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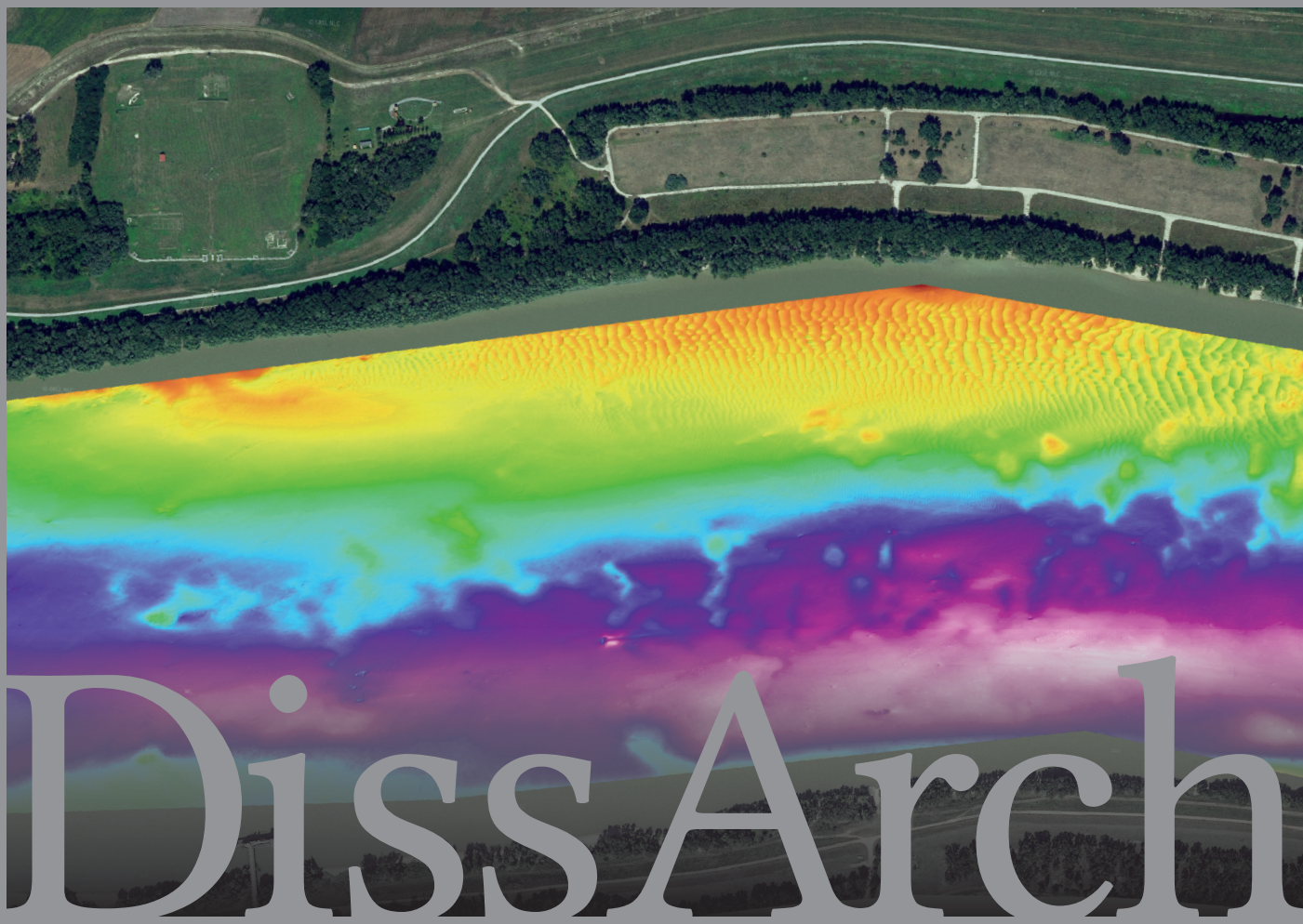

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Change and transformation during the transition from the Middle to the Late Bronze Age along the capital region of the Danube

Settlement structure analyses based on particular sites from the Vatya III – Koszider Period and the Early Tumulus Culture

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Abstract: Review article of the PhD dissertation submitted in 2024 to the Archaeology Doctoral Programme, Doctoral School of History, Eötvös Loránd University, Budapest, and written under the supervision of Gábor V. Szabó.

This study examines the transformation of settlement structures and material culture during the transition from the Middle to the Late Bronze Age in the Carpathian Basin, focusing on two large, single-layered sites along the Danube: a Middle Bronze Age settlement at Budapest-Királyok útja 291–295 and the Late Bronze Age site of Rákoscsaba-Majorhegy. Based on spatial data and ceramic analyses, the research reconstructs internal functional zones, explores inter-settlement connections, and identifies broader regional interaction networks during the Koszider period. The results show both continuity and change: while typological and decorative traditions demonstrate strong Middle Bronze Age roots, transformations in vessel function, storage capacity, and craft specialization reflect shifts in social and economic organisation. Least-cost path and viewshed analyses reveal that Middle Bronze Age settlements formed dense, interlinked networks, whereas Late Bronze Age communities were more dispersed and loosely connected. The emerging patterns indicate reorganisation of landscape use, household structure, and production strategies, with growing differentiation in metalwork. The study highlights the Koszider period as a key transitional phase marked by both cultural persistence and innovation, bridging the Vatya and Tumulus cultural spheres within an evolving, regionally varied system of social and spatial organisation.

Keywords: Middle and Late Bronze Age, Carpathian Basin, Koszider period, settlement networks, spatial analysis, material culture

Objectives of the dissertation

The transition from the Middle to the Late Bronze Age in the Carpathian Basin has long been a focal point of archaeological research, raising enduring questions about social and cultural change.[1] The end of the tell cultures, the deposition of bronze hoards, the transformation of settlement networks, and the disintegration of social order in the middle of the 2nd millennium BC affected nearly every

1 Mozsolics 1957; Bóna 1958; Kovács 1966; Kemenczei 1968; Hänsel 1968; Bóna 1975; Harding 2000; Poroszlai – Vicze 2002; David 2002; Blischke 2002; Reményi 2003; Reményi 2005; Reményi 2012; P. Fischl *et al.* 2013.

✉ Corresponding author

aspect of everyday life.[2] The underlying causes of these transformations, however, remain unclear. A period once described mainly as a time of warfare associated with the movements of the tumulus groups is now understood as reflecting a far more complex set of processes—including economic and social collapse, as well as climatic changes.[3]

While the differences between these periods are well known, our understanding of their connections, the development of material culture, the internal organisation of settlements, and the potential regional variations remains limited. The transitional phase between the two periods is framed by two entirely different research traditions. Research on the settlements of the Tumulus Culture is still at an early stage, mainly due to the smaller number and less prominent character of their settlements.[4] In contrast, a large amount of information is available on Middle Bronze Age settlements. The characteristic tells and fortified sites of this period have been investigated since the very the earliest phase of Hungarian archaeology.[5]

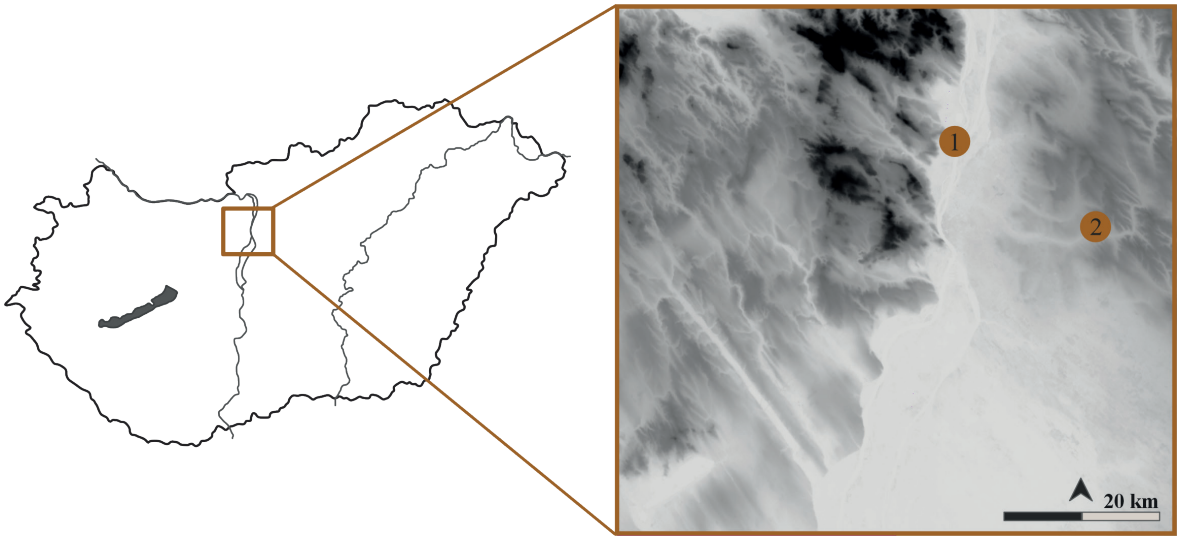


Fig. 1. Location of the sites examined in the dissertation within the Carpathian Basin context. 1 – Budapest, District III, Királyok útja 291–295, 2 – Rákoscsaba-Majorhegy.

Based on these investigations, the settlements of the Vatya culture were traditionally interpreted as forming a two-tier hierarchical system. This model, however, has undergone revision in recent decades. Thanks to large-scale excavations, regional studies, and the growing use of magnetometric surveys, an increasing number of extensive, single-layered sites have been mapped. These sites comprise thousands of features, often cover vast areas, and in some cases are partially enclosed by ditches.[6] The recognition of such sites led to questioning the two-level hierarchical model and to the emergence of three- or even multi-level interpretations as realistic alternatives.[7]

2 Hänsel 1968, Blischke 2002; David 2002; Reményi 2003; Reményi 2005; Reményi 2012; P. Fischl *et al.* 2013.

3 Gyulai 1993, 17; Blischke 2002, 277–279; David 2002, 412; Reményi 2003, 58; Vicze *et al.* 2013, 207.

4 Kőszegi 1973; Egry 2002, 9–14; Horváth *et al.* 2001, 119–123; Sánta 2004; L. Nagy 2005; L. Nagy 2007; Szilas 2007, 157; Sánta 2011; Sánta 2015.

5 Kubinyi 1861, 104–112; Römer 1866, 31; Miske 1898, 317–333; Hampel 1902, 420–421; Nagy 1904, 87–157; Nováki 1952, 16–17; Bándi 1960, 149–152; Kovács 1963; Nováki 1963, 68; Petres – Bándi 1969, 172; Bóna 1975, 59; Bóna – Nováki 1982, 1–140; Meier-Arendt 1992; Vicze 1992, 146–148; Poroszlai 1993, 9–20; Poroszlai 1996, 5–15; P. Fischl *et al.* 1999; Jaeger – Kulcsár 2013; Staniuk 2020.

6 For example: Budajenő-Hegyi szántók, Budapest, District III. Királyok útja 291–293, Kunszentmiklós-Cserépgyár, Sóskút-M7.

7 Dani *et al.* 2019, 855–857.

In my doctoral dissertation, I examined two large, single-layered settlements located in a specific region along the Danube: a Middle Bronze Age site (Budapest, District III, Királyok útja 291–295) and a Late Bronze Age site (Rákoscsaba-Majorhegy) (Fig. 1). Based on the assemblages recovered and the spatial distribution of archaeological features, I identified internal structural units, functional zones, and, extending beyond the individual sites, explored patterns of reconstructible interaction within their wider regional contexts.[8]

Spatial framework and theoretical background

As in archaeology in general,[9] one of the central pillars of this dissertation is the definition and interpretation of spatial frameworks.[10] In recent decades, both the theoretical and practical foundations for the analysis of micro-spatial data have been published. Numerous key works have addressed the archaeology of the surrounding landscape, the spatial use related to internal settlement structures, as well as theoretical problems concerning household archaeology and activity areas.[11]

Spaces can be interpreted at different scales (spatial hierarchies) and through different dimensions (mental or physical). The reconstruction of how people perceived and experienced these spaces depends primarily on absolute data (such as coordinates): these allow us to determine, for instance, where a building stood. Yet, by applying models, it becomes possible to explore the movement, daily routines, and even the economic motivations of individuals and communities.[12] The understanding and perception of space can never be fully reconstructed, as they are shaped by subjective associations—opinions, emotions, memories, preconceptions, and experiences—which vary from person to person. Accordingly, archaeological analysis must address not only tangible and visible phenomena, but also their social and mental dimensions.[13] Mental space, or the way a given environment is perceived, is not solely determined by sensory experience, but also by cultural value systems.[14] In parallel, landscape archaeology views the physical environment as an active agent:[15] rivers, roads, and natural boundaries could simultaneously offer opportunities and impose constraints.

The analysis of settlements and regional units reveals that settlements were not isolated entities but were closely connected with their surrounding landscapes and with other sites.[16] The hierarchical relationships observable within settlement networks—such as smaller satellite sites associated with

8 Previous research on Bronze Age settlements largely overlooked the comprehensive analysis of entire assemblages from extensive sites. Accordingly, one of the principal challenges of this study was developing a framework for recording the material (database) and employing the methods required for its systematic evaluation.

9 Kubinyi 1861, 104–112; Rómer 1871, 252; Rómer 1872, 89; Childe 1929, 269, 278–284; Nováki 1963, 3.

10 Accordingly, the dissertation provides an in-depth discussion of the theoretical background of the following topics: (1) social space; (2) nature and the built environment as key determinants of social space; (3) communication networks, including connections and boundary zones; (4) activity zones and spheres of practice; and (5) household archaeology.

11 Flannery 1976; Hodder 1978; Wilk – Rathje 1982, 619–637; Kent 1984; Bender 1993; Pearson – Richard 1994, xi–xii; Tilley 1994; Hirsch – O'hanlon 1995; Topping 1997; Knapp – Ashmore 1999, 9; Souvatzi 2008, 7–8; Kücükkaraca – Culunge 2010; Salisbury 2017, 49; Haug *et al.* 2018; Füzesi 2023, 51; Zatykó 2023, 13.

12 Earle *et al.* 2012, 1.

13 Tringham 2000, 132–134; Nemes Nagy 2009, 111–112.

14 Nemes Nagy 2009, 101.

15 Snead *et al.* 2009, 1.

16 Kalla 2015, 216.

central places or settlements with distinct functions (whether practical, related to subsistence, or connected to the belief system)—reflect the increasing differentiation of social organisation.[17]

A highly complex, multi-level analytical framework is required to obtain a comprehensive picture—from the level of individual features, through the reconstruction of road systems, to the broader role of a settlement within its period and its degree of interaction with neighbouring sites. Earlier research, especially in the 20th century, often relied on a static approach that emphasised the geography, overall structure, and striking features of sites.[18] My analysis sought to move beyond purely static spatial data. Thus, I examined sites not only according to their chronological attributes, but also based on evidence indicating activities and the presence of physically undefined boundary zones. This approach was grounded in a chapter devoted to the relationship between space and people, which provided the theoretical and conceptual foundation for the study.[19] Based on this theoretical background, the following principles guided the methodological framework of my analysis:

- Only a limited portion of spatial activities can be clearly observed,[20] as perishable materials and aspects of mental spatial perception[21] are either only partially or not at all reconstructible. Therefore, a strong source-critical approach is essential.
- It is possible to identify not only physical boundaries,[22] but also invisible dividing elements that can inform reconstructions of social, economic (e.g., vessel or settlement functions), or even belief-related systems.
- In addition to boundaries, 'bridges' or connecting links can also be recognised. Spatial relationships are not neutral forms of coexistence—settlements did not merely exist side by side, but interacted and engaged with one another.[23]
- Both landscapes and communities were influenced by the activities of individuals or smaller groups,[24] which, through their connections, became integral parts of the broader system. Data derived from intra-settlement phenomena and activities can therefore contribute to more refined models of settlement hierarchy.
- A certain degree of intentionality can be assumed in the establishment of settlements,[25] affecting both the choice of location and the design of internal organisation. Based on environmental competence, communities used space consciously, effectively, and purposefully[26]—whether in structured settlement layouts or in organically developed spatial patterns.
- The social dimension of cohabitation within settlements is central, whether structured or organic in form. Therefore, it is important to examine as many aspects as possible, including both active and passive spaces.[27]

17 Gogâltan 2005, 41. Fig 1; Gogâltan 2008, 44–45, 53; Gogâltan 2012; Nemes Nagy 2017, 12.

18 For example, tells or fortified settlements, as built elements, were central to the interpretation.

19 Szabó 2024, 34–58.

20 Kelly 2011, 287; Csippán 2012, 90.

21 Kneisel *et al.* 2008.

22 Pearson – Richard 1994, 4–5; Nemes Nagy 2017, 7; Salisbury 2017, 49; Szabó 2023a, 94.

23 Nemes Nagy 2009, 186; Dani *et al.* 2019, 855–857.

24 Flannery 1976; Kent 1984; Salisbury 2017, 49.

25 Binford 1982; Chapman 1989; Szabó 2023a.

26 Mester 2013, 49.

27 Mészáros 1994, 4.

- The definition of spatial functions (within and between settlements) requires the evaluation of artefact distributions, which can shed light on cooperation and the division of labour between communities.[28]
- When defining activity zones, it is necessary to establish a static starting point in contrast to theoretically dynamic models, dictated by the limits of interpreting archaeological objects and features. Accordingly, the artefacts were analysed according to the 'frozen moment' principle.[29]

Spatial and chronological framework of the research

The dissertation focuses on settlements associated with the Koszider period, although the chronological framework has been extended in both directions. Based on typological analyses, the Middle Bronze Age settlement excavated at Királyok útja was in use during the Vatya III and Koszider phases.[30] The settlement at Rákoscsaba-Majorhegy was founded during the Koszider period and may have remained occupied into the early phase of the classic tumulus period.[31]

The study area cannot be defined as a single microregion or as a set of homogeneous landscapes (Fig. 2). The Buda and Pest sides of Budapest differ significantly in their geographical characteristics, with distinct topographies, soil types, and natural water supplies. The greatest difference, however, lies in their distance from the Danube. The sites at Királyok útja 291–295 are situated directly along the Danube, whereas the Late Bronze Age settlement of Rákoscsaba-Majorhegy lies about 20 kilometres away from the river, along the Rákos stream.

The analysis aimed at exploring topographically based connections extended the geographical frame west, east, and south of Budapest. The selection of the study area was based on two main criteria: (1) to include as many prominent sites as possible (tells, fortified, or large-scale settlements) within the analytical zone, and (2) to encompass settlements located in different geographical environments. The resulting study area, which covers several microregions, extends from the Benta Valley in the north to the Zsámbék Basin, the Buda Hills, and the Pilis Mountains, encompassing more than 1,000 km². East of the Danube, the study zone includes the western parts of the Pest alluvial fan and the Gödöllő Hills, as well as the Vác–Pest Danube Valley.[32]

The investigated sites

The Middle Bronze Age and its final phase are represented by a settlement located on the Danube bank in Békásmegyer, in Budapest's 3rd district. The sites at Királyok útja 291, 293, and 295 occupy an area in the northern part of the city, bordered by the Danube to the east and by the foothills and alluvial fans of the Pilis and Buda Hills to the west (Fig. 3). The proximity of the river not only influenced the type and quality of subsistence strategies but also created excellent conditions for long-distance trade, communication, and social interaction. Owing to its topographical situation, a prehistoric crossing point may have existed in the strip of land between the Békásmegyer riverbank and the southern end of Szentendre Island. The settlement excavated at Királyok útja 291–295 lies

28 Bodu 1996; Richter 2001; Vaquero *et al.* 2001; Kneisel *et al.* 2008, 156; Jaeger 2009, 394; Gaudzinski – Winderheuser *et al.* 2011; Kneisel – Müller 2011, 305, Abb. 8; P. Fischl *et al.* 2012; P. Fischl – Kienlin 2013, 10, 20, 26; Gauss *et al.* 2013.

29 Binford 1981; Schiffer 1983; Kvetina 2010.

30 Szilas 2017b, 39–41.

31 Reményi *et al.* 2006, 175.

32 Dövényi 2010, 30–32, 706–708.

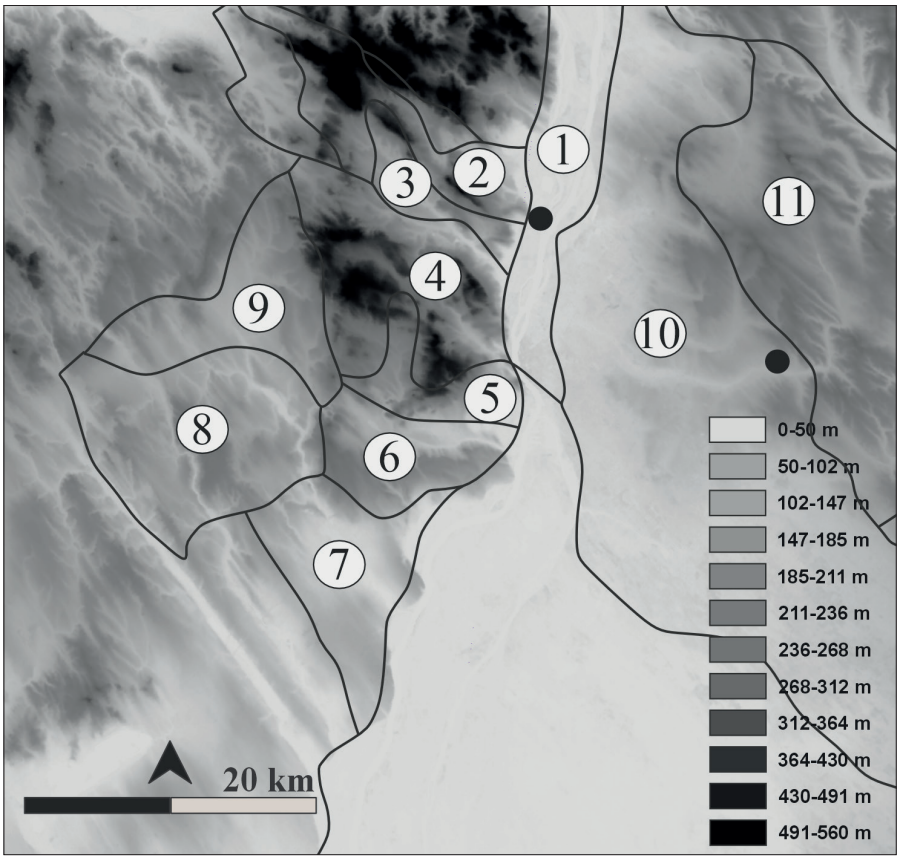


Fig. 2. Microregions surrounding the investigated sites. 1 – Vác–Pesti Danube Valley, 2–3 – Pilis Basins, 4 – Buda Hills, 5 – Budaörs and Budakeszi Basin, 6 – Tétény Plateau, 7 – Érd–Ercsi Ridge, 8 – Etyek Hills, 9 – Zsámbék Basin, 10 – Pest Alluvial Fan Plain, 11 – Gödöllő Hills.

in the most intensively used section of this riverside zone, only about 500 metres from the southern end of the island. The strategic role of this geographical setting is supported by the dense presence of Neolithic and Copper Age settlement traces, attesting to the area's long-term importance throughout prehistory.

Excavations at Királyok útja 291–295 uncovered 267 Middle Bronze Age features, mostly pits. In addition, two ditches, two postholes, one fireplace, and one well-defined Middle Bronze Age fill layer were identified. The most significant feature is ditch no. 177 (SE 177), which runs in a semicircular line, reaching a depth of 1.8 metres and a width of over two metres. It is connected to the old bed of the Csillaghegy ditch (Fig. 4),[33] which was still active during the Bronze Age, and may have enclosed an inner section of the settlement. The nearby postholes may indicate a built structure, perhaps a bridge connected to the ditch. A bronze hoard was also found along the course of the former Csillaghegy ditch.[34] The settlement features are concentrated in two main zones: one in the northern part of the site and another south of ditch 177, separated by the ditch itself, suggesting an internal division of space. The eastern boundary was defined by the river, while the western limit corresponded to the line of Királyok útja. Earlier estimates suggested a settlement size of about 25 hectares,[35] extending roughly 1,000 metres in length and 250 metres in width (Fig. 5). Recent analyses, however, indicate that the southern boundary lies farther north, implying a somewhat smaller total extent.

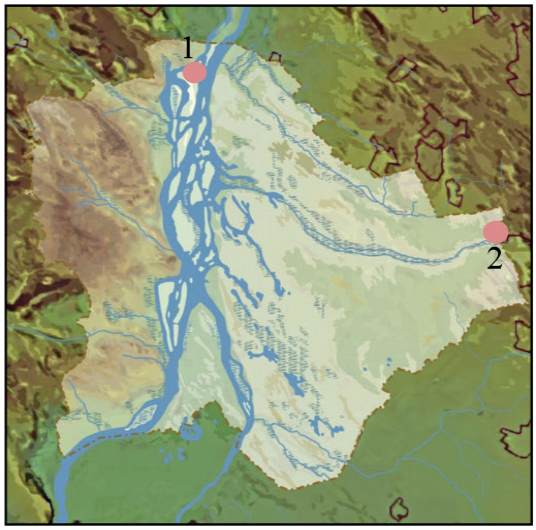
33 Szilas *et al.* 2023.

34 Szilas 2017b, 39.

35 Szilas 2017b, 40.

The settlement of Rákoscsaba-Majorhegy was founded during the Koszider period and continued to be occupied in the early phase of the Late Bronze Age Tumulus Culture. Located on the southern slope of Majorhegy (Fig. 6), north of the Rákos stream on the Pest alluvial fan, the site occupied a geographically advantageous position. The Holocene elevations and the stream valley may have provided strategic connections between northeastern Hungary, the Pest Plain, and the Danube region.

The site was excavated between 2005 and 2006 as part of rescue investigations preceding the construction of the M0 motorway.[36] Alongside the Late Bronze Age settlement, Neolithic, Copper Age, Iron Age, and Roman remains were also identified. Based on 379 Late Bronze Age features analysed, the settlement pattern appears mosaic-like. The earliest features date to the Koszider period (Rei. Br B1), while a large number of ceramics correspond to the early phase of the Tumulus Culture (Rei. Br B2–C). In the northern zone, features become less frequent, though a deposit of cups was found in this area. Fewer features were also recorded along the western and southern edges, while to the east, the settlement may continue beyond the excavated area. Rather than forming an elongated shape, the settlement appears to have had a compact layout, with dense clusters of pits forming a central core. No clearly distinct subunits were identified; instead, the spatial organisation of the Late Bronze Age community is represented by closely grouped, block-like clusters of features.



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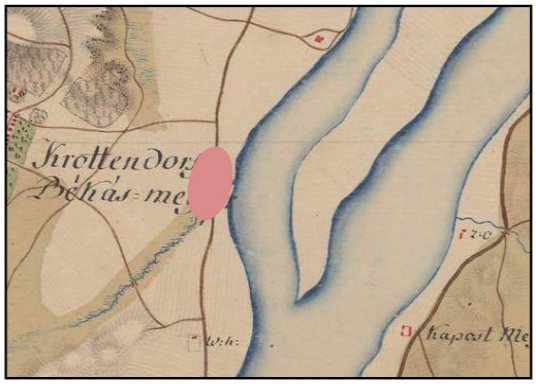

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Fig. 3. Reconstruction of the prehistoric water network and the position of the sites (1), location of the Királyok útja site (2), excavations at Királyok útja shown on the Google Earth map (3).

Methodology of the research

Material culture

Given the large scale of the two settlements analysed in the dissertation, the creation of a comprehensive database was essential.[37] The first step in building the database was to define the basic analytical units. As the main goal of the research was to reconstruct internal structures and functional

36 Reményi *et al.* 2006, 166; Csippán 2019, 219.

37 The database drew on previously used datasets (Szabó 2018). Its design ensured that the data were structured, transparent, easily queryable, and amenable to the statistical analyses applied.

zones—questions fundamentally related to spatial organisation—the individual features uncovered at the sites were taken as the basic units of analysis.[38]

Because settlement finds of this scale had not previously been analysed for this period, and since most typological frameworks for the studied phases are based on cemetery materials,[39] it was necessary to establish a new typological sequence (Fig. 7). Similarly, a systematic framework was developed for recording decorative elements and complex motifs (Fig. 8).

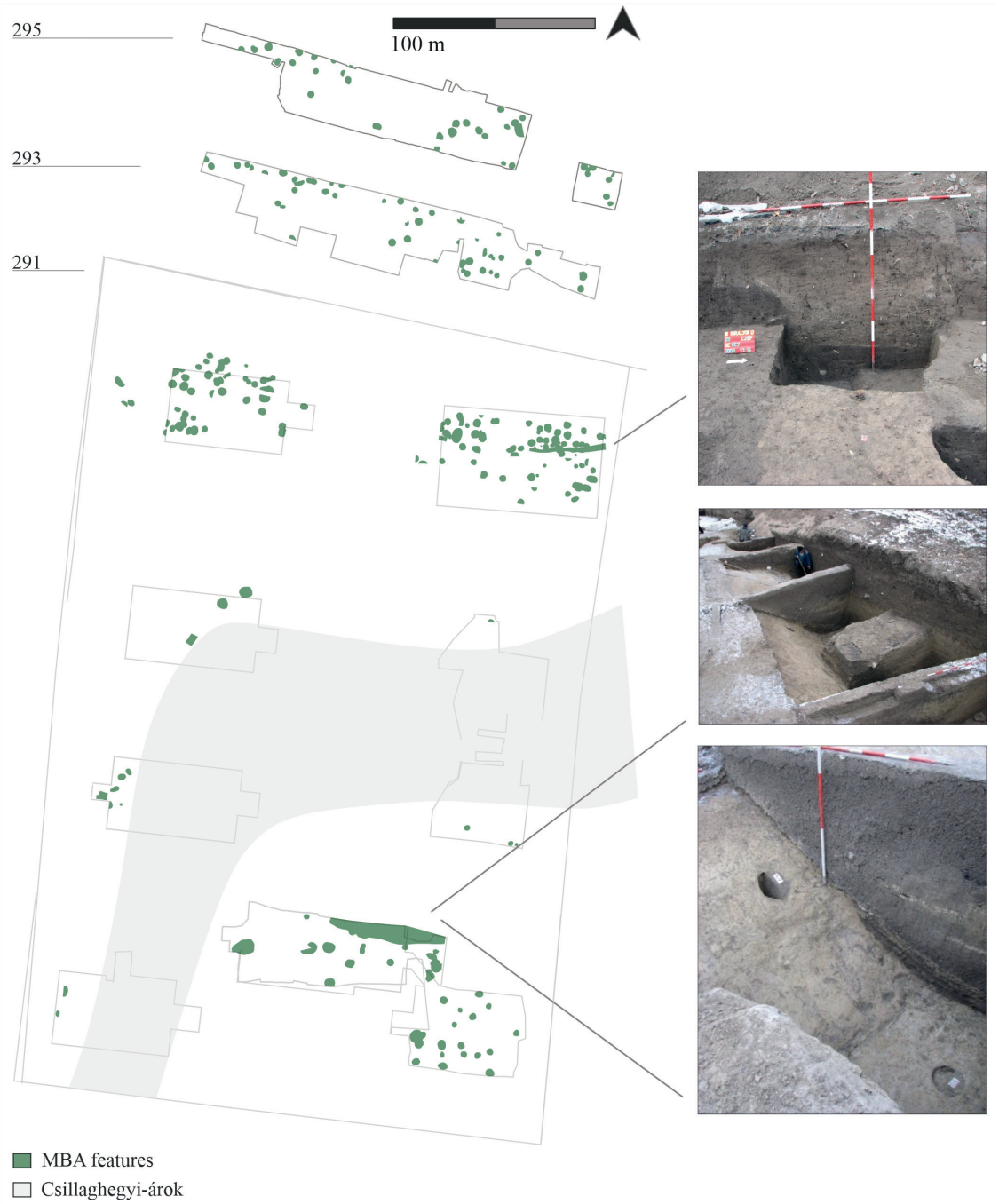

Fig. 4. The Királyok útja site and the distribution of Middle Bronze Age features, with photographs of ditch SE 177, presumably connected to the Csillaghegy Ditch.

38 For object-based data recording, I created a simple Excel document, in which the next step was to define the variables.

39 E.g., Bóna 1975; Trogmayer 1975; Vicze 2011.

The database was used in several ways: first, the material was evaluated through a classical typo-chronological approach; second, it was analysed using uni- and multivariate statistical methods.[40]

Spatial analysis

Starting from the geographical positions of the settlements, the study aimed to reconstruct settlement networks, hierarchical relations, and possible economic or social cooperation by examining the physical components of interaction networks.[41] The dissertation did not address long-distance exchange systems but focused instead on local and regional patterns of interaction and communication between settlements. These communication channels may have taken the form of roads or waterways.[42] Given that the Danube is the dominant geographical feature of the study area and that a crossing point may have existed near the settlement at Királyok útja, the possibility of navigable routes cannot be excluded. However, based on topographical conditions and the spatial distribution of sites, modelling the terrestrial road network is likely to yield more objective results.

Two main analytical objectives were defined:[43]

- the analysis of road networks between large, fortified, and tell-type settlements;[44]

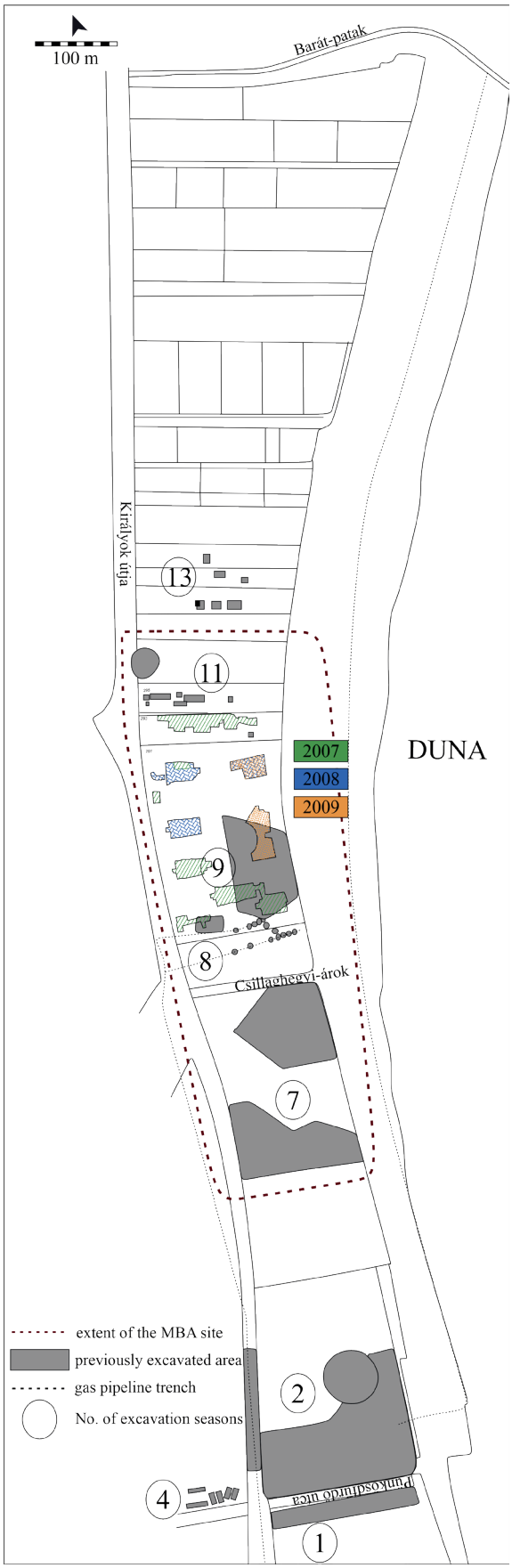

Fig. 5. Areas of earlier excavations at Királyok útja and the presumed extent of the site.

40 I carried out the analyses using Past version 4.7 (paleontological statistics).

41 Szabó 2024, 66.

42 Snead *et al.* 2009, 1.

43 The starting point for each type of analysis was the use of an appropriate raster dataset, which in the present study was the freely available EU-DEM (Digital Elevation Model over Europe). The employed elevation model was generated from SRTM and ASTER GDEM data using a weighted averaging method, with a horizontal accuracy error of 25 metres.

44 During the GIS-based modelling of least-cost paths and route networks, the spatial position of the routes is determined by an algorithm based on the principle of the shortest travel time or the lowest energy expenditure. For the network analysis, it was first necessary to create a slope category map (calculated in ▸

- the analysis of viewshed between large, fortified, and tell-type settlements.[45]

Analysis of the material culture

In the Late Bronze Age, both formal traditions and the complexity of decorative elements change, and in comparison, to the Vatya ceramic style they become more elaborate (Fig. 9). Alongside the emergence of more complex vessel forms, however, a decline in the overall aesthetic quality of the artefacts can be observed at the settlement of Rákoscsaba-Majorhegy. The well-finished surfaces typical of the Middle Bronze Age—often carefully burnished or smoothed—disappear by the Late Bronze Age, giving way to more roughly made vessels with uneven surfaces. A similar negative shift is observable in the quality of vessel morphology: asymmetrical or poorly proportioned vessels become increasingly common. Although decoration becomes more complex by the Koszider period relative to the Middle Bronze Age, at Majorhegy we frequently encounter vessels bearing numerous elements and multiple decorative types (Fig. 10). Yet these decorations reflect the same decline in quality seen in surface finishing and formal execution. A further reconfiguration can be detected within complex motifs: the frequency of negative decorations decreases, while knob (appliqué boss) ornaments become dominant. Accordingly, two parallel tendencies can be observed in vessel making: first, changes in form, which can largely be attributed to local foundations; second, a decorative system that becomes at once more complex and, in certain respects, simpler–implying a different worldview or mode of self-expression. At the same time, a marked deterioration is evident in the technical knowledge of Late Bronze Age pottery. This expertise did not necessarily disappear, however, since symmetrically formed, well-executed vessels are also present at Majorhegy. It is likely that less time and energy were invested in pottery production, while attention shifted toward other objects (e.g., metalwork).

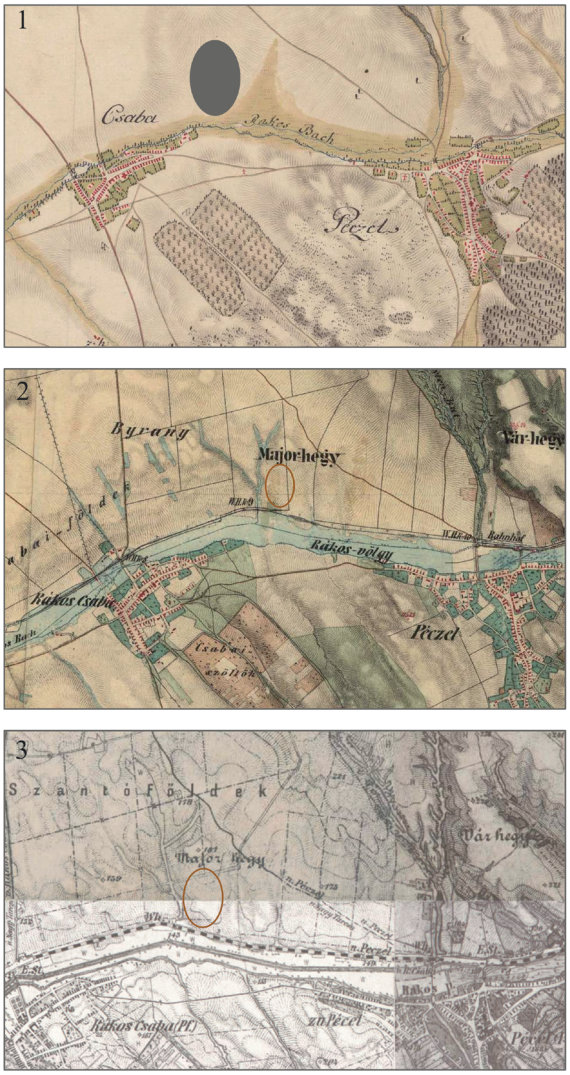

Fig. 6. The course of the Rákos Stream and the location of the Late Bronze Age site based on the First (1), Second (2), and Third (3) Military Surveys.

▸ degrees) from a raster file using the QGIS software. The slope category map and the archaeological sites included in the analysis were then examined in the Java-based Graphab software (Mesterházy 2018).

45 In addition to reconstructing the Middle and Late Bronze Age road networks, the visibility analysis (viewshed analysis) of key settlements is also based on variations in topography. This method reveals which parts of the landscape are visible and which remain hidden from a given viewpoint. I examined the areas visible from each settlement within four distinct zones. Although the limits of visual perception can be influenced by various environmental factors (e.g., vegetation, weather) and by the observer's own abilities—meaning that exact distances cannot be defined—general patterns and tendencies can still be identified.

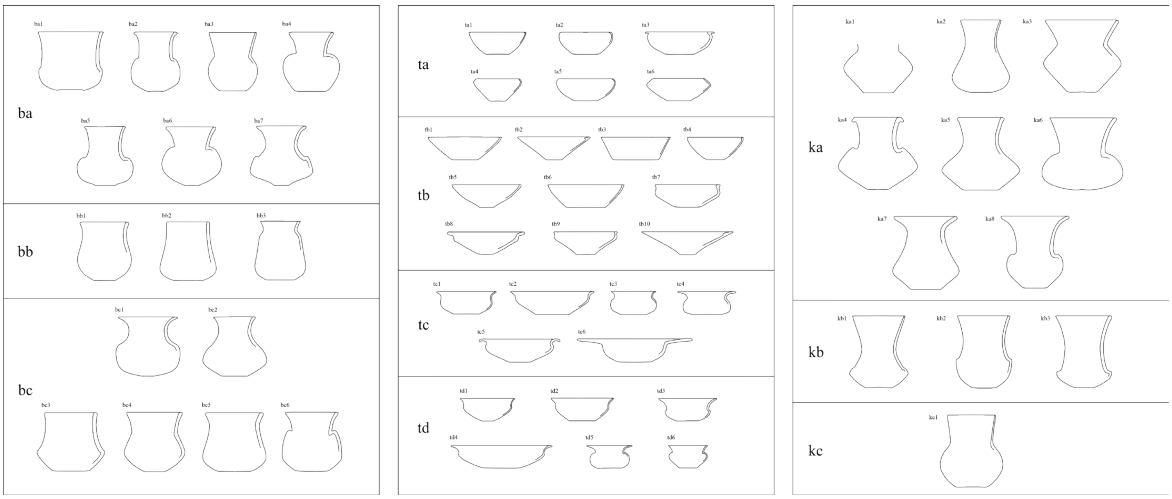

Fig. 7. Typological system established in this study: mugs, bowls, jugs.

In my view, the transformation of the artefact spectrum can be related to two main factors. On the one hand, developments in form and decoration can be explained by social change and the shaping of styles and worldviews; on the other, practical, economy-related mechanisms must also be considered. Among the practical aspects, changes in subsistence, food management, and storage capacity are particularly relevant. In the Middle Bronze Age, storage vessels account for 44–48% of all classifiable vessel types; by contrast, at the Late Bronze Age site this figure drops to only 27% (Figs 11–12).

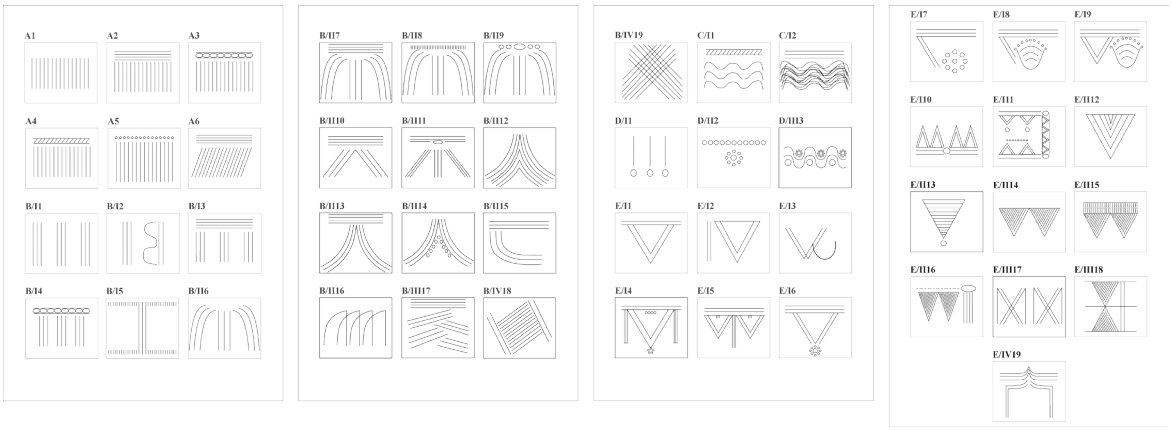

Fig. 8. System of complex decorative motifs occurring at the sites.

Ceramic containers do not, of course, cover the full range of storage possibilities (e.g., storage pits, organic storage solutions), yet the shift within the ceramic spectrum is unambiguous: while the proportion of storage capacity declines, the vessels associated with consumption and serving increase. This offers significant insights into lifestyle and economic practices, supporting the view that communities may have shifted from agriculture-based food production toward large-scale animal husbandry.[46] Such a transition would have entailed a comprehensive reorganisation of lifeways and daily rhythms, as the two economic orientations involve different cycles, practical activities, and provisioning strategies.

46 Kovács 1965, 82–84.

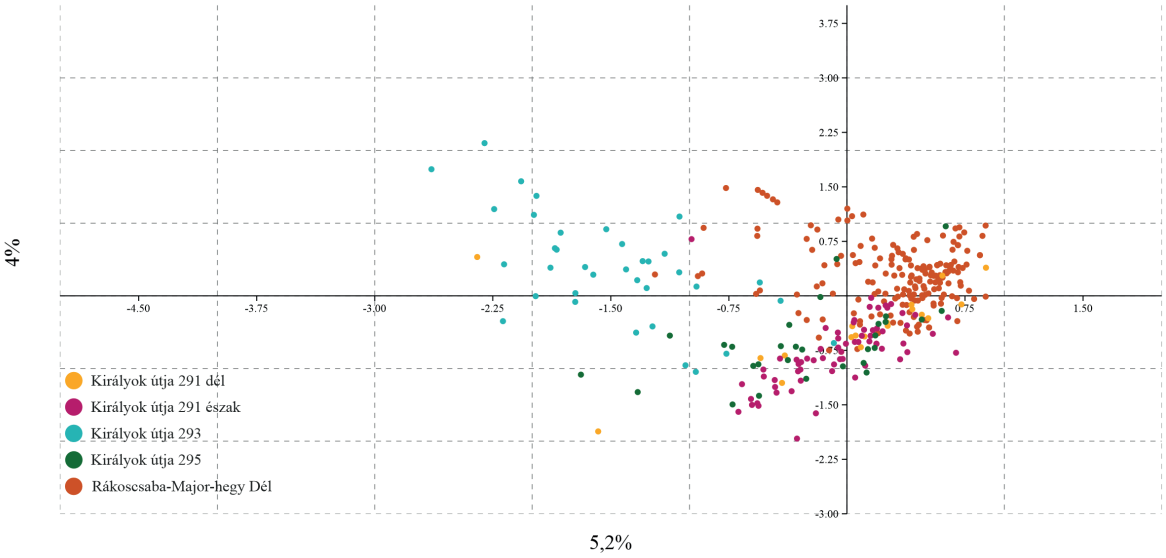

Fig. 9. Distribution of Middle and Late Bronze Age features in relation to decorative motifs.

Analyses of the settlement structure

Based on investigations aimed at reconstructing physical activities within the two settlements, only a few differences can be established. Analysis of vessel types does not allow for the delineation of clear internal boundaries at either site. Distinctive patterns identified through subgroups of vessel types and decorative elements are more likely to reflect chronological or identity-related factors than functional differentiation. In both cases, central parts of the settlements can be observed, where finds are denser and represent a higher percentage of the total assemblage. At Királyok útja, the northern sector of plot 291 emerges—based on features—as the most intensively used area; evidence of lively activity can also be reconstructed on areas 293 and 295. This is indicated not only by the ceramics but also by tokens and bone tools. Apart from special clay objects and spindle whorls, there is no strong dominance of areas 293 and 295. The concentration of spindle whorls along the settlement's boundary zone can relate to textile production.[47] Clusters of grinding stones are presented in plot 291, placing food-processing activities at the settlement's core (Fig. 13).[48]

The spatial distribution of vessels by function reveals a homogeneous settlement structure in which no clear separation can be demonstrated between areas of storage, preparation, and consumption. Worth highlighting is the almost even distribution of fermenting vessels across the Királyok útja settlement, which may point to cooperating households.[49]

A partially comparable situation can be outlined for the Late Bronze Age (Fig. 14). Certain object types tend to occur on the peripheral areas of the site, while others are concentrated in the centre. The dominance of finds in the central zone is especially evident, in contrast, elements indicating built structures (daub remains) become stronger in the south-eastern zone. Grinding stones related to food processing are concentrated in the northern and western parts of the site, whereas another group of objects associated with practical activities—loom-weights—cluster in the central and south-eastern parts.

47 Due to the limited amount of material, the spatial delineation of weaving activities is not entirely clear and remains uncertain.

48 At the Budajenő-Hegyi-szántók settlement, the grinding stones were likewise located near the denser area of the site, close to the ditch that delineates the central settlement zone.

49 Szabó 2023b, 1, 6.

Based on formal groups of vessel types, distinct zones cannot be separated. Sherds are densest in the central part of the settlement but occur in significant numbers in the northern and southern areas as well. The northern sector shows higher frequencies, especially for bowls, mugs, jugs, and pots. Sieves occur in the central and northern parts, similar to the distribution of ember covers. Spatially bounded, smaller differences can also be detected in the faunal[50] assemblage and in types of bronze artefacts. Regarding animal bones, the distributions of wild and domestic species diverge. The relatively central occurrence of wild animals—presumably of higher 'value'—may be linked to social practices and rites,[51] or to consumption by hierarchically distinct groups within the settlement. A similar association with social stratification may be suggested by the metal objects: while jewellery is concentrated in the central zone, tools are distributed over a wider area.

Fig. 10. Distribution of complex decorative motif types at the Middle and Late Bronze Age sites.

Comparing the sites suggests two slightly different modes of internal organisation, both of which are nuanced by the details. On the one hand, a centralised activity zone can be reconstructed from the distribution of grinding stones[52]—an arrangement that aligns well with models of a multi-tiered settlement hierarchy[53] operating within a Middle Bronze Age redistributive economy.[54] On the other hand, the Middle Bronze Age settlement analysed in the dissertation presents a more homogeneous picture, in which a large portion of practical, active tasks appears to have been carried out at the level of integrated households or economic units operating within equivalent activity spheres. The integrated households, as suggested by the layout of the settlement features, may have operated within a structured and cooperative system. At the Late Bronze Age site, activity zones show a greater degree of differentiation; here, however, food-processing activities tend to be pushed toward the periphery. Despite the seemingly simpler settlement hierarchy of Tumulus Culture groups, several internally distinct zones can be defined—manifesting within a more organic settlement layout. This organic internal pattern cannot be considered universally characteristic of the early Late Bronze Age, since at several settlements systems of similarly oriented buildings have also been identified.[55]

50 I am grateful to Péter Csippán for providing the data.

51 Raczky – Anders 2010, 147.

52 For example, at the Budajenő-Hegyi-szántók or Bruszczewo sites (Kneisel *et al.* 2008; Szabó 2018; Szabó 2023a).

53 Dani *et al.* 2019, 855.

54 Reményi 2012, 277–278.

55 For example, the Kóny-Barbacsi tópart site (Egry 2002, 9) or the settlement at Dunakeszi-Székesdűlő (Horváth *et al.* 2001, 119–123).

Analysis of settlement networks

The least-cost path analysis produced particularly informative results for the possible routes connecting settlements established around the Buda Hills.[56] The accessibility between gently sloping, open areas and the directions of communication networks following stream valleys had already been hypothesised in earlier research.[57] The southwestern part of the study area, defined by the analysed settlements, appears to have been more active and to have possessed a denser road network (Fig. 15). This can be attributed not only to the higher frequency of fortified settlements but also to the favourable topographic conditions. In contrast, settlements located in the northern and northeastern zones lie farther apart from one another, and the more fragmented, hilly terrain allows for fewer optimal routes. Nevertheless, pathways could still be reconstructed even within mountainous areas, connecting, for instance, the Zsámbék Basin and the Pilis valleys, as well as linking these to the lowland zones along the Danube.

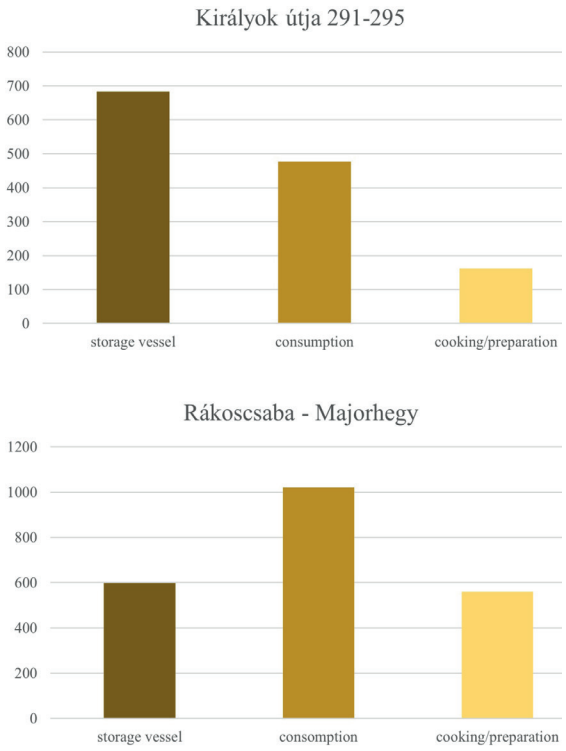

Fig. 11. Distribution of vessel functions at the sites.

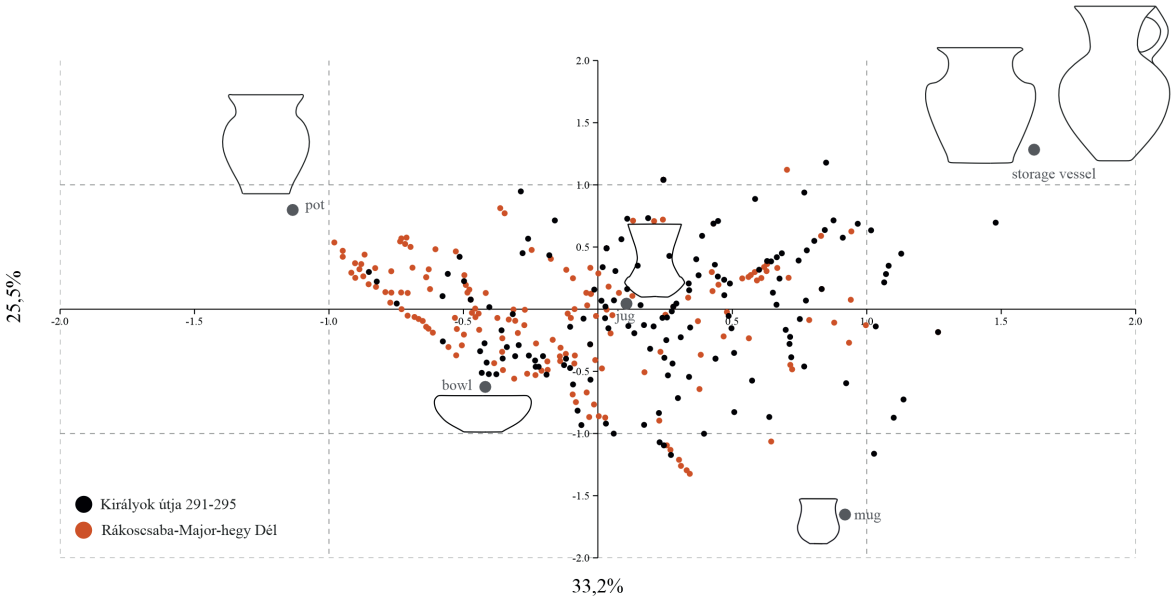

Fig. 12. Relationship between vessel functions and archaeological features.

56 Middle Bronze Age settlements: 1 – Budajenő-Hegyi-szántók, 2 – Solymár-Várhegy (Mátyásdomb), 3 – Budapest-Királyok útja 291–295, 4 – Budapest-Várhegy, 5 – Budaörs-Kamaraerdőv (Törzsgyümölcsös), 6 – Százhalombatta-Földvár (Téglagyár), 7 – Tárnok-Szőlőhegy, 8 – Sóskút-Kálvária-hegy (Baratház), 9 – Biatorbágy-Pap-réti dűlő, 10 – Biatorbágy-Öreg-hegy. Late Bronze Age settlements: 1 – Rákoscsaba-Majorhegy, 2 – Budaörs-Kamaraerdő (Törzsgyümölcsös), 3 – Biatorbágy-Papp-rét, 4 – Pomáz-Klanác-tető, 5 – Dunakeszi-Székesdűlő.

57 P. Fischl *et al.* 2013; Earle *et al.* 2014.

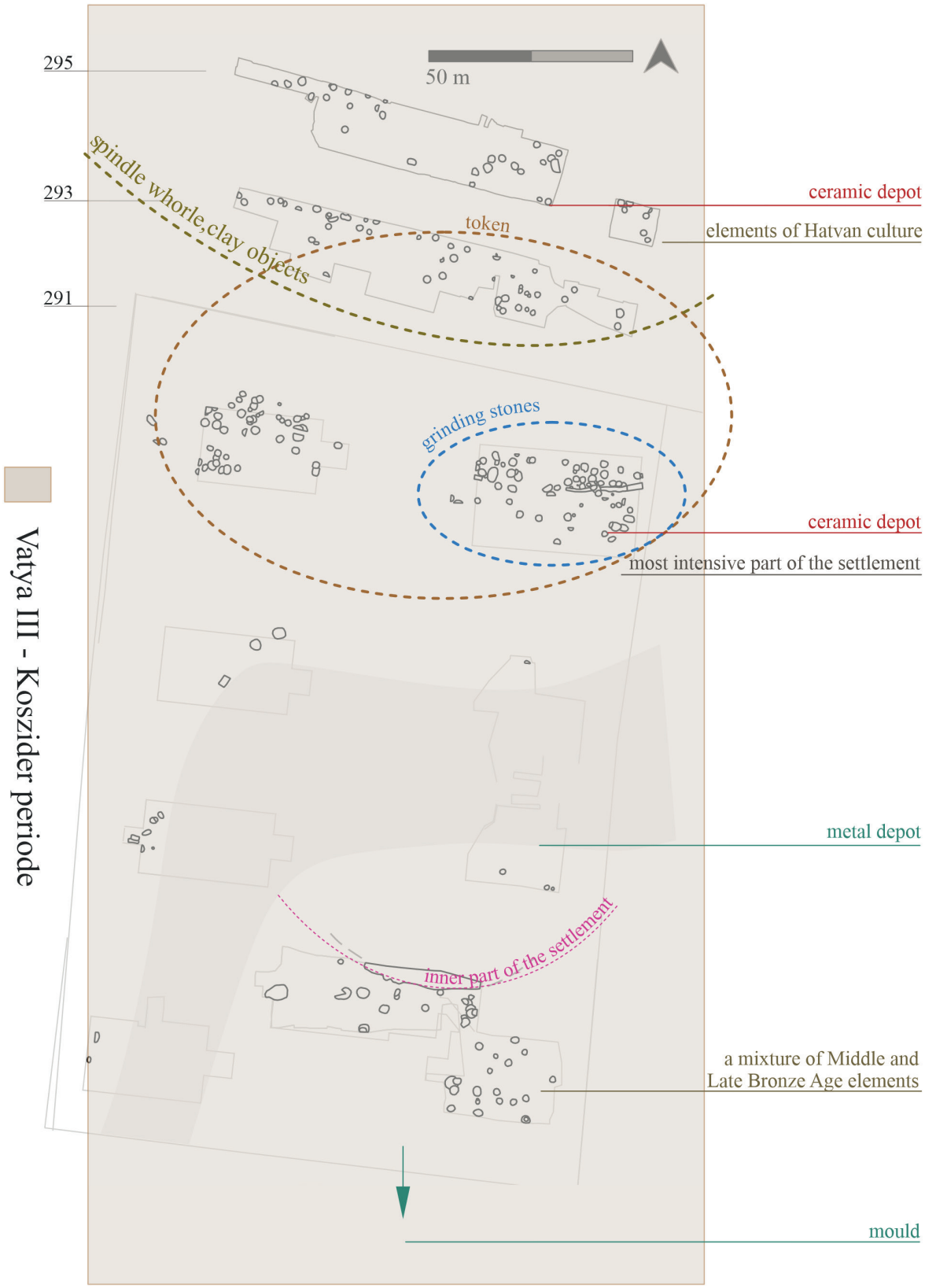

Fig. 13. Internal structural units of the Middle Bronze Age settlement at Királyok útja 291–295 based on artefact distribution.

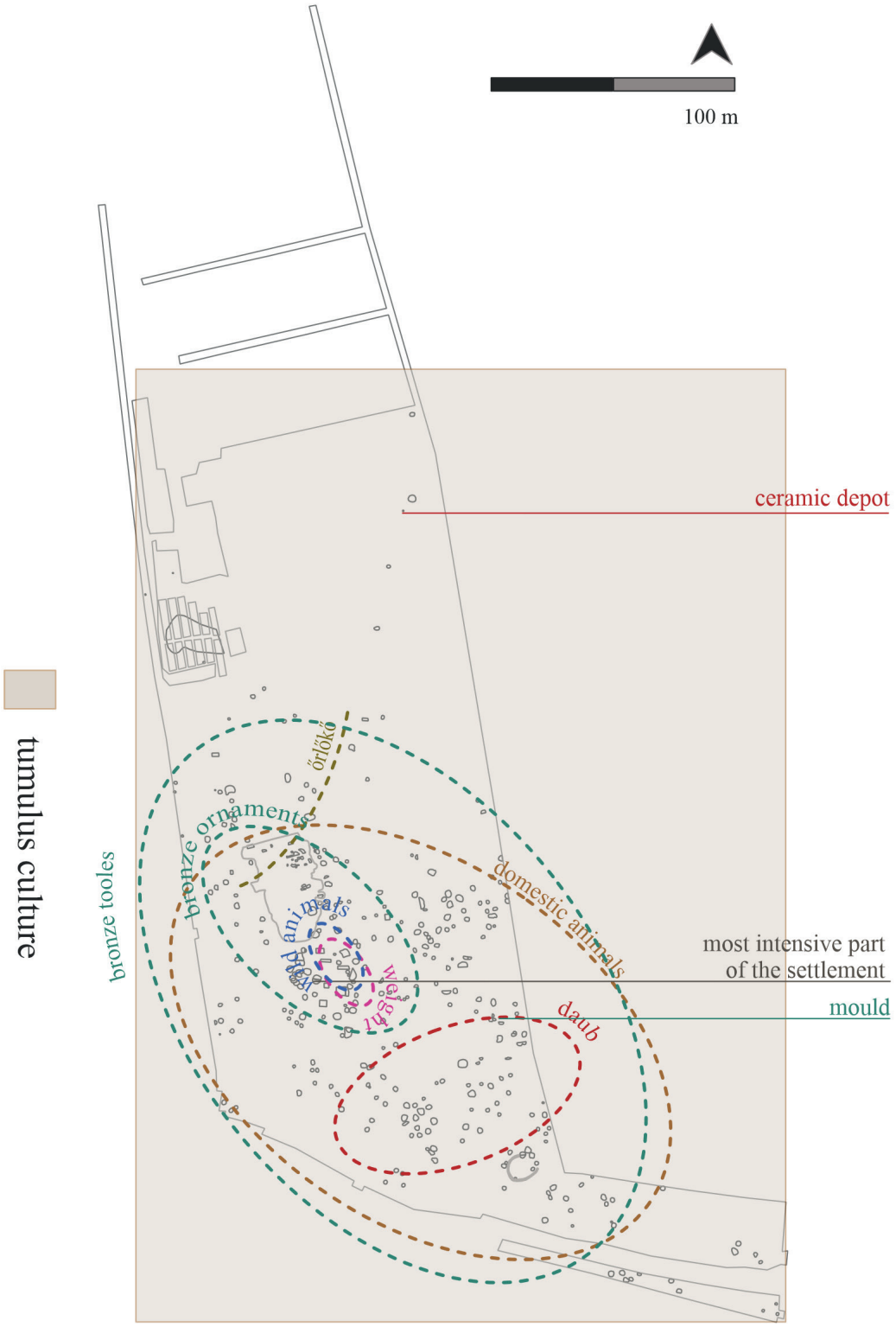

Fig. 14. Internal structural units of the Late Bronze Age settlement at Rákoscsaba-Majorhegy based on artefact distribution.

A viewshed analysis conducted for fortified and tell-type sites highlights the areas visible from the highest points of the settlements. As several sites occupy elevated positions, in most cases a large portion of the 5 km radius surrounding the site falls within the 'visible' zone (Fig. 16). However, according to current knowledge, no site exerted complete visual control over its surroundings. All examined settlements exhibited at least partial visibility across the four designated zones—

beyond detection, first detection, human recognition, and basic recognition (Fig. 17).[58] The site of Solymár-Várhegy (no. 2) represents an exception, as its beyond-detection zone is notably restricted.

The distances between the settlements and the extent of their corresponding visibility zones demonstrate clearly on the map that the areas visible from each site rarely overlap. The main exceptions are the closely spaced sites around Biatorbágy (nos 9 and 10), which lie near the boundary of each other's first detection zones, and the nearby site at Sóskút. Although the latter lacks direct visual contact with the Biatorbágy sites, partial overlap can be observed in the intervening areas within the beyond detection range.

When modelling routes between Late Bronze Age sites, a somewhat different pattern emerges (Fig. 18). Distinctions in settlement types and hierarchical organisation, already apparent in the archaeological record, are reflected in these models as well. The least-cost path model connecting the presumably fortified sites (nos 2–4) reveals a less intensive network compared to that of the Middle Bronze Age. This simplification is largely due to the marked decline in the number of settlements, which in turn implies a reduction in potential interactions between sites.

The analysis of the territories associated with key sites similarly suggests a more simplified and less complex system (Fig. 19). Examining five Late Bronze Age sites used in the road-network analysis

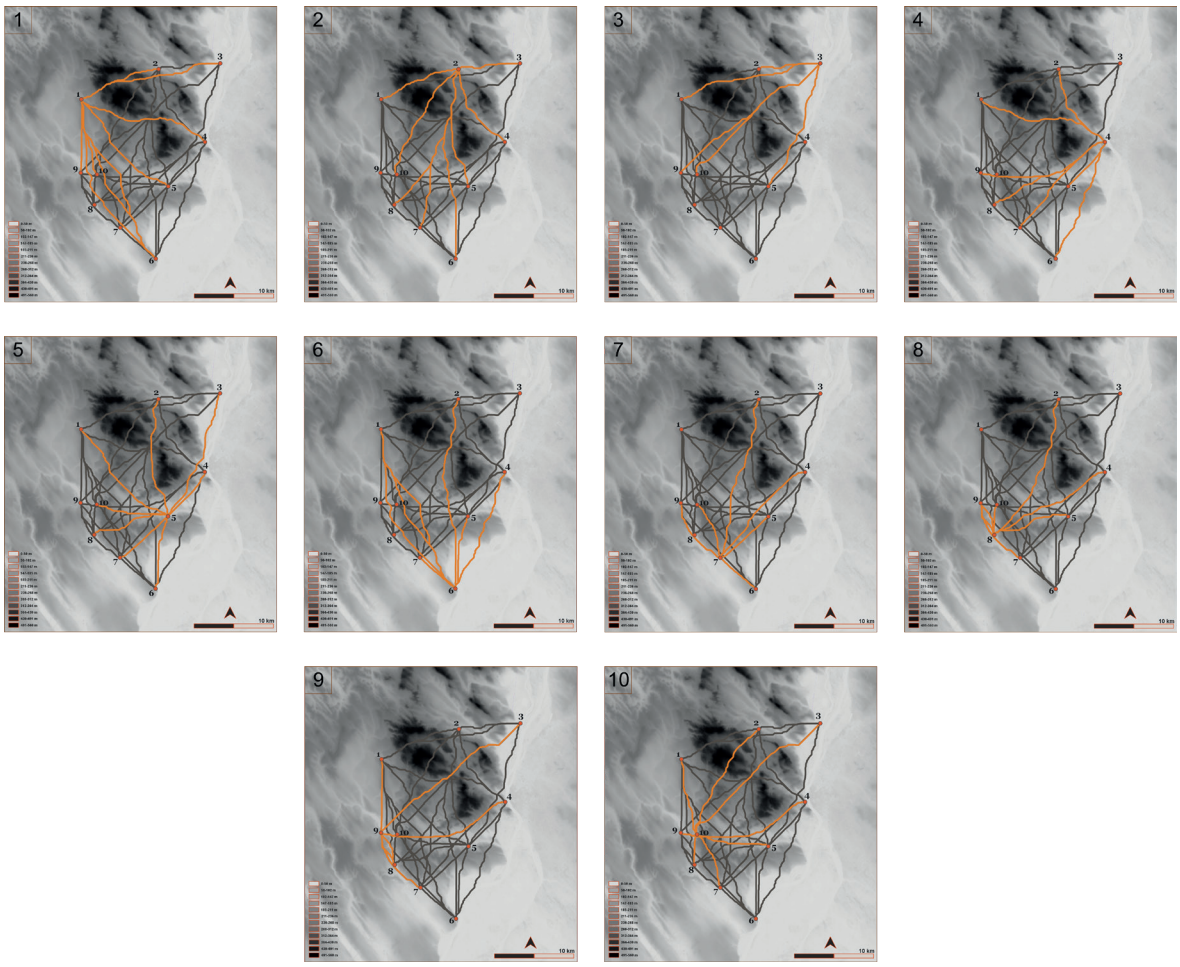

Fig. 15. Possible routes between the sites. 1 – Budajenő-Hegyi-szántók, 2 – Solymár-Várhegy (Mátyás-domb), 3 – Budapest, District III, Királyok útja 291–295, 4 – Budapest-Várhegy, 5 – Budaörs-Kamaraerdő (Törzsgyümölcsös), 6 – Százhalombatta-Földvár (Téglagyár), 7 – Tárnok-Szőlőhegy, 8 – Sóskút-Kálvária-hegy (Baratház), 9 – Biatorbágy-Pap-réti dűlő, 10 – Biatorbágy-Öreg-hegy.

58 Fábrega-Álvarez – Parcero-Oubiña 2019.

and delineating a 5 km radius around each leads to the following conclusions: the sites are located in widely separated zones; their visibility areas do not overlap; they occupy differing geographical settings; and, based on their visibility ranges, distinct types of territorial control can be associated with them.

The differentiated visibility zones are comparable to those observed for the Middle Bronze Age. For all settlements, distinct visibility areas can be identified, meaning that none were completely isolated. The settlement at Pomáz (no. 4) has a relatively limited visible area within a 600 m radius–barely perceptible on the map–yet its immediate surroundings would still have been under visual supervision.

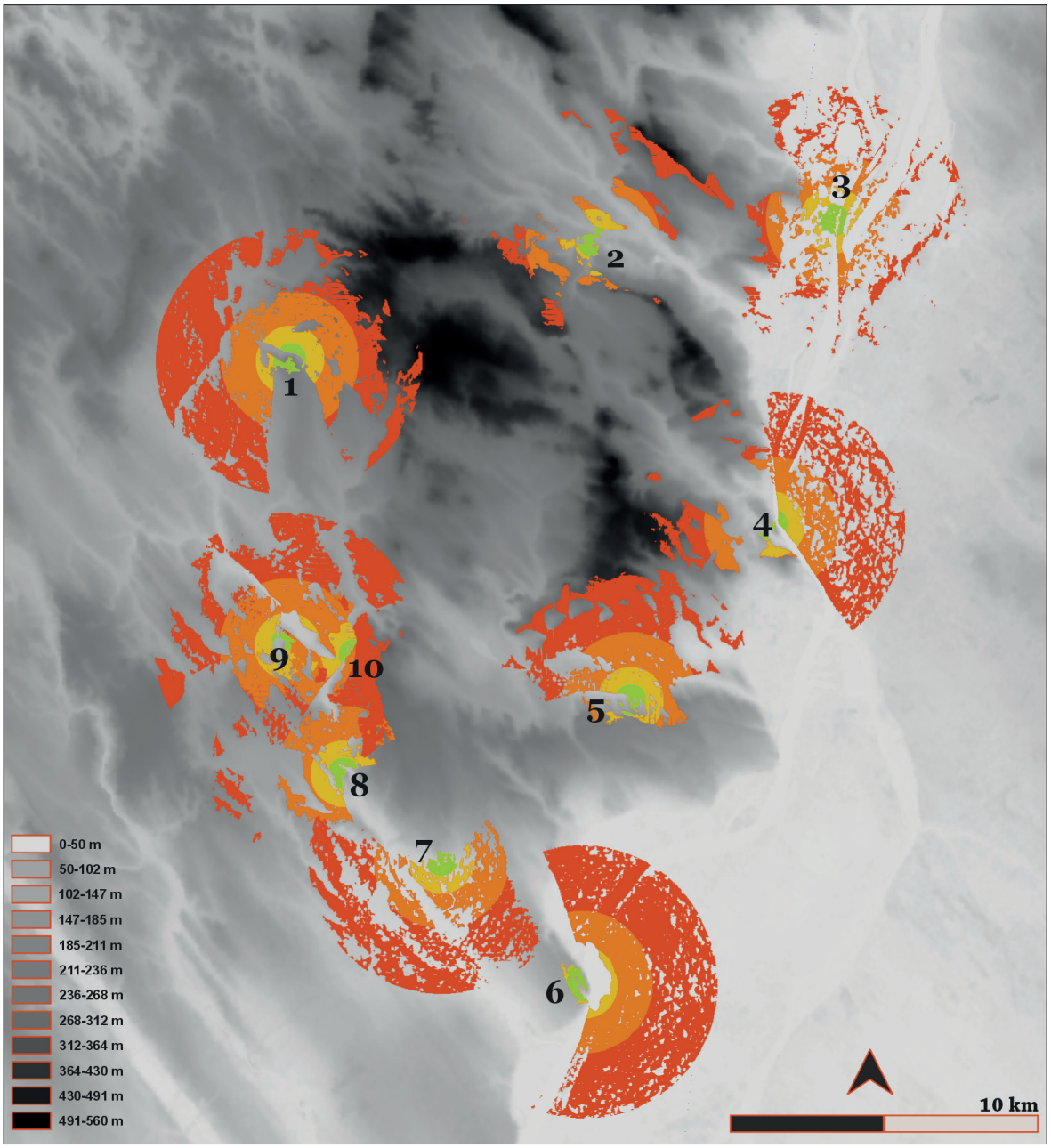

Fig. 16. Viewshed analysis of Middle Bronze Age settlements based on horizon zones. 1 – Budajenő-Hegyi-szántók, 2 – Solymár-Várhegy (Mátyásdomb), 3 – Budapest, District III, Királyok útja 291–295, 4 – Budapest-Várhegy, 5 – Budaörs-Kamaraerdő (Törzsgyümölcsös), 6 – Százhalombatta-Földvár (Téglagyár), 7 – Tárnok-Szőlőhegy, 8 – Sóskút-Kálvária-hegy (Baratház), 9 – Biatorbágy-Pap-réti dűlő, 10 – Biatorbágy-Öreg-hegy.

Fig. 17. Division of horizon zones based on the observations of Pastor Fábrega-Álvarez and César Parcero-Oubiña (after Fábrega-Álvarez – Parcero-Oubiña 2019).

In the case of the fortified hilltop settlements west of the Danube, I also looked at traces of smaller settlements from the Tumulus period. Around Pomáz, a concentration of such sites is evident, whereas around Biatorbágy and Budaörs no similar clustering can be observed.[59] This suggests that in some cases a settlement cluster can be recognised around key sites, indicating close cooperation within a local network. At the same time, a looser chain of settlements situated farther apart from each other can also be identified.

Although many questions remain regarding the relationship between the two periods, certain tendencies can nevertheless be identified. The selected geographical environment is diverse: some settlements occupy elevated ridges, others are located on gently sloping, non-prominent terrain, and at least one can be characterised as mountainous. This pattern is consistent across both periods—the Middle and Late Bronze Age—demonstrating that communities established settlements in all available environmental zones. The modelled routes connecting key settlements differ primarily in terms of network complexity. Although the number of settlement types declines in the Late Bronze Age, no significant change can be detected in the overall geographical setting. The visibility analyses show that some Middle Bronze Age sites were located in close proximity, forming a coherent and interconnected network. By the Late Bronze Age, however, this proximity diminishes: prominent settlements are situated farther apart, resulting in a looser and more dispersed pattern of inter-site connections.

Conclusion

Based on the analysed settlements, no clear evidence can be presented for a complete transformation of the settlement system. Differences in internal organisation are partially observable, yet they are not decisive. At the Királyok útja 291–295 site, distinct activity areas can be outlined: grinding stones concentrate in the central zone; objects possibly related to textile production occur in the northern zone; and a casting mould in the southern zone points to metalworking activity. In contrast, the Late Bronze Age site presents a different picture: grinding activities shift to the periphery, wild animal bones concentrate in the central zone, traces of metalworking appear in the eastern excavation area, and a distinction can be observed in the distribution of metal finds—jewellery clustering in the central zone, and tools scattered across the entire site. The metal finds of the Late Bronze Age settlement therefore indicate not only distinct activity zones but also possible social and hierarchical differentiation within the community.

59 Based on Volume 7 of MRT, the Benta Valley Project (Poroszlai – Vicze 2005), and the revision by Péter Mali (Mali 2020).

Despite these differences, several categories of finds and vessel types exhibit homogeneous distributions at both sites. However, differences in the proportions and stylistic characteristics (forms and decorative motifs) of artefacts are detectable. The most striking distinction concerns storage capacity. The proportion of storage vessels—classical Vatya urns and their Late Bronze Age counterparts, such as amphorae or urn-shaped containers—differs considerably between the two sites. This pattern is further supported by comparative data from the Budajenő-Hegyi-szántók settlement.[60] The phenomenon may reflect changes in the types of stored goods or in storage practices, alongside transformations in cooking, food preparation, and consumption habits.

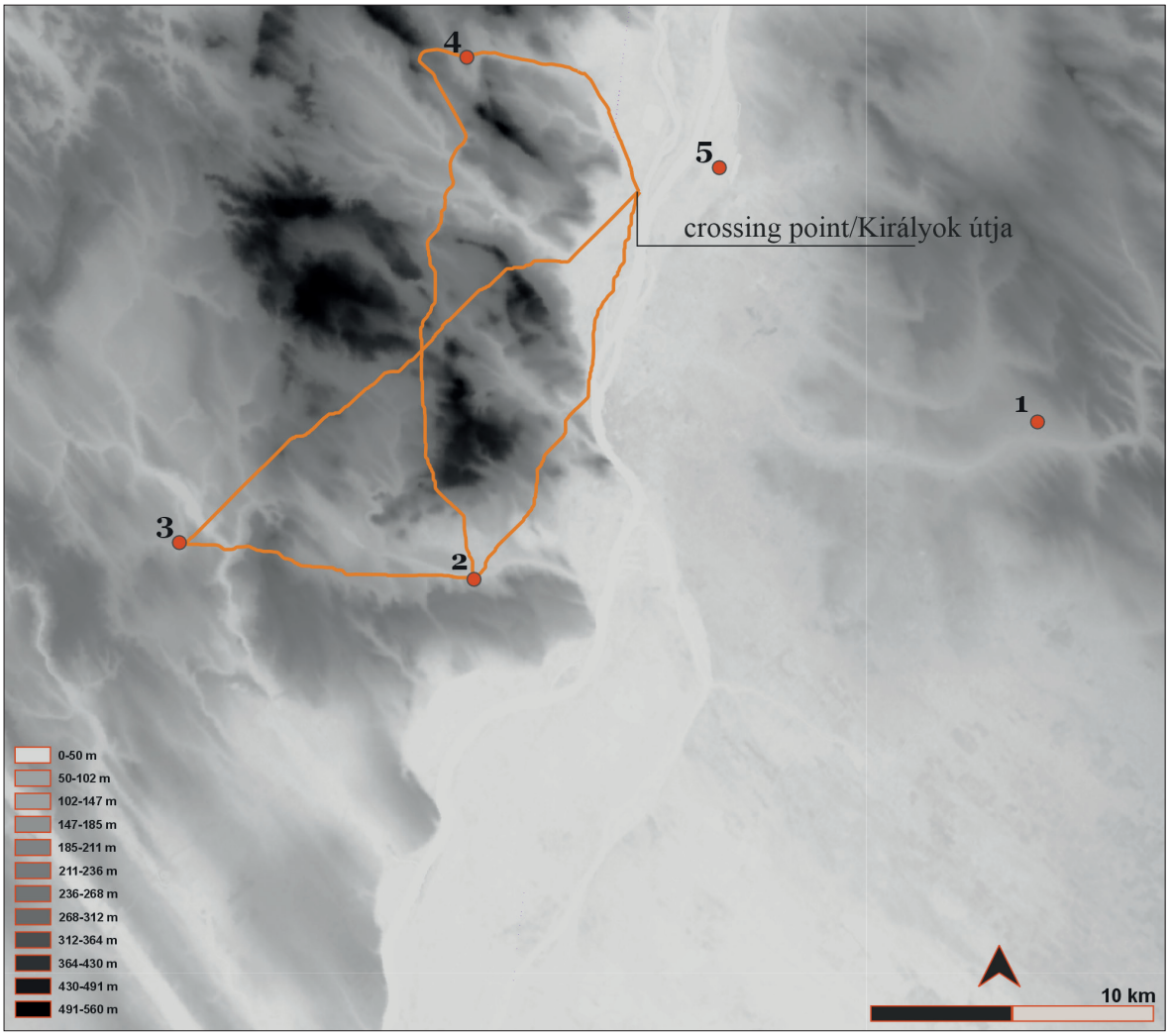

Fig. 18. Model of route networks between Late Bronze Age sites. 1 – Rákoscsaba-Majorhegy, 2 – Budaörs-Kamaraerdő (Törzsgyümölcsös), 3 – Biatorbágy-Papp-rét, 4 – Pomáz-Klanác-tető, 5 – Dunakeszi-Székesdűlő.

Both typological and multivariate statistical analyses demonstrate a strong connection between the two periods. The Late Bronze Age ceramic assemblage, developing from Middle Bronze Age foundations—particularly during the Koszider period—shows highly similar formal and decorative traits. These continuities are not unique: the blending of local and new stylistic elements is observable across several regions.[61] It is noteworthy that at Királyok útja, vessels displaying traits

60 Szabó 2018.

61 Foltiny 1957; Kovács 1965; Kovács 1966; Kemenczei 1968, 178; Bóna 1992a, 37–38; V. Szabó 1999, 62, 95–97; Vicze 2011.

characteristic of the Tumulus Culture already appear in the southern part of the site during the Koszider phase. Conversely, at Rákoscsaba-Majorhegy, a few elements dating to the Middle Bronze Age are present. Although the two sites are spatially and temporally distinct, and no Middle Bronze Age occupation is attested at Majorhegy, traditional elements of the earlier material culture were integrated into the younger site's assemblage. Overall, the Koszider period forms the link between the two settlements: the occupation at Királyok útja 291–295 began during the Vatya II–III phases and continued until the Rei. Br B1 (Koszider) period,[62] while the Tumulus Culture settlement at Rákoscsaba-Majorhegy was established in Rei. Br B1 and flourished mainly during the early Tumulus phase (Rei. Br B2–C).[63]

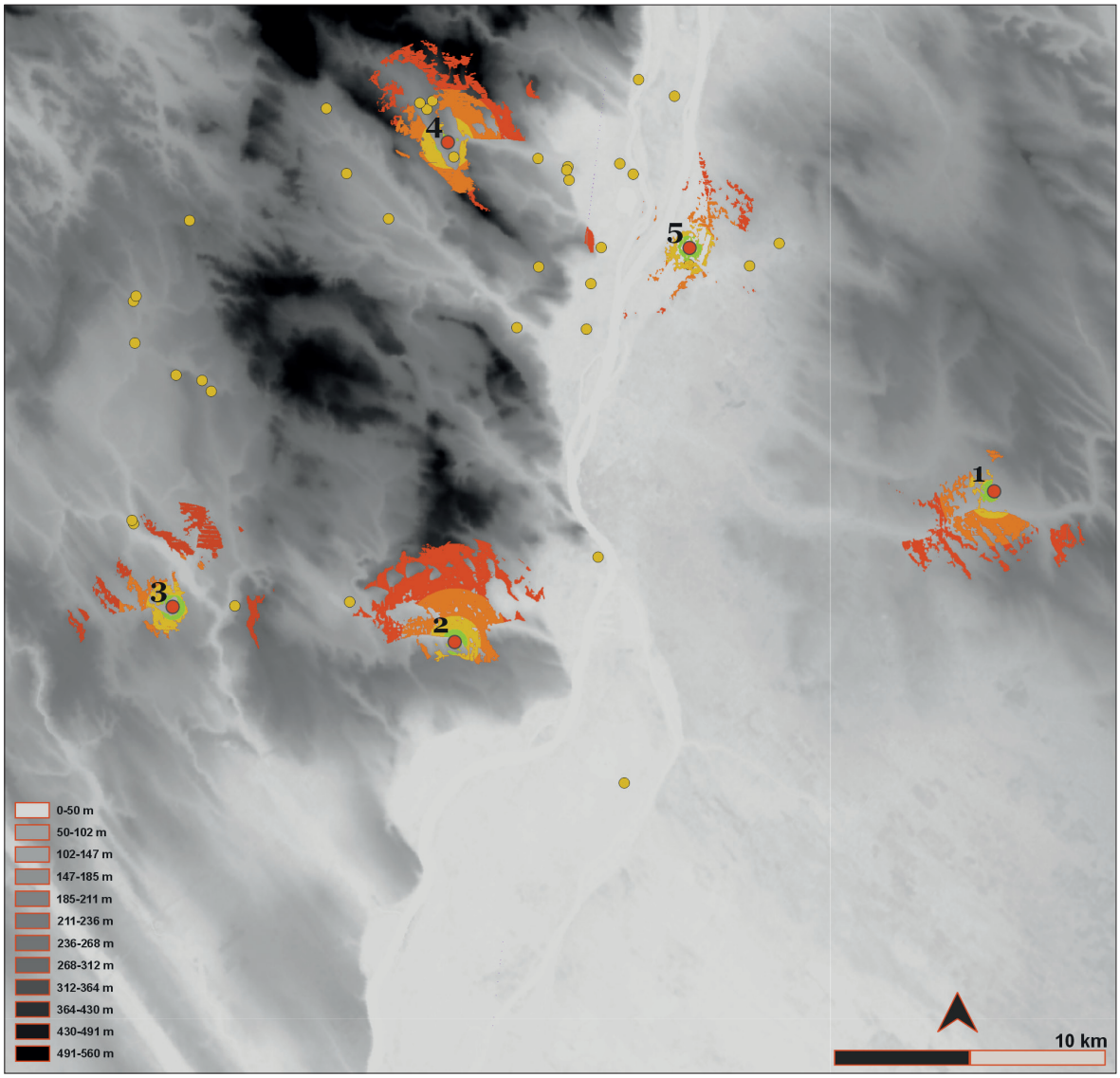

Fig. 19. Examination of territories of prominent Late Bronze Age sites and settlements west of the Danube.

The analysis of artefacts and spatial structures reveals both differences and parallels between the settlements. The most significant divergences concern subsistence (storage capacity) and the development of metallurgy. At Királyok útja, a single hoard represents the site's metal finds, whereas at Rákoscsaba-Majorhegy, bronze ornaments and tools were recovered from the fills of storage and

62 Szilas 2017b, 40.

63 Reményi *et al.* 2006, 166–180.

refuse pits across the entire settlement. Casting moulds were found at both sites, indicating some engagement with metalworking, though this is less clearly demonstrated at Királyok útja due to the limited number of related finds. The increase in bronze artefacts corresponds to the general development of the Late Bronze Age and may also reflect differences in site function and hierarchical position. While metalworking in the Middle Bronze Age is typically associated with fortified or tell-type settlements,[64] in the Late Bronze Age its presence may become widespread across various settlement types.

Based on the two compared sites, assessing the broader cultural relations between distinct regional groups remains challenging. Although this research focuses on a relatively short period, profound transformations can be observed in general.[65] These were strongly influenced by long-distance connections, the movement of metals and raw materials, and the accompanying circulation of innovations, people, and knowledge. These processes brought about denser interaction networks, the spread of innovations, and the movement of people and knowledge.[66] The connections linked to bronze objects may have allowed social and economic systems to become more interconnected and widespread.[67]

The Vatya groups expressed their shared identity not only through a homogeneous ceramic style but also through an extensive and structured settlement network. The long-lived tells[68] and, by the end of the period, the emergence of numerous large, one-layered settlements[69] both illustrate the enduring importance of traditional gathering places[70] and the cohesion of extended, cohabiting groups. Settlements often established in strategically significant locations defined the key zones of communication and interaction within this network. Such a complex, multi-tiered hierarchical system implies a well-organised social structure, in which each settlement's position and function formed part of the broader whole—mirroring the internal functional zoning observed within individual sites.[71]

This organised system of intra- and inter-settlement relationships extended beyond the boundaries of the Vatya culture, persisting throughout the Carpathian Basin and much of Europe, albeit with regional variations in its expression.[72] At the Királyok útja settlement, elements of the Tumulus Culture appear alongside Vatya-style ceramics—a pattern observable at several other sites as well.[73] The coexistence of these two ceramic traditions, even if temporary, is now unequivocal. The Koszider period, representing both the most dynamic phase of Middle Bronze Age material culture and the formative stage of the Late Bronze Age, can thus be seen as an extended and transformative era—clearly reflected in the two sites studied here.

64 A phenomenon that may be associated with metalworking is known from the site of Lovasberény-Mihályvár (Petres – Bándi 1969; Bóna 1992b) however, the theory is questionable: Găvan 2012; Găvan 2020; Jaeger 2016, 82.

65 Mozsolics 1957; Bóna 1958; Kovács 1966; Hänsel 1968; Kemenczei 1968; Bóna 1975; Harding 2000; Blischke 2002; David 2002; Poroszlai – Vicze 2000; Reményi 2003; Reményi 2005; Reményi 2012; P. Fischl *et al.* 2013.

66 Kristiansen 2017, 154.

67 Kristiansen 2017, 180.

68 Meier-Arendt 1992.

69 Repiszky 2004; Ottományi 2005; Pap *et al.* 2008; Earle *et al.* 2014; Szeverényi – Kiss 2018, 45; Szeverényi *et al.* 2020, 366; Szilas *et al.* 2020; Szabó 2023a.

70 Gogâltan 2005, 41, Fig. 1; Gogâltan 2008, 44–45, 53; Gogâltan 2012; Nemes Nagy 2017, 12; Kienlin 2020.

71 Kneisel *et al.* 2008, 156; Jaeger 2009, 394; Kneisel – Müller 2011, 305, Abb. 8; P. Fischl *et al.* 2012; P. Fischl – Kienlin 2013, 10, 20; 26; Gauss *et al.* 2013; Szabó 2018; Furholt 2020; Kienlin 2022, 261–263; Szabó 2023a.

72 P. Fischl *et al.* 2012; Dani *et al.* 2019; Szabó 2023a.

73 V. Szabó 1999, 62, 95–97; Vicze 2011.

During this time, Tumulus-style finds appear in both settlements and cemeteries, sometimes merging with, and at other times diverging from, Middle Bronze Age traditions.[74] The spread of the Tumulus Culture across the Carpathian Basin represents a supra-regional phenomenon, encompassing diverse local expressions. The homogenisation of ideological frameworks marked a sharp contrast with the earlier Middle Bronze Age, which, though unified on a regional level, exhibited a more mosaic-like structure overall.[75] This process of unification had already begun during the Koszider period through increasingly frequent interactions among Middle Bronze Age cultural groups.

Following the stable and relatively closed development of the Middle Bronze Age, a far more diverse ceramic spectrum emerges, reflecting greater flexibility and openness toward both neighbouring and distant cultural influences—a tendency clearly visible at Rákoscsaba-Majorhegy, where the higher frequency of Litzen pottery types stands out. This points to an internal social drive for change. Such receptiveness to transformation, apparent across multiple spheres of life, raises important questions concerning settlement patterns. Although Tumulus groups were aware of, and occasionally occupied, strategically located Middle Bronze Age sites—such as Királyok útja—they did not reuse them long-term, suggesting a conscious break from earlier traditions.

By the Late Bronze Age, the hierarchical complexity of settlement systems had diminished, though large settlements persisted.[76] In this formative phase, attempts were made—at least on a regional scale—to maintain major, potentially central settlements, yet the degree of communication and cooperation among them remains uncertain. The abandonment of earlier settlement locations cannot be explained solely by political tensions, as overlaps in material culture, particularly ceramics, are still evident. Nonetheless, given the extent of these transformations, it is questionable whether the transition was entirely peaceful or cooperative—though this does not necessarily imply widespread conflict. What is clear is that new, previously unoccupied areas were selected for settlement.

This shift is also reflected in reduced storage capacity during the Late Bronze Age, suggesting a decline in the accumulation of surplus goods. Although technological knowledge and subsistence practices from the earlier period were likely still known, they were no longer applied in the same way. The latter can partly be explained by the transformation of climatic conditions;[77] however, changes in social ideologies may also have played a significant role in the emergence of a new mode of subsistence distinct from the earlier one. The transformation of everyday subsistence practices implies new goals and norms of social organisation—changes that, extending beyond local contexts, may have fundamentally reshaped how communities across entire regions conceptualised their world.

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74 E.g., Vicze 2011; Duffy *et al.* 2019, 64.

75 Kristiansen 1998; Makarowicz 2017, 130.

76 Egry 2002, 9; Szilas 2007, 156; Horváth *et al.* 2001, 115–127; Sánta 2011.

77 Gyulai 1993, 17; Demény *et al.* 2010; Szilas *et al.* 2023.

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