MATERIALS

The research within this PhD project is built on the study of the lithic assemblages from three Late Middle Palaeolithic sites, namely the Upper site of Buhlen, Balver Höhle, both in Germany, and the Belgian site of Ramioul (**fig. 12**). The data will be obtained from selected samples of the associated lithic assemblages. The selection of asymmetric tools – more precisely *Keilmesser* and *Prądnik scrapers* – and *Prądnik spalls* as candidates for specific artefact categories and elements from the reduction sequence are a result of the topic itself and the formulated research questions.

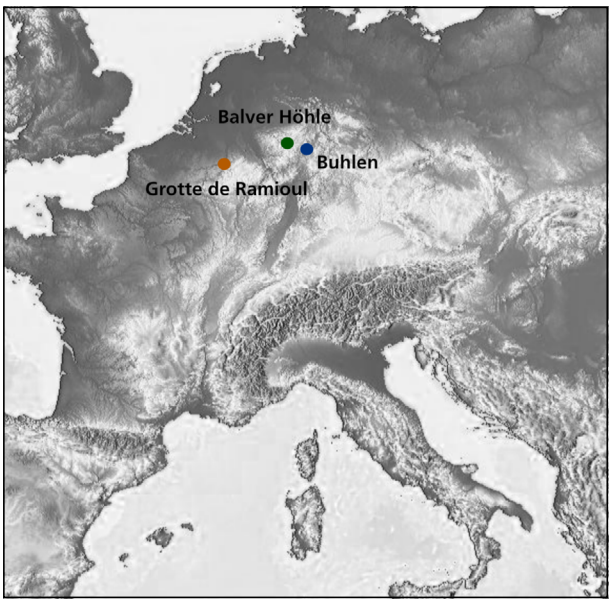

Fig. 12 Location of the three Middle Palaeolithic sites Buhlen (●), Balver Höhle (●) and Ramioul (●).

As explained in the »State-of-the-art«, *Prądnik scrapers* share certain technological and typological similarities with *Keilmesser* (Jöris 2001; 2004; **fig. 13**). The main discriminating feature is thereby the application of the *Prądnik method*, which also differentiates these *Prądnik scrapers* from other scrapers. The typological categorisation is based on an attribute analysis, explained hereafter.

Keilmesser are usually made from cores, rarely from flakes. They display in general a bifacially worked active edge. The retouch is applied sequentially, surface after surface (alternating unifacial edge regularization; see Bosinski 1967). The opposing back is natural (often with the presence of cortex) or roughly worked and builds mostly the thickest part of the tool. *Keilmesser* are in their morphology clearly asymmetric with a wedge-shaped cross section. Their lower surface is commonly flatter compared to the more strongly curved upper surface. *Keilmesser* are usually characterised by sequences of flat, standardised surface retouch, leading to the aforementioned typical shape. The complex pattern of scars on the surface often indicates numerous stages and phases of resharpening or modification. The application of the *Prądnik method* appears frequently not as a single event, judged by the overlying negatives of the removed *Prądnik spalls*.

Fig. 13 *Keilmesser* from Buhlen (ID BU-172) and *Prądnik scraper* from Balver Höhle (ID MU-290) in comparison. – (Photo Buhlen João Marreiros, RGZM). – Scale 2:3.

site		raw material			
		silicified schist	flint	other	total
Buhlen	n	195	2	1	**198**
	%	98.5	1.0	0.5	100.0
Balve	n	337	10	0	**347**
	%	97.1	2.9	0.0	100.0
Ramioul	n	2	18	0	**20**
	%	10.0	90.0	0.0	100.0
total	n	**534**	**30**	**1**	**565**
	%	94.5	5.3	0.2	100.0

Table 2 Distribution of the raw materials used for the production of the studied artefacts from Buhlen, Balver Höhle and Ramioul. For Buhlen, other refers to carnelian.

Prądnik scrapers, on the contrary, are commonly made from flakes, not from cores. They display one unifacial or semi-bifacial retouched active edge. The back, opposed to the active edge, is either natural or modified with a clear, intentional blunting. Thus, also *Prądnik scrapers* show a distinct asymmetry. Usually, retouch extension over the surface is far scarcer, which leads to a less obvious surface curvature. *Prądnik scrapers* are characterised by at least one negative scar, resulting from the application of the *Prądnik method*. Although *Keilmesser* and *Prądnik scrapers* share morphological attributes, *Prądnik scrapers* appear technologically less complex.

Sometimes, a distinction between the two artefact categories is not clear cut. However, based on these attributes, the artefacts can be analysed and categorised as either *Keilmesser* or *Prądnik scrapers.*

In general, all available artefacts belonging to one of these three categories – *Keilmesser*, *Prądnik scrapers* and *Prądnik spalls* – have been chosen for the study. The *Prądnik spalls* from the site Buhlen form a sole exception. In this case, only some representative pieces have been sampled out. Additionally, a small number of scrapers and flakes are part of the study. Within the analysis they form an outgroup. With the outgroup the possibility will be given to put the results of the other studied artefact categories in relation.

Brief information about the sites, their research history and the number of selected artefacts from the lithic assemblages will follow in this chapter. An extended version and a detailed description can be found in earlier published literature concerning the sites Buhlen (Bosinski 1969; Bosinski/Kulick 1973; Jöris 2001), Balver Höhle (Günther 1964; Kindler 2012) and Ramioul (Vandebosch 1921).

SELECTION OF THE SITES

Although the three sites, Buhlen, Balver Höhle and Ramioul are not dated radiometrically and not all finds are stratified, the classification of the material as Late Middle Palaeolithic assemblages is unquestioned. In fact, according to the research question, a refined chronological dating is not of major relevance for this study. Buhlen represents one of the richest *Keilmesser* assemblages and especially the huge quantity of lateral sharpening spalls is unique. In fact, the inventories of the Balver Höhle can be described as forming one of the largest *Keilmesser* assemblages in central Europe and are therefore especially suitable for the analysis of the artefact category itself, the main goal of the presented project. The assemblages from Buhlen and

Fig. 14 The site Buhlen seen from the East. The loess quarry is visible between the trees on the right of the picture. – (Photo Gerhard Bosinski).

Balver Höhle thus allow an in-depth study of the selected artefact categories concerning metric as well as qualitative aspects. Based on the numerous samples a statistic evaluation of the analysis is possible. Ramioul displays, in contrast to Buhlen and Balver Höhle, a small *Keilmesser* assemblage only. The reason to include the site is based on the technology concerning the tool manufacturing. All three sites attest similar technological sequences including the application of the *Prądnik method*. From a technological point of view, the sites are much alike and display a high inter-comparability. Additionally, the artefacts are so similar that an analogous function can be assumed. Also important to mention is that the raw materials used to produce the tools is the same in the three sites, silicified schist and flint (**tab. 2**). Buhlen, Balver Höhle and Ramioul are perfectly suitable for an inter-site comparison.

BUHLEN

Site location and excavations

The archaeological site of Buhlen is located in northern Hesse, Germany, roughly 200 m north-northeast of the village Buhlen in the district Waldeck-Fankenberg/ Nordhessen. The site consists of two units – the Lower Site of Buhlen at the banks of the Netze river and the Buhlen Upper Site, a small collapsed rock-shelter (Bosinski 1969; Bosinski/Kulick 1973; Jöris 2001; **fig. 14**). In this PhD project, only the material from the Upper site is addressed.

Buhlen has been known as a paleontological site in a loess quarry since 1840. At the beginning of the 1960s, a small Dolomitic limestone ridge was partly removed by road construction, during which Pleistocene animal bones became exposed. In the context of geological mapping work, two geologists, M. Horn and J. Kulick revisited the outcrop in 1963. Within the Upper Pleistocene loess sequence of the site, they found animal bones and the first lithic artefacts. As a consequence, Kulick started the first test trenches. After contacting Gerhard Bosinski at Cologne University, the site was excavated in 1966 to 1967 and in 1969, starting with the Lower Site and finally uncovering the Upper Site with the collapsed rock-shelter and its small terrace. Excavation standards also included wet-screening of the entire sediment. Thus, a high amount of artefacts belonging to smallest fraction is part of the excavated material. In cooperation with the Hessische

artefacts	n
Keilmesser	115
Keilmesser tip	15
Prądnik scraper	24
Prądnik spall	42
scraper	2
total	198

Table 3 Categories of the selected and studied artefacts from Buhlen.

layer	artefacts [n]					
	Keilmesser	*Keilmesser* tip	*Prądnik scraper*	*Prądnik spall*	scraper	total
I	3	2	2	1	1	**9**
II	15	0	2	2	0	**19**
II b	2	0	0	1	0	**3**
III a	3	0	0	3	0	**6**
III b	77	9	17	26	1	**130**
III c	6	3	2	5	0	**16**
III d	1	0	1	1	0	**3**
unknown	8	1	0	3	0	**12**
total	**115**	**15**	**24**	**42**	**2**	**198**

Table 4 Stratigraphic attribution of the artefacts from Buhlen. A small amount of n = 13 artefacts could not be ascribed to a layer.

Landesamt für Bodenforschung in Wiesbaden and the Institute for Palaeontology at the University of Mainz, Bosinski's excavation covered almost the entire spatial extent of the Upper Site (Bosinski/Kulick 1973; Jöris 2001). In total, the site yielded over a surface of less than 80 m² an extremely rich assemblage of around 200,000 lithic artefacts and 150,000 animal bones (Jöris 2001). The material is stored and also partly on display in the Hessisches Landesmuseum in Kassel. The majority of the artefacts relevant for this PhD project derive from one find complex: Bu-III. Based on sedimentological and biostratigraphical arguments, this find complex most likely dates to the transition from late OIS 5 into early OIS 4 (Jöris 2001; 2004).

Buhlen lithic assemblage

The lithics selected for this project are almost all associated with the basal find complex of the Upper Site of Buhlen, BU-III (**tabs 3-4**). However, in the periphery of the rock shelter, the material seems to have been mixed up with the succeeding complex, BU-II (Jöris 2001). Thus, single artefacts have to be ascribed to BU-II instead of BU-III. In the case of the selected lithics here n = 9 artefacts originate from BU-I, n = 22 artefacts from BU-II, while n = 155 artefacts are associated with BU-III. N = 13 artefacts cannot be ascribed to a specific find complex due to missing labels.

The artefacts from the Upper Site of Buhlen are with a few exceptions made of local silicified schist. On a rare occasion Baltic flint or carnelian have been used as raw material. Although the *Keilmesser* assemblage, as demonstrated by Jöris (2001) is known to be bigger than selected for this project, the accessibility of the material was a limiting factor. The present study refers therefore to n = 130 *Keilmesser* and n = 24 *Prądnik scrapers*. N = 42 *Prądnik spalls* were selected next to n = 2 scrapers as outgroup.

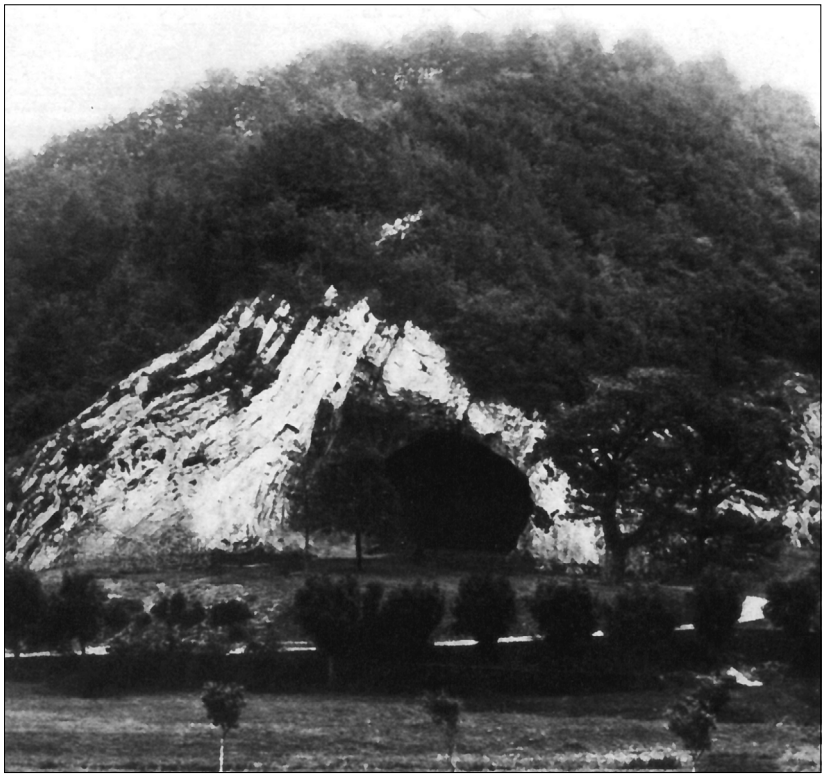

Fig. 15 Balver Höhle in North Rhine-Westphalia, Germany. – (After Günther 1964).

BALVER HÖHLE

Site location and excavations

The Balver Höhle describes a karst cave within the Rhenish Slate Massif in North Rhine-Westphalia, Germany (fig. 15). The cave is situated in the Hönne valley, one of the most important karst areas in the region, north of the city Balve in the district Märkischer Kreis. The Balver Höhle represents the largest archaeological cave in Germany (Andree 1939) and is used nowadays as a cultural venue. The cave system is composed of a main cave of circa 54 m length, the major distributary and two lateral distributaries, each about 20 m long (fig. 16). These latter are named after Heinrich von Dechen and Rudolf Virchow, scientists who were both responsible for early excavations at the site (Günther 1964).

Research history started early in the middle of the nineteenth century with the exploitation of phosphate-rich cave sediments, which were used as a fertilizer for the surrounding fields. The majority of the excavations took place at the end of the nineteenth century and the beginning of the twentieth century (Bahnschulte 1940; Günther 1964). The excavations opened an up to 7 m long stratigraphic sequence, covering large parts of the Upper Pleistocene and Holocene.

With the first reported findings of lithic artefacts in 1843 archaeologists became aware of the site. During the succeeding decades archaeological interest into the cave sequence intensified, resulting in a se-

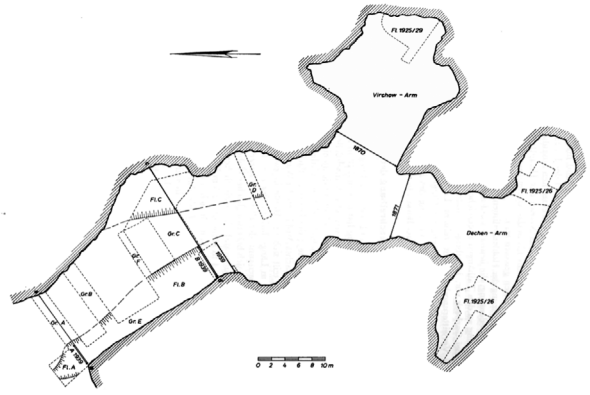

Fig. 16 Cave plan of the Balver Höhle in North Rhine-Westphalia, Germany. – (After Günther 1964).

ries of field campaigns that emptied large parts of the cave's interior and also examined the terrace in front of the cave's entrance (Andree 1928; Bahnschulte 1940; Günther 1988; 1964). Nevertheless, it was not until 1939 that major systematic excavations at different localities near the entrance and within the cave were conducted by Bernhard Bahnschulte (1940). Since the topmost layers, including Upper Palaeolithic sediments, had already been removed during earlier years, Bahnschulte's work concentrated on remnant sediments in lower fissures of the cave floor. Thereby, he excavated thousands of artefacts from a surface of several m² and from almost all sedimentary layers (I-V from bottom to top). The vast majority of these finds as well as the associated fauna are ascribed to the Late Middle Palaeolithic. In 1959, to gain new geoscientific data for an improved understanding of the site's stratigraphy, geochronology and site formation, Klaus Günther added small trenches immediately near to those of Bahnschulte. Most recently, in 2009, Michael Baales aimed at re-opening the site to obtain samples for OSL-dating, but unfortunately did not succeed in finding undisturbed horizons (Baales 2013). Due to the long and intensive research history at the site and later constructions to use the cave as a public cultural venue, no remaining *in situ* deposits could be detected. The majority of the material attributed to the Balver Höhle is today stored in the Amt für Archäologie und Denkmalpflege in Münster, the Landesmuseum für Archäologie in Herne and – until recently – in the Sauerlandmuseum in Arnsberg. The material derives mainly from Bahnschulte's excavations, to lesser degree from other archaeological fieldwork at the site, but also from several private collections. In total, the entire lithic inventory adds up to 40,600 artefacts, although only 9,100 artefacts are stratified and a substantial loss of material over time can be assumed (Günther 1964). This includes for example small chips, which have not been kept in the course of the excavations, except for those from Günther's 1959 sondages. The sediment removal to fertilize the surrounding fields has not spared the artefacts from being removed, either. As a result, artefacts can be found on the surrounding fields, which originate from the cave deposits. As mentioned before, the inventory represents a broad range of different Middle Palaeolithic artefact types, characterised by a particularly high amount of bifacial tools.
In particular, the material from archaeological horizon (AH) II up to AH V has been attributed to the Micoquian (Günther 1964; Bosinski 1967) and later referred to as KMG (Jöris 2004). Based on the results from Olaf Jöris (1992; 2004; 2006) and Lutz Kindler (2007), the sequence of Middle Palaeolithic layers in the Balver Höhle spans from late OIS 5 to early OIS 3 (Jöris 2004; 2006). The settlement in the Balver Höhle is characterised by recurrent Neanderthal presence (Kindler 2012).

Balver Höhle lithic assemblage

The selected assemblage from the Balver Höhle represents artefacts from the entire stratigraphic sequence (tabs 5-6). The stratigraphic correlation of the results from the various excavations is complicated and leads sometimes to an ambiguous attribution of the artefacts (Pastoors/Tafelmaier 2010). In total, the sequence extends from the lowest layer AH I to the uppermost layer with archaeological artefacts, layer AH VI (Günther 1964). For the production of the tools the local silicified schist served as a raw material. Although the entire lithic assemblage from the Balve cave is characterised by the use of this specific raw material, Baltic flint was also used in a few exceptional cases.
The material consists of n = 189 *Keilmesser* and n = 27 *Prądnik scrapers*. The amount of corresponding *Prądnik spalls* is n = 117. Additionally, n = 12 scrapers were selected for an outgroup comparison. From these 347 artefacts, only 94 samples can be attributed to a stratigraphic horizon. The majority originates thereby from layer AH II, followed by layer AH III. Due to missing labels the other three-quarters of the selected assemblages cannot be associated with a specific layer.

Table 5 Categories of the selected and studied artefacts from Balver Höhle.

artefacts	n
Keilmesser	170
Keilmesser tip	21
Prądnik scraper	27
Prądnik spall	117
scraper	12
total	347

layer (AH)	artefacts [n]					
	Keilmesser	*Keilmesser* tip	*Prądnik scraper*	*Prądnik spall*	scraper	total
IV	4	2	2	7	0	**15**
sterile	2	0	0	0	0	**2**
III	10	1	3	4	5	**23**
II + III	2	0	0	14	0	**16**
II	27	5	0	4	0	**36**
I	2	0	0	0	0	**2**
unknown	123	13	22	88	7	**253**
total	**170**	**21**	**27**	**117**	**12**	**347**

Table 6 Stratigraphic attribution of the artefacts from Balver Höhle. Out of the n = 347 studied artefacts, only n = 94 artefacts can be ascribed to one of the archaeological layers (AH = archaeological horizon).

RAMIOUL

Site location and excavations

La Grotte de Ramioul, short Ramioul (sometimes also Ramioulle) belongs to a karstic system on the right riverside of the Meuse, near Liege, in the municipal Flémalle, Belgium (Vandebosch 1921; Ulrix-Closset 1975; **fig. 17**). It is located between two quarries, Abime Martel to the West and Caverne à végétations to the East. The cave is separated in three vertical levels (**fig. 18**): the upper section (»*superieure*«), the mid section (»*moyenne*«) and the lower section (»*inférieur*« or »*réseau actif*«). The levels are connected through a shaft and linked to a main chamber (»*salle*«). Additionally, there is an open air area with a small rock shelter associated with the cave (»*terrasse*«) (Vandebosch 1921; Quinif et al. 2011).
In 1908, a group called »*Les Chercheurs de la Wallonie*« discovered two prehistoric burials (Vandebosch 1921; 1929; Ulrix-Closset 1975). The burials contained bones, but no further artefacts, which would have allowed for a more precise age estimation. By

Fig. 17 Entrance portal of the Grotte de Ramioul, Belgium. – (After Ulrix-Closset 1975).

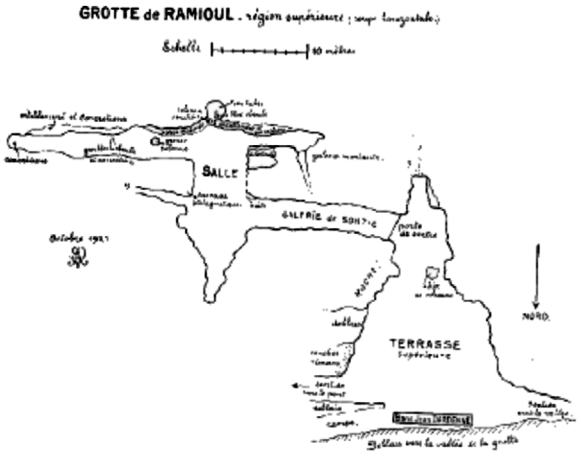

Fig. 18 Cave plan of the Grotte de Ramioul, Belgium. – (After Vandebosch 1921).

continuing the research within the cave, a total of seven child burials have been found. Additionally, lithic tools, ceramics and fauna have been unveiled. Together, these finds could be attributed to the Neolithic. This marks the beginning of the research in Ramioul. Back then, sediment layers reached a depth of 5.5 m. In total five different layers could be distinguished (layer one to five, from top to bottom, whereas layer five is connected to the bedrock). Based on the initial finds, a second excavation was initiated in 1911. During this excavation, Palaeolithic artefacts of undetermined age were found. Among them, numerous lithics (circa 200 pieces) mainly made of flint and glacial fauna. Most of these finds have been found in front of the cave (»terrasse«), rather than inside. However, the excavated layers of the terrace could be correlated with the cave's stratigraphy from the cave. In general, not all finds are stratified, since parts of the layers seemed somewhat disturbed. In the years 1914 and 1915, research has been continued further, unearthing the lowest level (»*inférieur*« or »*réseau actif*«) that contains no archaeological finds (Vandebosch 1921; 1957; Quinif et al. 2011).

Based on the finds and especially the lithic assemblage form the fourth layer, which contains a high percentage of bifaces, Levallois tools, scrapers and leaf-points (or leaf-point-like artefacts), the Ramioul assemblage has been associated with the »Mousterian« (Ulrix-Closset 1975). The entire occupation of the cave starts at the Late Middle Palaeolithic and spans into the Holocene.

Since 1994, the Préhistomuseum (before Préhistosite de Ramioul), is located near *La Grotte de Ramioul.* The finds from Ramioul are stored and partly displayed in the very same museum.

Ramioul assemblage

The material consists of n = 9 *Keilmesser* and n = 3 *Prądnik scrapers* (**tab. 7**). Unfortunately, *Prądnik spalls* could not be sampled, due to the fact, that all artefacts which have not been categorised as tools were stored together with material from a nearby located site. An identification of material clearly belonging to the site Ramioul is therefore impossible. N = 6 scrapers and n = 2 flakes were selected additionally. The stratigraphic or spatial assignment for these 20 samples is undetermined. Unfortunately, the assemblage is poorly published (Ulrix-Closset 1975; cf. Jöris 1992).

Concerning the raw material, the situation in Ramioul is different than in Buhlen or Balver Höhle. The predominantly used raw material is flint. In a few exceptions, silicified schist served as a raw material too.

artefacts	n
Keilmesser	9
Prądnik scraper	3
scraper	6
flake	2
total	20

Table 7 Categories of the selected and studied artefacts from Ramioul. For none of these artefacts a stratigraphic attribution is possible.