf. Müller et al. 2006).

## Boppard, Rhineland-Palatinate

### Research history

During construction works in December 2001 near the train station of Boppard, a small concentration of lithics and bones was found (Wenzel 2004) aside and partially disturbed by medieval latrines (Welker 2004). In approximately the following fortnight 10 m² were excavated according to modern standards, whereas due to the on-going construction work for a further 15 m² the coordinates were recorded and the sediment collected for wet-sieving. Since the foundation pit was already boarded at the discovery, the stratigraphy could only be documented in the underlying part. Moreover, the material was only published partially in a few articles thus far (Wenzel/Álvarez Fernández 2004; Wenzel 2004; Street et al. 2006) and, hence, not all lines of evidence can be quantified in the following.

### Topography

Boppard is situated on the southern bank of a large Rhine meander (**tab. 10**). The site was excavated some 150 m south of the modern river bed and less than 10 m above the modern river. During the Lateglacial the site was probably also set in the floodplain of the river. Towards the south the terrain rises very gradually. Moreover, the adjacent plateaus which rise up to 200 metres above the valley floor are cut by several valleys. In particular, the *Fraubach* valley opens the plateau south of the site allowing access to the higher plateaus and, possibly, containing a stream which could have passed near the site in the Lateglacial.

### Stratigraphy

The recorded stratigraphy was dominated by the position in the floodplains of the Rhine (Street et al. 2006, 758). Over sands and gravels an approximately 1 m thick sandy loam followed which was formed by high flood movements. On top of this unit a gravel band was deposited on top of which *c.* 10 cm of the brownish-grey sediment with the archaeological finds were preserved, whereas the upper part of this deposit was already capped by the construction works. Nevertheless, in some parts of the site remains of pumice from the LSE were observed above the sediment layer (Wenzel 2004, 13).

### Archaeological material

The lithic inventory appeared comparable with other Central Rhineland FMG assemblages (**tab. 11**) and was dominated by the Tertiary quartzite. This raw material could be found in blocks some 10 km southwestwards of the site or in the wider surrounding of the Laacher See volcano some 20 km north to northwestwards of the site (**tab. 12**; cf. Floss 1994). Along with this raw material, indurated slate, quartz, and Devonian quartzite which could be collected in the local Rhine gravels were used at the site. In addition, chalcedony which occurred at a minimum distance of 35 km in the north-west or 45 km and more from the south-western Mainz Basin as well as a special local variety of the Western European flint named the Eifel local flint were found. The latter raw material represented residual deposits of the same formation epoch as the Western European flint. The Eifel local flint could be found some 60 km north-westwards as well as in various gravel deposits of the small streams in the Eifel some 45 km distance to the west of the site and in

the gravels of the Ahr river over 45 km in the north-west. Furthermore, the Western European flint from a minimum distance of 100 km north-westwards was also used in Boppard (Wenzel 2004, 14).
The retouched tools comprised small end-scrapers, burins on truncation, and backed pieces (**tab. 14**; cf. Wenzel 2004, 13 Abb. 1). Of the four published LMP specimens two can be classified as curve-backed point (Wenzel 2004, 13 Abb. 1.2-3), whereas another one appeared straight to angle-backed (Wenzel 2004, 13 Abb. 1.1). A thin LMP was retouched along both edges and, thus, resembled a double borer (Wenzel 2004, 13 Abb. 1.4). However, the lithic material from Boppard is not finally analysed and, therefore, not yet completely published.
Organic material was preserved on the site. Red deer (*Cervus elaphus*) is represented by some single teeth, a mandible with two teeth and a few bones, of which some were fractured for marrow extraction (**tab. 15**; Wenzel 2004, 14). A metapodial fragment of red deer was directly $^{14}C$-dated (**tab. 20**; KIA-26644: 11,095 ± 55 years $^{14}C$-BP, ∂$^{13}C$: -25.1, written comm. and kind permission Stefan Wenzel, Mayen) producing an age comparable to the dates of the LSE (Baales / Bittmann / Kromer 1998; Baales et al. 2002). Along with red deer, wild boar (*Sus scrofa*) was identified in the assemblage with seven teeth and a possible bone fragment (written comm. Stefan Wenzel, Mayen). The dental abrasion indicated the death of the animal(s) in the spring-summer season (Street et al. 2006, 765). However, due to the rare indications of this species in Central Rhineland, the origin of such indications remained a matter of debate on whether wild boar was imported from elsewhere or present in the Central Rhineland by the end of the Lateglacial Interstadial (Baales 2002, 28; Street et al. 2006, 765). Furthermore, a considerable number of fish remains was also recovered, of which some pieces were burnt and, therefore, probably associated with the human activity on the site.
Furthermore, a 17 cm long spall from a metapodial of red deer was transformed into a tool which was interpreted as smoother (**tab. 17**; Wenzel / Álvarez Fernández 2004). Alongside the edges of the spall several horizontal lines were cut which the excavator interpreted as decoration (Wenzel 2004, 14). This specimen was particularly comparable to Magdalenian examples from Cantabrian Spain and southern France, Final Palaeolithic spatulas from northern Italy as well as a Mesolithic piece from southern Germany (Wenzel / Álvarez Fernández 2004).
Two small pieces of jet were also excavated (Wenzel 2004, 14) but according to the size these were perhaps not used.

### Spatial organisation

The Lateglacial remains of Boppard concentrated around a latent hearth (**tab. 19**; Street et al. 2006, 776) which was revealed by the accumulation of burnt bone fragments, heated lithic artefacts, and reddened quartz fragments (Wenzel 2004, 14). Assuming from the faunal and lithic remains in combination with the spatial distributions, the site equates for instance the concentrations of Niederbieber.

### Chronology

According to the stratigraphy and the $^{14}C$ date the accumulation of Boppard can be placed chronostratigraphically shortly before the LSE (**tab. 20**). The high number of special goods, the topographic position on the river banks, and occurrence of wild boar single out the site in contrast to the other FMG sites, whereas the lithic raw materials and typological classifications, the dominance of red deer, and spatial organisation were similar to the other FMG sites in Central Rhineland. The publication of a more comprehensive analysis in the future will allow further considerations about function and / or preservation of the site.

Bad Breisig, Rhineland-Palatinate

Research history

The Lateglacial concentration near Bad Breisig was found by biologist and geologist Georg Waldmann in a profile on the southern limit of a gravel pit which he reinvestigated for plant imprints in the LST (Waldmann/Jöris/Baales 2001). He recognised lithics, burnt bone fragments, and a darker patch which indicated a hearth in the profile above the various deposits of the LSE. Due to quarry works half of the single concentration had already been lost by then. The collected finds and the description of the stratigraphy led to a first inspection by local archaeologists and consecutively an 18 days excavation under the supervision of Michael Baales and Olaf Jöris in autumn 2000. During this first campaign *c.* 9 m² around the hearth were excavated. All finds larger 1 cm were given 3D coordinates, drawn in a map, and described separately. Smaller finds were collected per 50 cm × 50 cm × 5 cm units equally as the sediment which was wet sieved later. The limits of the concentration were not reached in this campaign and thus, a second season of 20 days duration led by Michael Baales followed in spring 2001 and uncovered a further *c.* 37 m² according to the above mentioned standards. The limits of the archaeological scatter were reached in the second campaign (Baales/Grimm/Jöris 2001). However, the distribution also revealed that about half the concentration was lost in the gravel pit. Furthermore, five one square-metre wide test pits were laid out in approximately five metre distance to the excavation limits to look for further indications of scattered archaeological material but no further artefacts were found in the test pits. An inspection of the gravel pit profiles provided only Roman material. Furthermore, a surface survey on the surrounding field of the concentration yielded no finds, only on a neighbouring field few lithic pieces were collected.

Topography

The river Ahr flows into the Rhine some 3.5 km northwards of the Lateglacial site of Bad Breisig (**tab. 10**). The Ahr mouth had widened the Rhine valley on the western bank between Bad Breisig and Remagen (*c.* 8 km) to an approximately 1.5 km wide basin (the so-called Golden Mile; Schirmer 1990). The site is located on the western bank of the Rhine at the southern end of this basin where the valley is still about 1.3 km wide but almost half of the width is occupied by the modern river. A kilometre towards the south-east of the site steeply rising hills put an end to the Golden Mile. Southwards the Rhine valley is formed tube-like with a maximum width of 900 m and ends some 11 km south-westwards at the so-called *Andernacher Pforte* (Andernach Gate). Nevertheless, the walls of this tube are frequently cut by steep valleys of small streams on the east as well as on the west side (main ones: *Frankenbach*, *Vinxtbach* and *Brohlbach*) which are of some importance for the stratigraphic sequence (see below). South of this gate the wide Neuwied Basin opens. The modern river passes only a few hundred meters east of the site and some 10 m below the terrace where the site is located. However, the site is situated on the edge of lower Rhine terrace 2 and the incision into the modern terrace of the Rhine began presumably in the Lateglacial. Thus, depending on the accomplished process of the incision of the river, the site was probably set some 10-30 m away from the Rhine i. e. on the river bank during the time of occupation. On the eastern bank of the Rhine the hills rise steeply towards the Westerwald and, opposite of the site, these hills are cut by the valley of the Ariendorf creek. Towards the west of the site the terrain only rises very gradually for *c.* 400-500 m before the Eifel hills rise sharply some 140 m upwards. These hills are also cut in a west-west-south direction by a small valley named *Tiefpfad* (deep path) in which also a small stream flows. This stream ends in a pond at the foot of the hills but during the Lateglacial it flew perhaps into the Rhine not far south of the site.

Stratigraphy

In Bad Breisig the recorded stratigraphy began with the reddish brown Allerød soil which was sealed by a thin greenish grey tephra band (Baales / Grimm / Jöris 2001). Probably, this band can be equated with fallout ashes from an intermediate stage of the LSE. The Laacher See is located *c.* 11.5 km south of the site. The tephra band was overlain by up to 25 cm of grey fluvial sands. In the lower part of this deposit single, small pieces of pumice were found and in the middle part displaced ashes were intermingled. These sands represented presumably the sediment redeposited after a catastrophic dam burst (Park / Schmincke 1997). During the LSE the Rhine was dammed by various materials which were pushed through the incised valleys on the western walls from the volcanic centre into the tube-like valley part at the Andernach gate. Subsequently, an approximately 80 km² wide lake established in the Neuwied Basin. The water table raised up to 15 m and *c.* 0.9 $km^3$ of water were stored. When the dam broke these waters were led out to the Rhine valley north of the dam in probably a single flood wave because the incisions of the flood can be traced up to Bonn, approximately *c.* 50 km north of the volcano. The flood wave washed away up to 4 m of pre-eruptive sediment from the valley floor and deposited secondary eruptive material such as the pumice-ash-sand deposit in Bad Breisig. On top of this deposit followed an approximately 10 cm thick layer of pumice on the site. The pieces were rounded and sorted by grain size. Therefore, this pumice layer swam probably on the lake waters and were spilled ashore when the waters of the lake drained through the broken dam. The pumice layer was sealed by a 7-8 cm thick, greenish dark grey tephra which was identified as a fallout ash from the late eruptive phase. Thus, the stratigraphy of Bad Breisig indicated that the dammed lake formed an episode of several days within the LSE (Baales et al. 2002). The greenish dark grey tephra was overlain by sands and silts with reworked volcanic material. Within these sands and silts a small band of obliquely deposited pumice can be found. On top of the sands and silts another layer of pumice followed. These units of sands, silts, and pumice were probably alluvial deposits at the river banks. If this deposition occurred within the eruptive process or shortly after remained unclear. The sealing layer of pumice was largely cut by the above formed high flood loams. This cutting was partially due to bioturbation but also due to erosion of some material from the unstable surface at the river banks after the eruption. The presence of single, heavily rounded pumice pieces could still be noticed in the lower half of the high flood loam deposit. This deposit was almost 1.1 m thick. 20-30 cm above the transition from the overlain, eruptive deposits the Lateglacial archaeological material was found. The lithic artefacts spread vertically over 35 cm within the high flood loam deposit but over 70 % of the material were found within 10 cm around the altitude of 66.35 m a. s. l. The vertical distribution can be explained by bioturbation, cryoturbation, and hydrological movements within the sediment. The dark brown Holocene topsoil formed the upper few centimetres of the profile.

Archaeological material

In the excavations 45,480 lithic remains were recovered which weigh more than 10 kg (**tab. 11**; Grimm 2004). 973 of the 5,956 lithic artefacts ≥ 1 cm displayed traces of heating. Cortex was still present on 478 of the pieces larger 1 cm. Only few artefacts were refitted (n = 69) but these refits connected all parts of the lithic concentration.

The main raw material was Tertiary quartzite ($n_{all}$ = 38,059; $n_{\geq 1\,cm}$ = 5,183) which was presumably gathered at a nearby source (**tab. 12**). Around the Laacher See and the nearby Herchenberg some banks and weathered blocks of this quartzite were recorded as well as volcanic bombs of this material in basalt deposits (Floss 1994, 30). Thus, besides fluvial transport by the Brohl stream and the Rhine, the LSE could have directly deposited one or several blocks of Tertiary quartzite in the immediate vicinity of the site where the material possibly began weathering and thereby produced many of the flinders-type material. Western European flint ($n_{all}$ = 7,145; $n_{\geq 1\,cm}$ = 708) was generally present in the form of gravel flints from presumably the Meuse

but some pieces were identified as a possible local Eifel variety ($n_{all} = 52$; $n_{\geq 1\,cm} = 34$) and single pieces were classified as the sub-units of Vetschau flint, Lixhe-Lanaye flint, and Lousberg-/Schneeberg flint. In general, the sources of these varieties of Western European flints were located in north-western directions in a distance of 45 km and more from Bad Breisig. The third raw material which was more numerously present was indurated slate which originated from the local gravels. The few hundred pieces ($n_{all} = 272$; $n_{\geq 1\,cm} = 187$) were assigned to two nodules, one of the classic black lydite type, the other of a greenish grey, glassy variety. Furthermore, a single flake of argillaceous shale which was also available locally in the gravels, a flake of possible chalcedony, and two pieces of probable Triassic chert were recovered. The latter was not locally available. The next resource was located over 80 km south-west of Bad Breisig in the southern Eifel region. One of the pieces was transformed into an end-scraper. A well known chalcedony resource of the FMG in Central Rhineland was situated around 18 km north-north-west of the site at Bonn-Muffendorf. However, single occurrences of chalcedony were reported in the valleys south of Bad Breisig. Whether these single specimens reached the site in the form of tools which were only resharpened or discarded or if more pieces of these raw materials were dumped elsewhere can no longer be securely reconstructed due to the loss of half of the concentration to the gravel pit.
According to the number of blocks, cores, and core fragments from Tertiary quartzite (n = 144; **tab. 13**), the site of Bad Breisig was perhaps visited mainly due to a nearby source of Tertiary quartzite and the exploration of this source for the production of blanks. A further two core fragments were made of flint and another core fragment made of lydite was found in the concentration. 57 cores and core fragments were not prepared except for distal abrasion. Most commonly crested edges (on 31 pieces) and the rejuvenation of the platform by flaking (on 31 pieces) were observed. In a further 21 cases both types of preparations occurred together. Among the cores and core fragments of Tertiary quartzite, the ones with flaking in opposing directions dominated (n = 53), although one direction was often preferred. Unidirectionally knapped cores (n = 39) were more frequent than cores with two striking directions which were laterally set to one another (n = 26). Furthermore, polydirectionally exploited cores (n = 13) or pieces with a single negative (n = 11) occurred. The lydite core was only worked from one striking platform which displayed some negatives of platform rejuvenations. Two faces were exploited from this platform without any further preparations. The lower part of this core was still covered by the rolled cortex. In contrast, the flint core was exhaustively used with several striking platforms, several striking directions and faces. Often the cores were exploited alongside one or both thinner sides (lateral edges; n = 66) giving some of them a burin-like appearance. These laterally exploited cores indicated the aim of the blank production process to receive slim and long bladelets which were comparable to burin-spalls. This aim was also sustained by the length-width distributions of all complete blanks. Moreover, 221 blanks with the remains of cresting on their dorsal face were found indicating the wish of a controlled blank production. However, several of the crested blanks were secondary ones and the cresting was often made discontinuously, on one side of a natural surface, or by pressing rather than retouching. Thus, the effort to stabilise a crest for directing the knapping force was minimised where possible. Rarely pieces yielded indications of the use of an organic hammer or of soft hammerstones. The signals for the use of (hard) hammerstones were more frequently found on the blanks. Furthermore, on more than 45 artefacts the intentional or accidental removal of the bulb was noticed which in the latter case was related to a high force of the percussion. In fact, at least two hammerstones made of Devonian quartzite and a hard sandstone were also found on the site. Moreover, a retoucher of argillaceous shale with only few use-wear patterns was also recovered.
Even though the blank production process appeared as an important factor at the site of Bad Breisig, 296 retouched lithic artefacts were also recovered (**tab. 14**). 41 tool production or resharpening flakes (17 Krukowski »micro-burins«, 20 burin spalls, three end-scraper caps) suggested the knapping and/or resharpen-

ing of these tools on the site. In addition to the intentionally retouched specimens, splintered to bruised edges were observed on over 150 pieces.

Among the intentionally retouched artefacts the backed pieces were most numerous (n = 114). The LMP were generally very fragmented. Consequently, only five pieces could be identified as backed blade or bladelet with some certainty. One of these was truncated; another very slim piece was truncated on both ends. One distal and two proximal fragments were only partially retouched appearing as backed bladelet production remains. However, they represent no typical micro-burins. Furthermore, the bulb was generally present on the ascertained backed bladelets and blades (except for the double truncated piece). Some eight pieces presumably represented point fragments and a further 38 specimens were reliably identified as backed points. Yet, of these 15 pieces were only tip fragments. Four backed points were basally retouched and classified as Malaurie points (Baales / Grimm / Jöris 2001). On seven pieces the blunted part was formed rather straight (Grimm 2004). On two particularly thick blanks the retouch appeared angular and reminded on the Andernach knives from Andernach 3-FMG. The remaining ten complete pieces were described as typical *Federmesser*.

Among the domestic tools the generally small end-scrapers (n = 98) formed the largest group. 14 end-scrapers were made on a blade or a blade fragment. The truncations (n = 31) and the burins (n = 25) occurred in similar numbers. In both classes very diverse types were present. Among the burins those on truncation were the most common type and dihedral examples occurred only twice. A single composite tool was a burin on truncation combined with an end-scraper. 19 pieces were classified as laterally retouched. A further eight specimen were notched and / or only partially retouched.

Alongside the lithic artefacts, some stone material was discovered at the site and were at least partially associated with the concentration. The hammerstone which was made of a hard sandstone gravel was roughened along one long lateral edge. The Devonian quartzite hammerstone was split and knapped into an end-scraper-like shape. The inspection under a microscope produced no clear evidence for the use of this »retouched« edge. Possibly, this effort was expended for a better handling of the hammerstone. However, a comparable piece was recovered from the area 1 in Niederbieber where the use remained comparably uncertain (Bolus 1992, 77). In addition to these two hammerstones and the retoucheur mentioned previously, some small plates mainly of Devonian quartzite were found. At least in one case splitting of a quartzite plate into thinner pieces was observed.

Besides the stone material, a few, mainly burnt bone fragments (n = 33) and teeth (n = 13) were recovered from the sediment and determined by Michael Baales (**tab. 15**; Grimm 2004). Except for a tooth of horse (*Equus* sp.), all other teeth and teeth fragments were assigned to red deer (*Cervus elaphus*) which was the most dominant species with eleven bone fragments and at least three individual animals determined by the state of the teeth. One sample suggested an age of 3 ¼ to 3 ½ years of age at the time of death and, thus, suggested a possible killing episode between September and December (**tab. 16**). A further three diaphyse fragments can only be classified in a size class of red deer and / or roe deer (*Capreolus capreolus*). Six bone fragments were determined as roe deer. The other six determinable pieces represented possible admixtures, partially of recent age or from the background fauna: Two pieces were identified as European bullhead (*Cottus gobio*) which perhaps was deposited by a high flood event. A phalanx was classified as rabbit (*Oryctolagus cuniculus*) or hare (*Lepus* sp.) which could have dug itself into the archaeological horizon. A diaphyse fragment could also be classified as hare but due to the poor preservation the distinction to bird (*Aves*) or fox (*Vulpes vulpes*) was not possible. Another bone fragment was also identified as red fox but it was unburnt and made a particularly fresh impression. Therefore, this piece was probably of recent age. Finally, a caudal vertebra could originate from a small canid presumably a dog (*Canis* sp.) or a badger (*Meles* sp.). A calcined bone which was found in the profile but not further determined was dated to the late Younger

Dryas (**tab. 20**; GrA-17716) in the burnt bone project of the Groningen laboratory (Lanting/Niekus/Stapert 2002). The project demonstrated that the dating of burnt material from the Lateglacial produced generally no reliable results. Thus, this date was rejected.

Five larger pieces of charcoal were recovered from the blackened sediment and Julian Wiethold (Göttingen) could determine four of the charcoal pieces as pine (*Pinus* sp.), as conifer, as deciduous hardwood with a good water transporting vascular system (such as *Betula* sp., *Salix* sp., *Populus* sp., *Corylus* sp.), and as a »… brown coal-like piece, possibly the residue of a heavily coaled organic material« (Waldmann/Jöris/Baales 2001, 177, translated by the present author). Flaky brown coal was present in the lower terraces of the Rhine (Terberger 1997, 34) and frequently used as probably fuel material on the Late Magdalenian sites (see **tab. 12**, p. 89, p. 105, and p. 119). Besides the use for firing, another application of this resource was suggested by the evidence from the recently excavated FMG site of Wesseling north of Bonn where some pendants made of brown coal-like material were recovered (Heinen 2010). However, due to the intense firing of the Bad Breisig sample no further conclusions on the material and its use were possible. The last sample of charcoal was indeterminable.

### Spatial organisation

In Bad Breisig a lithic concentration spread 2-3 m around an evident hearth (**tab. 19**). The hearth which was originally recognised in the profile became further apparent in the planum during the excavation. In addition to the concentration of burnt material such as calcined bone fragments, charcoal, and burnt flints, some reddish and blackening colour of the sediment and a few patches of bricked sediment were observed. The maximum length of the red coloured sediment was 0.4 m extending parallel to the profile and the maximum width of this colouring was 0.2 m into the excavated area. The brickened sediment was noticed slightly outside the reddish part in the blackened sediment. The blackened sediment extended in an east-west extension on *c.* 1.7 m and up to 0.7 m in north-south direction. Regarding the extension of the feature, probably half the hearth was lost to the gravel pit. The surrounding lithic concentration reached a maximum (preserved) extend of 4.5 m × 3 m. The dense concentration was directly south of the coloured sediment disrupted by a few centimetres wide strip with only few artefacts. This disturbance was presumably caused by ploughing which affected the southern limit of the concentration as well. If these disturbances were re-located to where the pieces were presumably deposited the already dense appearing concentration became even more solid. In the gravel pit profile two distinct concentrations at the same level separated by only a few centimetres were noticed. These centimetres were revealed in the horizontal display as a round to semi-circular spot in which the underlying pumice already emerged in the lower planum. Probably, a little tree or a bush had grown there sometime after the occupation and the roots partially disturbed the position of the Lateglacial material. The determination of a charcoal recovered from this area suggested the possible presence of hard wood during the Younger Dryas (see above). Nevertheless, the density of the lithic accumulation and the abruptness of its limits suggested that the site was only settled once because otherwise disturbance by further settlement dynamics could have occurred. Furthermore, the few refittings (n = 69) which connected all parts of the lithic concentration further substantiate the hypothesis of a single episode in which the archaeological material was deposited. Possibly, this generally remaining density was also due to the placing of the site in the high flood plain of the Lateglacial Rhine where the material could be quickly covered by sediment. However, the material appeared not much affected by water movements and, thus, the material remained generally *in situ*. Moreover, the abrupt decrease in material density could be explicable by some kind of restrictions of the concentration such as a wind shelter or the walls of a dwelling structure.

In general, the backed implements were found mainly in the immediate vicinity of the hearth, comparable to other Lateglacial sites. Moreover, around the hearth and in the eastern part of the concentration the re-

touched artefacts as well as the retouched debris were accumulated, whereas in the western part a majority of blank production debris was found. In particular, the fragmented cores and the little prepared cores were found in the western part and still exploitable cores were found tendentially in the east where also the hammerstones were recovered indicating that lithic production occurred around the hearth and in the eastern part of the concentration. The western part was either dump or storage area for lithic raw materials.
Thus, several occupation episodes formed the probably single occupation event. Along with the blank production, hafting and retooling took place as well as the consumption of red and roe deer. The compact accumulation of diverse materials in various activity areas suggested some type of barrier contributing to the dense concentration. The intense use of a local lithic resource reflected a good knowledge of the resources of the surrounding.

Chronology

The charcoal sample on deciduous hardwood and the pine sample were $^{14}C$-dated. Surprisingly, the hardwood sample resulted in a mid-Younger Dryas age (**tab. 20**) but could be rejected due to its position in a more recent disturbance. In contrast, the pine sample was found in an area south of the intensely red coloured sediment. This sample produced a late Lateglacial Interstadial/early Lateglacial Stadial date (**tab. 20**) This date is regarded the most reliable radiometric date for the site because of the congruence with the temperate faunal material (in particular roe deer) and the stratigraphic position above the LST and in the lower part of the pre-Holocene high-flood loams. Thus, the Final Palaeolithic site at Bad Breisig was probably settled in the late Allerød, possibly at the transition to the Younger Dryas. The connections of the activities of the remaining site suggested that even though several episodes were involved, a single occupation event was reflected by this material.

## Summary and context

In summary, the sites from the Central Rhineland were usually set near a watercourse, although only few sites were located immediately in the floodplain (**tab. 10**). The amounts of lithic material recovered from the sites were heterogeneous (**tab. 11**). This diverse numbers was not only a matter of the size of the excavated area as the varied concentrations from Niederbieber demonstrated.
In general, the resources for the raw materials were the same (**tab. 12**) but material from the very distant class was not found on the FMG sites. Moreover, the variety of lithic raw materials used at a single site decreased. Although the diversity of core types remained similar, the dominant type was less rigidly chosen on the FMG sites than on the Late Magdalenian sites (**tab. 13**) On all sites and in almost all concentrations the LMP were the most numerous artefact class or the second most numerous class (**tab. 14**). In the Late Magdalenian the burins were usually the second most numerous class, whereas in the FMG sites end-scrapers were generally this second most numerous class. The activities on the sites were consequently altered to produce a higher percentage of end-scrapers than burins. However, numerically the end-scrapers were more frequent on Late Magdalenian sites than on FMG sites and the burins were also regularly present in FMG assemblages. In fact, the FMG sites Niederbieber and Andernach displayed a larger variety in the most numerous classes on the level of concentrations.
Faunal remains were preserved regularly on the sites in the Central Rhineland (**tab. 15**) and yielded occasionally reliable information about the season of death for various animals (**tab. 16**). In contrast to the lithic retouched material, the faunal remains on FMG sites were homogeneously dominated by red deer (*Cervus elaphus*). The Late Magdalenian assemblages were predominated by horse (*Equus* sp.). Thus, the major spe-

cies horse (*Equus* sp.) was replaced by red deer (*Cervus elaphus*). Concerning the possible resource of furs, the arctic fox (*Alopex lagopus*) appeared rather replaced by badger (*Meles meles*) than by red fox (*Vulpes vulpes*). However, the connection of the latter species to the archaeological material was vague and, perhaps, the winter furs of arctic foxes were a resource which was discarded without substitution.

Organic artefacts were heterogeneously preserved (**tab. 17**). A diverse set of organic tools was usually found in the Late Magdalenian assemblages, whereas in the FMG assemblages rarely more than one type of organic artefacts was found.

Among the special goods were regularly engravings as well as jewellery (**tab. 18**). Although the presence of haematite was almost continuously attested, its use was more widely attested in the Late Magdalenian. Comparable to the organic artefacts, the types of special goods were more diverse in the Late Magdalenian than in the FMG assemblages. The occurrence of figurines ended between the Late Magdalenian and the FMG.

Hearths were the most commonly observed structures on the Central Rhineland sites (**tab. 19**). Evident structures were common on Late Magdalenian sites but rare on FMG sites resulting in the more ephemeral character of the FMG concentrations. However, in these concentrations latent structures were often reconstructed.

Finally, among the sites from the Central Rhineland were some of the most numerously $^{14}$C-dated sites in the Lateglacial of north-western Europe (**tab. 20**). Nevertheless, many dates produced arbitrary results which required some evaluation.

Besides the material presented previously, further sites were attributed to the period from the Late Magdalenian to the FMG in the extended Rhineland region (e. g. Bosinski/Richter 1997, 25. 27-32) such as the small Late Magdalenian assemblage of the layer V in the Wildscheuer cave (Terberger 1993, 115-140; Floss 1994, 261-263). However, the attempt of dating fauna material from this horizon failed to meet the minimum requirements. In addition, the documentation of the finds and the stratigraphy at the Wildscheuer cave was occasionally poor prohibiting to test the mixed character of the material for its originality. Thus, the material could take a possible intermediate position and represent an industry of the transformation period. Alternatively, the observation of two Magdalenian horizons in the Wildscheuer cave by the first excavator Karl August von Cohausen in 1874 could have been correct and, thus material from two different events of which one might represent a considerably younger occupation (early CBP Group?) were admixed in the following century. Thus, the integrity of the material can be doubted but cannot be tested due to the lack of documentation and, therefore, the material is not further considered in the present study. Furthermore, a small piece of elk antler which was transformed into a fish figurine was collected in a valley (Leerschlucht) north of the Wildscheuer (Terberger 1993, 186f. Taf. 76). According to traces of fire on the piece, Karin Terberger assumed the figurine to originate from a nearby cave filling. She suggested a Holocene origin due to the raw material and the absence of clear stylistic parallels, although she could not exclude an Upper to Final Palaeolithic age completely (Terberger 1993, 187). In the context of elk occurring in Gönnersdorf V this piece could well represent an expression from the phase of transformation and, hence, a reexamination and, perhaps, a $^{14}$C dating of this specimen could be of interest. In contrast, other previously supposed Late Magdalenian assemblages were meanwhile dated to other stages (Baales/Street 1998; Baales 2002, 10-12). In addition, many sites revealed singular activities such as a *Federmesser* shot into the ground at Miesenheim 2 (Street 1986), a possibly lost retoucher at Leutesdorf (Baales 2002, 13f.), or six hearths with no associated archaeological material or only few archaeologically relevant pieces covered by the LST (Berg 1994). These finds highlighted the roaming of people in the landscape, but due to the scarcity of this type of evidence patterns allowing the analysis of changes cannot be established from these sites. Therefore, they are not useful for the present study.

| site | approximate / average distance to water | type of water body | morphographic setting | site type | direction of cave opening / exposure |
|---|---|---|---|---|---|
| Saint Mihiel | close | river | slope | rock shelter/ open air | NW-W-S |
| Bois Laiterie | close | stream | slope | cave | N |

**Tab. 23** Topographic characteristics of sites from the western uplands. **immediate** 0-29 m; **close** 30-149 m; **near** 150-500 m; **distant** 500 > m; **×** not restricted; **N** north; **S** south; **W** west; **E** east.

Further sites often considered in reviews of Rhineland material such as Alsdorf or Kartstein fall into the western upland zone of the present study (see below and p. 180-182). In addition, south of the study area the assemblages from Fußgönheim containing shouldered points (Stodiek 1987) were associated with the transitional period in the Rhineland. However, the material originated partially from collections and partially from test pits which revealed stratigraphic disturbances at the site affecting the position of the archaeological material. Thus, besides the location outside the study area, the material from Fußgönheim cannot be evaluated concerning its material integrity based on literature studies.

## The western upland zone

In the archaeological record from the Central Rhineland only few concentrations were attributed to the transition period between the Late Magdalenian and the FMG. Thus, further sites are necessary to establish a chronologically dense web of archaeological assemblages across this period to characterise the progress of the transition. These archaeological assemblages have to originate from areas where a comparable development as in the Central Rhineland can be assumed to provide information on the same transition process. These areas can be identified by the comparison of the Late Magdalenian and the FMG material. Material from these periods which is particularly comparable to the material in the Central Rhineland was found in northern France meaning the Picardy and the Paris Basin as well as in the upland zone between the Central Rhineland and northern France. Substantial archaeological material from the period between the Late Magdalenian and the FMG was found in northern France (see Material-Archaeology-Northern France, p. 182-244) but also in the upland zone some sites were attributed to this period. However, only few of these sites appeared helpful in the description of the transition between the Late Magdalenian and the FMG.

### Saint Mihiel, Meuse

Research history

At Saint Mihiel, a first excavation near the rock *La Roche Plat* was conducted in 1886 by Dr. Mitour. Besides traces of a hearth, some hundred lithic artefacts, animal bones, and reindeer antler were recorded. This excavation was situated in the northern part in front of a monolith. Another excavation by Dr. Lenez in the late 19th century uncovered some lithic flakes and reindeer antlers from the southern part. During the 1st World War some defensive works (trenches) were installed beside the monoliths and, thus, presumably in parts disturbed the thin stratigraphy (Stocker et al. 2006, 25).

From 1965 to 1970 a test trench of 12 m² on the southern end and an excavation on the northern side provided further stratigraphic information as well as archaeological material (Tixier 1968; Tixier 1973; Stocker et al. 2006, 25). In addition, the spoil heaps of the old excavations as well as of the defensive works were successfully examined for lithic material and bones (Tixier 1968). The presented material was not strictly dis-

| site | excavated m² | total ≥ 10 mm (all) | cores and core fragments | retouched artefacts | % of burnt artefacts to total ≥ 10 mm (all) | ref. |
|---|---|---|---|---|---|---|
| Saint Mihiel | 12 | 602 (1,802) | 6 | 16 | × | 1 |
| Bois Laiterie | 31.5 | 1,814 (3,369) | 4 | 254 | × | 2-3 |

**Tab. 24** Numbers of lithic artefacts recovered at sites from the western uplands. – For further details see text. – References (ref.): **1** Stocker et al. 2006; **2** Straus/Orphal 1997; **3** Sano/Maier/Heidenreich 2011.

tinguished between the old excavations, the collection from the spoil heap, and the more recent excavation. However, refitted material suggested the cohesion of the archaeological remains.

Topography

The rock named *La Roche Plat* is one of seven monolithic blocks, which are situated on the eastern side of the Meuse at the northern exit of the town Saint-Mihiel. Today the rock rises about 25 m high above the ground and offers no shelter (**tab. 23**; Stocker et al. 2006, 25). Probably, only a small overhanging roof had existed which collapsed in the Late Pleniglacial as the stratigraphy seems to indicate (layer IIa, cf. Stocker et al. 2006, 26). The terrace at the base of the rock was approximately 5 m wide and situated some 12 m above the Meuse bank which is situated at the end of the slope, some 80 m west of the terrace. There the Meuse flows from a comparably meandering part with a narrow valley in the south into a wide, less curved valley in the north. Due to this position the view from the rock towards the north-west is several kilometres wide. Towards the south-west a small basin is formed by a dry valley which entered the Meuse valley from the east.

Stratigraphy

The stratigraphy is comparably short. Above the calcareous rock a yellow sandy deposit followed which in the lower most 5-6 cm (layer III) was free of gravel and calcareous pieces but towards the rock wall formed into a breccia (Stocker et al. 2006, 26). On top followed some 15 cm of yellowish sands (layer II). Within these sands 15-20 cm large calcareous blocs occurred along with medium sized gravels. This deposit was rich in small mammal remains. The archaeological material was spread over the whole thickness of this layer. Towards the rock this layer was overlain by cryoclastic debris (layer IIa) which reached a maximum thickness of 45 cm. On top of this layer an up to 30 cm thick deposit of brown soil mixed with calcareous rubble formed. This layer thinned out to 3 or 4 cm towards the end of the terrace. There the soft modern topsoil directly overlaid the archaeological layer. Thus, admixture of fossil and modern bones, antlers, and also lithic artefacts occurred in this part (Stocker et al. 2006, 25).

Archaeological material

Although the site was relatively small, a diverse archaeological assemblage was recovered. However, the lithic assemblage was relatively small (**tab. 24**).

A Western European flint of good quality was presumably accessible at the opposite side of the Meuse (**tab. 25**; Stocker et al. 2006, 31). The near presence of the raw material resource was considered as an explanation to the lack of cortical flakes because the initial knapping stage would have taken place at the resource site (Stocker et al. 2006, 31). However, some single blanks were made of non-local material, generally of further Western European flint varieties but also of a indurated sandstone. Comparable material to the indurated sandstone was found some 18 km up the Meuse (Stocker et al. 2006, 31-34). For the foreign flint material an origin in the westward Marne region as well as in the Vosges, east of the site, was considered (Stocker et al. 2006, 31). In particular, the retouched artefacts were usually made of the foreign material (Stocker et al. 2006, 31).

| site | distance classes of raw material exposure from the site | | | | | ref. |
|---|---|---|---|---|---|---|
| | 0-5 km | 6-15 km | 16-60 km | 61-250 km | 251 km > | |
| Saint Mihiel | **Western European flint**; quartzite | | indurated sandstone (18 km > S) | Western European flint (tools; 75 km > W or 110 km > E) | | 1 |
| Bois Laiterie | psammite | | ***flint*** *(35 km > N-NE or 60 km > W); type 9 flint (25-30 km S)* | **flint** (60 km > W); type 9 flint (75 km > S-SW); fossil molluscs (e. g. Dameray, 160 km > SSW or Valmondois, 235 km > SW) | | 2-3 |

**Tab. 25** Approximate distance classes of raw materials recovered at sites from the western uplands. The most numerous lithic raw material(s) is/are set in bold. Raw materials of which only single artefacts were found are marked as (single). Possible but not probable resources are set in italics. – For further details see text. – References (ref.): **1** Stocker et al. 2006; **2** Straus/Orphal 1997; **3** Miller/López Bayón 1997.

| site | blank production | cores total | 1 platform | 2 platforms, 1 preferred | 2 platforms | 3 and more platforms | others (e. g. fragments) | ref. |
|---|---|---|---|---|---|---|---|---|
| Saint Mihiel | blades/bladelets | 6 | 2 | 2 | 2 | 0 | 0 | 1 |
| Bois Laiterie | blades | 4 | 0 | 1 | 1 | 0 | 1 | 2-3 |

**Tab. 26** General concept of blank production and core types recovered at sites from the western uplands. **×** – this type is not mentioned or displayed in a publication. – For further details see text. – References (ref.): **1** Stocker et al. 2006; **2** Straus/Orphal 1997; **3** Sano/Maier/Heidenreich 2011.

| site | total | no. of retouched artefact groups | LMP | end-scrapers | truncations | borers | burins | composite tools | others | ref. |
|---|---|---|---|---|---|---|---|---|---|---|
| Saint Mihiel | 16 | 4 | **5** | **5** | 0 | 3 | 3 | 0 | 0 | 1 |
| Bois Laiterie | 254 | 7 | **114** | 22 | 24 | 21 | **31** | 2 | 20 | 2-3 |

**Tab. 27** Numbers of retouched lithic artefacts recovered at sites from the western uplands. The two most numerous classes are set in bold. – For further details see text. – References (ref.): **1** Stocker et al. 2006; **2** Straus/Orphal 1997; **3** Sano/Maier/Heidenreich 2011.

Although the resource was very close, only six cores were found at the site (**tab. 26**). Nevertheless, in regard to the total numbers in this small inventory these represent a significant number. However, the main preparations of the cores were presumably made elsewhere. The cores were not exhaustively used but had produced several larger flakes and blades. The shaping of these cores was relatively diverse (Stocker et al. 2006, 26-28) with two typical pyramid cores with one mainly used platform for the production of blades, two cores with a single platform for the production of bladelets, and a further two cores which were worked from two platforms to receive elongated flakes (cf. Tixier 1968, 347).

The retouched inventory comprised 16 retouched artefacts with the pieces from the previous excavations included (**tab. 27**; Stocker et al. 2006, 31). Furthermore, at least six blanks were used so intensely that they wear macroscopic use-wear patterns (Stocker et al. 2006, 31). The most numerous classes (n = 5) were LMP and end-scrapers. Among the LMP the fragments of backed points were clearly dominating. The blunted edge of these implements was made continuously and curved as well as discontinuously and angled. However, in one case, the piece seemed to display an impact fracture but it could also be classified as a burin on truncation (Stocker et al. 2006, 33 fig. 7.1). The end-scrapers were usually made on long blades. Furthermore, the three burins were made on truncation (n = 2) and on a breakage (n = 1). In addition, three borers were found of which one was identified as a perforator and two were attributed to the *bec* type. However, these were not very massively made, although one might represent a proper *Zinken*. Perhaps, this very limited inventory was substituted at the site, whereas the blanks of the local raw material were of greater

| site | Saint Mihiel | Bois Laiterie* |
|---|---|---|
| *Ovibos moschatus* | | + (teeth) |
| *Rangifer tarandus* | ++ | + |
| *Equus* sp. | + | + |
| *Alces alces* | | + |
| *Cervus elaphus* | | + |
| *Capreolus capreolus* | | ? |
| *Capra ibex* | + | + |
| *Rupicapra rupicapra* | | + |
| *Saiga tatarica* | + | ? |
| *Bison priscus* | + | + |
| *Canis lupus / familiaris* | | (+) |
| *Alopex lagopus / Vulpes vulpes* | | + |
| *Alopex lagopus* | + | |
| *Meles meles* | | + |
| *Ursus arctos / speleaus* | + | (+) |
| further carnivores | + | (+) |
| *Lepus* sp. | + | + |
| Aves | + | + |
| Pisces | | + |
| ref. | 1 | 2-4 |

**Tab. 28** Mammal species recovered at sites from the western uplands. For symbols see **tab. 15**. ***** In this only the species attributed to YSS and BSC are included. – For further details see text. – References (ref.): **1** Stocker et al. 2006; **2** Gautier 1997; **3** Deville/Gautier 1997; **4** van Neer 1997.

| site | season | indicator | ref. |
|---|---|---|---|
| Saint Mihiel | spring/autumn | reindeer foetus; reindeer antler | 1 |
| Bois Laiterie | summer – autumn | cementum increment analysis of reindeer teeth; migratory birds and fish | 2-4 |

**Tab. 29** Seasonality of sites from the western uplands as indicated by faunal material. – For further details see text. – References (ref.): **1** Stocker et al. 2006; **2** Stutz 1997; **3** Deville/Gautier 1997; **4** van Neer 1997.

importance and taken from the site. Nevertheless, a hammerstone made of quartzite was also found in the concentration and further confirmed the processing of lithic material on the site (Stocker et al. 2006, 28). Perhaps, the quartzite was taken from the gravels of the Meuse.

However, the main work on the site was probably related to bone and antler. Almost 500 antler remains of reindeer (*Rangifer tarandus*) were accumulated on the site (**tab. 28**). Five wore traces of use as a resource (Stocker et al. 2006, 34). Of the 926 bone fragments, 532 were determined (Stocker et al. 2006, 36). The majority was attributed to some seven reindeer (n=224). According to the presence of a reindeer foetus as well as the presence of antlers still adjacent to the skulls two seasons were identified spring and autumn (**tab. 29**). However, the shed of antlers is also dependent on the nutrition, the climate, and the age of the reindeer. Therefore, a single occupation cannot be excluded completely. In addition, 41 remains were attributed to birds. For the other determined remains only the identified species were given: Horse (*Equus* sp.), bison (*Bison priscus*), saïga (*Saiga tatarica*), ibex (*Capra ibex*), arctic fox (*Alopex lagopus*), brown bear (*Ursus arctos*), hare (*Lepus* sp.), and polecats (*Mustela* sp.; Stocker et al. 2006, 36). This assemblage reflected a typical Late Magdalenian faunal assemblage. In addition, the analysis of small mammals also suggested a cold period environment (Stocker et al. 2006, 36f.).

The preservation of the surfaces was limited. Carnivore marks were only found on three pieces suggesting that these agents played only a minor role for the accumulation of the material. However, only a hare bone and on a rib of a medium-sized artiodactyl, presumably reindeer, cut-marks were observed (Stocker et al.

| site | points | | | | fish hook | sewing instruments | | knives | bâtons | axes | hammers | others | ref. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | bevelled | barbed, single row | barbed, double row | others (incl. tip fragments) | | needles | awls | | | | | | |
| Saint Mihiel | | | | ? (b) | | | | | + | | | | 1 |
| Bois Laiterie | + (a) | | | + (b) | | + (b) | + (b+a) | | + | | | + (b+a) | 2 |

**Tab. 30** Modified organic material from sites from the western uplands. For symbols see **tab. 15**. Material abbreviations are: **(b)** bone; **(a)** antler; **(i)** ivory. – Within the brackets: **/** or; **+** and. – For further details see text. – References (ref.): **1** Stocker et al. 2006; **2** López Bayón et al. 1997.

| site | figurines | engravings | | | colour | | | | jewellery | | | | | ref. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | »cut« cortex | figures / symbols on portables | figures / symbols on walls | spots | paintings on gravels | paintings on walls | colourants / powder | molluscs | amber / jet | drilled teeth | incised teeth | pendants | |
| Saint Mihiel | | | + | | | | | | | | | | | 1 |
| Bois Laiterie | | + | + | | ? | ? | | ? | + | | | | + (s) | 2 |

**Tab. 31** »Special« goods recovered at sites from the western uplands. For symbols see **tab. 15**. Material abbreviations are: **(s)** coarse grained stone material; **(l)** lithic material; **(am)** amber; **(j)** jet, **(b)** bone; **(a)** antler; **(i)** ivory; **(h)** herbivore; **(c)** carnivore. – Within the brackets: **/** or; **+** and. – For further details see text. – References (ref.): **1** Stocker et al. 2006; **2** Lejeune 1997

2006, 36). Moreover, only a single fragment originated from a possible point with a groove made of antler (**tab. 30**). Nevertheless, few pieces wore grooves or engravings. Since several pieces wore figural engravings of two horse heads, a mammoth head, and an eye (**tab. 31**; Stocker et al. 2006, 34) the question remained whether these grooves were functional or ornamental. Nevertheless, the figural art was clearly comparable to the ones known from slate plates in the Central Rhineland (see p. 89 and p. 110). Thus, even though this large amount of material was gathered at the site, it displayed only few signs of use.

In summary, this assemblage appeared a typical Late Magdalenian one which was perhaps deposited at a special task camp where the remains of one or several reindeer hunting episodes were partially cached. However, the dominant presence of backed points among the LMP in this small assemblage was surprising.

Spatial organisation

During the 19th century excavation a hearth was observed which during the 1960s excavation was possibly sustained by a concentration of very small, burnt bone fragments found near the limit of the earlier excavation (**tab. 32**; Stocker et al. 2006, 26). Within the excavation two, possibly three discrete clusters were found. The one close to the rock yielded the majority of lithic material, whereas the second one formed a south-westward extension with a dense accumulation of bone and antler remains. This accumulation thinned out towards the west and was then followed by another small cluster. Comparable to the evidence from Niederbieber 12 (Gelhausen 2011b), an artefact free space was found in the northern part of the lithic accumulation, perhaps, also suggesting the seat of a flintknapper. However, this distribution indicated a relatively unaltered horizontal preservation. Presumably, the small site was used as post-processing a hunt in an area with sufficient high-quality material. Moreover, a cache-like installation for reindeer antler was also formed at the site.

| site | evident structures | | | | | latent structures | | grave | further | ref. |
|---|---|---|---|---|---|---|---|---|---|---|
| | pave-ment | stone set-ting | pit | hearth, stone packed | hearth, sediment alteration | hearth, latent | dwelling | | | |
| Saint Mihiel | | | | | | ? | | | ? (cache?) | 1 |
| Bois Laiterie | + | | | | | + | | | | 2 |

**Tab. 32** Structures on sites from the western uplands. For symbols see **tab. 15**; except **?** means possible but anthropogenic formation or relation to the archaeology is uncertain. – For further details see text. – References (ref.): **1** Stocker et al. 2006; **2** Straus/Martinez 1997.

| site | lab. no. | years $^{14}$C-BP | ± years | material | species | comment | years cal. b2k | ref. |
|---|---|---|---|---|---|---|---|---|
| Saint Mihiel | Lv-2096 | 13,160 | 110 | antler | *Rangifer tarandus* | bulked sample | 16,740-15,540 | 1 |
| Bois Laiterie | GX-20434 | 12,665 | 96 | bone | | YSS base | 15,580-14,660 | 2 |
| Bois Laiterie | OxA-4198 | 12,660 | 140 | antler | *Rangifer tarandus* | double bevelled point, YSS | 15,690-14,410 | 2-3 |
| Bois Laiterie | GX-20433 | 12,625 | 117 | bone | | YSS top | 15,590-14,430 | 2 |
| Bois Laiterie | *GX-21380* | *9,235* | *85* | bone | *Homo sapiens* | REJECT: Mesolithic burial from Breccia base | × | 4 |

**Tab. 33** $^{14}$C dates from sites from the western uplands. Rejected date is shaded grey and set in italics and, in addition, the main reason for rejection is given in comment. For further details see p. 265-269 and text. The dates were calibrated with the calibration curve of the present study (see p. 358-364) and the calibration program CalPal (Weninger/Jöris/Danzeglocke 2007). The result range of 95 % confidence is given for the calibrated ages (years cal. b2k). – References (ref.): **1** Stocker et al. 2006; **2** Charles 1996; **3** Hedges et al. 1994; **4** Krueger 1997.

### Chronology

According to the environmental indicators and the $^{14}$C date (**tab. 33**), the material was clearly attributed to the Late Pleniglacial. However, for how long the cache was collected remained unclear and the dating of a bulked sample of these antler fragment could overestimate the occupation period of the site.
Yet, the spatial distribution of the modern excavation suggested only a single workshop used presumably during a short period of time. Perhaps, further short-termed workshops were lost in the early excavations. Nevertheless, since the material recovered from these collections fitted in the excavated material, the lithic material seemed attributable to a single episode. Thus, the small lithic inventory sustained the hypothesis of a single event. However, the relatively large and diverse faunal assemblage could indicate several short visits to the site, possibly during the main migration period of reindeer in spring and autumn (Stocker et al. 2006, 36).

## Bois Laiterie, Namur

### Research history

The small cave Bois Laiterie was discovered in 1990 by Philippe Lacroix who in 1991 excavated some small test pits (Léotard/Lacroix 1997, 11). During this test excavations he realised that previous works by »pot hunters« had only caused superficial disturbance, whereas the Palaeolithic layers generally remained intact. During two field seasons in 1994 to 1995 an area of 23 m² was cleared from the remains of the former works in the cave and subsequently comprehensively excavated. This area encountered parts with remaining sediment deposits inside the cave as well as on the terrace in front of the cave. In addition, an area of 7 m² as well as a one-and-a-half square-metre wide test pit were examined in a passage towards an upper part of the cave and in the upslope part of the terrace (Straus 1997, 54). These additional areas produced few and no finds suggesting that the remains of the small camp were almost completely uncovered by these excavations. The supervision of these works were shared by Lawrence G. Straus and Philippe Lacroix with further assistance by Jean-Marc Léotard and Marcel Otte.

Topography

The small double cave is situated on the southern bank of a steep valley formed by the stream Burnot which is a small tributary to the Meuse (**tab. 23**). The confluence of the two watercourses is situated only 500 m westwards of the cave. The cave is cut into the Carboniferous limestone belonging to the Belgian Ardennes (Straus 1997, 25). The cave is situated *c.* 35 m above the present valley floor which was perhaps different in the Lateglacial (Straus 1997, 25) and above the entrance of the cave the hills rise approximately another 100 m. Two northward facing entrances lead into the cave system (Straus 1997, 28). Late Pleniglacial archaeological material was only found within the lower of the two entrances. The cave chamber opening behind the lower entrance sized at maximum 45 m² (Straus 1997, 30): It was 4-8 m wide, around 9.5 m deep, and approximately 2.5 m high during the Late Pleniglacial. Due to a connection to the upper chamber a constant draught was present inside this chamber (Straus 1997, 30). Thus, this small cave appeared as a rather uncomfortable place and, possibly, the ground was moist and required a pavement inside the cave. However, in comparison with the Lahn valley caves (see p. 133-138) a pavement inside a cave appeared common for a Late Magdalenian context. Moreover, the location at the cave entrance represented a strategically well chosen place for observation.

Stratigraphy

In Bois Laiterie as in most cave stratigraphies, the sequence was complex partially due to the protection inside and the erosion outside the cave (Straus 1997, 41-51). Inside the cave the bedrock was overlain by 7-15 cm of archaeologically sterile, grey sand (BGS). On top followed reddish clayey sands (RS) of up to 20 cm thickness containing almost no archaeological remains. In the area situated immediately inside the cave mouth grey sandy lenses were formed by disintegrated, decalcified scree (GL, YSS-grey lens or pseudo LGS). In the same area, these lenses were overlain by a pocket of silty clays (BSC) which contained artefacts. Inside the cave, 20-40 cm of coarse, grey sands (LGS) followed on top. This deposit was sterile of artefacts and was not documented outside the cave or in the cave mouth area. Overlaying was a yellowish-red to orange-brown sandy silt (YSS) which contained along with artefacts and faunal remains also some rock plates. This layer was 15 to 40 cm thick. On top followed various deposits depending on the topographic position: Inside the cave, 10-20 cm of grey sands (UGS) which contained few pieces of archaeological material were separated from YSS by some roof fall blocks. In a few profiles inside the cave, 15-25 cm of a grey-beige silt deposit (GBS) followed on top of UGS. This deposit was almost sterile of archaeological material. Along the cave wall GBS was partially covered by a 75-100 cm thick breccia containing pottery and bones, among which also human bones were identified. In the entrance area, the following light brown silts (LBS) showed already evidence of disturbance. On the terrace again large blocks delimited YSS and were overlain by reddish-brown colluvium (RC) which contained some amount of scree. Even though the archaeological remains were recovered from two stratigraphically distinct layers, the material appeared in a horizontal and vertical continuity, was typo-technologically indistinct, and could at least in parts be refitted. Hence, the remains from Bois Laiterie originated either from a single occupation event or more plausibly from several closely-spaces, nowadays indistinguishable episodes (Straus/Martinez 1997, 90). However, a projection of the finds in an approximate N-S profile indicated a significant downslope movement of a dense artefact band from inside to outside the cave (cf. Straus/Martinez 1997, 78 fig. 11). A micro-morphologicial analysis of the deposits from Bois Laiterie suggested that the material from YSS was deposited in a climatically variable period where severe cold episodes could still occur and, in fact, the layers following on top of the deposits containing the majority of archaeological remains were attributed to severe cold periods (Courty 1997). The palynological as well as the anthracological results from the site were rare and determined mainly as open forest species such as *Betula* sp. or *Corylus avellana* (Embry-Barbier 1997; Pernaud 1997). However, the intense sediment movements recommend caution about the relation of these remains and the archaeological unit. In fact, although the malacological analysis suggested the attribution of the YSS deposit to the onset of the Lateglacial Interstadial, the malacologist also considered a Preboreal disturbance of the material (López Bayón/Lacroix/Léotard 1997). This hypothesis was accompanied by the assumption based on the small mammals that the material was chronostratigraphically disturbed (Cordy/Lacroix 1997).

Archaeological material

Originally, the assemblage from Bois Laiterie was unambiguously attributed to the Late Magdalenian (Straus/Orphal 1997; López Bayón et al. 1997; Lejeune 1997). However, meanwhile some objections to this ascertained attribution occurred mainly based on the lithic inventory which yielded similarities to the Final Magdalenian faciès Cepoy-Marsangy (Sano/Maier/Heidenreich 2011).

In general, the lithic inventory (n = 3,369) was made of excellent quality material (**tab. 24**). The majority (91-96 %) is chalk flint, probably of Cretaceous age which originate perhaps from 35 km north to north-eastwards or some 60 km to the west (**tab. 25**). The only other raw material of considerable numbers (3-6 %) is a flint variety (type 9) which seemed to be secondary deposited and possibly originated from secondary deposits 25-30 km southwards or resources some 75 km south- south-westwards.

Only four cores were found (**tab. 26**). These cores were very small and exhaustively exploited. Still some very long blades were recovered at the site. Two of the cores were exploited from two platforms to receive blades or bladelets and display preparations of the platform (Sano/Maier/Heidenreich 2011). However, only few platform rejuvenation flakes and crested blades were found in the assemblage (Straus/Orphal 1997) indicating that the blank production was no important task at the site. The profiles of the blanks, the forming of their butts, and the shape of the bulb suggested the use of organic knapping instruments but predominantly of a soft hammerstone (Sano/Maier/Heidenreich 2011).

266 retouched ends were identified on 254 pieces (**tab. 27**). The biggest group was formed by LMP (n = 114) of which the majority were simple backed blades/bladelets (n = 91; Sano/Maier/Heidenreich 2011; cf. Straus/Orphal 1997). A truncated backed bladelet and three curve-backed points were already in the original publication observed, one point was identified as Microgravette (Straus/Orphal 1997, 237 fig. 12.21) and the other two as Azilian points (Straus/Orphal 1997, 255 Photo 1). In fact, one was a bipoint. The reanalysis of the lithic inventory with special emphasis on the traceological indicators revealed a total of 23 very heterogeneous points (Sano/Maier/Heidenreich 2011). Furthermore, the 35 burins were made more commonly on truncations (n = 14) than dihedral ones (n = 9). 24 blanks had at least one truncation. The 22 end-scrapers were various shapes but several (n = 10) were also retouched laterally. Some end-scrapers were made on very long blades (pers. comm. Katsuhiro Sano, Tokio; Straus/Orphal 1997, 235 fig. 10.5). Among the 21 borers several *becs* (n = 6 + 1 composite perforator-*bec* piece) occurred. Only two composite tools with various tool classes were found: a burin-end-scraper and a perforator-truncation. Among the other tools are laterally retouched, notched and denticulated pieces, as well as a raclette and two splintered pieces.

A first traceological analysis examined 129 artefacts of which eleven showed traces of use (Jardón Giner 1997). In a more recent study, 256 artefacts were analysed but 215 were too heavily patinated to produce reliable results (Sano 2009; Sano/Maier/Heidenreich 2011; Sano 2012b). Both study indicated that the lithics were mainly used on hard material and that several pieces wore impact scars suggesting the use as projectile implements.

The 788 plates found in Bois Laiterie were made of a type of sandstone (psammite) which was available up the hills (Miller / López Bayón 1997). In total, the stone material weighted more than 120 kg. 26 of the plate specimens were engraved with lines and signs or wore traces of colour (Lejeune 1997).

The assemblage from Bois Laiterie yielded a rich faunal assemblage, of which many pieces could be identified (**tab. 28**). In addition to the large mammals, small mammals, frogs, and molluscs were analysed contributing to the environmental setting of site. However, some of the faunal remains spread over several stratigraphic units and, thus, their connection with the archaeological material remained often unclear. Therefore, the larger fauna from the YSS and BSC deposits were considered most informative for the Lateglacial human presence. The most numerous remains from the cave were determined as fox remains (*Alopex lagopus / Vulpes vulpes*; n = 184). Nevertheless, this small carnivore could have used the cave as shelter in winter and, thus, be a natural intrusion. Further small carnivores such as stoat (*Mustela erminea*; n = 6) as well as badger (*Meles meles*; n = 10), wolf (*Canis lupus*; n = 1), and lynx (*Lynx lynx*; n = 5) were recovered from the site (Gautier 1997). In how far further animals such as cave bear (*Ursus spaeleus*; n = 1) and cave hyena (*Crocuta crocuta*; n = 1) were older intrusions would require further AMS dates. In equal numbers as the foxes were the remains of arctic hare present (*Lepus timidus*; n = 143). However, horse (*Equus* sp.) remains were most numerous among the larger mammals in these deposits (n = 54) suggesting the presence of at least two horses (Gautier 1997). In total, three horses were assumed at Bois Laiterie and, perhaps, a European ass (*Equus hydruntinus*) was also found among the remains (Gautier 1997). Although reindeer (*Rangifer tarandus)* remains were slightly less numerous (n = 44), these specimens were attributed to a minimum of three animals. An ibex (*Capra ibex*) was indicated by 28 remains. Eleven elements were attributed to chamois (*Rupicapra rupicapra*), although these pieces might be over-represented. Additional small ruminant remains could be attributable to this species, to ibex, or less probable to saïga antelope (*Saiga tatarica*) or roe deer (*Capreolus capreolus*). A further eleven teeth and teeth fragments from musk ox (*Ovibos moschatus*) were attributed to a single animal. Furthermore, five remains were determined as originating from an elk (*Alces alces*), three remains from a bison (*Bison priscus*), and a further three pieces from two red deer (*Cervus elaphus*). Among the fauna attributed to the YSS and BSC deposits were also several bird species (Deville / Gautier 1997). These remains comprised willow grouse (*Lagopus lagopus*; n = 23), jackdaw (*Corvus monedula*; n = 9), partridge (*Perdix perdix*; n = 3), greylag goose (*Anser anser*; n = 2) as well as five elements of a large duck (*Anser* sp.), and buzzard (*Buteo* sp.; n = 2). Furthermore, single elements of falcon (*Falco* sp.), long-eared owl (*Asio otus*), eagle owl (*Bubo bubo*), whimbrel (*Numenius phaeopus*), swallow (*Hirundo rustica*), and also a domestic fowl (*Gallus gallus*) were found in these deposits. Greylag goose as well as whimbrel are migratory birds and were assumed as possibly nesting in Belgium during the Late Pleniglacial (Deville / Gautier 1997, 217). In addition, of 66 fish remains 37 pieces were identified as brown trout (*Salmo trutta fario*), a further 20 specimens were determined as burbot (*Lota lota*), and a further three remains were attributed to a graling (*Thymallus thymallus*; van Neer 1997). The distance of the cave to the streams as well as the dimensions of the fish was assumed as hindering the introduction of these remains by smaller carnivores and, therefore, a human introduction to the site was considered most plausible (van Neer 1997, 207). This faunal composition is clearly comparable to the assemblages from Gönnersdorf and the lower horizon of Andernach (see **tab. 15**, p. 85-87, and p. 107-109; cf. Street et al. 2006).

Moreover, some pieces yielded marks of carnivore gnawing (Gautier 1997, 183) which could indicate a natural introduction of these remains to the site. Furthermore, the calcination of a few bones was also considered as a possibly natural exposure to fire (Gautier 1997, 183). However, a conservative search for indications of human modification on the relatively fragmentary remain yielded an astralagus of reindeer,

a mandible of horse, and a humerus of wild boar with cut-marks (Gautier 1997, 183). The latter originated from a stratigraphically unclear situation but was attributed to a Holocene occupation due to its biogeographic history and its habitat preference (Gautier 1997, 184). Nevertheless, at least for the Paris Basin wild boar is meanwhile confirmed for the early Lateglacial Interstadial (Bignon/Bodu 2006).
Six mammal teeth including reindeer (n = 2), ibex (n = 2), musk ox (n = 1), and elk (n = 1) were analysed in a cementum increment analysis to provide indications for the death period of these animals (**tab. 29**; Stutz 1997). However, only the reindeer teeth indicated a summer or, perhaps, autumn kill which was in accordance with the presence of migratory birds such the greylag goose or possible migratory fish (cf. Deville/Gautier 1997).
Twelve pieces show traces of human modification (López Bayón et al. 1997). Five fragments were single-bevelled points which were all made of reindeer antler (**tab. 30**). Another point fragment was made of bone. Furthermore, several pieces made of bone as well as antler were identified as awls, needles, an assumed needle container, and remains of the antler spall production. Several of these specimens wore parallel cut-marks, perhaps for ornamental reasons.
Of the eight, fossil shells five were perforated (**tab. 31**). These pieces originated presumably from Tertiary deposits in the Paris Basin (Lejeune 1997).
Finally, a small perforated plate comparable to the ones made of slate in Gönnersdorf (Bosinski 1977) was made of a polished sandstone (Lejeune 1997).

Spatial organisation
A pavement was installed inside the cave and on the terrace by psammite plates of various sizes which were partially refitted (**tab. 32**; Miller/López Bayón 1997). This evident structure was a considerable investment. Burnt material was related to the grey lenses, immediately outside the cave and were considered as indications of a hearth (Straus/Martinez 1997, 96). Many activities were performed around this fire but a second activity area was assumed for the cave wall inside the cave. However, the refits suggested the connection of these areas and made investigators assume that the various clusters were created quasi-contemporary (Straus/Martinez 1997, 112). According to the traceological analysis, the presence of faunal remains, and the composition of the lithic inventory, several activities related to the processing of one or several successful hunting events can be assumed.

Chronology
A $^{14}$C-dated human bone originated from a Mesolithic burial which was presumably dug into the Magdalenian horizon (Krueger 1997). However, the $^{14}$C dates formed a highly consistent cluster (**tab. 33**). These three, statistically indistinguishable dates emphasise the hypothesis of a single occupation event or quasi-contemporaneous events. These dates were very reliable indicator for the human presence, in particular, because one of the samples was made on an organic artefact. The refits, the dense cluster of the profile projection, the size of the assemblage, the composition of the lithic inventory, the activities, and the horizontal distribution suggested a single occupation event which according to the seasonal indicators occurred in the warm period of the year. In regard to the massive structures and depending on which faunal remains were actually associated with the human presence, a longer occupation period than only a temporary hunting camp could be assumed.
Based on the diverse archaeological inventory, the evident structures, and the dating, the site cannot be unambiguously attributed to a Lateglacial archaeological unit. Bois Laiterie combines characteristics of the Late Magdalenian, the MfCM, and Azilian elements. This heterogeneity could indicate a palimpsest which developed perhaps during the transition period. However, a single inventory from a period of change cannot be excluded. Therefore, this assemblage is considered more generally as Final Magdalenian for the moment.

## Summary and context

In the upland zone west of the Central Rhineland archaeological material was mainly found in caves or rock shelters. Open air material was often confined to surface collections. The valley bottoms were often traversed by water courses. Therefore, the morphographic setting of relevant sites was often in a position between the hill tops and the moist valley bottoms, i.e. on the slopes (**tab. 23**).

Moreover, due to the topographic conditions such as rock walls the extent of the excavation areas was often restricted (**tab. 24**). However, the numbers of the recovered lithic material were only partially influenced by this restriction. Presumably, the tasks performed in the excavated area had a greater influence. For instance, in Saint Mihiel where a more than 2.5 times smaller area than in Bois Laiterie was excavated 50 % more cores were found than in Bois Laiterie. This higher numbers as well as the higher proportion of material smaller than 1 cm suggest that the blank production took on a more important role in Saint Mihiel than in Bois Laiterie. This different focus of the two sites is also reflected in the raw material composition (**tab. 25**). Flints from the local gravels dominated in Saint Mihiel, whereas regional to distant flint varieties were generally preferred in Bois Laiterie. However, in both assemblages the blank production process was mainly focused on blades and bladelets (**tab. 26**).

The numbers as well as the composition of the retouched artefacts (**tab. 27**) further sustained the impression of different functions of the two assemblages.

In both assemblages faunal material was preserved (**tab. 28**). The composition of species at Saint Mihiel was clearly dominated by reindeer (*Rangifer tarandus*), whereas the composition at Bois Laiterie was much more diverse.

The seasonal indicators from both sites suggested human presence during the warmer period of the year from spring to autumn (**tab. 29**). Saint Mihiel was probably visited at the beginning and/or end of this period, whereas the occupation of Bois Laiterie occurred presumably within the warm period.

Comparable to the lithic tool inventory, the organic tools were more frequent and more diverse at Bois Laiterie than at Saint Mihiel (**tab. 30**). The materials with potential symbolic meaning (**tab. 31**) were also more common at Bois Laiterie than at Saint Mihiel.

Settlement structures were more evident at Bois Laiterie than at Saint Mihiel (**tab. 32**). Perhaps, the duration of the occupations were in addition to the function different between these two sites and, therefore, more effort was invested in the organisation of Bois Laiterie.

According to the $^{14}C$ dates (**tab. 33**), the assemblage at Saint Mihiel was deposited some centuries previous to the material from Bois Laiterie. However, the relation of the $^{14}C$ date from Saint Mihiel to the human activity seemed ambiguous and a closer temporal relation of the two assemblages is possible.

Besides the two presented sites, further inventories from the area west and east of the Rhineland were discussed in the context of the Late Magdalenian, the FMG, and the transition between the former two. Some important assemblages are mentioned briefly in the following. In the central Sieg valley, east of the Central Rhineland, an engraved retoucher was collected from the surface (Heuschen et al. 2006). On both sides of the piece a schematic animal silhouette was engraved. Both engravings were identified as probable elk. In reference to the engravings on slate plates in Gönnersdorf, the dating of the elk bone from the south-western area at Gönnersdorf, and the occurrence of elk in the art of the Lateglacial (cf. Veil et al. 2012), the retoucher was attributed to the Lateglacial Interstadial. However, this attribution relied only on typo-technological assumptions and lacked an independent and precise dating. Test pits and surface surveys near the findspot produced no conclusive results (Heuschen 2007).

In archaeological summaries of the extended Rhineland (e.g. Bosinski/Richter 1997, 25. 27-32) several sites from the Eifel region were frequently considered such as the Late Magdalenian site at Alsdorf (Löhr 1995a), possible Late Magdalenian and CBP Group artefacts in the Kartstein sequence (Baales 1996), or the small lithic CBP Group assemblage from the Katzensteine (Löhr 1995b).
The site at Alsdorf (North Rhine-Westfalia) was recovered in 1974 by an amateur archaeologists and, subsequently, excavated by Hartwig Löhr (Löhr 1995a). The excavation yielded 9,567 lithic artefacts among which 107 cores and 361 retouched pieces were found which were techno-typologically identical with the Late Magdalenian material from Central Rhineland (Löhr 1995a). Furthermore, structural similarities existed with Gönnersdorf and the lower horizon at Andernach. In addition to a possible pavement, pits were observed in which charcoal was preserved. However, the excavator assumed the charcoal to be a more recent intrusion and further organic material was not preserved. Hence, the site was not $^{14}C$-dated but the stratigraphy and the structural and techno-typological comparison clearly indicated a chronological attribution to the Late Pleniglacial, similar to the Central Rhineland Late Magdalenian. The geographic setting of this site is of some interest since Alsdorf is situated at the transition from the upland to the lowland zone. Additionally, the setting in the resource area of good-quality Western European flint is in regard to the connections to the Central Rhineland notable. Moreover, based on the Alsdorf material Hartwig Löhr developed a model of the functional differentiation of Palaeolithic and Mesolithic assemblages depending on the duration of the settlement (Löhr 1979).
The lithic material from the Kartstein sequence was excavated in the early 20th century according to the standards of this time. Thus, the single finds lack most stratigraphic information (Baales 1996) and, therefore, the pieces could not be attributed reliably.
The material 1969-1970 excavated in the Katzensteine could not be unambiguously attributed to a chronostratigraphic position due to their occurrence in reworked sediment (Löhr 1995b).
In the Lower Rhineland, at the transition from the Eifel uplands to the North European Plain, large-scale surface surveys in relation to brown coal quarrying fields, produced several concentrations of possible Magdalenian material (Nehren 2001). In particular, the concentration at Altdorf-Güldenberg WW 95/79 yielded indications for fire use and an engraved schist plaquette along with some 300 lithic tools of non-local flint (Nehren 2001). The lithic inventory contained no backed pieces. However, burins, *becs,* and end-scrapers were present which in combination with an engraved small plate suggested an affiliation with the Late Magdalenian. Further thorough examinations of the probable Lateglacial concentrations at this site are going to be published and, perhaps, add on the knowledge about the use of the landscape by Lateglacial hunter-gatherers (e.g. Nehren 2001, 58). The currently available information on this material was too little for the present study and, therefore, the site was excluded. In general, a precise and independent dating of the concentrations in these survey areas remained difficult due to the often rather limited stratigraphic depth and the poor organic preservation. Hence, further material which might relate to the period between the Late Magdalenian and the FMG (Höpken 1995; Thissen/Krull/Weiner 1997) was also neglected in the present study.
In the Belgian and the Dutch part of the North European Plain some sites were recovered which were discussed in the context of some type of Creswellian (Charles 1999; Barton et al. 2003). The classic British Creswellian was attributed to a Final Magdalenian and, thus, the period between the Late Magdalenian and the FMG (see p. 56-74; Barton et al. 2003). Consequently, the Belgian and Dutch sites could additionally be considered in the present study. However, these assemblages lacked usually an independent and precise chronostratigraphic determination and, moreover, many of these sites were found outside the study area in a different geomorphological zone.
At the transitional zone from the Belgian and Dutch part of the North European Plain to the upland region some classic Late Magdalenian sites such as Kanne, Orp, Sweikhuizen, Mesch, and Eyserheide were found

(Rensink 1995; Rensink 2012). These sites were probably related to lithic procurement. Further sites recovered in this transitional area east of the German border were, for instance, the site Bois de St. Macaire at Obourg (Letocart 1970) or, perhaps, also the collection from Mont de l'Enclus at Orroir (Charles 1997a). Material from the uplands between the Central Rhineland and northern France such as the remains found in the caves of Engis (4e Grotte d'Engis, also: Caverne funaire; Charles 1997a) and those of Goyet (Toussaint/Becker/Lacroix 1998; Stevens et al. 2009a) was also discussed in the context of a Final Magdalenian. Due to the often poor documentation of excavations conducted early in the research history many assemblages represented rather collections with little additional information. These collections were occasionally shown to be the result of various archaeological events from very different periods (Stevens et al. 2009a). Therefore, the integrity of the material cannot be tested and the chronostratigraphic attribution remained vague. Further sites from the western upland zone such as Sy Verlaine were presumably disturbed (Dewez 1987; Charles 1996). In other sites such as the Trou de l'Ossuaire the chronostratigraphic indications were contradictory and/or the archaeological material was heavily disturbed by previous excavations (Leotard/Otte 1988; Charles 1997a). Some excavated sites such as Caverne de Bois de la Saute yielded material which suggested a position in the period between the Late Magdalenian and the FMG but the deposition of these assemblages were not well dated (Charles 1997a; Charles 1999). Furthermore, very small inventories such as the single block and its knapping debris at the Trou Jadot (Toussaint et al. 1993) allowed no detailed classification except for the suggestion of a very brief halt.

Farther to the south, the site Roc-la-Tour I was attributed to the Late Magdalenian and comparable to Alsdorf (Rozoy 1988). This site was also set in the Rhenish slate mountains and, comparable to Gönnersdorf or the lower horizon from Andernach, slate plates were recovered from this site. Moreover, these plates were also partially engraved. However, comparable to Alsdorf, the chronostratigraphic attribution relied only on typo-technological consideration because the acidic soil had destroyed all organic materials which could have helped with an independent attribution (Rozoy 1988, 139). Moreover, in this southern part of the upland zone between the Central Rhineland and northern France several sites yielded archaeological material which possibly originated from the period between the Late Magdalenian and the FMG (Huet/Thévenin 1995; Guillot/Guillot/Thévenin 1995; Huet et al. 1995; Spier 1997; Charles 1997a; Guillot/Guillot/Thévenin 2000; Spier 2000). These assemblages were frequently recovered in surface collections. This recovery made only typo-technological considerations about the inventories possible and lacked independent dating or spatial information. Nevertheless, the presence of these sites indicated a probably continuous settlement area from the Central Rhineland to northern France during the Late Magdalenian in particular and suggested in general the habitual use of this intermediate area by Lateglacial hunter-gatherers.

### Northern France

The archaeological record is one of the main lines of evidence in the present study because it reflects the change in human behaviour. However, for the transition period between the Late Magdalenian and the FMG only few assemblages from the Central Rhineland were found and provided little evidence (see Material-Archaeology-The Central Rhineland, p. 75-170). Equally, in the western upland zone very few sites yielded reliable material from this transition period (see Material-Archaeology-Western uplands, p. 170-182). Therefore, assemblages from northern France meaning the Picardy and the Paris Basin which yielded material from this period were additionally considered in the present study. In this area also Late Magdalenian and FMG assemblages of comparable faciès as in the Central Rhineland were found suggesting a single social network during the Lateglacial.

| site | approximate distance to water | type of water body | morphographic setting | site type | direction of cave opening / exposure |
|---|---|---|---|---|---|
| Hallines | immediate/close | stream | slope | open air | × |
| Le Grand Canton | immediate | river | valley bottom | open air | × |
| Bonnières-sur-Seine | near | river | foothills in valley bottom | rock shelter | N |
| Étigny-Le Brassot, south | immediate | river | valley bottom | open air | × |
| Le Tureau des Gardes | immediate | river | valley bottom | open air | × |
| Le Closeau | immediate | river | valley bottom | open air | × |
| Cepoy | immediate | river | valley bottom | open air | × |
| Marsangy | immediate | river | valley bottom | open air | × |
| Belloy-sur-Somme | immediate | river | valley bottom | open air | × |
| Gouy | close | river | slope | cave | NW |
| Pincevent III.2 | immediate | river | valley bottom | open air | × |
| Conty | immediate | river | valley bottom | open air | × |
| Hangest-sur-Somme III.1 | immediate | river | gravel heap in valley bottom | open air | × |

**Tab. 34** Topographic characteristics of sites in the Paris Basin. **immediate** 0-29 m; **close** 30-149 m; **near** 150-500 m; **distant** 500 > m; **×** not restricted; **N** north; **W** west. – For further details see text.

## Hallines, Pas-de-Calais

### Research history

Near Hallines, in the area where northern France gradually merges into the lowlands of the North European Plain, the collector J. Boutry found in 1968 a few lithic artefacts and bones which came up during construction works on the property of J. M. Levert (Fagnart 1997, 33). As a result a rescue excavation of 5 m² (Fagnart 1997, 35) under the supervision of Alain Tuffreau was conducted on the property. Test pits which were dug in 1969 on the other side of the road produced no further results. In 1977 canalisation work alongside the road also on the Levert property yielded only few further artefacts.

### Topography

The rescue excavation area was located alongside the road from Hallines to Wisques on the northern slope of the valley formed by the Aa (**tab. 34**). The site was situated some 20-25 m above the valley floor at the foot of the Aa's middle terrace which formed a comparably steep slope to the north-east (Fagnart 1997, 33). From north-west to south-east the slope was cut immediately west of the site by a small thalweg within which the road was built.

### Stratigraphy

Due to the topographic position the lithostratigraphy was not completely comparable on both sides of the road. On the excavated side of the valley a 1.5 m thick gravel deposit with various lenses of yellowish sandy silts was found on top of light yellow silts. According to the malacological analysis, the latter were deposited in pleniglacial conditions (Fagnart 1997, 33 f.). Within the gravel deposit several archaeological horizons were observed. In the present study, two levels which were found within the sandy lenses and which were separated by only 7 cm of small gravels are considered. In the 1990s, Jean-Pierre Fagnart analysed the material from the two horizons conjointly because he regarded the material as very homogeneous from a typological as well as a stylistic point of view (Fagnart 1997, 35). Nevertheless, the two distinct horizons suggested that this assemblage was deposited by at least two different, temporally succeeding episodes. The gravel deposit was overlain by a 10 cm thick layer of flint gravels and brown sandy clay on top of which a 1 m thick brown-

| sites | excavated $m^2$ (p.r.n. relevant) | total ≥ 10 mm (all) | cores & core fragments | retouched artefacts | % burnt artefacts of total ≥ 10 mm (all) | ref. |
|---|---|---|---|---|---|---|
| Hallines | 5 | 790 | 46 | 122 | × | 1 |
| Le Grand Canton, lower horizon | *c.* 15 | 619 | 3 | 16 | × | 2 |
| Le Grand Canton, upper horizon | 1,020 | 24,556 | 1,015 | 1,029 | × | 2-3 |
| Le Grand Canton, sector 1 | 60 | 1,021 | 188 | 113 | × | 2-3 |
| Le Grand Canton, sector 2, upper horizon | 504 | 23,535 | 827 | 916 | × | 2-3 |
| Bonnières-sur-Seine* | 20-30 (5-10) | 1,316 | 7 | 13 | × | 4 |
| Étigny-Le Brassot, south | 201 | 8,252 | present | *c.* 100 | mentioned | 5 |
| Le Tureau des Gardes | 463 | 60,912 | 942 | 3,442 | × | 6-7 |
| Le Tureau des Gardes, *locus* 6 | 5 | 4,263 | 60 | 249 | × | 6 |
| Le Tureau des Gardes, *locus* 7 | 140 | 7,551 (15,984) | 84 | 784 | × few | 7 |
| Le Tureau des Gardes, *locus* 10 | 85 | 14,091 | 276 | 1,188 | × | 6 |
| Le Closeau, lower horizon | *c.* 1,000 | 5,650> | 47> | 495** | *c.* 3.4 | 8-9 |
| Le Closeau, *locus* 4+50 | 182> | 2,475 | 20 | 262** | 3.6 | 8 |
| Le Closeau, *locus* 46 | 193 | 2,309 | 23 | 201** | 3.3 | 8 |
| Le Closeau, greyish layers | 25,568 | 41,397 | 827 | 823** | 19.9 | 8 |
| Le Closeau, *locus* 25 (top) | 26 | 126 | 1 | 14 | 6.4 | 8 |
| Cepoy | 355 | *c.* 30,000 | 355 | *c.* 267 | × | 3; 10-11 |
| Cepoy, sector 1 | 205 | *c.* 14,500 | 252 | 142 | mentioned | 3; 10 |
| Cepoy, sector 2 | 150 | <15,000 | 103 | 125> | frequently | 11 |
| Marsangy< | 213 | 21,618 | 379 | 642 | mentioned | 12-13 |
| Marsangy N19 | 58 | 10,389 | 197 | 313 | mentioned | 12-13 |
| Belloy-sur-Somme, lower horizon | *c.* 470 | 6,415 | 108 | 158 | × | 1 |
| Gouy | ? | 116 | 1 | 16 | × | 14 |
| Pincevent III.2 | *c.* 280 (70) | 489 (561) | 10 | 31 | 18.4 (16.0) | 15-16 |
| Conty, lower horizon | 100 | (*c.* 2,000) | 3 | 42 | some | 1 |
| Hangest-sur-Somme III.1, lower horizon | 150 | 839 (1,945) | 21 | 100 | some | 1 |

**Tab. 35** Numbers of lithic artefacts recovered at sites in the Paris Basin. Sub-assemblages of a site are shaded grey. **×** this type is not mentioned in a publication; ***** numbers refer to the complete material from the site including the old excavations, therefore, the complete excavation activities are given but the modernly excavated square-metres were also given in parentheses; ****** numbers do not include the pieces with diverse traces of modification and, therefore, can differ from the numbers in the publication. – For further details see text. – References (ref.): **1** Fagnart 1997; **2** Valentin et al. 1999b; **3** Valentin 1995; **4** Barois-Basquin/Charier/Lécolle 1996; **5** Lhomme et al. 2004, 733; **6** Lang 1998, 90; **7** Weber 2006; **8** Bodu 1998; **9** Bodu/Debout/Bignon 2006; **10** Allain et al. 1978; **11** Wenzel 2009; **12** Croisset/Schmider 1992; **13** Schmider 1992b; **14** Bordes et al. 1974; **15** Bodu/Orliac/Baffier 1996; **16** Orliac 1996b.

yellowish silt layer followed. This layer was separated by a 5 cm thick band of chalk and flint fragments from a brownish sandy silt deposit of 1 m thickness. Above this deposit 40 to 80 cm of modern soil had formed.

Archaeological material

From the two horizons and including the various collections 995 lithic artefacts were found, of which 790 were larger than 2 cm (**tab. 35**).

The major raw material was the local Senonian flint (**tab. 36**; Fagnart 1997, 35) but a few artefacts, especially tools, were made of a beige coloured silex which presumably came from the Tertiary plateau in the central Paris Basin (Fagnart 1997, 37). In this case, this chalcedony originated from at least about 130 km south of the site.

Among the lithic artefacts, 46 cores were identified of which 29 were fragments or rather nodules with few knapped flakes (**tab. 37**). Only one prismatic core had two platforms, nine were single platform prismatic cores. Generally, blades were the aim of the blank production. The blanks often displayed an *en éperon* butt

| site | distance classes of raw material exposure from the site | | | | | ref. |
|---|---|---|---|---|---|---|
| | 0-5 km | 6-15 km | 16-60 km | 61-250 km | 251 km > | |
| Hallines | **Senonian flint** | | | Tertiary chalcedony (130 km > S) | | 1 |
| Le Grand Canton, lower horizon | **Senonian gravel flint** | | Tertiary chalcedony (45 km > WNW) | Tertiary chalcedony (85 km > SW) | | 2 |
| Le Grand Canton, upper horizon | **Senonian gravel flint**; sandstone; granite; Nautilus sp. (c. 5 km SW) | | gritstone (40 km > NW); *Tertiary chalcedony (45 km > WNW)* | Tertiary chalcedony (85 km > SW); Eocene mollusc (65 km > N or 65 km > NE) | | 2 |
| Bonnières-sur-Seine | **local flint**; local chalcedony | local Cretaceous flint (?) | | | | 3-4 |
| Étigny-Le Brassot, south | Senonian gravel flint | | | | | 5 |
| Le Tureau des Gardes | **local Cretaceous flint**; *Tertiary chalcedony;* sandstone | | Tertiary chalcedony (20 km > WNW) | | | 6 |
| Le Closeau | **Campanian flint**; *Tertiary chalcedony* (not present in *locus* 25) | | Tertiary chalcedony (25 km > WSW or 35-60 km > S) | | | 7 |
| Cepoy | **local Cretaceous gravel flint**; gritstone; sandstone; quartzite | | Tertiary chalcedony (45 km > N or 60 km > WSW) | | | 3; 8 |
| Marsangy | **local Cretaceous flint** | local Campanian flint (6 km > NW) | quartzitic sandstone (35 km > SE); glossy sandstone (sinlge, 35 km > SE) | jasper (single, 65 km > SW); Tertiary chalcedony (80 km > NW); fossil molluscs (80 km > N; 90 km > NW; 130 km > W) | | 6-8 |
| Belloy-sur-Somme | **local Turonian and Coniacian flints** | | | | | 1 |
| Gouy | local Senonian flint | high-quality Cretaceous flint (unknown origin) | **high-quality Cretaceous flint (unknown origin)**; Tertiary chalcedony (25 km > SE) | | | 3; 9-10 |
| Pincevent III.2 | **local gravel flint**; *granite (single)* | | Tertiary chalcedony (40 km > WNW) | Tertiary chalcedony (80 km > SW); granite (single, 150 km > SSE; 300 km > E) | | 11-12 |
| Conty, lower horizon | **local Turonian flint** | | | | | 1 |
| Hangest-sur-Somme III.1 lower horizon | **local Turonian and Coniacian flints** | | | | | 1 |

**Tab. 36** Distance classes of raw materials recovered at sites in the Paris Basin. The most numerous lithic raw material(s) is/are set in bold. Raw materials of which only single artefacts were found are marked as (single). Resources for which several places of origin are discussed are set in italics. – For further details see text. – References (ref.): **1** Fagnart 1997; **2** Julien/Rieu 1999; **3** Valentin 1995; **4** Barois-Basquin/Charier/Lécolle 1996; **5** Lhomme et al. 2004, 737; **6** Lang 1998, 91; **7** Bodu 1998, 43-47. 335; **8** Wenzel 2009; **9** Bordes et al. 1974; **10** Fosse 1997; **11** Bodu/Orliac/Baffier 1996; **12** Orliac 1996b.

(Fagnart 1997, 37). The blades seemed generally to have been knapped with an organic hammer (Fagnart 1997, 37). However, the preparation of the cores was presumably made with a hammerstone.

Among the 122 tools were only three pieces attributable to the LMP (**tab. 38**). These three implements were pointed Magdalenian blades. The retouched pieces were dominated by 55 burins. Most of these were stroke on a retouch (n = 32), often on a lateral retouch or a notch, only once on a truncation. Several of the

| site | blank production | cores total | 1 platform | 2 platforms, 1 preferred | 2 platforms | 3 and more platforms | others (e.g. fragments) | ref. |
|---|---|---|---|---|---|---|---|---|
| Hallines | blades | 46 | **9** | × | 1 | × | 29 | 1 |
| Le Grand Canton, lower horizon | bladelets/ blades | 3 | × | × | × | × | × | 2-3 |
| Le Grand Canton, upper horizon | bladelets/ blades | 1,015 | common | **dominant** | present | present | tested blocks | 2-3 |
| Bonnières-sur-Seine | blades | 7 | **1** | × | × | × | × | 4 |
| Étigny-Le Brassot, south | blades | × | **dominant** | present | present | × | × | 5 |
| Le Tureau des Gardes | blades/ bladelets | 942 | **common** | **common** | present | × | few abandoned fragments | 6 |
| Le Closeau, lower horizon | blades | 47> | × | × | × | × | × | 7 |
| Le Closeau, greyish layers | blades/ flakes | 827 | × | × | × | × | × | 7 |
| Le Closeau, *locus* 25 | blades | 1 | 0 | 1 | 0 | 0 | 0 | 7 |
| Cepoy | blades | 254 | 14 | 10> | <21 | × | 9 | 2; 8 |
| Cepoy, sector 1 | blades | 151 | 12 | 8> | **<20** | × | 9 | 2 |
| Cepoy, sector 2 | blades | 103 | **2** | **2** | 1 | × | × | 8 |
| Marsangy | blades | 379 | **164** | × | <126 | 48 | 0 | 9 |
| Belloy-sur-Somme, lower horizon | blades | 108 | 19 | **23** | 18 | 1 | 47 | 1 |
| Gouy | blades | 1 | 0 | 1 | 0 | 0 | 0 | 10 |
| Pincevent III.2 | blades/ bladelets | 10 | 3 | **4** | 2 | 0 | 1 | 11-12 |
| Conty, lower horizon | blades | 3 | 1 | **2** | 0 | 0 | 0 | 1 |
| Hangest-sur-Somme III.1, lower horizon | blades | 21 | **6** | 3 > | < 3 | 1 | 7 (c.) | 1 |

**Tab. 37** General concept of blank production and core types recovered at sites from the Paris Basin. Sub-assemblages are shaded grey. The most numerous class is set in bold. On some sites not all cores and core fragments were classified according to the number of platforms. In these cases the pieces displayed in the figures were classified. **×** this type is not mentioned or displayed in a publication. – For further details see text. – References (ref.): **1** Fagnart 1997; **2** Valentin 1995; **3** Valentin et al. 1999b; **4** Barois-Basquin/Charier/Lécolle 1996; **5** Lhomme et al. 2004, 733; **6** Lang 1998; **7** Bodu 1998; **8** Wenzel 2009; **9** Croisset/Schmider 1992; **10** Valentin 1995; **11** Bodu/Orliac/Baffier 1996; **12** Orliac 1996b.

burin blows on retouch ran transversally to the knapping direction of the blank (n = 17). In addition to these specimens, ten dihedral burins, five burins on a broken edge, four burins on a natural edge, and two burins on the cutting edge (*Corbiac*) occurred. Furthermore, two burins were classified as mixed ones. Additionally, 21 burin spalls were found indicating the production of burins on the site. The only composite tool was a burin-end-scraper. End-scrapers formed the second largest group of tools (n = 25). These specimens were usually made on long blades or blade fragments which were not laterally retouched except for one piece. The third major group of tools were borers (n = 23) which were dominated by heavily retouched pieces, i.e. *bec/Zinken* (n = 20). In addition, truncations (n = 2), denticulated blades (n = 3), laterally retouched (n = 8), and splintered pieces (n = 2) occurred in small numbers.

Furthermore, a small flint nodule was probably used as hammerstone.

In addition, fragments of heat altered sandstones were recovered during the rescue excavation.

Even though the faunal material from the site was comparably well preserved only some ten pieces were recovered (**tab. 39**). This assemblage was dominated by mammoth (*Mammuthus primigenius*) remains of which three vertebrae, two humeri, a part of a tusk, and some teeth fragments were identified. Besides these finds, only an equid tooth (presumably *Equus* sp.) and a rib fragment of an animal with the size of a red deer (cf. *Cervus elaphus*) were found. Nevertheless, the relation of these faunal remains with the archaeological material remained unclear (Fagnart 1997, 42).

| sites | total | LMP | end-scrapers | trun-cations | borers | burins | composite tools | others | ref. |
|---|---|---|---|---|---|---|---|---|---|
| Hallines | 122 | 3 | **25** | 2 | 23 | **55** | 1 | 13 | 1 |
| Le Grand Canton, lower horizon | 16 | **8** | 2 | 0 | 1 | **5** | 0 | 0 | 2 |
| Le Grand Canton, upper horizon | 1,029 | 174 | **209** | 32 | 123 | **349** | 70 | 72 | 2-3 |
| Le Grand Canton, sector 1 | 113 | **29** | 22 | 4 | 7 | **33** | 10 | 8 | 2-3 |
| Le Grand Canton, sector 2, upper horizon | 916 | 145 | **187** | 28 | 116 | **316** | 60 | 64 | 2-3 |
| Bonnières-sur-Seine | 13 | **4** | 2 | 0 | **4** | 2 | 1 | 0 | 4 |
| Étigny-Le Brassot, south | *c.* 100 | **23** | **25** | × | × | 15 | × | × | 5 |
| Le Tureau des Gardes | 3,442 | **1,057** | 509 | 184 | 442 | **596** | 104 | 528 | 6-7 |
| Le Tureau des Gardes, *locus* 6 | 249 | **122** | 21 | 18 | **29** | 22 | 4 | **33** | 6 |
| Le Tureau des Gardes, *locus* 7 | 784 | **313** | **121** | 47 | 80 | 86 | 16 | **121** | 6-7 |
| Le Tureau des Gardes, *locus* 10 | 1,188 | **336** | 157 | 71 | 144 | **231** | 38 | 211 | 6 |
| Le Closeau, lower horizon | 495** | **81** | **98** | 11 | 0 | 29 | 8 | **268** | 8 |
| Le Closeau, *locus* 4 (+ 50) | 252 (262)** | **40 (45)** | **46 (49)** | 9 (10) | 0 (0) | 23 (23) | 4 (4) | **130 (131)** | 8 |
| Le Closeau, *locus* 46 | 201** | **28** | **49** | 0 | 0 | 4 | 3 | **117** | 8 |
| Le Closeau, greyish layers | 823** | **480** | **119** | 41 | 24 | 31 | 2 | 66 | 8 |
| Le Closeau, *locus* 25 | 14 | **14** | 0 | 0 | 0 | 0 | 0 | 0 | 8 |
| Cepoy | *c.* 267 | 49 | **68** | 28 | **50** | 29 | 4 | 41 | 3; 9 |
| Cepoy, sector 1 | 142 | 25 | **39** | 17 | **34** | 18 | 4 | 5 | 3 |
| Cepoy, sector 2 | 125> | **22** | **29** | 11 | 16 | 11 | 0 | **36** | 9 |
| Marsangy | 642 | **168** | 68 | 61 | 111 | **179** | 17 | 38 | 10 |
| Marsangy N19 | 313 | **86** | 30 | 35 | 67 | 74 | 4 | 17 | 10 |
| Belloy-sur-Somme, lower horizon | 158 | 20 | **23** | 7 | 10 | **21** | 0 | **77** | 1 |
| Gouy | 116 | **6** | 1 | 2 | **3** | **3** | 1 | 0 | 11 |
| Pincevent III.2 | 32 (35) | 3 (5) | **8** | **7** | 0 | 2 | 0 | **11 (12)** | 12-13 |
| Conty, lower horizon | 42 | **24** | 2 | 5 | 2 | **6** | 0 | 3 | 1 |
| Hangest-sur-Somme III.1, lower horizon | 100 | **52** | 6 | 7 | 0 | **27** | 0 | 9 | 1 |

**Tab. 38** Numbers of retouched lithic artefacts recovered at sites in the Paris Basin. Sub-assemblages are shaded grey. The two most numerous classes are set in bold (except for the »others« class which can result from various types involved, then the three most numerous groups are given). **×** this type is not mentioned nor shown in a publication; ****** numbers do not include pieces with diverse traces of modification and, therefore, can differ from the numbers in the publication. – For further details see text. – References (ref.): **1** Fagnart 1997; **2** Valentin et al. 1999b; **3** Valentin 1995; **4** Barois-Basquin/Charier/Lécolle 1996; **5** Lhomme et al. 2004; **6** Lang 1998; **7** Weber 2006; **8** Bodu 1998, 169-173. 322-339; **9** Wenzel 2009; **10** Croisset/Schmider 1992; **11** Bordes et al. 1974; **12** Bodu/Orliac/Baffier 1996; **13** Orliac 1996b.

### Spatial organisation

According to the observations during the small rescue excavation, the material appeared to be *in situ* (Fagnart 1997, 35). An accumulation of heat altered sandstone fragments, some pieces of charcoal, and calcined bone fragments in the upper horizon suggested the presence of a hearth immediately outside the excavated area (**tab. 43**; Fagnart 1997, 35). The composition of the lithic inventory suggested more specialised activities at the site related in particular to burins and end-scrapers and, perhaps, explained the low number of LMP. However, the LMP were frequently found concentrated around a hearth (Gelhausen 2011b) and, thus, the numbers would possibly be higher if the hearth was excavated.

| site | *Mammutus primigenius* | *Rangifer tarandus* | *Equus* sp. | Cervus elaphus | *Megaloceros giganteus* | *Capreolus capreolus* | bovid | *Bos primigenius* | *Sus scrofa* | *Canis lupus* | *Vulpes vulpes* | further carnivores | *Lepus* sp. | further small mammals | Aves | Pisces | ref. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Hallines | ++ | | ? | ? | | | | | | | | | | | | | 1 |
| Le Grand Canton, upper horizon | (+) | + | ++ | | | | + | | | + | | | | | | | 2-3 |
| Le Grand Canton, sector 1 | | + | ++ | | | | | | | + | | | | | | | 2 |
| Le Grand Canton, sector 2, upper horizon | (+) | + | ++ | | | | + | | | + | | | | | | | 3 |
| Bonnières-sur-Seine | | + | ++ | ? | + | | | | + | | | | | | | | 4 |
| Étigny-Le Brassot, south | | ++ | | ++ | | | | | | | | | | | | | 5 |
| Le Tureau des Gardes | + | + | ++ | | | | + | | | + | | | | + (Lagomorpha, Spermophilus) | + | | 6-7 |
| Le Tureau des Gardes, *locus* 6 | | | ++ | | | | + | | | | | | | + (Lagomorpha, Spermophilus) | + | | 6-7 |
| Le Tureau des Gardes, *locus* 7 | | | ++ | | | | + | | | | | | | | | | 6 |
| Le Tureau des Gardes, *locus* 10 | | + | ++ | | | | + | | | + | | | | + (Lagomorpha) | | | 6-7 |
| Le Closeau, lower horizon | | | ++ | + | | | + | | + | + | | + (*Panthera spelea*) | + | | + | | 8-9 |
| Le Closeau, *locus* 4 | | | ++ | + | | | | | + | | | | + | | + | | 8-9 |
| Le Closeau, *locus* 46 | | | ++ | + | | | | | + | + | | + (*Panthera spelea)* | + | | | | 8-9 |
| Le Closeau, greyish layers | | | + | ++ | | ? | | | | | | (+) (*Meles meles*) | | | | | 9 |
| Marsangy | | ++ | + | + | | | | | | | | | | | | | 10 |
| Gouy | | | | + | | + | | | + | + | + | | | | + | | 7; 11 |
| Pincevent III.2 | | | | + | | | | + | | + | | + (*Meles meles*) | + | | | | 12-13 |
| Conty, lower horizon | | | | + | | + | | ++ | | | | | | | | | 1; 14 |
| Hangest-sur-Somme III.1, lower horizon | | | ++ | | | | | ++ | | | | | | | | | 1 |

**Tab. 39** Mammal species recovered at sites in the Paris Basin. Sub-assemblages of a site are shaded grey. For symbols see **tab. 15**. – For further details see text. – References (ref.): **1** Fagnart 1997; **2** Alix et al. 1993; **3** Bridault/Bemilli 1999; **4** Barois-Basquin/Charier/Lécolle 1996; **5** Lhomme et al. 2004; **6** Lang 1998, 86-90; **7** Bignon/Bodu 2006; **8** Bemilli 1998; **9** Bodu 1998, 234. 285; **10** Poplin 1992, 40-44. 733; **11** Cordy 1990; **12** Bodu/Orliac/Baffier 1996; **13** Orliac 1996b; **14** Coudret/Fagnart 2006.

Chronology

A $^{14}C$ date was made on a mammoth vertebra and produced a comparably imprecise and old date falling calibrated into the Late Pleniglacial (**tab. 44**). If the fauna and the archaeological material were associated, the assemblage would be one of the oldest indication of Lateglacial re-settlement in northern France (Fagnart 1997, 42). However, besides the uncertain connection of the fauna with the lithic industry, the use of fossil material by Magdalenian hunter-gatherers was another possible explanation for the very old age, especially, since this type of behaviour was known from some Late Magdalenian sites such as Gönnersdorf (Street et al. 2006). Therefore, the dating of the rare additional bone material might be of some interest.
The lithic inventory and the fauna material as well as the stratigraphic position were consistent with a Late Pleniglacial to early Lateglacial Interstadial age of the assemblage. However, the observation of two distinct horizons could stratigraphically indicate the presence of two occupation events and, therefore, Jean-Pierre Fagnart's remark (Fagnart 1997, 42) is supported that further excavation might be helpful to gather more detailed data for a more precise classification of this site.

## Le Grand Canton, Marolles-sur-Seine, Seine-et-Marne

Research history

The site Le Grand Canton near Marolles-sur-Seine was discovered in 1989 during archaeological surveys which were a preliminary stage for the construction of the motorway A5 (Alix/Rieu 1999). From 1990 to 1991 a total of 1,020 m² was excavated under the supervision of Jean-Luc Rieu and Philippe Alix. The archaeological material was found in depressions of the underlying river gravels. The excavation was located in an area of approximately 100 m × 100 m and was divided in sub-sections of 25 m × 25 m. Within this area three sectors (1-3) were excavated. Sector 1 was situated in the sections 1 and 2 and was the most southern sector. Sector 2 was located some 20 m northwards and was with almost 600 m² the largest excavated sector. The majority of this sector was located in section 18 but some uncovered square-metres lay already in the sections 9, 10, 17, 19, and 27. Some 25 m north-westwards of sector 2 followed sector 3. This sector was mainly found in section 25 but also parts of section 24, 33, and 34 were uncovered within the works on this sector.
Sector 1 was excavated carefully with 3D-measurements, whereas in the other two sector this procedure could not always be maintained and some parts of section 18 as well as sector 3 were uncovered in rescue works with collection of the material per square-metre or quarter-square-metre (Alix/Rieu 1999). Nevertheless, in sector 2 erosive displacements were observed in the layer above the main archaeological horizon including admixture with Neolithic material. However, in the bottom of the depression the material from sector 2 appeared *in situ* and in particular, the various indicators for hearths were examined in more detail. Furthermore, in section 9 at the limit of this large depression, a second horizon was observed underneath the main horizon with very well preserved organic remains. The extent of this lower horizon seemed limited but only some parts of the sector could be explored for this horizon also due to time pressure. In sector 3, a low number of material was found in an alluvial deposit in which organic material was not preserved well. However, the limits of the site were not reached. The archaeological excavations were accompanied by geological and various environmental studies.

Topography

The site Le Grand Canton was found in a wide basin formed by the Seine and the Yonne which confluence about 3-4 km west of the site (**tab. 34**; Alix et al. 1993). The site was located about 1 km south of the town Marolles-sur-Seine. The modern Seine passes approximately 1.5 km northwards and the modern Yonne flows at a distance of some 700 m south-west of the site in a large meander. However, in the alluvial plain several palaeochannels of both rivers were observed (Alix et al. 1993, 197). In particular, along the Seine this plain was morphologically varied by sand banks rising up to 5 m above the river (Lang 1998, 10), whereas the terrain along the Yonne remained relatively level (Alix et al. 1993, 198). Eastwards of the site the terrain remains relatively levelled for some 2-3 km before it rises gradually. More than 2 km north of the site, on the northern bank of the Seine, hills rise some 50 m upwards. This plateau is frequently cut by small valleys, often running parallel to the Seine. About 2.5 km south, on the southern bank of the Yonne, the terrain rises approximately 60 m upwards. Hence, the site was situated in approximately the centre of a wide alluvial plain. The site Le Grand Canton was set only a few metres above the modern Yonne on a low gravel terrace. In the Lateglacial the floodplain of various palaeochannels had formed an area of sand and gravel mounds on which the Lateglacial hunter-gatherers could settle between the various watercourses (Valentin 1995, 228).

Stratigraphy

Due to this landscape which was constantly changed by the channels of the two large rivers, the stratigraphy of the site is complex and the vertical stratigraphy depended on the position within this floodplain. Five main profiles were taken in the three sectors. One stratigraphy was approximately directed W-E and another one N-S in sector 2 as well as in sector 3. In sector 1 only a NNE-SSW directed stratigraphy was recorded.

The N-S stratigraphy in sector 2 produced the most comprehensive sequence. In general, the stratigraphy was formed by five stratigraphic units (Deloze et al. 1999, 27-32): The bedrock was not reached but the lowest unit was formed by calcareous scree (unit V). On top were alluvial gravels, sands, and clay deposited (unit IV). These deposits were cryoturbated and capped by erosion which led to the formation of the depressions. The alluvial material was overlain by yellowish to yellow-brown sandy silts which were partially affected by the development of a soil (unit III). This pedogenesis transformed the silts into a greyish compact calcite silt deposit. This approximately 20 cm thick deposit contained the lower archaeological horizon. The compact greyish calcite silts were cut by another erosive phase. This phase formed a limit on top of which the sediments were affected by pedogenic processes, whereas the underlying deposits were partially deformed by cryoturbation. The compact silt deposit was covered by a calcium carbonate deposit resulting from the outwashing of carbonates from the upper layers during the pedogenesis. This brownish soil was overlain by a brown clay layer on top of which 10-20 cm of yellowish silts followed. These silts were covered by a greyish green outwash horizon which blended into dark brown clayish silts. This clayish silt deposit was superimposed by almost 2 m of brown to brown-orange silts which were filling up the depressions in the terrain. In the upper part of these silts a blackish layer had formed in some of the depressions and yielded mainly Neolithic material. In the sector 1, these brown silts were more sandy and admixed with small gravels, presumably, as a result of colluvial processes. The unit II comprised all the layers from the erosive phase to the brown silts. Within this unit the material of the upper archaeological horizon was scattered. The sequence was covered by some 0.4 m thick, brown-grey silts which formed the topsoil.

In the pollen samples which were taken along the NNE-SSW transect of sector 1 and in the N-S profile of sector 2 only a low number of pollen was preserved (Deloze et al. 1999, 32-35). Moreover, among the few preserved pollen were modern as well as pre-Quaternary ones infiltrated in the Lateglacial deposits. In consequence, no reliable palynological attribution of the deposits was possible. The preserved molluscs were also rare (Deloze et al. 1999, 35-38). In addition, an admixture with post-glacial material could also not be excluded by the malacological analysis, although the hypothesis of an admixture was neglected due to the depth of the samples (Deloze et al. 1999, 37). Nevertheless, the temperate species were dominant among the preserved material from the archaeological horizons suggesting either an admixture or an attribution to an interstadial period (Deloze et al. 1999, 37). In fact, the preserved species were mainly indicating a steppe environment supplement by species of a covered and a semi-forested landscape. In a protected floodplain, this type of landscape could also occur in a not too dry and/or too cold stadial period.

Archaeological material of the lower horizon

This horizon was only examined on a small area and, therefore, the assemblage attributed to this horizon was not very numerous (**tab. 35**). Furthermore, the material was not presented in detail.

The majority of the raw material originated from the local Senonian flint gravels (**tab. 36**).

Only three cores were identified in the material (**tab. 37**). These pieces were not displayed and a technological analysis of them was not published. However, the 16 retouched artefacts were displayed (**tab. 38**). Based on the blanks used for these artefacts as well as the dorsal surface of these artefacts a production of regular blades and bladelets was deducible for this horizon.

The retouched artefacts were dominated by burins. They were made on fragments of regular blanks and exclusively on truncation (cf. Valentin et al. 1999b, 67 fig. 22). One of two end-scrapers was also made on a regular blade and the other one on a fragment of secondary crested blade. The LMP found in the lower horizon were short fragments of very thin and very slim bladelets. Some of these fragments were only partially retouched. In addition, a single *Zinken* was also found in this horizon.

Although the organic material was well preserved, neither numbers for these remains nor determinations were given. However, in comparison to the upper horizon, horse (*Equus* sp.) was presumably a major species. At least the $^{14}$C-dated sample originated from this species.

Even though only a limited part of the archaeological material was excavated and published, an attribution to the Late Magdalenian seemed probable. However, in regard to the extract character of the material this attribution can only be provisional.

Spatial organisation of the lower horizon

This horizon was only examined on a small sample area and, thus far, nothing was published concerning the spatial distribution of the material from this sub-area.

Chronology of the lower horizon

Very little is known about the chronostratigraphy of the lower horizon. However, the horizon clearly preceded the upper horizon. Nevertheless, the single $^{14}$C date on a horse sample (Gif-9606) produced a similar result to the reliable dates from the upper horizon (**tab. 44**). Thus, even though the horizons were stratigraphically distinct this difference was below the resolution of radiocarbon measurements. Calibrated this result dated the horizon into the early Lateglacial Interstadial (GI-1e/GI-1d). This attribution was in accordance with the stratigraphic position in a deposit affected by pedogenic processes as well as cryoturbation.

Due to the limited information on this material an intra-site chronology could not be examined.

Archaeological material of the upper horizon

The upper horizon at Le Grand Canton yielded a very rich corpus of archaeological material (**tab. 35**). The remains from sector 1 and 2 weighted almost 350 kg (Valentin 1995). Thus far, the inventory from sector 3 was not published.

The raw materials originated mainly from the gravel deposits accessible at the site (**tab. 36**; Valentin et al. 1999a). The Senonian flint gravels were relatively small and of a poor knapping quality. 32 pieces were made of a foreign Tertiary chalcedony of uncertain origin. This material occurred in particular in the upper

horizon of sector 2 (n = 30). However, the scarcity of debris material suggested that this material was either mainly imported as ready made blanks and few prepared cores or exploited in an unexcavated part of the site (Valentin et al. 1999b, 80).
The availability of the raw material immediately at the site led to a relatively high number of cores, core fragments, and merely tested blocks ($n_{sector2}$ = 51; **tab. 37**). The exploitation strategy was clearly adapted to this local origin and the poor quality of the material. For instance, a choice towards elongated gravels was observed which made possible an effective use with a minimised preparation of the cores (Valentin et al. 1999b, 81). However, some preparation were identified on the blanks which occasionally had a facetted butt or one with an *en éperon* preparation. The cores were generally exploited from one platform or at least one preferred platform (Valentin et al. 1999b, 82). The aim of the blank production process were blades as well as bladelets. Although the number of bladelet cores was higher in the analysed sample (98 bladelet cores, 61 blade cores, nine flake cores), almost 30 of these examples served previously for the production of blades (Valentin et al. 1999b, 83). In total, some 400 cores were used for the blade production and some 550 cores were used for the bladelet production (Valentin et al. 1999b, 85). However, taking the change of use into account the numbers for the cores were relatively even. In a final stage, some cores were used for the production of small, elongated flakes which demonstrated the opportunistic concept of the flintknappers (Valentin et al. 1999b, 84). However, this almost complete exploitation also revealed an exhaustive use of suitable raw material even though the material was accessible in large quantities at the site. According to the indications on the blanks, the knapping instrument used dominantly in the blade production was an organic hammer, whereas in the preparation of the cores various knapping instruments from an organic hammer to a hard hammerstone were used (Valentin et al. 1999b, 81 f.).
The formally retouched material comprised 1,029 artefacts among which burins were clearly dominant (**tab. 38**). Approximately two third were dihedral examples and less than 7.5 % of the burins were on broken edges (Valentin et al. 1999b, 69). About a quarter of the burins were made on truncations of various shaping. The burins were commonly made on thick flakes and irregular blades. In contrast, the end-scrapers were usually made on long and regular blades. Among the composite tools the combination of burins and end-scrapers was the most frequent one. The vast majority of the LMP were made on very thin bladelets (1-3 mm thick) and were mainly fragmented. No example with a truncation was displayed and only few pieces were also retouched on the opposite lateral edge. These pieces belonged to another group of backed bladelets which were made on thicker blanks (3-5 mm) and which were usually also preserved as longer pieces. Within the upper limit of the latter group fell also seven backed points which were found in the upper horizon of sector 2 (n = 3) and sector 1 (n = 4). These points were generally angle-backed and rarely curve-backed (Valentin et al. 1999b, 73). Furthermore, two pointed bladelets were recovered from sector 1 which seemed to represent partially retouched angle- and curve-backed points.
In addition to the lithic material, some 1,300 kg of mainly burnt stone material were recovered at the site (Valentin 1995, 155) of which some 970 kg were recovered from sector 2 (Julien et al. 1999, 132). Among this material sandstone and granite accessible in the gravels of the Yonne were dominant. Only single gritstones were used which could originate from the Plateau Briard some 40 km north-westwards (Valentin et al. 1999a, 42).
The upper layer produced a large quantity of organic remains (**tab. 39**). The material from sector 1 and two samples from the sector 2 were analysed in detail (Alix et al. 1993; Bridault/Bemilli 1999). The larger sample from sector 2 weighted already more than 83 kg. More than 60 kg were determinable material (n = 3,328) of which some 32 kg were teeth material. Equal relations were assumed for the second sample from sector 2 (Bridault/Bemilli 1999, 51). Horses (*Equus* sp.) were in all sectors clearly dominant and in sector 3 the only determined species (Alix et al. 1993, 200). A minimum of 74 individuals of horse were identified in the

| site | seasonality | indicator | ref. |
|---|---|---|---|
| Le Grand Canton, upper horizon | all year but probably not in winter | age structure of reindeer | 1 |
| Le Tureau des Gardes | all year but less frequent in winter | teeth eruption and bones of young horses | 2 |
| Le Closeau, lower horizon | all year but less frequent in summer | teeth eruption stages of horses | 3-4 |
| Conty, lower horizon | late winter season | not mentioned | 5 |

**Tab. 40** Seasonality of sites in the Paris Basin according to various indicators. – For further details see text. – References (ref.): **1** Bridault/Bemilli 1999; **2** Bignon 2006; **3** Bignon/Bodu 2006; **4** Bodu/Debout/Bignon 2006; **5** Coudret/Fagnart 2006.

larger sample from sector 2, a further 43 individuals in the smaller sample (Bridault/Bemilli 1999), and some 17 individuals in sector 1 (Alix et al. 1993). In addition to horse, only reindeer (*Rangifer tarandus*) occurred in larger quantities with a total of some 15 individuals. Furthermore, two teeth from sector 1 and a distal humerus fragment from sector 2 were attributed to wolf (*Canis lupus*). Moreover, a metacarpal fragment originated from a large bovid (*Bos* sp./*Bison* sp.) and a molar fragment was determined as mammoth (*Mammuthus primigenius*). The bovid bone was found in an area of low material frequency and the relation to the human presence remained unclear. The tooth fragments of mammoth and wolf showed also no traces of modification. According to the age structure of the horses and, in particular, of the reindeer as well as the varied presence of body parts on the site, repetitive stalking hunting events in the floodplain were suggested the best explanation for the accumulation (Bridault/Bemilli 1999, 64). Moreover, the removal of meat rich body parts was at least for the horses considered (Bridault/Bemilli 1999, 57). Although this representation at least for the reindeer remains seemed partially be related to preservation issues (Bridault/Bemilli 1999, 55), a selective preservation was probably not very influential in the preservation of horse (Bridault/Bemilli 1999, 62). In addition, the surfaces were affected by various processes during the deposition and, thus, no cut-marks were observed. Furthermore, only a few fractures were assumed as probably intentional and no burning of bones was observed (Bridault/Bemilli 1999, 55. 63). Based on the age structure of the reindeer only the winter period was excluded as hunting season which was sustained by the scarcity of antler on the site (**tab. 40**). However, Anne Bridault and Céline Bémilli considered these indicators as very vague because the age structure could also result from the differential preservation (Bridault/Bemilli 1999, 57).

Seven fragments of nautilus (*Nautilus* sp.) were found but displayed no traces of use. However, they were considered as possible containers due to their curved shape (Valentin et al. 1999a, 43). Along with the possibility of an alluvial origin, an *in situ* source with approved presence of large examples of *Nautilus* (*Hercoglossa*) *danicus* is known some 5 km south-westwards in the Bois d'Esmans. The nautilus fragments at Le Grand Canton were found in two groups: One group lay in section 9 (n = 4) and one group was found in section 17 (n = 3). The pieces were found in close relation to accumulations of burnt stone material. Based on this punctual spatial occurrence of the fragments, an alluvial transport seemed not probable.

Furthermore, a perforated Eocene molluscs (*Bayana lactea*) was also found in the surrounding of a hearth (**tab. 42**; Valentin et al. 1999a, 45). These fossils could originate from the region of Meaux (Seine-et-Marne) some 60 km northwards or the region of Montmirail (Marne) some 65 km to the north-east.

### Spatial organisation of the upper horizon

In sector 1 a dense scatter of lithic material, faunal remains, and burnt stone material was found but no spatial organisation of the material was observed (Rieu/March/Soler-Mayor 1999, 97). In the sector 3, the material was in general less numerous and relatively even spread revealing only some concentration of burnt stone material accompanied by lithic material (Alix et al. 1993, 200). Thus, the focus of the spatial analysis was on the sector 2. In total, some 14 concentrations of mainly burnt stones, occasionally accompanied by charcoal were recognised in sector 2 and at least nine of them were interpreted as hearth

| site | points | | | | fish hook | sewing instruments | | knives | bâtons | axes | hammers | others | ref. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | bevelled | barbed, single row | barbed, double row | others (incl. tip fragments) | | needles | awls | | | | | | |
| Le Closeau, lower horizon | | | | | | | | ? (pointed ribs) | | | | + | 1-2 |
| Conty, lower horizon | | | | | | | | | | ? (a) | | | 3 |

**Tab. 41** Modified organic material from sites in the Paris Basin. For symbols see **tab. 15**. – For further details see text. – References (ref.): **1** Bemilli 1998; **2** Bodu 1998, 234. 285; **3** Fagnart 1997, 112. 117 f.

| site | figurines | engravings | | | colour | | | | jewellery | | | | | ref. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | »cut« cortex | figures / symbols on portables | figures / symbols on walls | spots | paintings on gravels | paintings on walls | colourants / powder | molluscs | amber / jet | drilled teeth | incised teeth | pendants | |
| Le Grand Canton, upper horizon | | | | | | | | | + | | | | | 1 |
| Bonnières-sur-Seine | | | | | + | | | | | | | | | 2 |
| Étigny-Le Brassot, north | | + | | | | | | | | | | | | 3 |
| Le Closeau, lower horizon | ? | + | | | + | | | + | | | | | | 4 |
| Cepoy | | + | + (s) | | | | | | | | | | | 5 |
| Marsangy | ? | + | ? (l) | | | | | | + | | | | (+) | 6 |
| Gouy | | + | + (s) | + | + | | + | | | | + (h) | | | 8 |
| Pincevent III.2 | | | + (l) | | | | | | | | | | | 9 |
| Conty, lower horizon | | | + (a) | | | | | | | | | | | 10 |
| Hangest-sur-Somme III.1, lower horizon | | | | | | | | + | | | | | | 1 |

**Tab. 42** »Special« goods recovered at sites in the Paris Basin. For symbols see **tab. 15**. Abbreviations are: **(s)** coarse grained stone material; **(l)** lithic material; **(am)** amber; **(j)** jet; **(b)** bone; **(a)** antler; **(i)** ivory; **(h)** herbivore; **(c)** carnivore. – Within the brackets: **/** or; **+** and. – For further details see text. – References (ref.): **1** Valentin et al. 1999a; **2** Barois-Basquin / Charier / Lécolle 1996; **3** Lhomme et al. 2004, 732; **4** Bodu / Cary 1998; **5** Allain 1975; **6** Cremadès 1992; **7** Schmider 1992c; **8** Martin 2007a; **9** Bodu / Orliac / Baffier 1996; **10** Fagnart 1997.

constructions (**tab. 43**; Rieu / March / Soler-Mayor 1999). These structures were generally small but dense clusters and contained between 10 kg and 45 kg of stone material. However, two larger structures (1 and 6) with each yielding more than 70 kg of stone material were found in the depression in the south of sector 2 (Rieu / March / Soler-Mayor 1999, 96 Tabl. 19; Julien et al. 1999, 133 fig. 66). These structures were also surrounded by the densest concentration of lithic artefacts, whereas a dense ring of faunal remains was found in 1-2 m distance to the centres of these stone accumulations. However, in detail the proportions of blank production debris, various retouched artefacts classes, and the vicinity of faunal remains

| site | evident structures | | | | | latent structures | | grave | further | ref. |
|---|---|---|---|---|---|---|---|---|---|---|
| | pave-ment | stone set-ting | pit | hearth, stone packed | hearth, sediment alteration | hearth, latent | dwelling | | | |
| Hallines | | | | ? | | | | | | 1 |
| Le Grand Canton, up-per horizon | | | | + | | | | | | 2-3 |
| Bonnières-sur-Seine | | | | + | ? | + | | | | 4 |
| Étigny-Le Brassot, south | | | | ? | | + | | | | 5 |
| Le Tureau des Gardes | | | | + | | | | | | 6 |
| Le Tureau des Gardes, *locus* 7 | | | | + | | | | | | 6 |
| Le Closeau, lower horizon | | + | | | + | ? | + | | | 7-9 |
| Le Closeau, greyish deposits | | | | | | + | | | | 7 |
| Cepoy | | ? | | + | | | | | | 10-11 |
| Marsangy | | | ? (nests) | + | | | + | | | 12 |
| Belloy-sur-Somme, lower horizon | | | | + | | | | | | 1 |
| Pincevent III.2 | | | | | + | + | | | | 13-14 |
| Conty, lower horizon | | | | | | + | | | | 1 |

**Tab. 43** Structures on sites in the Paris Basin. Sub-assemblages of a site are shaded grey. For symbols see **tab. 15**; except **?** means possible but anthropogenic formation or relation to the archaeology is uncertain. – For further details see text. – References (ref.): **1** Fagnart 1997; **2** Rieu/March/Soler-Mayor 1999; **3** Julien et al. 1999; **4** Barois-Basquin/Charier/Lécolle 1996; **5** Lhomme et al. 2004; **6** Lang 1998; **7** Bodu 1998, 323-329; **8** Bodu/Debout/Bignon 2006; **9** Jöris/Terberger 2001; **10** Allain et al. 1978; **11** Wenzel 2009; **12** Schmider 1992b; **13** Bodu/Orliac/Baffier 1996; **14** Orliac 1996b.

were different suggesting some subtly different activities related to the structures (Julien et al. 1999, 152). Nevertheless, the large structure 1 was examined in more detailed and revealed a complex development of use. Furthermore, during the excavation no alteration of the sediment was observed in this structure and also a detailed analysis of the sediment revealed no indication for thermal alterations (Rieu/March/Soler-Mayor 1999, 119f.). According to an organic trace analysis, animal bones served perhaps also as fuel along with wood charcoal or the traces result from the roasting of meat in structure 1 (Rieu/March/Soler-Mayor 1999, 120-125).

In general, the lithic artefacts were scattered across the complete sector 2 in a relatively even density. This regular distribution could indicate significant disturbances by natural agents such as floods. Nevertheless, in the southern depression and also near the other hearths the densities usually increased. In particular, the differentiated distribution of cores and various retouched artefact classes indicated some recurrent clusters suggesting that non-human agents had only a minor influence on the distribution of the material (Bridault/Bemilli 1999, 60-63; Julien et al. 1999, 153). To clarify the relation of the different clusters to each other as well as to the hearths refitting of the material is the only possibility because stratigraphically as well as micro-stratigraphically only minor perturbations were found which prohibited attributions of the material to different events. Perhaps, the thus far unpublished spatial distribution of the small groups such as the backed points or the very few Tertiary chalcedony artefacts could already help to further precise the influences of the spatial dynamics on the site.

The variety of material clearly suggested that various tasks were performed at the site. Besides the production of blanks, these blanks were also transformed into tools. These tools were partially used on the site for the processing of the faunal resources but also in the repair of the hunting equipment. Parts of the faunal remains as well as some blanks were presumably taken away from the site. Nevertheless, based on the majority of retouched lithic artefacts serving the processing of faunal material, the character of the site seemed focused on the post-processing of successful hunting episodes. In addition, the blank production were a second focus in this vicinity of a material resource.

### Chronology of the upper horizon

Three samples from the upper horizon in sector 2, section 18 and one sample from sector 1 were $^{14}C$-dated (**tab. 44**). The sample from sector 1 produced two results which were very distinct. One date was the collagen fraction (OxA-3139) and the other were purified amino acids (OxA-3671). Both results were obtained with a pretreatment method including ion-exchanged gelatin which potentially caused some contamination (Higham / Jacobi / Bronk Ramsey 2006, 182). Usually, the purified amino acids represented the more reliable fraction but in this case the further treated fraction could have been subject of more intense contamination. However, the results from sector 2 scattered also over a considerable period. Nevertheless, the youngest date (Gif-9609) was probably due to the low amount of collagen in the sample and the consequently higher potential for contamination (Deloze et al. 1999, 38). Even though this very young date was rejected, a date on reindeer (Gif-9608) and the reliable date on horse (Gif-9607) were separated by 800 radiocarbon years. Were these results two representatives of two different phases? The date yielded by the lower horizon fell between those two dates of the upper horizon and, in fact, was almost identical with the younger date. However, the preservation of the sample material was described as generally poor (Deloze et al. 1999, 38). Therefore, only a small quantity of material was obtained for dating and produced no precise result. Moreover, the relation of the faunal material to the human activities remained often uncertain. Thus, several episodes were possible at the site but these episodes were not necessarily all related to human activity.
In most parts of the site, the dense scatter of archaeological material in the upper horizon was not useful in the reconstruction of an internal chronology. However, the development of structure 1 (Rieu / March / Soler-Mayor 1999) as well as the possible cleaning around hearth structures and the dumping of material in other areas (Julien et al. 1999, 153 f.) suggested that various episodes formed already the spatial patterns around single hearth structures. Nevertheless, the time between the various episodes could not be estimated and the relation of the various concentrations to one another remained also unclear (cf. Fougère 2011). The similarity of some lithic clusters in their composition as well as their spatial relation to a hearth indicated the recurrent performance of similar activities including processing and consumption of faunal material, blank production, and repair of equipment. In combination with the result of the faunal analysis that the large amount of horse remains was accumulated successively, repetitive visits to successful hunting grounds with a lithic resource supply appeared probable. In addition, the faunal analysis suggested that the organic remains were exposed in the open for some time. This exposed material would still be recognisable for preceding groups which, perhaps, also used this material remains of the former visits to the site. In consequence, an intense refitting program would be highly recommendable for this large palimpsest assemblage.

## Bonnières-sur-Seine, Yvelines

### Research history

A first excavation of 15-20 m² at the Abri de la Côte Masset at Bonnières-sur-Seine was conducted by Alphonse Georges Poulain in 1910. He located a hearth approximately 1 m from the back wall of the rockshelter. Around this feature Poulain found animal bones, lithic artefacts, and a sandstone which he interpreted as grinding stone. In 1991 the site was re-investigated by the archaeological service of Yvelines. Seven test

| site | lab. no. | years $^{14}$C-BP | ± years | material | species | comment | years cal. b2k | ref. |
|---|---|---|---|---|---|---|---|---|
| Hallines | Gif-1712 | 16,000 | 300 | vertebra | *Mammuthus primigenius* | PROBLEMATIC: fossil material? | 19,840-18,680 | 1 |
| Le Grand Canton, sector 2, upper horizon | Gif-9608 | 12,880 | 80 | bone | *Rangifer tarandus* | | 15,810-15,290 | 2-4 |
| Le Grand Canton, sector 1 | OxA-3139* | 12,650 | 130 | phalange | *Equus* sp. | same sample as OxA-3671 | 15,660-14,420 | 2-5 |
| Le Grand Canton, sector 2, lower horizon | Gif-9606 | 12,195 | 130 | bone | *Equus* sp. | attributed to the Late Magdalenian | 14,800-13,640 | 2-4 |
| Le Grand Canton, sector 2, upper horizon | Gif-9607 | 12,080 | 115 | bone | *Equus* sp. | | 14,250-13,650 | 2-4 |
| Le Grand Canton, sector 2, upper horizon | *Gif-9609* | *11,420* | *100* | bone | Equus sp. | REJECT: low collagen content | × | 2-4 |
| Le Grand Canton, sector 1 | *OxA-3671** | *11,030* | *105* | phalange | *Equus* sp. | REJECT: protein fraction; same sample as OxA-3139 | × | 2-5 |
| Bonnières-sur-Seine, level 4a | GifA-93014 | 12,770 | 120 | bone | | PROBLEMATIC: association? | 15,790-14,910 | 6 |
| Étigny-Le Brassot, southern *locus* | OxA-10096 (Ly) | 12,630 | 90 | bone | *Rangifer tarandus* | | 15,540-14,540 | 3; 7-8 |
| Étigny-Le Brassot, southern *locus* | Ly-9015 | 11,090 | 95 | bone | | PROBLEMATIC: bulked sample; association? | 13,150-12,710 | 7 |
| Le Tureau des Gardes, *locus* 10 | AA-44216 | 12,520 | 130 | radius | *Equus* sp. | | 15,510-14,070 | 3; 9 |
| Le Tureau des Gardes, *locus* 6 | Ly-6988 | 12,290 | 90 | bone | *Equus* sp. | attributed to the Late Magdalenian | 14,810-13,890 | 3-4; 9 |
| Le Tureau des Gardes, *locus* 10 | AA-44214 | 12,170 | 130 | phalange | *Equus* sp. | | 14,680-13,640 | 3; 9 |
| Le Tureau des Gardes, *locus* 10 | AA-44215 | 12,160 | 120 | humerus | *Equus* sp. | | 14,540-13,660 | 3; 9 |
| Le Tureau des Gardes, *locus* 6 | Ly-6989 | 11,560 | 100 | bone | *Rangifer tarandus* | attributed to the Late Magdalenian; PROBLEMATIC: reindeer in France? | 13,590-13,190 | 3-4 |
| Le Closeau, test pit 17 | *Ly-* | *12,575* | *75* | sediment | | REJECT: sediment; no association | × | 3 |
| Le Closeau, lower horizon, *locus* 33 | GrA-18860 | 12,510 | 80 | diaphyse of longbone | *Equus* sp. | | 15,340-14,260 | 3; 10 |
| Le Closeau, lower horizon, *locus* 33 | GrA-18815 | 12,480 | 70 | phalange | Bovinae | | 15,270-14,190 | 3; 10 |
| Le Closeau, lower horizon, *locus* 46 | AA-41881 | 12,423 | 67 | bone | *Sus scrofa* | | 15,160-14,080 | 3; 10 |

**Tab. 44** $^{14}$C dates from sites in the Paris Basin. If the sub-assemblage is known from which the sample originated, the sub-assemblage is given behind the site name. ***** dates which were pretreated by the use of ion-exchanged gelatin (Lab.code: AI) in the Oxford series (cf. Jacobi/Higham 2009, 1896); ****** dates which might be contaminated due to the use of a method leaving traces of a humectant in the collagen (Lab.code: AF*) in the Oxford series (cf. Higham et al. 2007, S55 & S2). Doubtful dates are shaded grey. Rejected dates are shaded grey and set in italics and, in addition, the main reason for rejection is given in comment. For further details see p. 265-269 and text. The dates were calibrated with the calibration curve of the present study (see p. 358-364) and the calibration program CalPal (Weninger/Jöris/Danzeglocke 2007). The result range of 95 % confidence is given for the calibrated ages (years cal. b2k). – References (ref.): **1** Fagnart 1997; **2** Deloze et al. 1999, 38; **3** Bodu 2004; **4** Lang 1998; **5** Hedges et al. 1993b; **6** Débout et al. 2012; **7** Stevens/Hedges 2004; **8** Lhomme et al. 2004, 732; **9** Bignon 2006; **10** Bodu/Debout/Bignon 2006; **11** Bodu/Valentin 1997, 343; **12** Stevens/Hedges 2004; **13** Gowlett et al. 1986b; **14** Gowlett et al. 1986a; **15** Gilot 1997; **16** Fosse 1997, 242; **17** Bodu et al. 2009b; **18** Leroi-Gourhan/Brézillon 1966; **19** Delibrias et al. 1976; **20** Delibrias/Guillier/Labeyrie 1970; **21** Ponel et al. 2005.

| site | lab. no. | years $^{14}$C-BP | ± years | material | species | comment | years cal. b2k | ref. |
|---|---|---|---|---|---|---|---|---|
| Le Closeau, lower horizon, *locus* 46 | GrA-11665 (Ly-790) | 12,360 | 60 | femur | Cervidae | | 14,820-14,060 | 3; 10 |
| Le Closeau, lower horizon, *locus* 46 | GrA-11664 (Ly-789) | 12,350 | 60 | tibia | *Equus* sp. | | 14,830-14,030 | 3; 10 |
| Le Closeau, lower horizon, *locus* 46 | GrA-18816 | 12,350 | 70 | femur | *Sus scrofa* | | 14,800-14,040 | 3; 10 |
| Le Closeau, lower horizon, *locus* 56 | GrA-18819 | 12,340 | 70 | radius, dext. | Cervidae | | 14,810-14,010 | 3; 10 |
| Le Closeau, lower horizon, *locus* 46 | AA-41882 | 12,248 | 66 | bone | *Panthera leo* | | 14,570-13,890 | 3; 10 |
| Le Closeau, lower horizon, *locus* 4 | OxA-5680* (Ly-166) | 12,090 | 90 | diaphyse | *Equus* sp. | | 14,180-13,700 | 3; 10-12 |
| Le Closeau, lower horizon, *locus* 4 | OxA-6338* (Ly-313) | 12,050 | 100 | diaphyse | | | 14,150-13,670 | 3; 10-11 |
| Le Closeau, light grey silts, test pit 17 | *Ly-793* | *11,750* | *90* | sediment | | REJECT: material; no association | × | 3 |
| Le Closeau, lower horizon, *locus* 4 | *GrA-18762* | *11,640* | *70* | diaphyse of longbone | *Sus scrofa* | REJECT: association unclear | 13,670-13,270 | 3; 10 |
| Le Closeau, intermediate horizon, *locus* 51 | Ly-570 (OxA) | 11,275 | 85 | charcoal | | | 13,290-12,970 | 3 |
| Le Closeau, intermediate horizon, *locus* 18 | Ly-562 (OxA) | 11,265 | 90 | charcoal | | | 13,280-12,960 | 3 |
| Le Closeau, intermediate horizon, *locus* 34 | Ly-566 (OxA) | 11,240 | 90 | charcoal | | | 13,260-12,940 | 3 |
| Le Closeau, intermediate horizon, *locus* 14 | Ly-358 (AA-21677) | 11,240 | 80 | charcoal | | | 13,240-12,960 | 3 |
| Le Closeau, upper horizon, *locus* 32 | Ly-565 (OxA) | 11,205 | 100 | charcoal | | | 13,260-12,860 | 3 |
| Le Closeau, undetermined horizon, *locus* 41 | Ly-567 | 11,170 | 105 | charcoal | | | 13,270-12,750 | 3 |
| Le Closeau, intermediate horizon, *locus* 19 | Ly-561 (OxA) | 11,165 | 90 | charcoal | | | 13,240-12,800 | 3 |
| Le Closeau, undetermined horizon, *locus* 41 | Ly-568 | 11,120 | 100 | charcoal | | | 13,200-12,720 | 3 |
| Le Closeau, undetermined horizon, *locus* 48 | Ly-569 | 11,105 | 95 | charcoal | | | 13,170-12,730 | 3 |
| Le Closeau, top horizon, *locus* 25 | Ly-564 (OxA) | 10,885 | 85 | charcoal | *Pinus sylvestris*? | | 12,990-12,630 | 3 |
| Le Closeau, upper horizon, *locus* 8 | OxA-6337* (Ly-312) | 10,840 | 110 | bone | | | 13,010-12,570 | 3; 11 |
| Le Closeau, top horizon, *locus* 25 | Ly-563 (OxA) | 10,755 | 90 | charcoal | *Pinus sylvestris*? | | 12,800-12,560 | 3 |

**Tab. 44** (continued)

| site | lab. no. | years $^{14}$C-BP | ± years | material | species | comment | years cal. b2k | ref. |
|---|---|---|---|---|---|---|---|---|
| Le Closeau, upper horizon, *locus* 3 | Ly-7189 | 10,670 | 110 | charcoal | | | 12,790-12,390 | 3; 11 |
| Le Closeau, greyish deposits, St. IV | Ly-206 (OxA) | 10,650 | 75 | charcoal | | | 12,760-12,440 | 3; 11 |
| Le Closeau, greyish deposits, St. III | *Ly-7190* | *10,470* | *110* | charcoal | | REJECT: no association | 12,730-12,010 | 3; 11 |
| Le Closeau, undetermined horizon, *locus* 45 | GrA-11662 | 10,410 | 50 | diaphyse | | | 12,520-12,080 | 3 |
| Le Closeau, lower horizon, *locus* 4 | *GrA-18697* | *10,240* | *150* | phalange | *Sus scrofa* | REJECT: association? | × | 3; 10 |
| Le Closeau, lower horizon, *locus* 33 | *GrA-10892 (Ly-814)* | *9,200* | *70* | diaphyse | | REJECT: too young | × | 3; 10 |
| Le Closeau, upper horizon, *locus* 26 | *GrA-10886* | *9,070* | *70* | jugale | *Equus* sp. | REJECT: too young | × | 3 |
| Le Closeau, light grey silts, I.F.P. 1 | *GrA-10895* | *6,850* | *80* | bone | | REJECT: too young | × | 3 |
| Le Closeau, upper horizon, *locus* 54 | *GrA-18699* | *6,470* | *70* | diaphyse | | REJECT: too young | × | 3 |
| Le Closeau, lower horizon, *locus* 46 | *GrA-18763* | *6,420* | *110* | femur | *Sus scrofa* | REJECT: association?; too young | × | 3, 10 |
| Le Closeau, lower horizon, *locus* 4 | *GrA-18701* | *5,380* | *100* | phalange | *Sus scrofa* | REJECT: association?; too young | × | 3; 10 |
| Le Closeau, upper horizon, *locus* 26 | *GrA-10885* | *5,290* | *90* | jugale | *Equus* sp. | REJECT: too young | × | 3 |
| Le Closeau, intermediate horizon, *locus* 34 | *GrA-10887* | *4,960* | *60* | bone | | REJECT: too young | × | 3 |
| Le Closeau, undetermined horizon, *locus* 43 | *GrA-10894* | *4,930* | *60* | tibia | | REJECT: too young | × | 3 |
| Le Closeau, undetermined horizon, *locus* 48 | *GrA-10675* | *4,520* | *80* | scapula | | REJECT: too young | × | 3 |
| Le Closeau, intermediate horizon, *locus* 34 | *GrA-10882* | *3,370* | *70* | bone | | REJECT: too young | × | 3 |
| Marsangy, conc. N19 | OxA-8453 | 12,140 | 75 | tooth | *Equus* sp. | found in M16 | 14,220-13,780 | 3; 12 |
| Marsangy, conc. D14 | OxA-740 | 12,120 | 200 | tooth | *Rangifer tarandus* | found in C14 | 14,920-13,440 | 3; 13 |
| Marsangy, conc. N19 | OxA-178 | 11,600 | 200 | antler | *Rangifer tarandus* | found in P16 | 13,850-13,050 | 3; 14 |
| Marsangy, conc. D14 | *OxA-505* | *9,770* | *180* | bone | *Rangifer tarandus* | found in B12, REJECT: insufficient collagen | × | 3; 13 |
| Marsangy | *Lv-1215* | *5,000* | *350* | antler | *Rangifer tarandus* | REJECT: too young | × | 15 |
| Gouy | GifA-92346 | 12,050 | 130 | bone | | PROBLEMATIC: association? | 14,250-13,610 | 3; 16 |

**Tab. 44** (continued)

| site | lab. no. | years $^{14}$C-BP | ± years | material | species | comment | years cal. b2k | ref. |
|---|---|---|---|---|---|---|---|---|
| Pincevent level IV.20, section 27 | OxA-148 | 12,600 | 200 | bone | *Rangifer tarandus* | | 15,800-14,000 | 3; 17 |
| Pincevent level IV.30 | ETH-37120 | 12,530 | 45 | charcoal | | | 15,260-14,540 | 17 |
| Pincevent level IV.20 | ETH-37119 | 12,450 | 45 | charcoal | | | 15,170-14,170 | 17 |
| Pincevent level IV.21.3, section 25 | OxA-149 | 12,400 | 200 | bone | *Rangifer tarandus* | | 15,480-13,760 | 3; 17 |
| Pincevent level IV, habitation 1 | Gif-358 | 12,300 | 400 | charcoal | | PROBLEMATIC: contamination? | 15,940-13,220 | 3; 17-18 |
| Pincevent level IV.21.3, section 25 | OxA-177 | 12,300 | 220 | bone | *Rangifer tarandus* | | 15,390-13,590 | 3; 17 |
| Pincevent level IV, habitation 1 | Erl-6786 | 12,277 | 96 | bone | *Rangifer tarandus* | | 14,810-13,850 | 3; 17-18 |
| Pincevent level IV.20, section 37 | OxA-467 | 12,250 | 160 | charcoal | | PROBLEMATIC: contamination? | 15,080-13,640 | 3; 17 |
| Pincevent level IV.20, section 27 | Gif-6283 | 12,120 | 130 | charcoal | | PROBLEMATIC: contamination? | 14,430-13,630 | 3; 17 |
| Pincevent level IV.30, section 36 | Gif-6310 | 12,100 | 130 | charcoal | | PROBLEMATIC: contamination? | 14,360-13,640 | 3; 17 |
| Pincevent level IV.40, section 36 | Gif-5971 | 12,100 | 120 | charcoal | | PROBLEMATIC: contamination? | 14,300-13,660 | 3; 17 |
| Pincevent level IV.21.3, section 25 | OxA-176 | 12,000 | 220 | bone | *Rangifer tarandus* | | 14,640-13,320 | 3; 17 |
| Pincevent level III.2, section 27 | OxA-391 | 11,870 | 130 | bone | | | 14,010-13,410 | 3; 11; 13 |
| Pincevent level IV.21.3, section 26 | Gif-6284 | 11,800 | 130 | charcoal | | PROBLEMATIC: contamination? | × | 3 |
| Pincevent level IV, habitation 1 | Lv-292 | 11,610 | 400 | charcoal | | PROBLEMATIC: contamination? | × | 19 |
| Pincevent level IV, habitation 1 | Lv-293 | 11,310 | 330 | charcoal | | PROBLEMATIC: contamination? | × | 19 |
| Pincevent level IV, habitation 1 | Lv-291 | 10,920 | 540 | charcoal | | PROBLEMATIC: contamination? | × | 19 |
| Pincevent level IV, habitation 1 | GrN-4383 | 10,760 | 60 | charcoal | | PROBLEMATIC: contamination? | × | 20 |
| Pincevent level IV, section 9 | Gif-349 | 9,840 | 350 | charcoal | | PROBLEMATIC: contamination? | × | 20 |
| Pincevent level IV.20, section 36 | Gif-3480 | 9,460 | 170 | charcoal | | PROBLEMATIC: contamination? | × | 3 |
| Conty | *Ly-6998* | *12,370* | *70* | silty peat | | same sample as Beta-86310; REJECT: no association; sediment | × | 21 |
| Conty | *OxA-6257* (Ly-286)* | *12,300* | *120* | antler | *Cervus elaphus* | REJECT: palaeontological sample | 14,990-13,830 | 21 |
| Conty | GifA-99527 | 12,220 | 90 | charcoal | | | 14,600-13,800 | 21 |
| Conty, lower horizon | OxA-6151* (Ly-260) | 11,890 | 90 | metacarpal | *Bos primigenius* | | 13,960-13,480 | 1; 21 |
| Conty | *Beta-86310* | *11,890* | *70* | silty peat | | same sample as Ly-6998; REJECT: no association; sediment | × | 21 |

**Tab. 44** (continued)

| site | lab. no. | years $^{14}$C-BP | ± years | material | species | comment | years cal. b2k | ref. |
|---|---|---|---|---|---|---|---|---|
| Conty, grey calcareous organic silts (6b3) | *GifA-99526* | *11,640* | *80* | charcoal | | REJECT: only stratigraphic association | 13,690-13,250 | 21 |
| Conty, lower horizon | OxA-6148* (Ly-257) | 11,620 | 90 | diaphysis | *Bos primigenius* | | 13,670-13,230 | 1; 21 |
| Conty, lower horizon | OxA-6149* (Ly-258) | 11,560 | 90 | diaphysis | *Bos primigenius* | | 13,570-13,210 | 1; 21 |
| Conty, upper grey organic silts (6b1) | *Ly-284 (OxA)* | *11,540* | *80* | *bark* | *Pinus sylvestris* | REJECT: only stratigraphic association | 13,560-13,200 | 21 |
| Conty, lower horizon | OxA-6150* (Ly-259) | 11,410 | 80 | tibia | *Bos primigenius* | | 13,440-13,080 | 1; 21 |
| Conty | *Ly-7407* | *11,130* | *80* | peat | | REJECT: sediment | × | 21 |
| Conty | *Ly-7000* | *11,080* | *80* | peat | | REJECT: sediment | × | 21 |
| Conty | *Ly-7408* | *10,960* | *85* | silt with organic horizon | | REJECT: no association; sediment | × | 21 |
| Conty | *Beta-132166* | *10,790* | *80* | calcareous organic silts | | REJECT: no association; sediment | × | 21 |
| Conty, lower horizon | *OxA-7653* | *9,815* | *60* | bone | *Equus* sp. | REJECT: too young; perhaps, top horizon? | × | 12 |
| Conty | *Ly-7409* | *9,310* | *60* | peat | | REJECT: no association; sediment | × | 21 |
| Hangest-sur-Somme III.1, lower horizon | OxA-4432* (Ly-22) | 11,660 | 110 | molar | *Bos primigenius / Equus* sp.? | | 13,760-13,240 | 1 |
| Hangest-sur-Somme III.1, lower horizon | OxA-4936* (Ly-86) | 11,630 | 90 | molar | *Bos primigenius / Equus* sp.? | | 13,700-13,220 | 1 |
| Hangest-sur-Somme III.1, upper horizon | OxA-4935* (Ly-85) | 10,920 | 90 | vertebra | *Bos primigenius* | | 13,010-12,650 | 1 |

**Tab. 44** (continued)

pits (A-G) and an area (H) alongside the rock wall was excavated under the supervision of Gilles Habasque. In the area H the limits of the excavations of Poulain were partially found. Four further concentrations of archaeological material were recovered in the 5-10 m² large modern excavations.

Topography

The rockshelter La Côte Masset is situated on the southern bank of the Seine, at the foot of Cretaceous rock formations which rise about 100 m above the site (**tab. 34**). The rock is partly made of dolomitic and Senonian flint layers. Around the site the formation is regularly cut by small valleys coming from the south or south-west. The rockshelter is situated at a meander of the Seine. Along the Seine, north of the rockshelter extends a wide basin which is *c.* 5 km long and approximately 1.5 km wide. The basin was formed by the confluence of the Epte into the Seine, some 4 km north of the site. Towards the north-east the Seine flows in an approximately 1 km wide valley for about 9 km until the next turning point occurs. This topographic setting makes the site a good point for observations (Barois-Basquin / Charier / Lécolle 1996, 36) and the rockshelter also opens towards this northern direction. The height of the rockshelter is around 4 m at the archaeological level (Barois-Basquin / Charier / Lécolle 1996, 33). The cavity is 7 m long and 1.6-2.6 m deep.

Stratigraphy

Above the dolomite bedrock a unit of brown clayey loess sands followed within which several pieces of chalk and cryofractured nodules of flint were found. This unit was overlain by brown and yellowish laminated sandy loess silts. They were superimposed by a unit of brown loess silts with compact chalk granules. These last two units were deposited under extreme dry conditions which was possibly associated with the Late Pleniglacial (Barois-Basquin / Charier / Lécolle 1996, 35). A light brown compact layer followed above which was composed of sandy loess clays and many chalk and flint fragments. The archaeological material was found in the lower part of this unit and the upper part of the underlain brown loess silts. Originally the material was probably deposited in the brown loess silt layer (Barois-Basquin / Charier / Lécolle 1996, 39) and then gradually moved upwards in the sediments into the light brown compact layer. Refitting of lithics from the two different layers indicated a single archaeological horizon. The compact unit was overlain by a brown layer of the same material. However, the upper deposit was much less compact and the chalk and flint fragments were smaller. This deposit was sealed by dark brown, loose, clayey loess sands and on top the Holocene topsoil had formed.

In the samples taken for palynological analysis from the site no pollen was preserved (Valentin 1995, 129).

Archaeological material

From both excavations a total of 1,316 lithics was recovered (**tab. 35**; Barois-Basquin / Charier / Lécolle 1996, 38). 86 of these pieces were still archived from the 1910 excavation. A further 318 pieces were found in the dumps of this excavation left at the site. 912 lithics were recorded *in situ* during the modern excavation. The material is partially patinated and many pieces are covered by a chalk crust. However, at least three different types of silex were identified as raw material (Barois-Basquin / Charier / Lécolle 1996, 38): A brown flint with grey inclusions, a fine-grained yellowish flint, and a translucent, light yellow flint or chalcedony. All of these are of local origin, possibly from the river deposits or the nearby, *in situ* flint layers which were presumably easy to access in the Lateglacial (**tab. 36**; Valentin 1995, 404). Only a few blades which were probably knapped elsewhere were made of a Cretaceous flint different from the local one (Valentin 1995, 408). A local origin of most of the raw materials was further emphasised by the presence of almost complete knapping sequences of the raw materials (Valentin 1995, 405). Moreover, the cortex parts and the found remains of the *chaîne opératoire* indicated an on-site testing of the raw material nodules.

The blank production was focused on elongated flakes or blades, even though the seven cores and core fragments were of an irregular shape and more flakes then blades were found (**tab. 37**). However, the blank indices strongly indicate that blades were the preferred blank type (Barois-Basquin / Charier / Lécolle 1996, 39). During the blank production process two types of hammer were in use: The preparation of the cores was performed with a hard stone or soft stone hammer, whereas the blades of the main sequence were struck with an organic hammer.

On the whole site only 13 lithic tools were found, of which ten were recovered during the modern excavations (**tab. 38**; Barois-Basquin / Charier / Lécolle 1996, 39). Among the four LMP were two shouldered points which were made on considerably shorter blades than the other tools. Two equally short backed fragments were retouched on narrower bladelets. In addition, four borers were found which were all attributed to the *bec* or *Zinken* group. Furthermore, there were two end-scrapers on blades and two burins on truncation as well as a composite tool of a dihedral burin and an end-scraper. All retouched artefacts wore also traces of use.

Along with these lithic artefacts, a sandstone which weighed over 1.5 kg was found during the excavation 1910. The sandstone originated probably from some kilometres away. The piece was recovered beside the observed hearth and its surface was polished and wore traces of red colour (**tab. 42**; Barois-Basquin /

Charier/Lécolle 1996, 39). Perhaps, the sandstone was used as a grinding stone, possibly, for minerals or something treated with colouring minerals.
A marcassite fragment which was found in a small concentration of lithics could not be proven to belong to the archaeological material due to lacking modification and the presence of this material in some geological layers of the site (Barois-Basquin/Charier/Lécolle 1996, 38). Nevertheless, a use of this mineral in an archaeological context and, in particular, in relation to a hearth is possible.
From the first excavation several bones were recovered. Subsequently, these remains were determined as coming from at least four horses (*Equus* sp.), a wild boar (*Sus scrofa*), and a *Megaloceros giganteus* (**tab. 39**; Barois-Basquin/Charier/Lécolle 1996, 36). In the modern excavation only some indeterminable bone fragments and a maxillary canine of a cervid were found. The canine might possibly be from a *Cervus elaphus* (Barois-Basquin/Charier/Lécolle 1996, 38). However, due to the presence of *Megaloceros giganteus* in the bone assemblage, the tooth could possibly also belong to the same individual.
Considering the early recovery of the material a $^{14}C$ date on the giant deer remains could be of particular interest to confirm the association with the Lateglacial material. Compared to the thus far confirmed distribution of this species during the Lateglacial, Bonnières-sur-Seine was situated considerably farther to the south where the appearance of giant deer was only dated to the LGM and earlier ages (Stuart et al. 2004). If the giant deer remains dated older but were still associated with a human presence, perhaps, associated with the Gravettian this finding could also be helpful in a discussion on human presence during this period in northern France (e.g. Pigeaud et al. 2010, 104-106). However, the presented archaeological material appeared congruent with only a Lateglacial human presence at the site.

Spatial organisation
Including the poorly documented concentration around a possible hearth from 1910 (**tab. 43**), the small assemblage was found in five different concentrations. Each concentration yielded a complete exploitation cycle of local material nodules including the preparation of cores, the blank production, and the transformation into formally retouched tools (Barois-Basquin/Charier/Lécolle 1996, 40). Thus far, material from the different concentrations could not be refitted which recommend caution about the integrity of the material with a single occupation episode.

Chronology
According to the stratigraphic evidence, the artefacts were deposited at the site shortly before or during the transition from the Late Pleniglacial to the early Lateglacial Interstadial. This chronostratigraphic position was further emphasised by the diverse fauna. A recently dated bone sample from the site produced a late Late Pleniglacial age (**tab. 44**). The piece was attributed to level 4a (Débout et al. 2012, 179 tab. 1) which were the light brown silts generally underlying the archaeological material underneath the rockshelter (Barois-Basquin/Charier/Lécolle 1996, 37). Thus, a bone from this level would predate the archaeological horizon. However, in a part excavated on the terrace in front of the abri (test pit A, area II) some strongly patinated lithic artefacts were found in the upper part of this level 4a. Moreover, refits related the material recovered from both levels and led Blandine Barois-Basquin and her colleagues to consider the level 4a as the actual living horizon (Barois-Basquin/Charier/Lécolle 1996, 39). Nevertheless, the relation of the bone sample to the archaeological material required further specification. Moreover, due to the lack of refits, multiple independent occupations of the site might be possible (Barois-Basquin/Charier/Lécolle 1996, 39). In this case, the exact relation of faunal material and lithic remains could be meaningful.
Nevertheless, the assemblages of each concentration appeared very small. These small numbers might be explicable with the site serving as an extremely short-term observation spot during hunting trips. However,

the various remains of the blank production process and the making of new tools, as well as the remaining of only some, fractured and heavily used tools on the site indicated the importance of the lithic preparation. On the one hand, this diverse remains could be in accordance with the hypothesis of an observation/hunting camp where hunters carried out other tasks while waiting for game to be spotted or while processing the carcasses after a successful hunt. On the other hand, the presence of bones from various animals in one concentration where also a grinding stone with possible traces of ochre were found in the combination with the existence of diverse tool types on the site rather suggested a non-specialised camp where various works were accomplished. Hence, the various concentrations could represent the dumps or remains from different workshops within the same occupation event (cf. Barois-Basquin/Charier/Lécolle 1996, 41).
To further evaluate the two different scenarios a spatial analysis of the site could be helpful, although the lacking spatial information of the main scatter would surely restrain the results (Barois-Basquin/Charier/Lécolle 1996, 40).

## Étigny, Yonne

### Research history

In 1998 archaeological material was excavated near the village Étigny at the site Le Brassot in two areas: a northern and a southern *locus* (Lhomme et al. 2004, 732). Although both *loci* were found in the same horizon, a considerable distance between them (*c.* 50 m) prohibited conclusions on the temporal connection of the two assemblages (Lhomme et al. 2004, 732). On the southern *locus* 201 m² were explored, whereas the northern *locus* was only tested on 4 m². The rest of this area which was estimated to encompass some 500 m² remained *in situ* for future research.

### Topography

The site Le Brassot was situated on the western bank of the Yonne (**tab. 34**). The meandering of the river formed a wide valley at Étigny. On the western side of the modern river the hills rise very gradually. On the eastern bank, approximately a kilometre east of the site, the plateau rises abruptly 40 m upwards. Towards the north the Vanne river, an eastern contributory of the Yonne, further widened the valley at its confluence with the Yonne near Sens. Moreover, to the north the valley widens further to the confluence of the Yonne into the Seine. Towards the south the valley gradually narrows. Thus, Étigny is already set in the transition from the Paris Basin to the surrounding upland areas. In the large meander of Étigny and Gron a former river branch located only 250 m east of the site was considered as possibly active in the time of the occupation. Further palaeochannels of the Yonne were observed several hundred metres westwards of the site (Lhomme et al. 2004, 723 f.).

### Stratigraphy

In Étigny a single artefact layer was found at the base of a grey soil which overlaid yellow silty sands. The soil was capped in its upper part by further yellow silty sands. These overlaying silty sands were in some parts laterally passed by sands which overlaid the deposits of the former river channel. Hence, these sands and the yellow silty sands above the grey soil might be contemporary (Chaussé 2003). However, the deposits of the river channel, peat and organic clay layers, had cut into the silty sand layer below the grey soil and it remained uncertain if the organic layers had completely capped the grey soil in the river bed (cf. Chaussé 2003, 42) or if the organic layers were contemporary to the grey soil (cf. Lhomme et al. 2004, 732). The biostratigraphical attribution based on a malacological and a palynological analyses were undertaken in the organic deposits of the river channel. In the pollen diagram pine pollen (*Pinus* sp.) dominated before birch (*Betula* sp.), juniper (*Juniperus* sp.), and willow pollen (*Salix* sp.; Chaussé 2003, 37). This result suggested an attribution to the forested period of the mid- to late Allerød which was further confirmed by the malacological analysis (Chaussé 2003, 37; Lhomme et al. 2004, 732). Hence, if the organic deposits and the archaeological horizon were contemporary, these results would clearly attribute the material of Étingy-Le Brassot to the younger part of the Lateglacial Interstadial. However, if the soil was capped, the down cutting of the river channel postdated the deposition of the archaeological material and this river branch did not exist contemporary with the Palaeolithic occupation and the biostratigaphical results would provide a *terminus ante quem*. Perhaps, in this scenario one or more of the palaeochannels westwards of the site were active at the time of occupation and, hence, could possibly produce biostratigraphic information on the occupation time.

Archaeological material of the northern *locus*

The northern *locus* yielded a very small assemblage of less than 200 pieces which were mainly determined as core preparation debris. Thus, the inventory was too small for a typological attribution but could well represent a supplementary knapping place to the southern *locus*. Yet, in this *locus*, the cortex of four flakes of which three were refitted was incised with many short, slightly curved lines before the stone knapping (**tab. 42**; Lhomme et al. 2004, 732).

No organic remains were recovered from the test pits in this area.

Archaeological material of the southern *locus*

On the southern *locus* 8,252 lithics of which more than half were smaller than 3 cm were excavated (**tab. 35**). These were generally made of local Senonian flint (**tab. 36**). The technology showed all characteristics of the so-called faciès Cepoy/Marsangy with differentiated use of percussion instruments and a blank production directed towards two sorts of blades (cf. Valentin 2008a, 123-125): long blades with curved profiles which were used for the production of the majority of tools and short blades with straight profiles served as blanks for the points (Lhomme et al. 2004, 733). Among the cores (**tab. 37**), the single platform specimens or these with a preferred platform were more frequent than the examples with two platforms and bidirectional exploitation (Lhomme et al. 2004, 733).

The approximately 23 LMP (**tab. 38**) which were found in the southern *locus* were mainly classified as various types of curve- and angle-backed points. The backed points were usually shaped from short blades. Typically for the so-called faciès Cepoy/Marsangy no specimen was identified as backed bladelet. In addition to these LMP, end-scrapers formed the most numerous tool class (n = 25) and were frequently made on long blades. Only 15 burins were found which were generally made on natural edges or as dihedral types (Lhomme et al. 2004, 733 f.). Some borers of which at least one belonged to the piercer group were also present at the *locus*.

Of the 102 recovered faunal elements only seven pieces were determined taxonomically (**tab. 39**). Along with several bones and teeth of reindeer (*Rangifer tarandus*), some elements of red deer (*Cervus elaphus*) were also identified (Lhomme et al. 2004, 733).

Spatial organisation

According to the spatial and vertical distribution, the material in both concentrations appeared relatively unaltered since its deposition and, hence, provided a high quality record.

Only one small accumulation of material was excavated in the northern *locus*. This area contained mainly debris of the preparation of cores including cortical material and preparation flakes. Hence, in this area a first step in the exploitation of the lithic raw material was performed and it could represent a knapping workshop.

On the southern *locus* the material was spatially distributed in two zones (Lhomme et al. 2004, 733). Due to the material found in each zone, the excavators suspected a functional differentiation. The northern zone contained mainly lithic debris and one third of the lithic tools indicating a workshop for the production and modification of blanks. In the southern zone, the majority of the preserved fauna and the tools were found. In the southern zone, heated stones indicated the presence of a hearth (**tab. 43**) and suggested a rather domestic function of this zone (Lhomme et al. 2004, 733). Between the two zones, no apparent limit was observed.

Chronology

The meander of Étigny yielded a complex chronostratigraphy with several palaeochannels and further archaeological sites such as Gron-Chemin de l'Évangile or Étigny-PLM revealing this part of the valley as interesting halt for different hunter-gatherer groups at various times.

Material from the southern *locus* of Étigny-Le Brassot produced two inconsistent $^{14}C$ dates (**tab. 44**). These dates have to be further evaluated in their biostratigraphic context (see p. 265-269).

The chronological relation of the two *loci* of Étigny-Le Brassot was not further specified except for a quasi-contemporaneity based on the stratigraphic position. In particular, for the northern *locus* a more precise chronostratigraphic position was not possible due to the lack of organic material. Moreover, refitting was not possible between the two *loci* but if they belonged to the same *chaîne opératoire* the first steps were performed presumably in the northern *locus* and further steps were accomplished in the southern *locus*. In total, the southern *locus* was considered as formed by peripheral activities suggesting the main settlement area in the not excavated west of the *locus*. Thus, at least several occupation episodes formed the assemblage but, perhaps, the site was even formed by some occupation events. Probably, further details of the spatial organisation and the sequence of the various processes on the site could be revealed by a publication of the results of two M.A. theses on the site (Soula 2000; Dumarçay 2001).

## Le Tureau des Gardes, Marolles-sur-Seine, Seine-et-Marne

Research history

Quarry works at the site Le Tureau des Gardes in the Seine valley near Marolles-sur-Seine revealed Late Pleistocene material which was excavated between 1991 and 1998 under the supervision of Patrick Gouge and later Laurent Lang (Lang 1998, 82). Ten distinct *loci* (1-10) were observed in an excavation area of less than 500 m² (Lang 1998, 83). Of particular interest became *locus* 7 where a significant number of backed points were found. *Locus* 7 was found in 1996 during a test pit program conducted by Patrick Gouge and in 1997, an excavation of 140 m² by Laurent Lang and his team followed (Weber 2006, 163) which formed the largest of the ten areas (Lang 1998, 83). The second largest area was *locus* 10 with 95 m² (cf. Bignon 2006) followed by the *locus* 5 with 62 m² and *locus* 8 with 60 m². The *loci* 6 and 9 were only partially excavated on 5 and 14 m²; the rest of these concentrations remained *in situ* for future research.

Topography

The topography of the site Le Tureau des Gardes is similar to the site Le Grand Canton. Le Tureau des Gardes was also located about 1 km west of the town Marolles-sur-Seine in the wide basin formed by the Seine and the Yonne in the vicinity of their confluence (**tab. 34**; Alix et al. 1993). The confluence is situated about 3-4 km west of the site which was situated on the southern bank of the Seine and the northern bank of the Yonne. Several hundreds metres north of the site, on the northern bank of the Seine hills rise some 50 m upwards. This plateau is frequently cut by small valleys, often running parallel to the Seine. Towards the east the plateau gradually rises between the valleys of the Seine and the Yonne. About 4.5 km south, on the southern bank of the Yonne the terrain rises approximately 60 m upwards. Hence, the site was situated in a wide alluvial plain. The site Le Tureau des Gardes was set on the transition of the lower gravel terrace where a step of some 6-8 m was observable in the terrain. However, in the alluvial plain several palaeochannels of both rivers were observed (Alix et al. 1993, 197) and, in particular, along the Seine this plain was morphologically varied by sand banks rising up to 5 m above the river (Lang 1998, 10). The archaeological material was preserved in general only in hollow areas of the past surface (Lang 1998, 84). Also, in the first sector of Le Tureau des Gardes (later combined with sector II and re-named *locus* 7; Weber 2006, 163) a circular depression of some 60 cm depth and 15 m in diameter was observed (Lang 1998, 18).

Stratigraphy

The archaeological material was found in silty sands which overlaid sands and silts (Alix et al. 1993, 209). The latter deposit suffered from cryogenic movements. Thus, the site was settled after a period of severe cold such as the Late Pleniglacial. On top of the silty sands calcite sand layers followed. The samples which were taken for pollen analysis from these layers were too disturbed to produce a reliable result (Alix et al. 1993, 214). The malacological samples from a profile several 100 m north-west of *locus* 7 yielded a small, though statistically significant assemblage for the archaeological layer (Lang 1998, 85) which was composed of cold steppe as well as semi-forested species (Alix et al. 1993, 214). The latter indicated a temperate period where steppe elements were still present (Lang 1998, 85). The steppe component was further sustained by the presence of horse among the mammalian fauna. This transitional environment was probably congruent with the late Late Pleniglacial and the early Lateglacial Interstadial.

Archaeological material in general

In total, Le Tureau des Gardes yielded more than 60,000 lithic artefacts without splinters smaller than 2 cm (**tab. 35**; Lang 1998, 23. 90).

The main lithic raw material was a Cretaceous flint which originated from alluvial gravels (**tab. 36**). Only a minor portion (less than 1 %) was made of Tertiary (Bartonian) chalcedony. The origin of this material remained uncertain, although an available resource in the surrounding was considered due to the frequency of the material in the region (Lang 1998, 91). Nevertheless, the raw material reached the site only in the shape of blanks and retouched tools with the exception of *locus* 7 where a core of this material was exploited. Due to this selected import a transport over a wider distance was also considered possible for this Tertiary material.

942 cores were found on the site (**tab. 37**). Among the cores, the ones used for bladelet production were most common but typical blade cores were also found (Lang 1998, 25 f. 91 f.). The relation of these types was comparable to the presence of backed bladelets in the different concentrations. However, the original raw material nodules were not very large and, thus, the production of blades longer than 10 cm was rarely possible (Lang 1998, 91). The cores were prepared with one as well as two platforms, although the second platform was frequently used only to maintain the knapping surface for the first platform (Lang 1998, 91). Blanks with a butt indicating the *en éperon* preparation were rarely present.

The 3,442 retouched artefacts (**tab. 38**) were clearly dominated by the LMP (n = 1,057). Among the LMP were 558 backed bladelets and backed bladelet fragments and a further 499 LMP were identified as points and point fragments. The majority of the latter was found in *locus* 7 (n = 299). Besides this *locus*, only the *locus* 8 yielded more points (n = 67) than backed bladelets (n = 19). In contrast, in *locus* 6 not a single point was found among the 122 LMP (Lang 1998, 94). The burins were the second largest group (n = 596) and among them the dihedral types was most frequent (Lang 1998, 92). In addition, many of the composite tools (n = 104) were combinations with burins (cf. Weber 2006, 169). The 509 end-scrapers were almost exclusively made on long blades. The 442 borers were also frequently made on longer blades (Weber 2006, 169) and included *bec* and *Zinken* as well as perforators. The truncations (n = 184) were generally oblique ones.

Furthermore, more than 235 kg of sandstone and granite were recovered at the site (Alix et al. 1993).

Even though the preservation of faunal material (**tab. 39**) was poor due to the high acidity in the soil, the documented faunal material comprised 5,567 determinable elements in 1998 (Lang 1998, 86) and additional 2,866 fragments were identified in the material from *locus* 10 by Olivier Bignon in 2003 (Bignon 2006, 185 Tabl. II). Among the faunal remains determined in 1998, horse (*Equus* sp.; n = 4,197) clearly dominated with a minimum of 76 individual animals followed by reindeer (*Rangifer tarandus*; n = 1,323) with a minimum of 29 animals (Lang 1998, 87). The final analysis of the material from *locus* 10 further emphasised these numbers and added at least 69 horses and eleven reindeer to the previous numbers (Bignon 2006). Further species were only identified by rare numbers of animals such as three lagomorphs (Lagomorpha; n = 7) and two bovids (*Bos* sp. / *Bison* sp.; n = 8) or even by singular remains such as wolf (*Canis lupus*; n = 1), mammoth (*Mammuthus primigenius*; n = 1), a spermophil (Spermophilus; n = 4; Lang 1998; 86-88), or birds (Aves; n = 16; Bignon 2006).

The various distribution of reindeer and horse was possibly due to taphonomy which affected the skeletal elements of reindeer stronger than the more resistant horse bones. However short- and intermediate-term chronological reasons such as the seasonal setting of the hunting episode or the general presence of larger herds of reindeer in the vicinity were also considered as reasons for this difference (Bridault 1996). The seasonal indications based on horse remains from *locus* 10 were more numerous for the warm season from spring to autumn but some indications for winter were also found (**tab. 40**; Bignon 2006, 193). These seasonal indicators allowed two hypotheses: Either *locus* 10 represented an occupation event encompassing a complete year or this *locus* was formed by various occupation events at various points in a complete yearly cycle (Bignon 2006, 193). Moreover, the age structure could be described as catastrophic, although the old and very old specimens were slightly over-represented for this model (Bignon 2006, 193).

One phalange from the site was possibly a human one (Bignon 2006, 193).

Spatial organisation in general

Thus far, only the evident structure from *locus* 7 was described in more detail (**tab. 43**). However, at least further three concentrations of burnt stone material were found at the site some might represent clearings of hearths (Alix et al. 1993).

Due to the fragmented preservation of the material in depressions in combination with partial rescue excavations for instance in *locus* 6, the connection between the ten sectors was generally difficult to establish (Lang 1998, 83 f.). For instance the successively excavated *loci* 6 and 7 were situated at a distance of 500 m to each other. Presumably, these scatters were as distant to one another as was the river for these places. Moreover, erosion within these depressions could not be excluded as important agent of the spatial distribution. However, a more comprehensive analysis of the refitted material and the spatial distribution of the various materials was not yet published (Lang 1998, 104).

Chronology in general

According to the two $^{14}$C results from *locus* 6 (**tab. 44**), Laurent Lang considered a taphonomic pollution of the samples as possible (Lang 1998, 99). However, the additionally made AMS dates from *locus* 10 further contributed to a heterogeneous impression of the results. In particular, since the assemblages with high numbers of backed points were supposed to be younger than the typical Late Magdalenian assemblages such as the inventory from *locus* 6 (Lang 1998, 100).

Nevertheless, based on the composition of the assemblages in these scattered patches and the indications of the seasonality, the site was probably visited repetitively for short episodes from one or perhaps some groups of horse and reindeer hunters (Lang 1998, 99-102) and, thus, the complete material represented a palimpsest of small installations and was accumulated over some decades or centuries alongside the river.

Archaeological material of *locus* 7

Over half of the 15,984 lithics found in *locus* 7 were splinters (n = 8,433; **tab. 35**; Weber 2006, 165).

The lithic raw material was dominantly local Cretaceous gravel flint. Only some pieces were made of a Tertiary chalcedony including the only core made of this material found at the site. Presumably, the resource was at a more regional distance.

In contrast to other concentrations of the site, the bladelet production was of minor importance in this area and, clearly, the blank production process was focused on blades (Weber 2006, 169-171). Only five of the 84 cores and core fragments were related to the production of bladelet sequences (Weber 2006, 170). In general, the cores showed traces of two types of percussion instruments: organic hammers as well as of soft hammerstones (Weber 2006, 173). The blades which served as blanks for points reached considerable widths and were often received from the cores by direct knapping with a soft hammerstone (Weber 2006, 172 f.). A few cores exploited with a soft hammerstone showed traces of an unskilled use of the hammerstone (Weber 2006, 173).

The 784 retouched artefacts from *locus* 7 were clearly dominated by the 313 LMP (**tab. 38**) among which 299 points and point fragments were found. These points were mainly determined as shouldered points and angle-backed points (Lang 1998, 28-36). In contrast, only 14 backed blades were found. The 121 end-scrapers were almost exclusively made on long blades which were often finely splintered along the lateral edges (Weber 2006, 167). The 86 burins were dominantly dihedral ones which were made on shorter blades. The 16 composite tools were mainly combinations with burins. Among the 80 borers, only 21 perforator examples with finely retouched tips were identified (Weber 2006, 169), the others were classified as *becs* or *Zinken*. The truncations (n = 47) were generally oblique.

Stone material, in particular, sandstone was also recorded with the emphasis on thermally altered material. Some 708 fragments weighing more than 82 kg were documented.

Several faunal elements (n = 225) of which 84 were taxonomically determined were found in this area. These remains were representing at least seven horses (*Equus* sp.) and a single bone was identified as originating from a bovid, perhaps, *Bos* sp. or *Bison* sp. (**tab. 39**; Lang 1998, 87). Of particular interest in comparison with the total inventory, reindeer was completely lacking in this area.

Spatial organisation of *locus* 7

During the excavation a hearth was already recognised by a cluster of heat altered stone fragments, mainly sandstone (**tab. 43**; Weber 2006, 163). However, a depression in the excavated area led to some uncertainties in the interpretation of this distribution of the material and the burnt stones were suggested as a possible accumulation due to erosion (Lang 1998, 20). Nevertheless, the accumulation was found in the centre of the lithic concentration and this correlation led the excavator to rather assume these remains as *in situ* (Lang 1998, 20). In contrast, the bones were recovered outside the margins of the lithic accumulation and, thus, led to a discussion on the association of the bones with the lithic material (Lang 1998, 20; Weber 2006, 163 f.). However, the position of faunal remains at the outer margins or even outside the lithic concentration was also reported from other Lateglacial concentrations around a centralised hearth (Jöris/Terberger 2001; Gelhausen/Kegler/Wenzel 2005). Thus, a spatial distinction of the density of lithic and organic material reflected a possible functional differentiation of various areas within the organisation of the concentration and further supported the assumption of an (almost) *in situ* situation of this concentration.

However, the distribution of lithic artefacts was relatively dense over an area of 10 m × 10 m with various smaller accumulation within. A more detailed spatial analysis of the distribution of various types of artefacts and refitting of the material would be particularly helpful to further evaluate whether different activity areas or several uniform concentrations were reflected by these accumulations. The latter would indicate that probably several independent events formed this *locus*.

Chronology of *locus* 7

Radiometric measurements were not performed for this area. Thus, the chronostratigraphic setting relied on the general lithostratigraphy and techno-typological considerations. However, as Laurent Lang already demonstrated, the techno-typological differences could also result from a functional or economic difference of the various Magdalenian assemblages (Lang 1998, 98-102; Weber 2006, 174 f.). Moreover, according to the spatial distribution (Weber 2006, 163 Abb. 3), the possibility that the assemblage resulted from multiple episodes, perhaps, different occupation events could not be excluded (Weber 2006, 175).

## Le Closeau, lower horizon, Rueil-Malmaison, Hauts-de-Seine

### Research history

On the western periphery of Paris, at the site Le Closeau in the municipal of Reuil-Malmaison, Hauts-de-Seine, a total of 44,041 m² (25,568 m² yielded Palaeolithic material) was excavated between late 1994 and mid-1998 prior to construction of the motorway A86 (Bodu 1998, 20. 24). Further material was yielded by the on-going excavations until early 2000 (Bodu/Debout/Bignon 2006). The excavation area was divided in various larger sectors, areas, and trenches. Moreover, at least four Lateglacial archaeological horizons (inférieur, intermédiare, supérieur, extra-supérieur) were observed. Each horizon yielded several concentrations and, thus, 72 Lateglacial units (*locus*) were distinguished. The continued excavation until early 2000 produced at least a further four Lateglacial units (Bignon/Bodu 2006; Bodu/Debout/Bignon 2006). One area of *c.* 170 m × 185 m was located north-west of the Route Nationale (RN) 13 and included the sector 6, sector 27, trenches 1 & 4, area I. F. P. (Bodu/Debout/Bignon 2006; furtheron »North RN13«). In this area the *loci* 1-59 were found. Farther north-westwards only the sector 5 yielded single lithic finds from the late Allerød (Bodu 1998, 27). However, another area of 7,000 m² was situated south of the RN 13 (furtheron: South RN13). This area provided mainly material from the end of the Lateglacial and encompassed a further 19 units (*loci* A-S). Nevertheless, the *loci* were not equivalent with concentrations of archaeological material. Often a single concentration spread over two *loci* or a single *locus* comprised several accumulations. Furthermore, some accumulations seemed to blur into one another especially on the South RN13 area and, therefore, the distinction of single concentrations became difficult.

Le Closeau is, thus far, the largest excavated site with archaeological remains from the Lateglacial in north-western Europe. Besides Final Palaeolithic remains, Mesolithic, Neolithic, and other prehistoric as well as historic material was uncovered. Furthermore, various palaeoenvironmental analyses were conducted parallel to the archaeological investigations. The main responsible for the excavation and analysis of the Palaeolithic material was Pierre Bodu (Bodu 1998).

Topography

The areas with Lateglacial remains were situated some 300 m south-east of the modern Seine at altitudes between 21 and 24 m a.s.l. on the North RN13 area and 25 to almost 28 m a.s.l. in the South RN13 area (**tab. 34**; Bodu 1998, 36). The river meanders strongly in the region around Rueil-Malmaison and, thus, the site lies near a south-eastern vertex of meanders and within a wide river loop which at the height of the site is about 5-6 km wide (NW-SE) and 14-15 km long (SW-NE). North-westwards and south-eastwards further wide loops of the river formed a relatively levelled basin of over 10 km in N-S direction and 30 km in W-E direction with occasional elevations such as the Montmatre in Paris. The site Le Closeau is situated in the south-western corner of this basin in the flood plain of the Palaeo-Seine. During the Pleistocene the Seine flowed probably in a widely braided system. One branch passed possibly at the foot of the adjacent mountain range and formed the *c.* 500 m wide modern southern embankment (Bodu 1998, 23. 36). In general, the Pleistocene terrace gradually slopes towards the modern Seine. South and south-west of the excavated area the terrain quickly rises about 100 m to a hill range which follows the river on its southern and western bank. The range is intersected by a small, gradually ascending valley *c.* 250 m south-east of the excavation area and again some 1.3 km westwards of the site by the wider valley of Bougival. Due to the geological formation, rich lithic raw materials weathered out of these ridges (Bodu 1998, 43-48). During the Lateglacial another, approximately 25 m wide branch of the Seine or an oxbow lake was situated immediately north-west of the main excavation area (Bodu 1998, 36). The presence of this open water might be the reason for the rare finds from sector 5 (Bodu 1998, 27) which was situated inside this former water course. Another depression running through the North RN13 area represented perhaps another shallow branch which was possibly still active in the first phase of the settlement. However, this channel became landed successively during the time of the Lateglacial occupation but could be re-activated occasionally until the Younger Dryas (Folz et al. 2001, 927). By cutting into the gravel terrace, a gravel ridge accumulated in the north of the North RN13 area (Bodu/Debout/Bignon 2006, 714 fig. 3) and protected partially the area in the depression against higher water tides. The terrain in the area South RN13 was already situated 1-4 m higher than the highest level of the northern area including the gravel ridge in the north. The South RN 13 area was also intersected longitudinally by an artificial water course and, furthermore, disturbed by house constructions mainly on the northern part of this area.

The topographic developments on the site during the Lateglacial also led to partially different distribution of the archaeological remains in the different horizons.

The eight units associated with the lower horizon (*couche inférieur*) were situated at the northern limits of the North RN13 area. These units were the *locus* 4, the lower horizon of the *locus* 33, the *locus* 46 (Bodu 1998, 322-421) and, possibly, some artefacts in *locus* 50 which probably belong to the material from *locus* 4 (Bodu 1998, 170). In addition, the material from the later uncovered *loci* 56-59 (Bodu/Debout/Bignon 2006) were also attributed to the lower horizon. The material was grouped along the gravel ridge north-west of the shallow palaeochannel and clearly spared out this depression which was considered as an indication that this area was perhaps still water bearing by the time of the occupation of the lower horizon. Thus, these concentrations were probably placed on an island- or peninsula-like setting during the occupation period. Only the concentration of *locus* 4 was set at the bank of this possible palaeochannel which, perhaps, also caused the stronger patination of the material from this area (Bodu/Mevel 2008, 514).

The 13 *loci* attributed to the intermediate horizon (*couche intermediaire*) were found in the extreme south of the North RN13 area (Bodu 1998, 240 fig. 205). The stratigraphic development was comparably poor in this part of the North RN13 area. For instance, the Lateglacial horizon was generally overlain immediately by a layer containing Neolithic material. The distinction of the intermediate material from the upper horizon was therefore based on techno-typological considerations and assumed to be confirmed by $^{14}C$ dates (**tab. 44**; Bodu 1998, 240). However, by a critical evaluation of the dates and the consideration about the standard deviation, this confirmation cannot be given unambiguously (see p. 265-269).

From 26 *loci* material was attributed to the upper horizon (*couche supérieur*). These *loci* were generally located in the south-eastern part of the North RN13 area, immediately alongside the edges of the palaeo-channel. Some material occurred even inside the depression at the southern end of the excavated area. Thus, the channel was presumably silted up at the time of these occupation episodes.

The very ephemeral material from *locus* 25 was attributed to the top horizon (*couche extra-supérieur*). The material originated from the uppermost part of the same stratigraphic position as the upper layer of Le Closeau (Bodu 2000a, 17). This *locus* was excavated on a surface of 25 m² in the central southern part of the North RN13 area during the summer 1996 (Bodu 1998, 236). Furthermore, most of the material from the South RN13 area was attributed to this uppermost horizon.

Stratigraphy

Almost 85 profiles were recorded on the two areas with Lateglacial remains (Bodu 1998, figs 35-36). In general, the site was set on the eastern bank of the Seine where a Weichselian gravel terrace reached a thickness of *c.* 10 m above the bedrock.

In the South RN 13 area, the gravels were interspersed by sandstone scree from the adjacent hills and were overlain by a deposit of brownish yellow silty gravels in the northern part (Gebhardt 1998, 68). These silty gravels were attributed to the Holocene but occasionally in the lower part some orange-brown sandy silts were preserved and regularly associated with some Palaeolithic material (Bodu 1998, figs 479-481). On top of the silty gravels followed a thin layer of Holocene brown silts which were overlain by brownish black modern rubble. Thus, in the South RN 13 area the stratigraphy was reduced significantly which was mainly due to erosive processes. Therefore, the distinction of the various archaeological horizons became difficult and, furthermore, in this part of the site only lithic material was preserved from the Lateglacial (Bodu 1998, 433).

In the part North RN 13 the stratigraphy was more complex, probably, due to representing the development of a braided flood plain. In this area yellowish fluvial sands followed generally on top of the Weichselian gravels. The lower parts of these sands were oxidised and of yellowish orange colour and contained only few gravels (Gebhardt 1998, 64). Light yellowish brown sands which were widely whitened and of a glossy structure followed on top. These two sand deposits were laminated. Furthermore, in the light yellowish brown sands the archaeological material of the lower horizon was found. In the area north-west of the gravel ridge, micro-morphological studies indicated pedogenic processes associated with the lower archaeological horizon (Chaussé 2005). However, the soil development in this layer was weak and Christine Chaussé concluded that the pedogenic process represented perhaps a first weak stabilisation of the grounds in the early Lateglacial Interstadial (Chaussé 2005, 93). The sands containing the lower horizon were overlain by a light yellowish orange sandy loam. In depressions on the site, this loam was covered by a gleyed sandy loam of yellowish brown colour on top of which clays followed. The two sandy loams were affected by processes of the pedogenesis resulting partially in a greyish colouring of the sediments. The archaeological material of the intermediate and upper horizon as well as the material of the top horizon (*locus* 25) originated generally from the upper part of these greyish deposits. Samples from the upper sandy loams failed to produce microscopic indications for particles of the LST (Pastre 1998). These upper loams were overlain by silts which were of light grey to yellow-orange colour but occasionally lenses of gravels in a sandy-silty matrix were interspersed. The silt deposit was partially sealed by bands of small calcareous gravels. The upper band formed already part of another yellowish brown silt deposit containing Neolithic artefacts and occasionally small gravels (Gebhardt 1998, 63). Sometimes, this deposit was slightly gleyed in the lower part. On top of the silt

deposit a dark organic silty soil formed. Further towards the Seine the latter two deposits were intersected by an up to 1 m thick deposit of whitish high flood silts. The sequence ended with the modern anthropogenic fillings of the flood plain formed by stone rubble in a context of brownish black organic silty soil.
The preservation of pollen in the sediments from the areas North and South RN13 were poor, prohibiting reliable classification (Leroyer / Allenet 1998, 100). However, in the area northwards of the gravel ridge (sector 3 which yielded mainly Mesolithic and Neolithic remains) deposits of a presumable Lateglacial age were reached and correlated to the layers on the area North RN13 (Leroyer / Allenet 1998, 106). According to this correlation, a four-phased Allerød section and a Younger Dryas section with three phases were identified palynologically in the greyish humic and the overlying clayish deposits. Both sections were dominated by pine (*Pinus* sp.) but in the younger section herbaceous pollen and birch (*Betula* sp.) became more numerous indicating an opening of the landscape. Furthermore, the lowest phase of the Allerød pollen deposit was characterised by a generally low number of arboreal pollen among which nevertheless pine dominated and a high number of pre-Quaternary pollen. These numbers indicated a poor and / or selective pollen preservation. Moreover, the assumed Younger Dryas section was found in sediments which were correlated to the upper Lateglacial Interstadial deposits on the North RN13 area (Leroyer / Allenet 1998, 106 f.). The malacological analysis from this area suggested that the onset of the Younger Dryas might be found in the white silts on top of the correlated deposits (Limondin 1998, 114). Nevertheless, the preserved pollen in the stadial section and the lower Allerød phase (Clo a1) were only found in one test pit (no. 17). In regard to the complex stratigraphic development in the flood plain, a stratigraphic mis-correlation and / or erosion were further possible explanations as well as a disturbed palynological record due to a particular local vegetation development. Certainly, the pollen profiles indicated a generally light forested phase dominated by pine overlain by an even more open landscape with still existing light forests. Nevertheless, the exact correlation with the archaeological horizons remained unclear and, thus, the palynological analysis could not further refine the chronostratigraphic position. However, samples analysed from the various charcoal concentrations in the archaeological horizons were determined exclusively as Scots pine (*Pinus sylvestris*; Pernaud 1998). Since several of these charcoal concentrations were assumed to originate from natural fires, the combination of the correlated pollen profile and the anthracological analysis suggested an environment dominated by a stand of Scots pines in the river plain during the time from the end of the Lateglacial Interstadial to the onset of the Holocene. Additionally, the number of aquatic plant pollen typical for river plains decreased successively throughout the phases indicating an increasingly dry environment of this part of the plain during the Younger Dryas and suggesting a down cutting of the river into the modern bed (Leroyer / Allenet 1998, 108 f.). In contrast, the malacological samples from the north-western part of North RN13 indicated increasing humidity from the early Lateglacial Interstadial to the Lateglacial Stadial (Limondin 1998, 115 f.). Moreover, the samples taken from the palaeochannel deposits in the northern North RN13 area showed an increasing amount of aquatic molluscs species from base to top of the greyish deposits (Limondin 1998, 119). However, the preservation of shells in the sandy environment is usually poor (Limondin 1998, 118). Nevertheless, in comparison with malacological samples taken at other areas of Le Closeau the presence of freshwater species clearly increased in the palaeochannel part of North RN13 in the greyish deposits. However, of particular interest was the determination of the species *Avenionia brevis* which preferred underground water environments suggesting an at least regular upwelling of the ground water table in this area and, consequently, might explain the general absence of archaeological material in this possibly swampy channel band during the Lateglacial. Furthermore, a silting up of palaeochannels could explain the discrepancy between the decrease of water plants and the increase of molluscs inhabiting wet environments. However, these detailed analyses clearly indicated the specific local development of the Seine flood plain at Le Closeau and, therefore, restricted comparison with more regional or global developments.

With the lower archaeological horizon neither pollen nor charcoal could be associated, but molluscs and small mammal remains made possible some comments on the environment. However, the malacological zone summarised the whole Lateglacial Interstadial in one lower and the Lateglacial Stadial in another zone. The former was characterised by a dry and cool environment. Such a climate was assumed possible for GI-1d and, thus, in accordance with the calibrated $^{14}C$ dates from *locus* 4 (**tab. 44**) which was located adjacent to the profile. However, some of the cold adapted species found in this profile rather indicated special temperature ranges and were considered as pioneer species (Limondin 1998, 115). These species emphasised the presence of the on-going re-settlement process in the Lateglacial Paris Basin. Small mammal remains were only preserved in the lower layer at *locus* 4 but provided an environmentally indifferent picture for a flood plain with only remains of water vole (*Arvicola terrestris*) and common vole (*Microtus* cf. *arvalis*) as well as of an amphibian being determined (Mistrot 1998, 344).

Archaeological material in general

In total, some 48,000 Lateglacial lithic artefacts were found (**tab. 35**).

Among the lithic raw materials the Campanian flint which occurred at the site and in the immediate surrounding in secondary deposits (**tab. 36**) was clearly preferred in all horizons. Furthermore, a high-quality Tertiary chalcedony which might be of foreign origin (Bodu/Cary 1998, 335) but might as well be gathered at the foot of the hills west of Rueil-Malmaison (Bodu 1998, 44) was identified sporadically in the inventories. However, in the intermediate horizon this material was slightly more frequent, whereas it was absent from *locus* 25. Nevertheless, the retouched pieces of the latter *locus* were made of a higher quality material which perhaps originated from elsewhere (Bodu 1998, 237).

The blank production of the lower horizon was still very similar to the Late Magdalenian. In contrast, the concept of core reduction was more flexible in the upper horizons and appeared often unsystematic. Moreover, an increasing number of blanks yielded indications for the use of hard hammerstones in the main blank production process. However, the debris material from the top horizon was too small to produce significant indications.

Among the retouched lithic artefacts, the LMP dominated in all horizons accompanied by the end-scrapers (**tab. 38**).

In the greyish deposits some fragments of sandstone and, rarely, of quartzite were presumably used as hammerstones as well as a flint nodule with thick cortex.

In addition, inside a perhaps anthropogenic combustion structure in *locus* 38 a limestone was deposited which wore parallel ripple lines and traces of heating. Linear engravings in the cortex were also observed on five pieces from *locus* 20. In *locus* 28, a small bead was recovered but the association with the Lateglacial archaeology remained unclear. A pointed lump of ochre was found at the periphery of *locus* 14.

Furthermore, 5,000 fragments of faunal remains were attributed to the Lateglacial at the site. The majority of determinable remains were found in the lower horizon; in the upper horizon the preservation was limited, and in the intermediate horizon little faunal material was preserved. In the *locus* 25, no faunal material was found. However, in the upper horizon red deer (*Cervus elaphus*) superseded horse (*Equus* sp.) as dominant species. Nevertheless, both species were found in the two horizons. These species were the only commonalities. For the other species from the greyish deposits the determination was uncertain and/or the relation to the archaeological remains was unclear. Only for the lower horizon seasonal indicators were found (see p. 217).

In detail, the material was relatively diverse. The material from the lower horizon was attributed to the transition period from the Late Magdalenian to the FMG, whereas the remains from the intermediate, the upper, and the top horizon were clearly equivalents of the FMG material from the Central Rhineland. Therefore, only the lower horizon is described in more detail below.

| site | sample | years OSL-BP | ± years | material | comment | ref. |
|---|---|---|---|---|---|---|
| Le Closeau, C04, west of *locus* 43 | A | 19,200 | 1,300 | sand size grains with few fine grain particles and clay | white sandy loam (attributed to Younger Dryas) | 1-2 |
| Le Closeau, C04, west of *locus* 43 | B | 18,400 | 1,300 | sand size grains with few fine grain particles and clay | grey sand (attributed to the Lateglacial Interstadial) | 1-2 |
| Le Closeau, C04, west of *locus* 43 | C | 21,900 | 1,500 | sand size grains with few fine grain particles and clay | yellowish sand (Weichselian fluvial terrace) | 1-2 |

**Tab. 45** OSL dates from the stratigraphy at Le Closeau. References (ref.): **1** Folz et al. 1998; **2** Folz et al. 2001.

Spatial organisation in general

Since the *loci* were not equivalent to concentrations, the distinction of single accumulations was difficult. However, counting from the lithic density map (Bodu 1998, fig. 2) the archaeological material was organised in some 90 concentrations (*c.* 60 in North RN13 and *c.* 30 in South RN13). Nevertheless, the archaeological material was published according to the *loci*. Consequently, in some inventories the impression of lacking parts could arise because this part was published as another *locus* or assemblages represented admixtures of spatially different episodes. These constraints should be kept in mind when reading numbers given for single *loci* from Le Closeau. Therefore, the major archaeological horizon (lower and greyish deposits) are given in the following. However, such large units are even more inevitable for admixing diachronic characteristics and, therefore, some single units are described as representative from the lower horizon. The material from South RN 13 yielded indicators for an even younger occupation of the site, perhaps, up into the Holocene but due to the lack of stratigraphic or radiometric indications these concentrations cannot be positioned reliably in a chronostratigraphic framework and, therefore, the South RN 13 is not included further in the present work.

On the site more than 350 »structures de combustion« were identified in the main archaeological horizons (Bodu 1998, 41; cf. Bodu/Debout/Bignon 2006, 718). These structures were filled with charcoal and, thus, yielding the main preserved organic material. However, some of these patches of charcoal were very small and referring to these structures as anthropogenic hearths was not always possible. In fact, some of these structures were probably results of natural events which were perhaps frequently a cause of large amounts of burnt lithic material (Bodu 1998, 49). Perhaps, the on-going analysis of the Lateglacial remains in the flood plain at Le Closeau (e. g. Bodu 2000b; Bodu/Debout/Bignon 2006; Bodu et al. 2009a) will provide more precise distinction between the natural and the anthropogenic patterns in the future.

Perhaps, a functional interpretation of the lithic assemblages from the different horizons – possibly, in combination with a temporal distinction – should be considered in the future research. Such results could possibly supplement the knowledge on complex spatial behaviour patterns in the FMG. Certainly, the on-going research such as refitting of material and spatial analyses on the rich inventory from the whole site will produce further insights in the settlement dynamics of this important site (Bodu/Debout/Bignon 2006, 718).

Chronology in general

Several $^{14}$C dates taken on samples of charcoal and bone were helping in combination with the stratigraphy and the varied environmental analyses to reconstruct a reliable chronology for the development of the site. Nevertheless, the charcoal samples frequently originated from burning events which were not securely associated with the human occupation of the site and, thus, dated perhaps natural fires in the Lateglacial (Bodu 1998, 58). Thus, the $^{14}$C dates from the site require a more comprehensive evaluation to become meaningful (see p. 265-269 and p. 474-481).

OSL measurements sampled at various heights in the stratigraphy of the intra-site palaeochannel produced clearly overestimated results (**tab. 45**). However, the reason for this false dating remained unclear (Folz et al.

1998; Folz et al. 2001), although the setting in fluvial sediments was a cause for a post-human displacement of the dated sediment (cf. Folz et al. 2001, 932).

In general, the sediment containing the lower archaeological horizon was attributed to the early Lateglacial Interstadial (GI-1e and, perhaps, GI-1d) based on the lithostratigraphy, the environmental indicators, and the radiometric results. The greyish deposits were generally attributed to the younger Lateglacial Interstadial (GI-1b and GI-1a) and the older part of the Lateglacial Stadial (GS-1) due to the stratigraphy and the environmental indicators. Although three archaeological horizons were distinguished in this deposit, the stratigraphic and chronological distinctions for the intermediate and the upper horizon were very thin. In fact, the stratigraphic positions and the radiometric results of the intermediate, upper, and top horizon were significantly overlapping (**tab. 44**). Therefore, the distinction of the archaeological horizon in the greyish deposits was based on typo-technological considerations. In general, the material of all three horizons in the greyish deposits was attributed to the FMG with an early phase (intermediate horizon), a typical phase (upper horizon) and, perhaps, a younger phase (top horizon) which was comparable to Bad Breisig in the Central Rhineland. However, the distinctions were gradual and other explanations such as functional differentiations of the inventories or the duration of use were possible alternative explanations. Probably, the on-going analysis of the settlement dynamics of these horizons from the greyish deposits will help explaining the differences in the material of the various *loci* in the future.

Nevertheless, a clear gap between the lower horizon (GI-1e – GI-1d) and the archaeological material from the greyish deposits (GI-1b – GS-1) became apparent by this short chronostratigraphic presentation. Whether this lack of material from GI-1c was due to the topography (concentrations were not excavated), the taphonomy (concentrations were not preserved), the chronostratigraphy (concentration were not identified as mid-Lateglacial Interstadial), a true settlement gap, or combinations of these possibilities cannot be answered by the present work. However, this observation of a gap in the data is of some significance in the consideration about the precise development from Late Magdalenian to the typical FMG.

Archaeological material of the lower horizon

5,650 lithic artefacts were found in the lower horizon (**tab. 35**). A further 337 lithic remains without traces of knapping were recorded (cf. Bodu 1998, 169 f. tab. 12). In addition, approximately 1,500-2,000 knapped pieces were recovered from the *loci* 56-59 (cf. Bodu/Debout/Bignon 2006, 714 fig. 3) but exact numbers of these assemblages are not published yet. Therefore, the numbers in the following will only refer to the inventories from the *loci* 4 and 46 as well as the ones from the lower layer at the *loci* 33 and 50. The raw material is majorly Campanian flint which can be gathered on and around the site from secondary deposits (**tab. 36**). Only five blades, one of which was transformed into an end-scraper, were made of a high-quality Tertiary chalcedony which might be of foreign origin (Bodu/Cary 1998, 335) but might as well be gathered at the foot of the hills west of Rueil-Malmaison (Bodu 1998, 44).

47 cores were found in the four areas (**tab. 37**). The aim of the blank production process were clearly blades which is further supported by the almost exclusive use of this blank type for the tool production (Bodu/Cary 1998, 336). The characteristics on the blanks indicated the direct use of soft hammerstones in the production of the blanks. Such soft stones made of granite, limestone, sandstone, or flint with a thick calcareous cortex were also found in *locus* 46, partially with indications of use such as splintering, scratches, or picking. However, in *locus* 4 some blades with the »*en éperon*« butt type indicating the use of organic hammers were found, whereas this type was completely lacking at *locus* 46. In general, the butt was not retouched or wore only little modifications on the blanks in both assemblages.

In total, 861 artefacts were classified as tools in the lower horizon of Le Closeau (**tab. 38**). However, Pierre Bodu assumed that the modification on 366 pieces resulted from use rather than intended retouch (Bodu

1998, 170f.). Among this artefact class were also grouped specimens which otherwise would be classified as notched or laterally retouched pieces as well as burin spalls and other debris of the retouching process. Since these pieces were usually not displayed in figures, they cannot be exactly addressed. Furthermore, a conclusion on whether a retouch resulted from use or intention is often difficult when analysing the actual piece and even more difficult based on a drawing. Therefore, this group is generally not neglected in the classification of the retouched artefacts (**tab. 38**). Moreover, of the remaining 495 retouched artefacts were a further 267 blades identified as bruised blades. Again, judging from the drawings the bruised blades generally also form a heterogeneous group. They represented pieces with various kinds of modification along their edges such as notches or lateral retouch and are counted among the tool class »others« in the present study.
Thus, based on these restrictions, the most numerous formally retouched artefacts in the lower horizon were end-scrapers (n = 98) followed by the LMP group (n = 81). Judging from the relevant material displayed from the *loci* 4 and 33, the end-scrapers were made on long blades and the preferred point shape was the bipoint (Bodu 1998, figs 415. 418-419). The other tool classes were significantly less frequent with 29 burins, eleven truncations, and eight composite tools. The latter were mainly combinations of burin and end-scraper. Finally, one splintered piece was found among the material from *locus* 46.
Micro-wear analyses on almost 800 blanks from the lower horizon supported the hypothesis of intensive processing of meat and skin at this site (Christensen 1998; Bodu / Cary 1998; Mevel 2004). Nevertheless, the analysed lithics were used presumably also on bone, plants, and minerals (Christensen 1998) as well as on cortex which was also proven by the parallel linear engravings on remaining cortex parts of some flints (**tab. 42**; Jessen 1935).
In the *locus* 46, seven nodules with picking, scratching, and splintering marks were found indicating a use as hammerstones (cf. Bodu / Mevel 2008). On one of these nodules also some red colourant was preserved (**tab. 42**; Bodu / Cary 1998, fig. 434bis.2). Moreover, artificial grooves were observed on a sandstone block found in the same area. Another special find was an unmodified flint nodule found at the periphery of *locus* 46. The piece was heavily reddened by ochre. Possibly, this colouration is associated with the particular shape of the piece reminding of an anthropomorphic figure (Bodu / Cary 1998, fig. 437.2). However, the cylindrical form was perhaps simply handy and used in the grinding procedure of the red mineral.
In addition, in the *loci* 4 and 46 several boulder of sandstone, gritstone, and limestone were found. The lithic and faunal concentrations seemed to be limited by these stones weighing some 400 kg (*locus* 4) and 600 kg (*locus* 46) in total (Bodu / Debout / Bignon 2006).
In this horizon the preservation of faunal remains was significantly better than in the other horizons (**tab. 39**). The main represented species was horse (cf. *Equus arcelini*; Bignon / Bodu 2006) followed by red deer (*Cervus elaphus*) and wild boar (*Sus scrofa*; Bemilli 1998). Occasionally, also hare (*Lepus* sp.) remains were found. Rarely, other species were determined such as wolf (*Canis lupus*), cave lion (*Panthera spaelea*), a bovid (presumably *Bos* sp.), and a bird (Aves; Bemilli 1998, 405). Rarely carnivore gnawing was observed which, in general, was found rather on the material not affected by weathering (Bignon / Bodu 2006, 408). Also the traces of human processing of these bones was more commonly observed on unweathered material, although this material was usually more fragmented, probably due to human impact. In addition, this fragmented material was often burnt. Nevertheless, the traces of fire could have a natural cause in Le Closeau. According to the presence of body parts, the horses were processed completely at the site, whereas the meat parts of wild boar were probably taken elsewhere (Bignon / Bodu 2006). Based on the dental material of horse mainly from *locus* 46, these animals were hunted in all seasons (**tab. 40**; Bignon / Bodu 2006, 411f.). In particular, the late winter-early spring and the autumn period were indicated, whereas the indications for summer were least frequent. In contrast, the indications from *locus* 4 were very meagre and rather pointed to late spring and early summer as hunting season (Bodu / Debout / Bignon 2006, 723). Com-

parable to the considerations formulated about the material from Le Tureau des Gardes, these heterogeneous seasonal indicators could imply recurrently used areas or areas used over a considerably longer period. Three herbivore rib fragments were modified to a pointed shape which perhaps was used in the processing of animal skins (**tab. 41**; Bemilli 1998, 402). Furthermore, three bones of cave lion (n = 2) and hare (n = 1) show striated traces of human modification.

Spatial organisation of the lower horizon

Spatially, the remains of the lower horizon were found centred in two main areas:
In the south-west, the *locus* 4 was set immediately south-east of the gravel barrier and in the north-west, the *locus* 46 was located some metres north-west of this barrier and already some 2 m lower than the summit of this mound.
The main concentration of *locus* 4 was a dense accumulation of lithic artefacts with the vast majority of retouched artefacts deposited in the periphery of the main concentration. In addition, the few remains of the lower horizon of *locus* 50 represented a western appendix of the material from *locus* 4 rather than representing an independent working area (Bodu/Cary 1998, 322). Hence, these specimens were added onto the assemblage from *locus* 4. A large area of sediment inside the main concentration of *locus* 4 was blackened with charcoal. A few centimetres westwards of this blackened area, a zone of reddish colour was found as well as a very dense cluster of lithic material. On the opposite site of the charcoal patch, another but much smaller coloured zone was found. Presumably, these coloured zones represented a central hearth which was cleared occasionally (**tab. 43**; cf. Bodu/Debout/Bignon 2006, 721). Towards the north and east, the main concentration of *locus* 4 was limited by a small accumulation of large boulders (n = 60; Bodu/Debout/Bignon 2006, 720). This limit was set some 20-50 cm away from the dense concentration. Some smaller stones scattered farther south-eastwards. This scatter was supplemented by lithic material forming a small concentration. East of this small concentration, a patch of reddish sediment and charcoal was found yielding only few lithic artefacts. This structure was either an external hearth or more probable an external dump area (cf. Bodu/Debout/Bignon 2006, 721). Some 4 m north-eastwards of the boulder accumulation another small lithic concentration was found. In the eastern periphery of this accumulation a small concentration of retouched artefacts was found.
Comparable to the *locus* 4, the *locus* 46 was also organised around a central hearth and limited by large boulders (almost 200; Bodu/Debout/Bignon 2006, 720 f.). However, in *locus* 46 the stones were completely encircling the main concentration at a distance of some centimetres to the main lithic scatter. In addition, these boulders formed some type of an inner structure (cf. Jöris/Terberger 2001, 168-171). Again, the majority of retouched pieces was found in the periphery of the main concentration inside the boulder limits. Furthermore, outside the circle were again two further lithic concentrations, one towards the west and one towards the east of the boulder structure.
Moreover, the north-eastward adjacent *locus* 33 was connected to the main area of *locus* 46 by refitted lithic material. Probably, this additional concentration served as workshop for the retouching of tools, in particular hunting equipment, and/or as a butchering place (Bodu/Debout/Bignon 2006, 722). This setting again reflects the pattern of *locus* 4 where besides the retouched material in the periphery of the main concentration, another concentration of lithic tools was found in the north-eastern concentration.
Additionally, the *loci* 56 and 58 were probably satellite workshops as the refitting of lithic artefacts between these areas indicated (Bodu/Debout/Bignon 2006). Furthermore, the presence of cave lion in *locus* 56 and 46 suggested a connection of these satellites to the main concentration of *locus* 46. Hence, the concentrations in the *loci* 33, 56, and 58 were presumably supplementary working areas to the main concentration of *locus* 46.

Pierre Bodu stated that the lithic material was organised and not distributed randomly around the hearths (Bodu 2010). For instance, some of the blanks used for processing vegetal material were found in the periphery of the inner structure of *locus* 46 (Christensen 1998; cf. Jöris/Terberger 2001). Moreover, the faunal remains were clearly concentrated around the central hearths (Bodu/Mevel 2008). In *locus* 46, further faunal remains were found in the additional concentration in the west of the larger structure. In addition, blades with splintered edges by use were also found concentrated around the hearth areas (Bodu/Mevel 2008). Thus, some intense works related to the processing of faunal material seemed to have taken place in these areas.
From the *locus* 46 two blade fragments were connected by refitting to a blank production sequence from *locus* 4 which was set in a distance of some 80 m (Bodu/Debout/Bignon 2006, 722). Of some significance was the observation that the debris of the blank production was heavily patinated, whereas the blade fragments found at *locus* 46 were not patinated. This difference suggested that the blades reached *locus* 46 in a relatively fresh state and were not deposited in *locus* 4 earlier. However, various explanations could be found for this singular refittings and, therefore, Pierre Bodu and his colleagues remained sceptical whether this indication already sustained a contemporaneity of the two occupations (Bodu/Debout/Bignon 2006, 722). The composition of the processed faunal remains was almost identical in *locus* 4 and 46 (Bemilli 1998; Bignon/Bodu 2006). The faunal material could not be directly refitted even though it appeared very similar. Nevertheless, the horse material seemed to represent, at least, two independent cycles of animal processing centred on the two main concentrations (Bignon/Bodu 2006).

Chronology of the lower horizon

The samples of the faunal remains from the *loci* of the lower horizon were $^{14}$C-dated and produced in general early Lateglacial Interstadial ages (**tab. 44**). In particular, the two reliable $^{14}$C dates from *locus* 4 indicated after calibration a chronostratigraphic position in GI-1d which is in accordance with indications from the nearby sampled malacological analysis. However, this attribution to a severe cold episode seemed to contradict the faunal composition including wild boar. Perhaps, the occurrence of these forest inhabitants could be explained by sustaining forest stands in the protected river flood plains. Nevertheless, some samples of wild boar resulted in significantly younger dates proposing that either this animal was dispersed at a later period or that a systematic error occurred in these samples. The reliable $^{14}$C dates from the *locus* 46 and its satellites produced older results falling to the transition from the Late Pleniglacial (GS-2a) and the onset of the Lateglacial Interstadial (GI-1e). This transition period was associated with rapid temperature rises and gradual afforestation. Nevertheless, in the early part of this transition still cold and dry environments as suggested by the malacological analysis still prevailed. Thus, the rare environmental data could not help to further refine the chronostratigraphic attribution of this horizon.
Based on the faunal material as well as the completeness of the lithic inventories at both areas, the two sub-areas of the lower horizon in Le Closeau seemed to represent two events which were temporally distinct. Whether the offset was only seasonally or, in fact, comprised some centuries could not be resolved, although the comparable typo-technological patterns, the similar spatial organisation, and the very equivalent faunal composition rather support the hypothesis of a short temporal offset. Furthermore, the singular refittings sustained a close chronological relation. However, the presence of various satellite concentrations and the effort in the construction of *locus* 4 and even more so *locus* 46 suggested a longer temporal use of these structures comparably to the Late Magdalenian installations at Gönnersdorf or the lower horizon of Andernach (see p. 89-93 and p. 111-122). Whether these central areas were used for one longer halt or repetitively could not be answered unambiguously. Nevertheless, if the settlement occurred repetitively, the various visits were not related to a single season.

## Cepoy, Loiret

### Research history

After the discovery of archaeological material during quarry works near Cepoy in 1972 a test pit program under the direction of Jacques Allain was conducted to decide which part of the site should be protected from quarry works for the future. Accordingly, the site *La Pierre aux Fées* was divided into two sectors. In the sector where the test pits yielded less material (sector 1) 205 m² were excavated in 1972 by François Guillon and Dominique Jagu with their team in a rescue project. The material was collected per square-metre and distinguished in two Palaeolithic horizons (horizon III and horizon IV). Sector 2 yielded a denser scatter of archaeological material in the test pits and was put under governmental protection. Between 1972 and 1977, another area of 150 m² was excavated by François Guillon and Dominique Jagu with their team in the protected sector, some 50 m north-east of the first excavation area. This second excavation was conducted according to modern standards with three-dimensional documentation and sieving of the sediment.

### Topography

The site is situated on the eastern bank of the river Loing (**tab. 34**), some 500 m west of the town centre of Cepoy. In this part the river formed an approximately 1 km wide valley. Only at the site the valley is slightly narrowed to approximately 800 m and the valley turns from a SW-NE direction to a SSW-NNE direction. On the western side, the terrain rises steeply to a plateau which is elevated some 20 m above the valley floor. The hills on the eastern side rise also in a step of some 20-30 m but then the terrain rises further to a ridge some 50 m above the valley floor. Small valleys cut these uplands on both sides of the river valley only a few 100 m south of the site. Some 3 km south of the site the valley opens to a large basin around Montargis. Modern quarry works have exploited the floodplains around Cepoy and the resulting pits were subsequently filled with water leaving an artificial lake landscape. Thus, today the remaining part of the protected site is situated on an island within one of these lakes.

### Stratigraphy

The stratigraphy began with alluvial gravel deposits which were overlain by up to 0.6 m of clay. In this deposit a lower archaeological horizon (V) was found yielding material which was attributed very generally to the Late Magdalenian. Only in this horizon some undetermined bones, charcoal, ashes, and ochre were found. However, these remains were only excavated in a small area of the protected part of the site and the rest remained covered *in situ* for future research. This material is not further considered in the present study. On top of the clay, yellowish white fine sands were deposited in a varying thickness of 0.1-0.8 m. Archaeological horizons were found at the base (horizon IV) and at the top (horizon III) of this sand deposit indicating that these occupations were placed on a sandy beach alongside the river. Most of the artefacts from horizon IV were found in a horizontal position (Valentin 1995, 314) suggesting little movement within the sediment and, hence, no recognizable disturbance of this archaeological material. This layer produced the majority of material and was used to describe the »faciès Cepoy/Marsangy«. The horizon III was mostly destroyed during quarry work and yielded too few diagnostic artefacts to further classify the industry. Comparable to the horizon V, this material is not further considered. The sands were overlain by some 0.3 m of topsoil in which the upper two archaeological horizons were found.

In some parts of the site, periglacial processes moved the alluvial gravels vent-like upwards into the fine sand deposit (Allain et al. 1978). Thus, stone material became naturally introduced into the archaeological horizons. In a maîtrise thesis, Claire Guillon reconstructed the presence of a clay-filled channel across sector 2 which she assumed to be younger than horizon IV (Wenzel 2009, 48 f.). However, Stefan Wenzel argued that this channel did not affect the archaeological horizon according to the horizontal position as well as the inclination of most artefacts in the vicinity of the channel (Wenzel 2009, 49). Nevertheless, some younger archaeological material such as pottery was found in the horizon IV clearly attesting some disturbances in the stratigraphy.

Archaeological material of horizon IV

The material of sector 1 from Cepoy comprised *c.* 14,500 lithics (**tab. 35**) and was used by Boris Valentin as basis for the definition of the Magdalenian »faciès Cepoy/Marsangy« (MfCM; Valentin 1995, 352).
The sector 2 provided more than 15,000 finds (Valentin 1995, 313) but among these finds were many unmodified gravels (Valentin 1995, 315). In contrast to the test pits, the find density in the excavated parts appeared poorer in sector 2 than in sector 1. A thorough analysis of the material from sector 2 was thus far not published (Wenzel 2009, 47). However, Stefan Wenzel included a short description of the excavated material from horizon IV in his chapter on the settlement structures of sector 2 (Wenzel 2009, 47-61).
Local Cretaceous flint which could be gathered from the river gravels was dominantly used as raw material (**tab. 36**). This local material was of a good knapping quality. In sector 1, only eight artefacts were made of different materials. The resources of these materials are unknown. However, three tools were made of a material which was comparable to Tertiary chalcedonies from the Île-d-France or material found near Orléans. An end-scraper and a point were made of materials which, perhaps, were also formed in the Tertiary. A further two points and two blades were made of foreign silices. In sector 2 only two artefacts made of different raw materials were found. One blade was made of a flint with rich microfossil inclusions and a blade fragment was made of a Senonian flint (Wenzel 2009, 51).
In total, 355 cores were recovered in Cepoy (**tab. 37**). For sector 1, Boris Valentin analysed the reduction sequence in detail (Valentin 1995, 343-370). The reduction sequence showed all the defining characteristics of the »faciès Cepoy/Marsangy« with the use of soft organic hammers for the production of long blades and the knapping with soft hammerstones for the production of short blades and flakes. Bladelets were no particularly required blanks. In sector 2, blades with a butt of the *en éperon* type were found (Wenzel 2009, 50) as well as cores indicating the production of short blades (Wenzel 2009, 53 Abb. 54.1). In addition, four flint nodules were found which were used as hammerstones according to the traces on their cortex (Wenzel 2009, 51. 54 Abb. 55).
Among the 142 retouched artefacts from sector 1, end-scrapers which were usually made on long blades were most numerous (n = 39; **tab. 38**). In sector 2, the end-scrapers also formed the most numerous group (n = 29) of the 125 retouched artefacts (Wenzel 2009, 51). Similar to sector 1, these tools were commonly made on long blades. In sector 1, the majority of borers (n = 34) could be classified as *bec* (n = 13) or *Zinken* (n = 7). Although ten of the 16 borers were also classified as *bec/Zinken* in sector 2 (Wenzel 2009, 51. 57), this class was not as prominent as it was in sector 1. In sector 2, the LMP formed the second numerous group (n = 22). Among the LMP were almost as many backed bladelets (n = 8) found as there were shouldered points (n = 9). In addition, five backed forms were found of which some were identified as bipoints, although the fragments might also be classified as shouldered points. In difference to sector 2, the 25 LMP of sector 1 were clearly dominated by 19 shouldered points and four curve-backed points but only two backed blades were identified. Among the 18 burins of sector 1 and the eleven burins of sector 2 was the dihedral type the most common one.
On several cores of sector 1 the cortex was engraved with lines. On two stone slabs (one fragmented into two pieces) figurative engravings were found. One shows the posterior legs of a quadruped, a further decoration shows a detailed horse head (Allain 1975, 468).
No organic material was preserved in this horizon.

Spatial organisation

Some hearths, clusters of heated stones, concentrations of lithic material, and possible stone settings were observed during the excavation (**tab. 43**; Allain et al. 1978, 10f.). However, thus far no detailed spatial analysis of sector 1 was published.

In contrast, the spatial distribution of the material of sector 2 was analysed in an unpublished maîtrise by Claire Guillon and a detailed study on the western part of this sector was published by Stefan Wenzel (Wenzel 2009, 47-61). A possible disturbance of the material by a fissure or channel in this area suggested by Guillon was ruled out by Wenzel according to the vertical and horizontal distribution of finds (Wenzel 2009, 48f.).

In the western part of sector 2, two evident structures were found. These structures were formed by dense clusters of partially burnt stone material and were interpreted as hearths (Wenzel 2009, 51-57). The northern one was mainly formed by gritstone plates and the other one was filled with gravels of flint and set almost centrally in the analysed area (Wenzel 2009, 51). However, the two areas were connected by a refitted plate (Wenzel 2009, 52). Burnt lithic material seemed to occur frequently and was spread over large parts of the analysed area. However, a concentration of burnt flint material was found east of the central hearth.

Moreover, several small concentrations of cores and blank production debris were found and considered as possible working spots. However, the cores were distributed relative randomly in the analysed area. Only in the area east of the hearth cores were significantly scarce. In contrast, a dense accumulation was found north-east of the southern hearth. In addition, the retouched artefacts were also spread on the complete area but a significant accumulation of LMP, in particular, shouldered points was found around the central hearth. Another concentration of various types of retouched pieces was located east of the central hearth. Perhaps, this area represented a place where blanks were transformed into tools. The hypothesis was further sustained by the spread of Krukowski micro-burins in this area (Wenzel 2009, 57). Between this concentration and the core concentration in the north-east, an area with relatively few artefacts was found. The dense concentration of burnt flint material was spread from the accumulation of retouched material into this artefact poor area. Refitting connected various concentrations but the core concentration in the north-east of the central hearth was spared out by these refits. In addition, Stefan Wenzel noted that the refitting lines seemed to create two clusters. These fan-like clusters were separated by the central hearth and ran into different directions: one fan towards the north-west and the northern hearth and the other fan spread to the south-east. According to Wenzel, this pattern seemed to show that activities were performed in strictly separated areas (Wenzel 2009, 58). Furthermore, he considered this strongly standardised occupation behaviour as only comparable to Late Magdalenian sites (Wenzel 2009, 61). Nevertheless, Stefan Wenzel also stated that some areas were affected by various settlement dynamics (Wenzel 2009, 57) and he concluded that repetitive but standardised activities formed the analysed area (Wenzel 2009, 61).

Even though no organic material was preserved, the comparison with other sites in river valleys such as Le Grand Canton and the dominance of end-scrapers and burins suggested the processing of faunal remains as an important task at the site. The number of LMP was relatively small but their distribution around hearth structures suggested some hafting and re-tooling activity there. In contrast to the retouched implements of the so-called *fond commun*, LMP were made at a site but used elsewhere. Thus, the scarcity of LMP at a site implied that the necessity of discarding used material was not very high and/or the rejects in the production were low. Furthermore, the blank production as well as the modification of lithic artefacts were also important activities at this site.

### Chronology

The chronostratigraphic attribution of the assemblage was based only on the stratigraphic position which was near the change of a sediment regime. A comparable change of regimes in river valleys was often observed at the transition from the Late Pleniglacial to the Lateglacial Interstadial (Pastre et al. 2003). Therefore, the episodes which formed the assemblage from horizon IV in Cepoy dated probably to the early Lateglacial Interstadial.

Even though the material of sector 2 was thoroughly analysed, thus far, the number of occupation episodes and/or distinct occupation events remained uncertain. Consequently, an admixture of remains from various times could not be excluded. However, a separation of the material seemed not possible according to the horizontal distribution. Furthermore, Boris Valentin stated correctly that the coherence of the same technical and typological traits on various other sites was probably no accidental melange (Valentin 2008a, 125). Besides the technical comparability of the material, shouldered points, backed pieces, and backed bladelets were observed in close spatial vicinity on several spots of the site. In addition, the strictly standardised spatial behaviour suggested by Stefan Wenzel (Wenzel 2009, 61) also indicated that the performed activities were similar and, probably, the tools used in these activities as well. Thus, the repetitive accumulation of comparable material in a comparable manner should reveal the behavioural pattern at this site more clearly.

## Marsangy, Yonne

### Research history

The main excavation area of the site *Le Pré des Forges* in Marsangy was excavated from 1974 to 1981 on 220 m² under the supervision of Béatrice Schmider with modern standards. From 1972 until 1974, Henri Carré had already excavated two areas of test pits located north and south of the main excavation area.

### Topography

The site is situated on the western bank of the modern river bed of the Yonne (**tab. 34**) and approximately 3 km south of Étigny. In this part, the Yonne valley is already flanked by a 90-100 m uprising plateau. The valley at Marsangy is about 2 km wide. This width is partly due to a meander of the Yonne and partly due to two tributary streams of which one (Montgerin) cut into the adjacent hills north-westwards and another one cut the hills south-west of the site. North of the site on the eastern bank of the Yonne another meander of the river widened the valley and, in addition, another valley coming from the east enlarged the Yonne valley. Hence, the site is located in an area with many east-west running valleys crossing the wide, north-south running Yonne valley. These valleys made the surrounding plateaus relatively easy accessible but they also caused considerable erosion of sediment towards the Yonne. Therefore, no further *in situ* concentrations were supposed to be found north of the excavated site.

Within the Late Pleistocene the Yonne began down cutting and regularising (Roblin-Jouve 1992, 29). In addition to a river branch immediately east of the site, another channel formed some 100 m farther to the east (Roblin-Jouve 1992, 26 fig. 12). This channel became the major stream in the Lateglacial but it was affected by erosion during the Holocene. In consequence, the river branch near the site was re-activated during the Holocene (Roblin-Jouve 1992, 27. 30) and the erosion connected with this process affected the archaeological horizon. Thus, some of the prehistoric material drifted downwards the river embankment (Schmider 1992d, 13-18). Nevertheless, the majority of the excavated material remained *in situ* (Schmider 1992d, 18).

Stratigraphy

On top of the river gravels two deposits of silts were recorded in Marsangy. These silts were overlain by loamy silts which became sandier in the upper part. In the lower part of these loamy silts the archaeological material from the excavation of Béatrice Schmider was found in a single horizon (Roblin-Jouve 1992, 27). The malacological analysis placed this part of the stratigraphy into a cold period in which the river banks were covered by regularly flooded grassland. On top of the sandy-loamy silts a very loamy silt layer with calcareous fragments and many molluscs was found.

In the northern area excavated by Henri Carré, a hearth construction was found on top of a lithic concentration indicating the presence of two distinct archaeological horizons. This evidence suggested a possible re-settlement of the site during the Lateglacial (Schmider 1992d, 13) and, thus, would imply at least two occupation events at the site. However, the structures in this northern area were more heavily affected by erosion as well as settlement dynamics than the structures in the main excavation area (Schmider 1992d, 13). In addition, structures of Hallstatt age further disturbed the Pleistocene concentrations of the site (Schmider 1992d, 11). Nevertheless, more recent analyses of small particles of charcoal from the hearths excavated by Béatrice Schmider suggested partial intrusion of Holocene material in these structures (Bodu et al. 2009b, 97-101), and, consequently, sustained a more complex stratigraphic development on the excavated area. In analogy, the distinction in the excavation of Carré should be considered with the necessary caution.

Archaeological material

The over 21,500 lithics from the main excavation (**tab. 35**) weighted some 405 kg (Croisset / Schmider 1992). The artefacts were dominantly made of local Cretaceous flint (**tab. 36**). Only four tools from the southern part of the main site were made of foreign material. This material was mainly identified as Tertiary chalcedony which possibly originated from some 80 km north-west of the site. One piece was made of a yellow jasper-like material of which the origin is unknown. Possible deposits are located some 100 km to the south (Schmider 1992a, 133). Some processed material from a single core in the northern concentration (N19) was made of quartzitic sandstone which originated from some 30 km south of Marsangy (Croisset / Schmider 1992, 89). A blade which was also found in the north of the main excavation was made of a glossy sandstone which, perhaps, originated from the same area as the quartzitic sandstone.

The inventory includes 379 cores and core fragments (**tab. 37**). Several of the fully exploited cores show knapping accidents which might be the result of inexperienced stone knappers (Pelegrin 1992, 111. 115). Blades were the main aim of the blank production process. Besides long blades, shorter ones were produced. The butt of the blanks was often well prepared (Croisset / Schmider 1992, 94 f.). A spur (*en éperon*) was regularly formed as preferred impact point (Pelegrin 1992, 111). The percussion was either direct hard or direct soft. In fact, some hammerstones were also found at the site (Bodu 1992).

642 tools are present within the material from the main excavation area (**tab. 38**). In general, the burins were the largest group of retouched artefacts (n = 179). These were frequently dihedral types or on broken edges. However, burins on truncations were also common, in particular, in the northern part of the site. In this part the LMP (n = 86) were also more frequent than the burins (n = 74). In total, the LMP (n = 168) were the second largest group of retouched artefacts. Among the LMP, simple backed blades (n = 116) occurred more than twice as often as backed points (n = 52). The points were mainly classified as shouldered points (n = 14 unbroken ones), although in some cases the shaping of the base even tended towards a tanged point (Schmider 1992a, 190 fig. 108.4; Schmider 1992a, 191 fig. 109.6). Furthermore, angle-backed points with a single angle (n = 2) and with two angles (Schmider 1992a, 191 fig. 109.5), *Federmesser* (n = 3), Malaurie points (n = 3), and a bipoint were found. Thus, the shaping of the points was very diverse. The third most numerous group were borers (n = 111). Among these implements, *becs* and *Zinken* were the dominant

types. Only in the northern part of the site, *becs* with very long formed tips (*Langbohrer*) were found. The end-scrapers (n = 68) were usually made on blades of which some were very long. The lithic inventory from the excavation of Henri Carré appeared similar with *becs* and shouldered points (Schmider 1992d, 11).
The poorly preserved fauna was dominantly determined as reindeer (*Rangifer tarandus*) but also bones and teeth of horse (*Equus* sp.) and red deer (*Cervus elaphus*) were found (**tab. 39**).
One perforated mollusc which originated from deposits either 80 km north, 90 km north-west, or 130 km west of Marsangy was found in the centre of the main excavation (**tab. 42**; Schmider 1992c, 231).
Furthermore, in the northern part of the main excavation area three stones with lines engraved on their cortex were found of which one might be an abstract figuration (Cremadès 1992). Another stone resembled a female figurine with an incision parting the upper part of the stone from the rest but this piece was found in a disturbed area in the south of the main excavation (Schmider 1992c).

Spatial organisation

In the excavation area of Béatrice Schmider four concentrations were distinguished. Henri Carré had excavated a further three concentrations: one several metres to the south and two farther north than Schmider's excavation area (Schmider 1992d, 11). The three concentrations found by Henri Carré were disturbed by prehistoric structures (Hallstatt age).
All four concentrations on the main excavation area were organised around a hearth which was filled with stones. 13 samples of charcoal material from around the presumable hearths were analysed. However, only samples from the southern most concentration were considered undisturbed (Bodu et al. 2009b). Within these samples, no wood charcoal was identified but many small, burnt bone fragments (Bodu et al. 2009b, 100 f.) indicating the possible use of bone material as fuel for the hearth. Within each concentration, several refits were found giving a relatively undisturbed impression. Béatrice Schmider stated that there was no significant difference in the lithic material from the four concentrations observable (Schmider 1992a, 223).
The three southern concentrations of the main excavation area were connected by refits and, hence, their material was not further distinguished during the analysis (Croisset / Schmider 1992). However, the connection of the southern most concentration (X18) to the intermediate ones (D14, H17) was considerably meagre based on three refitting lines. Since the concentrations were lying relatively close to one another and because the material was very homogeneous, the assignment of artefacts between the different concentrations to the one or to the other concentration was partially impossible.
The spatial organisation of the concentrations H17 and D14 were very comparable, whereas the concentration X18 appeared more ephemeral in material and the concentration N19 was much denser. Around N19 several nests of knapping debris were deposited, whereas around concentration H17 and D14 only two major zones of artefact accumulation were observed.
The three southern concentrations (X18, D14 and H17) yielded a comparable number of lithic artefacts (n = 11,229) and retouched artefacts (n = 329) as did the northern most concentration (n = 10,389 artefacts; n = 313 tools). Furthermore, 197 cores were found in concentration N19, whereas the other concentrations yielded only about a third each of these (H17: n = 64; D14: n = 56; X18: n = 62). Thus, Béatrice Schmider interpreted the differences as a functional variation of the concentrations (Schmider 1992a, 223; Schmider 1992e, 245) with the blank production process mainly occurring around concentration N19. She also noted that the concentration of material generally rises towards the north-western tributary (Schmider 1992d, 13).
The concentration N19 seemed to represent a single event and the thoroughly analysed material displayed all characteristics of the MfCM. Moreover, the spatial analysis based on the distribution of artefacts and the patterns of refitting lines indicated that this concentration was a workshop in the open air (Schmider 1984,

| site | lab. no. | years TL-BP | ± years | material | comment | ref. |
|---|---|---|---|---|---|---|
| Marsangy, conc. H17 | Gif-M2 | 11,900 | 700 | burnt sandstone | found in H16-17 | 1-2 |
| Marsangy, conc. H17 | Gif-M3 | 11,700 | 700 | burnt sandstone | found in H16-17 | 1-2 |
| Marsangy, conc. H17 | Gif-M4 | 11,600 | 800 | burnt sandstone | found in F16 | 1-2 |
| Marsangy, conc. H17 | Gif-M5 | 11,500 | 1,250 | burnt sandstone | found in F18 | 1-2 |

**Tab. 46** TL dates from Marsangy. References (ref.): **1** Valladas 1994; **2** Bodu 2004, 175.

176). However, the lack of refits suggested that this workshop did not serve as blank production area for the other concentrations.

The ring and sector method (Stapert 1992; cf. Gelhausen/Kegler/Wenzel 2004) which was created to detect barrier effects within accumulation patterns of material around centralised hearths was applied to the material from Marsangy. The result of the ring analysis indicated that the southern hearths were probably located inside limited spaces of approximately 4m in diameter (Stapert 2003, 7).

In these small areas, various types of retouched pieces as well as the debris of their modification and debris of the blank production process were found. Thus, around these hearths similar activities were made in a repetitive pattern.

Chronology

For Marsangy the indications for a chronostratigraphic attribution are multiple. Four TL dates which were taken on burnt sandstones from the concentration H17 indicated that the occupation had taken place before the Younger Dryas (**tab. 46**; Valladas 1994). The archaeological horizon was situated in the lower part of loamy silts indicating a generally more temperate and humid regime than in the Late Pleniglacial. The presence of red deer combined with the remaining occurrence of reindeer pointed to an occupation at the transition from the Late Pleniglacial to the early Lateglacial Interstadial. Furthermore, the malacofauna placed the sediment of the archaeological horizon into a cold period which was consistent with a dating of the assemblages from Marsangy to GI-1d. Three $^{14}$C dates were taken on reindeer material and a further date was taken on a tooth of horse. The results vary considerably (**tab. 44**). The incongruence of the dates resulted either from several occupation episodes or a thus far undetected contamination in the samples. However, the reliable $^{14}$C dates sustained a chronostratigraphic position in GI-1e/d.

Even though the material cannot be fully distinguished for the three southern concentrations, their spatial organisation appeared unaltered. Nevertheless, the central concentrations D14 and H17 were connected by many refits suggesting either a contemporaneous existence or that one concentration served as resource for the other concentration. Nevertheless, these two concentrations were quasi-contemporaneous. The southern most concentration produced less material and represented perhaps another, short-termed occupation episodes or a special work place during the existence of the other concentrations. The relation to the northern concentration N19 remained unclear. However, since the same activities as in the other concentrations were indicated by the lithic material, this represented possibly another occupation event. Nevertheless, this area could also represent a knapping place which provided material for other areas along the river bank.

Belloy-sur-Somme, Somme

Research history

In the valley of the Somme near Belloy-sur-Somme, Victor Commont excavated a test pit in 1905 on the site La Plaisance which was discovered by surface survey in the late 19th century (Fagnart 1997, 43). In the following excavations between 1907 and 1910, some 916 m² were uncovered. Commont observed two archaeological horizons: In the lower horizon a small concentration yielded *bec* and bi-truncated implements and in the upper horizon many bruised blades were found. Some 50-200 m north-west of the limit of Commont's excavation, modern excavations were conducted between 1984 and 1990 after the promising results of a test pit in 1983. These works were supervised by Jean-Pierre Fagnart. In addition, between 1990 and 1992 another area was excavated in a dry valley west of the previous excavation area. The approximately 2,000 m² large area was divided in twelve sections. In particular, in the western part of these sections, three Lateglacial and a Mesolithic assemblage were found during the modern works. The Lateglacial assemblages were attributed to a Final Magdalenian (lower horizon), to the FMG (intermediate horizon), and to the Long Blade Technology (upper horizon; Fagnart 1997, 53-104). The Final Magdalenian material was found on an almost 500 m² large area in the very south-west on the lower slopes, whereas the FMG and the Long Blade Technology material was found farther uphill. The FMG were concentrated in the south-eastern part of the main excavation area and the Long Blade Technology was mainly recovered from the north of this area.

Topography

The site La Plaisance is situated on the eastern bank in the swampy valley of the Somme (**tab. 34**). At the site the valley is approximately 1 km wide. Towards the north and the north-east hills rise steadily 25-50 m above the valley floor. On the south-western bank of the Somme the adjacent plateau rises abruptly 50-65 m upwards. On both sides of the south-east to north-west flowing river the plateau is regularly cut by the valleys of small contributories, often running in a north-south axis. The concentration of archaeological material from the lower horizon was found on the south-eastern margins of a today dry valley within which several erosion events were documented (Fagnart 1997, 46 f. 53).

Stratigraphy

On top of the Cretaceous bedrock Victor Commont registered 2-3 m of gravels (Fagnart 1997, 44). These gravels were overlain by a yellowish white sandy clay deposit of approximately 40 cm thickness. This deposit was covered by a thin band of gravels on top of which about 1 m of whitish, calcareous silts followed. These silts were also reached in the modern excavations occasionally and were again covered by a thin gravel layer. These gravels were superimposed by greyish yellow silts which were identified as Late Pleniglacial loess. This loess deposit was about 0.9-1.6 m thick. In the profiles from the dry valley this loess was again covered by a very thin band of gravels which were partly ice-damaged. On top followed a blackish silt humus which was named Belloy-sur-Somme soil (Fagnart 1997, 46). This soil was 0.05-0.2 m thick. The pollen samples produced only a general attribution to the Lateglacial (Fagnart 1997, 48-51), presumably, due to the bioturbation which was often observed in this soil. The lower archaeological horizon was found at the base of this soil. The upper part of this deposit yielded artefacts assigned to the FMG. Moreover, the material classified as Long blade Technology (»*Belloisian*«, Fagnart 1997, 103 f.) was also found in the upper part of this soil. The Belloy-sur-Somme soil was overlain by a sandy silt layer which was attributed palynologically to the Boreal. The stratigraphic hiatus might be explained with erosive processes near the adjacent valley. Or the infiltration of modern pollen in a pre-existing sediment (Fagnart 1997, 51). This sandy silt was overlain by the modern topsoil. Only in the dry valley approximately 1-1.5 m of various peat and silt layers were formed between the sandy silts and the modern topsoil.

Archaeological material of the lower horizon

In the lower horizon, 6,415 lithics of which 1,880 pieces were larger than 2 cm were found (**tab. 35**).

The raw material (Turonian and Coniacian flints) was taken from local gravels, immediately accessible near the site (**tab. 36**).
The 108 cores and core fragments (Fagnart 1997, 55) were dominantly prismatic cores with two platforms (n = 41) or one platform (n = 19; **tab. 37**). A further seven cores were made on larger flakes and probably also with just one platform. Bladelets were removed alongside a lateral edge of these flakes. Only one multiple platform core occurred. The other pieces were either fragments (n = 31), preforms (n = 4), or merely tested blocs (n = 5). On some cores traces were observed which demonstrated an unskilled handling of the hammerstone such as an apprentice use of the material (Valentin 2008a, 129 f.). Furthermore, traces indicating the used of organic hammers were found on at least one core and demonstrated the use of organic hammers besides soft hammerstones (Valentin 2008a, 130). The traces were related to the production of some long blades. Moreover, the butt of several blades was facetted and some blades had a preparation of the »*en éperon*« type (Fagnart 1997, 55). In general, the blank production process in the lower horizon of Belloy-sur-Somme was clearly oriented towards the production of long blades (Fagnart 1997, 54 f.). Bladelets were rare.
Among the 158 tools, 23 end-scrapers formed the most numerous tool class (**tab. 38**). The end-scrapers were generally made on long blades and only two examples were made on flakes. The 21 burins were also mainly made on blades. The dihedral types were slightly more numerous than the examples on truncation (Fagnart 1997, 59). Among the 20 LMP were six backed bladelets of which two were additionally truncated. Furthermore, one backed blade and a microlith of trapezoidal shape was found. The twelve backed points were of various shapes (Fagnart 1997, 63. 255) including shouldered points, angle-backed points, and curve-backed points. Furthermore, ten borers were found which were clearly dominated by *becs* and *Zinken* (n = 8; Fagnart 1997, 59. 62 f. 255). In general, the seven truncations were also made on blades. Only twice double truncated blanks were found. The majority of retouched artefacts were blades with various retouches. Combinations of different types of retouched working edges were not described.
Organic material was not preserved in this archaeological horizon.

### Spatial organisation of the lower horizon

At least one hearth (M13) was identified by a concentration of burnt stone plates (**tab. 43**; Fagnart 1997, 54). The majority of lithic material was found around and northwards of this accumulation. In particular, in the north-east was a dense cluster of used blades indicating an intense working place there (Fagnart 1997, 54). In the north, several cores and core fragments were found. Further cores were deposited northwestwards and a dense cluster of retouched artefacts was found in this working area. In addition, material accumulations were found in two consecutive concentrations (G8/9 and E4) 6 and 10 m westwards of the hearth. In these concentrations, further cores and retouched artefacts were found. A very small cluster containing two cores was also found in some 10 m distance to the hearth but north-eastwards in the section 151. In section 151, some 13 m eastwards of the hearth, a second more diffuse scatter of blanks was found.

### Chronology of the lower horizon

The malacology in combination with the stratigraphy attributed the layer below the artefact horizon to the Late Pleniglacial. Consequently, the Belloy-sur-Somme soil in which the artefacts were found was probably formed in the Lateglacial Interstadial. Due to the position in the lower part of this soil, the artefacts of the lower horizon were presumably deposited in the first part of the Lateglacial Interstadial.
Jean-Pierre Fagnart assumed in analogy to Late Magdalenian sites in the Paris Basin that the lower horizon represented two patches with each being related to one or two knapping places in the periphery (Fagnart

1997, 54). In consequence, the lower horizon was clearly formed by several episodes, possibly two distinct events. Core and retouched artefacts were found in both patches. Nevertheless, except for a *couteau à dos* the LMP were found in the periphery of the concentrations related to the hearth. Thus, work related to these implements was either not performed in the north-western patch or the concentration related to this work was not excavated. Moreover, no indications for a hearth were connected to this area. Thus, either this patch represented a single occupation event which was possibly not completely excavated or very short-termed or this patch formed perhaps a satellite of the central area around the hearth. However, without refitted material the relation of the various concentrations remained unclear.

### Gouy, Seine-Maritime

#### Research history

Presumably, the three successive chambers of the small cave *Grotte du Cheval* or *Gouy I* were just the remains of a larger system which was destroyed during the construction of a National road alongside the Seine in the 1930s (Graindor 1959, 87f.). The small cave was discovered in 1956 by Pierre and Yves Martin (Breuil/Graindor 1959; Martin 2010). For preservation reasons the cave was put under protection in 1959. In the 1960s, some small, superficial excavations were conducted in the cave (Graindor 1965) and revealed a small inventory (Bordes et al. 1974).

#### Topography

The *Grotte du Cheval* is a small cave on the western bank of the Seine (**tab. 34**). The entrance is some 3m above the modern road (Graindor 1965, 29f.) and some 15m above the modern level of the Seine. In regard to the partial destruction of the Cretaceous (Senonian) rocks and the inclination of the cave (Graindor 1959), the prehistoric entrance was probably further elevated in the cliff. The modern cave opens towards the north-west. The remaining part of the cave runs in a straight passage some 15m into the rock with a downward inclination (Graindor 1959). In general, the passage is a very narrow but three successive chambers gradually widen up the cave.

#### Stratigraphy

The upper 2-2.5m of the cave deposit was mainly composed of calcareous scree which eroded from the surrounding cliffs. However, the cave deposit was probably slumped into the cave until the material closed the entrance. Presumably, down slope erosion of the material after the road construction led to a more significant re-opening of the cave entrance (Graindor 1959). The archaeological remains were found during the excavations in the upper part of the deposit (Graindor/Martin 1972). However, some of the engravings of the wall seemed to continue below the cave deposit and were in consequence presumably older than the archaeological remains (Lorblanchet 1973). In addition, some pieces of local flints were classified as »pseudo-artefacts« and resulted from frost fracturing and compression in the deposit (Bordes et al. 1974). Probably, the sediment slumped into the cave was susceptible to the severe cryoturbation process outside the cave and, thus, prior to the relocation into the cave.

#### Archaeological material

Inside the cave a small lithic inventory (n = 116) was recovered (**tab. 35**). Even though the site was located in a Cretaceous rock formation with flint bands, the spectrum of raw materials was originally considered as extremely varied with more than three quarters of the assemblage being made of foreign material (**tab. 36**).

Less than a quarter of the material (n = 33) was assumed as the same material as the pseudo-artefacts and, thus, originated presumably from the immediate surrounding of the site. A further five materials were described mainly by colour, but prohibited further determination of the origin of the raw material (Bordes et al. 1974). However, in comparison with the descriptions of raw materials from other sites in the Seine valley at least some other pieces originated possibly from the fluvial deposits and in this case were also of local origin. Nevertheless, few pieces appeared as of a different, high-quality raw material (Fosse 1997, 242) which according to the cortex was a Cretaceous flint collected at a primary resource (Valentin 1995, 582). In addition, a blade resembled the Tertiary chalcedonies of the Île-de-France (Valentin 1995, 582).
The only core of the assemblages was also made of the very local raw material (**tab. 37**). It was described as a prismatic core with two platforms of which one was used dominantly (Bordes et al. 1974, 118). The blank production dominantly was aimed to create blades (Valentin 1995, 584 f.). Among the various types of butt on the analysed blanks (n = 66) were few pieces (n = 3) with an *en éperon* type of preparation. François Bordes and his colleagues considered the material to be generally knapped directly with a hard hammerstone but they also found indications of an indirect knapping technique (Bordes et al. 1974, 118). Boris Valentin suggested the use of soft hammerstones (Valentin 1995, 583. 586). However, debris material is relatively rare in the assemblage of Gouy and either played no important role at the site or remained in unexcavated areas.
Among the heterogeneous finds were 16 retouched pieces (**tab. 38**). Six artefacts were classified as LMP, generally, as bipoints (n = 3). Another curve-backed point fragment was perhaps also a bipoint before fragmentation. Furthermore, another LMP fragment was an angle-backed remain. The sixth LMP was a large *couteau à dos* with the shape of a *Federmesser*. Boris Valentin noted that these points wore no traces of use (Valentin 1995, 569 note 10). However, in the retouches of a partially truncated *couteau à dos* traces of haematite were found (Bordes et al. 1974). Besides the LMP, three burins, three borers, two truncations, an end-scraper, and a composite tool were determined by François Bordes and his colleagues. In fact, the composite tool was an end-scraper which was modified on a burin. Thus, the piece did not represent a combination but a conversion. Of the three burins only one was made on truncation and the other two burin blows were set at a breakage negative. The end-scraper was made on an elongated flake. The opposite edge on the oblique truncation showed heavy traces of use and was possibly a broken borer. The borers were large, crude pieces with a *Zinken*-like working edge.
Hugues Plisson named in a comparative study of traceological analyses on material from caves also 113 pieces from the Gouy cave (Plisson 2007). They displayed the use for cutting or engraving of mineral material, butchering and cutting of hides, and working of bone material.
Among the fauna were only remains of large mammals preserved (**tab. 39**). In the assemblage red deer (*Cervus elaphus*), wild boar (*Sus scrofa*), and roe deer (*Capreolus capreolus*) were determined in addition to remains of wolf (*Canis lupus*), fox (*Vulpes vulpes*), a merlin (*Falco colombarius*), and a Western Jackdaw (*Corvus monedula*; Cordy 1990).
Furthermore, a drilled red deer canine was found (**tab. 42**; Lorblanchet 1973).
On the cave walls several engravings were documented (Martin 2007a) and some traces of colour were found (Martin 2004). Along with the eponymous horse, further horses, bovids, a possible bird, a female silhouette of Laline / Gönnersdorf type, several signs including vulvas, triangles, and barbed symbols were recognised thus far. The animal bodies were usually filled with parallel or hatched lines. Presumably, these various expressions of art were created in several visits to the cave reflected by different phases of rock art (Martin 2007b). Furthermore, some blocks with engravings were also recovered from the cave floor but whether these represent portable art or collapsed from the cave walls remained mainly uncertain (Martin 2007b).

Spatial organisation

The spatial distribution of the material within the calcareous scree was not testable.

Although the assemblage was relatively small, the composition was a relatively usual one with few remains of the blank production process, various retouched artefacts, various organic remains, and some ornamental pieces. Thus, the assemblage as well as the wear traces on the lithic artefacts suggested some type of engraving activities as well as processing of faunal remains. Nevertheless, the variability of raw material as well as the almost complete preservation of the LMP could also indicate some type of selection and/or bias.

Chronology

One of the bones was $^{14}$C-dated (GifA-92346; **tab. 44**) and produced an age which calibrated fell to the transition from the first Lateglacial warming (GI-1e) to the first Lateglacial cooling period (GI-1d). According to the composition of fauna, the assemblage should rather originate from the latest GI-1e. However, neither was the contemporaneity of the faunal remains nor the relation to the archaeological material unambiguously proven (cf. Valentin 1995, 569).

Some of the engravings appeared to cover parts of the cave wall which seemed to continue below the horizon from which the lithic artefacts and bones were recovered. Thus, at least two phases seemed probable. This division in two events was also suggested by the composition of the cave art (Martin 2007b).

The significance of this cave was recurrently attributed to the most northern occurrence of cave art in France. However, meanwhile Lateglacial cave art was also found in the closer and wider surrounding of the site (Pigeaud et al. 2010) as well as in central England (Pettitt/Bahn/Ripoll 2007). For the present study, the archaeological material which presumably was related to the transition period between the Late Magdalenian and the FMG is of interest. Even though the analysis of Hugues Plisson indicted the use of some lithic artefacts for graving on mineral material (Plisson 2007, 129. 131), the question remained which engravings were made with this lithic material. Furthermore, Plisson could not exclude that some pieces were already used before they arrived at the site (Plisson 2007, 131). Thus, the relation of the archaeological material to the cave art remained as in most caves unclear.

## Pincevent III.2, Seine-et-Marne

Research history

In the basin formed by the confluences of the Yonne and the Loing into the Seine the gravel pit of Pincevent had grown from 1926 to 1964 to an extent of approximately 12 ha. The pit was set on the southern bank of the Seine in the municipality La Grande Paroisse between Montereau-Fault-Yonne and Moret-sur-Loing. Since 1957 the gravel mining had been accompanied by archaeological investigations which focused on early Dark Ages, Gallo-Roman period, and Iron Ages. In 1963 first hearths related to Late Magdalenian material were recognised in the clays immediately above the quarried gravels (Leroi-Gourhan/Brézillon 1966, 263). However, only when in 1964 the gravel pit had cut again Palaeolithic layers the exploitation was stopped. The remaining land adjacent to the gravel pit, which was subsequently flooded, was declared site of national interest and several 1,000 m² were bought from the mining company.

From 1964 until 1985 the excavations were supervised by André Leroi-Gourhan and afterwards by members of his CNRS team, currently Pierre Bodu is in charge. The excavations which until the early 2000s explored only the western part of the protected site have been uncovering numerous concentrations in some 25 different archaeological horizons (Gaucher 1996; Bodu et al. 2006b, 8). To distinguish the various assemblages the large concentrations were named according to their vertical and horizontal position. The latter position

was defined by a square-metre grid which was plotted on the complete site and the adjacent part of the gravel pit with numbers 1 onwards for the west to east running axis beginning in the west and zones of 26 m length labelled alphabetically (A-Z) on the north-south axis beginning in the south. Habitation no. 1 (Leroi-Gourhan / Brézillon 1966) marked, thus far, the south-western end of the excavated area. After this first excavation, intersections were added at every 25 m from west to east. The thereby created 25 m (intersections) by 26 m (zones) wide rectangles (sections) were again numbered from south-west to north-east resulting in approximately 70 sections. Large concentrations were subsequently identifiable by the section in which they were found and further defined by the centre which were generally given the exact square coordinates such as horizon IV0, section 35, unit T125 (Bodu et al. 2006a) or horizon III.2, section 27, unit N91 (Bodu / Orliac / Baffier 1996). In fact, archaeological remains from horizon III.2 which is described in more detail below were recovered in the sections 17, possibly 18, and 27. In total, these areas comprise approximately 280 m² but faunal and lithic remains were recovered from only some 70 m² (Bodu / Orliac / Baffier 1996).
Pincevent was among the first sites to be excavated in a modern style with precise documentation of the position of the material. In addition, from the beginning of the investigations on the site the study of the setting, the surrounding, and the recovered material formed subject of a communal project of various specialists including besides archaeologists, for example malacologists and sedimentologists (cf. Leroi-Gourhan / Brézillon 1966, 267). Therefore, the site is presumably one of the most famous open air sites of the Late Upper Palaeolithic. Moreover, the excellent preservation of organic material along with lithic, mineral, and fossil assemblages in numerous concentrations, which were dominantly attributed to the Late Magdalenian, allowed for detailed analyses of subsistence, technical, and spatial behaviour (e. g. Leroi-Gourhan / Brézillon 1972; Enloe / David 1989; Bodu et al. 2006b). This good condition of the material was attributed to the favourable position in the floodplain of the Seine where the regular flooding covered the archaeological remains with sand and silt layers quickly after abandonment of the concentrations.

Topography

Approximately 7 km towards west-north-west of Pincevent the Loing flows into the Seine and some 5 km towards the east-north-east the Yonne joins the Seine (**tab. 34**). In this part the Seine flows from east to west before it directs towards the north-west shortly after the mouth of the Loing. The meandering Seine had formed a large valley of almost 2 km width in north-south direction in the surrounding of the site. Pincevent is set approximately in the centre of this valley with relatively levelled terrain for more than 1 km northwards and southwards. Around the Yonne mouth the width of the valley was further increased to c. 3 km. This widening reaches eastwards almost to Marolles-sur-Seine where the terrain rises more rapidly towards the east. Approximately 2.7 km westwards of Pincevent a ridge runs towards the Seine from the south and narrows the valley to only some 500 m width. Hence, the wide Seine-Loing-Yonne basin extends some 10-12 km with Pincevent set in its western part and the sites Le Tureau des Gardes and Le Grand Canton (see p. 189-196 and p. 206-210) located on the eastern end. Approximately 1 km north and south of Pincevent the terrain rises quickly some 40-60 m above the basin floor. However, directly south of the site the hills were cut by a small, dry valley which gradually ascended towards Ville-Saint-Jacques.

Stratigraphy

Situated in the floodplain, the stratigraphy at the site was dominantly influenced by the Seine. On top of the Cretaceous bedrock some 10 m of alluvial sediments beginning with light beige sands and gravels were deposited (Leroi-Gourhan / Brézillon 1966, 268; Roblin-Jouve 1996, 17-19). These sediments were partially exploited in the mining and termed horizon V in the general stratigraphic sequence of Pincevent. Analysed in more detail the lowest part (layer 6) is formed by obliquely deposited sands followed by an approximately 2 m thick sand and gravel deposit alternated with layers of clay (layer 5). This layer 5 is intersected by a *c.* 60 cm thick, yellowish brown clay band in which Middle Palaeolithic remains were observed (Roblin-Jouve 1996, 18).

The horizon V was overlain by the relatively homogeneous silts of the so-called horizon IV in which the Late Magdalenian remains were found. This deposit was divided in four subunits by two different classification systems. The sedimentological division was based on mainly pedological criteria (Roblin-Jouve 1996, 17-19), whereas the archaeological division was based on general depositional criteria (Orliac 1996a, 35-45):

According to the pedological criteria, the lower *c.* 50 cm of horizon IV which were formed by sands and clays (layer 4d) were affected by the overload of sediment as well as by microfaults. In consequence, these sediments were only preserved in protected areas. On top deposited beige silts were more clayish (layer 4c) and contained in the upper part the lower Late Magdalenian archaeological horizons such as level IV40. The level IV30 was situated at the base of the next subunit formed by sandy loam (layer 4b). In this layer 4b the stratification of the sediment turned from oblique to almost horizontal and wavy in the upper part where at the transition to the next subunit the various IV2 levels were deposited. On top followed a homogeneous, laminated sandy loam (layer 4a). In the upper part this sandy loam became increasingly sandy and at this stratigraphic position level IV1 was found. However, this part was often eroded. Late Magdalenian remains were not found above this sandy loam.

However, in the second division system the lower Late Magdalenian levels up to the horizon of habitation no. 1 belonged to the approximately 1.5 m thick phase of lower silts (PLI – *phase limoneuse inférieure*) which was followed by a transition phase of sandy loams (PTLS – *phase de transition limono-sableuse*) which ended at the level IV21. On top, between the horizons IV21 and IV201, an approximately 1 m thick sandy deposit (PS – *phase sableuse*) which was sterile of archaeological horizons was observed. The remaining sediment of horizon IV from level IV20 upwards was characterised as upper silts (PLS – *phase limoneuse supérieure*) which can be correlated approximately with the layer 4a in the pedological subdivision of horizon IV.

The pollen recovered in horizon IV were redeposited Tertiary material (Emery-Barbier / Rodriguez 1996, 53) and, hence, prohibited further environmental differentiation of this deposit. The malacofauna was also poorly preserved in these deposits (Emery-Barbier / Rodriguez 1996, 63). However, the few pieces which were found in horizon IV indicated a cold and dry steppe environment at the time of deposition.

These fine-grained layers were succeeded by horizon III which was formed by sands. In the lower section sands and gravels which were partially obliquely bedded were free of archaeological remains. Presumably, this lower section correlated with a formation of a new channel of the Seine (SLL) which eroded the silts of the horizon IV partially or completely in the north-western part of the area explored until the 1990s. The on average 20 cm thick layer 2b or horizon III.2 formed by greyish coarse sands with an important humic component (Roblin-Jouve 1996, 18) followed on top of the lower sands and gravels. Thus, the formation of the Seine channel and the connected erosive processes occurred before the deposition of the horizon III.2 (Orliac 1996a, 48 f.). However, this erosion represented a gap of unknown temporal dimension between the last Late Magdalenian and the archaeological remains found in the upper part of horizon III. Perhaps, the erosion was connected to an increase of occasional but significant flooding events suggested by the presence of alluvial molluscs (Emery-Barbier / Rodriguez 1996, 58. 64). The archaeological material from horizon III.2 is represented in more detail in the following. The 30 cm on top of layer 2b were of equally greyish humified coarse sands but these were very bioturbated and the upper part was eroded or altered by the overlying soils. The malacological analysis suggested that this upper horizon III represented the Younger Dryas to Preboreal transition (Emery-Barbier / Rodriguez 1996, 64). Moreover, at least one hiatus within horizon III and, perhaps, another one at the transition from horizon IV and III was proposed based on the sparse and quickly changing mollusc fauna. The malacological bisection within horizon III yielded a lower mollusc community which was comparable to horizon IV with relatively cold conditions but also with first indicators of shrubby and moist environments, whereas the upper community represented already a stronger forest component and a relatively moist ground (Emery-Barbier/Rodriguez 1996, 58-60). Only in the sediment above the archaeological horizon III.2 Late Quaternary and Holocene pollen were recovered (Emery-Barbier/Rodriguez 1996, 54-57). However, this observation confirmed that the material of III.2 was clearly deposited before the Holocene.

On top of the greyish humified coarse sands followed reddish, clayey sands which were already attributed to horizon II (layer 1c and b). These sands contained Neolithic to Gallo-Roman archaeology. Comparable to the upper part of horizon III, these deposits were bioturbated heavily, probably, because they were overlain by the topsoil (layer 1a) in which only Gallo-Roman remains were found.

Thus far, approximately 15 different Late Magdalenian horizons were identified of which at least seven formed living floors and were therefore frequently mentioned in the literature on the late Upper Palaeolithic (IV-0, IV-20, IV-21, IV-21-3, habitation no. 1, IV-30, IV-40; Orliac 1996a, 38; cf. Valentin 2008a; Bodu 2010). In addition, at least one horizon attributed to the Lateglacial Interstadial (III.2) was found (Bodu/Orliac/Baffier 1996; Orliac 1996b, 4). The vertical spread of the archaeological material encompassing approximately 10 cm within this Lateglacial Interstadial horizon was in contrast to the dense but thin Late Magdalenian horizons considerable and, probably, due to intense bioturbation in the horizon III (Bodu/Orliac/Baffier 1996, 69). However, the archaeological horizon III.2 was located stratigraphically 0.5-1 m higher than the last Late Magdalenian horizon and clearly fell to the transition period between Late Magdalenian and FMG. Therefore, the material from this horizon is considered in the present study. Although $^{14}C$ dates taken on samples of the Late Magdalenian material from horizon IV (Débout et al. 2012) also attributed these remains to the transition period, the archaeological material as well as the environmental data (e. g. Bodu et al. 2006b; Bignon 2006; cf. Limondin-Lozouet et al. 2002) clearly aligned these remains with the Late Magdalenian occupations of Gönnersdorf and the lower horizon of Andernach.

Archaeological remains of the horizon III.2

In total, 561 lithic artefacts were attributed to this horizon (**tab. 35**). Perhaps, a previously recovered blade which was found isolated in the same stratigraphic context and which wore splinters of use along the lateral edges could be added to this inventory. However, 72 pieces were only splinters. 119 artefacts and two stones were altered by heat.

The raw material was a Cretaceous flint which according to the rolled cortex was recovered from secondary deposits such as the river gravels (**tab. 36**; Bodu/Orliac/Baffier 1996, 69). Some pieces showed alterations due to frost (Orliac 1996b, 87). The resource of this material was presumably the same as for the Late Magdalenian at Pincevent but the quality for knapping of the chosen pieces was not as high as in the Late Magdalenian inventories (Bodu/Orliac/Baffier 1996, 72). Nevertheless, a blade from section 17 and, perhaps, a further six pieces (two backed points, four flakes) from the same section were made of higher quality material which was possibly a Tertiary chalcedony (Orliac 1996b, 87-89). Such material was described from other sites in Paris Basin and, possibly, originated from the Loire region or the hills west of the Seine. Thus, the material was brought from at least 40 km distance. Moreover, a granite cobble with traces of heating was recovered in section 17. Unless, a vein of granite was found by chance in the surrounding underlying bed rocks, the next resources of proper granite were recorded at least 150 km south-eastwards in the Morvan region or over 300 km eastwards in the Alsace-Lorraine region.

A total of ten cores were found (**tab. 37**) but additionally fragments and raw material nodules were also recovered suggesting the discard of inferior quality material. The artefacts yielding indications of the percussion technique indicated the use of direct hard hammerstone percussion throughout the complete *chaîne opératoire*. (Bodu/Orliac/Baffier 1996, 74f.). According to the technical observations on the blank production debris and the choice of the blanks for further retouching, the blank production of this horizon was focused on blades and bladelets (Bodu/Orliac/Baffier 1996, 72-74). Several of the blades and flakes found at the site showed clear traces of use such as splintering.

Furthermore, the largest group among the 32 retouched artefacts from horizon III.2 were flakes but mainly blades with unspecific retouches along one or more edges (n=11; **tab. 38**). In addition, a retouched blade from approximately the same stratigraphic level was attributed to this inventory. The most numerous class of typical tools were end-scrapers which made up a fourth of the retouched artefacts (n=8). However, seven pieces were identified as truncation mainly of the oblique type. Three LMP were recovered during the excavation and a further two pieces were previously collected on the surface. The two collected finds were comparable to an excavated point and, thus, identified as bipoint, although one of the pieces and the excavated specimen had a small oblique basal retouch which was set apart from the curved back by an angle. In addition, a medial fragment and a large, angle-backed *couteau à dos* were determined. Only two burins were found which were made either on a natural edge or breakage. However, borers and composite tools were absent.

Only 199 bone fragments were recovered from this horizon in section 27 (Bodu/Orliac/Baffier 1996, 81) and a further 25 fragments in section 17 (Orliac 1996b, 89 and 91). Some 15-20 elements were attributed to red deer (*Cervus elaphus*) and approximately a further ten pieces were attributed to aurochs (*Bos primigenius*; **tab. 39**). Although only one adult animal of each species was attested by these remains, the spatial distribution suggested that the faunal material was partially unconnected and, thus, result from various, independent hunting episodes. Moreover, single bones were determined as originating from wolf (*Canis lupus*), badger (*Meles meles*), and arctic hare (*Lepus timidus*). The later represented a typical member of the Late Pleniglacial cold steppe, whereas the other two were known from a wide range of habitats. Nevertheless, the singular occurrences of these species prohibited further connections to the human dynamics on the site. Further small mammals including five pieces of mole (*Talpa europaea*) were recovered. In general, there is no clear association of such animals to the archaeological remains and, in addition, many of them were usually considered as originating from Holocene burrowing which was in accordance with the fact that the greyish humic coarse sands on top of the archaeological level were heavily bioturbated.

The lack of horse remains needed special emphasis since an engraving represented such an animal (**tab. 42**). This engraving was in the calcareous cortex of a large flake. It represented a horse head which was comparable to several such images from the Late Upper Palaeolithic to the Mesolithic and was positioned stylistically at the transition between the realistic figurative and the expressive silhouette art (Bodu/Orliac/Baffier 1996, 85; cf. Pigeaud 2007). Although the piece was not found *in situ* but in the spoil heap of a ten year previously made mechanical detachment, refitting to material from horizon III.2 in section 27 was possible and proved the connection to this assemblage (Bodu/Orliac/Baffier 1996, 82).

### Spatial organisation of the horizon III.2

The archaeological material originated from two concentrations, one in the north-eastern part of section 27 (Bodu/Orliac/Baffier 1996) and the other one in section 17 and, perhaps, spreading northwards into section 18 (Orliac 1996b, 87). In addition, an isolated blade and few bones were also recovered from the intermediate area, including the undisturbed parts of section 18 (Bodu/Orliac/Baffier 1996, 68). These finds suggested further episodes and, perhaps, a more complex settlement behaviour in this horizon. However, in section 27 the artefacts were associated with a brownish olive sandy soil (layer 2b), whereas in section 17 the horizon III was only formed by undifferentiated sands and the archaeological material occurred approxi-

mately from the middle of the deposit. Thus, the stratigraphic comparison did not make possible a decision between the two suggestions. Moreover, refitting attempts provided no result.
The only evident structures were two hearths from section 17. However, these structures were found some 3-4 m north of the small accumulation (Orliac 1996b, 87) where mainly blank production was performed. The western hearth was very small and observable by alteration of the sediment. In addition, some lithic material was associated with the western structure. The larger hearth was disturbed by bioturbation. Nevertheless, the sediment alteration allowed for the identification of a basin-set hearth. Within this basin a 10 cm large stone was found which was probably used as heating material. Presumably, this hearth was used in at least two phases. However, no unambiguous connection to the main lithic concentration could be established. 14 burnt flakes and six calcined fragments of bone were clustered in the eastern part of the main lithic accumulation that had a dimension of 4 m × 3 m. Possibly, a latent hearth or a dump was represented by these pieces. On the opposite side of the concentration, the core and some produced blades were found, whereas the retouched material was accumulated around the possible fire.
In contrast to section 17, a more significant accumulation of material was observed in the north-east of section 27 but no evident structure was documented in this area (Bodu/Orliac/Baffier 1996, 68 f.). Nevertheless, the distribution of fire indicators was spread across the accumulation with a diffuse cluster in the centre of the concentration (Bodu/Orliac/Baffier 1996, 69 f.). The fauna was mainly associated with this concentration which was only half preserved, whereas the second half was probably cut by mechanical diggers. Some of the raw material nodules were recorded in the periphery of the concentration. Thus, blank production was one of the main aims at this concentration. This interpretation was further supported by the rare number of retouched pieces. In fact, nine of the ten cores attributed to horizon III.2 originated from the concentration in section 27, indicating a significant blank production activity in this area. However, only a few of the resulting blanks were found in this accumulation (Bodu/Orliac/Baffier 1996, 74). Nevertheless, a bipoint was also recorded in this concentration. In addition, the low number of faunal material as well as of burins, borers, and end-scrapers implied that no significant processing of faunal material was accomplished in this area.

### Chronology of the horizon III.2

From the section 27 an undetermined bone sample from the brownish olive soil was $^{14}$C-dated (OxA-391) in the early days of AMS dating and produced a mid-Lateglacial age (**tab. 44**). Due to the lack of information on the dated material an unambiguous association with the human presence cannot be evaluated. However, faunal material was attested in relation to the archaeological material but it was also possible that the sampled material came from a natural intrusion. Nevertheless, the date was in accordance with the stratigraphic evidence of horizon III.2 which was separated from the Late Magdalenian horizons by a significant erosion deposit. If the date reflected human activity at the site the erosion encompassed the first part of the Lateglacial Interstadial. The molluscs on top of this erosion channel suggested still a cold though moister environment which could be correlated with the transition towards the mid-Lateglacial Interstadial (GI-1d/GI-1$c_3$). In addition, the development of an olive soil further sustained an attribution to the early Lateglacial Interstadial (GI-1$c_3$) where forest communities quickly spread forming the habitat for red deer and aurochs.
In contrast, many $^{14}$C dates from the underlying horizon IV provided comparable results. However, the stratigraphic as well as the environmental data clearly attributed the Late Magdalenian occupation of Pincevent to a period comparable to the occupation period of Gönnersdorf and the lower horizon of Andernach. Thus, a systematic error or contamination needs to be considered. Many of these dates were taken on charcoal usually from hearths. However, a microscopic analysis revealed that the burnt material from hearths in Pincevent represented a conglomeration of materials (Bodu et al. 2009b). In samples taken for the same analysis in

Marsangy, modern intrusions were revealed (Bodu et al. 2009b, 99 f.). Perhaps, the position in a floodplain intensified this partial exchange of material. Furthermore, this type of infiltration of more recent material could explain some of the very young results at Pincevent. In fact, two recently dated samples of charcoal material which was previously screened microscopically (ETH-37120, ETH-37119) resulted in considerably older dates (**tab. 44**). These results were still younger than the material from the Central Rhineland but if these results were calibrated they were clearly attributable to the Late Pleniglacial. Nevertheless, also dates on bone resulted in comparatively young result. However, these dates were made in the early use of AMS dating at Oxford and contained significantly high standard deviations. Perhaps, further dating on precisely chosen material could help clarifying the problems with the precise chronostratigraphic development of the site.
Certainly, the material from section 27 and the remains from section 17 represent two distinct occupation episodes. Moreover, the eastern hearth of section 17 was suggested as two-phased. However, whether the material originated from the same occupation event could no longer be tested. The technological analysis suggested that the lithic material from both sections was comparable and comparably different from the techniques applied to the material during the Late Magdalenian (Orliac 1996b, 92). Moreover, the sparse faunal evidence were also comparable. However, the relative stratigraphic position of these areas cannot be determined due to the considerable spatial distance of over 30 m and the reduced stratigraphic development in section 17. Perhaps, the two concentrations represented complementary activity areas within a single, larger occupation event. Nevertheless, in this scenario material should be refittable from the two concentrations but this was not possible thus far. Therefore, the two episodes could reflect recurrent visits to the site which would represent a continuation of the Late Magdalenian behaviour at the site.

### Conty, Somme

#### Research history

The site *Le Marais* near Conty was found during surveys led by Thierry Ducrocq and Pascal Le Guen in advance of gravel exploitation in early 1994. Subsequently, Jean-Pierre Fagnart with his team conducted a rescue excavation of the material which was preserved *c.* 1.3 m underneath the water table (Fagnart 1997, 109). During this excavation a concentration of lithics and bones in the lower horizon was uncovered on an approximately 100 m² large area. However, due to the ingress of water, the spatial and stratigraphical positions were only observed in a very general way per square-metre.

#### Topography

The site was located north of Conty in the valley of the Selle (**tab. 34**) which confluences into the Somme almost 20 km north-east of the site. Around Conty the Selle flows approximately from south to north. The confluence of the tributary Evoissons into the Selle lies 200-300 m south of the site. Due to this confluence a small basin measuring approximately 1 km × 1 km was formed south-west of the site. Around the basin and on both sites of the approximately 500 m wide Selle valley the hills rise up gradually some 30 m. East of the site a small dry valley cuts the surrounding hills. The site was located centrally in the valley. According to the stratigraphic observations, the site was situated in the floodplain of the river between two stream beds during the Lateglacial (Fagnart 1997, 110 f.).

#### Stratigraphy

Above river gravels a small band of sandy silts were deposited which were attributed by comparison with the development in the Somme valley to the Late Pleniglacial or early Lateglacial Interstadial (Fagnart 1997, 110). In some parts of the valley down cutting occurred in these deposits which were partially filled with peaty material (Antoine et al. 2003b). Palynologically, these peaty fillings revealed in their upper part a very high amount of arboreal pollen which was mainly due to a significant presence of willow (*Salix* sp.). The sandy silt deposits were overlain at the site by a 30-40 cm thick, very loamy, organic silt deposit which was assumed as correlative to the Belloy-sur-Somme soil (Fagnart 1997, 46). The artefacts of the lower archaeological horizon were found at the base of these silts, whereas the intermediate archaeological horizon was stratified in the upper part of this deposit. The intermediate horizon produced only a few lithic and faunal remains and was attributed to the end of the Lateglacial Interstadial. However, due to this chronostratigraphic attribution, the small number, and the publishing status, this material is not incorporated in the present study. In the palynological analysis the two parts of the deposit appeared very different (Antoine et al. 2003b): In the lower part the arboreal pollen were not as frequent as in the peaty deposits but at this level the pollen diagram was clearly dominated by birch (*Betula* sp.). In the upper part, the arboreal pollen were nearly as frequent as in the peaty deposits and at this level of the stratigraphy, the predominant pollen were pine (*Pinus* sp.). On top the loamy silt deposit 50-70 cm of very calcareous, sandy silts followed (Fagnart 1997, 110) which were attributed to the Younger Dryas by the malacological and the palynological analyses (Antoine et al. 2003b). In the upper part of these silts, the upper archaeological horizon was found and accordingly placed to the early Preboreal. This horizon provided material attributed to the Long Blade Technology with bruised blades. Loamy silts and the modern topsoil formed the upper part of the stratigraphy.

Archaeological material of the lower horizon

In the lithic concentration of Conty were approximately 2,000 artefacts found including the splinters of the blank production process (**tab. 35**). A more detailed study of the archaeological material (Coudret/Fagnart 2012; Fritz 2012; Auguste 2012) was not available to the present author in time to be incorporated in this study. Therefore, the following descriptions are based only on previous presentations of the material (Fagnart 1997; Coudret/Fagnart 2006).

They were made of the local Turonian flint (**tab. 36**) which due to its homogeneity is an excellent raw material. Presumably, the material was taken from a primary resource some 500 m west of the site.

At least three cores were recovered from the site (**tab. 37**). They were used to produce short blades. These blades were knapped with a soft hammerstone. The butt of these blanks was generally plain, rarely facetted, indicating little core preparation.

In the assemblage 42 retouched artefacts (**tab. 38**) and ten blades with heavy use-wear were detected. The LMP were clearly the largest tool category (n = 24) which Jean-Pierre Fagnart divided in the couteaux à dos (n = 7), the *pointes aziliennes* or *Federmesser* (n = 16), and a single backed bladelet. As mentioned previously, the terms Azilian point and *Federmesser* were used variedly and according to the published drawings (Fagnart 1997, 114 fig. 89) several pieces were re-classified in the present study (see p. 275-282). Furthermore, six burins were found of which five were dihedral types and one was made on a truncation. However, five truncations were recovered. The end-scrapers were rare with two short examples. In addition, two borers were found and both classified as bec.

Furthermore, some 2,000 faunal fragments were recovered from the concentration. Due to the very good preservation the majority was determinable (**tab. 39**). Among the determined bones were those of aurochs (*Bos primigenius*) more frequent than the remains of red deer (*Cervus elaphus*; Fagnart 1997, 111). In addition, roe deer (*Capreolus capreolus*) was also attested (Coudret/Fagnart 2006, 731) which was, thus far, considered as a younger element in the Lateglacial fauna of North-western Europe (Sommer et al. 2009).

The good preservation also made it possible to observe various traces of human manipulation on the bones. An on-going analysis of these traces will provide more insights into the animal exploitation strategies of these mid-Lateglacial hunter-gatherers (Fagnart 1997, 111). Preliminary results of this archaeozoological analysis indicated an occupation of the site during the late winter season (**tab. 40**; Coudret/Fagnart 2006, 738).
An antler fragment of red deer was worked and decorated (Fagnart 1997, 112). This heavily fractured piece consisted of the basal shaft which was preserved over 20 cm long and the fractured lowest prong (Fagnart 1997, 118). The use of this object remained unclear but closest parallels were the so called Lyngby axes of northern Europe (**tab. 41**; cf. Clausen 2004). Even though the piece was very fractured, groups of engraved zig-zag lines were visible on several parts of the specimen (**tab. 42**; Fagnart 1997, 117). This type of geometric decoration was widely known in Lateglacial Europe (e.g. Rozoy 1990; d'Errico 1994; David/d'Errico/Thévenin 1998; d'Errico/Ucelli Gnesutta 1999; Veil/Terberger 2009).

Spatial organisation of the lower horizon

Due to the observed accumulation of burnt bones and lithic artefacts, a hearth was reconstructed in the east of the artefact scatter (**tab. 43**; Fagnart 1997, 111). A concentration of larger bone fragments was recorded some metres to the south of the hearth and the scatter of artefacts and, possibly, represented a dump site or a special working place.
The presence of the bones supplemented by the dominance of LMP and used blanks led to the interpretation of a specialised camp for hunting preparation and/or processing of the prey after a successful hunt. However, the diversity of the faunal material as well as the presence of a dump/special task area and the presence of the hearth could suggest a longer duration with more complex spatial organisation. Perhaps, the detailed archaeozoological study will help to explain this assemblage. For instance, if the accumulation of larger bones represented a workshop and some of the species were introduced as provision material, the hypothesis of a special task camp could be sustained.

Chronology of the lower horizon

Four bones of *Bos primigenius* were $^{14}$C-dated (**tab. 44**) and produced a homogeneous scatter between 11,980 and 11,330 years $^{14}$C-BP (Fagnart 1997, 112). Two dates from samples of charcoal (GifA-99526) and bark (Ly-284) taken for the stratigraphic analysis of the site yielded again comparable results. Further dates were taken on samples of sediment for the stratigraphic analysis (cf. Ponel et al. 2005). These dates were excluded due to the lacking association with the archaeological material as well as the general scepticism towards the reliability of sediment samples (see p. 265-269). However, the combination of all these dates clearly placed the human activity at the site of Conty to the mid-Lateglacial Interstadial. This chronological position was in accordance with the stratigraphy and could be further sustained by the palynological and malacological analysis.
The material from the lower horizon of Conty represented, perhaps, the remains of very few events in a temporally close succession or, more probable, of a single episode in the mid-Lateglacial Interstadial.

## Hangest-sur-Somme III.1, Somme

Research history

The site III.1 from Hangest-sur-Somme was found in a test pit program conducted prior to gravel exploitation in the Somme valley. After quarrying work had already begun in the gravel pit, the site Hangest-sur-Somme III.1 was excavated in 1992 in a rescue project by Jean-Pierre Fagnart and his team. The work was particularly complicated by the elevated water table. Hence, the relevant sediment of 150 m² was mechanically recovered in 1-2 m³ and subsequently »excavated« (Fagnart 1997, 189). Thus, even though the excavation method was adapted to the circumstances of a high water table and the short time, the recovery of the material were according to modern standards.

Topography

The site was located only several 10 m away from the western banks of the modern Somme (**tab. 34**). In this area the river flows in a large, over 1 km wide valley. During the Lateglacial, the site was probably situated on a gravel heap which rose some 1-2 m above the floodplain (Fagnart 1997, 189). The terrain rises very gradually to the south-west but 300-400 m away from the site hills rise abruptly *c.* 60 m upwards. However, a small dry valley cuts into these hills south-west of the site. Approximately 800 m northwards another, larger valley cuts these hills and gradually ascends to the elevated plateau. On the eastern side of the floodplain the hills gradually rise some 40 m. The confluence of the Somme and its tributary the Nièvre is only a few hundred metres northwards of the site. This tributary had cut a wide valley into the hills on the eastern bank.

Stratigraphy

At the site the gravels of an old river terrace were overlain by a 50 cm thick deposit of Late Pleniglacial yellowish, sandy silts on top of which a small band of sand and gravels followed (5-6 cm). Yellowish calcareous, sandy silts of 35 cm thickness were deposited on top (Fagnart 1997, 189). These silts were attributed palynologically to the early Lateglacial Interstadial (Fagnart 1997, 190 f.). On top of these silts a blackish, organic silt horizon was formed which was assumed as correlative to the Belloy-sur-Somme soil (Fagnart 1997, 46. 190). The lower archaeological horizon was found at the transition from the sandy silts to this Lateglacial organic layer (Fagnart 1997, 189; Coudret/Fagnart 2006, 731). Palynologically the lower part of the organic silt horizon was correlated to the highest arboreal values and high numbers of birch (*Betula* sp.) pollen (Fagnart 1997, 190). However, the pollen profile was partially affected by the infiltration of Holocene material but this influence decreased with increasing depth (Fagnart 1997, 191). The increased diversity of the malacological assemblage indicated a developed vegetation cover (Fagnart 1997, 191). The upper archaeological horizon was located in the same deposit but some 10-15 cm higher in the stratigraphy. The arboreal pollen were considerably less frequent in this upper part than in the lower part. Pine (*Pinus* sp.) pollen increased but birch remained dominant throughout the pollen diagram. The occurrence of *Helicopsis striata* was considered as diagnostic for the Allerød (Fagnart 1997, 191). However, the upper archaeological horizon spread to the transition to the overlaying slightly sandy, loamy silts. This 20-30 cm thick deposit was affected by cryo-turbation and attributed malacologically to the Younger Dryas. The upper part of the stratigraphy was formed by Holocene brown and blackish organic silts and peat.

Archaeological material of the lower horizon

The 1,945 lithic artefacts of the lower horizon were mainly found in an area of 15 m × 15 m (**tab. 35**). The majority (n = 1,106) were smaller than 2 cm (Fagnart 1997, 193). Some artefacts were burnt.
The flint material used in the lower horizon of Hangest-sur-Somme III.1 was from the local Cretaceous deposits and of excellent quality (**tab. 36**; Fagnart 1997, 193).
21 cores and core fragments were recovered from the lower horizon (**tab. 37**). Blades were the main aim of the blank production process. Among the blades were some long ones but the majority were short blades. The indications of the knapping technique suggested the use of a soft hammerstone. Generally, the butt was

plain but facetted ones also occurred frequently. A considerable part (41 %) of the analysed butts showed traces of abrasion but no preparation of the *en éperon* type was observed (Fagnart 1997, 197).
Among the approximately 100 tools (**tab. 38**) the LMP formed the largest category (n = 49; Fagnart 1997, 197. 255). In addition to 24 simple backed blades and bladelets, 13 truncated backed blades were identified. Three small truncated shouldered points were accompanied by three shouldered piece fragments. Furthermore, eight curve-backed points were recovered from the site among which a bipoint and a Malaurie point were found. Three large *Federmesser*-like shaped *couteaux à dos* were also found and one which resembled a large penknife point. Generally, the LMP were preserved comparatively completely. A long blade was finely retouched on its lateral edge and at the tip part an oblique abrupt retouch was made. In regard to abrading traces along the upper and lower part of the cutting edge, this piece could also be considered as *couteau à dos*. Nevertheless, formally it was regarded as truncation. A further six truncations were found in the assemblage. The 27 burins were dominantly made on truncation (n = 20) and less frequently were dihedral types (n = 6). The six end-scrapers were mainly made on flakes.
Numerous fragments of red ochre were also recovered from the site (**tab. 42**; Fagnart 1997, 193).
The fauna was poorly preserved. Determinable bones and teeth belonged to aurochs (*Bos primigenius*) and horse (*Equus* sp.; **tab. 39**; Fagnart 1997, 193). The co-occurrence of these species reflected perhaps the still mixed character of the mid-Lateglacial Interstadial landscape with forests in the floodplain where the bovid could roam but still enough grassland areas for the horses. A molar of aurochs as well as a tibia of a large herbivore, presumably also aurochs were $^{14}$C-dated.

Spatial organisation of the lower horizon
Evident structures were not observed. The lithic artefacts were distributed in small concentrations of debris from the blank production process (Fagnart 1997, 193). Furthermore, the retouched artefacts formed distinct and differentiated clusters. Thus far, no spatial analysis of the material was published.

Chronology
Chronostratigraphically, the site was attributed to the mid-Lateglacial Interstadial based on the lithostratigraphy, the palynology, malacology, and composition of the mammal fauna. Furthermore, $^{14}$C dating sustained this attribution.
According to the observations of the investigators of the site, the lower horizon from Hangest-sur-Somme III.1 represented a relatively undisturbed single occupation event (Coudret / Fagnart 2006, 738). However, without a detailed publication of the spatial information, the intra-site chronology cannot be further tested.

## Summary and context

In general, the sites in northern France were usually located in valleys at the banks of rivers (**tab. 34**). The areas investigated around the sites vary considerably (**tab. 35**) mainly depending on the research history. For instance, the sites found in gravel pits were often analysed in large campaigns, whereas the extent of excavations in caves were naturally limited. However, the amount of lithic material seemed unrelated to the extent of the excavated area but in contrast appeared dependent on the number of concentrations in this area and the type of site. For example, the 5 m² from Le Tureau des Gardes, *locus* 6 yielded more than five times as many artefacts as the 5 m² from Hallines and almost as much material as the 75 times larger area from the *loci* 4, 46, and 50 of Le Closeau.

In the exploitation of raw materials a distinction between the Paris Basin and the Somme sites is observable (**tab. 36**). In the Paris Basin occasionally foreign lithic raw materials accompanied the local raw material of varying qualities, whereas in the Somme region only the local, usually high-quality material was used.

The general tendency in the blank production process is the disappearing importance of bladelets (**tab. 37**). In contrast to the Central Rhineland, the general dominance of LMP was not observable in northern France, although some sites were also dominated by this tool class (**tab. 38**).

The preserved fauna showed diverse species compositions with horse (*Equus* sp.), reindeer (*Rangifer tarandus*), red deer (*Cervus elaphus*), and aurochs (*Bos primigenius*) being of some importance (**tab. 39**). However, the quality of the preserved material was usually not very good. Therefore, indications for human modification and the seasonal attribution of the sites are scarce (**tab. 40**). In consequence, organic artefacts were also very rarely preserved and / or recognisable (**tab. 41**).

In contrast, a group of diverse »special goods« including mineral and fossil material or engravings were usually better preserved (**tab. 42**). However, whether some of these materials such as ochre or the line engravings on cortex were of symbolic importance or utilitarian remained a matter of discussion (Barton 1992; Holzkämper 2006, 86-88).

Hearths represented also the typical structures on northern French sites (**tab. 43**). They were generally recognised by small and dense accumulation of gravels in the concentrations.

The corpus of $^{14}$C dates from northern France is relatively rich (**tab. 44**) but many dates produced arbitrary results and, thus, the record has to be evaluated rigorously (p. 265-269 and p. 474-481).

Clearly, in northern France numerous sites from the Late Magdalenian were also found such as Pincevent (Bodu et al. 2006b; Débout et al. 2012) or Étiolles (Pigeot 1987; Olive 2004). Furthermore, sites of unambiguous FMG character such as Saleux *La Vierge Catherine* (Fagnart 1997, 131-143) were also found. These sites were clearly comparable to the record from the Central Rhineland and would not provide information on the transition between the Late Magdalenian and the FMG.

Therefore, these sites were not considered in the present study.

Besides the relevant assemblages presented previously, further assemblages from northern France provided potential information on the transitional period but were excluded for various reasons:

In the late 19$^{th}$ century the 17 m × 10 m wide Grotte de Clèves near Rinxent (Pas-de-Calais) was excavated and yielded Mousterian as well as supposed Magdalenian material along with three human mandibles (Fagnart 1997, 105 f.). The latter were considered as possibly intrusive burial remains of Chalcolithic age. Among the faunal remains were at least ten reindeer (*Rangifer tarandus*) identified which were accompanied by two red deer (*Cervus elaphus*), a bovid (*Bison* sp. / *Bos* sp.), and a wild boar (*Sus scorfa*). This assemblage suggested either a transitional environmental period where wild boar and reindeer found suitable habitats in close vicinity or an admixture of the assemblage, perhaps, due to recovery. However, a piece of reindeer antler was dated to a Late Pleniglacial age (OxA-1343: 13,030 ± 120 years $^{14}$C-BP; Hedges et al. 1988a) which is comparable to the oldest group of dates from Gönnersdorf and the lower horizon of Andernach (see **tab. 20**). In this case, the reindeer remains were possibly from a different episode than the other bones. In particular, if the reindeer antler was a shed piece it could also result from the collection of fossil material and in this case the radiometric date would date the shed of the antler but not the human collection of it. Indications of human modification were found on a rib of the bovid which was described as perforated (Fagnart 1997, 106). The lithic inventory comprised some 30 artefacts of which six were retouched. Besides a shouldered point, two end-scrapers made on large flakes were the most typical pieces. Moreover, a straight truncation, an oblique truncation with a retouch from the ventral on the shorter edge, and a further two pieces with lateral retouches were found. Thus, the lithic shapes equated rather material from the intermediate period and is therefore mentioned here. However, the lack of more detailed information due to the time of recovery prohibited detailed analysis of the assemblage. Comparable lithic material with additional faunal remains were reported from another cave and a rockshelter in the vicinity of the Grotte de Clèves but both collections from the 19th century are lost (Fagnart 1997, 106).

In Flixecourt (Somme), only a few kilometres northwards of Belloy-sur-Somme, a large assemblage attributed to the Long Blade Technology with bruised blades was recovered in the late 1980s and early 1990s (Fagnart 1997, 165). Besides this assemblage, a small lithic inventory comparable to the material from the lower horizon in Belloy-sur-Somme was recovered from this site. Moreover, some artefacts were of FMG character (Fagnart 1997, 165) and, perhaps, could originate from the later Lateglacial but these specimens were not well stratified. Thus far, these assemblages from Flixecourt were not thoroughly published and, therefore, this material is not included in the present study. Nevertheless, the close locational presence of possible chronologically distinct assemblages which, perhaps, were partially independent of a continuous tradition emphasised the persistent attraction of these places in the Somme valley for Lateglacial hunter-gatherers and advised caution in the interpretation of unstratified assemblages. For instance, the lithic inventories from the gravel pits in Dreuil-lès-Amiens (Somme) and Amiens-Étouvie (Somme) were recovered during various collections and excavations (Fagnart 1982; Fagnart 1997, 120-130). Jean-Pierre Fagnart and his crew finally excavated both sites successively from 1979 to 1982. However, no spatial organization was observed, due to the acidic ground no organic material was preserved, and the stratigraphy also did prohibited further narrowing of the dating of the geological layer. Nevertheless, due to the typo-technology of the material these assemblages were discussed in the context of the Hengistbury Head type industries (e. g. Barton 1992; Barton et al. 2009) and, hence, were attributed to the mid-Lateglacial Interstadial. However, since neither the chronostratigraphic position nor the integrity of the material can be ascertained, these inventories are not further considered in the present approach.

In contrast, the material from the *locus* 244 in Saleux *Les Baquets* produced along with an assemblage comparable to the Hengistbury Head type industries also a $^{14}$C date (Coudret/Fagnart 2006; Barton et al. 2009). The site Saleux was excavated between 1993 and 2006 in three sectors. The southern one *La Vierge Catherine* yielded unambiguous FMG assemblages which were dated to the transition from the Lateglacial Interstadial to the Lateglacial Stadial (Fagnart 1997, 131-143). This chronostratigraphic position was in accordance with the stratigraphy and the palaeoenvironmental data. *Les Baquets* was the central sector and north of this a third, unnamed sector was excavated. All sectors were found along a palaeochannel in the Selle valley some kilometres north-east of Conty. In *Les Baquets* at least two concentrations were recognised. The northern one was *locus* 244. From this concentration, a metapodial of an aurochs (*Bos primigenius*) was $^{14}$C-dated (GrA-18832 (Ly-1566): 11,640 ± 70 years $^{14}$C-BP; Coudret/Fagnart 2004). The date is similar to the dates from Conty and Hangest-sur-Somme III.1. Besides aurochs, also red deer (*Cervus elaphus*) was determined in the faunal assemblage of *Les Baquets* (Coudret/Fagnart 2004). The lithic artefacts of *locus* 244 comprised very large curve-backed *couteaux à dos*, penknife points, *Federmesser* as well as some angle-backed pieces (Coudret/Fagnart 2004). Besides the LMP, end-scrapers and burins were common, whereas borers were rare. The lithic material scattered in several concentrations each presumably centred around a hearth (Coudret/Fagnart 2006). Thus, the spatial distribution suggested a complex spatial development of the site. However, the analysis of the material is on-going and too few details were published yet to incorporate this interesting assemblage in the present study. The 15 m south-eastwards located *locus* 234 was found in a stratigraphic higher position than the material from *locus* 244. This single concentration contained a human cranium (Coudret/Fagnart 2004; Coudret/Fagnart 2006). Furthermore, the lithic material was similar to the material from *locus* 244 only that among the LMP very large *couteaux à dos* occurred and also the *Federmesser* were of a considerable size (Coudret/Fagnart 2004). Of some interest was one piece which could be interpreted as Lyngby-Bromme type tanged point (Coudret/Fagnart 2004, 13 fig. 12.9). From this material two samples from aurochs were $^{14}$C-dated (GrA-15945 (Ly-1141): 11,200 ± 70 years $^{14}$C-BP; GrA-15946 (Ly-1142): 11,160 ± 70 years $^{14}$C-BP; Coudret/Fagnart 2004) and sustained the younger chronostratigraphic position. However, for this material the analysis is also on-going.

In Normandy, the assemblage of the *locus* 33 at the site Le Cornet near the village Ambenay was techno-typologically related to the material from Conty, Saleux, *locus* 244, and the upper horizon at Hangest-sur-Somme III.1 as well as Pincevent III.2 (Valentin/Fosse/Billard 2004). This inventory yielded various types of monopoints, some very large *couteau à dos*, and a flexible exploitation strategy in which mainly soft hammerstones were used (Valentin/Fosse/Billard 2004). However, the remains were found in a poorly developed stratigraphy within a very acidic soil in which no organic remains were preserved. Thus, the chronostratigraphic attribution of the site was very generally possible to the Lateglacial but, furthermore, it was solely based on the comparisons of the lithic inventory. However, since the chronostratigraphic position cannot be ascertained independently, this assemblage is neglected in the present approach.

Faunal remains from the Abri du Mammouth near Saint-Pierre-d'Autils produced a $^{14}$C date (GifA-92344: 11,040 ± 110 years $^{14}$C-BP; Fosse 1997, 241) falling calibrated to the end of the Lateglacial Interstadial and, thus, in the chronological proximity to the LSE and the onset of GS-1. In general, the date was reliable but it remained unclear which sample was exactly dated. Furthermore, the association of the specimen to the human activity around the rockshelter was equally uncertain because the archaeological material appeared of Late Magdalenian character and was found in a possible colluvium (Fosse 1997, 241). Thus, the chronological indications were inconsistent and the specification unclear. Therefore, the date and the material were excluded from the present study. Nevertheless, due to the geographic position in northern France between the concentrations of sites in the Paris Basin and those in the Somme region a re-analysis of this assemblage could provide interesting new insights in the relations of these regions.

In the near future, the remains from a test pit near Decize (Nièvre) might yield further insights in the developments within the transition period, in particular, in the southern part of the Paris Basin. However, the analyses are, thus far, still in progress and, therefore, this material was only published in a very preliminary report (Nicoud et al. 2011). The 115 lithic remains and few burnt bone fragments from test pit 1044 were associated with two dark coloured pockets in an alluvial sand deposit. Some of the lithic remains were also burnt and, in consequence these dark spots might be considered as hearths. However, the sedimentological analysis is on-going and another organic origin of the dark colour such as soil formation cannot be excluded yet. The material was found in a small cluster within and around these pockets and was assumed as a small assemblage of a single occupation event. The LMP techno-typology could either be compared to assemblages such as Amiens-Étouvie (Fagnart 1982; Fagnart 1997, 120-130) and also to Conty and Hangest-sur-Somme III.1 but it could also be compared to material such as found in *locus* 25 of Le Closeau. Perhaps, the organic remains from this site allow for a more precise chronostratigraphic position which in combination with the spatial and techno-typological analysis of the material are of particular interest in this otherwise poorly known archaeological region.