
Abstract: In the last few decades, archaeological research has invested more energy into better understanding of past societies than ever before. There are several different factors that have made these changes possible. The development of non-destructive investigating techniques has made it possible to choose more precisely where to collect new data. Furthermore, advances in information technologies and the natural sciences have provided new tools to analyze and evaluate the data. Our project started in 2012 in order to evaluate the enormous amount of archaeological material excavated at Polgár-Csőszhalom, the most significant site of the post-LBK period in North-East Hungary. Our main motivation was to reconstruct the community of this complex site with the application of multilevel statistical methods and spatial information technologies. The investigation of raw material from the chipped stone industry yielded sixteen different activity zones on the flat settlement. The differentiation of these zones was possible through the recognition of the repeated patterns of the raw materials used. The analyses show that whilst individual households, as the elementary building modules of the settlement community, were self-sufficient in tool making, the procurement of raw materials seems to have been communal. The homogenous picture apparent from the distribution of the local raw materials and the lack of accumulation from more distant sources suggest conformity at household level.

Keywords: Late Neolithic; chipped stone tools; household archaeology; intra-site archaeology; spatial analysis

1 Introduction

Polgár-Csőszhalom, located 3 km east of the modern town of Polgár in Northeast Hungary, has often featured in archaeological literature over the years, both in Hungary and abroad (Fig. 1). Vere Gordon Childe referenced this place as the eponymous site of the “Polgár culture”, and he placed it chronologically among many other painted ceramic styles—Jordansmühl, Lengyel, Erősd, Vinča—in the “Danubian II” phase (Childe 1929). The long history of research at this site began in the 1950s, when Ida Bognár-Kutzián opened a small trench at the top of the mound (Bognár-Kutzián 1958, Bognár-Kutzián 1966, Bánffy 2007, Bánffy, Bognár-Kutzián 2007). In addition to clarifying the stratigraphical sequence of the tell, this early investigation also outlined the site’s features and problems, thus informing later archaeological research.
here as well. The burnt buildings, the burials, the ceramic styles from the neighbouring cultural units—Tisza, Herpály, Lengyel, Samborzec-Opatow, Iclod—, and the imported raw materials all indicated that this northernmost tell was exceptional at the beginning of the 5th Millennium cal BC.

Figure 1: Situation of Polgár-Csőszhalom and the two settlement structures.

In 1989, a new research project was initiated with support of the Institute of Archaeological Sciences of Eötvös Loránd University (Budapest) under the direction of Pál Raczy. The project aimed to excavate as much as possible from the tell of Polgár-Csőszhalom. The preliminary magnetometric and aerial archaeological survey revealed a roundel of five ditches with a maximum diameter of 180–190 m and a palisade system surrounding the mound, which shed new light on the intensity of the relations with the Lengyel culture (Raczky et al. 1994). Altogether 750 m² were excavated in four trenches, revealing eleven burnt structures, while also providing a chronological framework for the evolution of the site. Several burnt layers and unburnt levelling episodes followed each other, indicating continuous reconstruction and destruction of the houses (Raczky et al. 2007, 61). Meanwhile, as the mound grew bigger, the encircling roundel became larger during the period 4820–4530 cal BC (Raczky 2002, 849). Early preliminary reports highlighted two unique assemblages from the excavations of the tell (Raczky et al. 1996). One of them contained miniature figurines from the floor of a house analogous to the finds of Čičarovce, Slovakia. The other also indicated a ritual context, having been found in a sacrificial pit below the same house. It consisted of a copper string and several copper and bone beads.

Soon the fortuitous construction of the M3 motorway provided an opportunity to reveal that this tell was surrounded by a ca. 35 ha. external, flat settlement. From 1995 through several seasons, a 3.5 ha part of it has been systematically excavated, resulting in the discovery of 79 buildings, 145 burials, 68 wells, and more than 230 pits. Since then, more than a dozen preliminary and detailed reports have been published. The relationship between the two distinct settlement areas was investigated in more detail, on the basis of the assumption that the tell was not a simple residential mound; rather, it provided space for the ritual activities of the society, (Raczky 1998). The first comprehensive study consisted of an archaeological evaluation of both the tell and the flat settlement, a paleohydrological and geoarchaeological study about the site and its wider surroundings, and a preliminary report about the animal bones (Raczky et al. 2002). Later, the duality of the site was emphasized based on the observed differences in human burials, animal remains, copper objects, and social dimensions between the two settlement parts—tell and flat settlement (Raczky and Anders 2006, Raczy and Anders 2008). This subsequent excavation of the mound yielded more male burials, more remains of wild animals and more copper finds. Another interesting topic is the relationship of the settlement with the Lengyel culture, considering the enclosure system and the detailed chronology of the tell (Raczky et al. 2007). The first evaluation of the burial rites (Anders and Nagy 2007)
and the ceramic forms (Sebők 2007) provided further information about the internal social structure and the external cultural contacts of the inhabitants of Polgár-Csőszhalom. Later, the duality of the two settlement parts was outlined again by reconstructing different types of activities through the analysis of the built environment and the evaluation of the animal remains (Raczky et al. 2011). The frequency of deliberate house destruction by fire, the significant human labour invested in the construction of the mound and the enclosure system, and the huge numbers of consumed wild animals strengthens the sacral role of the tell (Raczky et al. 2011). Meanwhile, the published AMS dates indicate that the two settlement parts were used contemporaneously between 4920–4845 cal BC and 4515–4460 cal BC; however, their activities were not uniform and had their own frequency (Raczky et al. 2015).

Concerning the chipped stone tools, only two preliminary papers have discussed this site complex. Katalin T. Biró and Erzsébet Bácskay drew a general picture about the raw material kit based on only a selected part of the collection (Bácskay and Biró 2002), while Erzsébet Bácskay published a short report about the use-wear analysis of the retouched pieces (Erdélyi-Bácskay 2007). Although evaluation of the complete assemblage is still in progress, detailed examination of the raw material composition of the twelve thousand pieces retrieved from the flat settlement has provided interesting results. Our project started in 2012 in order to evaluate the enormous amount of the archaeological material excavated at Polgár-Csőszhalom. Our main motivation was to reconstruct the community of this complex site with the application of multilevel statistical methods and spatial information technologies (Faragó 2015). The usefulness of these tools has been already discussed in greater detail in the complex household network analysis of the material of Polgár-Csőszhalom. Some fundamental questions about the chipped stones, which have rarely been investigated in this way on Hungarian Late Neolithic sites, relate to:

- The level of raw material procurement (household or settlement?)
- The level of knapping activity (household or specialist?)
- The distribution of the prestige/exotic raw material (even or irregular?)

## 2 Materials

Including all excavation seasons and all parts of the surface assemblage, 12,276 chipped artefacts were discovered during fieldwork at the flat settlement of Polgár-Csőszhalom. Collectively, these materials weigh more than 228 kilograms. Table 1 presents the frequency of the different raw material types, identified and calculated based on macroscopic examination of all artefacts, occasionally at 14x magnification level with a loupe. The different types are presented here according to the distance of their provenance from the site. During their classification, the already-published preliminary report (Bácskay, Biró 2002, 849-852) was as essential as the reference collection created for the research program on the prehistoric raw material acquisition at the Eötvös Loránd University (Mester et al. 2012, 275-293).

### 2.1 Raw Materials Sourced from a Distance of 50-70 km

As more than 98% of the provenanced artefacts come from the Tokaj Mountains, this territory will be discussed in greater detail (Fig. 2, Tab. 1). The genesis of these silica-containingrock types is associated with tertiary volcanic and subvolcanic processes (Biró 1998, 34, Gyarmati and Szepesi 2007, 18, 32-33, Mester et. al 2012, 281). Approximately sixteen million years ago, the research area was situated within the coastal area of the late Paratethys Sea, at the foothills of the North Hungarian Range. Later, during the Miocene, this shore retracted towards the south, leaving lagoons and gulfs behind. As a result, the products of any subvolcanic activities such as those alluded to above could have come into contact with other water sediments connected with the lagoons and lakes. The typical outcome of these formation processes is the creation of various heterogeneous rock types; moreover, it is typical for the whole North Hungarian Range. In archaeological terminology, these types of stones are called hydric- and limnic quartzites, or limnoopalites and limnosilicites. Despite the difficulties inherent to a more localised provenancing of the different types of rocks and their outcrops, some results have been achieved in the last couple of years. A comparative analysis
of both archaeological materials and natural sources, undertaken by Adrienn Szekszárdi (Szekszárdi et al. 2010), was successful in the sense that she distinguished five different zones in the area of the Tokaj Mountains. Moreover, her microscopic analysis confirmed the macroscopic observations in most cases.

Table 1: Raw material composition at Polgár-Csőszhalom.

<table>
<thead>
<tr>
<th>Raw materials from 50-70 km distance</th>
<th>No.</th>
<th>Weight (g)</th>
<th>Analysed in this paper</th>
<th>No.</th>
<th>Weight (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type limnosilicate</td>
<td>4369</td>
<td>68693</td>
<td>Type 1 limnosilicate</td>
<td>3847</td>
<td>58814</td>
</tr>
<tr>
<td>Type 2 limnosilicate</td>
<td>2592</td>
<td>54727</td>
<td>Type 2 limnosilicate</td>
<td>2292</td>
<td>44731</td>
</tr>
<tr>
<td>Mezőzombor type limnosilicate</td>
<td>1982</td>
<td>57888</td>
<td>Mezőzombor type limnosilicate</td>
<td>1765</td>
<td>50226</td>
</tr>
<tr>
<td>Obsidian</td>
<td>1351</td>
<td>6113</td>
<td>Obsidian</td>
<td>1200</td>
<td>5579</td>
</tr>
<tr>
<td>Other limnosilicates, opalites</td>
<td>1672</td>
<td>36681</td>
<td>Other limnosilicates, opalites</td>
<td>1457</td>
<td>32680</td>
</tr>
<tr>
<td>Felsitic quartz porphyry</td>
<td>8</td>
<td>284</td>
<td>Felsitic quartz porphyry</td>
<td>6</td>
<td>90</td>
</tr>
<tr>
<td>Raw materials from 250-400 km distance</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bakony radiolarites</td>
<td>39</td>
<td>296</td>
<td>Bakony radiolarites</td>
<td>38</td>
<td>295</td>
</tr>
<tr>
<td>Cracow Jurassic</td>
<td>185</td>
<td>2063</td>
<td>Cracow Jurassic</td>
<td>145</td>
<td>1511</td>
</tr>
<tr>
<td>Volhynian/Prut flint</td>
<td>3</td>
<td>9</td>
<td>Volhynian/Prut flint</td>
<td>3</td>
<td>9</td>
</tr>
<tr>
<td>Other raw materials</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other radiolarite</td>
<td>12</td>
<td>343</td>
<td>Other radiolarite</td>
<td>12</td>
<td>343</td>
</tr>
<tr>
<td>Mátra limnosilicates</td>
<td>1</td>
<td>20</td>
<td>Mátra limnosilicates</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Quartzite pebble</td>
<td>3</td>
<td>190</td>
<td>Quartzite pebble</td>
<td>2</td>
<td>189</td>
</tr>
<tr>
<td>Andesite</td>
<td>1</td>
<td>95</td>
<td>Andesite</td>
<td>1</td>
<td>95</td>
</tr>
<tr>
<td>Limestone</td>
<td>1</td>
<td>5</td>
<td>Limestone</td>
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<td>5</td>
</tr>
<tr>
<td>Other</td>
<td>17</td>
<td>552</td>
<td>Other</td>
<td>16</td>
<td>412</td>
</tr>
<tr>
<td>Burnt, unidentifiable</td>
<td>40</td>
<td>420</td>
<td>Burnt, unidentifiable</td>
<td>39</td>
<td>415</td>
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<tr>
<td>Sum</td>
<td>12276</td>
<td>228379</td>
<td>Sum</td>
<td>10824</td>
<td>195394</td>
</tr>
</tbody>
</table>

Three main types of limnosilicates were identified among the material from the flat settlement. Type 1 is brownish in colour, translucent, and has a white cortex. This type is the most abundant with 4,369 pieces found at the site, with a cumulative weight of 68,693 grams. Type 2 is light brown with a white colour, and is less translucent; it has a similar cortex to examples of type 1, and it is possible to see fossils inside without any magnification. Of this second type, 2,592 artefacts were recovered from the site, representing a total weight of 54,727 grams. Type 1 limnic quartzite is similar to that found in the Arka-Korlát region, so it is connected to the northwestern side of the Tokaj Mountains (Szekszárdi et al. 2010, Fig. 6.). The exact provenance of type 2 is unknown, although the similarity of its cortex to that of type 1 and some transition pieces between the two types indicate that it is from the same region. Type 3 is already known from the Hungarian literature as Mád-Mezőzombor type limnosilicate (Bácskay, Biró 2002, Fig. 11.). It can be distinguished easily from other limnic quartzite types by its creamy, silky grey colour and banded character. Their outcrop is significant because nowadays it is associated exclusively with the region around Rátka-Mád in the southern zone of the Tokaj Mountains. Within the assemblage, 1,982 pieces examples of this type occur, which together weigh 57,888 grams.

Apart from these main subtypes, many other limnosilicates and opalites appeared at the settlement, totaling 1,672 artifacts with a cumulative weight of 36,681 grams. It seems to be a great number of chipped stones; however, it consists of many different types from yellow and orange to grey and dark grey, transparent and translucent to opaque, and homogenous variants to more heterogenous types with plant fossils. Some stones are most likely connected to the same Arka-Korlát region, but others are likely from Erdőbénye, Gönc-Telkibánya, or Óhuta (Szekszárdi et al. 2010, fig. 7; fig. 8, fig 12.).
Another part of the assemblage also originated in the Tokaj Mountains; however, its genesis is a little bit different. The Carpathian obsidian is a product of the same period and same geologic processes—namely, tertiary volcanism. Its formation is connected to volcanic activity by the fast solidification of the rhyolite lava, together with a very quick loss of heat and water containment without any crystallization (Gyarmati and Szepesi 2007, 28.). Within the literature, there are two subtypes in the Tokaj Mountains: one is from the Slovakian part of the region and it is more translucent; the other, from the Hungarian part, is more opaque and sometimes grey banded (Biró 1998, 33). The different characters of their cortex also aids in their identification—while the former has rough surface, the latter is plainer and finer. Both subtypes appear in Polgár-Csőszhalom, with 1,351 examples cumulatively weighing 6,113 grams.

Another raw material type can be found at a similar distance from the site, but in a different direction. The quartz porphyry is from the eastern side of the Bükk Mountains, namely in the region of Bükkzentlászló.
It is greyish-bluish green, more layered, and more opaque. Its genesis can be associated with mesozoic volcanic activity—it is possibly silicified rhyolite that later came into contact with metamorphic effects (Simán 1986, 271). Only eight pieces were found in Polgár-Csőszhalom, together weighing 284 grams. The significance of this raw material lies in its general archaeological context, for it is more common on Paleolithic sites than on Neolithic sites (Biró 1998, 17).

2.2 Raw Materials Sourced from a Distance of 250–400 km

The remaining 2% of the assemblage showed important connections with territories located 250–400 kilometers from North-East Hungary—namely Transdanubia, Cracow/Częstochowa plateau, and the region of Volhynia and Podolia (Fig. 2, Tab. 1). Several varieties of radiolarites are associated to the whole Transdanubian range, from the Bakony Mountains to the Gerecse Mountains (Biró 1998, 35.). Although this raw material remained important during the whole Neolithic period of Transdanubia, only thirty-nine pieces were found in the studied assemblage, weighing a total of 296 grams, and all of them belonging to the Szentgál subtype. The Cracow Jurassic flint is from Little Poland and, as the name indicates, it comes from a Mesozoic bedrock (Kaczanowska 1985, 23). It is brown in colour, translucent, and fine grained, while the cortex is also brownish. 186 chipped pieces appear among the artefacts from this site and together they weigh 2,063 grams. Additional raw material is the farthest from the Northern Tisza region. The Volhynian/Prut flint came from the Volhynian-Podolian Plateau, from a typical cretaceous bedrock at a 400 km distance from the site. This bluish, very fine grained raw material is not common on the flat settlement, with only 3 pieces totaling grams.

3 Methods and Results

3.1 Restrictions

Before outlining the results, some restrictions must be noted. Their rationale has been introduced and explained elsewhere in greater detail with plentiful and sufficient literature, but it is necessary to briefly present them here (Faragó 2015, in press). The first two considerations are emphasized in this paper and they are strongly related to each other—namely the spatial and temporal position of the given finds. This analysis focuses exclusively on the spatial and temporal position of those chipped stones from closed late Neolithic contexts within the flat settlement. Twelve percent of the assemblage comes from Iron Age and Migration period secondary contexts (1. table). For this reason, 152 features from the four hundred on the site are excluded from the analysis presented here.

The third concern is about those finds most likely related to activities beyond everyday practices. Feature 272 provides examples of such finds, having originally served as a well that was subsequently filled up with numerous, intentionally deposited vessels (Sebők et al. 2013, 29-79, Faragó in press). The eleven pieces of chipped stones connected to this feature did not show any significance at first glance; however, upon closer examination it becomes obvious that the products of the different stages of the chaîne opératoire are arranged from the bottom section of the well to its upper layers. Obviously their deposition was not solely the result of economic reasons, because these pieces belong to neither the same raw material, nor to the same debitage process. For this reason, the chipped stones connected to the graves, structured depositions, and the tell are excluded from this analysis.

The fourth concern relates to the selection of excavation methods. Material from the stratigraphic unit 205 in pit 44 offer some insight on this matter. Using only ordinary excavation tools—shovel and spade—eighty-nine chipped pieces were collected from this feature. To look for further finds, all of the excavated soil went through a careful screening (Faragó in press). Among several other conclusions from this case study, changes in the relative frequency of different raw materials according to method were particularly insightful. Prior to sieving, no obsidian pieces were recovered, but more than three hundred were identified using this more precise method. This case study thus recommends careful interpretation of the distribution of the obsidian on the settlement.
For these reasons, the basis of the investigation presented here is the chipped stone material of the flat settlement, exclusively from closed Neolithic contexts, where stone tool deposition was the likely result of a more profane process. Moreover, the backbone of our analysis is the spatial and statistical examination of the scatter of the three main subtypes of limnosilicates.

3.2 Activity Zones

Keeping in mind these restrictions, four categories were created for each piece. Apart from registering their raw material feature by feature, these categories were used to record pieces as cores or debitage products, and corticated or uncorticated. The frequency of each type, as well as their weight, was recorded. The resulting database was subject to a correspondence analysis to look for relationships between these properties and archaeological features. This kind of statistical analysis is suitable to detect inherent, otherwise invisible correlation between different kinds of variables. To work properly, a crosstabulation is needed, denoting the properties of the chipped stones in the columns and the features in the rows. The next step is to create ordinal, homogenous variables from the frequencies and the weights, so with the aid of the method of Jenks natural breaks, the continuous data were divided into five intervals for each variable. Thus, the analysis created three raw material types (Type 1, 2 and Mezőzombor type), four categories (corticated core, uncorticated core, corticated debitage, uncorticated debitage), and two dimensions (frequency, weight) with five possible values (1 to 5) each. The resulting plot shows which variables are positively correlated, which are negatively correlated, and which are independent from each other. Those features with less than four pieces were excluded from the correspondence analysis in order to avoid insignificant alignment of points.

The resulting plot supported the earlier assumption that each of the three main limnosilicate types followed different preparation tendencies (Fig. 3-8). Type 1 was generally corticated, while types 2 and 3 were not. The corticated and uncorticated properties are in negatively correlated in the case of type 2 and Mezőzombor type, and these properties are situated on different sides of the same axis (blue dots). The number of pieces and their weight are positively correlated in all technological categories and all types, which means that there were no features where only numerous small pieces or bigger nodules were accumulated. The different technological categories are also negatively correlated, and the cores and debitage products are situated in the different sides of the other axis of the plot. Type 1 is an exception, because the uncorticated cores form a distinct category, while the rest of the properties are negatively correlated with them. Nevertheless, the whole assemblage is very homogenous, because the features are always accumulated around the origin (black dots). One can interpret this distribution to mean that there are no groups of features according to the different parameters, the former observations show only weak correspondence in the dataset.

![Figure 3](image-url)  
*Figure 3: Correspondence analysis of Type 1 limnosilicate and the plot according to the first and second axis.*
Figure 4: Correspondence analysis of Type 1 limnosilicate and the plot according to the second and third axis.

Figure 5: Correspondence analysis of Type 2 limnosilicate and the plot according to the first and second axis.
Figure 6: Correspondence analysis of Type 2 limnosilicite and the plot according to the second and third axis.

Figure 7: Correspondence analysis of Mezőzombor type limnosilicite and the plot according to the first and second axis.
In order to conduct a spatial analysis and to check the results of the statistics, Thiessen polygons were created around the central points of the features, making it possible to project the distribution of the chipped stones onto the excavated surface. A series of maps were created and analyzed visually, but due to the limited space, only some examples have been chosen (Fig. 9-12). The general distribution shows that the most prominent features are scattered evenly all around the excavated part of the settlement. There are no zones where the chipped stones accumulated in an extraordinary way, where only the cores or the half-products of the knapping activity were deposited, or where only one or two kinds of raw material exclusively rule the assemblage. Instead, they formed loose spatial clusters together, where both the cores and the debitage products could have been found very close to each other (Fig. 13-14). Between these clusters, only insignificant quantities of chipped stone were deposited in the pits. This distribution pattern proved to be valid for all three sub types of limnic quartzites, as well as the obsidian and the extra-local raw materials.

### 3.3 Raw Material Ratio Clusters

The detailed spatial analysis of the three main limnosilicite types does not reveal any significant relationship between them. It seems that the same raw material composition occurs everywhere in the settlement. Moreover, they are in the same ratio in every feature, suggesting they were distributed evenly. The general picture seems to be very homogenous. In order to compare the distribution of the three main raw material types with each other in a more appropriate way, correspondence analysis was used again. The input data are the frequencies and weights of the different raw materials, counted feature by feature and transformed to ordinal variables by creating intervals with Jenks natural break method.

The statistical comparison of the three main raw material types revealed a surprising pattern (Fig. 15). Firstly, it is apparent that frequencies and weights are positively correlated only in the case of type 2 limnic quartzite (blue dots), while there is some negative correlation in the occurrence of type 1 and Mezőzombor type along the vertical axis. The Mezőzombor type limnosilicite is on the left side of the plot, while types 1 and 2 are on the right side. This distribution means that they are negatively correlated, while the 1 and 2 types are negatively correlated with each other also if we consider the vertical axis. The correspondence analysis showed that most of the features were arranged in two raw material ratio clusters. The cluster on the left side of the distribution represents the Mezőzombor type limnosilicite, which originates from the southern slopes of Tokaj Mountains. The other cluster on the right side of the plot contains those features associated with the northern limnosilicite types.
Figure 9: Spatial distribution of Type 1 limnosilicite.

Figure 10: Spatial distribution of Mezőzombor type limnosilcite.

Figure 11: Spatial distribution of obsidian.

Figure 12: Spatial distribution of Cracow Jurassic flint.
Figure 13: Part of the spatial distribution of the debitage products made on Type 2 limnosilicite. Note the accumulation of the finds north of the building complex in the middle.

Figure 14: Part of the spatial distribution of the cores made on Type 2 limnosilicite. Note the accumulation of the finds south of the building complex in the middle.

In projecting these raw material ratio clusters back onto the map of the settlement, it becomes clear that they are spatially distinct as well (Fig. 16). The northwestern and southeastern areas belong to the southern raw material ratio cluster, while the remaining middle zone is the territory of the northern raw material ratio cluster. Those features that do not belong to either group are readily apparent. Thus, one can observe that, despite the general picture, there is some moderate discrimination in the spatial pattern of the three main raw material types. It is not an exclusive one, but it defines the raw material ratio of each segment of the settlement.
Figure 15: Correspondence analysis of the three main raw material types (Type 1, Type 2 and Mezőzombor type limnosilicite). Note the two clusters of the points in the middle of the plot.

Figure 16: Spatial distribution of the raw material ratio clusters.
3.4 Houses, House Groups

Connecting our former observations with the spatial structure of the buildings, it becomes obvious that it is not possible to cluster the knapping activity according to house, because even the pits themselves cannot be clustered in such a manner. Moreover, the distribution of the chipped material is uneven among the different settlement features. However, the dense spots are situated at approximately the same localities, regardless of raw material, technological category, weight, or frequency. One can likely identify discrete knapping activity zone according to the features containing significant proportions of the assemblage. In their vicinity, several smaller assemblages can be found in most of the times, consisting mainly of debitage products or cores. The space between these encircled activity zones seems deserted, considering the occurrence of the chipped material.

In order to look at the relationship of these results with the houses, Thiessen polygons were again created using the central points of these structures. The two spatial structure systems, the nearest zones of the features, and the scope of the houses outlined sixteen house groups, which are considered as cooperating communities and households (Fig. 17-19). To some degree, all the elements of knapping activity can be attributed to every single house group. However, there are some examples where there is no sign of this kind of human activity. Most of the house groups can be classified exclusively into one of the raw material ratio clusters; however, there are some exceptions, where both ratio clusters occur.

To compare these economic units with each other, it is necessary to first note their similarities. All house groups are bounded by the border of the excavation, so their real boundaries are hypothetical. The knapping activity area is surrounded by the buildings, and these zones are 30 to 50 meters away from each other. Between them there are features with only limited numbers of chipped stones. Most of these activity zones consist of several pits, rather than just one. The material is more dispersed by weight than number, which means the cores are more dispersed, but the knapping activity was more focused.

<table>
<thead>
<tr>
<th>Housegroup</th>
<th>Number of buildings</th>
<th>Number of chipped stones</th>
<th>Weight of chipped stones (g)</th>
<th>Raw material ratio cluster</th>
<th>Phase</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>4</td>
<td>484</td>
<td>7625</td>
<td>southern</td>
<td>2,3,4</td>
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<tr>
<td>2</td>
<td>7</td>
<td>765</td>
<td>14310</td>
<td>northern</td>
<td>1,4</td>
</tr>
<tr>
<td>3</td>
<td>4</td>
<td>948</td>
<td>14482</td>
<td>southern</td>
<td>2,3</td>
</tr>
<tr>
<td>4</td>
<td>5</td>
<td>2</td>
<td>20</td>
<td>-</td>
<td>3,4</td>
</tr>
<tr>
<td>5</td>
<td>14</td>
<td>1876</td>
<td>30358</td>
<td>mixed</td>
<td>2,3,4</td>
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<td>1</td>
<td>230</td>
<td>3716</td>
<td>southern</td>
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<td>7</td>
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<td>southern</td>
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<td>4</td>
<td>32</td>
<td>1702</td>
<td>-</td>
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</table>
Figure 17: Houses, house groups, and activity zones in the northern section of the horizontal settlement.

Figure 18: Houses, house groups, and activity zones in the middle section of the horizontal settlement.

Among these house groups, one can derive two size classes (Table 2). The smaller of the two consists of one to seven buildings, with three-hundred to nine-hundred chipped stones. Nos. 5 and 16 are exceptions, as only very limited finds can be attributed to them. The big ones contain eleven to fourteen buildings, but most of them are superimposed so it is obvious that they were not standing simultaneously. The features around them yielded 1,200 to 1,800 chipped pieces. Among them, no. 14 is the smallest with only 578 pieces. Three house groups contained only one building, and the number of chipped stones attributed to them varies between twenty-one and 732 pieces. Considering the weight of the finds, house groups nos. 1 and 10 are exceptions among the smaller units, while we can state the same regarding no. 13 among the bigger ones. According to the ratio of the numbers and weights of house groups nos. 7 and 8, they differ from the average, as one would expect a smaller mass of finds, given the number of pieces.
Analyzing the raw material ratio clusters, it becomes clear that the house groups are similarly arranged. Two-thirds of the households belong exclusively to either to the southern raw material ratio cluster or to the northern raw material ratio cluster. House groups no. 1, no. 3, no. 6, no. 7, and no. 14 belong to the former cluster; three of these groups contain four houses and only one house group consists of more than ten buildings. These units are also spatially distinct—they can be found at the northwestern and southeastern corners of the excavation. House groups no. 2, no. 9, no. 10, no. 11, no. 13, and no. 15 belong to the northern raw material ratio cluster. Three of them are smaller, two of them are bigger according to the numbers of their buildings. They are situated in the northeastern to the southwestern corner of the excavated part of the settlement. Some of the units contain a mixture of features, which means that they belong to both ratio clusters—namely nos. 5 and 8. The rest of the house groups follow different raw material ratios, or they contain an insufficient amount of chipped material—namely house groups no. 4, no. 12 and no. 16.

The last point relates to the question of internal chronology. Having 74 AMS dates, mainly from graves all around the settlement, four phases were created after calibration (Fig. 20). The first is 4870/4850–4855/4790 cal BC, the second 4850/4770–4830/4725 cal BC, the third 4800/4720–4770/4660 cal BC and the fourth 4730/4655–4625 cal BC. Unfortunately, there are only seven features that are dated precisely and contain a significant amount of chipped stones. Features nos. 44 and 997 from the first phase, nos. 916 and 932 from the second phase, and nos. 546, 932, and 966 from the third phase. Their detailed analysis is still pending, but the raw material composition did not indicate any differences or changes through time. Such a result is important because the observed raw material ratio clusters cannot be interpreted as signs of a temporal shift in raw material acquisition. With only two exceptions, every house group contains graves with data from at least two phases. Five house groups can be associated with the earliest phase—namely nos. 2, 7, 13, 15, and 16. The second phase can be associated with house groups nos. 1, 3, 5, 9, 10, 14, and 15. The third phase is the most numerous, as only one house group—no. 2—does not show any data from this period. The fourth phase has a wide distribution as well—with the exception of house groups nos. 3, 6, 8, 13, and 16, it can be found in numerous units.
Figure 20: Distribution of the features with AMS dates and the house groups.

4 Discussion

4.1 Raw Material Composition at Other Late Neolithic Settlements on the Great Hungarian Plain

In the period since the work of Małgorzata Kaczanowska and Katalin T. Biró, the general picture has not changed a lot (Kaczanowska 1985; Biró 1998). It seems the different settlements and regions along the Tisza River maintained different contact networks during the Late Neolithic, although there is one common element among them: the generally low profile of Carpathian obsidian. At Gorzsa, the proportion of Banat flint is the highest, while Transdanubian and Mecsek radiolarites played their roles as well (Starnini et al. 2007; 2015). At Öcsöd limno- and hydroquartzites and opalites rule the assemblage, possibly originating from the North Hungarian Range (Kaczanowska et al. 2009; Kaczanowska, Kozłowski 2015). Moving northwards, at Herpály the extra-regional raw materials were favoured, with the Volhynian/Prut (or Dniester) flint and the chocolate flint occurring in most of the times (Biró 1998). The northernmost and the closest tell-like settlement to our subject, Polgár-Bosnyákdomb also differs, although it is a slightly younger than the others (Kozłowski, Kaczanowska 2009, Kaczanowska, Kozłowski 2015). Here, apart from an unknown Mesozoic flint limno- and hydroquartzites, obsidian and Volhynian/Prut flint dominates the assemblage.

4.2 Results of Other Intra-Site Analyses

It is not easy to compare our model with the results of other projects or to cite similar intra-site analyses in order to consider the scale of Polgár-Csőszhalom and the amount of the archaeological material. In the Hungarian literature, the case of Balatonkeresztúr-Réti-dűlő, which is dated to the late Copper Age Baden culture is similar
In this example, the various features and the distribution of the zoological remains encircled late households, without detecting any built structures. At Balatonszárszó-Kis-Erdei-dűlő, using selected LBK material an attempt was made to verify the existence of two distinct household units (Marton 2013). The ceramics indicate a clear temporal distinction may have existed. With regards to the international research, LBK households have posed a burning question since the 1980s (Boelicke 1982, 25., Wolfram, Stauble 2012). Without citing all the important papers on this topic, the article of Thomas Link is of particular relevance here (Link 2012). According to this study, the “Zeilensiedlung” and “Hofplatz” models can perhaps be merged into one, where single houses formed bigger, cooperating economical units, which could have existed for a very long time. The analysis of hide processing tools at Elsloo showed somewhat similar results (van Gijn, Mazzucco 2013). Although every household produced enough chipped stones for themselves, some of them seem to have been more specialized and made better quality tools for specific reasons, producing a surplus that could be handed over to other people. At Bylany, evaluation of the non-ceramic material suggests that the bigger the settlement, the greater the necessity to handle the waste cooperatively (Květina 2010). In an example from a later chronological horizon at Okolište, Bosnia, the different tool types showed heterogeneous spatial distributions, which was interpreted by the authors as sharing the handcraft activities among the different households (Müller et al. 2010). However, the site of Okolište is, in fact, a tell, which makes the direct comparison with the flat settlement part of Polgár-Csőszhalom problematic. A study of the domestic units of Catalhöyük East revealed a complex picture of the social relationships of the settlement (Wright 2014). Although simple ground stone tools were distributed evenly, the larger mill stones were used cooperatively. The author suggests that the deliberately destroyed items indicate the prohibition of inheritance, while the distribution of the unfinished or unbroken querns reflects social inequality.

5 Conclusion

In summary, most of the chipped stones (98%) originate in areas 50-70 km distant from the Tokaj Mountains; among them three limnic quartzite subtypes ruled the assemblage. Those chipped stones were excluded from the investigation, as they are connected to other, non-closed Neolithic contexts or connected to specific human activity beyond everyday life. A case study investigated the taphonomic effect of the archaeological excavating methods, determining that the data connecting to the obsidian is likely underestimated. Thus, this investigation concentrated on the more numerous limnosilicite subtypes 1 and 2 from the northern Tokaj Mountains and the Mezőzombor type limnosilicite from the southern Tokaj Mountains.

A detailed statistical and spatial analysis using correspondence analysis and Thiessen polygons showed that all three subtypes reached the settlement in different preparation phases—generally type 1 was corticated while type 2 and Mezőzombor type was not. The distribution of the debitage pieces and the cores was negatively correlated, as were the corticated and uncorticated pieces. However, these results were not reflected in the distribution of the features on the plot, which means these are only weak correlations. The spatial analysis of the features revealed that they are distributed evenly, all over the settlement. Evidence of knapping was detectable in virtually all excavated parts of the horizontal settlement. The most prominent zones are always situated in the same localities. The relative distribution of the obsidian, the other limnosilicates and the distant raw materials strengthens this general picture, although they are too infrequent to analyze them statistically. More than a dozen frequented spatial segments could be identified, where all the different stages of the tool making could be found.

By comparing the three main limnosilicates using correspondence analysis, their distribution followed two rules with most of the significant features arranged within two groups on the plot. One can differentiate them according to their raw material orientation, as one group is more closely associated with the northern Tokaj Mountains, while the other is more readily associated with the southern Tokaj Mountains. The projection of these raw material ratio clusters on the settlement map shows that they have distinct spatial pattern as well, as they are located in different zones on the site.

In comparing the two types of spatial structure—the settlement features/pits and the buildings—, one can conclude that the borders of the activity zones define the borders of the house groups, but they are
not identical. In this way, the definition of the activity zones, the households and the houses are not the same; rather, they differ according to their role in the spatial system of the settlement. According to the raw material kit of these households—or house groups, as they are more or less equal—, there are no significant signs of accumulation of prestigious rocks. Moreover, raw materials sourced from a distance of 50-70 km were used over 95% of the settlement. The noted regularities in the raw material ratio clusters indicate that the acquisition was centralized, or the same distribution line was followed. The tools were manufactured on the level of the households, and there are no signs of special craftsmen or workshops. According to the AMS dates, these house groups maintained their existence over a long period of time, typically representing two or more chronological phases. Although these attributes draw a common picture about the settlement, there are also some irregularities. There are no identical house groups; at best, they can be divided into two general classes, a smaller and a bigger one. There are no strict rules for the situation of the houses inside a cluster, as they could be aligned or could be arranged around a central zone. There is no strict rule for the distribution of the chipped material—sometimes it can be found in one single feature or it can be collected from several different pits. Moreover, there are no strict rules for the knapping activity, as in some house clusters it could have been an intensive activity and in other cases, it was insignificant with only a few pieces deposited.

To obtain further insights regarding the past social structure of Polgár-Csőszhalom, it is necessary to evaluate the chipped stones in a technological and typological manner. Moreover, other categories of archaeological evidence, like the ceramics, animal bones, etc. need to be evaluated in order to compare them with each other. The establishment of the internal chronology remains a crucial task as does the symbolic interpretation of the settlement’s components, and the structural analysis of buildings and the settlement. In our future investigations, network analysis would be a more precise method to note the latent relations between the features, the archaeological evidence, and the wider region. One example where its application brought groundbreaking results is in the case of the Baden culture (Furholt 2011). In this paper, the investigation of different sub-groups of the large-scaled cultural entity was conducted using network analysis. The main results were that cultures, cultural sub-groups, groups, or other entities are often not discrete. It is important to remember that these sets of attributes will not overlap perfectly and the different social units are hidden somewhere in their common intersection, just like the polythetic model assumes (Clarke 1968, Fig. 67). Another similar, inter-site application of network analysis demonstrates the need for a close focus on the unique character of archaeological sites (Reepmeyer et al. 2011, 94.). In this paper, despite several interesting conclusions about the distribution of Rijckholt flint, even the authors state that little is known about the real sizes and internal spatial structures of the single settlements.

Since the beginning of household archaeology, research has consciously been addressing the social, material, and functional aspects of households (Wilk, Rathje 1982). There are no general rules for these basic units of human societies, and its development and operation could be very different in every case. Furthermore, even within a cultural group, the definition of ‘household’ can be problematic, because it might be false from another point of view. In our opinion, the distinction of “house”, “household”, and “activity zone” is very important, and they can be defined from settlement to settlement with the detailed analysis of built structures and the distribution of the finds (Jongsma, Greenfield 2004). Instead of reconstructing static and uniform units, we should imagine dynamic and variable societies, which adapt to, but are also indicative of change. One of the best examples from the Swiss lakeside settlements proved the continuous, intensive dynamism of the residential area (Ebersbach 2013, 205). Inspired by the well-known work of Bill Hillier and Julienne Hanson, the author classified this prehistoric society as a noncorrespondence system (Hillier, Hanson 1984). Over the course of their investigation into the relationship between space and society, Hillier and Hanson created two different types of groups. The spatial group consists of those people who are connected through the same spatial segment—in other words, they live together. The label sharing group gathers those people who share the same identity—for example, the same lineage. If these two groups overlap then, we are faced with a correspondence system, like in modern day society. Otherwise, it is a noncorrespondence system. According to this theory, the members of a human group who live together in a given spatial segment may not always have the same identity (Salisbury 2012, 207-208). It means that individuals within the household maintain contacts with other groups as well, which might be so strong
that at some point they may leave the original household. The household itself might be constant, but not the members of it. Of course, this type of settlement dynamism can be better detected by detailed analysis of organic materials, wooden structures, etc., which reveal the biography of the artefacts or the buildings (Trebsche 2010, 156). These households likely emphasized both their uniqueness and equality at the same time, just like Stella Souvatzi suggested (Souvatzi 2012, 25). In this sense, the differences of the activity zones at Polgár-Csőszhalom could represent the self-expressions of the households, while their common attributes could be the sign of the self-identity with the settlement as a whole.

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