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RADIOCARBON DATING OF MULTIPLE MATERIALS FOR CLARIFYING THE FORMATION OF THE MEDIEVAL SETTLEMENT ON THE OUTSKIRTS OF PRAGUE CASTLE (CZECH REPUBLIC)

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ABSTRACT. An archaeological excavation conducted on U Kasáren St. in the Prague Castle area (Czech Republic) in 2020 revealed the remains of a medieval settlement consisting of houses of different constructions (pit dwelling, masonry construction), pyrotechnical (possibly metallurgical) features and unspecified pits. The excavation also revealed evidence of fire events and traces of viniculture on the outskirts of the Prague Castle area. Archaeological data allowed only a rough dating of the investigated settlement in the 10th–13th centuries. This paper presents the results of the radiocarbon dating of various materials (animal bones, archaeobotanical samples) from the settlement features and the contribution of the results to the clarification of the chronology of the site.

KEYWORDS: Middle Ages, Prague Castle area, radiocarbon dating, settlement site.

INTRODUCTION

U Kasáren St. is located in the western part of the Prague Castle area, in the historical center of Prague, Czech Republic (coordinates of the midpoint of the street are 50.0896986N, 14.3938681E; see Figure 1; Tomková 2000; Boháčová 2008; Boháčová and Herichová 2008). In 2020, the area of the street was the subject of an archaeological excavation related to the reconstruction of water and sewer lines. The excavation uncovered relics from an extensive medieval settlement consisting of pit dwelling and houses with masonry constructions, fireplaces, pyrotechnological units, and unspecified pits. An ashy sediment implied a local fire event. Flotation of the sediment samples provided information on the ecology and agricultural production at the site, e.g., legumes, cereal grains, and a fragment of carbonized grapevine wood—evidence of viniculture on the outskirts of Prague Castle. Based on the artifacts and stratigraphy, most of the features were dated to the 10th–13th century. However, only a limited number of datable pottery fragments were obtained. Also, the extension of the excavated area was limited according to the needs of the construction company, and the degree of preservation of the investigated remains was rather poor. Thus, the archaeological data does not allow conclusions to be drawn on the detailed chronology of the site. The goal of the radiocarbon (^{14}C) analyses was to establish the archaeological dating and clarify the formation of the medieval settlement on U Kasáren St.

SAMPLING AND TREATMENT

Five animal bones and 10 carbonized archaeobotanical samples were chosen for precise ^{14}C dating of the medieval settlement on U Kasáren St. They were selected from various units, as displayed in Figure 2:

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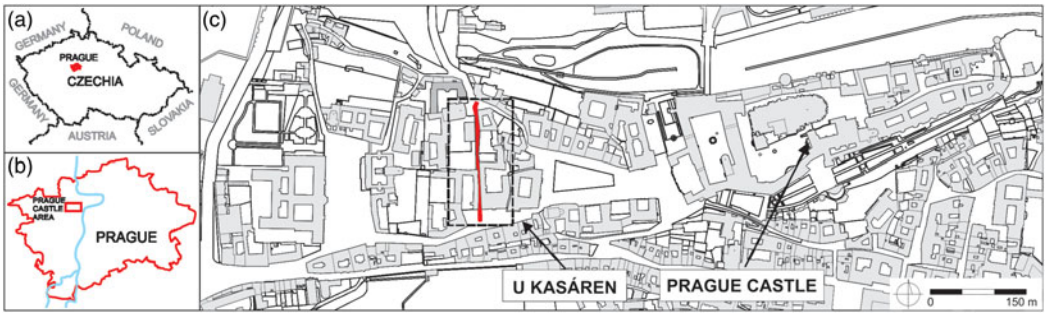

Figure 1 Location of the site on U Kasáren St. in the cadastral map. Figure by F. Adámek.

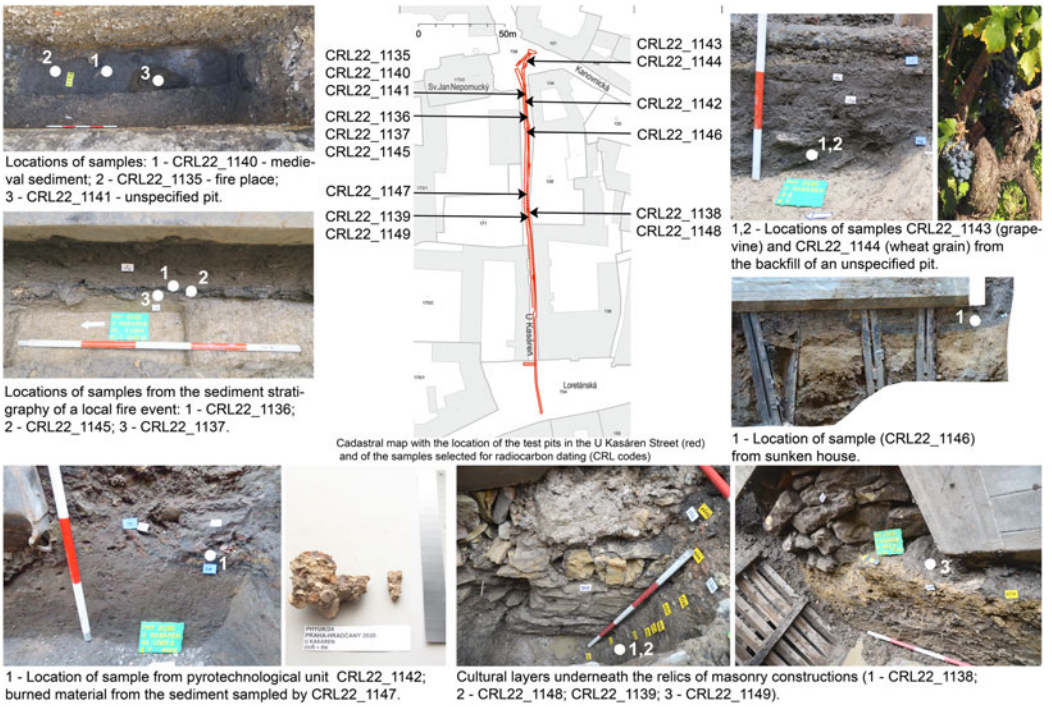

Figure 2 Location and definition of the sampled features. Figure by P. Tomanová and M. Housková.

- sediment (CRL22_1140), fireplace (CRL22_1135) and an unspecified pit (CRL22_1141) in the northern part of U Kasáren St.;
- backfill of a pit dwelling (CRL22_1146);
- stratigraphy of sediments reflecting a local fire event: ashy sediment (CRL22_1145), sediment above the ash (CRL22_1136), sediment underneath the ash (CRL22_1137);
- fragment of carbonized grapevine wood (CRL22_1143) and a carbonized wheat grain from the same backfill of pit (CRL22_1144) as a control sample to the grapevine sample;

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- traces of pyrotechnological activities at the site: pyrotechnological unit (CRL22_1142) and sediment layer, including burned materials (CRL22_1147); and
- sediments relating to the construction of the masonry (CRL22_1138, CRL22_1139, CRL22_1148, CRL22_1149).

Sample selection took place at the Institute of Archaeology of the Czech Academy of Sciences (CAS). The archaeobotanical samples (CRL22_1140–1149) represented mostly carbonized grains (wheat/*Triticum aestivum* and barley/*Hordeum vulgare*), a fragment of carbonized wood of grapevine (*Vitis* sp.) and another one of blackthorn (*Prunus spinosa*). The grains were chosen to avoid the old-wood effect, as they represent annual plants. The carbonized wood samples do not represent long-aged woody species, still the old-wood effect should be taken into consideration when interpreting the ^{14}C data. The samples of animal bones (CRL22_1135–1139) were selected from osteological finds of ruminants: domestic cattle (*Bos taurus*) or sheep/goat (*Ovis*/*Capra*). These animals were selected primarily to avoid the freshwater reservoir effect, as these herbivores were probably not fed a diet originating from water sources, which is the case of fish, water birds, and turtles, or even omnivorous pigs and some wild mammals (Ascough et al. 2010; Philippsen and Heinemeier 2013; Ervynck et al 2018). Secondly, they were selected to avoid the bias caused by longevity. Like humans, the difference between the end of the collagen formation and death of the individual can be several decades (Barta and Štolc 2007). This can also concern some long-lived animal species, but the domestic animals selected here are usually slaughtered before reaching the individual age of 10 years, which does not affect the conclusions drawn from the ^{14}C analyses. Finally, the selection of these two animal species was also affected by the fact that cattle and caprines are the most frequent categories in animal bone assemblages from medieval settlement contexts in the Czech Republic.

The samples were then processed at the Czech Radiocarbon Laboratory (CRL) of the Nuclear Physics Institute of the CAS. First, their careful inspection revealed no traces of biological contamination such as lichen, fungi, or mold. Following mechanical cleaning, the samples were pretreated by the acid-base-acid (ABA) procedure (Gupta and Polach 1985; Jull et al. 2006). The collagen extracted from the animal bones was gelatinized at 90°C, filtrated and dried at 60°C. All the samples were then combusted with CuO, graphitized with zinc reductant, and measured together with ^{14}C reference material (Oxalic Acid II, NIST SRM 4990C) and ^{14}C-free material (phthalic acid anhydride) on a MILEA accelerator mass spectrometry (AMS) system (Kučera et al. 2022). AMS data was processed with BATS software (Wacker at al. 2010) and calibrated with Oxcal 4.4 (Ramsey 2009) using the IntCal20 calibration curve (Reimer et al. 2020).

RESULTS AND DISCUSSION

The raw data is listed in Table 1 and presented graphically in Figure 3. During the ABA procedure, the yield of the isolated collagen is in the range of 15.9–46.1%, while the carbonized materials yielded from 16.3% to 63.2%.

Settlement Features in the Northern Part of U Kasáren St.

Samples from three settlement features in the northern part of U Kasáren St. were analyzed: sample no. CRL22_1140 (carbonized barley grain) was taken from a sediment layer, no. CRL22_1135 (probably cattle bone) from a fireplace, and no. CRL22_1141 (carbonized

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Table 1 Results of ^{14}C analyses of the samples from the U Kasáren site. Yield is the amount of collagen (for bones) and carbon (for archaeobotanical remains).

CRL label	Material	Yield (%)	CRA[1] (BP)	Calendar date interval[2] (cal AD)
CRL22_1135	cf. *Bos taurus*, costa	1.59	1169 ± 15	772–950
CRL22_1136	*Bos taurus*, scapula	2.89	1019 ± 14	993–1032
CRL22_1137	*Bos taurus*, scapula sinistra	4.61	1047 ± 14	991–1025
CRL22_1138	*Ovis/Capra*, mandibula dextra	1.64	566 ± 15	1323–1414
CRL22_1139	*Bos taurus*, mandibula dextra	1.93	627 ± 14	1298–1395
CRL22_1140	*Triticum aestivum*, carbonized material	63.2	1087 ± 15	895–1014
CRL22_1141	*Triticum aestivum*, carbonized material	55.8	1120 ± 15	890–987
CRL22_1142	*Hordeum vulgare*, carbonized material	30.6	861 ± 15	1166–1221
CRL22_1143	*Vitis*, carbonized material	48.3	786 ± 15	1225–1273
CRL22_1144	*Triticum aestivum*, carbonized material	16.4	890 ± 17	1051–1218
CRL22_1145	*Prunus spinosa*, carbonized material	62.0	1031 ± 15	993–1027
CRL22_1146	*Triticum aestivum*, carbonized material	63.1	1095 ± 15	893–995
CRL22_1147	*Hordeum vulgare*, carbonized material	48.7	659 ± 15	1286–1389
CRL22_1148	*Triticum aestivum*, carbonized material	46.0	1198 ± 15	774–884
CRL22_1149	*Hordeum vulgare*, carbonized material	51.3	775 ± 15	1227–1278

[1]Conventional ^{14}C age with uncertainty corresponding to 1σ.
[2]Calibrated calendar date intervals corresponding to ca. 95% confidence interval.

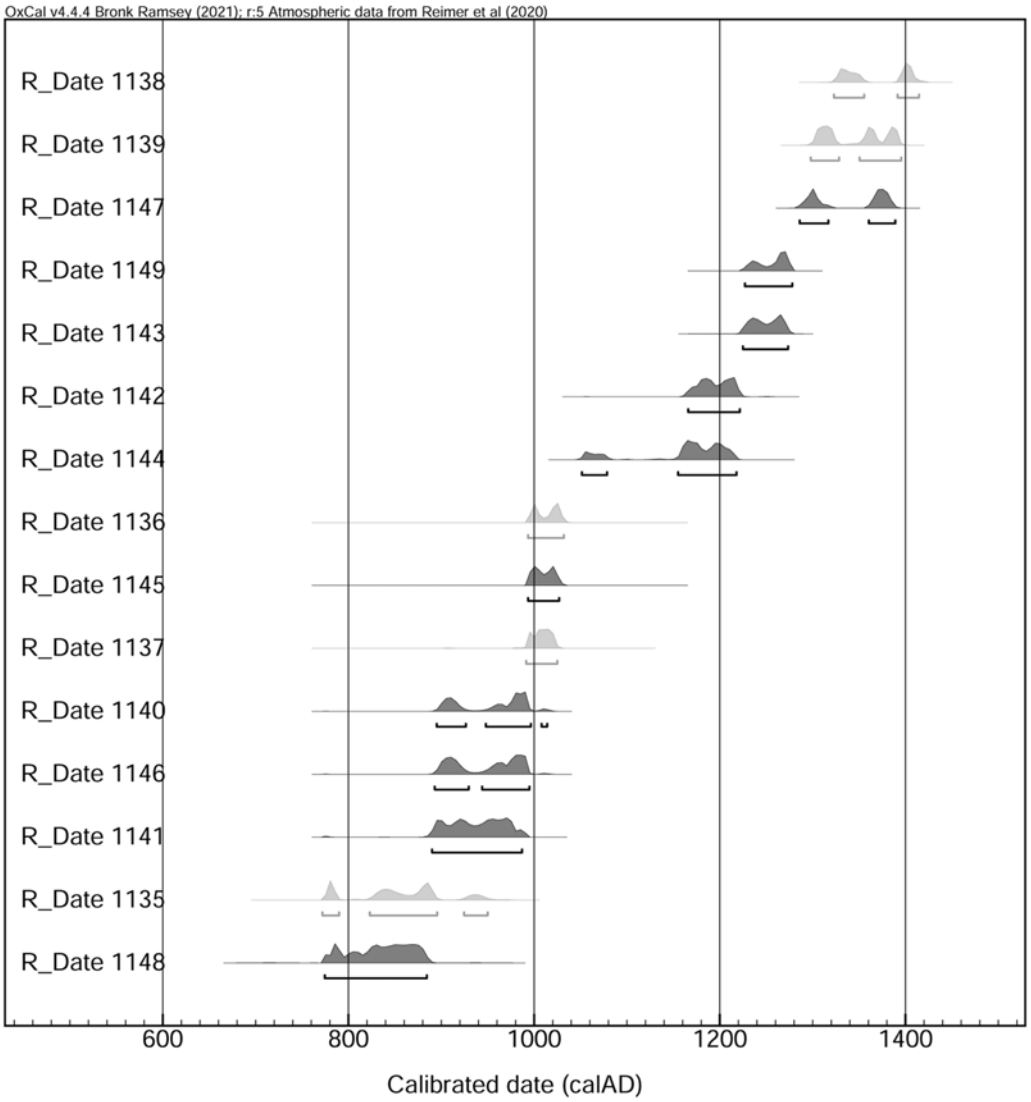

Figure 3 Probability distributions with underlined 95% confidence intervals of calibrated calendar dates for individual samples dated independently. Sampled animal bones are depicted as gray, archaeobotanical remains as black.

barley grain) from an unspecified settlement pit. Samples CRL22_1140 and CRL22_1141 were dated to cal AD 895–1014 and 890–987, respectively. Sample no. CRL22_1135 resulted in an earlier date, cal AD 772–950. However, the credibility of the later result is questionable due to the low collagen yield of sample no. CRL22_1135 (1.59%).

The analyzed sediment layer and features in the northern part of U Kasáren St. included pottery fragments typical for the 9th–10th century and sporadic intrusions from later periods. Based on the ^{14}C dates and the archaeological artifacts, the situation of settlement features in the northern part of U Kasáren St. can be dated to the 10th century.

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Pit Dwelling

The remains of a pit dwelling were documented in the vertical profiles of the test pit in U Kasáren St. Due to the working pace at the excavation and the needs of the building company, it was not possible to investigate this feature in detail. Only individual pottery fragments and sediment samples for flotation were collected from the backfill of the pit dwelling. The sediment sample included archaeobotanical remains, from which a carbonized barley grain was the subject of ^{14}C dating as sample CRL22_1146. The results of the ^{14}C dating cover the whole 10th century, due to the shape of the calibration curve. Also in this case, the ^{14}C dating corresponds to the archaeological dating of the pottery fragments.

Local Fire Event

Evidence of a local fire event was documented in a stratigraphy of three sediment layers. All three layers were sampled for ^{14}C dating: sample no. CRL22_1145 (fragment of carbonized blackthorn wood) was taken from the ashy layer representing the fire event itself. Sample no. CRL22_1136 (cattle scapula) comes from the sediment above the ashy layer. Sample no. CRL22_1137 (cattle scapula) comes from the sediment underneath the ashy layer. All the results speak for dating the event in the last decade of the 10th or first third of the 11th century.

Small collections of pottery fragments were retrieved from all three analyzed sediments. Most of the fragments correspond to the late 10th and 11th century. Some sporadic fragments were also typical for the late 9th or early 10th century. Thus, the archaeological dating generally corresponds to the ^{14}C dates. The earlier fragments probably reflect the taphonomical processes relating to sediment formation.

Viniculture in the Hinterlands of Prague Castle

A carbonized fragment of grapevine wood (*Vitis* sp.) was found in the backfill of a pit in the northern part of the archaeological test pit and represents early evidence of viniculture in the hinterlands of Prague Castle. Finds of grape pips from Prague Castle and its outskirts are dated to the 9th century (Tomková 2021) but primarily document the consumption of grapes themselves and might not prove viniculture. However, the find from the U Kasáren St. represents the carbonized wood of the grapevine, which is the first archaeological evidence of viniculture in the studied area.

The grapevine sample (CRL22_1143) is dated to cal AD 1225–1273. For verification, a carbonized wheat grain from the same backfill was also analyzed (CRL22_1144) and was dated to cal AD 1051–1218. Although the dates do not overlap, they both, at least partly, refer to the 13th century AD. The incoherence can be caused by the taphonomical process of the formation of the backfill of the pit. The formation of the backfill was probably not a single event. The pit could had been opened for a longer time and filled over a considerably long period. Moreover, the backfill could include transferred components of varying age.

Archaeological dating of the backfill based on sporadic and not very specific pottery fragments refers to the 12th–13th century. Combining the archaeological and ^{14}C dates, the evidence of viniculture on the outskirts of Prague Castle can be dated to the 13th century.

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Evidence of Metallurgy

Several features at the site on U Kasáren St. provided us with evidence of pyrotechnological activities (metallurgy?), as they included pieces of melaphyre rock (the stone used in heating units), slag fragments and other burned materials. Two of these features were chosen for ^{14}C dating: a pyrotechnological unit (sample no. CRL22_1142, carbonized barley grain) and a sediment layer containing fragments of burned materials (sample no. CRL22_1147, carbonized barley grain). These samples are dated to cal. AD 1166–1221 and 1286–1389, respectively.

The difference in intervals can be interpreted in various ways. First, pyrotechnological activities were pursued in different periods of the occupancy of the site. Alternatively, the absolute dating of the analyzed samples does not have to correspond to the period of the pyrotechnological processes. Especially sample no. CRL22_1147 from a sediment layer does not have to represent the time of the pyrotechnological activities, as the sediment layer could have been formed over a long period of time.

Considering archaeological dating of the analyzed features, only sporadic pottery fragments were obtained from the pyrotechnological unit. They represent pottery of the 12th–13th century and correspond to the ^{14}C dating of the archaeobotanical sample from the unit. On the other hand, the analyzed sediment layer did not contain any significant pottery fragments that would allow a precise dating.

In this case, although the ^{14}C analyses did not provide clear results either, the date is still valuable support for the dating of pyrotechnological activities at the site back to the 12th–13th century (and perhaps also later).

Masonry Constructions

Two relics of masonry were uncovered in the central part of the test pit on U Kasáren St. Both relics probably represented the same construction. The masonry was made of blocks of calcareous siltstone and clay binder. Plaster remains were documented on the face side of one of the masonry relics. The plaster oozed from the wall surface onto the surrounding terrain. The situation with the plaster marked the ground level of the time of construction of the masonry. To estimate the construction period of the masonry, samples from the layers underneath the plaster were collected: CRL22_1138 (sheep/goat mandibula) and CRL22_1148 (carbonized wheat grain). Sample CRL22_1139 (cattle mandibula) was taken from analogical layer by another masonry relic. Sample no. CRL22_1149 (carbonized barley grain) came from the sediment located underneath one of the masonry relics and should pre-date the construction of the masonry.

The analysis results of the bone samples CRL22_1138 and CRL22_1139 date the construction of the masonry to the 14th century (cal AD 1323–1414 and cal AD 1298–1395, respectively). Sample no. CRL22_1149 was dated to the 13th century (cal AD 1227–1278). This corresponds to the archaeological stratigraphy and the period before the construction of the masonry. However, archaeobotanical sample no. CRL22_1148 representing the same context as both the bone samples is dated to a much earlier interval, cal AD 774–884. This carbonized material might represent a residual ecofact that reflects long-time occupation and earthmoving on the outskirts of Prague Castle. Another explanation would be measurement error.

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All the analyzed sediments included pottery fragments typical for the 12th and later centuries. Based only on the archaeological dating, the construction was dated back to the 12th–13th century. In combination with the ^{14}C data, the construction interval must be first shifted to the 14th century.

General Chronology of the Settlement in the Western Hinterland of Prague Castle

The calibrated calendar age of all the analyzed samples from the site on U Kasáren St. covers the period 772–1414 AD. However, the two earliest dates indicating the 8th century might be rather less representative for the absolute chronology of the occupancy of the site. One of the early dates comes with the bone sample CRL22_1135. This sample contained a low collagen yield (15.9%) and thus the accuracy of the result is questionable. The other early date comes from the carbonized wheat grain no. CRL22_1148. This is one of the multiple samples from the sediments relating to the construction of the masonry. Since the other samples from these sediments are dated to the late 13th and 14th century, sample no. CRL22_1148 is extraordinarily old and might represent residual carbonized material.

Taking away the two early samples, the results of the ^{14}C dating of the other 13 samples are distributed in the time span of the 10th–14th century that can be interpreted as the era of continuous occupation in the western hinterland of Prague Castle. The plot (Figure 3) shows a hiatus from the late 11th century to the mid-12th century. It is not possible to decide whether this reflects a real hiatus in the occupancy of the site, or whether the missing dates are caused by the selection of the samples. The later explanation seems more plausible.

CONCLUSION

Results of the ^{14}C analyses apparently contributed to the investigation of the medieval settlement on the outskirts of Prague Castle. The analyses allowed us to get more precise absolute data and helped clarify the vague archaeological dating of individual features, as well as the occupancy of the investigated area in general.

In the analyses, animal bones and carbonized archaeobotanical samples were successfully dated. We can assume that the results of the dating of animal bones are not biased by the freshwater reservoir effect and by longevity. However, up to three bone samples showed a low collagen yield (CRL22_1135–1.59%; CRL22_1138–1.64%; CRL22_1139–1.93%) and one of these samples (CRL22_1135) resulted in a rather early date. Eight of the 10 archaeobotanical samples represented carbonized grains that avoid the old wood effect and should provide high-quality data.

Results of the ^{14}C dating of the medieval settlement uncovered on U Kasáren St. cover the interval of 770–1410 AD. Two of 15 dates are dated back remarkably early to the 8th–9th century and should be interpreted cautiously (see the discussion of the dates above). Most of the dates cover the period from the second half of the 9th century to the early 15th century, with a hiatus from the late 11th century to the mid-12th century. These results imply the more-or-less continuous medieval occupation of the western outskirts of Prague Castle, with regard to the fact that the hiatus reflects either a lack of data or discontinuity in occupation in the late 11th to mid-12th century.

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The period of the 9th–11th century is represented by a pit dwelling, a fireplace, an unspecified settlement pit and a local fire event evidenced by an ashy sediment. In the later centuries, there is evidence of more complex activities such as pyrotechnology (most likely metallurgy), viniculture, and of more advanced building technologies—masonry construction.

Finally, the interpretation of data from settlement features, both the results of ^{14}C analyses and archaeological dating of artifacts, is complicated by problematic taphonomy. Most of the settlement features under investigation do not represent single events. Sediments and backfills were formed for unknown periods and may include residual artifacts or ecofacts. Dating these artifacts or ecofacts provides information about the age of the objects themselves. The age of individual items—artifacts or ecofacts—cannot be directly linked to the investigated contexts. To avoid taphonomical problems, we need to combine multiple dating methods. This paper presents a successful case study of that type.

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