Middle Paleolithic Open-Air Sites of the Swabian Jura

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ABSTRACT

For several decades, Paleolithic research in the Swabian Jura has mainly focused on the numerous cave sites situated in the Ach and Lone valleys. These sites, such as Vogelherd, Hohle Fels, Geißenklösterle or Hohlenstein-Stadel, are famous for producing evidence for the world's oldest figurative art and musical instruments, dating to the Aurignacian, and have also yielded important Middle and Upper Paleolithic assemblages.

In recent years, the work group directed by H. Floss has begun to intensify research efforts regarding Paleolithic open-air sites in the Swabian Jura and adjacent areas. With the discovery of the Aurignacian open-air site of Königsbach-Stein near Pforzheim as a starting point, ongoing systematic surveys led to the discovery of the site of Börslingen-Eisenberg in 2009. The site is situated directly on an outcrop of Jurassic chert and has yielded c. 300 Middle Paleolithic artifacts, including Keilmesser, other bifacial elements and a strong Levallois component, as well as some Upper Paleolithic pieces. The local raw material was used in nearby cave sites, e.g., Bockstein (Middle Paleolithic context) and Vogelherd (Upper Paleolithic context).

In the northern part of the Swabian Jura, cooperation with local amateur archaeologists belonging to the *Arbeitskreis Steinzeit Schwäbisch Gmünd* has led to the identification of several new Paleolithic open-air sites, including the so-called "Schlattäcker" near Waldstetten. This site is located near an outcrop of Triassic chert. Apart from several Upper Paleolithic finds, we have identified c. 100 Middle Paleolithic artifacts, mostly made from local Triassic chert. The assemblage is mainly comprised of Levallois artifacts and scrapers, but also contains several Keilmesser and other bifacial tools.

On the Blaubeurer Alb, which is particularly known for its Neolithic chert mining sites, a review of several private collections and recent field survey have revealed artifacts dating to the Middle Paleolithic, including a leaf point, Keilmesser, other bifacial pieces, scrapers and several Levallois artifacts.

Another important research area is situated in the Rems Valley, in the northern foothills of the Swabian Jura. Very few Middle Paleolithic artifacts are known to have come from here, apart from the recent discovery of several handaxes. Coop-

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eration with local amateur archaeologists and the examination of several private collections have allowed us to identify new sites in the area which are of relevance to our research. Ultimately, it is our goal to progress from isolated observations to a dense network of open-air sites in order to shed new light on the Paleolithic occupation of the Swabian Jura and its surrounding areas.

RÉSUMÉ

Pendant plusieurs décennies, l'étude du paléolithique dans le Jura souabe s'est concentrée sur les nombreux sites de grottes des vallées de l'Ach et de la Lone. Ces sites, parmi lesquels figurent le Vogelherd, le Hohle Fels, le Geißenklösterle ou le Hohlenstein-Stadel, sont connus pour abriter le plus ancien art figuratif et des instruments de musique aurignacien, et ont en outre fourni d'importants assemblages lithiques du Paléolithique moyen et supérieur.

Ces dernières années, le groupe de travail dirigé par H. Floss a commencé à intensifier les efforts de recherche concernant les sites paléolithiques de plein air dans le Jura souabe et les régions voisines. Partant de la découverte du site aurignacien de plein air de Königsbach-Stein près de Pforzheim, des prospections systématiques ont conduit en 2009 à la découverte du site de plein air de Börslingen-Eisenberg. Le site se trouve directement sur un affleurement de chaille jurassique et a livré environ 300 artefacts du Paléolithique moyen, dont des *Keilmesser*, d'autres éléments bifaciaux et une composante Levallois très marquée, ainsi que quelques artefacts du Paléolithique supérieur. Le matériau brut local a été utilisé dans un contexte paléolithique moyen sur le site de grotte de Bockstein, situé à proximité.

Dans la partie nord du Jura souabe, la collaboration avec les archéologues amateurs du groupe *Arbeitskreis Steinzeit Schwäbisch Gmünd* a permis d'identifier plusieurs nouveaux sites paléolithiques en plein air, dont celui dit des "Schlattäcker" près de Waldstetten. Ce site se trouve à proximité d'un affleurement de chaille triasique. Outre quelques objets du Paléolithique supérieur, nous avons pu identifier une centaine d'artefacts du Paléolithique moyen, pour la plupart fabriqués en chaille triasique. L'inventaire comprend principalement des artefacts Levallois et des racloirs, mais aussi plusieurs *Keilmesser* et d'autres artefacts bifaciaux.

Dans le Blaubeurer Alb, connu notamment pour ses nombreux sites d'extraction néolithique de chaille, une nouvelle étude de plusieurs collections privées et des prospections de surface ont permis de mettre au jour des artefacts du Paléolithique moyen. Parmi les découvertes figurent une *Blattspitze*, des *Keilmesser*, d'autres pièces bifaciales et plusieurs artefacts Levallois.

Notre objectif est de passer d'observations isolées à un réseau dense de sites en plein air afin d'éclairer davantage l'occupation paléolithique du Jura souabe et de ses environs.

ZUSAMMENFASSUNG

Mehrere Jahrzehnte lang hat sich die Erforschung des Paläolithikums auf der Schwäbischen Alb auf die zahlreichen Höhlenfundstellen des Ach- und Lonetals konzentriert. Diese Fundstellen, zu denen der Vogelherd, der Hohle Fels, das Geißenklösterle oder der Hohlenstein-Stadel zählen, sind bekannt für die älteste, aurignacienzeitliche figürliche Kunst und Musikinstrumente und lieferten darüber hinaus wichtige mittel- und jungpaläolithische Inventare.

In den letzten Jahren hat die von H. Floss geleitete Arbeitsgruppe damit begonnen, die Forschungsbemühungen bezüglich paläolithischer Freilandfundstellen auf der Schwäbischen Alb und angrenzenden Gebieten zu intensivieren. Ausgehend von der Entdeckung der Aurignacien-Freilandfundstelle Königsbach-Stein nahe Pforzheim führten systematische Prospektionen im Jahr 2009 zur Entdek-

kung der Freilandfundstelle Börslingen-Eisenberg. Die Fundstelle befindet sich direkt auf einem Aufschluss von Jurahornsteinen und lieferte ca. 300 mittelpaläolithische Artefakte, darunter Keilmesser, andere bifazielle Elemente und eine stark ausgeprägte Levallois-Komponente, sowie wenige jungpaläolithische Artefakte. Das lokale Rohmaterial wurde in mittelpaläolithischem Kontext in der nahegelegenen Höhlenfundstelle Bockstein verwendet.
Im nördlichen Teil der Schwäbischen Alb hat die Zusammenarbeit mit den Amateurarchäologen des Arbeitskreis Steinzeit Schwäbisch Gmünd zur Identifizierung mehrerer neuer paläolithischer Freilandfundstellen geführt, darunter auch die sogenannten "Schlattäcker" bei Waldstetten. Diese Fundstelle liegt nahe eines Aufschlusses von Keuperhornsteinen. Neben einigen jungpaläolithischen Funden konnten wir ca. 100 mittelpaläolithische Artefakte identifizieren, die zum Großteil aus Keuperhornstein hergestellt wurden. Das Inventar umfasst hauptsächlich Levallois-Artefakte und Schaber, aber auch mehrere Keilmesser und andere bifazielle Artefakte.
Auf der Blaubeurer Alb, die insbesondere für die zahlreichen Stellen neolithischen Hornsteinabbaus bekannt ist, haben eine Neuuntersuchung mehrerer Privatsammlungen und Oberflächenprospektionen mittelpaläolithische Artefakte ans Licht gebracht. Zu den Funden zählen eine Blattspitze, Keilmesser, andere bifazielle Stücke und mehrere Levallois-Artefakte.
Unser Ziel ist es, von isolierten Beobachtungen zu einem dichten Netz von Freilandfundstellen zu gelangen, um die paläolithische Besiedlung der Schwäbischen Alb und deren Umgebung näher zu beleuchten.

INTRODUCTION: HISTORY OF RESEARCH AND PROBLEMATICS

Nearly 150 years of archaeological research in the Swabian Jura has led to important discoveries that have vastly increased our understanding of the technology, art and subsistence in Upper Paleolithic hunter-gatherer societies. However, there has been a tendency among both old and recent investigations to focus on the numerous cave sites in the valleys of the Swabian Jura. Some exceptions, where research on open-air sites was intensified, include a number of late Upper Paleolithic sites in the area around the Randeck Maar. The Middle Paleolithic occupation of caves is documented at several sites in the Ach and Lone valleys, but until recently, apart from Wittlingen, only one Middle Paleolithic open-air site, located in Baden-Württemberg, was known on the plateau of the Swabian Jura.

The oldest record of Neanderthal presence in the Swabian Jura is currently attributed to MIS 5, at Bockstein, Hohlenstein-Stadel and at Vogelherd Cave. At Bockstein, results of pollen analysis and the faunal remains led P. Krönneck (2012) to position the site in a warm phase of the MIS 5–5e, 5c or 5a. The presence of a straight-tusked elephant in the lowest Middle Paleolithic layer of Vogelherd also hints at one of these warmer phases (Niven 2006). However, it is also possible that Bockstein dates to MIS 3. At Hohlenstein-Stadel, a Neanderthal femur (Kunter and Wahl 1992) was recently dated as belonging most likely into the context of MIS 5 (Posth et al. 2017).

We currently face several issues when looking at open-air sites in the Swabian Jura (Fig. 1) that affect both Middle Paleolithic and Upper Paleolithic sites. Besides the threat posed to sites and artifacts by agriculture,

another problem is the unwillingness on the part of some amateur archaeologists to share access to their collections and knowledge. However, the most serious issue is the erosion which the Swabian Jura plateau was, and still is, exposed to; this erosion has hampered the discovery of Paleolithic open-air sites with intact stratigraphic contexts. Instead, at every site discovered to date, we observe palimpsest situations, e.g., at Börslingen, where different techno-complexes from the Pleistocene to the Holocene were either mixed on the surface or within a single geological layer. At least we know that intact geological layers can be observed in Wippingen-Sonderbuch (Eitelmann 2009).

These problems are not to be underestimated, but some precautions and measures can be taken during fieldwork and the study of artifact assemblages in order to minimize or avoid their impact.

First, through the extensive study of the geology of the Swabian Jura plateau, we can attempt to identify natural sediment traps, such as sinkholes or dolinas, located near sites. This could allow us to obtain stratigraphic information, or even new archaeological finds and features, as for example in Wippingen-Sonderbuch. These karstic phenomena may have been focal points for Paleolithic people either as sources of water (see below) or as shelters from the weather.

Second, in order to minimize the effect of palimpsest situations and the mixing together of techno-complexes, we must define and apply strict litho-technological markers so as to avoid incorrect classification of artifacts. This is especially true for the separation of Upper Paleolithic, Mesolithic and Neolithic artifacts.

Third, in order to increase our base data, we must continue our search for new sites through systematic surveys, not only in the Swabian Jura, but also in their northern and southern foothills and in adjacent areas.

Fourth, we will have to extend our contacts and increase cooperation with private collectors in our study area, as well as with museum structures and the heritage protection agency (*Landesamt für Denkmalpflege*). Again, this will allow us to build up our base data.

Fifth, a systematic review of existing literature, particularly of older publications, may allow us to rediscover forgotten sites or to identify new ones.

Börslingen-Eisenberg

The site of Börslingen-Eisenberg was discovered in 2009 by amateur archaeologist Hans-Walter Poenicke during systematic survey activities undertaken following the discovery of the first Aurignacian open-air site in Baden-Wurttemberg, Königsbach-Stein (Floss and Poenicke 2006), some years earlier. The site is situated in a cultivated field on the plateau of the Swabian Jura, only about 1 km north of the Lone Valley (Floss et al. 2012).

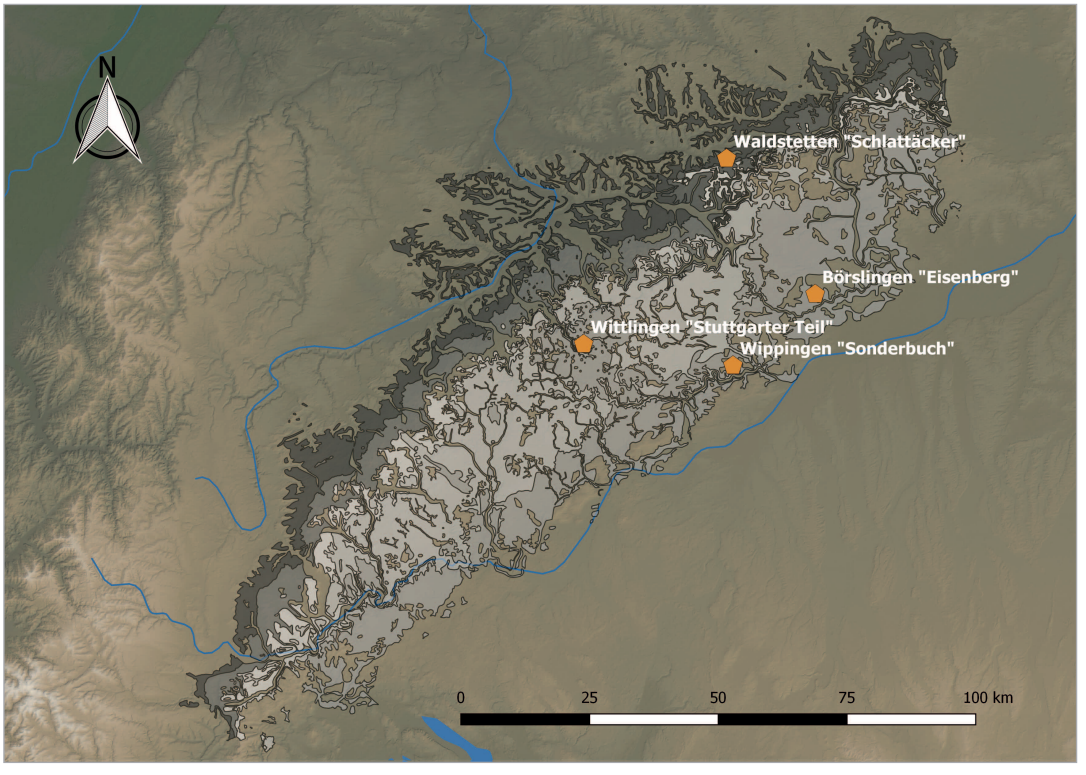

Fig. 1.
Mapping of the working area with four Middle Paleolithic open-air sites. Börslingen, Waldstetten and Wippingen are described in more detail below (basemap: upload.wikimedia.org).

Geology and raw material

The Eisenberg, which in English means "iron mountain" due to the presence of bean ore, is situated in the Upper Jurassic, although parts of the site are covered by quaternary loam or loess-containing fluviatile soils, respectively.

The presence of Jurassic chert (*Jurahornstein*), which weathers out of the Upper Jurassic bedrock, probably explains why the site was attractive to Paleolithic groups. The nodules can be found either loose or still embedded within chunks or blocks of Jurassic limestone. The quality of the material is variable, ranging from a state which is close to siliceous limestone (*Kieselkalk*), up to nodules with excellent properties, and sometimes it appears to be close to chalcedony. The color of the chert ranges from brown to blue, and often there is banding close to the cortex which is ochre in color and chalk-like in appearance.

Due to its distinctiveness, it was possible to prove that Börslingen chert had been transported to at least two cave sites in the nearby Lone Valley, i.e., Bockstein (in a Middle Paleolithic context) and Vogelherd (in an Upper Paleolithic context; J. Chang and M. Siegeris, oral communication). At Bockstein (Çep and Krönneck 2015), the Börslingen chert was mainly used to produce unifacial tools. Thus, a further research goal will

be to examine other assemblages from the Lone Valley, such as those from Hohlenstein-Stadel, Bärenhöhle or Fohlenhaus, for the presence of Börslingen chert.

Surface finds

Between 2009 and 2014, H.-W. Poenicke collected nearly 4500 artifacts from the surface of the site and a single GPS single reading was taken for each object (Floss et al. 2015). This made it possible to compile detailed plots and to carry out density analyses for the surface finds, revealing three find concentrations (Fig. 2) (Floss et al. 2017). Many pieces showed the influence of fire, such as red or greyish discoloration or a crackled surface, but there are no intentionally tempered pieces. The fire-damaged pieces do not show an affinity to any of the three concentrations, but are instead evenly distributed among them (Fig. 2). At this point, we must assume a connection either to Neolithic mining or to more recent clearance activities.

Most of the artifacts collected from the surface are undiagnostic in a chronological sense. Nonetheless, ca. 400 artifacts could be assigned to either the Middle Paleolithic or the Upper Paleolithic, and a few to the Neolithic. As for the finds showing traces of fire, there is no evidence for

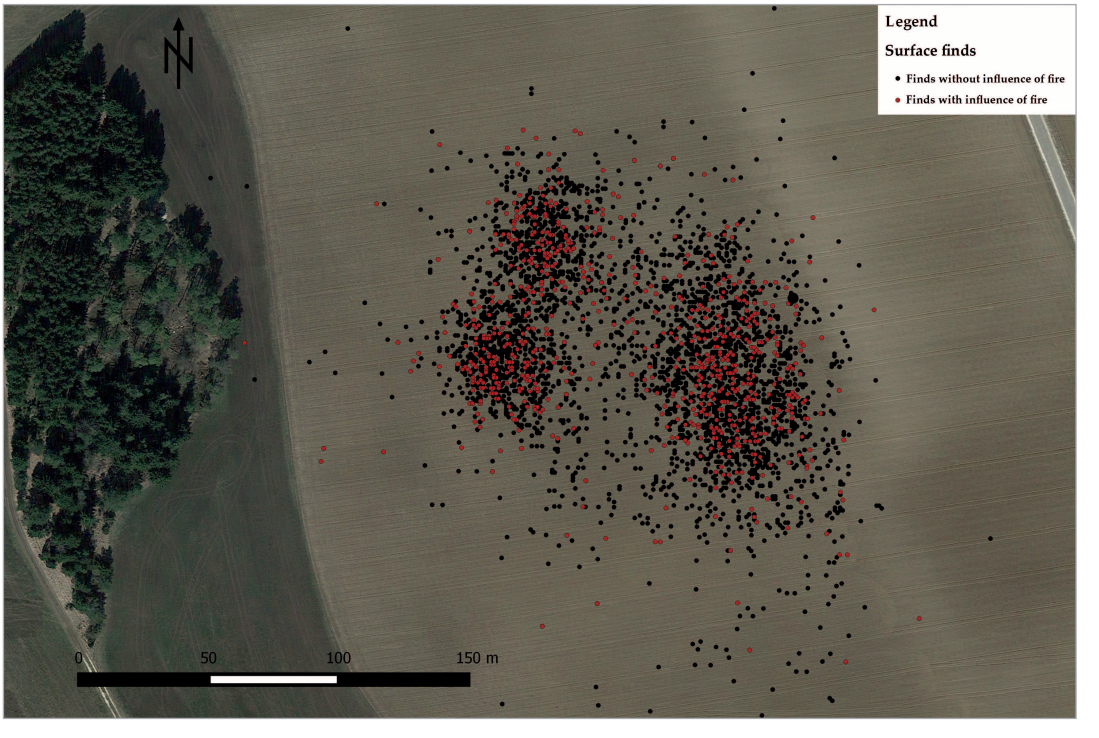

Fig. 2.
Surface concentrations of artifacts at Börslingen-Eisenberg. Red dots indicate artifacts with traces of fire (basemap: GeoBasis-DE/BGK, Google).

affinities of the chronologically assignable artifacts to any one of the main concentrations. Instead, the existence of the three large find concentrations seems to be linked to the micro-local availability of raw material on the site; in these zones the sediment cover is, or was, shallower and thus, by extension, the bedrock of the Upper Jurassic containing the chert is closer to the surface.

Excavations

Excavations in Börslingen took place over four short field seasons between 2011 and 2014. Over the four seasons, 10 m^2 were excavated and over 4700 lithic objects were recovered. Most of the pieces are frost debris, and the few recovered blanks and cores are chronologically undiagnostic. Several archaeological features were also observed and recorded (Fig. 3). A hearth in the south-western area (Sq. 508/511) had a diameter of c. 30 cm and consisted of erect limestones which displayed traces of fire on their inner faces. Within this structure numerous charcoal fragments were observed and several larger pieces were recovered for absolute dating. The results of C^{14}-dating, performed at the ETH Zurich, place the hearth in a Neolithic context (Table 1)

Directly north of the hearth, two pit features were observed. They are probably related to the direct extraction of the Jurassic chert from the decomposing bedrock. In the eastern part of the excavated area (rows 510, 511, 512), many darkly discolored limestones were found in combi-

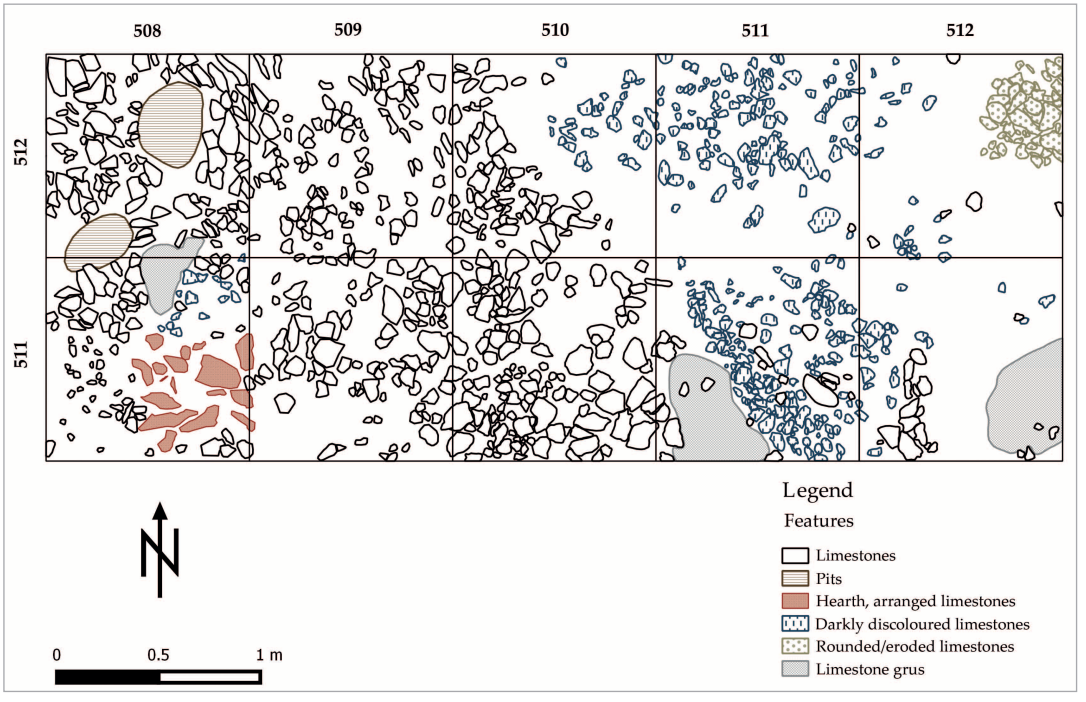

Fig. 3.
Features of the excavated area at Börslingen-Eisenberg.

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

Table 1.
^{14}C-Dates of the hearth at Börslingen-Eisenberg.

nation with c. 1500 tiny charcoal fragments (< 5 mm). This deposit may reflect either dumping or erosional processes linked to the presence of a hearth, or, as with the surface finds, may result from mining activities.

The Middle Paleolithic Assemblage

The Middle Paleolithic assemblage from Börslingen consists of 269 artifacts (Table 2). All of these pieces are made from the local chert, except for one scraper, which is made from a particular chert variant found near Bockstein (Çep et al. 2011).

In general, cores—Levallois cores and Kombewa cores—account for more than half of the assemblage, while tools are much less common. The assemblage is also dominated by artifacts that indicate a Levallois technique (Fig. 4). Nonetheless, various tool types, such as *Keilmesser*, leaf points and sidescrapers, are present on the site (Fig. 5).

Concerning the Levallois cores from Börslingen, we observe a selection of raw material units with certain shapes and sizes that is directly linked to the quality of the nodules. The larger nodules of Börslingen chert tend to be of lesser quality than smaller nodules. Although there are large nodules available on site, smaller convex nodules were specifically selected for implementing the Levallois technique: Levallois cores are quite small, with an average length of 45.9 mm, width of 39.7 mm and thickness of 21.2 mm. In addition, one of the most striking features of the Börslingen Levallois cores is the reduced level of preparation of their lower surface: more than half of the cores (n = 72) show a cortex coverage of ≥ 50% on

Table 2.
Middle Paleolithic artifact assemblage from Börslingen-Eisenberg.

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

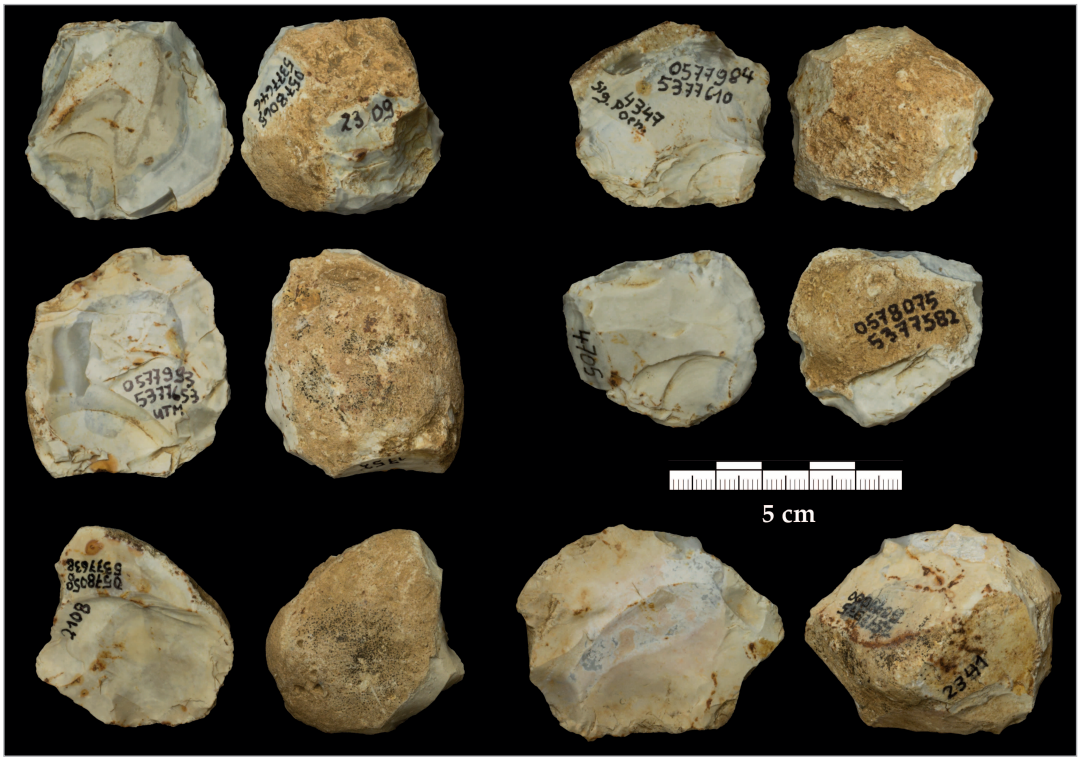

Fig. 4.
Börslingen-Eisenberg: Levallois cores made on the local Jurassic chert (photo: S. Fröhle).

their lower sides. Again, the natural convexity of the nodules selected was exploited to reduce the necessary preparation. Most of the cores were reduced using the preferential or centripetal method, but other methods are also represented (Table 3). Currently, there is no evidence for the production of Levallois points.

Another peculiar technique we assigned to the Middle Paleolithic assemblage—as this concept is currently not known from an Upper Paleolithic or Mesolithic context, and Neolithic artifacts from Börslingen are very rare—is the Kombewa technique. This flaking approach was first described by W. E. Owen (1938) in Africa and named after the locality where he first collected cores of this type. This is a secondary flaking technique and is carried out on (large) flakes, where the ventral face was used

single flaking	recurrent flaking			
preferential	*unipolar-parallel*	*bipolar-parallel*	*orthogonal*	*centripetal*
45	22	9	12	41
n = 45	n = 84			
n_{total} = 129				

Table 3.
Flaking methods observed on the undamaged Börslingen Levallois cores.

Fig. 5.
Börslingen-Eisenberg: Bifacial tools, *Keilmesser* and a scraper made on exogenous material (photo: S. Fröhle).

as a flaking surface. In Börslingen, 36 Kombewa cores and 1 Kombewa flake were found. As regards their dimensions, Kombewa cores are strikingly close to the Levallois cores, with an average length of 42.2 mm, width of 39.1 mm and thickness of 15.6 mm. Furthermore, there are technological similarities involving the flaking methods used in their manufacture (Table 4).

As is apparent from Table 2, tools are quite rare in the assemblage: in total there are only 10 sidescrapers, 9 *Keilmesser* and 1 leaf point. For the most part, scrapers are made on flakes, but several pieces were manufactured from frost debris, and often the retouch seems to be quite basic and rather opportunistic. In addition, several bifacially worked pieces are

		ventral flaking region				Number of cores (n)
		proximal (Janus method)	*distal*	*lateral left*	*lateral right*	
flaking method	*preferential*	4	6	5	7	22
	unipolar-parallel	-	4	5	3	12
	bipolar-parallel	-		1		1
	centripetal	-	-	-	-	-
	orthogonal	1				1
						n_{total} = 36

Table 4.
Comparison of ventral flaking regions and methods on Kombewa cores from Börslingen-Eisenberg.

present, but they cannot be formally assigned to a specific typological category as they appear to be semi-finished products.

In summary, it seems that the Börslingen Middle Paleolithic assemblage most likely reflects singular but extensive raw material procurement and blank production rather than domestic or hunting activities.

Waldstetten-Schlattäcker

The site of Waldstetten-Schlattäcker is situated on the northern edge of the Swabian Jura, near Schwäbisch Gmünd. A few kilometers to the north, the Rems Valley forms several hills where Middle Paleolithic artifacts have been found, e.g., in the area known as "Kleinheppacher Kopf" surrounding the Belzberg near Stuttgart (Freising 1954). The site of Waldstetten was discovered in the late 1980s by Adolf Regen, and although only a few artifacts have been published (Kind 2012), around 3000 lithic objects have been recovered so far through surface collection. In this case, there is no GPS data available, but the provenance of most objects is recorded by cadastral unit. As in Börslingen, the artifacts are attributed to several techno-complexes dating from the Middle Paleolithic to the Neolithic.

Geology and Raw Material

Geologically, the Schlatt is situated in the Lower Jurassic (Lias alpha) which forms a spur that provides a wide view as far as the foothills of the Swabian Jura and the Rems Valley. This spur was created by two small streams; the Waldstetten Creek to the west and the Bettringen Creek to the east. The valley of the Waldstetten Creek is also a source of Triassic chert and constitutes one of the reasons why Paleolithic people visited the area. In addition, it constitutes an easy ascent to the plateau of the Swabian Jura.

The Schlatt is not the only known site in the local area; just a few hundred meters to the west and the south, surrounding the small valley of the

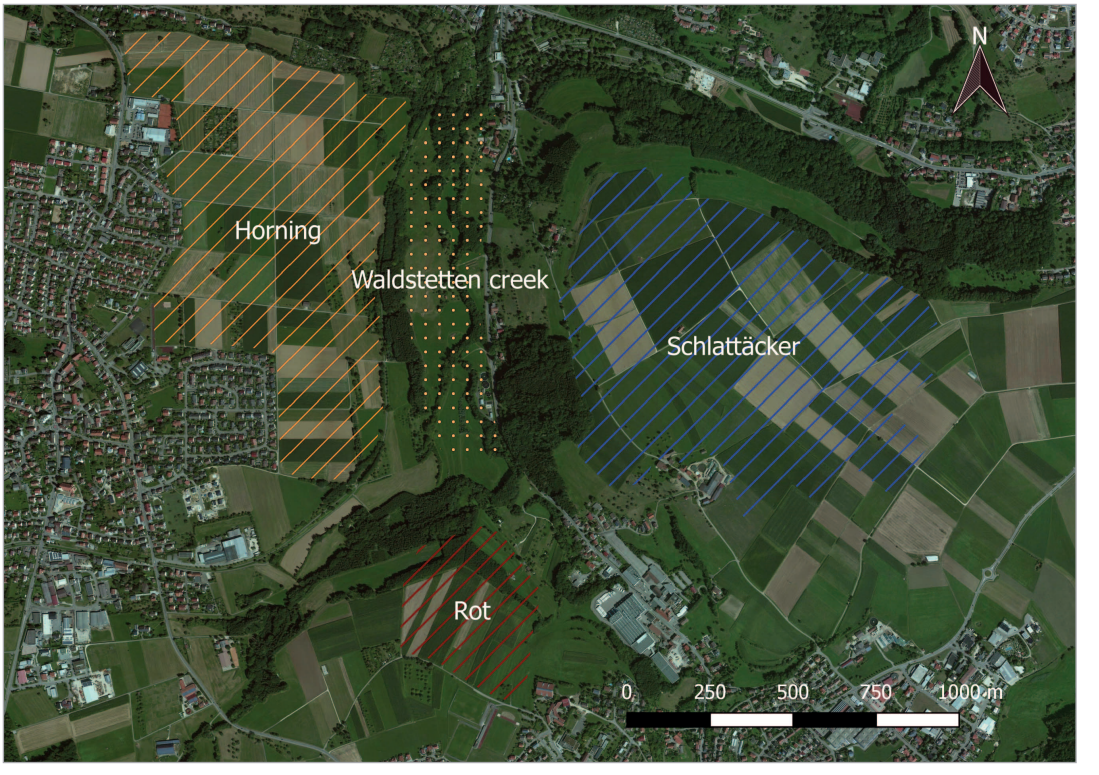

Fig. 6.
Overview over Waldstetten-Schlattäcker and the local find zones (basemap: GeoBasis-DE/BGK, Google).

Waldstetten Creek, are the sites of Horning and Rot (Fig. 6). According to A. Regen, there are additional Middle Paleolithic finds from Rot, along with c. 200 artifacts that probably belong to an Upper Paleolithic context.

The Middle Paleolithic Assemblage

So far, we have examined c. 1000 of the estimated 3000 pieces collected from the surface at Waldstetten-Schlatt, and the Middle Paleolithic assemblage from the site already consists of more than 100 artifacts (Table 5). Most of these finds come from the tip of the spur, although there are a few smaller concentrations of artifacts in the wider area (Fig. 7).

The assemblage is mainly composed of scrapers (38 pieces), which constitute the most common artifact and tool category, followed by 11 *Keilmesser* (Figs. 8, 9). Several reduction concepts are evident, such as Levallois, Kombewa and, in one case, the discoid concept.

Interestingly, although there is an abundant source of Triassic chert close to the site, there is a notable percentage of exogenous raw materials such as Jurassic chert or Radiolarite. In total, we have identified 24 Middle Paleolithic artifacts made from non-local raw material, representing 23.3% of the assemblage: 20 pieces are made of Jurassic chert, two pieces

Artifact type	n
Levallois cores	15
Discoid cores	1
Levallois flakes	24
Levallois points	1
Keilmesser	11
Handaxes	1
Other bifacial artifacts	5
Kombewa cores	5
Kombewa flakes	1
Sidescrapers	38
Backed knives	1
Total	**103**

Table 5.
Middle Paleolithic assemblage from Waldstetten-Schlatt.

of Bohnerz chert, one piece of Chalcedony and one piece of Radiolarite. This could reflect a direct choice of better quality raw material to produce technologically more sophisticated artifacts, which seems to be especially true for bifacial pieces, where 5 of 14 artifacts (including *Keilmesser*) are made of Jurassic chert and 1 is of Radiolarite.

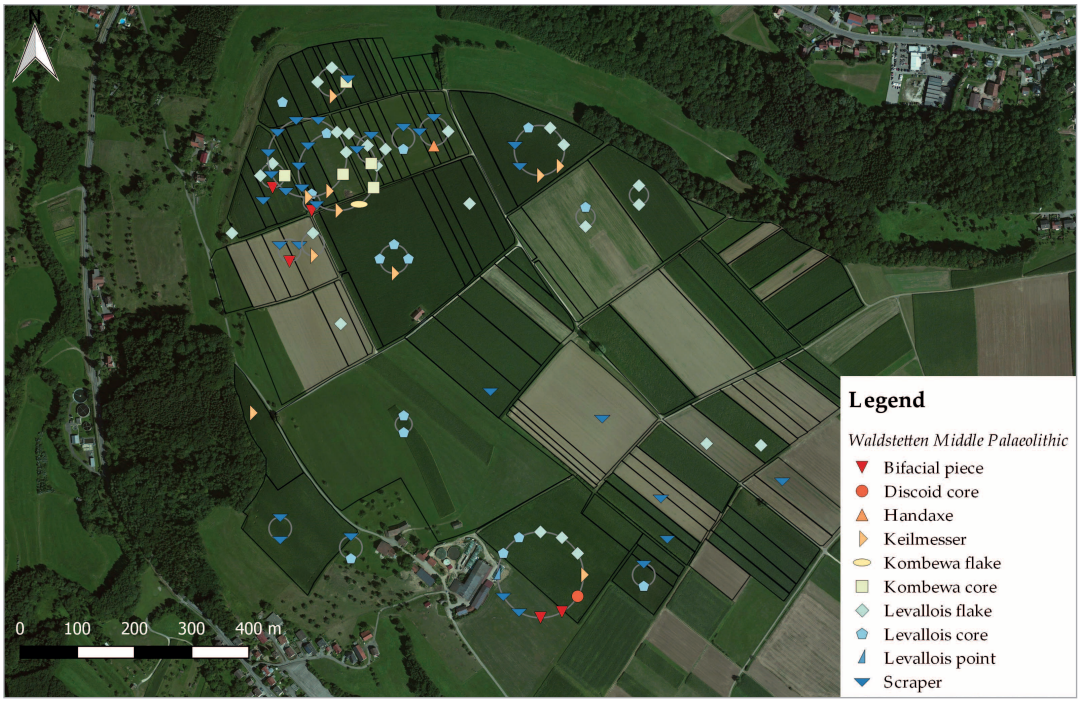

Fig. 7.
Artifact concentrations and tool types (basemap: GeoBasis-DE/BGK, Google).

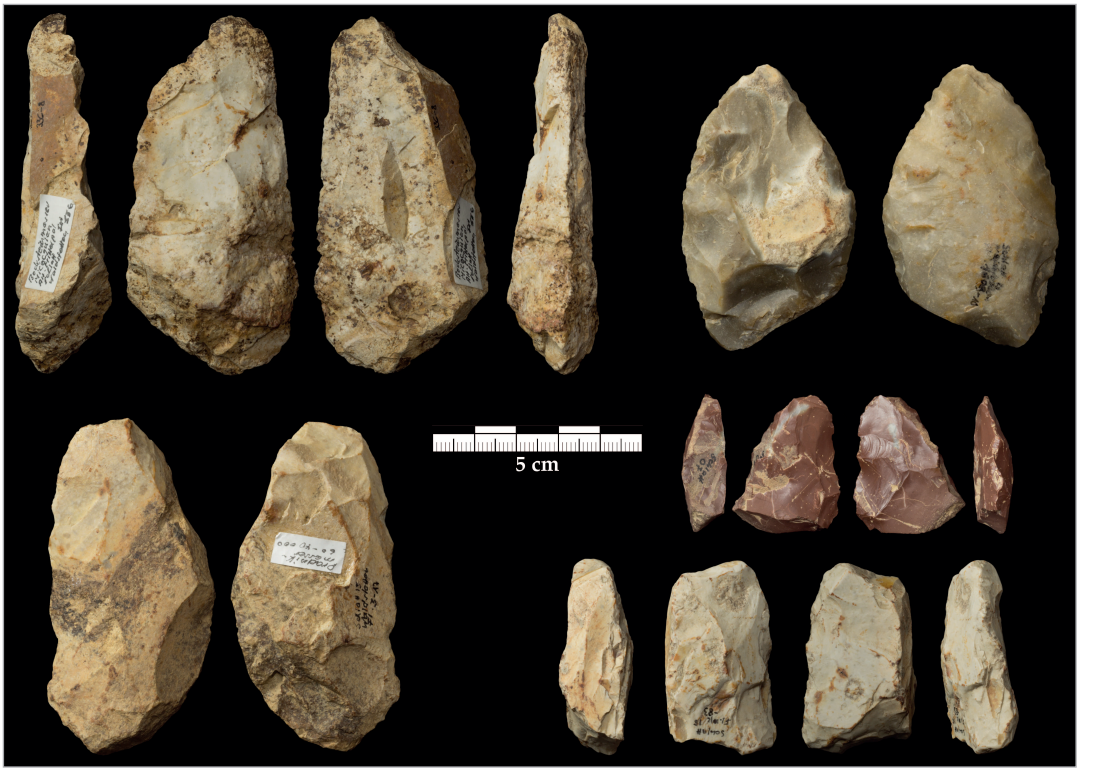

Fig. 8.
Waldstetten-Schlattäcker: Bifacial tools and *Keilmesser*.

Although the site is situated in the immediate vicinity of an outcrop of Triassic chert, it seems likely that, unlike Börslingen, the purpose of the site was not primarily the procurement of lithic raw material. We observe a considerable amount of imported raw material on the site and within the Middle Paleolithic assemblage. Also, we observe a high number of tools, namely scrapers, but also *Keilmesser*. Here we can assume several short stopovers or one prolonged stay, during which domestic activities were carried out. Additionally, the presence of water sources in the form of two small creeks is an important factor in the frequentation of the site by Middle Paleolithic people.

Wippingen-Sonderbuch

The site of Wippingen-Sonderbuch was discovered by amateur archaeologist Robert Bollow in the 1990s. In addition, Jörg Sauer carried out surface collections in the southern part of the site. The site consists of separate areas which contain different techno-complexes dating from the Pleistocene to the Holocene. In the southwestern part of the site there is a Middle and Upper Paleolithic component, which is reflected in the collection of J. Sauer. In the southern areas, there is a linear pottery settlement. The

Fig. 9.
Waldstetten-Schlattäcker: *Keilmesser* and scraper variants (photo: S. Wettengl and S. Fröhle).

central area of the site contains colluvial sediments containing Pleistocene and Holocene finds. In the northern part, there is another Neolithic settlement of unknown date. In the region surrounding Wippingen-Sonderbuch, there are numerous Middle and Late Neolithic sites, mostly related to rich sources of Jurassic chert.

Geology and raw material

Wippingen-Sonderbuch is situated in the southern part of the Swabian Jura. The site is located within an uvala (several dolines or Karstwanne). This uvala features a complex geological structure with colluvial sediments. These sediments contain Paleolithic artifacts which can be found on the surface at the edges of the uvala. We assume that intact Paleolithic layers survive under the colluvial layers. This assumption is supported by geological research that suggests a minimal thickness of sediments of 1.15 m (Eitelmann 2009). However, the sediment cover could be even thicker. Furthermore, the remains of loess cover on other sites in the region could also indicate the likely presence of loess at Wippingen-Sonderbuch (L. Fisher, personal communication). Thus, the preservation of Paleolithic layers might be favored by the particular geological context of the uvala (see below). The site is surrounded by outcrops of good quality raw material (Fisher et al. 2008a, 2008b; Bertsch 2013; Floss and Schürch 2015).

The Middle Paleolithic Assemblage

Thus far, there is no clear spatial concentration of Middle Paleolithic artifacts on the site. We suppose that the Middle Paleolithic artifacts mainly stem from the erosional zones of the uvala (Fig. 10). Most of the artifacts are scrapers and are made of local Jurassic chert and raw materials such as Radiolarite and Microquarzite from nearby Danube gravels (Fig. 11, Table 6). The Levallois technique is represented by 6 small cores. Technologically and typologically they are common for the Middle Paleolithic in the Ach Valley. They can be found in Geissenklösterle and Sirgenstein. There is one leaf-shaped point and one Mousterian point. In addition, there are three bifacially-shaped tools. It must be pointed out that the Middle Paleolithic artifacts represent a very small part of the whole assemblage. This means the majority of the preparation flakes and unmodified flakes are yet to be identified.

Excursus: Water supply in the Swabian Jura

Today the water supply on the Swabian Jura Plain is assured by modern engineering. In the past, however, access to fresh water was difficult. The Karst system of the Swabian Jura means that water flowing out of the valleys onto the plateau and the foothills drains away beneath the surface. This leads to the existence of several springs in these valleys. However, there is no source of fresh water on the plain itself. In Medieval times communities solved this problem by sealing certain Dolines (Schreg 2009: 32). The water in these so-called "*Hülen*" was of poor quality. Today there are still some small villages with a *Hüle* at their center.

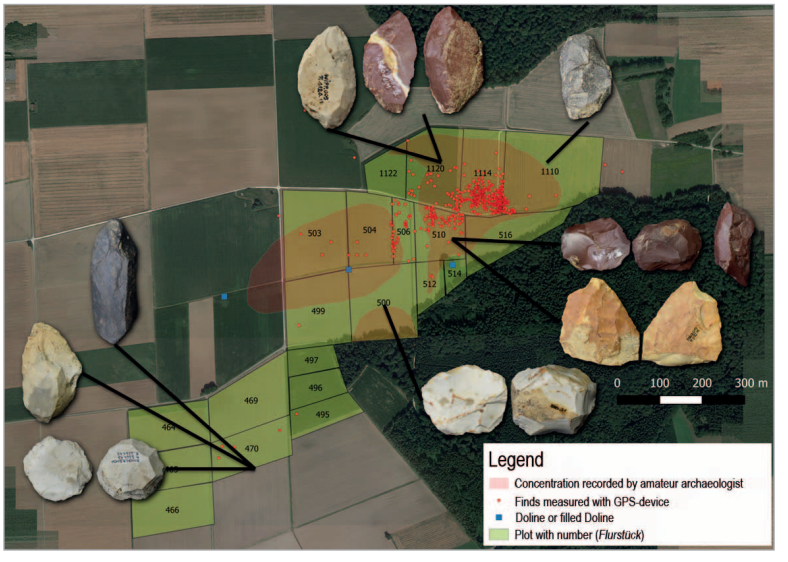

Fig. 10.
Surface concentration of artifacts at Wippingen-Sonderbuch with several Middle Paleolithic tools (basemap: GeoBasis-DE/BGK, Google).

During the Pleistocene there were different geological conditions governing the water supply. The tundra and permafrost soils changed the way the water drained from the plateau. It has been demonstrated that permafrost soils existed in southern Germany during the LGM (Vandenberghe et al. 2014; Andrieux et al. 2015; Van Vliet-Lonoë et al. 2001). These permafrost soils led to the sealing of the subterranean drainage system (Woo 1983). The water now had to find another way to drain off the

Artifact type	n
Sidescraper	13
Bifacial tools	3
Levallois core	6
Levallois flakes	6
Levallois point	1
Pseudo Levallois point	2
Discoid core	1
Leaf-shaped point	1
Total	**33**

Table 6.
Middle Paleolithic assemblage from Wippingen-Sonderbuch.

Fig. 11.
Wippingen-Sonderbuch: Sidescrapers (photo: B. Schürch).

plateau of the Swabian Jura. The route the water took was predetermined by the structure of the valleys, which formed the channels of the drainage system through the formation process of the dry valleys. These are the remains of an older subterranean drainage system that collapsed after a long period of undercutting (Binder 1993). When the snow on the plain begins to melt or rainfall begins, the draining of the water begins. At the beginning of this process flood-like conditions can occur and the water masses can carry large amounts of mud with them (Woo 1983). The last time this process was observed was in February 1955 (Binder 1993). After the dry valleys are washed out by this process, the remaining drainage can resemble a regular creek. These drainage channels were probably present in wider areas of the Swabian Jura whilst holding water and possibly constituted focal points for Paleolithic people. This is an important aspect because in its current state the plain of the Swabian Jura lacks accessible fresh water. Some of the processes mentioned were observed and recorded in the 1950s after very cold winters (Binder 1993). When the winter ends and the ice begins to melt, white waters can be observed in the dry valleys of the Swabian Jura.

These processes not only affect the drainage system but also the sediments. Sediments that are situated on slopes are influenced by solifluction, also referred to as periglacial downhill movement (Embleton et al. 1975: 125).

The periglacial downhill movement on the slopes, and other processes linked to agricultural practices, led to the accumulation of colluvial sediments at the foot of the slopes. This process can be observed at several sites in southern Germany, e.g., Wippingen-Sonderbuch (Eitelmann 2009), Bretten-Bauerbach (Kadereit et al. 2010) and Datthausen (Sauer et al. 2016). Therefore, depressions like *Karstwannen* or uvalas are suitable for finding intact paleosoils under the colluvium formed by these processes.

Loess sediments are only preserved as remnants on the plain of the Swabian Jura. However, sites such as Wippingen-Sonderbuch not only offer an opportunity to understand the wider geological setting, but also offer the possibility of finding intact Paleolithic layers with artifacts. Large karst depressions or uvalas provide a minimum depth of over 20 m, e.g., the "Battenau" karst depression near Geislingen (Bayer et al. 1993).

SUMMARY

In contrast to the numerous known cave sites, the Middle Paleolithic open-air occupation of the Swabian Jura is still difficult to grasp at this point in archaeological research. In recent years, we have identified several new sites, adding to only one previously known Middle Paleolithic open-air site on the plateau near Wittlingen (Burkert et al. 1992). Despite the low number of sites, we have been able to infer at least some basic information regarding Neanderthal preferences and necessities regarding the choice of locations for open-air settlement. There seem to be two important factors:

raw material availability and access to water. The first point is apparent by the fact that all three sites presented here, and even Wittlingen, are located directly on top of, or in the immediate vicinity of, outcrops of Jurassic chert (Börslingen, Wippingen and Wittlingen) or Keuper chert (Waldstetten). Water supply also played an important role: at Waldstetten, there are two creeks surrounding the spur on which the site is located and at Wippingen, dolines may have functioned as water basins. At Börslingen, the Lone River is situated ca. 1 km to the south of the site, and at Wittlingen, there are some springs and small creeks in the vicinity. Regarding site function, we can only assume different activities on site, based on the topographic setting and the lithic assemblage of each site. In addition, we should bear in mind that each site is directly associated with raw material outcrops that were used in different techno-complexes of the Pleistocene and the Holocene. Thus, we must assume that we are currently seeing only a part of the original assemblage and that there is probably a considerable quantity of hitherto undiscovered Middle Paleolithic artifacts. We are confident that future investigations and detailed technological analyses can resolve this bias.

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