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A study of rocks and flints from Bilzingsleben

Eine Untersuchung von Steinen und Feuersteinen aus Bilzingsleben

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Abstract - Bilzingsleben (Thuringia, Germany) is a Middle Pleistocene interglacial travertine deposit where Dietrich Mania excavated for three decades, resulting in a huge amount of well preserved faunal remains, the oldest human fossils in Central Germany and the interpretation that the remains of a Lower Palaeolithic camp site are present. In 2004-2007 new excavations were made with a non-selective recovery strategy. The results of vertical distribution and orientation are interpreted as evidence of complex natural site formation processes which were responsible for the accumulation of the 1m thick sandy, find-bearing layer. With this interpretation a detailed study of the excavated flints is presented. Two poles – obvious non-artefacts and objects resembling man-made flakes – mark the two ends of a continuous ´grey area´ with a wide range of lithic chunks, frost shatter and flakes, some of them without edge scars, others with marginal or heavy scars. It is difficult or impossible to separate this ´grey area´ into distinct classes. Only subjective criteria, depending on the choice of each investigator, may result in qualifying a specimen as artefact. This topic is discussed against the background of research history. Therefore the main result of the recent excavations at Bilzingsleben is to emphasize the ´grey-area´ of lithics ranging without breaks from obvious non-artefacts to possible artefacts.

***Zusammenfassung -** Bilzingsleben (Freistaat Thüringen, Bundesrepublik Deutschland) ist eine mittelpleistozäne Travertinfundstelle, auf der Dietrich Mania über drei Jahrzehnte Ausgrabungen durchführte. Bekannt ist der Fundplatz aufgrund der guten Knochenerhaltung als Referenzfundort für das ´Holstein-Interglazial´ für die paläontologische Forschung, als Vorkommen der ältesten Menschenknochen Mitteldeutschlands und durch seine Interpretation als Beleg für ein altpaläolithisches Jagdlager. Zwischen 2004 und 2007 wurden Ausgrabungen durchgeführt, dabei alle Funde unabhängig von Größe und Qualität geborgen. Die Auswertung der vertikalen Verteilung und der Einregelung wird als Beleg für komplexe natürliche Ablagerung des bis zu 1m mächtigen, sandigen Fundhorizonts gedeutet. Vor dem Hintergrund dieser Interpretation wurden die Feuersteine ausgewertet. Neben eindeutigen Nichtartefakten gibt es nur wenige Feuersteine, die – außerhalb ihres geologischen Kontexts – als Artefakte bestimmbar wären. Beide Extreme belegen aber nur ein Kontinuum, eine Grauzone von verschiedensten Frostaussprüngen, Trümmern und Abschlagformen, von denen einige lateral keine, andere marginale oder deutliche und viele Negative zeigen. Objektive Merkmale zur Unterteilung der Grauzone liessen sich nicht formulieren. Nur subjektive Einschätzungen, abhängig vom jeweiligen Maßstab des Betrachters, würden eine Qualifizierung als Artefakt erlauben. Dieses Problem wird mittels forschungsgeschichtlicher Rückblicke diskutiert. Daher ist das Hauptergebnis der jüngst in Bilzingsleben durchgeführten Ausgrabungen die Betonung der Grauzone der Feuersteine, die ohne Brüche von klaren Nichtartefakten zu möglichen Artefakten reicht.*

Keywords - Middle Pleistocene, interglacial, stratigraphy, site formation, lithic artefacts
Mittelpleistozän, Interglazial, Stratigraphie, Fundplatzgenese, Silexartefakte

"Pay a visit to my Palaeolithic paradise and examine for themselves."
Benjamin Harrison in a letter, 1880s (O`Connor 2007, 140)

Introduction

The Steinrinne is a Quaternary travertine deposit situated 1 km south of the village of Bilzingsleben (County Sömmerda, Federal State of Thuringia, Germany). The name Steinrinne, which can be translated as "gully in a rock", may derive from an artificial, path-like groove present until the middle of the 19th century (Toepfer 1980). Today, travertine is preserved on a 200x800 m large ridge at approx. 170 m a.s.l., 30 m above a small river, the Wipper (Fig. 1). Flowing from the north, the Wipper river runs through the Hainleite Mountain in a more than 100 m deep, canyon-like valley; then the slopes retreat and the river has four pronounced meanders. The last meander is situated beside the Steinrinne where a tributary, the Wirbelbach flows in from west. Here, the Wipper turns to the east, flowing now into a broader valley floor before its confluence with the main river, the Unstrut. Towards the northwest (Fig. 2), the Steinrinne forms part of a vast plain with late Triassic (lower Keuper) marls and (upper Muschelkalk) shelly limestone (Seidel 1992).

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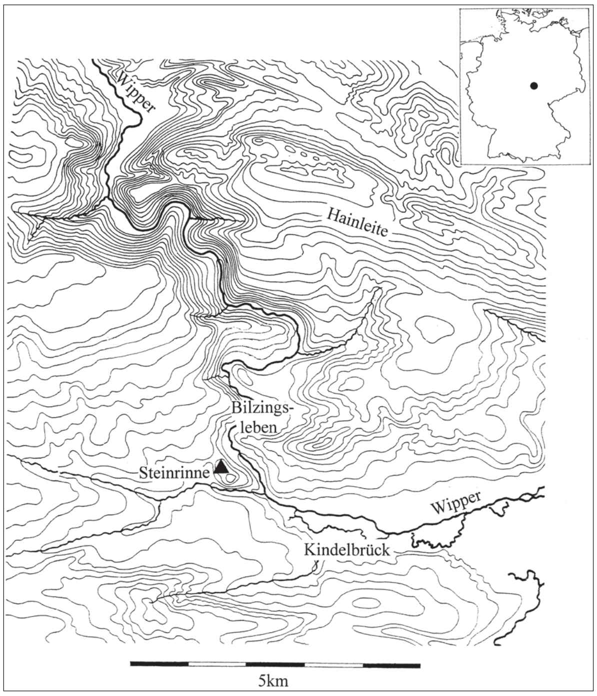

Fig. 1. Relief of the landscape around the Steinrinne (triangle) with present day major villages and mountains (adapted from Mania 1990: Abb. 18), inset: location of Bilzingsleben within the Federal Republic of Germany.

Abb. 1. *Relief der Landschaft um die Steinrinne (Dreieck) mit wichtigen, heutigen Orten und Mittelgebirgen (verändert nach Mania 1990: Abb. 18), kleines Bild: Lage von Bilzingsleben in der Bundesrepublik Deutschland.*

Since the second half of the 19th century the Steinrinne is a location well-known to geologists (Toepfer 1980). While doing research on Pleistocene stratigraphy and ecology by investigating several Quaternary deposits between the rivers Elbe and Saale, Dietrich Mania came to the Steinrinne and, in 1971 officially, started excavations as part of the scientific research of the State Museum of Prehistory at Halle/Saale (Grünberg 2002: 41). After discovering the first specimen of the oldest human fossil in Central Germany, the Steinrinne became a well-known "Lower Palaeolithic travertine site" (Mania 1974: 157) and excavations continued for nearly three decades (Gramsch 2003). With reference to palaeontological data, this research produced "one of the most detailed accounts we have of a Holsteinian interglacial locale" (Gamble 1999: 155). From an archaeological point of view, data produced by these excavations have been interpreted as evidence for remains of a Lower Palaeolithic base camp on the shore of a travertine lake with huts inhabited for some years, an artificial pavement – today partly conserved (Fig. 3: blue area) –, more than 100,000 stone artefacts with small tools, modified bones and bone tools, evidence of large mammal hunting, ritual use of human skulls as well as seasonal information (Mania & Mania 2005). This interpretation has been challenged since the early 1990s (e.g. Becker 2003: 84; Davidson 1990; Gamble 1999: 159, 161; Gaudzinski 1998: 199; Kolen

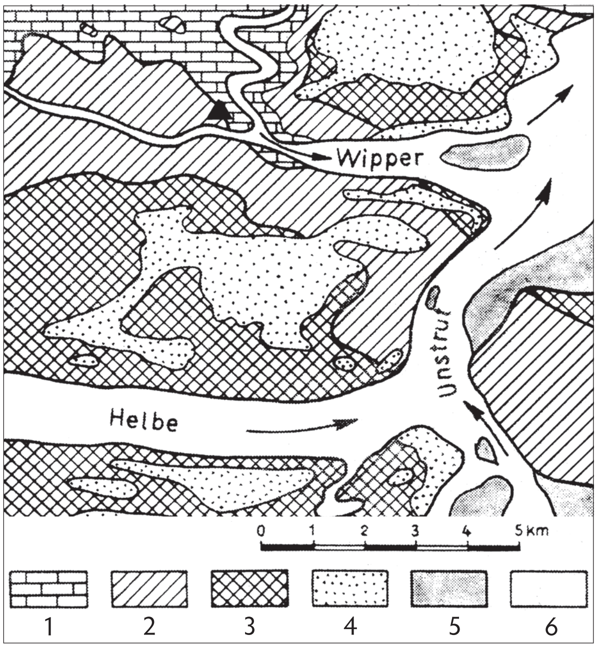

Fig. 2. Geology of the area around the Steinrinne (triangle) – 1 Muschelkalk, 2 lower Keuper, 3 middle Keuper, 4 Quaternary deposits on high plains, 5 Pleistocene deposits of valley floors, 6 Holocene deposits (adapted from Rau 1997: 5).

Abb. 2. *Geologie des Gebiets um die Steinrinne (Dreieck) – 1 Muschelkalk, 2 unterer Keuper, 3 mittlerer Keuper, 4 eiszeitliche Ablagerungen auf den Hochflächen, 5 eiszeitliche Ablagerungen im Talgrund, 6 nacheiszeitliche Ablagerungen (verändert nach Rau 1997: 5).*

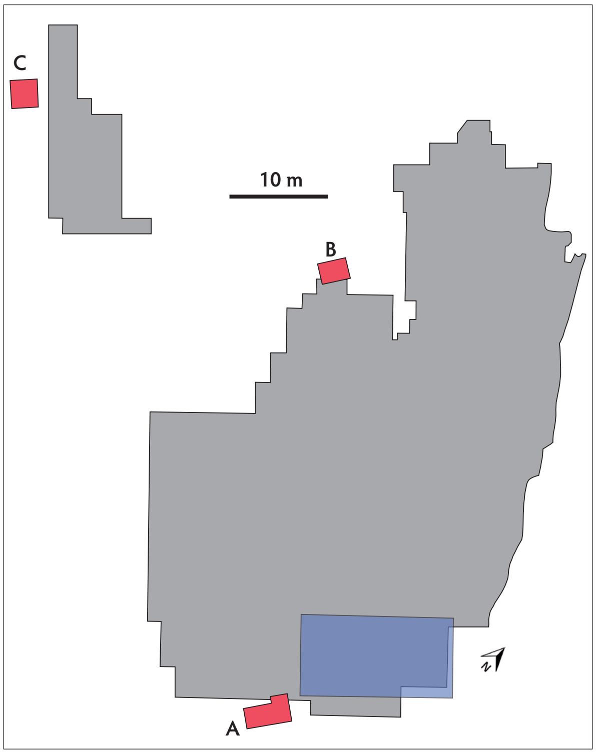

Fig. 3. Excavation areas. grey: areas excavated from 1969-2003; red: areas A, B & C excavated from 2004-2007; blue: part of the supposed pavement that has been conserved and is now protected by an exhibition hall (note: C30-C110 are not shown).

Abb. 3. *Grabungsflächen. Grau: Flächen ausgegraben von 1969-2003; Rot: Flächen A, B & C, ausgegraben von 2004-2007; Blau: Teil der vermeintlichen Pflasterung, welcher heute von einer Ausstellungshalle überdacht ist (Anm.: C30-C110 nicht dargestellt).*

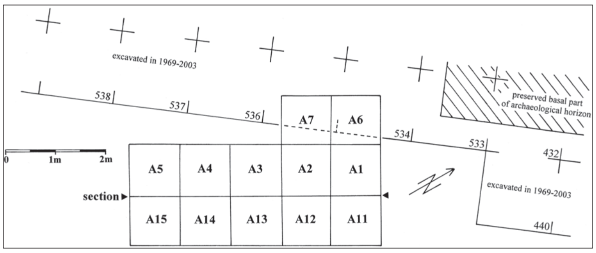

Fig. 4. Plan of metre squares at area A.
Abb. 4. *Quadratmeterplan von Areal A.*

1999: 144-145; Orschiedt 1999: 60; Steguweit 2003; Stopp 1997: 41-43, 46; Vollbrecht 2000; White & Plunkett 2004: 155) but new interpretations have been unsatisfactory as site formation and site integrity could not be discussed without new excavations.

In 2003, a professorship of Palaeolithic and Mesolithic Archaeology, newly established by the University of Jena, was charged with taking over the scientific research at Bilzingsleben. For fieldwork, three areas were chosen for excavation (Fig. 3): area A (Fig. 4) is situated at the supposed living-floor on a lake shore, area B (Fig. 5) in the supposed fluvial fan deposits, and area C (Fig. 6) near the supposed travertine spring. Field methods followed the standard of Hahn (1989) with three-dimensional recording of single finds. For metre squares A1-A7 and B1-B3 small finds were mass-collected by hand in ¼ m² large units of 3 cm depth recorded in three dimensions. In contrast, at metre squares A11-A15, B4-B6 and C0-C110 small finds were collected by dry-sieving ¼ m² large entities of 3 cm depth. Post-fieldwork was done by student researchers who conserved bones, made a computer-based recording of fieldwork data and determined approx. 30 000 stones (Figs. 14-16), and a graduate researcher who did the recording and determination of part of the flint/chert. Analysis of the molluscs of areas A-C is finished (Vökler 2009) and members of the Institute of Earth Sciences at the University of Jena took samples in areas A-C for micro-palaeontological (Daniel & Frenzel 2010), micro-facial and geochemical analysis.

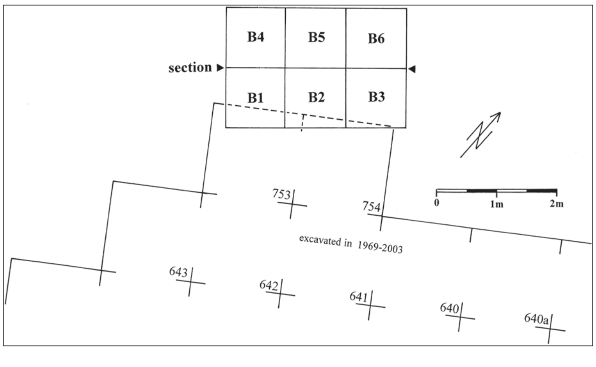

Fig. 5. Plan of metre squares at area B.
Abb. 5. *Quadratmeterplan von Areal B.*

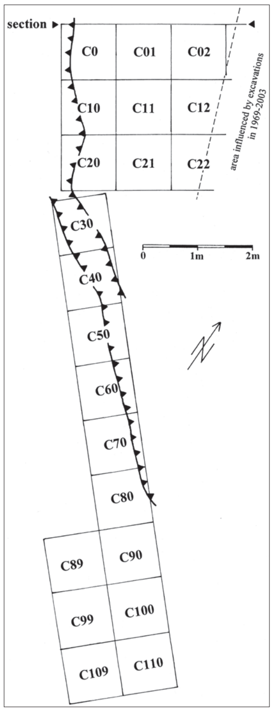

Fig. 6. Plan of metre squares at area C.
Abb. 6. *Quadratmeterplan von Areal C.*

Quaternary geology and landscape development

The Steinrinne is situated on a major tectonic fault running NW/SE (Seidel 1992), resulting in a large step in the geological layers (Fig. 7). The bedrock is an erosional surface on late Triassic (lower Keuper) marls (Eissmann 1994: 84-85). During the Elsterian, ice-marginal lakes produced laminated clay which was covered by moraine deposits when the Scandinavian ice-sheet reached its southernmost extension far west and south of Bilzingsleben. The advance of the Elsterian ice-sheet was rapid, as indicated by Central German varve chronologies, with mean velocities of 600-900 m/year (Junge 1998: 169-170). After the retreat of the ice-sheet, pre-Elsterian valleys were filled by glacial-limnic and moraine deposits, resulting in a wide, plain-like landscape (Unger 2003; Unger & Kahlke 1995: 210). The rivers cut down into this glacially smoothened landscape with subsequent stages of fluvial erosion, resulting in the accumulation of several terraces (Fig. 8) and incorporation of nordic material and quartz in post-Elsterian fluvial deposits (Unger 2003: 434; Unger & Kahlke 1995: 210). In Thuringia generally, a late Elsterian terrace, the so-called Obere Mittelterrasse, is situated approx. 35 m above the recent valley bottom (Fig. 8: OMT). Unfortunately, in the Wipper valley this terrace is conserved "relatively rarely" (Unger 1963: 52).

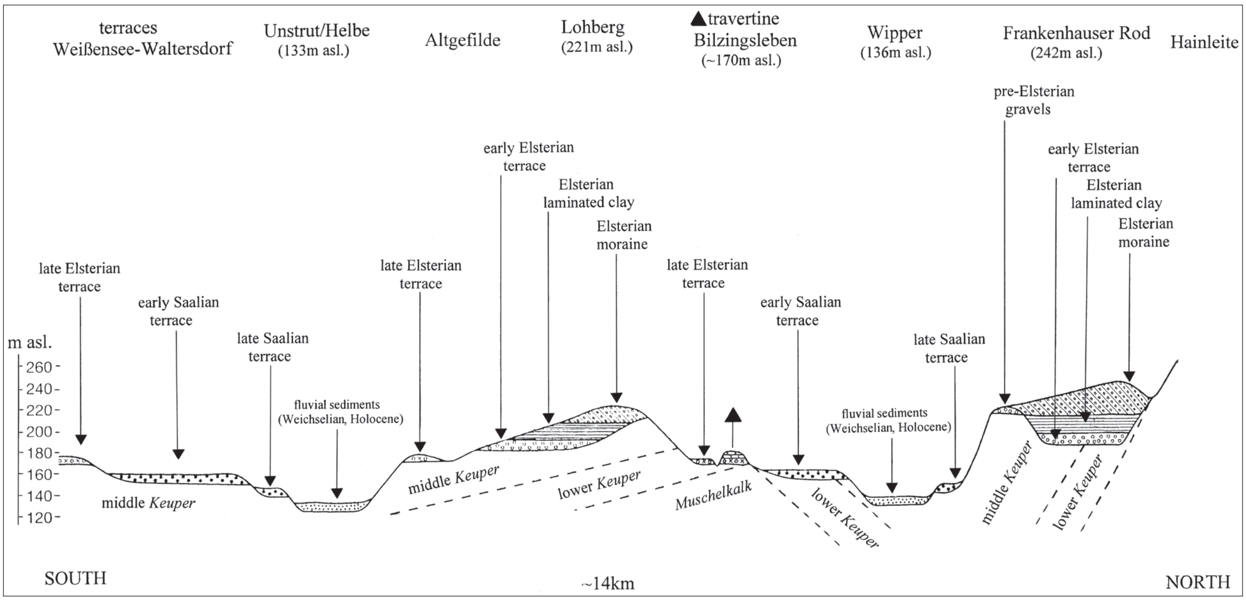

Fig.7. Generalized geological profile from the Thuringian basin (south) to the Hainleite mountain (north). (adapted from Eissmann 1994: Abb. 6).

Abb. 7. *Generalisiertes, geologisches Profil vom Thüringer Becken im Süden zur Hainleite nach Norden (verändert nach Eissmann 1994: Abb. 6).*

According to Eissmann (1994: 84-85) and Unger (1963: 52-53; 2003: 434; Unger & Kahlke 1995: 211) this deposit was accumulated under cold climate conditions and contains the highest amount of moraine clasts: of 500-1 400 gravels, 8 % are quartz and 5 % are flint (Unger 1963: Tab. 3). In general, gravels are smaller than 3 cm diameter but at the base of the terrace occurs a concentration of Muschelkalk, granite or gneiss blocks, often with diameters >50 cm (Mania 1980: 52; Unger 1963: 52-53; 1974: 762-763).

In the Thuringian basin the upper part of the OMT terrace is influenced by weathering due to interglacial soil development. This interglacial is also present at the Steinrinne as a travertine deposit situated on top

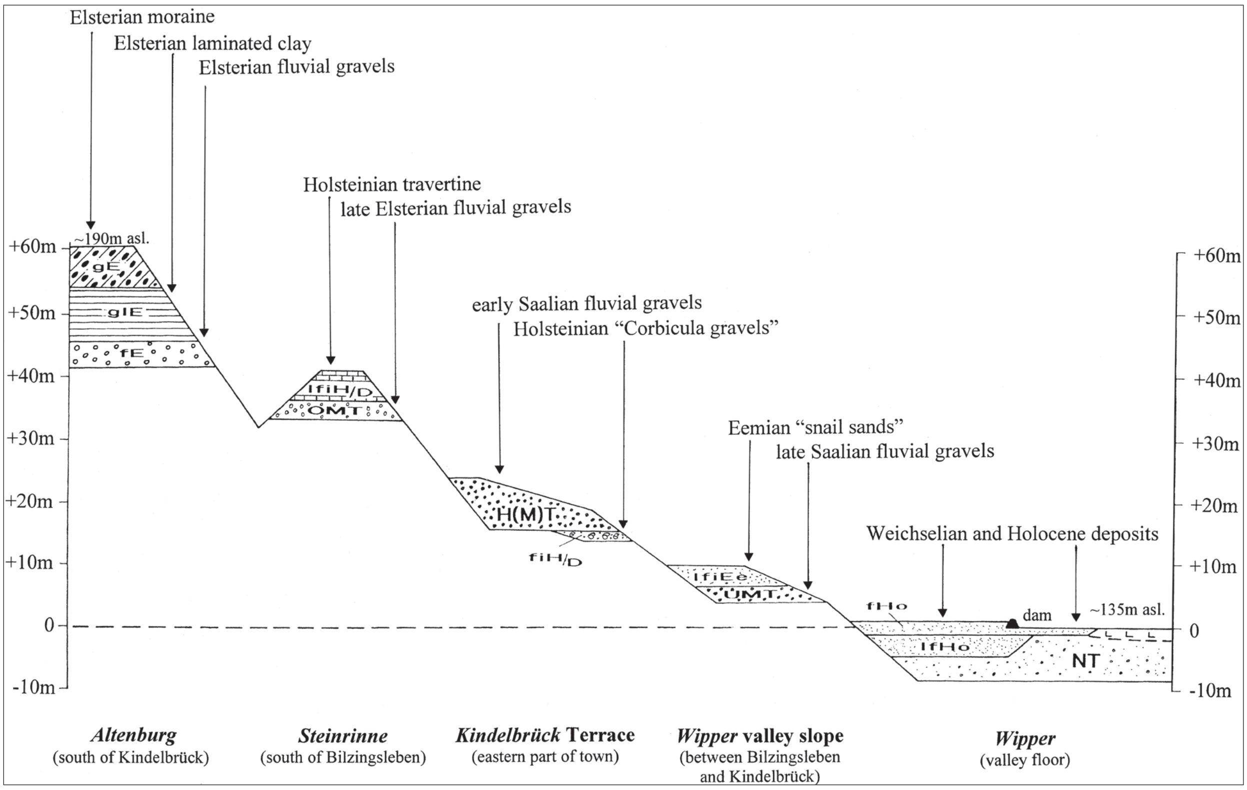

Fig. 8. Synthetic section through the quaternary layers of the lower Wipper valley (adapted from Unger & Kahlke 1995: Abb. 7).

Abb. 8. *Synthetischer Querschnitt mit quartären Ablagerungen des unteren Wippertals (verändert nach Unger & Kahlke 1995: Abb. 7).*

data	source	reference	interpretation
annual temperature	ostracods	Daniel & Frenzel 2010	July: +16 to +20 °C (mean +18 °C) January: -7 to +4 °C (mean +0,5 °C)
lowest winter temperature	macro remains of European nettle tree *(Celtis australis)*	Mai 1983, 112	-19 °C
vegetation cover around the site	plant remains fossilized in rock travertine	Mai 1983	park-like forests dominated by oak, with presence of maple, ash-tree and box-tree as well as, growing locally, some shrub vegetation but a fertile plain vegetation with water-loving plants on the valley bottom
soil on the site	fossilized eggs of the European water tortoise *(Emys orbicularis)*	Böhme 2001	presence of dry areas with loose earth but without vegetation

Fig. 9. Palaeoenvironmetal data from the Steinrinne interglacial deposit.

Abb. 9. *Paläoumweltdaten zum Interglazial der Steinrinne.*

of the terrace. This travertine is correlated with the Holsteinian or the Dömnitz interglacial (Eissmann 1994: 84-85; Mania 1997; Unger & Kahlke 1995: 211, 217). At the Steinrinne this interglacial is correlated with global environmental records in various ways: >OIS 11 (Mallick 2001), OIS 11 (Bridgland et al. 2004; Jöris & Baales 2003: Anm. 3; Steguweit 2003: 29), OIS 11/9 (Gamble 1999: Tab. 4.3) or OIS 9/7 (Eissmann 1994: 85). In the past analyses of various sources provided detailed palaeoenvironemtal data for this interglacial (Fig. 9).

The development of the travertine resulted out of the tectonic fault influencing Keuper and Muschelkalk layers (Fig. 7): when the incising river Wipper reached this fault, the calcareous waters from karstic Muschelkalk underneath could reach the surface via fresh water sources (Unger 1963: 80-81). Generally in Thuringia, the occurrence of Quaternary travertine is almost exclusively related to spring water derived from Muschelkalk aquifers (Beck et al. 2007: 11). Thus, the travertine of the Steinrinne could also have had a continuation to a Muschelkalk outcrop with a spring water discharge. Bedrock under the Steinrinne travertine deposits are late Triassic (Keuper) marls which are prone to be mass-moved due to their ability of water absorption (Wilhelmy 1974: 104, 117). Therefore, deformation by micro-tectonics, as can be seen in all profiles (Figs. 11-13) is due likely to extensional deformation during incision of the river and resultant landscape evolution (Mania 1980: 67, 1983: 36).

In general in Central Germany, the landscape history between the Holsteinian and the advance/cover by the Saalian ice-sheet is not well documented lithostratigraphically as during that time period valleys were not incised but widened, resulting in an intensive accumulation of a 5-20 m thick terrace, the so-called Hauptterrasse (Eissmann 1994: 83-86, 1997: 43-45; Unger 2003: 435). Frost marks indicate its accumulation under cold-climate conditions but, near Halle and Leipzig, the Hauptterrasse also contains oak tree fragments of 30 cm diameter, indicating that the Hauptterrasse gravels were also accumulated in an interglacial. At the river systems of Saale and Unstrut (with Wipper), at the base of the Hauptterrasse, 1-2 m fine, fluvial sediments with interglacial molluscs, containing *Corbicula fluminalis*, represent the so-called ´*Corbicula* gravels´ which are reported as being of Holsteinian or Dömnitz age (Eissmann 1994; 1997). In the Wipper valley the Haupt(mittel)terrasse (Fig. 8: H(M)T) is situated 25-15 m above the recent valley floor, often representing a nearly closed band with a maximum thickness of 8-10 m (Unger 1963: 53-57). Not at the Steinrinne but approx. 4 km east, east of Kindelbrück, the ´*Corbicula* gravels´ are present at its base (Fig. 8: fiH/D), in contrast to fine sediments in the upper part of the gravels which exhibit frost-related phenomena (Unger 1963: 53-57; 2003; Unger & Kahlke 1995). In the H(M)T gravels the amount of quartz and flints has decreased to 2 % (Unger 1963: 54). Correlating the H(M)T terrace lithostratigraphically is no easy task as river activity in the Wipper valley resulted also in erosion when reaching the soft rocks and marls of the lower and middle Keuper (Fig. 7) and terraces are best visible only outside of areas which are influenced by karst phenomena (Unger 2003: 435; Unger & Kahlke 1995: 211-212). Therefore, the exact morphology of the ´Holsteinian´ Wipper valley is difficult to interpret, e.g. proximity of the Steinrinne to the Middle Pleistocene valley slope or relative height of the travertine deposit above the ´Holsteinian´ valley bottom (Fig. 8). In contrast, the last Middle Pleistocene terrace of the Wipper valley, the so-called Untere Mittelterrasse (Fig. 8: UMT) is of late Saalian age (Unger & Kahlke 1995: 212). It is situated approximately 10-5 m above the valley floor with a maximum thickness of 5 m and contains the lowest amount (<2 %) of quartz and flints (Unger 1963: 57). Near Kindelbrück this deposit is covered by Eemian "snail sands" (Unger 1963: 63).

A remark on the described Middle Pleistocene landscape evolution of the Wipper valley has to be made: in contrast to Figure 10, another terrace stratigraphy of the Wipper valley is published by British scholars (e.g. Bridgland et al. 2004: Fig. 3; Schreve & Bridgland 2002) showing not one but two terraces below the rock travertine and many more terraces stratigraphically between the ´Holsteinian´ travertine and the recent valley floor. This stratigraphic

name	height above valley bottom	age	quartz/ flint
Obere Mittelterrasse	35 m	late Elsterian	13 %
Hauptterrasse	25-15 m	Holsteinian/early Saalian	2 %
Untere Mittelterrasse	10-5 m	late Saalian/Eemian	<2 %

Fig. 10. Middle Pleistocene terraces in the Wipper valley (references: see text).

Abb. 10. *Mittelpleistozäne Flußterrassen im Wippertal (Zitate: siehe Text).*

division is not accepted by Quaternary geologists who have done fieldwork in this area (Steinmüller 2002: 276; Unger & Kahlke 1995: 212) as well as by publishers of textbooks on physical geography and Pleistocene stratigraphy (Benda 1995; Eissmann 1997; Liedtke & Marcinek 2002). Further comments have to be added as at Bilzingsleben the preservation of lithics and bones may not be driven by global climate change only but also by events on a micro-scale. For example, due to plant remains which are preserved in the Steinrinne rock travertine, the local ´Holsteinian´ climate is characterized as having 800-1200 mm annual precipitation with a dry winter and a wet summer, the latter with two rainy periods in spring and autumn (Mai 1983: 114). Therefore maybe geomorphodynamic processes which characterize comparable recent environments, e.g. frequent high floods (Bradshaw et al. 2003: 277; Schultz 1995: 208), erosion phenomena due to wet soils on sparsely vegetation-covered valley slopes (Wilhelmy 1974: 154, 203) or mass displacement on the exposed parts of the limestone scarp (Schmidt & Beyer 2002), can be expected. However, other morphodynamic processes may have been present: recent creeks with travertine step-pools are characterized by erosive flood flows (Fuller et al. 2010) but beaver, which are present at the Steinrinne (Müller & Pasda 2011), also heavily influence water flow, valley floor morphology, vegetation and accumulation of silty alluvial sediments (Butler & Malanson 2005; Hillman 1998; Holtmeier 2002: 198-212; Hyvönen & Nummi 2008; Rosell et al. 2005). Therefore, changes between limnic periods and erosive processes due to build-up and destruction of travertine pools and beaver dams are not out of the question. Also, sediments on slopes and lakes shores may have been influenced by elephants (Haynes 2006), which are present at Bilzingsleben (Müller & Pasda 2011). Moreover, woody debris, which was also excavated (chapter 4) has a strong morphologic alluvial control (Abe & Montgomery 2003; Keil 2003), e.g. in-channel debris dams locally increase the frequency and extent of overbank flows (Jeffries et al. 2003).

The geological horizons of the 2004-2007 excavations

In 1922, the 4-6 m deep rock travertine was covered by 1.0-1.25 m loess as well as by deep humic layers (Wiegers 1922: 32). Due to quarrying, the rock travertines were removed from the excavated area.

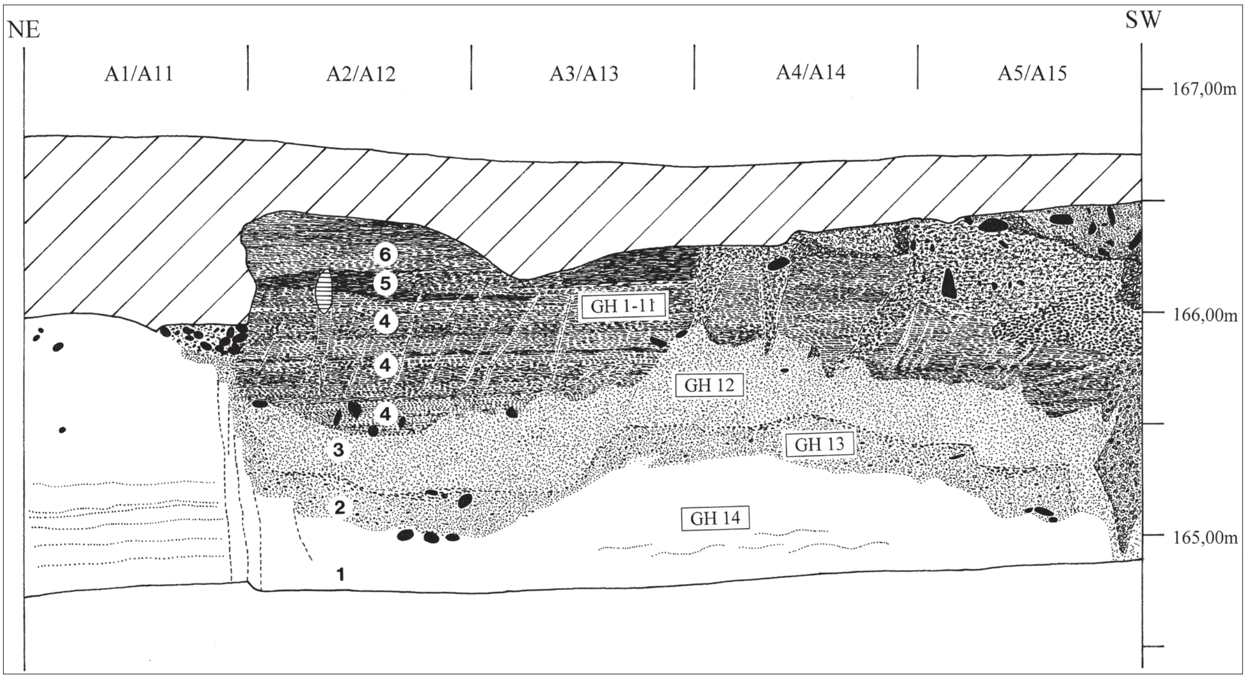

Fig. 11. Profile at area A.

Abb. 11. *Profil in Area A.*

Therefore recent deposits and quarry dump (Figs. 11-13: hatched) are situated on top of the Middle Pleistocene sediments. Geological horizons are offset (<2 m) vertically by micro-tectonics. Opening fractures and fault gaps were co-genetically filled by debris from the surface.

At area A, the stratigraphy was already published by Beck et al. (2007) who analyzed micromorphological samples (Fig. 11: 1-6) also. The bottom of the profile (Fig. 11: GH 14) is a grey to greenish, silty layer. Its base was not reached during the excavation. It contains 70-80 vol.-% quartz particles, at maximum 20 vol.-% carbonate grains (partly micro-concretions), minor contents of feldspar and mica as well as traces of heavy minerals. The silt is mainly well sorted (0.03-0.06 mm) with minor fine sand (<0.225 mm) and loosely cemented by carbonate cement bridges between grains. The silt is not devoid of finds as some flint, rocks and bones were excavated. The sediment above the basal silty layer is the horizon where most finds were excavated. It may be subdivided into a coarser, sandy part and a finer, silty part on top. The lower part (Fig. 11: GH 13) is 20 cm thick and a pale-grey to brownish-grey silty, gravel-bearing carbonate sand. Phytoclastic travertine sand particles dominate. At maximum 30 vol.-% are varying contents of siliciclastic grains (quartz, weathered feldspar), bone fragments, gastropod shells, characean remains, traces of heavy minerals and opaque clasts and pollen grains. Chert fragments <1 cm were found during the excavation (Fig. 14), but are not or only very indistinctly present in finer (<1 mm) grain fractions. No internal stratification is recognizable, and sorting is very poor. The basal boundary is sharp but irregular and non-planar. A concentration of oversized clasts occurs in lenses only near the top. The upper part of the main find-bearing horizon (Fig. 11: GH 12) is a 15-30 cm thick, pale-grey, silty carbonate sand with minor contents of gravel-sized clasts. The phytoclastic travertine sand occurs with <10 vol.-% siliciclastic grains (quartz, heavy minerals, opaques) and bioclasts (gastropods, *Chara oogonia*). Large gravel-sized clasts are bone and travertine fragments. Patches with indistinct boundaries, very poor sorting and no concentration of oversized clasts in lenses or layers were detected. The basal boundary is irregular and non-planar. The sandy sediments contain bones, stones, travertines, calcareous rocks, chert/flint and quartz pebbles as well as erratics and up to 40 cm long wooden fragments, compacted to mm-thickness (Fig. 17). The find-bearing layer is covered by 0.5-1.0 m thick, lacustrine carbonatic deposits (travertine), ranging from carbonate coarse sand to gravel (Fig. 11: GHs 1-11). The poorly sorted, partly phytoclastic travertine contains characean remains, mollusc shell fragments, and ostracods. An indistinct sub-planar internal stratification is visible. Platy large clasts are oriented parallel to bending. There are only minor contents or traces of siliciclastic silt and sand grains but abundant coarse sand to gravel size carbonate (travertine) clasts are dispersed

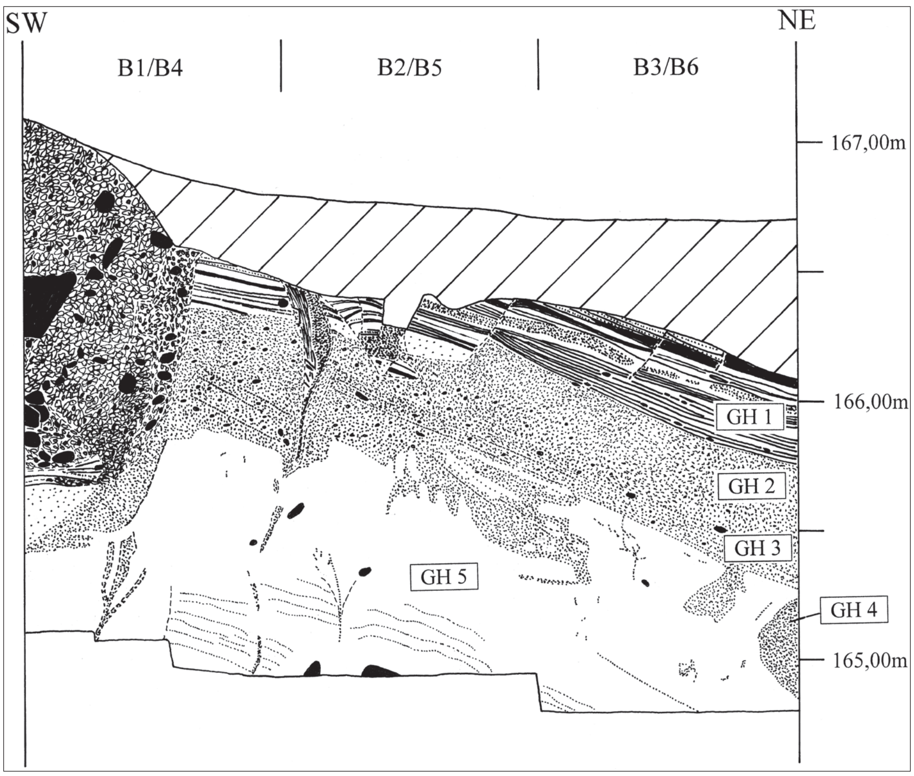

Fig. 12. Profile at area B.
Abb. 12. *Profil in Areal B.*

in a carbonate sandy matrix.

Ostracod analysis (Daniel & Frenzel 2010: 75) does not reveal any internal stratification but a presence of species which prefer lake-like environments. Species from fresh water sources are present but decrease from the base to the top of the layer. Furthermore, mixing with older sediments is obvious as single Mesozoic species were found and single ostracods valves occur in lenses of pure carbonatic sands. This shows that area A is characterized not only by limnic sedimentation but by single delivery episodes of coarser material also (Daniel & Frenzel 2010: 75). By molluscs (Vökler 2009), area A is distinct from areas B and C: fragmentation is low (47 %), species representation much higher (n=34), presence of terrestrial species very high (n=20) and presence of water-loving species elevated (n=14). The number of mollusc individuals is high, in particular in the upper part of the find horizon. Mollusc species indicate a dominant sedimentation by fresh-water sources but species also occur which prefer forested and open, steppe-like environments. According to the occurrence of ostracod species and only fragmented mollusc shells in the most lowest part of the find horizon at area A, this part was sedimented in a more turbulent way, indicating that the top of the silt does not represent a living-floor (Daniel & Frenzel 2010; Vökler 2009: 123). Whether these observations – processes by running water at the base as well as in the upper parts of the find bearing layer – have significance for the interpretation that an artificial pavement is present some metres north of area A (Fig. 3) is open to further discussion.

At area B, faulting and opening fractures (Fig. 12: left) are visible as well as mixing of sandy and clayey sediments (Fig. 12: GH 4) due to pseudo-tectonics. A silty clay (Fig. 12: GH 5) characterizes the bottom of the sequence. Above the silt, a sandy deposit contains most of the bones, gravels and chert/flint. As at area A, this layer is subdivided into a lower part of poorly sorted sands with a high amount of quartz and other minerals (Fig. 12: GH 3) and an upper part with more fine sediment (Fig. 12: GH 2). The top of the stratigraphical sequence is characterized by laminar sub-horizontally bedded, silty and sandy carbonatic horizons (Fig.12: GH 1) which underlay recent deposits (Fig. 12: hatched). In the laminar layers several travertine clasts up to 15 cm length occur as well as single, 1 - 3.5 cm long quartz, Muschelkalk and metamorphic rocks. In GH 3 different ostracod species were found which prefer running freshwater conditions (Daniel & Frenzel 2010: 73). In contrast, equal amounts of mollusc species from freshwater source, open and forested habitats characterize GH 3 (Vökler 2009). In GH 2, the upper part of the find-bearing layer, ostracod species out of lake-like environments with salty water occur (Daniel & Frenzel 2010: 75). As at area A, Mesozoic ostracods are present in GH 3 and 2, the incorporation of particles of older, pre-Pleistocene sediments is obvious (Daniel & Frenzel 2010: 75). In area B, as in area C, molluscs (Vökler 2009) are much more fragmented (80-85 %), species representation is much lower (16 species in B, 21 species in C), presence of terrestrial species is very low (5 species in B, 9 species in C) and the presence of water-loving species is lower than in area A (11 species in B, 12 species in C). In the find horizon of areas B and C numbers of mollusc individuals are low in general but increase in the upper part and are much higher above the find horizon.

The most pronounced pseudo-tectonic of the 2004-2007 excavation is situated at area C: metre squares northeast of the fault (Fig. 6: C0-C22) are situated approx 1.5 m below metre squares (Fig. 6: C50-C110) southwest of the fault. The latter metre squares are not incorporated in this study as only the lower part of the stratigraphy is present here. At C0-C22, the lowest layer (Fig. 13: GH 6) is a brownish to greenish clay with minor contents of silt. It is not devoid of rocks as Muschelkalk fragments up to 25 cm length were found e.g. in metre square C1. Greyish-brown, silty sands characterize the lower part of the find-bearing layer (Fig. 13: GH 5). Several 2-3 cm sized Muschelkalk gravels and up to 40-100 cm long, platy Muschelkalk rocks with well-rounded edges characterize this horizon (Beck et al. 2007: Fig. 12: 1). Rarely, travertine gravels are present. Darker, up to 10 cm thick bands without rocks occur. Mollusc species representation is low (Vökler 2009) but ostracod species preferring running water conditions were found (Daniel & Frenzel 2010). Above this layer ostracod species indicate decreasing influence of running water but an increase of detritic input, e.g. with Mesozoic clasts (Daniel & Frenzel 2010). The geological horizon above (Fig. 13: GH 4) begins on top with a 10 cm thick band which is laminated in different, 2 cm thick light-brown to grey silts. Here, freshwater loving molluscs were found (Vökler 2009). Below a band up to 10 cm thick is characterized by mm - to 2 cm thick layers of light-brown to orange silts. Because the transition between GH 4 and GH 5 was indistinct during excavation, this part was recorded as GH 4/5. It is represented by greyish and dark brown, clayey silts laminated by 2 cm thick, darker bands. Micro-tectonic influences can be seen from the next geological horizon (Fig. 13: GH 3) down to the bottom of the profile. The third geological horizon (Fig. 13: GH 3) is characterized by different layers: on top laminated bands occur, at maximum 10 cm thick. The bands change between a 0.3 - 1 cm thick black to dark brown, clayey silt and maximally 5 cm thick, brown, sandy silts with sharp-edged, up to 5 mm long travertine rocks. Below these laminated bands follows a 5 cm thick, silty layer which is sorted in up to 0.5 cm thick bands of changing (light brown to grey) colours. The lower, at maximum 5 cm thick, brown, sandy silt includes up to 5 mm long, sharp-edged travertine rock splinters. The base of GH 3 is characterized by a distinct, 2 mm thick, black band. Whether this band is volcanic ash or local organic

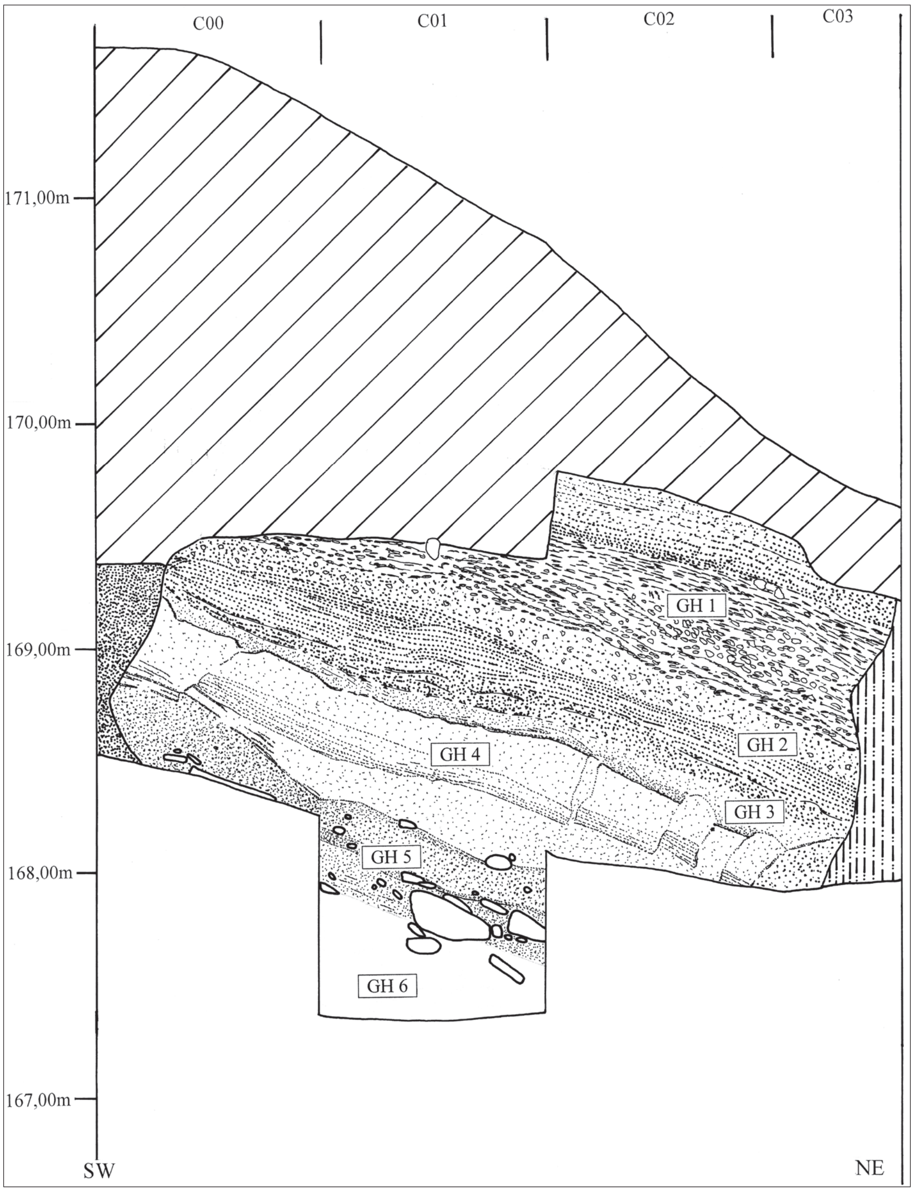

Fig. 13. Profile at area C.
Abb. 13. *Profil in Areal C.*

material is under investigation. Ostracods indicate that the layers above the black band are characterized by limnic species and those loving wet, swampy or marshy conditions (Daniel & Frenzel 2010). The second geological horizon (Fig. 13: GH 2) consists in its upper 10 cm of smallest (mm-sized), sharp, whitish-grey travertine clasts with a minor amount of orange travertine gravels. Some 1 cm thick layers made of travertine rocks and broken mollusc shells can be seen as well as, rarely, flat, 5 cm long travertine gravels. The lower 15 cm are represented by 1 cm thick bands of light-orange silt and orange travertine rock particles. The first recorded geological horizon (Fig. 13: GH 1) consists of different layers: the top 15 cm are laminated silts with minor content of sand and some small (<5 mm) travertine rocks. Lamination results of changes in colour (orange to grey) and thickness of bands (0.2 - 5 cm). The lower 20-30 cm are characterized by rounded, orange travertine gravels of different size (some mm up to 15 cm diameter) in a silty and sandy matrix. Often, gravels are coated with fine sediment. A lamination in 1-3 cm strong, wavy bands of different dark to light orange sands with 2 cm strong, sandy, light grey to light orange bands is visible. The uppermost sediments (Fig. 13: hatched) could not be excavated nor recorded in detail. These sediments were 5-10 cm, sometimes up to 40 cm long travertine rocks with rounded edges in a silty to sandy, yellowish to reddish, sometimes grey or dark grey matrix. On top a humic soil has developed. According to Steguweit (2003: 9) these sediments are not Weichselian Deckschichten but redistributed Middle Pleistocene sediments.

As the general stratigraphy of areas A-C does not differ from that of the 1969-2002 excavation (Mania & Altermann 2004) the results present in this article may have significance for the interpretation of the whole Steinrinne. In all areas excavated from 2004-2007 the base of the excavation is a distinct layer of silt (area A: GH 14; area B: GH 5; area C: GH 6). At area C the top of this deposit is situated at approx. 167.50 m a.s.l., at area B at 165.50 m a.s.l., at area A at 165.25 m a.s.l. Above this layer an approx. 1 m thick sandy layer is present which is divided into a coarser, lower part (area A: GH 13, area B: GH 3, area C: GH 5) and a finer, upper part (area A: GH 12, area B: GH 2, area C: GH 4). As will be shown in the next chapter, these layers contain the majority of rocks and flint/chert but lack any obvious internal stratification. The inclination of this sandy layer is most pronounced at the highest spot of the Steinrinne (area C), obvious in the centre (area B) but not present in the lowest part (area A). Coarser travertine clasts (area A and C) as well as laminated sediments (area B) are present on top of the find-bearing layer.

Rock clasts of the geological horizons

In this chapter, analysis of rocks is presented only for metre squares which were excavated with dry-sieving (chapter 1). The recovery strategy of residues out of sieves was focused on taking by hand all large clasts and as many smaller clasts as possible in the course of the running excavation. Of course, this strategy resulted in an obvious under-representation of clasts <1.5 cm (Figs. 14-16). However, total numbers (Figs. 14-16) indicate that a high amount of rock clasts characterizes the find-bearing layer: in each metre square with a find-bearing depth between 50-100 cm approx. 3 000 rocks were recorded. Exceptions are metre square A11 (Fig. 14) because of a several centimetre thick sandy sediment (Fig. 11), and metre square C0 (Fig. 16) with its reduced western half due to a micro-tectonic fault (Fig. 6). The obvious domination of size class 1.5-3.4 cm in all metre squares (Figs. 14-16) indicates that small rocks characterize the find-bearing sediment of the Steinrinne. In each area, travertine, flint/chert, quartz, Muschelkalk, magmatic and metamorphic rocks occur (Figs. 14-16). The same numbers roughly have been published by Mania & Altermann (2004: Tab. 4-7) for the area excavated in 1969-2002. Travertine is present in rounded, gravel-like clasts mainly as well as in softer, platy particles with visible, filigree plant structures. Nordic flint is a characteristic element but also shelly limestone Muschelkalk chert is present. Among the gravels,

rock type	A11	A12	A13	A14	A15	total	
	n	n	n	n	n	n	%
travertine <1.5 cm	35	330	216	279	229	1089	*8.7*
travertine 1.5-3.4 cm	53	2881	2039	2109	2620	9702	*77.8*
travertine 3.5-5.4 cm	19	281	276	137	187	900	*7.2*
travertine 5.5-9.4 cm	13	66	54	42	44	219	*1.8*
travertine 9.5.-14.4 cm	1	12	2	4	5	24	*0.2*
travertine 14.5-19.4 cm	-	2	1	2	2	7	*0.0*
travertine 19.5-24.4 cm	-	2	-	-	2	4	*0.0*
travertine total	**121**	**3574**	**2588**	**2573**	**3089**	**11945**	***95.7***
flint/chert <1 cm	3	27	25	34	41	130	*1.0*
flint/chert >1 cm	13	55	80	87	69	304	*2.4*
flint/chert total	**16**	**82**	**105**	**121**	**110**	**434**	***3.5***
quartz 1.5-3.4 cm	6	3	3	6	5	23	*0.2*
quartz 3.5-5.4 cm	-	1	1	2	6	10	*0.1*
quartz 5.5-9.4 cm	-	1	-	1	-	2	*0.0*
quartz total	**6**	**5**	**4**	**9**	**11**	**35**	***0.3***
Muschelkalk <1.5 cm	1	-	3	-	3	7	*0.0*
Muschelkalk 1.5-3.4 cm	4	4	2	11	11	32	*0.3*
Muschelkalk 3.5-5.4 cm	1	-	-	-	1	2	*0.0*
Muschelkalk 5.5-9.4 cm	-	-	-	1	-	1	*0.0*
Muschelkalk total	**6**	**4**	**5**	**12**	**15**	**42**	**0.3**
magmatic rock <1.5 cm	2	-	-	4	-	6	*0.0*
magmatic rock 1.5-3.4 cm	1	1	-	1	-	3	*0.0*
magmatic rock 5.5-9.4 cm	-	1	-	-	-	1	*0.0*
magmatic rock total	3	2	-	5	-	10	*0.1*
metamorphic rock <1.5 cm	-	-	1	2	2	5	*0.0*
metamorphic rock 1.5-3.4 cm	1	1	-	-	3	5	*0.0*
metamorphic rock total	**1**	**1**	**1**	**2**	**5**	**10**	***0.1***
total	**153**	**3668**	**2703**	**2722**	**3230**	**12476**	***100***

Fig. 14. Rock types per metre square at area A.

Abb. 14. *Gesteinsarten pro Quadratmeter in Areal A.*

quartz is a distinct rock type. All rocks found during excavation derive from nearby deposits: today, Muschelkalk outcrops occur north of the excavated area, and limestone pebbles are part of the Middle Pleistocene fluvial deposits in the more immediate surrounding (chapter 2). The huge amount of hard and soft travertines show that travertine deposits were present in the immediate surrounding as well as in more distant parts of the landscape with higher elevation. Before the Holsteinian interglacial, the region was covered by Elsterian till rich in flint and rock erratics which were eroded by later fluvial processes due to valley incision, followed by accumulation of the so-called OMT terrace (chapter 2). Locally, the characteristics of this terrace are i) high amount of flint and quartz as well as ii) the presence of a Blocksohle with huge rocks at its base (Eissmann 1975; Mania 1980: 52; Unger 1963: Tab. 3, 52-53). Therefore the occurrence of huge gravels and high amounts of flint can be expected when eroded Elsterian deposits were incorporated into younger layers.

At area A (Fig. 14) rock types are dominated by travertine (96 %). The amount of flint/chert (4 %) is the lowest of all areas. Other rock types are present by amounts <0.5 %. The presence of several larger (10-25 cm) travertine clasts is another characteristic of area A. One travertine rock with a 50 cm diameter, present at metre square A14 (Beck et al. 2007: Fig. 11), is not incorporated in this analysis as it remained in the profile.

In contrast to area A, at area B (Fig. 15) the amount of travertine decreases significantly (40 %) and the amount of flint/chert (38 %) has risen to numbers nearly as high as for travertine. Also, the amount of Muschelkalk (12 %) and quartz (6 %) has increased. Several larger (10-20 cm) Muschelkalk rocks and (10-25 cm) travertines are present. Other rock types, metamorphic and magmatic stones, are present in small numbers but their total amount has increased (1.5 %) in contrast to area A. Sandstone, which was not found at area A, is present in very low numbers.

At area C a different situation can be documented (Fig. 16): Muschelkalk is the most dominant rock type (68 %), flint/chert (15 %) and travertine (12 %) are present in lower amounts. All other rock types occur

rock type	B4	B5	B6	total	
	n	n	n	n	%
travertine <1.5 cm	330	277	110	717	*7.9*
travertine 1.5-3.4 cm	869	586	940	2395	*26.4*
travertine 3.5-5.4 cm	75	128	188	391	*4.3*
travertine 5.5-9.4 cm	27	46	65	138	*1.5*
travertine 9.5.-14.4 cm	2	3	4	9	*0.1*
travertine 19.5-24.4 cm	2	-	-	2	*0.0*
travertine total	**1305**	**1040**	**1307**	**3652**	***40.3***
flint/chert <1 cm	264	336	372	972	*10.7*
flint/chert >1 cm	685	820	1009	2514	*27.7*
flint/chert total	**949**	**1156**	**1381**	**3586**	***38.5***
Muschelkalk <1.5 cm	71	67	20	158	*1.7*
Muschelkalk 1.5-3.4 cm	323	270	270	863	*9.5*
Muschelkalk 3.5-5.4 cm	29	31	31	91	*1.0*
Muschelkalk 5.5-9.4 cm	5	3	4	12	*0.1*
Muschelkalk 9.5-14.4 cm	2	2	-	4	*0.0*
Muschelkalk 14.5-19.4 cm	-	1	-	1	*0.0*
Muschelkalk total	**430**	**374**	**325**	**1129**	***12.5***
quartz <1.5 cm	162	80	43	285	*3.1*
quartz 1.5-3.4 cm	77	71	83	231	*2.5*
quartz 3.5-5.4 cm	2	2	-	4	*0.0*
quartz total	**241**	**153**	**126**	**520**	***5.7***
metamorphic rock <1.5 cm	63	22	5	90	*1.0*
metamorphic rock 1.5-3.4 cm	21	14	8	43	*0.5*
metamorphic rock 3.5-5.4 cm	4	-	-	4	*0.0*
metamorphic rock total	**88**	**36**	**13**	**137**	***1.5***
magmatic rock <1.5 cm	26	27	14	67	*0.7*
magmatic rock 1.5-3.4 cm	13	21	29	63	*0.7*
magmatic rock total	**39**	**48**	**43**	**130**	***1.4***
sandstone 1.5-3.4 cm	2	1	4	7	*0.1*
sandstone 3.5-5.4 cm	-	-	3	3	*0.0*
sandstone total	**2**	**1**	**7**	**10**	***0.1***
total	**3054**	**2808**	**3202**	**9064**	***100***

Fig. 15. Rock types per metre square at area B.

Abb. 15. *Gesteinsarten pro Quadratmeter in Areal B.*

rock type	C0	C1	total	
	n	n	n	%
Muschelkalk <1.5 cm	52	186	238	*9.9*
Muschelkalk 1.5-3.4 cm	192	768	960	*40.0*
Muschelkalk 3.5-5.4 cm	61	208	269	*11.2*
Muschelkalk 5.5-9.4 cm	25	102	127	*5.3*
Muschelkalk 9.5-14.4 cm	2	24	26	*1.1*
Muschelkalk 14.5-19.4 cm	-	4	4	*0.2*
Muschelkalk 19.5-24.4 cm	-	2	2	*0.1*
Muschelkalk 24.5-29.4 cm	-	1	1	*0.0*
Muschelkalk total	**332**	**1295**	**1627**	***67.8***
flint/chert <1 cm	31	113	144	*6.0*
flint/chert >1 cm	27	184	211	*8.8*
flint/chert total	**58**	**297**	**355**	***14.8***
travertine <1.5 cm	26	72	98	*4.1*
travertine 1.5-3.4 cm	29	160	189	*7.9*
travertine 3.5-5.4 cm	3	5	8	*0.3*
travertine total	**58**	**237**	**295**	***12.3***
quartz <1.5 cm	10	32	42	*1.8*
quartz 1.5-3.4 cm	4	42	46	*1.9*
quartz total	**14**	**74**	**88**	***3.7***
magmatic rock <1.5 cm	4	8	12	*0.5*
magmatic rock 1.5-3.4 cm	-	7	7	*0.3*
magmatic rock total	**4**	**15**	**19**	***0.8***
metamorphic rock <1.5 cm	1	4	5	*0.2*
metamorphic rock 1.5-3.4 cm	1	4	5	*0.2*
metamorphic rock total	**2**	**8**	**10**	***0.4***
sandstone 1.5-3.4 cm	-	3	3	*0.1*
sandstone 3.5-9.4 cm	-	1	1	*0.1*
sandstone total	**-**	**4**	**4**	***0.2***
total	**468**	**1930**	**2398**	***100***

Fig. 16. Rock types per metre square at area C.

Abb. 16. *Gesteinsarten pro Quadratmeter in Areal C.*

metre square	5-10 cm	10-20 cm	>40 cm	total (n)
A2	-	-	1	1
A3	1	-	-	1
A14	-	1	-	1
A15	1	-	-	1

Fig. 17. Length of wooden clasts.
Abb. 17. *Länge von Holzrückständen.*

rarely (<1 %), only quartz is present with 4 %. In general, travertine clasts are small as no specimen >5.4 cm was found. In contrast, 1.4 % of all rocks at area C are represented by larger (>10 cm) Muschelkalk specimens, e.g. at metre squares C11 and C21 where approx. 100x50 cm large slabs of Muschelkalk were found (Beck et al. 2007: Fig. 12: 1).

In sum, the area highest above sea level (area C) is characterized by a huge amount of Muschelkalk with specimens up to 1 m in length. Approx. 30 m west (area B) where the find-bearing layer is situated approx. 2 m lower, Muschelkalk has decreased significantly in contrast to travertine and flint/chert which both now predominate. More or less at the same height but approx. 45 m in southwestern direction (area A) the find-bearing layer is characterized by domination of travertine clasts.

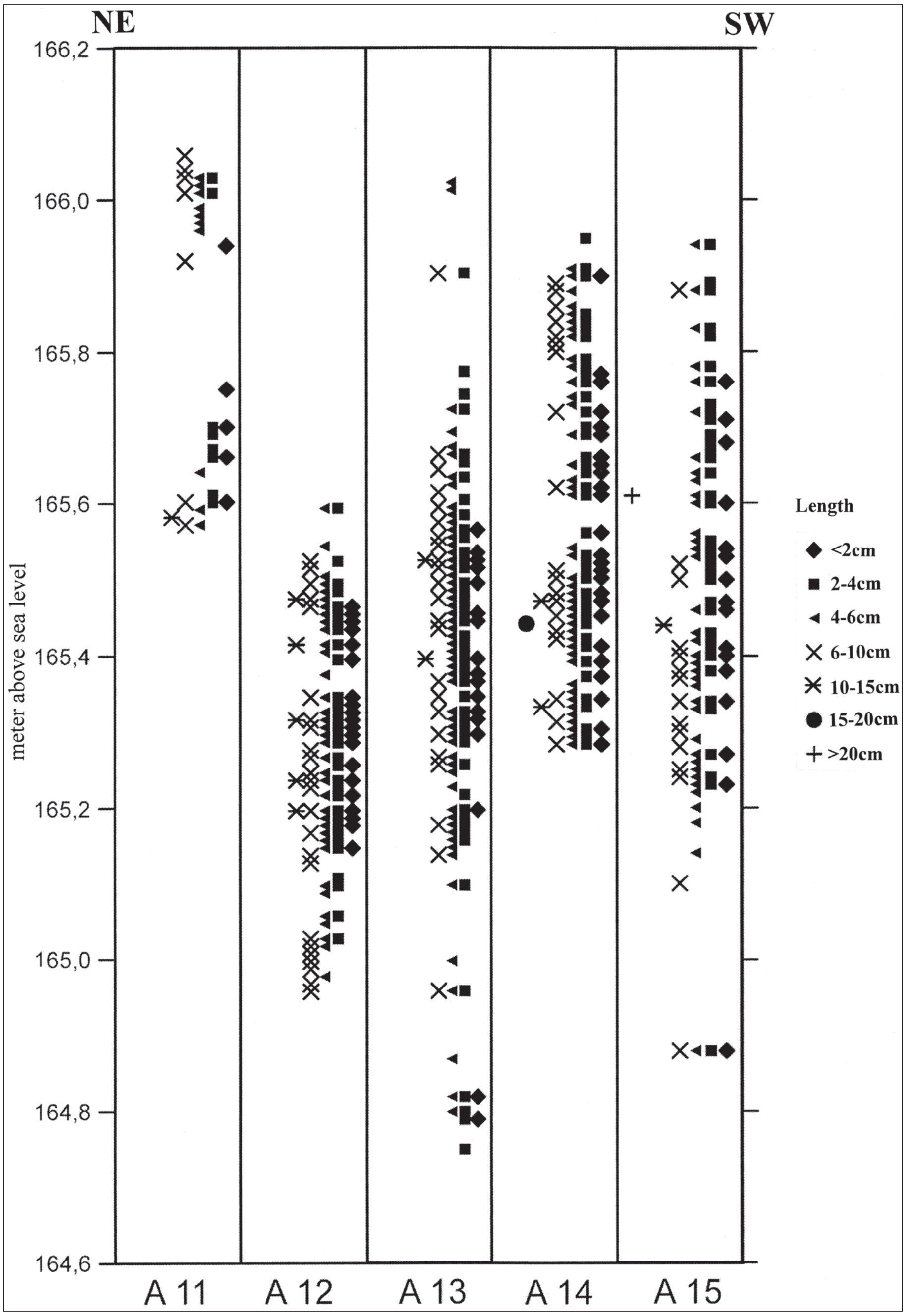

Fig. 18. Vertical distribution of rocks at area A.
Abb. 18. *Vertikalverteilung der Steine in Areal A.*

Area A is also characterized by presence of wooden remains (Fig. 17) now compacted to a thickness of few millimetres. In 1969-2002, several small but also up to 1 m long wooden remains were found in the same stratigraphic position (Mania & Mania 1998: 36, Taf. 4, 5, 7-9). Schoch (2003) analyzed 73 mineralized wooden remains which were dominated by *Alnus* sp. (n=32) and drupe species (n=29). Of course, wooden fragments are an ordinary component of river valleys (Montgomery & Piégay 2003) but wooden fragments may also be a common component of a Middle Pleistocene environment due to beaver and elephants, both present in the Bilzingsleben faunal remains (Müller & Pasda 2011): elephants in recent African savannah destroy a mean of four trees a day (Walter 1984: 107) and wood, charred or not, forms part of Pleistocene beaver dam deposits (Aalto et al. 1989).

At area A rocks occur vertically in an approx. 80-100 cm thick wavy band between c. 166.00-165.00 m a.s.l. (Fig. 18). No vertical sorting of different length classes is present. At metre square A15 only, rocks >6 cm do not occur or are very rare in the upper half. The rocks which occur at A11 on a height around 165.60 m a.s.l. and at A13 around 164.80 m a.s.l. show that larger clasts also occur in the silty layer GH 14.

The vertical distribution of rocks at area B displays the same situation (Fig. 19): all objects occur in a 80-100 cm thick band between 166.20-165.20 m a.s.l.

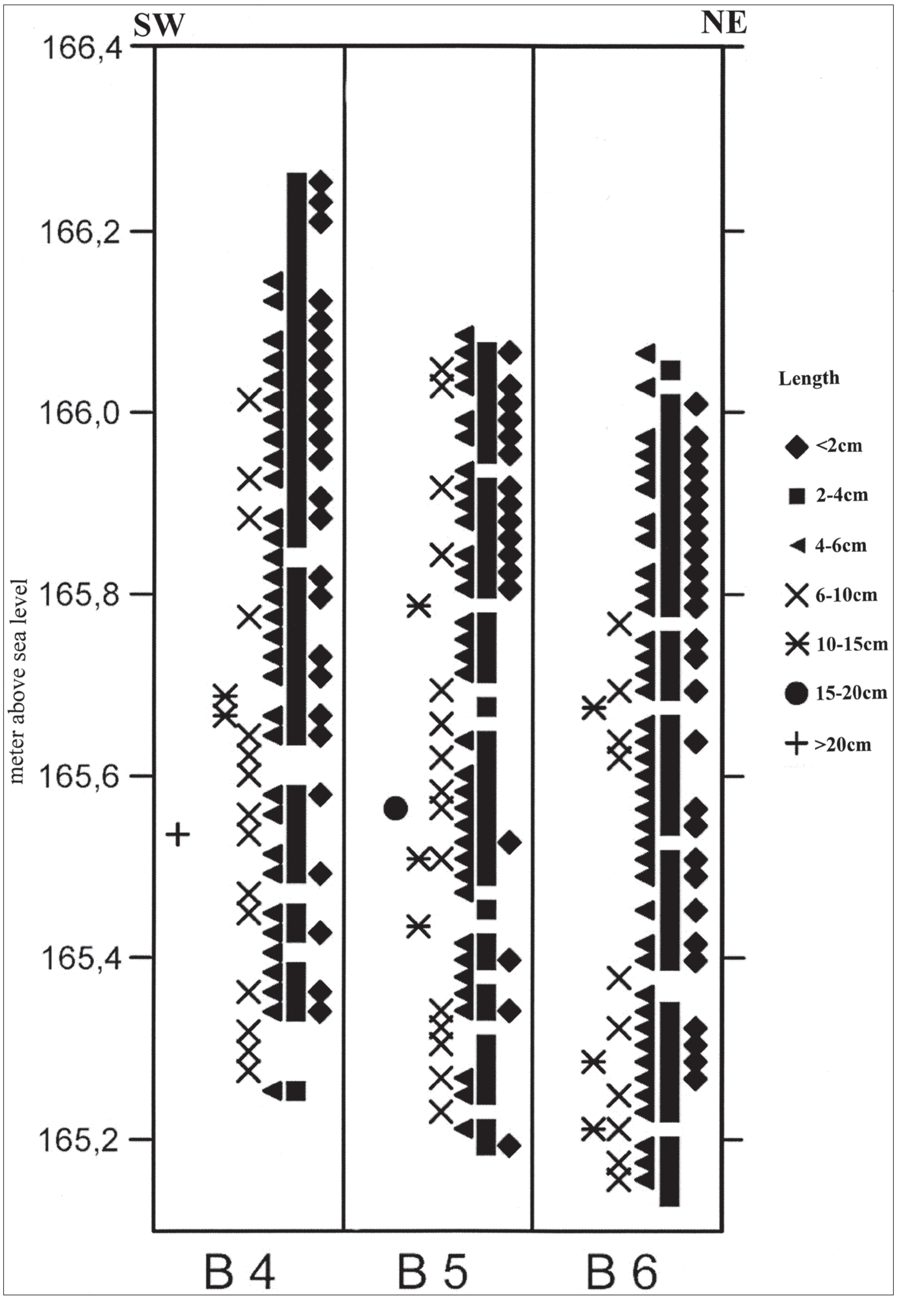

Fig. 19. Vertical distribution of rocks at area B.
Abb. 19. *Vertikalverteilung der Steine in Areal B.*

Also, no vertical sorting of different length classes can be detected but objects >6 cm are more common in the lower part of the vertical distribution.

In the vertical distribution of rocks at area C (Fig. 20), metre square C2 does not represent a full sample as the excavation here was hampered by the

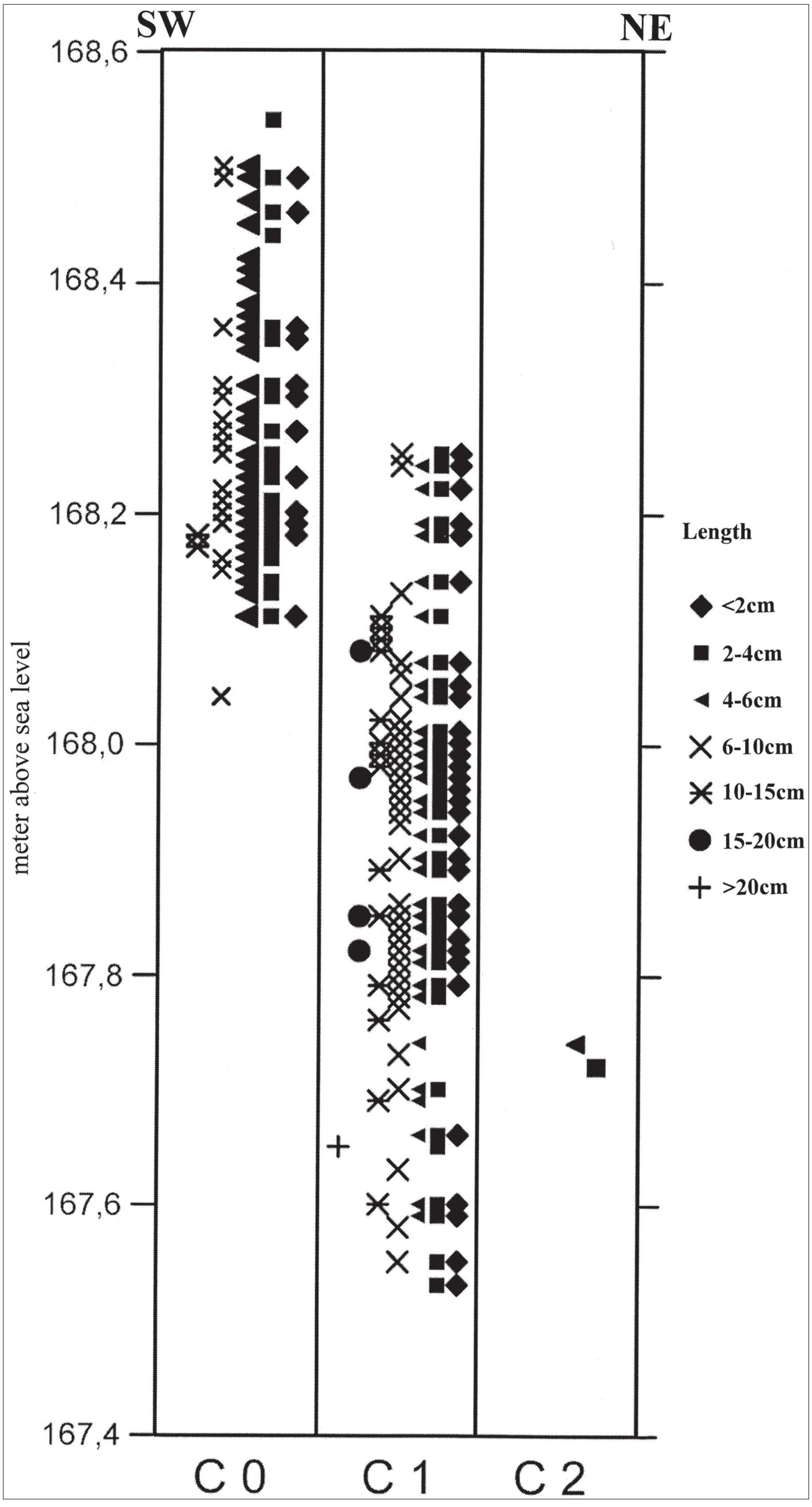

Fig. 20. Vertical distribution of rocks at area C.
Abb. 20. *Vertikalverteilung der Steine in Areal C.*

metre square	GH 7	GH 8	GH 10	GH 12	GH 13	GH 14	total	
	n	n	n	n	n	n	n	%
A11	-	-	-	4	-	12	16	*3.7*
A12	-	7	-	30	47	-	84	*19.6*
A13	-	2	-	70	31	1	104	*24.2*
A14	3	-	-	53	60	11	127	*29.7*
A15	-	-	1	22	63	12	98	*22.8*
total	**3**	**9**	**1**	**179**	**201**	**36**	**429**	***100***

Fig. 21. Flint/chert recorded in geological horizons (GH) at area A. note: objects found in GH 0-6 not included

Abb. 21. *Feuerstein/Hornstein in den geologischen Horizonten (GH) in Areal A. Anmerkung: Objekte aus GH 0-6 nicht aufgeführt.*

lateral restrictions (Fig. 6). However, at metre square C1 rocks occur in an approx. 80 cm thick band. Obvious sorting according to length classes is not present but at C0 more and longer objects occur in the lower half. In contrast, in C1 more and longer rocks are present in the centre of the vertical distribution.

At area A, the majority of flint/chert occurs in the main find-bearing layer (Fig. 21), the sandy sediment (GH 12 and GH 13). Single specimens of flint/chert were found also in the coarse travertine deposits above (GH7-10) as well as in the basal silt (GH 14).

At area A most flint/chert seems to be distributed vertically between 165.80-165.00 m a.s.l. (Fig. 22). However, single specimens of flint/chert also occur above and below, resulting in the presence of an undulating, at maximum 1 m deep find-bearing horizon.

Area B is characterized by the highest amount of flint/chert: in metre squares B4-B6 nearly 3 500 specimens were found (Fig. 23). In contrast to other areas, this huge amount of finds affected excavation strategy and therefore influenced the vertical distribution: the cloudy distribution of dots in the upper part of Figure 24 results out of recording many single finds at the start of the summer campaign in 2004. To finish these metre squares in late summer, excavation speed had to be increased, resulting in more finds recorded by dry-sieving. Therefore in the lower part of the vertical distribution (Fig. 24) only single dots appear but these represent more than one flint. Therefore as in the other areas, at area B flint/chert is distributed vertically over 1 m at maximum within a find-bearing horizon (between 166.40-165.40 m a.s.l.) which inclines 30-40 cm in height over 3 m to northeast.

At area B (Fig. 23), single specimens of flint/chert were found also in the fine-grained, laminated sediments on top (GH 1), in mixed sediments (GH 4, GH 4/5) and in the basal silt (GH 5). However, more or less all objects were recorded in the main find-bearing horizon, the sandy layer (GH 2, GH 2/3, GH 3) in the central part.

Proper presentation of vertical distribution at area C is hampered by the lateral restrictions but also due to the presence of large Muschelkalk slabs. However, vertical distribution of flint/chert displays a steep incline of the find-bearing horizon (Fig. 25) which starts at 168.40 m a.s.l. in the southwest and dips to 167.25 m a.s.l. within 1 m in northeastern direction.

At area C (Fig. 26), flint/chert occurs in the silty to sandy layers (GH 4; GH 4/5, GH 5). However, single objects were situated in the basal silt (GH 5/6, GH 6) as well.

As shown above, in areas A-C the highest amount of flint/chert was found in the sandy layer mainly but also in the silt below and in the coarse travertine deposits above (Figs. 21, 23 & 26). However, stratigraphic occurrence of flint is much more widespread as information from the Steinrinne research history may show: in the 1920s flints were collected by Adolf Spengler from deposits inside rock travertine (Toepfer

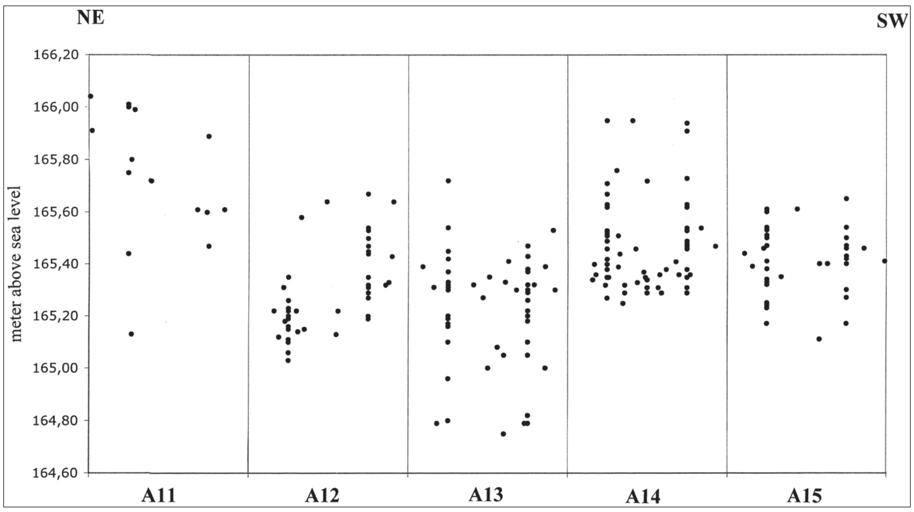

Fig. 22. Vertical distribution of flint at area A (note: each dot can represent more than one lithic).

Abb. 22. *Vertikalverteilung der Feuersteine in Areal A (Anm.: jeder Punkt repräsentiert mindestens ein Fundobjekt).*

metre square	GH 1	GH 2	GH 2/3	GH 3	GH 4	GH 4/5	GH5	total	
	n	n	n	n	n	n	n	n	%
B4	3	154	3	662	77	4	3	906	*26.0*
B5	-	604	-	551	36	-	3	1194	*34.3*
B6	1	814	-	556	4	5	-	1380	*39.7*
total	**4**	**1572**	**3**	**1769**	**117**	**9**	**6**	**3480**	***100***

Fig. 23. Flint/chert recorded in geological horizons (GH) at area B. note: objects found in GH 0 not included.

Abb. 23. *Feuerstein/Hornstein in den geologischen Horizonten (GH) in Areal B. Anmerkung: Objekte aus GH 0 sind nicht enthalten.*

1980: 25). Flints of the collection made in 1910-25 by members of the Weimar museum were found inside rock travertines too (Wiegers 1922: 39) but also on surrounding fields (Toepfer 1980: 23). In the 1930s, flints were also reported from a sandy layer (Wiegers 1941: 335) as well as from sand below rock travertine (Toepfer 1980: 28) where thirty years later Dietrich Mania made his excavations. Additionally, lithics were also collected on the surface of ploughed fields 100 m west of the excavation (Weber & Mania 1982). According to Dietrich Mania (2010: 96) in the OMT-gravels were found two 3-5 cm long flakes and a 6 cm long scraper, and at the base of the basal silt a patinated flake. This information shows that flints occur widely distributed both vertically and horizontally in different parts of former and recent landsurfaces.

The study of clast fabric investigates the spatial attitude of larger clasts lying within a geological layer. This research topic, common in the earth sciences (e.g. Heyer 1968; Leser 1977), recently came into the focus of archaeologists again (Bertran & Lenoble 2002; Bertran & Texier 1995; Lenoble 2005; Lenoble & Bertran 2004; Lenoble et al. 2008). At Bilzingsleben, the dip of rocks exhibit differences between areas (Fig. 27): the number of objects embedded in a horizontal situation (=parallel to the surface of the geoid) decreases from area A via B to C. In contrast, the number of objects embedded in an oblique position (=length axes parallel to the incline of the geological layer) increases from A via B to C. This observation corresponds with the visible inclination of the find-bearing layers which is the most pronounced at area C (Fig. 13; 20; 25) and not present at area A (Fig. 11; 18; 22), with area B (Fig. 12; 19; 24) in a medium position. The orientation of animal bones displays the same pattern but is hampered by low numbers. For example, of 27 bones at area A only few are inclined towards the southwest (Müller & Pasda 2011: Fig. 9) but with the much higher number of rocks no preferred orientation of inclined objects is detectable here (Fig. 28: lower right). However, at area B inclined rocks (Fig. 28: middle) and bones (Müller & Pasda 2011: Fig. 14) are oriented in an eastern direction in contrast to horizontal objects which are mainly embedded on a N/S and W/E axis. At area C only some bones could be used to study clast fabric but inclined ones show again a preferential orientation in an eastern direction (Müller & Pasda 2011: Fig. 19). With a much higher number of rocks an obvious preference for inclined objects to be embedded

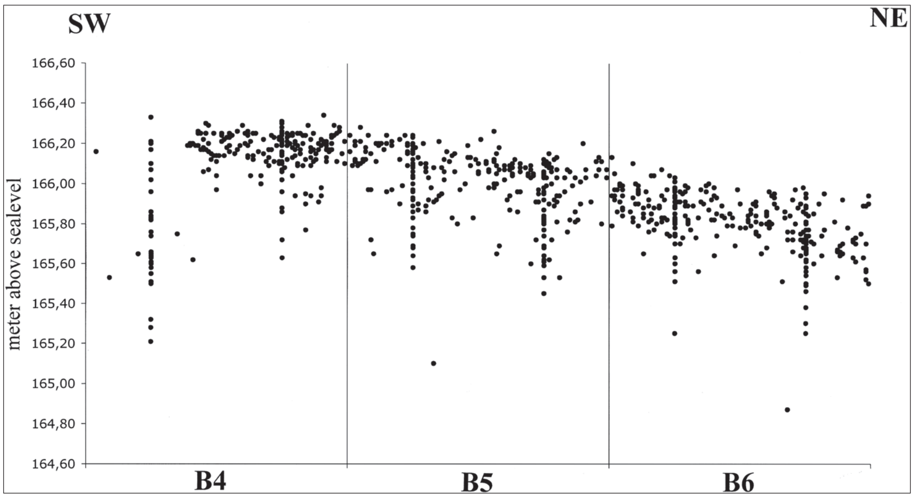

Fig. 24. Vertical distribution of flint at area B (note: each dot can represent more than one lithic).

Abb. 24. *Vertikalverteilung der Feuersteine in Areal B (Anmerkung: jeder Punkt repräsentiert mindestens ein Fundobjekt).*

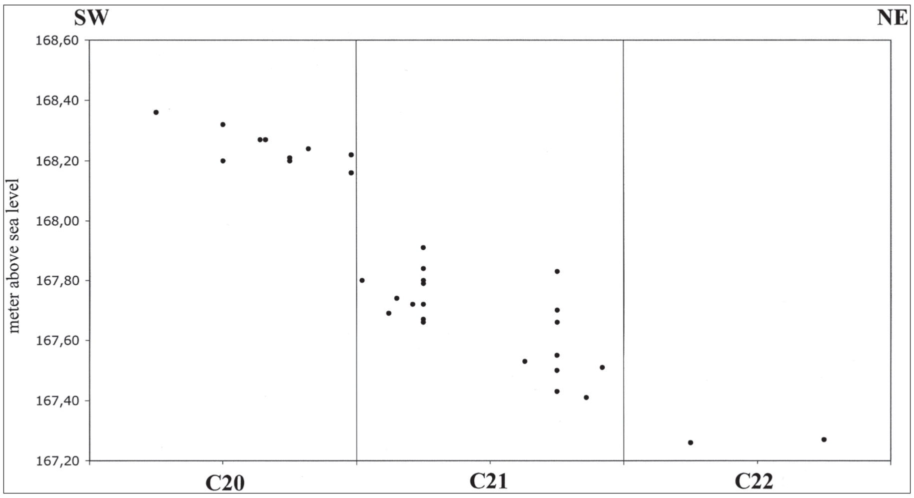

Fig. 25. Vertical distribution of flint at area C (note: each dot can represent more than one lithic).

Abb. 25. *Vertikalverteilung der Feuersteine in Areal C (Anmerkung: jeder Punkt repräsentiert mindestens ein Fundobjekt).*

towards the northeast (Fig. 28: above right), parallel to the steep incline of the find-bearing layer (Fig. 25), becomes visible.

As expected by geologists (Leser 1977: 228), at Bilzingsleben dip and strike of small clasts (1-5 cm), like flint/chert, showed no preferred orientation.

Interpretation: Site formation processes

The basal layer of the excavation (area A: GH 14; area B: GH 5, area C: GH 6) is interpreted as loess with concretionary (pedogenic) redistribution of carbonate. As the sediment is not devoid of finds, it is not out of the question that this sediment has been reworked or redeposited. The top of this layer slopes, a feature which is well pronounced at the highest spot (area C), obvious at the central area B, situated approx. 2 m lower, but not present at area A. A distinct change in sedimentology characterizes the boundary between the basal layer and the find-bearing horizon. As indicated by molluscs and ostracods in the lowermost part of the find-bearing layer of area A (chapter 3), a stratigraphic hiatus produced by running water may have been present.

The main find-bearing layer of all three excavated areas (area A: GH 12+13; area B: GH 2+3, area C: GH 4+5) is a maximally 1 m thick, sandy horizon with huge quantities of small and large finds. The random vertical distribution of small and larger rocks (chapter 4) and bones (Müller & Pasda 2011) in a sandy deposit qualifies the find-bearing layer as a matrix-supported sediment (Tucker 1996: 102). A reduction in sediment volume by natural overburden loading by several metres thick rock travertine (Andrews 2006) as well as post-depositional homogenisation, e.g. by root turbation or trampling by animals, may be present at area A (pers. comm. P. Frenzel, Jena 2011).

There is an obvious correlation between height above sea-level, inclination of layers and orientation of larger clasts: at area C this is the most pronounced, in contrast to area A, with area B in an intermediate position (Fig. 29). This may indicate that the inclination of the find-bearing layer does not result out of post-Holsteinian pseudo-tectonics but that the original situation is preserved at areas A-C.

In areas C and B, rocks and bones are oriented parallel to the inclination of the layer towards the east (chapter 4; Beck et al. 2007: Fig. 10; Müller & Pasda 2011). This is interpreted as accumulation of coarser clasts within a fine matrix by mass-movement (Bertran & Lenoble 2002; Bertran & Texier 1995: 524; Bertran

metre square	GH 4	GH 4/5	GH 5	GH 5/6	GH 6	total	
	n	n	n	n	n	n	%
C0	51	-	1	-	-	52	*12.4*
C1	35	3	153	-	-	191	*45.3*
C10	49	-	-	-	-	49	*11.6*
C11	10	-	19	-	1	30	*7.1*
C20	20	-	-	-	-	20	*4.8*
C21	4	6	56	4	1	71	*16.9*
C22	-	-	8	-	-	8	*1.9*
total	**169**	**9**	**237**	**4**	**2**	**42**	***100***

Fig. 26. Flint/cherts recorded in geological horizons (GH) at area C. note: objects found in GH 0 - 3 not included.

Abb. 26. *Feuerstein/Hornstein in geologischen Horizonten (GH) in Areal C. Anmerkung: Objekte aus GH 0 - 3 nicht enthalten.*

dip	A11-15		B4-6		C0-1	
	n	%	n	%	n	%
oblique	457	*53.6*	535	*78.6*	492	*93.9*
horizontal	335	*39.3*	138	*20.3*	17	*3.2*
vertical	42	*4.9*	8	*1.2*	15	*2.9*
total	**852**	***100***	**681**	***100***	**524**	***100***

Fig. 27. Fabric (dip) of rocks at areas A-C.

Abb. 27. *Gefüge (Stellung) der Gesteine in den Arealen A-C.*

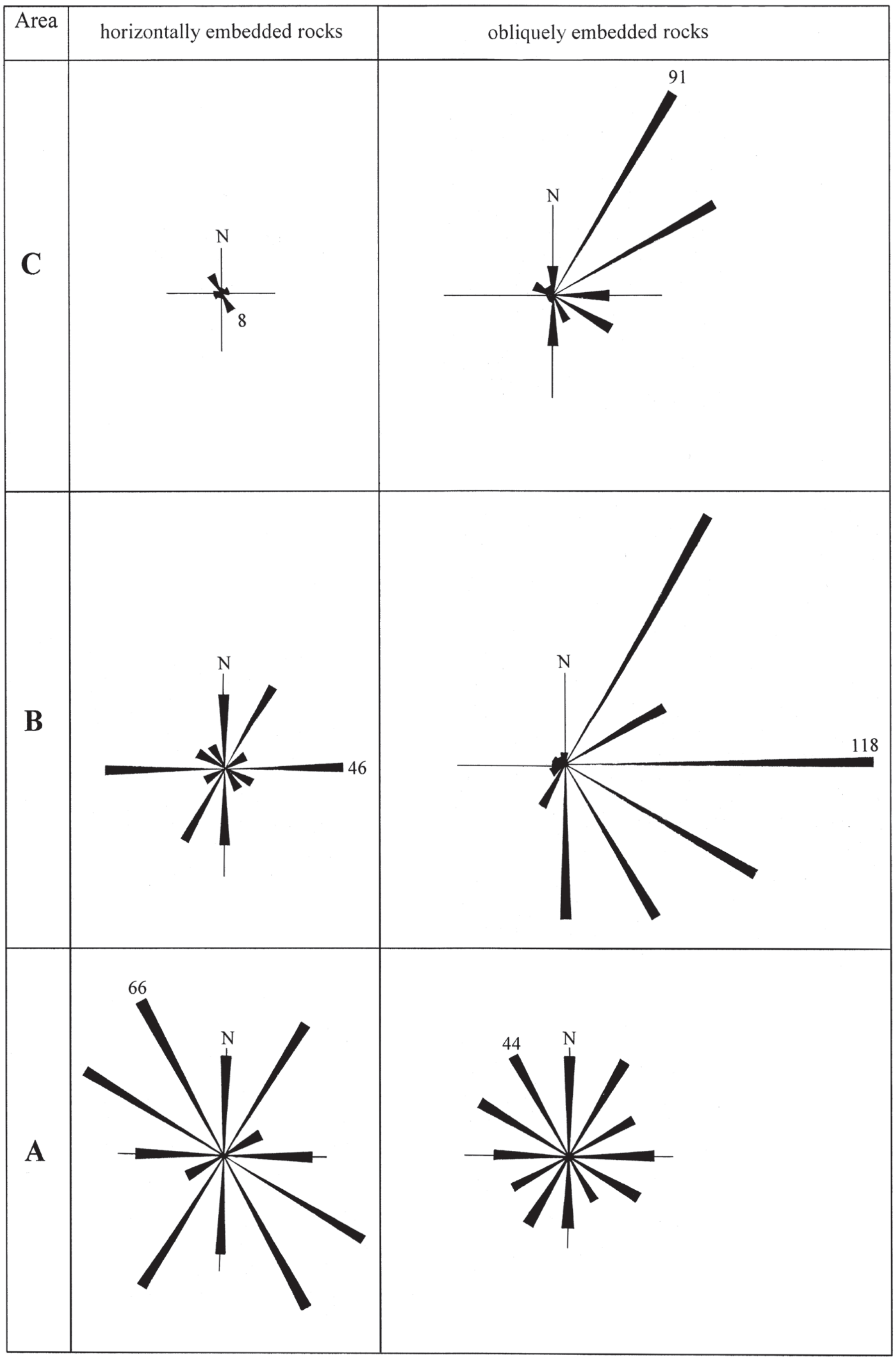

Fig. 28. Orientation of the elongated rocks at areas A, B, and C (note: data is presented without elongation criteria, e.g. a length to width ratio).

Abb. 28. *Orientierung der Steine in den Arealen A, B und C (Datenwiedergabe ohne Berücksichtigung des Längen-Breiten-Verhältnisses).*

et al. 1997: 10; Heyer 1968: 96; Lenoble et al. 2003: Fig. 3; Leser 1977: 234-235; Tucker 1996: 35). Gravity-driven movement of solid-fluid mixtures, like mass- or debris-flows play an important role in moving sediment from steep land into river systems (Cornforth 2005; Jakob & Hungr 2005; Phillips 2006). This movement is influenced by the instability of steep slopes, overlay of different materials and water influx, e.g. by direct infiltration of rainfall or snow-melt water (Savage & Baum 2005). As mentioned in chapter 2, mass movement due to bedrock geology, high floods and changes between limnic periods and erosive processes are not out of the question. As ostracods characterize the depositional environment, the sandy matrix of the Steinrinne mainly derived from fluvial and limnic deposits (chapter 3) but molluscs (Vökler 2009) and animal bones (Müller & Pasda 2011) indicate incorporation of terrestrial sediments and land surfaces also. As Mesozoic ostracods (chapter 3) and Mesozoic fish bones (Böhme

characteristic	area A	area B	area C
height above sealevel	165.25 m	165.50 m	167.50 m
inclination of geological layers	-	+	++
dip of clasts	-	+	++
vertical find distribution	~80-100 cm	~80-100 cm	~80-100 cm
bones (n/m² - kg/m²)	40 - 1.0	313 - 6.6	26 - 1.3
rocks (n/m²)	c. 3080	c. 3020	c. 1930
amount of travertine	*96%*	*40%*	*12%*
amount of flint/chert	*4%*	*38%*	*15%*
amount/presence of quartz	*<1%*	*6%*	*4%*
amount/presence of Muschelkalk	*<1%*	*13%*	*68%*
presence of Magmatic/metamorphic rocks	*<1%*	*<1%*	*<1%*
presence of sandstone	*<1%*	*<1%*	*<1%*
presence of wood	+	-	-

Fig. 29. Geoarchaeological characteristics of the find-bearing layer. - not present; + present; ++ dominant.

Abb. 29. *Geoarchäologische Eigenschaften des fundführenden Horizonts. - nicht vorhanden; + vorhanden; ++ dominierend.*

2009: 29) are present, Pre-Pleistocene sediment clasts have also been incorporated. However, a spatial divison is present: at area C a fluvial sediment is traceable, area B is characterized by predominantly fluvial influences (lower part) and a predominantly limnic sediment (upper part), in contrast to area A where a limnic sediment is the most represented. However, it has to be emphasized that in every area molluscs and ostracods as well as quartz sands indicate input of fluvial sediments into limnic sediments and vice versa or mixing of different sediments.

The difference in rock-types between areas (Fig. 29) indicate that the find-bearing layer at area C was accumulated near the former valley slope where many and sometimes huge Muschelkalk slabs were incorporated under high-energy conditions. Maybe the precursor of the Wirbelbach was active here. In contrast, at area A, where travertine gravels predominate and clasts show no distinct orientation, the find-bearing layer was accumulated under low-energy conditions, maybe related to travertine pools, beaver ponds or oxbow lakes although short-term fluvial influx as well as high-energy reworking, e.g. by remants of block fall or clast avalanches from nearby cascades, walls and slopes, may also have been present. Area B is situated in an intermediate position where flood plain and channel dynamics as well as aquatic reworking were responsible for the decrease of travertine, the increase of Muschelkalk and a predominance of local gravel clasts.

Orientation of animal bones (Müller & Pasda 2011) as well as marks on bones produced by sediment crushing (Steguweit 2003) indicate that faunal remains were accumulated in the same way as rock clasts. Skeletal part representation of large mammals, and the presence of single bird bones and fish remains show that faunal remains from terrestric and aquatic environments are present (Müller & Pasda 2011). Therefore the accumulating processes incorporated older sediments but mainly rocks and bones which were part of the Holsteinian landscape. Humans were of minor importance for presence of animal remains on this land surface (Müller & Pasda 2011). Therefore in the next section a detailed look on the flints of the Steinrinne will be made to discuss human presence by artefacts.

Flint

Introduction

Recent research on Middle Pleistocene archaeology in England and northern France (e.g. Ashton 1998b; 2004; Field 2005; Hallos 2004; 2005; Langbroek 2004; Pope & Roberts 2005) indicates that short-term activities connected with production and use of cutting devices were the main human site formation processes: preparation, débitage of blanks and modification, such as manufacture of rough-outs, biface-preparation or several episodes to produce flakes from cores with migrating platforms, resulted in lithic debris in distinct, patchy concentrations. In contrast, only single artefacts were left in the area where tools were used, resulting in spatially faint scatters. Consequently, the Middle Pleistocene landscape was characterized by a scatter of lithic litter which concentrated at certain spots. The same has to be expected for the former landscape at Bilzingsleben. Therefore it is possible that at least single flint artefacts may have been incorporated into the find-bearing layer.

Research history

Since the 18th century written sources document that the Steinrinne travertine deposit was well-known for its huge amount of Pleistocene mammal and plant remains (Toepfer 1980: 14-15). Although the palaeontologist Ewald Wüst claimed to be the first one to have recognized a single modified flint tool while doing research at the Steinrinne in 1908 (Wiegers 1922: 32), this discovery had no impact on archaeological research. Between 1910-1915, members of the Museum of Natural History at Weimar - the preparator Ernst Lindig and curator Armin Möller as well as medical court servant Dr. Ludwig Pfeiffer, author of a monograph on the techniques of the Stone Age - made four single day excursions to the Steinrinne travertine quarry and collected animal bones, travertine rocks, stones and flint in travertine deposits as well as from surface scatters on neighbouring fields (Toepfer 1980: 22-23). Perhaps because they knew Middle Palaeolithic stone artefacts well from travertine sites at Weimar, e.g. from Ehringsdorf, they did not put too much emphasize on the flint objects of the Steinrinne which were stored in the museum at Weimar. Only around 1920, while investigating the Weimar collection for plant imprints on the Steinrinne travertine rocks, did the palaeontologist Emil Werth become aware of the flint objects claiming them to be "lithic sherds" (Toepfer 1980: 22). Werth introduced Adolf Spengler to the Steinrinne quarry to look for faunal remains and flints (Wiegers 1922: 39). Spengler, a joiner from nearby Sangerhausen, was a passionate collector of palaeontological and archaeological specimens but also searched among railway gravels, collecting a lot of pseudoartefacts (Wiegers 1922: 34-39), perhaps because at this time the perception was popular in Central Germany that the oldest human tools should be the most primitive ones, resembling simple, unretouched splinters (Lehmann & Lehmann 1921: 283-285, 305). In 1922, geologist Fritz Wiegers, who as a student was a regular visitor of the Steinrinne (Toepfer 1980: 25), examined the Spengler finds, among them "some flints (…) of which one has a retouched edge" (Wiegers 1922: 33; translation by the author). Later he described the flints from the Steinrinne as being "typologically (…) indistinct. [These lithics] are small, sharp-edged, angular flakes, with traces of modification" (Wiegers 1928: 67; translation by the author). This qualification of the Steinrinne lithics was widespread as, despite two more excursions to the Steinrinne in 1925, the members of the Weimar museum remained "somehow disappointed" (Toepfer 1980: 23) about the appearance of these flints. The first drawings of lithics from Bilzingsleben were made from objects of the Spengler collection (Fig. 30) and published in 1928 by

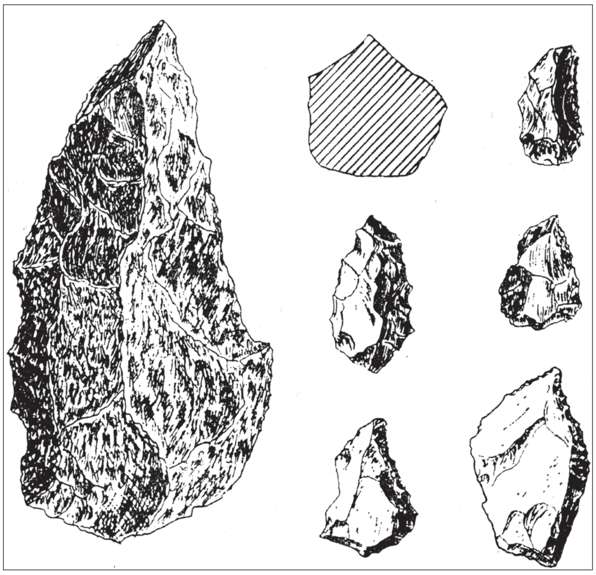

Fig. 30. The first published lithics of Bilzingsleben. Scale unknown (adapted from Toepfer 1980: Abb. 3).

Abb. 30. *Die ersten publizierten Steinartefakte aus Bilzingsleben. Maßstab unbekannt (verändert nach Toepfer 1980: Abb. 3).*

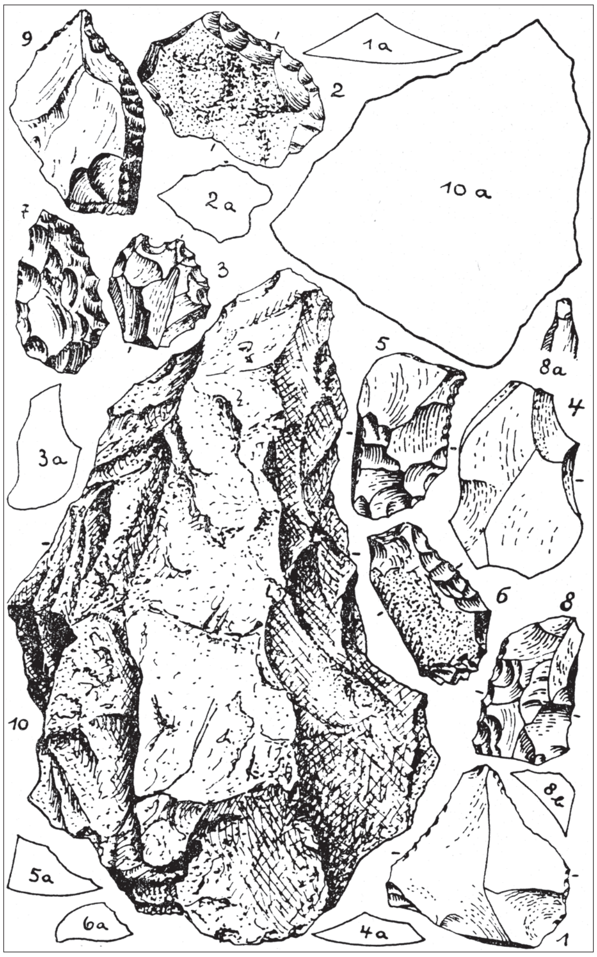

Fig. 31. Lithics from Bilzingsleben published in 1939 (adapted from Toepfer 1980: Abb. 5).

Abb. 31. *Im Jahr 1939 publizierte Steinartefakte von Bilzingsleben (verändert nach Toepfer 1980: Abb. 5).*

Carl Engel, a bookseller responsible for the Prehistoric Department of the Museum of Culture History of Magdeburg (Toepfer 1980: 26). He described several hundred small flakes, some 3-5 cm long cores, point-like flakes with crude retouch as well as a large pebble tool (Engel 1928: 173). In the late 1930s, only few further lithics of the Steinrinne (Fig. 31) from both the Spengler and Weimar collections were published in a compilation of German Palaeolithic sites (Andree 1939: 241-243) which also contained many localities with pseudoartefacts (Rust 1942). During this period, the local schoolteacher Arnold Schütze collected flints from sandy deposits below rock travertine (Toepfer 1980: 28). Fritz Wiegers, who was active in the ´eolith debate´ of Central Germany (Wiegers 1939, 1942; see also: Vollbrecht 1997: 68-69), mentioned that local geologist Julius Hesemann also made a collection of flints from a sandy deposit, among which "some were flaked artificially" (Wiegers 1941: 335; translation by the author). In 1960, Volker Toepfer (1960; 1980: 30-32) published his own investigation of the lithic objects collected by Adolf Spengler (Fig. 32). Toepfer, born near Bilzingsleben in 1908, knew the lithics from the Steinrinne since 1925 when he, as a pupil at Weimar, was working at the museum (Toepfer 1980: 23). With a geological doctor diploma on the stratigraphy of the central Saale river valley, he was employed from 1952-1978 at the Federal State Museum of Prehistory at Halle/Saale being responsible for Palaeolithic and Mesolithic Archaeology (Gramsch 2010: 157; Grünberg 2002: 35). By reading intensively, Toepfer acquired detailed knowledge about contemporary trends in French Palaeolithic research, e.g. about the so-called ´Tayacien´ by emphasizing the site of Fontéchevade (Toepfer 1968a: 26-27). Perhaps as a consequence of this, but only once, he assigned the lithics of Bilzingsleben to the Tayacien (Toepfer 1961: 578, 585). The approx. 900 flints from the Spengler collection are described (Toepfer 1960, 1980: 31) as being dominated by chunks (54 %) and flakes (35 %), the latter being smaller than 2 cm often. 6 % of the lithics were qualified as tools, among them small scrapers, perforator-like pieces as well as so called Tayac points (Fig. 32). The small dimensions of the lithics were argued as resulting out of human use of local sources as here the Elsterian moraine contains just small flint erratics. Toepfer (1960) published these "microlithic" flint objects together with flints from another travertine site at Weimar as evidence of a specific Lower Palaeolithic culture of the last interglacial.

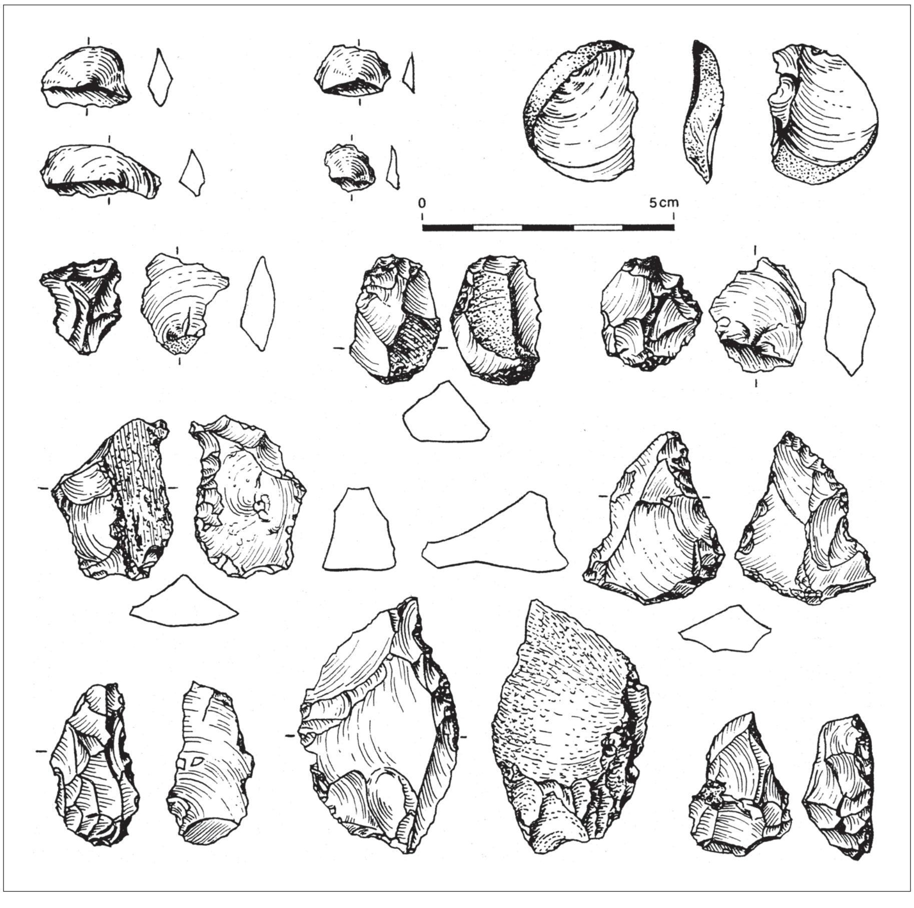

Fig. 32. Flints of the Spengler collection from Bilzingsleben published in 1960 (adapted from Toepfer 1980: Abb. 6).

Abb. 32. *Im Jahr 1960 publizierte Feuersteine aus der Sammlung-Spengler von Bilzingsleben (verändert nach Toepfer 1980: Abb. 6).*

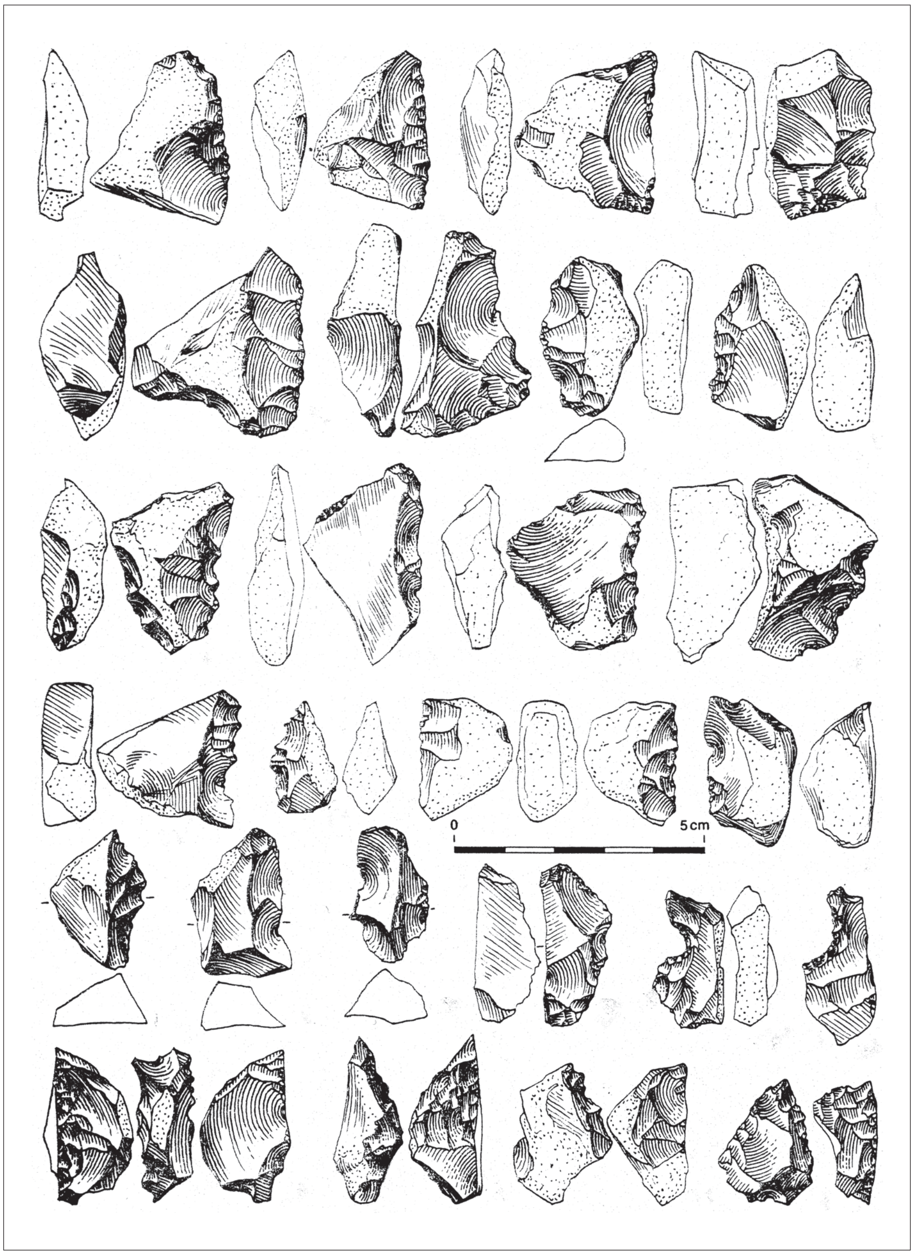

Fig. 33. Flints excavated at Bilzingsleben in 1969-2002 (adapted from Mania & Weber 1986: Taf. 6).

Abb.33. *Zwischen 1969-2002 in Bilzingsleben ausgegrabene Feuersteine (verändert nach Mania & Weber 1986: Taf. 6).*

Volker Toepfer had huge influence on archaeology in East Germany, e.g. he is claimed as being "the father of Palaeolithic research" in the German Democratic Republic (Gramsch 2010: 160). Starting in 1956, Dietrich Mania was in close contact with Volker Toepfer, first as a student, later as a researcher (Gramsch 2003: 15-16, 2010: 159-161). Consequently, by excavating for three decades at the Steinrinne, Dietrich Mania found several thousands of flint artefacts (Fig. 33) of which approximately 10 000 lithics were investigated by attribute analysis (Burdukiewicz et al. 1979; Weber 1986; 1994). Recent investigations followed (e.g. Brühl 2003; Laurat 2001; 2002; Mania 1993; Valoch 1989; 2000) resulting in the determination of selected specimens as Quinson points (Fig. 34: 1-3), Tayac points (Fig. 34: 4-7), small handaxe-like points (Fig. 34: 8, 9), picks (Fig. 34: 10, 11) or unifacially retouched points (Fig. 34: 12-15).

Flint / chert of the 2003-2007 excavations

Lithics from the excavations contain both nordic flint, which is dominant, as well as a shelly Triassic limestone (Muschelkalk) chert. Both raw materials occur in the vicinity of the excavated area naturally: today, Muschelkalk rock outcrops start several hundred metres north and west of the excavated area and Triassic limestone pebbles are part of Middle Pleistocene fluvial deposits in the more immediate surrounding (Mania 1980: 49, 52; Mania & Altermann 2004: Tab. 1). According to Dietrich Mania, the excavated flint

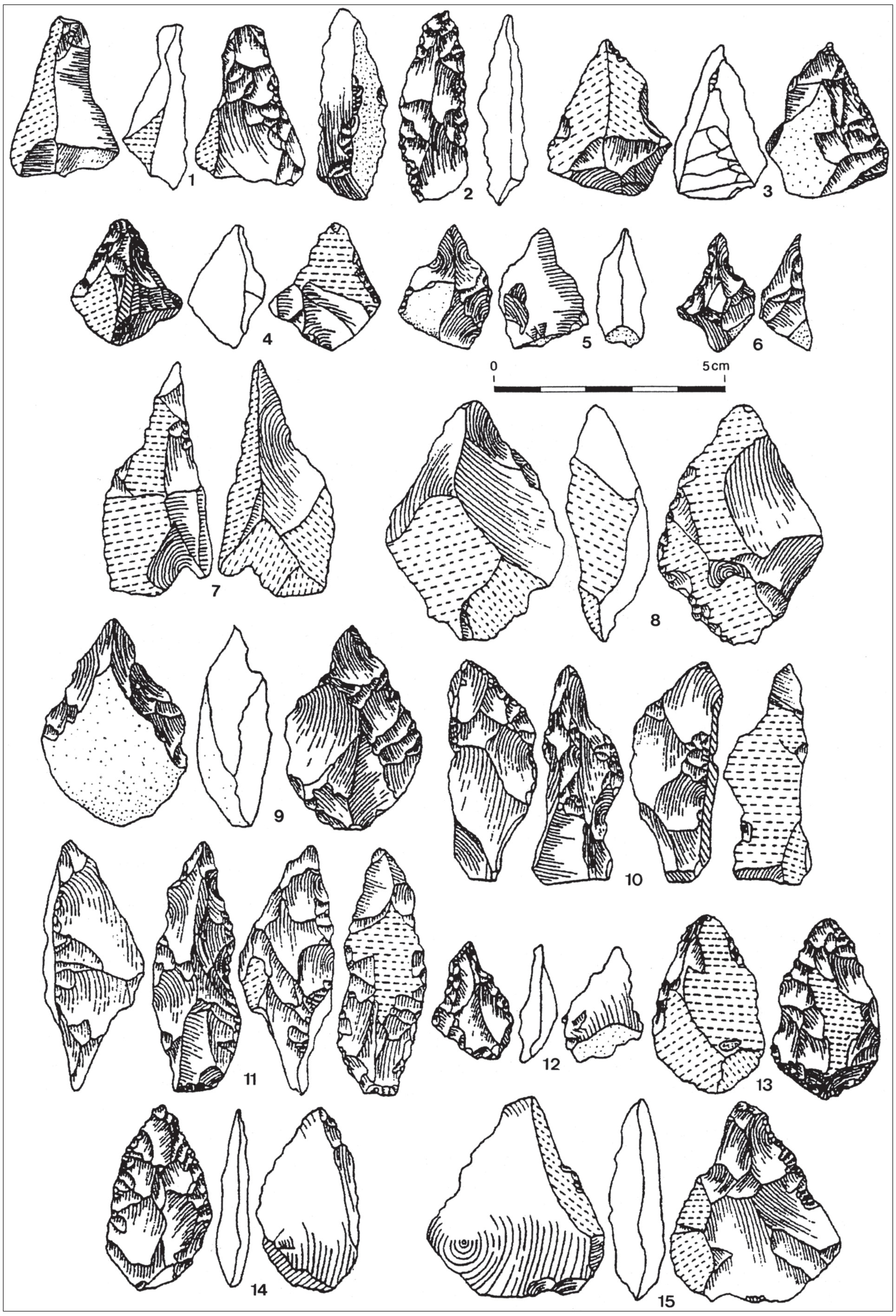

Fig. 34. Flints excavated at Bilzingsleben in 1969-2002 (adapted from Laurat 2001: Abb. 2-5).

Abb. 34. Zwischen 1969-2002 in Bilzingsleben ausgegrabene Feuersteine (verändert nach Laurat 2001: Abb. 2-5).

derived from Elsterian sediments as well as from "interglacial land surfaces" (Mania & Weber 1986: 36). Today, nordic flint can be found in the Elsterian moraine approximately 1.5 km east of the excavation (Fig. 2). Elsterian moraines in Central Germany contain 3 - 21 % (mean: 10 %) of chalk-derived chert fragments in the grain fraction 4 - 40 mm, beside a wide spectrum of nordic crystalline and sediment pebbles (Eissmann 1975: Tab. 4). Elsterian till in the vicinity of Bilzingsleben, e.g. at Bad Kösen or Bad Sulza, contains siliceous clasts predominantly well rounded or just in the nodular concretionary form in which they were freed from chalky sediments (Beck et al. 2007: 13). Sharp-edged flints are relatively rare in tills but are found often in the Steinrinne deposit (Figs. 48-50). This shows that the flint at Bilzingsleben is not a simple outwash of till and/or fluvio-glacial gravel deposits. However, as described in chapter 2, the flint-rich Elsterian glacial sediments were influenced by fluvial erosion immediately after retreat of the glaciers (Unger & Kahlke 1995: 210). The first post-Elsterian fluvial terrace, preserved today below the silty layer, contains gravels generally smaller than 3 cm but with the highest amount of nordic moraine clasts, e.g. up to 5 % flint (Eissmann 1994: 84-85; Unger 1963: Tab. 3, 52-53, 2003: 434; Unger & Kahlke 1995: 211). At other localities the amount of flint in this terrace is as high as 13 % (Eissmann 1975: 96, 97) or is mentioned as being "extremely rich" (Unger 2003: 436). In comparison to this amount, flint is underrepresented at area A (Fig. 14) but overrepresented at areas B and C (Figs. 15; 16). This overrepresentation is difficult to interpret. Today no pits are present to investigate the few small OMT deposits beside the Steinrinne (Unger 1963: 52) but in general in Central Germany post-Elsterian fluvial action resulted in an outwash of fine particles of Elsterian moraines on top of the moraine or at the base of terrace deposits, producing a Steinsohle or Blocksohle which contains huge amounts of flint (Eissmann 1994: 85-86; Meng & Wansa 2005: 196; Mania 2010: 84: 89; Miersch & Kühl 2003: 58). An analyzed sample of 1.6 m^3 Blocksohle contained 1.040 kg gravel specimens >5 cm among which flint (120 kg) is the most dominant rock type: 93 % flints are 5-10 cm long, 7 % are 10-20 cm long and three single flints are >20 cm (Pasda 1996). Of course, it is not known if a comparable flint-rich Blocksohle was present at the Steinrinne but the huge amount of flint in areas B and C is not necessarily to be explained by human action. However, the Blocksohle was an attractive flint source for Middle Pleistocene humans as indicated at Markkleeberg (Schäfer et al. 2003) or by in situ preserved Levallois knapping workshops, indicated by refitting sequences, at Zwochau (Pasda 1996). Therefore it is no surprise that in Central Germany true stone artefacts, among them obvious scrapers and bifaces, can be collected out of Middle Pleistocene fluvial deposits (e.g. Eissmann et al. 1996; Rudolph et al. 1995). In contrast to these Middle Pleistocene gravels, at approximately ten other localities flints were found which resemble types published from the Bilzingsleben site. These localities, at which some flints correspond to the Steinrinne specimens in size and shape (Laurat 2003; Laurat & Brühl 2006; Laurat et al. 2004a, 2004b; Mania 2010: 96-117), are assigned variously to the Clactonian (Mania 1995: 85; Toepfer 1968b), a microlithic Lower Palaeolithic or an unspecified early Middle Pleistocene Palaeolithic (Weber 1997; Weber & Thum 1991; Weber et al. 1996). With one exception, no site was excavated but finds were made by checking outcrops in gravel quarries or by taking objects out of industrial gravel dumps. Taking into consideration only sites with detailed information (Fig. 35), find numbers are very low. Only from one site known since 100 years, Wallendorf, were several thousands of flints collected. The only excavated sample is Neumark-Nord where, in 2003-2004, an excavation was carried out over 30 m^2 (Brühl & Laurat 2007; Laurat & Brühl 2010). Here, approx. 400 flints (4 kg) were counted from a sample of 1.6 m^3 containing 2 tons of gravels. Flint length ranges between 0.7-12.5 cm, among which <2.5 cm long specimens dominate. After sieving 65 tons of fluvial sediment "106 definite artefacts were found, additionally there are several items of uncertain artificial character" (Brühl & Laurat 2007, 13; translation by the author). All objects are characterized by "strong rounding" (Brühl & Laurat 2007: 15). 96 pieces were 0.6 - 4.4 cm long flakes. The length of eight "cores or core-like pieces" (Brühl & Laurat 2007: 15) ranges between 1.3 - 7.3 cm. Two objects were determined as presenting a "rough scraper-like retouch [and] a unifacial surface retouch" (Brühl & Laurat 2007: 17; translation by the author). These statements exemplify the general problem with these localities:

i) published finds are selected out of fluvial gravels containing natural flints and

ii) specimens with doubtful artificial character are present but

iii) criteria to distinguish between artefacts and natural flints are not mentioned and

iv) site-formation processes are not discussed.

However, as for all sites the Bilzingsleben flints are a reference (Laurat & Brühl 2010: 132; Mania 2010: 103, 117); a more detailed look on these lithics will be done in the following section (in which Nordic flint and Muschelkalk chert will be classed together as flint only).

The strategy of the 2004-2007 fieldwork was to keep every excavated flint without selection of certain kinds of artefact, blank or tool types. When

site	research strategy (time period)	artefacts (n)	Reference
Markröhlitz	surface collection (since 1988)	~30	Rudolph et al. 2005
Uichteritz	selected from industrial gravel dumps (since 1994)	39	Rudolph et al. 2005
Neumark-Nord	excavation of 65 tons of gravels (2003-2004)	106	Brühl & Laurat 2007
Tollwitz	selected from industrial gravel dumps (since 1994)	170	Laurat et al. 2004b
Wallendorf	collection from gravel pits (since 1915)	~6500	Laurat et al. 2004a

Fig. 35. So-called ´Lower Palaeolithic sites´ from late Elsterian/early Saalian fluvial gravels in Central Germany.

Abb. 35. *Dem Altpaläolithikum zugewiesene Lokalitäten in spätelster- bis frühsaale-zeitlichen Flußschottern in Mitteldeutschland.*

area	year of excavation	square-metre/quadrant	m²	flint (n)	n/m²
A	2004-2007	A11-A15	5.0	434	86.8
near A	1969-2003	Qu. 537	2.25	2	0.9
B	2004-2007	B4-B6	3.0	3486	1162.0
near B	1969-2003	Qu. 641, Qu. 642	4.5	658	146.2
C	2004-2007	C0, C1	2.0	355	177.5
near C	1969-2003	Qu. 506, Qu. 507	4.5	55	12.2

Fig. 36. Presence of flint in excavated areas of the Steinrinne. note: see Figs. 4-6 for exact location of excavated metre squares (1.0x1.0 m) and quadrants (1.5x1.5 m); numbers of flints from the 1969-2002 excavation were counted on the original material stored at the University of Jena.

Abb. 36. *Feuersteinhäufigkeiten in ausgegrabenen Arealen der Steinrinne.*

comparing areas A-C with neighbouring areas excavated in 1969-2002 a clear difference is obvious although, as in the former excavation the amount and density of flint is very low (Fig. 36). When taking into account the total amount of flint (n=5 907) excavated from 22 m² in 2004-2007, the calculated number of flints which should be present in the 1 770 m² (Mania & Altermann 2004: 151) excavated in 1969-2002 is approximately 475 250. By contrast, the material excavated in 1969-2002 contains only 140 000 single finds of flints (Laurat 2006: 21). The contradicting numbers of flints from the 1969-2002 and the 2004-2007 excavations may be explained by a selection of flint during the earlier excavation. As the 1969-2002 material stored at the University of Jena contains a few boxes full of flint, labelled "flint rubble – remnant of sieving", this interpretation of a selection of flints during fieldwork may be confirmed.

Flint chips, defined here as any unretouched flint whose broadest surface is less than 1 cm², are an important source of scientific research in archaeology (Newcomer & Karlin 1987). Actualistic studies show that in undisturbed contexts the number of small flakes should be greater than larger flakes by several orders of magnitude (Bertran et al. 2006: 14, Fig. 6, tab. 2; Dibble et al. 1997: 637-638; Lenoble 2005: 36-37; Wenban-Smith et al. 2000: 225-226). In contrast, at Bilzingsleben just one third of all lithics are smaller than 1 cm (Fig. 37). Numbers in Fig. 37 are confirmed by thin-sections of the find bearing layer where ´flint dust´ is lacking and flint-fragments are either not at all or very indistinctively present in <1 mm grain sections (Beck et al. 2007: 14; written info. T. Daniel, Jena 2011).

In general, at areas A-C, flint objects are smaller than 5 cm (Fig. 38-40). Only one 6 cm long Muschelkalk chert has been excavated. The majority of lithics is restricted to approximate dimensions in length <3.5 cm and breadth <2.5 cm. This means that all flints result out of one population well defined as distinct small pieces with a length/breadth ratio of approx. 1.5. Former researchers agree that the small size of the excavated flints reflects the use of local flint sources which contain only small flint erratics (Schäfer & Weber 1988; Toepfer 1960).

Approx. 4 % of flints from the Steinrinne are non-artefacts, e.g. pebbles with rolled surfaces as well as with chalky cortex. In all areas approx. 70-90 % of all flints are non-flakes (Figs. 41-43). The majority of these non-flakes are chunks (e.g. Fig. 48: 7, 8), representing approximately 30-40 % of all flints in each area. In contrast, among the objects excavated in 1969-2002 "flake material includes more than 75,000 specimens" (Laurat 2006: 21). However, in the most recent report on this assemblage (Mania 2010: 101), the Steinrinne flints contain only 30 % flakes.

In earlier publications of flints from the Steinrinne, the presence of pot-lid fractures is not mentioned (Figs. 30-33) but is a common characteristic of flints drawn later (Figs. 34; 48-50). Scars produced by frost (Adrian 1948: 30-32; Obermaier 1925: 103) can be seen on most of the flints from the 2004-2007 excavation (Fig. 48: 4-7, 10; Fig. 50: 1-5). In areas A-C approx. 7-14 % of all flints are represented by frost shatter, like pot-lid fractures (Fig. 48: 1-3; Fig. 49: 1, 2, 5-8). Hammat (1975) emphasized that these fractures result from a combination of chemical and mechanical forces which vary from one context to another. Macrogelivation results out of optimal moisture environments and temperatures <0 °C in water-filled

length class	A1-A5		A11-A15*		B1-B3		B4-B6*		C0-C21*		total	
	n	%	n	%	n	%	n	%	n	%	n	%
<1 cm	44	*24.2*	130	*27.3*	431	*34.0*	972	*27.9*	229	*43.5*	1806	*31.5*
>1 cm	138	*75.8*	314	*72.7*	838	*66.0*	2514	*72.1*	297	*56.5*	4101	*68.5*
total	**182**	***100***	**444**	***100***	**1269**	***100***	**3486**	***100***	**526**	***100***	**5907**	***100***

Fig. 37. Length of flint excavated in 2004-07 without and with (*) dry-sieving.

Abb. 37. *Länge von Feuerstein, der 2004-07 ohne und mit (*) Sieben ausgegraben wurde.*

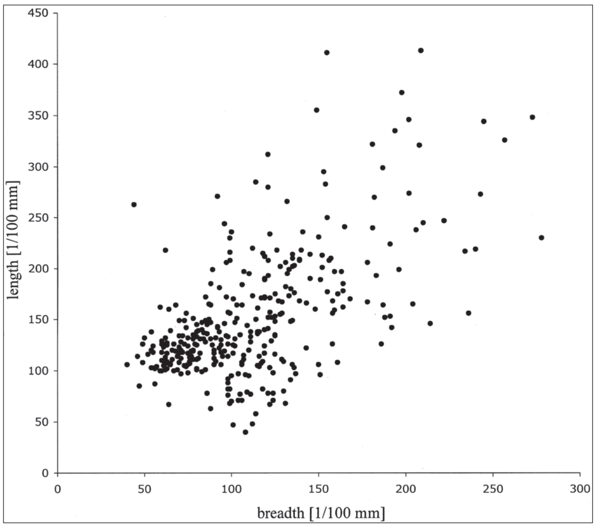

Fig. 38. Length and breadth of flint >1cm at area A.

Abb. 38. *Länge und Breite der Feuersteine >1cm von Areal A.*

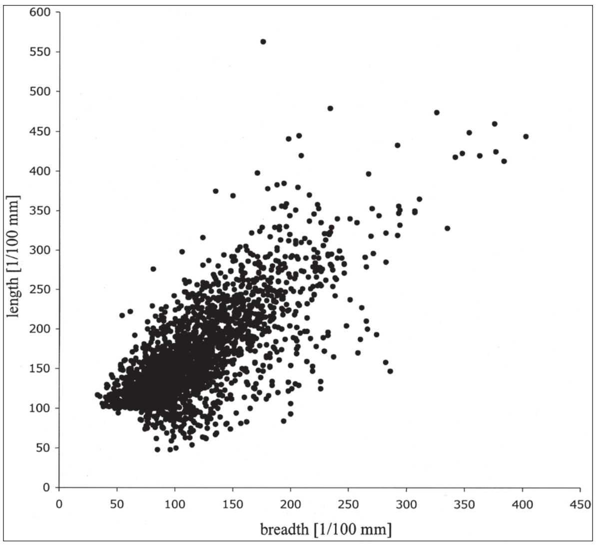

Fig. 39. Length and breadth of flint >1cm at area B.

Abb. 39. *Länge und Breite der Feuersteine >1cm von Areal B.*

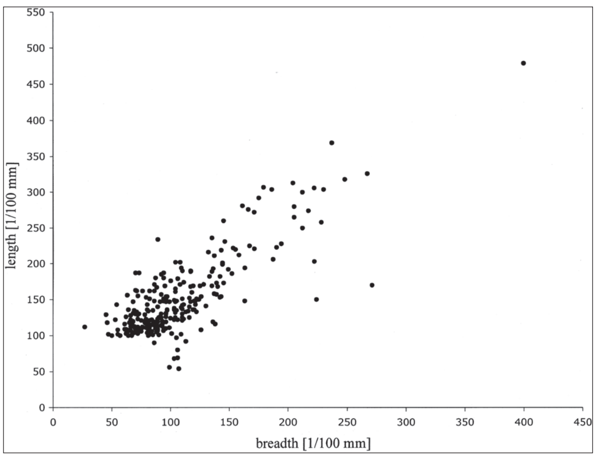

Fig. 40. Length and breadth of flint >1cm at area C.

Abb. 40. *Länge und Breite der Feuersteine >1cm von Areal C.*

joints (Matsuoka 2001). These thermal fractures can occur in temperate environments within a series of sharp frosts if water is contained within the flint itself or is absorbed through the outer surfaces (Sieveking & Clayton 1983). Therefore frost damage is not confined to cold-climate Pleistocene flint artefacts since it can also be observed on ´interglacial´ Mesolithic sites (Brinch Petersen 2009: 105).

The amount of frost shatter in area B (14 %) is nearly twice as high as in areas A (8 %) and C (7 %). The amount of chunks ranges between 40 % (area C), 35 % (area B) and 31 % (area A). In contrast, the amount of flakes increase from area C (4 %) via area B (17 %) to area A (30 %).

As already mentioned by Beck et al. (2007), obvious non-artefact flints, like pebbles, chunks and frost shatter without lateral negatives, are a characteristic element of the find-bearing layer. Taking into consideration the characteristics of man-made flakes (Hahn 1993: 32-44), only few (6-30 %, depending on the area) of the excavated flint may be designated as ´flakes´ showing at least one ventral or interior surface (Figs. 41-43). These flakes will now be discussed in more detail.

On some flints the ventral surface cannot always be reliably identified. It cannot be said with certainty that these objects may not be broken frost shatter. Therefore up to 3 % of all lithics were recorded with an indeterminable ventral side (Figs. 41-43: ventral indet.). Some other flints also may be fragmented frost shatter, but the subjective impression is that a ventral face is present. Therefore these objects – up to 2 % of all flints (Figs. 41-43) – were determined as broken flakes, meaning that the break hides if a clear butt was originally present. As many as approximately 1 % of all flints have two ventral sides (Fig. 50: 2), indicating strong force from both ends.

At each area 1-3 % of the flints found during the excavation (Figs. 41-43) are flakes with a dorsal surface more or less completely covered with a natural chalky cortex (Fig. 50: 4), a rolled cortex, a cleft, a pot-lid fracture (Fig. 48: 19) or a patinated area (Fig. 50: 5). This frequency is low in comparison with a neighbouring Middle Pleistocene Levallois workshop-site where 8 % of flakes are fully covered with cortex and 17 % bear some cortex on the dorsal side (Pasda 1996: Tab. 10). It is even low in comparison to the eolith sites discussed by Baales et al. (2000: 8) where cortex flakes dominate. Maybe at Bilzingsleben this low number is produced by the small dimension of flakes since at both Middle and Late Palaeolithic sites in Central Germany cortex bearing flakes are the largest ones (Pasda 1996: 48, 1999: 34).

In areas A-C up to 2 % of flints are flakes with only one dorsal ridge (Fig. 48: 21; Fig. 50: 6) which may have been a guiding-ridge for easier removal. Among the flakes, specimens were found where the ventral side is only a small part of the inferior surface of the flake (e.g. Fig. 48: 14, 16, 17). That means that these flakes

type	A1	A2	A3	A4	A5	A11	A12	A13	A14	A15	total	
	n	n	n	n	n	n	n	n	n	n	n	%
<1 cm	1	25	8	8	2	3	27	25	34	41	174	*27.8*
pebble	-	7	2	2	-	1	1	-	4	3	20	*3.2*
chunk	-	17	14	14	5	8	19	34	47	35	193	*30.8*
frost shatter	1	10	4	5	-	-	6	10	8	6	50	*8.0*
2 ventral faces	-	-	1	-	-	1	-	-	-	-	2	*0.3*
ventral indet.	-	2	6	2	2	-	4	1	-	-	17	*2.7*
broken flake	-	-	1	1	1	-	4	5	-	2	14	*2.2*
cortex flake/1 negative	-	2	3	1	2	2	3	1	3	2	19	*3.0*
flake with ridge	-	-	-	-	-	1	2	3	2	4	12	*1.9*
flake	2	14	10	6	1	1	15	26	33	17	125	*20.0*
total	**4**	**77**	**49**	**39**	**13**	**16**	**82**	**105**	**121**	**110**	**626**	***100***

Fig. 41. Flint types per metre square of area A.
Abb. 41. *Grundformtypen pro Quadratmeter in Areal A.*

type	B1	B2	B3	B4	B5	B6	total	
	n	n	n	n	n	n	n	%
<1 cm	42	165	224	264	336	372	1403	*29.5*
pebble	14	35	37	26	38	37	187	*3.9*
chunk	71	163	104	408	428	489	1663	*35.0*
frost shatter	42	82	76	82	150	250	682	*14.3*
2 ventral faces	1	5	5	1	-	-	12	*0.3*
ventral indet.	5	6	8	43	41	40	143	*3.0*
broken flake	4	7	3	19	29	34	96	*2.0*
cortex flake/1 negative	8	28	17	17	15	23	108	*2.3*
flake with ridge	7	4	16	10	4	11	52	*1.1*
flake	19	32	39	79	115	125	409	*8.6*
total	**213**	**527**	**529**	**949**	**1156**	**1381**	**4755**	***100***

Fig. 42. Flint types per metre square at area B.
Abb. 42. *Grundformtypen pro Quadratmeter in Areal B.*

type	C0	C1	C10	C11	C20	C21	total	
	n	n	n	n	n	n	n	%
<1 cm	31	113	27	14	10	34	229	*43.5*
pebble	1	11	-	2	1	1	16	*3.0*
chunk	21	129	12	14	8	28	212	*40.3*
frost shatter	2	24	3	3	-	3	357	*6.7*
ventral indet.	-	2	-	1	-	1	4	*0.8*
broken flake	1	1	-	-	1	1	4	*0.8*
flake with cortex/1 negative	1	3	1	-	-	1	6	*1.1*
flake with ridge	-	2	-	-	-	-	2	*0.4*
flake	1	12	2	1	-	2	18	*3.4*
total	**58**	**297**	**45**	**35**	**20**	**71**	**526**	***100***

Fig. 43. Flint types per metre square at area C.
Abb. 43. *Grundformtypen pro Quadrameter in Areal C.*

butt type	A1-A15	B1-B6	C0-C22	total	
	n	n	n	n	%
plain	106	266	16	388	59.3
pointed	17	64	5	86	13.1
cortex/cleft	11	56	1	68	10.4
linear	14	38	1	53	8.1
splintered	11	24	-	35	5.4
facetted	11	12	1	24	3.7
total	**170**	**460**	**24**	**654**	***100***

Fig. 44. Butt types on flakes per area.

Abb. 44. *Schlagflächenrestarten von Abschlägen.*

edge condition	A11-A15		B4-B6		C0-C22		total	
	n	%	n	%	n	%	n	%
sharp	172	40.5	430	17.0	22	8.6	624	19.5
negatives	255	59.5	2094	83.0	233	91.4	2582	80.5
total	**427**	***100***	**2524**	***100***	**255**	***100***	**3206**	***100***

Fig. 45. Preservation of edges of flints per area.

Abb. 45. *Kantenzustand der Silices.*

negatives	A11-A15	B3-B6	C0-C22	total	
	n	n	n	n	%
single, mm-sized	218	1845	209	2272	88.0
some, <1 cm	14	119	4	137	5.3
some, >1 cm	11	45	2	58	2.2
many, mm-sized	3	43	13	59	2.3
many, <1 cm	4	31	4	39	1.5
many, >1 cm	5	11	1	17	0.7
total	**255**	**2094**	**233**	**2582**	***100***

Fig. 46. Numbers and length of negatives on edges of flint per area.

Abb. 46. *Anzahl und Länge der Negative auf Silexkanten.*

negatives	A11-A15	B3-B6	C0-C22	total	
	n	n	n	n	%
on more then two edges	190	1979	230	2399	92.9
on one edge, unifacially	48	81	1	130	5.0
on two edges, unifacially	12	24	1	37	1.4
on one edge, bifacially	4	10	1	15	0.6
on two edges, bifacially	1	-	-	1	0.03
total	**255**	**2094**	**233**	**2582**	***100***

Fig. 47. Layout of edges with negatives of flints per area.

Abb. 47. *Lage der Kanten mit Negativen auf Silices.*

were removed from pieces/cores which afterwards were smaller than the flake itself. Additionally, forces on edges (Fig. 48: 14, 21; Fig. 50: 5), pointed (Fig. 50: 1, 4) or crushed parts of flints (Fig. 48: 18) can also be recognized. Flakes with a butt, a ventral side and a dorsal side with complex scars occur in frequencies between 3-20 % (Fig. 41-43). That means that only a small portion of all flint from areas A-C (Fig. 48: 25; Fig. 50: 13-16) shows criteria of man-made flakes (Baales et al. 2000: 8; Patterson 1983: 302).

On flakes plain butts (Fig. 48: 14, 25) dominate (Fig. 44). Pointed butts (Fig. 48: 18), cortex or clefts on butts (Fig. 48: 20, 21) and linear butts (Fig. 48: 15) are represented in low numbers and splintered and facetted butts occur rarely (Fig. 44). Facetted butts are extremely rare and are not easy to distinguish from scars produced by natural edge damage (e.g. Fig. 50: 9, 14). On plain butts impact cones are sometimes visible (Fig. 48: 14) but are more obvious on chunks (Fig. 48: 9, 10, 13). The low amount of facetted butts (3.7 %) in areas A-C is in contrast to the 1969-2002 assemblage where 15 % of all flake butts are reported as being prepared (Laurat 2006: 21).

When seeing the lithics excavated in 2004-2007 as single specimens out of their geological context, some resemble defined lithic tools, like Tayac-points (Fig. 49: 7), small bifacially retouched tools (Fig. 48: 13) or possible Quinson-points (Fig. 49: 11, 12). To discuss them, a more detailed investigation of the edge condition of these lithics is necessary. This investigation was made without selecting certain pre-defined types but by incorporation of all flint and by trying to describe preservation of edges, number and length of negatives on edges as well as layout of negatives.

More than two-thirds of all flints have secondary negatives on the edges (Fig. 45). The negatives can be seen on flakes (Fig. 48: 17, 18, 23; Fig. 50: 1, 3, 4, 6, 8, 11, 13-15), on chunks (Fig. 48: 7-11; Fig. 49: 8-12) or after a lithic piece broke through frost damage (Fig. 48: 3-6; Fig. 49: 1-3, 7). The preservation of edges on flints is different in relation to excavation areas (Fig. 45): the amount of sharp edges increases from area C (9 %) via area B (17 %) to area A (40 %).

Most of the negatives on edges (Fig. 46) occur as single and very small negatives (Fig. 50: 4, 6, 10, 12). Other attributes sufficient to qualify and quantify negatives (Fig. 48: 1-2; Fig. 50: 11, 13-15) occur rarely.

Negatives (Fig. 47) occur most commonly on more than two edges of flints (Fig. 49: 8, 10-12). Negatives on just one lateral side (Fig. 49: 5; Fig. 50: 3), unifacially on two lateral sides (Fig. 49: 2) and bifacial occurrence of negatives are rare.

However, results presented in Figs. 45-47 cannot be taken at face value as the used attributes cannot define precisely the large variety of edge conditions. Data recording made by two Palaeolithic archaeologists with different archaeological schooling (Carmen Liebermann for flints of A11-15, B4-6 and C0-C22, the author for flints of A1-5 and B1-3)

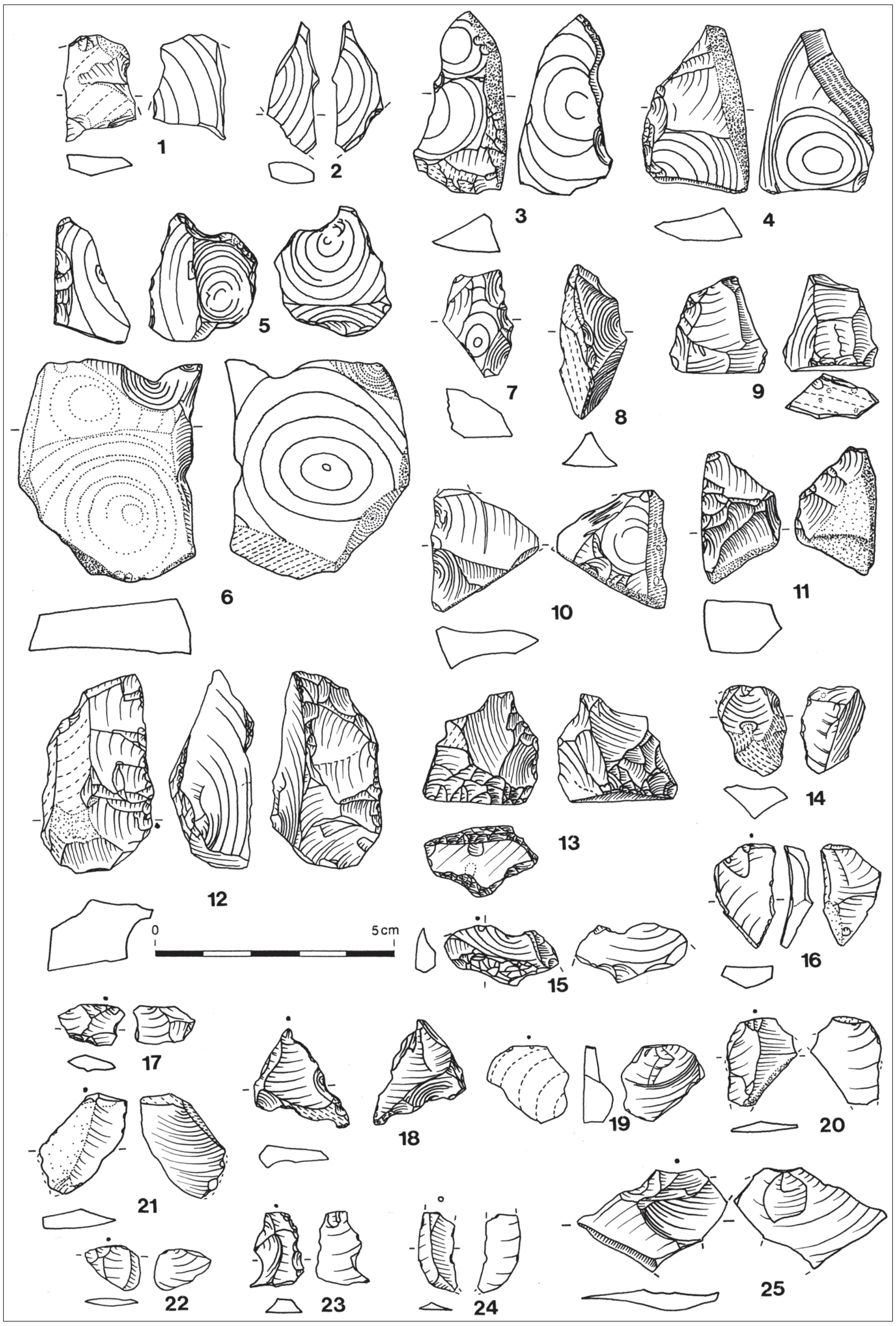

Fig. 48. Flints from area A.

Abb. 48. *Feuersteine aus Areal A.*

resulted in the same numbers of blank and butt types (Figs. 41-44). This shows that defined blank and butt attributes can be seen as elements of objective classification. In contrast, classification of negatives is a more subjective enterprise, as numbers presented in Beck et al. (2007) differ from numbers recorded in Figs. 45-47. Therefore a more detailed look at single specimens is necessary.

In metre squares A1-A5 frost-shatter without lateral negatives occurs (Fig. 48: 2) beside specimens with few negatives on thin (Fig. 48: 3, 4) and thick edges (Fig. 48: 6-8). Some of these objects are obvious non-artefacts (Fig. 48: 1, 2), on others scar series look like retouch (Fig. 48: 5, 7). On some chunks only one trapezoidal scar is visible (Fig. 48: 8) but with increasing numbers of negatives, lithics may look like cores (Fig. 48: 10). On flints with many larger negatives the scars are oriented in a chaotic way, and the pieces are not easily interpretable as cores or tools (Fig. 48: 9, 11, 13). On some of these specimens impact cones on the ´striking platform´ can be seen (Fig. 48: 9, 10, 13). On another lithic piece, at first glance resembling a

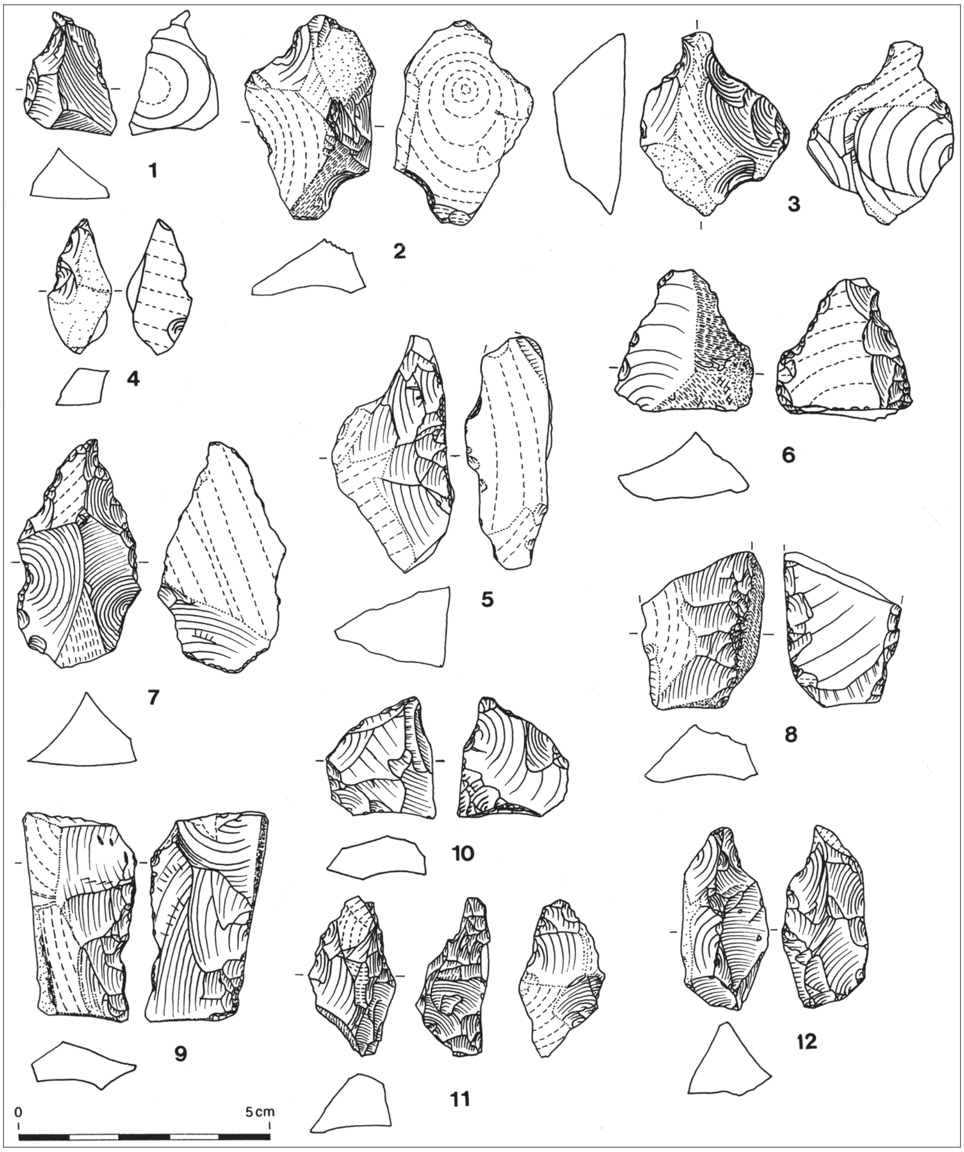

Fig. 49. Flints from area B.
Abb. 49. *Feuersteine aus Areal B.*

bifacially worked piece, a first series of scars is present (Fig. 48: 12 right). After this series the piece broke from the opposite side thus developing into a flake with a ventral side (Fig. 48: 12 middle). Afterwards, from this ventral side a second series of scars was produced (Fig. 48: 12 left). On the other side at least a series of small scars was produced (Fig. 48: 12: right). Here, different agencies were active to produce both flat lateral retouch and flaking over the whole piece. Different patination shows that on one flint with an old frost-shattered surface (Fig. 48: 6 left), another surface developed later through frost action (Fig. 48: 6 right) with the formation of two large flake scars.

In metre squares B1-B3 frost-shatter with few negatives was found (Fig. 49: 1-4). When lithics have more negatives they look like artefacts, resembling cores (Fig. 49: 5) or tools (Fig. 49: 6, 7, 9-12). On one flint only heavy lateral scars occur (Fig. 49: 8). On another flint the first flake was vertical (Fig. 49: 6 left) to later lateral negatives on the opposite side (Fig. 49: 6 right). In contrast, the first and second series of scars on another lithic were lateral, whereas only one of the last scars is vertical to the axis (Fig. 49: 9 right). Here, the second series of scars also resulted in a ventral surface on the upper left side (Fig. 49: 9 left).

Some of the flakes found in metre squares B1-B3 derive from flints covered by cleavage planes which are smaller than the flake itself (Fig. 50: 1). Other flints may be a result of forces from different sides, resulting in flakes with two ventral-sides (Fig. 50: 2). Other flakes have a flat dorsal surface (Fig. 50: 3), a dorsal surface fully covered with cortex (Fig. 50: 4), cleavage (Fig. 50: 5) or with a natural guiding-ridge (Fig. 50: 6). Flakes with pronounced ventral features occur (Fig. 50: 7, 8). Trapezoidal flakes were found (Fig. 50: 11, 12) which may derive from objects like the one found at area B (Fig. 48: 8). Only few specimens with complex scars on the dorsal surface resemble

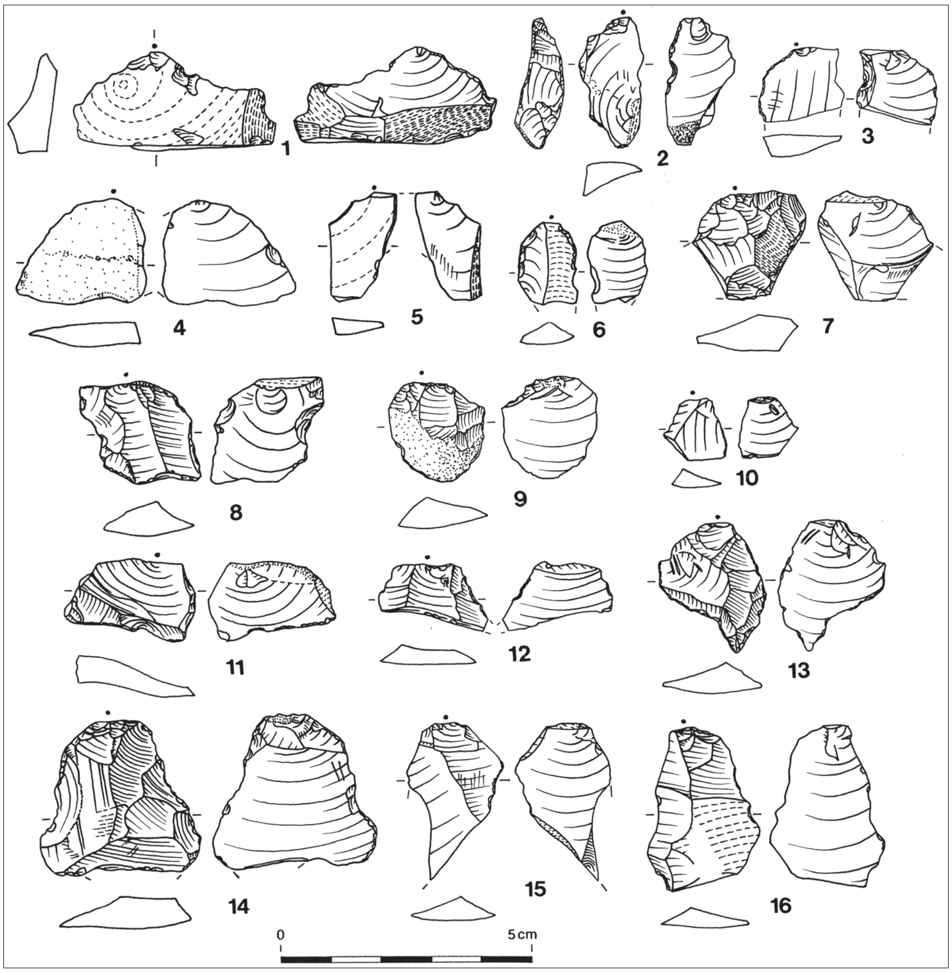

Fig. 50. Flints from area B.
Abb. 50. *Feuersteine aus Areal B.*

man-made flakes (Fig. 50: 13, 14) but show many small as well as single large negatives on the dorsal and ventral sides.

Discussion

A review of the research history on flints of Bilzingsleben (chapter 6) showed that from the 1900s to the 1940s flints were collected randomly by amateurs and geologists from stratified contexts as well as from outside the travertine quarry. The strange appearance of the flints, their small size and non-formal shape were recognized but nothing substantial was published. That changed in 1960 when the first article on one of these collections was published by the founder of Palaeolithic research in East Germany (Toepfer 1960). His conclusion, the existence of a distinct Palaeolithic culture with small flint tools, was expanded later by his students and co-researchers, who during the 1969-2002 excavation selected specimens out of a sandy matrix full of rocks, flints and bones.

All analysts of the Bilzingsleben lithics agree that the excavated flints derived from local sources nearby. The small dimensions of excavated flints therefore correspond well with the small size of local natural flints. Due to the non-selective recovery strategy of the 2004-2007 excavation the majority of flints are non-flakes such as chunks or frost shatter. This feature is in contrast to Palaeolithic sites where flakes dominate the lithic assemblage (Baales et al. 2000: 7). The recognition of humanly made artefacts is hampered due to two facts:

i) a situation is evident – a combination of different natural site formation processes (chapter 5) – which is a prerequisite for the formation of eoliths (Obermaier 1925: 100),

ii) the low amount of flints <1 cm indicates that no pristine assemblage from a Holsteinian living-floor is conserved but that a selective natural transport of different size clasts has occurred (Bertran & Lenoble 2002; Bertran et al. 2006: 11, 20, 23; Paddaya & Petraglia 1993: 67-68). However, it cannot be ruled out that single flint artefacts, being produced, used and left by Middle Pleistocene humans in the landscape have been incorporated into the sediment (chapter 6).

Investigating flakes (from the recent excavation only), the predominance of plain and natural butts may be a criterion for identifying natural processes as an agency for producing these flakes (Baales et al. 2000: 10) and the presence of pointed, linear and splintered butts may indicate natural high-pressure forces on edges of flint (Patterson 1983: 302). Facetted butts, as evidence of man-made flakes (Patterson 1983: 302), are extremely rare. Impact cones visible on plain butts of flakes and on chunks indicate strong natural forces on lithics (Albrecht & Müller-Beck 1994: 124; Chambers 2004: 30). However, all these attributes are mentioned as being typical characteristics of the Lower Palaeolithic of Central Germany (Schäfer 1993: 113) as well as of the British Clactonian (White 2000: 14). In contrast, the description of selected specimens in chapter 6 shows small flakes which were detached from pieces/cores which afterward were smaller than the flake itself. Also a change from flat lateral ´retouch´ to flaking over the whole piece has been described.

Another problem with the Steinrinne flints was already described by former investigators, e.g. by Dietrich Mania who wrote that the tools of the 1969-2002 excavation "appear non-uniform and not assignable to tool types" (Mania & Weber 1986: 39) and that these tools are characterized by their "enormous diversity in shape (…), the marked individuality of each object, a very low degree of standardization whichs fails every attempt to classify them in a system of formal tool types" (Mania & Weber 1986: 66; translations by the author). When only counting specimens resembling defined lithic tool types – e.g. points, backed knifes, denticulates or perforators – Steguweit (2003: 45) emphasized the contradicting numbers published by four different archaeologists who investigated the flints excavated in 1969-2002 in that manner. The assemblage excavated in 2004-2007 is characterized by an obvious number of secondary negatives on flints (chapter 6). This may indicate transport in turbulent flows (Hosfield & Chambers 2004: 63). Experiments with lithics in powerful floods have shown "that only a minimal natural disturbance in deposition is sufficient to significantly affect tool morphology" (Grosman et al. 2010: 8; see also Albrecht & Müller-Beck 1994: 125; Chambers 2004: 30; Harding et al. 1987). The domination of micro-flaking scars and the under-representation of larger negatives are also characteristic products of fluvial damage (Hosfield & Chambers 2004: 63-64). This interpretation may be reinforced since for area A there is a positive correlation between high numbers of sharp edges and the presence of low-energy sedimentation (chapter 6). Ridge abrasion, which is typical of fluvially damaged bifaces (Chambers 2004: 35), is not obvious in areas A-C. However, as presence of ridge abrasion is linked to variation in flint shape (Chambers 2004: 34, 37), maybe, at Bilzingsleben the flint was more prone to be fractured than to be abraded (Petraglia & Potts 1994: 234). Moreover, edge damage and pointed and crushed parts can be seen on the Steinrinne flints. Damage by pressure and crushing occurs on the hard plane surfaces of lithics which did not allow the removal of small spalls, the latter being more effectively formed on edges of lithics (Adrian 1948: 76). Flakes with pronounced ventral features are produced by strong pressure and not by man-made flaking (Hahn 1993: 68). In chapter 6 different patinated scars on some lithics were described which indicate natural edge-damage (Obermaier 1925: 100, 102; Patterson 1983: 302). The lithics at Bilzingsleben are not influenced by movement through sediment due to cryoturbation since typical rounding of edges and ridges (Hahn 1988: 151) is not present. However, effects of freezing have to be taken into consideration as frost shatter is one of the most dominant flint types at the Steinrinne. Might the microscopic characteristics of edge conditions of the Bilzingsleben lithics (Steguweit 2003: 105) also be produced naturally through ice polish (Caspar et al. 2003)? According to François Bordes (1988) and Joachim Hahn (1988), the frequency of edge scars on lithics may be an indicator of natural processes responsible for the edge damage. However all tool-like, ´retouched´ pieces of the Steinrinne have the same small dimensions as lithics without edge-scars (Figs. 38-40) whether they are frost shattered, chunks or flakes. This means that the shape of small tool-like implements is determined by the shape of the chunk, pot-lid fracture or pebble (Adrian 1948: 70) and not by different stages of human chaîne opératoire. This contrasts with results from a Weichselian site near Wrocłav in Poland where the exhausted core (or small tool) was produced step-wise, first by fragmentation of a big chunk and than by secondary flaking (Wiśniewski 2003). If flints from the Steinrinne were edge-damaged naturally (e.g. Fig. 48: 3-13), then detached flakes may look like flakes found in this area (Fig. 48: 14-25). However, an objective decision which flint is an artefact is impossible bearing in mind that the longer a flint is transported fluvially the more closely micro-flaking resembles intentional retouch, since micro-flaking damage is then more intense (Hosfield & Chambers 2004: 68).

The documentation of data and the description of single specimens in chapter 6 and the discussion above show the difficulty, or maybe the impossibility of judging which flint is an artefact or not. To visualize this difficulty, flints from area A are presented in Figure 48 in a subjective progression ranging from obvious non-artefacts (Fig. 48: 1, 2) to flints resembling man-made flakes (Fig. 48: 25). Envisaging more scars on a core-like piece (Fig. 49: 5) will result in a Quinson point-like lithic specimen (Fig. 49: 11, 12). Therefore, at area B a subjective progression may also be present, ranging from dubious (Fig. 49: above) to artefact-like specimens (Fig. 49: below). This result is not new: the archaeologist Thomas Weber (1986: 89) was the first one to realize during his investigation of the Bilzingsleben lithics that the distinction between artefacts, manuports and natural objects was not that obvious, e.g. flakes were often mentioned as being shattered, making them difficult to distinguish from chunks. He concluded that it will remain impossible to distinguish with certainty artefacts from naturally broken stones. Unfortunately, this observation was neither objectified nor challenged by later investigators of the Bilzingsleben lithics. It was only two decades later that Steguweit (2003: 46) mentioned a so called "grey area" between artefacts and naturally broken lithics.

This problem can be discussed in a wider context. Different natural agencies, like glacial and fluvioglacial action, rock fall, fluvial disturbance, frost action, sediment load and trampling can result in artefact-like features such as bulbs, radial lines, butts, ventral and dorsal faces (e.g. Adrian 1948; Bjerck 2000; Bordes 1988: 67-68; Boule 1905; Bradbury 2001; Breuil 1910; Caspar et al. 2005; Clark 1958; de la Torre & Mora 2005; Demeter et al. 2009; Driver 2001; Gillespie et al. 2004; Lopinot & Ray 2007; Nash 1993; Oakley 1957: 19; Warren 1905). Therefore it has to be emphasized that "nature can produce modifications to stone specimens similar or identical to those produced during human percussion flaking" (Nash 1993: 127). This problem is reinforced when only a biased sample, due to selection of lithics that resemble man-made tools (Peacock 1991: 345), is kept from the original sediment clasts. This problem results in disputes about controversial lithics - supposed by some as being artefacts, claimed by others as being pseudo-artefacts - which are as old as archaeology and will continue to be part of archaeological research in the future. In the middle of the 19th century, Boucher de Perthes recognized old, human-made stone artefacts and their stratification with pre-diluvial animal bones. This result is seen as being part of the birth of archaeology as a science in a modern sense (Gamble & Moutsiou 2011; Trigger 2007: 146-147). Often forgotten is that Boucher de Perthes also published obvious non-artefacts as representing man-made lithics (Groenen 1994: 240-243). This shows the existence of a fundamental problem in archaeology: right from the start as a science in todays´ sense, Stone Age archaeologists had difficulties in distinguishing whether human action or natural processes produced a given lithic. As early as in 1881 an ´eolithic epoch´ was propose by Gabriel and Adrien de Mortillet (O´Connor 2007: 187), resulting out of the expectation that the oldest artefacts of humankind have to be the most primitive looking ones (Grayson 1986: 79). In contrast, recent research in Plio/Pleistocene Africa (de la Torre 2004) and Middle Pleistocene Europe (Ashton et al. 1992; Roberts & Parfitt 1998) has shown that high absolute age is not correlated with primitive shaped stone artefacts. Research history of the ´eolith controversy´ does not need to be repeated here (de Bont 2003; Ellen 2011; Grayson 1986; Groenen 1994; O´Connor 2003; 2007; Sommer 2004) but some aspects have to be expanded upon. Already 100 years ago nearly every argument necessary to discuss whether a given lithic was produced by human action or derived from natural processes had already been published. However, the ´eolith controversy´ continued as long as scientists were able or willing to participate, resulting in a quarrel which is characterized as a "picture of two opponents firing missiles past each other, never managing to achieve a direct hit" (O´Connor 2007: 167). Therefore this debate cannot be seen as a discussion between two distinct opponents or two scientific ´schools´, the one arguing against eoliths and the other supposing eoliths to be artefacts (who, seen from todays´ perspective, failed). The former did not ´win´ as the distinction between artefacts and naturally derived lithics remains difficult (Adrian 1948: 21; Albrecht & Müller-Beck 1994: 121; Dies 1975: 155; Oakley 1957: 19; Obermaier 1925: 104-105): two of the most popular representatives arguing against the eoliths, Marcelin Boule and Henri Breuil, are admired because of participating in the eolith debate in a scientific way by objectifying it with proper field observation and experiments. However, both these archaeologists wrote about the "difficulty, often the impossibility" (Boule 1905: 265-266; translation by the author) of distinguishing between rudimentary human retouch and natural forces on flints. They concluded that criteria required to distinguish the effects of non-intensive human stone working from the effects of nature had not been found and probably did not exist (Breuil 1910: 406). Therefore it is no surprise that some of the members of the "anti-eolith school", e.g. Henri Breuil at Foxhall Hall (O´Connor 2007: 199) or Louis Leakey at Calico Hills (Duvall & Wenner 1979), also ´failed´ since they determined naturally derived stones as being artefacts.

Here, some excursive sentences have to be presented as the discussion whether negatives on the edges of lithics are produced through retouch by human action or by natural forces shows several parallels to the ´eolith debate´. The master of Palaeolithic typology, François Bordes (1984: 57) recognized that in South-West France the tools of the so-called ´Tayacian culture´ are in fact Lower and Middle Palaeolithic artefacts edge-damaged by cryoturbation. Support for this result was published by Dibble et al. (2006) for Fontéchevade, the site with which Volker Toepfer correlated the lithics from Bilzingsleben based upon his knowledge of it (chapter 6). Bordes (1988: 67-68) described in detail the damage produced by natural processes on flakes and blades but published tools with notches as well as denticulates as products of human retouch, leaving his followers with the problem how to separate this retouch from comparable negatives produced by post-depositional disturbance and heavy utilization (Debénath & Dibble 1994: 104, 107, 114). The same can be seen in recent studies of Lower Palaeolithic sites in England, where due to the context of the Clactonian in fluvial sands and gravels it is difficult to differentiate between natural and human retouch (Ashton & McNabb 1992: 166; Ashton 1998b: 219) but where some of the ´flaked flakes´ were described as being produced by humans only (Ashton 1992; 1998a). At other sites, lithics with sharp edges occur alongside stone artefacts damaged in situ by slight movement and consolidation of the sediment (Wenban-Smith et al. 2000: 226-227). Lateral negatives can also be produced by trampling (Adrian 1948: 33; Lopinot & Ray 2007; Obermaier 1925: 104). Naturally derived damage resembling retouch can be seen on lithics from Tertiary deposits (Adrian 1948: Abb. 37, 38). Without a discussion of the geological context even refitting (e.g. Rieder 1990: 126) provides no evidence that the presence of notches is not the result of natural processes (Caspar et al. 2005; Vallin et al. 2001). Only a high proportion of lithics with notches, denticulated edges, rolled crests or laterally alternating negatives - more than 30 % after Hahn (1988, 152) and up to 60 % following Bordes (1988: 67) - was seen as evidence that natural processes are responsible for edge damage. Faced with this situation some researchers dealing with German Upper Palaeolithic stone tools (Hahn 1988: 152, 1993: 167; Owen 1988: 145) conceded that it is impossible to determine accurately if this kind of retouch was produced by Ice Age humans, by post-depositional processes, by excavation or during storage in a laboratory or museum. They concluded that lithics affected macroscopically by these processes have to be counted but treated separately from the other modified, but typologically unambiguous tools.

The discussion above shows that "the data and narratives surrounding the [eolith] controversy provide an excellent example of how in science no less than in ordinary perception, cognitive mechanisms (…) create groupings of similar objects in the natural world, drawing on the imaginative redistribution of cultural images. (…) the interpretation of the past is replete with examples of difficulty of distinguishing authentic objects from imaginative reconstructions, whether they be deliberate forgeries or attempts to describe a reality that we now know to be false" (Ellen & Muthana 2010: 372). Therefore, Fritz Wiegers may be right as he emphasized polemically that a controversial find cannot be judged by a single scientist alone as "problematic finds remain problematic and pseudo tools will only result in some kind of pseudo science" (Wiegers 1941: 52; translation by the author). Consequently, debates on pseudoartefacts are characterized often as being "unproductive" (Roe 1981: 27) because the "controversies (…) are a clear indication that this fundamental problem of distinguishing simple stone artefacts from "naturefacts" (…) has never been adequately resolved" (Nash 1993: 126). The problem is not even solved yet (e.g. Rapp & Hill 2006: 32) since, for example, in the 1990s the discussion of a long or short human occupation of Europe was again linked with the distinction between artefacts and eoliths, "incertofacts, possibiliths" (Roebroeks & Kolfschoten 1995). Maybe distinction between natural fracture and artefact is impossible as each researcher decides by her/his "standard" (Adrian 1948: 21) whether questionable stones are artefacts or eoliths. To overcome individual standards, scientists have proclaimed other criteria than the discussion of the lithic itself. This leads to the requirement of a non-selective recovery of every stone, whether artefact or not (Adrian 1948: 23; Baales et al. 2000: 7; Patterson 1983: 298), and a focus on the geological context (Baales et al. 2000: 12; Oakley 1957: 12; Obermaier 1925: 106; Patterson 1983: 299; Roebroeks & Kolfschoten 1995). The argument that the presence of man-made structures increase the possibility that questionable lithics result from human activities (Adrian 1948: 24; Obermaier 1925: 106) does not take into consideration recent interpretations of Lower Palaeolithic site formation where man-made camp-like structures cannot be expected (e.g. Ashton 1998b, 2004; Field 2005; Hallos 2004, 2005; Langbroek 2004; Pope & Roberts 2005). Therefore another approach to dealing with the controversy is to accept stones as artefacts only when any natural forces which might have produced them can be ruled out with certainty. This position among researchers is as old as archaeology has existed as a scientific discipline (Adam 1974; Adrian 1948: 20, 25; Baales et al. 2000: 12; Olshausen 1904).

Result

In summary, there is a dispute within archaeology on pseudoartefacts and pseudoretouch which is as old as archaeological science and is not yet solved. As shown here, the flints of Bilzingsleben occur in a sandy sediment together with a huge amount of small and large bones and rocks which are oriented and dipped and vertically distributed in a random order throughout the whole body of sediment. Without specifying exact site formation processes – a combination of mass flow and fluvial inundation as well as other (minor?) processes may be the most likely – no indication for any kind of Palaeolithic ´living floor´ is present. When natural site formation processes dominate, as at Bilzingsleben, the natural creation of pseudoartefacts seems the most likely explanation. Among the excavated flint, other than clear non-artefacts (Fig. 48: 1-3; Fig. 49: 1, 2), only few specimens were found which – seen without regard to their context – resemble man-made flakes (Fig. 48: 25; Fig. 50: 14-16). These two poles mark the two ends of a continuum comprising a ´grey area´ with a wide range of lithic chunks, frost shatter and flakes, some of them without edge scars, others with marginal or heavy scars (Fig. 48: 4-24; Fig. 49: 3-12; Fig. 50: 1-13). Some objects in this ´grey area´ look like non-artefacts, others resemble human-made tools. No objective criteria, e.g. differences in dimensions and occurrence of edge scars, were found for their separation into distinct classes. Only subjective criteria, as defined by the individual standard of each scientist, may result in qualifying a given specimen as artefact. The main result of the 2004-2007 excavations at Bilzingsleben is therefore to emphasize once more the large ´grey area´ for the flints recovered at the site, ranging without interruption from obvious non-artefacts to possible artefacts.

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