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Painted Pottery Networks During the 5th Millennium BCE in Southern Iran

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Abstract:

During the 5th millennium BCE in southern Iran, black-on-buff painted pottery spread from the Susiana Plain to the Zagros Mountains. Some researchers argued that the expansion of the painted pottery was due to the specialist potter's migration from the Susiana Plain to the Zagros mountains. However, others also considered potteresses' movement due to interregional marriage and exchange of the pottery as another mechanism for expanding the painted pottery. This presentation approaches the expansion process of the black-on-buff pottery using social network analysis to understand this mechanism's dynamics. This paper uses published/unpublished drawings of exterior-painted black-on-buff ceramics reported in archaeological sites ranging from Luristan to Kerman for this analysis. These materials were roughly subdivided into three phases (the Early, Middle, Late phases) of the 5th millennium BCE to reveal diachronic changes of network patterns. One of the pottery attributes, horizontal design structures, was used to reconstruct networks based on the Brainerd-Robinson coefficient of similarity, thereby allowing for visualization of two different kinds of networks. This paper presents a preliminary result of network analyses and discusses the potentials and limits of this approach.

Keywords:

Chalcolithic, Southern Iran, Black-on-Buff Pottery, Social Network Analysis.

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1. Introduction

The 5th millennium BCE in southern Iran, the southern piedmont of the Zagros Mountains, has been characterized as the widespread distribution of the black-on-buff painted pottery, one of the more predominant ware-types than other ware-types such as black-on-red ware in southeastern Iran (Mutin 2012). In Susiana and Deh Luran, the black-on-buff ware appeared as early as the 6th millennium BCE (Early Susiana phase and Sabz phase respectively) and then developed (from Early Middle Susiana phase to Late Susiana 2 or Susa I phase and from Khazineh phase to Farukh phase respectively). On the other hand, it appeared in Fars at the beginning of the 5th millennium BCE and developed there for about 1000 years (Bakun phase). Finally, in Kerman, it appeared in the late 5th millennium BCE (Yahya VC-VA).

Several previous studies have studied the mechanisms behind the expansion of the Black

-on-buff painted pottery in southern Iran. Abbas Alizadeh argued that the specialized potter groups migrated from Susiana towards the east and expanded the material culture of the black-on-buff ceramics (Alizadeh 2006). On the other hand, Lloyd Weeks and his colleagues proposed one hypothesis that exogamous marriage relationships between villages contributed to the dispersal of black-on-buff ceramics (Weeks et al. 2010).

This debate concerning the expansion process of the black-on-buff ceramics is still ongoing and remains unsolved. One of the reasons is the lack of empirical and comparative studies of the black-on-buff ceramics throughout the southern Iran ranging from Susiana to Kerman. It is well known that interregional variabilities exist in the black-on-buff ceramics throughout southern Iran, as clearly indicated by different typological terminology used in each region (Ubaid, Susiana, Bakun, etc.). These interregional variabilities and their diachronic change might reflect the difference in the adoption and development of the black-on-buff ceramics in each region, that is, one of the best clues to understand the expansion mechanism of this painted pottery. As cited below, this kind of research direction towards exploring the interregional variation of the black-on-buff painted pottery empirically was already pointed out by Weeks and his colleagues in 2010;

"It is clear that interpretation cannot be separated from the measurement and quantification of stylistic variability within and between ceramic assemblages. One way forward in this regard would be a structured examination of the known excavated and surveyed black-on-buff ceramic material from Fars to determine what types of internal homogeneity and variety exist in terms of approaches to production, vessel form, and especially ceramic decoration. (Weeks et al. 2010: 267) "

Hence, in this paper which focuses on the expansion mechanism of the black-on-buff pottery in the southern Iran, my research questions are "what kind of interregional differences and similarities can we characterize from the black-on-buff ware in southern Iran?", "How can we visualize interregional differences and similarities among southern Iran?", and "How did interregional differences and similarities change through time in southern Iran?"

One of the solutions for these research questions is the application of social network analysis to archaeological materials. Social network analysis sees groups, assemblages, or societies as networks consisting of nodes and edges, then statistically explores these network patterns. These network approaches are applied to interdisciplinary fields, including computer sciences, social sciences, physics, life sciences, and digital humanities (Mills 2017). Recently an increasing number of archaeological studies attempted to utilize social network analysis (Birch and Hart 2018, 2021; Brughmans 2010, 2013; Brughmans and Peeples 2019; Collar et al. 2015; Donnellann ed. 2020; Golitko and Feinman 2014; Knappett 2011; Hart and Engelbrecht 2012; Hodder and Mol 2015; Lulewicz 2019; Lulewicz and Coker 2018; Mazzucato 2019; Mills 2017; Mills et al. 2013, 2015, 2018; Mizoguchi 2013; Peeples 2018, 2019; Peeples et al. 2015). From these studies, it has turned out that this network approach helps visualize and assess long-distance trade networks, household relationships among one archaeological site, entanglements between humans and things, and inter/intraregional differences and similarities from archaeological datasets.

The approach of social network analysis not only provides a new way to visualize interregional differences/ similarities through time but also assesses patterns of relationships between sites. This point helps us discussing the interregional interactions behind the expansion mechanism of black – on - buff

ceramics over time. Thus, the purpose of this presentation is to attempt to reconsider the expansion process of the black-on-buff pottery by using the network approach and through visualizing the transformation of the black-on-buff painted pottery networks.

2. Material and methods

I selected the horizontal design structure of exterior-painted open vessels as the pottery attribute used for social network analysis (Figure 1).

This attribute has been previously studied by Hole (1984) and Alizadeh (2006), but the interregional comparison was not conducted. The horizontal design structure is less remarkable than motif elements such as animals, geometric motifs (triangles, diamonds). So, I presume that in order to transmit the same/ similar characteristics of design structures, more direct/in-person communication is required than for painted motifs. I adopted one terminological system for this design structure comprising a rim band, secondary motifs, an upper body band, upper optional lines, an upper frieze line, friezes, a lower frieze line, lower optional lines, a lower body band, and a base band (Figure 1). This terminology is just one of the classification attempts based on my previous analysis of the Bakun pottery (Miki in press). For that reason, this coding system does not neatly work in other regions, especially Susiana and Deh Luran. In the following result section, I will present the classification result of horizontal design structure types (DE1-DE12) and the description of each structure types and its frequency in time and space. It should be noted that the classification still needs to be improved in the future and therefore is preliminary in this paper.

In this paper, to discuss the diachronic change of painted pottery networks, I roughly subdivided the chronology of archaeological sites associated with black-on-buff ceramics into three phases, the Early phase (approximately sixth and early fifth millennium BCE), the Middle phase (middle fifth millennium BCE), and the Late phase (late fifth Millennium BCE). This chronological subdivision basically follows previous chronological systems (Hole 1987, Voigt and Dyson 1992, Mutin 2012, Petrie 2011) and radiocarbon dates collected from archaeological excavations.

Below, I list 27 archaeological sites (Figure 3) with more than five published/ unpublished pottery drawings or pictures that I find diagnostic for judging horizontal design structures. I also present the total number of drawings/ pictures used for each site, its chronological subdivision, regional subdivision, and references; Chaga Sefid (8 vessels, the Early phase, Deh Luran, Hole 1977), Tepe Sabz (46 vessels, the Early phase, Deh Luran, Hole et al. 1969), Chogha Mish (111 vessels, the Early phase, Susiana, Delougaz and Kantor 1996; Alizadeh 2008), Tepe Jowi (10 vessels, the Early phase, Susiana, Dollfus 1978, 1983), Jaffarabad (58 vessels of the Early phase, 15 vessels of the Late phase, Susiana, Dollfus 1975), Tall-e Bakun B (32 vessels, the Early phase, Fars, McCown 1942; Egami and Masuda 1962; Alizadeh 2006), Tall-e Jari A (15 vessels, the Early phase, Fars, Egami et al. 1977; Miki in press), Hakalan (18 vessels, the Middle phase, Luristan, Haerink and Overlaet 1996), Parchineh (56 vessels, the Middle phase, Luristan, Haerink and Overlaet 1996), Qabr Sheykheyn (34 vessels, the Middle phase, Susiana, Weiss 1976), Tepe Bendebal (36 vessels, the Middle phase, Susiana, Dollfus 1983), Tepe Sohz (26 vessels, the Middle phase, Behbahan, unpublished), Bolaghi Valley TB131, 73, 91 (28, 15, 39 vessels respectively, the Middle phase, Fars, Karami 2015), Rahmatabad (55 vessels, the Middle phase, Fars, unpublished), Tall-i Siah (7 vessels, the Middle phase, Fars, Stein 1936), Tall-i Skau (6 vessels, the Middle phase, Fars, Stein 1936), Tall-i Regi, Khusu (7 vessels, the Middle phase, Fars, Stein 1936), Tol-e Nurabad (5 vessels, the Middle phase, Fars, Potts and Roustaei 2006), Tall-e Gap (72 vessels, the Middle phase, Fars, Egami and Sono 1962, Miki in press), Susa (269 vessels,

the Late phase, Susiana, Pottier 1912; Louvre collections database https:// collections. louvre.fr/en), Tol-e Chegha Sofla (32 vessels, the Late phase, Zuhreh, Moghaddam 2018, 2020), Tall-e Bakun A (205 vessels, the Late phase, Fars, Herzfeld 1932; Langsdorff and McCown 1942; Egami and Masuda 1962; Alizadeh 2006), Tall-i Nokhodi (5 vessels, the Late phase, Fars, Goff 1963), Tepe Yahya (6 vessels, the Middle phase, Kerman, Lamberg-Karlovsky and Beale 1986, following the chronological understanding by Vidale and Desset 2013, Eskandari 2018, and Eskandari et al. 2021), and Tal-i Iblis (7 vessels, the Middle phase, Kerman, Caldwell 1967). As a result, the total number of vessels used for social network analysis amounts to 1223.

Various kinds of software and applications can conduct social network analysis and visualize networks, such as Pajek, Gephi, Cytoscape, visone, and R packages statnet and tnet. In this paper, I adopted and followed Matthew A. Peeple's R markdown script using statnet and tnet (Peeples 2017). In this paper, nodes of painted pottery networks are 27 archaeological sites. Edges connecting these sites were calculated and judged from the Brainerd-Robinson similarity coefficient (Brainerd 1951; Robinson 1951; Peeples 2011) of the classification result of horizontal design structures. This coefficient expresses the degree of similarity between two different assemblages in terms of proportions of categorical types (design structural types in this paper). Because this coefficient deals with proportions of categorical types, the difference in the original sample size of assemblages causes a serious problem. In this paper, when the Brainerd-Robinson similarity coefficient is more than 0.75, an edge is connected between two sites.

3. Result: classification of horizontal design structures

As a result of the classification of horizontal design structures on exterior-painted open vessels, I subdivided them into twelve types (DE1-12, Figure 2). Below I will describe the character of each DE type and its frequency in time and space.

DE1: with lower body bands and with upper/lower optional lines

This type and DE2, DE3, DE10, and DE11 have the lower body band on the middle part of the body. Hence their painted decoration exists mainly on the upper part of vessels. This first structure pattern was the most frequent in open vessels painted on their exteriors in southern Iran (36.1 % of all the analyzed samples). This type was preferred in the Middle and Late phases, especially in Fars.

DE2: with lower body bands and without upper/lower optional lines

This type accounts for 14.1 % of all the analyzed samples. It frequently appeared in the Middle and Early phases. In these phases, it is common in Susiana and Behbahan. It became common at Kerman in the Middle phase.

DE3: with lower body bands and without upper/lower frieze line

The proportion of this structural type in the whole analyzed vessels was 13.4. This type was popular in the Early phase and Susiana and Deh Luran.

DE4: without lower body bands and with upper/lower optional lines

This type and DE5, DE6, DE9, and DE12 expands the range of painted decoration to the whole part of vessels, allowing painters to draw larger and more complex designs to ceramic vessels. This type accounts for 12.4% of all analyzed vessels. This type became preferred in the Late and Middle phases.

DE5: with neither lower body bands nor upper/lower optional lines

This type accounts for 13.4 % of total analyzed vessels. It is present in the Middle and Late phases.

DE6: with neither lower body bands nor upper/lower frieze line

The proportion of this type is 12.3 % of all the samples. It is present in the Late phase of Fars and the Early phase of Susiana.

DE7: without rim bands

This type and the following structural types appeared much less than those mentioned above (0.7 – 4.3 % of total samples). DE7 is present in the Early phase of Susiana and the Late phase of Fars.

DE8: without rim bands and with lower body bands and upper frieze line

This type is present in Chogha Mish (the Early phase, Susiana) and Tal-i Iblis (the Middle phase, Kerman).

DE9: filled with black paint

This minor type is present only in Early phase of Susiana.

DE10: with upper body bands and lower body bands

This type and DE12 appeared only in high vessels and have upper body bands. This type is present in Susiana, especially in the Late phase.

DE11: without rim bands and with lower body bands

This type appeared only in Parchineh.

DE12: with upper body bands and without lower body bands

This final type appeared only in the funerary assemblage at Susa.

4. Result: visualizing the painted pottery network

Figure 3 shows the relationships of 27 archaeological sites of all phases (the Early phase: white, the Middle phase: black, the Late phase: gray) in one graph. The archaeological sites are plotted based on their geocoordinates. This graph visualizes the general similarity between Susiana and Fars and the difference of Kerman sites from those in other regions.

However, this graph does not consider that horizontal design structures changed over time. In fact, they changed at least in the Kur River Basin (Miki 2022). The next step is to seek the diachronic change of these painted pottery networks.

Figure 4 presents the visualization of painted-pottery network patterns in the Early, Middle, and Late phases respectively. In the Early phase, Sites in Deh Luran and Susiana were connected, but sites in Fars had no connections with them. In the Middle phase, similarity connections became extended from Deh Luran to Fars. Finally, in the Late phase, edges of similarity connecting sites decreased.

Besides visualizing the connections between archaeological sites, social network analysis can also quantitatively present network patterns characteristics using centrality measures. Among these centrality measures, here I focus on degree centrality. Degree centrality means the number of ties that each node has. In the Early phase, the maximum degree centrality was one (Tepe Sabz and Chogha Mish). In the Middle phase, the maximum degree centrality increased to five (Hakalan, TB73, Tall-i Skau, Tall-i Regi, Khusu). Finally, in the Late phase, it decreased again to one.

5. Discussion

The previous section showed the classification result of twelve horizontal design structure types of exterior-painted open vessels and their diachronic and regional patterns. Subsequently, I visualized the painted-pottery networks and their diachronic changes based on the pottery attribute. This visualization result shows more regionalized phases (the Early and Late phases) and a more homogenized phase (the Middle phase). As already noted, horizontal design structures require more direct modes of communication to be transmitted from one potter in one region to another. Hence, it implies three hypotheses about interregional interactions and regional manifestation below:

1) The direct interregional interaction increased toward the Middle phase and then decreased in the Late phase.

2) Although the interregional interaction remained active in the Late phases, potters in each region enhanced the regionally specific

characters of horizontal design structures for some reasons (for example, for strengthening regional identities).

3) Both the degree of interregional interaction and the degree of emphasizing regional variabilities played a role in the phenomenon of regionalization of the Late phase.

By comparing network patterns of horizontal design structures with those of motif elements, vessel forms, or other materials, we will know more about the diachronic change of interregional interactions in southern Iran. As for the debate on the expansion mechanism of black-on-buff ceramics, while the expansion mechanism during a more homogenized phase (the Middle phase) can be both the migration of specialist potters (Alizadeh 2006) and the active exogamous marriage of potteresses (Weeks et al. 2010), those during more regionalized phases remains a question. One might say that the transmission via exogamous marriages was more likely in these phases given its possibly shorter-distance movement of potteresses than the migration of potters/ potteresses. As with hypotheses about interregional interactions, comparison with networks of other attributes can get more clues regarding the expansion mechanism.

6. Concluding remarks

In this paper, I attempted to approach the expansion mechanism of black-on-buff ceramics through social network analysis. For this attempt, I focused on horizontal design structures on exterior-painted open vessels. I could define twelve design structural types from 1223 published/unpublished vessels from 27 sites ranging from Luristan to Kerman in space and from the sixth to late fifth millennium BCE in time. In addition, I visualized painted-pottery networks in the Early, Middle, and Late phases and measured their degree centralities, indicated that the degree of homogeneity increased and then decreased. I raised three hypotheses concerning interregional interactions behind the expansion mechanism.

There are still several limits to this study. The first and the most crucial problem is the deficiency of targeted archaeological sites. The actual painted-pottery networks, including both excavated sites and unexcavated sites, would be quite different from the result presented above in the future. Further excavation projects and subsequent publication is required. Second, this study's chronological subdivision (the Early, Middle, and Late phases) and the classification system of horizontal design structures (DE1-12) are rough and preliminary, requiring much refinement. Third, one problem lies in edges expressed by Brainerd-Robinson's similarity coefficient; this measure is influenced by sample sizes and is reductive. We need further qualitative considerations.

Although these methodological drawbacks still exist, this paper could provide the empirical result to the debate on the expansion mechanism of black-on-buff ceramics. In the future, the same kind of social network analysis based on other pottery attributes like painted motifs and vessel forms will further clarify the detail of this expansion process.

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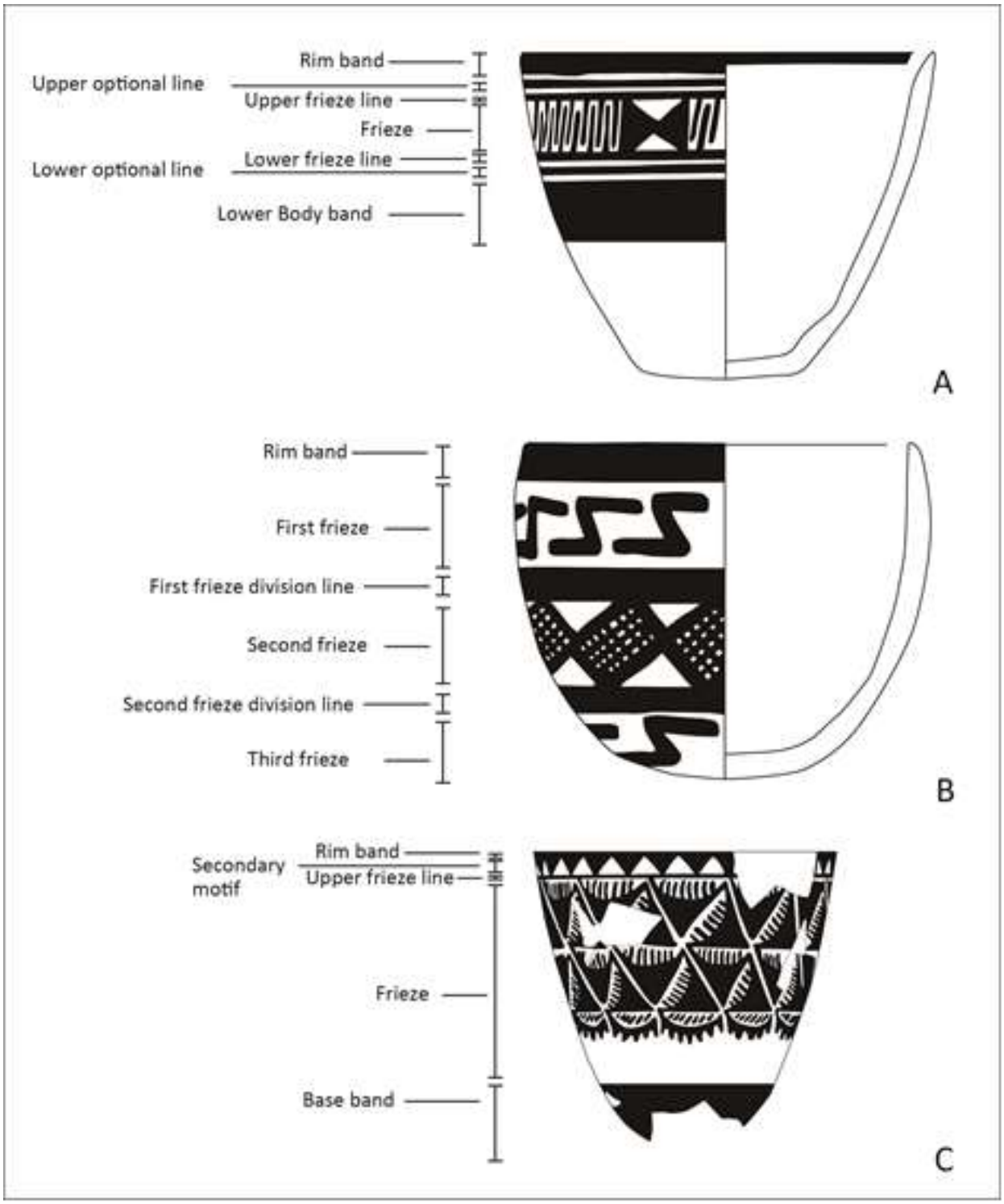

Figure 1. Terminology of horizontal design structures of exterior-painted open vessels (retraced from Egami and Sono 1962: Fig.24:1; Egami and Masuda 1962: Fig.20:5; Langsdorff and McCown 1942: Pl. 26:8)

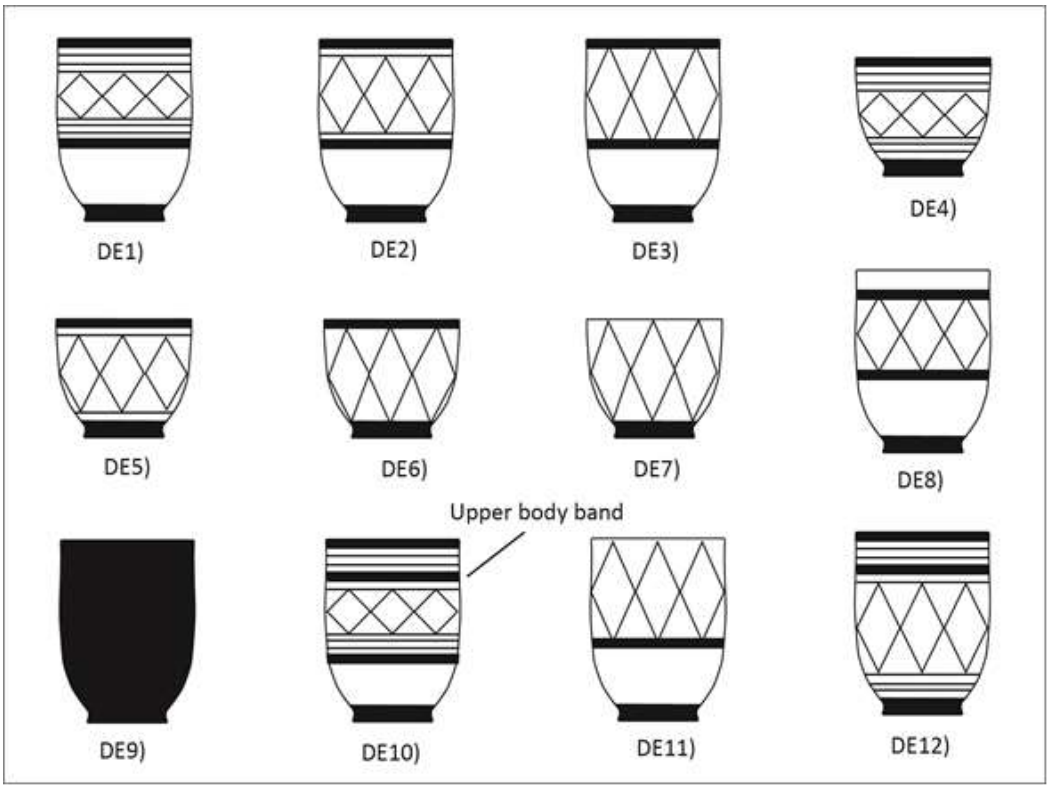

Figure 2. Schematic examples of horizontal design structure patterns of open vessels painted on their exteriors (DE1-12)

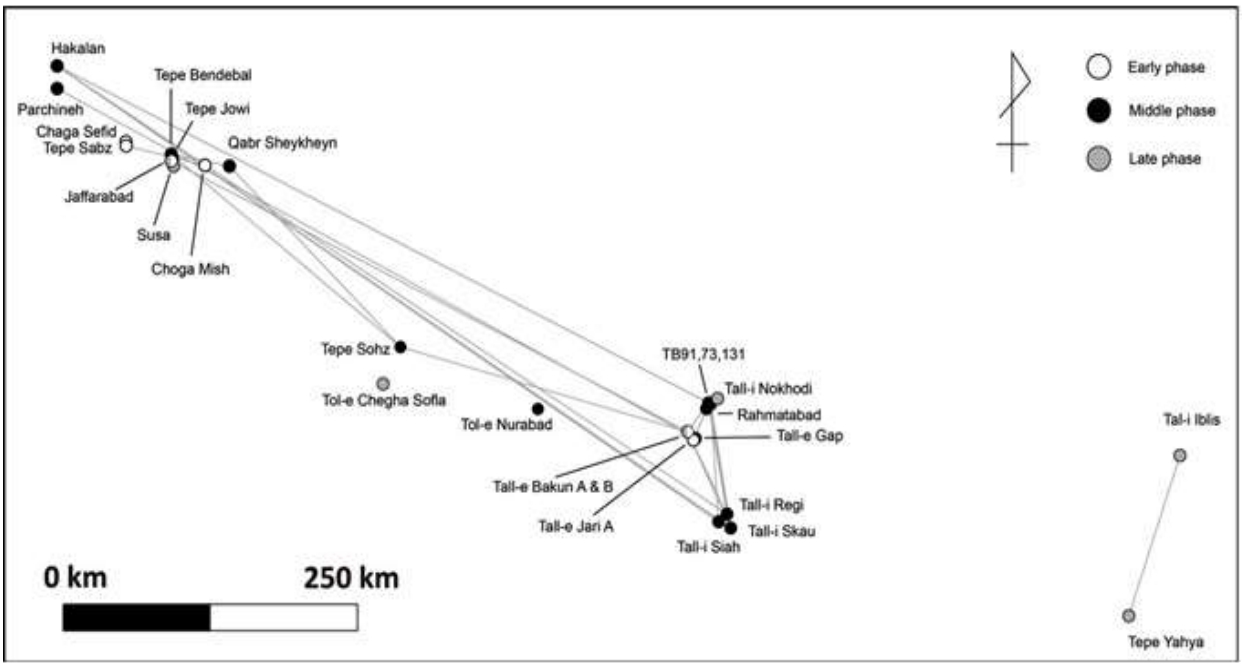

Figure 3: Painted pottery network of 27 archaeological sites of all phases (the Early phase: white, the Middle phase: black, the Late phase: gray). The nodes (archaeological sites) are plotted following their geocoordinates.

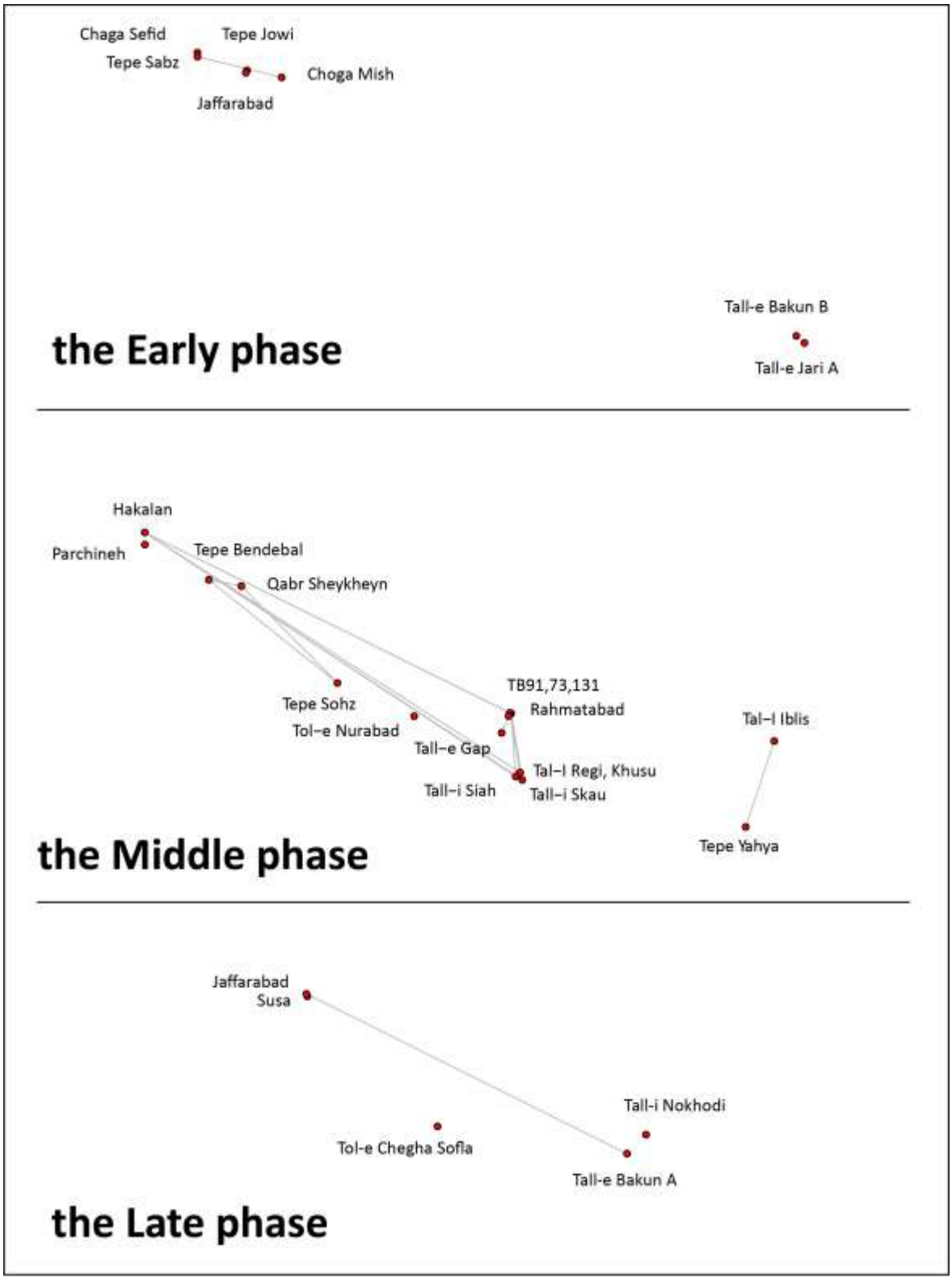

Figure 4. Painted pottery networks in the Early, Middle, and Late phases.The nodes (archaeological sites) are plotted following their geocoordinates.

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