ANTHROPOLOGIE • LIII/1–2 • pp. 181–202 • 2015

MICHAEL BRANDL, LUC MOREAU, OLIVER SCHMITSBERGER, CHRISTINE NEUGEBAUER-MARESCH

THE SOUTHERN MORAVIAN CHERTS AT THE AURIGNACIAN SITE OF STRATZING-GALGENBERG, AUSTRIA

ABSTRACT: The scientific investigation of Palaeolithic stone tool assemblages requires close transdisciplinary collaborations involving raw material studies and typological and techno-economic analyses. It has also become clear that such in-depth analyses have to be conducted by trained specialists followed by recombination of the datasets. Our current paper presents successful cooperative efforts in a case study concerning specific raw material types in the lithic assemblage from Stratzing-Galgenberg, one of the most important Aurignacian open-air sites in Central Europe. The structure of our study follows the imperative analytical steps to achieve conclusive results for such an investigation. First, we demonstrate the application of the analytical classification system used for stereomicroscopic single artefact raw material determination. Secondly, we discuss the problematic nature of purely macroscopic raw material investigation for particular raw material types, in this case Southern Moravian chert varieties. Subsequently, the behavioural assessments focus on the results provided by raw material analyses and allow for preliminary reflections concerning resource management strategies of late Aurignacian hunter-gatherer societies in the Middle Danube region.

KEY WORDS: Stratzing-Galgenberg – Raw material studies – Southern Moravian chert – Lithic resource management

INTRODUCTION

The Stratzing-Galgenberg site in Lower Austria represents the most extensive early Upper Palaeolithic (EUP) open air settlement in Austria, and belongs among the most prominent Aurignacian sites in Central Europe (Neugebauer-Maresch 1999). The name of the site derives from the Galgenberg, a hill situated between the villages of Gneixendorf, Krems-Rehberg/Imbach and Stratzing, raising to an elevation of 374 m a.s.l. The topographic character of the Galgenberg is determined by its position between two significant regions, the

Received 24 March 2014; accepted 15 October 2014.

Tullnerfeld in the East and the Wachau in the Southwest. The geological setting reflects its location at the transition from the Molasse Zone to the Bohemian Massif. Tertiary (neogene) gravels which can be considered raw material sources for stone tool production by the local prehistoric occupants occur at the base of the hilltop. These gravels are partly covered by loess deposits reaching a thickness of up to 13 m (Neugebauer-Maresch 2008). The cultural layers cover the eastern part of the ridge and predominantly the northern slope of the Galgenberg. To the east, the view opens into the Danube basin, to the west a ravine leads into the Krems valley. The Palaeolithic site covers an area of c. 350×150 meters.

J. Bayer was the first to report finds from the Galgenberg, and E. Weinfurther published finds from surface collections in 1950, dating them to the Aurignacien period. However, systematic archaeological research was only initiated in 1985, when reports from Palaeolithic finds excavated in the course of construction work reached J. W. Neugebauer. Subsequently, the loess ridge on which the site is located has been explored over 1200 m² between 1985 and 2003, first as a rescue excavation funded by the Cultural Heritage, then in the scope of a long-term multidisciplinary research project (Neugebauer-Maresch 1996, 2008). Altogether, three cultural layers were identified in the excavated area (Neugebauer-Maresch 1993: 10–19, 1995: 14–25, 1996: 67–79). Besides the discovery of Austria's oldest work of art – an anthropomorphic figurine produced from amphibolitic slate – the outstanding character of the site relates to the preservation of the main archaeological horizon (AH 2), which lead to the recovery of several *in situ* features, among which fireplaces, some of which were "constructed", i.e. circumscribed by a ring of stones (Neugebauer-Maresch 1996, 2008).

A consistent series of radiocarbon dates on charcoal were obtained for the main archaeological horizon (AH 2) (Neugebauer-Maresch 1996). Three samples directly taken from hearths in the main area cluster between 31.4 ka and 31.2 ka BP and support the late Aurignacian character of the occupation already indicated by the typological composition of the lithic assemblage (Neugebauer-Maresch 1996, 2008).

This paper examines the Moravian cherts present at the Stratzing-Galgenberg site from the point of view of lithic raw material provenance and transformation. The analysed assemblage derives from the main, mostly *in situ* area of the site with a surface of ca. 500 m^2, which was excavated between 1988 and 1991. In particular, this study investigates silicites (sedimentary SiO_2-raw materials following Přichystal 2010) in the lithic assemblage from Stratzing-Galgenberg presumably originating from the Southern Moravian catchment area. We demonstrate an applicable approach to chert source provenance developed at the Austrian Academy of Sciences by applying a holistic classification system based on multi layered raw material determinations. The method encompasses visual comparison and stereomicroscopy. Such an approach allows for in-depth analysis of specific raw material groups and challenges approaches exclusively conducted using superficial visual raw material identification.

RAW MATERIAL DETERMINATION

Scientific background

The investigation of prehistoric chipped stone tools frequently raises questions concerning non-local ("exotic") raw materials in such assemblages. The presence of material transported over long distances is an important cultural marker associated with prehistoric resource management. The identification of non-local raw materials in chipped stone tool assemblages sheds light on interaction spheres, acquisition strategies and – especially in the case of hunter-gatherer groups – mobility patterns. A crucial and inherent factor for discussions related to socio-economic implications of stone tools made from non-local materials is the accurate determination of the raw materials. Often, the identification and provenance of exotic lithics is based on superficial criteria, predominantly visual (macroscopic) examination. However, archaeologists making such assumptions are typically unaware of the complexities of lithic raw material science.

Until recently, no systematic chert sourcing approach existed in Austrian prehistoric research. Unlike Eastern European countries, e.g. the Czech Republic (e.g. Mateiciucová 2008, Přichystal 2009, 2013), Austria lacks a long tradition in raw material sciences. However, research in Austria is now catching up by combining natural sciences and archaeology in a new transdisciplinary effort for raw material characterization as demonstrated by Brandl *et al.* (2014).

The goals of this contribution are multi-fold:

1. We introduce the method used for raw material determination.
2. The classification system for recording distinctive attributes of lithic artefacts is presented.
3. We demonstrate the method's applicability on material that visually corresponds to "Southern Moravian chert" (SMC).
4. Frequent problems observed in the course of the identification of "Southern Moravian cherts" in lithic

assemblages from Lower Austria will be discussed as a case study.

Methods of raw material determination

The method used for this study is defined as the "Multi Layered Approach" (MLA), combining multiple analytical steps. The MLA as proposed by Brandl *et al.* (2014) consists of a tripartite investigation system comprising visual, microscopic and geochemical analysis. Here, we will focus on macroscopic and microscopic examination; geochemistry was not conducted in the present study.

One great advantage of the MLA is its non-destructive nature, meeting the principle requirements for examining archaeological material. Destructive methods, e.g. thin sections or X-ray Powder Diffraction (XRD), are not regularly used because they are both expensive and not applicable for large assemblages, restricting their suitability only to particular cases.

Visual (macroscopic) investigation

The first and indispensable step in lithic raw material analysis is a precise description of visually characteristic properties. The investigation of these allows for the initial classification of the raw material. Colour, knapping features (quality) and texture (homogeneity) are basic attributes to be investigated. Colour descriptions are based on the Munsell geological rock-colour chart (GSA 2009), and the evaluation of granularity follows *Table 1* (Classification system for lithic raw materials).

The translucidity of raw material samples is described according to a three-grade system:

Translucent: A specimen placed in front of a light source allows light to permeate without major darkening effect.

Semi-translucent: The light passes through the specimen, but is partly blocked by inclusions and/or the rock structure.

Non translucent: Light is not able to pass through the specimen.

Certain type varieties can be defined within archaeological assemblages and in geological deposits. It is well known that every geological source contains several type varieties, and in many cases these varieties display higher variability within the same source than between distant sources. This effect makes a purely macroscopic assignment of archaeological material especially difficult

TABLE 1. Granularity of sediments and rocks. *Adapted from BSI 2009: 7, Tab. 1a.*

ISO 14688-1 according to BSI 2009				Classification system for lithic raw materials
Name		Size range		
Very coarse soil		Large boulder, LBo	>630 mm	n.d.
		Boulder, Bo	>200–630 mm	
		Cobble, Co	>63–200 mm	
Coarse soil	Gravel	Coarse gravel, CGr	>20–63 mm	
		Medium gravel, MGr	>6.3–20 mm	
		Fine gravel, FGr	>2.0–6.3 mm	
	Sand	Coarse sand, CSa	>0.63–2.0 mm	3. coarse grained
		Medium sand, MSa	>0.2–0.63 mm	
		Fine sand, FSa	>0.063–0.2 mm	
Fine soil	Silt	Coarse silt, CSi	>0.02–0.063 mm	2. medium grained
		Medium silt, MSi	>0.0063–0.02 mm	
		Fine silt, FSi	>0.002–0.0063 mm	1. fine grained
	Clay, Cl		≤0.002 mm	

(Bustillo *et al.* 2008: 20–21, Elekes *et al.* 2000: 503, Luedtke 1992: 71–72, Mateiciucová 2008: 44–56). However, natural scientific studies have addressed this issue in order to verify the accuracy of visual assignments (Biró *et al.* 2009: 25, Elekes *et al.* 2000: 504).

Microscopic analysis

The second level of investigation – microscopic analysis – provides detailed information concerning inclusions, particularly fossils, in chert. The goal of these investigations is the classification of characteristic fauna communities in specific sources to help identify or narrow down raw material clusters (e.g. Brooks 1989). For comparison, micropictures are produced using a reflected light stereomicroscope (standardised 20× – 40× – 70× magnification). All pictures are taken from unpolished surfaces from representative specimens of both archaeological artefacts and geological comparative samples.

The classification system

The 2007 classification system

Since 2007, a classification system consisting of three main categories has been used for the determination of lithic raw materials at the Austrian Academy of Sciences (Brandl, Reiter 2008). These categories are as follows:

1. **Raw material** (chert, flint, radiolarite, etc.): Organogenic-sedimentary silicites are classified according to the fossil content, i.e. the dominating "index fossil" as defined by Brandl (2010).
2. A clearly defined **Principle Definition Category (PDC)** is composed of parameters such as colour, granularity, texture, natural surface, fossil inclusions and non-fossil inclusions, with fossil inclusions as the prevailing determinant. In the classification system, the PDC was addressed as **"variant"** (not to be confused with "variety", which indicates distinct modifications of a rock type, e.g. chert as a specific modification of microcrystalline quartz).
3. An optional **Subdefinition Category (SDC)**. If several parameters did not afford a clear assignment to one Principle Definition Category, the SDC allows for a wider range of attribution. The SDC was predominantly designed as an auxiliary means for refitting.

The resulting code consisted of a fore number defining the raw material and a following number indicating the "variant" according to the PDC.

A Northern Alpine radiolarite of high quality, displaying a natural gravel surface and slight burning serves as an example for the coding based on the old classification system (*Table 2*).

TABLE 2. Coding according to the 2007 classification system.

raw material	variant	SDC	fire influence	comment
2	1	-	1	Northern Alpine

Breakdown of the code in *Table 2*:

– **raw material**: 2 = radiolarite;
– **variant (PDC):** 1 = main colour red-green, fine grained and homogeneous, radiolarians as the main traits, barely foreign mineral inclusions visible;
– no **SDC** needed;
– **fire influence:** 1 = slightly burnt, indicated by fine cracks, colour change and a characteristic greasy sheen;

comment: indicates the assumed origin and/or other observations.

The 2013 classification system

In 2013, an advanced classification system was implemented. The new system facilitates a more flexible operability for independent researchers by isolating the determining parameters used to define the PDC. In other words, the determination criteria remained practically the same, however, the individual steps of the "analytical path" towards the former PDC were explicated (see *Table 3*).

This new classification system was specifically designed for an easy, comprehensible and flexible recording of lithic raw materials used for the production of chipped stone tools. It comprises criteria that can be determined independently, without forcing the analyst to make misleading decisions. Even if single criteria have to remain indeterminable, the rest remains unaffected and provides basic information for a final evaluation (e.g. the presence of a natural surface or burning of a specimen).

Breakdown of the parameters in *Table 3*:

Column 1 – Raw material

The raw material determination follows the terminological system proposed by Brandl (2010), which is based on sound geological and mineralogical groundwork. The raw material varieties listed in *Table 3* encompass the most frequently used SiO_2-modifications for chipped stone tools in an archaeological context.

TABLE 3. Coding according to the newly implemented 2013 classification system.

raw material		prov	granularity	natural surface	fire influence	PDC	SDC	comment
0	not determined (n.d.)	0 not determined (n.d.)	0 no granularity	0 not present	0 not present	represents the "variant" from the old system	Sub-definition Category	if a source can be defined more precisely, e.g. Krumlovský Les area for the Southern Moravian cherts
999	un-identifyable	999 un-identifyable	1 fine	999 un-identifyable	1 minor			
1	chert	1 Northern Alpine	2 medium	1 gravel	2 medium			
2	radiolarite	2 Flysch Zone	3 coarse	2 not transported	3 heavy			
3	chalcedony	3 Bohemian Massif		3 erratic	4 uncertain			
4	quartzite	4 catchment area Vienna Basin		4 uncertain which type				
5	silicified limestone							
6	opal							
7	spiculite	10 Southern Moravian						
8	obsidian	20 erratic flint	0 for chalcedony, jasper and quartz					
9	flint							
10	tectite							
11	vein quartz							
12	rock crystal							
13	jasper							
14	spongiolite							
15	lydite							
16	silicified wood							
17	agate							

Column 2 – Prov (provenance)

This determinant indicates the raw material source region of a lithic artefact. The assessment of the raw material provenance is mainly based on the identification of characteristic fossil and non-fossil inclusions. Further parameters are granularity and the natural surface (if present), narrowing down the possible source area.

Determinability decreases with specimens derived from secondary sources (e.g. rivers), since the primary source region of a rock found in river gravels may be located hundreds of kilometres further upstream than the place where it was picked up by prehistoric people for stone tool production. In other words, the place of origin is therefore not necessarily the place of recovery.

Column 3 - Granularity

The granularity is an important indicator for the quality of specific raw materials, since it reflects the knapping properties of a rock and – linked to those properties – choices made by prehistoric people. Granularity is recorded within a three-step model from fine to coarse (compare *Table 1*), a finer resolution of granularity proved to be inapplicable in the course of the classification.

Column 4 – Natural Surface

Remains of the natural surface of a silicite provide information concerning the source of the rock. In the case of organogenic silicites from the chert group, the natural surface can also be referred to as "cortex" indicating the transitional area from chalk or limestone to the silicious rock matrix (Brandl 2010). In the 2013 classification system, the natural surface is determined following four main categories (see *Table 3*).

Raw materials deriving from primary, subprimary and residual geological contexts often allow for an assignment to specific source regions, whereas raw materials from secondary deposits (e.g. rivers) may originate from distant source areas (compare 2. Provenance). However, river gravels were in many cases preferred over rocks from other contexts due to the fact that only the most homogeneous and suitable rocks survived the transport path over long distances, representing a natural pre-selection. Additionally, river gravels could easily be obtained by gathering from gravel terraces.

Column 5 – Fire influence

A four-stage determination is used to indicate the degree of fire influence on stone tools. These stages are defined as follows: ***Not fire influenced:*** No indication of burning. ***Minor:*** Specimens with minor burning predominantly display a colour change and no mechanical destruction of the rock structure. Coarse-grained silicites regularly display a dull surface texture, whereas fine-grained raw materials display a greasy sheen with additional fine cracks. ***Medium:***

Specimens of that category show distinctive cracks (craquelée) that can be substantial, and they display characteristic potlid scars. ***Heavy:*** Heavily burnt silicites display breakage patterns with deep cracks and partly large rock parts missing. In many cases the original rock material is substantially altered and a secure determination is not possible. ***Uncertain:*** Some artefacts show attributes that could derive from (predominantly modest) fire influence; however, this observation cannot be confirmed. Such specimens remain undetermined with the possibility that they were burnt.

Column 6 – PDC (Principle Definition Category)

The 2007 classification system demonstrably produced significant results in terms of refitting. Therefore, the "variant" of the old system remained in the new system. The variant consisted of multiple components defined as Principle Definition Category.

As an intermediary step, the variant was renamed as raw material unit (RMU); however, since this term was used ambiguously in archaeological literature (e.g. Roebroeks 1988: 29) we decided to apply an unmistakable term, i.e. the abbreviation for Principle Definition Category, PDC.

Column 7 – SDC (Subdefinition Category)

Together with the PDC, the optional Subdefinition Category (SDC), also a useful tool for refitting, is retained in the new classification system.

Column 8 – Comment

This field enables the analyst to note characteristics and assessments that one does not want to put into one of the parameter-fields. This may be due to reasons of uncertainty or closer specification, e.g. of an assumed source region not contained in the Prov-field.

Complete and accurate application of the above criteria allows one to draw combinatorial conclusions concerning lithic artefacts. This is of special significance for exploring prehistoric raw material gathering strategies. When determinable, the origin of the raw material of a stone tool is indicated by the **Prov-field**, e.g. Northern Alpine. A more accurate determination of prehistoric raw material procurement can be achieved by incorporating the **natural surface** criterion. Continuing with the example, if a Northern Alpine chert displays a gravel surface the source region can be narrowed down to areas with rivers (or river and/or palaeo-coastal sediments) carrying Northern Alpine rock components. The **granularity** of a silicite allows one to draw inferences concerning raw material selection and can be an important factor for exploring the production of specific artefact types from specific raw materials. This may also be of importance for chronological assessments (e.g. were certain raw materials exclusively/predominantly used during certain time periods?).

Fire influence typically reduces the possibility of raw material and provenance determination. It has been observed that some effects caused by heavy burning resemble massive weathering effects on silicites, if the weathering happens under certain depositional circumstances (burial time and aggressive (alkaline) environment). In such cases, additional information is required to securely determine whether an artefact was subjected to burning or weathering effects.

The identification of burning of stone tools provides information concerning fire events (even in the case of the absence of fire places or hearths), activity zones within an archaeological site and possible waste management strategies. Applying microscopic investigation, assessments regarding intentional heat-treating of raw materials are only possible to a very limited extent. This technique should not heavily impact the rock if it should remain usable for stone tool production. A phenomenon described in previous studies (Brandl *et al.* 2011: 59) and defined as "chert pest" needs to be addressed in the discussion concerning fire influence on silicites. Despite the fact that the rock surface may appear solid, specimens affected by chert pest display a significant reduction in weight and parts of the solid rock matrix were altered into a chalk-like state. Mineralogical investigations applying XRD revealed that the altered material still comprises SiO_2, however, the substance is soft and scratchable even with a fingernail. To date, it is not completely clarified how chert pest evolves. Most likely, it is a combination of both, initial fire influence producing micro cracks on the rock surface and subsequent weathering. Intrusive alkaline solutions penetrating through the micro cracks can eventually cause a complete chemical alteration of the rock structure without affecting the rock surface. The presence of chert pest significantly exacerbates the determination of other classification parameters in the system. Thus, we will include a separate column into the 2013 classification system indicating the presence or absence of chert pest in the course of the revision of the system.

Returning to the coding example from 2007 (*Table 2*), the coding according to the new 2013 version is displayed in *Table 4*. Again, it is a Northern Alpine radiolarite of high quality with a natural gravel surface and slight burning:

Breakdown of the code in *Table 4*:

- **raw material**: 2 = radiolarite;
- **prov:** provenance 1 = Northern Alpine;
- **granularity:** 1 = fine;
- **natural surface:** 1 = river gravel;
- **fire influence:** 1 = slightly burnt, indicated by fine cracks, colour change and a characteristic greasy sheen;
- **PDC:** 1 = former variant 1 in the 2007 classification system;
- no **SDC** needed;
- **comment:** no further information added.

In the course of the application of the new system to the Palaeolithic assemblage from Stratzing, it became clear that researches with different background knowledge were able to successfully manage the data input into the database. This is mainly due to the fact that the new system leaves an ample range in the case of uncertainties, without forcing the analyst to make doubtful decisions. When using the old system, a researcher was obliged to decide for a variant, with the possibility of weakening the assessment by adding one or more Subdefinition Categories. In the new system, single parameter fields can be skipped as unknowns without losing the entire determination. The biggest advantage of the new system lies in the possibility for researchers with different levels of geological knowledge to handle it according to their personal experience in raw material science and to produce reliable results.

Southern Moravian silicites

Terminology

Due to the variety of systems applied by archaeologists when defining their lithic raw materials, there is no consistent terminology used to classify SiO_2-modifications. It would exceed the scope of this work to discuss these terminological issues in detail. In order to achieve an internally coherent system, we follow Götze (2010) and Brandl (2010).

According to these classification approaches, Southern Moravian silicites would be characterised

TABLE 4. Coding according to the 2013 classification system.

raw material	prov.	granularity	natural surface	fire influence	PDC	SDC	comment
2	1	1	1	1	1	-	-

TABLE 5. Petrographic description of the most important chert types discussed in the current study.

main type	subtypes	colour	geol. context	gran-ularity	natural surface	fossil inclusions	non-fossil inclusions	references
Moravian Jurassic chert	MJC in a broader sense	blue to gray colour variations	Jurassic (Oxfordian) cherts from the eastern fringe of the Brno Basin	fine-coarse	variable	many spicula, rarely radiolarians and unidentifyable detrital remains of marine oganisms	geodes filled with quartz crystals and a characteristic cloudy appearance of the internal rock structure ("background noise")	Mateiciucová 2008, 44-45, Papp *et al.* 1973, Přichystal 2013: 79-82
	Stránská skála type chert	gray-beige-bluish, partly striped		fine-coarse	in most cases not rounded	only few fossil inclusions, characteristic remains of crinoidea, rarely spicula	mosaic structure from SiO_2-precipitations, sometimes small black, brown and reddisch foreign mineral inclusions (heavy minerals, iron oxides)	
	Olomučany type chert	grayish-brown to dark grey, beige-white cortex	Jurassic chert from the central part of the Moravian Karst	fine-medium	in most cases not rounded	predominantly spicula (Porifera), rarely radiolarians and forams	glauconite, mainly in the poorly silicified rock matrix towards the cortex area, small black, brown and reddisch foreign mineral inclusions (heavy minerals, iron oxides, limonite)	
Krumlovský Les type chert	KLI	bluish-gray, sometimes banded, rarely reddish-pink	Jurassic and possibly cretaceous silicites in Lower Miocene (Ottnangian) sediments, Rzehakia-Formation	fine-coarse	gravel, regularly desert varnish	massively spicula (Porifera), detrital sponge remains	poorly silicified isometric relics of the original clastic host rock, sometimes small black and brown foreign mineral inclusions (heavy minerals, iron oxides), massively SiO_2-precipitations mainly towards the cortex, clefts and cavities (geodes) secondaryly filled with SiO_2-modifications	
	KLII	brownish-gray and brown, partly rose coloured	Jurassic silicites in Lower Miocene (Ottnangian) sediments, Rzehakia-Formation	fine	gravel, regularly desert varnish	rarely spicula, detritus	rarely small black, brown and reddisch foreign mineral inclusions (heavy minerals, iron oxides), massively SiO_2-precipitations	

based on their specific fossil content. However, following the Moravian research tradition, we decided to generally refer to these raw materials as "chert" (Mateiciucová 2008).

As an example, Krumlovský Les type chert variety I (KL I; see *Table 5*) is described as containing "large numbers of microfossils", predominantly consisting of sponge spicula (Mateiciucová 2008: 45, Přichystal 2013: 81). Pursuant to our classification system and in accordance with Přichystal (2013: 81), this chert variety would clearly be identified as spongiolite or spiculite provided that a sufficient number of identifiable fossil remains is detected.

Southern Moravian chert type varieties are distinguished after type localities, e.g. Krumlovský Les

main type	site location	colour	geol. context	gran-ularity	natural surface	fossil inclusions	non-fossil inclusions	references
Northern Lower Austria	Gobelsburg	grayish-blue laminated	Plio-/Pleistocene Danube gravels	fine-medium	gravel	spicula, remains of marine organisms, small detritus	rarely accumulated pyrite, inclusions of trigonale crystal cavities (most likely calcite), brown and black foreign mineral inclusions (heavy minerals), small quartz grains, SiO_2-precipitations	defined by the authors
	Unter-duernbach	bluish-gray light laminated	Miocene (Karpatian) gravels of the Laa Formation	fine-medium	gravel	unidentifiable globular structures, spicula, radiolaria, sponge remains (?), partly large remains of marine organisms, detritus	partly accumulated inclusions of trigonale crystal cavities (most likely calcite), SiO_2-precipitations	
	Ruppersthal west	bluish-brown speckled	Miocene (Pannonian) gravels of the Hollabrunn-Mistelbach-Formation (HMF)	fine-medium	gravel	spicula, rarely radiolaria, partly large remains of marine organisms, small detritus	massively yellow, brown, black and reddish foreign mineral inclusions (limonite, heavy minerals, etc.), mica, small quartz grains, rarely trigonale crystal cavities (most likely calcite), some SiO_2-precipitations	

type chert and "Moravian Jurassic chert", which is again subdivided into several subtypes. Amongst those, Stránská skála chert and Olomučany chert are the most important types (Mateiciucová 2008). In order to provide the necessary background information, the most frequently occurring chert varieties discussed in the present study are described in *Table 5*.

For Palaeolithic assemblages in Lower Austria, we are in many cases forced to stay within the broadest level of classification, i.e. "Moravian Jurassic chert in a broader sense" (MJC s. l. in *Table 6*). This is mainly due to the following reasons:

1. Many "potentially Southern Moravian" cherts in (Lower) Austrian Palaeolithic assemblages are too small for a secure identification.
2. The identification of distinct Southern Moravian chert type varieties is in many cases problematic. Krumlovský Les type chert, which is the most abundant chert variety found at prehistoric sites in Southern Moravia and adjacent regions, has been transported and relocated multiple times until its final deposition in Lower Miocene Ottnang sediments (Mateiciucová 2008: 45). The KL chert deposit is not comprised of homogeneous components and contains material from Jurassic and possibly Cretaceous primary sources. Thus, the KL chert source displays a high variability in its components, hampering a secure assessment in the case of uncharacteristic specimens (unless it is the "typical" KL type I or II material, which is highly recognisable). Additionally, deposits containing KL type chert cover vast areas, predominantly the Krumlovský Les upland, the Brno-Country and Znojmo districts. Similar raw material is also described from the Vienna Basin catchment area (Přichystal 2013: 87–88).
3. Recently, chert types visually very similar to Southern Moravian cherts have been recognised within neogene (predominantly Miocene) gravels in northern Lower Austria. Very little is so-far known about the chert components in these paleo-gravels and their origin (see "discussion"). Especially in the case of small pieces, it is often not possible to differentiate between material from northern Lower Austrian sources and Southern Moravian chert types, even under the stereomicroscope. Additionally, chert

TABLE 6. Petrographic description of selected artefacts from Stratzing.

find No.	colour	granularity	natural surface	fire influence	fossil inclusions	non-fossil inclusions	geol comparative sample(s)
nodule 1a, **233_12**	light brownisch-bluish	fine	none	none	mainly spicula and marine detritus	SiO_2 precipitations, small black and brown foreign mineral inclusions (heavy minerals, iron oxides)	Krumlovský Les chert type II
nodule 1b, **758_42**	light brownisch-bluish	fine	indet.	none	mainly spicula and marine detritus	SiO_2 precipitations, small black and brown foreign mineral inclusions (heavy minerals, iron oxides)	Krumlovský Les chert type II
nodule 2a, **295_5**	grayish-blue laminated	fine	none	none	spicula, radiolaria, detrital remains of marine organisms	accumulated pyrite, inclusions of trigonale crystal cavities (most likely calcite), brown, black and more rarely reddish foreign mineral inclusions (heavy minerals, iron oxides), clefts secondarily filled with chalcedony	Gobelsburg, less similarities with Ruppersthal
nodule 2b, **298_3**	blueish	fine	none	none	spicula, radiolaria, detrital remains of marine organisms	massively large inclusions of trigonale crystal cavities (most likely calcite, giving the material a very porous structure), brown and black foreign mineral inclusions (heavy minerals), SiO_2-precipitations	no matching comparative sources known
nodule 3, **281_7**	bluish-gray	coarse	none	none	spicula, unidentifiable large rmarine fossil remains, detritus	inclusions of trigonale crystal cavities (most likely calcite, giving the material a porous structure), greenish, brown and black foreign mineral inclusions (possibly chlorite (?) and heavy minerals), frequently SiO_2-precipitations and oftentimes quartz geodes	Weyerburg, Ruppersthal, Gobelsburg

TABLE 7. Petrographic description of the geological comparative samples.

locality	type variety	colour	geol. context	granularity	natural surface	fossil inclusions	non-fossil inclusions
Krumlovský Les neolithic mining area I, sample 1	KL I	bluish-slightly striped	Ottnangian sediments, Rzehakia-Formation	medium	gravel, characteristic desert varnish	massively spicula (Porifera), detrital sponge remains	rarely small black and brown foreign mineral inclusions (heavy minerals, iron oxides), massively SiO_2-precipitations
Krumlovský Les neolithic mining area I, sample 2	KL II	bluish-light gray, thick beige cortex area		fine	gravel	some spicula, detritus	sometimes small black and brown foreign mineral inclusions (heavy minerals, iron oxides), massively SiO_2-precipitations maily towards the cortex
Krumlovský Les neolithic mining area I, sample 3	KL II	bluish-gray, thick beige cortex area		fine	gravel	some spicula, detritus	small black and brown foreign mineral inclusions (heavy minerals, iron oxides), massively SiO_2-precipitations
Krumlovský Les neolithic mining area I, sample 4	KL II	bluish-gray, partly rose coloured		fine	gravel	some spicula, detritus	sometimes small black and brown foreign mineral inclusions (heavy minerals, iron oxides), massively SiO_2-precipitations, clefts secondarily filled with SiO_2-modifications
Gobelsburg	northern Lower Austrian chert from kenozoic (neogene) gravels	grayish-blue laminated	Plio-/Pleistocene Danube gravels	fine	gravel	spicula, remains of marine organisms, small detritus	rarely accumulated pyrite, inclusions of trigonale crystal cavities (most likely calcite), brown and black foreign mineral inclusions (heavy minerals), small quartz grains, SiO_2-precipitations
Unterduernbach	northern Lower Austrian chert from Miocene gravels	bluish-gray slightly laminated	Laa-Formation	fine	gravel	spicula, radiolaria, sponge remains (?), partly large remains of marine organisms, detritus	partly accumulated inclusions of trigonale crystal cavities (most likely calcite), SiO_2-precipitations
Ruppersthal	northern Lower Austrian chert from Miocene gravels	bluish-brown speckled	Hollabrunn-Mistelbach-Formation (HMF)	fine	gravel	spicula, rarely radiolaria, partly large remains of marine organisms, small detritus	massively yellow, brown, black and reddish foreign mineral inclusions (limonite, heavy minerals, etc.), mica, small quartz grains, rarely trigonale crystal cavities (most likely calcite), some SiO_2-precipitations

pebbles deriving from the Laa-Fm often display a black cortex resembling the characteristic desert varnish observed at KL-chert.

4. Confusion with other raw materials regularly occurs in the case of heavily patinated (chemically altered; Brandl *et al.* 2011: 59) artefacts of Southern Moravian origin. Erratic flints, for example, that do not display characteristic traits (e.g. remains of bryozoa) are sources of possible misidentification.

"Southern Moravian" silicites in the Stratzing-Galgenberg assemblage

For this study, all lithic artefacts from the excavation campaigns between 1988 and 1991 were analysed, and ca. 7000 datasets were recorded. [Note: The assemblage from the 1985 and 1986 excavation campaigns at Stratzing were analysed by Umgeher-Mayer (2007)]. Since the analysis was conducted only visually, a direct comparison between the datasets of this previous study and the current investigation is not useful. The vast majority of the raw material derives from local Danube gravels. The second largest group consists of erratic flint, whereas other raw materials are clearly underrepresented. Surprisingly, approximately only 50 specimens could be determined as Southern Moravian raw material type varieties (*Table 8*, end of the text). Due to the reasons mentioned above, it is possible that the amount is actually slightly higher. Most of all, in this case the small size of the artefacts was a limiting factor for secure determination.

In order to demonstrate the problematic nature in macroscopic determination of Southern Moravian chert varieties in Palaeolithic assemblages from Lower Austria, artefacts from Stratzing were visually assigned to three potential chert nodules (Moreau *et al.* 2013: 128). Initially, all three were identified as Moravian Jurassic chert. For this study, they were investigated microscopically in greater detail, producing the following results:

Macroscopically defined nodule No. 1:

Macroscopically, find numbers 482/1, 272/1, 233/12, 664/5, 391/14, 758/42, 675/2, 266/1 and 377/1 were identified as parts of one chert nodule (*Table 8*). In-depth microscopic analysis revealed a clear separation into at least two nodules, 1a consisting of find numbers 482/1, 272/1, 233/12, 664/5, 391/14 and 1b containing 758/42 and 675/2 and possibly 266/1 and 377/1. Due to diagnostic fossil inclusions and the characteristic structure of the raw material, it was safe to identify both nodules as Krumlovský Les type chert variety II (*Tables 6, 7, Figure 1:a–b, Figure 2:b–d*).

Macroscopically defined nodule No. 2:

The find numbers "refitting 21", 295/5, 253, 254, 616, 274/1, 298/3 and 296/19 were visually assigned to nodule 2. Microscopic investigation showed the presence of components of at least two nodules displaying different raw material properties.

Nodule 2a, consisting of the find numbers "refitting 21", 295/5, 253, 254, 616 and 274/1, shows some similarities to Moravian Jurassic cherts (i.e. bluish colour, striped appearance). However, some of the properties of nodule 2a are not characteristic for such chert types, specifically the presence of calcite-cavities and traces of pyrite inclusions in the rock matrix (*Figure 1:c*). Comparisons with raw materials from local gravels make it more plausible that nodule 2a originates from the northern Lower Austrian catchment area, since it displays the closest similarities to material from Gobelsburg (see *Tables 6, 7, Figure 2:e*).

Nodule 2b is represented by only two flakes, find number 298/3 and 296/19. They show properties similar to nodule 2a, except the calcite-cavities are larger and better preserved (*Figure 1:d*). Nodule 2b also displays a more vitreous texture than nodule 2a. To date, no matching material is known from local gravels, however, an origin from a source located in Lower Austria seems more likely than from a Southern Moravian deposit due to the similarities with nodule 2a (see *Tables 6, 7, Figure 1:e–g*).

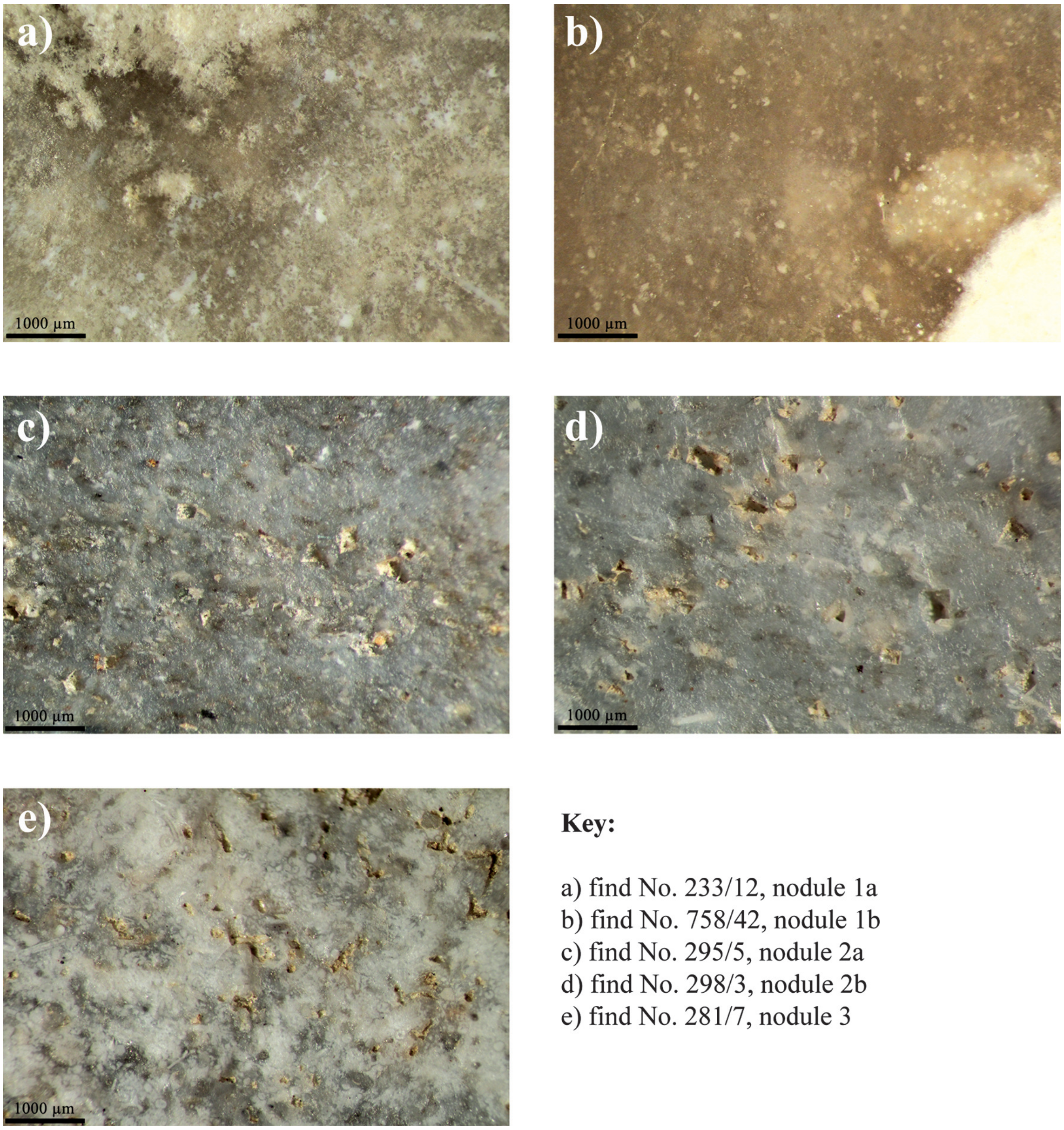
Macroscopically defined nodule No. 3:

Nodule 3, consisting of find numbers 281/6, 7, 8; 296/20, 22 and 296/23, seems visually and microscopically consistent. It was provisorily assigned to the catchment area of Krumlovský Les considering the high similarity of the majority of its properties (i.e. large amounts of spicula, cloudy SiO_2-precipitations, quartz geodes, bluish colour) (*Tables 6, 7, Figure 1:e; compare with Figure 2:a*). However, the presence of calcite-cavities, clearly identifiable quartz grains in the rock matrix and not yet identified green foreign mineral inclusions (most likely chlorite) are uncharacteristic for Southern Moravian silicites. Thus, we decided to leave the determination within the "catchment area of KL" until further research clarifies questions concerning the local Lower Austrian cherts from palaeo-gravels.

ASSEMBLAGE CHARACTERISTICS

Typological composition

Among the 47 artefacts on Moravian Jurassic Chert (MJC) five blanks (i.e. 10.6 %) have been transformed



Key:

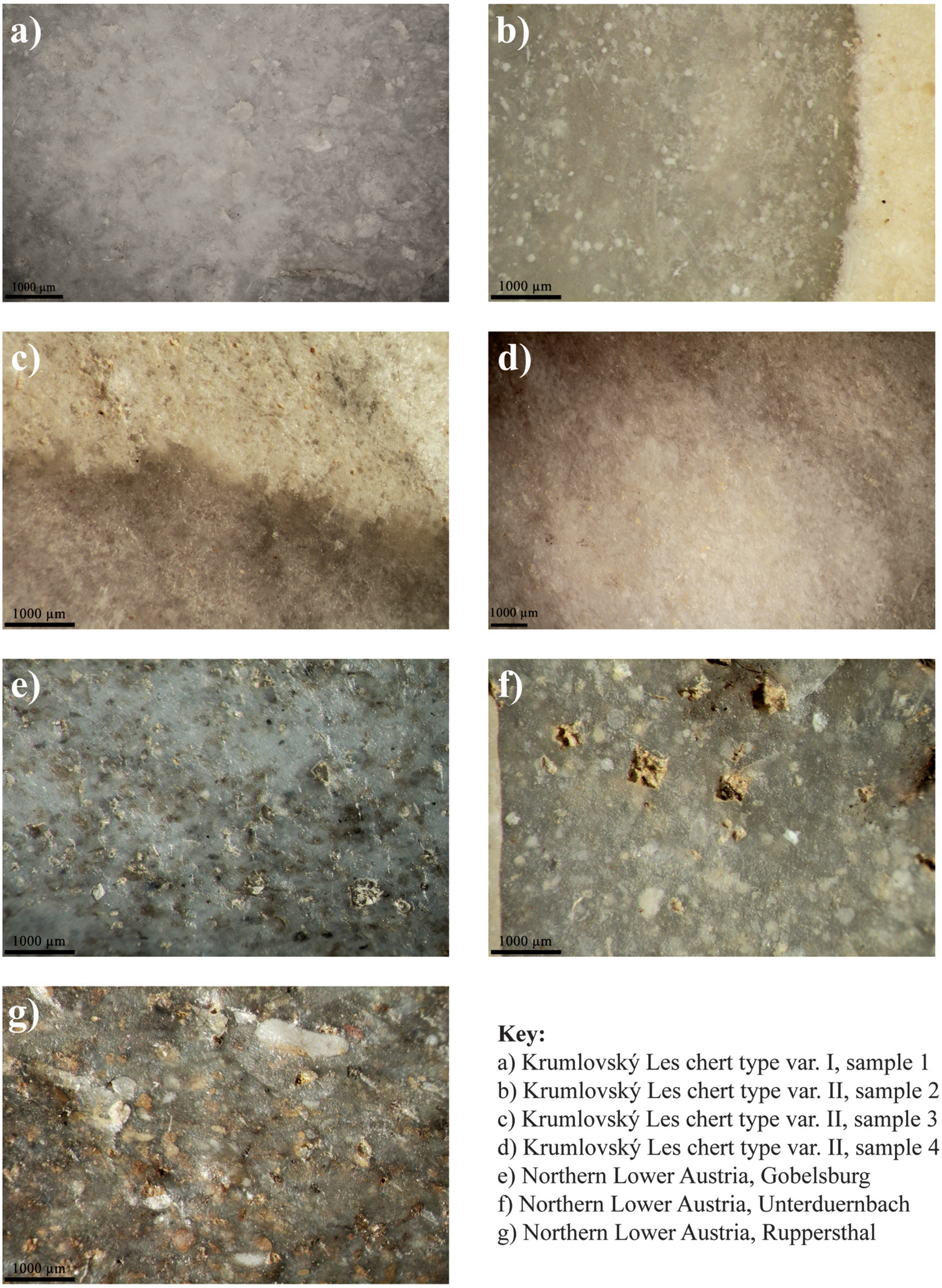
a) find No. 233/12, nodule 1a
b) find No. 758/42, nodule 1b
c) find No. 295/5, nodule 2a
d) find No. 298/3, nodule 2b
e) find No. 281/7, nodule 3

FIGURE 1:a–e. Micropictures of the artefacts investigated for this study. Photos: M. Brandl.

into formal tools (*Tables 9, 10*). The latter comprise one pointed blade with bilateral retouch (*Figure 3:1*), two laterally retouched blade and flake blanks (*Figure 3:2*), and two burins: one burin on break (*Figure 3:3*) and one Vachons burin (*Figure 4:2*).

The small number of formal tools hampers inter-assemblage comparisons by means of statistical analysis. However, the presence of an Aurignacian "type fossil" in the toolkit is worth mentioning: a typical Vachons burin matching all criteria of its typological definition (Demars, Laurent 1992: 56). In Western Europe, Vachons burin are considered to represent a variant of carinated and busqued burins, and to characterise the final stages of the evolved Aurignacian (Demars, Laurent 1992, Hahn 1977, Perpère 1972). The Vachons burin from Stratzing represents one of the easternmost occurrences of this fossil type outside its eponymous region.

The Vachons burin from Stratzing is made on a thick flake (*Figure 4:2*), measuring 26 mm in thickness in its final stage. Its distal end exhibits a flat surface obtained



Key:
a) Krumlovský Les chert type var. I, sample 1
b) Krumlovský Les chert type var. II, sample 2
c) Krumlovský Les chert type var. II, sample 3
d) Krumlovský Les chert type var. II, sample 4
e) Northern Lower Austria, Gobelsburg
f) Northern Lower Austria, Unterduernbach
g) Northern Lower Austria, Ruppersthal

FIGURE 2:a–g. Micropictures of the geological comparative samples. Photos: M. Brandl.

TABLE 8. Artefacts from Stratzing-Galgenberg of potential Southern Moravian origin.

find no	sub no	raw material	prov	granularity	natural surface	fire infl.	comment	nodule
227	2	1	10	1	999	4	MJC s.l.	
232	4	1	10	1	0	4	MJC s.l.	
233	12	1	10	1	0	0	type KL II	1a
266	1	1	10	1	999	0	type KL II	1b (?)
269	3_5	1	10	2	0	0	MJC s.l.	
272	1	1	10	1	1	0	type KL II	1a
274	1	1	0	1	0	0	MJC s.l. (?), NLA (?)	2a
281	6	1	10	2	0	0	catchment area KL	3
281	7	1	10	2	0	0	catchment area KL	3
281	8	1	10	2	0	0	catchment area KL	3
296	19	1	10	2	0	0	MJC s.l. (?), NLA (?)	2b
296	20	1	10	2	0	0	catchment area KL	3
296	22	1	10	2	0	0	catchment area KL	3
296	23	1	10	1	0	0	catchment area KL	3
298	3	1	10	1	0	0	MJC s.l. (?), NLA (?)	2b
298	5	1	10	1	1	0	MJC s.l.	
332	1	1	10	2	0	0	MJC s.l.	
340	1_9	1	10	2	0	4	type OL (?)	
377	1	1	10	1	999	0	type KL II	1b (?)
389	A_3	1	10	2	1	0	type KL I	
391	14	1	10	1	0	0	type KL II	1a
416	1	1	10	2	0	4	MJC s.l. (?), NLA (?)	
482	1	1	10	1	2	0	type KL II	1a
537	42	1	10	1	0	0	MJC s.l.	
616	0	1	0	1	0	0	MJC s.l. (?), NLA (?)	2a
646	2	1	10	1	0	4	MJC s.l.	
664	5	1	10	1	999	0	type KL II	
671	0	1	10	1	999	1	MJC s.l.	
672	8	1	10	2	1	0	MJC s.l.	
675	2	1	10	1	999	0	type KL II	1b
688	81	1	10	2	0	0	MJC s.l.	
688	103	1	10	2	1	0	MJC s.l.	
719	19	1	10	2	0	0	MJC (?)	
734	11	1	10	1	0	4	MJC s.l.	
734	24	1	10	1	1	4	MJC s.l.	
734	26	1	10	1	1	0	MJC s.l.	
734	39	1	10	1	0	4	MJC s.l.	
734	82	1	10	1	1	0	MJC s.l.	
758	42	1	10	1	999	0	type KL II	1b
779	4	1	10	1	1	0	MJC s.l.	
814	1	1	10	1	0	0	MJC s.l.	
815	1	1	10	1	0	0	type SK (?)	
824	4	1	10	2	1	4	MJC s.l.	
Ref. Gr.21		1	0	1	0	4	MJC s.l. (?), NLA (?)	2a
295_5		1	0	1	0	4	MJC s.l. (?), NLA (?)	2a
253		1	0	1	0	0	MJC s.l. (?), NLA (?)	2a
254		1	0	1	0	0	MJC s.l. (?), NLA (?)	2a

by means of a first burin spall removal, from which a series of opposed specific burin-spall negatives (*enlèvements de coup de burin d'angle et plan*) were taken off. The latter negatives tend to largely extend onto the ventral face of the flake blank, and are limited in length by a small notch (*encoche d'arrêt*). Typically, the invasive burin-spall removals at the distal end of the burin determine an acute angle.

In recent years, it has been demonstrated based on a technological approach that a number of formal tool

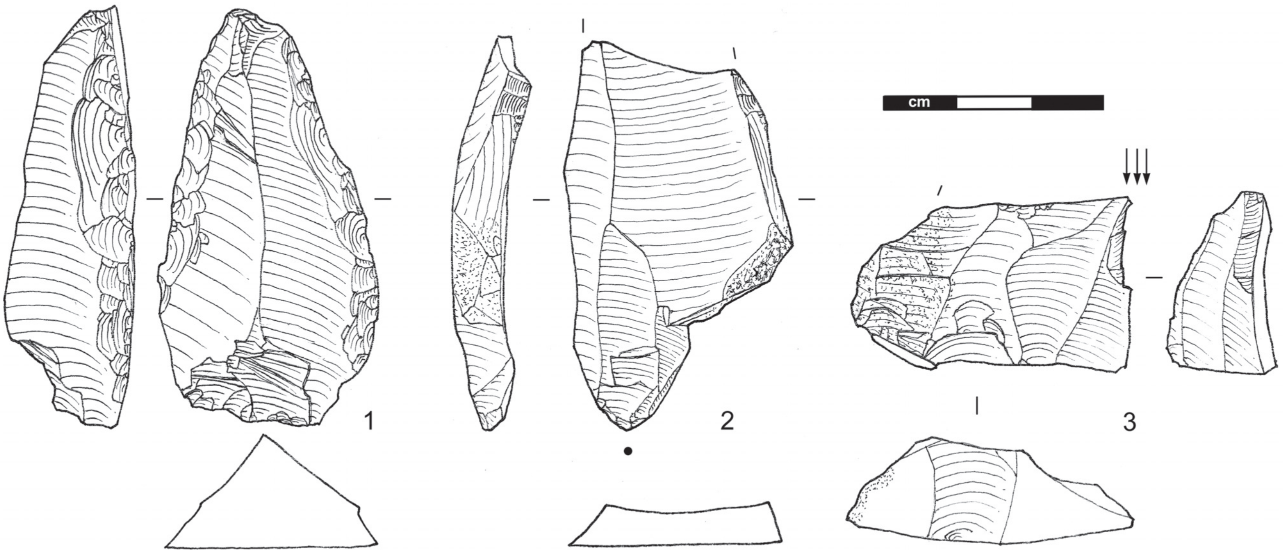


FIGURE 3. Stratzing-Galgenberg (excavations 1988–1991). Toolkit on MJC: 1, pointed blade with bilateral retouch (ID 646/2); 2, laterally retouched blade (ID 272/1, nodule 1a); 3, burin on break (ID 482/1, nodule 1a) (drawings L. Moreau).

types characteristic of the Aurignacian, including Vachons burins, are in fact parts of specific systems of bladelet production (Chazan 2001, Lucas 2006, Pesesse, Michel 2006). In conformity with this technological approach three by-products could be refitted to the Vachons burin from Stratzing (ID 281/7): one twisted bladelet aimed at rejuvenating the transversal convexity of the carinated debitage surface (ID 296/23) (*Figure 4:1*), as well as two lateral flakes related to the maintenance of the striking platform (i.e. first burin spall removal surface) (ID 281/8, 296/20). Two more preparation flakes (ID 296/22, 281/6) belong to the same raw material unit 3, however they could not be integrated into the refitting group. Neither does any of these by-products present a formal retouch, nor does the analysed MJC assemblage contain any straight and rectilinear bladelet with direct marginal retouch allegedly deriving from this specific bladelet production schemata, at least in southwestern France (Pesesse, Michel 2006).

Techno-economic characterisation

Besides assessing the assemblage characteristics of Stratzing in typological terms we use the concept of "workpiece" or "raw material unit" to investigate in more detail the reduction and transformation of one single nodule, defined according to macroscopic characteristics, against the background of an idealized reduction sequence (i.e. *chaîne opératoire*). The concept of "raw material unit" pertains to the analytical method known as "transformation analysis" (*Transformationsanalyse*) developed by J. Hahn (1988) and W. Roebroeks (1988), and is widely used in European lithic studies (e.g. Richter 1997, Weißmüller 1995, Nigst 2012). This method aims to show in which reduction state a given raw material unit (i.e. nodule) has been brought into the site, to assess its reduction intensity, and whether or not artefacts have been exported. Ideally, raw material units are backed up by refitting groups of lithic artefacts in order to demonstrate their appartenance to a single unit. In practice, lithic artefacts sharing a number of visual and possibly microscopic characters regarding colour, texture (i.e. grain size), fossil inclusions and cortex structure are considered to belong to one raw material unit. While the present study is limited to the excavation material from 1988 to 1991 we assume here that the MJC assemblage analysed by means of transformation analysis represents a closed ensemble.

Five raw material units (i.e. nodules) have been identified based on both visual and microscopic criteria (see part A). Almost half of the MJC artefacts in the present assemblage have been assigned to one of these units. The remaining artefacts were classified as MJC *sensu lato* (*Table 10*). Each raw material unit comprises between two and six artefacts, including tools. Solely units 2a and 3 comprise respectively four artefacts which could be refitted (*Table 10*).

TABLE 9. Stratzing-Galgenberg (excavations 1988–1991). Retouched and non retouched artefacts on MJC by technological categories in absolute numbers. Blades with a width < 12 mm were classified as bladelets.

	not retouched	retouched
Blade	1	2
Bladelet	5	0
Flake	28	3
Burin spall	0	0
Chip (<10mm)	4	0
Shatter	2	0
Frost shard	1	0
Core	1	0
Total	**42**	**5**

TABLE 10. Stratzing-Galgenberg (excavations 1988–1991). Tool types and their eventual attribution to one of the five identified MJC raw material units. The pointed blade and the modified flake could not be assigned to one precise unit, thus they have been classified as MJC *sensu lato* (cf. *Table 8*).

	Number of specimens	ID	Nodule unit
Vachons burin	1	281/7	3
Burin on break	1	482/1	1a
Pointed blade with bilateral retouch	1	646/2	MJC s.l.
Laterally retouched blade	1	272/1	1a
Laterally retouched flake	1	389A/3	MJC s.l.
Total	5		

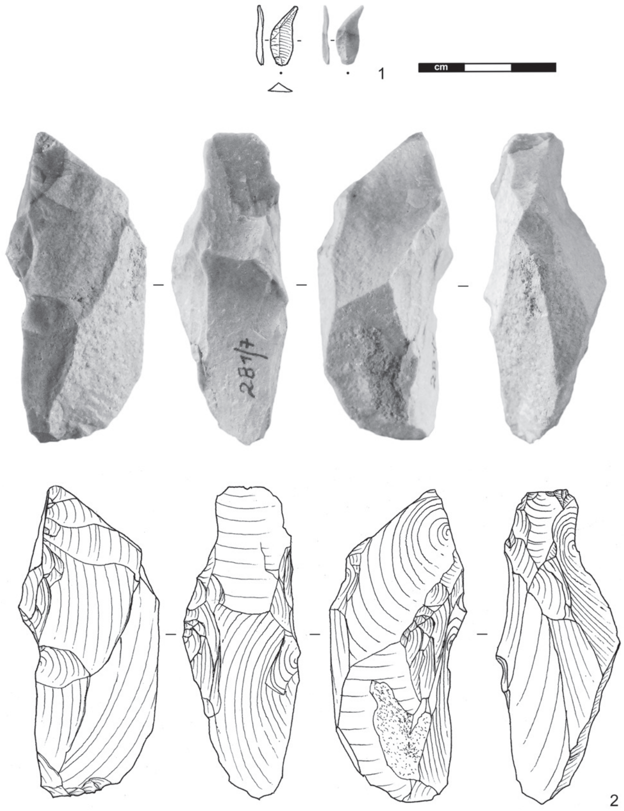


FIGURE 4. Stratzing-Galgenberg (excavations 1988–1991). Vachons burin on Moravian chert type Krumlovský les. The burin itself (ID 281/7) and the twisted rejuvenation bladelet (ID: 296/23) belong to nodule 3 and could be refitted. Photos and drawings: L. Moreau.

The presence in the MJC assemblage of one exhausted volumetric core, alongside many preparation flakes and non modified laminar blanks, indicates blank and tool production on-site (*Table 9*). Formal tools were possibly imported and discarded after exhaustion. The limited number of artefacts that could be refitted or securely assigned to one of the defined raw material units suggests a spatial segmentation of the reduction sequence of each workpiece between the initial procurement at Moravian sources and their processing on-site, before being replaced by local raw material readily available. The absence of retouched bladelets derived from the reduction of the Vachons burin in the MJC assemblage could be related to a subsequent export of MJC end-products in anticipation of future needs.

Intensity of raw material use

In the analysed assemblage, MJC represents an extra-local raw material class. The average distance separating the site from the nearest MJC occurrences in South Moravia is estimated to at least 100 km. At Stratzing, MJC accounts for only 47 artefacts, thus representing less than 1 % of the entire assemblage from 1988–1991. We interpret the low amount of MJC artefacts primarily as a function of the distance over which the material has been moved, independently of the adopted procurement strategy.

It is expected that provisioning distance would have exerted a significant constraint on raw material use, manifested by an increased intensity of reduction and utilisation of tools (e.g. Féblot-Augustins 1997, Kuhn

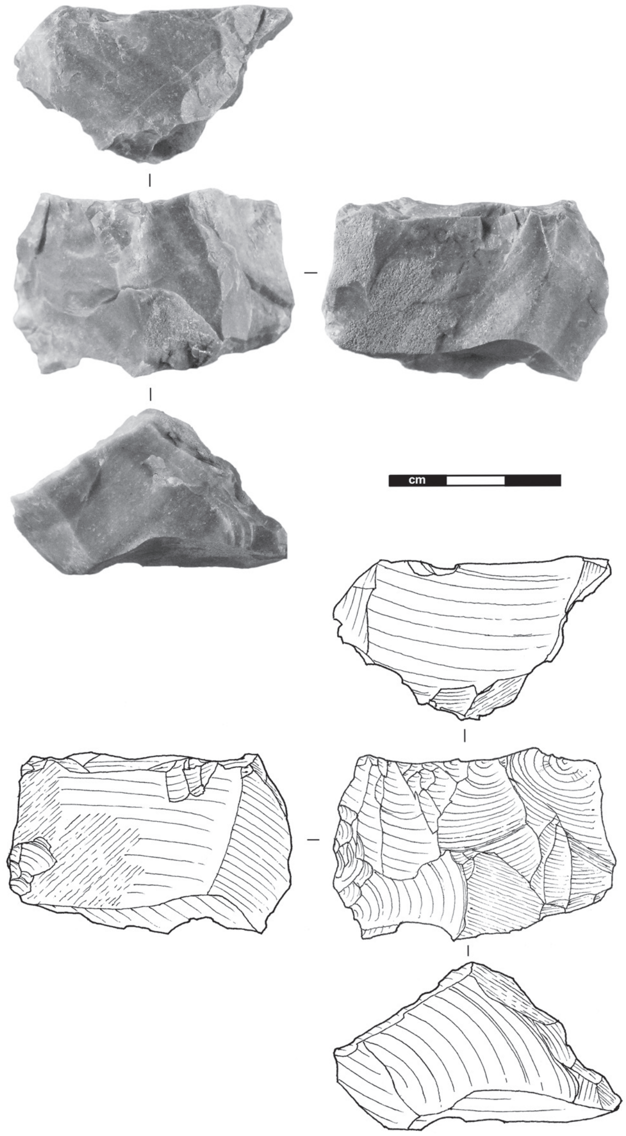


FIGURE 5. Stratzing-Galgenberg (excavations 1988–1991). Exhausted core (ID 295/5), attributed to nodule 2a. Photos and drawings: L. Moreau.

1992). At Stratzing, intensity of MJC use is attested by the small size of the single exhausted volumetric core in the assemblage (*Figure 5*). Three blanks (ID 253, 254, unreadable) could be refitted to the core, while other six artefacts could be assigned to raw material unit 2a, to which the core belongs. As core reduction increases, the number of blanks per core and the extent of core preparation increase while average core size, flake size, flake platform area and cortex decrease (Dibble *et al.* 1995). At Stratzing, nearly 90 % of MJC artefacts, mostly preparation flakes (N = 28), including one core tablet (ID 233/12) and chips (N = 4) measure less than 35 mm in length. Moreover, MJC blanks with less than 40 % cortex account for 2/3 of cortical artefacts (N = 8). Keeping in mind the high degree of fragmentation of MJC artefacts, obviously larger blanks were preferentially selected for retouch (*Figures 3, 4*), with three from five formal tools exceeding 50 mm in length.

Judging from the last negatives visible on the single MJC core, the final reduction stage possibly aimed at obtaining thick flakes to be transformed into carinated bladelet cores, such as the aforementioned Vachons burin. However, the question of a possible predetermination of flake production in the lithic technological system at Stratzing remains to be investigated. At the pene-contemporaneous late Aurignacian site Breitenbach, Germany, where flakes mainly represent by-products of the laminar operational sequences attested at the site, flakes for carinates appear to have been systematically struck off by hard hammer technique (Moreau 2012). Moreover, metrical analyses of both unretouched and retouched flakes indicate that at Breitenbach the selection of blanks for carinates was based primarily on thickness, not on morphology or technological class (Moreau 2012).

DISCUSSION

Classification systems are important tools for data comparison and for the evaluation of archaeological find material that extend beyond lithic studies (e.g. Luedtke 1992). Coherent systems allow for testing hypotheses; furthermore, combinatorial conclusions drawn from the evaluation of a sound database are essential for shaping theories in archaeological sciences. However, a classification system is only as useful as the information contained within the database. Thus, careful assessments rather than daring assumptions (= responsible handling of the datasets) in combination with at least basic geological knowledge within the study area are the necessary requirements for creating an effective research tool.

While the classification system from 2007 turned out to be easily manageable by the creator of the data input structure, it was nearly impossible to achieve comparable results with different researchers working with this system. Thus, a revised version was implemented in 2013, breaking up the implied analytical steps, affording a far higher resolution in the data input and providing the possibility for more than one analyst to handle the system. The 2013 classification system is frequently adapted to new requirements and research results. This is especially true for the provenance field, which is continuously expanded.

In the course of the analysis of the Stratzing assemblage it became obvious that assigning specimens to the broad Southern Moravian category (10 in the prov-field, *Table 3*) required additional provenance and/or attribute information in the comments. This did not constitute a major problem for this specific assemblage since we only detected approx. 50 artefacts within this group. However, regarding statistical evaluation and comparability with other find complexes containing lager amounts of potential Southern Moravian silicites, this could lead to serious problems. It would in such cases not be possible to easily differentiate between certain chert type varieties within the Southern Moravian category. Therefore, we are already working on the definition of subgroups for "provenance-10-artefacts" in the following version of our system.

The "Southern Moravian cherts in Stratzing" case study has clearly demonstrated the issues occurring in the course of the determination of specific raw materials. This is especially true for chert source provenance studies. In the course of a preliminary microscopic investigation, all artefacts in *Table 8* were assigned to a Southern Moravian origin, and some were specifically identified as raw materials from distinct type localities, e.g. Krumlovský Les type chert. In-depth analysis revealed a much higher diversity within the "Southern Moravian chert"-group than initially assumed, indicating the presence of previously unrecognised local gravel components within this group.

From a geological point of view, it is unclear from where the bluish-grey cherts from Lower Austrian palaeo-gravels that resemble Moravian Jurassic silicites originate. This raw material was discovered in the course of surveys in palaeo-gravels predominantly bound to the Laa- and the Hollabrunn-Mistelbach-Formations (Wessely 2006: 56–59; also see the geological map on pg. 42).

The Laa-Fm (Miocene, Karpatian stage) occurs in an area north of the Danube and stretches roughly in the Weinviertel region, with the pebbles mainly present in its northwestern part. It was deposited in a former surf zone and consists of banked clayish marls with intercalated sand lenses and gravels rounded by submarine debris flow. These gravels contain components of the Waschbergzone, *inter alia* chert cobbles believed to originate from the Ernstbrunn limestone area ("Ernstbrunner Kalke") (Wessely 2006: 56–57).

The Hollabrunn-Mistelbach Fm (HMF, Miocene, Pannonian stage) comprises fluviatile gravels and sands expanding from the end of the Wachau at Krems into the Vienna Basin. The HMF contains components of the Molassezone and also of the Waschbergzone (Nehyba, Rötzel 2004, Wessely 2006). However, Wessely (2006: 59) assigns the quartz components to gravels from a kalkalpine provenance.

Palaeo-gravels bound to the HMF also occur close to the Stratzing site on the Galgenberg, which theoretically could have delivered some of those cherts (Rötzel 1998). However, this possibility seems rather unlikely due to the fact that these surface outcrops do not produce sufficient amounts of raw material suitable for knapping.

For this study, comparative samples were chosen from Unterduernbach (*Figure 2:f*) deriving from the Laa-Fm, from Ruppersthal (*Figure 2:g*)**,** recovered within gravels of the HMF, and additionally from Gobelsburg (*Figure 2:e*)**,** found in old Danube gravels dating to the Plio-/Pleistocene boundary.

The typo-technological analysis conducted on the MJC from Stratzing indicates the centrality of bladelet production in Aurignacian technology. This is best illustrated by the presence of a typical Vachons burin in the assemblage, which is understood as part of a specific system of bladelet production allowing for a high degree of control over the morphology of the desired blank (Chazan 2001, Lucas 2006). This burin core on MJC was doubtlessly part of a mobile toolkit, in which portability was of major concern. Whether the burin core technology attested at Stratzing reflects a high degree of mobility will have to be assessed in the light of the other raw material classes represented at the site. At this stage, the possibility of differential use of raw material types for different artefact types, and the question of whether tools on MJC show significantly more reduction than local ones must remain open issues.

The provisioning and reliance on Krumlovský les chert has been considered to be a typical feature of the EUP Aurignacian in the Middle Danube region based on the observation that Krumlovský les cherts are typical for Moravian surface finds with Aurignacian character, whereas they are rather sparse in the Pavlovian (Oliva 1996). As far as Austria is concerned, while at Stratzing MJC, especially Krumlovský les chert, accounts for less than 1% of the assemblage, it totalises up to 90 % at the late Aurignacian site of Alberndorf 1 (Steguweit 2010, Trnka 2005: 198). One explanation for the limited amount of South Moravian cherts at Stratzing can tentatively be related to the provisioning distance of this material over at least 100 km, compared to ca. 45 km in the case of Alberndorf 1. By the same token, given the numerical importance of exogenous erratic flint at

Stratzing over other, even less distant, raw material classes, including MJC, factors other than transport distance will have to be taken into consideration if we want to understand the organization of economic behaviour at Stratzing and its outcomes in terms of mobility (Moreau *et al.* 2013).

CONCLUSION

The application of the newly implemented 2013 classification system to the material from Stratzing-Galgenberg has demonstrated the importance of recording clearly defined and diagnostic parameters of lithic artefacts. This system can be utilised as a powerful tool for prehistoric research; however, our case study has also stressed the importance of the adaptability of such a system. This also coincides with the degree of resolution desired in a given research programme. Because the identification of foreign raw materials, especially Southern Moravian cherts, in Austrian Palaeolithic assemblages plays an important role in the interpretation of prehistoric resource management strategies, the highest possible resolution in raw material analysis is required.

The visual and microscopic analysis of the Stratzing-Galgenberg assemblage revealed a surprisingly low amount of raw materials that could securely be identified as Southern Moravian. In many cases, this is due to the small size of the artefacts. However, the majority of these artefacts had to be determined as cherts of Southern Moravian origin *sensu lato*. Only 10 artefacts could clearly be identified as chert of the Krumlovský Les type with the variety KL II prevailing. Two specimens displayed attributes resembling the Stránská skála and Olomučany type varieties respectively; however, the specimens are too uncharacteristic for a secure determination. The recent discovery of local gravels displaying similar attributes to Southern Moravian cherts illustrates further possibilities for a misidentification.

At present, extended surveys are planned to obtain significant amounts of sample material from the local palaeo-gravels. Further research aims at a clear characterisation of raw materials from the Laa-Fm and the HMF in order to achieve a better distinction between the cherts from northern Lower Austrian gravels and the Southern Moravian catchment area. An additional goal will be the further exploration of potential Southern Moravian cherts in the Vienna Basin for comparison studies. Eventually, geochemical analysis will be conducted on these silicite varieties in order to complete the proposed Multi Layered Approach as demonstrated by Brandl *et al.* (2014).

The reason why Southern Moravian silicites are only present in low quantities as compared to erratic flints, which had to be transported over significantly longer distances, is subject of further investigations (Moreau *et al.* 2013).

ACKNOWLEDGEMENTS

Dr. Luc Moreau was supported by the German Science Foundation (DFG) (Grant No. MO-2369/1).

REFERENCES

BIRÓ K. T., SZILÁGYI V., KASZTOVSZKY Z., 2009: Új adatok a Kárpát-Medence Régésteti Radiolarit forrásainak ismeretéhez (New data on the characterisation of radiolarite sources of the Carpathian Basin). *Archeometriai Műhely* 3: 25–43.

BRANDL M., 2010: Classification of rocks within the chert group: Austrian practice. *Archeometriai Műhely* 3: 183–190.

BRANDL M., HAUZENBERGER C., POSTL W., MARTINEZ M. M., FILZMOSER P., TRNKA G., 2014: Radiolarite studies at Krems-Wachtberg (Lower Austria): Northern Alpine vs. Carpathian lithic resources. *Quaternary International*, 351: 146–162.

BRANDL M., HAUZENBERGER C., POSTL W., MODL D., KURTA C., TRNKA G., 2011: Repolust Cave (Austria) revisited: Provenance studies of the chert finds. *Quartär* 58: 51–65.

BRANDL M., REITER V., 2008: Erstellung einer Rohmaterialdatenbank auf Grundlage der Silexfunde der Paläolithstationen von Krems – Hundssteig und Krems – Wachtberg. *Archäologie Österreichs* 19, 1: 43–49.

BROOKS I. P., 1989: Debugging the system: the characterisation of flint by micropalaeontology. In: I. P. Brooks, P. Phillips (Eds.): *Breaking the stony silence: papers from the Sheffield Lithics Conference 1988*. B.A.R. British Series 213. Pp. 53–71. Archaeopress, Oxford.

BSI 2009: *BSI British Standards. Code of practice for earthworks*. BS 6031: 2009.

BUSTILLO M. A., CASTAÑEDA N., CAPOTE M., CONSUEGRA S., CRIADO C., DÍAZ-DEL-RÍO P., OROZCO T., PÉREZ-JIMÉNEZ J. L., TERRADAS X., 2008: Is the macroscopic classification of flint useful? A petroarchaeological analysis and characterization of flint raw materials from the Iberian Neolithic mine of Casa Montero. *Archaeometry* 51, 2, 2009: 175–196.

CHAZAN M., 2001: Bladelet production in the Aurignacian of La Ferrassie (Dordogne, France). *Lithic Technology* 26, 1: 16–28.

DEMARS P.-Y., LAURENT P., 1992: *Types d'outils lithiques du Paléolithique supérieur en Europe*. Presses du CNRS, Paris.

DIBBLE H. L., ROTH B., LENOIR M., 1995: The use of raw materials at Combe-Capelle Bas. In: H. L. Dibble, M. Lenoir (Eds.): *The Middle Paleolithic site of Combe-Capelle Bas (France)*. Pp. 259–287. University Museum Press, Philadelphia.

ELEKES Z., BIRÓ K. T., UZONYI I., RAJTA I., KISS Á. Z., 2000: Geochemical analysis of radiolarite samples from the Carpathian Basin. *Nuclear Instruments and Methods in Physics Research B* 170: 501–514.

FÉBLOT-AUGUSTINS J., 1997: *La circulation des matières premières au Paléolithique. Synthèse des données, perspectives comportementales.* Vol. 2. Études et recherches archéologiques de l'Université de Liège 75. Service de préhistoire, Université de Liège, Liège.

GÖTZE J., 2010: Origin, mineralogy, nomenclature and provenance of silica and SiO_2 rocks. *Archeometriai Műhely* 3: 163–176.

GSA 2009: *Geological Rock-Color Chart with genuine Munsell color strips*. Geological Society of America, 2009 revised version.

HAHN J., 1977: *Aurignacien. Das ältere Jungpaläolithikum in Mittel- und Osteuropa*. Fundamenta (Reihe A) 9. Böhlau, Cologne.

HAHN J., 1988: *Die Geißenklösterle-Höhle im Achtal bei Blaubeuren I: Fundhorizontbildung und Besiedlung im Mittelpaläolithikum und im Aurignacien*. Forschungen und Berichte zur Vor- und Frühgeschichte in Baden-Württemberg 26. Theiss, Stuttgart.

KUHN S., 1992: On planning and curated technologies in the Middle Paleolithic. *Journal of Anthropological Research* 48: 185–214.

LUCAS G., 2006: Re-evaluation of the principal diagnostic criteria of the Aurignacian: the example from Grotte XVI (Cénac-et-Saint-Julien, Dordogne). In: O. Bar-Yosef, J. Zilhão (Eds.): *Towards a definition of the Aurignacian*. *Proceedings of the Symposium held in Lisbon, Portugal, June 25–30, 2002*. Trabalhos de Arqueologia 45. Pp. 173–186. Instituto Português de Arqueologia, Lisbon.

LUEDTKE B. E., 1992: *An archaeologist's guide to chert and flint*. Archaeological Research Tools 7. University of California, Los Angeles.

MATEICIUCOVÁ I., 2008: *Talking stones: the chipped stone industry in Lower Austria and Moravia and the beginnings of the Neolithic in Central Europe (LBK), 5700–4900 BC.* Dissertationes Archaeologicae Brunenses/Pragensesque 4. Masaryk University, Brno.

MOREAU L., 2012: Status of flake production The Aurignacian of Breitenbach (Sachsen-Anhalt, Germany): status of flake production. In: A. Pastoors, M. Peresani (Eds.): *Flakes not blades: the role of flake production at the onset of the Upper Palaeolithic in Europe*. Wissenschaftliche Schriften des Neanderthal Museums 5. Pp. 181–197. Neanderthal Museum, Mettmann.

MOREAU L., BRANDL M., SCHMITSBERGER O., NEUGEBAUER-MARESCH C., 2013: *Stratzing/Krems-Rehberg in its lithic landscape: economic behaviour in the late Aurignacian of the Middle Danube region*. Poster presentation. ESHE-Abstracts, European Society for the study of Human Evolution, Vienna September 2013.

NEHYBA S., RÖTZEL R., 2004: The Hollabrunn-Mistelbach formation (Upper Miocene, Pannonian) in the Alpine-Carpathian foredeep and the Vienna Basin in Lower Austria: an example of a coarse-grained fluvial system. *Jahrbuch der Geologischen Bundesanstalt* 144, 2: 191–221.

NEUGEBAUER-MARESCH C., 1993: Zur altsteinzeitlichen Besiedlungsgeschichte des Galgenberges von Stratzing/ Krems-Rehberg (with contributions by W. H. Schoch and S. Verginis). *Archäologie Österreichs* 4, 1: 10–19.

NEUGEBAUER-MARESCH C., 1995: Altsteinzeitforschung im Kremser Raum. In: A. Krenn-Leeb (Eds.): *Perspektiven zum Werdegang von Krems und Stein, Festgabe zum 1000-Jahr-Jubiläum der Stadt Krems-Stein*. Österreichische Gesellschaft für Ur- und Frühgeschichte 5. Pp. 14–25. Hartleben, Wien.

NEUGEBAUER-MARESCH C., 1996: Zu Stratigraphie und Datierung der Aurignac-Station am Galgenberg von Stratzing/Krems-Rehberg, Niederösterreich. In: J. Svoboda (Ed.): *Paleolithic in the Middle Danube Region, Anniversary volume to Bohuslav Klíma*. Pp. 67–80. Archeologický ústav AV ČR, Brno.

NEUGEBAUER-MARESCH C., 1999: *Le Paléolithique en Autriche*. Préhistoire d'Europe 8. Millon, Grenoble.

NEUGEBAUER-MARESCH C., 2008: Galgenberg-Stratzing/ Krems-Rehberg and its 32,000 years old female statuette. *Wissenschaftliche Mitteilungen Niederösterreichisches Landesmuseum* 19: 119–128.

NIGST P.R., 2012: *The Early Upper Palaeolithic of the Middle Danube Region.* Studies in Human Evolution. Leiden University Press, Leiden.

OLIVA M., 1996: Prehistoric exploitation and utilization of the Krumlovský les hornstone. In: J. Svoboda (Ed.): *Paleolithic in the Middle Danube region*. *Anniversary volume to Bohuslav Klíma*. Pp. 49–66. Archeologický ústav AV ČR, Brno.

PAPP A., RÖGL F., SENEŠ J. (Eds.), 1973: *M2 Ottnangien. Die Innviertler, Salgótarjáner, Bántapusztaer Schichtengruppe und die Rzehakia Formation.* Chronostratigraphie und Neostratotypen: Miozän der zentralen Paratethys, Vol. 3. Slowakische Akademie der Wissenschaften, Bratislava.

PERPÈRE M., 1972: Les burins aurignaciens du gisemant des Vachons (Charente). In: *Congrès Préhistorique de France, XIX*[ème] *session, Auvergne, 1969*. Pp. 320–323. Société préhistorique française, Paris.

PESESSE D., MICHEL A., 2006: Le burin des Vachons : apports d'une relecture technologique à la compréhension de l'Aurignacien récent du nord de l'Aquitaine et des Charentes. *Paléo* 18: 143–160.

PŘICHYSTAL A., 2009: *Kamenné suroviny v pravěku východní části střední Evropy*. Masarykova univerzita, Brno.

PŘICHYSTAL A., 2010: Classification of lithic raw materials used for prehistoric chipped artefacts in general and siliceous sediments (silicites) in particular: the Czech proposal. *Archeometriai Műhely* 3: 177–182.

PŘICHYSTAL A., 2013: *Lithic raw materials in prehistoric times of Eastern Central Europe*. Masarykova univerzita, Brno.

RICHTER J., 1997: *Sesselfelsgrotte III. Der G-Schichten-Komplex der Sesselfelsgrotte. Zum Verständnis des Micoquien*. Quartär-Bibliothek 7. Saarbrücker Druckerei und Verlag, Saarbrücken.

ROEBROEKS W., 1988: *From find scatters to early homind behaviour: a study of Middle Palaeolithic Riverside Settlements at Maastricht-Belvédère (The Netherlands*). Analecta Praehistorica Leidensia 21. University of Leiden, Leiden.

RÖTZEL R., 1998: *Geologische Karte der Republik Österreich 1:50000 – 22 Hollabrunn*. Geologische Bundesanstalt, Wien.

STEGUWEIT L., 2010: New insights into the inventory of Alberndorf (Lower Austria) and some remarks on the "Epi-Aurignacian" controversy. In: C. Neugebauer-Maresch, L. R. Owen (Eds.): *New aspects of the Central and Eastern European Upper Palaeolithic – methods, chronology, technology and subsistence*. Mitteilungen der Prähistorischen Kommission 72. Pp. 221–229. Verlag der Österreichischen Akademie der Wissenschaften, Vienna.

TRNKA G., 2005: Die jungpaläolithischen Stationen von Alberndorf im Pulkautal im nördlichen Niederosterreich (Weinviertel). *Mitteilungen der Kommission für Quartärforschung der Österreichischen Akademie der Wissenschaften* 14: 195–212.

UMGEHER-MAYER S., 2007: Die vergleichende Statistik der Artefaktmorphologie der Grabung Stratzing/Krems-Rehberg der Jahre 1985/1986. *Archäologie Österreichs* 18, 2: 19–20.

WEISSMÜLLER W., 1995: *Sesselfelsgrotte II. Die Silexartefakte der Unteren Schichten der Sesselfelsgrotte. Ein Beitrag zum Problem des Moustérien*. Quartär-Bibliothek 6. Saarbrücker Druckerei und Verlag, Saarbrücken.

WESSELY G. (Ed.), 2006: *Geologie der österreichischen Bundesländer: Niederösterreich*. Geologische Bundesanstalt, Wien.

Michael Brandl
Oliver Schmitsberger
Christine Neugebauer-Maresch
Austrian Academy of Sciences
OREA – Institute for Oriental and European Archaeology
Dept. of European Archaeology
Fleischmarkt 22
A-1010 Vienna
Austria
E-mail: michael.brandl@oeaw.ac.at
E-mail: oliver.schmitsberger@aon.at
E-mail: christine.neugebauer-maresch@oeaw.ac.at

Luc Moreau
MONREPOS Archaeological Research Centre and Museum for Human Behavioural Evolution
Schloss Monrepos
D-56567 Neuwied
Germany
E-mail: moreau@rgzm.de