Radiocarbon, Vol 63, Nr 2, 2021, p 473–480 DOI:10.1017/RDC.2021.5

PREHISTORIC CHARCOAL GRAFFITI DISCOVERED IN KATEŘINSKÁ CAVE, CZECH REPUBLIC

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ABSTRACT. The article reports on a new sampling method and the archaeological context of cave drawings, which include the oldest currently known graffiti in the Czech Republic. Between 2016 and 2020, samples with a small amount of charcoal were taken from drawings found in Kateřinská Cave (Catherine's Cave) of the Moravian Karst in the Czech Republic. A new gentle method of sampling charcoal from the cave walls was developed for the purpose of radiocarbon (^{14}C) dating cave drawings of unknown age, while preserving the contours of the drawings. ^{14}C analysis has provided data from four periods of prehistory and history: from the Neolithic around 5000 BC, the turn of the Neolithic and Eneolithic around 4300 BC, the Hallstatt Period from 800–450 BC, and also from the Middle Ages (13th century). The radiocarbon dates of the graffiti correspond to the dates of the pottery finds from the entrance portal of Kateřinská Cave, thus validating the dates and the sampling method.

KEYWORDS: cave graffiti, prehistoric and historic periods, wipe-sampling method.

INTRODUCTION

Traces of human activity are commonly found in many European caves. There are three primary motivations for the presence Neolithic people in caves that were recognized: the use of cave spaces as dwellings; the use for periodic sheltering of cattle; and the use of caves for ritual/cult purposes, for example Peša (2014). It can be assumed that a large part of the caves with preserved drawings or markings was used for the latter reason. The "artistic style" of the Neolithic/Eneolithic differs significantly from the realistic Palaeolithic drawings, and it is encountered mainly in southern Europe. The Italian cave La Grotta dei Cervi (Deer Cave) near Porto Badisco in the Apulia region is a typical Neolithic gallery, in which stylized figural scenes of hunting and other activities have been preserved, as well as abstract patterns reminiscent of phosphenes—optical phenomena of biochemical or neurological origin induced, for instance, by hallucinogenic substances (Leone 2009). The dating of the site to the Neolithic is based solely on the presence of archaeological finds (Leone 2009). Similar drawings can be found in the Bulgarian caves Magura and Bailovo (Stoev and Maglova 2014). Magura's drawings were created by fossilized bat guano. According to the ^{14}C measurement, the material dates to the period around 3600 BC (Kunov et al. 2014). In Central Europe, rather simpler features predominate. Kateřinská Cave shows similarities to Domica Cave, Ardovská Cave, Silická Ladnica Cave, and Praslen Cave in Slovakia (Šefčáková 2017). Using radiocarbon (^{14}C) measurement, the drawings preserved in Domica Cave were dated to the late Mesolithic and Neolithic–Eneolithic, while the drawings in Ardovská Cave to the Bronze Age–Hallstatt Period and La Tène–Roman Period (Šefčáková and Levchenko 2018). Up until now, the only Czech Eneolithic drawing had been found in Býčí Skála Cave (Bull Rock Cave), part of the Moravian Karst. ^{14}C analysis performed in 2005 dated three samples from Býčí Skála Cave to the Middle Eneolithic 3100–2925 BC, 2930–2885 BC and 3630–3360 BC (Svoboda et al. 2005; Svoboda and van der Plicht 2007; Golec 2020). Now, even older drawings have been

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found in Kateřinská Cave of the same karst system, with ^{14}C analysis, never previously applied there.

Sampling for ^{14}C dating is performed typically by scraping parts of the cave drawing, which often results in its at least partial degradation. This study introduces a gentler wipe-sampling method, which allows us to preserve the contours of the graffiti.

MATERIALS AND METHODS

Archaeological Situation of Kateřinská Cave

The Moravian Karst is the largest and most developed karst area in the Czech Republic (Figure 1A). Devonian limestones cover a continuous area of 75 km^2, with 1134 currently known caves (Balák 2009). Kateřinská Cave is one of the few large caves (Figure 1B). It has been known for centuries for its high Gothic-shaped portal. Archaeological research works have been conducted repeatedly in the entrance to the cave since the second half of the 19th century. Behind the entrance portal, there is a low-vaulted entry hall of 60 m in length, which opens into the massive Main Dome with dimensions of 95 × 42 × 23 m, the so-called Old Kateřinská Cave. Many inscriptions and signatures document numerous visits to the cave from the 18th century. There is an extensive "signature centre" in the back part of the Ice Passage. The Main Dome branches into several dead-end corridors. In 1909, a continuation into the large New Kateřinská Cave was discovered in the eastern back parts of the Main Dome.

The caves of the Moravian Karst had been repeatedly used as a settlement since the Middle Palaeolithic and gained further utilization during the post-Palaeolithic periods. For Kateřinská Cave, this has been proved by pottery found in different layers at the entrance of the cave (Geislerová et al. 1986). The pottery falls in a varied spectrum dated from prehistory (with identified findings from the Neolithic, Eneolithic, Bronze Age, and Hallstatt Period), through Protohistory (La Tène and Roman Period), Middle Ages, up to Modern Age; the details are introduced in Figure 2. No pottery has ever been found deeper inside the cave; therefore, the newly discovered graffiti represent significant progress in the research of human activity in this locality.

Sampling Sites

Sampling and documentation of charcoal lines and patterns in Kateřinská Cave began in 2016 and have continued to the present day. We present six samplings in total, three from the Ice Passage, one from the "Nameless Passage" and two from the Main Dome (Table 1).

Analytical Methods

A new wipe-sampling method of fine charcoal particles has been employed, using quartz wool swabs pretreated in diluted HCl and heated in the air (550°C). Each drawing was gently wiped for about 10 min with a swab soaked again in the diluted HCl. This enabled us to control the amount of the pigment being wiped away and thus to preserve at least a part of it on the cave wall. Figure 3 illustrates the extent to which the drawing has been preserved after the sampling. Figure 3A shows an almost ideal case, where a charcoal-rich drawing has maintained its contours. Figure 3B illustrates the worse case, where the original drawing contained a lesser amount of the charcoal and therefore the sampling was more damaging. However,

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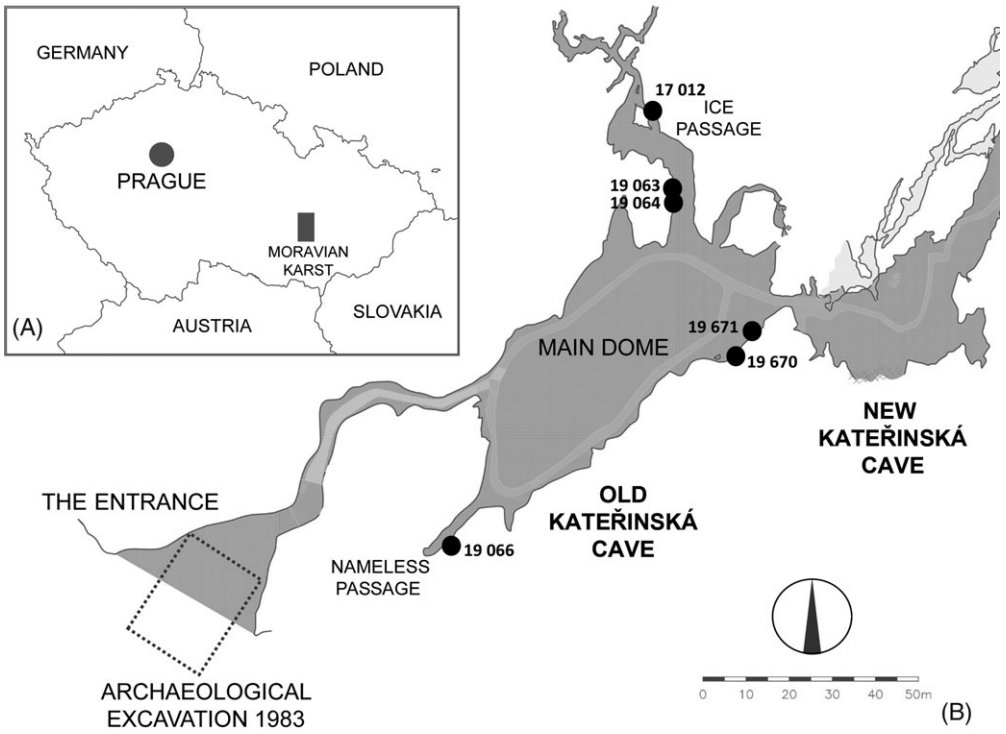

Figure 1 Map of the Czech Republic and location of the Moravian Karst (A); sampling points in Kateřinská Cave (B).

the pigment remained preserved at the bottom of the protrusions of the cave wall. The quartz wool swabs containing the sampled material were stored in 20-mL glass vials. In the laboratory, each swab with the sampled material was leached repeatedly in 0.5 M HCl followed by 0.1 M NaOH and demineralized water and finally in 0.01 M HCl (Gupta and Polach 1985; Jull et al. 2006). Subsequently, the samples were dried at 60°C to reach constant weight. After pretreatment, the dry samples (SiO_2 with fine charcoal particles) together with a small amount of CuO were torch sealed under a dynamic vacuum into quartz glass tubes and combusted at 900ºC. By using liquid nitrogen, the combusted samples were transferred to the Pyrex tubes prefilled with powdered Zn and Fe and sealed. The dedicated apparatus has a vacuum below 0.5 Pa. The maximal filling pressure of CO_2 transferred to the Pyrex tube was 40 mm Hg, which corresponds to 1.6 mg of carbon. The actual filling pressures and the corresponding carbon amounts of the samples are summarized in Table 1. Subsequently, the samples were graphitized using metallic zinc as a sole reduction agent (Rinyu et al. 2013, 2015; Orsovszki and Rinyu 2015). Measurement of graphites was performed at the MICADAS system in the Hertelendi Laboratory of Environmental Studies (DebA), ATOMKI HAS in Debrecen, Hungary (Molnár et al. 2013a, 2013b; Handlos et al. 2018; Svetlik et al. 2019).

Calibration

The results of acceleratory mass spectrometry (AMS) measurement were reported in years of Conventional ^{14}C Age (CRA) following the Stuiver and Polach convention (1977). Calibration

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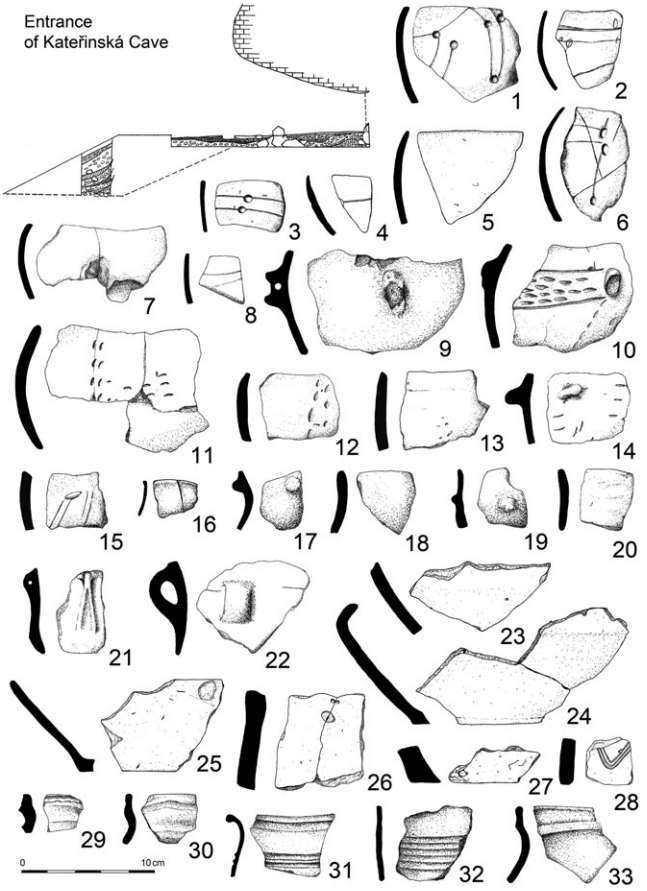

Figure 2 Pottery recovered at the entrance of Kateřinská Cave. The archaeological site, including the layers, is introduced in the upper-left corner of the figure (after Geislerová et al. 1986). The drawing of each sherd is accompanied by a black-depicted profile and marked with a number. The periods of their origin were identified as Early Neolithic (1–15), Late Neolithic/Early Eneolithic (16–20), Early Eneolithic (21), Early Bronze Age (22), Hallstatt Period (23–25), La Tène Period (26–27), Roman Period (28), Early Middle Ages (29–30), and High and Late Middle Ages (31–33).

was performed by the software OxCal 4.4 with the ^{14}C calibration curve IntCal20 (Bronk Ramsey 2009; Reimer et al. 2020). If the calibrated age with 95% probability falls in several intervals with similar probabilities, they are merged into a single combined interval. If there is a main interval with prevailing probability, other intervals are omitted.

RESULTS AND DISCUSSION

The results are summarized in Table 2. The uncertainties of ^{14}C analysis (CRA) correspond to 68% probability; the probabilities of the calibrated ages are listed.

The ^{14}C analysis of the graffiti in Kateřinská Cave provided dates (Table 1) that correspond to some periods dated using the ceramics found at the cave entrance. The sample from the Main Dome called "Brain" (CRL 19_670) dates to the Early Neolithic.

https://doi.org/10.1017/RDC.2021.5 Published online by Cambridge University Press

Table 1 Six samples from different sampling sites in Kateřinská Cave together with filling pressure of graphitized CO_2 and corresponding carbon weight.

Sample	Site	Filling pressure of CO_2 for graphitization, mm Hg	Corresponding carbon weight in graphite, μg
CRL17_012	Ice Passage, "Goddess"	22.0	880
CRL19_063	Ice Passage, "P"	5.9	236
CRL19_064	Ice Passage, "L"	5.9	236
CRL19_066	"Nameless Passage"	3.0	120
CRL19_670	Main Dome, "Brain"	15.5	620
CRL19_671	Main Dome, "Devil"	10.9	436

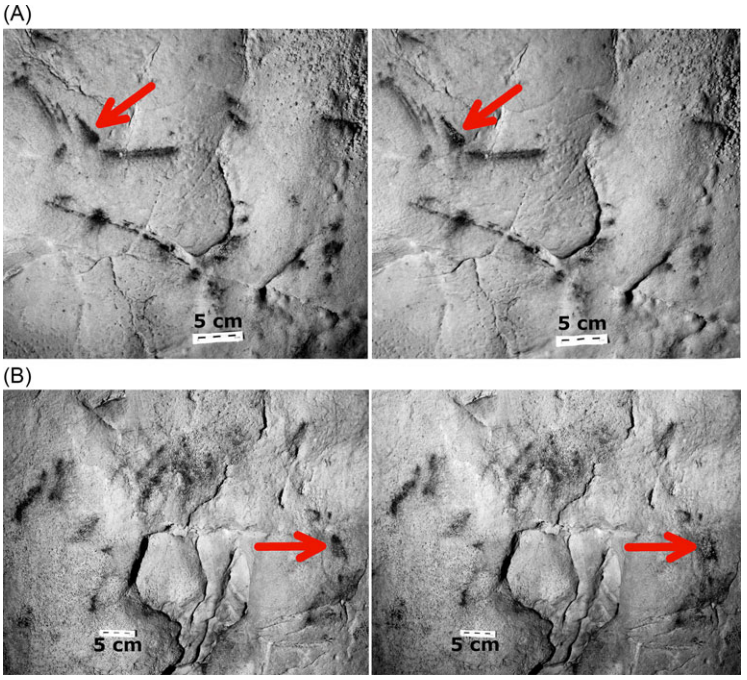

Figure 3 Examples of graffiti sampled in Kateřinská Cave: the sample CRL19_063 (A) and the sample CRL19_064 (B). The photographs were taken before (left) and after (right) the sampling, thus illustrating preservation status.

Another three samples from the Ice Passage "P", "L" and the "Nameless Passage" (CRL 19_063, 19_064, 19_066) correspond to the transition between the Late Neolithic and Early Eneolithic. All these specimens are dated older than the graffiti preserved in Býčí Skála Cave dated to the Middle Eneolithic, which had previously been considered as the oldest in the Czech Republic. Observed ^{14}C activities of these three samples are without significant difference. It can be stated, that this group provided very reliable results due to good accordance, despite small carbon quantity which was processed using a graphitization routine. The carbon amount corresponding to the sample CRL19_066 was 120 μg only (Table 1). Such a small sample, which could be suggested for direct CO_2 measurement

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Table 2 Results of ^{14}C dating of samples with origin in Neolithic, Eneolithic, Hallstatt Period, and Middle Ages in the Kateřinská Cave (the uncertainties of ^{14}C analysis correspond to 68% probability, the intervals of the calibrated age correspond to the listed probabilities).

Sample	CRA (BP)	Calibrated age (BC/AD)	Probability (%)	Period
CRL17_012	796 ± 22	1220–1274 AD	95	Early/High Middle Ages
CRL19_063	5491 ± 43	4446–4252 BC*	96	Late Neolithic/Early Eneolithic
CRL19_064	5508 ± 44	4449–4259 BC*	96	Late Neolithic/Early Eneolithic
CRL19_066	5487 ± 61	4456–4232 BC**	93	Late Neolithic/Early Eneolithic
CRL19_670	6185 ± 31	5218–5031 BC**	94	Early Neolithic
CRL19_671	2535 ± 28	794–547 BC*	96	Hallstatt Period

*Combined interval.
**Main interval.

using gas ion source, made it possible to verify the lower limit of the graphitization procedure used in our CRL laboratory on a real sample. The carbon weight of approximately 120 μg obtained from a sample is currently considered by our laboratory to be the minimum needed for the graphitization process.

The sample "Devil" (CRL 19_671) from the Main Dome corresponds to the Hallstatt Period and the sample "Goddess" (CRL 17_012) from the Ice Passage to the transition between the Early and High Middle Ages. These four periods (Early Neolithic, Late Neolithic/Early Eneolithic, Hallstatt and Middle Ages) have been previously identified with pottery found at the cave entrance (Figure 2). This agreement between the dating methods provides important mutual validation and gives the method and the results a high degree of credibility.

The Moravian Karst influenced settlement strategies, which completely changed with the onset of the Neolithic. The first farmers established permanent settlements on fertile loess soils near watercourses, which provided conditions suitable for the development of productive agriculture. Although in the margins of interest, the caves were used repeatedly, most likely as temporary campsites on long-distance roads, temporary residences for prospectors looking for, perhaps, stone raw materials, or as ritual sites. In addition to the utilitarian function, since the Neolithic the rituals associated with the Great Mother, and the caves as a symbol of a mother's womb, can also be expected. Penetration into the depths of the cave might have been carried out by the light of torches, the remains of which probably served to create the graffiti.

The used wipe sampling of charcoal from the cave drawings allows the controlled preservation of the original contours on the sampled area. The examined drawing can be sampled from two relatively spaced points and the results of the ^{14}C analyses could then be compared to verify the success of decontamination of samples by the acid/alkali/acid procedure. If decontamination is insufficient, it is improbable that both the samples would be affected equally. We can further increase the effectivity of this comparison by repeating or extending the pretreatment of one of these sub-samples. However, the need to provide a sufficient amount of datable material for AMS measurements remains a significant problem, even in future sampling.

CONCLUSION

Given the age of the ceramic finds and taking into account the three results from the Late Neolithic and Early Eneolithic transition (reporting ^{14}C activities without statistically

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significant differences, thus disturbing influences can be considered unlikely), the wipe sampling together with the subsequent pretreatment procedure seems to provide relevant information.

The graffiti preserved in the deeper parts of Kateřinská Cave in the Moravian Karst were dated to four periods: the Early Neolithic, the Late Neolithic/Early Eneolithic, the Hallstatt Period, and the Early/High Middle Ages. Archaeological research of the entrance to Kateřinská Cave has proved eight periods, four of which correspond to the ^{14}C dates obtained. The discovery of the graffiti proved human activity deep in the cave.

ACKNOWLEDGMENTS

The authors gratefully acknowledge the financial support of the MEYS CR granted to UP in Olomouc (IGA_FF_2021_014), "Společnost v historickém vývoji od pravěku po moderní věk V.–VI.". This publication was supported by OP RDE, MEYS, under the project "Ultra-trace isotope research in social and environmental studies using accelerator mass spectrometry", Reg. No. CZ.02.1.01/0.0/0.0/16_019/0000728.

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