APPENDIX

ABBREVIATIONS AND GLOSSARY

A.D. *anno domini*. Referring to »after year 1 of Christian (Gregorian) calendar«.

AMS accelerator mass spectrometry. By the use of this instrument, carbon ions can be counted (Fifield 1999). This precise counting allows precise calculations of the isotopic composition of a sample and, hence, its age. The AMS is often set equivalent with this ^{14}C-dating method. The AMS is able to produce quicker results than the classic β-counting (Libby 1952) and the precision of AMS dating was improved in the last decade and can meanwhile also reach down to 0.2 % (Bronk Ramsey/Higham/Leach 2004; Higham/Jacobi/Bronk Ramsey 2006, 181). Moreover, for AMS dating a small sample size is often sufficient (Trumbore 2000, 48 tab. 1). Nevertheless, the small size of the samples may also cause problems because the effect of small contaminations rises with the decreasing size of the sampled material (Wohlfarth et al. 1998, 144; Bronk Ramsey 2008, 259). Therefore, minimum amounts of datable carbon are also required for AMS dating. At the moment this minimum is usually ranging around 1 mg C (Higham/Jacobi/Bronk Ramsey 2006; Bronk Ramsey 2008).

AP arboreal pollen. Pollen from trees and shrubs such as *Betula* sp., *Salix* sp., or *Pinus* sp.

a. s. l. above (modern) sea level.

^{10}Be beryllium isotope 10. This isotope is a cosmogenic radionuclides comparable to ^{14}C, meaning it is »produced in the atmosphere by the cascade of nuclear reactions induced by the high-energy galactic cosmic rays« (Muscheler et al. 2008, 2). It is measured in the ice-core records (Muscheler et al. 2000; Muscheler et al. 2004) as well as in moraines (Ivy-Ochs et al. 2008). The latter allows for the calculation of exposure ages of previously glaciated grounds but requires supplementary information in advance. This supplementary information includes for example the production rate of the cosmogenic radionuclides being effective at the specific location, the snow cover as well as the erosion rate (Ivy-Ochs et al. 2006, 121 f.). Even with this information the results are still given with large standard deviations (cf. Ivy-Ochs et al. 2009, 2141 f. tabs 1-2 and fig. 4). Based on the similar production, the ^{10}Be flux record of the Greenland ice-cores should reflect the same major changes as the Δ^{14}C record (Muscheler et al. 2008). However, dating uncertainties, climatic influence on the ^{10}Be deposition, and the influence of the carbon cycle on the distribution of ^{14}C between the major carbon reservoirs could cause offsets between the two records (Muscheler et al. 2008, 2). Therefore, some objections to an exact correlation were particularly discussed for the Lateglacial period and a critical use of the correlative data was proposed (Hughen et al. 2000).

b2k before 2,000. Referring to »before 2000 A.D.«. This reference was introduced as correlation point, i. e. zero year in the construction of a stratigraphic timescale based on a multi-parameter analysis of the Greenland ice-core records (Rasmussen et al. 2006, X-2). If BC ages are converted to b2k ages it needs to be noted that the year zero does not exist in the Christian calendar (i. e. b2k age = BC age + 2000 – 1; cf. Spurk et al. 1998, 1107 note 4).

β-counting β-counting or »conventional dating« is the classic method in radiocarbon dating (Libby 1952). The remaining radioactivity of the sample is measured/counted in this method (Trumbore 2000). Thus, with increasing age of the sample the measuring time also increased to produce a reliable statistical counting. Furthermore, the amount of sample material necessary for receiving reliable results is relatively high (10 g>; Trumbore 2000). In the past, this requirement often resulted in the dating of bulked material. These bulked samples only yielded a reliable date if the material originated from a single event such as a hunting episode. In the other cases, the dates were more or less arbitrary admixtures with frequently low precision and high standard deviations. Basically, due to the necessary amount of sample material, Pleistocene archaeological samples are currently mainly dated by the use of AMS.

BC before Christ. Referring to »before year 1 of Christian (Gregorian) calendar«.

BP before present/physics. Referring to »before 1950 A.D.«; originally used for the timescale of radiocarbon measurements (Godwin 1962) but later also adopted for other scientific timescales. If BC ages are

converted to BP ages it needs to be noted that the year zero does not exist in the Christian calendar (i. e. BP age = BC age + 1950 – 1; Spurk et al. 1998, 1107 note 4).

b. s. l. below (modern) sea level.

^{14}C carbon isotope 14; also radiocarbon. Willard F. Libby introduced this instable natural carbon isotope as a means for dating organic samples from the past (Libby/Anderson/Arnold 1949; Libby 1952).

c. *circa*. approximately.

Ca^{2+} calcium ions. These ions are the soluble part of the mineral aerosols deposited in ice layers (Ruth et al. 2007). The Ca^{2+} content is one of the parameters frequently analysed in ice-core sequences because it can help to identify annual layers in the ice-core record (Rasmussen et al. 2006). Furthermore, these calcium ions, particularly, in combination with the insoluble dust concentration are assumed to »reflect both source strength and transport conditions from terrestrial sources« (Steffensen et al. 2008, 681). These conditions allow further assumptions on the organisation of the atmospheric dust circulation and, thus, on the climate system.

CBP groups Curve-Backed Point groups. Assemblages in which curve-backed points (Kozłowski 1987) are more abundant than other point types. Thus, the term is identical with the term arch-backed point technocomplex (Schild 1984). Most common types of Lateglacial curve-backed points are bipoints, *Federmesser sensu stricto*, penknife points, and Malaurie points. Thus, the CBP groups can also be regarded as equivalent with the Azilian *sensu lato* (see p. 65-74). However, assemblages with dominantly straight-backed points or angle-backed points are excluded by this definition. Assemblages where mainly these types of points were found formed further sub-groups such as the Angle-Backed or Shouldered Point groups which occurred partially contemporaneous with CBP groups.

cal. calendar. This addition to reference points means that the datum or age is expressed on a sun year (calendar/solar) timescale. Generally, cal. is referring to the Gregorian calendar.

CELM Central European Lateglacial Master Chronology. Chronology based on cross-dated raw data of Swiss and southern German tree-ring sequences building an almost continuous connection to the Central European dendrochronology spanning the Holocene into the Mid-Younger Dryas (Kaiser et al. 2012).

CEDC Central European Dendrochronology. A continuous tree-ring record back to the mid-Lateglacial Stadial based on German and Swiss oak and pine material (Friedrich et al. 2004; Schaub et al. 2008b; Hua et al. 2009). Besides the comprehensive ^{14}C data set, the record also provided insights into climatic and environmental developments by means of tree-ring widths (Friedrich et al. 1999; Friedrich et al. 2001b).

CFA continuous flow analysis (Rasmussen et al. 2006). This term refers to a broad range of techniques which are automated procedures allowing the simultaneous analysis of several chemical elements from a liquid sample such as ice water (Spolaor et al. 2013).

cf. *confer*. compare further.

D deuterium (^{2}H). Deuterium is the stable isotope 2 of hydrogen. In palaeoclimatology, D usually refers to δD which is the ratio of ^{2}H to ^{1}H expressed in ‰. In ice-core records and tree-rings, it is considered as a proxy for the local temperature change (Petit et al. 1999; McCarroll/Loader 2004). Since in both types of records the hydrogen isotopes originate from precipitation, the hydrological cycle also has some influence on this proxy.

d deuterium excess. The deuterium excess is the difference of eight times the ^{18}O content from the deuterium ratio ($d = \delta D - 8\delta^{18}O$). It is assumed to be a proxy for past ocean surface temperatures at the moisture-source region (Steffensen et al. 2008). Besides the temperature at the source region, d is influenced by the position of this source region and, thus, by the seasonal precipitation patterns in the North Atlantic (Masson-Delmotte et al. 2005; Sodemann et al. 2008).

$\Delta^{14}C$ level of atmospheric ^{14}C. This level is calculated by the comparison of ^{14}C with ^{12}C isotopes and the modern standard (Stuiver/Polach 1977).

di density index. In this study, the di is used to give the density of artefacts on an excavated site. It is calculated by dividing the number of artefacts by the number of excavated square-metres (see p. 270, **tab. 83**, and p. 491-495).

ECM electrical conductivity measurement. Electrical conductivity in ice-cores depends on the acidity of the ice. This acidity changes in measurable degrees with the input of alkaline dust (Taylor et al. 1993a) or

volcanic aerosols (Moore et al. 1992). Therefore, the method is used as a proxy for the moisture regime at the source region of the dust or as marker for volcanic activities.

e. g. *exempli gratia.* for example.

ei exploitation index of artefacts ≥ 1 cm. In the present project, the ei is calculated by dividing the number of artefacts ≥ 1 cm by the number of cores (see p. 271 f., **tab. 83**, p. 491 f., and p. 500-503). The index is used to give an approximation of artefacts produced by a single core.

ei_T exploitation index of total numbers of artefacts. In contrast to the ei above, this index is calculated by dividing the total number of artefacts by the number of cores (see p. 271 f., **tab. 83**, p. 491 f., and p. 503). Thereby also the splinters are encountered and, thus, allowing for some assumptions on the splintering of the raw material either due to its properties or the knapping performance.

ELA equilibrium line altitude. In glacier studies, the term refers to an altitude where a stability of total net ablation and accumulation of the glacier is reached within a year (e. g. Benn/Lehmkuhl 2000; Osmaston 2005; Zemp/Hoelzle/Haeberli 2007; Federici et al. 2008). Thus, the variation of this theoretical line indicates climatic fluctuations.

ELSA Eifel laminated sediment archive (Sirocko et al. 2005). Within this project sediment cores from dry volcanic lakes in the Eifel region are taken. These cores produced high-resolution (annually layered) litho- and biostratigraphic sequences spanning together a period from the middle Pleistocene to the Holocene. In the present study ELSA refers in particular to a combined sequence of undisturbed sections from four ELSA cores, which form the »ELSA greyscale stack 2005« (Sirocko et al. 2005, 834). The greyscale results from the sediment being darker in warmer periods due to higher organic carbon content and lighter in colder periods due to higher amounts of silt-sized quartz, i. e. it can be taken as an indicator of increasing/decreasing organic material in the catchment area of the lakes.

esp. especially.

eventstratigraphy succession of identifiable sections in which distinguishable, widely occurring, short-term phenomena (<100 kyrs) form the geochronological system such as geomagnetic reversals (Kauffman 1988). – In the present study, eventstratigraphy usually refers to the Greenland oxygen isotope eventstratigraphy (Björck et al. 1998; Walker et al. 1999; Lowe et al. 2008). The Greenland oxygen isotope record is largely influenced by the climate regime of the North Atlantic. In particular, changes between periods of cold and dry climate (Greenland stadials, GS) and periods of warm and moist climate (Greenland interstadials, GI) resulted in very different values. The developments of these periods form distinguishable sections which are often separated by very short-term shifts. Thus, these periods can be described as events. These events are counted parallelly (GS-1, GI-1, GS-2, GI-2, GS-3 etc.) top-down in the stratigraphy of the ice-cores, meaning from young to old. The Holocene is in fact the current Greenland interstadial but counting only began after the first significant shift in the record, i. e. the onset of the Holocene. Therefore, the Holocene is not numbered and abbreviated as GH. Significant shifts towards generally lower or higher values than in the period before are used as limits of the events. Due to the annually formed ice layers in the Greenland ice-cores, these limits can be dated precisely. Since the significant shifts in the Greenland records reflect major changes in the North Atlantic climate regime, the onsets of these Greenland events were assumed as markers which should also affect the marine and terrestrial environments. Therefore, these climate events should be detectable in other records and the onsets of these marine and terrestrial changes were often tuned to the Greenland chronology.

etc. *et cetera*. and the rest/and so forth.

FAD first appearance datum. Commonly used in palaeontology, it gives the oldest dating for a specific phylogenetic order; usually it is used on the species level (Fahlke 2009, 13). In the present project, the FAD is given according to directly ^{14}C-dated remains of a specific species in the sub-areas of this study. These dates are further limited between the LGM and the onset of the Holocene (cf. Aaris-Sørensen 2009).

fi function index. This index is calculated by dividing the number of formally retouched artefacts by the number of cores (see p. 273, **tab. 83**, and p. 504-506). The fi is considered to reflect the relation of the major functions within the lithic assemblages in this study.

FMG *Federmesser-Gruppen/Federmessergruppen/groupe à Federmesser*. This term was introduced by Hermann Schwabedissen (Schwabedissen 1944b; Schwabedissen 1944a, Schwabedissen 1954) and can refer to a (chronological significant) sub-group of the Azilian (cf. Baales 2002). However, occasionally

the term is also used synonymous to the CBP groups and/or the Azilian. The main projectiles within the assemblages attributed to the FMG are small lithic points with a curved, blunting retouch of one lateral edge ending in a single tip, the so called *Federmesser*. These points represent one of the most common types of the curve-backed points and are chronologically insignificant (Célérier/Nisole/Beaune 1993, 89-92; cf. Ikinger 1998). Furthermore, in the lithic inventories of the FMG small end-scrapers, unstandardised burins, and some various truncations occur. Little is known about the organic tool inventory (e. g. Baales 2002; cf. Clausen 2004) as well as the personal ornamentation or art of the FMG. Evident settlement structures are rare and only the distribution of the archaeological material allows some latent structures to be identified. The concentrations are generally small dense clusters of lithic artefacts often distributed around an area with burnt artefacts and/or burnt bones which are interpreted as latent hearths. In general, FMG characterised in this way were found in a light forest environment. Unambiguous dates for the FMG place them in the second half of the Lateglacial Interstadial (i. e. GI-1c_1 – GI-1a).

GH — Greenland Holocene. See eventstratigraphy, p. 593.

GI — Greenland Interstadial. See eventstratigraphy, p. 593.

GICC05 — Greenland ice-core chronology 2005 (Vinther et al. 2006; Rasmussen et al. 2006; Andersen et al. 2006; Svensson et al. 2006; Rasmussen et al. 2008; Svensson et al. 2008; Wolff et al. 2010). The currently (effective: mid-2011) best available, annually resolved ice-core chronology for the last 60,000 years based on the analysis of seven chemical parameters added up by the visible stratigraphy from the records of the Greenland ice-cores GRIP, NGRIP, DYE-3 and GISP2. The resolution of the single parameters differed between 3 and 50 years (Rasmussen et al. 2006, X-3 tab. 1). In the Holocene and below the beginning of the Lateglacial Interstadial the records were correlated by volcanic marker events as documented in the ECM (electrical conductivity measurement) and furthermore the NH_4^+ record (Rasmussen et al. 2008). The chronology was counted back 60,200 years (Svensson et al. 2008) and an age model was applied to it further back to 123,000 years (Wolff et al. 2010).

GISP2 — Greenland Ice Sheet Project 2 (e. g. Grootes et al. 1993; Zielinski et al. 1996; Stuiver/Grootes 2000). This over 3,050 m long Greenland ice-core was drilled at 72.58 N and 38.47 W (3,208 m a. s. l.), some 28 km westwards of the GRIP ice-core (Taylor et al. 1993b). Visible layers were counted in the Pleistocene part of this ice-core (Alley et al. 1997; Meese et al. 1997).

GLPC — German Lateglacial pine chronology. Abbreviation used in the present work for the thus far floating data set of ^{14}C-dated Lateglacial tree-rings of mainly pine (Kromer et al. 2004) but also some poplars which were recovered in Kruft within the deposits from the LSE (Baales/Bittmann/Kromer 1998; Friedrich et al. 1999; Kromer et al. 2004).

GRIP — Greenland Ice Core Project (e. g. Johnsen et al. 1992; Taylor et al. 1993a; Johnsen et al. 1995; Johnsen et al. 2001; Masson-Delmotte et al. 2005). This Greenland ice-core was drilled 3,028.8 m deep at 72.58 N and 37.64 W (3,238 m a. s. l.), i. e. 28 km east of the GISP2 ice-core, and covers approximately the last 250,000 years, although beyond 160,000 years the lamination becomes indistinct (Dansgaard et al. 1993). It was originally defined as the stratotype for the Greenland isotope eventstratigraphy (Björck et al. 1998; Walker et al. 1999).

GS — Greenland Stadial. See eventstratigraphy.

Heinrich event — A Heinrich event refers to a period of massive iceberg discharges in the North Atlantic (Heinrich 1988). This discharge is identified by the deposition of notable amounts of ice-rafted debris (IRD) and occurred periodically in the North Atlantic with frequencies of 5,000-14,000 years (Stanford et al. 2011b). Heinrich events are usually assumed to result from massive collapses of ice sheets in the northern hemisphere (Peck et al. 2007). The resulting iceberg flux led to a halt in the North Atlantic thermo-haline conveyor belt (Rahmstorf 2002). These processes are assumed to have caused exceptionally cold and arid climates in Europe (Bartov et al. 2003; McManus et al. 2004; Wohlfarth et al. 2008; Sima et al. 2009).

HULU — speleothem record from five cave stalagmites in the Hulu Cave encompassing the time period between *c.* 11,000-75,000 years cal. b2k (Wang et al. 2001). The record yielded a calcite $\delta^{18}O$ sequence which is closely connected to the Asian monsoon. The stalagmites have been partially band counted and additionally $^{230}Th/^{234}U$ dated providing a precise timescale for the encompassed time period (cf. Weninger/Jöris 2008).

IACP — Inner or Intra-Allerød Cold Period (Lehman/Keigwin 1992). This period occurred within the generally temperate phase of the Allerød in the North Atlantic records. The IACP is assumed to be equivalent

to the isotopic event GI-1b in the Greenland ice-core archives, the Gerzensee oscillation in the Swiss lake environments (Lotter et al. 1992), and the Killarney oscillation in North American lake records (Levesque/Cwynar/Walker 1997). Since the impact of this oscillation was recognisable around the North Atlantic seaboard this period was also named »Amphi-Atlantic Oscillation« (Levesque et al. 1993).

i. e. *id est*: this (what is said before) is/means

IRD ice-rafted debris. Layers of this material in sediment cores from the North Atlantic indicate Heinrich events. The debris originated from icebergs which melted and thereby set indissoluble material free which was enclosed in the ice during its formation and movement processes. Thus, an analysis of the petrological and geochemical composition of the debris provides indications for the origin of the icebergs (Peck et al. 2007; Bigg et al. 2010). The layer thickness indicates the intensity of the iceberg discharge. In addition, the latitudinal position at which these layers occur provides an indication of the magnitude of the iceberg discharge.

ITCZ Inter-Tropical Convergence Zone. The ITCZ is an atmospheric zone located around the equator. It is strongly influenced by the sun and, consequently, the position of this zone shifts seasonally with the angle of the sun. The intense heating of the air in the equatorial area by the sun causes the air to rise. Subsequently, the cooler air masses of the northern and the southern hemisphere push into this zone leading to cloud formation and heavy rains in the zone and wind formation around this zone (e. g. Hasenrath 2002). Furthermore, in the Atlantic the ITCZ is also closely connected to the sea-surface temperatures (e. g. Marshall et al. 2001).

kyrs kilo years. 1,000 years.

LAD last appearance datum. Commonly used in palaeontology, it gives the youngest dating for a specific phylogenetic order; usually it is used on the species level (Fahlke 2009, 13). In the present project, the LAD is given according to directly ^{14}C-dated remains of a specific species in the sub-areas of this study. These dates are further limited between the LGM and the onset of the Holocene (cf. Aaris-Sørensen 2009).

LGM Last Glacial Maximum. Depending on the definition the LGM refers to the time of the maximum low of the global sea level or the last maximal ice sheet advance. In general, the latter is in Europe correlated with GS-3 (*c.* 27,500-23,340 ± 298 years cal. b2k, Andersen et al. 2006) or, precisely, late GS-3 (cf. Weninger/Jöris 2008). However, the marine records and the global ice sheet developments as well as terrestrial indicators suggested a more complex development resulting in a range of times given for the LGM from GS-3 to approximately GS-2c (Clark et al. 2009; Starnberger/Rodnight/Spötl 2011). Also in the archaeological record, a period with scarce archaeological evidences is mainly related to the LGM and dated around 23,000-16,000 years ^{14}C-BP (*c.* 28,000-19,000 years cal. b2k; Terberger/Street 2002; cf. Verpoorte 2004). In particular, archaeological material is almost absent from Central Europe between 22,000-19,000 years ^{14}C-BP (*c.* 27,000-22,500 years cal.b2k).

LMP laterally (abruptly) modified (laminar) pieces. A general term for »backed pieces« introduced by Jean-Paul Caspar and Marc de Bie (Caspar/De Bie 1996). A comparable term »abruptly modified pieces« was used by Roger Jacobi (Jacobi 2004, 34-45). While LMP refers to the position of the retouch, Jacobi's term refers to the retouch itself. Under both terms almost all Upper and Final Palaeolithic projectile implements and their fragments as well as various »knives« can be understood. However, LMP can also refer to not abruptly retouched pieces, which were possibly not used as projectiles (laterally retouched pieces), whereas abruptly modified pieces could also refer to various types of truncations. However, in the present work, LMP refers to laminar pieces with abrupt modification along at least one lateral edge.

LSE Laacher See (volcano) eruption. The LSE is a major volcanic marker event in the late Lateglacial Interstadial, which spread visible ashes (see below) across most parts of western Central Europe (Schmincke/Park/Harms 1999, Baales et al. 2002).

LST Laacher See Tephra. These are the ashes of the LSE, which have been identified as visible ashes as well as microtephras across most parts of Central Europe (e. g. Baales et al. 2002; Davies et al. 2002; Turney et al. 2006). These are chemically and mineralogically well defined (Wörner/Schmincke 1984) and therefore could e. g. be excluded from volcanic ashes preserved in the northern Greenland ice-core records (Mortensen et al. 2005, 214).

MfCM (Final) Magdalenian faciès Cepoy-Marsangy. This term was introduced by Béatrice Schmider (Schmider 1982) and further defined by Boris Valentin (Valentin 1995; Valentin 2008a) based on the inventories

of the eponymous sites Cepoy and Marsangy. The MfCM was considered as a special variety of the Late Magdalenian in the Paris Basin which contained lithic points, usually of an angle-backed shape, and heavy borers but almost no backed bladelets similar to Final Magdalenian assemblages in northern Europe (Schmider 1982). Moreover, the regular use of soft hammerstones in the production of blanks for points was suggested to result in different, more suitable characteristics from the classic Late Magdalenian blank production process (Valentin 1995). This process was meanwhile also observed in northern European assemblages attributed to the classic Hamburgian (Weber 2012). Thus, some kind of connection between northern Europe and northern France were considered a probable explanation for the related development (cf. Valentin 2008a). The lithic inventory was generally similar to a Late Magdalenian assemblage, besides the lithic points, the heavy *bec,* and the absence of backed bladelets. Organic tools or special goods were not found on these sites, although the organic preservation was occasionally good. The sites were usually set along river banks and contained a more or less dense scatters of stone-filled hearths surrounded by large amounts of lithic and faunal material. The dates for these sites appeared surprisingly young but are comparable to the dating of the similar northern European development (Grimm/Weber 2008).

MFM — Meerfelder Maar. This abbreviation is only used in the present study since the chronostratigraphic (e. g. Brauer/Endres/Negendank 1999) and environmental record (e. g. Litt/Stebich 1999) from the MFM represent one of the fundamental records to which human behaviour is compared.

MONREPOS — MONREPOS Archaeological Research Centre and Museum for Human Behavioural Evolution, part of the Römisch-Germanisches Zentralmuseum, Forschungsinstitut für Archäologie which is a member of the Leibniz Gemeinschaft. MONREPOS is located at Schloss Monrepos in Neuwied/Rhine (Germany). Research at MONREPOS is focused on the process of becoming human. This research focus is generally borne by the themes of chronologies, strategies, and social networks. Analyses of these themes are based particularly on hunter-gatherer societies, mainly from the Pleistocene period.

NAP — non-arboreal pollen. These are all herbaceous pollen such as *Artemisia* sp., Poaceae, or Cyperaceae.

NGRIP — North Greenland ice core project (Andersen et al. 2004). At this Greenland ice-core position located at 75.10 N and 42.32 W (2,917 m a. s. l.) an approximately 3,085 m deep ice-core sequence was drilled (Andersen et al. 2004). The sequence comprises approximately the last 123,000 years and was mainly used for the construction of the GICC05 replacing the GRIP ice-core partially as stratotype (Rasmussen et al. 2006; Vinther et al. 2006).

NH_4^+ — ammonium cation. These atoms are used as a seasonal tracer in the formation of the ice-core chronology (Rasmussen et al. 2006). NH_4^+ concentration is particularly high during the summer season but during cold periods the annual signal is not very clear.

^{18}O — oxygen isotope 18, but correctly: »$\delta^{18}O$ which is defined as the ‰ deviation in $^{18}O/^{16}O$ ratio relative to the SMOW (Standard Mean Ocean Water)« (Hammer/Clausen/Tauber 1986, 284 note 1). This ratio is linked generally to the climate system by temperature (Johnsen et al. 1992, 312) and precipitation (Mattey et al. 2008; Vinther et al. 2009; cf. Landais et al. 2010). Thus, it is commonly used as a palaeoproxy for air temperature at the coring site (Steffensen et al. 2008), although modern comparisons have shown a constant underestimation, presumably due to the additional dependency on the hydrological cycle (Masson-Delmotte et al. 2005).

p — (statistical) probability

PAZ — pollen assemblage zone. The term is used in palynology to group characteristic pollen communities of a defined stratigraphic unit.

p. r. n. — *pro re nata*. as the occasion arises; if necessary.

RGZM — Römisch-Germanisches Zentralmuseum, Leibniz-Forschungsinstitut für Archäologie. The RGZM is the parent research institution of MONREPOS and located in Mainz (Germany). Beside MONREPOS, it encompasses further five research fields and departments (see VAT, p. 598) studying the time period from the Lower Palaeolithic to the Middle Ages. In addition, the RGZM runs a publishing house and several laboratories and workshops specialised in conservation. The RGZM is a foundation under German law and a member of the Leibniz Gemeinschaft. Thus, the RGZM is a research institution of national importance and federal scientific interest. Therefore, it is financed by the federal and the individual German States with substantial involvement of the state of Rhineland-Palatinate and a contribution by the town of Mainz.

SRTM — Shuttle Radar Topography Mission. This mission of the US-American NASA was accomplished in 2000 and aimed »[...] to generate the most complete high-resolution digital topographic database of Earth.« (http://www2.jpl.nasa.gov/srtm/, verified 23-Feb-2012). Therefore, land surface of Earth were scanned. This elevation data contains (modern) noise such as anthropogenic disturbances created by roads, buildings, or extraction pits and environmental variations in the form of trees or aeolian sand or loess dunes. In particular, the latter developments have changed the landscape of Northern Europe significantly since the LGM. Moreover, interesting parts for Late Weichselian research are data of landscapes which are submerged today. These data were usually obtained by depth-sounding on ships that were subsequently combined with the SRTM-data to provide also a dataset containing the bathymetric data. This combined dataset is used in this project (SRTM30_Plus, version 6.0; available for non-profit use from the Scripps Institution of Oceanography, University of California San Diego at: ftp://topex.ucsd.edu/pub/srtm30_plus/; Becker et al. 2009; cf. Sandwell/Smith 2009). These combined data reach a precision of *c.* 900 m (30 × 30 arc-seconds; for further information and references read the Readme.V6.0 and References_SRTM30_Plus text files provided at the homepage mentioned above). Further detailed data of the complete surface of Earth in a single data set can be expected in the near future by the European TanDEM-X project (www.dlr.de/hr/en/desktopdefault.aspx/tabid-2317 verified 23-Feb-2012).

ss09 — An age model formed mainly by data from the DYE-3 and GRIP ice-cores. The model was based on layer counting (mainly in DYE-3), correlation of DYE-3 and GRIP along volcanic markers in this upper parts, and an age estimate for the lower part of GRIP according to an ice flow model in which accumulation was considered as a function of ^{18}O values (Johnsen et al. 1992; Dansgaard et al. 1993; Johnsen et al. 1995; Johnsen et al. 1997). This age model was usually used as the standard Greenland ice-core chronology until the updated version (ss09sea) was published.

ss09sea — An updated version of the age model ss09 which became also known as GRIP2001 (Johnsen et al. 2001). In contrast to ss09, the improved ss09sea used more precise seawater-corrected isotope values for the ice flow model. From 2001 to 2006 (publication of GICC05), this age model was the most commonly used ice-core chronology.

SST — sea-surface temperature. The temperature below the water surface of oceans, i. e. in the top layer of the ocean water column. These temperatures reflect major changes in the global heat conveyor and also the hydrological transport system because evaporation and sea ice formation depend on the SST. Thus, near continental shores these temperatures are important indicators for the terrestrial climate (Palmer/Zhaobo 1985; Hurrell 1995; Rodwell/Rowell/Folland 1999; Sutton/Hodson 2005). In palaeoclimatology, various proxies are used to estimate the SST such as strontium/calcium (Sr/Ca) ratios in shallow water corals (Alibert/McCulloch 1997), magnesium/calcium (Mg/Ca) ratios in fossil material (Mashiotta/Lea/Spero 1999), or frequencies of foraminifera species in sediment cores (Kucera et al. 2005).

$^{230}Th/^{234}U$ — relation of thorium isotope 230 to uranium isotope 234. Also known as uran-thorium dating. Equally to radiocarbon, this dating method is based on a decay process including radioactive elements (e. g. Schwarcz 1980). However, the half life age of uranium is 245,500 years and, thus, significantly longer than in the radiocarbon cycle, but the thorium isotope 230 also decays with a half life of 75,000 years. Consequently, the limit of this method is set by the half life of thorium. Nevertheless, approximately ten times older material than in ^{14}C dating can be dated by $^{230}Th/^{234}U$, thus, approximately 0.5 million years old material (Lawrence Edwards/Chen/Wasserburg 1987) if the material contains a minimum of *c.* 0.01 g (Hellstrom 2012).

TIMS — thermal ionization mass spectrometry. With this instrument a high precision isotope abundance measurement is performed on environmental samples (Heumann et al. 1995). In particular, ratios of elements used in **geochronology** and **tracer** studies such as $^{230}Th/^{234}U$ are measured. Meanwhile, further improvements in this field allowed for a decrease of the necessary sample material and an increase of the accuracy and the precision of the results compared with other dating techniques (Luo et al. 1997).

TL — thermoluminescence. TL is a radiometric dating method (Daniels/Boyd/Saunders 1953). It is commonly used in the dating of Pleistocene sites, especially, for sites which produced no material for radiocarbon dating (Richter 2007). In the TL method radiation damage such as burning is identified, for instance, on flints by measuring of the radiation dose in relation to the »undamage« radiation dose. On the temporal scale the measured radiation dose accumulates in a stable and linear process (Richter 2007)

and, consequently, the results can be calculated in calendar years. In general, the dates resulting from TL measurements represent good indications for the actual age of human activity because the burning events, particularly of lithic material, can often be closely connected to hearths. Furthermore, an increasing number of assemblages can be dated with this method due to the decreasing amount of required material for the dating procedure (Richter/Krbetschek 2006).

UMT — Ulmener Maar Tephra. Volcanic deposits of the youngest volcanic eruption in the Eifel field forming the Ulmener Maar (Zolitschka/Negendank/Lottermoser 1995). The eruption occurred in the early Holocene (*c.* 10,945 varve-years b2k) and the deposits can be found in the surrounding Maar sequences such as the Schalkenmehrener Maar, Holzmaar, and Meerfelder Maar.

VAT — Department of volcanology, archaeology and history of technology studies. VAT is a diachronic focused department of the RGZM located within the Eastern Eifel volcanic field at Mayen (Germany). The research focus is set on the emergence of the industrial landscape within which the department is located.

Weichselian — last major glacial cycle as identified in the stratigraphies of Northern Europe. According to the stratigraphic nomenclature, the Weichselian encompasses the period from GS-5 to the onset of the Holocene (Litt et al. 2007, 46). The Weichselian ice sheet formation is generally correlated to the Würmian from the Alpine region and the Devensian from the British Isles.

WGS 84 — World Geodetic System 1984. WGS 84 is a standard coordinate system to which also the GPS (global positioning system) today is referenced.