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GEOARCHAEOLOGICAL AND ARCHAEOBOTANICAL METHODS IN ACTIVITY AREA ANALYSIS

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According to certain analyses, the find materials at archaeological sites that are the most common and available in the greatest quantity are the soil or sediment materials created through human vital functions and activities.[3] These altered soil formations or sediments have been called in many different ways in the professional literature in recent decades (e.g. cultural layer, cultural deposit etc.), although today we typically and uniformly use the designation "anthropogenic sediment." In the environment of settlements it is not only archaeological methods that are available for the definition or spatial demarcation of activity areas.[4] In addition to the interpretation of the spatial distribution and location of archaeological find materials, as well as their quantitative and qualitative attributes, the scientific examination of soil and anthropogenic deposit samples – collected systematically and with necessary precision – is also able to provide information on the details and spatial extent of the activities of each human community. Similar to the material relics, the 'memory of the soils' – in the form of chemical and physical parameters, as well as botanical and zoological remains – and the spatial distribution of these parameters can tell us about the economic and everyday life of the cultures that lived in the past.

INTRODUCTION

Activity area analysis provides a wide theoretical framework and methodological repertoire that (can) include the examination of activity patterns outside the site,[5] inside the site or even within a given archaeological features. The subject of examinations of activities within the features is primarily the excavated buildings within the context of the settlement that provided locations for numerous everyday and extraordinary activities, the understanding of which brings us closer to describing the economic, social or even ritual actions of a given culture or human community. The demarcation of activity areas within the features – that is the evidence of activities performed in the distant past – is based upon an understanding of the distribution of the archaeological find materials, while at the same time there are many known soil scientific[6] and botanical methods that can be used in a wide scope for the uncovering and understanding of spatial use patterns.[7]

Already in the 1920s Olaf Arrhenius brought attention to the properties of various phosphates to indicate former human activity and the outstanding importance of the archaeological opportunities inherent in this method.[8] During the nearly one hundred years that have passed since then the methods in this area have been developed at a rapid pace, which has been accompanied not only by technological leaps, but

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3 Wells, E.C.: Sampling design and inferential bias in archaeological soil chemistry. *Journal of Archaeological Method and Theory* 17 (2011), 209–230.

4 Kalla, G.: A háztartások régészete mint kutatási probléma (Household Archaeology as a Research Problem). *Ősrégészeti Levelek* 13 (2011), 9–36. (ΜΩΜΟΣ VII. – Őskoros Kutatók VII. Összejövetele, Százhalombatta, Matrica Múzeum, 2011. március 16–18. – Tanulmánygyűjtemény [Proceedings of the 7th Meeting for the Researchers of Prehistory, Százhalombatta, Matrica Museum, 16–18 March 2011 – Collection of Essays])

5 The comprehensive designation of the analysis of activities outside the site used in the professional literature is the so-called *site catchment analysis* (SCA).

6 The pedological, sedimentological and geochemical methods overlap, but since the method of approaching the examination of anthropogenic deposits is based on pedology (as well), we use this designation in this article.

7 Holliday, V.T. – Lawrence-Zuniga, D. – Buchli, V.: Prologue to uses of chemical residues to make statements about human activity. *Journal of Archaeological Method and Theory* 17 (2011), 175–182.

8 Arrhenius, O.: Die Phosphatfrage. *Zeitschrift für Pflanzenernährung, Düngung und Bodenkunde* 10 (1929), 185–194.

also necessarily has included the incorporation of other branches of science and knowledge. The linking of known patterns of soil chemistry with certain concrete human activities has become a prominent aspect.[9] In addition to importing the achievements and experimental results from cultural anthropology as well as ethnography[10] into the methodology of activity area analysis, another important natural science, botany, and within this the methods of archaeobotany, have proven useful in understanding everyday human activities. As we just mentioned earlier, the main goal of using soil scientific methods in activity area analysis is to decipher the "invisible" fingerprints that provide the spatial pattern for vital functions and activities that occurred in the past. At the same time, the archaeobotanical finds and knowledge can provide concrete, tangible evidence for the understanding of activities that occurred within a feature.[11] While for a long time it has been known that the spatial distribution of macro-archaeobotanical finds is able to determine and demarcate human activities, the utilization of micro-archaeobotanical remains[12] according to the same principles was only integrated into the field of activity area analysis later.[13]

TAPHONOMICAL BACKGROUND OF THE ACTIVITY AREA ANALYSIS OF SEMI-SUBTERRANEAN FEATURES

One of the highly debated topics in Hungarian archaeological research is determining the function of so-called semi-subterranean buildings[14] *(Fig. 1)*. The determination of the range of uses or archaeological interpretation of buildings excavated in Hungary can typically be divided into two main methodological approaches.

The material remains (personal and crafting belongings) found in the interiors of the excavated buildings can provide a guide related to the functionality and use of the building, to the extent that they can be clearly linked to the functioning of the building and were not put in the building pit subsequently – for example as waste. However, characteristically these features – naturally depending on

Fig. 1: Reconstruction of a semi-subterranean building with a storage function (storage pit with a lean-to roof) at the Matrica Museum and Archaeological Park in Százhalombatta (photo by the authors)[15]

[9] Hutson, S.R. – Magnonib, A. – Beach, T. – Terry, R.E. – Dahlin, B.H. – Schabelf, M.J.: Phosphate fractionation and spatial patterning in ancient ruins: a case study from Yucatan. *Catena* 78 (3) (2009): 260–269.

[10] Amongst others see: Knudson, K. J. – Frink, L.: Soil chemical signatures of a historic sod house: activity area analysis of an arctic semisubterranean structure on Nelson Island, Alaska. *Archaeological and Anthropological Sciences* 2 (2010), 265–282.

[11] Amongst others see: Jones, V. H.: The Nature and Status of Ethnobotany. *Chron. Bot.* 6 (10) (1941), 219–221. and Jacomet, S. & Kreuz, A.: *Archäobotanik: Aufgaben, Methoden und Ergebnisse vegetations- und agrargeschichtlicher Forschung*. Stuttgart (1999), 368.

[12] Archaeobotany is the scientific field dealing with the analysis of botanical remains from archaeological sites and the interpretation of the relationships between humans and plants or humans and their environment. On this basis as well, it is possible to divide this field into research areas, according to which size domain the examined botanical materials belong. This is the basis for differentiating between macro-archaeobotany (typical areas of study: seed and crop analysis, charcoal and wood analysis) and micro-archaeobotany (e.g. analysis of pollen, starch particles and phytoliths).

[13] Amongst others see: Rondelli, B. – Lancelotti, C. – Madella, M. – Pecci, A. – Balbo, A. – Ruiz Perez, J. – Inserra, F. – Gadekar, C. – Cau Ontiveros, M.Á. – Ajithprasad, P.: Anthropic activity markers and spatial variability: an ethnoarchaeological experiment in a domestic unit of Northern Gujarat (India). *Journal of Archaeological Science* 41 (2014), 482–492.

[14] In the present essay we consciously avoid using the term "house", because that predestinates one of the possible types of functions.

[15] The building displayed is a reconstruction of feature number 194 from the Iron Age settlement excavated at Sopron-Krautacker by Erzsébet Jerem: Jerem, E. – Facsar, G. – Kordos, L. – Krolopp, E.: A Sopronn-Krautackeri vaskori telep régészeti és környezetrekonstrukciós vizsgálata II (Te archaeological and environmental investigation of the Iron Age settlement dicovered at Sopron-Krautacker. II.). *Archaeológiai Értesítő* 112 (1) (1985), 3–24.

the site and age – contain scanty finds. Further confounding the determination of the building's function is that in many cases the – deliberately abandoned (?) – pit of the building was used by the human population inhabiting the settlement as a rubbish (disposal) pit, and thus the objects subsequently placed there cannot be linked to the use of the building.

The second method for determining the function starts from the architectural and structural characteristics of the buildings, the basis for which is provided by the ground plan, the dimensions, the number of posts that held up the roof beam, which can be inferred from the number of post holes, as well as the relative placement and location of these posts. The available software for the 3D reconstruction of the buildings' possible superstructures provides a good opportunity to be able to analyze in more detail the capacities of the building in question – so, for example, determining how many people could have slept or resided in a building at the same time – and its interior height.[16]

In addition to the two aforementioned methodological approaches, the methods of geoarchaeology and archaeobotany – if the proper criteria are met – can also contribute to understanding the functions of these buildings. In recent years we have begun a series of methodological experiments and evaluations[17] with the goal of using these scientific methods to perform examinations on the anthropogenic sediments of archaeological phenomena that have not been tested from this perspective, but have an important – in some cases outstanding – place in the archaeology of Carpathian Basin settlements and households, and thereby can supplement our knowledge related to the use of the buildings' interior spaces.

To understand the use of semi-subterranean buildings, it is not of primary importance to be thoroughly familiar with their origins, but it is necessary to define the possible processes of destruction, which aids in determining whether the layers in the fill of the pit and the physical, chemical and botanical "fingerprint" of these layers can be linked to the original function of the building. The remains and deposits classified as subsequent accumulations cannot be linked to the results coming from our examinations on the use of the buildings.

In contrast to buildings with vertical walls, in semi-subterranean buildings, often simply referred to as pit dwellings, the floor sunk below the ground level and the pit of the living space itself creates a specific micro-environmental condition. The waste materials accumulating on the floor level[18] through human activity cannot get out of the interior space of the building purely through natural means, even through the entrance opening. The debris materials accumulating through activities occurring in the interior space of the

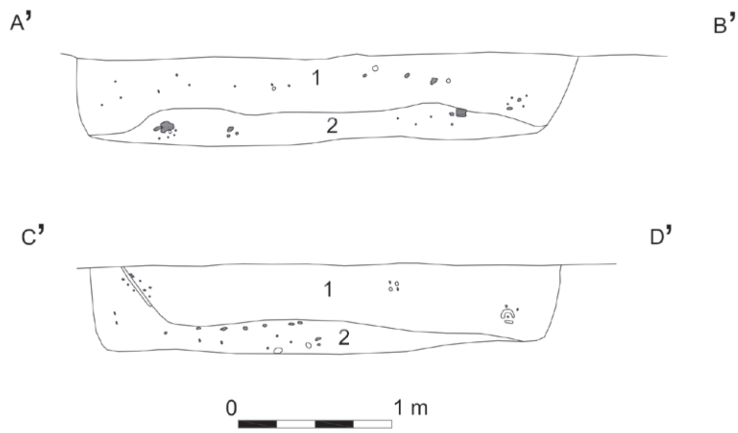

Fig. 2: Possible stratigraphical relationships of the section of a semi-subterranean building. The accumulation of debris (2) from use and its location in the interior of the building is clearly delineated on the A-B and C-D sections, as well as the sealing layer (1) that filled the pit during the course of the building's destruction. During the precise and careful sampling for the activity area analysis these two layers with differing genetics must not be mixed, since only the lower layer can be linked to the building's use.

16 For the digital and morphometrical reconstruction of semi-subterranean buildings, see the work of Lőrinc Tímár.

17 The examinations were initiated in 2009 through the cooperation of the professionals working at the Field Service for Cultural Heritage Protection Laboratory for Archaeological Diagnostics, and later its successor organization, the Applied Research Laboratory of the Hungarian National Museum's National Heritage Protection Center, as well as the archaeologists of the aforementioned institutions. The aforementioned institutions have since been dissolved, so the center for the research has been transferred to the Institute of Nature Conservation and Landscape Ecology of Szent István University, Gödöllő.

18 We explicitly do not simply use the term "floor," since experience up to now has shown that these semi-subterranean buildings rarely had a demonstrable clay or compacted, packed floor level as have been excavated in Neolithic or Bronze Age settlements (e.g. the clay floors at Százhalombatta–Földvár).

building create a so-called activity layer, which if it becomes buried – and we are able to detect its verifiable traces in relation to the stratigraphy of the fill – we then are able to link the botanical remains or the data from soil laboratory analysis performed on samples collected from that layer with great certainty to the building's original function. During his study of Iron Age phenomena Lőrinc Tímár clearly described and showed the possible processes of destruction for semi-subterranean buildings.[19] On the basis of his conclusions, the roof structure and then the walls of the abandoned building collapse first into the interior of the pit. Naturally, erosion of the sides must be reckoned with during this gradual collapse. Following the partial or complete collapse of the superstructure the filling of the pit begins. The process outlined leaves an observable trace in the cross section of the building's fill *(Fig. 2)*, so if sufficiently precise excavation techniques are used, it can be preliminarily estimated and determined whether the semi-subterranean feature in question contains a layer suitable for scientific examination.

METHODOLOGICAL CONSIDERATIONS

In contrast to the so-called site catchment analysis (SCA) outside the archaeological site or the spatial use analysis within the site, the activity area analysis of a feature has given physical boundaries for the taking of samples.[20] Within the physical boundaries of the examined building a horizontal sampling protocol must be drawn up for its interior space, which will either cover the entire interior, thereby producing a so-called full horizontal sampling, or the sampling may only be performed in part, with either random or systematic sampling. The essence of the sampling is that the interior of the building is covered by a grid of a pre-determined size. Within this chessboard-like network of squares created, each square or quadrant represents a sampling unit. Therefore, in this respect the borders are given for the planning of the sampling strategy, while at the same time it must be kept in mind that whatever the frequency of sampling is (in other words, whatever the size of the sampling units the interior of the building is divided into), we always create an artificial , map-like model for examining the extent of the possible traces of the human activities from the past. Since we cannot know ahead of time what types of activities we are looking for, and in most cases it is not clear the extent to which a given activity may appear within a given archaeological context, it is difficult to judge whether a full examination performed on the basis of a sampling network of 1x1 m units or of 20x20 cm units will lead to suitable results. There is a significant difference in the amount of sampling between the aforementioned two examples, and exponentially increasing expenses due to

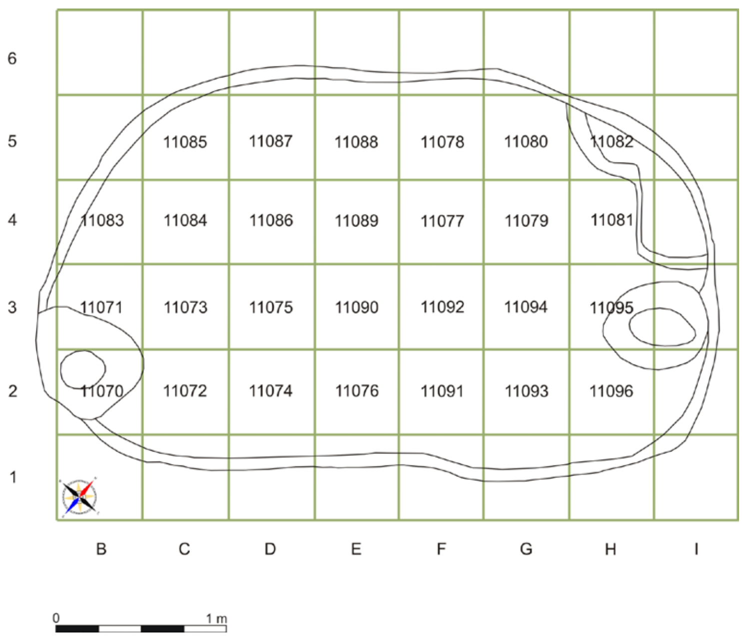

Fig. 3: Virtual image of a sampling grid and the sampling quadrant codes set up in the interior space of a semi-subterranean building (example: Győr-Ménfőcsnak-Széles-földek feature 210/7124, unpublished data)

[19] Tímár, L.: Késő vaskori veremházak maradványainak értelmezése (Interpretation of the sunken houses of the Late Iron Age). *Ősrégészeti Levelek* 13 (2011), 290–300. (ΜΩΜΟΣ VII. – Őskoros Kutatók VII. Összejövetele, Százhalombatta, Matrica Múzeum, 2011. március 16–18. – Tanulmánygyűjtemény [Proceedings of the 7th Meeting for the Researchers of Prehistory, Százhalombatta, Matrica Museum, 16-18 March 2011 – Collection of Essays])

[20] Naturally, on the basis of the term *household cluster*/*compound* the functional area of a household is not restricted to a single building, but in the present case we are concentrating on the interior space of a building, and therefore the simplified conception.

this difference, since in the case of the latter examination – which offers greater resolution – strictly speaking twenty-five times as many samples would be collected from the same surface area.[21]

The experience of the examinations performed in recent years has shown that typically in the case of 9-15 m^2 buildings, the establishment of 50x50 cm *(Fig. 3)*, or 0.25 m^2 sampling units[22] results in a data resolution in which demonstrable differences arise during the spatial use analysis *(Fig. 4)*. At the same time it must be noted that on the basis of the actual archaeological question studied or on the basis of accrued experience a deviation from the given value may be justified, since there may be types of activities that either require higher horizontal resolution or allow for lower resolution. During the Hungarian methodological experiments the set of soil scientific and archaeobotanical means is continuously expanding, and the use of these techniques may be effective for understanding the use of the features selected for examination. Below we will briefly summarize what type of information the various methods of examination are able to provide, and how it is possible to translate the data obtained through the given method into the language of an archaeological activity area analysis.

The so-called total organic carbon (TOC)[23] and total phosphorus content (Ptotal) from the anthropogenic sediment samples collected from the activity layer of the semi-subterranean building determines the locally occurring organic material input, or in other words if a defined area has a high deposit or accumulation of material containing organic materials in contrast to the surrounding environment, then this can be shown through the analysis of the aforementioned parameters. It must also

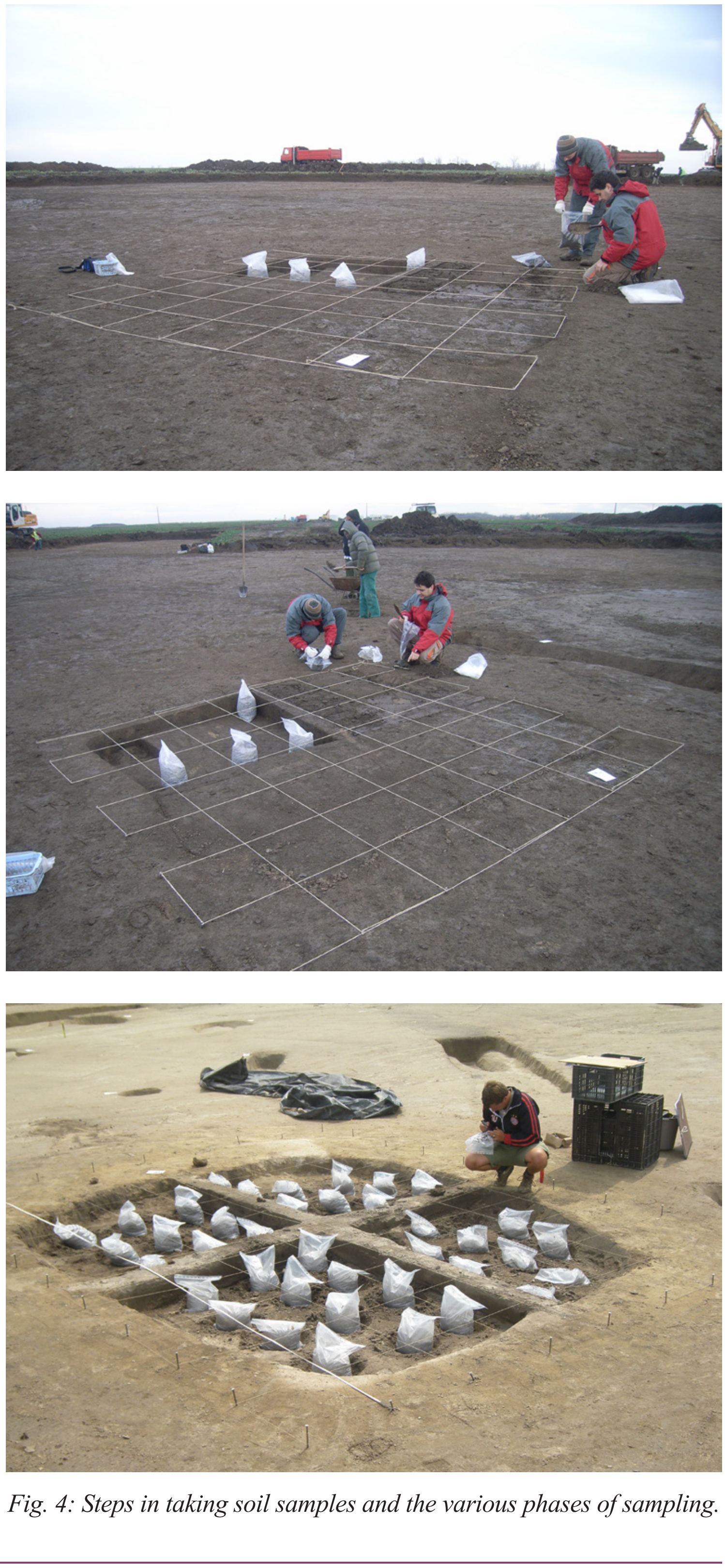

Fig. 4: Steps in taking soil samples and the various phases of sampling.

[21] For example: in the interior of an hypothetic 2x2 m building an examination performed according to 1x1 m squares would result in 4 samples, while for the same building divided into 20x20 cm sampling units each 1x1 m area would include 25 further sampling units, so instead of 4 samples there would be 100 samples to collectand process.

[22] This typically covers a feature with a ground area of 3–4 x 3–4 meters. Naturally these ground plans are not regularly shaped, so the number of sampling units varies from case to case. The issue is further complicated by the fact that the quadrants along the side walls are often damaged and found in a disturbed condition due to the intrusion of external materials during the process of the destruction of the building.

[23] The TOC is measured through the loss on ignition (LOI) method.

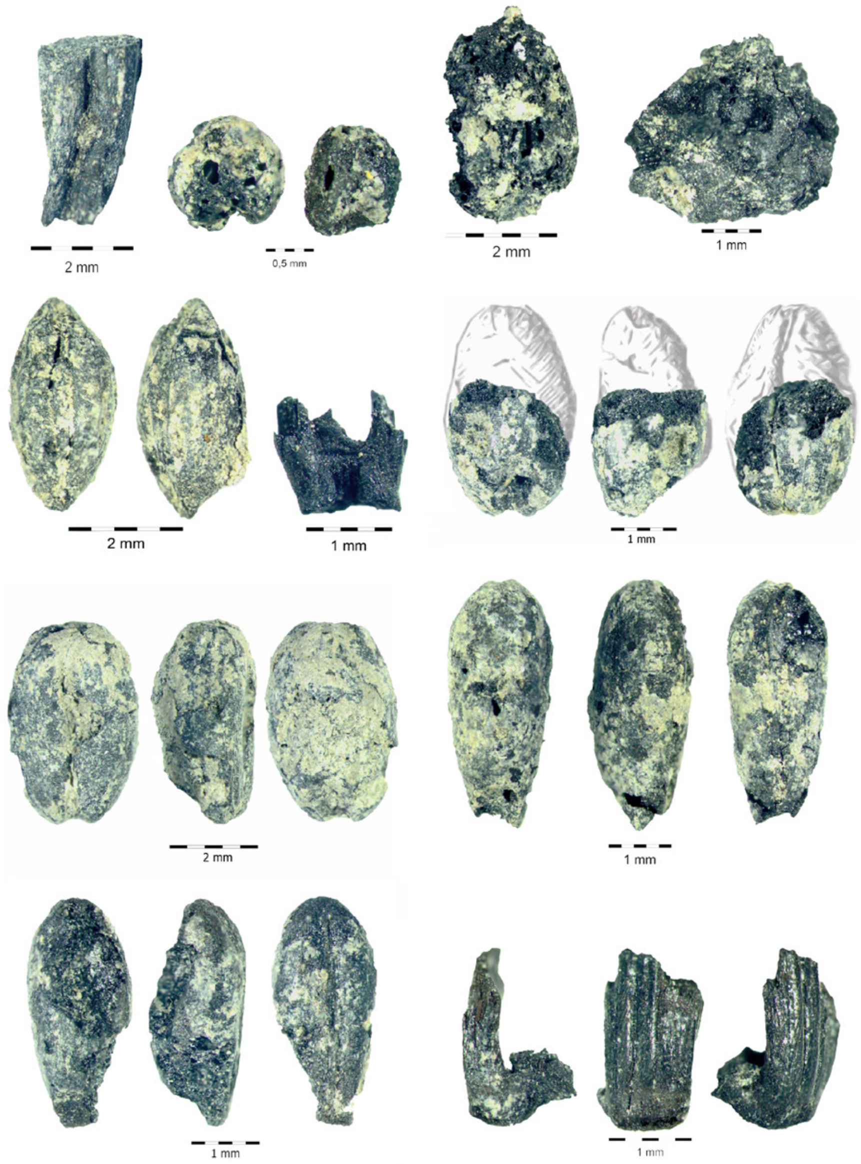

Fig. 5: Example of cereal remains excavated and identified during a macro-archaeobotanical (carpological) examination on the interior of a semi-subterranean building (example: Győr-Ménfőcsnak-Széles-földek feature 210/7124, unpublished data).

be emphasized that these parameters are indicators not of the quality of the materials but their quantity, so on the basis of these we cannot provide the actual type of material, just indicate the extent of the impact. At the same time, the range of usable high organic content materials can be determined, so an extremely high indicator signals primarily the former presence of manure as well as by-products and processed goods of animal origin (bone, wool, etc.).

The particulate composition, otherwise referred to as the texture of the examined samples can provide information on whether they brought into or stored in the building "clay" for producing ceramics or for satisfying the raw material demands of other technologies. The so-called geochemical examinations[24] show the amount of chemical elements appearing in the samples. A special activity – such as metalworking or the accumulation of waste materials from food made from aquatic animals – can be distinctly related to the enrichment of a certain chemical element, so in the case of particular chemical signatures possibility of the existence of these activities arises.

The examples above can in and of themselves indicate whether a building should be considered a house or possibly a workshop. In addition to this, the botanical methods provide us with yet another tool. The analysis of seeds and crops, which belongs to the field of macro-archaeobotany,[25] can show the plant remains that may have been processed, treated or stored in a building or section of a building *(Fig. 5).* In this regard, the distribution of the presence of grains and types of remains that are of outstanding importance from the aspect of providing nutrition or preparing food has value as an indicator. In a (part of a) building used for cereal storage there will be a high ratio of whole grains in the carpological material, while in the case of a building used for the processing cereals, there will be a greater proportion of broken grains from threshing, or inflorescence bracts and hulls, the so-called chaff that is the waste or by-product from threshing. The amount or ratio of weed species found in the samples of the examined building provides information about the technology for the cultivation of cereals and the purity of the raw cereal stock produced. The preparation of food can be shown not only through geochemical meth-

[24] e.g. the ICP-AES method – inductively coupled plasma atomic emission spectroscopy – an instrumental analytical method showing the concentration values of chemical elements.

[25] *syn.*: carpology

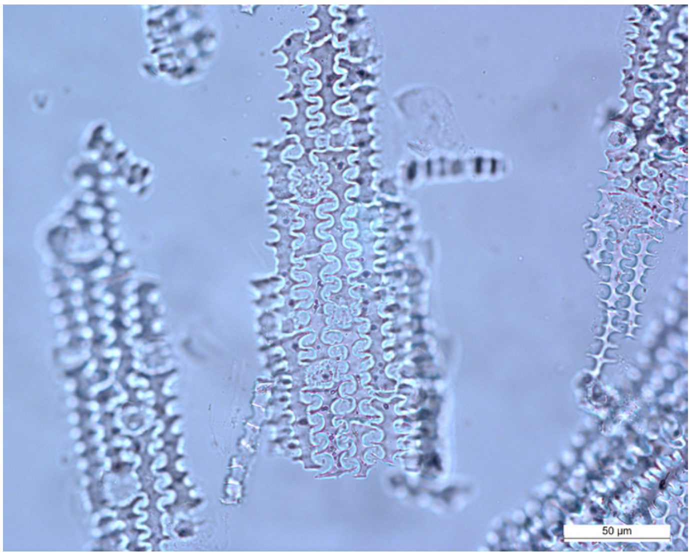

Fig. 6: Optical microscope image of easily identifiable phytolith morphotypes that originate from the inflorescence bracts of Old World cereals (e.g. glume,palea and lemma) (morphotype name: elongate dendritic LC)

ods, but the distribution and composition of accumulated foodstuff remains in the area of hearths or other presumed temporary fireplace sites can also indicate household activities.

A supplement to the macro-archaeobotanical material can be the so-called phytolith analysis.[26] The plant opal particles or phytoliths are good indicators of the accumulation of various plant parts *(Fig. 6)*. With their help, for example, it is possible to differentiate within the waste from the winnowing of cereals between their storage and deposition in different areas of vegetative and generative parts (organs). At the same time with their help we can also obtain data on the (plant) materials used in the construction of the building. While the reed used for roofing only appears in the rarest cases in the macro-archaeobotanical materials, the discovery of its characteristic leaf phytoliths in the micro-archaeobotanical materials can reveal its presence.

BRIEF CASE STUDIES

Fig. 7: Hódmezővásárhely-Kopáncs I. (Olasz-tanya) Late Avar Period building feature (photo: Nándor Bárdos, FSCH[29]/HNM-NHPC) (after: Herendi–Pető, in publication)[30]

Spindle whorl, cooking pots, phosphorus and cereal phytoliths: Hódmezővásárhely-Kopáncs I. (Olasz-tanya) Late Avar Period Building[27]

During an excavation performed at a Csongrád County archaeological site before the planned opening of a sand quarry, a section of an Avar Period settlement was discovered. The archaeologist leading the excavation was able to isolate the floor layer within semi-subterranean building 23/23 *(Fig. 7)*.[28] During the excavation of the building signs of vertical walls were not discovered, but at the bottom of the feature a 1-2 cm thick compacted layer with a differing color could be observed in the section wall, which we defined as the floor level of the building. The layer

[26] Inorganic cellular and tissue inclusions containing silica that form in plants (so-called phytoliths) are extraordinarily durable and survive for a long time.

[27] For further details, see: Herendi, O. – Pető, Á.: Avar kori településnyom Hódmezővásárhely-Kopáncs I., Olasz-tanya lelőhelyen (Csongrád megye): egy félig földbe mélyített épületobjektum régészeti és természettudományos értékelése (Remains of an Avar-Age settlement at the Hódmezővásárhely-Kopáncs I., Olasz-tanya archaeological site (Csongrád county, Hungary). Archaeological and scientific assessement of a semi-subterranean feature. In: Türk, Attila – Balogh, Csilla et al. (eds.): *Hadak útján. A népvándorláskor fiatal kutatóinak XXIV. összejövetelének konferenciakötete (Hadak útján – Assembly of Young Scholars on the Migration Period XXIV.*(Budapest-Esztergom, 2015) (in press).

[28] The excavation was performed by the Field Service for Cultural Heritage, excavation leader: Orsolya Herendi.

[29] FSCH: Field Service for Cultural Heritage; HNM-NHPC: Hungarian National Museum, National Heritage Protection Centre

[30] In: Türk, Attila – Balogh, Csilla et al. (eds.): *Hadak útján. A népvándorláskor fiatal kutatóinak XXIV. összejövetelének konferenciakötete (Hadak útján – Assembly of Young Scholars on the Migration Period XXIV.)* (Budapest-Esztergom, 2015) (in publication).

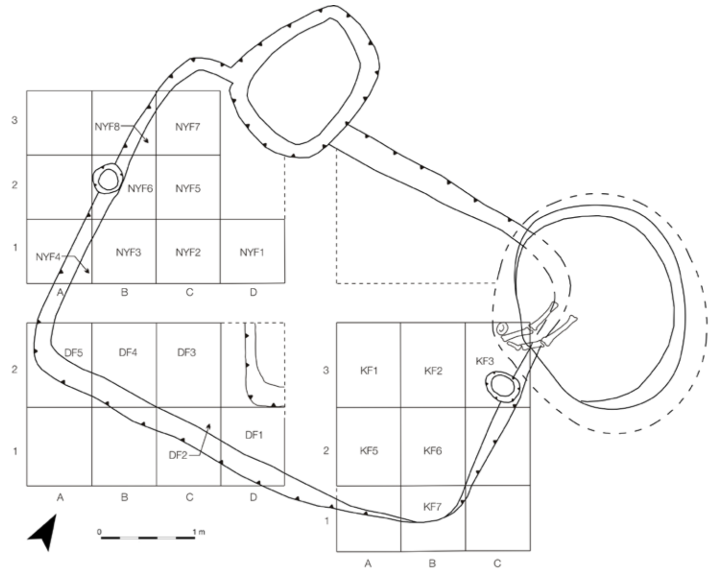

Fig. 8: Digital ground plan of the Hódmezővásárhely-Kopáncs I. (Olasz-tanya) Late Avar Period building feature, as well as the partial horizontal sampling protocol developed on the basis of the presence of the floor level.

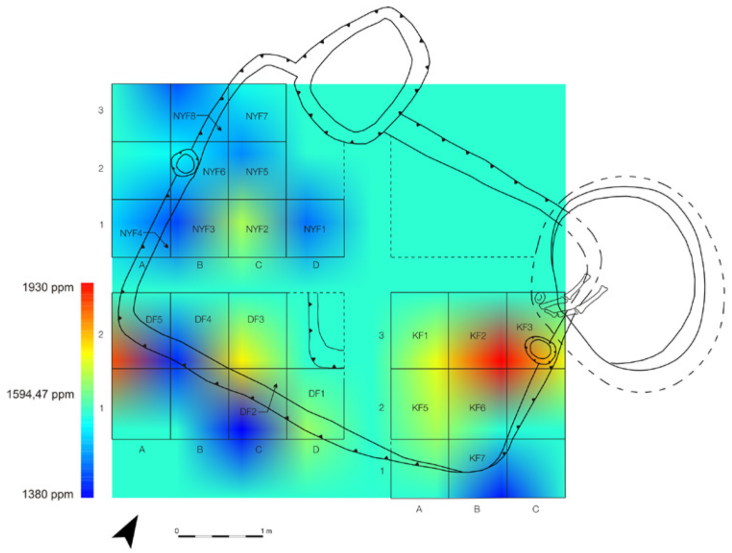

Fig. 9: P_{total} distribution map drafted on the basis of the total phosphorus content test performed on the floor sediment samples of Hódmezővásárhely-Kopáncs I. (Olasz-tanya) Late Avar Period building (after: Herendi–Pető, in publication).[34]

indicating the floor could not be prepared for the entire interior space of the feature, so we only performed sampling on ¾ of the building *(Fig. 8)*. Due to sampling performed in 1x1 m squares and the narrowness of the floor layer there was little deposit material available for performing the scientific examinations, so in the end we opted to test only for the total phosphorus content (Ptotal) and phytolith analysis.[31]

The feature examined was an example of a semi-subterranean building with a rectangular ground plan and a post and lintel roof structure, a form that was generally widespread in the (Late) Avar Period.[32] Due to the lack of a hearth, the idea arose that the building did not function as a dwelling, and indirectly the possibility of interpretation as an agricultural outbuilding or workshop came up. The finds from the building provided further proof for this question, since the spindle whorl, fragments of pot bottoms and sides as well as fragments of the rim and sides of a bell-shaped baking lid can each indicate a clearly definable sphere of activities.[33]

A possible excess organic matter load for the interior space was indicated by a phosphorus concentration higher than the 1000-1200 ppm value limit that is considered natural, while at the same time only minimal spatial variations showed up in relation to the phosphorus concentration in the interior space of the feature *(Fig. 9)*. These two observations brought up the possible conclusion that although an excess load arising from a human activity can be reconstructed, the spatial monotony of the sampling for phosphorus data suggests a uniform use of the building interior. The placement of the archaeological finds in context provides a handhold on this point, since the presence of spindle whorl can raise the possibility for interpretation that the higher phosphorus concentration comes from materials of animal origin (wool?) that were used for the weaving activities performed in the building.

31 These two methods call for the least amount of material (samples).
32 Madaras, L.: Az avar ház (The Avar House). In: Novák, L., Selmeczi, L. (eds.): *Építészet az Alföldön I (Architecture on the Great Hungarian Plain I)*. Nagykőrös, 1989: 23–32.
33 Naturally, in these cases the possibility that they landed up in the feature with the collapse of the roof – which was most likely made of thatch of reed – cannot be ruled out.
34 Ibid.

A further shadow is cast on the picture by the discovery of fragments of a bell-shaped baking lid and a pot, which can be linked to a higher concentration of phosphorus through the preparation and processing of food. This latter interpretation is refuted to a certain degree by the fact that evidence of a permanent hearth was not discovered in the feature. During the micro-archaeobotanical analysis in the interior of the building we were able to show the presence of phytoliths that originate from (waterside) plants that grow large vegetative organs above the surface (e.g. reeds – *Phragmites communis*). The presence of the morphotypes of these and their proportion that can be measured in the samples can be important indicators of the raw plant materials, such as reeds, used for covering the floor or making everyday utensils used indoors. However, the results of the examination of the phytoliths showed something different. The presence and distribution of phytolith morphotypes from the inflorescence bracts of cereals (chaff) also supports the proposed food processing and preparation activities for interpreting the higher phosphorus concentration in the building.

Previously as a result of our examinations we referred to the fact[35] that in addition to the raising of large livestock, the human communities practicing a partially or fully settled lifestyle in the Late Avar Period actively utilized their environment, including the exploitation and use of wild and cultivated plants. Our archaeobotanical data on the cultivation of cereals by the Avar communities are not yet complete, so it cannot be stated with complete assurance that the inhabitants of the Kopáncs settlement cultivated cereals, but the results of archaeobotanical analysis on several sites from the period allow us to conclude that cereal processing was a part of their subsistence strategy. The phytolith analysis of samples deriving from building 23/23 also fits to this profile, since we found phytolith forms in the interior of the feature that originate from cereals, or more precisely from the waste created from threshing grain.

Stable or Cereal Processing Shed? Roman Period Building at Győr-Ménfőcsanak-Széles-földek[36]

The area Győr-Ménfőcsanak-Széles-földek is bordered by the M1 highway, Route 83 and the meander lake of the Marcal River. This area has long been known in Hungarian archaeological research. Many researchers have already studied the settlement structures, household units and pit dwellings of the ethnic groups and cultures that settled here in various archaeological periods.[37] During the excavation performed in the area between 2009 and 2011 as a part of a greenfield project the excavating archaeologist paid particular attention to assure that the precise sampling criteria for activity area analysis of building features is met.[38]

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35 Pető, Á., Kenéz, Á., Herendi, O., Gyulai, F.: A késő avar kor növényhasznosítási és tájgazdálkodási potenciáljának értékelése egy dél-alföldi telepen végzett mikro- és makro-archaeobotanikai vizsgálat tükrében (Assessment of potential plant exploitation and land use of the Late Avar period in the light of micro- and macro-archaeobotanical analyses of an archaeological site in Southeastern Hungary . In: Kreiter, A., Pető, Á., Tugya, B. (eds.): *Környezet – Ember – Kultúra. A természettudományok és a régészet párbeszéde (Environment – Man – Culture. The Dialogue between the Applied Sciences and Archaeology)*. Volume of essays from the conference organized 6-8 October 2010 by the National Heritage Protection Center of the Hungarian National Museum. Hungarian National Museum, National Heritage Protection Center, Budapest, 2012: 181–194.

36 For further details, see: Pető, Á., Kenéz, Á., Csabainé Prunner, A., Lisztes-Szabó, Zs.: Activity area analysis of a Roman period semi-subterranean building by means of integrated archaeobotanical and geoarchaeological data. *Vegetation History and Archaeobotany* 24 (2015): 101–120.

37 Amongst others, see: Egry, M.I.: Beszámoló a Győr-Marcalváros-Bevásárlóközpont területén végzett megelőző régészeti feltárásokról (Report on the Preventive Archaeological Excavations Performed on the Area of Győr-Marcalváros-Bevásárlóközpont). *Arrabona* 39 (2001): 57–78.
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38 The excavation was performed by the Field Service for Cultural Heritage (and as its legal successor, the Hungarian National Museum, National Heritage Protection Center), led by the regional director, archaeologist Gábor Ilon.

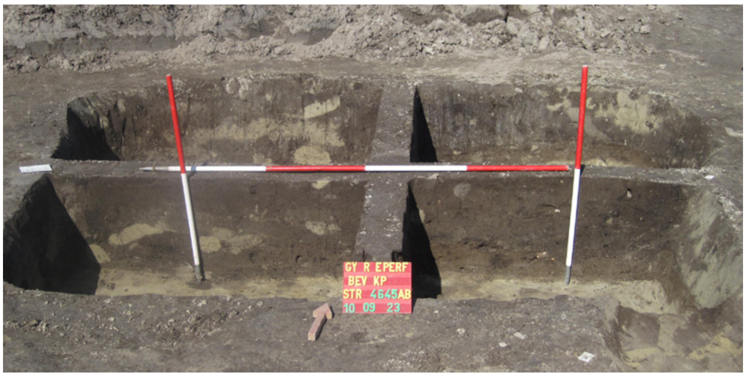

Fig. 10: Excavated Roman Period indigenous building (129/4645) from Győr-Ménfőcsanak-Széles-földek site (photograph: Tamás Csuti,HNM-NHPC[40]).

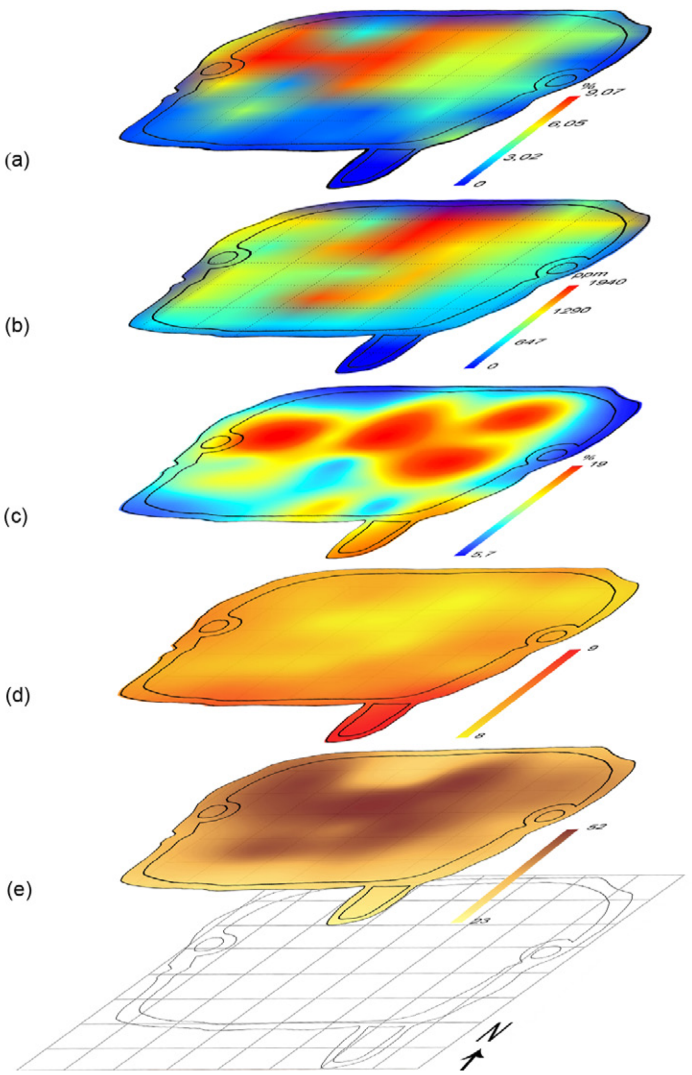

Fig. 11: Horizontal distribution maps for the data obtained during the geoarchaeological analysis performed on the interior space of building feature number 129/4645; a: TOC%; b: Ptotal; c: CaCO3%; d: pH; e: KA (modified after: Pető et al. 2015).

For the interior activity areaanalysis of indigenous building 129/4645 from the Roman Period *(Fig. 10)* we were able to collect samples from a total of 33 50x50 cm quadrants. In contrast to the experience with the Late Avar Period feature presented above, in this case we were able to collect a greater amount of soil materials for our examinations from the anthropogenic sediment layer sealed by the collapse of the building. This opened the possibility to expand the range of tests following the Kopáncs study. In addition to analyzing the basic chemical and physical parameters of the soil,[39] we were not only able to perform phytolith analysis, but also the analysis of the seeds and crops.

During the chemical examination of the soil of the feature's anthropogenic sediment samples it came to light that there were significant variations in the total organic carbon content. This fluctuation could not be traced back to natural processes, but could only be interpreted as patterns related to the spatial use of the feature's interior. On the basis of their distribution, the samples with the highest values were concentrated in the squares in the northwestern quarter of the feature *(Fig. 11)*. As a result of this, we hypothesized a tangible difference in the use of the building's interior space. On the basis of our measurements the excess organic material causing the enrichment of the total organic carbon content was clearly concentrated in the northwestern half of the feature, while the other parameter of soil chemistry, the total phosphorus content, showed enrichment points in the northern half as well as the center of the feature *(Fig. 11 a and b)*.

The archaeobotanical results showed that in feature 129/4645 cereal remains turned up in significant quantities. Besides a few exceptions, cereals were present in essentially every examined quadrant *(Fig. 12 a)*, so just on the basis of their presence we can speak of an uniform distribution. At the same time, in addi-

[39] These were the following:: Arany-type texture coefficient (K_A), carbonate content ($CaCO_3$%), pH, total organic carbon (TOC %) and total phosphorus (P_{total}).

[40] HNM-NHPC: Hungarian National Museum, National Heritage Protection Centre

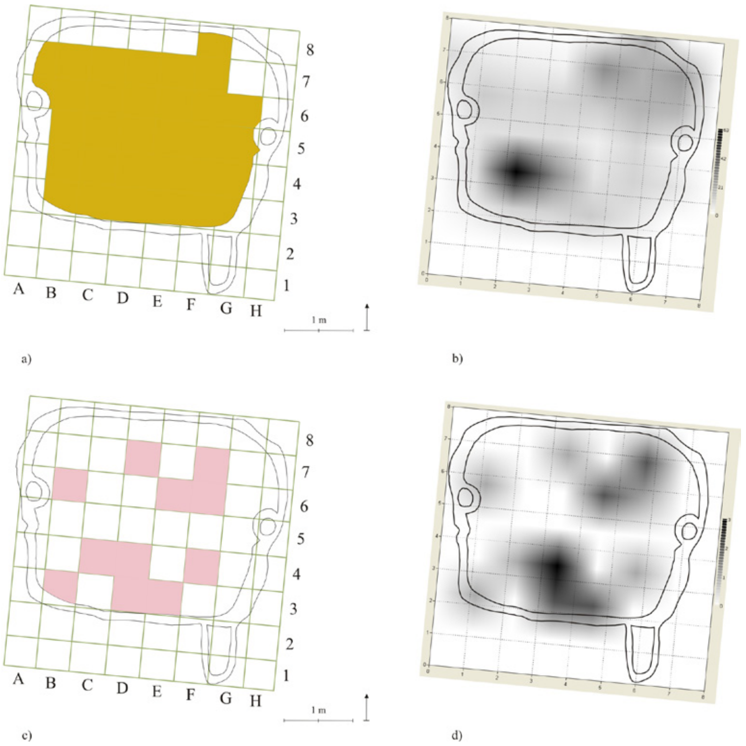

Fig. 12: Cereal and weed distribution maps for the data obtained during the archaeobotanical analyses performed on the interior space of building feature number 129/4645; a: presence of cereals; b: weighted distribution of cereals; c: presence of weeds; d: weighted distribution of weeds (after: Pető et al. 2015).

tion to the judgment of presence/lack, the relative frequency measured in the individual quadrants plays a more significant role. On the basis of this, the distribution of the cereal remains paints a more nuanced picture of the spatial use of the building's interior *(Fig. 12 b)*. The evaluation of the weeds present is able to provide even more nuance to the information content provided by the cereal remains. On the basis of the composition of weed species in the building it is clear that they appeared as an accompaniment to the cereal material that is to say they could have been brought into the settlement from the cultivated fields along with the harvest. However, their distribution was sporadic, not following any clearly discernible pattern.

In addition to the distribution pattern, the assortment of cereals also holds important information, in other words according to the specific remains what species of cereals were utilized. In the case of feature129/4645, barley, millet and free-threshing wheats were primarily found. The more ancient hulled wheat species (e.g. einkorn, emmer and spelt) were only represented in small quantities, with one remain of each. All of this in part also supports the fact that by the Roman Period plant cultivation had undergone changes, free-threshing wheats (bread wheat and club wheat) had come to the forefront and the more ancient hulled varieties had been supplanted. At the same time millet is not typically Roman, but instead suggests Roman Period barbarian customs of cultivation, whose roots can be found in the Iron Age.

During the phytolith analysis it came to light that plant opal particles indicating cereals were found in great quantities within the samples of feature 129/4645 in a manner significantly differing from the natural environmental conditions *–(Fig. 13)*. Their high concentrations clearly indicate storage, stockpiling and/or handling of cereals in this location. From the quantitative aspect the data from the examination of the phytoliths were in harmony with the findings of the macro-archaeobotanical analysis, while important differences appeared from the qualitative perspective. While only one piece of chaff from the cereal macro-remains tells of winnowing waste from cereal threshing, the high concentration of *elongate dendritic LC (c.f. Fig. 6)* is clearly an indicator of the inflorescence bract elements

During the examination of building 129/4645 there was an opportunity to compare the horizontal distribution pattern of certain examination parameters, or to look for relationships in the appearance of the parameters by mathematical means. In relation to this, the total phosphorus content and the total organic carbon content maximum produces an overlap with the maximum of phytolith morphotypes indicating waste from cereal threshing. If we take into account the subsets and information content of these two types of indicators, then it seems logical that plant waste from threshing – possibly mixed with manure – accumulated or was deposited in the north-northeastern part of the feature. The pattern of distribution of the cereals provides a clear relationship with the aforementioned, and when separated from the hypothesized waste material shows an accumulation focus on the south-southwestern side of the feature. If we take into account that in addition to the barley, which is suitable for fodder, in the case of the indigenous Roman Period fea-

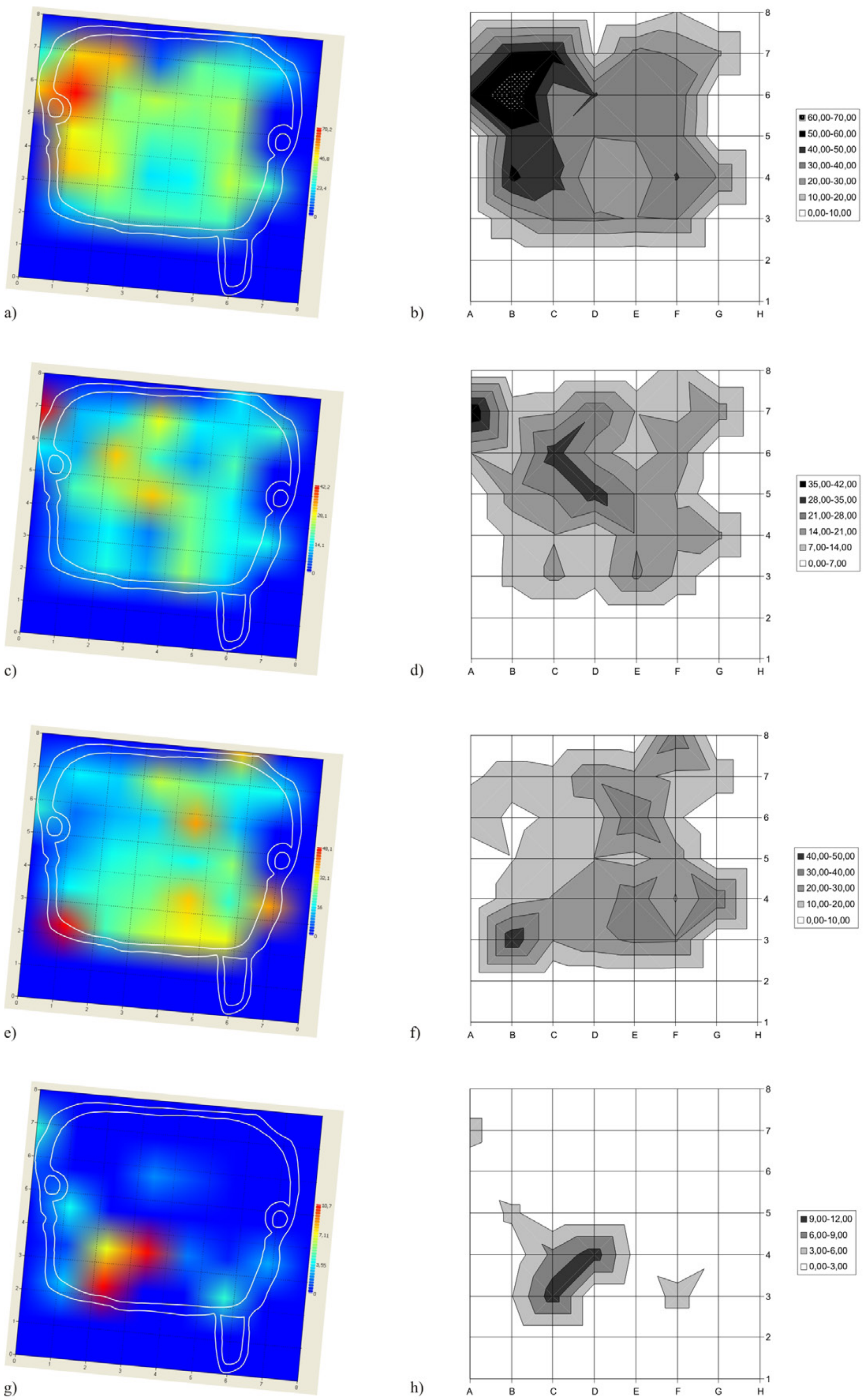

Fig. 13: Distribution maps for the data obtained during the phytolith analysis performed on the interior space of building feature number 129/4645; a and b: rondel SC; c and d: elongate dendritic LC; e and f: elongate smooth psilate LC; g and h: bulliforms. The a/b and c/d subsets are indicators of cereal inflorescence bracts bracts, that is the glume, the lemma and the palea, from the cereal threshing by-products(waste), while the e/f and g/h subsets are indicators of the stems and leaves of cereal species.

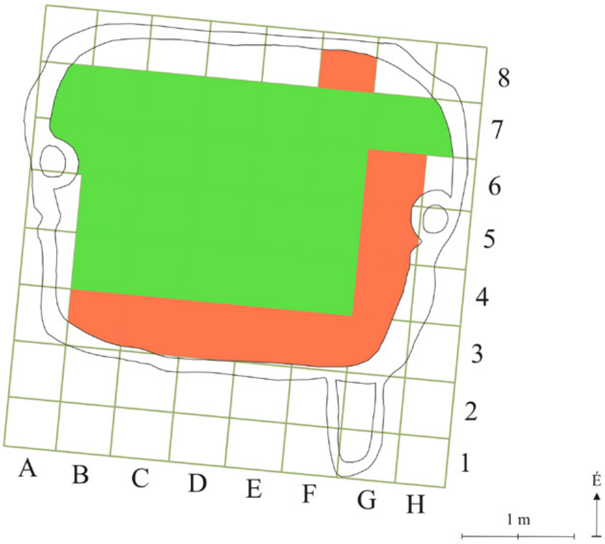

Fig. 14: Visual interpretation of the statistical analysis (PCA) prepared using the geoarchaeological and archaeobotanical parameters obtained from the complex activity area analysis performed on the interior space of building feature number 129/4645, the projection of the results onto the ground plan of the building examined (after: Pető et al. 2015).

ture 129/4645 alongside the lentils and common vetch that can be used as fodder we also found seeds from *black medick* that can grow in pastures, then it is conceivable that the feature functioned as some kind of pen or stable. At the same time it is important to highlight that in the case of feature 129/4645, variations are shown in terms of the spatial use of the interior on the basis of the unique distribution pattern of the soil indicators as well as the macro- and micro-archaeobotanical indicators. These could be informing us about activities related to their way of life, waste storage – or perhaps storage of secondary raw materials – or the multiple functions of the feature that over time overlapped one another.

By the visualisation of the statistical result of the PCA[41] performed on the data from feature 129/4645 the interior of the building can be divided into two areas with separate activities *(Fig. 14)*. It is our opinion that the two groups (green and orange), that is the two sample unit groups, depict two activity areas that are separated from one another. The orange area, which runs along the southern and western border (wall?) of the feature, was exposed to a lower level of utilization. In other words, the spatial use in this area of the feature was not of a sufficient intensity to lead to the enrichment of the indicators examined (here: Ptotal, TOC%, grains). In contrast to this, in the quadrants indicated in green in the interior of the feature the combined effect of the indicators examined implies a human impact of nearly uniform degree and nature.

With the aid of the PCA we outlined the pattern of interior spatial use sketched out by the combined effect of the most demonstrative indicators, and on the basis of this it is possible to delve into the archaeological interpretation of the feature's possible method of use.

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