Population mobility and lithic tool diversity in the Late Gravettian – the case study of Lubná VI (Bohemian Massif)

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Abstract

This paper presents the results of excavations conducted at the Late Gravettian site of Lubná VI in 2012 and 2018. This site is an exceptional example of a short-term Late Gravettian campsite, occupied between 27.5 and 27.1 ka cal BP. Due to the specific location of this site, in an area situated far from lithic raw material sources, the archaeological remains offer a rare possibility to understand the subsistence strategy of highly mobile hunter-gatherers in the Late Pleistocene. The knapped lithic assemblage is composed of erratic Cretaceous flint imported over long distances, and the tool inventory is typical of Late Gravettian assemblages from Central Europe, with a dominance of burins and backed implements. However, the lack of chert and flint raw material in the vicinity of the site inspired the occupants to use bladelet blanks to make hunting weaponry from burin spalls. This specific behaviour is unique among Gravettian inventories known from the western Carpathians. Reindeer dominate the faunal assemblage over other species. The season of occupation at Lubná VI was probably early autumn, and may be associated with the maximum use of environmental resources by the hunter-gatherers. The small campsite was located at a convenient spot for processing reindeer carcasses, where some hearth stone constructions were arranged. Because there was no woody vegetation in the closest vicinity of the site, reindeer bones and fat were used as fuel in hearths. Given the lack of nearby flint raw materials, the accessibility of large numbers of reindeer near Lubná, probably present on a seasonal basis, explains the occurrence of Late Gravettian occupation in this micro-region.

I. Introduction

This paper presents the results of an excavation conducted at the site of Lubná VI in 2018, which was a continuation of fieldwork carried out here in 2012. Both excavation seasons revealed traces of an intense Late Gravettian settlement, consisting of two fireplaces, around which were abundant archaeological and zoological materials. Due to the specific location of this site, in an area situated far from lithic raw material sources, its archaeological remains offer a rare possibility to understand the subsistence strategy of highly mobile hunter-gatherers in the Late Pleistocene.

II. The site

The complex of archaeological sites at Lubná is situated at the Rakovnik Foothills, within the Pilsen Hills in the Berounka Upland, in the central part of the Bohemian Massif (Fig. 1A). The sites are located north of the village of Lubná, in the central part of the Černy Potok river valley, the fifth stream that flows into the Rakovnický Potok in Rakovník, i.e. 3.72 km north of the site (Fig. 1B, C). The valley yielded a number of archaeological sites, all of which are located on a gentle ridge slope facing southeast, protruding northeast from the Na pláni hill (409 m a.s.l.). Lubná I was found at the local brickyard, 100 m from the watercourse, at approx. 364 m a.s.l. and currently elevated 2 m above the watercourse, while Lubná VI, was discovered in a road cutting about 300 m southwest from Lubná I, at a similar altitude and distance from the watercourse (Šída 2009, 2016) (Tab. 1). Research at the Lubná site cadastre began in the 1880s, when the palaeontologist J. Kušta, found Pleistocene bones (Kušta 1891). Kušta terminated his research in 1891 recording animal remains and lithic assemblages. The second phase of research began in 1905 with fieldwork conducted by J. Haken, J. Soukup, and J. Renner. They all acquired small lithic collections and discovered new locations (Lubná IV, VII and probably V and VIII). The third period of research occurred in 1933 by J. Böhm (1934). In the sixties S. Vencl excavated sites III and IV (Vencl, 1964). Recent excavations started in 2012 by P. Šída, and concerned site VI, where a fireplace lined with large numbers of stones and accompanied by lithic artefacts was discovered (Šída 2016).

Fig. 1. Location of the Lubná site complex in the background of: A) digital relief model of the Bohemian Massif; B) shaded relief model C) topographic map of the Lubná–Rakovník region.

Fig. 2. Map of surface sediments of the area between Lubná and Rakovník according to the Czech Geological Survey (geology.cz). Abbreviations of geological labels: Carboniferous: C_r – sandstones, siltstones, claystones, conglomerates, breccias, coal seams, volcanoclastics; C_{r1} – sandstones, siltstones, claystones, coal seams, breccias, volcanoclastics; C_{r2} – sandstones, conglomerates, siltstones, claystones, volcanoclastics, coal seams; $^{pe}C_n$ – reddish–brown siltstones and claystones, sandstones, conglomerates; c – lamprophyre; ^{mi}gd – microgranodiorite; ^{q}d – quartz diorite. Palaeozoic: $^{h}{}_{w}NP_{bl}$ – coarse–grained sediments; $_{p}N$ – sandstones, conglomerates, sands, sandy clays, quartzites; $^{si}{}_{w}NP_{bl}$ – silicified weathering and slate; $_{š}N$ – coarse–grained gravel with a predominance of silicites and quartz, sandy gravel; $_{w}NP_{bl}$ – fine to medium–grained slates and siltstones; $^{za}{}_{w}NP_{bl}$ – coarse–grained sediments with fragments of slates. Quaternary: ^{a}Qh – anthropogenic deposits (heaps, landfills); $^{es}Qp^{3}$ – slope sandy silts, sometimes clayey silts with rock fragments and loess; ^{f}Qh – fluvial silts, sands and gravels; $^{f}Qp^{2a}$ – fluvial sands and gravels; ^{n}Qh – sediments of water reservoirs, water

areas; Qh – silts and sandy silts, places with rock fragments and boulders; $^{s}{}_{hj}$Q – slope clays and clays with rock fragments, places with gravels.

Site	coordinates (WGS84)	altitude of topographic surface (m a.s.l.)	cultural layer altitude (m a.s.l.)	distance to water source (m)	distance to Lubná I (m)
Lubná I	50.0837608°N, 13.7026861°E	366	364	110	0
Lubná VI	50.0812875°N, 13.7006286°E	373	371,2	75	300

Table 1. Main location parameters of Lubná I and VI sites.

During the excavations, abundant bone materials were discovered, of which selected specimens were radiocarbon dated. To date, we have two sets of radiocarbon dates, one measured at the Centre for Isotope Research (University of Groningen, the Netherlands), and another at the Poznan Radiocarbon Laboratory (Poland). The 11 radiocarbon dates were obtained from reindeer and single Alpine ibex remains (Wilczyński et al., 2020a). The results indicate that the human occupation at Lubná VI falls between 27.5 and 27.1 ka cal BP and is contemporaneous with other Late Gravettian sites in central Europe (Lengyel and Wilczyński, 2018; Wilczyński et al., 2020a). Applying the Greenland ice core chronology (Rasmussen et al. 2014), the human occupation falls at the beginning of the GS-3 stadial.

III. Material and method

Fieldwork

In 2018 an area of 20 square meters were excavated, including a 2 square metre area that had been explored previously in 2012. Because of the impressive preservation of the stone structures, the excavation in 2018 aimed at leaving them in situ for further investigations. The excavated sediment was wet-sieved using 1 mm mesh. The positions of all archaeological finds and animal remains greater than 1 cm were recorded by total station.

Geology

The geological context to the complex of archaeological sites were carried out on the basis of the geoportal resources made available by the Czech Geological Survey (geology.cz) with particular emphasis on topographic (various scales) and geological maps (scales 1:25,000 and 1:50,000). Based on these, cartographic materials were developed and planimetric measurements were taken. Moreover, the resources of orthophotomaps and digital elevation models at various scales were used. These analyses were complemented by geological-geomorphological field mapping of the surroundings near the archaeological sites carried out simultaneously with archaeological works in August 2018.

Field descriptions of the sedimentary-soil sequences selected for further laboratory tests were based on the Fieldguide for soil description (2017). Laser particle size analyses in the 0.001-2000 µm range were performed on a Malvern Mastersizer 2000 HydroG. Gravel particles (>2000 µm) were separated on sieves and included in the calculation of the main fractions.

Lithic studies

All lithic materials collected at Lubná VI during the 2012 and 2018 field seasons were included in this analysis. Lithic raw materials were identified macroscopically following Přichystal (2013) and the Lithic Reference Collection of the ELTE University of Budapest (Mester 2013). The raw materials used to build the stone pavement beneath the hearths were studied macroscopically, using samples of local rocks (carboniferous and Miocene sandstones). We performed a lithic refitting analysis. Fragments which compose a complete artefact after conjoining them were counted as a single object regardless of the number of fragments. Therefore, the number of recovered artefacts is greater.

The knapped lithic assemblage was divided into four groups: cores (including lumps with single scars and pre-cores), chips/chunks, blanks (including flakes, blades and bladelets), and retouched tools. All of the complete unretouched artefacts and fragments >1.5 cm were included in our analysis. Retouched artefacts were studied regardless of their size. A lithic tool was defined here as a knapped stone product with an edge modified by retouching or burin spall removal. The tools were analysed in terms of lithic raw material, blanks of the tools, typology and use-wear. Retouched tools were described following the criteria proposed by Inizan et al. (1999), and were divided into major type classes: end-scrapers, burins, edge retouched tools, perforators, truncations and armature. Unfinished backed blades and bladelets were included as armatures. The category of armatures was subdivided into points, backed and backed-truncated artefacts. The points were further divided into Gravette/microgravette point, backed point, shouldered point and retouched point. The Gravette/microgravette definition here, following Demars and Laurent (1992), was restricted to those specimens having inverse mostly flat basal or rarely distal retouch opposed to the backed edge (Lengyel 2016, 2018). We included notched and denticulated artefacts within the group of edge retouched tools.

Use-wear analysis

Reconstructing human activities at the site was supported by functional analysis of the lithic tools. We analysed 426 artefacts, including 176 retouched tools, 103 blades, 62 flakes, and 85 burin spalls. Armatures were the most numerous among the group of formal tools (N=139), followed by burins (N=22), retouched blades (N=12), retouched flakes (N=2) and perforator (Table 7). Use-wear analysis was carried out at the Laboratory of Archaeometry and Archaeological Conservation, Institute of Archaeology, University of Wrocław, with the use of optical microscopes: an Olympus SZX9 stereomicroscope (×6.3–114) for recording fractures and scars, and a Nikon ECLIPSE LV100 metallographic microscope (×50–500) for analysing polish and other microtraces. Prior to microscopic observations the artefacts were cleaned briefly in an ultrasonic tank. Unfortunately, white patina was a common post-depositional modification present on most of the Lubná lithics. It covered all types particularly along edges, mimicked edge rounding and prevented observation of polish from use-wear processes. This is why, in many cases, the interpretation of traces was based on forms and direction of scars and was limited to determining the direction of movement. Final interpretations were made using a comparative experimental reference collection housed at Wroclaw University and published use-wear models (*e.g.* Sano 2012).

Archaeozoology

The identification of bone remains from Lubná VI was undertaken using comparative material housed at the Institute of Systematics and Evolution of Animals, the Polish Academy of Sciences in Kraków, and publications concerning animal bone identifications (Pales and Garcia 1981; Schmid 1972; Hillson 1992). Three quantification methods were used to calculate the species proportions, NISP (Number of Identified Specimens), MNI (Minimum Number of Individual Animals) and MNE (Minimal Number of Skeletal Elements) (Klein and Cruz-Uribe 1984; Lyman 1994; Reitz and Wing 1999). Significant fragmentation and lack of characteristic features meant that part of the bone assemblage could only be assigned generally to three categories based on size: large (*Bos*/bison size), medium (reindeer size) and small mammals (fox/hare size). Further, bone fragments without visible morphological features were classified as undetermined.

All the bone remains were subjected to detailed observations in order to identify any marks left by humans, carnivores and rodents, or plant root activity. The bones were examined closely to document all possible human modifications including cut marks, percussion marks and traces of burning (Bennet 1999; Binford 1981; Lyman 1994; Olsen and Shipman 1988; Stiner et al. 1995; Villa et al. 2002; Fernandez-Jalvo & Andrews 2016). Binford's (1981) criteria were used for interpreting cut marks on the bones of mammal taxa discovered on the site. Carnivore modifications were assessed based on numerous papers (Binford 1981; Haynes 1980, 1983; Lyman 1994; Fosse et al., 2012).

In archaeological studies, relevant information on the animal exploitation includes an analysis of the age at death profile of individual species. The age of animals represented at Lubná VI, whenever possible, was determined on the basis of the degree of formation and abrasion of individual teeth (Reitz and Wing 1999; Hillson 2005).

Isotopic studies of faunal material

Intratooth strontium, oxygen and carbon isotope analysis was used to investigate the seasonal mobility and dietary patterns of the reindeer individuals found at Lubná. Strontium in tooth enamel is resistant to diagenetic contamination and $^{87}Sr/^{86}Sr$ constitutes an effective proxy for establishing prey mobility across different geological units during the period of tooth growth (Price et al., 2002). Conversely, tooth dentine is porous to diagenesis and following burial endogenous strontium ratios are overprinted by exogenous strontium absorbed from the burial environment. Strontium in tooth dentine can therefore be used to estimate $^{87}Sr/^{86}Sr$ ratios at the burial location, and comparisons between dentine and enamel from the same site can reveal whether individuals grew up locally or migrated into the area near the site during life (e.g. Viner et al., 2010). Meanwhile, intra-tooth oxygen isotope ratios in fauna in mid-high latitudes vary according to seasonal temperature changes, while carbon isotopes reflect seasonal changes in diet (Pederzani & Britton, 2019). In total, 22 reindeer teeth from eight individuals were analysed, including some sets of M1-M2-M3 and P2-P3-P4 from the same individual. Additionally, eight plant samples collected from different geologies across the west Czech Republic were also analysed to improve the resolution of data available for constructing a basemap of strontium isotope variability in the region. Results from these analyses are still being interpreted and will be presented in full in a future dedicated paper (Pryor et al. in prep.). Here, we summarise only the main findings.

IV. Results

IV.1. Relief and surface sediments

The Lubná site complex is located at an altitude of 360 to 372 m a.s.l. (Fig. 1C). It is basically the lower, anthropogenically modelled edge of the slope (up to 5 m high), steeply descending to the bottom of the valley of the Černy Potok. The maximum peaks of the terrain are in the watershed zone and reach up to 409 m a.s.l. ("Na Pláni " Hill) to the west of the site at a distance of only 1.25 km. Even higher absolute heights built of Palaeozoic quartz diorites are present in the watershed zone, south of Lubná (the Senecka Hůra, 535 m a.s.l.), i.e. about 2.1 km from the site (Fig. 1C).

In the area surrounding the archaeological site the surface sediments are clearly differentiated both in terms of age and lithology. The sites are located within a patch of silty-sandy (loess-like) sediments (Fig. 2), covering the left (western) slope of the Černy Potok valley, which is generally oriented SW-NE. The Aeolian-diluvial, silty-sandy layer (Upper Pleistocene) marked on the geological map covers the entire slope and reaches as far as the plateau zone, on the boundary of which they completely disappear. This patch has a surface area of 1578 m^2, which represents 15% of the entire river basin. In the plateau zone, these covers go into the reddish-brown weatherings of siltstones, claystones and sandstones (Westphal, Carbon). Such a pattern of slope and plateau sedimentation in this part of the Rakovnik Foothills is also repeated in neighbouring, similarly oriented river valleys (Fig. 1B, C). This explains the location of the Aeolian covers by the occurrence of orographic barriers, forcing the accumulation of sediments just behind them. A characteristic feature of the slopes is the occurrence of dry erosive-denudational valleys. These forms are more readable on slopes built of Carboniferous rocks, while on loess-like slopes they are more straightforward, but less numerous, less dismembered, and reach as far as the watershed zones (Fig. 1C). In contrast, the narrow bottom of the valley of the Černy Potok (~50 m wide) is filled with young Holocene silty-sands with gravel. Fan-type accumulation forms are not recorded (Fig. 1C).

IV.2. Sediment-soil sequence at Lubná VI

The sediment-soil sequence is only 3 metres thick (Table 2; Fig. 3). Morphology of the section indicates that these are sub-horizontally layered sediments. The dominant fraction is silt, accompanied by sands and gravel. These thicker fractions are particularly visible in the form of several macroscopically recorded sandy-gravel layers usually 1-2 centimetres thick. These layers can be treated as lithological and stratigraphic markers. The profile base is a unit of layered, decalcified sandy-gravel sediments of red-brown colour. In the light of laser grain-size analyses, the sequence is built up by silts of different compactness and thicker fractions, i.e. sand and gravel. The presence of sandy grains is constantly recorded, but the share of this fraction generally decreases towards the topographic surface. Similarly, the presence of gravels is also recorded in almost all the samples, but their share is characterized by abrupt changes of content - from minimum values (close to zero) to maximum values (up to 23%). In the upper layers of the analysed sequence, generally up to a depth of 1.35 m, the Ap-Bt-BC soil horizons corresponding to lessivé soils are well readable. The diagnostic illuvial horizon is rich in clay coatings and infilling inside free spaces. The main cultural layer is documented at a depth of 1.75-1.85 m (Table 2; Fig. 3) within the carbonate dust-sand layer, which can generally be considered as an Aeolian loess deposit.

The formation of the sequence allows us to deduce the genesis of the diluvial-Aeolian layer covering the slope of the left bank of the Černy Potok. The main material forming these covers are older weathered clastic sediments (sands and gravels of the Carboniferous age) redeposited over short distances by both Aeolian and slope processes. The relatively large (~3 m) thickness of dust-sand sediments indicates the activity of weeding processes in higher hypsometric positions (the plateau and slopes), followed by short-distance transport and accumulation in the lower part of the slope in contact with the valley bottom. On the other hand, the formation of soil horizons formed from the topographical surface allows only conclusions about the post-sedimentary activity of pedogenic processes, which masks lithogenic processes and possible traces of human existence. Additionally, the formation of the topmost soil horizon, in the form of a mixed arable layer and composed of the material of all horizons, indicates intensive activity of soil erosion processes. Its considerable thickness, good formation of the topmost part, comprising an illuvial horizon and complete lack of the eluvial horizon, testifies to at least medium-advanced erosion, covering at least the upper 50 cm and perhaps even more than 1 m.

Depth [m]	Litho- and pedological characteristic
0-0.50	Ap soil horizon: silty loam, greyish brown, numerous plant roots, very numerous bio-channels, coprolites, drying cracks, sharp and horizontal border in colour and lithology, HCl-
0.5-0.85	Bt soil horizon: silty loam, brown-orange, solid, compact, porous, numerous vertical clay fillings in biochannels and fissures, HCl-, clear horizontal boundary
0.85-1.35	BC soil horizon: silty loam, light brown-yellow, structureless, massive, less cracked than Bt soil horizon, numerous vertical fissures (continuation of those described above), clay coatings as above (but less numerous), HCl-, boundary clear in colour and carbonate content
1.35-1.75	Ck soil horizon: calcareous silty loam with layers of sand and gravel (up to 5 mm in diameter), dark yellow with a reddish tint, rich in carbonates (gap fillings and small concretions), numerous horizontal layers of sand (1-2 cm thick) - especially visible at depths: 1.5 and 1.6 m, HCl+
1.75-1.85	Cultural layer; horizontal, compact layer composed of artefacts, bones, stones fragments of rocks embedded in ash. Stones – very varied (diameter up to 10 cm), both sharp-edged and rounded. Sharp and horizontal border in colour and lithology
1.85-3.00	Sandy silt turning downwards into sand, dark yellow-red with depth changing into reddish-rust, horizontally layered (sandy and gravel-sandy layers), numerous grey and white carbonate root pseudomorphoses, HCl-

Table 2. Characteristics of the sediment-soil sequence representative of the Lubná VI site.

Fig. 3. Lithological and pedological characteristics of soil-sediment sequence representative of Lubná VI site.

The silty-sandy sediment cover is accumulated to several meters depth in the lower parts of the slopes. This is probably the only sediment where occupational layers of Upper Palaeolithic date could have been preserved. The site location is within easy access of running water as it lies close to the riverbed. The low hypsometric and geomorphological position ensured good topoclimatic conditions for settlement. The zone covered by the site complex is an area located in the seclusion of a deep sub-south valley. The "disadvantage" of the Lubná VI location is the limited lookout in all directions.

IV.3 Spatial distribution

All finds were found in a single archaeological layer situated 1.8 m beneath the modern topographic surface embedded in a loess-like sediment. There is no evidence of cryoturbation or solifluction that would have disturbed the archaeological layer (Fig. 4). The archaeological layer tilts gently in the northern direction but without visible slope movements. Traces of solifluction are readable directly above the archaeological layer, in the younger loess unit. This is evidenced primarily by the layer of sediments with thicker grains (sandy-gravel), genetically linked to older rocks forming slopes in higher topographic positions, as well as documented in the floor of the section.

Fig. 4. Lubná VI (excavation in 2012 and 2018). NW section with lithic industry marked by black spots and bones marked on grey.

Fig. 5. Lubná VI (excavation in 2012 and 2018). General view of site surface and spatial distribution of all lithic artefacts including refittings A – red colour for tool refittings and blue for technological, and B – retouched tools.

These statements are supported by the spatial distribution of stone and knapped lithic finds. They were concentrated around two hearths (Fig. 5.). This pattern is similar for retouched tools, which do not form spatial clusters. The refittings of knapped stone artefacts include conjoins of breakage surfaces and removals siting into their negative scars. The distance between refitted elements is usually less than one meter (average distance between pieces is 0.81 m), and the farthest compilation includes artefacts spread over an area of 5 square meters. The spatial distribution of refitted objects vividly shows the way in which the whole technological process, together with retouched tool production, was carried out at the site. Both hearths were constructed with a number of stones (Fig. 6). The most commonly-used stone to construct a hearth was a local ferrous sandstone derived from carboniferous sediments, the closest outcrops of which can be found on the opposite slope of the valley. Rarely, iron-rich Neogene sandstones from Rakovník and quartz boulders of unclear origin were parts of the stone structure. Based on the distribution of knapped lithic refits it is possible to conclude that both hearth structures were contemporaneous, and are a consequence of undertaking similar activities within a limited area of a single occupational event.

Fig. 6. Lubná VI (excavation in 2012 and 2018). Stones from pavement. 1-2 – fine grained carboniferous ironsandstones, 3 – carboniferous ironsandstone with quartz cobbles, 4 – iron conglomerate, most probably Miocene, 1 – No. 1301, 2 – No. 898, 3 – No. 1036, 4 – No. 489. Scale bar is 10 cm.

IV.4 Lithic studies

A total of 13,742 chipped stone artefacts were discovered, 12,744 of which are chips and chunks we omitted from this study. The lithic assemblage consists of flakes (N=262), blades (N=274), retouched tools (N=198), and burins spalls (N=261). There are a further two cores, and a flint hammerstone made on a core (Table 3).

Lithic inventory:	N	%
Cores	2	0.20
Flint hammerstone	1	0.10
Flakes	262	26.25
Blades	274	27.46
Burin spalls	261	26.15
Retouched tools	198	19.84
Subtotal	998	100.00
Chips and chunks	12744	-
Total	13742	-

Table 3. Lubná VI (excavation in 2012 and 2018). General structure of the chipped stone inventory.

The complete knapped lithic assemblage was made of Cretaceous erratic flint originating in glacial moraines and glacio-fluvial sediments deposited north of the Ore Mountains or the Sudetes. The minimal distance of transport therefore is ca. 120 km. The lithic raw material is good quality and, according to the size of cores and blanks, was brought to the site as small nodules not exceeding over a dozen centimetres. The surfaces of the lithic finds do not show traces of rolling or other alterations caused by exposure to weathering. Among the artefacts numerous specimens are patinated. The patina consists of a thin film, light-blue in colour (N=545; 54.7%) or white in colour (N=106; 10.4%). Only 24 artefacts were burned (2.4%).

The cores do not exceed 6 cm (Fig. 7:2, 3). One core has two striking platforms which were used to remove mainly blades but flake scars are also visible on the flaking surface. It was made of a small nodule of flint. The second core has a single striking platform and yielded only blade removals. It was made on a nodule initially used as a flint hammerstone (Fig. 7:3). Both cores were intensively reduced.

Fig. 7. Lubná VI (excavation in 2012 and 2018). 1 – flint hammerstone, 2, 3 – cores, 4-7, 10-11 - burins, 8 - truncated blade, 9 - perforator.

A flint hammerstone was made on a blade core (Fig. 7:1). This specimen has strong traces of impacts at both ends. We cannot clearly determine whether this artefact was used for flint processing, or was also used for other activities, for example related to bone splitting.

The 262 flakes make up 26.17% of all artefacts excluding chips and chunks (Table 3). A total of 212 specimens are complete, 13 are proximal fragments, 2 are medial fragments, and 262 are distal fragments. Only 50 specimens are cortical or have naturally weathered surfaces (19.1%). The fully or nearly fully cortical items make up 3.5% of the flake inventory (N=9). The flakes are dominated by unidirectional dorsal scar patterns (N=146; 55.7%); specimens with transversally or obliquely oriented dorsal scars are less frequent (N=75; 28.6%). Sporadically, core trimming flakes occur (N=20). Rejuvenation of the core platform is evidenced by core tablets and small flakes that have been removed from the platform edge (N=22). The flake platforms are mostly plain (N=78; 34.7%), or faceted (N=70; 31.1%). Linear and punctiform platforms are less numerous (N=41; 18.2%). The butts often are dihedral (N=32; 14.2%). Only four flakes bear marks of natural cortical surface on their platforms. The mean dimension of the intact flakes (including refitted ones) is 22.8 x 21 x 3.8 mm; whereas only two items are greater than 50 mm (representing 0.8% of all the flakes). The biggest flake size is 51 x 37 x 11 mm.

A total of 274 blades are in the lithic inventory, representing (excluding chips and chunks) 27.4% of all lithics (Table 3). Only 75 specimens are complete, and 67 are proximal, 58 medial, and 74 are distal fragments. The majority of the blades are free of cortex or natural flint surfaces (N=235; 85.8%), and only four blades (6.9%) are almost fully covered by a natural surface. Unidirectional scar patterns predominate the blades' dorsal face (N=170; 62.0%) over bi-directional dorsal scar pattern (N=14; 5.1%). There also is a variety of crested blades (N=37; 13.5%) and secondary crested blades (N=36; 13.1%). Blade platforms are usually plain (N=74; 52.1%), and the number of faceted platforms (N=50; 35.2%) is smaller. Linear or punctiform butts are less numerous (N=13; 9.2%). Additionally, we have distinguished five blades with dihedral butts. Numerous blades have a regularised butt edge (N=77; 54.2%) and additionally, 26 specimens (18.3%) have clearly visible traces of abrasion (sometimes very strong, similar to polishing). The frequency of the lips on the ventral face is high (N=88; 62%). Generally, the blades are narrow and slender. The usage of burin-shaped cores also raise the frequency of this blade shape. The average dimensions of the complete blades, including the refittings, are 34.4 x 11 x 3.2 mm; while 19 specimens (6.9%) are more than 50 mm in length. The longest blade has dimensions of 74 x 21 x 3.5 mm.

Burin spalls are numerous and make up a quarter of the whole flint inventory (Table 3). Often they form refittings with burins, core/burins and themselves. Among them 119 pieces are complete. The dimensions of the burin spalls are only slightly smaller in comparison to blades from this site (Table 4), where the largest specimen has dimensions 58 x 9 x 7 mm. Additionally, 63 burin spalls showed evidence of retouching, present on the original surface of the blanks used for burin and burin/core production.

Tool	Parameter	Length	Width	Thickness
Blades	Average dimension	34.4	11	3.2
	Max	74	21	3.5
Burin spalls	Average dimension	27.2	5.1	3.4
	Max	58	9	7

Table 4. Lubná VI (excavation in 2012 and 2018). Comparison of average dimension of blades and burin spalls.

Retouched tools make up one fifth of the whole inventory (Table 3.). The most numerous type is the backed implement (N=136), representing less than 70% of the tools. Other tool groups occur less frequently, and among them burins (N=29) and retouched blades (N=17) are the most numerous. Other tool types are represented only by single pieces (Table 5).

Retouched tools, unfinished pieces and by-products:	N	%
Burins	29	14.65
Truncated blade	1	0.51
Perforator	1	0.51
Backed implements	136	68.69
Unfinished backed blades/backed by-product	11	5.56
Retouched blades	17	8.59
Retouched flakes	3	1.52

Total	198	100.00

Table 5. Lubná VI (excavation in 2012 and 2018). General structure of retouched tools inventory.

Fig. 8. Lubná VI (excavation in 2012 and 2018). 1-9 burins.

The burins comprise the second largest tool group in this inventory (N=29; 14.65% of the tools). There are dihedral (N=11), truncation (N=7), burin shaped cores (N=6), and on a break (N=2) subtypes (Fig. 7:4-10; 7). Also, combinations of different kinds of burins can be distinguished (N=2), as well as fragments of damaged/broken specimens of an undetermined type (N=1). The blanks of the burins are mainly blades (N=27) and two specimens were made on an undetermined blank and a flake. The burins were mainly produced on blanks of a trapezoid (N=12), triangular (N=5) or polygonal (N=4) cross section. The average dimensions of a complete burin (estimated from refitted items) are 52.8 x 19.7 x 7.7 mm. The biggest specimen is 80.3 x 29.1 x 8.9 mm. The dihedral burins (N=11) are generally specimens made by a number of blows, among which there are two double specimens. Burins on truncation (N=7) are composed of specimens made on medium-sized slender blades. The retouch which created the truncation was most often made by a fine regular set of removals. In the discussed inventory six burin shaped cores were described (Fig. 7: 4-7). These specimens, from the typological point of view, are polygonal, multi-scars burins, made on massive blanks, from which a series of slender burin spalls were detached. They seem to have been exploited first like a regular (most often dihedral) burin where the spalls were obtained from the blank's dorsal-ventral edge. The removal surface then moved onto the dorsal side of the blank, or rarely onto the ventral surface. The striking platform was created by (1) a truncation, or by (2) transversal percussion similar to the method used for creating dihedral burins. Two specimens have striking platforms created like those in Kostienki knives (Fig. 7: 4, 7). The largest piece of burin-shaped core measures 61 x 34 x 10 mm, and the smallest 24 x 15 x 15 mm. In two cases it was possible to refit single burin-spalls. Among them, three are transversal burins and two are combined burins: on break and truncation burin, and a dihedral burin in combination with an undetermined one.

A single truncated blade is represented by a distal fragment of a concave specimen, made on a non-cortical blade (Fig. 7:8). A single fragment of asymmetrical perforator was made on a regular blade and a triangular cross section. The working edge was formed by semi-abrupt retouch (Fig. 7:9).

Backed implements (N=136; 68.69%) are the most numerous groups among the retouched tools. (Table 5.). Tools in this category are very regular and slender. Blades (N=99, 72.8%) and burin spalls (N=37, 27.2%) were used to produce these items.

Backed implements:		N	%
Backed blade/lets		93	68.4
Points	Backed points	3	2.2
	Double backed points	2	1.5
	Gravette points	5	3.7
	Microgravette points	33	24.3
Total		136	100.0

Table 6. Lubná VI (excavation in 2012 and 2018). General structure of backed pieces tool category.

Backed implements were divided into two categories: backed blades/bladelets and points, including backed points, double backed points, Gravette and microgravette points (Tab. 6). Among the backed blades (N=93), there are two whole specimens, 63 mesial, 15 proximal and 15 distal fragments (Fig. 9: 23-27, 30-36). Among points, microgravettes are the most numerous (N=33), characterised by the presence of flat ventral retouch or semi-abrupt retouching in basal or distal ends (Fig. 9: 3-14). Other categories of points, like Gravette points (Fig. 9: 1-2) and double backed points (Fig. 9: 15), are less numerous (Tab. 6). The backed implements are frequently fragmented; therefore, it is difficult to determine the whole length of this type of tool. The dimensions of the largest wholly preserved Gravette point are 62.9 x 10.6 x 5.9 mm, and for microgravette points is 44.2 x 5.5 x 4.9 mm.

There are eight unfinished backed fragments and three by-products broken during production.

Fig. 9. Lubná VI (excavation in 2012 and 2018). 1-2 Gravette point, 3-14 microgravette points, 15 double backed point, 16-22, 28, 29 backed points, 23-27, 30-36 backed blades.

Retouched blades (N=17) include two complete, seven proximal, three medial and five distal fragments. The biggest specimen is a proximal fragment, 105.3 x 21.6 x 5.7 mm. The retouch is fine, semi-abrupt or abrupt, usually located on one of the edges.

The retouched flakes (N=3) bear on the edges semi-abrupt and denticulated retouch. They are small specimens, only a single flake was preserved whole and has dimensions of 42 x 38 x 17 mm.

Fig. 10. Lubná VI (excavation in 2012 and 2018). Refittings made from Cretaceous flint. 1 - two striking platforms core, 2, 3 – dihedral burins, 4 – burin on a break. Scale bar is 10 cm.

From the 998 artefacts of the studied assemblage (not including chips and small debris), 106 conjoins of various types were made. They involve 223 artefacts in total, which comprise almost 22.3% of the inventory. This result can be considered quite satisfactory, given that not all of the campsite area has been excavated. The majority of refits consist of just a few elements (especially burins and burin spalls), but several link over a dozen individual pieces. The largest refitted complex comprises 19 elements, including a core (Fig. 10:1). The refitted complexes enable us to reconstruct the whole technological process, except the stage of initial reduction of the raw material. Based on the presence of large blades and tools that do not refit with cores, it is certain that some raw large blades have been brought to this site from outside. The refitted items also include tools – mainly burins and burin spalls (Fig. 10: 2-4).

IV.5 Use wear analysis

Traces of use were recorded on 65 retouched tool: four blades, a flake, and 13 burin spalls, comprising almost 20% (83/426) of the group selected for microscopic analysis (Table 7). Armatures, produced from bladelets and burin spalls, are the most abundant forms in the lithic assemblage from Lubná. They displayed various types of traces resulting from hunting activity (Fig. 11; 12:1-4) and processing of animal carcass (Fig. 12:5-8; 12:1-4). Hunting was confirmed by impact fractures on distal and/or proximal parts of backed pieces (13), microgravettes (2), and retouched blades (2). They bear parallel, flute-like fractures on their distal portions (Fig. 11:4; 12:1), transverse bending fractures (Fig. 11:1,5), and burin-like fractures (Fig. 11:2,3,7; 12:3) in the middle or proximal parts. No microscopic linear impact polish was observed in these cases. Instead, all the pieces with impact fractures exhibited meat/hide/bone processing with longitudinal microtraces (rounding, polish, oblique scars) on one sharp lateral edge (Fig. 11:6,8; 12:2,4). The same traces were also visible on 6 pieces of armature with non-diagnostic snap fractures (Fig. 12:5-6). The latter two specimens were probably used for butchering or sawing bone, though their use as parts of hunting weaponry cannot be excluded as well. Moreover, several items of backed bladelets and microgravettes bear no polish, but have edge scars that suggest longitudinal motion during utilisation. The scarcity of diagnostic impact traces on armatures of Lubná VI, compared to other Gravettian sites (Kufel-Diakowska et al., 2016), showed that the hunting weapons were more complex (Borgia et al., 2011; Borgia, 2017). Most probably, at least some of the backed elements were inserted in a lateral rather than apical position on the shaft.

Type	1	2	3	4	5	6	7	8	No traces	Total
Backed/unfinished backed	13	4	-	-	7	4	8	1	63	100
Backed point/double backed point	-	-	1	-	-	1	-	-	2	4
Gravette point	-	-	-	-	1	1	1	-	-	3
Microgravette point	2	2	-	-	5	2	2	-	18	31
Truncation	-	-	-	-	-	-	-	-	1	1
Perforator	-	-	-	-	-	1	-	-	-	1
Burin and burin/core	-	-	3	1	-	-	-	9	9	22
Retouched blade	2	-	2	-	1	-	-	-	7	12
Retouched flake	-	-	-	-	-	-	1	-	1	2
Total (retouched tools)	**17**	**6**	**6**	**1**	**14**	**9**	**12**	**10**	**101**	**176**
Blade	-	-	1	1	-	-	2	-	99	103
Flake	-	-	-	-	1	-	-	-	61	62
Burin spall	-	-	2	2	-	-	9	1	71	85
Total (blanks)	**-**	**-**	**3**	**3**	**1**	**-**	**11**	**1**	**231**	**250**
Total	**17**	**6**	**9**	**4**	**15**	**9**	**23**	**11**	**332**	**426**

Table 7**.** Lubná VI (excavation in 2012 and 2018). Results of the use-wear analysis: 1 - impact traces; 2 - butchering (meat, hide, bone); 3 - bone/antler/teeth; 4 - hard material; 5 - longitudinal motion; 6 - rotary motion/perforation; 7 - undetermined/passive part; 8 - surface abrasion.

Eight pieces described typologically as armatures but with different morphology were used for a rotary motion, such as boring. These pieces show removals on the tip surfaces adjoining edges and ridges suggesting working of bone/antler material. A small flute-like or burin-like scar detached from one of the sides also occurred (Fig. 12:7-8). Another lithic classified typologically as a perforator, displaying slight edge-rounding and a tiny burin-like fracture, resulted from piercing soft material.

Apart from armatures used for boring, hard animal and mineral materials were also worked with some of the burins and blades of longer size, between approximately 40mm and 90mm, including blades modified by intentional retouch. Edges of burination of three burins and lateral edges of four blades were used for sawing and scraping bone/antler. They exhibit retouch caused by use, the size of which varies according to the edge angle of the burin or blade, as well as bright or more abraded bone/antler polish on the very edge, or sometimes more distant from the edge in case of tools for sawing (Fig. 13:1,3). A tip of a fourth burin showed considerable rounding and bright, flat polish which probably resulted from incising or engraving teeth, shell, or soft stone. Moreover, two burin spalls display such traces produced before, and two other after detaching. The tip of one of these is very rounded and abraded, with densely distributed scratches from working hard, probably mineral material (Fig. 13:2).

Residues of a red substance were detected on the lateral edges of three artefacts: a backed bladelet, a blade, and a burin spall (Fig. 13:8). All specimens displayed edge scarring and no polish from ochre processing. Further archaeometric analysis is required to confirm the origins and nature of the red residue.

Fig. 11. Lubná VI (excavation in 2012 and 2018). Use-wear traces on the lithic tools: 1,2 - backed no. 1238; 3,4 - backed no. 350; 5,6 -retouched blade 672; 7,8 - backed no. 2001.

Fig. 12. Lubná VI (excavation in 2012 and 2018). Use-wear traces on the lithic tools: 1,2 - backed no. 1238+1443; 3,4 - backed no. 1739; 5 - microgravette no. 1249; 6 - backed no. 528; 7 - backed no. 1443; 8 - backed no. 1538.

Fig. 13. Lubná VI (excavation in 2012 and 2018). Use-wear traces on the lithic tools: 1 - retouched blade no. 2484; 2 - spall no. 2019+2004; 3 - burin no. 849; 4 - spall no 2046; 5 - burin no. 2668; 6 - burin no. 231; 7 - burin no. 2482; 8 - backed no. 2413.

More than 80% of the studied lithics (343/428) bear no traces of use or exhibit non-diagnostic fractures. No use-wear was detected on almost the entire group of blades (99/103), flakes (61/62), and burin spalls (71/85). Armatures are fragmented in most of the cases. However, more or less half of each armature type, i.e. backed bladelets (63/101), microgravettes (18/31), backed points (2/4), and truncations (1/1), show snap fractures, which are not characteristic to any use or natural process.

Despite numerous groups of burins from Lubná, no traces of use were recorded on most of them (17/24). Instead, large parts of the ventral surface were covered by thick, matt polish of merged topography or distributed over almost all of the surface (Fig. 13:5-7). In some cases this looked like abraded, well-developed hafting polish, in others the traces probably resulted from friction (see Rots 2010). Similar rubbed surfaces were also recorded on a burin spall and a backed element made from spall. Clearly, this kind of surface alteration occurred only on burins, furthermore on one surface of each specimen. The morphology of several burins, which served rather as cores than tools, also excluded hafting. The modifications probably resulted from transport or storage.

IV.6 Archaeozoology

Most remains discovered at the site were found within and in close proximity to hearths, however, the vast majority did not show traces of fire or other thermal alternation. Together with the flint artefacts, they create a single rather well stratified cultural layer. They were never found in anatomical order, but can be associated with intensive human activity. The animal remains are badly preserved due to human activity (observed in the high number of splintered and/or burnt bones) and natural factors (root etching and calcite precipitation). Root etching covers 79.4% of all identified bones while calcite precipitation is observed on 60.1% of bones, which significantly hindered the archaeozoological analysis. Very often, the remains were excavated as conglomerates of bones, teeth and flint artefacts joined by calcite that was impossible to detach without causing damage (Fig. 14:1).

Taxon:	NISP	MNI	Tools	Cut marks	Percussion marks	Gnawing marks
Mammoth (*Mammuthus primigenius*)	1	1	1	-	-	-
Reindeer (*Rangifer tarandus*)	345	7	2	1	1	-
Alpine ibex (*Capra ibex*)	6	1	-	-	-	-
Identified to taxon	**352**	**9**	**-**	**-**	**-**	**-**
Large Bovinae	2	-	-	-	-	-
Large size mammal	14	-	-	-	1	-
Medium size mammal	1224	-	-	6	5	1
Small size mammal	14	-	-	-	-	-
Unidentified	4418	-	-	-	-	-
Total	**6024**	**9**	**3**	**7**	**7**	**1**

Table 8. Lubná VI (excavation in 2012 and 2018). Mammalian remains (not including rodents) expressed by NISP (Number of Identified Specimens) and MNI (Minimal Number of Individual), human activity marks and gnawing marks.

Fig. 14. Lubná VI (excavation in 2012 and 2018). 1 – conglomerate of bones and tooth , 2-4 - reindeer half-mandible in different stage of dentition, 5 – reindeer metacarpus, 6 – reindeer metatarsus, 7 – Alpine ibex metacarpus, 8 – Alpine ibex metatarsus.

Within the assemblage, 352 animal bones and teeth could be identified to taxon and skeletal element (Table 8). The most numerous identified species is the reindeer (*Rangifer tarandus*)(Tab. X). It should be noted that no complete long bones were discovered, and the finds consisted of just fragments. Among reindeer long bones 71.2% were preserved as small fragments <25% complete, 22.7% were preserved as fragments 26-50% complete and only 6.8% were preserved as larger fragments 51-75% complete. Dominance of green breaks (93%) and presence of longitudinal ones suggests intentional splitting of long bones for marrow extraction. On the basis of mandibular fragments and isolated last 3rd molars, we estimate that the skeletal remains belonged to an MNI of seven. The most numerous elements (except isolated teeth) are mandibular fragments (N=29), metacarpals (N=26) and metatarsals (N=88), while other long bones are represented in much smaller numbers e.g. radius (N=8) or ulna (n=2), femur (N=7) or tibia (N=3)(Table. 9). The paucity of many skeletal elements is surprising, such as thoracic and lumbar vertebra, scapula, humerus or phalanges (Fig. 15).

	NISP	NISP	NISP	NISP	MNE	MNE	MNE	MNE	MAU	%MAU

	dex	sin	indet	Total	dex	sin	indet	Total		
Cranial bone										
Antler			4	4			1	1	0.5	7.1
Maxilla	4	5		9	4	5		9	4.5	64.3
Upper isolated teeth	6	15	7	28						
Cranium total	**10**	**20**	**11**	**41**	**4**	**5**	**1**	**10**		
Mandibular bone	17	9	3	29	7	6		13	6.5	92.8
Lower isolated teeth	26	30	19	75						
Mandible total	**43**	**39**	**22**	**104**	**7**	**6**		**13**		
Isolated teeth indet.			12	12						
Sternebrae										
Atlas			1	1			1	1	1	14.3
Axis			3	3			2	2	2	28.6
Cervicals II-VII			5	5			3	3	1	14.3
Thoracic			3	3			3	3	1	14.3
Lumbar										
Sacrum										
Caudal										
Vertebrae indet.										
Vertebrae total										
Scapula										
Humerus										
Radius	5	1	1	7	3	1		4	2	28.6
Ulna	2			2	2			2	1	14.3
Carpals		1	4	5			2	2		
Metacarpal	13	10	3	26	6	5	3	14	7	100
Metacarpals total										
Innominate	3	2		5	2	2		4	2	28.6
Femur	2	4	1	7	1	2		3	1.5	21.4
Patella										
Tibia		3		3		2		2	1	14.3
Os malleolare		1		1		1		1	0,5	7.1
Calcaneus	1	1	1	3	1	1		2	1	14.3
Astragalus			2	2			1	1	0.5	7.1
Tarsals	3		1	4		2	1	3		
Metatarsal	7	12	69	88	4	4	6	14	7	100
Metatarsals total										
Reduced metapodium										
Metapodial			20	20						
Phalanx I										
Phalanx II										
Phalanx III			1	1			1	1	0.12	1.7
Reduced phalanx I										
Reduced phalanx II										
Reduced phalanx III										
Phalanx total										
Sesamoids			2	2			2	2		
Total NISP/MNE	**89**	**94**	**162**	**345**	**30**	**31**	**26**	**87**		

Table 9. Lubná VI (excavation in 2012 and 2018). Skeletal element representation of reindeer, expressed as NISP, MNE, MAU and %MAU.

Among reindeers, different age classes can be recognized (Fig. 14: 2-4). We have four juvenile individuals (3-5 months old with worn dP4 and with erupted but unworn M1), and three sub-adults or adults (more than 22 months old with M3 fully in wear) (Miller 1974). Based on the presence of 3-5 month year old reindeer individuals, we may assume that the season of occupation was early autumn. Only a single small fragment of antler (female?; Sturdy 1975) was found at Lubná VI, despite the presence of numerous cranial and tooth arch fragments. We may explain this fact by suggesting that antler processing (if any) took place in another, unexcavated part of the site.

Fig. 15. Lubná VI (excavation in 2012 and 2018). Relative skeletal element abundance of reindeer expressed as standardized minimal animal units (%MAU).

The Alpine ibex remains, similarly to the bones of the reindeer are strongly fragmented. They are represented by a fragment of atlas, a fragment of proximal end of a radius, a distal part of a metacarpal, and three fragments of a metatarsal (Fig. 14: 7, 8). They belong to minimum of one individual.

A single fragment of mammoth ivory, ca 5 cm long was also found. This small piece is very fragmented and badly preserved. Probably it is a tool fragment or waste created during tool fabrication.

Additionally, two small fragments of large Bovine (steppe wisent or aurochs) metapodium were identified. To this category probably belongs also bone fragments described generally as large size mammal remains.

More than 8 kg of burned bones were found among the faunal material, consisting of small pieces from ca. 0.2 to 5 mm burned to a colour from black to white. They concentrated mostly in the hearth areas; square meters D5-6, F6-7 and G6-7 (Fig. 16). All burned bones belong to medium-sized mammals, probably reindeer, suggested by the structure of the bones or direct identification of fragments coming from long bones. The wet-sieving of excavated sediments yielded rodent remains of the typical tundra-steppe community, such as narrow-skulled vole (*Microtus gregalis*), common/field vole (M. *arvalis/agrestis*), and lemming (*Dicrostonyx gulielmi*), but these remains were not numerous. Another important observation is that, despite wet-sieving, no fish and only a single indeterminate bird bone were discovered at the site.

Fig. 16. Lubná VI (excavation in 2012 and 2018). Spatial distribution of animal burned bones.

Direct signs of human activity were noted on several of the animal bones discovered at Lubná VI. Cut marks are visible on the distal artificial surface of a reindeer metacarpus and six bones of a medium-sized mammal (probably reindeer); four small fragments of long bone shafts, a femur fragment and a single rib fragment. Because of the strong fragmentation of bones, it was not possible to determine the stages of carcass processing to which these cut marks belong. Additionally, percussion marks visible on a reindeer metatarsal, five long bones of a medium mammal and a single long bone shaft of a large mammal were described. In the entire bone assemblage, only a single rib fragment of a medium-sized mammal bears clear marks of carnivore gnawing.

IV.7 Isotopic studies

The isotopic dataset is large and complex. Tooth dentine strontium isotope measurements fell within a restricted range from 0.7103-0.7109, reflecting the isotopic composition of the burial environment. Meanwhile, reindeer enamel strontium isotope ratios spanned a larger range between approximately 0.7087-0.7116, but within this range comparisons between reindeer individuals are characterized by high heterogeneity with at least three distinct patterns of movement distinguishable in the data. This may indicate either that Gravettian hunters at Lubná targeted a single herd with variable year-to-year movements, or that reindeer from several independent herds were targeted, or possibly a combination of both. The data also reveal that several reindeer spent periods of at least six months during the period of tooth growth living on geologies isotopically indistinguishable from the Lubná site, consistent with an interpretation that hunters chose Lubná as a settlement location at least partly due to the easy availability of reindeer prey nearby. The total range in $\delta^{18}O$ and $\delta^{13}C$ across all individuals is ~4‰, but again there are marked differences between individuals with some reindeer showing intra-tooth variability of 2-3‰ while others show minimal variability of <1‰, including where multiple teeth from the same individual have been sampled. This might be due to a stronger attenuation of the seasonal signal in some individuals, linked to periods of mobility during enamel formation and/or consumption of food and water that was itself buffered from seasonal fluctuations in climate (see Britton et al., 2009).

V. Discussion

Deposition of the cultural layer directly on much older sandy sediments indicates that hunter-gatherers entered this area before activation of the solifluction-aeolian processes. The solifluction and Aeolian processes were clearly activated after the period of human occupation and in effect they buried the hearths preserved in this way. The site itself is "specifically located" - low in the valley, but very close to the water, which probably favoured hunting activity. Human occupation at Lubná VI was focused on reindeer hunting, which explains the choice of site location, far away from lithic raw material sources suitable for tool production. We revealed two hearths surrounded by numerous lithic and osseous material. The spatial distribution of the artefacts, and their refitting, demonstrates that both hearth features were used contemporaneously. Although the lithic and bone assemblages were spatially related with the two hearths, the low frequency of burned flint artefacts (N=24, 2.4%) indicates that the site features formed sequentially over a short period of time ~~and it is likely that the majority of lithics were deposited after the hearths were used. This interpretation is based on the following: the use-wear analysis did not point out post-depositional wear on the artefacts; the stratigraphy did not reveal any hiatus in the deposition of loess; and the bones do not have burnt surfaces. We therefore infer an internal site chronology that started with the creation of combustion features and minor input of lithic residues, followed by a main activity stage that accumulated most of the bones and lithics at the site. In this sense, the archaeological layer is a palimpsest of a continuous occupation consisting of two phases~~. The lithic inventory of Lubná VI is similar to other localities known from this area (Lubná I-VIII), in terms of raw material, general structure of the inventory, core technology and techno-morphology of retouched tools – especially of burins and backed implements (Šída 2015). The only substantial differences are found with respect to Lubná I, which has significantly fewer small backed implements (probably caused by fieldwork methodology – wet-sieving not used) and a more varied range of raw materials (single pieces of Tušimice quartzite, limnosilicite, and plattensilex).

Gravettian hunters at Lubná carried their lithic tool supply all the way from Lower Silesia and used the local stone resources to construct the hearths. Thus, the knapped lithic assemblage is composed of extra-local erratic Cretaceous flint. This is very unusual in the Late Gravettian, which is very often dominated by locally-sourced lithic materials (Kozłowski 2013; Lengyel 2018; ~~Novak 2016; Svoboda 1997; Verpoorte 2005;~~ Oliva 2009; Svoboda 2002; Wilczyński 2016). A similar situation was found in the Late Epigravettian of Hungary (Lengyel 2018), where over 90% of the lithic assemblage from Esztergom Gyurgyalag comprised imported flints originating about 600 km from the site (Dobosi and Kövecses-Varga 1991). The low number of cores and cortical flakes and blades at Lubná VI prove that most of the lithics arrived at the site in a pre-processed state, including unretouched blanks and tools. That also explains why hunter-gatherers used the cores as hammerstones. Transporting blades, especially long specimens, instead of cores or nodules from remote lithic raw material sources in the Late Gravettian of Central Europe was noticed in relation with overcoming logistical issues of mobility (Lengyel and Chu 2016). This may explain the rarity of cores in the case of Lubná VI assemblage, too. Among retouched tools, burins and backed implements are the most numerous. The lack of other tool types (e.g. endscrapers) may result from the limited area of the site so far excavated. In France, the Magdalenian sites of Pincevent and Verberie yielded similar archaeological remains, and their toolkits recovered from around the hearths include a wider spectrum of domestic tools than Lubná VI (Leroi-Gourhan and Brezillion 1966; Adouz et al. 1981). Therefore, the Lubná VI record most probably represents a special occupation related to hunting and hunting equipment maintenance, such as replacing backed inserts in spears, and maintaining/making grooves in the sides of the spears with burins. The lack of chert and flint raw material in the area of Lubná inspired the hunter-gatherers to obtain bladelet blanks to make hunting weaponry from burin spalls, which in turn resulted in a high frequency of burins in the lithic inventory. A very similar armature technology was recovered in Portugal at the Early Gravettian site of Vale Boi, where burins without any traces of use served as cores for bladelet production (Marreiros et al. 2018) and in France, where Middle Gravettian sites distinguished as Rayssian, dated to 31.2–27.4 ky cal BP, have produced burins used to produce blanks for backed artefacts and Gravette/microgravette points (Klaric 2007). Use of burin spalls as blanks for microgravette production, although not so numerous (8%) as that at Lubná VI (27%), is also observed at layer 2 of the Kostenki 8 site (Reynolds 2014; Borgia 2017). However, this strategy has never previously been observed in Central European Gravettian sites, even at Pavlovian localities where the dominant raw materials were transported similarly from large distances, comparable to the Lubná VI case (Novak 2016; Svoboda 1997; Verpoorte 2005). The proportion of burin spalls in Lubná VI is far higher than at other central European Gravettian sites (Moreau 2010; Novák 2004; 2008; Nuzhny 2009; Oliva 2009; Verpoorte 2005; Wilczyński et al., 2012; 2015; 2020b). This may be the result of a highly curated lithic assemblage with restricted diversity of artefacts due to the frequency of long distance movements (Shott 1986). Burins from Lubná VI, as well as most of the spalls that could be refitted to burins, exhibit little traces of use. However, burin ventral surfaces are covered by polish (as a result of transport and storage?). As a high number of armatures were made from burin spalls, it appears that burins functioned mainly as elements in the production of armatures, and were rarely used as tools themselves. The whole lithic inventory indicates a short stay of hunter-gatherers with hunting and processing of game (butchering and cutting soft animal material) as the predominant activities, reflected in use-wear analysis, as well as moderate scale reconstruction of hunting weapons (incising, boring, scraping of bone and antler). The scarcity of diagnostic impact traces in apical portions of armatures and a high number of fragmented backed pieces could have been caused by the specific hafting mode used in Gravettian hunting weapon (Borgia 2017). Armatures functioned as barbs more often than tips of a hunting weapon, as well as knives for butchering game.

Lubná VI yielded a number of reindeer remains, outnumbering other species at the site. Specialized hunting has been observed at other Late Gravettian sites in central Europe (Lipecki and Wojtal 1998; Brugère and Fontana 2009; Vlačiky 2012; Wilczyński et al. 2012; Wilczyński 2015). Reindeer remains are often described at Pleistocene localities of Europe, and it is clear that during the Late Pleistocene, this species was widespread and common and was one of the main game for hunter-gatherers (Bratlund 1996; Discamps et al., 2011; Grayson et al., 2001; Mellars 2004; Piskorska et al. 2015; Thacker 1997). The faunal assemblage discovered at Lubná VI is similar to other assemblages known from other Lubná sites, where reindeer is the dominant faunal component (Nývltová Fišáková et al., 2018; Šída 2015). The only differences are a lower taxonomic diversity of faunal material and concurrently the presence of a few bones of Alpine ibex at Lubná VI, which has not been observed at other Lubná sites. Given the lack of nearby flint raw materials, the accessibility of large numbers of reindeer near Lubná, probably present on a seasonal basis, explains the occurrence of Late Gravettian occupation in this micro-region. According to central-place foraging concepts (Egeland and Byerly, 2005; Lupo, 2006; O'Connell et al., 1990; Orians and Pearson 1979; Schoener 1979) we infer that hunting activities probably took place near the site, and the entire carcasses were transported to the camp for processing. The body-part representation observed at Lubná VI clearly shows an artificial distribution, caused by human activity. We found that the specific pattern of survival of reindeer carcass elements is the result of human choices; skinning of carcasses outside the hearth zone (lack of distal limb elements like phalanges), splitting long bones for marrow extraction and using residues as fuel in hearths. We need to add that despite the fact that numerous samples were taken directly from the cultural layer, no trace of the burned plant remains was found. Distinguishing the various activities, carried out in different places around the site, is rarely achieved, but we have good evidence of such behaviour both at Lubná VI, and for example from the Epigravettian site at Targowisko (Kufel-Diakowska and Wilczyński 2014). The season of occupation at Lubná VI was probably early autumn, and may be associated with the maximum use of environmental resources by the Gravettian hunters. This proposition stems from the fact that during the autumn season the fat content of the animals is highest, and the hides are of the best quality. Because of this, scheduling the taking of such resources during the autumn is most profitable and efficient for hunters (Driver 1990). The lack of antler within the excavated area, which should be present if the site was occupied in early autumn, is not observed at other Upper Palaeolithic sites where reindeer dominate the faunal assemblage e.g. Moravany-Lopata II, Trenčianske Bohuslavice or Grubgraben (Lipecki and Wojtal 1998; West 1997; Vlačiky 2012), with the exception of Jaksice II (Wilczyński 2015). The presence of numerous cranial fragments (especially teeth and mandibles), attesting the presence of whole carcasses, may indicate the collection of antler as a valuable raw material for processing elsewhere in an unexcavated area. The low number of gnawing marks and the lack of other signs of carnivore activity may be the result of intensified human activity that strongly fragmented the animal remains, and is not a result of a long human presence at this locality.

VI. Conclusions

The Lubná VI site is an exceptional example of a short-term camp of Late Gravettian reindeer hunters, occupied between 27.5 and 27.1 ka cal BP. Thus, it is a rare example of a Late Gravettian site from Bohemia and Czechia in general, from where only a single Late Gravettian site is known, which is especially striking, given the richness of the earlier Gravettian Pavlovian settlement (Oliva 2007; Svoboda 2007). The tool inventory from Lubná VI is typical for Late Gravettian assemblages from Central Europe, with a dominance of burins and backed implements, containing typical Gravette and microgravette points. However, the lack of chert and flint raw material in the vicinity of the site inspired the occupants to obtain bladelet blanks to make hunting weaponry from burin spalls. This specific behaviour is unique among Gravettian inventories known from the western Carpathians (Lengyel 2018; Kaminska 2014; Oliva 2007; Svoboda 2002; Wilczyński 2016). Also, the fact that the site was located at long range from available fine-quality raw material is exceptional, if we compare it with other Late Gravettian localities. In our opinion this strategy was strongly related to hunting activity, which increases understand of how hunter-gatherer groups settled the western Carpathians and organised their seasonal settlement strategy. Based on the quantity of lithic materials and density of artefacts we may state that the group was not numerous, and the whole camp was rather temporary in nature. The main task of the hunting group was obtaining the necessary quantities of meat, skins and antler, as well as repairing the worn-out hunting inventory by using the raw materials brought with them. Since the group had to move great distances, probably following the reindeer, this inventory could not be large (heavy), which resulted in the development of a technique to use burins for obtaining blanks for flint point production. The hunt itself probably took place near the excavated site, where whole reindeer carcasses were subsequently brought. The small campsite was located at a convenient spot for processing the carcasses, where some hearth stone constructions were arranged. Because there was no woody vegetation in the closest vicinity of the site, reindeer bones and their fat were used as fuel in hearths. It was likely that various activities took place at different part of the site (skinning, antler processing), unfortunately without fieldwork covering a larger area of this site, we cannot confirm our supposition. The site was abandoned relatively quickly, and then buried as a result of activation of solifluction and Aeolian processes.

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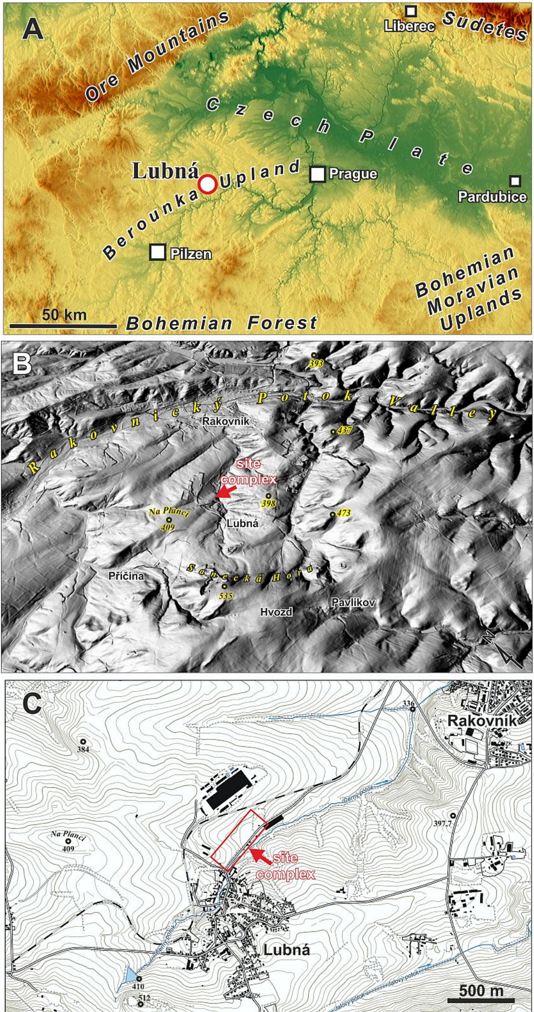
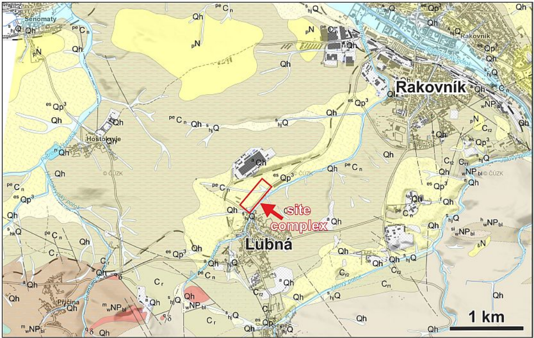
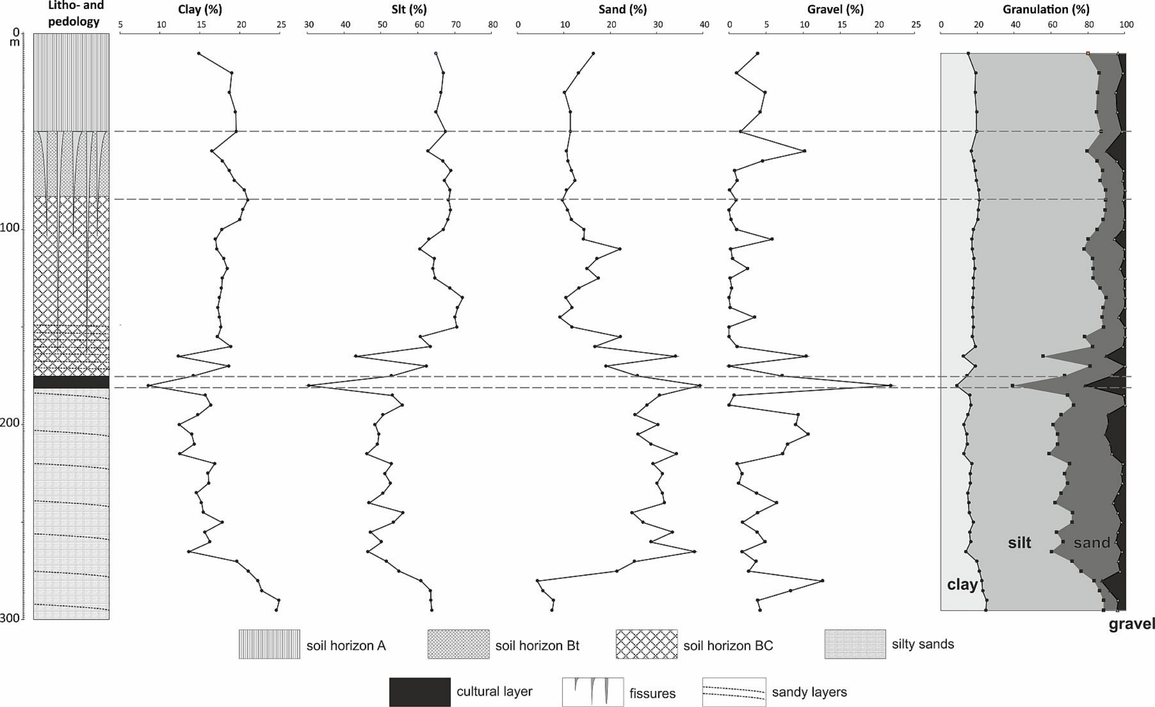
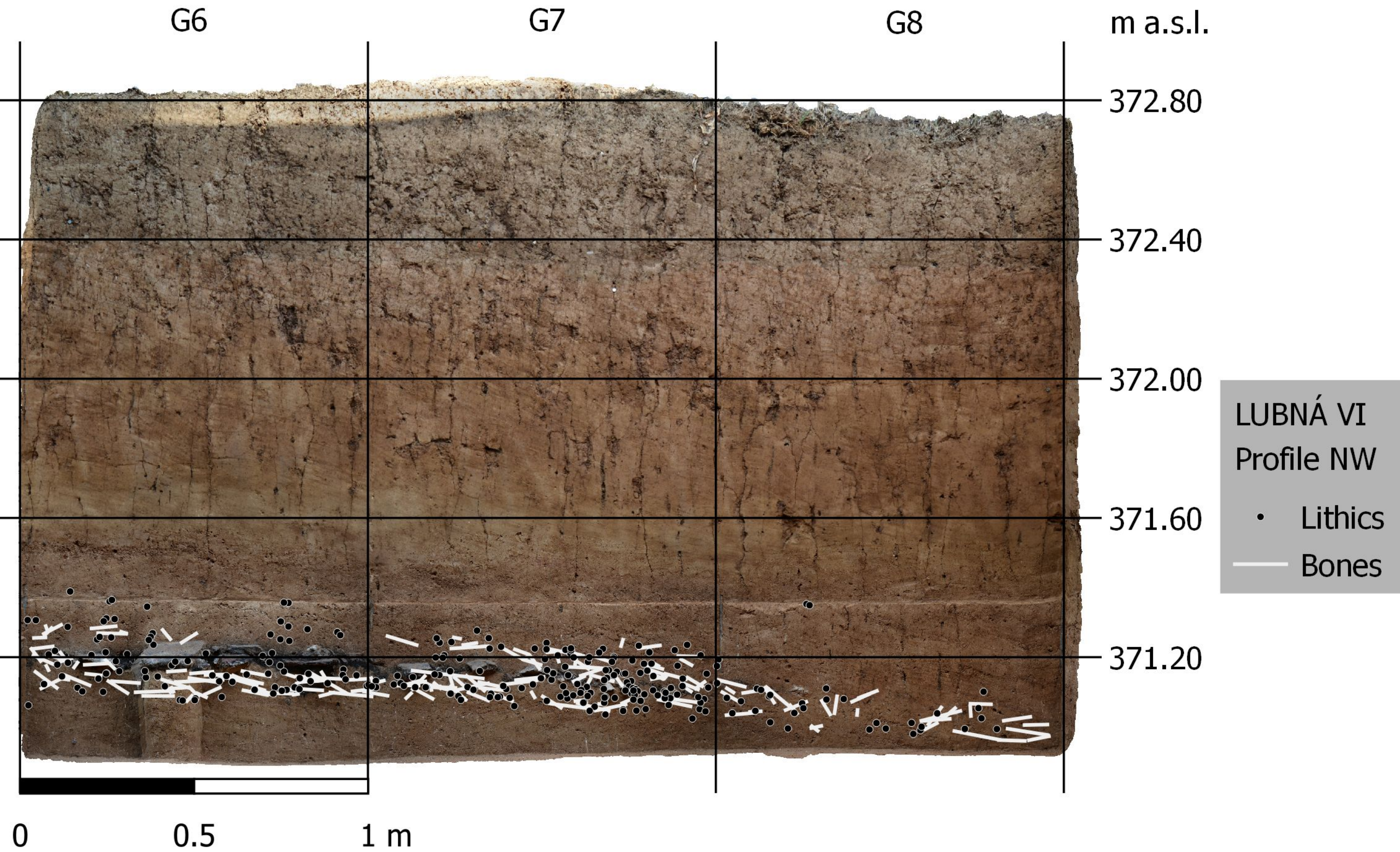

A
Ore Mountains
Liberec
Sudetes
Czech Plate
Lubná
Berounka Upland
Prague
Pardubice
Pilzen
Bohemian Moravian Uplands
50 km
Bohemian Forest
B
393
Rakovnický Potok Valley
Rakovník
437
site complex
398
473
Na Planci
409
Lubná
Příčina
Sanecká Hora
535
Hvozd
Pavlíkov
C
336
Rakovník
384
Černý potok
397,7
Na Planci
409
site complex
Lubná
410
512
Jalový potok
500 m

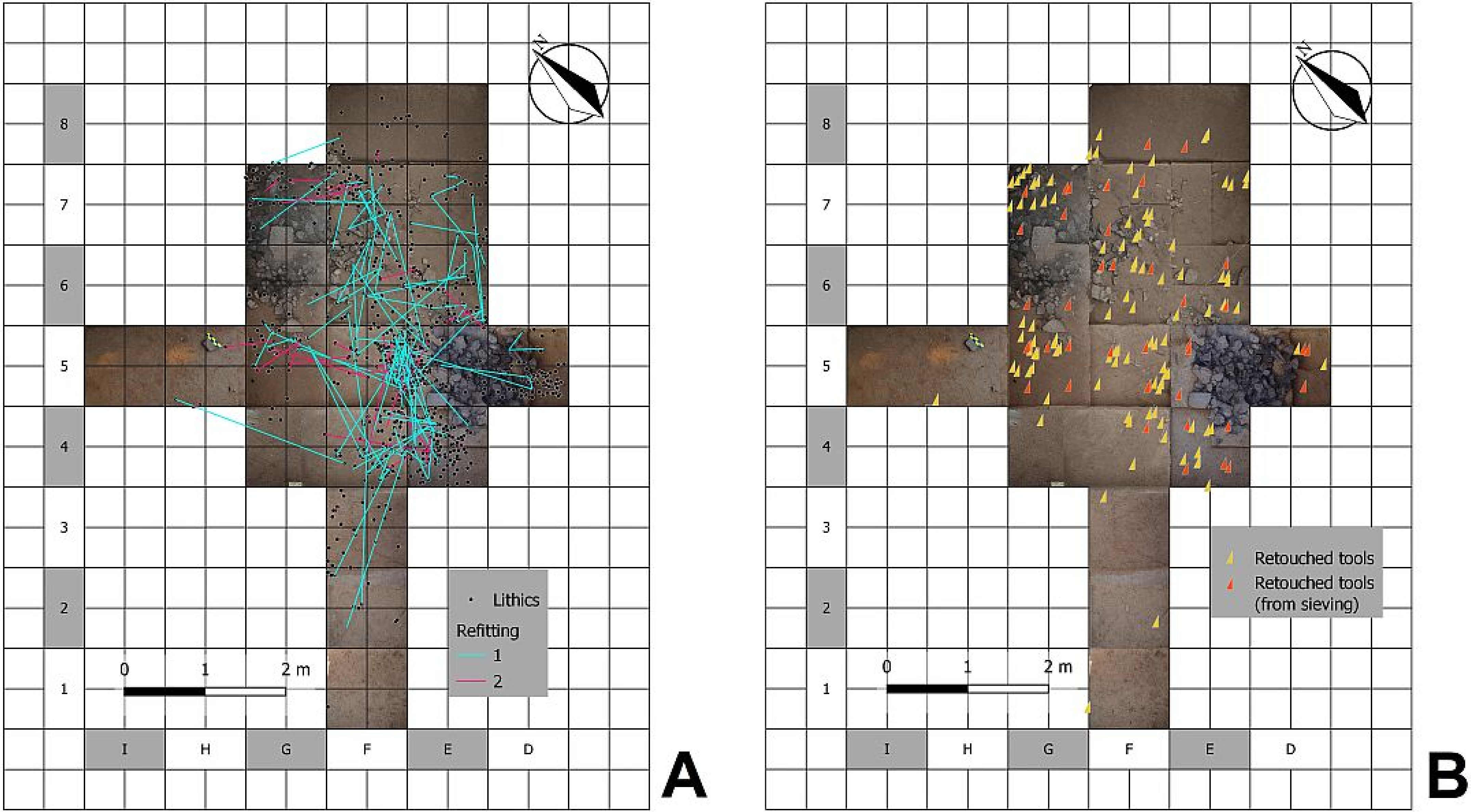


Senomaty
Rakovník
Hostokryje
Lubná
Přičina
site
complex
1 km
© ČÚZK

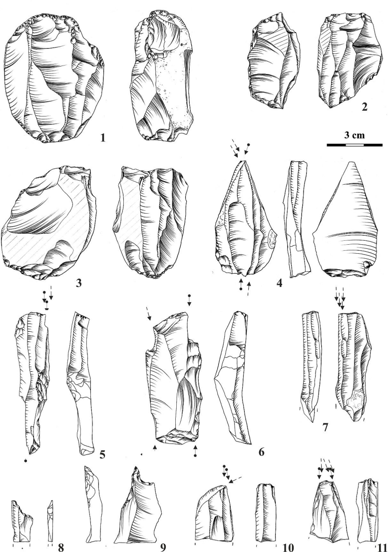

Litho- and pedology
Clay (%)
Slt (%)
Sand (%)
Gravel (%)
Granulation (%)
0 m
100
200
300
5 10 15 20 25
30 40 50 60 70 80
0 10 20 30 40
0 5 10 15 20 25
0 20 40 60 80 100
clay
silt
sand
gravel
soil horizon A
soil horizon Bt
soil horizon BC
silty sands
cultural layer
fissures
sandy layers

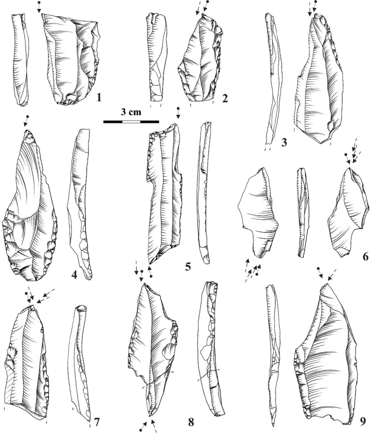


G6
G7
G8
m a.s.l.
372.80
372.40
372.00
371.60
371.20
LUBNÁ VI
Profile NW
Lithics
Bones
0
0.5
1 m

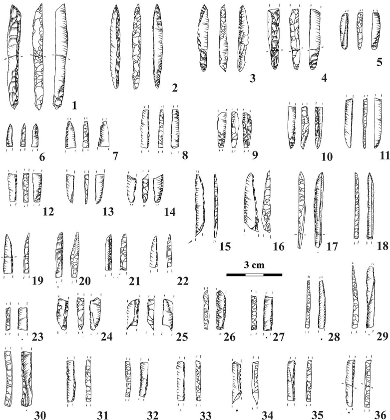

8
7
6
5
4
3
2
1
I
H
G
F
E
D
0
1
2 m
Lithics
Refitting
1
2
A
Retouched tools
Retouched tools
(from sieving)
B


1
2
3
4

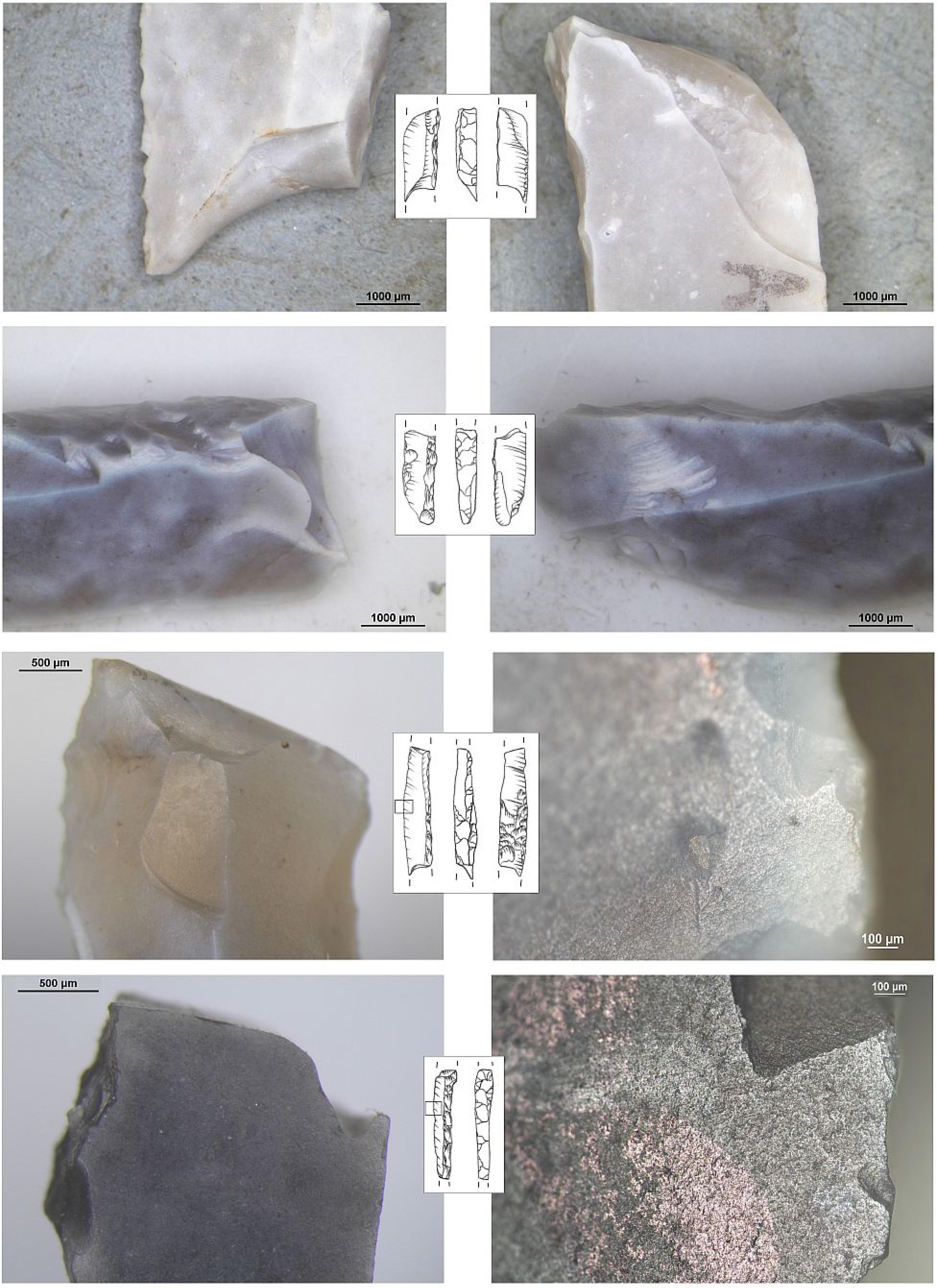

1
2
3 cm
3
4
5
6
7
8
9
10
11



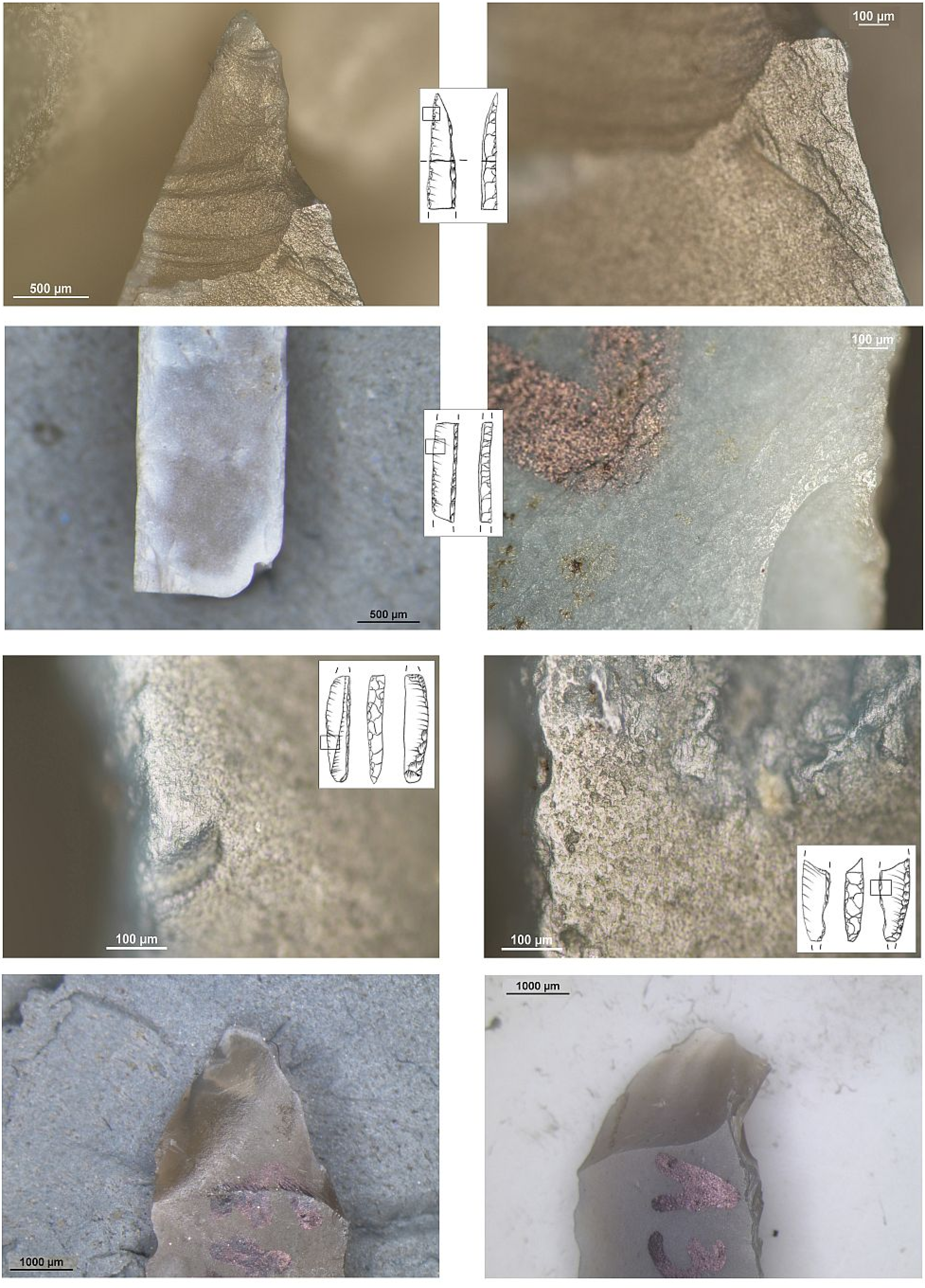
3 cm
1
2
3
4
5
6
7
8
9

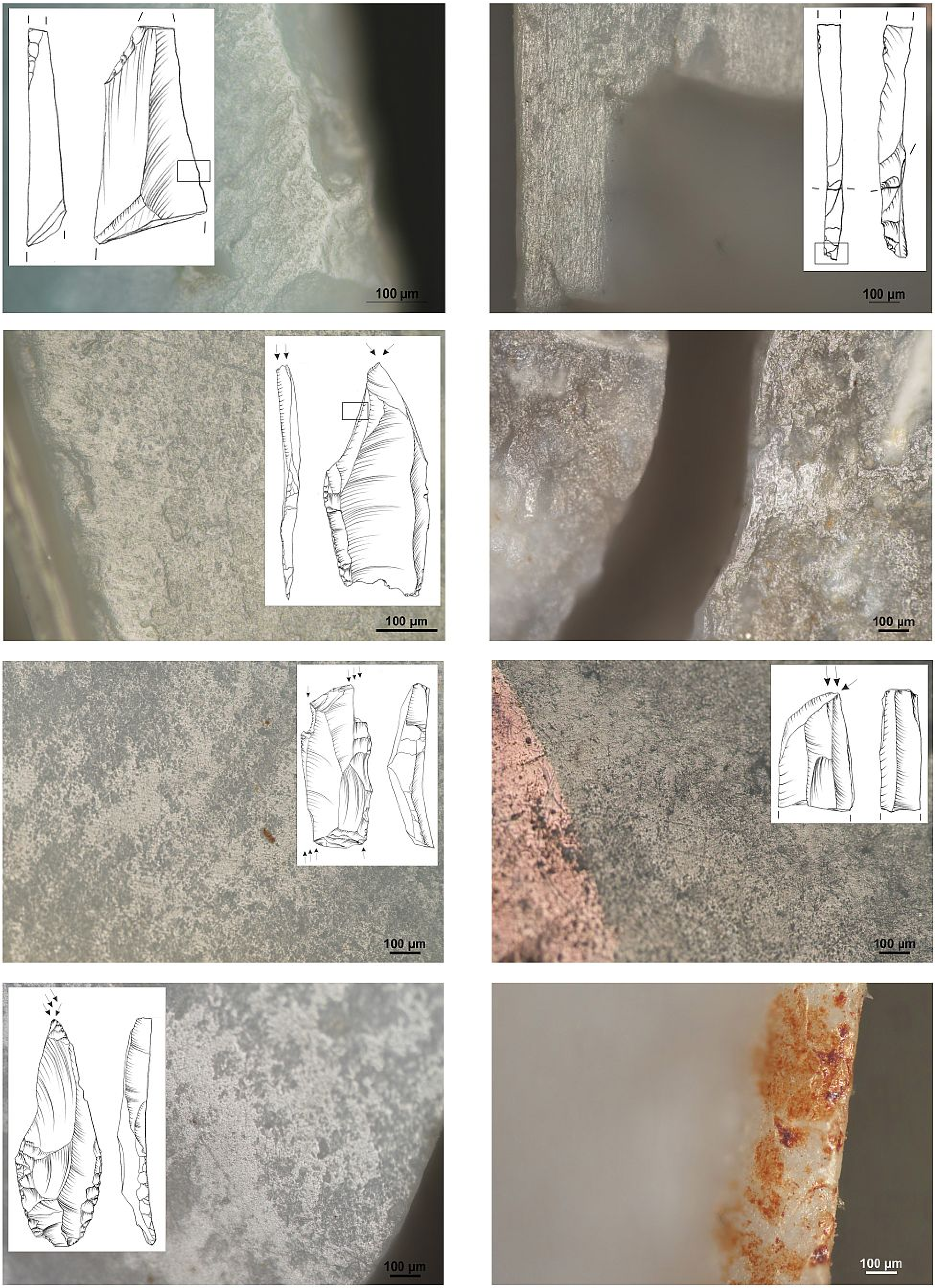

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
3 cm
23
24
25
26
27
28
29
30
31
32
33
34
35
36


1
2
3
4

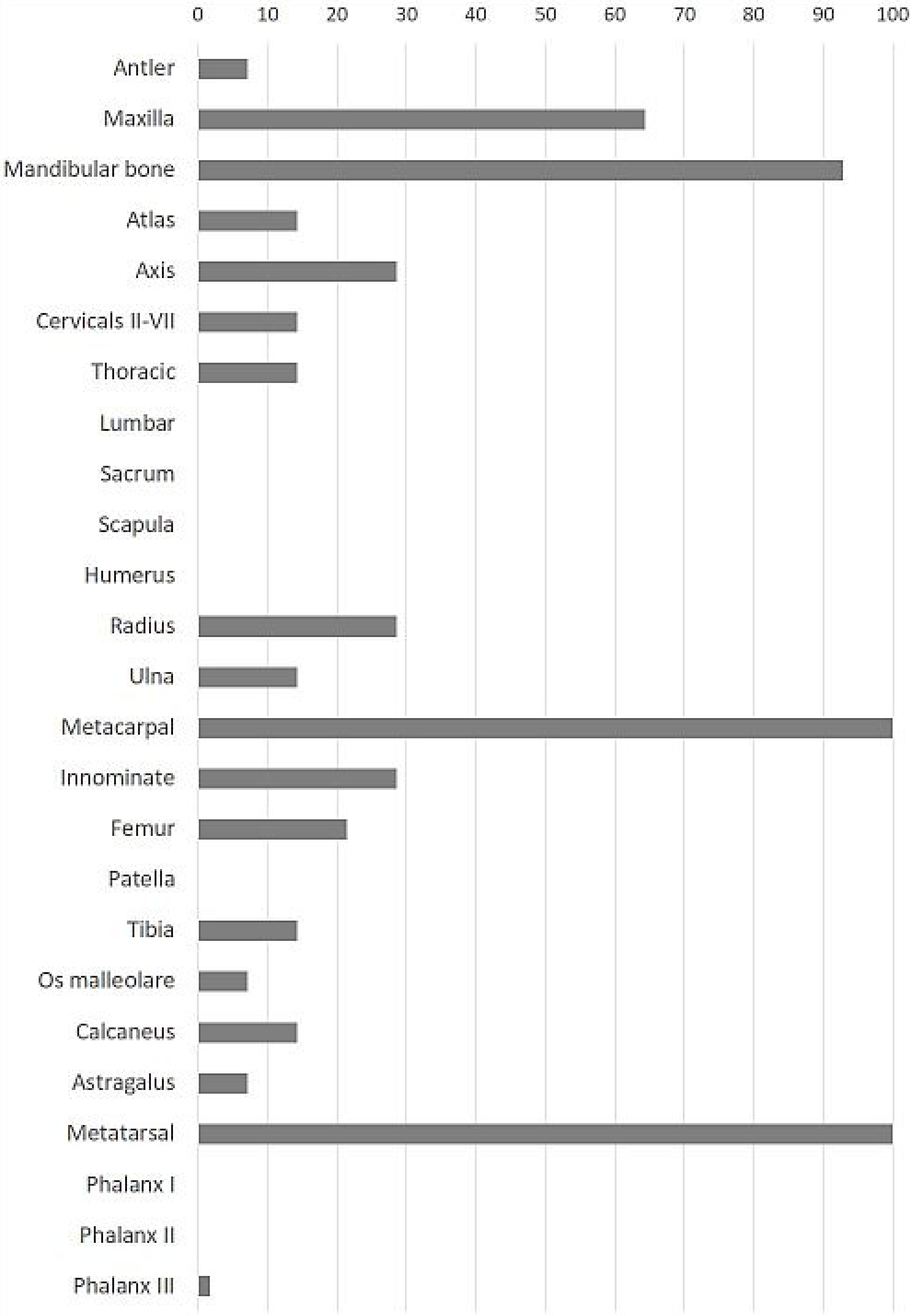


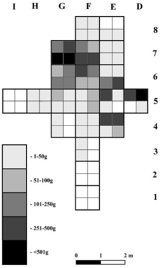
1000 µm
1000 µm
1000 µm
1000 µm
500 µm
100 µm
500 µm
100 µm


500 µm
100 µm
100 µm
500 µm
100 µm
100 µm
1000 µm
1000 µm


100 µm
100 µm
100 µm
100 µm
100 µm
100 µm
100 µm
100 µm


1
2
3
4
5
6
7
8


0
10
20
30
40
50
60
70
80
90
100
Antler
Maxilla
Mandibular bone
Atlas
Axis
Cervicals II-VII
Thoracic
Lumbar
Sacrum
Scapula
Humerus
Radius
Ulna
Metacarpal
Innominate
Femur
Patella
Tibia
Os malleolare
Calcaneus
Astragalus
Metatarsal
Phalanx I
Phalanx II
Phalanx III


I
H
G
F
E
D
8
7
6
5
4
3
2
1
- 1-50g
- 51-100g
- 101-250g
- 251-500g
- <501g
0
1
2 m