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Field Reports

Thesis Abstracts

Why is it so rare and random to find pyre sites?

Two cremation experiments to understand the characteristics of pyre sites and their investigational possibilities

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Abstract
The cremation rite is well-defined in space and time as it is the central part of a series of complex ritual events. Although it is one of the most significant and representative elements of the funeral, yet we know very little about it due to its destructive nature, the scarcity of pyre sites and the indirect character of cremated bones and artefacts found in graves. The two experimental cremations presented in this article, on the one hand, address this rare occurrence of pyre sites. On the other hand, by the detailed documentation of the cremation process and the formation of pyre sites, it is possible to examine in detail several new issues related to the pyre sites. Thus, the shape, orientation, dimension, and structure of the funeral pyre, as well as some moments of the cremation are discussed in detail. Furthermore, the representation of the body and pyre goods after the pyre's burndown, the movement of artefacts during burning, and the watering of pyre remains, as well as the problem of the mixture are also examined. At the same time, the experimental observations also draw attention, besides the investigational possibilities, to the archaeological limitations of pyre sites.

Cremation as the central part of the funeral

Cremation is the central part of the funeral and it consists of a series of events, which are distinct and well-defined in space and time. However, in the archaeological record, this complex rite usually appears only indirectly in a different phase of the burial sequence, namely in the context of graves. Thus, the only evidence of this central event is the collected and carefully buried cremated human remains, burnt artefacts, and sometimes the various amount of charcoals. However, due to this indirectness and to the fragmented and transformed character of the archaeological material caused by fire, we only have sparse information about the process of cremation. As a result, a number of important issues such as the location of cremation, the use of these sites, the type and structure of the funeral pyre, the circumstances of the collection of human remains and pyre goods, cannot or only be rarely studied by these indirect data. The only *in situ* archaeological evidence and direct examination of cremation are the pyre sites. However, these come to light only rarely and randomly either during large-scale rescue excavations or targeted and meticulous small-scale excavations. Although the reason for this scarcity might be obvious, yet it is surprising. However, to see and understand these reasons and to study the aforementioned issues in detail, we need to look more closely at the formation of pyre sites. Therefore, in 2017 and 2018 we built two Late Bronze Age pyres to reconstruct the complex processes of cremation.

The cremation experiments

The primary purpose of the experiments was to study the transformation of the Late Bronze Age vessel and metal copies on the funeral pyre. So the pyres were burnt stacked with artefacts. During the first experiment, a 62 kg pig wrapped in a linen sheet was laid on the top of the pyre, while during the second experiment a bare 59 kg pig was placed on it. The bodies were surrounded by copies of Late Bronze Age vessels filled with various types of food and drink, and also by copies of Late Bronze Age bronze weapons and jewellery. The pyres were burning without any external interference (e.g. additional fuels, control, moving), so their final condition is natural and their transformations can be examined in their entirety. The whole process of the cremations has been documented by photos and videos. In addition, the burning temperature was measured in every 30 seconds by two K-type thermocouples. After the pyre has burnt down, the cremated bones and artefacts were documented and thoroughly collected. In the end, the pyre sites were cleaned, excavated and documented.

The first pyre

The pyre was built directly on the grassy humic soil at the edge of a pasture. The site was not protected from the wind. For the construction, 1.5 m^3 dry oak log *(Quercus cerris)* was used whole and split. In some places, dry and small pinewood pieces were also added. The pyre was 210 cm long, 100 cm wide and 130 cm high, and it consisted of six layers. On its sides, it was supported by 6 split logs. Three thick logs (diameter: 20 cm) laid 80 cm from each other and four similar logs placed at its longitudinal edges formed the base structure of the pyre. The superstructure of the pyre was made up of thinner logs split into four and six. Finally, 12–16 cm-thick logs split into halves formed the last two layers of the pyre *(Fig 1)*.

Ignition took place inside the pyre directly on the ground by two pre-built pinewood piles. In the middle of the pyre, the temperature reached 1000 °C in 30 minutes. After this maxi-

Fig. 1. The 210 cm long, 100 cm wide and 130 cm high first pyre.

mum (1006 ℃), the temperature suddenly dropped, then in the next 2.5 hours the pyre was steadily burning at 750–850 ℃ with minimal fluctuation. Later the temperature started to fall evenly. 6.5 hours after the ignition, the 140 ℃ pyre was sprinkled with water. After the documentation, the cremated bones and the objects scattered among the pyre debris were thoroughly collected.

Fig. 2. The first pyre site after cleaning.

The excavation of the approx. 270×340 cm pyre site was carried out 13 days later. During this time, the remains were drenched with dew and rain. They were also exposed to the temperature fluctuations of the May nights and days. Thanks to these effects (i.e. water and wind), the dimensions of the pyre site immediately started to decrease. The fine layer of ashes and tiny charcoals covering the vegetation in a 1 m wide area on the northern side of the pyre were almost completely leached.

After cleaning the pyre place by very light brushing, we found a highly porous and poorly maintained surface *(Fig. 2)*. In terms of the surface patch, it can be said that only a part of the pyre's contour reddened where the glowing base logs were in direct contact with the ground. In these heavily burnt areas, impressions of grass burnt into the soil were also visible *(Fig. 3)*. However, in most parts of the surface, only black charred soil could be observed. In many places, even this soil transformation could not be discerned.

Fig. 3. Impressions of grass burnt into the reddened soil.

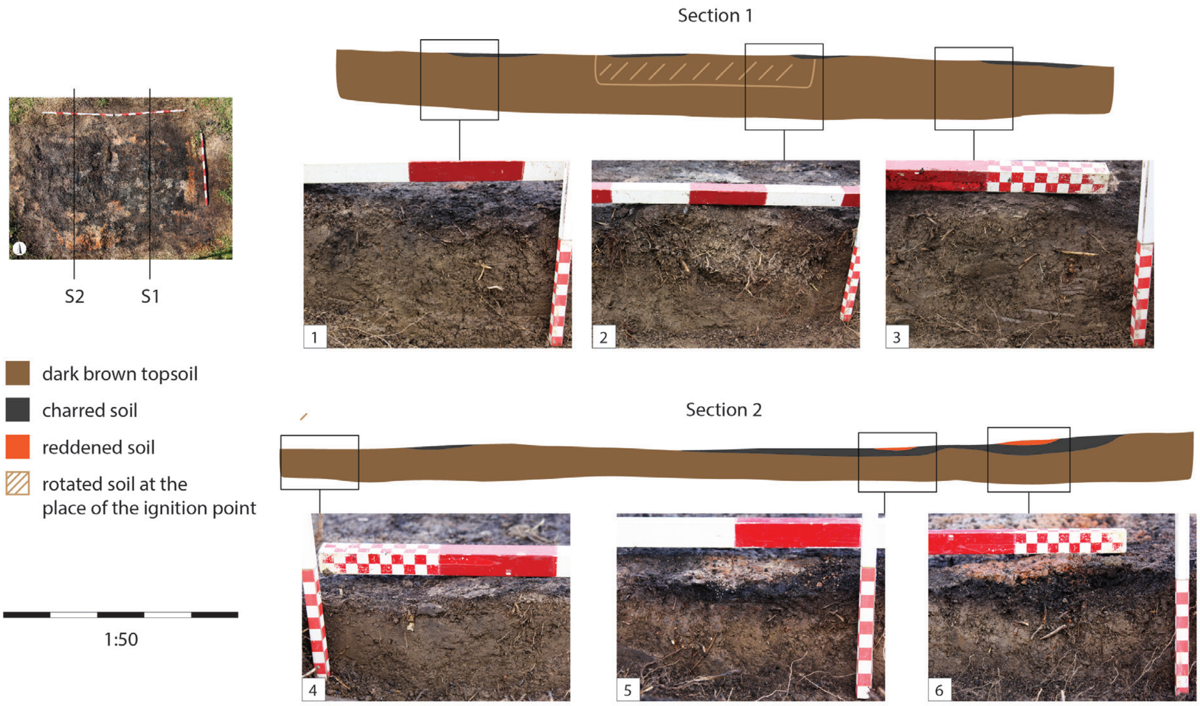

Fig. 4. Section 1 and Section 2 of the first pyre site.

Beside the surface character and extent of the pyre site, we also examined the character and extent of the vertical burn. Therefore two sections were made perpendicular to the longitudinal axis of the pyre 1 m apart *(Fig. 4)*. Section 1 examined the location and environment of one of the ignition points. It is clearly visible in the photograph that the 10–15 cm deep rotated soil under the ignition point is not or only slightly charred *(Fig. 4.2)*. A similar picture can be seen at the rest of the section. In most cases, there was no trace of burning. Where it was observable, the charred layer was no more than 1–2 cm thick *(Fig. 4.1–3)*. Section 2 focused on the reddened parts and more intensely charred areas. However, there is a similar picture here. The charred parts are poorly maintained *(Fig. 4.4)*. On the eastern side of the section, the charred layer is somewhat thicker but it still did not exceed 2–3 cm *(Fig. 4.5,6)*. The completely burnt, reddened parts are similarly friable and have a thickness of only 1 cm *(Fig. 4.5,6)*.

The second pyre

The pyre was built again in the middle of the pasture, directly on the grassy humic soil. For the construction, 1.3 m^3 dry, 5–20 cm diameter oak log *(Quercus cerris)* was used, this time without splitting. The pyre was 225 cm long, 115 cm wide and 130 cm high, and it consisted of 10 layers. On its sides, it was supported by six logs. Based on the experience of the first experiment, the structure of the pyre was changed at several points. In order to ensure the stability of the pyre, the base was made of six pieces of logs instead of three pieces. The 17.5–21.5 cm thick logs were laid 20–30 cm from each other. The 12–20 cm thick logs of the superstructure were slid in relation to each other in every second layer. On the one hand, this joint technique has increased the stability of the pyre. On the other hand, the fire could burn more freely with sufficient air movement due to the looser pyre structure. The design of the top layer also served this latter purpose. The top was made of thin, dry twigs covered with a 10 cm thick layer of straw. Finally, two thick logs were placed on the shorter sides *(Fig. 5)*.

Fig. 5. The 225 cm long, 115 cm wide and 130 cm high second pyre.

This time the ignition was not on the bottom but on the upper third of the pyre. Between the thinner logs of layer 7, we have created six ignition points from dry branches and straw. The temperature, measured on both sides of the pyre between layers 6 and 7, reached 1000 ℃ in 25 minutes. Then in the next 2–2.5 hours, the pyre was steadily burning at 800–1000 ℃ with some fluctuation depending on the wind strength. Later the temperature started to fall evenly. 5.5 hours after the ignition, the 325 ℃ pyre was sprinkled with water. After the documentation, the cremated bones and the objects scattered among the pyre debris were thoroughly collected.

The cleaning of the approx. 210×290 cm pyre site, i.e. the removal of the charred logs and the collection of the cremated bones, took place after the documentation of the pyre remains. So the pyre site was recorded in the afternoon right after the cremation *(Fig. 6.1)*. However, the excavation was carried out the following morning. This re-documentation of the site in the early morning allowed us to examine the changes within the shortest possible time span. Though there was no rainfall during the night, the morning dew of the cool May night moistened the pyre site *(Fig. 6.2)*. These only 12 hours were enough for the surface patch to loose some of its characters. Similarly to the first experiment, the areas under the base logs and the logs fallen down from the pyre burned more intensively. The most obvious sign of the night transformation of the pyre site was that the reddened parts started to fade. Due to its poor maintenance and porosity, erosion started. Even in some places, the black charred ground underneath these reddened patches appeared. This eroding process also appears in the gradual size reduction of the surface patch. The water started to wash away the ashy edges of the pyre site.

The reason for the poor maintenance and porosity of the pyre site is not only the surface characteristics but also the characteristics of the vertical burn. Therefore two sections were made perpendicular to the longitudinal axis of the pyre 40 cm apart *(Fig. 7)*. Both sections were set to examine in detail the various burnt areas under the base logs. In the northern section (Section 2), the soil was burned to brick-red in four smaller and highly porous patches. Their thickness did not exceed 1 cm *(Fig. 7.4, 6)*. A black charred layer could be observed in the whole width of the pyre and beyond. Its thickness was uniformly 2–3 cm *(Fig. 7.4–6)*. On the contrary, in the southern section (Section 1) only a single, 1 cm thick porous patch showed the reddening of soil *(Fig. 7.1)*. A black charred layer could also be detected in the whole width of the pyre. However, it was no more than 1–1.5 cm thick. Underneath there was a slightly burned, greyish brown layer in a thickness of 1–2 cm *(Fig. 7.1–3)*.

In the end, we removed all the reddened, black and greyish black layers. After the removal, a uniformly grey and hard surface appeared *(Fig. 8)*. At this depth, the soil was not burnt, only slightly roasted and dried. The rectangular patch clearly shows the shape and the approximate dimensions of the pyre. In some places, this layer was already observed in the sections *(Fig. 7.2, 5)*.

Fig. 6. 1 – The cleaned second pyre site right after the cremation, 2 – The second pyre site in the next morning.

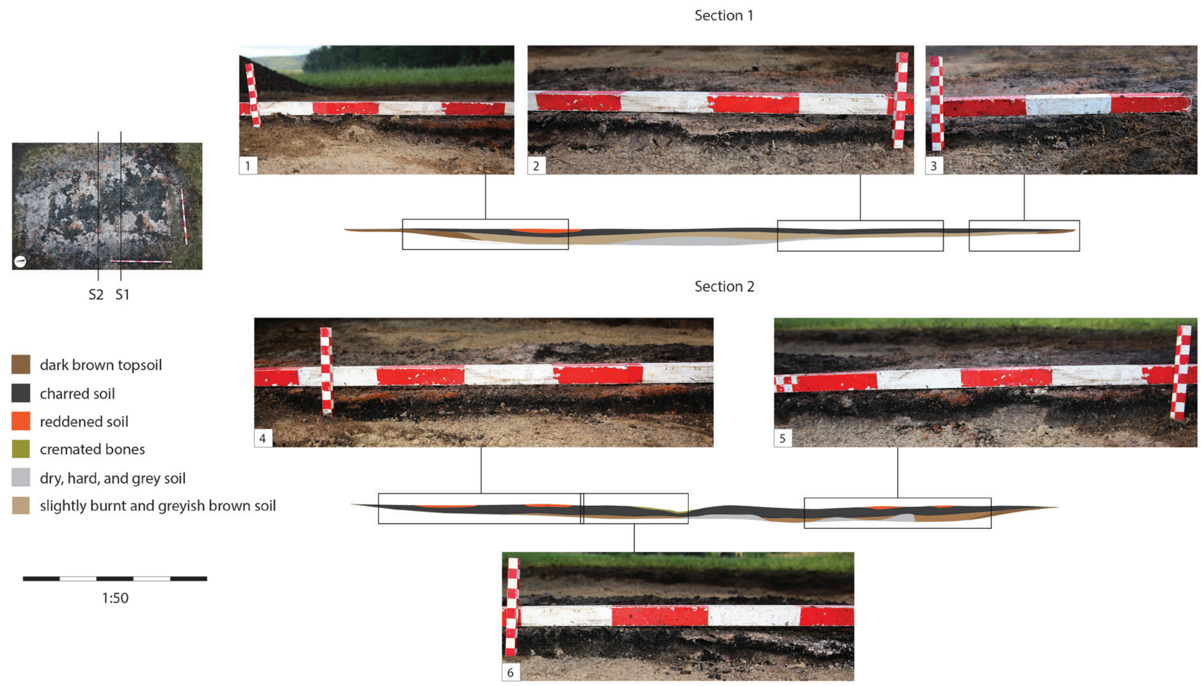

Fig. 7. Section 1 and Section 2 of the second pyre site.

Theoretical and practical possibilities of studying pyre sites

One of the main goals of the experiments was to document the characteristics of the pyre sites. By examining the size and quality of the surface patches formed during cremation, we can answer as to what extent the characteristics of the formation affect the survival of cremation sites. So why is it so rare and random to find pyre sites?

By detailed experimental observations, however, we can not only understand the conservational conditions, but by learning about the formation and the characteristics of the pyre sites, certain elements of the funeral pyre and some moments of the incineration and subsequent rituals can also be reconstructed. Thus, the size and shape of pyre sites and certain structural elements of the pyres and their state of combustion will be examined in detail below.

Finally, the circumstances for collecting the cremated bones and pyre goods can be outlined. Thus, archaeological problems such as the representation, condition, and minglement of objects and cremains in the grave are also linked to the issue of pyre sites.

The degree of soil burning and the problem of preservation

In spite of the high and long-lasting temperature, the maximum thickness of soil burning was 4 and 5 cm for both pyres. On the basis of the sections, the average of this thickness value was only 1–2 and 3–4 cm.

In both cases, the variable burning of the sections draws attention to the constantly changing circumstances of cremation. Different quality and extent of burning can be observed not only at a distance of 1 m (see Experiment 1), but also in closer parts (40 cm) of the pyre (see Experiment 2) *(Fig. 4; Fig. 7)*. This clearly indicates the variability of burning conditions within a small area. These variables fundamentally determine the characteristics of the soil's vertical burn, thereby they significantly influence the survival chances of the individual parts

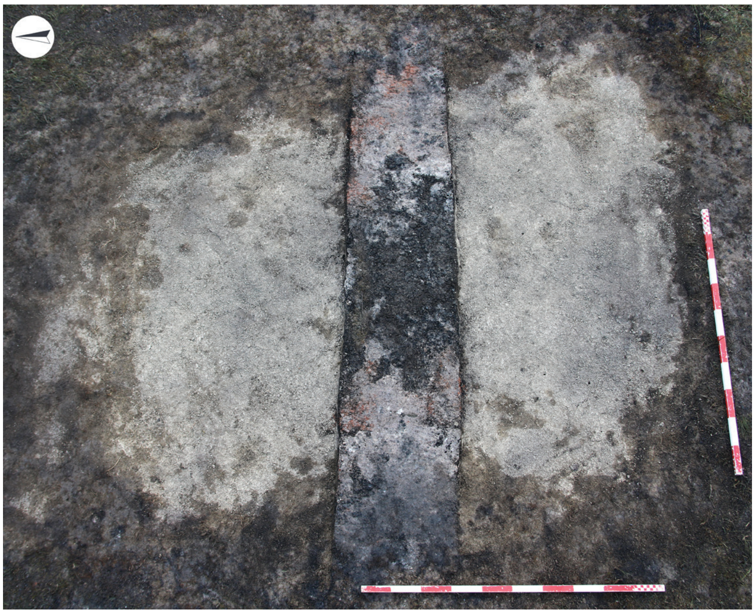

Fig. 8. The surface after the removal of the reddened, black and greyish black burnt layers.

of the pyre sites. These sudden and/or gradual changes affecting smaller or larger areas are also confirmed by the recorded weather conditions (temperature, precipitation, wind) and burning temperature values, as well as the documented displacements of pyre goods and logs during the cremation.

In spite of the same soil conditions, outside temperature and humidity, the second pyre site is better burnt, even though it consisted of a smaller amount of firewood, the cremation time was one hour shorter, and a drizzle of rain was falling for 15 minutes *(Fig. 2; Fig. 6)*. The reason for this difference is the permanently higher and more consistent burning temperature. However, despite the more complete and more characteristic vertical burn of the second pyre site, the difference in the thickness of burning is only 2–3 cm. Also, it appears in the thicker charred layer and not in the greater extent or thickness of reddened parts. In addition, both the brick-red and the black, greyish-brown charred traces are poorly maintained and friable in both experiments regardless of the burning conditions.

The slight burn-through, poor maintenance and friability of the pyre sites can also be observed in other cremation experiments without exception.[1] In experiment No. 2, A. Marshall removed the topsoil and built the pyre on clay soil free from any vegetation. In spite of this, the soil burned only 1–5 cm thick.[2] R. Leineweber's experiment No. 4 (SH4) reconstructing Germanic cremation burials of the Roman Imperial Period had the same result, despite the fact that the fire was occasionally fed with wood and the pyre was burning and smouldering more than 24 hours. Under the pyre built from 3.2 m^3 wood, the soil reddened only 2 cm thick and a charred layer was observed to a depth of only 5 cm.[3] The degree of burn-through does not depend on the amount of wood, nor the size of the pyre. The pyre reconstructed by the description and depictions of Johann Ernst Clausen (1763–1842), executioner of Lemgo, was 1.5 times larger (200×300×150 cm) and the amount of wood was 3 times more (4.5 m^3) than our two pyres. In spite of this, the soil burned only 3–5 cm thick.[4] In a series of experiments organized in Hallstatt, the pyres were built at the same place for years, yet the soil burned only 1–2 cm thick.[5]

1 Lambot 1994, 256; Reiter 2009, 202–203; Marshall 2011; McKinley 2017, 260, Fig. 10.3; Pany-Kucera et al. 2013, 214.
2 Marshall 2011, 35, Fig. 8, Plate 6.
3 Leineweber 2002, 168; Becker et al. 2006, 120.
4 Graefe et al. 2009.
5 Pany-Kucera et al. 2013, 209.

In the light of the above examples, it can be stated that the thickness of soil burn never exceeds 5–10 cm regardless of the location of the incineration, the structure, composition, and size of the funeral pyre, the type of the soil, the manipulation of the fire, the watering of the pyre remains and the weather conditions. This can be explained by several factors and circumstances. During burning, most of the heat is lost to the atmosphere. The efficiency of the remaining heat can be further decreased by weather conditions, especially wind strength, wind direction, and high amount of rainfall.[6] The temperature data of B. Lambot's experiment illustrate this phenomenon spectacularly. A thermocouple placed 5–8 cm deep under the pyre recorded a very slow, gradual increase in temperature (80–200 °C) during the 17 hours of the experiment. The soil temperature did not reach 100 °C during the most intensive first 3–4 hours of the burning. All this clearly shows that special conditions occur in the topmost part of the soil independently of the temperature and conditions recorded during the most intense burning period directly on the ground surface (300–700 °C) and inside the pyre (800–1100 °C).[7] Furthermore, the degree of soil burning is also determined by the type of soil.[8] In the quality of soil burning the structure of the pyre is also decisive. The soil typically reddens on the bottom line of the pyre due to the direct and intense heat radiation from the blazing logs. In contrast, the inner part of the pyre is mostly charred to black because the accumulating ash layer shields from intense heat on the one hand, while on the other hand, it prevents oxidations processes.[9] The first experiment illustrates spectacularly the phenomenon of escaping heat and the emergence of various insulating areas during cremation. Under the pyre's partially charred eastern base log, intact living green grass was preserved *(Fig. 11.7)*. The ground beneath the pot which stood next to the southeast corner of the pyre was not burnt at all, only the grass desiccated *(Fig. 11.8)*.

Fig. 9. The brick-red patch beyond the southern edge indicating the southern collapse of the first pyre.

The results presented above give a clear answer to the fundamental question of why we find so few pyre sites. Cremation leaves minimal and often only surface traces. Even if the conditions of the cremation are ideal (see above), the degree of soil burning is no more than 5–10 cm.

6 Jonuks – Konsa 2007, 104–105; Marshall 2011, 28, 35–36; McKinley 2013, 158.
7 Lambot 1994, 256–258; Andrieux 1994, 263, Fig. 1, Fig. 3.
8 Graefe 2009, 622; McKinley 2013, 152.
9 Andrieux 1994, 263; Marshall 2011, 28, 35.

Fig. 10. The oblong brick-red patches beyond the eastern edge indicating the eastern scatter of the second pyre.

Similarly, the extent and amount of the pyre debris, namely the thickness and weight of ashes and charred woods remaining on the surface after collection of the bones and pyre goods, is quite low.[10] Thus the chance of the survival of the cleaned or uncleansed pyre sites, regardless of the size of the burnt and covered surface, is extremely little even within a few decades. Due to the shallow depth, poor maintenance and friability, the pyre site is heavily exposed to erosion and various types of disturbances (e.g. bioturbation, agriculture). Therefore, the chance of preservation is much greater if the pyre site is covered immediately or shortly after incineration, for example in the form of a mound. This protected environment is the reason why pyre sites more often come to light under tumuli.[11] In some cases, the specialty of the cremation site, such as a cremation platform[12] or a paved cremation site,[13] helps to preserve and recognize the pyre site. In other cases, various pyre-related features, such as *ustrinum*,[14] *bustum*,[15] hollows to ensure adequate airflow and repository for ashes,[16] as well as postholes[17] may also indicate the site of cremation.

Shape and dimension

The original rectangular shape and orientation of the pyres in both experiments could be reconstructed not only immediately after the pyre's burndown, but also after the cleansing of the pyre site. A similar conclusion was reached by A. Marshall after a series of experiments comprising five pyres of different structure, shape and size.[18] Furthermore, our two experiments also draw attention to the fact that the reddened surface areas in the line of the base logs do not only allow the reconstruction of the former pyre contour but also occasionally provide information on the pyre's base structure.

It is important to note, however, that the dimensions of the pyre sites allow only the approximate reconstruction of the original pyre size. In both experiments, the pyre sites were larger

10 Becker et al. 2006, 131–133; McKinley 2017, 260, 271.
11 Bakonyjákó (Hungary): Jankovits 1992; Pitten (Austria): Stig-Sørensen – Rebay 2005, 167.
12 Pitten (Austria): Stig-Sørensen – Rebay 2005, 164–165.
13 Korytnica (Poland): Moskal-del Hoyo 2012, 3387.
14 Encosta de Sant'Ana (Portugal): Angelucci 2008.
15 Bonyhád-Biogáz üzem (Hungary): Szabó – Hajdu 2011, 94, Fig. 3.
16 Rockfield (Ireland): Lynch – O'Donnell 2007, 107–108.
17 Bölcske-Magyarhalom (Hungary): Szabó 2004, 449–451.
18 Marshall 2011, 27.

Fig. 11. First experiment. 1 – The complete, small mug found under the thick layer of ashes and cremated bones, 2 – The ceramic slab found under the thick layer of ashes and cremated bones, 3 – The rim fragment of a bowl found under the thick layer of ashes and cremated bones, 4 – The side fragment of a bowl found 13 days later during the full cleansing of the pyre site, 5–6 – A small amount of calcined bones found 13 days later during the full cleansing of the pyre site, 7 – The intact and living green grass beneath the pyre's partially charred eastern base log, 8 – The merely desiccated grass underneath the pot standing next to the southeast corner of the pyre.

in both width and length than the original pyres due to their sudden or gradual scatter during the burndown. The first pyre site (270×340 cm) differs from the original 100×210 cm in width by 170 cm and in length by 120 cm. The second pyre site (190×310 cm) differs from the original 115×225 cm in width by 95 cm and in length by 65 cm. This considerable size difference between the two originally almost identically sized pyres can be explained by the processes of cremation. Due to its structure and the ground-level ignition, the first pyre collapsed several times during incineration causing the dispersion of glowing logs, hot ashes and pyre goods around the pyre. In contrast, the second pyre gradually burned down and spread. The data also show that the lateral scatter of the pyre debris is 30 and 50 cm larger than the longitudinal dispersion. This generally observable phenomenon is due to the tendency that the pyre tends to incline and collapse towards the longitudinal sides thanks to its rectangular shape and box-like structure. It is important to note, however, that the final shape and dimensions of the pyre site may be influenced by, besides the pyre's movement, sink, and collapse during burning, by the type, original shape and construction technique of the pyre as well as the direction and strength of the wind.[19]

In view of all this, it can be said that discovered pyre sites cannot be paralleled directly to the size and shape of the original pyre. What we archaeologically reveal is the dispersion of a burnt-down, collapsed pyre in a much larger area and in a somewhat modified form. This scattering might be significantly distorted by the various types of taphonomic factors.

In contrast to the surface patch, the extent of the vertical burn rarely provides information on the original size and shape of the pyre. In addition, it does not always provide real data on the characteristics of the post-cremation conditions. In Experiment 1, the soil burned through only partially and in small patches in relation to the original and post-cremation size of the pyre *(Fig. 4)*. In contrast, in Experiment 2, the soil burned through in a much wider (190–200 cm) area than the originally 115 cm wide pyre, referring to the real extent of the pyre debris *(Fig. 7)*. In addition, if we consider the soil under the burnt layers of Experiment 2, we can see that the characteristic grey and hard soil shows the approximate shape and size of the pyre *(Fig. 8)*.

Under fortunate circumstances, some moments of the incineration can be reconstructed by the more characteristic, reddened soil parts. Although the fine layer of ashes observed on the northern side of the first pyre disappeared within a few days (see the description of the first pyre), the brick-red patch visible beyond the southern edge of the pyre clearly indicates its southern collapse *(Fig. 9)*. On the eastern side of the second pyre, oblong brick-red patches running northwest-southeast show the position of the glowing logs fallen down from the pyre during burning *(Fig. 10)*. Likewise, the reddened areas around R. Leineweber's fourth pyre (SH4) refer to the glowing logs fallen down and to collapses and possible inclination of the pyre.[20] A typical well-oxidized, red-burnt area under the smouldering logs was observed also by A. Marshall.[21] These examples clearly indicate that some information may be obtained about the characteristics, extent and condition of the pyre not only before the cremation but also during and after it.

19 Marshall 2011, 26–28, 35.
20 Becker et al. 2006, 120.
21 Marshall 2011, 41.

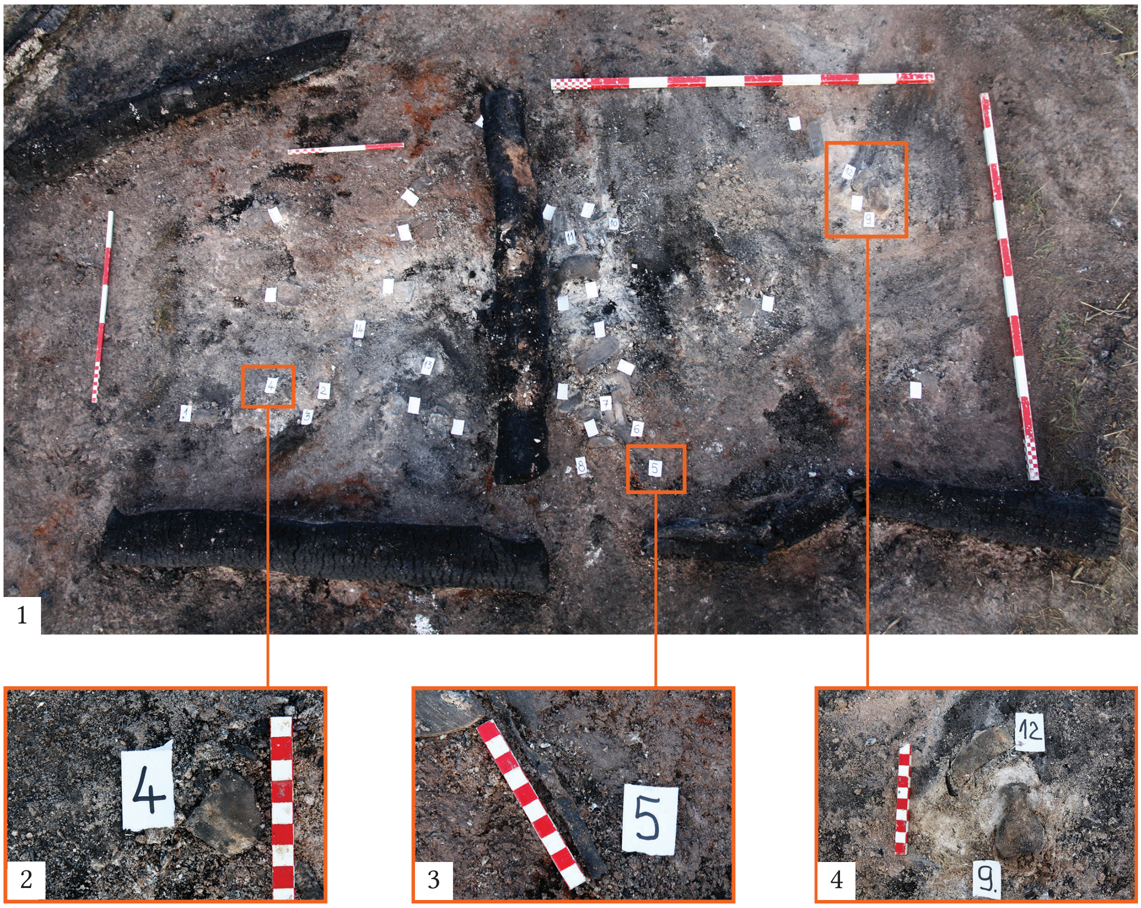

Fig. 12. Second experiment. 1 – The 29 vessel and 17 bronze fragments found under the thick layer of ashes and cremated bones despite the previous systematic collection, 2–4 – Bronze fragments found partially or completely embedded in the soil.

Collecting the artefacts and cremated bones

Representation

The study of pyre sites also draws attention to another important issue, namely the problem of collecting the pyre remains after cremation. In the first experiment, 21 vessels, while in the second, 29 vessels and 6 bronze artefacts were placed on, under, between and next to the pyre. Many of them were damaged or broken by the high, long-lasting and sudden heat, and in some cases due to the condition of the objects or the content of vessels. The smaller fragments and the small objects have fallen frequently and often very quickly as a result of the gradual burndown and movement of the pyre. In parallel with the gradual burndown of the pyre, large amounts of ashes, charcoals and animal remains were deposited on these objects, even some pieces were embedded in the ground.

After the burndown of the first pyre, the pyre goods were immediately documented and collected systematically. However, during the collection of the bones on the next day, four more vessel fragments and one complete, small mug were found, which were completely covered by the thick layer of ashes and cremated bones *(Fig. 11.1–3)*. Despite the meticulous collection of the cremated remains in a 20×20 cm grid, when we 13 days later fully cleaned and excavated the pyre site, one more side fragment of a bowl was found embedded in the soil amongst the tiny charcoals *(Fig. 11.4)*. Experiment 2 illustrates the difficulties of collecting even more spectacularly. This time, the artefacts fragmented more often and to a much larger degree. The cremation was followed by the systematic collection of objects and the removal of the various-sized charred logs. The pyre site was excavated in the late afternoon. This resulted in an additional 29 vessel and 17 bronze fragments, which were completely covered by the thick layer of ashes and cremated bones and were not visible to the naked eye despite the careful collection. The fragments were scattered mainly in the middle and north of the pyre site *(Fig. 12.1)*. While some pieces could easily be found between and below the pyre debris, some fragments, especially those of cast bronze objects with greater weight, were found only after a long search as they were usually partially or completely embedded in the soil *(Fig. 12.2–4)*. Despite the meticulous and long-lasting search, we did not find every single fragment of the pyre goods.

The time- and energy consuming finding of the tiny fragmented and molten metal objects is also emphasized by T. Jonuks and M. Konsa. Certain pieces were only found using a metal detector, nevertheless, two small bronze items were never found.[22] Difficulties in collecting objects with the naked eye are also mentioned by R. Leineweber. X-ray examinations of the pyre debris (SH3 and SH4) revealed a large number and varied spectrum of non-found metal fragments.[23] Considering the size of the metal artefacts, the smaller and lighter the object, the smaller the chance of its preservation.[24] However, R. Leineweber's Experiment 3 (SH3) also draws attention to the fact that a large metal object (e.g. a 15–20 gram silver bowl) may turn up after cremation as a handful of molten nuggets.[25]

On the basis of the above, it can be clearly stated that the objects collected from the pyre debris in most cases do not represent the complete set of artefacts placed on the funeral pyre. The completeness of the collection depends on the material and size of the pyre goods, the circumstances of the cremation (see *'The movement of objects during cremation'*), and the time- and energy investment and purpose of the collectors. Thus, in the course of archaeological interpretation, in addition to deliberate selection, we must also take into account the transformation of pyre goods placed in the grave, their accidental deficiency, and possible mixture (see *'The mixture of pyre remains'*). The transformation of pyre goods can be recognized in the archaeological material, both in the case of metal objects and in pottery (together with animals and stone artefacts). This makes it possible to separate the pyre goods from the grave goods placed directly into the grave. Furthermore, due to the characteristics of these transformations, it is sometimes possible to reconstruct the circumstances of the objects and the cremation.[26]

A similar phenomenon can be observed in the case of cremated bones. In Experiment 1, the pyre site was divided into 72 squares, each 20×20 cm large, and the remains of the 62 kg pig were documented and collected in this grid one by one. Two people needed more than two hours to sort out and collect the various sized (0.1 cm to 10 cm) cremated bones from the pyre debris. In spite of meticulous collection, 13 days later during the excavation of the pyre site, we discovered additional cremated remains due to the rainfall, wind and morning dew that further cleaned the pyre site *(Fig. 11.5–6)*. In Experiment 2, the cremated remains

22 Jonuks – Konsa 2007, 105.
23 Leineweber 2002, 165, 168; Becker et al. 2006, 105–107, 116–120.
24 Marshall 2011, 32.
25 Becker et al. 2006, 106–107.
26 Fülöp – Váczi 2016.

were not collected. However, the entire surface of the pyre site was completely cleaned before its excavation. Despite the cleansing, we found a small number of tiny bone fragments embedded in the soil, which is well visible on Section 2 *(Fig. 7.6)*.

R. Leineweber's second experiment (SH2) provides a spectacular example of the inevitable and even significant shortcomings in the collection. After cremation, 1893g of cremated bones of the 85 kg pig was collected. Later, an additional 550 g (!) of bones were collected by sieving the pyre debris.[27] The first experiment in Asparn an der Zaya performed in 2012 shows a similar tendency. After collecting the remains of the 60 kg pig (741 g), an additional 181 g of cremated bones was collected by the re-examination of the entire pyre debris.[28] A. Marshall's experiments also show that the amount of the collected cremated bones is roughly proportional to the amount of time spent on collection. However, despite the thoroughness of collection, it is almost certain that tiny bone fragments will remain at the pyre site.[29]

On the basis of the above, it can be clearly asserted that the collected human remains never fully represent the dead body placed on the pyre, even though the anatomical order of the body is preserved during cremation.[30] The completeness of the collection depends on the condition of the body before cremation, the circumstances of cremation, the size of bones, and the time- and energy investment and purpose of the collectors. However, an unintentional selection cannot give a general explanation for the wide variety of amounts of the human remains, ranging from a few gramms to 2–3000 grams, which is observed in the Bronze Age across Europe.[31] Beyond the biological conditions[32] and the taphonomic processes,[33] this phenomenon can be explained in most cases by a special body treatment, such as deliberate selection, different and extended use, or more deposit sites.[34]

The movement of objects during cremation

The two experiments also draw attention to the fact that the complete collection of the pyre goods is difficult not only because of the small size and hard recognisability of the fragments. The collection is further complicated by the fact that the objects and the fragments may fall from the pyre at any time as a result of the gradual burning and movement of the pyre, thereby they may be displaced from their original position. Experiment 1 illustrates the problem well, where after the cremation some of the vessels were located 50–80 cm from their original position *(Fig. 13.1)*. The distant and varied scatter and small size of the bronze fragments of Experiment 2 make the issue even more pronounced *(Fig. 13.2)*. The significant rearrangements and the frequent downfall of the artefacts caused by the movements and collapses of the pyre can be observed in the experiments of A. Werner and B. Lambot.[35] Similarly to our first attempt, in the experiments of T. Jonuks and M. Konsa some objects fell from the pyre already at the very beginning of the cremation.[36]

27 Becker et al. 2006, 95.
28 Pany-Kucera et al. 2013, 212.
29 Marshall 2011, 34.
30 Williams 2004, 275, 281; Becker et al. 2006, 91, 95, 99.
31 McKinley 2013,163–164; Köhler et al. in press.
32 McKinley 1993.
33 Wahl 1982, 24–25; Ubelaker 2009; Pankowská et al. 2017.
34 Stig-Sørensen – Rebay 2005, 167–169; Gramsch 2013, 464–465; Cerezo-Román 2014.
35 Werner 1990, 228–230; Lambot 1994, 256.
36 Jonuks – Konsa 2007, 105.

Fig. 13. 1 – The original and final position of the vessels placed on the top of, under and next to the first pyre, 2 – The original position of the bronze artefacts of the second experiment and the scatter of their fragments after cremation.

Beside the movement of the pyre and the size of the objects, the degree of displacement is also fundamentally influenced by the original position of the artefacts. The vessels of the first experiment placed around and beneath the pyre in a stable location did not move or only to a minimal degree. In contrast, vessels placed freely on top of the pyre, especially on the edges, fell sooner or later to a smaller or larger distance *(Fig. 13.1).* The displacement of objects attached to the body (e.g. jewellery) or to the pyre is delayed and has a lesser extent. In addition, our two experiments and the experiments of A. Marshall have clearly demonstrated that the position of objects during the cremation fundamentally determines the transformation and final condition of the artefacts.[37]

Various external factors can also influence the movement and final position of pyre goods during the cremation. Due to its size and weight, the firewood added to the pyre can easily displace the artefacts from their position. The movement and collapses of the pyre may necessitate or require the manipulation of the pyre during burning, for the purpose of more complete cremation (e.g. adjustment of the displaced body, replacement of fallen objects). This was the reason why in the Asparn an der Zaya experiment the pig torso was adjusted twice.[38] A. Werner notes in his experiment that during the adjustment of the pig torso two glass vessels fell from the bonfire.[39] In Nepal, cremation priests with special and inherited knowledge take care of the burning process and control it with long bamboo sticks and rearrange the pyre if necessary.[40]

In the light of all this, it can be said that if the collection focuses only on the original position of an object, it may easily happen that the object, especially if it is fragmented, does enter the grave incompletely or not at all.

The watering of pyre remains

The time and energy invested in the collection, as well as the quality and completeness of the collection, are significantly influenced by the watering of pyre remains after cremation. In the two experiments, the remains were sprinkled with water 6.5 and 5.5 hours after ignition. Thanks to this, the pyre's glowing, greyish-white, and homogeneous world came to life. The cremated bones lighted white amongst the black charcoal pieces. The water washed down the vessels and their fragments and removed the grey ashes that covered everything. Only the black burnt bronze fragments could still not be distinguished because they merged into the similarly dark colour soil and charcoal remains *(Fig. 14.1–2).* Based on the results of the experiments, it can be stated that without the watering, the collection, especially in the case of cremated bones, is much more difficult and the chances of incomplete collection are much higher.

R. Leineweber's (SH1, SH2) and the Asparn an der Zaya experiments also emphasize the much easier collection of human remains and artefacts after watering.[41] Watering as the closing event of the cremation is mentioned by various written sources. At the funerary ceremony for Patroclus and Hector, the remains of the pyre were sprinkled with wine next dawn and then the bones were collected.[42] This example also suggests that the watering of pyre remains may become an expression of other symbolic meanings beyond practicality.

37 Marshall 2011, 29–31.
38 Pany-Kucera et al. 2013, 214.
39 Werner 1990, 230.
40 Oestigaard 2005, 13–15, Fig. 1.6.
41 Leineweber 2002, 169; Becker et al. 2006, 91, 95; Pany-Kucera et al. 2013, 209, 214.
42 Homer, Iliad XXIII. 249–253, XXIV. 780–784. (Devecseri 1974).

Fig. 14. 1 – The remains of the second pyre before watering, 2 – The pyre remains after watering.

The watering of remains may leave traces on the calcinated bones. In contrast to the already cooled remains, hot cremains are more fragile and more sensitive to external mechanical and thermal effects. Therefore, a high degree of fragmentation can be observed when the hot bones are sprinkled with any liquid.[43] In India, the fragmentation of human remains is done by their crushing and watering.[44] In R. Leineweber's second experiment the remains were sprinkled with water, while in the third and fourth experiment they were not. However, the size of the bones did not differ significantly. The only difference was the higher proportion of small fragments in Experiment 2.[45] From this example, it can be clearly seen that the archaeological observation of watering is theoretically possible, however, due to the thousands of possible causes of bone fragmentation,[46] it can only be confirmed in special cases. Thus it is more likely to recognize its absence. In the case of graves with uniformly large calcined bones, it can be said that the watering of pyre remains was not part of the cremation ritual.[47]

There is also another great advantage of watering: it quickly cools the hot remains, allowing the bones and objects to be collected immediately after cremation. The first pyre was 140 °C and the second was 325 °C at the time of water sprinkling. With the watering, however, the remains were cooled down to 50 °C and 100 °C in 2–3 minutes. In the first case, it allowed immediate collection of the artefacts and bones. In the second experiment, it significantly accelerated the cooling process, so after 35 minutes of waiting (60 °C), it was possible to collect the remains also at the former hottest points of the pyre.

Without watering, the only possible way of collecting is the gradual cooling of the pyre remains. However, this may take hours or even days depending on the weather (e.g. rainfall, winter cold). The charred large logs of Experiment 1, despite the watering in the previous day, the cold night and the morning dew, were still so hot that they burned the string of the grid stretched to collect the cremated bones. In the first experiment in Asparn an der Zaya performed in 2012, the pyre remains were still 360 °C 24 hours after ignition.[48] In R. Leineweber's Experiment 4 (SH4), the burnt-down pyre was still glowing in some places even more than a day after ignition. Therefore, the residues had to be poured with water for the collection of remains.[49]

During the time of cooling, the rain can even clean the remains, helping not only to cool them down but also to collect them. This function of rain and morning dew was observed in the first pyre site. It cleaned the few bone fragments left behind and the lost dish fragment, helping their discovery *(Fig. 11.4–6)*. The cleaning effect of the wind, especially blowing away some of the ashes, is noted by B. Lambot and J. McKinley.[50]

The mixture of pyre remains

The above-mentioned difficulties and incompletions of collecting pyre remains also draw attention to another important issue, the problem of mixture. The continuous use of the cremation site, lacking thorough cleaning, may cause the minglement of remains.

43 McKinley 1994, 340; Grosskopf 2004, 23, 105, 110; Szabó 2004, 452–458.
44 Köhler et al. in press.
45 Becker et al. 2006, 145.
46 Pankowská et al. 2017, 144–146, Fig. 1.
47 e.g. Cottbus Alvensleben-Kaserne (Germany): Grosskopf – Gramsch 2007, 77.
48 Pany-Kucera et al. 2013, 211.
49 Leineweber 2002, 168; Becker et al. 2006, 109.
50 Lambot 1994, 256, Fig. 13; McKinley 2017, 260.

Human remains are the most unambiguous way to observe this mixture. However, it is important not to confuse this with the phenomenon of multiple burials. The significant disproportion of the remains of individuals, the special treatment of the cremated bones or their separate placement in the grave can help the distinction between these two phenomena. Both, that is mixture during collection and dual burial can be observed in the Middle Bronze Age cemetery of Bonyhád-Biogáz üzem (Hungary).[51] The geo-archaeological study of the Roman *ustrinum* found in the cemetery of Encosta de Sant'Ana (Portugal) showed that the cremation site was in use for a longer period of time, during which it was only negligently cleaned or not cleaned at all.[52] Thus, in this case, we must reckon on the minglement of human remains. These examples draw attention to the fact that a few pieces of bone fragments of another person do not necessarily mean that the deceased is deliberately and symbolically placed in the grave.[53]

The experiments clearly indicate that also the pyre goods may be mixed during the collection. The risk of the mixture is particularly high for small size, molten metal fragments (e.g. nuggets) or other small items (e.g. beads). Due to the frequent damage of ceramic vessels during cremation (e.g. fragmentation, spalling, cracking),[54] fragments of pottery also have the potential for mixing. Thus, we have to consider also the possibility that a tiny single bronze nugget or the side fragment of a pot found in a grave could also be the part of another pyre good set belonging to a former cremation.

In some cases, charcoal remains are deliberately or accidentally mixed with human remains or deposited in the infill of the grave.[55] However, in the absence of thorough cleaning of the cremation site, the chance of the mixture of charcoals is particularly high, due to its large quantity, its great dispersion, the diverse size of the fragments and the general lack of their complete or partial collection. Therefore, the possibility of minglement should always be taken into account in the various anthracological analyses.[56]

At the same time, the observed mixture of the pyre remains also provides indirect information on certain ritual elements of the cremation and the treatment of the pyre site. On the one hand, it indicates the repeated use of the cremation site and the lack of its thorough cleaning, and on the other hand, it refers to the characteristics of collecting after cremation.

Conclusion

Based on the experiences of the two experimental cremations presented in this article and other experiments, it becomes clear why we find so few *in situ* pyre sites. In spite of the long-lasting, extreme conditions and processes of burning, the cremation leaves only minimal and poorly maintained traces. The thickness of soil burn never exceeds 5–10 cm regardless of the location of the incineration, the structure, composition and size of the funeral pyre, the type of the soil, the manipulation of the fire, the watering of the pyre remains, and the weather conditions. Similarly, the thickness and amount of the pyre debris, namely

51 Szabó – Hajdu 2011, 94–96.
52 Angelucci 2008, 2631.
53 comp. McKinley 2013, 154–155.
54 Becker et al. 2006, 151; Fülöp – Váczi 2016, 4, Fig. 3.
55 Jobbágyi (Hungary): Fülöp – Váczi 2014, 414; Templenoe (Ireland): O'Donnell 2016.
56 e.g. Moskal-del Hoyo 2012; Deforce – Haneca 2012.

the ashes and charred woods remaining on the surface, is quite low. Therefore, both, the cleansed or uncleansed pyre sites are heavily exposed to the various taphonomic processes and the chance of their preservation and archaeological discovery is minimal and in most cases, a matter of luck. However, the likelihood of their conservation and location is greatly enhanced by the special treatment of the pyre site (e.g. burial mound) or the various pyre-related features (e.g. platform, pavement, pits and postholes). It is not surprising, therefore, that these types of pyre sites appear much more frequently and in better condition in the archaeological records than those sites where the pyres were constructed directly on the ground surface and left uncovered after cremation. That is why we need to be careful about the direct comparison between the pyre sites found in intact archaeological contexts (e.g. under a burial mound) and the pyre sites found in contexts that are intensely exposed to disturbances.

In the light of the entire process of cremation (construction of the pyre – placement of the body and pyre goods – ignition – burning – watering – collecting), a detailed examination of the pyre site can provide various general or specific information on the characteristics of the funeral pyre, the processes of burning, and the post-cremation collection.

In general, the original shape and orientation of the pyre can be reliably reconstructed based on the scattering of pyre debris and the characteristics of the burnt ground surface. Furthermore, the special characteristics of soil burning can be used to reconstruct some elements of the pyre's base structure and certain circumstances of the burning process (e.g. the movement, collapse and scatter of the pyre). However, the dimensions of the pyre site allow only the approximate reconstruction of the original pyre size. The final shape and dimension of the pyre site may be influenced by the type of the pyre, its movements and collapses during burning, its original shape and construction technique, as well as the direction and strength of the wind.

The experiments clearly drew attention to the difficulties of collecting cremated bones and pyre goods which may influence the archaeological interpretation. The collected human remains never fully represent the dead body placed on the pyre. The completeness of the collection depends on the condition of the body before cremation, the circumstances of the cremation (e.g. manipulation of burning, watering of pyre remains), the size of the bones and the time and energy investment and purpose of the collectors. Similar conclusions can be made regarding the pyre goods. The objects collected from the pyre debris in many cases do not represent the complete set of artefacts placed on the funeral pyre. The completeness of the collection depends on the material and size of the pyre goods, the circumstances of the cremation (e.g. the movements and manipulation of the pyre, the watering of pyre remains), as well as the time and energy investment and purpose of the collectors. Thus, in the interpretation of the incompletion of human remains and pyre goods placed in the grave, we must consider not only the deliberate manipulation of the pyre remains (e.g. selection, extended use, various depositions) but also the possibility of their unintentional selection.

Due to this inevitable, minor or major deficiencies in the collection, the continuous use of the cremation site in the absence of its thorough cleaning is highly likely to result in the mixture of pyre remains. Although this phenomenon can be most clearly identified in the case of human remains, we also have to consider the possible minglement of pyre goods (e.g. molten metal nuggets, side fragments of vessels) and charcoals.

Because of the destructive and transformative characteristics of cremation and the indirect nature of most of the archaeological data associated with it, it is particularly important to have a detailed interdisciplinary study of the preserved pyre sites in order to understand the whole process of the funeral ritual. Especially in the light of the fact that, beside the body and the pyre goods, the pyre complements and defines the central element of the funeral, namely the deceased person.[57] In this way, beyond its simple practical function, the pyre becomes a communication medium (e.g. representation, identity) towards the deceased and also the living. These practical and symbolic functions can appear in many forms and in many elements of the pyre. The location of the pyre[58] and its size[59], the type of firewood,[60] and also the treatment of the pyre site and the pyre debris may have a symbolic meaning.[61]

Although our two experiments reconstruct Late Bronze Age cremations, the results and investigational possibilities presented in this article can also be generalized to other periods due to the general characteristics of cremation and pyre sites. However, we should not forget that the questions raised in this article and studied under experimental conditions are based on the intact state of the pyre sites within a short time interval. The archaeological study of these questions is often limited by the significant elapsed time and the condition of the discovered pyre sites, such as the degree of disturbances and the possible manipulation after cremation (e.g. cleansing of the pyre debris). Therefore, it is particularly important to keep in mind the archaeological limitations of the investigations presented in detail in this article. In spite of all this, a detailed study of these issues allows us not only to localize pyre sites but to gain insight into the above mentioned practical and symbolic characteristics and functions of pyres, as well as the processes of the cremation rite poorly understood so far.

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57 Williams 2004, 270–271.
58 Stig-Sørensen – Rebay 2005, 164–165.
59 Homer, Iliad XXIII. 164. (Devecseri 1974).
60 Moskal-del Hoyo 2012, 3390–3392.
61 O'Donnell 2016, 169–170.

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