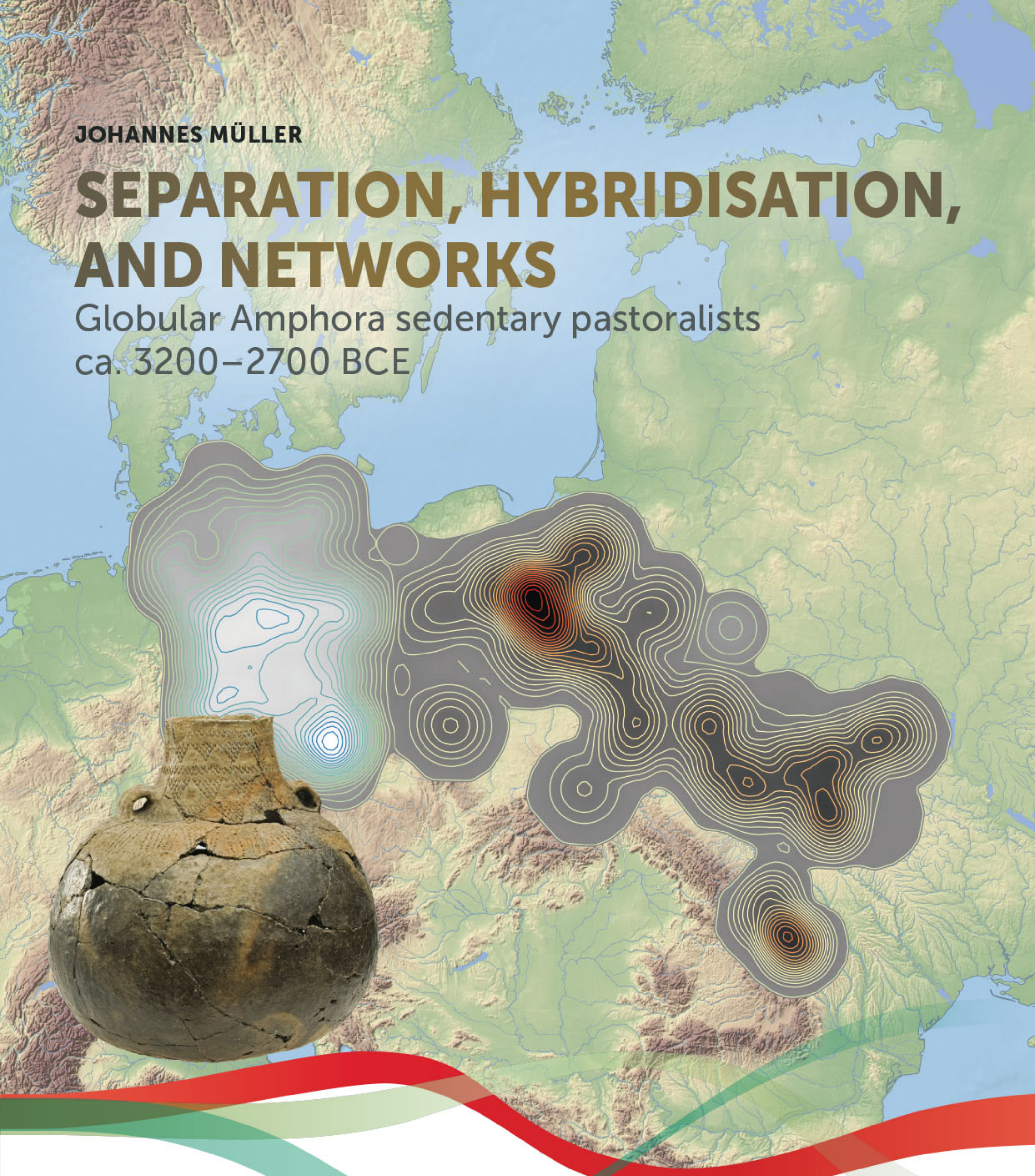
JOHANNES MÜLLER

SEPARATION, HYBRIDISATION, AND NETWORKS

Globular Amphora sedentary pastoralists ca. 3200–2700 BCE



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Preface of the series editors

With this book series, the Collaborative Research Centre *Scales of Transformation: Human-Environmental Interaction in Prehistoric and Archaic Societies* (CRC 1266) at Kiel University enables the bundled presentation of current research outcomes of the multiple aspects of socio-environmental transformations in ancient societies. As editors of this publication platform, we are pleased to be able to publish monographs with detailed basic data and comprehensive interpretations from different case studies and landscapes as well as the extensive output from numerous scientific meetings and international workshops.

The book series is dedicated to the fundamental research questions of CRC 1266, dealing with transformations on different temporal, spatial and social scales, here defined as processes leading to a substantial and enduring reorganization of socio-environmental interaction patterns. What are the substantial transformations that describe human development from 15,000 years ago to the beginning of the Common Era? How did interactions between the natural environment and human populations change over time? What role did humans play as cognitive actors trying to deal with changing social and environmental conditions? Which factors triggered the transformations that led to substantial societal and economic inequality?

The understanding of human practices within often intertwined social and environmental contexts is one of the most fundamental aspects of archaeological research. Moreover, in current debates, the dynamics and feedback involved in human-environmental relationships have become a major issue, particularly when looking at the detectable and sometimes devastating consequences of human interference with nature. Archaeology, with its long-term perspective on human societies and landscapes, is in the unique position to trace and link comparable phenomena in the past, to study human involvement with the natural environment, to investigate the impact of humans on nature, and to outline the consequences of environmental change on human societies. Modern interdisciplinary research enables us to reach beyond simplistic monocausal lines of explanation and overcome evolutionary perspectives. Looking at the period from 15,000 to 1 BCE, CRC 1266 takes a diachronic view in order to investigate transformations involved in the development of Late Pleistocene hunter-gatherers, horticulturalists, early agriculturalists, early metallurgists as well as early state societies, thus covering a wide array of societal formations and environmental conditions.

With the monograph presented here, we approach a period of intense transformation: the changes in Europe around 3000 BCE. The author combines results from different fields of research, from material culture studies to bioarchaeological and palaeogenetic enquiries. As a result, a new picture of the so-called Globular Amphora Societies becomes discernible, in which sedentary pastoralists not only monopolise ritual practices but also build large interaction networks. Separation, hybridisation and socio-environmental transformations become discernible and form the basis for huge cultural changes.

As editors of the series, we would like to thank Nicole Taylor and Eileen Kücüküraca for the scientific editing and translation work, and Ralf Opitz for the graphic editing of the illustrations. Thanks are also extended to Sidestone Press, as always, for the smooth organisation of the publication process.

Wiebke Kirleis and Johannes Müller

Preface of the author

Globular amphorae have occupied archaeological research for almost 130 years. Almost 30 years ago, I was confronted with the special role of this phenomenon, which developed around 3000 BCE, in the context of sociochronological studies on the Central German Neolithic. Starting with regional studies, a few years later it was the collaboration with Marzena Szymt (first as a Humboldt Fellow at our university) that paved the way to more detailed studies. She further introduced me to the study of this subcontinental phenomenon, and I am extremely thankful for this GA-friendship.

Within the framework of the CRC 1266, we have been working intensively at a conceptual level since 2016 on the transformations at the transition from the fourth to the third millennium BCE. Globular Amphora societies play an important role in these transformation processes as the first larger phenomenon of subcontinental size. The attempt to bring together analyses of material culture, settlement remains, ecology, demography and economy, and ritual questions, on the basis of settlement archaeological and typochronological studies on the one hand, and environmental and bioarchaeological investigations on the other, led to a new, additional model of Globular Amphora networks, which is now presented here in book form.

The presented results would not have been possible without the help of numerous colleagues and friends. Ilja Saev created the basis for a ceramic database back in 2010 and extreme thanks are due to him for the rigorous work that resulted in his diploma thesis. For their work on programming, implementation and support regarding GIS work, and the discussion of statistical questions, thanks go to Julian Laabs, Clemens Kruckenberg and Jan Eric Schlicht, as well as to Ben Krause-Kyora for advice and help with palaeogenetic questions. Archaeobotanical and palaeoclimatic aspects could always be discussed with Walter Dörfler, Ingo Feeser, Wiebke Kirleis and Mara Weinelt. Information or fruitful discourse was also provided by Jonas Beran, Miroslav Dobeš, Martin Furholt, Volker Heyd, Verena Hubensack, Niels Johannson, Sławek Kadrow, Jan Kolar, Kerstin Lehmann, Jaroslav Peška, Knut Rassmann, Robert Staniuk, Bettina Stoll-Tucker, Piotr Włodarczak and many others. Discussions on the topic of Globular Amphora and contemporary regional groups could always be held with Barbara Fritsch and Marzena Szmyt. Many thanks to all of them.

The work presented here was partly completed during a visiting professorship at Gothenburg University. Thanks for hospitality and discussions are due to the colleagues there, including Karl Göran Sjoegren, Bettina Schulz-Paulson and Kristian Kristiansen. The stay in Gothenburg was made possible by the Swedish Riksbank's Research Award for Swedish-German Scientific Cooperation.

I am extremely grateful to Eileen Kücükaraca for the English translations and scientific editing, Nicole Taylor for the scientific editing and especially Ralf Opitz, who patiently carried out most of the graphic work. Thanks also go to Karin Winter and Janina Cordts for help with some of the illustrations.

The book would not have been possible without the patience of my wife Barbara Fritsch and my daughter Charlotte Fritsch. Sincere thanks go to them as well.

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Johannes Müller

Contents

1. Globular Amphora communities: A matter of connectivity and transformation

> *'[…] it is undisputed that during these 500 years an intensive development of the GAC took place. At the same time, it needs to be stressed that there was not such instance that the people associated with this phenomenon composed the entire human population in a given area at any point of time. The opposite argument seems to be more reasonably supported: this population often coexisted, competed, or cooperated with other communities […]'* (Szmyt 2017, 212).

The so-called Globular Amphora phenomenon between the Black Sea and the North Sea has become an important part of European prehistory since its discovery at the beginning of the 20th century: Around 3000 BCE, in addition to regional societies, there is first evidence of a large-scale economic, political, social and ritual network spanning Europe, which introduces the history of such large networks of the 3rd millennium BCE (Fig. 1). Due to the improved source situation and the increased diversity of data of both material culture and bioarchaeology, it is possible and necessary to reassess the characteristics of the GAC (Globular Amphora Communities) from a general historical and anthropological perspective. When, how and why did the Globular Amphora phenomenon emerge? How did it develop regionally and how and why did it disappear?

Recorded are societies of a decisive European transformation phase during which interestingly new large-scale connectivities developed. Based on our theoretical understanding, we will attempt to associate almost classical-looking statistical-typological studies with geo- and bioarchaeological studies to form a picture of economic, political, social and ritual practices of the GA phenomenon.

1.1 Definitions

However, before we can delve into the respective perspectives, certain terminological definitions are useful, which are subsequently important in the interpretations of the GA phenomenon. Included are "transformation", "connectivity" as well as "mobility" and "habitus".

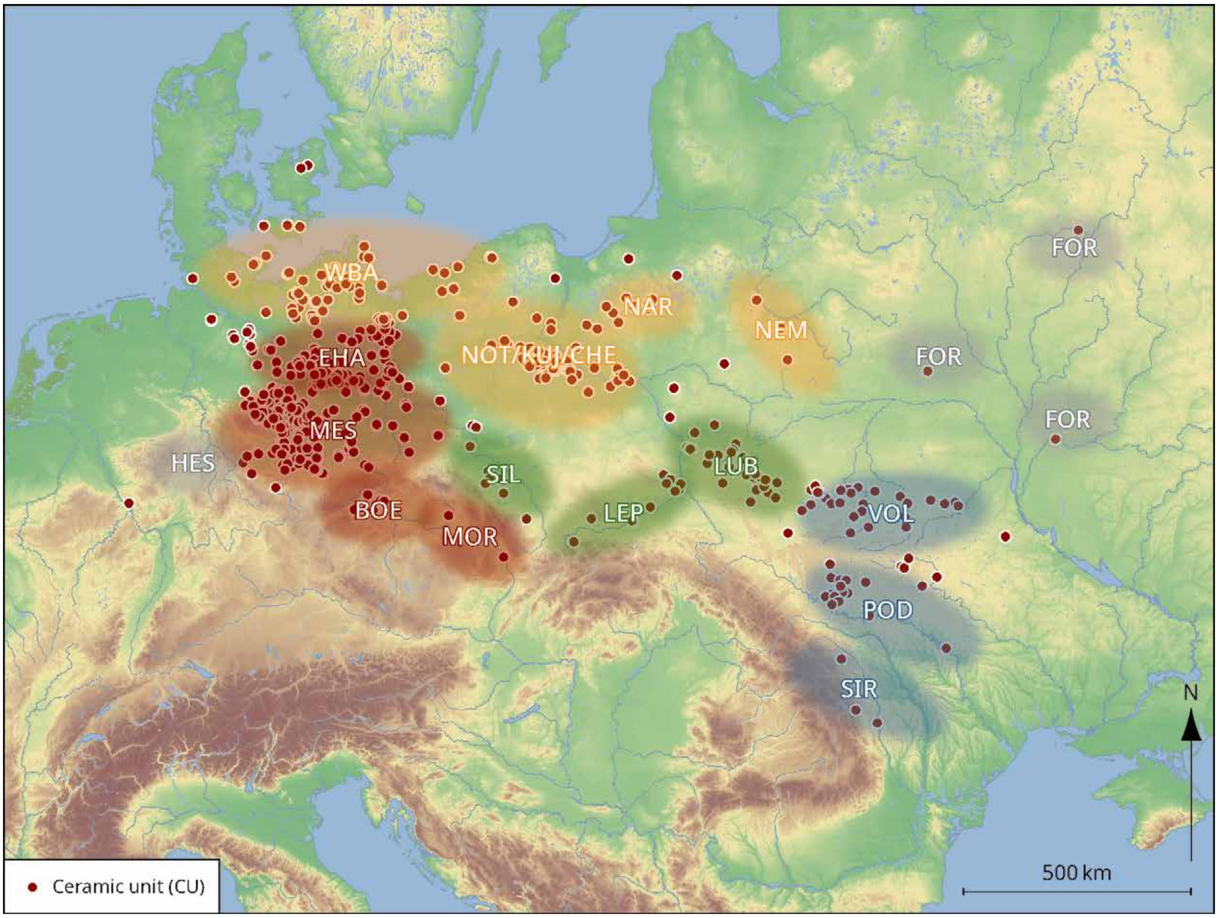

Figure 1. Globular Amphora communities occur in a wide variety of regions between the Baltic Sea and the Northwest Pontic region. In the west: the Southwest Baltic (WBA), the Elbe-Saale-Havel region (EHA), the Middle Elbe Saale region (MES), Hessen (HES), Bohemia (BOE), and Moravia (MOR); on the Eastern European Plain: Middle Noteć (NOT)/ Kuyavia (KUJ)/ Chełmno Land (CHE), Podlasie on the Upper Narew (NAR) and sites on the upper reaches of the Neman (NEM); on the southern plateaus and the lower mountain range: Lower Silesia (SIL), Lesser Poland (LEP) and the Lublin Plateau (LUB), followed in the east by: Volhynia (VOL), Podolia (POD), and the Moldavian Plateau on the Siret (SIR). Some influences are visible even further east in the Dnieper area (FOR). The colours indicate geographical links, the dots sites, from which ceramic units have been used in this study.

1.1.1 Transformation

'We define transformations primarily as condensed processes leading to a substantial and enduring reorganisation of socio-environmental interaction patterns. Transformations in prehistoric and archaic societies occur on different temporal, spatial and social scales, and thus have effects of differing degrees. The possibility is envisaged to detect the impact of certain triggers on the respective scales: human adaptation and coping strategies, the role of certain environmental constraints and societal patterns, like the shape of socio-economic and cultural systems. Furthermore, the delineation of the general structure, shape and impact of socio-environmental transformation processes is of great importance' (Müller and Kirleis 2019).

1.1.2 Connectivity and globalisation

> *'Connectivity might be seen in different scenarios and different degrees. The connectivity between environments and societies is represented on different scales, from the construction of local interconnectivities between, e.g., technologies of subsistence economies and the local environs to global climatic hazards and societal transformations (cf. Kneisel et al. 2015)'* (Müller et al. 2022, 14).

From a historical viewpoint, prehistoric and historical societies developed new forms of interconnecting, gradually becoming more complex and more numerous. At the same time, globalisation and de-globalisation processes occurred, processes we can observe today in the material record (Scholte 2017). Globalisation, viewed as a kind of combination of complex connectivities, involves

> *'a dense network of intense interactions and interdependences between disparate people brought together through a long-distance flow of goods, ideas and individuals (Jennings 2017)'* (Müller et al. 2022, 14).

During processes of increasing connectivity and through the development of shared practices, the establishment of new links as well as an increasing 'awareness' of cultural differences can be observed (Hodos 2017a). In principle, an increase in connectivities involves a sharing of cultural customs and environments, and within localised learning processes (habitus) translocal influences and networks become active (cf. Furholt 2018; Shennan 2009). Moreover, this leads to the repeated character of certain phenomena in history, which in turn, leaves traces in environmental records and societal archives (Feeser and Dörfler 2015; Gronenborn *et al.* 2014; Zimmerman 2012). However, we should recognise that recent globalisation led to a number of socio-economic tensions and the destruction of socio-cultural milieus, especially on a local scale (cf. Angelbeck and Grier 2012; Scholte 2017). In principle, the dialectic relationship between global phenomena and local reactions has to be noted.

1.1.3 Mobility

Mobility is defined as an umbrella term for the most diverse forms of mobility (cf. Burmeister 2016; Furholt 2018), ranging from (1) changes of place of residence due to marriage or age-group rules, to (2) economically or ritually determined mobility of individual persons in exchange processes of goods or commodities, and to (3) migrations. The term migration covers a wide range of different practices, starting with (1) demic migration of individual families from regions with strong population growth, through (2) immigration due to political interests, to (3) larger population movements that involve spatial changes for parts or entire societies, the latter caused, for example, by climate events, political instability, or social needs. Acculturation is understood as the adoption of innovations or entire ways of life by a local population. Integration means the joining together of non-local individuals in the local population either by maintaining different cultural practices or by adopting local practices or developing new hybrid cultural practices.

1.1.4 Habitus

> *'Habitus is the central concept because it allows us to explain and understand the multiple conditions surrounding every manufacture. It is a system of permanent dispositions, functioning as structuring structures, that is to say, as principles generating and organizing practices and ideas that can be objectively adapted to goals, without requiring conscious goal orientation and deliberate mastery of the activities*

necessary to achieve this goal. Habitus is the internalization of external structures (norms, moral orders) and generates strategies that allow a person to deal with different situations in a consistent and systematic way. Habitus leaves some space for improvisation, which is also important' (Kadrow and Müller 2019, 11).

Accordingly, the production of material goods by human communities also serves different purposes, marked by *habitus*. In addition to profane necessities, for example, to provide vessels for consumption purposes, material culture also becomes an expression of social practices. In all forms of societies, universal material objects are the product of learned practices, *i.e.*, of *habitus*, but they become medially signalling especially in non-literate societies. For objects of local production, commonalities or differences can consciously or unconsciously inform about the intensity of communication and interaction.

Due to the uniqueness of globular amphorae as locally produced material objects with supra-regional distribution, we assume that in Bourdieu's sense, differences and commonalities are the expression of more or less strongly connected learned practices (Bourdieu 1977; Arponen 2019). Thus, in terms of a descriptive heuristic, we would like to use GA (Globular Amphora) ceramics for the analysis of such connections.

With these terminological determinations, we can now turn to our actual questions and goals of the GA analysis from three perspectives.

1.2 Globular Amphora perspectives

1.2.1 Globular Amphora and globalisation

Social developments are influenced by local, regional and supra-regional ("global") events, processes and structures (Müller *et al.* 2022). In certain phases of history, we observe globalisation according to specific conditions, which always also includes regional counter-reactions: an interplay of supra-regional uniformity and regional diversity. This is visible in recent globalisation, but also repeatedly in past times during moments of unification of political, social and cultural practices (Hodos 2017b).

In most cases, different degrees of local, regional, supra-regional and global networking of the involved actors exist, based on different qualities of spatial mobility and economic, social or cultural networks. Locally and regionally anchored societies are confronted with those societies, which are organised in supra-regional network structures. Due to the different "identities" that people can assume at the same time when belonging to different social spheres, diverse spatial structures are possible: fluid, territorial or non-territorial organisational formations, depending on the local *habitus* and ecological, economic or political framework conditions (Müller 2006). Examples of actors in supra-regional networks include mobile craftsmen (*e.g.* smiths, cf. Amborn 1987) or nomadic cattle herders. Such supra-regional groups are often more mobile and restrictive than, for example, those whose economic activities are more localised. At best, there is a dichotomy between more large-scale oriented groups and social groups that are more localised.

In prehistory, we can also observe such connectivities of varying spatial and social degrees, in particular, during specific transformation processes. In Europe, for example, this is the case at the turn of the 4th to the 3rd millennium BCE. After a time of strongly regionalised archaeological groups, the emergence of large-scale almost pan-European phenomena is detectable for the first time (Furholt 2019). In Central and Eastern European societies, this is the case with the Globular Amphora phenomenon, which, from ca. 3100 BCE with a distribution ca. 230.000 km^2 across a total area for more than 300 years, is extremely distinct from the previous and contemporaneous agriculturally-oriented regional groups with less than a 10,000 km^2 populated area (Wotzka 1997, 167 fig. 3). The spatially larger network, which is visible in the material culture, is bound, on the one hand, to extensive lowland areas in the landscape and, on the other hand, often symbiotically connected to simultaneous groups of the other landscape areas. Thereby, "globular amphorae" are first of all nothing else than a specific form of ceramics. Discovered and defined at the end of the 19th century (Götze 1900), their uniformity, on the one hand, but also their diversity in regional contexts, on the other, led to a strong archaeological interest (see below). In connection with the described globalisation aspects, it will also be interesting to clarify the relationship between "global" (GA) and "regional" (*e.g.* late Funnel Beaker [TRB groups]).

1.2.2 Globular Amphora and separation: Identity construction?

There are also further aspects to the mentioned localisation of the Globular Amphora phenomenon in the context of globalisation theories (global/regional). As we will see, in most Central European distribution areas of the GA phenomenon, there is no population-genetic difference between the GAC and contemporary or earlier TRB groups. While research history has long reconstructed (in)migration scenarios for the GAC, the new aDNA analyses provide evidence of local ancestry for most areas with GA. Individuals from GA burials are genetically the same as those, who were not equipped with GA (first Tassi *et al.* 2017; Mathieson *et al.* 2018). Nevertheless, independent cultural practices developed, which enabled different references to identity – and thus also different material cultures – of the involved individuals. Social and culture identity has nothing to do with biological origin, but there is a need for explanation, since the argument of immigration in Central Europe no longer applies due to the genetic data, among other things.

For this purpose, a model could be used that should be verified. As already demonstrated, in most Central European distribution areas of the GAC settlement remains, a strong orientation to more fluvial lowland regions was noticed in contrast to the distribution of contemporaneous TRB groups in more arable areas (*e.g.* Beier 1988; Ostritz 2000). Without detailed data from archives on the subsistence economy, it has long been postulated that a contrast exists between the more supra-regionally distributed, livestock-oriented Globular Amphora representatives and the more regionally-oriented farming groups (cf. Wiślański 1964, 91). Accordingly, we want to investigate to what extent a relationship between more agriculturally-oriented and more livestock-oriented farmers can actually be substantiated.

These aspects are connected with questions concerning identity formation (Barth 1969; Hodder 1982). We want to pose the question, whether a political, social or cultural separation can be verified within the same social environment between economically differently used areas (*i.e.* more pastoral and more agriculturally used). Moreover, whether a separation of different social reference groups, which have a separate perception of identity, results from the use of ecologically different areas with different economic activities. Do different social practices develop that lead to a separation?

Such scenarios are ethnographically and ethnohistorically well proven (*e.g.* the emergence of Sami *versus* Nordic identity due to inland and coastal use of Central and Northern Scandinavia under different economic conditions (Kent 2014) or the separation of the Shuwa, Mousgoum, Sara and Kotoko in North Cameroon due to differently used ecological zones (Holl 1993)).

Of course, there may be different triggers leading to such developments. Accordingly, we will investigate various aspects of environmental developments and the state of societies at the transition to the GAC.

1.2.2.1 Globular Amphora and hybridisation

The established GA network can act very differently to the political, social and cultural practices of other regional groups – these, too, can react very differently in the context of a separation. This results in very different trajectories that are dependent on the cultural and ecological conditions of the respective regions. Principally, we observe three different qualities of the mentioned relationships: 1) regions in which only individual GA objects are integrated into the local world; 2) regions in which a hybridisation of the regional groups and the GA occurs through common sign systems; 3) regions in which GA dominate and only single objects of other groups can be identified (cf. Szmyt 2003; Woidich 2014; Stockhammer 2012). This somewhat schematic tripartite representation can be quite different in different GA phases.

1.2.3 Globular Amphora: Translocation and networks

Apart from the mentioned questions on the origin of the GA phenomenon, we must fundamentally ask ourselves what the relationships between the people in the 260,000 km^2 distribution area of the globular amphorae looked like. We assume that the respective archaeologically ascertainable manifestations of material culture reflect the *habitus* on site just as the political economy is archaeologically ascertainable through the subsistence. The degree of similarity of everyday sign systems can be implemented to describe the proximity of cultural practices and thus to reconstruct the density of communicative actions (cf. Clarke 1968, 375-395; Trigger 1998). How large and intensive were such "networks" that enabled the exchange of goods and humans – the translocation? On the one hand, this actually will be concerned with the reconstruction of mobility areas and, on the other hand, with questions of internal mobility, *i.e.* the organisation of the domestic mode of production. In the most plausible models presented thus far, the fluid settlement remains of the GAC were more likely to be identified with a less site-specific settlement behaviour, in which the communities oriented themselves more towards ritual places as memorable fixed locations (Szmyt 1996). The similarities of material culture, which presuppose internal mobile translocation, can surely also be explained by an investigation of the question of the local, regional and supra-regional character of mobility.

1.3 Methods

In order to condense the three mentioned aspects, a certain methodological path will be followed, which is reflected in the chapter structure of the book:

1. First, the state of the art and the environmental conditions, among others, will be presented as the basis of GAC development.
2. A spatially-oriented, typological comparison of the GA is used to question the spatial extent and typological grouping. We assume that the locally produced ceramics with their decorations in non-literate societies reflect the *habitus* of local contexts. Thus, phenomenological similarities and differences can be interpreted in the sense of a communicative and cultural proximity or distance. Proceeding from a basis of 1987 spatially located GA ceramics, vessel forms, decoration techniques and decorations are investigated from a spatial-statistical perspective. The basis of the approach is, on the one hand, a spatial representation of single characteristics and, on the other hand, a summary of the

ceramic multidimensionality according to CA (Correspondence Analyses) and PCA (Principal Component Analysis), whose factors are spatially represented. In this analysis, a chronological differentiation is deliberately omitted, since the focus is placed on the basic spatial structures of GA networks and not yet on their development.

3. An evaluation of the currently available ^{14}C data for the GA phenomenon serves to globally record the chronological depth of the phenomenon, but also to describe the regional differences. With Bayesian dating of individual finds and sites, but also regional inventory groups, existing regional chronologies will initially be evaluated and developed. Bayesian dates according to the type of finds enable the chronological presentation of certain phenomena on a regional and transregional basis, for example, of animal burials. Subsequently, a spatial-statistical overall evaluation of all GA data will be conducted. As a result, on the basis of the investigated spatial structures in the second chapter, chronological developments can now be presented in a dedicated manner. Thus, the emergence of certain social or ritual practices can be chronologically verified. Among other things, the following questions will be addressed: In which regions of globular amphora distribution can the earliest GA currently be observed? With which typological traditions can the GA be associated here?
4. A consideration of the development in one region (the Middle-Elbe-Saale region [MES]) serves to decode a regional development, particularly in relation to contemporaneous ceramics. Here, the relationship between more agricultural and more pastoralist-oriented groups is discussed and not only the question of the economic focus, but above all of the ritual exchange is addressed. For the chosen region, the first step deals with the statistical evaluation of the regional chronological development of both the GA and the regional groups. Based on these results, available information on settlement patterns, the economy and the overall development can be discussed.
5. With the spatial and chronological location and the regional example, we turn to the available information on the economy. These are collected and evaluated.
6. The same is done regarding the settlement processes. Here, the respective GA remains are classified and evaluated.
7. Based on the available data, the aDNA and isotope values are evaluated with regard to the question of mobility.
8. In a comprehensive overview, a verification or a falsification of the initial questions is conducted. Is it possible to design a 'global' model for the GA based on the new results or do we have to assume that the elements of material culture, which are phenomenologically similar, are used with completely different meanings?

Based on this procedure, we can turn to the state of the art and the geographical conditions of the GA phenomenon.

1.4 Integration into previous research

Without having to go into the "entire research history" of the GAC, which is presented elsewhere (cf. Beier 1988; Szmyt 1996; Szmyt 1999; Woidich 2014), only a few aspects of the state of the art will be briefly presented here.

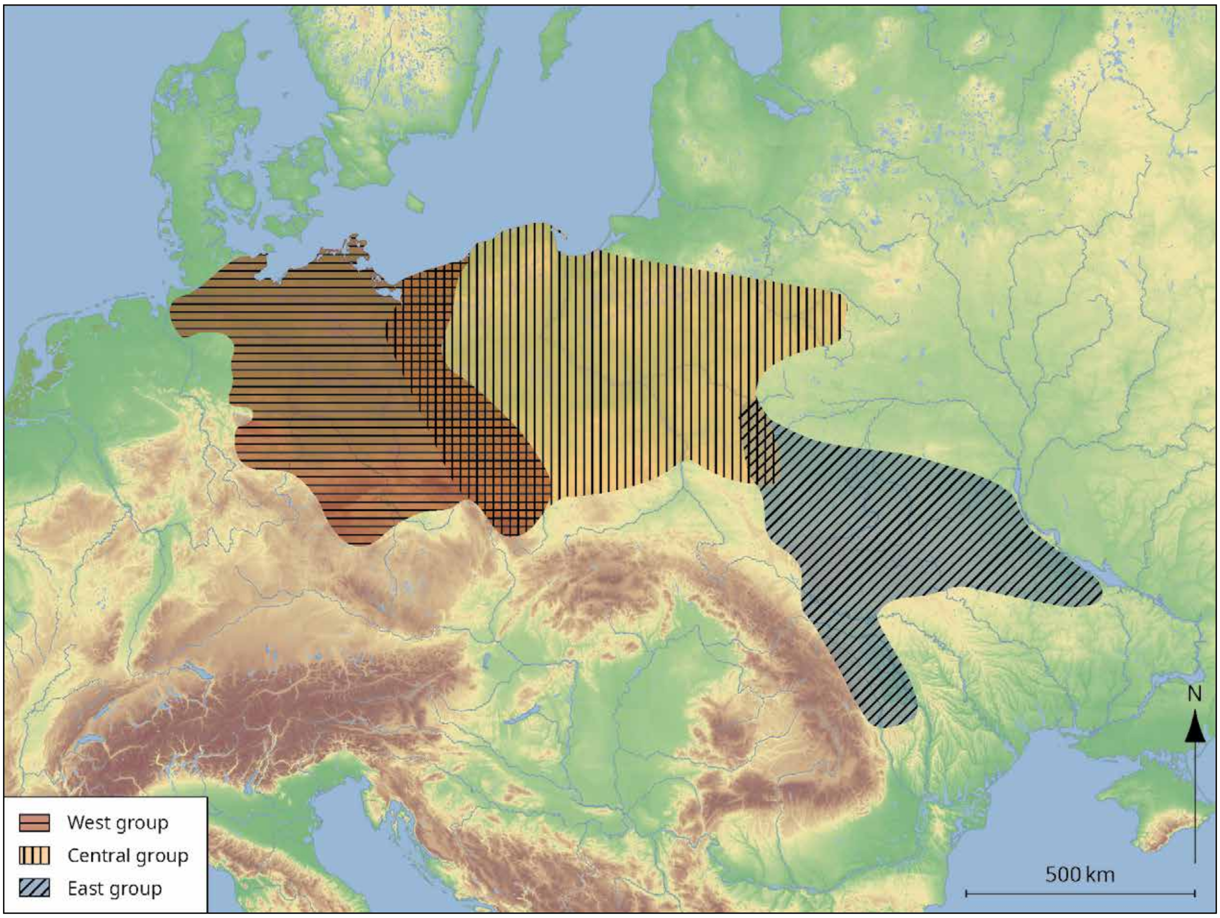

Figure 2. Globular Amphora communities have been divided in a West, Central and an East Group (cf. Wiślański 1964; Szmyt 2003, 404, fig. 1).

1.4.1 Regional and transregional studies

Since the definition of the Globular Amphorae phenomenon by Götze in 1900 and the reconstructions of migrations movements, for example, by Kossinna and Gimbutas (Kossinna 1926; Gimbutas 1994) during the first half of the 20th century, numerous regional studies have been conducted, in which GA inventories were presented as find catalogues (cf. Chap. 2). Among the larger summarising works, those by Wiślański should be particularly mentioned (Wiślański 1966).

The last transregional comparisons of the GA phenomenon were made in a study on the western GA phenomenon (Woidich 2014), on the central group, especially in Kuyavia (Szmyt 1996) and on the eastern group (Szmyt 1999) (Fig. 2). Moreover, different studies are available on models of the settlement processes and on aspects of the transregional distribution of the GA according to core, edge and peripheral zones (Szmyt 2003). Intensive discussions of regional aspects of the GA are known for the MES (Beier 1988; Müller 2001; Woidich 2014), for the Central Group in Kuyavia (Szmyt 1996) and for the Moldavian and Ukrainian East Group (Szmyt 1999). Basically, a spatial division into a West Group, a Central Group and an East Group is currently used.

1.4.2 Chronologies

In the aforementioned works, a transregional chronology proposal was made for the West Group based on the decoration techniques (Woidich 2014), which corresponds to Wiślański's ideas on the periodisation of the GAC in Poland. For various regional groups of the GA, chronological attempts are available (Müller 2001; Szmyt 1996;

Szmyt 1999). In all chronology systems, interactions with other local and regional, but also transregional phenomena (such as Corded Ware) play a role. Terminologically, the term GAC is not always understood to mean the same thing. Thus, for questions of chronological synchronisation, the term "Classic GAC" is comparable to what is understood elsewhere by GAC: Globular Amphorae have to be observed in phases that are labelled as GAC.

1.4.3 Settlement patterns and economy

The most mature model on the settlement patterns has been presented by M. Szmyt. She views grave groups and cemeteries of the GAC as constant places in the landscape, while the groups which interred their dead there change their domestic location in a rotating system of a larger region around the corresponding places (Szmyt 1996). J. Beran observes GA settlement sites aligned like a string of pearls on the edges of lowland areas as a settlement principle (Beran 2004). Economically, it is generally assumed that there is a strong livestock component, which, however, does not exclude arable farming.

1.4.4 Graves

Graves are a main part of the GA sources. There are numerous studies on the GA burial ritual, which discuss and present the entire range of burial processes (cf. Woidich 2014).

1.4.5 Distribution model

Different models are provided for the origin and distribution of globular amphorae. We recognise migration models, which assume a region of origin and associate a time-delayed appearance of GA in other regions with migrations (*e.g.* Szmyt 2017). In contrast, there are ideas of a polythetic origin of the Globular Amphora phenomenon (cf. *e.g.* Beier 1988), where the interaction of various elements in a number of regions leads to the emergence of the GAC. In a systematic compilation of a few ^{14}C dates and a typological comparison, Beier (1991a) suggests that the GA phenomenon emerged simultaneously in numerous regions between the Vistula and Central Germany. Due to recent aDNA analyses, it can be assumed that the GAC are native in most regions (cf. Schroeder *et al.* 2019; but Papac *et al.* 2021).

Basically, the possibility of a re-evaluation of the currently available typologies of the GA, the absolute chronological data of the GAC, the settlement and economic data and the mobility data exists. This is attempted here with certain priorities. More or less disregarded are the burial practices, since these have been repeatedly and intensively presented and described elsewhere (cf. Beier 1988; Dobeš 1998; Müller 2001; Nagel 1985; Szmyt 1996; Szmyt 1999a; Woidich 2014).

1.5 Distribution across space and landscape

GA occur in a wide variety of various regions between the Baltic Sea and the Northwest Pontic region (Fig. 1). In the west, these include the *Southwest Baltic region*, the *Middle Elbe-Saale-Havel region* and *Bohemia/Moravia*. Apart from some ceramics, which are similar to GA, these are sites in the Southwest Baltic region in the lowlands of the East Holstein-Mecklenburg sand and moraine landscape. A main focus of the site distribution is observed along the western lowlands of the Oder River, the Havel region and finally the wide Central German black earth regions. For the latter, particularly the boundaries and marginal areas to the lowlands are important. In Bohemia and Moravia, we can also identify fertile black earth areas and their marginal areas as regions with GA sites. Isolated GA are also found further west, *e.g.*, in North Hessian-Westphalian and Franconian or in Northeast Bavarian regions as single objects in other inventories.

In eastern distribution regions, sites from the eastern North Central European lowlands are located in the *Middle Noteć* and *Kuyavia* regions to the west of the Vistula bend, and to the east of the Vistula bend from *Chełmno Land*. A certain accumulation of finds is also known from *Podlasie* on the Upper Narew. On the one hand, loamy sand and moraine areas are again affected and, on the other hand, the edges of fertile black earth-like areas, *e.g.*, in Kuyavia. Further sites are located upstream of the Vistula up to the eastern low mountain range zone or the plateaus in front of it with the regions of *Lower Silesia, Lesser Poland with the eastern Lesser Poland Plateau* and also the *Lublin Plateau*. Here we are also dealing with black earth areas or the edges of lowlands. Further east and southeast, the eastern plateaus of *Volhynia*, *Podolia* and the adjacent regions of the Moldavian Plateau on the *Siret* to the south are involved with a similar geomorphological-pedological background. Just as in the west, different sites further east that are influenced by GAC elements are finally found on the Dnieper and further north sites are also located on the upper reaches of the Neman.

In summary, the entire distribution region can be described as a connection of an Elbe-oriented concentration in the West and a NW-SE Baltic-Pontic corridor in the east, which is filled with additional sites on the Upper Oder and Vistula rivers or on the Baltic coast. Based on vegetation and sedimentological investigations, we can basically assume open spaces in the loess regions with forest-steppe-like vegetation between mixed oak forests. Interestingly, with the availability of enough precisely dated pollen archives, an increased presence of shrubs and a decrease of human impact on the vegetation is observed at the beginning of the GAC (cf. Chap. 5). Whether these ecological changes are the result of anthropogenic and climatic changes will be discussed later.

2. Space and decoration: Patterns of Globular Amphorae

2.1 Research questions and methodology: General comments

2.1.1 Research questions

The production of material items by human societies serves various purposes. In addition to profane necessities, for example, to provide vessels for consumption purposes, material culture also becomes an expression of social practices. Although universal to all forms of societies, material objects are products of learned practices, *i.e.,* of *habitus,* which especially have medially signalling effects in non-literate societies.

For objects of local production, similarities or differences can consciously or unconsciously provide information about the intensity of communication and interaction. Due to the uniqueness of globular amphorae (GA) as locally produced material objects with supra-regional distribution, we assume that, in Bourdieu's sense, differences and similarities are the expression of more or less strongly connected learned practices. Thus, in the sense of a descriptive heuristic, we want to use Globular Amphorae ceramics for the analysis of such relationships.

For the assessment of the "Globular Amphora" phenomenon, a spatial differentiation of social and cultural practices between the North Pontic region and the North Sea is significant. In addition to ritual practices, a determination of similarities and differences in the multi-dimensional material culture is an important means in order to assess the relevant phenomena. Thus, for a reconstruction of the communication structures, the analysis of locally produced ceramics is a crucial tool to detect local, regional and transregional patterns. Accordingly, these relationships will be analysed here both quantitatively and qualitatively.

Research questions include: Do clear boundaries exist between typologically defined regional groups, as they have been repeatedly postulated? Can we differentiate between a West, a Central and an East Group purely on the basis of typological features? Or are completely different spatial relationships implied if the existing data is evaluated spatially and statistically and the different research traditions that have often been generated due to language barriers are not followed? Can the typological differences that have been noted in over almost 200 years of scientific history be reaffirmed, and if so, are clear spatial boundaries or rather transitions, perhaps even non-territorially existing network structures, discernible?

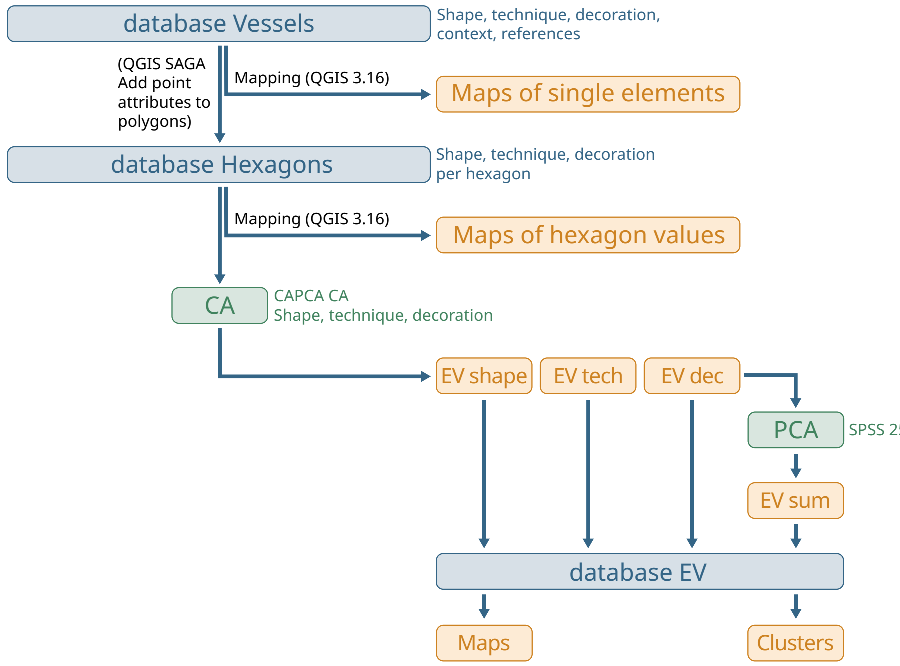

Figure 3. The workflow of the analysis. Databases are marked blue, statistics green and results orange. CA: Correspondence Analysis; PCA: Principal Component Analysis; EV: Eigenvector.

The significance of the possible results lies in the fact that corresponding spatial patterns can be descriptively recognised and thus lead to a better assessment of questions concerning the chronological development of phenomena of the Globular Amphora communities (GAC). For example, is there a clear separation between a West and a Central Group, or do smooth transitions enable a postulate of a common emergence in a common transitional field? This appears to be all the more important since the origin of the Globular Amphora phenomenon has been variously postulated from an older complex between Kuyavia and Central Germany with only a subsequent differentiation between a West, a Central and an East Group (Beier 1991a; Wiślański 1964; Szmyt 2003) (Fig. 2).

Overall, the character of the similarities and dissimilarities of the decorative sign systems used in the ceramics, including their range in the overall discussion, will assist in deciphering the form and nature of the contacts at different spatial levels.

2.1.2 Methods

Since ceramics are the largest find group in the material remains of the GAC phenomenon, vessel forms, decoration techniques and decoration elements were recorded for the entire distribution area of the GAC. Although there are numerous local and regional studies based on relevant data (Szmyt; 1996, Müller 2001; Woidich 2014), viewed 'globally', this is the first attempt of this kind since Nortmann's 1985 study on GAC decoration elements and techniques.

Taking into account the known classification systems, schemes were developed with which vessel forms, decoration techniques and decoration elements can be uniformly classified (see below; Saev 2010). Due to the improved publication situation, it was possible to include a large number of vessels from all GAC distribution regions. Those vessels were included for which the vessel form could be reconstructed.

On the basis of 1987 recorded vessels (Suppl. 1; Figs. 1 and 4), it was possible to map specific elements using queries about individual vessel types, decoration techniques or decoration motifs (Fig. 3). On this basis and with additional statistics, univariate and bivariate analyses were conducted.

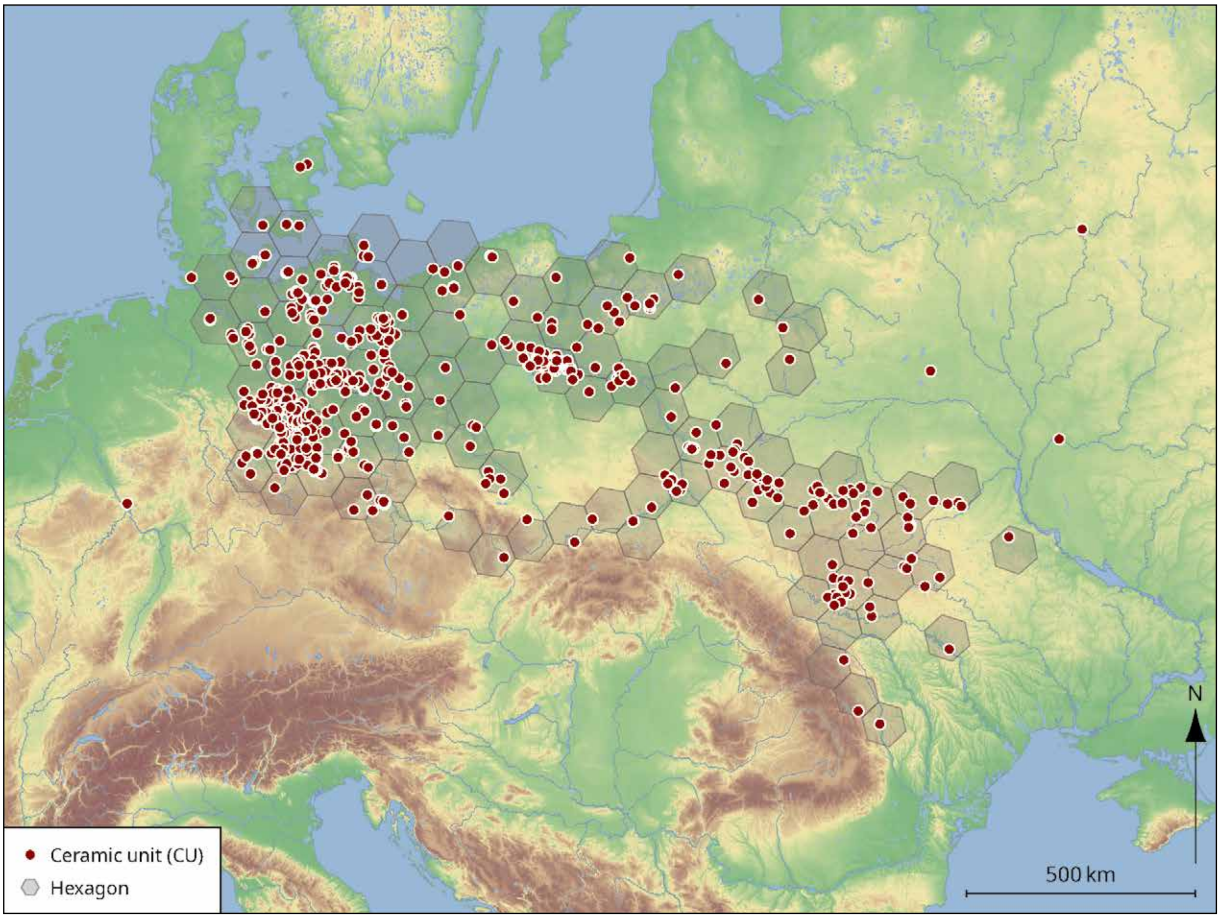

Figure 4. In order to enable multivariate analyses, the entire distribution area of the GA was divided into hexagons with a circle radius of 50 km. Categorised according to vessel form, decoration technique and decorations, correspondence analyses were conducted with the CAPCA programme (Madsen 2016) on the basis of the vessels that appear in the hexagon areas. The separate analysis of the three categories is necessary because experience has shown that mutual dependencies can exist. These could mask possible patterns in the individual categories. The results of the correspondence analyses (CA) are, among other parameters, eigenvectors that synthesise the main pattern of the data matrix.

In order to enable multivariate analyses, the entire distribution area of the globular amphorae was divided into hexagons with a circle radius of 50 km (Fig. 4). The absolute occurrence of vessel types, decoration techniques or decoration motifs pro hexagon was summarised in further data matrices (Suppl. 4-8). Thus, on the one hand, it was possible to specifically attribute the distribution to individual vessels via point mapping and, on the other hand, to relatively compare the centres of distribution with each other via the hexagon areas. With the choice of hexagons as a means of representation, a form was chosen that is independent of spatial presuppositions based on research history (Fig. 4).

For the spatial representation, the eigenvalues of the hexagon eigenvectors were used to visualise the similarities and differences between the hexagons. As a consequence, the multivariate CA enabled the representational reduction of the multidimensional space to the eigenvectors, which contain the synthesised basic patterns of the data distribution.

With this method, in addition to mapping individual elements and types, the spatial differentiation can be shown in total. The calculation of contour lines serves to further visualise the intensity of differences and similarities in the ceramic inventory. High value differences in small spaces describe existing typological boundaries, while low value differences in small spaces tend to mark ‘boundlessness’.

In order to statistically combine the results after the independent analyses of shape, technique and decoration, the overall analysis of the data stock was conducted with a Principal Component Analysis (PCA) of the first three CA eigenvectors of each of the three typological categories. The spatial representation of the results was also generated here on a trial basis using the hexagon values.

The chosen methodological path serves to instrumentalise typological studies as a descriptive element for the types of human interaction. In contrast to often dominating chronological questions, the spatial connections of social and cultural practices become recognisable, which are responsible for the practices learned in the production and use of ceramics.

2.1.3 Sources

Examining vessels according to their morphological criteria, among other things, in order to assign them to a vessel form, requires the recording of only complete or clearly reconstructable vessels, which enable the vessel shape to be established. Since the desired overall analysis consists of the triad: form, technique, and decoration, techniques and decorations were included only for those ceramic units (CUs) that enable a complete reconstruction of the vessel body. In total, 1987 CUs were recorded.

Due to data collection from published catalogues, the varying degree of fragmentation of the ceramics was unfortunately not considered. Since there are particularly well reconstructable vessels from individual graves, in our recording an overrepresentation of regions is probable in which grave inventories with their non-destroyed vessels dominate the data stock. Thus, for example, there may be an underrepresentation of the Kuyavian region in the database, since settlement contexts dominate over burial contexts there. Nevertheless, it was possible to integrate a sufficiently high number of GA from all GA regions into the database for the intended analyses.

The classification of the vessel forms occurred according to a scheme that combined the classification principles of various research traditions (see below). With some additions, the classification of the decoration techniques was based on the classification principles of Nortmann (1985) and Woidich (2014), whereas the decoration motifs were based on the classification principles of Müller (2001, 197-199) with considerable extensions based on Nortmann (1985), Meyer (1993), and Szmyt (1996; 1999a).

In addition to the site (grave, settlement) and type of find (individual find, *etc.*), vessel characteristics, decoration techniques and decoration motifs were recorded for each CU. Moreover, in addition to the vessel types and their sub-types, the number of handles, their positions on the vessels as well as the base types of the vessels were recorded, provided that the condition of the CUs and the quality of the published descriptions and illustrations enabled this.

The typological classification of GA ceramics that is conducted (Saev 2010) does not include the production technology in the basic analysis, since this is only described for a small part of GAC ceramics. It does refer to local and small regional production contexts that are discussed elsewhere, but never indicates a chronological development within GAC (Chap. 5 and 7).

Regardless of this category, which is also chronologically used in Kuyavian GAC studies (cf. Szmyt 1996), in particular, the results of the conducted investigations enable a conclusive description of the Globular Amphora phenomenon and, from our point of view, at least confirm the relevance of the methodological path followed here, which is naturally only one of many possibilities.

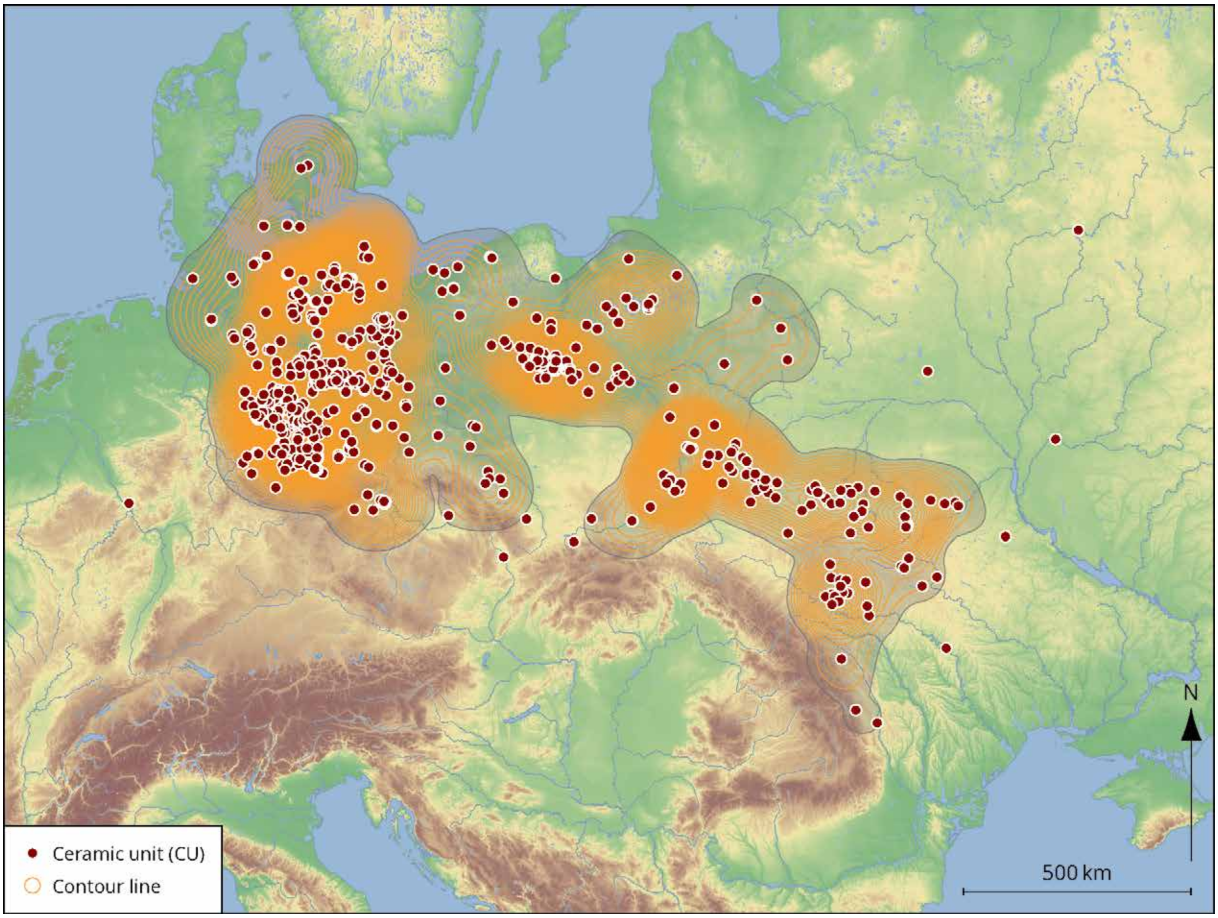

Figure 5. The contour lines of the heat mapping of the recorded GA ceramic sites describe a "western density cluster" between the Weser and the Oder rivers, a central density cluster in the Lower Vistula region, and an eastern density cluster from the Upper Vistula to Podolia and Volhynia (cf. Suppl. 1).

2.2 The database: Recorded ceramic finds

From the entire GAC distribution region, 1987 CUs from 502 sites (Fig. 4) were integrated into the database, of which 1413 were decorated CUs. As described, the qualitative criterion for inclusion was the possibility of determining the vessel form. The term "ceramic unit" includes vessel units whose vessel form is complete or can be reconstructed. Most of the recorded CUs represent complete or reconstructable vessels. A smaller proportion consisted of distinctive vessel parts, which were morphologically classified according to primary features.

The basis of the database is constituted from the CUs of the published catalogues by Struve (1953), Ebbesen (1975), Laux (1982), Meyer (1993), Maier (1991), Nagel (1985), Kirsch (1993; 1994), Beier (1988), Weber (1964; 1974), Nosek (1967), Krzak *et al.* (1977), Prinke and Wiślański (1977), Wiślański (1979), Szmyt (1996; 1999) and Svešnikov (1987). If possible, corresponding catalogues from larger regions were supplemented by accessible newer publications. This pertains mainly to excavation results from rescue excavations, which are well published, especially from Poland (Becker and Benecke 2002; Beran and Beier 1994; Beran *et al.* 2016; Bronicki 2016; Conrad *et al.* 2009; Dirks 2016; Döhle and Pape 2006; Döhle and Schlenker 1998; Heiner 2018; Przybyla *et al.* 2013; Rola 2009; Szmyt 2000a; 2004b; 2006a; 2007a; 2014; 2015a; Szmyt 2016a; Szmyt *et al.* 1997).

The sites lie in an area that mainly reaches from the Southern Cimbrian Peninsula to the Moldavian highlands (Fig. 5). The density mapping of the recorded CUs describes a "western density cluster" between the Weser and the Oder rivers, a central density cluster in the Lower Vistula region, and an eastern density cluster from the Upper Vistula to Podolia and Volhynia. The "west" is spatially separated from the Lower Vistula area by more or less find-free zones and the latter to a lesser extent also from the eastern area.

In the west, the Middle Elbe-Saale region (MES), the Elbe-Havel region, including the Uckermark, and the Southwestern Baltic region can be distinguished, as well as Bohemia, Silesia, and probably also Moravia. In the central cluster, Masuria is separated from Kuyavia and adjacent areas. Included in the eastern cluster are Lesser Poland and the Lublin Plateau, Volhynia, Podolia and the Moldavian Plateau. In addition, there are other GAC areas that are weakly recorded or only documented by individual GAC sites, for example, on the Neman and the Upper Dnieper, but also in Pomerania. In terms of density, it is a core area measuring 260,000 km^2, out of the ca. 400,000 km^2-large wider GAC-distribution area and of the ca. 1,771,000 km^2 of Central and Eastern Europe.

Since the density mapping, which takes the quantitative occurrence of the GA into account, does not contradict the traditional typological differentiation of the Globular Amphora phenomenon into a West, a Central (Polish), and an East Group (cf. Fig. 2), individual descriptive analyses were initially carried out separately for technical reasons according to this spatial threefold segmentation. The West Group includes vessels from Schleswig-Holstein and Denmark (data from Struve 1953; Ebbesen 1975), Lower Saxony and Hamburg (data from Laux 1982; Meyer 1993; Maier 1991), Mecklenburg-Western Pomerania (data from Nagel 1985), Brandenburg (data from Kirsch 1993), the Middle Elbe-Saale (MES) region (data from Beier 1988; Weber 1964; 1974) and Bohemia/Moravia (data from Dobeš 1998; Peška 2013a; 2013b). The Central Group includes the Polish sites (data from Nosek 1967; Krzak 1977; Wiślański 1979; Szmyt 1996), while the East Group includes vessels from the Ukraine, Moldavia and Belarus (data from Svešnikov 1987; Szmyt 1999a; 1999b).

2.3 Investigations of vessel forms

2.3.1 Vessel types and individual observations

The CUs were divided into 10 vessel types according to morphological criteria. The classification into these main types along with some subtypes for the entire distribution area is based on the vessel types previously described in regional and supra-regional studies in three languages (Beier 1988; Nagel 1985; Meyer 1993; Nosek 1967; Szmyt 1996; Svešnikov 1983). Thus, expert knowledge is used which has been recorded in the relevant publications from almost 150 years of typological globular amphora investigations (Tab. 1). Table 1 lists the terminology available in several languages and how it is assigned to the classification system developed here.[1]

Classified as the main vessel types are (Plates 1-8): amphorae (classical globular amphorae (V1), wide-mouthed amphorae (V2), and broad-shouldered amphorae (V4)), dishes/bowls (V3), funnel-rimmed pots (V5), steep-walled pots (V6), biconical vessels (V7), drums (V8), lids (V9) and beakers (V10). Quantitatively, globular amphorae dominate the entire assemblage (Suppl. 2). Their main distribution is located in the regional groups in the west (Suppl. 2).[2]

1 Since, in general, "[t]he attempt to identify culture-specific characteristics from the handle forms and their positioning on the vessels, [produced] no results" (Nagel 1985, 15), we dispensed with a consideration of the number of handles and their positioning on the vessels when classifying the main types of vessels. The handle and base forms enable finer differentiation of a CU within a type.

2 Potentially, the already mentioned high degree of fragmentation in the Kuyavian settlement inventories may play a role in the reconstructability of the vessel forms and thus their inclusion in the database.

Type	Term	Beier 1988	Nagel 1985	Meyer 1993	Nosek 1967	Szmyt 1996	Svešnikov 1983
V1	Globular amphora Kugelamphore	Kugelamphore	Kugelamphore	Kugelamphore	amfora kulista/ amfora jajowate/ dzban	amfora/dzban	шаровидная амфора
V2	Wide-mouthed amphora/ pot Weitmundige Amphore/Topf	Weitmundiger Topf	-	-	amfora kujawska/ amfora typu kujawskiego	amfora	шаровидная амфора/амфора
V3	Dishes/Bowl Schale/Schüssel	Schale/Schüsse/ Tasse	Schale	Schale	Misa/czara/czarka misowata	misa	миска
V4	Broad-shouldered amphora Breitschultrige Amphore	-	-	-	amfora beczułkowata	amfora	амфора с раздутым в плечиках туловом
V5	Funnel-rimmed pot Trichterrandtopf	Topf/ Trichterrandschüssel	-	Trichtertopf	pulchar/naczyn jajowaty	puchar/waza	сосуд с воронковой шейкой
V6	Steep-walled pot Toneimer	Topf mit hochliegen-dem Umbruch	Gefäß mit hochlie-gendem Umbruch	Steilrandtopf	naczyn jajowaty	garnek	сосуд с выпуклым туловом
V7	Biconical vessel Doppelkoschnisches Gefäß	Weitmundiger Topf	Doppelkonisches Gefäß	Zweihenkeltopf	amfora baniasta	amfora	амфора
V8	Drum Tontrommel	-	-	Trommel	bęben	bęben	-
V9	Lid Deckel	-	-	-	pokrywka	pokrywka	крышка
V10	Beaker/Cup Kumpf/Napf/Becher	Napf/Warzenbecher	Kumpf/Napf	Steilwandiger Becher/ Henkelbecher	czarka pucha-rowata/czarka kubkowate/kubek	kubek	кубок

Table 1. The terminology of Globular Amphora vessel shapes (modified after Saev 2010).

2.3.1.1 Globular Amphorae

2.3.1.1.1 Classification

The still generally recognised definition of globular amphorae originates from Götze (1900, 154): A globular amphora is a

> *'kugelbauchiges Gefäß mit einem zylindrischen oder zuweilen leicht konischem Hals, der nur in Ausnahmefällen leicht ausschwingend gestaltet ist' [transl.: 'globular vessel with a cylindrical or sometimes slightly conical neck, which is designed to slightly swing out only in exceptional cases'].*

Schumann (1904) described an ideal type of globular amphora: vessels that are decorated on the neck and shoulders with a round spherical belly, a sharp shoulder between the neck and belly and two handles facing each other that span the shoulders. 803 globular amphorae were included in the database, which amounts to ca. half of all the vessels, making them the dominant vessel type.

Depending on the extent of the neck, three subtypes (V1.1 to V1.3) were distinguished (Plates 1-2). Subtype V1.1 is characterised by its distinctive, relatively long neck – the height of the neck must measure at least one quarter of the height of the vessel.[3] Subtype V1.2 includes globular amphorae, which have a neck that is clearly distinct from the shoulder, but the neck height is less than one quarter of the total height of the vessel. Subtype V1.3 includes globular amphorae, which have no pronounced neck-shoulder break, but are nevertheless assigned to the globular amphorae according to Götze's (1900) definition.

3 The neck-shoulder transition is the zero point from which measurements are made upwards. The vessel height is the distance between the highest point of the neck and the lowest point of the base. This measuring method, which initially appears to be self-evident, should be maintained, especially in the case of irregularities in the neck or base structure.

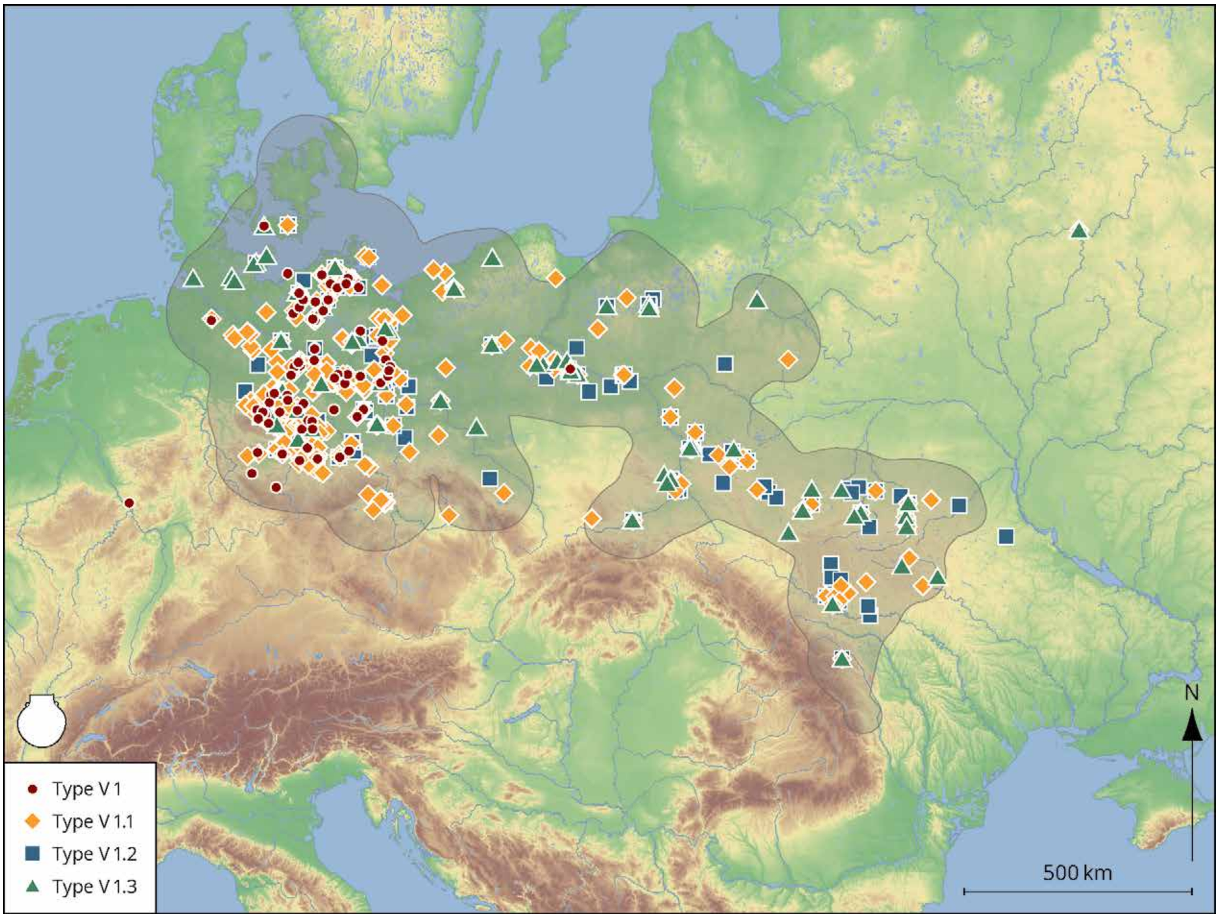

Figure 6. The distribution of Globular Amphora vessel types. In the West Group, V1.1 globular amphora vessels are dominant, whereas the distribution in the Central Group and the East Group is more balanced (cf. Suppl. 2).

For 131 CUs, it was not possible to determine a subtype (V1.0). 414 CUs belong to subtype V1.1, 169 to subtype V1.2 and 89 to subtype V1.3 (Suppl. 2). In the West Group, V1.1 globular amphorae are dominant, whereas the distribution in the Central Group and the East Group is more balanced (Suppl. 2; Fig. 6). The differences between the Central Group and the East Group are minimal and statistically non-significant.

2.3.1.1.2 Observations on the GA belly form

Differentiations in the globular amphora vessel form that are found elsewhere in the literature are not pursued further here. The subdivision of the globular amphorae into globular ("Amfora kulista") and egg-shaped ("Amfora jajowata") amphorae, as used by Nosek (1967, 433-434, cf. tab. 1 and 2) for the Central Group, did not lead to any spatial differentiation in the evaluation. The subdivision of the globular amphorae in Beier (cf. 1988, 15), including the belly form, appears to complicate things and is statistically not relevant. Faßhauer (1956) experimentally reproduced the structure of the globular amphorae. In comparison to the subdivision of Beier (1988), he already came to the conclusion that the different characteristics of the belly cannot be implemented as a classification feature for the derivation of form development. A statistical analysis of Central German GA, which examined this question, also came to the conclusion that a subdivision in categories based on the belly form is not expedient (Fig. 7).

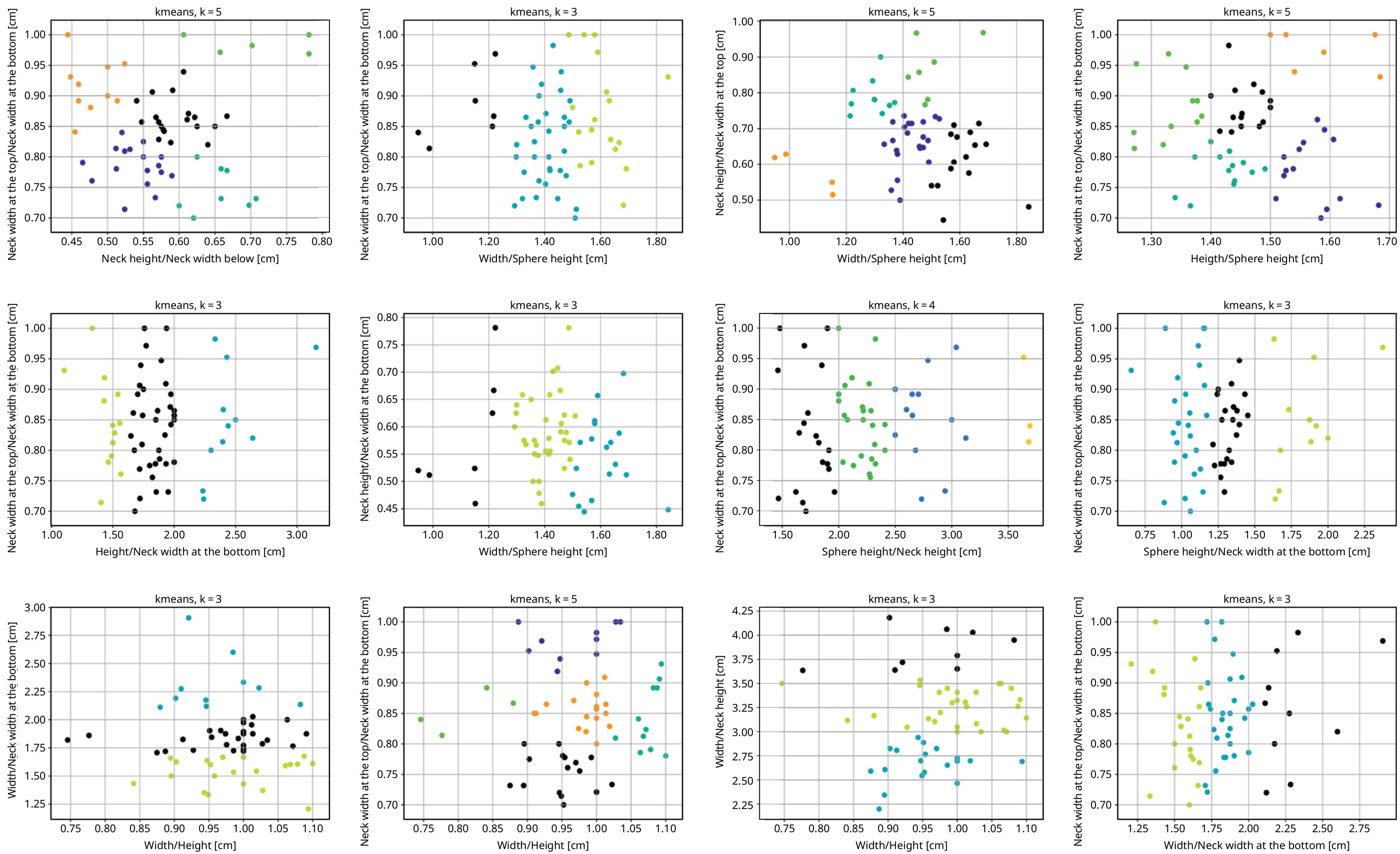

Figure 7. A statistical analysis of Central German GA did not indicate any statistical relevant subdivision of vessel shapes based on the belly form. The comparison of different ratios of vessel shape variables does not display relevant clusters. The display of the six best index combinations does not indicate any clustering with the best silhouette scores (cf. Suppl. 3).

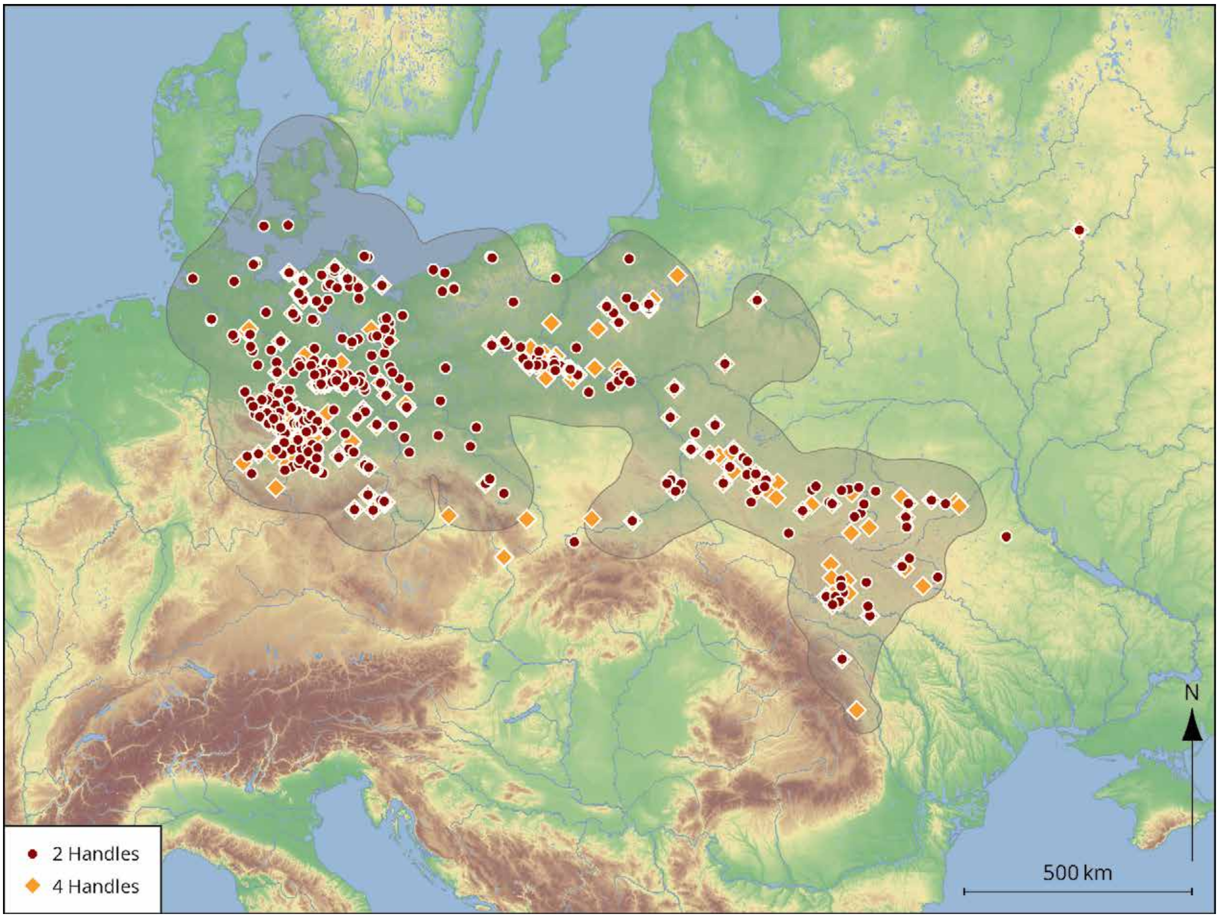

Figure 8. The distribution of GA with two and four handles. GA with two opposing handles are most prevalent in the West Group. Four-handled amphorae, which are relatively seldom known from the West Group, mostly occur in the Central and the East Groups.

J. Müller (2001, 197) maintained that

> *'eine Unterteilung der Kugelamphoren in Untertypen […] sich nicht an[bietet], da ein Vergleich der Längen- und Breitenmaße einzelner Gefäßteile keine natürliche Klassenbildung ergibt.' [transl.: 'a subdivision of globular amphorae in subtypes […] is not useful, since a comparison of the length and width dimensions of individual vessel parts does not provide a natural class formation.'].*

In contrast, the analysis conducted here showed that the shape of the neck in comparison to the vessel height can serve as a feature for the formation of GA subtypes, which provides information on the spatial differentiation of regional groups.

2.3.1.1.3 Observations on GA handles

The number of handles on globular amphorae can vary between one and four, as can their position, either facing each other or side by side. Most common are two opposing lugged handles, usually with a rounded, rectangular cross-section at the neck-shoulder transition (Suppl. 2). The lugs are usually drilled through horizontally.

In the regional groups (Suppl. 2), GA with two opposing handles are always in the majority, but they are most prevalent in the West Group. The Central Group and the East Group do not differ here. Instead, four-handled amphorae, which are hardly known from the West Group, mostly occur in the Central and the East Groups (Fig. 8).

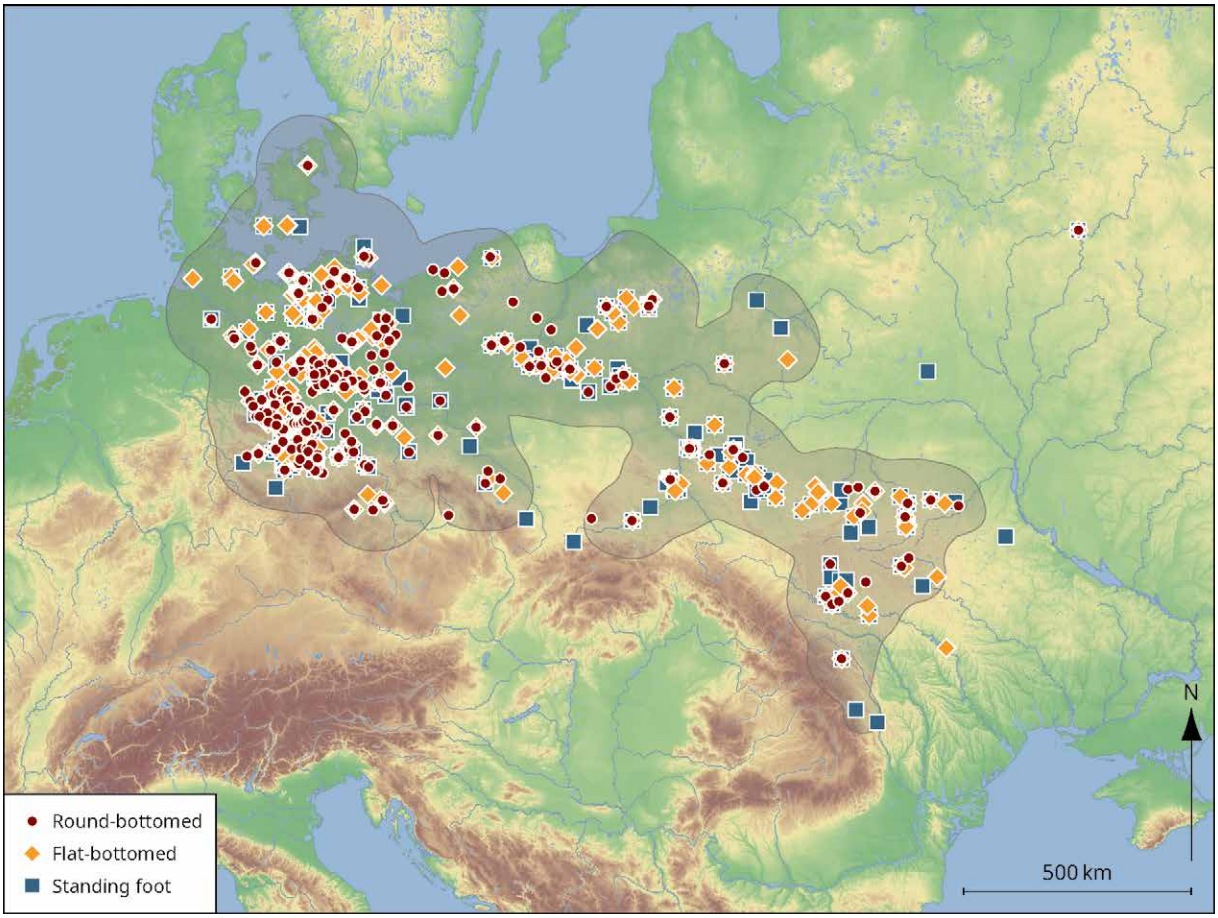

Figure 9. The distribution of GA base forms. Round-bottomed GA dominate in the West Group, while the base distributions in the Central Group and the East Group are more balanced (cf. Suppl. 2).

2.3.1.1.4 Observations on GA bases

The bases of the globular amphorae are primarily round, seldom flattened. Even rarer are flat-bottomed GA and GA with a pronounced standing foot (Suppl. 2). Spatially, round-bottomed globular amphorae dominate in the West Group, while the base distributions in the Central Group and the East Group are more balanced. Again, there are hardly any differences between the Central Group and the East Group (Suppl. 2; Fig. 9).

2.3.1.1.5 Observations on GA decoration zones

GA decoration zones are regularly found on the necks and shoulders. These zones were rarely (mostly in the eastern part of the distribution areas) extended almost to the base. Most of the globular amphorae are decorated (72%).

2.3.1.2 Wide-mouthed amphorae/pots

The vessels known as "Kuyavian amphorae" are grouped as "wide-mouthed amphorae/pots" V2 (Plate 3). Three subtypes are differentiated according to the presence and form of the neck-shoulder transition and the shape of the neck and the belly. The relative mouth diameter was included as a subtype feature. Subtype V2.1 represents the classic Kuyavian globular amphorae, subtypes V2.2 and V2.3 wide-mouthed vessels.

A common characteristic feature of the proportions is a mouth diameter, which is almost always larger than the base diameter (in very few cases are both values equal). The mouth diameter is at least as large as half of the vessel height. The maximum

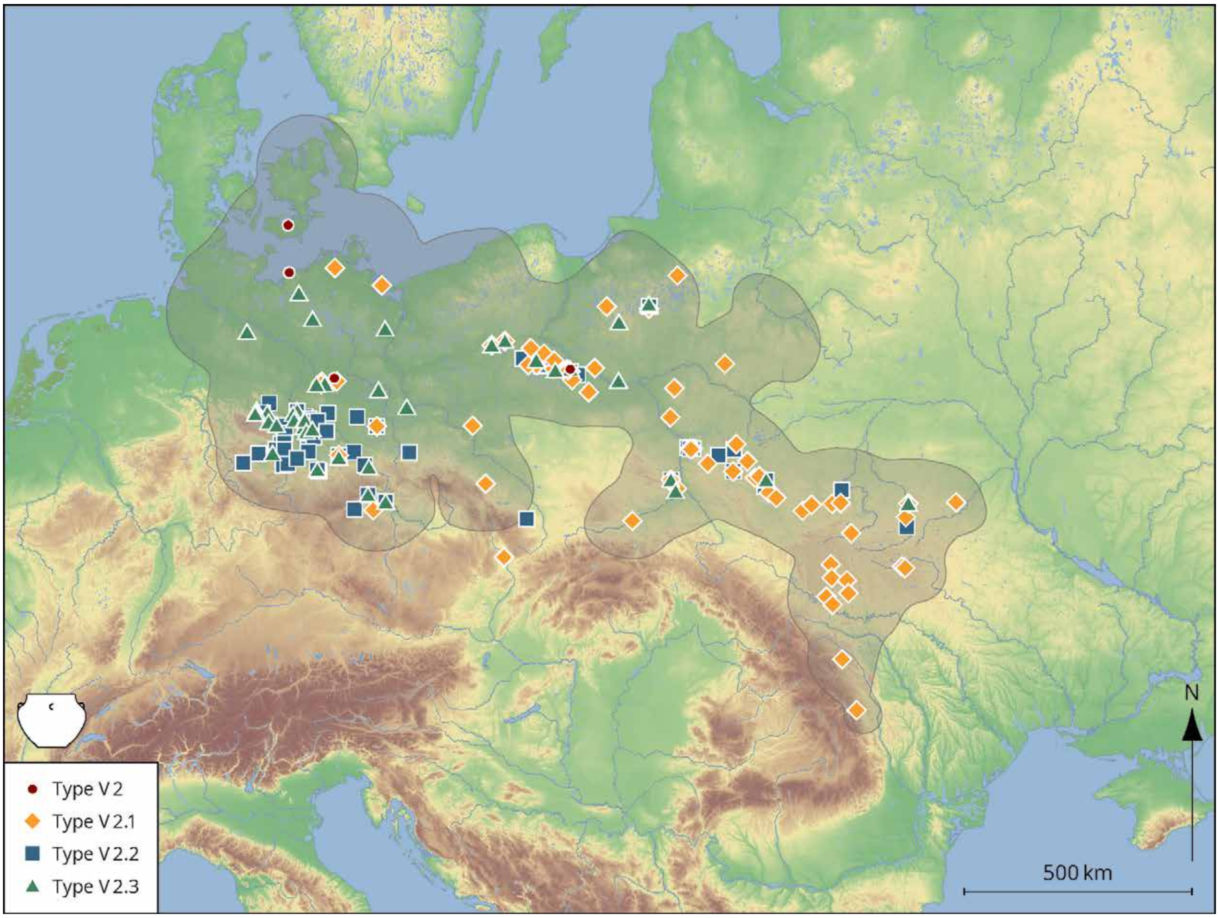

Figure 10. The distribution of 'Kuyavian amphorae' or 'wide-mouthed amphorae/pots'". While wide-mouthed amphora types with slightly or weakly distinct necks dominate in the West Group (V2.2 and V2.3), in the Central and above all in the East Groups, the wide-mouthed Kuyavian GA with distinct necks are dominant (V2.1) (Suppl. 2).

diameter (according to the structure) is usually in the middle of the vessel height. The neck is relatively short (usually a fifth, at most a quarter of the vessel height).[4]

Subtype V2.1 consists of vessels with a pronounced neck and, in contrast to other subtypes, a narrow mouth. The neck, which is clearly distinct from the shoulder, runs straight upwards or with a slight incline towards the interior of the vessel. The diameter of the distinct (footed) base is usually less than half of the mouth diameter. Furthermore, the mouth diameter does not exceed 2/3 of the maximum diameter of the vessel, which is usually centred (Plate 3; Fig. 10).

Subtype V2.2 is characterised by a shorter neck and, in comparison to V2.1, a wider mouth diameter, which exceeds ¾ of the maximum diameter. The maximum diameter may be slightly offset, above the centre of the vessel height. A neck-shoulder transition is still present, but less pronounced than in subtype V2.1. The diameter of the (usually distinct) base rarely reaches half of the mouth diameter (Fig. 10).

Subtype V2.3 includes wide-mouthed amphorae/pots with no or almost no neck-shoulder break, so that the belly merges smoothly into the neck. The remaining characteristics correspond to the general characteristics of V2.2 vessels (Fig. 10).

A total of 213 CUs belongs to the category "wide-mouthed amphora/pot" (Fig. 10), of which 4 CUs were not categorised more precisely. 98 CUs belong to subtype V2.1, 72 CUs to subtype V2.2 and 48 CUs to V2.3 subtype (Suppl. 2). 81% are decorated (172 CUs). While wide-mouthed amphora types with slightly or weakly distinct necks dominate in the West Group (V2.2 and V2.3), in the Central and above all in the East Groups, the wide-mouthed Kuyavian globular amphorae with distinct necks are dominant (V2.1).

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4 In some vessels, which otherwise agree with all other characteristics, the neck is almost not pronounced and the shoulders smoothly merge into the mouth (subtype V2.3).

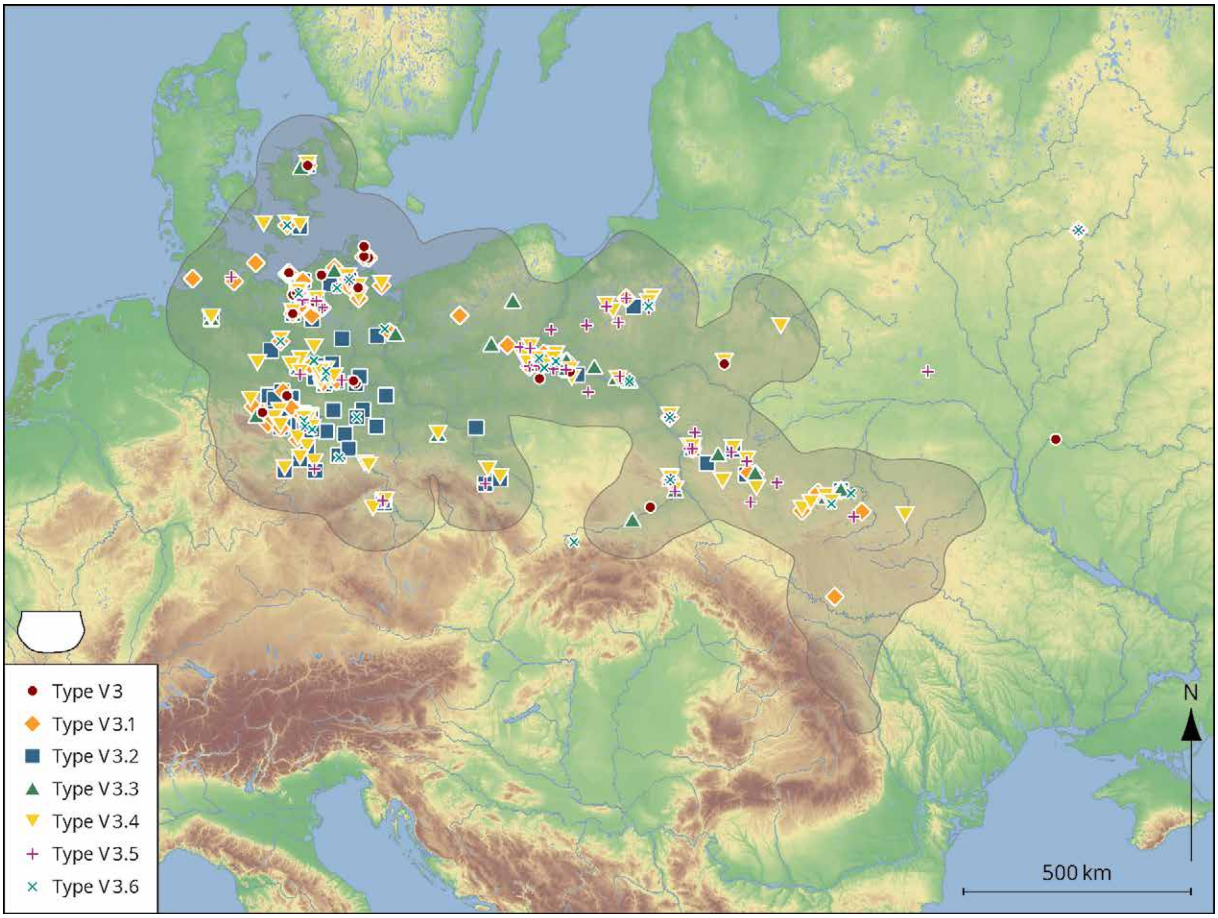

Figure 11. The distribution of bowls and dishes. In the regional groups (Suppl. 2), calotte dishes ('Kalottenschalen') (V3.2) are the majority in the West Group. In the Central and the East Groups, bowls with an S-profile (V3.4) dominate, but in principle, a distribution of all dish/bowl subtypes is observed throughout the entire distribution area.

2.3.1.3 Dishes/Bowls

Relatively flat, wide-mouthed vessels are denoted as dishes, *i.e.*, those whose mouth is larger than their height (cf. Nagel 1985, 11). Bowls, which, *e.g.*, Schuldt (1972, 58-71) describes as "dishes with uniformly sloping walls", are not separated, but rather combined with the bowls to the main type dishes/bowls (V3) (Plates 4-5).

With 464 CUs, dishes/bowls represent the second most common vessel type of the GAC. Differences between the mouth diameter/vessel height range from 7.5:2 (almost flat plates) and 4:3.5 (almost cup-shaped) with an average value of ca. 5:3.5 (relatively tall vessels).

For dishes/bowls, six subtypes were distinguished based on diverse profile characteristics of the necks and walls. The belly form varies from a pronounced S-profile to straight walls that slope up diagonally. The independence of the vessel forms defined here from the vessel size, the base type or the number and form of the handles simplifies the classification of subtypes without a loss of data on the morphological structure.[5] The bases were (as with the globular amphorae) divided into rounded bases, flattened spherical bases, flat bases and distinct (footed) bases. Dishes can have one or two opposite, four opposite, or two side by side handles or grips on the belly.

Subtype V3.1 is characterised by a rather cylindrical upper body. The mouth diameter is the maximum vessel diameter. The base varies between a distinct (footed) base and a flat base (Plate 4; Fig. 11).

5 The form of the base, the position, form (handle *vs.* grip) and number of handles were listed separately in the catalogue.

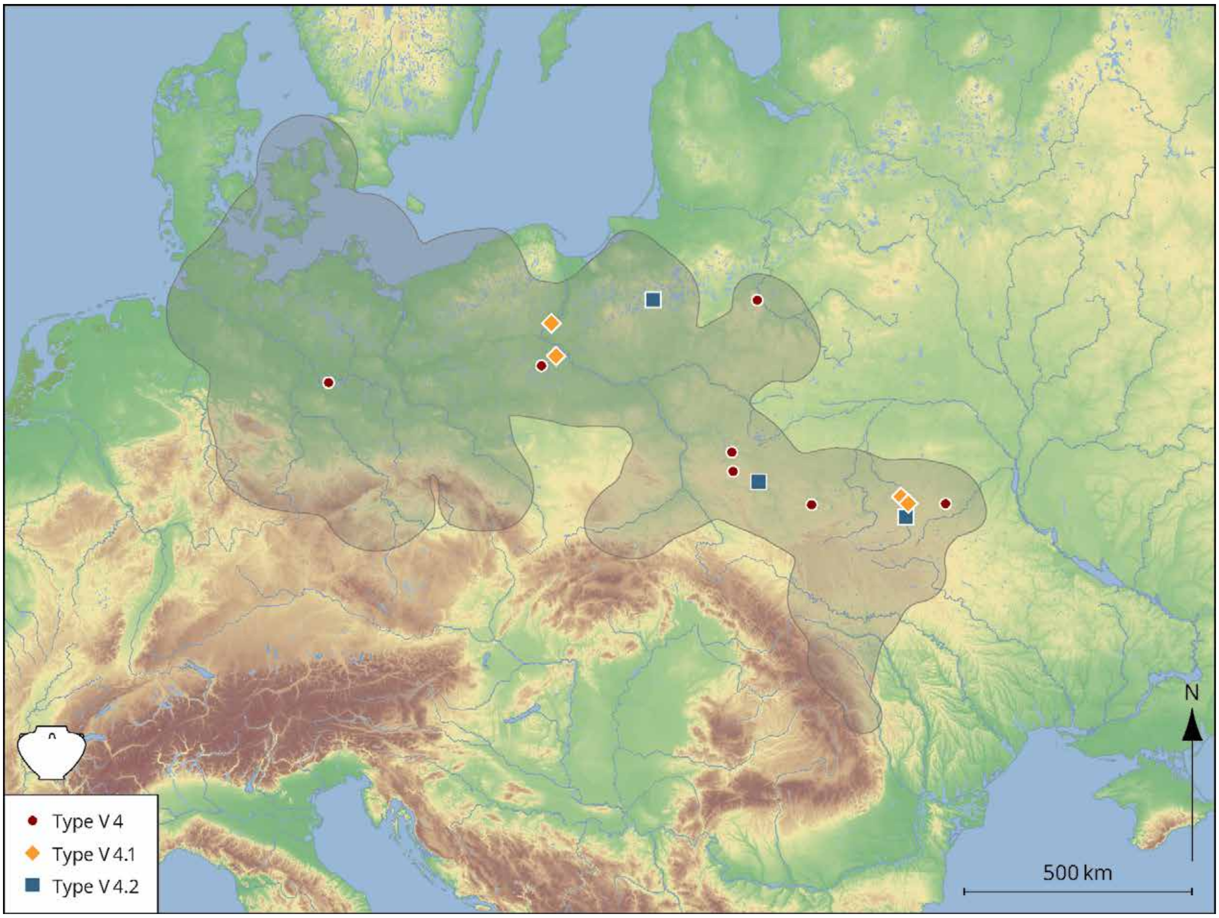

Figure 12. The distribution of 'broad-shouldered' vessels. Most of the CUs originate from the eastern distribution area, particularly from the Volhynian-Podolian Plateau.

Vessels of subtype V3.2 (often referred to as calotte bowls, *e.g.*, in Beier 1988; Kirsch 1993; 1994) are characterised by their vertical walls that slightly slope from the inside of the vessel outward or upward, which smoothly blend into the rounded base. The edge can be less pronounced, so that a slight S-profile results. The base varies between a round base and a flattened spherical base (Plate 4; Fig. 11). Subtype V3.2 can have one to four handles/lugs, while two adjacent lugged handles are the definite majority and three to four lugs/handles the exception.

Subtype V3.3 includes dishes with conical and slightly rounded walls. Attested for this subtype are round bases, flattened spherical bases, flat bases and distinct (footed) bases (Plate 4; Fig. 11).

Subtype V3.4 includes dishes with an S-profile. In spite of strongly changing profile characteristics, the mouth diameter remains greater than or equal to the maximum belly diameter. The bases vary between flattened spherical bases, distinct (footed) bases and flat bases (Plate 5; Fig. 11).

Bowls with a pronounced round belly and a mouth diameter that is smaller than the maximum diameter (which is usually in the middle of the vessel height) belong to subtype V3.5. The majority of these vessels has a small distinct rim. Flat bases and distinct (footed) bases are also recorded (Plate 5; Fig. 11).

Bowls of subtype V3.6 have conically-ascending straight walls and either flat or distinct (footed) bases (Plate 5; Fig. 11).

For sixty-two CUs of the main type V3, no further classification was possible. Fifty-nine CUs belong to subtype V3.1, ninty-seven to subtype V3.2, sixty-eight to subtype V3.3, ninety-nine to subtype V3.4, thirty-four to subtype V3.5 and fourty-five to subtype V3.6 (Suppl. 2; Fig. 11). In the regional groups (Suppl. 2), calotte dishes ("Kalottenschalen") (V3.2) are the majority in the West Group. In the Central and the

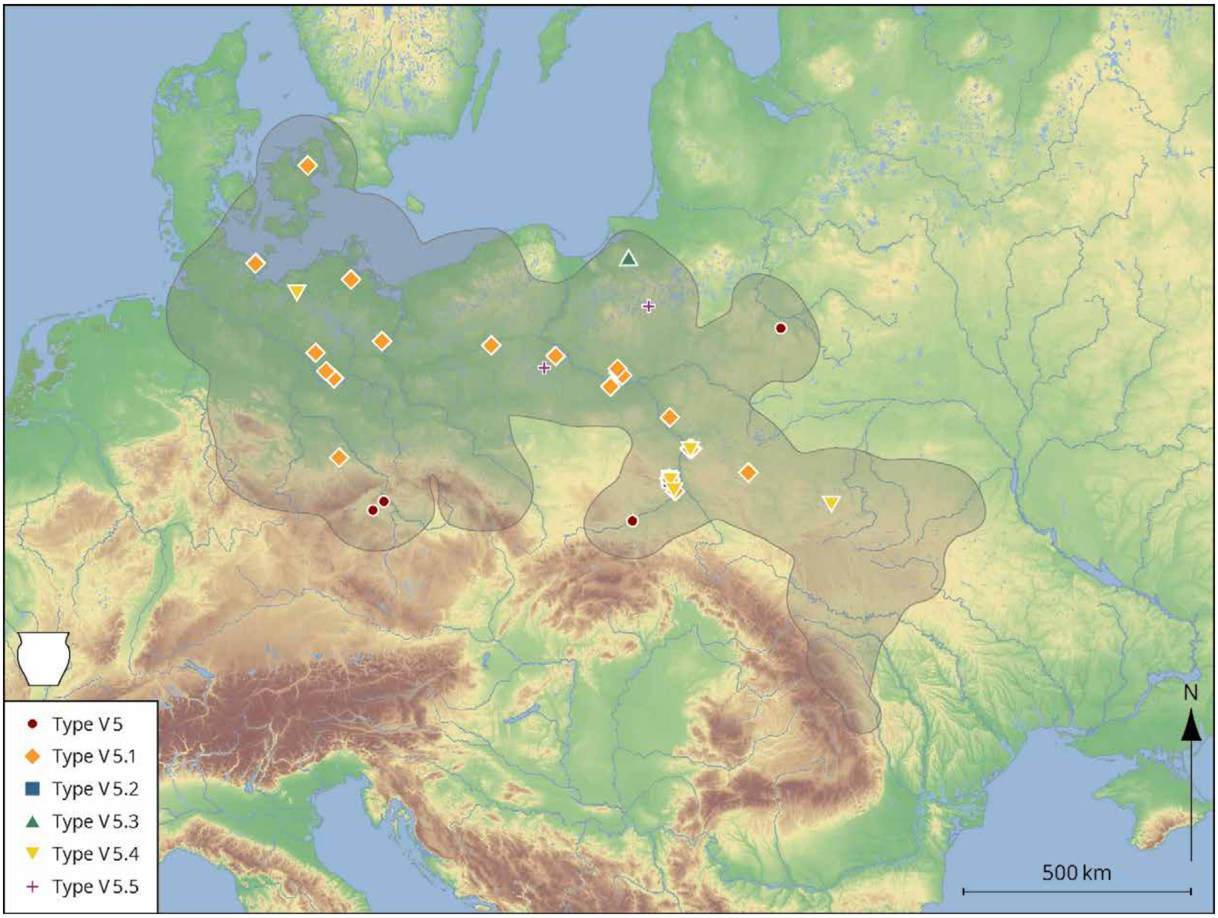

Figure 13. The distribution of funnel-rimmed pots. They are mostly distributed in the Central Group and the West Group.

East Groups, bowls with an S-profile (V3.4) dominate, but in principle, a distribution of all dish/bowl subtypes is observed throughout the entire distribution area. If any decorations were applied, they were located on the upper half of the vessels, regardless of the forms. The proportion of the decorated dishes/bowls amounts to 68% (316 CUs).

2.3.1.4 Broad-shouldered amphorae

"Broad-shouldered" vessels (Plate 6) have a pronounced broad shoulder with a mostly slender lower body and a relatively narrow base. Usually, the mouth diameter is larger than the base diameter and the maximum diameter (of the upper body) is equal to or larger than the vessel height. A relatively short neck is characteristic, either vertical or flared slightly outwards.

Most of the CUs originate from the eastern distribution area (Fig. 12), particularly from the Volhynian-Podolian Plateau. Thirteen of the fifteen CUs have four handles on the shoulders, two have two opposite handles on the shoulders. Eight distinct (footed) bases, six flat bases and one round base were registered. Ten vessels are decorated – each on the shoulder.

2.3.1.5 Funnel-rimmed pots

Vessels that have a wide, funnel-shaped mouth are denoted here as funnel-rimmed pots (V5) (Plate 6). The mouth diameter is larger than the base diameter and, in most cases, it is the maximum diameter of the vessels. A pronounced belly with maximum width usually located in the upper half of the vessel is characteristic. In some cases, the maximum belly diameter and the diameter of the mouth are the same.

In contrast to the funnel beaker, the funnel-shaped mouth is relatively short in comparison to the overall height of the vessel (usually only ¼ of the overall height).

Fifty CUs of the main type V5 were registered – above all in the Central Group and the West Group (Fig. 13). Distinct (footed) bases (22 CUs), flat bases (18 CUs) and two round bases are recorded. Sometimes, vessels of this type are equipped with grips or handles, which can vary from one, two, or four in number. Decorations, if any are registered, are located on the neck, sometimes on the shoulders.

2.3.1.6 Steep-walled pots

Large vessels, whose mouth diameter does not exceed the height and which do not have a pronounced neck, form their own morphological main type, which is denoted here as steep-walled pots. In most cases, the mouth diameter exceeds half of the vessel height. A kink in the wall is mostly found in the upper half of the vessel. Depending on the extent of the kink, V6 vessels were divided into two subtypes (Plate 6-7).

Subtype V6.1 does not have a pronounced kink in the wall, but rather a bulge in the belly that extends convexly upwards to the critical point, which is located in the upper half of the vessel or in the middle, and gently decreases inwards again from this point.

Subtype V6.2 has a pronounced kink in the wall. The wall runs almost straight up to the critical point in the upper half of the vessel and then steeply inwards from this point. The angle of the kink is not particularly sharp and it rarely falls below 130°. The kink is nevertheless clearly visible.

Of the 68 CUs, 23 vessels could be assigned to subtype V6.1 and 13 CUs to subtype V6.2 (Suppl. 2). Most of the recorded CUs belongs to the West Group (56; ten are from the Central Group and two are from the East Group) (Suppl. 2; Fig. 14). Subtype V6.2 is found in the West and Central Group, V6.1 mainly in the West Group (Fig. 14).

Flat bases or distinct (footed) bases are recorded. Steep-walled pots with handles are rare. If they exist, they have four handles. Fourty-five CUs are decorated (on the rim lip), twenty-three are undecorated.

2.3.1.7 Biconical vessels

Vessels with a pronounced belly, which Nagel (1985) described as double-conical, form the main type V7 (Plate 7). The maximum diameter is found in the middle of the vessel height. Vessels that Meyer (1993) denoted as two-handled pots are also classified in this type. The characteristic feature is the biconical tapered wall, which usually has its maximum outer bend at the middle height of the vessel. The position of the maximum diameter can deviate downwards and upwards from the centre of the vessel. The upper body of the vessel runs conically inwards.[6] However, the slant is minimal in some cases. The morphological composition enables the formation of three subtypes (Suppl. 2, Plate 7).

Subtype V7.1 includes extremely distinct biconical vessels. The narrow mouth diameter roughly corresponds to the diameter of the base. If there are any handles, they are located on the break point.

Vessels, whose walls are not conical but rather curved, were assigned to subtype V7.2. The maximum diameter, located at the centre of the vessel height, almost always exceeds the vessel height. If there are any handles, they are placed on the upper part of the vessel near the mouth.

Figure 14 (right, above). The distribution of steep-walled pots. Most of the recorded CUs belong to the West Group.

Figure 15 (right, below). The distribution of biconical vessels. The vessels are dominantly distributed in the West Group.

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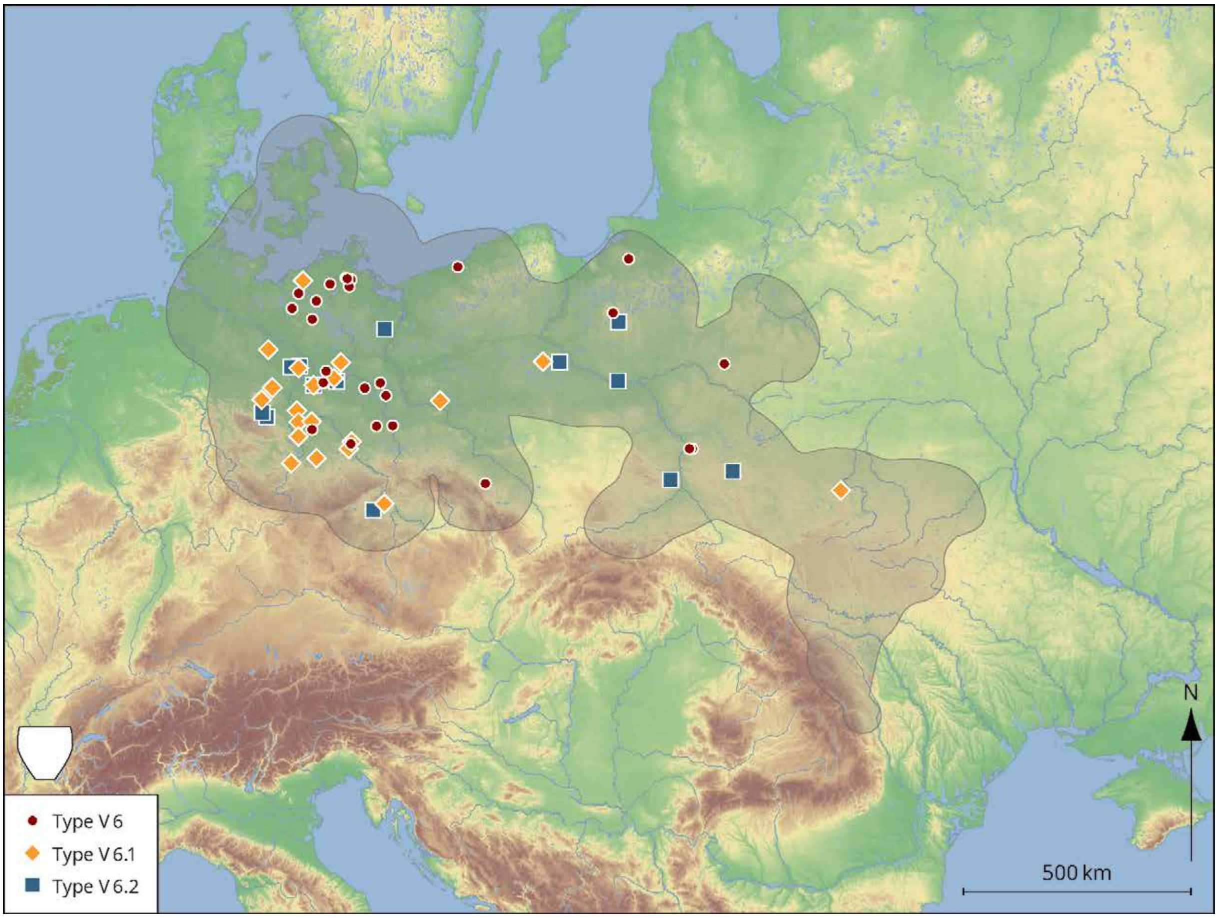
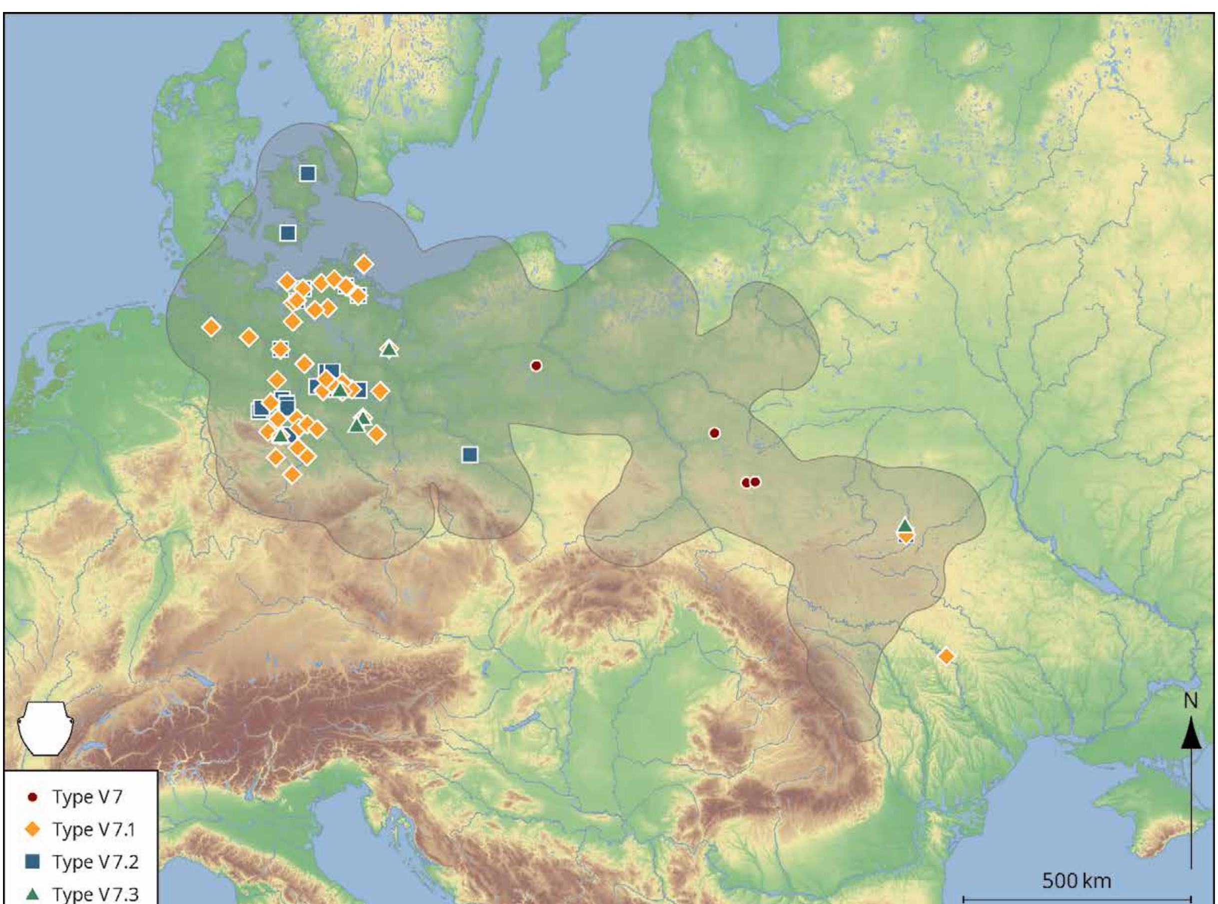
6 Formally, this type is similar to the “wide-mouthed amphora/pot”, type 2.2, but in comparison to the short neck of V2.2, the upper vessel body measures at least 1/3 of the pot height of V7. The belly is not as pronounced in comparison to the height as in the wide-mouthed amphora/pot, which gives V7 vessels a more slender appearance.


Type V 6
Type V 6.1
Type V 6.2
N
500 km


Type V 7
Type V 7.1
Type V 7.2
Type V 7.3
N
500 km

The characteristic feature of subtype V7.3 is the maximum diameter that is located in the lower half of the vessel. Five of nine CUs have a round base.

In total, 108 vessels were assigned to this main type. The vessels are dominantly distributed in the West Group (Suppl. 2; Fig. 15). Seventy-one CUs were assigned to subtype V7.1 (Fig. 15), twenty-five CUs to subtype V7.2 (Fig. 15), and six CUs to subtype V7.3 (Fig. 15).

The number of handles varies between two (on four of the sixty CUs next to each other) and four (29 CUs). Round bases (ten CUs), flattened spherical bases (five CUs), flat bases (64 CUs) and distinct (footed) bases (24 CUs) are recorded. 82 CUs are decorated; decoration zones are on the neck and the break point.

2.3.1.8 Drums

Only a very small number of clay drums are known from findings of the GAC (Wiślański 1966; Behrens 1980, 145-143; Beier 1988, 24; Meyer 1993, 46). Obviously, we are dealing here with a form borrowed from contemporaneous groups (Wyatt 2008). Due to the special form of the CUs, the eight drums were nevertheless defined as the morphological main type V8, which can be divided into three subtypes due to their diversity (Plate 8; Fig. 16).

Subtype V8.1 includes drums, which have concave, inwardly curved walls. Individual drums of this subtype differ from each other in the height of the maximum internal curving of the walls, which can vary from the centre of the vessel height downwards. Also included in this subtype is a vessel, which was described by Beier (cf. 1988, pl. 36,6) as the upper part of a goblet, but shows similarities with drums of the Central Group (cf. Wiślański 1979, fig. 155,14).

Subtype V8.2 is characterised by its slim appearance and a rounded mouth. Only one find from Pevestorf (cf. Meyer 1993, fig. 37,4) can be assigned to this subtype.

Characteristic for subtype V8.3 is the funnel-shaped upper body on a lower body that also extends in a funnel shape to the base.

Subtype V8.1 is represented by five, subtype V8.2 by one and subtype V8.3 by two CUs, known from the Central Group and the West Group (Fig. 16).

All eight drums have a flat base. The four drums of subtype V8.1 have a handle on the lower body, one drum of subtype V8.3 has a handle on the upper body. The drum from Rahmstorf (Harburg district) is said to have two large, opposite handles, which connect the lower and the upper parts of the vessel (Maier 1991, fig. 17,7). The drum from Oldendorf (Lüneburg district) has, according to Laux (1982, pl. 7), two opposite handles near the mouth. The vessels may be decorated on the lower half and have a row of holes or knobs/lugs on the upper rim, which obviously served for covering.

2.3.1.9 Lids

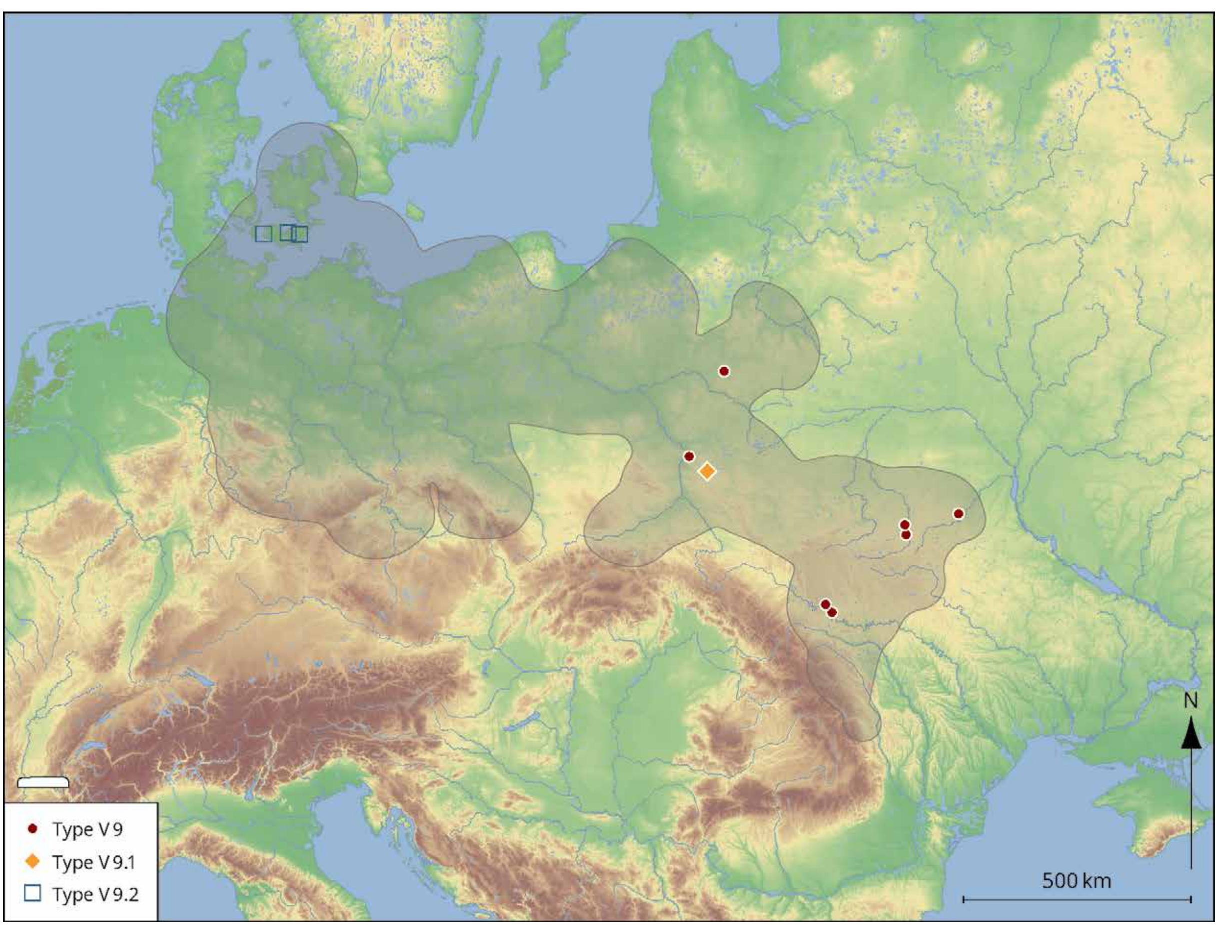
Lids are listed as main type V9. Lids of subtype V9.1 are round and flat, and disc or trapezoidal in shape. The lids of subtype V9.2 are hollow in the inside, three of which have an angular and one with a curved cross-section (Plate 8).

Of the 16 identified lids, only one could be assigned to subtype V9.1 and three to subtype V9.2. Lids are a phenomenon of the East and Central Group. Most of the lids originate from the East Group (nine CUs), some from the Central Group (four CUs). For the West Group, only three lids are mentioned from the Danish sites. Their classification as globular amphorae appears problematic and they are not linked to GA assemblages (Fig. 17). In consequence, they have to be excluded as GA lids. Almost all lids are decorated, mostly rich on the surface and the sides (14 CUs).

Figure 16 (right, above). The distribution of drums from GAC contexts.

Figure 17 (right, below). The distribution of lids. Lids are a phenomenon of the East Group and the Central Group. For the West Group, only three lids are mentioned from the Danish sites. Their classification as GA appears problematic.

Type V 8.1
Type V 8.2
Type V 8.3
N
500 km



Type V 9
Type V 9.1
Type V 9.2
N
500 km

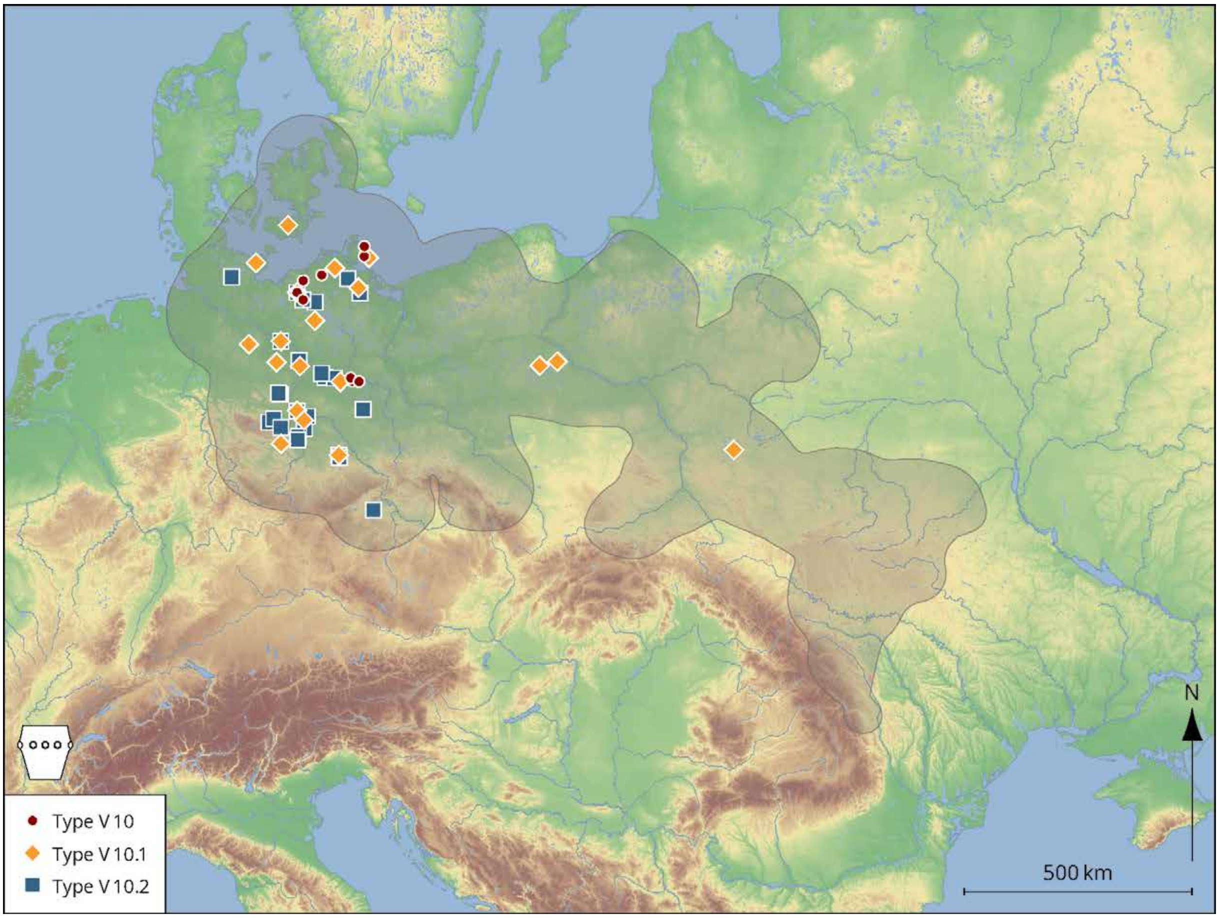


Figure 18. The distribution of cups and beakers. They are primarily distributed in the West Group.

2.3.1.10 Cups and beakers (V10)

Grouped together in the main type cups/beakers are cups (*e.g.* of Meseberg type, cf. Beier 1988, 22 or the cup type referred to by Meyer 1993 as "Henkelbecher"), beaker-shaped vessels and knobbed beakers (Beier 1988, 21) (Plate 8).

Bucket-like beakers (V10.1) have vessel walls that rise steeply upwards or in a slight angle upwards from the base and can exhibit a slight kink or a concave shape. Cups of subtype V10.2 have a pronounced belly, the maximal diameter of which is located in the centre or the lower half of the cup. The mouth is wide; large handles are centrally affixed to the vessel.

Thirty-six vessels were assigned to this main type, which are primarily distributed in the West Group (Fig. 18).[7] Flat bases are observed. Decorations can be observed on the entire body of the vessels (there are 16 decorated and 20 undecorated CUs).

Overall, the implemented classification proves to be practicable for the analysis of spatial distribution patterns, although, of course, completely different classification models are possible. No claim is made that a "natural" classification of the morphological vessel characteristics has been performed. Instead, an "artificial" classification has been developed that depends on the posed question at hand.

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7 '*Czarka*', which could be translated from Polish into German as 'Napf' or 'Kumpf', represent vessels, the height of which was smaller than the mouth diameter when the accompanying illustrations were examined. Accordingly, such vessels from the Polish area were assigned to the V3 dishes/bowls.

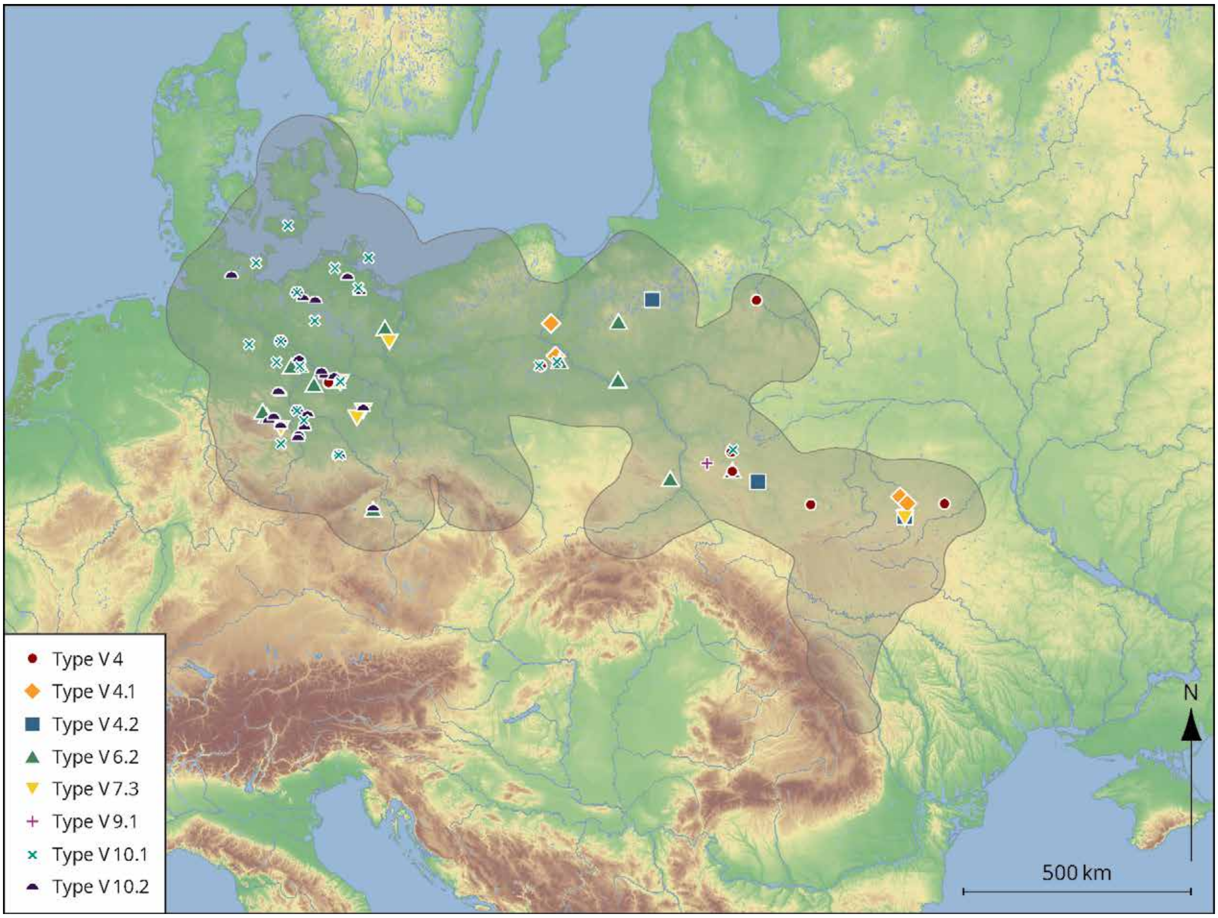


Figure 19. The distribution of vessels with restricted distribution patterns. Two large regional groups: the west (West Group) and the east (Central and East Groups) can be differentiated.

2.3.2 Vessel types: Univariate and multivariate analyses

2.3.2.1 Individual distributions of vessel types

The supra-regional distribution of most vessel types confirms a certain large-scale uniformity of the GAC phenomenon. In spite of the different main areas of spatial distribution, the globular amphorae (V1) with their various subtypes (V1.1-3), but also the broad-shouldered globular amphorae and pots (V2), are distributed across the entire GAC area, comparable to the dishes/bowls (V3).

In addition to these similarities in the spatial distribution of the mentioned main types and subtypes, differences between the West Group, on the one hand, and the Central and the East Groups, on the other hand, could be determined. This concerns, *e.g.*, the share of the classic globular amphorae in the total spectrum, which dominate the GA in the West Group (V1.1, V1.2), and the steep-walled vessels (V2.3). Moreover, certain vessel shapes only occur almost exclusively in the West Group: beakers and cups (V10, V10.1, V10.2), biconical vessels (V7.1, V7.2, V7.3), and predominantly steep-walled vessels (V6.2).

In contrast, the Central and East Groups *cannot* be distinguished from each other according to the distribution of vessel types. With the broad-shouldered amphorae (V4) and the lids (V9.1), one can delimit the eastern regions from the West Group, but it is not possible to delimit the Central from the East Group. Thus, in terms of the spatial distribution of the vessel types, two large regional groups: the west (West Group) and the east (Central and East Groups) can be differentiated (Fig. 19).

2.3.2.2 Multivariate description of vessel types

2.3.2.2.1 CA1: Amphorae

For a comprehensive description of the typological and spatial distribution patterns of amphorae of GAC ceramics, the amphora types (V1, V2 and V4) were first subjected to a correspondence analysis. The hexagonal areas form the spatial unit, for which the occurrences of corresponding vessel types were added up.

Cases that can only be generally classified at the vessel type level (V1, V2 and V4) were excluded as types and only those cases that could be assigned to subtypes (V1.1, V.2, *etc.*) were used. In the course of the analyses, the hexagons 149 and 170 proved to be outliers. They were excluded. Due to the required sum of variable occurrences across the hexagons and across the types, the eight defined amphora types and 68 hexagons were valid for the analysis (Suppl. 4).

The parabola-like structure of the scatter plot of the eigenvectors of the 1st and 2nd eigenvector indicates that a certain normal distribution of the types can be expected (Fig. 20).

Significantly, as **Group 1** in the negative range of the 1st eigenvector <-2.0 EV, we find mostly flat-bottomed, four-handled globular amphorae of the Kuyavian type (V2.1) together with steep-walled amphorae of type V4.2. As **Group 2,** we record globular amphorae with an only moderately distinct neck (V1.3) and steep-walled amphorae with distinct broad shoulders (V4.1) in the middle negative range of the 1st eigenvector (-1.5-1.0 EV). Finally, in the lower negative area, we observe in **Group 3** those globular amphorae that have a distinct cylindrical neck (V1.2) and two handles. In the positive area of the 1st eigenvector, as **Group 4**, we note broad-shouldered amphorae without a distinct neck (V2.3), classic globular amphorae with a long neck (V1.1), and broad-shouldered amphorae with a large mouth diameter (V2.2).

Due to the quantitative number as well as their different classification to the four hypothetical vessel form groups, we want to – in principle – understand those amphorae as leading types

- those that are flat bottomed, have a distinct neck and four handles (GA V2.1) (Group 1),
- whose neck is only slightly distinct from the rest of the vessel body (GA V1.3) (Group 2),
- which exhibit a distinct cylindrical neck (GA V1.2) and have two handles (Group 3),
- and those, which are two handled and have a high neck (GA V1.1), and additionally those that are rather pot-like, but are four-handled (V2.2) (Group 4).

The vessel forms and groups have a spatially different distribution (Fig. 6; Fig. 10; Fig. 12). According to the individual mapping, the two-handled amphorae with a distinctive cylindrical neck and pot-like amphorae are found in the entire distribution area, but dominate in Eastern and Central Germany (V1.2, V.1.1, and V2.2). Four-handled amphorae (V2.1) are particularly distributed in the Baltic-Pontic region, whereas non-distinct GA (V1.3) are found throughout the entire distribution area. The less strongly represented broad-shouldered amphorae (V4, V4.1, V4.2) are again mainly represented in the Baltic-Pontic region, whereby the wide-mouthed vessels of type V2.3 are found in the entire distribution area, but with a focus in the west.

With the spatial representation of the 1st eigenvector of the correspondence analysis, the differences – especially between the focal points of the vessel types of the West Group and the Central/East Group – are revealed (Fig. 21). *Group 1* and *Group 2* with Kuyavian amphorae and those with moderately distinct necks are mainly found between the Lower Vistula and the Moldavian Plateau, *Group 3* from

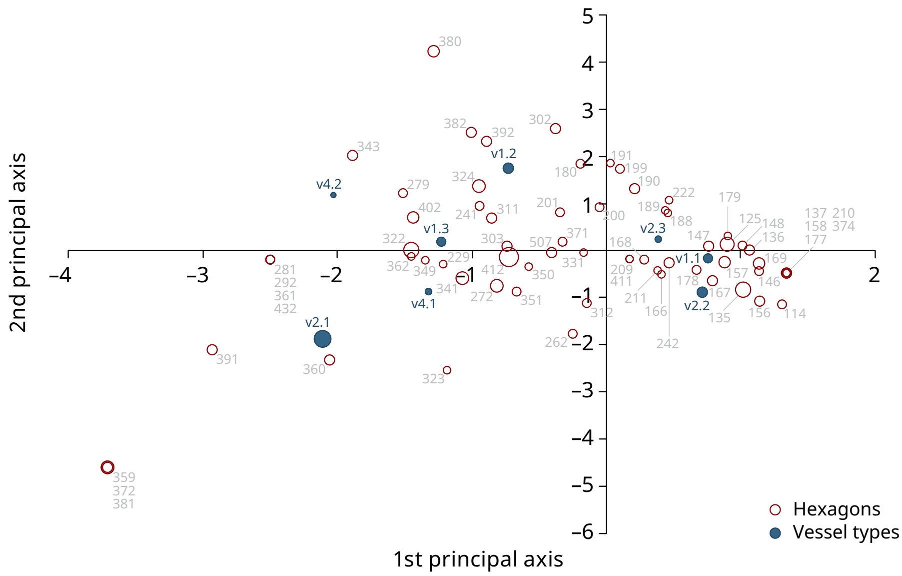


Figure 20. The correspondence analysis of GA vessel types. The hexagonal areas form the spatial unit, for which the occurrences of corresponding vessel types were added up (Suppl. 4).

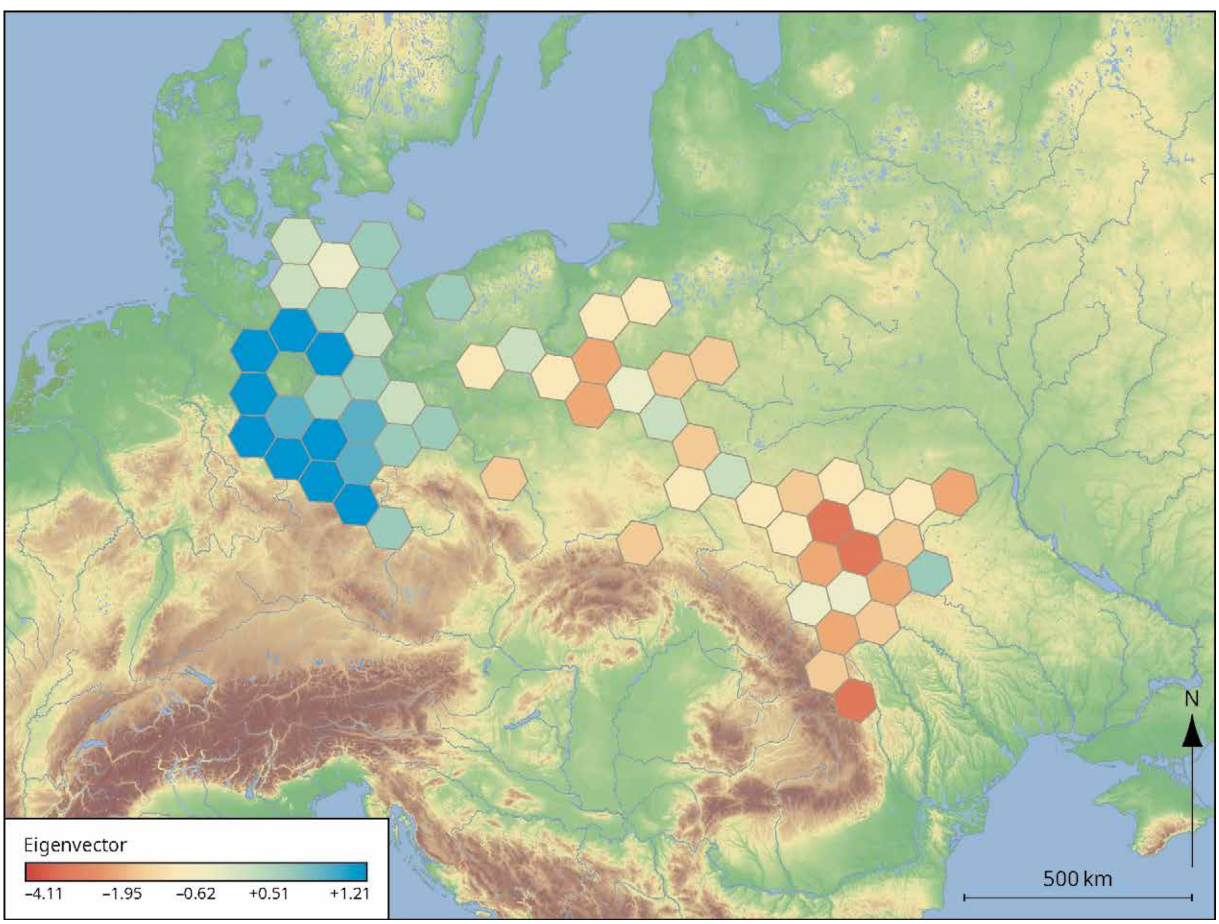


Figure 21. With the spatial display of the 1st eigenvector of the correspondence analysis, the differences – especially between the focal points of the vessel types of the West Group and the Central/East Group – are revealed (cf. Fig. 20; Suppl. 4).

the Western Baltic Sea to Podolia, and *Group 4* dominates in Central Germany and adjacent areas.

2.3.2.2.2 CA2: Amphorae and other vessel types

In addition to the amphorae, all other vessels that could be clearly assigned to subtypes were included in a further correspondence analysis (Suppl. 5). Based on the same exclusion conditions, 26 types and 74 hexagons remain. In the smooth transition, we can identify the following six foci in the correspondence analytic distribution of the first two eigenvalues (Fig. 22):

- **Group 1**: Broad-shouldered amphorae (V4.1) (range EV1: -4 – -3);
- **Group 2**: Kuyavian amphorae (V2.1), funnel-shaped vessels with slightly projecting rims (V5.2, V5.4) (range EV1: -3 – -2);
- **Group 3**: Broad-shouldered amphorae (V4.2), globular amphorae with an only slightly distinct neck (V1.3), plus dishes/bowls (V3.3, V3.5), and funnel-shaped vessels with a slightly projecting rim (V5.1, V5.5) (range EV1: -2 – -1);
- **Group 4**: Classic short-necked globular amphorae (V1.2) (range EV1: -1 – -0.5);
- **Group 5**: Wide amphorae with a tapered rim (V2.3), plus dishes/bowls (V3.4, V3.6, V3.1), steep-walled pots (V6.2) and lids (V9.2) (range EV1: -0.5-0.5);
- **Group 6**: Classic long-necked globular amphorae (V1.1), wide-mouthed amphorae (V2.2), biconical curved drums (V8.3), biconical vessels (V7.1, V7.2, V7.3), cups/beakers (V10.1, V10.2) (range EV1: -0.5-1.5).

Again, the spatial distribution of the 1st eigenvector shows a spatial pattern comparable to the spatial distribution of the 1st eigenvector of the “pure” globular amphorae CA (Fig. 23). Without anything having changed in the basic structure of the amphora types named above as main types, the locally and regionally distributed vessel types are assigned to the overall spectrum. The Central German and the Western Baltic block (Groups 5-6) can be clearly distinguished from that of the Lower Vistula as far as Moldova (Groups 1-4). Spatially separate foci with a respective dominance of the Kuyavian vessel types appear to exist in the eastern Carpathian foothills and in Kuyavia (Group 1).

2.3.3 Results and interpretation

In the basic spatial distribution of the globular amphorae, an east-west division is fundamentally apparent. The dividing line lies likely east of the Oder in western West Poland. The division follows the spatial division of both areas by an almost find-free corridor, which is clearly visible in the depiction of the hexagons.

The narrow, typological block, which particularly includes Central Germany and large parts of Northern Germany, is interrupted in the north by a placement of globular amphorae, the neck of which cannot be clearly differentiated from the rest of the body. Here, a higher variation of the globular amphorae is indicated, as can similarly be noted for the entire eastern GAC region from Pomerania via Greater Poland and Kuyavia to Podolia and Volhynia, but also for the Siret (Fig. 23). Considering all vessel forms, which especially include regionally influenced vessel types of obviously local styles, the difference between West and East Groups is emphasised, while in the Central Group rather a transitional area can be identified (Fig. 23).

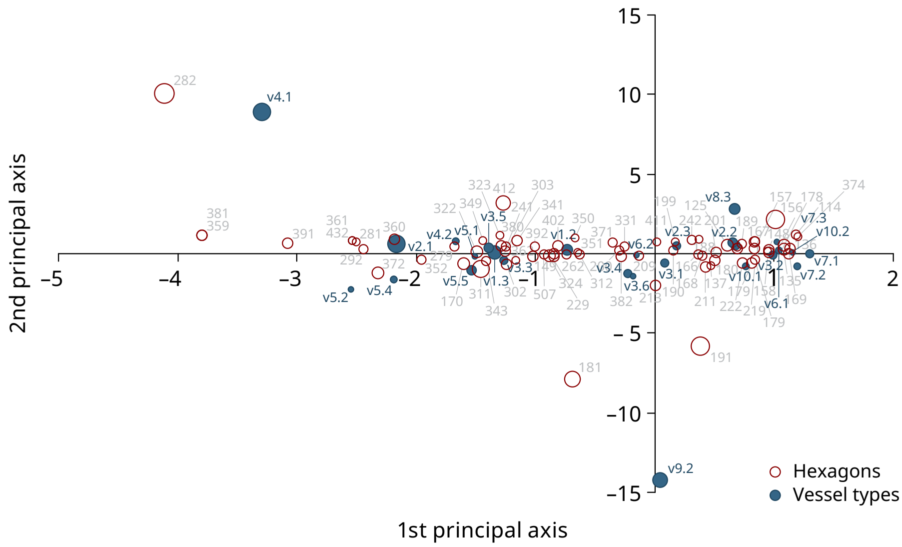


Figure 22. The correspondence analysis of GA vessel types and all other vessel types. The hexagonal areas form the spatial unit, for which the occurrences of corresponding vessel types were added up (Suppl. 5).

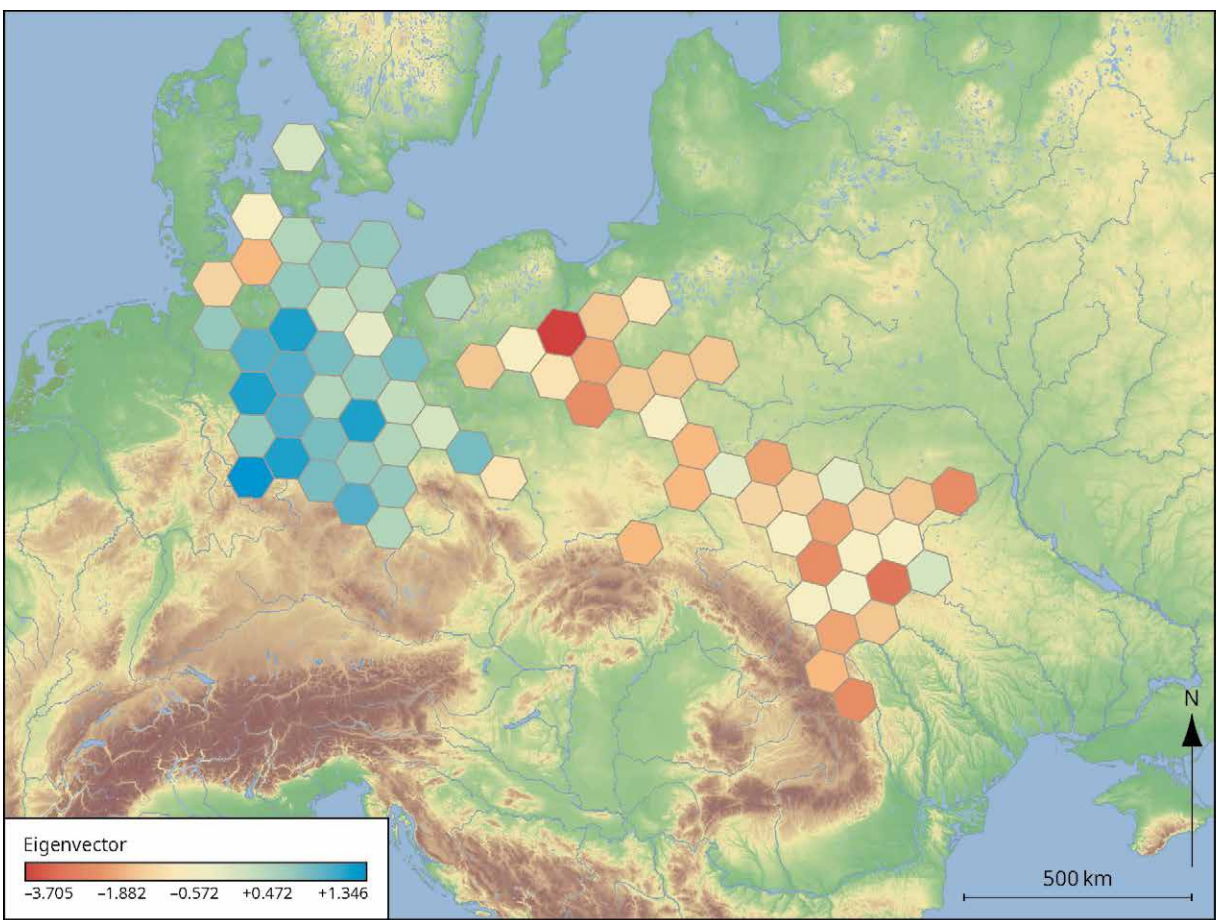


Figure 23. With the spatial display of the 1st eigenvector of the correspondence analysis of all vessel types, differences similar to those in Fig. 21 are revealed.

2.4 Investigations on decoration techniques

2.4.1 Decoration techniques and individual observations

Sixteen decoration techniques that partly appear together on single vessels[8] can be differentiated (Priebe 1938, 33; Nortmann 1985, 17; Beier 1988; Tab. 2). The decoration techniques include the method of applying decorations determined by the decoration tool.[9] In addition, the guidance of the handling of the tool, *e.g.*, the recurring change of direction of a chisel can be understood as a secondary element of the decorative technique (Plate 13). In detail, the following decoration techniques were distinguished:

Arch incisions (T1): Arch incisions occur in 252 of the recorded vessels, which are widespread across the entire GAC area, but with a focus in the west (Fig. 24). A secondary technique feature is the orientation of the decoration tool that produces the arches: down, up, right, or left (Plate 13).

Angle incisions (T2): Angle incisions are recorded for 82 CUs, which are distributed across the entire GAC area, again with a focus in the west (Fig. 24). A secondary technique feature is the orientation of the tip of the tool that produces the angles: down, up, right, or left (Plate 13).

Point incisions (T3): Point incisions are found on 294 of the recorded vessels, which are distributed across the entire GAC area (Fig. 25). The size difference between the very small (T3.1), medium-sized (T3.2), and relatively large depressions (T3.3) is noted as a secondary technique feature. Double punctures are additionally listed (T3.4).

Scored incisions (T4): Scored incisions are recorded for 403 vessels, which are distributed across the entire GAC area (Fig. 25).

Chisel incisions (T5): Chisel incisions, *i.e.*, the impression of rectangular engravings, is noted for 345 vessels, which are distributed across the entire GAC area (Fig. 26). Resulting from the orientation of the "chisel", either standing, lying, or left or right-tilted marks emerge as secondary technique features (Plate 13).

Cord technique (T6): Cord decoration is observed on 286 recorded vessels, which are spread across the entire GAC area (Fig. 26). The guidance of the cord to form long lines or closed signs/motifs (T6.1) and the formation of short vertical cord strokes (T6.2) were differentiated as secondary technique features (Plate 13).

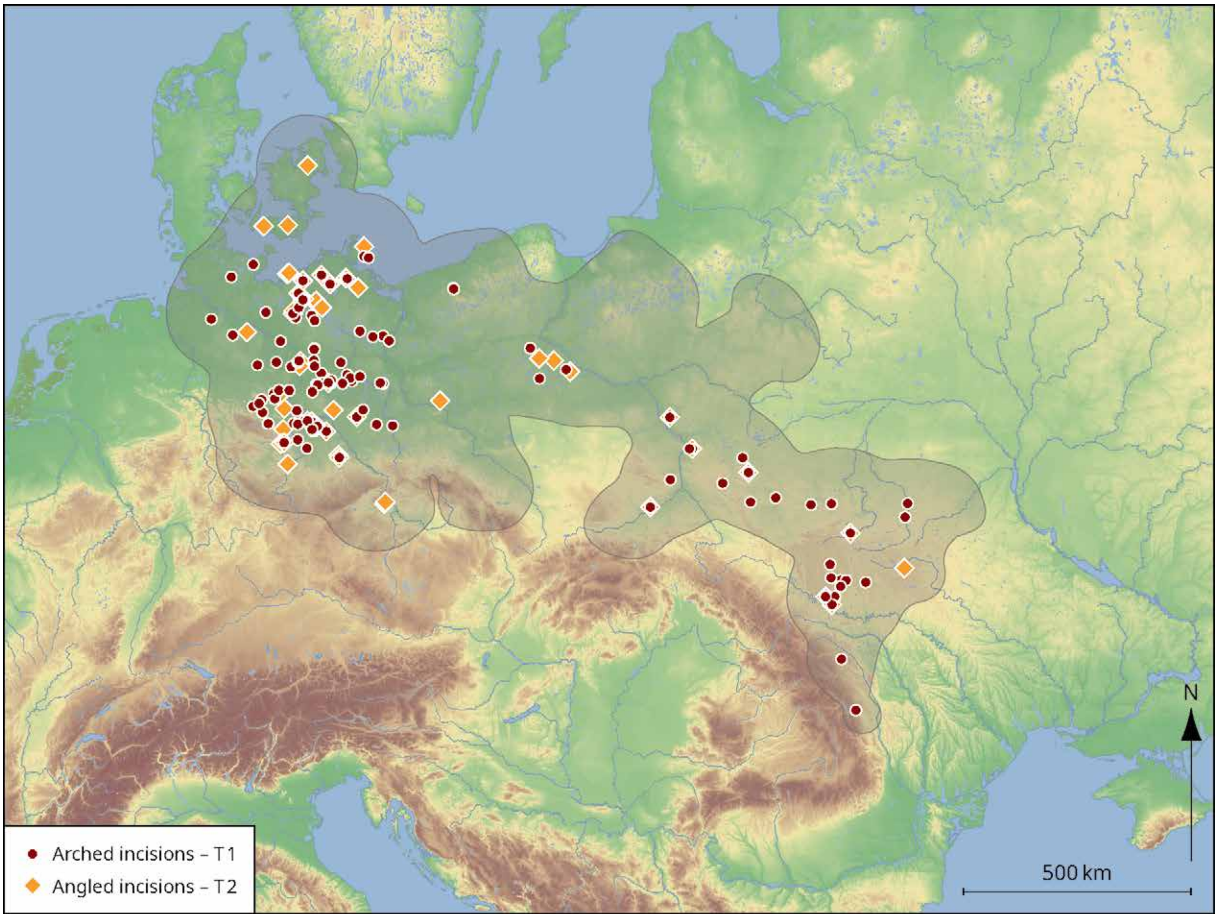
Finger dabs (T7) and fingernail impressions (T8): Although finger dabs (51 CUs) and fingernail impressions (33 CUs) are found throughout the entire GAC distribution area, they are particularly concentrated in the area of the West Group (Fig. 27). Finger dabs appear primarily on steep-walled vessels (V6). Fingernail impressions were differentiated as either vertically (T8.1) or horizontally (T8.2) applied decorations (Plate 13).

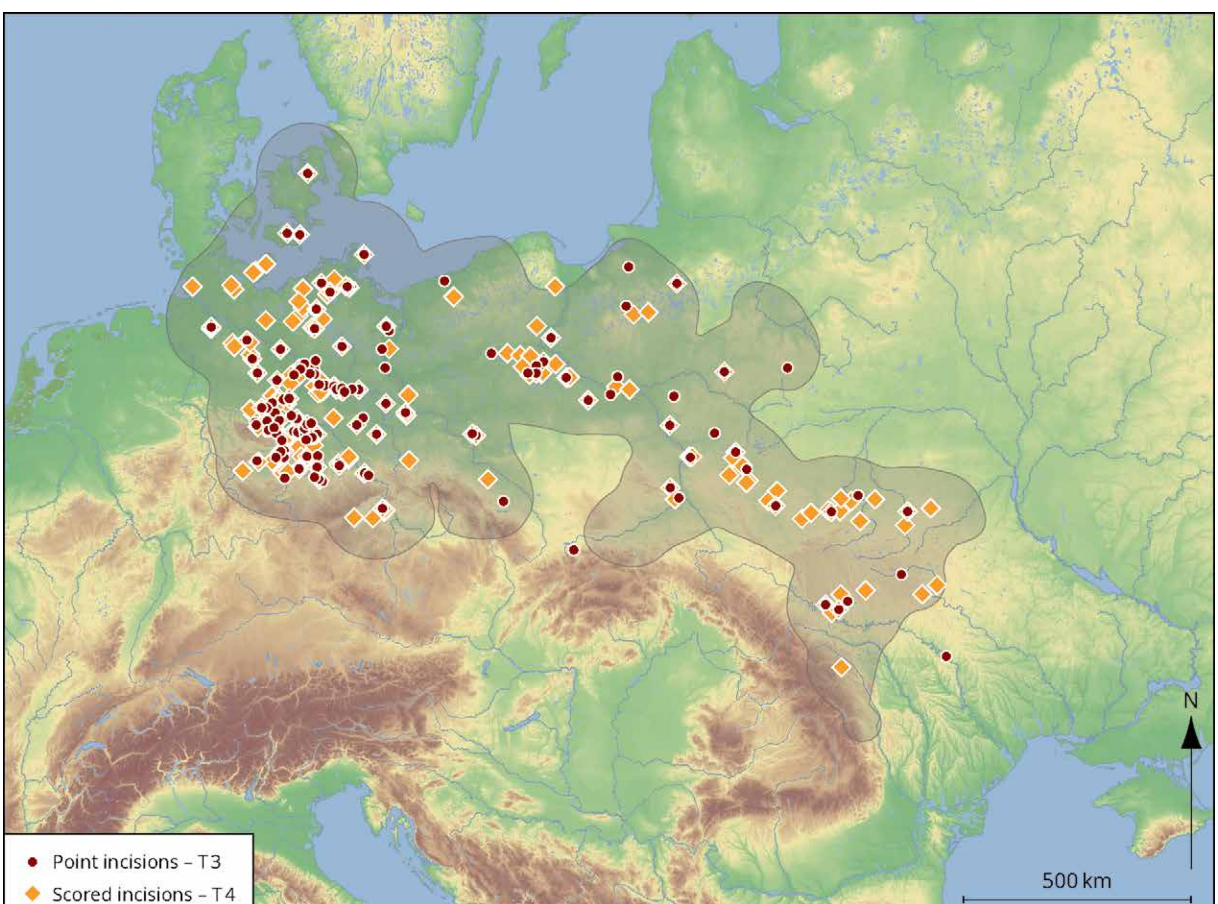
Figure 24 (right, above). The distribution of arched and angled incisions.

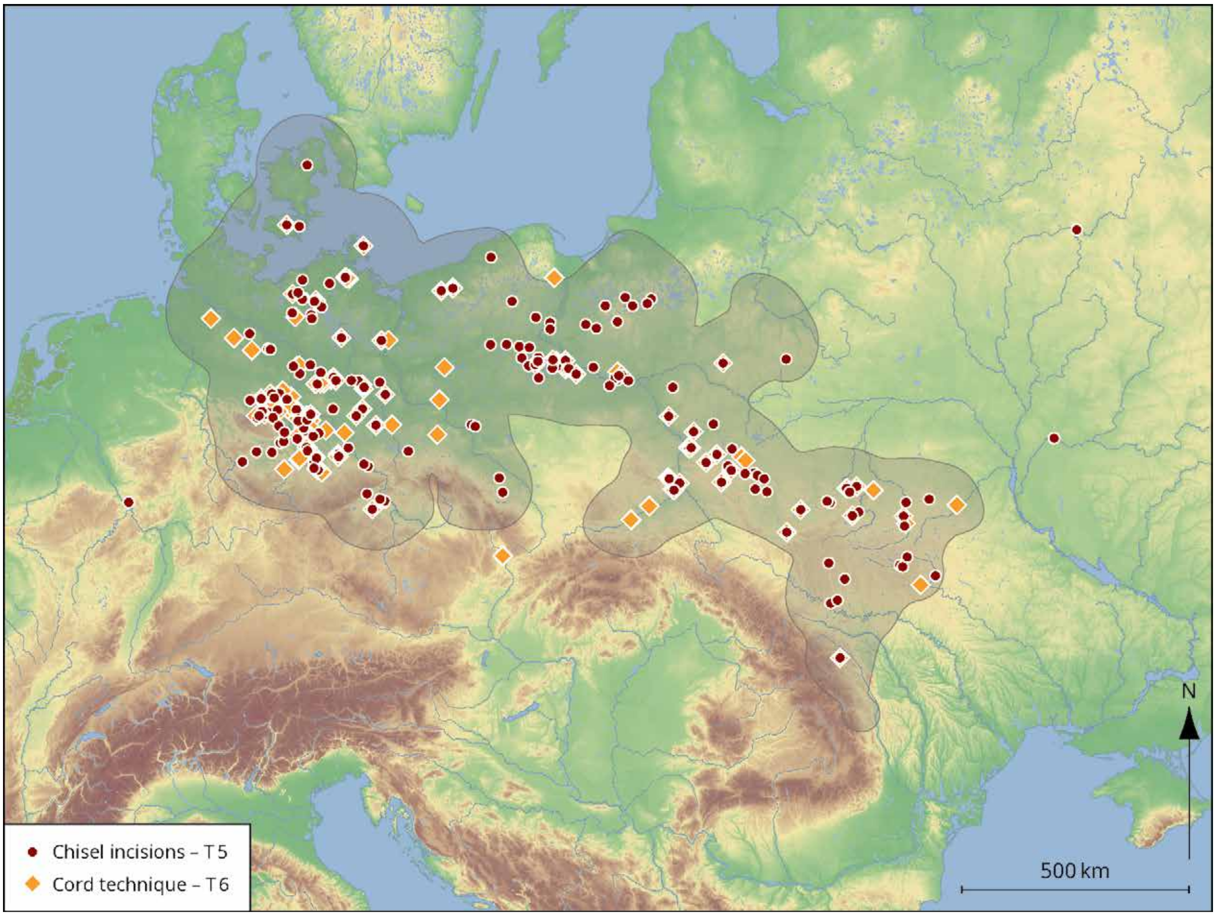
Figure 25 (right, below). The distribution of point and scored incisions.

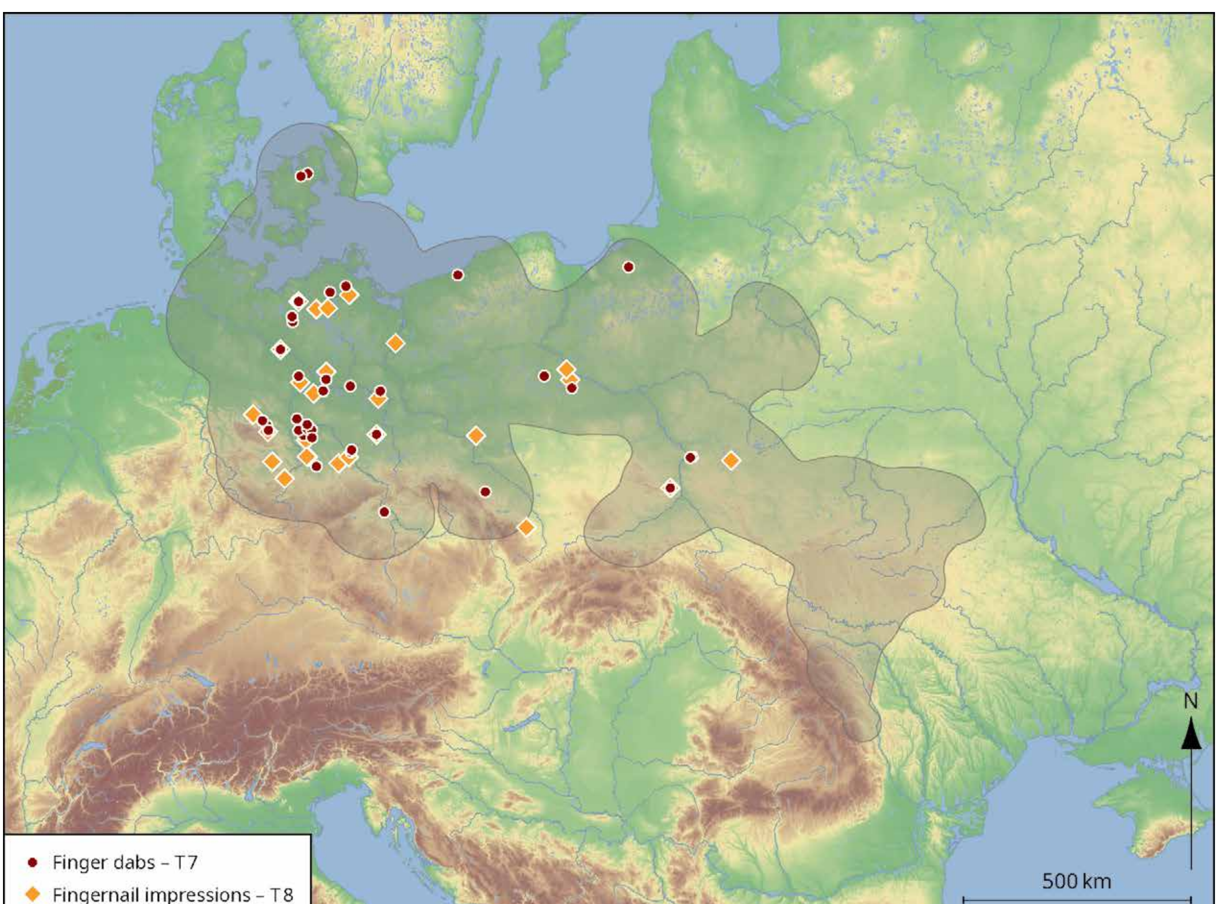
8 In the data matrix, the decoration techniques are located at the third and fourth variable positions, with the third digit pointing to the primary technique and the fourth to the secondary feature.

9 „Man hat sich zur Anbringung der Verzierung verschiedener Geräte bedient, die aus Knochen, Stein, Holz und anderen Stoffen gefertigt werden" [transl.: 'To make the decorations, various tools made of bone, stone and wood were used'] (Priebe 1938, 33). Furthermore, Nortmann assumes a light-coloured incrustation, so that the pottery had a bichrome character (Nortmann 1985, 17).


Arched incisions – T1
Angled incisions – T2
N
500 km


Point incisions – T3
Scored incisions – T4
N
500 km


Chisel incisions – T5
Cord technique – T6
N
500 km


Finger dabs – T7
Fingernail impressions – T8
N
500 km

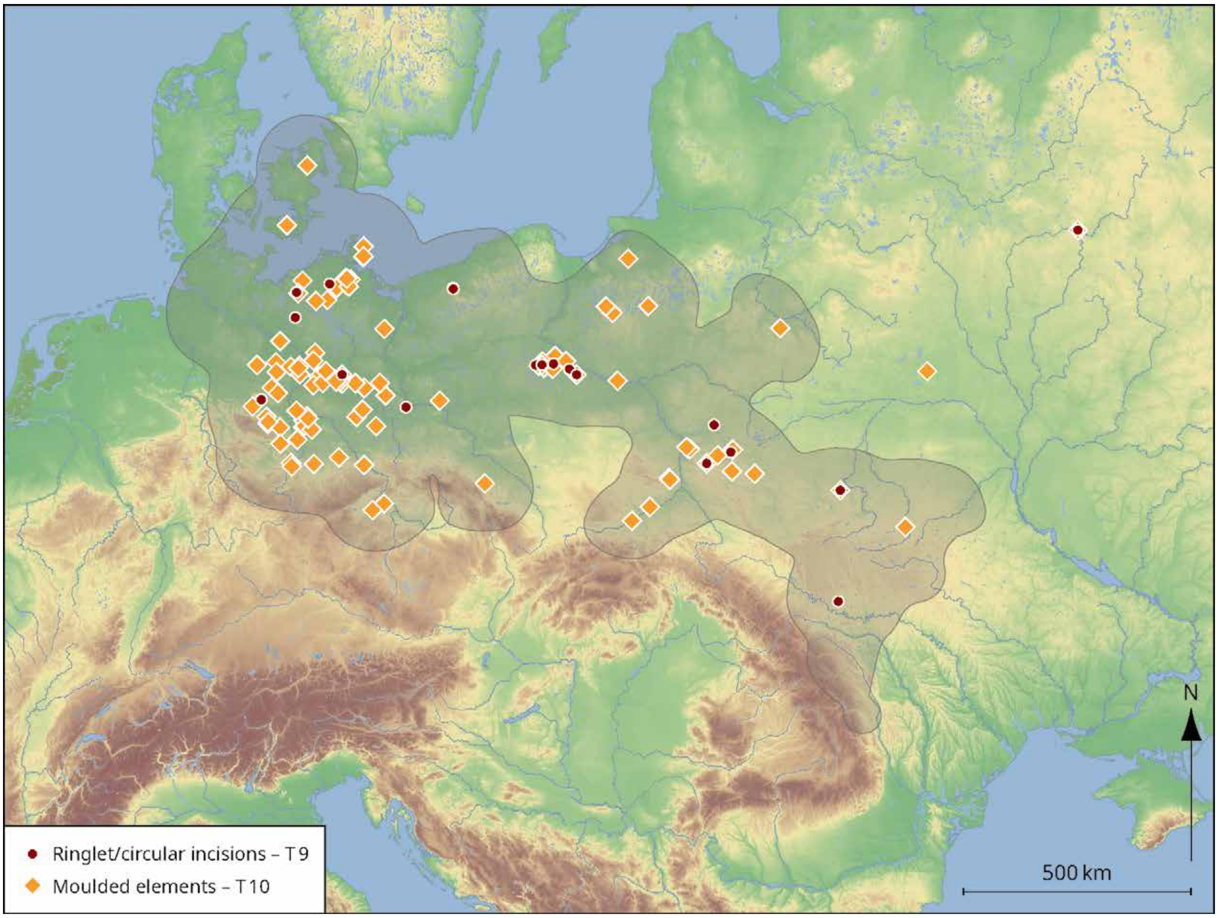


Figure 28. The distribution of ringlet/circular incisions and plastic elements.

Ringlet/circular incisions (T9): Ringlet and circular incisions[10] (44 CUs) are found throughout the entire GAC distribution area (Fig. 28).

Plastic elements (T10): Although plastic decoration techniques (113 CUs) are found throughout the GAC distribution area, they are particularly concentrated in the area of the West Group (Fig. 28).[11] Four secondary technique features are distinguished: T10.1 plastic strips, T10.2 knobs, T10.3 lugs and T10.4 pairs of lugs (Plate 13). The resulting decoration motifs are straightforward: Rows and wavy lines of plastic strips, simple rows of knobs, and lugs that appear as loosely plastic elements. Decorations with knobs or rings of knobs, especially on beakers, are characteristic for the West Group (cf. Nagel 1985, 15).

Holes (T11): Holes are arranged in simple rows along the rims of a vessel (Plate 13; 15 CUs) and can be found throughout the entire distribution area (Fig. 29).

Cross incisions (T12): Although cross incisions (20 CUs) are found within the entire area of the GAC distribution area, they are especially found in the area of the West Group (Fig. 29).

---

10 Priebe (1938, 33) writes: „Ringelstiche […] lassen auf die Verwendung von Strohhalmen oder Federstilen schließen". [transl.: 'Ringlet incisions […] indicate the use of straws or penholders.'].

11 „Wiederholt befinden sich auf Schalen und Gefäßen mit hochliegendem Umbruch einfache oder mit Kerben versehene horizontal umlaufende plastische Leisten, die sowohl unterhalb des Randes als auch auf dem Umbruch angebracht wurden". [transl.: 'Repeatedly, simple or notched horizontal circumferential plastic mouldings were applied on bowls and vessels with raised rims both below and on the rims.'] (Nagel 1985, 15).

Figure 26 (left, above). The distribution of chisel incisions and cord techniques.

Figure 27 (left, below). The distribution of finger dabs and fingernail impressions.

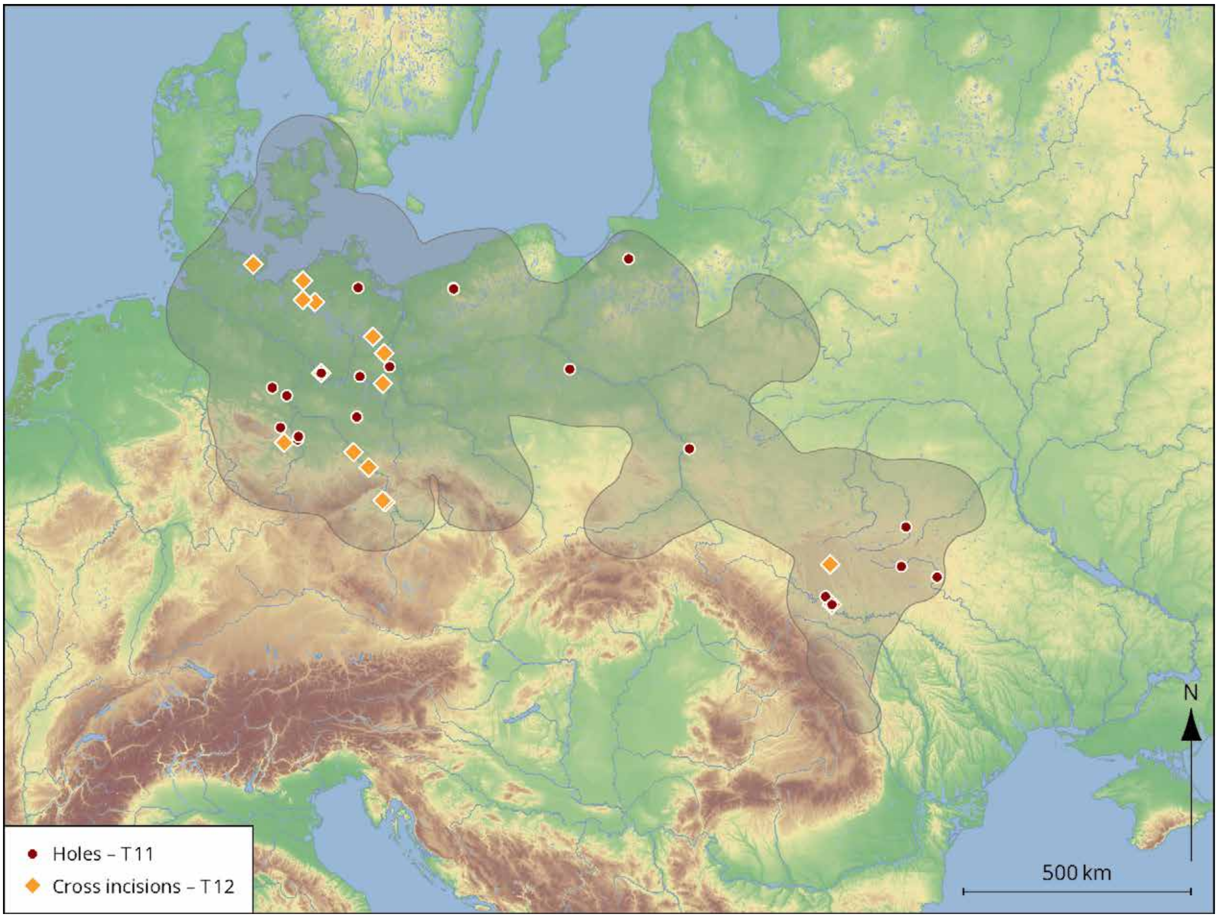


Figure 29. The distribution of holes (along the vessel rim) and cross incisions.

Stab-and-drag incisions (T13): Although stab-and-drag incisions (111 CUs) are reported for the entire GAC distribution area, they are concentrated in the West Group (Fig. 30). Distinguished as features of secondary techniques are long lines made of stab-and-drag incisions, which form rows or motifs (T13.1), and short vertical lines made of stab-and-drag incisions, which form rows or figures and are comparable to the cord technique T6.2 (T13.2) (Plate 13).

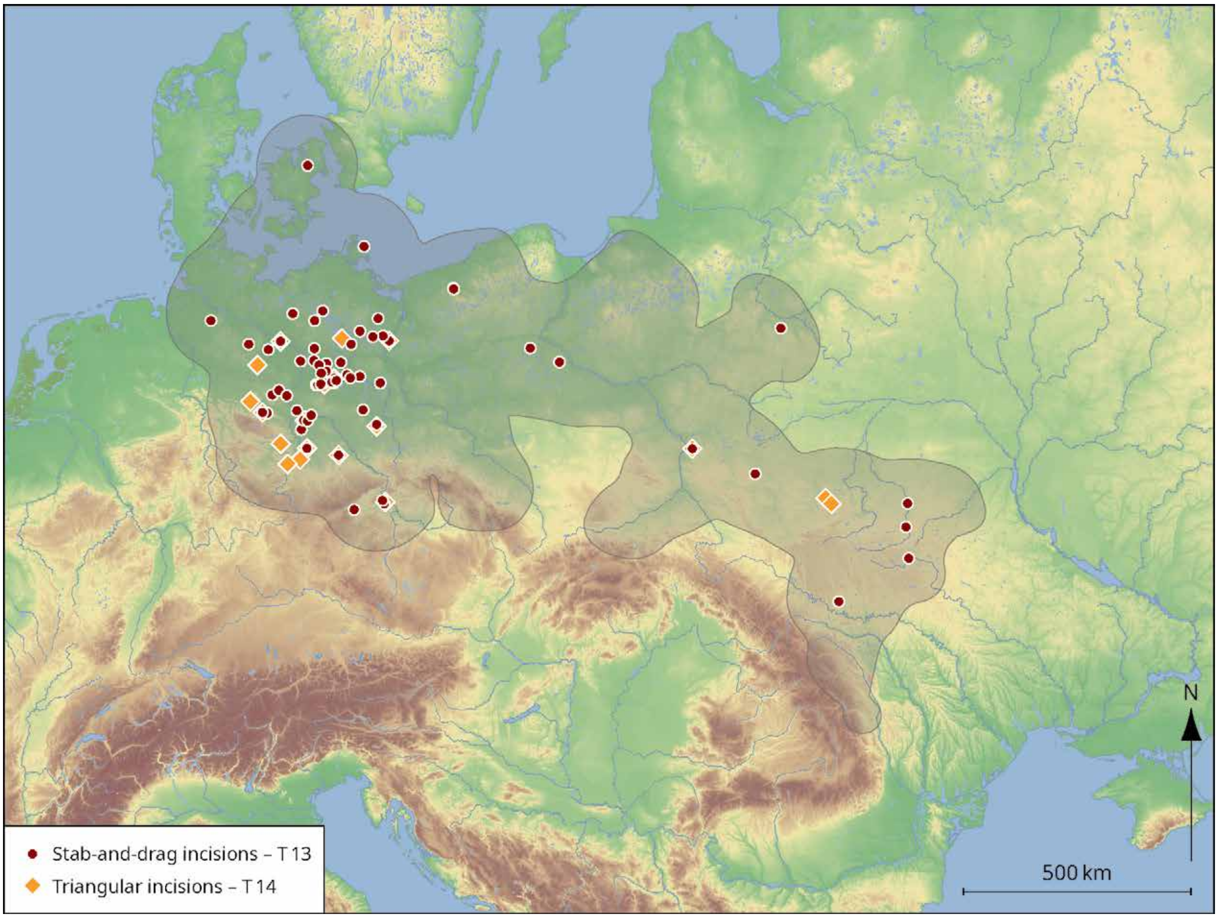
Triangle incisions (T14): Triangle incisions (27 CUs), also often referred to as notched incisions (*e.g.* Meyer 1993, 35), are primarily distributed in the West Group (Fig. 30). Two secondary technique features can be described according to the position of the tip of the tool used for decoration, either upwards (T14.1) or downwards (T14.2) (Plate 13).

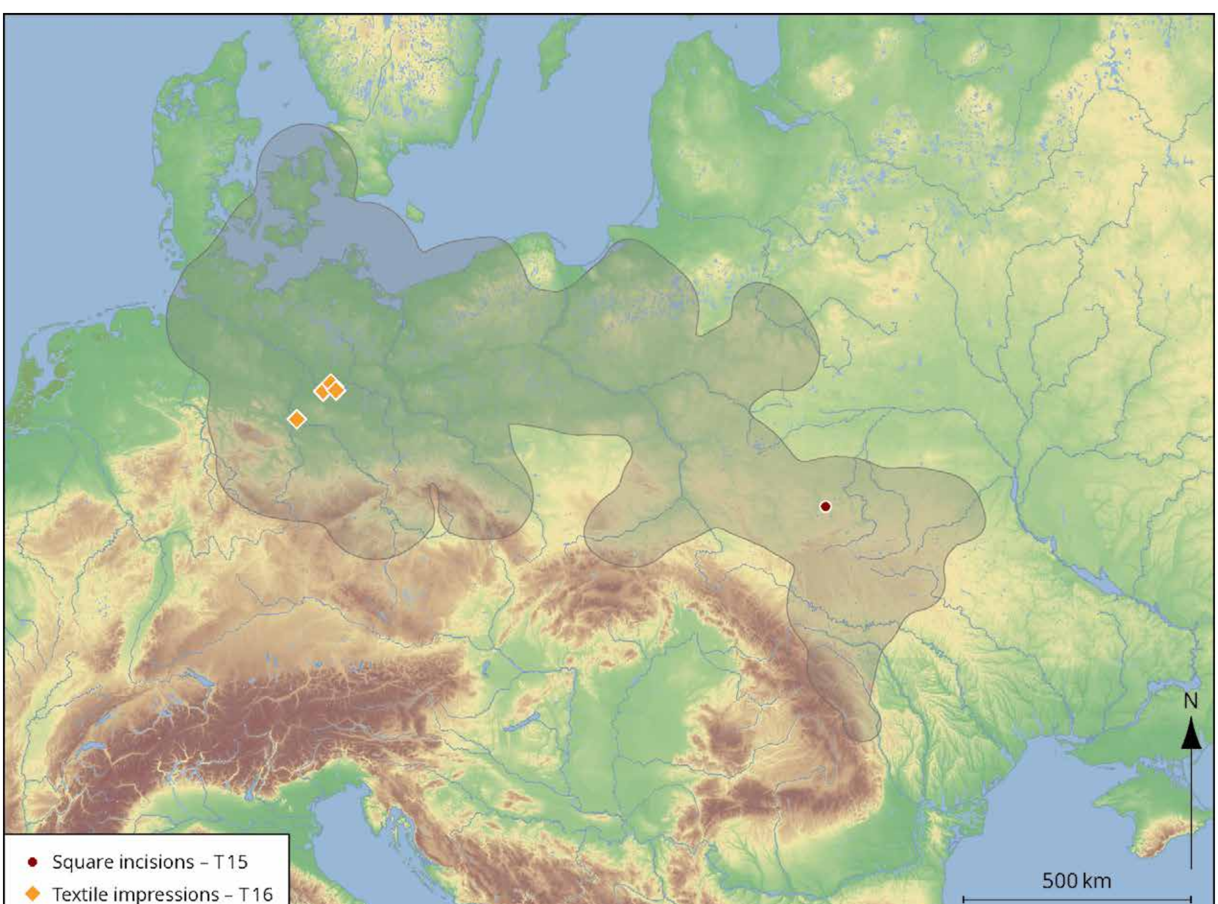
Square incisions (T15): Square incisions, only included separately for formal reasons, are only found on one vessel from the East Group (Plate 13; Fig. 31).

Textile impressions (T16): Textile impressions (six CUs), which are implemented in the West Group (Plate 13, Fig. 31), are only used for decoration motif D10.3.

Figure 30 (right, above). The distribution of stab-and-drag incisions and triangular incisions.

Figure 31 (right, below). The distribution of square incisions and textile impressions.


Stab-and-drag incisions – T13
Triangular incisions – T14
N
500 km


Square incisions – T15
Textile impressions – T16
N
500 km

No.	Basic elements/primary features	Variant/secondary characteristic
D1	**Horizontal line/row**	x – the number of horizontal lines hanging under each other
D2	**Vertical line/column**	x – the number of vertical lines hanging next to each other
		0 – around vessel
D3	**Triangles**	1 – hanging, several on top of each other
		2 – standing, several on top of each other
		3 – hanging, diagonally hatched
		4 – hanging, grid
		5 – hanging, not touching, lattice
		6 – hanging, several nested in each other with an empty space in the middle
		7 – hanging, several nested in each other with an empty space in the middle delimited by vertical lines
		8 – hanging, several nested in each other and crossed with a vertical line
		9 – hanging, filled
		10 – hanging, diagonally hatched, with a double line on left side
		11 – hanging, not filled
		12 – hanging, horizontally hatched
		13 – hanging, several nested in each other with two vertical lines of arched incisions
		14 – hanging, not touching, filled
		15 – standing, filled
		16 – standing, diagonally hatched
		17 – standing, not touching each other, filled
		18 – standing, grid
		19 – standing, horizontally hatched
		20 – hanging, vertically hatched
		21 – standing, vertically hatched
		22 – hanging, scored and filled
		23 – standing, scored and filled
D4	**Rhombs**	1 – with grid
		2 – filled
		3 – not filled
		4 – scored and filled
		5 – diagonally hatched
		6 – horizontally hatched
D5	**Lozenges**	1 – with grid
		2 – filled
		3 – not filled
		4 – diagonally hatched
D6	**Arches**	1 – hanging, several nested in each other
		2 – hanging, several nested in each other and crossed with a line
		3 – hanging, diagonally hatched
		4 – hanging, vertically hatched
		5 – hanging, several on top of each other with an empty space in the middle
		6 – hanging, simple arches next to each other
		7 – standing, several nested in each other
		8 – hanging, double arch diagonally hatched
D7	**Recessed chevrons**	1 – horizontal, with formed contours
		2 – horizontal, without formed contours
		3 – vertical, without formed contours

Table 2. The coding of decoration motifs and techniques (modified after Saev 2010). The code is used as follows: Decoration motif, variant/secondary characteristic, decoration technique, variants. For example, 1.1.1.1 would mean 'one horizontal line of arch incisions which curve downwards'.

No.	Basic elements/primary features	Variant/secondary characteristic
D8	**Herringbone pattern**	1 – pointing downwards
		2 – pointing downwards, empty space between individual motifs
		3 – pointing upwards
		4 – pointing upwards, empty space between individual motifs
		5 – pointing to the right
		6 – pointing to the right, empty space between individual motifs
		7 – pointing to the left
		8 – pointing to the left, empty space between individual motifs
		9 – pointing upwards, crossed through the middle with a line
		10 – pointing downwards, crossed through the middle with a line
D9	**Wavy lines**	x – the number of wavy lines
D10	**Hatched area**	1 – grid, diagonal
		2 – grid, straight
		3 – compound punctures, systemless, vertical or diagonal
		4 – lines, diagonal
D11	**Fringe groups**	1 – rectangular groups
		2 – v-shaped lines next to each other
		3 – groups of vertical lines
		4 – vertical lines around vessel
		5 – square group of horizontal lines
D12	**Hatched band**	1 – grid, straight
		2 – grid, diagonal
		3 – compound punctures applied around vessel, horizontal
		4 – compound punctures, systemless, vertical or diagonal
D13	**Zigzag**	x –the number of zigzags hanging next to each other
		0 – vertical
D14	**Ladder**	1 – horizontal
		2 – vertical
D15	**Comb decoration**	
D16	**Notched rim**	
D17	**Rectangular groups**	1 – composed of symbols
		2 – with frames, filled
		3 – grid

Table 2, continued.

No.	Techniques	Variants
T1	**Arch incision**	1 – curving downwards
		2 – curving upwards
		3 – curving to the right
		4 – curving to the left
T2	**Angle incision**	1 – pointing downwards
		2 – pointing upwards
		3 – pointing to the right
		4 – pointing to the left
T3	**Point incisions**	1 – small punctures
		2 – round incisions
		3 – larger recesses
		4 – double incisions
T4	**Scored incisions**	

Table 2, continued.

No.	Techniques	Variants
T5	**Chisel incision**	1 – vertical
		2 – horizontal
		3 – diagonal, leaning to the right
		4 – diagonal, leaning to the left
T6	**Cord technique**	1 – long lines forming either rows or figures
		2 – short vertical lines placed next to each other to form rows
T7	**Finger dab**	
T8	**Fingernail impression**	1 – vertical
		2 – horizontal
T9	**Ring/Circular incision**	
T10	**Plastic elements**	1 – bands
		2 – knobs
		3 – lugs
		4 – pairs of lugs
T11	**Holes**	
T12	**Cross incision**	
T13	**Stab-and-drag incision**	1 – long lines forming either rows or figures
		2 – short vertical lines placed next to each other to form rows
T14	**Triangular incision**	1 – pointing upwards
		2 – pointing downwards
T15	**Square incision /Rhomb incision**	
T16	**Textile impressions**	

Table 2, continued.

2.4.2 Correspondence analysis and spatial distribution of decoration techniques

The CA of decoration techniques shows a parabolic distribution (Fig. 32; Suppl. 6), which provides the possibility of a breakdown into four obvious groups with dominating techniques:

Group 1: Chisel incisions (T5), cord technique (T6), ringlet/circular incisions (T9) (<0 1st eigenv.);

Group 2: Scored incisions (T4), point incisions (T3), finger dabs (T7), fingernail impressions (T8), plastic elements (T10), holes (T11), angle incisions (T2), triangle incisions (T14) (0-1 1st eigenv.);

Group 3: Stab-and-drag incisions (T13), arch incisions (T1);

Group 4: Textile impressions (T16), cross incisions (T12) (both >1).

With the selection of the form of spatial representation, the decoration techniques of the globular amphorae are drawn together in hexagonal areas and the corresponding eigenvector value is mapped in colour (Fig. 33). The somewhat astonishing observation of similarly high eigenvalues of the 1st eigenvector in the southeast and the west is primarily due to the use of the arch incision technique (T1), and also partially of the cross-incision technique (T12). Decorations with triangle incisions may also play a role here (T14).

Group 1 (cord decoration) is more prevalent in Northeastern Central Europe, but also strongly represented in Eastern European areas, including Podolia and Volyhnia. *Group 2* with a variety of different techniques is clearly observed

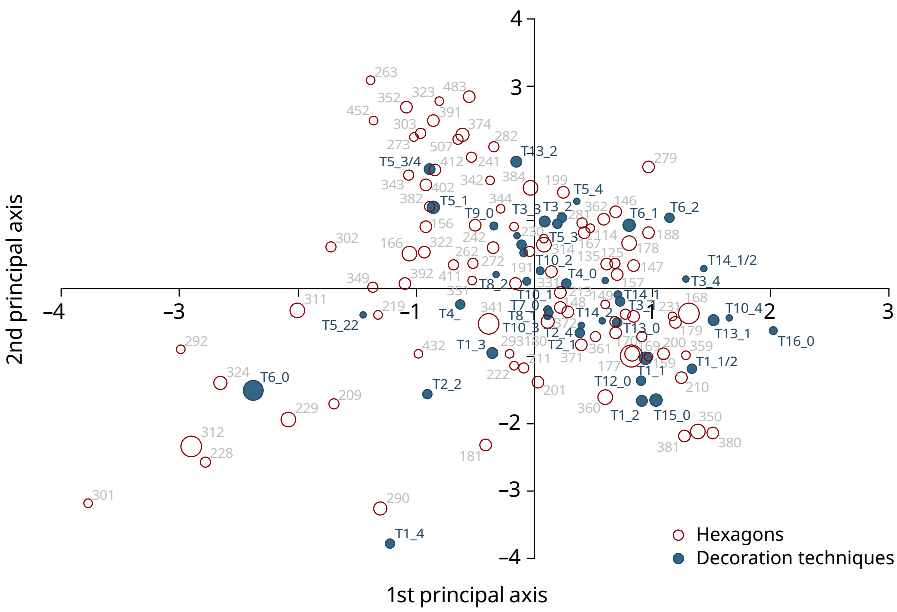


Figure 32. Scatterplot of the 1st and the 2nd eigenvector of the correspondence analysis of GA decoration techniques. The hexagonal areas form the spatial unit, for which the occurrences of corresponding techniques were added up (Suppl. 6).

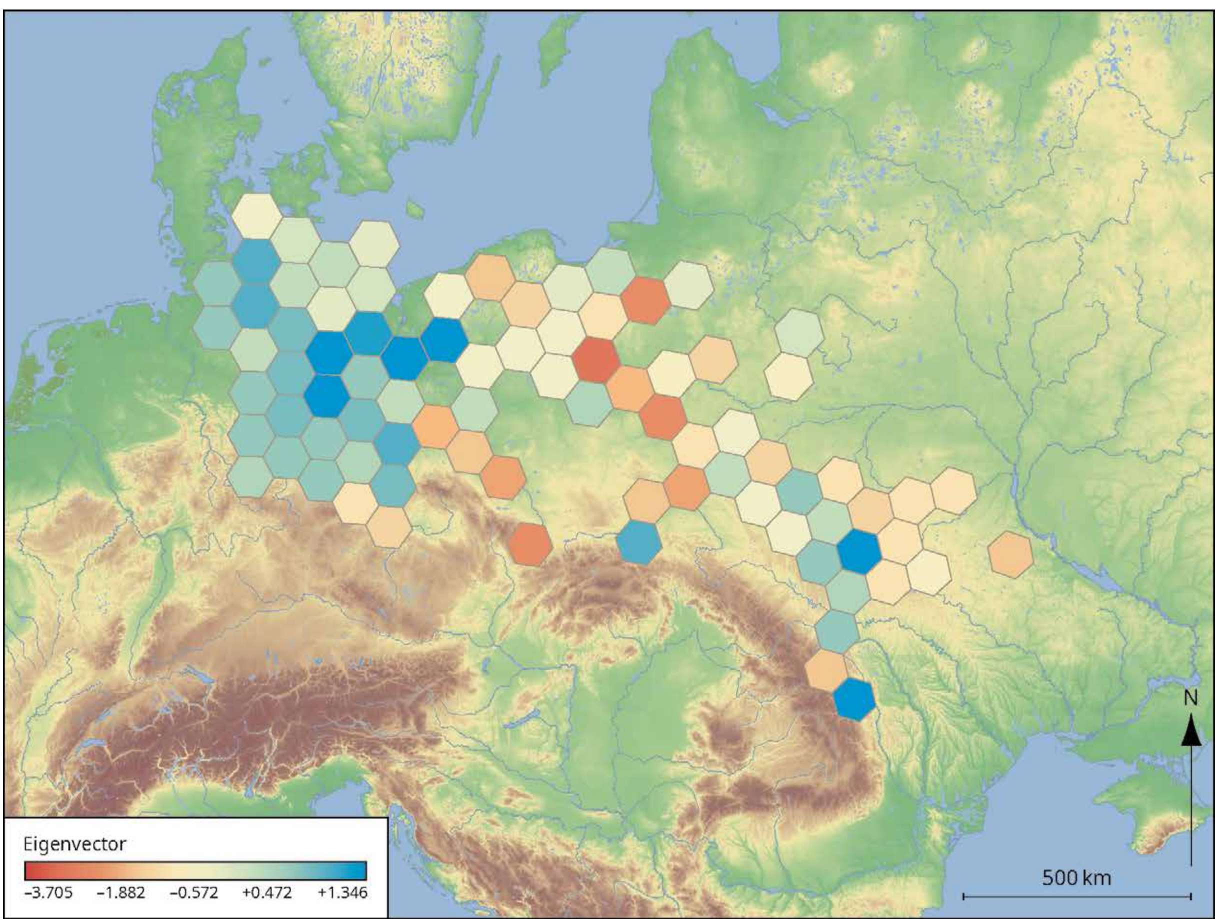


Figure 33. Display of the 1st eigenvector of the CA of decoration techniques (cf. Fig. 32). The somewhat astonishing observation of similarly high eigenvalues of the 1st eigenvector in the southeast and the west is primarily due to the use of the arch incision technique (T1), and also partially of the cross-incision technique (T12) (cf. Fig. 32; Suppl. 6).

throughout the area. *Groups 3 and 4* dominate, on the one hand, in Central Germany and, on the other hand, *Group 4* very strongly at the Moldavian Siret. A map by N. Nortmann shows, however, that the arch incision has a vertical orientation in the western area of the distribution, while it is rather horizontal in the eastern area (Nortmann 1985, 36, fig. 9). This points to possible independent convergence phenomena. The East Group, which exhibits strong cord decoration, is then clearly separated from the West Group, which displays decoration with arches and stab-and-drag incisions (Fig. 33).

A CA based on the differentiated secondary decoration techniques (Plate 13) leads to a visually relatively similar spatial result, but the distribution of the eigenvalues in the CA proves that the mass of the variables is clustered in just one area. Accordingly, while the results are visually interesting, they are not particularly meaningful archaeologically.

2.4.3 Results and interpretation

Most of the individual mappings of the decoration techniques demonstrate the use and knowledge of them throughout the entire GAC distribution area. This applies above all to arch (T1), angle (T2), and point (T3) incisions as well as to scoring (T4), chisel (T5) and cord (T6) techniques. Other techniques, such as circular (T9), cross (T12), stab-and-drag (T13) and triangle incisions (T14), but also textile impressions (T16) are predominantly spread in the West Group.

Although the distribution of practically all decoration techniques in the entire GAC area can be observed from the individual mappings, clear preferences for certain techniques in certain GAC regions could be determined by the multivariate analysis. Thus, the hexagon representation provides the possibility to emphasise the dominating technique elements (Fig. 33). In principle, a spatial differentiation can be recognised similar to that found for the vessel types: on the one hand, a western area (primarily dominated by arch and chisel incisions) and an eastern area from Pomerania to Volhynia (with dominant cord decoration). However, differences become visible in the details. For example, the western area is no longer closed, but three areas can be distinguished: A core area with arch, angle and chisel incisions, a southern area, in which cord decorations are obviously more strongly represented and the Western Baltic region, which also exhibits greater differentiation.

In the eastern regions as well, differences become apparent between Volhynia and Podolia (with a dominance of cord decoration corresponding to the Vistula region), on the one hand, and the Moldavian Siret on the other. In the latter area, angle and chisel incisions lead to the differentiation. Apparently, decoration techniques dominate here that are quite similar to those in Central Germany, but other secondary techniques dominate, so that a convergence in the local or regional development of certain technical instruments can be assumed. Regardless of these detailed observations, in summary, a certain east-west differentiation in techniques is discernible for the North Central European lowlands, but also a north-south differentiation within the West Group and within the East Group is identifiable.

2.5 Investigations on decoration motifs

2.5.1 Decoration motifs and individual observations

Ca. 70% of the recorded vessels are decorated (1413 of the 1987 CUs). For the processing of the decorations, a decoration recording system was developed by Ilja Saev (2010), which is based on the recording systems of Priebe (1938), Nortmann (1985) and

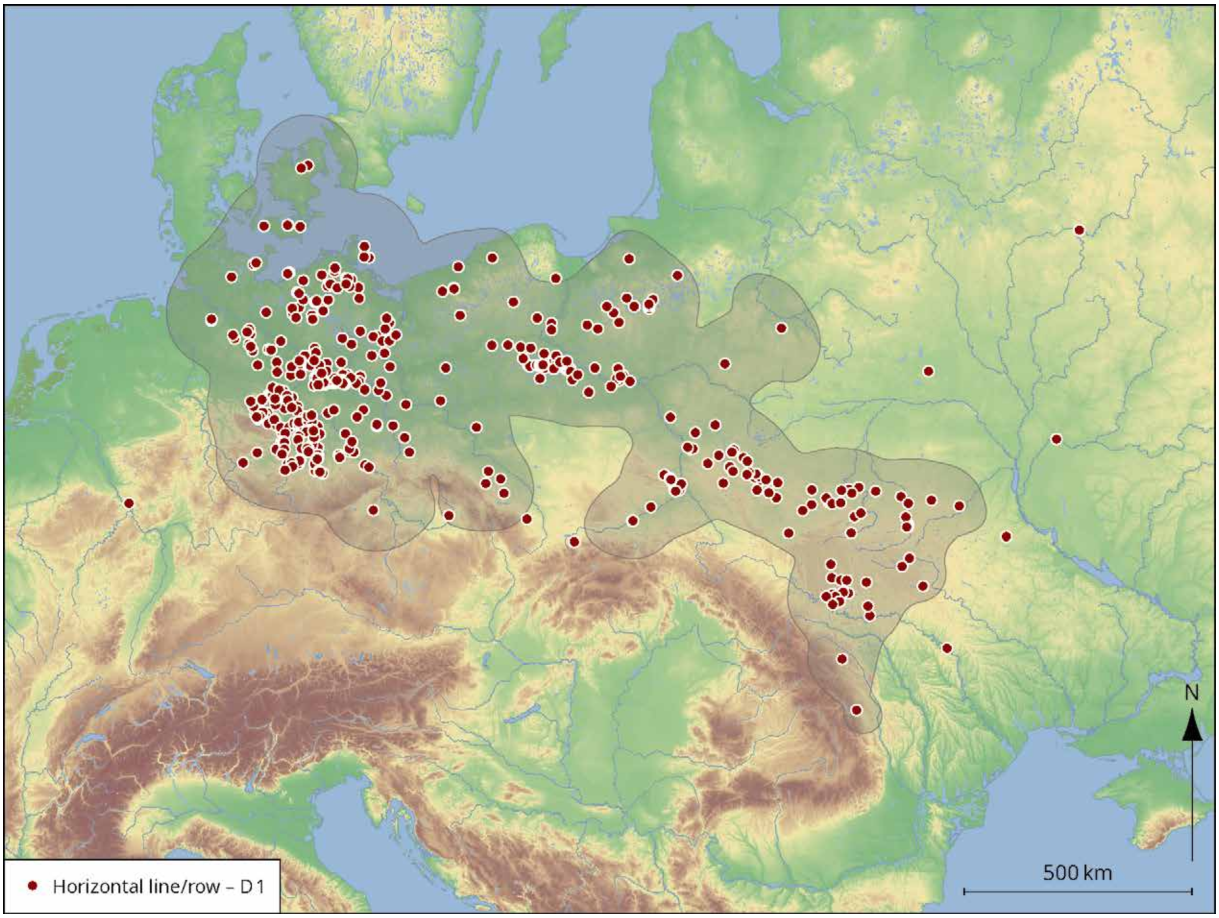


Figure 34. The distribution of decorations with horizontal lines and rows.

Meyer (1993). In principle, our system does not differentiate between secondary and primary decorations or refer to the positions on the vessels (cf. Müller 2001, 197). The decoration motifs, which are defined in the recording system, can theoretically appear on any vessel shape, at any place on the vessel body and in any composition.[12]

Basically, simple geometrical features serve to divide the basic elements into motif classes. The detailed expression of the basic elements is used for a finer structuring of the decoration motifs (cf. Table 3). Seventeen basic elements with secondary features were distinguished (Plates 9-13).

Horizontal line/row (D1)

Phenomenologically, the simple geometrical horizontal "line" was supplemented by "rows". With certain techniques (*e.g.* chisel or arch incisions), horizontal rows instead of solid, incised lines result, which appear to be visually comparable (Plate 9). Secondarily, the number of lines/rows, which lie uninterrupted below each other and as such represent a closed decoration motif, is recorded. Horizontal lines are present on 943 vessels and occur throughout the entire distribution area (Fig. 34).

12 The decoration motifs were classified with numerical codes (cf. Suppl. 1). The first two digits refer to the motif, the following two to the decoration technique. All other digits of the codes are used to further differentiate the basic decoration motif, if necessary, without leaving the basic classification system. Following Nortmann (1985, 17), in the classification of the decoration motifs, the basic elements, which come first in the numerical code, are denoted as primary features and the possible special expressions of the basic elements (the second digit of the code) as secondary features.

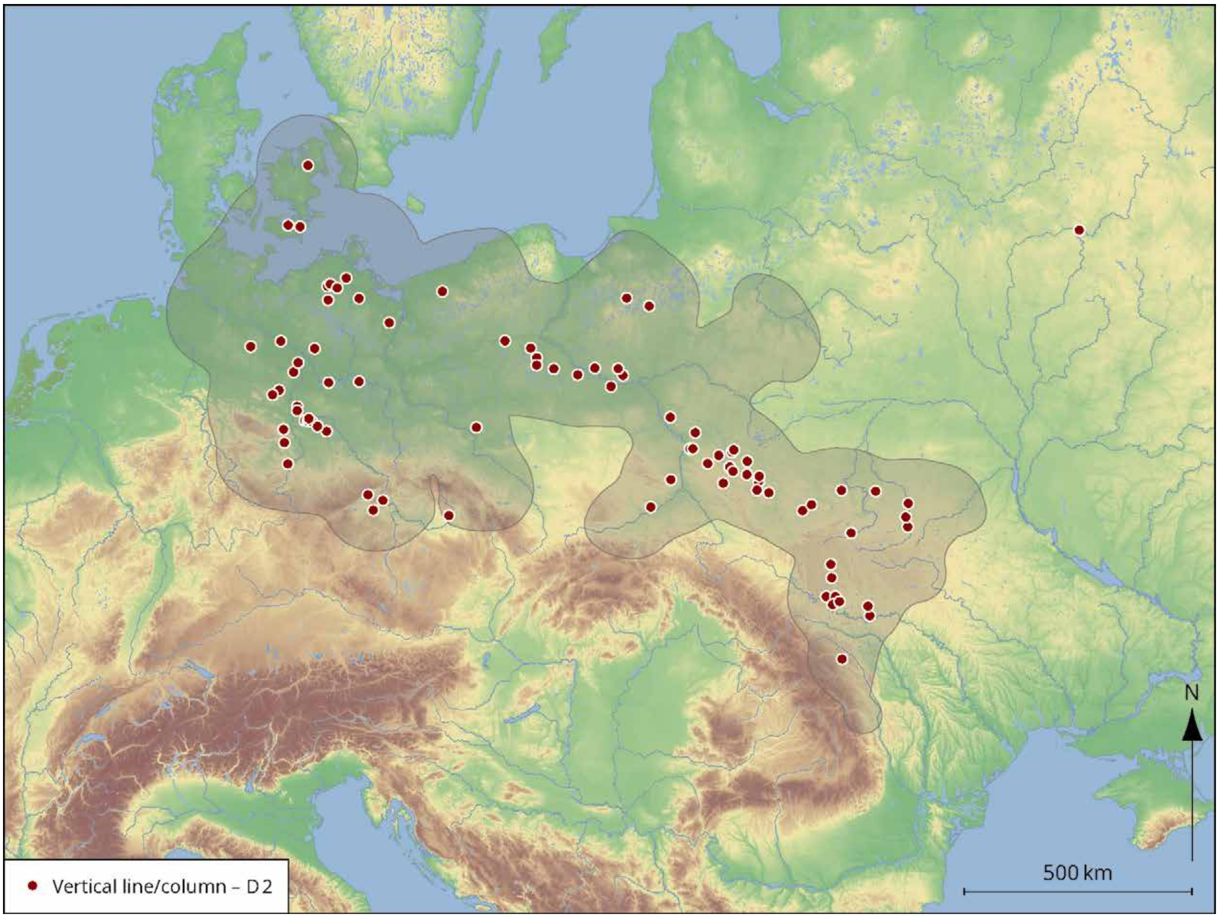


Figure 35. The distribution of decorations with vertical lines and columns.

Vertical line/column (D2)

Vertical lines form their own decoration motif. With the extension "column", just like the "horizontal line" with the "row", the assignment of specific technical applications is meant that achieve a comparable linear optical effect. Secondarily, the number of lines/rows, which stand uninterrupted next to each other and as such represent a closed decoration motif, is recorded. In contrast to the frequently represented horizontal lines/rows, the vertical lines/columns are only recorded for 80 vessels (3% of all recorded motifs, 1% in the West Group, 7% in the Central Group and the East Group; Fig. 35).

Triangles (D3)

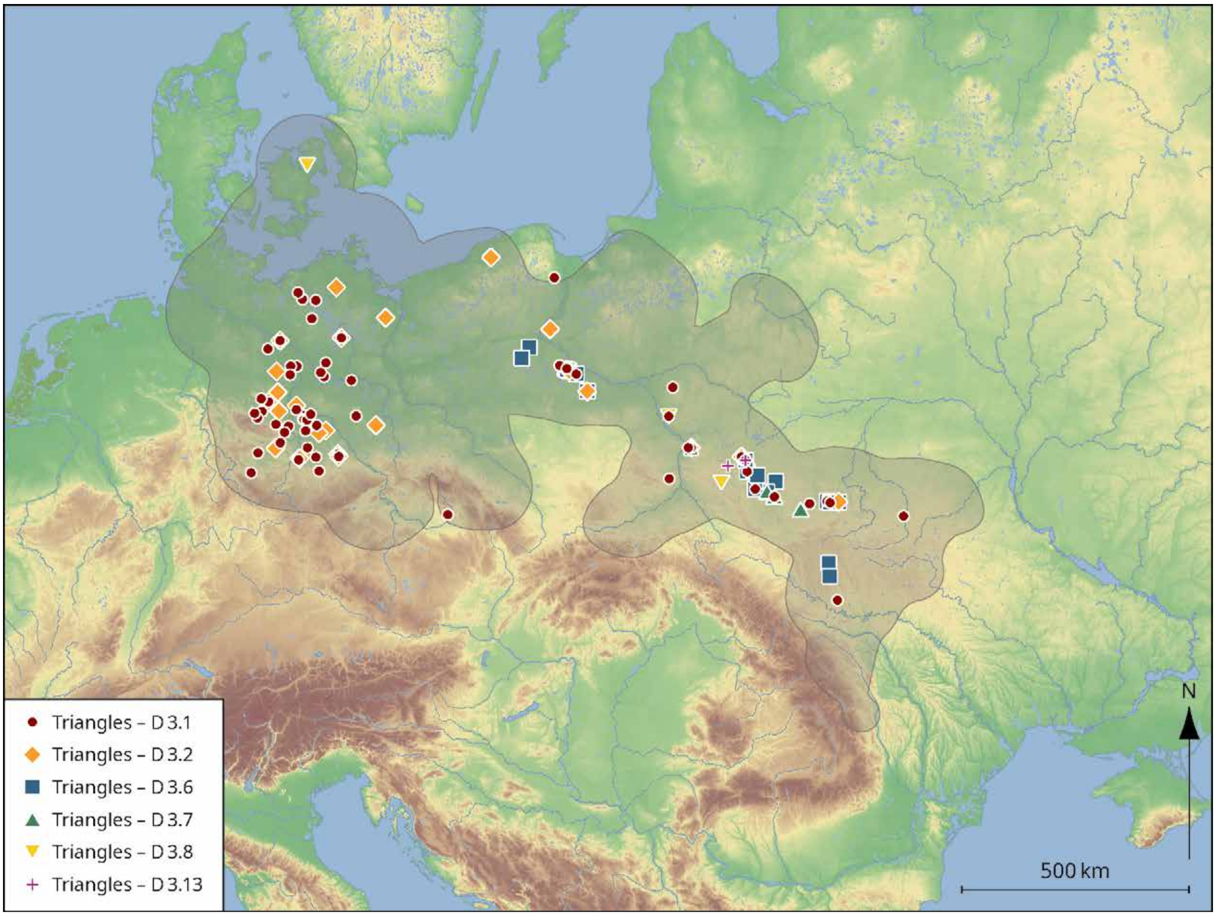
Triangles represent the most varied group of decoration motifs. The basic element is a closed, geometric form ("triangle"), either hanging or standing. The filling is variable: hatched in different directions with lines and grids, filled with characters, filled with and without scored contours, triangles of stacked, ever-smaller repetitions of contours, sometimes with one or two vertically stroked lines. 660 CUs exhibit the triangle motif – triangles are the second most common decoration motif of the GAC (Plate 9; Fig. 36). Nortmann (1985, 24-25) already assigned certain secondary forms of triangular motifs to different regional groups.

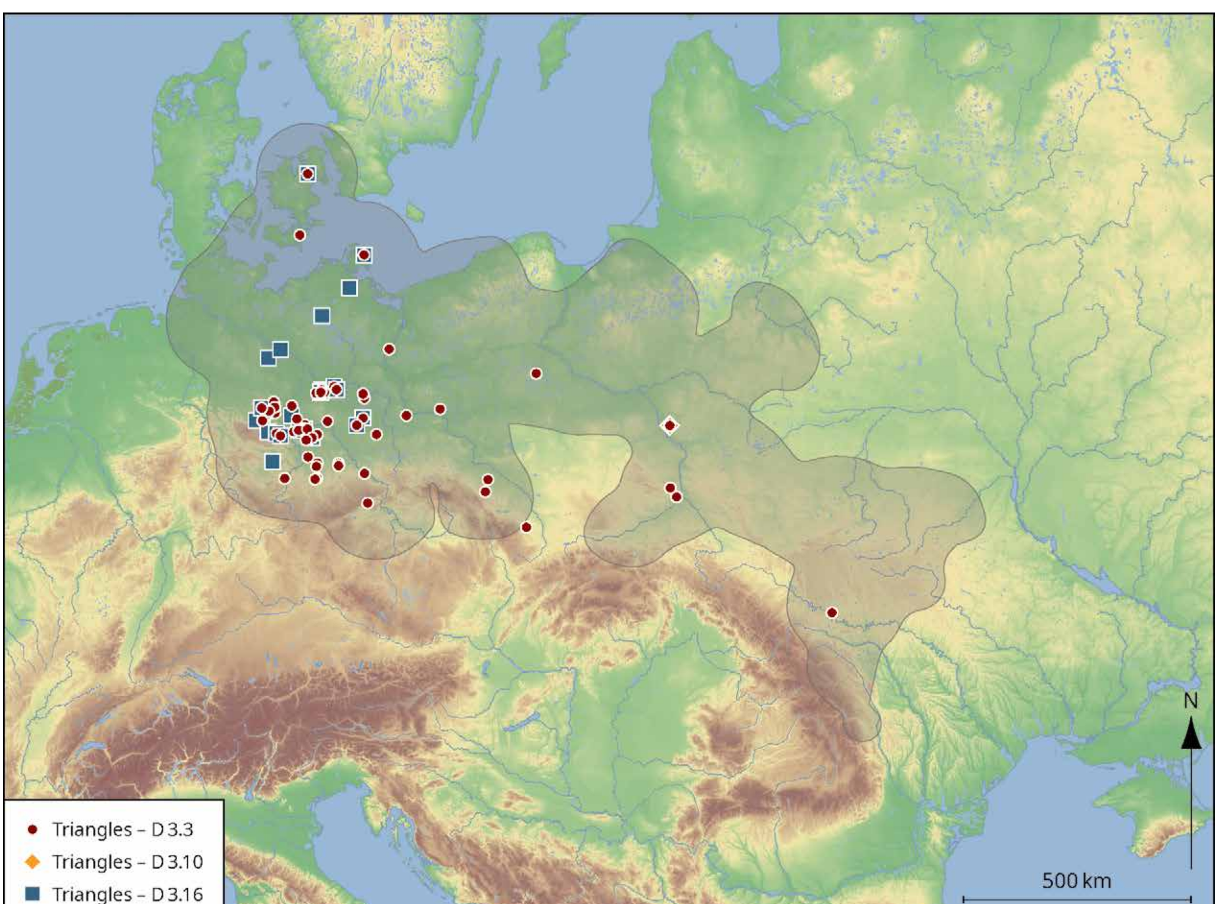
Figure 36 (right, above). The distribution of decorations with triangles.

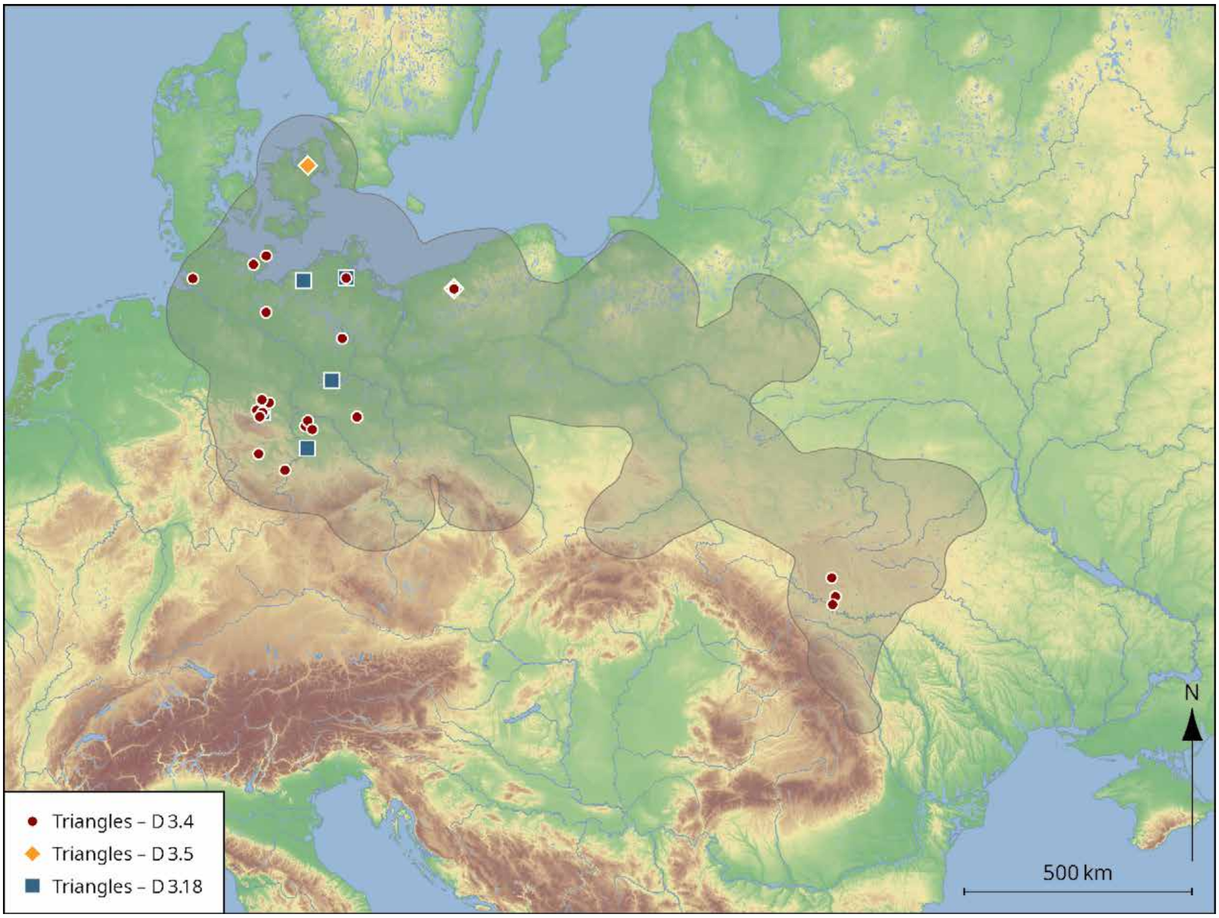
Figure 37 (right, below). The distribution of decorations with diagonally hatched triangles.

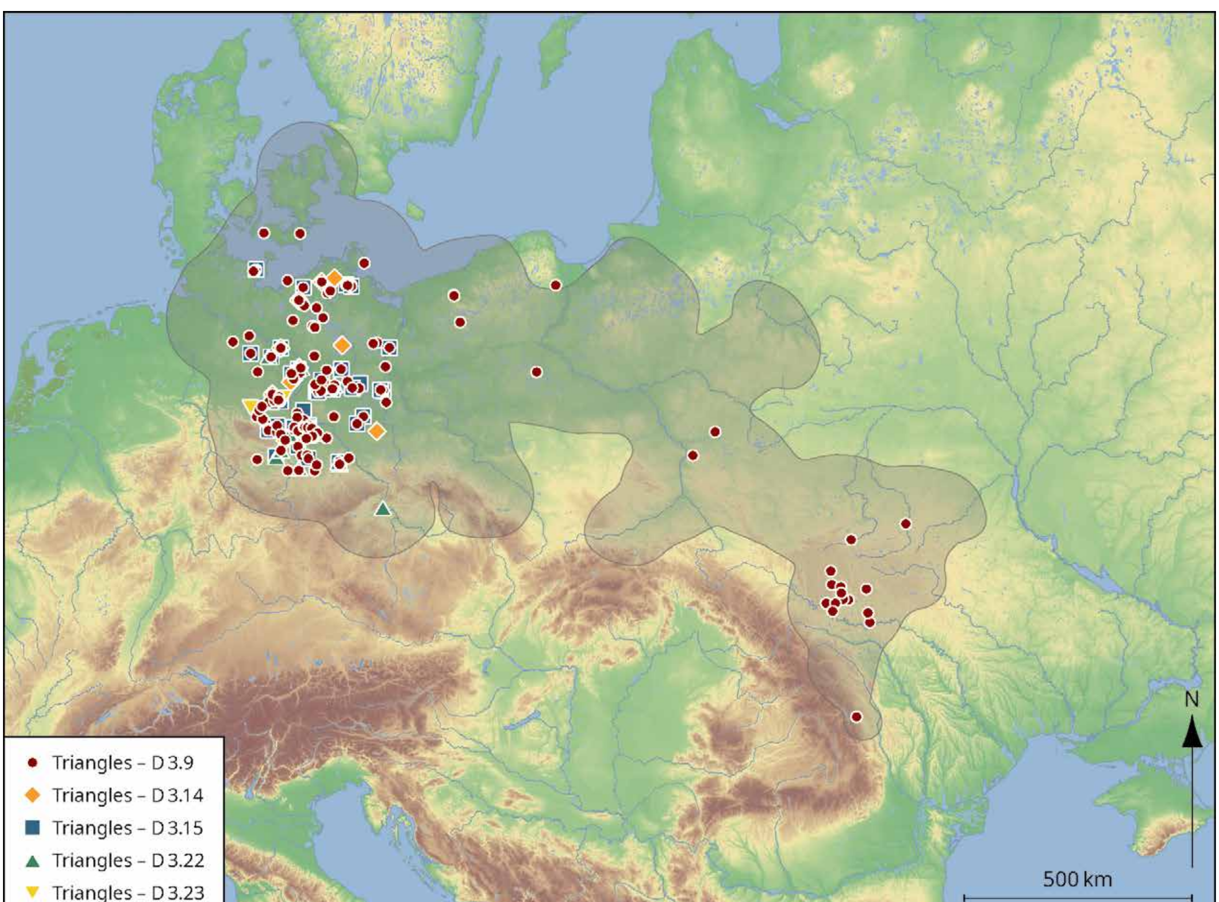
Motif D3.1 (Nortmann's motif H1) represents a hanging triangle that is filled with decreasing triangular contours (Plate 9). Of the 95 CUs with motif D3.1, the majority are from the West Group and only a few from the Central Group and the East Group. Related to the motif, but standing (D3.2), are 29 decorated vessels that again are mainly found in the West Group.

Motifs comparable to D3.1, but with one or two vertical lines or free vertical space in the centre, were recorded for D3.6 (25 CUs), D3.7 (six CUs; after


Triangles – D3.1
Triangles – D3.2
Triangles – D3.6
Triangles – D3.7
Triangles – D3.8
Triangles – D3.13
N
500 km


Triangles – D3.3
Triangles – D3.10
Triangles – D3.16
N
500 km


Triangles – D 3.4
Triangles – D 3.5
Triangles – D 3.18
N
500 km


Triangles – D 3.9
Triangles – D 3.14
Triangles – D 3.15
Triangles – D 3.22
Triangles – D 3.23
N
500 km

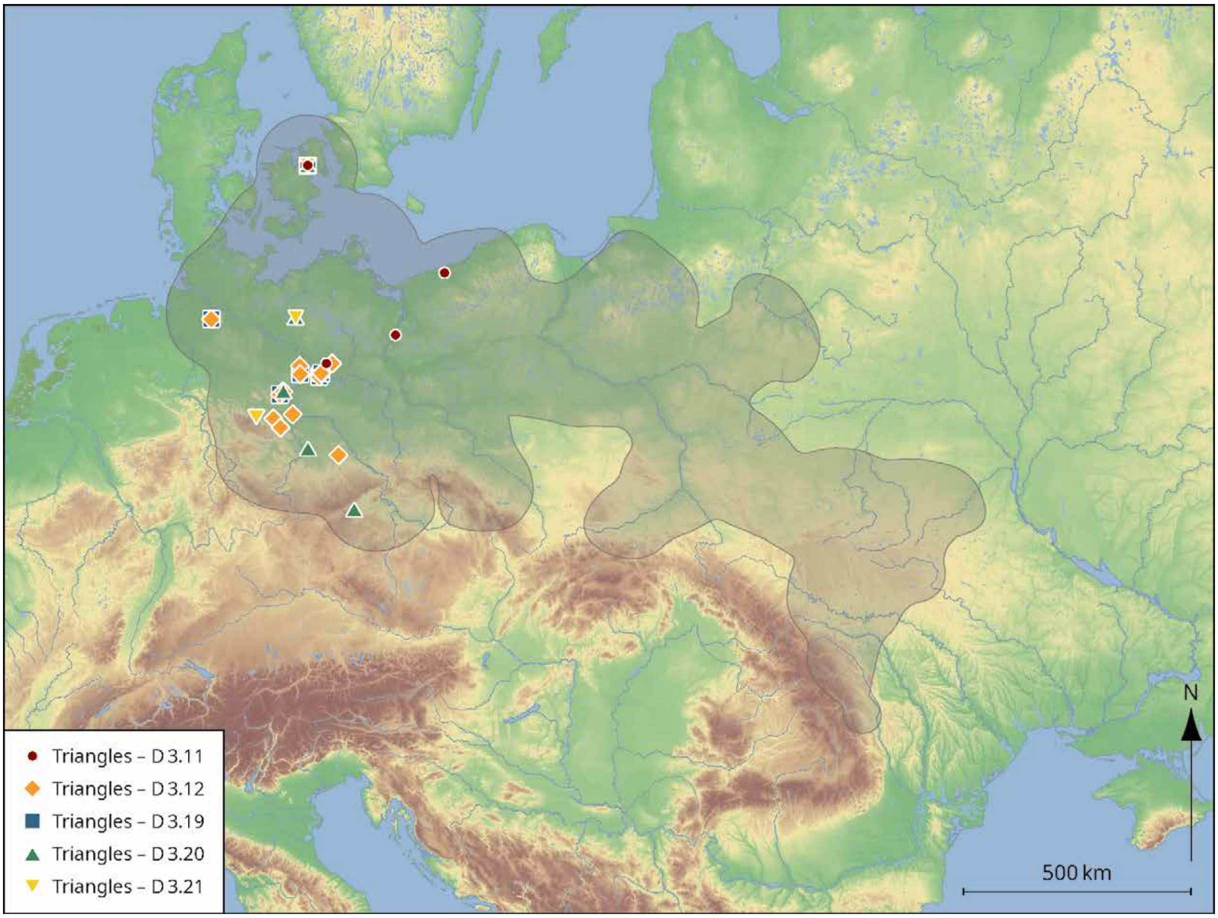


Figure 40. The distribution of decorations with triangles hatched with horizontal or vertical lines.

Nortmann 1985, 25 H2), D3.8 (three CUs) and D3.13 (three CUs) (Plate 10), making a total of 37 CUs. They are known exclusively from the Central Group and the East Group (Fig. 36). Nortmann (1985) already identified them as typical vessels for the eastern GAC.

Diagonally hatched triangles (D3.3 hanging; D3.16 standing; D3.10 with an additional line outside the triangle) form another category of secondary features (Plate 10), with 124 CUs. D3.16 (33 CUs) is only represented in the West Group, D3.3 (87 CUs) primarily in the West Group, and D3.10 (four CUs) is a special feature on the Vistula (Fig. 37).

Grid-filled triangles (D3.4, D3.5 and D3.18) are represented on 38 CUs, above all in the West Group (Plate 10-11; Fig. 38). Completely filled triangles (D3.9, D3.14, D3.15, D3.22, and D3.23) were noted on 91 CUs (Plate 10). While motif D3.9 (41 CUs) is mainly concentrated in the West Group and the East Group, the other completely filled motifs are limited to the West Group (Fig. 39). Rather rare (19 CUs) and also limited to the West Group are triangles that are hatched with horizontal (D3.12 and D3.19) or vertical lines (D3.20 and D3.21) (Plate 10; Fig. 40).

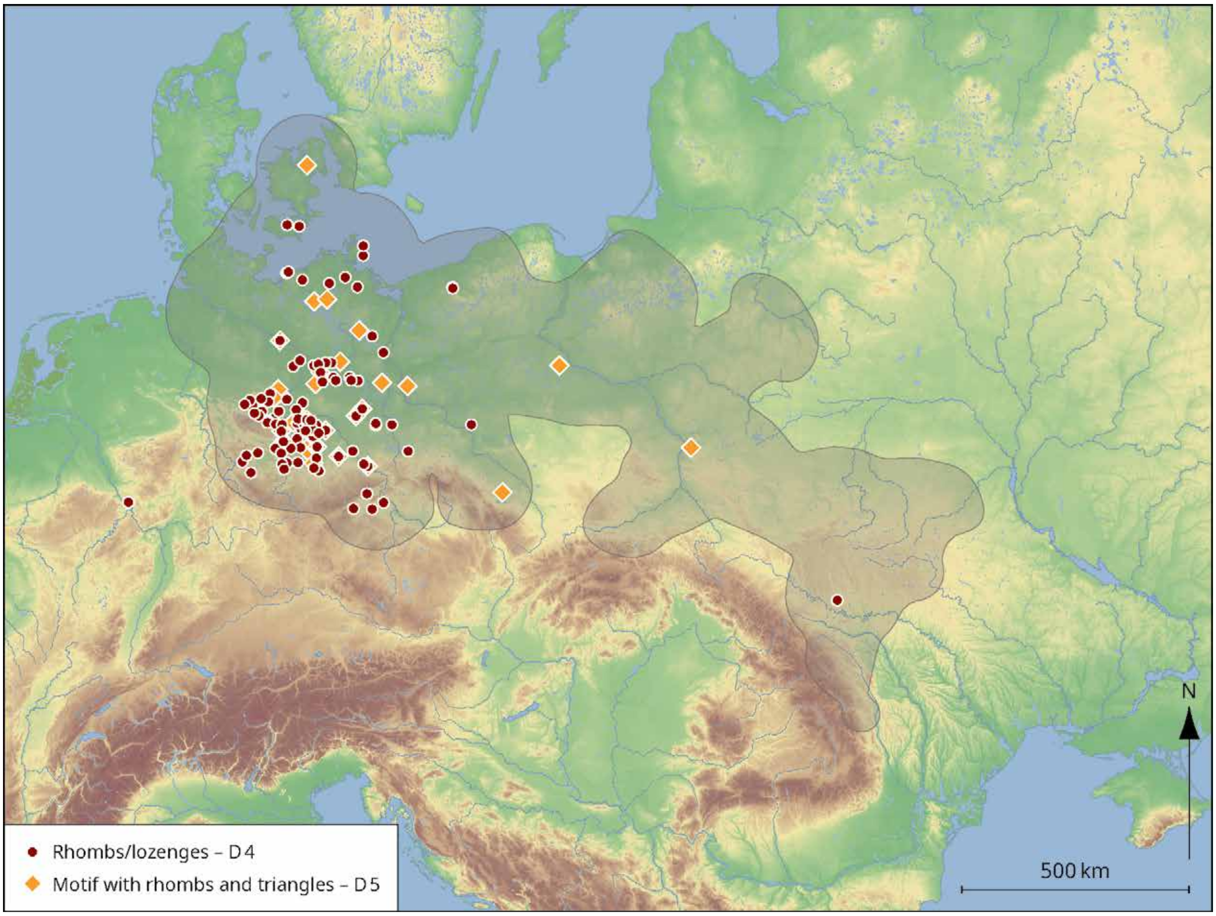
Thus, for triangular motifs, a concentration of numerous secondary motifs is suggested for the West Group, although specific designs may only occur in the Central Group and the East Group.

Rhombs/Lozenges (D4 and D5)

Separate rhombs (D4) and lozenges, which form a motif (D5) together with standing and hanging triangles, were recorded for 95 CUs (Plates 11), the great majority thereof in the West Group (Fig. 41).

Figure 38 (left, above). The distribution of decorations with grid-filled triangles.

Figure 39 (left, below). The distribution of decorations with completely filled triangles.


Rhombs/lozenges – D4
Motif with rhombs and triangles – D5
N
500 km


Arches – D6
N
500 km

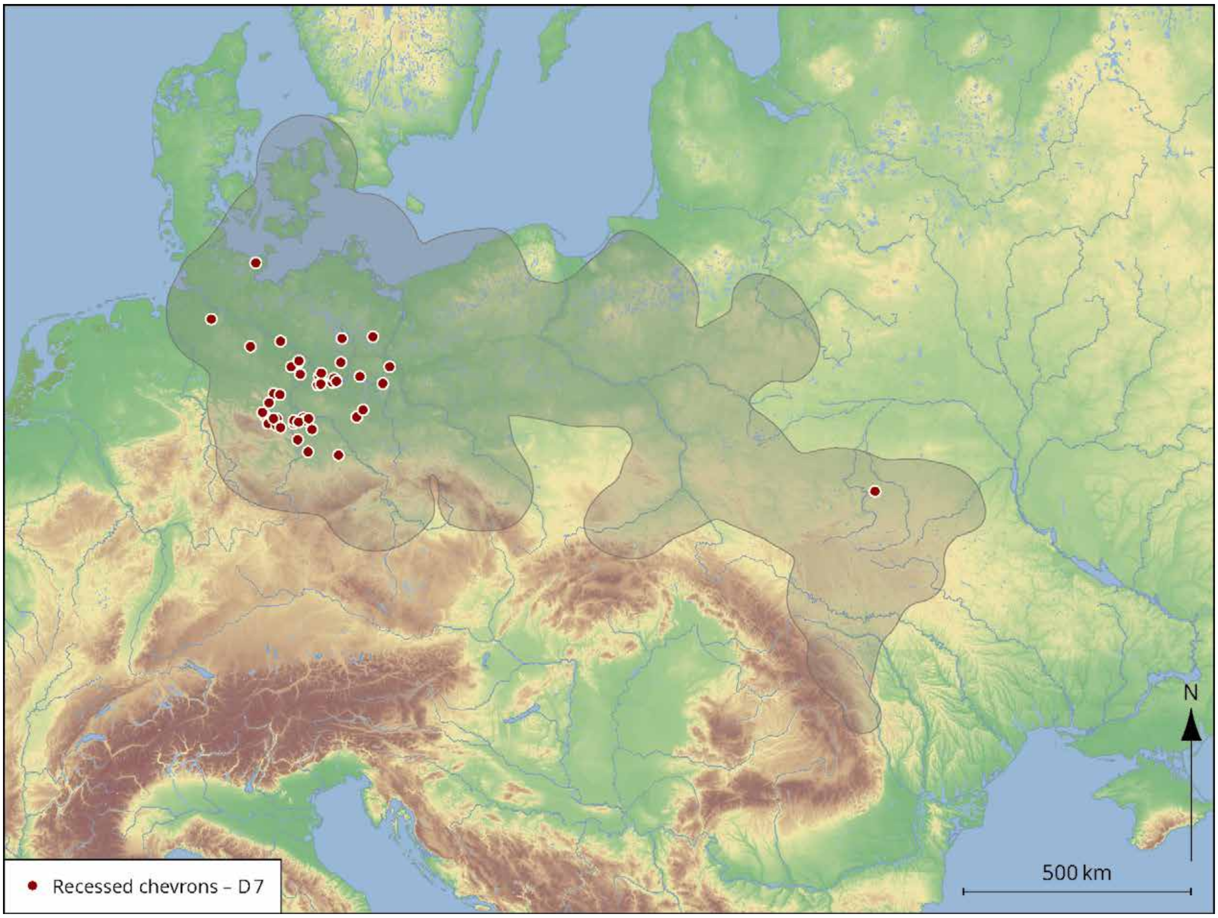


Figure 43. The distribution of decorations with recessed chevrons.

Arches (D6)

As an independent motif with eight secondary variants, arches (in Nortmann 1985, 26 H3) occur on 43 CUs (Plate 11-12). Their distribution is limited to the Central Group and the East Group (Fig. 42).

Recessed chevrons (D7)

Recessed chevrons (Nortmann 1985, 24 E1) are formed by connected standing and hanging triangles around a recessed chevron (Plate 12). A distinction is made between the bordered (D7.1) and non-bordered (D7.2) subtypes. This motif was documented for 25 CUs and is limited to the GAC West Group (Fig. 43).

Herringbone pattern (D8)

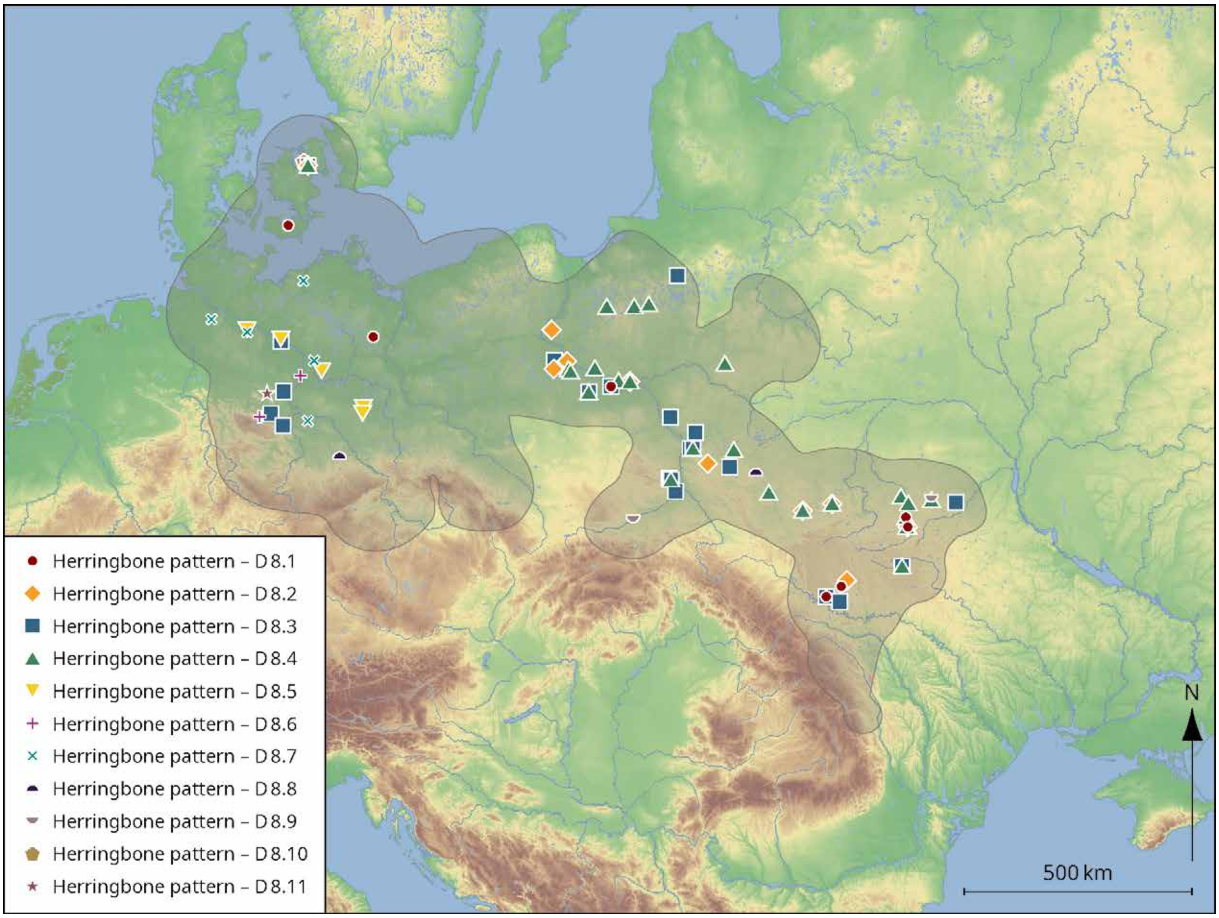
The “herringbone” or “fir branch pattern” (referred to in Nortmann 1985, 26 as “single-line, vertically nested angles”) are divided into ten subtypes (Plate 12). 105 CUs bear the motif, of which subtypes D8.1 and D8.2 are found in the Central Group, the East Group and in the Western Baltic region, D8.4 and D8.9 primarily in the Central Group and the East Group, subtypes D8.5, D8.6, D8.7 and D8.10 in the West Group, and subtype D8.8 (only weakly represented) possibly throughout the entire distribution range (Fig. 44).

Wavy lines (D9)

Sixteen CUs are decorated with this motif (Plate 12) (Nortmann 1985, 25 V4). Secondarily, the number of wavy lines lying beneath each other was considered. The 16 CUs are concentrated in the East and Central Group, but are also known in the West (Fig. 45).

Figure 41 (left, above). The distribution of decorations with rhombs/lozenges and rhombs/triangles.

Figure 42 (left, below). The distribution of decorations with arches.



Herringbone pattern – D8.1
Herringbone pattern – D8.2
Herringbone pattern – D8.3
Herringbone pattern – D8.4
Herringbone pattern – D8.5
Herringbone pattern – D8.6
Herringbone pattern – D8.7
Herringbone pattern – D8.8
Herringbone pattern – D8.9
Herringbone pattern – D8.10
Herringbone pattern – D8.11
N
500 km

Wavy lines – D9
N
500 km

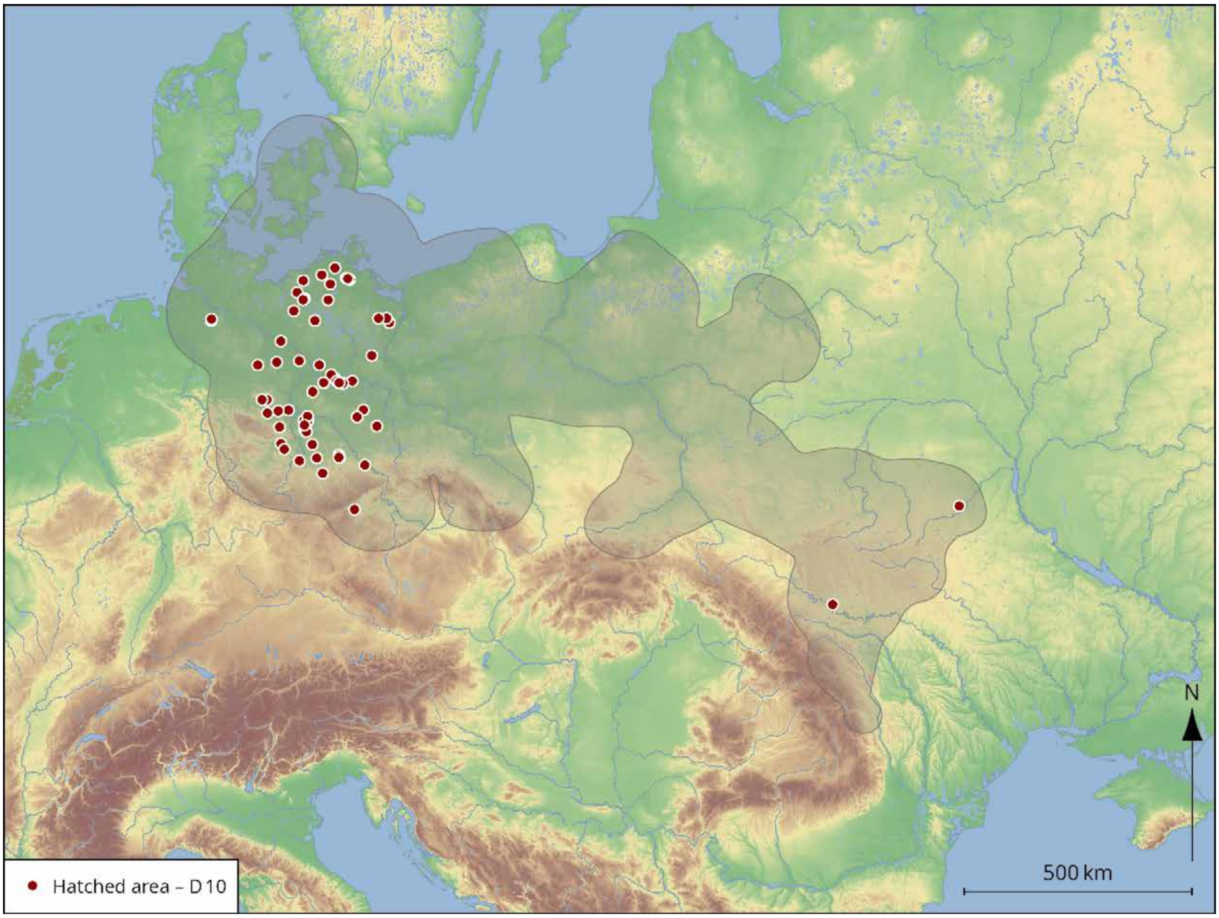


Figure 46. The distribution of decorations with a hatched area.

Hatched area (D10)

Hatched areas appear as diagonal grids (D10.1) or straight grids (D10.2) (Plate 12). The 89 CUs are limited to the West Group (Fig. 46).

Fringe groups (D11)

Fringe groups are located on the shoulders of the vessel bodies. Five subtypes have been identified (Plate 13). With 508 CUs, fringe groups represent the third largest motif of the GAC and are registered in principle in the entire distribution area (Fig. 47-50). In contrast, fringe groups of V-shaped lines are limited to the West Group (D11.2).

Hatched band (D12)

This closed band, running around the neck or shoulder of a vessel, is essentially smaller than motif D10 (hatched area) and can be applied to a vessel more than once. Four subtypes were identified, with a total of 39 CUs exhibiting hatched bands. Motif D12 is primarily found in the West Group, the variants D12.3 and D12.4 only in the West Group (Fig. 51).

Zigzag (D13)

In the case of the zigzag bands, the angle usually measures 90°, but sometimes it can be as high as 130° (obtuse) or as acute as nearly 60°. As a secondary feature, the number of zigzag lines lying one below the other was recorded. As a subtype, vertically arranged zigzags were noted (D13.0) (Plate 13). The 271 CUs are distributed throughout the entire distribution area (Fig. 52).

Figure 44 (left, above). The distribution of decorations with herringbone patterns.

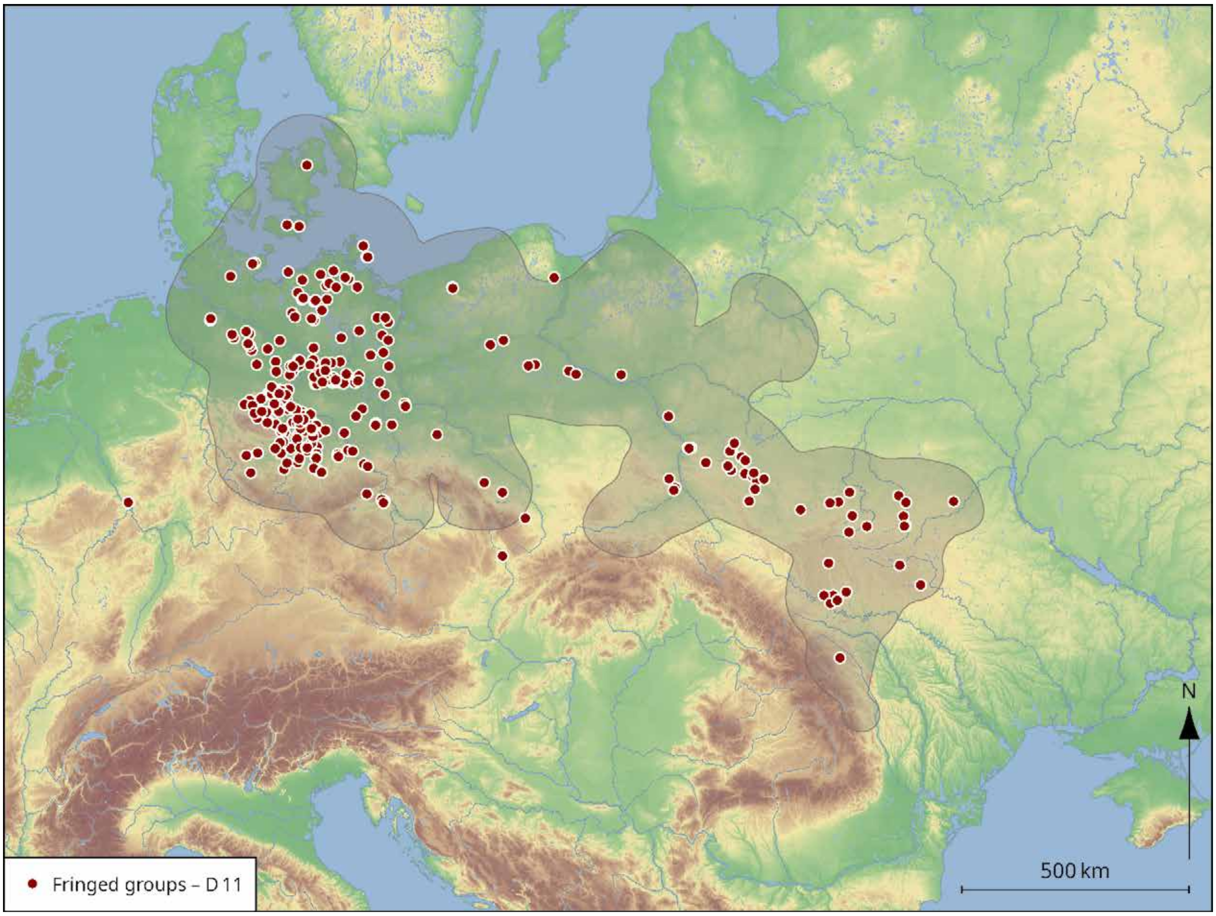
Figure 45 (left, below). The distribution of decorations with wavy lines.

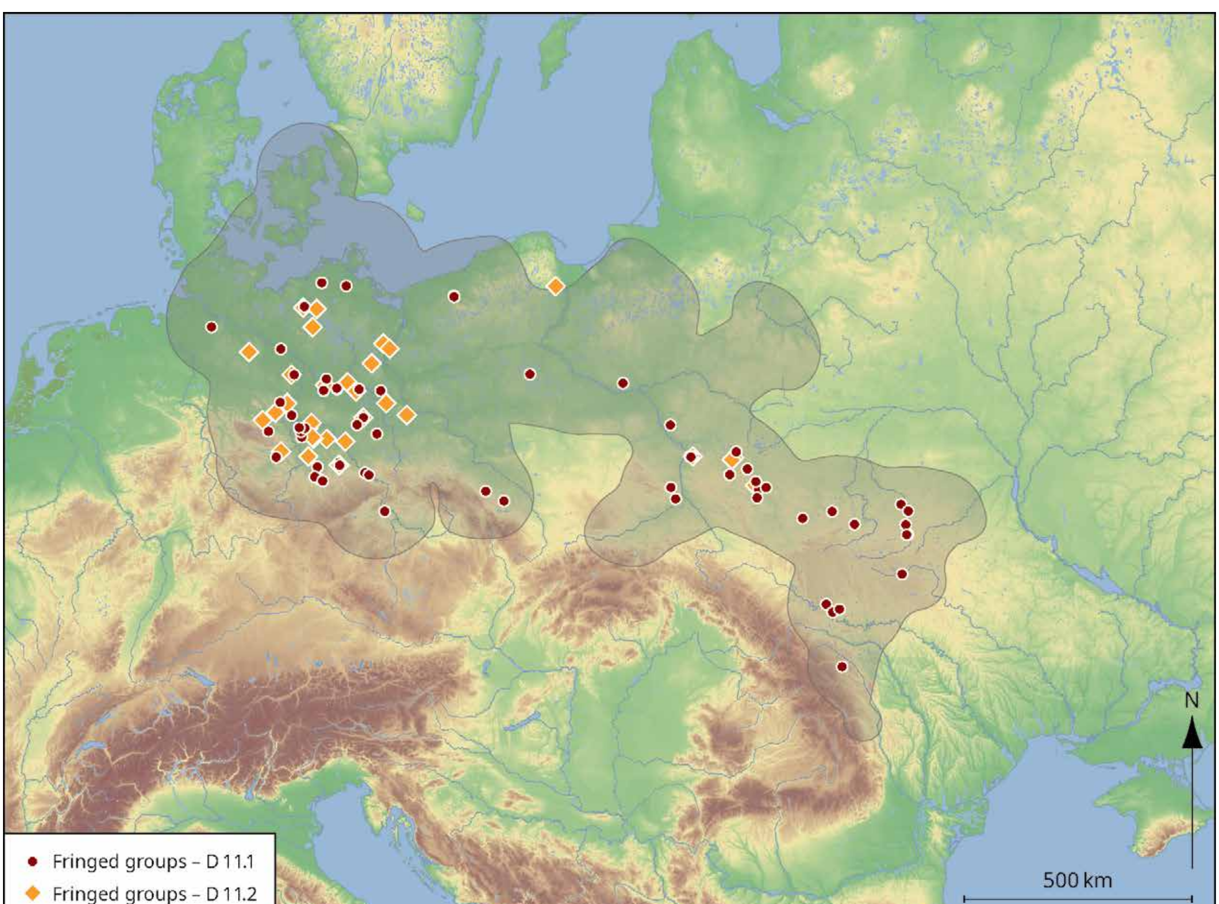
Figure 47 (following page, above). The distribution of decorations with fringed groups (D11).

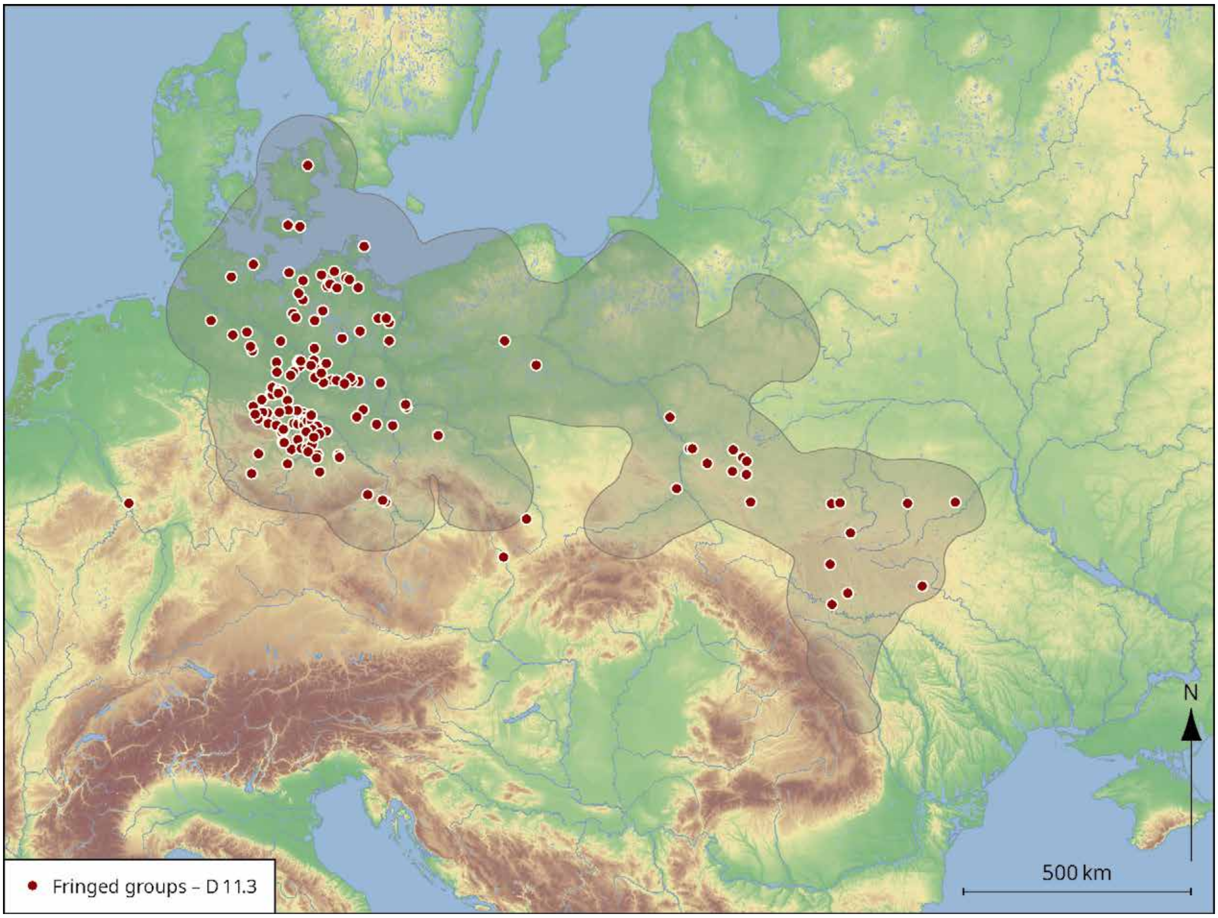
Figure 48 (following page, below). The distribution of decorations with fringed groups (D11.1 and D11.2).

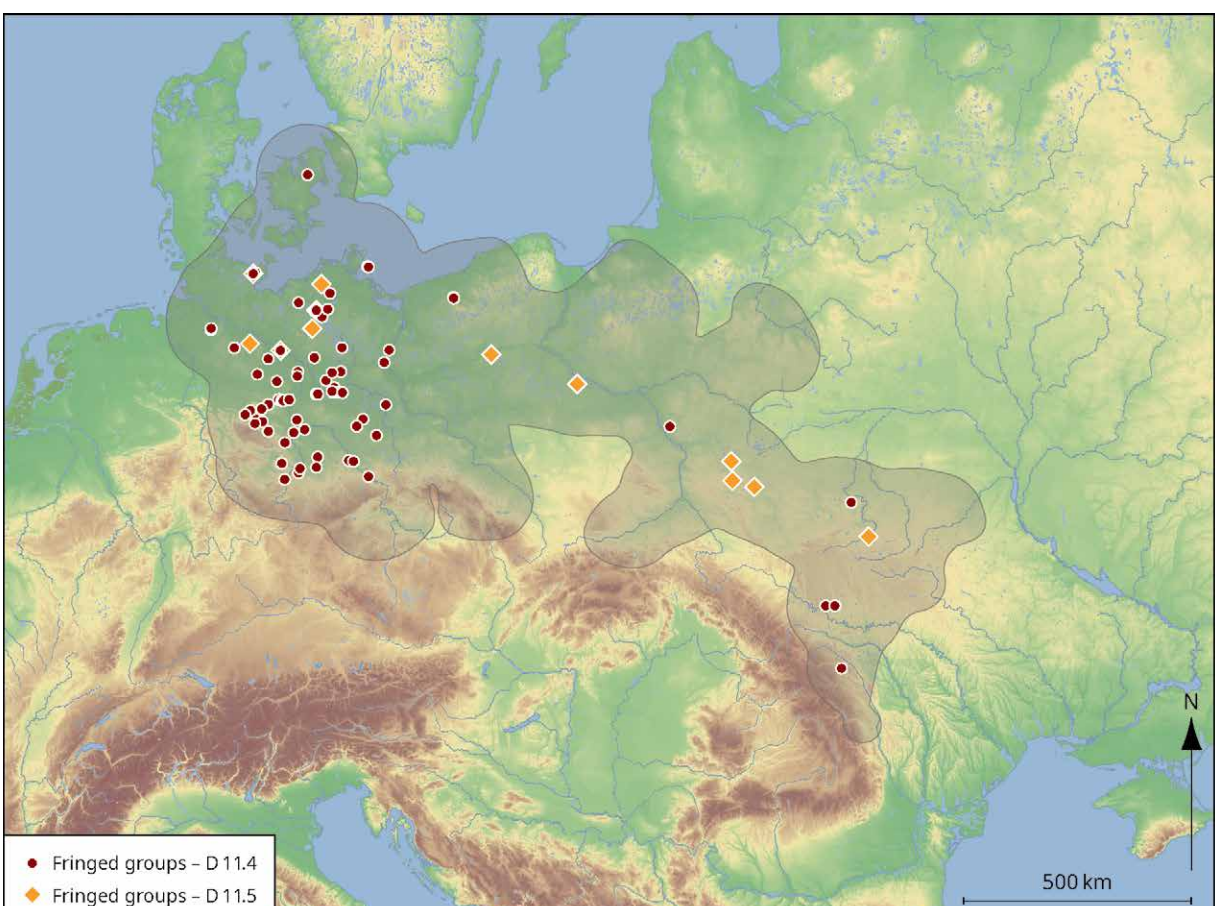
Figure 49 (page 69, above). The distribution of decorations with fringed groups (D11.3).

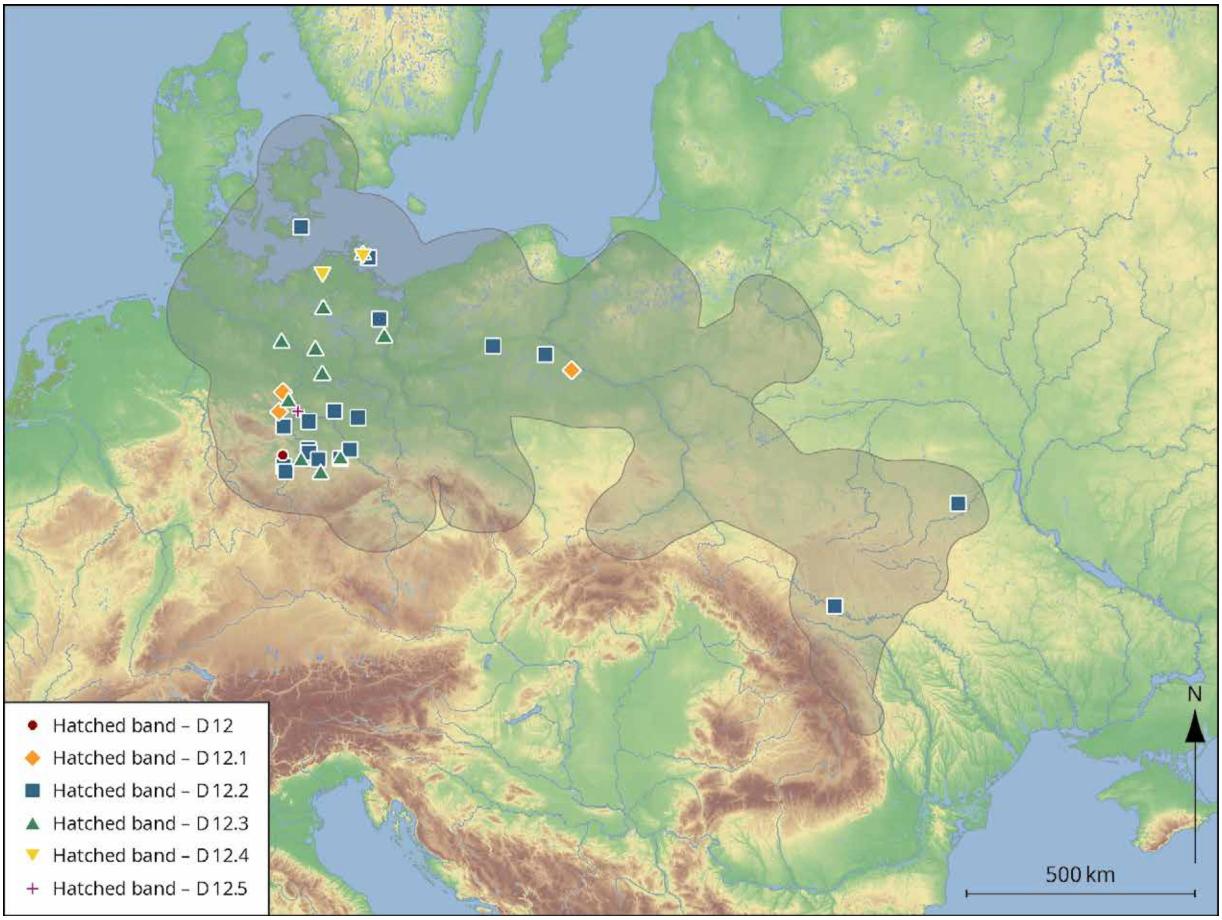
Figure 50 (page 69, below). The distribution of decorations with fringed groups (D11.4 and D11.5).

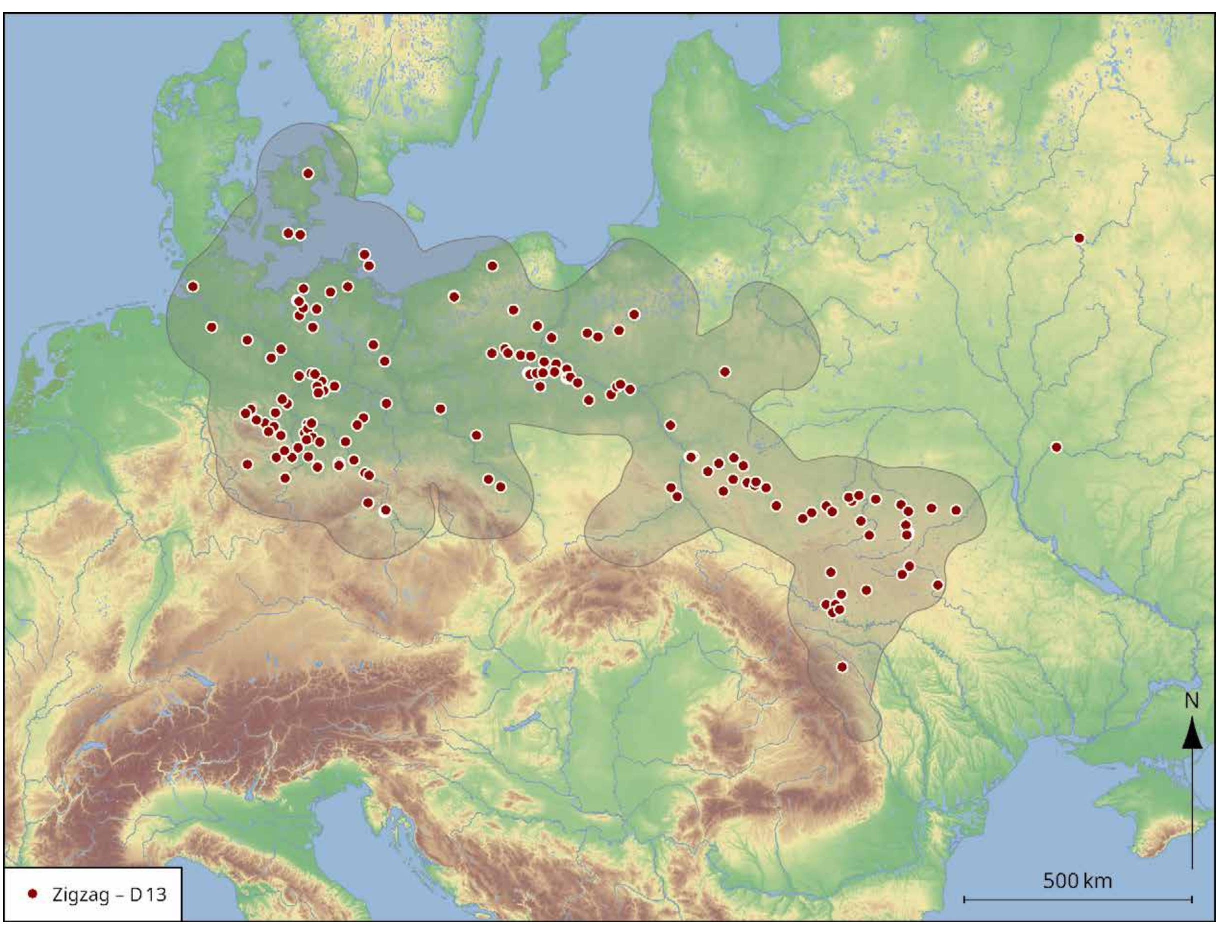

Fringed groups – D 11
N
500 km


Fringed groups – D 11.1
Fringed groups – D 11.2
N
500 km


Fringed groups – D 11.3
N
500 km


Fringed groups – D 11.4
Fringed groups – D 11.5
N
500 km


Hatched band – D12
Hatched band – D12.1
Hatched band – D12.2
Hatched band – D12.3
Hatched band – D12.4
Hatched band – D12.5
N
500 km


Zigzag – D13
N
500 km

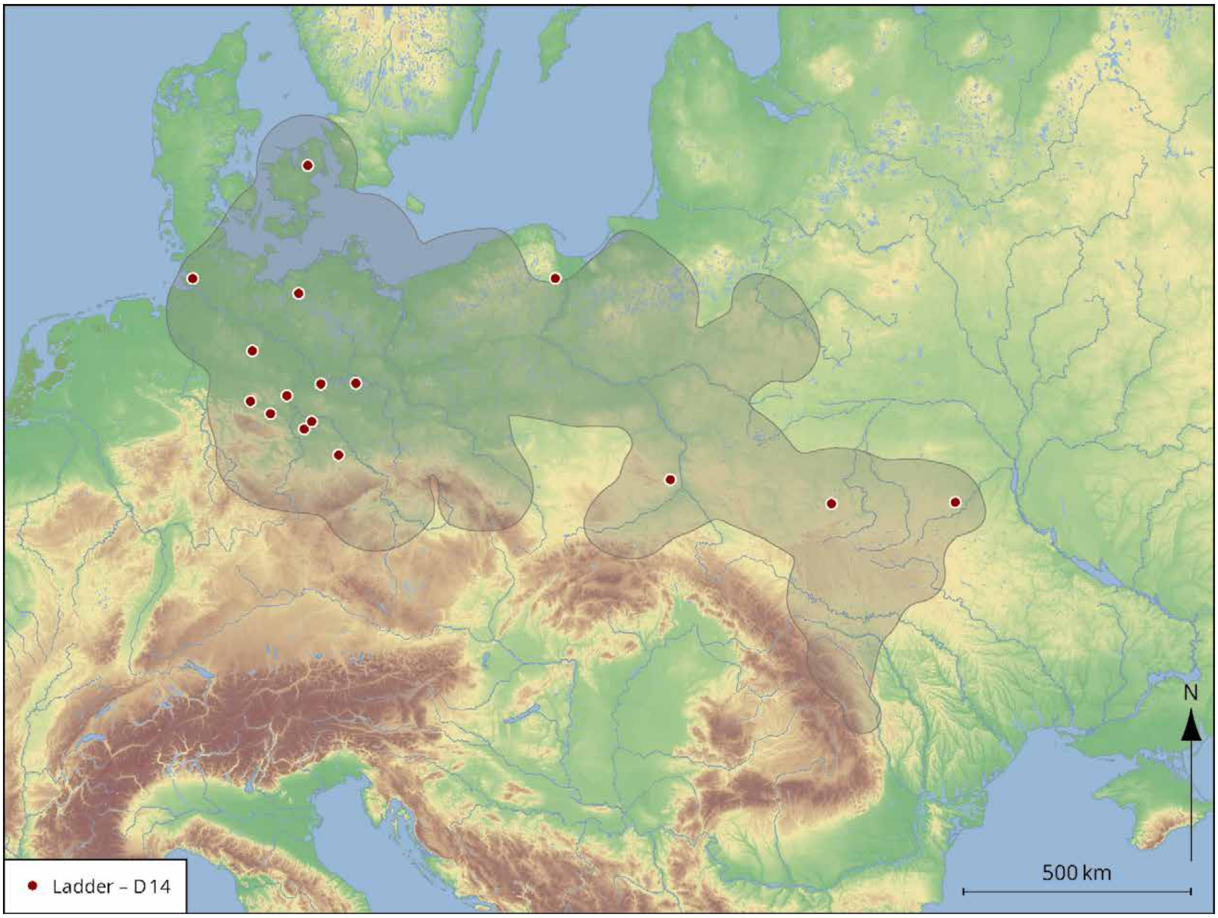


Figure 53. The distribution of decorations with ladder motifs.

Ladder (D14), comb (D15), notched rim (D16) and rectangular groups (D17)
These decoration motifs are seldom observed. The ladder motif (D14) was identified on 18 CUs, the comb (D15) on two, the notched rim (D16) on 15 and rectangular groups (D17) on 14 CUs (Plate 13). D15 and D17 are distributed across the entire distribution range, D16 only in the West Group with one exception (Fig. 53-54).

Figure 51 (left, above). The distribution of decorations with a hatched band.

Figure 52 (left, below). The distribution of decorations with zigzag motifs.

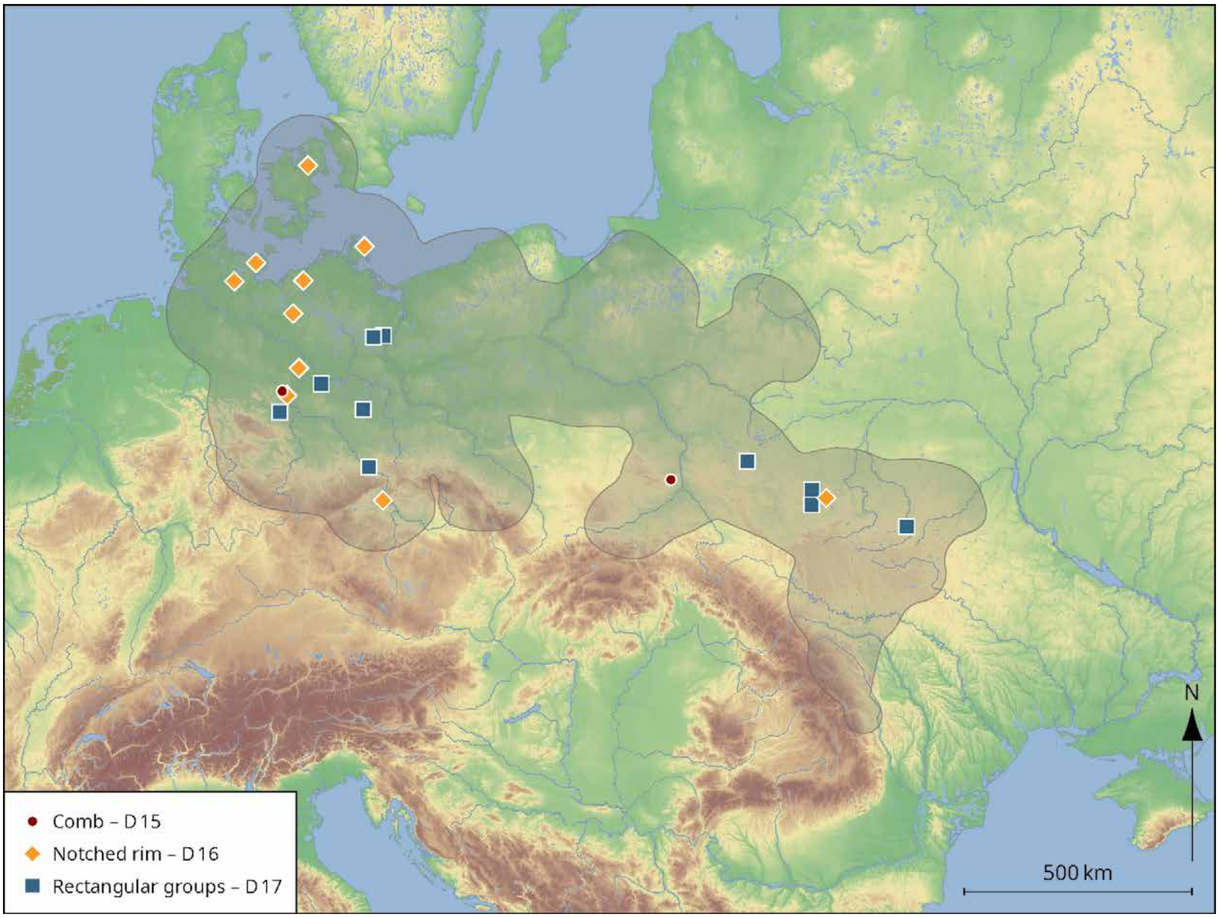


Figure 54. The distribution of decorations with a comb motif, a notched rim or rectangular groups.

2.5.2 Decoration motifs: Univariate and multivariate analyses

2.5.2.1 Individual distributions of the vessel types according to decoration motifs

Of the 17 decoration motifs with secondary features, the motifs D1, D2, D8, D8.8, D11.1, D11.3, D13, D15 and D17 could be identified as generally widespread.[13] The motifs D4, D8.5, D8.6, D8.7, D8.10, D11.2, D11.4, D11.5, D12.1, D12.2, D14 and D16 are mostly known from the West Group and with extremely small numbers further east. Decoration motifs D5, D7, D10, D12.3, and D12.4 can also be considered typical of the West Group. D6, D8.3, D8.4, D8.9 und D9 appear as motifs of the Central Group and the East Group. The motifs D8.1 and D8.2 are known from the Western Baltic region, the Central Group and the East Group (Fig. 55).

Spatial differences of subtypes can be observed for the triangle motif D3 and the herringbone pattern D8. The triangle motifs D3.1, D3.2, D3.3, D3.4, D3.5, D3.12, D3.14, D3.15, D3.16, D3.18, D3.19, D3.20, D3.21, D3.22, and D3.23 are typical of the West Group. Only few variations could be identified for the Central Group and the East Group (D3.6, D3.7, D3.8, D3.10, and D3.13) (Fig. 39; Fig. 56-57). Particularly widespread is motif D3.9, which is primarily found in the West Group and the East

13 The motif D15 occurs only at one site of both the western and eastern parts of the GAC region, so that it theoretically can be considered to have a distribution in the entire area, but practically it is too infrequent to be able to make an assessment.

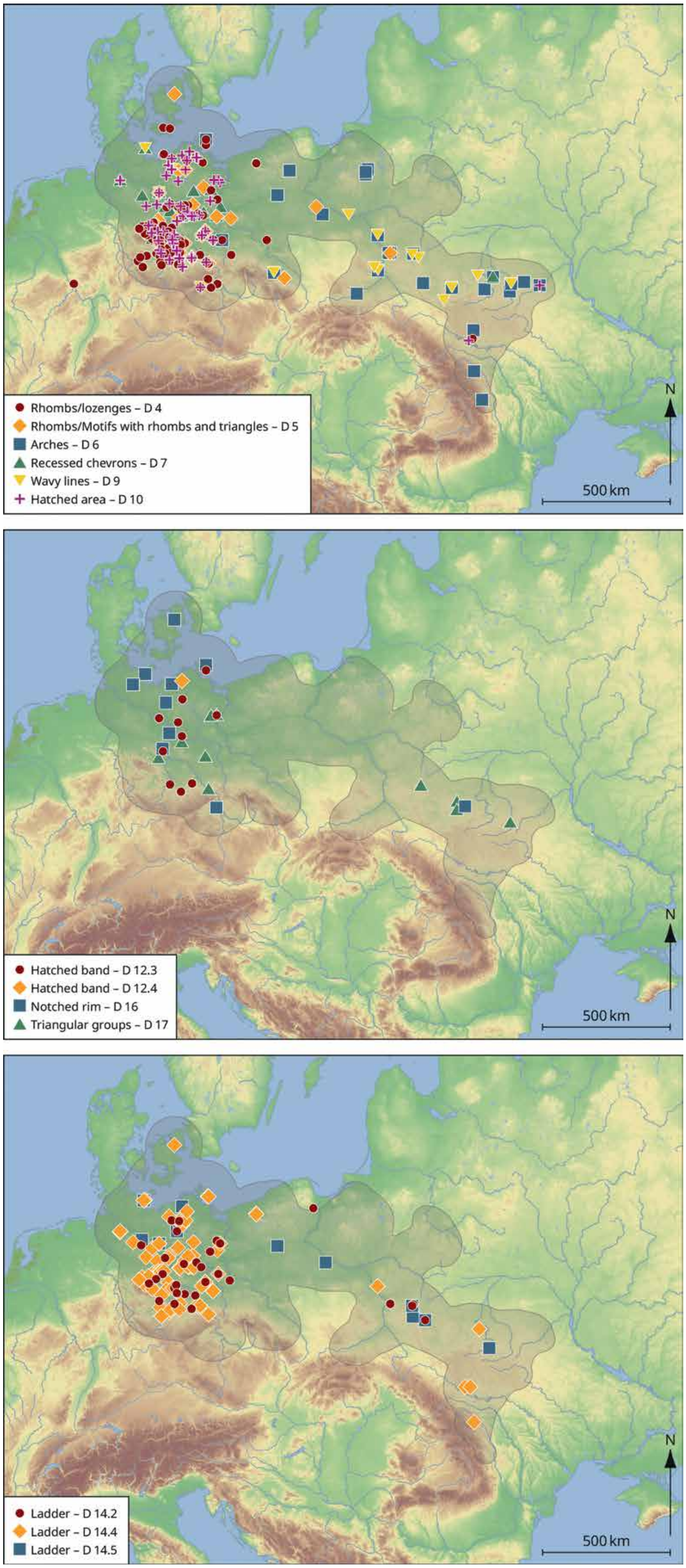
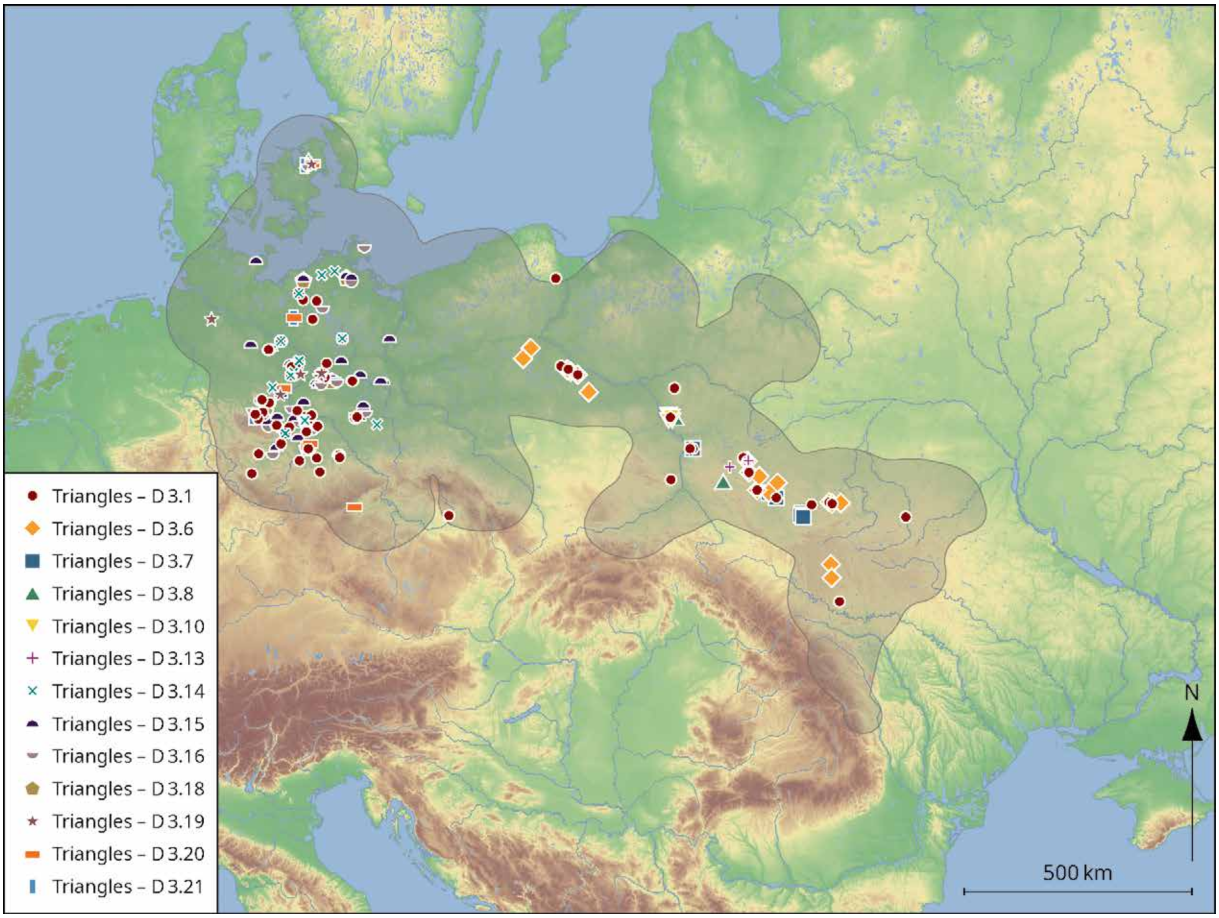
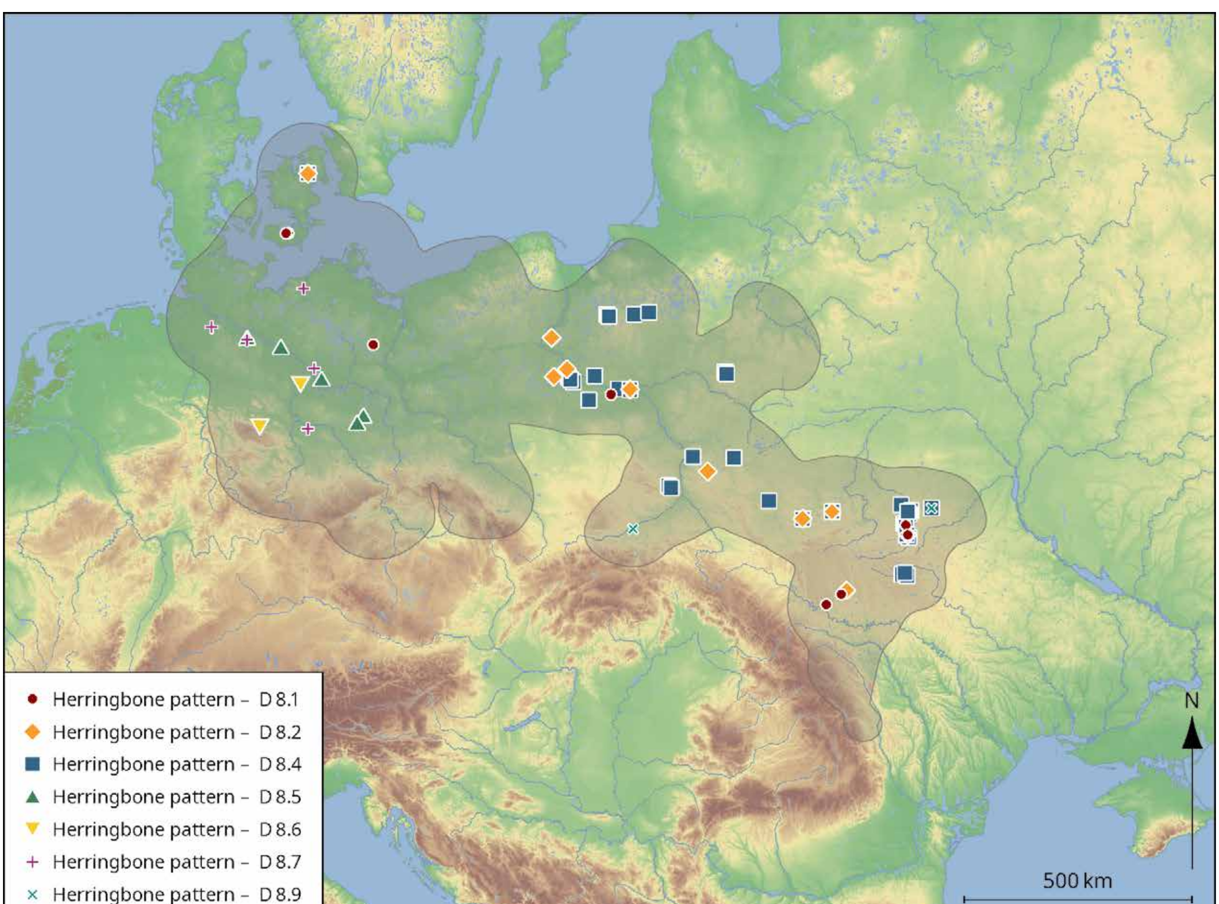


Figure 55. The distribution of decorations with restricted distribution patterns. Two large regional groups: the west (West Group) and the east (Central and East Groups) can be differentiated.



Triangles – D 3.1
Triangles – D 3.6
Triangles – D 3.7
Triangles – D 3.8
Triangles – D 3.10
Triangles – D 3.13
Triangles – D 3.14
Triangles – D 3.15
Triangles – D 3.16
Triangles – D 3.18
Triangles – D 3.19
Triangles – D 3.20
Triangles – D 3.21
N
500 km



Herringbone pattern – D 8.1
Herringbone pattern – D 8.2
Herringbone pattern – D 8.4
Herringbone pattern – D 8.5
Herringbone pattern – D 8.6
Herringbone pattern – D 8.7
Herringbone pattern – D 8.9
N
500 km

Decoration pattern classes	Entire distribution area	West Group	Central Group and East Group
Horizontal line/row (D1)	D1		
Vertical line/column (D2)	D2		
Triangle (D3)	D3.9 (W+O)	D3.1, D3.2, D3.3, D3.4, D3.5, D3.12, D3.14, D3.15, D3.16, D3.18, D3.19, D3.20, D3.21, D3.22, D3.23	D3.6, D3.7, D3.8, D3.10, D3.13
Rhombus/lozenge (D4 und D5)		D4, D5	
Arch (D6)			D6
Recessed chevron (D7)		D7, D7.1, D7.2	
Herringbone pattern (D8)	D8, D8.8	D8.5, D8.6, D8.7, D8.10	D8.3, D8.4, D8.9 D8.1, D8.2 both also west Baltic
Wavy line (D9)	(D9)		D9 (konc. East)
Hatched area (D10)		D10, D10.1, D10.2	
Fringed group (D11)	D11.1, D11.3	D11.2, D11.4, D11.5	
Hatched band (D12)		D12.1, D12.2, D12.3, D12.4	
Zigzag (D13)	D13		
Ladder (D14), comb (D15), notched rim (D16) and rectangle groups (V17)	D15, D17	D14, D16	

Table 3. The distribution of decoration patterns between the Western and the Central/Eastern GAC group.

Group. For the herringbone patterns, motifs D8.5, D8.6, D8.7, and D8.10 can be assigned to the West Group, motifs D8.3, D8.4, and D8.9 to the Central Group and the East Group, and D8.1 as well as D8.2 to the Western Baltic region, the Central Group and the East Group.

In summary, the GAC West Group can be distinguished from the eastern regions by mapping certain decoration motifs (Tab. 3). A separation of the Central Group and the East Group is not recognisable – group-specific motifs are missing for this. The individual mappings of the decoration motifs rather confirm the sole separation into a West and an East Group, as suggested by Nortmann (1985).

2.5.2.2 Multivariate description of decoration motifs

For the multivariate analysis, the decoration motifs of the recorded vessels were merged for the hexagon surfaces and a corresponding file of the decoration motifs that were present in the hexagons was created. On this basis, a correspondence analysis was calculated, which indicated a spatially normally distributed data set in spite of the more scattered parabolic structure of the 1st and 2nd eigenvectors (Fig. 58; Suppl. 7). Due to the basic conditions of the occurrence of two cases of an ornament motif and two cases of hexagons, 296 decoration motifs and 83 hexagons remain for the CA.

Accordingly, we use the 1st eigenvector to describe the continuously acting differentiation from – to + values of the eigenvalues of the eigenvector. The following groups of decoration motifs could be distinguished:

Figure 56 (left, above). The distribution of triangle decorations with restricted distribution patterns. Two large regional groups: the west (West Group) and the east (Central and East Groups) can be differentiated.

Figure 57 (left, below). The distribution of herringbone decorations with restricted distribution patterns. Two large regional groups: the west (West Group) and the east (Central and East Groups) can be differentiated.

Group 1 (-6 to -2.5): Arch motifs and quite wide vertical or horizontal line fields.

Group 2 (-2.5 to -1.5): Hanging triangles, medium-width vertical or horizontal line fields, standing herringbone motifs.

Group 3 (-1.5 to 0.0): Multiple chevrons, filled hanging triangles, vertical ladder bands, lozenge motifs, herringbone motifs.

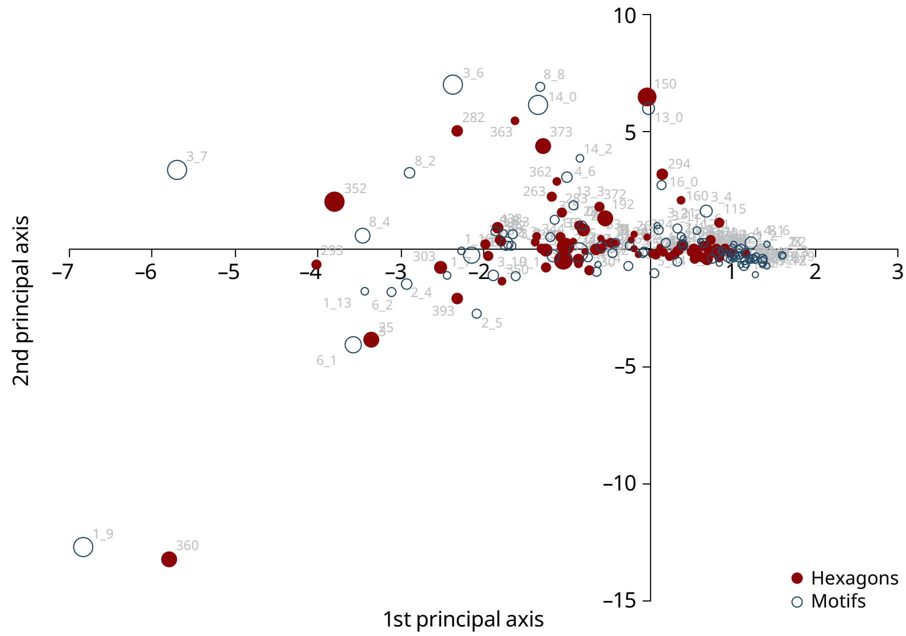


Figure 58. Scatterplot of the 1st and the 2nd eigenvector of the correspondence analysis of GA decoration motifs. The hexagonal areas form the spatial unit, for which the occurrences of corresponding motifs were added up (cf. Suppl. 7).

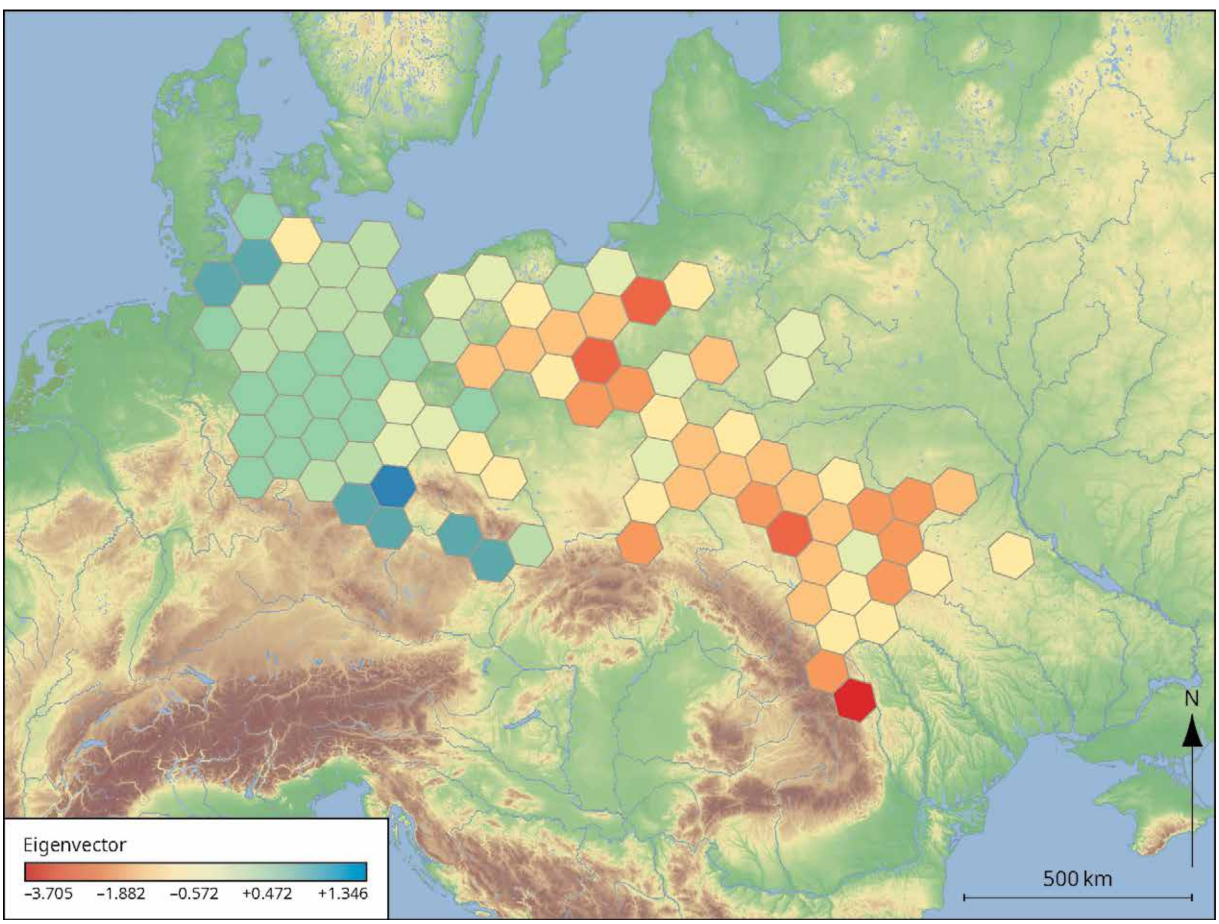


Figure 59. With the spatial display of the 1st eigenvector of the CA of decoration motifs (Fig. 58), the differences – especially between the decoration types of the West Group and the Central/East Group – are revealed. With this classifying, the eigenvector values according to natural interruptions (jenks) display further differences in the West Group.

Group 4 (0.0 to 0.7): Single and multiple chevrons, standing triangles, narrow horizontal line bands.

Group 5 (0.7 to 1.2): Triangles and lozenges made of arch incisions, filled standing triangles, recessed chevrons and wide chevrons.

With this differentiation of the decoration motifs, Western GAC regions with complex angle motifs, including arch and angle incision motifs, are differentiated from eastern regions, in which particularly garland and wavy motifs also appear (Fig. 59).

Visually, the division between west and east, also observed in the vessel forms and decoration techniques, becomes apparent. In the west, the dominance of Group 5 is evident, especially in the Middle Elbe-Saale region and the Havelland, while further north, Group 2 tends to dominate with single and multiple chevrons, standing triangles and narrow horizontal chevrons. In Bohemia and Moravia, horizontal bands and large decoration areas are notable. In Greater Poland and Lower Silesia, but also in all regions to the east or southeast of these areas, Groups 1-3 dominate with varying strength in the different areas.

2.5.3 Results and interpretation

Based on the results of the individual mappings, certain decoration motifs can be identified as having an overall widespread distribution. These include horizontal and vertical lines/rows (D1, D2), herringbone patterns in general (D8), the principle of fringe decoration in square-looking areas (D11.1) or vertically applied lines (D11.3), as well as zigzag bands (D13), comb decorations (D15) and rectangular decoration groups (D17). The basic set of such decorative motifs acts as a basis upon which the differences between the individual regions and GAC style groups are determined.

In the west, these include rhombs and lozenges (D4, D5), recessed chevrons (D7), hatched areas (D10), oblique or horizontal fringes (D11.2 and D11.5), ladder motifs (D14) or notched rims (D16). In the Central Group and the East Group, there is a wide variety of arch (D6) and wavy line (D9) motifs. Detailed typological differences between the West and the Central/East Group are observed in the respective characteristic triangle (D3) or herringbone (D8) motifs.

The spatial representation of the CA results is conducted with the representation of the 1st eigenvector values. When classifying the eigenvector values according to natural interruptions (jerks), the multivariate analysis points to the spatial differences between basic tendencies of the decoration motifs, in particular in the West Group, comparable to the spatial differences which are also recognisable in the decoration techniques (Fig. 33). In this way, the Southwestern Baltic region can be separated from the Havel region and the Middle Elbe-Saale region (Fig. 59). In the east, no further clear separation is apparent. In contrast, the east-west motif differentiation on the North Central European lowlands is visible, but also a north-south differentiation within the West Group. Spatially, we then recognise the connection between the areas of the West Group, which suggests intensive communication with recognisable differences. Thus, the Middle Elbe-Saale region is an intensive zone that slightly differs from the Southwestern Baltic region and the Bohemian-Moravian region. East of the Oder River, a large communication area becomes recognisable, which leads from the Lower Vistula via Bug and San to the Upper Dniester and the Upper Dnieper, but also to the Prut and Siret. The representation according to equal intervals also underpins the mentioned tendencies, although the transitions are much more fluid. The special position of the Bohemian-Moravian region becomes evident, but also the fluid connection in the Southwestern Baltic region, which rather suggests a certain demarcation to the Lower Vistula region (Fig. 60).

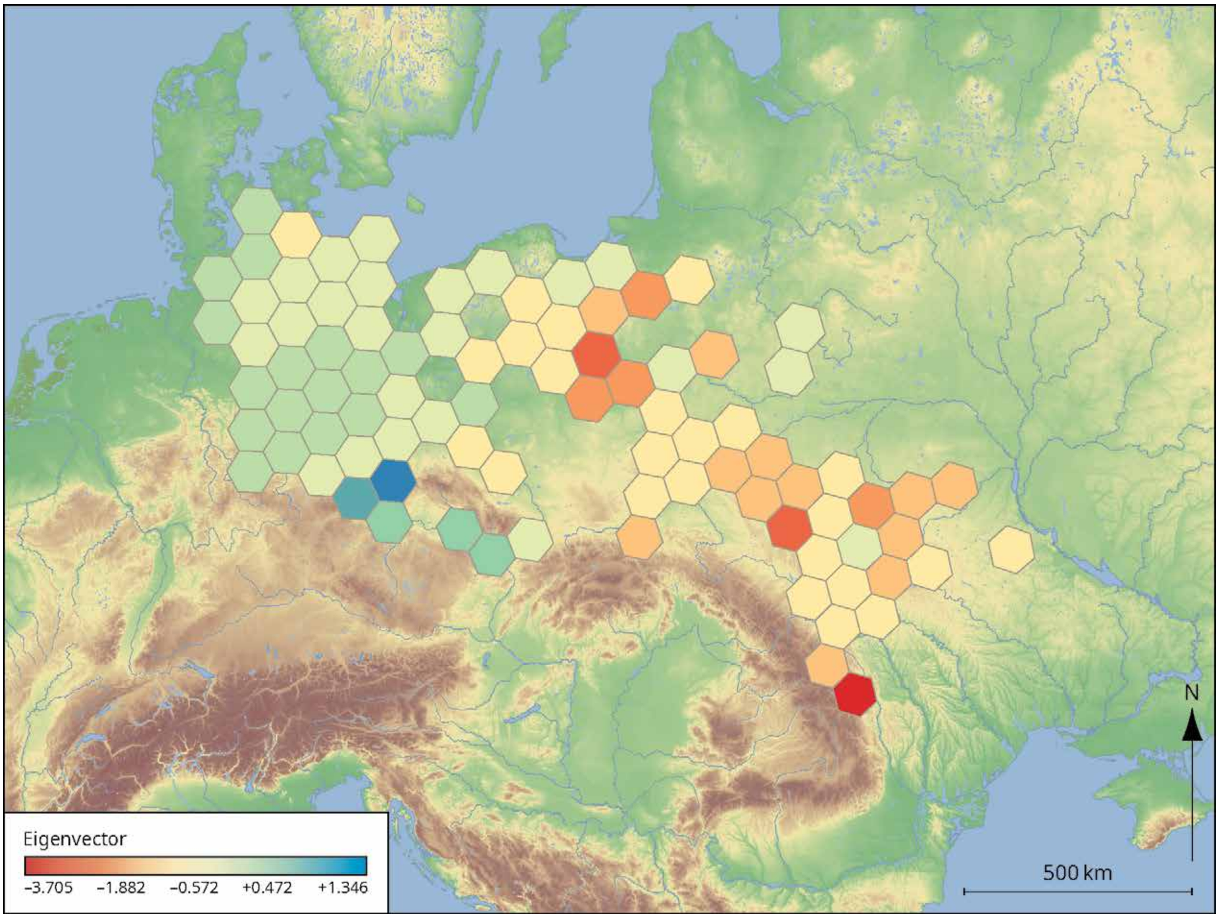


Figure 60. The spatial display of the 1st eigenvector of the CA of decoration motifs according to equal intervals underpins a special position of the Bohemian-Moravian region, but also the fluid connection in the entire Southern Baltic zone, which rather suggests a certain demarcation to the Lower Vistula region (cf. Fig. 58-59).

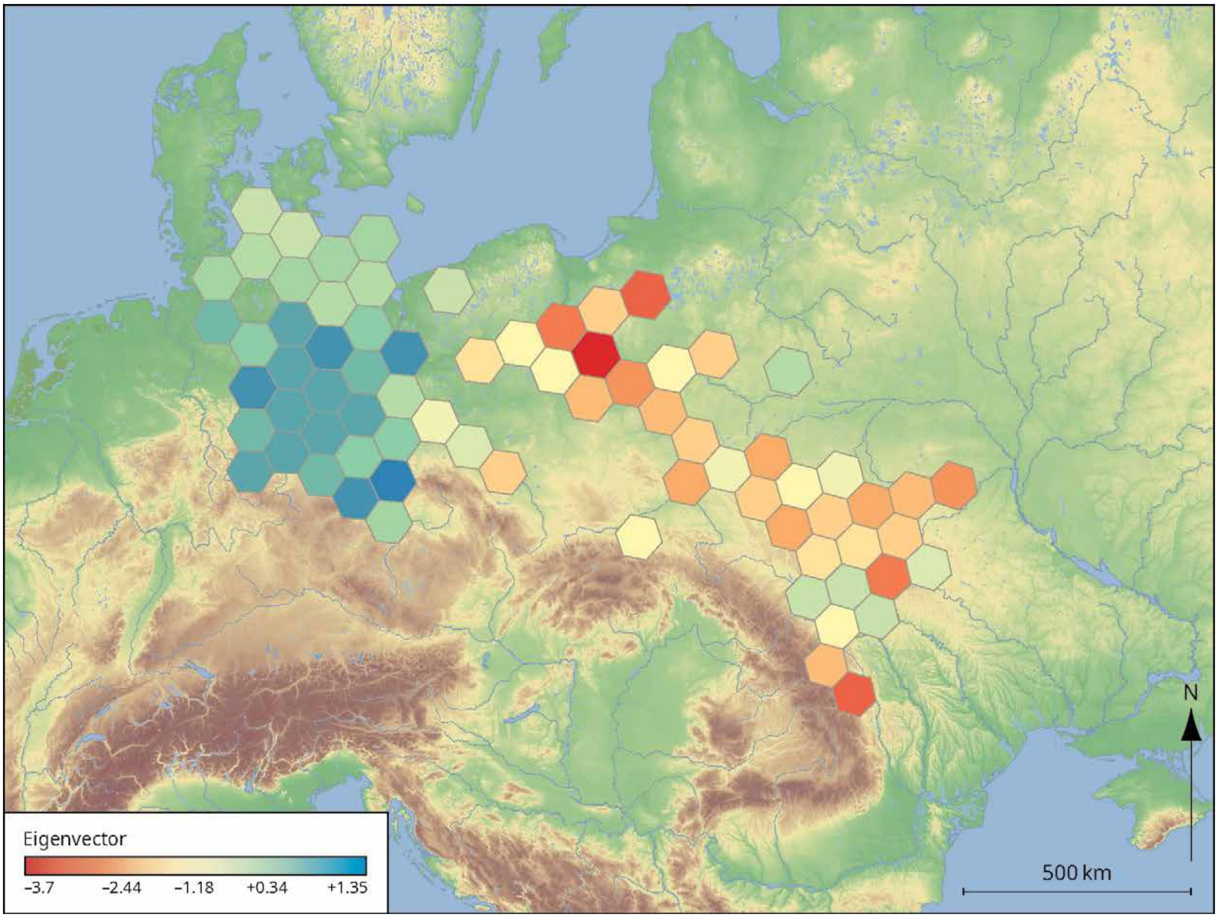
2.6 Comprehensive analysis

2.6.1 Multivariate description of Globular Amphora ceramics

In addition to the basic constants, the different correspondence analyses for vessel forms, decoration techniques and decoration motifs have demonstrated the possibility of differentiating the small regions recorded in the hexagons. Moreover, the spatial representation of the respective eigenvector, which has the highest explanatory value in the correspondence analysis, also proves a spatial differentiation between the vessel forms, techniques and motifs, even if certain differences were visible in themselves. Accordingly, it can be assumed that a combination of the respective 1st eigenvectors contributes to an overall visualisation of the typological similarities and dissimilarities within the entire GAC area.

2.6.1.1 Analysis of all three eigenvectors

Correspondingly, for an overall analysis, the respective 1st eigenvectors of the correspondence analyses on decorations, techniques and vessel forms were combined for a main component analysis. The 1st eigenvector of the principle component analysis (PCA) (explanation 62.5%) shows high charges on the vessel eigenvector and the decoration eigenvector, and moderate charges on the technique eigenvector (Suppl. 8a). Thus, recorded very strongly as techniques in the positive range are decorations of classical globular amphorae with long necks, wide-mouthed


Eigenvector
−3.7
−2.44
−1.18
+0.34
+1.35
N
500 km

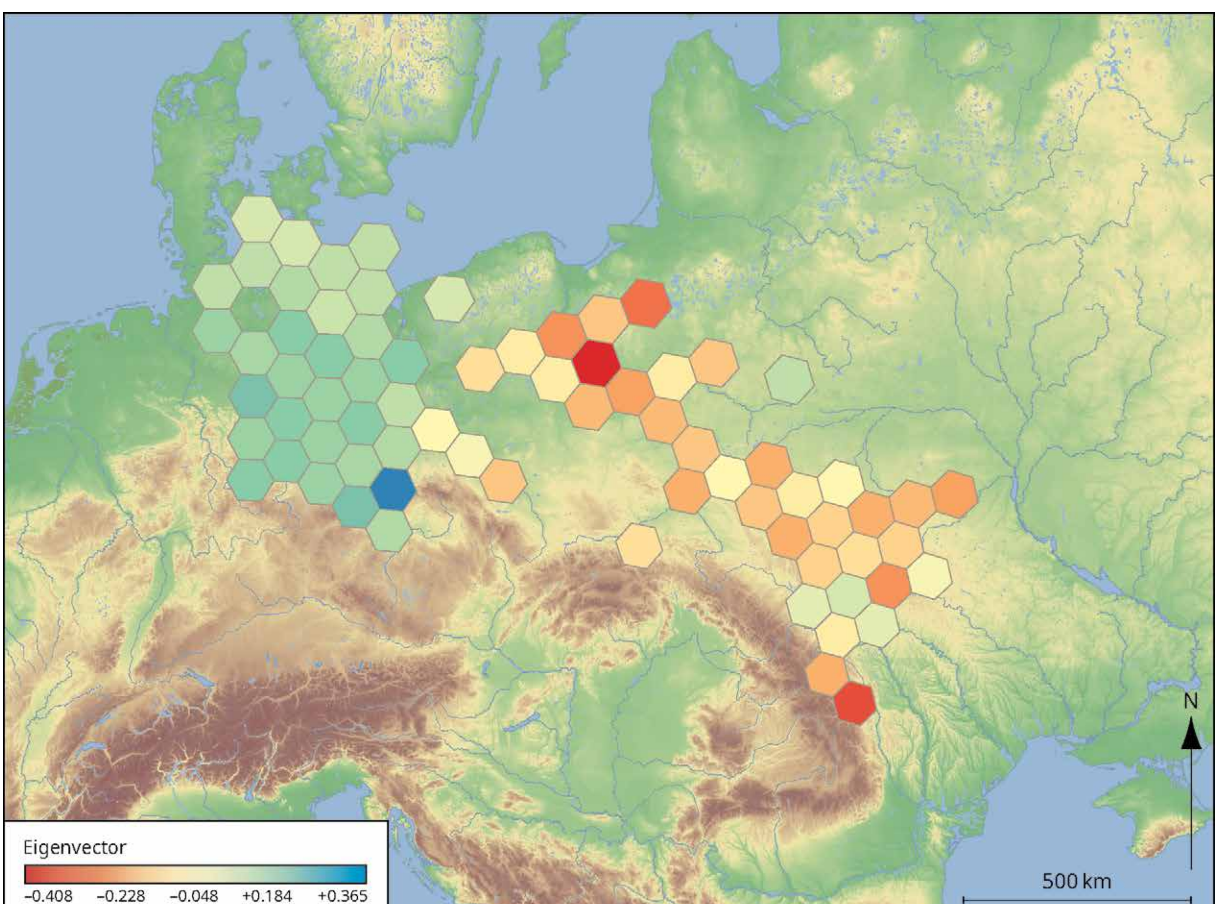

Eigenvector
−0.408
−0.228
−0.048
+0.184
+0.365
N
500 km

Figure 61 (previous page, above). The spatial display of the 1st eigenvector of the PCA (cf. Suppl. 8a) according to natural interruptions (jerks) of the 1st eigenvectors from the three CAs on shape, decoration and technique shows differences between the West Group and the Central/East Group and possibly also between the Baltic and other areas in the West Group or certain areas in Podolia and the Moldavian highlands in the Central/East Group.

Figure 62 (previous page, below). The spatial display of the 1st eigenvector of the PCA according to equal intervals of the 1st eigenvectors from the three CAs on shape, decoration and technique verifies the mentioned distinctions (cf. Fig. 61).

amphorae, biconical vessels and cups/beakers, as well as triangles and lozenges from arch decorations, filled standing triangles, recessed chevrons, wide chevrons, and arch decorations, whereas the other vessel shapes, techniques and decorations are in the negative range.

In the representation of the PCA-EV1, the differences are clearly recognisable between the West Group and the Central/East Group and possibly also between the Baltic and other areas in the West Group or certain areas in Podolia and the Moldavian highlands in the Central/East Group (Fig. 61). The representation according to equal intervals verifies the mentioned distinctions (Fig. 62).

2.6.1.2 Analysis of all nine eigenvectors

If we do not only consider the dominant, but also the respective two following eigenvectors of the correspondence analyses for a further principal component analysis, there are no fundamental changes in the result. Here, the obtained 1st eigenvector has an acceptable value with an explanatory value of 24.5%. With the 2nd eigenvector, we record another 18.5%.

The positive eigenvalues of all three components of the eigenvectors from the three separate correspondence analyses (Fig. 63; Suppl. 8b) enable an interpretation.

In the positive eigenvalue area, the 1st eigenvector dominantly identifies globular amphorae of western style with high necks, arch and angle decorations with, among others, recessed chevrons and as techniques also arch and angle incisions. In contrast, in the negative eigenvalue area, other globular amphorae with cord technique and garlands or wavy motifs are identified. In the spatial representation with jenks, the West Group is particularly differentiated from the Central/East Group (Fig. 64). However, values are also recognisable in Podolia, which are probably evocative of the West Group as signs of convergence – we mentioned above, for example, the occurrence of arch incisions of very different design in both areas. The representation with equal intervals of the 1st eigenvector values also verifies the difference between the West Group and the Central/East Group.

2.6.2 Interpretation

Overall, it was our goal to use the quantitative spatial representation of the frequencies of decoration types, decoration techniques and vessel types of GAC ceramics to examine the group classifications of the GAC phenomenon, which have been heavily discussed in the history of research. With certain variations, very similar basic spatial tendencies emerged for the three mentioned categories. In all analyses, this included the more or less clear difference between the GA west of a line from the Pomeranian Bay to the Sudetes and the region from the Lower Vistula to the Volhynian-Podolian area.

For the overall analysis, the 1st eigenvector of the PCA was accordingly selected for the 1st three eigenvectors of the correspondence analyses for vessel types, decoration motifs and decoration techniques.[14] For the representation, the centroids of the hexagons were first calculated in order to ensure a spatially uniform distribution of the values. Weighted over the 1st eigenvector values, kernel density estimation was carried out in a second step and a heat map was generated from this (smoothing over the radius value of 100 km; pixel width 10,000 [10 km]). Finally, contour lines were generated using the contour extraction option. Their interval

14 Even though the same representation using the 1st eigenvector of each of the first three eigenvectors of the three categories yielded quite similar results, the aforementioned approach was preferred here, since a greater fuzziness of the data would be expected in the other procedure.

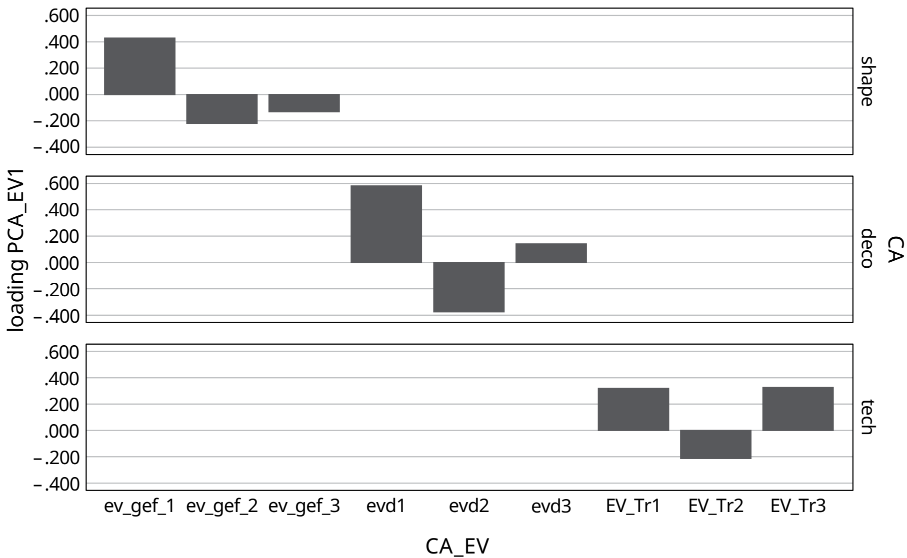


Figure 63. The eigenvalues of all three components of the eigenvectors from the three separate correspondence analyses (Suppl. 8b) enable an interpretation.

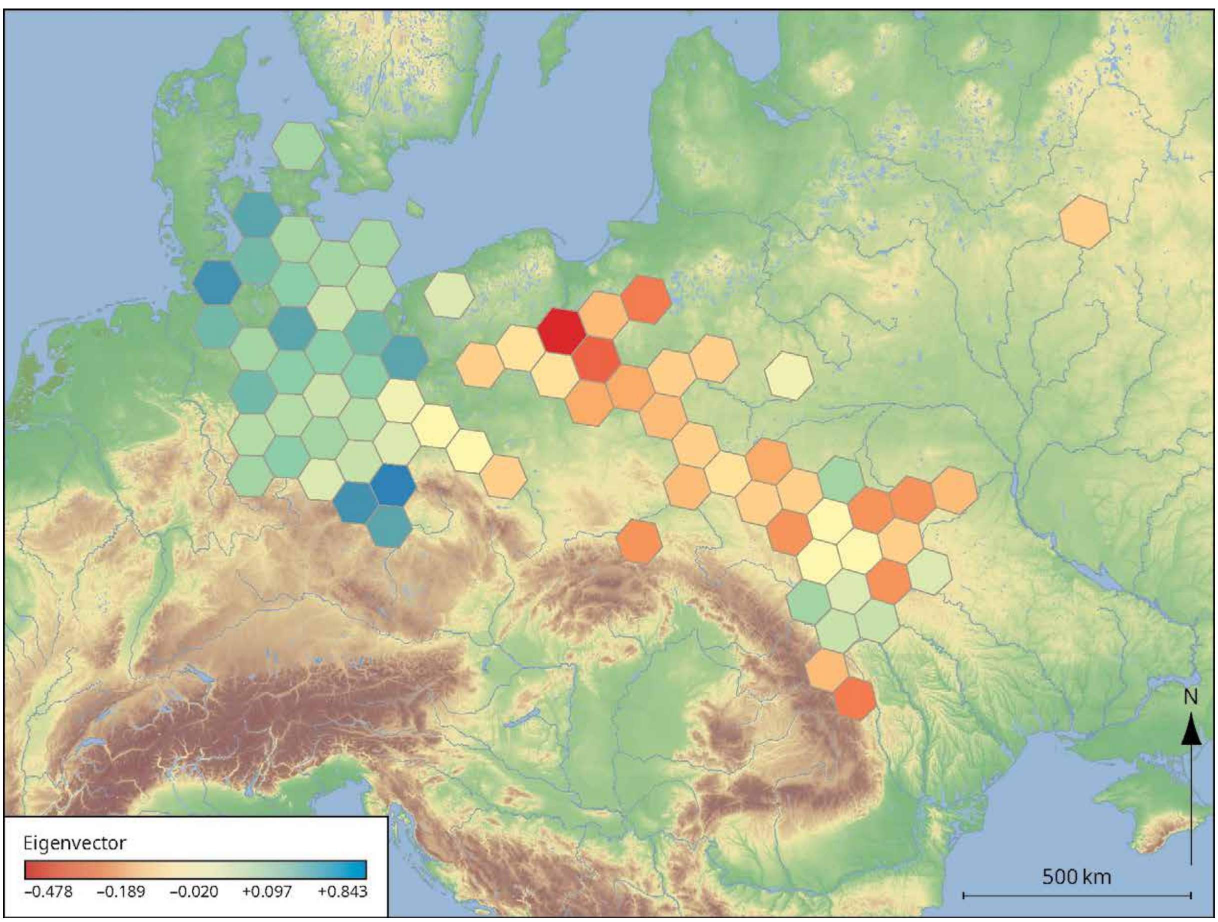


Figure 64. The display of the 1st eigenvector of the PCA on the 9 eigenvectors of the three CAs (shape, technique, decoration) identifies GA of western style with high necks, arch and angle decorations with, among others, recessed chevrons, and as techniques also arch and angle incisions. In contrast, in the negative eigenvalue area, other globular amphorae with cord technique and garlands or wavy motifs are identified. In the spatial representation with jenks, the West Group is particularly differentiated from the Central/East Group.

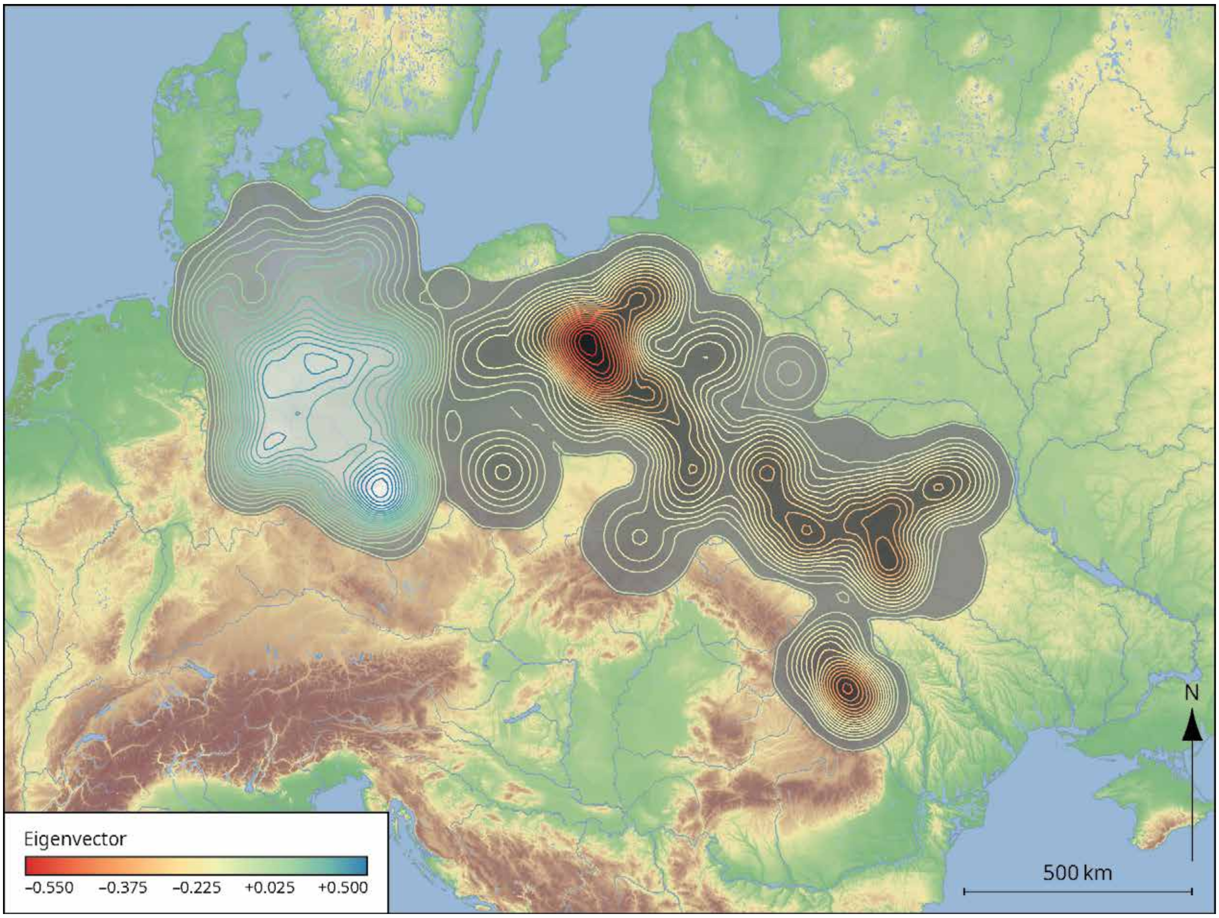


Figure 65. For the overall analysis, the 1st eigenvector of the PCA was accordingly selected for the 1st three eigenvectors of the CAs for vessel types, decoration motifs and decoration techniques. Weighted over the 1st eigenvector values, kernel density estimation was carried out in a second step and a heat map was generated from this (smoothing over the radius value of 100 km; pixel width 10,000 [10 km]). Contour lines were generated using the contour extraction option. Their interval was set to 0.025 eigenvalue loading and the value differences were visualised with the help of 30 natural interruptions (jenks). In result, the typological distances of the GA inventories are spatially shown.

was set to 0.025 eigenvalue loading and the value differences were visualised with the help of 30 natural interruptions (jenks).

Visualised in this way, the typological distances of the GA inventories are spatially shown in Fig. 65. The results are blatantly clear and require an unambiguous interpretation.

2.6.2.1 Two communication networks?

The extreme difference between the GA ceramics of the Elbe Group, on the one hand, and the Vistula-Podolia Group, on the other hand, becomes clear due to the contour values. This is recognisable

- firstly, due to the clear value differences between positive and negative eigenvector values,
- secondly, due to the steeply pronounced slopes of the contours at the eastern border of the Elbe and not so strong but comparable on the western border of the Vistula-Podolia Group, but
- thirdly, also at the almost find-free corridor east of a line that leads from the Pomeranian coast to the Giant Mountains.

The spatial coherence of the Elbe Group, but also of various areas of the Vistula-Podolia Group, can only be interpreted as an indication of relatively closed and separate communication networks with different economic, cultural and social practices of the social spheres for which the ceramic objects were produced.

2.6.2.2 Elbe network

The delineation of the Elbe Group is particularly striking. The steep slopes in the east, south and west, but also in the north with a tapering off into the SW Baltic riparian areas, illustrates the strong delimitation of the phenomenon. Within the Elbe Group, value differences between the Upper Elbe (especially of Bohemia and Saxony), the Middle Elbe-Saale-Havel region and the Southwestern Baltic region indicate a north-south internal differentiation. The communication networks, which enabled the numerous dimensions of locally produced ceramic designs, are obviously closely linked, but show regionally specific manifestations.

It remains to be emphasised that only GA ceramics are responsible for the spatial distribution pattern. In the Middle Elbe-Saale-Havel area, Bernburg, Altmark Tiefstich or Elbe-Havel ceramics have similar decoration patterns as GA ceramics (cf. Chap. 4), in Bohemia the same applies to Řivnáč, in the Southwest Baltic region for Late Funnel Beaker pottery. This could be partly responsible for the regional trends within the GA.

Nevertheless, the steep slopes of the contours and thus the extreme boundaries to the western TRB, Wartberg, Cham and partly Řivnáč are striking and require a final interpretation (cf. Chap. 7). The same applies to the stronger "openness" towards the north, which could indicate a stronger symbiosis with social practices there.

2.6.2.3 Vistula-Podolia network

In contrast to the uniform and clearly delineated spatial structure of the Elbe network, the Vistula-Podolia network is also clearly delineated, but it is divided into several larger sub-areas that are also clearly delineated. We observe a focal point in the area of the Lower Vistula River bend, which is closely connected to the middle course of the Vistula. Although the highest eigenvector values are particularly visible in the Chełmno region east of the Vistula, Kuyavia to the west of the Vistula also belongs to it. The Vistula Group is connected with the other focal point, which is recognisable in the area of the Volhynian-Podolian Plateau. Separately, the Siret Group is also localised further south on the Moldavian Plateau.

Basically, the close connection from the Vistula River bend in the northwest to Podolia in the southeast is indicated by the contour lines, while the Siret Group, comparable to Lesser Poland, Lower Silesia and the Narew deposits, is also integrated in the Vistula-Podolia network due to lower eigenvector values.

Interestingly, the gaps observed between the mentioned subgroups cannot be traced back to empty areas, in contrast to a certain lack of finds, for example, between Pomerania and Kuyavia. Thus, the contour differences between Podolia and the Middle Vistula cannot be interpreted as a lack of finds, since a greater find density has been documented for the affected Lublin Plateau. This also applies to the differences between the Volhynian and the Moldavian Plateau (Siret), since a density of finds also exists here in the intermediate area. In contrast, typological similarities are documented in many areas, but also those with only few find sites.

In consequence, it is tempting to especially consider the route from the Lower Vistula to the Upper and the Middle Dniester and back as a communication zone where an obviously established GA network is again present in different regional manifestations. In contrast to the Elbe network, we can demonstrate chronological differences here, which indicate a delayed expansion of social practices in the production of GA ceramics, among others, for Volyhnia and Podolia (see Chap. 3). This also applies to the outliers in other areas, for example, on the Upper Dnieper.

2.6.2.4 Spatial structures of the GA networks

With the presented distributions, spatial structures for the networks of GA social practices should fundamentally result, which terminologically involve an Elbe network with a subdivision into three sub-units (GA Bohemia, GA Middle Elbe-Saale-Havel, and GA Southwest Baltic) and a Vistula-Podolia network with a subdivision into three sub-units (GA Vistula, GA Volhynia-Podolia, GA Siret). While the agglomeration of typological similarities in the west suggests communication in a more closed space, in the east more elongated spatial structures appear that follow the courses of rivers and topographically elongated plateaus.

3. Absolute chronological dating of the Globular Amphora phenomenon

The absolute chronological dating of the GA phenomenon is primarily possible with the use of ^{14}C data. For inventories of GA, there are still too few, but nevertheless a total of more than 300 available radiometric dates, which pass a quality control regarding the actual samples and their direct allocation to find inventories. Independent of the amount of data and the data quality that vary from region to region, it is possible to describe the development of inventories with the radiometric dates of GA between the Cimbrian Peninsula and Moldavia. Accordingly, the data was implemented for an overall investigation and interpretation.

3.1 Methodological procedure

A comprehensive analysis of the radiometric dates for GA is faced with certain methodological challenges:

- Due to the diverse character of the find inventories that include GA, it is clear that there are different qualities of associations of the GA inventories with the samples of radiometric dates. Thus, very different lengths of use and depositional backgrounds are to be expected *a priori* for single graves, multiple or mass graves, settlement pits and collective burials. The varying security of the data allocation to an archaeological inventory must be considered in every analysis.
- Moreover, in the handling of the radiometric data, the recording of the sample material is often only partially sufficient, for example, the often-recorded detail 'charcoal' cannot be adequately valued without a botanical determination of the sample material, since the aspect of the old wood effect always seems possible. In connection with the recording of 'bones', certain reservoir effects can also not be disregarded without further determination.
- In addition, usual dating differences between laboratories exist and, in particular (with regard to the consideration of older determinations), differences between conventional and AMS-dates.[15]
- Furthermore, in light of the rarity of vertical stratgraphies, there are only few sites where Bayesian dating is possible based on contexts with vertical stratigraphies or the reconstruction of the relative deposition processes. However, established

15 Examples: Nakonowo for the difference between conventional and AMS-dates (Gerling *et al.* 2022); Ilyatka for differences between dating from the laboratories Mannheim and Poznań (Szymt *et al.* 2021); Koszyce for differences between dating from the laboratories Aarhus, Poznań and Uppsala (Schroeder *et al.* 2019; Włodarczak *et al.* 2021, 199, fig. 7).

Table 4. The structure of a calibration curve with wiggle sections (Reimer et al. 2014) and breakpoints or "turning points" that separate two different dating sections.

Areas of the calibration curve	Character	Breakpoints for map displays
01 3640-3525 BCE	Plateau	
02 3525-3350 BCE	Plateau	3350 BCE
03 3350-3090 BCE	Plateau	
04 3090-2920 BCE	Plateau	3090 BCE
05 2920-2875 BCE	Steep section	2920 BCE
06 2875-2625 BCE	Plateau	
07 2625-2575 BCE	Steep section	2625 BCE
08 2575-2475 BCE	Plateau	
09 2475-2460 BCE	Steep section	2475 BCE
10 2460-2300 BCE	Plateau	
11 2300-2200 BCE	Plateau	2300 BCE
12 2200-2150 BCE	Steep section	2150 BCE
13 2150-2025 BCE	Plateau	2025 BCE

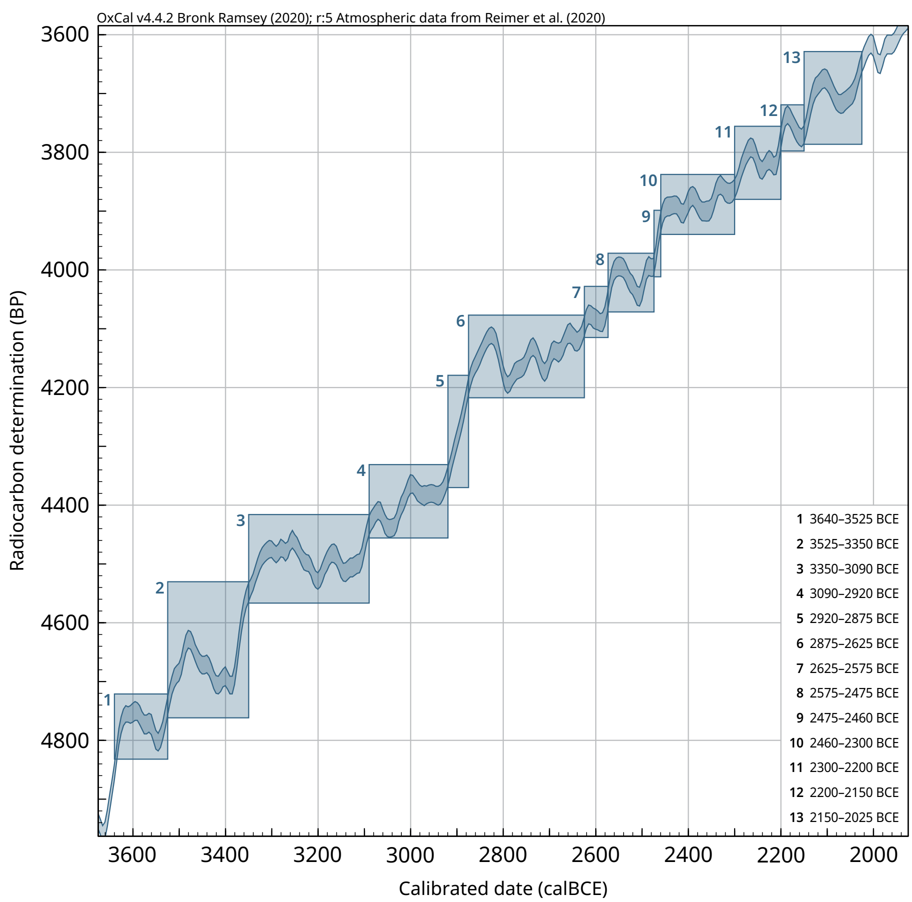


Figure 66. The interpretation of radiometric dates depends on the dating precision that results from the exactness or non-exactness of the wiggle-sections of the calibration curves. The structure of a calibration curve enables a dating from ca. 3650-2580 BCE in numerous plateaus and steep sections of the calibration curve that lie in between (cf. Tab. 4).

typological models can be considered as independent archaeological information and their relevance can be checked against the suitability of the models.

In principle, all interpretations of the radiometric dates of the GA inventories are dependent on the dating precision, which results from the exactness or non-exactness of the wiggle-sections of the calibration curves. The structure of a calibration curve (Reimer *et al.* 2014; 2020) enables, for example, a date from ca. 3650-2580 BCE in numerous plateaus and steep sections of the calibration curve that lie between (Tab. 4; Fig. 66). From the character of the calibration curve, breakpoints or "turning points" result that separate two different dating sections. Thus, these breakpoints can not only be implemented in analyses, but also used technically for presentation, *e.g.*, on maps. In the section of the period of interest for the GA, this includes the turning points 3640 BCE, 3350 BCE, 3090 BCE, 2920 BCE, 2625 BCE, 2475 BCE, 2300 BCE, 2150 BCE and 2025 BCE.

3.1.1 Approach

In the analyses, we carried out an overall comparison of the data for individual regions and also integrated Bayesian model calculations and data on model accuracy, which enable an evaluation of the radiometric data. Two approaches were implemented in dealing with the radiometric data:

On the one hand, the radiometric dates were subjected to Bayesian calibrations on a regional basis in order to estimate the chronological position and the development of the inventories of GA for well-dated individual sites and for entire corresponding regions on the basis of a critical discussion of the ^{14}C data.

On the other hand, the radiometric data was mapped in its entirety and investigated for chronological differences or similarities for the entire region between the Black Sea and the North Sea. A final interpretation of the data led to a chronological model. In structuring the GA expanse, we refer to both the traditional division in spatial groups as well as spatial networks, which are the result of the analysis of the previous chapter.

3.2 The database

Currently, 337 ^{14}C dates are available for GA inventories. Included are 161 conventional and 178 AMS dates, divided in 79 animal bones, 141 human bones, 30 unspecified bones, 59 unspecified charcoals or such long-lived materials, 13 grains and other short-lived materials, 21 wood remains, one piece of an organic ceramic material and further unspecified sample materials (Suppl. 9). The radiometric data originates from animal depositions/burials (43), single graves (91), a mass burial (24), collective chamber graves (1), megalithic graves (69), a flint mine (7), settlement contexts (95) and ditch systems (7). For ca. 45% (150) of the dates, due to the find circumstances and the short-lived sample material, it is assumed that the inventories were directly dated, 38% (129) of the dates are relatively certain, whereas for the remaining 17% (58), an association with GA is only probable (for classification of the dating quality, see Fig. 67). The latter include 27 dates for find associations from medium-term occupied settlements that can be considered to have been contemporaneous with documented GAC inventories from the same sites.

Geographically, the data is distributed across several main areas (Fig. 68). Most of the data is available from the Southwestern Baltic region (22 dates), the Middle Elbe-Saale region (56), Bohemia/Moravia (22), Kuyavia (107), Lesser Poland (24) and the Lublin Uplands (28). From other regions, only smaller amounts of data

	short-lived	long-lived sample
Single grave	a	b
Animal deposition	a	b
Pit	b	c
Layer	b	c

a good
b medium
c bad

Figure 67. The dating quality of ^{14}C dates depends on context association and sample quality.

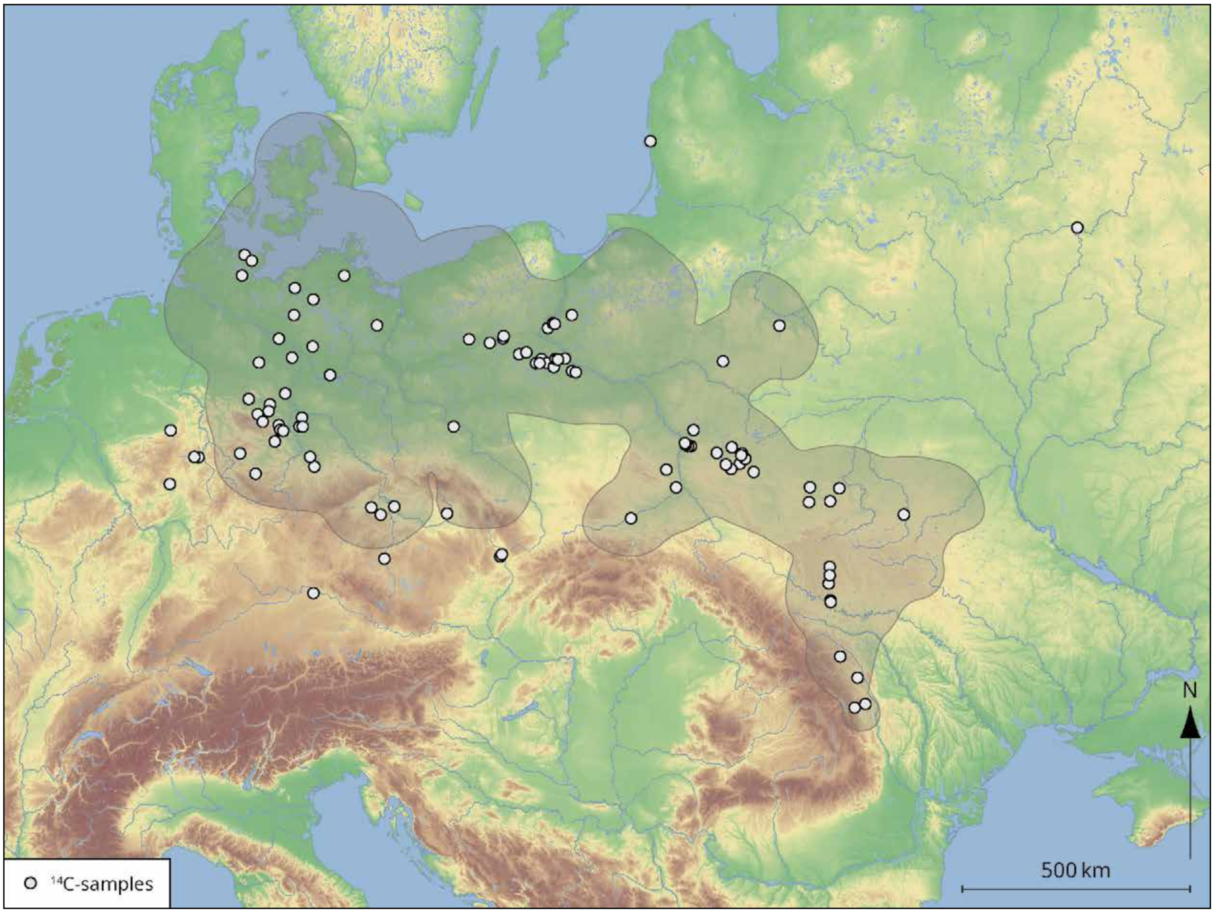


Figure 68. ¹⁴C samples from GAC or associated contexts are available from all GA regions (cf. Suppl. 9).

are available. It should be noted that AMS data is only available from Western Germany, Kuyavia, Lesser Poland and the Lublin Uplands, the Middle Elbe-Saale region, Bohemia/Moravia, the Southwestern Baltic Sea region and Podolia. From the other regions, only conventional data is available. Among the sites, there are 16 with more than five dates (Barleben 5, Bozejewice, Derenburg, Gajowizna, Kierzkowo 13, Koszyce 3, Kowal 14, Krzemionki Opatowiskie, Kuczkowo 1, Malice 1, Nakonowo 1, Olomouc-Slavonin-Horní Lán, Opatowice, Sandomierz 78, Wangels and Żuławka Mała 1), but among these only six with more than ten dates (Derenburg, Gajowizna, Kierzkowo 13, Koszyce 3, Nakonowo 1 and Opatowice). The possibility to perform Bayesian calibrations is thus limited by the small number of dates. Moreover, a detailed discussion of the different dating techniques (conv./acc.) is useful in case older lab dates are included in the evaluations. Nevertheless, the investigations have shown that local, regional and supra-regional assertions on chronological questions open up new perspectives.

3.3 Regional investigations with Bayesian dates

According to the common but mostly also geographically comprehensible spatial division of the GAC in regional groups, which is partly due to research history, in the following, Bayesian calibrations will be conducted, if possible, for individual sites, on the one hand, and for distribution regions on the other. The radiometric dates are classified into the phase models of the respective regions, which were set up by previous investigators. We orientate ourselves first to the traditionally defined spatial groups, since they are available for the typological classification attempts (West, Central and East Groups with respective subgroups). In a second step, we transfer the obtained results to the spatial network structures, which are the result of the analyses that were carried out in the previous chapter.

3.3.1 Western GAC

For the Western GAC, we differentiate between several regional areas, which can be traced back to historical research traditions and were postulated in the context of different typological studies. Accordingly, it is useful to distinguish the *Southwest Baltic region* with sites in Denmark and Schleswig-Holstein, but also the north of Mecklenburg-Vorpommern, from the *Elbe-Havel region,* including the *Uckermark* and the core area of the *Middle Elbe-Saale region*. To the south, the sites in *Bohemia/ Moravia* should also be distinguished.[16] In the west, GAC influences are found in the *Hessian-Westphalian Wartberg region* and also in *Southern Germany*. These could very well be zones of influence outside of the actual GAC core distribution (Szmyt 2003; 2004a). The newly defined central and interconnected spatial networks of the Western GA network (cf. Chap. 2) concern the GA networks of the Southwest Baltic region, the Middle Elbe-Saale-Havel region, and Bohemia/Moravia.

3.3.1.1 Middle Elbe-Saale region

In the Central German region (*i.e.* the current German states of Saxony, Saxony-Anhalt and Thuringia), GA ceramics occur, on the one hand, in single graves and a few domestic sites as the sole or dominant pottery and, on the other hand, in collective graves and numerous settlements or sporadically in enclosures alongside Bernburg pottery (Beier 1988; Müller 2001; Woidich 2014). New chronological studies verify a possible classification in four phases of a stylistic GAC development (Fig. 198; Müller 2023; cf. Chapter 4). Chronologically relevant are particularly the decorations and not the vessel forms. We identify a sequence of dominating arch/ angle incisions (starting with GAC A), cord techniques (starting with GAC B), scored incisions (starting with GAC C), and point incisions (starting with GAC D), whereby definitely all techniques were known and remained known in all phases. Triangle motifs (starting with GAC A) are followed by simple chevrons (starting with GAC B), then recessed chevrons (starting with GAC C). Lozenges are executed first in arch incisions (GAC A), then in scoring technique (starting with GAC C). In contrast to the graves, a differentiation is more difficult for the few settlement pits since here a stronger mixture of the inventories is to be expected. Although the number of ^{14}C dates is still too low, new dates from Düsedau for Phase A (Heiner 2018, 189-190) and from Zauschwitz (Bergemann 2018, 313-330) for Phase D confirm the typochronological relevance of these inventory groups.

A total of 57 dates from the Middle Elbe-Saale region is currently available, which is considered relevant for the GAC. However, among them are 26 dates, which are not directly associated with GAC ceramics and were only listed due to the assumed on-site simultaneity of regional inventories with GAC inventories (Suppl. 10). Furthermore, due to the dating quality, the number of usable dates is reduced to 24. Sequential calibration by typological inventory groups is only possible for 19 dates due to their association with typologically clearly identifiable GAC inventories (Fig. 69).

16 Typologically, there are similarities with both Silesian and Central German GAC inventories (cf. Peška 2013a; 2013b).

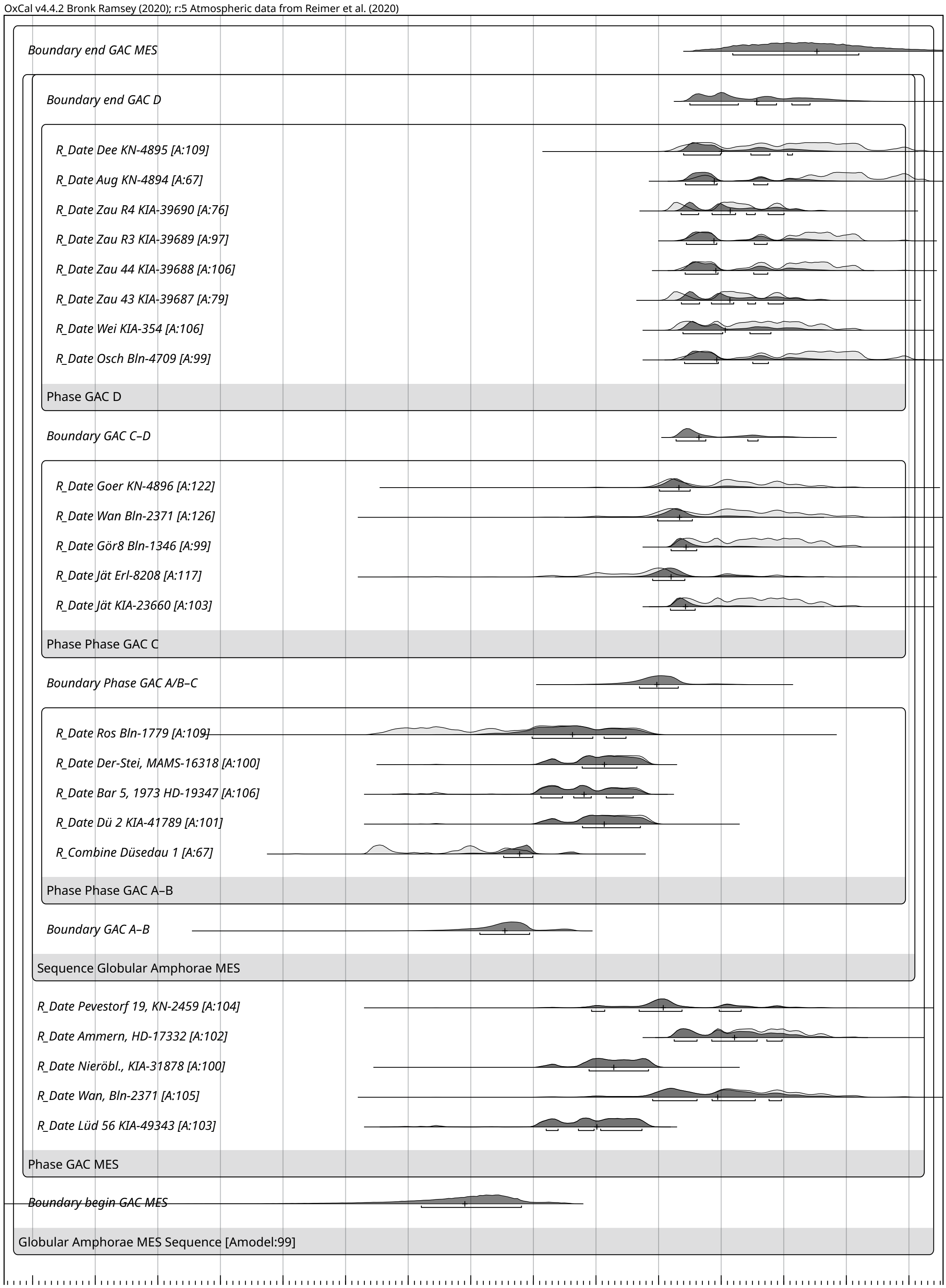


Figure 69. The Bayesian calibrations of GAC assemblages from the Middle Elbe-Saale region (cf. Suppl. 10).

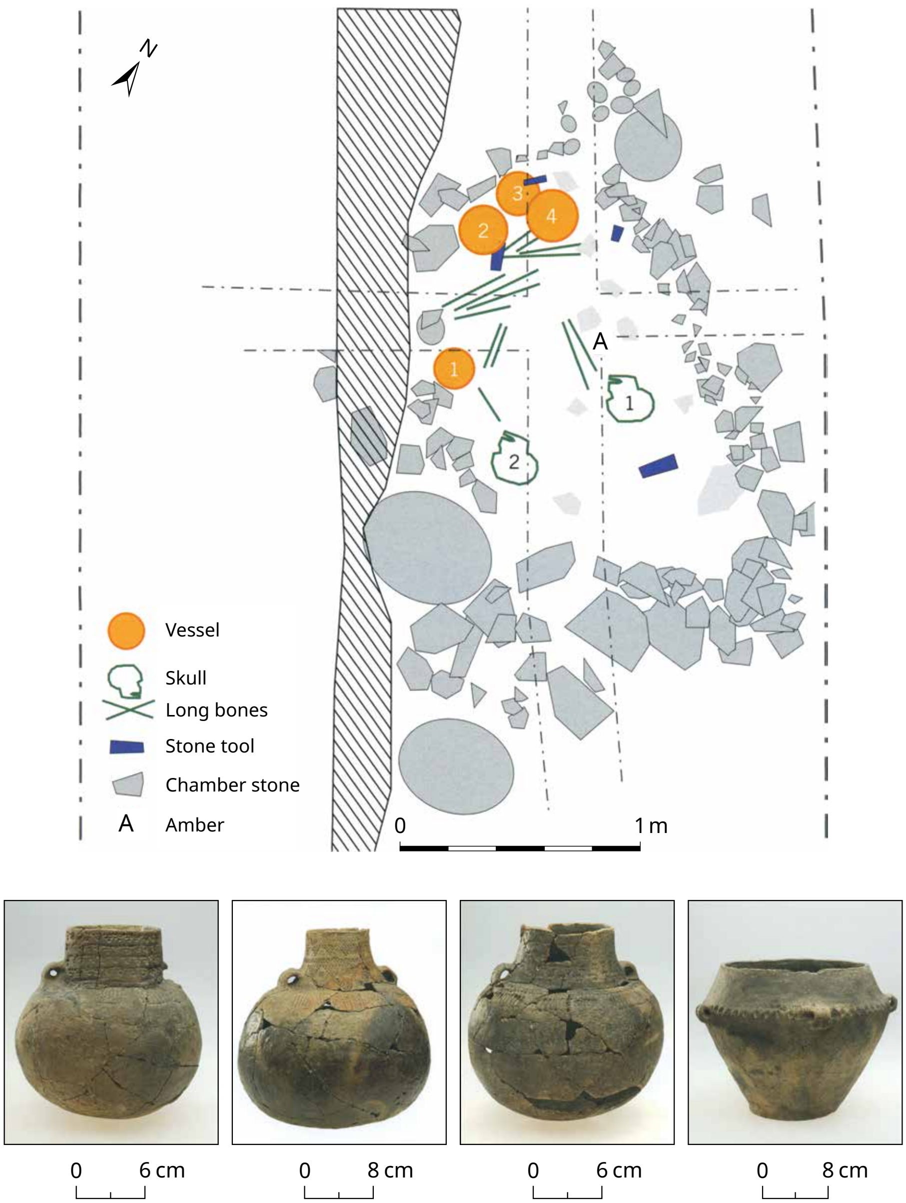


Figure 70. Context and inventory of the GA grave Osterburg-Düsedau, Sachsen-Anhalt (after Heiner 2018).

The sequential calibration of the radiometric dates yields a model that is statistically acceptable (cf. Fig. 196; Chapter 4). Accordingly, the beginning of first Globular Amphora graves at ca. 3200 BCE and an end at ca. 2675 BCE can be expected. Although no radiometric dates are available for GAC B, we assume that the transition to GAC C occurs at ca. 2900 BCE. GAC D starts around 2760 BCE and lasts until ca. 2680 BCE. Globular amphorae are already contemporaneously found with the regional inventory group Bernburg 1, but also still contemporaneously with the older Corded Ware ceramics. If we combine all dates that are broken down by phases with the dates generally assigned to the GAC in a Bayesian analysis, a total duration results for inventories with GA in the Middle Elbe-Saale region from ca. 3200-2650 BCE (Fig. 69).

In a critique of the data, it becomes clear that with the GA graves in Osterburg-Düsedau (Fig. 70), an inventory is recorded that still falls on the calibration plateau 03 3350-3090 BCE or at the border between 03 3350-3090 BCE and 04 3090-2920 BCE. The majority of the radiometric dates, however, date to areas of the calibration curve after ca. 3000 BCE.

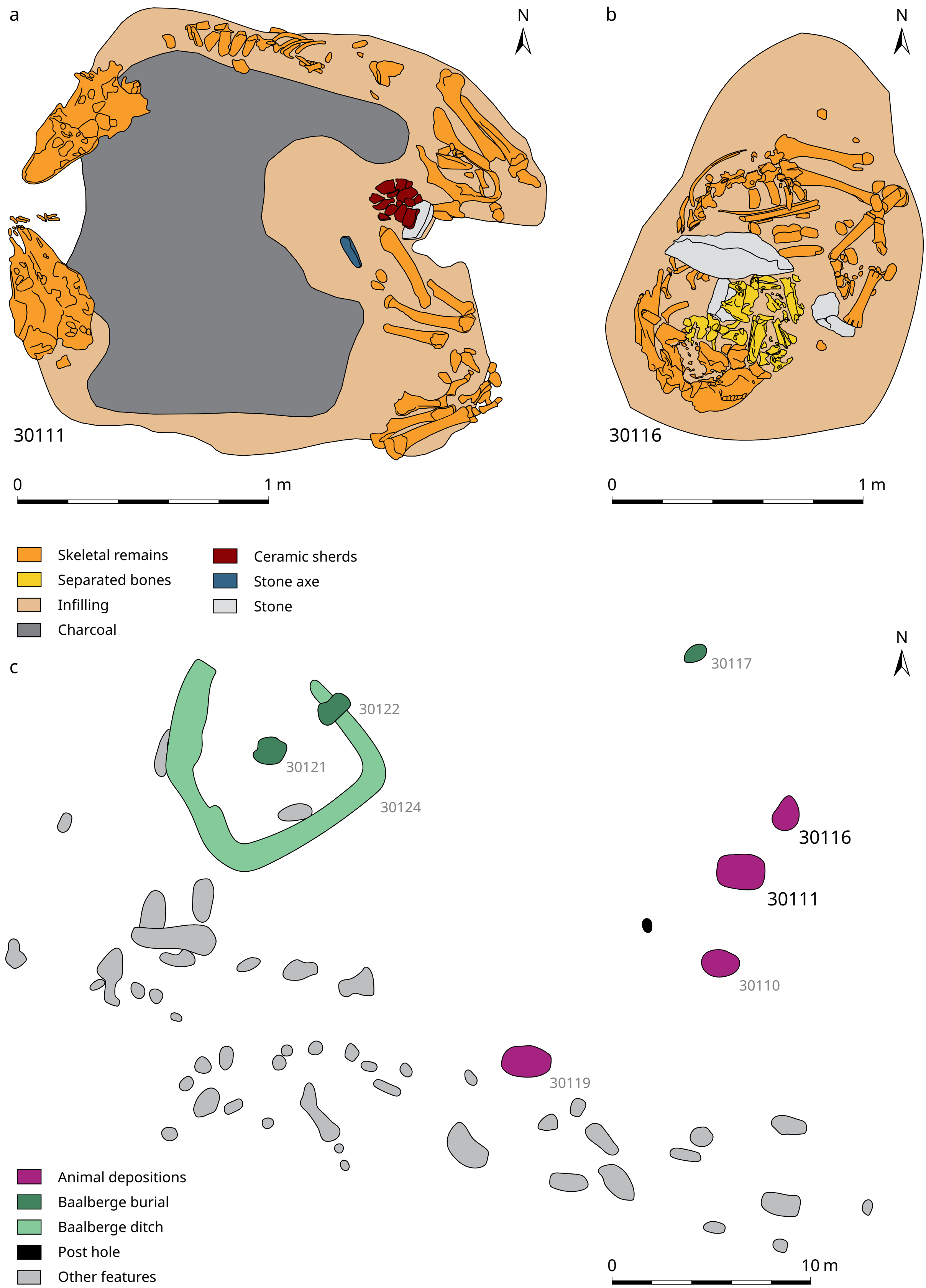
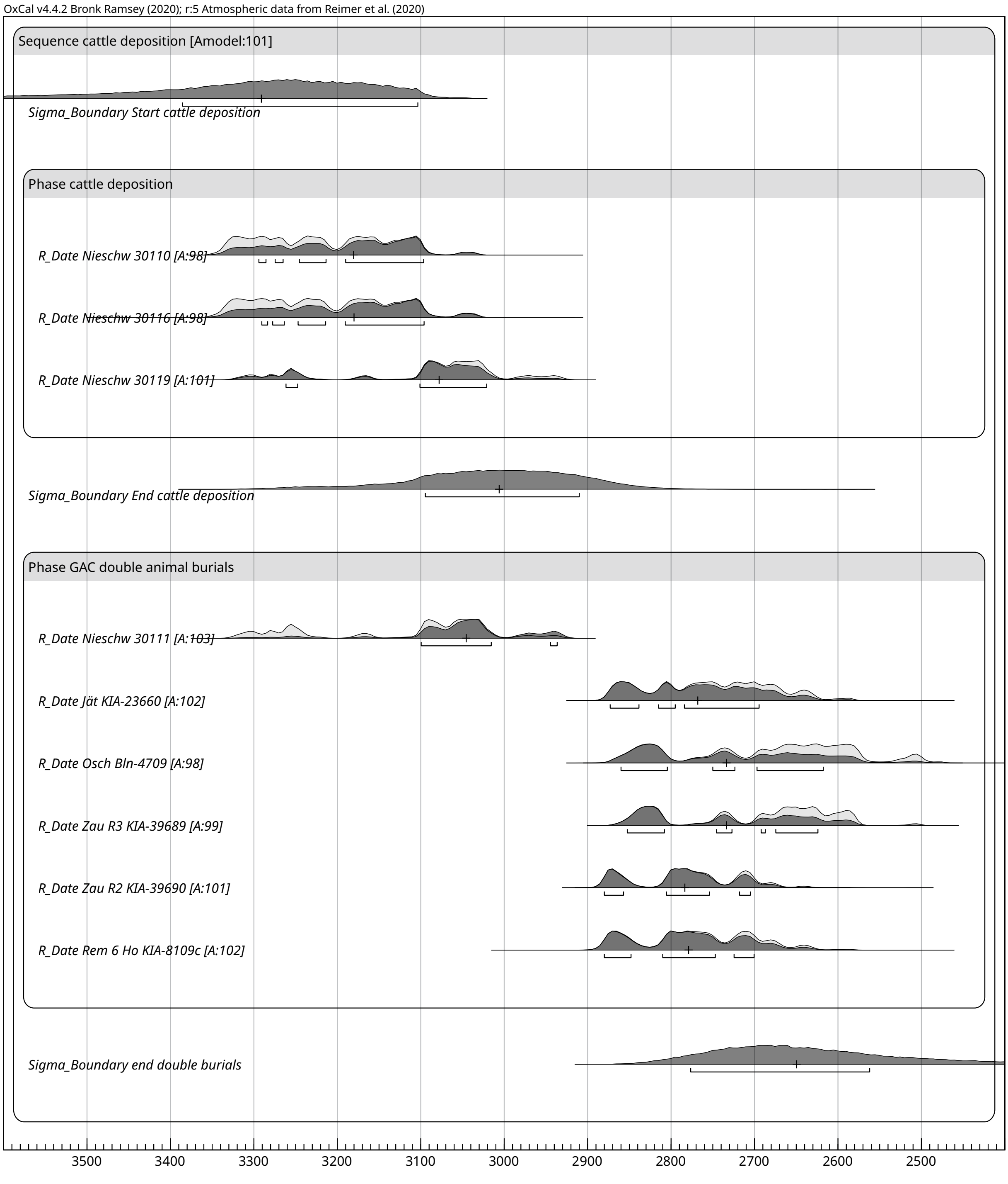


Figure 71. Pits with individual cattle depositions from Niederwünsch, Sachsen-Anhalt (a – articulated and antipodic; b – articulated) (after Müller 2017, 112, fig. 10-11).



A consideration of the find contexts highlights certain differences. While the few dates from megalithic tombs, dry stone walled chamber tombs and stone cist burials date earlier (ca. 3250-2826 BCE, 3254-3100 BCE, 3392-2830 BCE), the majority of earthen pit tombs and GAC double animal burials were probably created later (ca. 2914-2709 BCE, 2830-2661 BCE).[17]

Figure 72. The Bayesian calibrations of GAC double cattle burials from the Middle Elbe-Saale region (cf. Suppl. 10).

17 But see footnote 3.

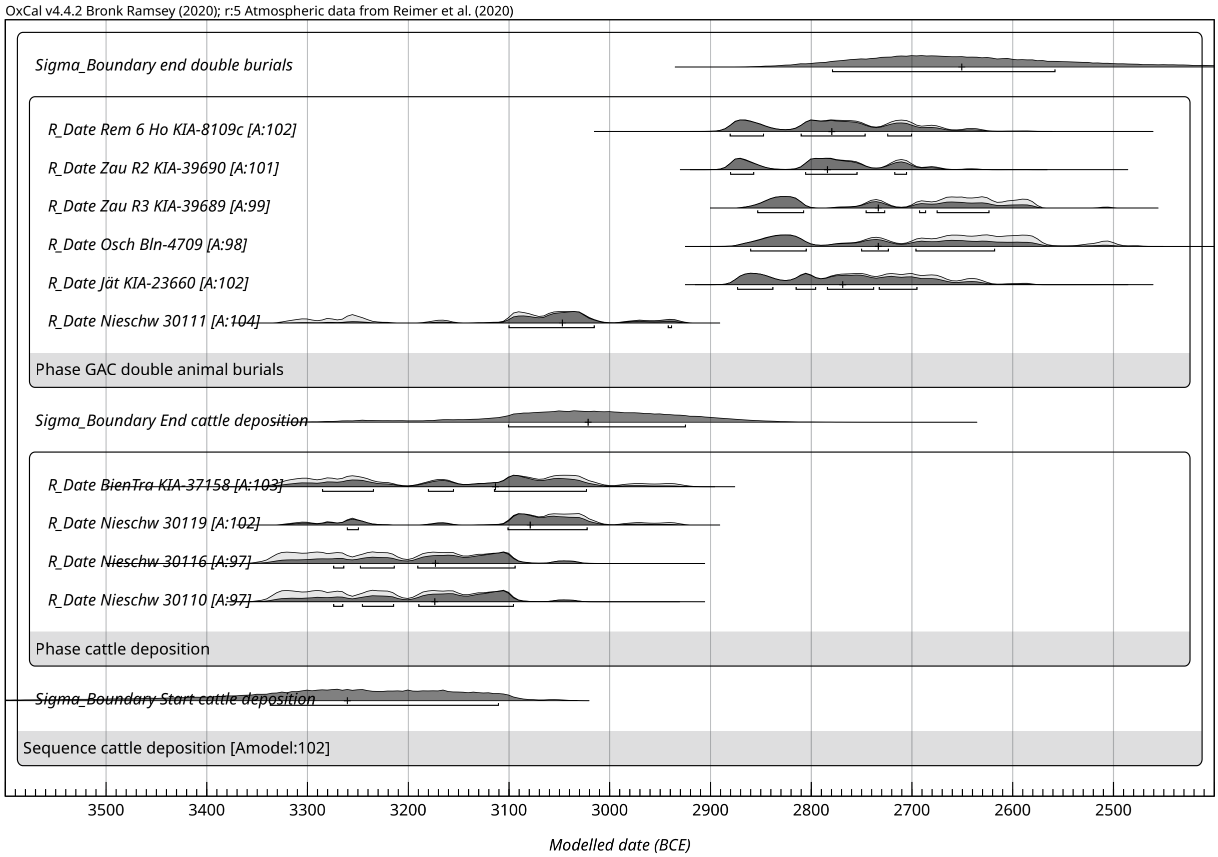


Figure 73. The Bayesian calibrations of GAC double cattle burials and cattle depositions from the Middle Elbe-Saale region, including Biendorf-Trappenberg (cf. Suppl. 10).

In the case of the double animal burials, we possibly know older ritual animal deposition practices that already existed towards the end of the 4th millennium BCE, which become clear when considering non-GAC features. For example, there is – without GAC pottery – a cattle deposition of two cattle not positioned antipodally to each other from Biendorf-Trappenberg (Teegen *et al.* 2017)[18] and pits with individual cattle depositions from Niederwünsch, which date to the period 3290-3010 BCE (Fig. 71-73). The latter are oriented exactly like further double cattle depositions at a Baalberger burial mound (Müller 2017; Müller and Schunke 2013).

The ritual practices in Niederwünsch are quite diverse. In the northernmost pit (feature 30116), a bovine was deposited that was dismembered before being interred – the pelvis is missing; the deposition of the rest of the bones occurred with anatomically correct positioning. In the southernmost pit, feature 30119,[19] the bones

18 Biendorf-Trappenberg (Bernburg district, Salzland district), cattle and single burials (Teegen *et al.* 2017; Müller 1999, 48; Müller 2001, 164-173, esp. fig. 69). Cattle burial, child, human bone, MAMS 16123 4510±24 bp. Cattle burial, cattle, cattle bone, KIA-37158 4445±35 bp. Secondary burial, adult woman, human bone, HD 18703 4235±31 bp; KIA-37400 4217±30 bp; KIA-37399 4131±31 bp. Assignment: Child and cattle Older Bernburg; secondary burial without grave goods.

19 A radiometric date is available from here: Niederwünsch (Mücheln district, Saale district), animal burial (Müller 2017, fig. 16). Animal burial feature 30119, cattle bone, lab no. ? 4431±22 bp. Assignment: Middle Bernburg. There, the other dates are found (unfortunately without naming the lab number: feature 30110 4489±21 bp (single bovine; bovine bone); feature 30111 4437±22 (double cattle deposit; bovine bone); feature 30116 4488±24 bp (divided bovine; bovine bone). In addition, dates are provided for an earthen pit grave without grave goods (feature 30117 4488±23 bp; human bone), an earthen pit grave over the trapezoidal ditch (feature 30122 4816±20 bp; human bone), and for an antler from the trapezoidal ditch (feature 30124: 4793±20 bp).

of a bovine were located individually between large quantities of limestones. There, the drum finds probably belong to the Middle Bernburg phase. Two middle pits also exhibit cattle depositions – in a pit, feature 30111, there is a double cattle deposition. These can be attributed to a proper sacrifice: The cattle were killed by hatchets and bone points, partially burned, and marked by the addition of a dish and a hatchet (*ibid.*, 87 fig. 3). In the other pit, feature 30110, a partially burned deposition of an individual cow/bull with an undecorated dish in the abdominal area is observed. If we combine the date of the double cattle deposition with the other double cattle burials, the modelling yields a time period of 3010-2650 BCE (Fig. 72), with Biendorf 3020-2650 BCE (Fig. 73). The apparently contemporaneous wagon burials without grave goods but with double cattle depositions from Profen probably also fall within this time period (Friederich and Hoffmann 2013).

The dates of domestic sites with GAC ceramics tend towards ca. 3103-2793 BCE. These are always settlement features in which, in addition to GAC pottery, there are also other vessels, primarily Bernburg ceramics, or inventories that are dominated by Bernburg ceramics or other pottery.

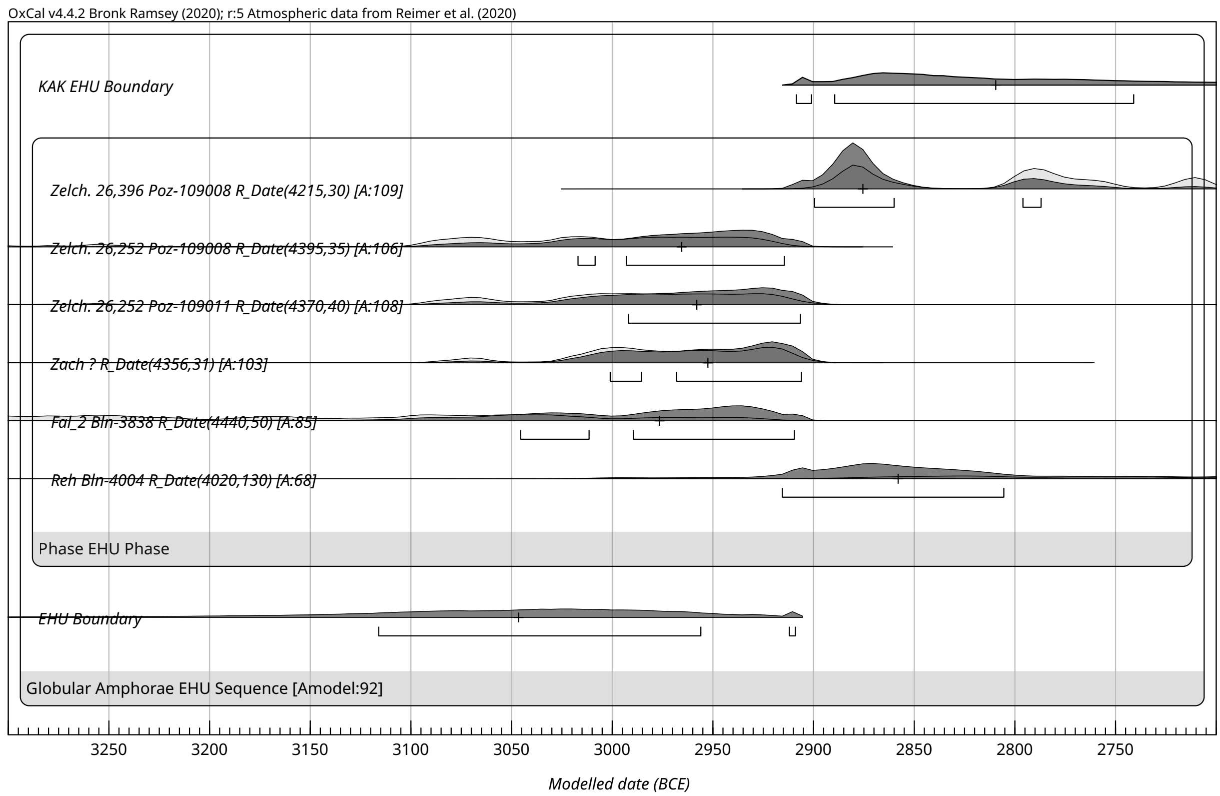
3.3.1.2 Elbe-Havel region

From the Elbe-Havel region, we still have only six radiometric dates that are directly associated with the GAC: for a GAC single grave from Rehfeldt and a burnt offering site from Zachow near Ketzin (Havelland), for a GAC pit from Falkenwalde (Uckermark, a second date with Havelland pottery), and three dates for two pits with a GAC cattle deposition from Zelchow 26 (Uckermark). Statistically, the inventories date between ca. 3050 and 2810 BCE (Fig. 74). Based on the few available radiometric dates, the Elbe-Havel ceramics can be assumed to be dated to ca. 3200-2800 BCE (Müller 2001, 245-247), which bear very similar decoration patterns as the Elbe-Havel GA.

Of interest is the stratigraphic relationship at the burnt-offering sites (Woidich 2014, 136-141; see below) and the existence of corresponding sites with GAC ceramics:

- In addition to GAC and Elbe-Havel ceramics in pit II of Falkenwalde 50, there is a “bone deposit” of four cattle, two pigs and five sheep, which dates to ca. 3330-3010 BCE using a conventional bone date (Bln-3838). A second pit I – with secondarily relocated Elbe-Havel ceramics, globular amphorae and a double cattle deposition – dates with a conventional bone date (Bln-3839) to ca. 2890-2670 BCE (Lehmkuhl and Nagel 1991).
- In Zachow 12, there is a ritual site with at least 11 pits, from which 8 cattle jaws and other disarticulated bones are observed. Pit 12 contained flint axes, charred bones, 2 cattle jaws, pig teeth and a shoulder sherd of a hanging vessel (*ibid.,* fig. 5,22), as well as numerous undecorated sherds. A charred beam dates the pit (Bln-4005) to ca. 3260-2920 BCE. Pit 6, including teeth fragments of cattle and a GA (*ibid.*, pl. 23,1), is overlain by pit 1 with sherds of bipartite Walternienburg ceramics, charred animal bones and a bovine skull, which dates to ca. 3010-2910 BCE.
- In Flechow 26, an earlier double cattle burial with burial items (ca. 2960 BCE) is followed by a younger offering pit (ca. 2860 BCE), also with a globular amphora (Fig. 75) (Dirks 2022).
- From Waltersdorf, we know of 3 pits, one which includes a double cattle deposition and a GAC A globular amphora (Dirks 2016).

In this respect, we recognise a bicultural ritual use of the burnt offering sites from the first two find complexes, including cattle depositions and GAC ceramics in the Elbe-Havel area from ca. 3310-3000 BCE at the earliest and a shift to double cattle



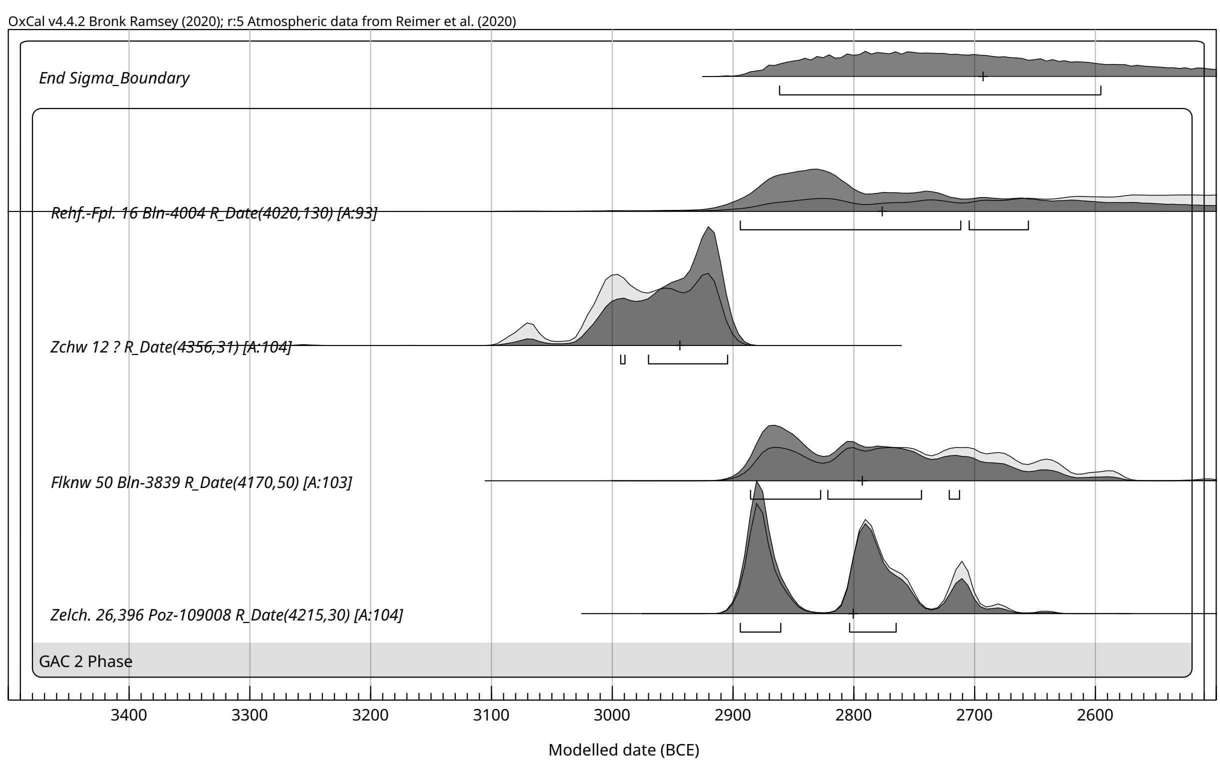
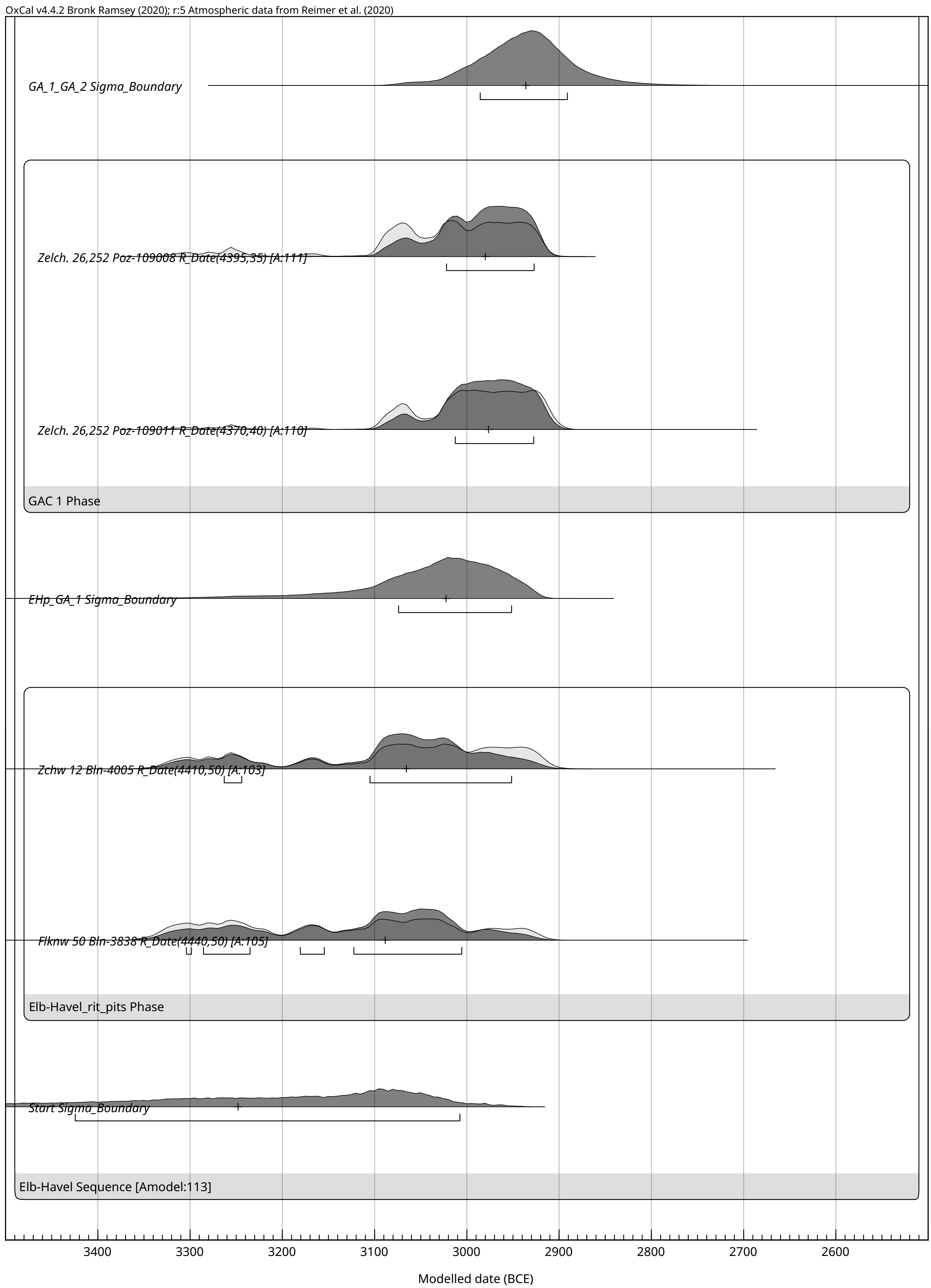


Figure 74. The Bayesian calibrations of GAC assemblages from the Elbe-Havel region (cf. Suppl. 10): a (above) – with Elbe-Havel ceramic assemblages; b – only GAC assemblages (part 1, this page, below, and part 2, following page).


OxCal v4.4.2 Bronk Ramsey (2020); r:5 Atmospheric data from Reimer et al. (2020)
GA_1_GA_2 Sigma_Boundary
Zelch. 26,252 Poz-109008 R_Date(4395,35) [A:111]
Zelch. 26,252 Poz-109011 R_Date(4370,40) [A:110]
GAC 1 Phase
EHp_GA_1 Sigma_Boundary
Zchw 12 Bln-4005 R_Date(4410,50) [A:103]
Flknw 50 Bln-3838 R_Date(4440,50) [A:105]
Elb-Havel_rit_pits Phase
Start Sigma_Boundary
Elb-Havel Sequence [Amodel:113]
3400
3300
3200
3100
3000
2900
2800
2700
2600
Modelled date (BCE)

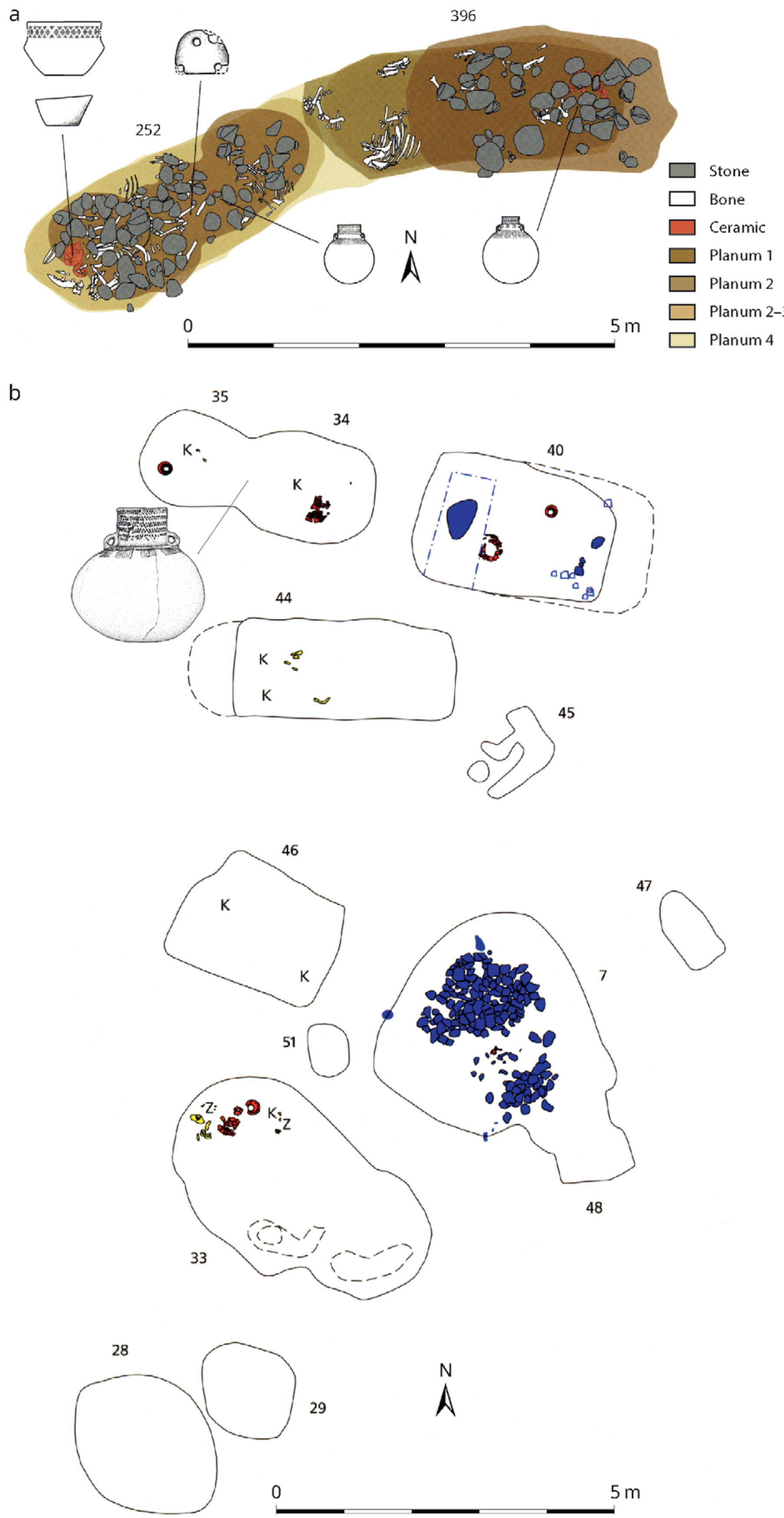


Figure 75. The cattle burials and depositions Felchow 26 (a) and Schmerzke 29 (b), both Brandenburg (after Dirks 2020, 65, fig. 6; Uhl 2022, 36, fig. 20-21). K = cattle skull; Z = cattle tooth; yellow = cattle bone; red = ceramic; blue = stones.

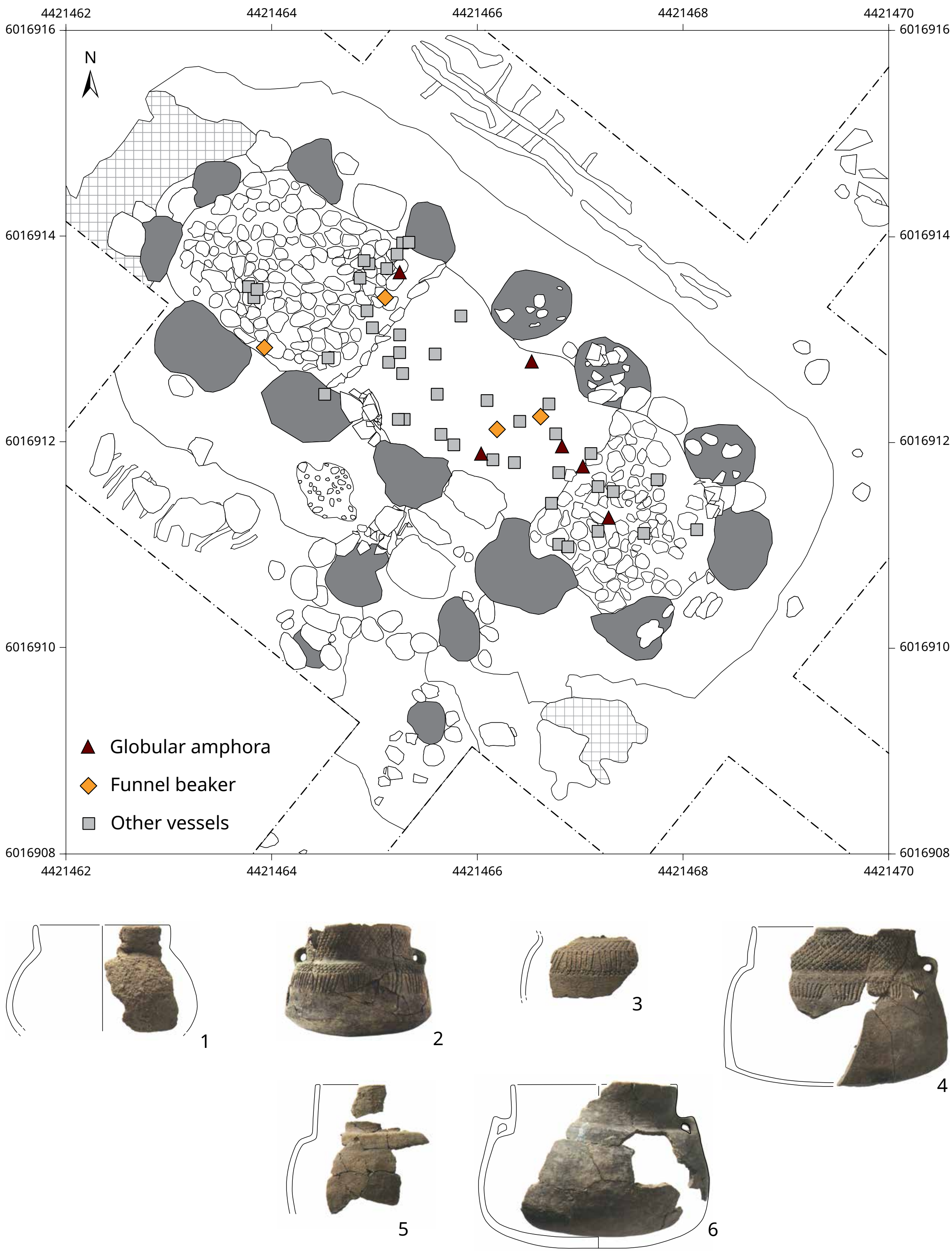


Figure 76. The passage grave Wangels, Schleswig-Holstein with the GA of Baltic type (after Brozio 2016, 165, fig. 128; 493-509, pl. 203-219).

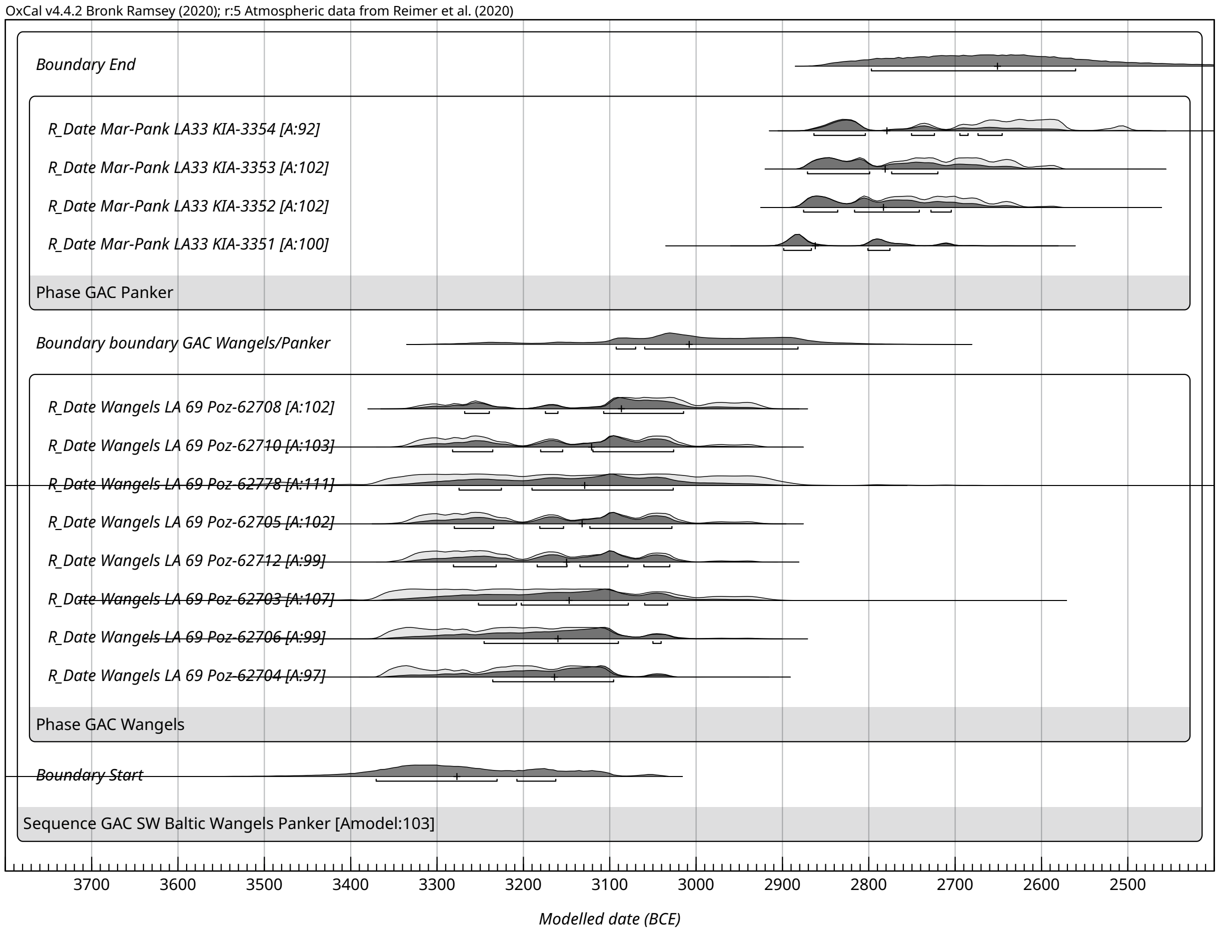


Figure 77. The Bayesian calibrations of inventories with GA from the megalithic tombs of Wangles and Panker, both Schleswig-Holstein (cf. Suppl. 10).

burials probably also in antipodal position possibly from 2900 BCE at the latest.[20] A Bayesian model of radiometric dates from Elbe-Havel and GA contexts of the aforementioned sites displays early offering practices ca. 3250-3020 BCE, early GAC double cattle burials ca. 3020-2940 BCE and later ritual depositions ca. 2940-2690 BCE (Fig. 74b).

3.3.1.3 Southwest Baltic region

From the Southwest Baltic region, we know the typologically significant Baltic globular amphorae with a thickset, almost flat-bottomed body and the dominance of cross-hatching (Fig. 75). Such GA are only known until now from megalithic tombs. The depositional praxis in the passage grave Dannau LA 69 points to a deposition of several globular amphorae, possibly together with other TRB vessels already from 3300 BCE, however, this cannot be postulated with certainty. In the megalithic grave at Matzwitz-Panker LA 33, the GA depositions date from ca. 2900-2600 BCE (Fig. 75-77).

In the wetland settlement Parchim-Löddigsee, various dates from the lower cultural layer could be associated with GA and others from the upper layer with Corded Ware ceramics and ceramics with finger pinch bars (Fig. 78). This results in

20 Further data from Buchow-Karpzow 8 from a mortuary hut (charred wooden beam Bln-1445 4405±50bp; charcoal post Bln-1446 4353±60bp) with cattle deposition pits in front and the cattle deposition site Buchow-Karpzow 2 (pit 5 charcoal Bln-2667 4320±50 bp) also date from ca. 3060-2890 BCE (cf. Müller 2001, 245).

GA dating from ca. 3040-2700 BCE; for Corded Ware pottery from ca. 2890-2460 BCE (Becker and Benecke 2002, 42), which could be narrowed down by Bayesian dating to ca. 3150-2850 BCE for the GAC occupation (Fig. 79). The reconstructed GA from Parchim-Löddigsee (*ibid.* pl. 2,1-3) are more reminiscent of the Southwest Baltic Group due to the vessel form with flattened bottoms, while the decoration style definitely corresponds to Central German GAC C.

A total of 16 dates was included for the Bayesian phase calibration (Fig. 80). Obviously, both megalithic graves and settlement remains date over the total period of occupation – earlier dates are from Wangels and Parchim-Löddigsee, later dates are from Panker, Serrahn 2 and Parchim. The occupation probability for the entire GAC sequence is ca. 3300-2700 BCE.[21]

Typologically, the GA from Wangels and those from Panker differ in that the latter have recessed angle belts, cross incision motifs and point incisions (Hirsch (2008/09) 2011, 74 pl. 2,6), which are not present in Wangels. The ringlet impressions on a GA from Panker (Hirsch (2008/09) 2011, 73 pl. 1,1) are comparable to the stamp-decorated GA with round stamps from Parchim-Löddigsee (Becker and Benecke 2002, pl. 1-2). The angular incision motifs can also be compared with those known from Panker (Becker and Benecke 2002, pl. 1-2). A chronological comparison of both inventory groups indicates a deposition of the GA in Wangels from ca. 3275-3010 BCE, in Panker from ca. 3010-2650 BCE (Fig. 77).

If the 'stone heap' graves (Steinhaufengräber) of Northwest Jutland actually do represent cattle and human burials under Globular Amphora influence, which is to be presumed, then their dating can also be used to chronologically situate the GAC of the Baltic region. Based on typochronological considerations, it is assumed that they were created on Jutland between ca. 3100-2800 BCE (Johannsen and Laursen 2010, 49). However, these are not possible double cattle burials in one grave pit, but rather burials in two parallel elongated earthen pits. In this respect, it may also be an independent variant of the implementation of the introduction of wheel and wagon in a ritual context, which is not necessarily connected with the GAC. If ceramics were recovered, they were specified as Store-Valby MN V ceramics, that is, the regional TRB expression that existed contemporaneously with the GAC.

21 Three dates from Katelbogen (Bln-554), Poggendorfer Forst (Bln-990) and Heidmoor (KIA-8121) were not included because they appeared to be too young and their association with the GAC was not documented.

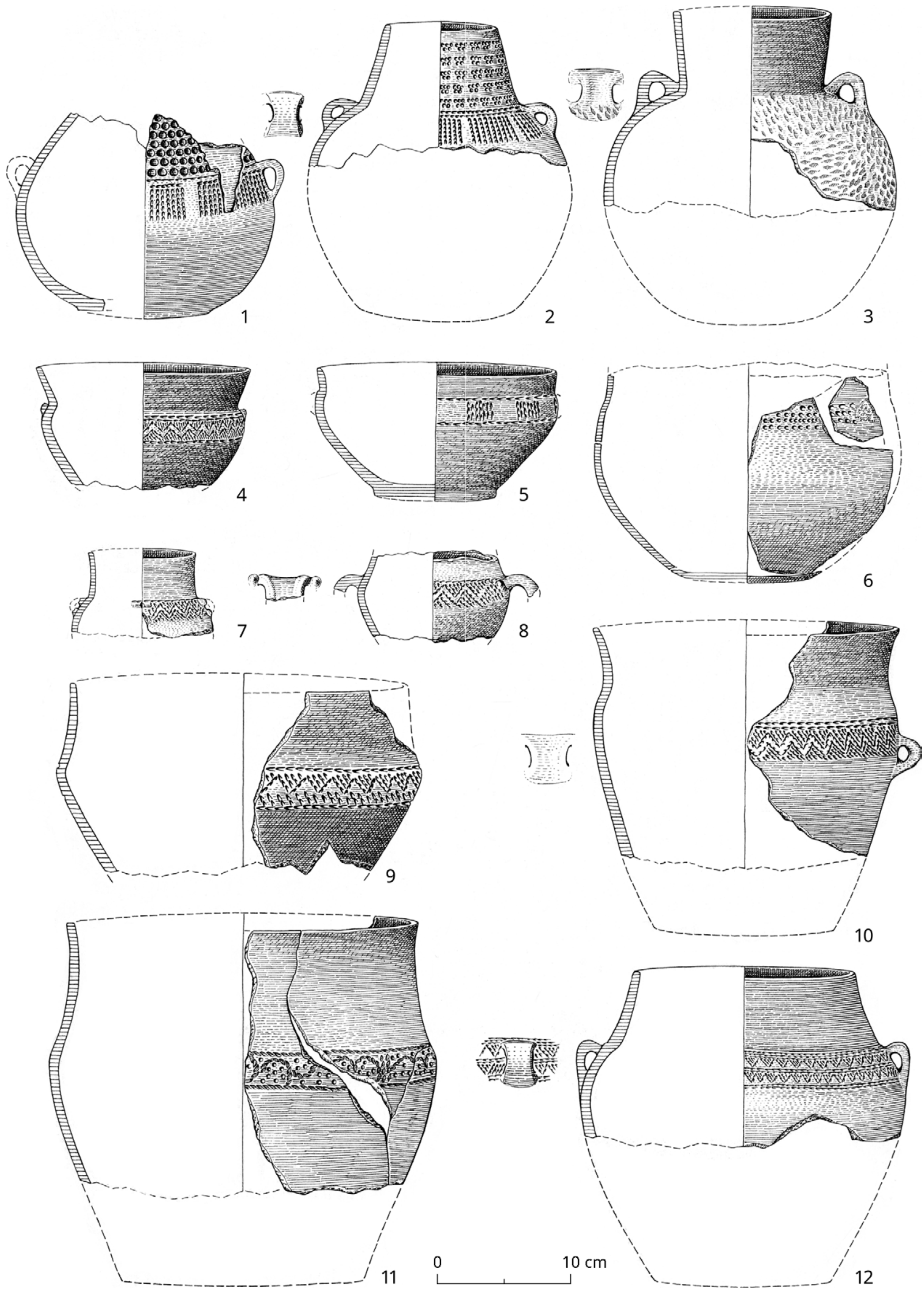


Figure 78. In the wetland settlement Parchim-Löddigsee, a lower cultural layer could be associated with GA (1-3) and others with the Bernburg style including chevron bands and hanging triangles as decoration (4-12) (after Becker and Benecke 2002, pl. 2).

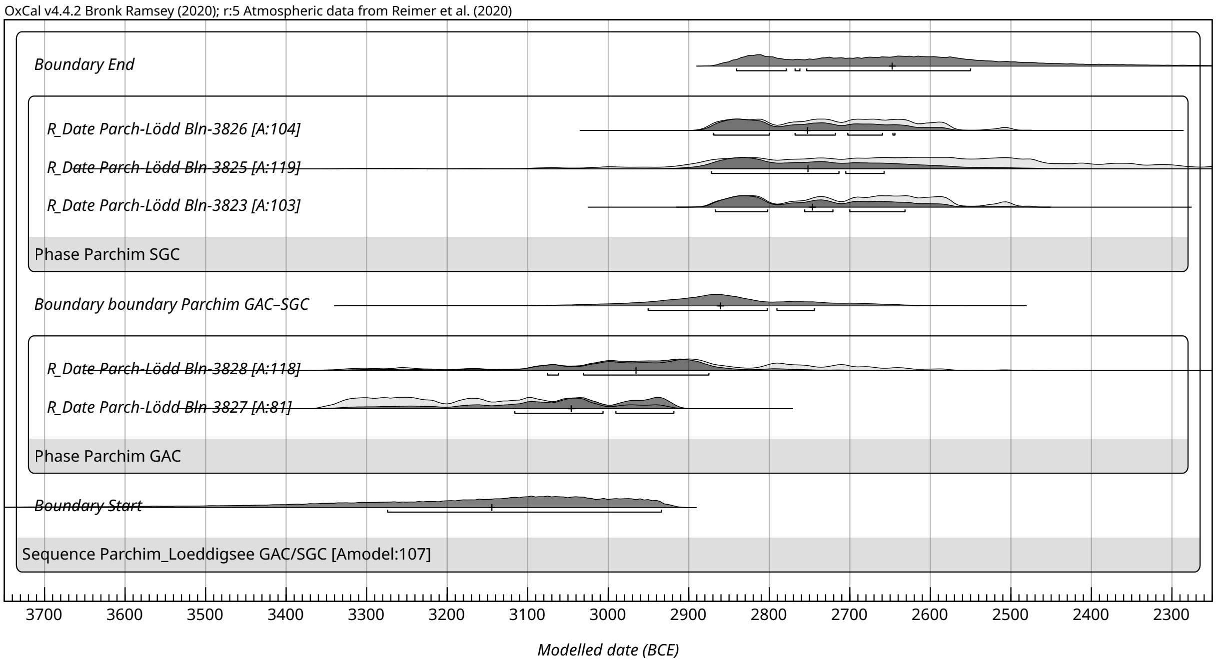


Figure 79. The Bayesian calibrations of inventories with GA and Corded Ware from the wetland site Parchim-Löddigsee, Meckelnburg-Vorpommern (cf. Suppl. 10).

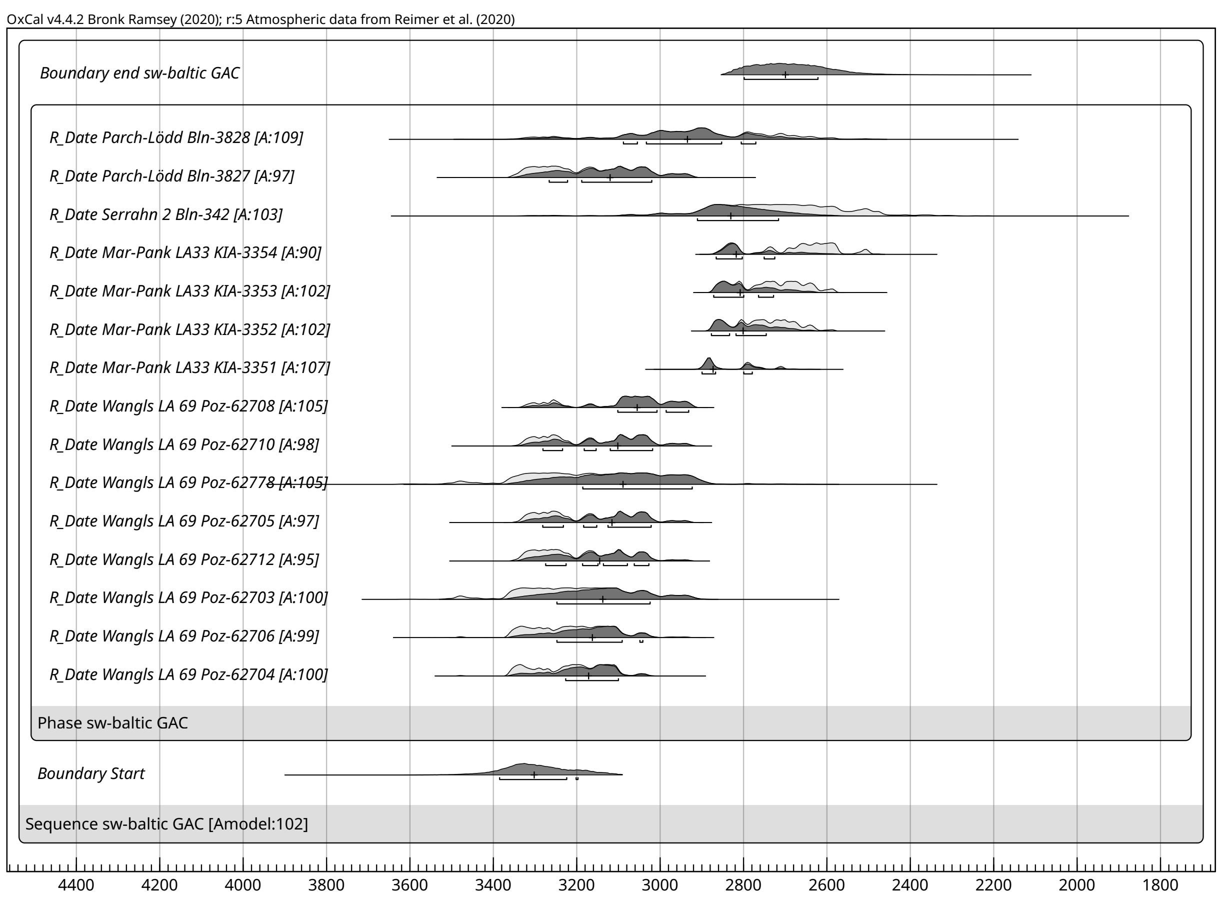


Figure 80. The Bayesian calibrations of assemblages with GA from the Southwest Baltic region (cf. Suppl. 10).

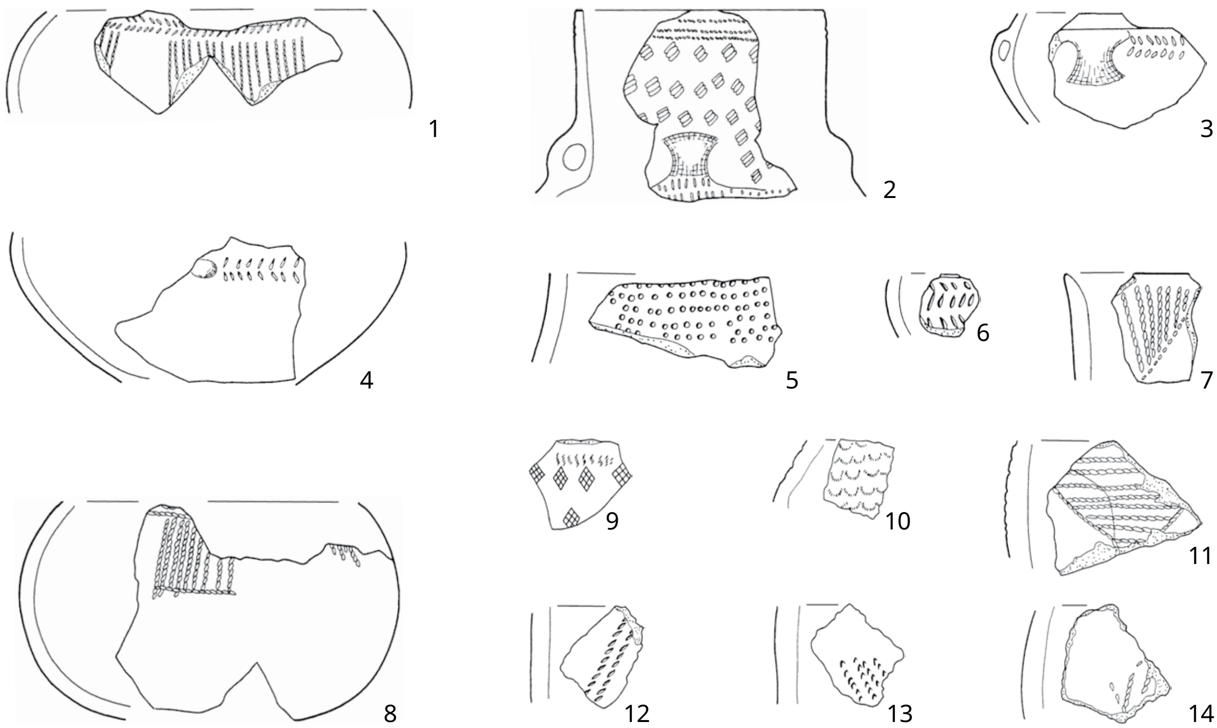


Figure 81. Wartberg ceramics with GAC elements (after Szmyt 2003: 429, fig. 15). 1-4 – Gudensberg-Bürgel; 5-6 – Lohne-Hasenberg; 7-8 – Gudensberg-Güntersberg; 9 – Wartberg; 10 – Hiddigsen; 11-14 – Warburg I).

3.3.1.4 Wartberg and other areas in the west

Another area with a somewhat more regular occurrence of individual GA ceramic units is the Wartberg distribution area in the west. GA from gallery graves and settlements are known here. Radiometric dates for settlements with GA ceramic are available from Lohne-Hasenberg and Gudensberg-Bürgel, for gallery graves from Lohra-Gernsten and Wewelsburg I. In all cases, the contexts date radiometrically after 3000 BCE (Fig. 81). The common phase calibration of the four usable dates verifies a possible beginning at ca. 3000 BCE and an end around 2775 BCE (Fig. 82). The data from the hilltop settlements Gudensberg-Bürgel and Lohne-Hasenberg turns out to be somewhat younger than those from Wewelsburg und Lohra-Gernstein, which possibly indicates a chronological change in the archaeological sources, as is generally observed in Wartberg. The wide-mouthed vessel from Lohra (cf. Raetzel-Fabian 2001, 334 fig. 6,1) with grid decoration is not necessarily GA pottery, which is why the radiometric date cannot be placed in the local context.

A comparable date is also recognisable for the few GA sherds from Southern German groups (Goldberg III and Horgen). With the exception of the sherds from Goldberg near Goldburghausen, published by Stroh in 1938 (cf. Woidich 2014, 219 fig.76; Stroh 1938, 219 fig. 1-2), the repeatedly cited ceramics with recessed chevron bands or hanging triangles are Bernburg rather than GA ceramics (Woidich 2014, 219 fig. 76). Just as doubtful from a typological point of view are the links between the Cham amphorae from Riekofen to the GAC (Fig. 83; Matuschik 1989 pl. 31,1.3; 32,1-3; Woidich 2014, 219 fig. 75), but the amphora forms correspond typologically to those from Olomouc-Slavonin-Horní Lán (Nová Ulice) (see below). On the basis of radiometric dates, Riekofen dates to 2900 BCE (Raetzel-Fabian 2000, 181-183 fig. 117; Fig. 84; ca. 2910-2890 BCE), Goldberg III after 2900 BCE (Bleicher 2006).

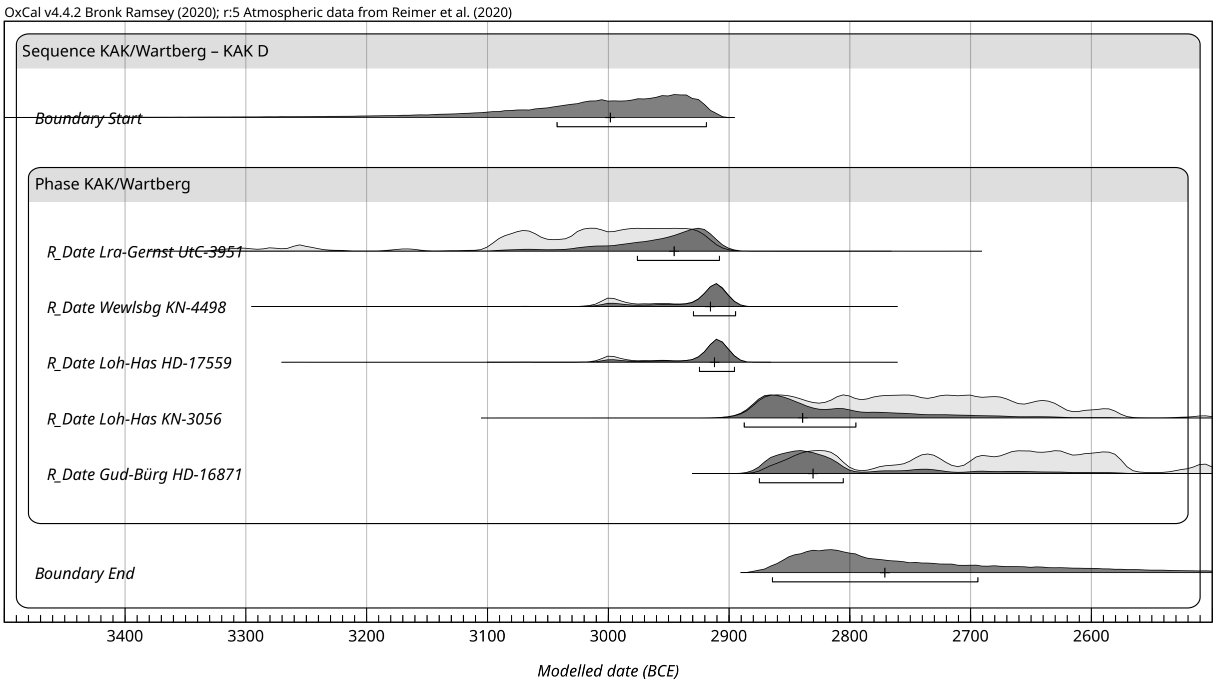


Figure 82. The Bayesian calibrations of inventories with GA from Wartberg assemblages (cf. Suppl. 10).

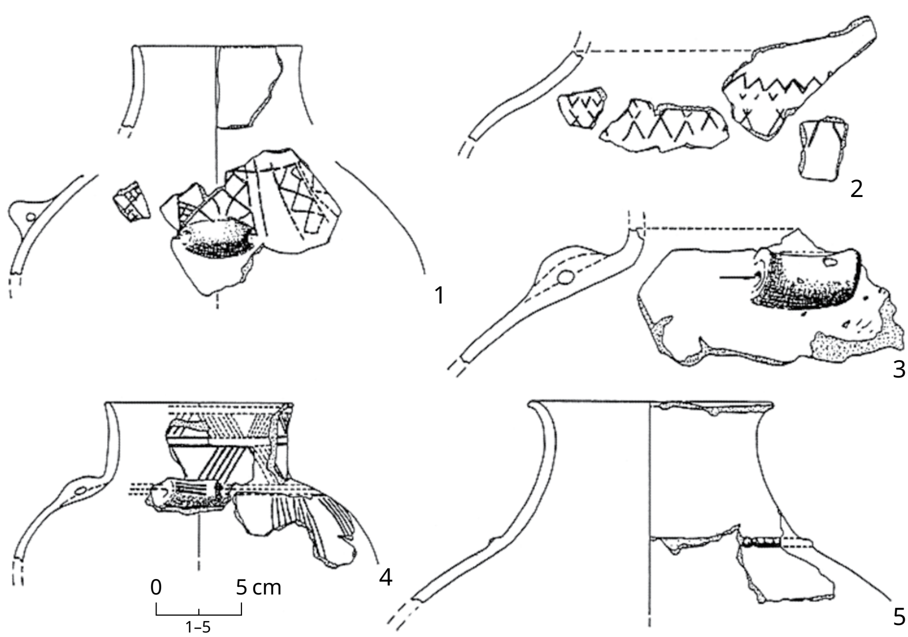


Figure 83. Amphorae from Riekofen, Bavaria (after Matuschik 1989, pl. 31,1.3; 32,1-3; Woidich 2014: 219, fig. 75) correspond typologically to amphorae from Olomouc-Slavonin-Horní Lán (Nová Ulice) (cf. Fig. 85).

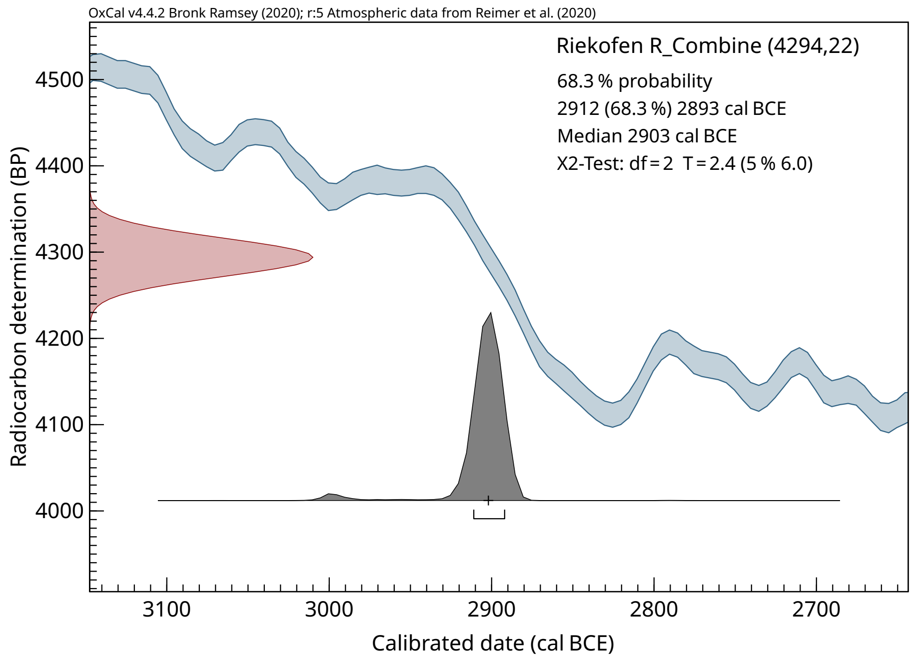


Figure 84. The ¹⁴C results from Riekofen, Bavaria (cf. Suppl. 10).

3.3.1.5 Bohemia/Moravia

Five AMS and one conventional date are published from Bohemian burials (Papac *et al.* 2021, suppl.). These are direct dates from skull fragments and one rib bone that originate from earthen pit burials. For the four dates from the triple burial of Vliněves, the inventories have been published recently (Dobeš *et al.* 2022). The ceramic inventory includes only a cup, which also could be associated with Řivnáč. In the two graves from Blšany u Loun and Předměřice nad Labem, cord ornamentation is strongly represented (Dobeš 1998, 134-135; 145; 155-156). A conventional date from Vliněves has an extremely high standard deviation >100 and is excluded from the following calculations.

Thirteen conventional and three AMS dates from Bohemia/Moravia are available from five settlements. Among them is the Řivnáč/GAC hilltop settlement Stehelčeves-Homolka, in which individual GAC ceramic units are available from Řivnáč settings (Szmyt 2003, 417-419 fig. 9,1-10). It corresponds typologically to the early phases in the MES region and is denoted as a "Homolka variant" (without cord decoration). To be typologically connected is, among others, Lovosice-Schwarcenberská cihelna, whose ^{14}C date (Bln-4165), however, can be associated with an old wood effect (Szmyt 2003, 419).

Separate from the GAC "Homolka" inventories is a strongly cord decorated GAC Klučov variant, which occurs typologically in Silesia and Moravia (Szmyt 2003). Radiometric dates are available from Olomouc-Slavonin-Horní Lán (Nová Ulice), in particular from pit 835, and from the settlement Bystročice (Peška (2006/07) 2011, 37 fig. 34; Peška 2013a; 2013b)[22] (Fig. 85). Although one date deviates from the basic inventory (Erl-7614), this does not disturb the model in the sigma-boundary concept (Fig. 86).

Further data from the Southern Bohemian hilltop settlement Kostelec nad Vltavou, which can be attributed to the Late Řivnáč, is said to be associated with globular amphorae (John *et al.* 2012). However, since there is no GA pottery from the site, the evaluation remains difficult.

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22 A date from object 2238 is not assigned in more detail and probably has an only limited informative value due to the high delta ^{13}C value (Peška (2006/07) 2011, 29).

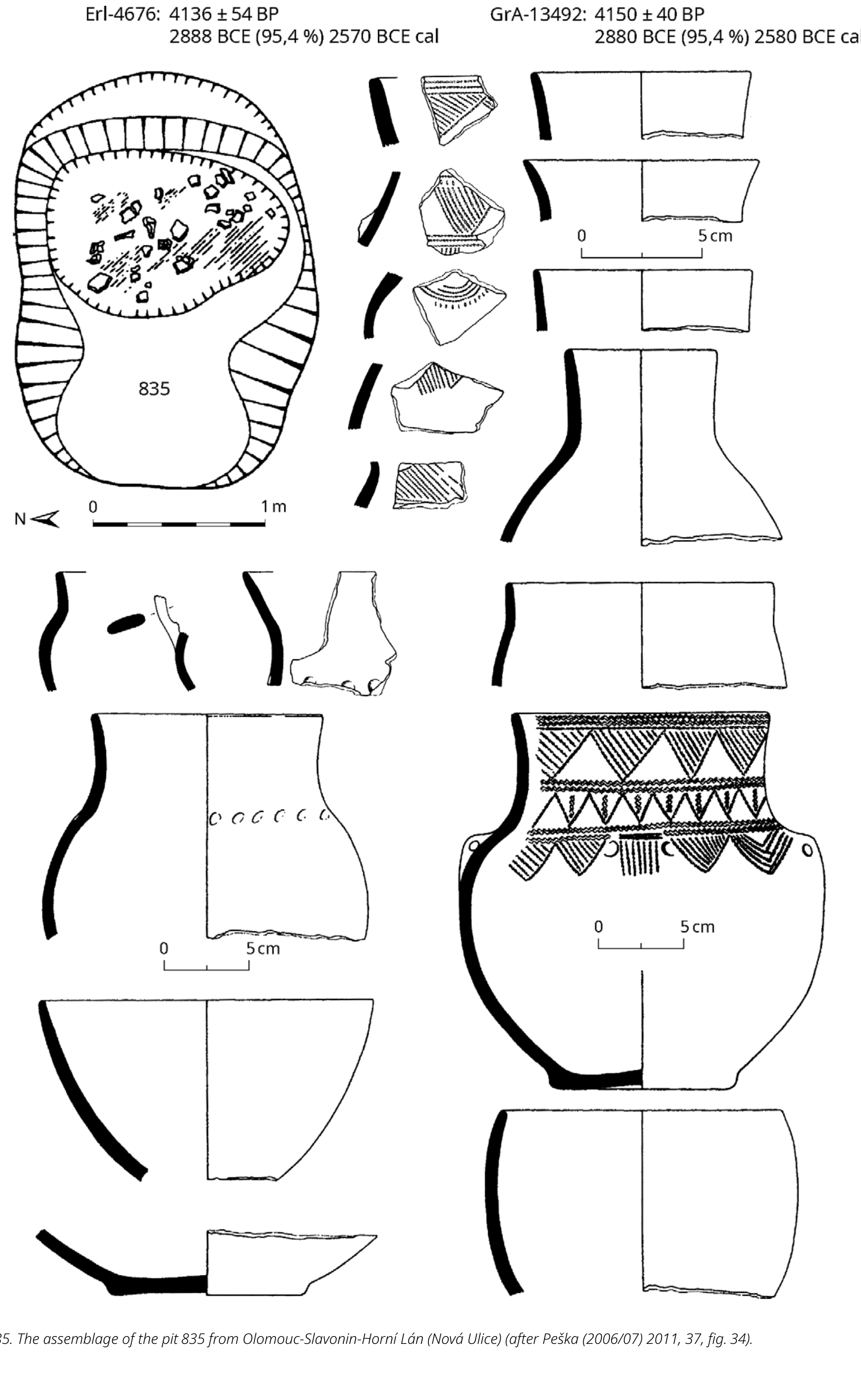

Figure 85. The assemblage of the pit 835 from Olomouc-Slavonin-Horní Lán (Nová Ulice) (after Peška (2006/07) 2011, 37, fig. 34).

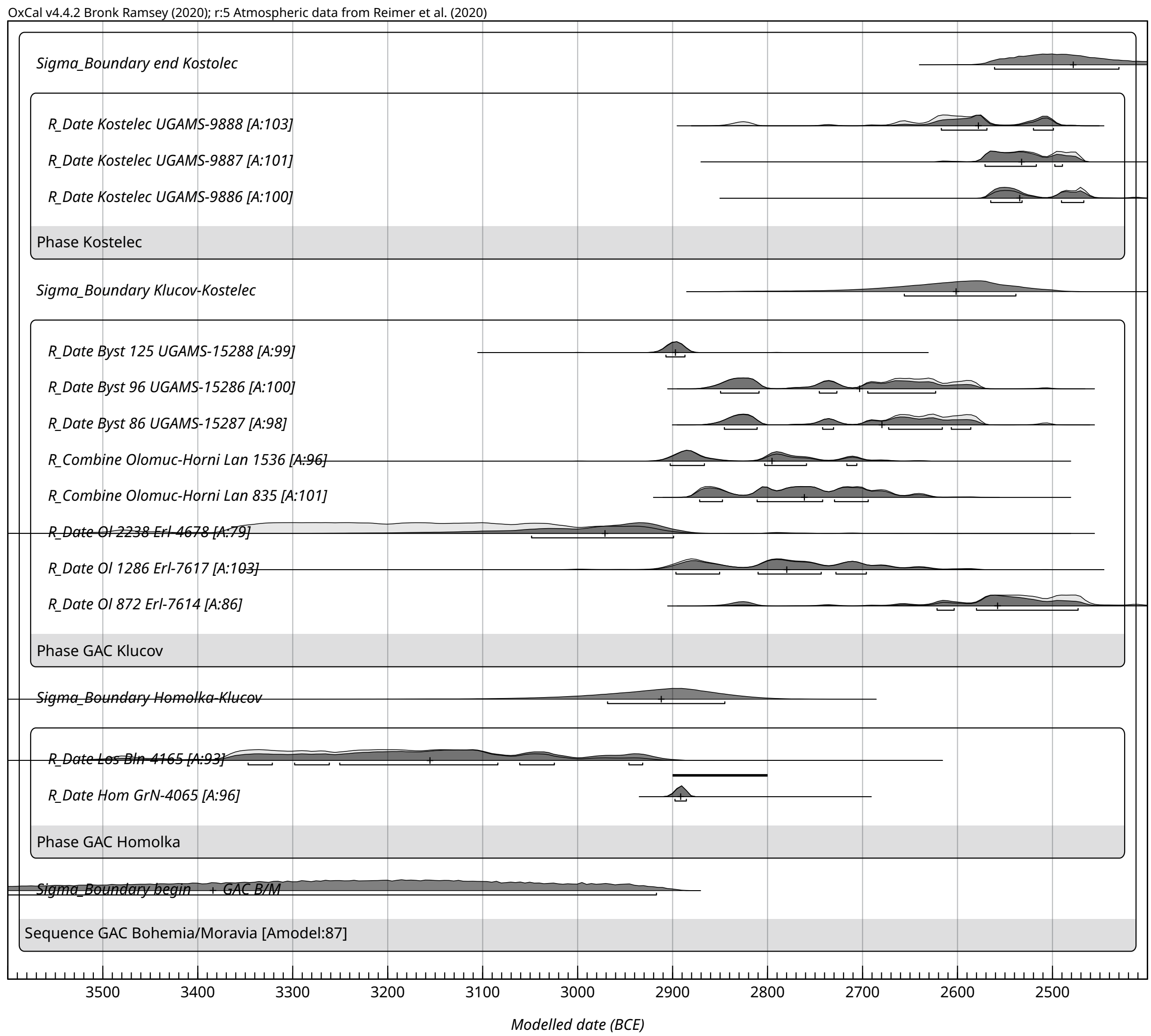

Figure 86. The Bayesian calibrations of Bohemian and Moravian assemblages with GA and Kostelec nad Vltavou, which can be attributed to the Late Řivnáč (cf. Suppl. 10). GA phases are differentiated.

Considering the 22 dates, a conclusive model results with a total timeframe for the GAC from ca. 3950-2600 BCE. In addition, the Late Řivnáč lasts until ca. 2480 BCE (Fig. 87). A differentiation between Homolka and Klučov cannot be made due to low data availability for Homolka and difficulties with the old dates (Bln-4165).[23] Moreover, the Lower Silesian data, which can definitely be typologically connected with Klučov, is concurrent with Homolka (see below). Typologically, the amphora forms from Olomouc-Slavonin-Horní Lán (Nová Ulice), pit 835 (Fig. 85; Peška (2006/07) 2011, 37 fig. 34) correspond quite well to what is known, for instance, of "Chamer" amphorae from the Chamer settlement Riekhofen (Fig. 83; Matuschik 1989, pl. 31.13; 32,1-3; Woidich 2014, 218 fig. 75).[24]

23 When differentiated into phases, the dating of the Homolka phase is 3330-2880 BCE, the Klučov phase 2880-2590 BCE and the Late Řivnáč 2590-2490 BCE (Suppl. 10). The contradiction concerning the beginning can be partially explained by the old wood effect of Bln-1465, but also by the low number of dates for the Homolka phase.

24 Here, too, the usable radiometric data indicates a period around ca. 2900 BCE (conventional H-7412 4327±35 bp; H-7411 4307±45 bp; H-7409 4252±35 bp, charcoals, cf. Raetzel-Fabian 1996, 181-183 fig. 116).

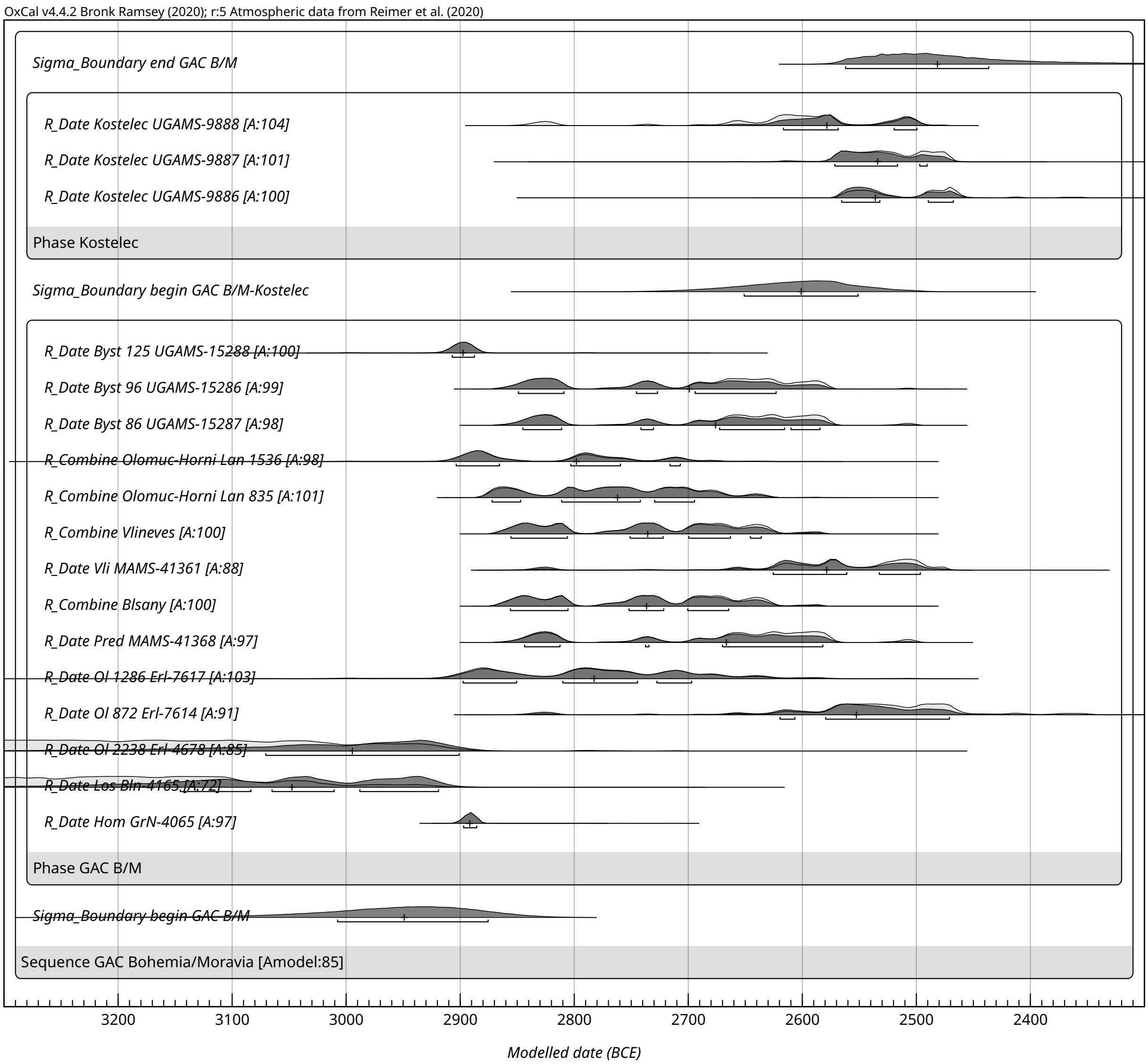

Figure 87. The Bayesian calibrations of Bohemian and Moravian assemblages with GA and Kostelec nad Vltavou, which can be attributed to the Late Řivnáč (cf. Suppl. 10). GA phases are not differentiated.

3.3.1.6 Summary

From ca. 3200 BCE, the GAC is present in Central Germany, possibly also in the Elbe-Havel region and in the Southwestern Baltic Sea region. While for the MES, numerous studies and data support this, the data situation in the Southwestern Baltic region certainly remains controversial due to the only possible associations of the GAC, for example, in megalithic tombs. Nonetheless, due to the data from the Parchim-Löddigsee settlement, for example, a beginning of the GAC before 3100 BCE, possibly even before 3200 BCE, is also probable.

Finally, a west and a north dispersal of influences of the GA from a Central or North German core area is supported by Hessian-Westphalian data from ca. 3000 BCE, possibly also with the Northwest Jutland stone heap graves from ca. 3100 BCE. In these areas as well as in possible Goldberg 3 contexts (from 2900 BCE), only isolated, but regularly occurring artefacts are connected with the GAC. In Bohemia and Moravia, in contrast, an increased and independent GAC presence is observed, which begins around ca. 3000 BCE. The end of the phenomenon is noticeable everywhere in the 28th century and is surely the case in the 27th century.

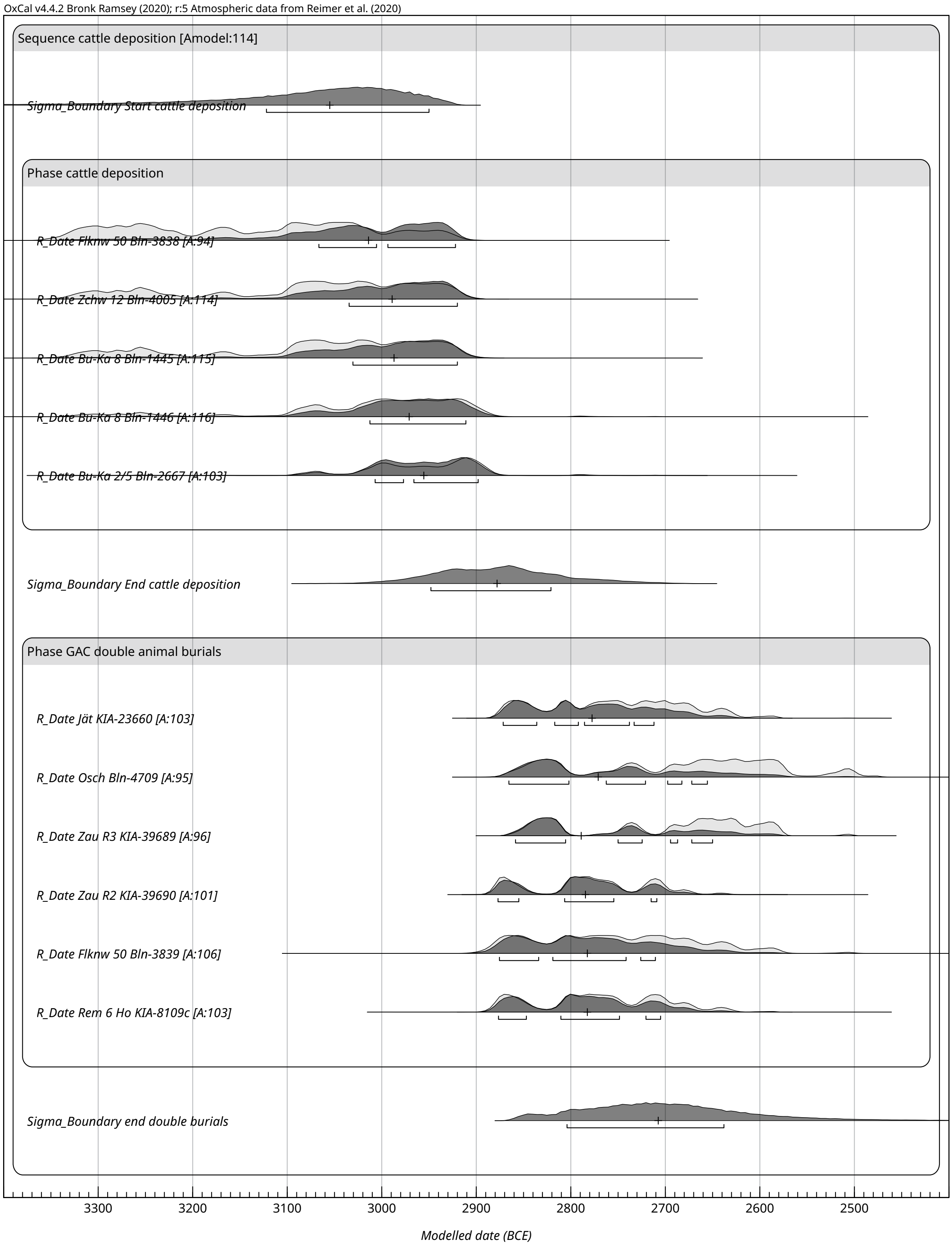

Figure 88. The Bayesian calibrations of GAC cattle burials and depositions from the GAC West Group (cf. Suppl. 10). a (above) – only GAC assemblages; b (opposite) – also other assemblages.

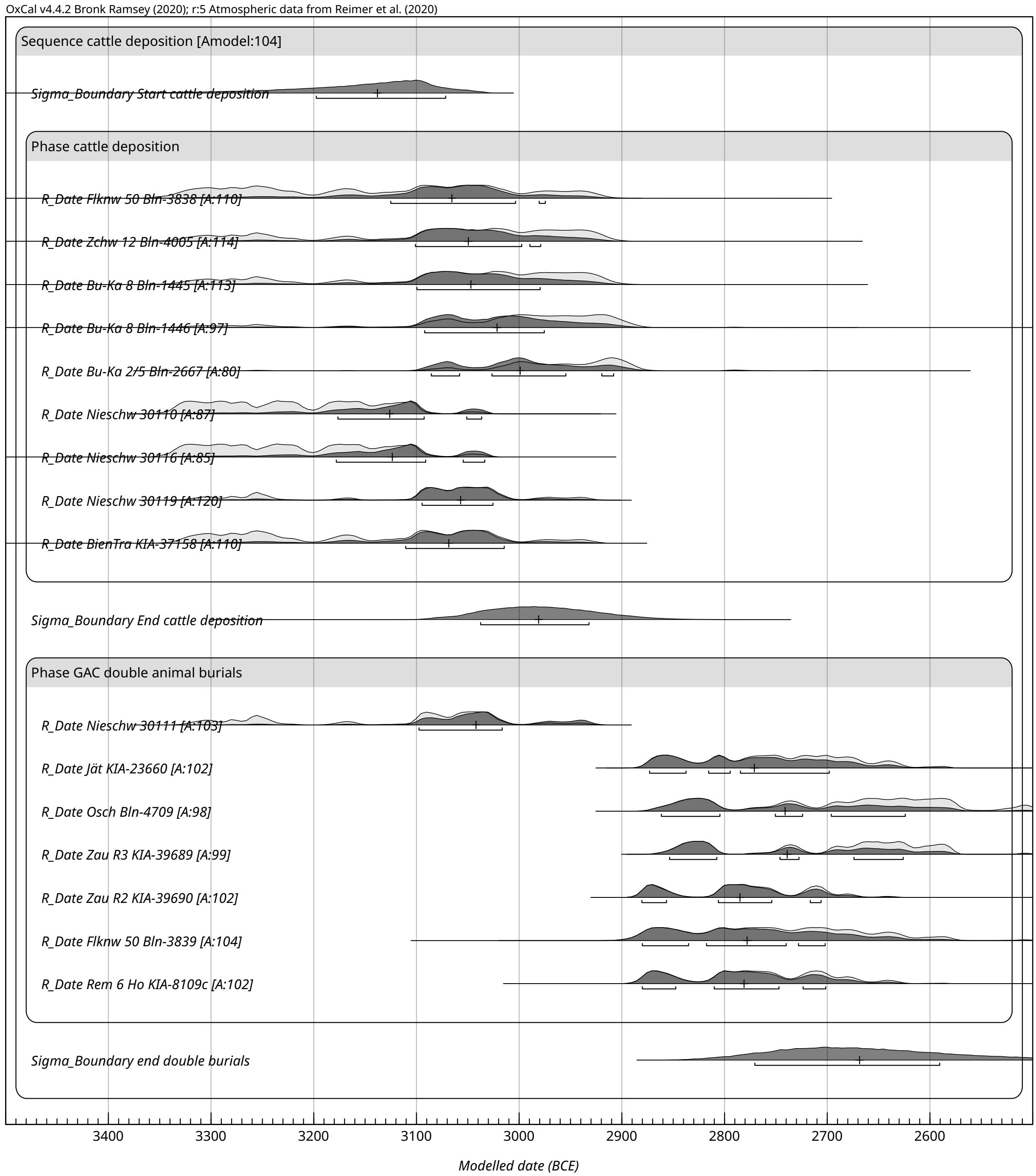

Figure 88. continued.

Accordingly, we assume a scenario in which the GAC is present somewhat earlier in Central Germany and Northern Germany than in Bohemia/Moravia and the western and southwestern regions with the influence of the Western GAC.

Apart from the meaning that the "Baltic Globular Amphora" type attains in the Western Baltic region, in the areas outside of GAC dominance (Wartberg, Cham, Řivnáč), it is obviously always a question of communities, for which the single GAC sherds or individual vessels have a rather exotic meaning.

This corresponds to the results on the clear delimitation of the Western GAC network. According to the data available thus far, the chronological beginning of the Middle Elbe-Saale-Havel network and the Southwestern Baltic network

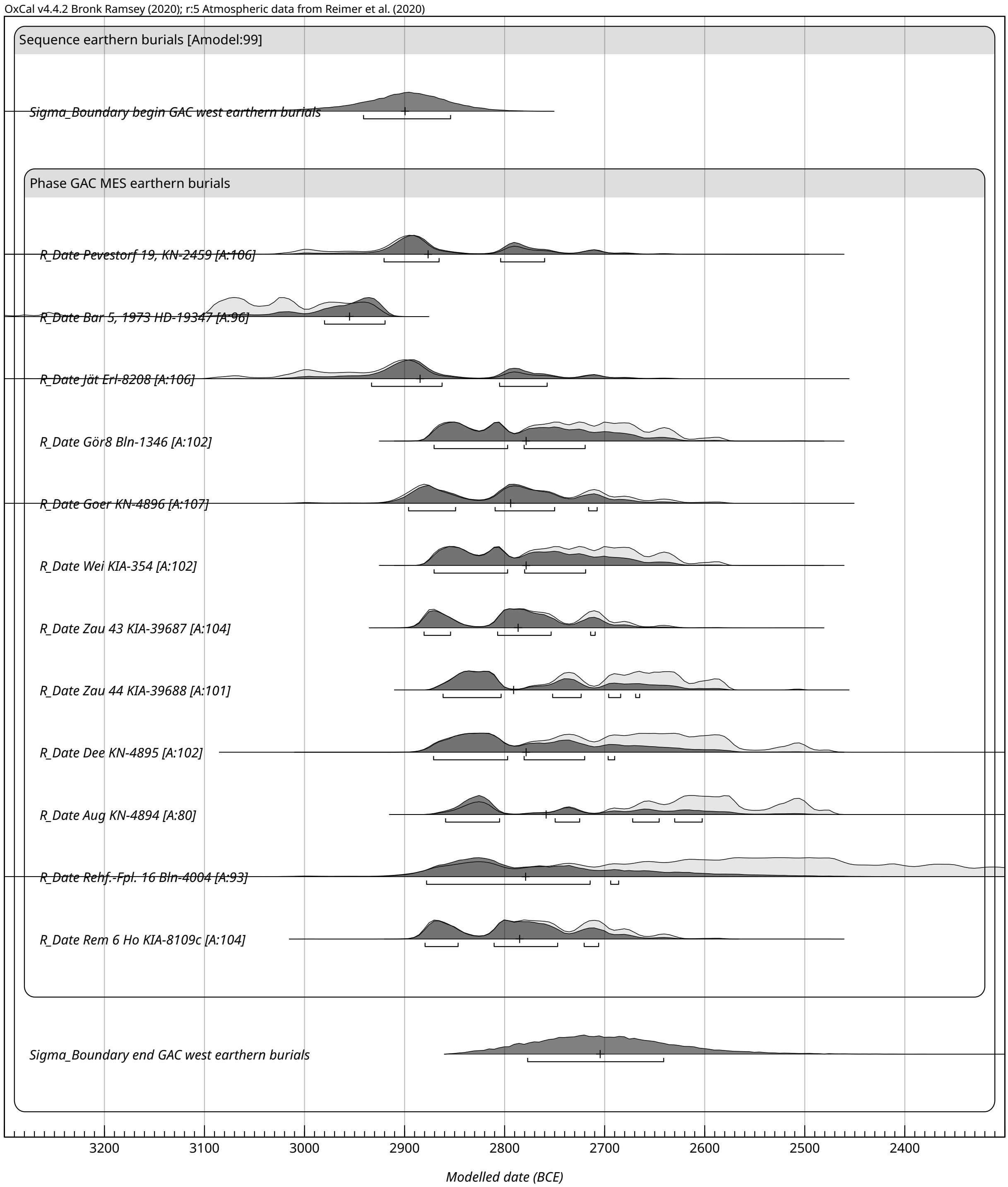

Figure 89. The Bayesian calibrations of GAC earthen burials from the GAC West Group (cf. Suppl. 10).

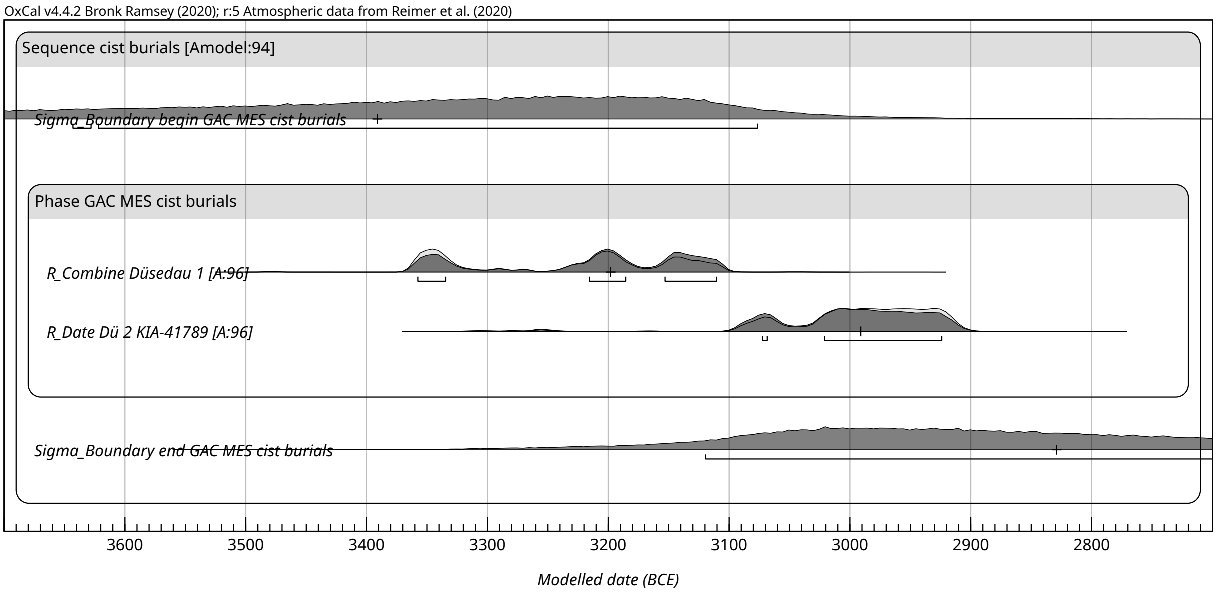

Figure 90. The Bayesian calibrations of GAC cist burials from the GAC West Group (cf. Suppl. 10).

was around 3200 BCE, followed by the integration of Bohemia at the latest around 3000 BCE. The practice of exchange with Wartberg, Goldberg III and possibly Cham does not begin before ca. 2900 BCE.

If we differentiate the available data according to find types for the entire West Group, different temporal localisations of individual practices become clear. In the case of cattle depositions and graves, with the addition of non-GAC inventories from Buchow-Karpzow in Brandenburg (Kirsch and Plate 1984), from Central German Niederwünsch (features 30110, 30116, 30119; Müller 2017, 237, fig. 16) and Biendorf-Trappenberg (Teegen *et al.* 2017), which are linked with cattle depositions, and from Lower Saxon Remlingen 6 (Dirks 2001) and Niederwünsch (feature 30111), which are associated with an antipodal double cattle burial,[25] it is recognisable that at least antipodal double cattle burials are first expected from ca. 2980 BCE and are verifiable until ca. 2670 BCE, while partial burials or also single cattle burials occur primarily from ca. 3140-2980 BCE (Fig. 88). The earthen pit graves also appear to date from ca. 2900-2700 BCE (Fig. 89), while cist graves appear to exist earlier (ca. 3250-2826 BCE, cf. Düsedau, Fig. 90).[26] In both cases, however, typochronologically early and late dated inventories are available, for which no radiometric data is available and thus only an indirect dating can be made. The GAC occupation of megalithic tombs (or collective chamber graves and gallery graves) is likely to have occurred from ca. 3160 BCE and to have lasted until ca. 2810 BCE. Settlement remains can also be dated to ca. 3020-2720 BCE (Fig. 91). The date from the pit field for flint extraction Eula 7 is ca. 2860-2730 BCE (Suppl. 9).

In this respect, we assume a very different intensity of the formation of the GAC phenomenon. The differentiation between stone cist and earthen pit burials in the single burials and the dominance of antipodal double cattle burials from the 29th century BCE onwards describes differences to the preceding two centuries, in which cattle depositions of a simpler type dominate, particularly in interaction

25 From the feature, the last layer in the Remlingen 6 walled chamber grave results in a simultaneity between the double cattle burial and crouched burial, which is dated with a human bone (KIA-8109c 4180±32 bp).

26 However, the only early dating of the cist tombs is certainly due to the small amount of data. Where more data is available, for example, in the Central Group, cist graves date throughout the period of the Classic GAC (see below). In the Middle Elbe-Saale region, too, no general tendency can be determined in the typologically dated inventories of phases A-D, but in each case an occupation of both the earthen pits and stone cist graves.

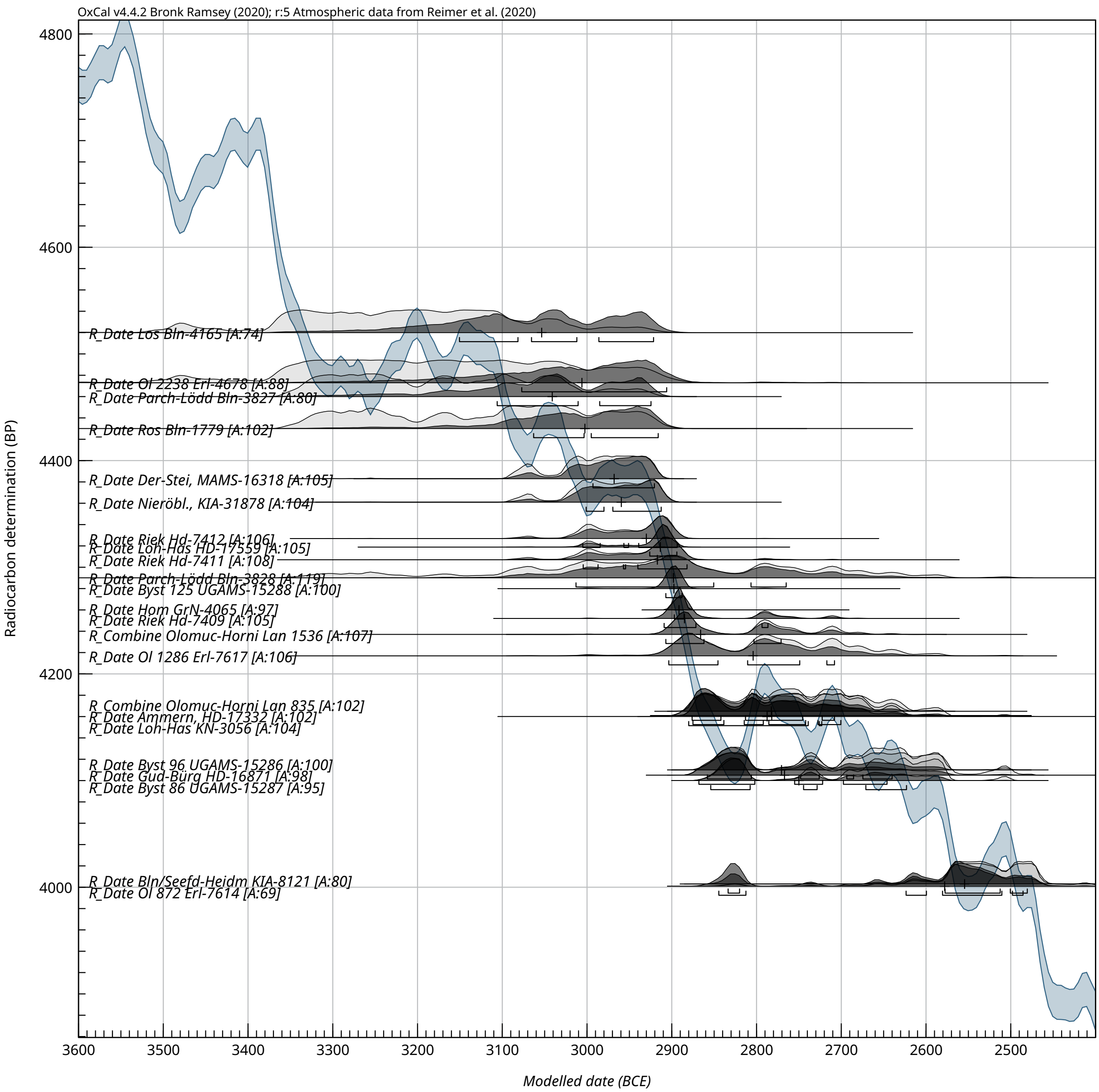

Figure 91. The Bayesian calibrations of GAC settlement remains from the GAC West Group (cf. Suppl. 10).

with other pottery groups, and GAC burials are more likely present from grave contexts that are also typical for other Late Neolithic groups.[27]

3.3.2 Central GAC

The Central Group is traditionally divided into several sub-regions, which are spatially oriented according to site concentrations (Fig. 1). In the area of the eastern North Central European lowlands, we are dealing with the regions of the *Middle Notec and Kuyavia* west of the Vistula bend, the *Chełmno (Kulmer) Land* east of the Vistula bend between the Vistula in the west, Drewenz in the south and Ossa in the north, and the *Podlasia* region (on the Upper Narew). In the eastern low mountain zone to the south and the plateaus before it, the regions of *Lower Silesia*, *Lesser*

27 The term 'Late Neolithic' is used analogue to the periodisation systems of Lüning (1996) and Müller (2001) for Western Central Europe, and Szmyt (2013, 39) with the term Late Neolithic 1 and Czerniak *et al.* (1991) with the term Middle Neolithic for Eastern Central Europe.

Poland with the eastern Lesser Poland Plateau and the *Lublin Plateau* are affected. Partly, there are different chronological systems for the internal classification of the globular amphorae, for example, more oriented to technological changes of the ceramics or more oriented to the vessel forms and decoration motifs. In the following, the respective regionally used chronological systems are subjected to Bayesian dating.

The typological-spatial analyses conducted in chapter 2 prove the social differentiation in a supra-regional network of the Western GA and the Eastern Vistula-Podolia GA network. The latter is divided into the Vistula GA, the Volhynia-Podolia GA, and the Siret GA, thus concerning both the central and the eastern GAC. For practical reasons, in the following analysis we first spatially summarise the assemblages from the eastern North Central European lowlands, on the one hand, and the eastern low mountain zone with plateaus in front on the other. This enables a later improved comparison with the mentioned GA network structures.

3.3.2.1 Eastern North Central European lowlands

3.3.2.1.1 Middle Notec river drainage

The Middle Notec river drainage is located west of Kuyavia, from where three sites with radiometric dates of the GA ceramics are available. These include the sub-megalithic structures of Chodzież 3, the animal depositions of Straduń 17 and the settlement of Żuławka Mała 1 with a planked trackway. At Chodzież 3, parts of 30 skeletons were apparently deposited in a stone packing over a long period of time, above all, with pigs and vessels (Prinke and Wiślański 1977, pl. 235; Pospieszny 2010, 150-153; Szmyt 2001, 38; Szmyt 1996, 71). The pottery inventory exhibits typological similarities with elements of Western GA ceramics (Szmyt 2001, 38), so that an assignment to the phases IIIa/GAC C seems probable.[28] A conventional date of a human bone is dated to ca. 2925-2890 BCE (Bln-1549). A conventional date (Ki-5952) of the animal deposition in Straduń 17, whose ceramic inventory is also typologically associated with Western GAC pottery (probably IIIa/GAC C),[29] dates to ca. 2870-2740 BCE (Szmyt 2001, 28. 59, fig. 19) (Fig. 92).

3.3.2.1.1.1 Żuławka Mała 1

Żuławka Mała 1 is a multi-period site with excavations in four areas: first in a settlement above the northern slope to the lowland (area in Rola 2009, 37 fig. 8), second, in the lowland area in a ford with an embankment, respectively a planked trackway (area of section 2), third in a former lake (area of section 1) in the lowland area (Fig. 93), and fourth, putative settlement remains on the southeastern slope to the lowland area (area of section 3). Moreover, there are further GAC settlements in the vicinity.

Of particular interest for the GAC are the features from the planked trackway (Nowaczyk and Rola 2009). Due to the preservation of the wood, numerous analyses were carried out, particularly on TRB and GAC occupation. Thus, it was possible to conduct both 76 radiometric datings (Rola 2009, 326-332 pl. 26) and dendrochronological datings (Krapiec *et al.* 1999; 2009) for all mentioned areas. It was possible to synchronise 20 timbers from section 2 to a local floating dendro-curve of 150 years. The sapwood was present in six timbers. By wiggle-matching with timber 65, the curve could be absolutely chronologically fixed as a floating curve (Krapiec 2009, 117-118 fig. 62; cf. Fig. 95).

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28 Cross-hatching (Szmyt 2001, 58 fig. 18B, 54), single and multiline chevrons (Szmyt 2001, 58 fig. 18B, 35.54); Kuyavian amphorae (Szmyt 2001, 58 fig. 18B, 51).

29 Lozenge motifs, chevrons (Szmyt 2001, 59 fig. 19).

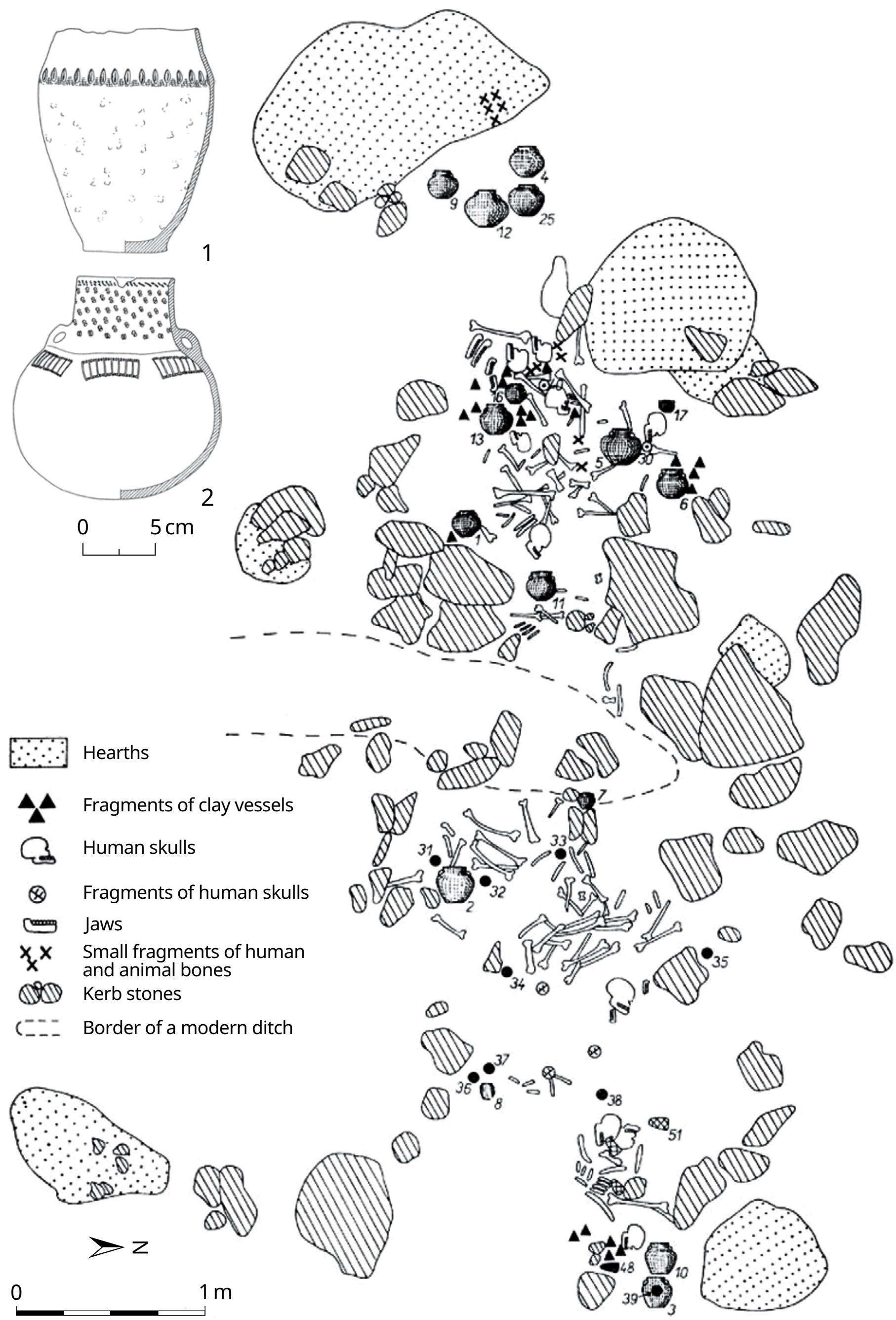


Figure 92. The ceramic assemblage from Straduń 17 (1-2) and the stone packing at Chodzież 3, Middle Notec region (after Szmyt 2001, 57, fig. 18A; 59, fig.19).

Although a complex stratigraphy with different taphonomic aspects complicates the overall interpretation of the numerous dates, a coherent model is offered in the detailed chronological discussion of J. Rola (Rola 2009, 153-154; 224-225). Due to the radiometric dates, the occupation period of Żuławka Mała 1 extends from 3215±111 – 2367±98 BCE and the beginning of the occupation is linked with the classical phase of the GAC (IIb/IIIa). The dating of the planked trackway (Fig. 94) can be fixed dendrochronologically from 2490±10 den BCE to 2448 den BCE (Fig. 95),[30] whereas the dendrochronological date of the settlement is from 2540-2448 BCE, starting about 50 years earlier. The earlier radiometric dates are considered to be legacies of

30 Cf. Krapiec (2009, 119): '[…] so the dyke was created around 2490 and functioned for another 40-50 years until around 2440 BC'.

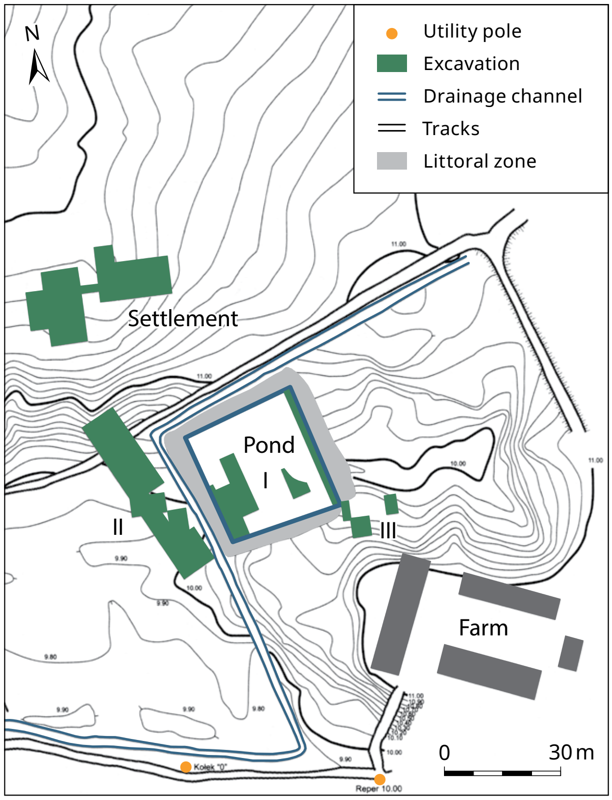


Figure 93. The site of Żuławka Mała 1 (after Rola 2009, 33, fig. 7).

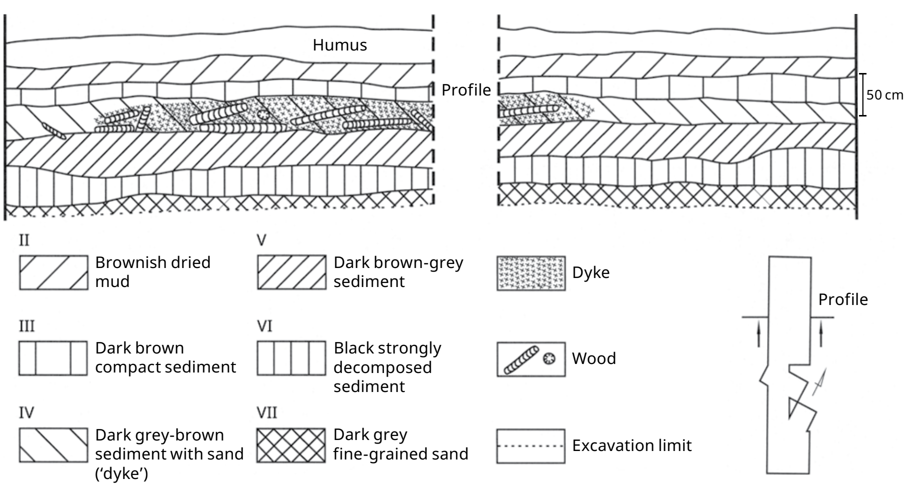


Figure 94. The profile of the planked trackway at Żuławka Mała 1 (after Rola 2009, 83, fig. 40).

older settlement activities. A typochronological classification leads to the assignment of the older settlement remains to phase IIb, all other legacies to phase IIb/IIIa with the exception of the late settlement dates, which should correspond typologically to phase IIIb/IIIc (Fig. 96).

Twenty-one conventional and two AMS dates are available for GAC contexts, of which five belong to the southwestern settlement, three to the northern settlement, one to the lake area and fourteen to the embankment or the planked trackway and the phase of use of the embankment (five dates from the posts, four dates from the fascine[31] and five dates from the fill material).

31 The term 'fascine', used by Rola (2009), has a different meaning from the normally used definition. It does not signify a vertical, braided wooden fixture, but horizontal layers of small horizontal pieces of wood. Posts/piles were then driven into these.

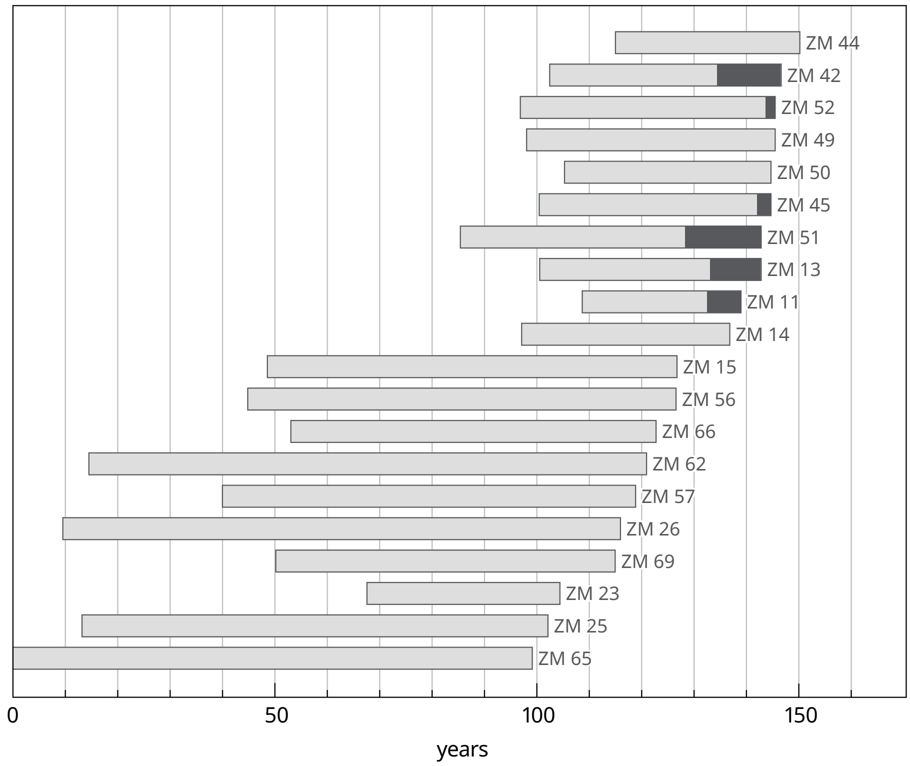


Figure 95. The dendrochronological dating of the planked trackway around 2490±10 den BCE to 2448 den BCE (after Rola 2009, 117, fig. 62). Timber posts with sapwood are marked in dark grey.

With the available data, we performed a new Bayesian analysis of the radiometric dates. The following was considered:

- The four excavation areas are understood as separate units, so that there is the possibility, *e.g.*, to consider the settlement of the northern terrace and the southeast terrace independently of each other and to relate them to the embankment with the planked trackway.
- In the case of the embankment and the planked trackway, the contexts of the posts, fascine and the fill material are differentiated. Stratigraphically, for the GAC, a distinction is made between layer IV with the GAC construction of the planked trackway and layer V with GAC and Later TRB ceramics beneath the planked trackway (Fig. 94). The radiometric data from the posts and the fascine belongs to layer IV. For the data of the fill material, a differentiation of the affiliation to layer IV or layer V could not be made due to the documentation (with the exception of data of the profile). The ceramics from layer IV belong to GAC phase IIIa.

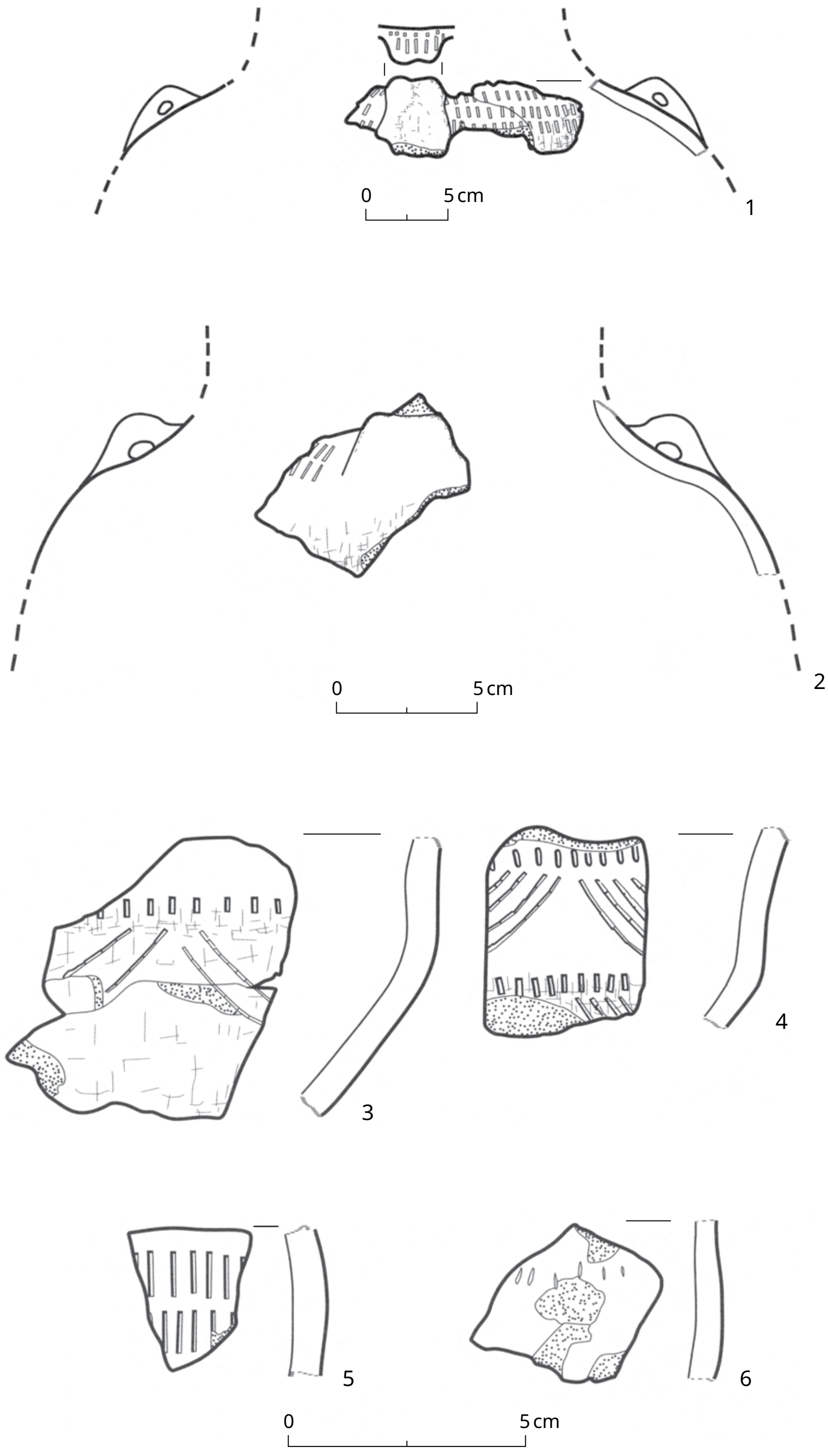


Figure 96. Examples of GA pottery from Żuławka Mała 1 (after Rola 2009, 101, fig. 55).

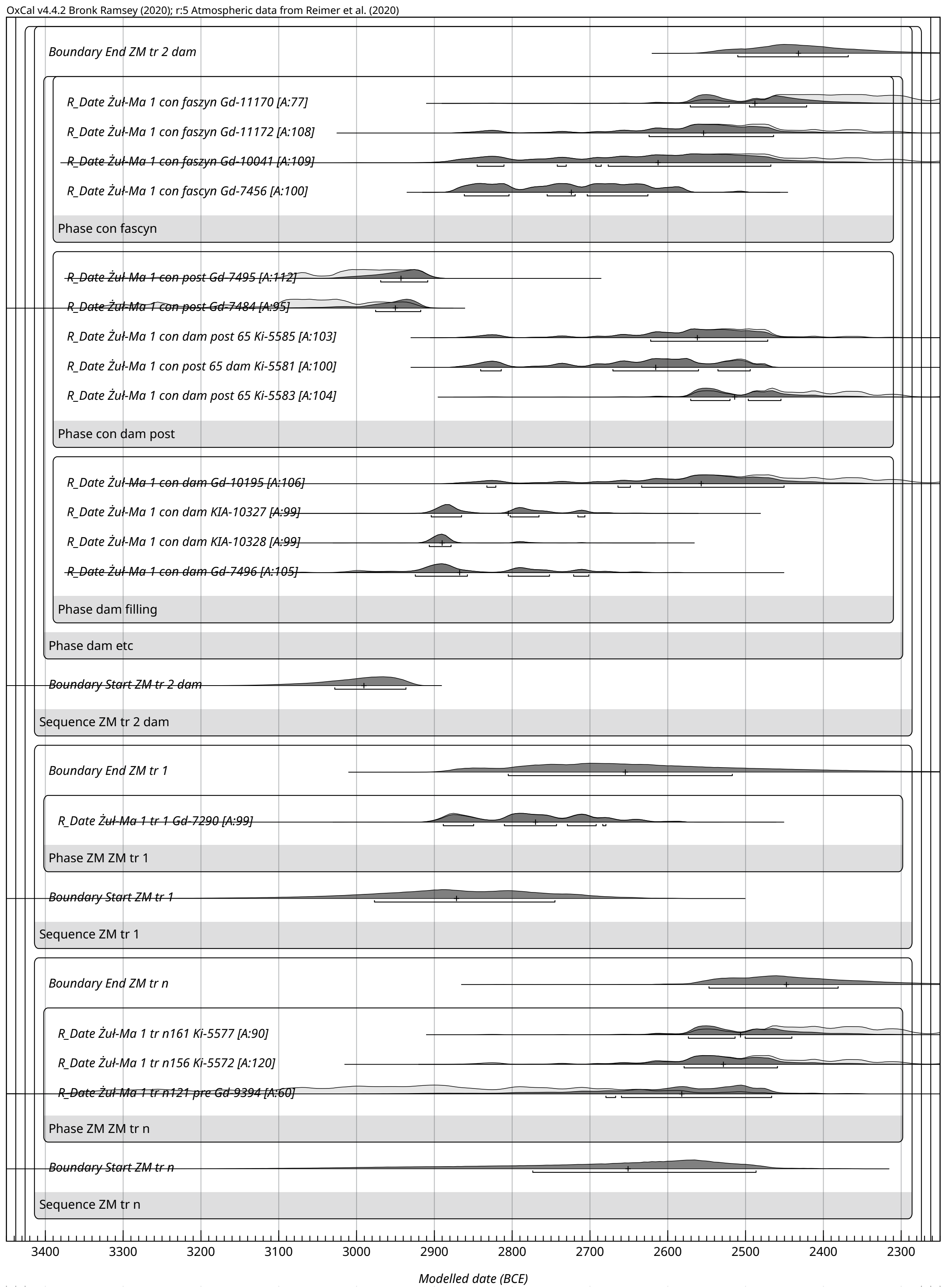


Figure 97. The Bayesian calibrations of Żuławka Mała 1 (cf. Suppl. 10).

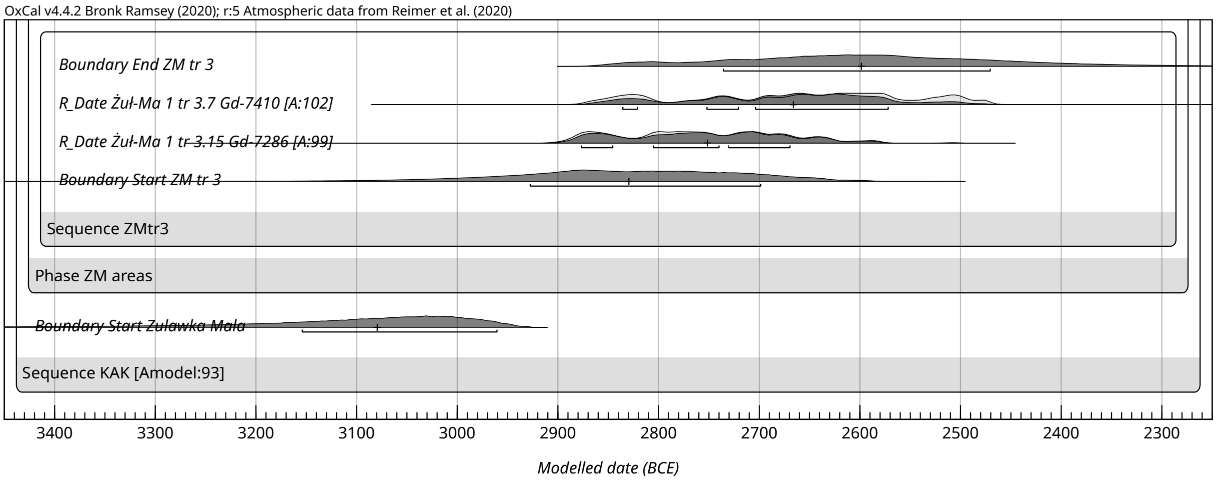


Figure 97. continued.

	Cal BCE			den BCE
		Without Gd-7416, Gd-3687, Gd-6989, Ki-5582. Indices 93.1; 93.1		
Total duration	3150-2310	3080-2320		
Southwest settlement (Area 3)	2940-2880	2830-2600		
North settlement	2660-2450	2650-2450		
Lake (Area 1)	2880-2650	2870-2660		
Embankment /planked trackway (Area 2)	3040-2430	2990-2430		
Fill material			3000-2850	
Fascine			2850-2530	
Posts			2530-2460	**2490-2448**

Table 5. Overview of the dating results for Żuławka Mała 1.

From a corresponding calibration (Fig. 97), the values in Table 5 result.

During the calibration, the layers from area 3 were first sequentially calibrated according to their layer affiliation (to layers 15, 9 and 7). Apart from the fact that the differences of the data within layers 15 and 7 are very high, there were only poor agreements. Accordingly, the data Gd-7416, Gd-3687 and Gd-6989 were removed. They obviously represent artefacts from older deposits that were secondarily mixed. The same applies to the embankment filling for the date Ki-5582.

The resulting calculations lead to a result with good agreement. The planked trackway was apparently built and maintained around 2990-2430 BCE. The values for the posts, the fascine as well as the fill material are comparable in this range. The total occupation is likely to have spanned a period from 3080-2320 BCE.

Maintenance and renewal work on the embankment, the planked trackway and the fascine also apparently occurred over several centuries (fill: 2910-2780 BCE, posts of the planked trackway: 3000-2480 BCE, fascine: 2680-2480 BCE). However, the taphonomic processes and the assignment of the radiometric dates to respective contexts are difficult for some samples, especially because there is a contradiction with the dendrochronological dating in one case (post 191, Gd-7495 to dendro-sample Z31, cf. Rola 2009, 142). Post 131 also dates early (Gd-7484). If we consider both to be the parts of an older construction, which can be dated to the embankment for the planked trackway and if a younger backfill date belongs to the fascine construction (Gd-10195), then the following stratigraphic sequence results: dam filling and first

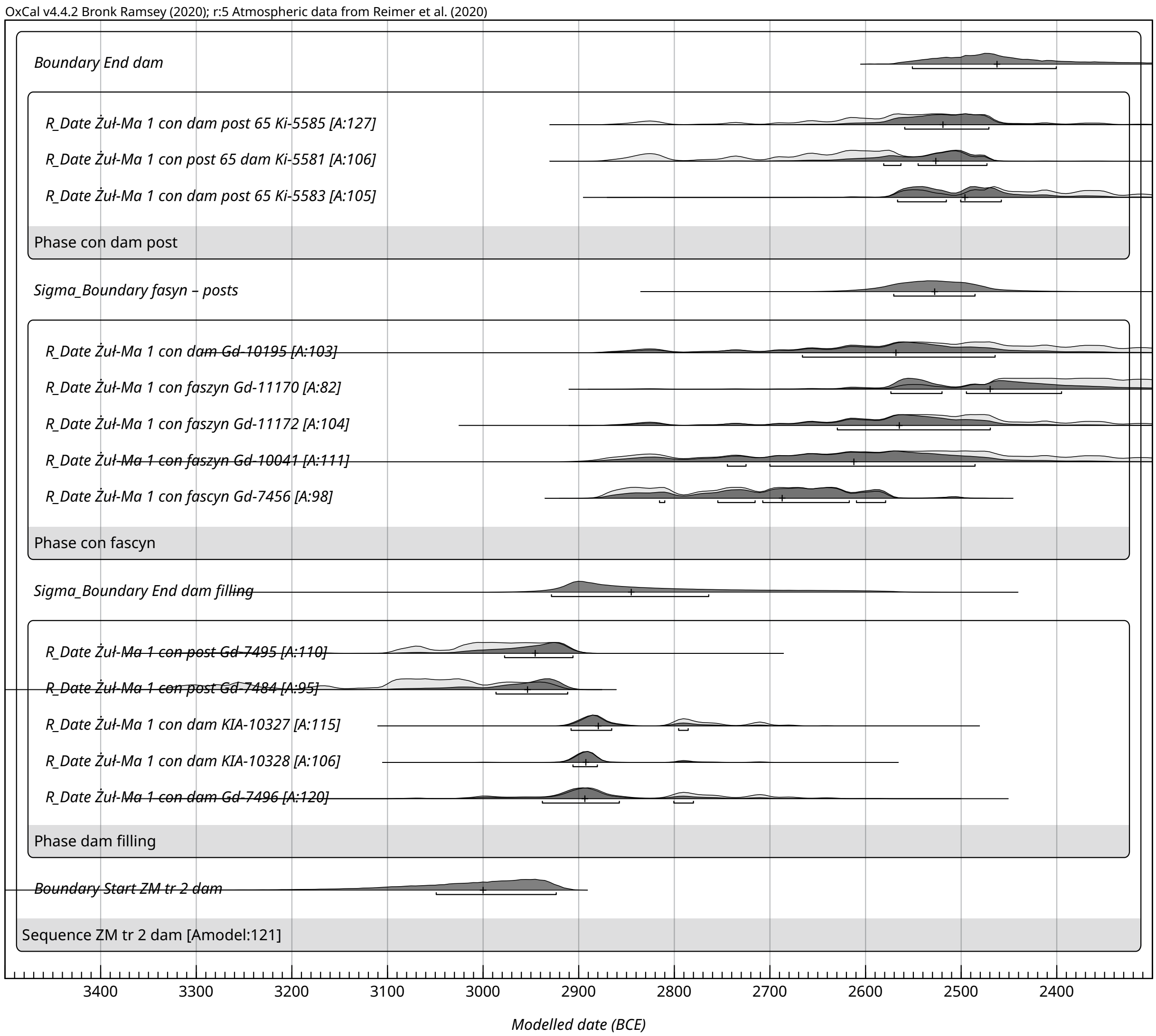


Figure 98. The Bayesian calibrations of the Żuławka Mała 1 trackway according to the stratigraphic sequence (cf. Suppl. 10).

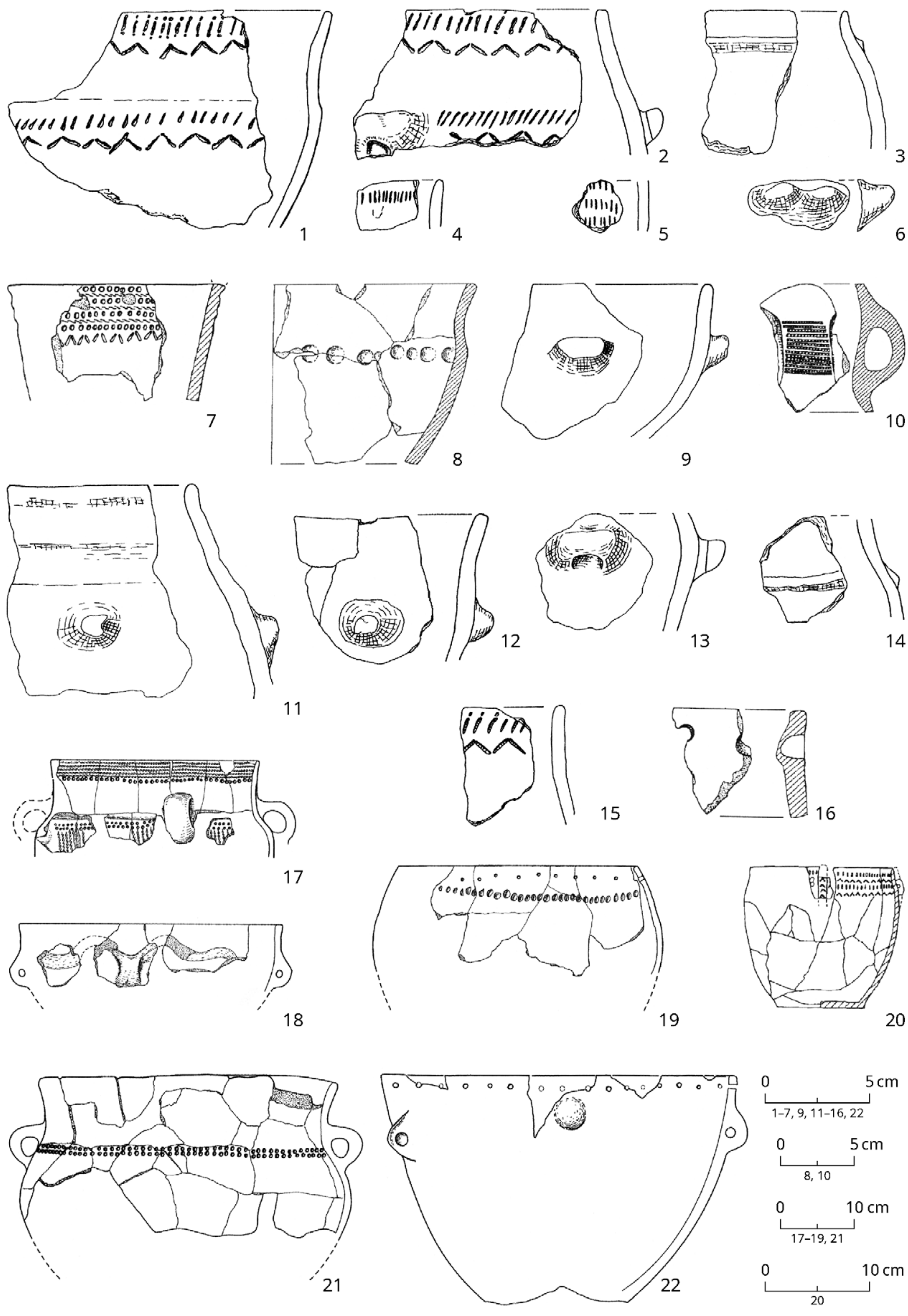
Figure 99 (following page). Ceramic examples of the Kuyavian phases I and IIa, which are referred to as Early GAC in the literature, but do not exhibit the globular amphora vessel type: 1-9, 11-15 – Krusza Zamkowa 3 (feature 65); 10 and 16-22 – Deby 29 (feature 32) (after Szmyt 2001, 45, fig. 5; Szmyt 2013, 52-53, fig. 1.16-17).

construction, fascine construction with further filling and finally the posts of the youngest planked trackway (Fig. 98). The time intervals for the fill material with older post settings are ca. 3000-2850 BCE, for the fascine construction that supports the planked trackway ca. 2850-2530 BCE and for the younger posts of the planked trackway ca. 2530-2460 BCE, where the even younger wane of other posts of the dendrochronolgical sequence was not recorded via radiometric dates. Based on the typological differentiation by Rola, IIb would extend to ca. 2850 BCE, IIb/IIIa to 2460 BCE and to 2448 den BCE, respectively (Rola 2009, 154).

The new results can indicate that a planked trackway was actually used here over a number of centuries and not only maintained and renewed for a very short time. Accordingly, we can assume a route system that was used for a longer period of time.

3.3.2.1.1.2 Summary

Including the other two dates from Chodzież 3 und Straduń 17, the duration of the GAC in the Middle Notec river drainage ranges from ca. 3080-2480 BCE, although a differentiation between IIb and IIIa is currently difficult.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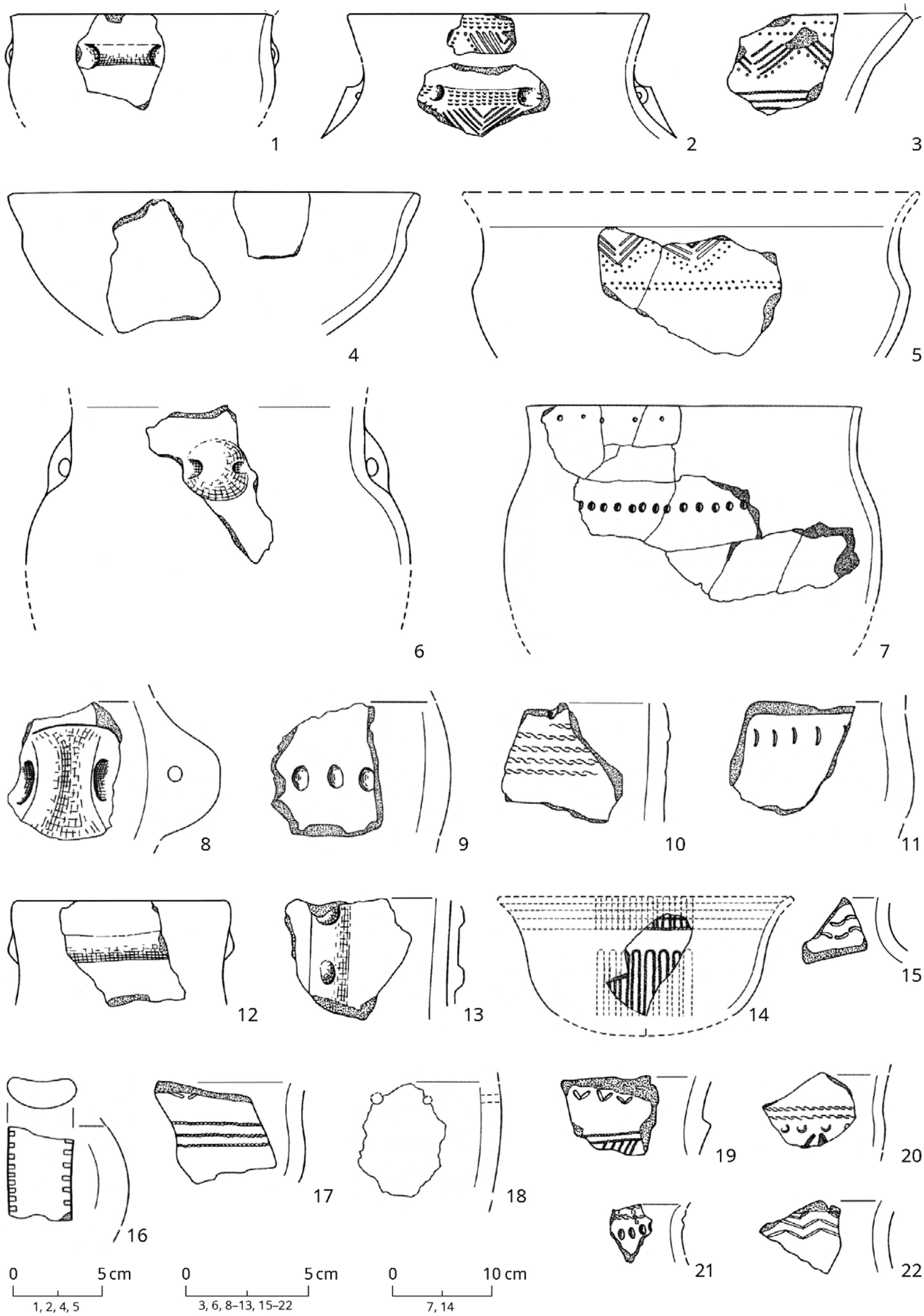
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3.3.2.1.2 Kuyavia

Intensive studies are available on the entire Central GAC, particularly on the division in different phases – above all based on settlement findings at Kuyavia (Szmyt 1996; 2013). For the supra-regional comparison of radiometric dates intended here, differences in the classification between, for example, the Kuyavian and the Central German terminology, must be mentioned. Globular amphora inventories in a classic sense, *i.e.*, those with globular amphorae, are, for example, only available from phases IIb and IIIa onwards (Szymt 2001, 26). Thus, the so-called middle phase of Kuyavian globular amphorae, for instance, can be compared with Western Globular Amphora groups, in which solely the presence of globular amphorae is typologically defined. The Kuyavian phases I and IIa, which are referred to as Early GAC in the literature, are less comparable: here, inventories are considered that do not exhibit the globular amphora vessel type (Fig. 99).

Moreover, only one date for Kuyavia phase I and two dates for Kuyavia phase II are available until now (Szmyt 1999a, 72). The date for phase I originates from Krusza Zamkowa 13 (Gd-309, charcoal) and is not recognised due to another younger bone date of the same finding (Szmyt 1999a, 73-74). For this charcoal date, an old wood effect is considered and a direct association with a find inventory is not possible. The younger date (GrN-14022) concerns human bones from an individual C, which is assigned to phase IIb/IIIa based on accompanying finds (Szmyt 2001, 26).

For phase IIa, a date from Deby 29/32 (Gd-2148, charcoal; cf. Szmyt 1996, 16 fig. 4; Szmyt 2001, 45 fig. 5) is available, but it is assumed to be subject to an old wood effect. It comes from a rectangular longitudinal pit, whereby the find inventory does not contain any globular amphorae and its ceramics are comparable to TRB IVA ceramics, which were found very close by (Szymt 2001, 26 and 45 fig. 5). Another date from Koluda Wielka 13/3 (GrN-13593, animal bones; cf. Szmyt 1996, 40 fig. 20 and Szmyt 1996, 132 fig. 54; Szymt 2001, 46 fig. 6) is from a sample from a pit complex. The published inventory illustrations do not include any globular amphorae. Since both sites do not exhibit any globular amphorae in the true sense, they are not necessarily to be understood as an indication of the GAC. In addition, a relatively early charcoal date from Kowal 14/374 (Poz-21969; cf. Osipowicz *et al.* 2014 a, 123, tab. 7) is associated with ceramics that do not correspond to classical Globular Amphora ceramics, but rather resembles TRB amphorae (Bokiniec and Kurzyk 2014, 83-85 fig. 35,4).[32]

In the classic Kuyavian GAC, the inventories of the phases IIb and IIIa can hardly be distinguished, so that that they are combined here in a block (Fig. 100). The oldest values originate from a cattle burial without grave goods from Kuczkowo 1/C2, where the combined four dates together (except for one outlier) provide a dating of ca. 3260-3090 BCE.[33] Kuczkowo is one of the sites where, due to the amount of radiometric data, it makes sense to consider them individually.

3.3.2.1.2.1 Kuczkowo 1

With animal deposits, a human burial and various pits and postholes, Kuczkowo appears to have been a ritual site, such as those that we have observed at Buchow-Karpzow, Zachow or Falkenwalde (Szmyt 2000a; Makowiecki and Makowiecki 2000) (Fig. 101a, b). From the site Kuczkowo 1, 14 usable conventional radiometric dates from animal bones are available, and one more from Kuczkowo 5 (Suppl. 9).

32 In comparison to the other dates from the site, the date is ca. 300 years older than the others, which also suggests an old wood effect.

33 From Wilkostowo 23/24, Globular Amphorae ceramics are available as an admixture to TRB contexts. The typological analysis leads Seweryn Rzepecki to suggest an assignment to ceramic phase IIb (Rzepecki 2015, 245). Two associated ^{14}C dates (context 26, animal bones: Poz-48003, 4800±35 bp; context 290, animal bones: Poz-48009, 4775±30) date from ca. 3550-3390 BCE (Rzepecki 2015, 260-282 Table 8.1; fig. 8.24-25). They are related to the TRB ceramics in the findings.

Figure 100 (previous page). Ceramic examples of the Kuyavian phases IIb/IIIa: 1-6, 12-13, 15, 17, 19 – Polanowice 3 (feature 108); 7-11, 14, 16, 18, 20-22 – Deby 29 (feature 5) (Szymt 2013, 54-55, fig. 1.18-19).

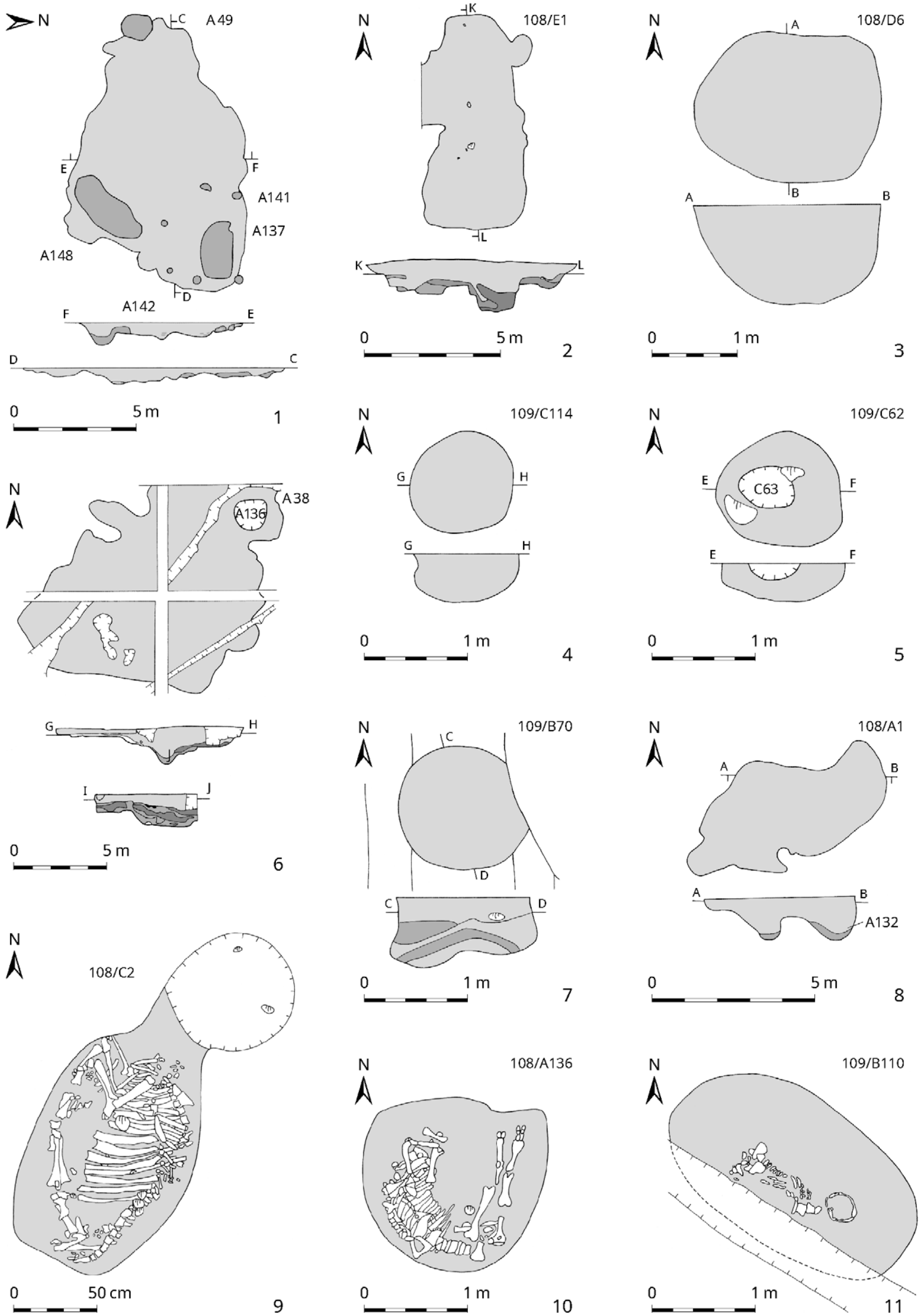

Figure 101a. Kuczkowo 1. Contexts and ceramic assemblages (after Szymt 2000, 183-184, fig. 11-13; 223, fig. 46-51).

Figure 101b. Kuczkowo 1. Contexts and ceramic assemblages continued (after Szymt 2000, 183-184, fig. 11-13; 223, fig. 46-51).

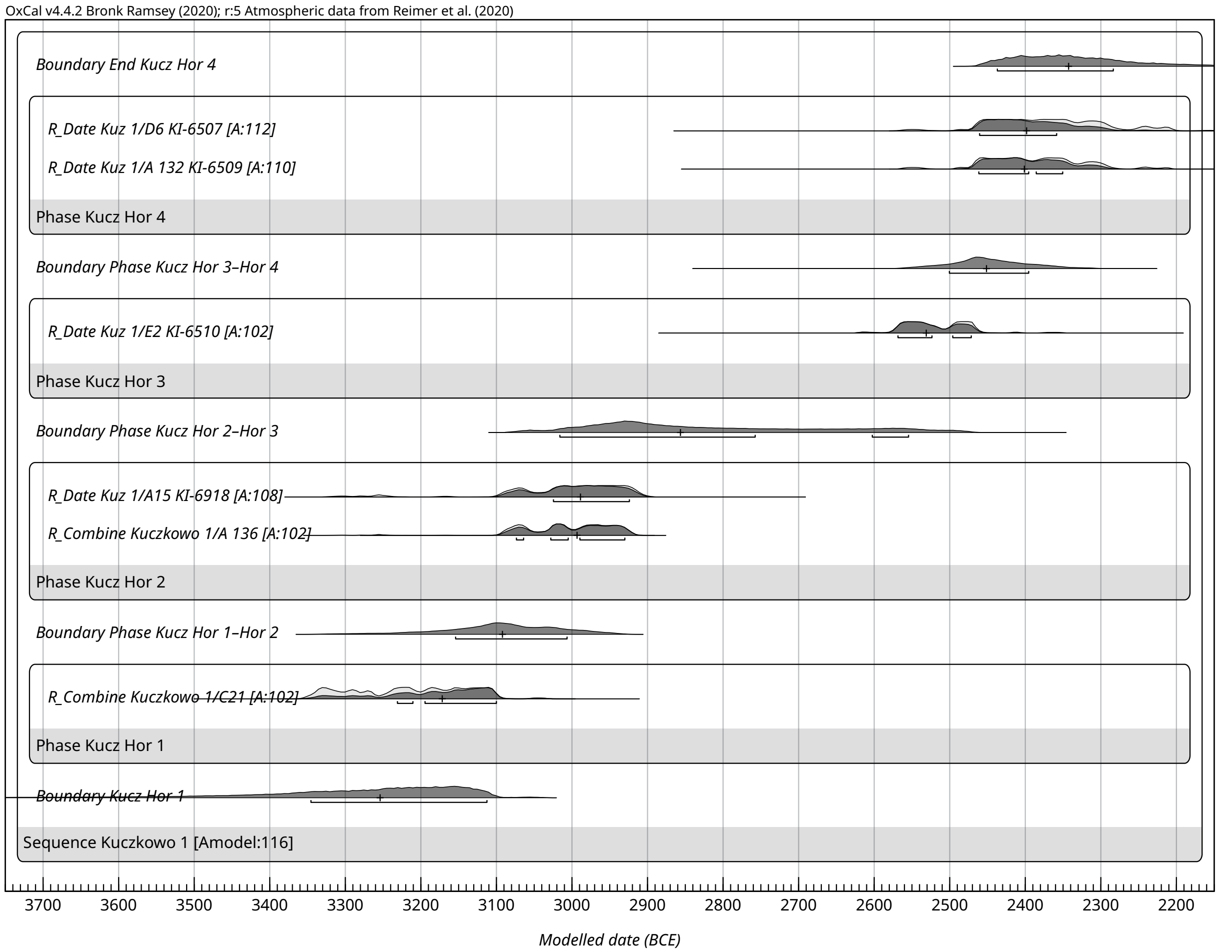

Figure 102. The Bayesian calibrations of Kuczkowo 1 (cf. Suppl. 10).

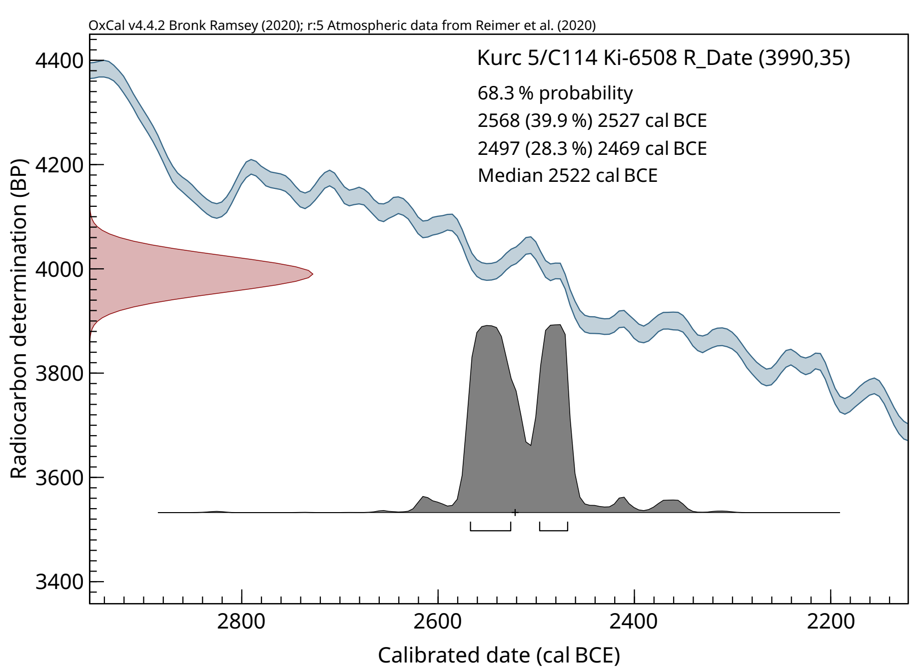

Figure 103. The radiometric dating of Kuczkowo 5, pit C114 (cf. Suppl. 10).

In Kuczkowo 1, M. Szmyt distinguishes 4 phases (cf. Szmyt 2000a, 289, Tab. 29):

1. The oldest GAC-horizon is attested by a single animal deposition. The bovine deposited in context C2 of Kuczkowo 1 (Szmyt 2000a, 175-176 and fig. 11,1) '*did not have any related vessels or other intact artefacts, only few pottery sherds (7 very small fragments of Late TRB, 1 sherd of the GAC and 1 fragment of the Pomeranian society, dated to the Early Iron Age). Its hypothetical association with the GAC is based on the 14C date*' (the calcite for incrustation is also a GAC variable), but the animal deposition could also belong to the Late TRB.[34]
2. Kuczkowo horizon 2 is verified by radiometric dates from the cattle deposition A136 (Szmyt 2000a, 182-183, fig. 11 below and fig. 10,3) and an unclassified pit A15. It can be typologically assigned to GAC phases IIb-IIIa. The animal deposition A136 intersects an elongated feature A 38, which can possibly be interpreted as a residential structure (Syzmt 2000a, 182, fig. 10,3).
3. Kuczkowo horizon 3 is represented by pit E2 and can be typologically assigned to phase IIIa/IIIb.
4. A possible Kuczkowo horizon 4 is represented by the animal deposit of an ovicaprid A132 (Szmyt 2000a, 182, fig. 10,1) and pit D6, which can be assigned to phase IIIb.

The sequential calibration of the data enables detailed absolute chronological propositions (Fig. 102). The oldest animal deposition (Kuczkowo phase I) dates to ca. 3260-3090 BCE, the animal deposition and pit of GAC phase IIb-IIIa (Kuczkowo phase 2) to ca. 3090-2860 BCE, the pit E2 of phase IIIa/IIIb (Kuczkowo phase 3) to ca. 2860-2450 BCE, and the animal deposition and pit of phase IIIb (Kuczkowo phase 4) to ca. 2450-2350 BCE. The calculation is based on the assumption that there is no hiatus between the phases, what is not necessarily the case. When looking at the individual dates, Kuczkowo phase 1 would date from ca. 3340-3100 BCE, Kuczkowo phase 2 from ca. 3085-2930 BCE, Kuczkowo phase 3 from ca. 2570-2480 BCE und Kuczkowo phase 4 from ca. 2470-2360 BCE. As a consequence, a hiatus of ca. 250 years lies between phases 2 and 3. The young positioning of phase 4 is verified by a single date from Kuczkowo 5, pit C114 (ca. 2570-2470 BCE; Fig. 103).

Thus, in an overall view of Kuzczkowo, we find an animal burial without grave goods, which was deposited between 3260-3030 BCE, pits and animal burials of phase IIa/IIIb from ca. 3090 BCE until at least 2840 BCE, and phase IIIb until at least 2390 BCE. The fact that animal burials, which were buried before ca. 3100 BCE, did not contain any grave goods and, for example, analogous to the situation in Northeast Germany, cannot necessarily be associated with the GAC, proves that the first dates of the GAC in Kuczkowo 1 are only first from ca. 3090.[35]

Whether the GAC existed until ca. 2390 BCE remains open at this point. It should be emphasised that the early animal burial in Kuczkowo 1 can mostly be associated with TRB sherds (Szmyt 2000a, 175-176 and fig. 11:1). Thus, it can obviously be typologically assigned to the TRB. In principle, the current data from Kuczkowo 1, but also from other sites, provides the impression of a synchronous beginning of the GAC in an area between Kuyavia and the Middle Elbe-Saale region (see below). The core area of the data is concentrated in the period from ca. 3100-2600 BCE, which almost exactly corresponds to the dates of the Central German and Northeast German GAC groups. Apparently, globular amphorae exist longer in Kuyavia than in Central Germany.

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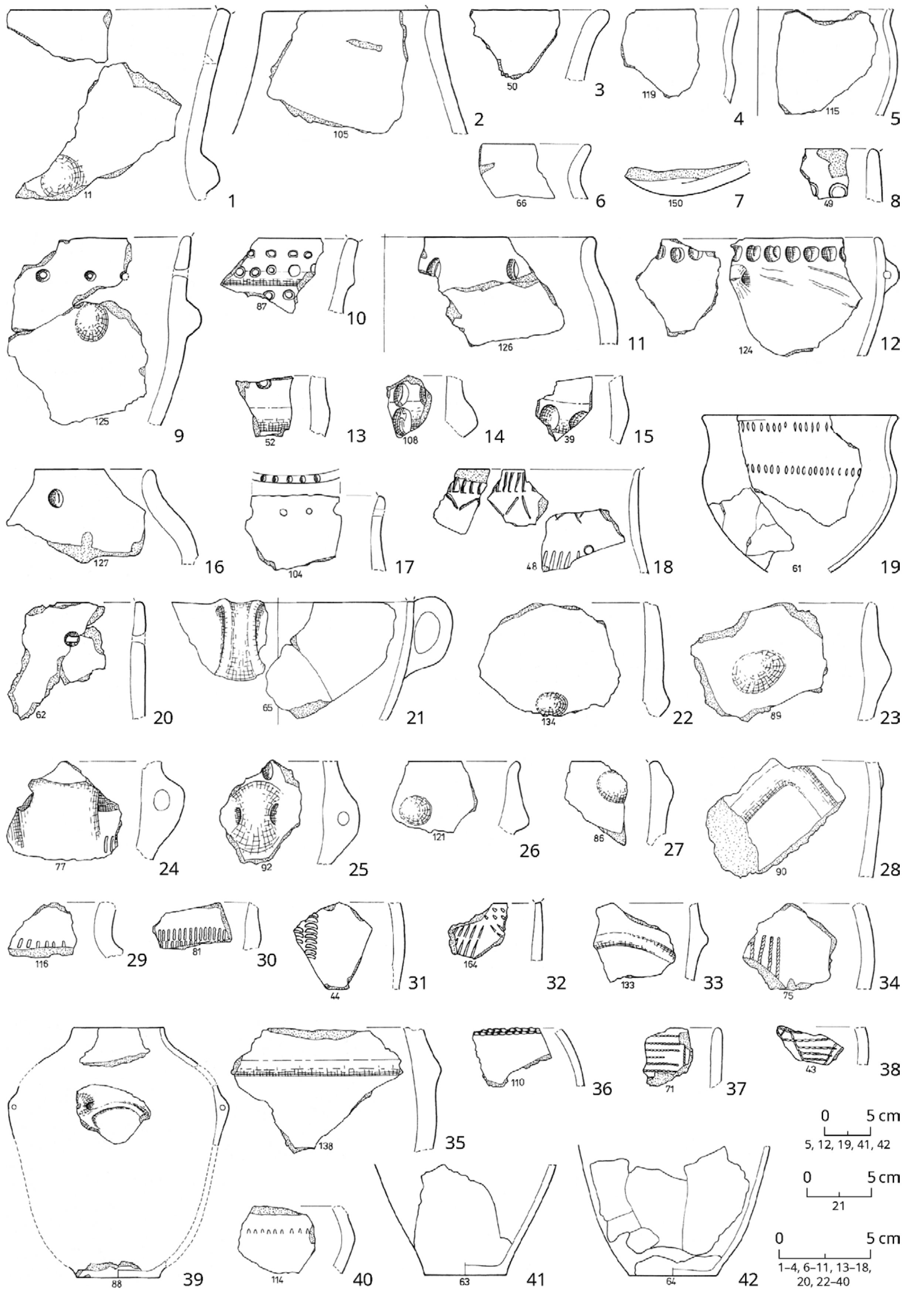
34 'It cannot be completely excluded […] that this feature is linked to the Radzijow group of the FBC' (Szmyt 2000, 176).

35 In general, globular amphorae are missing in Kuczkowo 1, at least in the observed ceramics (cf. Szmyt 2000a, 218-230 fig. 46-57; Szmyt 2001, 47 fig. 7).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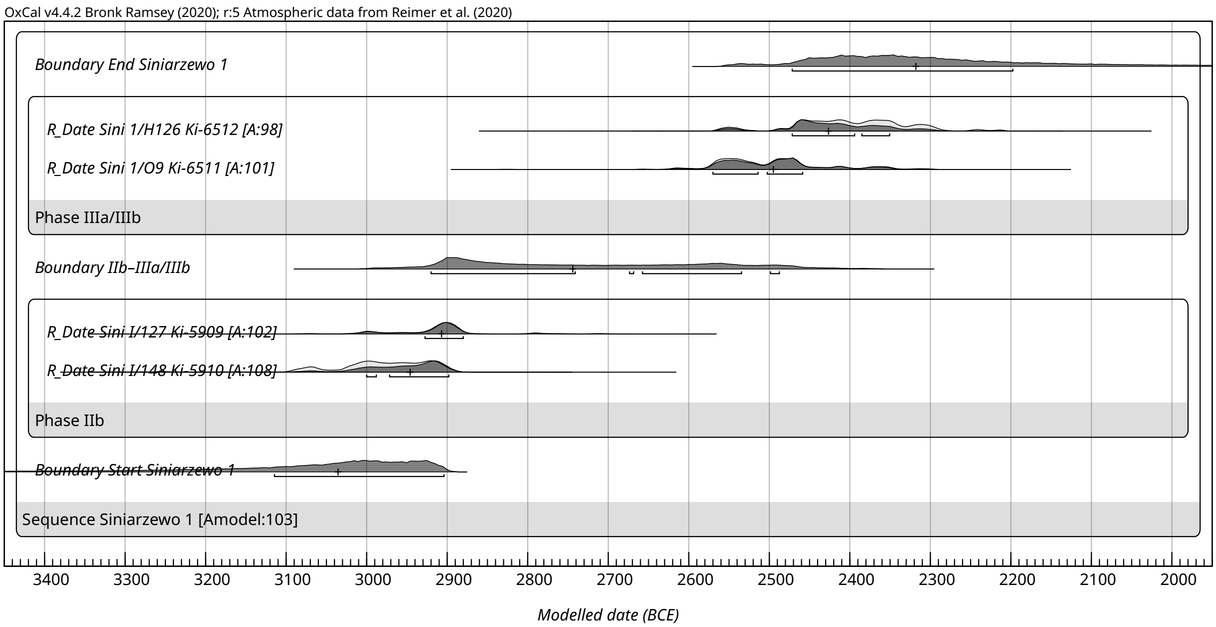


Figure 105. The Bayesian calibrations of Siniarzewo 1 (cf. Suppl. 10).

3.3.2.1.2.2 Siniarzewo 1 and Zegotki 2

Near Kuczkowo is the settlement site Siniarzewo 1, from which conventional radiometric dates of animal bones from three pits and one animal burial are available (Szmyt 2000a, 289-292). Typologically, the finds from the possible animal deposit I48 and the pit I127 correspond to phase IIb, whereas the pits 09 and H126 correspond to phase IIIa (Fig. 104). According to Bayesian calibration, the beginning of a first phase is calculated to IIb at ca. 3040 BCE and an end at ca. 2750 BCE. Phase 2 (IIIa/IIIb) extends therefore until ca. 2320 BCE (Fig. 105). However, the data pairs of the phases are so far apart that a hiatus also appears possible, what would result in ca. 2950-2910 BCE for phase 1 and 2500-2430 BCE for phase 2 (Fig. 106). From the site Zegotki 2, two dates for a cattle burial (Fig. 107) and a settlement pit are available, which both can be assigned to phase IIIa (Szmyt 2000a, 289-293). Bayesian calibration results in a value of ca. 2890-2450 BCE, with the actual dates tending to ca. 2720-2610 BCE (Fig. 108).

Figure 104 (left). The inventory of Siniarzewo 1 (GAC phase IIIa), selection of ceramics (after Szmyt 2000a, 289-292, fig. 58-59). Key: the small numbers indicate find numbers (cf. Szmyt 2000a, 250-253, tab. 8).

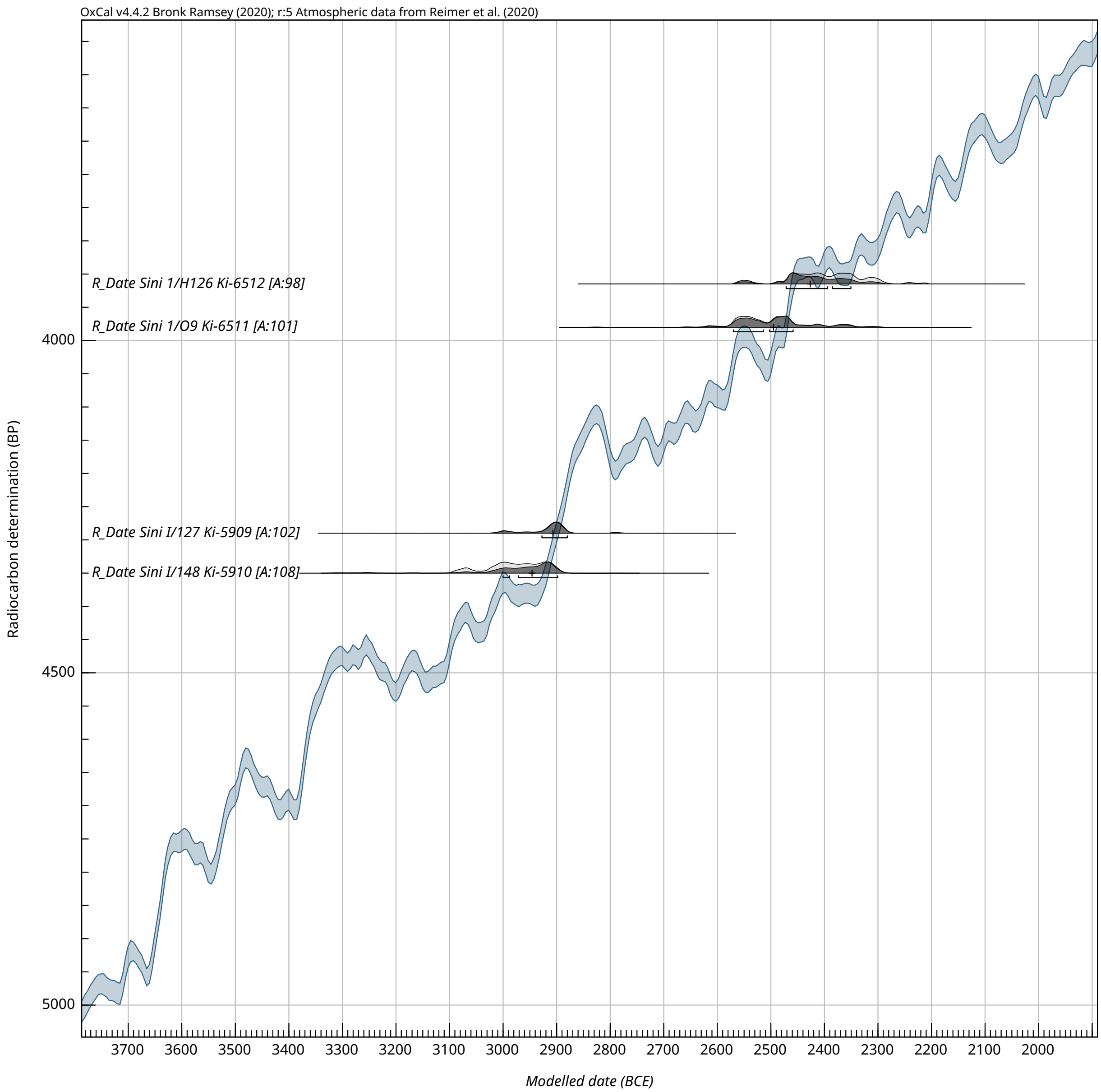


Figure 106. The display on the calibration curve of the Bayesian calibrations of Siniarzewo 1 makes a hiatus within the sequence probable (cf. Suppl. 10).

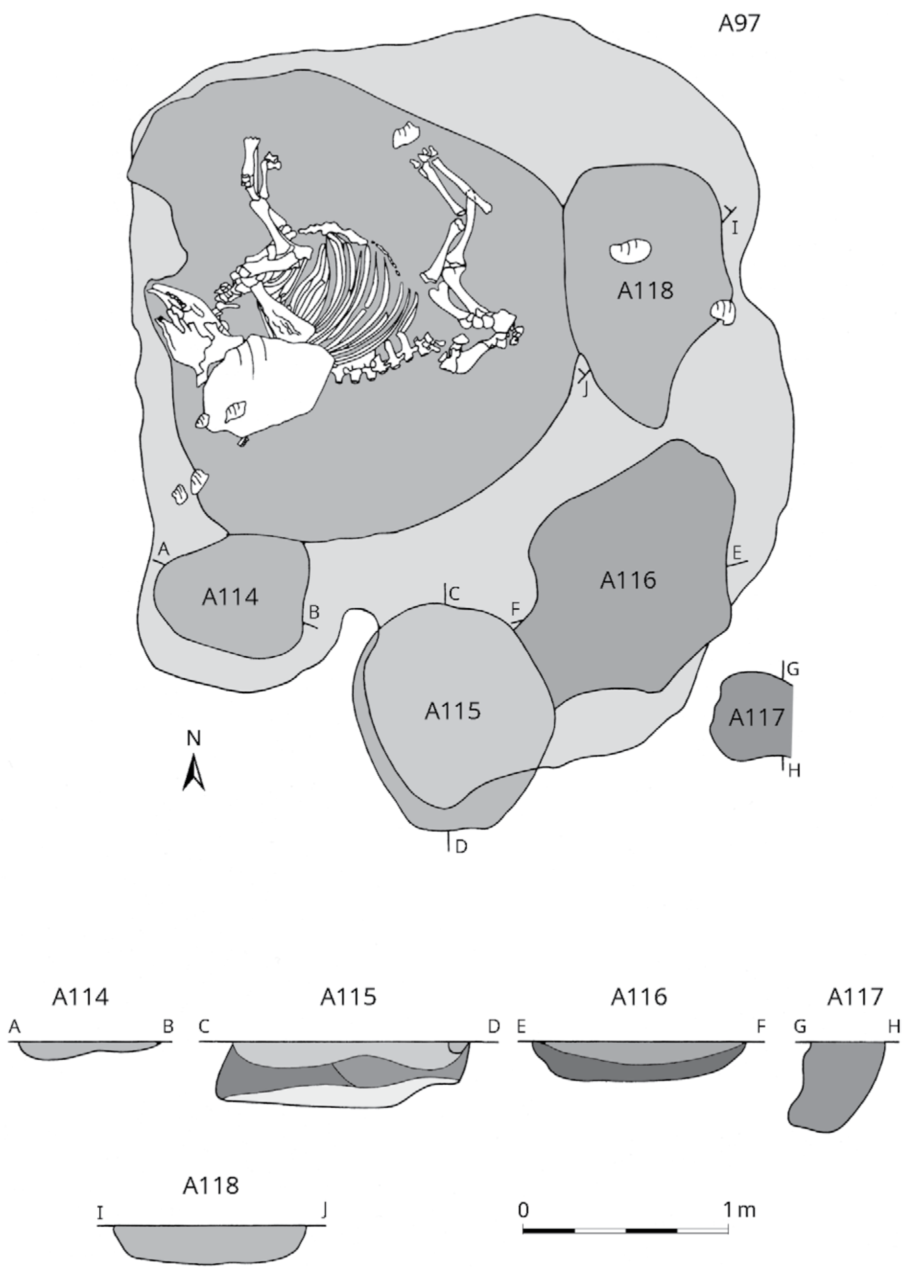


Figure 107. The cattle burial from Zegotki 2 (after Szmyt 2000a, 168, fig. 5).

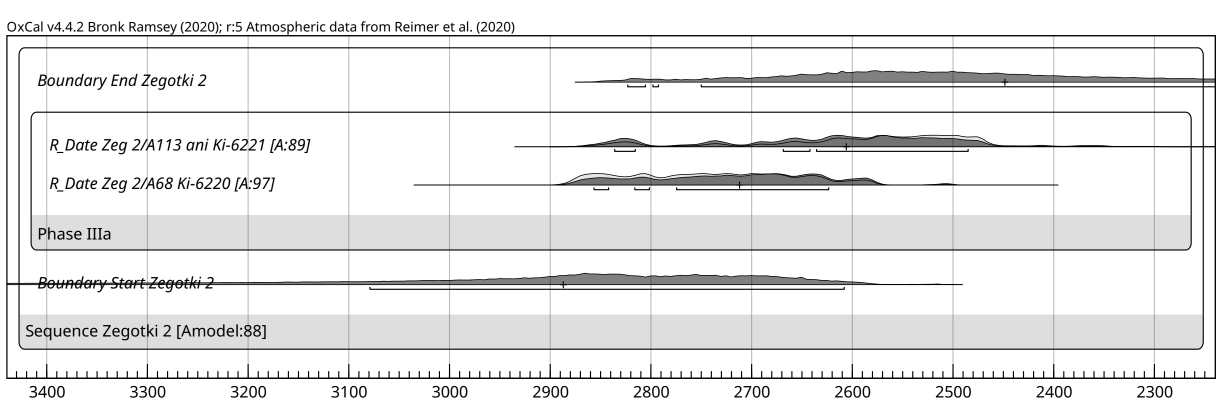


Figure 108. The Bayesian calibrations of Zegotki 2 (cf. Suppl. 10).

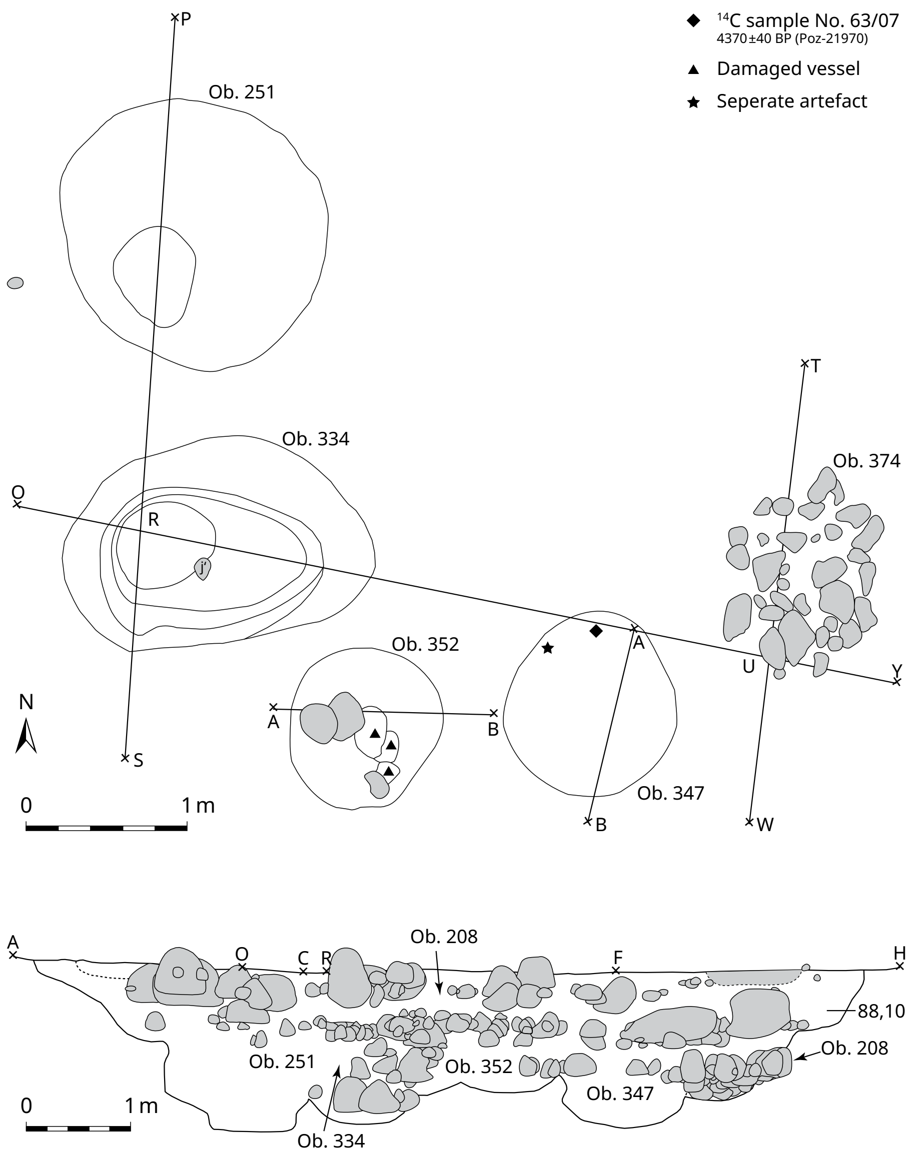


Figure 109. The sub-megalithic structure and pits from Kowal 14 (after Osipowicz 2014, 208. 57, fig. 19-20).

3.3.2.1.2.3 Kowal 14

In the context of rescue excavations for a gas pipeline, the site Kowal 14 with sub-megalithic structure 208, a single grave and an animal burial was found in Central Kuyavia and presented with typological and scientific analyses (Osipowicz 2014). Of the six AMS dates, two are from the sub-megalithic structure, two from the animal deposition and two from the earthen pit burial. The sub-megalithic structure 208 is a sequence of stone packing and ceramic deposits (Fig. 109). Stone packing 374 (Poz-21969), situated within feature 208 and stratigraphically beneath feature 347, displays a TRB amphora (Bokiniec and Kurzyk 2014, 84-85 fig. 35,4) (Fig. 110). Burial 347 (Poz-21970) is associated with ceramics, which are attributed to phases IIa/IIb (Osipowicz *et al.* 2014a, 122-123) (Fig. 111). Both dates are based on charcoal, so that an old wood effect cannot be ruled out. Irrespective of this, a sequence of ceramic depositions is obviously documented within the framework of repeatedly laid out stone packings.

Two radiocarbon dates (Poz-21911; Poz-21959) from the near cattle deposition 234 are associated with ceramics of phase IIb/IIIa (Osipowicz *et al.* 2014 a, 125). The charcoal date is from a burnt branch, so that an old wood effect can possibly be ruled out. From the earthen pit grave (Fig. 112), whose T-shaped belt pendant

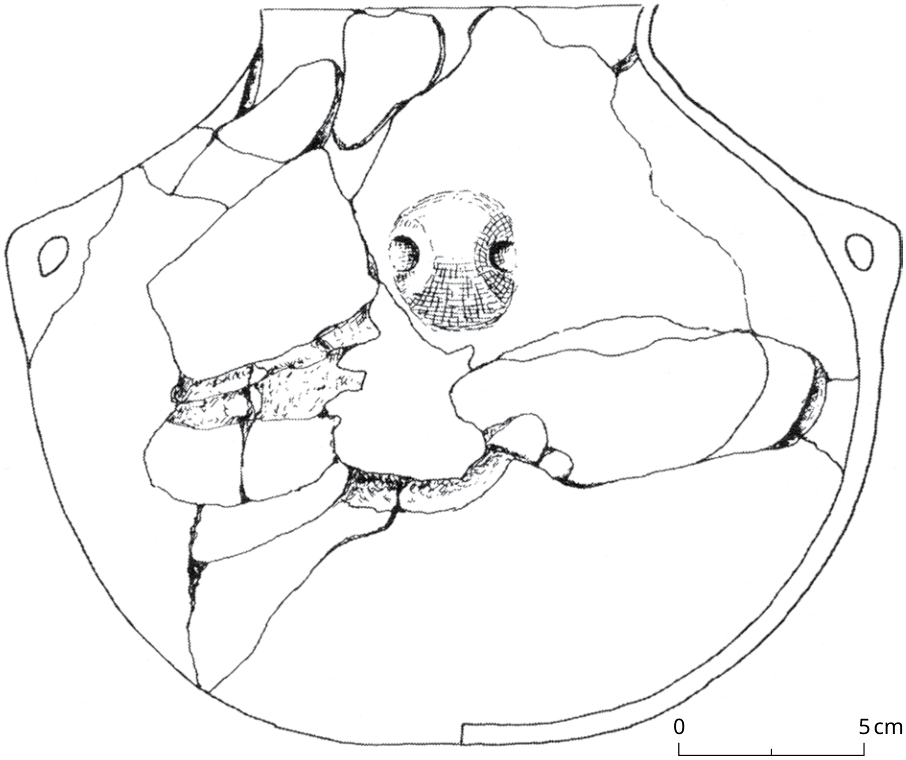


Figure 110. A TRB amphora from stone packing 374 at Kowal 14 (after Bokiniec and Kurzyk 2014, 84-85, fig. 35,4).

tends typologically more towards phase IIb/IIIa, dates from a human bone and an animal bone (pig) are available. Considering this data, an initial sequence of the sub-megalithic structure with first ritual practices, further actions on the sub-megalithic structure and the animal depositions, and finally the construction of the earthen pit grave should result (Fig. 113). If we do not exclude the older charcoal date, the beginning of sub-megalithic practices could be around ca. 3600 BCE, the beginning of phase IIb/IIIa around ca. 3200 BCE (until ca. 2860 BCE) and the end of IIIa at ca. 2530 BCE (Fig. 114). However, if we exclude the charcoal dates, phase IIb/IIIa begins locally at ca. 3050 BCE and lasts until ca. 2800 BCE, phase IIIa until ca. 2510 BCE (Fig. 115). All other calculated models did not lead to any significant results.

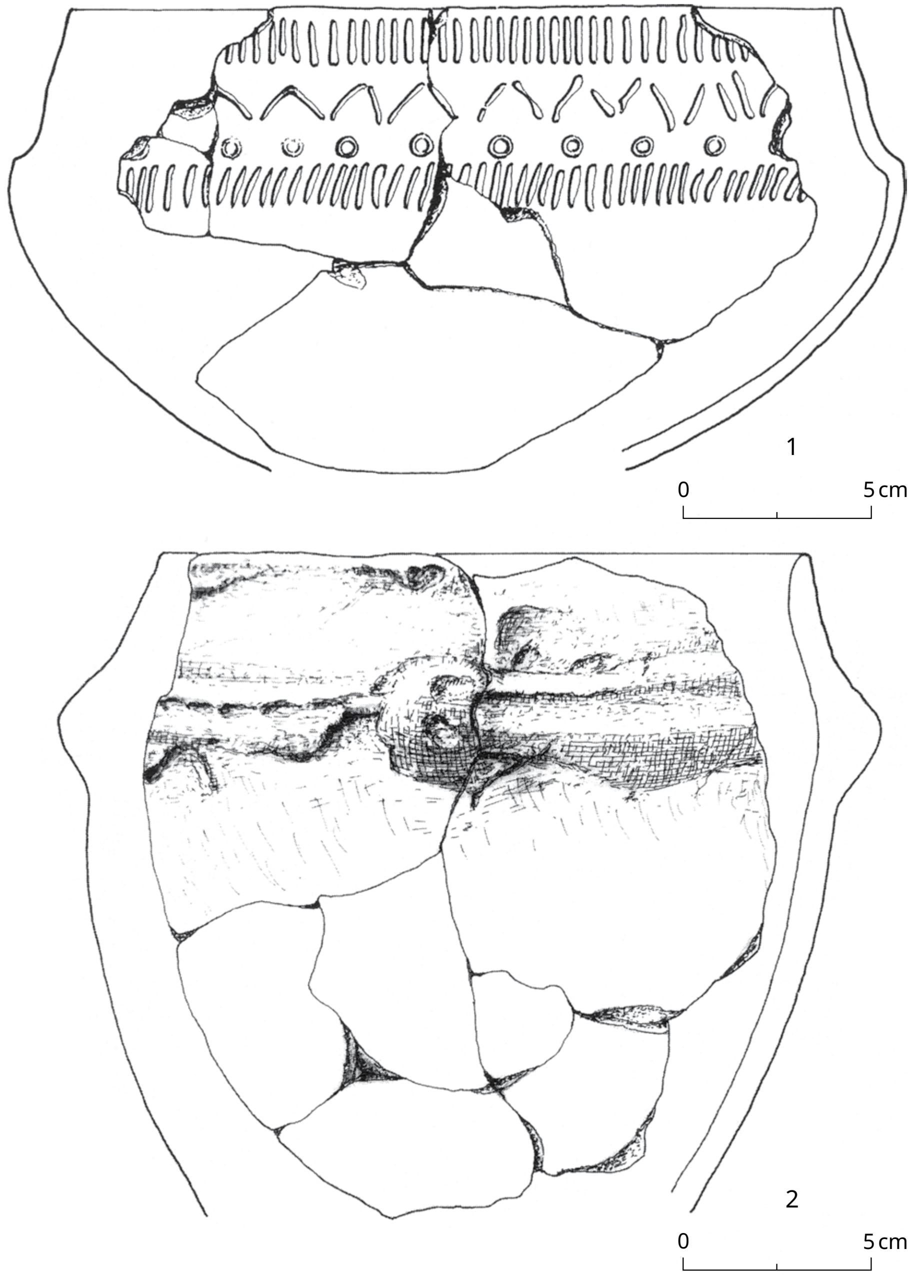


Figure 111. The ceramic assemblages associated with Kowal 14, burial 347, attributed to phases IIa/IIb (after Osipowicz et al. 2014a, 82, fig. 34).

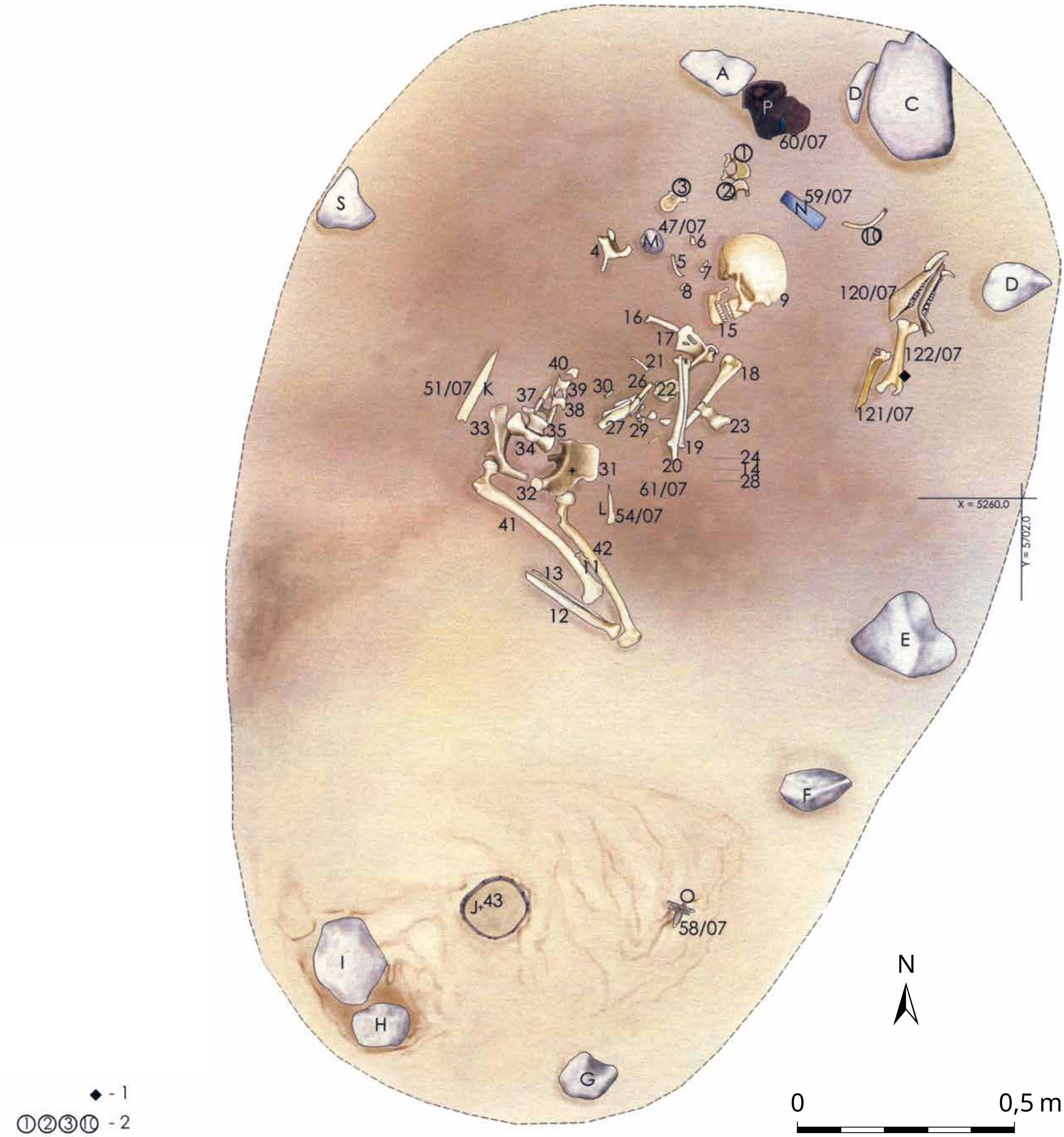


Figure 112. The Kowal 14 earthen pit grave 238. Key: 1 - ^{14}C sample Poz-21910; 2 - bones, mixed (after Osipowicz et al. 2014a, 62, fig. 24).

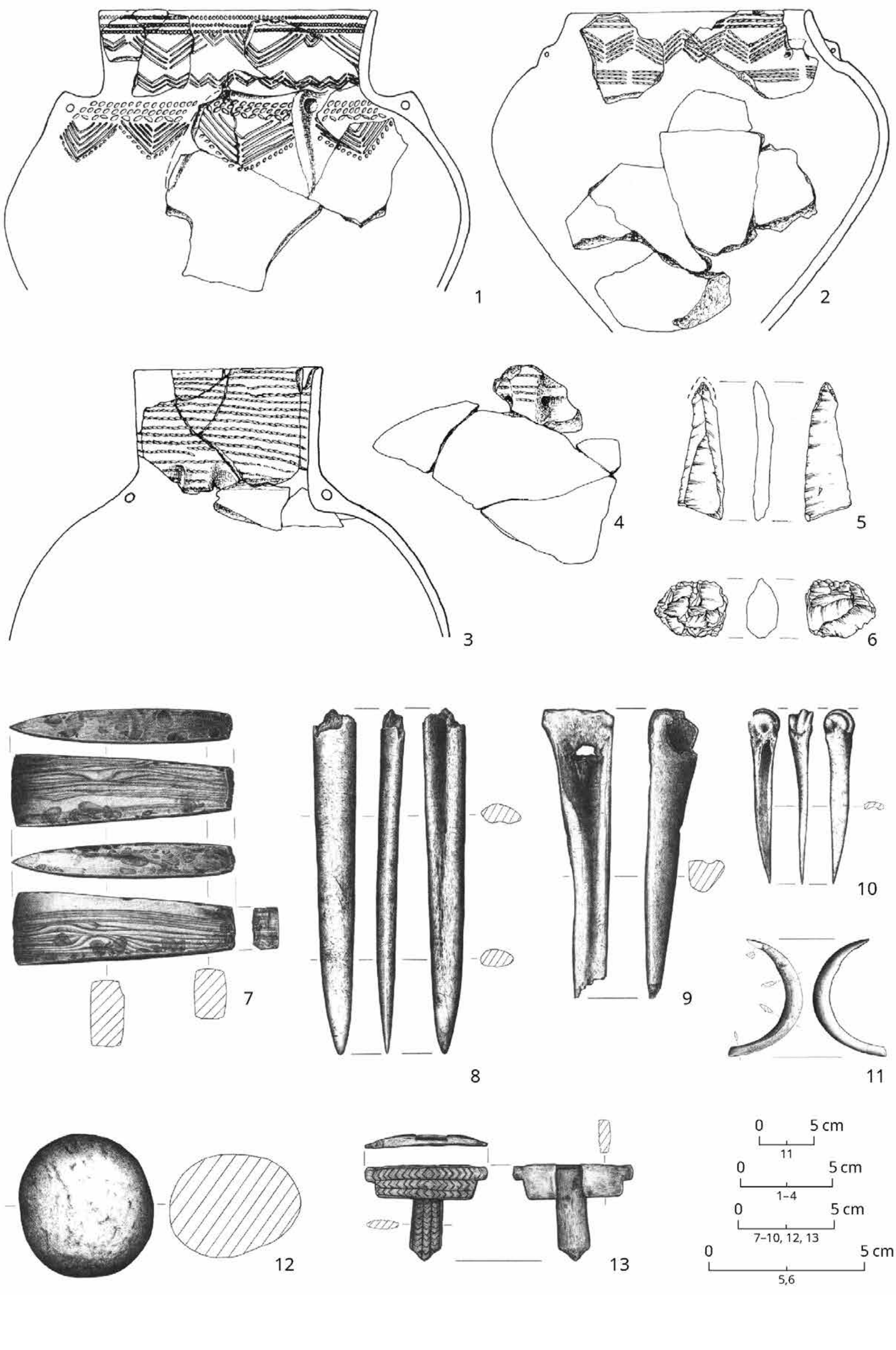


Figure 113. The inventory of Kowal 14 earthen pit grave 238 (after Osipowicz et al. 2014a, 88, fig. 37-39, 47, 49, 54, 58, 61, 63).

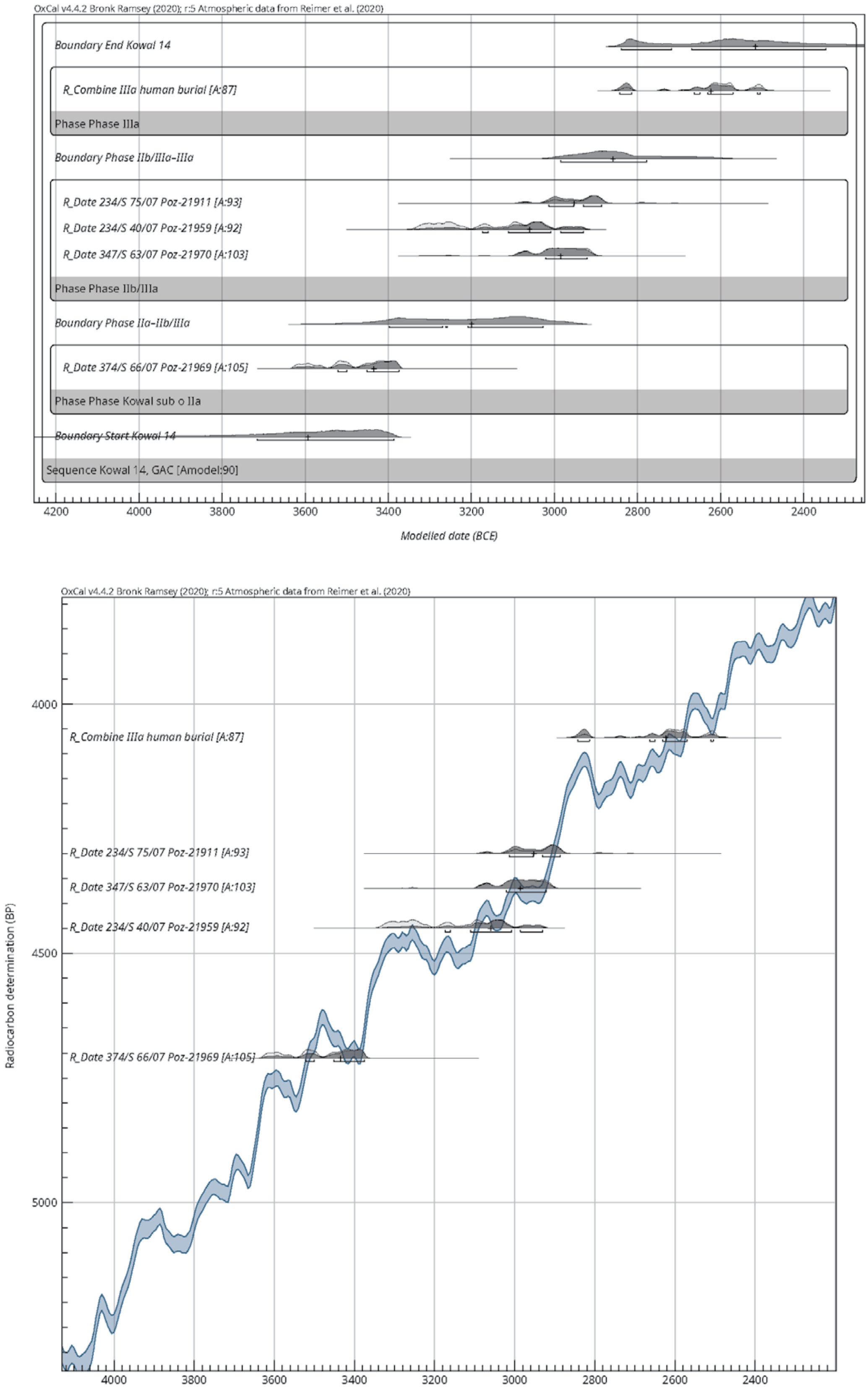
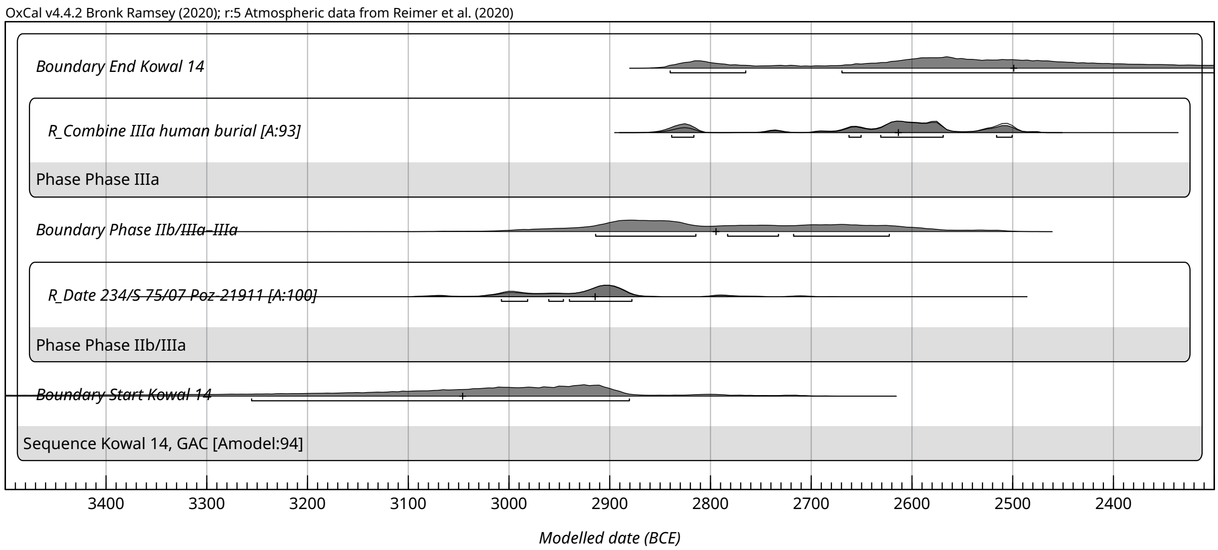
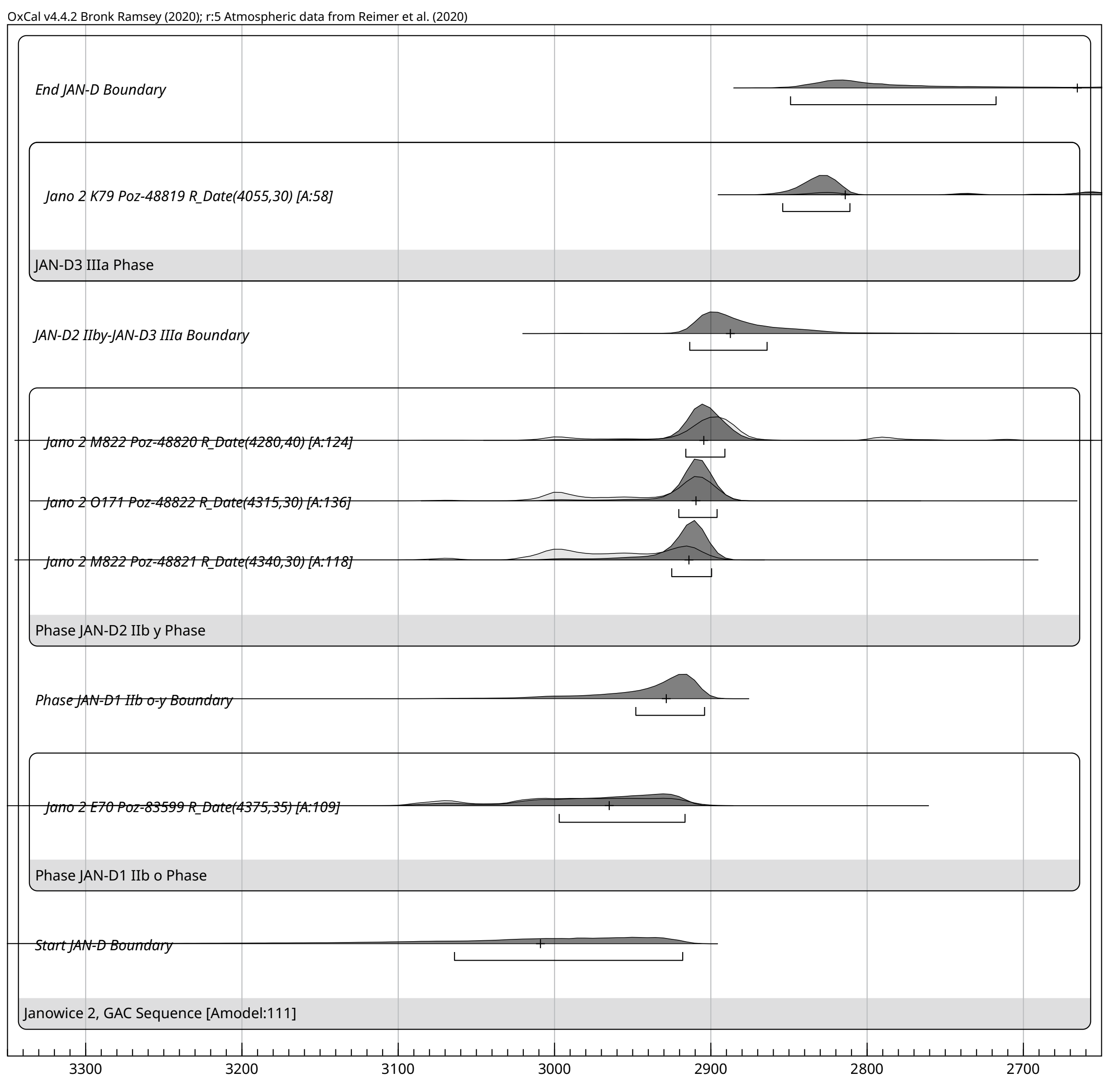


Figure 114. The Bayesian calibrations of Kowal 14, including charcoal dates (cf. Suppl. 10).


OxCal v4.4.2 Bronk Ramsey (2020); r:5 Atmospheric data from Reimer et al. (2020)
Boundary End Kowal 14
R_Combine IIIa human burial [A:93]
Phase Phase IIIa
Boundary Phase IIb/IIIa–IIIa
R_Date 234/S 75/07 Poz-21911 [A:100]
Phase Phase IIb/IIIa
Boundary Start Kowal 14
Sequence Kowal 14, GAC [Amodel:94]
3400
3300
3200
3100
3000
2900
2800
2700
2600
2500
2400
Modelled date (BCE)


OxCal v4.4.2 Bronk Ramsey (2020); r:5 Atmospheric data from Reimer et al. (2020)
End JAN-D Boundary
Jano 2 K79 Poz-48819 R_Date(4055,30) [A:58]
JAN-D3 IIIa Phase
JAN-D2 IIby-JAN-D3 IIIa Boundary
Jano 2 M822 Poz-48820 R_Date(4280,40) [A:124]
Jano 2 O171 Poz-48822 R_Date(4315,30) [A:136]
Jano 2 M822 Poz-48821 R_Date(4340,30) [A:118]
Phase JAN-D2 IIb y Phase
Phase JAN-D1 IIb o-y Boundary
Jano 2 E70 Poz-83599 R_Date(4375,35) [A:109]
Phase JAN-D1 IIb o Phase
Start JAN-D Boundary
Janowice 2, GAC Sequence [Amodel:111]
3300
3200
3100
3000
2900
2800
2700
Modelled date (BCE)

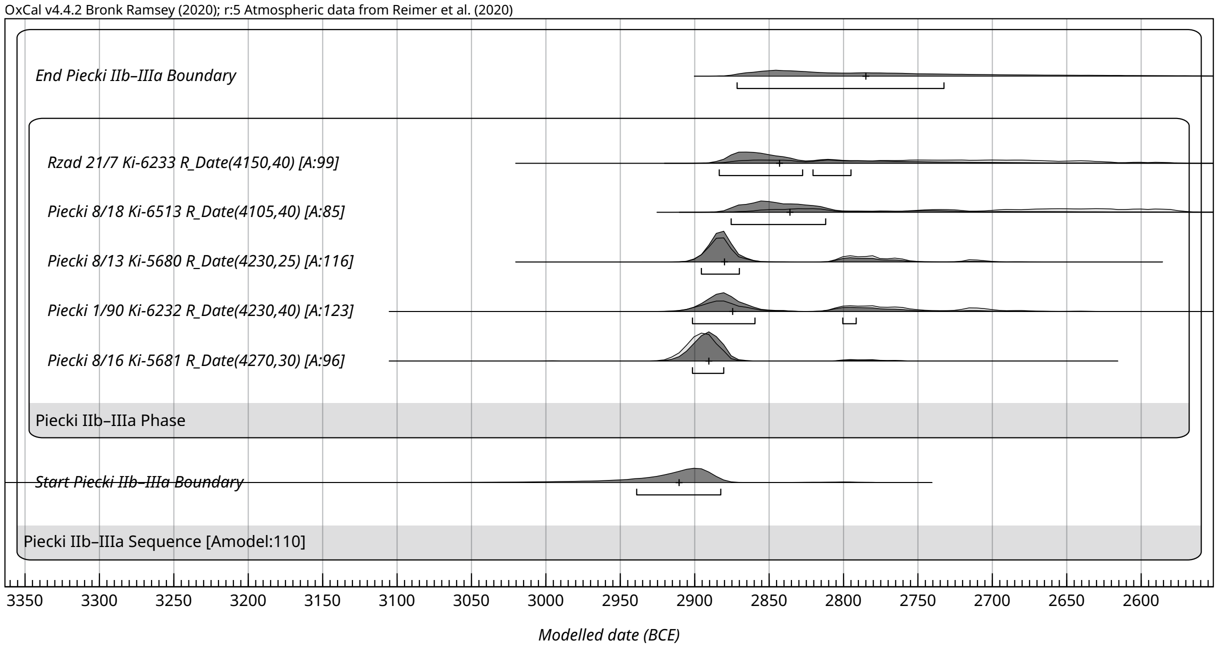


Figure 117. The Bayesian calibrations of Piecki (cf. Suppl. 10).

3.3.2.1.2.4 Janowice 2

Janowice 2 is a GAC settlement with numerous pits, a well and pit complexes that have been entirely published (Szmyt 2016a; 2016b). From five pits, AMS dates were obtained from animal bones. The associated inventories could be attributed to an older and a younger phase IIb (JAN-D1 und JAN-D2) and phase IIIa (JAN-D3) (Goslar and Szmyt 2016b). The settlement JAN D2 begins at ca. 3010 BCE, phase IIb ends at 2890 BCE and phase IIIa lasts until ca. 2730 BCE (Fig. 116). The data lies very much within the steep curve section 2940-2850 BCE.

3.3.2.1.2.5 Piecki

Rescue excavations at the gas pipeline near Moglino revealed various GAC settlement remains in the western and central parts of Kuyavia. Three conventional radiometric dates from Piecki 8 are available from a single grave (Piecki 8/18, phase IIb/IIIa), a GAC pit (Piecki 8/13, phase IIb/IIIa) and a secondary GAC relocation in a younger Iwno settlement pit (Piecki 8/16, phase IIb/IIIa). Another conventional date from a settlement pit at site Piecki 1 (1/90, phase IIb) and a pit hut in Rzadkwin 21 (21/7, phase IIIa) fall radiometrically in a very similar period (Szmyt 2004b, 331-341). With a sequential calibration, all dates lie within the time period ca. 2910-2780 BCE (Fig. 117). In particular, the date from pit Piezcki 8/16 lies in the steep calibration interval (Fig. 118)(cf. also Szmyt 2004b, 351, fig. 188-190).

Figure 115 (left, above). The Bayesian calibrations of Kowal 14, excluding charcoal dates (cf. Suppl. 10).

Figure 116 (left, below). The Bayesian calibrations of Janowice 2 (cf. Suppl. 10).

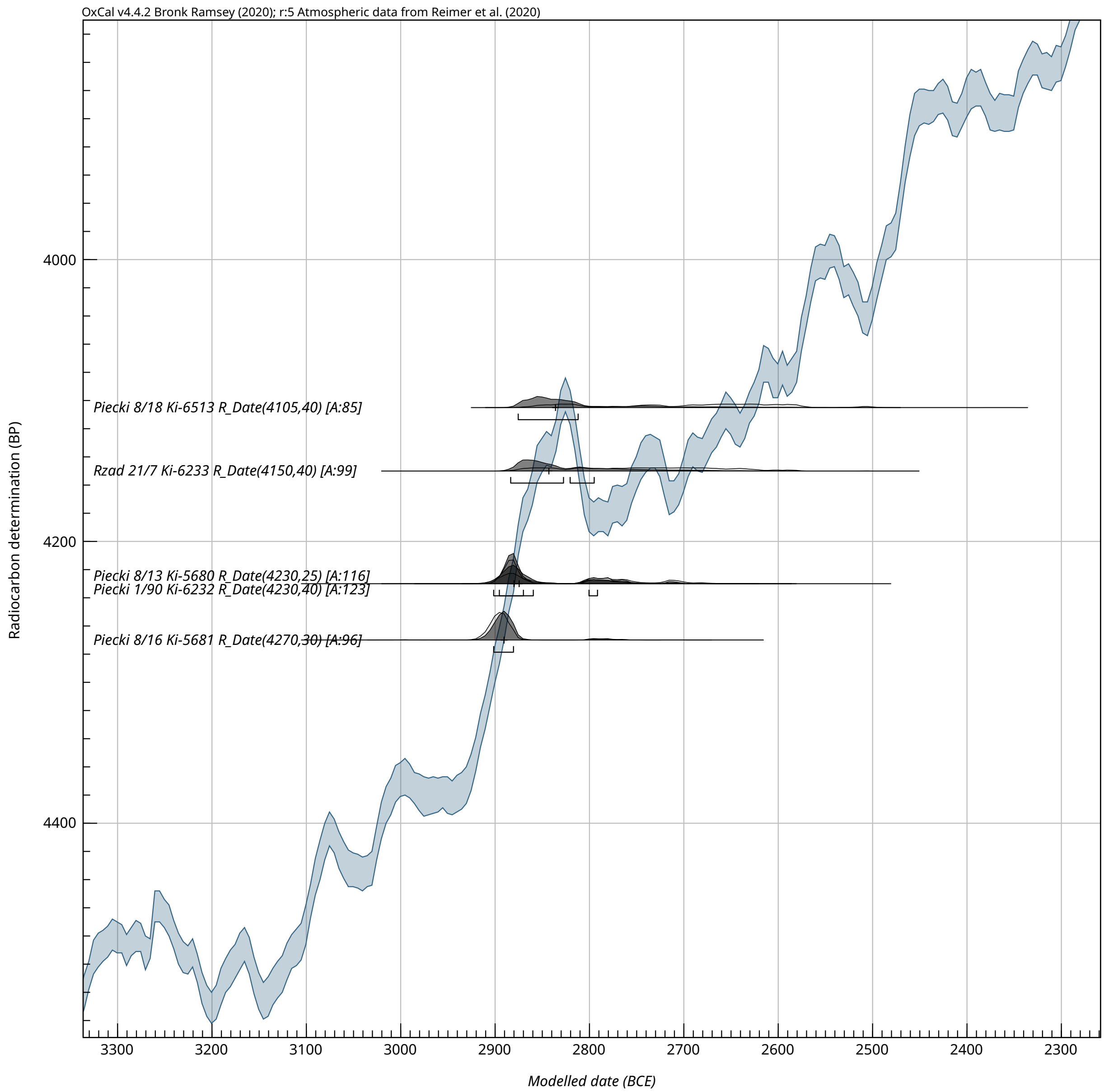


Figure 118. The Bayesian calibrations of Piecki 1 (1/90, phase IIb) and a pit hut in Rzadkwin 21 (21/7, phase IIIa) (cf. Suppl. 10).

3.3.2.1.2.6 Opatowice

In Southeast Kuyavia, the elevated Prokopiak Plateau of Opatowice is located, which overlooks the surrounding black earth plain at an elevation difference of 20 m and measures ca. 20 ha. It served as a settlement area at different times. From the Late Neolithic, TRB and GAC occupation are documented in different places. 21 radiometric dates, which show an association to the GAC, are available from the ritual site Opatowice 1 and the settlement sites Opatowice 3, 32, 33, 35 and 36 (Suppl. 9; for an overview, see Szmyt 2017, 224-225 fig. A) (Fig. 119). The remains, which can be assigned mainly to phases IIb/IIIa, date in total over ca. 740 years: from ca. 3010-2280 BCE (Fig. 120-121).

From Opatowice 1, an animal deposit (feature 38) is available with numerous ceramic units that can be assigned typologically to phase IIIa (Po1-E) (Szmyt 2007a; Kosko and Szmyt 2007a, 291; Szmyt 2013, 176-179, fig. 4.33). Both conventional radiometric dates of animal bones yield a combined dating probability of ca. 2460-2230 BCE (Fig. 122-123). Even if the typological identification belongs to

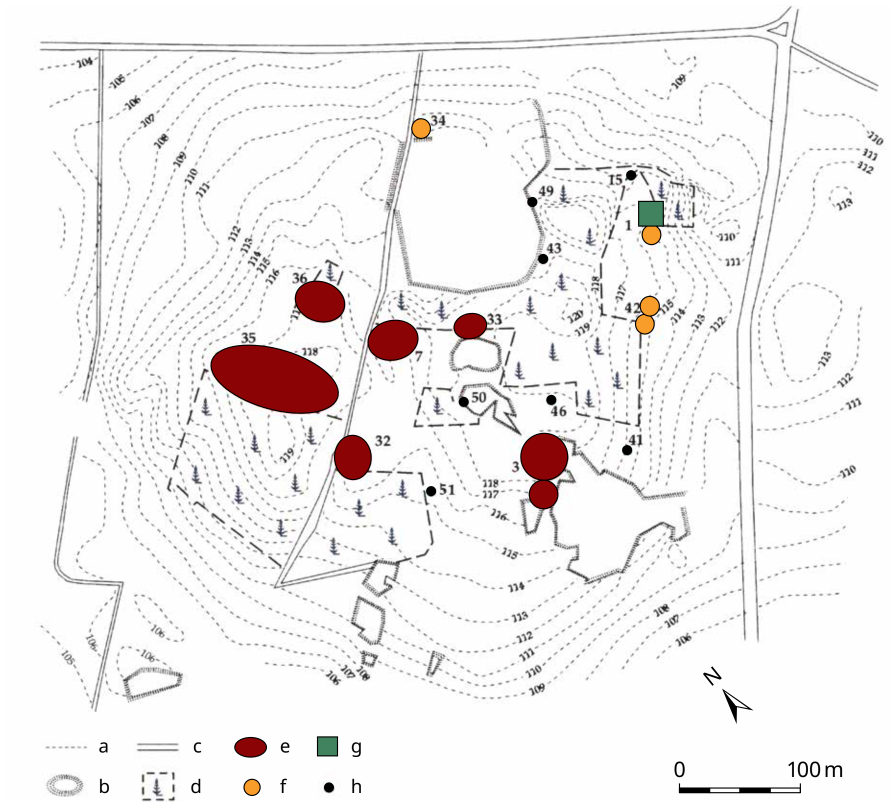


Figure 119. The site of Opatowice (after Szmyt 2017, 224-225, fig. A 1).

GAC phase IIIa, the overall range of finds with ceramics typologically designated as "foreign elements" indicates an additional possible date between at least ca. 3100-1950 BCE (Szmyt 2007a, 150 Table 9.7). This makes the direct assignment to a GAC phase more difficult and also allows other assignments.

In Opatowice 3, a settlement area with five pits of phase IIb (Op3-C1) and one pit plus a ditch structure of phase IIIa (Op3-C1) was excavated (Fig. 124). Significant here is the joint occupation of the GAC and the TRB, which is also stratigraphically verified (Szmyt 2014, 325 fig. 7.34). Taking the typochronological classification into account, the four conventional and AMS radiometric dates provide a total duration between ca. 3010-2690 BCE, whereby the oldest GAC IIb occupation is assumed from ca. 3010-2870 and the Younger GAC IIIa occupation from ca. 2870-2690 BCE (Fig. 125-126).

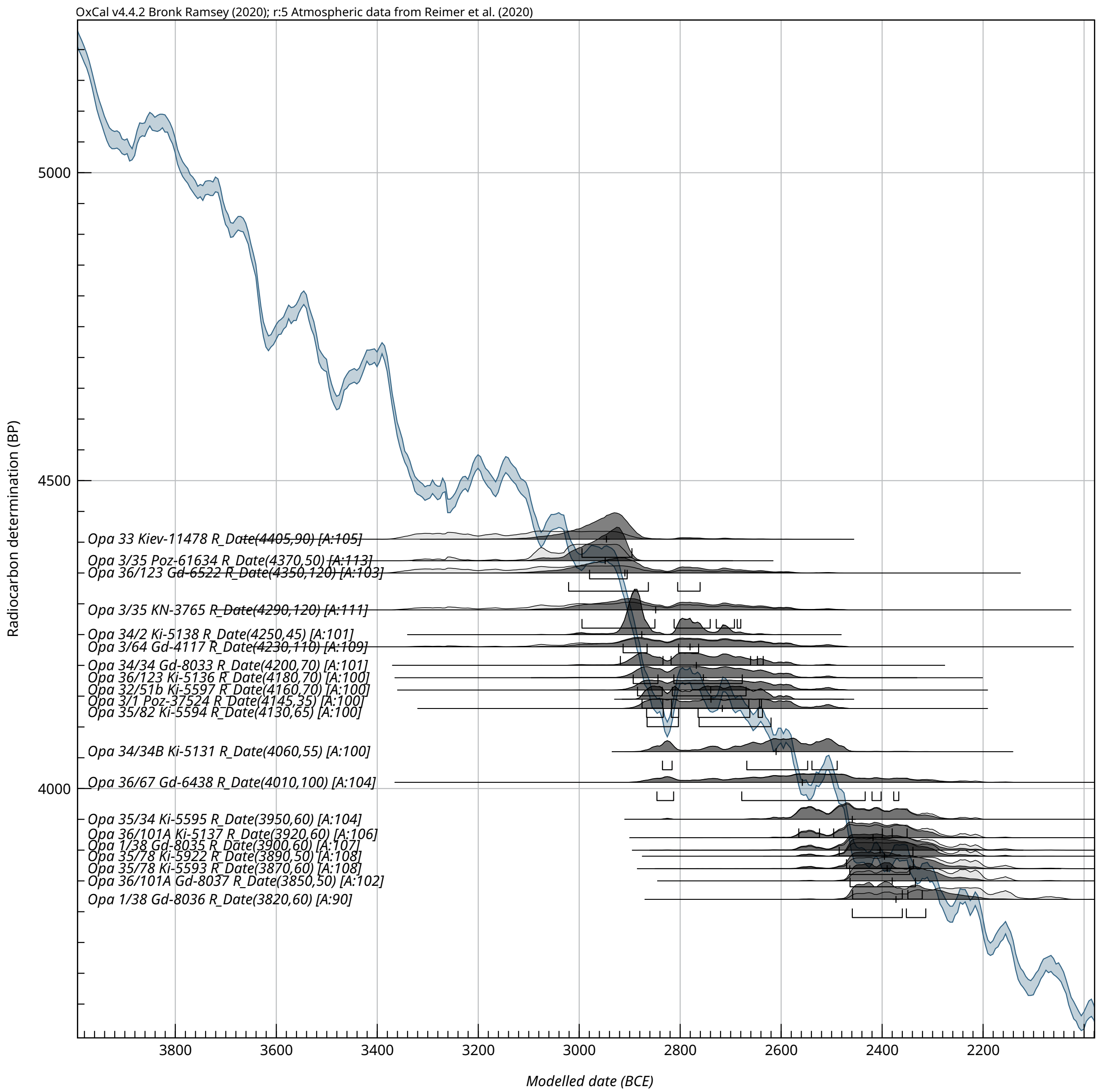


Figure 120. Overview of the Bayesian calibrations of Opatowice GAC sites (cf. Suppl. 10).

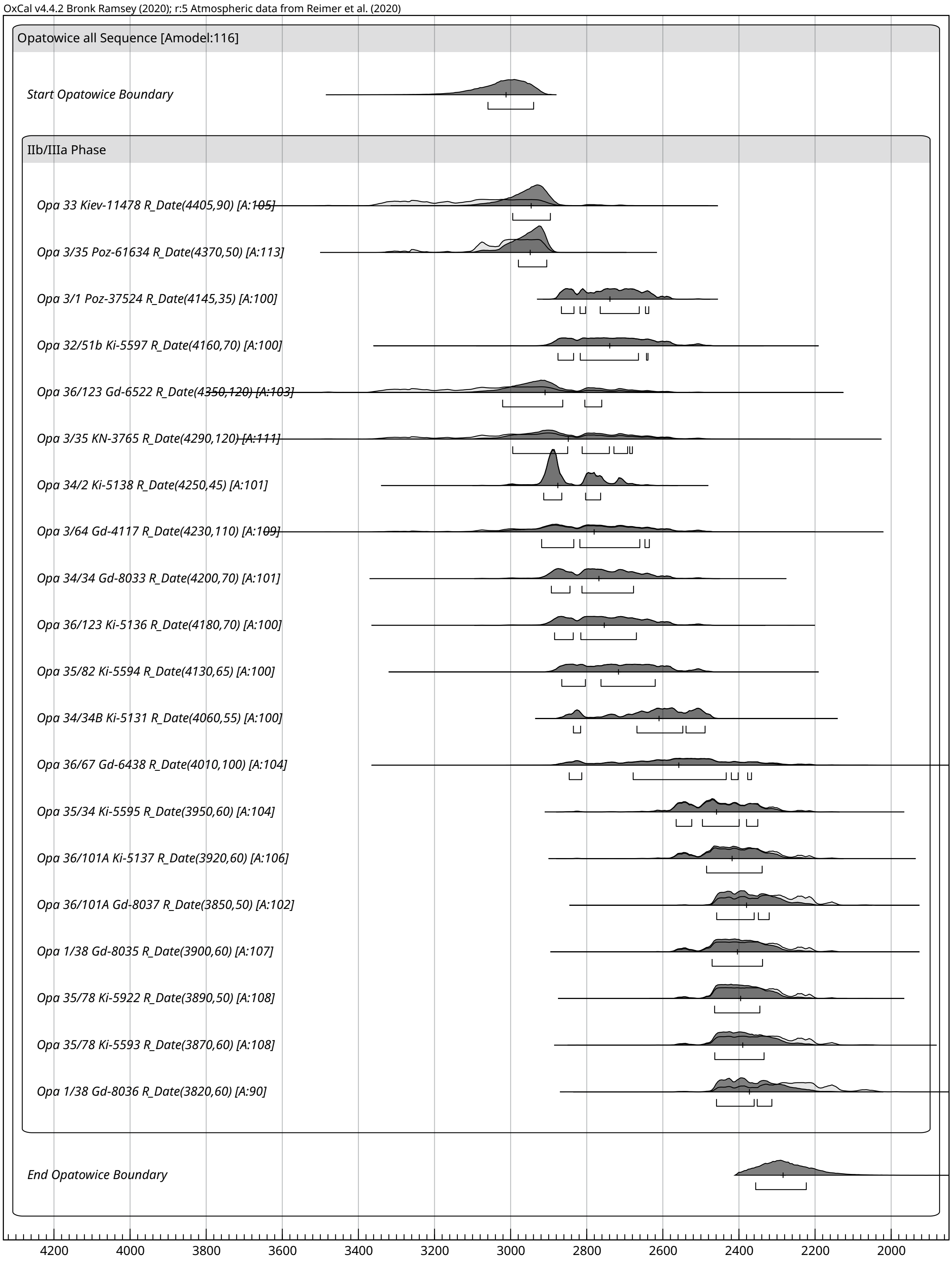


Figure 121. Multiplot of the Bayesian calibrations of Opatowice GAC sites (cf. Suppl. 10).

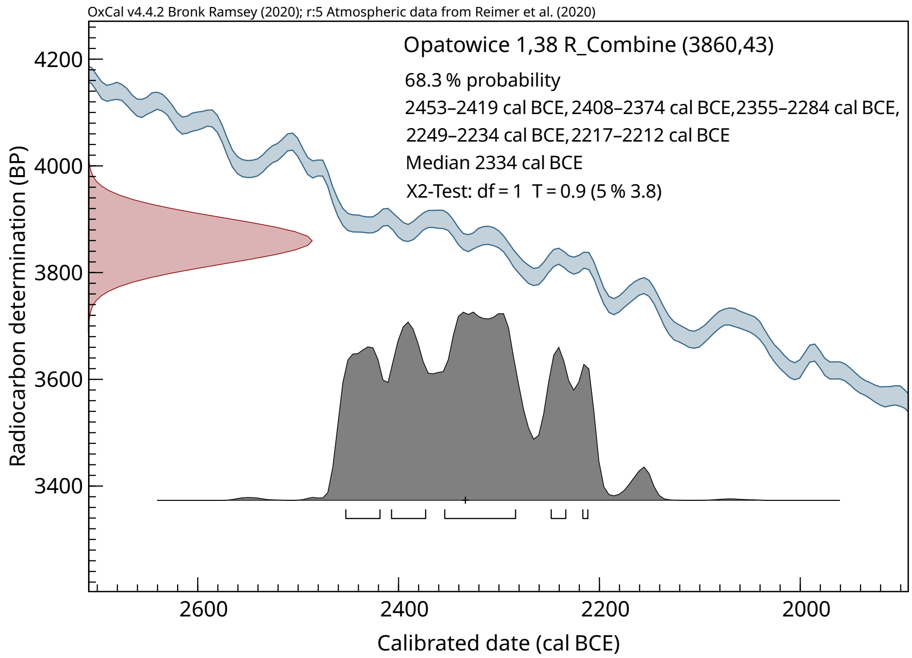


Figure 122. Statistics of the combined calibration of the Opatowice 1,38 sample (cf. Suppl. 10).

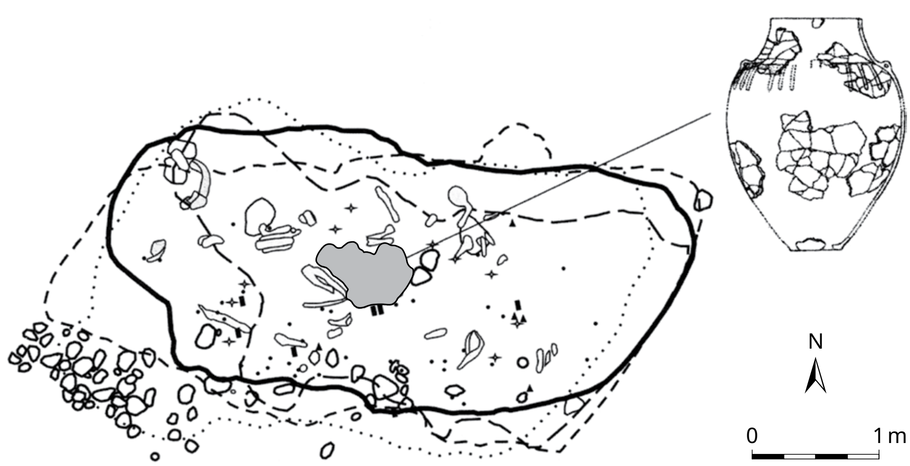


Figure 123. The animal deposition of Opatowice 1, feature 38, with associated ceramic (after Szymt 2017, 236, fig. 23,6).

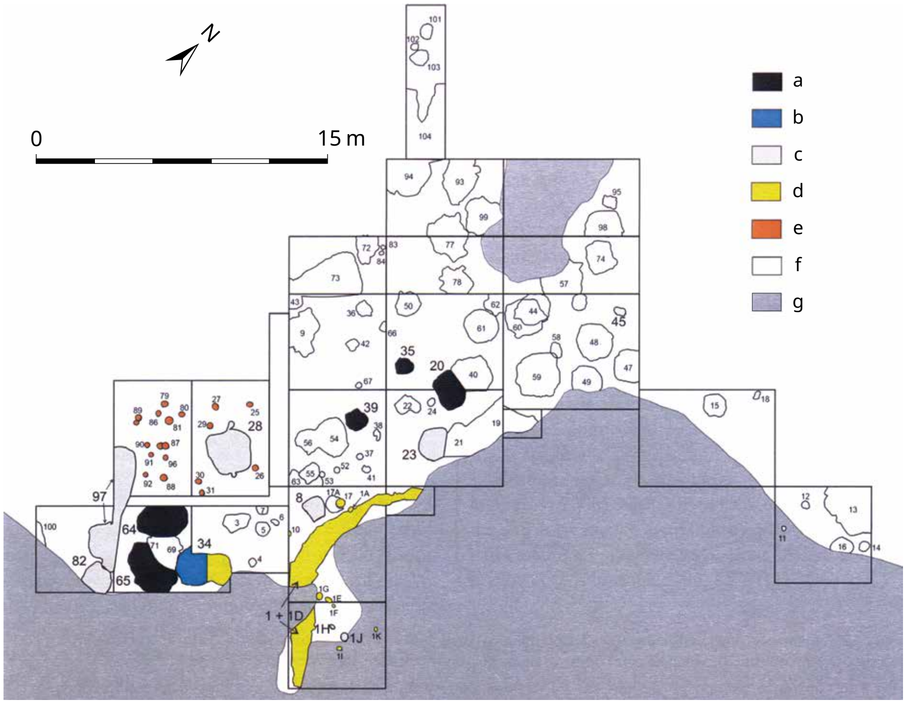


Figure 124. The site of Opatowice 3 with five pits of phase IIb (Op3-C1) and one pit plus a ditch structure of phase IIIa (Op3-C1) (after Szmyt 2014, 325, fig. 7.35). Key: a -GAC pits; b – TRB/GAC pit; c – TRB pits; d – GAC ditch; e – postholes; f – features of other periods; g – destroyed.

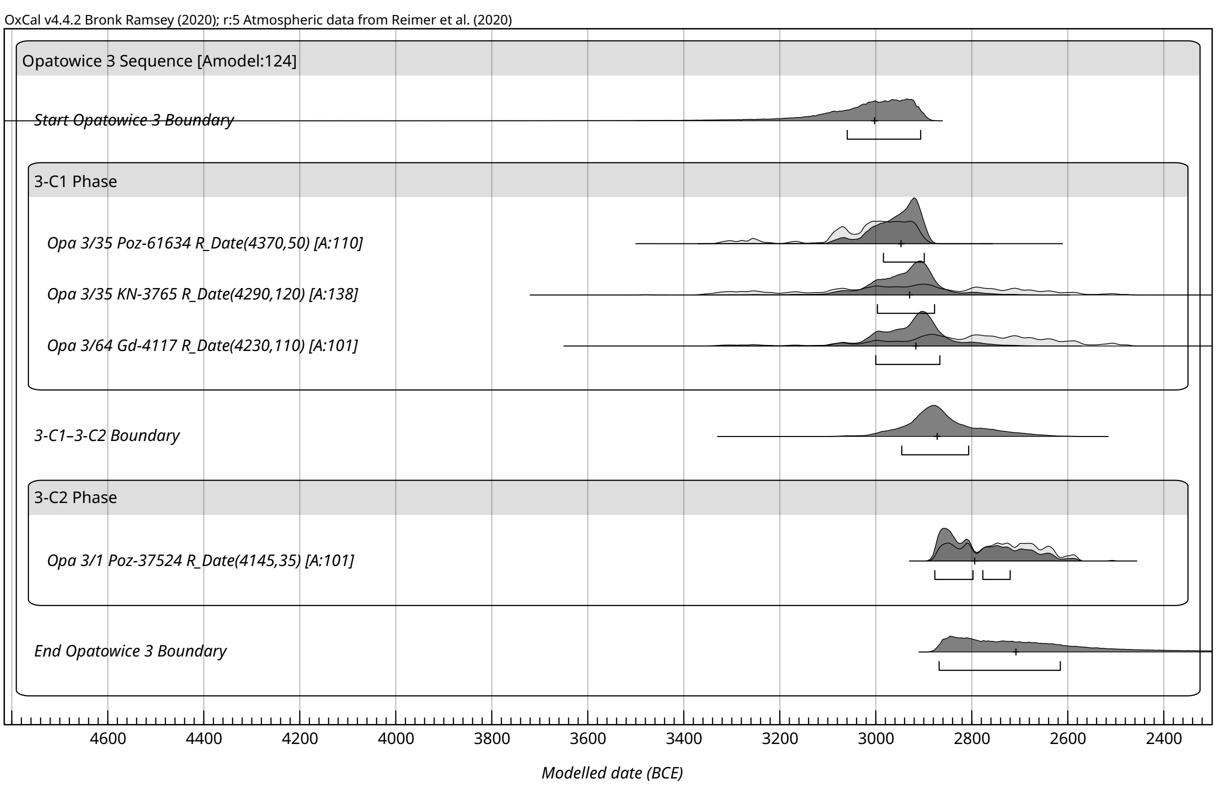


Figure 125. Multiplot of the Bayesian calibrations of Opatowice 3 (cf. Suppl. 10).

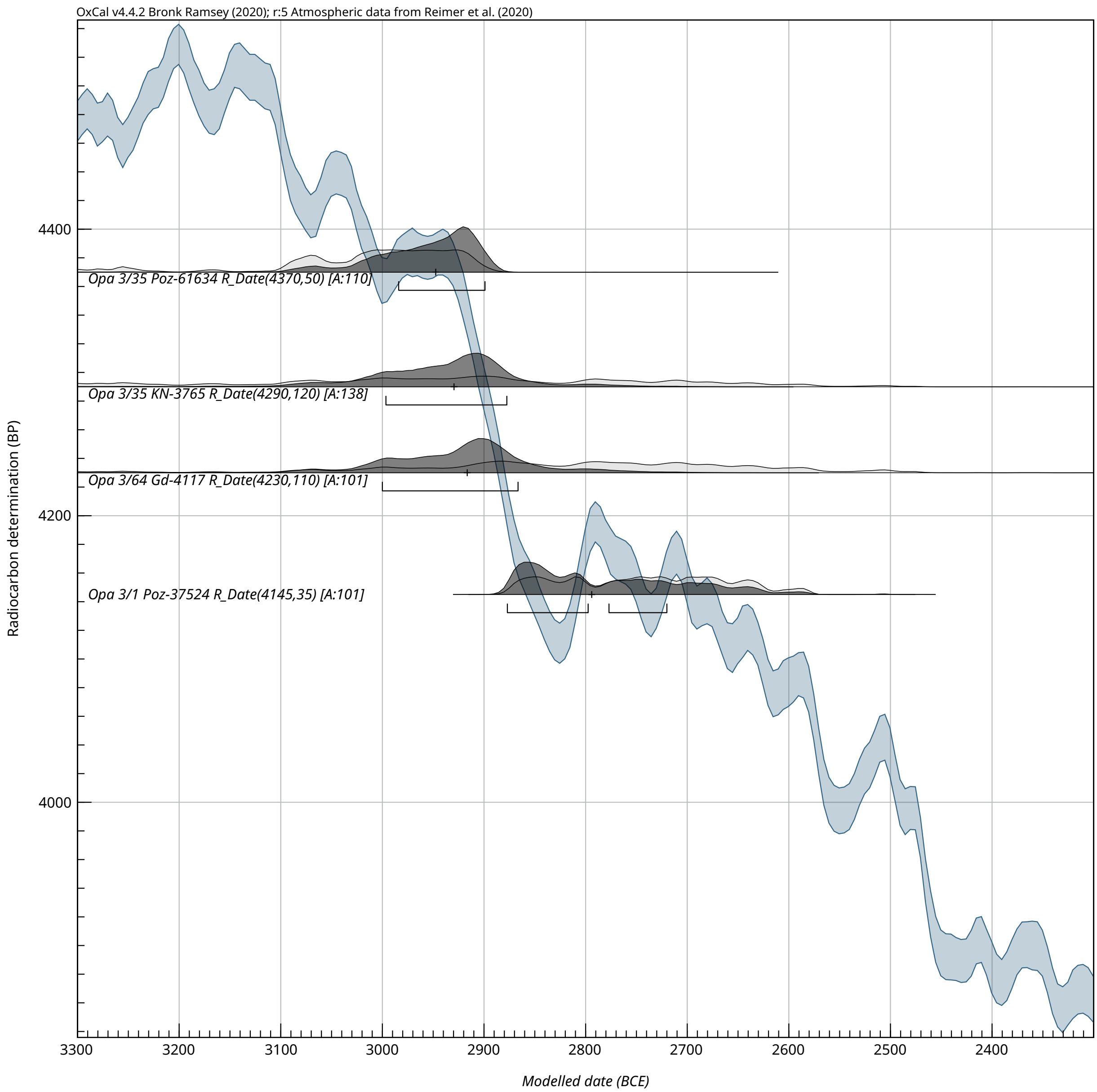


Figure 126. Overview of he Bayesian calibrations of Opatowice 3 (cf. Suppl. 10).

At Opatowice 33, 3 pits and one find concentration were found alongside a general scatter of CUs, which are assigned to the GAC (Kosko and Szmyt 2006a, 195 fig. 10.1) and belong stylistically to phase IIIa. A conventional radiometric dating on the organic remains of a sherd dates primarily to ca. 3110-2910 BCE (cf. Suppl. 9; 1 sigma-Bereich 3320-2910) (Kosko and Szmyt 2006a, 277).

In Opatowice 36, a house (sunken floor) with associated pits and three cattle burials could be reconstructed as a coherent unit, belonging to phase IIIa. Two occupation phases were differentiated (Szmyt 2015a; 2015b; Kosko and Szmyt 2015a). Five conventional radiometric dates and an AMS date from cattle bones originated from three features – a cattle deposition (pit 123) of the occupation phase Op-36-B1 and two other cattle depositions (pits 67 and 101A) of the occupation phase 36-B2. There are no stratigraphical overlaps (cf. Fig. 127). Based on stratigraphic calibration, the beginning of the house occupation should have occurred around ca. 2920 BCE and the end of the first occupation phase around ca. 2780 BCE. The deposition of the cattle in the second occupation phase may have been conducted between ca. 2470-2290 BCE (Fig. 128-129).

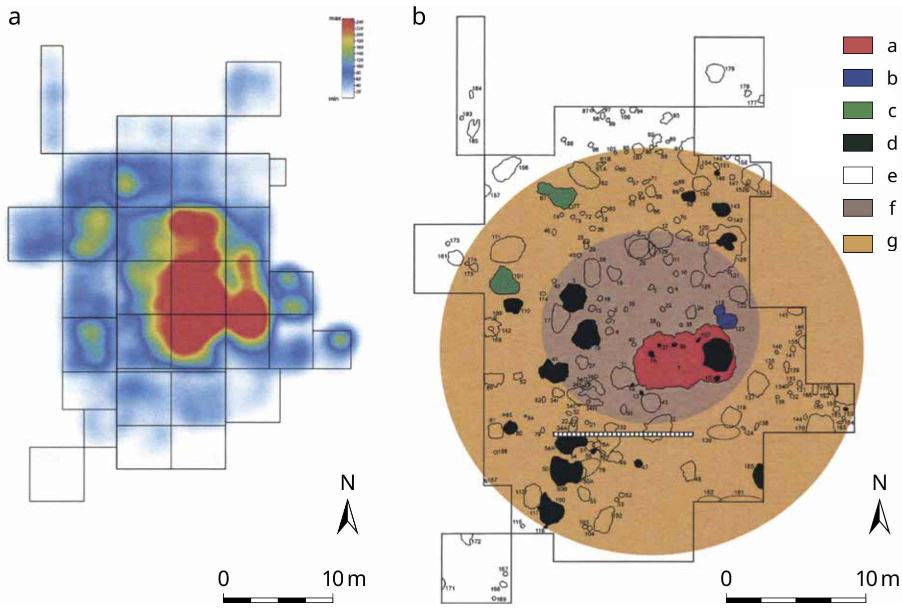
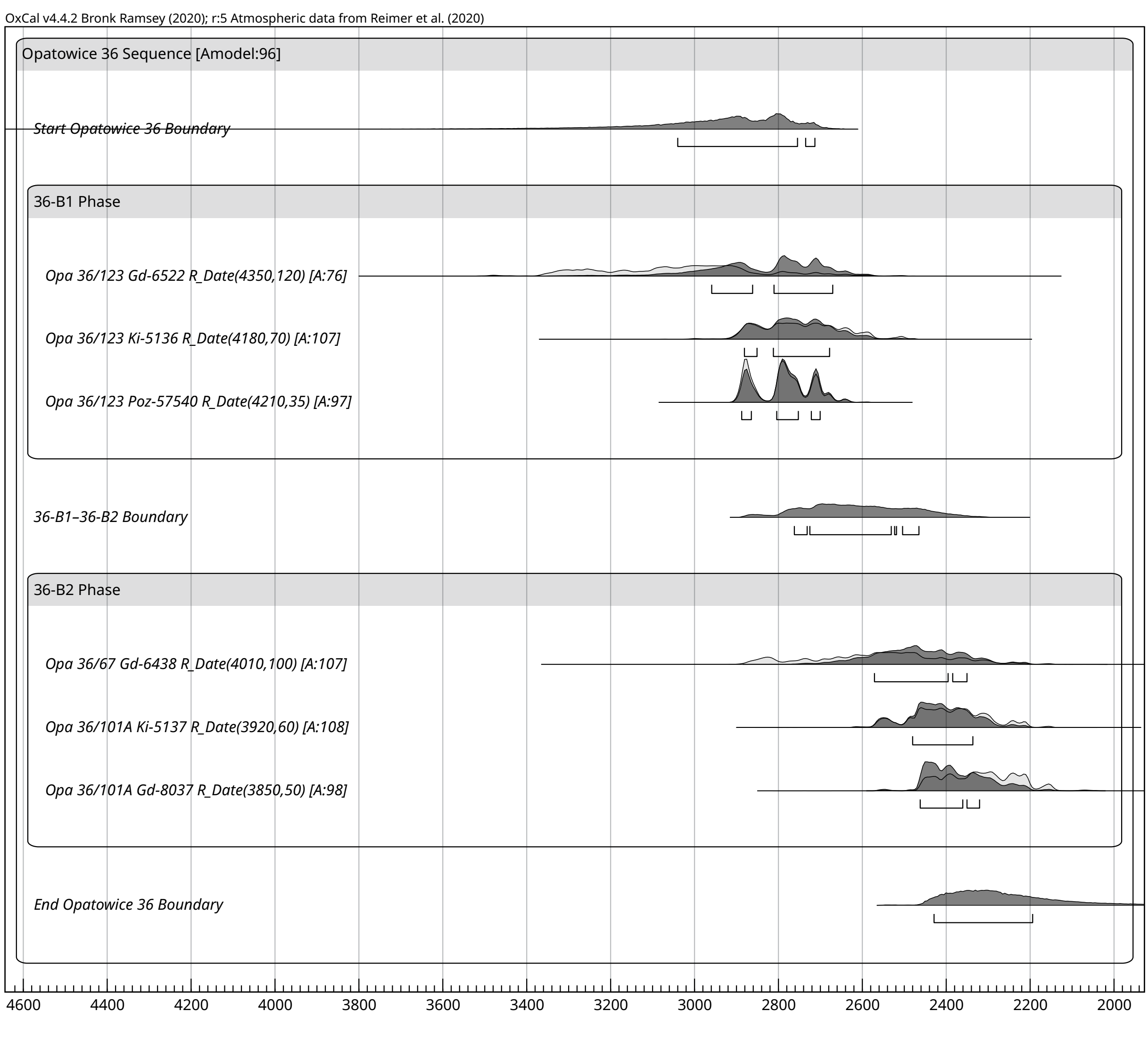


Figure 127. The site of Opatowice 36. a: density of artefact distribution; b: features, key: a – sunken floor; b – inner animal deposition; c – outer animal depositions; d – GAC pits; e – features of other periods; f – inner domestic areal; g – outer domestic areal (after Szmyt 2017, 226, fig. B).

Figure 128. Multiplot of the Bayesian calibrations of Opatowice 36 (cf. Suppl. 10).



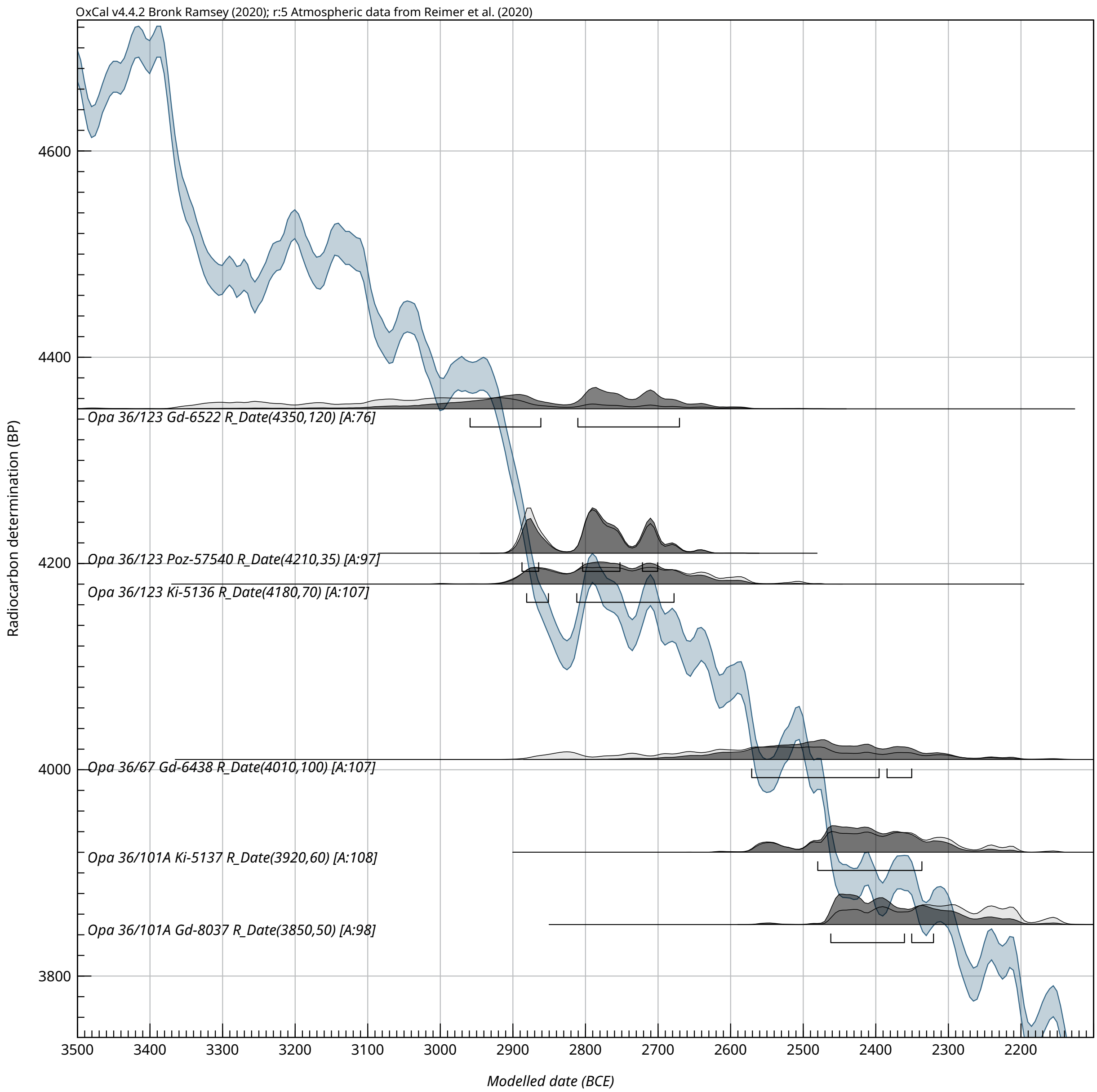


Figure 129. Overview of the Bayesian calibrations of Opatowice 36 (cf. Suppl. 10).

Opatowice 32, 34 and 35 have not been fully reprocessed archaeologically – but the radiometric dates have been published with additional usable information (Czebreszuk and Szmyt 1998, 210-211; Szmyt 2001, 37-39). From Opatowice 32, one conventional bone date comes from a settlement pit, whereas in Opatowice 43, three conventional dates originate from three settlement pits, and in Opatowice 35, there are four conventional dates from two settlement pits and an animal deposition. All dates belong to inventories typologically assigned to phases IIb/IIIa.

Considering all radiometric dates, the beginning of GAC occupation at Opatowice probably took place at ca. 3050 BCE. A first phase, IIb, probably lasted until 2890 BCE, phase IIIa probably until 2750 BCE. Activities in and around the GAC contexts, for example, cattle depositions, continued until ca. 2275 BCE. Whether these can still be interpreted in connection with the GAC must remain open at this point in time (Fig. 130-131).

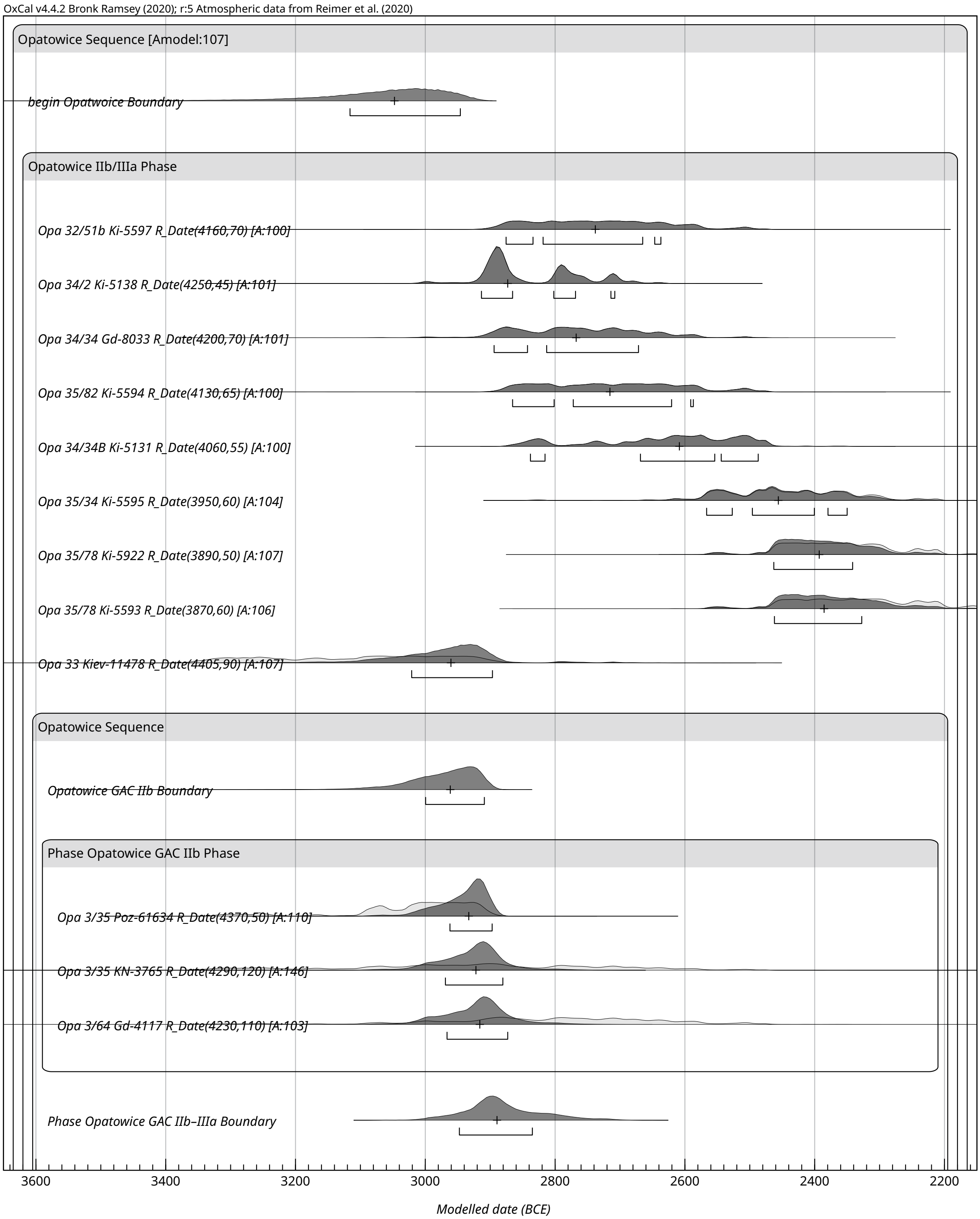


Figure 130. The Bayesian calibrations of GAC Opatowice (continued in Fig. 131) (cf. Suppl. 10).

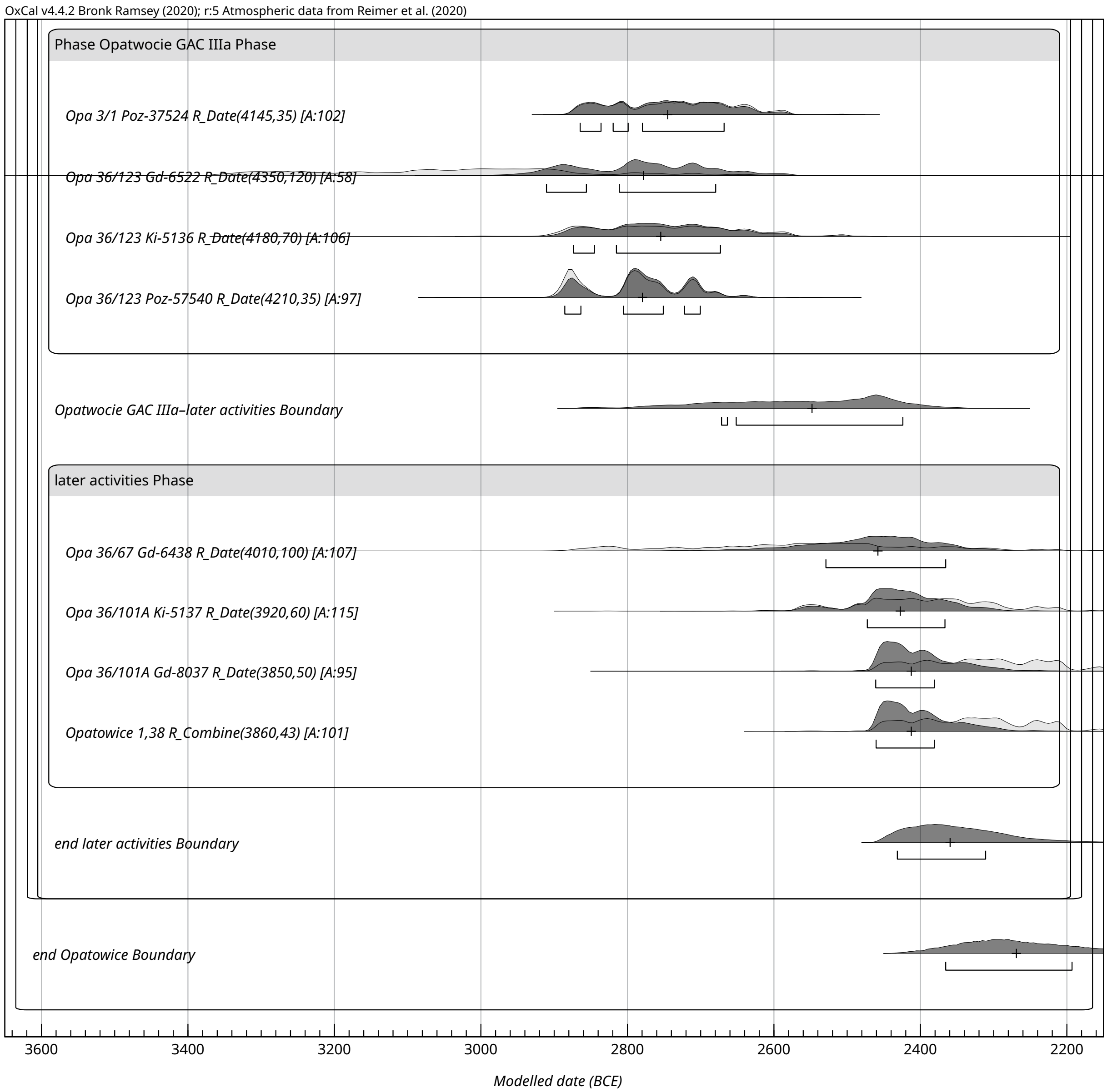


Figure 131. The Bayesian calibrations of GAC Opatowice including later activities (continued from Fig. 130) (cf. Suppl. 10).

3.3.2.1.2.7 Bożejewice

Five conventional ^{14}C dates from animal bones of the settlement sites Bożejewice 22 and 28 are from pits – one of them with an animal deposition of a dog. The inventories can be differentiated within phases IIb/IIIa, so that a stratigraphic calibration with enough overlapping possibilities of the sigma-boundary could provide some clues to the internal phase sequence (Szmyt 2001, 37; Szmyt 2000a, 205-211; 289 fig. 33-39). Accordingly, there is an occupation from ca. 2960 BCE with IIb ceramics, a transition to IIb/IIIa at ca. 2920 BCE, a change to IIb/IIIb at 2880 BCE and an end probably by ca. 2700 BCE (cf. Fig. 132- 133). The dates lie overall on the steep calibration interval 2930-2850 BCE and thus indicate a relatively short-term occupation.

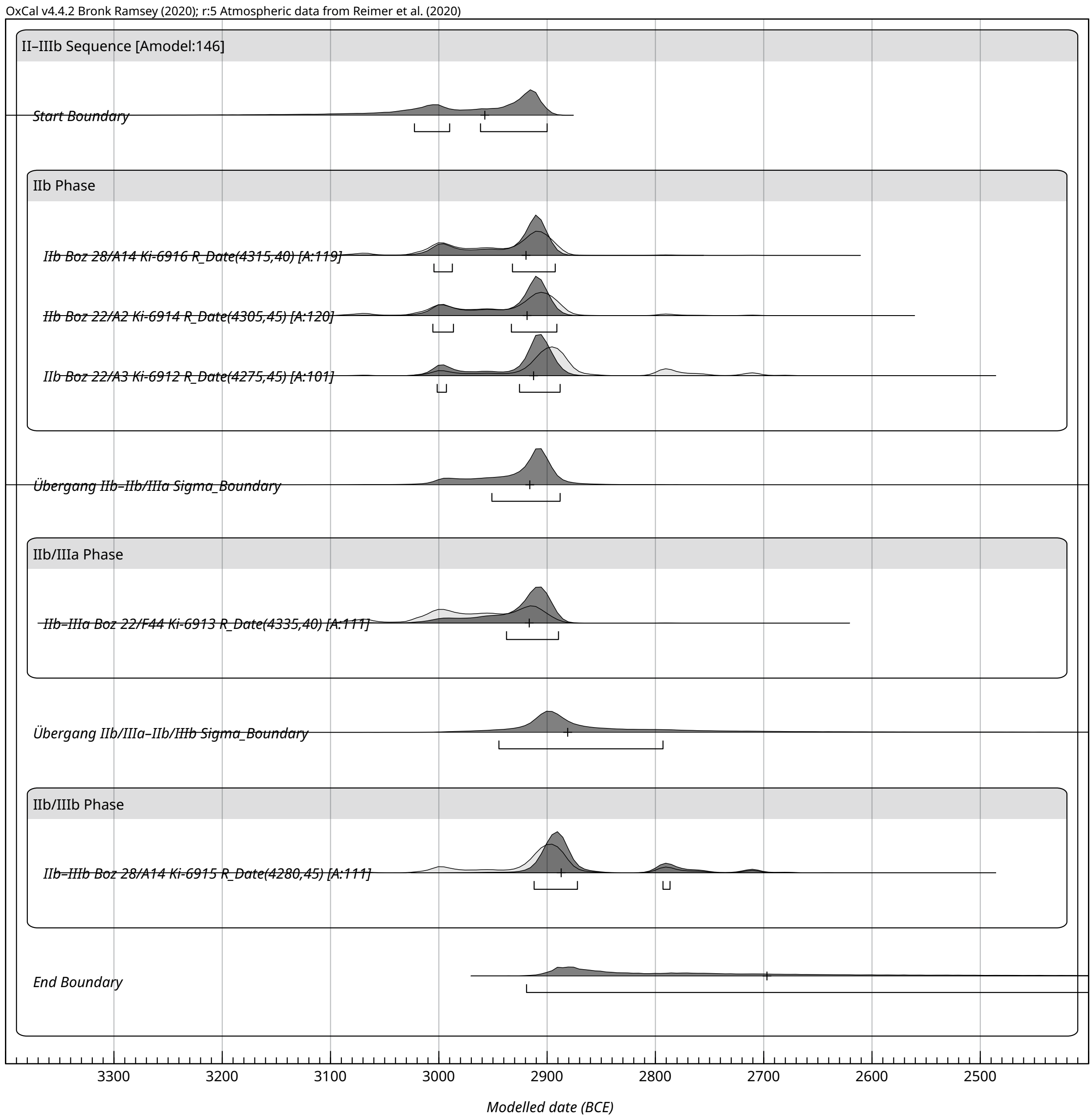


Figure 132. Multiplot of the Bayesian calibrations of Bozejewice (cf. Suppl. 10).

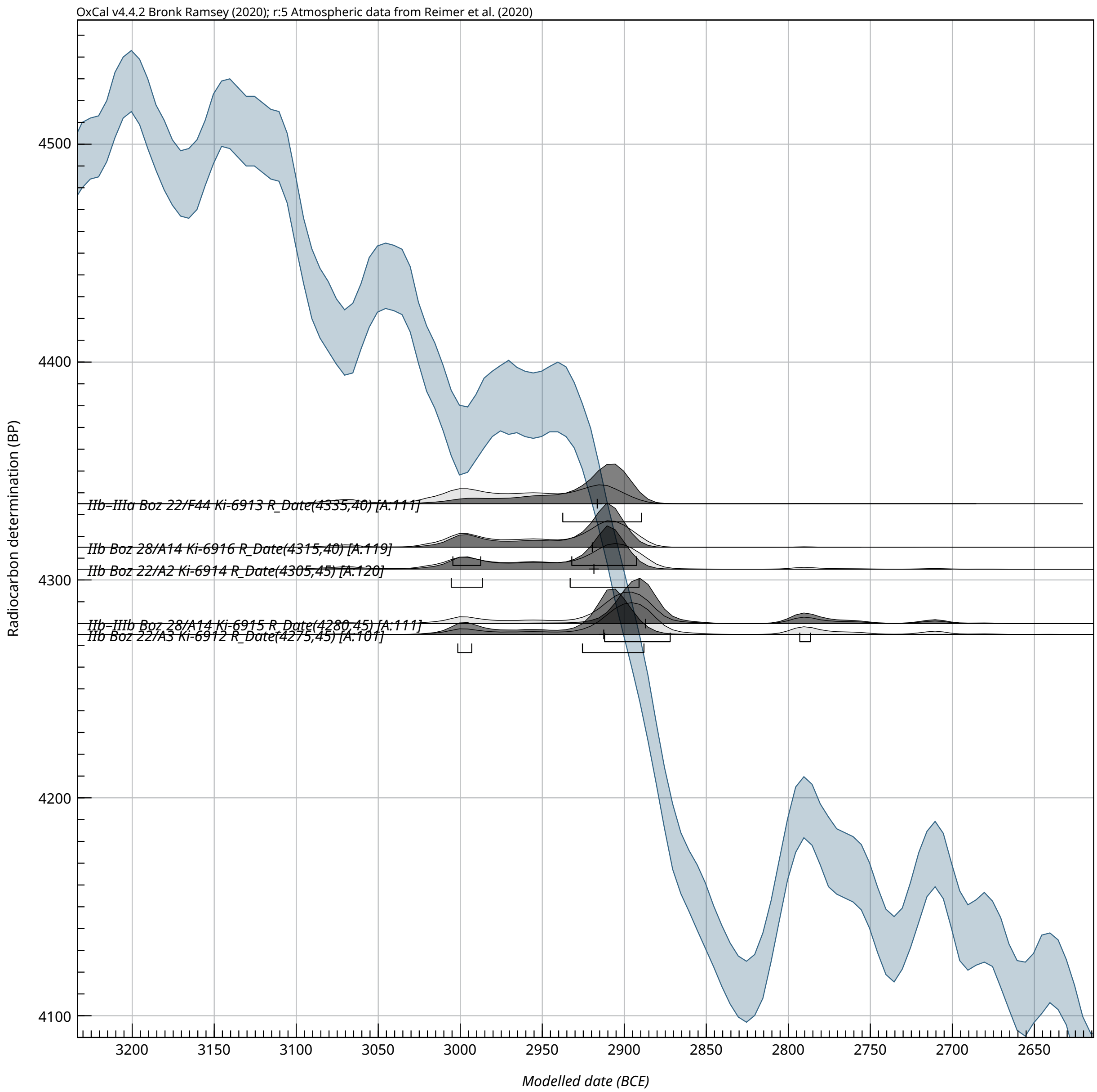


Figure 133. Overview of the Bayesian calibrations of Bozejewice (cf. Suppl. 10).

3.3.2.1.2.8 Kierzkowo 13

From the double passage tomb with a Globular Amphora inventory, six conventional and twenty-eight AMS dates are available (Pospieszny 2017a). With 34 dates, Kierzkowo 13 belongs to one of the best dated complexes with globular amphorae. The grave has a two-part burial chamber with two parallel short corridors, which we primarily know from Danish graves of the TRB North Group (Fig. 134). The mound of the long barrow is divided into two parts: a long barrow around the actual burial chamber and a slightly offset long barrow to the west with an open depositional area. There were 25 individuals from the grave chamber and two from the depositional area (eleven subadults, two adolescents, and fourteen adults) – sex determination was only possible in one case (Budnik *et al.* 2017).

Noteworthy is that a megalithic grave in Kierzkowo exhibited 'only' Globular Amphora ceramics and thus its construction could in principle also be associated with the GAC. Typologically, the inventory is determined from the burial chamber, *e.g.*, by a knobbed beaker (*Warzenbecher*), and from the deposition area by a

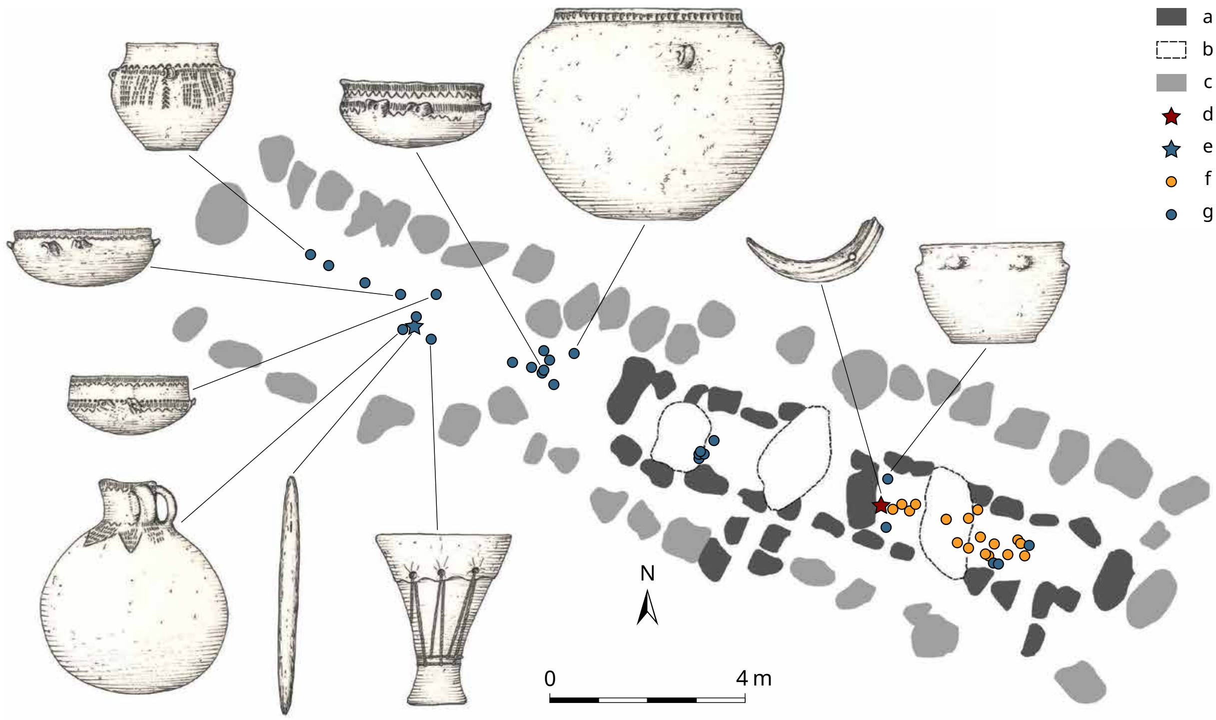


Figure 134. The megalithic tomb Kierzkowo 13. Key: a – chamber orthostats; b – chamber capstones; c – kerbstones; d – boar tusk; e – bone knife; f – amber artefacts; g – ceramics (after Nowaczyk et al. 2019, 125, fig. 2).

Kuyavian globular amphora and by cups of Meseberg type. Additionally, two elements – a conical drum and a two-handled jug – can be derived typologically from the Britzer Group (Form C, cf. Kirsch and Plate 1984, 115-117, fig. 58). The GA vessels are assigned to the classic phases IIb/IIIa (Nowaczyk *et al.* 2017; Pospieszny 2017a).

The radiometric dates come both from the burial chamber (n=29) and from the deposition area in the long barrow west of the chamber (n=5). Two datings of human bones from the depositional site (individual 19, Poz-86562 und individual 20, Poz-86560) fall into the early modern period and are therefore not considered further. By using all other data and attempting Bayesian phase modelling with boundaries, the dated fox bone (Poz-87638) turns out to be at least 200 years younger than the rest of the data group and is responsible for the non-fitness of the model. Accordingly, the remaining 31 dates were used for further calculations.

In considering these dates, a probability of use between ca. 3130 BCE and 2790 BCE resulted (Fig. 135). The affected areas of the calibration curve strongly indicate a duration from ca. 3050-2830 BCE (Fig. 136). A different positioning of the conventional and the AMS dates cannot be determined (cf. also Pospieszny 2017a, 269, fig. 1). With the help of grouped calibrations, it is clear that human burials in the chamber occurred from ca. 3130 - 2800 BCE, depositions of cattle and other objects in the western long barrow from ca. 2970-2860 BCE; cattle bones from the chamber also date to this period: ca. 2940-2850 BCE (Fig. 136-137). It is noticeable that the oldest human individuals are arranged at the beginning, the middle and the end of the occupation (5 Poz-86570 adultus-maturus; 14 Poz-86574 maturus; 2 Poz-86784 adultus-maturus; 19 Poz-86783 adultus-maturus).

A stratigraphic calibration for nine assignable human bones by strata does not lead to any usable chronological differentiations. Apparently, prehistorically, younger bones were cleared downward and older ones upward, *e.g.*, as part of clearing processes, which led to a mixing of human skeletal remains of different ages (Pospieszny 2017a, 282, tab. 6).

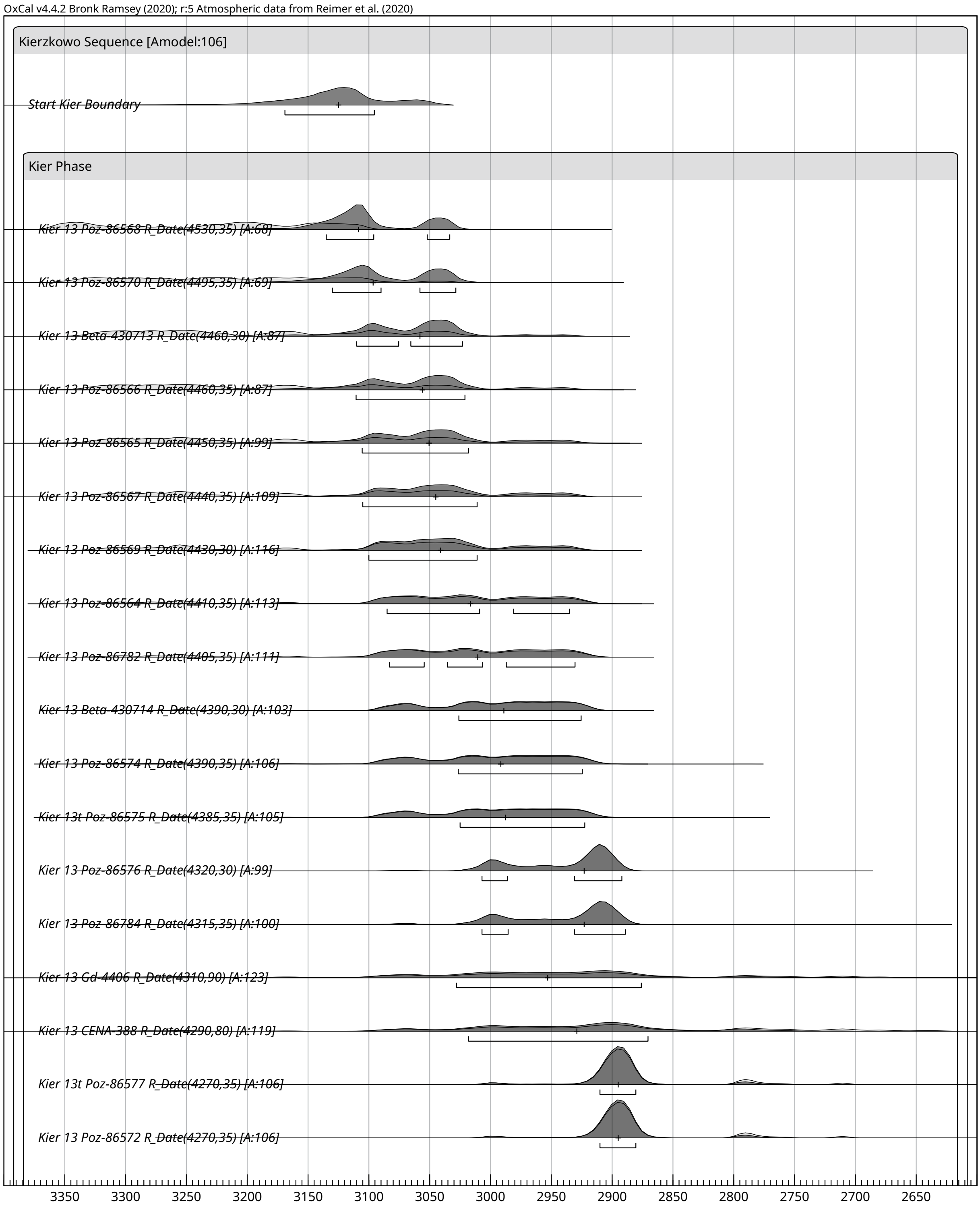


Figure 135. Multiplot of the Bayesian calibrations of Kierzkowo 13 (cf. Suppl. 10).

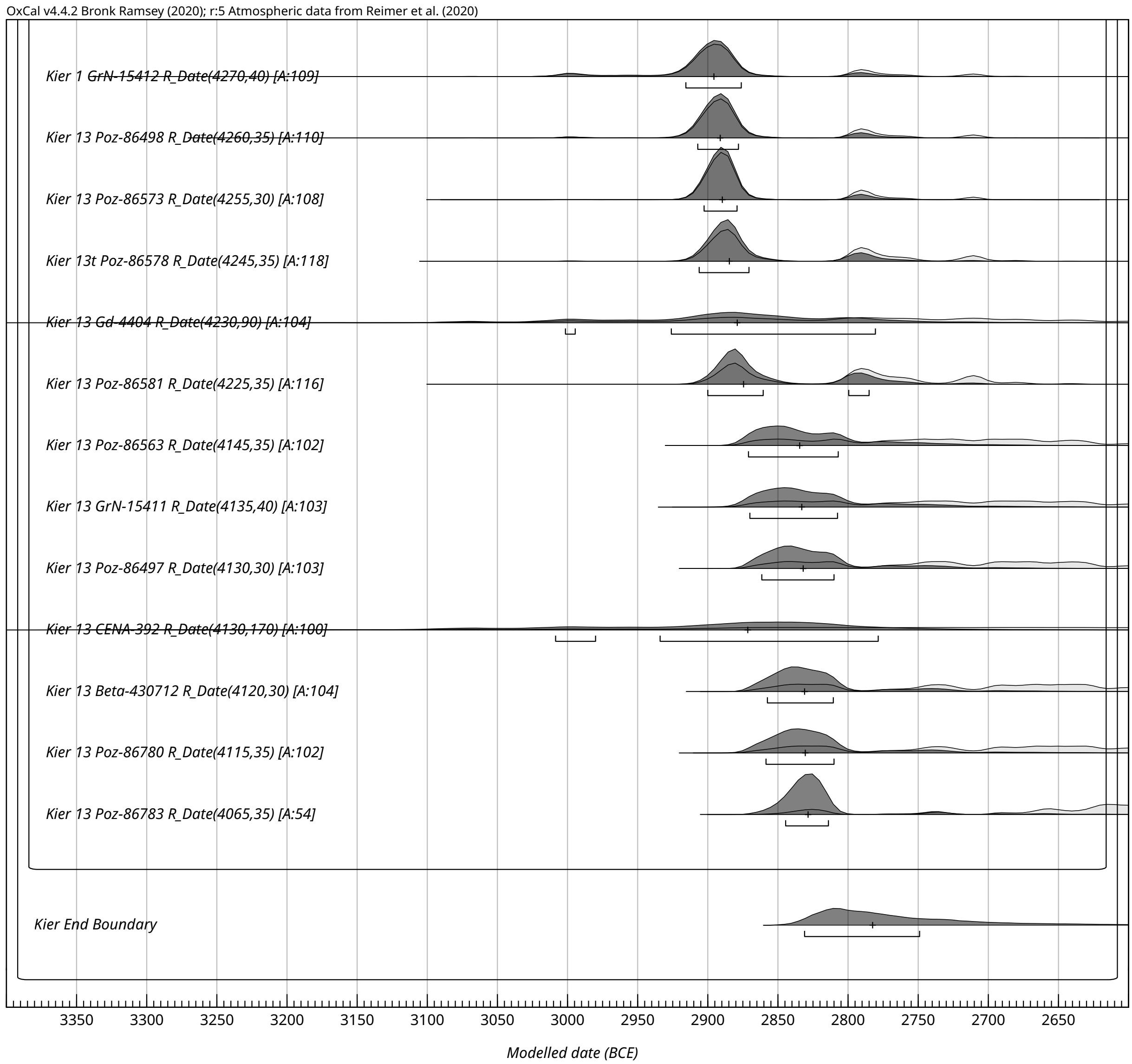


Figure 135. continued.

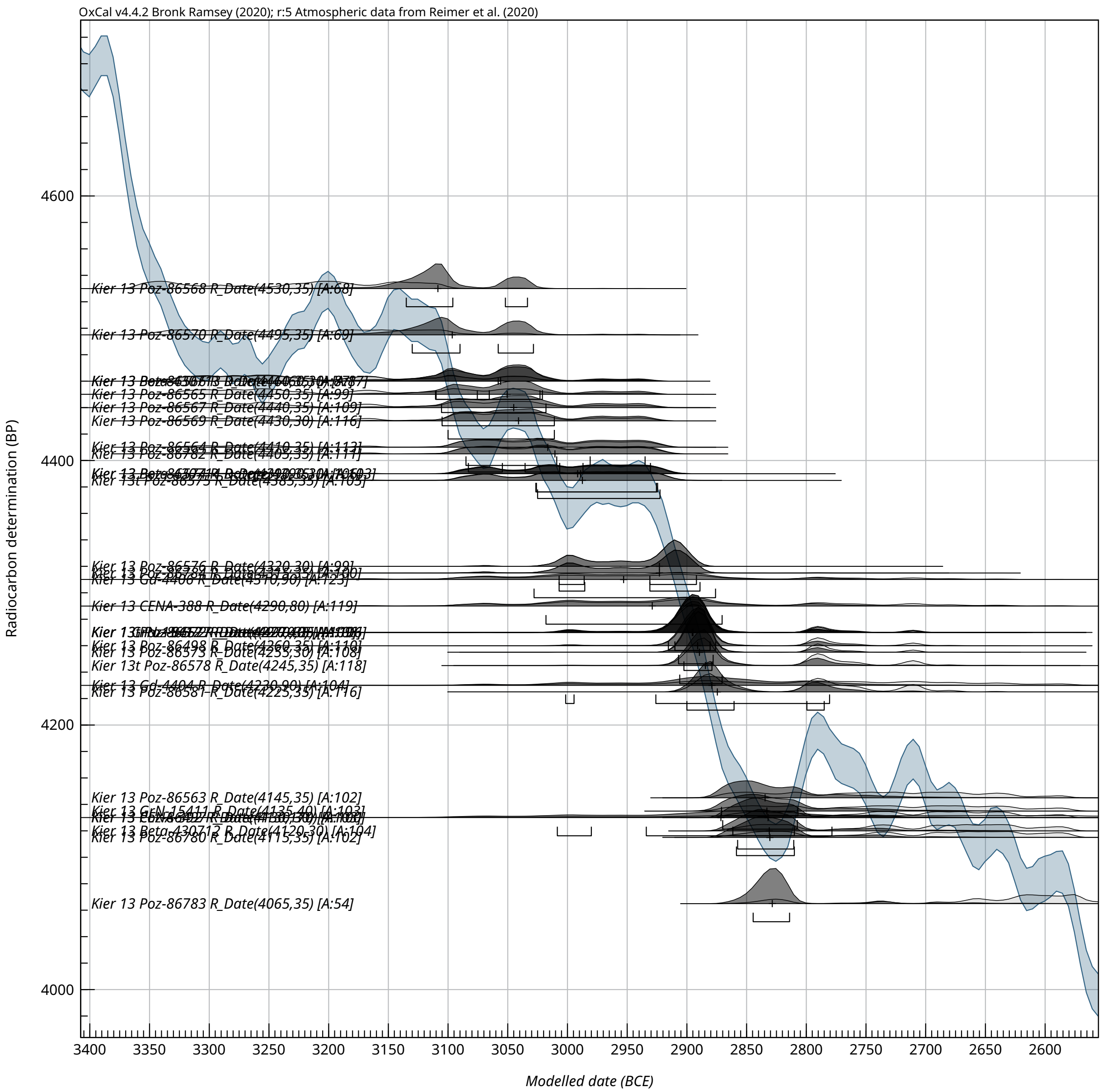


Figure 136. Overview of the Bayesian calibrations of Kierzkowo 13 (cf. Suppl. 10).

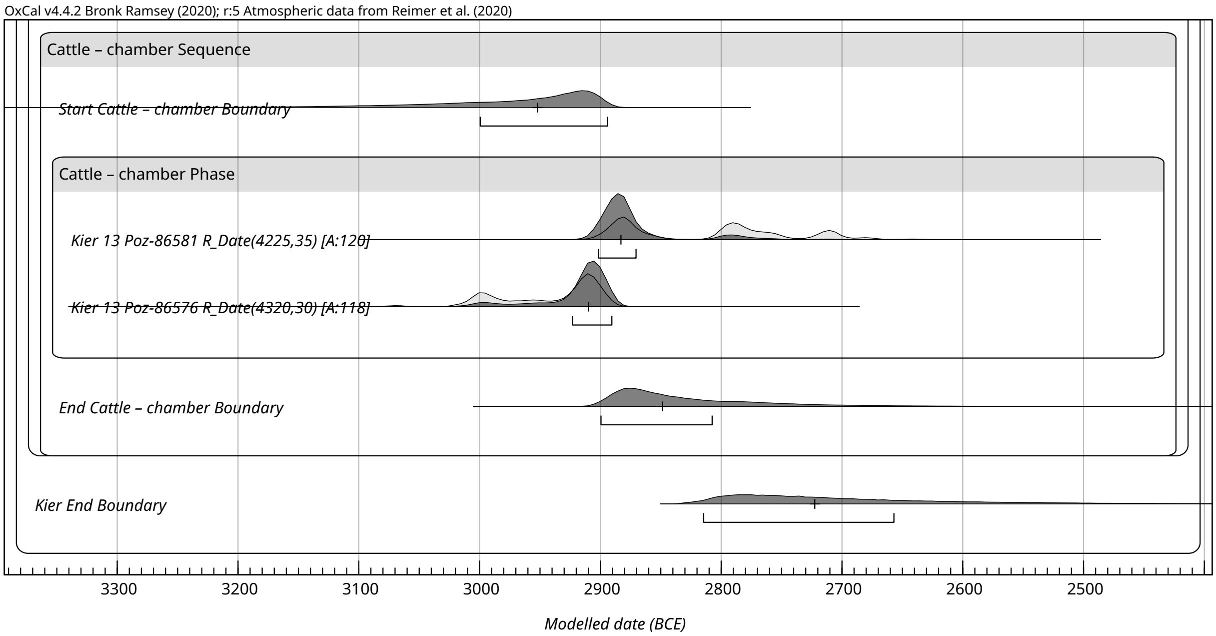


Figure 137. The Bayesian calibrations of Kierzkowo 13 cattle depositions (cf. Suppl. 10).

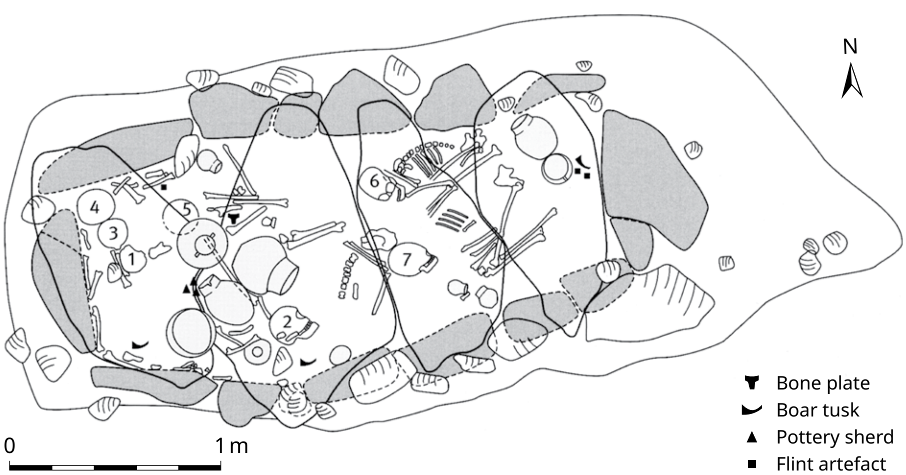


Figure 138. The megalithic tomb of Nakonowo (after Gerling et al. 2022, 334, fig. 3).

3.3.2.1.2.9 Nakonowo

Seven conventional and a further seven AMS dates of human bones are available from a megalithic tomb at Nakonowo (Fig. 138). The publication of the grave is still pending, but the inventory can be generally assigned to phases IIb/IIIa (Gerling *et al.* 2022). A Bayesian phase calibration of the AMS dates provides an occupancy period between ca. 2730-2310 BCE. However, the dates are very strongly divided into those before ca. 2500 BCE and those afterwards (cf. Fig. 139). As long as the grave has not yet been presented, we cannot judge if the last occupation period with globular amphorae lasted until 2300 BCE. Spatially, the oldest indviduals were placed in the western part, the youngest in the eastern part (near the entrance) of the tomb (cf. Fig. 138).

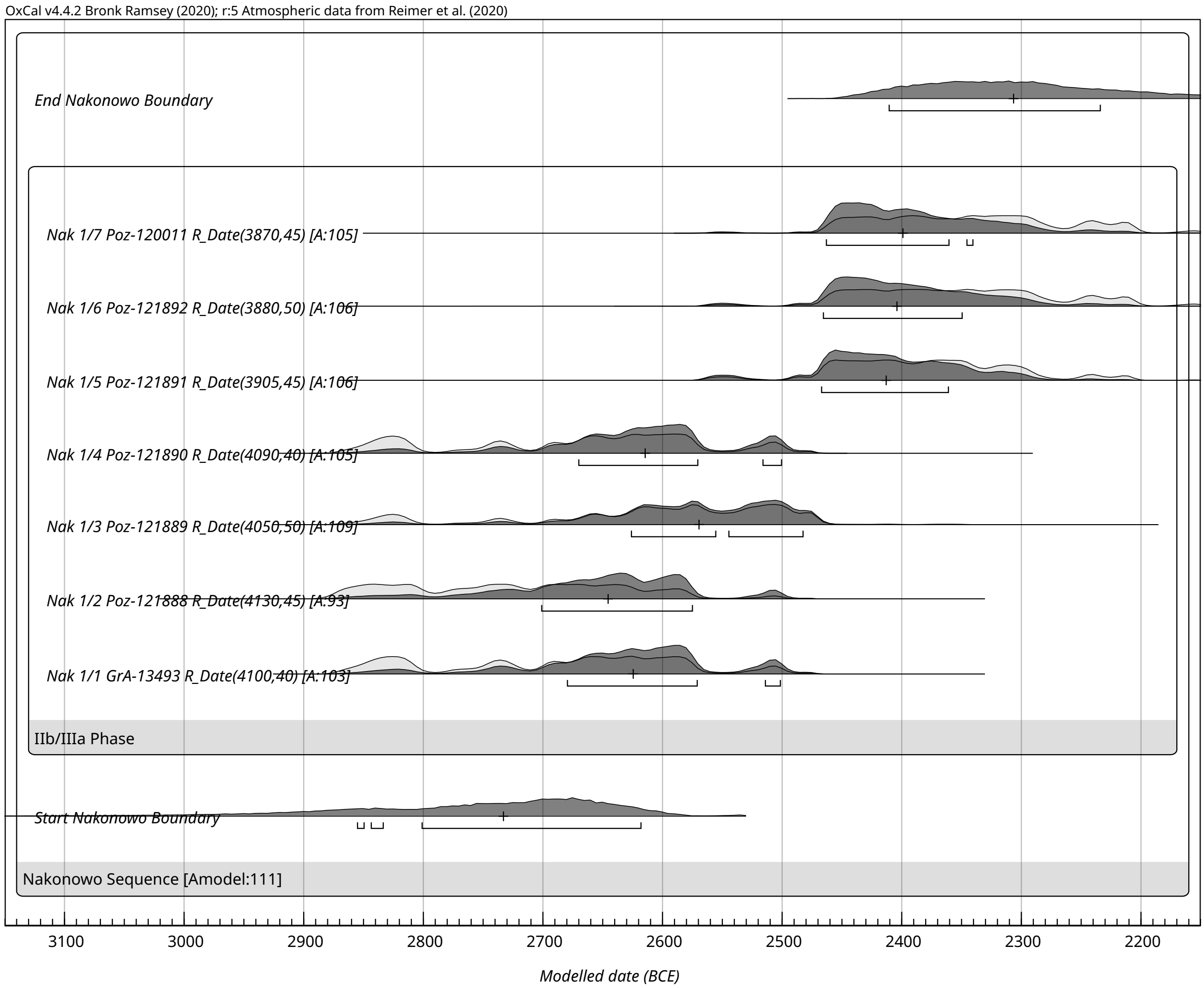


Figure 139. The Bayesian calibrations of Nakonowo (cf. Suppl. 10).

3.3.2.1.2.10 Ludwinowo 3

At the multi-periodical site Ludwinowo 3 GAC cattle depositions and human burials were discovered in addition to GAC pits and two probable wells (Nowak 2017). ^{14}C dates are available from a well (feature 3456), which typologically is associated with the local Late TRB local Radziejów group, and was later infilled probably with GAC-deposits, and from one GAC cattle and two human burials (Papiernik *et al.* 2017; Novak 2017).

The 5 dates available for GAC features derive from two human graves (1558 and 1585) and from a double cattle burial (2555). Beside cattle skeletons, two male skeletons and one female were dated. All dates confirm that the cemetery was set up ca. 3060-2790 BCE (Fig. 140; cf. Papiernik *et al.* 2017). The human and cattle burials are contemporary and typologically belong to the GAC-phases IIb/early IIIa (Nowak 2017).

3.3.2.1.2.11 Lekarzewice 6

At the domestic site Lekarzewice 6 (Fig. 245) (IIb/IIIa) two ^{14}C dates are available from two pits. While one dates relatively young (ca. 2575-2534 BCE) for unknown reasons, the second indicates the expected age (ca. 3010-2895 BCE) (Grygiel 2013, 171; cf. Suppl. 9).

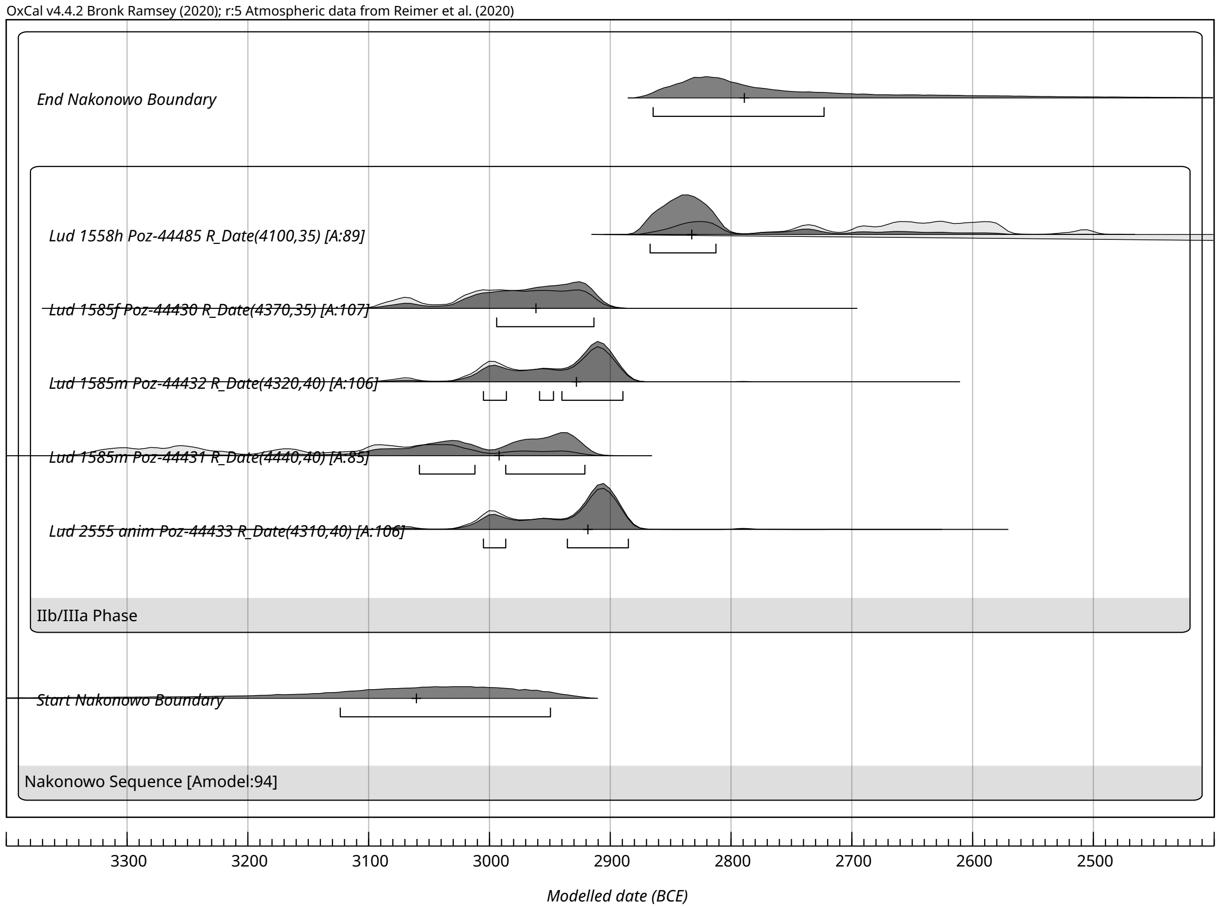


Figure 140. The Bayesian calibrations of Ludwinowo 3 (cf. Suppl. 10).

3.3.2.1.2.12 Summary considerations

The overall calibration of the available data leads to a calibration result from which the beginning of animal depositions without grave goods can be set to about 3260 BCE (Fig. 141), while the first data for classic globular amphorae is pinpointed to ca. 3100 BCE. These are inventories of phases IIb/IIIa. If a differentiation is possible at the sites between phases IIb and IIIa, then phase IIb exists until ca. 2900 BCE (Opatowice, Janowice 2) and the beginning of phase IIIa is around 2900/2800 BCE at the latest (Zegotki 2; Janowice 2, Kowal 14). Phase IIIa lasts at least until ca. 2700/2800 BCE (Janowice 2, Kowal 14, Zegotki 2). If phase IIIb is proven to be the only inventory group without proof of phase IIIa, then it begins around 2500 BCE (Kuczskowo 1) and lasts until ca. 2350 BCE. In summary, the pre-GAC period is dated from 3260-3100 BCE, GAC IIb from 3100-2900/2800 BCE, IIIa from 2900/2800-2600/2500 BCE and IIIb from 2500-2350 BCE. In IIIb, GA in a classical sense are no longer represented, so that the classical GAC ends at ca. 2600/2500 BCE.

Based on different find contexts, it can be observed that early cattle depositions without GA occur from 3500 BCE at the latest and younger cattle depositions without GAC (TRB V) can probably be verified up to 2440 BCE.[36] We observe those with GA from ca. 3060-2290 BCE (Fig. 141). Cattle depositions are already observed – also comparable to those in Central Germany – before the GA in Kuyavia and are verifiable over the entire duration (Fig. 142). Unfortunately, no antipodal cattle burials, such as those found in Bresc Kujawski 4 (Wiślański 1966; Szmyt 2017, 236 fig. 23, 3), were

36 The radiometric data for Kuyavian TRB V with cattle burials (Szmyt 2006b, 3, tab. 1) includes Inowrocław 58 (Gd-7118: 4270±50 bp), Krusza Podlotowa 2 (Gd-1983: 4250±70 bp) and Krusza Zamkowa 13 (Bln-2187: 3920±60 bp).

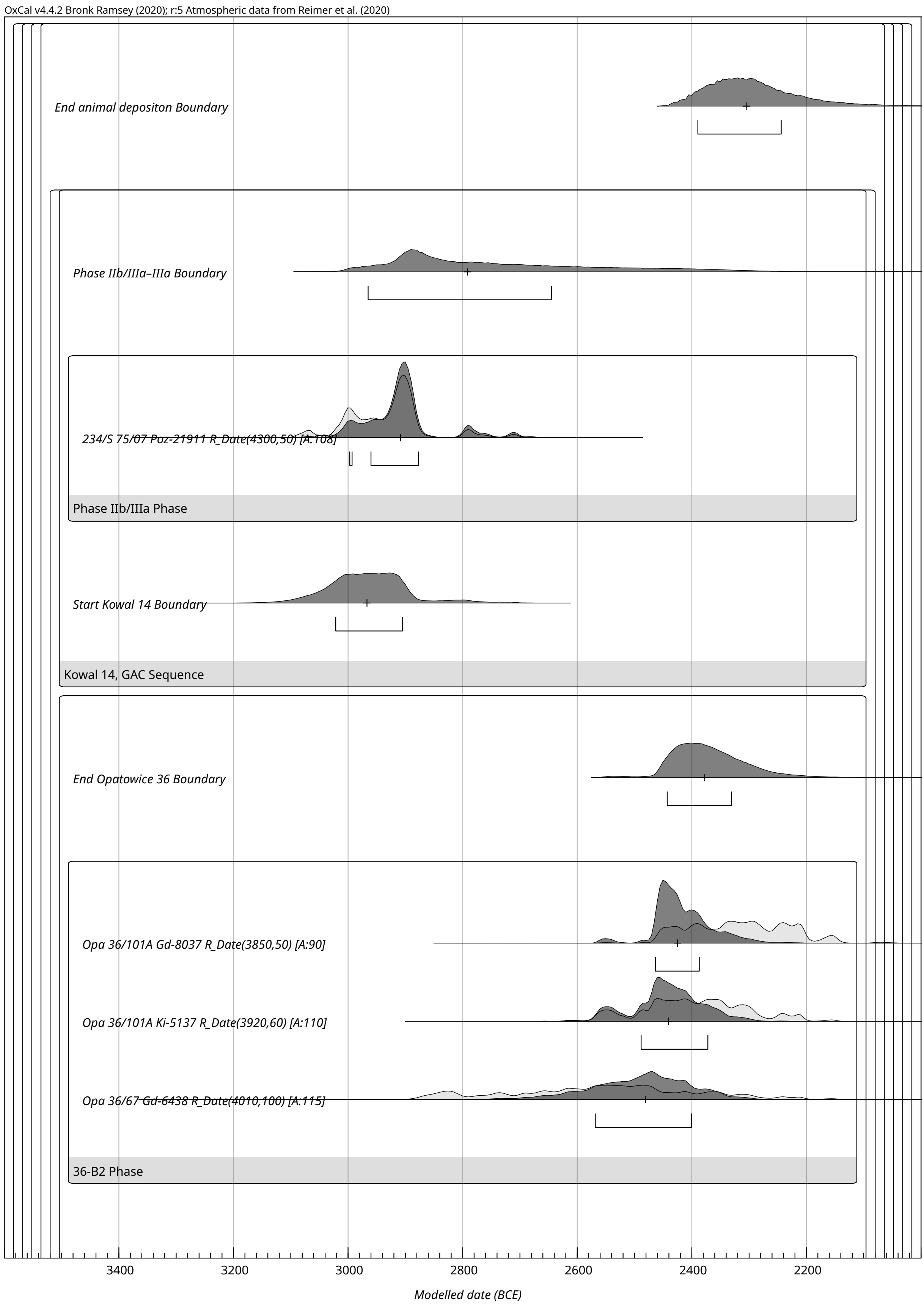


Figure 141. The Bayesian calibrations of the Kuyavian samples differentiated by context categories (cf. Suppl. 10).

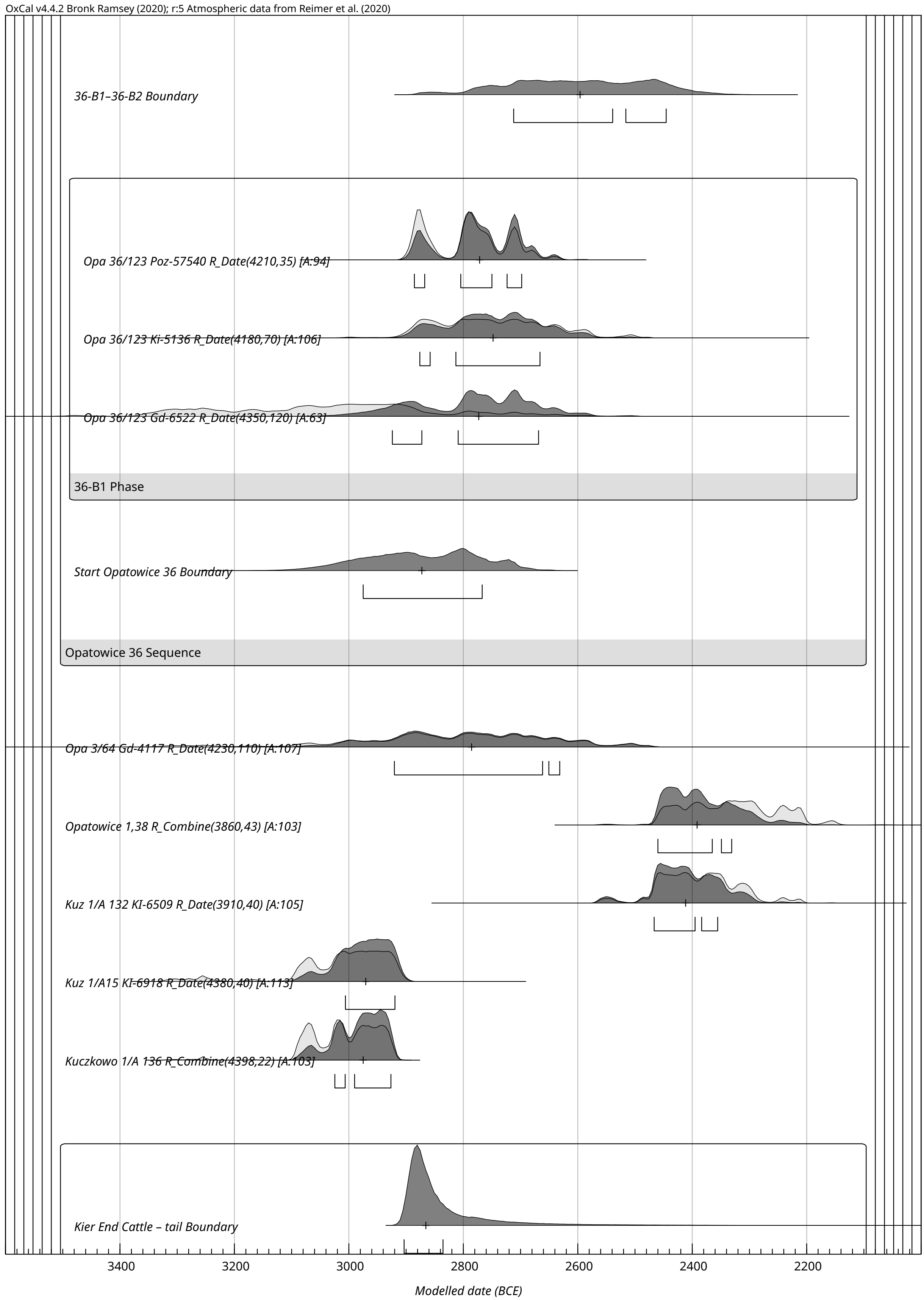


Figure 141. continued.

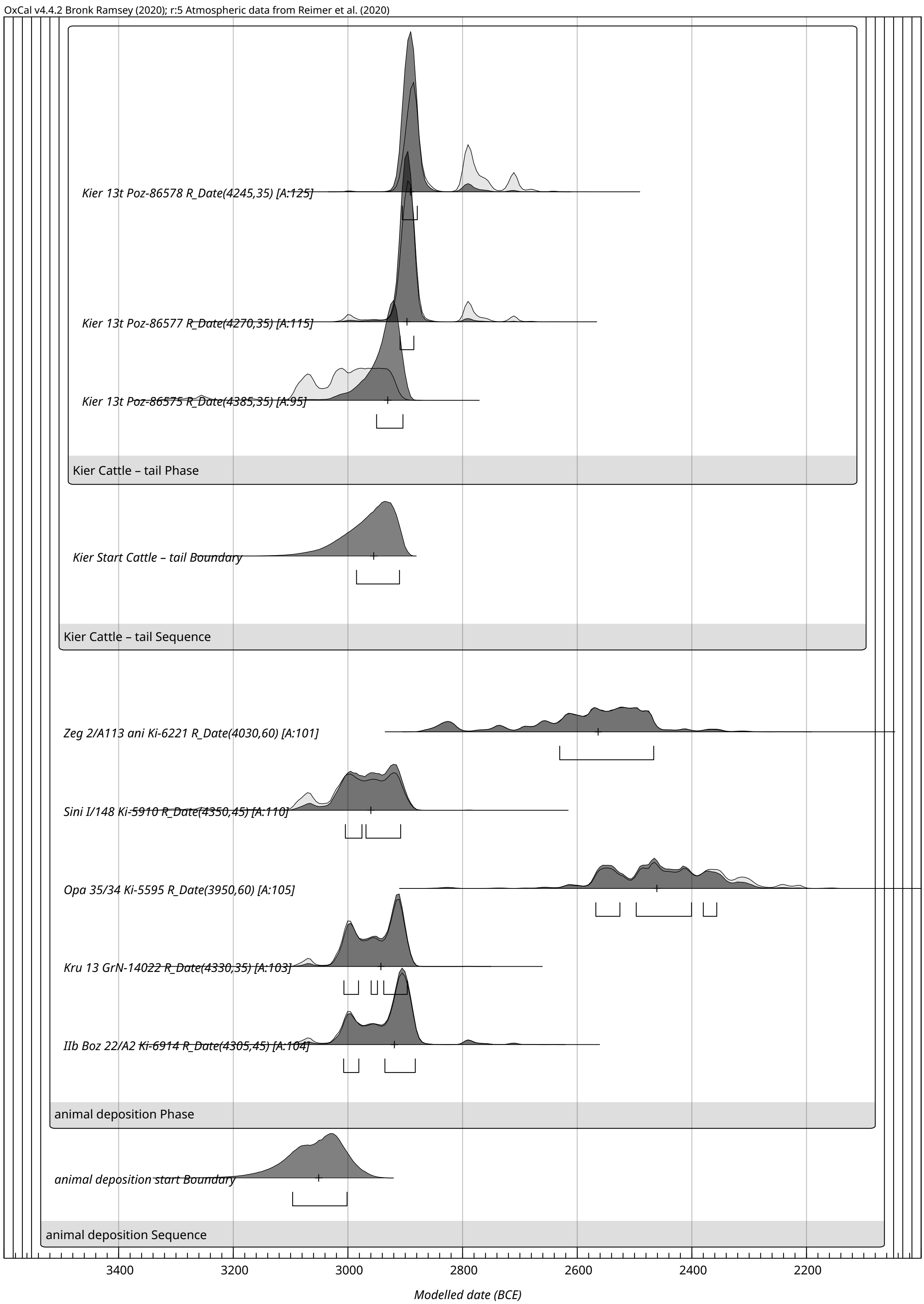


Figure 141. continued.

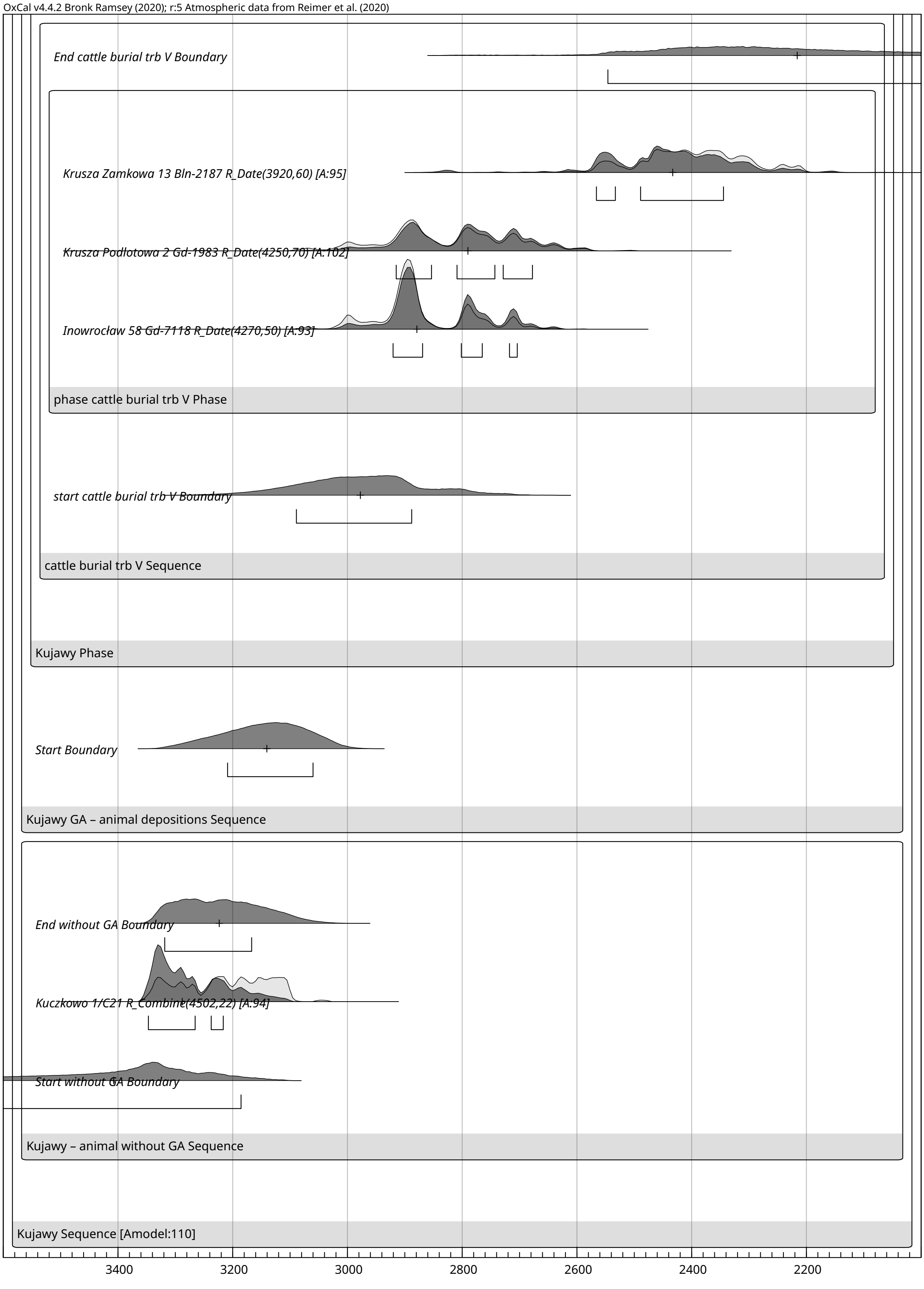
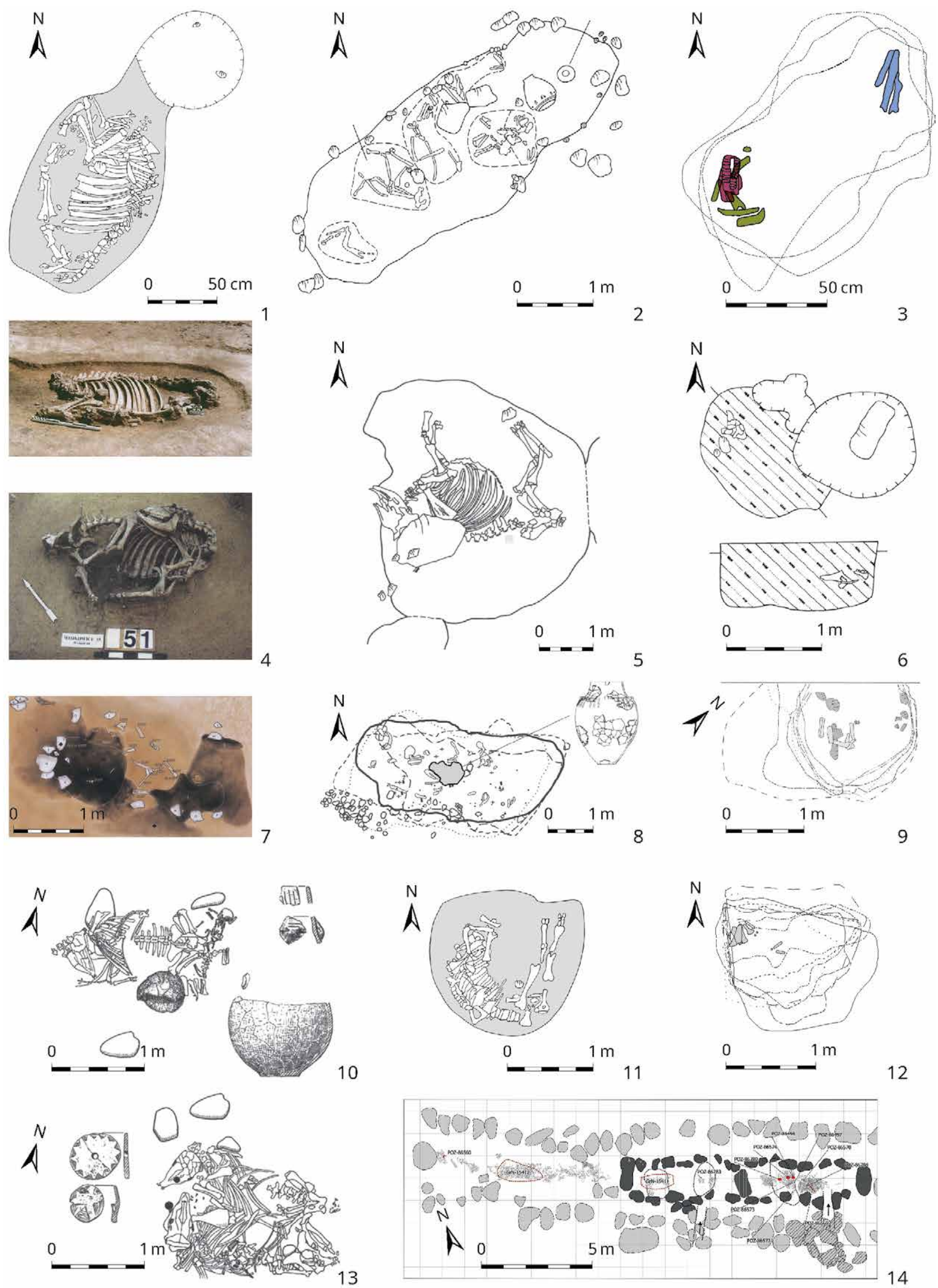


Figure 141. continued.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0 50 cm
1
N
0 1 m
2
N
0 50 cm
3
4
N
0 1 m
5
N
0 1 m
6
0 1 m
7
N
0 1 m
8
N
0 1 m
9
N
0 1 m
10
N
0 1 m
11
N
0 1 m
12
N
0 1 m
13
N
0 5 m
14

dated. The differences highlighted by Marzena Szmyt between partial depositions of animals and deposits of entire skeletons or the number of individuals present (Szmyt 2006b) are not chronologically relevant (although no depositions of two complete cattle were dated, so that the trend recognisable in Central Germany cannot be assessed here using radiometric data).

The performance of ritual acts on stone pavements or packings (referred to as "sub-megalithic") is found in Kowal 14 over a long period of time from ca. 3790-2680 BCE, suggesting similarly long ritual practices. Megaliths are used as burial sites from ca. 3060-2530 BCE, flat graves appear from ca. 2810-2500 BCE, although too few ^{14}C dates are available to make definite assessments. In the settlement remains, we determine a period from ca. 3060-2325 BCE, pit huts even earlier (ca. 3520-2560 BCE). As a result, a development for Kuyavia is observed that is based on pre-GAC ritual practices (animal burials, sub-megaliths), leading to the use of megaliths and the construction of pits in phase IIb, and also the construction of flat graves in phase IIIa.

3.3.2.1.3 Chełmno Land (Kulmerland)

6 radiometric dates are known from the pits of the four settlement sites Bartlewo 21, Linowo 25, Stablewice 4 and Wichorze 24. These are conventional dates, which can be assigned to all inventories of Kuyavian phase IIb (Szmyt 1996, 72; Szmyt 2001, 38. 56, fig. 17) (Fig. 143). In a Bayesian phase calibration, the date from Linowo 25 proves to be an outlier (Gd-6755, too young), so that only the rest of the data provides consistent results. The duration of phase IIb in Chełlmno Land can be set between ca. 3030-2810 BCE (Fig. 144). The data appears to be consistently positioned on the steeper calibration interval 2920-2875 BCE. Although they are conventional dates and charcoals, the dates fit very well in the radiometrically positioned typochronology, for example, of neighbouring Kuyavia. Since phase IIb appears to be even ca. 50 years longer in Chełlmno Land, an old wood effect of the dates can be ruled out in comparison.

Figure 142. Cattle burials and depositions from Kuyavia. 1 – Kuczkowo 1-C2 (after Szmyt 2000a, 183, fig. 11; 185, fig. 13,4); 2 – Krusza Zamkowa 3 (after Szmyt 2001, 44, fig. 4); 3 – Opatowice 36/101A (after Makowiecki et al. 2015, 444, fig. 16.2); 4 – Wojkowice 15 (after Szymt 2017, 236, fig. 23,4); 5 – Zegotki 2 (after Szmyt 2017, 236, fig. 23,1); 6 – Snierzanowo I/148 (after Szmyt 2000, 177, fig. 9); 7 – Kowal 60 (after Osipowicz 2014, 60, fig. 22); 8 – Opatowice 1 (after Szymt 2017, 236, fig. 23,6); 9 – Opatowice 3/64 (after Makowiecki et al. 2014, 440, fig.16,7); 10 – Brzesc Kujawski 4 (after Szymt 2017, 236, fig. 23,2); 11 – Kuczkowo 1-A136 (after Szmyt 2000a, 183, fig. 11); 12 – Opatowice 36/67 (after Makowiecki et al. 2015, 444, fig. 16.1); 13 – Brzesc Kujawski 4 (after Szymt 2017, 236, fig. 23,3); 14 – Kierzkowo (after Nowaczyk et al. 2017, suppl.).

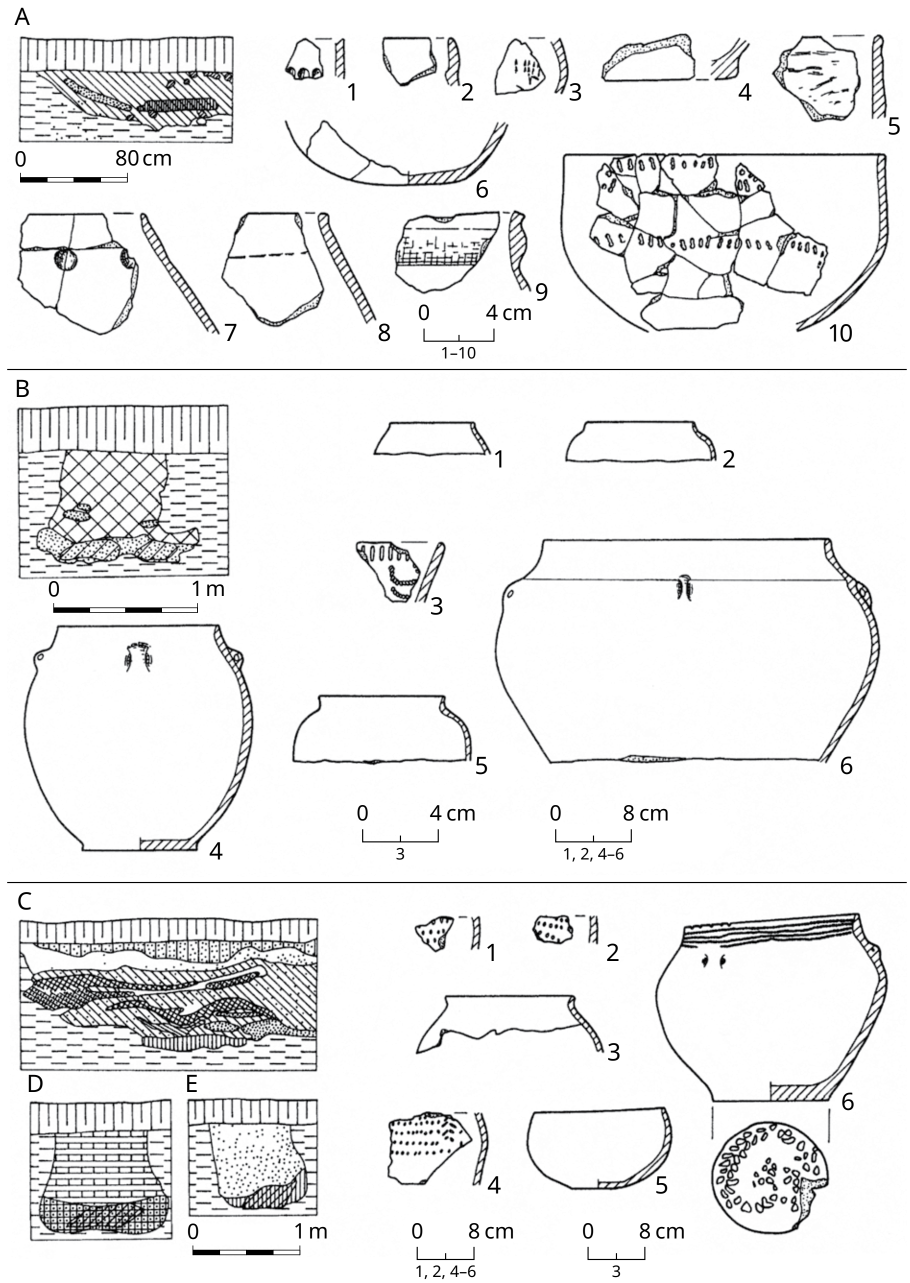


Figure 143. GAC assemblages from Chelmno Land. a – Stablewice 4, feature 1; b – Wichorze 24, feature 2; c – Bartlewo 21, feature 2; d – Bartlewo 21, feature 9; e – Bartlewo 21, feature 8 (after Szmyt 2001, 38.56, fig. 17).

3.3.2.1.4 Upper Narew and South East Baltic Sea

To the east, in Podlasie on the Upper Narew River, the tomb of Bransk-Khojewo is located, from which a human bone (Ki-6909) dates from 3020-2900 (median 2970) BCE (Fig. 145). At the Baltic Sea, four dates from layers 4 and 6 in Sventoji are likely to reflect GAC influence, probably affective from ca. 2840-2610 BCE based on Bayesian calibration (Fig. 146).

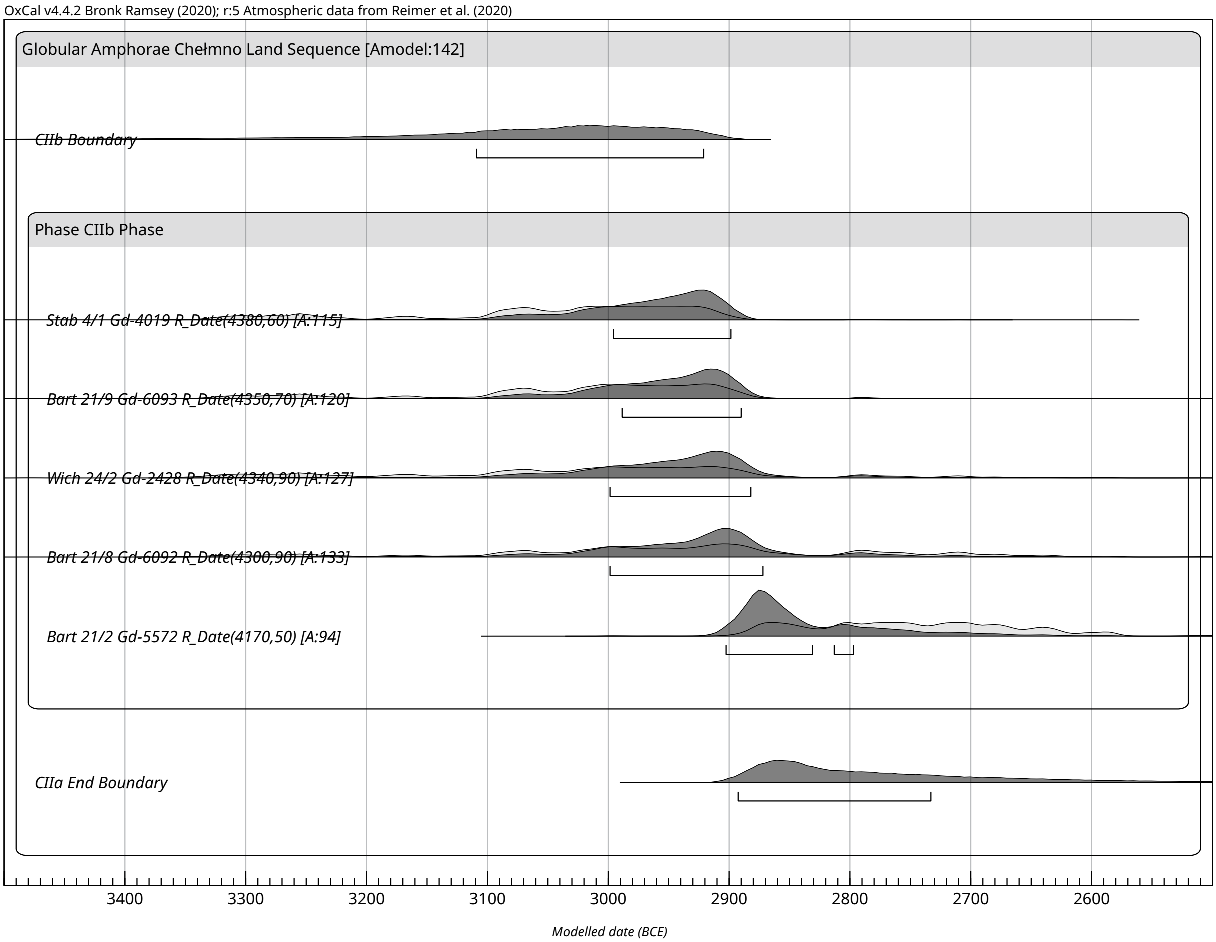


Figure 144. The Bayesian calibration of Chelmno Land (cf. Suppl. 10).

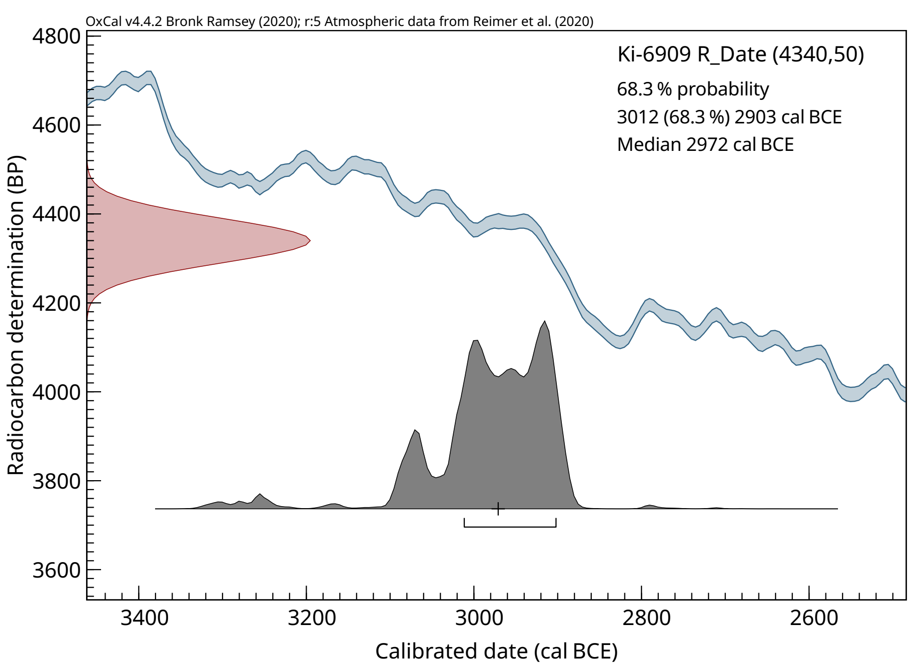
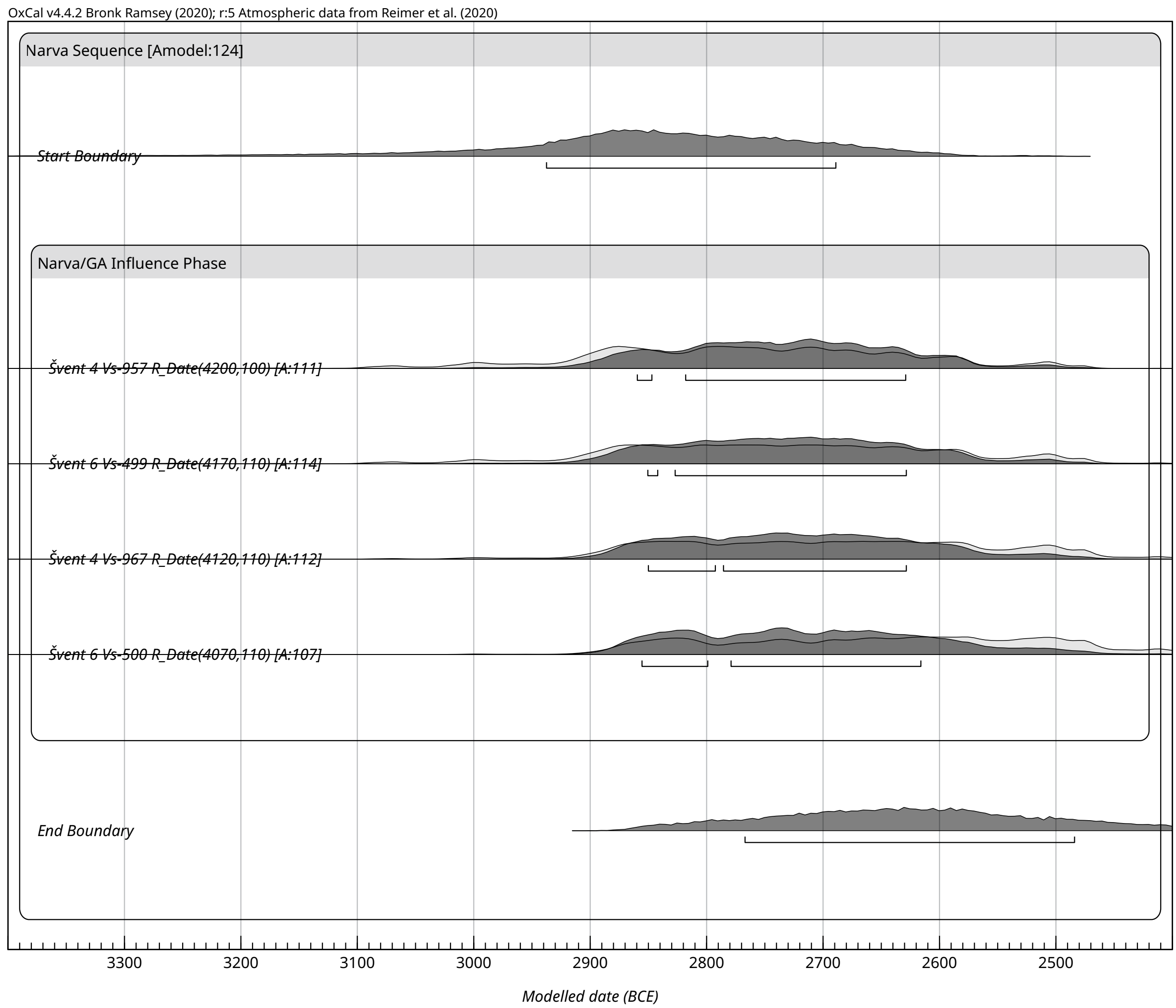
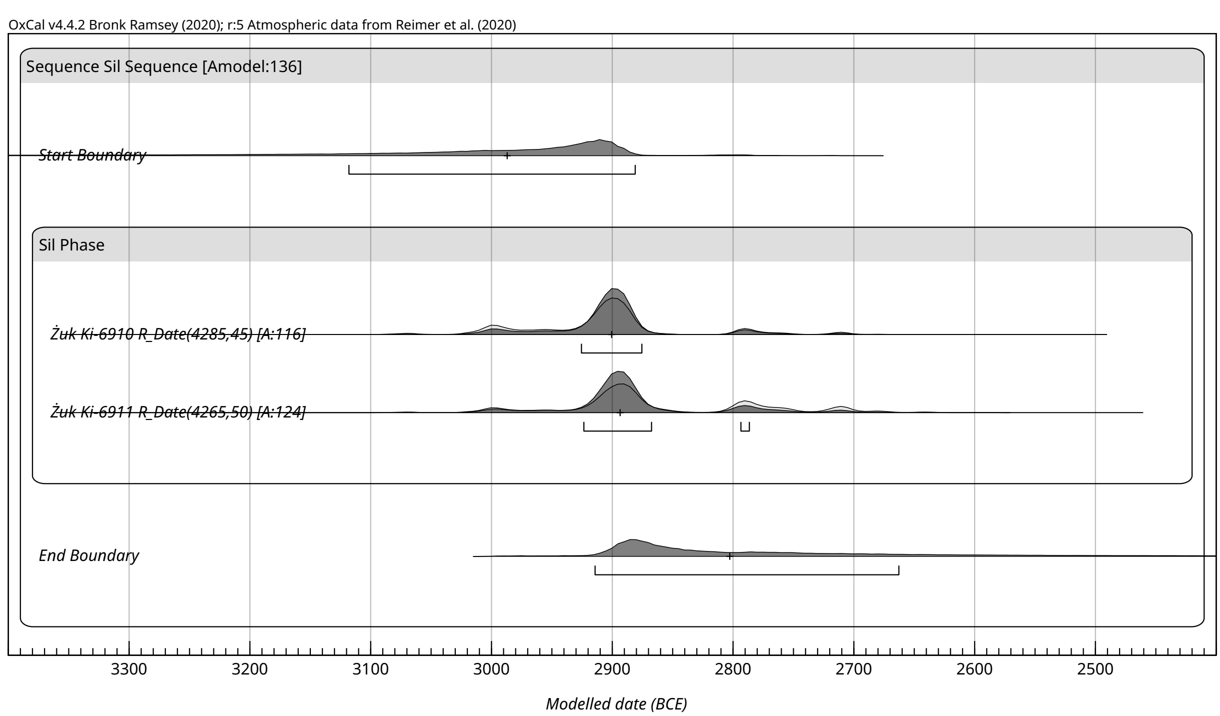


Figure 145. Bransk-Khojewo, Podlasie on the Upper Narew River. The calibrated sample from human bone (cf. Suppl. 10).


OxCal v4.4.2 Bronk Ramsey (2020); r:5 Atmospheric data from Reimer et al. (2020)
Narva Sequence [Amodel:124]
Start Boundary
Narva/GA Influence Phase
Švent 4 Vs-957 R_Date(4200,100) [A:111]
Švent 6 Vs-499 R_Date(4170,110) [A:114]
Švent 4 Vs-967 R_Date(4120,110) [A:112]
Švent 6 Vs-500 R_Date(4070,110) [A:107]
End Boundary
3300 3200 3100 3000 2900 2800 2700 2600 2500
Modelled date (BCE)


OxCal v4.4.2 Bronk Ramsey (2020); r:5 Atmospheric data from Reimer et al. (2020)
Sequence Sil Sequence [Amodel:136]
Start Boundary
Sil Phase
Żuk Ki-6910 R_Date(4285,45) [A:116]
Żuk Ki-6911 R_Date(4265,50) [A:124]
End Boundary
3300 3200 3100 3000 2900 2800 2700 2600 2500
Modelled date (BCE)

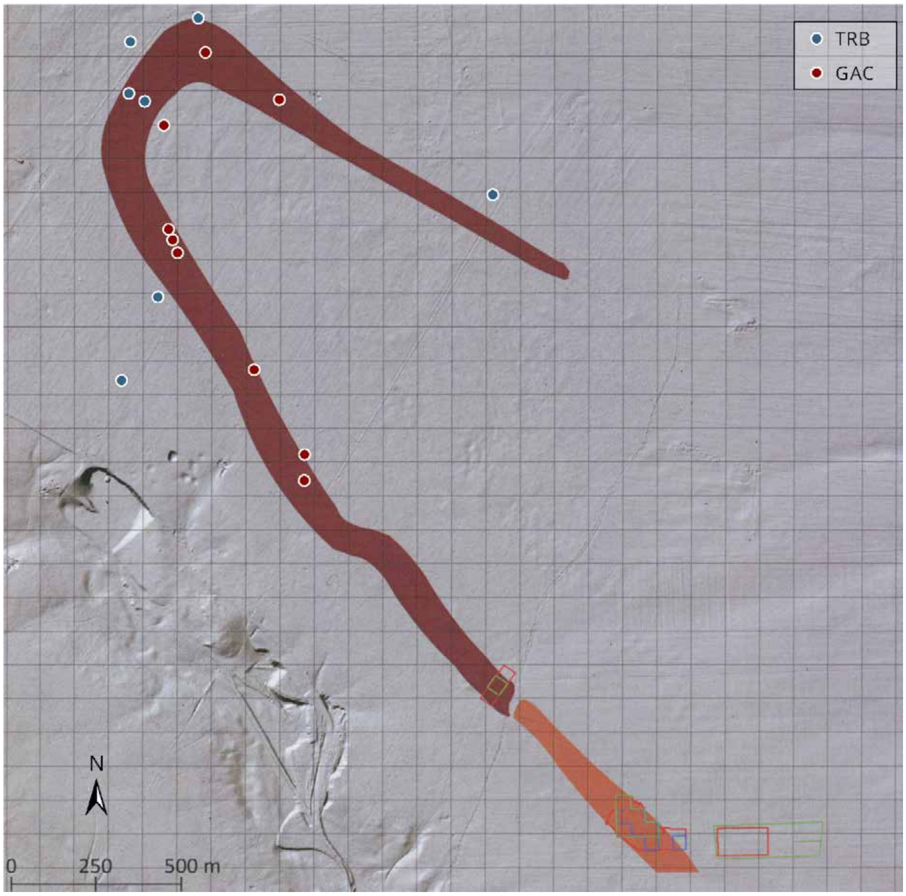


Figure 148. The Krzemionki silex mine with TRB and GAC areas (after Borkowski 1995, 30, fig. 13; Jedynak and Wronicki 2022, 57, fig. 10).

3.3.2.2 Eastern low mountain range zone with plateaus

3.3.2.2.1 Lower Silesia

As already determined by Marzena Szmyt in 2000 (Szmyt 2001, 29), only two conventional radiometric dates from Zukowice near Glogow are available from the Central Oder region in spite of numerous GAC settlement sites. The date (ca. 2990-2800 BCE, Fig. 147) corresponds with expectations for the classic Globular Amphora phase.

3.3.2.2.2 Northeast Lesser Poland

From the area of Lesser Poland and Sandomierz west of the Elbe River, there are 59 radiometric dates available; from the mass grave of Koszyce, from the burial sites of Złota-Gajowizna, Mierzanowice, Sandomierz-Kruków and Malice, two from the domestic site Wilczyce 10 and seven from the surrounding area of the flint mine in Krzemionki Opatwskie, for which the association with GAC is not entirely secure (Borkowski 1995). The eight dates from Krzemionki and Sandomierz are conventional dates, the others are all AMS values (Witkowska *et al.* 2020, 78, tab. 2; Witkowska 2021; Witkowska *et al.* 2021; Pasterkiewicz 2021).

With Bayesian calibration, the dates from Krzemionki (Fig. 148), which cannot be clearly assigned typologically, are earlier than those from Wilczyce 10 (probably Lublin phase I), and from all the other sites, which can be typologically assigned to the Lublin phase II (see below) (Fig. 149). Thus, we would have a date of the mine from ca. 3150-2965 BCE and the graves from ca. 2940-2520 BCE. However, conventional charcoal dates from Krzemionki are also compared here with AMS dates from the other sites, so that the dating differences could also be the result of an old wood effect of the charcoal.

Figure 146 (left, above). The Bayesian calibrations of four dates from layers 4 and 6 in Sventoji, Latvia (cf. Suppl. 10).

Figure 147 (left, below). The Bayesian calibrations of dates from Zukowice near Glogow, Lower Silesia, Poland (cf. Suppl. 10).

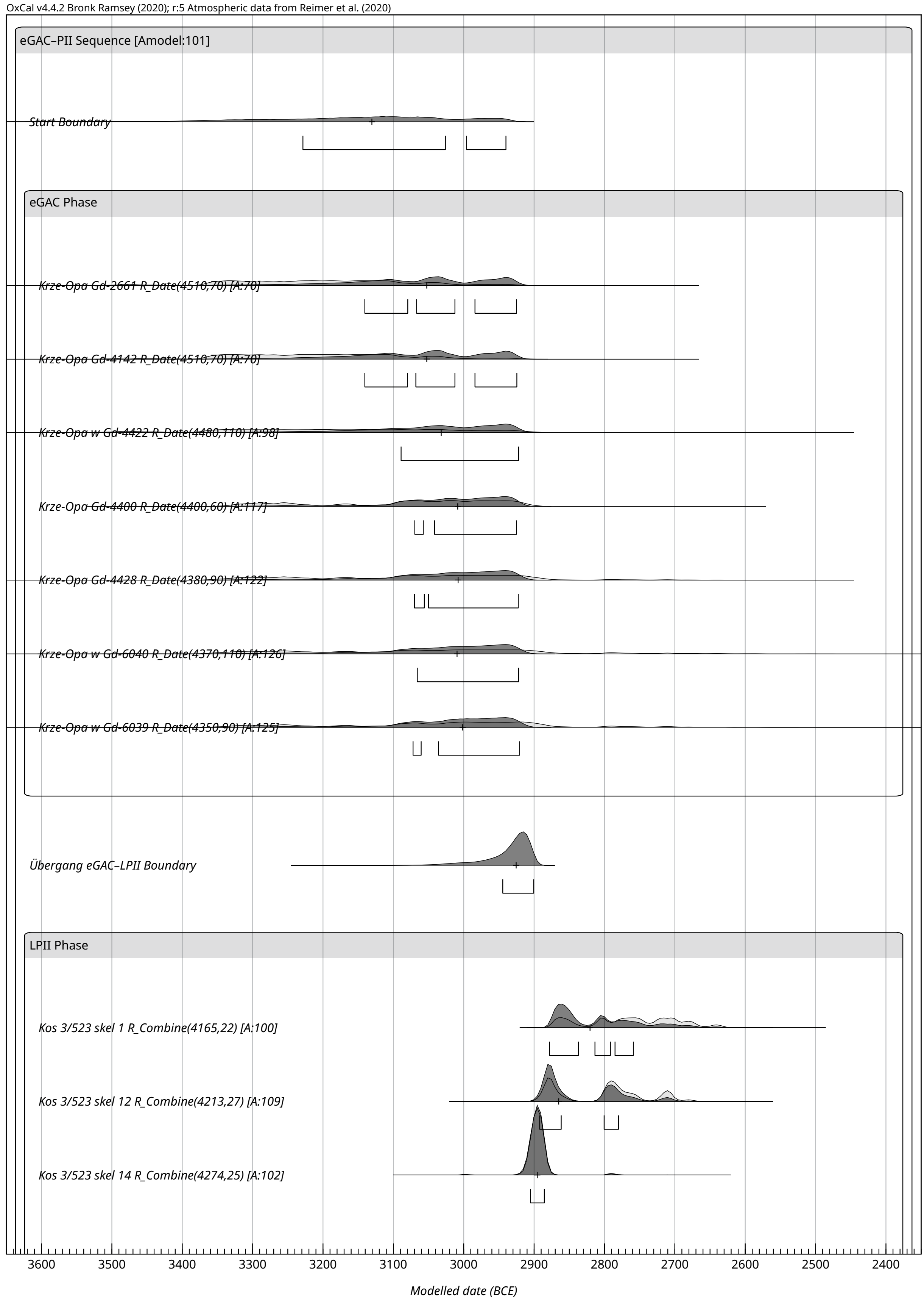


Figure 149. The Bayesian calibrations of dates from Lesser Poland (cf. Suppl. 10).

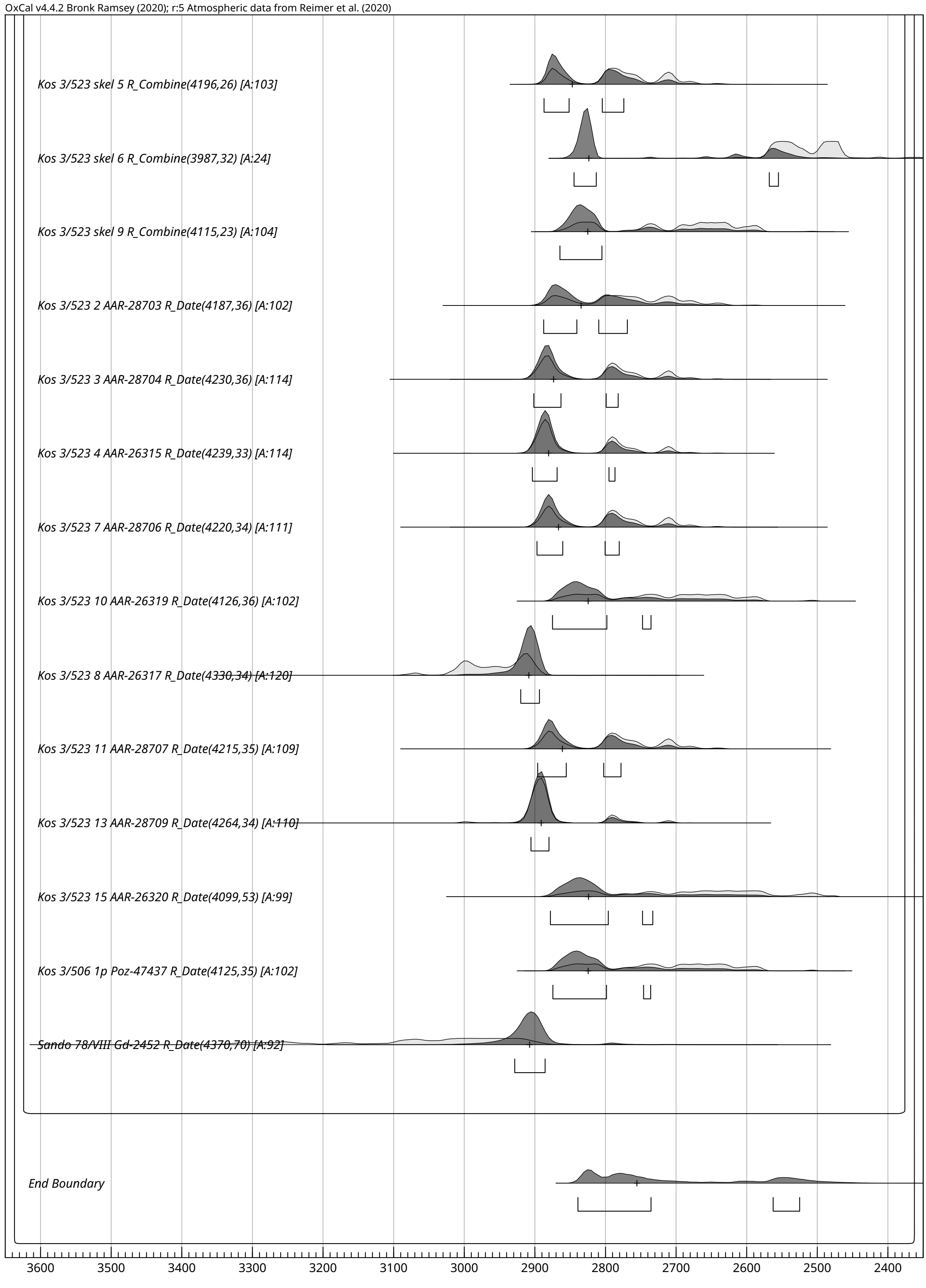


Figure 149. continued.

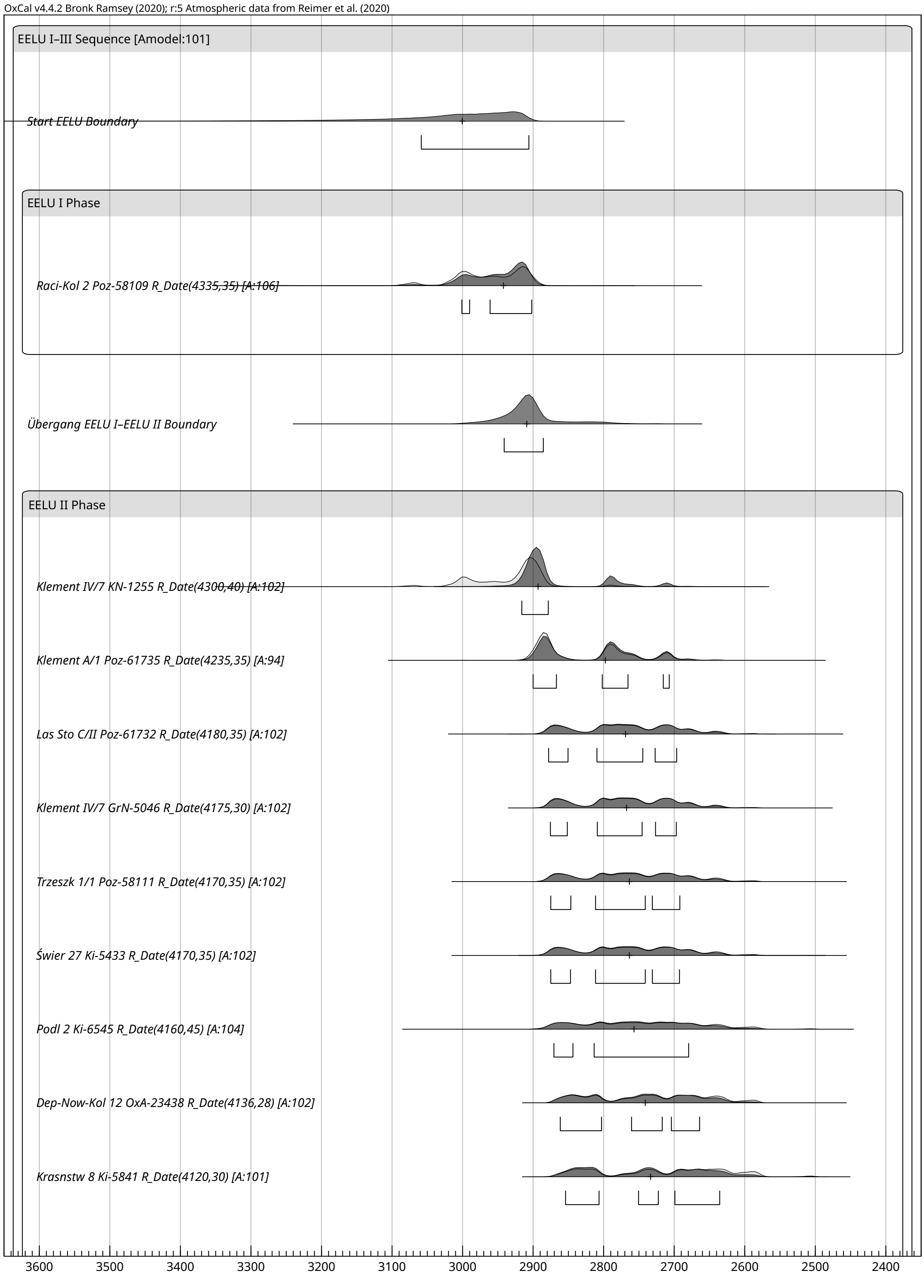


Figure 149. continued.

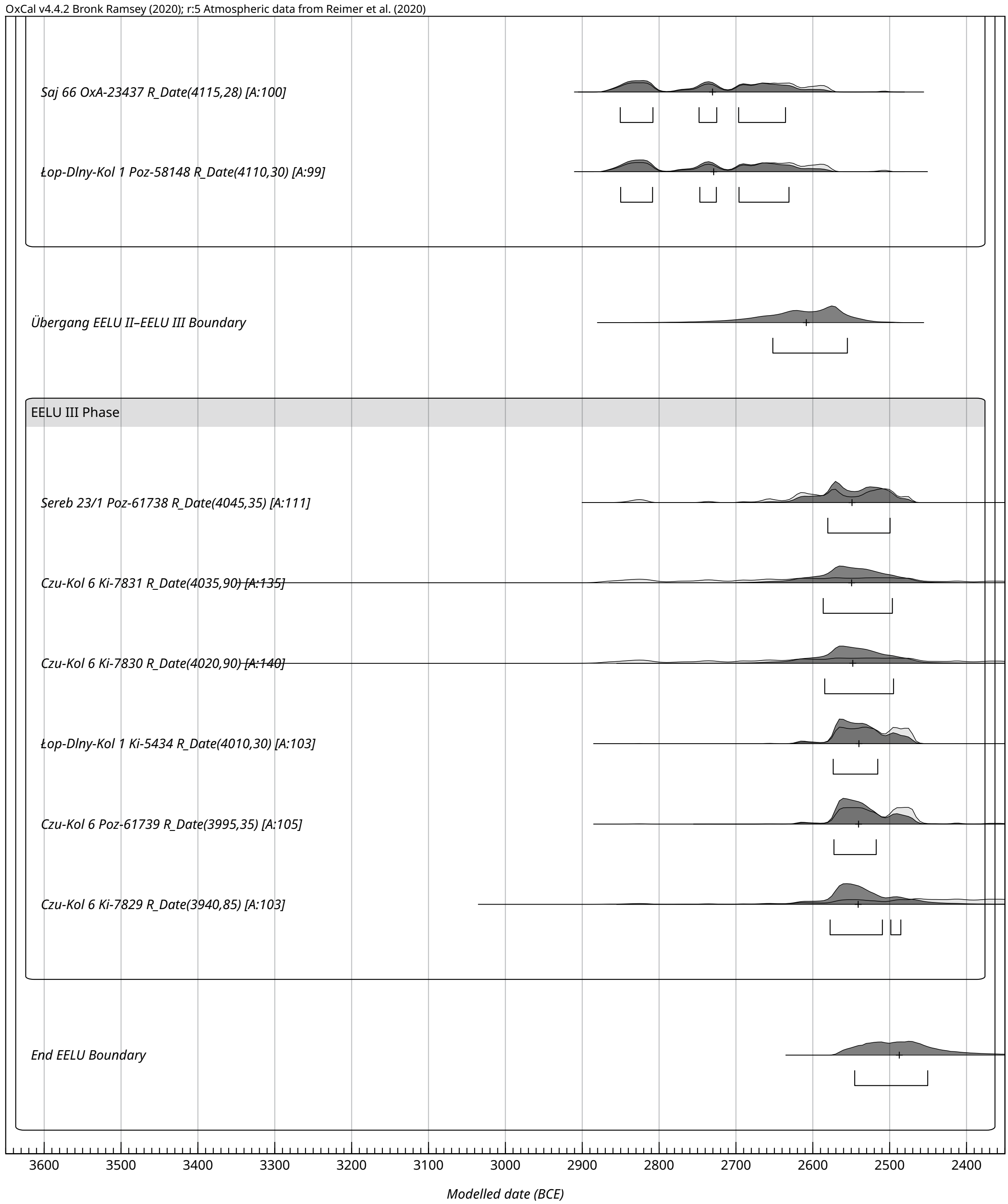


Figure 149. continued.

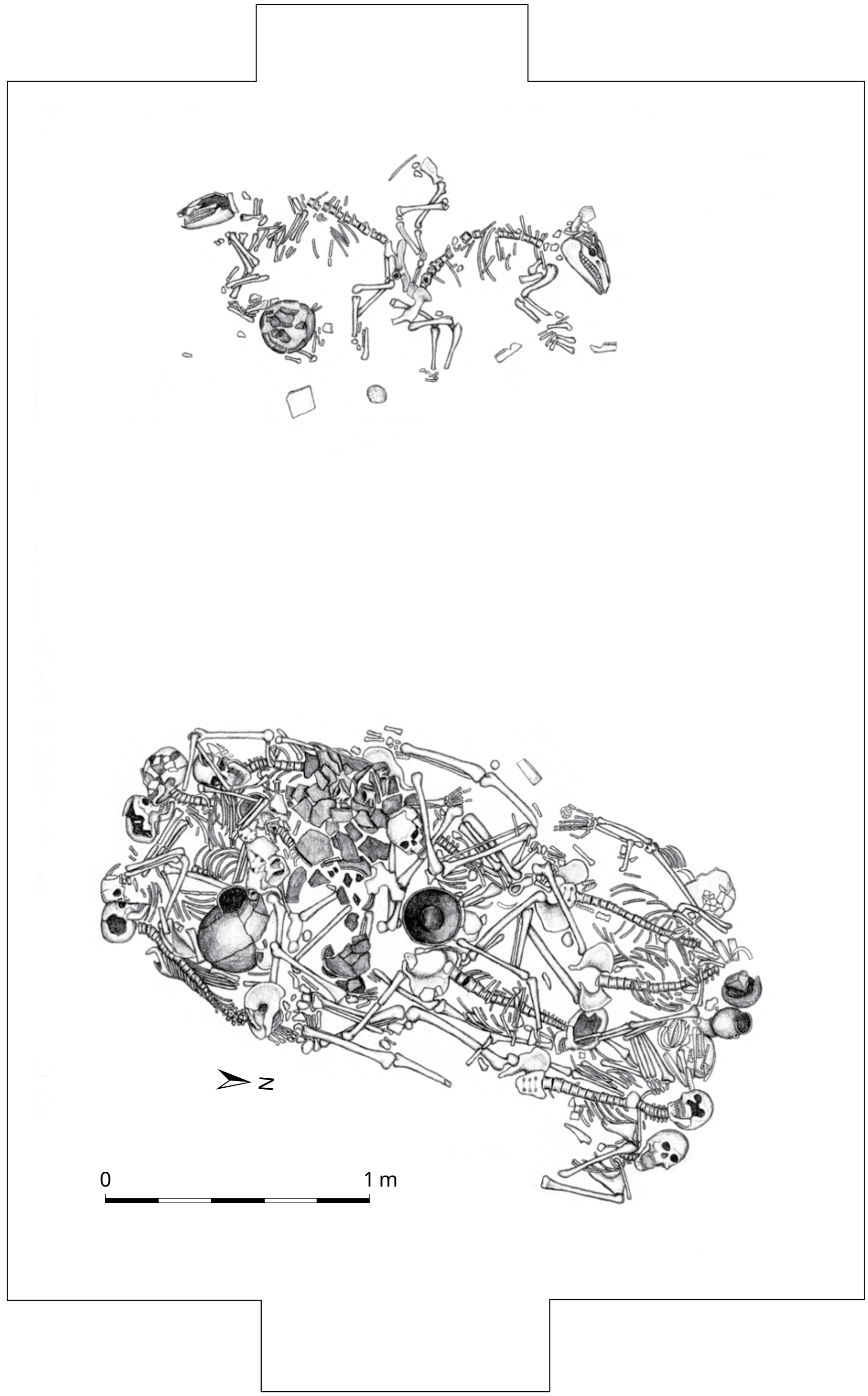


Figure 150. The human and animal group burials of Koszyce, Lesser Poland were buried synchronously based on the archaeological context and artefacts (after Przybyla et al. 2013, 12, fig. 1).

In Koszyce, we can assume that the burials were synchronously buried based on the archaeological context and artefacts (Fig. 150). For skeletons with more than one ^{14}C date, there are discrepancies that indicate a small misdating.[37] Thus, dates Poz-47439, AAR-28710 and Ua-45619 were excluded. Why skeleton 6 dates younger with AAR-26316 and AAR-26318 is unclear. Admittedly, it is a skeleton lying on top

37 And in the combined calibration, a fit is prevented in skeletons 1, 9 and 14.

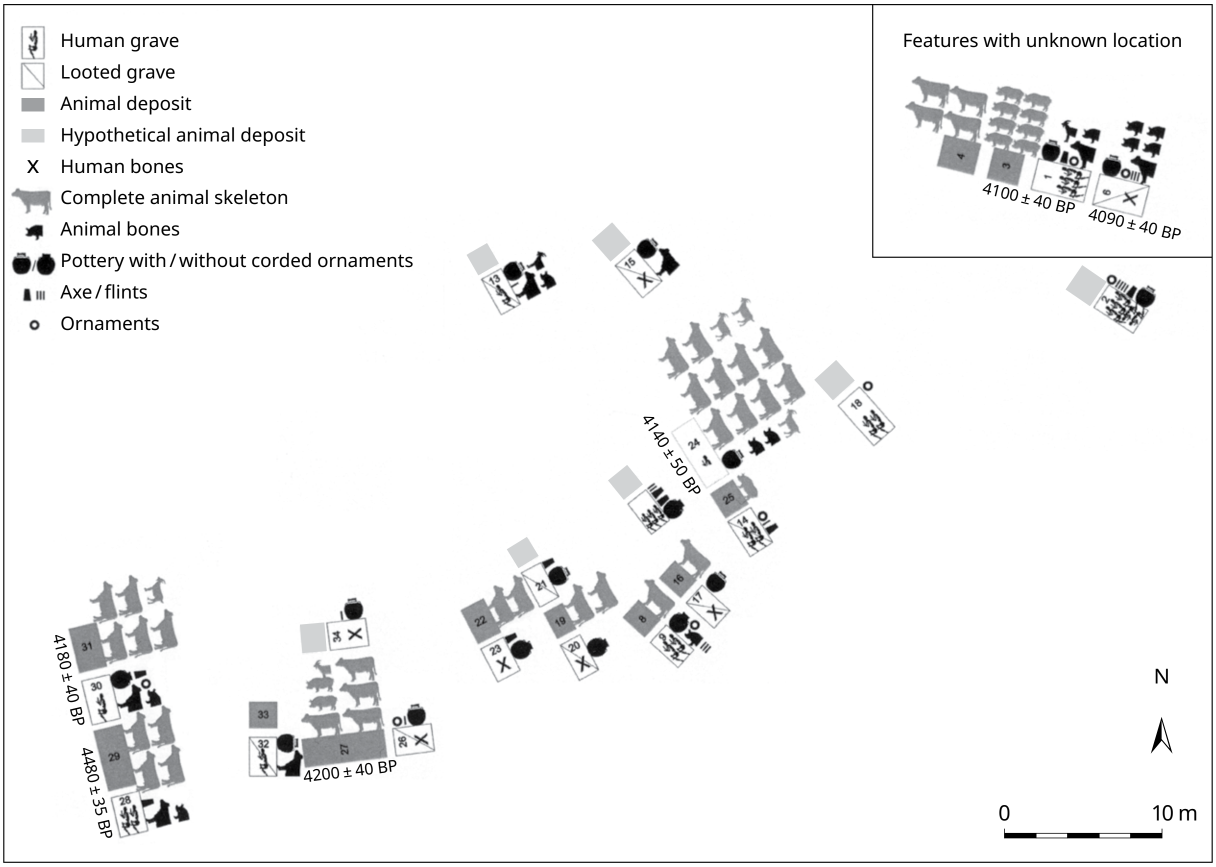


Figure 151. From Złota-Gajowizna, Lesser Poland, many animal burials and deposits as well as human burials were dated (after Witkowska et al. 2020, 75, fig. 9).

that is not overlaid by any other skeleton. However, a vessel above it is associated with the entire ensemble, so that a simultaneous deposition with the other burials can also be assumed here.[38] Furthermore, there are certain differences between the laboratory values from Aarhus, Poznań and Uppsala concerning the AMS dates of Koszyce. Even with this selection, the Bayesian Calibration produces clear results (Fig. 149). A combined date of the Koszyce dates leads to a range that roughly corresponds to that provided recently (ca. 2880-2776 BCE; Schroeder *et al.* 2019): ca. 2880-2780 BCE.

In 1926, investigations at Złota-Gajowizna (Witkowska *et al.* 2020; Witkowska 2021) discovered 18 Late Neolithic human burials and 12 animal depositions (Fig. 151). Samples could be analysed from six features that are related to the GAC: an animal deposit with eight pigs and a single bear bone (feature 3), a damaged human grave (feature 6), a complex with 10 cattle skeletons and human bones (feature 24), an animal deposition with four cows, two pigs and sheep and goat bones (feature 27) which are associated with a human grave, a human double grave (feature 28), and an animal deposit with five cows and one sheep/goat (feature 31). Nine radiometric dates were obtained from Gajowizna, of which 8 belong to the GAC. The attempt to date wooden remains from grave 28 resulted in two ^{14}C dates within a 31 year-ring distance, ending with a date of 3333-3025 BCE which is dismissed by the investigators (Witkowska 2021, 31-32):

> *'The false seniority of the sample [...] results in all likelihood from the special nature of the organic material used for dating.'*

38 No deviations from other skeletons are found in the isotopy.

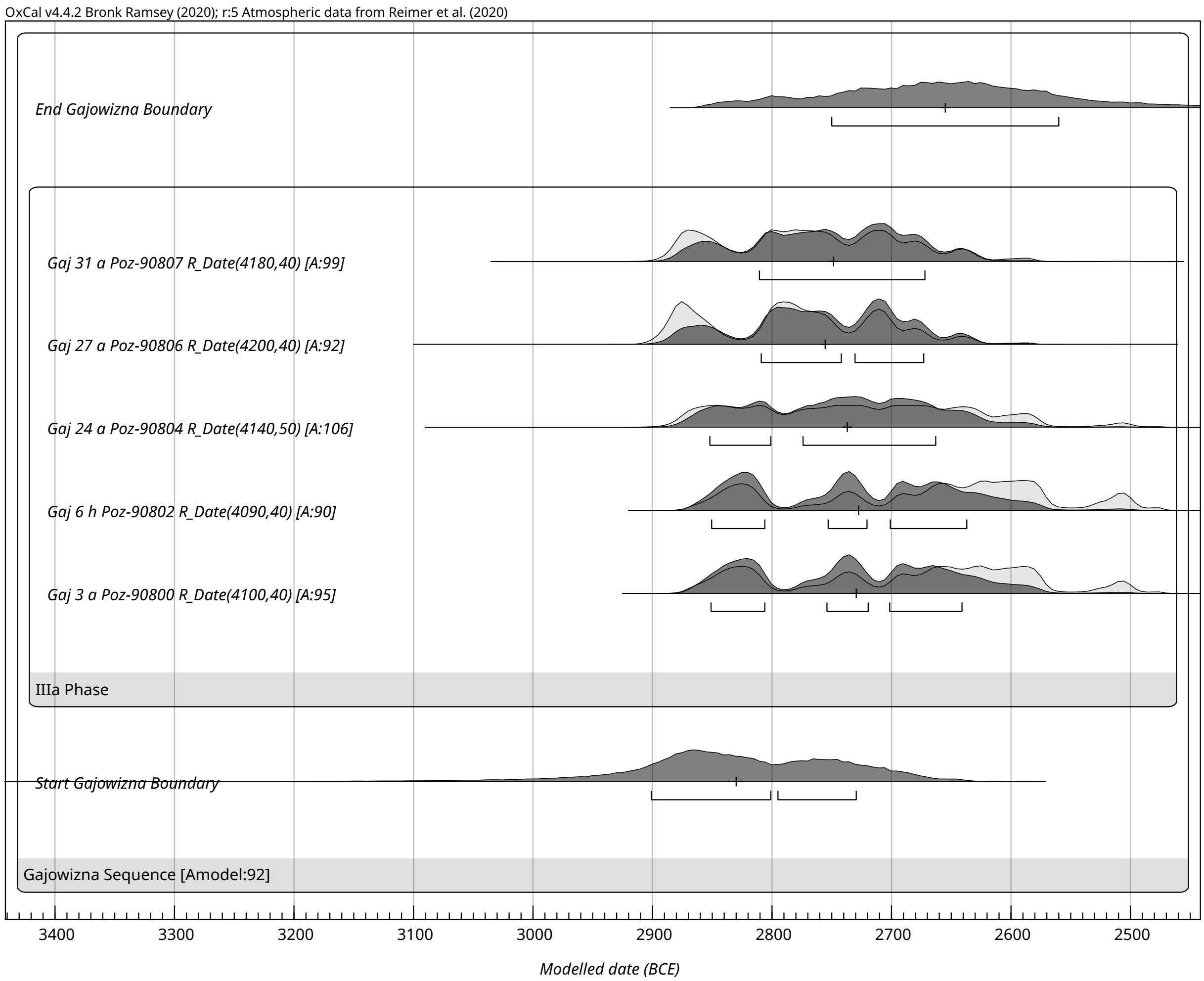


Figure 152. The Bayesian calibrations of dates from Złota-Gajowizna, Lesser Poland (cf. Suppl. 10).

Furthermore, two dates which were much too young were rejected by the investigators. The bone material had probably been mixed during the long timespan since the excavation. The remaining 5 dates all fall into a timespan ca. 2830-2560 BCE (Fig. 152).

Six dates are known from Sandomierz-Kruków, of which four are well-documented and could be accepted. An old wood effect can be assumed for the date from Grave 8 (Gd-4252 4370+70 bp, charcoal (Ścibior 1990: 195)), in contrast to the human bone dates from the burial (AAR-? 4222+23 bp (Schroeder *et al.* 2019); Poz-90784 4155+35 bp).[39] The assemblage dates to ca. 2891-2697 BCE (Witkowska *et al.* 2021).

From the domestic and burial site Mierzanowice 1 (Witkowska 2021), three dates on human bones from three different individual burials probably date into the 28th century BCE (Fig. 149).

From the cemetery of Malice 1 (Witkowska 2021; Witkowska *et al.* 2021) 10 dates are known from three features. The samples provide dates for a cattle deposition (one animal bone sample from feature 31), four individuals in the multiple burial (8 human bone samples from feature 32) and a further individual burial (another human bone sample from feature 33). For grave 32, a Bayesian dating was already conducted by Barbara Witkowska (Witkowska *et al.* 2021), in which the different

39 Witkowska *et al.* 2021, 32 mentions a further date GrN-20927 3950+30 bp (letter of A. Lanting to K. Tunia from 1996).

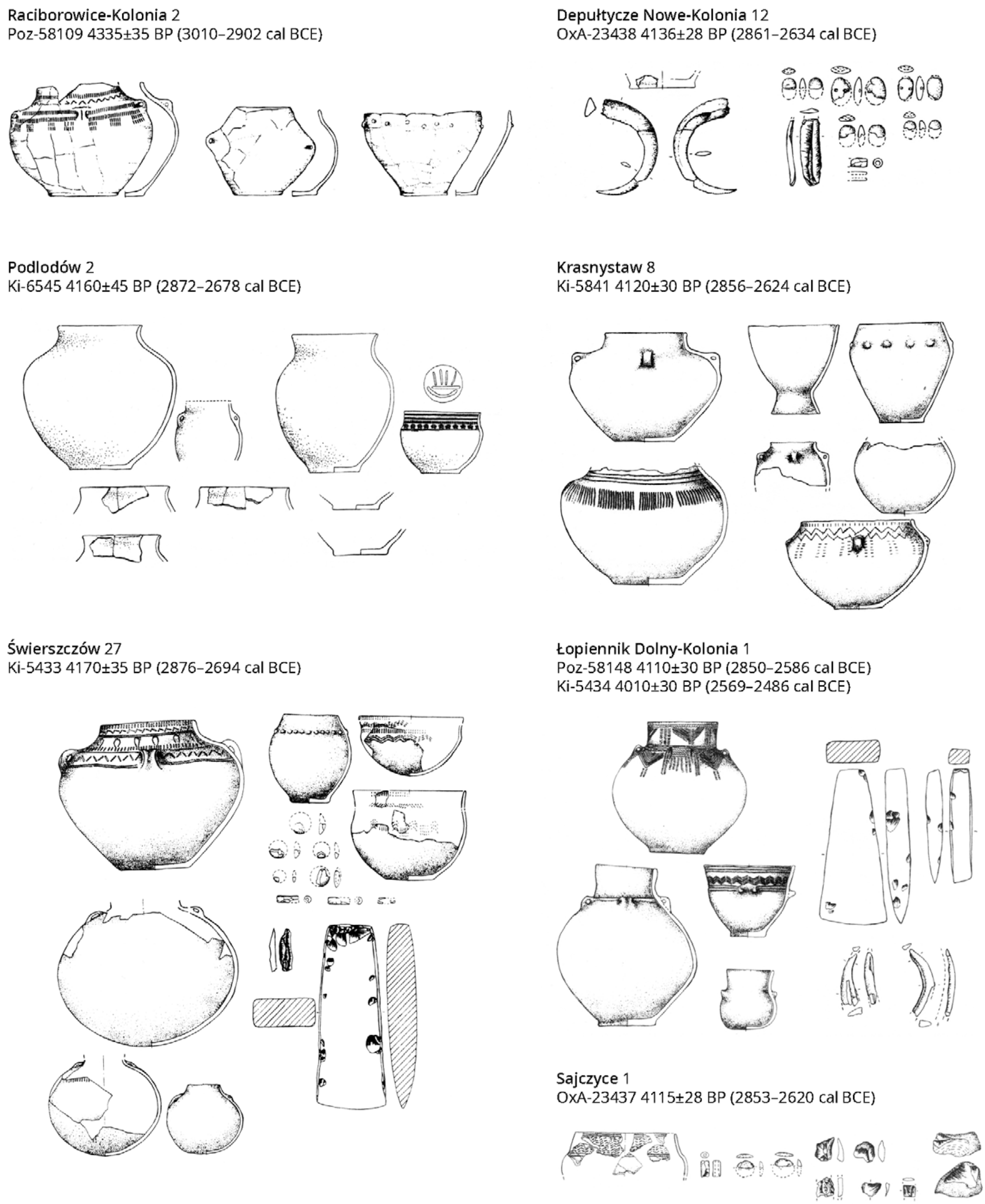


Figure 153. With new radiometric dates of Lublin Upland grave inventories, a chronological differentiation into 3 phases was possible (after Bronicki 2019, 213-215, fig 4-6). Phase 1 is only represented by one radiometric date. In addition to changes in the vessel forms in phases 2 and 3, there is also a change from pit and stone cist graves to exclusively stone cist graves (after Bronicki 2019).

life age of the individuals was taken into account. As a result, the stratigraphically-older skeleton D has an age range of ca. 2860-2819 BCE, the stratigraphical-youngest skeleton A an age range of ca. 2850-2628 BCE and the stratigraphically-intermediate skeletons B and C, which are contemporary, an age range of ca. 2863-2751 BCE.

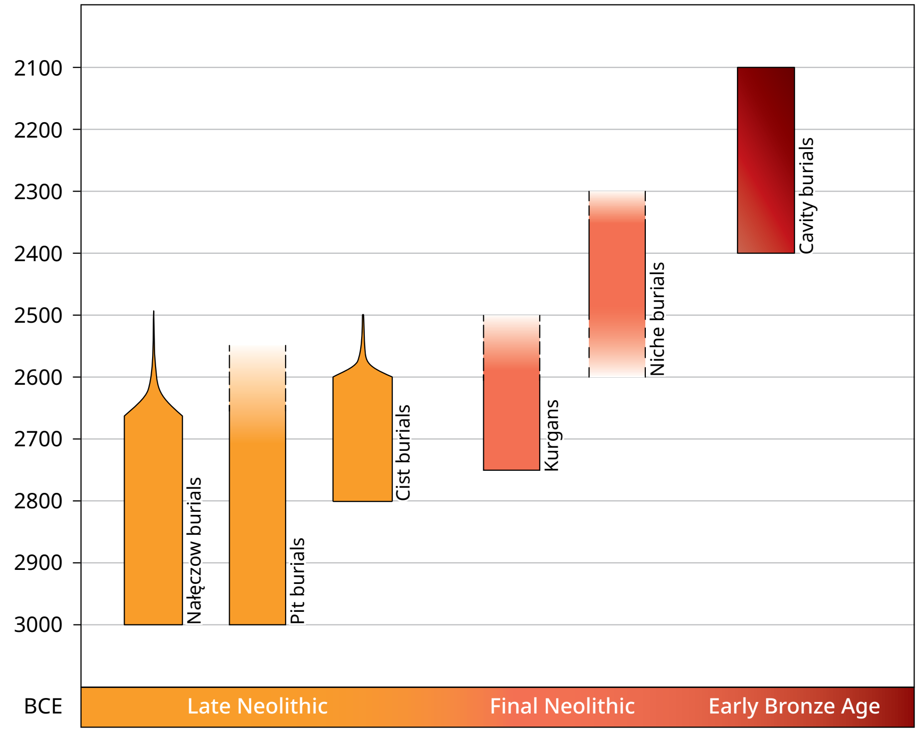


Figure 154. Different types of burial mounds existed partly contemporaneously in Lesser Poland and the Lublin Uplands (after Wlodarczak 2016b, 551, fig. 1).

From the burial ground of Sadowie 23 (Pasterkiewicz 2021) 5 dates on bones from 5 burials probably date into the 28th or 27th century BCE. While the dates from Graves 1 and 4 belong to humans, the dates from graves 3-4 and 7 belong to cattle depositions; in burial 3 a single cattle burial, in the two others from double cattle burials.

Overall, as all the aforementioned site assemblages are typologically similar to the phase LPII inventories of the Lublin Upland (cf. Fig. 153), the GAC phase LPII in eastern Lesser Poland appears to date from ca. 2950-2520 BCE.

The only inventories which might typologically be linked to the phase LPI were recently dated at the domestic site Wilczyce 10 (Lesser Poland). Two radiometric dates derive from two pits of a GAC domestic site (Boron *et al.* 2021) and date to ca. 3075-2950 BCE (Fig. 149).

With the uncertainty of old wood effects at Krzemionki, we therefore assume an occupation of the GAC between ca. 2950 and 2520 BCE, whereby the use of the Krzemionki mine from ca. 3150 BCE by GAC groups seems possible.

3.3.2.2.3 Lublin Uplands (East Lublin Group and Naleczowska Group)

With a chronological classification oriented according to decoration patterns and vessel forms, three alternating phases can be distinguished by radiometric dates of Lublin Upland grave inventories, which date from 3000/2950-2900/2850, 2900/2850-2650/2600 and 2650/2600-ca. 2400 BCE (Bronicki 2019; Bronicki 2021) (Fig. 153). Phase 1 is only represented by a radiometric date. In addition to changes in the vessel forms in phases 2 and 3, there is also a change from pit and stone cist graves to exclusively stone cist graves (Bronicki 2019).

The dates are based on a dating program with which older dates could be controlled with new dates from the Poznań laboratory (Wlodarczak 2016a). Accordingly, the GAC probably begins around ca. 3000-2900 BCE and experiences a peak in occupancy around 2900-2600 BCE, probably in the early section (Wlodarczak 2016a, 548). There is simultaneity of rituals of the GAC and Corded Ware around 2800-2600 BCE. At the same time, there are burial mounds, Nałęczów graves and GA earthen pit graves. Finally, there are also CW flat burials. The resulting burial mound practice can be described as an open confluence of different cultural elements (Fig. 154).

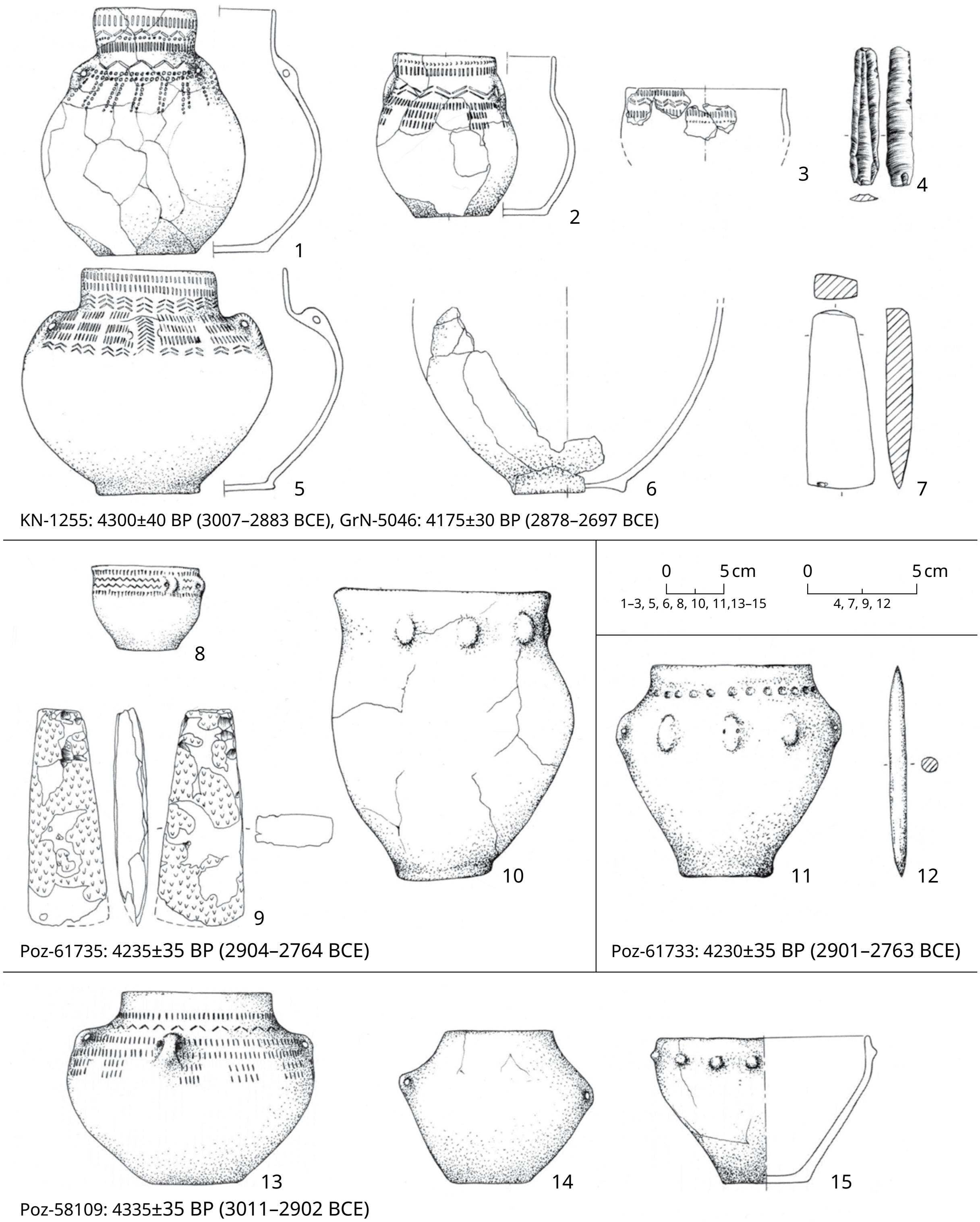


Figure 155. Examples of GAC inventories of the eastern low mountain range zone with plateaus in front of it, in particular the Upper Vistula Plateau and the Lublin Plateau, include both classic "Kuyavian" GA and applied steep-walled vessels as well as knobbed beakers. 1-7 Klementowice cemetery D, grave 7; 8-10 Klementowice cemetery A, grave 1; 11-12 Parchatka; 13-15 Raciborowice-Kolonia 2, grave 5/56 (after Wlodarczak 2016a, 542, fig. 2).

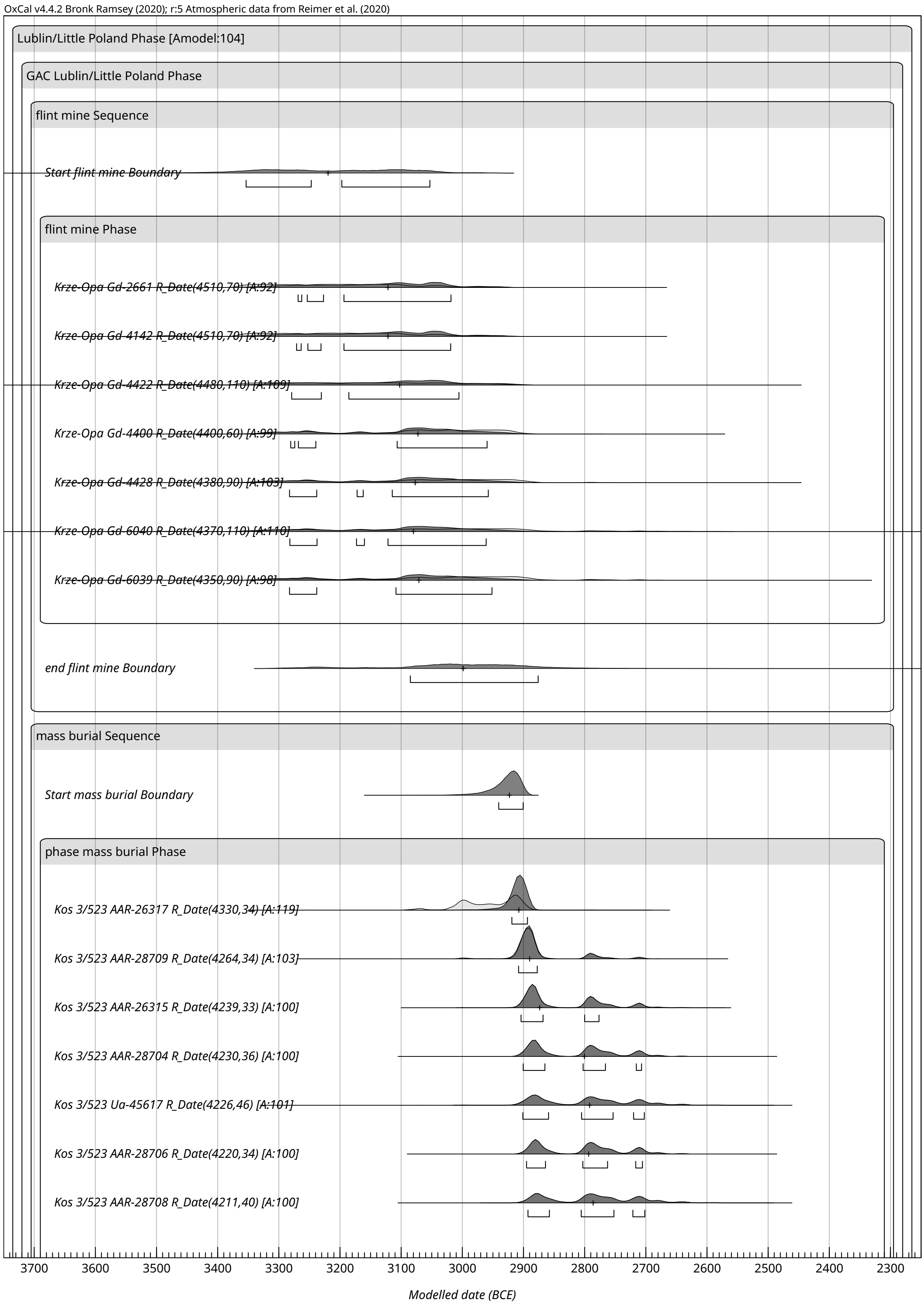


Figure 156. The Bayesian calibrations according to archaeological contexts of Lesser Poland and Lublin Upland assemblages (cf. Suppl. 10).

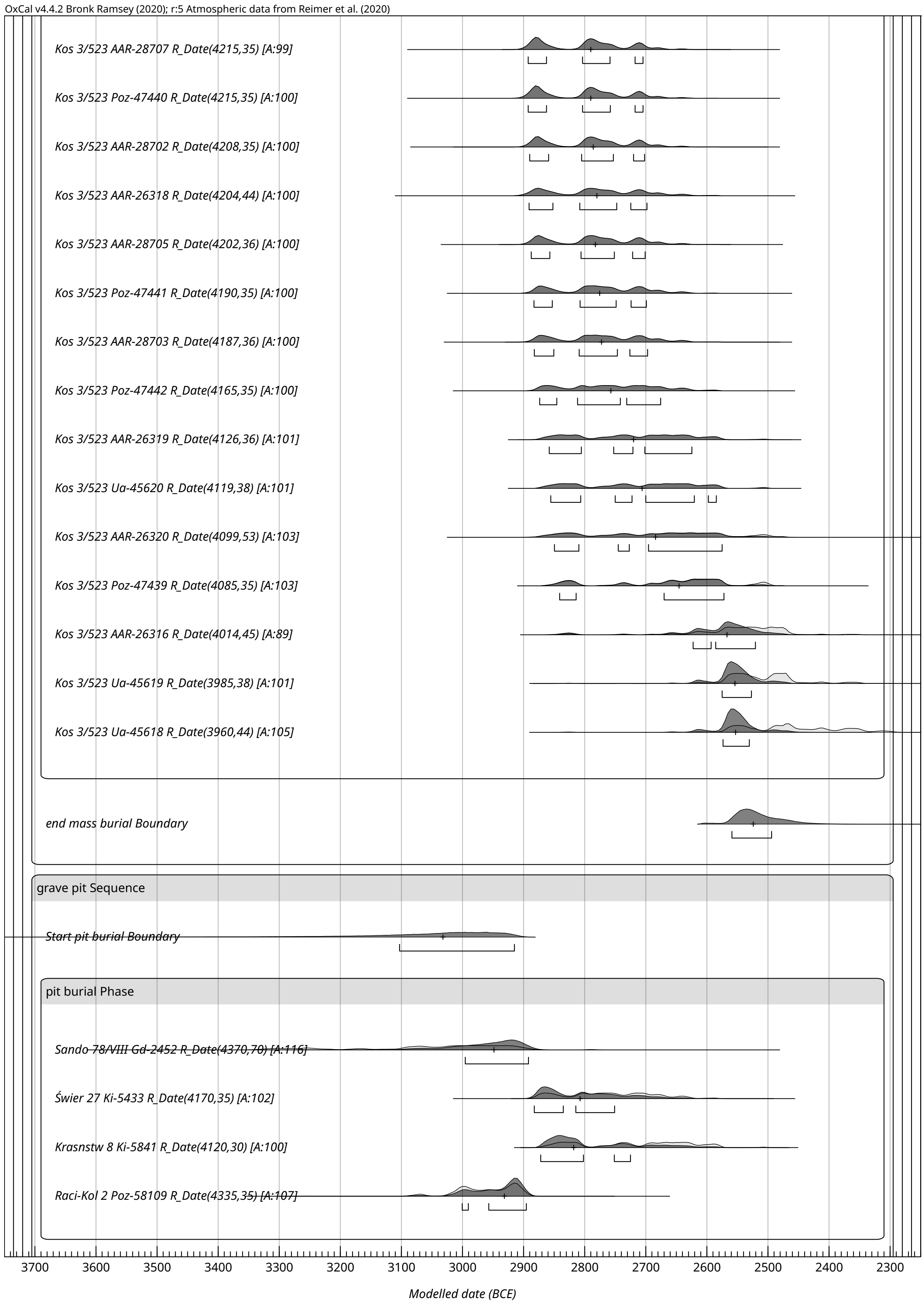


Figure 156. continued.

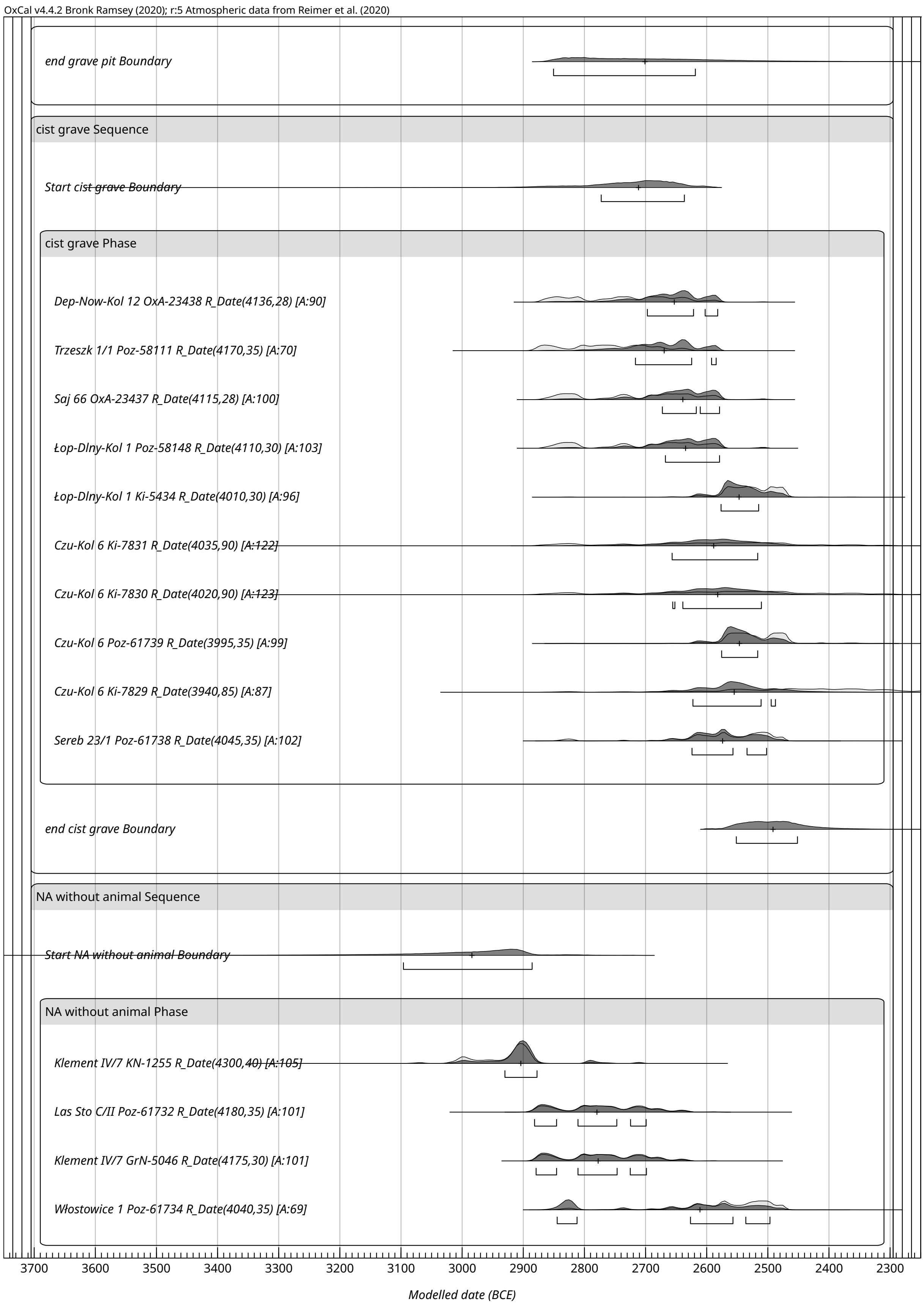


Figure 156. continued.

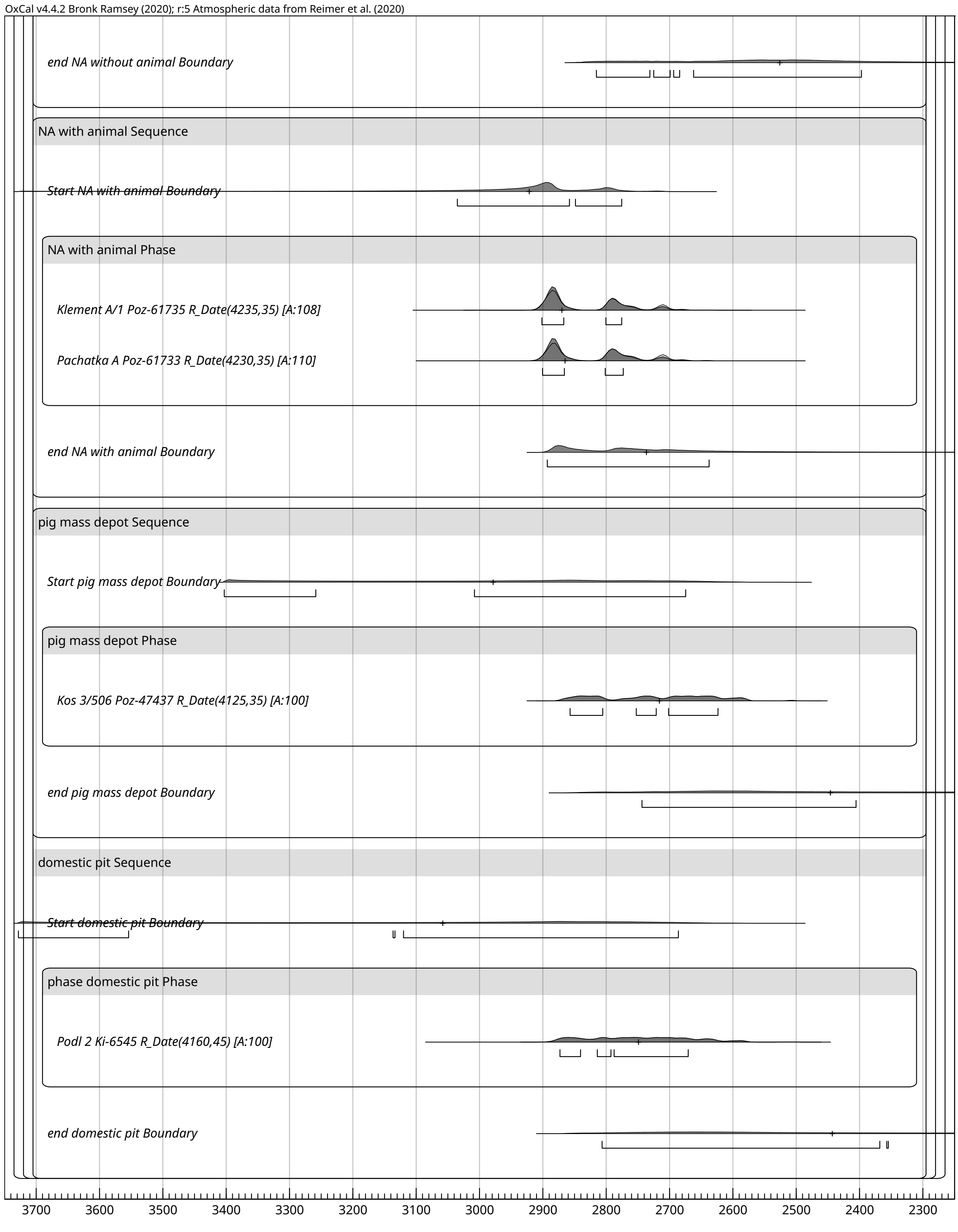


Figure 156. continued.

The corresponding Bayesian sequencing leads to a comparable dating: Phase LP 1 from ca. 2990-2910 BCE, phase LP2 from ca. 2910-2610 BCE and phase LP3 from ca. 2610-2490 BCE (Fig. 149).

3.3.2.2.4 Summary for the Eastern low mountain range zone with plateaus

Overall, there is a fairly well traceable development of the GAC for the eastern low mountain range zone with plateaus in front of it, in particular the Upper Vistula Plateau and the Lublin Plateau, whereby the radiometrically oldest dates originate from both human graves and animal depositions (if we do not consider the dates of the flint mine Krzemionki). The inventories include both classic "Kuyavian" globular amphorae and applied steep-walled vessels as well as knobbed beakers (Fig. 155).

Thus, Bayesian calibration by contexts shows a dating of the flint mine from ca. 3220-3000 BCE, the Koszyce mass grave from ca. 2920-2520 BCE, the earthen pit graves from ca. 3030-2700 BCE, the grave cists from ca. 2710-2490 BCE, the Nałęczów graves without evidence of animal burials from ca. 2980-2530 BCE, such Nałęczów graves with double cattle burials from ca. 2920-2750 BCE, the pig burial of Koszyce from ca. 2980-2450 BCE and a settlement grave also from ca. 3060-2450 BCE (Fig. 156). While the dating of Koszyce can be narrowed down further on the basis of various arguments (see above), the dating of the Nałęczów graves starting in the 29th century BCE and the cist graves first from the 28th century BCE are unambiguous. This also corresponds to the consideration of Piotr Wlodarczak (2016b, 551 fig. 1). The simultaneity of the symmetrical and asymmetrical Nałęczów cattle and human graves with the antipodal cattle burials of Central Germany, which also increasingly appear as of the 29th century BCE, is interesting. Even if there are major differences in construction, the grave of Remlingen, in which a former walled chamber grave is used for the burial, and the grave of Plotha exhibit similar design ideas (Fig. 157).

3.3.2.3 Summary of the Central GAC

The radiometric data verifies a beginning of the GAC in Kuyavia and Lesser Poland from ca. 3100 BCE at the latest, while in the southeast the beginning possibly occurred a few generations later from ca. 3000/2950 and 2900 BCE, respectively. Thus, this suggests a similar chronology for the North Central European Polish lowlands as for the Northwest and Central German area, while the younger appearance of the GAC extension further to the east appears to correspond in time to the more recent Globular Amphora influences in Western Germany.

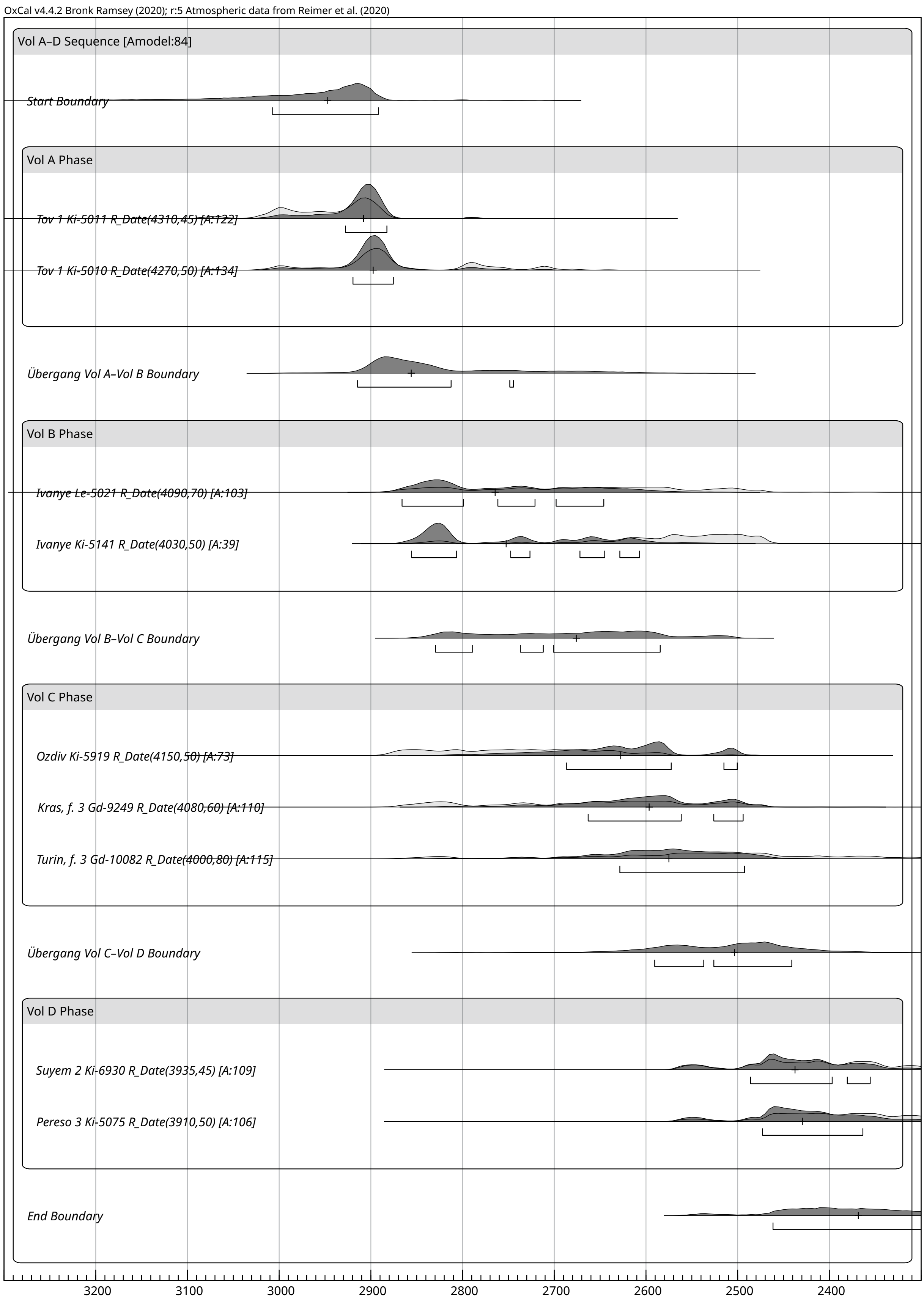
3.3.3 Eastern GAC

To the east and southeast of the Lublin Plateau, the occurrence of the GAC is concentrated in Volhynia, Podolia and the southern adjoining areas of the Moldavian Uplands at the Siret. In addition, further east there are various sites influenced by GAC elements on the Dnieper and sites further north on the upper reaches of the Neman. Thus, the sites are located in areas of the forest zone and the forest steppe – but do not cross the border to the grass steppe in the south (cf. Sulimirski 1968, Map V; Szmyt 1999a, fig. 2.43, fig. 7). The typological differentiation of the inventories led to clear inventory groups, which were recognised as chronologically relevant in the works of Marzena Szmyt and were fixed in absolute chronology (Szmyt 1999a). The new Bayesian calibration of the data confirms this.

3.3.3.1 Volhynia

From Volhynia, there are nine conventional dates of human bones from graves and animal bones from pits, which date from ca. 2950-2370 BCE (Fig. 158). The subdivision

Figure 157. The contemporaneity of the symmetrical and asymmetrical Nałęczów cattle and human graves with the antipodal cattle burials of Central Germany, which also increasingly appear as of the 29th century BCE, is interesting. 1 – Las Stocky H; 2 – Las Stocky G1 (both after Wlodarczak 2016b, 552, fig. 2); 3 – Remlingen (after Dirks 2001, 129, fig. 15); 4 Plotha (after Beier 1988, 55, fig. 7,3).


OxCal v4.4.2 Bronk Ramsey (2020); r:5 Atmospheric data from Reimer et al. (2020)
Vol A–D Sequence [Amodel:84]
Start Boundary
Vol A Phase
Tov 1 Ki-5011 R_Date(4310,45) [A:122]
Tov 1 Ki-5010 R_Date(4270,50) [A:134]
Übergang Vol A–Vol B Boundary
Vol B Phase
Ivanye Le-5021 R_Date(4090,70) [A:103]
Ivanye Ki-5141 R_Date(4030,50) [A:39]
Übergang Vol B–Vol C Boundary
Vol C Phase
Ozdiv Ki-5919 R_Date(4150,50) [A:73]
Kras, f. 3 Gd-9249 R_Date(4080,60) [A:110]
Turin, f. 3 Gd-10082 R_Date(4000,80) [A:115]
Übergang Vol C–Vol D Boundary
Vol D Phase
Suyem 2 Ki-6930 R_Date(3935,45) [A:109]
Pereso 3 Ki-5075 R_Date(3910,50) [A:106]
End Boundary
3200
3100
3000
2900
2800
2700
2600
2500
2400
Modelled date (BCE)

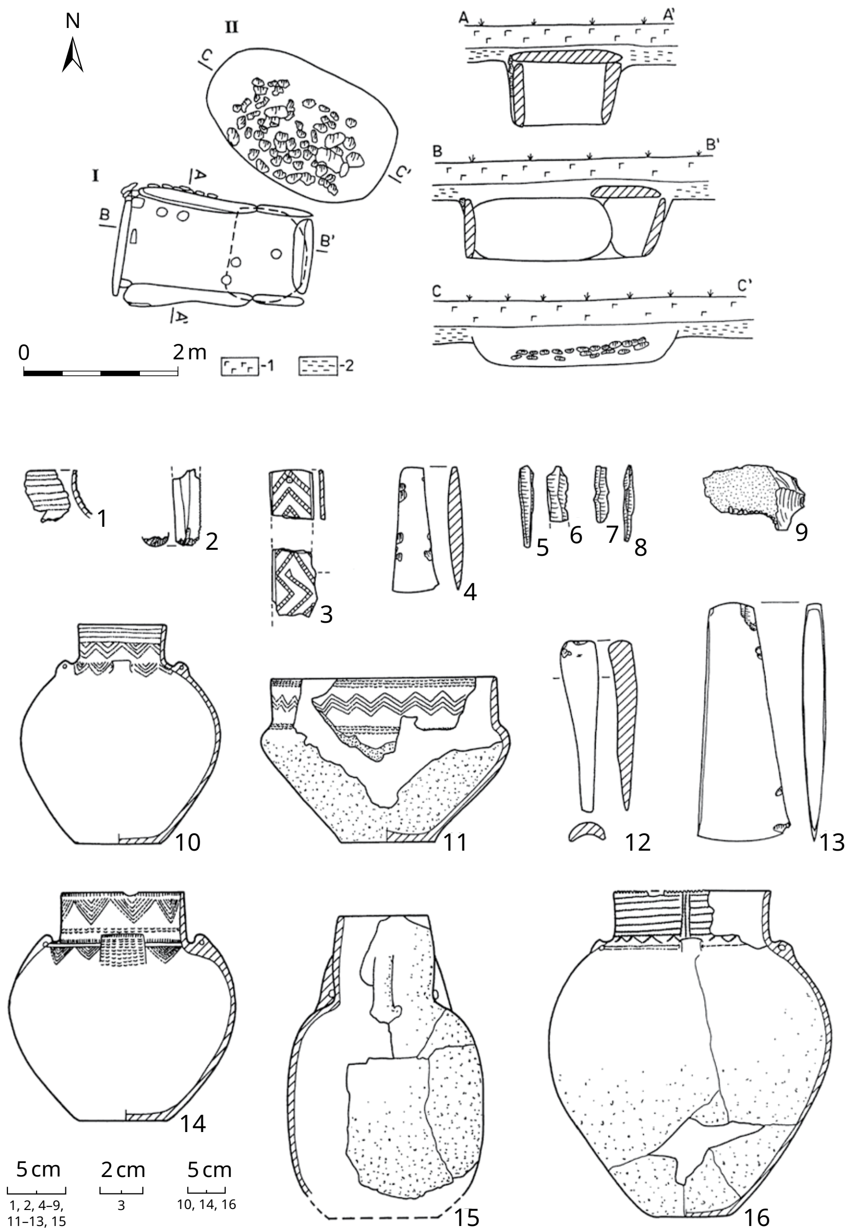


Figure 159. Tovpyzhynis is an example of an early GAC stone cist burial in Volhynia. Key: 1 - Humus; 2 - Sandy clay (after Szmyt 1999a, 320, pl. 40).

Figure 158 (left). The Bayesian calibration of Volhynian GAC phases (cf. Suppl. 10).

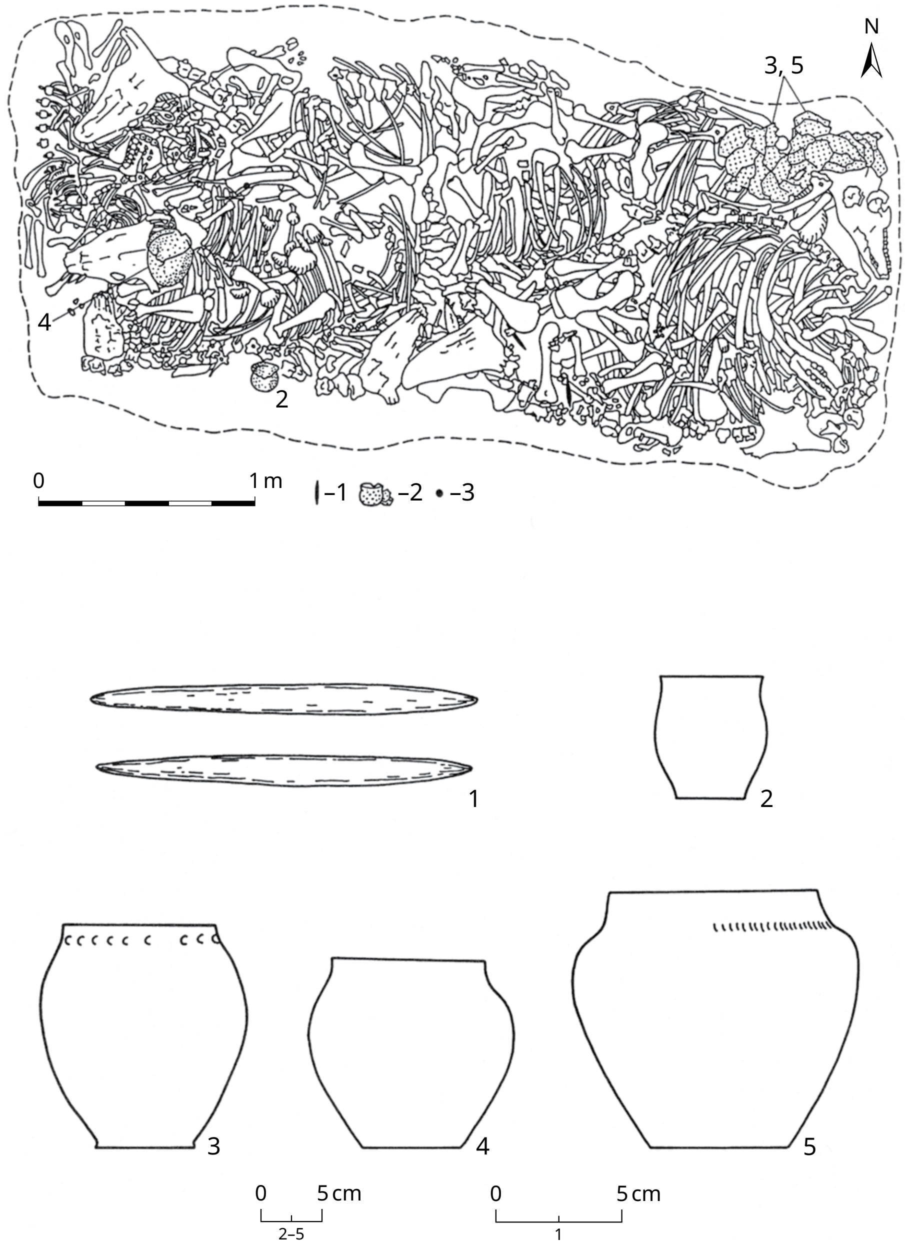
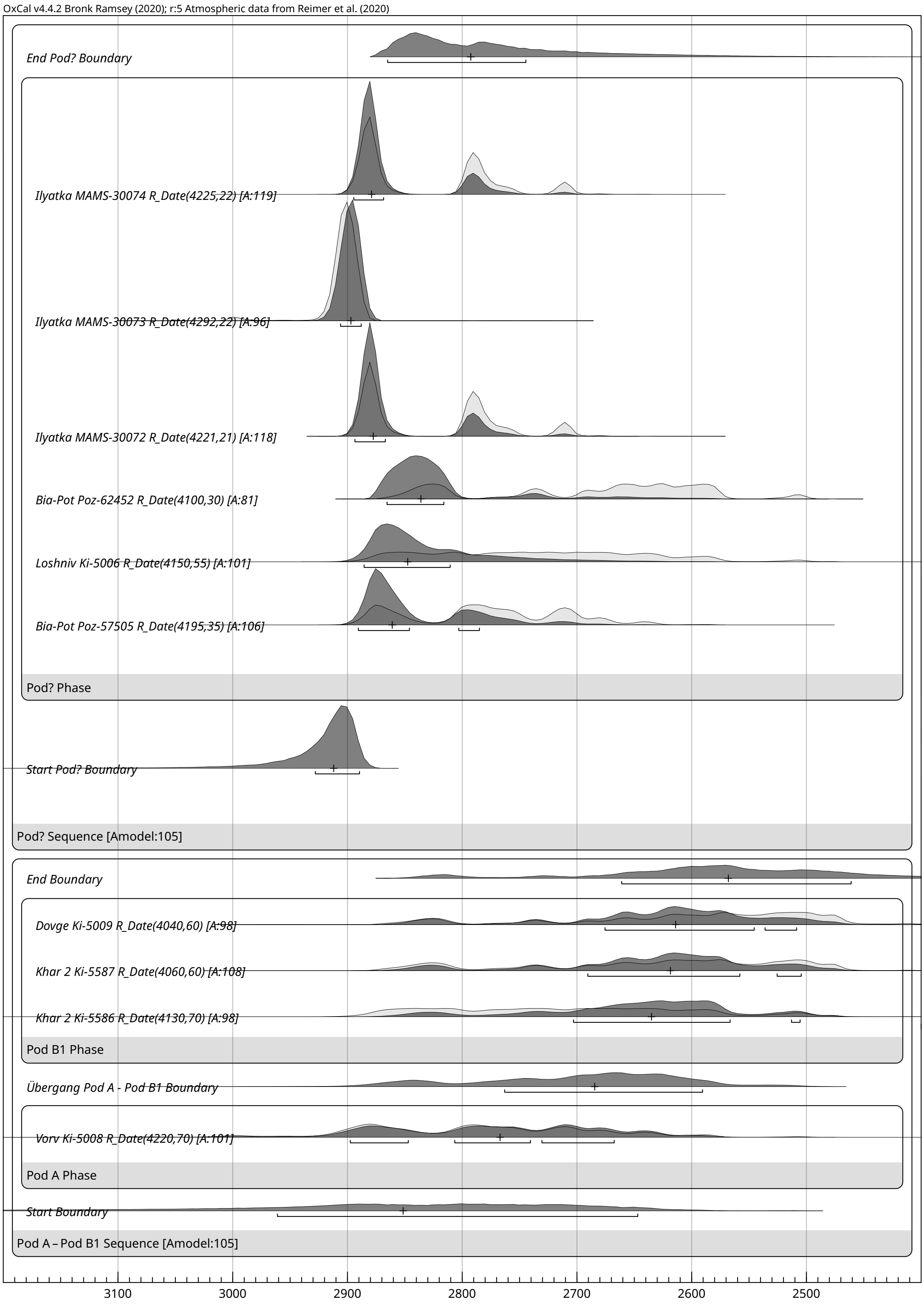


Figure 160. The animal deposition Krasnaselski, pit 3 with thirteen animal skeletons from the Upper Neman, both probably dating after ca. 2650 BCE. Key: 1 - Bone spearhead; 2 - Pottery; 3 - Amber (after Szmyt 1999a, 302, pl. 22).

in phases (Vol A 2950-2860 BCE; Vol B 2860-2680 BCE; Vol C 2680-2510 BCE and Vol D 2510-2370 BCE) is consistent with the available dating approaches (cf. Szmyt 1999a, 84 fig. 25; Szmyt 2009, 242), based on the stone cist graves Topyzhyn, Ozdiv, Ivanye and Suyemtsy II, plus the settlement pit Peresopnitsa (cf. also Szmyt 2001, 30-31) (Fig. 159). Also integrated in the Bayesian modelling were the Vol C-like inventory Turinshchina, pit 3 from the Middle Dnieper and that of the animal deposition Krasnaselski, pit 3 with thirteen animal skeletons from the Upper Neman, both probably dating after ca. 2650 BCE (Fig. 160). From the Krasnaselski animal deposition, we know of nine cattle, two caprovids, one pig, and one horse. Seven cattle were deposited as complete individuals, all other animals as partial depositions (Szmyt 1999a, 31).

Figure 161 (right). The Bayesian calibrations of inventories from Podolia (cf. Suppl. 10).


OxCal v4.4.2 Bronk Ramsey (2020); r:5 Atmospheric data from Reimer et al. (2020)
End Pod? Boundary
Ilyatka MAMS-30074 R_Date(4225,22) [A:119]
Ilyatka MAMS-30073 R_Date(4292,22) [A:96]
Ilyatka MAMS-30072 R_Date(4221,21) [A:118]
Bia-Pot Poz-62452 R_Date(4100,30) [A:81]
Loshniv Ki-5006 R_Date(4150,55) [A:101]
Bia-Pot Poz-57505 R_Date(4195,35) [A:106]
Pod? Phase
Start Pod? Boundary
Pod? Sequence [Amodel:105]
End Boundary
Dovge Ki-5009 R_Date(4040,60) [A:98]
Khar 2 Ki-5587 R_Date(4060,60) [A:108]
Khar 2 Ki-5586 R_Date(4130,70) [A:98]
Pod B1 Phase
Übergang Pod A - Pod B1 Boundary
Vorv Ki-5008 R_Date(4220,70) [A:101]
Pod A Phase
Start Boundary
Pod A – Pod B1 Sequence [Amodel:105]
3100
3000
2900
2800
2700
2600
2500
Modelled date (BCE)

3.3.3.2 Podolia

From Podolia, five conventional and twelve AMS dates of human bones are available, which originate from two earthen pit burials, three stone cist burials and one pit burial with stone covering slabs. They correspond with the chronology developed by Marzena Szmyt (Szmyt 1999a, 84), as far as individual phases can be dated (Fig. 161). The entire period covers the range of ca. 2860-2570 BCE, although only inventories of phase Pod A (2780-2640 BCE) and phase Pod B1 (2640-2580 BCE) could be dated and not phase Pod B2. Radiometric dates from Loshniv, Biały Potok (Goslar and Szmyt 2016a, 215), which could not be assigned to any particular phase, date within a chronological span ca. 2860-2635 BCE.

The burial at Ilyatka is of special importance, as both bioarchaeological dates as well as ^{14}C dates from different laboraties have been produced (Szymt *et al.* 2021). Within a pit, which was covered by limestone slabs, remains of seven human individuals were found, partly as articulated inhumations, and partly as disarticulated bone heaps. From all seven individuals ^{14}C dates were processed, for three of these indivduals dates were obtained from two labs. Unfortunately, the chi-square test of combined dates failed, so the results of the two laboratories do not support each other. In consequence, the span of both labs has to be taken as separate temporal options for the site. While the three MAMS dates display a modelled median boundary timespan between 2910 and 2870 BCE (Amodel 127/Amodel overall 128), the seven Poznań dates result in a modelled median boundary timespan between 2640 and 2540 BCE (Amodel 122/Amodel overall 123). As the ceramic inventory might typologically be associated with phase Pod B1 (cf. Szymt *et al.* 2021 with Szmyt 1999, 58, fig. 14), the temporally-contemporary lab data might be taken into account. This is the case with the samples which had been processed in Poznań. As such, in Fig. 161 the three MAMS dates have been excluded from the calculation.

3.3.3.3 Siret

GAC settlements and graves are located on the upper reaches of the Siret in Northern Bukovina, Ukraine and the Romanian province of Moldova, from which conventional dates of human bones from three stone cist graves and one other grave are available without further descriptions (Szmyt 2009, 243-244). The phase model calculated here (Fig. 162) describes a rather early onset period of ca. 3340-2660 BCE, whereby the fitting of the two combined dates from Dolhestii Mari, grave 2, skeleton 1 matches the model calculations most weakly. Based on the criteria for handling outliers (Bronk Ramsey 2009; 2017), the problematic data may be excluded.[40] If we take the data only from Basar, Bargauani and Piatra Neam, the period is restricted to the time interval from ca. 3060-2730 BCE (Fig. 163).

40 They do not fulfil the 95% confidence condition.

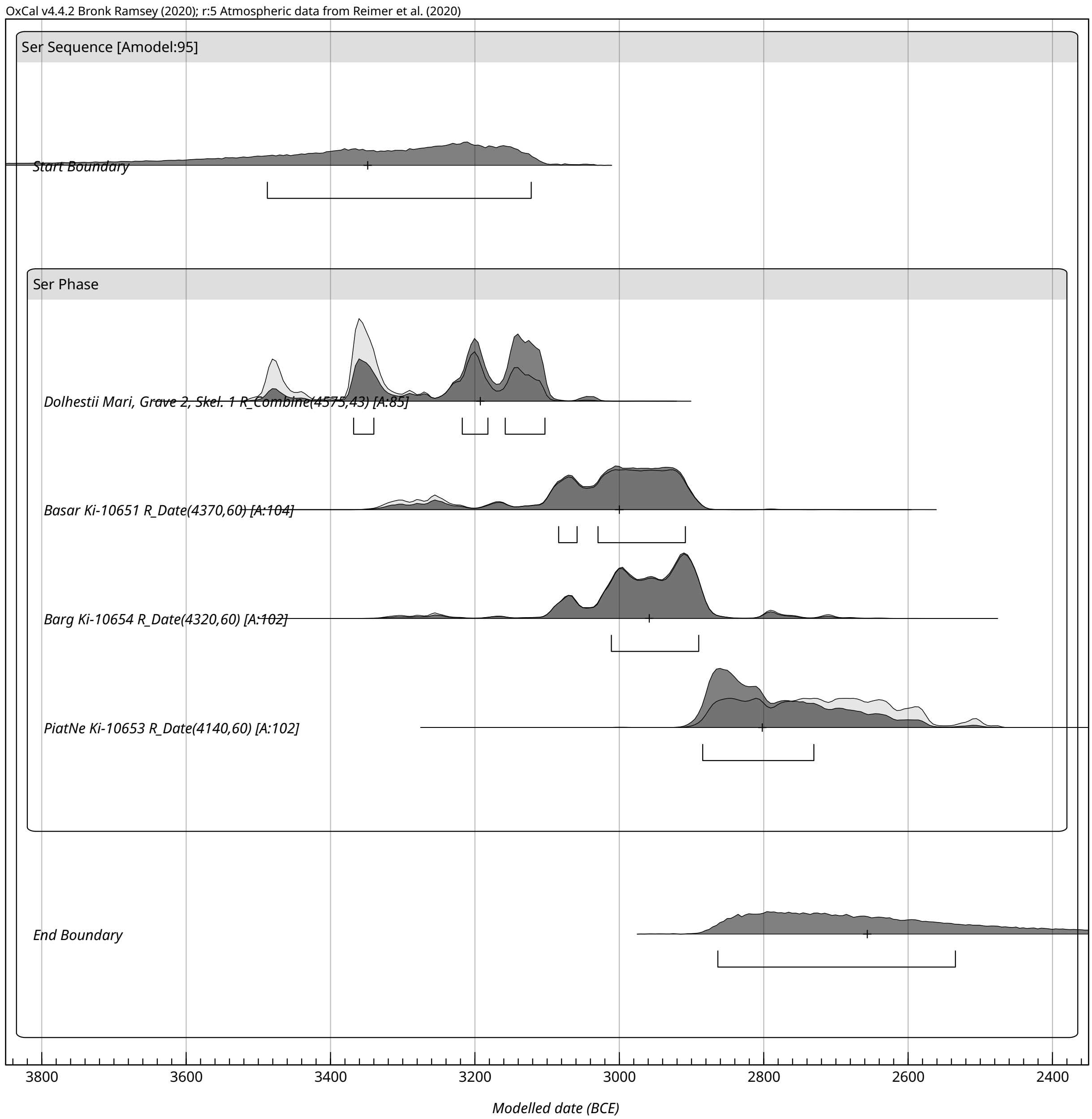


Figure 162. For the Moldavian Uplands, the conventional ^{14}C dates seem to be problematic. The Bayesian model describes a rather early onset (cf. Suppl. 10).

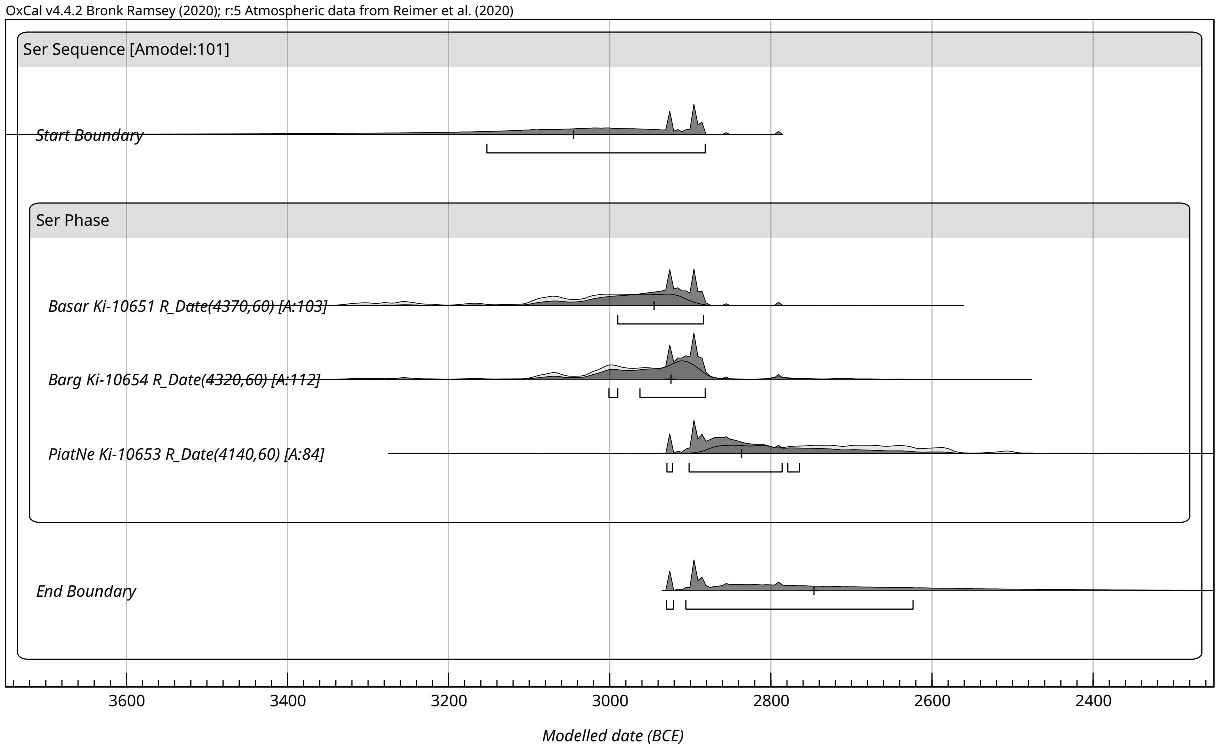


Figure 163. Based on the criteria for handling outliers (Bronk Ramsey 2009), the problematic Siret data may be excluded. This Bayesian model is more convincing than Fig. 162 (cf. Suppl. 10).

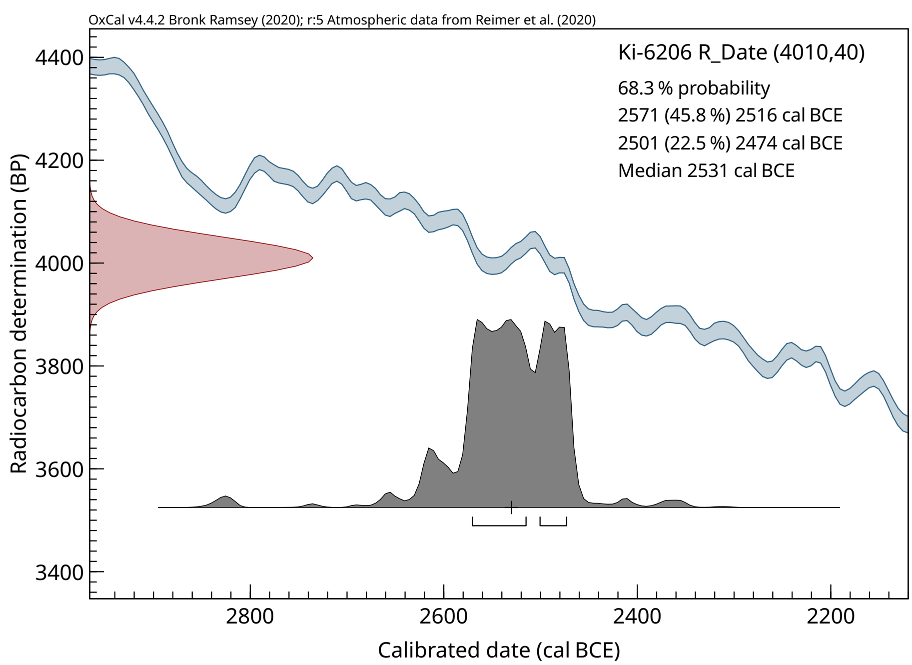


Figure 164. A mixed inventory from Provra on the Middle Dnieper dates ca. 2570-2475 BCE (cf. Suppl. 10).

3.3.3.4 Forest zone

In addition to the already mentioned dates from Krasnaselski und Turinshchina in the forest zone, the mixed inventories from Provra on the Middle Dnieper should be mentioned, which date in one grave from around 2570-2474 BCE (Fig. 164) (cf. Szmyt 2001, 31).

3.3.3.5 Summary

The radiometric dates verify, in line with the analyses of Marzena Szmyt (2009, 245), an occurrence of GAC inventories from around ca. 3050/2950 BCE in Volhynia and the Moldavian Plateaus, a possibly somewhat later occurrence in Podolia (from ca. 2910 BCE) and the GAC influence in even more eastern sites from about 2650 BCE onwards.

In the typological sense, the time horizons can be compared relatively well with typological time markers in the Lublin Plateaus or Lesser Poland (Fig. 165-167). Probably in the first half of the 30th century BC, globular amphorae can be found in the Lublin Plateaus and Volhynia with phase LP1 and phase Vol A. Around ca. 2900/2850 BCE, a change to phase LP2 occurs in the Lublin area, in Volhynia to phase Vol B – at the same time in Podolia, GA of the Pod A phase occur for the first time. In the 27th century BC, we can observe the change in all three regions to the phases LP III, VC and Pod B1, as well as the spread in the Middle Dnieper region with Vol C-like inventories and to the Upper Neman. At ca. 2500 BCE or shortly thereafter, GAC occupation ended in all mentioned regions, including Lesser Poland with the exception of Volhynia (until ca. 2370 BCE). The dates from the Moldavian Plateaus are difficult to access. They begin earlier and also end earlier (ca. 3060-2730 BCE).

A distinction between stone cist graves and earthen pit graves cannot be made chronologically – both are present early. This could also be attributed to locally existing traditions. Associations with cattle depositions are more likely present after ca. 2600 BCE (Turinshchina 3 und Krasnaselski 1).

For the cultural GAC network Vistula-Podolia, the data obviously refers to a certain temporal NW-SE staggering, which suggests the integration of the areas in question into the eastern network between ca. 3200 BCE at the Lower Vistula bend, at ca. 3050/2950 BCE in the Lublin Plateaus and Volhynia and from 2900/2850 BCE in Podolia. A corresponding extension under other spatial conditions can certainly be compared with distribution phenomena in the Western GAC network.

3.4 Overall results of Bayesian dating

In the framework of the intended Bayesian modelling, the radiometric dates were not only evaluated in their data context but also against the background of the archaeological information. In the overall compilation of the individual results, corresponding time markers and absolute chronologically positioned tendencies can be determined, which enable a stronger relevance of the evaluation of individual radiometric dates and the archaeological contexts. A different approach is applied here than for the supra-regional presentation of the individual dates (see Chapter 3.5 below).

3.4.1 Beginnings

If we compare the Bayesian dates of individual find sites, regional developments and supra-regional tendencies, we obtain a very conclusive picture for the emergence, the duration and the renewed disappearance of the classic globular amphorae (Fig. 165-167). In the west, we have an occurrence of GA at ca. 3200/3100 BCE in the

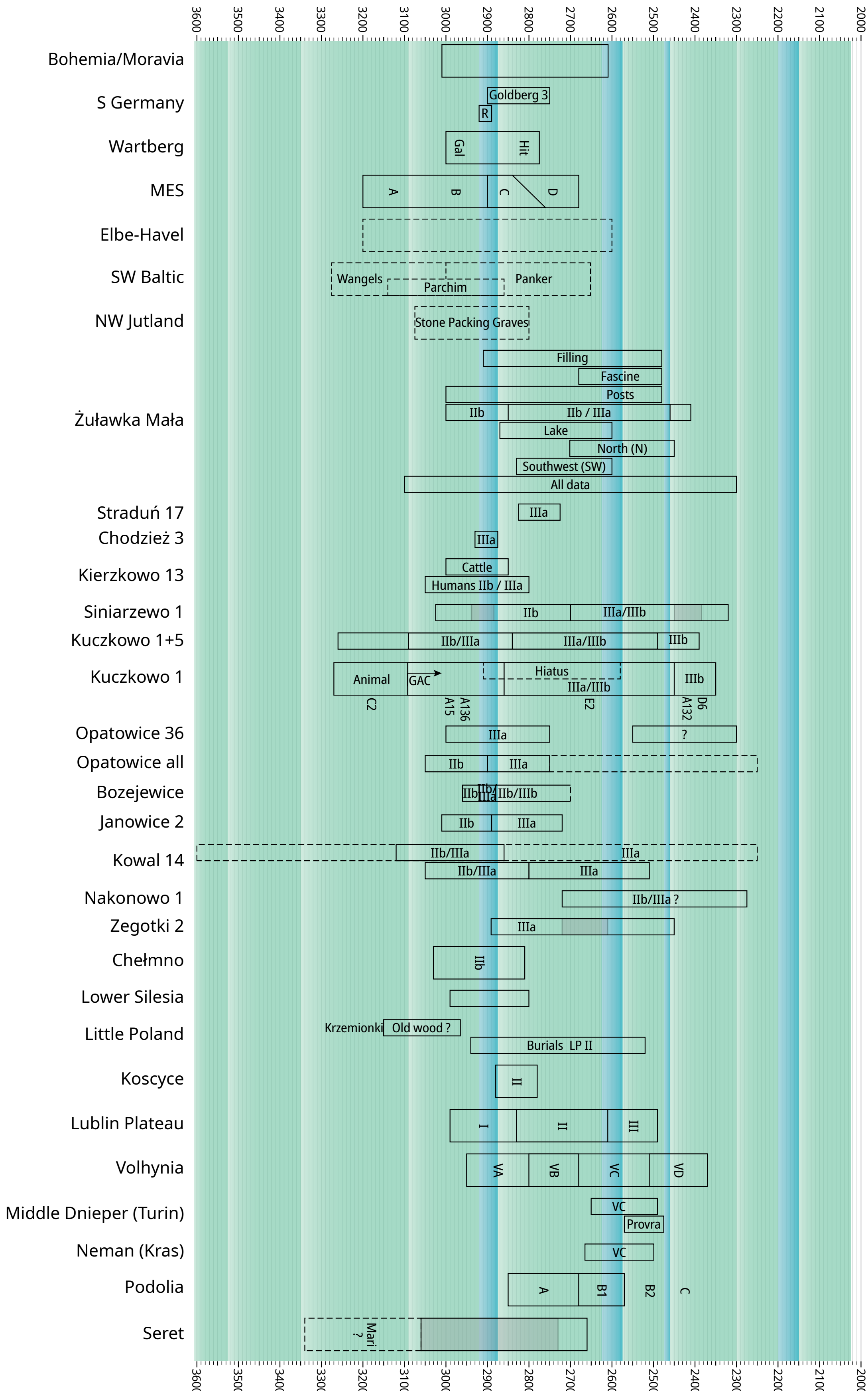


Figure 165. The comparison of Bayesian dates of individual find sites, regional developments and supra-regional tendencies describes the emergence, the duration and the renewed disappearance of the classic GA. The colouring of the background refers to the ^{14}C wiggle distribution in the calibration curve. Grey marks unsecure data.

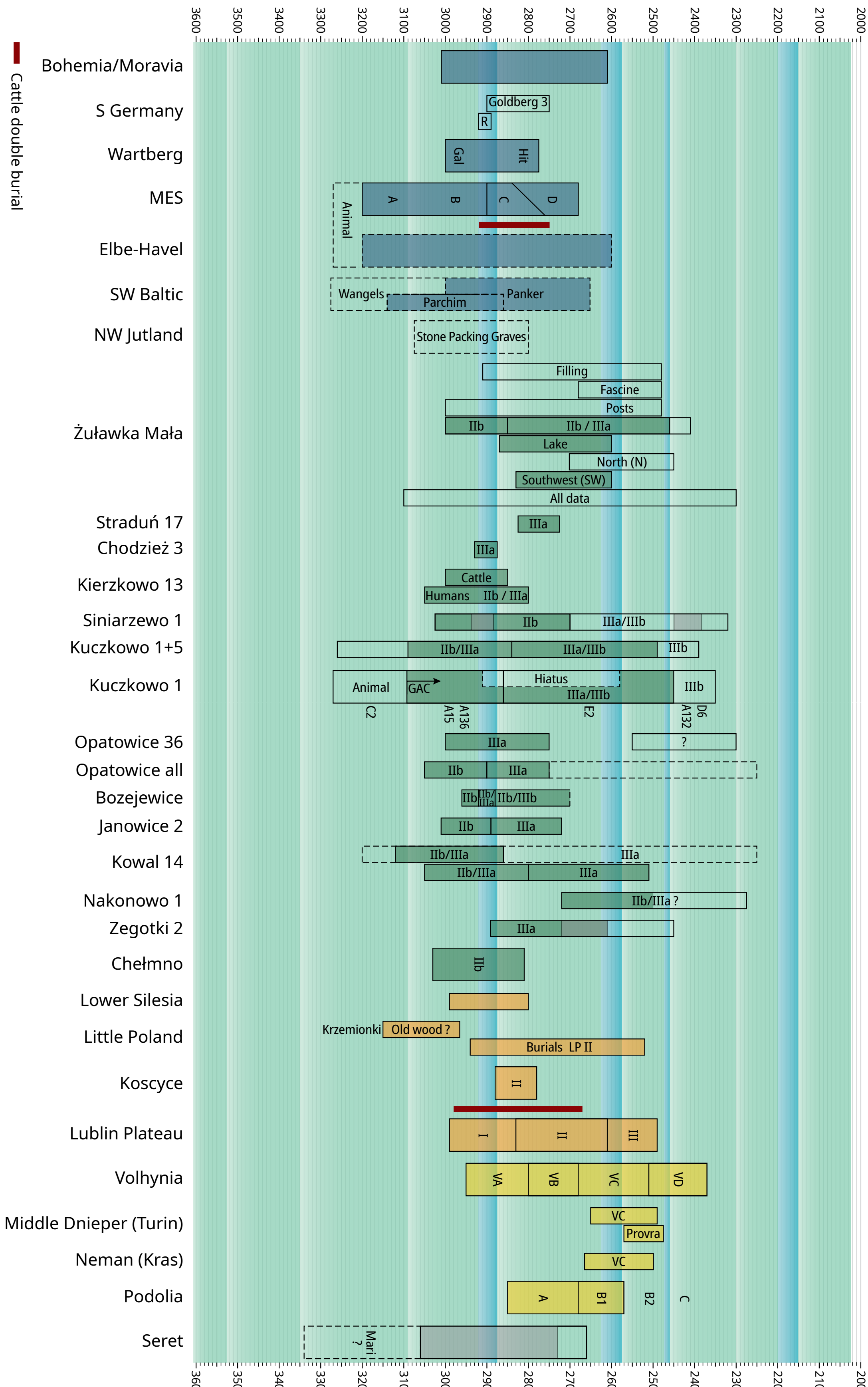


Figure 166. The colour chart displays assemblages with classical GA. blue: GAC West Group; green: Central Group; orange: Eastern Lower Mountain Ranges; yellow: East Group (cf. caption of Fig. 165).

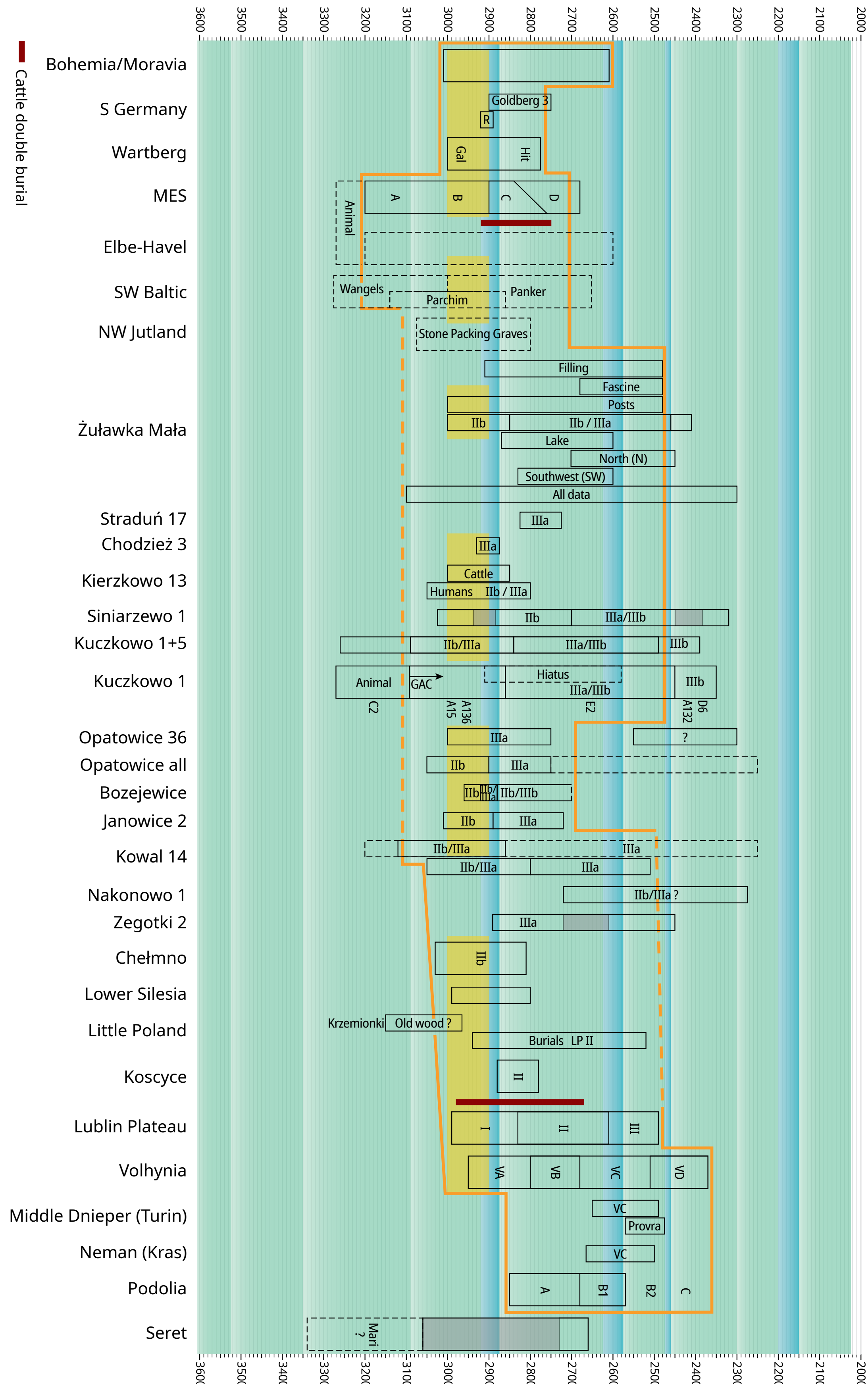


Figure 167. The chart displays the presence of classical GA in the assemblages (orange) and the similar early regional development (yellow).

Middle Elbe-Saale region including inventory groups A/B. In Kuyavia, a comparable time span is indicated by the sites Kuczkowo 1/5 and Janowice 2, while the first GA can probably be first expected around 3000/2950 BCE in the foothills of the southeastern low mountain range, for example, in Lesser Poland and the Lublin Plateaus, but also on the Volhynian Plateaus. In Podolia, GA seem to be expected again ca. 100 years later.

Apart from these basic tendencies, GA “minority inventories” can be detected in the west from about 3000 BCE in Wartberg with gallery graves and from about 2900 BCE with individual sherds in Goldberg 3 or Cham contexts (see above; Szmyt 2003). The Bohemian/Moravian GAC region (ca. 3010-2620 BCE) should also belong to this time frame. In the east, a further expansion into the Middle Dnieper region and on the upper reaches of the Neman are observed around 2700/2600 BCE. How the rather early data from the Moldavian Plateaus (probably from 3060 BCE) is to be judged must remain open at this point.

The data from the Baltic region is more difficult to judge. Globular Amphora influences in the area of the West Jutland stone heap graves and the East Holstein megalithic tomb Panker could indicate the presence of the GAC phenomenon from ca. 3100/3000 BCE – according to the data from the Wangels megalithic tomb and the Parchim-Löddigsee settlement probably already from ca. 3200/3100 BCE. However, these are burials in already existing ritual structures and not GAC single graves or something similar. The few Brandenburg dates also indicate a beginning at ca. 3200/3100 BCE. With uncertainties, which are caused by the depositional processes of the dated sites, the Southwest Baltic Lowland can also be included in the early dating of the GAC between the MES and Kuyavia.[41]

In the area of the Southeastern Baltic Ridge (*e.g.* on the upper reaches of the Narew) or in Memelland, a short presence or influence of GA begins from ca. 2950 BCE or again 100 years later.

Thus, if we can narrow down the beginning of the classical GAC and determine basic tendencies, which suggest a spread or further spread of certain basic elements to the west, north and south within a few generations, there are precursor ceramics that – depending on the field of activity – are named differently due to regional terminologies. For example, typological similarities can be found between the Walterdorfer Group (Kirsch and Plate 1984, 99), the non-classical GAC phases I and IIa (Szmyt 2013, 51-53) and FBC IIIb-IIIc (Szmyt 2013, 44-45 fig. 1.9-10). This also includes the emergence of animal depositions in pre-GAC contexts.

In addition to the existing tradition of animal depositions, the development of the tradition of double antipodal cattle depositions can be observed from ca. 3000 BCE between the Lublin Plateau and the Harz foothills. The oldest examples are currently from Niederschür, which suggests knowledge of this ritual deposition practice from ca. 3300/3100 BCE onwards.

3.4.2 Decoration change

Even if the radiometric dates reach the limits of accuracy, a change in the ceramic phases in the 29th century BCE can be observed in numerous GAC regions. This concerns the change from GAC B to GAC C in the west, the change from IIb to IIIa in the Central Group (if differentiable, in Bożejewice, Janowice 2, Opatowice, Żuławka Mała 1, Siniarzewo 1 and generally in Chełmno Land), a change from LPI to LPII in the Lublin Plateau region and in Volhynia from Vol A to Vol B. Regardless of

41 It is possible that the classic GA, which are distributed in larger inventories up to West Mecklenburg (Parchim), can be dated from 3200/3100 BCE, while the Baltic GA only date from 3100/3000 BCE (*e.g.* Panker) and the earlier data from Wangels cannot be associated with the GA due to contextual connections.

the fact that we have specific basic stylistic patterns in every region, a transition can be observed in the MES from simple chevrons and triangle patterns to more complex motifs, including recessed chevrons (Müller 2001, 192-243; cf. Chapter 4, Fig. 199-200), in Kuyavia from garland and herringbone motifs to filled triangles (Szmyt 2013, 53-54), in Lesser Poland and the Lublin Plateau from vertical stanchion or broken line impressions and small conical appliqué bosses to herringbone impressions and multiple chevrons, and in Volhynia from herringbone motifs to the "delayed" appearance of garland motifs (Szmyt 1999a, 58).

3.4.3 Disappearance

In the Western GAC regions, a duration of the classic globular amphorae into the 27th century BCE can be assumed. This applies not only to the MES but also to the western and southern reception areas in Hesse or in Southern Germany (Fig. 165-167). This could also be the case in the Southwest Baltic region, as the data from the Panker megalithic tomb seems to indicate. However, a termination in Parchim-Löddigsee can already be observed in the 29th century BCE. This is also the period in which the influence in Northwest Jutland ceases.

An assessment for the North Central GAC regions is more difficult. Terminologically, there are no more globular amphorae in phases IIIb and IIIc, so that the endpoint marked for the west can be pinpointed here at the transition from IIIa to IIIb. At many sites, this transition cannot be dated since IIIa/IIIb are typologically combined. The few inventories, which are exclusively assigned to IIIa, apparently end at ca. 2750 BCE (Opatowice), at ca. 2700 BCE (Janowice 2) and probably at ca. 2600 BCE (Kowal 14).[42] Radiometrically dated inventories, which exclusively represent IIIb, are only available from Kuczkowo (ca. 2450-2350 BCE). From other sites, where no detailed typological differentiation between IIIa/IIIb can be made, there are also time periods until 2400/2300 BCE (Siniarzewo 1, Zegotki 2, Nakonowo, Żuławka Mała 1). Accordingly, we can assume that classical GA "disappear" around 2700/2600 BCE, the so-called Late GA ceramics (without globular amphorae) around 2400/2300 BCE.

In the Southern Central GAC areas, classical GA are verified for phases LP II and LP III until ca. 2500 BCE, whereby the change to phase LP III obviously takes place, *e.g.*, in the Lublin Plateaus, at ca. 2600 BCE, thus in a time when the classical GA disappear in the more northern Vistula areas. This is also the period when (as already mentioned) the transitions to phase Vol C in Volhynia and to phase B1 in Podolia become visible, and GA appear for the first time on the Middle Dnieper and on the Neman.

The end of GA in Eastern Poland at ca. 2500 BCE appears to be accompanied by a typological change to phase Vol D in Volhynia, to phase Pod C in Podolia, but also by the disappearance of the GAC in the areas located further to the east. It is evident from the radiometric data that in contrast to other regions, classical GA continue in Volhynia and Podolia after ca. 2700/2600 BCE – in Volhynia actually up to ca. 2370 BCE and in Podolia certainly until at least ca. 2500 BCE.[43] In the case of the data from the Moldavian Plateaus, an end of GA inventories is indicated around 2700/2600 BCE. In consequence, we recognise a delayed emergence of classical GA in the eastern group, but with the exception of Siret, also a longer duration.

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42 In Kierzkowo 13, a IIb/IIIa inventory ends at ca. 2800 BCE that is not followed by another inventory. In all other cases of an inventory designated as IIb/IIIa, a further phase designation IIIa/IIIb follows, so that the available data in these cases cannot be used for a chronological fixation.

43 Here, ^{14}C data for Pod B2 and C is missing. In C, only GA derivatives are available, but no GA in the classical sense.

3.4.4 Modelling

Based on the available radiometric dates, a core area of the emergence of the Globular Amphora phenomenon can be identified, which develops in the ecologically quite similarly distinct Elbe-Vistula glacial valley between Kuyavia and Central Germany (cf. Szmyt 2013, 38 fig. 1.6).

In the entire Elbe-Warsaw region, globular amphora co-exists with the more regional groups, in particular the Late Kuyavian Funnel Beaker pottery, the Northeast German Elbe-Havel Group and the Central German Bernburg Group. In all three mentioned areas, local and regional elements (*e.g.* decoration styles) are evidently adopted. Typological differences, for example, in the amphora forms can be traced back to locally existing predecessor amphorae. A strong ritual similarity, in particular of the Elbe-Havel and the Kuyavian groups, exists in the occupation of animal sacrifice sites, which were already used by predecessor groups. The dominance of settlement finds over grave finds in the eastern part of the core area postulated here and of grave finds over settlement finds in the west could be related to different mechanisms of hybridisation.

The GA evidence from the Western Baltic region could possibly be of the same age as the GA in the discussed core area, if the above-mentioned radiometric dates are accepted, regardless of the fact that they originate from megalithic graves and not from individual burials, *i.e.*, that the findings are only relatively closed. Interestingly, the *Nackenkammäxte* (neck comb axes) of the western distribution area of the globular amphorae are obviously developed here from predecessor forms and integrated into the GA interaction space.

In the western and southwestern regions, we can observe the GA influences regularly – according to present knowledge, however, only first after ca. 2950 BCE. With the exception of Bohemia/Moravia, these are mostly individual ceramics, which always occur together with the dominant regional group (Wartburg, Western Funnel Beaker Group).

In the regions adjoining the core region to the east and southeast, the ^{14}C dates for the beginning of the GA also lie after 2950 BCE. In contrast to the Western Central European area, however, we observe a direct occupation of graves with globular amphora inventories in Eastern Central Europe and Western East Europe.

Due to the strong spatial differentiation of the two networks of social practices in a Western Elbe network and an eastern Vistula-Podolia network, it is striking that this divides the area of origin of a separation postulated on the basis of the radiometric data. An explanation of this is necessary. In fact, there is not only a spatial-cognitive separation but also a separation into two distinct artefact frequencies and by no means a continuous “core area” of an Early GAC.

3.4.5 Interpretation: Spatial distribution pattern

The observations made in the illustrated transect between the Baltic Sea and the Lower Mountain Range suggest a ritual centre of origin, which extends in the area between the Elbe and Kuyavia according to the explanations of the radiometric dates. We observe how new ritual practices emerge, which become visible, *e.g.*, when GA cattle depositions overlay animal deposition sites. The fundamental spatial separation of the GAC into two dominating networks, which break through the mentioned core area, and the early discernible spatial separation in the formation zone of the GAC indicate that at the outset it must have been a matter of non-territorially organised network structures – *i.e.* an exchange network.

The statistical results on the typological distributions of the West, Central and East Groups of the globular amphorae indicate at least from a typological point of view that we should only speak of two supra-regionally separated networks. From the beginning, their spatial differentiation becomes clear in the clearly separated frequency zones of the sites, which appear to be separated by a corridor. The spatial development can be explained from these already established differences: from the region of origin of the GAC (from ca. 3200 BCE), referred to here as the core area, via the western network to the south and west and over the eastern network to the southeast.

It is decisive for settlement behaviour in the west that a symbiotic relationship is established with the local pre-existing groups (cf. Maier 1991; Woidich 2014, 94-95; cf. Chapter 6). For example, there are no independent GA hilltop settlements or enclosed settlements – but in the Řivnáč-Bernburg-Wartberg triangle, there are numerous such settlements with GA ceramics in addition to the regional ceramics. Altitudes above 200 m NN are rather avoided (Weber 1964, 180). The highest site density at the eastern edge of the Middle Elbe-Saale area and at the northern edge of the Řivnáč distribution in North Bohemia verify, in contrast, that the noted separation processes obviously took place in different regions (Woidich 2014, 95).

3.5 Overall consideration of the individual radiometric dates

In addition to the Bayesian analysis, with which individual sites and regions were processed, an overall consideration of the radiometric data was also conducted. For a spatial evaluation of the 373 radiometric dates with GAC connections or 341 ^{14}C dates from features with GAC ceramics, mappings were carried out in qGIS. The median, the oldest and the youngest age of the calibrated 1-Sigma-value of each date were integrated into the base files (Suppl. 9). With these values,

- a single-point, cartographic representation was carried out, on the one hand, separated by the wiggle ranges of the calibration curve with corresponding breakpoints (Tab. 4; Fig. 66) and
- a mapping, on the other hand, of the respective oldest data in standardised hexagonal polygons.

Thus, the aim is to visualise the basic trends in the entire GAC region.

3.5.1 Mapping of the individual ^{14}C data

Although there is too little data in total, almost all GAC distribution areas are included with the dates – with certain exceptions in Silesia (Fig. 68). Thus, the data can be used in order to recognise basic trends (Fig. 168). Density mapping shows that the most data is available from Kuyavia and adjacent areas in particular. We also have some data from the Central and Northern German areas, and also from Lesser Poland, the Lublin Plateau and Volhynia. In the following, inventories are used, which exhibit classical Globular Amphora ceramics with globular amphora.

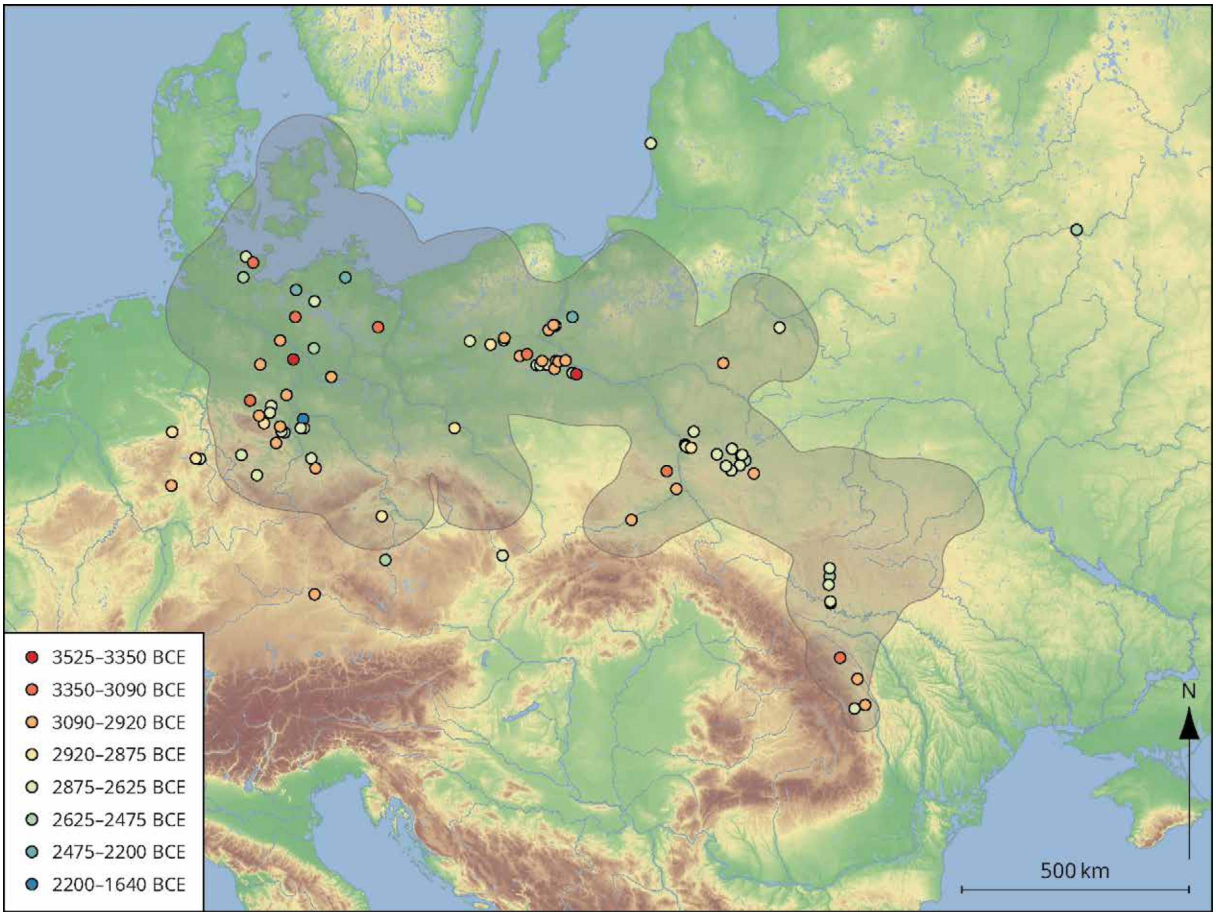
The earliest data falls within the *calibration range ca. 3525-3350 BCE*[44] (Fig. 169). Even if the two dates from Kowal 14 and Düsedau appear to be problematic, a basic trend is already evident here: The oldest GAC occupancies are to be expected between the Lower Vistula and the Middle Elbe.

The medians of 33 dates lie in the *calibration range ca. 3350-3090 BCE* (Fig. 170). Apart from two possible too early dates from the Dolhestii Mari cist grave in the Moldavian Plateaus, we know six dates from the MES, and from the Elbe-Havel area, eight dates from the Southwestern Baltic region, thirteen dates from Kuyavia and

Figure 168 (right, above). The calibrated median ^{14}C values within different calibration ranges.

Figure 169 (right, below). The oldest GAC calibrated median ^{14}C values are between the Lower Vistula and the Middle Elbe.

44 One date from Kuczkowo 1/C2 (Ki-6238) from an animal deposition lacks grave goods and does not date GAC contexts, although this is variously cited. Another date from Dęby 29/32 (Gd-2148) is classified in the literature as an old wood effect due to a different date (Szmyt 1999a, 74).


3525–3350 BCE
3350–3090 BCE
3090–2920 BCE
2920–2875 BCE
2875–2625 BCE
2625–2475 BCE
2475–2200 BCE
2200–1640 BCE
N
500 km

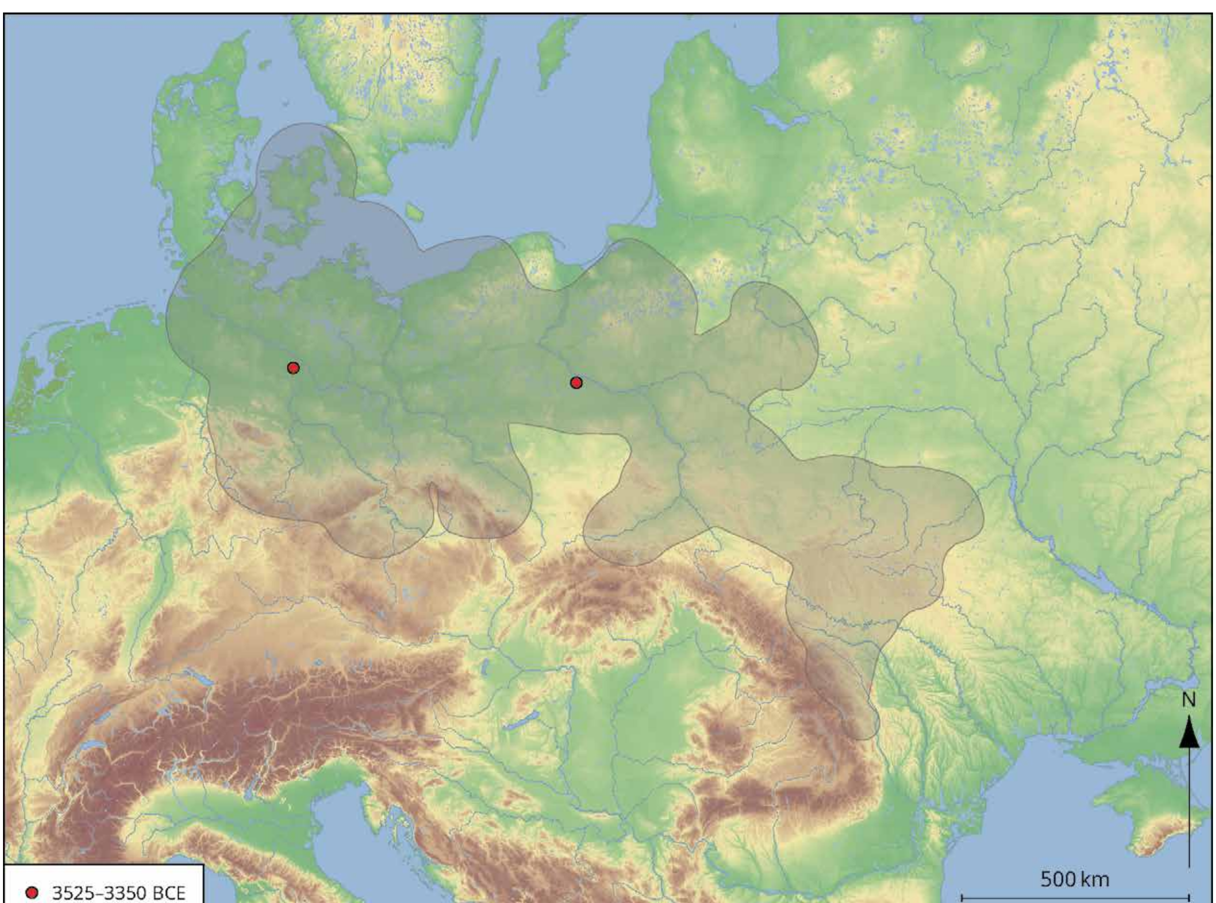

3525–3350 BCE
N
500 km

Figure 170. The calibrated median ^{14}C values within the calibration ranges ca. 3525-3350 BCE and ca. 3350-3090 BCE.

three dates from the Northeastern Lublin Plateau. The data consists of six dates from five settlement sites (one of them enclosed), six dates from three sites with cattle depositions, four dates from two cist graves, one date from an earthern flat grave, one date from a walled chamber grave, thirteen dates from two passage graves plus three dates from a flint mine.

The dates from the cist graves in Dolhestii Mari and Osterburg-Düsedau, which represent the only single and double burials dated so early, should possibly be doubted. Nevertheless, no reduction of the data set was initially carried out. The data from Wangels (a passage grave with GAC pottery) is also difficult to assess, but via the settlement contexts of Parchim-Löddigsee, a date in this calibration range in the northwestern area is also given. The three dates from the flint mine of Krzemionki Opatowskie could either refer to a GAC exploitation of the mine in this period or be due to an unverifiable old wood effect. But, from our point of view, the use of the chocolate silex can be traced back to its use by GAC expeditions.

Basically, the distribution area of the GAC in the mentioned period is again concentrated on the areas of the Lower Vistula/Middle Elbe.

In the *calibration range ca. 3090-2920 BCE*, the medians of 75 dates from 33 sites are located (Fig. 171). In addition to numerous dates from settlements and an enclosed settlement (15 sites with 31 dates), megalithic, chamber or mass graves (seven sites with nineteen dates) and animal depositions (8 sites with 12 dates), there is above all an increased number of earthen pit and cist graves (11 sites with 15 dates). In this time period, the practice of burials in single graves likely became more established.

Spatially, an expansion of the GAC area can be identified from ca. 3100 BCE, first to Lesser Poland and then to the Lublin Plateau, subsequently from ca. 3000 BCE also to Volhynia, the Narew and possibly also to the Moldavian Plateaus. In the west,

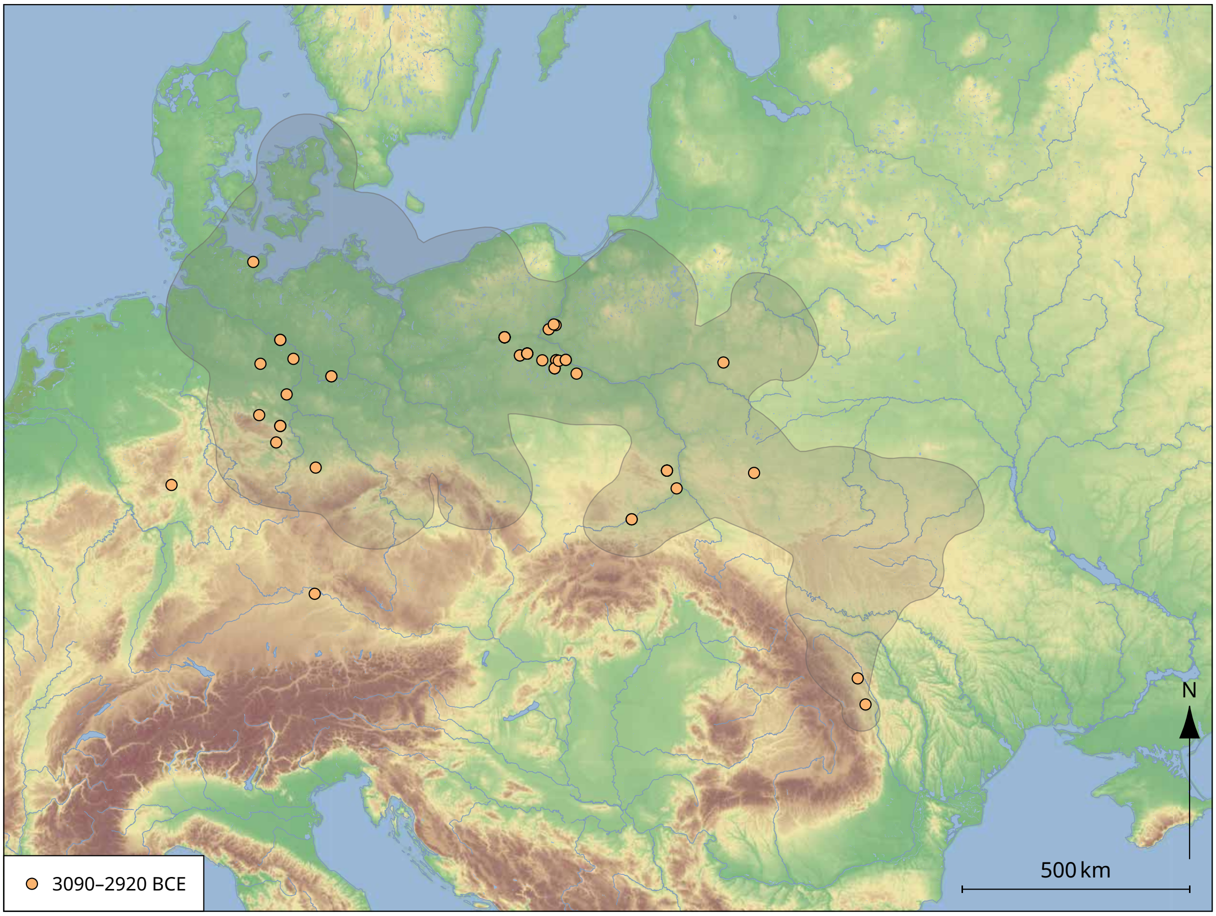


Figure 171. The calibrated median ^{14}C values within the calibration range ca. 3090-2920 BCE.

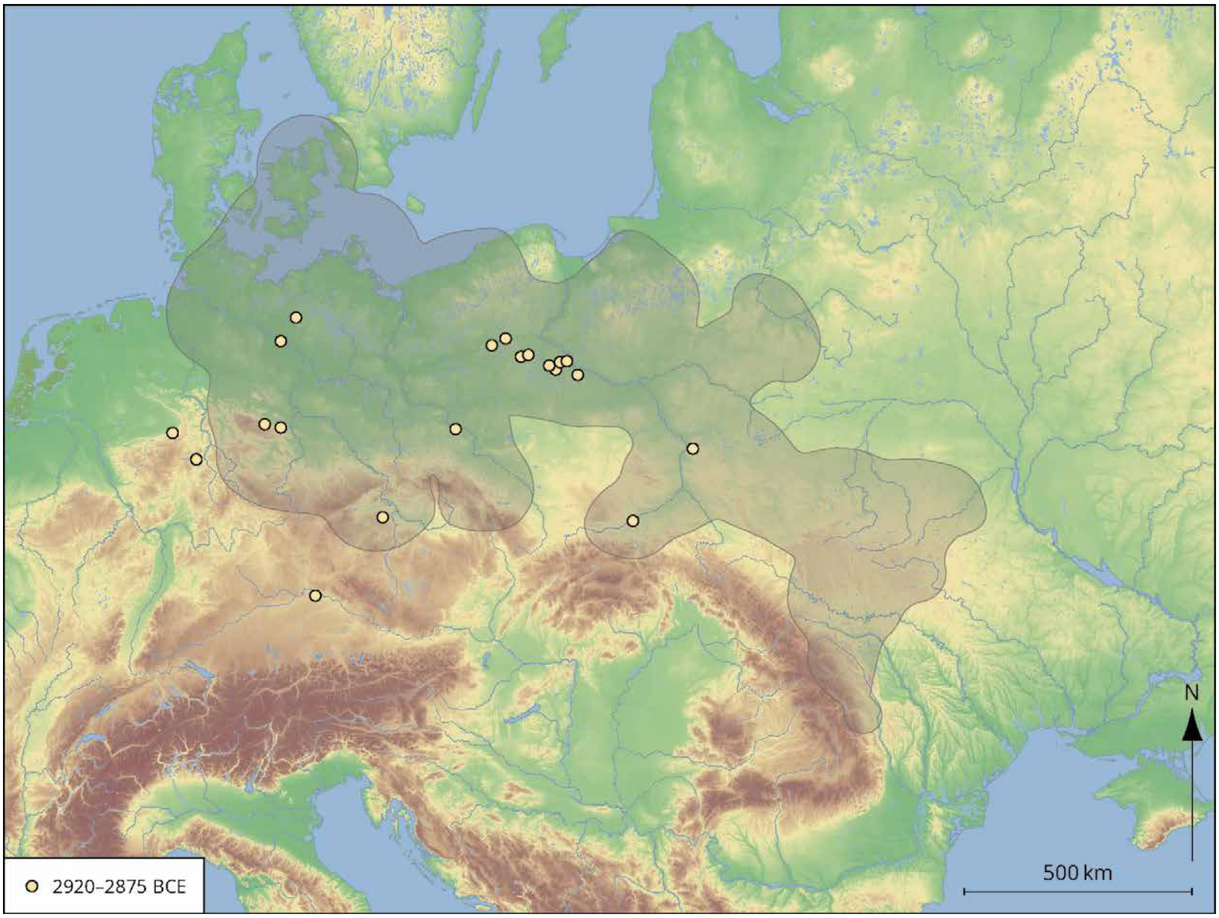
influences in the Wartberg zones from ca. 3100 BCE and probably also in Cham from around 3000 BCE are recognisable.

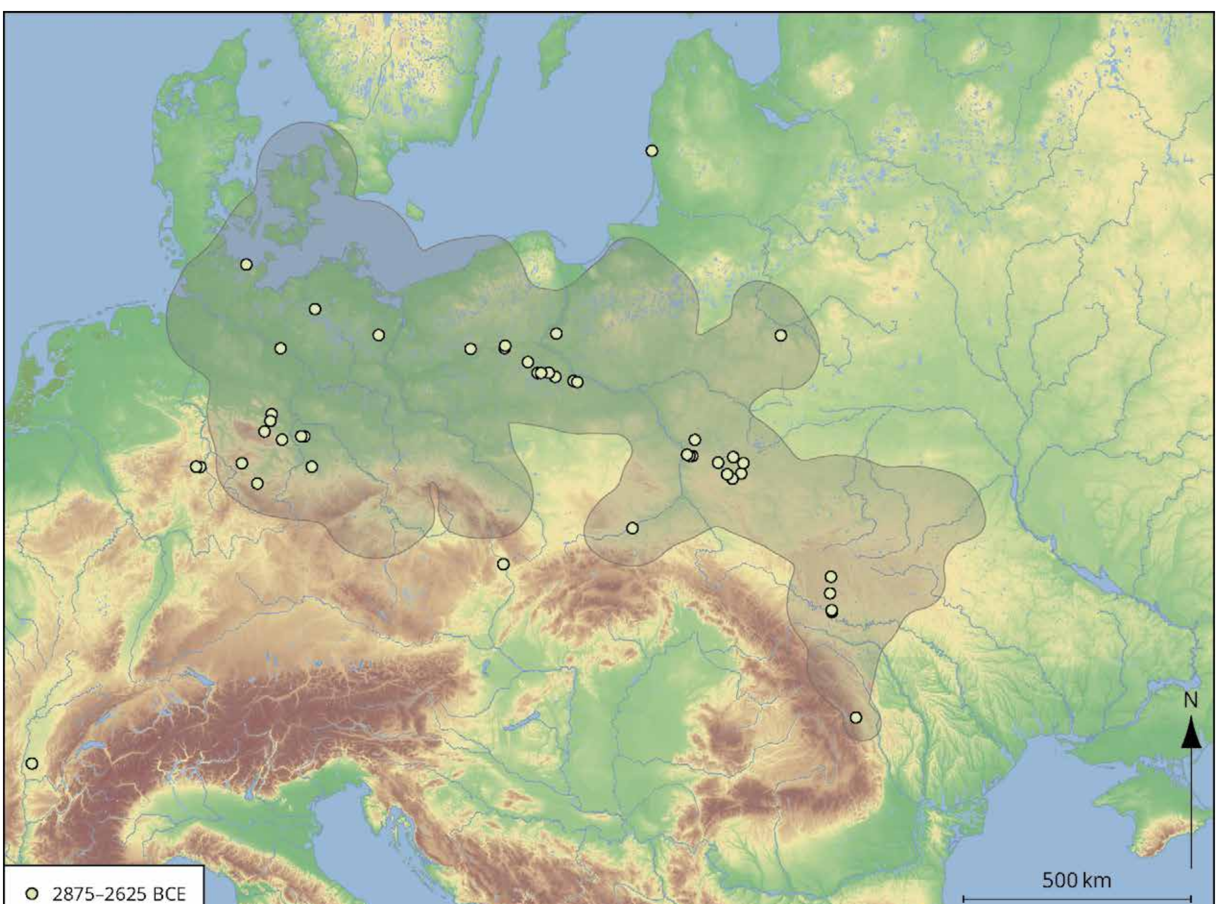
From the steep *calibration range ca. 2920-2875 BCE*, medians of eighteen radiometric dates from twelve sites are available (Fig. 172), including six settlement sites and one enclosure (seven dates), two megalithic graves (seven dates), one mass burial (two dates), and one date from both a cist grave and a pit grave (one date each). Due to the short time span, only a few ^{14}C dates are available, thus all practiced contexts are certainly not represented. For example, the megalithic grave Kierzkowo 13 includes two dates of cattle bones from the western deposition site. Therefore, it is obvious that animal depositions still continued.

In the steep *calibration range ca. 2920-2875 BCE,* we initially record an occupation of the North Bohemian and Silesian regions, and in the *calibration range ca. 2875-2625 BCE* additionally the Central Moravian area (Fig. 173). In the same time span, the dense occupation of Podolia and the Siret occurs, moreover, influences on the Neman and in the Southeastern Baltic region. In principle, this is now the period in which the Globular Amphora phenomenon reached its greatest extension.

From this period, 142 radiometric dates from 60 sites are available. In addition to 11 settlements with 29 dates, the main proportion of the dates are from the Koszyce mass burial (16 dates), still numerous dates (17) are available from other contexts; from five megalithic graves, two dates from two walled chamber graves, seven dates from cist graves (seven sites) and 44 dates from 28 sites with earthen pit graves. The eight sites with animal depositions provided 14 dates.

From the *calibration range ca. 2625-2475 BCE,* 39 radiometric dates from 27 sites are available, of which 17 are from 14 sites with earthen pit graves and cist graves,


2920–2875 BCE
N
500 km


2875–2625 BCE
N
500 km

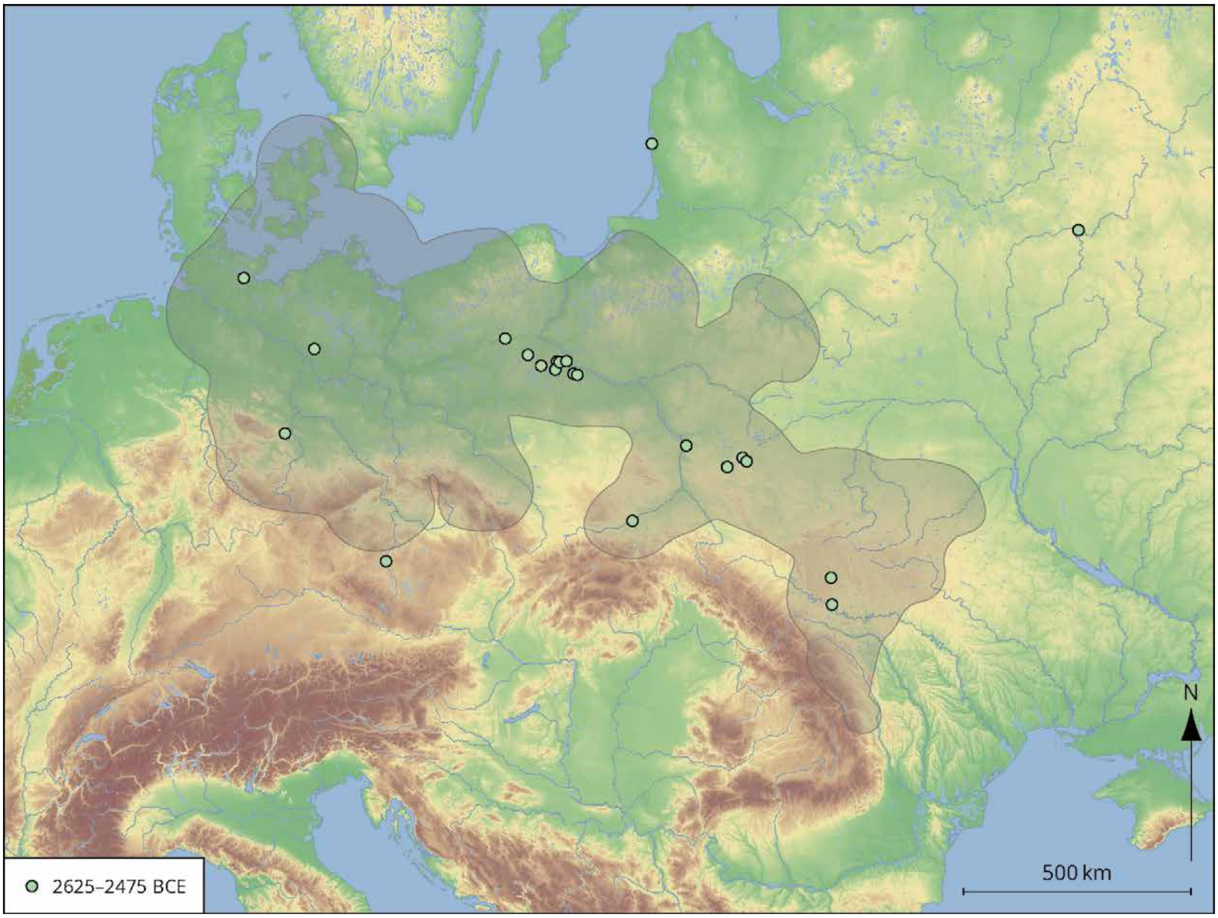


Figure 174. The calibrated median [14]C values within the calibration range ca. 2625-2475 BCE.

only three from two megalithic graves, two from the mentioned mass grave and two from two animal depositions (Fig. 174). 11 dates are assigned to eight settlement sites.

Although the spatial distribution of the data includes data from western to eastern regions of the GAC phenomenon, the distribution should be viewed with caution. The "western data" represents a cist grave from Augsdorf-Bröddelberg (KN-4894), the median of which lies early at ca. 2610 BCE. For the cremation burial at Rehfeldt, site 16, a date with an extremely high standard deviation is available (Bln-4004), the median of which is also ca. 2600 BCE. The date from Berlin/Seedorf-Heidmoor (KIA-8121) cannot be clearly assigned to the GAC finds there. The three dates from Kostelec nad Vltavou are also not associated with GAC ceramics, but were only wrongly associated with the GAC. Moreover, even with the date from Vliněves, the other dates from the same triple burial indicate that this date can be ignored. In summary, in the "west", the duration of the GAC can only be assumed until ca. 2600 BCE.

In the *calibration range ca. 2625-2475 BCE*, the west between the Baltic and Bohemia can be excluded from the distribution area of the GAC from ca. 2600 BCE, while settlement continues between Kuyavia and Podolia and influences even become tangible for the first time on the Middle Dnieper. Classic globular amphorae can be noted between Kuyavia and Podolia, *e.g.*, in Kowal 14 (Poz-21910) with the latest dates for classic GA ceramics.

From the *calibration range ca. 2475-2200 BCE*, we know of twenty dates from ten sites (Fig. 175), including six dates from animal depositions in Opatowice, seven dates from settlement pits at seven sites, two cist graves, one date from a mass burial and four dates from two sites with megalithic graves.

The two dates from the "west" may certainly be neglected. In Wangels LA 69 (Poz-62707), we are dealing with a *terminus ante quem*, in Gudensberg-Bürgel an

Figure 172 (left, above). The calibrated median [14]C values within the calibration range ca. 2920-2875 BCE.

Figure 173 (left, below). The calibrated median [14]C values within the calibration range ca. 2875-2625 BCE.

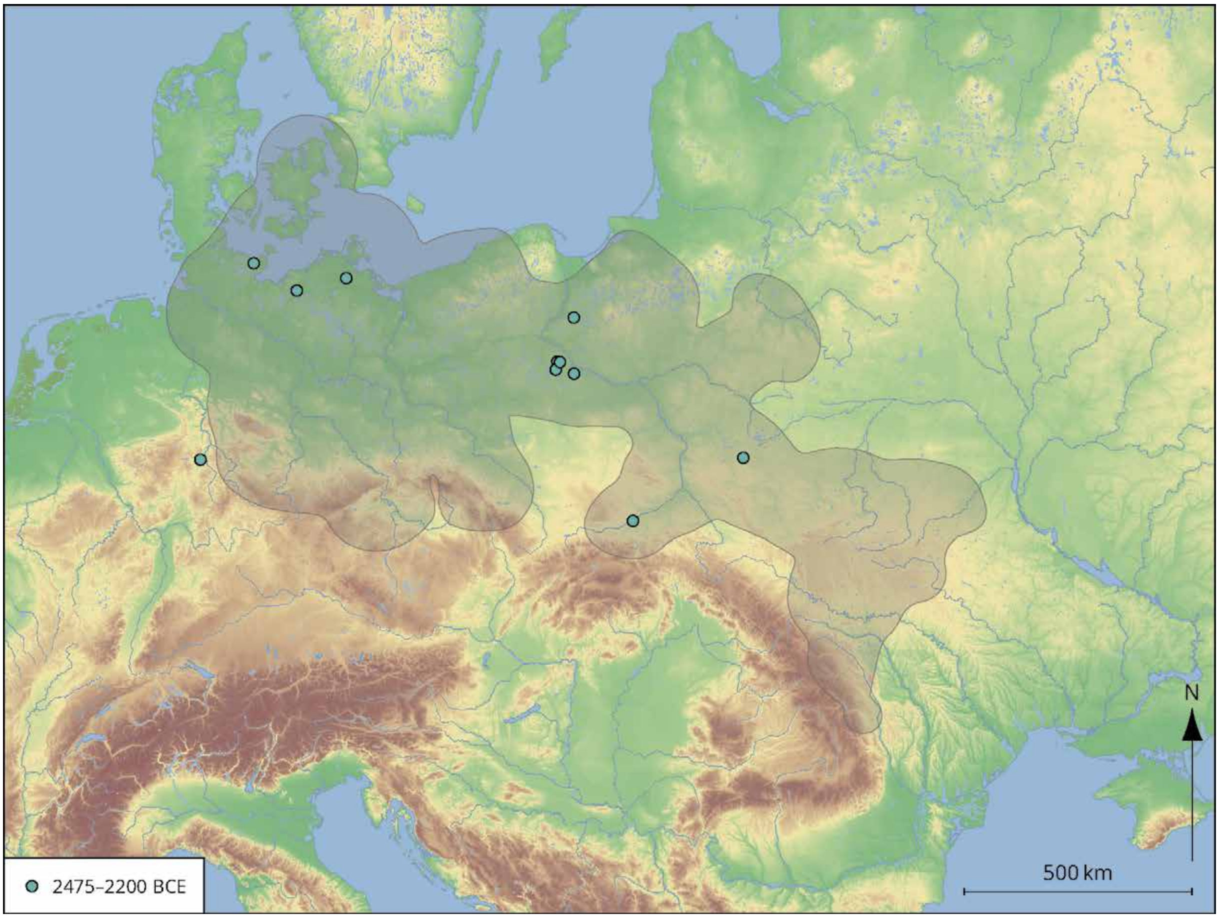


Figure 175. The calibrated median ¹⁴C values within the calibration range ca. 2475-2200 BCE.

association with GAC pottery is unclear. Therefore, globular amphorae occur only sporadically in an area between Kuyavia and Volhynia. The youngest secure date from Opatowice 36/101A dates with the median shortly before 2300 BCE. However, the features from Opatowice 36/101A are without GAC pottery (cf. Szmyt 2015a, tab. 8.5). The youngest date from Opatowice 1/38 (Gd-8036) is represented by a lifted, two-handled vessel (Szmyt 2007a, 146 fig. 9.3).

3.5.1.1 Distribution according to the site types

When considering the development of the individual contexts, it is striking that at the beginning of the development, megalithic graves, sub-megalithic structures and animal depositions are present alongside the remains of settlements, but with the exception of two possible difficult sites, evidence for individual graves is practically absent (Fig. 176). Thus, dates for earthen pit graves are only available for the third calibration period considered here (ca. 3090-2920 BCE), and cist burials – when excluding the cist burials of Düsedau and Dolhestii Marii – are also only available from ca. 3090 BCE. We interpret the high proportion of animal depositions and the use of megalithic graves as ritual practices derivable from pre-existing local and regional contexts.

The increased emergence of single graves, in particular, the increase of earthen pit graves to a peak at ca. 2875-2625 might characterise the climax of the GAC development, initially very strongly but also after 2920 BCE still characterised by animal depositions.

The end of the GAC, which is then above all spatially based on data from the East Group, is characterised by a decrease in earthen pit graves and the construction

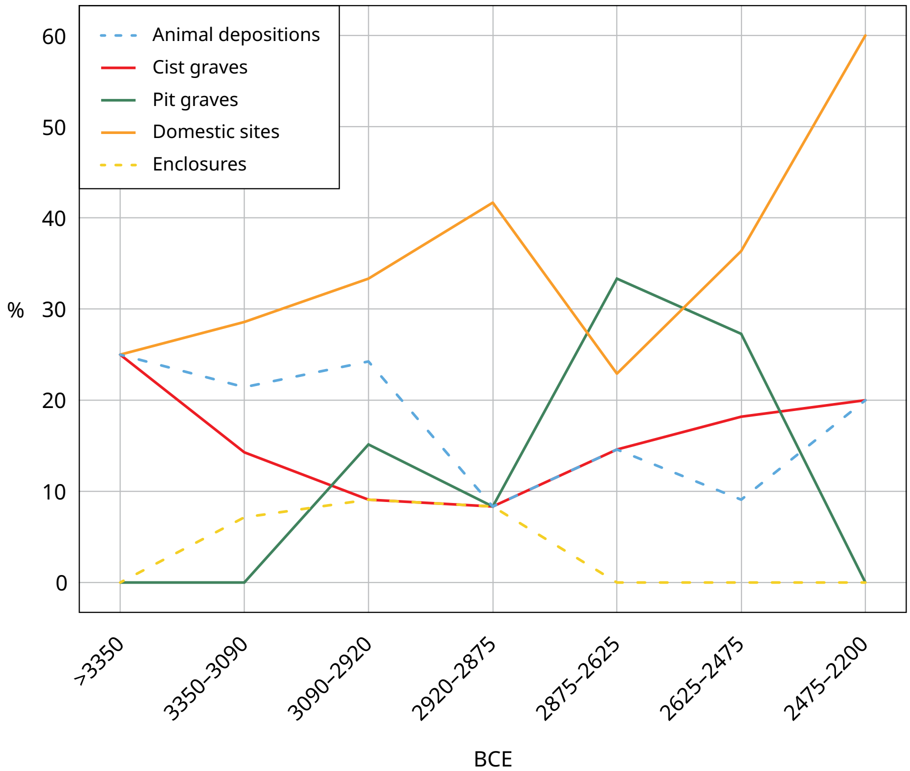


Figure 176. Tendencies in the distribution of context categories.

Figure 177 (following page, above). The distribution of early animal depositions with GA (median calibrated ^{14}C values mapped for the calibration range 3350-2920 BCE). The animals were not for consumption.

Figure 178 (following page, below). The distribution of ^{14}C-dated depositions of non-consumed animal contexts with GA (median calibrated ^{14}C values mapped for the calibration range 2920-2625 BCE).

Figure 179 (page 211, above). The distribution of ^{14}C-dated depositions of non-consumed animal contexts with GA (median calibrated ^{14}C values mapped for the calibration range 2625-2200 BCE).

Figure 180 (page 211, below). The distribution of ^{14}C-dated animal depositions without GA (median calibrated ^{14}C values mapped for the calibration range 3750-3090 BCE).

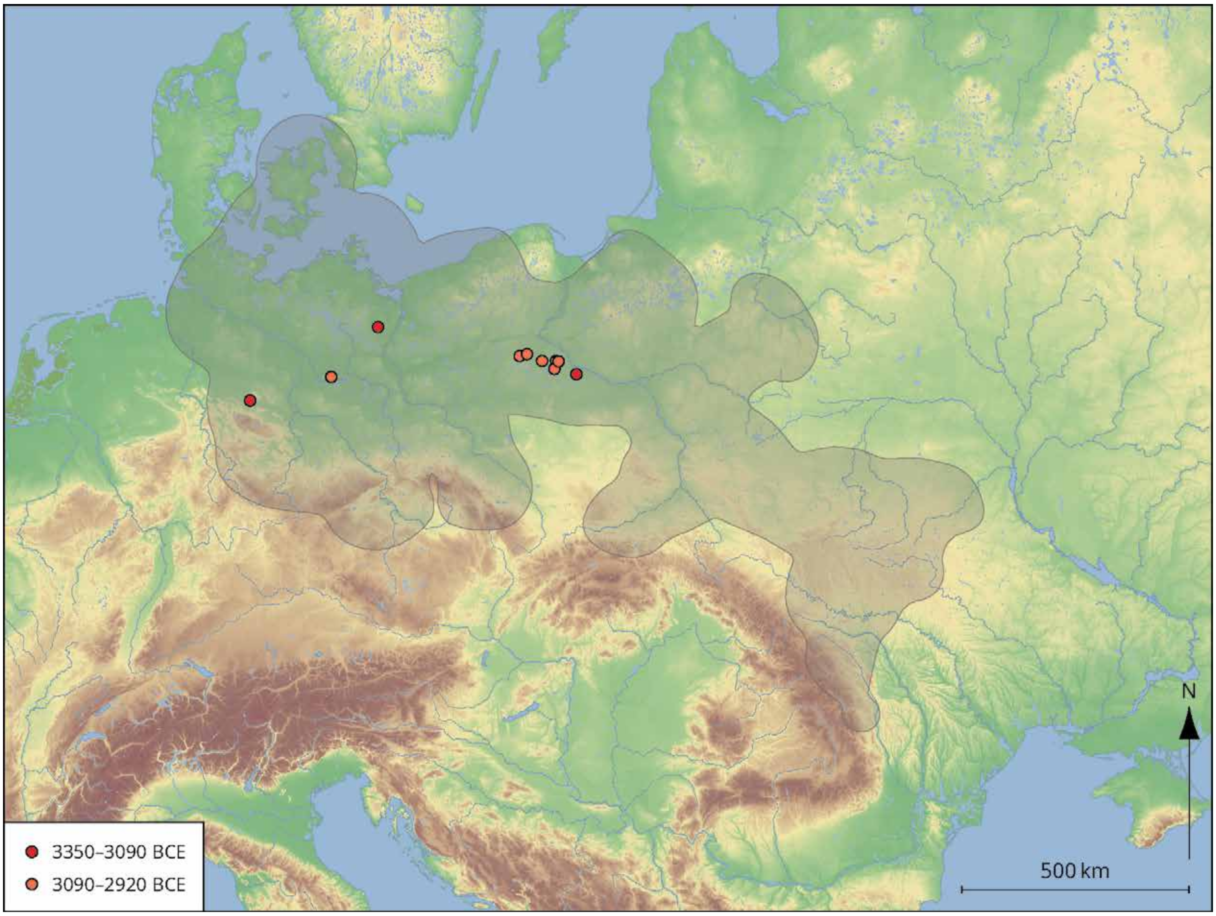
of cist graves. Here, the local characteristics of the East Group become discernible. In principle, most radiometric dates after ca. 2475 BCE originate from settlement contexts. Thus, it is recognisable how the ritual behaviour, which is characteristic for the GAC, abates and finally ceases.

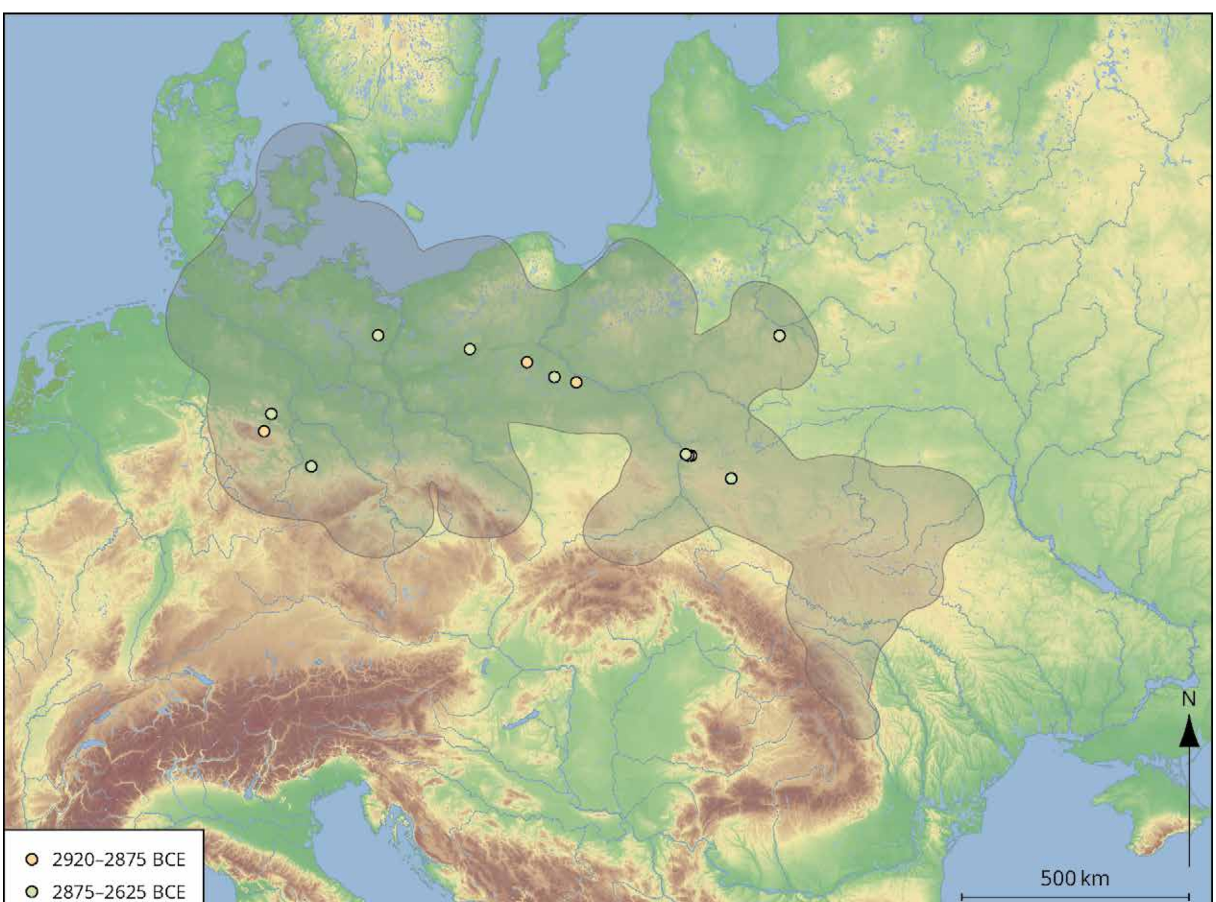
Of particular interest are the animal depositions, in which animals are not consumed, but their remains are rather usually deposited as complete or partial skeletons. We observe early animal depositions including GA in the Lower Vistula/ Middle Elbe distribution region from ca. 3200 BCE (Fig. 177) with a spatial extension of the practice up to ca. 2620 BCE (Fig. 178). Afterwards, the practice may have been limited to the Vistula area (Fig. 179). Considering the other animal depositions, which also do not contain GAC inventories, the picture of an early distribution in the Middle Elbe/Lower Vistula area becomes even more concentrated (Fig. 180). If we refer to double cattle burials in mostly antipodal positions, this indicates an early emergence in the west until ca. 3100 BCE and an eastward spread of the practice from ca. 2930 BCE (Fig. 181, cf. also Fig. 182). However, no dates are available from Kuyavia with the exception of the feature 234 from Kowal 14, the character of which remains unclear.

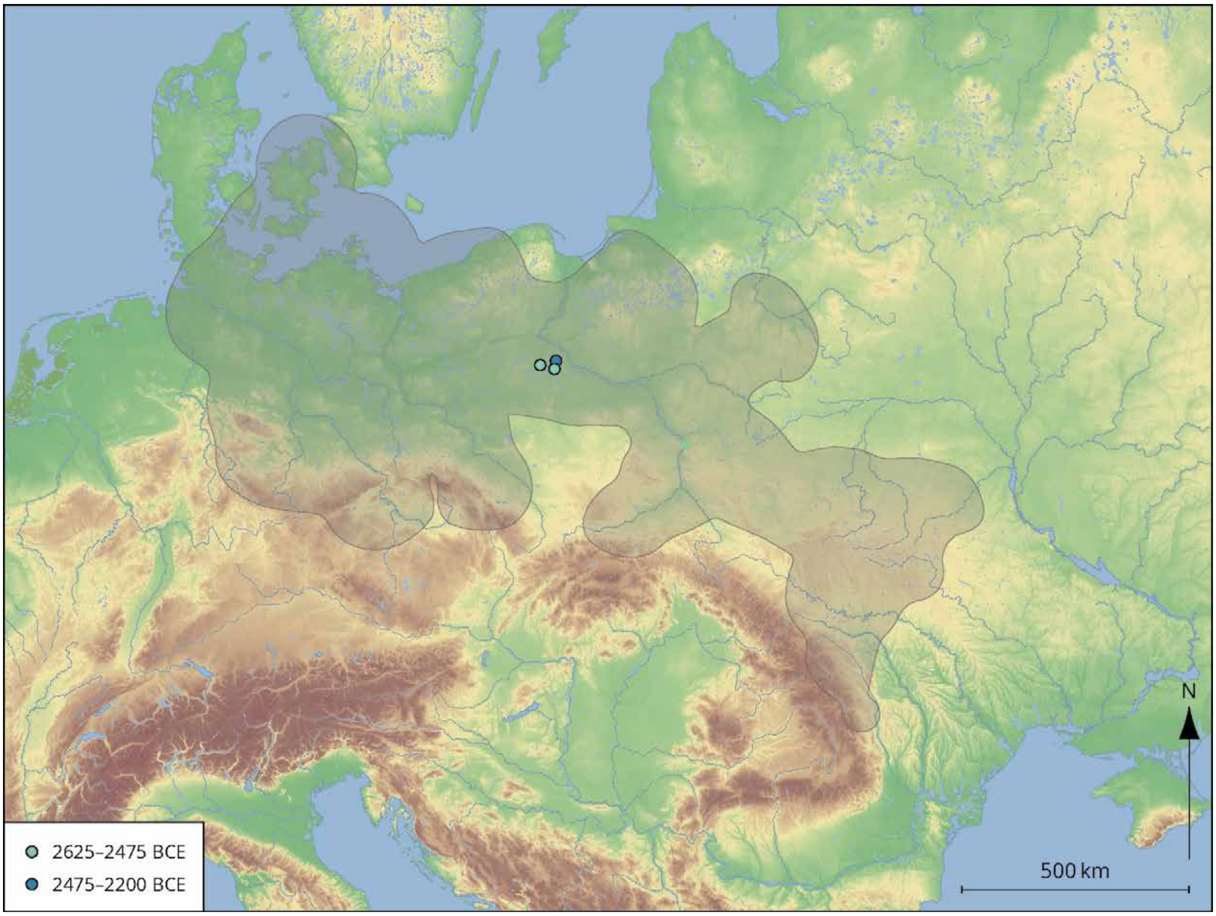
Thus, we can fairly well describe the emergence, the peak and the cessation of a ritual practice. Their causes can only be evaluated from an overall appraisal of the arguments.

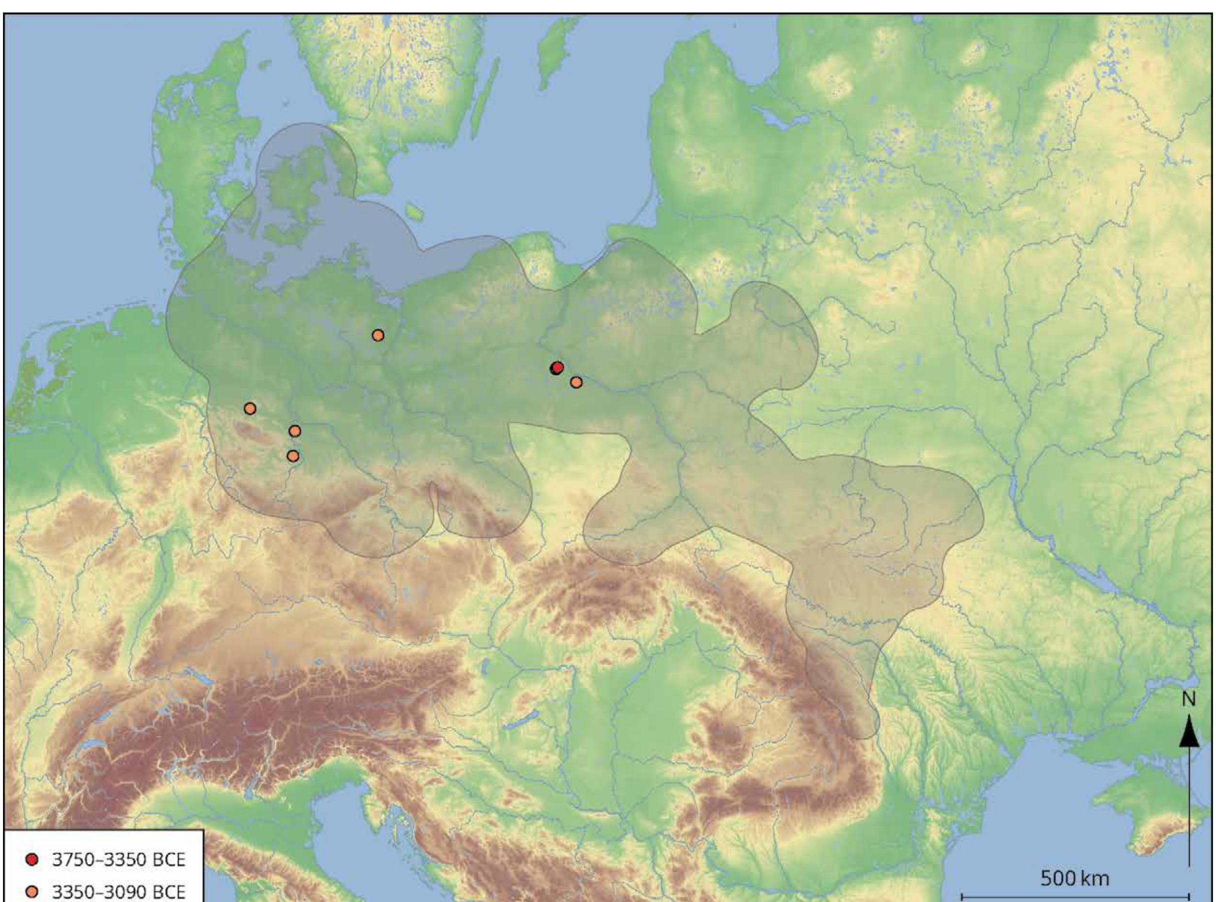
3.5.2 Spatial-temporal distribution according to hexagonal surfaces

In three different steps, the youngest, the median and the oldest values were integrated into the hexagonal areas measuring ca. 100 km in diameter and mapped. The colour classification is based on the breakpoints of the calibration curve (see Tab. 4; Fig. 66 above), so that the colours stand for the plateaus of the calibration


3350–3090 BCE
3090–2920 BCE
N
500 km


2920–2875 BCE
2875–2625 BCE
N
500 km


2625–2475 BCE
2475–2200 BCE
N
500 km


3750–3350 BCE
3350–3090 BCE
N
500 km

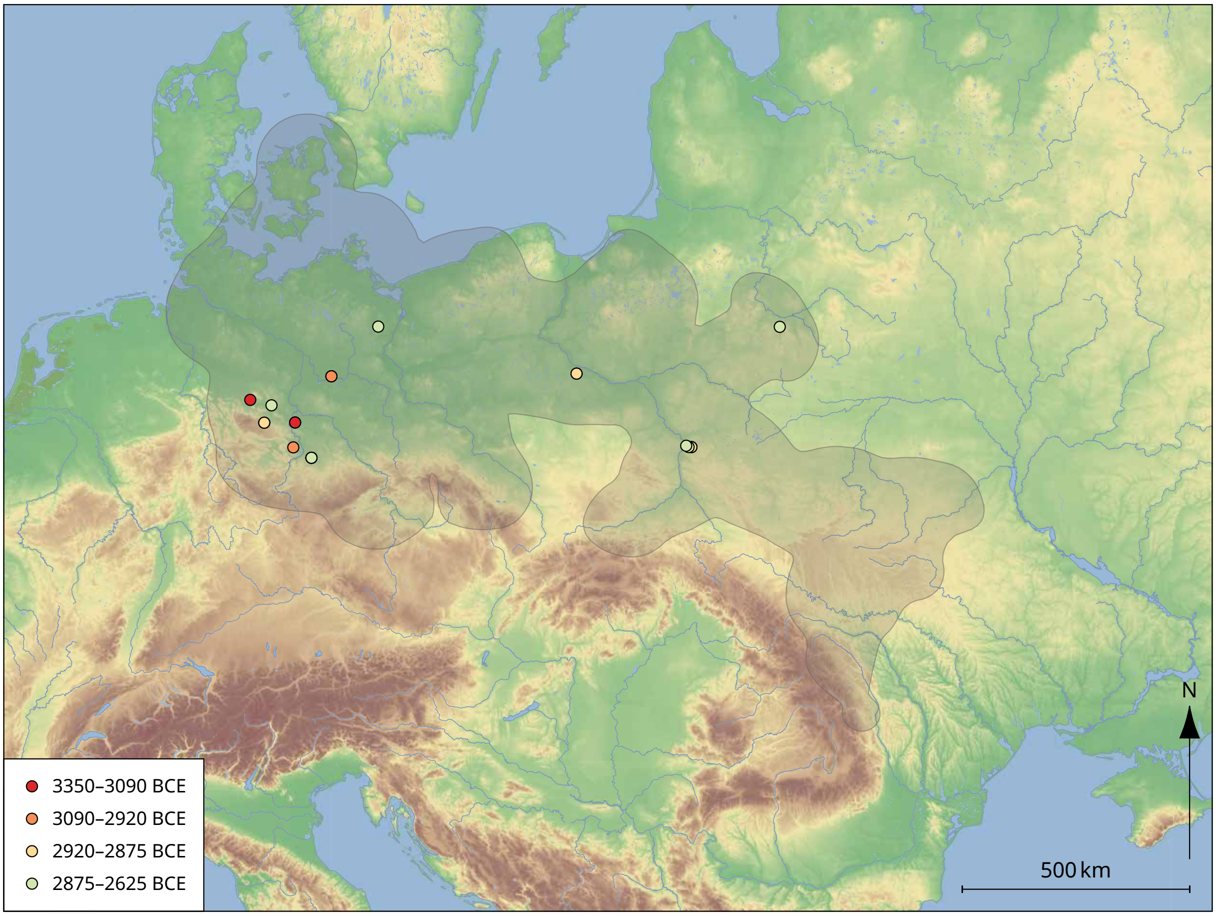


Figure 181. The distribution of ¹⁴C-dated double cattle burials (median calibrated ¹⁴C values are mapped).

curve. With this representation method, it was possible to make the age differences of the entire area of the GAC visible (Fig. 183).

In principal, the absolute chronological differences are smaller than expected (Tab. 6). For the median representations, data from Kuyavia and Central Germany is available that date to the first plateau <3350 BCE.[45] Dates of the second plateau <3120 BCE are found in an area between the Lublin Plateau, Bohemia, Central Germany, the Western Baltic and Kuyavia. However, dealing with the charcoal data from Krezmonkin as well as the early Western Baltic data from megalithic graves is difficult, so that the Lower Vistula/Middle Elbe area is obviously covered again.

With the third plateau <2910 BCE, further areas, in particular in Volhynia, on the Upper Bug and in the Moldavian Plateaus, are recorded. In the west, influences in both Hessian-Westphalian and Bavarian regions are now recognisable, and up to 2870 BCE, the Bohemian and Moravian areas of distribution are also recorded. Up to ca. 2630 BCE, GA ceramics are also represented in Podolia, on the Upper Nema and on the Southeastern Baltic coast. While influences are still documented on the Upper Dnieper until ca. 2500 BCE, classic globular amphorae are now missing almost everywhere else. They can only be found until about 2300 BCE in Volhynia and Podolia. The presentation of the youngest data illustrates that the occurrence of GA ceramics in Western GAC areas ceased earlier than in the central and eastern areas (Fig. 184).

45 Data from the Siret is not considered here.

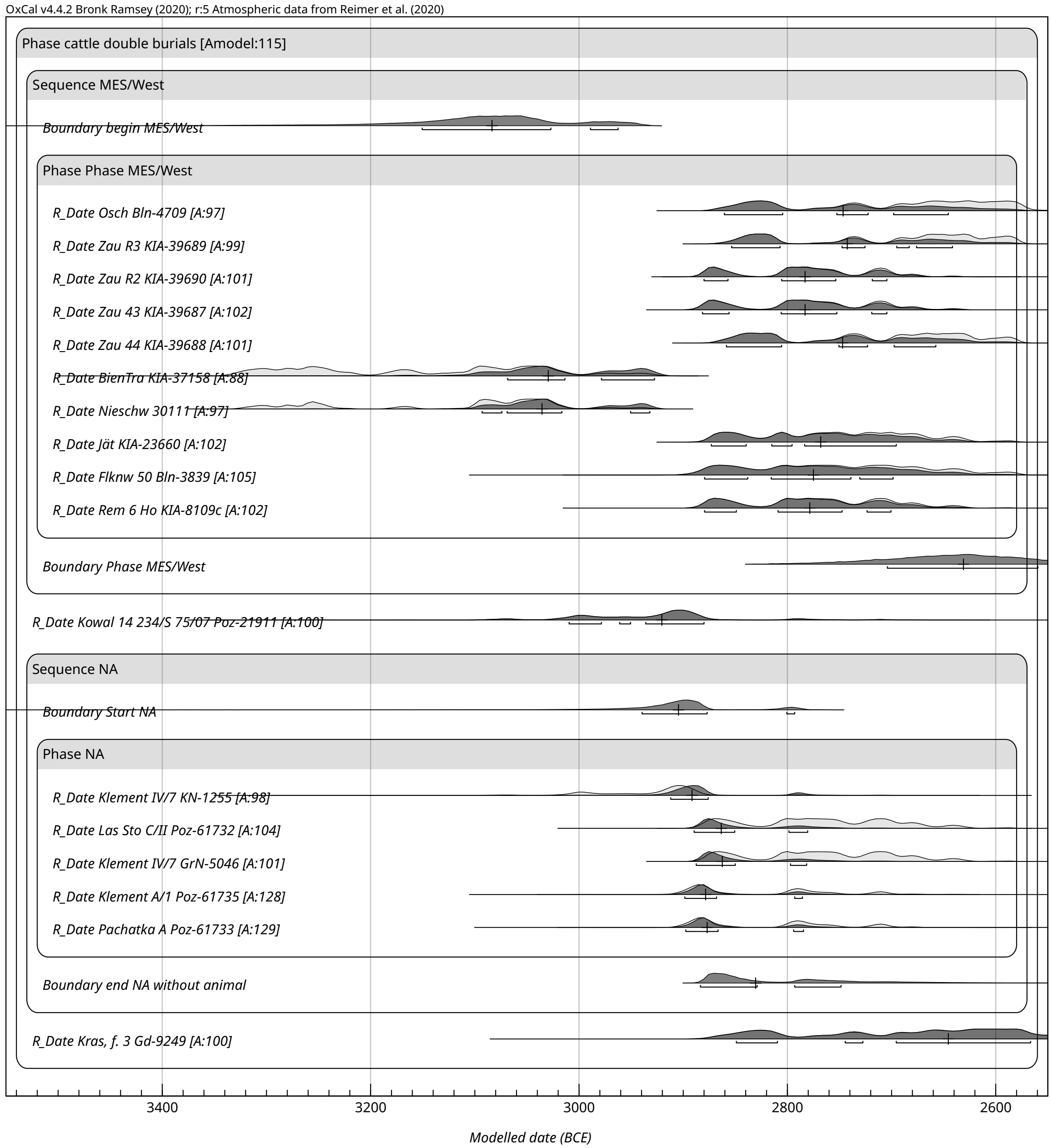


Figure 182. The Bayesian calibrations of Western double cattle burials and Nałęczów type cattle burials (cf. Suppl. 10).

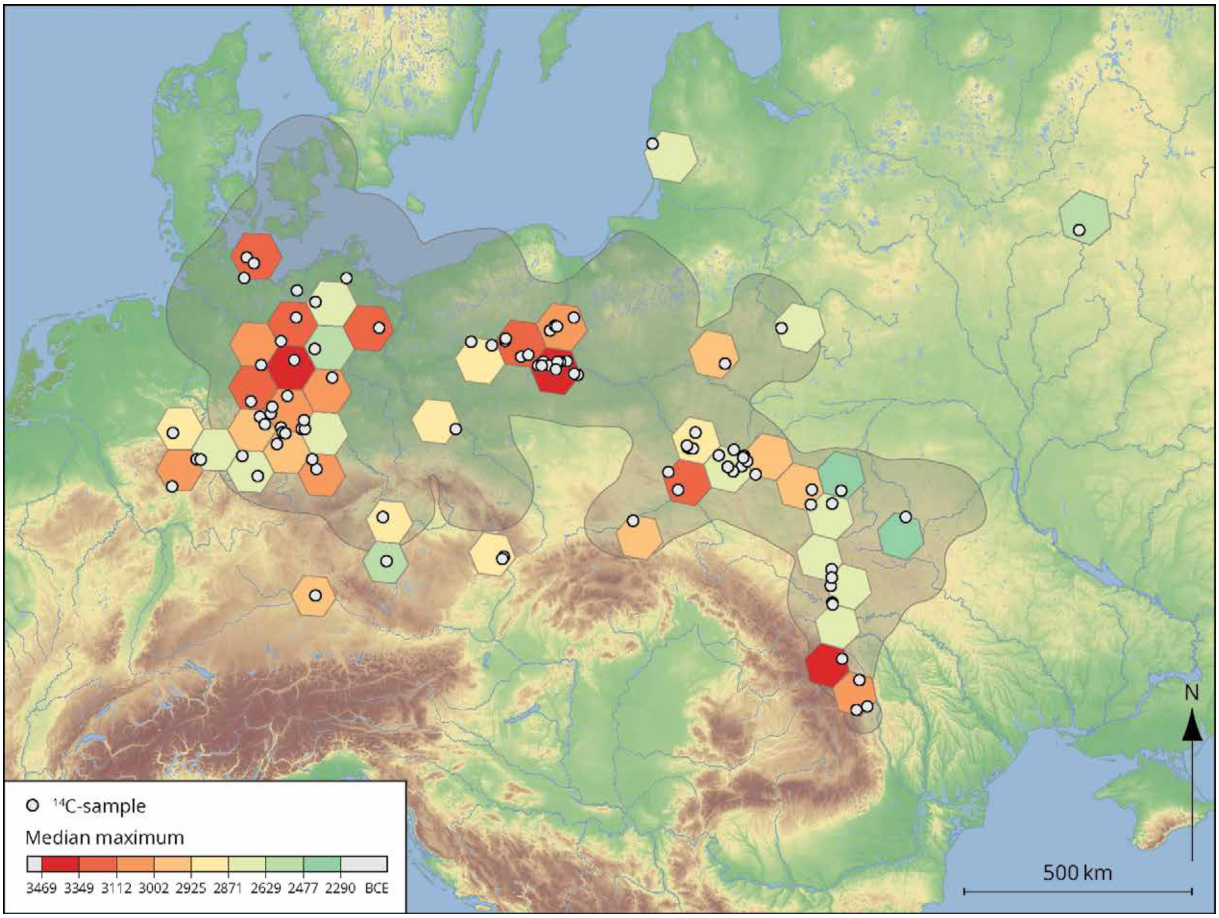


Figure 183. The oldest median 14C values of the hexagonal areas.

Table 6. The duration of GAC in different regions.

	Begin	Median	End	Median acc.
Kuyavia-MES	<3400	<3350	MES <2600 Kuy <2200	<3350
(Lublin-Bohemia-MES-wBaltic_Kuyavia)	<3360	<3120	<2600	<3100
+ Seret	<2900	<2900	<2600	
+ Volhynia/Podolia	<2900	<2900	<2300	<2900
+ Northeastern Baltic	<2500	<2700	<2500	
+ Neman-Dnieper	<2500	<2500	<2300	

3.6 Summary and consequences

The compilation and analysis of the radiometric dates provided a fairly clear picture of the development of the GAC in the entire area between the Moldavian Plateaus and the Cimbrian Peninsula and between the western low mountain range and the Middle Dnieper.

It first becomes clear that there is by no means a large temporal difference between western, central and eastern distribution regions (Fig. 185). Instead, classical globular amphorae prove to occur simultaneously in an area between the Middle Elbe and the Lower Vistula. The earliest dates, which can still be doubted, lie around 3200 BCE, but the emergence of GA can be observed consistently before ca. 3100 BCE in the area in question. This occurs in connection with cattle depositions and other ritual practices, whereby older depositional principles are also first continued, *e.g.*, depositions in megalithic graves.

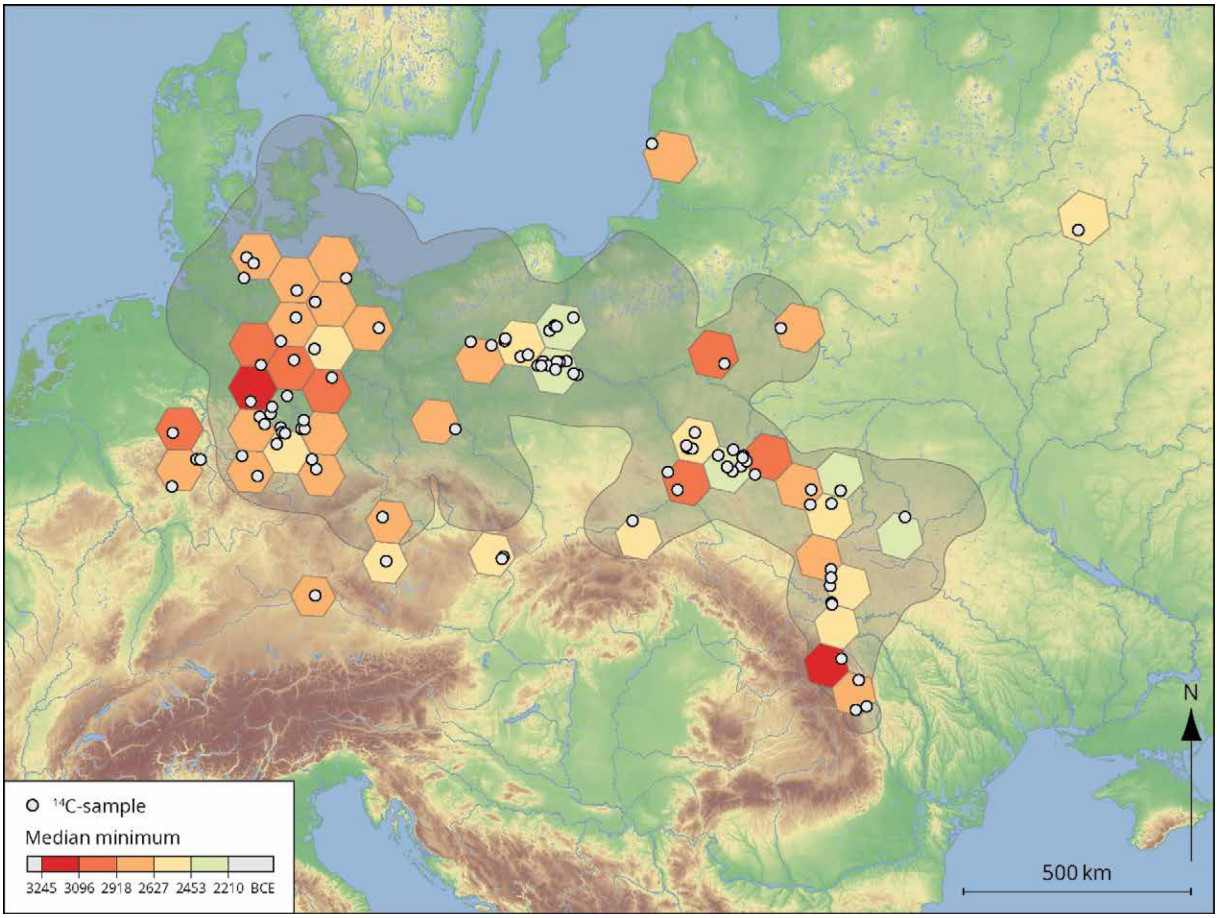


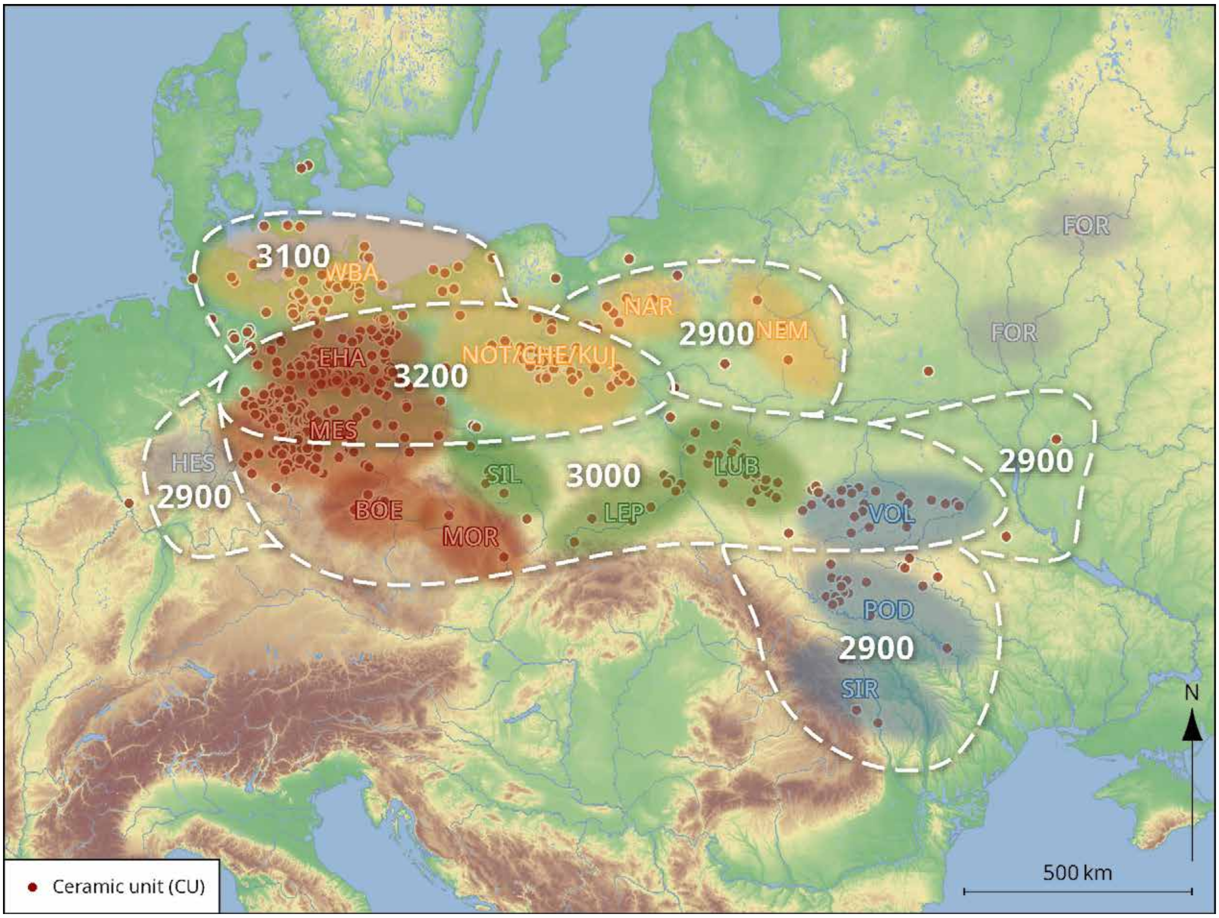
Figure 184. The youngest median 14C values of the hexagonal areas.

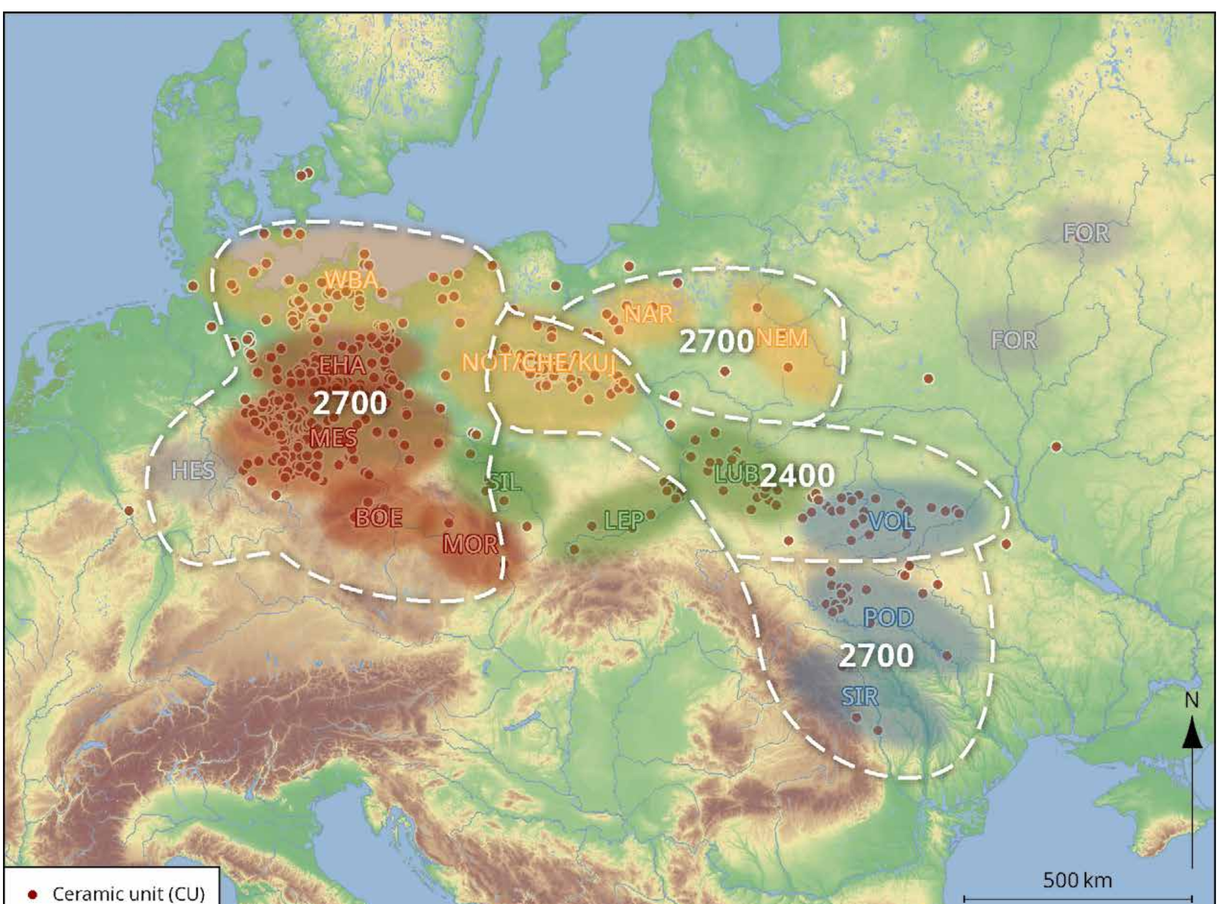
Spatially, a separation of the early "core zone" into a western and an eastern zone can be observed, out of which both separate western and eastern networks of social practices (cf. Chap. 2) develop and cause a further spread of the GAC phenomenon: from ca. 3000 BCE at the latest in numerous regions, *e.g.*, also in Southeast Poland and then in Volhynia or with a separate settlement area in Bohemia/Moravia. Significant influences are also visible from ca. 3000 BCE and 2900 BCE in other neighbouring areas – in the west in the Wartberg area, in the south in the Cham and Goldberg III areas, in the east in the Nama area and partly up to the Middle Dnieper. The GAC exists in many areas for several generations until ca. 2700 BCE at the latest. From ca. 2600 BCE, it is very strongly reduced to areas between the Lower Vistula and Podolia, where it still is present until ca. 2400 BCE (Fig. 186).

Thus, we have arrived at network connections via the large-scale analyses of cultural practices and at the patterns of emergence and distribution of the GAC as an overall phenomenon via the absolute chronological investigations. We now want to approach the relationship of the GAC phenomenon to the local and regional groups with a clear look into a region.

Figure 185 (following page, above). The spread of classical GA in Europe according to the 14C analysis.

Figure 186 (following page, below). The disappearance of classical GA according to the 14C analysis.


3100
WBA
EHA
3200
NOT/CHE/KUJ
NAR
2900
NEM
FOR
FOR
MES
HES
2900
SIL
3000
LUB
2900
BOE
MOR
LEP
VOL
POD
2900
SIR
N
Ceramic unit (CU)
500 km


WBA
NAR
2700
NEM
FOR
FOR
EHA
NOT/CHE/KUJ
2700
MES
HES
SIL
LUB
2400
BOE
MOR
LEP
VOL
POD
2700
SIR
N
Ceramic unit (CU)
500 km

4. The Middle Elbe-Saale region: A mosaic of diverse cultural and social practices around 3000 BCE

In contrast to the analyses and interpretations on GA networks presented thus far, we would like to first begin with an examination of the conditions in the Middle Elbe-Saale (MES) region for a more regional perspective. How strongly can we distinguish the Globular Amphora phenomenon from regional practices and groups there?

The MES region is one of the main distribution areas of the GAC (Fig. 1). The MES is characterised, on the one hand, by the extremely fertile black earth areas around the Harz and, on the other hand, by the fluvial plains shaped by the Elbe and Saale rivers. The whole region, which is divided into several basins, is bordered by the Thuringian and Saxon-Bohemian mountains to the south, and open in the other cardinal directions and thus can be interpreted in terms of landscape as the outskirts of the North Central European Lowlands. For the decisive period here, the so-called Bernburg group with its regional, Central German ceramic style has often been discussed in relation to the regional Central German GAC (Beier 1984; 1988; Beran 1989; Dirks 2000; Müller 2001; Rinne 2003; Woidich 2014; Müller 2023).

From a regional perspective, we would like to pose questions about the character and differences between Bernburg and GA inventories, both in terms of the material culture as well as economic and demographic issues. For us, the geographically open Middle Elbe-Saale region is first of all a multiculturally shaped Late Neolithic area of locally acting hamlets and village communities, in which the GA play a special role. Their character needs to be evaluated. This might serve as an example of regional GA practices in the overall GA study area between the Moldavian Uplands and the Cimbrian Peninsula.

4.1 The Central German Bernburg society: Chronology and interpretation

Since the beginning of scientific investigations into Central German prehistory, sites with and developments concerning Bernburg ceramics have had a prominent position in research: The diversity of remains from simple settlements, enclosures, flat graves, burial mounds or wooden and walled chamber graves, plus their association with developing metallurgy have always required a detailed analysis of the find material (Fig. 187).

Equipped with Bernburg ceramics and published, 128 flat graves, 143 settlement pits and 43 walled chamber graves are currently available (Suppl. 11). The number of available radiometric dates that have been published with find inventories amounts to 149 (Suppl. 12).

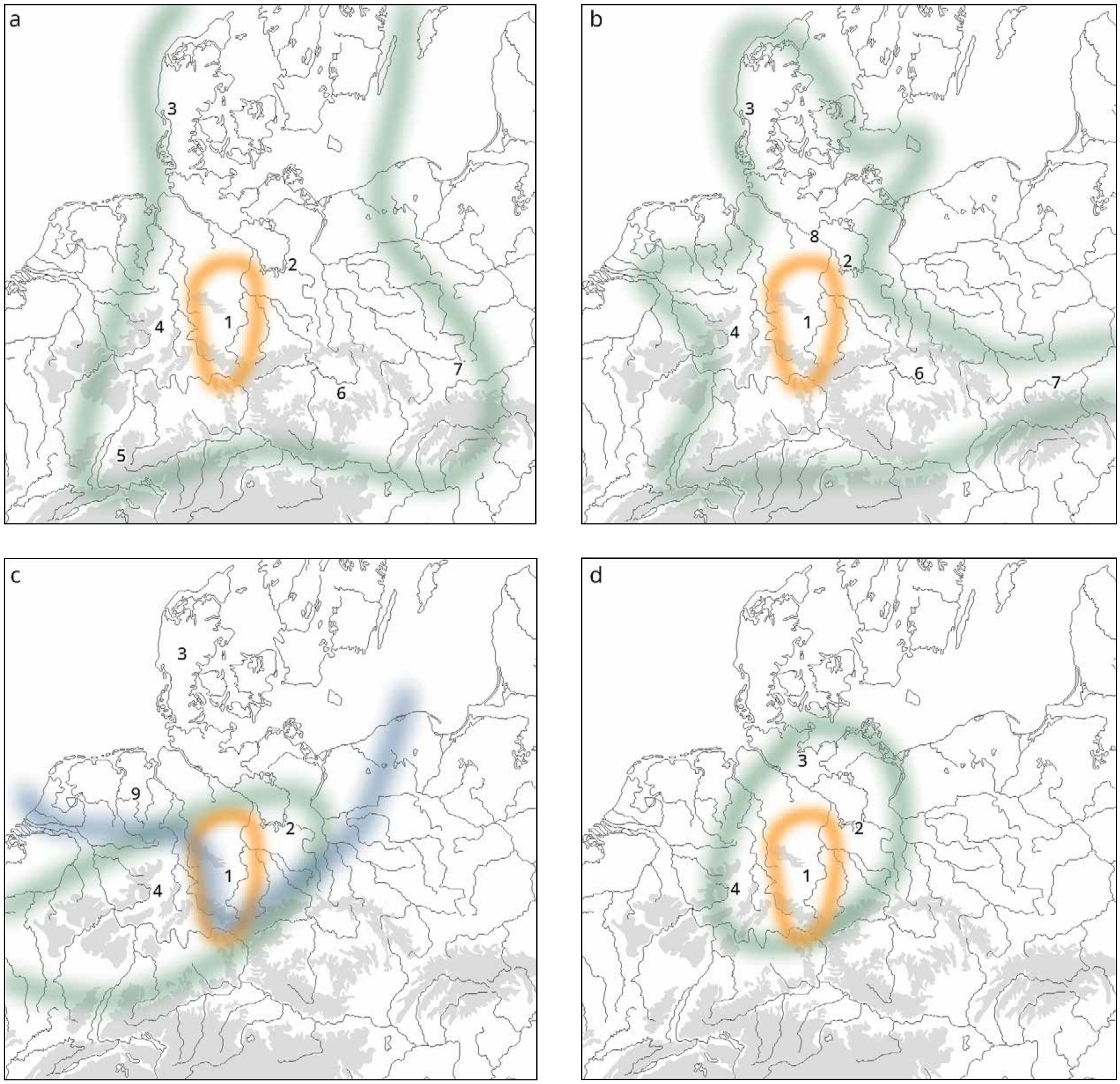


Figure 187. Bernburg elements in the framework of phenomena of the Central European Late Neolithic. Late Neolithic: a – pit huts; b – enclosures; c – walled chamber tombs and flat graves; d – exchange systems: Wiedaer slate. 1 – Bernburg; 2 – Elbe-Havel Group; 3 – TRB North Group; 4 – Wartberg; 5 – Horgen; 6 – Řivnáč; 7 – TRB-Southeast Group; 8 – Altmärkische TRB-Tiefstich Group; 9 – TRB-West Group. The respective groups are marked if they are important for the mapped aspect. orange: Bernburg; green: main distribution of general phenomena pit huts, enclosures, chamber tombs, Wiedaer slate; blue: main distribution of flat graves.

4.1.1 Basic chronological trends

Founded on the appropriate basis and resting on existing classification systems, various correspondence analyses (CAs) were conducted. Thus, 319 'closed' features with 124 type indications were combined according to vessel and decoration motifs (Fig. 188; Suppl. 13) in a correspondence analysis for features which were identified as Walternienburgian or Bernburgian. Although features with very different depositional conditions and assumed deposition and use durations are included here,[46] the result is surprisingly clear: basic patterns of a typological sequence apparently exist in all feature categories (single graves, collective graves, and settlements), which are connected with different prehistoric activities in different social spheres. There are also both grave and settlement remains that are distributed throughout the entire sequence. An assignment of the radiometric dates to the features basically verifies a coherent absolute chronological development between 3350-2800 BCE.[47] Accordingly, we observe the relevant chronological development of the Walternienburg-Bernburg ceramic style, as it corresponds to a classification by Niklasson already in 1925: from tripartite Walternienburg cups (Walternienburg I) to bipartite cups (Walternienburg II/ Bernburg I), single-unit bellied cups (Bernburg II) and single-unit bellied cups with a stepped rim (Bernburg III). With reference to the decorations, a development from simple via complex to recessed chevrons can be noted, which is additionally complemented by further complex patterns in Bernburg II and III, such as recessed metope bands. The sequential calibration of the inventories attributed to the different inventory groups results in the beginning of Bernburg 1 already around 3340 BCE, a relatively broad transition to Bernburg 2 (ca. 100 years) around 3060 BCE, a transition to Bernburg 3 around 2925 BCE and an end of the Bernburg style around 2840 BCE (cf. Fig. 193a, b).[48] These basic trends are also verified in separate typological seriations according to site categories.

4.1.2 Chronology of the graves

The correspondence analysis of the chamber and flat graves, considering the radiometric dating, again reveals a chronological sequence (Fig. 189).[49] In addition, regional differences become visible, differentiating a more Havelland-influenced design area in Tangermünde (Stendal district) from a less-decorated Salzmündian-influenced area in the early development. The former is more characterised by bipartite amphorae and arched/angular incisions, the latter by less-decorated tripartite forms.[50]

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46 In the case of a flat grave, the grave goods certainly refer primarily to the lifetime of an individual, in the case of settlement pits generally less than 50 years, and in the case of walled chamber graves to ca. 150-200 years, which results in the corresponding blurriness.

47 Only three of 31 usable dates are 'wrong', which can be attributed to faulty typological indications or depositional processes.

48 Roman numerals are deliberately not used here in order to maintain the difference to Niklasson's classification. Even if the basic trends coincide, there are differences in detail.

49 From the nine usable ^{14}C dates, only one contradicts the predicted chronological sequence.

50 As far as flat graves or multiple burials are concerned, new radiometric data has resolved findings and datings formerly considered difficult to interpret. In the joint seriation of graves and settlements published in 2001, the radiometric date from, *e.g.*, Bernburg-Biendorf-Trappenberg (Salzland district), was rather "too young", *e.g.*, for the tripartite reconstructed cup fragment (cf. Müller 1999, 48; Müller 2001, 164-173, especially fig. 69). New radiometric dating and the reinterpretation of burial processes as a multi-phase deposition, first of children (MAMS 16123, 4510 ± 24 bp) and cattle (KIA-37158, 4445 ± 35 bp), later of an adult female (HD 18703, 4235 ± 31 bp; KIA 37400, 4217 ± 30 bp; KIA 37399 4131 ± 31 bp), correspond to the correspondence analytical position of the complex in the correspondence analysis of Müller 2001 (Teegen *et al.* 2017). They have been included in the joint correspondence analysis of flat and walled chamber graves (Fig. 189).

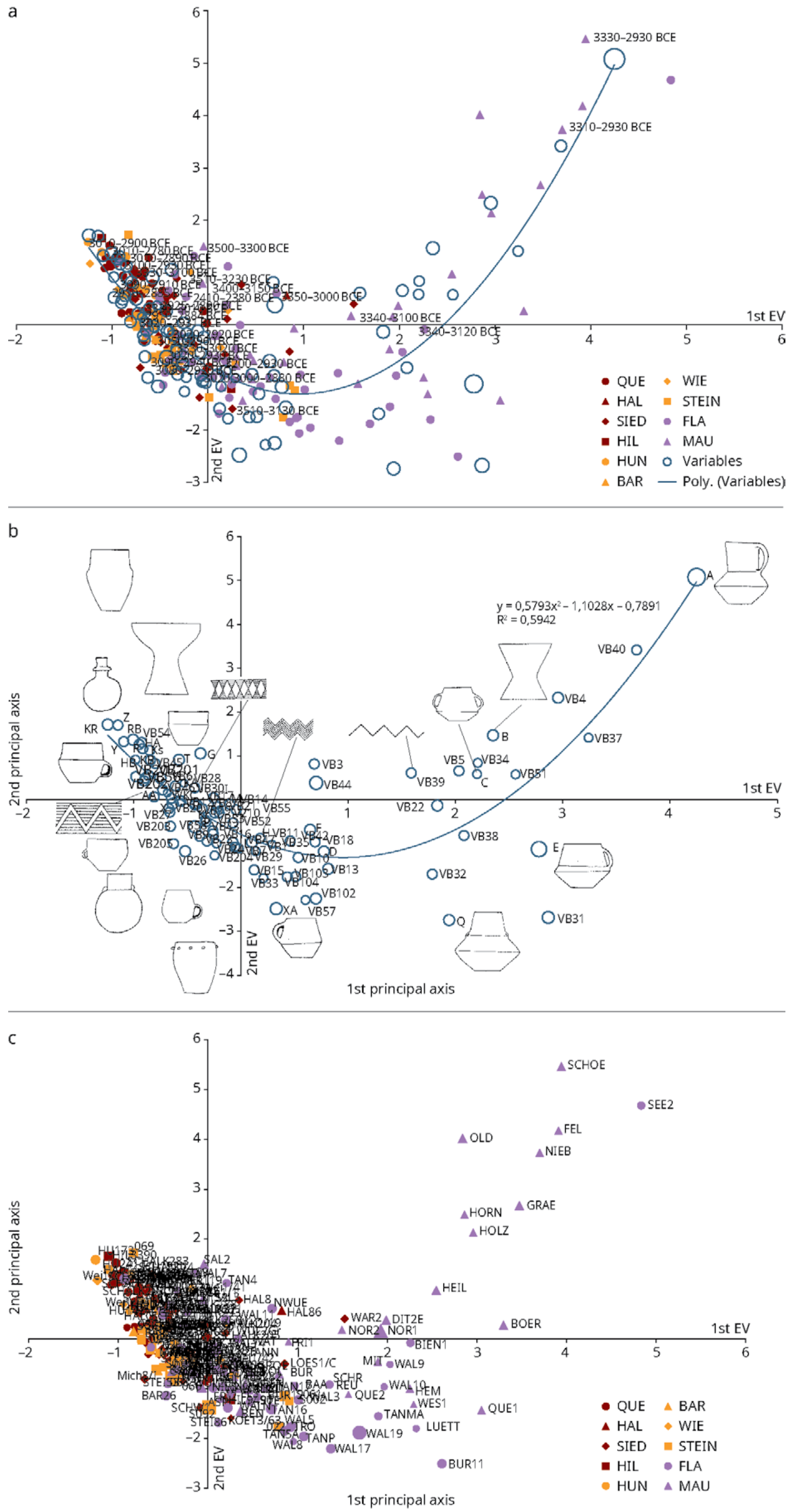


Figure 188. Correspondence analysis of all published Bernburg assemblages. a – Basic result on the 1st and 2nd eigenvector of the CA with marking of the available ^{14}C data. b – Representation of important vessel types and decoration motifs. c – Differentiation according to feature types with inventory abbreviations (see Suppl. 11). Legend of feature types: Settlements (QUE – Quenstedt-Schalkenburg; HAL – Halle-Dölauer Heide; HIL – Hildesheim; HUN – Hundisburg-Olbetal; BAR – Barleben-Schweinemästerei; WIE – Weißenfels-Eselweg; STEIN – Derenburg-Steinkuhlenberg), FLA – Flat grave, MAU – Walled chamber grave, SIED – Settlement; site abbreviations see Suppl. 11. For details, compare also Müller (2023) and Suppl. 12-13.

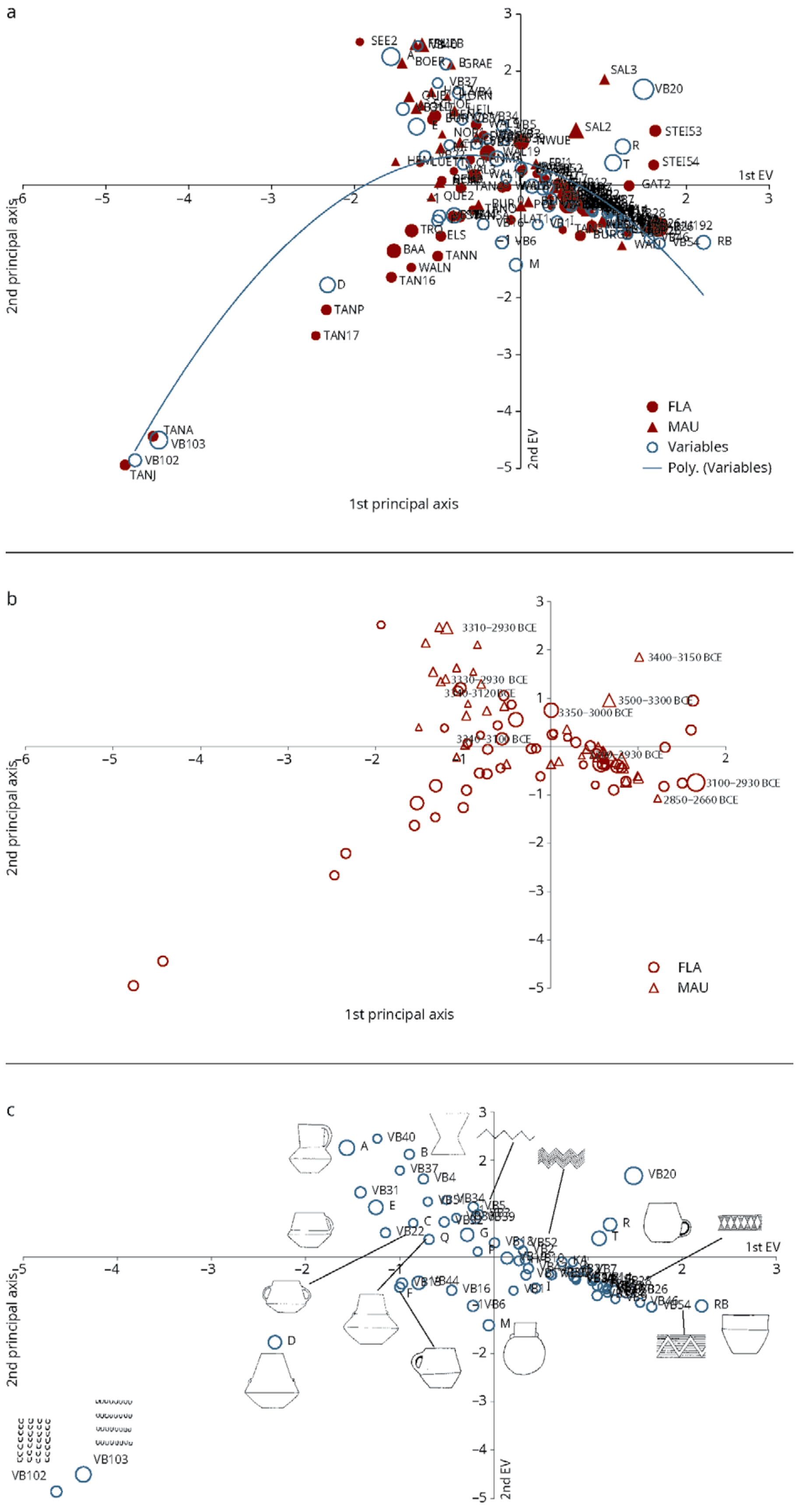


Figure 189. Correspondence analysis of the Bernburg walled chamber graves and flat graves. a – Basic results of the 1st and the 2nd eigenvector of the CA. b – The assemblages with the projection of the ^{14}C data into the CA. c – Representation of important vessel types and decoration motifs. Legend: FLA – Flat grave; MAU – walled chamber grave; site abbreviations cf. Suppl. 11. For details, compare also Müller (2023) and Suppl. 12-13.

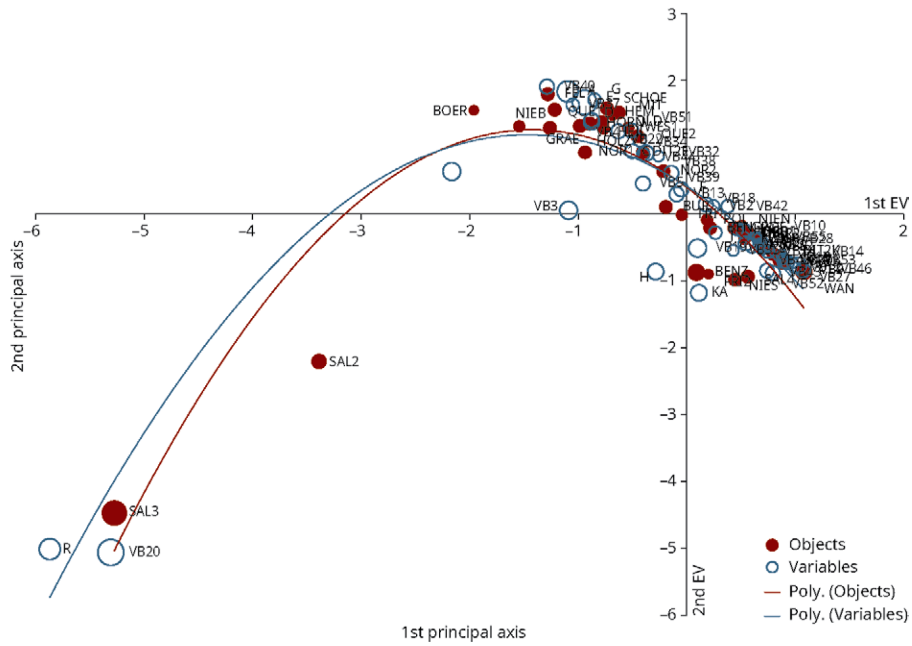


Figure 190. Correspondence analysis of the walled chamber graves with the inventory from Salzmünde-Schiepzig, Saalekreis, which is presented in the literature as a candidate for a reburial of a Bernburg chamber tomb. See Suppl. 11 for site abbreviations. For details, compare also Müller (2023) and Suppl. 12-13.

4.1.3 Chronology of the chamber graves

The correspondence analysis of inventories which are addressed as walled chamber graves, first verifies the large typological distance between inventories from the Salzmünde site, which possibly represent different depositional horizons of a reburied Bernburg walled chamber (Schunke *et al.* 2013; Schunke 2019), and the remaining group of walled chamber grave inventories (Fig. 190). Since the selective character of the reburial and the loss of inventory parts obviously make it difficult to characterise it as exclusively "Bernburgian" with typological arguments, the concerned inventories are excluded from the analysis. This correspondence analysis of the walled chamber graves (Fig. 191) exhibits a sequence in which the few radiometric dates are generally coherent, although it is well known that the seriated inventories can have an individual duration of ca. 150 years (cf. Müller 1994; Müller 2001). A block of early inventories with tripartite forms is separate from bipartite and single-unit cup forms. Inventories with shouldered cups are missing in the grave chambers. The stylistic development from simple to multiple and recessed chevrons, and to more complex decoration patterns, is also recognisable.[51]

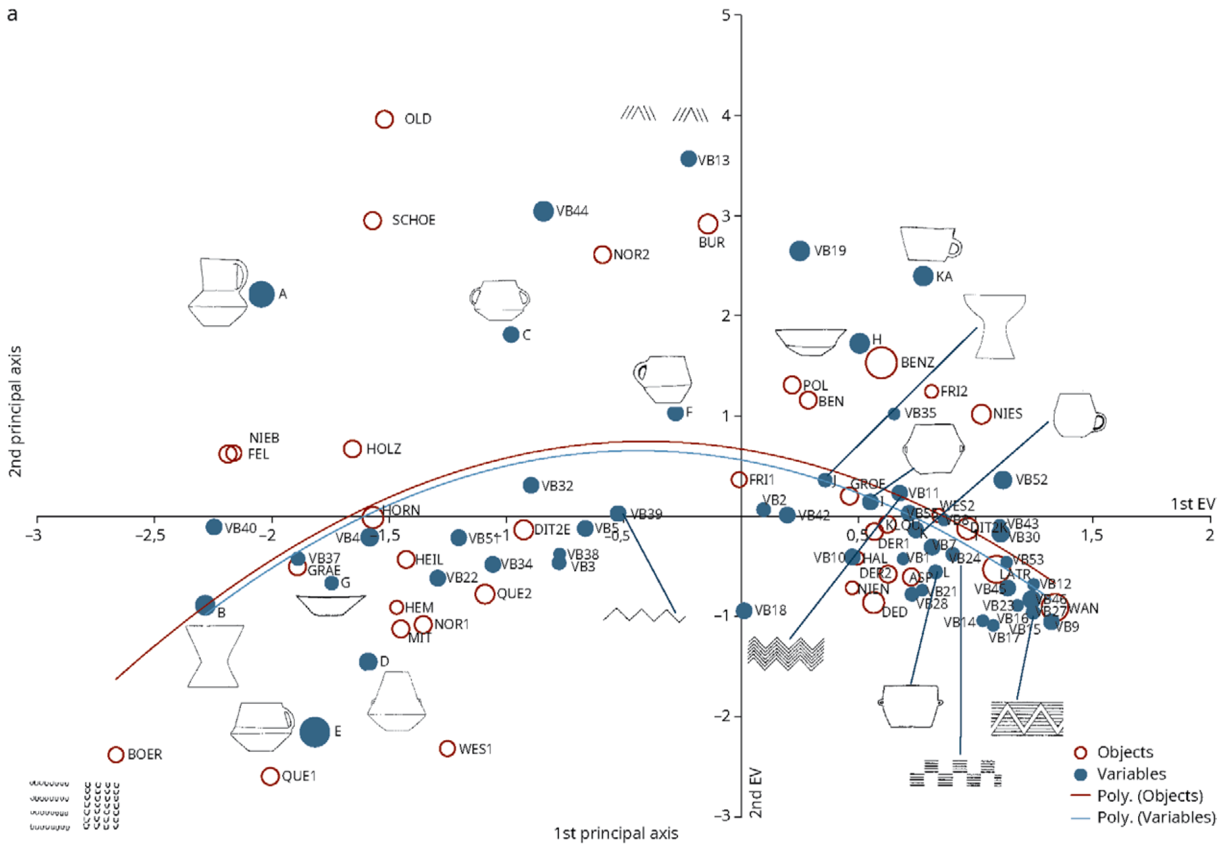
4.1.4 Chronology of the settlement pits

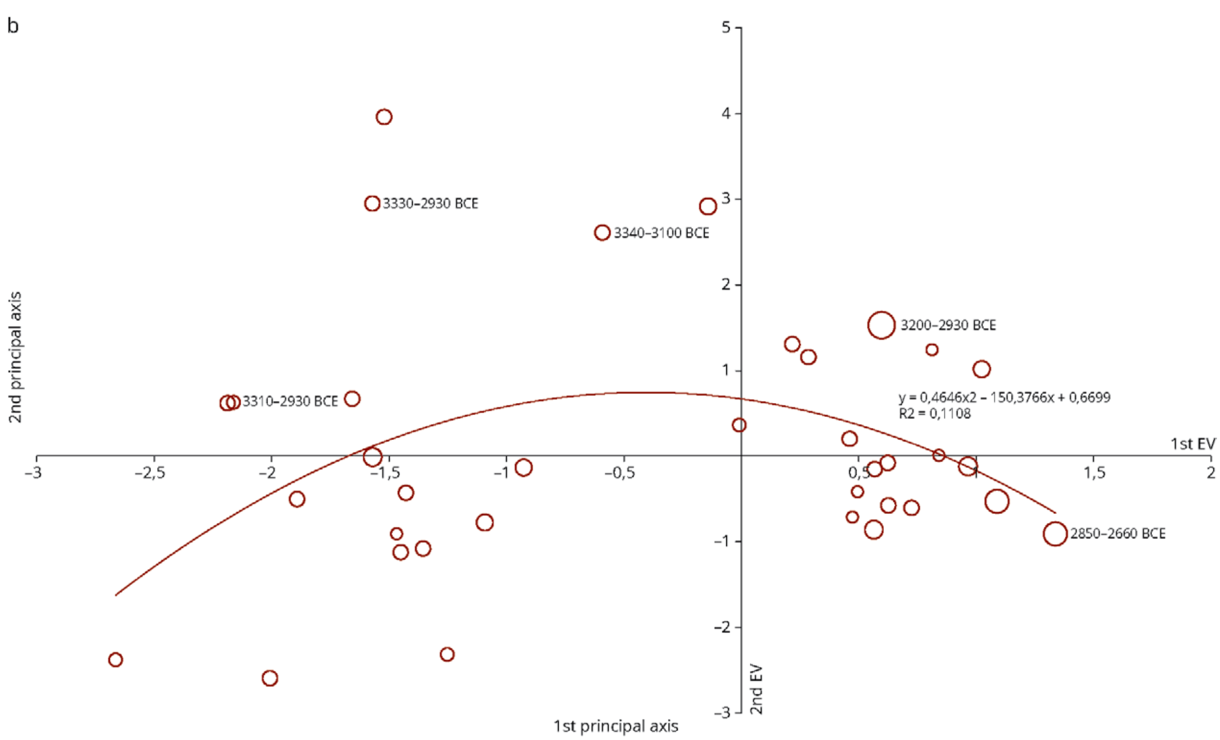
The correspondence analysis of the settlement pits turns out to be more difficult to interpret, whereby here obviously small regional differences between the local inventories, *e.g.*, between Derenburg-Steinkuhlenberg and Hundisburg-Olbetal, are expressed. At least, a chronological differentiability is indicated, which is better understood in the individual seriation of the inventories not only from Steinkuhlenberg, but also from Kirschberg (Hundisburg-Olbetal) (Fig. 192).

In the correspondence analysis for both decoration patterns and vessel forms, only two of the 21 available radiometric dates prove to be inconsistent when projecting the 21 available radiometric dates of the settlement pits, so that the chronological significance of the sequence is unambiguous (Fig. 192). The observed

Figure 191 (right). Correspondence analysis of the chamber tombs. a – Basic results of the 1st and the 2nd eigenvector of the CA with the representation of important vessel types and ornamental motifs; b – Projection of the ^{14}C data onto the results. See Suppl. 11 for site abbreviations. For details, compare also Müller (2023) and Suppl. 12-13.

51 The wider dispersion of the inventories on the 2nd eigenvector likely reflects the merely relative cohesiveness of the features.


a
1st EV
2nd EV
2nd principal axis
1st principal axis
OLD
SCHOE
NOR2
BUR
NIEB
FEL
HOLZ
BENZ
POL
BEN
FRI2
NIES
FRI1
HORN
DIT2E
QUE2
HEIL
HEM
NOR1
MIT
WES1
BOER
QUE1
Objects
Variables
Poly. (Objects)
Poly. (Variables)


b
3330–2930 BCE
3340–3100 BCE
3200–2930 BCE
3310–2930 BCE
y = 0,4646x2 – 150,3766x + 0,6699
R2 = 0,1108
2850–2660 BCE
1st EV
2nd EV
2nd principal axis
1st principal axis

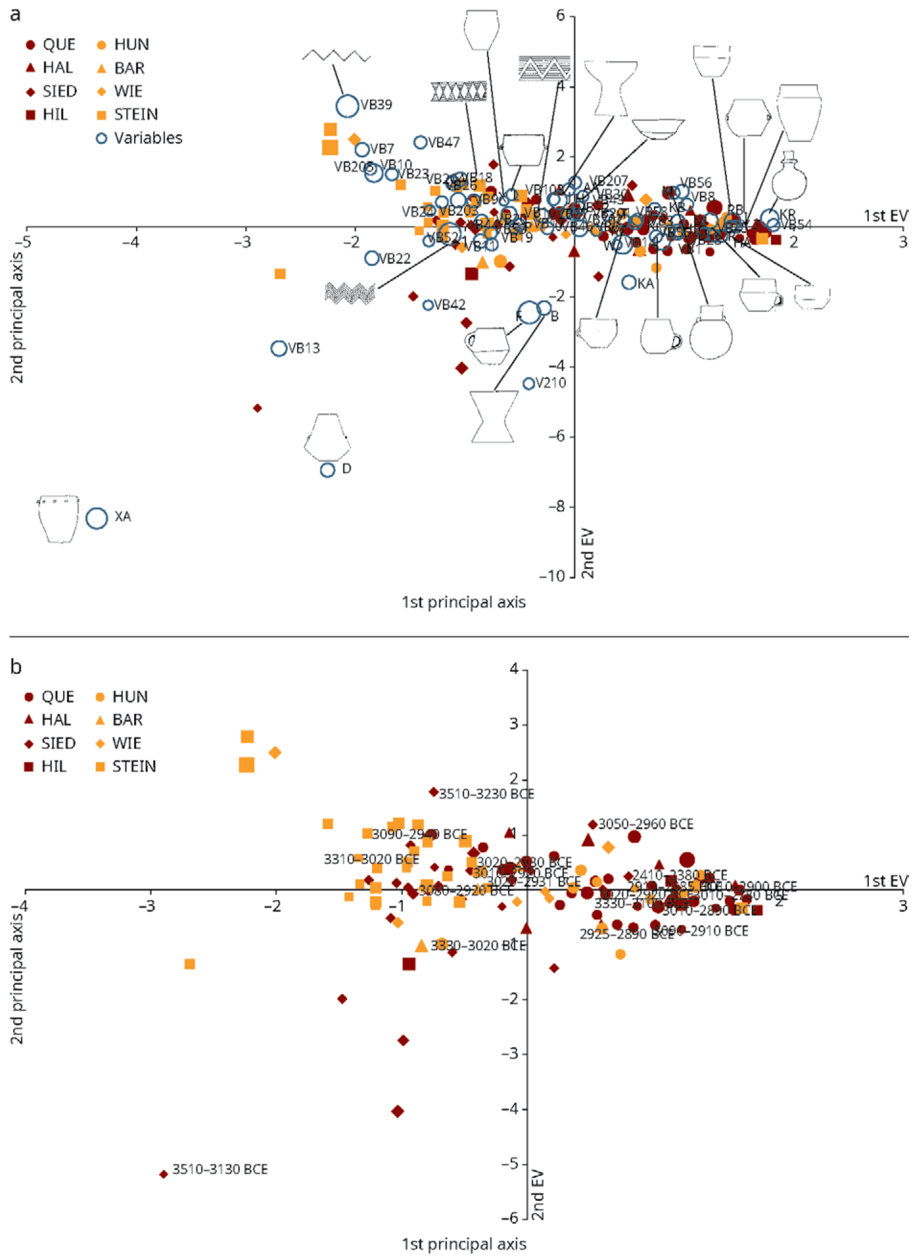
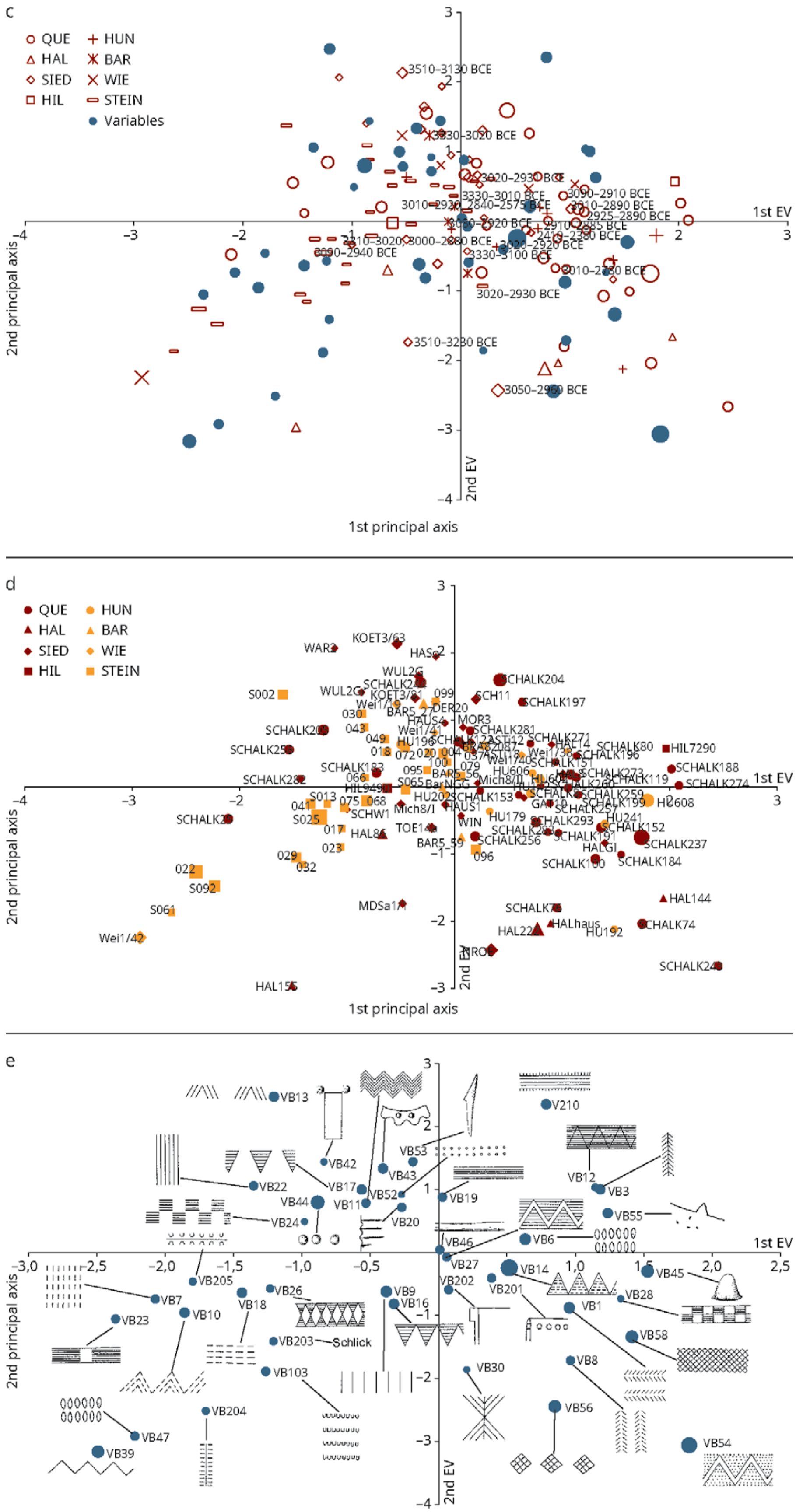


Figure 192 (continued right). Correspondence analysis of Bernburg settlement pits. a – Basic results of the 1st and the 2nd eigenvector of CA with vessel forms and pottery decoration. b – Representation of the basic trend of the ^{14}C data of a. c – Basic results of the 1st and the 2nd eigenvector of CA with pottery decoration. d – Representation of the basic trend of the ^{14}C data of c. e – Display of the development of the Bernburg decoration patterns. See Suppl. 11 for site abbreviations. For details, compare also Müller (2023) and Suppl. 12-13.

trends can also be traced in vessel types and decoration patterns, from bipartite to single-unit cups and shouldered single-unit cups, or also from single to multiline and to recessed chevron bands. Among the storage vessels, less profiled ones are likely to differ from more profiled ones, the former are older. Collared flasks are again known quite late. Slight chronological differences are likely to be indicated between the few settlements with numerous presented features: A large part of the pit inventories from Derenburg-Steinkuhlenberg might be older than the majority of features from Halle-Dölauer Heide, Quenstedt-Schalkenburg or Hundisburg-Olbetal (Fig. 192).

If we restrict ourselves to the processing of decoration motifs, the 19 radiometric dates assigned to the correspondence analytical sequence are consistent with a chronological sequence with one exception (Fig. 192). The simple angular lines are replaced by multiline and finally by recessed chevrons. Among the latter, those made of line fields are eventually replaced by those made of stab-and-drag, cord and point decorations. More complex patterns appear quite early, but here, too,


c
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1st principal axis
2nd principal axis

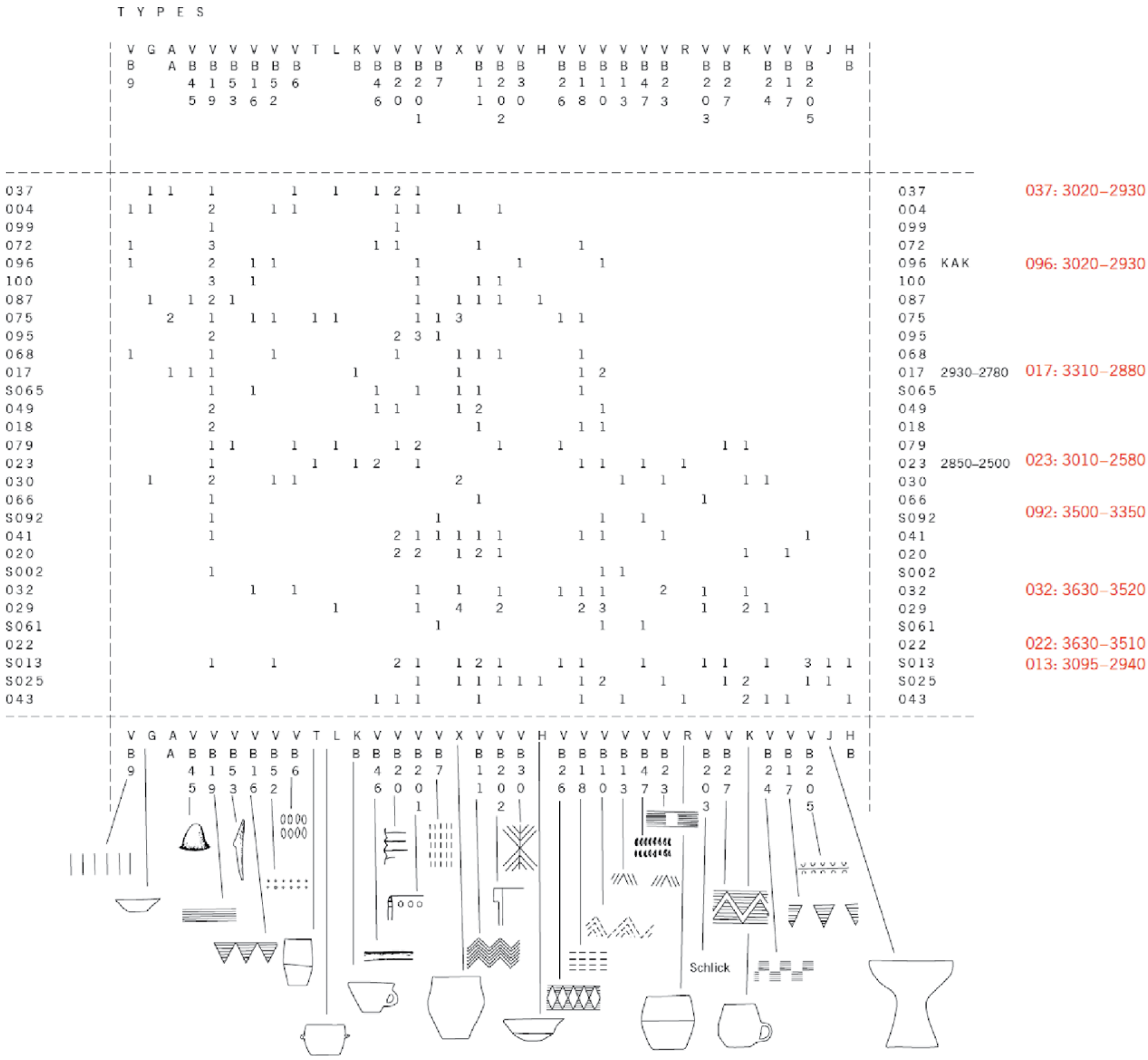


Figure 193a. Seriation of the pit assemblages Derenburg-Steinkuhlenberg with the projection of ^{14}C datings. The sequence of the 2nd eigenvector of the correspondence analysis (after Müller 2001, 156, fig. 59) includes the inventories designated as Salzmündian by A. Hille (1986 and 2020). Legend: Pit numbers with S correspond to the inventories designated by Hille as Salzmündian sherds; red ^{14}C dates are new dates; black are old dates (Suppl. 11-13).

the initially recessed rectangles or lozenges are decorated by more elaborate line fields. From the younger decoration phase, bull handles, pointed rims, but also incised lozenge patterns are known, while from the older phase, knob and groove decorations should be mentioned. Thus, especially for the time after 3000 BCE, increased differentiations are recognisable.

Such differentiations can also be traced in individual site analyses. When projecting the new ^{14}C data onto the seriation results, especially for the Derenburg inventories, we can observe that a temporal development is visible in the typological projection (Fig. 193 a, b).[52] The radiometric dates support the chronological interpretation of the seriation results obtained by Rinne (2014). In contrast to the author, who both in 2001 and in this study did not include the subtype classification of the cups in the correspondence analyses, C. Rinne has done this (cf. with Fig. 10; Rinne 2014, 28 fig. 23). The differentiation between younger findings of non-classified cups with a shoulder break and those without a shoulder break is clearer than in Müller (2001), *i.e.*, the distinction between Niklasson Bernburg II and III.

52 The projection in Schwarz's (2018) proposal proves a blatant contradiction between scientific dating and the typological order proposed there, so that his chronological classification of the material probably has non-chronological causes (Fig. 193b).

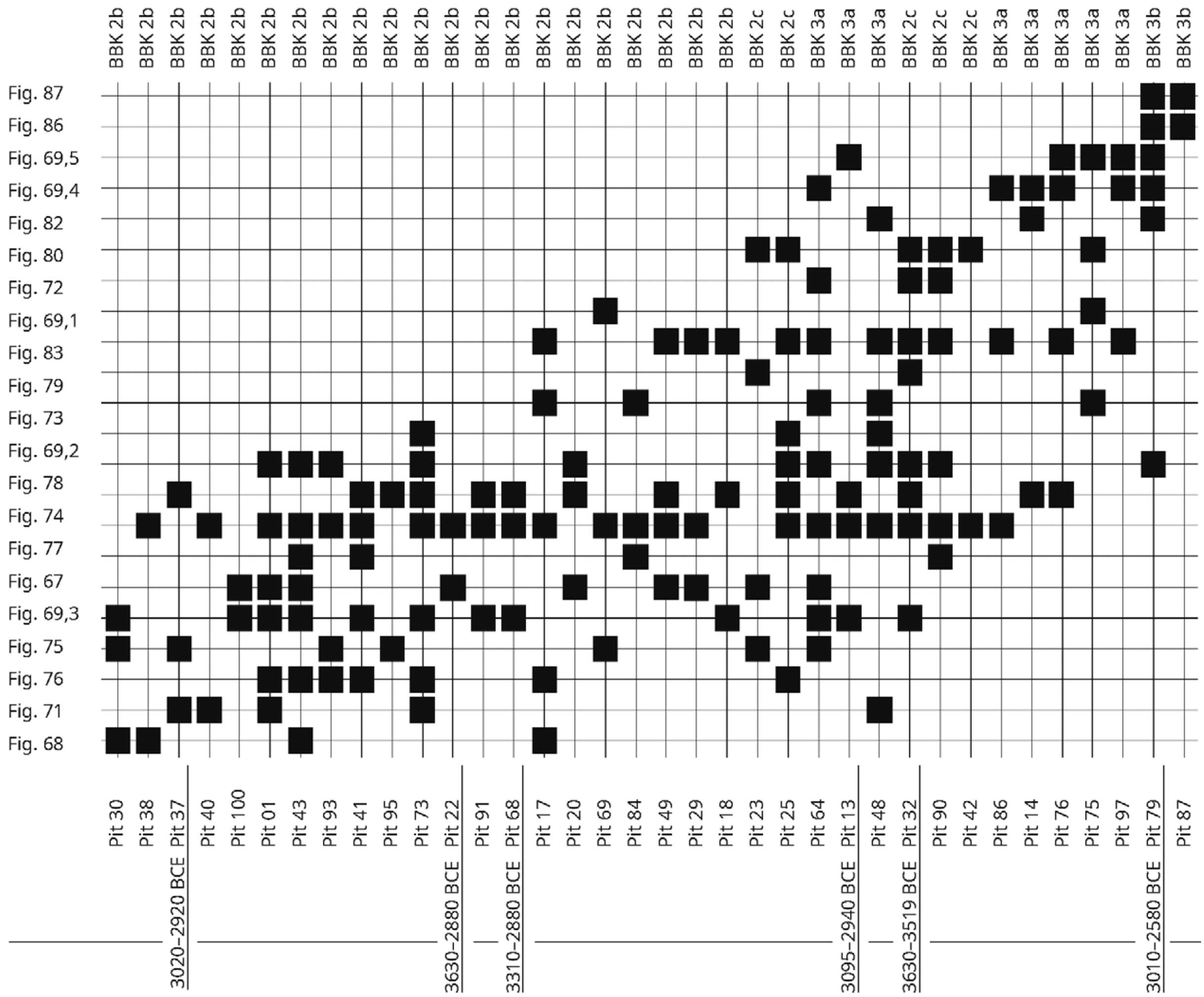


Figure 193b. Seriation of the pit assemblages Derenburg-Steinkuhlenberg with the projection of ^{14}C dates. Seriation of selected pit features (after Schwarz 2018).

In particular, the correspondence analysis with 47 pits and 50 variables reflects a chronological order consistent with the new radiometric dates (Fig. 194).

The investigations by K. Schmütz on the unfortified settlement Hundisburg-Olbetal verify a chronological trend in the ceramic inventory of the settlement pits. If 14 clearly Late Neolithic pit inventories are subjected to a correspondence analysis, continuous typological transitions emerge, from, for example, bipartite conically-rimmed cups and single-unit bellied cups to single-unit cups with slight shoulder breaks, perforated rims, wavy rims and handles (Schmütz 2017, 141 Abb. 91). If we project the data of the Poznań laboratory into the plot of the 1st and the 2nd eigenvector, a slight chronological trend results from ca. 3020-2900 BCE to ca. 2925-2885 BCE (Fig. 195).

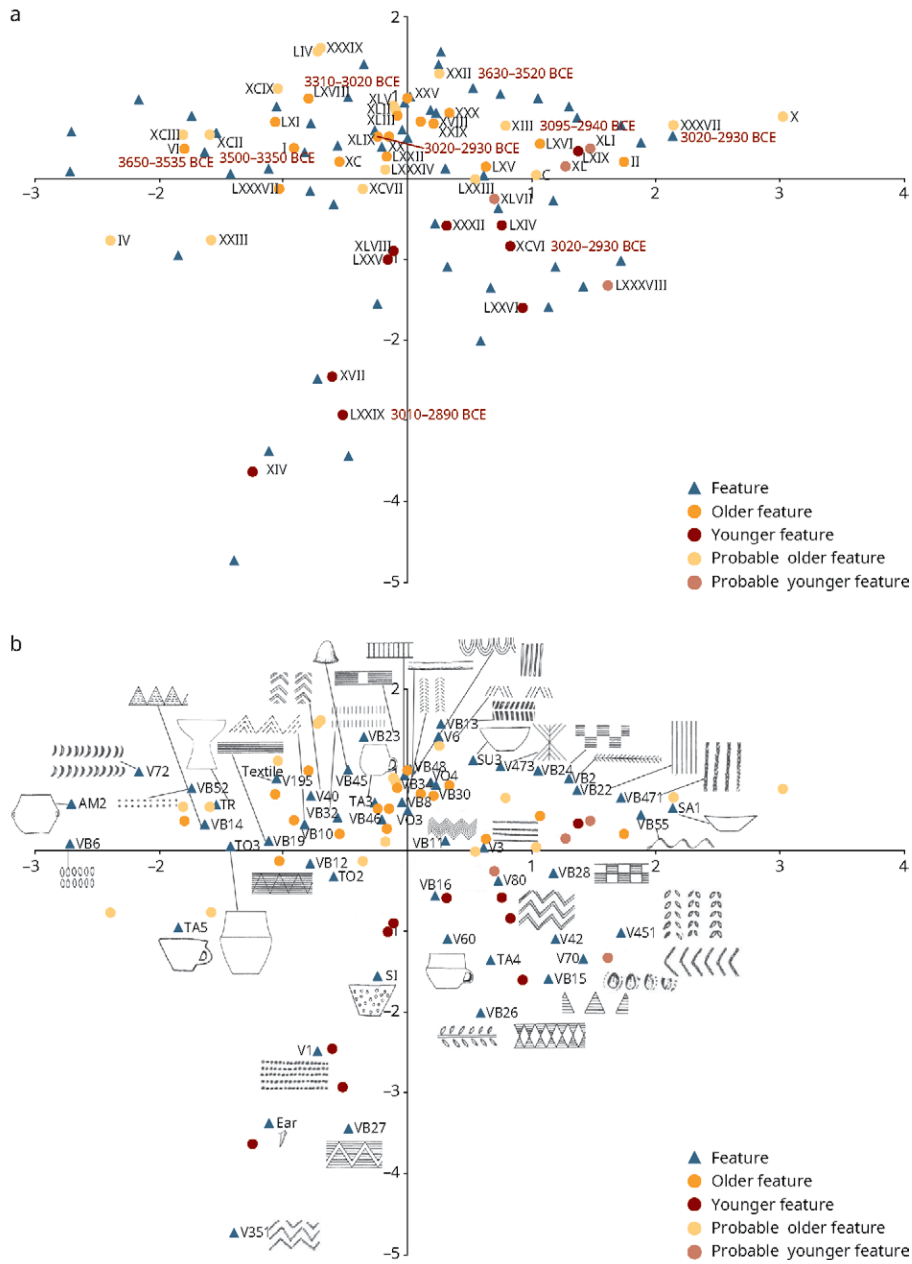
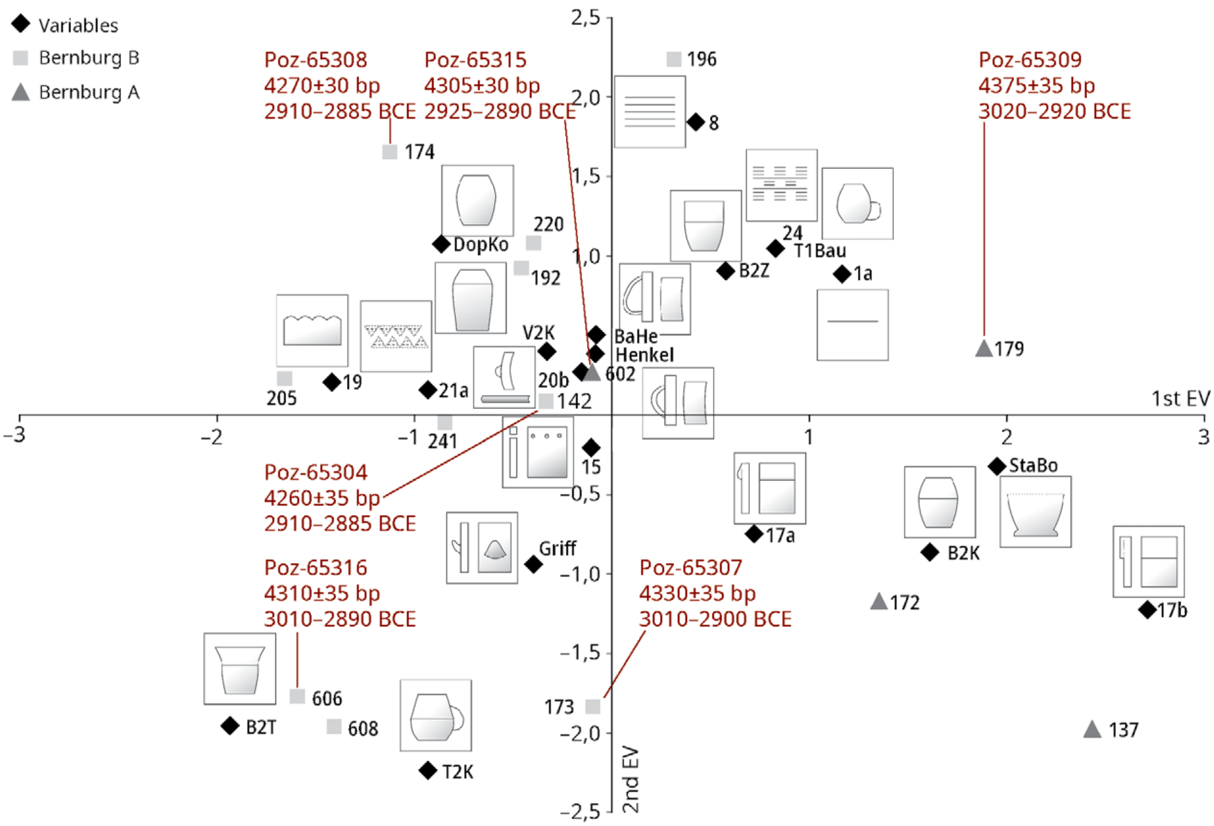


Figure 194. Correspondence analysis of pit inventories of Derenburg-Steinkuhlenberg (after Rinne 2014) (cf. Suppl. 11-13). a – The new radiometric datings are projected. It is clear that a parabola-like structure lies slightly offset in the spanned space and that the chronological development extends from the left to the bottom centre. The early dates are joined by a late phase. b – Representation of the same correspondence analysis with the assigned decoration motifs and vessel types.



4.1.5 Overall results: The chronology of a ceramic style

If we summarise the chronological results, we can determine the following trends in the ceramic inventories:

1. In all inventory categories, *i.e.*, graves and settlements together, a continual development from tripartite via bipartite and to single-unit cups and amphora forms can be observed; in the case of the single-unit cups, there is again the development from round-bellied cups to those with a slight shoulder.
2. For all inventory categories, a continuous development from simple via complex and to recessed chevrons and finally to more complex motifs, such as recessed metope patterns, can be observed.
3. For all inventory categories, the development towards simpler vessel shapes and more complex decoration patterns is correlated.

Figure 195. Display of the 1st and the 2nd eigenvector of the correspondence analysis of the closed pit inventories of Hundisburg-Olbetal (after Schmütz 2017, 141, fig. 91). Projected are the ^{14}C data of the Poznań laboratory (1σ [calibrated with Oxcal 4.3 Intcal 13]). A chronological trend is discernible from the slightly older data in the right-hand panel of the diagram (3020-2900 BCE) and the younger ones in the left (2925-2885 BCE).

Apart from local tendencies, these basic patterns are also verified by the sequencing of the settlement pits – from single angular lines to recessed chevrons. For the latter, then a trend from those made with line fields to those made with stab-and-drag, cord and point decorations is observed. Bull handles, pointed rims, but also incised rhombus patterns are known from the younger phase, from the older phase also knob and grooved decorations. How we transfer the determined chronological trends into a chronological classification depends on different aspects: the practicable differentiation of the vessel forms, to which the assemblages can be easily assigned, the conditions that specify the flat areas of the calibration curve for a phase division (Fig. 66; Tab. 4), or an arbitrary subdivision of the tendencies in order to present a non-existent type sharpness of prehistoric ceramic production.

Due to the radiometric dates, the different typological trends should be treated cautiously. Nevertheless, based on the Bayesian calibration, a subdivision

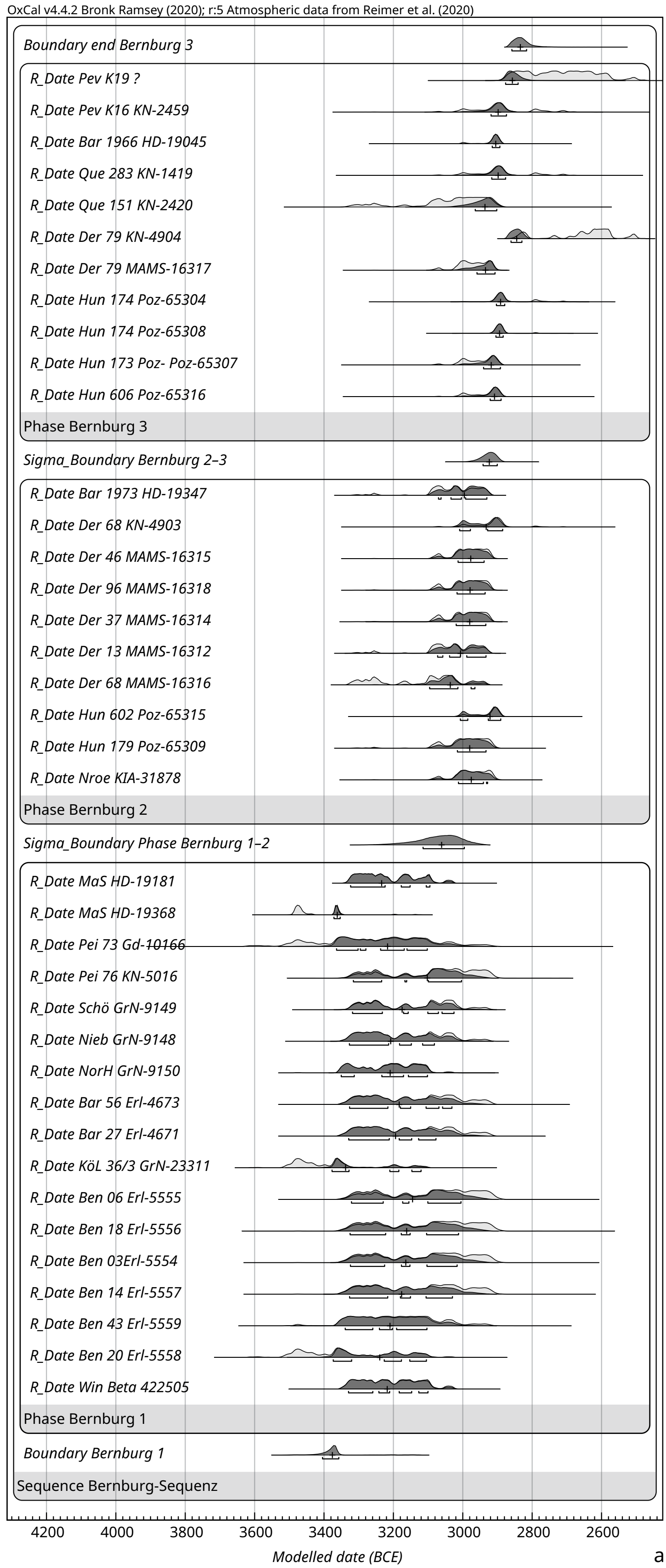
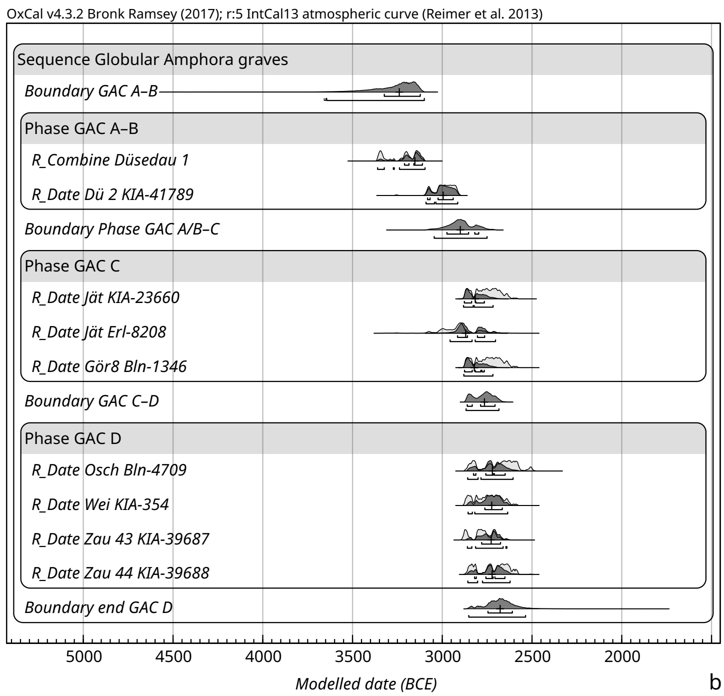


Figure 196. The Bayesian calibration of Bernburg (a) and Globular Amphora (b) inventories. Sigma_Boundary was chosen as the boundary function.



of the Bernburg style into three stages is possible (Fig. 196). Early Bernburg (Bernburg 1) begins at ca. 3380 BCE, whereby an overlap with tripartite forms (Walternienburg 3 und Salzmünde) is present up to 3120 BCE. A transition to Middle Bernburg (Bernburg 2) is positioned around 3060 BCE, with a transition range of about 110 years between 3110-3000 BCE. At ca. 2920 BCE, the transition to Younger Bernburg 3 takes place (boundary span 2940-2900 BCE). Bernburg 3 ends at ca. 2840 BCE (boundary span 2860-2820). Certainly, this represents a continuous and also overlapping style development, whose chronological differentiability is also limited due to the structure of the calibration curve (cf. Fig. 66): primarily, the plateaus 3-4 are affected, within which a more precise breakdown is difficult.

4.1.6 Interpretation: The Bernburg style in the multicultural environment of the Central German Late Neolithic

As in numerous other regions, a small regional differentiation and a coexistence of different regional ceramic styles are present in the Middle Elbe-Saale region, which, due to historical research traditions, are denoted, *e.g.*, as “Salzmünde”, “Bernburg”, “Haldensleben”, and supra-regional styles, such as “Globular Amphora” and “Early Corded Ware”. In Fig. 197, the chronological relationship is shown between Globular Amphora phases, the Bernburg phases and the radiometric dates from the Salzmünde site with Salzmünde inventories (Meller and Friederich 2014).

If a delimitation is made according to ceramic forms, this does not concern other aspects of cultural practices: We know ditch enclosure systems from Bernburg, Salzmünde and Haldensleben contexts, burial mounds above individual graves as well as individual flat graves from all mentioned groups, and collective burials with chamber graves from Bernburg, Elbe-Havel and Wartberg contexts. Meanwhile, a comparable picture can be recognised by the new settlement and house features, but also by new economic data for settlement and dietary patterns (see below).

Accordingly, the different aspects were identified as the interaction of different ceramic productions in the TRB-MES V phase (Müller 2001, 248-267, particularly fig. 141).

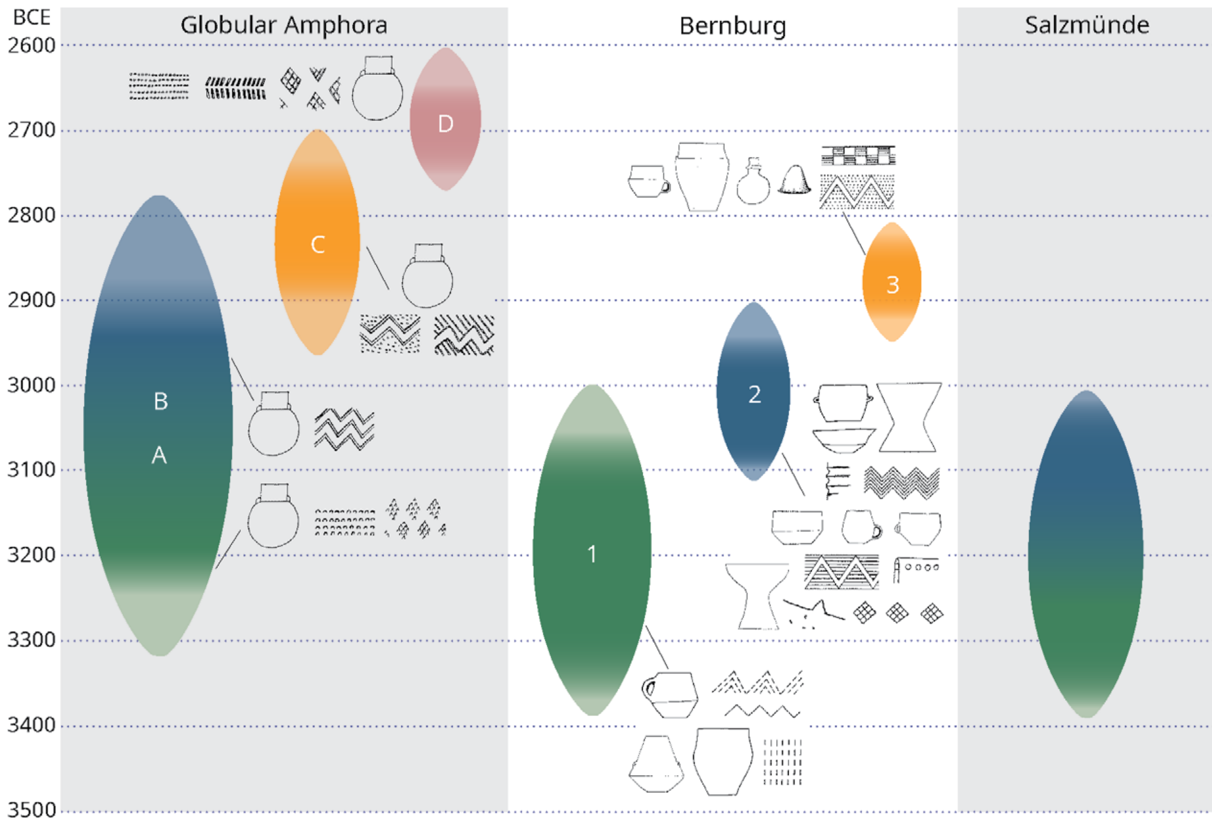
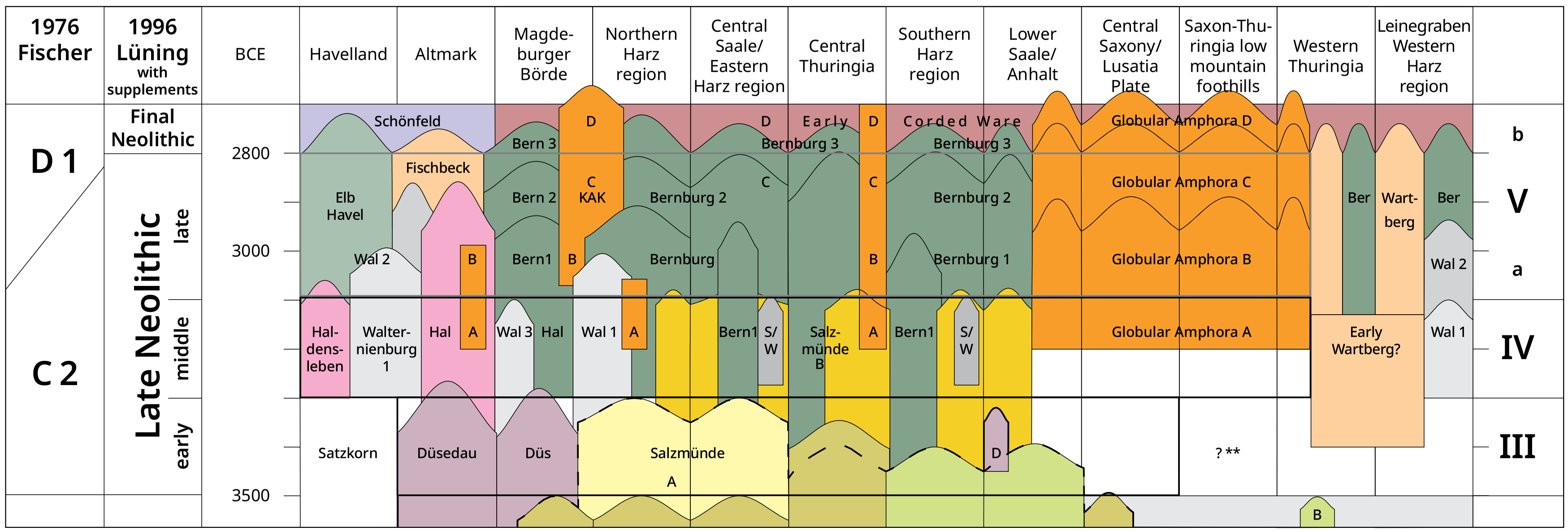


Figure 197. The chronological result: The development of the Globular Amphora and the Bernburg Style. The dating results are related to typological changes. For comparison, the calibration of the new radiometric data from Salzmünde-Schiepzig, Saalekreis, is added. The individual stages are shown (GAC A-D; Bernburg 1-3). The colour correspondences between the Globular Amphora, the Bernburg and the Salzmünde ceramic styles describe the similarities in decoration design, those between the Bernburg and the Salzmünde of the vessel types. The flowing colour changes mark the smooth typological transitions.

The diversity of the ceramic form groups, which are dispersed not only 'territorially' but more 'network'-oriented, corresponds to the geographical openness of Central Germany. In summary, the Central German societies referred to as "Younger Funnel Beaker groups" by older research of the last century (*e.g.* Behrens 1973a) existed from ca. 3350 BCE to ca. 2800 BCE according to the ^{14}C dates. In this time span, a development in the Walternienburg and Bernburg styles can be observed from tripartite to bipartite and to single-unit forms, especially cups. Additionally, there are vessel decorations, which initially only include single lined, later multi-lined and finally recessed chevron bands or other complex patterns, the latter often with single-unit forms with a stepped rim at the end of the development. Moreover, especially in the southeast area, there are often Opperschöner jugs, including fluting, which obviously appear as a Baden influence, first synchronously with Baalberg and Later Walternienburg-Bernburg ceramics.

On the one hand, this view of the ceramic development (Fig. 197-198) corresponds approximately to Niklasson's (1925) phase breakdown but, on the other hand, it contradicts the predominantly postulated sequence of "Salzmünde" before "Bernburg" (see Behrens 1973a, 85-88). In fact, *e.g.*, the lack of vertical stratigraphical overlaps between Bernburg and Salzmünde inventories – already detected by Preuß (1980, 24) – supports the interpretation of the ^{14}C data. The postulated reburial of a Bernburg collective burial by 'Salzmünder' people at the Salzmünde site supports this notion (Schunke *et al.* 2017). Moreover, the chorological differences between the distribution focus of Opperschöner jugs and Walternienburg/Bernburg cups emphasise the picture of "typological diversity" in the Late Neolithic, which can certainly be traced back to various directions of influence (cf. Schindler 1994, 158 map 1 with Torres-Blanco 1994, 177 map 1). Since an interpretation of the closed finds in a correspondence-analytical view also documents the interplay of the addressed inventories (Müller 2001, 176-80), it is reasonable to speak of TRB phases (here TRB IV, TRB Va and TRB Vb) with different styles instead of assuming cultural sequences.



* Not differentiable
** Low probability of ^{14}C

Figure 198. The Late Neolithic in the Middle Elbe-Saale region. The new chronological results are inserted into the scheme (cf. Müller 2001).

4.2 The Central German Globular Amphora societies: Chronology and interpretation

Within the discussed structure, the relationship between the regional Bernburg ceramic style and the supra-regionally distributed Globular Amphora ceramics had and has a special role (cf. Beier 1988; Müller 2001; Woidich 2014). In contrast to the regionally distinctive Bernburg style, which is particularly characterised by bipartite and single-unit cups, various chevron motifs and single-unit amphorae or drums, we recognise a supra-regional vessel form: the globular amphorae.

After the extensive presentation of the globular amphorae inventories in the Middle Elbe-Saale region (Beier 1988), the author (Müller 2001) attempted a chronological classification on a regional basis, in which a sequence of chevron developments was particularly used as a basis for the chronological classification. On a supra-regional level, M. Woidich (2014) examined western globular amphorae in an intensive study. He also arrives at a chronological classification that only seemingly contradicts the study presented by the author: On a supra-regional level by correspondence analysis, Woidich succeeds in distinguishing an arch/angle incision phase without cord decorations but already with stab-and-drag incisions from a cord decoration phase, the latter already increasingly exhibiting scored decoration (Woidich 2014, 167-174 esp. diagr. 41). It also becomes clear that the regionally developed chronology fits into a supra-regional pattern in which the ceramic development comes together especially with regard to the decoration techniques in Central Germany. This is also clear in the suggested phase distribution, where the younger phase is rather oriented to the south, the older more to the north (cf. Woidich 2014, 170 fig. 56).

The renewed correspondence analysis of the Globular Amphora graves of the Middle Elbe-Saale regions provides a sequence that is identified as chronological, among others, by new radiometric dates from Zauschwitz (Leipzig district), Westerhausen-Jätchenberg (Harz didstrict), and Osterburg-Düsedau (Stendal district) (Fig. 199-200; Suppl. 13). In detail, we recognise an early phase A, which is dominated by arch and angle incisions and triangle motifs, but not yet chevrons, followed by phase B, in which cord decoration dominates and multiline chevron bands appear for the first time. A third phase C is characterised by recessed chevron bands, but with a dominance of scored decorations as well as point incisions, and still an occasional use of cord technique. In a late phase D, point incision ornamentation is dominant (cf. Fig. 199-200).

Thus, we can recognise a sequence of dominating arch incision technique (from GAC A), cord technique (from GAC B), scoring technique (from GAC C), and point incision technique (from GAC D), whereby all techniques were definitely known or remained known in all phases. Simple chevrons (from GAC B) are followed by recessed chevrons (from GAC C), lozenges are first executed in arch incisions (GAC A) and then in scoring technique (from GAC C).

With the few settlement pits, a differentiation is more difficult, since a stronger mixing of the inventories is to be expected. Although the number of ^{14}C dates is still too low, new dates from Düsedau for phase A (Heiner 2018, 189-190) and from Zauschwitz for phase D (Bergemann 2018, 313-321) have confirmed the absolute chronological assessment of the chronology compiled in 2001.

The sequential calibration of the radiometric dates, which belong to inventories represented in the correspondence analysis, yields a model that is statistically acceptable (cf. Fig. 196). Afterwards, the beginning of first Globular Amphora graves can be expected around 3250 BCE. Although no radiometric dates are available for GAC B, we assume that the transition to GAC C occurred around ca. 2900 BCE. GAC D begins around 2760 BCE and lasts until ca. 2680 BCE. Therefore, globular amphorae

Graves	V72	V22	V231	V15	V232	V2	V17	V73	V1A	V421	V211	V352	V70	V154	V80	V62	V3	V281	V995	V71	V6	V151	V302	V60	V351	V52	V51	V1	V475	V19	V991	cal BCE	Phase
OHEL	1				1																												
EMD		1				2	1																										
SON				1			1																										
SAR			1				2																										GAC A
STOE						2	1																										
DUE2						1	1																									3360–3120	
VEL				1		1	1	1																									
ACK		1		1						1																							
BAA	1			1		1	1				1																						
BAR4			1	2		1	2		1		1																						
DUE1						2	3						1																			3360–3125	
GQU						2							1																				
DOR					1		2								1																		
SOEL							2							1																			
PRO								1					1																				
ROT						1	2		1		1			1		1						1											GAC B
STOB3											1	2																					
BOE5											1		1																				
COSS2											1	1	1	4																			
ORA										1			1					1															
BOE6											1						1																
PRITT													1							1													
ZAB													1										1										
STOB1														2					1														
MEM																1						1											
ROSS													1							1	1												
KRI																	1					1											
KOED															1				2			1											
ZWEIM																			2		3												GAC C
EIM																		1				1											
FLA																					2	1											
GOER8																					1	1										2880–2640	
BAR8																					1	2											
JAE																					2	2	1									2870–2680	
BEC																						1	1										
REM																					1	1				1							
COSS1																				1	1	1			1			1					
SCHOE																		1					1	1									
KAL																						1					2						
BAD																							1					2					
MES																								1					1				
LAN2																										1		1					
ZA1aW(43)																									1		2	4					GAC D
MEN1b																										1				1			
ZA1aO(44)																											1	2				2870–2641	
PRI																											1		1				
WIE																												1	2			2870–2640	
OSCH																												1		1		2860–2620	
SCH																												1			1		
AKE																												2		3	1		

Blue: cord decoration
Light brown: impressed decorations
Red: scored decorations
Olive: grooved incisions
Black: moulded decorations
Green: arch incisions/angle incisions
Violet: incised decorations

Figure 199. Seriation of GA burials of the Middle Elbe-Saale area (using Capca, version 3.1). The ornamentation motifs (cf. Fig. 200) are colour-coded according to decoration techniques. The inventory groups GAC A-D are arranged chronologically (according to radiometric data). Each group is dominated by a particular ornamentation technique. For site abbreviations see Suppl. 11; for data Suppl. 13.

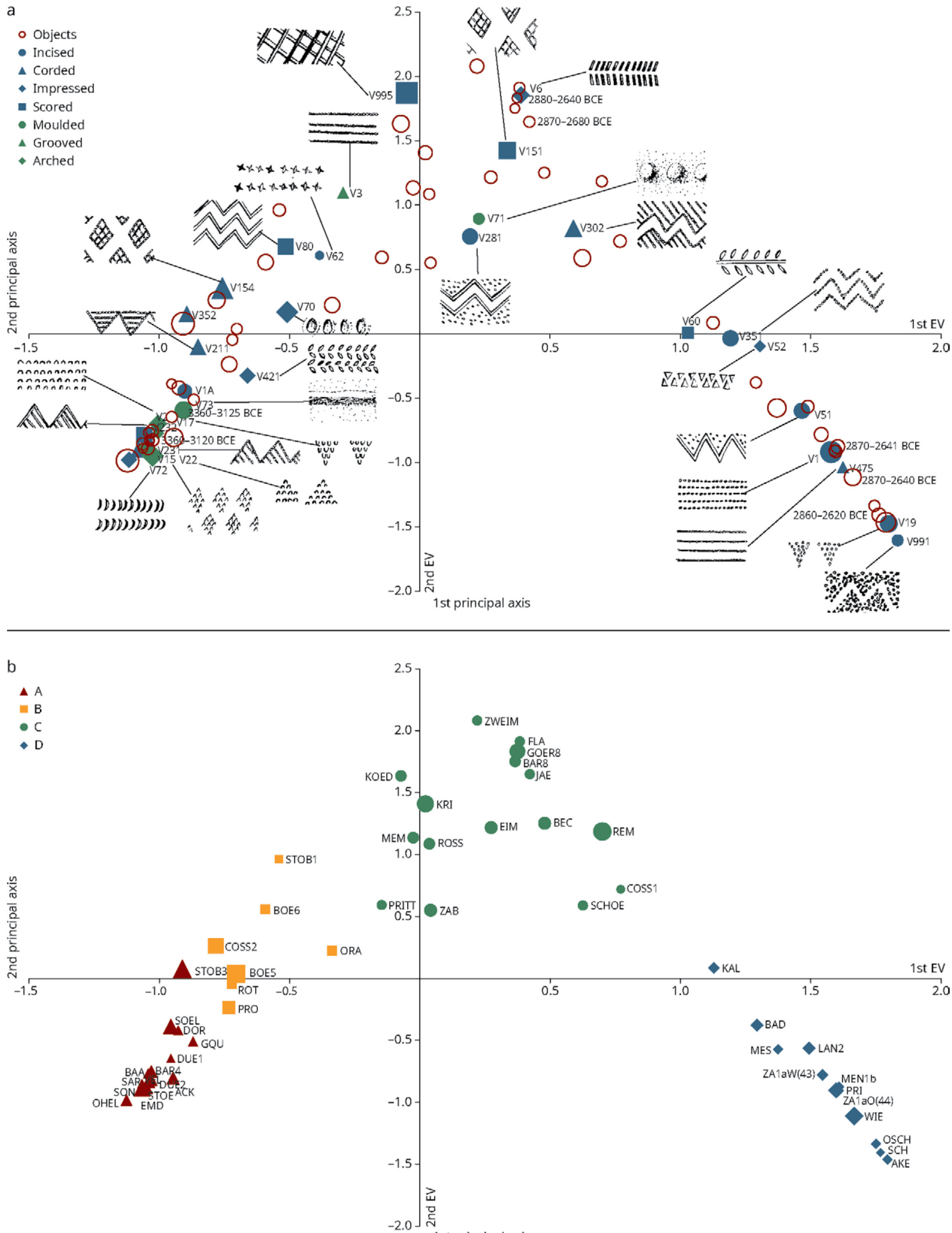


Figure 200. Correspondence analysis of the GA graves. For site abbreviations see Suppl. 11; for data Suppl. 13.

are already found contemporaneously with Bernburg 1, but also at the same time as the Early Corded Ware.[53]

Basically, it shows that globular amphorae are used by people who are buried according to local burial customs and also use the local decorations[54] (Woidich 2014). Thus, arch/angular incision decoration is typical for the Elbe-Havel groups in Northeastern Germany (as well as burials in megalithic graves in the area of the northern Funnel Beaker societies), the multiline or recessed chevrons for the Central German Late Neolithic (and partially the burial practice in earthen pits and cist graves), or the almost absent occurrence of burials in Northern Bohemia (analogous to Řivnáč). Therefore, it becomes clear that we probably do not have independent societies, but rather adaptations to the local conditions both with regard to the rites of passage and the decoration of the ceramics.[55] All the more interesting is the question how the subsistence economy and diet of the Late Neolithic were shaped in the Central German region. The evidence of specific oils, at least in recent studies of globular amphorae in the Baltic region, suggests that the distribution of globular amphorae may have been increasingly associated with the distribution of certain goods (Weber *et al.* 2020).

4.3 Economy and settlement patterns: A complex mosaic

Considering the chronological results, the diversity of the Central German Late Neolithic can be traced. New results, although too few, are now also available from settlement contexts, primarily from rescue excavations but also from research excavations. Accordingly, we can first concretise assumptions on economy and settlement patterns in order to integrate them into a chronological context.

4.3.1 Bernburg subsistence economy

Regarding the Bernburg subsistence economy, we still have animal bone analyses and botanical macroremains analyses from too few sites. Both the traditional counts of the number of bones and the corresponding meat proportion calculations show values with a dominance of domestic cattle, followed by sheep/goat and pig and a small proportion of wild animals (Becker 2001; Döhle 1997; Höltkemeier 2018; Winter-Schuh *et al.* 2018). In fact, the few analyses do not verify any differences between Globular Amphora and Bernburg inventories.[56] For Bernburg, different inventories indicate differences between regional wild horses of Northern and Central Germany and numerous Bernburg horses (Becker 1999; Benecke 1999;

53 The use duration of globular amphorae probably reaches up to the Middle Corded Ware, *i.e.* the Mansfeld Group. Thus, the transfer of the recessed chevron band motifs is possible between the Late Globular Amphora and the Mansfeld style. The early dating of the Mansfeld Group by M. Hein due to similarities in Mansfeld and Bernburg decoration with recessed chevrons (Hein 1987) would thus not be necessary from a typological point of view.

54 If they are not local themselves.

55 Ceramic forms and styles do not represent societies, but, for example, in the case of globular amphorae, transregional typological trends, which are integrated in local conditions. To what extent this has to do with the mobility of people is a question to be answered independently of ceramics.

56 Evidence for domestic contexts with Globular Amphora ceramic dominance is still rare in Germany (cf. Woidich 2014, 100-104). The site of Gärtitz (Central Saxony district) (Conrad *et al.* 2009), published in the preliminary report as a Globular Amphora settlement, probably also contains Iron Age ceramics in the features and corresponds to a typical Iron Age farmstead of the region in its feature composition. Thus, only the GAC pits can be used in our context.

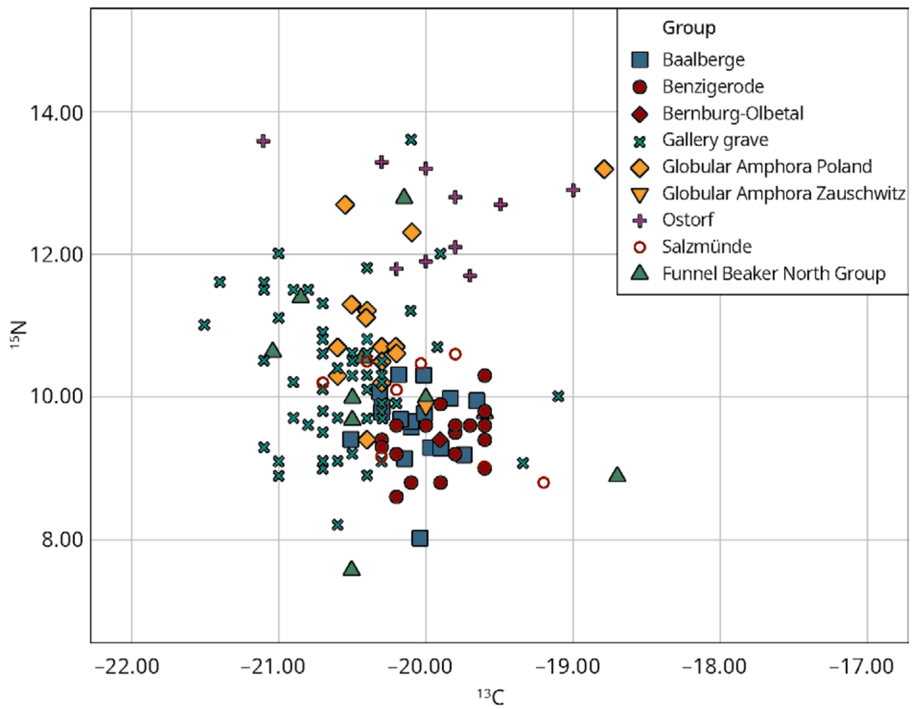


Figure 201. Scatterplot of $^{15}N/^{13}C$ isotopes for Bernburg and other societies. Shown are $^{15}N/^{13}C$ values of Western German gallery and chamber graves as well as values from the cemetery Ostorf, Bernburg values are from Benzingerode and from Hundisburg-Olbetal; furthermore, Salzmünde graves and GA graves are from Lesser Poland and Zauschwitz. In addition, there are those of the TRB North Group. Clearly recognisable are the Bernburg, Salzmünde and GA graves grouped in the generally agrarian area (for data see Suppl. 14).

Döhle and Schunke 2014; Höltkemeier and Döhle 2017), which cannot be derived from native wild horses and are already domestic animals.

Considering the macroremain analyses, emmer and einkorn, but also barley – more strongly than in the Early or Late Neolithic (Müller 2001, 272-273) – have been verified for Bernburg sites. However, for submitted inventories we only recognise thus far those from Halle-Dölauer Heide (Behrens and Schröter 1980), Weißenfels-Eselsweg, Burgenlandkreis (Behrens 1953), Derenburg-Steinkuhlenberg (both Hummel 1968, 62) and Hundisburg-Olbetal (Klooß and Kirleis 2012). In principle, the botanical finds correspond, for example, to that what is known from Salzmünde-Schiepzig (Hellmund 2017).

Isotope analyses carried out on human bones prove an 'agrarian' diet, whereby we want to understand here both a pastoral component and an agricultural or horticultural one. In a sampling from the site of Zauschwitz, which concerns graves from the Early Neolithic to the Bronze Age, S. Bergemann succeeded in determining a continuous trend (Bergemann 2018, 337-358), which can certainly be applied to other regions of Central Germany. While the proportion of a plant-based diet is high during the Linear Band Ceramic, a higher proportion of meat can be determined from Baalberge onwards, which continues to increase until the Bronze Age. Nevertheless, a relatively balanced ratio between animal and plant food is basically observed, which partially shows certain age-dependent dietary differences in the detailed analysis.

The few isotope analyses of Bernburg burials fit into this picture. Thus, the isotope values from Benzingerode correspond to this picture, as do isolated isotope values, *e.g.*, for an individual from a Bernburg settlement burial at the site Hundisburg-Olbetal (Terberger *et al.* 2018, 69; Rinne and Fuchs 2013; Schmütz 2017, 31-35) or a Globular Amphora burial from Zauschwitz (Bergemann 2018, 338 tab. 33) (Fig. 201). We can assume that the Bernburg subsistence economy was agrarian – obviously also that of the individuals buried with globular amphorae at least in Zauschwitz.[57]

57 In the only more intensive isotope analyses from the Globular Amphora mass grave Koszyce, Lesser Poland (Schroeder *et al.* 2019) near Kraków, this picture is confirmed. The Globular Amphora individuals there also exhibit an 'agrarian' diet.

A more detailed analysis of the animal bones from a Bernburg 'normal settlement' is available from Hundisburg-Olbetal (Winter-Schuh *et al.* 2018). In spite of the small sample size, it is clear that domestic cattle (*Bos p.*) played an important role (ca. 68% NISP), followed by sheep/goat (12%) and domestic pig (6%). In the case of cattle, the bimodal sex-related size curve indicates a main emphasis in the exploitation of female cattle, according to which 80% of the cattle survive the age curve at the age of three, after which the focus is on meat production. The special exploitation of older female cattle also proves the use of milk. At other Bernburg settlements, such as the fortified settlement of Quenstedt-Schalkenburg, the balanced sex ratio and the slaughter of subadult animals rather indicates a focus on meat processing, while in the Bernburg ditch system at Krautheim (Weimarer Land district), the "post-lactation slaughtering peak" describes the high importance of milk utilisation (Höltkemeier 2018).

In addition to the product question, the strontium isotope values, also related to the different ages of the teeth, indicate a local herd strategy with only local changes of space, which contradicts previous assumptions (Winter-Schuh *et al.* 2018, 293). Locally, due to the variations in δ^{13} and δ^{18} oxygen values, it is likely that cattle were herded in the Elbe and Beber river plains during plant growth periods, *i.e.*, in spring and early summer, while they then spent the autumn near the settlement on the harvested fields. The botanical remains indicate high-quality wheat as the main grain (emmer *Triticum dicoccum*; einkorn *Triticum monococcum*) as well as barley (*Hordeum vulgare*) (Kirleis *et al.* 2012; Klooß and Kirleis 2012). Gathered plants are rarely documented. Based on the weed spectrum, ear harvest can be assumed. The recorded field weeds are annual and verify nutrient-rich soils.

Thus, we can assume a locally organised agricultural economy for Bernberg. On this basis, however, differences between settlements, for example, in the distribution of secondary products (weaving) or in the organisation of tool production (flint, copper objects) can be noted (see below).

4.3.2 Settlement distribution

The distribution of settlements with the Bernburg ceramic style has often been described and analysed according to ecological parameters (cf. Ostritz 2000, 53-57). The settlement areas of the Bernburg sites (Fig. 202) are oriented towards the black earth soils and are focused in the Northern Harz foreland, the Saale estuary region, in the Halle area and the Erfurt Mulde (Ostritz 2000, 106 map 9).

Globular Amphora sites are also known from the Bernburg areas, but rather in those with lower Bernburg site numbers.

> '*Die größten Besiedlungskonzentrationen [mit Kugelamphoren-Inventaren] […] liegen aber unmittelbar* östlich *vorgelagert*' [transl.: '*The largest settlement concentrations (with inventories of globular amphorae) are located immediately to the east*'] (Ostritz 2000, 57).

When differentiating the sites according to graves and settlement sites, this difference becomes even clearer (Müller 2001, 134-258 fig. 134-139): While Globular Amphora graves are located in the entire Bernburg distribution area (Fig. 202), the few settlement remains are concentrated in more easterly small regions of the Southern Leipzig lowland bay, the area between the mouths of the Mulde and Saale rivers on the Elbe (cf. also Woidich 2014, 94-95 fig. 20a). This concerns sandy and loamy soils near watercourses that are preferred, which contrasts to the loess-oriented Bernburg sites (with or without isolated Globular Amphora ceramics) (cf. Beier 1988, 44).[58]

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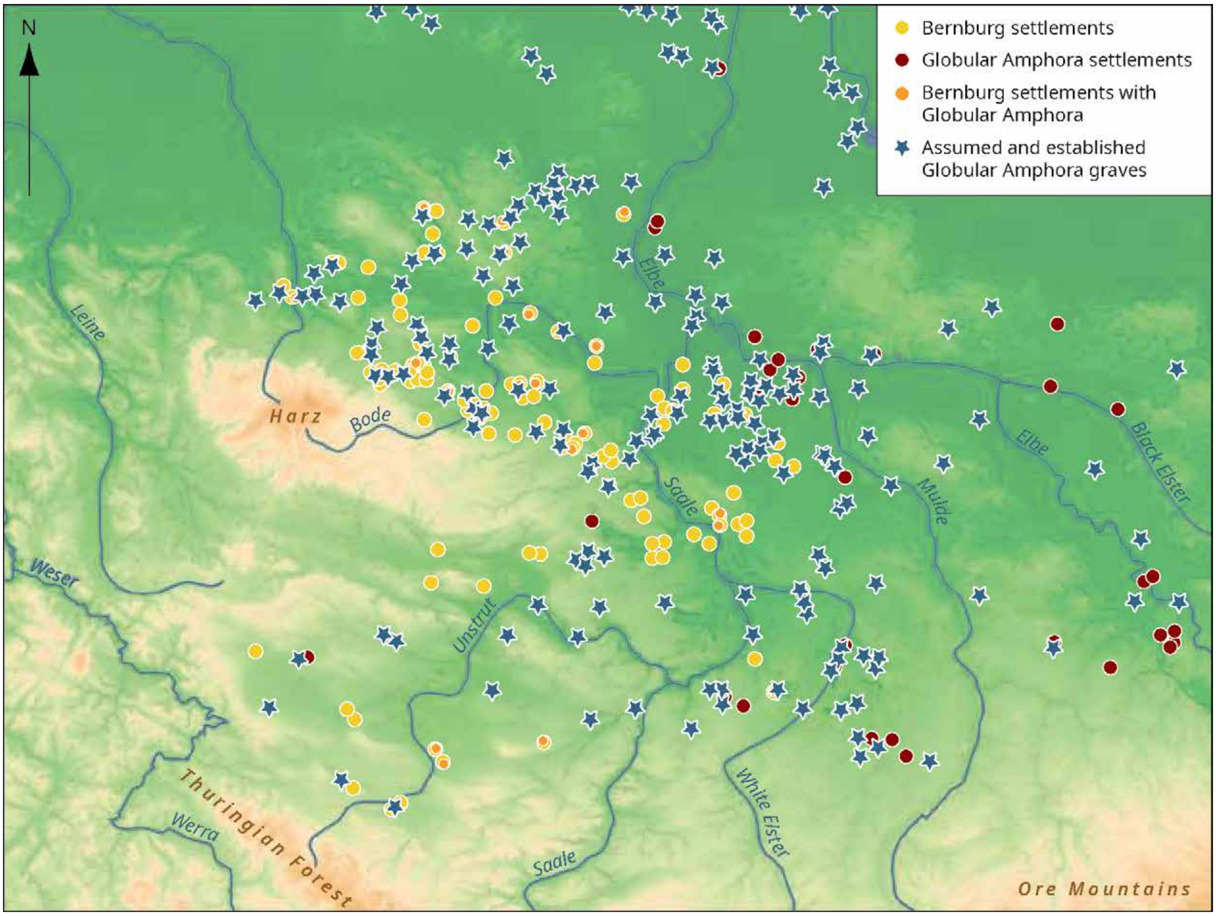
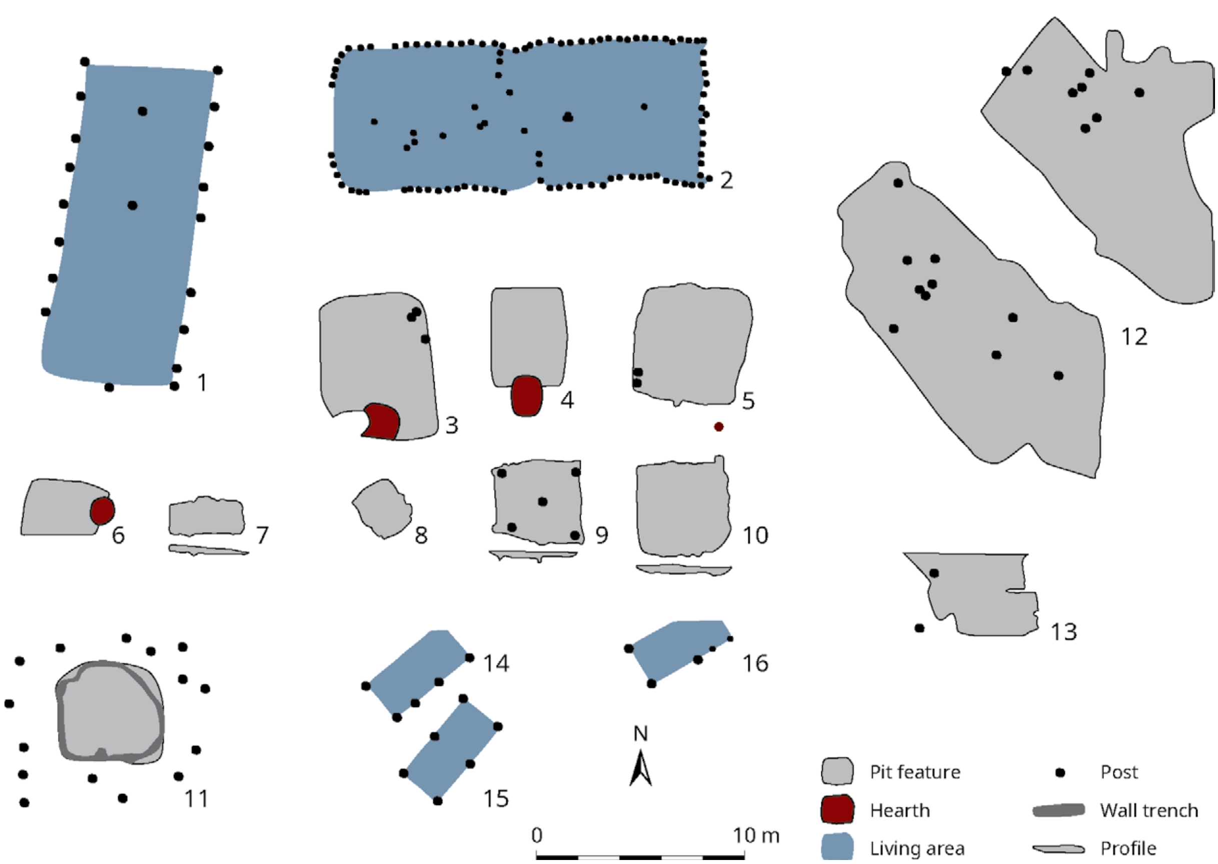
58 A similar spatial differentiation can also be observed in the Řivnáč area and in the area of Elbe-Havel ceramics (see Woidich 2014, 95).


N
Bernburg settlements
Globular Amphora settlements
Bernburg settlements with Globular Amphora
Assumed and established Globular Amphora graves
Leine
Harz
Bode
Elbe
Saale
Mulde
Black Elster
Weser
Unstrut
White Elster
Thuringian Forest
Werra
Saale
Ore Mountains


1
2
3
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5
6
7
8
9
10
11
12
13
14
15
16
N
0
10 m
Pit feature
Hearth
Living area
Post
Wall trench
Profile

4.3.3 Settlement types

Irrespective of the preservation of the finds, the excavation results so far refer to relatively small, hamlet-like, enclosed or non-enclosed settlements of most likely less than 0.7 ha in area, which could have existed in addition to medium-sized (<1.5 ha) and larger (<3ha) fortified and unfortified, possibly village-like, settlements (Fig. 203-204).

4.3.3.1 Unfortified settlements

The standard model of an unfortified Bernburg settlement is known from Günthersdorf (Saale district), where M. Fröhlich (2023) was able to document five house sites with wells, workshops, graves and 150 pits on an area of 10 ha. Both the more or less square work pits and a 13 × 7 m large two-aisled post building correspond to what is known both from isolated findings and from other settlements. With bipartite Bernburg ceramics, the settlement dates to the Early Bernburg phase from 3350-3100 BCE, which is also confirmed by a ^{14}C date. While this important settlement is still in the evaluation stage, there are mostly only find evaluations of individual pit features from other places.

Of settlement sites with Bernburg ceramics *without* ditch enclosures, Hundisburg-Olbetal (Schmütz 2017) and – as far as the flint tools are concerned – also Eilsleben (Börde district) (Wechler 1993) have been published on a larger scale so far. Hundisburg-Olbetal is a Bernburg settlement deposit with different pits and a waste layer in the depression zone of the former Schiepzig ditch enclosure. The ^{14}C dates and the typochronological interpretation indicate a settlement from the Early to the Younger Bernburg, *i.e.,* probably from 3350-3100 BCE and from 3100-2900 BCE (Schmütz 2017, 76-79). From the multi-period excavation site, 157 pits were documented on 1770 m^2. Approximately half of the dated pits are associated with the Late Neolithic. Due to the considerable density of Late Neolithic pits within the centre of the Schiepzig ditch system, we assume an area of about 1.5 ha, which was occupied by the Bernburg settlement.[59] No significant differences can be observed in the pit inventories, which would indicate a spatially differentiated specialisation in certain activities in the settlement.

4.3.3.2 Fortified settlements

At the Bernburg sites with enclosures, we know quite different analyses and interpretations of the few excavated structures: Halle-Dölauer Heide, Quenstedt-Schalkenburg, Derenburg-Steinkuhlenberg (Behrens and Schröter 1980; Hille 1986; Müller 2001; Rinne 2014; Hille 2020), Westerhausen-Jätchenberg, whereby at the latter, the spatial relationship between the Bernburg ditch and the palisade, on the one hand, and the pit field, on the other, is not clear (Rinne 2006a, 77 fig. 1; 2006b), and Barleben-Schweinemästerei. At Barleben-Schweinemästerei, there are pit inventories that date between 3350-2900 BCE and also include Haldensleben and Walternienburg elements in addition to the Bernburg inventory (Dittrich 2004; 2009; 2012). Two features correspond to the pit huts described below, an enclosure is obviously present, and some nearby flat graves are reminiscent of the situation at Günthersdorf.

It is striking that functional differences were found in the pit spectrum of all five settlements, which indicate, for example, three places of flint distribution at

Figure 202 (left, above). Domestic sites with Bernburg pottery and pure GA settlement sites with presumed and certain GA graves (after Woidich 2014, 203, fig. 67).

Figure 203 (left, below). Rectangular post dwellings and pit huts from Bernburg settlements. The dimensions of the two-aisled rectangular houses correspond to the dimensions of corresponding buildings from Salzmünde context. Pit huts are a comparable phenomenon known, for example, from Řivnáč or Wartberg. 1 – Derenburg-Steinkuhlenberg; 2 – Alt Töplitz 14a; 3 – Halle-Dölauer Heide; 4 – Schraplau; 5 – Schwanfeld Stelle 81; 6 – Werschen-Oberwerschen; 7 – Helmstedt-Pfingstberg; 8 – Windehausen; 9-10 – Großobringen, Lkr. Weimarer Land; 11 – Weißenfels-Eselsweg; 12 – Neukyhna-Zschernitz 8; 13 – Barleben-Schweinemästerei; 14-16 – Uthleben (cf. Müller 2023).

59 Since we can expect ca. 80 pits per 0.2 ha on the basis of the excavated areas, a maximum of ca. 1200 Bernburg pits is to be assumed. With a possible settlement duration of ca. 550 years and a use duration of ca. 25 years per pit, we would assume approx. 55 simultaneously existing pits (1200 × 25/550).

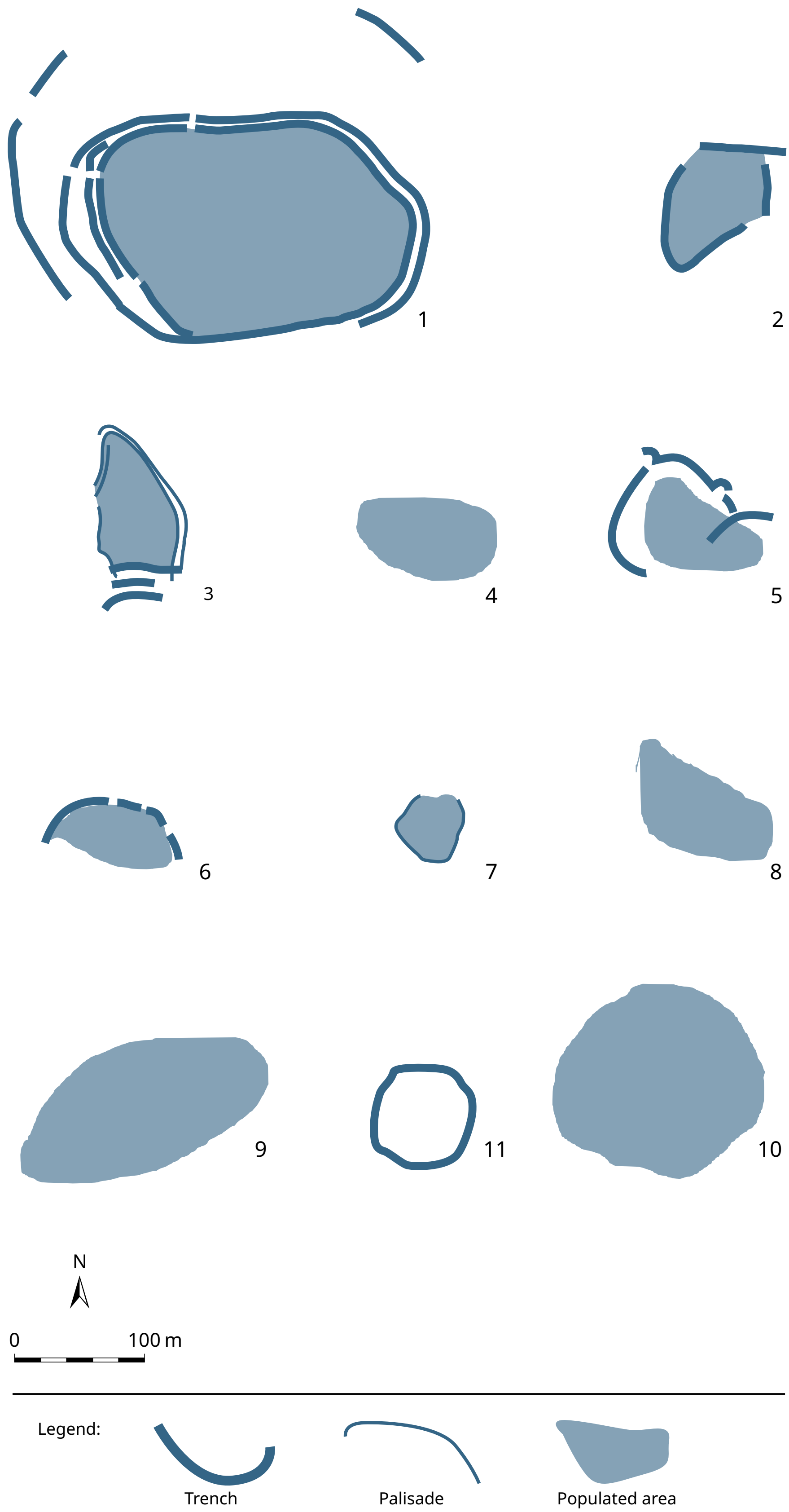

Figure 204. Bernburg settlements, where a reconstruction of original settlement sizes is possible.
1 – Derenburg-Steinkuhlenberg;
2 – Quenstedt-Schalkenburg;
3 – Halle-Dölauer Heide;
4 – Westerhausen-Jätchenberg;
5 – Barleben- Schweinemästerei;
6 – Peißen; 7 – Gollhofen;
8 – Helmstedt-Pfingstberg;
9 – Hundisburg-Olbetal;
10 – Werlaburgdorf-Kreuzberg;
11 – Groß Rosenburg
(cf. Müller 2023).

Halle-Dölauer Heide and different areas of grain and animal processing or storage at Quenstedt-Schalkenburg (Müller 2001, 287-303 esp. fig. 150-160) as well as a difference between production and consumption areas on the Steinkuhlenberg (Rinne 2014, 36-38 fig. 33-34). Certain distribution differences are also visible between the pits on the Jätchenberg in Westerhausen (Rinne 2006a).

Ceramic stool models, *i.e.,* possible representations of early furniture, are practically only observed at enclosed settlements. These are known from Quenstedt-Schalkenburg, Halle-Dölauer Heide, but also from Barleben-Schweinemästerei (Behrens and Schröter 1980; Dittrich 2004, 31 pl. 27, 59-A). As early as 1973, Behrens pointed out the typological parallels to the Moravian Aeneolithic (Behrens 1973b). Moreover, the low proportion of rubble and core stones in contrast to the proportion of flint implements might indicate differences in flint supply and processing: larger, enclosed settlements were apparently equipped with semi-finished products (Müller 2001, 304 fig. 163; Wechler 1993, 50). K.-P. Wechler had already pointed out that from the Osterberg at the Bottmersdorf-Kiesgrube site (Börde district), the remains of a flint opencast mine with sinkholes are concealed, which stands at the beginning of the supply chain (Wechler 1991, 34).

Even if the special functions of the enclosed Bernburg hill or spur settlements may be very different, both the spatial associations of the briquetage finds of Halle-Dölauer Heide (Müller 1987) and Großobringen (Weimarer Land district) (Walter 1991, 34-51) as well as the large number of finds of spindle whorls and loom weights in Quenstedt-Schalkenburg (Müller 2001, 298 fig. 157) indicate special functions of the enclosed settlements. In comparison to the few published non-enclosed and enclosed settlements with Bernburg ceramics, it is to be noted that supra-regional foreign elements (such as Proto-Řivnáč) appear in the typological inventory of ceramics from the enclosed settlements and are absent in the non-enclosed ones (Müller 2001).

In addition to the ditch systems discussed here, others are also known from rescue excavations, *e.g.*, from Nehlitz-Groitschfeld (Saale district), Sundhausen (Unstrut-Hainich district) (Walter 1990), Sülzenbrücken (Ilm district) (Küßner 2015), and Urbach (Nordhausen district) (Seidel *et al.* 2000), which have thus far only been published in preliminary reports. However, it is clear that these are ditches in other landscape positions (mostly open) and the corresponding enclosures are also larger than those discussed here. The ceramic material published so far and the ^{14}C data indicate an Early Bernburg date.

4.3.4 Pit huts, posts and houses

Pit huts, pits with *sunken floors* and houses can be sporadically identified at residential and work areas at Bernburg settlements. In the majority of the settlement remains, either erosion or construction methods, which left no archaeological traces, resulted in sites that primarily consist of pits with settlement waste.

In contrast, a shallow square pit hut from Windehausen (Nordhausen district), which can be assigned to Early Bernburg, corresponds to the rectangular residential or work pits as known from Günthersdorf or also other sites (Wehmer 2016; cf. also Lüning *et al.* 1999). These are always more or less rectangular or rectangular-oval flat pits of up to 5-6 m side length, which, would be addressed, *e.g.*, in Southern Scandinavia as *sunken floors* (cf., for example, Reedtz Sparrevohn *et al.* 2019). Corresponding structures are known, *e.g.*, from Barleben-Schweinemästerei, Menz (Jerichower Land district), Schinne (Stendal district), and Großobringen, sometimes with post settings (cf. Dittrich 2004, 14; Müller 2001, list 18; Walter 1991, 16 fig. 5). From the Bernburg settlement Halberstadt-Sonntagsfeld (Harz district), we also know a 5.00 × 4.00 m large and 0.25 × 0.35 m deep rectangular pit hut with a hearth, from which, among other things, a grinding plate and a flax comb originate (Autze 2005, 139).

From the southern periphery of the distribution of Bernburg-type ceramics, we also know of corresponding pit huts from Frankish settlement sites (*e.g.* Schwanfeld (Schweinfurt district), or Burgerroth-Altenberg (Würzburg district)). A Late Neolithic ditch system from Gollhofen (Neustadt district) on the Aisch-Bad Windsheim, exhibits an arrangement of four such pit huts and, in the southwest, apparently a possible two-aisled post structure, which are also assigned here to a Late Neolithic inventory with Bernburg influences (Nadler 2019, 702-708 fig. 3-4). These pit huts, either alone, in smaller enclosures or larger settlements, are a supra-regional phenomenon that we know from Wartberg, Cham, Bernburg, Goldberg III and Řivnáč (cf., for example, Nadler 2019) and that can certainly be addressed as sites of special function in addition to houses as documented from Günthersdodrf and Gollhofen.

In the case of larger rectangular subterranean pit structures with hearths and smaller post settings, the similarity to houses with *sunken floors* from Scandinavia is even greater than in the case of the already mentioned pit huts: the sunken houses from Kyhna-Zschernitz (Nordsachsen district), measuring 12-13 m in length and 4-6 m in width (Dalidowski and Stäuble 2004), but also the somewhat uncertain finding from Barleben-Schweinemästerei, which we have also mapped, corresponds to this type of house (cf. Fig. 203.13; Dittrich 2004, 13-15 Abb. 9).

The lack of clearly reconstructed post constructions from the Younger and Late Neolithic in Central Germany should not hide the fact that in spite of the eroded loess areas, post pits have been found in large numbers, but most of them could not be related in order to illustrate house plans. This is a phenomenon that we also see in other places. In the Netherlands, for example, the team for the evaluation of the settlement Schipluiden (Zuid-Holland province, Netherlands), dealt intensively with this question (Louwe Kooijmans and Jongste 2006). Although practically no complete house floor plans could be reconstructed, discovered standard distances between ridge post installations provide a possibility to reconstruct the maximal number of former houses. J. Beran also successfully attempted to reconstruct Late Neolithic house floor plans during his Brandenburg excavations (Beran 2017, 136-141 esp. fig. 6-7). In contrast, sites are also known where almost no post pits are left due to the high erosion rate. This is the case, *e.g.*, in Hundisburg-Olbetal, where soil displacement amounting to 40 t per year and hectare was detected for the time of the Late Neolithic settlement, which corresponds to a minimum removal of soil height of at least 0.30 m (Rinne and Bork 2017).

In addition to the newly discovered two-aisled post house from Günthersdorf and the reconstruction attempt at Gollhofen (see above), the few relatively clear post construction features with Bernburg ceramics are from Uthleben (Nordhausen district) (Walter and Seidel 1998), Alt Töplitz 14a (Potsdam-Mittelmark district) (Kirsch 1993, 271-272), Halle-Dölauer Heide (Behrens and Schröter 1980, 34-36 fig. 14-15) and Derenburg-Steinkuhlenberg: measuring 6.6 × 5.5 m and 5.0 × 12.0 m, respectively (Rinne 2014, fig. 13). The latter corresponds to the Salzmünde house floor plan from Esperstedt (Saale district) (11.0 × 5.5 m; Faron-Bartels *et al.* 2006), or also the three three-aisled houses from Salzmünde.[60] The similarities between the Salzmünde and the Derenburg houses are striking, both with regard to the distance between the posts and the number of posts in the longitudinal walls. In this respect, we can assume a common house construction tradition of smaller two-aisled rectangular buildings. The house from Alt Töplitz 14a, which can be assigned to the Younger Walternienburg/Early Bernburg, also corresponds to the size specifications, measuring 17.0 × 6.5 m (Kirsch 1993, 271-272 fig. 185, 1138).

60 Features 6193-6202: 9.70 × 6.16 m; feature 15972: 11.00 × 5.20 m; feature 15973: 15.00 × 5.50 m (von Rauchhaupt 2014).

Another form of the post house is from Nordhausen. Here, there are three smaller, single-aisle hut layouts, measuring 2.00-2.50 m in length and 5.00-6.00 m in width. The small size measuring 13-15 m^2 is surprising at first, but it corresponds to the floor space of the sunken hut floor plans. The site itself lies in a flood zone near favourable farmland. While Bernburg cultural layers were found, due to the location in a fluvial valley, the usual pit finds are probably missing. For the huts themselves, D. Walter and M. Seidel can also imagine an originally elevated construction method. In fact, we also know of contemporaneous house ground plans from the circum-alpine lake and wetland settlements, which exhibit a corresponding small size, as is the case in Uthleben. The postholes, which can only be detected at a shallow depth, indicate that no archaeologically detectable remains could have been excavated due to the already mentioned erosion (Walter and Seidel 1998).

Even at settlements, where supposedly no houses can be reconstructed from the post assemblages, there is the possibility to approximate house sites according to the described methodological model of Schipluiden. With his spatial-statistical analyses for Derenburg-Steinkuhlenberg, C. Rinne has comprehensively shown how the spatial groupings of post pits are to be associated with the distribution centres of Bernburg pits: Post clusters, which cannot be deciphered, but occupy sites of former houses, are directly adjacent to pit concentrations. Thus, he can identify six economic units in the excavated area that become archaeologically inferable from post concentrations and adjacent pit concentrations and which, with one exception (454 m^2), are between 180-270 m^2 in size. For the enclosed inner Steinkuhlenberg with its 13,600 m^2, there are ca. 30 possible economic or farm areas (Rinne 2014; 2019). The pits of each of these economic units contain most of the activities classified from the find record of individual pits, including production, consumption, and communal activities, as well as those more domestically assigned activities. This is an argument to speak of autonomous economic units.

4.3.5 Settlement patterns and chronology

In the compilation of the few published features and artefacts, it becomes clear that we are dealing with two-aisled houses, pits and rectangular pit huts as the main features in all Bernburg settlements. In addition to individual farms and small hamlets, we can assume that there were smaller, enclosed structures with less than 500 m ditch length, which are then, if topographically possible, located at high altitudes or on spurs. Furthermore, there are also larger, enclosed structures with up to 1500 m ditch[61] length in similar locations, which, on the one hand, represent normal settlements but, on the other hand, are characterised by internal spatial specialisations, particular economic functions, special functions in local, regional and supra-regional exchange systems and possibly differ from other settlements by special symbols (furniture imitations). The enclosed Bernburg settlements in question are clearly different from other enclosed ritual sites in Central Germany from the Younger and Late Neolithic (*e.g.* Baalberg and Salzmünde enclosures), but also from those, *e.g.*, of the TRB North Group: They are settlement sites, not only sites with a ritual background. To be differentiated from this is a rondel type, as first attested for Groß Rosenburg (Salzland district) for the Late Neolithic and described with Early Bernburg/Düsedau/Salzmünde ceramics (cf. Spatzier 2017, 275-276 pl. 193, 1-5, pl. 198; ^{14}C: 3344-3018 BCE[62]). In the context of our chronological considerations,

61 The classificatory distinction goes back to D. Raetzel-Fabian (1999, 92-95 fig. 5-6). He distinguished the size classes Cc-Cd (<500 m ditch length, <2 or 10 ha base area) from the size class Dc-Dd (ditch length 500-1499 m, base area <2 or 10 ha). Size class Cd is observed, *e.g.*, at Gollhofen and Morl (Saale district), CC at Derenburg-Steinkuhlenberg and Halle-Dölauer Heide.

62 Cf. Suppl. 11 and Spatzier (2017, 456 tab. A71).

it becomes clear that probably normal settlements, whether enclosed or mostly unenclosed, already existed since the Early Bernburg.

Larger enclosed settlements, *e.g.*, also Derenburg-Steinkuhlenberg and those known from rescue excavations, *e.g.*, Nehlitz-Groitschfeld, Sundhausen, Sülzenbrücken and Urbach (see above), are more likely to be attributed to the Early Bernburg, while enclosed medium-sized Bernburg settlements on spur or promontory landscape locations in the northern and eastern Harz regions mainly date to the Middle and Younger Bernburg[63] (Fig. 204). In the course of the Bernburg development, a tendency for a reduction in the size of the enclosed settlements is recognisable. The complexes of the Middle and Younger Bernburg are mostly associated with a minor presence of Globular Amphora ceramics. This is not yet the case with the older fortified structures.

Thus, a basic pattern of settlement types emerges, which is connected with the generally Late Neolithic two-aisled post houses, the pit houses, the local agrarian subsistence economy, the unchanged flint technology (Wechler 1993, 59-62), and ceramic traditions. Obviously, the fortified settlements of the Early Bernburg are according to the basic tendency not yet located on topographically elevated positions, while those of the Middle and Younger Bernburg are mainly found in topographically prominent locations. Settlement processes can be reconstructed, which are, *e.g.*, comparable with Wartberg, where hilltop settlements also only first appear from the 31st century BCE with the Younger Wartberg (Raetzel-Fabian 2000).

4.4 Patrilocality and admixture

With all the presented tendencies, it is clear that we are dealing with settlement contexts, which in no case exceed 200-300 inhabitants per settlement. Accordingly, exogamous marriage practices must have prevailed in order to maintain the population. If, on the one hand, the exchange and partly the uniformity of, for example, ceramic production can be explained by such a translocation, questions of mobility, on the other hand, have to be discussed under other conditions. Palaeogenetic results can be consulted for this purpose.

The composition of the mitochondrial haplotypes in the Bernburg walled chamber of Benzingerode has been correctly interpreted in such a way that patrilinearity and probably also partilocality can be detected (Meyer *et al.* 2008, 101-130; Brandt *et al.* 2013). Corresponding results are also available for new aDNA analyses from the Wartberg gallery grave Niedertiefenbach (Rhein-Lahn district) (Immel *et al.* 2019). Furthermore, in addition to the usual South-Central European haplotypes, U-types could also be detected, which are readily associated with the Funnel Beaker North Group based on originally local forager groups (Meyer *et al.* 2008, 122 tab. 14). Corresponding U-types are also found in other contexts, *e.g.*, near Salzmünde (cf. Haak *et al.* 2015). Thus, we can assume a quite varied marriage practice between different groups in the Central German region. Since corresponding conclusions are also available for the only larger aDNA analyses from a Lesser Poland Globular Amphora mass grave (Schroeder *et al.* 2019), it is obviously a pattern of Late Neolithic societies.

Nuclear genome analyses are only available on a small-scale from Central Germany for the time period 4800-2600 BCE. These are five successfully evaluated individuals from Esperstedt, Quedlinburg and not certain from Salzmünde (Haak *et al.* 2015, supplement data 1, tab. 2), which can be assigned to Baalberge, Bernburg

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63 In contrast, we know of a fortified complex from Sülzenbrücken-Laitberg with a palisade, moat and pincer gate and with Early Bernburg ceramics (^{14}C KIA-30216, 4598 ± 32 bp, 3500-3157 BCE) (Küßner 2016, 176).

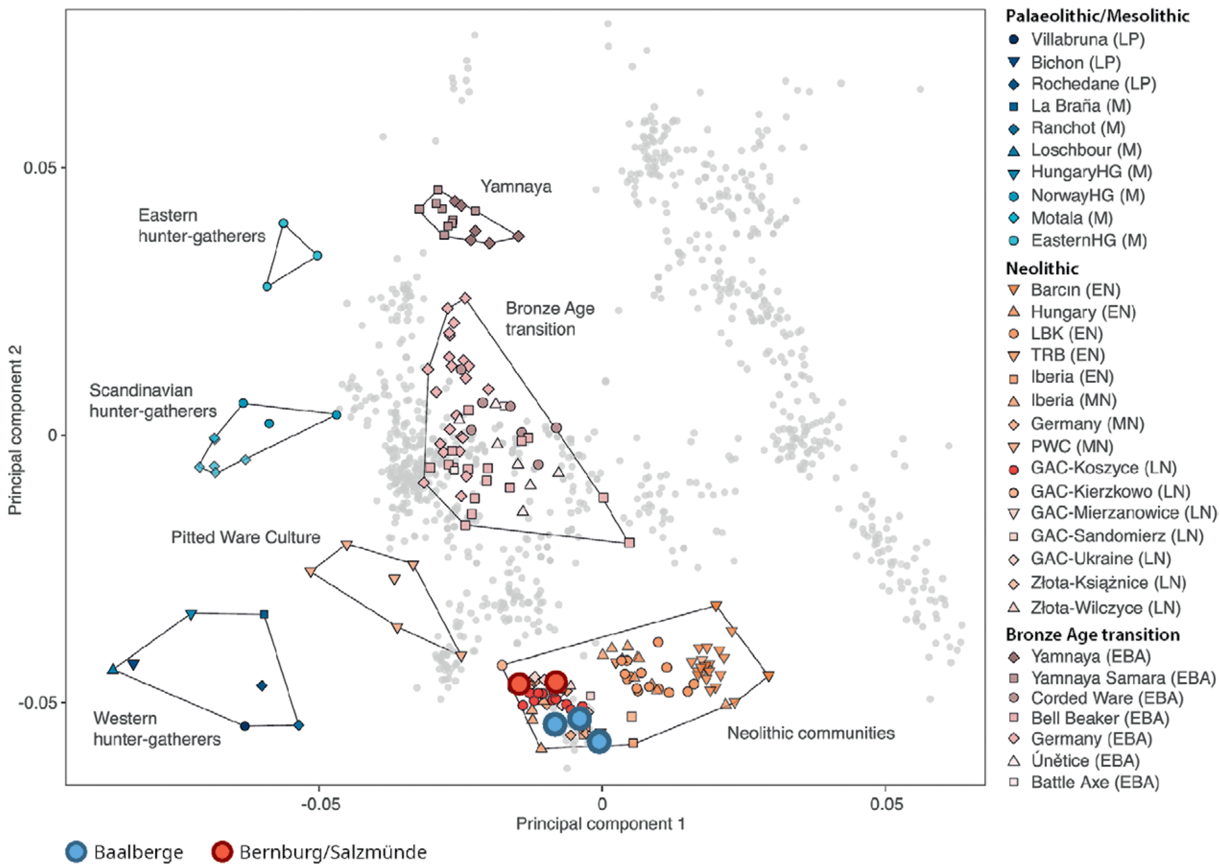


Figure 205. Possible chronological differences of the nuclear genetic analyses (cf. Müller 2023).

and Salzmünde.[64] With the exception of four skeletons from Gotland, genome analyses are missing thus far, *e.g.*, also for the entire TRB communities, including the Tiefstich Group. Since mitochondrial aDNA is no longer used to reconstruct migration phenomena due to technological advancements, the migration movements do not apply which are only based on a few mitochondrial analyses (Friederich *et al.* 2013; Friederich *et al.* 2015; Schwarz 2014). The proved similarity of nuclear genomes of Globular Amphora burials with those of the rest of the agrarian Central European population, demonstrated at least for burials in Southern Poland (Schroeder *et al.* 2019), currently exonerates previous postulates of migrating pastoralists from a genetic perspective.

For the timeframe considered here, we know of only two nuclear genome analyses from Central Germany: Esperstedt (Bernburger grave) und Salzmünde-Schiepzig (Salzmünder grave) (Fig. 205). Significant for Esperstedt is the relatively high proportion of the genetic fingerprint of "Western Hunter-Gatherer" (WHG) ancestry of ca. 40%, which corresponds to the findings from the already mentioned gallery grave of Niedertiefenbach (Haak *et al.* 2015; Schroeder *et al.* 2019). Obviously, we observe here an 'admixture' that possibly occurred from ca. 3800 BCE onwards (possibly in connection with Michelsberg, cf. Immel *et al.* 2019), and may indicate a similar intensification of human mobility between Central and Western Europe, as we observe at the beginning of the 3rd century BCE with regard to 'eastern steppe influences'. The proportion of the Esperstedt Bernburg individual differs from

64 There are still no nuclear genome analyses for the Central German area for all post-Linear Pottery groups or Late Lengyel groups, but also none for the Early Corded Ware. The available data for Central Germany includes I0172 Esperstedt, context 1841; I0559 Quedlinburg, context 21033; Quedlinburg, context 21039; I0807 Esperstedt, context 6220; I0554 Salzmünde-Schiebzig sample SALZ88A (Haak *et al.* 2015).

three Baalberger individuals from Esperstedt and Quedlinburg, which have much lower Western Hunter-Gatherer (WHG) proportions (cf. also Schroeder *et al.* 2019, 10707 fig. 2B). The genetic analyses of Globular Amphora individuals are primarily available from Southern Poland thus far and also exhibit a higher proportion of WHGs there (Schroeder *et al.* 2019). Whether the four Gotland TRB individuals, who are the only TRB individuals analysed to date, can represent the TRB (as has been the practice in various articles, cf. Haak *et al.* 2015; Schroeder *et al.* 2019), shall be left open here. These individuals also have a high WHG fingerprint, which could be consistent with the Michelsberg background of the TRB phenomenon. The only analysis of an individual associated with Salzmünde from Salzmünde-Schiepzig corresponds to the individual associated with Bernburg.

Even if the few genome analyses from Central Germany can provide only limited evidence, chronological differences become clear, which we can certainly model: An admixture situation is probable from 3800 BCE on with increasing proportions of WHG, a genetically quite uniform population in the Late Neolithic and a decreasing WHG proportion towards the end of the development, which is also visible, *e.g.*, in the Polish GAC analyses. In general, we observe a mixed population in the genetic analyses in which genetic lineages cannot be identified. Main admixture events are positioned before or after the time horizon that we consider here. However, given the small number of published nuclear genome analyses, it must be assumed that the picture drawn here can only be described as a hypothesis, which is based on the genome analyses available to date. Nevertheless, a diverse ancestry definitely becomes apparent as a genetic lineage that points to a diverse and multicultural past.

4.5 Consequences: Symbiotic relationships

The predominant simultaneity of the regional Bernburg and the Central German GA Group and their close connection are interesting, since dominantly different concepts can nevertheless be assumed: Bernburg ceramics can mostly be associated with populated enclosure and walled chamber graves, while globular amphorae are found in domestic sites that are difficult to verify and predominantly in single graves. There are similarities with regard to the use of other grave forms (burial mounds, megalithic tombs) and a similarity of decoration motifs. The mutual occurrence of Bernburg types in GA contexts or of GA types in Bernburg contexts is frequent in settlements, but rare in burial rituals.

There is a tendency for a rather low decoration diversity in the Early GAC phases (A/B) and an increase of diversity with a concurrent increase in the construction of graves in the Younger GAC phases (C/D). The increase in GAC graves after 2900 BCE is linked with a decrease of Bernburg inventories – suggesting a deeper process of change. This represents the time marker when GA elements also first appear in western (Wartberg) and southern directions.

The described tendency is also perceptible in the innovation and simplification index of the ceramic inventories (Fig. 206).[65] For the GAC, there is a high innovation index at the beginning followed by a low index around 3000 BCE, which, however, rises again strongly to 0.6 until ca. 2800 BCE. Bernburg exhibits a low innovation index of only 0.5 from 3200 BCE, which drops sharply again to 0.3 around 3000 BCE. In contrast, the simplification index increases extremely from 3000-2900 BCE (from 0.3 to 0.95). Thus, while GAC ceramics become a "sign carrier", Bernburg ceramics lose this

65 According to Robert Hofmann (2013, 360), we calculate the innovation index ((A/C)/D)*100 and the simplification index from ((B/C)/D)*100, whereby A is the number of motifs appearing for the first time, B the number of motifs appearing for the last time, C the total number of motifs, and D the phase duration in years.

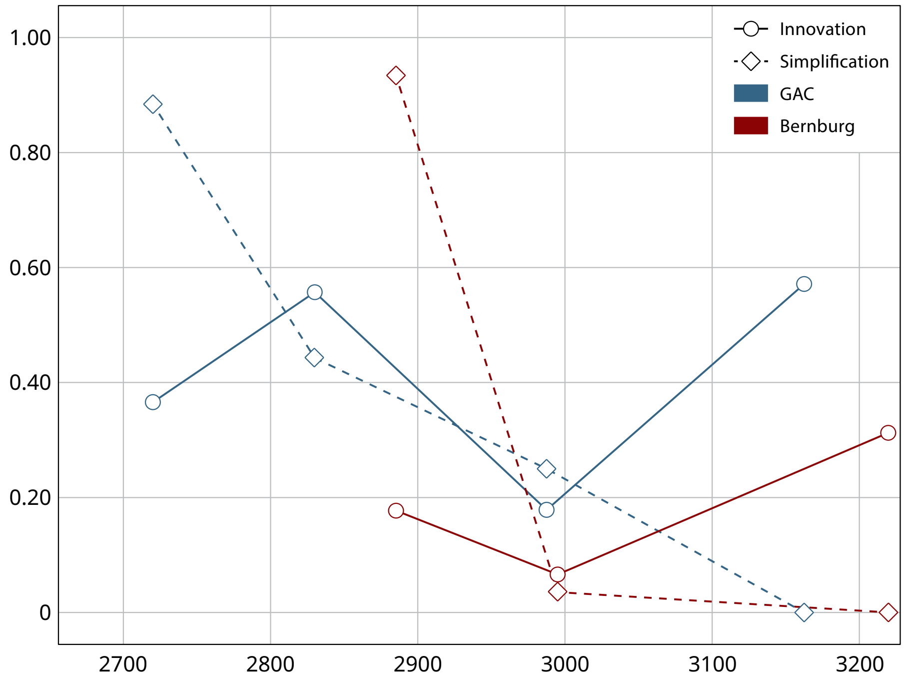


Figure 206. Innovation and simplification index of Bernburg and GAC ceramics. While GAC ceramics become a "sign carrier", Bernburg ceramics lose this function in the meanwhile. A similar development with an extremely increasing simplification index first follows in the case of the GAC around the 27th century BCE.

function in the meanwhile. A similar development with an extremely increasing simplification index first follows in the case of the GAC around the 27th century BCE.

From the combination of the radiometric dates and correspondence analytical observations, but also from the interdependent innovation and simplification indices for decorations, a picture of the strong connection of the use of Globular Amphora and Bernburg ceramics emerges. Settlement evidence in sandy-loamy fluvial areas are more connected with GA ceramics, whereas settlements and enclosed settlements of the black earth and loess areas are more connected with Bernburg ceramics. This suggests a separation of economic activities associated with specific identities. Moreover, the single graves with GA, in contrast to the Bernburg collective burials, possibly indicate different social roles. Since both isotopes as well as aDNA analyses show no differences, a similar food supply must be assumed: the exchange of products from the economies of the lowland with those of the black earth – perhaps those with a higher pastoral component as opposed to those with a higher agricultural component?

4.6 A Western GAC pattern?

The symbiotic and yet conceptually different practices of GA and regional ceramics in the MES can also be traced in other areas of the Western GAC. For example, Erika Nagel (1985, 30-31) could demonstrate the strong overlap of the GAC and the Younger TRB groups for the Mecklenburg area. In the megalithic graves, TRB and GAC ceramics appear together and cannot be differentiated. The filling of the chambers occurred after the burials with GAC and TRB ceramics, what also speaks for a combined deposition. Similar conditions are available for East Holstein (Brozio 2006). That corresponding GA ceramics also appear in TRB settlements is shown, *e.g.*, by settlement pit 2 at Glasow (Pasewalk district) (Nagel 1980, 31 and 26 fig. 13d, i) or by the riparian settlement of Parchim-Löddigsee (Becker 2002). Similar conditions are also assumed for Pomerania (Wiślański 1964; 1966). Wiślański already suggested a separation between the more agriculturally oriented TRB elements and the more livestock-oriented GAC elements (Wiślański 1964, 91). Irrespective of this, no site in Northeastern Germany or Northwestern Poland indicates an exclusive GA presence.

In the area of the Elbe-Havel Group, there is typologically a great agreement between both the decoration techniques and decorations between Elbe-Havel ceramics and globular amphorae (Woidich 2014, 193-198). Even though the number of radiometric dates for the Elbe-Havel Group is too low, their main focus can be observed with bipartite and single-unit vessel forms around ca. 3100-2900 BCE, possibly until 2700 BCE (cf. Woidich 2014, 195; Müller 2001, 247). The few tripartite Elbe-Havel ceramics can be parallelised with Walternienburg 1, so probably from 3350-3100 BCE (Müller 2001, 247). Globular Amphora ceramics are often found, in contrast to Mecklenburg/Pomerania, in numerous grave finds without other pottery, often in single burials, but also in megalithic tombs. Additionally, globular amphorae are also observed from animal sacrifice sites of the Elbe-Havel Group.[66] This corresponds to the ritual canon of the Elbe-Havel Group. In contrast to the ritual sites, there is hardly any evidence for settlement activities that can be unambiguously assigned to the GAC according to the inventory. Seven sites[67] are located on the southern edge of the Elbe-Havel distribution, and with the exception of Schönfeld-Walterdorf 29 (Govedarica and Schatz 2006), all sites exhibit Havelland or other TRB ceramics in addition to GA ceramics (Bremer 1991; Dirks 2008). Thus, in principle, we recognise in the Elbe-Havel region, on the one hand, a strong typological relationship of the inventories and similar or common burial customs but, on the other hand, also the development of separate typological inventories.

The decisive factor for the settlement behaviour in the west is that a symbiotic relationship generally existed in all regions with the locally existing groups (cf. Maier 1991; Woidich 2014, 94-95). For example, there are no independent GA hilltop settlements or enclosed settlements – but in the Řivnáč-Bernburg-Wartberg triangle, there are numerous such settlements with GA ceramics in addition to the regional pottery. Altitudes higher than 200 m NN are rather avoided (Weber 1964, 180). In contrast, the highest site density on the eastern edge of the Middle-Elbe-Saale region and on the northern edge of the Řivnáč distribution in North Bohemia verifies that the mentioned separation processes obviously take place in different regions (Woidich 2014, 95).

4.7 Conclusions

Ceramics are a product of local practices of people, who develop forms functionally and decoration patterns in the framework of their traditions and networks. Ceramics are therefore material culture that represent the *habitus* of individuals and communities. Due to the supra-regional distribution of numerous aspects of Bernburg societies, we recognise that Bernburg ceramics continuously develop as a distinct style, but that they are integrated into the general Late Neolithic framework of commonalities: be it collective burial customs with TRB and Wartberg societies, be it the locally organised subsistence economy, or be it enclosed settlements. Both

66 Pure GAC sites in the Elbe-Havel region: Kirsch 1993, Catalogue no. 38, 50, 55.1, 61.1, 61.2, 62.1, 70, 71, 106, 109.1, 109.2, 109.3, 109.4, 118, 205, 221.2, 223.4, 265, 292, 330, 356, 363, 369.2, 379, 384, 772.5 (sacrificial pit?), 862.1, 869, 889, 900, 925, 931.2, 972.1, (sacrificial pit?), 972.2 (sacrificial pit?), 981, 1044.2.1, 1080, 1082, 1137.1 (animal burial), 1143, 1149,1158.1, 1168.1, 1181, 1225, 1235, 1239.1, 1243.1, 1248, 1253, 1254.1, 1257. 52 sites are without a settlement.

67 Settlements acc. to Woidich 2014, 273 ff. Site catalogue: 22 Berlin Lankwitz (Bremer 1991); 30 Berlin – Müggelheim 2 (Bremer 1991); 35 Berlin-Schmöckwitz 5 pit (Kirsch 1993, 13.2 unclear typological assignment); 72 Königs Wusterhausen – Diepensee 5 pits (Govedarica and Schatz 2006, 324; Dirks 2008, 66-67 fig. 2-4) (4 pits with mixed-inventory GAC-Elbe-Havel). Schönfeld – Selchow 10 2 pits (Grothe and Stapelfeldt 2008, 303-305) (mixed-inventory Britzer Fazies and GAC); Schönfeld- Walterdsorf 28 3 pits (Govedarica and Schatz 2006, 324); 87 Schönfeld- Walterdsorf 29 (Govedarica and Schatz 2006, 323-324, 329 fig. 4); 191 Altlandsberg – Wesendahl 12 pit (Jones and Wrzesniowski 2003, 35 fig. 19).

similar 'genetic fingerprints' and exchanged goods indicate an open, multiculturally oriented society, *i.e.*, a constant mixture of social groups supported by social mobility and open/fluid social group boundaries. Examples of this are also the use of globular amphorae, which adopted local and regional elements in different regions, but also the use of Tiefstich ceramic bowls that are decorated on the inner rim in Central Germany (Dittrich 2004, 158 fig. 14). Whether the increased use of high altitude or spur locations from ca. 3100 BCE and the increased use of globular amphorae at this time is a reaction to larger upheavals in other regions (*e.g.* in Northern Germany and Southern Scandinavia, see Brozio *et al.* 2019a; 2019b), will be discussed later in the overall context (see Chap. 7).

In this process, basic trends of an increased separation are certainly apparent. While Bernburg ceramics are distributed in the entire Central German loess region in enclosures, settlements and walled chamber graves, as well as in single graves, GA tend to be more widespread in the adjoining fluviatile regions to the east. But the graves overlap in the entire distribution area.

5. Environment, economy and nutrition of the Globular Amphora communities

Besides accessible information on environmental conditions and processes throughout the GAC development, there is still very little information on the economic practices and population size of the communities with globular amphorae. As sources, direct and indirect economic data with archaeozoological and macrobotanical analyses are available from a few settlement sites, as well as isotope analyses on a few cereals, animals and humans, through which dietary habits and questions on organisation and mobility within the subsistence practices can be explored. Furthermore, it is possible to investigate the remains of the few settlements concerning their relevance for the subsistence economy. In addition, site analyses on both the ecological background and pollen or other forms of analysis can contribute to a reconstruction of GAC economic practices. The origin of raw materials, among other things, also provides evidence for the size of existing networks.

In spite of these diverse possibilities, assertions are extremely limited, since there are actually too few analyses or hardly any available sources. In contrast, it can be assumed that the character of the sources in many regions is responsible for the low number of analyses. In the following, a brief overview of environmental, economic and nutritional data is provided.

5.1 The environment of the GAC

5.1.1 Topography, soils and climate

GA sites occur in a wide variety of regions between the Baltic Sea and the Northwest Pontic (cf. Fig. 1). The spatial structure, including communication traits, of these huge areas is preconditioned both by the hydrological regiment and by the mountain ranges. While the coast of the Baltic sea, and the adjacent marine areas with their sandy and moraine background, narrow the northern GAC distribution, the southern distribution limits lie within the Lower Mountain Ranges both of the Bohemian and Moravian mountains west of the Carpathians, and the Carpathians themselves. In the eastern southernmost distribution, on the Moldavian and Ukrainian plateaus, the border between grass steppe and forest steppe never was crossed.

These geographically east-west oriented limits are crossed by different river systems that are mostly oriented N/NW to S/SE, namely the Elbe, the Odra, the Vistula including the Western Bug, but also the Siret, Prut and Dniester, and partly also the Dnepr. In the northern GAC regions these N-S oriented natural communication routes are complemented by mainly E-W orientated glacial lowland belts: the *Urstromtäler* like the Elbe-Warthe-Vistula *Urstromtal* or the Glogau-Baruther *Urstromtal*, and others. Within this hydrological frame, the areas in between are characterised in the Northern European Plain mainly by Pleistocene deposits that consist of washed-out sands and gravels, gravels, glacial gravels, glacial sands, and silts. Northward and within the Central European mountain range, loess basins and plateaus with different types of black soils are present. They are even more present in the Eastern and Southeastern Forest steppe areas, where huge loess layers with deeply developed chernozems are typical for a landscape which is otherwise mainly broken by canyons of different size. Overall, the topographical background of the GAC area enables both pastoral and agricultural subsistence economies on different scales, and an intense communication especially along the water ways and the glacial belts, which together display a natural capability of affording a network for communication.

In western GAC distribution regions (from the western North Central European lowlands to the Central Lower Mountain Ranges), sites are located in the *Southwest Baltic region*, the *Middle Elbe-Saale-Havel region* and *Bohemia/Moravia*. While in the Hessian and Westphalien areas volcanic basalt formations and loess soils within *boerde* basins are decisive, in the circum-Hercynian region huge black soil plains are most fertile settlement areas. Pleistocene deposits within the adjacent alluvial lowlands of the Elbe, Saale, Havel and Odra consist of alluvial sediments, including washed-out sands, gravels, and silts. To the south in Bohemia and Moravia the geomorphological situation is comparable. Huge loess areas are located within Elbe and Danube tributary areas with alluvial soils and framed by calcareous and sandstone mountain ranges. To the North the west Baltic area consists of coastal flatlands, lakelands, large valleys with peaty floor, sandy and clayey areas.

In GAC eastern distribution regions, sites from the eastern North Central European lowlands are located in the *Middle Noteć*, *Kuyavia* to the west of the Vistula bend, and to the east of the Vistula bend from *Chełmno Land*. A certain accumulation of finds is also known from *Podlasie* on the *Upper Narew*. Many GA sites are located in the Polish Lowlands, where Pleistocene deposits are geologically composed of glacial and alluvial origin with a thickness of 50-100 m. In Central Poland, these Pleistocene deposits consist of washed-out sands and gravels, gravels, glacial gravels, glacial sands, and silts (Sokołowski *et al.* 2021). Towards the south of the Lowlands, sands and loams are interrupted by loess, collected in the river valleys.

Within the northern European plain, and especially the Polish Lowlands, very diversified landscapes and soils exist (Prusinkiewicz and Bednarek 1999). Lakelands, large valleys with peaty floors, sandy and clayey areas, and plains with very fertile black soils exist.

> '*The latter form [...] a kind of 'fertile islands' [...] (large: 845 km² in Kujawy; smaller: 100-300 km² in Kosican district; very small: e.g. 80 km² in the Szamotully district)* (Czebreszuk and Szmyt 2011, 12-13).

This landscape was used differently during the Neolithic, as described by Janusz Czebreszuk and Marzena Szmyt for Kuyavia, one of the focal settlement areas.

> '*A good example is the Kujawy region that consisted of several different parts: the Kujawy Plain, which is in the centre, lakelands in the west and the south, and large valleys in the north and east. The very flat Kujawy Plain is covered with black soils. Both lakelands and valleys have a varied relief and are mainly covered with sandy or clayey soils. The Danubian newcomers exclusively settled the central part of the region (the Kujawy Plain), covered with black soils. What is remarkable, hunter-gatherers perceived the same part of Kujawy as not useful…From the Early Neolithic,*

> *during the Middle Neolithic and the Late Neolithic as well as in the Bronze Age and even later, the Kujawy Plain was most intensively used by people. However [...] the almost exclusive connection between agricultural settlement and fertile soils, so strongly marked in the early Neolithic, is severed. The process starts in the Middle Neolithic with the rise of TRB, the population of which took advantage of economic strategies adjusted to less fertile clayey and sandy soils. As a result, in the Middle Neolithic, settlement and economic dualism emerges in Kujawy [...] Late Danubian settlement was exclusively linked to black soil areas, while contemporaneous early Funnel Beaker (phase 1) sites were located only on sandy areas [...] From ca. 3500 BC on, one of the most distinctive characteristics of the Polish Lowlands is the wide variety of cultural groups [...] e.g. populations of the GAC [...] Late Neolithic societies followed diverse economic strategies (from the domination of crop cultivation to that of animal rearing), making environmental limitations, so conspicuous earlier, disappear'* (Czebreszuk and Szmyt 2011, 13-15).

In consequence, both loamy sand and moraine areas, as well as fertile black earth-like areas, *e.g.*, in Kuyavia, were used.

Further sites are located upstream of the Vistula, up to the eastern low mountain range zone or the plateaus in front of it, including the regions of *Lower Silesia*, *Lesser Poland* with the eastern *Lesser Poland Plateau* and also the *Lublin Plateau*. These are areas with a more varied geology, which is predominated by Upper Cretaceous carbonate rocks like chalk and (siliceous) marls (Sokołowski *et al.* 2021). While Palaeogene deposits are fragmentarily preserved in some areas (Machalski *et al.* 2016), heavy loess and sandy deposits of up to 30 m cover the Upper Cretaceous rocks in the south of the Lublin Uplands (Dolecki and Rzechowski 2008; Sokołowski *et al.* 2021). Beside the high variability at the northern fringe of the Carpathians, huge loess areas with black soils are also dominant beside the alluvial environment of the huge rivers like the Middle and Upper Vistula and the Bug. Further east and southeast, the eastern plateaus of Volhynia, Podolia and the adjacent regions of the Moldavian Plateau on the Siret to the south, are involved with a similar geomorphological-pedological background. Just as in the west, different sites further east that are influenced by GAC elements are finally found on the Dnieper and further north, sites are found on the upper reaches of the Neman. In the southernmost part of the GAC distribution, the present-day border between the forest steppe and the grass steppe was never crossed.

With respect to past climatic conditions, we can distinguish between a relatively warm and wet middle Holocene phase until ca. 3100 BCE, and a dry and colder phase ca. 3100-2800 BCE. Such climate variations are especially observed at a regional scale in Central and Southern Germany and Bohemia/Moravia during the middle and late Holocene (Großmann *et al.* 2023). As a climatic archive, the speleothems from the Bleßberg, Spannagel and Bunker Cave show that a predominantly warm and humid climate prevailed in the named regions from ca. 3500 to ca. 3100 BCE. From ca. 3100 to about 2800 BCE, the trend changed to a predominantly cold and dry climate. From ca. 2800 BCE onwards, however, an overall trend back towards a significantly warmer climate can be observed. A similar trend is visible, for example, in Southeast Poland, within the $\delta^{13}C$ values at the Wolhyninen lake site of Komarow (Dobrowolski *et al.* 2016). Further to the east ca.3300-2900 BCE, the start of cold and arid conditions (dry steppe) were also reconstructed with a reforestation (Bolikhovskaya *et al.* 2017). In addition, in the Northern European plain different archives indicate similar climatic changes (cf. Warden *et al.* 2017).

These regional observations correlate with different temperature and precipitation curves, based on supraregional or even global archives like the GISP 2 ice core (Wanner *et al.* 2011), the North Atlantic Oscillation curve (Olsen *et al.*

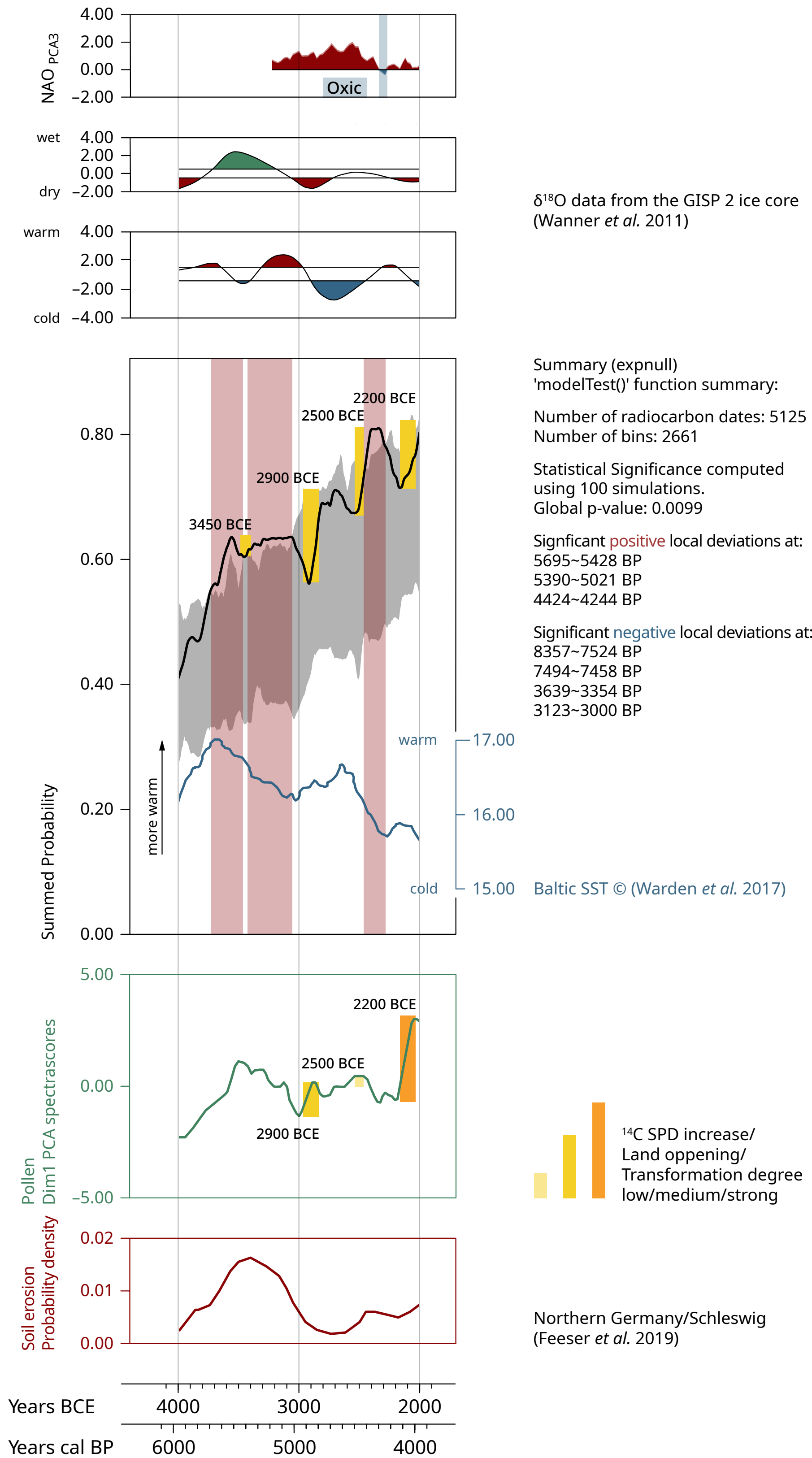


Figure 207. Temperature and precipitation reconstructions based on supra-regional or even global archives, like the GISP 2 ice core (after Wanner et al. 2011), the North Atlantic Oscillation curve (after Olsen et al. 2012), and the Summer SST record from the Baltic Sea (after Warden et al. 2017) that is based on TEX86 palaeothermometry, indicate different climatic conditions during the GAC development: (1) a generally warmer and wetter phase before 3100 BCE; (2) a generally cooler and dryer phase ca. 3100-2900 BCE; (3) again an increase of warmer and wetter conditions after ca. 2900 BCE (after Großmann et al. 2023).

2012), and the Summer SST record from the Baltic Sea (Warden *et al.* 2017) that is based on TEX86 palaeothermometry (Fig. 207).[68] Overall, beside regional variations, the GAC-durations seem to be associated with three different climatic conditions: (1) a generally warmer and wetter phase before 3100 BCE; (2) a generally cooler and dryer phase ca. 3100-2900 BCE; (3) again an increase in warmer and wetter conditions after ca. 2900 BCE.

The described general variation of the climatic conditions ca. 3100-2900 BCE was associated with changes in the vegetation cover, which might have been influenced both by anthropogenic and the described climatic factors.

5.1.2 Vegetation and vegetation changes

For the reconstruction of the vegetation cover and human impact, different pollen profiles and sedimentological analyses are available. We can basically assume open spaces in the loess regions with forest-steppe-like vegetation between mixed oak forests (Dörfler *et al.* in print)

In the north-western Central European Plain, partly laminated pollen profiles with a decadal chronological resolution are available. General trends of vegetation and human impact during the GAC development in northern Central Europe were reconstructed by Walter Dörfler and Ingo Feeser (2015) as a "crisis" for the later middle TRB and the beginning of the GAC (Fig. 208). Meanwhile, during the TRB at 3750-3500 BCE, the expansion of new land-use practices is reflected in an opening of the landscape with a peak around 3500 BCE,

> '*at around 3300 BCE most of the mixed oak forest taxa (*Ulmus, Quercus, Fraxinus*) begin to increase before achieving a temporary maximum representation.* Corylus *representation shows an opposite development, and non-arboreal pollen also generally decreases. Sedimentological investigations at Poggensee and Belauer See [...] suggest that these changes fall into a period of climatic deterioration with increased lake levels and a sudden drop of summer temperatures between c. 3350-3000 cal BC (Dreibrodt et al. 2012; Feeser et al. 2012) [...] From around 3125 BCE land-use activities remained at low levels, and woodland recovered strongly for about c. 100 years [...] Shortly before 3000 calBC, most arboreal taxa show declining representations and Corylus increases again. Also non-arboreal pollen representation increases slightly. This is interpreted as a sign of increasing human activities and renewed woodland clearances [...] It is [...] shortly after 2900 calBC, that most anthropogenic indicators (cf.* Plantago lanceolate, Rumex *and Cereal-type pollen) increase distinctly and regain pre-collapse levels*' (Feeser and Dörfler 2015, 298-299).

In the north-eastern Central European Plain, a similar pattern is detectable in the pollen profiles from Lake Woniec in Greater Poland and Lake Gościąż in Kuyavia. At Lake Woniec

> '*[...] at around 3490 BCE, a steep increase in* Plantago lanceolata *(ribwort plantain) and other anthropogenic indicators mark an economic change with consequent opening of the still dominating forests [...] and a stronger share of*

68 After centuries of more continental climate conditions in Central Europe, an increase of Atlantic influences charactises the last century of the fourth and the first centuries of the third millennium BCE with an increase of the North Atlantic Oscillation (Fig. 207). Westerly winds blowing across the Atlantic bring moist air into Europe. In years when westerlies are strong (North Atlantic Oscillation NAO+), summers are cool, winters are mild and rain is frequent. If westerlies are suppressed, the temperature is more extreme in summer and winter leading to heat waves, deep freezes and reduced rainfall (North Atlantic Oscillation NAO-). Nevertheless, this tendency did not overrule the described colder and dryer conditions.

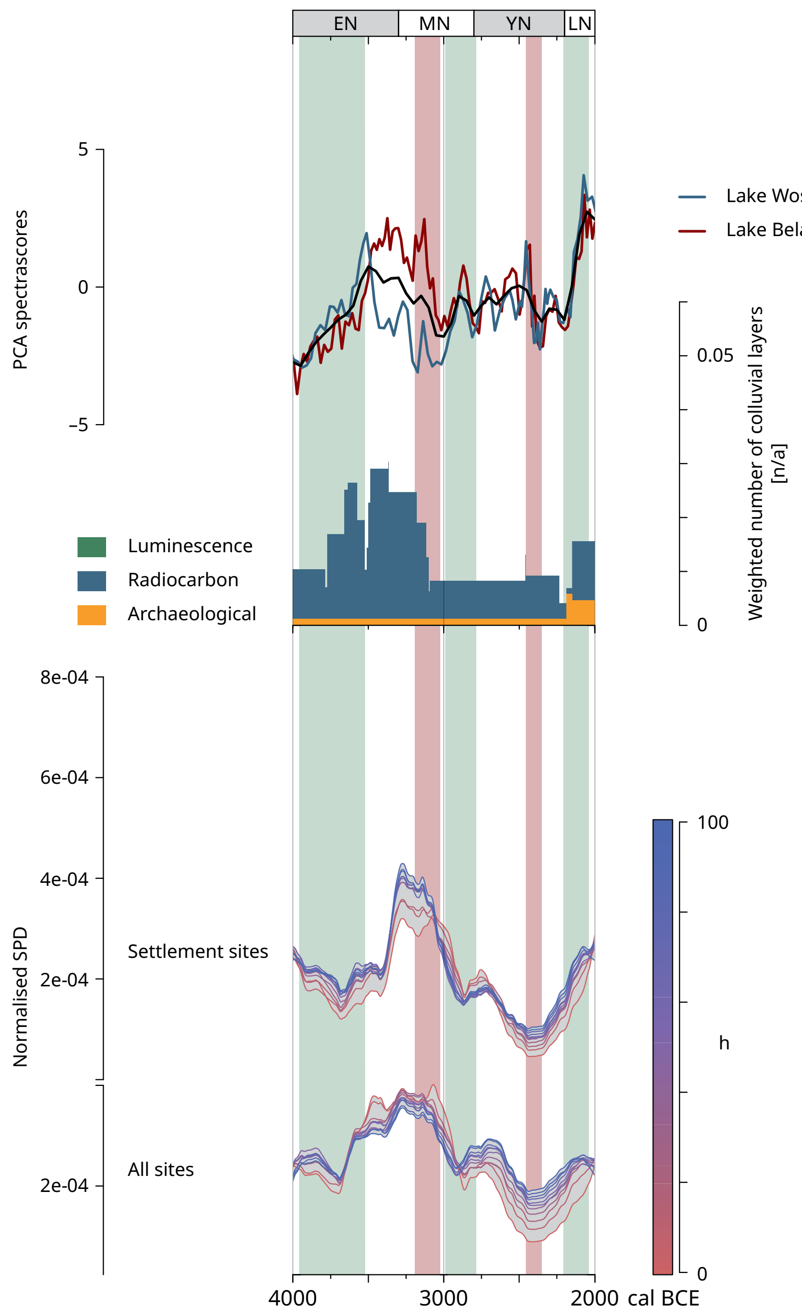


Figure 208. On the north-western Central European Plain, partly laminated pollen profiles with a decadal chronological resolution are available, indicating a reduced human impact during the GAC development (after Feeser et al. 2019, 7, fig. 6). Walter Dörfler and Ingo Feeser (2015), reconstruct a "crisis" for the later middle TRB and the beginning of GAC.

arable farming. From this time onward a strong anthropogenic component is visible in the environmental development […]. As the intensity of land use reflects human pressure on the environment and is thus also an indicator for population density (Feeser & Dörfler 2015), we interpret such phases of deforestation and reforestation as boom and bust phases of the regional settlement or human population density, respectively. At ca. 3230 cal. BC, after ca. 260 years of strong human influence on the landscape […], a ca. 160 years long phase of woodland regeneration occurs, indicating a decline in human pressure and most probable also population […] Betula *(birch) has a short maximum as a pioneer tree and* Ulmus *(elm) regenerated as well. At the same time* Corylus *(hazel) values decrease, indicating a decline of hazel probably due to less open woodland situations or a more closed woodland canopy, respectively'* (Dörfler *et al.* 2022).

In Kuyavia, at Lake Gościąż, a similar development was detected.

> *'Summing up the phases of high settlement activity and of abandonment (boom and bust phases) we can see a first strong increase in settlement indicators at 3500 cal. BC. A first decrease is recorded after just 30 years (ca. 3470 cal. BC) but the curve lasts with still high values until 3260 when a peak in the* Betula *curve and a succeeding increase in* Ulmus *indicate forest regeneration. In Lake Wonieść the first settlement phase with higher* Plantago lanceolata *values is recorded [...] from 3490 to 3230 cal. BC. Thus, this boom and bust during the final funnel beaker time seems to be a common phenomenon of the two sites that also is recorded from many sites in Northern Germany (Feeser et al. 2016, 2019). The next phase of enhanced settlement activities occurs between ca. 3100 and 2800 cal. BC in Lake Gościąż [...] followed by a regression phase from ca. 2800 to 2200 cal. BC. The onset is also synchronous with the onset of new settlement activities in the Lake Wonieść region but here we see just a medium level of landuse intensity at this stage that lasts until 2140 cal. BC'* (Dörfler *et al.* 2022: 201-202).

This kind of reduced visibility of human activities within the pollen records around 3200- 3000 BCE is also confirmed in pollen analyses from the Neuenhagener Oderinsel within the Grosser See, in close vicinity to the Odra river (Jahns 2011) and in the Arendsee, Altmark (see below, Diers 2008). In conclusion, between Holstein and Kuyavia a similar trend is observable: shortly before or during its appearance, the GAC is linked to a phase in which a recovery of the forest and a decrease in general in human impact is visible in the pollen and sedimentological records. This kind of reforestation was also detected in other neighbouring areas of North Europe (British Isles: Stevens and Fuller 2012; Sweden: Sjögren 2006). The described phenomenon is not visible east of the described area in Northeast Poland (Lake Szurpily, Kinder *et al.* 2019), and also not in the few pollen analyses from the Mittelebe-Saale region and probably also not in Lesser Poland.

While the profiles described thus far had a regional pollen influx, pollen profiles with a local pollen influx surely describe domestic and other activities on a local level (cf. Gabelsee, Southeast Brandenburg (Jahns and Münch 2003), Oldenburg-Dannau (Feeser and Dörfler 2019)). The pattern from Lake Biskupin, with a decrease of the proportion of elm and ash trees and an increase in the proportion of hazel (Niewiarowski *et al.* 1995), is reported from other pollen profiles with local influx, indicating certain herding strategies. In consequence, we observe the described general changes in the vegetation within regional pollen influxes, while locally other patterns are also possible.

5.1.3 Summary

Based on vegetation and sedimentological investigations, we can basically assume open spaces in the loess regions with forest-steppe-like vegetation between mixed oak forests. Interestingly, with the availability of enough precisely dated pollen archives, an increased presence of shrubs and a decrease of human impact on the vegetation is observed at the beginning of the GAC around 3200/3100 BCE. This phenomenon is observable contemporaneously with a general shift from warm and wet climatic conditions to colder and dryer conditions. After 2900 BCE, climate conditions again became more humid and warmer and the vegetation cover changed accordingly. In consequence, most of the GAC regions were affected by changing environmental conditions, which required the new economic strategies by GAC societies, which in turn produced new ecological conditions due to changes in human impact.

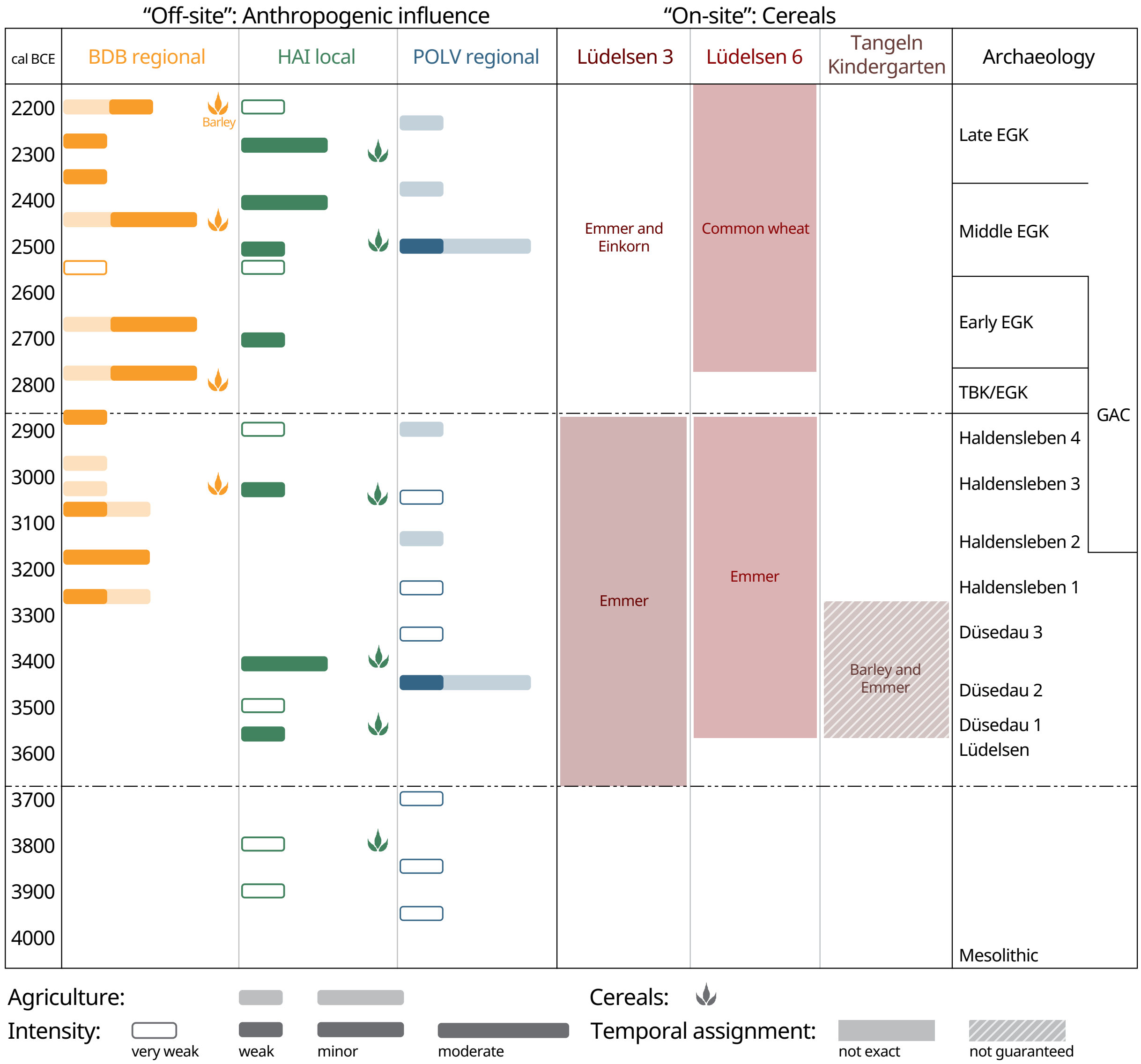


Figure 209. In the Altmark, Germany, cereals and agricultural activities were identified during GA presence. This applies to the megalithic tomb Lüdelsen 3 with emmer and einkorn, from which both GA and Tiefstich ceramics are available (after Diers 2018, 158, fig. 4.40).

5.2 Economic data from the Western GAC

5.2.1 Central Germany and the Southwest Baltic regions

There is hardly any data available from Central Germany about the subsistence economy of the groups who used GA ceramics. Although we are informed about the economic practices of concurrent agrarian groups (see Chap. 4), *e.g.*, we know of animal bones from ritual GAC contexts, until now there is no archive from any of the GAC settlement remains that could rudimentarily inform us about the subsistence. Evidence for cereals from various places cannot be clearly assigned to the GAC due to the unclear contextualisation, or they belong to negative imprints in ceramics, which could also be traced back to exchanged grain (Beier 1988, 47 tab. 9, *e.g.* Trebus, cf. Kirsch 1993, 94). Cereals have only been identified from inventories in which both GAC and Bernburg or Tiefstich ceramics appear. This applies to the megalithic tomb Lüdelsen 3 with emmer and einkorn, from which both GA and Tiefstich ceramics are available (Diers 2018, 158 fig. 4.40; Fig. 209), and to Halle-Dölauer Heide and Quenstedt-Schalkenburg with

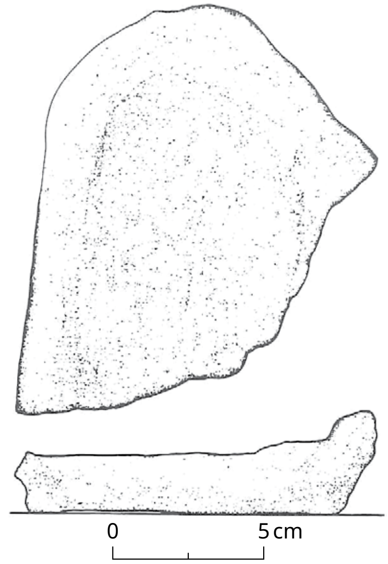


Figure 210. A sandstone slab from Berlin-Alt Lankwitz 63 (after Bremer 1991, pl. 3,3) can possibly be identified as a grinding stone.

emmer, einkorn and barley, from which Bernburg and GAC are available (Behrens and Schröter 1980; Behrens 1973a). Thus, according to a report by J. Schultze-Motel, the analyses of half of the Bernburg pits in Quenstedt-Schalkenburg refer

> '*mostly to emmer* (Triticum dicoccon *Schrank*) *with occasional grains of barley* (Hordeum vulgare *L.*)' (Behrens and Schröter 1980, 99).

In Halle-Dölauer Heide, emmer also dominates with an analysed loam clump that has grain imprints including one grain of barley and one lentil seed (*Lens culinaris*) (Behrens and Schröter 1980, Müller 2001, 510).

For settlement pits, querns and grinders have been repeatedly cited as an indication of grain processing (Beier 1988, 47; Woidich 2014, 100), but there is a lack of clearly presented evidence.[69] Even in more recent rescue excavations, GAC pits with querns have seldom appeared (cf. Fahr 2018). Four grinding stones and a blade with sickle sheen from finds of the settlement Gärtitz, which is assigned to the GAC, can be cited as evidence for the processing of grain (Conrad *et al.* 2009, 29). Querns are also known from pits of the GAC domestic site Großstrokwitz, south of Leipzig (pers. comm. Conrad). Furthermore, a sandstone slab from Berlin-Alt Lankwitz 63 (Bremer 1991, plate 3,3; Fig. 210) can possibly be identified as a grinding stone.

For animal bone statistics, very little data for "pure" GAC contexts is available from the MES region. Höltkammer (2020, 207 tab. 37) integrated this into an overall presentation of animal bone development in the Neolithic MES. Most animal bones from direct GAC contexts do not originate from settlements, but from ritual contexts (in the walled chamber grave of Wandersleben and the animal depositions of Oschersleben, Westerhausen, Zauschwitz and Stobra). In spite of the assumed differences between intentional depositions and settlement remains, values result which can more or less be compared, for example, with Bernburg bone inventories from settlements (Höltkemeier 2020, 212, fig. 127; Fig. 211). This pertains to the minimal number of wild animal bones and the high proportion of *Bos taurus* (ca. 70%) in the bones of domesticated animals, which is also the case at "pure" Bernburg settlements (without GAC infiltrate). The proportion of *Sus dom.* (ca. 25%) is increased in ritual GAC contexts, whereas the proportion of *Ovis/Capra* (5%) is lower in comparison to that of Bernburg settlements.

69 Due to the multi-phase character of the finds material, the aforementioned grinding stones of the settlement pits assigned to the GAC cannot be clearly classified (Bergemann 2018, 316).

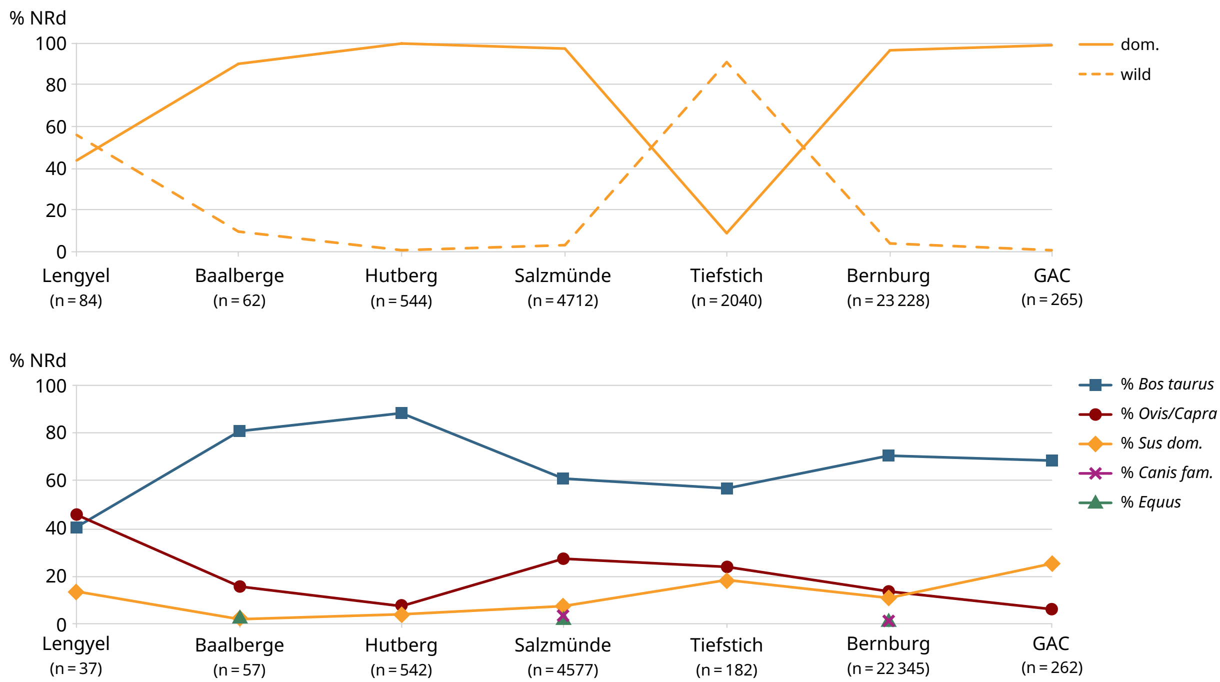


Figure 211. Development of animal husbandry of Neolithic societies in the Middle Elbe-Saale region. Relative proportion given in certain numbers of bones (NRd) of domestic and wild animals (above) and of the most important domestic species (below): Domestic cattle (Bos taurus), Caprinae (Ovis aries/Capra hircus), Domestic pig (Sus domesticus), dog (Canis familiaris), and horse (Equus). Bernburg animal bone assemblages pertain to the minimal number of wild animal bones and the high proportion of Bos taurus (ca. 70%) in the bones of domesticated animals, which is also the case at "pure" Bernburg settlements. The proportion of Sus dom. (ca. 25%) is increased in ritual GAC contexts (used for the GA calculation), whereas the proportion of Ovis/Capra (5%) is lower in comparison to that of Bernburg settlements (after Höltkemeier 2020, 212, fig. 127).

For the contemporaneous and preceding agrarian communities (Salzmünde/Bernburg), mixed-purpose animal husbandry can be consistently demonstrated, although some sites appear to be more specialised than others.[70] Thus, meat production likely dominates in Quenstedt-Schalkenburg, milk production in Krautheim and the use of cattle for draught purposes and sheep for textile production in Salzmünde. Pathological changes in cattle bones also from numerous other sites prove that cattle were used everywhere for draught purposes (Höltkemeier 2020, 302). Pigs were kept for meat production (Höltekmeier 2018, 10).

The sites Quenstedt-Schalkenburg and Halle-Dölauer Heide are important to us in this context because the use of Globular Amphora ceramics alongside the dominant Bernburg ceramics has been proven. In Quenstedt-Schalkenburg, GA ceramics are found in four of the ca. 200 pits together with Younger Bernburg (pits 74, 293, 308, 339), in addition to GAC single finds, which document the simultaneous presence of at least two ceramic styles (and meanings?) (Beier 1988, 112-113). More specifically for Quenstedt-Schalkenburg, the estimated slaughter ages based on domestic cattle teeth (*Bos taurus*) and caprinae teeth (*Ovis aries/Capra hircus*) verify the use of cattle primarily for meat production (Höltkemeier 2020, annexes 4.2.4 and 4.2.10; 4.2.15 for domestic pig teeth; 4.2.27 for the animal withers) (Fig. 212). According to Höltkemeier, the composition of the Young and Late Neolithic cattle herds was different – the sex ratio was only balanced in Quenstedt. Bulls were castrated. At Quenstedt, rams for meat and/or textile production were also castrated. Domestic pigs were held in Quenstedt for the production of tender meat, dogs were probably eaten as well (Höltkemeier 2020, 302). Horses were apparently used in Quenstedt as beasts of burden (Höltkemeier 2020, 305).

Among the 240 pits and 120 posts of Halle-Dölauer Heide, GA ceramics can be verified in seven pits (pits 51, 57, 58, 129, 136, 202, 222), the northeastern house and by numerous single finds, also exhibiting the presence of two ceramic styles (with the dominance of the Bernburg style). At Dölauer Heide (Höltkemeier 2020, 301-304), horse was eaten, domestic cattle are less frequently represented, but sheep/goat more so. Meat dissections were conducted on site. The composition of the

70 Evaluated sites: Höltkemeier (2020, 206-207 Table 37).

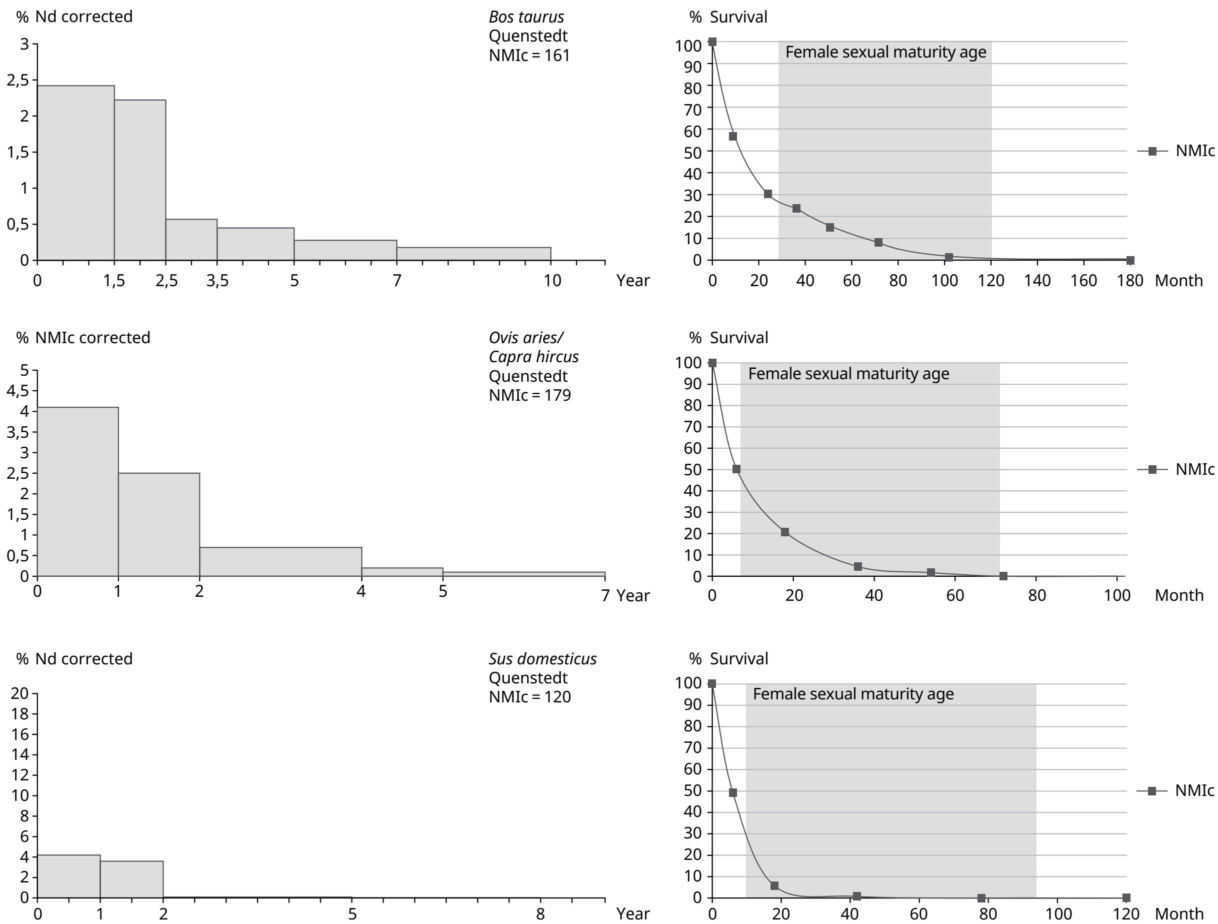


Figure 212. For Quenstedt-Schalkenburg, a Bernburg site with GAC ceramics, the estimated slaughter ages based on domestic cattle teeth (Bos taurus) and caprinae teeth (Ovis aries/Capra hircus) verify the use of cattle primarily for meat. Bulls were castrated. At Quenstedt, rams for meat and/or textile production were also castrated. Domestic pigs were held in Quenstedt for the production of tender meat (after Höltkemeier 2020, 213, fig. 128 and 216; 218, fig. 130 and 132).

animal bones indicates for both Halle Dölauer Heide and Quenstedt-Schalkenburg that more was consumed here than slaughtered.

Interestingly, in both Bernburg sites with GA ceramics, the proportion of cattle in the total animal population was lower and that of caprovids and pigs higher than that of the other Bernburg sites (without GA ceramics) for which animal bone analyses are available (cf. Höltkemeier 2020, 212 fig. 127).

Although there is currently hardly any evidence of agrarian activities from pure GAC settlement sites in the west, different pollen analyses from the vicinity of GAC sites confirm the agrarian use of the landscape (cf. Woidich 2014, 100-101). To be mentioned here are pollen sequences from the Altmark (Diers 2018), the Uckermark (Jahns 2001, 101-102 fig. 4) and the Lower Oder region (Jahns 2000). In the Altmark, agroeconomic activities could be proven in the pollen analyses in particular for the time period from which the GAC is verified. This results in a regional vegetation model based on the pollen analyses POLV III and BDB 23 from the Arndsee,

- for the time span 3200-3000 BCE with a very high degree of forestation, on the one hand, and evidence of cereals, on the other;
- for the time span 3000-2800 BCE with a considerable clearing, including extensive landscape opening and a high proportion of “herbaceous plants” and a low proportion of trees, moreover also cereal cultivation (Diers 2018, 163-165 fig. 5.2; Fig. 213).

Local vegetation reconstruction directly from the area of the settlement sites also indicates a steady opening of the landscape ca. 3200-2600 BCE (Diers 2018, 169 fig. 5.5 – 5.6; Fig. 214).

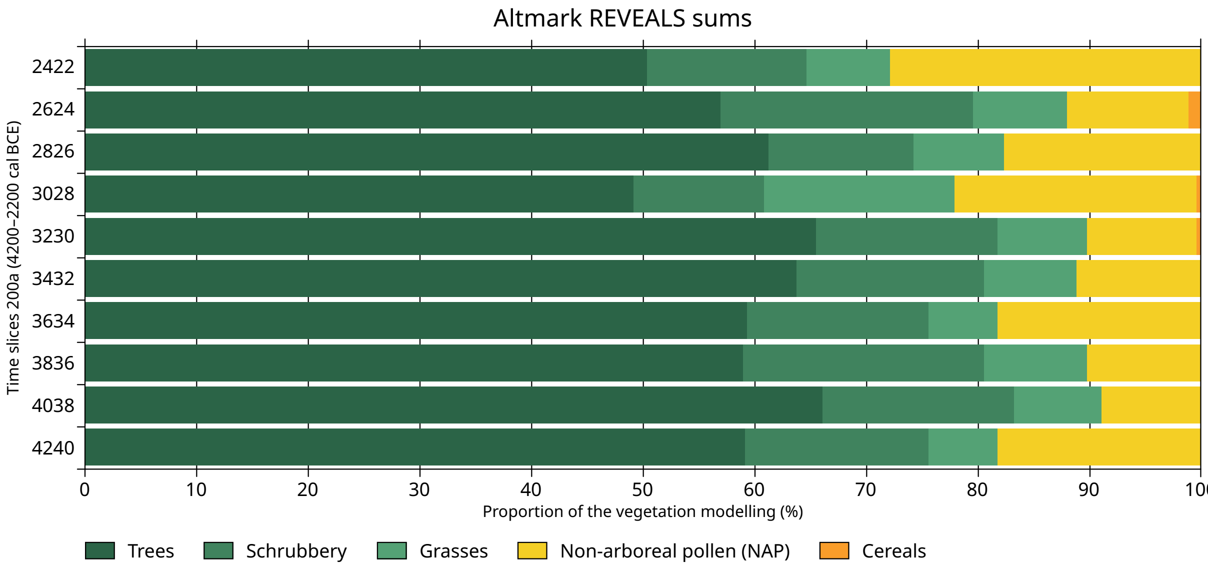


Figure 213. A regional vegetation model based on the pollen analyses POLV III and BDB 23 from the Arendsee verifies at ca. 3200-3000 BCE both a very high degree of forestation as well as evidence of cereals and at ca. 3000-2800 BCE considerable clearings, including extensive landscape opening, a high proportion of "herbaceous plants" and a low proportion of trees, moreover also cereal cultivation (after Diers 2018, 163-165, fig. 5.2).

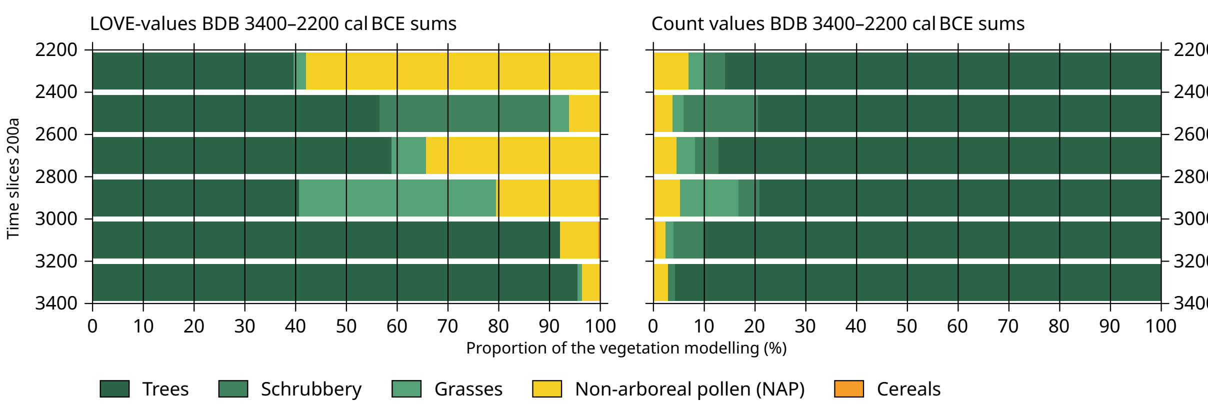


Figure 214. Local vegetation reconstruction directly from the Altmark settlement site Beetzendorfer Bruch indicates a steady opening of the landscape at ca. 3200-2600 BCE (after Diers 2018, 169, fig. 5,5).

From the megalithic grave Lüdelsen 3, from which GA ceramics are available, emmer and einkorn are attested for the period in question, as already mentioned (*ibid.* 158 fig. 4.40; Fig. 209).

In addition to botanical macro remains and animal bones, isotope analyses of human skeletons provide evidence of the diet and organisation of the subsistence economy. Unfortunately, isotope analyses from Central Germany are only available so far for three human GAC individuals and for one contemporaneous GAC livestock animal. However, the results fit well in the overall picture of the analyses from Central Germany (cf. Münster *et al.* 2018; Bergemann 2018, 337-358; Winter-Schuh *et al.* 2018). For the GAC individuals, there is one mature female individual from Quedlinburg VII (QLB 29) (Münster *et al.* 2018, suppl.) and two male individuals from a double burial in Zauschwitz – a juvenile from grave 43 and an adult-mature from grave 44 (Bergemann 2018, 313).

In the general evaluation of the data of Neolithic and Bronze Age findings, the following basic trends can be determined in which the mentioned GAC individuals can be classified:

- From the Early Neolithic to the Early Bronze Age, a consistent increase of ^{15}N values can be discerned. A stronger increase in the Young Neolithic can probably be determined with Baalberge and a renewed increase with Corded Ware (Münster *et al.* 2018, fig. 8). The GAC individual from Quedlinburg and one from Zauschwitz correspond more with Young to Late Neolithic values, the other one from Zauschwitz fits more into the Final Neolithic phase. Nevertheless, the basic tendency points more towards the Final Neolithic, if the quartile ranges are considered (cf. Münster *et al.* 2018, fig. 7).
- For the ^{13}C values, there are no chronological differences (Münster *et al.* 2018, fig. 6). The basically determined slightly increased value of ^{13}C for males compared to females (Münster *et al.* 2018, fig. 4) and the likewise slightly increased ^{15}N value in males compared to women can also be found for the one female and the two male GAC individuals of the MES.

If we follow the various arguments of Münster *et al.* (2018), the increased ^{15}N values are to be associated with an increase in animal food, with the GAC individuals fitting in here.[71] The increased proportion of ^{15}N in male individuals is thus also interpreted as an increased meat diet in males compared to females.

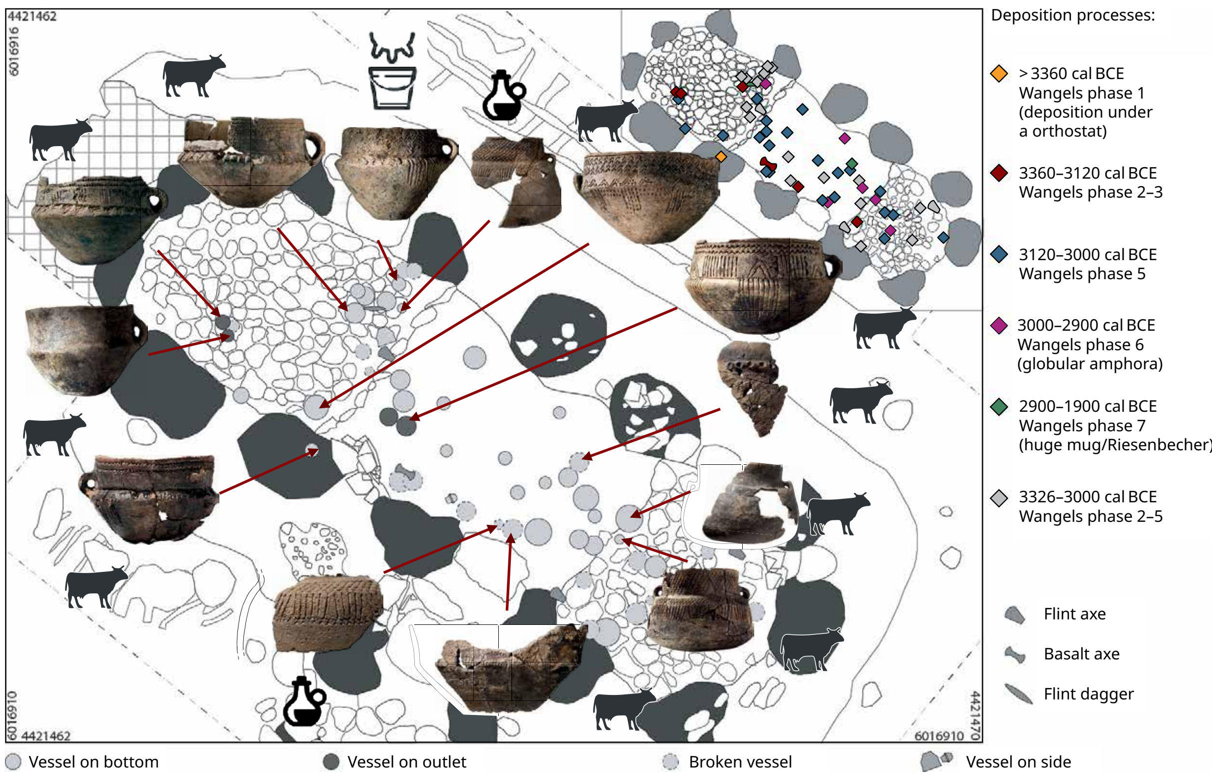
Strontium and oxygen isotope analyses were carried out for cattle and human graves at Zauschwitz. For both cattle and humans, a certain, possibly seasonal mobility can be assumed. For the current state of the baselines, the eastern Harz foreland could be considered the place of origin, for example, of two cattle. The variability in laser-ablation also argues for the mobility of humans in a corresponding radius of possibly 50 km (Gerling 2015, 230-241). If we compare this with the strontium analyses of animal bones from the contemporaneous settlement of Hundisburg-Olbetal, from which no GA ceramics are available, there is no evidence of the non-local grazing of animals (Winter-Schuh *et al.* 2018). Thus, differences in livestock husbandry between the GAC and Bernburg are likely discernible here, or the selection of certain animals or people for specific burial practices.

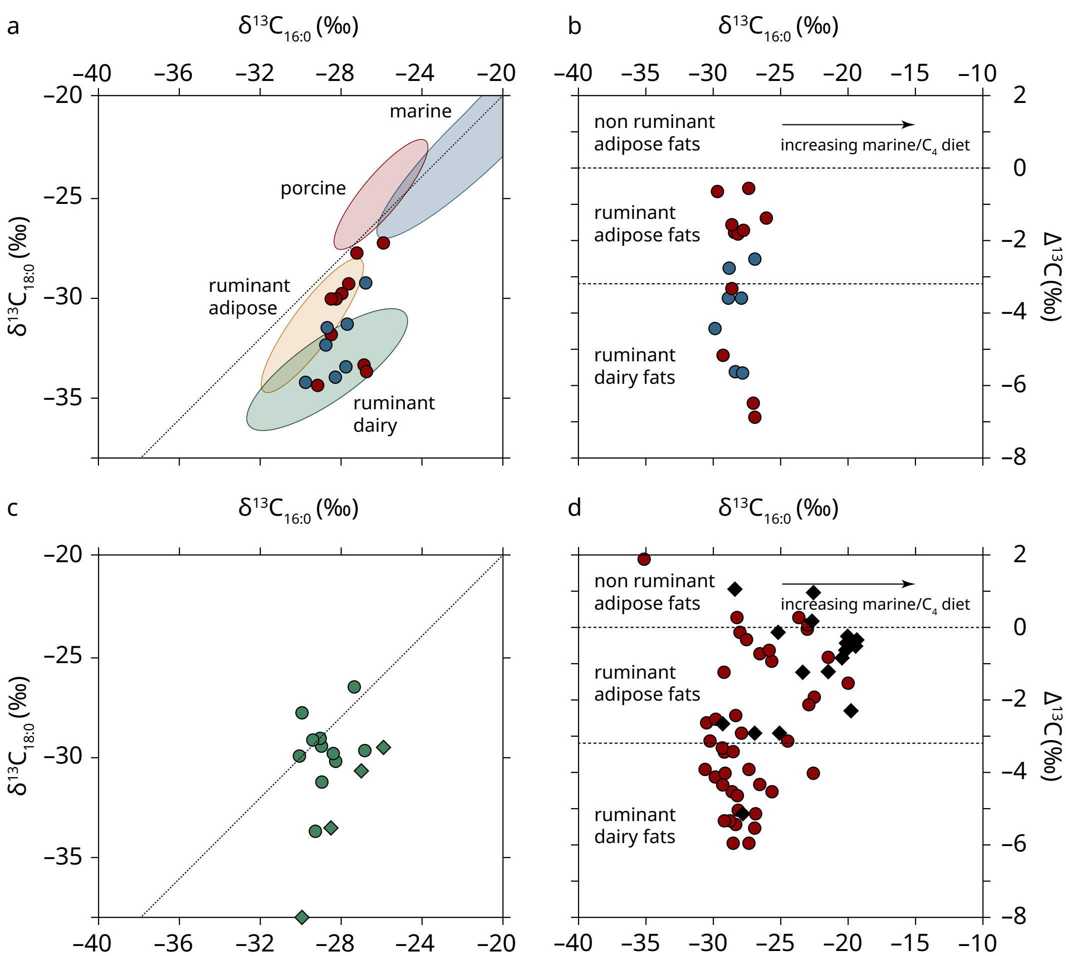
Differences between the ritual and the domestic spheres are also perceptible in other contexts. Lipid analyses are available from globular amphora of the Wangels passage grave, which suggest the deposition of vessels with cattle fat and specific oils, probably sea buckthorn oil (Fig. 215; Weber *et al.* 2020). In contemporaneous settlements from Oldenburg-Dannau (which, however, do not contain any GAC ceramics), the lipid analyses indicate, on the one hand, the use of milk products and above all plant remains, while, on the other hand, animal bones indicate an almost unchanged proportion of cattle bones of ca. 50-60%, pig bones of approx. 30% and sheep/goat between 10-20% among domesticated animals, which make up approx. 90% of all animal bones (Brozio *et al.* in prep.; Fig. 216). The time period, in which GA ceramics appear here in East Holstein in addition to TRB ceramics, is characterised in the overall development by an increase in domestic animals compared to previous and subsequent phases and by an increase of grazing areas (Knitter *et al.* 2019, 10; Fig. 217).

Detailed animal bone analyses are also available from the site of Parchim-Löddigsee, where, however, no stratigraphic separation was made between GAC/Younger Bernburg and single grave remains (Becker and Benecke 2002). This is a pure hunting station with a high proportion of wild horse consumption.

In summary, we therefore recognise the following basic trends for Central and Northern Germany: The diet of the individuals equipped with GA does not differ from contemporary groups, the food supply includes cattle, pig and sheep/goats,

71 Due to a lack of studies, this assumption is based on the fact that there is no increase in ^{15}N in animals from the MES that eat waste (dogs, pigs) and thus probably also eat grain that would have an increased ^{15}N value with fertilisation – which can therefore be excluded.


4421462
6016916
6016910
4421462
4421470
6016910
Deposition processes:
> 3360 cal BCE Wangels phase 1 (deposition under a orthostat)
3360–3120 cal BCE Wangels phase 2–3
3120–3000 cal BCE Wangels phase 5
3000–2900 cal BCE Wangels phase 6 (globular amphora)
2900–1900 cal BCE Wangels phase 7 (huge mug/Riesenbecher)
3326–3000 cal BCE Wangels phase 2–5
Flint axe
Basalt axe
Flint dagger
Vessel on bottom
Vessel on outlet
Broken vessel
Vessel on side


a
δ13C16:0 (‰)
δ13C18:0 (‰)
marine
porcine
ruminant adipose
ruminant dairy
b
δ13C16:0 (‰)
Δ13C (‰)
non ruminant adipose fats
increasing marine/C4 diet
ruminant adipose fats
ruminant dairy fats
c
δ13C16:0 (‰)
δ13C18:0 (‰)
d
δ13C16:0 (‰)
Δ13C (‰)
non ruminant adipose fats
increasing marine/C4 diet
ruminant adipose fats
ruminant dairy fats

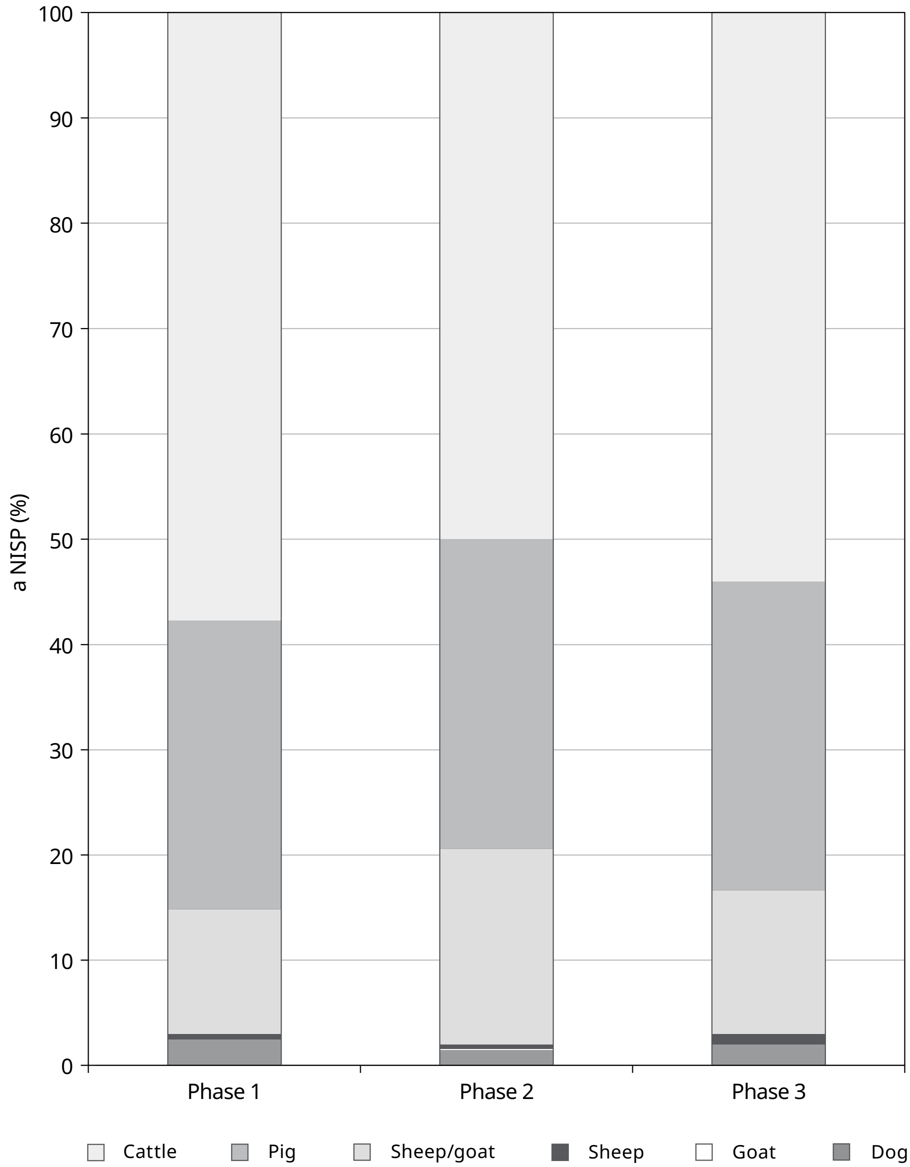


Figure 216. For the domestic site Oldenburg-Dannau, animal bones indicate an almost unchanged proportion of cattle bones of ca. 50-60%, pig bones of approx. 30% and sheep/goat between 10-20% among domesticated animals, which make up approx. 90% of all animal bones (Brozio et al. in prep.).

evidence of cereal cultivation is difficult (similar to the contemporary groups), but the landscape openings at least in Central Germany and the Altmark are considerable. Data from cattle and human burials in Zauschwitz indicates possible seasonal mobility within a radius of at least 40 km, which contradicts the local herding pattern, for example, of a contemporaneous Bernburg settlement. It is possible that different animal husbandry and mobility practices are recorded here. The composition of the animal bone spectrum of Bernburg settlements with GA ceramics shows increased values of caprovids and domestic pigs in comparison to cattle – the values are comparable with the animal bone conditions in the Southwest Baltic region.

Figure 215 (left). Lipid analyses are available from globular amphora and TRB pottery of the Wangels passage grave, which suggest the deposition of vessels with cattle fat and specific oils, probably sea buckthorn oil (Weber et al. 2020, 105122, fig. 3).

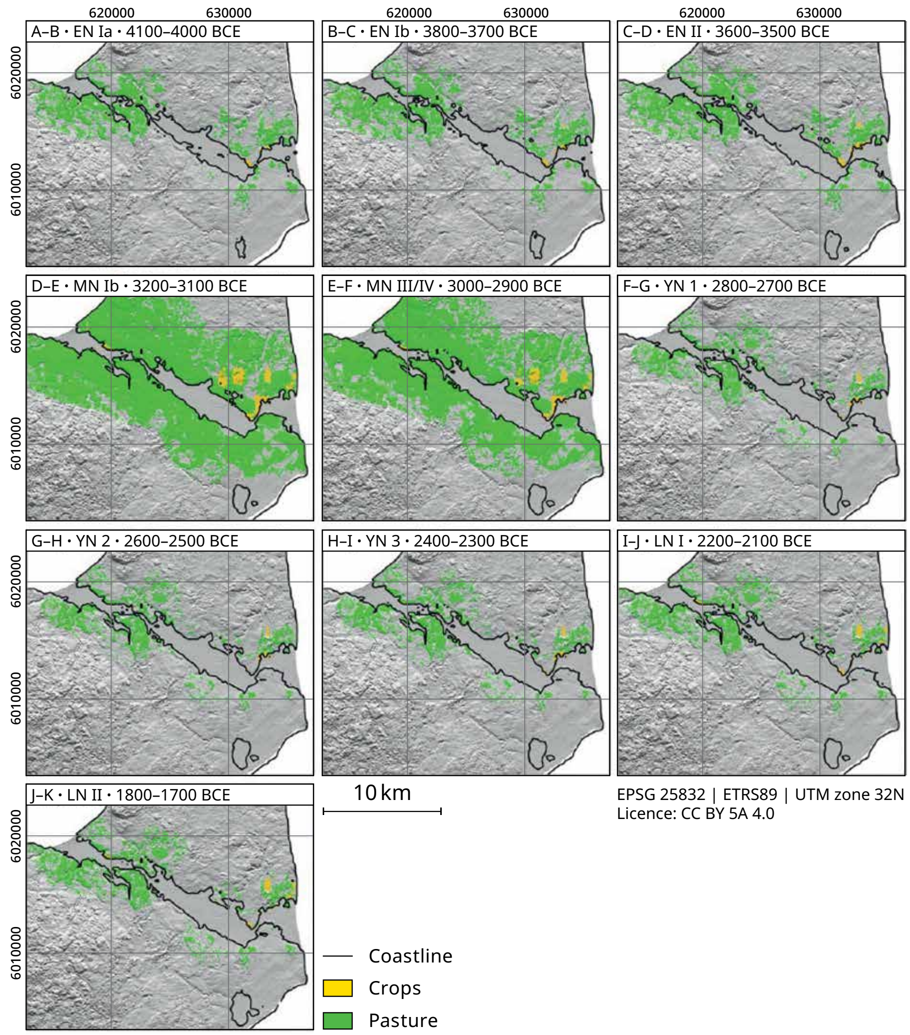


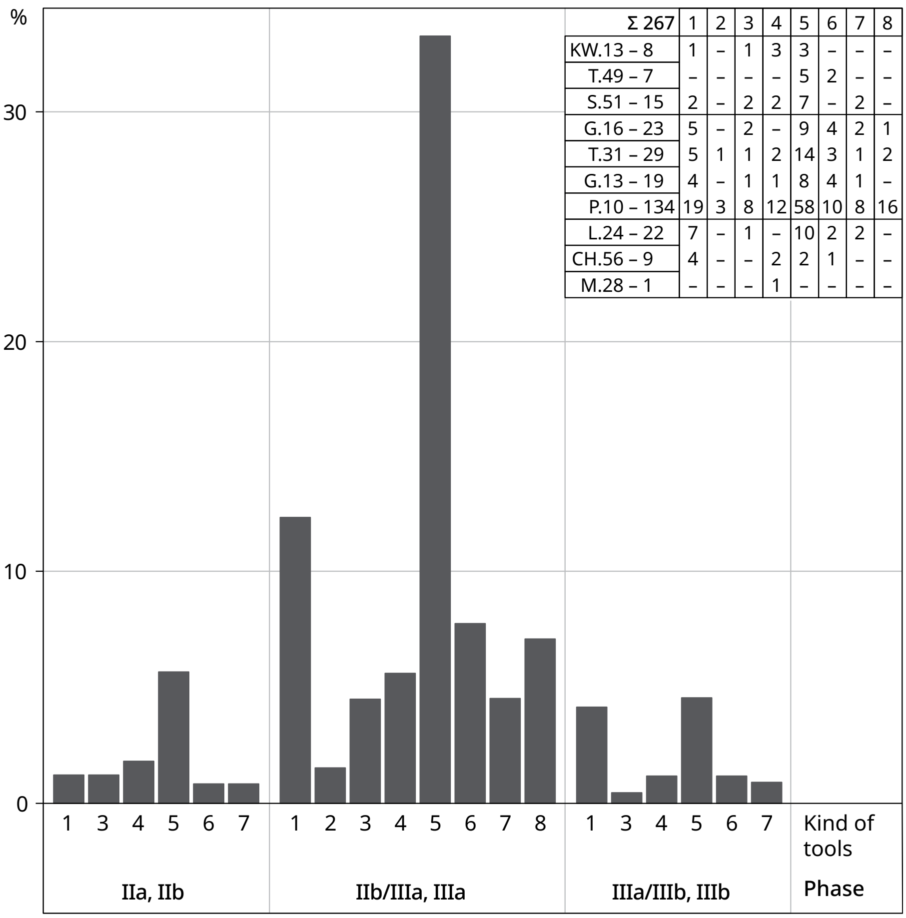
Figure 217. The period, in which GA ceramics appear in East Holstein in addition to TRB ceramics, is characterised by an increase of grazing areas, which were modelled according to palaeoecological and bioarchaeological data as well as settlement patterns. Especially at 3200-2900 BCE, an increase of pasture areas is significant (after Knitter et al. 2019, 10).

5.2.2 Bohemia/Moravia

Information about economic activities are available from the Moravian settlement of Bystročice:

> [transl.: *'In all of the settlement pits assigned to the GAC,* [there is] *relatively abundant domestic waste in the form of some very well preserved animal bones. The analysis of M. Nývltová-Fišáková shows the exclusive presence of domestic animal bones, whereby the domestic pig is dominant (also the highest number of individuals), followed by cattle, sheep/goat and bones of large (cow or horse) and small (sheep or goat size) mammals (Fig. 17). The animals died at sexual or skeletal maturity. The most common remains were those of animals bred for meat (pig), meat and milk (cattle) or meat, milk and wool (sheep/goat)'* (Peška 2013b, 220).

Furthermore, a number of macrofossils were recovered from samples of the settlement pits. Grains and threshing remains (glume bases) of known cereals, such as einkorn (*Triticum monoccocum*) and emmer (*T. diccocon*) predominated; barley (*Hordeum vulgare*) and – probably as a later intrusion – millet (*Panicum milliaceum)* also appeared. Barley was also identified as an imprint in the fat of feature 99 (cf. Fig. 239). It is assumed that oats (*Agena sp.*) found at this time was still wild and only formed a part of the crop (Bernadová 2009). This was accompanied by typical



Σ 267	1	2	3	4	5	6	7	8
KW.13 – 8	1	–	1	3	3	–	–	–
T.49 – 7	–	–	–	–	5	2	–	–
S.51 – 15	2	–	2	2	7	–	2	–
G.16 – 23	5	–	2	–	9	4	2	1
T.31 – 29	5	1	1	2	14	3	1	2
G.13 – 19	4	–	1	1	8	4	1	–
P.10 – 134	19	3	8	12	58	10	8	16
L.24 – 22	7	–	1	–	10	2	2	–
CH.56 – 9	4	–	–	2	2	1	–	–
M.28 – 1	–	–	–	1	–	–	–	–

Figure 218. The increase in the production of axes, querns and grinders around 3200 BCE (GAC IIb/IIIa) is interpreted as a greater demand for macrolithic tools for grubbing, wood working and "milling" (after Chachlikkowski 1991, 191, fig. 18).

weeds – field wild weed (*Agrostemma githago*) and two species of ruderalised sites – and merlin (*Chenopodium sp.*) as well as checkerboard flower (*Sambucus ebulus*).

The results of the malacological survey (Bernadová 2009), particularly with the species *Segmentina nitida*, indicate an open landscape with habitats of varying degrees of humidity, from dry areas to waterlogged steppes (with alders, stream or river banks and stagnant waters). The charcoal composition of the firewood is quite diverse (Fig. 19), with a clear dominance of oak (61.1%) and ash (29.3%), followed by maple, hazel, birch, beech, hornbeam, lime and apple tree with only a 1% share. The occurrence of willow/poplar and alder is very low (Novák 2009). The woodland spectrum shows a vegetation form of a species-rich mixed oak forest with numerous oaks and ash trees. It indicates a relatively small impact of human activities on the surrounding habitats, unlike, *e.g.*, during the earlier Bronze Age (Věteř-Gruppe) (cf. Novák 2009; Peška 2013b, 221).

5.3 Economic data from Kuyavia and Lesser Poland

In the reconstruction of the subsistence mode, the conditions are in principle better, especially on the East Central European lowlands than in Central Germany, *e.g.*, since the dominant part of the GAC sites are settlements. In the source inventory, it is nevertheless conspicuous that, *e.g.*, animal analyses are available from numerous sites, but botanical macroremains analyses primarily refer to imprints from the cereal spectrum. This is by no means a result of the sampling strategy, *e.g.*, from rescue excavations, but is due to the low evidence of cereals in GAC contexts. Clear

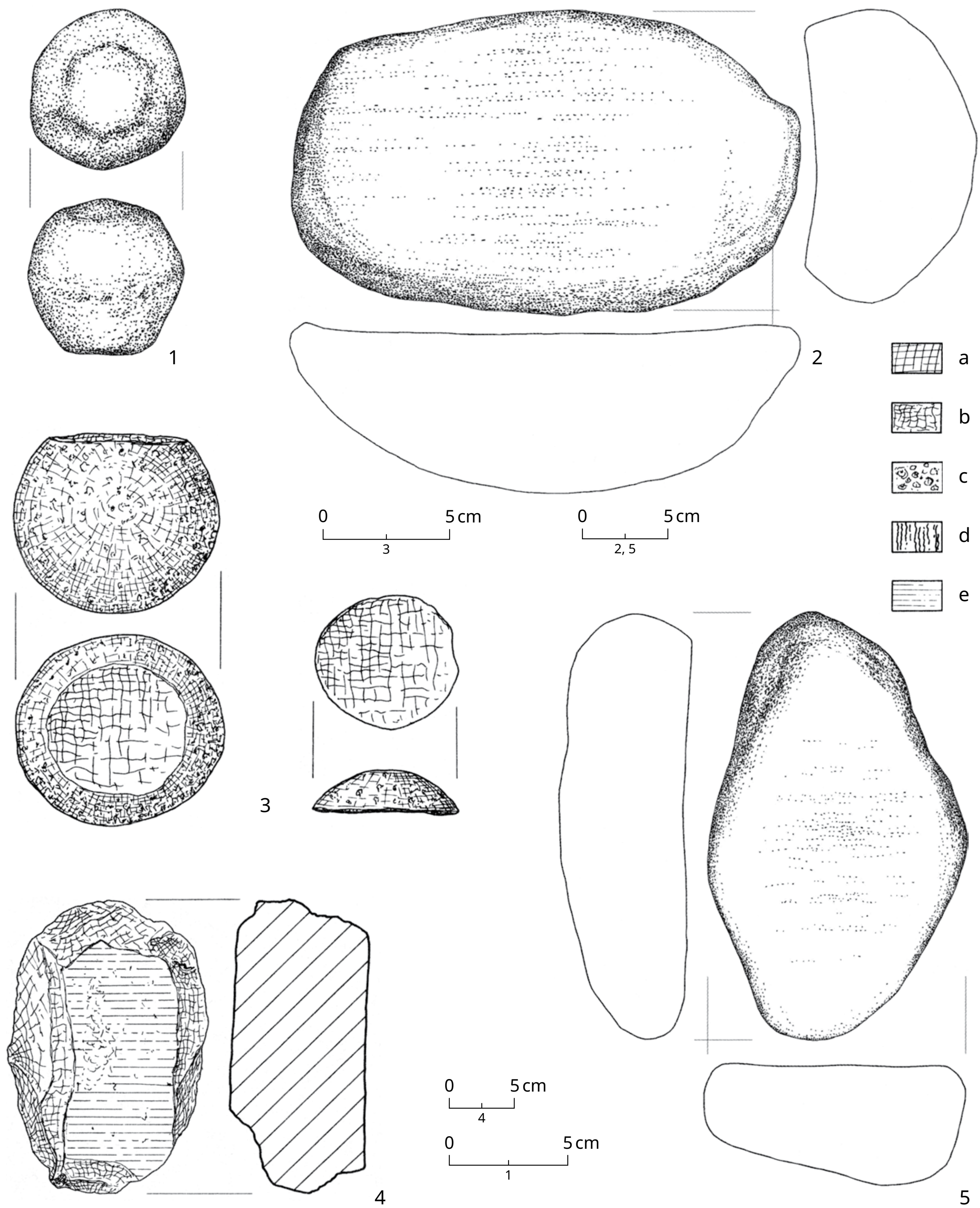


Figure 219. Querns and rubbers from different Kuyavian GAC sites. 1-2, 5 – Lekarzewice 6 (after Grygiel 2013, 170, fig. 7); 3 – Samrglin 51 (after Chachlikowski 1991, 177, fig, 1,5); Przybanowo 10 (after Chachlikowski 1991, 181, fig. 6,8).

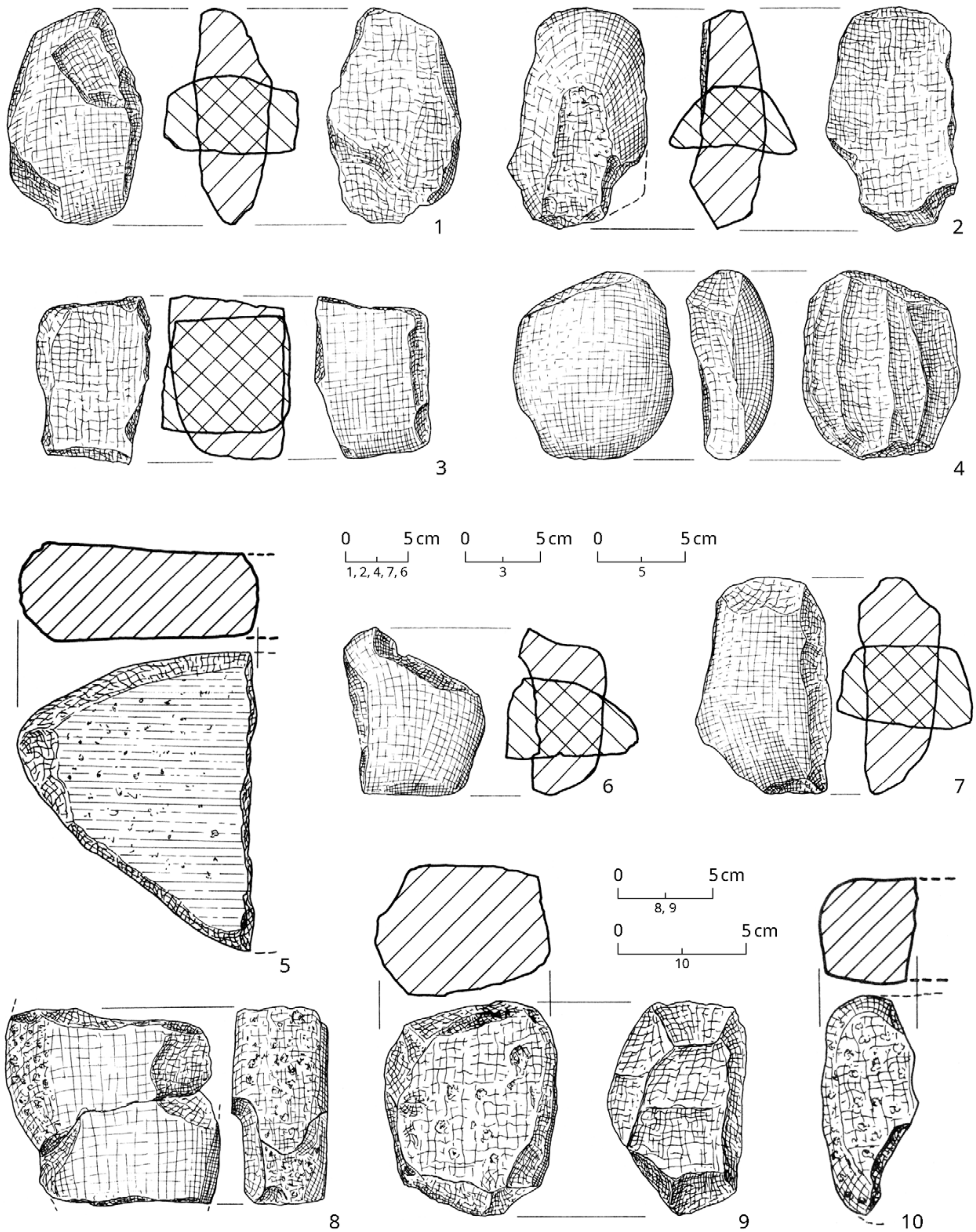


Figure 220. Querns and rubbers from different Kuyavian GAC sites. 1-7 – Przybanowo 10 (after Chachlikowski 1991, fig, 1, 1-5; fig. 3, 6-7); 8-9 – Goszczewo 16 (after Chachlikowski 1991, 181, fig. 3,9-10); 10 – Liskowice (after Chachlikowski 1991, 184, fig. 8,9).

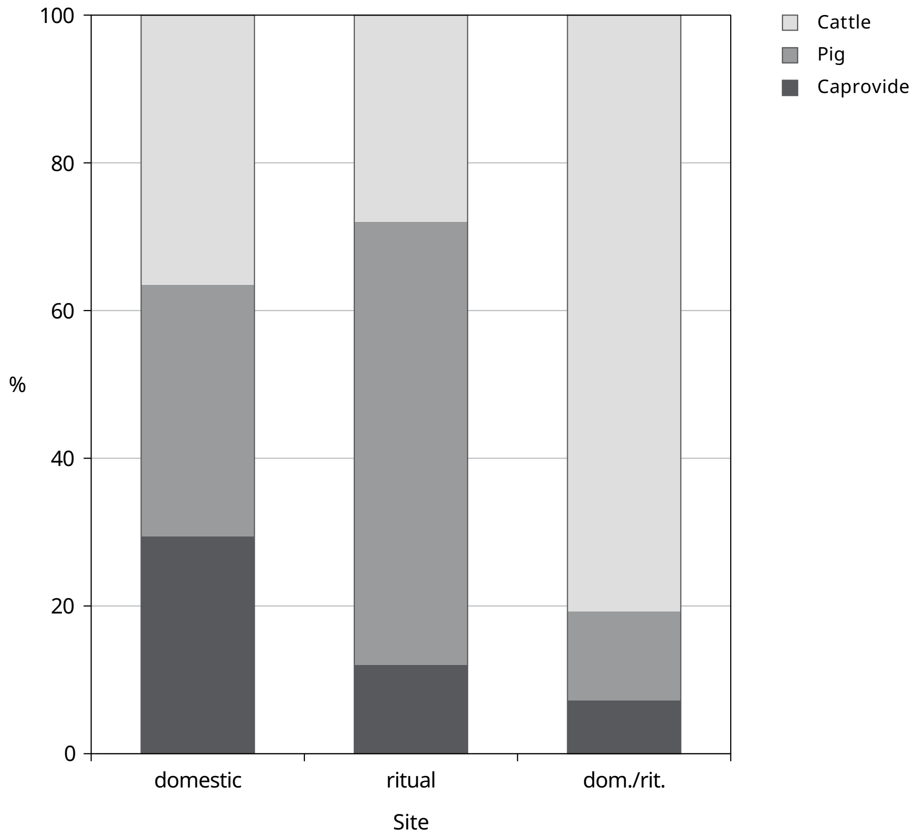


Figure 221. In GAC bone assemblages, a rather balanced relationship between cattle, pigs and ovicaprids is obvious in domestic sites, while in ritual contexts, pigs dominate over both cattle and caprovids (after Kosko and Szmyt 2004, 108, tab. 3).

evidence of cereals appears to only be available from the pit filling in Koszyce – a few caryopses of broomcorn millet *Panicum miliaceum* (relocation?) and wheat *Triticum* sp. are known (Litynska-Zajac 2013). The numerous imprints in the ceramics that have been investigated indicate various cereals: wheat, emmer and barley.

The increase in the production of axes, querns and grinders in the Kuyvian GAC IIb/IIIa, which became clear within a tool analysis of domestic sites, may be interpreted as 'a response to a greater demand for macrolithic tools useful in grubbing and wood working (axes and adzes), but especially also in "milling" implements (querns and grinders)' (Chachlikkowski 1991, 174). In principle, the distribution of functional categories within the CA development of Kuyavian GAC domestic sites underlines the importance of agrarian subsistence activities both in respect to clearances as well as to cereal processing (Fig. 218; Chachlikkowski 1991, 191). The Kuyavian site of Lekarzewice 6 might serve as a local example, as the normal small-sized GAC domestic group is indicated (see below). Here two querns and rubber stones (Fig. 219-220) were associated with the area of the site, which obviously denotes subsistence activities (Grygiel 2013, 170 fig. 7).

Although isotope analyses of macrobotanical remains are still lacking, conclusions about agricultural activities may be drawn from the isotope analyses of animals and humans. In Western Kuyavia, for example, there is growing evidence of manuring in a local TRB settlement, while there is no evidence for manuring in the isotope values of nearby GAC Kierzkowo (see below).

In contrast to the small amount of direct evidence on agricultural activities, we are well informed about animal husbandry. The animal bone analyses from the Kuyavian GAC show very different proportions of domestic animals. Thus, in the animal bone inventories, the proportion of cattle is mostly <50%, which represents a considerable difference to the Middle and Younger TRB phase with mostly more than 54% of cattle bones (Kosko and Szmyt 2004, 105-108 fig. 3; Tab. 1-3). While in the

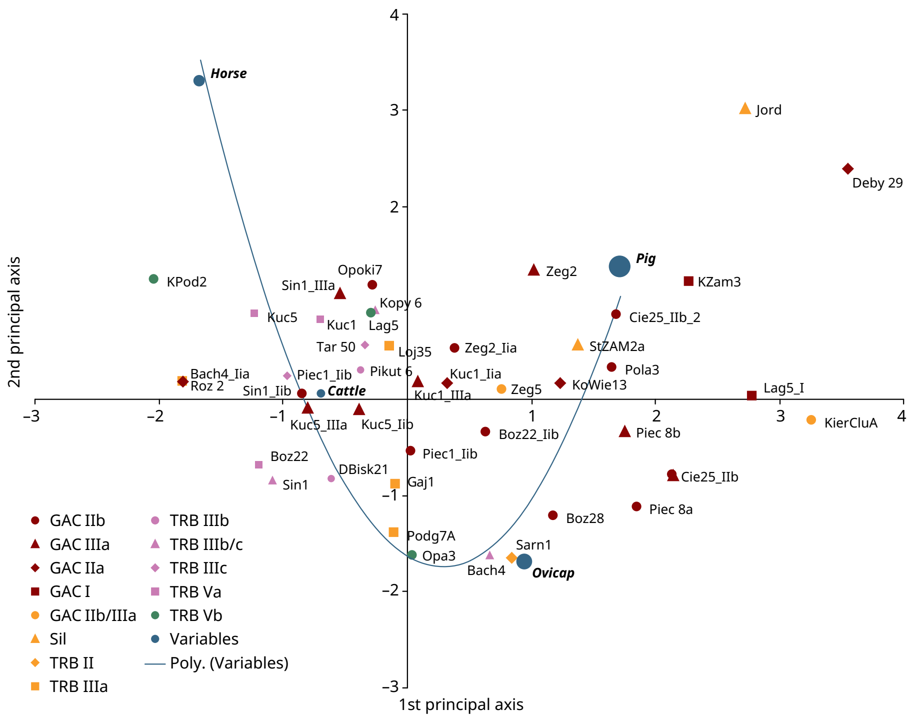


Figure 222. CA of the Kuyavian, but also Silesian bone inventories of TRB and GAC settlements illustrate differences. TRB inventories are determined by the dominance of cattle bones and also a significant role of horses. GAC inventories exhibit a mixture of cattle, pigs, and caprovids among domesticated animals (Suppl. 15).

non-classical GAC phases, the proportion of cattle bones is usually below 25% and is thus statistically relevant (even in inventories with more animal bones) and the pig proportion, in comparison, is especially high, we find in the classical GAC sites cattle bone proportions of up to 50% and a balanced ratio of pigs and caprovids at ca. 25%.

Correspondence analyses of the Kuyavian, but also Silesian bone inventories of TRB and GAC settlements illustrate the noted differences. While the TRB inventories are primarily determined by the dominance of cattle bones and also a significant role of horses, possibly also for food, the GAC inventories exhibit the described mixture of cattle, pigs, and caprovids among domesticated animals (Fig. 221; Suppl. 15). If primarily domestic and ritual consumption in the GAC are compared with each other, the rather balanced relationship between cattle, pigs and ovicaprids are obvious in the settlements, while in ritual contexts, pigs dominate over both cattle and caprovids (Fig. 222) (Kosko and Szmyt 2004, 108 tab. 3). We also observed an increase in the meaning of pigs in the ritual sector in Central Germany (Höltkemeier 2020, 212 fig. 127).

If we reduce the CA to the GA ceramic inventories from the Kuyavian and Silesian regions, differences between “cattle-oriented” inventories, on the one hand, and “caprovid/pig/cattle-oriented” inventories, on the other hand, result (Fig. 223; Suppl. 15) without a recognisable chronological or spatial differentiation. Therefore, pigs and ovicaprids play an important role, as made clear, among other things, in the correspondence analysis (Fig. 221; Suppl. 15) (cf. Woidich 2014, 103, diagr. 27; Kosko and Szmyt 2004, 108 tab. 2).

In the Kuyavian region, based on age distributions, cattle can be associated with meat and milk production, but also transport functions (Makowiecki and Makowiecki 2000, tab. 27). For other domestic animals, the data situation remains too small to enable more exact statements. The deposition of the bones generally occurred after exploitation. Particularly at Opatowice 3, the importance of meat consumption could be illustrated for both cattle and goats due to the age and sex distribution (Makowiecki 2014). The slaughtering of animals took place outside of the site at the water. The fish bones from Opatowice 3 indicate the local exploitation of water resources – due to the bone size, these are rather small waters and not large lakes, and it appears that this was a supplementary strategy, as they are young species from the spring.

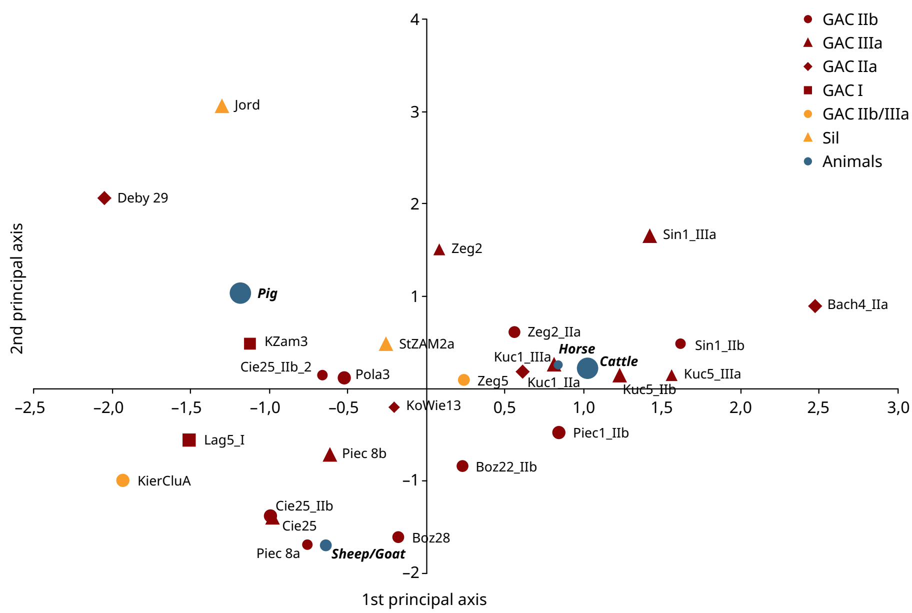


Figure 223. The CA of GAC inventories from the Kuyavia and Silesia inventories displays the differences between "cattle-oriented" and "caprovid/pig/cattle-oriented" inventories without a recognisable chronological or spatial differentiation (cf. Fig. 222; Suppl. 15).

In addition to the various animal depositions, the detailed analyses of the animal depositions at the chamber grave of Chodiez led to interesting results (Makowiecki and Makowiecki 2009). These are male pigs in the *juvenis subadultus* age, so that due to the presence of 'more or less the main parts of the pig body, it is interpreted as an intentional gift of living members to those, who are dead. One may suppose that flesh of the 6 pigs was eaten during the burial ceremony.' (*ibid.* 379). An assumed magical significance is associated with the significance of the deposited heads belonging only to male individuals. Daniel Makowiecki reconstructs funerals accompanied by pig slaughter, which are said to have occurred repeatedly in the summer months for the dead as part of ritual cycles. In contrast to these fixed ritual cycles, the age of death and the actual funeral are rather random.

As an example of the special role of animals in the ritual sphere, the megalithic grave at Kierzkowo can be mentioned, for which both osteological and isotope analyses are available. Due to missing evidence of skinning and cutting of the carcass or filleting in Kierzkowo, it is assumed that these were non-consumed animals offered to the dead (Lasota-Moskalewska and Osypinska 2017). Three spatial concentrations of animal bones were identified within the structure, two in the burial chamber, one in the megalithic tail-like structure. Of the 4077 animal remains, 2028 fragments were determined. The differences between the three depositions are significant. Cluster A to the left of the entrance (112 animal bones) included numerous animal species. Belonging to Cluster B in the northwestern part of the chamber (481 remains) are, above all, 6 cattle, including a castrated ox.

> '*The proportions of the metapodial bones of the female and castrated male indicate that during their lifetime they were used as draught animals*' (Lasota-Moskalewska and Osypinska 2017, 221).

In Cluster C, 1688 of the determined 3484 remains include mostly cattle (1642) – at least 12 animals – again including a castrated bull. While Cluster A, with at least 12 animals, contains both wild and domesticated animals and a bird, the other clusters are primarily occupied by bovids with a small number of caprovids. It is assumed that the caprovids rather represent an incidental admixture. The prevalence of skulls in Cluster B is significant.

In addition to osteological and macrobotanical investigations, further information on the diet but also animal husbandry can be taken from isotope analyses of human

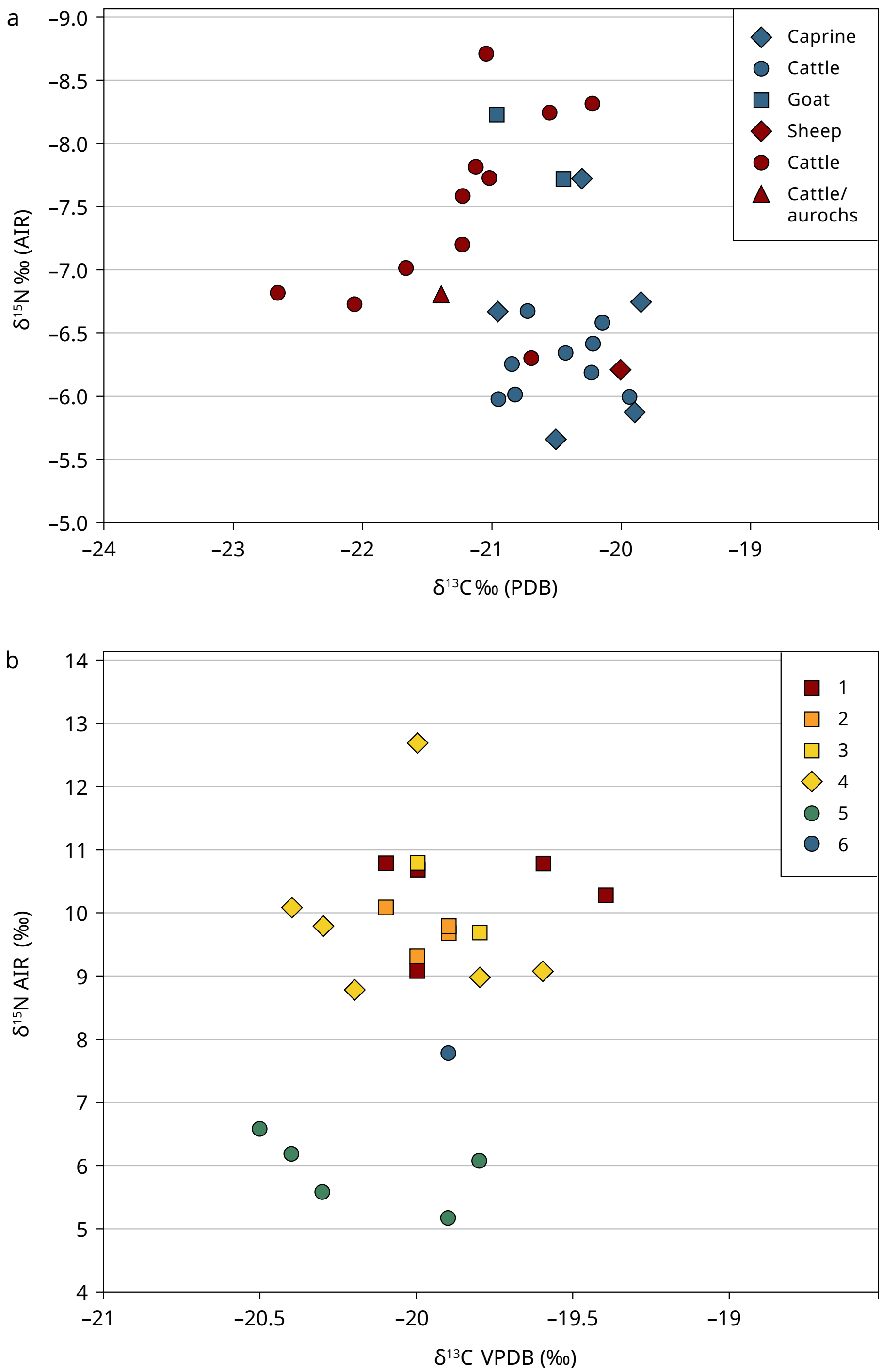


Figure 224. In contrast to LBK and TRB Kopdlow (a), where a group of domesticated animals with higher ^{15}N values is associated with manuring practices, in Kierzkowo (b) the values speak against a practice of field fertilisation (after Marciniak et al. 2017, 1472, fig. 7; Pospieszny 2017a, 296, fig. 1). The lower variance of the $^{13}C/^{15}N$ values of the GAC animals of Kierzkowo also probably points to a more targeted use of specific ecotopes. Key: a – Kopdlow: Blue symbols – LBK; Red symbols – TRB; b – Kierzkowo: 1 – male humans >20 years; 2 – female humans > 20 years; 3 – humans 14-19 years; 4 – humans < 14 years; 5 – cattle; 6 – fox.

and animal individuals, which can provide information, in particular, on the composition of the diet, on herd husbandry and cultivation practices. The GAC sites of Kierzkowo and Koszyce (Nowaczyk 2017) should be mentioned in this context.

In Kuyavian Kierzkowo, ^{13}C and ^{15}N analyses of eighteen human skeletons and six animals are available, moreover $^{87}Sr/^{86}Sr$ analyses of bioavailable strontium (from three archaeological sources – goat, pig, fox, and two from groundwater), from a molar of a bovine (fourteen enamel samples) and from two, four, and six teeth of human individuals (skeletons two, seven, and nineteen) (Pospieszny 2017b). The ^{13}C and ^{15}N values from the bone collagen of the cattle show only small variance (^{13}C: -20.5-19.8;

^{15}N: 5.2-6.6). The relatively high ^{13}C values are normally interpreted as evidence of animal grazing in areas of low vegetation, which would correspond to the pollen analytical results from Lake Biskupin nearby. There, a decrease of the proportion of elm and ash trees and an increase in the proportion of hazel are reported for the Late Neolithic (Niewiarowski *et al.* 1995). The values and low variability correspond to data, which is known from the LBK settlement Kopdlow, also located on the western border of Kuyavia (Marciniak *et al.* 2017). They differ from the values of the local TRB settlement of Kopdlow (TRB phase IIIb/IIIc, Wiorek phase, 3650-3350 BCE ^{14}C dates), which shows a much greater variability of dates associated with husbandry in significantly more diverse local ecotopes. Moreover, the animal bone values are divided into two groups. The group of domesticated animals with higher ^{15}N values is associated with manuring practices. This is not the case with the GAC isotope values of the animals from Kierzkowo and speaks against a practice of fertilisation (Fig. 224). Furthermore, the lower variance of the $^{13}C/^{15}N$ values of the GAC animals of Kierzkowo also probably points to a more targeted use of specific ecotopes – more comparable with the LBK values and less with the TRB practice. The higher ^{13}C values of the GAC and the LBK compared to the TRB values indicate that the LBK and the GAC herds were more likely kept on open country under drier conditions, while at least some of the TRB herds were also driven into more woody/wetter areas. The latter could also apply to the pigs from Koszyce, which, however, were probably also fed with grain or something similar (low ^{13}C values, in some cases relatively high ^{15}N values).

Evidence of mobility practices of animals and humans can be provided by strontium isotope values, provided that a baseline is reconstructed. In Kierzkowo, the $^{87}Sr/^{86}Sr$ variance in a cattle tooth shows a rather wide variance (0.7106-0.7113), on the one hand, what, however, hardly deviates from the locally assumed $^{87}Sr/^{86}Sr$ variance (0.711-0.7135). On the other hand, a seasonal change expressed in the range could also, however, indicate connections to a more calcareous region, *e.g.*, the nearest area of Western Pomerania (Pospieszny 2017a). (Fig. 225). Thus, although a seasonality is clearly visible, the baseline reconstruction is currently still too unsatisfactory to actually be able to make clear interpretations regarding the mobility of the cattle herds.

Therefore, we assume for Kierzkowo that cattle husbandry was rather local (low $^{15}N/^{13}C$ variability) and that the $^{87}Sr/^{86}Sr$ values hint to seasonality but do not necessarily provide evidence for the origin of the cattle or some cattle from another area further away (*e.g.* Westpomerania).

As far as human individuals are concerned, there are at least twenty-seven individuals from Kierzkowo, including eleven subadults (<14 years old), two adolescents (14-19 years old) and fourteen adults (>20 years old) (Budnik *et al.* 2017). Illness was only verified in two cases of infectious lesions of the mastoid process (mastoiditis), thus an overall interpretation of good health is assumed. The human individuals from Kierzkowo show – similar to the cattle – only a slight variability of the ^{13}C values (-20.4 – -19.4), while there is a relatively high variability of the ^{15}N values (8.8-12.7). This can be attributed to age and sex differences. The ^{15}N variability is attributed to differences in the accessibility of the “most valuable food, such as meat or dairy products” according to Lukasz Popieszny (Nowaczyk 2017; Pospieszny 2017b).

The lower ^{15}N values in comparison to Koszyce (see below) could possibly be attributed to other manuring practices or a lower proportion of meat-containing food. The higher ^{13}C values in comparison to Koszyce could also indicate an intake of products from more arid and deforested habitats (Pospieszny 2017b, 298 fig. 2). That this may possibly be a specific pattern of the Kuyavian GAC region could be verified by a $^{13}C/^{15}N$ value of the burial from Kowal 14, which corresponds to the values from Kierzkowo. The Kierzkowo strontium values of the tooth enamel from three humans indicate a change of location in childhood – also possible during adolescence – for the adult male individuals two and nineteen. However, this change may also have occurred in a local or small-regional setting.

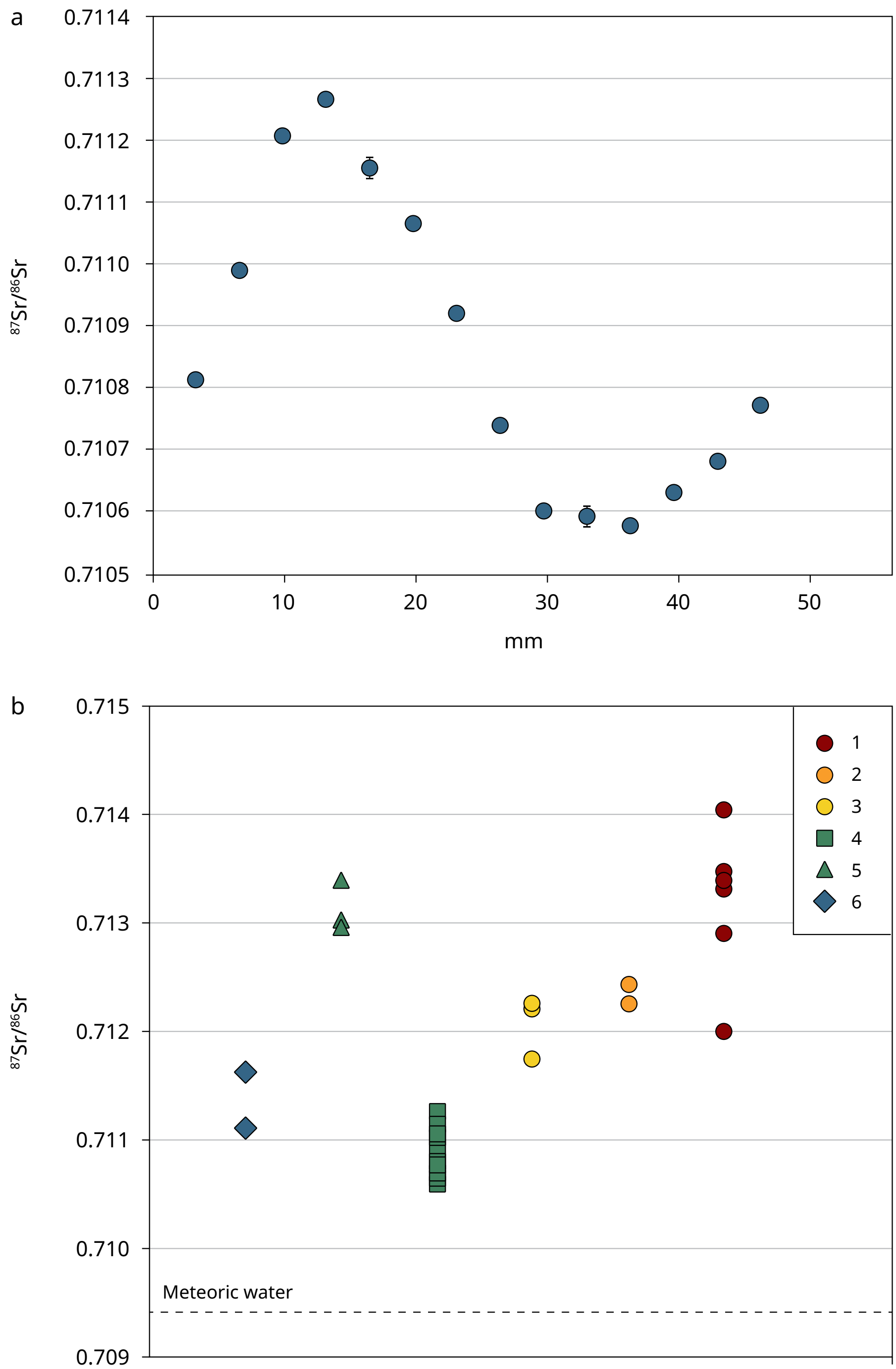
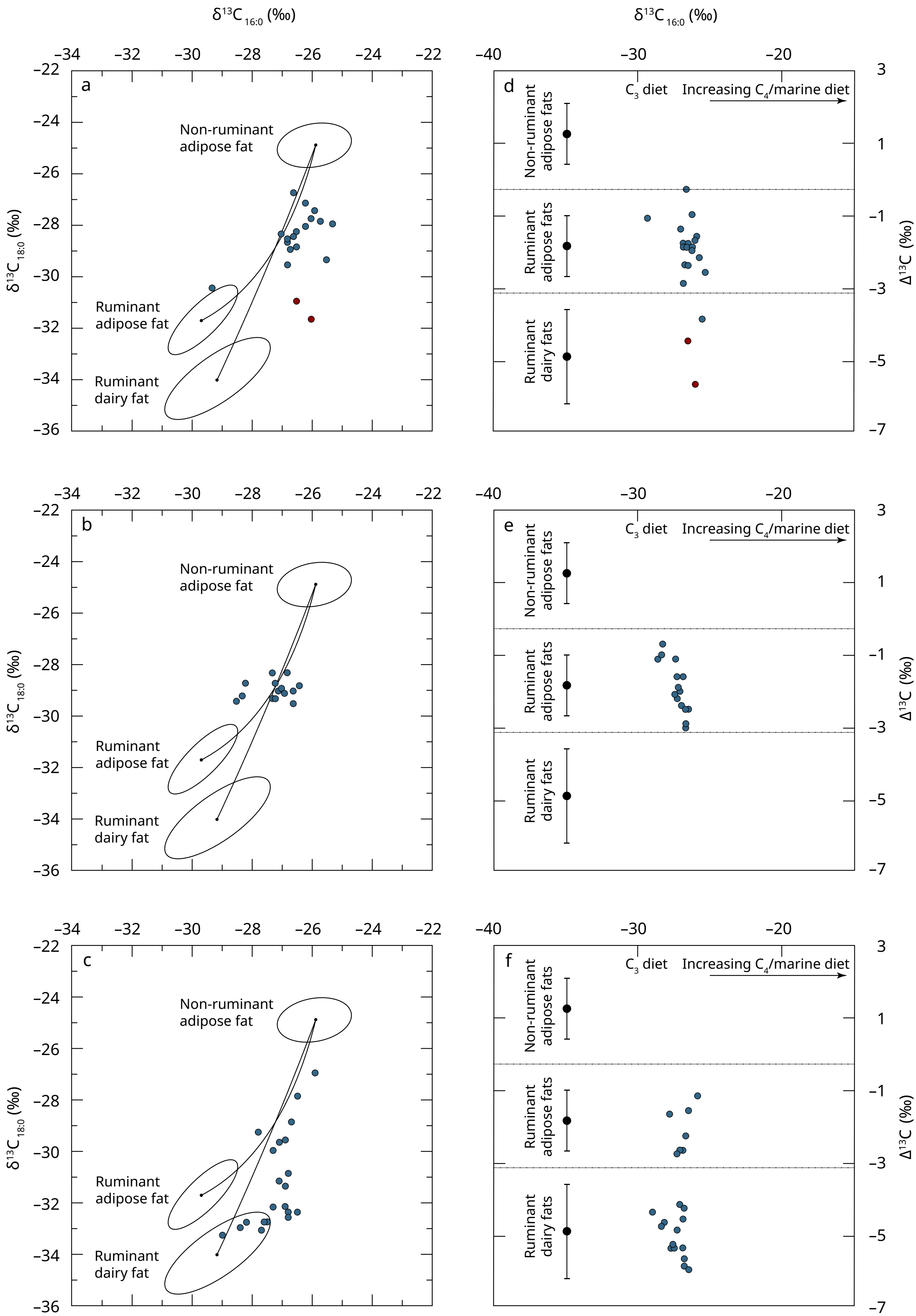


Figure 225. In Kierzkowo, the $^{87}Sr/^{86}Sr$ variance in a cattle tooth shows a rather wide variance (0.7106-0.7113). (a) Although a seasonality is clearly visible, the baseline reconstruction is currently still too unsatisfactory to actually be able to make clear interpretations regarding the mobility of the cattle herds and humans (b). Key: 1 – human No. 19; 2 – human No. 17; 3 – human No. 2; 4 – cattle; 5 – archaeofauna; 6 – groundwater (after Pospieszny 2017a, 300, fig. 3; 302, fig. 4).

A further indication of the consumed products is provided by lipid analyses. Lipid analyses on fifteen ceramic sherds in Kierzkowo indicate dairy products for all examined vessel types (amphorae, bowls and vases), without a more precise differentiation being possible (Roffet-Salque *et al.* 2017).[72] Conspicuous is the absence of non-ruminant fats, which corresponds to the results from Wangels (Weber *et al.* 2020).

Evidence of dairy products for the GAC could also be provided for Opatowice, once for a vessel from the animal deposition 38 of the settlement Opatowice 1 and once

72 The lower proportion in amphorae could indicate that they were used in these vessels for sealing rather than for storage or cooking.


δ13C 16:0 (‰)
δ13C 18:0 (‰)
Δ13C (‰)
a
b
c
d
e
f
Non-ruminant adipose fat
Ruminant adipose fat
Ruminant dairy fat
Non-ruminant adipose fats
Ruminant adipose fats
Ruminant dairy fats
C3 diet
Increasing C4/marine diet

for pit 143 from Opatowice 36 (Szmyt 2015b, 380-381 fig. 11.4-11.5). Such evidence is missing for GA from the Wangels grave, while meat from ruminants and oils is associated with the GAC there. From Lithuania, too, there is evidence of dairy products only in one case, otherwise again of ruminants, but also aquatic products (see above). The image of the TRB from Opatowice with ruminant dairy fats (Szmyt 2015b) corresponds to the TRB interpretation from Wangels. In contrast, the associated Dannau settlement exhibits vegetable fats and milk products. In fact, an increase in milk yield can be observed in Kopydlowo (Fig. 226; Roffet-Salque and Evershed 2015).

In general, the lipid analyses indicate the importance of animal products from ruminants, on the one hand, and of the importance of milk products in the diet on the other.

A large number of isotope analyses are available from Koszyce 3. Both pig depositions and the humans were analysed. With the exception of three younger children, the rest of the individuals exhibit very uniform $^{13}C/^{15}N$ values with only minor variation, which speaks for a fairly uniform diet (^{13}C: -21.1 – -20.1; ^{15}N: 9.6-11.2). According to the underlying standards, these values fall within a range which also suggests the consumption of pigs. Thus, a diet can be assumed that primarily relied on meat and milk, added to plant foods (Eriksson and Howcroft 2013, 116). The $\delta^{13}C$ and $\delta^{15}N$ prove that the Koszyce individuals primarily "relied on a terrestrial diet" (Schroeder *et al*. 2019, suppl. 1, 7). It is difficult to determine how high the plant or animal content was (Stepanczak *et al.* 2013). Interestingly, use-wear analysis of the flint blades indicates that they were used for the processing of both plant and animal products (Pyzewicz 2013, 184). The axes show signs of use from wood processing.

The data for the three mentioned children indicates that complete breastfeeding took place until the sixth month. Assuming supplementary feeding, complete weaning probably occurred at two years for two children, for another child much earlier (Eriksson and Howcroft 2013, 117-118). In Kowal 14, ^{18}O examinations of the teeth of burial 238 were carried out (Stepanczak *et al*. 2014) for which a decrease of ^{18}O content can be attributed to weaning at the age of 4-5 years. The $^{18}O/^{16}O$ values from Koszyce indicate a local Southeastern Polish population (Stepanczak *et al.* 2013).

Due to the diverse geology, the baseline for $^{87}Sr/^{86}Sr$ can only be incompletely reconstructed, but certain evidence (Schroeder *et al*. 2019, suppl. 1, 9) is available based on the water values and also a neighbouring analysis (Szczepanek 2018). In contrast to the analysis on Corded Ware burials in Lesser Poland, no individuals could be identified in Koszyce that did not originate from the region. Of course, an origin is possible not only from the local area of Koszyce but also from the regional surroundings.

Such an interpretation is also valid for five individual burials from the nearby Chelm area (eastern Poland) in the Lublin Uplands. The $^{87}Sr/^{86}Sr$ values from their human dental enamel are considerably more varied (0.7095-0.7131, n=5) than the already variable environment, but

> '*the data may either signify geographical and geological uniformity vs. heterogeneity, or increased mobility outside the GAC core area*' (Gerling *et al.* 2022).

Similar results are available based on $^{87}Sr/^{86}Sr$ values from Nakonowo, Kuyavia, where seven skeletons from the collective burial were analysed (Gerling *et al.* 2022). Strontium values from the surrounding glacial till and silt would be expected to be around 0.7200. However, the values of freshwater samples from two rivers in the broader region – a tributary of the Vistula (0.7105-0.7110) and Notec (0.7090-0.7095, > 0.7120) are much more varied. In contrast, the $^{87}Sr/^{86}Sr$ values from the human dental enamel of the seven individuals show very limited variation (0.7125-0.7129, n=7). In addition, the ^{18}O values are not very variable (-4.2+-0,6, n=7). In consequence there is a high probability that all seven individuals were from the same environmental origin, living near to the Kuyavian burial place.

Figure 226 (left). From LBK (a/d) to TRB (b/e) and GAC (c/f), an increase in milk yield can be observed in Kopydlowo (after Roffet-Salque and Evershed 2015).

5.3.1 Flint raw material supply and tool use

Four sorts of siliceous rocks were identified in Koszyce: Swieciechow flint, associated with blade exploitation, banded flint, one rudimentary core of chocolate flint, and three flakes made of various kinds of Cracovian Jurassic flint. In addition to the different knapping techniques, with which adult male (individual no. 15) is associated, the refitted material suggests that the flint offerings are more or less restricted to this individual. Two methods of obtaining blades, including pressure technique, and the amazing quality of the elaboration of the semi-finished axe products "indicate that the man was a highly skilled flint-knapper" (Budziszewski and Gruzdz 2013, 178).

In contrast to Koszyce, where the use-analyses showed that the grave goods were objects that were previously used in daily life, an axe was identified in Kowal 14, grave 238, which bears no signs of daily use. Instead, the axe was probably polished for use as a burial object (Osipowicz *et al.* 2014b, 97). From feature 208, sickle inserts for harvesting could be identified according to use-wear analysis (*ibid.* 97-98, tab. 5). In Kierzkowo, the flint tools could also be identified as flint sickle inserts for grain harvesting and as tools for woodworking or fur processing (Winiarska-Kabacinska 2017). Again, these are objects that were used during the life of the deceased person.

5.3.2 Examples of local economies: Rocks, Janowice and Wilostowo

In Greater Poland and Kuyavia, diverse rock raw materials were used to produce tools – primarily quartzite sandstone, quartzite, gneiss and granite (Osipowicz *et al.* 2014b, 102). The corresponding rocks could be gathered locally.

Important economic data is available from the GAC settlement of Janiwice 2 (Szmyt 2016b). The settlement is located at the most northeastern edge of the Kuyavian Plateau. The settlement lies on a promontory bordered by two streams that flow together in the east. Three settlement concentrations are located about 80 m apart, whereby one well (M356) and two pit huts (M822, O85) in D3 should be mentioned (Szmyt 2016a, 208 fig. 5,5; 216 fig. 5,13; 220 fig. 5,17). The settlement remains from area one cover an area of 30-60 m, including a concentration of ceramics with a radius of ca. 10 m. There are seven cellar pits, twenty-one flat pits for economic purposes, two hearths and some postholes. On settlement area 2, there are seven cellar pits, two hearths, fifteen flat pits for economic purposes and some postholes. The dimension of the area is similar, except that the ceramic concentration is divided into four areas. From settlement area 3, we also note four cellar pits, seventeen flat pits for economic purposes, two hearths and a few postholes.

The GAC remains (Janowice phase D) basically include pits, a grave hut, hearths and a well. The three mentioned spatial concentrations of findings are identified with three "subphases" (D1-D3), which can be typologically assigned to the classic Globular Amphora phase (D1 older IIb, D2 younger IIb, D3 IIIb, also cf. the chronology chapter). For the subsistence economy, domesticated animals, above all cattle, and a low use of wild resources (mussels and *black grouse bones*) are verified (Kurzawska 2016; Makowiecki 2016).[73] Cereals and grasses are verified only by a few ceramic imprints (Koszalka 2016), including *Triticum dicoccum*. In the anthrocological analyses, mostly oaks could be detected (Stepnik 2016).[74] Local raw

73 53 animal bones could be identified: 36 domestic cattle (67%), 9 domestic pigs (16.9%), 2 dogs (3.8%), and one bone each of ovicaprids, horses, black grouse (1.9% each), and 3 deer (5.7%). Skulls and forelegs are dominant among the cattle bones (Makowiecki 2016).

74 122 determinations, including 103 *Quercus* sp., 4 *Ulmus* sp., and 15 *Pinus* sp. (Stepnik 2016, 366 Table 11).

material deposits were used (clay, wood (mostly oak), as well as Baltic erratic flints and erratic rocks). As foreign raw materials, chocolate flint and possibly basalt were used in very small amounts.

From the domestic site at Wilkostowo 23/24 in Eastern Kuyavia, there is an interpretation of a settlement (Rzepecki 2014), where a tent-like GAC settlement is said to be located next to a TRB settlement reconstructed as a circular hamlet (*ibid.* 568 fig. 20.14). An attempt was made to describe a process of separation from which a livestock component is to emerge. It is significant that the ceramic technology of the GAC corresponds to that of the TRB. However, the connections should be interpreted with caution, since it is not a question of the classic GAC, but GAC Kuyavian stage Ia without globular amphorae.

One of the most significant analyses of raw material supply and the lithic industry is available from the Kuyavian Goszczwesko 13 site (see above; Chachlikowski 1991). At the investigated site, the non-siliceous stone raw material was aquired by digging small pits, partly with sounding shafts. The extracted erratics were processed in a workshop within the area where the raw material was concentrated. Perhaps a nearby GA-domestic site was involved in regional distribution processes of the produced tools.

In an analysis of stone tool assemblages from Kuyavian domestic sites, Chachlikkowski could detect important patterns:

1. The basic method for making axes, as well as querns and grinders, was the “morphometric adaptation technique” (“directly” on the pebble), especially in the GAC phases IIb/IIIa.
2. Most of the erratics were processed outside the areas of their natural occurrence, within the settlements. Gneiss, granite, quartzite, quartzite sandstones, pegmatite and syenite were used.
3. While identified workshops in the non-classic GAC-phases are missing and the finds distribution points to processing within or near the houses, in the IIb/IIIa phases stone processing workshops and places set aside for tool production are indicated. After the classical phase non-speparated tool-production seems to dominate once again.

5.3.3 Summary

The GAC complexes of the eastern North Central European lowlands and the Polish low mountain range verify the use of cereals mainly based on cereal imprints on vessels, a few cereal finds and isotope values, which include plant food, and also by the regular production and use of querns. How intensive cereal cultivation was must remain open at present. In contrast to the TRB, indications of manuring are missing in the Kuyavian GAC.

In animal husbandry, communities with a stronger focus on cattle husbandry can be distinguished from those with also a high proportion of caprovids and domestic pigs. The latter dominate the picture. This represents a clear difference to the TRB, where mainly cattle dominate the spectrum. The use of animals for both meat production, but also for secondary milk products and for use as draught or pack animals is beyond question for cattle. Seasonality in cattle husbandry can be proved, whereby indications of high mobility are lacking to date, and corresponding herding practices seem to exist on a small regional basis. Differences may exist in certain herding practices. While primarily drier open land was used for herding on the North Central European lowlands, in the area of Lesser Poland, for example, pigs were probably also driven into the forests. Until now, isotope analyses point towards a local origin for both humans and animals, with a kind of seasonal mobility within a limited small region. In this respect, sedentary pastoralism was practiced.

5.4 Eastern Globular Amphorae

From the ecological very diverse region, almost no economic data is available. Thus, with the current state of research, it is not possible to interpret the data.

From one of the few remains of settlements from Peresopnitsa (Volhynia), there are at least 47 specific animal bones from a pit, most of which indicate hunting and fishing, but only a few also indicate caprovid husbandry (Shelomentsev-Terskiy 1996, 72 tab. 1). Local flint is used. From the Turinshchina ritual complex, context 1, there is a globular amphora that shows imprints of grain on the bottom – either barley or wheat, possibly millet (Shmidt and Szmyt 1996, 80-83 fig. 3.1; fig. 4).

From the Podolian burial site of Ilyatka, carbon (^{13}C) and nitrogen (^{15}N) values have been recorded for the seven burials (Szymt *et al.* 2021, tab. 2).

> *'The series is very compact and shows a basic agreement of isotope content in all individuals: intra-site δ13C range is 0.4‰, and intra-site δ15N range is 0.6‰. The content of both isotopes indicates a diet of chiefly animal-origin products with a share of C3 plants, with the food coming mainly from terrestrial eco-systems [cf. Gerling 2015, Fig. 6.16]. No significant differences were noticed between men and women. For the former, 274 δ13C ranges from -20.1‰ to -19.8‰, while δ15N – from 9.2‰ to 9.8‰. For the latter, the respective ranges are -20.2‰ to 19.9‰ and 9.3‰ to 9.5‰. This small variability can be explained by a similar diet of all examined individuals. Perhaps only the narrower variability range of δ15N in women suggests a very close similarity of their diet and slightly greater differences in the case of males'* (Szmyt *et al.* 2021, 273-274).

From Lithuania and the Southeastern Baltic region, mainly lipid analyses indicate the use of vessels and thus subsistence agriculture and the processing of subsistence products (Robson *et al.* 2019). In the examined series, which extends from sub-Neolithic to Neolithic groups and to the Early Bronze Age, the use of aquatic resources has proven to be important in many cases, regardless of affiliation to any one of the periods. A general change in the use of vessels is not observable, even if a clear shift in the general isotope values of human individuals seems to contradict this.

Food crust remains of Globular Amphora-influenced ceramics in Lithuania were analysed for their organic content from Šventoji 2, Šventoji 4, Šventoji 6, Daktariškė 1, Daktariškė 5, Gribaša 4 and Karaviskes 6 (Robson *et al.* 2019). For the GAC vessels, indications of aquatic fish and ruminant fats (ruminant carcass fat) and dairy fats emerged (*ibid.* Fig. 6). Proof of dairy fats is apparently only first significant from Corded Ware. However, it is not limited to specific vessel forms, which was once postulated for other Corded Ware groups. Evidence of cereals is first available in the Baltic states in the Bronze Age, in fact there was no evidence in the analysis for the processing of domesticated cereals.

Altogether, for the eastern regions of the GAC in the southern loess plateaus, in addition to the verified livestock husbandry in the graves, both continued foraging subsistence strategies and the use of cereals are indicated. In the Baltic regions, animal husbandry with the use of dairy products can be demonstrated while maintaining the exploitation of aquatic resources.

5.5 Economic catchment areas? Ceramic transport as a proxy

In addition to the economic data presented, with different approaches statements can certainly be made about the size of the economic catchment area. One way to evaluate this is to determine the origin of the ceramics produced, including their

Method	Result		
Typology	Typological - stylistic determination		
1. Quantitative grain size analysis in thin section and chemical analysis 2. Qualitative thin section analysis and chemical analysis	1. Quantity of the clay matrix 2. Quality of the temper components	- Sites of raw materials and locations of workshops - Temper techniques	a) "Raw material group" b) "Production regions" c) "Technical group"
Macroscopic and cross-sectional ceramic analysis	Further outer differentiation and agreement in clay sorts and temper components	Reflected light microscopic determination of temper technique in sherd cross-section	

Table 7. The potential of ceramic-technological analyses in combination with typological-stylistic analyses (Lehmann 2000, 39, tab. 1).

raw material supply. We might record an economic catchment area that possibly extends beyond the actual subsistence area and thus also allows indications of the mobility of local individuals or even communities.

The potential of ceramic-technological analyses in combination with typological-stylistic analyses is shown in Tab. 7 (Lehmann 2000, 39, tab. 1). Ideally, information on the quantity of the clay matrix and the quality of the temper can be used to make statements about raw material groups, production regions and technical groups. This makes it possible to identify production conditions, production techniques and, above all, the origin of vessels. For the GAC, various ceramic technological studies are available, among others from the Central German region (Lehmann 1996; 2000), Kuyavia and neighbouring areas (Rauba-Bukowska 2014; 2016), and from northern Hesse (Talma *et al.* in print).

In an analysis of the Central German area, 114 Neolithic sherds were examined for ceramic technology, including 38 Bernburg ceramic units, 24 of the Globular Amphorae (Lehmann 2000, 42 Tab.2; Suppl.16). The following results should be interesting in our context:

1. Temper technique

> '*In general, the pottery of the globular amphora inventory group of almost all investigated sites in the Middle Elbe-Saale area was produced using a similar tempering technique. Although the vessel walls of their pottery are worked relatively thin (0.4-0.7 cm), they were relatively coarsely bedded in relation to this. The clay matrix contains predominantly little silt. This hiatus between the coarse tempering and the fine clay matrix is a characteristic feature of this pottery. Depending on the geological region of the sites, the qualities of the added coarse temper differ. In isolated samples the clay naturally contains some sand, and the temper with the coarse, angular rock fragments is not obvious at first sight.... The characteristic temper technique of the sampled Bernburg pottery differs from the pottery of the globular amphora pottery in general by its serial grain size distribution and often the admixture of chamotte'* (Lehmann 2000, 102).

2. Origin of the clay

In contrast to the differences in the tempering technique, the quantitative grain size analyses prove that there is clearly almost no difference between GA and contemporaneous groups, e.g. Bernburg, with regard to the origin of the potters' clays. This becomes clear in the inventories of the cist burial Baalberge-Schneiderberg, the cemetery Barby (even higher agreement between Bernburg and CA vessels than within the groups), the settlements Großobringen-Sportplatz and Oberwerschen, and from the walled chamber grave (*Mauerkammergrab*) Wandersleben. Other clay sources were obviously used for GA vessels at the Pevestorf and Tangermünde-

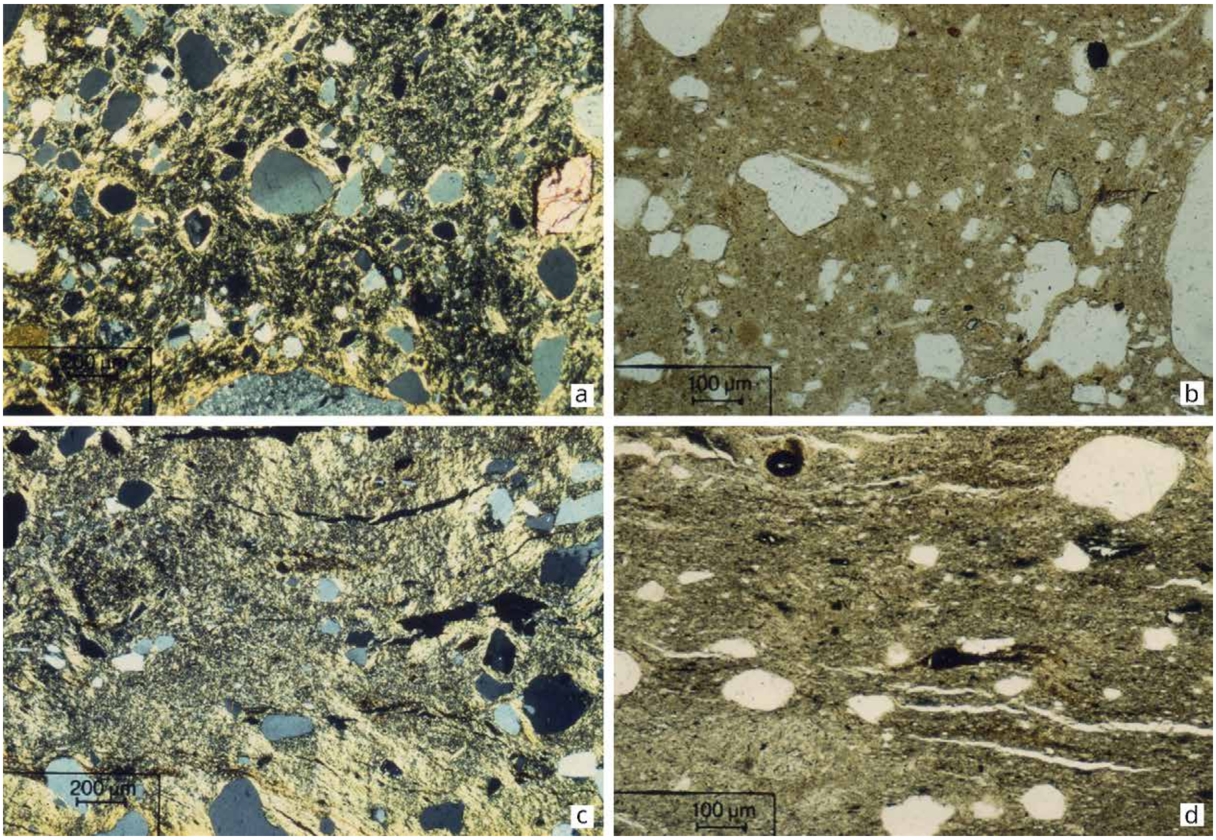


Figure 227. In the case of the magmatic materials, volcanic rock fragments, kaolinised orthoclase with quartz inclusions and metamorphic gneiss fragments are primarily used for GA ceramics of the West Group (after Lehmann 2020; Suppl. 16). Key: a – E907 Pevestorf 19; b – E907 Pevestorf 19; c – E894 Schinne 1; d – E894 Schinne.

Eßmannsche Ziegelei cemeteries. It should be noted that the variability of possible clay sources is quite high at all sites.

3. Temper material

In the case of the magmatic materials, volcanic rock fragments, kaolinised orthoclase with quartz inclusions, and metamorphic gneiss fragments are primarily used in the case of the globular amphorae (Fig. 227). In the study by Kerstin Lehmann, which covers different stylistic groups of the MES, different technique groups are defined. "Technique group 1" (including volcanic rock fragments, but no chamotte as a temper) contains exclusively GAC ceramics. The absence of chamotte in CA vessels fundamentally distinguishes them from the processing technique of Bernburg, and possibly also Salzmünder and Altmärkische Tiefstichkeramik (Lehmann 2000, 67). The volcanic rock fragments are often the volcanic trachyte ("Leuchtenburg rock") found in the Thuringian Forest. Vessels of Technique Group 1 are produced in a southern, Thuringian manufacturing region (region of origin "Großobringen"), 'which is characterised by its volcanic groundmass fragments of acidic effusives and trachyte' (Lehmann 2000, 104).

This makes it possible, for example, to evaluate the spatial dimension of the export of vessels for Technique Group 1.

> *'It is interesting that the connection of the settlement of Großobringen-Sportplatz to the settlement of Werschen-Oberwerschen could also be proven for the globular amphora pottery. This inventory group also made their pottery in the area around Großobringen and carried it with them to the settlement at Werschen-Oberwerschen. Another pot (E895, plate 2) was probably also produced in the Thuringian region around Großobringen and added to the cemetery of Barby as a burial vessel …*

> *The volcanic groundmass fragments of acid effusives, which are also present in combination with the trachyte groundmass fragments typical of Großobringen, are foreign to this region. Thus, the export of a vessel over about 50 km can be proven for the globular amphora inventory group'* (Lehmann 2000, 104).

Bernburg vessels, but also sporadic globular amphorae, were produced within the framework of Lehmann's Technique Group 4 (kaolinised othoclases with quartz inclusions) in the northern Harz region.

> '*Exports from Derenburg-Steinkuhlenberg 1 could be detected in the settlement of Tangermünde-Eßmannsche Ziegelei. The sherd samples E831 and E832 … agree well with the samples of the large Bernburg group of Derenburg samples in all analytical results and also in the serial, Bernburg grain size distribution. Archaeologically, however, they are assigned as globular amphora pottery*' (Lehmann 2000, 107).

Here, too, the spatial distance is about 50 km.

> '*That interrelations with the "Altmärkisch" area existed within the Globular Amphora Group is proven by sample E809 … from Werschen-Oberwerschen (Saale). According to the chemical analysis, it consists of a local clay, but still shows the typical technique of gneiss admixture from the "Altmärkische" area. This could indicate marriage relations, through which the old customary tradition of the gneiss-temper technique from the more northerly areas reached the south with them and was retained and applied there'* (Lehmann 2000, 106).

In another study, K. Lehmann subjected 26 GA sherds from the Saxon low mountain foothills to chemical-mineralogical analyses (Lehmann 1996). Different clays (with portions of kaolinitic clay minerals or illitic clay minerals and calcium-rich clays) could be identified. These are located close to the site in each case.

> '*In the temper materials, a coarse, reddish temper of potassic feldspars or alkali feldspars was often added. The coarse alkali feldspar temper was obtained by crushing either volcanic rocks from quartz porphyry outcrops or from outcropping monozonitic rocks. Both rock types are present in Saxony*' (Lehmann 1996, 226).

Since monozonitic rocks are known in Germany exclusively from the vicinity of Meissen, the corresponding temper certainly come from a monozonitic deposit of the Meissen Massif. This applies to 7 sites, of which Zauschwitz and Trachenau are located at a distance of about 40 km from the area of origin (cf. Lehmann 1996, 227). Consequently, Kerstin Lehmann assumes that the clays were extracted locally, but that the dominant reddish alkali feldspar deposit was transported over distances of up to 50 km, with an average transport distance of about 20 km.

Thus, on the one hand, a partially GA-specific technical group was identified, with a temper of exclusively volcanic rock fragments, whose places of production are in the Großobringen area. GA exports can be traced from here over approx. 50 km (Großobringen-Barby), with an average transport radius of approx. 20 km. GAs are also produced in other technology groups and correspond, for example, to the production of Bernburg vessels. Exports of the Technique Group 4 (temper: kaolinised orthoclase with quartz inclusions), whose place of production is located in the northern Harz region ("Derenburg"), show distances of up to approx. 170 km, including GA from the site Tangermünde-Eßmannsche Ziegelei at approx. 100 km, with an average transport radius of approx. 35 km. Distances of about 40 km have also been proven for GA ceramics with a temper containing volcanic rocks from monzonitic rocks, whose origin lies in the Meissen mountain massif (Tab. 8).

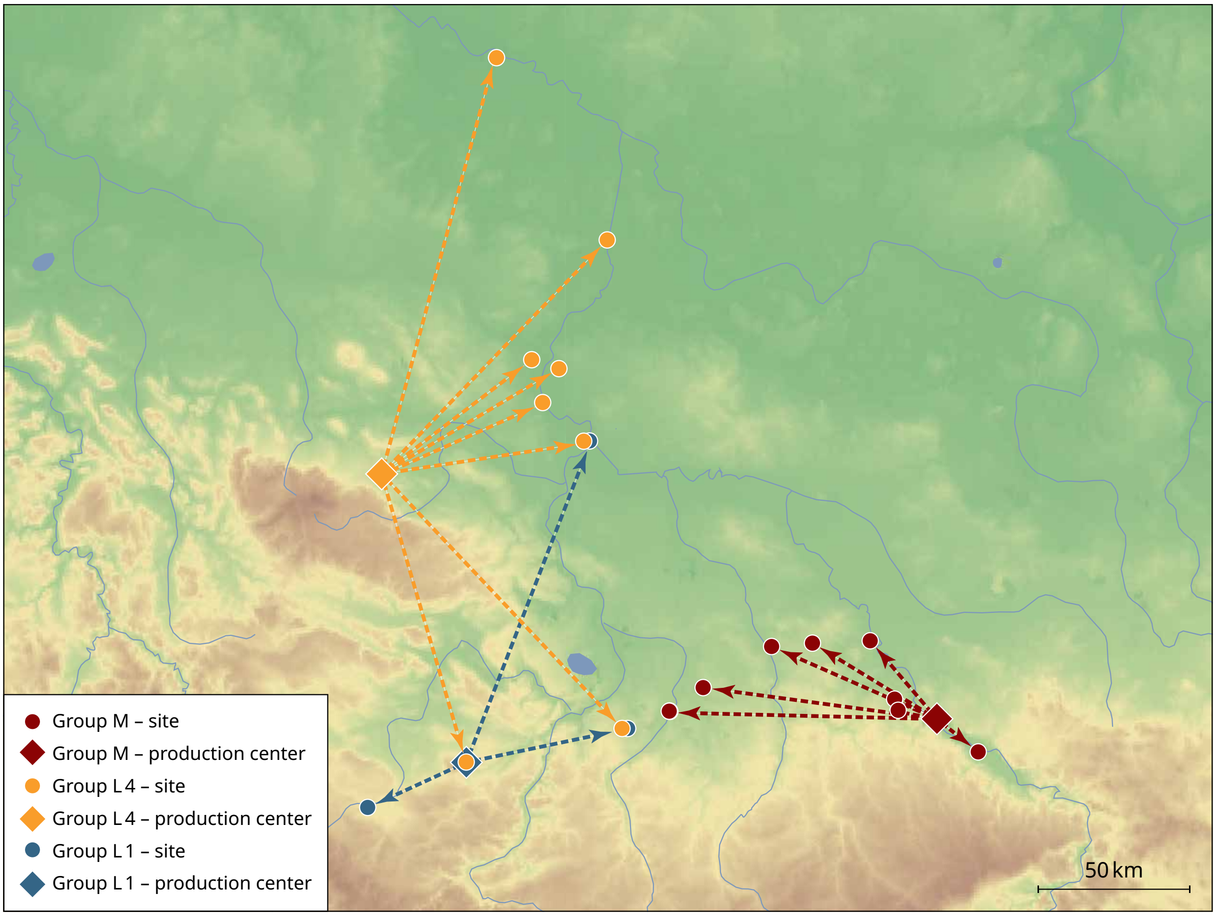


Figure 228. Both local production and exchange of GA ceramics took place within a radius of at most 50 km. This is exemplified by the distribution pattern of the production groups L1, L4 and M (after Lehmann 2000, 105, fig. 33; Suppl. 16).

Table 8. Distances of ceramics from sites of their raw material sources.

Technical group	n sites	Mean value (km)	Standard deviation (km)	Largest distance (km)	Largest distance GA (km)
1+4	13	30.4	19.3	170	100
1	4	22.2	20.7	100	100
4	9	34.0	18.7	170	100
Meissen	13	20.3	5.5	42	42

In addition to this evidence of GA transport within a radius of up to 50 km, there are numerous indications of the local production of globular amphorae. In particular, a study on the ceramic technology of the Wartberg group could prove the use of local clays and tempering materials in ceramic production. This also applies to the GA, e.g. from Wartberg or Güntersberg (Talma *et al.* in print). The use of grog in the North Hessian GAs, which is untypical in other regions and is also practised in the regional Wartberg, also proves the local production framework.

In the ceramic technological analyses from Kuyavia, all investigations so far also point to the use of locally accessible clays and temper materials. For example, in the ceramics from the Janowice site, the use of local glacial soil substrates, and accessible sands plus gravels, as clays and tempering for the ceramic production of both GAC and TRB vessels could be demonstrated.

> '*The main constituents of the clays used to make the vessels are quartz, feldspar, crumbs of igneous rock (granite), mica (muscovite, biotite), small amphiboles (mainly hornblende), pyroxenes, carbonates, opaque minerals, flints and glauconite. Based on the content of crumb constituents, we can distinguish between fatty and temper clays. Fat clays are characterised by a low content of dust grains and the absence of mica. Temper clays contain larger amounts of dust grains and are mineral diverse*.' (Rauba-Bukowska 2016).

It is striking that all four of the TRB sherds analysed are embedded with grog, whereas no grog was used in the eight GAC sherds, but rather igneous rocks (Rauba-Bukowska 2016). Additionally, in Opatowice 3 the main difference between GAC and TRB is the addition of grog to most TRB sherds (Rauba-Bukowska 2014).

As a result, we can thus assume both local production and exchange of GA within a radius of 50 km at most (Fig. 228). Different production techniques for different GAC phases were not demonstrated. On the other hand, there were often differences to other, simultaneous ceramics, e.g. in the use of fireclay in the tempering process.

As far as GAC mobility is concerned, there is currently no need – except regarding Bohemia and Western Ukraine – to explain mobility with the demic diffusion model, for example. On the contrary: in large areas of Central Europe, it is a matter of individuals, nuclear families or extended families living within their economically determined catchment areas without needing supraregional mobility. Based on the isotopic analyses, for example of Zauschwitz or Koszyce, and the presented chemical-physical ceramic analyses, we can currently assume that these catchment areas generally only included distances of up to 50 km.

At a small regional scale, the area outlined by the aDNA similarities is thus reduced to numerous areas that naturally interact with each other: with regards to the exchange of animals and goods, but also ritual practices.

5.6 Overall interpretation

There is no uniform GAC economy. The economic data that is available indicates local to small-regional herding of cattle and an increased proportion of caprovids and pigs in the livestock spectrum in contrast to previous and contemporaneous farming groups. There is sporadic evidence of grain cultivation and evidence of grain processing, but this is unlikely to have occurred on a large-scale. Meat production and consumption played a large role, along with milk production. In the eastern regions, but also in various other areas, the appropriative economic practices play a role insofar as this was also practiced beforehand. In addition to supra-regional raw material networks (flint) and local raw material exploitation, the identified mobility patterns only refer to local and small-regional mobility of humans and animals. The spatial distribution patterns point to a kind of sedentary pastoralism within an area of about 50 km diameter.

6. Discernible domestic activities: Settlement patterns and population densities

While burials are known from all main distribution regions of the GAC, it is difficult to identify settlements or camps. Accordingly, in the following, evidence from the individual regions will first be compiled, in order to possibly arrive at a model of settlement behaviour (Fig. 229; Suppl. 17).

6.1 Western GAC

In the area of the Western GAC, we know of different indications of settlement remains of the GAC. As often variously described, these are frequently "cultural layers", which cannot be differentiated in more detail, or pits and postholes. In addition, there are also small huts or houses and sunken floors, which are often denoted as "pit huts" in Central Europe.

6.1.1 Central Germany and Northwest Germany

From Central Germany, there are at first various sites, where only individual pits or pit huts with GA ceramics are documented, partly also in larger excavated areas.

Waste pits: Isolated pits with GA ceramics were uncovered at different sites in the MES regions: Paltzschen (Meißen district) (six pits under 9.5 × 7.7 m, large discolorations, four of them from the GAC), Kleinzerbst (a pit hut near to three graves), further pits are known from Altenburg, Eichholz (Zerbst district), Güntersdorf (Merseburg district), Kroptewitz (Döbeln district), Tangermünde (isolated pit 1 m in diameter), Günthersdorf (pit with an additional depression 3.5 m in diameter), Strehla (Riesa district) (round pit with vertical walls), moreover, numerous round tub-shaped pits from Roßlau, Wimmelburg (Boerde district).

Residential pits (Beier 1988, 45-47): Kleinzerbst (rectangular pit 4 × 1.9 × 0.85 m in size), Altenburg (rectangular pit 8 × 4.9 × 1.5 in size), Schieplitz (Naumburg district) (rectangular pit with a preserved length of 8 m); Oberwerschen (Hohenmölsen district) (rectangular pit 3.50 m long, preserved with a width of 2.50 m with Bernburg and GA ceramics, side walls with dark strips interpreted as traces of beam layers (sill beam construction)).

Zauschwitz: Three linear arranged pits and cattle and human burials form a settlement site (Fig. 230; Bergemann 2018, 313-316) (ca. 100 m × 20 m, 200 m^2), from

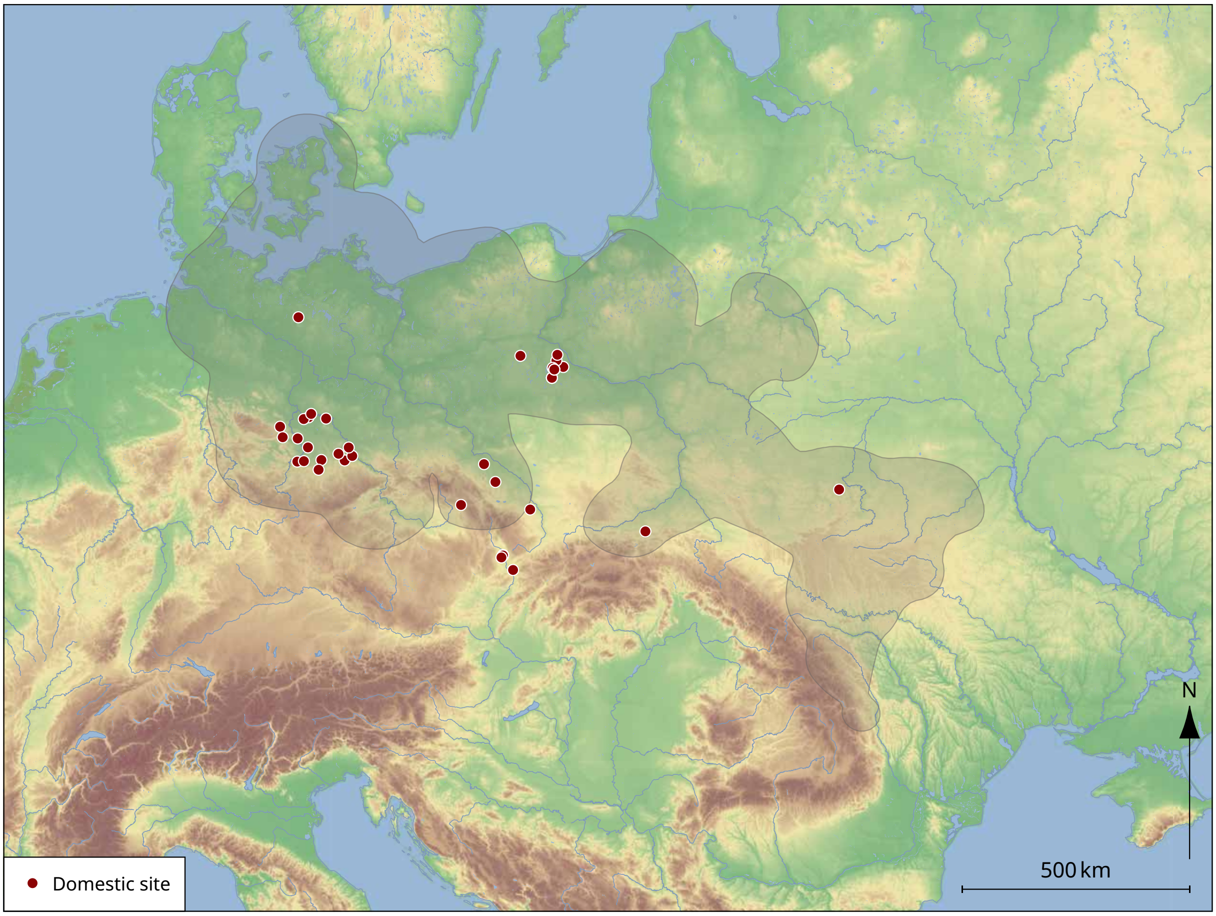


Figure 229. Distribution of GAC domestic sites with settlement structures (Suppl. 17).

which, inter alia, quern fragments are mentioned (Beier 1988, 143). Noteworthy is that 30,000 m^2 were excavated here and, accordingly, the few features actually represent the only evidence of a small settlement.

Rositz-Schulgarten (Beier 1988, 143; Weber 1964, 126-139): A rectangular pit (8.0 × 4.9 × 1.5 m) revealed, i.a., red clay with log impressions.

Barleben-Nord (Dittrich 2004; 2009): From the enclosed Bernburg settlement Barleben-Schweinemästerei, there are two pit inventories with GA ceramics. Kiertizsch KIE-16 (Kretschmer and Viol 2020, 27-28): Near a natural depression 3 pits could be associated directly with GA and a further five are probably associated with GA. Within ca. 100 m distance in the depression, in a multi-layered pit, two GA pots were found. Obviously, we are dealing with a pit cluster of about 50 m diameter and an extra feature (Kretschmer and Viol 2020, 27-28, 22 fig. 2).

Another category of sites that can be identified, is those where multiple features with pits, pit huts and postholes occur over an area of approximately 0.1-0.25 hectares. Included are larger settlements on the edges of terraces or on dunes and sand islands with post buildings (*e.g.* Dessau-Kleinkühnau), as are also documented elsewhere by surface finds in Gerwisch or in Rietzmeck (Beier 1988, 45).

Dessau-Kleinkühnau (Beier 1988, 45, 118-121 pl. 47; 48, 1-7; 85; Fig. 231): Settlement site with 300 postholes, 23 settlement pits (1933, 2500 m^2 exposed, settlement area 1200 m^2). The site is divided into a small eastern and a larger western area separated by a 5 m wide strip. It is difficult to associate the postholes to hut or house

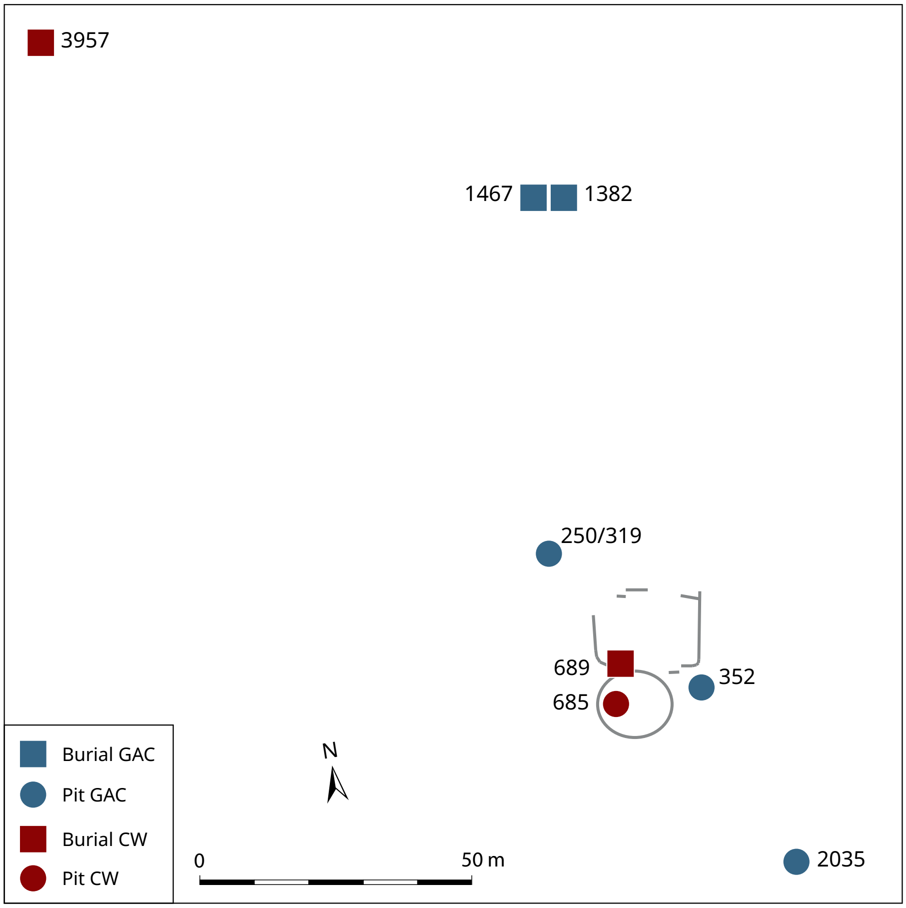


Figure 230. Zauschwitz, Sachsen. Three linear arranged pits and cattle and human burials form a domestic site (after Bergemann 2018, 313-316, fig. 180).

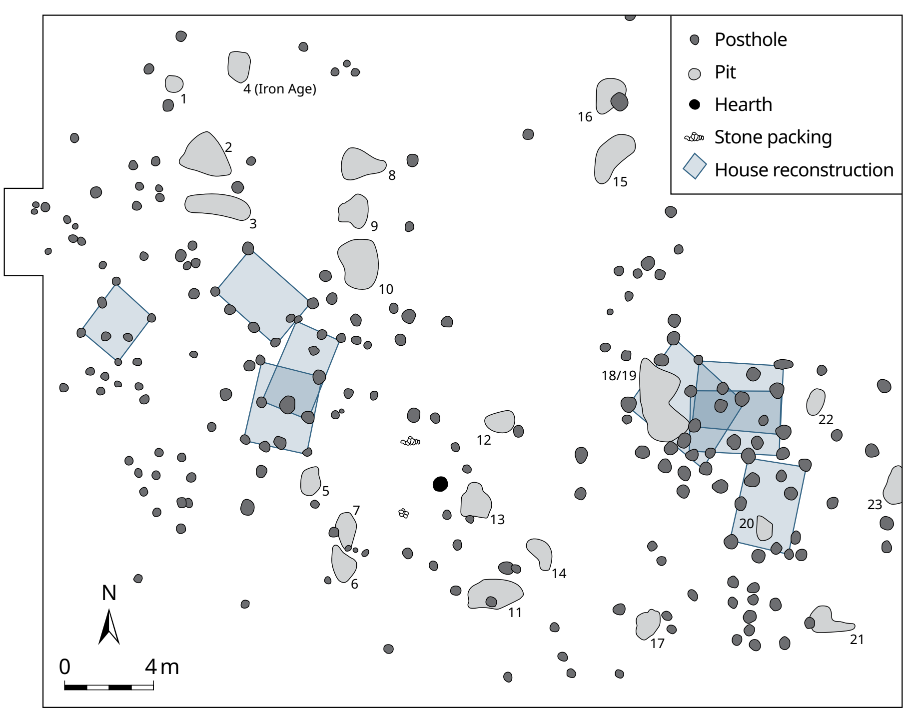


Figure 231. Dessau-Kleinkühnau. 300 postholes and 23 pits of an old excavation area associated with GA (after Beier 1988, 45, 118-121; pl. 47; 48, 1-7; 85).

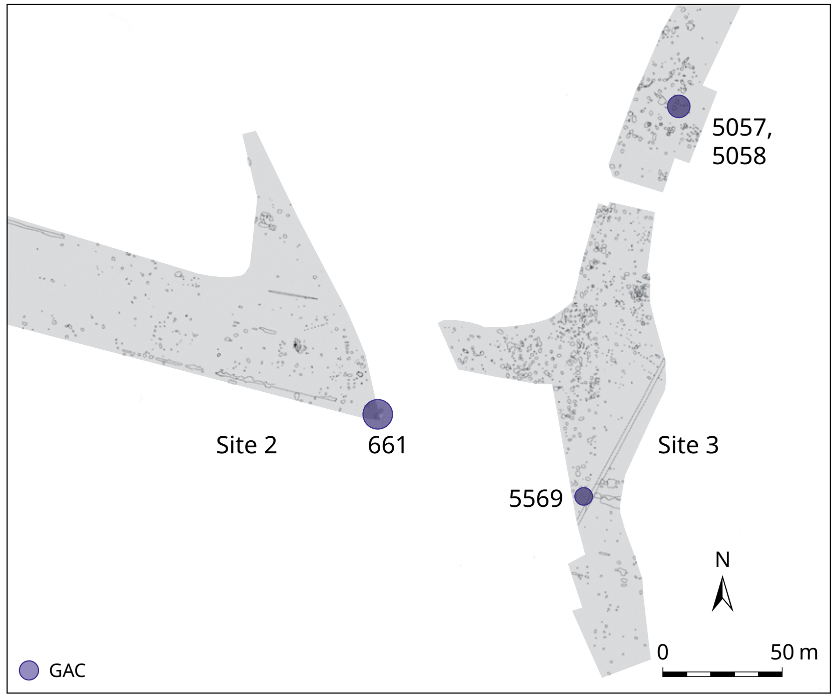


Figure 232. Eutzsch, Sachsen-Anhalt. In the central area of a valley-edge island in clayey-loamy river alluvium, two GA pits and two possible water extraction points (5057, 5058) were documented (after Fahr 2018, 47, fig. 4).

ground plans, different models are conceivable. On the one hand, smaller (storage?) buildings, measuring 2-3 m × 4 m, might have existed or, on the other hand, larger post buildings measuring 6 m × 10 m (?). A round construction (7 m in diameter) with a hearth is located in the central area of the settlement.[75]

Aken (Beier 1988, 45 pl. 86): The post traces of a Middle Neolithic settlement that was detected a few km to the south present a few sherds with different styles (Walterniernburg, GAC), so that a direct assignment of individual pit and post features to the GAC is difficult.

Eutzsch (Fahr 2018): In the central area of a valley-edge island in clayey-loamy river alluvium, two pits and two possible water extraction points were documented from an area measuring 150 × 200 m (3000 m^2), although due to destruction caused by other phases in the area, originally more findings are certainly to be expected (Fig. 232).

Gärtitz (Conrad *et al.* 2009): In the context of a rescue excavation, 2500 m^2 were excavated on a loess ridge running in NW-SE direction. On an area of ca. 50 × 50 m (2500 m^2), this revealed eight pits, three huts and one house which are assigned to the GAC (Conrad *et al.* 2009, 25 fig. 1). The two-aisled post construction (6 × 4.5 m) has four bays, whereby the dating is secured by a globular amphora from a posthole. Moreover, three other small buildings with six posts are known (2 × 3 m), which are interpreted as adjacent buildings. Other postholes in the area also prove further areas

75 Find classifications are made by Beier in detail: East area of the settlement: Pits 15-23 are without datable finds, but dating is made with 60 finds that are distributed over the area with a concentration of flint artefacts in the northwest corner (pl. 47, 11-21). The middle area exhibits some postholes and pit 12, moreover a 20 m^2 area with sherd concentrations (pl. 47, 22.24-33.35.39-44). A circular enclosure is located at the edge of the western settlement area with a find-rich posthole 86 (pl. 47,49). The western area of the settlement exhibits 13 pits: Silex is observed (pl. 47,34.36.37) from the 40 m^2 sherd concentration (pl. 47,38.45-48.50-58.60.67.63), from a second concentration (pl. 47,59. 61.64-66) and distributed across the entire western area (pl. 47,62.68.69; pl. 48,1-7.10.17). From the scattering area of the settlement: (pl. 48,11-14).

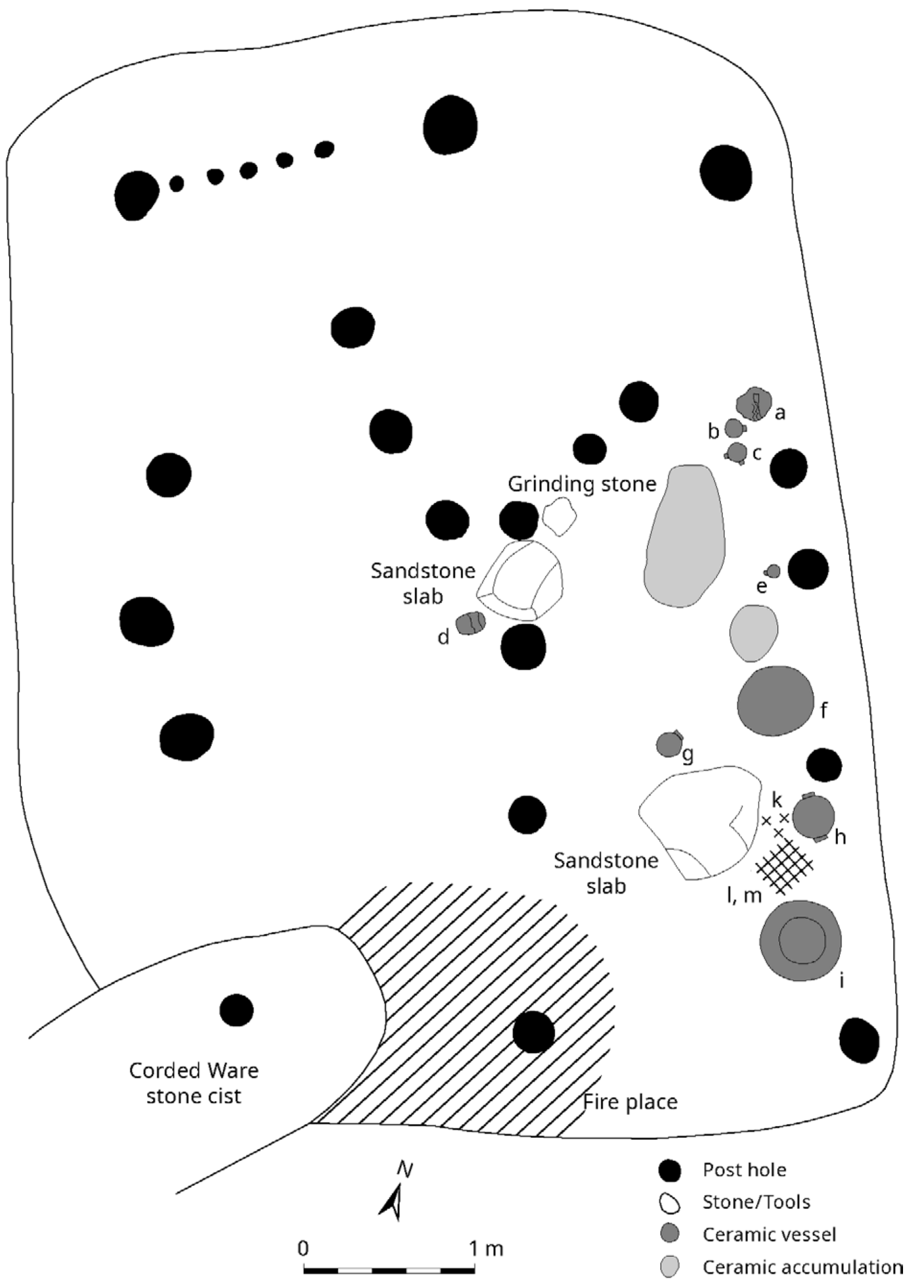


Figure 233. Halle-Dölauer Heide, Sachsen-Anhalt. The NNE-SSW oriented post construction (6.60 × 5.50 m), which was preserved under barrow 1, was recessed into the ground and "a y-shaped post configuration" was observed within it (after Behrens and Schröter 1980, 34-35, fig. 14; 62, fig. 31). A fire place, the vessels and semi-finished products made of rock, flint and bone speak for a living and production area.

of the GAC without a possible exact reconstruction. From the 40 features, 11.5 kg of red clay were recovered, indicating "clay-covered wattle and daub walls made of brushwood" (Conrad *et al.* 2009, 28). As the architectural structures are comparable with Iron Age hamlets, they have recently been seen as Iron Age remains, while the pits and the cultural layer are assigned to GA (because of the lack of other findings).

Potsdam-Nedlitz (Beran/Richter 2014): The situation at a domestic site of the Britzer Group in Nedlitz is not quite clear. The authors report GA ceramics within pits at one area, where one two-aisled house of the Britzer Group is documented. The authors integrate the site into a chain of sites with scattered GA artefacts that they interpret as domestic sites (Fig. 260; cf. Chapter 6.4).

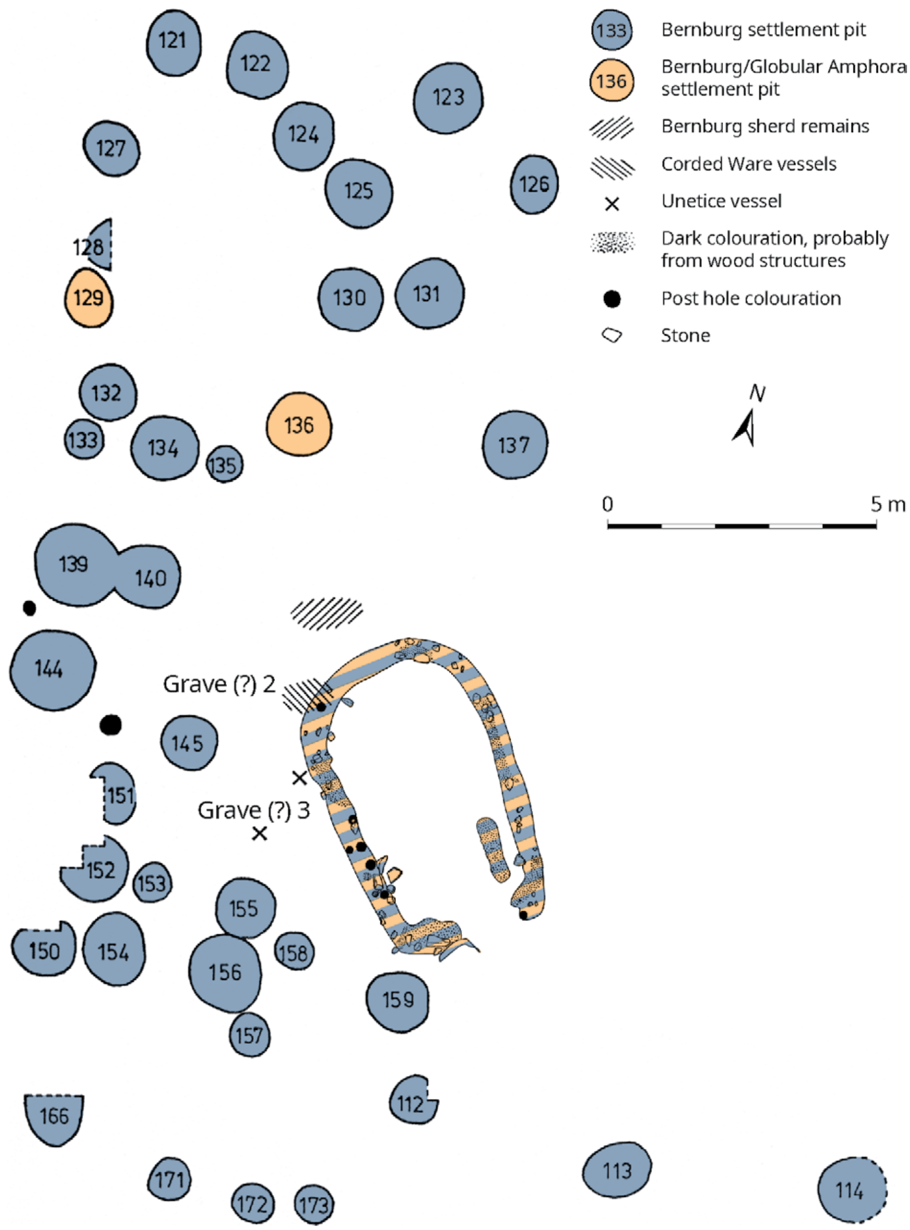
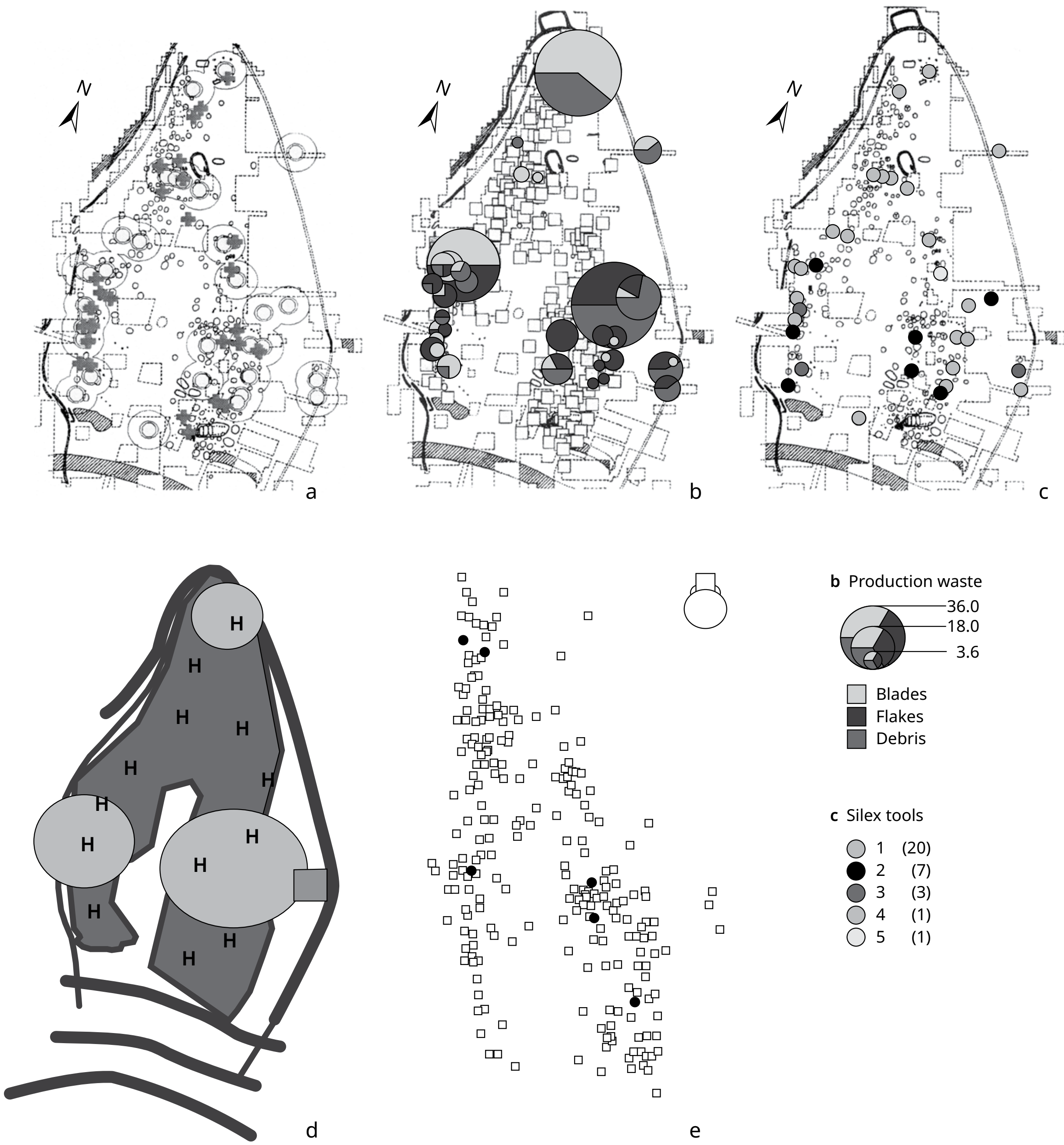


Figure 234. Halle-Dölauer Heide, Sachsen-Anhalt. Another NW-SE aligned, horseshoe-shaped wall trench (5.80 × 3 m) under barrow 2 probably also dates in the Bernburg/GAC period due to the stratigraphic relationships. Up to 7 m distance away to the north, two pits (129, 136) with GAC and Bernburg ceramics are located (after Behrens and Schröter 1980, 60-64, fig. 30-31).

Parchim-Löddigsee: On a sand island of about 1200 m^2 in a former lake, posts were found that cannot be related to indicate structures. In addition to Bernburg and Corded Ware ceramics, globular amphorae are attested, which occur stratigraphically together with Bernburg (Becker 2002). Moreover, there are domestic sites measuring ca. 1 ha total area, which can be considered Bernburg/GAC mixed inventories and are fortified. These include Halle-Dölauer Heide, where the GAC features extend over the entire settlement and Quenstedt-Schalkenburg, where GAC features are only known from the western settlement area.

Halle-Dölauer Heide: In the settlement Halle-Dölauer Heide, which was fortified by palisades and ditches, GAC ceramics in seven pits (from a total of 240 pits and ca. 120 posts), the northeastern house and numerous single finds were verified. Even though the vast majority of the features is associated with the Bernburg ceramic style, two ceramic styles exist at the site. The NNE-SSW oriented post construction (6.60 × 5.50 m), which was preserved under barrow 1, was recessed into the ground



and "a y-shaped post configuration" was observed within (Fig. 233: Behrens and Schröter 1980, 34-35, fig. 14; 62 fig. 31). A hearth, the vessels and semi-finished products made of rock, flint and bone speak for a living and production area. Another NW-SE aligned, horseshoe-shaped wall trench (5.80 × 3 m) under barrow 2 probably also dates in the Bernburg/GAC period due to the stratigraphic relationships. Up to 7 m distance away to the north, two pits (129, 136) with GAC and Bernburg ceramics are located (Fig. 234; Behrens and Schröter 1980, 60-64, fig. 30-31). The overall distribution of the findings with Bernburg and GAC ceramics shows that the globular amphorae are represented in the entire settlement area in the concentrations of Bernburg and flint finds (Fig. 235; cf. Müller 2001, 161-163 fig. 64d; 287-291 fig. 150). The total size of the settlement measures ca. 60 × 120 m (0.8 hectares).

Figure 235. The overall distribution of Bernburg and GAC ceramics shows that the GA are represented in the entire settlement area in the concentrations of Bernburg and flint finds (cf. Müller 2001, 161-163, fig. 64d; 287-291, fig. 150).

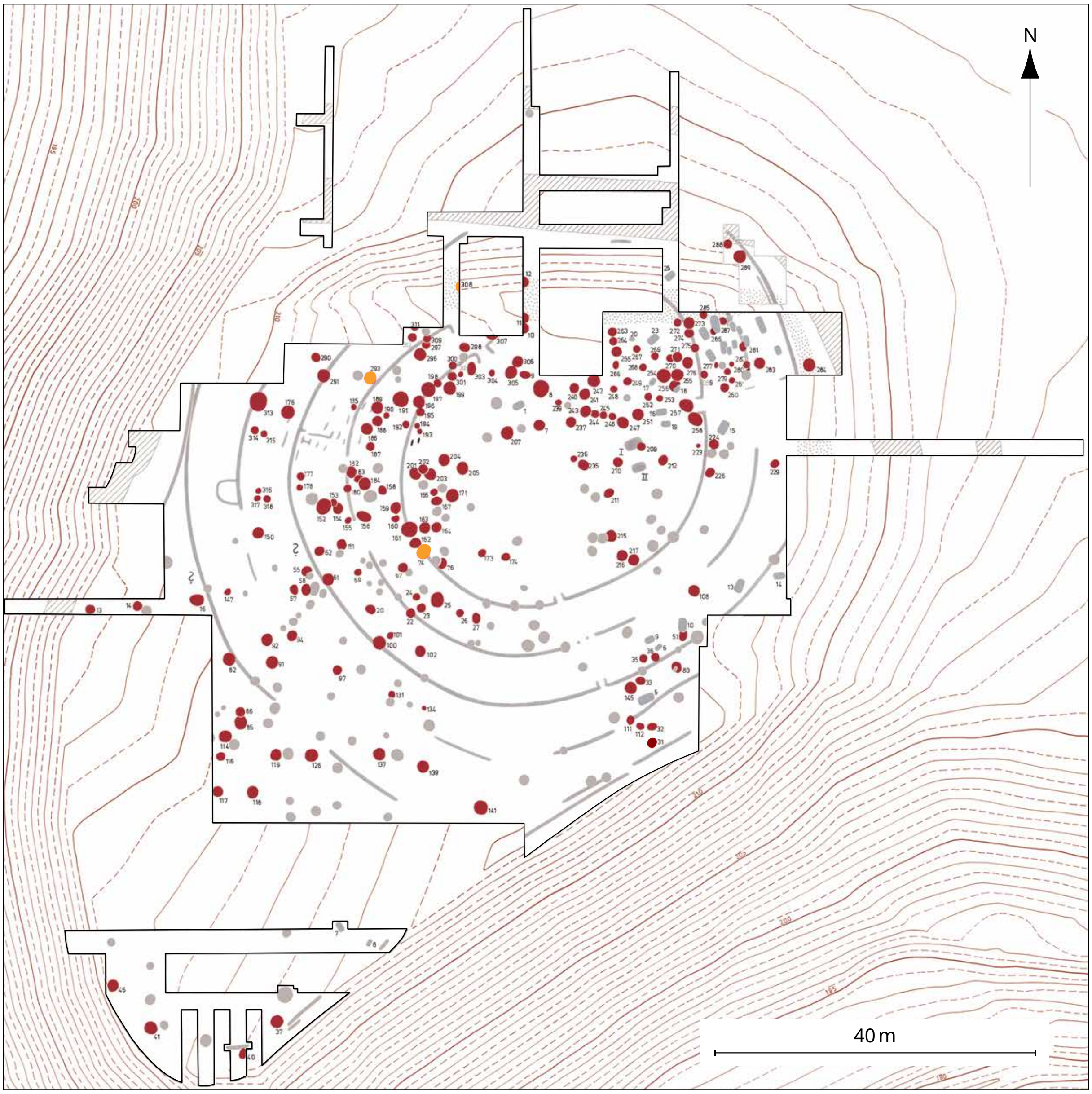


Figure 236. Quenstedt-Schalkenburg, Sachsen-Anhalt. Within the Bernburg domestic sites, three or possibly four pits with GAC ceramics (pits 74, 293, 308, 339) and numerous GAC single finds verify the presence of two ceramic styles. The GAC pits are from the north-western area, where spindle whorl finds suggest a processing of secondary products (after Müller 2001, 294-300, fig. 153, 159; Behrens and Schröter 1980, suppl. VI). Key: red – Bernburg pit; orange – GAC pit; grey – other periods.

Quenstedt-Schalkenburg (Behrens and Schröter 1980; Müller 2001, 291-294): This settlement, surrounded by a flat bottom ditch with causeways and steep slope palisades, includes 169 pits. In addition to features dominated by Bernburg ceramics, there are at least three, possibly four pits with GAC ceramics (pits 74, 293, 308, 339), plus numerous GAC single finds, which verify the presence of at least two ceramic styles (Beier 1988, 112-13). The settlement is 80 × 150 m in size (1200 m^2), the pit distribution is horseshoe-shaped around a free, central square. The GAC pits are from the northwestern area, where the spindle whorl finds obviously suggest a processing of secondary products. At least an area of 100 m^2 exhibits GAC pits (Müller 2001, 294-300 fig. 153, 159; Behrens and Schröter 1980, suppl. VI; Fig. 236).

The largest GAC site in the MES is certainly a flint mining site.

Eula (Hubensack 2016): The settlement is located on a sandy hill on the edge of a stream flowing west and north of the Eula and consists of a pit field. The total

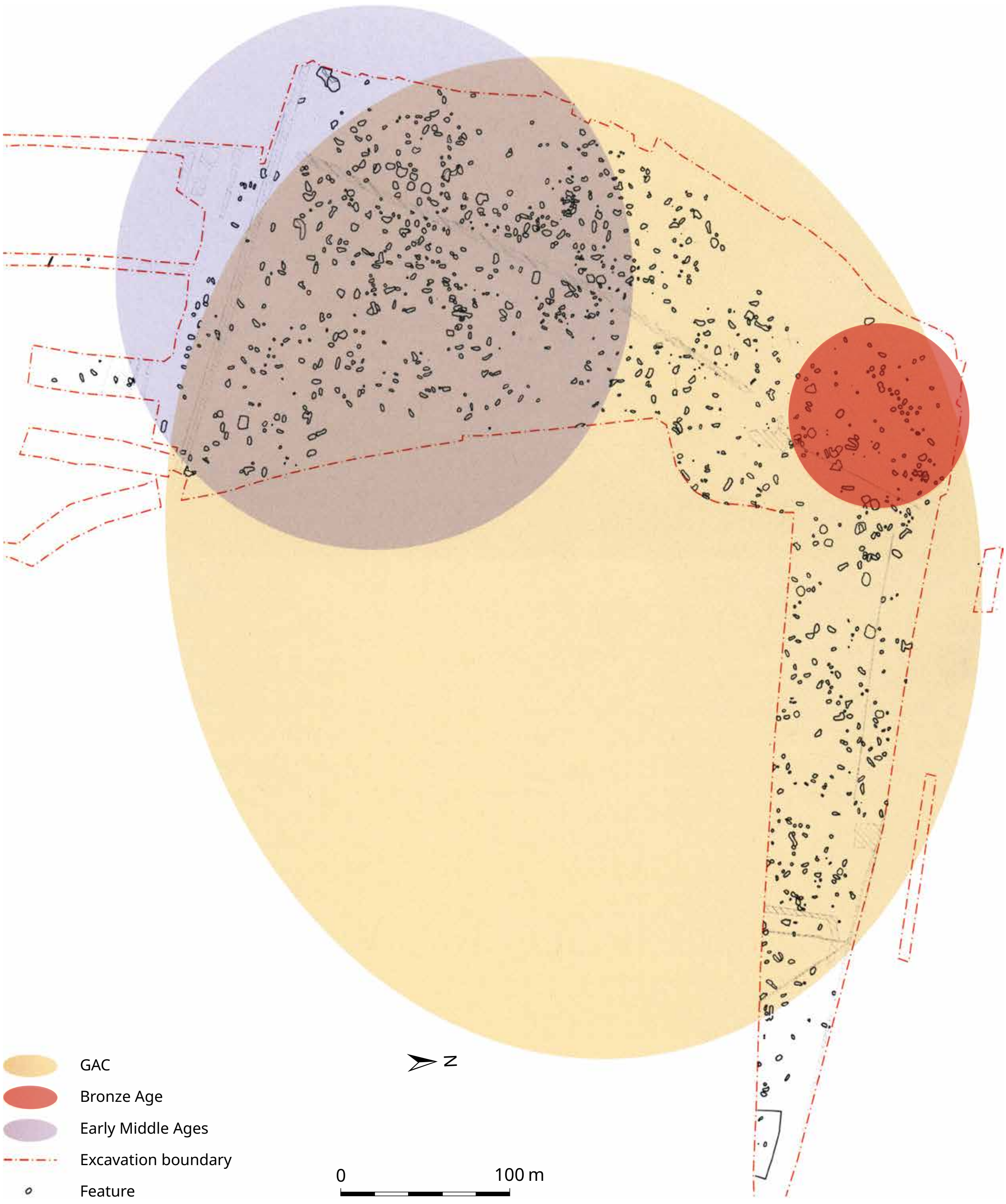


Figure 237. Eula, Sachsen. 475 pits are interpreted as extraction pits for flint rubble in the glacially formed sandy hill exploited by GA communities (after Hubensack 2016; Fahr 2018, 45, fig. 3a).

area amounts to 4 ha with ca. 475 pits. However, typical GAC ceramics are only available from nine pits, but the excavator succeeded in distinguishing specific thin-walled ceramics from the pottery, which would have normally been categorised as Bronze Age. The pit shape, including the dark brown fill, also distinguishes the GAC pits from the other Early Medieval or Bronze Age pits at the site (Fig. 237). 'The typical form of the globular amphora features at Eula was elongated-oval, about 2-3 m long and up to 1.5 m wide, mostly trough- to tub-shaped with depths of up to 1.36 m.' (*ibid.*) The size of the settlement is explained by Vera Hubensack to be a result of the search for flint in the glacially formed sandy hill.

The few documented settlement remains can thus be divided into three groups: individual settlement remains in the form of pits (Zauschwitz) or pit huts (Rositz), smaller settlements with wooden post buildings, pits and pit huts, which cover an area of less than 0.25 ha (Kleinkühnau, Görtitz) and can be interpreted as individual farms or small hamlets, and fortified settlements of ca. 1 ha in size, in which GA ceramics are observed together with other ceramic styles (Halle-Dölauer Heide, Quenstedt-Schalkenburg). The ca. 4 ha large pit accumulation from Eula can more likely be classified as a "flint mining" area.

The respective hut or house structures are also rather small, *i.e.*, 2-3 m wide and 5-10 m long.

The density of GAC features in the sites varies considerably. If we do not consider the site Eutzsch, where obviously single findings were recorded on a very large area, which are rather to be regarded as single sites, the find density of features amounts to ca. 325 m^2 per feature and site, however, with rather high differences from site to site. This high variability leads to the fact that no correlation exists between the area of the sites and the number of features. We take this be an argument to consider the described settlement categories as qualitatively different groups (Suppl. 17). In the six settlements for which data is available, the feature site size is variable, measuring between ca. 50-100 m^2 with a mean size of 325 m^2. Clearly distinguishable is the group of sites with context densities of <250 m^2 and those that occupy 800-1000 m^2. Two settlements belong to the latter group, including Halle-Dölauer Heide, where a density of ca. 35 m^2 is achieved when also considering the pit features with pure Bernburg ceramics.

6.1.2 Bohemia/Moravia

With the domestic sites from Bohemia/Moravia, we can also distinguish several groups. Extensively excavated areas can exhibit individual finds.

Pravčice 2 (Losky 2009-2010) (Peška 2013a, 245 fig. 11): A single pit on a large excavated area refers to a single feature.

Relatively loosely scattered pit agglomerations indicate a loose settlement pattern.

Olomouc-Slavonin, Horni Ian (Peška 2013a): Eighteen pits are spread over an area of 500 × 150 m, where concentrations of ten pits in the north of the area, four pits in the middle and four pits in the south with a spacing of more or less 100 m can be determined (Peška 2013a, 237 fig. 2). Obviously, three settlement areas can be assumed (10,000 m^2; 3200 m^2; 3000 m^2). Larger, shallow pit complexes (872/877: 6 × 5 m; 752/751: 8 × 6 m) differ from normal pits (Peška 2013a, 238 fig. 3).

Olomouc-Slavonín 1 (U hvězdárny – 2000-2001) (Peška 2013a, fig. 7; Fig. 238): On an area of ca. 250 × 100 m (25,000 m^2), there are nineteen pits, again including two especially large ones (31.5 × 4 m; Peška 2013a, 242 fig. 8).

Bystročice (Peška 2013b; Fig. 239): The smaller flat settlement (100 × 50 m; 5000 m^2) of the GAC was located at the foot of a slope just above the terrace edge. In the salvage excavations, a total of four GAC pits (no. 86, 96, 99 und 125) and possibly a part of the cultural layer (marker S1 around area 125) were exposed. The original larger extent of the settlement is evidenced by a number of intrusions of GAC vessel fragments in

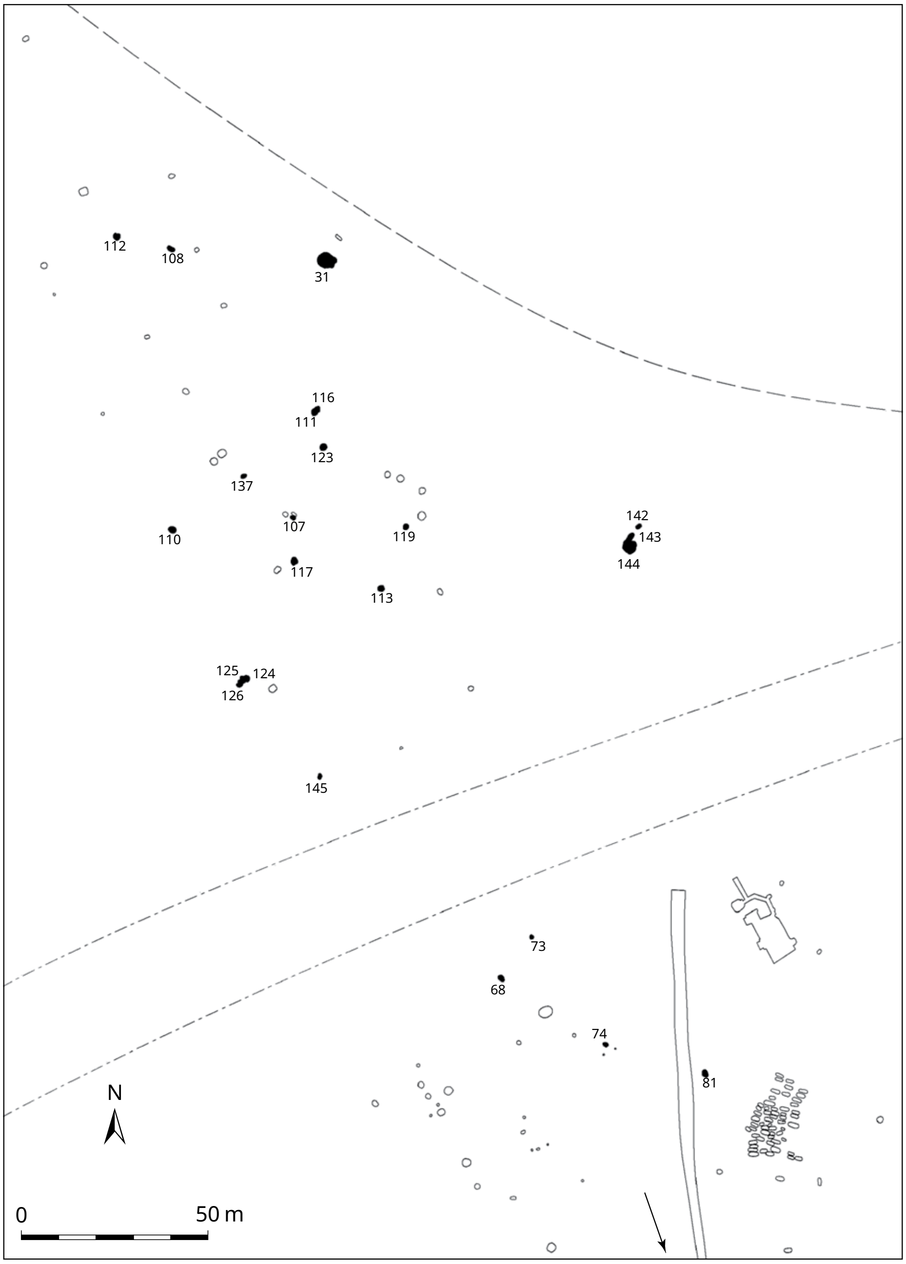


Figure 238. Olomouc-Slavonín 1 (U hvězdárny – 2000-2001), Moravia. 19 pits, including two especially large ones, form a GAC domestic site (after Peška 2013a, 241, fig. 7).

the younger objects (8x) in the non-central area (Peška 2013b, 215 fig. 2). Pit 99 is a funnel pit (Peška 2013b, 222 fig. 10).

A third category corresponds to the features from Central Germany with fortified settlements of less than 1 ha in size, in which GA ceramics occur together with other ceramic styles.

Stehelceves, site Homolka (Szmyt 2003; Pleslova-Stikova 1995; Fig. 240): A large settlement of hybrid character is located at Homolka. Of the twenty pit huts, eleven also exhibit GA ceramics. Moreover, there are eight pits with GA ceramics in addition to the usual Řivnáč ceramics. We consider this settlement to be a village, which is fortified by ditches and palisades (ca. 90 × 90 m, trapezoidal, 4500 m²). The pit huts are mostly 10 × 10 m in size.

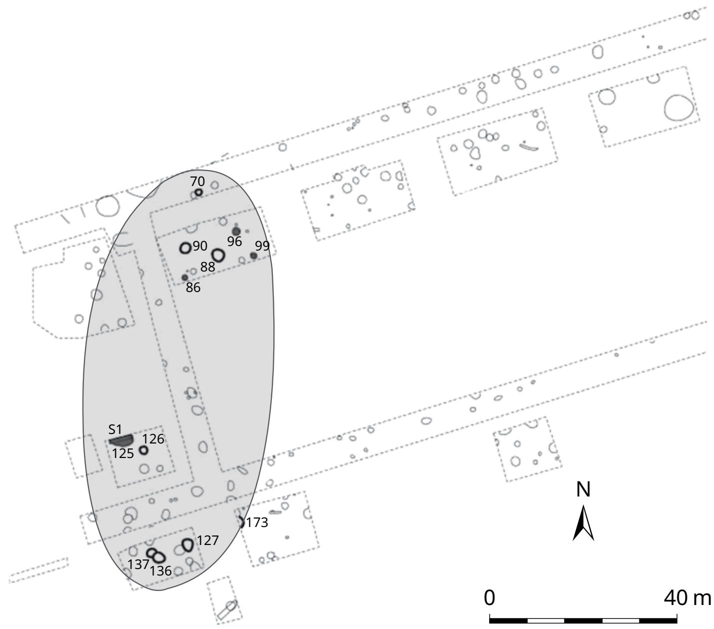


Figure 239. Bystročice, Moravia. Different pits and a larger structure belong to a GAC domestic site (after Peška 2013b).

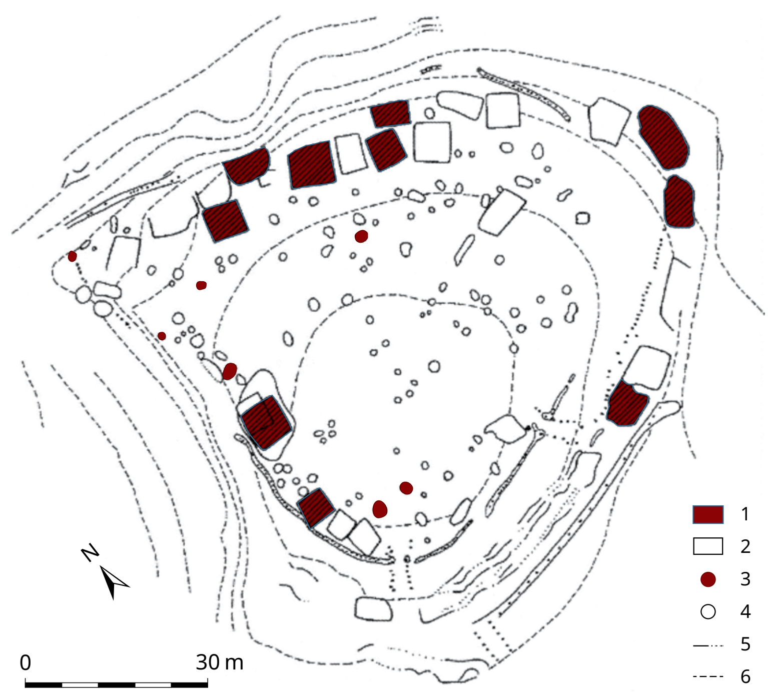


Figure 240. Stehelceves, site Homolka. A fortified village includes 20 pit huts, 10 also exhibit GA ceramics. Key: 1 – pit hut with GA ceramics; 2 – pit huts without GA ceramics; 3 – pits with GA ceramics; 4 – pits; 5 – ditches and palisades; 6 – contour lines (after Pleslova-Stikova 1995).

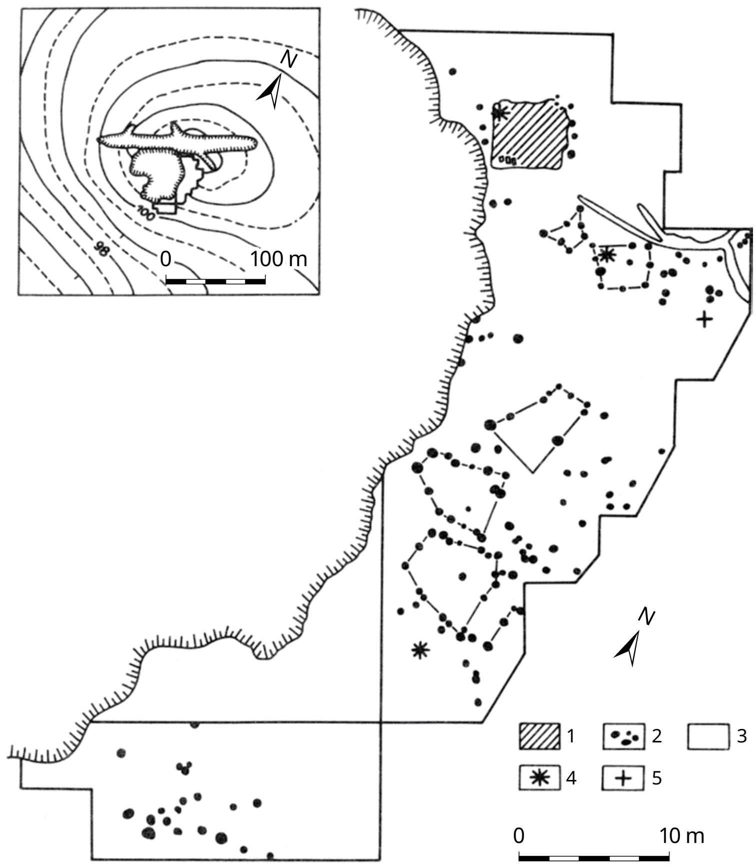


Figure 241. Siciny, Lower Silesia. Different houses were reconstructed for the GA site. Key: 1 – sunken floor; 2 – posts; 3 – ditches; 4 – fireplace; 5 – grave (after Kulczycka-Leciejewiczowa 1993, 144, fig. 49).

Thus, the settlements are, apart from individual pits (*e.g.* Pravčice 2), relatively large pit fields mostly on hillside terraces, which are usually much larger than what we know from the MES. In the six settlements for which data exists, the feature area is variable between ca. 400-1300 m^2 with an average of ca. 920 m^2. The density of the features is therefore much less pronounced than in the MES or in Kuyavia. There is a significant correlation between the number of features and the size of the settlement area.

6.2 Central Group

From *Silesia and neighbouring regions*, we know of various sites and settlements, of which three sites are documented in more detail:

Biedrzychowice (Kulczycka-Leciejewiczowa 1993, 146 fig. 50): Rectangular post placement with a sloping wall around a hearth (6 × 9 m) and a sunken floor (Szmyt 2017, 228 fig. 15,6).

Siciny (sw Lezno) (Kulczycka-Leciejewiczowa 1993, 144 fig. 49; Szmyt 2017, 230, fig. 17,4; Fig. 241): On the excavated area, there is a rectangular pit hut, aligned NNW-SSE, with a hearth and postholes on the broad sides (5 × 4 m), and five further posthole concentrations, which can at least be reconstructed as three trapezoidal houses of different sizes (5-10 m length, 5-7 m width). Again, two hearths have been uncovered here. The excavated area has a total extension of ca. 20 × 70 m (ca. 1400 m^2).

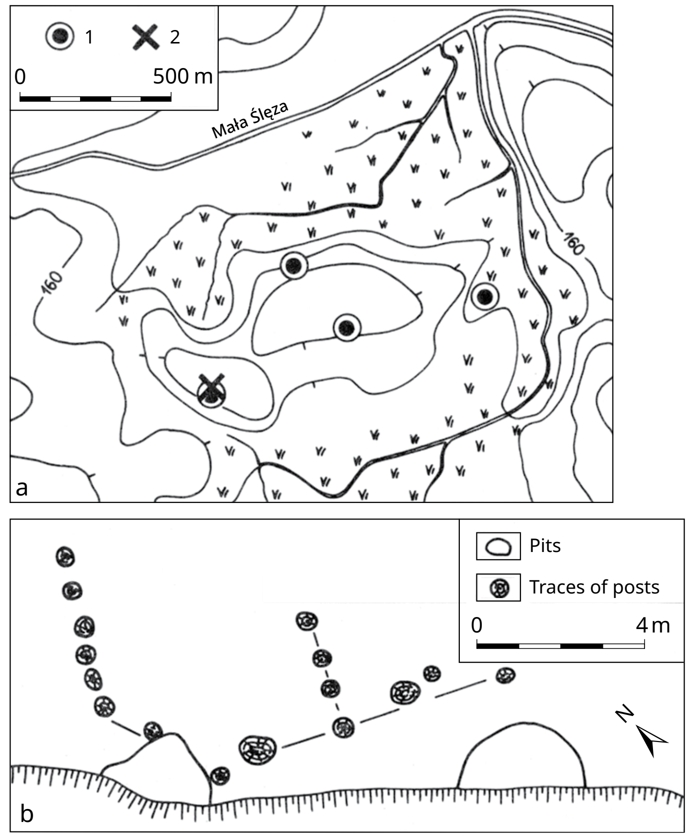


Figure 242. Pecz, Lower Silesia. On a promontory, four sites are associated with GA ceramics. At one site, parts of a house were reconstructed. Key: a – site location; b – excavation plan (after Kulczycka-Leciejewiczowa 1993, 142, fig. 48).

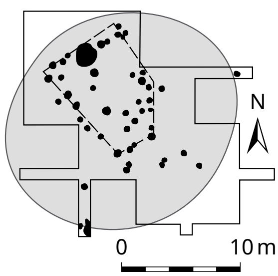


Figure 243. Liszkowice 24, Kuyavia. A cultural layer of ca. 20 m in diameter forms the surrounding of a hut structure (after Szmyt 2017, 230, fig. 17,1).

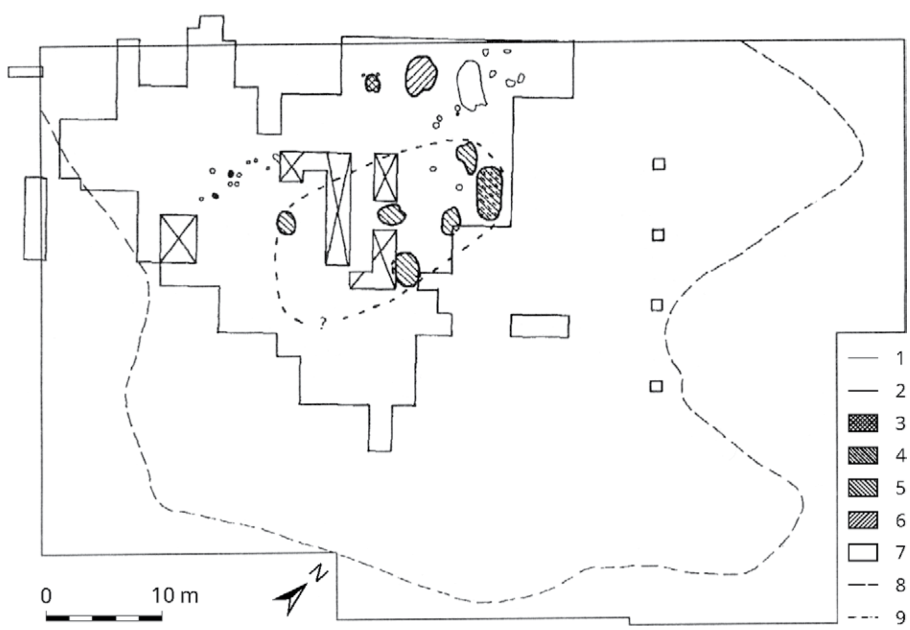


Figure 244. Debach 29, Kuyavia. Different sized pits and a cultural layer describe a GAC domestic site. Key: 1 – surveyed area; 2 – excavation; 3 – GAC feature; 4 – pit hut (GAC IIa); 5 – pits (GAC IIa); 6 – pit hut (GAC IIIa); 7 – features of other periods; 8 – border of artefact distribution; 9 – probable site centre (after Szmyt 1996, 135, fig. 56).

Pecz (south of Wrocław) (Kulczycka-Leciejewiczowa 1993, 142, fig. 48; Fig. 242): In the area of a promontory surrounded by two streams, 4 sites with GA ceramics are known. At one of these, post walls measuring 6 × 5 m were excavated. A possible intermediate wall, also with post placements, is also observed.

Pit huts, partly with post settings, correspond to what we know from other settlements. The context density in Siciny corresponds to that of the middle group of the other areas (ca. 350 m^2).

From *Kuyavia*, we know of various domestic sites, where posts indicate the construction of huts or houses and pits or "cultural layers" enable the determination of the size of the domestic space.

In principle, we can see a correlation between site size and the number of features at the usable sites, whereby the density of features decreases at larger sites, although there are also small sites with a low density of features (Fig. 258). Since no settlement categories clearly occur statistically, they are listed below according to area size.

Liszkowice 24 (Fig. 243): According to find layers and pits, the total size of the settlement is reconstructed, measuring 20 m in diameter (ca. 400 m^2). Within this, slightly aligned to the NNW-SSE, there is a ca. 10 m long and 7 m wide hut, the side walls of which can be reconstructed via traces of posts (Szmyt 1996, 136 fig. 57; Szmyt 2017, 230, fig. 17,1). A possible two-roomed post construction (10 × 7 m) was recorded in the vicinity of a hearth and two pits. Moreover, the find distribution in the direct surroundings is recorded on an area of ca. 400 m^2.

Debach 29 (Szmyt 1996, 135 fig. 56; Fig. 244): In an almost completely excavated settlement area, five pits of phase GAC IIa, one pit of phase IIIa and two more of general GAC background were excavated, including possibly a rather oval pit hut (2.5 × 5 m). The entire find spread is distributed over 1400 m^2, the actual settlement IIa is limited to ca. 450 m^2.

Lekarzewice 6 (Grygiel 2013, 165, fig. 2; Fig. 245): Around a small, NNW-SSE oriented reconstructed house (3 × 6 m), there are pits and a pit hut of a settlement site, which can thus be determined to be ca. 30 × 20 m in size (ca. 500 m^2) (Szmyt 2017, 230, fig. 17,3). As the whole area was excavated, the site represents the size of a small GA domestic unit. The reconstruction of the central house is based on remains of wall daub in three pits (Grygiel 2013). 'The imprints indicated that the walls were built from split timbers with small diameters (10-15 cm) as well as wattle' (Grygiel 2013, 164; Grygiel 2013, 169, fig. 6; Fig. 246). Two querns from pit 4 and a rubber from a cultural layer indicate domestic activities (Grygiel 2013, 164, 170, fig. 7; Fig. 220). Concentrations of flint objects and a small fragment of a stone axe with a polished surface were found in features 5, 11 and 31. Beside the reconstructed house, the cellar pit (feature 10 with an intact pot *in situ*) and the subterranean hut (feature 34) indicate domestic structures north of the house. In the southern half of the site, subsistence activities are indicated by the remains of cattle and of two querns from


a
Lekarzewice
Konary
1,1
1,4
91,7
1,1
2,4
2,0
90
90,2
1,1
0
200 m
b
N
0
15 m
c
N
0
10 m
40
34
10
A
B
3
4
HOUSE ?
5
15
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6
12
18
31

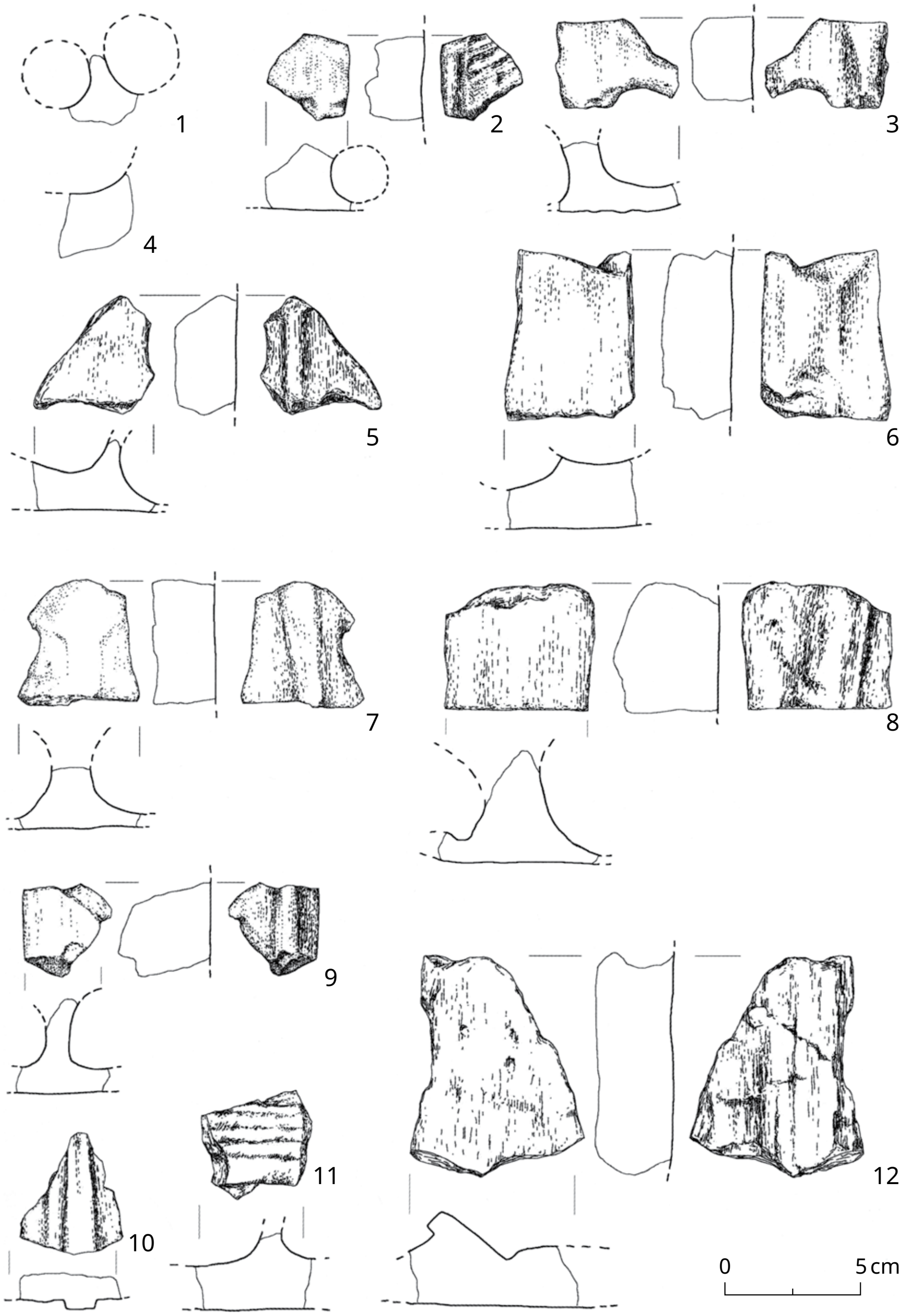


Figure 246. Lekarzewice 6, Kuyavia. Remains of wall daub. The imprints indicated walls of split timbers with small diameters (after Grygiel 2013, 169, fig. 6).

pit 4, by the roe dear remains from pit 31, and by a flint scraper from pit 5 and flint blades from pit 31. Typologically, the site inventory belongs to a transition between phases IIb/IIIa; two ^{14}C dates on charcoal are slightly contradictionary but, according to Ryszard Grygiel, point to around 2795-2710 BCE (Grygiel 2013, 170).

Figure 245 (left). Lekarzewice 6, Kuyavia. Around a small reconstructed house, pits and a pit hut belong to a GAC domestic site. Key: a – site location; b – trenches; red oval area with GAC features; A-B – concentration of vessel fragments; circle – features with daub; arrow 4-31 – distribution of the same vessel (after Grygiel 2013, 165, fig. 2).

Wilkostowo 23/24 (Rzepecki 2014): From the Wilkostowo 23/24 site in eastern Kuyavia, there is an interpretation (Rzepecki 2014), where a tent-like GAC settlement is assumed to be located next to the TRB domestic site that was reconstructed as a circular settlement (*ibid.* 568, fig. 20.14; Fig. 247). The find concentrations of the GA ceramics (features are not available here) refer to a domestic area of about 750 m^2 (25 × 30 m) with two find concentrations (of about 5 m in

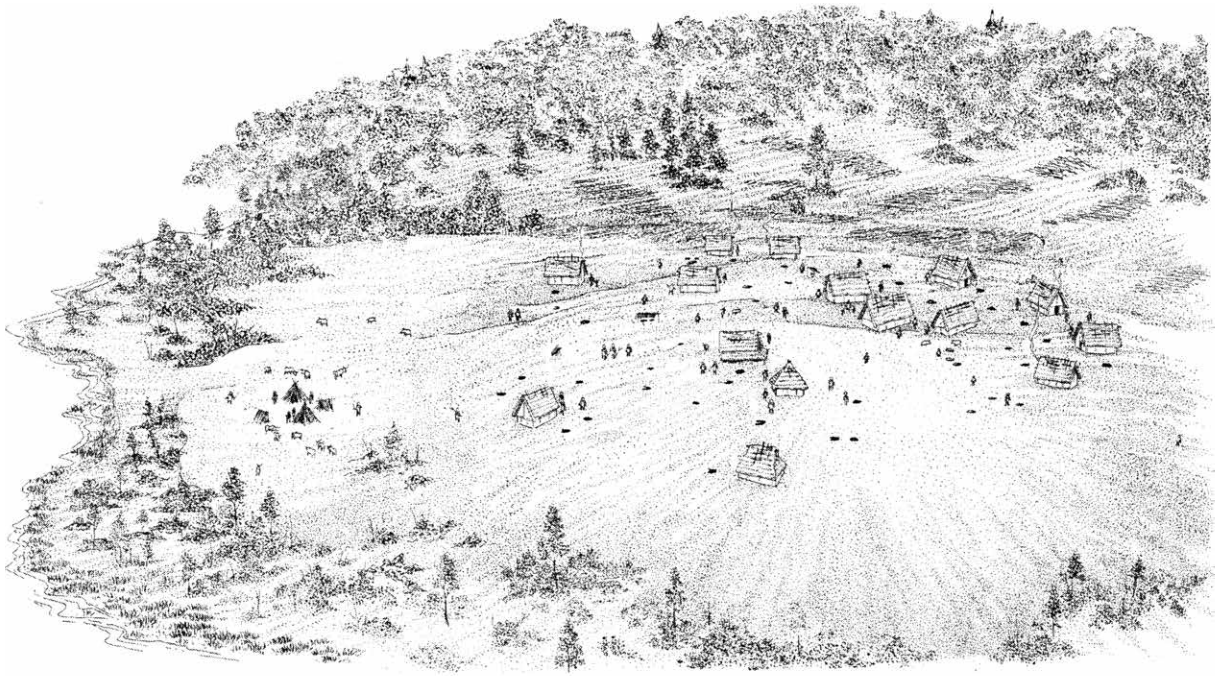


Figure 247. Wilkostowo 23/24, Kuyavia. A tent-like GAC settlement is assumed to be located next to the TRB domestic site (after Rzepecki 2014, 568, fig. 20.14).

diameter and a slightly trapezoidal NNW-SSE orientation, 6 × 10 m). Dating: GAC Kuyavian stage Ia.

Radziejwoie Kuj (Rybicka 1995, 69-72 Abb. 16-18; Fig. 248): From here, in addition to pits of the TRB, four GAC pits and postholes are located with mixed distribution frequencies of GAC and TRB sherds (area: 40 × 20 m, 800 m^2).

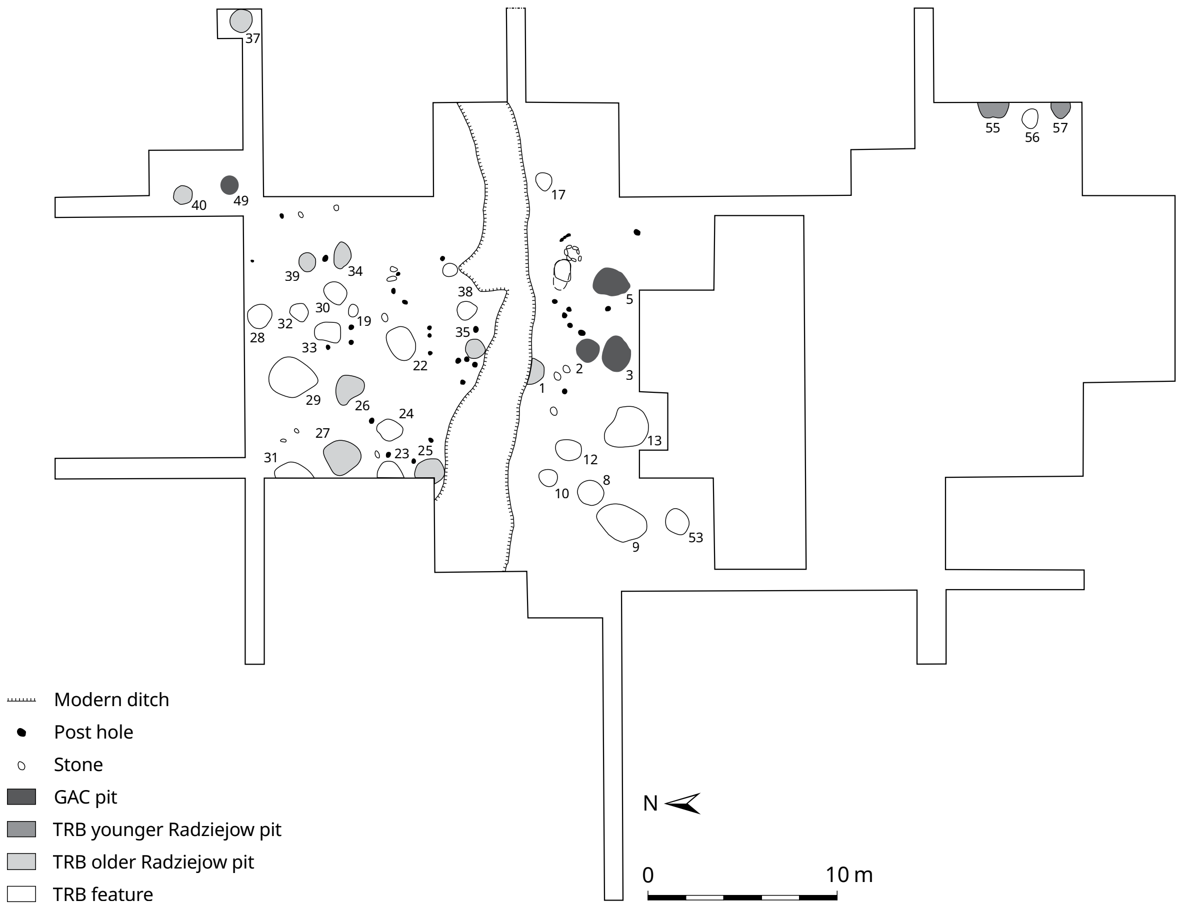
Bozejewice 22 (Szmyt 2000a, 320 fig. 82; Szmyt 2017; Fig. 249): Nine pits are located in an area of a rounded structure, which is referred to as a pit hut (ca. 5 m in diameter) (total extension of the settlement: 45 m in diameter – ca. 1600 m^2).

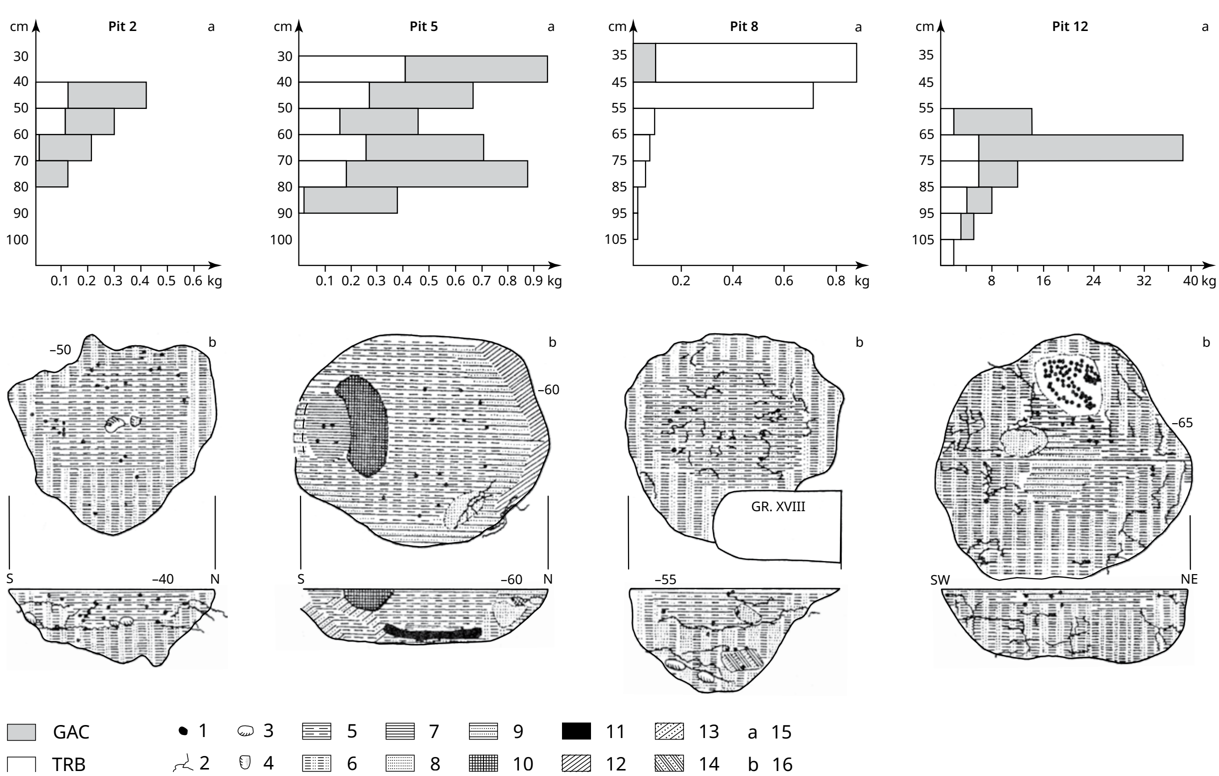
Opatowice: The Prokopiak Ridge is a plateau measuring ca. 14 ha on which different prehistoric settlements were located. At five sites, remains of the GAC were uncovered.

Opatowice 1 (Szmyt 2007a, 141 fig. 9.1; Czebreszuk *et al.* 2007, 306-307 fig. 26.6-26.8): In a GAC IIIa find scatter of a cultural layer measuring 35 × 20 m (700 m^2), feature 38 represents an E-W aligned longitudinal pit including an animal deposition (4 × 3 m).

Opatowice 3 (Szmyt 2014, 324-325; Kosko and Szmyt 2014a; 2014b, 495-500 fig. 20.2): On a ca. 800 m^2 large excavation area, the remains of a TRB and a GAC settlement were excavated. For the GAC phase IIb (Op3-C1), four pits are noted. For the GAC phase IIIa (Op3-C2), one further pit as well as five other pits that generally belong to the GAC are observed. There is also a crescent-shaped pit ditch segment that, along with a few postholes, can be assigned to the TRB and the GAC. Object 28 is a NNW-SSE oriented 5 × 10 m large house with a sunken floor (Fig. 250). This pit segment is reconstructed as part of a larger circular ditch measuring 10 m in diameter (Kosko *et al.* 2014, 43 fig. 2.6). Overall, the sixteen pit features, the ditch segment and the house form the impression of a sub-segment of a larger settlement, whose boundaries were not recorded (Fig. 251; Kosko *et al.* 2014, 76 fig. 2.32).

Figure 248 (right). Radziejwoie Kuj, Kuyavia. GAC pits and postholes are located with mixed distribution frequencies of GAC and TRB sherds within a TRB settlement (after Rybicka 1995, 69-72, fig. 16-18.


Modern ditch
Post hole
Stone
GAC pit
TRB younger Radziejow pit
TRB older Radziejow pit
TRB feature
N
0
10 m


Pit 2
Pit 5
Pit 8
Pit 12
cm
kg
a
b
S
N
SW
NE
GR. XVIII
GAC
TRB

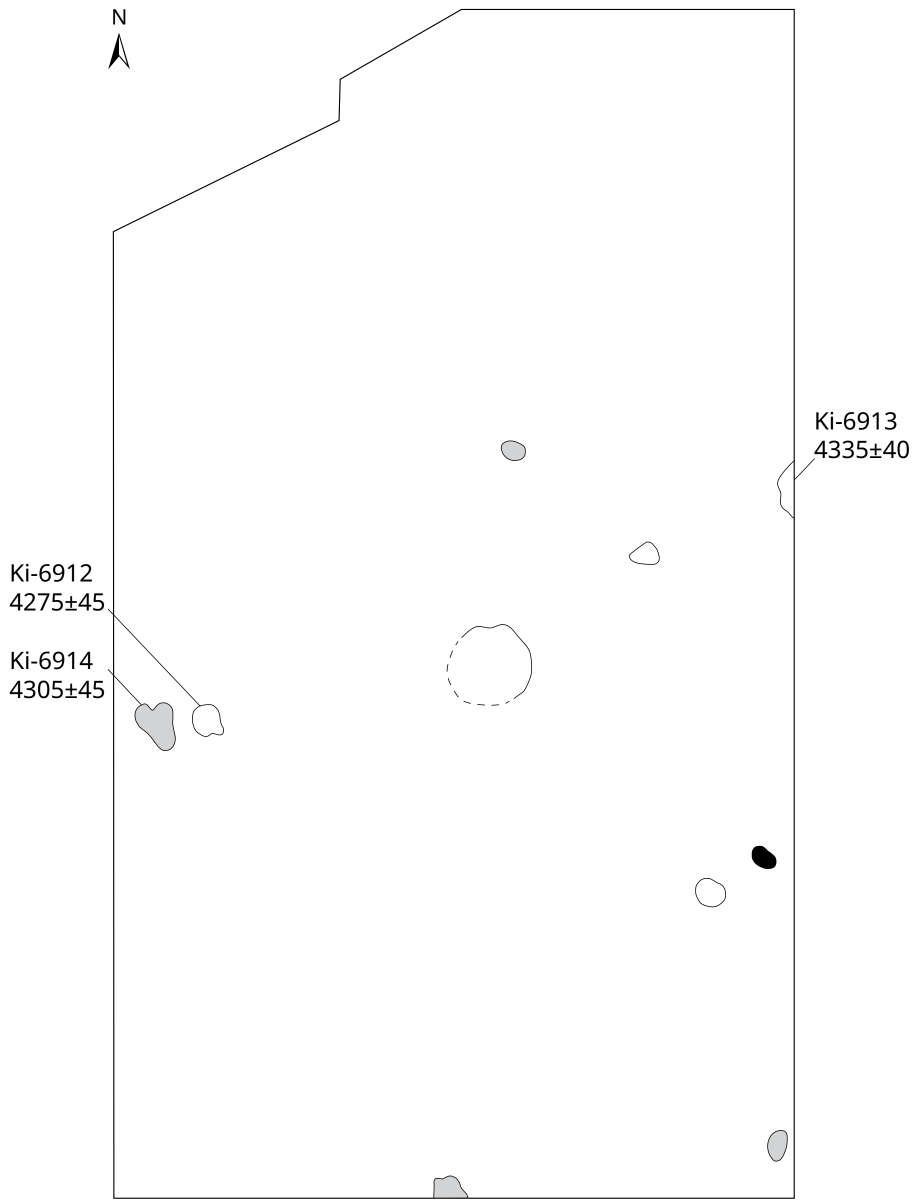


Figure 249. Bozejewice 22, Kuyavia. Nine pits are located in an area of a rounded structure, which is referred to as a pit hut. Scale 1:125. (after Szmyt 2000a, 320, fig. 82).

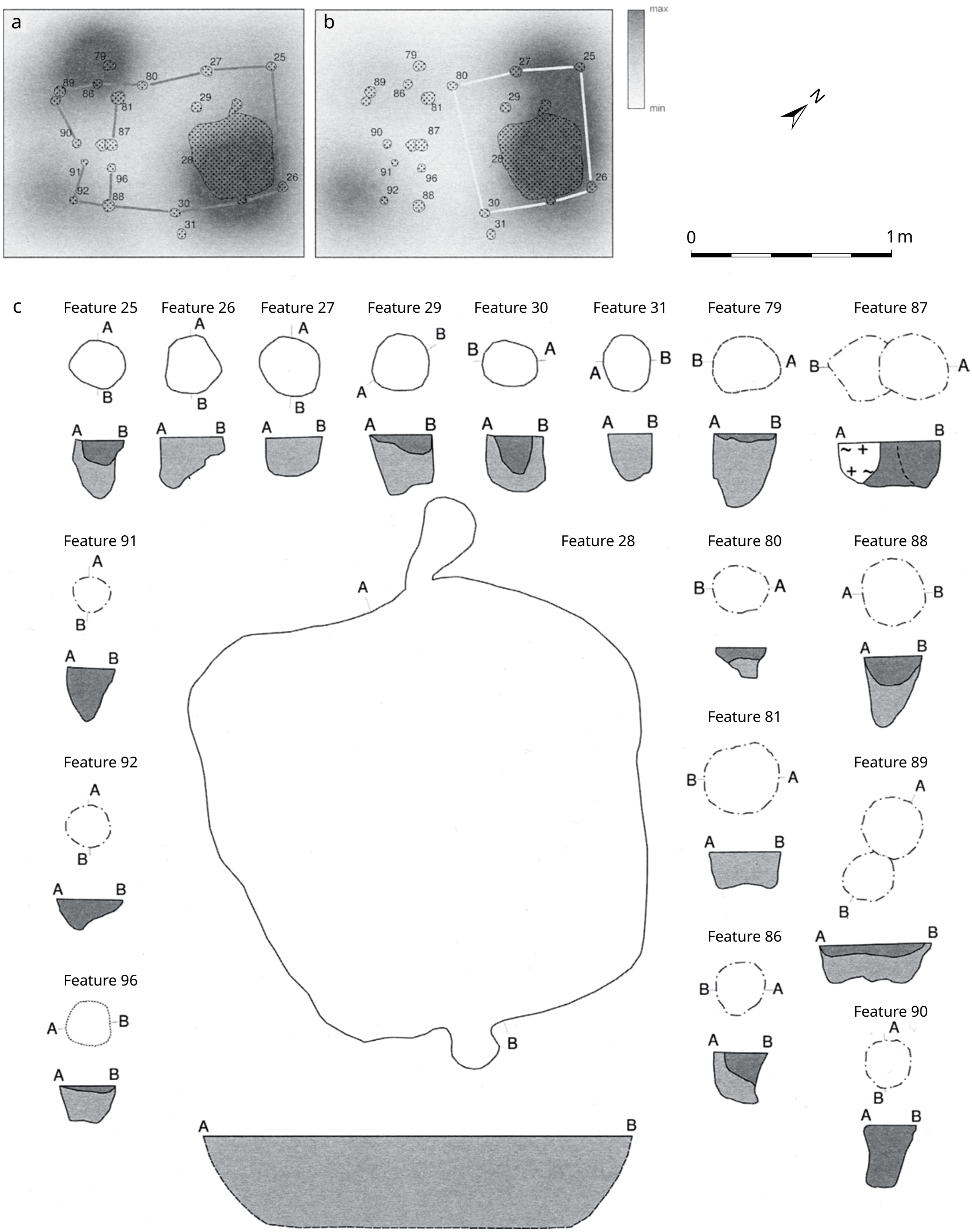


Figure 250. Opatowice 3, Kuyavia. Object 28 is a 5 × 10 m large house with a sunken floor (after Kosko et al. 2014, 48, fig. 2.11).

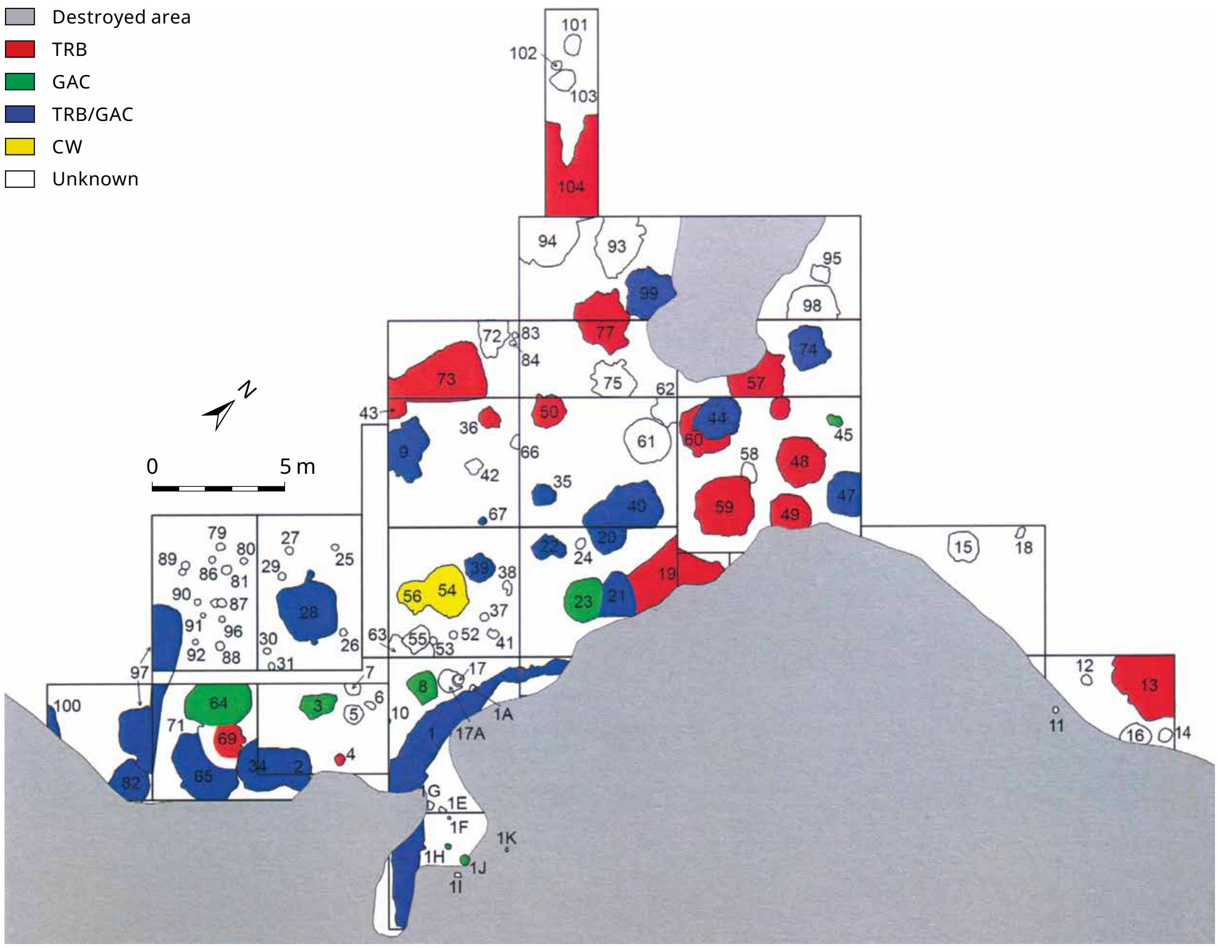


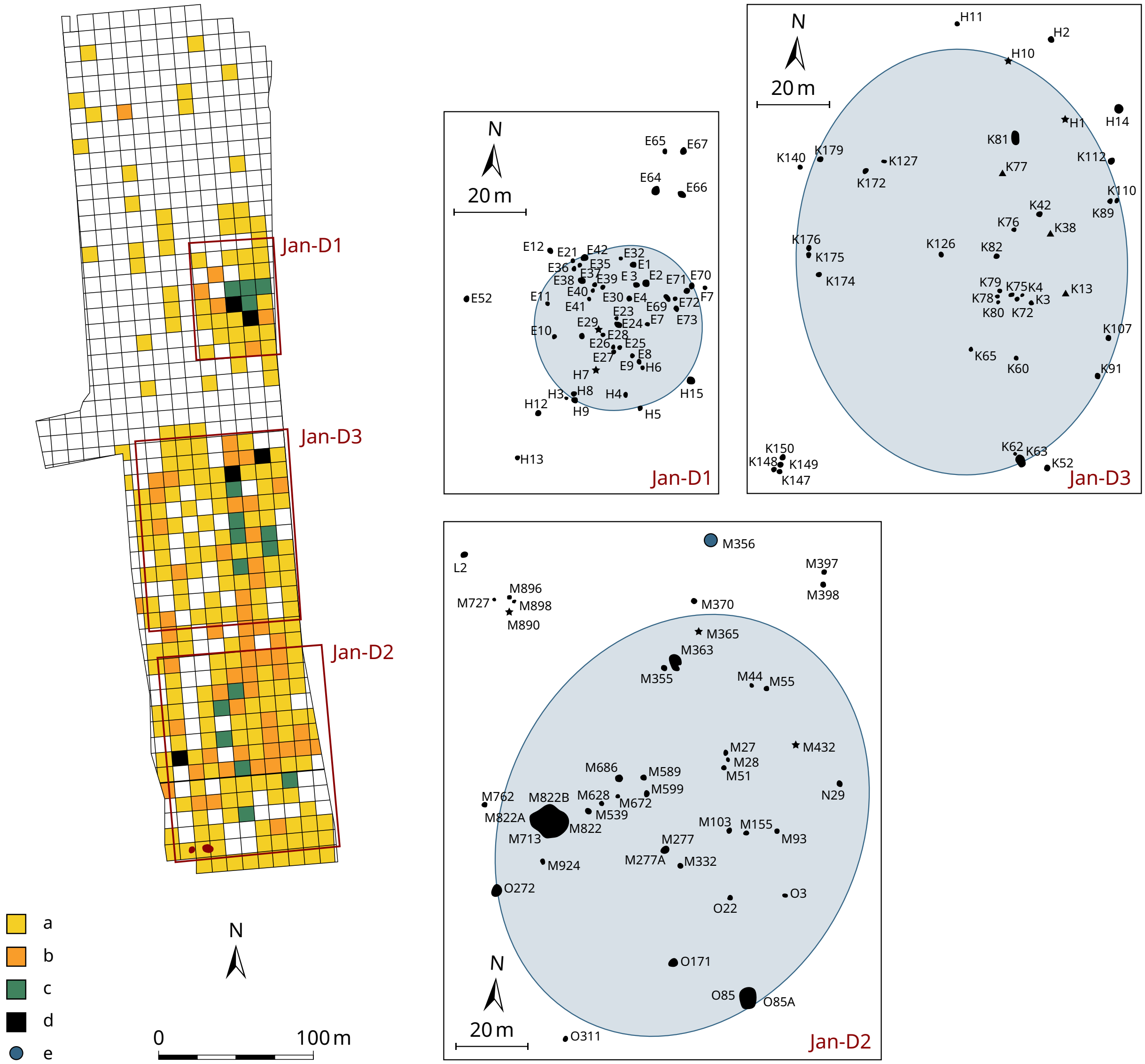
Figure 251. Opatowice 3, Kuyavia. Object 28 (cf. Fig. 250) is reconstructed as part of a larger circular ditch measuring 10 m in diameter (Kosko et al. 2014, 43, fig. 2.6). Pit features, the ditch segment and the house form a sub-segment of a larger settlement, whose boundaries were not recorded (after Kosko et al. 2014, 76, fig. 2.32).

Opatowice 33 (Szmyt 2006a; 2006b, 195, fig. 10.1): Three pits with GAC ceramics, a ceramic concentration and a wide GAC ceramic distribution belong to a settlement site together with Late TRB ceramics, where a common occurrence of both ceramic styles is likely (plan Late TRB and GAC) (Kosko and Szmyt 2006b, 285-287 fig. 21.5-7). Area: 20-80 m (1600 m^2).

Opatowice 36 (Kosko and Szmyt 2015a; 2015b, 485-487 fig. 20.1-2; Szmyt 2017, 226, fig. A-B): A pit hut (6 × 4 m) with animal depositions from two different phases characterises the settlement site with a diameter of ca. 30 m (area: ca. 700 m^2). The limit of the settlement is indicated by the density of the finds.

Opatowice 42 (Szmyt 2007b, 258 fig. 6.1; Kosko and Szmyt 2007a; 2007b, 389-392 fig. 16.1-16.4): On an area of ca. 30 × 30 m (900 m^2), there are GAC sherd scatters that can be attributed to a settlement.

Janowice 2 (Szmyt 2017, 231, fig. 19; cf. also Szmyt 2016a, 206-228 fig. 5.3-5.25; Fig. 252): Three settlement concentrations are located on a promontory that is enclosed by two streams converging in the east. Three settlement concentrations are found in north-south alignment with one another, whereby particularly in settlement site D3, a well (M356) that is marginally located to the north and two pit huts (M822, O85) are noteworthy (Szmyt 2016a, 208 fig. 5,5; 216 fig. 5,13; 220 fig. 5,17). The *settlement site D1* encompasses an area of 30-60 m (ca. 1800 m^2), including an additional ceramic concentration with a radius of ca. 10 m. There are seven cellar pits, twenty-one flat pits with economic functions, two hearths, and some postholes. At the *settlement site* D2, there are seven cellar pits (including two larger ones



measuring 8 × 8 m with a NNW-SSE orientation and one measuring 4 × 6 m in size), two hearths, fifteen flat pits and some postholes. The dimension of the site is similar, except that the ceramic concentrations are associated with four areas (in total an oval area of 90 × 120 m – ca. 10,000 m²). From *settlement site D3*, we also know of four smaller cellar pits, seventeen flat pits, two hearths, and only a few postholes (on an area of ca. 10,000 m²) and the already mentioned well. The GAC settlement sites (Janowice phase D) basically include pits, pit huts, hearths and a well. The settlement sites are equated with three "sub-phases" (D1-D3), which are typologically assigned to the classic Globular Amphora phase (D1 older IIb, D2 younger IIb, D3 IIIb, cf. the chronology chapter).

Figure 252. Janowice 2, Kuyavia. Three settlement concentrations are located on a promontory that is enclosed by two streams converging in the east. The settlement sites are equated with three "sub-phases" (D1-D3), which are typologically assigned to the classic Globular Amphora phase (D1 older IIb, D2 younger IIb, D3 IIIb). Key: a-d – number of potshards within 100 m² (a: 1-10; b: 11-50; c: 51-300; d: 301-800); e – a well; gray colour marks probable settled area (after Szmyt 2017, 231, fig. 19; cf. also Szmyt 2016a, 206-228, fig. 5.3-5.25).

Goszczewo (Chachlikowski 1991, 162-164, fig. 9): On a small moraine island in a glacial melt-water trough, a mining camp was discovered. Stone pavements of erratics were exploited, horizontally and vertically, within two concentrations with sounding shafts. In concentration I there was a workshop where the extracted erratics were processed and axes, querns and grinders were produced. Outside the stone concentrations was located a circular sunken floor of about 30 m² which served as the "home area" of the workshop and exploitation zone (Fig. 253).

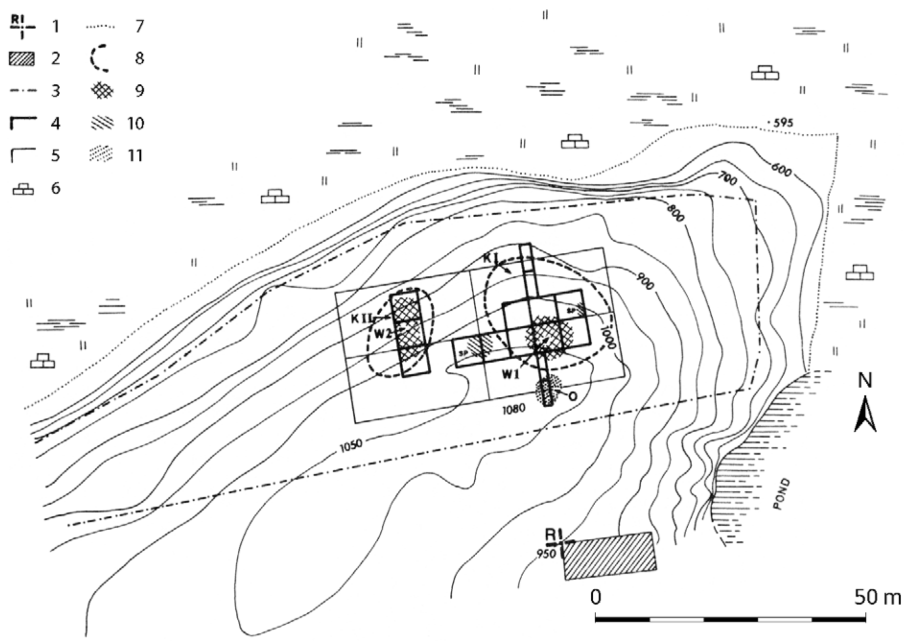


Figure 253. Goszczewo, Kuyavia. On a small moraine island in a glacial melt-water trough, a camp-mine existed. Horizontally and vertically, stone pavements of erratics were exploited within two concentrations with sounding shafts. In concentration I, a workshop, the extracted erratics were processed and axes, querns and grinders were produced. Outside the stone concentrations, a circular sunken floor of about 30 m² was based as the "home area" of the workshop and exploitation zone (after Chachlikowski 1991, 162-164, fig. 9).

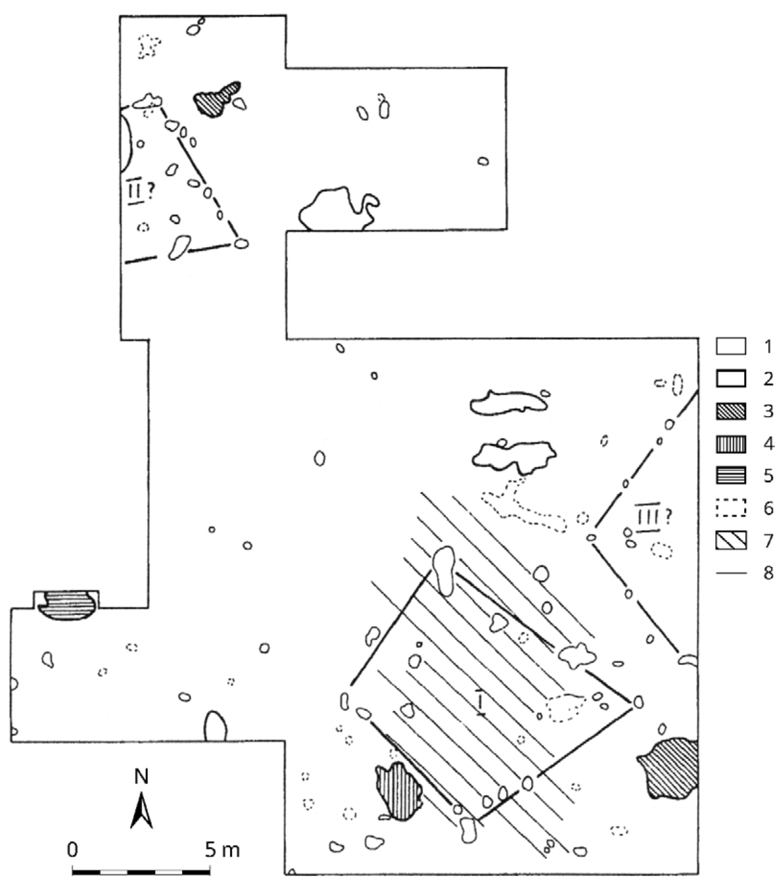


Figure 254. Takowice 49, Kuyavia. Three more or less quadratic post settings can be related, which add up to three huts (8 × 6 m), plus two hearths and one pit that were uncovered in connection with a find layer. Key: 1 – post holes; 2 – context not dated; 3 – GAC fireplace; 4 – pit hut of economic purpose; 5 – TRB context; 6 – possible contexts; 7 – concentration of GAC artefacts; 8 – probable border of dwellings (after Szmyt 1996, 139, fig. 60).

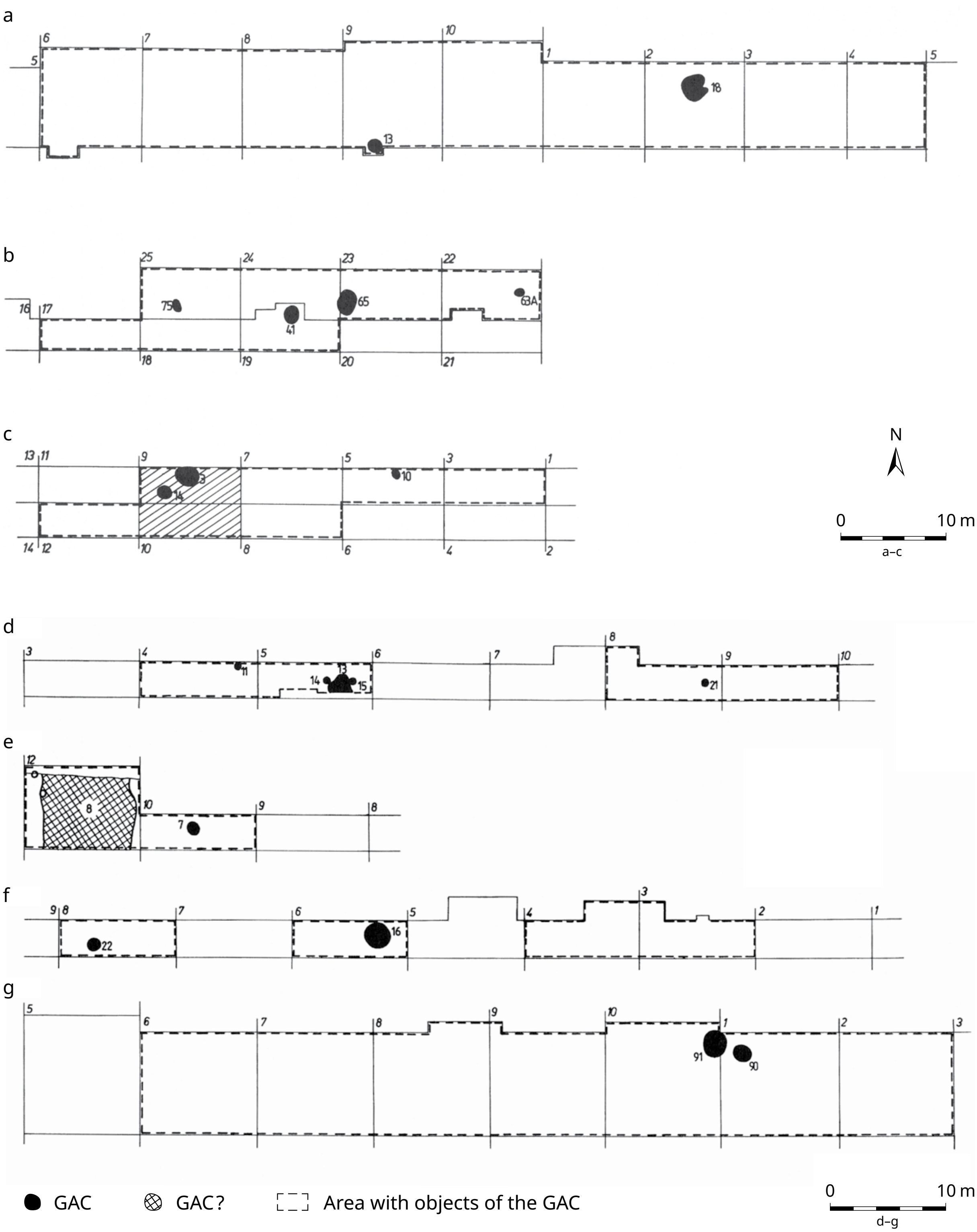


Figure 255. GAC pits from various Kuyavian sites. a – Baba 12; b – Rzadkwin 21; c – Slawsko Dolne 38; d – Piecki 1; e – Piecki 8; f – Bachorce 4; g – Huta Padniewska 7 (after Szmyt 2004b, 352-352, fig. 191-192).

In addition, there are other sites for which the total extent of the GAC remains has not been determined.

Żuławka Mała (Rola 2009): During the excavations, in addition to a planked trackway, postholes and pits were excavated, which are located in an area that measures 40 × 40 m (pit plan: Rola 2009, 37 fig. 8; planked trackway: Rola 2009, 77 fig. 36-38; 83 fig. 40).

Zegotcki 2 (Szmyt 2000a, 319 fig. 81): On an area 70 m long and 15 m wide, postholes, a pit with an animal deposition, four storage pits and a possible sunken floor were determined (in a minimum area of 1050 m^2).

Kuczkowo 5 (Szmyt 2000a, 322 fig. 84): On the partially excavated site, animal depositions and a pit hut (7 × 10 m) were found on an area that measures 30 × 15 m (a minimum area of 1050 m^2).

Kruszy Zamkowej 3 (Szmyt 1996, 134 fig. 55): On a hill, two find scatters were excavated with one or two pits (measuring ca. 30 × 30 m and 10 × 5 m, the areas are only partially recorded, including together 950 m^2).

Chleswikach 56 (Szmyt 1996, 134-141 fig. 58): Two GAC find scatters were recorded. In one, there are posts that can be related to represent a building that measures ca. 5 × 4 m.

Takowice 49 (Fig. 254; Szmyt 1996, 139 fig. 60): Three more or less quadratic post settings can be related, which add up to three huts (8 × 6 m), plus two hearths and one pit that were uncovered in connection with a find layer.

Opokach 7 (Szmyt 1996, 140 fig. 61): Several smaller dwelling pits could be related to represent a settlement area in connection with GAC find scatters (Phase IIb).

Przybranowie 10 (Szmyt 1996, 141 fig. 62): Three irregular dwelling pits measuring 4 × 3 m were uncovered on an escarpment.

Other pits were uncovered on various sites: Baba 12, Rzadkwin 21, Slawsko Dolne 38, Piecki 1, Piecki 8, Bachorce 4, Huta Padniewska 7 (Fig. 255; Szmyt 2004b, 352-352 fig. 191-192), Siniarzewo 1, and Kuczkowo 5 (Szmyt 2000a, 322 fig. 83-85). Further pits were documented at Zabno 31, Chiechrz 25, Zegotcki 4, Bozejewice 28, and Radojewice 29 (Szmyt 2000a, 165-171 fig. 2.1-fig. 8.1). These are areas that were only partially excavated during the rescue excavations. We know of other features interpreted as dwelling pits from Deby 29, Stary Bresc, Opoki 7, Przybranowo 10, Koluda Wielka, Brzesc Kuj. 4, Koscielec Kuj. 16, and Tuczno 1, as well as a small possible post construction from Chlewiska 56 (Szmyt 1996, 128-132 fig. 52-54).

Correspondingly, in the case of the GAC settlement sites, we can also recognise features – from individual features to pit huts and post constructions – that were probably settled more continuously. Here, the features from Janowice, with size dimensions of up to 1 ha, reflect the size relationships that we also note, for example, from the Bernburg hybrid settlements of Central Germany or from Homolka.

In the eastern areas of the GAC, settlement features are almost completely missing thus far. A GAC settlement is only known from Volhynia with a settlement pit from Peresopnitsa (Shelomentsev-Terskiy 1996, 71-73 fig. 1-2).

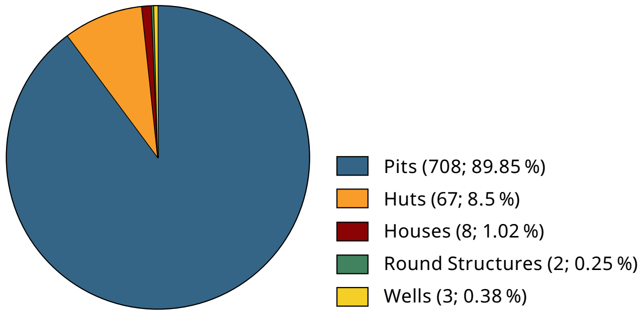


Figure 256. Except for "cultural layers", the evidence for domestic structures is very limited (Suppl. 17).

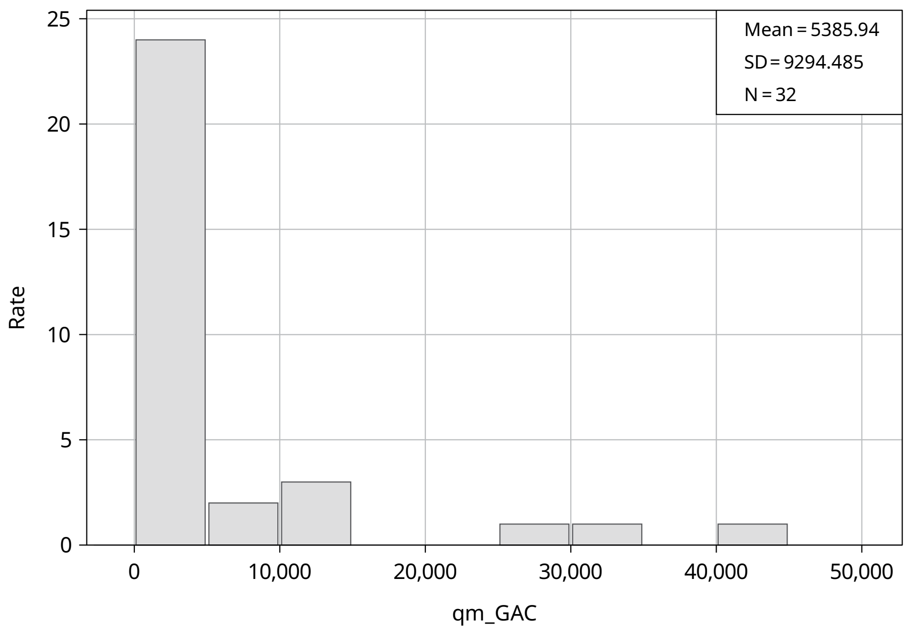


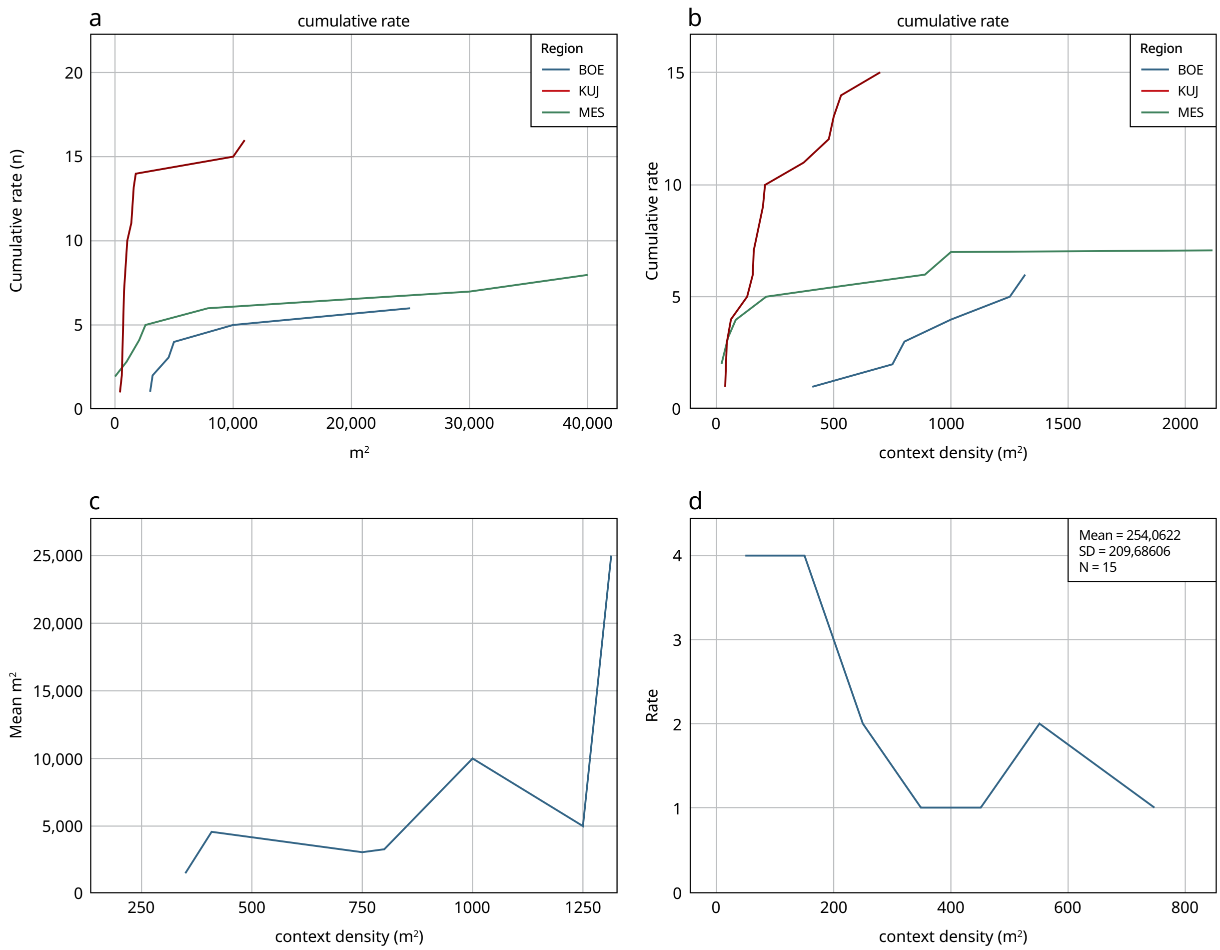
Figure 257. A differentiation is recognisable between the smaller and larger domestic sites. For 32 sites, the size of the sites is recorded. Most of the sites are smaller than 15,000 m², only three are larger (mean ca. 5400 m²) (Suppl. 17).

6.3 Summary and interpretation

Overall, the picture of the domestic remains of the GAC is not very differentiated. From the entire GAC distribution area, there are forty-six sites (Fig. 229), where pits, huts, houses, and, in general, posts, round structures or wells can be identified (Suppl. 17). These are sixteen sites from the Middle Elbe-Saale region and one from the Southwest Baltic region, seven from Bohemia/Moravia, three from Silesia, eighteen from Kuyavia and one from Volhynia. There are no more than 708 pits, 67 huts, eight houses, two round structures and three wells that can be assigned to the GAC (Fig. 256). Maximal values of the individual categories are available with twenty-one pits in Janowice D1,[76] eleven GAC huts of twenty huts in Homolka, three houses in Siciny, a round structure in Dessau-Kleinkühnau and Opatowice 3, and two wells in Eutzsch. On average, 1.25 huts, 0.2 houses and five pits can be expected per site. The average settlement measures 0.53 ha in size, although the context density of ca. 400 m² per feature might indicate that the settlement intensity is not very dense.

Apart from special situations, for example, the mining site in Eula, the ground areas of the largest settlements measure ca. 1 hectare in size. These include Halle-Dölauer Heide, Slavonin Horni 1 and Slavonin Horni in the West Group, and Janowice D2 and Janowice D3 in the eastern GAC network. Exemplarily, we know of seventeen pits and four huts from Janowice D3, and seven pits, one hut and one house from

76 With 475 pits, Eula is a mining site. In Dessau-Kleinkühnau, the 23 pits can only presumably be assigned to the GAC.



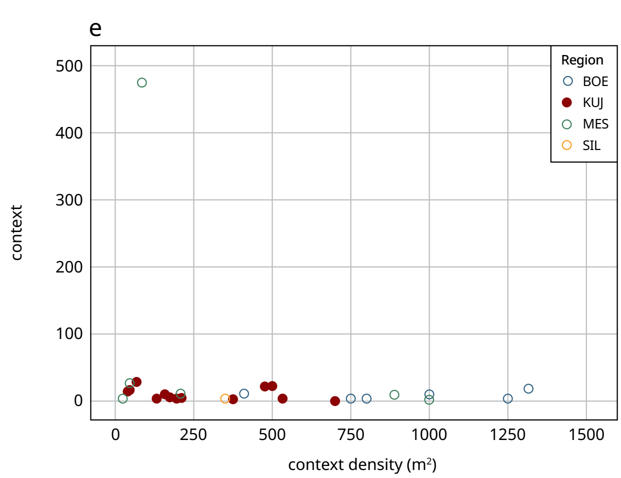


Figure 258. The majority of the site sizes measures below 3000 m² and the frequency of features is also very low (cf. Fig. 257). a – Cumulative rate of m² size per domestic GAC site (n); b – Cumulative rate of domestic GAC sites per context density (m² areal per context); c – Mean m² size of domestic GAC sites per context density; d – Number of GAC domestic sites per context density; e – Number of contexts per site per context density. Key: BOE – Bohemia; KUJ – Kuyavia; MES – Mittelelbe-Saale region; SIL – Lower Silesia.

Halle-Dölauer Heide, which are assigned to the GAC. However, most of the domestic sites are smaller than 0.5 ha, for example, Zauschwitz or the five domestic sites of Opatowice. A clear differentiation is recognisable between the smaller and larger domestic sites (Fig. 257).

On some sites, the GAC is accompanied by other ceramic styles. Included here are Opatowice 33 (with three GAC pits and nine Late TRB pits), Homolka (with eleven GAC huts and nine Řivnáč huts) or also Halle-Dölauer Heide (with seven GAC pits

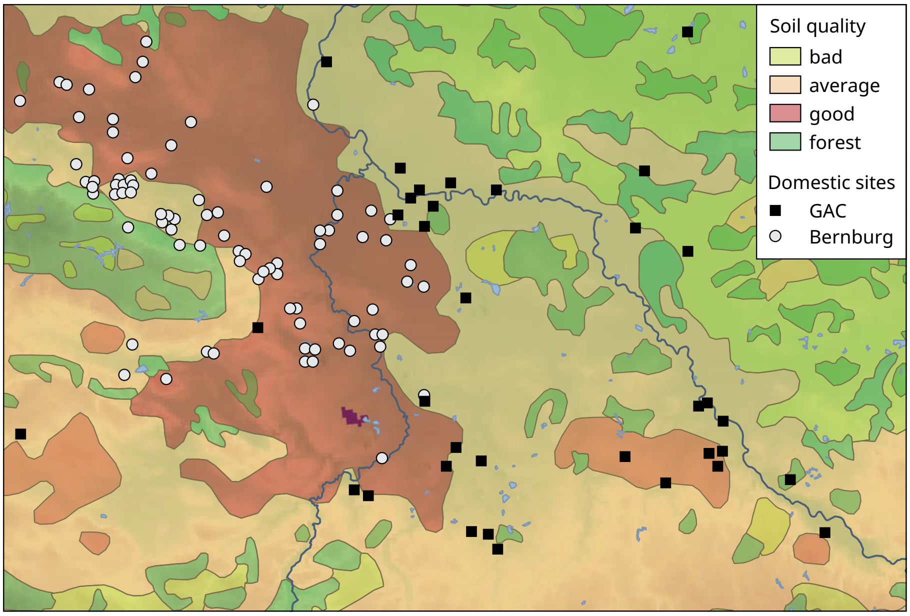


Figure 259. Central Germany: the distribution of Bernburg and GAC domestic sites on different soil types (cf. Woidich 2014, 96 fig. 21).

and 233 Bernburg pits). Corresponding associations are known for both small and large settlement sites.

In summary, the majority of the site sizes measure below 3000 m^2 and the frequency of features is also very low (Fig. 258; cf. Fig. 257). Accordingly, we must assume small reference groups, which depend, *e.g.*, on exogamous marriage practices. Larger context accumulations, such as pits or several pit huts are only found in connection with settlements, where especially regional ceramics are common. These are likely to be communication sites for the entire population of an area. Three of these larger sites are enclosed (Quenstedt-Schalkenburg, Halle-Dölauer Heide, and Homolka), which is a political practice of regional expression and not of the GAC.

In conclusion, the settlement remains of the GAC are obviously of ephemeral character. This is likely to be related to the described herding strategies. Sites with pits and pit huts, also occasionally with post settings for smaller dwellings, are known, but rectangular houses with ridge posts and clearly long-lasting settlement structures are nearly lacking. In both the Elbe and the Vistula-Podolia networks, occasional pits can be found at a regular distance from the nearest site with scattered pits, sometimes along valley edges. Moreover, there are also larger pit accumulations, which indicate special domestic agglomerations. Ephemeral domestic activities are obviously both integrated and in existence beside the "other" domestic structures of the primarily farming regional groups.

6.4 Spatial patterns of GAC domestic sites

For the interpretation of the GAC settlement pattern, the spatial distribution of domestic sites in relation to such contemporaneous groups is informative.

In some GAC areas, considerable differences in location exist between domestic sites of GAC and contemporary groups. In the MES this is the case for GAC and Bernburg settlements (Fig. 259). While the GAC settlements tend to have a strong orientation to more fluvial lowland regions, with a site distribution in the eastern area close to the Elbe and Mulde, Bernburg settlements are more oriented towards the circum-Hercynian loess areas close to the water (*e.g.* Beier 1988; Ostritz 2000). This difference leads to statistically significant differences with regard to certain ecological factors:

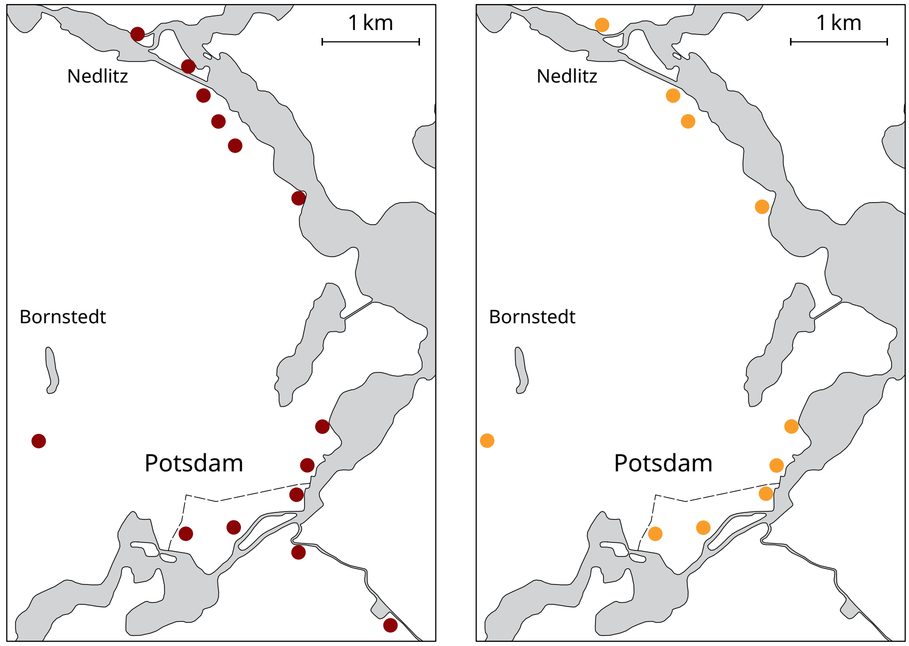


Figure 260. The distribution of site locations is only slightly different between TRB (left) and GAC (right) in the Havel region (Beran and Richter 2014, 101, fig. 9). Here not only GA domestic sites are distributed very closely to lakes or water sources, but also middle and late TRB sites.

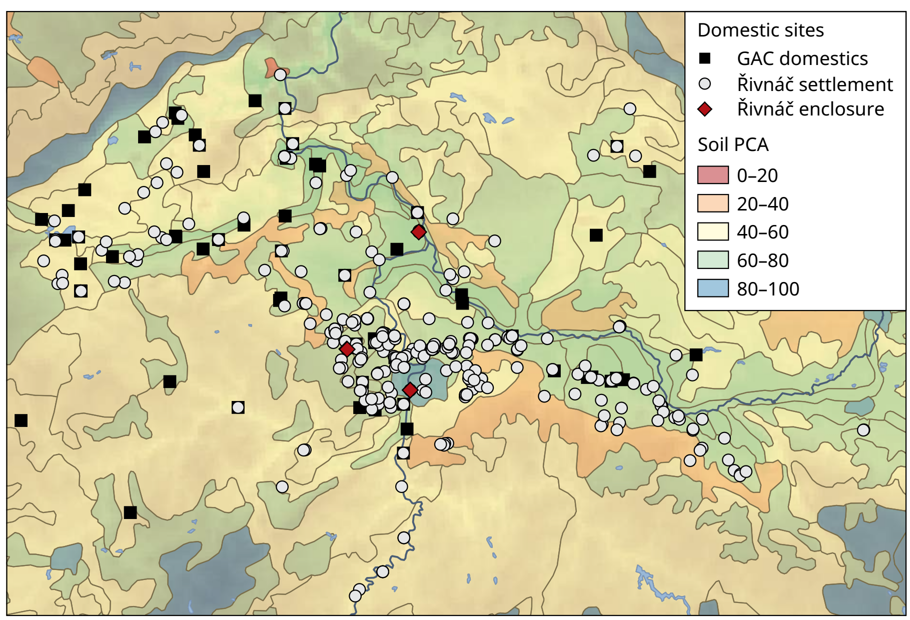


Figure 261. Bohemia: the distribution of Bernberg and GAC sites on different soil types.

soil quality, orientation towards the water and also altitude above sea level are highly significant. We observe a similar pattern in the Altmark. While Tiefstich settlements of the Haldensleben phase are mainly known far from the Elbe, GAC settlements are strongly linked to the alluvial plains near the Elbe (Diers 2018, 24-25 fig. 2.8-9).

The distribution of site locations is different in the Havel region (Beran and Richter 2014, 101 fig. 9; Fig. 260). Here not only GA-doemstic sites are distributed very closely to lakes or water sources, but also middle and late TRB sites. Nevertheless, the orientation of GAC sites points towards resources that are very suitable for pastoral purposes.

In Bohemia, these clear differences can only be partially demonstrated. On the one hand, a separate GAC settlement area is described in northern Bohemia (Woidich 2014, 95), on the other hand, the ecological values are not different from those of contemporary Řivnáč settlements (Fig. 261).

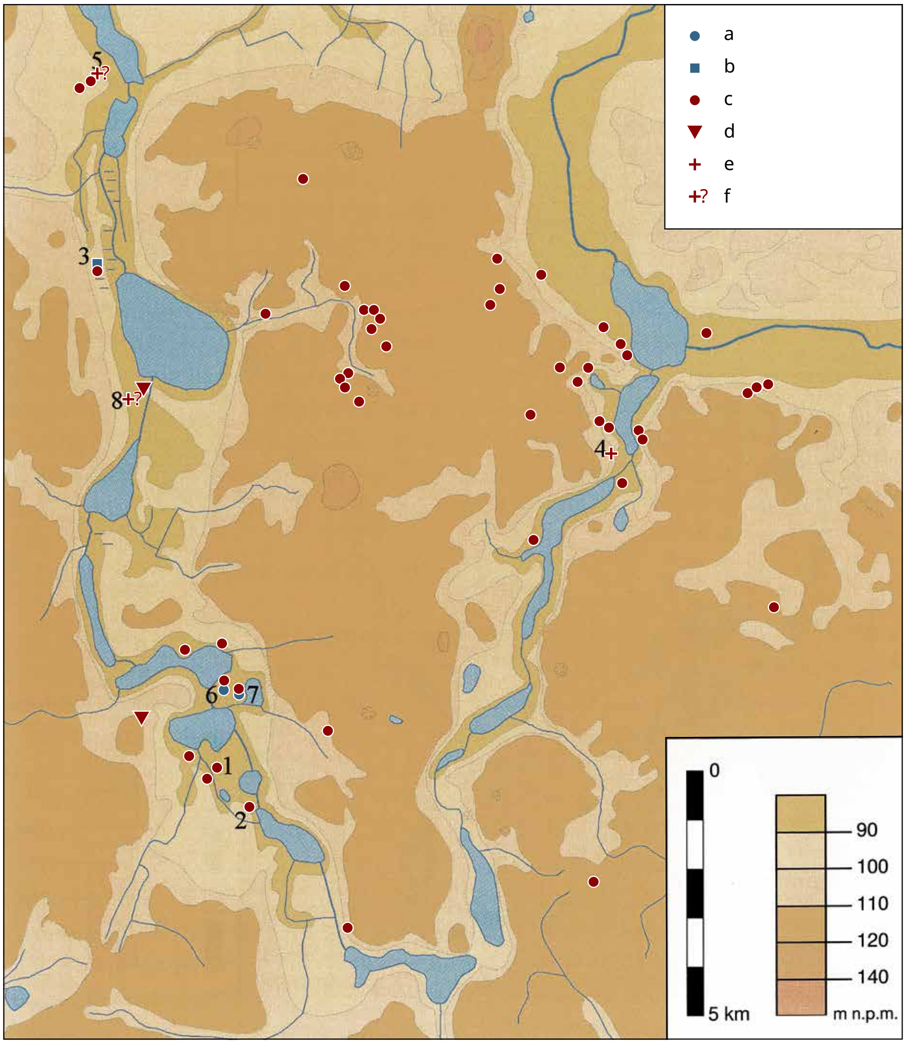


Figure 262. TRB and GAC distribution in north-western Kuyavia with the Chomiasko-Wolicka subglacial channel, the Znin subglacial channel and the surrounding uplands. Both the channels with the watercourses and ribbon lakes were settled by Middle and Late TRB communities, while the GAC communities were present both within the channels and the 20-30 m higher plateau in between. Key: a – Late TRB domestic sites; b – Late TRB loose finds; c – GAC domestic sites; d – GAC macrolithic stray finds; e – GAC cemetery; f – possible GAC cemetery; 1 – Biskupin 2a; 2 – Gasawa; 3 – Jaroszewo; 4 – Kierzkowo 13; 5 – Sobiejuchy; 6 – Wenecja 6; 7 – Wenecja 7; 8 – Znin (after Nowaczyk 2017, 73, fig. 5).

In 1993, in South-West Poland within the drainage basin of the upper and middle Odra, and north of the infertile sandy region of the Lower Silesian Forests stretching northward from the Sudeten mountains, Anna Kulczycka-Leciejewiczowa previously conducted analyses on Late TRB and GAC site locational patterns (Kulczycka-Leciejewiczowa 1993, 7-139, fig. 1; 24, fig. 4; 56-57, fig. 14-15; 136-139, fig. 44-47). The microregions of Strachów and Gniechowice were chosen for detailed settlement studies.

The river networks and the areas close to river courses and irrigated parts of the drainage areas were most important for the choice of both Late TRB and GAC domestic sites. But the GAC

> *'penetrated most often into non-loess regions, rather unfertile, especially young silts in river valleys, covered with grassy vegetation. They settled on a smaller scale in zones of fertile soils. What attracted them there was probably, above all, the relative openness of those lands, stripped by previous users of the once dense forest cover'* (Kulczycka-Leciejewiczowa 1993, 219)

The tendency is that GAC sites are less frequently distributed on loess- and loess-like soils, but more frequently distributed on central parts of peripherical soils than TRB sites.

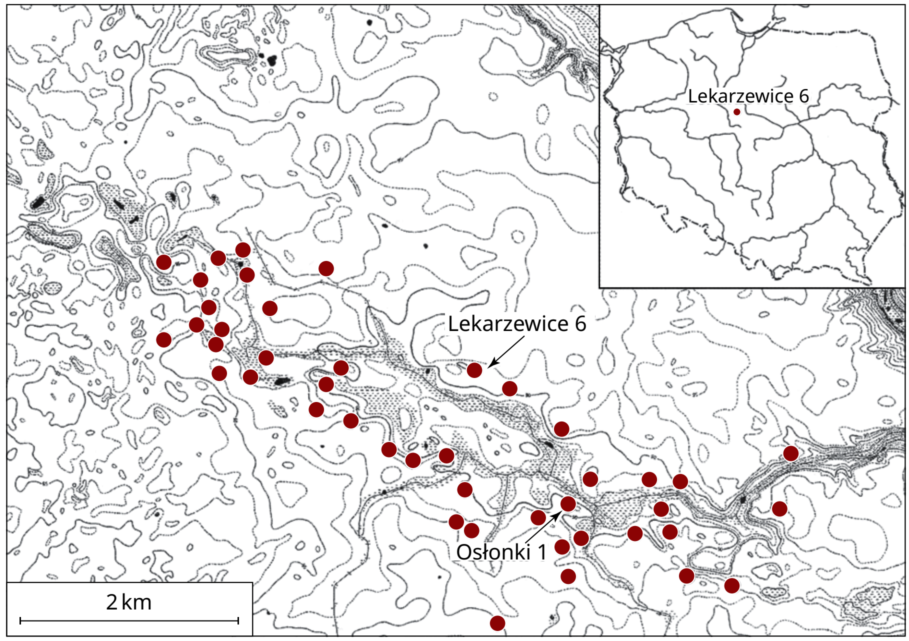


Figure 263. The location of most of the GAC domestic sites within lowlands or within or at the edge of fluvial areas is also contested in the South Kuyavian region of Oslonki (after Grygiel 2014, 164, fig. 1).

Extensive analysis on locational processes of TRB and GAC sites have been conducted in Kuyavia. Lech Czerniak (1994) confirmed the relationship of early TRB domestic sites with mainly sandy settlement places, but also black soils.

> *'As many as 98% of the middle Neolithic TRB sites were located on the terrains earlier uninhabitatd. Its population penetrated mainly areas of river valleys. The borderland areas between sandy soils and brown soils or black soils (on the ground of clay) as well as zones where sandy soils occur exlusively were most frequently settled'* (Rzepecki 2004, 219).

With the GAC,

> *'there appeared optimalization and maximalization of exploiting the local environmental conditions'* (Czerniak 1994, 190).

Marzena Szmyt (1996, 313) identified two types of topographic locations: in comparison with settlements/camps, cemeteries

> *'were decidedly more often located in small uplands beyond the large or middle valleys. In the localization of the settlements the preference was decisively visible for soils made of loose sands and lightly clays…On the other hand, the analysis of the direct hinterland of settlement points provided more balanced results: with the prevalence of areas dominated by the above mentioned soils the share of heavy soils (black, brown and the like) is similar'* (Szmyt 1996, 314).

The extension of the GAC domestic activity area, in comparison with Middle and Late TRB, is also contested by a study on the northwestern Kuyavian region; namely the Chomiasko-Wolicka subglacial channel, the Znin subglacial channel and the surrounding uplands (Fig. 262). Both the channels with the watercourses and ribbow lakes were settled by Middle and Late TRB communities, while the GAC communities were present both within the channels and the 20-30 m higher plateau in between (Nowaczyk 2017). Also statistically significant is the obvious extension of the areas used for subsistence practices. The newly used silty sandy areas were especially suitable for pastoral subsistence practices.

Microregion	n sites	km²	a GAC	a per camp	P/ site	P/km²	Reference
Ldkr. Lutherstadt Wittenberge	18 (3 dom)	1932 km²	300	25	10		Fahr 2018, 43, Abb. 1
Potsdam (Brandenburg)	40	42	300	25	10	0.79	Beran/Richter 2014
Middle and Lower Noteć	114	2572 2000	300	25	10		Rola 2009, 200, fig. 75
Bachorzy/Zglowiiacky (Kuyavia)	88 (46)	140	300	25	10	0.52	Rybicka 1995,28-29, fig. 5., tab. 4
Oslonki microregion (Kuyavia)	44	46	300	25	10	0.8	Grygiel 2013
Chomiasko-Wolicka microregion (Kuyavia)	47	55	300	25	10	0.71	Nowaczyk 2017, 73, fig. 5
Strachow microregion (Silesia)	10	182	300	25	10	0.05	Kulczycka-Leciejewiczowa 1993, 136, fig. 44
Gniechowice microregion (Silesia)	10	182	300	25	10	0.05	Kulczycka-Leciejewiczowa 1993, 137, fig. 45

Table 9. Calculation of GAC population densities in different regions. Key: blue – population reconstruction possible; red/grey – population reconstruction not possible due to incomplete record; n: number; a: year; P: person.

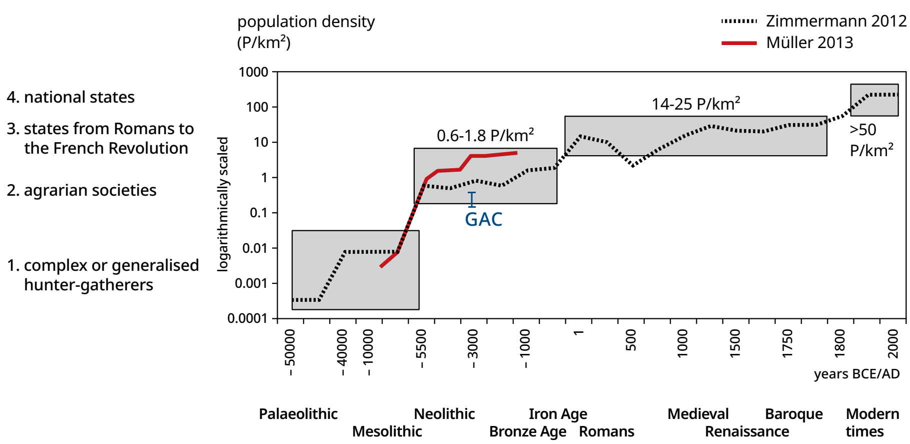


Figure 264. The GAC population is calculated from ca. 130.000 to 210.000 contemporaneously living persons (0.5-0.8 P/km²). In comparison with more general demographic calculations, these values tend to be at the smallest population size of prehistoric agrarian societies (after Zimmermann 2012, 252, fig. 1: 0.6-1.8 P/km²; Müller 2013, fig. 4: 1-2 P/km²).

In other GAC areas, the differentiation between GAC and late TRB sites in respect to ecological factors is not as pronounced as in the MES. A separation is detectable in the site distribution along rivers and basins, but not for different ecological zones. Differences are small-scale or non-existent. Thus, of course, we also find here, *e.g.* in Northeastern Germany, small riverine landscapes or distinct moraine areas. However, there is no large-scale separation. In Kuyavia a difference such as in the MES is also not detectable.

The differences between lowland areas with primarily fluvial soils, and plateau areas with primarily fertile loess soils, display the different economic usage of the lowlands and the plateaus, due to the contrast between the agrarian and pastoral orientation of the farming communities. While the lowlands are intensively used year-round, the plateaus are only intensively used at certain times of the year by GAC communities, usually after the harvest. As a result, there are individual GA graves everywhere, but GA settlements primarily within or on the edge of the aforementioned lowland areas.

The latter orientation of most of the GAC domestic sites within the lowlands, or within or at the edge of fluvial areas, is not only contrasted in the MES, the Havel region, Boehemia and Northern Kuyavia, but also in the South Kuyavian region of Oslonki (Fig. 263; Grygiel 2014, 164, fig. 1).

6.5 Population densities

For the reconstruction of population densities, we can only present the following rough estimations. Suitable areas for this are well-researched micro-regions with domestic sites, where we can assume that the majority of the originally present sites have been recorded.

We assume that, using the following calculation, we can gain an approximate idea of the size of the population who used GA on the basis of the good state of research:

((n sites / km²) / (duration GAC / average site duration)) * person per site

Model calculations from two micro-regions are presented here as examples; one from Kuyavia and another from Central Germany. For the Kuyavian region Oslonki, Ryszard Grygiel (2013) described 44 domestic sites of the type Lekarzewice 6 over 46 km² (Fig. 246 and 263). Chronologically, we can assume a time span of ca. 300 years. With an estimated duration of individual sites at ca. 25 years, and a population of ca. 5 people, using the formula gives us an assumed average population density of

((44 s / 46 km²) / (300 a / 25 a)) * 10p = 0.8 P/km².

For the Havel region of Potsdam, Jonas Beran and Frank Richter name 11 settlement sites over 42.25 km² (Beran and Richter 2014; Fig. 260). On the basis of the restrictions they describe due to the nature of contract archaeology and the destruction of the site by city structures, we can assume that here the GA domestic sites were located like a string of beads at intervals of ca. 500 m, so that we are dealing with a total of ca. 40 campsites. Using similar assumptions regarding GA duration and population, we obtain here an average population density of

((ca. 40 s / 42 km²) / (300 a / 25 a)) * 10p = 0.79 P/km².[77]

From other areas of the GA distribution we obtain comparable data (cf. Tab. 9). In this way, we can distinguish between those with good sources and from the central distribution area of the GAC, and those which can be regarded as more peripheral in the economic system (cf. Tab. 9). The latter is the case for two Lower Silesian micro-regions, which were discussed as pasture areas outside of the actual distribution region by Kulczycka-Leciejewiczowa (1993).

If we want to transfer these numbers to the entire spread of the GAC, it results in an assumed population density for the central distribution areas of 0.5-0.8 inhabitants per km².

We could, therefore, envisage ca. 130,000 to 210,000 people who use GA living at the same time over the ca. 260,000 km² area where GAC is present. In comparison with more general population calculations, the values are on the lower end of the scale for prehistoric agrarian societies (Zimmermann 2012, 252, fig. 1: 0.6-1.8 P/km²; Müller 2013, fig. 4: 1-2 P/km²)(Fig. 264).

77 Using only the extant archaeological sites, the result is 0.24 P/km².

7. Scales of Mobility: The historical dimension of the Globular Amphora phenomenon

The results presented here thus far show that the GAC phenomenon presents itself as a social practice of certain groups between the Western Baltic region and the Moldavian plateaus with high similarities in the ritual sphere (*e.g.* cattle depositions and single graves), an economy oriented towards lowland areas, but also significant differences in household-produced items. Accordingly, we could reconstruct a Western and an Eastern GAC exchange network. Both emerged at about the same time in the Middle Elbe-Lower Vistula area through processes of separation and identity formation from existing societies from ca. 3200 BCE. An expansion of the GAC phenomenon and an infiltration of neighbouring groups can be observed in the west and the south from ca. 3000 BCE, but especially in the southeast. From 2900 BCE, areas are settled here – probably ten generations after GAC networks were long established in the rest of Central Europe. The palaeological and economic changes, which appear from ca. 3200-2900 in the high-resolution profiles of the North Central European lowlands, confirm reforestation and thus social and climatic changes that certainly mirror the emergence of the GAC.

Can we reconstruct mobility patterns on the basis of spatial scales for the carriers of the described historical processes? In addition to the local and small-regional catchment areas described in the previous chapters, we would like to compile and evaluate arguments for different or similar mobility forms, particularly at the meso and macro levels. In principle, main mobility areas are indicated by palaeogenetic results, while the material analysis studies and the isotope analyses can further specify the scope of mobility.

7.1 Kinship and ancestry of GAC individuals: The database

Since the first aDNA analyses on single GAC graves were presented in 2017, the GAC – although only very few analyses are available – has assumed a front position in the discussion of large narratives on the European-wide processes of change around 3000 BCE. In the following, the results of previous studies are presented and evaluated.

Thus far, palaeogenetic analyses are available for 42 individuals who are directly associated with the GAC (Suppl. 18). Of these, three are from Volhynia, eighteen from Lesser Poland and adjacent areas, and six from Bohemia. In Koszyce and

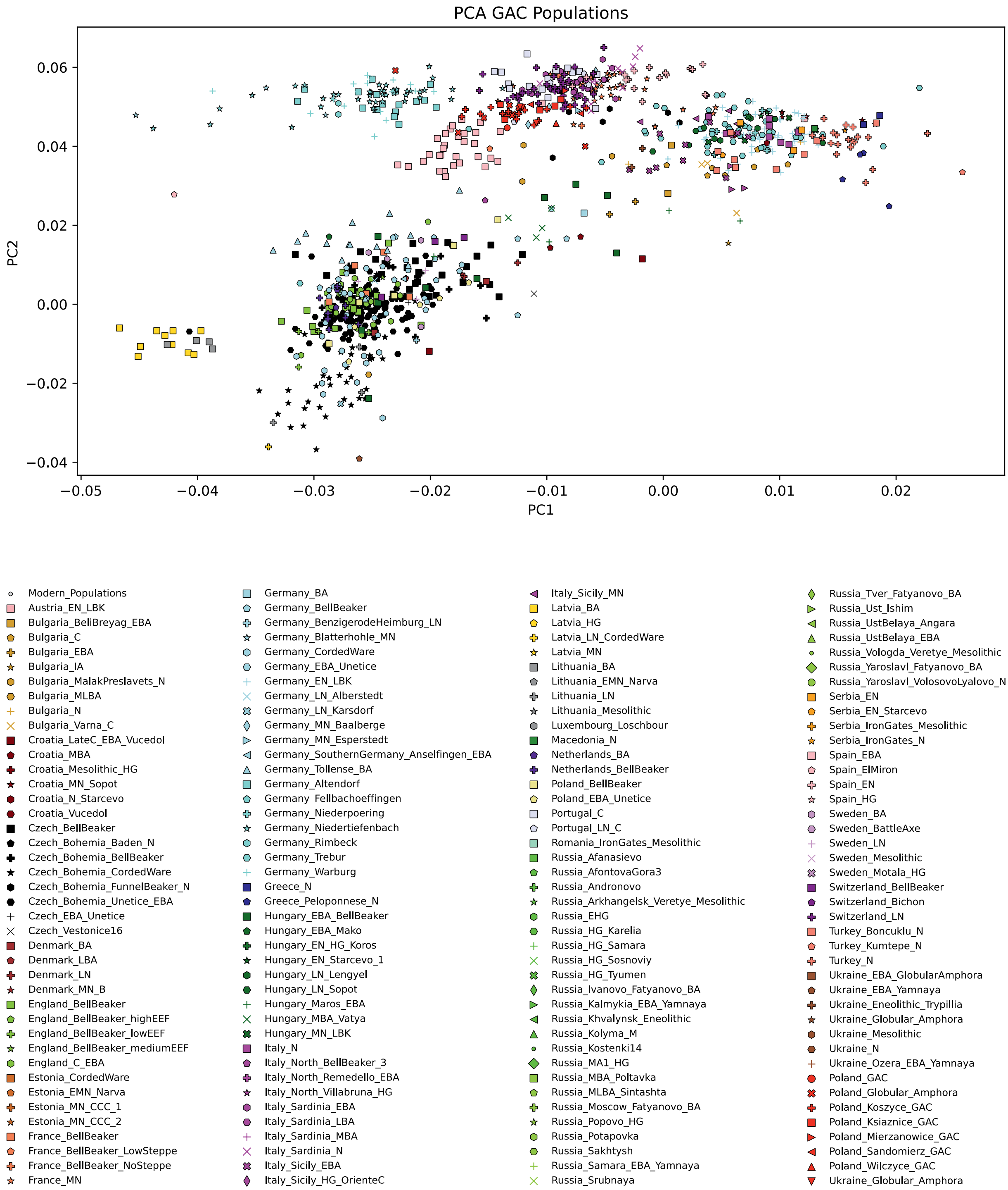
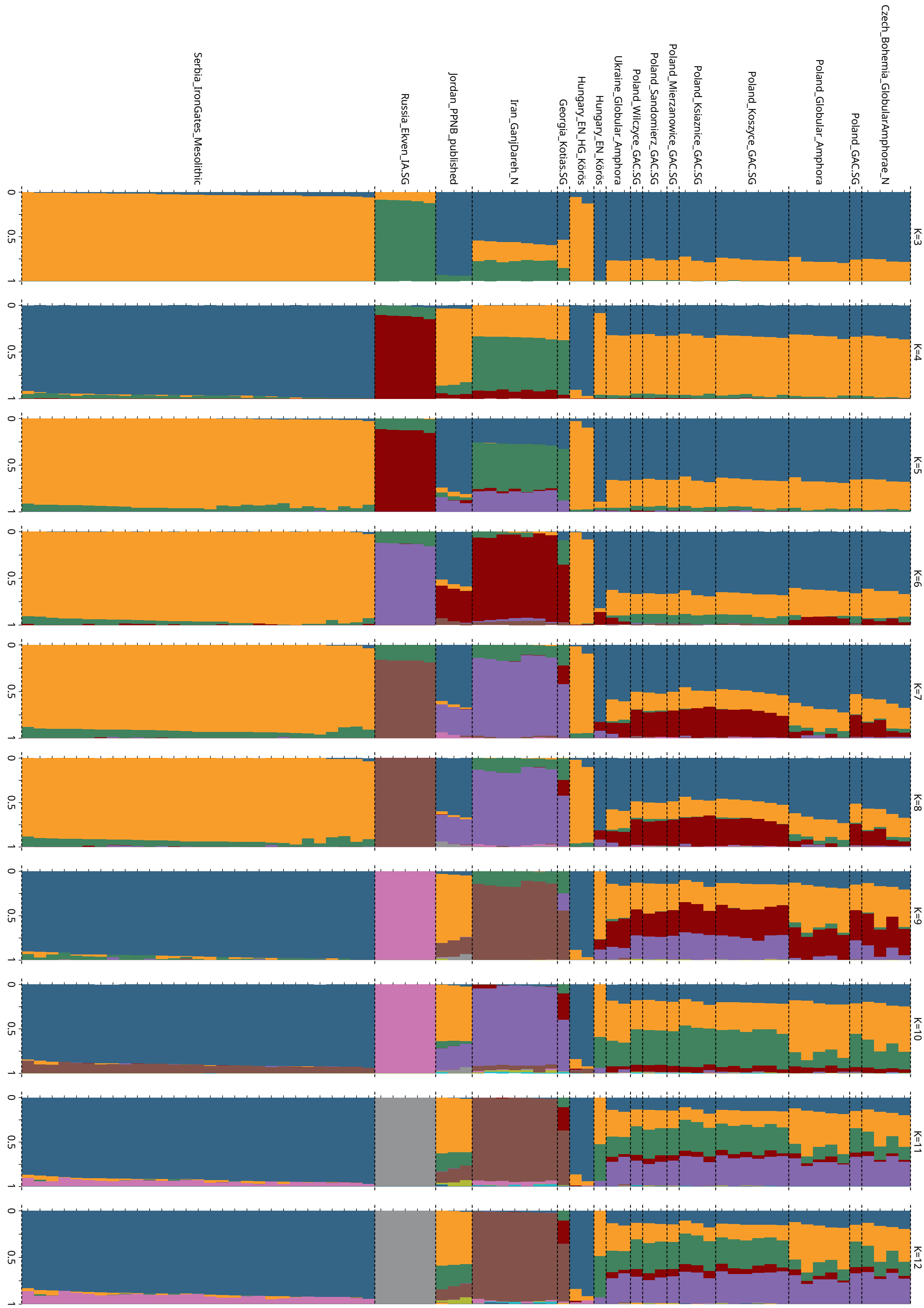


Figure 265a and b. In the display of the first two eigenvectors of the PCAs on the basis of all currently available aDNA data, the GAC individuals are positioned as a largely closed block in the range of the European Anatolian Neolithic, however, somewhat deviating by the higher WHG proportions (after Papac et al. 2021, 5, fig. 3).



Serbia_IronGates_Mesolithic
Russia_Ekven_IA.SG
Jordan_PPNB_published
Iran_GanjDareh_N
Georgia_Kotias.SG
Hungary_EN_HG_Körös
Hungary_EN_Körös
Ukraine_Globular_Amphora
Poland_Wilczyce_GAC.SG
Poland_Sandomierz_GAC.SG
Poland_Mierzanowice_GAC.SG
Poland_Ksiaznice_GAC.SG
Poland_Koszyce_GAC.SG
Poland_Globular_Amphora
Poland_GAC.SG
Czech_Bohemia_GlobularAmphorae_N
K=3
K=4
K=5
K=6
K=7
K=8
K=9
K=10
K=11
K=12
0
0.5
1

Kierzkowo, a mass grave or burials in a megalithic tomb (together already twenty-one individuals), a multiple burial with three specific individuals and ten single graves from different sites are recorded. A determination from a Southwest Baltic megalithic tomb might be associated with the GAC. Twenty males and fourteen females are sex-determined. Mitochondrial haplotypes were determined in thirty-four individuals, Y-haplotypes in eighteen individuals.

The first GAC analyses, among others, were published by Tassi *et al.* (2017) on the Central Polish megalithic tomb Kierzkowo, followed by Mathieson *et al.* (2017), Mathieson *et al.* (2018) with three dates from Volhynia, and by Fernandes *et al.* (2018) with one further date on Kuyavia. Schroeder *et al.* (2019) published 2018 results on the mass grave of Koszyce; Papac *et al.* (2021) presented results for Bohemia. With the available data, first statements can be made about genetic origin and mobility, but also about family structures.

7.2 Genetic continuities between Middle and Late Neolithic Groups and the GAC

With a few aDNA analyses, Tassi *et al.* (2017) were already able to determine that the GAC individuals are not generally distinct from other contemporaneous or older Central European regional groups. Thus, the genetic ancestry of the studied GAC individuals can be explained as an admixture of components of the Anatolian Neolithic (AN) in Central European Neolithic “agrarian” groups and of the component of primarily Western Hunter-Gatherers (WHG). Steppe ancestry is only proven in one case (Kierzkowo with 15% steppe ancestry in one genome; Tassi *et al.* 2017, 5), so that practically no genetic exchange exists between the GAC and steppe groups. Instead, GAC ancestry is to be inferred from Central European genetic groups. This is also the result of Mathieson *et al.* (2018; Fig. 3), who plot the genetic ancestry from the Anatolia Neolithic through the Balkan Neolithic to the LBK, the Central Middle Neolithic and finally the GAC with increasing WHG proportions.

In the representations of the first two eigenvectors of the PCAs on the basis of all currently available data, the GAC individuals are accordingly positioned as a largely closed block in the range of the European Anatolia Neolithic, however, somewhat deviating by the higher WHG proportions (Fig. 265-266).

7.3 Regional variances

Apart from these basic similarities, differences can be observed between GAC genomes as well as between GAC genomes and regional groups. Basically, the proportion in the admixtures of the Anatolia Neolithic and the WHG is similar, and that of Yamnaya from Samara and EHG (Eastern hunter-gatherer) is absent or extremely low (Fig. 266).

However, a certain west-east difference between the Bohemian and the Polish/Ukrainian data is noticeable in the representation of the PCA values, which can be interpreted as a reflection of regional differences.[78] Moreover, there are detailed indications of regional mobilities, which indicate “internal migrations” in some regions.

Accordingly, we would like to observe the results on a west-east axis for the individual regions.

78 This concerns the difference between Bohemian data and the other Polish and Ukrainian data (cf. Fig. 265). Eventually, differences between the western and the eastern GAC networks become tangible here.

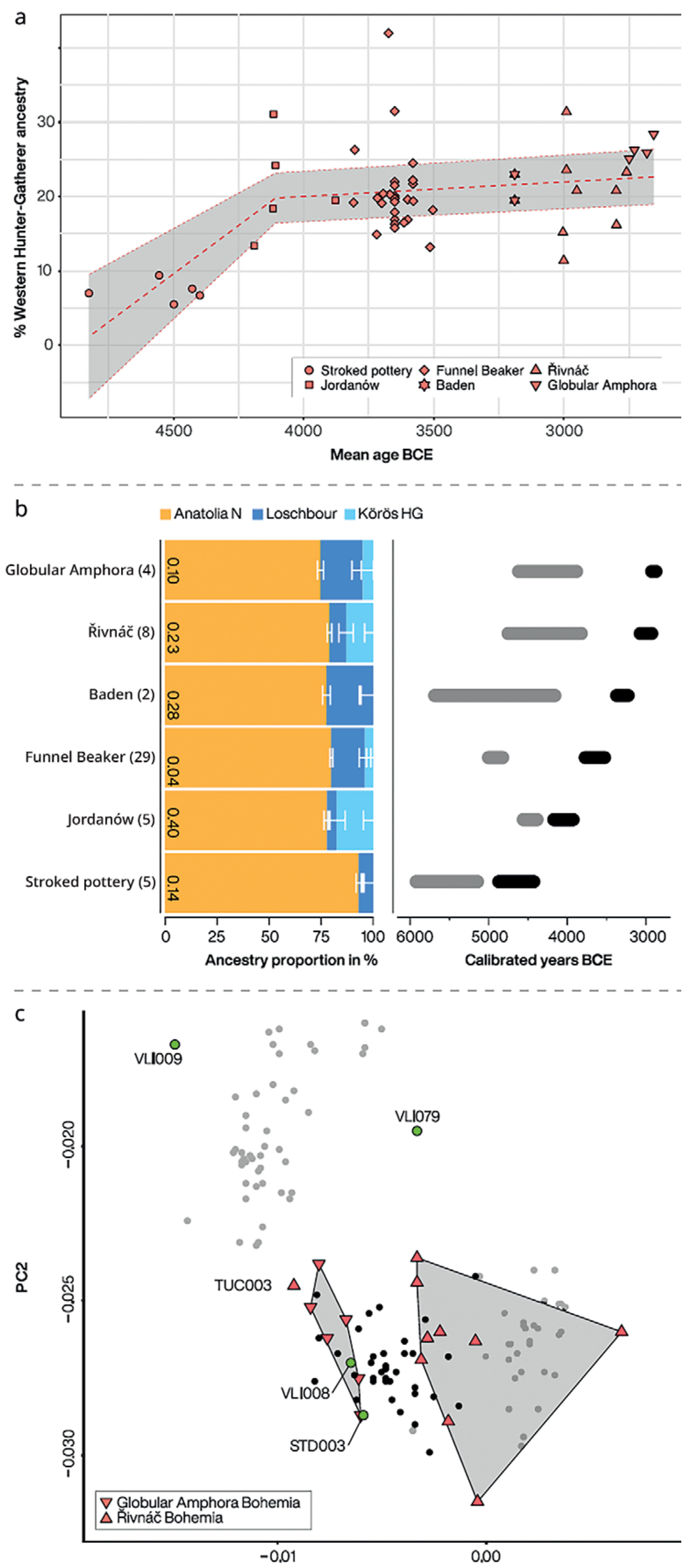


Figure 266. The high WHG values of the Bohemian GAC line up in the pattern of a high WHG component as an admixture to the Anatolian Neolithic component (after Papac et al. 2021, 5, fig. 3). a – Proportion of WHG ancestry in pre-Corded Ware individuals from Bohemia (95% confidence interval marked); b – Proportion of ancestry. Right: HG admixture (grey) relative to group dating (black); c – PCA display of Bohemian GAC, Řivnáč, early Corded Ware females without steppe ancestry (green circles) and Polish and Ukranian GAC individuals (Black dots).

7.3.1 Western Germany

Even if Wartberg in Western Germany does not belong to the actual distribution area of ritual practices with GA ceramics, the occurrence of isolated GA ceramic units is regular here. Accordingly, it may also be significant for the GAC that the proportion of WHG in the Late Neolithic groups of Western Germany is obviously very high, as confirmed by the Wartberg individuals from the collective gallery grave of Niedertiefenbach (Immel *et al.* 2021).

Forty-two individuals of the Hessian gallery grave Niedertiefenbach (ca. 3299-3175) could be genetically analysed (eleven as female, twenty-six as male). The proportion of European HG (hunter-gatherers) is ca. 40% (34-56%), that of the Anatolia Neolithic 60% (Suppl. data 2). The admixture of WHG Loschbour occurred 14.85±2.82 or, according to DATES, 16.6±2.65 generations, *i.e.* ca. 480 years before the burial of the dead (Immel *et al.* 2021, Suppl. data 2) at ca. 3710-3550 (3630) BCE.

In the ca. 150 km distant Blätterhöhle near Hagen, in which four individuals (ca. 4100-3000 BCE) were interred, there is a similar genetic ancestry as in Niedertiefenbach (Bollongino *et al.* 2013; Immel *et al.* 2021, 5). Since these burials without burial goods can be assigned to Michelsberg due to the regional temporal context, there is a certain probability that the high WHG component of the individuals could be assigned to Michelsberg (usually without burials) and thus to the West Central European Middle and Late Neolithic. For the individuals of the Blätterhöhle, the average dating to 3414±84 BCE is to be expected with an admixture of 18-26 generations before deposition, *i.e.*, approx. 3940-4170 (4055) BCE.

Even though we are outside the actual GAC region with Niedertiefenbach and the Blätterhöhle and the local ceramic groups show GAC imports, the agreement of high WHG and AN proportions is nevertheless significant. Thus, we assume that the GAC has its genetic roots where the WHG proportion is high in the regional predecessor groups.[79]

7.3.2 Middle Elbe-Saale region

A Bernburg burial in Central Germany also has WHG values that are comparable to those of Niedertiefenbach and the Blätterhöhle.

Overall, we only know of two nuclear genome analyses from Central Germany for the time frame considered here: Esperstedt (Bernburg grave) and Salzmünde-Schiepzig (Salzmünder grave) (Haak *et al.* 2015; Schroeder *et al.* 2019). The relatively high WHG proportion of ca. 40% is significant for Esperstedt, which corresponds to the features from the already mentioned gallery grave of Niedertiefenbach (cf. Immel *et al.* 2021). Obviously, we observe an "admixture" here, which possibly took place from ca. 3800 BCE (possibly in connection with Michelsberg), and could indicate a similar intensification of human mobility between Central and Western Europe, as we note at the beginning of the 3rd millennium BCE in relation to "eastern steppe influences". The proportion of the Esperstedt Bernburg individuals differs from three Baalberg individuals from Esperstedt and Quedlinburg, who have significantly lower WHG proportions (less than 20%; cf. also Schroeder *et al.* 2019, 10707 fig. 2B).

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79 The evidence of a general western component of GAC individuals is indicated on a large-scale in Tassi *et al.* (2017) in the admixture calculation there with four components. 'When the ADMIXTURE is asked to cluster the samples into four rather than three groups, the Early Neolithic cluster fissions into two, and the new component […] is present in the GAC, as well as in several other Western European populations. This second Neolithic component, here referred to as Western Europe Neolithic, accounts for a large share of the ancestry of individuals such as those from Iberia (Iberia_CA), La Mina (LaMina_MN) and Els Trocs (Els_Trocs_EN)' (Tassi *et al.* 2017, 15).

In the farming groups further east, this WHG proportion is only partially as high. In the case of the GAC, it is only ca. 25% continuously from west to east, although there is no data for GAC individuals from Central Germany.

7.3.3 Bohemia

The high WHG values of the Bohemian GAC line up (four individuals) in the pattern of a high WHG component as an admixture to the Anatolia Neolithic component (Fig. 266). The WHG proportion of the eleven studied individuals of the regional Řivnáč group is comparable to that of the Bohemian GAC. Moreover, comparable values are calculated by Papac *et al.* (2021) for the time span of the admixture events of AN/WHG for the eight Řivnáč individuals (Řivnáč 4830-3747, mean 4289 BCE; GAC: 4696-3807, mean 4252 BCE; Papac *et al.* 2021, suppl. tab. S11). But Řivnáč has lower WHG values and, in contrast, additional Körös-HG values. From this, a different lineage for Řivnáč and an immigration of the GAC from regions with high WHG and missing Körös-HG to Bohemia can be postulated. One of the eight Řivnáč individuals, individual TUC003 from Tuchoměřice, has a GAC genetic fingerprint in a burial ground typologically assigned to Řivnáč. It is a 3-5-year-old male child (Papac *et al.* 2021, suppl. tab. S3). If fixed boundaries are postulated between GAC and Řivnáč, it was probably a child from a GAC group.

Possibly, there may be differences in origin within samples that look similar. Although simultaneous WHG/AN admixture events exist, an earlier regional existence of Řivnáč is observed due to the earlier Körös-HG-admixture. Irrespective of this, the high interaction of the affected individuals is nevertheless recognisable, *e.g.*, with individual TUC003 from Tuchoměřice. Furthermore, the identification of the individuals from Vliněvsi, crouched together in a former storage pit, and labelled by Papac *et al.* (2021) as GAC-individuals, might belong to Řivnáč (Dobeš *et al.* 2022). The only diagnostic cup, which was associated with the burials, is a variation of a Řivnáč type. Again, the local and regional interacting practices are visible. The study also verifies that the GAC makes a significant contribution to the multicultural composition of the Early Corded Ware in Bohemia (Papac *et al.* 2021).

Even if this method is generally deemed to be difficult, it is noticeable that the calculated GAC admixture period and also the high WHG proportion correspond to that of the individuals of the Niedertiefenbach (Hesse) gallery grave. In this respect, the similarity of GAC with Wartberg and certainly also Bernburg is indicated, in which corresponding Körös-HG proportions are not present.[80] Apart from small-regional shifts and differences, the diversity of Late Neolithic groups in Central Europe is represented by the admixture differences of WHG, but not the fundamental difference between these individuals equipped with GA ceramics, Apparently, in addition to local constancy, regional immigration is also possible. This results rather in a mosaic-like overall structure of different mobilities (see below).

7.3.4 Northern Poland

From the Northern and Southern Polish regions, it is mainly the GAC mass burial from Koszyce with fifteen and the megalithic tomb Kierzkowo with four genetically determined GAC individuals that also reflect the high WHG proportions among GAC individuals (Mathieson *et al.* 2018; Schroeder *et al.* 2019).

In the Northwestern Polish region, it is a megalithic tomb Kierzkowo. Within the chamber, Neolithic human remains were found, in many cases mixed with animal bones. While three genetically analysed individuals from outside the chamber proved to be modern, four individuals could be genetically analysed and assigned to

80 Admixture models with Körös-HG were falsified in Niedertiefenbach.

the GAC based on finds and radiometric dates (Mathieson *et al.* 2018; Nowaczyk *et al.* 2017). It is an admixture of AN (Barcin)/WHG with a WHG share of more than 20%.

A 20-30-year-old female GAC individual from Brescj Kujawski, who originates from a stone protected double grave with a 50-year-old male burial, reflects the relatively high proportion of WHG in addition to the AN proportion. The regional TRB is represented by three individuals, whose genetic ancestry is comparable to that of the GAC. The WHG proportion is surprisingly high compared to the AN proportion. In fact, no differences can be detected between the TRB and the GAC (Fernandes *et al.* 2018).

7.3.5 Lesser Poland

In Koszyce, the GAC burials consistently show AN and WHG with high WHG proportions of ca. 25%. This picture is also confirmed by the GAC graves from Mierzanowice and Sandormierz, but also by the Zlota graves of Zlota-Ksiaznince and Zlota-Wilczyce (Schroeder *et al.* 2019, 10707 fig. 2).

> *'We find that the Koszyce burial represents a large extended family connected via several first- and second-degree relationships'* (Schroeder *et al.* 2019, 10707-10708 fig. 3 and SI appendix fig. S9).

Unfortunately, genetic analyses of contemporaneous or earlier TRB individuals are lacking for Southern Poland.

7.3.6 Western Ukraine

Stronger differences between regional groups and the GAC are likely to exist in the Western Ukraine. While the Late Tripolye individuals from the Vertebra Cave dating to ca. 3500 BCE exhibit a much lower proportion of WHG as the Globular Amphora individuals from Ilyatka, in addition to a Balkan proportion missing in the GA individuals, the GA individuals from Ilyatka show a constantly high WHG proportion (Kadrow 2013; Mathieson *et al.* 2018). In this respect, quite strong genetic differences are likely to be present here.

The four genetically determined individuals of the Vertebra Cave are represented by four skulls from site 7.[81] They were deposited as skull depositions at the same level as the cave floor, separated from the main cave by a dry-stone wall. The four individuals were not directly dated, however, site 7 dates from ca. 3700-2700 BCE with a focus around 3500 BCE (Mathieson *et al.* 2018, suppl.). The Ilytaka site is a burial complex under stone slabs, consisting of a pit with arranged bones of five disarticulated, mixed individuals and two laterally separated articulated individuals. From the mixed and disarticulated multiple burial of five individuals, two individuals were genetically determined (the 45-55-year-old male individual 1 ILK001 and the 40-50-year-old individual 2 ILK002). The two other articulated individuals were placed to the west and east of the grave pit: Under the western stone slab, separated from the main burial by a stone slab, was a female skeleton that was also genetically determined (the 20-30-year-old female individual 7, I ILK003).

81 I1926 / 1 V1a-H1 – V3.17.1; I2110 / 4 V4a-H4 – V3.14.1; I2111 / 5 V5a-H5 – V3.13.1; I3151 / 6 V6a-H6 – V3.15.1.

7.4 The Central European Globular Amphora societies and the emergence of the Corded Ware societies

Globular Amphora individuals correspond to the AN ancestry of the regional predecessors or even contemporaneous Neolithic societies of Central Europe. Recent studies also confirm this phenomenon already presented by Fernandes *et al.* (2018), Mathieson *et al.* (2018), and Schroeder *et al.* (2019). This supports the typological connections that have long postulated the linkage of GAC to regional TRB or Michelsberg groups of Central Europe (cf. Beier 1988; Müller 2001). In addition, in the rather uniformly high proportion of WHG occurring in GAC individuals, we recognise a correspondence with regional Late Neolithic groups of Central Europe. In the narrower GAC distribution area (with the typical ritual GAC practices), this includes Central Germany and Northern Poland, and beyond this, also Western Germany, where, however, the GAC is only represented by material imports in regional Late Neolithic groups.

Due to the genetic differences of the GAC individuals to those of the regional groups in Bohemia and Western Ukraine, regional migrations can be reconstructed for this area. Unfortunately, data on individuals of the regional societies is missing for Southern Poland thus far. The genetic investigations that are available confirm the basic tendency of the area of origin of the GAC postulated in this study between the Middle Elbe and the Lower Vistula.

In a new study (Allentoft *et al.* 2022), the GAC is assigned a prominent role in the postulated genetic exchange processes. After the role of the so-called Yamnaya steppe invasion and the genetic transmission of Yamnaya to CWC were significantly reduced in importance due to the mismatch of the Y haplotypes, new scenarios for the changes in the 3rd millennium are sought. In particular, Papac *et al.* (2021) have already pointed out the genetically diverse structure of the Bohemian CWC and the proportion of local GAC individuals – among others – in the emergence of the CWC in the area there. Even if there is – analogous to the CWC – practically no genetic transmission between the GAC and Yamnaya, an ideological common ground is implied by Allentoft *et al.* (2022) from typologically proven regional exchange references in the material culture in the border area between the easternmost GAC and Yamnaya, which should pave the way for the spread of the steppe gene during the Yamnaya period.

The latter ideas are not comprehensible from a chronological perspective. The mutual exchange between the GAC in Volhynia and other eastern areas occurred around 2700-2500 BCE (Szmyt 1999b; Szymt 2000b, 461), at a time when the classical GAC no longer existed in Central Europe and Corded Ware was already established (*e.g.* in Bohemia already before 2900 BCE, cf. Papac *et al.* 2021, 5). Y-haplotypes show that the Y-haplotypes associated with the Yamnaya complex do not occur in the Early and Middle Corded Ware until about 2600 BCE (cf. Müller 2021), which Allenthoft *et al.* (2022) did not discuss due to the long timespan used there for the presentation of the developments.

Accordingly, we can discuss the origin of the CWC and the contribution of the GAC to this, completely independent of a grass steppe ancestry. The most detailed genetic analyses are again available from Bohemia (Papac *et al.* 2021). Due to the dating of several individuals from the Early Vliněves Corded Ware burial ground, the extremely high genetic variability of the Early Corded Ware could be recognised (*ibid.* fig. 5; tab. S27) (Fig. 267). The variability is greater than all modern-day European populations (*ibid.* 6). Basically, the genetic variability of the Early Corded Ware can best be modeled by a mixture of Northeastern European groups, local groups and to a lesser extent by a grass steppe ancestry. This results in a fundamentally

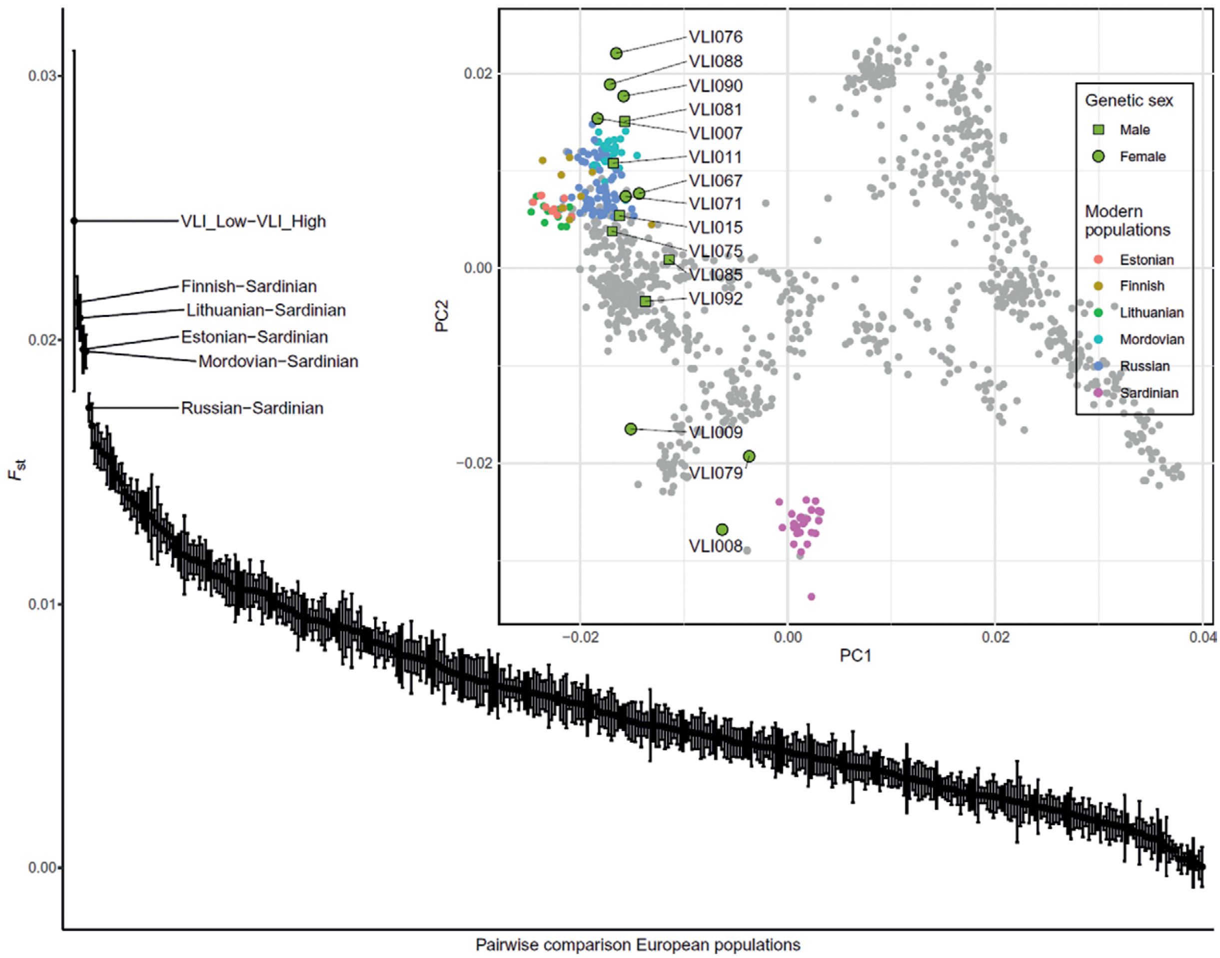

Figure 267. Due to the dating of several individuals from the Early Vliněves Corded Ware burial ground, the extremely high genetic variability of the Early Corded Ware could be recognised. The variability is greater than all modern-day European populations (after Papac et al. 2021, 8, fig. 5).

high level of interaction between the entire Corded Ware areas, which include the Northeastern European regions.

Interestingly, the Early Bohemian CW individuals without steppe ancestry are all female (Papac *et al.* 2021, 6). 2 of these females correspond to GAC females, as genetically identified from Bohemia or Poland. The high WHG proportion within these individuals probably refers to the assimilation process that took place in areas where the GAC can, in principle, be genetically derived from the regional groups – *i.e.* also in the area of GAC origin postulated here. Purely quantitatively according to haplotypes, for the Early Corded Ware in Bohemia, we can identify nine individuals with R1b-variants, three with R1a variants and three with other variants (*ibid.* 7 fig. 4a). In principle, this results in a genetic diversity also among males, which could originate from the entire Corded Ware area (Central Europe and Northeastern European forest areas and forest steppes) and only to a small extent from the grass steppe areas.

7.5 Kinship structures and marriage practices

In addition to the reconstruction of the genetic positioning of individuals in relation to predecessor and successor phenomena, or neighbouring societies on a spatial macro level, corresponding data on the local level can be used for the reconstruction of concrete kinship relationships between people, if there is sufficient data. From this, conclusions can be drawn about, for example, the form of partnerships or the practice of partner selection.

Thus far, the Kierzkowo megalithic tomb, the Koszyce mass grave and the Benzingerode walled chamber provided indications for the reconstruction of Late Neolithic family relationships from the core area of the GAC. Moreover, there is also the Niedertiefenbach gallery grave on the western edge of the GAC.

In Kierzkowo, Northwest Poland, the relationships of the individuals already described above could be reconstructed from the contextual conditions (Mathieson *et al.* 2018; Nowaczyk *et al.* 2017). On the basis of haplotypes, a 50-60-year-old mother (I2433 / 5.1), a father (I2440 / 7.6, no age information) and the two sons (I2407 / 7.1 and 8.4), who were identified as young men, were determined. Therefore, we record a nuclear family.

Genetic and strontium isotope analyses are available from the Lesser Polish mass grave of Koszyce, which enables a reconstruction of family relationships (Schroeder *et al.* 2019, 10707 fig. 2). Of the fifteen individuals, eight are male and seven are female. Close relatives were interred spatially close to each other (Fig. 268; Schroeder *et al.* 2019). Thus, the kinship principle likely determined the spatial placement of the deceased. In the burials, a mother embraced her child and twins were interred next to each other. The oldest individual 14 of the mass grave, a 50-60-year-old woman, was buried very close to her two 20-25 and 40-50-year-old sons (individuals 5 and 15, respectively), whereas a 30-35-year-old mother (individual 8) was buried close to her 15-16-year-old daughter (individual 9) and her 5 year-old son (individual 13). Individuals 5 (20-25-years old), 10 (18-20-years-old), 11 (40-50-years old) and 15 (40-50-years old) could be identified as brothers, although they did not have the same mother (individual 14 is the mother of 5 and 15, but not of 10 and 11). They were half-brothers. However, since the four brothers share the same mtDNA, their mothers were related. In addition, the 18-20-year-old half-brother 10 is interred together opposite his 25-30-year-old (life stage?) partner (individual 1) and their common 1.5-2-year-old son (individual 2).

Three older men/fathers and a woman/mother are missing from the burial for a completion of the nuclear families. Individual 7 is a 2-2.5-year-old boy, whose parents are not buried in the grave. He is buried near the other individuals to whom he is related to a second or third degree. Individual 3 is a 30-35-year-old female, who is not related to anyone in the grave, but directly next to individual 4, a 16-17-year-old male. He is the child of the 30-40-year-old woman (individual 12), whose 13-14-year-old daughter (individual 6) is also with her.

Included among the buried individuals are chromosomally seven female and eight male individuals. In the female individuals, four haplotypes were distinguished, in the male individuals five mtDNA, but in total only one Y-haplotype. Because of the much lower mutation rate of Y-haplotypes to mt-haplotypes, these quantitative differences cannot be necessarily interpreted *a priori* as evidence of patrilinearity. In Koszyce, the lack of differences in the $^{87}Sr/^{86}Sr$ ratio (Schroeder *et al.* 2019, 10708) rather speaks against patrilocality. Thus, it is not possible to draw conclusions about exogamic marriage relations, virilocal residence and patrilineal descent (as suggested by Schroeder *et al.* 2019 and Sjögren *et al.* 2020, 23). In addition to the evidence of three core families in the true sense of the word, a fourth family with non-monogamous or serially monogamous male life practices is conceivable (cf. Sjögren *et al.* 2020, 23). The considerable age difference between the half-brothers of the respective mothers speaks more for polygamy.[82]

The kinship relationships of the entire group of interred individuals in Koszyce refer to the principle of an extended family, which is made up of four possible nuclear families with monogamous and polygamous living conditions, as well as other individuals. In this way, the burial community in Koszyce apparently differs from the principles of the pure core family as postulated for the subsequent Corded

82 Arithmetically, ca. 22.5 years are expected between individuals 5 and 15, and ca. 26 years between individuals 10 and 11.

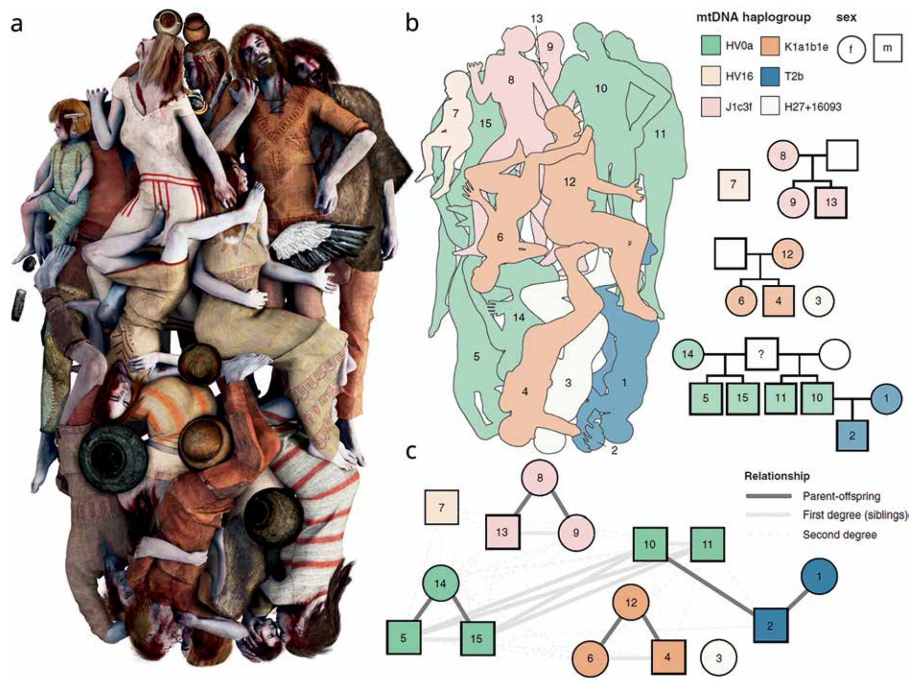

Figure 268. Genetic and strontium isotope analyses are available from the Lesser Polish mass grave of Koszyce, which enables a reconstruction of family relationships (after Schroeder et al. 2019, 10707, fig. 2).

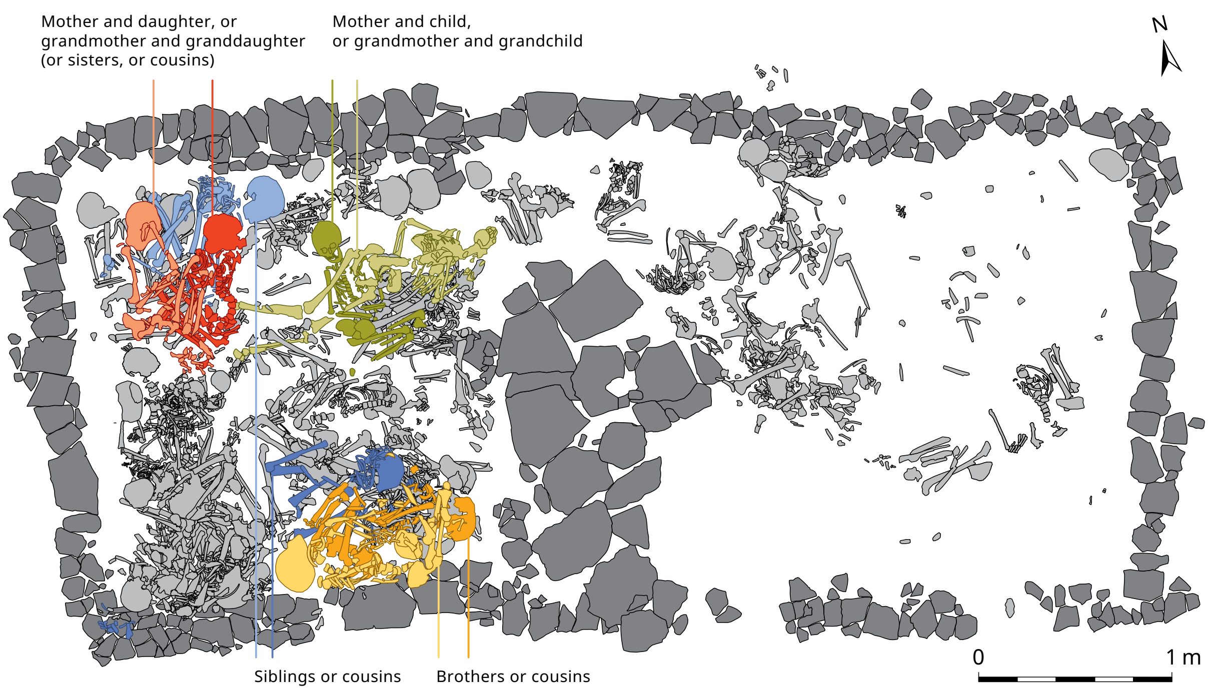

Figure 269. The composition of the mitochondrial haplotypes in the Bernburg walled chamber of Benzingerode has been legitimately interpreted in the context of the physical anthropological data and the location of the skeletons in the tomb, indicating that four spatial pairs of individuals were interred – probably mother and child (individuals 14/20), brother and cousins with a common grandmother (individuals 3/27), mother and daughter (or siblings, individuals 6/19), and siblings (17/36) (after Berthold 2008, cover image).

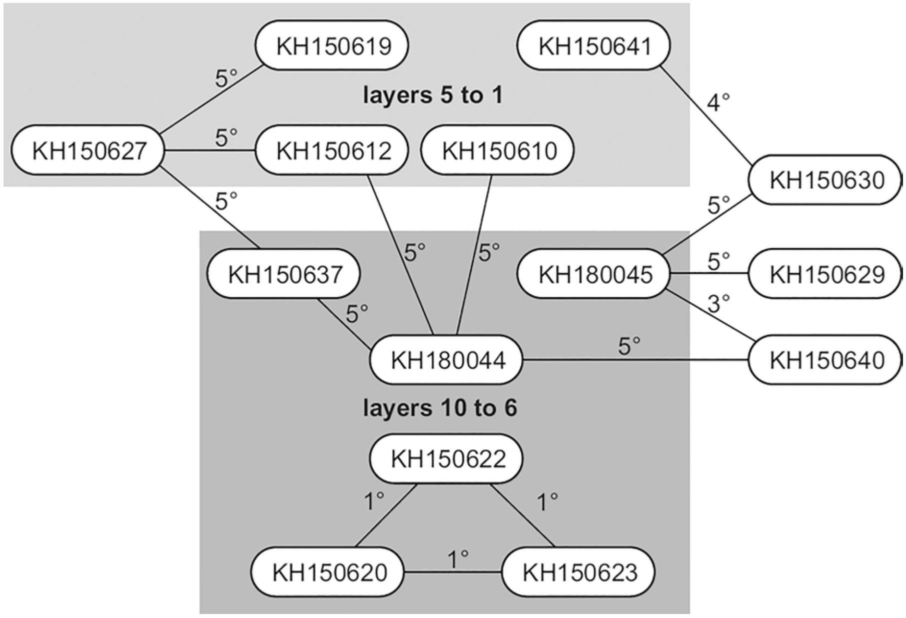

Figure 270. In the Wartberg gallery grave Niedertiefenbach, at least 177 individuals were interred from 3-6 generations (3275-3175 BCE), of which 42 were genetically analysed. With the exception of a first-degree relationship between three young male individuals at the beginning of occupancy (brothers), only one third- and fourth-degree relationship and nine fifth-degree relationships or no relationship at all have been reconstructed (after Immel et al. 2021, suppl. fig. 5).

Ware societies and Bell Beaker societies in Central Europe (Sjögren *et al.* 2020). The partner practice could also be more diverse than in the following groups, *e.g.*, in relation to monogamy and polygamy.

The composition of the mitochondrial haplotypes in the Bernburg walled chamber of Benzingerode has been legitimately interpreted in the context of the physical anthropological data and the location of the skeletons in the tomb, indicating that four spatial pairs of individuals were interred – probably mother and child (individuals 14/20), brother and cousins with a common grandmother (individuals 3/27), mother and daughter (or siblings, individuals 6/19), and siblings (17/36) (Berthold 2008, Meyer *et al.* 2008, 101-130; Brandt *et al.* 2013; 2017). Thus, burial by kinship is also indicated here, however, no statements can be made about matrilocality or patrilocality, *etc*. Basically, similar to Koszyce, these are probably nuclear families or extended families that were interred here (Fig. 269).

Very different from the three burial practices is that from contemporaneous Niedertiefenbach (Immel *et al.* 2021; Meadows *et al.* 2020). In the Wartberg gallery grave, at least 177 individuals were interred from 3-6 generations (3275-3175), of which 42 were genetically analysed. With the exception of a first-degree relationship between three young male individuals at the beginning of occupancy (brothers), only one third- and fourth-degree relationship and nine fifth-degree relationships or no relationship at all have been reconstructed (Fig. 270).

Consequently, Niedertiefenbach is a burial community, which differs greatly from the ones discussed thus far. Instead of family relationships, there are other institutions that are responsible for an individual to have been interred in the Niedertiefenbach gallery grave.

In summary, in the GAC core area, basic principles of society in the burial ritual become clear, which indicate the existence of nuclear families, which could have been related to extended families. In the burial process, at least in the collective graves, relatives are interred spatially close together.

Caution should be exercised in a hasty interpretation of the relationship of the number of mt-haplotypes to Y-haplotypes. Here, higher mutation rates of the mt-haplotypea could reflect "virilocal residence and patrilineal descent". Even if exogamous partner practices are vital for the survival of the small groups, currently nothing can be stated about the question of woman/man. In addition to the nuclear family model, the data from Koszyce confirms that non-monogamous partnerships also existed.

7.6 Scales of sedentism and mobility of a phenomenon with new ritual practices: the Globular Amphora societies

Mobility is defined as an umbrella term for the most diverse forms of mobility (cf. Burmeister 2016; Furholt 2018), ranging from (1) changes of place of residence due to marriage or age-group rules, to (2) economically or ritually determined mobility of individual persons in exchange processes of goods or commodities, and to (3) migrations. The term migration covers a wide range of different practices, starting with (1) demic migration of individual families from regions with strong population growth, through (2) immigration due to political interests, to (3) larger population movements that involve spatial changes for parts or entire societies, the latter caused, for example, by climate events, political instability, or social needs. Acculturation is understood as the adoption of innovations or entire ways of life by a local population. Integration means the joining together of non-local individuals in the local population either by maintaining different cultural practices or by adopting local practices or developing new hybrid cultural practices.[83]

As far as mobility is concerned, there is – except for Bohemia and Western Ukraine – currently no need to explain mobility, *e.g.*, with the demic diffusion model. On the contrary: in large regions of Central Europe, we are dealing with individuals, nuclear families, or extended families living within their economically determined catchment areas without the need for transregional mobility. Based on the isotope analyses, *e.g.*, on Zauschwitz or Koszyce and the thin section analyses of the ceramics (see Chap. 5), we can assume at present that these catchment areas were comprised of distances mostly of up to 50 km. On a small-regional basis, the area outlined by the aDNA similarities is reduced into numerous areas that naturally interact with each other: in terms of the exchange of animals and goods, but also ritual practices.

The situation is different in Bohemia and Western Ukraine. For Bohemia, we can assume immigration from at least 150 km from Central Germany or from Southern Poland. Immigration of up to 300 km from the Lesser Poland area can also be postulated in Western Ukraine.

Consequently, based on the aDNA analyses, we understand the Globular Amphora phenomenon as a newly emerging, everyday social practice developed by parts of the indigenous population of Central Europe. Of course, this does not exclude the possibility that outside Central Europe, for instance, towards Ukraine, migrations from the Globular Amphora core area may have taken place.

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83 It should be noted that concepts of sedentarism or non-sedentarism may well need to be modified in the light of anthropological observations (cf. Furholt 2018; Kelly 1992; Piezonka 2021; Ricci *et al.* 2018; Scharl-Gehlen 2017). Ethnographic and ethnohistorical examples point to continuous mobility even in sedentary groups (*e.g.* the non-presence of part of the household for activities in other areas often for economic reasons) or elements of permanence even in mobile groups (*e.g.* the regular return to the same places often also for economic reasons, cf. Gunawan 2000). A general comparison of, *e.g.*, strontium isotope analyses of prehistoric Central Europe obviously confirms this picture (cf. Müller 2013, 11-12, tab. 3). In this comparison, mobility within Neolithic and Chalcolithic societies of Central Europe was found to be consistently represented by over 7% non-locals, on average about 30% non-locals.

8. Separation and hybridisation on a global scale: The Globular Amphora networks

In the past, numerous studies on the Globular Amphora phenomenon have dealt with questions of burial rituals, the reconstruction of settlement patterns, the meaning of animal depositions or on typochronological developments from previous societies and their influence on subsequent societies. The latter gained new relevance through mostly historically descriptive migration models rather than from explanatory models as an interpretation of palaeogenetic data.

In the future, new possibilities will emerge from the sometimes already practiced analysis combination of material culture, scientific dating, isotopy and genetics. This will interpretively enable the combination of different spatial and temporal levels for the positioning of events, processes and structures. Even if it would have been very desirable, such a combined analytical approach could not yet be the basis for at least part of the new studies presented here.

Nevertheless, the conducted investigations provide us with a new model on the origin and significance of the Globular Amphora phenomenon and its role in both the globalisation and diversifying world at the turn of the fourth to third millennium BCE. Our initial questions were quite simple: How and why did the Globular Amphora phenomenon arise, what is the Globular Amphora phenomenon and what contribution did the Globular Amphora phenomenon make to transformation and development in prehistoric Europa?

In principle, we followed a very simple path (and certainly quite different studies would have been possible), which included und yielded various aspects with partly unexpected results:

First, similarities of cultural features of people who used globular amphora were investigated on a global-scale. To this end, a comparison of ceramic forms and decorations was conducted, which are considered to be a structural representation of the non-utilitarian visualisation of the *habitus* of humans. By means of a comparative spatial-quantitative approach, it was possible to represent the interaction intensity of the involved people. Regardless of the question on the use of clay sources, the determination of the origin, *etc.*, enabled the investigation of the symbolic level of life, here the simple visualisation of common sign practices and the depiction of the reception of one's own role as producers of ceramic "art works" in the same, neighbouring or other *habita*.

As a result, we recognised, on the one hand, the basic uniformity of the entire GAC phenomenon and, on the other hand, the strong differentiation in two spatial and content-related blocks of sign systems. By no means mosaic-like, but rather clearly differentiated are an Elbe network from a Vistula-Podolia network, which we interpreted as western and eastern concentrations of communication and translocation. While the western network appears to be strongly defined, the spatial boundaries of the eastern network are more fluid. Internal differentiations are recognisable, which concern differences between the Bohemian area, the Middle Elbe-Saale area and the Southwest Baltic area. In the east, there are rather spatial density differences between the Vistula area, the Volhynia-Podolia region and the Siret region.

With this background information on the spatial uniformity and the simultaneous diversity of Globular Amphora networks, we turned to the chronological perspective. On the basis of an unambiguous definition of the global GAC phenomenon (presence of GA in the local inventories), Bayesian evaluations of the still too few scientific datings made it possible to compare and position regionally developed chronological systems.

Accordingly, the first inventories with GA were located from ca. 3200 BCE between the Lower Vistula and the Middle Elbe – possibly also in the Southwestern Baltic Sea region. Corresponding regions can be interpreted as the area of origin of the GAC, from where a spread of new social practices to the south, southeast and west occurred. While Lesser Poland and the Lublin Highlands along with Podolia were probably transformed around 3000 BCE, in the west and the south, GAC influences can be registered in the Western German low mountain range zone from ca. 2950 BCE (*e.g.* in Wartberg contexts). At the same time, regular GA practices begin in the east, *e.g.*, in Volhynia and on the Moldavian Plateau. With the exception of these easternmost GAC regions, all GAC inventories disappear by about 2700 BCE at the latest. They only continue to exist on the easternmost periphery until ca. 2400 BCE.

In a differentiated chronological analysis according to find types, it could be highlighted that certain practices (*e.g.* burials in earthen pit graves) were seamlessly continued by predecessor societies or contemporaneous groups. In the case of animal depositions, it is striking that ritual animal deposition is monopolised and transformed by the GAC at corresponding older sacrificial or animal burial sites: the practice of ritual double cattle burials becomes a GAC feature – observable at the same time in a short phase around ca. 2950 BCE between the West Ukraine and the North Sea. These connections to cattle burials illustrate the cultural separation of the GAC into a distinct social practice.

With this “global” background knowledge on the spatial interaction of the habitus fields in GAC networks and the GAC chronology, we explicitly turned to an important sub-region of the GAC phenomenon, the Middle Elbe-Saale region (MES). This is the area from which the most GA per km^2 are known quantitatively. In the detailed study, the interaction with the concurrent regional Bernburg TRB pastoral group could be highlighted. Strikingly, the canon of Bernburg’s decoration motifs with its chronological sequence is also recognisable on GA, which impressively demonstrates the interrelationships.

In the MES region, GAC settlement remains tend to be concentrated in the loess-free lowland zones. GA elements from domestic contexts are also found in enclosed Bernburg settlements, which can be addressed as places of special processing of animal secondary products. In terms of economy and nutrition, hardly any differences can be presented between Central German GA and Bernburg inventories. However, the enclosed Bernburg settlements with GA elements in the pastoral component correspond more to the basic GA pattern (see below) than to Bernburg settlements without GA elements.

With regard to the ritual practices, strong differences can also be registered. Individuals with Bernburg inventories are primarily buried in walled chamber graves, whereas individuals with GA are primarily known from single graves. While, spatially speaking, corresponding GA earthen pit graves and cist graves are distributed over the entire circum-Hercynian area, *i.e.*, also in the Bernburg settlement areas, the walled chamber graves are mostly limited to areas west of the GA settlement remains.

Basically, we recognise a division in GA settlement regions in the lowlands to the east of the Central German chernozem and the Bernburg areas in the chernozem regions, but in contrast, a complex symbiotic relationship, which as a result "allows", *e.g.*, the burial of GA individuals in Bernburg settlement regions. Elements of this separation are thus accompanied by elements of hybridisation, including the adoption of decorations mentioned at the beginning.

There is no uniform GAC economy in the entire GAC distribution area with its ecological and topographical differences. In detail, grazing strategies are verifiable for the *Central German* area, which include a longer cattle drive, *e.g.*, from the lowlands into the mountainous Harz foreland (in contrast to local catchment areas of Bernburg settlements). The diets of the GA-equipped individuals do not differ from that of concurrent groups. Food supply includes cattle, pigs and sheep/goats, whereas evidence of cereal cultivation is difficult (similar to concurrent groups), but landscape openings at least in Central Germany and the Altmark are substantial. In a Moravian GA settlement, einkorn, emmer and to a lesser extent barley are also attested.

The GAC complexes of the *Northeast Central European lowlands and the Polish low mountain zone* prove the use of cereals mainly by cereal impressions on vessels, but also by few macroremains and isotope values. How intensive cereal cultivation was practiced must remain open at the present. In contrast to the TRB, there is no evidence of manuring in Kuyavia so far. With regard to animal husbandry, inventories with high proportions of cattle husbandry can be distinguished from those with high proportions of also caprovids and domestic pigs. The latter dominate the picture. This represents a clear difference to the TRB, in which mainly cattle dominate the domestic animal spectrum. Animals are used for meat and secondary milk products. They are also used as draught or pack animals. Seasonality can be confirmed for cattle husbandry, although evidence for high mobility is lacking so far and corresponding herding practices seem to take place on small-regional scales. While primarily drier open land is used for herding on the North Central European lowlands, in the Lesser Polish area, for example, pigs may have also been driven into the forests. In the *Southeastern Polish/West Ukrainian regions*, but also in other different areas, appropriative husbandry plays a role, if it was also practised before. In the Baltic regions, animal husbandry with the use of dairy products, while maintaining the exploitation of aquatic resources, can be proven.

In general, the data on subsistence farming thus basically points to a local to small-regional herding of cattle and an increased share of caprovids and pigs in the livestock spectrum in comparison to preceding and contemporaneous farming groups. Evidence of cereal cultivation is sporadic, but it is unlikely to have occurred on a large-scale. Meat production and consumption play a major role along with milk production. In addition to supra-regional raw material networks (flint) and local raw material use, the identified mobility patterns indicate only local to small-regional mobility of humans and animals. Both the isotope analyses on animals and humans as well as the raw material analyses on pottery identify mobility areas of less than 50 km radius.

The settlement remains of the GAC can thus far be described as ephemeral. This is likely to be related to the described herding strategies. Sites with pits and pit huts, also occasionally with post settings for smaller dwellings, are known, but rectangular houses with ridge posts and clearly long-lasting settlement structures are lacking. In both the Elbe and the Vistula-Podolia networks, occasional pits can be found at a regular distance from the nearest site with scattered pits, sometimes along valley edges. Moreover, there are also larger pit accumulations, which indicate special domestic agglomerations.

The interpretations of these ephemeral remains appears to be difficult, as there is no evidence of house structures for all Late Neolithic groups in the entire region between the Oder and the Dnieper and only a negligible number of house buildings have also been found in the region between the Rhine and the Oder. However, evidence of settlements with many pits is significantly more frequent and denser in these groups than for the GAC – a clear difference: Obviously, the TRB groups with their subsistence farming more strongly based on cereal cultivation and cattle husbandry are more sedentary than the GAC communities.

Therefore, we want to assume small reference groups for the GAC, which depend, *e.g.*, on exogamous marriage practices. Larger accumulations of pits or several pit huts are only found in connection with settlements at which especially other regional ceramic styles are common or even dominant. These are probably communication sites of the total population of an area. Three of these larger sites are enclosed (Quenstedt-Schalkenburg, Halle-Dölauer Heide, and Homolka), which is a practice of the regional groups and not the GAC.

On the North Central European Plain in the area of the main distribution of the GAC between the Elbe and the Vistula, especially the palynological results of laminated profiles indicate a reduction of the influence of human activities on the vegetation. Both palaeoecological investigations and the frequency of above-ground visible grave monuments show that the occurrence of the Globular Amphorae phenomenon coincides with a reduced openness of the landscape, a reduced human impact and the end of the construction of megalithic tombs (Brozio *et al.* 2019b; Feeser *et al.* 2019), where this had been practiced (Fig. 271). This decline may be associated with the described settlement pattern of the GAC, which especially may have led to a reforestation or restocking of shrubs of the loess areas. Obviously, the settlement and economic practices of the GAC have a different ecological fingerprint than those of preceding or concurrent Late Neolithic groups.

Based on the previous genome analyses, the GAC groups are Central Europeans who do not differ from contemporaneous or earlier individuals of regional TRB groups. Significant is an admixture process, which apparently already occurred at the beginning of the 4th millennium BCE and includes a combination of AN and WHG components of peasant groups. Western Ukraine and Bohemia are exceptions, where the regional groups have a different genetic ancestry and internal migration of GAC groups can be assumed. As a consequence, this means that the emergence of the GAC phenomenon took place independent of migration. During the existence of the GAC networks, among other things, the GAC contributed to the emergence of the multicultural Corded Ware network or a significant exchange with local and regional groups that exhibit a different ceramic style.[84] The disappearance of the GAC around 2700 BCE in Central Europe can be related to the establishment of new networks, which are increasingly linked to the entry of Y-haplotypes from the northern Pontic steppes, especially from the 27th century. A "survival" of the GAC can only be observed where – in the marginal area between the GAC and the Yamnaya – a lively exchange between both cultural groups was discerned (Szmyt 1999b).

84 Cf. above Bohemian Corded Ware and Bohemian Řivnáč with women or children, who are "married in".

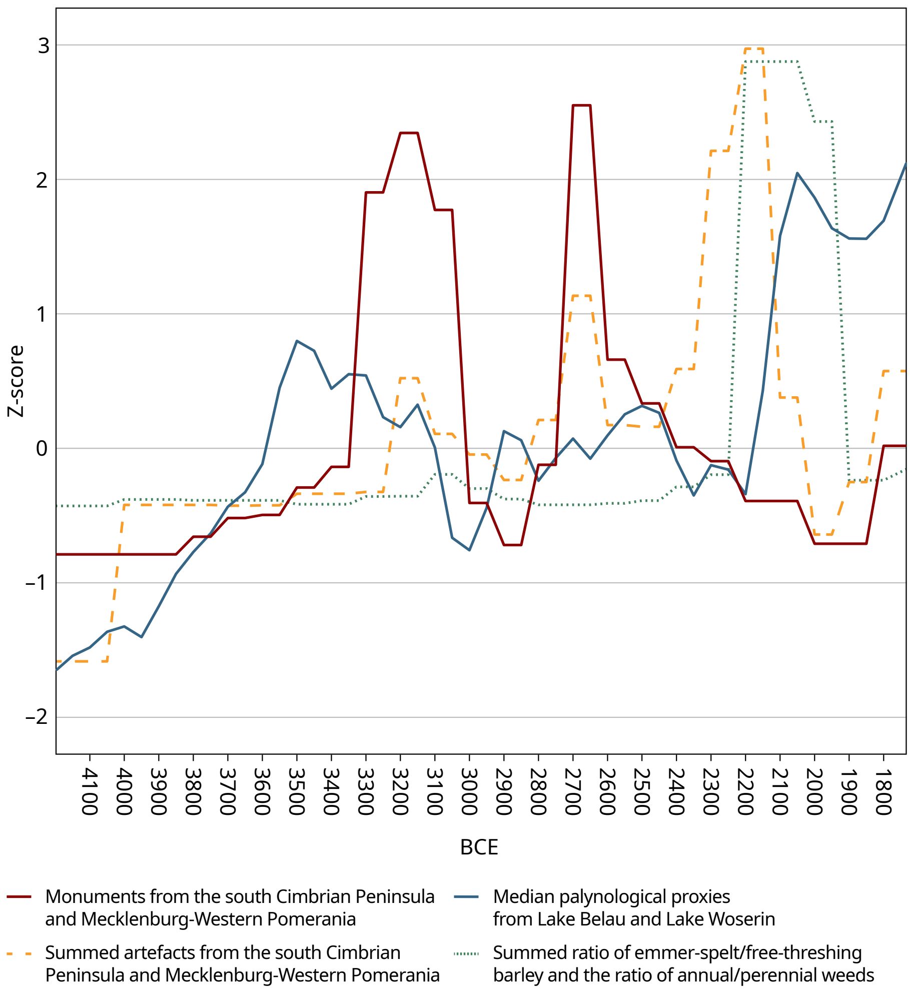


Figure 271. Palaeoecological studies and the frequency of above-ground visible grave monuments show that the occurrence of the Globular Amphora phenomenon in North Germany coincides with a reduced openness of the landscape, a reduced human impact and the end of the construction of megalithic tombs, where this had been practiced (after Brozio et al. 2019b; Feeser et al. 2019).

8.1 A model

How can the results be described and linked interpretatively? In the following, we want to present a model that, among other things, also attempts to describe the causes of the changes.

In principle, we recognise at least two categories of landscape areas in the GAC distribution area, which influence human behaviour with their different ecological conditions (Fig. 272): Small-scale regions of type A, in which the difference between lowland areas with primarily fluvial soils and plateau areas with primarily fertile loess soils contrast with those of type B, in which differences are either small-scale or non-existent. The MES can serve as an example for type A, and Northeastern Germany for type B. In landscape type A, we observe an economically different use of the lowlands and the plateaus, due to the contrast between the agrarian and pastoral orientation of the farming communities. While the lowlands are intensively used year-round, this is only the case for the plateaus at certain times of the year, usually after field harvest. As a result, there are individual GA graves everywhere, but GA settlements primarily within or on the edge of the mentioned lowland areas. The separation obviously also effects the communication structures, which enables the development of an interregional network along the lowlands. In contrast, enclosed settlements regionally ensure more hierarchical regional communication structures.

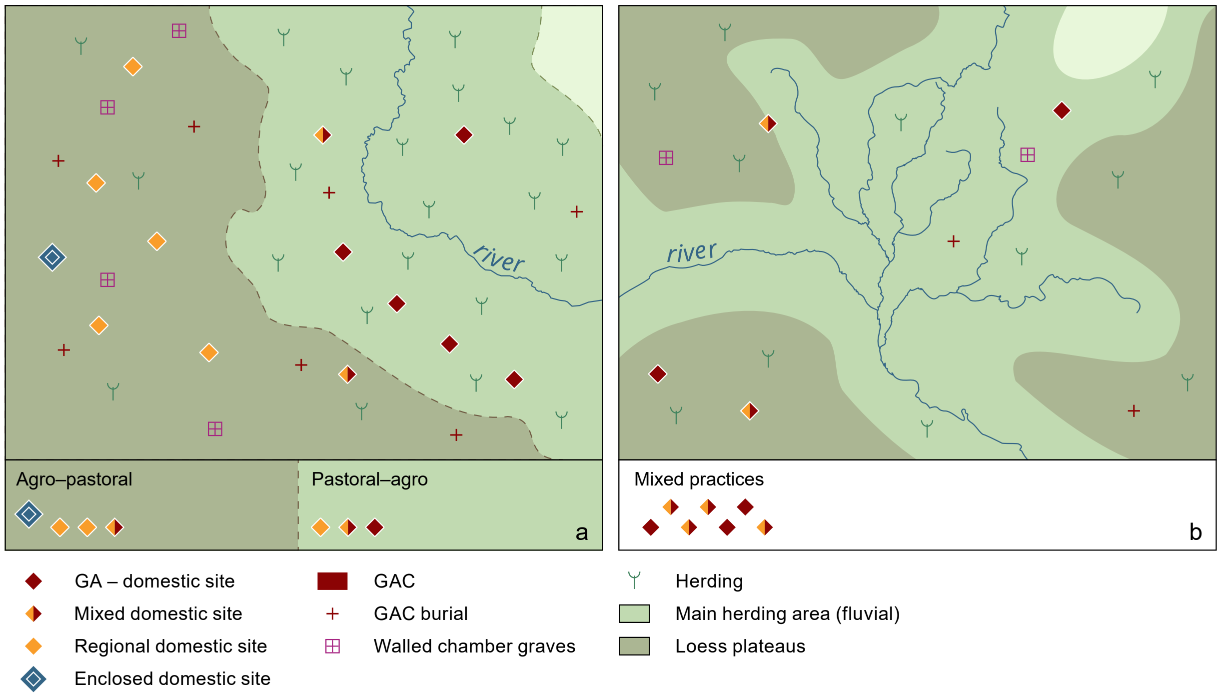


Figure 272. Two categories of landscape areas existed in the GAC distribution area, which influence human behaviour with their different ecological conditions: Small-scale regions of type A, in which the difference between lowland areas with primarily fluvial soils and plateau areas with primarily fertile loess soils contrast with those of type B, in which differences are either small-scale or non-existent.

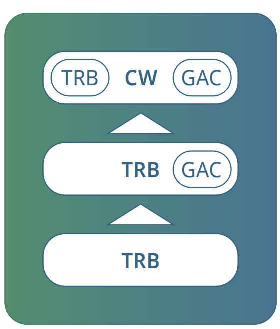


Figure 273. Even if fundamentally phenomenologically very different regional and small-regional characteristics of the relationship of the GA to other materialities can be determined, after a certain time, a separation with new social practices dominates. For the new social practice, utilitarian and non-utilitarian items or also practices that come from previous societies are adopted, changed or omitted.

In contrast, in small regions of type B, the ecological differences are only small-scale or hardly pronounced. Thus, of course, we also find here, *e.g.*, in Northeastern Germany, small riverine landscapes or distinct moraine areas. However, there is no large-scale separation. Accordingly, the GAC and local or regional ceramic styles and burial forms remain mostly, at least spatially, unseparated. In reality, there are many patterns in between and beside the tendencies the multi-faced appearance of the GAC phenomenon in different regions is obvious.

Even if fundamentally phenomenologically very different regional and small-regional characteristics of the relationship of the GA to other materialities can be determined, after a certain time a separation with new social practices dominates (Fig. 273). For the new social practice, utilitarian and non-utilitarian items or also practices that come from previous societies are adopted, changed or omitted. This is possible from both ecoregions A and B. This includes the changed practice of cattle burials (Fig. 274) as well as the development (Fig. 275 Beran) and adoption of the *Nackenkammäxte* or the exploitation of Krzemionki silex (Fig. 276).

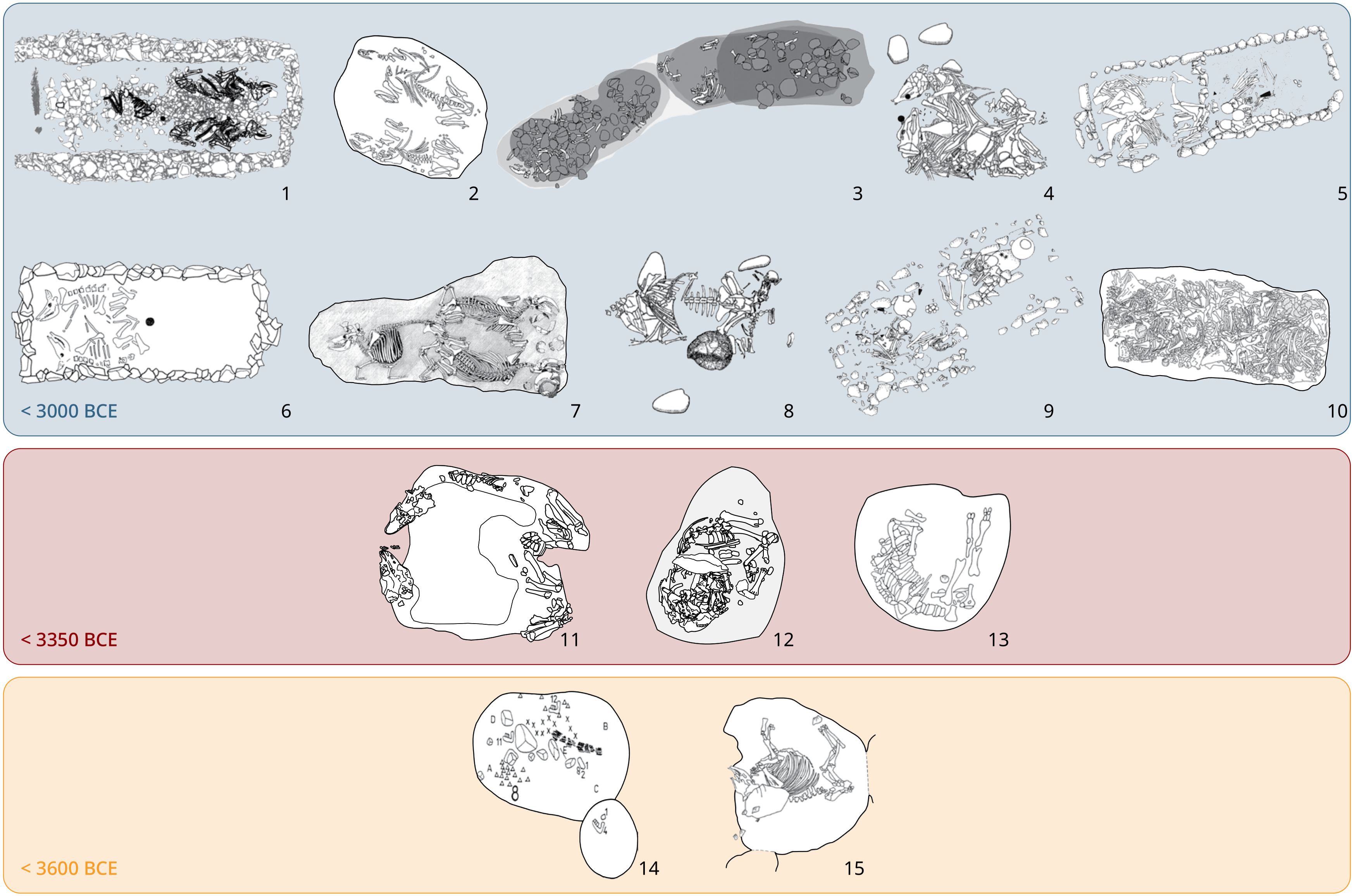


Figure 274. The changed practice of cattle burials. Key: 1 – Remlingen; 2 – Derenburg; 3 – Felchow 26; 4 – Brzesc Kujawski 4; 5 – Las Stocky H; 6 – Plotha; 7 – Zauschwitz; 8 – Brzesc Kujawski 4; 9 – Las Stocky G1; 10 – Krasanaselky; 11 – Niederwünsch; 12 – Niederwünsch; 13 – Kuczkowo 1-A136; 14 – Zachow; 15 – Zegotki 2.

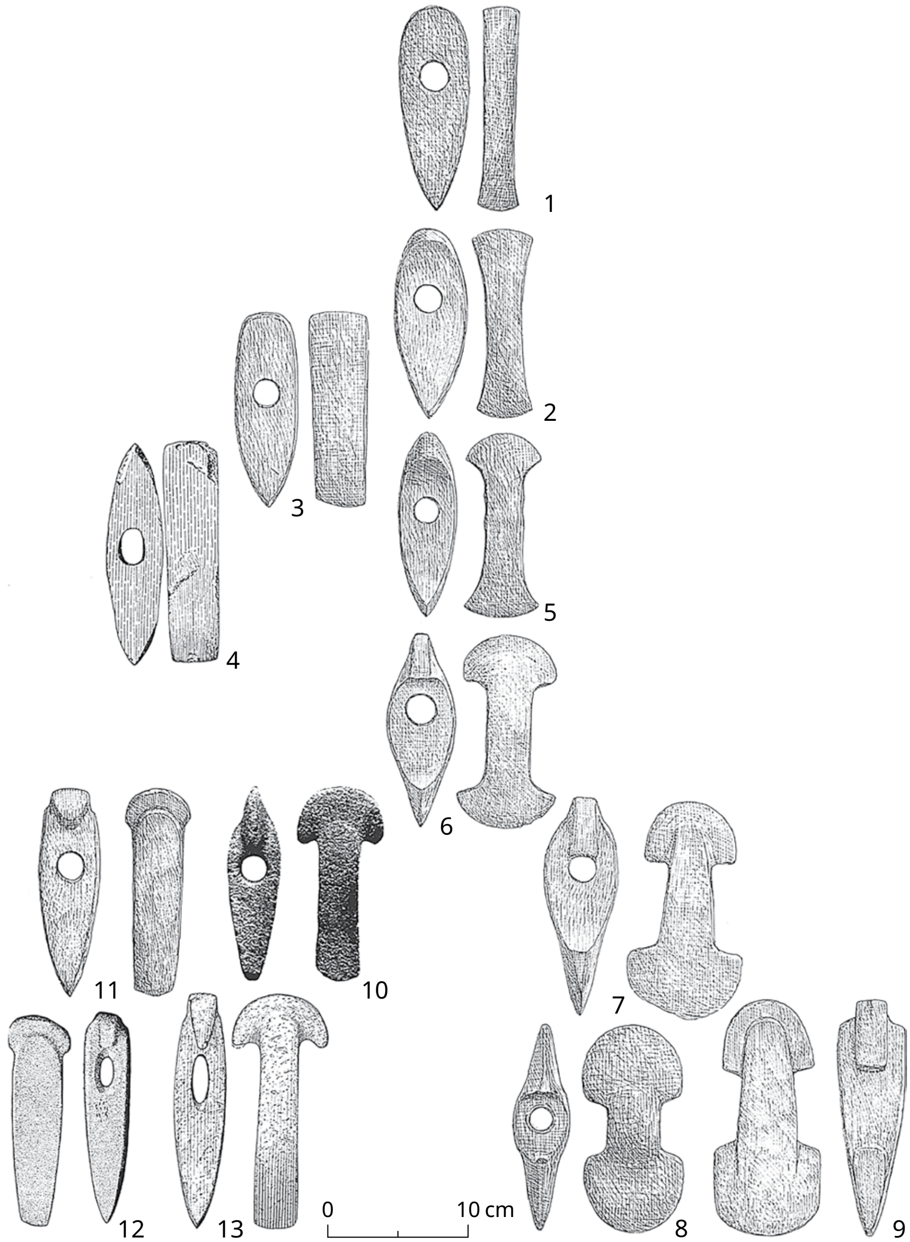


Figure 275. The development of Nackenkammäxte from TRB axes (after Beran 2014, 25, fig. 4).

Obviously, the general basic attitude changes for a part of Central European people from ca. 3200 BCE. Part of the new behaviour includes the new internalisation of the production and reproduction of new goods and practices. These include mostly crouched inhumations in earthen pits or cist graves and also the globular amphorae, which developed from TRB predecessor amphorae of the TRB groups, now leading to a materially expressed participation in socially produced goods (Fig. 277). From the experience-related construction, a new generative grammar of people, animals and things with a new social context develops. This change to fundamentally new living conditions on the fringes of the people, who otherwise continue to act as farmers, leads to a form of practice of the social actors with GA ceramics, which includes stronger regional mobility.

The developing structures are a general phenomenon that can occur with considerable variability. In the canon of origins of the Middle Elbe and Lower Vistula, the innovations spread along existing large-scale networks and within the

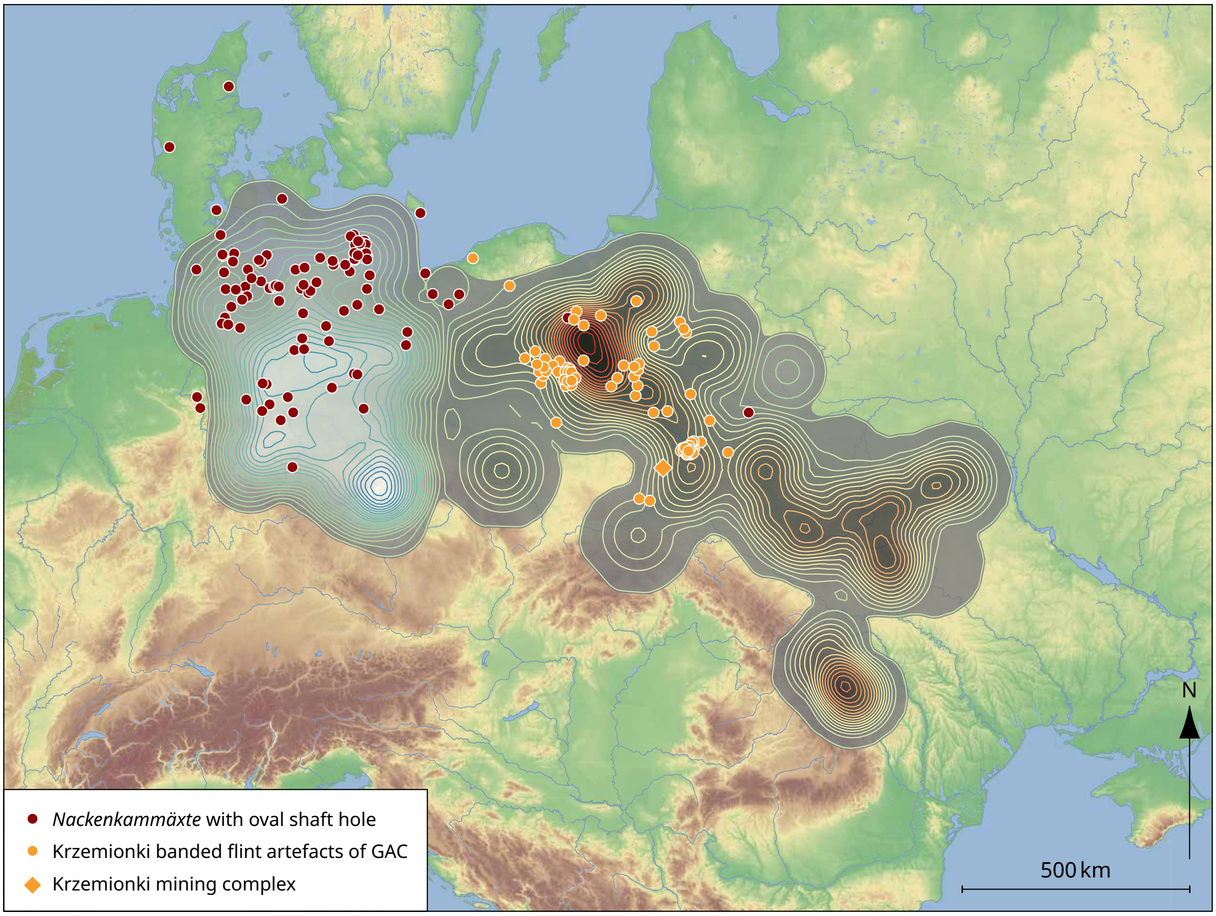


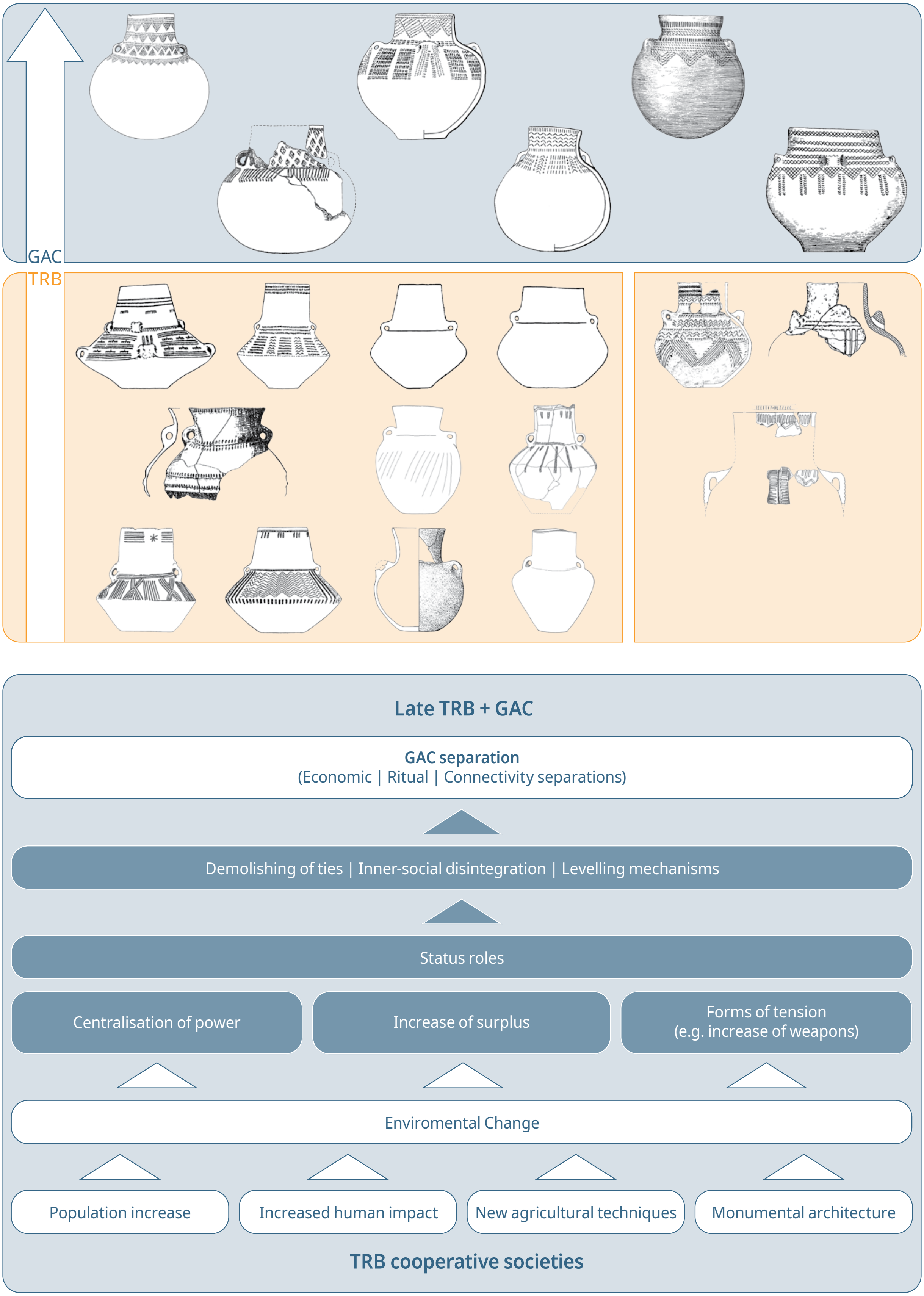
Figure 276. The adoption of the Nackenkammäxte or the exploitation of Krzemionki silex are two examples for the distribution pattern in the GAC Elbe and the Vistula-Podolia network.

framework of hybridisations with local and regional groups, assuming a large range of variations in social practice. In the course of time, fragmented GA entities can emerge such as the easternmost groups. The demarcation of new social practices from pre-existing ones can be variable and diverse.

The aspect of the identification of the new ways of life remains problematic. Symbolically important is the practice of cattle burials, especially double burials. As already described, this practice is monopolised by the GAC from 2950 BCE at the latest. The lower detection of cattle in the settlement remains compared to the TRB is striking. However, this can be described as a phenomenon familiar to livestock farmers. Due to the increased importance of cattle, they are slaughtered less or traded to the outside to a greater extent than is the case with regional farming groups. Furthermore, cattle become more and more a social value, as also known from ethnoarcheaological investigations (Jeunesse 2016; Wunderlich 2019).

Similar examples of the separation postulated here in existing groups can be repeatedly found in ethnographic documentation. For example, the Holour region in Northern Cameroon (Holl 1993; Müller 2001, 22-23) should be mentioned here, where different economic forms of production and ecological conditions determine the spatial structuring of the ethnonyms with their limiting structures. Another example is represented by the Scandinavian Sami: During the course of the Middle Ages, the contrast between inland and coastal economies in Norway intensified, eventually leading to the formation of separate cultural identities.

Basically, the question is posed, which causes led to the separation of the GAC from the previous TRB societies. In fact, from various studies we can observe an increase in population and human impact in various regions, which are also noted in connection with the introduction of new agricultural techniques. It is also clear that



GAC
TRB
Late TRB + GAC
GAC separation
(Economic | Ritual | Connectivity separations)
Demolishing of ties | Inner-social disintegration | Levelling mechanisms
Status roles
Centralisation of power
Increase of surplus
Forms of tension
(e.g. increase of weapons)
Enviromental Change
Population increase
Increased human impact
New agricultural techniques
Monumental architecture
TRB cooperative societies

after a successful increase in the surplus, *e.g.*, in the area of monumental buildings (megalithic tombs/walled chamber graves), a centralisation of power and forms of social tension are noticeable, for example, in the relative increase in the proportion of artefacts suitable as weapons. Precisely these visible problems apparently led to the emergence of status roles and put the cooperative basic principles of the TRB societies more strongly into question. This could also have led to a conscious demolishing of ties and inner-social disintegration in order not to have to "go along" with the indicated development (Fig. 278).

The ideological separation of the GAC, which effected the more pastorally emphasised areas, is thus causally connected with the social difficulties in the TRB societies. A stronger economic, finally ritual separation and obviously the development of own interaction networks are possibly the effects of a social crisis of the society as a whole. The rather rank and status structures of the TRB societies contrast with the more prestige-oriented social structures of the GAC societies. The new, strongly ephemeral settlement structures with distinctive individual representation in single graves in parts of the GAC should also be an expression of the social separation. A new, previously unknown relationship between shepherds and farmers develops with numerous transitions. As a consequence, this means that the original societies were also subject to strong changes. Recognisable is a diversity of partner relationships of nuclear families with monogamy, polygamy and extended family ties.

The basic discernible dichotomy between farmers and herdsmen develops at a time of degrowth or is possibly part of a strategy for this. The palaeoecological records indicate – as already shown – a reduction of human impact from ca. 3200 BCE. A population reduction has often been postulated. A new form of agro-pastoral system develops that is essentially more open for the integration of other regional elements. The elements of the globalising and diversifying world finally open the way for new social worlds after 15 generations: that of the Corded Ware phenomenon.

Figure 277 (left, above). Part of the new behaviour includes the new internalisation of the production and reproduction of new goods and practices. These include mostly crouched inhumations in earthen pits or cist graves and also the globular amphorae, which developed from TRB predecessor amphorae of the TRB groups, now leading to a materially expressed participation in socially produced goods.

Figure 278 (left, below). Reasons for the separation of GAC societies.

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Plates

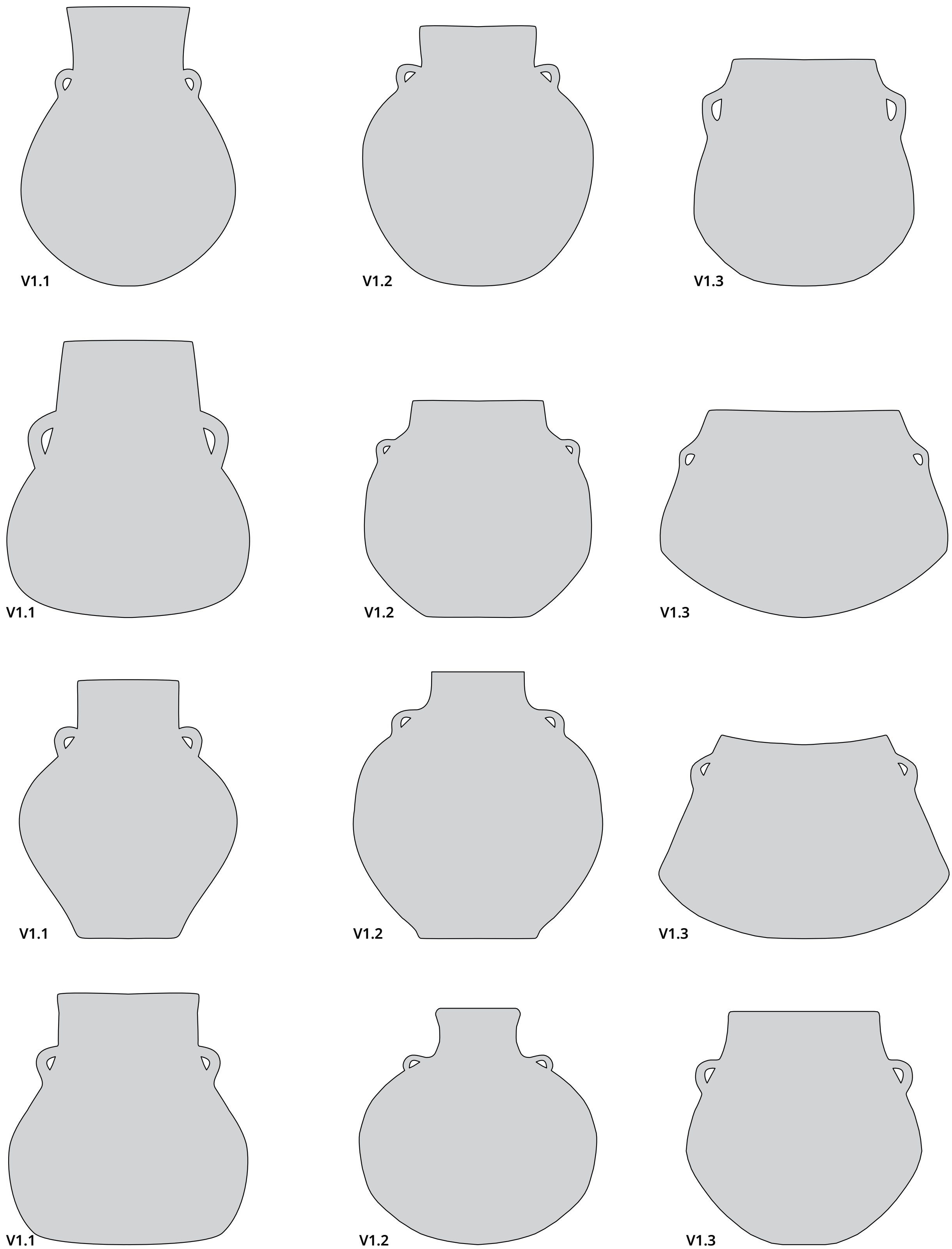


Plate 1. Vessel shapes: Globular Amphorae (category V1).

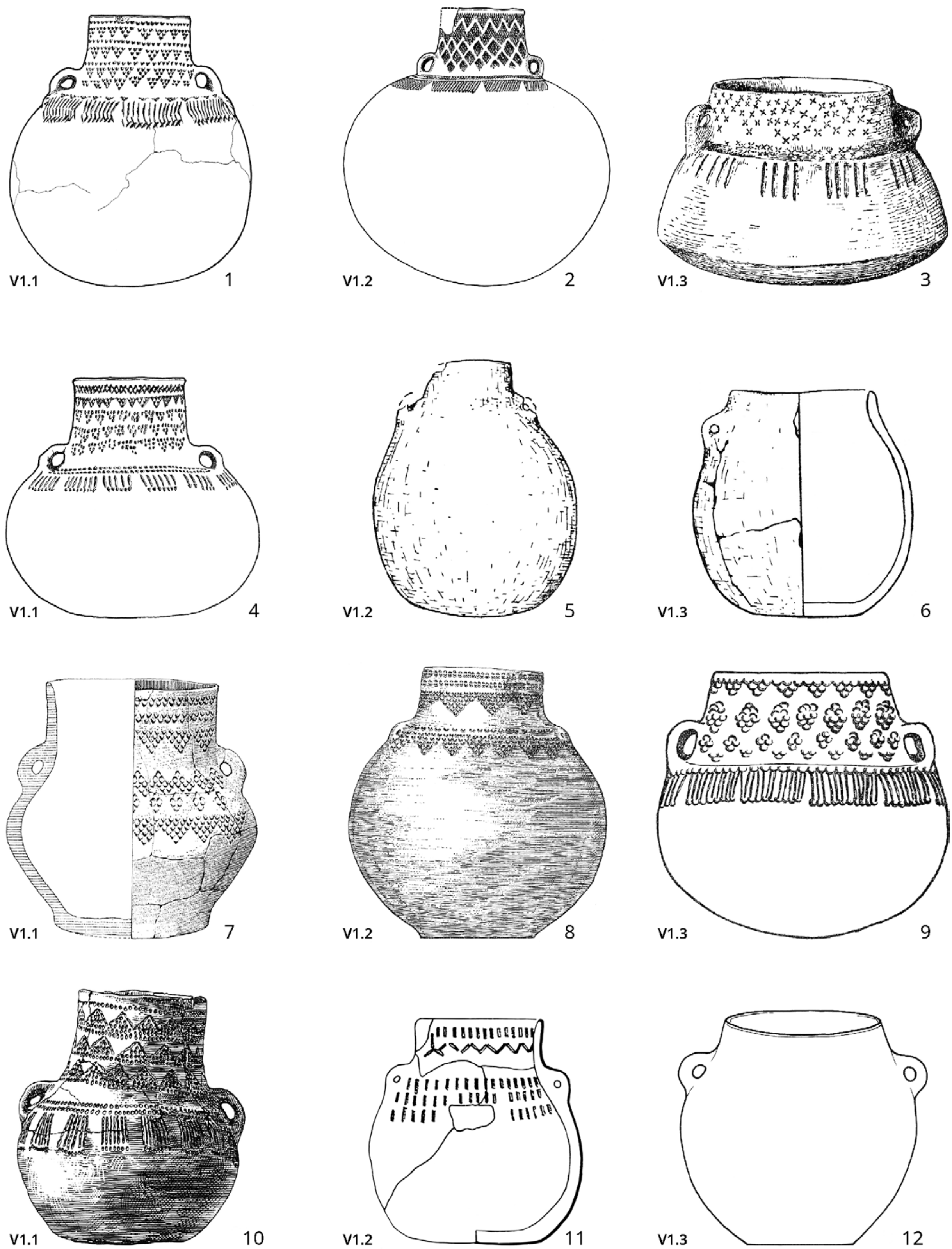


Plate 2. Vessel shapes: Globular Amphorae (category V1). 1 – Beier 1988, pl. 14,4; 2 – Beier 1988, pl. 38,1; 3 – Struve 1953, fig. 3,4; 4 – Beier 1988, pl. 69,1; 5 – Nosek 1967, fig. 103,3; 6 – Nosek 1967, fig. 44,1; 7 – Nagel 1985, pl. 1,102; 8 – Svešnikov 1983, pl. 17,9; 9 – Beier 1988, pl. 64,19; 10 – Meyer 1993, pl. 5a,2; 11 – Wiślański 1979, fig. 156,4; 12 – Kirsch 1993, fig. 149,3.

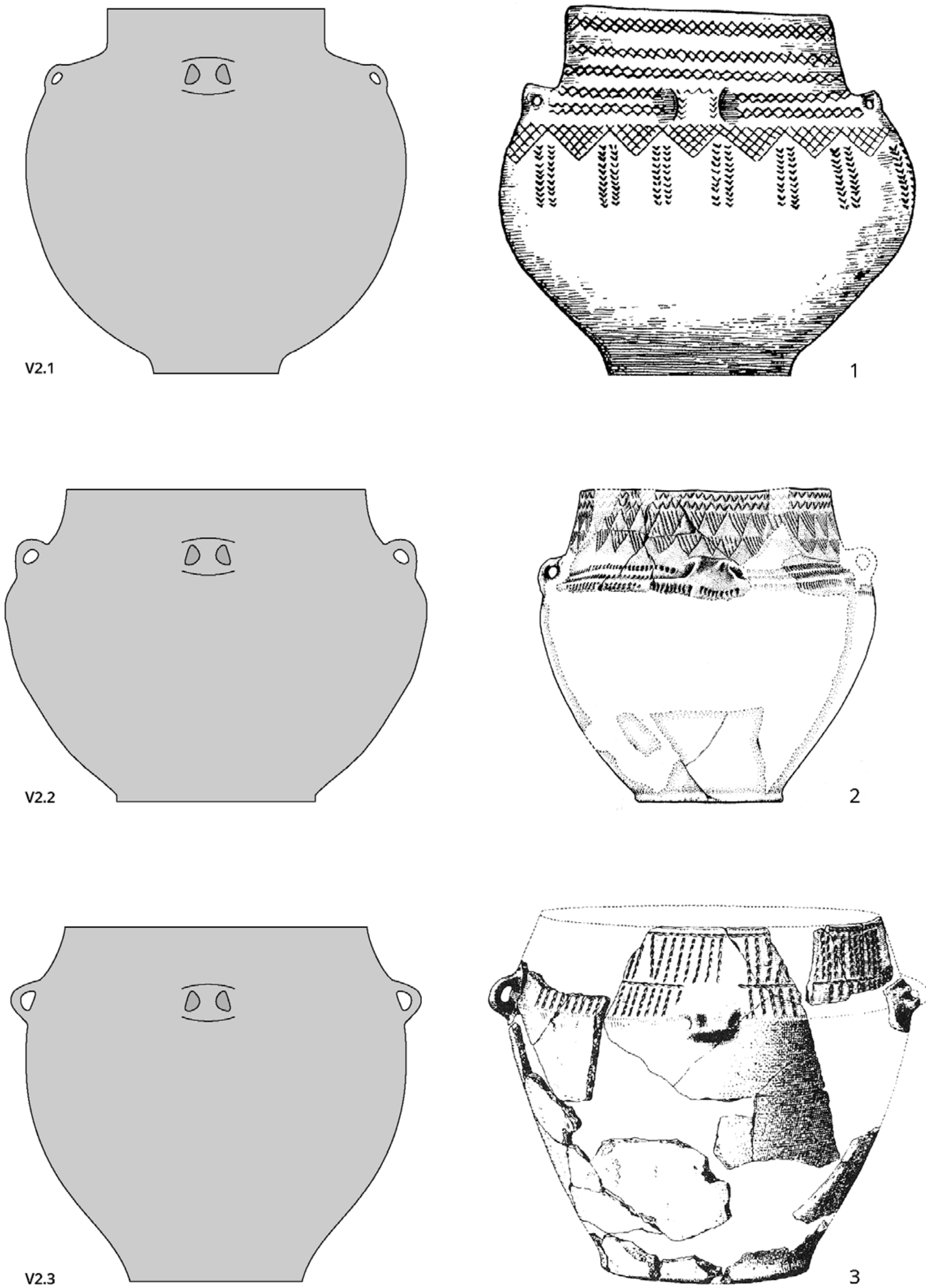


Plate 3. Vessel shapes: Wide-mouthed Amphorae/Pots (category V2). 1 – Svešnikov 1983, pl. 22,20; 2 – Weber 1964, fig. 13,3; 3 – Maier 1991, fig. 29,2.

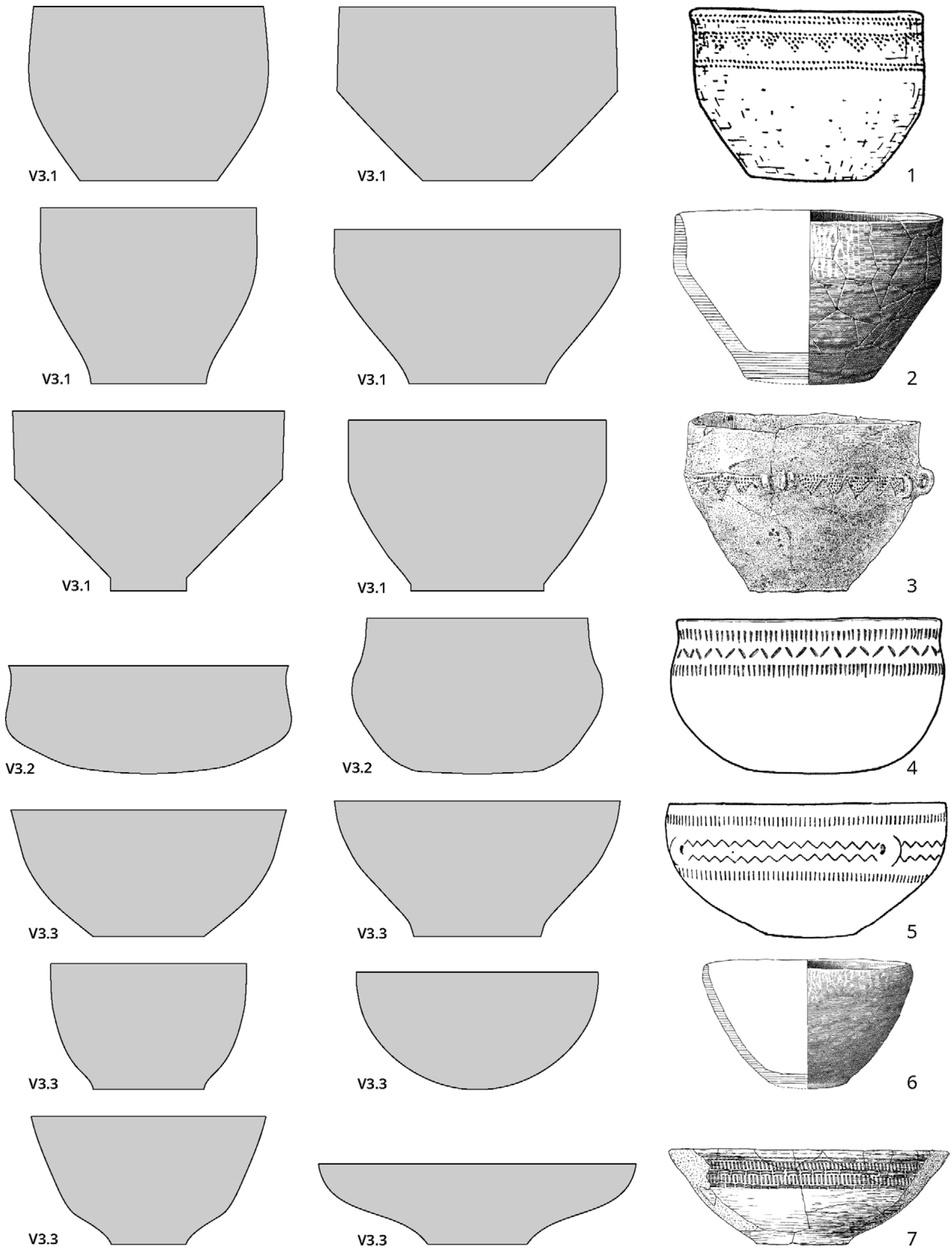


Plate 4. Vessel shapes: Bowls (category V3). 1 – Nosek 1967, fig. 4; 2 – Nagel 1985, pl. 19,30./79; 3 – Meyer 1993, fig. 10c,1; 4 – Beier 1988, pl. 56,2; 5 – Nosek 1967, fig. 50; 6 – Nagel 1985, pl. 18,29/60; 7 – Krzak 1977, fig. 75.

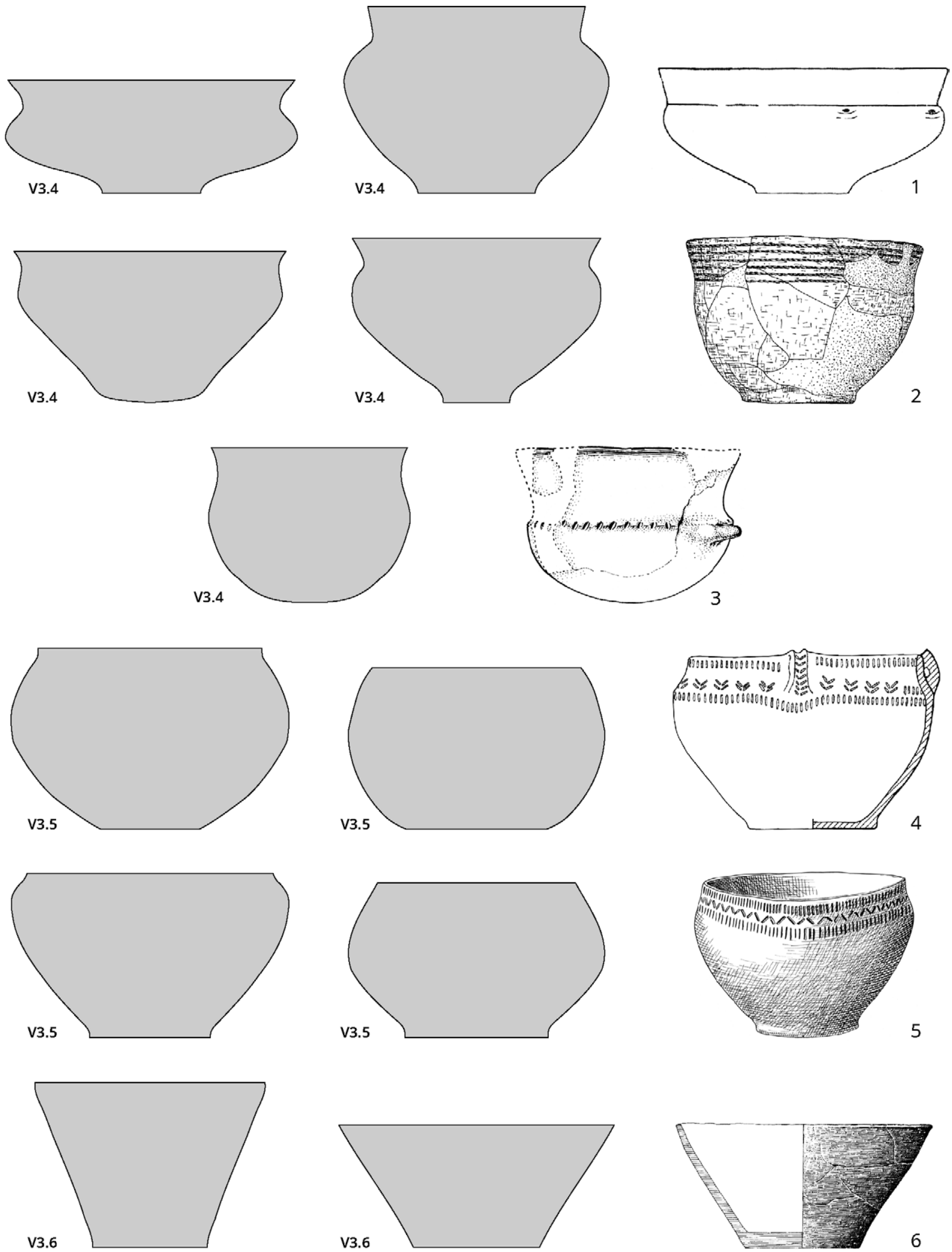


Plate 5. Vessel shapes: Bowls (category V3). 1 – Nosek 1967, fig. 15,8; 2 – Krzak 1977, fig. 4; 3 – Weber 1964, fig. 13,2; 4 – Szmyt 1996, fig. 23,3; 5 – La Baume 1933, pl. 16a; 6 – Nagel 1985, pl. 20,32/32.

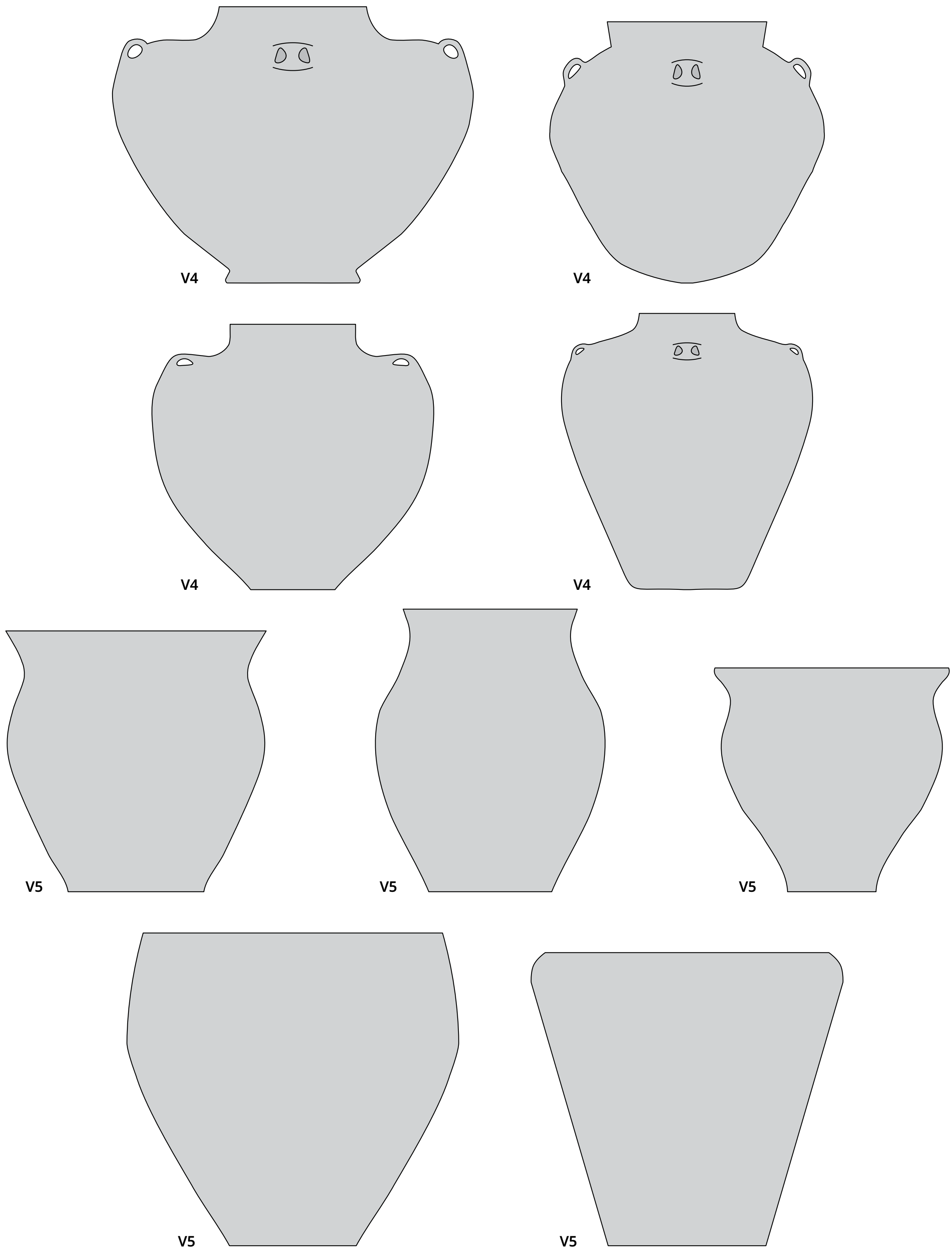


Plate 6. Vessel shapes: Wide-shouldered Amphorae (category V4) and Funnel Rim Pots (category V5).

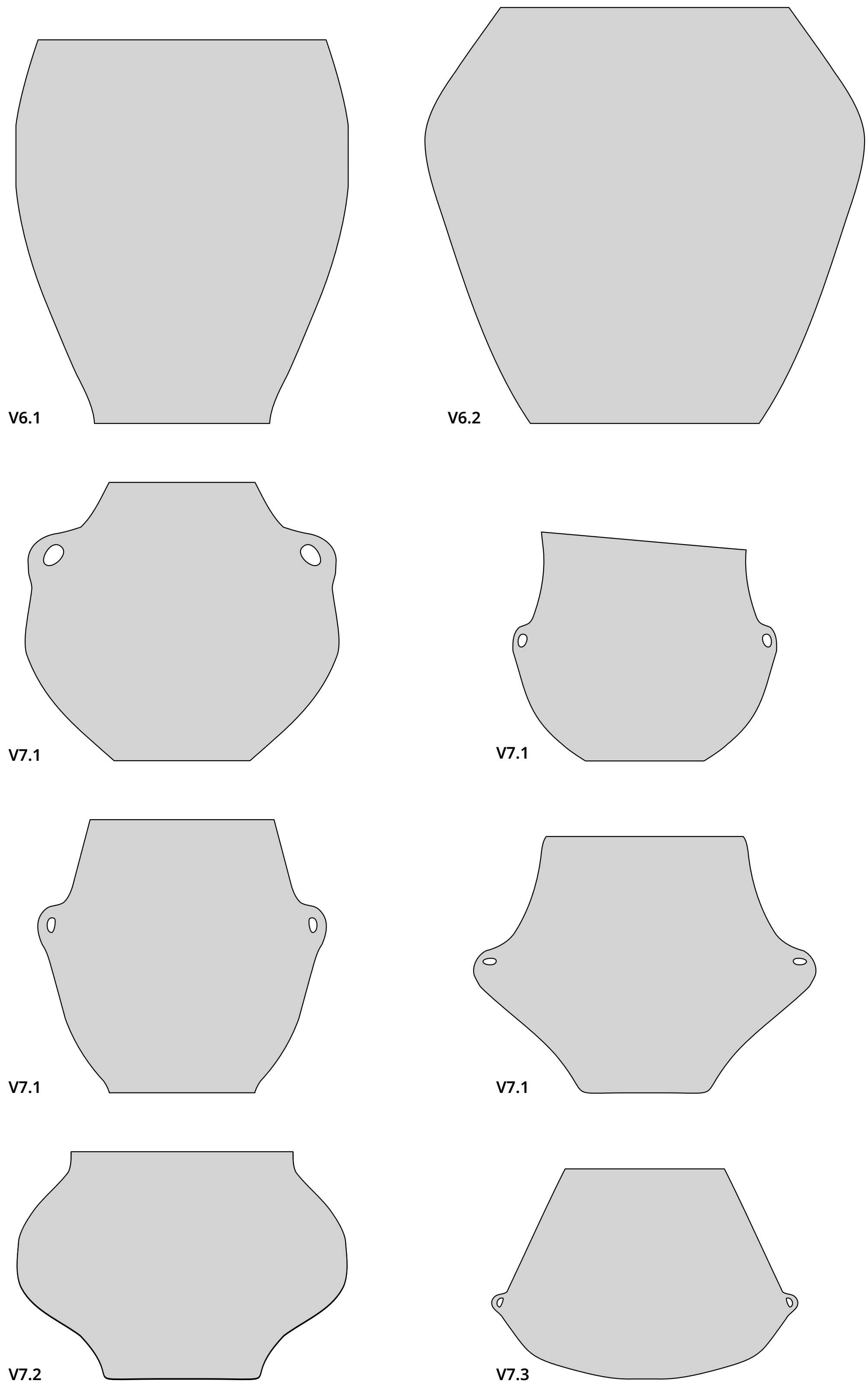


Plate 7. Vessel shapes: Steep-walled pots (category V6) and Biconical Vessels (category V7).

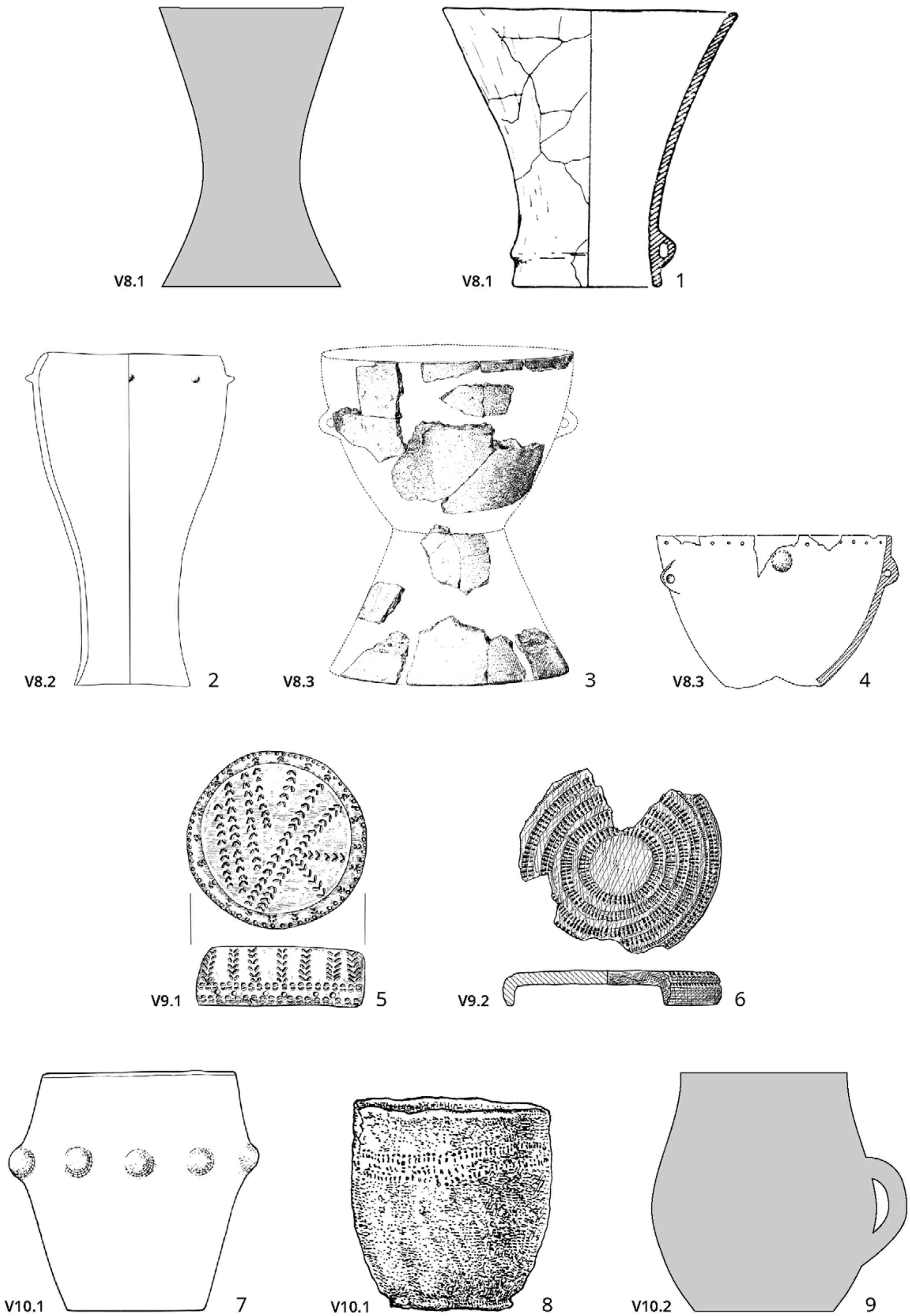


Plate 8. Vessel shapes: Drums (category V8), Lids (category V9) and Beakers/Cups (category V10). 1 – Nosek 1967, fig. 49,2; 2 – Meyer 1993, pl. 37,4; 3 – Laux 1982, pl. 7,1; 4 – Szmyt 1996, fig. 4,7; 5 – Svešnikov 1983, pl. 20,4; 6 – Ebbesen 1975, fig. 222,5; 7 – Meyer 1993, pl. 17b,5; 8 – Kirsch 1993, fig. 29,22.

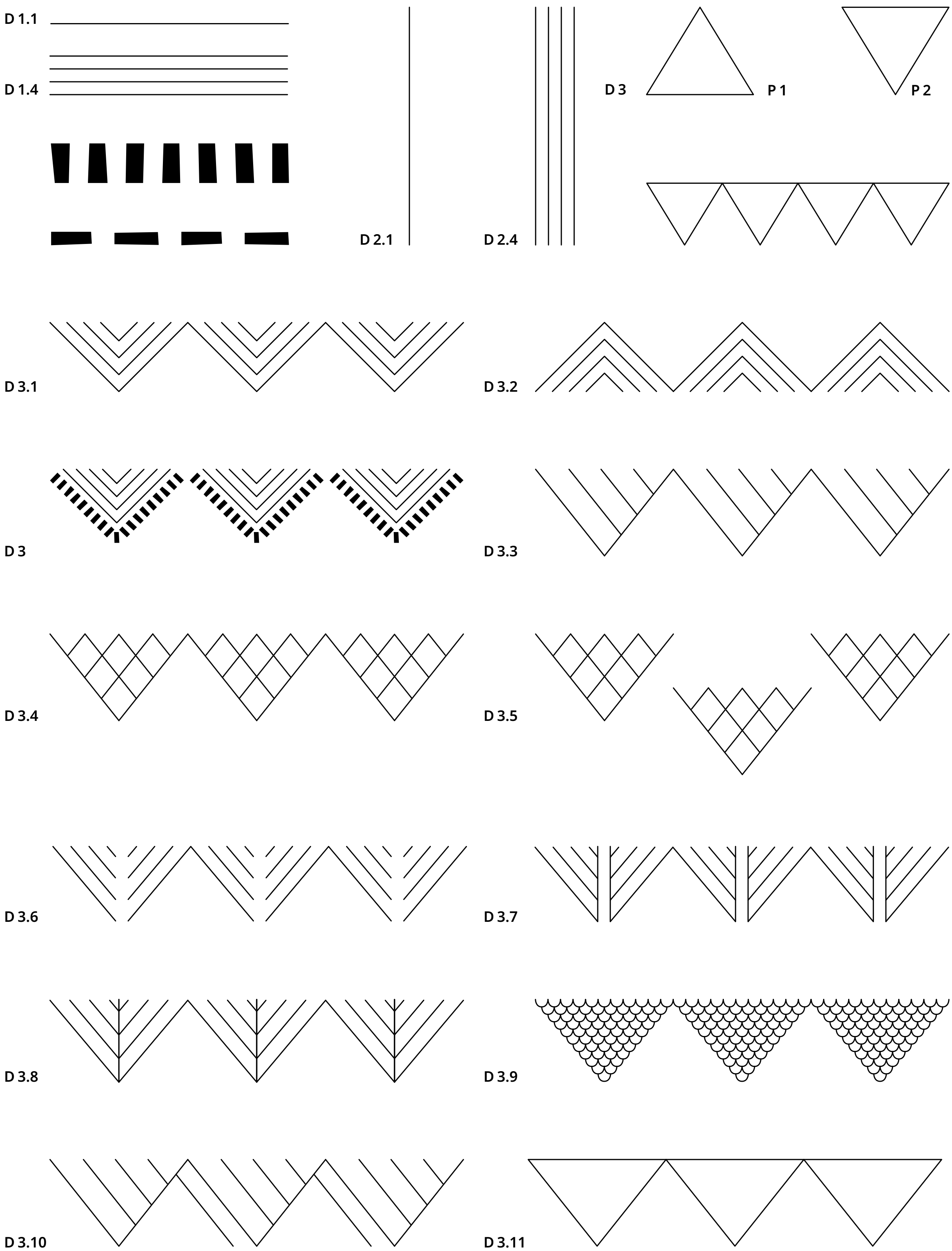
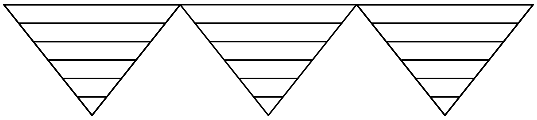
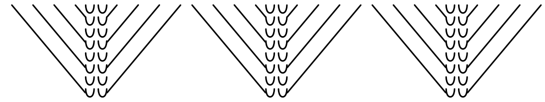


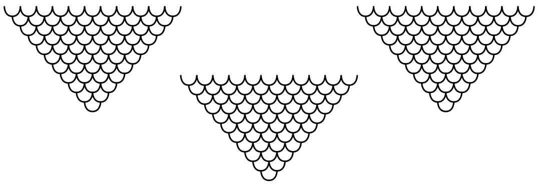
Plate 9. Decoration motifs (categories: Horizontal line/row D1, Vertical line/column D2, Triangles D3).



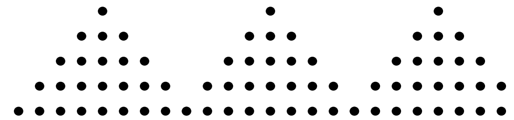
D 3.12



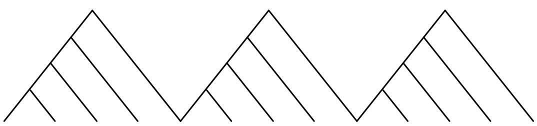
D 3.13



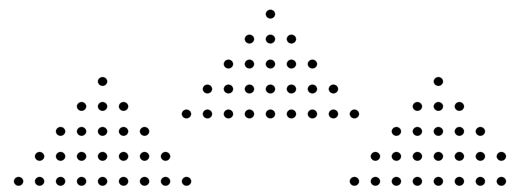
D 3.14



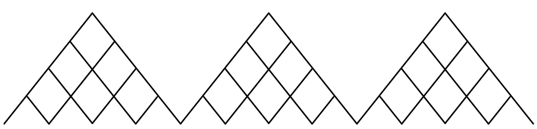
D 3.15



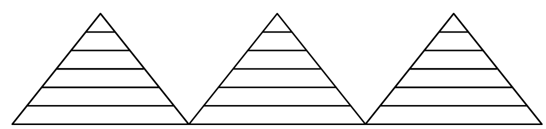
D 3.16



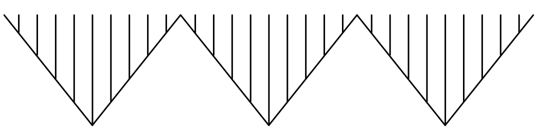
D 3.17



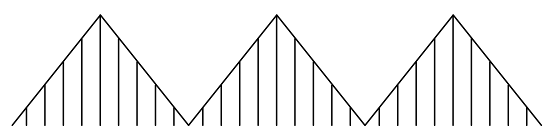
D 3.18



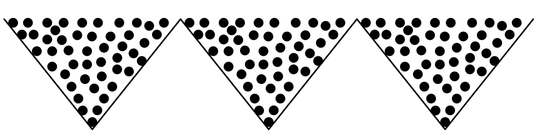
D 3.19



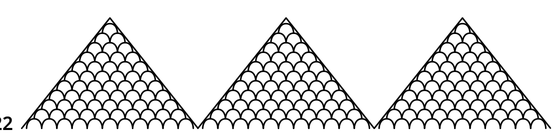
D 3.20



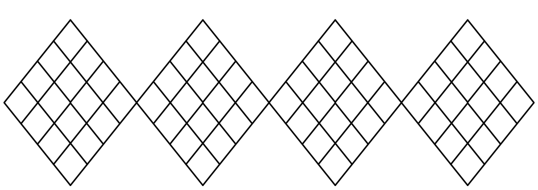
D 3.21



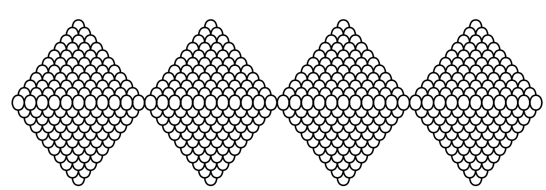
D 3.22



D 3.22

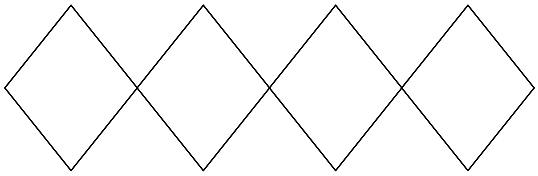


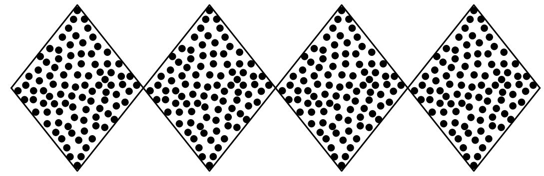
D 4.1

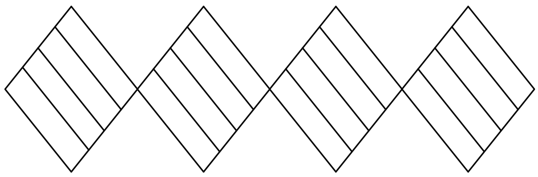


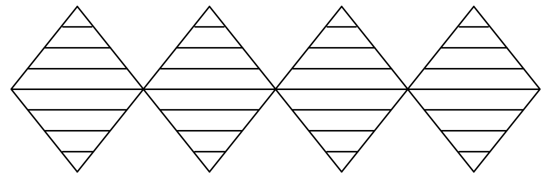
D 4.2

Plate 10. Decoration motifs (categories: Triangles D3, Rhombs D4).


D 4.3


D 4.4


D 4.5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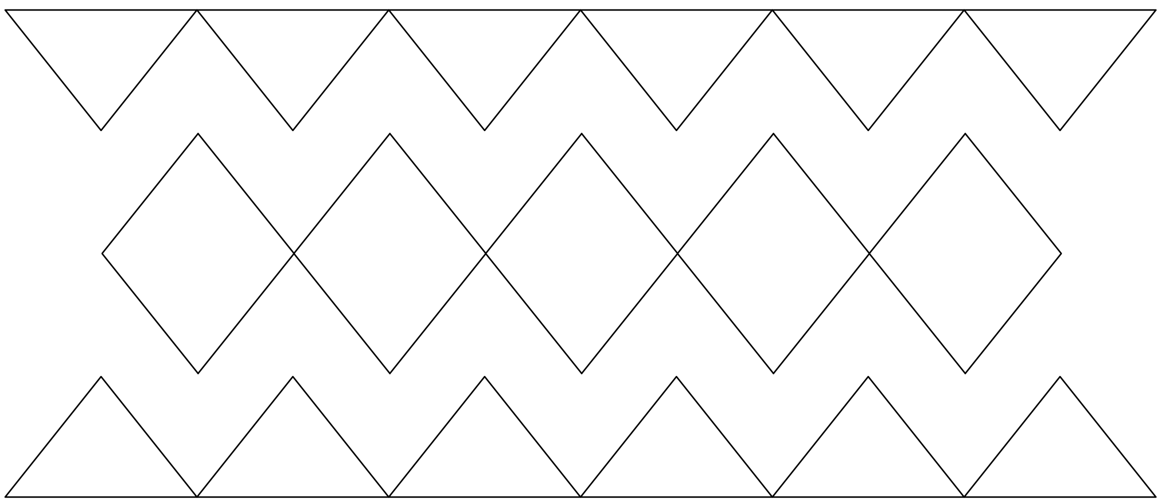
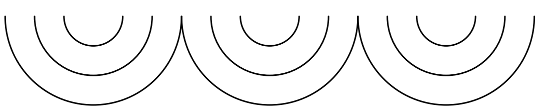
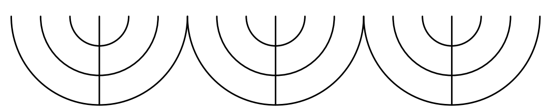

D 5


D 6.1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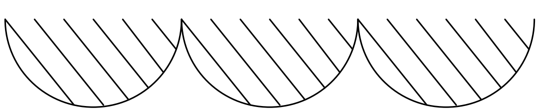
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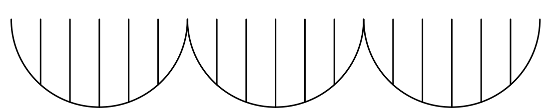
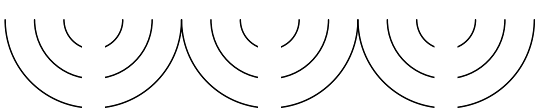

D 6.4


D 6.5

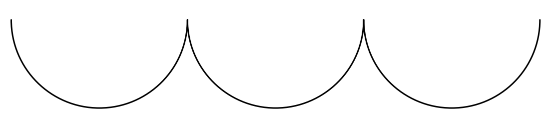

D 6.6

Plate 11. Decoration motifs (categories: Separete rhombs D4, Lozenges with standing and hanging triangles D5, Arches D6).

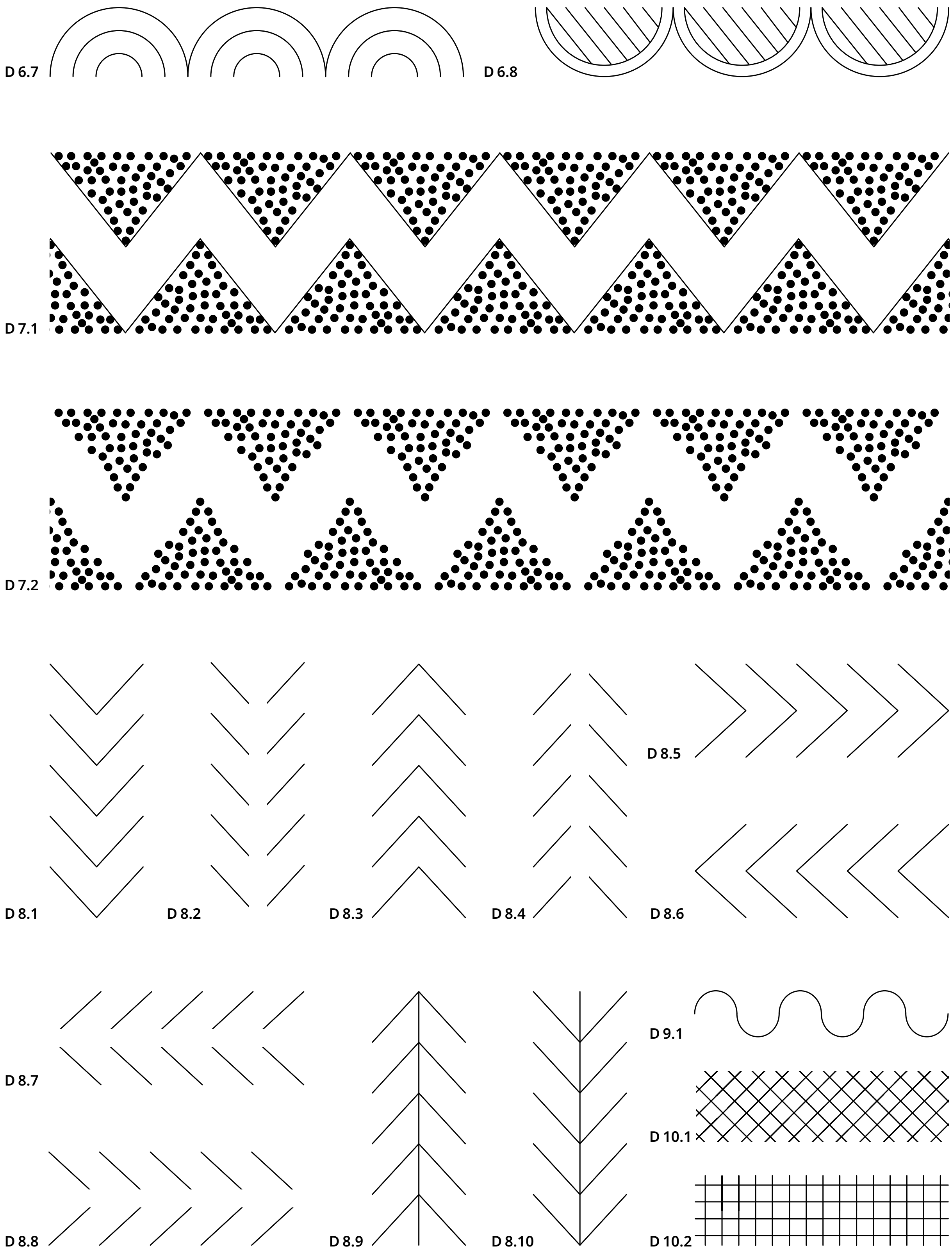


Plate 12. Decoration motifs (categories: Arches D6, Recessed chevrons D7, Herringbone pattern D8, Wavy lines D9, Hatched areas D10).

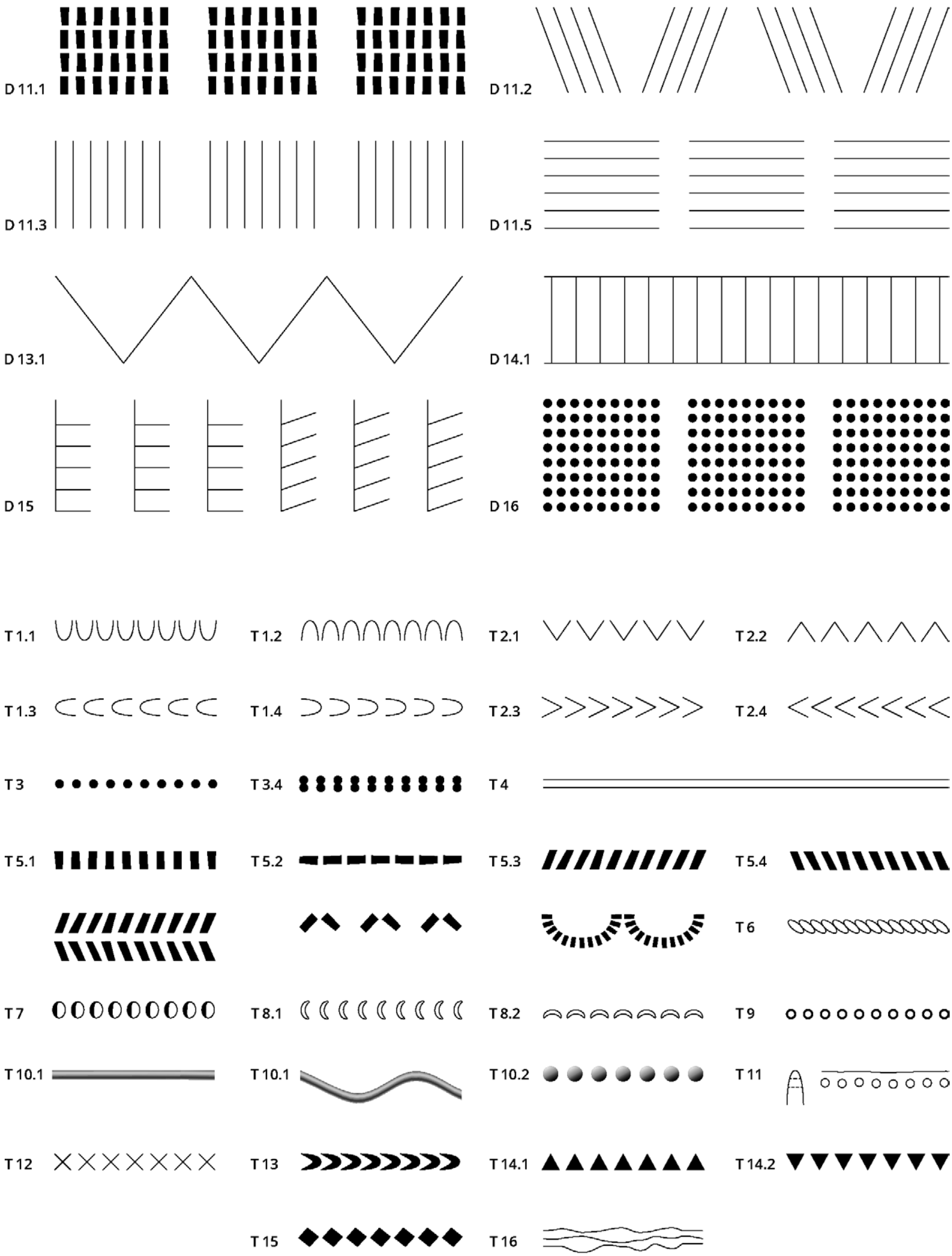


Plate 13. Decoration motifs (categories: Fringe groups D11; Zigzag D13; Ladder D14, Comb D15, Notched Rim D16) and decoration techniques (categories: T1-T16).

Supplements

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Suppl. 2.	Graphical display of GAC distribution patterns.
Suppl. 3.	The sample of GA vessel shapes from the Middle-Elbe-Saale region.
Suppl. 4.	Database and statistics of the correspondence analysis of GA vessel types.
Suppl. 5.	Database and statistics of the correspondence analysis of GAC vessel types (GA and all other vessel types).
Suppl. 6.	Database and statistics of the correspondence analysis of GA decoration technique types.
Suppl. 7.	Database and statistics of the correspondence analysis of GA decoration motifs.
Suppl. 8.	Statistics of Principal Component Analyses (PCA) eigenvectors from the CAs on GAC vessel shapes, decorations and techniques.
Suppl. 9.	Database of GAC ^{14}C dates.
Suppl. 10.	Database and statistics of the Bayesian calibration of GAC assemblages.
Suppl. 11.	Late Neolithic sites and site abbreviations of the Middle-Elbe-Saale region.
Suppl. 12.	Late Neolithic radiometric datings of the Middle-Elbe-Saale region.
Suppl. 13.	Database and statistics of the correspondence analysis of Late Neolithic assemblages from the Middle-Elbe-Saale region.
Suppl. 14.	Isotope values of GAC assemblages.
Suppl. 15.	Database and statistics of correspondence analyses of Late Neolithic bone assemblages.
Suppl. 16.	Database of GAC ceramic-technological analyses.
Suppl. 17.	Database of GAC domestic sites.
Suppl. 18.	Database of GAC ancient DNA analyses.

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SEPARATION, HYBRIDISATION, AND NETWORKS

Globular Amphora sedentary pastoralists ca. 3200–2700 BCE

Around 3000 BCE, a turning point occurred in Europe: Long-existing regional societies entered into a process of transformation. The result is a world in which new global communication networks brought different regions closer together. From 3200/3100 BCE, the Globular Amphora phenomenon (GA) was the trailblazer in Eastern and Central Europe. Due to a focus on pastoral subsistence, in comparison to more agrarian economic systems, new ritual practices formed in light of a more flexible form of settlement. We initially observe the symbolic separation manifested through the "Globular Amphora" in an area between the Lower Vistula and Middle Elbe. Communication networks form rapidly in the West (the Elbe-Network) and in the East (the Vistula-Podolia Network). The monopolisation of the practice of double cattle burials connected regional patterns of mobility in the lowlands between the Elbe and the Dniester.

With the aid of spatial analyses of the systems of symbols (Zeichensysteme) on locally/micro-regionally produced Globular Amphorae, a proxy is developed for the degree of similarity of the GA-habitus in different regions. Bayesian modelling and spatial visualisations of the radiometric dates indicate temporal sequences and synchronic changes within the newly-developed "global" GA-connectivity.

Genetic analyses attest to the indigenous character of the GA individuals in Central Europe. Both isotopic and ceramic technology analyses provide evidence for a mobility radius of up to 50 km for the local groups.

In the main phase of the GA, the Elbe and Vistula-Podolia networks appear separated. In the West the core areas are in Bohemia/Moravia, the Middle Elbe-Saale-Havel area, and the north-western Baltic areas; in the East, they are along the Vistula, in Podolia-Volhynia, and in the Siret area.

GA networks are mostly symbiotically connected with the local and regional agricultural groups. The GA is, among other things, heavily involved in the formation of the multicultural Corded Ware phenomenon. Its end in 2600 BCE is linked to processes of change which also affected the change from Corded Ware to the Bell Beaker phenomenon. Only in the eastern areas, where a strong reciprocal influence with elements from the Steppe existed, can GA still be found until c. 2400 BCE.

The emergence of the GA networks is described as social separation on the basis of social disharmonies within the Funnel Beaker societies, which is also visible via a reduction of the human impact in the palaeoecological archives. A new connectivity of diversified groups developed as a form of levelling mechanism, which in the long-term was part of the transformation of the entirety of European prehistory around 3000 BCE.

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