News from the Eastern Fringe – The Baunzen Site near Vienna, Austria

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Abstract: As previously suspected, the St. Veit Klippen Belt series west of the city limits of Vienna produced evidence for prehistoric quarrying and knapping activities linked to radiolarite outcrops additional to the well-known site of Vienna-Mauer. However, the density of this recently discovered 'mining cluster' west of Vienna surpassed even the most optimistic expectations. The present study discusses one of the largest newly discovered knapping sites within this mining landscape, the Baunzen site, St. Pölten-Land district. Surveys of the archaeological evidence, a characterization of 'Baunzen type' silicites and initial techno-typological investigations on a representative sample of debitage allowed for preliminary assessments of the new finding`s nature.

The site is composed of an extensive waste heap of on-the-spot knapping and testing debris, weathering out of a steep slope bounded by a small river, and additionally cut by a recently constructed road. The Baunzen type raw material consists of two main radiolarite varieties. Both are in most cases fine grained but frequently display tectonic clefts, reducing the overall knapping quality significantly. As a result, oftentimes only small angular broken specimens could be used as initial cores.

Chronologically, quarrying and knapping activities at the Baunzen site appear to cover an extended period of time. The investigated sample of debitage, exclusively surface finds, suggests a relatively young dating within the Neolithic period and potentially beyond, with the majority of the lithic material assignable to the flake dominated Late Neolithic (Copper Age) industries in northeastern Austria. However, based on the admittedly poor state of research concerning the Late- and Eneolithic in the study area, only a small number of assemblages dating to those periods contain Baunzen type material, and to date there exists no evidence for Post-Neolithic stone tool production on Baunzen radiolarite. Hopefully, ongoing projects will be able to answer the most pressing chronological issues of the 'Neolithic mining landscape of Vienna', with the Baunzen site as starting point.

Keywords: St. Veit Klippen Belt, prehistoric mining, Baunzen, radiolarite, petrography, lithic debris heap, on-the-spot knapping, lithic technology, Late Neolithic/Copper Age

Introduction

In an initial paper, Michael Brandl and Gerhard Trnka (2014) outlined the geo-archaeological potential of the easternmost part of the Eastern (Calcareous) Alps concerning resources for chipped stone tool production. The goal of this paper was to characterize and present the range of prehistorically used SiO_2 raw materials in the study area, the macro- and microscopic characterization of defined type varieties in order to provide a 'source catalogue', and to create a framework within which further investigations and an expansion of our knowledge of prehistoric raw material sources at the Eastern Fringe of the Northern Calcareous Alps (NCA) could take place.

Of late, specifically the geologically complex St. Veit Klippen Belt (linked to the Flysch Zone north of the Eastern Alps) has produced evidence for a higher density of prehistoric quarrying and mining activities in the western parts and west of the city limits of Vienna than previously anticipated. Amongst scientists, the potential and likeliness of prehistorically used chert and radiolarite outcrops additional to Vienna-Mauer and the Gemeindeberg in Vienna district, along the carbonatic geological formations of the St. Veit Klippen Belt was more or less taken for granted, and has been proposed by Brandl and Trnka (2014: 344), however, the proof and verification was only recently achieved. This area can now indeed be considered a prehistoric 'mining hot-spot', which allows to establish what we would like to term the 'Neolithic mining landscape of Vienna'. The current study is specifically focused on one site situated within this mining cluster, the Baunzen site in the district St. Pölten-Land. We present preliminary archaeological evidence, provide

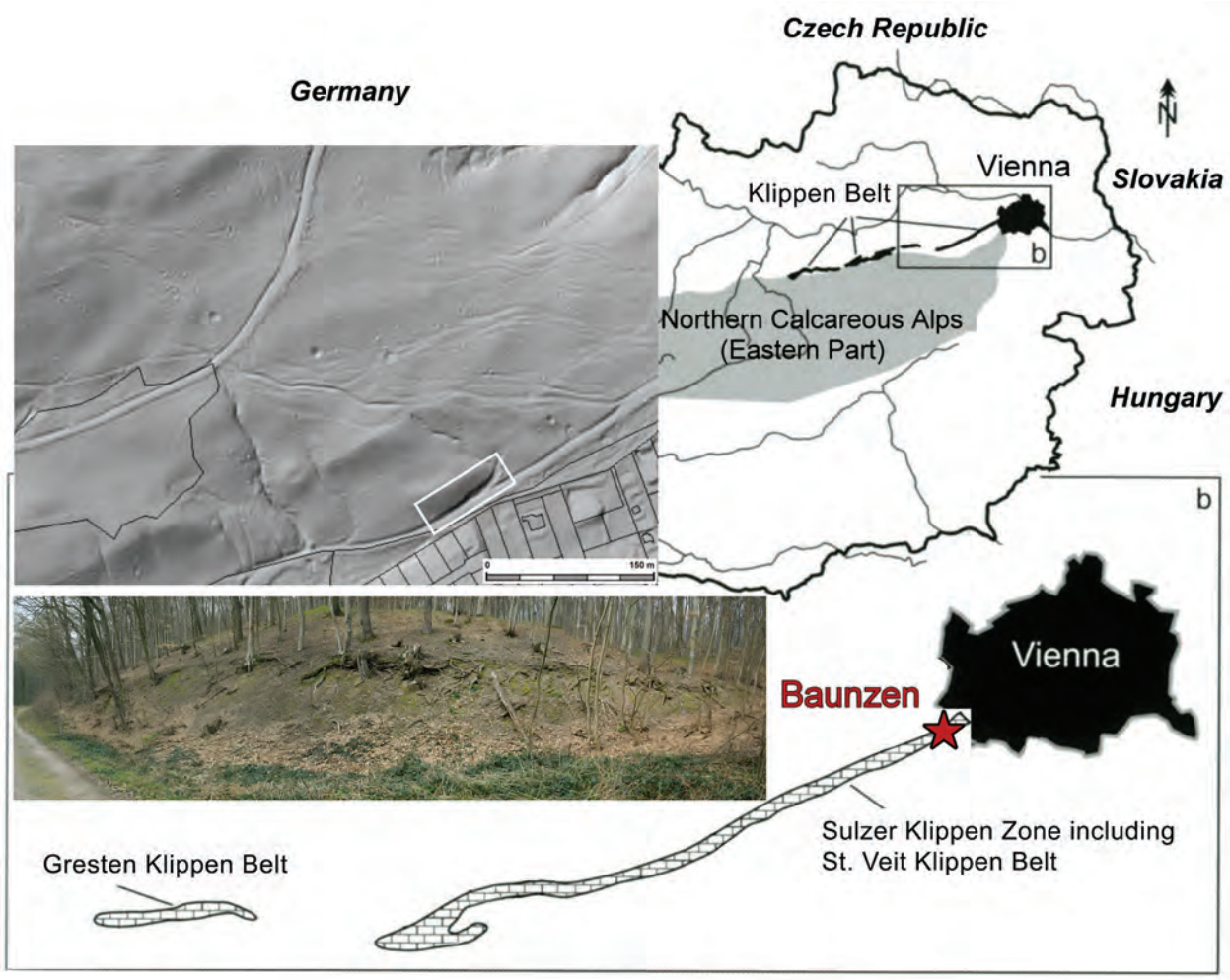

Fig. 1. Location and overview of the Baunzen site, St. Pölten-Land distrit. Photo: G. Trnka.

a characterization of 'Baunzen type' silicites and offer insight into techno-typological aspects of a representative sample of debitage collected at the site in order to make assessments of the nature of the new findings, which shed new light on the area immediately west of present-day Vienna.

The Baunzen site

Geographical setting

Located in the eastern part of the Wienerwald and north of the Northern Calcareous Alps (NCA), St. Veit Klippen Belt rock units occur in the westernmost areas of Vienna and form the hill ranges of the Gemeindeberg, Trazerberg, Girzenberg, Roter Berg and Flohberg (Penz 2007). The Klippen Belt extends throughout the entire Wienerwald area and comprises numerous independent units. In the southwestern extension of the St. Veit Klippen Belt, nine Klippen located at the small village of Baunzen south of Purkersdorf, St. Pölten-Land district, and west of Vienna constitute the Baunzen Klippen range (Prey 1979: 215). The archaeological site is linked to one of those Klippen formations and situated on a slightly north-south inclining slope which forms the southern foothills of the Feuersteinberg (= 'flint hill') immediately northwest of Baunzen (Fig. 1). At this locale, an extensive accumulation of loose silicified limestone and radiolarite scatter weathers out from the surface, and rapidly erodes out of steeper parts of the hill which drops to the bed of a small river in the south (Fig. 2). There, the slope is additionally cut by a road.

Geology

At the northern fringe of the Northern Calcareous Alps (NCA) carbonates genetically belonging to the latter overlay rock masses of the Flysch Zone. Intercalated in the Flysch Zone are Upper Jurassic and Lower Cretaceous multicoloured limestones associated with shaly clays, marls, and sandstones. The limestones frequently contain deep sea radiolarites and cherts, evidence of the subsidence processes of the ocean floor during Middle Jurassic times. These geological

Fig. 2. Lithic scatter on the surface of the debris heap at Baunzen, St. Pölten-Land district. Photo: G. Trnka.

Fig. 3. Radiolarite outcrop at the Baunzen site, St. Pölten-Land district. Photo: G. Trnka.

formations are defined as Klippen Zones (Janoschek *et al.* 1954; Prey 1979, 1991, 1993; Trnka 2014).

In the Flysch Zone of the Wienerwald area west of Vienna occur rock formations associated with the Gresten Klippen Zone and the Sulzer Klippen Zone, including the St. Veit Klippen Belt (Prey 1991), which are tectonically separated. Characteristic for Gresten type Klippen is the presence of Buntmergel Serie, which are not found at formations of St. Veit Klippen. At Baunzen near Purkersdorf occur Klippen built up from mica-rich sandy Posidonia beds at the base and shales, cherty shales and radiolarites of Upper Jurassic age on top imbedded in Middle Cretaceous shales and Gault Flysch. This geological set-up is characteristic for St. Veit Klippen Belt rock units, more precisely the Rotenberg formation (Prey 1979: 215–216; Wessely 2006: 99).

Archaeological evidence

At close examination we found that almost every single lithic specimen at the Baunzen site displays traces of working, identifying the locale as the waste heap of an extensive on-the-spot knapping site. The surficial visible part of the dump site extends roughly 60m from north to south and 80m from east to west. At the western end of the debris field, close to the brook bed, radiolarite crops out as large boulders measuring up to 100cm (Fig. 3). Since no excavation has been conducted it is unclear how far they extend and if or how they are linked to the underlying bedrock. Mining traces, e.g. levelled quarrying pits, were not detected. It is possible that it was sufficient to extract material from the surface outcrops or top soil residual deposits. A possible mining tool in the form of a crudely shaped radiolarite flake with splintering on one broad edge which could have been used as a pick was also discovered (Fig. 4). Additionally, pieces are frequently fire influenced, indicated by a reddish to violet hue and characteristic micro-cracks (and thus clearly differentiable from type 2b, Fig. 5 and 6).

Fig. 4: Potential mining tool (pick) of poor quality raw material. Photo: G. Trnka.

Raw material characterisation

A small sample of Baunzen type material was presented by Brandl and Trnka (2014), however, a more detailed characterization is now possible based on the sample collected from the extensive waste debris fields at this locale.

Fig. 5. Macroscopic varieties of Baunzen type radiolarite. Photo: G. Trnka.

General information

Proposed name:	Baunzen radiolarite.
Material:	Jurassic radiolarite.
Geological age:	Upper Jurassic.
Geological formation:	Rotenberg Formation.

Facies

Deep marine Upper Jurassic Beckenfacies. Recent geochemical investigations of material from the St. Veit Klippen belt revealed a closer relation between St. Veit Klippen and NCA rock formations rather than with Pienidic units (Brandl *et al.* 2014: 150).

Source of silica

The source of the silica responsible for radiolarite formation at Baunzen can be identified as skeletal opal diagenetically derived from the tests of silica-bearing marine microorganisms, predominantly radiolarians.

Petrography

Two main raw material types can be distinguished based on macroscopic and microscopic properties of the investigated material from Baunzen (Tab. 1). Type 2 is again subdivided into two categories, with colour as the distinguishing element. The macroscopic variety of Baunzen radiolarites is illustrated in Fig. 5.

Type 1 and either type 2a or 2b often occur in one nodule, and in these cases the finer grained types 2a or 2b form the core material or patches in nodules and flat nodules of type 1 material (Fig. 6:d and e; Table 1). The transition between the coarser and the finer rock parts is always gradual. Rarely, all types can display banding or lamination. In some cases the bands are built up from alternating pale green and bluish-grey rock parts, and occasionally light blue banding occurs related to chalcedony as cleft filling material. Sometimes accumulated POM (particulate organic matter) occurs in the form of black flakes or flitter causing dark splotches in the rock matrix (Fig. 6:f).

Raw material quality

Both types are fine grained (type 1 is micro-, types 2a and 2b are cryptocrystalline). The material is frequently cleft due to tectonic stress. Consequently, small pieces can display high quality, however, caused by tectonic clefts the overall quality is significantly reduced and only allowed for the use of angular broken small pieces as initial cores.

Table 1. Characterization of varieties of Baunzen type radiolarite.

Features	Type 1	Type 2a	Type 2b
Colour range acc. to Munsell (GSA 2009)	10Y 6/2 Pale Olive – 5GY 7/2 Grayish Yellow. Green – 5GY 5/2 Dusky Yellow Green – 5GY 6/1 Greenish Gray	5B 5/1 Medium Bluish Gray – 5B 6/2 Pale Blue	5P 4/2 Grayish Purple – N6 Medium Light Gray
Micropicture	Fig. 6:a	Fig. 6:b	Fig. 6:c
Translucidity	Non translucent	Semitranslucent / rarely translucent	
Grain size according to ISO14688-1 (BSI 2009: 7)	Medium – coarse silt	Clay – fine silt	
Texture acc. to Dunham (1962) and Embry and Klovan (1971)	Mudstone – wackestone	Mudstone	
Structure	Microcrystalline	Cryptocrystalline	
Fossil inclusions	Predominantly radiolarians, occasionally monaxon sponge spicules, POM (particulate organic matter in the form of black flakes, sometimes accumulated; for a definition of POM see Volkman, Tanoue 2002)	Radiolarian phantoms (sometimes barely visible), rarely sponge spicules, sometimes POM (particulate organic matter in the form of black flakes)	
Non-fossil inclusions	Black and brown accessory minerals (e.g. heavy minerals, Fe-oxides), sometimes occurring in streaks, carbonates (interspersed crystal faces are discernable)	Black and brown accessory minerals (e.g. heavy minerals, Fe-oxides), residues of the host rock (carbonates) in the form of white dissolved structures ('swimming' in a glassy matrix and causing pores or irregularly shaped voids when situated at the rock surface and weathered).	

Attempt of a morphological and chronological assessment of the chipped stone tool assemblage

The investigated material is a random sample collected in the course of two surveys conducted in 2014 and 2015 by a team of geologists and archaeologists. In order to achieve a representative cross section of the knapping debris present at the Baunzen site no specific selection criteria were applied for sampling. Noticeably, almost every siliceous rock that can be found at the site displays traces of (at least initial) chipping or testing.

For this preliminary assessment 318 specimens were investigated.[1] Here, technological characteristics were not individually recorded and statistically evaluated but summarily described and interpreted. Hence, facts and observations provided in the present study were utilized for a basic characterization of the lithic technology and may not be confused with results obtained in the course of an investigation according to strict methodological criteria.

One of the well-known limitations when investigating material from waste heaps associated with on-the-spot workshops at raw material quarrying locals is the absence of cores prepared for further exploitation and suitable blanks, which were typically taken to further processing sites. Consequently, solely unsuitable knapping debris, broken debitage and misfired (and very rarely exploited) cores remained on spot hampering any techno-typological analyses. Furthermore, traces of minor looting activities were recorded at the site, and it is possible that some of the 'nice' specimens were removed unauthorized. Nevertheless, the collected sample is suitable for preliminary assessments and will be discussed according to artifact types.

Cores

Frequently natural debris or debris derived from the quarrying activities, and large flakes or heat-splinters were used for uncurated cores, which were not extensively exploited. Some of these specimens were only minimally chipped which can be interpreted as raw material testing (Fig. 7:a). Many of these initial cores were rejected after only one or two test blows.

As initially stated, it is very likely that suitable cores were exported from the site. Cores displaying further exploitation chiefly attest for opportunistic and even unsystematic core reduction technology. This is additionally supported by the observation that

[1] The investigated assemblage is housed at the Oriental and European Archaeology Institute of the Austrian Academy of Sciences. Additional material stored at the Vienna Lithothek (VLI) and in other collections was not included into the current study.

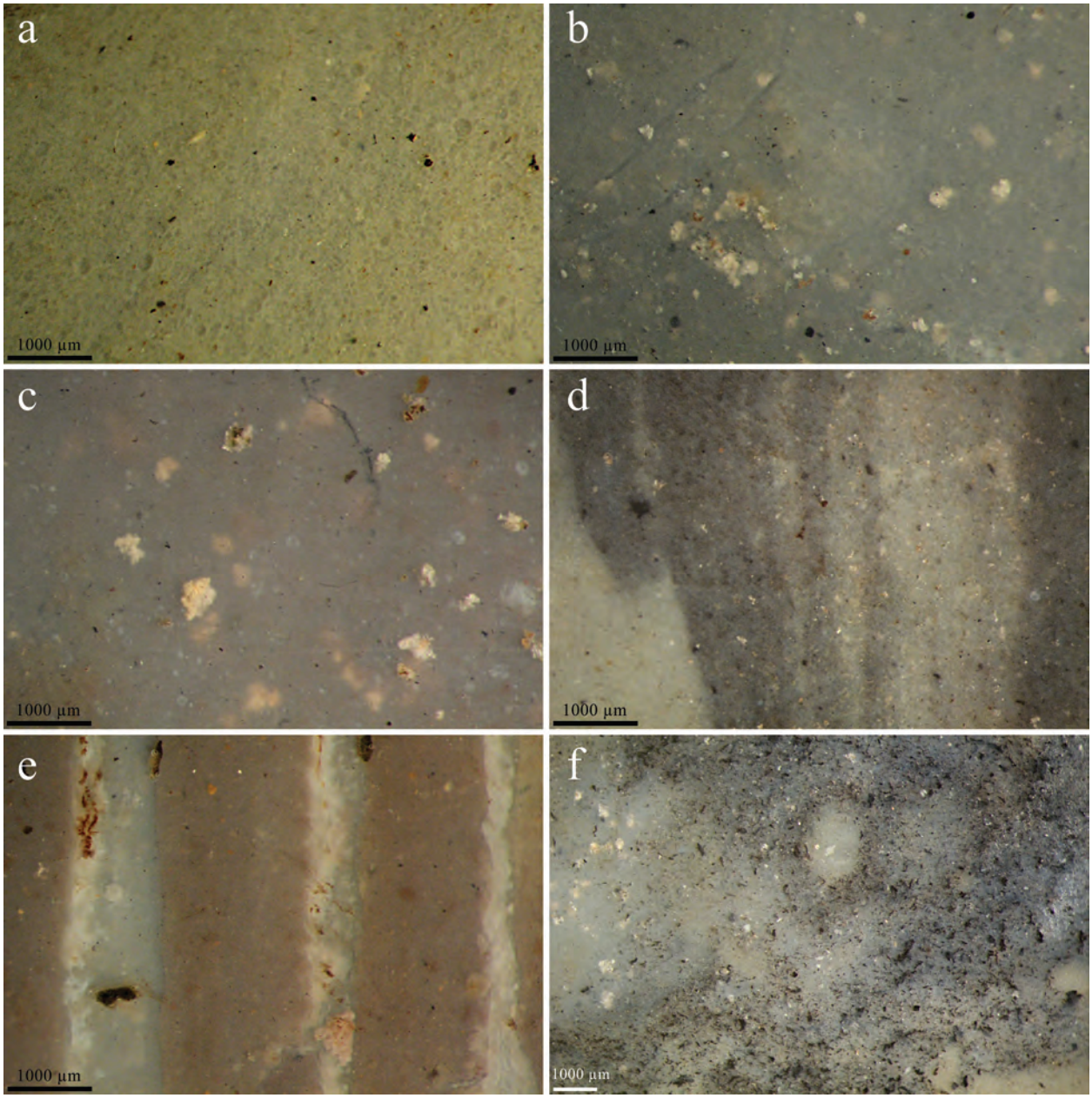

Fig. 6. Microscopic varieties of Baunzen type radiolarite. Photo: G. Trnka.

preparation flakes very rarely illustrate regular scars and ridges on their dorsal sides and dorsal reduction. The rare specimens displaying these features (dorsal regular parallel blade and bladelet scars) indicate the use of extensively exploited blade and bladelet cores for flake production (Fig. 7:b).

The almost complete absence of rejected as well as exhausted blade cores (Fig. 7:c) allows for the conclusion that blades were not the primary objective of the knappers at Baunzen. Regularly or at least roughly regularly worked flake cores are also scarce, however, some exhausted specimens and fragments indicate that they must have been present (Fig. 7:d and e). The majority of cores at Baunzen can broadly be defined as irregular flake cores (Fig. 7:f). Some exhausted cores display features characteristic for splintered pieces (Fig. 7:g), which is indicative of bipolar technology with the use of an anvil. Additionally, the distal ends of some blade-like flakes possess scars corresponding to this kind of core reduction.

Debitage

As can be expected at such a lithic quarry and initial processing site flakes clearly dominate the lithic assemblage. Blades and blade-like debitage occur in a much smaller amount and are rather irregularly shaped

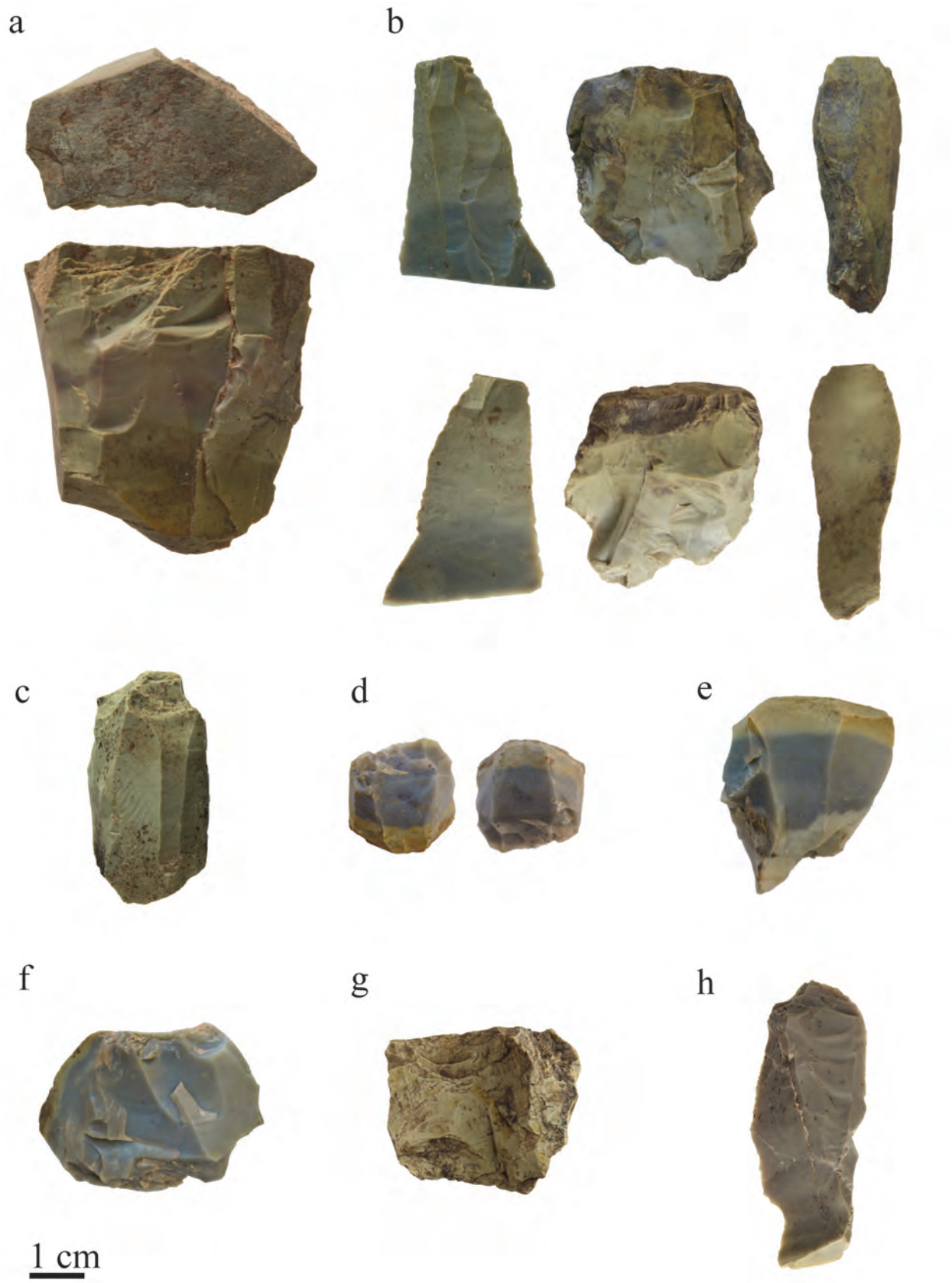

Fig. 7. Baunzen site, St. Pölten-Land district. Sample of debitage collected from the surface for techno-typological investigations. Photo: G. Trnka.

Fig. 8. Hammer stones from the Baunzen site St. Pölten-Land district. Photo: G. Trnka.

(Fig. 7:b and h). This can be explained by two possible scenarios: either, as already stated at the description of the cores, flakes were the primary target products of the lithic industry, or flakes only represent the waste of core preparation and blades as final products were exported. The absence of failed blades displaying e.g. hinge, step, or plunging terminations, supports the idea that altogether the production of flakes and elongated blade-like flakes was the primary objective of the Baunzen lithic industry rather than blade or bladelet technology.

Large flakes are typically wide, thick and short, suggesting that the majority derived from shaping the raw pieces. A further indication is the abundance of decortification flakes, with their dorsal sides completely or largely covered by natural or cleft surfaces.

Knapping properties

Most debitage displays well pronounced bulbs or cones sometimes with additional impact scars, whereas diffuse bulbs are rather rare. In combination with pronounced Wallner lines and partly 'irregular' ventral sides this is an indication for the preference of direct, hard percussion, also supported by the find of hammer stones associated with the knapping debris (Fig. 8). Specifically the combination of frequently irregular ventral sides and dorsal scar patterns gives the impression that those specimens were not only knapped applying hard percussion but crudely crushed.

All striking platforms are plane and irregularly shaped and rarely on ridges or punctiform. There exists no indication for platform preparation. The platforms are frequently on the natural surface or on clefts and unintentional breaks, which conforms to the observation of the use of shatter and natural debris for cores.

Dorsal reduction is also scarcely detected at flakes from Baunzen. This might be due to the fact that at the site quarrying debris and material from initial stage reduction sequences prevails in contrast to more advanced core preparation products. Dorsal reduction was observed at some blade-like flakes and fragments (Fig. 7:h) and at the exploitation edges of few irregularly shaped cores.

Core exploitation techniques

As mentioned above, natural surfaces or clefts and rarely old flake scars served as striking platforms. Crested flakes or blades occur only very infrequently. Almost all cores with only few flake scars display unidirectional striking; in the course of intensified reduction cores were also turned and exploited multidirectionally. The reduction sequence corresponds to an expedient technology producing irregular and non-uniform core types predominantly based on the generally poor quality and angular shape of the raw pieces.

During the initial reduction stages or if applicable, sometimes small sequences of elongated and blade-like flakes were struck off the narrow sides of tabular specimens, which functioned as 'natural crests' remotely resembling what came to be known as 'Abensberg method' (Binsteiner 1990: 37–38 and Fig. 21). Some cores correspond to the category of splintered pieces which attest for bipolar technology applying *percussion posée* on a hard anvil. The identifiable waste debris, mainly consisting of short small flakes, oftentimes displays hinge fractures which attest for knapping accidents.

Reduction strategies

The observed reduction techniques appear predominantly expedient and strongly determined by the shape of the raw pieces (i.e. nodules, flat nodules, angular and tabular pieces) leaving an unsystematic impression of the core exploitation process. The minor role of dorsal reduction matches this concept.

More systematic planned core reduction is only observable in very few cases displaying parallel ridges or regular dorsal scar patterns. These rare cases (as far as determinable from the small investigated sample), predominantly blades and blade-like flakes, prevailingly show unidirectional exploitation, flake cores commonly display rotated reduction.

Summarily, it can be stated that at the Baunzen site no curated core technology is present, but on the contrary expedient and unsystematic core reduction

was performed on unprepared nodules and angular debris. Lithic debitage is dominated by flakes which were knapped applying hard direct percussion and sometimes *percussion posée*. The striking platforms are typically plane and irregularly shaped, and dorsal reduction is of minor importance for core exploitation. This scenario allows for a preliminary chronological assignment of the investigated assemblage into a Copper Age/Eneolithic context. Within the closer catchment area (i.e. the vicinity of Vienna), the Baunzen assemblage best compares to Vienna Gemeindeberg, which produced evidence for cultural material dating to the Boleráz and Jevišovice cultures (Penz 2007: 194–197), however, it differs from Vienna-Mauer Antonshöhe, which dates to the Neolithic Late Lengyel/early Epilengyel Mährisch-Ostösterreichische Gruppe (MOG) IIb stage (Trnka 2014). These similarities and differences are based both on the raw material used for chipped stone tool production and the applied technology and reduction strategy.

Based on the rare presence of blade cores at Baunzen, an onset of raw material exploitation at this locale (and maybe of quarrying) can be expected already in the Middle Neolithic, roughly corresponding to the Lengyel culture or the Early Copper Age/Epilengyel period. The peak of activities appears to fall into the 'classical' eastern Austrian Eneolithic and probably extends into the Bronze Age (compare Oliva 2010, 2014). Particularly indicative for post-Neolithic knapping activities at Baunzen are the crudely crushed specimens, which differ significantly from the waste debris recorded at Vienna-Mauer and also from material recently discovered at Vienna Inzersdorfer Wald, which is located ca. 5 km southeast of Baunzen and, according to preliminary investigations, most likely dates to the Eneolithic or the Copper Age (Penz and Schmitsberger 2016).

The toponym *Feuersteinberg* (= flint hill) additionally points to a supposedly post-Medieval use of Baunzen material, however the extent of these activities remains elusive. It is possible that they were confined to the gathering of loose pieces from the surface for the utilization as simple strike-a-lights. However, the archaeological framework of raw material exploitation sites in the Wienerwald area linked to Klippen Belt series is only at its incipient stages. At present a project concerned with the cultural background of these knapping activities is ongoing and will hopefully provide a more precise chronological assessment.

Conclusive remarks

The Baunzen site is one of several newly discovered waste heaps of on-the-spot knapping sites in the west of Vienna linked to the St. Veit Klippen Belt and plays an important role in the understanding of the scale of prehistoric resource management strategies in the Wienerwald area of Northern Austria.

The lithic raw material at Baunzen comprises of Upper Jurassic radiolarites displaying two main types. The knapping properties are generally good on small angular pieces, however, heavy tectonic fracturing does not allow for core preparation on larger nodules or blocks. The material typically shows a pale green appearance, with inclusions and/or core parts of bluish or violet finer grained rock components.

Morphological investigations of a sample from the Baunzen debris field revealed an expedient flake based core exploitation strategy. On site, raw pieces were tested and in some cases shaped into cores. The suitable specimens as well as the desired finished products of the chipped stone industry are in most cases missing. Archaeological traces include discarded exhausted cores (rarely), misfired cores and broken elements of the *chaîne opératoire* (flakes and blades broken on natural clefts or misfired pieces). The discarded cores display no sign of curated technology and core preparation (e.g. dorsal reduction), hence we can consider extensive but expedient raw material procurement strategies at this locale.

Generally an extended time period of activities has to be expected at the Baunzen site. Our sample, exclusively consisting of surface finds, suggests a relatively young dating within the Neolithic, maybe even extending into the Bronze Age and occasionally into more recent times. With a high likelihood the majority of the lithic material can be assigned to the flake dominated Late Neolithic (Copper Age) lithic industries in northeastern Austria, i.e. Vienna, Lower Austria, Upper Austria and potentially beyond.

Presently there are only few archaeological settlements known which produced this kind of material in their lithic assemblages (e.g. on the slopes of the Buchberg at Maria Anzbach, St. Pölten-Land district), however this is chiefly due to the state of the research of the Late Neolithic/Eneolithic in the region. With increasing research it will hopefully soon be possible to locate further archaeological sites that were supplied with St. Veit Klippen Belt raw material, however, it might turn out that it was only distributed in the closer vicinity of the quarrying sites.

Translated by Michael Brandl

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