

The Na Skalici site near Měňany in the Bohemian Karst: Hunter-gatherer occupation during the Pleistocene/Holocene transition

Lokalita Na Skalici u Měňan v Českém krasu: osídlení lovců a sběračů v období přechodu mezi pleistocénem a holocénem

– Katarína Kapustka*, Nikola Košťová, Karolína Pauknerová, František Adámek –

KEYWORDS

Mesolithic – Late Palaeolithic – radiocarbon dating – lithics – Pleistocene/Holocene transition – Bohemian Karst

ABSTRACT

The Bohemian Karst (Central Bohemian Region) represents a key area for understanding human adaptation during the Pleistocene/Holocene transition in Central Europe. Despite its high palaeoenvironmental significance, systematic archaeological study of hunter-gatherer activity has long been limited. This paper presents new results from the Na Skalici site near Měňany, where an unique stratified record is preserved covering a period from the Late Upper Palaeolithic to the Mesolithic. Excavations undertaken between 1989 and 2016 within a biostratigraphic framework, and renewed archaeological research initiated in 2025, revealed well-preserved cultural layers containing lithic assemblages, faunal remains, and charcoal concentrations interpreted as hearths. Radiocarbon dating of small vertebrate bones defines three major phases of human presence: the first during the Late Glacial period (c. 13900–13100 cal BC), Early Holocene (c. 8500 cal. BC) and the second in the Middle Holocene (c. 5500–5000 cal BC). Stratigraphic and palaeoecological data indicate intermittent, recurrent human use of the site in response to climatic and environmental shifts. The lithic assemblage, dominated by local cherts with supplementary erratic flint and minor exotic materials, reflects flexible raw material procurement typical of postglacial foragers. Na Skalici thus provides one of the most complete and securely dated sequences of late hunter-gatherer occupation in the Bohemian Karst and offers valuable evidence for settlement dynamics and adaptive strategies in Central Europe.

* Corresponding author – E-mail address: culakova@arup.cas.cz

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1. Introduction

The aim of this study is to present and interpret new archaeological, stratigraphic, and radiocarbon data from the Na Skalici site near Měňany in the Bohemian Karst (Czech: Český kras), Czech Republic. The research examines human occupation during the transition from the Late Pleistocene to the Holocene and investigates how hunter-gatherer groups adapted to climatic and environmental changes in this karstic landscape. By integrating stratigraphic evidence, radiocarbon chronology, and lithic analysis, the study seeks to establish Na Skalici as a key reference spot for understanding Late Glacial and Mesolithic settlement dynamics within Central Europe and to contribute to broader discussions on mobility, resource procurement, and adaptive strategies of postglacial forager communities.

The article is structured as a comprehensive site study, presenting archaeological materials which were obtained during the 1989–2016 field seasons of the biostratigraphic research.¹ First there is the description of the Bohemian Karst and then the Na Skalici site is situated within the broader archaeological and environmental context of the Bohemian Karst (Fig. 1; Tab. 1). This is followed by a detailed description of the site and its stratigraphy, including the excavation methods and sediment analysis. Then we present the archaeological materials, focusing mainly on the lithic assemblage. The radiocarbon dating results and their interpretation then establish the site's chronological framework. Finally, the paper offers a discussion and synthesis comparing Na Skalici with other sites in the vicinity, and concludes with interpretations of human activity, environmental adaptation, and settlement patterns during the Late Glacial and Mesolithic periods.

1.1 Landscape settings

The Bohemian Karst is situated in the southwestern part of Central Bohemia and covers an area of approximately 130 km², making it the largest continuous limestone region in Bohemia. It is underlain by Silurian and Devonian limestones with frequent intercalations of nonkarstic rocks such as volcanic diabase, volcanoclastic tuffs, shales and siltstones (Žák et al. 2014). Climatically, the area lies within a relatively warm, moderately dry zone by Central Bohemian standards, with mean annual temperatures ranging between 7.5 and 9°C depending on altitude and exposure, an average annual precipitation of about 550–600 mm (Žák et al. 2014). The surface relief is highly variable, with elevations ranging from approximately 200 to 500 m a.s.l., divided by deep valleys formed by the Berounka River and its tributaries. Karst hydrology is strongly influenced by the solubility of the limestone bedrock, resulting in an underground drainage system, springs (often located along lithological boundaries), caves, and sinkholes.

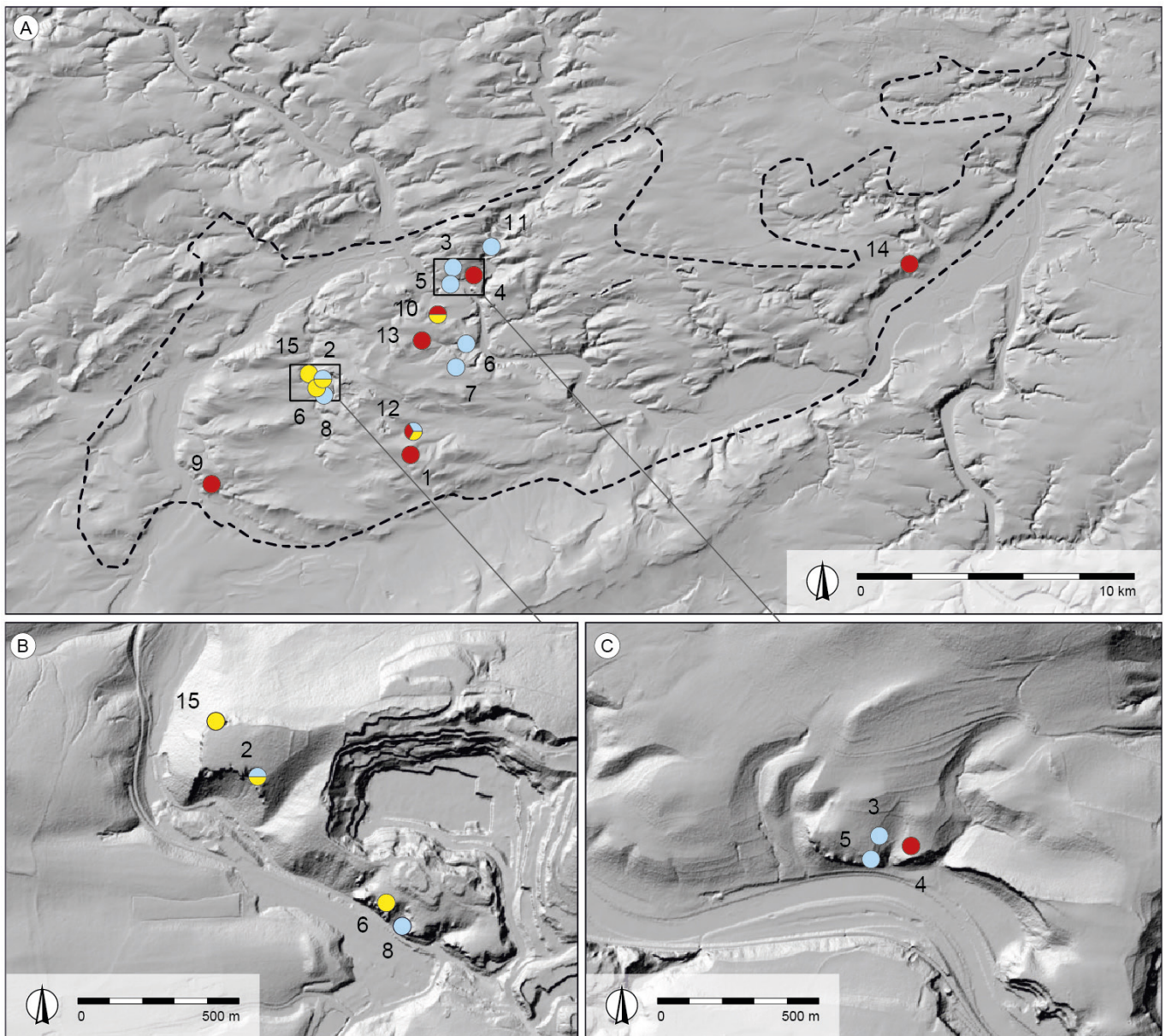


Fig. 1. Position of sites from the period of the Pleistocene/Holocene transition in Bohemian Karst. Blue – Magdalenian sites; yellow – Late Palaeolithic sites; red – Mesolithic sites. Numbers in the picture correspond to the numbers in Tab. 1. Author F. Adámek.

Obř. 1. Umístění nalezišť z období přelomu pleistocénu/holocénu v Českém krasu. Modře – naleziště magdalenienů; žlutě – naleziště z pozdního paleolitu; červeně – mezolitická naleziště. Čísla na obrázku odkazují na čísla v Tab. 1. Sestavil F. Adámek.

No.	Site	Municipality	Magdalenian	Late Palaeolithic	Meso-lithic	Site type	Number of lithics	References
18	Koněprusy	Koněprusy	0	0	1	Open air	Up to 10	Stolz et al. 2006
17	Nad Kačákem	Hostim	1	0	0	Cave	Hundreds	Fridrich, Sklenář 1976
16	Ve Stráni	Tetín	1	0	0	Cave	Up to 10	Vencl 1995
15	Tmaň	Tmaň	0	1	0	Open air	Up to 10	Stolz, Matoušek 2006
14	Radotín	Radotín	0	0	1	Open air	347	Vencl 1970
13	Nad Kodsskou roklí	Tetín	0	0	1	Open air	64	Vencl 1970
12	Na Skalici	Měňany	1	1	1	Cave	Over 1000	Svoboda 2002
11	Na Průchodě	Sv. Jan pod Skalou	1	0	0	Cave	41	Vencl 1995
10	Martina	Tetín	0	1	1	Cave	Up to 10	Vencl et al. 2009; Žák et al. 2018
9	Libomyšl	Libomyšl	0	0	1	Open air	Unknown	Stolz et al. 2006
8	Dolní Cave	Tmaň	1	0	0	Cave	30	Matoušek 1990
7	Koda	Tetín	1	0	0	Cave	Unknown	Vencl 1995
6	Tři voli Cave	Tmaň	0	1	0	Cave	Around 200	Prošek et al. 1958
5	Krápníková Cave (Hostim 2)	Hostim	1	0	0	Cave	80	Vencl 1995
4	Hostim 3	Hostim	0	0	1	Open air	154	Vencl 1970
3	Hostim 1	Hostim	1	0	0	Open air	16516	Vencl 1995
2	Děravá	Tmaň	1	1	0	Cave	1800	Vencl 1995
1	Bacín	Vinařice	0	0	1	Cave	Up to 10	Matoušek 2000

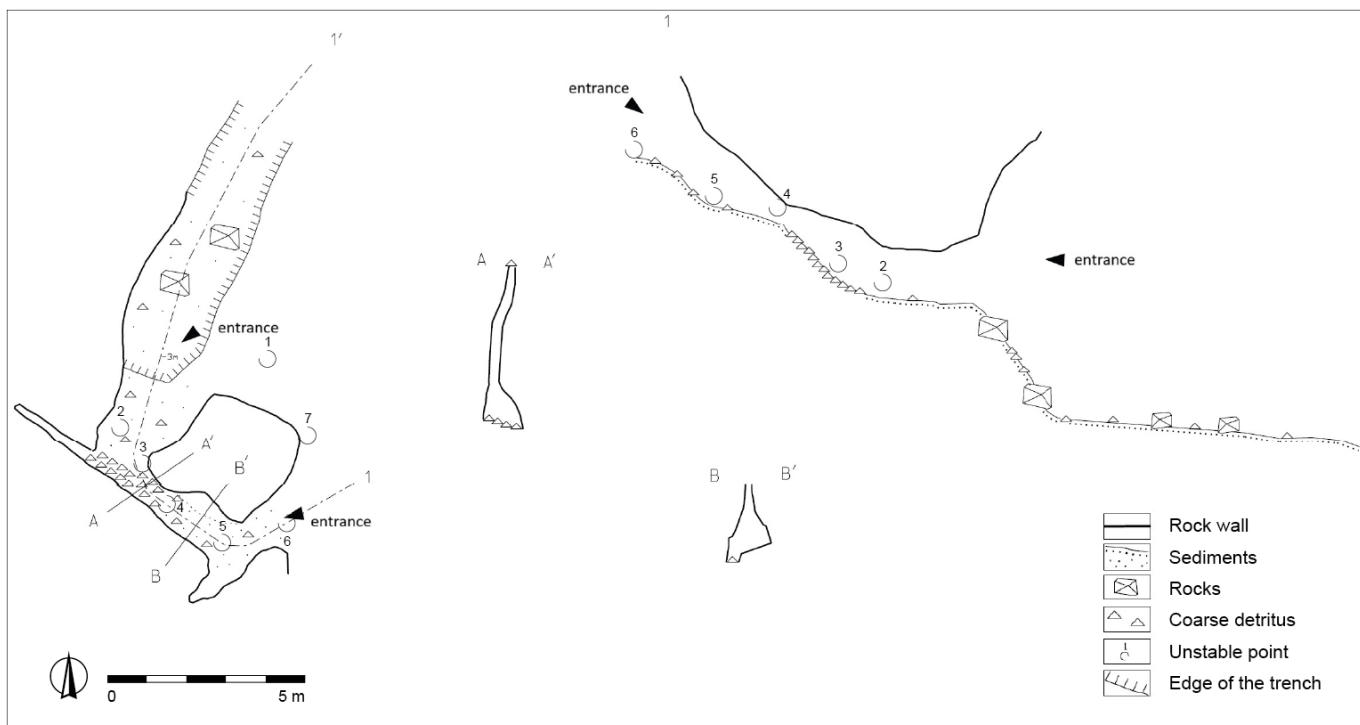


Fig. 2. Speleological plan of the Na Skalici Cave. Author M. Hejna.

Obr. 2. Speleologický plán jeskyně Na Skalici. Autor M. Hejna.

The soils in the Bohemian Karst reflect the combined effects of bedrock composition, climate, and topography, typically forming thin, shallow profiles over exposed limestone and richer, brown calcareous soil in more sheltered or colluvial settings. Flora tends to reflect these conditions, favouring calciphilous species. On more sheltered, deeper, or colluvial sites, thicker soil profiles may develop, with an accumulation of organic matter and a more developed structure, but still generally with limestone-derived carbonate influence. Human land-use (grazing, mowing, occasional forest cover) has interacted with soil and landscape processes for centuries, influencing erosion, organic matter accumulation, and soil horizons.

Due to the soluble nature of limestone, the Bohemian Karst shows classic karst landforms: caves (e.g. Koněprusy Caves), sinkholes, dry valleys, outcrops of limestone pavements, rocky

plateaux, cliffs and gorges especially associated with river incision (e.g. along the Berounka River). There are more than 700 caves in the area, with c. 25 km of explored underground passages. Prehistoric activities are present in c. 100 of them (Žák et al. 2003). The archaeology yielded rich and important findings especially from the prehistoric period. Hunter-gatherer presence in the Bohemian Karst is documented particularly by finds in caves and rockshelters, where stratified sediments preserve lithic assemblages, faunal remains, and occasionally human bones, from the Early Upper Palaeolithic and Mesolithic periods. There are also presented important open-air and cave sites with settlements from the Magdalenian. These densified human occupations are usually intermittent and reflect seasonal or episodic use, likely as hunting camps or temporary refuges rather than permanent settlements.

14C dated	Data collection	Coordinates S-JTSK X	Coordinates S-JTSK Y	Cave ID	Notes
0	Surface survey	773365	1058422	Not applicable	
0	Excavation	765558	1055111	21-001	Magdalenian material present, but not published in greater detail
0	Excavation	766250	1057030	15-004	Magdalenian bone point, but no lithics
0	Surface survey	771976	1058096,1	Not applicable	Not published
0	Surface survey	750151	1054135	Not applicable	Not published
0	Surface survey	767857	1056911	Not applicable	Not published
1	Excavation	768170	1060205	19-008	Not published
1	Excavation	765335	1053506	21-004	
1	Excavation	767283	1055969	15-005	
0	Surface survey	775497	1062120	Not applicable	Not published, position is not precise
0	Excavation	771390	1058740	11-019	
0	Excavation	766623	1057533	15-001	Not published
0	Excavation	771440	1058685	11-008	Not published
0	Excavation	766519	1054698	20-003	
0	Surface survey	766393	1054529	Not applicable	
1	Excavation	766493	1054656	Not applicable	
1	Excavation	771845	1058270	11-003	Late Palaeolithic 14C dates, but no lithics
1	Excavation	768270	1060880	19-004	

Tab. 1. Basic information on Late Palaeolithic and Mesolithic sites in the Bohemian Karst. The numbers in the table correspond with the numbers in Fig. 1. Compiled by K. Kapustka.

Tab. 1. Základní popis nalezišť z období závěru paleolitu a mezolitu v Českém krasu. Čísla v tabulce se shodují s čísly na obr. 1. Sestavila K. Kapustka.

Environmental reconstructions for the Bohemian Karst suggest that during the Late Palaeolithic and into the Mesolithic the landscape alternated between more open, coldadapted steppetundra and forested zones, depending on climatic oscillations (Podroužková et al. 2020). Hunter-gatherer groups seem to have adapted to this variability by shifting foraging and hunting focus, possibly manipulating local vegetation, and exploiting forestedge ecotones. There is also evidence that rock cavities and overhangs in this area preserved well developed stratigraphies across these periods, which permit reconstructions of human interaction with the changing environment.

The Na Skalici site (registry No. 19-008; JESO cave database code K1128719-J-00008, cadastral area: Měňany; Fig. 2) is of exceptional importance as one of the few localities in the Bohemian Karst that was not excavated during the late 19th or early 20th centuries, thus providing an ideal opportunity for modern systematic research. The deposits exhibit excellent preservation of both palaeoecological and archaeological materials. This study evaluates the archaeological evidence obtained in 1997, 2015 and 2016 within the broader context of the Bohemian Karst. The site encompasses a significant chronological span from the Late Magdalenian to the Late Mesolithic. It is situated above the former Early Holocene Malina Lake and in the proximity of the former Měňanské Lake (Měňanské jezero), a key locality for understanding environmental changes in the Bohemian Karst during the Late Pleistocene and Early Holocene through malacozoological lenses. This geomorphological and environmental setting makes Na Skalici a crucial point of reference for studying transformations in hunter-gatherer lifestyles during a period of profound climatic and ecological change.

2. Overview of the Na Skalici site in the context of the Bohemian Karst

South of the Dlouhý Forest (Dlouhý les) the terrain ascends toward Bacín Hill (498.9 m a.s.l.), the highest elevation of the Bohemian Karst and a site of notable archaeological significance (Benková 1994; Benková et al. 1994; Sýkorová 1994; Matoušek 2005). Historical Austro-Hungarian maps (Second Military Mapping 1806–1869) indicate continuous forest cover in the area of Na Skalici with no evidence of extensive limestone extraction. Minor quarries and lime kilns operated in the 19th century on the northern slopes of a shallow valley. The forest was historically managed as a coppice woodland, likely used for grazing, and is now dominated by oak–hornbeam stands with scattered old oaks and areas of scree forest below limestone outcrops.

Biostratigraphic investigations at the Na Skalici Cave began in 1989, when I. Horáček and V. Ložek excavated the first test pit; further work occurred in 1997 (Cílek et al. 2000). Subsequent excavations between 2014 and 2016 (Fig. 3) yielded approximately one ton of material from four tons of washed sediment. Stratigraphic sequences document deposits from the Late Glacial period through the Holocene. Additional test pits (Skalice B, C) were excavated below nearby cave entrances (Nad Malinou, site 19-009).

Na Skalici Cave is developed in a sloping outcrop of Lower Devonian limestones extending c. 150 m in the northwestern–southeastern direction. The portal occurs within the Kotýz Limestones of the Lochkov Formation, near their contact with Koněprusy Limestones of the Prague Formation (Chlupáč ed. 1989). The strata dip in a northwestern direction (average 290°/40°) and are disrupted by northwestern–southeastern faults and local deformation. The cave follows a minor anticline, and a tectonically induced fracture zone related to the Tobolský Hill (Tobolský vrch), which facilitated karstification. To the

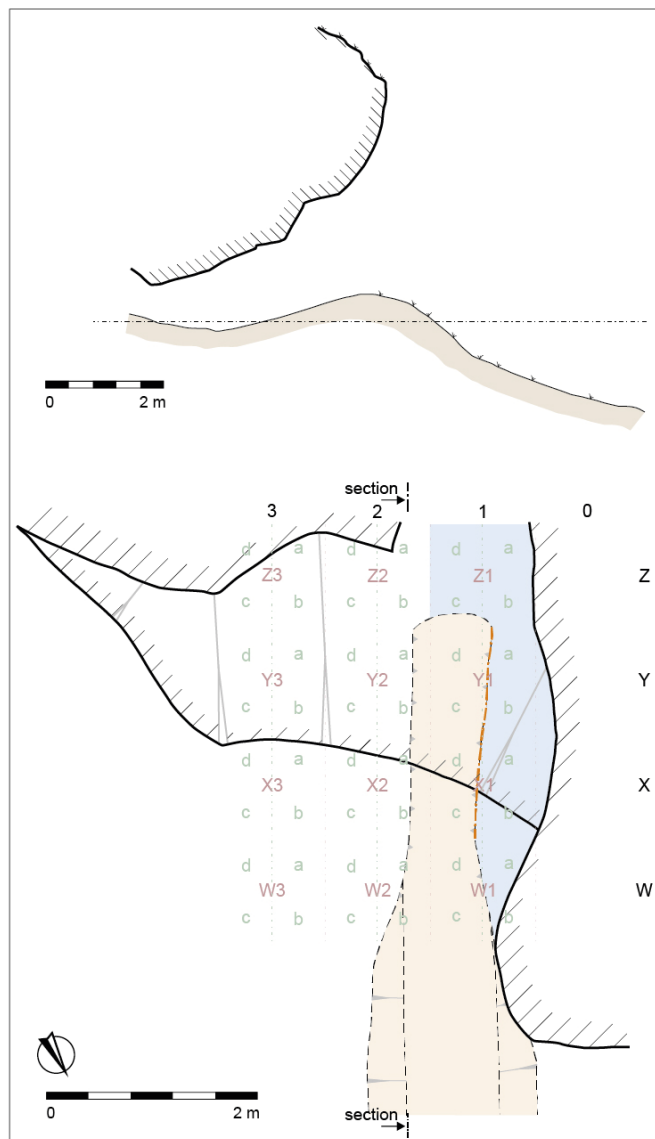


Fig. 3. Planigraphy of the site. Orange – area excavated by I. Horáček until 2016; blue – area excavated in 2025. Author F. Adámek.

Obr. 3. Planigrafie lokality. Oranžově – prostor zkoumaný I. Horáčkem do r. 2016; modře – prostor zkoumaný v roce 2025. Autor F. Adámek.

northeast of the fault, Silurian Kopanina Formation rocks are exposed. Surface hydrology is currently absent; infiltration dominates except during torrential rainfall. Occasional springs feed the Stříbrný stream (Stříbrný potok), and Holocene carbonate deposits at Malina Lake and Měňanské Lake record former shallow lacustrine environments (Kovanda 1958; 2015). The cave portal, originally less than 2 m wide and about 0.4 m high, was infilled with debris and recent vertebrate remains. Excavations in May 2025 connected the main portal with a smaller upper entrance along a transverse fissure approximately 4 m high and 10 m long. This structure likely represents a tectonic fracture later enlarged by karstification. The current morphology reflects roof collapse and sediment infilling; the original cavity was probably 1–2 m longer and up to 4 m high. Given its elevation, morphology, and absence of Quaternary surface drainage, the Na Skalici Cave system is best interpreted as a relict karst feature of probable Tertiary origin.

On 29 October 1988, speleologist M. Hahn and colleagues conducted a brief reconnaissance at the portal of the Na Skalici Cave, discovering prehistoric pottery fragments approximately 40 cm below the surface on the left side of the entrance. The finds,

together with associated faunal remains, were deposited in the Museum of the Bohemian Karst (accession No. 136/89; BČK/002-05-07/163002), where they remain (Fig. 4: a, b). Prior to the systematic excavations initiated by I. Horáček and V. Ložek (1989–2016), no professional publication addressed this site. Their early observations were summarized only briefly in the excursion guide (Cílek et al. 2000), based on a limited profile of the findings excavated before the later enlargement of the trench.

The focus of V. Ložek and I. Horáček was on understanding of the biostratigraphy of the site; they studied malacozoological and microfaunal records, while assuming minimal post-depositional displacement of shells or small vertebrate remains. Although such vertical migration is possible in debris-rich sediments, the statistical methodology applied provides robust ecological interpretation. The stratigraphic sequence in front of the cave portal is inclined outward and displays variable thickness. The lowermost units (9–8) contain open-habitat and boreal-taiga elements (*Helicopsis striata*, *Chondrula tridens*, *Discus ruderatus*), corresponding to the Late Glacial–Preboreal transition. The overlying complex (7–5) exhibits increased *Fruticicola fruticum* and first occurrences of mesic thermophiles (*Helix pomatia*), characteristic of the Boreal phase. A carbonized black horizon (6) rich in charcoal, grading into a calcic horizon (7) that yielded a Mesolithic artefact, marks a sedimentary hiatus and major faunal turnover. The subsequent layer (4b) contains thermophilous woodland species (*Aegopinella minor*, *Euomphalia strigella*, *Granaria frumentum*), indicating a semi-open forest typical of the Early Atlantic period. In layer 4a, woodland taxa increase (*Carychium tridentatum*), culminating in layers 3–2 with *Helicodonta obvoluta*, reflecting a closed forest with small open patches —interpreted as the Epiatlantic phase according to V. Ložek and K. D. Jäger (1968). The uppermost layer 1 shows a decline of both woodland and open-habitat molluscs, consistent with the Late Holocene (Subboreal–Recent) and reduced sediment accumulation due to erosional reworking at the cave entrance (Cílek et al. 2000; Svoboda ed. 2002).

The Mesolithic material is the most numerous archaeological component at this site, but there are also present Late Palaeolithic and Magdalenian components, as will be described below. The Mesolithic and Late Palaeolithic periods of the Bohemian Karst have never been systematically studied. However, some collections from all periods are known. The main characteristics and locations of these sites are summarized in Table 1 and indicated in Figure 1. These findings confirm that the site is situated in a region that was occupied during these periods.

3. Materials and methods

Prior to 2025, the site had not been subject to archaeological excavations aimed at investigating human occupation. Methodology of the biostratigraphic research however yielded numerous lithic finds. The site was excavated using a 1 × 1 m grid. The area excavated between 1989 and 2016 covered 3 m². Sediments were removed in spits 5 to 10 cm thick. All sediments were wet sieved on 2 mm mesh. The maximal depth which was achieved was c. 2.5 m deep, and test trench combined with a coring hit more than 4 m of the sediments. Wet sieved sediments were sorted in the lab. During 2025 the main strategy remained the same, but most of the sediments were not only wet sieved, but also floated on the 0.25 mm mesh. The square metres were excavated in quadrants. The course of the excavation was documented with drawings and photography. All finds that were found *in situ* were measured with a total station and the extent of the pit and edges of the sheltered area were tracked with a total station as well. A photogrammetric model of the cave was prepared. Various samples were taken

(phytolith, susceptibility, starches, malacozoology, microfaunal remains, charcoal), but their processing was not finished yet. The positions of samples taken directly from the profile were marked on the profile itself, while all other samples can be associated with a specific quadrant of a given square meter (Fig. 2). As most analyses are still in preparation for the final report, the results section below will focus on the main features of the site's stratigraphy; the archaeological finds identified in the wet-sieved residues obtained from the biostratigraphic research conducted between 1989 and 2016; and the site's absolute chronology based on the radiocarbon dating.

3.1 Stratigraphy and site formation processes

The site stratigraphy seems to be well preserved, however we still speak about a cave in the karstic environment and in the forested area, thus there are considerably big blocks which were falling from the rock to the occupation surfaces and there was a forested spot, so the plant roots and animal activity necessarily affected preservation of the stratigraphy and we expect at least some movements of the materials between the layers. The profile shows a sequence of approximately eight main stratigraphic units (labelled 0–6) overlying a stony basal layer, however from the coring of this site we know, that there is depth of profile at least 4.5 m, thus high probability of having even lower occupational horizons, however further research is needed to confirm their existence and chronology (Fig. 4).

Layer 0 (topsoil/humic layer): The uppermost horizon is a thin, dark brown to greyish-brown layer with a loose, humic texture. It contains scattered small to medium-sized stones. This represents the current ground surface, or a recent topsoil accumulation formed through natural paedogenic processes.

Layer 1 (dark brownish grey humic loam): Beneath the topsoil lies a lighter, sandy to loamy layer with fewer inclusions. The texture suggests a natural sedimentation process, possibly colluvial in nature. Occasional larger stones appear dispersed throughout, indicating minor disturbance or redeposition. This layer does not contain much archaeological material, the prehistoric sherds that were found at the site very probably come from this stratigraphic unit.

Layer 2 (brownish grey humic loam) with texture of the natural sedimentation process. It has a coarse crumb structure, numerous stone fragments. The layer is divided into the 'a' and 'b', according to the number of rock and its colour. Layer 2a is lighter and with more rocks, 2b is a little bit darker with occasional presence of the limestone rocks.

At the boundary of the layers 2b and 3a a clearly anthropogenic feature was situated. Dark greyish black dusty sediment with a high concentration of charcoal. This area was interpreted as the fireplace.

Layer 3a, 3b (light grey loam with coarser scree): Below the fireplace, a distinct horizon rich in angular to subrounded stones forms a compact, organised structure. The stones appear set within a darker matrix, indicating a deliberate deposit – possibly the remains of a stone feature, such as a foundation, pavement, or collapse layer. The lower part (3b) shows a denser concentration of stones with a clearer alignment, which may mark the base of the construction or a structural interface.

Layer 4 (loess): this layer had the character of the loess deposit; it is compact dust of a yellow-light brown colour. It shows characteristics of the natural sedimentation process and there is considerable density of the limestone rocks.

The layers below layer 4 were not recently excavated, their characteristics are mentioned according to the earlier publications, especially Cílek et al. 2000: Layer 5 (dark grey compacted

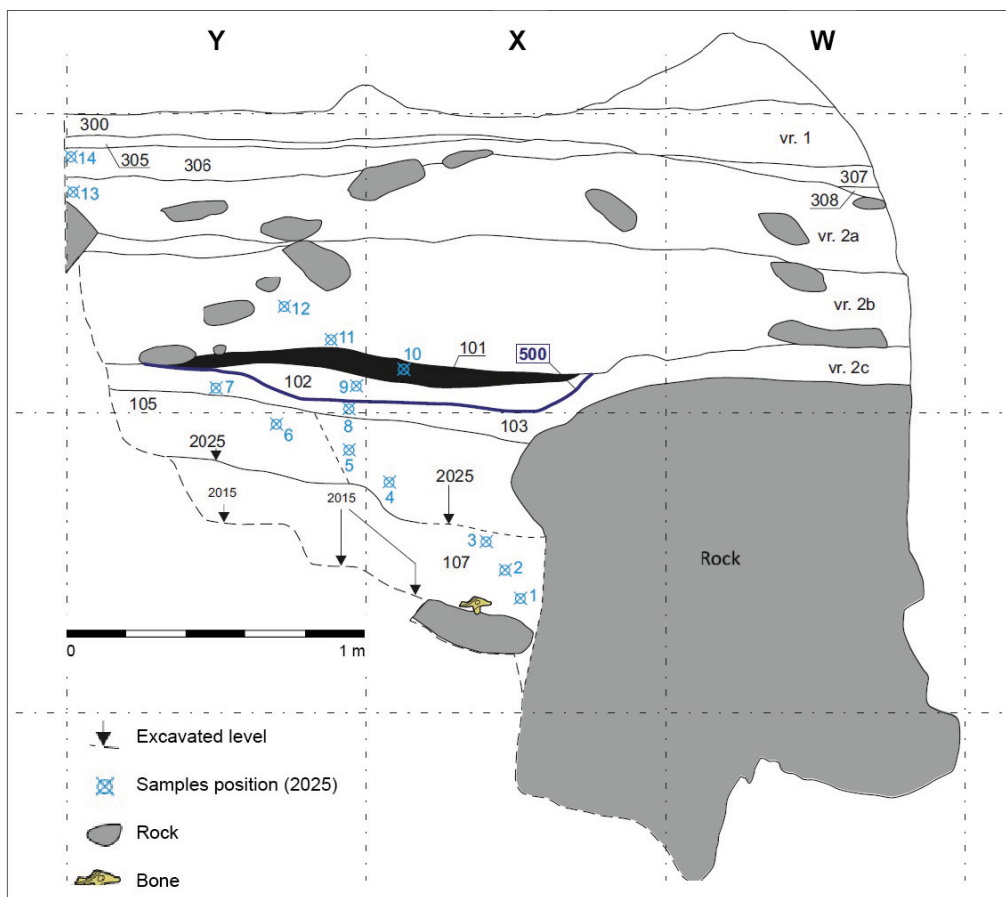


Fig. 4. Stratigraphic profile site, part of the sequence excavated in 2025. Position of the profile marked in Fig. 3 by the orange line. Author F. Adáček.
Obr. 4. Stratigrafický profil zkoumané části naleziště, část sekvence zkoumaná v r. 2025. Poloha řezu je na obr. 3 vyznačena oranžovou linií. Autor F. Adáček.

humic loam); layer 6 (dark compacted horizon); layer 7 (grey calcic horizon), layer 8 (coarse pale brownish grey), layer 9 (coarse brownish grey). Their chronology seems to be clearly associated with the course of the Last Glacial.

Deeper layers have not yet been excavated. The cored part of the profile contained two more layers up to the depth of the 4.5 m. The site is situated in a quite steep hill with a maximum slope c. 30%. This also affected the deposition and post-depositional processes of the layers. Stratigraphic units considerably wedge towards the valley and their thickness vary, they are thin at the entrance of the cave and thicker towards the valley.

The profile records a stratified sequence transitioning from recent surface deposits through anthropogenic or reworked layers to a substantial stony feature resting upon the natural subsoil. The archaeologically richest horizon (Layer 3a, 3b) corresponds with the area where the Mesolithic hearth was identified, while the overlying sandy and humic layers indicate later sedimentation and soil formation following abandonment or erosion.

3.2 Lithic assemblage

The lithic assemblage from the Na Skalici site represents a stratified sequence covering the Late Upper Palaeolithic (Magdalenian, layers from layer 5 to layer 8), Late Palaeolithic (layer 4), and Mesolithic (layers from 2a to 3b). Altogether, 227 artefacts were recovered from the previously excavated deposits, originating from biostratigraphic trenches conducted between 1989 and 2016. The assemblage comprises tools, bladelets/blades, technical flakes, and production waste. Despite the modest quantity, the collection provides valuable insight into raw material procurement and knapping strategies in the Bohemian Karst region.

Raw materials were dominantly exploited from local sources. Local chert derived from the Devonian limestone of the Bohemian

Karst dominates the assemblage (approximately 60% of all artefacts). Non-imported materials include erratic flint and quartzite from northwestern Bohemia (Fig. 5). Small quantities of burnt silicite and limnosilicite also occur, indicating limited import or secondary use of exotic raw materials. Part of the raw materials was not determined yet. The diversity of raw materials reflects opportunistic use of both local and regional lithic sources, consistent with hunter-gatherer mobility patterns within the karstic landscape.

The upper layers with the Neolithic 14C dates might be either shows two options for their interpretation. According to the technology of production, indirect percussion, there seems to be a clear Neolithic component (Fig. 5: 10). However, there is also a high proportion of local cherts which is not typical for the Neolithic. It might indicate survival of a Mesolithic lifestyle into a later period than previously expected. To clarify this point, further analyses should be conducted. The Mesolithic assemblage is the most numerous, comprising over 180 artefacts (Fig. 2; Tab. 2). Waste and technical flakes predominate, suggesting on-site tool production or maintenance. Bladelets and small blades (n = 17) are frequent (Fig. 6: 1–3), with standardised morphology and occasional retouch, consistent with microlithic production strategies typical for the Early Mesolithic. Tools include scrapers and retouched bladelets made predominantly of local chert and erratic flint. The presence of burnt silicite artefacts suggests occasional exposure to fire, possibly related to hearth activity documented in the stratigraphy. The present microlith triangles (Fig. 6: 4, 5) are typical for the Early Mesolithic period, and even though radiocarbon dates for this specific phase are not present typologically, it is clear that Early Mesolithic occupation was present at this site.

The Late Palaeolithic assemblage is considerably smaller (n = 13), yet technologically coherent (Fig. 6: 6, 7). It is dominated

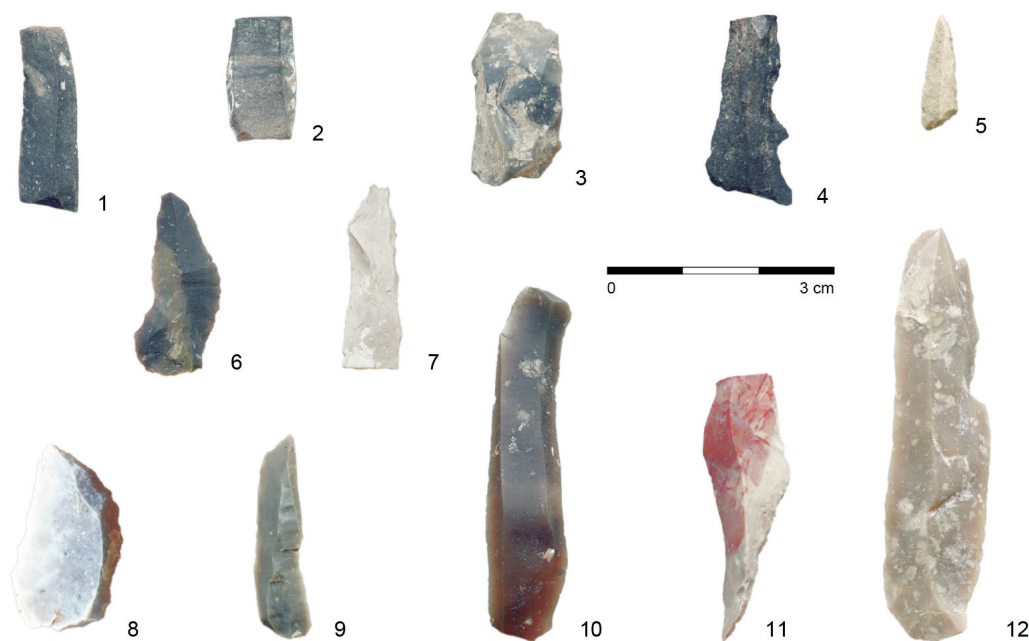


Fig. 5. Na Skalici – used raw materials. 1, 4 – local schist (Liteň); 2, 3, 6 – local chert; 5 – quartzite (Tušimice); 7 – burnt silicite; 8, 10, 12 – erratic flint; 9 – Jurassic radiolarite; 11 – quartzite (Skršín). Photo by M. Housková.

Obr. 5. Na Skalici – použité suroviny. 1, 4 – místní břidlice (Liteň); 2, 3, 6 – místní rohovec; 5 – křemenec (Tušimice); 7 – přepálený silicit; 8, 10, 12 – silicit glacienních sedimentů; 9 – jurský radiolarit; 11 – křemenec (Skršín). Photo by M. Housková.

by blades and waste, with the raw material spectrum emphasizing erratic flint and minor local chert. The production technology reflects a transitional stage between Late Upper Palaeolithic and Mesolithic knapping systems, focused on controlled bladelet production with limited core preparation evidence. The typical Late Palaeolithic, unfortunately broken, backed bladelet (Fig. 5: 7) shows, not only through radiocarbon but also typologically, that this component is clearly present at the studied site, even though the collection of this component is very limited with respect to the number of pieces.

The Magdalenian component is represented by about 16 artefacts. Waste dominates the collection, produced mainly from local chert and erratic flint (Fig. 6: 12), and accompanied by a single piece of limnosilicite. Although no diagnostic backed pieces were found, according to the radiocarbon dating this part is associated with Late Magdalenian, an idea supported by the patination of the silicites. Tools are present, such as the scraper (Fig. 5: 8) and non-diagnostic fragments of retouched pieces, thus the presence of the Magdalenian component is mostly confirmed by radiocarbon dating and composition of the fauna, we need to enlarge the collection to have typical artefacts recorded too.

Overall, the lithic materials from the Na Skalici site document repeated use of the site during the Late Pleistocene and Holocene. The technological and raw material patterns indicate local procurement combined with limited introduction of non-local flints, typical for mobile hunter-gatherer groups exploiting diverse karst resources. The Mesolithic assemblage, characterised by small standardised bladelets, high waste proportion, and diverse raw materials, represents one of the most complete examples of Early Holocene lithic production within the Bohemian Karst.

The lithic assemblage from Na Skalici represents a rare, stratified Mesolithic context in the Bohemian Karst. Older excavation strategies did not include systematic sieving, often missing small artefacts. In contrast, materials from Na Skalici were collected for this study with high-resolution recovery, making this assemblage particularly valuable. The lithics show extensive use of local raw materials, especially cherts of the Bohemian Karst type, which dominate the assemblage. Non-local materials – such as quartzites and silicites of glacial origin – also occur and may originate from regions to the north or northwest. All raw materials were worked using similar reduction strategies, aiming for standardised blade/bladelet production – even from local cherts. Typologically, the artefacts align with the Early Mesolithic. Heavily patinated tools from lower layers likely belong to the Upper Palaeolithic (Magdalenian).

Chronology	Raw material	Local chert	Quartzites	Erratic flint	Undetermined	Burnt silicite	Limnosilicite
Mesolithic	Tools	2	3	2	0	2	0
	Bladelets/ blades	11	0	5	0	1	0
	Technical flakes	4	2	1	0	0	0
	Waste	106	7	41	3	3	3
Late Palaeolithic	Tools	0	0	1	0	1	0
	Bladelets/ blades	4	0	1	0	0	0
	Technical flakes	0	0	1	0	0	0
	Waste	2	0	4	0	0	0
Magdalenian	Tools	2	0	2	1	0	0
	Bladelets/ blades	0	0	0	0	0	0
	Technical flakes	0	0	0	0	0	0
	Waste	10	1	0	0	0	1

Tab. 2. Description of the lithic finds from the Na Skalici site. Compiled by K. Kapustka.

Tab. 2. Základní popis štípané industrie z lokality Na Skalici. Sestavila K. Kapustka.

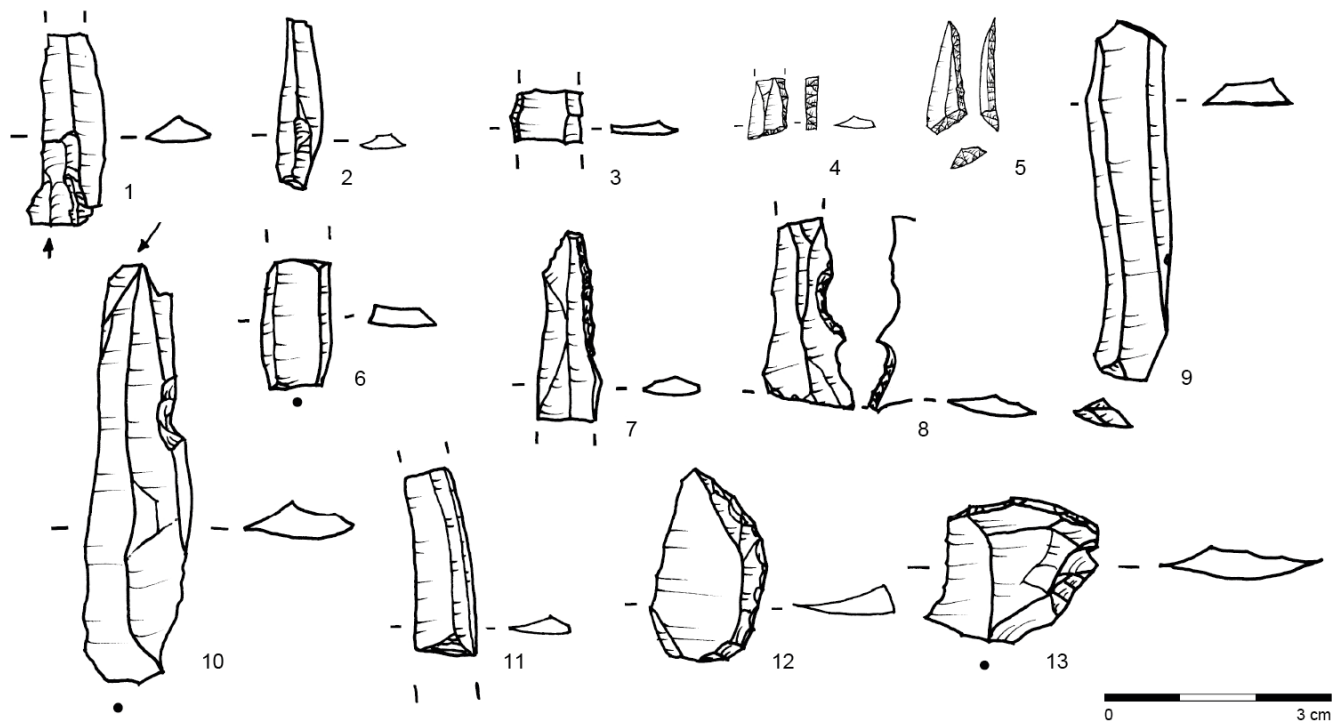


Fig. 6. Drawings of selected finds from the Na Skalici site. Stratigraphic position of the finds: 1, 2, 8–11, 13 – layer 2; 3–5 – layer 3; 6, 7 – layer 4; 12 – layer 5. Used raw material: 1, 2, 6, 8, 11, 13 – chert (Bohemian Karst type); 5 – quartzite; 3, 7 – burnt silicite; 4, 9, 10, 12 – erratic flint. Drawing by K. Kapustka.

Obr. 6. Kresební dokumentace vybraných nálezů z lokality Na Skalici. Stratigrafická poloha nálezů: 1, 2, 8–11, 13 – vrstva 2; 3–5 – vrstva 3; 4, 7 – vrstva 4; 12 – vrstva 5. Použité suroviny: 1, 2, 6, 8, 11, 13 – rohovec typu Český kras; 5 – křemenec; 3, 7 – přepálený silicit; 4, 9, 10, 12 – silicit glacienních sedimentů. Kresba K. Kapustka.

3.3 Radiocarbon dating and chronological context

Typological classification of archaeological finds is commonly used to date Mesolithic sites. However, radiocarbon dating offers more precise chronological association, especially for hunter-gatherer contexts, where mainly lithic artefacts are often preserved. At Na Skalici, eight radiocarbon samples were successfully dated (all from small mammal bones). Two samples were dated shortly after Horáček’s test trench, and the remaining were selected to represent distinct stratigraphic layers. All samples were analysed by the Czech Radiocarbon Laboratory. Previously published dates were recalibrated using the OxCal v4.4 program and IntCal20 calibration curve (Bronk Ramsey 2009; Reimer et al. 2020) (Fig. 7, Tab. 3). Another set of dates from the charcoal and macroremains are planned to be dated soon, however this has not been proceeded yet.

Radiocarbon data from the Na Skalici site indicate a long and complex sequence of occupation and sedimentation spanning from the Late Pleistocene to the Middle Holocene. The lowest dated horizons (Layers 6, 8a, and the basal level) correspond to the period between approximately 13900–13200 cal BC, representing the Late Glacial phase. These early deposits (especially Layers 6 and 8a) likely relate to the initial formation of the sedimentary sequence, possibly reflecting natural accumulation processes with intermittent traces of human presence.

Above these, Layers 5 and 4b yielded radiocarbon ages around 11500–10800 cal BC, falling within the final phase of the Bølling-Allerød interstadial to the Younger Dryas event, covering Late Palaeolithic occupation. These horizons are characterised by compact, stony deposits with angular to subrounded clasts embedded in a darker sediment matrix. The composition and structure of these layers suggest anthropogenic influence, potentially relating to the construction or use of stone surfaces or working areas. The radiocarbon ages correspond closely with contemporaneous sites in the region, such as Martina Cave and Tři voli, indicating that

Na Skalici formed part of a broader network of Late Palaeolithic activity within the area. These early occupations likely represent short-term or seasonal use of the locality by hunter-gatherer groups adapting to postglacial environments.

A distinct chronological gap separates these early levels from the uppermost part of the sequence. Above the Late Glacial levels, the profile shows a distinct stratigraphic and chronological break. No radiocarbon ages were obtained for the intermediate layers, and sediment characteristics suggest a phase of stability or abandonment. This gap spans several millennia during the Early to Middle Holocene, implying that the site was not continuously occupied and may have undergone natural sedimentation or soil development during this interval. The Early Mesolithic phase, which is clearly visible in the archaeological material, was not confirmed by the first set of radiocarbon dates, but it is present in the later evidence from the material from 2025 excavations.

The latest occupational phase is from layer 2a and is significantly younger, dating to approximately 5500–5000 cal BC, corresponding to the Middle Holocene (Late Mesolithic to Early Neolithic). The absolute chronology indicates a Neolithic age of the material, however its characteristics show typical Mesolithic features. The overlying topsoil and humic deposits represent modern soil development following the abandonment of the site.

When placed within the broader framework of regional radiocarbon evidence, the dates from Na Skalici define two distinct chronological horizons that align well with known phases of Late Glacial and Early-Middle Holocene occupation in the region. The site thus forms part of a broader regional sequence, illustrating the transition from Late Glacial forager occupation to the latest phases of the Mesolithic hunter-gatherer activity. Radiocarbon dating and stratigraphic analysis at Na Skalici provide evidence for several occupational phases of human activity, separated by a considerable chronological hiatus.

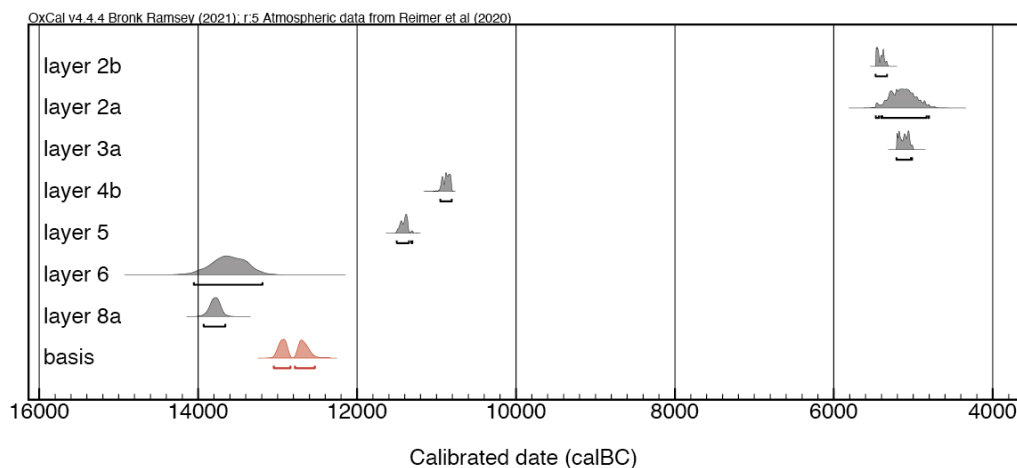


Fig. 7. Calibrated radiocarbon dates from the Na Skalici site. Author N. Košťová.

Obr. 7. Kalibrovaná radiouhlíková data z lokality Na Skalici. Autor N. Košťová.

Site	Layer	Sample No.	Years BP	± (years)	Cal. BC, 95.4% prob.	Collagen, mg/g	Bone quality
Na Skalici	2a	CRL-24_0670	6424	21	5474–5330 (95.4%)	43	4.5
Na Skalici	2b	Unknown	6198	132	5390–4834 (92.7%);		4.5
Na Skalici	2b	CRL-24_0671	6159	21	5210–5030 (94.9%);	41	4.5
Na Skalici	4b	CRL-24_0672	10933	33	10952–10808 (95.4%)	16	4.5
Na Skalici	5	CRL-24_0673	11474	30	11500–11348 (94.0%);	22	5
Na Skalici	6	Unknown	13000	150	14055–13192 (95.4%)		
Na Skalici	8a	CRL-24_0674	13124	32	13931–13658 (95.4%)	24	5
Na Skalici	Basis	CRL-24_0675	12496	28	13047–12838 (46.5%); 12781–12533 (48.9%)	43	4.5

Tab. 3. Basic information on radiocarbon dates from the Na Skalici site. Compiled by N. Košťová.

Tab. 3. Základní informace o radiouhlíkových datech z lokality Na Skalici. Sestavila N. Košťová.

4. Discussion

The raw material spectrum from the Mesolithic levels at Na Skalici aligns well within the broader pattern observed in the Bohemian Karst, where local silicite resources were supplemented by a limited presence of non-local lithotypes. Local chert of Devonian origin dominates the assemblage, representing over half of all artefacts, while erratic flint, quartzite, and minor exotic rocks form secondary components. This composition closely parallels patterns documented at other regional Mesolithic sites, yet also reveals subtle distinctions that reflect local resource accessibility and mobility range.

At Bacín site, located roughly 500 m to the northeast, Mesolithic assemblages show a similar predominance of local cherts, with erratic flint rarely exceeding 10–15% of the total lithic inventory. The material economy there appears highly localised, suggesting repeated short-term visits by small groups exploiting nearby raw material sources directly within the karstic valleys. By contrast, Na Skalici exhibits a somewhat greater proportion of erratic flint (c. 25%), indicating either a broader foraging radius or the incorporation of transported cores and tools from other zones of activity. The simultaneous presence of quartzite – absent or rare at Bacín – points to opportunistic collection of raw materials from fluvial gravels along the Berounka River or its tributaries.

At the Martina and Hostim cave sites, local chert again forms the technological backbone of the lithic assemblages, but burnt silicite and fine-grained erratic flint appear more frequently. These differences may reflect site function: caves such as Martina were likely used for longer residential occupations, where selected tools were reworked and occasionally heat-treated, whereas rockshelters and small caves like Na Skalici served primarily as logistical camps or specialised stations.

The appearance of limnosilicite in both Na Skalici and Martina caves is noteworthy, as this raw material originates from limited lacustrine deposits in the wider Central Bohemian region.

Its sporadic presence likely represents exchange or transport within a small-scale interaction network connecting hunter-gatherer groups along the Berounka and Sázava rivers valleys during the Early Holocene.

Overall, the raw material economy of Na Skalici reflects a flexible, low-intensity procurement strategy typical of postglacial forager groups in karstic environments. The predominance of local cherts demonstrates a reliance on immediately available resources, while the presence of exotic raw materials suggests periodic movement. In comparison with neighbouring sites, Na Skalici thus occupies an intermediate position between strictly local procurement systems (e.g. Bacín) and more regionally connected assemblages (e.g. Martina, Hostim), highlighting the diversity of Mesolithic adaptive strategies within the Bohemian Karst (Tab. 4, Graph 1).

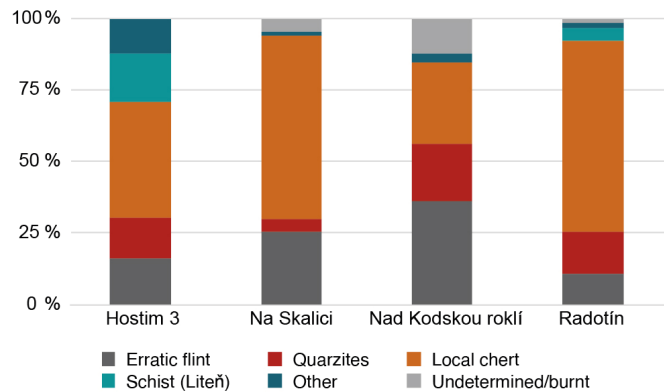
The composition of the lithic assemblage at Na Skalici contributes to a refined understanding of Mesolithic mobility and settlement dynamics in Central Bohemia. The combination of dominant local raw materials with a consistent, though minor, influx of erratic flint and other exotic rocks indicates a mobile settlement system characterised by repeated seasonal visits to key topographic zones. The site's position on the margin of the karst plateau, near access routes to river valleys, supports its interpretation as a short-term camp integrated within a broader foraging territory.

Such mobility patterns are consistent with models proposed for the Early Holocene of Central Europe, where hunter-gatherer groups organised their movements around predictable resource zones, combining stable habitation cores with peripheral task-specific sites. Na Skalici thus provides evidence for a locally anchored, yet regionally connected Mesolithic settlement system, reflecting both environmental opportunities of the Bohemian Karst and long-term adaptive continuity from the Late Glacial period (Graph 2).

Raw material	Hostim 3	Na Skalici	Nad Kodskou roklí	Radotín
Erratic flint	25	49	23	37
Quartzite (Bečov)	7	3	8	30
Quartzite (Tušimice)	5	6	2	10
Quartzite (Žatec)	4	0	0	9
Other quartzite	6	3	3	2
Local chert	62	123	18	232
Schist (Liteň)	26	0	0	15
Bavarian chert	0	0	0	3
Other silicite	15	3	0	1
Quartz	4	0	1	2
Jaspers	0	0	1	0
Burnt silicite	0	6	0	0
Undetermined	0	3	8	6
Total	154	196	64	347

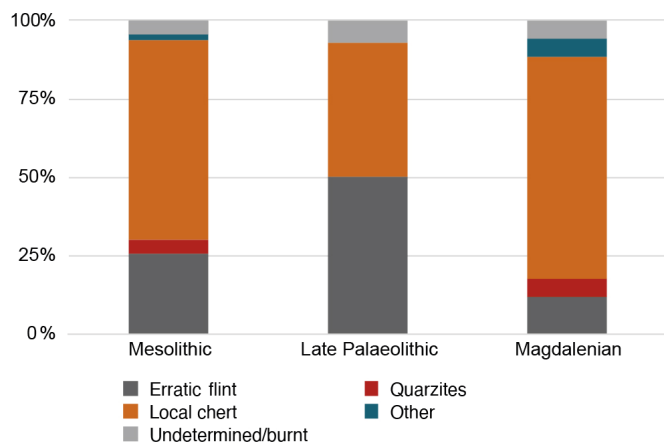
Tab. 4. Comparison of the lithic raw material composition of the Mesolithic sites in the vicinity of the Na Skalici site. Compiled by K. Kapustka.

Tab. 4. Porovnáni skladby surovin na štípanou industrii z mezolitických nalezišť v okolí lokality Na Skalici. Sestavila K. Kapustka.



Graph 1. Comparison of the composition of raw materials from other Mesolithic sites in the proximity of the Na Skalici site. Compiled by K. Kapustka.

Graf 1. Porovnáni skladby surovin na štípanou industrii z mezolitických nalezišť v okolí lokality Na Skalici. Sestavila K. Kapustka.



Graph 2. Comparison of the composition of the raw materials from different chronological periods at the Na Skalici site. Compiled by K. Kapustka.

Graf 2. Porovnáni skladby surovin na štípanou industrii v různých chronologických úsecích na lokalitě Na Skalici. Sestavila K. Kapustka.

The typological aspects of the collection are problematic as the collection is rather small. However, fortunately, the typical tools of the Early Mesolithic and Late Palaeolithic are present and respect the radiocarbon chronology and the typology of these periods. We do not yet have any typical tools for the Late Mesolithic/Neolithic and Magdalenian, and hopefully we will be able to identify some after the collection is enlarged by the future excavation.

The stratigraphy of the site seems to be well preserved and it does not seem that any considerable redepositions were running at the site. The Neolithic radiocarbon dates of the upper layers might confirm Neolithic occupation at the site, which was also present at Martina Cave, or these dates might be supporting a longer presence of the Mesolithic lifestyle in this region. This will hopefully be solved during the next seasons of research at the site and its surroundings, based on the confirmed plant use, residual and other analyses that should be conducted.

5. Conclusion

Na Skalici stands out as a stratified and well-preserved site, documenting a long sequence of human activity from the Late Upper Palaeolithic through the Mesolithic. The archaeological record aligns well with both faunal evidence and radiocarbon data, and the site yielded a remarkably rich lithic assemblage. Excavations in 2025, though still under analysis, confirm the previous findings and further underscore the importance of this site for reconstructing lifestyles during the Pleistocene/Holocene transition.

This site provides valuable insight into changing patterns of settlement, mobility, and resource use among forager groups in Central Europe. Detailed study of the materials from Na Skalici may help clarify how hunting strategies evolved during the Late Pleistocene and Holocene, as well as the types of natural resources exploited. In the broader regional context, the site allows us to observe long-term changes across surrounding sites, particularly during periods of significant climatic shifts. Comparison of the collection with other regional assemblages reveals both continuities and discontinuities in the raw material use.

Crucial for further, more detailed study is the presence of a well-stratified profile, whose radiocarbon chronology is coherent with biostratigraphic evidence. Within Czechia, Na Skalici represents the best-known record of late hunter-gatherer settlement, offering significant potential for future analyses, including sedimentary DNA, use-wear and isotope studies. Such research may shed light on settlement strategies, seasonal occupation and their evolution during the preserved time span of the site.

CRedit authorship contribution statement

Katarína Kapustka: Conceptualization, Data curation, Formal analysis, Writing – original draft.

Nikola Košťová: Data curation, Formal analysis.

Karolína Pauknerová: Conceptualization, Writing – review & editing.

František Adámek: Data curation, Visualization.

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Note

- 1 We would like to thank to Ivan Horáček (Faculty of Science, Charles University) who gave us access to the initial finds and enabled the research.

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Resumé

Český kras, nejrozsáhlejší vápencová oblast v Čechách, představuje významný region pro studium interakce člověka a prostředí na přelomu pozdního pleistocénu a raného holocénu. Ačkoli má oblast velký paleoekologický význam a je dlouhodobě zkoumána, systematický archeologický výzkum aktivit lovců a sběračů byl v posledních desítkách let omezený a nemohly být aplikovány mnohé z dnes dostupných metod. Tento článek se zaměřuje na lokalitu Na Skalici u Měňan, kde se dochovala unikátní stratigrafie, která pokrývá období od magdalénienu přes pozdní paleolit až do konce mezolitu. Nalezště s některými z těchto období se v regionu vyskytují (obr. 1; tab. 1), ale lokality s opakovanými návštěvami v tak dlouhém období jsou v Českém krasu vzácné a umožňují rekonstruovat způsoby využívání krajiny, strategie mobility a odpověď lovců a sběračů na klimatické změny.

Biostratigrafický výzkum jeskyně Na Skalici (obr. 2) probíhal od roku 1989 do roku 2016 a v rámci něj byly získány první archeologické nálezy, především štípaná industrie. Archeologickému výzkumu zahájenému v roce 2025 (obr. 3) předcházelo radiouhlíkové datování vzorků z předchozího výzkumu a také zpracování dříve získaných archeologických nálezů. Vrstvy obsahují kamenné nástroje, pozůstatky fauny a množství archeobotanického materiálu (uhlíků i makrozbytků). Dále byly

objevy rozsáhlé koncentrace uhlíků interpretované jako ohniště. Radiouhlíkové datování kostí drobných obratlovců ukázalo tři fáze osídlení: první proběhla během pozdního glaciálu, přibližně 13900–13100 cal. BC, druhá v období pozdního paleolitu kolem 10000 cal. BC a třetí v období středního holocénu, mezi 5500–5000 cal. BC (obr. 7; tab. 3), spojená s pozdně mezolitickými až neolitickými aktivitami. Vzhledem k charakteru štipané industrie a novým radiouhlíkovým datům z uhlíků se však zdá, že fáze osídlení bylo na lokalitě více, nepochybně ve starším mezolitu. Situace indikují přerušované, ale opakované využívání lokality v reakci na klimatické a environmentální změny během přelomu pleistocénu a holocénu.

Stratigrafie lokality je zachována velmi dobře a zahrnuje osm hlavních jednotek (obr. 4). Zatím nejbohatší archeologická vrstva (3a–3b) obsahuje mezolitické ohniště a kamenné artefakty a je možné ji zařadit do starší fáze mezolitu. Nad ní se nacházejí humózní a písčité vrstvy odpovídající pozdějším sedimentačním procesům a tvorbě půd po opuštění lokality, přítomný tu je také materiál z úplného závěru mezolitu, resp. ze zemědělského pravěku. Hluběji situované vrstvy (6–8a) obsahují stopy pozdně glaciální lidské aktivity. Celková hloubka profilu přesahuje 2 m, což naznačuje možnou přítomnost dalších, dosud neprozkoumaných horizontů.

V souborech štipané industrie je dominantním materiálem místní rohovec, dále se vyskytují silicité glacienních sedimentů, křemence a limnosilicity (obr. 5; tab. 2), což odráží strategie lovců-sběračů kombinující lokální využívání surovin s příležitostným přinášením materiálů z okolních oblastí. Mezolitická industrie je nejpočetnější, zahrnuje malé standardizované čepele a odpad z výroby nástrojů, naznačující místní produkci přímo na místě. Z typologického hlediska jsou cenné nálezy pěkných trojúhelníků z různých surovin (obr. 6).

Porovnání s okolními lokalitami, jako jsou Bacín, Martina a Hostim (tab. 4; graf 1, 2), ukazuje, že Na Skalici reprezentuje střední model mezi lokálně orientovanými a regionálně propojenými subsistenčními systémy. Přítomnost limnosilicidů a silicidů glacienních sedimentů naznačuje širší oblast využívanou skupinou, která se zastavila i Na Skalici. Strategicky se lokalita nachází na okraji krasového plató, v mezolitu měla výhled na tehdy přítomné staroholocenní jezero. Geneze jezera bude dále zkoumána, aby bylo možné zjistit, jestli přítomnost jezera koreluje s osídlením na nalezišti.

Na Skalici je jedním z nejlépe zachovaných a přesně datovaných nalezišť pozdních lovců-sběračů v Českém krasu a poskytuje unikátní možnost studia adaptačních strategií, sezónního

využívání prostoru a interakce člověka s měnícím se prostředím. Výsledky výzkumu přinášejí cenné informace o proměnách způsobu obživy, získávání surovin a mobility během přelomu pozdního pleistocénu a raného holocénu. Naleziště má také potenciál pro další analýzy, například sedimentární DNA, tra-seologickou analýzu nástrojů či izotopové studie, které mohou dále obohatit naše znalosti o životě mezolitických komunit ve střední Evropě.

Contacts:

Katarína Kapustka

Czech Academy of Sciences
Institute of Archaeology, Praha
Letenská 4
118 00 Praha 1
Czech Republic
e-mail: culakova@arup.cas.cz
ORCID: 0000-0003-3174-5614

Nikola Košťová

Czech Academy of Sciences
Institute of Archaeology, Praha
Letenská 4
118 00 Praha 1
Czech Republic
e-mail: kostova@arup.cas.cz
ORCID: 0000-0001-8165-8370

Karolína Pauknerová

Charles University
Center for Theoretical Study
Jilská 1
110 00 Praha 1
Czech Republic
e-mail: pauknerova@cts.cuni.cz
ORCID: 0000-0001-5592-2297

František Adámek

Czech Academy of Sciences
Institute of Archaeology, Praha
Letenská 4
118 00 Praha 1
Czech Republic
e-mail: adamek@arup.cas.cz
ORCID: 0009-0008-4161-6537