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Focus on the lithics: raw materials and their utilisation during the Stone Age in Central Europe

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OPEN AIR OCCUPATIONS IN A CAVE DOMINATED ARCHAEOLOGICAL LANDSCAPE – NEW PERSPECTIVES ON THE PALAEOLITHIC OF THE SWABIAN JURA (SOUTHERN GERMANY)

ABSTRACT: In the current state of research, Palaeolithic open-air sites in the Swabian Jura are not very numerous nor in the most cases well researched, although a great potential for these sites exists. The main problem is, that over the last decades, Palaeolithic research in the Swabian Jura focused mainly on cave sites and that subsequently, open-air sites existed mostly in the shadows of these well known caves. The data basis for our research composed of a large number of stone artefacts. Based on meticulous typological and technological analyses of stone artefacts recovered either by surface prospections or by excavations, we were able to identify several new Palaeolithic open-air sites in this region that cover a time span from the Middle to the Upper Palaeolithic. The Middle Palaeolithic is present at Börslingen-Eisenberg, Wippingen-Sonderbuch (both Alb-Donau-Kreis) and Waldstetten-Schlatt (Ostalbkreis). An Early Upper Palaeolithic component is proven for all previous sites as well, but additionally we can name the Magdalenian site Heubach-Sand (Ostalbkreis). These sites have in common, that they are all connected to raw-material outcrops situated either directly on site or in their immediate surroundings.

KEY WORDS: Open-air sites – Middle Palaeolithic – Upper Palaeolithic – Swabian Jura – Research bias – Raw material

INTRODUCTION

The Swabian Jura constitutes without any doubt one of the most famous Palaeolithic landscapes in Europe. Based on an early Neanderthal occupation, several cave sites, such as Vogelherd, Hohlenstein-Stadel, Geißenklösterle and Hohle Fels yield important Aurignacian layers containing the oldest complex of figurative art and musical instruments in the world. As well Gravettian, Magdalenian and final Palaeolithic occupations are well reported from these cave sites. Due to geological reasons and the permanent research focus on caves, open-air occupations have for a long while been almost totally ignored or underestimated in

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their significance. As a consequence, open-air sites in the area are extremely rare (*Figure 1a*). This is also reflected in the state of publications for the last 20 years (*Figure 1b*). First more systematic surveys had been conducted in the framework of a Tübingen Collaborative Research Center (CRC) at the end of the 1990ies, but drillings and sondage excavations in the Lone valley floor near the Hohlenstein massif remained of poor archaeological information (Bolus *et al*. 1999). The only more significant open-air sites in the region are Wittlingen near Bad Urach (Burkert *et al*. 1992), the Randecker Maar area (Auffermann 1998) and the site of Speckberg, situated in western Bavaria (Hahn 1982). Most of these sites show connections to outcrops of different types of lithic raw material. In this contribution, we want to focus on four recently discovered open-air sites in the Swabian Jura: Börslingen-Eisenberg, Heubach-Sand, Waldstetten-Schlatt and Wippingen-Sonderbuch.

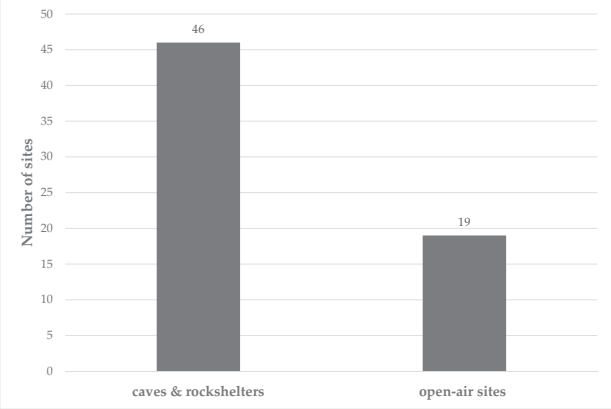

FIGURE 1a. Number of Palaeolithic open-air and cave sites in southwestern Germany.

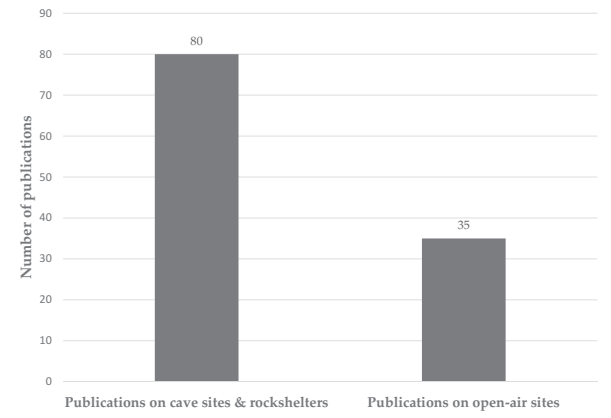

FIGURE 1b. Quantity of publications on Palaeolithic caves and open-air sites in Baden-Württemberg from 1995 to 2015 (source: Archäologische Ausgrabungen in Baden-Württemberg, Mitteilungen der Gesellschaft für Urgeschichte Blaubeuren and Fundberichte Baden-Württemberg).

For several years, a work group directed by Harald Floss has tried to balance the bias regarding research in cave-sites and at open-air sites. The starting point of our studies was the discovery of the Early Upper Palaeolithic open-air site of Königsbach-Stein near Pforzheim by Hans-Walter Poenicke (Floss, Poenicke 2006). This successful cooperation led us to intensify and systemize surveys on the plateau of the Swabian Jura. These activities resulted in the discovery of the open air site of Börslingen (Floss *et al*. 2012, 2015, Fröhle 2013, 2016, see intra). In the meantime, two further areas of investigation became important: the Blaubeurer Alb, and the area just north of the Swabian Jura, situated near the city of Heubach. Most of these insights are due to contacts with local amateur archaeologists. Some sites are suitable for conducting further investigations, such as drilling, ^{14}C-dating and test excavations.

The aim of this article is to summarise the current state of knowledge about these newly discovered open air sites with the aim of combining isolated observations in order to obtain a representative network of sites. By means of raw material provenience analysis it should then be possible to establish internal contacts among the sites and to evaluate small-scale relations between cave and open-air sites.

The data basis for our work is exclusively consisting of Palaeolithic artefacts made from different lithic raw materials, as the preservation of bone or other organic material in these open-air sites of the Swabian Jura is very bad to non-existant due to soil chemistry. The artefacts described in the following text were carefully chosen because of specific characteristics. This includes core configuration and preparation, striking features on cores and blanks as well as tools that are known as *fossils directeurs* for the Middle or Upper Palaeolithic. To substantiate this selection, we also compared our assemblages with the ones from several Neolithic sites in the region (Fisher, Knipper 2003, Kind 1989, 1990, Waiblinger 1997). We are confident that in this way we are able to isolate and define the Palaeolithic presence in the sites presented here.

THE MIDDLE AND EARLY UPPER PALAEOLITHIC SITE OF BÖRSLINGEN-EISENBERG

Location, geology and lithic raw material

The open-air site of Börslingen-Eisenberg is located approximately 16 km north-east of the city of Ulm. It is situated on the small "Eisenberg" plateau on the otherwise even plain of the Swabian Jura. A distance of ca. 1,5 km to the south, the Lone valley with its cave sites, such as Bockstein, Vogelherd or the Hohlenstein-Stadel, is located (*Figures 2, 3*). Those sites are famous for their Aurignacian figurative art objects, such as horse and mammoth from Vogelherd, or the so-called Lion-Man from Hohlenstein-Stadel. The plateau of the Eisenberg declines slightly to the west and the south, and thereby grants a wide view of the surrounding landscape.

The Swabian Alb or Swabian Jura represents an escarpment landscape that is composed of several Jurassic stages: the Lower Jurassic, the Middle Jurassic, and the Upper Jurassic. Lithostratigraphically, these stages can be further subdivided (Geyer, Gwinner 2011). The Upper Jurassic consists of micritic, slightly clayey till marly limestones, and its sedimentation conditions are exclusively marine. Petrogenesis occured by siliceous and calcaerous marine sponges, which lead to the genesis of deposits of Jurassic chert.

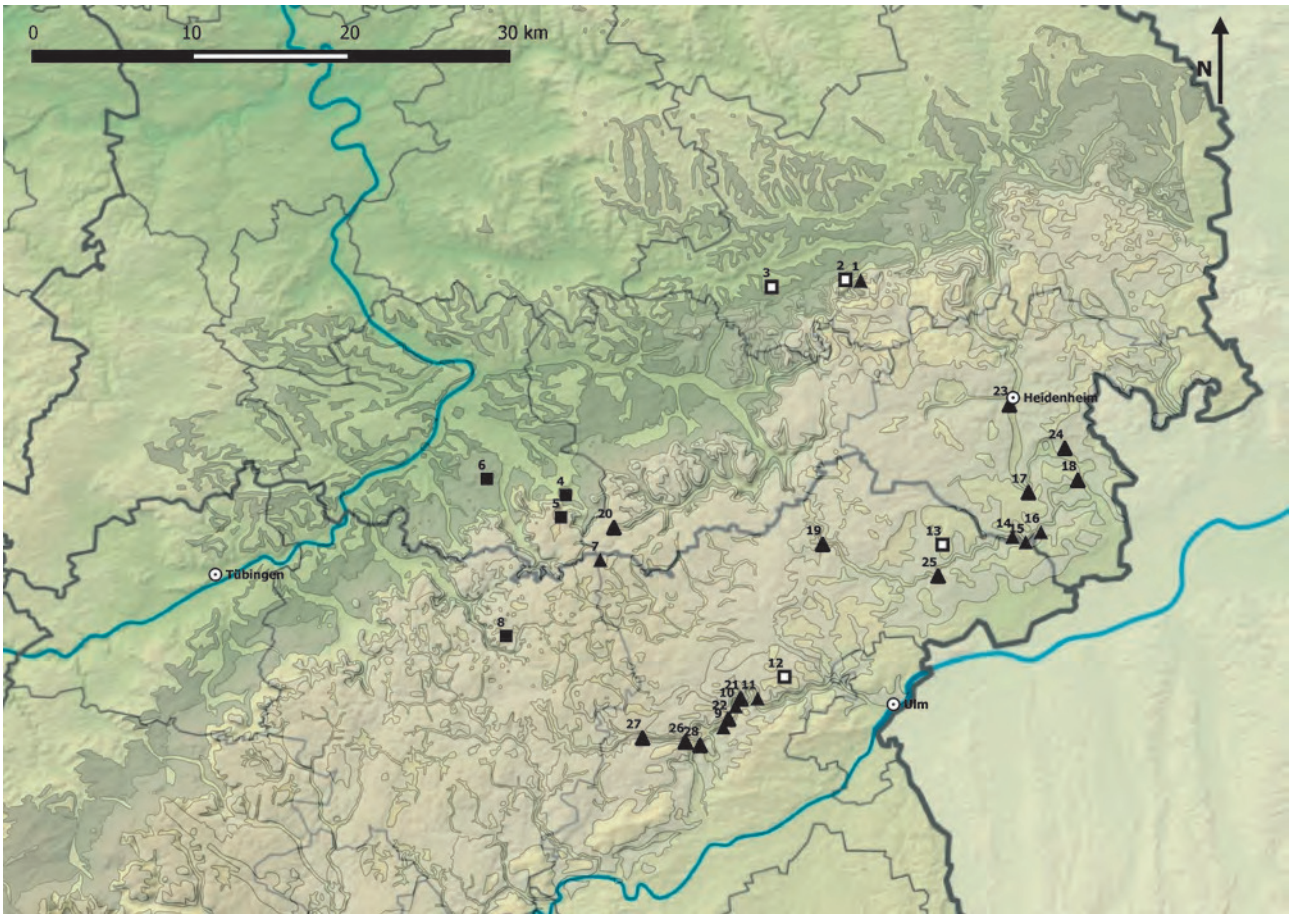

FIGURE 2. Mapping of the working area. 1, Kleine Scheuer; 2, *Heubach-Sand*; 3, *Waldstetten-Schlatt*; 4, Braunfirst; 5, Randecker Maar; 6, Käppele; 7, Burkhardtshöhle; 8, Wittlingen; 9, Hohle Fels; 10: Geißenklösterle; 11: Große Grotte; 12: *Wippingen-Sonderbuch*; 13: *Börslingen-Eisenberg*; 14, Bockstein; 15, Hohlenstein-Stadel and Bärenhöhle; 16, Vogelherd; 17, Spitzbubenhöhle; 18, Bruckersbergstationen; 19, Haldensteinhöhle; 20, Papierfels; 21, Brillenhöhle; 22, Sirgenstein; 23, Heidenschmiede; 24, Irpfelhöhle; 25, Fohlenhaus; 26, Schmiechenfels; 27, Hohle Fels-Hütten; 28, Kogelstein (basemap: upload.wikimedia.org).

FIGURE 3. Detailed mapping: Börslingen. 13, Börslingen; 14, Bockstein; 15, Hohlenstein-Stadel and Bärenhöhle; 16, Vogelherd; 25, Fohlenhaus (basemap: GeoBasis-DE/BGK, Google).

These occurrences are especially prevalent in the eastern Swabian Alb in the Upper Jurassic delta (Burkert 2001, 2012).

At Börslingen-Eisenberg, a limit from quaternary clays to Upper Jurassic deposits can be observed. For the purpose of the excavations (see below) the covering layers were labelled as GH1 (geological horizon 1), and GH2 (geological horizon 2) for a layer of residual clay superimposing the *in-situ* Jurassic limestones. The most important feature of the site, and the reason for Palaeolithic hunter-gatherers to frequent the place, is a rich, local deposit of Jurassic chert. This raw-material played a dominant role within the Palaeolithic assemblages of Southern Germany (Floss 1994). The chert nodules of Börslingen can be found on the surface, as well as inbetween the decomposed limestones of the Upper Jurassic at a depth of ca. 30–85 cm, and in some cases, still embedded in the limestone. The chert itself is partially of high quality and shows generally a grey-brown colour sometimes with banding following a chalk-like, light-brown cortex. When exposed to heat, the material changes its colour to rose till dark red. The majority of the nodules are 5 to 8 cm in diameter, rarely do they exceed the size of a human fist. It is important to mention that the Jurassic chert from Börslingen was identified in a Middle Palaeolithic context in the assemblage of Bockstein (Çep, Krönneck 2015) and in an Upper Palaeolithic context in the Aurignacian of Vogelherd cave (personal communication J. Chang and M. Siegeris).

Discovery and surface findings

After successful cooperation between Harald Floss (Department of Prehistory and Quaternary Ecology of the University of Tübingen) and Hans-Walter Poenicke and the associated discovery of the Aurignacian open-air site Königsbach-Stein (Floss, Poenicke 2006), the area of systematic prospecting was shifted towards the Swabian Jura. Here, H.-W. Poenicke discovered the site of Börslingen-Eisenberg in 2009. During his prospections at the site, he took single GPS-measurements for every artefact he discovered. To date,

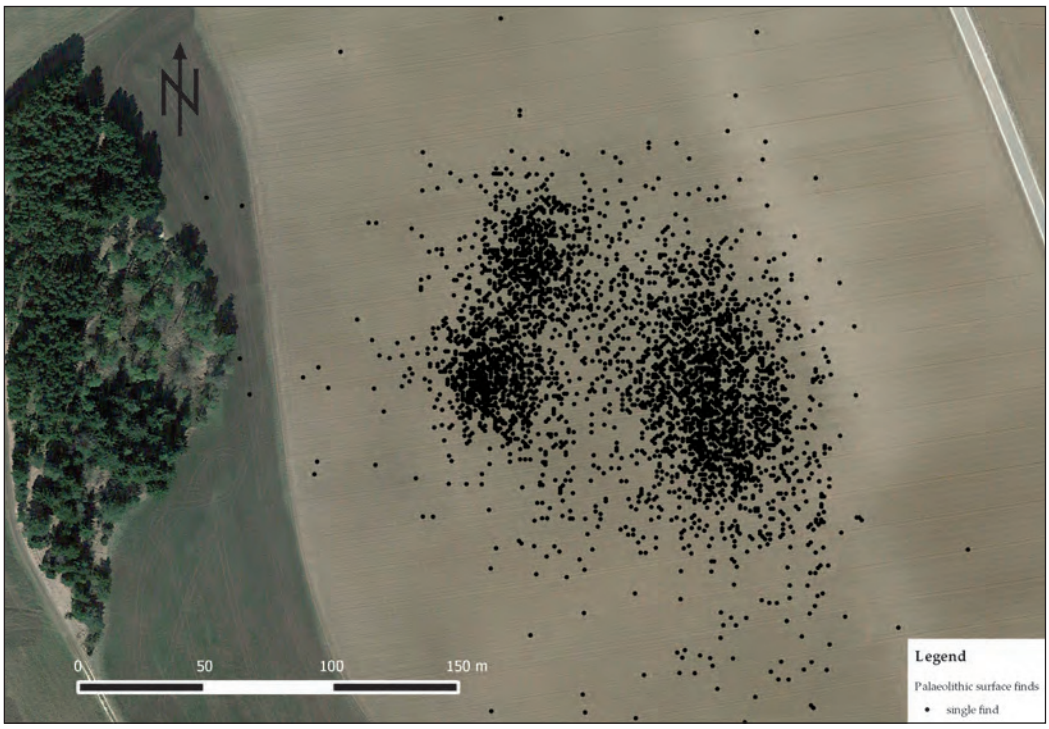

FIGURE 4. Surface concentration of artefacts at Börslingen-Eisenberg (basemap: GeoBasis-DE/BGK, Google).

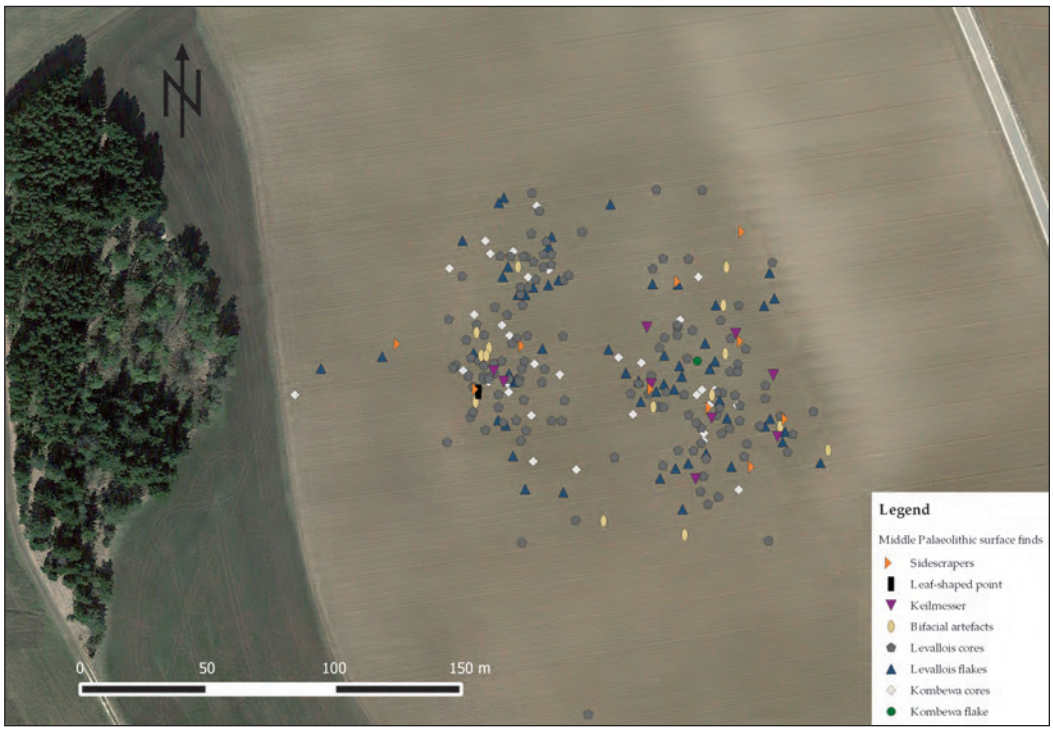

FIGURE 5. Dispersal of Middle Palaeolithic surface finds at Börslingen-Eisenberg (basemap: GeoBasis-DE/BGK, Google).

approximately 4,500 artefacts have been discovered on the surface. This procedure made it possible to create distribution- and density-maps for the total of the surface finds. As a result, it was possible to locate three large concentrations of artefacts. The area itself has been used agriculturally only for the last 50 years, and before that as a pasture. The depth of the plough is only between 15 and 25 cm due to the shallow depth of the limestones of the Upper Jurassic. For this reason, we can assume a limited disturbance within the find concentrations. Especially notable is the breaking down of the eastern surface concentration along a north to south oriented line (*Figure 4*), probably caused by the submerging of the find containing layers under quaternary clays, mentioned above.

The majority of the surface finds cannot be classified in a chronological sense, but numerous pieces can be referred to the Middle Palaeolithic as well as to the Upper Palaeolithic. The Middle Palaeolithic (*Figure 5*) assemblage consists mainly of Levallois cores, but other artefact types, such as bifacial pieces (*Keilmesser* and leaf points) and unifacial tools such as side scrapers can be identified. In terms of the Upper Palaeolithic (*Figure 6*), we observed the presence of several carinated artefacts, blade- and bladelet cores. Upper Palaeolithic blades and bladelets are present, but rare, as well as tools such as burins and scrapers.

Excavations

Between 2011 and 2014, annual excavations under the direction of Harald Floss were performed on site. During the campaign in 2011, three test trenches were conducted within the surface concentrations, to examine the possible presence of remaining intact layers. An eastern trench was mainly of geological interest and was located in an area, where the density of finds from the surface thinned out. The *in-situ* Jurassic limestones

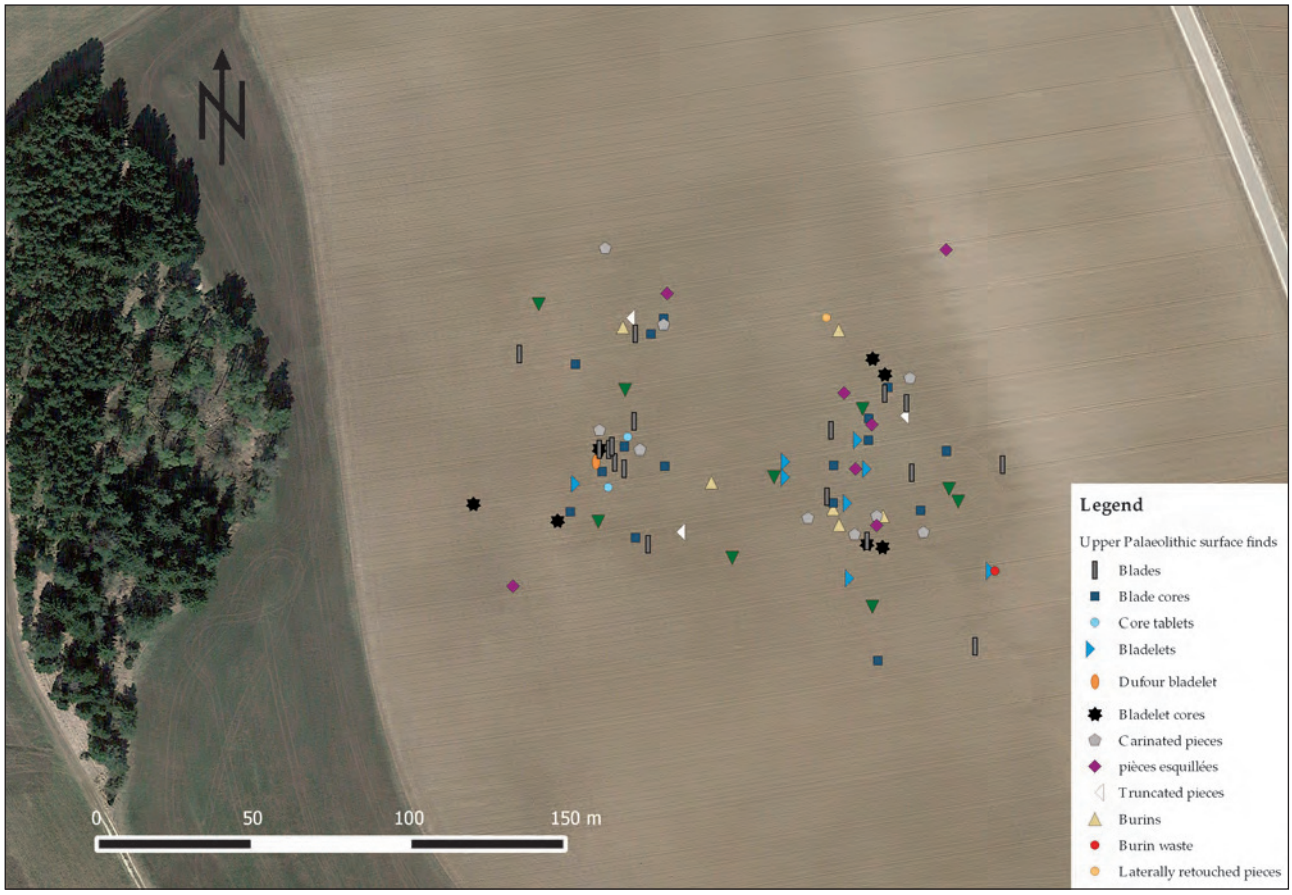

FIGURE 6. Dispersal of Upper Palaeolithic surface finds at Börslingen-Eisenberg (basemap: GeoBasis-DE/BGK, Google).

were reached here at a depth of 40–80 cm. This trench was expanded to the south, and at its base, few small charcoals and chert pieces were recovered. The second trench, located between the eastern and the western trench was also only important from a geological point of view. The western, L-shaped trench was of archaeological importance. Here, the *in-situ* limestones were already reached at a depth of ca. 25 cm. In the intersection of the axes of this trench, a hearth of ca. 40 cm diameter was discovered in GH2 (Qu 508/511; *Figure 7*). It consisted of arranged, erected limestones showing strong evidence for heat on their inner faces (Brenner 2013). Within this structure, burnt clay and several large pieces of charcoal were recovered. Two ^{14}C dates were obtained from this structure:

These dates place the hearth in the early Middle Neolithic. In and near the fire place have been discovered several carinated artefacts and bladelets. As the thickness of the quaternary deposits on site is low, we have to assume a palimpsest-like situation, where different phases of occupations of the site coincide within one layer.

In 2012, larger zones with influences of heat were observed, one of which was directly adjoining east of the hearth. Additionally, two pit-features of 30 cm in diameter were discovered north of the hearth. These pits were dug into the weathered limestone and were most probably used to extract chert nodules. In the eastern part of the excavation area, an increased find density was noticed, accompanied by a number of

1. BOE508/511.431	ETH-65841	5758 14C BP ± 27	1 Sig. 95,4%	4961–4536 calBC
2. BOE508/511.533	ETH-66727	5853 14C BP ± 25	1 Sig. 95,4%	4792–4682 calBC

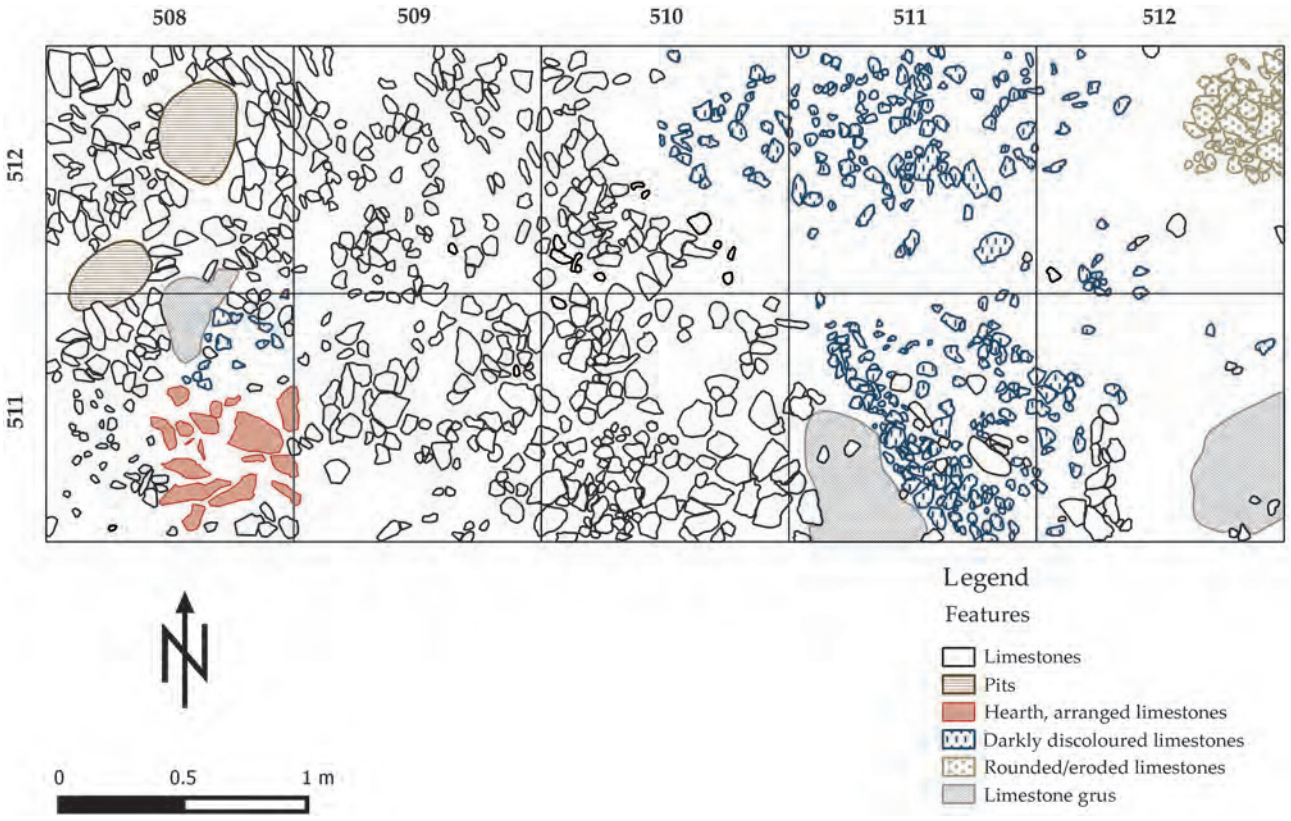

FIGURE 7. Features of the excavated area at Börslingen-Eisenberg.

artefacts showing influence of heat. At the same time, large amounts of charcoals up to 1 cm in size were observed. One particular heat feature consisted of darkly discoloured limestones, small pieces of charcoal and reddish sediment in an area of about 0.25 m² (Qu 510/512, *Figure 7*). During the excavations in 2013 and 2014, this feature could be traced farther to the east, but also was observed in the southern part of the excavation area. In both cases, it was connected with many small pieces of charcoal. The limestones representing these two features were of dark colour and displayed sharp edges setting them apart from the *in-situ* limestones of the Upper Jurassic. In the north-eastern zone (Qu 512/512) another feature, consisting of limestones which were arranged as a round cluster, was revealed. In this case, the limestones did not have the same colour as the *in-situ* ones as well; they were slightly brighter, and additionally, their edges were rounded.

The anthracological analysis of the charcoals recovered during the excavations revealed mixed results: willow (*Salix*), poplar (*Populus*), apple (*Pyrus malus*), common pear (*Pyrus communis*), hawthorn (*Crataegus sp.*), quince (*Cydonia oblonga*) and chestnut (*cf. Castanea sp.*). Most of these species are present in this region of Europe from the Holocene.

THE LITHIC ASSEMBLAGE

Middle Palaeolithic

Most Palaeolithic artefacts can be assigned to the Middle Palaeolithic. They comprise 263 artefacts from prospections and excavations (*Table 1*). They are made exclusively from the local chert, with one exception: a side-scraper was produced from a material called ‚Bohnerzhornstein', that cannot be found locally and had been brought to the site. Following the small dimensions of the local chert nodules, the Middle Palaeolithic artefacts are of minor size, too. In this, they are quite distinguishable from artefacts from Neolithic settlements and chert-mining areas in the region (Fisher, Knipper 2003), where raw-material units and cores are of much larger size. Middle Palaeolithic artefacts characterised by their small size are also known from so called *micro-moustérien* assemblages from other regions in Europe (e.g. Moles, Boutié 2009). Compared to Upper Palaeolithic finds from the site, Middle Palaeolithic artefacts often show a thick white patina that is much more pronounced and they are, in general, more formatively influenced by different taphonomic processes, resulting in eroded edges.

Most of the Middle Palaeolithic artefacts from Börslingen (about 200) are linked to the Levallois-concept (*Figure 8*). There are about 140 Levallois cores and about 60 Levallois flakes. Other blanks related to this concept, as Levallois blades or points, are not recorded. The most striking feature of the Börslingen

TABLE 1. The Middle Palaeolithic assemblage from Börslingen-Eisenberg (survey and excavations).

artefact type	**n**
Levallois cores	136
Levallois flakes	58
Keilmesser	9
Leaf points	1
Other bifacial artefacts	16
Kombewa cores	36
Kombewa flakes	1
Sidescrapers	10
Flakes with lateral thinning	2
total	269

TABLE 2. Butt types of Levallois flakes from Börslingen-Eisenberg.

butt type	**n**
plain (single negative)	23
facetted	23
dièdre	7
natural surface	3
not appraisable	2
total	58

Levallois cores is their reduced preparation on the lower part of the core. Instead of a meticulous preparation of this lower part, the convex form of the chert nodules was exploited. The upper part however was subject to ample preparation, as can be recognized on the dorsal faces of the Levallois flakes. Due to the low level of preparation, many Levallois flakes do not show typical facetted butts (including *châpeau de gendarme*), although the general wing-like shape is maintained at many pieces (*Table 2*). Concerning the reduction methods, single flaking and recurrent flaking are both observed, with the bipolar method especially frequent within recurrent flaking. A preliminary study shows a very similar technological behaviour within the Middle Palaeolithic assemblages of Hohlenstein-Stadel and the Bärenhöhle, where the Levallois cores show similar degrees of nodule exploitation and preparation, as well as nearly identical reduction methods on the cores. However, the Jurassic chert artefacts in the assemblages of Hohlenstein and Bärenhöhle were not clearly connected to specific raw material sources in the immediate surroundings of these two sites (Beck 1999). This, in addition to the technological correlations and the vicinity of Börslingen-Eisenberg and the two cave-sites, could imply the procuration of the Börslingen chert by the Middle Palaeolithic inhabitants of the Stadel and the Bärenhöhle.

Another technological feature in the Börslingen Middle Palaeolithic is the presence of ventrally exploited flakes that are commonly referred to as Kombewa cores (Balout 1967, Inizan *et al*. 1995, Owen 1938, Tixier, Turq 1999). About 40 artefacts can be assigned to this reduction concept (*Figure 9*). The Kombewa concept was described first in Africa (Owen 1938), but it shows widespread geographical and chronological distributions. It is known from the Lower Palaeolithic in Africa, England and France, but also

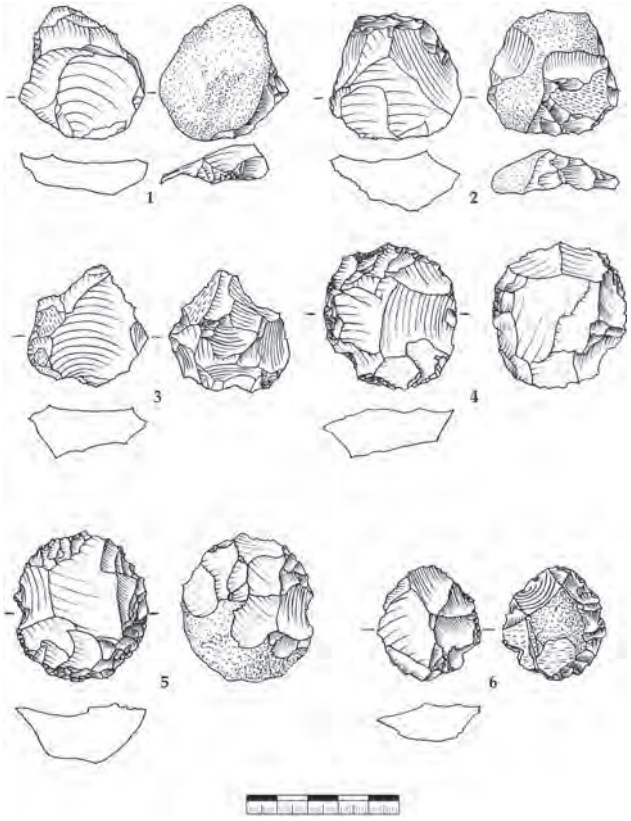

FIGURE 8. Börslingen-Eisenberg: Levallois cores (Jurassic chert) (Drawings: S. Wettengl).

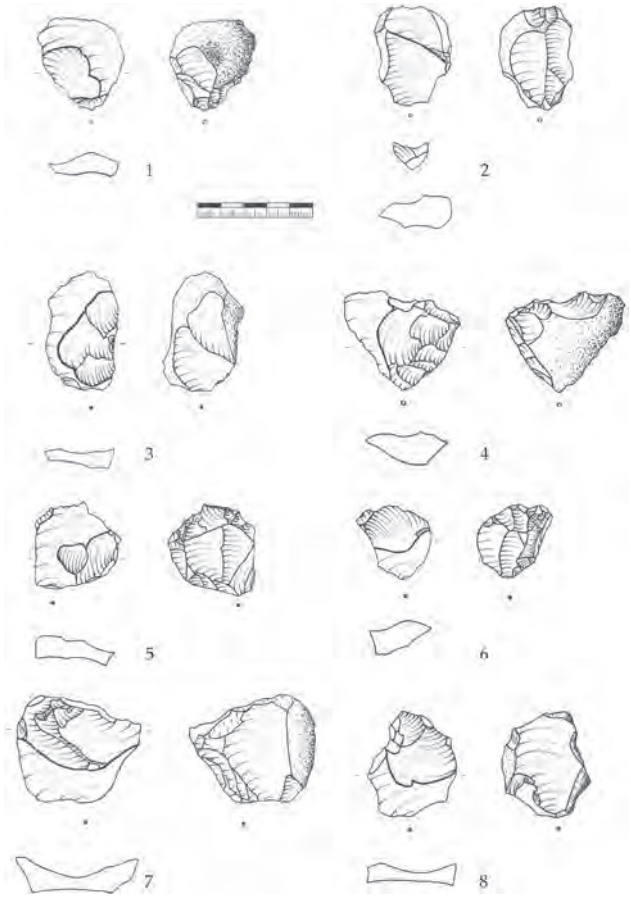

FIGURE 9. Börslingen-Eisenberg: Kombewa cores (Jurassic chert) (Drawings: S. Fröhle).

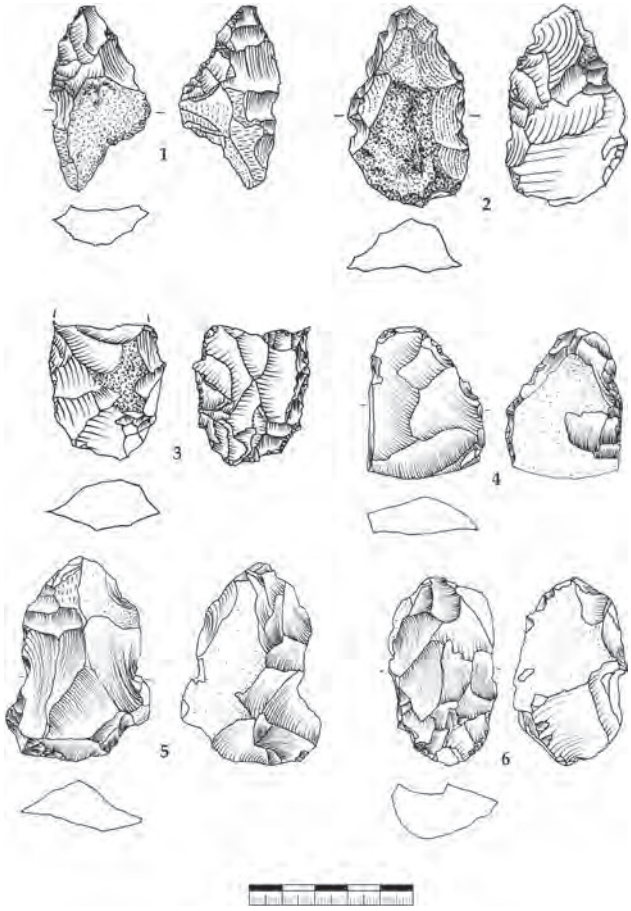

FIGURE 10. Börslingen-Eisenberg: bifacial artefacts (Jurassic chert). 1, leaf-shaped point; 2–6, bifacially worked pieces (Drawings: S. Wettengl & B. Schürch).

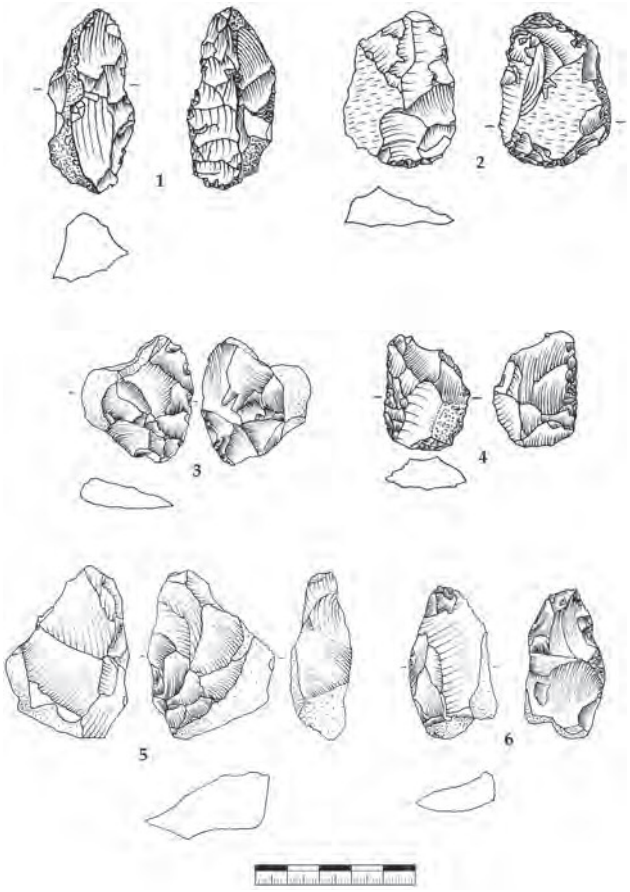

FIGURE 11. Börslingen-Eisenberg: *Keilmesser* (Jurassic chert).

played an important role in the French Middle Palaeolithic, with particular emphasis on the Aquitaine region. The concept was even used in historical times in the production of flintstones for flintlock-weapons (Tixier, Turq 1999). Often, the term Janus-flakes is used to describe the blanks produced with the Kombewa concept, but actually, these flakes are produced with a special method within the Kombewa concept. At that, the butt of the primary flake – the Kombewa core – is used as the striking platform for the production of the secondary Kombewa flake. In an ideal case, the so-called Janus flake shows at its basal part the typical striking traits, such as the bulb or the flaking scar, on both the ventral and the dorsal faces. In Börslingen, only five Kombewa cores show the application of this method. Instead, we can observe a preferred exploitation of the ventral surface from lateral, or in some cases, from distal edges. Interestingly, we were not able to identify more than one Kombewa flake in the inventory that exceeds the size of the identified Kombewa cores. Although the occurrence of this concept is chronologically widespread, we could assign these artefacts from Börslingen to the Middle Palaeolithic Period, because some Levallois flakes were used as Kombewa cores.

Bifacially modified artefacts are also a component of the Middle Palaeolithic assemblage of Börslingen (*Figure 10*). They comprise nine *Keilmesser* (*Figure 11*), the fragment of a leaf point and some semi-finished bifacial tools. There are several Middle Palaeolithic sites in the region that yielded leaf points, such as the Haldensteinhöhle (Riek 1938, Conard *et al.* 2015) and Mundelsheim (Schneidermeier *et al.* 1999). Other recently discovered open-air sites in the Swabian Jura also provided some of these bifacially

worked artefacts (Floss, Schürch 2015, Schürch 2015; see intra). Typical Middle Palaeolithic unifacial tools are present, but they appear opportunistic and atypical. In this regard we can mention some sidescrapers.

Upper Palaeolithic

Compared to the rich Middle Palaeolithic assemblage, Upper Palaeolithic finds are scarce. This might be caused by very critical distinction criteria due to a strong Neolithic presence in the region. In total, we can assign about 110 artefacts (*Table 3*) to the Upper Palaeolithic period. Most important are ca. 10 carinated artefacts, with bladelet negatives and an aurignacoid habitus (*Figure 12*). There are ca. 100 bladelets from Börslingen that cannot be strongly argued to originate from carinated artefacts (*Figure 13*). Only a few pieces show the typical torsion observed with the reduction from carinated artefacts (Le Brun-Ricalens, Brou 2012). Most of the bladelets do not show any retouch, but two pieces can be placed in proximity with Dufour-bladelets due to a slight marginal retouch. Currently, we are testing, if this type of blank production can occur in the local Neolithic, too.

Another important category of Upper Palaeolithic artefacts are about 20 blade cores (*Figure 14*). These cores are clearly distinct from Neolithic blade cores. The Upper Palaeolithic cores have a much sharper angle at the striking platform and the platform itself shows preparation on a regular basis. They are stalk-like or nearly conical in form, with one or two striking platforms. Core tablets are also present in the inventory. Several blades show typical Upper Palaeolithic striking features, such as a diffuse bulb or a lip at the transition to the butt. Some blades do have characteristic dorsal crests, and they are robust and compact (*Figure 13*). As many of these blades are only represented in a fragmentary state, it is difficult to assign them to a specific period of the Upper Palaeolithic, but the features described show an affinity to the Early Upper Palaeolithic. Tools on blades (*outils de fonds commun*) are rare. Some atypical endscrapers can be identified, as well as several burins. The most frequent tools are splintered pieces (*pièces esquillées*). These artefacts appear to be Palaeolithic due to their habitus and their patina, but they are very common in the regional Neolithic, too. Besides, the Upper Palaeolithic tool-array (*Table 4*) is supplemented by some truncated pieces or artefacts with a lateral retouch. Projectiles are missing completely if one sets aside the two Dufour bladelets and a doubtful point-fragment with basal retouch. To conclude, the Upper Palaeolithic inventory from Börslingen shows obvious aspects of raw material exploitation and blank production on site, whereas artefacts indicating a prolonged occupation or a specific hunting function are missing.

TABLE 3. Composition of the Upper Palaeolithic assemblage from Börslingen (surveys and excavations).

artefact type	**n**
Blade cores	21
Blades	25
Carinated artefacts	13
Bladelet cores	13
Bladelets	13
Splintered pieces (*pièces esquillées)*	8
Retouched flakes	13
Retouched frost splittings	2
Other retouched pieces	4
total	112

TABLE 4. Upper Palaeolithic tools from Börslingen (survey and excavations).

tool type	**n**
Burins	9
End scrapers	11
Truncated pieces	3
Laterally retouched pieces	1
Dufour bladelets	2
total	26

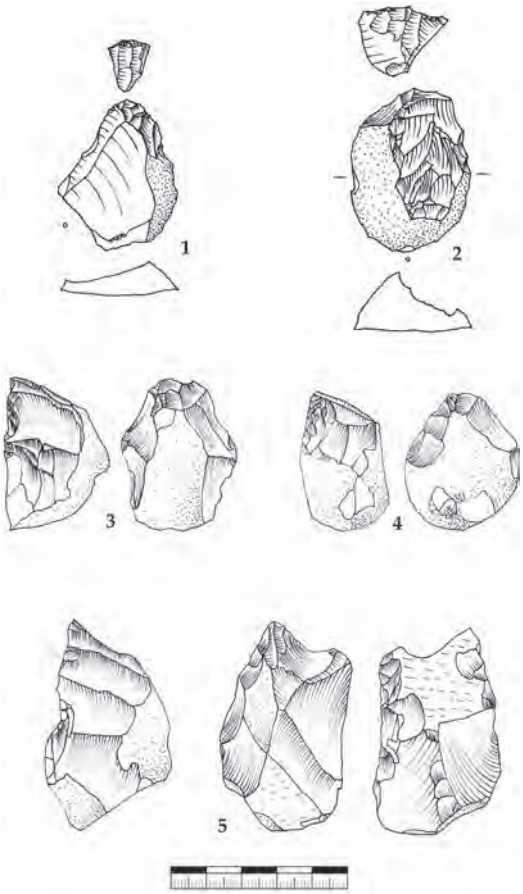

FIGURE 12. Börslingen-Eisenberg: carinated pieces (Jurassic chert) (Drawings: S. Wettengl & B. Schürch).

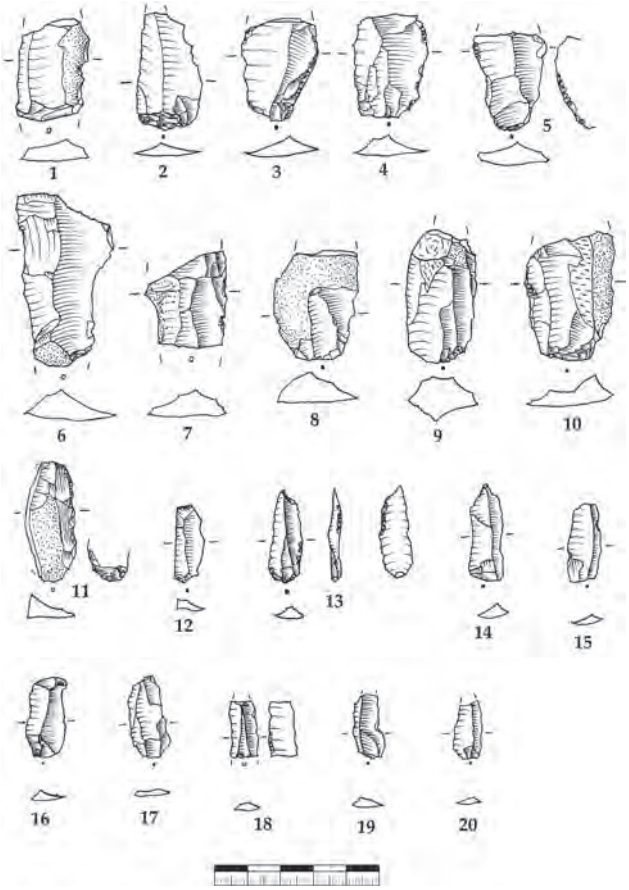

FIGURE 13. Börslingen-Eisenberg: blades and bladelets (Jurassic chert) (Drawings: S. Wettengl).

THE MAGDALENIAN OPEN AIR SITE HEUBACH-SAND

History

2016 marks the centennial of Stone Age archaeology in southwestern Germany, more specifically in the northern Swabian Jura. The first excavations in the Kleine Scheuer, which is situated in the Rosenstein massif in Heubach, 60 km east to Stuttgart (*Figure 2*), were conducted 100 years ago by the founder of the Prehistoric Institute of the University Tübingen, R. R. Schmidt. Further excavations by Franz Keller in the early 1920s strengthened evidence for the presence of a Magdalenian occupation. Typical forms like end scrapers, burins, organic points and a harpoon were found (Keller 1933, Riek 1935, Maier 1936, Oeftiger, Wagner 1985, Wettengl 2013). The most striking find is the carving of a botfly larva made of jet. Jet from the Lower Jurassic also appears in several inventories of the Swabian Jura, for example in the Magdalenian layers of Petersfels (Peters 1930, Dingfelder 1961). A bone point from the Magdalenian layer II was recently ^{14}C dated at the ETH Zürich. The age of 13,930 ± 148 calBP fits perfectly in the Meiendorf-Interstadial which lasted from 14,450–13,800 calBP (Litt *et al*. 2007).

2 km northwest from the Kleine Scheuer a spur-like promontory of the Swabian Jura, the Sand upon the Galgenberg, provides an exposed position to the surrounding landscape, and each site is visible from the other (*Figure 15*). The first investigations were initiated around 100 years ago by a local teacher, only a few finds are known and are exhibited in the town museum. Further connections were built with the Working

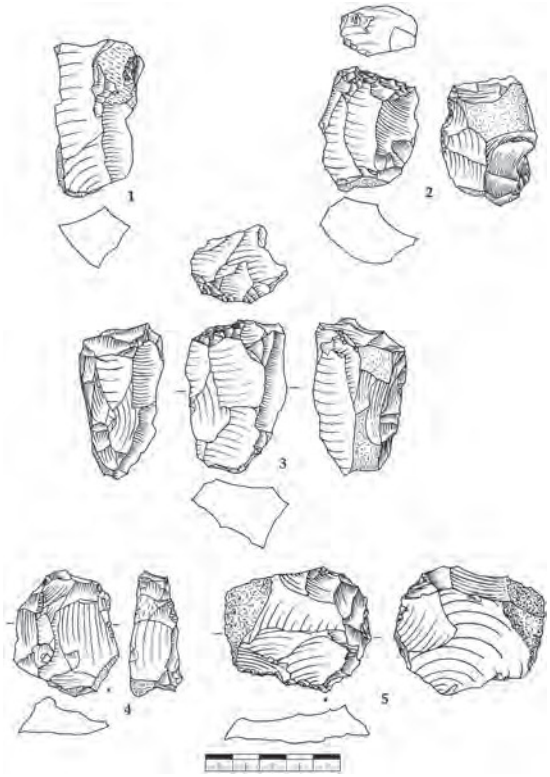

FIGURE 14. Börslingen-Eisenberg: Upper Palaeolithic blade cores & core tablets (Jurassic chert). 1–3, blade cores; 4–5, core tablets (Drawings: S. Wettengl).

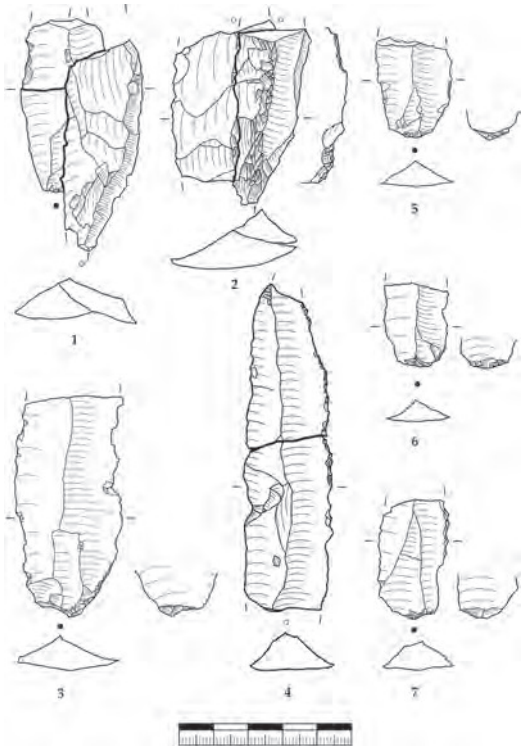

FIGURE 16. Heubach-Sand: *Kieselkalk* blades. 1–2, *Aufeinanderpassung*; 4, Refitting of two medial blade fragments; 3, 5–7, basal blade fragments with characteristics of direct soft hammer and *en éperon* preparation (Drawings: S. Wettengl).

FIGURE 15. Detailed mapping of Heubach. 1, Kleine Scheuer; 2, Heubach-Sand; 3, Waldstetten-Schlatt. A, Kieselkalk-outcrop Scheuelberg; B, Keuper chert-outcrop Waldstetter Bach (basemap: GeoBasis-DE/BGK, Google).

Group for the Stone Age in Schwäbisch Gmünd. Palaeolithic open air sites at the northern Swabian Jura could be detected in this area (Wettengl 2013), one of which is the outstanding Magdalenian site of Heubach-Sand (Wettengl 2016). From there, more than 3,350 surface finds resulted from decades of prospecting by Gebhard Haag, Adolf Regen and Wolfgang Naak, the latter members in the Working Group for the Stone Age in Schwäbisch Gmünd. A characteristic raw material unit of local siliceous limestone (*Kieselkalk*) shows technological affinities to the Magdalenian. Big blades up to 10 cm and more, soft organic hammer characteristics and *en éperon* butts lead to this conclusion (*Figure 16*). This assumption is substantiated by the presence of end scrapers, (dihedral) burins and backed bladelets.

Unfortunately there was no GPS mapping of the surface finds until 2013, but A. Regen provided a handmade map where a concentration of Upper Palaeolithic finds is visible. In 2014 a team of Harald Floss' working group, from the University of Tübingen, conducted test excavations in the position of the surface concentration. This work revealed that agricultural activities destroyed potential intact archaeological layers in this area. On the surface of the first geologically intact layer a few lithic artefacts could be found and related to the surface finds although in this area, we could not detect an intact archaeological layer.

From Heubach-Sand surface finds are known from the Middle Ages to the Palaeolithic. Neolithic and Mesolithic finds are mainly represented by lithic points and microliths (Kind 2002: Tafel 4 and 15). Cores are small and not well prepared. A few pieces show traces of heat treatment and punch technology. Jurassic chert is clearly dominating in the mixed inventory with 79 %. 310 finds can be attributed to a raw material unit of local *Kieselkalk* from the upper Jurassic beds at the Scheuelberg. These finds are ascribed to a Magdalenian settlement due to technological details of the blade production and this is, why unidentified blanks and debris are also added in the table, providing a better overview of the assemblage (*Table 5*). Further artefacts like burins, endscrapers, backed bladelets and some cores and blanks made of various raw materials further support the chronological attribution (*Tables 8, 10*).

TABLE 5. Magdalenian artefacts from Heubach-Sand (tools included).

Finds attributed to the Magdalenian	**n**	**%**
Cores	24	5.9
Blades	208	50.8
Bladelets	24	5.9
Flakes	111	27.1
unidentified blanks / debris	42	10.3
Total	**409**	**100**

TABLE 6. Butt-form and preparation of the blades of *Kieselkalk*.

Butt form and preparation	**n**	**%**
pointed oval / plain	15	27.8
pointed oval / dièdre	8	14.8
triangular / plain	4	7.4
irregular / plain	8	14.8
other (punctiform etc.)	19	35.2
Total	**54**	**100**

Location, geology and raw material

The Sand is a foothill of the Swabian Jura on top of the Galgenberg, located in the Middle Jurassic layers containing sandstones and brown haematite in a sandy sediment (Dongus 1974: 13, Geyer, Gwinner 1991). In a southerly direction the Scheuelberg towers about 150 m over the Sand. The massif of compact limestone from the Upper Jurassic layers is characterized by karst formations and many caves. Furthermore on the southern slope the distinctive *Kieselkalk* (*Figures 18–20*) is eroding on the slopes and can be found in big nodules up to 20 cm. Besides the local Jurassic chert from the Swabian Jura (Beurer 1971, Burkert 2001) the *Kieselkalk* played a major role in the raw material supply of the Magdalenian hunters from Heubach. Further materials like radiolarite, Keuper chert and Bavarian Tabular chert were also imported from outcrops up to 150 km distant (*Figure 17*).

***Kieselkalk* artefacts**

The raw material appears coarse and fissured. Hahn (1991, 84) mentions similar characteristics for the

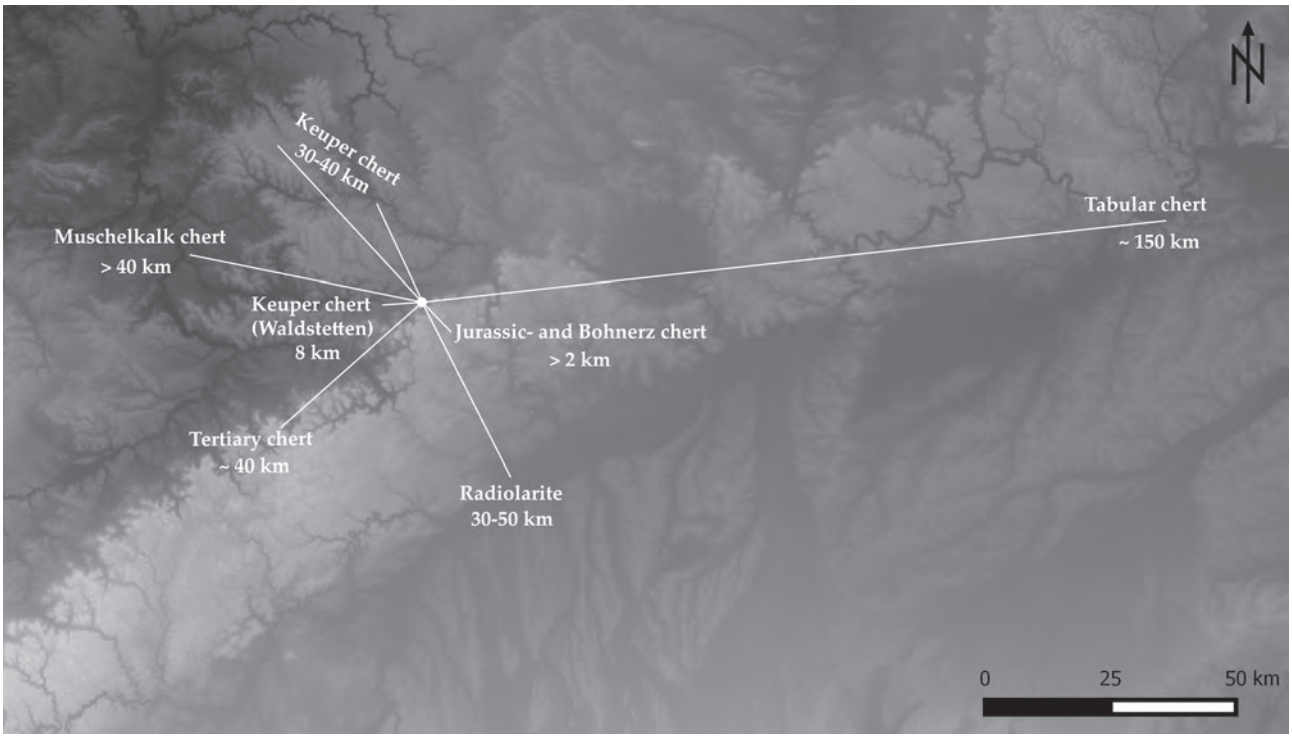

FIGURE 17. Non-local raw material sources identified for Heubach-Sand (basemap: opendem.info/download_srtm).

Tertiary chert from the Randecker Maar. The material once was of very good quality but taphonomic processes at the open air sites lead to a desilication on most of the pieces. Finds from Magdalenian cave sites such as the Kleine Scheuer (Wettengl 2013) or the Hohle Fels (Taller 2014) show the good quality of the material. The Kieselkalk artefacts from Heubach show different quality grades. It is noticeable that bigger blades are mostly made of more homogenous material, but some pieces show bigger inclusions that make the material more irregular. By trend a selection of more qualitative nodules is perceivable, always with the fact in mind, that pieces have changed after being discarded.

Cores

Most of the 15 cores are indifferent blade or flake cores showing no regular reduction sequence. Blanks were occasionally reduced from core fragments or debris. Three cores are bladelet cores, the only blade core is the most significant one (*Figure 18*).

The blade core (6.7 cm length) shows the status during the blade production. Many features of the preparation, like the *en éperon* can be attributed to

Figure 18. *Kieselkalk* blade core during the reduction process. Note the preparation of the striking surface (Photo: S. Wettengl).

several blades in the assemblage. While the back of the core is prepared through a crest, the lateral surfaces, as well as the striking platform, are prepared by flaking. The reduction face of the core is prepared by the regular production of blades. This meticulous preparation of the striking platform is typical for Magdalenian cores. On the transition to the reduction face, there are two small negatives proceeding onto the striking surface and thereby building a skit. Furthermore, the appearance of dorsal reduction shows that the blade was ready to be reduced with a flaking angle about 70°. This pattern of preparation is typical for the Magdalenian, and is known in many inventories from France and Germany (Olive *et al*. 2005, Floss, Terberger 2002, Floss 2012). More precisely it is called *talon en éperon* which describes the skit-like transition from the striking surface to the reduction face (Tixier *et al*. 1980, Floss 2012).

Blades

Blades are the most important pieces to detect an Upper Palaeolithic inventory; 158 of the finds are blades. Most of the pieces are medial fragments (88), followed by 48 basal and 13 terminal fragments. Only 9 pieces are completely preserved. 50 pieces are modified tools, mostly on medial fragments. To apply a technological analysis, the basal fragments and whole pieces played a major role.

Butt features

54 blades yielded butt features (*Table 6*). On blades most of the butts have a pointed oval form, followed by irregular butts. Other forms like punctiform or triangular butts do not play a dominant role. No butt shows cortex which suggests that the decortification of cores happened before their importation to the site. Another explanation is that cortex is only slightly developed on the *Kieselkalk* nodules.

If the surface is not plain the mode of preparation, shows mostly *dièdre* negatives as it is often combined with pointed oval butts. Other butts show facetted preparation, splintered or natural surfaces. Nine blades show the typical *talon en éperon* (Tixier *et al*. 1980, Floss 2012) preparation with dorsal reduction (*Figure 16: 5-7*). Eight butts are *dièdre* and one is facetted showing the high level of preparation during the blade production. More than 50% of the blades show traces of dorsal reduction, which was applied to stabilise the striking angle.

Striking features

It was possible to examine the striking features of 57 blades. For this work the appearance of lips, bulbs and bulbar scars was studied to determine the percussion techniques. Lips combined with a diffuse bulb and without a bulbar scar play a dominant role in the inventory (*Table 7*). Those features occur when the reduction is performed by direct percussion with a soft hammer (Floss 2012: 385, Tinnes 2002). Fewer pieces show traces of the direct hard hammer, e.g. nine pieces with pronounced bulbs and a bulbar scar. Especially pointed oval butts mostly display lips (19 pieces, 31.6 %).

TABLE 7. Striking features of *Kieselkalk* blades.

Striking features	**n**	**%**
lip	2	3.5
lip / diffuse bulb	22	38.6
lip / diffuse bulb / bulbar scar	6	10.5
diffuse bulb	6	10.5
diffuse bulb / bulbar scar	7	12.3
pronounced bulb	4	7.0
pronounced bulb / lip	1	1.8
pronounced bulb / bulbar scar	9	15.8
Total	**57**	**100**

The percentages indicate primary use of a soft hammer. Even pronounced bulbs and bulbar scars can appear by the soft hammer, while lips and diffuse bulbs can also appear by the hard hammer percussion (Floss 2002, Weiner 1989).

Cortex and dorsal surface

As mentioned above, cortex is not very distinctive or sometimes not present on the *Kieselkalk* nodules. More than 90 % of the blades do not bear cortex, which is a characteristic of regular blade production (Floss 2002: 47). Flakes show a higher cortex-percentage on the dorsal surface (75 % without cortex).

Because of their high degree of fragmentation, the dorsal negatives can lead only to restricted conclusions. About 50 % show a unidirectional reduction, 37 % are

indeterminate and 10 % show traces of bidirectional reduction.

Metrics

A summary of the metrics allows us to define a standardized frame for the blades on the assumption that they were the intended product. The width reveals a regularity between 15 and 30 mm, although medial fragments up to 49 mm width show that the former size of some blades was huge. The lengths of all fragments concentrate between 20 and 40 mm, while exceptions up to 90 mm are scarcer (*Figure 16: 1-4*). Fully preserved (crested) blades are up to 81 mm long and their average length is over 40 mm. The thickness also shows a distinct concentration between 7 and 9 mm.

Refittings

Open-air sites are subjected to many taphonomic processes, such as weathering, heat, frost and not least agricultural activities. The plough seems to have been a big influence at Heubach-Sand: most of the artefacts show typical traces of brown oxidations caused by abrasion of the plough iron, and many pieces are broken and irregularly distributed on the site. Nonetheless, refittings have been possible which makes this site an outstanding one in comparison to the southwestern German open-air sites. Two *Aufeinanderpassungen* (Floss, Terberger 1990) show the

FIGURE 19. *Aufeinanderpassung* of two blade fragments. The upper piece is a secondary crested blade.

FIGURE 20. Refitting of two medial blade fragments (left) and following an *Aufeinanderpassung* with a medial blade fragment. The pieces have been collected in a distance of seven years.

mode of reduction (*Figure 16: 1, 2*). In the first case, a crested blade fits perfectly upon a thick medial blade fragment (*Figure 19*). The second case shows two blades with a clearly shifted striking platform (*Figure 20*). The lower blade shows typical Magdalenian preparations on the butt as described above. Similar refittings are known from the famous Magdalenian site of Andernach-Martinsberg (Floss 2002).

Tools

The assemblage of the *Kieselkalk* unit shows a homogenous production of blanks, mostly blades and some tools for on-site usage. Prospections for about 30 years, refittings and the fact that no intact layer was found during the excavation lead to the conclusion that the greater part of the inventory is available. It seems likely that there were a few short occupations using easily accessible raw material outcrops in the production of basal household tools (*Table 8*).

Even if we know that the assemblage is barely complete, the tools are represented with 85 pieces (27.3 %) and fairly frequent. A selective bias by the amateur archaeologists can be excluded because not only tools, but also debris and raw material pieces have been collected. But it has to be mentioned that 60 pieces are regular lateral retouched or partial retouched pieces that are not regularly worked. Excluding those pieces still leaves 8 % of the assemblage as tools. 50 tools are worked on blades, 26 on flakes and 9 on undefined blanks or debris. Flakes and undefined blanks mostly show a simple retouch.

TABLE 8. *Kieselkalk* tools.

Modified blanks	**n**	**%**
Lateral retouched pieces	45	52.9
Burins	12	14.1
Partially retouched pieces	15	17.6
Endscrapers	5	5.9
Borer	3	3.5
Truncated pieces	3	3.5
Scrapers	1	1.2
Points	1	1.2
Total	**85**	**100**

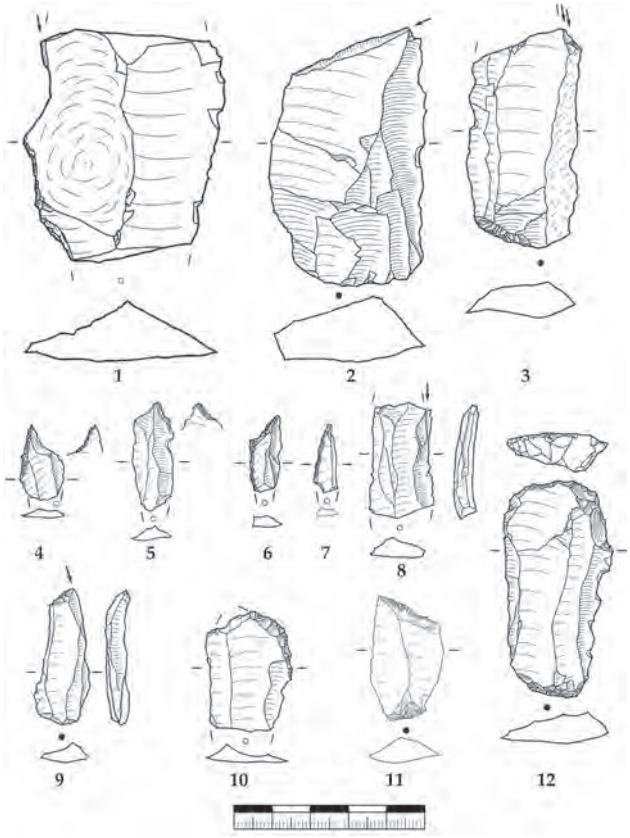

FIGURE 21. Heubach-Sand: tools. 1, burin on a break (*Kieselkalk*); 2, transversal burin (*Kieselkalk*); 3, burin-scraper combination tool (*Kieselkalk*); 4, borer (Keuper chert); 5, borer (Jurassic chert); 6–7, backed bladelets (Jurassic chert); 8, burin on a break (Jurassic chert); 9, burin on truncation (Jurassic chert); 10, endscraper (Tertiary chert); 11, truncated piece (Jurassic chert); 12, endscraper (Keuper chert) (Drawings: S. Wettengl).

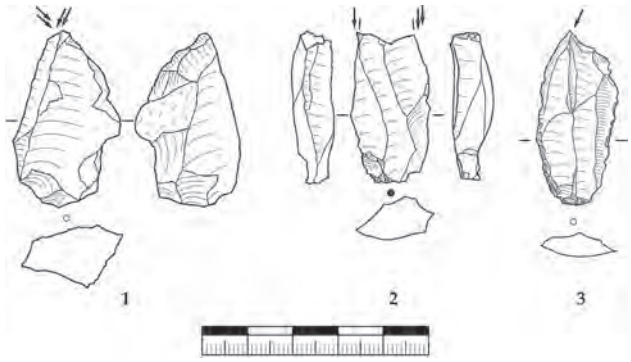

FIGURE 22. Heubach-Sand: burins. 1, dihedral burin (Keuper chert); 2, twin burin (Jurassic chert); 3, burin-scraper combination tool (Keuper chert) (Drawings: S. Wettengl).

The 12 burins are composed of 8 burins on a break, two on natural surfaces and one transversal burin. 9 pieces are produced on blades, respectively one piece on a flake, a debris and a not determined blank. One burin is a combination tool with an endscraper at the basal end (*Figure 21: 3*).

Various Materials and their significant tools

Raw Material sources

Local Jurassic chert plays the major role in the assemblage of Heubach-Sand. It was used from the Magdalenian to the Neolithic and imported from outcrops from the surface of the Swabian Jura, at least 5 km south to the site. Pieces of Keuper chert were possibly imported from outcrops in Waldstetten (8 km west) and the Mainhardter Wald/Murr-Region 30–40 km northwest (Burkert 2012: 71–72). Tertiary chert from the Randecker Maar (40 km southwest) is represented by 3 pieces. 40–50 km southern, radiolarite can be found in the river gravels of the Danube (Çep 2013: 68, Çep, Krönneck 2015: 244–245). At Heubach-Sand the red and green varieties are present. The farthest imports are pieces of Tabular chert from the Franconian Jura which is located around 150 km east to Heubach (*Figure 17*).

Burins

Typical for Magdalenian industries, burins are present in the assemblage. Different forms are visible:

- 1 burin without preparation (Jurassic chert)
- 5 burins on truncation (1 Bohnerz chert, 4 Jurassic chert) (e.g. *Figure 21: 9*)
- 4 dihedral burins (1 Bohnerz chert, 1 Keuper chert, 2 Jurassic chert) (e.g. *Figure 22:1*)
- 6 burins on break (1 Keuper chert which is a combination of burin and endscraper, 5 Jurassic chert) (e.g. *Figure 21: 8*)
- 1 burin on striking surface (Jurassic chert)

The most characteristic forms for the Magdalenian are the dihedral burins (two pieces published by Kind 2002: 77). Moreover a twin burin (*Figure 22: 2*) and a combination tool of burin and endscraper (*Figure 22: 3*) complete this category.

Endscrapers

It is more difficult to assign endscrapers chronologically, because they appear more or less from the Upper Palaeolithic to the Neolithic (Kind 2012a). Endscrapers from a post Palaeolithic context are mostly worked on flakes and show a circular retouch around almost the whole piece. Some endscrapers from the Mesolithic are very small and show red discolouring that are possibly traces of heat treatment. Endscrapers on elongated and robust blades with a semicircular cap are related to the Magdalenian context. Most of the palaeoltihic endscrapers are worked on local Jurassic chert and *Kieselkalk*, but also on Tertiary chert and Keuper chert (*Figure 21: 10, 12*).

Backed Bladelets

Whilst not as frequent as, for example in the Hohle Fels inventory (Taller 2014), backed bladelets are nonetheless present at Heubach-Sand. The fact that backed bladelets (*Figure 21: 6, 7*) could be found on the surface at all is fortunate. As demonstrated in the Kleine Scheuer, backed bladelets are not always highly present in Magdalenian inventories. Only one backed bladelet is known from there which reflects the old excavation technique. But also at the Randecker Maar, backed bladelets are not present in the assemblage (Auffermann 1998: 43). Two pieces are made on Tabular chert from the Franconian Jura, the rest is made on local Jurassic chert.

The backed bladelets are 4-9 mm broad and 12-24 mm long. Four pieces have been already published by Kind (2002: 77). They can be classified by means of Christensen and Valentin (2004: 122) according to the different states of the backed retouch.

Two backed bladelets show retouch to form a pointed end (*Figure 21: 6*). This is a hint that their function as Borers is also possible, as it is shown in Hohle Fels (Taller 2014: Fig. 115).

Another piece shows two spin-offs (burin blow like negatives; *Figure 21: 7*) at its terminal end, which indicates use as insets for organic points (see also Taller 2014: Fig. 94). Two other pieces are also backed points. Pointed backed bladelets used at the tip of the organic point are termed head bladelets (Petillon *et al.* 2011, Taller 2014: Fig. 143).

Other tools

Borer (*Figure 21: 4, 5*), laterally retouched pieces and truncated pieces (*Figure 21: 11*) are present in the assemblage. These categories can also appear in younger periods, so just the artefacts fitting securely in the Magdalenian were considered.

Conclusion

Heubach-Sand is an outstanding open-air site with refittings showing that the *Kieselkalk* artefacts belong to a standardized assemblage produced for immediate usage. Tools like Burins and Endscrapers, but

especially the long blades and their technology, substantiate the assumption that the collection provides a clear Magdalenian component. Furthermore, local Jurassic and *Bohnerz* chert have been processed at the site, while imported materials from more than 20 km are mostly represented as blanks or tools. These pieces can be assigned to basal equipment which was brought to the site. Several of the various materials mentioned above also fit to the Magdalenian assemblage. The site possibly represents a short occupation or several short occupations on the way across the northern Swabian Jura.

NEW PALAEOLITHIC FINDS FROM WALDSTETTEN

The site of Waldstetten-Schlatt has been regularly prospected by A. Regen (AK Steinzeit Schwäbisch Gmünd) since 1988. He pointed out different find concentrations reaching from the Middle Palaeolithic to the Neolithic, with most finds dating, based on technological and typological features, in a Middle Palaeolithic, Early Upper Palaeolithic and late Upper Palaeolithic contexts. The site is located in the black Jura (Lias alpha) and builds a spur with a wide outlook to the foreland of the Swabian Jura and the Rems valley (Kind 2012b). The spur is formed by small streams, the Waldstetter Bach western and the Bettringer Bach eastern to the site.

Typical for Waldstetten-Schlatt is the use of local raw material outcrops of upper Keuper cherts which can be found at the slopes of the Waldstetter Bach (Burkert 2012, 72). After visiting A. Regen to get a first idea of his collection, it seems that most of the artefacts are made of the local material, but some pieces could be identified as *Kieselkalk* from Heubach, as it appears in the Magdalenian of Heubach-Sand. Especially for the Middle Palaeolithic, the local Keuper chert seems to have played the major role.

Finds

The Middle Palaeolithic is represented by Levallois cores, bifacial tools, *Keilmesser* and Scrapers (*Figure 23*). Chronologically it could be located in the late Middle Palaeolithic, like Bockstein (Çep, Krönneck 2015)

An Early Upper Palaeolithic component is given by a carinated artefact, solid blades with an invasive retouch and burins (*Figure 24: 7, 8*). For the more detailed investigation and examination of the collection in the future, the Aurignacian component has to be substantiated by further typical finds.

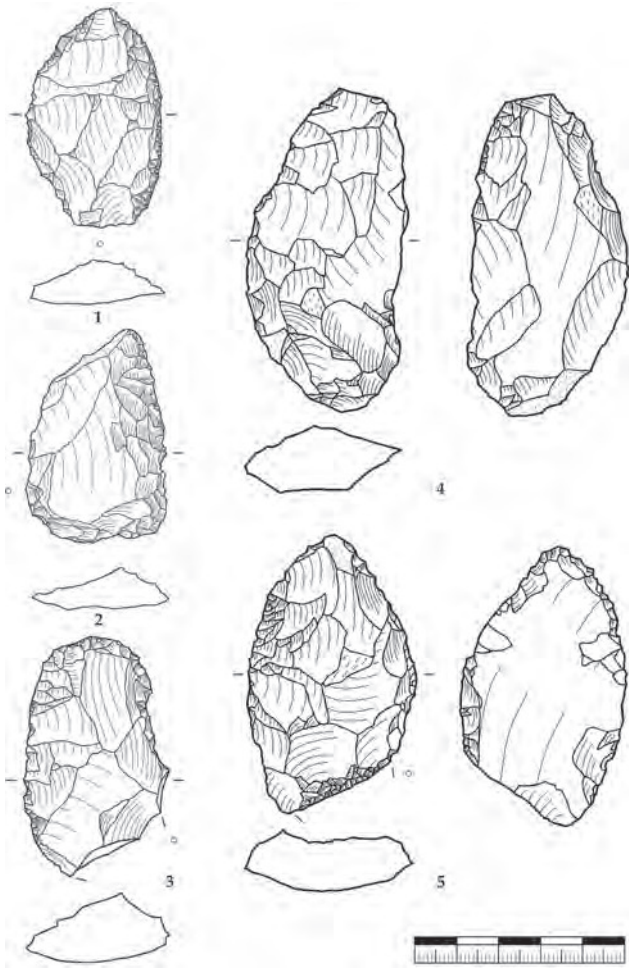

FIGURE 23. Waldstetten-Schlatt: Middle Palaeolithic tools. 1–3, side scrapers (1 & 2. Jurassic chert; 3, Keuper chert); 4, *Keilmesser* (Jurassic chert); 5, bifacially worked piece (Jurassic chert) (Drawings: S. Wettengl).

A Magdalenian occupation of the site is undoubtedly proven by many backed bladelets, blades and burins (*Figure 24: 1–6*). The most remarkable phenomenon is the raw material used for the backed bladelets. Most of them are made of local Jurassic chert, but some of them are made of exotic raw materials. As in Heubach-Sand, two backed bladelets are worked on Tabular chert (*Figure 24: 1, 2*) from the Franconian Jura (Binsteiner 2005). The import of this chert on a route along the Danube valley, the Ries crater and the northern Swabian Jura seems possible. Another parallel to Magdalenian open-air sites is

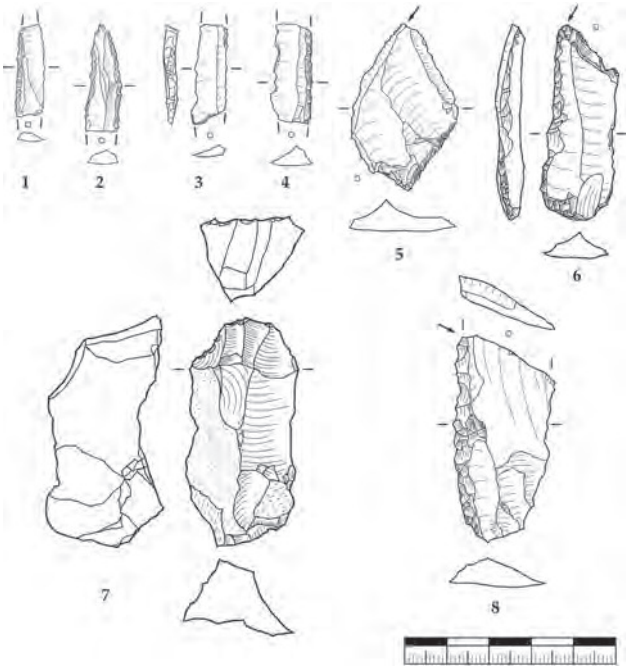

FIGURE 24. Waldstetten-Schlatt: Upper Palaeolithic tools. 1–2, backed bladelets (Tabular chert); 3, backed bladelet (Jurassic chert); 4, backed bladelet (Tertiary chert); 5, burin-borer combination tool (Jurassic chert); 6, burin on truncation-scraper combination tool (Jurassic chert); 7, carinated piece (Keuper chert); 8, transversal burin on a break with aurignacian retouch (Jurassic chert) (Drawings: S. Wettengl).

a backed bladelet made out of Tertiary chert from the Randecker Maar (*Figure 24: 4*). This very specific raw material is common in several Magdalenian assemblages on the Swabian Jura, like in the Hohle Fels (Taller 2014), the Kleine Scheuer near Heubach (Auffermann 1998, Wettengl 2013), or the Burkhardtshöhle (Simon 1993) and also at Heubach-Sand. Especially the backed bladelets from Hohle Fels, made of Tertiary chert show the transport of high quality raw materials across the Swabian Jura (Taller 2014: Fig. 87). Geographically, Waldstetten-Schlatt is located 8 km west to Heubach-Sand and about 30 km northwest to the Magdalenian sites of Braunfirst, Randecker Maar and Dettingen-Käppele (Auffermann 1991, 1998). Despite the flexible movements of Magdalenian societies, a connection and route between the sites on the northern and western surrounding of the Swabian Jura can be drawn and, these sites can be associated with each other, albeit not in a chronological frame. Magdalenian groups had the same focal points for their movements if raw material use is considered. Further investigations may well reveal more connections between open-air sites and the caves of the Swabian Jura.

THE MIDDLE AND EARLY UPPER PALAEOLITHIC SITES OF WIPPINGEN-SONDERBUCH AND THE BLAUBEURER ALB

Introduction

The archaeological activities at the Blaubeurer Alb over the last 60 years are mainly dominated by amateur archaeologists: one of the very few scientific projects was the excavation of H.A. Nuber in 1956 (Nuber 1962). The collectors are Jörg Sauer, Albert Kley, Michael Ulmer, Helmut Mollenkopf, Robert Bollow, Peter Blankenstein and Ulrich Linse. Their collections are the primary reason for this research project at the Blaubeurer Alb. The same is true for the initiation of Neolithic research at the Blaubeurer and Ulmer Alb by L. Fisher, K. Knipper, R. Schreg and S. Harris (Fisher, Knipper 2003, Knipper *et al*. 2005, Fisher *et al*. 2008a, Fisher *et al.* 2008b).

However this project focuses on the Palaeolithic component of the collections. Today these are partly in private ownership or part of the archaeological collection (Archäologische Sammlung) of the Ulmer Museum. Some of the artefacts have already been published (Floss, Schürch 2015). These artefacts originate from seven open-air sites (*Figure 25*), of which three only provided isolated Palaeolithic artefacts. In this article we set the focus on the site of Wippingen-Sonderbuch since this has recently provided significant new Upper- and Middle Palaeolithic artefacts (collection of Robert Bollow). The Palaeolithic cave sites of the Blaubeurer Alb – Große Grotte, Brillenhöhle, Geißenklösterle, Sirgenstein and Hohle Fels (Conard *et al*. 2015) – are another reason to examine finds from the open-air sites.

Further research on the open-air sites could lead to a better understanding of the lifeways of Neanderthals and Modern Humans (Herkert et al. 2015: 145). One approach to understanding patterns of behaviour is to identify possible connections and differences between open-air sites, the associated raw-material outcrops and the cave sites. The connections could be illustrated by identifying raw materials from local outcrops and the same raw materials in the open-air and cave sites.

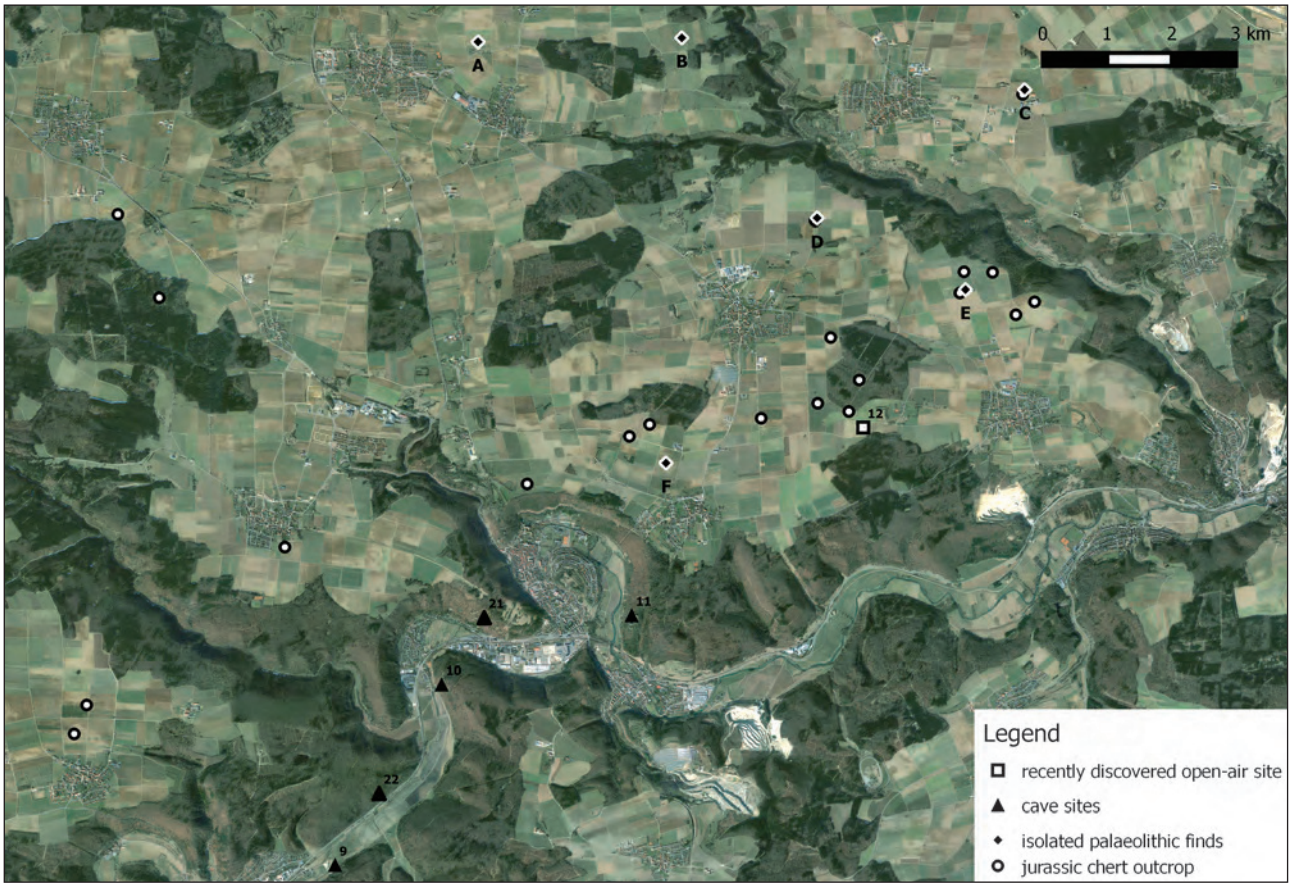

FIGURE 25. Detailed mapping of the Blaubeurer Alb. 9, Hohle Fels; 10, Geißenklösterle; 11, Große Grotte; 12, Wippingen-Sonderbuch; 21, Brillenhöhle; 22, Sirgenstein. A, Asanger Steig; B, Tauner unter dem Asang; C, Bermaringen Ziegelhütte; D, Asch-Brennerhäule; E, Wippingen-Höfermahd; F, Sonderbuch-Grund (basemap: GeoBasis-DE/BGK, Google).

TABLE 9. Retouch modes on backed bladelets.

Retouch	**n**	**%**
bordered	1	7.1
marginal	2	14.3
invasive	9	64.4
total	1	7.1
inverse	1	7.1
Total	**14**	**100**

TABLE 10. Tools made from various raw materials.

Tools (various raw materials)	**n**	**%**
Lateral retouched pieces	12	18.8
Burins	17	26.5
Backed bladelets	14	21.9
Endscrapers	12	18.8
Borer	4	6.2
Truncated pieces	5	7.8
Total	**64**	**100**

Another way to connect the open-air sites and the cave sites is by technological analogies between the assemblages. These connections may be supported by the distances of the cave sites of the Ach valley and open-air sites of the Blaubeurer Alb that are generally under ten kilometers. The most reliable way to establish such connections would be by refittings. For using these methods the open air sites have to be considered as a nearly closed assemblage whereas until now the artefacts from most open-air sites have been considered as single finds rather than a closed assemblage. However perceptions of the Wippingen-Sonderbuch assemblage have changed from a single find assemblage to a more associated assemblage given the accumulation of key forms of the Middle Palaeolthic and Early Upper Palaeolithic. The key forms are presented here and played a major role by identifying the Palaeolithic component of the site. This is because the Palaeolithic artefacts are mixed with Neolithic tools that originate from a nearby Neolithic settlement, called Schlaghau (Fischer *et al*. 2008). Borgerhau, another nearby source of raw material (Fisher *et al*. 2008a) is an open pit quarry complex. The sample of the key forms of the Middle Palaeolithic and Early Upper Palaeolithic yielded a reliable picture of possible settlement and raw material extraction activities which took place at Wippingen-Sonderbuch. Due to the absence of stratigraphic information at the site it is not enough merely to identify the key forms of the Palaeolithic, because there may be a small overlap of Palaeolithic and Neolithic key forms. To verify this comparison all artefact types from Middle Palaeolithic up to the Neolithic have to be well known. The following tools for instance existed in the Neolithic: end scrapers, borers, truncated pieces, arrowheads, points, splintered pieces, lateral retouched blades and artefacts with sickle gloss (Kind 1989, 1990, Waiblinger 1997). There is a list of attributes which can be used for the differentiation between Neolithic and Palaeolithic artefacts. The core technology (Floss, Schürch 2015: 84) is one of the keys to understand Neolithic blank production at the Blaubeurer Alb. During the Neolithic three primary percussion techniques existed: the direct hard hammer, the punch and the pressure technique. The Neolithic blade cores are characterized by a plain platform remnant, an obtuse flaking angle, deep and small bulb negatives, the conical shape and the relative low degree of patina (Floss, Schürch 2015: 84). In the Neolithic local chert is used almost exclusively as the lithic raw material, whereas other materials such as radiolarite and micro quartzite were not used. By adopting a combined analysis of the used raw materials, patina, subtle technological and typological details and microware analysis a differentiation of Palaeolithic and Neolithic artefact is possible (Floss, Schürch 2015: 85).

Location, geology and raw material

The Wippingen-Sonderbuch site is located on the upper layers of the Swabian Jura in the south central part of the Blaubeurer Alb, a region bordered by four rivers: the Schmiech, the Ach, the Blau and the Kleine Lauter. The landscape of the Blaubeurer Alb has been formed by several geological events, of which the most important was the valley deepening of the ancestral Danube (Dongus 1977) which led to the sedimentation of river gravels on the Blaubeurer Alb plateau. Remains of loess sediments can also be found on the Blaubeurer Alb Valley deepening and natural karst-phenomena lead to the building of dry valley, dolines, karst springs and other features characteristic of a karst landscape. One feature of such a landscape is that there is no water available on the Swabian Jura plateau due to the dewatering of the karst system. The Wippingen-Sonderbuch site may be an exceptional case in an otherwise depopulated landscape. Here a small uvala (formed by three Dolines; Karstsenke or Karstwanne) with erosion at its margins can be observed (Eitelmann 2009: 64). This erosion may be one reason for the appearance of the Palaeolithic finds. During glacial periods the perma-frost soil could interrupt dewatering through the karst (Villinger 1973: 212, Dongus 1977: 112, Hönle 1991: 52), leading to the formation of small lakes at the depressions of the dolines and especially at the small uvala. The dry valleys bordering the Blaubeurer Alb would change their character to water bearing valleys – a change already observed at other dry valleys of the Swabian Jura (Villinger 1975: 212). Another phenomenon called *Hüle* can still be observed today (Schreg 2009). A *Hüle* is a doline that is closed by natural processes or human activities which also leads to the formation of small lakes, a process supported by the loamy sediment of the Blaureurer Alb.

There are several raw material outcrops with good quality, large chert nodules (Nuber 1962, Hahn 1988, Floss 1994, Burkert 2001, Fisher *et al*. 2008a, Fisher *et al.* 2008b, Bertsch 2013, Floss, Schürch 2015). This raw material possibly played a major role in subsistence activities throughout the Palaeolithic (Burkert 2001: 65). The open-air sites correspond with the raw material deposits and are concentrated on the south eastern part of the Blaubeurer Alb. At Wippingen-

Sonderbuch different variations of the local chert can be observed, with the colour varying from grey, beige, and white to pink. Non-local raw materials that can be found at the site are radiolarite, micro-quartzite and *Muschelkalk* chert. Radiolarite and micro quartzite can be found in the Middle Palaeolithic assemblage, the *Muschelkalk* chert in the Early Upper Palaeolithic assemblage. The closest outcrop of *Muschelkalk* chert is located at the Neckar some 60 km distant (Çep 2013: 68).

The river gravels of the ancestral Danube are another raw material source. These gravels mainly consist of quartz, quartzite (Tillmanns 1984: 125). Radiolarite and other raw materials such as sandstone are rare.

Wippingen-Sonderbuch

As already mentioned the Wippingen-Sonderbuch site is situated at a small uvala and the artefacts were collected from the parcels Schlaghau, Hessen, Herrenäcker and Langes Mahd. The artefacts have not been located with a GPS-device and further surveys must follow in the near future to locate any concentration of the artefacts. Analysis of both the Middle and Upper Palaeolithic artefacts is currently in progress and this article can only provide interim results.

Artefacts from six open-air sites of the Blaubeurer Alb

While the Wippingen-Sonderbuch artefacts are the most remarkable ones of the Blaubeurer Alb there are six other open-air sites that provided significant artefacts (Floss, Schürch 2015), named after the village and area of land from which they originate. Wippingen-Höfermahd provided Middle and Upper Palaeolithic artefacts; Asch-Brennerhäule provided Middle Palaeolithic artefacts, as did Sonderbuch-Grund. However, these three sites are dominated by Neolithic settlement activities, and the Palaeolithic artefacts have been selected out of the Neolithic assemblages, and represent a small percentage of the whole assemblage. The sites Bermaringen-Ziegelhütte, Berghülen-Am Asanger Steig and Berghülen-Tauner unter dem Asang are three sites that each provided one isolated Palaeolithic artefact.

Middle Palaeolithic

The Middle Palaeolithic assemblage is dominated by tools, cores are rare (*Tables 11 and 12*). There are just two Levallois cores. The tools that may be an indicator for the age of the finds are a leaf point and the *bifacial tools* which are characteristic for the late Middle Palaeolithic. This is also true for the Middle Palaeolithic artefacts from other open-air sites of the Blaubeurer Alb and Börslingen (Fröhle 2013, Floss *et al*. 2015; see intra).

While not all the artefacts could be identified with the same level of certainty as Palaeolithic, the Middle Palaeolithic origin of the leaf point is one of the most impressive examples (*Figure 26*). The artefact is worked bifacially and has a brown patina. Besides this piece there are five more bifacially worked artefacts from Asch-Brennerhäule, Wippingen-Höfermahd and Bermaringen-Ziegelhütte. These artefacts differentiate from the leaf point because they lack the brown patina.

TABLE 11. Middle Palaeolithic artefacts of the site Wippingen-Sonderbuch.

Artefact type	**n**
Sidescraper	13
Bifacial tools	3
Levallois core	2
Mousterian point	1
Leaf-shaped point	1
Total	20

TABLE 12. Middle Palaeolithic artefacts from the sites: Wippingen-Höfermahd, Asch-Brennerhäule, Sonderbuch-Grund, Bermaringen-Ziegelhütte, Berghülen-Am Asanger Steig and Berghülen-Tauner.

Artefact type	**n**
Sidescraper	8
Bifacial tools	6
Keilmesser	1
Levallois core	1
Levallois point	1
Levallois flake	1
Total	18

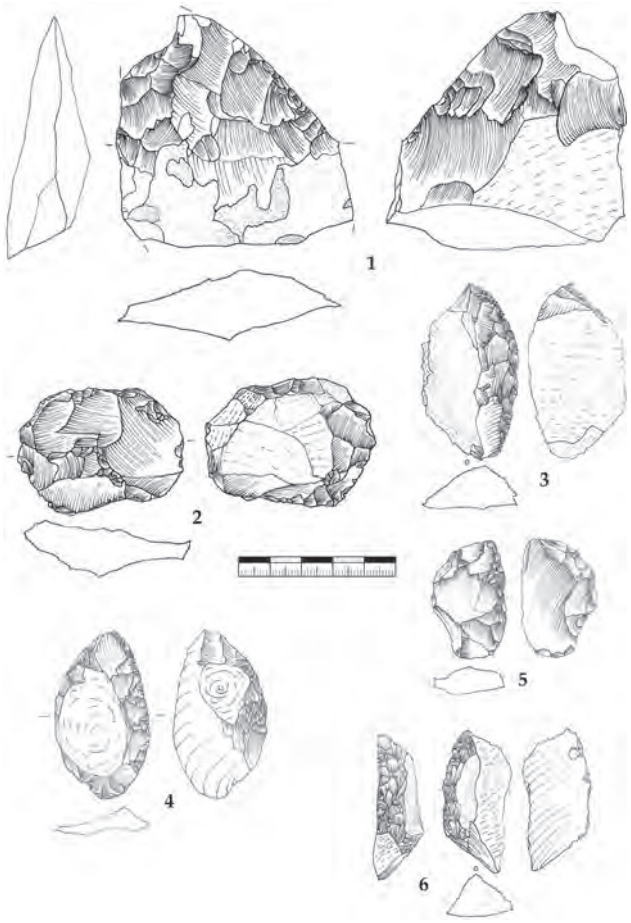

FIGURE 26. Middle Palaeolithic tools and cores from Wippingen-Sonderbuch. 1, leaf-shaped point (Jurassic chert); 2, levallois core (radiolarite); 3, sidescraper (radiolarite); 4, sidescraper (Jurassic chert); 5, sidescraper (microquarzite); 6, sidescraper (radiolarite) (Drawings: B. Schürch).

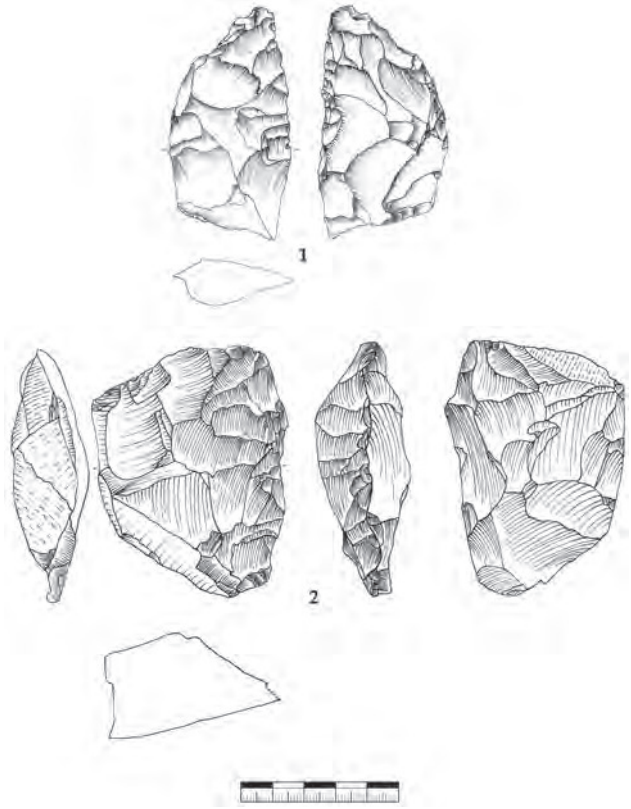

FIGURE 27. Bifacial tool and Keilmesser (Jurassic chert). 1, bifacial tool (Wippingen Höfermahd); 2, Keilmesser (Asch Brennerhäule) (Drawings: B. Schürch).

Keilmesser are another artefact category. The only *Keilmesser* come from Asch-Brennerhäule (*Figure 27: 2*). The Levallois concept is also present at the open-air sites. The relevant artefacts are three Levallois cores, one Levallois point and a Levallois flake.

Upper Palaeolithic of Wippingen-Sonderbuch

Upper Palaeolithic artefacts are more frequent than Middle Palaeolithic ones, and Upper Palaeolithic cores are particularly more frequent than Middle Palaeolithic ones. The number of cores and the high percentage of cortex on the blanks are an indicator that knapping was done at the location and this is underlined by the local raw material outcrops that surround the site. It is very unlikely that the location of the site was chosen at random when the site is located in the center of raw material outcrops. This is also supported by the recognition that raw material was obtained within a 5 km radius around Early Upper Palaeolithic sites (Floss 1994). Furthermore glossy Jurassic chert was favoured by the Upper Palaeolithic people.

While it is only possible to give a preliminary overview of the cores and tools of the site, there is already a clear indication of an Early Upper Palaeolithic origin for the artefacts.

Cores

The most significant Upper Palaeolithic cores (*Table 13*) are the carinated pieces (*Figure 28*), characteristic of the Aurignacian from the Swabian Jura. The carinated pieces include carinated end scrapers, nosed end scrapers, carinated "burins" and busked burins. Not only carinated cores are present at the site but also more bladelet cores and even bladelets.

TABLE 13. Upper Palaeolithic cores from Wippingen-Sonderbuch.

Cores	n
Blade core	21
Bladelet core	8
Carinated pieces	29
Total	58

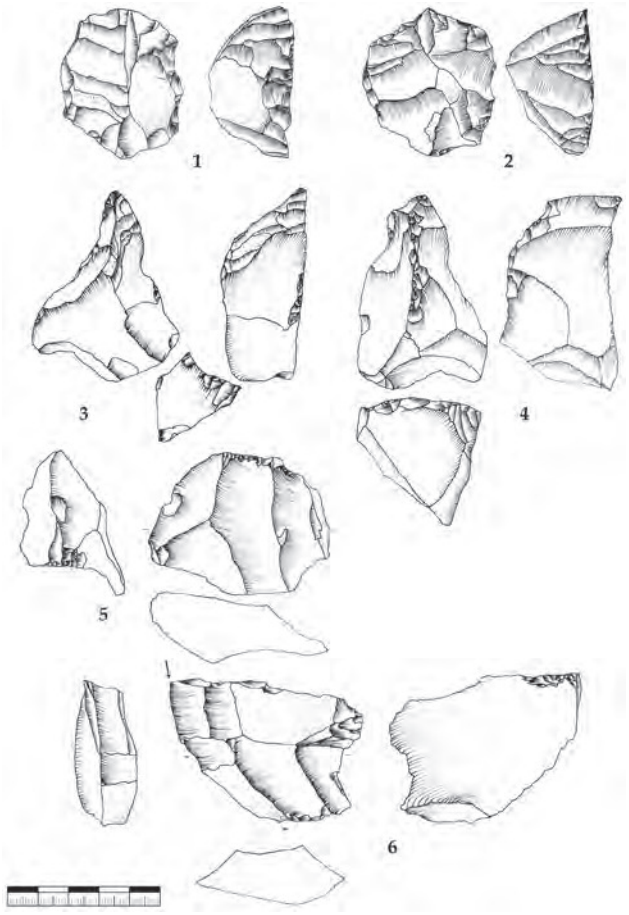

FIGURE 28. Carinated pieces from Wippingen-Sonderbuch (Jurassic chert). 1–5, carinated end scraper; 6, carinated burin (Drawings: B. Schürch).

The bladelets were mainly produced by direct soft-hammer percussion and are partly modified (*Figure 30*). In addition an opportunistic approach was often used to produce the blanks, with the natural shape of the cores used to produce the blanks. The cores often

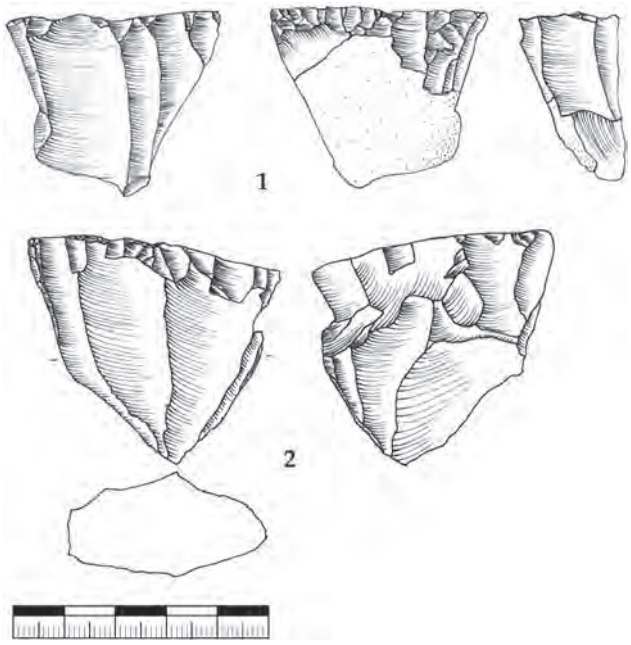

FIGURE 29. Upper Palaeolithic cores from Wippingen-Sonderbuch (Jurassic chert). 1, bladelet core; 2, blade core (Drawings: B. Schürch).

show a natural ridge that was used to start the reduction sequence. This opportunistic approach can also be observed with the carinated burins and is also typical for the local Aurignacian (Hahn 1988: 145). To complete the picture of the bladelet production from the carinated end scrapers, carinated and busked burins, and also torqued bladelets exist (*Figure 30*).

Besides the carinated cores there are several conical single platform blade and bladelet cores (Pl. XVI). Crested blades show another way to start the reduction sequence. Some of the crested blades have been reworked into tools (*Figure 30: 3*).

Blades, bladelets and a refitting

Some of the blades and bladelets show the typical Upper Palaeolithic striking features like a diffuse bulb or a lip. But a lot of the blanks were knapped with a hard hammer. These blanks can only be identified as Palaeolithic if they can be distinguished from the Neolithic blanks by other characteristics, for example retouch, patina or burin blows that do not occur during the Neolithic. To aid this differentiation modifications of the blades and bladelets are the best feature. If such modifications are missing. A clear differentiation between Neolithic and Palaeolithic blades and bladelets

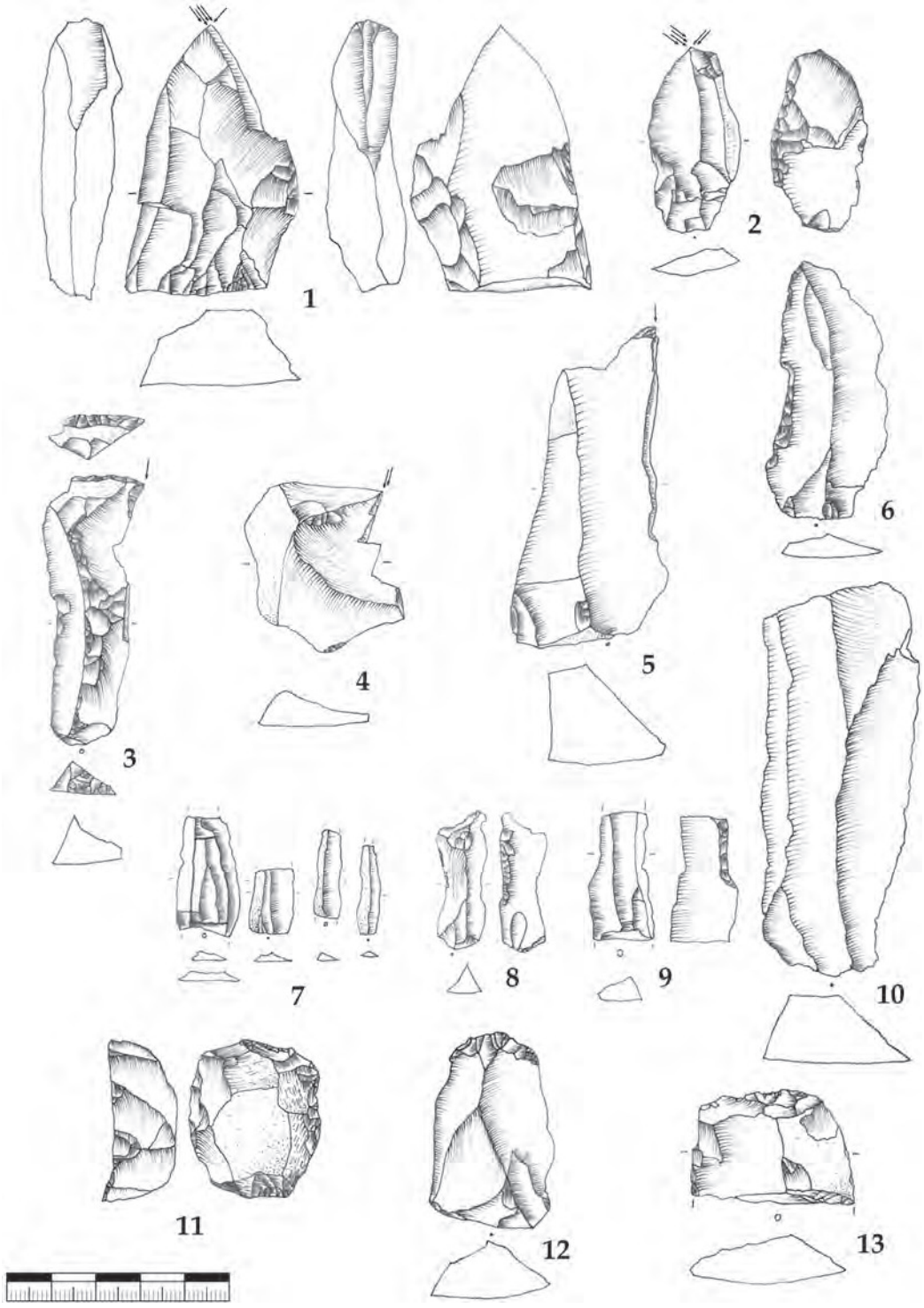

FIGURE 30. Upper Palaeolithic tools and blades from Wippingen-Sonderbuch (Jurassic chert). 1–2, dihedral burin; 3, combination tool (double end scraper and burin); 4, burin on striking surface; 5, burin on truncation; 6, retouched blade; 7, two refitted bladelets (left) and three more bladelets; 8–9, retouched blades; 10, blade; 11, double end scraper; 12–13, end scraper (Drawings: B. Schürch).

is always uncertain. Probably five of the bladelets come from one core, and were knapped with soft hammer. Two of the bladelets could be refitted (*Figure 30: 7*).

Tools

The Upper Palaeolithic tools (*Table 14*) are dominated by burins and end scrapers (*Figure 30*), the typical Early Upper Palaeolithic tools of the region. Burins enable a clear differentiation between the local Palaeolithic and the Neolithic assemblages since the latter lack burins. The identification of the Wippingen-Sonderbuch assemblage as Palaeolithic is also underlined by the different burin types that occur at the site, including dihedral burins, burins on truncations, burins on striking surfaces, burins on breaks and transverse burins. The typical Early Upper Palaeolithic burins like the carinated and the busked burins assist classification of the assemblage as an Early Upper Palaeolithic context.

The Palaeolithic origin of the end scrapers at the site has to be considered carefully. As mentioned above several criteria can be used to differentiate between Neolithic and Palaeolithic contexts. Besides the approach used above there are some outstanding examples that indicate that a major part of the end scrapers are Palaeolithic. One of these examples is a combination tool comprising a reworked burin that was transformed into a double end scraper (*Figure 30: 3*). Another example is a nose ended scraper which has one carinated end and a scraper at the opposite end.

RESULTS AND PERSPECTIVE

Open-air sites in the Region of the Swabian Jura have been investigated only sporadically over the last few decades, because the research focus was so predominantly fixed on cave excavations. In our approach we have attempted to understand the Palaeolithic occupation of the Swabian Jura from evidence derived from open-air sites but also in relation to the numerous cave sites. The sites introduced here are only a starting point, but in our opinion they are nonetheless suitable to demonstrate the potential of open-air Palaeolithic archaeology in Southwestern Germany. They provide evidence from both the Middle Palaeolithic (Börslingen, Waldstetten-Schlatt and Wippingen-Sonderbuch) and Upper Palaeolithic (Börslingen (Early Upper Palaeolithic), Heubach-Sand (Magdalenian), Waldstetten-Schlatt (Aurignacian & Magdalenian) and Wippingen-Sonderbuch (Early Upper Palaeolithic)). In multiple cases, these sites are directly situated at or in immediate vicinity of raw material outcrops, especially in Börslingen. For Wippingen-Sonderbuch, Heubach-Sand and Waldstetten-Schlatt the sources of water and the overview over the surrounding landscape are favourable and most probably one of the main reason for the habitation of these areas by Palaeolithic groups. Therefore it is one of our major goals to link open-air sites or specific raw material outcrops respectively to cave sites, as was possible with Börslingen and caves in the Lone valley.

Additionally, we are expanding and intensifying prospecting in our work area, and we are also establishing connections with several amateur archaeologists and private collectors in order to gain further knowledge of Palaeolithic sites and finds. These links have already supplied us with new pointers to sites most probably dating to the Middle Palaeolithic and the Magdalenian. One of our future goals is to investigate the spatial relationships between open-air sites and cave sites on a deeper level. This includes, besides raw material procurement and transport, also viewshed analyses, to identify and to interpret human movement patterns during the Palaeolithic occupation of the Swabian Jura.

We trust that with this contribution we have been able to present a preliminary report on our approach, as well as adding further information to the data base of palaeolithic sites and their distribution.

TABLE 14. Upper Palaeolithic tools from the site of Wippingen-Sonderbuch.

Tools	**n**
Burin	32
End scraper	21
Combination tool	1
Retouched Blades	2
Total	56

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