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POTTERY PRODUCTION, FUNCTION AND MEANING DURING THE BRONZE AND PRE-ROMAN IRON AGE IN THE EASTERN BALTIC

DOCTORAL THESIS

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RIGA 2022

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Annotation

The PhD thesis “Pottery production, function and meaning during the Bronze and Pre-Roman Iron Age in the Eastern Baltic” addresses various aspects of prehistoric pottery, where production encompasses the availability and use of clays, and pottery construction, firing and morphology, while function covers its primary and secondary and role in the communities of the Eastern Baltic during the Bronze and Pre-Roman Iron Age as well as change in these traditions during the period. The aim of the thesis is to analyze pottery production, function and meaning, and its role in the societies of Eastern Baltic Bronze and Pre-Roman Iron Age.

Within the scope of the thesis, various methods were used in order to achieve this aim: visual and statistical analysis, reflective transformation imaging and laboratory methods, namely organic residue analysis, wavelength dispersive X-ray fluorescence and ceramic petrography. The clays from regions near the living sites were also surveyed, sampled, analyzed and compared to pottery assemblages.

It was ascertained that potters had access to good-quality clays and used highly plastic clays from glacial till, in some cases purified. Eight pottery fabrics, with subgroups, were distinguished, indicating different contemporaneous traditions, which might have been dependent on the quality of the clays or potters’ preferences. Mostly granitic rock temper was used; however, organics, grog, sand and quartzite temper were also distinguished. The perception of pottery changed during the Bronze Age, as it became less ornamented and simpler, and thus came to have more of a practical role in the societies. The change of styles from the Early Bronze Age to the Pre-Roman Iron Age was traced in the visual appearance of the pottery; however, a change in tempering traditions was distinguished only at the end of the Pre-Roman Iron Age. Pottery vessels served not only a practical role, namely for cooking, storage and as tableware, but also a socio-ideological role, which is indicated by offerings as well as by their inclusion in burial rites as feasting tools and burial urns. Transmission of knowledge and communication between societies was observed as well, where different surface treatments indicate influences from Scandinavia as well as Central Europe and even between Eastern Baltic communities themselves.

Anotācija

Promocijas darbs “Keramikas izgatavošana, pielietojums un nozīme bronzas un senākajā dzelzs laikmetā Austrumbaltijā” ir veltīts dažādiem aizvēstures keramikas trauku aspektiem – to izgatavošanai – mālu pieejamībai un izmantošanai, trauku izstrādei, apdedzināšanai un morfoloģijai, funkcijai – primārajai un sekundārajai un to nozīmei, un tradīciju izmaiņām aizvēstures kopienās. Promocijas darba mērķis ir analizēt keramikas trauku izgatavošanu, pielietojumu un nozīmi, kā arī tās lomu Austrumbaltijas bronzas un senākā dzelzs laikmeta sabiedrībās.

Lai sasniegtu šo mērķi tika izmantotas vairākas metodes – vizuālās un statistiskās analīzes, reflektīvās transformācijas attēlmodelēšana, laboratorijas metodes – organisko atlieku analīzes, rentgenstaru fluorescences spektrometrija un keramikas petrogrāfija. Tika arī apzināti un atlasīti vietējo mālu paraugi, kuri tika salīdzināti ar arheoloģisko keramiku.

Promocijas darbā tika noskaidrots, ka podniekiem bijis pieejams labas kvalitātes māls, tie izmantojuši ļoti plastisku morēnmālu vai attīrītu morēnmālu. Tika konstatētas astoņas māla masas receptes ar vairākām apakšgrupām, kas norāda uz dažādām vienlaicīgi pastāvējušām liesinātāju tradīcijām, kas bijušas atkarīgas vai nu no māla kvalitātes vai podnieka preferencēm. Par liesinātāju pārsvarā izmantoti granītiskie ieži, taču sastopama arī organika, šamots, smilts un kvarcīts. Sākoties bronzas laikmetam aizvēstures kopienu uzskati par keramiku mainījās, tā kļuva vienkāršāka, ieņemot praktiskāku nozīmi. Tika konstatētas keramikas veidu izmaiņas no agrā bronzas līdz senākajam dzelzs laikmetam. Savukārt, liesinātāju un recepšu izmaiņas tika konstatētas vien senākā dzelzs laikmeta beigās. Keramikai bija ne vien praktiska – ēdiena pagatavošanas un uzglabāšanas, nozīme, bet arī socio-ideoloģiska nozīme aizvēstures kopienās. Šī loma atspoguļojas tajā, ka keramika tika izmantota gan ziedojumos, gan apbedīšanas rituālos, gan arī kā urnas. Zināšanu pārnese un savstarpējie kontakti starp kopienām keramikā izpaudās kā dažādu stilu sajaukums un ornamenti, kam analoģijas meklējamas Skandināvijā un Centrāleiropā. Tika konstatēti arī savstarpēji kontakti starp Austrumbaltijas kopienām.

Abbreviations

A – code for collections of the National History Museum of Latvia

AA – code for archival documents of the National History Museum of Latvia

AI – code for collections of Tallinn University Archaeological Research Collection

AMS – accelerator mass spectrometry

AR – code for collections of the Lithuanian National Museum

CHI – cultural heritage imaging

CM – code for collections of Cēsis History and Art Museum

CP – ceramic petrography

EBA – Early Bronze Age

EGK – Estonian Geological Survey (*Eesti Geoloogiakeskus*)

GC-MS – gas chromatography-mass spectrometry

KAM – Russian *Kelty Akozinsko-Melarskie* (Akozino-Mälar celts)

LBA – Late Bronze Age

LGT – Lithuanian Geological Survey (*Lietuvos geologijos tarnyba*)

LII – Lithuanian Institute of History (*Lietuvos istorijos institutas*)

LNM – Lithuanian National Museum

LNVM – National History Museum of Latvia (*Latvijas Nacionālais vēstures muzejs*)

LVĢMC – Latvian Environment, Geology and Meteorology Centre (*Latvijas Vides, ģeoloģijas un meteoroloģijas centrs*)

PCA – principal component analysis

PIA – Pre-Roman Iron Age

RTI – reflectance transformation imaging

TLÜ – Tallinn University (*Tallinna Ülikool*)

TÜ – University of Tartu (*Tartu Ülikool*)

VI – Code for collections of the National History Museum of Latvia

VIAA – Code for collections of the Repository of Archaeological Material, Institute of Latvian History, University of Latvia

WD-XRF – wavelength dispersive X-ray fluorescence

XRD – X-ray diffraction

XRF – X-ray fluorescence

Introduction

The period from the Early Bronze Age to the Pre-Roman Iron Age (1800 BC – 1st century BC) is a time of changes that were not restricted to the Eastern Baltic region. In this period, new materials – bronze and later iron – appear, being imported from other regions, adapted and used in everyday practice. There are significant changes in socioeconomic processes as well, the hunter-gatherer model changing to an agricultural model. Changes are seen in other aspects too: a new type of living site appears, the early hillfort, most of these sites constituting major centres of bronze casting and trade, and new funerary traditions emerge, namely barrow graves and stone ship settings. A change in traditions is seen in the pottery as well. The abundant ornamentation on the surface of the vessels decreases in the Early Bronze Age and almost disappears in the Late Bronze and Pre-Roman Iron Age, with the exception of Asva type fine ware. Changes are seen in the shape of the pots and tempering materials as well, crushed granitic rock becoming dominant.

Pottery is an important artefact class: on the basis of characteristics such as surface treatment, ornamentation, morphology and tempering tendencies, it is possible to distinguish local and regional influences, knowledge transmission, craftsmanship in ceramics and aesthetic values in societies. Accordingly, pottery has been quite thoroughly studied, and this applies also to the ceramics of the Bronze and Pre-Roman Iron Age. Thus, the Early Bronze Age pottery in the territory of the Eastern Baltic has been investigated by archaeologists Ilze Loze, Normunds Grasis, Gytis Piličiauskas and Rokas Vengalis, while Late Bronze and Pre-Roman Iron Age ceramics have been researched by Jānis Graudonis, Andrejs Vasks, Elena Grigalavičienė-Danilaitė, Vello Lõugas, Valter Lang and others.

These studies provide meaningful information about pottery types, their distribution and overall tempering tendencies, along with interpretations concerning the inhabitants and their changing traditions regarding ceramics. However, they do not cover all three periods (Early Bronze Age – Late Bronze Age – Pre-Roman Iron Age) in a comparative context. Thus, Early Bronze Age pottery has always been analyzed in the context of the Neolithic, whereas no detailed study has been done to analyze the change in ceramic production tendencies and function between the Early and Late Bronze Age, and between the Late Bronze and Pre-Roman Iron Age. Certain of these studies are also partly outdated, as they do not include data from some of the recently excavated sites, such as Antilgė, Krievu kalns, Mineikiškės, Garniai I and Padure hillforts, Bīlavas stone ship setting, etc. It must be noted that practically none of these studies include laboratory methods, and therefore such

characteristics as clay paste and temper, and thus also the possible production region, and likewise pottery function, have either not been studied or have received insufficient attention.

The methods used in this thesis, such as ceramic petrography, X-ray fluorescence analysis (XRF), organic residue analysis as well as the study of environmental materials, namely clays, provide new and more precise data about production and use of pottery and offer an insight into the processes occurring in the societies of the Bronze and Pre-Roman Iron Age. The focus in this thesis is on the pottery of living sites and burials in the territory of the Eastern Baltic, namely present-day Estonia, Latvia and Lithuania. The reasoning behind such a choice is that in the research period there were no such borders, the historical space and mode of social identification being rather different than today; accordingly, in order to adequately compare aspects of pottery production , it is essential to analyze the material from these territories as a whole. The archaeological sites included in this study have been chosen according to the criterion of their location within the region, i.e., they are Early Bronze Age to Pre-Roman Iron Age living sites and burials in various regions of the Eastern Baltic, allowing determination of the main trends and potential differences in pottery production and use.

The **aim of the thesis** is to analyze pottery production, function and meaning, and its role in the societies of the Eastern Baltic Bronze and Pre-Roman Iron Age.

In order to attain this aim, the following **tasks** need to be addressed:

1. Study of geological fieldwork and research reports, in order to understand the available clay resources in nearby regions, as well as archaeological excavation reports, in order to understand the context of the living sites and burials, the standard of excavation and documentation (e.g., for living sites, the stratigraphy, placement of trenches and distribution of finds, and for burials, the placement of grave goods etc.), ascertaining the precision of fieldwork and the conditions of preservation.
2. Macroscopic analysis of the living site and burial pottery assemblages, i.e. statistical analysis of surface treatment, wall thickness, height and shape of the vessels, as well as size, ornamentation and coiling techniques. These visual characteristics are compared between regions in all three periods to determine the local and regional aspects of pottery production as well as changes in this craft in the periods under study;
3. Reflective transformation imaging (RTI) analysis of surface treatments and imprints on the pottery remaining from the process of building the vessel and the

application of surface treatment, in order to understand these processes and analyze them;

4. Fieldwork to sample clays from the studied settlement regions, sample processing, and petrographic and XRF analysis. Such a database of environmental materials is necessary as a body of comparative material permitting characterization of the pottery samples in relation to the clays of the region;
5. Petrographic and X-ray fluorescence analysis on the pottery samples in order to analyze the mineralogical and chemical composition of the clay fabric, as well as to determine the tempering materials and identify trends;
6. Organic residue analysis and study of the vessels' intended and actual use through context analysis to understand pottery function and meaning in the Bronze and Pre-Roman Iron Age.

The thesis consists of **seven chapters**, characterizing the period under study, the archaeological context and various aspects of pottery production, meaning and function. Chapter 1 provides a brief research history of pottery analysis in the Eastern Baltic, presenting the main tendencies in each period, from the 19th century up to the present day, and the main conclusions of each study.

Chapter 2 sets out the contextual and chronological framework of the thesis: the course of development during the Eastern Baltic Bronze and Pre-Roman Iron Age and the context of the sites analyzed. This chapter presents the chronology and brief description of each period as well as detailed description of the most important finds and research history of each site analyzed in the thesis.

Chapter 3 covers the material and methods used in the thesis. First, the materials themselves – clays and ceramics – are described, considering aspects of their condition. The visual and laboratory methods as well as sampling procedures are described in detail. Survey and preparation of the clay samples are also treated in this chapter.

Chapter 4 presents the results obtained from the visual and laboratory methods used to analyze pottery production and materials utilized in making ceramic vessels. This chapter considers the availability of clays as well as the tempering materials used and the natural impurities. Mineralogical and chemical data is presented and analyzed. In this chapter, ware types of pottery and their main trends are also analyzed and described.

Chapter 5 deals with the spatial analysis of pottery found on living sites as well as contextual studies of the pottery from burial sites. This chapter also includes analysis of use-

alteration patterns, such as sooting and food crusts. The results of organic residue analysis are presented. This data is used to interpret pottery function.

Chapter 6 provides a brief overview of pottery traditions during the Bronze and Pre-Roman Iron Age in Scandinavia, Central Europe as well as present-day Belarus. This chapter contributes to understanding possible influences between regions as well as the overall trends of pottery in Central and Northern Europe.

Chapter 7 sets out the interpretations of pottery production, function and meaning during the Bronze and Pre-Roman Iron Age. This concluding chapter integrates previous research and the new information obtained in this study.

REVIEW OF SOURCES AND LITERATURE

The thesis is based on an analysis of 46 pottery assemblages, utilizing 41 unpublished archival sources, 12 published sources, 191 items of literature and six items of reference literature.

Pottery assemblages[1] constitute the key element of the thesis, as this is the basic source analyzed. The assemblages utilized in the study are held in the Tallinn University Archaeological Research Collection (*Tallinna Ülikool Arheoloogia teaduskogu*), the Department of Archaeology of the National History Museum of Latvia (*Latvijas Nacionālais Vēstures muzejs, Arheoloģijas departaments*), the Department of Prehistoric Archaeology of the National Museum of Lithuania (*Lietuvos Nacionalinis Muziejus Priešistorinės archeologijos rinkinių skyrius*) and the History and Art Museum of Cēsis (*Cēsu Vēstures un mākslas muzejs*). These pottery assemblages (Table 1) are diverse in quantitative and qualitative terms, referring to the size of the sherds and their preservation, as well as such criteria as documentation of the find context: the excavation trench, square and more precise coordinates. In this regard, more information is available for the assemblages from more recent excavations, starting from the beginning of the 21st century.

The pottery assemblages showing a better quality of preservation are from living sites, especially hillforts, such as Asva, Brikuļi, Krievu kalns, Ķivutkalns, Narkūnai, Sokiškiai, Vīnakalns, etc., and in these cases it is possible to reconstruct numerous vessels. However, in the case of some hillforts it was not possible to reconstruct vessels due to the highly fragmented nature of the assemblage and the large extent of the excavation area: these include Antilgė, Garniai I, Padure and Ridala hillforts as well as the Kaali and Priednieki settlements. Likewise, highly fragmented are assemblages from cemeteries such as Buļļumuiža, Pukuļi and Reznes, where small amounts of sherds were collected without precise recording of find position. Assemblages from cemeteries with urns, such as Ėgliškiai and Paveisininkai, are in better condition, and in the majority of cases reconstructable vessels were distinguished. Most of the pottery assemblages have been analyzed in full by the author of the thesis, and only in some cases has the analysis included only part of the assemblage. Four hillfort assemblages covered in this thesis have not been analyzed in full: Asva, Ķivutkalns and Sokiškiai. Approximately 65% of the Ķivutkalns assemblage and 30% of the Asva and Sokiškiai and 10% of Asote assemblages have been analyzed by the author in order

[1] The quality criteria of pottery assemblages are described in detail in the chapter “Material and methods”.

to determine the main statistical trends of the pottery, obtaining the missing data from publications in which the pottery from these sites has been analyzed in detail.

Table 1. Data on pottery assemblages and the related sources analyzed in this study.

No.	Site	Museum collections code	Source data (as used in this study)	Publication data (as used in this study)
1.	Abora I	LNVM AD VI 76	-	LOZE 1979, 2021
2.	Antilgė	LNM, AN16, AN17	ČIVILYTĖ 2017, POŠKIENĖ 2018	-
3.	Asote	LNVM AD, VI 15	-	ŠNORE 1961, URTĀNS 2021
4.	Asva	TLÜ, AI 3307, AI 3658, AI 3799, AI 3994, AI 4366	SPERLING *et al.* 2015, 2020	LÕUGAS 1970, SPERLING 2014
5.	Bašķi	LNVM AD, A 10086	STEPIŅŠ 1938	CIGLIS 2021
6.	Bīlavas	LNVM AD, VI 325	GREWINGK 1879	VASKS 2000
7.	Brikuļi	LNVM AD, A 12405, A12468, A12379	VASKS 1974, 1977, 1978, LOZE, VASKS 1974	VASKS 1994, VISOCKA 2022
8.	Buļļumuiža	LNVM AD, A 7406, A 9961, A 6395, A 63907, A 63908	ĢINTERS 1930, ŠTURMS 1929	VASKS 2021
9.	Cīravas Dārznieki	LNVM AD, A 162, A 9160, A 8848	ŠTURMS 1936	VASKS 2021
10.	Dievukalns	LVNV AD, unregistered	ZARIŅA 1979, 1982	VASKS 2021
11.	Ėgliškiai	LNM, AR 636	DANILAITĖ 1970, GRIGALAVIČIENĖ 1974	GRIGALAVIČIENĖ 1979, MERKEVIČIUS 2014
12.	Garniai I	LNM, AR 997	ČIVILYTĖ 2017, PODĖNAS 2018	-
13.	Gārsenes Bērzkalni	LNVM AD, unregistered	-	GUŠČIKA 2010
14.	Kaali	TLÜ, AI 4915	-	VESKI *et al.* 2004

15.	Kerkūzi I	LNVM AD, VI 274	VASKS 1985, 1986, 1987	VASKS 1995, 2021
16.	Kalnapiļas	CM 7191, 7196, 7198	-	-
17.	Klaņģukalns	LNVM AD, A 9960	-	ŠNORE 1936, VASKS 2021
18.	Klosterkalns	LNVM AD, VI 219	-	VASKS 2021
19.	Kõivuküla	TÜ 1915	VALK *et al.* 2012	-
20.	Krievu kalns	LNVM AD, A 13958, A 13957	VASKS, DONIŅA 2013, VASKS, VILKA 2014, DONIŅA *et al.* 2014	VASKS *et al.* 2020
21.	Ķivutkalns	LNVM AD, VI 120	GRAUDONIS 1966-1967	DEŅISOVA *et al.* 1985, GRAUDONIS 1989, OINONEN *et al.* 2013, VASKS, ZARIŅA 2014
22.	Lagaža	LNVM AD, VI 118	LOZE 1966, 1968	LOZE 1979, 2021
23.	Laukskola	LNVM AD, VI 128	ZARIŅA 1975	ŠULTE, GUNNARSSON 2017, VISOCKA *et al.* 2021
24.	Lejasbitēni	LNVM AD, unregistered	-	CIGLIS 2021
25.	Lipši	LNVM AD, A 185	-	VILCĀNE 2021
26.	Mineikiškės	LNM, MNK20	MINKEVIČIUS 2021, PODĖNAS 2020	-
27.	Mūkukalns	LNVM AD, A 1048, A 11848	-	VASKS 2021
28.	Mušiņas	TÜ, 1303	GREWINGK 1879	-
29.	Narkūnai	LNM, NA77, NA78	-	PODĖNAS *et al.* 2016
30.	Padure	LNVM AD, A 13517, A 13372	VASKS 2008	VASKS *et al.* 2011, 2021
31.	Paplaka	LNVM AD, A 12438	VASKS 1976	VASKS 2021
32.	Paveisininkai	LNM, AR440	KULIKAUSKAS	MERKEVIČIUS

			1962	2014
33.	Priednieki	LNVM AD, A 13375	VASKS 2006	-
34.	Pukuļi	LNVM AD, A 12493	-	VASKS 2000, 2021
35.	Reznes	LNVM AD, A 11769, VI 133	-	VASKS *et al.* 2021, VASKS 2021
36.	Ridala	TLÜ, AI 4261	-	SPERLING, LUIK 2010
37.	Soe	TÜ 2672	VALK 2018	-
38.	Sokiškiai	LNM, SOK80, SOK81, SOK82	GRIGALAVIČIENĖ 1980, 1981, 1983	-
39.	Sõrve, Lülle	TLÜ, AI 4409	-	LÕUGAS 1970
40.	Strīķi	LNVM AD, A 10811	-	GRAUDONIS 2001
41.	Tojāti	LNVM AD, A2222-2232	-	GRASIS 2021
42.	Vampenieši	LNVM AD, VI 124	-	VILCĀNE 2021
43.	Vilmaņi III	LNVM AD, VI 254	ZAGORSKA 1988	-
44.	Vīnakalns	LNVM AD, VI 125	GRAUDONIS, DAIGA 1967	GRAUDONIS 1989, VISOCKA 2017
45.	Žalioji	LNM, unregistered	GAILIUŠAS 1952, RIMANTIENĖ 1958	-

The **unpublished sources** consist of archival documents: reports of archaeological investigations on the sites and reports of geological surveys and analyses of clay deposits. The archaeological reports used in the study are held at the Lithuanian Institute of History (*Lietuvos istorijos institutas*), the Department of Archaeology of the National History Museum of Latvia and the Repository of Archaeological Material of the Institute of Latvian History, University of Latvia (*Latvijas Universitātes Latvijas vēstures institūta Arheoloģisko materiālu krātuve*).

The archaeological reports are used in order to understand the archaeological context of the site and the pottery assemblage (Table 1). More detailed reports, such as those from Antilgė, Krievu kalns, Mineikiškės, etc., have been used for spatial analysis of pottery, as they contain detailed information regarding the distribution of the sherds and vessels across the site. In the case of Ķivutkalns and Vīnakalns, there is only field documentation from archaeological excavation on the sites, i.e. there are no official archaeological excavation reports. This excavation documentation is quite detailed, especially with respect to hearths

and similar features. However, there are a few errors, and information is missing: thus, the pottery list for Ķivutkalns does not include all of the sherds recovered, while Vīnakalns has no list at all. The text of the report contains very vague references to the pottery, only indicating that large or small amounts of pottery were been found in a particular area, without giving the precise find positions for the pottery from these sites. The situation is similar in the case of excavation reports, where Sokiškiai hillfort and Žalioji settlement have no list of finds or precise coordinates, making it difficult to interpret the context and distribution of the pottery. Errors regarding the trench coordinate system appear in the reports for the Lagaža settlement, where the coordinates in trenches C and E do not correspond to those given in the reports, making it impossible to ascertain the position of the pottery finds. In the case of the Brikuļi reports, although very detailed and thorough information is given concerning the finds, only in few cases has the precise position of pottery finds been recorded, giving the square metre, while the rest of the material is documented only as recovered in a particular trench.

Most of the archaeological reports of the cemeteries are from the mid 20th century, and so they do not contain detailed information regarding pottery. Only in few cases has the pottery been documented in the context of the burials. Moreover, in the case of Paveisininkai there are no excavation plans of the burials at all, and so it is impossible to interpret the location of the urns in the context of the cemetery. The best documentation is in the Ėgliškiai report, where detailed drawings of the vessels in their context as well as schemes of the location of vessels found in the barrows are presented. Detailed description of each barrow and interpretations are given as well.

The geological survey documentation is held in the geological collections of the Estonian Geological Survey (*Eesti Geoloogiakeskus*), the Latvian Environment, Geology and Meteorology Centre (*Latvijas Vides, ģeoloģijas un meteoroloģijas centrs*) and the Lithuanian Geological Survey (*Lietuvos geologijos tarnyba*). The geological records[2] compiled in the

[2] KARLIS SKRASTINSH. Otchet o razvedke Dolessalskogo mestorozhdenjija mergeljei (kafelnjih gljini). 1948. In: Latvijas vides, ģeoloģijas un meteroloģijas centrs, Ģeoloģijas fonds (LVĢMC ĢF), Inv. Nr. 84; SERGEJS ILJINSKIS. Lubānas līdzenuma centrālās daļas kvartārģeoloģija. Rīga, 1949. In: LVĢMC ĢF, Inv. nr. 108; R. RAJESKAS. O Poiskah i razvedke glin mestorozhdenjija "Darvinaj" Objaljskogo raijona Lit. SSR. Vilnjus, 1953. In: Lietuvos geologijos tarnyba (LGT), Inv. no. 517; D. NENARTAVICHIENE, I. MOCKKJAVICHJUS. Svodnij otchet o detaljhoij razvedke mestorozhdenjija glini Disna i poiskovo-ochenochnim rabotam na gliny, prigodnuju dlja proizdvostva licevogo kirpicha v Ignalinskom rajone Litovskoj SSR. Vilnjus, 1979. In: LGT, inv. No. 3149; N. DILAKTORSKIJ. Otchet. Rezultata fizikohimicheskah i

course of investigation of clay deposits have been used in order to understand the geological context – the properties and distribution of clays in the environs of living sites. Most of these documents contain detailed information about the clay deposits, including results of chemical and geological analysis. However, such reports are generally only available for large clay deposits used for mass production of bricks and other ceramic materials. An exception is the report on Quaternary sediments in the Lake Lubāns area by Sergejs Iljinskis, which was subject to detailed survey. However, this report does not contain chemical analysis of the clays.

The **published sources** include brief archaeological reports published in the proceedings of the Sessions of Scientific Reports on Research by Archaeologists and Ethnographers (*Zinātniskās atskaites sesijas materiāli par arheologu un etnogrāfu* […] *pētījumu rezultātiem*),[3] *Archaeological Research in Latvia* (*Arheologu pētījumi Latvijā*)[4] and *Archaeological Fieldwork in Estonia*.[5] These archaeological reports consist of a short

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laboratornih keramicheskih issledovanij chetireh obrazcov glin c ostrova Saaremaa. 1950. In: Eesti Geoloogiakeskus (EGK), inv.no. 1586; N. DILAKTORSKIJ. Issledovanije sostava i voistje glin ESSR. Rezultati fizikohimicheskih i laboratornih keramicheskih issledovanij glin mestorozhdenija Kallemjae, Pilva, Viru, Vastselina, Sinka. Tallinn, 1951 In: EGK, inv.no. 2966; I. ELVRE, R. METS. 1958. aastal teostatud detailse geoloogilise luure lühikokkuvõte. Kiiu, 1961. In: EGK, inv.no. 3084.

[3] ILGA ZAGORSKA. Izrakumi Vilmaņu III apmetnē. In: Zinātniskās atskaites sesijas materiāli (ZASM) par arheologu un etnogrāfu 1986. un 1987. gada pētījumu rezultātiem, 1988; ILZE LOZE, ANDREJS VASKS. Izrakumi Brikuļu apmetnē. In: ZASM par arheologu un etnogrāfu 1973. gada pētījumu rezultātiem, 1974, 48-50. lpp; ANNA ZARIŅA. Izrakumi Lilevārdē 1978. gadā. ZASM par arheologu un etnogrāfu 1978. gada pētījumu rezultātiem, 1979, 97-100. lpp; ANNA ZARIŅA. Izrakumi Lielvārdes Dievukalnā 1980. gadā. In: ZASM par arheologu un etnogrāfu 1980. un 1981. gada pētījumu rezultātiem, 1982, 159-163. lpp; ILGA ZAGORSKA. Izrakumi Vilmaņu III apmetnē. In: ZASM par arheologu un etnogrāfu 1986. un 1987. gada pētījumu rezultātiem, 1988, 151-156. lpp

[4] INGA DONIŅA, ANDREJS VASKS, AIJA VILKA. Izrakumi Skrundas Krievu kalnā. In: Arheologu pētījumi Latvijā 2012. un 2013. gadā. Rīga, 2014; ANDREJS VASKS. Arheoloģiskie izrakumi pie Ventas. Arheologu pētījumi Latvijā (APL) 2004. un 2005. gadā. Rīga, 2006, 64.-75. lpp; ANDREJS VASKS. Arheoloģiskie izrakumi Padures (Beltu) pilskalnā 2006. un 2007. gadā. APL 2006. un 2007. gadā. Rīga, 2008, 63-70. lpp

[5] HEIKI VALK, PIKNE KAMA, MAARJA OLLI, EVE RANNAMÄE. Excavations on the hill forts of south-east Estonia: Kõivuküla, Märdi, Truuta and Aakre. In: Archaeological fieldwork in Estonia 2011, 2012; HEIKI VALK. A find of Bronze Age pottery at Soe inn in Võrumaa. Archaeological fieldwork in Estonia 2017, 2018; UWE SPERLING, VALTER LANG, KRISTIINA PAAVEL UND ANDRES KIMBER. Neue Ausgrabungen in der Bronzezeit siedlung von Asva – vorläufiger Untersuchungsstand und weitere Ergebnisse. In: Archaeological fieldwork in Estonia 2014, 2015; UWE SPERLING, HANS-JÖRG KARLSEN, VALTER LANG, LEMBI

description of the excavations and the main finds, often also including ^{14}C dates. Thus, these reports were not only used in the context chapters but also contributed to the detailed chronological framework. The author has included as a published source Constantin Grewingk's work *The Stone Ship Setting of Mušiņas and the Vella laives or Devil's Boats of Courland*,[6] which includes information from the excavation of stone ship settings in the 19th century. It is notable that, except for this work, there are no reports or other information from the excavations of stone ship settings, so that this publication serves as source material. For the 19th century this was a very innovative study, including contextual analysis and various drawings and schemes of stone structures and pottery *in situ*.

The **literature** utilized in the study, consisting of monographs and research articles, can be divided into two groups in terms of its use in the thesis, namely methodological literature and research literature. The methodological literature includes all research or study literature which relates to the methods used in this study. For example, use has been made of Patrick S. Quinn's *Ceramic Petrography* […],[7] James Stoltman's *The Role of Petrography* […][8] and Dennis Braekman and Patrick Degryse's *Petrography* […][9], which provided guidance in preparing and analyzing pottery thin sections. These studies set out the potential of ceramic petrography, with additional analysis of how to differentiate tempering materials and impurities and how to obtain information about the clay paste in general. For understanding and interpreting chemical analysis performed using XRF analysis, the author employed as study literature the paper by Edward Hall *X-ray fluorescence dispersive* […].[10] This study describes the physics behind the two methods of XRF analysis – wavelength dispersive (WD-XRF) and energy dispersive (ED-XRF) – as well as the role of each of these in archaeological pottery analysis, describing their potential and limitations. Methodological

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LÕUGAS, ANDRES KIMBER, RONJA LAU. Ausgrabungen in der Bronzezeit Siedlung von Asva im Jahr 2019. In: Archaeological Fieldwork in Estonia 2019, 2020, pp. 51-60

[6] CONSTANTIN GREWINGK. Die Steinschiffe von Musching un die Wella-Laiwe oder Teufelsböte Kurlands überhaupt. In: Verhandlungen der gelehrten Lettischen Geselschaft. Dorpat, 1879, pp. 1–49

[7] PATRICK QUINN. Ceramic petrography: The interpretation of archaeological pottery and related artefacts in thin section. Oxford

[8] JAMES STOLTMAN. The Role of Petrography in the Study of Archaeological Ceramics. In: PAUL GOLDBERG, VANCE HOLLIDAY, REID FERRING (eds). Earth Sciences and Archaeology. 2001

[9] DENNIS BRAEKMANS, PATRICK DEGRYSE. Petrography: Optical microscopy. In: ALICE HUNT (ed), The Oxford handbook of archaeological ceramic analysis, Oxford, 2016

[10] EDWARD HALL. X-ray fluorescence-energy dispersive (ED-XRF) and wavelength dispersive (WD-XRF) spectrometry. In: ALICE HUNT (ed), The Oxford handbook of archaeological ceramic analysis, Oxford, 2016

literature was also used to understand and interpret organic residue analysis,[11] radiocarbon dating[12] as well as the photogrammetric method of RTI.[13]

Also important for the study were two monographs on pottery analysis and processes in pottery production. The first is the monograph by Valentine Roux *Ceramics and Society: A Technological Approach to Archaeological Assemblages*, which is used in order to understand the production of the vessels and classification of petrographic fabrics[14] This monograph presents and employs in pottery analysis the approach known as *chaîne opératoire*. The other is the monograph by Prudence M. Rice *Pottery Analysis: A Sourcebook*.[15] This monograph has been used in order to understand the function of vessels based on characteristics such as use-alteration patterns and find context.

Research literature was used for various purposes, firstly for establishing and assessing the chronological and theoretical framework. The chronology of various sites, such as hillforts and cemeteries, has been widely investigated and is the subject of numerous studies. The emergence of early hillforts has been studied on the basis of ^{14}C datings by Vytenis Podėnas.[16] In his study, he concludes that hilltop settlements (early hillforts) first appear in the 11th–9th century cal BC in the coastal part of western Latvia, whereas inland hillforts appear during the 10th–6th century cal BC. This study includes new datings for Antilgė, Garniai I, Mineikiškės, Narkūnai and Sokiškiai hillforts as well as radiocarbon

[11] HANS BARNARD, JELMER EERKENS. J. 2016. Assessing Vessel Function by Organic Residue Analysis. In: ALICE HUNT (ed), The Oxford handbook of archaeological ceramic analysis, Oxford, 2016; RICHARD EVERSHED. Experimental approaches to the interpretation of absorbed organic residues in archaeological ceramics. In: World Archaeology, 2008, vol. 40, pp. 26–47; HISTORIC ENGLAND. Organic Residue Analysis and Archaeology. Guidance for Good Practice, 2017. Available: https://historicengland.org.uk/images-books/publications/organic-residue-analysis-and-archaeology/

[12] WALTER KUTSCHERA. Accelerator mass spectrometry: state of the art and perspectives. In: Advances in Physics, 2016, no. X, 1, 4

[13] HAROLD MYTUM, JOHN PETERSON. The Application of Reflectance Transformation Imaging (RTI) in Historical Archaeology. In: Historical Archaeology, 2018, vol. 52; MARK MUDGE, MARLIN LUM, CARLA SCHROER, TOM MALZBENDER. Reflectance Transformation Imaging: Guide to Highlight Image Capture, v2.0. Cultural Heritage Imaging, 2013, pp. 1–32. Available from: http://culturalheritageimaging.org/What_We_Offer/Downloads/Capture/index.html

[14] VALENTINE ROUX. Ceramics and Society: A Technological Approach to Archaeological Assemblages. Nanterre, 2019.

[15] PRUDENCE M. RICE. Pottery Analysis. A Sourcebook. Second Edition. Chicago, 2015.

[16] VYTENIS PODĖNAS. Emergence of Hilltop Settlements in the Southeastern Baltic: New AMS 14 C Dates from Lithuania and Revised Chronology. In: Radiocarbon, 2019, vol. 62(2)

datings published in previous studies. Radiocarbon dates for Ķivutkalns hillfort and cemetery have been published in several studies, the latest of which, by Andrejs Vasks and Gunita Zariņa, *Ķivutkalns hillfort and cemetery: new data and new problems*, includes all the dates from the site.[17] In total, ^{14}C datings for 20 samples, as well as isotopic data for animals and humans, are analyzed in their study. Some radiocarbon dates indicate an overlap between the cemetery and hillfort, which is not likely, as the cemetery is known to be older than the hillfort. Thus, based on analogies and ^{14}C dates, the authors conclude that Ķivutkalns cemetery was used from approximately 800 cal BC up to 680 cal BC, the hillfort being established at about 650 cal BC. A thorough study of the changes in Bronze and Pre-Roman Iron Age burial practices in present-day Latvia has been undertaken on the basis of ^{14}C dates by Dardega Legzdiņa *et al.*[18] The study analyzes a total of 48 previously published and new datings. Important data regarding the chronology of pottery has been published by Gytis Piličiauskas *et al.*[19] Their study presents the analysis of 23 samples from pottery food crust, animal bones, humans and charcoal. These include dates from Paveisininkai cemetery and Žalioji settlement. The study *New radiocarbon datings of Bronze and Earliest Iron Age burial sites*[20] presents the results of dating of 27 samples from various cemeteries, such as Bašķi, Buļļumuiža, Dārznieki, Kalnieši, Pukuļi, Reznes, etc. Based on these dates, the authors conclude that barrow cemeteries appeared during the 17th and 16th century cal BC, which is earlier than previously thought, first appearing in western Latvia and subsequently spreading across the whole region. The rest of the studies utilized constitute research having a specific focus, which does not address chronological questions in general, the ^{14}C dates being provided as additional information regarding the chronology of the site.

Various studies were utilized in order to understand clays and their impurities, and the geology behind their composition. For example, one of the most detailed studies, widely used in the thesis, is the monograph by Visvaldis Kuršs and Austra Stinkule *Clays in the*

[17] ANDREJS VASKS, GUNITA ZARIŅA. Ķivutkalna pilskalns un kapulauks: jauni dati un jaunas problēmas. In: Latvijas Vēstures Institūta žurnāls, 2014, nr. 3(92), 5.–36.lpp

[18] DARDEGA LEGZDIŅA, ANDREJS VASKS, EDUARDS PLANKĀJS, GUNITA ZARIŅA. Re-evaluating the Bronze and Earliest Iron Age in Latvia: changes in burial traditions in the light of 14C dates. In: Radiocarbon, 2020, vol. 62, pp. 1845–1868.

[19] GYTIS PILIČIAUSKAS, MIKA LAVENTO, MARKKU OINONEN, GYTIS GRIŽAS. New 14C Dates of Neolithic and Early Metal Period Ceramics in Lithuania. In: Radiocarbon, 2011, 53(4), pp. 629-643

[20] JĀNIS CIGLIS, ANDREJS VASKS. Jauni bronzas un senākā dzelzs laikmeta apbedīšanas vietu datējumi ar radioaktīvā oglekļa metodi. In: Latvijas Vēstures Institūta žurnāls, 2017, nr. 1, 35.-61. lpp

Earth and in Industry in Latvia.[21] This study provides a detailed description of clays from different geological periods, giving their chemical and geophysical properties. This study also includes description of possible impurities, such as carbonate concretions, in the clay. Unfortunately, the authors do not explain the methodology used in clay analysis, which is especially important for the chemical analysis used in this study. Estonian Quaternary cover is described in detail in a study by Anto Raukas and Kalju Kajak.[22] This study was used in order to understand Estonian geological formations consisting of clays. In turn, clays in Lithuania are presented in *Lithuanian Geology*.[23] Various minerals and their uses are presented in Uldis Sedmalis's monograph *Minerals and their Use in Latvia*.[24] This study was used in order to interpret the iron concretion impurities found in the pottery clay matrix.

One of the most-cited and important monographs used in the thesis is *Late Bronze and Early Iron Age Pottery in Latvia* by Andrejs Vasks.[25] This is by far the most detailed and thorough study of the pottery in this region. This study presents an analysis of 229 pottery assemblages. As the work was published in 1991, it does not include data from the sites investigated in recent years, such as Krievu kalns and Padure hillforts. Specific attention in Vasks' monograph is given to the archaeological culture of striated pottery. The descriptions of the sites analyzed in the study as well as the treatment of pottery chronology draw heavily on studies published in the *Handbook of Latvian Archaeology*.[26] This work brings together all the most recent data of Latvian archaeology: methods, sites and their chronology as well as artefact groups, which are thoroughly described. Also important for the thesis is the monograph *Aspects of Change in the Bronze Age of the Eastern Baltic. The Settlements of the Asva Group in Estonia* by Uwe Sperling.[27] The author presents a detailed analysis of Asva type pottery, with a grouping into types based on morphology, surface treatment as well as spatial distribution, and the pattern of change during the Bronze Age. The author has used this thesis as a supplementary source of data on the characteristics of the Asva pottery.

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[21] VISVALDIS KURŠS, AUSTRA STINKULE. Māli Latvijas zemes dzīlēs un rūpniecībā. Rīga, 1972

[22] ANTO RAUKAS, KALJU KAJAK. Quaternary cover. In: ANTO RAUKAS, AADA TEEDUMÄE (eds), Geology and mineral resources of Estonia,. Tallinn, 1997

[23] ALGIMANTAS GRIGELIS, VALENTINAS KADŪNAS. Lietuvos Geologija: Monografija. Vilnius, 1994

[24] ULDIS SEDMALIS. Latvijas minerālās izejvielas un to izmantošana. Rīga, 2002

[25] ANDREJS VASKS. Keramika epokhi bronzi i rannego zheleza Latvii. Riga, 1991

[26] ANDREJS VASKS, GUNITA ZARIŅA (sast.). Latvijas Arheoloģijas Rokasgrāmata. Rīga, 2021

[27] UWE SPERLING. Aspekte des Wandels in der Bronzezeit im Ostbaltikum. Die Siedlungen der Asva-Gruppe in Estland. Estonian Journal of Archaeology, 2014, 18(2)

The rest of the studies are used in order to understand various processes of pottery production, their possible significance and function, and as sources of analogies.

1. BRIEF HISTORY OF RESEARCH ON POTTERY IN THE EASTERN BALTIC

For a long time, pottery was not assigned an important role by Bronze and Pre-Roman Iron Age researchers, as it was a mass find and not as interesting as other artifacts, such as bronze, iron and silver artefacts, due to its fragmentary nature and "boring" visual appearance. The first description and attempt at pottery reconstruction, although far from precise, was done by Constantin Grewingk at the end of the 19th century (Fig. 1).[28] However, the first attempt at pottery reconstruction *in situ* can also be observed at the close of the 19th century, when Adalbert Bezzenberger recorded in a drawing a burial urn from the Mišeikiai barrow.[29]

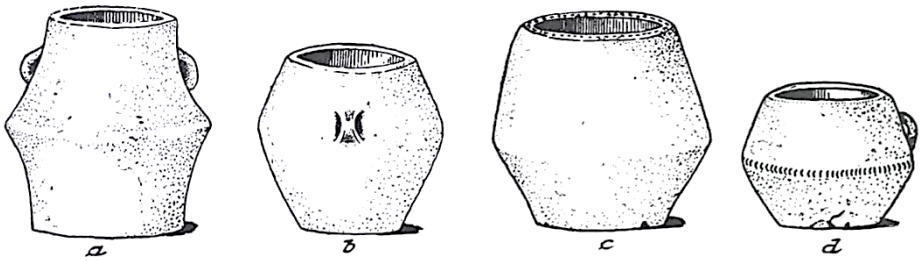

Figure 1. C. Grewingk's reconstructions of pottery from Mušiņas stone ship setting (From: EDUARDS ŠTURMS. Die Bronzezeitlichen funde in Lettland…, pp. 128, redrawn after CONSTANTIN GREWINGK. Die Steinschiffe von Musching und die Wella-Laiwe…).

In the interwar period, few researchers engaged in the analysis of pottery, and it still had secondary role in relation to other artefacts. The first study in which pottery is described and, in a way, systematized is by Harri Moora in his fundamental work *The Iron Age in Latvia*…[30] He describes pottery from burials – stone cist graves and flat cemeteries. Moora distinguishes two main groups of pottery found in graves, namely fine and coarse ware. He argues that the coarse ware found at the Kaugars and Salenieki cemeteries had its roots in the Bronze Age vessels from Buļļumuiža cemetery. In the case of fine ware, he sees similarities with Asva pottery, although the main influences, in the opinion of Moora, come from the

[28] CONSTANTIN GREWINGK. Die Steinschiffe von Musching und die Wella-Laiwe oder Tenfelsböte Kurlands überhaupt. In: Verhandlungen der gelehrten Lettischen Geselschaft. Dorpat, 1879, pp. 1–49

[29] ALGIMANTAS MERKEVIČIUS. West Lithuania during the Early Metal Age. In: GITAUTAS ZABIELA, ZENONAS BAUBONIS, EGLĖ MARCINKEVIČIŪTĖ (eds). A Hundred Years of Archaeological Discoveries in Lithuania. Vilnius, 2016, p. 132

[30] HARRI MOORA. Die Eisenzeit in Lettland bis etwa 500 n. chr. Tartu, 1938, pp. 555–565

Lusatian Culture. He concludes that the pottery tradition comes from the Vistula region and spreads in northern Estonia and then in present-day Latvia.

During the Soviet period there was a boom in pottery analysis. Pottery was associated with archaeological cultures and used for ethnogenetic studies of ancient communities. One of the first thorough studies in which pottery was systematized and analyzed was by Vytautas Daugudis in 1966.[31] In his work he systematized Rusticated Ware and interpreted its chronology. Bronze and Pre-Roman Iron Age pottery was thoroughly researched by Jānis Graudonis. In his 1967 monograph *Latvia during the Late Bronze and Earliest Iron Age…*[32] he systematizes pottery according to surface treatment: smooth, striated, textile and rusticated.

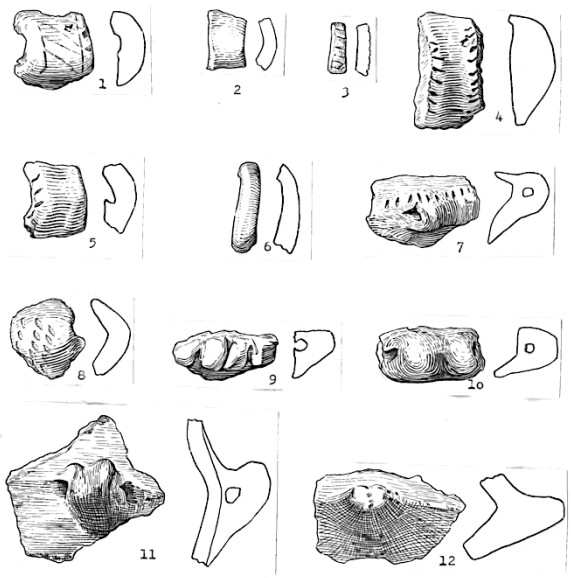

Figure 2. Pottery drawings from V. Lõugas's dissertation (From: VELLO LÕUGAS. Eesti varane metalliaeg… Appendix, pp. 60)

He also characterizes vessel morphology and the distribution pattern of pottery characteristics in present-day of Latvia. He argues that striated pottery is characteristic of the Balts, being common in present-day Latvia, Lithuania and Belarus, with small amounts in Estonia and Finland.

Graudonis also provides a chronological frame for striated pottery. He is also most likely the first researcher in the Eastern Baltic who adopted an interdisciplinary approach in the study of pottery. In the 1960s he commissioned geologists to undertake various analyses, such as petrography and granulometric analysis, on pottery from various regions and periods. Unfortunately, all that remains are reports of the analysis, held at the National History Museum of Latvia (unregistered). In 1967, another systematic work was published by Elena Grigalavičienė-Danilaitė, *Striated Pottery in Lithuania…*,[33] where she analyzes striated pottery in present-day Lithuania in the context of the ethnogenesis of the Lithuanians. In her

[31] VITAUTAS DAUGUDIS. Nekotorije dannije o proishozhdenii i hronologii sherohovatoij keramiki v Litve. In: Lietuvos TSR mokslu akademijos darbai. Serija A, 1966, nr. 3(22), s. 55–66

[32] JANIS GRAUDONIS. Latvija v epokhu pozdneij bronzi i rannego zheleza. Riga, 1967, s. 103–113

[33] ELENA GRIGALAVIČIENĖ-DANILAITĖ. Shtrihovannaja keramika v Litve (nekotorije Dannie po voprosam ob etnogeneze litovcev). Vilnjus, 1967.

work she analyzes pottery in terms of regional stylistic tendencies and chronology, distinguishing several pottery groups in Lithuania. Asva pottery was morphologically and stylistically systematized by Vello Lõugas in his dissertation of 1970 (Fig. 2).[34] Lubāns type pottery was systematized in 1979 by Ilze Loze.[35] She concluded that this type of pottery belongs to the Early Bronze Age, identifying at least 90 ornamentation motifs as characteristic of this kind of ceramics. In 1980, Graudonis published the study *Striated Pottery in the Territory of the Latvian SSR…*[36] He analyzes the distribution of striated pottery in the context of the ethnogenesis of the Balts. Here Graudonis distinguishes two types of striated pottery in terms of stylistics and morphology: early and late. In his opinion, striated pottery evolved from Corded Ware. In the 1980s another interdisciplinary analysis of pottery was undertaken: *Kernavė Pottery of the 10th–14th century* by J. Milkevičiūtė.[37] This work involved geochemical analysis of pottery. Milkevičiūtė concluded that sand was not added as tempering material to pottery, in view of the low content of SiO_2 (50–60%) in the ceramics. In his fundamental 1991 work on pottery in present-day Latvia during Bronze and Early Iron Age, Vasks analyzes pottery clay paste and recipes, studying the material by reflected- light microscopy, using a stereoscopic microscope, and examines pottery stylistics and morphology as well as distributional trends and chronology. He does not agree with Graudonis's view that striated pottery evolved from Corded Ware; in his opinion, it developed from Narva pottery. [38] This is the first detailed study covering all the material found in present-day Latvia.

In the early 2000s pottery systematization and analysis of the distribution of pottery continued. For example, Vasks looked at the distribution of Bronze and Iron Age textile pottery.[39] He distinguishes early and late textile pottery, the former belonging to the Neolithic, and the latter to the Bronze and Iron Age. In Vasks's opinion, the main distribution area of textile pottery is in the north-eastern part of present-day Latvia, and the small amounts

[34] VELLO LÕUGAS. Eesti varane metalliaeg (II a. -tuh. Keskpaigast e.m.a – 1. sajandini m.a.j.). Dissertatsioon ajalooteaduste kandidaadi kraadi taotlemiseks. Manuscript, 1970.

[35] ILZE LOZE. Pozdnij neolit i ranjaja bronza Lubanskoij ravnini. Riga, 1979.

[36] JANIS GRAUDONIS. Shtrihovannaja keramika na teritorii Latviskoij SSR i nekotoriye voprosi etnogeneza Baltov. In: Dverneisheij Istorii Baltiskih Narodov. S. 59–69

[37] J. MILKEVIČIŪTĖ. Kernavės keramika X – XIV a. Diplominis darbas. Vilnius, 1988.

[38] ANDREJS VASKS. Keramika epokhi bronzi i rannego zheleza Latvii. Riga, 1991

[39] ANDREJS VASKS. Par tekstilās keramikas izplatību Latvijā bronzas un dzelzs laikmetā. In: Latvijas Vēstures Institūta žurnāls, 2001, nr. 4, 51–62. lpp

of this type of ceramics in the Lower Daugava area indicate that the latter region lay at the periphery of influences from present-day Estonia. Important is the research by Valter Lang, who thoroughly analyzed the Bronze and Pre-Roman Iron Age pottery in present-day Estonia.[40] After detailed description of pottery wares (Asva, Ilmandu), he offers an interpretation in socio-cultural terms. In Lang's opinion, there is social differentiation within the communities, indicated by the simultaneous use of fine and coarse Asva pottery, fine ware being used by the elite. In the early 2000s the first studies based on folkloristic and experimental approaches appeared. For example, Baiba Dumpe has analyzed spells and rhymes in Latvian folklore to see how pottery, clay and other materials associated with pottery are described and what techniques were used in pottery production during the time when the spells and rhymes came into being.[41] Dumpe and Valdis Bērziņš were among the first in the Baltics to conduct experiments in order to understand technological aspects of pottery production – coiling techniques, shaping and surface treatments, and use-alteration patterns after cooking.[42]

Since the 2010s a new interdisciplinary and methodological approach has been developing in the Baltic States. One of the new methods applied in the Eastern Baltic is the study of the spatial distribution of pottery on archaeological sites and its relation to structures and artefacts. For example, such studies have been done by Uwe Sperling and by Vytenis Podėnas *et al.*[43]

Interdisciplinary research using such analyses as ceramic petrography, organic residue and X-ray diffraction analysis has been conducted. For example, Narva and Ertebølle

[40] VALTER LANG. Late Bronze and Pre-Roman Iron Age pottery styles in Estonia. In: MERVI SUHONEN (ed). Lightning the darkness – the attraction of archaeology. Papers in honour of Christian Carpelan. Helsinki, 2006, pp. 122–136

[41] BAIBA DUMPE. Podniecība Latviešu folklorā. In: Kultūras Krustpunkti, 2006, nr. 3. Rīga, 2006, 32–43. lpp

[42] BAIBA DUMPE. Jauni atzinumi par neolīta klājošās auklas keramiku. In: Arheoloģija un Etnogrāfija, 2003, nr. 21, 2003, 110–117. lpp; BAIBA DUMPE. Agrās tekstilās keramikas faktūru veidošanas īpatnības. In: Arheoloģija un etnogrāfija, 2006, nr. 23, 71–84. lpp; BAIBA DUMPE. Agrā neolīta keramikas rekonstrukcijas. In: Latvijas Nacionālā vēstures muzeja zinātniskie lasījumi 2004. – 2006, 2007; VALDIS BĒRZIŅŠ, BAIBA DUMPE. Ēdiena eksperimentāla gatavošana, lietojot neolīta laika māla trauku rekonstrukcijas. In: Latvijas Vēstures Institūta žurnāls, 2005, nr. 1, 5.–22. lpp

[43] UWE SPERLING. Aspekte des Wandels in der Bronzezeit im Ostbaltikum. Die Siedlungen der Asva-Gruppe in Estland. Estonian Journal of Archaeology, 2014, 18(2); VYTENIS PODĖNAS, AGNĖ ČIVILYTĖ, ALEKSIEJUS LUCHTANAS. Narkūnų piliakalnių ir papėdės gyvenvietės keramika: elgsenos atspindžiai. In: Lietuvos Archaeologija, 2016, T. 42.

ceramics of the Neolithic have been analyzed using petrographic analysis and experiments by Dumpe *et al.*[44] In this study they distinguish differences and similarities between two archaeological cultures through pottery technology. Thus, Narva pottery was tempered with shell, whereas Ertebølle pottery was tempered with crushed granitic rock and was built using H technique; on the other hand, there are similar morphological traits, which the authors interpret in terms of the similar function of the vessels. Benaičiai and Turlojiškės pottery was analyzed using powder X-Ray Diffraction (XRD) analysis to study the mineral phases of vessels.[45] Dumpe *et al.*[46] used XRD in order to determine the firing temperatures of Iron Age vessels fired without using a potters' kiln. Thorough research regarding organic residues on Corded Ware vessels has been undertaken by Gytis Piličiauskas *et al.* and Carl Heron *et al.*[47]

Pottery analysis of Bronze and Pre-Roman Iron Age has come a long way, from neglect to detailed analysis using a range of interdisciplinary methods. Whereas ceramics were initially considered unimportant, nowadays every sherd matters and can be analyzed by using various microscopic and laboratory methods. This change has affected archaeological excavation methodologies – from pottery not being registered in the context to its detailed recording in all contexts. Systematization of pottery started already in the interwar period and flourished in the Soviet occupation period. Nowadays, pottery is being researched using an interdisciplinary and multi-method approach.

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[44] BAIBA DUMPE, VALDIS BĒRZIŅŠ, OLE STILBORG. A dialogue across the Baltic on Narva and Ertebølle pottery. In: SÖNKE HARTZ, FRIEDRICH LÜTH, THOMAS TERBERGER (eds). Early Pottery in the Baltic – Dating, Origin and Social Context. International Workshop at Schleswig from 20th to 21st October 2006, 2011, pp. 409–441

[45] AIVARAS KAREIVA, JONAS KIUBERIS, ALGIMANTAS MERKEVIČIUS. Analytical characterization of Baltic amber and pottery. Archaeologia Lithuania, 2011, vol. 12, pp. 25–35

[46] BAIBA DUMPE, AGNESE STUNDA-ZUJEVA, JANA VECSTAUDŽA. Firing Without a Kiln – Hand-Built pottery in the Territory of Present-Day Latvia in the Middle and Late Iron Age (5th-12th centuries AD). In: PAUL PETTERSSON (ed). Prehistoric Pottery Across the Baltic: Regions, Influences and Methods. Oxford, 2016.

[47] GYTIS PILIČIAUSKAS, GRZEGORZ OSIPOWICZ, OLIVIER EDWARD CRAIG, ALEXANDER LUCQUIN, HARRY KENNETH ROBSON, VITALI ASHEICHYK. The Corded Ware culture in the Eastern Baltic: New evidence on chronology, diet, beaker, bone and flint tool function. Journal of Archaeological Science: Reports, 2018, vol. 21(361), pp. 538–552; CARL HERON, OLIVER EDWARD CRAIG, ALEXANDRE JULES, ANDRE LUCQUIN, VALERIE J. STEELE, ANU THOMPSON, GYTIS PILIČIAUSKAS. Cooking fish and drinking milk? Patterns in pottery use in the southeastern Baltic, 3300-2400 Cal BC. In: Journal of archaeological science, 2015, vol. 63, pp. 33-43

2. THE COURSE OF DEVELOPMENT DURING THE EAST BALTIC BRONZE AND PRE-ROMAN IRON AGE AND THE CONTEXT OF THE SITES ANALYSED

In order to understand the changes in material and intangible culture as well as the impact of trade and exchange between inhabitants of different regions, it is important to characterize the processes (trade, cultural features, subsistence strategies, etc.) which led to the pattern of development seen in the Early Bronze Age and the continued evolution in the Pre-Roman Iron Age. Not only the general picture of processes in Eastern Baltic prehistory but also the context within the archaeological sites is crucial for tracing changes in pottery production, function and meaning. Accordingly, this chapter also presents an overview of chronology, finds and the context of the sites analyzed in the study.

2.1. Chronological framework

This study utilizes the generally accepted chronology of the Eastern Baltic Bronze and Pre-Roman Iron Age: Early Bronze Age (EBA) – 1800–1100 cal BC, Late Bronze Age (LBA) – 1100–500 cal BC and Pre-Roman Iron Age (PIA) – 500 cal BC–1/50 cal AD.[48] However, in order to understand and make sense of overall changes and developments, and thus also to permit comparison of pottery traditions and trace the changes they underwent, it is necessary to comprehensively overview and group the archaeological sites researched in this study. The chronological grouping of the sites, as given below, is based on both typological and radiocarbon dating (Table 2).

Neolithic/Early Bronze Age sites. Only living sites were included in this group, since in the context of this study only they show traces of continuity from the Neolithic to the Early Bronze Age. This group includes four sites: Abora I, Lagaža, Lejasbitēni and Kalnapiļas. Radiocarbon dates from Abora I indicate a period of use lasting from 3400 to 1800 cal BC; in the case of Lagaža, the time span is 2400–1300 cal BC.[49] It is important to note that Abora I shows no clear material culture traces of habitation in the Early Bronze

[48] VALTER LANG. The Bronze and Early Iron Ages in Estonia. Tartu, 2007; GYTIS PILIČIAUSKAS. Lietuvos neolito ir ankstyvojo metalų laikotarpio chronologija naujų radiometrinių datų šviesoje. In: Lietuvos Archeologija, 2012, T. 38; ANDREJS VASKS. No medniekiem un zvejniekiem līdz lopkopjiem un zemkopjiem: Latvijas aizvēstures senākais posms (10500-1. g. pr .Kr.). Rīga, 2015.

[49] ILZE LOZE. Pozdnij neolit i ranjaja bronza Lubanskoij ravnini. Riga, 1979, 121 s.; VYTENIS PODĖNAS, AGNĖ ČIVILYTĖ. Bronze casting and communication in the southeastern Baltic Bronze Age. In: Lietuvos archeologija. 2019, T. 45, p. 171

Age, except for Lubāns Ware pottery, which is considered characteristic of the Early Bronze Age.[50] Recently obtained ^{14}C data from charred food crusts on Lubāns Ware from Lagaža indicates that the chronological frame of the tradition on this settlement ranges from 2600 to 1500 cal BC.[51] Thus, it can be assumed that the Lubāns Ware tradition began in the Neolithic and continued during the first half of the Early Bronze Age. However, this does not indicate that the Abora I settlement was definitely inhabited during the Early Bronze Age, as the chronological frame of this settlement partly overlaps with the earliest phase of the Lubāns type pottery tradition. On the other hand, that Lagaža was habited during the Early Bronze Age is shown not only by radiocarbon dates and Lubāns type pottery but also by the presence of four crucibles.[52] The crucible fragments were found in a part of the excavation site somewhat distant from the location where the ^{14}C samples were taken, in an area from which no samples have been dated. Therefore, the possibility that these finds are later, perhaps of Late Bronze Age origin, cannot be ruled out. Thus, further excavation of the Lagaža settlement site would be desirable. Although there are no radiocarbon datings and insufficient amounts of finds from Lejasbitēni and Kalnapiļas to indicate a more precise chronological phase, the occurrence of Post-Corded Ware sherds on these sites indicates that the habitation period might range from 2400 to 1300 cal BC.[53] Thus, Lejasbitēni and Kalnapiļas also fall into this chronological category.

Early Bronze Age sites: This group includes sites which were inhabited and/or established during the Early Bronze Age and were in existence during this period. Three open settlements (Kvietiniai, Tojāti and Vampenieši) and one barrow cemetery (Pukuļi) are included in this group. Radiocarbon dates of charred crops and pottery food crust from Kvietiniai settlement range from 1400 to 1000 cal BC; Tojāti could be similar in chronology,

[50] ILZE LOZE. Pozdnij neolit…, s. 100-107; ILZE LOZE. Aboras I apmetne. In: ANDREJS VASKS, GUNITA ZARIŅA (sast.). Latvijas Arheoloģijas Rokasgrāmata. Rīga, 2021, 112. lpp

[51]These dates might be affected by reservoir effect, as they were not tested with Fourier transform infrared (FTIR) spectroscopy for aquatic residues, because the charred food crusts were too small to permit the additional analysis. According to Gunita Zariņa and Dardega Legzdiņa, reservoir effect in Lake Lubāns is approximately 260 years (pers. comm.).

[52] ILZE LOZE. Poznij neolit…, s. 80; ILZE LOZE. Lagažas apmetne. In: ANDREJS VASKS, GUNITA ZARIŅA (sast.). Latvijas Arheoloģijas Rokasgrāmata. Rīga, 2021, 122. lpp

[53] GYTIS PILIČIAUSKAS. Virvelinės keramikos kultūra lietuvoje 2800–2400 cal BC. Vilnius, 2018, p. 148, 155

as both sites share the same pottery tradition.[54] It is notable, that unlike Tojāti, Kvietiniai was also periodically inhabited during the Neolithic, the Late Bronze Age and the Early Iron Age; however, in this study only the material from the Early Bronze Age has been studied, and so it is included in this group.[55] In the case of Vampenieši, the period of habitation, based on radiocarbon dates, is 1400–1200 cal BC.[56] Pukuļi barrow cemetery can be considered the earliest site within this group, with a date range of 1600–1000 cal BC.[57]

Early Bronze Age/Late Bronze Age sites: This group includes sites which have been used in both the Early and the Late Bronze Age. Four sites fall into this category: Padure and Klosterkalns hillforts, Bīlavas stone ship setting and Reznes barrow cemetery. The chronology of habitation at Padure (early phase) and Klosterkalns hillforts is 1300–900 cal BC,[58] while the Reznes chronology ranges from 1400 to 600 cal BC.[59] Bīlavas stone ship setting has a similar chronology, 1400–800 cal BC.[60]

Late Bronze Age sites: This can be considered the largest group of all, as it includes the majority of the sites analyzed in this study. Significantly, the majority of the sites have ^{14}C dates. This group also displays a much more diverse chronology and accordingly is divided into three subgroups: 1) 1100–800 cal BC, with a single site – Dārznieki barrow

[54] NORMUNDS GRASIS. Tojātu apmetne. In: ANDREJS VASKS, GUNITA ZARIŅA (sast.). Latvijas Arheoloģijas Rokasgrāmata. Rīga, 2021, 141. lpp; GYTIS PILIČIAUSKAS. Virvelinės keramikos…; ROKAS VENGALIS, GYTIS PILIČIAUSKAS, MINDAUGAS PILKAUSKAS, JUSTINA KOZAKAITĖ, VYTAUTAS JUŠKAITIS. The Large-Scale Rescue Excavation of a Multi-Period Site at Kvietiniai Sheds Light on the so far Little Explored Bronze Age in Western Lithuania. In: Archaeologica Baltica 27, 2020, pp. 37-38

[55] ROKAS VENGALIS et al. The Large-Scale Rescue Excavation…, pp. 37-39

[56] ANDREJS VASKS. The lower reaches of the Daugava in the Bronze and the Earliest Iron Age (1800-500 to the 1st century BC). In: Archaeologica Baltica, 2021, vol. 28, pp. 132–148

[57] JĀNIS CIGLIS, ANDREJS VASKS. Jauni bronzas un senākā dzelzs laikmeta apbedīšanas vietu datējumi ar radioaktīvā oglekļa metodi. In: Latvijas Vēstures Institūta žurnāls, 2017, nr. 1., 35-61. lpp

[58] VALDIS BĒRZIŅŠ, NORMUNDS GRASIS, ANDREJS VASKS, EGITA ZIEDIŅA. Jauni 14C datējumi arheoloģiskajiem pieminekļiem Rietumlatvijā. In: Latvijas Vēstures Institūta žurnāls, 2009, nr. 1, 15. lpp

[59] DARDEGA LEGZDIŅA, ANDREJS VASKS, EDUARDS PLANKĀJS, GUNITA ZARIŅA. Re-evaluating the Bronze and Earliest Iron Age in Latvia: changes in burial traditions in the light of 14C dates. In: Radiocarbon, 2020, vol. 62, Table 1; ANDREJS VASKS, GUNITA ZARIŅA, DARDEGA LEGZDIŅA, EDUARDS PLANKĀJS. New data on funeral customs and burials of the Bronze Age Reznes cemetery in Latvia. In: Estonian Journal of Archaeology, 2021, vol. 25(1), p. 13.

[60] JOAKIM WEHLIN. Östersjöns skeppssättningar – monument och mötesplatser under yngre bronsålder. GOTARC Serie B. Gothenburg Archaeological Theses 59. Gothenburg, 2013, p. 64.

cemetery;[61] 2) 1000–550 cal BC, with four sites – Buļļumuiža barrow cemetery, Kõivuküla and Ridala hillforts, and Soe settlement[62] and 3) 800–500 cal BC, with 14 sites – Bašķi, Paveisinikai barrow cemeteries, Ķivutkalns flat cemetery[63], Ėgliškiai barrow cemetery, the hillforts of Antilgė, Asote, Garniai I, Mineikiškės, Mūkukalns, Narkūnai, Sokiškiai and Vīnakalns, and the settlements of Laukskola and Žalioji.[64]

Late Bronze Age/Pre-Roman Iron Age sites: This group includes nine sites which were inhabited or established during the Late Bronze Age and still in use during the Pre-Roman Iron Age. We may regard as the two earliest-established sites Krievu kalns hillfort, which was established at about 1050 cal BC and was used until 400 cal BC, and Dievukalns hillfort, the habitation period of which is quite long: from about 1000 to 1 cal BC.[65] A similar chronological span can be proposed for Asva and Brikuļi hillforts (900–400 cal BC) and Kerkūzi I settlement (800–400 cal BC), although it should be noted that all of the Asva

[61] JĀNIS CIGLIS, ANDREJS VASKS. Jauni bronzas un senākā dzelzs laikmeta…, 54. lpp

[62] JĀNIS CIGLIS, ANDREJS VASKS. Jauni bronzas un senākā dzelzs laikmeta…, 56-57. lpp; UWE SPERLING, HEIDI LUIK. Arrowheads, Palisades and an Attack Scenario. Ridala Bronze Age Hill-Fort Revisited. In: Archaeologica Baltica, 2010, vol. 13, p. 141; HEIKI VALK, PIKNE KAMA, MAARJA OLLI, EVE RANNAMÄE. Excavations on the hill forts of south-east Estonia: Kõivuküla, Märdi, Truuta and Aakre. In: Archaeological fieldwork in Estonia 2011, 2012, p. 30; HEIKI VALK. A find of Bronze Age pottery at Soe inn in Võrumaa. Archaeological fieldwork in Estonia 2017, 2018, p. 42

[63] Ķivutkalns flat cemetery was established at about 800 cal BC and was used until about 680 cal BC. As majority of the time frame of this site falls in the overall chronology of this subgroup, Ķivutkalns cemetery is included here.

[64] JĀNIS CIGLIS, ANDREJS VASKS. Jauni bronzas un senākā dzelzs laikmeta…, 57. lpp; ELENA GRIGALAVIČIENĖ. Egliškių pilkapiai. In: Lietuvos Archeologija, 1979, T.1.; GYTIS PILIČIAUSKAS, MIKA LAVENTO, MARKKU OINONEN, GYTIS GRIŽAS. New 14C Dates of Neolithic and Early Metal Period Ceramics in Lithuania. In: Radiocarbon, 2011, 53(4), Table 1, pp. 634; VYTENIS PODĖNAS. Emergence of Hilltop Settlements in the Southeastern Baltic: New AMS 14 C Dates from Lithuania and Revised Chronology. In: Radiocarbon, 2019, vol. 62(2), Table 1, pp. 5; ANDREJS VASKS, GUNITA ZARIŅA. Ķivutkalna pilskalns un kapulauks: jauni dati un jaunas problēmas. In: Latvijas Vēstures Institūta žurnāls, 2014, nr. 3(92), 29. lpp; VANDA VISOCKA, ALISE GUNNARSSONE, MĀRCIS KALNIŅŠ, EDUARDS PLANKĀJS. Between mighty hillforts: A multi-method study of Laukskola Bronze Age settlement pottery. Archaeologica Baltica, 2021, vol. 27.

[65] INGA DONIŅA, ANDREJS VASKS, AIJA VILKA. Izrakumi Skrundas Krievu kalnā. In: Arheologu pētījumi Latvijā 2012. un 2013. gadā. Rīga, 2014, 164; ANNA ZARIŅA. Celtniecība nocietinātā apmetnē Lielvārdes Dievukalnā. In: Latvijas PSR Zinātņu Akadēmijas Vēstis, 1982, 7, 46-64. lpp

datings fall in the Hallstatt Plateau.[66] Two sites, namely the Kaali and Priednieki settlements, were inhabited up to the end of the second half of the Pre-Roman Iron Age: 800–200 cal BC.[67] Finally, Ķivutkalns hillfort was established at the end of the Late Bronze Age, 650 cal BC, and was used until about 200 cal AD.[68]

Pre-Roman Iron Age sites: This group consists of sites established and used during the time frame 500–1 cal BC. Overall, four such sites were distinguished among those analyzed in this study: Paplaka hillfort, Vilmaņi III settlement and the barrow cemeteries Gārsenes Bērzkalni and Strīķi.[69]

A few sites could not be assigned to a particular chronological group due to the absence of information about the excavation, or the absence of datable artefacts and material. In this study, three such sites were identified: Lipši barrow cemetery, Mušiņas stone ship setting and Klaņģukalns hillfort. At Lipši barrow cemetery there were a few graves with striated vessels, including one grave where an amber pendant had been placed in the vessel; however, neither the pottery nor the pendant provides a precise chronological pointer.[70] Mušiņas stone ship setting was excavated in the 19th century; besides the lack of precise

[66] UWE SPERLING. Aspekte des Wandels in der Bronzezeit im Ostbaltikum. Die Siedlungen der Asva-Gruppe in Estland. Estonian Journal of Archaeology, 2014, 18(2), pp. 307-315; UWE SPERLING, VALTER LANG, KRISTIINA PAAVEL UND ANDRES KIMBER. Neue Ausgrabungen in der Bronzezeit siedlung von Asva – vorläufiger Untersuchungsstand und weitere Ergebnisse. In: Archaeological fieldwork in Estonia 2014, 2015, pp. 58-59; ANDREJS VASKS. New data on Early Iron Age settlement in south-eastern Latvia. In: Archaeologica Baltica, 1995, pp. 55.

[67] VALDIS BĒRZIŅŠ et al. Jauni 14C datējumi…, 15. lpp ; VALTER LANG. The Bronze and Early Iron Ages…, p. 71; SIIM VESKI, ATKO HEINSALU, VALTER LANG, ÜLO KESTLANE, GÖRAN POSSNERT The age of the Kaali meteorite craters and the effect of the impact on the environment and man: Evidence from inside the Kaali craters, island of Saaremaa, Estonia. In: Vegetation History and Archaeobotany, 2004, vol. 13, pp. 200

[68] ANDREJS VASKS, GUNITA ZARIŅA. Ķivutkalna pilskalns un kapulauks…, 29. lpp

[69] ELĪNA GUŠČIKA. Elvīra Šnore un Latvijas agrā dzelzs laikmeta pētniecība. In: Latvijas Vēstures Institūta žurnāls, 2010, Nr.1, 123. lpp; ARTŪRS HAFERBERGS. Celtniecība vēlajā bronzas un senākajā dzelzs laikmetā Latvijas teritorijā. Bakalaura darbs. Rīga, 2018, 84. lpp; ANDREJS VASKS. Pārskats par izrakumiem Paplakas pilskalnā 1976. g. no 29. jūnija līdz 22. jūlijam, 4. lpp In: LNVM Arheoloģijas departaments, inv. nr. AA 473; ILGA ZAGORSKA. Izrakumi Vilmaņu III apmetnē. In: Zinātniskās atskaites sesijas materiāli (ZASM) par arheologu un etnogrāfu 1986. un 1987. gada pētījumu rezultātiem, 1988, 156. lpp.

[70] ANTONIJA VILCĀNE. Lipšu senkapi. In: ANDREJS VASKS, GUNITA ZARIŅA (sast.). Latvijas Arheoloģijas Rokasgrāmata. Rīga, 2021, 328. lpp.

documentation, no datable material was obtained.[71] Unfortunately, the striated and smooth vessels found here do not indicate a more precise date either. Lastly, Klaņģukalns hillfort was studied in 1935, and unfortunately no stratigraphy or precise find positions were documented; neither is there any datable material with a good context that could provide ^{14}C datings.[72]

Table 2. Approximate chronological frame of the sites analyzed in this study.[73]

Clear chronology based on specific finds and/or radiocarbon dates		
Time frame BC	**Sites**	**Chronological group**
3400–1800	Abora I settlement	Neolithic/EBA
2400–1300	Lagaža, Lejasbitēni and Kalnapiļas settlements	Neolithic/EBA
1600–1000	Pukuļi barrow cemetery	EBA
1400–1200	Vampenieši settlement	EBA
1400–1000	Kvietiniai and Tojāti settlements	EBA
1400–800	Bīlavas stone ship setting	EBA/LBA
1400–600	Reznes barrow cemetery	EBA/LBA
1300–900	Padure and Klosterkalns hillforts	EBA/LBA
1100–800	Dārznieki barrow cemetery	LBA
1050–400	Krievu kalns hillfort	LBA/PIA
1000–550	Buļļumuiža barrow cemetery and Ridala hillfort	LBA
900–550	Kõivuküla hillfort, Soe and Ėgliškiai barrow cemeteries	LBA
1000–1	Dievukalns hillfort	LBA/PIA
900–400	Asva and Brikuļi hillforts	LBA/PIA
800–500	Bašķi and Paveisinikai barrow cemeteries, Ķivutkalns flat cemetery, Antilgė, Asote, Garniai I, Mineikiškės, Mūkukalns, Narkūnai, Sokiškiai and Vīnakalns hillforts, Laukskola and Žalioji settlements	LBA
800–400	Kerkūzi I settlement	LBA/PIA
800–200	Kaali and Priednieki settlements	LBA/PIA

[71] JĀNIS GRAUDONIS. Agro metālu periods 1500.-1. g. pr. Kr. In: ĒVALDS MUGURĒVIČS, ANDREJS VASKS (sast.). Latvijas senākā vēsture. Rīga, 2001, 161. lpp

[72] RAULS ŠNORE. Izrakumi Doles pag. Klaņģu pilskalnā. Senatne un Māksla, 1936, nr. 1, 62. lpp

[73] For a detailed radiocarbon table see Appendix I.

650–AD 200	Ķivutkalns hillfort	LBA/PIA
500–1	Paplaka hillfort, Vilmaņi III settlement, Gārsenes Bērzkalni and Strīķi barrow cemeteries	PIA
Impossible to determine more precise chronology		
1100–500	Lipši barrow cemetery and Mušiņas stone ship setting	LBA
1000–AD 200	Klaņģukalns hillfort	LBA/PIA

2.2. Characterization of the Early Bronze Age

Very little is known about Early Bronze Age, as the material from this period is quite sparse, there being only a few known sites in the Eastern Baltic, thus making it one of the least-studied periods. The lack of material also makes it hard to determine the overall characteristics which define the Early Bronze Age. For example, some of the earliest known metal (most likely copper) artefacts found in the Eastern Baltic are dated to the Neolithic. These include two bracelets found in a grave on the Zvejnieki Neolithic burial site, a bronze halberd from Veliuonos and an arrowhead or small dagger from the vicinity of Rokiškio.[74] However, it is only with the appearance and spread of imported bronze artefacts, possibly along with local casting in the region, can we assume the beginning of the Early Bronze Age.[75] Importantly, the Early Bronze Age can be considered a transitional period between the Neolithic and the Late Bronze Age: in spite of the strong similarities to the Neolithic, new processes occurred, such as a change in subsistence strategies and the appearance of bronze. On the basis of the chronological data, and the characteristics of sites and artefacts, the Early Bronze Age can be divided into two phases: 1) an early phase (1800–1400 cal BC), which mainly includes the Late Neolithic/Early Bronze Age settlements and a few cemeteries with Early Bronze Age graves only, and 2) a late phase (1400–1100 cal BC), which includes most of the Early Bronze Age settlements and cemeteries dated to the 1400s cal BC.

[74] FRANCIS ZAGORSKIS. Zvejnieku akmens laikmeta kapulauks. Rīga, 1987; ALGIMANTAS MERKEVIČIUS. Ankstyvieji metaliniai dirbiniai Lietuvoje. Vilnius, 2011, pp. 136; AGNE ČIVILYTĖ. Žmogus ir metalas priešistorėje: žvilgančios bronzos trauka. Vilnius, 2014, pp. 22; KPD sulaukia vis daugiau atsitiktinai rastų archeologinių radinių. Kultūros paveldo departamentas, 2021. Available on: http://kpd.lt/news/5335/158/KPD-sulaukia-vis-daugiau-atsitiktinai-rastu-archeologiniu-radiniu/d,pagrindinis.html?fbclid=IwAR1LlwScqOORmpGpF0Cs-ED65oyKNH3rbUFMpInHGxFbhhyl-vaMa1kAfnU
(seen: 15.09.2021.)

[75] ANDREJS VASKS. No medniekiem un zvejniekiem…, 99. lpp

Problematics: One of the most challenging aspects of the early phase of the Early Bronze Age is the problem of distinguishing it from the Late Neolithic, as most of the artefacts used locally were more or less the same.[76] A recent study by Tõrv and Meadows[77] also indicates that some graves of flat cemeteries in present-day Estonia with burial traditions seemingly characteristic of the Neolithic are actually from the Early Bronze Age. This might indicate that other, similar graves across the whole Eastern Baltic might likewise be Early Bronze Age, although wider study is needed before reaching such a conclusion. Unfortunately, the settlements of the earliest phase, such as Lejasbitēni and Kalnapiļas, were most likely short-term, in addition to which they have been disturbed by later Iron Age burials and thus are too fragmentary to indicate specific material culture tendencies. Abora I, on the other hand, may not even be Early Bronze Age in date. Lagaža can be considered the earliest known Late Neolithic/Early Bronze Age settlement in the Eastern Baltic, the finds from this site, such as Lubāns type pottery, bronze-casting crucibles, animal bones and shaft-hole axes, providing a comparatively large amount of information regarding material culture and everyday practices. However, the most information regarding the early phase is provided by the earliest burials.

A different situation is seen with regarding the later phase of the Early Bronze Age, where a much larger amount of information is available. For example, the Daktariškė 5 and Kvietiniai settlements provide significant information about subsistence strategies and everyday life, while a large number of graves, such as Muuksi, Riigiküla, Rebala and Reznes, give an insight into burial traditions.

Settlement pattern: During the Early Bronze Age the Subboreal climate changed to Subatlantic conditions, and the water level rose in most of the waterbodies, making habitation impossible on the majority of the Neolithic sites. Climate change also had its impact on the fauna: the populations of forest animals, birds and fish decreased during this period. This situation led to a change in subsistence strategies, with a greater focus on farming and animal husbandry and thus on habitation areas more suitable for these activities.[78]

The distribution of the Early Bronze Age population can be traced from the location of known settlements as well as stray finds. As indicated by sites and stray finds, during the

[76] VALTER LANG. The Bronze and Early Iron Ages…, pp. 20; ANDREJS VASKS. No medniekiem un zvejniekiem…, 99-100. lpp

[77] MARI TÕRV, JOHN MEADOWS. Radiocarbon Dates and Stable Isotope Data from the Early Bronze Age Burials in Riigiküla I and Kivisaare Settlement Sites, Estonia. In: Radiocarbon, 2015, 57(4).

[78] ANDREJS VASKS. No medniekiem un zvejniekiem…, 100. lpp

Early Bronze Age most settlement (and movement) concentrated in the surroundings of waterbodies and watercourses: the rivers Abava, Daugava, Emajõgi, Minija and Žeimena, lakes Biržulis, Lubāns, Peipsi, Võrtsjärv, Žemeinys, etc.[79] So far, there is only one known true micro-region during the Early Bronze Age: the Lake Lubāns plain, where at least seven settlements inhabited in this period are known.[80]

Individual Early Bronze Age sites[81] are known in the Daugava basin (Lejasbitēni, Reznes and Vampenieši), in central Vidzeme (Kalnapiļas), in the north of Kurzeme (Bīlavas, Tojāti and Darbužas), in western Kurzeme (Pukuļi) and in western Lithuania (Kvietiniai and Daktariškė 5). Quite a large number of sites have also been found in present-day Estonia: in the south-east of the country (Akali, Kääpa, Kullamägi, Laossina II and Villa), at the northern shore of Lake Võrtsjärv (Kivisaare), in the north-east (Joaorg and Riigiküla) and north (Assaku and Muuksi), and on the island of Saaremaa (Loona and Kuninguste). However, it is notable that only few sites in present-day Estonia can be considered pure Early Bronze Age sites, most of them spanning the Late Neolithic/Early Bronze Age and with poor preservation conditions.

Everyday practices and subsistence strategies: Practices such as bronze-casting, various crafts and subsistence strategies can be best described using the material obtained from the well-studied settlements and burials, such as the Lagaža and Kvietiniai settlements, Reznes, Riigiküla I and Kivisaare cemeteries, etc. Long-term settlements indicate more or less stable societies, whereas short-term settlements, such as Kalnapiļas, Lejasbitēni and Vampenieši, although they provide only a small amount of data, indicate that seasonal activities, such as fishing and/or hunting, took place during the Early Bronze Age.

As the Early Bronze Age is characterized by frequent import of bronze artefacts, it is also assumed that local bronze-casting already took place during this period, as crucibles

[79] VALTER LANG. The Bronze and Early Iron Ages…; KRISTIINA JOHANSON. Putting stray finds in context – what can we read from the distribution of stone axes. Culture and material culture. In: Papers from the First Theoretical Seminar of the Baltic Archaeologists (BASE) held at the University of Tartu, Estonia, October 17th–19th, 2003. Interarchaeologica I, pp. 167–181; ANDREJS VASKS. No medniekiem un zvejniekiem…, 100-103. lpp

[80] ILZE LOZE. Pozdnij neolit…; ILZE LOZE. Lubāna mitrāja apdzīvotība akmens laikmetā. Rīga-Rēzekne, 2015; ANDREJS VASKS. Brikuļu nocietinātā apmetne: Lubāna zemiene vēlajā bronzas un dzelzs laikmetā (1000. g. pr. Kr. – 1000. g. pēc Kr.). Rīga, 1994.

[81] Only those sites are listed which the author is able to date securely to the Late Neolithic/Early Bronze Age or Early Bronze Age either by radiocarbon or typology of finds.

have been found at Lagaža and apparently also on the Kreutonas 1C settlement.[82] However, as stressed by Podėnas and Čivilytė,[83] the radiocarbon dates pertaining to the Lagaža crucibles come from a completely different context, while the find from Kreutonas 1C is not available for investigation, is typologically impossible to interpret as a crucible and is not mentioned in the original excavation report. Therefore, the existing data provides no clear indications that local bronze-casting took place during the Early Bronze Age.

A study by Piličiauskas *et al.*[84] gives an insight into fishing in inland Lithuania during prehistory. Analysis of the Kaltanėnai underwater site revealed it to be a long-lasting fishing site, also used during the Early Bronze Age, as indicated by Lubāns type pottery and ^{14}C datings. An antler shaft-hole axe found on this site, which was dated to 1600–1400 cal BC, shows that similar tools to those of the Neolithic were used in the Early Bronze Age.[85] Bearing in mind the location of long-term settlements and existence of short-term ones next to rivers, it may be assumed that similar fishing sites existed across the Eastern Baltic. As mentioned above, alongside fishing and hunting, farming and animal husbandry slowly came to obtain a large role in subsistence strategies. This is shown by the faunal remains from the Lagaža settlement, where domesticated animals, such as cattle and other ruminants, were found.[86] It is important to note that the count of individuals of domesticated animals does not even reach five, compared to over 100 individuals of undomesticated, i.e. hunted, animals, which shows that farming, at least at the Lagaža settlement, still had a secondary role. Clear traces of food crop cultivation were uncovered at the Kvietiniai settlement, where charred barley grains dated to the second half of the Early Bronze Age were found.[87] This is the earliest known evidence of food crop farming in the Eastern Baltic region.

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[82] ILZE LOZE. Pozdnij neolit…; ALGIRDAS GIRININKAS. Ankstyvasis metalų laikotarpis. Klaipėda, 2013.

[83] VYTENIS PODĖNAS, AGNE ČIVILYTĖ. Bronze casting and communication…

[84] GYTIS PILIČIAUSKAS, KESTUTIS PESECKAS, JONAS MAŽEIKA, GRZEGORZ OSIPOWICZ, GIEDRĖ PILIČIAUSKIENĖ, EVE RANNAMÄE, ELENA PRANCKĖNAITĖ, ROKAS VENGALIS, MINDAUGAS PILKAUSKAS. Fishing history of the East Baltic during the Holocene according to underwater multiperiod riverine site Kaltanėnai, northeastern Lithuania. In: Archaeological and Anthropological Sciences, 2020, 12(12).

[85] Ibidem.

[86] ILZE LOZE. Pozdnij neolit…, p. 125

[87] GYTIS PILIČIAUSKAS, ROKAS VENGALIS, KAROLIS MINKEVIČIUS, DALIA KISIELIENE, ŽILVINAS EŽERINSKIS, JUSTINA ŠAPOLAITĖ, RAMINTA SKIPITYTĖ, HARRY KENNETH ROBSON. The earliest evidence for crop cultivation during the Early Bronze Age in the southeastern Baltic. In: Journal of Archaeological Science: Reports, 2021, 36(1), pp. 4-6

It may be assumed that the role of agriculture and animal husbandry was increasing during this period. This is also partly shown by human stable isotope data from Reznes, Kivisaare and Riigiküla I, which indicates a decrease in freshwater resource consumption and an increase in terrestrial resources starting from the Early Bronze Age, which could be explained as reflecting either hunting or animal husbandry.[88]

Burial practices: Studies show that three types of burial traditions existed during the Early Bronze Age: barrow graves, flat cemeteries and, at the end of the Early Bronze Age, stone cist graves as well. Barrow graves represent a new kind of burial practice and are common in the western part of the Eastern Baltic (Pukuļi and Šlažiai) and Lower Daugava area (Reznes), while flat cemeteries are currently known in central, northern and north-eastern Estonia (Kivisaare and Riigiküla I), the stone cist graves, also a new type of cemetery, occurring in central Estonia (Muuksi and Rebala).

2.3. Characterization of the Late Bronze and Pre-Roman Iron Age

As the Late Bronze Age and Pre-Roman Iron Age have been studied in great detail,[89] this section will only characterize the main trends seen in these two periods.

Settlement pattern: During the Late Bronze Age there was a marked increase in habitation, and settlements were mostly placed by the riverbanks and seashores, since trade and exchange, providing the precious and rare bronze, had a very important role during Late Bronze Age. Quite a few micro-regions of settlement emerged, for example in the Lower Daugava area (Ķivutkalns, Klaņģukalns, Vīnakalns, Dievukalns and Ķentes kalns hillforts, Lauskola and Vējstūri settlements), in an area of the Utena district (Sokiškiai, Narkūnai, Antilgė and Garniai I hillforts and Žalioji settlement), on Saaremaa island (Asva and Ridala hillforts), etc. Some habitation is seen along the banks of other rivers, such as the Venta (Padure and Krievu kalns hillforts), the Lielupe (Klosterkalns) as well as along the shore of the Gulf of Finland (Iru). Some hillforts in the Eastern Baltic are also located inland, with no major waterway nearby (Paplaka, Soe and Kõivuküla hillforts).

Bronze-casting and trade: Since the Eastern Baltic region has no tin or copper ores for bronze production, the metal needed to be imported from other regions. It should be noted that the first bronze-smiths might not have been locals but rather itinerant craftsmen from whom

[88] MARI TÕRV, JOHN MEADOWS. Radiocarbon Dates…, pp. 649-652; ANDREJS VASKS et al. New data on funeral customs…, 27. lpp

[89] For example, VALTER LANG. The Bronze and Early Iron Ages…; ALGIRDAS GIRININKAS. Ankstyvasis metalų laikotarpis…; ANDREJS VASKS. No medniekiem un zvejniekiem…, ect.

locals obtained their knowledge. Intensive bronze trade is indicated by the stray finds and finds of KAM-type axes and moulds for casting them, as well as bronze artefact hoards, such as the Staldzene hoard. Such axes have been found at Baltkāji, Brikuļi, Ķivutkalns, Narkūnai and Vosgėliai hillforts, and there are numerous stray finds.[90] Evidence of bronze-casting has been found practically on every early hillfort that has been excavated but not on the open settlements. It is assumed that hillforts were major bronze-casting centres, with active trade and exchange from Scandinavia to the Volga regions and even Central Europe.[91] Indications of exchange are seen in the archaeological material, where, along with KAM-type axes, other non-local artefacts are found. For example, at Ķivutkalns a hoard consisting of a tutulus, two neck-rings and a head pendant were uncovered, which share the traits of Central European archaeological cultures (Fig. 3).[92]

Figure 3. The hoard of Ķivutkalns – tutulus and two neck rings (LNVM VI 120: 1887-1889). Photo: V. Visocka.

Everyday life – hillforts and open settlements: During the Late Bronze Age, in addition to open settlements, a new type of living site appeared, the (early) hillfort. On these hillforts not only active trade and bronze-casting took place, but also other every day practices, such as pottery-making, preparation of various tools, and processing of leather and textiles. All of these practices are seen in the archaeological material, where bone needles, pins, awls, stone axes, etc., are represented. Due to the characteristics of the open settlements, not so much rich material has been preserved as in the hillfort assemblages. Nonetheless, everyday practices were actively pursued at the open settlements as well. Such evidence is clearly seen, for example, on the Kerkūzi I settlement.[93] Significantly, bronze-casting did not

[90] VYTENIS PODĖNAS, AGNE ČIVILYTĖ. Bronze casting and communication…

[91] ANDREJS VASKS. No medniekiem un zvejniekiem…; ANDREJS VASKS. Latvia as Part of a Sphere of Contacts in the Bronze Age. Archaeologica Baltica, 2010, vol. 13, pp. 153-161.

[92] JĀNIS GRAUDONIS. Nocietinātās apmetnes Daugavas lejtecē. Rīga, 1989. BAIBA VASKA. Rotas un ornaments Latvijā no Bronzas laikmeta līdz 13. gadsimtam. Rīga, 2019.

[93] ANDREJS VASKS. New data on Early Iron Age…, pp. 57-80

take place at the open settlements, an exception being the Krigāni lake dwelling settlement, where a bronze-casting mould fragment for a neck-ring has been found.

Subsistence strategies: The food consumed came from several different sources: fishing still played an important role in the everyday diet, as most of the sites were located near water; the same goes for hunting, as the remains of hunted animals continue to occur in the archaeological record. However, most of the faunal remains are from domesticated animals, which in some cases constitute 90% and more.[94] Evidence of farming has also been identified: antler axes, grinding stones and even charred food crops and/or their imprints in pottery.[95] Thus, farming and animal husbandry were the dominant food sources during the Late Bronze Age/Pre-Roman Iron Age.

Burial practices: During the Late Bronze Age/Pre-Roman Iron Age barrow and stone cist graves continued to be used, representing one of the main burial traditions, in addition to which there were flat cemeteries and stone cist graves, and in present-day Estonia *tarand* graves slowly emerged during the Pre-Roman Iron Age.[96] Just as during Early Bronze Age, so too in the Late Bronze Age and the Pre-Roman Iron Age, the graves are almost unfurnished.

2.4. Background to the sites analyzed

This section provides background information about the sites analyzed in the thesis. The sites are grouped typologically (Fig. 4).

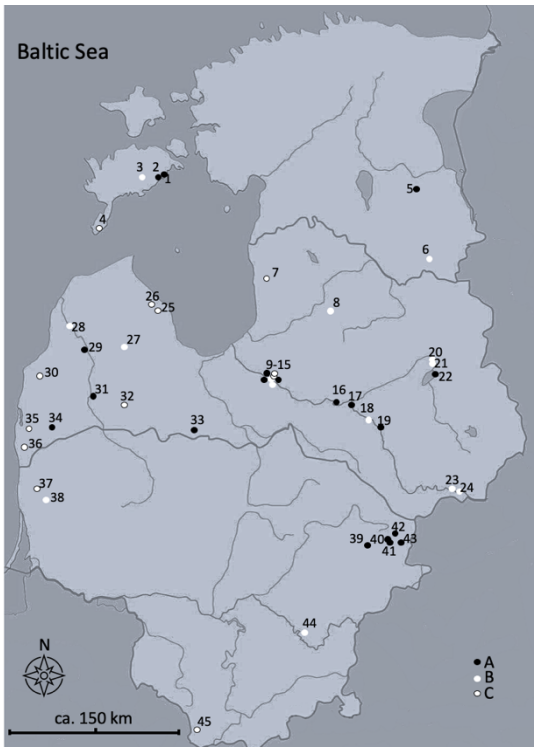

Figure 4. Location of the sites analyzed. A – hillforts (1 – Ridala, 2 – Asva, 5 – Kõivuküla, 9 – Klaņģukalns, 10 – Ķivutkalns, 11 – Vīnakalns, 16 – Dievukalns, 17 – Mūkukalns, 19 – Asote, 22 – Brikuļi, 29 – Padure (Belti), 31 – Krievu kalns, 33 – Klosterkalns, 34 – Paplaka, 39 – Narkūnai, 40 – Antilgė, 41 – Garniai I, 42 – Mineikiškės, 43 – Sokiškiai); B – settlements (3 – Kaali, 6 – Soe, 8 – Kalnapiļas, 12 –

[94] JĀNIS GRAUDONIS. Agro metālu periods…, 121. lpp

[95] KAROLIS MINKEVIČIUS, VYTENIS PODĖNAS, MIGLĖ URBONAITĖ-UBĖ, EDVINAS UBIS, DALIA KISIELIENĖ. New evidence on the southeast Baltic Late Bronze Age agrarian intensification and the earliest AMS dates of *Lens culinaris* and *Vicia faba*. In: Vegetation History of Archaeobotany, 2020, vol. 29, pp. 327-338; ALFRĒDS RASIŅŠ, MARINA TAURIŅA. Pārskats par Latvijas PSR Arheoloģiskajos izrakumos konstatētajām kultūraugu un nezāļu sēklām. In: Arheoloģija un Etnogrāfija, 1983, nr. 14, 152-175

[96] JĀNIS GRAUDONIS. Agro metālu periods…; VALTER LANG. The Bronze and Early Iron Ages…

Vampenieši, 13 – Laukskola, 18 – Lejasbitēni, 20 – Abora I, 21 – Lagaža, 23 – Kerkūzi I, 24 – Vilmaņi III, 27 – Tojāti, 28 – Priednieki, 38 – Kvietiniai, 44 – Žalioji); C – cemeteries (4 – Sorve, Lulle, 7 – Buļļumuiža, 14 – Lipši, 15 – Reznes, 25 – Mušiņas, 26 – Bīlavas, 30 – Dārznieki, 32 – Strīķi, 35 – Pukuļi, 36 – Bašķi, 37 – Ėgliškiai, 45 – Paveisininkai).

2.4.1. Living sites

2.4.1.1. Early hillforts

Antilgė (Fig. 5) is located in the Utena district of Lithuania, north-west of Lake Sylio. The hillfort was archaeologically investigated in 2016 by Agnė Čivilytė and in 2017 by Justina Poškienė, excavating a total area of 71.5 m^2.[97] During these excavations, 77 artefacts and 9705 pottery sherds were recovered. The period of habitation is 764–414 cal BC.[98]

Figure 5. Antilgė hillfort. From: AGNĖ ČIVILYTĖ. Antilgės piliakalnio…, p. 67

Asote (Fig. 6) was established on a 10 m high promontory of glacial till, delimited on three sides by the course of the Dārzupīte stream. The hillfort is located in Latvia, on the right bank of the River Daugava, about 2 km north of the town of Jēkabpils. Archaeological excavation took place in 1949–1954, directed by Elvīra Šnore, excavating an area of 792 m^2.[99] In the course of this excavation, 3470 artefacts

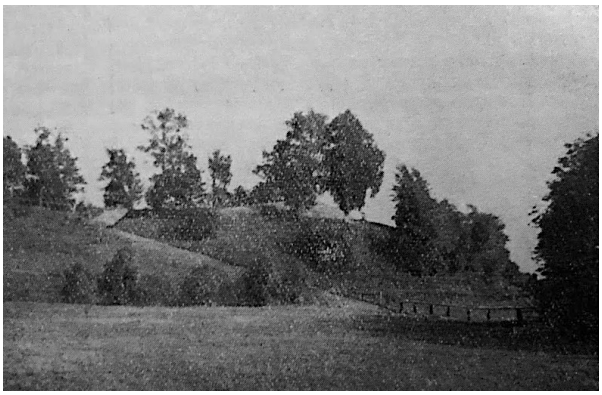

Figure 6. Asote hillfort. From: ELVIRA ŠNORE. Asotskoje Gorodishche…, s. 6

[97] AGNĖ ČIVILYTĖ. Antilgės piliakalnio (u.k. 3572), Utenos r. sav., Daugailių sen., Antilgės k., 2016 m. archeologinių žvalgomųjų tyrimų. Ataskaita. Vilnius, 2017. In: Lietuvos Istorijos Institutas (LII), fondas F1-8188.; JUSTINA POŠKIENĖ Antilgės piliakalnio (u.k. 3572), Utenos r. sav., Daugailių sen., Antilgės k., 2017 m. detaliųjų archeologinių tyrimų. Ataskaita. Vilnius, 2018. In: LII, fondas F1-8355.

[98] VYTENIS PODĖNAS. Emergence of Hilltop Settlements…, Table 1.

[99] ANDREJS VASKS. Keramika epokhi bronzi i rannego zheleza Latvii. Riga, 1991, s. 132

approximately 61,000 pottery fragments were recovered.[100] The characteristics of the finds indicate that Asote hillfort was established during the Late Bronze Age and was periodically inhabited until the 14th century AD.[101] ^{14}C dating of the striated pottery from the oldest layers gave a date of 775–486 cal BC.

Asva hillfort (Fig. 7) is located in Estonia, about 3 km inland from the south-eastern shore of Saaremaa Island, but during the Late Bronze Age it was partly surrounded by the sea and a lagoon. The site is situated on a moraine elevated up to 5 m above the surrounding flat terrain. Archaeological research was undertaken in the 1930s, 1940s and 1960s and has been continuing since 2012. The excavation has taken place at the edges of the c. 3500 m^2 elongated plateau, uncovering a total area of approximately 600 m^2.[102] The site was inhabited between 900 and 600/500 cal BC. During the Late Bronze Age, the Asva site was only temporarily enclosed within a stone fence. More than 50,000 pottery fragments, about 2000 fragments of clay casting moulds, and some 800 bone and antler artefacts have been found on the site during these excavations.

Figure 7. Asva hillfort. Photo: V. Visocka.

Brikuļi is located in Latvia, on a sandy promontory by the south-eastern shore of Lake Lubāns, near Īdeņa village. Small-scale test excavation took place in 1963, directed by archaeologist Ilze Loze, and in 1973 two trenches were excavated by Andrejs Vasks.[103] With the establishment of fisheries, fishponds were created at Īdeņa, and sand for construction was to be quarried from the area of Brikuļi hillfort. Accordingly, the site was completely

[100] ELVĪRA ŠNORE. Asotskoje Gorodishche. Riga, 1961, tablica II; ANDREJS VASKS. Keramika epokhi pozdnej bronzi…, s. 133.

[101] JURIS URTĀNS. Asotes pilskalns. In: ANDREJS VASKS, GUNITA ZARIŅA (sast.). Latvijas Arheoloģijas Rokasgrāmata. Rīga, 2021, 157. lpp

[102] UWE SPERLING, HANS-JÖRG KARLSEN, VALTER LANG, LEMBI LÕUGAS, ANDRES KIMBER, RONJA LAU. Ausgrabungen in der Bronzezeit Siedlung von Asva im Jahr 2019. In: Archaeological Fieldwork in Estonia 2019, 2020, pp. 51-60.

[103] ILZE LOZE, ANDREJS VASKS. Izrakumi Brikuļu apmetnē. In: ZASM par arheologu un etnogrāfu 1973. gada pētījumu rezultātiem, 1974, 48-50. lpp

excavated in four seasons, 1974, 1977, 1978 and 1979, the work being led by A. Vasks. As a result, the total hillfort area of 3410 m^2 was excavated, the cultural layer reaching 0.9 m.[104] In total, 1092 artefacts and 33,000 pottery sherds were found during the excavation.[105] Based on the characteristics of these finds as well as ^{14}C dating, two habitation phases were distinguished: 1) an early phase: 9th century BC – 2nd century AD (Late Bronze Age to beginning of Early Iron Age), and 2) a late phase: 7th–11th century AD (Late Iron Age).[106]

Dievukalns was established on a promontory on the right bank of the River Daugava next to a tributary, the Rumbiņa stream, located in the town of Lielvārde, Latvia. Archaeological excavation took place from 1977 to 1980, led by Anna Zariņa, in the course of which an area of 455 m^2 was opened up.[107] A total of 420 artefacts, more than 3000 pottery sherds and more than 2000 animal and fish bones were recovered.[108] Based on the characteristics of the finds, habitation of the hillfort is considered to have begun during the 1st millennium BC, continuing until the second half of the 1st millennium AD.[109]

Garniai I is located in Utena district, Lithuania, on an isolated oval hill, surrounded by the Kriauklė stream and the emerging wetlands – which may once have formed part of the larger Pelakis lake. The hillfort was archaeologically excavated in 2016 by Agnė Čivilytė and in 2017 by Vytenis Podėnas, uncovering a total area of 80 m^2.[110] In total during the excavations, 74 artefacts and 1006 pottery sherds, as well as barley seeds and animal bones were recovered. Radiocarbon dates indicate habitation from 792 to 540 cal BC.[111]

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[104] ANDREJS VASKS. Brikuļu nocietinātā apmetne…

[105] Ibidem.

[106] ANDREJS VASKS. Brikuļu nocietinātā apmetne…

[107] ANNA ZARIŅA. Izrakumi Lilevārdē 1978. gadā. ZASM par arheologu un etnogrāfu 1978. gada pētījumu rezultātiem, 1979, 97-100. lpp; ANNA ZARIŅA. Izrakumi Lielvārdes Dievukalnā 1980. gadā. In: ZASM par arheologu un etnogrāfu 1980. un 1981. gada pētījumu rezultātiem, 1982, 159-163. lpp

[108] Ibidem.

[109] ANDREJS VASKS. Dievukalna pilskalns. In: ANDREJS VASKS, GUNITA ZARIŅA (sast.). Latvijas Arheoloģijas Rokasgrāmata. Rīga, 2021, 164. lpp

[110] AGNĖ ČIVILYTĖ. Garnių I piliakalnio (u.k. 3575), Utenos r. sav., Daugailių sen., 2016 m. archeologinių žvalgomųjų tyrimų. Ataskaita. Vilnius, 2017. In: LII, fondas F1-8189; VYTENIS PODĖNAS. Garnių I piliakalnio (u.k. 3575), Utenos r. sav., Daugailių sen., Garnių k., 2017 m. detaliųjų archeologinių tyrimų. Ataskaita. Vilnius, 2018. In: LII, fondas F1-8722

[111] VYTENIS PODĖNAS. Emergence of Hilltop Settlements…, Table 1.

Ķivutkalns (Fig. 8) was established on Dole Island in Latvia, located in the River Daugava, on a promontory reaching a height of 10 m on the riverbank side and rising 3 m above the surrounding area.[112] The promontory was delimited by the Pižaga stream and an oxbow lake of this stream.[113] Archaeological excavation directed by Jānis Graudonis and Jolanta Daiga took place from 1966 to 1967.[114] Due to the construction of the Riga hydroelectric plant, which was to flood the area where Ķivutkalns was situated, the site was fully excavated, uncovering an area of 2276 m^2.[115] Very significant was the discovery of a cemetery underneath the Ķivutkalns fortified settlement, with 247 inhumations and 21 cremations, making this a unique double Late Bronze Age archaeological site.[116] The archaeological assemblage from the hillfort includes a stray find of two bronze bracelets found in 1942 in addition to the archaeologically excavated finds, which consist of 2700 individual artefacts, approximately 38,000 pottery fragments and 11,600 animal bones.[117] Most of the artefacts were made of stone and bone. Based on ^{14}C dating, researchers have concluded that Ķivutkalns was established approximately at 650 cal BC and periodically inhabited until the first half of the 2nd century AD, the end of the period of use indicated by the occurrence of three iron knives.[118]

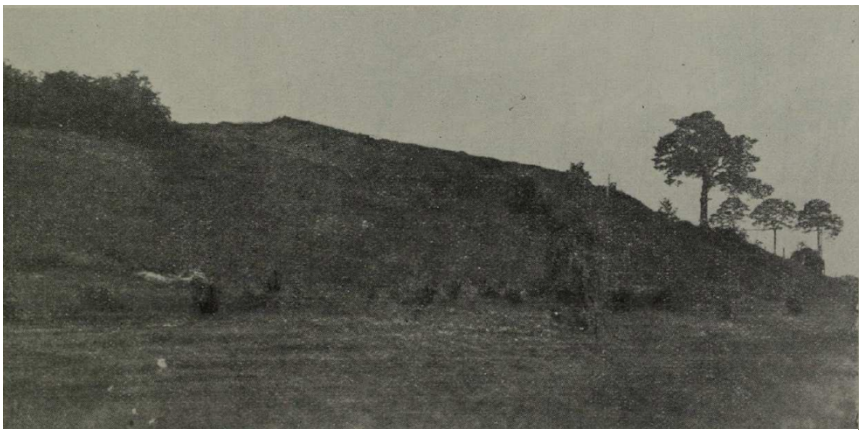

Figure 8. Ķivutkalns hillfort. From: ERNESTS BRASTIŅŠ. Latvijas pilskalni…, 17. lpp

[112] ERNESTS BRASTIŅŠ. Latvijas pilskalni: Vidzeme. Rīga, 1930, 15. lpp

[113] JĀNIS GRAUDONIS. Nocietinātās apmetnes…, 11. lpp

[114] Ibidem.

[115] JĀNIS GRAUDONIS. Nocietinātās apmetnes…, 11–12. lpp

[116] RAISA DEŅISOVA, JANIS GRAUDONIS, RITA GRĀVERE. Kivutkalnskij mogilnik epochki bronzy. Riga, 1985, s. 10

[117] JĀNIS GRAUDONIS. Nocietinātās apmetnes…, 11., 20. lpp

[118] Ibidem, 49. lpp; MARKKU OINONEN, ANDREJS VASKS, GUNITA ZARIŅA, MIKA LAVENTO. Stones, Bones, and Hillfort: Radiocarbon Dating of Ķivutkalns Bronze-Working Center. Radiocarbon, 2013, vol. 55(2-3), pp. 1261; ANDREJS VASKS, GUNITA ZARIŅA. Ķivutkalna pilskalns un kapulauks…, 8–11, 13, 16–19, 29. lpp

Klaņģukalns is located on the left bank of the River Daugava next to Riga hydroelectric power plant, Latvia. Before the power plant was built, it was on the west bank of the Sausā Daugava watercourse, south of Dole Island.[119] The hillfort was established on a promontory reaching 4 m in height. Excavation at Klaņģukalns took place in 1935 under the direction of Rauls Šnore.[120] In the course of the excavation, 93 artefacts and 3700 pottery sherds as well as animal bones were found.[121] Based on the characteristics of the finds, Klaņģukalns is considered to have been inhabited from the 1st century BC up to the 1st or 2nd century AD.[122]

Klosterkalns was established on a promontory on the left bank of the River Tērvete in Latvia, about 200 m south of Tērvete hillfort, which is located on the right bank of the river. Archaeological excavation at Klosterkalns took place in 1975–1976, led by Māris Atgāzis, excavating an area of 1000 m^2.[123] Building remains, such as houses and defensive walls, were distinguished. Artefact finds included stone axe fragments, grinding stones, bone pins, amber and casting moulds as well as 507 pottery sherds.[124] Radiocarbon dating of pottery from Klosterkalns indicates habitation in the period 1381–1056 cal BC (95.4%).

Kõivuküla was established on a 70 m long promontory between the valley of the River Mõra and another valley running diagonally into it.[125] The hillfort is located 8 km south-east of Tartu, Estonia, and 3 km from the river Emajõgi, on the south bank of the River Mõra, which is a tributary of the Emajõgi.[126] The hillfort was discovered in 2010 by Andres Vindi and excavated in 2011 under the direction of Heiki Valk, uncovering an area of 30 m^2.[127] Building remains consisting of granite and limestone rocks were distinguished, the excavated finds including a small iron artefact, a bone awl, a casting mould, slag and pottery with striation and textile and fingernail impressions, as well as animal bones.[128] The radiocarbon

[119] ERNESTS BRASTIŅŠ. Latvijas pilskalni: Vidzeme…, 17. lpp

[120] RAULS ŠNORE. Izrakumi Doles pag. Klaņģu pilskalnā…

[121] ANDREJS VASKS. Klaņģukalna pilskalns. In: ANDREJS VASKS, GUNITA ZARIŅA (sast.). Latvijas Arheoloģijas Rokasgrāmata. Rīga, 2021, 174. lpp

[122] RAULS ŠNORE. Izrakumi Doles pag. Klaņģu pilskalnā…, 64.lpp

[123] ANDREJS VASKS. Klosterkalna pilskalns. In: ANDREJS VASKS, GUNITA ZARIŅA (sast.). Latvijas Arheoloģijas Rokasgrāmata. Rīga, 2021, 174. lpp

[124] Ibidem.

[125] HEIKI VALK et al. Excavations on the hill forts of south-east Estonia… p. 27

[126] Ibidem.

[127] Ibid., pp. 27-28

[128] Ibid., pp. 28-31

dates serve to separate two periods of habitation: 1) Late Bronze Age, 922–551 cal BC, and 2) Early Iron Age, 234–576 cal AD.[129]

Krievu kalns was established 600 m from the right bank of the River Venta in Skrunda Parish, Latvia. Archaeological excavation took place in 2012 and 2013 under the direction of Andrejs Vasks, Inga Doniņa and Aija Vilka.[130] In the course of the excavation, several buildings as well as a defensive wall were revealed. During these excavations 37 artefacts and 10,056 pottery sherds, 350 daub fragments and animal bones were found.[131] The characteristics of the finds and the ^{14}C dates indicated that hillfort was inhabited during the Late Bronze Age, 1047–390 cal BC.[132]

Mineikiškės hillfort is located in Zarasai District, Lithuania, established on a promontory on the left bank of the River Nikajaus. Archaeological excavation took place in 2017, led by Vytenis Podėnas, and in 2020, led by Karolis Minkevičius, excavating a total of 40 m^2.[133] A total of 114 artefacts and 5889 pottery sherds were recovered in the course of the excavation. Radiocarbon dates indicate habitation in the period 793–548 cal BC.[134]

Mūkukalns was established on a dolomite promontory, reaching a height of 36 m on the south side, and 12 m on the north side. The hillfort was located on the right bank of the River Daugava near the town of Koknese, Latvia, and is nowadays flooded by the Pļaviņas hydroelectric reservoir. Archaeological excavation took place in 1899, directed by Alvil Buchholtz, in 1913 under the direction of Max Ebert and in 1959–1962 under the direction of by Jānis Graudonis.[135] In all, an area of 3613 m^2 has been archaeologically excavated,

[129] HEIKI VALK et al. Excavations on the hill forts of south-east Estonia… pp. 29-30

[130] INGA DONIŅA, et al. Izrakumi Skrundas Krievu kalnā…

[131] ANDREJS VASKS. Krievu kalna pilskalns. In: ANDREJS VASKS, GUNITA ZARIŅA (sast.). Latvijas Arheoloģijas rokasgrāmata. Rīga, 2021.

[132] ANDREJS VASKS, VANDA VISOCKA, LINAS DAUGNORA, AIJA CERIŅA, LAIMDOTA KALNIŅA. Krievu Kalns Hill-Fort: New Data on the Late Bronze Age and Pre-Roman Iron Age in Western Latvia. In: Archaeologica Baltica, 2020, vol. 26, p. 85

[133] VYTENIS PODĖNAS Mineikiškių piliakalnio (5705) teritorijos, Mineikiškių k., Zarasų sen., Zarasų r. sav., 2017 m. detaliųjų archeologinių tyrimų. Ataskaita. Vilnius, 2020. In: LII, fondas, unregistered; KAROLIS MINKEVIČIUS. Mineikiškių piliakalnio (5705) teritorijos, Mineikiškių k., Zarasų sen., Zarasų r. sav., 2020 m. detaliųjų archeologinių tyrimų. Ataskaita. Vilnius, 2021. In: LII, fondas, unregistered

[134] VYTENIS PODĖNAS. Emergence of Hilltop Settlements…, Table 1.

[135] ANDREJS VASKS. Mūkukalna pilskalns. In: ANDREJS VASKS, GUNITA ZARIŅA (sast.). Latvijas Arheoloģijas Rokasgrāmata. Rīga, 2021, 184. lpp

recovering a total of 1017 artefacts and 9160 pottery sherds.[136] Based on the characteristics of the finds, the hillfort is considered to have been established during the Late Bronze Age and inhabited periodically until the 10th century AD.[137]

Narkūnai is located in the Utena district, eastern Lithuania. The hillfort was established on a promontory reaching a height of 14 m above the immediate surroundings, about 60 m from the Utenėlė rivulet. On the western side, the promontory was delimited by the course of a smaller rivulet. The site was archaeologically investigated in the years from 1835 to 1912, and in 1976–1978 an area of 660 m^2 was excavated under the direction of Regina Volkaitė-Kulikauskienė and Aleksiejus Luchtanas.[138] In the course of these excavations over 800 individual finds, 12,047 pottery fragments and over 7000 animal bones were recovered.[139] Based on the characteristics of the finds, it was concluded that the hillfort had been established during the Late Bronze Age. Radiocarbon dating shows that the hillfort was inhabited in the period 796–550 cal BC.[140] The Late Bronze Age site was enclosed by a wooden palisade. Besides the Late Bronze Age horizon, the promontory was settled again during the 1st century BC – 2nd century AD and in the 13th–15th century AD.[141]

Padure (Belti) hillfort was established on the left bank of the River Venta, Latvia, about 220 m north-east of the Beltes farm. Archaeological excavation took place in 2003 and 2005–2007, directed by Andrejs Vasks, excavating an area of 279 m^2. The excavation yielded a total of 483 artefacts, 7492 pottery sherds and 147 animal bones.[142] The characteristics of the finds and ^{14}C dating indicate two habitation periods: 1) Late Bronze Age and Pre-Roman Iron

[136] ANDREJS VASKS. Mūkukalna pilskalns… 185-187. lpp

[137] Ibid., 187. lpp

[138] VYTENIS PODĖNAS, AGNĖ ČIVILYTĖ, ALEKSIEJUS LUCHTANAS. Narkūnų piliakalnių ir papėdės gyvenvietės keramika: elgsenos atspindžiai. In: Lietuvos Archaeologija, 2016, T. 42, pp. 193; REGINA VOLKAITĖ-KULIKAUSKIENĖ. Narkūnų Didžiojo piliakalnio tyrinėjimų rezultatai (Apatinis kultūrinis sluoksnis). Lietuvos Archeologija, 1986, T. 5, pp. 5–49

[139] ZENONAS BAUBONIS, GINTAUTAS ZABIELA. Lietuvos piliakalniai. Atlasas. III tomas. Vilnius, 2005, p. 244; VYTENIS PODĖNAS et al. Narkūnų piliakalnių ir papėdės gyvenvietės keramika…, p. 204

[140] VYTENIS PODĖNAS. Emergence of hilltop settlements…, 361–377.

[141] VOLKAITĖ-KULIKAUSKIENĖ. Narkūnų Didžiojo piliakalnio…; VYTENIS PODĖNAS et al. Narkūnų piliakalnių ir papėdės gyvenvietės keramika…

[142] ANDREJS VASKS. Arheoloģiskie izrakumi pie Ventas. Arheologu pētījumi Latvijā (APL) 2004. un 2005. gadā. Rīga, 2006, 64.-75. lpp; ANDREJS VASKS. Arheoloģiskie izrakumi Padures (Beltu) pilskalnā 2006. un 2007. Gadā. APL 2006. un 2007. gadā. Rīga, 2008, 63-70. lpp

Age and 2) Middle Iron Age and second half of the Late Iron Age.[143] The site was used again during the 16th–17th century AD.

Paplaka hillfort is located on the left bank of the River Virga, Latvia, about 2 km south-east of Paplaka village. Archaeological excavation took place in 1976, led by Andrejs Vasks, uncovering an area of 84 m^2.[144] The excavation produced such artefacts as fragments of a bronze ring bracelet, an iron hook, a sandstone whetstone, etc., and 810 pottery fragments.[145] Based on the characteristics of the finds and radiocarbon dating, two habitation periods can be distinguished: 1) Pre-Roman Iron Age; 2) Early Iron Age – first half of the 1st millennium AD.[146]

Ridala hillfort is located, on Saaremaa Island in Estonia, near Ridala village, about 5 km from Asva hillfort. During the Late Bronze Age it was located in the coastal area.[147] Archaeological excavation took place in 1961–1963, directed by Aita Kustin and Artur Vassar and uncovering a total area of 435 m^2.[148] Based on the characteristics of the finds, it was concluded that Ridala hillfort was inhabited during the Late Bronze Age.

Sokiškiai (Fig. 9) was established on a promontory approximately 300 m south-west of the Dūkštas–Salakas road, east of road to Sokiškiai village, north-west of Lake Samanio, Lithuania. Archaeological excavation took place in 1980–1983 under the direction of Elena Grigalavičienė-Danilaitė, with an overall extent of 1115 m^2.[149] In total,

Figure 9. Sokiškiai hillfort. Photo: V. Visocka

[143] ANDREJS VASKS. Beltu (Padures) pilskalns. In: ANDREJS VASKS, GUNITA ZARIŅA (sast.). Latvijas Arheoloģijas Rokasgrāmata. Rīga, 2021, 158. lpp

[144] ANDREJS VASKS. Paplakas pilskalns. In: ANDREJS VASKS, GUNITA ZARIŅA (sast.). Latvijas Arheoloģijas Rokasgrāmata. Rīga, 2021, 190. lpp

[145] ANDREJS VASKS. Keramika epokhi bronzi…, 159. lpp; ANDREJS VASKS. Paplakas pilskalns…, 190. lpp

[146] ARTŪRS HAFERBERGS. Celtniecība…, 84. lpp; ANDREJS VASKS. Paplakas pilskalns…, 190. lpp

[147] UWE SPERLING, HEIDI LUIK. Arrowheads, Palisades…, pp. 140)

[148] Ibidem.

[149] ALGIMANTAS MERKEVIČIUS. Ankstyvojo metalų laikotarpio gyvenvietės Lietuvoje. Vilnius, 2018, p. 1053

700 artefacts, 10,000 pottery sherds and 11,000 bone fragments were recovered during the excavation.[150] The hillfort is dated to the Late Bronze Age, 800–500 cal BC.

Vīnakalns hillfort was established on a glacial till promontory. The hillfort was located about 2 km west of Ikšķile railway station, near the right bank of the River Daugava, Latvia.[151] Archaeological excavation was conducted in 1967 under the direction of archaeologist Jānis Graudonis. Due to the construction of the Riga–Ogre highway, in the construction zone of which the hillfort was located, it was completely excavated, leaving a small mound of till near the highway. A total area of 1550 m^2 was excavated, and 280 artefacts and 3057 pottery sherds were obtained.[152] The characteristics of the finds and radiocarbon dating indicate that Vīnakalns hillfort was inhabited during the second half of the 1st millennium BC.[153]

2.4.1.2. Open settlements

Abora I is located on the Lake Lubāns plain in Latvia, on the right bank of the River Abora, near its confluence with the River Abaine. The extent of the settlement is about 5000 m^2, of which 1311 m^2 was archaeologically excavated in 1964–1965 and 1970–1971 under the direction of Ilze Loze.[154] In 2021, additional excavation took place, led by Dardega Legzdiņa and Eduards Plankājs, uncovering an area of 35 m^2. In the course of the excavation by I. Loze, 3885 artefacts and 18,000 pottery sherds were recovered. Radiocarbon dating shows that Abora I settlement was inhabited in the period 3370–2025 cal BC and possibly during the Early Bronze Age.[155]

Kaali is located in the central part of Saaremaa Island, Estonia. This is one of the most thoroughly researched meteor craters, investigated geologically and geomorphologically. The

[150] ELENA GRIGALAVIČIENĖ. Sokiškių piliakalnio, vad. "Juodžeminto kalnu" (Ignalinos raj., Dūkšto Apyl) 1980 m. Birželio 28 – Rugpjūčio 11 D. Tyrinėjimų ataskaita. In: LII, fondas 809; ELENA GRIGALAVIČIENĖ. Sokiškių piliakalnio, vad. "Juodžeminto kalnu" (Ignalinos raj., Dūkšto Apyl) 1981 m. Birželio 28 – Rugpjūčio 11 D. Tyrinėjimų ataskaita. In: LII, fondas 818; ELENA GRIGALAVIČIENĖ. Sokiškių piliakalnio, vad. "Juodžeminto kalnu" (Ignalinos raj., Dūkšto Apyl) 1983 m. Birželio 28 – Rugpjūčio 11 D. Tyrinėjimų ataskaita. In: LII, fondas 1101

[151] JĀNIS GRAUDONIS. Nocietinātās apmetnes…

[152] Ibidem.

[153] VANDA VISOCKA et al. Between mighty hillforts…

[154] ILZE LOZE. Aboras I apmetne. In: ANDREJS VASKS, GUNITA ZARIŅA (sast.). Latvijas Arheoloģijas Rokasgrāmata. Rīga, 2021, 112. lpp

[155] Ibidem.

main crater is 105–110 m in diameter and 16–22 m deep.[156] Geoarchaeological excavation took place in 1976, co-directed by Vello Lõugas.[157] The few finds and ^{14}C dates indicate habitation in the crater at the end of the Late Bronze Age and in the Pre-Roman Iron Age, 515–208 cal BC.

Kalnapiļas is located in Cēsis District, Latvia, about 15 km east of the town of Cēsis; however, the precise location is nowadays not known. Archaeological excavation took place in in 1943 and 1958, directed by Konstance Ozola, and 1988–1990, directed by Zigrīda Apala.[158] At Kalnapiļas, beneath an Iron Age cemetery, a few sherds belonging to Early Bronze Age Post-Corded Ware were found, indicating a settlement preceding the cemetery.

Kerkūzi I is located in Saliena Parish, Latvia, next to the former location of the Kerkūzi farm, on the left bank of the River Daugava next to the River Šaltepka. The extent of the settlement is approximately 7000 m^2 of which 2310 m^2 was archaeologically excavated in 1985–1987 under the direction of Andrejs Vasks.[159] Structures such as houses and a palisade were discovered. The finds include such artefacts as stone axes, flint tools, iron pins, knives, etc., and 8918 pottery sherds.[160] Based on the characteristics of the finds, the settlement was established during the 1st millennium BC and inhabited until the 4th–5th century AD.[161]

Kvietiniai is located in Klaipėda District, Lithuania, in the valley of the River Minija, near Kvietininiai village, about 20 km from the Baltic Sea. Archaeological excavation of the settlement took place in 2014–2015 and 2017, led by Rokas Vengalis.[162] Overall during the excavations, 144 artefacts and 11 kg of pottery as well as 300 animal bones and rich palaeobotanical material, including charred food crops, were found.[163] Based on the finds and ^{14}C dates, the chronology of Kvietiniai settlement is quite wide: from the Neolithic to the Early Iron Age. Radiocarbon dates indicate the time periods 1257–1012, 728–388 and 542–388 cal BC.[164]

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[156] UWE SPERLING. Aspekte des Wandels in der Bronzezeit…, pp. 81

[157] UWE SPERLING. Aspekte des Wandels in der Bronzezeit… pp. 83

[158] ĒVALDS MUGURĒVIČS, ANDREJS VASKS (sast.). Latvijas senākā vēsture. 9. g. t. pr. Kr. – 1200. g. Rīga, 2001, 390. lpp

[159] ANDREJS VASKS. Kerkūzu I un II apmetne. In: ANDREJS VASKS, GUNITA ZARIŅA (sast.). Latvijas Arheoloģijas Rokasgrāmata. Rīga, 2021, 118. lpp

[160] ANDREJS VASKS. Keramika epokhi bronzi…, 148; ANDREJS VASKS. Kerkūzu I un II apmetne, 118. lpp

[161] ANDREJS VASKS. Kerkūzu I un II apmetne…, 119. lpp

[162] ROKAS VENGALIS et al. The Large-Scale Rescue Excavation…, pp. 18

[163] Ibidem.

[164] Ibid., pp. 37

Lagaža is located in Latvia, on the north-east side of the Lake Lubāns plain, at the confluence of the Lagaža and Posma rivers, about 300 m from where their waters enter the Aiviekste river. The size of the settlement is unknown. During archaeological excavations from 1965–1966 and in 1968, led by I. Loze, 377 m^2 were excavated.[165] Overall, 464 artefacts and 17,677 pottery sherds were recovered. Two habitation periods were distinguished, based on the characteristics of the cultural layers and ^{14}C dates: 1) 2338–1829 cal BC and 2) 2205–1776 cal BC.[166]

Laukskola archaeological site, which includes several monuments, was located on the right bank of the Lower Daugava, in Salaspils Parish, Latvia, between the school and Budeskalni farm, facing Daugmale hillfort, which is located on the left bank of the Daugava.[167] Due to the planned construction of the Riga hydroelectric plant, Laukskola was archaeologically excavated during the period 1967–1975 under the direction of Anna Zariņa and is nowadays flooded by the Daugava. At Laukskola, three chronological horizons were identified: Palaeolithic and Late Bronze Age settlements, as well as Liv settlements and a burial ground from the Late Iron Age.[168] At least 11 reconstructable vessels and numerous sherds from the Late Bronze Age were found in various features during the excavation.[169] Although the quantity of vessels indicates habitation, it is impossible to determine if this was long- or short-term settlement. Radiocarbon dating of a striated vessel from a Bronze Age context indicates a habitation period from 791 to 544 cal BC.[170]

Lejasbitēni was located on a terrace on the right bank of the River Daugava, about 3 km north-east of Pļaviņas hydroelectric plant, Latvia. A large Iron Age cemetery was established on top of the earlier settlement.[171] Archaeological excavation took place in 1961–1964, led by Vladislavs Urtāns. Based on the characteristics of pottery found in this settlement (Post-Corded Ware), it was dated to the Early Bronze Age (1800–1100 cal BC).

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[165] ILZE LOZE. Lagažas apmetne.In: ANDREJS VASKS, GUNITA ZARIŅA (sast.). Latvijas Arheoloģijas Rokasgrāmata. Rīga, 2021, 121. lpp

[166] Ibid., 122. lpp

[167] ANNA ZARIŅA. Salaspils Laukskolas kapulauks 10.–13. gadsimts. Rīga, 2006, 9. lpp

[168] ANNA ZARIŅA. Salaspils Laukskolas 1975. g. izrakumu pārskats. In: Latvijas Universitātes Latvijas Vēstures Institūts Arheoloģisko materiālu krātuve (LU LVI AMK), Inv.Nr. AA 335, 181. lpp

[169] ALISE ŠULTE, DANIEL GUNNARSSON. Ieskats Salaspils Laukskolas apmetnes un kapulauka keramikas telpiskajā analīzē. In: Latvijas nacionālā vēstures muzeja raksti, 2017, nr. 23., 11–19. lpp

[170] VANDA VISOCKA et al. Between Mighty Hillforts…

[171] JĀNIS CIGLIS. Lejasbitēnu senkapi. In: ANDREJS VASKS, GUNITA ZARIŅA (sast.). Latvijas Arheoloģijas Rokasgrāmata. Rīga, 2021, 319. lpp

Priednieki is located in Ventspils District, Latvia, 700 m from the left bank of the River Venta. Archaeological excavation took place in 2004, led by Andrejs Vasks, uncovering 181 m^2.[172] Overall during the excavation, 99 artefacts and 4725 pottery sherds were recovered.[173] Based on the characteristics of the finds and ^{14}C, dates several habitation periods were distinguished: Mesolithic, Late Bronze Age/Pre-Roman Iron Age (800–230 cal BC) and Iron Age.[174]

Soe is located in Urvaste parish, Estonia, 50 m west-north-west of the end of the Soe inn farm, south of the road connecting Võru – Viljandi highway.[175] On this settlement the only concentration of pottery vessels has been found near the road. Based on analogies for the characteristics of the pottery, the Soe assemblage is dated to the Late Bronze Age (900–500 cal BC) and Early Iron Age.[176]

Tojāti is located in Abava Parish, Latvia, on a terrace on the left bank of Abava river. The settlement was discovered in 1923 by Max Ebert as an Iron Age barrow grave cemetery.[177] It was archaeologically excavated in 1928 by Francis Balodis and in 1976 by Māris Atgāzis. The total number of finds from the Early Bronze Age settlement period is quite small: only three artefacts and 300 pottery sherds. According to analogies with Kvietiniai settlement, which has produced similar pottery, Tojāti settlement may be dated to the second half of the Early Bronze Age (1400–1100 cal BC).[178]

Vampenieši was located in the upstream part of Dole Island in the River Daugava, Latvia. A large Iron Age cemetery was established on top of the settlement.[179] Archaeological excavation took place in 1966–1967, 1969 and 1971–1974, led by Elvīra Šnore. Because of the construction of the Riga hydroelectric plant, the cemetery, together with the settlement, is now underwater. Based on the characteristics of pottery found in this settlement, it has been dated to the Early Bronze Age, and this conclusion is supported by ^{14}C dates: 1412–1213 cal BC.[180]

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[172] ANDREJS VASKS. Arheoloģiskie izrakumi pie Ventas…, 65. lpp

[173] Ibidem.

[174] Ibid., 66-67. lpp

[175] HEIKI VALK. A find of Bronze Age pottery…, p. 39

[176] Ibid., 42

[177] NORMUNDS GRASIS. Tojātu apmetne…, 141. lpp

[178] Ibidem.

[179] ANTONIJA VILCĀNE. Vampeniešu I senkapi. In: ANDREJS VASKS, GUNITA ZARIŅA (sast.). Latvijas Arheoloģijas Rokasgrāmata. Rīga, 2021, 363. lpp

[180] ANDREJS VASKS. The lower reaches of the Daugava…

Vilmaņi III is located in Krāslava Parish, Latvia, near the Razboja river, where it enters the River Daugava. Excavation was undertaken in 1986–1987, led by Ilga Zagorska, uncovering an area of 590 m^2.[181] Overall, the excavation yielded 187 artefacts and 2950 pottery sherds.[182] Based on the characteristics of the finds, two habitation periods were distinguished: 1) an early period – Late Bronze Age, characterized by striated pottery, stone and flint tools, and 2) a late period – 2nd–4th century AD.[183] Radiocarbon dating of pottery indicates a habitation period from 41 cal BC – 126 cal AD, corresponding to the Pre-Roman Iron Age – Early Iron Age.

Žalioji is located in Kaunas District, Lithuania, near Žalioji village and the town of Kernavė. Archaeological excavation took place in 1952, directed by archaeologists of the Lithuanian SSR History Institute led by Rimutė Rimantienė and Regina Kulikauskienė. Several concentrations of crushed pots were discovered.[184] The latest ^{14}C dates of pottery crust indicates that they are from the second half of the Late Bronze Age: 760–515 cal BC.[185]

2.4.2. Cemeteries

2.4.2.1. Barrow graves

Bašķi is located in Rucava Parish, Latvia, around 1 km east-north-east of Šimju farm, Latvia. The barrows were established in the valley of the Sventāja River, on a 1 m high promontory. The cemetery consists of three barrows.[186] Archaeological excavation took place in 1938, led by Pēteris Stepiņš, who excavated two barrows.[187] At least four fragments of urns with calcined bones were found, and in the embankment the archaeologists found fragments of split stone, a bronze ring and a late La Tène brooch.[188] The period of use of the cemetery, based on the characteristics of the finds and ^{14}C dating, is the 9th–8th century cal BC.[189]

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[181] ILGA ZAGORSKA. Izrakumi Vilmaņu III apmetnē. In: ZASM par arheologu un etnogrāfu 1986. un 1987. gada pētījumu rezultātiem, 1988, 151-156. lpp

[182] Ibid., 151

[183] Ibid., 156

[184] L. GAILIUŠAS. Ataskaites Pranešimas [Žalioji], 1952. In: LII, fondas 21; RIMUTĖ RIMANTIENĖ. 1958 m. KVDM vykdytų tyrinėjimų Lapainėje, Kaišiadorių raj. ir Žaliojoje, Vilniaus raj. Ataskaita, 1958. In: LII, fondas 83.

[185] GYTIS PILIČIAUSKAS et al. New 14C dates…

[186] JĀNIS CIGLIS. Bašķu senkapi. In: ANDREJS VASKS, GUNITA ZARIŅA (sast.). Latvijas Arheoloģijas Rokasgrāmata. Rīga, 2021, 271. lpp

[187] Ibidem.

[188] Ibidem.

Buļļumuiža (Fig. 10) is located in Limbaži Parish, Latvia, about 300 m east of Dravnieki farm (the former estate Buļļumuiža). In the 1930s, about 30 barrows were registered, but some were subsequently destroyed by ploughing and drainage work.[190] Archaeological excavation took place in the 1930, directed by Valdemārs Ģinters, and in 1965, directed by Jānis Graudonis, excavating five barrows in total.[191] The period of use of the cemetery is the 10th–5th century cal BC.[192]

Figure 10. Buļļumuiža barrow. From: EDUARDS ŠTURMS. Buļļumuiža…, LNVM, AA 37

Dārznieki is located in Cīrava Parish, Latvia, on the north bank of the River Zīle, next to Dārznieki farm. The barrow grave was discovered in 1935 by the owner of the farm, who dug up an inhumation grave and a clay urn with calcined bones.[193] In 1936, archaeological excavation took place, led by Eduards Šturms, who excavated 20 m^2 and discovered six 18th-century graves as well as two cists deeper down.[194] Pottery sherds were found in several places within the barrow. The ^{14}C dates and characteristics of the urn grave indicated that it dated from the first half of the Late Bronze Age: 983–827 cal BC.[195]

Ėgliškiai is located about 0.3–1.3 km east of the Klaipėda–Kretingos highway, on both sides of Klaipėda–Trušelių–Kretingos road, on the left bank of the River Danė, Lithuania. The barrows are separated into three groups. Archaeological excavation was undertaken in 1895 by Alfred Götze, in 1898 by Adalbert Bezzenberger, in 1969 and 1974–1975 by Elena Grigalavičienė and Ingas Jablonskis, in 1980–1981 by I. Jablonskis and in 2005 by Julius

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[189] Ibid., 272. lpp

[190] ANDREJS VASKS. Buļļumuižas senkapi. In: ANDREJS VASKS, GUNITA ZARIŅA (sast.). Latvijas Arheoloģijas Rokasgrāmata. Rīga, 2021, 273. lpp

[191] Ibidem.

[192] Ibidem.

[193] ANDREJS VASKS. Dārznieku senkapi. In: ANDREJS VASKS, GUNITA ZARIŅA (sast.). Latvijas Arheoloģijas Rokasgrāmata. Rīga, 2021, 274. lpp

[194] ANDREJS VASKS. Dārznieku senkapi. In: ANDREJS VASKS, GUNITA ZARIŅA (sast.). Latvijas Arheoloģijas Rokasgrāmata. Rīga, 2021, 274. lpp

[195] JĀNIS CIGLIS et al. Jauni bronzas…

Kanarskas.[196] A total of nine barrows have been excavated. A variety of grave goods have been found, such as a bronze diadem and bracelets, as well as cremated burials in urns. Radiocarbon dating of charcoal indicates the period 753–407 cal BC (95.4%).

Lipši was located 23 km from Riga, in Salaspils Lipši village, Latvia, on the west side of the Saulkalne dolomite quarry. Archaeological excavation took place in 1973–1975, directed by Jolanta Daiga.[197] There were mainly 11th–13th century barrow graves of Livs, some 14th–18th century graves and only a few Late Bronze Age graves, characterized by striated pottery.[198]

Pukuļi is located near Bārta village in Latvia, next to the farms Pukuļi and Stiebri. The cemetery consists of a total of 13 barrows established on a promontory of glacial till. Archaeological excavation took place in 1962–1963, directed by Pēteris Stepiņš, and in 1979–1981, led by A. Vasks, completely excavating all of the barrows.[199] In the course of excavation cremated remains were discovered, but skeletal remains were not preserved. Only barrow 14 yielded a grave good – a bronze bracelet. Altogether, 15 potsherds were found in the barrows.[200] Radiocarbon dates indicate the period 1752–1018 cal BC.[201]

Reznes (Fig. 11) was located in Latvia, on the right bank of the River Daugava, on a peninsula delimited by the River Jurupīte. The barrows were established on a 500 m long and 200 m wide promontory, which during the Late

Figure 11. Reznes barrow. From: EDUARDS ŠTURMS. Reznes II, LNVM, AA 267₂

[196] ALGIMANTAS MERKEVIČIUS. Ankstyvojo metalų laikotarpio laidojimo paminklai Lietuvoje. Vilnius, 2014, pp. 36

[197] ANTONIJA VILCĀNE. Lipšu senkapi. In: ANDREJS VASKS, GUNITA ZARIŅA (sast.). Latvijas Arheoloģijas Rokasgrāmata. Rīga, 2021, 327. lpp

[198] Ibidem, 328. lpp

[199] ANDREJS VASKS. Pukuļu senkapi.In: ANDREJS VASKS, GUNITA ZARIŅA (sast.). Latvijas Arheoloģijas Rokasgrāmata. Rīga, 2021, 275. lpp

[200] Ibidem, 276. lpp

[201] DARDEGA LEGZDIŅA et al. Re-evaluating the Bronze and Earliest Iron Age…

Bronze Age was an island.[202] The cemetery consisted of at least eight barrows. Archaeological excavation was undertaken in 1900 by A. Buchholtz, in 1933 and 1935 by Eduards Šturms, and in 1958 and 1969 by Jānis Graudonis. Overall, five barrows were archaeologically excavated.[203] The small quantity of finds included pottery sherds, a bronze button, a stone axe, bronze razors, etc.[204] Radiocarbon dates indicate the period 1442–1001 cal BC – the second half of the Early Bronze Age and beginning of the Late Bronze Age.

2.4.2.2. Cemeteries under hillforts

Ķivutkalns. See section 2.4.1.1.

Paveisininkai was established on a promontory on the southern shore of Lake Veisiejo, Lithuania. The cemetery, discovered under a hillfort, was archaeologically studied in 1962 by Pranas Kulikauskas. A total of 27 cremation burials were discovered: six of the graves were calcined bones in pits, eight were in stone cists and 13 in urns.[205] Radiocarbon dating shows that the cemetery was in use from 790 to 570 cal BC.[206]

2.4.2.3.Stone ship settings

Bīlavas is located in Talsi Parish, Latvia, about 300 m north-west of Bīlavi farm, in the forest on the right-hand side of the Nogale–Lube road. It consists of two "ships" connected together. Archaeological excavation was undertaken in 1863 by Julius Döring and in 1999 by Andrejs Vasks.[207] In the 1999 excavation no undisturbed graves were discovered, but a total of 91 pottery sherds and calcined bones were found.[208] It was concluded that the ship had possibly contained four graves, one of which could have been in an urn.[209] Radiocarbon dates indicate a period of use from 1401 to 806 cal BC.[210]

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[202] ANDREJS VASKS. Reznu senkapi.In: ANDREJS VASKS, GUNITA ZARIŅA (sast.). Latvijas Arheoloģijas Rokasgrāmata. Rīga, 2021, 276. lpp; ANDREJS VASKS et al. New data on funeral customs and burials…

[203] ANDREJS VASKS. Reznu senkapi…, p. 276

[204] Ibid., 276.-277. lpp

[205] ALGIMANTAS MERKEVIČIUS. Ankstyvojo metalų laikotarpio…, pp. 117

[206] GYTIS PILIČIAUSKAS et al. New 14C dates…

[207] ANDREJS VASKS. Bīlavu "velna laivas" izrakumi un rekonstrukcija 1999. gadā. In: APL 1998. un 1999. gadā, 2000, 36. lpp

[208] Ibidem. 41. lpp

[209] Ibid.

[210] JOAKIM WEHLIN. Östersjöns skeppssättningar…

Lülle is located on Saaremaa Island in Sõrve District near Lülle village, Estonia. It consists of two "ships" connected together. It was discovered in 1940 by Artur Vassar. Archaeological excavation was undertaken in 1967 by V. Lõugas.[211] Pottery urns and tools of stone and bronze were found within the ship settings.[212] Radiocarbon dating indicates that the site was in use in the period 791–544 cal BC.[213]

Mušiņas was located in Talsi Parish, near Ārlava village, Latvia. It consisted of two "ships" connected together. Archaeological excavation of Mušiņas stone ship setting was undertaken in 1874 by Theodor Burchard.[214] Various urns and pottery sherds were found in the course of excavation. Unfortunately, precise dating of the site is not possible due to the lack of datable material.

[211] VELLO LÕUGAS. Sõrve laevkalmed. In: Studia Archaeologica in memoriam Harri Moora. Tallinn, 1970.

[212] Ibidem.

[213] JOAKIM WEHLIN. Östersjöns skeppssättningar…

[214] ĒVALDS MUGURĒVIČS, ANDREJS VASKS (sast.). Latvijas senākā vēsture. 9. g. t. pr. Kr. – 1200. g. Rīga, 2001, 400. lpp

3. MATERIAL AND METHODS

As mentioned above, the thesis is strongly based on material sources, namely archaeological pottery and clay. Due to their nature, these sources on their own cannot answer the question posed in this study. Thus, in order to achieve the aim of the thesis, several different methods were used. These methods can be divided into **three** groups: 1) survey and sample selection – this group includes fieldwork and preparation of the selected samples; 2) contextual, spatial and visual analysis – this group includes all of the basic analysis used in pottery studies as well as photogrammetric analysis; 3) laboratory techniques – this group includes all analysis which requires laboratory work and equipment.

3.1. Material

Before describing the methodology, it is essential to describe the condition of the material and the problems regarding analysis of the clay resources and pottery assemblages. As mentioned above, two types of material are analyzed in this study: pottery and clay. As each of these materials have different problems and characteristics, they are described separately.

3.1.1. Pottery assemblages

The condition of the pottery assemblages depends on various aspects: 1) disturbance to the cultural layer. On those sites, especially hillforts, which have been inhabited for a long period, later construction of ramps and defensive systems has disturbed the lower cultural layer. The same kind of disturbance can be caused by agricultural work or military trenches; this has happened on various sites before their inclusion in the list of cultural monuments as well as through the activities of metal detectorists, which have particularly affected burials. As a result, pottery vessels can be partly or completely crushed and broken into pieces, or in the worst case dug out of their context (burials, buildings, hearths and waste pits); 2) Quality of the excavations and reports. As with other sciences, archaeology and its methodology have developed over time. The quality of the excavations in the Baltic region in the 19th century, carried out by amateurs, was, with some exceptions, quite poor in terms of excavation and documentation. “Uninteresting” artefacts, including pottery, were often just discarded. As a result, the context of the pottery or other “uninteresting” artefacts was lost, therefore making it impossible to interpret the role of these finds and the processes involving them. 3) Impact of War. During the wars, especially World War II, a large number of artefacts were lost. For example, all the material from the excavated stone ship settings of the 19th century, except for

Mušiņas, has been completely lost. Nowadays the data regarding these artefacts can, in the best case, only be obtained from a few publications and photographs from the interwar period.[215]

Although all of the above-described factors apply to a greater or lesser degree to all of the analyzed assemblages, their overall condition is good. All of the habitation-site assemblages mainly consist of large or fairly large sherds; only a few whole vessels have been recovered. The situation is better in the case of burial pottery, especially where there was a tradition of urns: most of them are either whole or else can be reassembled as whole vessels, and therefore can be very well restored, as is the case with vessels from Mušiņas stone ship setting, Bašķi, Ėgliškiai barrow and Paveisininkai flat cemetery. The Early Bronze Age Post-Corded Ware can be considered most problematic for overall analysis, since it has rarely been found and is in very fragmented condition. Only in a few cases is it possible to distinguish more or less precise morphological traits, for example in the material from Kvietiniai, Tojāti and Vampenieši settlements.

Due to the nature of pottery as class of archaeological finds (recovered from living sites in massive amounts), detailed analysis was undertaken on sherds from vessel rims and bases with specific parameters, chosen as follows: known context (location, trench, layer and approximate chronology), and distinguishable surface treatment, shape and wall thickness. Pottery fragments (including sherds from the base of the vessel) with distinguishable coiling technique and rim diameter as well as ornamentation were also studied, if they could be distinguished in the assemblage.

3.1.2. Clay resources

Clay is one of the most abundant resources in the Eastern Baltic region, differing in terms of the amounts available, the clay types and qualities within this region.[216] As potters most likely used small nearby clay deposits, including till clays, in pottery production the

[215] For example: EDUARDS ŠTURMS. Die ältere Bronzezeit im Ostbaltikum. Walter de Gruyter, 1936.

[216] See ANTO RAUKAS, KALJU KAJAK. Quaternary cover. In: ANTO RAUKAS, AADA TEEDUMÄE (eds), Geology and mineral resources of Estonia,. Tallinn, 1997, pp. 125–136; VISVALDIS KURŠS, AUSTRA STINKULE. Māli Latvijas zemes dzīlēs un rūpniecībā. Rīga, 1972; RIMANTĖ GUOBYTĖ. A revision of the Quaternary geological maps at a scale 1:50 000. In: Lithuanian Geological Survey Annual Report 2010, 2011, pp. 20–21.

main attention in this study is given to the study of small clay beds in the surroundings of the living sites.[217]

Distinguishing the clay sources and potentially utilised clay resources during the Bronze and the Pre-Roman Iron Age involves several problems: 1) Clay is an exhaustible resource. Therefore, if the clay bed was small enough, potters could have used it up completely, making it impossible to locate and analyze nowadays; 2) Mixing clays. In various ethnographic and archaeological studies, it has been proved that potters often mixed various clays for producing ceramic vessels,[218] making it quite impossible to trace the clay resources used, even if they still exist; 3) Changes in the environment. Over time, quite many changes have happened in the surroundings of the archaeological sites, mostly relating to construction work. The largest-scale changes have been caused by the construction of hydroelectric power plants, especially the cascade of power stations on the Daugava,[219] which has flooded extensive areas. For example, a large part of Dole Island and the whole of the nearby island Mārtiņsala are nowadays underwater. As a result, possible clay sources in these territories have been lost.

Although the above-described problems significantly affect research on clays, it needs to be stressed that even if the clay sources actually used are not found, it is still possible to characterize trends and clay availability and make comparisons with the clay matrix of the pottery. Importantly, mineralogical tendencies distinguished in the surrounding clays can also provide meaningful information regarding the regional mineralogical tendencies in clays, which helps in pottery provenance studies. For further analysis, clay samples were taken, if the material was plastic enough to potentially enable the building of vessels.

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[217] OWEN RYE. Pottery Technology: Principles and Reconstruction. Manuals on Archaeology, No. 4. Taraxacum, Washington, 1981, pp. 12–13

[218] DEAN ARNOLD, HECTOR NEFF, RONALD BISHOP. Compositional Analysis and "Sources" of Pottery: An Ethnoarchaeological Approach. In: American Anthropologist, 1991, vol. 93(1), pp. 75; VANDA VISOCKA. Late Bronze and Pre-Roman Iron Age Pottery in the Lower Reaches of River Daugava. In: MARKO MARILA MARJA AHOLA, KRISTIINA MANNERMAA, MIKA LAVENTO (eds). Interarchaeologia 6: Archaeology and analogy. Papers from the eighth theoretical seminar of the Baltic archaeologists (BASE) held at the University of Helsinki and tvärminne zoological station, Hanko, Finland, November 30th–December 2nd, 2017. Helsinki, 2020, 88)

[219] The cascade consists of three hydroelectric plants: Riga (constructed 1966–1975), Ķegums (1936–1939) and Pļaviņas (1959–1965).

3.2. Survey and preparation of clay samples

In order to study possible pottery provenance and clay resource availability in the area of the living sites, as well their physical tendencies and appropriateness for pottery production, the study of clay resources is crucial. Accordingly, clay beds in the surroundings of the living sites were surveyed and sampled. The collected clays were subsequently analyzed petrographically using the thin-sectioning method and WD-XRF.

3.2.1. Survey

The environmental characteristics and trends of the clay beds are crucial in pottery production and provenance studies. Various types of clay beds – Quaternary (till and glaciolacustrine clays), Devonian etc. – were surveyed and samples collected for further analysis. Clay is one of the most common resources in the Eastern Baltic. The large Quaternary clay deposits, such as Lielauce and Brocēni etc., which are suitable for mass production, have been widely studied.[220] However, for small clay deposits with various clays, less usable for large-scale production, the state of research varies. Although there have been quite detailed studies on resources available in different regions and surveys intended to find clays for mass production, detailed studies and mapping of small clay beds and till clays, relevant to resource availability in prehistory, are lacking.

Due to the large extent of the study region (the Eastern Baltic), preliminary study of regions of interest was undertaken and several criteria for the survey were set. The preliminary study includes analysis of the topography and reports of the geological surveys, which are nowadays stored in the Geology Collections of the Latvian Environment, Geology and Meteorology Centre (*Latvijas Vides, ģeoloģijas un meteoroloģijas centrs*), the Lithuanian Geological Survey (*Lietuvos geologijos tarnyba*) and the Geological Survey of Estonia (*Eesti Geoloogiakeskus*).[221] It also involves analysis of previous studies, which includes questions relating to ethnographic and folklore material regarding pottery and clay beds used in pottery production in the Eastern Baltic.[222] Communication with locals was also part of the survey work, and if clays were found, then permission to take samples was sought from the landowner.

[220] VISVALDIS KURŠS, AUSTRA STINKULE. Māli Latvijas zemes dzīlēs…

[221] A detailed description of the survey materials is given in the chapter "Review of sources and literature".

[222] See V. JULLA. Māla trauku rūpniecība vidzemē. In: Austrums. J. Ozola grāmatu spiestuve, 1903; BAIBA DUMPE. Podniecība Latviešu folklorā. In: Kultūras Krustpunkti, 2006, nr. 3. Rīga, 2006, 32–43. lpp

The surroundings of the living site (except for the monument protection zone) in an approximate radius of 10 km were also surveyed, including nearby exposed fields and riverbanks. A 10 km radius was chosen based on the ethnographic analogies drawn from various ethnoarchaeological surveys by Dean Arnold, from which he concluded that potters mostly used resources within 10 km of the living site, reaching a maximum of 50 km if no resources are available closer.[223] The rest of the survey regions included riverbanks and lakeshores (Daugava, Lubāns), and in some cases the seacoast (Labrags and Jūrkalne) was also surveyed. Folklore provides indications that clay has been transported (and therefore probably also collected) along rivers, thus making these regions of interest.[224] In some cases, it was possible to sample clay from archaeological sites, for example during excavation (Asva hillfort and Abora I settlement).

Clay beds found in the course of surveys were documented photographically, the depth of the clay bed was recorded, the characteristics *in situ* were described and the colour of the clay was determined using the Munsell soil colour chart, in addition to which the coordinates of the location were taken. Approximately 0.5 to 1 litre clay samples were collected for further analysis.

3.2.2. Processing of clay samples

The collected clay samples were air dried for approximately two[225] weeks and afterwards made into clay briquettes for further laboratory analysis.

It is impossible to compare raw clay with pottery, as the former has not been subject to the chemical and mineralogical alterations caused by the process of firing ceramics.[226] Therefore, clay needs to be prepared in the form of clay briquettes and fired in similar conditions. This was done in accordance with the clay analysis standard set out by Ann S. Cordell[227] with a few modifications by the author. Clay briquettes were made as follows:

1) Dry clay samples were ground into powder. In this process all of the impurities (rocks and weeds), larger than approximately 2 mm were taken out manually.

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[223] DEAN ARNOLD. The Threshold Model for Ceramic Resources: A Refinement. In: Ceramic Studies: Papers on the Social and Cultural Significance on Ceramics in Europe and Eurasia from Prehistoric to Historic Times, BAR International Series. 2006, pp. 5

[224] BAIBA DUMPE. Podniecība Latviešu folklorā…, 37. lpp

[225] Some of the clay samples, due to their characteristics, took less than or more than two weeks to dry.

[226] MARK POLLARD, CARL HERON. Archaeological chemistry. Cambridge, 1996, pp. 105–107, 122–134

[227] ANN CORDELL, NEIL WALLIS, GERALD KIDDER. Comparative Clay Analysis and Curation for Archaeological Pottery Studies. In: Advances in Archaeological Practice, 2017, no. 5(1), pp. 93–106

2) The powder was mixed with distilled[228] water until it was plastic enough to create a clay briquette. The briquette was weighed in wet condition and its colour determined using the Munsell soil colour chart. The briquettes were left to dry for 24 hours and then heated in a drying oven at 100°C for one hour.

3) After cooling down, the briquettes were fired in an oven at fixed temperatures from 100 °C to 700°C, slowly increasing the heat by 150°C every hour.[229] They were left in the oven for 12 hours to slowly cool down together with the oven.

4) When the samples had cooled, they were weighed and the Munsell colour determined.

In the process of briquette preparation, clay plasticity and texture were observed by "feel". It is important to note that these kinds of observations of the clay properties are subjective and based on the author's perception. Collection of clay samples and preparation of briquettes were done by the author.

3.3. Contextual, spatial and visual analysis

3.3.1. Context and spatial analysis

One of the most commonly used approaches in pottery studies, applied in order to interpret the role of the vessels in the prehistoric communities, is analysis of their context and spatial distribution, i.e. study of the ceramics *in situ*. Accordingly, this kind of analysis was used only to analyze pottery from living sites and burials, as it is not possible to analyze the context and spatial distribution of stray finds. Regarding study of the context and spatial analysis of the **pottery from living sites**, the following principles were used as a basis: a) distribution of the sherds and/or whole vessels in relation to the spatial layout of the site; b) the relationships of vessels to features (hearth pits, houses etc.); c) the relationships of vessels to other artefacts. The **burial pottery** was studied according to the following principles: a) characteristics of burial; b) vessel placement in the burial; c) the relation to grave goods and humans.

Archaeological excavation reports, including photographs, were analyzed (as described in detail above) to determine the context and spatial distribution. Precise, detailed

[228] Distilled water was used in order to not alter the chemical composition of the clay samples, as they were subsequently analyzed by WD-XRF.

[229] The temperature of 700°C was chosen, as this is the approximate firing temperature of pre-wheel pottery. It should be noted that this does not indicate that all of the vessels were fired at this temperature, as they would not have been fired in a kiln but rather using a pit firing technique, where temperatures can vary, as they cannot be controlled so easily.

and well-recorded archaeological reports are crucial for this study; therefore, vaguely reported settlements and burials with no definite location coordinates and stratigraphy were not analyzed.

3.3.2. Analysis of techno-stylistics

The term *techno-stylistic analysis* is used here to refer to the grouping and classification as well as statistical analysis of various outward features of the vessels, such as tempering, surface treatment, wall thickness, building techniques as well size and shape.

Temper was measured only for granitic rock added to the clay paste. For statistical analysis, the largest grain size was measured in the clay paste; thus, it is possible that the vessel had smaller-sized grains in the paste as well. However, trends in the clay paste overall are considered: if the temper grain was not accidental, i.e. there was more than one grain of similar size, then the largest grain was counted in the statistics. Grain sizes are divided into five groups, from fine (2–4 mm) and medium (4–6 mm) to extra coarse (10–12 mm). The grouping of grain sizes requires some explanation. It may seem that the size groups overlap, but this is not the case. For example, all grains from 2 to up to 4 mm are counted as belonging to the class of fine grains, while medium-sized grains include those larger than 4 mm (starting from 4.1 mm) up to 6 mm, etc. Finally, grain size was measured for the sherds analyzed in detail, such as vessel rim sherds.

There are two approaches among archaeologists towards the primary classification of the vessels: they are classified either according to **surface treatment** (end result of the processed surface) or according to **ware** (a set of several vessel features: shape, size, surface treatment, tempering tendencies, etc.). Regarding the Early Bronze Age, archaeologists mostly use classification by pottery wares: Lubāns type, Kvietiniai-Tojāti Ware etc.[230] The situation is different in the studies of Late Bronze and Pre-Roman Iron Age pottery. Latvian and Lithuanian archaeologists prefer using a classification by surface treatments, since the dominant striated pottery is quite uniform, changing little between different regions.[231] On the other hand, Estonian researchers mostly use ware systems.[232] It is significant in this regard that the vessels which occur on Late Bronze and the Pre-Roman Iron Age sites in present-day

[230] ILZE LOZE. Pozdnij neolit…; ANDREJS VASKS. Keramika epokhi pozdnej bronzi…; ROKAS VENGALIS et al. The Large-Scale Rescue Excavation…

[231] ANDREJS VASKS. Keramika epokhi pozdnej bronzi…; ELENA GRIGALAVIČIENE. Žalvario ir Ankstyvasis Geležies Amžius Lietuvoje. Vilnius, 1995.

[232] VALTER LANG. The Bronze and Early Iron Ages; UWE SPERLING. Aspekte des Wandels…

Estonia have a wider variety of surface treatments (textile and polished) as well as a specific, distinctive set of characteristics.[233] Therefore, it is reasonable to use a ware system if the main focus is Estonian material. Regarding the Early Bronze Age, in this study ware systems will be used, as pottery from this period is characterized on the basis of several different features. On the other hand, regarding the Late Bronze and Pre-Roman Iron Age, the author has chosen to use a surface-treatment system, as it seems most appropriate for comparing tecno-stylistics and distinguishing possible regions of influences in the Eastern Baltic.

Similar problems are encountered in the classification of the **profile forms** of the vessels. In the first place, the characteristics of the pre-wheel pottery vessels themselves, i.e., the shape of the vessel sides, as built up manually, can differ even on a single pot.[234] Therefore, it is easy to misinterpret vessel morphology if the sample is too fragmentary, or else it can be problematic to assign the vessel to a particular group. Secondly, almost every researcher studying archaeological pottery has created their own specific system.[235] However, most Eastern Baltic researchers[236] are have based their profile shape classification system on that created by Rimutė Rimantienė (I and C – barrel-shaped vessels; CS and S – curved vessels).[237] The author likewise uses a system based on Rimantienė's classification, with additions by herself and Vasks.[238] The additions and corrections are as follows: 1) for barrel-shaped vessels subcategories I and C have been merged into the category IC, as it is often difficult to distinguish these vessels when the sample is not big enough;[239] 2) two additional shapes have been added from Vasks' studies: IK and K (biconical vessels), as there are vessels distinguished by a carination at the shoulder.

Regarding the building of pre-wheel pottery vessels and its classification, it is important to note that there are two steps in building the vessel: 1) coiling and 2) modelling (inner and

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[233] VALTER LANG. Late Bronze and Pre-Roman Iron Age pottery styles in Estonia. In: MERVI SUHONEN (ed). Lightning the darkness – the attraction of archaeology. Papers in honour of Christian Carpelan. Helsinki, 2006, pp. 122–136

[234] CLIVE ORTON, PAUL TYERS, ALAN VINCE. Pottery in archaeology. Cambridge, 1993, p. 77

[235] VALDIS BĒRZIŅŠ. Sārnates apmetnes keramikas klasifikācija un statistiskā analīze. In: Arheoloģija un Etnogrāfija, 2003, nr. 21, 54.–55. lpp; Vello Lõugas system presented in UWE SPERLING. Aspekte des Wandels…, pp. 180–190

[236] ANDREJS VASKS. Keramika epokhi pozdnej bronzi…; ELENA GRIGALAVIČIENĖ–DANILAITĖ. Shtrihovannaja keramika v Litve (nekotorije Dannie po voprosam ob etnogeneze litovcev). Vilnjus, 1967

[237] RIMUTĖ RIMANTIENĖ. Die Steinzeitfischer an der Ostseelagune in Litauen. Vilnius, 2005, p. 45

[238] ANDREJS VASKS. Keramika epokhi pozdnej bronzi…, s. 21

[239] VALDIS BĒRZIŅŠ. Sārnates apmetnes keramikas klasifikācija…, 55. lpp

outer surface).[240] Unlike other typologies, the typology of **coiling techniques** is internationally recognized by researchers, i.e. there is only one system. Therefore, the author will also use this typology. There are three types of coiling techniques: H, N and U. The H technique involves pressing the fingers into the upper or lower surfaces of the coils, creating a "straight" surface between the coils which in profile resembles the letter "H"; this technique has been identified only in Ertebølle pottery.[241] In the N technique coils were smoothed in opposite directions, creating a slanting distortion.[242] In U technique, both sides of the clay band are smoothed downwards, creating an upside down or upright U-shaped distortion.[243] As modelling traces are generally uniform (simple finger pressure and pulling), a descriptive approach is used in this study.

For uniform statistical analysis, recording of properties followed Birgitta Hulthén's instructions regarding pottery documentation,[244] with a few modifications by the author, as follows: 1) sherds from one vessel were counted as one unit; 2) as wall thickness varies in the vessel, in this study the thickest part of the wall was measured, thereby creating comparable data; 3) height was measured only for whole and restored vessels; 4) macroscopic remains, such as crust and soot preserved on pottery, were recorded, as these provide information regarding the function of the vessels. All of the obtained measurements were analyzed statistically.

3.3.3. Reflectance transformation imaging

Reflectance transformation imaging (RTI) is a photographic method that captures surface texture and colour by photographing a fixed artefact and illuminating it from different

[240] HÉLÈNE PIOFFET, VINCENT ARD. From sherds to potters: The contribution of techno-morphological approaches to understanding the British Neolithic. In: Archeologicke Rozhledy, 2017, vol. 69(2), p. 288

[241] VASILIKI PAPAKOSTA, OLALLA LÓPEZ-COSTAS, SVEN ISAKSSON. Multi-method (FTIR, XRD, PXRF) Analysis of Ertebølle Pottery Ceramics from Scania, Southern Sweden. In: Archaeometry, 2020, vol. 62(4), p. 679

[242] BAIBA DUMPE. Jauni atzinumi par neolīta klājošās auklas keramiku. In: Arheoloģija un Etnogrāfija, 2003, nr. 21, 2003, 116. lpp; KLÁRA NEUMANNOVÁ et al.. Variability in coiling technique…, p. 174

[243] BAIBA DUMPE. Jauni atzinumi…, 115; KLÁRA NEUMANNOVÁ, JAN PETŘÍK, IVANA VOSTROVSKÁ, PETR DVOŘÁK, TOMÁŠ ZIKMUND, JOZEF KAISER. Variability in coiling technique in LBK pottery inferred by experiments and pore structure micro-tomography analysis. In: Archeologické Rozhledy, 2017, vol. 69, p. 174

[244] BIRGITTA HULTHÉN. On documentation of pottery. Acta archaeologica Lundensia: Series in 8º minore. Lund, 1974

angles with a known light source; using RTI software to create a three-dimensional virtual surface topography of the artifact from multiple photographs combined.[245] It is also possible to virtually change the light source, without affecting the topographic and colour information of the sample, in order to detect the contrast between details of the artifact's surface texture.[246] Thus it is possible to analyze the texture of the artifacts in more detail.

In this study, RTI was primarily used to analyze different pottery surface treatment textures and imprints, such as cord-impressed, textile, striated and early rusticated, in order to study the technological aspects of their application. RTI was also used to analyze and identify topographic models of different impressions on the surface of pottery and clay workpieces found in living sites and burials, such as seed impressions. Due to the characteristics of seed impressions (they are "negatives" of the original), moulding clay was used in order to obtain a positive, subsequently creating an RTI model for further analysis.

In this study the highlight RTI image-capture method was used. This method allows the photographs to be taken without using a fixed lighting rig, which is more precise, but unfortunately is costly and not currently available. Visualizations of the samples were made by following the cultural heritage imaging (CHI) guidelines for RTI highlight image capture.[247] An SLR camera (for surface treatments) and a USB microscope (for seed imprints) were used to take photos with manually set focus and exposure. The light source was attached to a pole and moved in a "hemisphere" around the sample. A metal sphere was placed next to the sample in each shot, in order to enable the software to determine the angle of light in the recorded image, and a colour chart and neutral greys with known values were used for colour balancing and adjusting the exposure. Each sample was illuminated from different directions at angles of 15°–65° to the horizontal plane, with additional angles appropriate to the specific characteristics of the sample, creating 30–60 photos for each sample. All illumination angles were at a manually fixed distance: about 60 cm for

[245] HAROLD MYTUM, JOHN PETERSON. The Application of Reflectance Transformation Imaging (RTI) in Historical Archaeology. In: Historical Archaeology, 2018, vol. 52. p. 490; MARK MUDGE, MARLIN LUM, CARLA SCHROER, TOM MALZBENDER. Reflectance Transformation Imaging: Guide to Highlight Image Capture, v2.0. Cultural Heritage Imaging, 2013, pp. 1–32. Available from: http://culturalheritageimaging.org/What_We_Offer/Downloads/Capture/index.html (seen: 15.02.2021.)

[246] SILVIA MANRIQUE TAMAYO, ANDRES VALCARCEL, PONS OSCA. Applications of Reflectance Transformation Imaging for Documentation and Surface Analysis in Conservation. In: International Journal of Conservation Science, 2013, no. 4, p. 537

[247] MARK MUDGE et al. Reflectance Transformation Imaging…

macroscopic objects and about 30 cm for macroscopic objects. *RTIBuilder* was used for image processing and *RTIViewer* for viewing the results, both software programmes written and provided by CHI. RTI and creation of the models was performed by the author.

3.4. Laboratory techniques

3.4.1. Ceramic petrography

In order to study ceramic fabric in detail, ceramic petrography was undertaken, using thin section analysis under a polarizing microscope. Ceramic petrography is geology-based analysis of non-plastic inclusions or tempering materials (minerals, rocks and organics), microstructure of clay paste, porosity as well as slips, glazes, paints and other such remains in pottery and technical[248] ceramics.[249] In geology, thin sections are made from rocks and minerals, while in archaeology they are prepared from ceramic artefacts. According to the standard, they have to be 0.03 mm thick in order to reveal the specific optical characteristics of rocks and minerals, thereby enabling identification.[250] There are two approaches to thin section analysis: 1) **qualitative**, which concentrates on identification of the inclusions and temper in the paste, and 2) **quantitative**, using measures of aplastic inclusions, such as size and temper volume and percentage of natural impurities in the sample.[251] The author, like other ceramologists, studies thin sections using both of these approaches, as this is the best way of characterizing and identifying differences in the tempering of wares.

For petrographic analysis, pottery sherds and clay briquettes were selected and thin sections prepared. Since the process of thin section preparation involves partly destroying the sample (cutting and grinding), samples were chosen carefully. Pottery samples for petrographic analysis were chosen according to the principle of known context, surface treatment and wall thickness. Choice of the samples was semi-random: the author concentrated on choosing sherds exhibiting the most common surface treatment and with no

[248] Technical ceramics are a group of clay artefacts which do not function as household vessels, such as crucibles, moulds, loom weights, daub, etc.

[249] DENNIS BRAEKMANS, PATRICK DEGRYSE. Petrography: Optical microscopy. In: ALICE HUNT (ed), The Oxford handbook of archaeological ceramic analysis, Oxford, 2016, p. 234; PATRICK QUINN. Ceramic petrography: The interpretation of archaeological pottery and related artefacts in thin section. Oxford, 2013, p. 4; JAMES STOLTMAN. The Role of Petrography in the Study of Archaeological Ceramics. In: PAUL GOLDBERG, VANCE HOLLIDAY, REID FERRING (eds). Earth Sciences and Archaeology. 2001, p. 297

[250] DENNIS BRAEKMANS, PATRICK DEGRYSE.. Petrography: Optical microscopy…, p. 237

[251] JAMES STOLTMAN. The Role of Petrography…, pp. 301–307

particular macroscopic tempering tendencies. Rare, unique and fragile fragments of the vessels were not chosen for petrographic analysis. Importantly, the author mainly selected sherds from the body of the pottery vessels, rarely choosing part of a rim. With a few exceptions, thin sections were made from all of the clay briquettes, in order to compare mineralogical characteristics.

The protocol for thin section preparation, with a few additions by the author, is based on that set out by Patrick S. Quinn in *Ceramic Petrography* […].[252] The selected sherds were cut with a diamond saw (500 rpg/min) in a vertical position towards the rim or putative direction of the rim; in the case of a clay briquette, a small slice was cut. The cut surface chosen for analysis was impregnated with epoxy resin, previously heated to 50°C for 15 minutes. Afterwards the surface was ground and polished with silicone carbide powder (abrasives: 150–800 grits) and glued to the microscope slide. Then the sample was cut, leaving a 1–2 mm thick slice, and manually ground with silicone carbide powder (abrasive: 800 grits) until it was 30 microns thin. Thin sections were analyzed using petrographic microscopes *Bresser Science MPO 401* and *Leica DM4500 P*. Thin section preparation and analysis were carried out by the author at the Faculty of Geography and Earth Sciences, University of Latvia.

3.4.2. X-ray fluorescence-wavelength dispersive spectrometry

In order to study and group pottery by its chemical composition, X-ray fluorescence-wavelength dispersive spectrometry (WD-XRF) was used. WD-XRF is an analytical technique which uses X-rays to obtain chemical compositional data from an object.[253] Samples for WD-XRF analysis were chosen randomly from the same sherds analyzed using ceramic petrography, in a few cases analyzing additional unique samples. All clay briquettes were analyzed by WD-XRF.

A non-destructive approach, by irradiating the surface of the selected samples, was used for pottery and clay, in order to compare them to unique and fragile samples, where a destructive approach was not used. Therefore, no particular preparation of the samples before analysis was needed. A *Brucker S8 Tiger* spectrometer was used, with a sample holder size of surface irradiation of 8 mm. Oxide full analysis in a helium atmosphere was carried out.

[252] PATRICK QUINN. Ceramic petrography…

[253] For the physics and technical aspects of XRF see EDWARD HALL. X-ray fluorescence-energy dispersive (ED-XRF) and wavelength dispersive (WD-XRF) spectrometry. In: ALICE HUNT (ed), The Oxford handbook of archaeological ceramic analysis, Oxford, 2016, pp. 344–345, 350

Three measurements were taken for each sample, calculating the average value and sigma (standard error).

WD-XRF was performed by the author at the Faculty of Chemistry, University of Latvia, under the supervision of chemists Anna Trubača-Boginska and Artis Kons. Data analysis by agglomerative hierarchical clustering using the Ward linkage method and PCA analysis from average values of element concentration in the samples was carried out by the author.

3.4.3. Radiocarbon dating by accelerator mass spectrometry

In order to determine the chronology of different styles of ceramic vessels, radiocarbon dating by accelerator mass spectrometry (^{14}C AMS) was used. It is possible to date the radioactive carbon isotope ^{14}C, because it is absorbed into the molecular structure of live organisms, and as carbon isotope atoms decrease at a specific rate, this makes it possible to determine when the specific organism died.[254]

The AMS method of direct ^{14}C isotope counting is widely used, as it is more precise and a smaller amount of material (around 1 mg) is needed to perform the analysis.[255] Mostly food crust left from cooking pottery was analyzed by ^{14}C AMS, and only in two cases (Vampenieši settlement and Klosterkalns hillfort) was charcoal dated, as no crust was found on pottery. Food crust from the selected pottery samples was removed using a clean scalpel and placed in aluminium foil. The sample amount depended on the amount of food crust preserved on the vessels (0.01–1 g).

The selected samples were sent to the Poznań Radiocarbon Laboratory Foundation of the A. Mickiewicz University for ^{14}C AMS dating. Calibration of ^{14}C age was performed using the program OxCal 4.2 (2014), as described by Christopher Bronk Ramsey, and for the

[254] ROBERT HEDGES, JOHN GOWLETT. Radiocarbon Dating by Accelerator Mass Spectrometry. In: Scientific American, 1986, 254 (1), p. 100

[255] WALTER KUTSCHERA. Accelerator mass spectrometry: state of the art and perspectives. In: Advances in Physics, 2016, no. X, 1, 4, p. 575

recent version by C. Bronk Ramsey and Sharen Lee.[256] Calibration was performed using the latest version of the ^{14}C calibration curve, i.e. IntCal20.[257]

3.4.4. Organic residue analysis

In order to determine the primary use of the vessels (cooking, storage ware etc.) organic residue analysis was used together with contextual analysis. The term "organic residues" is understood to mean the group of "carbon-based remains of plants, animals, or humans, either in their original or a decomposed state".[258] This group includes lipids, alkaloids, carbohydrates, proteins as well as DNA and other biopolymers.[259] The organic residues which occur in archaeological ceramics mainly consist of lipids, proteins and carbohydrates.[260] There are two types of remains preserved on and in the pottery: 1) macro-remains (also known as visible remains), which consist of food crust and/or soot, and, if preserved, the actual contents of the vessel (for example, porridge). These types of remains are mainly distinguished on cooking pottery; 2) absorbed remains (also known as invisible remains). Such remains are created when a substance has been heated in the vessel and in

[256] CHRISTOPHER BRONK RAMSEY. Development of the Radiocarbon Calibration Program. In: Radiocarbon, 2001, 43(2A), pp. 355-363, CHRISTOPHER BRONK RAMSEY. Bayesian Analysis of Radiocarbon Dates. In: Radiocarbon, 2009, 51(1), pp 337-360; CHRISTOPHER BRONK RAMSEY, S. LEE. Recent and Planned Developments of the Program OxCal. In: Radiocarbon, 2013, 55, pp. 720-730

[257] PAULA J REIMER, WILLIAM E N AUSTIN, EDOUARD BARD, ALEX BAYLISS, PAUL G BLACKWELL, CHRISTOPHER BRONK RAMSEY, MARTIN BUTZIN, HAI CHENG, R LAWRENCE EDWARDS, MICHAEL FRIEDRICH, PIETER M GROOTES, THOMAS P GUILDERSON, IRKA HAJDAS, TIMOTHY J HEATON, ALAN G HOGG, KONRAD A HUGHEN, BERND KROMER, STURT W MANNING, RAIMUND MUSCHELER, JONATHAN G PALMER, CHARLOTTE PEARSON, JOHANNES VAN DER PLICHT , RON W REIMER , DAVID A RICHARDS, E MARIAN SCOTT, JOHN R SOUTHON, CHRISTIAN S M TURNEY, LUKAS WACKER, FLORIAN ADOLPHI, ULF BÜNTGEN, MANUELA CAPANO, SIMON M FAHRNI, ALEXANDRA FOGTMANN-SCHULZ, RONNY FRIEDRICH, PETER KÖHLER, SABRINA KUDSK, FUSA MIYAKE, JESPER OLSEN, FREDERICK REINIG, MINORU SAKAMOTO, ADAM SOOKDEO AND SAHRA TALAMO. The IntCal20 Northern Hemisphere Radiocarbon Age Calibration Curve (0–55 cal kBP). Radiocarbon, vol. 62 (4). 2020, pp. 725–757.

[258] HANS BARNARD, JELMER EERKENS. J. 2016. Assessing Vessel Function by Organic Residue Analysis. In: ALICE HUNT (ed), The Oxford handbook of archaeological ceramic analysis, Oxford, 2016, p. 625

[259] Ibidem.

[260] CARL HERON, RICHARD EVERSHED. The Analysis of Organic Residues and the study of Pottery Use. In: Archaeological Method and Theory, 1993, no. 5, p. 253

result soaks into the walls of the vessel.[261] Depending on the environment in which the sherds have lain and the chemo-physical characteristics of the organic residues, they can survive for a significant period of time.[262] By analysing biomarkers and isotopes of these remains, it is possible to identify the substance (animal, plant, fish based, resins, waxes, etc.) cooked or stored in the vessel.[263]

There are several approaches to organic residue analysis: macroscopic, elemental, chemical, etc. This study used biochemical analysis by GC-MS (gas chromatography mass spectrometry).

Organic residue analysis was performed on 25 samples from coastal and inland areas. Although the main focus was on pottery from living sites, in a few cases burial pottery was also analyzed (Bīlavas stone ship setting, Reznes barrow cemetery and Ķivutkalns flat cemetery). Analysis was done mostly from absorbed residues in vessel walls, while in rare cases (mainly burial pottery) food crust was analyzed instead. The analysis was carried out by Ester Oras at the *Archemy* laboratory at the Chair of Analytical Chemistry and Department of Archaeology, University of Tartu, Estonia.

Samples were prepared by the following procedures:[264]

1) Food crusts were removed using clean scalpels, and ceramic powder samples obtained from the internal surface of the sherds using clean drill bits by first removing and discarding the upper approximately 1 mm layer to avoid any post-excavational or storage-related contamination, and then drilling into the sherd, removing about 1–2 g of ceramic powder from an area of roughly 1 cm^2.

2) GC-MS analysis. Lipid extraction was conducted for about 1 g of ceramic powder or about 20 mg of food crust, using the acid-catalysed methylation procedure with methanol (MeOH) and sulphuric acid (H_2SO_4), followed by lipid removal with n-hexane (3×2 ml) according to previously reported procedures.[265] The extracted samples were dissolved in 100

[261] HANS BARNARD, JELMER EERKENS. J. 2016. Assessing Vessel Function…, pp. 635–636; CARL HERON, RICHARD EVERSHED. The Analysis of Organic Residues…, pp. 250–251

[262] CARL HERON, RICHARD EVERSHED. The Analysis of Organic Residues…, pp. 255–257; HISTORIC ENGLAND. Organic Residue Analysis and Archaeology. Guidance for Good Practice, 2017. Available: https://historicengland.org.uk/images-books/publications/organic-residue-analysis-and-archaeology/ (seen: 8.02.2022.)

[263] CARL HERON, RICHARD EVERSHED. The Analysis of Organic Residues…

[264] Information about the sample preparation procedure was provided to the author by Ester Oras.

[265] OLIVER CRAIG, HAYLEY SAUL., ALEXANDRE LUCQUIN, Y. NISHIDA, KARINE TACHE, LEONARD CLARKE., A. THOMPSON, DAVID ALTOFT, JUNZO UCHIYAMA, MAYUMI AJIMOTO,

ml of n-hexane with the addition of 10 µg of internal standard of C36 (n-hexatriacontane) to allow lipid quantification. GC-MS and -FID (flame ionization detector) analysis for detecting and quantifying different lipid components was conducted at the Institute of Chemistry (University of Tartu). An *Agilent 7890A Series* gas chromatograph and *Agilent 5975C* Inert XL mass-selective and FID detector with a DB5-MS (5%-phenyl)-methylpolysiloxane column (30 m × 0.25 mm × 0.25 µm) was used, dividing the injected 1 µl sample so that 1/10 was directed into the FID and the rest into the MS detector. The injector and interface were maintained at 300°C and 280°C, respectively, helium 6.0 being used as the carrier gas at a constant flow. The GC column was inserted directly into the ion source of the mass spectrometer. The ionization energy was 70 eV, and spectra were obtained by scanning between m/z 50 and 800 amu. The temperature programme was set as follows: 50°C for 2 min, thereafter a gradient of 10 °C/min up to 325°C, kept there for 14.5 min, with a total run time of 44 min. FID was kept at 260°C, with hydrogen flow of 30 ml min^{-1} and air flow of 400 ml min^{-1}. Compounds from MS runs were identified with *Agilent Chemstation* software using the NIST mass spectral library.

KEVIN GIBBS, SVEN ISAKSSON, CARL HERON, PETER JORDAN. Earliest evidence for the use of pottery. In: Nature, 2013, no. 496, pp. 351–354; CARL HERON, OLIVER CRAIG, ALEXANDRE LUQUIN, VAL STEELE, A. THOMPSON, GYTIS PILIČIAUSKAS. Cooking fish and drinking milk? Patterns in pottery use in the southeastern Baltic, 3300-2400 cal BC. Journal of Archaeological Science, 2015, vol. 63, pp. 33–43

4. POTTERY PRODUCTION AND MATERIALS USED

In this chapter the availability of the clay resources, their physical characteristics as well as the main tendencies in pottery production are reviewed and analyzed.

4.1. Clay deposits in the surroundings of the sites and their properties

Clay is one of the most readily available resources in the Eastern Baltic region. Numerous large Quaternary clay deposits occur in this region; there are also quite a large number of till clay and small Quaternary clay deposits in the surroundings of the living sites analyzed in this study. In this section the results of the clay surveys as well as their chemical and mineralogical properties are analyzed. The clay resources were surveyed only near the living sites, as this is where pottery production most likely took place. In this study, clays were surveyed near Sokiškiai, Antilgė, Grania I, Narkūnai and Mineikiškės hillforts in the Utena district of Lithuania; near Krievu kalns and Padure hillforts and from the coast at Labrags in the Kurzeme region of Latvia; in the Lower Daugava area of Latvia, between Klaņģukalns and Daugmale on left bank and Vīnakalns on right bank of the river; in the environs of Lake Lubāns, Latvia; one sample from Gotland, used by present-day potters; on Asva hillfort in Estonia, sampled during the 2019 excavation; and Abora I settlement, Latvia, sampled during the excavation in 2021.

4.1.1. Availability of clays

Clay is the most common and one of the most-researched raw materials in the Baltic states.[266] At least six clay deposits are usable for production in Estonia, more than 30 in Latvia and ten in Lithuania.[267] The distribution of glaciolacustrine sediments, which include clays, varies. In Latvia they are common in Kurzeme near the Venta River, mostly on its right bank, and near Lake Usma; they occur in the Zemgale region and in Riga District, as well as between the towns of Valka, Alūksne and Gulbene, and in the Latgale region (Jēkabpils town, Lake Lubāns etc.), thus more or less covering the whole country.[268] In Lithuania, glaciolacustrine sediments are most common in the south-western part of the country, and

[266] See ALGIMANTAS GRIGELIS, VALENTINAS KADŪNAS. Lietuvos Geologija: Monografija. Vilnius, 1994; VISVALDIS KURŠS, AUSTRA STINKULE. Māli Latvijas zemes dzīlēs…; ANTO RAUKAS, KALJU KAJAK. Quaternary cover…

[267] Ibidem.

[268] MĀLI LATVIJĀ. 2021. Available: https://www.lu.lv/vpp/arhivs/zeme/malu-petijumi/latvija/ (seen: 08.02.2022.)

between the cities of Vilnius, Kaunas and Tauragė.[269] In Estonia, they are most common in the north-eastern part of the country and in the vicinity of Iisaku and Illuka, but clay deposits, as such, occur on Saaremaa Island as well.[270]

Lower Daugava: In the Lower Daugava area the most common minerals are Devonian dolomite and gypsum; no Quaternary clay deposits are found in this area, except for till clay deposits, which are most easily accessible and usable for pottery production. On the other hand, the only studied clay deposit in the lower Daugava is the Devonian clay (marl clay) deposit of Dole Island. At the end of the 1940s, in connection with the plans to construct the Riga hydroelectric plant, several geological surveys and studies were carried out on Dole Island, including the Dole marl clay deposit.[271] Chemical analysis showed a relatively low SiO_2 concentration (28.29%) and very high concentrations of CaO (20.49%) and MgO (14.18%), which is typical for marl clays.[272] The Devonian clay of Dole Island is, in general, of medium plasticity due to the high concentration of carbonates.[273] Therefore, it is not very likely to have been used (or at least on its own) for prehistoric pottery production due to the high possibility of breakage during the firing process.

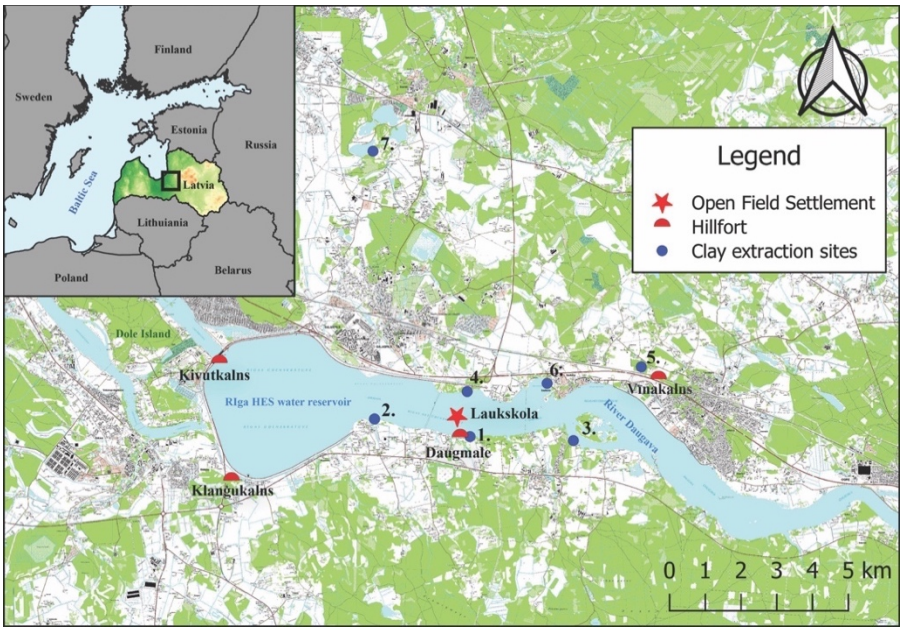

Figure 12. Surveyed area and location of the clays sampled: 1 – Daugmale, 2 – Dzintari, 3 – Nāvessala, 4 – Salaspils, 5 – Saulesdārzs, 6 – Saulkalne, 7 – Saurieši. Map from: https://kartes.lgia.gov.lv/ (Author: M. Kalniņš)

[269] LIETUVOS GEOLOGIJOS TARNYBA. Map, 2021
Available: https://www.lgt.lt/epaslaugos/elpaslauga.xhtml (seen: 08.02.2022.)

[270] ANTO RAUKAS, KALJU KAJAK. Quaternary cover…

[271] VANDA VISOCKA et al. Between mighty hillforts…

[272] KARLIS SKRASTINSH. Otchet o razvedke Dolessalskogo mestorozhdenjija mergeljei (kafelnjih gljini). 1948. In: Latvijas vides, ģeoloģijas un meteroloģijas centrs, Ģeoloģijas fonds (LVĢMC ĢF), Inv. Nr. 84, 52–53. lpp

[273] VISVALDIS KURŠS, AUSTRA STINKULE. Māli Latvijas zemes dzīlēs…, 43. lpp

Both banks of the Daugava were surveyed in an approximately 10 km radius of Riga hydroelectric plant (Fig. 12, Appendix II), where the living sites are concentrated. Ten samples from seven areas were collected. One clay sample (SRS1) was taken from the Saurieši gypsum deposit, where blue clays with gypsum and dolomite grains as impurities are characteristic.[274] This sample was chosen as a *statistical point* for petrographic and chemical analysis, as it is clear that this clay was not used in pottery production, as it is full of sharp gypsum needles and was located at the lower level of the excavated area (at ca. 15 m depth). All of the samples (except SRS1) collected were plastic reddish or reddish-brown till clays, generally containing small grains of feldspars, quartz and pebbles. In one case (SLKL1) the Daugava river had purified the clay (violet-brown, very plastic), cleaning it of all impurities.[275] These till clays were plastic and generally suitable for pottery production as well as being easily accessible, occurring either in the banks (DZI, DGM1, NAS1, SLKL) of the river or just under the sod (DGM2, SLD).

Kurzeme: the Kurzeme region is quite rich in Quaternary and to a lesser degree also Jurassic clay deposits. Out of 12 Quaternary clay deposits, five are located near the town of Saldus, while southern Kurzeme is richer in sand and gravel deposits. Jurassic formation clays are common in southern Kurzeme, quite near Krievu kalns hillfort (ca. 30 km distant).[276] The biggest clay deposit, at Pulvernieki, has been studied since the end of the 1940s.[277] Chemical analysis shows high SiO_2 (44.32–

Figure 13. Surveyed area and location of the clays sampled (1 – Labrags, 2 – Umuļi, 3 – Kuldīga radio station, 4 – Klūgas, 5 – Kalvene station. Map from: https://kartes.lgia.gov.lv/ (Author: V. Visocka).

[274] JŪLIJS EIDUKS, M. KALNIŅŠ. Latvijas PSR Derīgie izrakteņi un to izmantošana. Rīga, 1961, 351. lpp

[275] VANDA VISOCKA et al. Between mighty hillforts…

[276] JŪLIJS EIDUKS. Pētījumi par Latvijas PSR māliem. In: Latvijas PSR Zinātņu Akadēmija. Ģeogrāfijas un Ģeoloģijas Institūts. Raksi I, 1947, 233-234. lpp

[277] EDA RINKS. Pulvernieku Juras formācijas māli. In: Latvijas PSR Zinātņu Akadēmija. Ģeogrāfijas un Ģeoloģijas Institūts. Raksi I, 1947

61.17%) and high Al_2O_3 (20.99–22.36%) concentrations, making it plastic and appropriate for use in pottery production.[278] Moreover, the Pulvernieki clay deposit would hypothetically have been easily accessible to the inhabitants of Krievu kalns hillfort, as it is next to the River Letiža, a tributary of the Venta. Near Padure hillfort was the Padure Quaternary clay deposit, which the author was not able to locate. Chemical analysis shows a high SiO_2 (47.68–55.64%) and high Al_2O_3 (11.38–16.94%) and only a moderately high CaO (6.73–10.67%) concentration, making it usable for pottery production.[279]

Clays were surveyed within a radius of approximately 30 km around Krievu kalns hillfort, and about 10 km around Padure hillfort (Fig. 13, Appendix II). In total, six samples were collected from five locations. Although Kurzeme is quite rich in clay deposits, it was much harder to find small clay deposits, as the banks of the Venta river are not steep, making them impossible to survey, and detailed information regarding small clay deposits near the living sites is not available. After personal communication with locals, it was possible to find a clay deposit used for stove tile production during the Soviet period: Klūgas (KLG).[280] This clay deposit was located near Skrundas Krievu kalns hillfort, less than 5 km from it. One till clay sample was taken near Kalvene train station (KLV-ST), one in Kuldīga near the radio station (RDS), a Devonian clay was sampled from the coastal bluff at Labrags (JRN-M), and till clay was collected at Umuļi (UML) near Padure. In general, clay nowadays seems to be less readily available near Padure and Krievu kalns than in the Lower Daugava area.

Lake Lubāns: the Lake Lubāns plain is one of the regions where glaciolacustrine sediments are widespread, and this includes layers of clay and till clay. The Quaternary geology was studied in detail at the end of the 1940s.[281] On the Lake Lubāns plain three types of clays are common: 1) Upper Devonian red clay next to Lake Balvi and along the banks of the River Kurna; 2) lean till clay,

[278] EDA RINKS. Pulvernieku Juras formācijas māli…, 244-245. lpp

[279] V. VOLŠAKOVS. Kuldīgas rajona Padures māla atradnes meklēšanas un izpētes darbu pārskats. Rīga, 1963. Available: https://www.lu.lv/fileadmin/user_upload/lu_portal/projekti/vpp/Iegulas/Q/Padure.pdf (seen: 08.02.2022.)

[280] The deposits were named by the author after the nearest farms or other features.

[281] SERGEJS ILJINSKIS. Lubānas līdzenuma centrālās daļas kvartārģeoloģija. Rīga, 1949. In: LVĢMC ĢF, Inv. nr. 108.

used by locals to make stoves; 3) glaciolacustrine clay, which is suitable for brick production.[282] On the Lake Lubāns plain there are quite many small deposits of pure clay forming mounds in the till.[283] Significantly, the hill at Īdeņa where Brikuļi hillfort is located consists of glaciolacustrine sediments: the part facing the lake consists of sand, while the eastern part consists of glaciolacustrine clay.[284] A map provided by Sergejs Iļjinskis in his study shows that clay is common in the whole area surrounding Lake Lubāns.

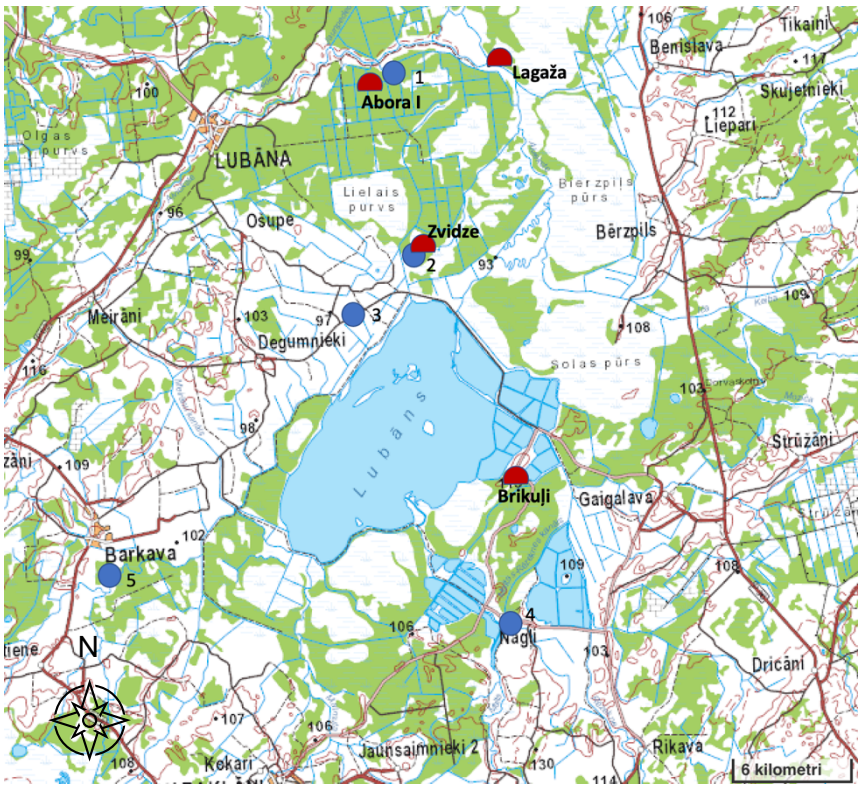

Figure 14. Surveyed area and locations of the clays sampled (1 – Abora I, 2 – Vilkanči, 3 – Liberti, 4 – Zvejnieki, 5 – Barkava). Map from: https://kartes.lgia.gov.lv/ (Author: V. Visocka).

A large surrounding area was surveyed near the living sites of the Lake Lubāns plain: in total, five samples were collected from five different locations (Fig. 14, Appendix II). One of the samples collected was from the bank of the River Abaine near Abora settlement (AB-M).[285] A sample was taken from Īdeņa, next to the Zvejnieki farm (ID-ZV); it was just under the sod and is used by locals to make bricks for stoves. A sample of clay was also taken from the Barkava clay deposit (BAR), which was likewise just under the sod and was used during the Soviet period for mass production of ceramics. About 3 km from the Zvidze settlement another clay sample was collected, from a deposit located near Vilkanči farm on the bank of the canal (VIL). The clay layer was under peat and marl, at a depth of approximately 2 m. Lastly, one clay sample was collected from a ploughed field near the Liberti farm (LIB), at a depth of about 50 cm.

[282] SERGEJS ILJINSKIS. Lubānas līdzenuma…, 50. lpp

[283] Ibid., 44. lpp

[284] Ibid., 45. lpp

[285] This sample was taken during the excavation in 2021 led by Dardega Legzdiņa and Eduards Plankājs.

Utena district: In the Utena district mainly peat and gravel deposits are common, with less sand and glauconite loam.[286] Clay deposits as such are not common in this region, and there are only two deposits – Dysna and Derviniai – where active studies have been carried out during the 1950s and 1970s.[287] These two deposits are quite far from each other and from the living sites analyzed in this region. Derviniai is about 50 km from Narkūnai, Garniai I and Mineikiškės hillforts, even more, about 50 km from Antilgė, Mineikiškės and Sokiškiai hillforts. The Dysna deposit is somewhat closer to Sokiškiai hillfort, at a distance of about 30 km, and about 50 km from the rest of the hillforts. Chemical analysis of Dysna shows high concentrations of SiO_2 (50.23–54.27%) and Al_2O_3 (16.11–19.87%), and low CaO (3.70–6.13%) concentrations, making it plastic and suitable for production.[288] Similar chemical results are seen in the analysis of clay from Derviniai: SiO_2 53.30–57.42%, Al_2O_3 12.78–16.49% and CaO 3.08–7.09%.[289] In accordance with the theory of Arnold,[290] it is possible that the people of these hillforts would have travelled so far for good-quality clay. But was it necessary to do so?

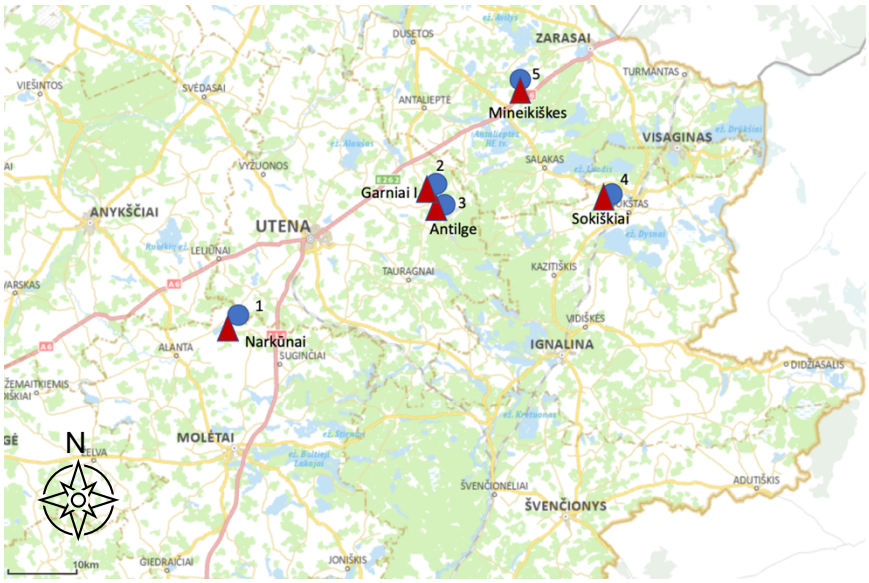

Figure 15. Surveyed area and location of the clays sampled (1 – Narkūnai, 2 – Garniai I, 3 – Antilgė, 4 – Sokiškiai, 5 – Mineikiškes). Map from: https://www.geoportal.lt/map/ (Author: V. Visocka).

[286] SKIRMANTAS SKRINSKAS, VYDA ELENA GASIŪNIENĖ, ALFREDAS LAURINAVIČIUS, IGORIS PODAGĖLIS. Lithuanian Mineral Resources, Their Reserves and Possibilities for Their Usage in Road Building. In: The Baltic Journal of Road and Bridge Engineering, 2010, 5(4), p. 220, Fig.1

[287] R. RAJESKAS. O Poiskah i razvedke glin mestorozhdenjija "Darvinaj" Objaljskogo raijona Lit. SSR. Vilnjus, 1953. In: Lietuvos geologijos tarnyba (LGT), Inv. no. 517; D. NENARTAVICHIENE, I. MOCKKJAVICHJUS. Svodnij otchet o detaljhoij razvedke mestorozhdenjija glini Disna i poiskovo-ochenochnim rabotam na gliny, prigodnuju dlja proizdvostva licevogo kirpicha v Ignalinskom rajone Litovskoj SSR. Vilnjus, 1979. In: LGT, inv. No. 3149

[288] D. NENARTAVICHIENE, I. MOCKKJAVICHJUS. Svodnij otchet o detaljhoij razvedke…, s. 51-52

[289] R. RAJESKAS. O Poiskah i razvedke glin mestorozhdenjija "Darvinaj"…, s. 55

[290] DEAN ARNOLD. The Threshold Model for Ceramic Resources…

Clay deposits in the vicinity of Narkūnai hillfort have been identified by stereoscopic analysis of the relief, and the hillfort itself was established on a clay promontory.[291] In geological surveys, four clay deposits were distinguished within a radius of 3 km from the hillfort (NA),[292] making it unnecessary to travel such far distances. A similar situation was observed when surveying the surroundings of Antilgė, Garnai I, Mineikiškės and Sokiškiai hillforts (Fig. 15, Appendix II). Near Antilgė hillfort, approximately 1 km from the hillfort, 50–80 cm under the sod, dark brown and dark blue plastic clays, possibly from Jurassic structures, were obtained (AN). At Garniai I the local till clays were also easily accessible near the hillfort, about 1 km from the site, just under the sod. One sample was also taken during the excavation of the hillfort in 2021 (GA). In the case of Mineikiškės hillfort, no clays were obtained in the surrounding area, only on the hillfort itself, where a sample of till clay was collected (MI). At Sokiškiai, only till clay full of pebbles and sand was obtained about 2 km from the settlement (SOK). Altogether, six samples were collected from five locations.

Saaremaa: Clay is very common in this region. Saaremaa has three large clay deposits, Kallemäe, Kuressaare and Valjala, all of which have been studied during the Soviet period.[293] Kallemäe has high concentrations of SiO_2 (45.46–46.99%) and Al_2O_3

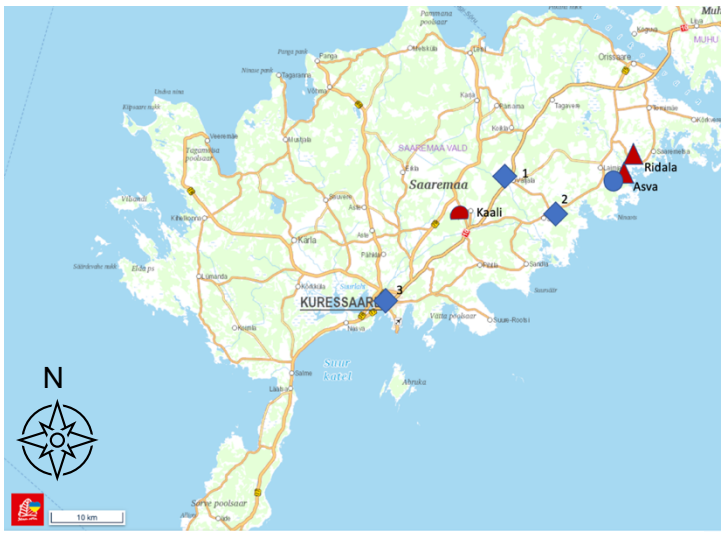

Figure 16. Location of the clay deposits in Saaremaa (1 – Valjala, 2 – Kallemäe, 3 – Kuressaare). Map from: www.balticmaps.eu (Author: V. Visocka)

[291] VANDA VISOCKA, VYTENIS PODĖNAS, UWE SPERLING. From the Seaside to the Inland: Comparing Late Bronze Age pottery production and styles in the eastern Baltic. In: DANIELA HOFMANN, ROBERT SCHUMANN, FRANK NIKULKA (eds). The Baltic in the Bronze Age – regional patterns, interactions and boundaries. Leiden, In print.

[292] VYTENIS PODĖNAS et al. Narkūnų piliakalnių ir papėdės gyvenvietės keramika…, p. 213

[293] N. DILAKTORSKIJ. Otchet. Rezultata fizikohimicheskah i laboratornih keramicheskih issledovanij chetireh obrazcov glin c ostrova Saaremaa. In: Eesti Geoloogiakeskus (EGK), inv.no. 1586 1950; N. DILAKTORSKIJ. Issledovanije sostava i voistje glin ESSR. Rezultati fizikohimicheskih i laboratornih keramicheskih issledovanij glin mestorozhdenija Kallemjae, Pilva, Viru, Vastselina, Sinka. Tallinn, 1951 In: EGK, inv.no. 2966; I. ELVRE, R. METS. 1958. aastal teostatud detailse geoloogilise luure lühikokkuvõte. Kiiu, 1961. In: EGK, inv.no. 3084

(15.91–16.80%) and low concentrations of CaO (6.34–7.67%) and MgO (3.59–3.68%).[294] Clay composition for Kuressaare is similar, with high concentrations of SiO_2 (51.3–46.7%) and Al_2O_3 (17.2–18.6%) and much lower concentrations of CaO (2.1–1%) and MgO (0.2–1.7%),[295] making these clay deposits usable for ceramic production. Unfortunately, there is no detailed chemical analysis for the Valjala clay, but it might still have been used for production

These clay deposits are quite close to the Asva, Kaali and Ridala living sites. Kallemäe is located about 16 km from Kaali and Ridala and about 10 km from Asva (Fig. 16, Appendix II).[296] Kuressaare is located quite far from Asva and Ridala, about 40 km, while Valjala is about 20 km from Asva and Ridala and about 13 km from Kaali. Thus, there is a strong possibility that people from Asva, Kaali and Ridala might have used the good-quality Kallemäe and Valjala clays for pottery production. Asva itself was located on till, where thick till clay layers are common, and it is also possible that in there are glaciolacustrine clay deposits nearby, although more detailed survey is needed to prove this claim.[297] From Saaremaa only one sample – a till clay from Asva hillfort – was taken during the excavation in 2019 (AS-CL).

4.1.2. Quality of clays: chemical and mineralogical composition

Chemical composition: In total, 18 collected clay samples were analyzed using WD-XRF (Appendix III). The results show that most of the clays analyzed are high in SiO_2 (38.66–71.29%) and Al_2O_3 (11.29–18.59%). Most of the samples from the Lower Daugava area (DGM1, DZI2, NAS1, SAL2, SLKL1 and SRS) and all samples from Kurzeme and Saaremaa have quite high CaO concentrations (8.05–24.99%). Only in two cases was the MgO concentration quite high (SRS1, 10.24%, and SLKL1, 11.21%), where the former sample comes from a gypsum deposit. Clay with higher levels of aluminium and alkali metal oxides and less silica oxide are considered fatty and therefore highly plastic, whereas clays with higher calcium and magnesium oxide concentrations are lean – relatively non-plastic.[298]

[294] N. DILAKTORSKIJ. Issledovanije sostava i voistje glin ESSR…, s. 6

[295] N. DILAKTORSKIJ. Otchet. Rezultata fizikohimicheskah…, s. 3

[296] ANTO RAUKAS, KALJU KAJAK. Quaternary cover…; UWE SPERLING. Aspekte des Wandels in der Bronzezeit…, pp. 194

[297] VANDA VISOCKA et al. From the Seaside to the Inland…

[298] VISVALDIS KURŠS, AUSTRA STINKULE. Māli Latvijas zemes dzīlēs…, 65. lpp

However, the samples high in CaO and MgO were plastic enough to make briquettes and thus usable for pottery production as well.

All of the samples also contained trace and rare elements, such as TiO, BaO, ZnO, V_2O_5, etc. TiO in different concentrations (0.54–1.06%) and likewise ZrO_2 (0.01–0.05%) and SrO (0.01–0.04%) were found in all of the samples. There is variation in the rest of the elements detected. It is interesting that V_2O_5 is mainly common in the Lower Daugava samples, and was detected only in one sample from Narkūnai hillfort. Cs_2O was detected only in two Lower Daugava samples. Lastly, it may be noted that MoO_3 was detected only in Saaremaa clay.

PCA analysis of the sampled clays, where all elements are included, shows one characteristic Lower Daugava clay group and one group which includes Lower Daugava, Utena and Kurzeme clays (Fig. 17). The Saaremaa and Gotland clays are in separate groups, although one Kurzeme sample seems to be similar to a sample from Gotland.

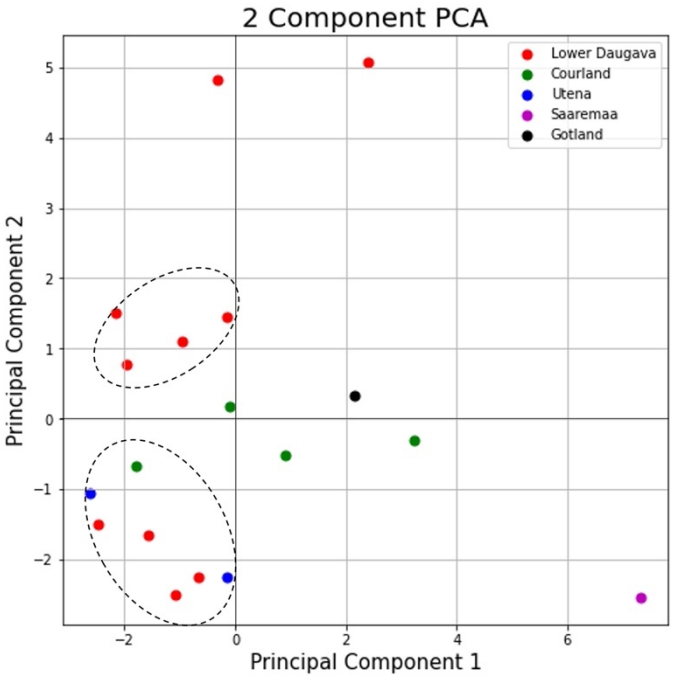

Figure 17. Graph of PCA analysis of the WD-XRF results. Made using https://colab.research.google.com/ (Author: V. Visocka)

Mineralogy of clays: All of the samples collected had greater or smaller amounts of impurities, such as sand, organics and pebbles, and in some cases also carbonates (KLG1 and AS-CL1). Petrographic analysis gives a much more detailed picture. A total of 17 collected clay thin section samples have been petrographically analyzed (Fig. 18).

The Lower Daugava clays are rich in sand and silt, except for SLKL1, which has been purified by the River Daugava and thus contains only a few sand grains. As predicted, SRS1 contains not only sand but also gypsum (GP), which has been carbonated. DZI2 contains some carbonate concretions, possibly from dolomite. The Lake Lubāns clay from Abora I settlement is fine; some silt and fine sand grains are common. Significantly, this sample contains iron compounds, possibly due to the iron-rich soil uncovered during the excavation in 2021.

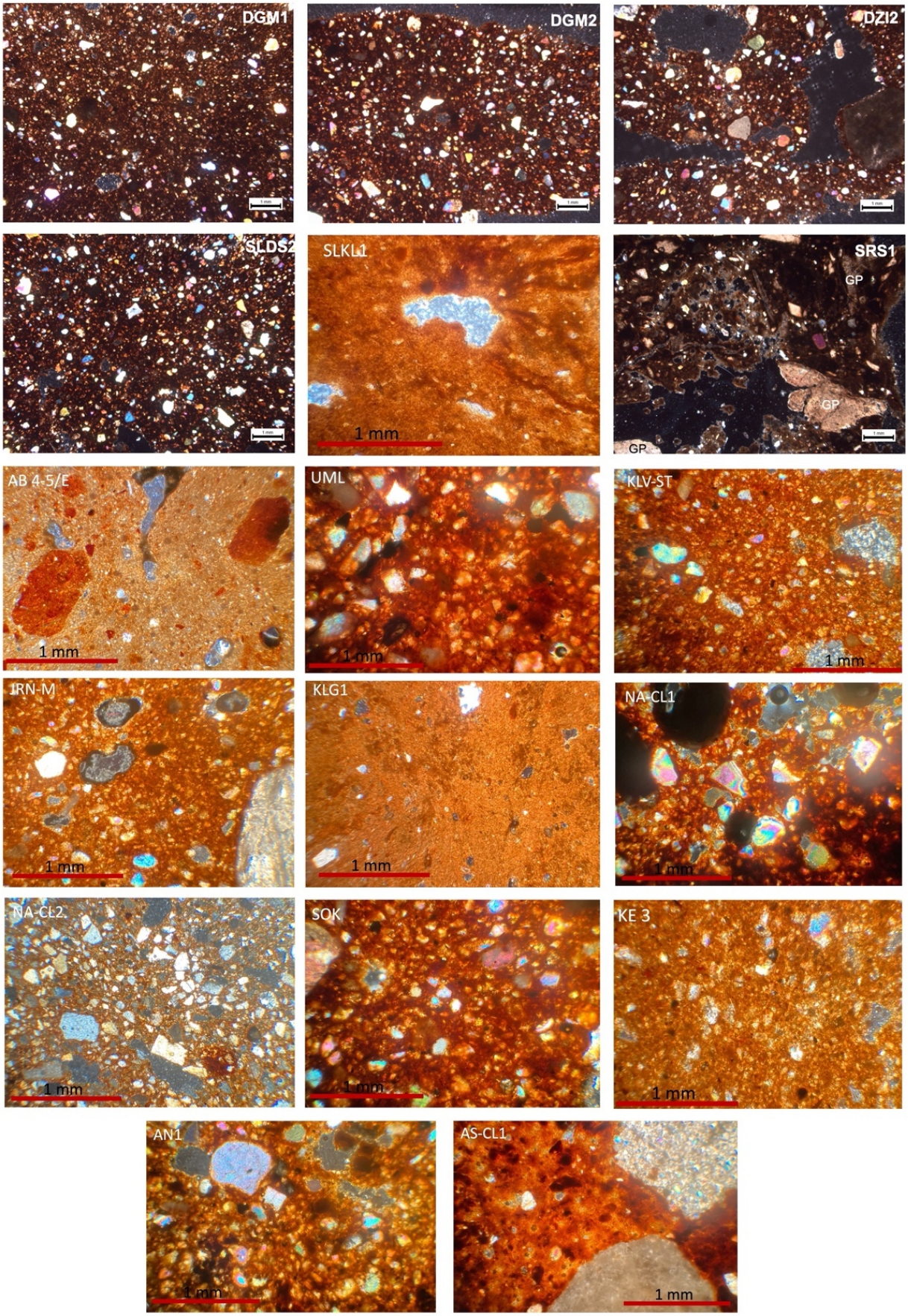

Figure 18. Clay thin sections (crossed polarizers). Author: V. Visocka. DGM – Daugmale, DZI – Dszintari, SLDS – Saulesdārzs, SLKL – Saulkalne, SRS – Saurieši, AB – Abora I, UML – Umuļi, KLV-ST – Kalvenes' station, JRN-M – Labrags, KLG – Klūgas, NA-CL – Narkūnai, SOK – Sokiškiai, KE3 – Kernave, AN1 – Antilge, AS-CL – Asva.

The Kurzeme clays are rich in sand and silt, and are very coarse. The only exception is KLG1, which is fine, with only a few sand and silt grains. The presence of a minor amount of iron compounds is also distinguishable in this sample. It is notable that no carbonates were found in this sample, although the deposit itself contains large amounts of this material. The Utena district samples are very coarse and rich in sand. It may be noted that iron compound concretions have been found in Na-CL2. Lastly, the sample from Saaremaa (Asva hillfort) is medium-textured, containing sand, pebbles and carbonate concretions.

4.2. Clay pastes and tempering tendencies of pottery

4.2.1. Chemical composition of pottery and comparison with clays

A total of 87 pottery samples were analyzed by WD-XRF. The results show that most of the samples are similar in chemical composition, although some local traits are seen as well and are described below.

Analysis shows that the Lower Daugava potters used highly plastic clay with abundant concentrations of Al_2O_3 (11.16–20.42%) and less Fe_2O_3 (4.53–13.39%) (Appendix IV). Only a few samples were rich in CaO (7.49–9.94%), mostly those from Ķivutkalns. All of the samples have low MgO, the concentration of which does not even reach 3%. TiO_2 and ZnO can be considered characteristic trace and rare elements, these being detected in all 27 samples; a little less common are BaO (25 samples), Rb_2O (22 samples) and SrO. Also quite common is ZrO_2 (11 samples). In a few samples such elements as La_2O_3, CeO_2, Sc_2O_3 and Cs_2O were detected. It may be noted that that the Ķivutkalns samples have a much higher P_2O_3 concentration than the rest, something that might relate to postdepositional alteration.[299] PCA analysis shows that none of the clays collected are chemically similar to the ones used in pottery production, as they are much richer in CaO and MgO (max. 24.99% and 11.21%, respectively) (Fig. 19:A). However, they do have the same trace elements detected, except for ZnO, which is not characteristic of these clays, as only one sample has this element in its composition. There is only one pottery group which includes samples only from one site – those from Ķivutkalns cemetery.

[299] EDWARD HALL. X-ray fluorescence-energy dispersive (ED-XRF)..., pp. 34789

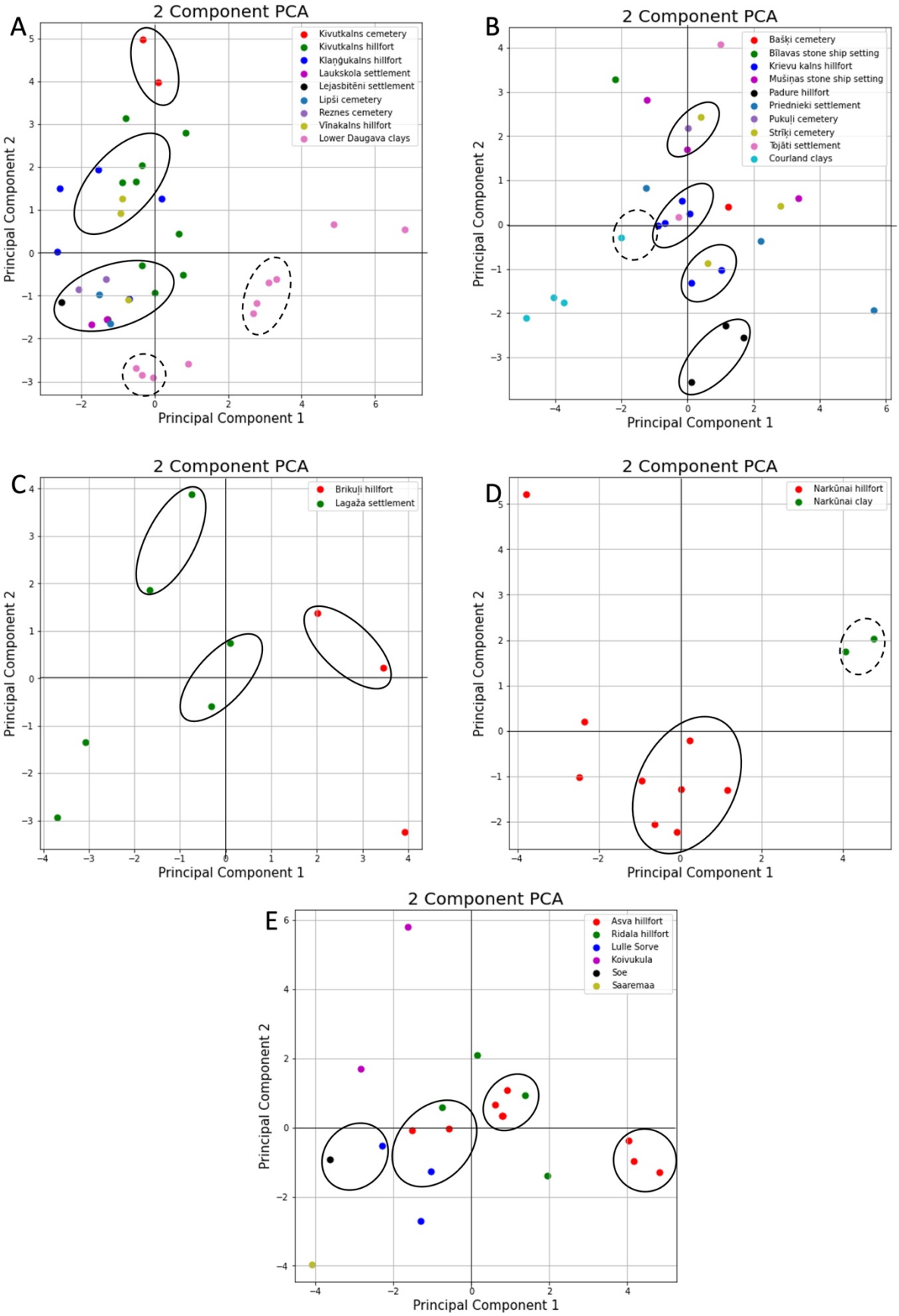

Figure 19. Graphs from PCA of WD-XRF results. A – Lower Daugava samples, B – Kurzeme samples, C – Lubāns samples, D – Narkūnai samples, E – Estonian samples. Made using https://colab.research.google.com/ (Author: V. Visocka)

Another group includes samples from Klaņģukalns, Ķivutkalns and Vīnakalns hillforts, and a third group includes samples from Ķivutkalns hillfort, Laukskola and Lejasbitēni settlements, Vīnakalns hillfort as well as Lipši and Reznes cemeteries.

Kurzeme potters also used highly plastic clay rich in Al_2O_3 (15.2–22.17%) and Fe_2O_3 (8.68–18.96%) (Appendix IV). The clays used by Kurzeme potters had low CaO concentrations (0–3.69%), except for the Padure samples and one Krievu kalns sample, where the concentration was 5.31–13.52%. Significantly, the clay samples are generally richer in MgO than CaO (1.37–3.44%). As in the Lower Daugava area, TiO_2 and ZnO can be considered characteristic trace and rare elements, being detected in all 23 samples; less common are BaO (20 samples), Rb_2O (21 samples) and SrO. As is the case in the Lower Daugava area, La_2O_3, CeO_2 and Sc_2O_3 have been detected in a few samples. It may be noted that one Mušiņas stone ship setting sample was found to contain Pr_2O_3, and one Krievu kalns sample had Tb_2O_3. PCA analysis shows that the collected clays, except for one (KLG1), do not correspond to the chemical composition of the pottery (Fig. 19:B). Four groups can be distinguished: 1) includes Strīķi, Pukuļi and Mušiņas; 2) consists of Krievu kalns, Tojāti and Priednieki; 3) includes Krievu kalns and Strīķi and 4) consists of Padure hillfort samples.

The Lake Lubāns potters, unlike those of the Lower Daugava area and Kurzeme, used clays rich in Al_2O_3 and with quite high Fe_2O_3 and CaO concentrations (max. 17.98%, 11.17% and 12.86%, respectively) (Appendix IV). By comparison, MgO is quite rare, not even reaching 2.5%. Characteristic rare and trace elements in the Lagaža and Brikuļi pottery are TiO_2, BaO, ZnO, SrO and ZrO_2 which have been detected in all nine samples. Also common are SrO (seven samples), CeO_2 (eight samples) and Cr_2O_3 (six samples). PCA analysis shows that the Brikuļi and Lagaža potters used several different clay resources in pottery production. At least six groups can be identified (Fig. 19:C).

Of all the hillforts in the Utena district, only clay and pottery samples from Narkūnai hillfort have been analyzed (Appendix IV). The clay used in pottery production was abundant in Al_2O_3 and Fe_2O_3 (max. 16.04% and 12.01%, respectively). In some samples CaO is present in large concentrations (12.76–19.7%), while MgO is less common (2.13–4.01%). The characteristic rare and trace elements are TiO_2, BaO, ZnO and SrO, which have been detected in all nine samples; quite common is V_2O_5 (six samples). It may be noted that RuO_2 has been detected in one sample. PCA analysis shows that none of the clays collected near Narkūnai correspond to the pottery samples (Fig. 19:D). Even more, ZrO_2 was detected in the collected clays, whereas these elements were not detected in any of the Narkūnai hillfort

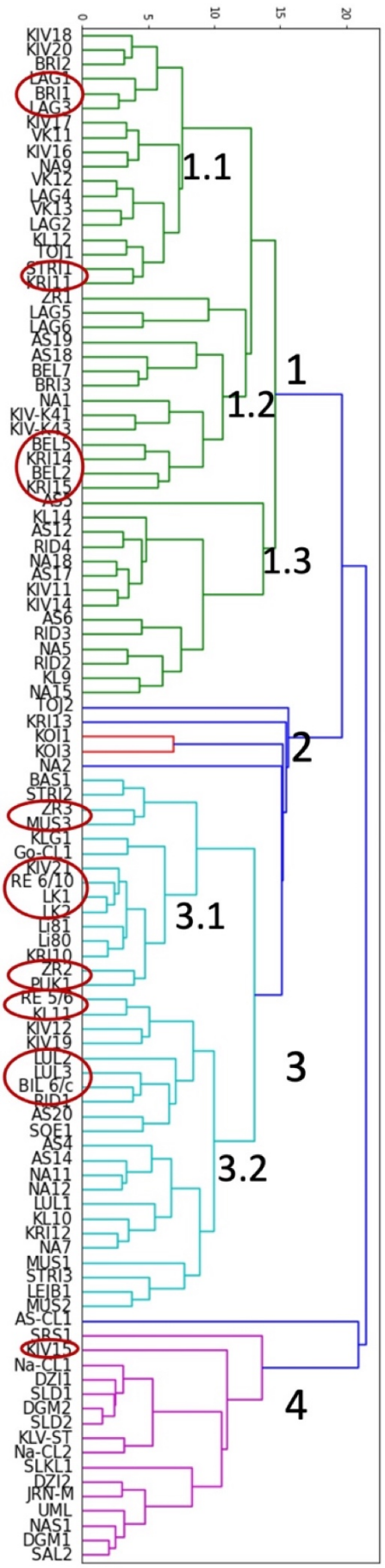

Figure 20. Dendrogram of all samples analyzed by WD-XRF. Made using https://colab.research.google.com/ (Author: V. Visocka)

pottery samples. Overall, most of the pottery samples belong to one group or share similar chemical traits.

The Saaremaa and inland Estonia potters used clay high in Al_2O_3 (11.54–24.91%) and Fe_2O_3 (8.15–14.35%); however, in a few samples CaO is quite high (2.97–13.91%) (Appendix IV). The characteristic rare elements are TiO_2, BaO, SrO and ZnO, which have been detected in all 19 samples. Quite common are Rb_2O, V_2O_5 and La_2O_3. It may be noted that PbO has been detected in two samples from Kõivuküla hillfort. PCA analysis shows no clear correlation between the clay and pottery samples (Fig. 19:E). Three groups can be distinguished, one of which consists only of Asva samples.

A dendrogram constructed from chemical data of all 105 samples indicates four large pottery and clay groups with various subgroups (Fig. 20).

Four samples, namely AS-CL1 (Asva clay), NA2 (Narkūnai hillfort pottery), KRI13 (Krievu kalns hillfort pottery) and TOJ2 (Tojāti settlement pottery) are simplificious clades, which means that they do not correspond to any of the groups distinguished. These groups and their subgroups indicate that the clays used by potters were chemically similar and thus correspond to each other, creating groups which include various living sites and cemeteries from different regions and periods. The only exception is Kõivuküla hillfort, which falls into a separate group (group 2). The most similar of all pottery sample clades are LK1 and LK2 (Laukskola settlement) and LI80 and KRI10 (Lipši cemetery and Krievu kalns hillfort).

Group 1 consists of 46 samples and can be divided into three subgroups. No clear regional

correlation between samples is seen in this group. However, there is one clade group consisting only of Lagaža and Brikuļi pottery. Significantly, the Strīķi cemetery pottery is similar to Krievu kalns pottery (STRI1, KRI11), which could mean that these two sites are connected or used the same clay resource in pottery production. Group 2 consists only of two samples from Kõivuküla hillfort. Group 3 consists of 37 samples. This group includes the Gotland (Go-CL1) clay and Kurzeme clay from Klūgas (KLG1). Here, the subgroups generally do not create clear regional groups, but there is one group of clades consisting of Lower Daugava samples: Ķivutkalns hillfort, Laukskola settlement and Reznes cemetery. It should be noted that the Reznes sample is more similar to Lauskola settlement than Ķivutkalns. It is interesting that the Mušiņas stone ship setting (MUS3) pottery corresponds to Priednieki (ZR3) settlement. Also, the Pukuļi cemetery sample corresponds to Priednieki settlement. It is unlikely that the same or a very similar clay source was used, as both sites are chronologically incompatible and too far from each other. Interestingly, Reznes cemetery sample (RE 5/6) corresponds to the Klaņģukalns hillfort sample (KL11). Lastly, Lülle and Bīlavas stone ship settings are similar to the Ridala hillfort samples. Significantly, group 4 consists of collected clay samples, the only exception being a sample from Ķivutkalns hillfort (KIV15). This means that, although this vessel was made from a different type of clay than the rest on the settlement, it was made either from local clay or clay similar to those of Kurzeme and the Utena district (possibly imported?).

4.2.2. Tempering materials

In order to give a clay or vessel specific properties, for example to increase plasticity, strengthen thermal shock resistance and reduce shrinkage, the clay paste was tempered with various materials, such as organics, granitic rock etc. In this section, the tempering materials distinguished are analyzed, along with description of the properties contributed by these materials. Overall, four different tempering materials have been observed in the pottery analyzed in the study: organics, granitic rock, quartzite and grog.

4.2.2.1. Granitic rock

Crushed granitic rock (Fig. 21) is the most common tempering material used at all of the sites analyzed and in the Baltic region overall. For this reason, it is possible to analyze this tempering material in great detail. The use of granitic rock serves to increase thermal shock resistance as well as thermal conductivity and toughness of the vessel.[300] This means that the vessel will be more likely to survive the firing process and will retain heat better while cooking. The density of the temper as well as the grain size of this tempering material vary between vessels and could be dependent on the function of the vessel. In some vessels granitic rock tempering in the paste is very dense, reaching up to 50% of the clay paste. For example, some vessels from the Žalioji settlement, Vīnakalns, Dievukalns and Ķivutkalns hillforts have such high amounts of granitic rock temper added to the paste.

Figure 21. Crushed granitic rock temper (A, B – Mūkukalns, LNVM A 11848, C – Krievu kalns, LNVM A 13958). Photo: V. Visocka

The grain size of the granitic rock temper can vary from 2 to more than 10 mm. The grains can be classified as: 1) fine (2–4 mm); 2) medium (4–6 mm); 3) coarse (6–8 mm); 4) very coarse (8–10 mm) and 5) extra coarse (10–12 mm).

[300] NOÉMI SUZANNE MÜLLER, VASSILIS KILIKOGLOU, PETER M DAY, ANNO HEIN, GEORGE VEKINIS. The influence of temper on performance characteristics of cooking ware ceramics. In: KATALIN BIRÓ, VERONIKA SZILÁGYI, ATTILA KREITER (eds). Vessels: inside and outside, Proceedings of the conference EMAC'07, 9th European meeting on ancient ceramics Publisher: Hungarian National Museum, Budapest 2009, p. 146; PATRICK QUINN. Ceramic petrography…, pp. 158

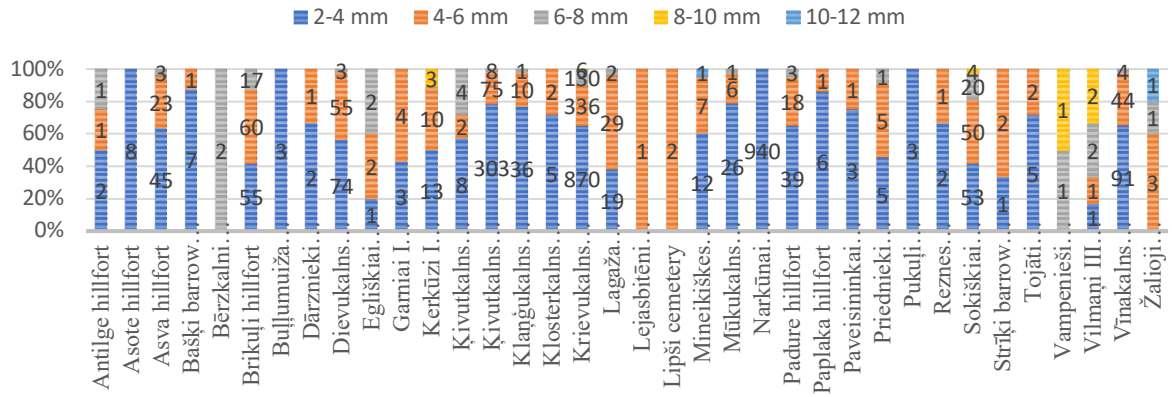

Figure 22. Graph of the main granitic rock size tendencies in the analyzed sites. Author: V. Visocka

Analysis of tempering tendencies (Fig. 22) shows that for most sites the most common temper size is 2–4 mm, except for Bērzkalni, Ėgliškiai, Lipši and Strīķi cemeteries, Brikuļi and Sokiškiai hillforts and Lagaža, Priednieki, Vampenieši, Vilmaņi III and Žalioji settlements. It may be noted that for Narkūnai hillfort and Pukuļi barrow graves the grain size of granitic rock does not exceed 4 mm. The 4–6 mm grain size dominates at five sites: Lipši and Strīķi cemeteries as well as Lagaža, Lejasbitēni and Žalioji settlements. The 6–8 mm grain size dominates in the case of Bērzkalni cemetery and Vampenieši settlement, but is also quite common at Antilgė hillfort, Ėgliškiai and Ķivutkalns cemeteries, and Vilmaņi III and Žalioji settlements. It may be noted that very coarse grains, 8–10 mm, dominate in the case of Vampenieši settlement and are also common at Vilmaņi III settlement, less so for Kerkūzi I settlement and Sokiškiai hillfort. Extra coarse temper was distinguished only for two living sites: Mineikiškės hillfort and Žalioji settlement.

4.2.2.2. Organics

Organics include such materials as shells, various kinds of plant matter etc. Shell temper is characteristic of Neolithic pottery and is not common in Baltic Early Bronze Age to Pre-Roman

Figure 23. Burnt-out organic remains and pores in the clay paste from Lagaža settlement (LNVM VI 118). Photo: V. Visocka

Iron Age pottery.[301] However, Early Bronze Age to Pre-Roman Iron Age vessels could be tempered with organics, such as plant matter, since pores and imprints from burnt-out organics can be observed in a few vessels (for example in the Krievu kalns and Ķivutkalns hillfort and Lagaža settlement assemblages) (Fig. 23). Vessels tempered with organics tend to dry faster than those with mineral temper and are lighter, as well being less susceptible to cracks and deformation during the firing.[302] The addition of organics also improves mechanical handling and plasticity of the clay paste. Such tempering materials as dung also favour plasticity, as they contain large amounts of organics as well as polysaccharides of bacterial origin, which act as lubricants.[303]

Andrejs Vasks[304] argues that organic temper occurs in the Latvian Late Bronze Age to Pre-Roman Iron Age pottery, because small, round pores are distinguishable in the paste. Such pores were observed in small amounts in the Ķivutkalns, Krievu kalns and Asva hillfort pottery as well. Based on the characteristics of the pores, Vasks concludes that the tempering material used was dung. The pores found in these few vessels were small, round and quite evenly spread in the clay paste. An experiment conducted by Andreja Kudelié [305] shows that small pores form from cow dung, whereas other organic materials, such as weeds, straw and chaff, left much larger pores. It is notable that in all of these cases granitic rock was used in additional to the organic temper. However, the clay itself can also include of organics, leaving such pores. It was observed that clays from Kurzeme show similar pores to those observed in the pottery.

[301] BAIBA DUMPE. Trauki. In: ANDREJS VASKS, GUNITA ZARIŅA (sast.). Latvijas Arheoloģijas Rokasgrāmata. Rīga, 2021, 494. lpp

[302] JAMES SKIBO, MICHAEL SCHIFFER, KENNETH REID. Organic-Tempered Pottery: An Experimental Study. In: American Antiquity, 1989, Vol. 54 (1), p. 134

[303] VALENTINE ROUX. Ceramics and Society: A technological Approach to Archaeological Assemblages. Nanterre, 2019. p. 36

[304] ANDREJS VASKS. Keramika epokhi pozdnej bronzi…

[305] ANDREJA KUDELIÉ. Preparation and composition of clay paste in Bronze Age pottery from north-western Croatia: the role of experiments. In: The Old Potter's Almanack, 2017.

4.2.2.3. Grog

A few samples from Klaņģukalns, Padure and Paplaka hillforts were found to contain grog (crushed pottery) in addition to mineral temper (Fig. 24). The grog contributes similar properties to the vessel as granitic rock, i.e. resistance to thermal shock as well as a higher degree of hardness; however, there might also be a symbolic meaning behind the addition of this kind of temper.[306] Ethnoarchaeological data shows that potters add grog to pottery vessels to connect old vessels to the new ones, making them as strong as the previous ones.[307]

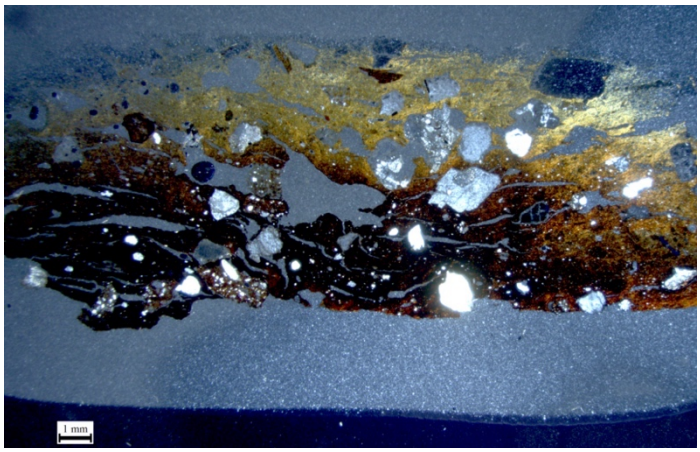

Figure 24. Grog temper (at left) in the clay paste of a sherd from Padure. Micrograph (cross polarized): V. Visocka

It may be noted that in all of these cases the size of the grog fragments did not exceed 2 mm and they were added to the paste very sparsely (no more than 5% of the clay paste), indicating that this practice was more symbolic than practical, or even accidental.

4.2.2.4. Quartzite

In one sample from the Laukskola pottery, quartzite added as a tempering material was found (Fig. 25).[308] No analogies for this tempering material are known. Quartz temper increases the toughness of the

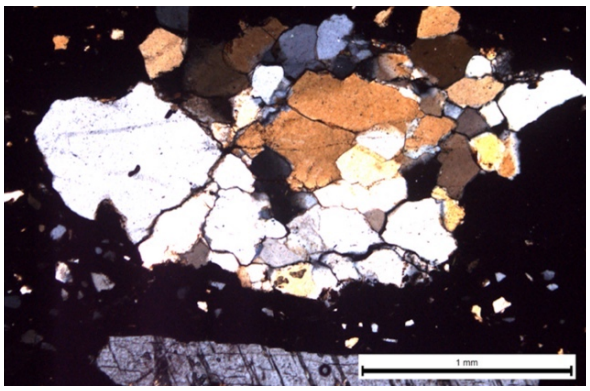

Figure 25. Quartzite in the clay paste of a sherd from Laukskola. Micrograph (crossed polarizers): V. Visocka.

[306] THOMAS ERIKSSON. Grog tempering during the Scandinavian Bronze Age. In: BRITTA RAMMINGER, OLE STILBORG, MARKUS HELFERT (eds). Naturwissenschaftliche Analysen vor- und frühgeschichtlicher Keramik 3. Universitätsforschungen zur prähistorischen Archäologie 238. Bonn, 2013, p. 331; VALENTINE ROUX. Ceramics and Society: A technological Approach to Archaeological Assemblages. Nanterre, 2019. p. 37

[307] OLIVIER GOSSELAIN, ALEXANDRE LIVINGSTONE SMITH. The Source Clay Selection and Processing Practices in Sub-Saharan Africa. In: ALEXANDRE LIVINGSTONE SMITH, DOMINIQUE BOSQUET, RÉMI MARTINEAU (eds). Pottery Manufacturing Processes: Reconstruction and Interpretation. British Archaeological Reports, 2005, p. 41

[308] VANDA VISOCKA et al. Between mighty hillforts…, p. 94

vessel.[309] However, this material decreases the strength of the vessel if added to the paste in amounts greater than 20%.[310] This could also be applicable to quartzite temper. In thisparticular case the amount of temper in the paste is 15.6%, thus not decreasing the overall strength of the vessel.[311]

4.2.3. Impurities in the clay matrix

4.2.3.1. Iron compound concretions

Iron compound concretion lumps (ferrihydrite group) have been found in pottery from Brikuļi, Krievu kalns and Padure hillforts as well as Priednieki settlement and Mušiņas stone ship setting. These compounds are mostly oval and irregular. The hardness level relates to the colour: light reddish-brown inclusions are fragile and crumbling, while dark reddish-brown ones are stable and hard, 4.5 on the scale of hardness.

Vessels containing these compounds are best represented in the assemblage from Krievu kalns hillfort, where 12% of all sherds contain them, while other sites have only a few sherds with such impurities. Accordingly, the analysis below is based on this site.[312] The concentration of ferrihydrite lumps depends on the vessel: some have only a few large grains, while others have an abundance of small grains. It should be noted such ferrihydrite lumps have also been found on daub fragments (light reddish-brown). The size of the ferrihydrite inclusions can reach 10 mm, although the most common range is 2–6 mm. In all of the cases granitic rock temper has been added, but this does not correspond to iron compounds in terms of their emplacement in the paste, indicating that these ferrihydrites were in the clay before the addition of tempering material.

Figure 26. An iron compound broken in half from Krievu kalns hillfort (LNVM A 13958). Photo: V. Visocka

These ferrihydrite lumps most

[309] VASSILIS KILIKOGLOU, GEORGE VEKINIS, Y. MANIATIS, PETER DAY. Mechanical performance of quartz-tempered ceramics: Part I, strength and toughness. In: Archaeometry, 1998, vol. 40 (2), p. 274

[310] Ibidem.

[311] VANDA VISOCKA et al. Between mighty hillforts…, p. 97

[312] VANDA VISOCKA. Pottery and Hillforts: Some Aspects of Pottery Production During the Late Bronze Age in the Territory of Latvia. In: Latvijas Universitātes žurnāls. Vēsture, 2017, 4, 60. lpp

probably originate from bog ore, i.e. brown limonite iron ore.[313] The limonite formed during the Postglacial period of the Quaternary, when underground waters rich in iron compounds came to the surface of the Earth.[314] The source of limonite is usually water-permeable Quaternary and Devonian sandy strata, where grains of quartz and feldspar are coated with iron oxides.[315] A specimen broken in half was found in the Krievu kalns hillfort collection (Fig. 26). The centre of this iron compound had been empty and was filled with clay (it may have broken during clay preparation). It is possible that there was originally a quartz sand or feldspar grain, which indicates that limonite is indeed the compound found in the clay paste at Krievu kalns and the other sites. Large bog ore deposits occur in Ventspils district (Sārnate bog) and in Ulmale Parish near Pāvilosta.[316] It is likely that the limonite entered the clay accidentally from the surface when it was collected.

It is interesting that these big iron lumps (max. 10 mm) were not sorted out of clay. Baiba Dumpe suggests some possible reasons for leaving limonite in the clay paste: 1) technological – it lowers the temperature of clay melting, making it easier to fire pottery; 2) aesthetic – iron compounds make clay redder and brighter; 3) symbolic – a possible connection with ochre might have played a role in leaving it in the clay paste.[317]

4.2.3.2. Food crops

Imprints of burned-out food crops were distinguished in the assemblages from several living sites. Cereal grain imprints are mainly represented in the case of sites where active farming took place: Asva, Brikuļi, Ķivutkalns, Narkūnai and Vīnakalns hillforts and the Laukskola settlements, with the single exception of a find from Dārznieki cemetery. In general, just a few fragments of grain imprints occur in the pottery paste, indicating they were accidentally incorporated. The only exception is Narkūnai hillfort, where base of a vessel is covered with millet (*Panicum miliaceum*) imprints.[318] At Laukskola only one grain has been identified: common wheat (*Triticum*).

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[313] The ferrihydrites were identified as limonite by Vija Hodireva and Laimdota Kalniņa at the UL Faculty of Geology and Earth Sciences in 2017.

[314] ULDIS SEDMALIS. Latvijas minerālās izejvielas un to izmantošana. Rīga, 2002, 170. lpp

[315] Ibidem, 171. lpp

[316] ULDIS SEDMALIS. Latvijas minerālās izejvielas un to izmantošana. Rīga, 2002, 171. lpp

[317] BAIBA DUMPE. Bezripas keramika Tērvetes senvietās. In: LNVM Zinātniskie lasījumi 2011.–2013., 2014, 26. lpp

[318] VYTENIS PODĖNAS et al. Narkūnų piliakalnių ir papėdės gyvenvietės keramika…, pp. 214, fig. 15)

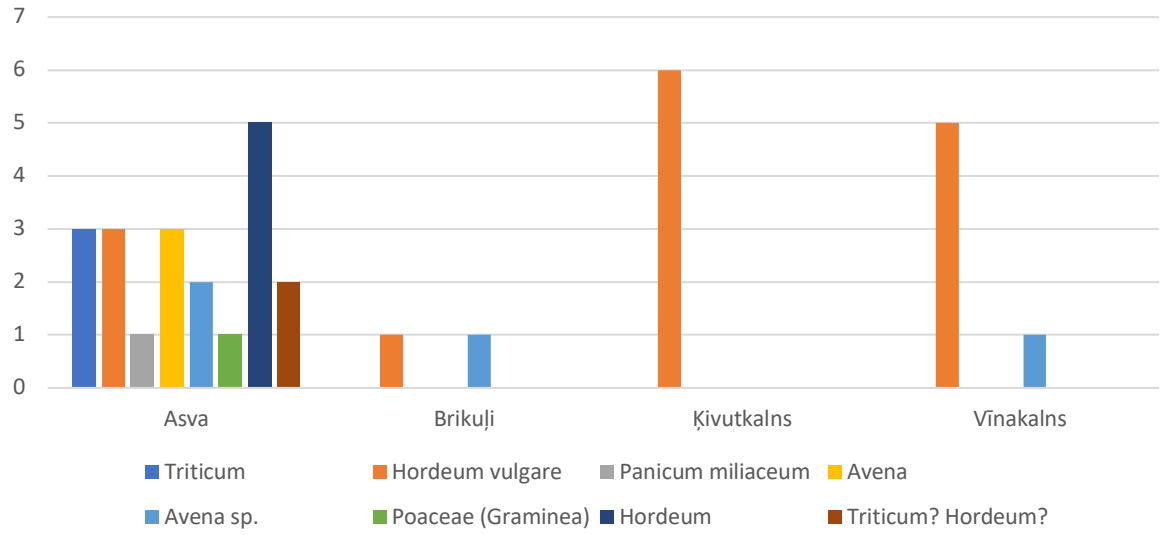

Figure 27. Graph of the cereal species (from imprints) found in the pottery clay paste (X – sites, Y – number of seed imprints). Author: V. Visocka

More detailed analysis has been conducted on assemblages in which more than one sample has been found: Asva, Brikuļi, Ķivutkalns and Vīnakalns hillforts (Fig. 27, Appendix V). In the case of Asva, 24 imprints have been found, 20 of which could be identified to species; two out of three could be identified in the case of Brikuļi, six out of 13 at Ķivutkalns, and six out of seven at Vīnakalns.[319] By analysing moulded positives of seed imprints, it is seen that Asva has a larger variety of food crops found in the pottery: barley (*Hordeum vulgare*), oats (*Avena* sp.), common wheat (*Triticum*), etc.

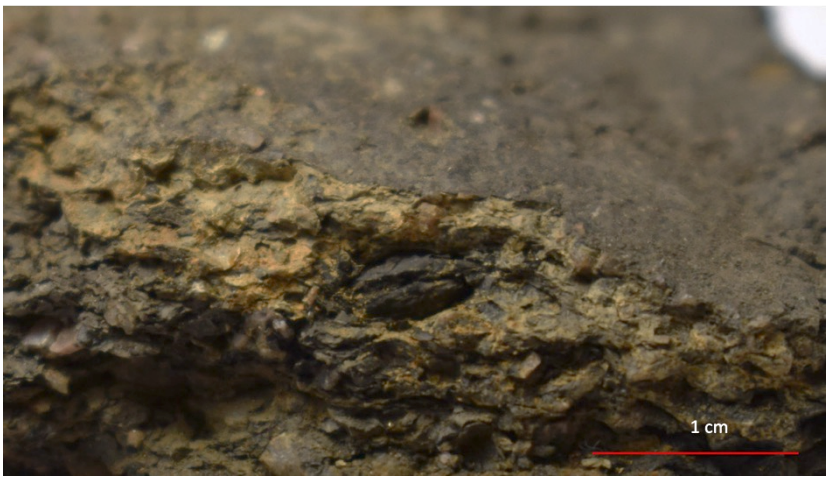

Figure 28. Charred grain in the clay paste of a vessel from Asva (TLÜ AI 4366: 1429). Photo: V. Visocka.

Also significant is the occurrence of charred food crop remains within the paste of the vessel, which indicates that the firing temperature was not high enough to burn out the grain (Fig. 28). On the other hand, in the case of Brikuļi and Vīnakalns only oats and barley, and at Ķivutkalns only barley has been distinguished. It is important to note that one vessel from the

[319] Seed imprints were identified by palaeobotanists Aija Ceriņa and Janta Meža in 2021.

Dārznieki cemetery also had seed imprints (unidentified), found in the inner part of the vessel, indicating that this vessel was made on a living site.

These cereal grain imprints, although they provide significant information about food crops on the living sites, do not represent the real situation at the site. For example, large amounts of charred grain were preserved at Ķivutkalns, representing a wide variety of species: in addition to barley, there were oats and common wheat, garden pea (*Pisum sativum*), yellow millet (*Panicum miliaceum*), beans and camelina (*Camelina sativa*) as well as summer and winter-hardy and perennial weeds, indicative of ploughing.[320]

4.2.3.3. Carbonate concretions

In some of the Asva pottery sherds chalk-like carbonate concretions have been distinguished.[321] They are round or sub-angular and, with some exceptions, mostly do not exceed 2 mm size (Fig. 29).

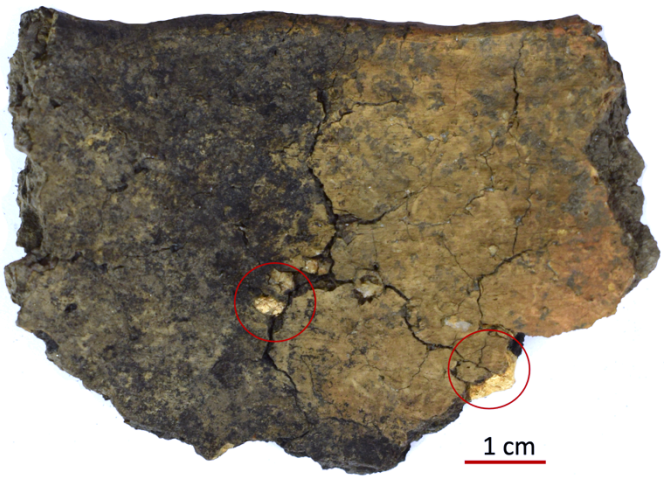

Figure 29. Carbonate concretions in the clay paste of Asva pottery (TLÜ AI 4366: 375). Photo: V. Visocka.

As they have been found in the pottery paste, not only on the surface of the vessels, it can likewise be assumed that they were already present in the clay naturally. A few such carbonate concretion impurities have been found in pottery from other sites as well, but in most of these cases just one grain is present, and so does not indicate some kind of pattern, unlike with Asva. Such carbonate concretions often occur naturally in clay deposits, mostly the upper layer of the clay bed at depths of 0.5–1.5 m.[322] This could mean that potters have used the upper part of the clay deposit for making these vessels. In the clay sample collected from Asva hillfort the same kind of carbonate concretions have been distinguished, indicating the use of local clay in pottery production.

[320] ALFRĒDS RASIŅŠ, MARINA TAURIŅA. Pārskats par Latvijas PSR Arheoloģiskajos izrakumos…

[321] These impurities were identified by geologist Vija Hodireva at UL Faculty of Geology and Earth Sciences in 2019.

[322] VISVALDIS KURŠS, AUSTRA STINKULE. Māli Latvijas zemes dzīlēs…, 60., 64. lpp

4.2.4. Fabric types

Various types of pottery clay pastes can be distinguished by petrographic analysis. In total, 146 pottery samples were studied by thin section analysis. Eight different fabrics altogether, with various subgroups, as well as three loner samples were distinguished from the petrographic data (Table 3, Figure 30, Appendix VI).

Table 3. Description of the fabrics obtained from the petrographic data. All variables – such as coarseness, sorting, impurities such as silt and sand, as well as tempering tendencies – volume added, max. avg. grain size etc. were taken into account when grouping the data (for detailed description of variables see Appendix VI).

Fabric	Tendency	Characteristic	Clay paste	Temper	Wares/pottery types	Samples
1	1.1. Medium	Iron compound concretions	Moderately sorted to unsorted clay, rich in silt and fine sand, occasionally coarse sand; mica and iron oxides are common	Granitic rock temper, added volume: 4–10%, max. avg. grain size: 0.77–3.2 mm	Striated, textile, coarse-slipped, striated coarse-slipped	BEL6, KRI1, KRI3, KRI4, KRI5, MUS3
				Granitic rock temper, added volume: 13–17%, max. avg. grain size: 1.74–3.27 mm	Striated, smooth	KRI10, KRI11, KRI15
	1.2. Fine	Iron compound concretions	Fine, well-sorted; silt and sand rare, mica and iron oxides common	Granitic rock temper, added volume: 5%, max. avg. grain size: 1.5 mm	Smooth	KRI8
2	2.1. Fine	Carbonate concretions	Fine, well-sorted; silt and fine sand rare; coarse sand and iron oxides common	Granitic rock temper, added volume: 5%, max. avg. grain size: 1.89 mm	Striated	AS6
	2.2. Coarse	Carbonate concretions	Coarse, unsorted; rich in silt and coarse sand; fine sand and mica common	Granitic rock temper, added volume: 10%, max. avg. grain size: 2.01 mm	Smooth	KIV16
3	3.1. Fine	-	Fine, well-sorted; silt or fine sand occasionally common, otherwise rare;	Granitic rock temper, added volume: 4–10%, max. avg. grain size: 1.2–2.88 mm	Striated, smooth, coarse-slipped, polished	AS7, AS11, AS15, BEL2, BEL8, DK6, KRI13, PAP3,

			the same with mica and iron oxides	Granitic rock temper, added volume: 11–18%, max. avg. grain size: 0.77–2.85 mm	Striated, smooth, polished, coarse-slipped, textile	AS1, AS2, AS10, AS15, NA13, RID2, BEL7, DK1
	3.2. Fine	-	Fine, unsorted; fine sand and coarse sand common; mica rarely common; the same with iron oxides	Granitic rock temper, added volume: 5–10%, max. avg. grain size: 0.83–2.16 mm	Striated, polished	AS8, NA7, NA8, NA10, LUL1
				Granitic rock temper, added volume: 11–20%, max. avg. grain size: 1.15–2.97 mm	Striated, smooth, polished	AS9, AS16, NA6, NA16, LUL3, RID3
				Sand temper, added volume: 9%, max. avg. grain size: 1.08 mm	Polished	AS20
4	4.1. Coarse	-	Coarse, unsorted; rich in silt, fine and coarse sand; mica and iron oxides common	Granitic rock temper, added volume: 10–30%, max. avg. grain size: 1.04–3.48 mm	Striated, smooth, coarse-slipped, textile, Lubāns Ware, Kvietiniai-Tojāti Ware	AS19, KIV2, KIV3, KIV4, KIV6, KIV8, KIV9, KIV10, KIV11, KIV19, NA3, NA9, NA18, AB2, AB4, AB8, AB10, KIV-K41, BEL9, PAP2, KL3, KL6, KRI12, VK1, VK4, KOI1, KOI2, TOJ1
				Granitic rock temper, added volume: 5–10%, max. avg. grain size: 0.52–2 mm	Striated, polished, smooth, Lubāns Ware	AS3, AS14, KIV12, NA9, AB7, KIV-K43, KRI14, KOI3
	4.2. Coarse	-	Coarse, unsorted; rich in silt fine	Sand temper, added volume:	Polished	AS18

			and coarse sand; mica and iron oxides rare	11%, max. avg. grain size: 1.68 mm		
5	Medium	-	Medium-textured, unsorted; rich in silt; fine sand common; mica rare; rich in iron oxides	Grog? + granitic rock temper, added volume: 13–20%, max. avg. grain size: 2.5 mm	Striated coarse-slipped, coarse-slipped	PAP1, PAP4
6	6.1. Medium	-	Medium-textured, moderately sorted to unsorted; fine and coarse sand common; mica and iron oxides also common	Granitic rock temper, added volume: 4.1–10%, max. avg. grain size: 0.99–2.46 mm	Striated, striated textile, smooth, coarse-slipped	AS13, AS17, NA2, NA4, NA5, NA11, NA15, LK1, MUS1, MUS2, BR8, PAP5
				Granitic rock temper, added volume: 11–30%, max. avg. grain size: 1.05–2.6 mm	Striated, smooth, striated coarse-slipped	AS4, AS5, AS12, NA1, NA12, NA17, RID1, BEL1, BEL3, BEL4, BR9, KRI7
				Granitic rock temper, added volume: 13%, max. avg. grain size: 4.2 mm	Striated	BR2
	6.2. Medium	-	Medium-textured, well-sorted; rich in silt; fine and coarse sand rare; mica and iron oxides not common	Granitic rock temper, added volume: 4–15%, max. avg. grain size: 0.87–1.75 mm	Textile, striated coarse-slipped, Post-Corded Ware	BEL5, SOE1, LEJB1
				Sand temper, added volume: 17%, max. avg. grain size: 0.63 mm	Smooth	RID4
7	Medium	-	Medium-textured, unsorted; rich in silt and fine sand; coarse sand rare; mica and iron oxides not common	Granitic rock temper, added volume: 10–15%, max. avg. grain size: 1.34–2.9 mm	Striated, smooth, coarse-slipped, textile	KIV14, KIV20, KL4, KRI6, VK3, LI80
				Granitic rock temper, added	Striated, striated coarse-slipped,	KIV1, KIV5, KIV15, KIV17,

				volume: 17–32%, max. avg. grain size: 1.8–4.32 mm	smooth, textile	KIV18, NA14, BIL 6/c, BR1, BRI4, BRI5, BRI6, BRI7, DK4, KL1, KL7, VK8
8	Coarse	-	Coarse, well-sorted; rich in coarse sand; mica and iron oxides rare	Granitic rock temper, added volume: 20–30%, max. avg. grain size: 2.3–3 mm	Textile, smooth	KIV7, DK9, VK5, VK6, VK10
			Coarse, unsorted; fine sand common; rich in coarse sand; mica and iron oxides rare	Granitic rock temper, added volume: 18–40%, max. avg. grain size: 2.5–3.7 mm	Striated, smooth, textile	BR3, DK2, DK3, DK5, DK7, DK10, KL5, VK2
Loner	Medium	-	Medium-textured, unsorted; silt, fine and coarse sand common; rich in mica; iron oxides rare	Quartzite temper, added volume: 15.6%, max. avg. grain size: 2.74 mm	Striated	LK2
Loner	Medium	-	Medium-textured, well-sorted; fine sand, iron oxides common; mica rare	Grog and granitic rock temper, added volume: 10%, max. avg. grain size: 1.9 mm	Smooth	BEL10
Loner	Coarse	-	Coarse, unsorted; rich in silt and fine sand; coarse sand common; mica rare; iron oxides common	Grog and granitic rock temper, added volume: 22%, max. avg. grain size: 3.3 mm	Striated	KL2

Petrographic analysis of thin sections shows a wide variety of clay paste recipes (i.e. fabrics). Group 1 is characterized by iron compound concretions in the clay. This group has two subgroups, with fine and medium-textured clay, both tempered with granitic rock. This group contains 10 samples from three living sites: Krievu kalns and Padure hillforts and Mušiņas stone ship setting. The characteristics of the iron compound lumps (dark brown, almost black, round) indicate that the Krievu kalns and Mušiņas samples are more similar to each other than to the sample from Padure hillfort. The main characteristic of Group 2 is the occurrence of carbonate concretions in the clay paste. This group likewise has two subgroups:

coarse and fine, both tempered with granitic rock. The group consists of two samples, one from Asva, the other from Ķivutkalns hillfort.

Group 3 is quite complex, with two subgroups, each of which, in turn, has various subgroups. Subgroup 3.1 is fine and well-sorted, with two subgroups, both tempered with granitic rock. Subgroup 3.2 is fine and unsorted, with three subgroups – two of which are tempered with granitic rock and one with sand. This group consists of 28 samples from eight sites: Asva, Dievukalns, Krievu kalns, Narkūnai, Padure, Paplaka and Ridala hillforts and Lülle stone ship setting.

Group 4 is divided into two subgroups. Subgroup 4.1 is divided into two subgroups, while subgroup 4.2. does not have any subgroups. These groups are characterized by coarse, unsorted clay tempered with granitic rock (sand in subgroup 4.2). This is the most common group of all, consisting of 37 samples from ten sites: Abora, Asva, Ķivutkalns hillfort and cemetery, Klaņģukalns, Kõivuküla, Krievu kalns, Narkūnai, Padure, Paplaka and Vīnakalns.

Group 5 consists of only two samples from Paplaka hillfort. The group is characterized by medium-textured, unsorted clay tempered with granitic rock and possibly grog.

Group 6 consists of two subgroups, each of which have further subgroups. This group is characterized by medium-textured, unsorted to sorted clay tempered with granitic rock, or in one case sand. This is the second most common group and consists of 29 samples from Asva, Brikuļi, Laukskola, Lejasbitēni, Krievu kalns, Mušiņas, Narkūnai, Padure, Paplaka, Ridala and Soe.

Group 7 consists of two subgroups. This group is characterized by medium-textured, unsorted clay tempered with granitic rock. The group consists of 22 samples and is thus the third most common of all. This fabric is common to nine sites: Bīlavas, Brikuļi, Dievukalns, Ķivutkalns, Klaņģukalns, Krievu kalns, Lipši, Narkūnai and Vīnakalns.

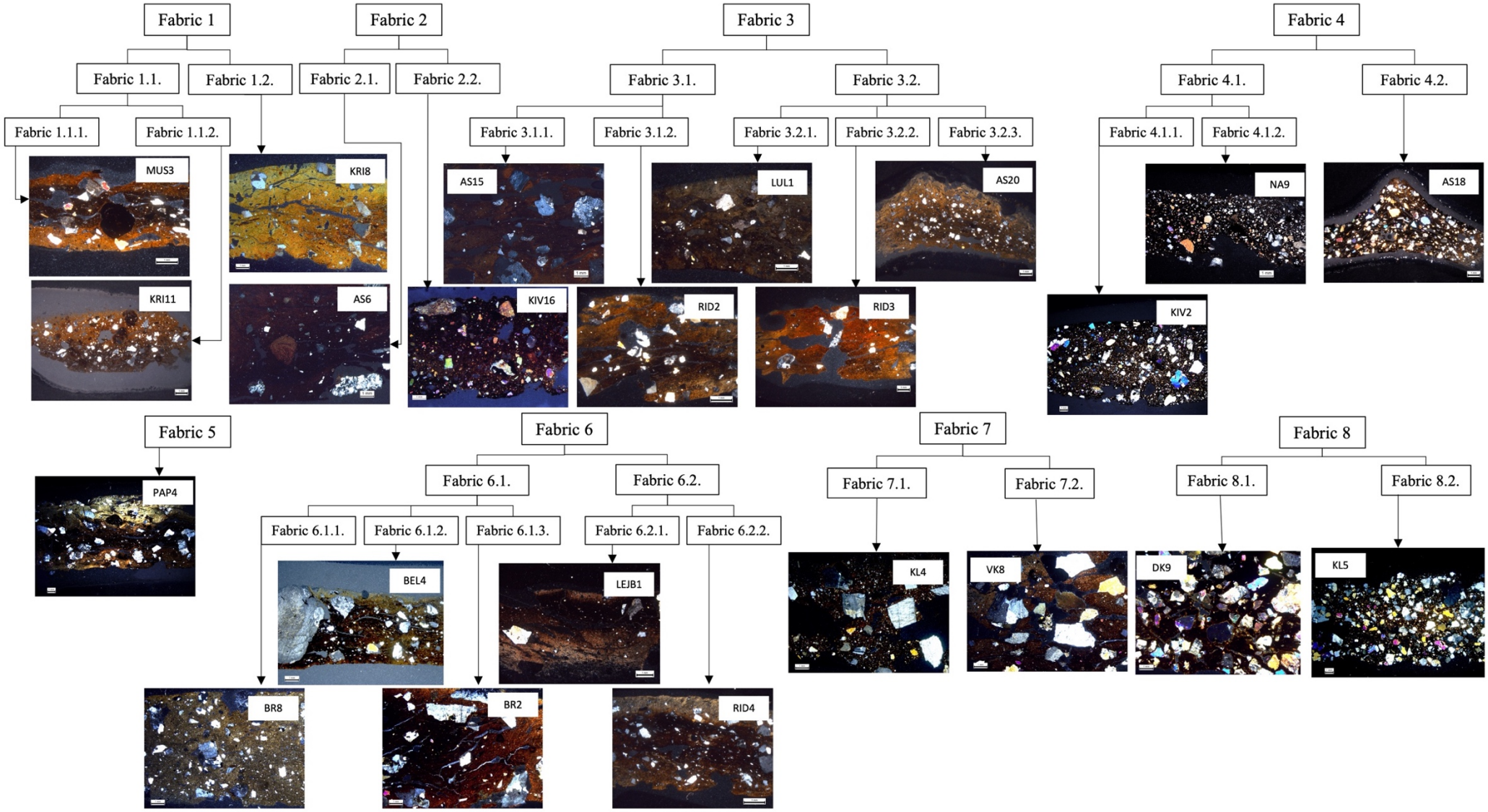

Figure 30. Graph of pottery thin sections based on the petrographic data. Most representative thin sections have been chosen as samples in this graph (micrographs in XPL, author: V. Visocka).

Group 8 consists of two subgroups and is characterized by a coarse clay paste richly tempered with granitic rock. This group consists of 13 samples from Brikuļi, Dievukalns, Ķivutkalns, Klaņģukalns and Vīnakalns.

Among the samples there are three loners which do not belong to any group because they show specific characteristics: a sample from Laukskola with quartzite temper and medium unsorted clay paste, a sample from Padure with medium-sorted clay paste and grog temper and lastly a sample from Klaņģukalns with coarse, unsorted clay with grog and granitic rock temper.

By analysing the surface treatments in relation to different fabrics, it is seen that, as expected, striated pottery is common in the majority of the groups (Fig. 31). This is because striated pottery is the most common surface treatment in all of the analyzed assemblages and was sampled most often. Most diverse is group 4, in which almost all of the pottery surface treatments are represented. Polished pottery is common with fabrics 3 (fine clay paste) and 4 (coarse clay paste). Textile pottery is common in groups 1, 3, 4, 7 and 8, while coarse-slipped pottery is common in all groups, except for groups 2 and 7. Lubāns Ware is common in fabric 4, and the same is true of Kvietiniai-Tojāti Ware. Post-Corded Ware is common in fabric 6. Overall, except for polished pottery, there are no specific correlations between fabrics and surface treatments. More samples are needed for thin section analysis to interpret questions regarding the relationship of surface treatments to fabrics.

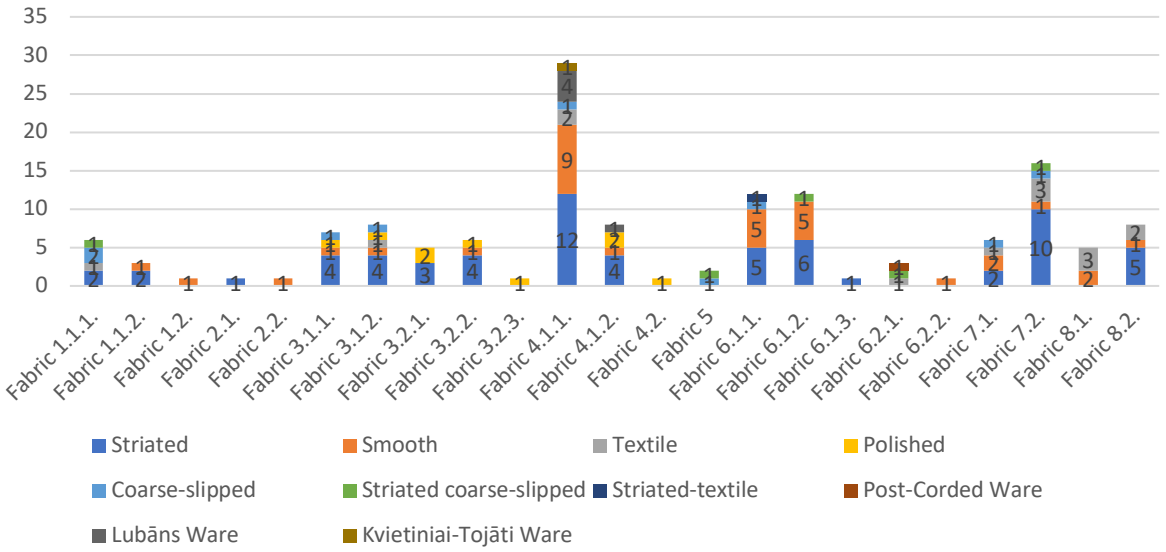

Figure 31. Pottery surface treatments within the fabrics distinguished by petrographic data. X – fabrics, Y – number of samples (author: V. Visocka).

4.3. Building the vessels

4.3.1. Pottery construction

Folklore data shows that potters used their legs to knead the clay paste.[323] Although this applies to the 18th century, it is not impossible that potters used their legs to knead large amounts of clay during the Early Bronze Age to Pre-Roman Iron Age period as well. Ethnographic and archaeological data from Sweden and Estonia shows that potters prepared the clay paste and stored it in pits dug in the houses, which were frost-free during the winter period.[324] Unfortunately, no archaeological evidence of this has been distinguished in the Eastern Baltic material. Two clay paste lumps have been distinguished in the material from Asva and Ķivutkalns hillforts, indicating that clays were previously prepared and used just before pottery construction, and that pottery production took place on the living sites (Fig. 32).

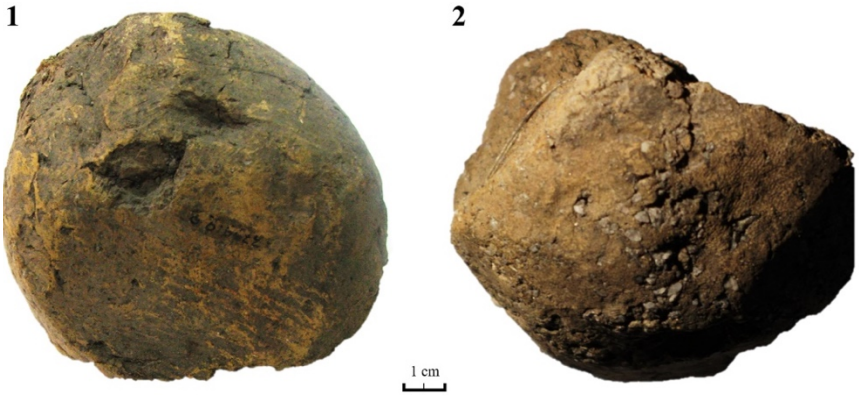

Figure 32. Prepared tempered clay lumps from 1) Asva (TLÜ AI 3799:22) and 2) Ķivutkalns (LNVM VI 120:359). Photo: V. Visocka

In the Early Bronze Age to Pre-Roman Iron Age of the Eastern Baltic, pottery was made without a potter's wheel using a coiling method. "The coil is a roll of paste obtained either by rolling an elementary volume of paste between the palms or on a flat surface with both palms or by modelling exerting interdigital pressure."[325] First, potters created a separate round-bottom base or one-piece base with a small side pulled upwards, then positioned clay bands in a coil-like way one on top of another, and pressed the coils together and smoothed them out using various tools.[326] Coils were pressed together by two different techniques: N and/or U. Using the U technique, both sides of what is to be the clay band are smoothed

[323] BAIBA DUMPE. Podniecība Latviešu folklorā…, 35.-36. lpp

[324] KATARINA BOTWID. Understanding Bronze Age life: Pryssgården (LBA) in Sweden from an Artisanal Perspective. Lund, 2017, pp. 90-95, 117; VALTER LANG. The Bronze and Early Iron Ages…, p. 125

[325] VALENTINE ROUX. Ceramics and Society…, p. 54

[326] BAIBA DUMPE. Jauni atzinumi…, 114. lpp, UWE SPERLING. Aspekte des Wandels in der Bronzezeit…, 199, ANDREJS VASKS. Brikuļu nocietinātā apmetne…, 49. lpp

downwards, creating an upwards U-shaped distortion in the coils.[327] On the other hand, when using N technique, the coils are smoothed in opposite directions, creating an oblique distortion.[328] According to Baiba Dumpe, in the process of pottery building N technique is more progressive and faster than U technique.

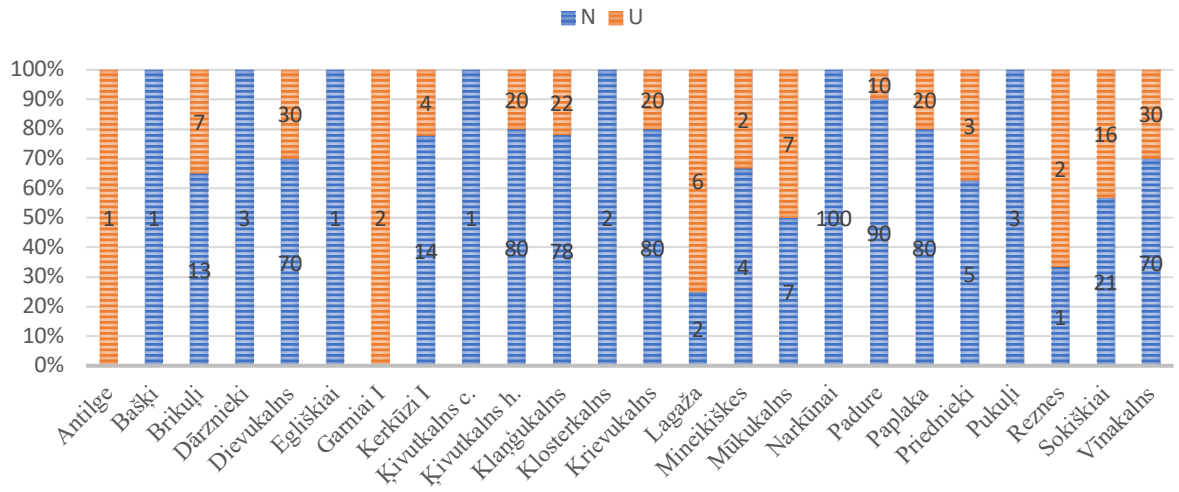

Figure 33. Graph of the percentages of coiling techniques in the analyzed assemblages. Author: V. Visocka

N technique can be considered the most common coil pressing technique, dominating at the majority of sites (Fig. 33). U technique, on the other hand, is dominant only at Lagaža settlement, and is common at Mūkukalns hillfort and in the Reznes cemetery pottery. It should be noted that in the assemblages from Antilgė and Garniai I hillforts only U technique has been distinguished; however, this could be due to the small amount of pottery obtained from these living sites and thus might not represent the real technical character of pottery production. For some pottery sherds it was possible to distinguish the height of the coil in the vessel wall, which is generally from 3 to 6 cm, but sometimes reaches as much as

Figure 34. Fingerprints on the inside of the upper body of the clay vessel (sherd from Asva 2019 excavation, unregistered). Photo: V. Visocka

[327] BAIBA DUMPE. Jauni atzinumi…115; KLÁRA NEUMANNOVÁ et al. Variability in coiling technique…, 174

[328] Ibid.116; Ibid., 174

For example, such coils are distinguished in the assemblages from Ķivutkalns, Padure and Sokiškiai hillforts.[329] Wall thickness of the coils varies from 0.6 to 1.2 cm. In general, the height of the coils does not correlate with their thickness: larger coils are not always thicker than smaller ones. It is possible that smaller coils were not pressed as much, making them as thick as the ones pressed harder. Pressings on the coils and shaping are also seen on those vessels where fingerprints have not been smoothed out. These fingerprints show that coils were pressed in the same direction and that vessels were shaped evenly (Fig. 34).

The wall thickness of all the vessels analyzed varies from 0.4 to 1.5 cm and depends on various properties of the vessel, such as the intended size and amount of temper. Simply put, bigger vessels need thicker walls to provide stability during production.

4.3.2. Pottery firing

Firing is one of the key elements of pottery production and is the finishing step in order for a product to become a vessel. Non-wheel pottery in the Eastern Baltic was fired without a potter's kiln, as archaeological records show no traces of such constructions on the living sites. The first indications of pottery kilns are seen in the 11th–13th century AD, when wheel-thrown pottery appears.[330] Two types of pottery firing techniques without a kiln can be distinguished: open pit firing and bonfire firing.[331] Open pit firing means that the dried vessels were put in a small ditch and fuel stacked around and/or below them; bonfire firing means that they were placed on the ground surface and surrounded with fuel and/or sherds.[332]

Bonfire and open pit firing techniques have a much lower firing temperature and a shorter soaking time, and the temperature is harder to regulate than in kiln firing techniques.[333] "Objects that were in contact with the burning fuel or close to a draught could

[329] VANDA VISOCKA. Pottery and Hillforts…

[330] BAIBA DUMPE, AGNESE STUNDA-ZUJEVA, JANA VECSTAUDŽA. Firing Without a Kiln – Hand-Built pottery in the Territory of Present-Day Latvia in the Middle and Late Iron Age (5th-12th centuries AD). In: PAUL PETTERSSON (ed). Prehistoric Pottery Across the Baltic: Regions, Influences and Methods. Oxford, 2016, p. 43

[331] RICHARD THÉR. Experimental Pottery Firing in Closed Firing Devices from the Neolithic – Hallstatt Period in Central Europe. A pilot study based on experiments executed at the Centre of Experimental Archaeology in Všestary. In: euroREA, 2004, no. 1, p. 36

[332] MARINO MAGGETTI. CHRISTOPH NEURURER, JACOB RAMSEYER. Temperature evolution inside a pot during experimental surface (bon fi re) firing. In: Applied Clay Science, 2011, vol. 53, p. 500

[333] PATRICK QUINN. Ceramic petrography…, p. 203

have been higher fired and better oxidized than those that were sheltered".[334] These kinds of processes can happen on one vessel as well, creating "fire clouding" on its surface.[335]

Dumpe *et al.*[336] argue that yellow-, brown- and red-coloured pottery fabric indicates open pit firing with an available air supply, whereas dark grey or black pottery was exposed to a reducing environment at the end of the firing. Based on experiments, they conclude that the firing temperature of the open firing technique was 600–700°C.[337] Thus, it is possible that the pottery analyzed in this study was fired in similar conditions and temperatures. However, charred seed found in the paste of the pottery indicates that on some occasions the firing temperature might have been much lower.

4.4. Exterior

4.4.1. Morphology

Different types of profile forms have been distinguished in the pottery assemblages: IC (barrel-shaped), CS (slightly profiled), S (profiled), IK (slightly biconical) and K (biconical) (Fig. 35). Based on the data obtained, some regional and chronological patterns can be distinguished.

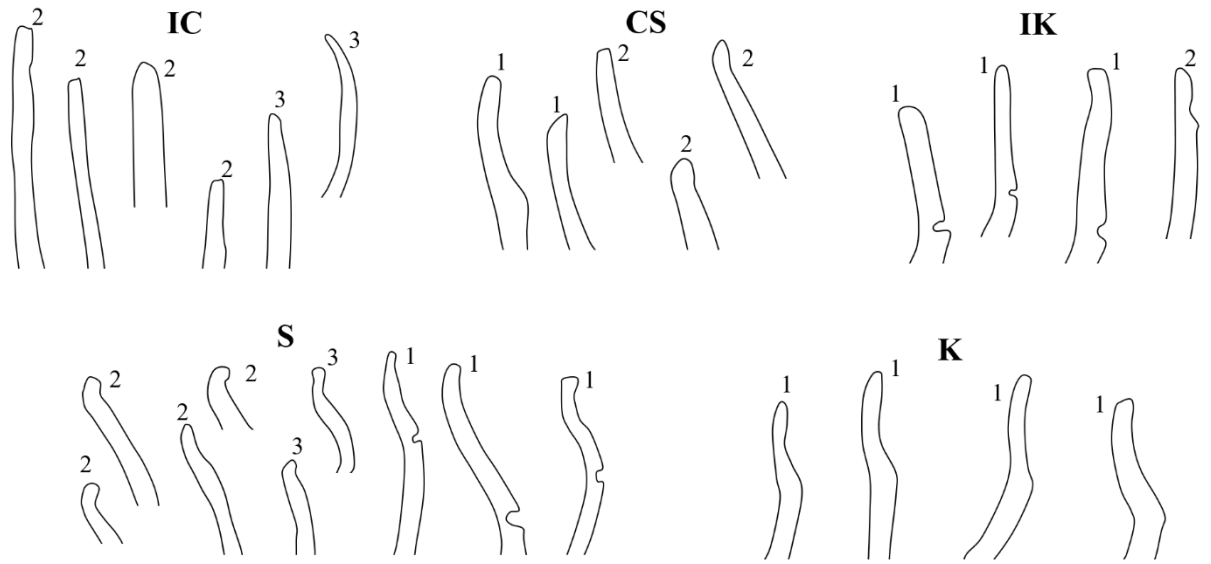

Figure 35. Profile shapes of vessels (1 – Asva, 2 – Ķivutkalns, 3 – Narkūnai hillforts). Author: V. Visocka

[334] PATRICK QUINN. Ceramic petrography…, p. 203

[335] Ibid.

[336] BAIBA DUMPE et al. Firing Without a Kiln…

[337] Ibid., p. 53

The data table shows that on the majority of sites – Antilgė, Asva, Brikuļi, Dievukalns, Ķivutkalns, Mineikiškes, Mūkukalns, Paplaka and Vīnakalns hillforts, Ķivutkalns cemetery, Lejasbitēni and Priednieki settlement and Lipši and Pukuļi cemeteries the dominant profile shape is IC (Fig. 36). CS is dominant in the case of Buļļumuiža cemetery, Garniai I, Krievu kalns, Padure and Sokiškiai hillforts as well as Lagaža and Žalioji settlements. The S shape is dominant at Bašķi, Dārznieki, Ėgliškiai and Strīķi cemeteries and Narkūnai hillfort as well as Tojāti settlement. The K shape is dominant at Kerkūzi I settlement. It is notable that Asva hillfort has the most variety in terms of profile shapes. Tableware, represented by bowls and cups, also occurs at Asva hillfort. Thus, additional shapes can be distinguished and are described by Sperling as the B category, fine ware bowls, where the most common are bowls with an S-profiled rim shape, B II.[338]

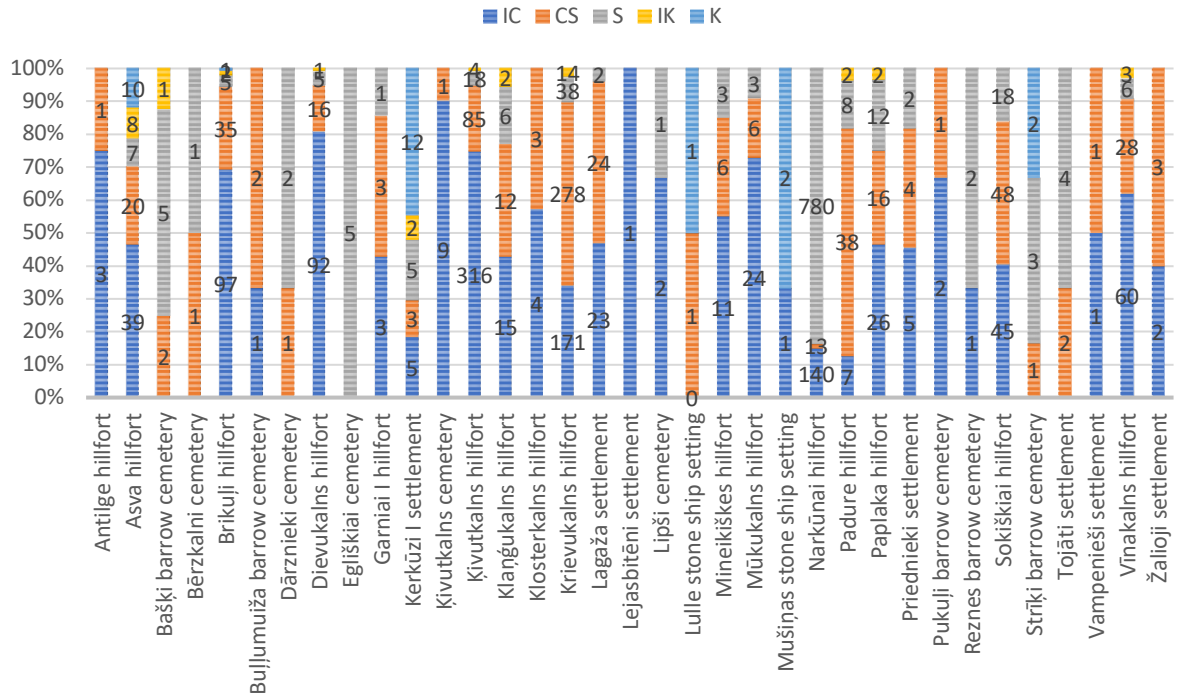

Figure 36. Graph of the percentages of profile shapes in the analyzed assemblages. Author: V. Visocka

From this data it is seen that profiled vessels dominate in Early Bronze Age pottery. However, in the Late Bronze Age in Kurzeme and the Utena district profiled and slightly profiled, and in the Lower Daugava area, at Lake Lubāns and on Saaremaa barrel-shaped vessels are dominant. Lastly, during the Pre-Roman Iron Age, K-shaped vessels were

[338] For details see UWE SPERLING. Aspekte des Wandels in der Bronzezeit…, pp. 188–190

common in the Upper Daugava area (Kerkūzi I and Daugmale), while barrel-shaped and profiled vessels were common in Kurzeme.

4.4.2. Surface treatment

Due to the specific characteristics of the Early Bronze Age assemblages, it is only possible to statistically compare the Late Bronze Age and Pre-Roman Iron Age sites. Thus, this section is devoted to statistical analysis of the Late Bronze Age and Pre-Roman Iron Age surface treatments (Appendix VII).

The data shows that the most common surface treatment on the majority of sites is striation. These include Antilgė, Brikuļi, Dievukalns, Garniai I, Ķivutkalns, Klaņģukalns, Klosterkalns, Krievu kalns, Mineikiškės, Mūkukalns, Narkūnai, Paplaka, Sokiškiai and Vīnakalns hillforts, as well as Priednieki, Žalioji and Kerkūzi I settlements, and Bērzkalni, Buļļumuiža, Lipši and Paveisininkai cemeteries (Fig. 37). Smooth pottery is more common at Bašķi, Ėgliškiai, Ķivutkalns and Mušiņas cemeteries. Coarse-slipped (early rusticated) surface treatment is quite common in the case of Bašķi, Dārznieki, Ėgliškiai and Paveisininkai cemeteries, Krievu kalns, Padure and Paplaka hillforts, and Priednieki settlement, being less common in the case of Asva, Brikuļi, Ķivutkalns and Vīnakalns hillforts. Textile pottery has been found in small amounts at Asva, Brikuļi, Ķivutkalns, Padure and Vīnakalns hillforts. It may be noted that polished pottery is found in large amounts at Asva and is less common at Ķivutkalns and Paplaka hillforts.

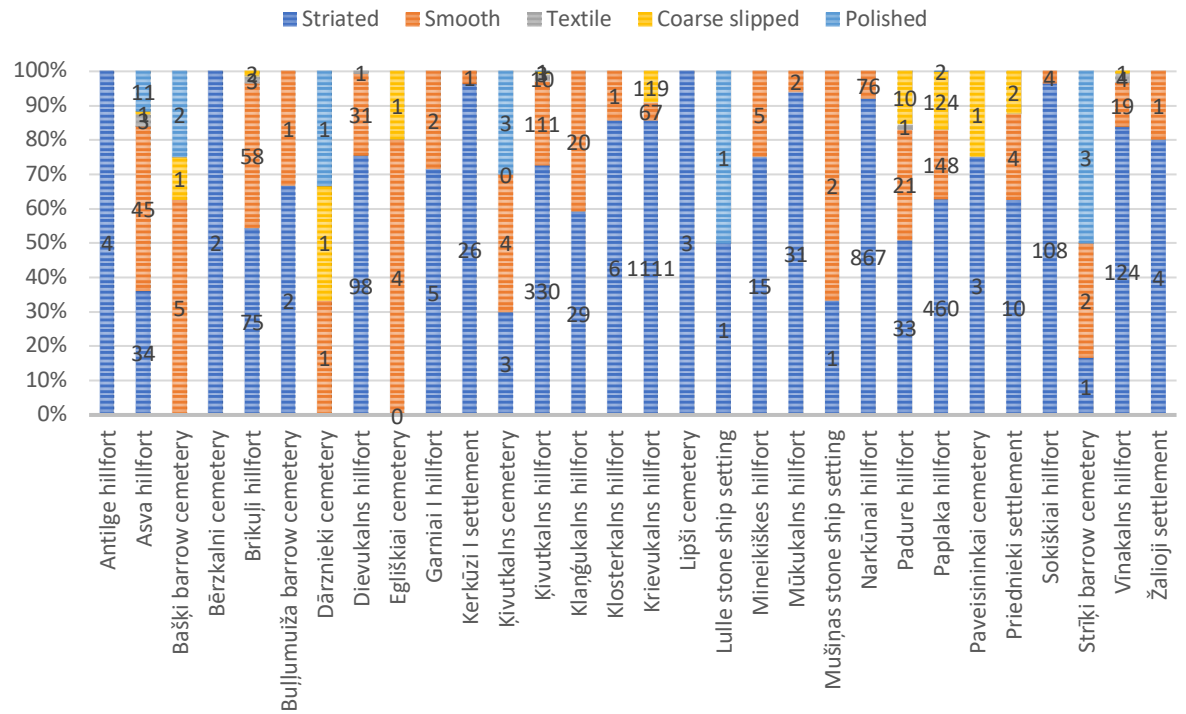

Figure 37. Graph of the percentages of surface treatments in the analyzed assemblages. Author: V. Visocka

Some regional tendencies are seen from the data. Thus, coarse-slipped pottery is more common in Kurzeme and the western part of Lithuania, while textile pottery is more common in the Lower Daugava area, on Saaremaa and at Lake Lubāns. Significantly, Padure hillfort is the only hillfort in the western part of Latvia where textile pottery has been found, indicating some regional contacts.[339]

4.4.3. Ornamentation

Ornamentation drastically decreases during the Late Bronze Age and is mainly common on living sites near the coast or major rivers, the only exception being the inland site of Brikuļi hillfort, where approximately two thirds of the vessels are ornamented, while the assemblages from the other inland areas, such as in Utena district, contain only single vessels, or up to a maximum of three, that have ornamentation.[340] The only ornamentation found on inland sites is pit ornamentation and, in the case of Sokiškiai, coils around the neck of the vessel. Among all the sites, Asva and Brikuļi hillforts can be considered the ones with the most ornamentation in the assemblages, whereas the rest of the sites have only a few such vessels or none at all.

Various elements have been used in ornamentation: pits of different sizes and shapes, incised lines, fingernails as well as plastic elements, such as coils and oval bumps (Table 4, Appendix VIII). In most cases the upper part of the vessel is ornamented. Pit ornamentation is the most common at various living sites, applied in one, two or rarely three to five rows. These pits usually do not form any particular motifs, an exception being a vessel from Laukskola settlement, which has a triangle-like motif, and there are similar examples from Asva and Brikuļi hillforts.

It should be emphasized that Asva fine ware is the most highly ornamented in comparison to all the other vessels analyzed. The ornamentation consists mainly of incised lines that form vertical zigzags, rhombuses etc.[341] Ornamentation of incised lines occurs at Ķivutkalns hillfort, where it forms a motif in combination with pits. Incised line

[339] ANDREJS VASKS, LAIMDOTA KALNIŅA, LINAS DAUGNORA. Beltu pilskalns. In: Arheoloģija un Etnogrāfija, 2011, nr. 25.

[340] VANDA VISOCKA et al. From the Seaside to the Inland…; VANDA VISOCKA. In a search of pottery function and meaning by context, techno- stylistics and use-wear patterns: a case study of Brikuļi hillfort pottery. In: JASNA VUKOVIĆ, VESNA BIKIĆ (eds). Pots in context: Vessels' use, function, and consumption, research strategies and methodology. Belgrade, In print.

[341] For details see UWE SPERLING. Aspekte des Wandels in der Bronzezeit…

ornamentation is most common at the Kurzeme cemeteries Bašķi and Strīķi, where such ornamentation has been applied on the lip, or rarely on the shoulder, as is the case with Ilmandu Ware.[342]

Other common ornaments include plastic elements in the form of coils around the shoulder or neck of the vessel and oval bumps.[343] These elements have been found in relatively large amounts at Asva (coarse ware) and Krievu kalns hillforts, being less common at Dievukalns, Ķivutkalns and Vīnakalns hillforts. Sometimes these coils are ornamented with fingernails or finger impressions, such motifs occurring at Asva, Krievu kalns and Klosterkalns hillforts.

Table 4. Numbers of sherds with ornamentation from Late Bronze and Pre-Roman Iron Age sites.

Sites	**Ornamentation**														
	Cord imprints	Cord imprints + pits	Cord imprints + line incisions	Pits	Fingernail impressions	Oval bumps	Line incisions	Line incisions + pits	Coils	Coils + nail impressions	Snicks	Snicks + pits	Fish bone ornamentation	Cat paw ornamentation	**Overall**
Asva (among 30% of vessels)	3	-	-	63	3	-	3	4	4	2	-	-	-	-	**82**
Bašķi	-	-	-	-	-	-	6	-	-	-	-	-	-	-	**6**
Brikuļi (among 112 vessels)	-	-	1	47	-	-	2	1	-	-	2	1	-	-	**54**
Dievukalns	1	-	-	27	1	-	3	-	2	-	-	-	-	-	**34**
Garniai I	-	-	-	1	-	-	-	-	-	-	-	-	-	-	**1**
Kerkūzi I	-	-	-	-	-	-	-	-	-	-	-	-	-	1	**1**
Ķivutkalns (among 60%)	19	3	-	81	-	2	-	9	6	-	-	-	-	-	**120**
Klaņģukalns	-	-	-	30	-	-	2	-	-	-	-	-	-	-	**32**
Klosterkalns	-	-	-	-	-	-	-	-	-	1	-	-	-	-	**1**
Krievu kalns	-	-	-	13	21	5	1	-	3	2	-	-	-	-	**45**
Laukskola	-	-	-	5	-	-	-	-	-	-	-	-	1	-	**6**
Mineikiškes	-	-	-	2	-	-	-	-	-	-	-	-	-	-	**2**
Mūkukalns	8	4	1	64	4	-	-	4	4	-	-	1	-	-	**94**
Padure	-	-	-	1	-	-	-	-	-	1	-	-	-	-	**2**
Paplaka	-	-	-	-	6	-	-	-	1	-	-	-	-	-	**7**

[342] VALTER LANG. The Bronze and Early Iron Ages…

[343] VANDA VISOCKA. Dekoratīvie elementi vēlā bronzas laikmeta keramikā Latvijas teritorijā. In: VALDIS SEGLIŅŠ (ed). Lietišķi ģeoloģiskie pētījumi, jaunas tehnoloģijas, materiāli un produkti. Zinātnisko rakstu krājums. Rīga, 2016, 78.–89. lpp

Paveisininkai	-	-	-	3	-	-	-	-	-	-	-	-	-	-	**3**
Priednieki	-	-	-	1	-	-	-	-	-	-	-	-	-	-	**1**
Sokiškiai (among 30%)	-	-	-	3	-	-	-	-	2	-	-	-	-	-	**5**
Strīķi	-	-	-	-	1	-	1	-	-	-	-	-	-	-	**2**
Vīnakalns	-	-	-	23	-	-	2	-	6	-	-	-	-	-	**30**

These kinds of ornamentation and the similarities between them indicate regional transfer of knowledge and aesthetic values. It is seen that Dievukalns, Krievu kalns, Ķivutkalns and Vīnakalns might have had contacts with the Asva communities, where pots with specific ornaments are the most common. Very interesting is the case of Brikuļi, which shares the same kind of ornamentation tendency as in Asva coarse ware, i.e. abundant pit ornamentation.

4.4.4. Wares and types of pottery

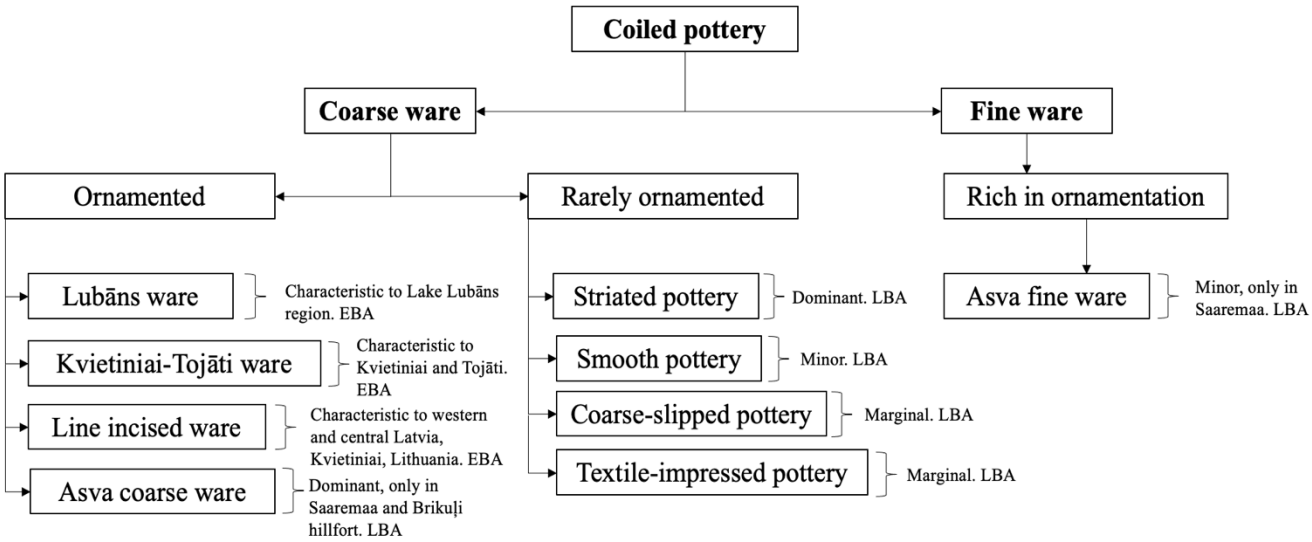

Figure 38. Basic classification of the wares and types of the pottery assemblages analyzed (author: V. Visocka).

Overall, in the Eastern Baltic during the Bronze and Pre-Roman Iron Age seven wares/pottery types can be distinguished: Lubāns Ware, Kvietiniai-Tojāti Ware, Line-Incised Ware, striated pottery, Asva Ware, coarse-slipped pottery and textile-impressed pottery (Fig. 38). It is important to stress that smooth pottery is also common in the analyzed assemblages, but because of the absence of distinctive features it is not described in detail.

4.4.4.1. Lubāns Ware

Lubāns Ware is one of the most characteristic Late Neolithic – Early Bronze Age pottery styles. These vessels are rich in ornamentation, which consists of various motifs, such as rhombuses, lines and zigzags, created using a variety of stamps, such as smooth stamps

and combs, pits and notches, cords and line incisions, covering the whole body of the vessel.[344] In these motifs, pits are the dominant element on the majority of the vessels. The motifs consist of one, two or three elements.[345] Ilze Loze distinguishes 90 different motifs on Lubāns Ware, which indicates the large variety of aesthetics in the Lake Lubāns communities. The lip is always ornamented with comb lines, incisions or pits. It should be noted that the inner surface of these vessels is often striated.

These vessels are made from paste with coarse granitic rock and, in some cases, are tempered with plant matter as well.[346] Wall thickness generally varies from 0.7 to 1.1 cm, very rarely as thin as 0.4–0.5 cm.[347] The diameter of the vessels is from 12 to 28 cm. The dominant vessel shapes of Lake Lubāns Ware are profiled and slightly profiled. According to Dumpe,[348] in Lubāns Ware, potters returned to the construction of round-shaped bases. For example, at Lagaža there is only one vessel with a flat base, the rest being oval-shaped. The dominant shapes of the vessels are slightly profiled and profiled.

4.4.4.2. Kvietiniai-Tojāti Ware

Kvietiniai-Tojāti Ware is a subgroup of Post-Corded Ware and is dated to the Early Bronze Age. For now, this type of pottery has been found only at the Kvietiniai and Tojāti settlements. This type of pottery is decorated with impressions of cord twisted tightly in Z direction, which have been applied horizontally.[349] It is important to note that Z twist is exclusive to this type of pottery. In some cases, cord was impressed on the everted rim. The surface of the pottery is slightly brushed or smooth.

Kvietiniai-Tojāti Ware was tempered with coarse crushed granitic rock. The rim diameter is from 12 to 24 cm.[350] Wall thickness is from 0.8 to 1 cm. Profile shapes include slightly profiled and profiled with a markedly everted rim.

4.4.4.3. Line-Incised Ware

Line-Incised Ware has been found at Pukuļi, Reznes and Ķivutkalns cemeteries, as well as Kvietiniai settlement. In accordance with the chronology of these settlements, it might

[344] ILZE LOZE. Pozdnij neolit…, s. 100

[345] Ibidem.

[346] BAIBA DUMPE. Keramika Latvijā. In: Mākslas vēsture un teorija, in print, 36. lpp

[347] ILZE LOZE. Pozdnij neolit…, s. 100

[348] BAIBA DUMPE. Keramika Latvijā…

[349] ROKAS VENGALIS *et al.* The Large-Scale Rescue Excavation…, p. 29

[350] Ibid.

be dated to the Early Bronze Age. It should be noted that in the case of Kvietiniai, Rokas Vengalis *et al.*[351] include this style in a single group with Kvietiniai-Tojāti Ware. However, this appears to be a separate style, considering the vessel form and ornamentation, even though the clay matrix is similar. The surfaces of these vessels are smooth or slightly striated and ornamented with incised lines, vertically or rarely horizontally.

The vessels have been tempered with granitic rock, with a grain size of 2–4 mm, or in one case at Ķivutkalns – 7 mm. The profile shape is determinable only for two vessels from Reznes and Ķivutkalns cemeteries (S), and so it is hard to interpret the main tendencies of vessel morphology. The wall thickness of the vessels varies from 0.8 to 1 cm.

4.4.4.4. Striated pottery

Striated pottery can be assumed to have originated in the 1400s cal BC, but as a separate style which spread across large areas of the Eastern Baltic, we can place it in the Late Bronze Age. This type of pottery is dominant on the majority of sites. Based on its characteristics and chronology, striated pottery can be divided into two groups: 1) early striated, characterized by a barrel or profiled shape, with vertical or horizontal striation, and 2) late striated, characterized by a biconical shape and vertical striation downwards from the neck.[352] The former relates to the Late Bronze Age, and the latter to the end of the Late Bronze Age and the Pre-Roman Iron Age.

Striation was made by smoothing the vessel's surface with various kinds of tools, such as a bundle of weeds, shells, bone or wooden combs, etc.[353] Brushing (striating) the surface is done in order to regularize and homogenize the walls and so cover the junctions between coils.[354] The inner surface of these vessels was commonly striated as well. Vessels with striation on the inside have been regarded as chronologically later. However, as Vasks[355] argues, analysis of the material shows that this is often not the case: no chronological pattern emerges regarding vessels with a striated or smooth interior. The striation on the exterior is most commonly coarse and vertical, showing some finer striations, indicating that generally a

[351] ROKAS VENGALIS *et al.* The Large-Scale Rescue Excavation…, p. 29

[352] JANIS GRAUDONIS, Shtrihovannaja keramika na teritorii Latviskoi SSR i nekotorye voprosi etnogeneza Baltov. In: Iz Dverneishei Istorii Baltskih Narodov. Riga, 1980. s. 65

[353] VANDA VISOCKA. Švīkātās keramikas izgatavošanas tehniskie aspekti Latvijas teritorijas pilskalnu materiālā. In: JĀNIS ĶERUSS, ILGVARS MISĀNS (eds). Studenti vēstures zinātnē, 1. Pirmās starpdisciplinārās Latvijas jauno vēstures pētnieku konferences materiāli. Rīga, 2018, 11.-25. lpp

[354] VALENTINE ROUX. Ceramics and Society…, p. 94

[355] ANDREJS VASKS. Keramika epokhi pozdnej bronzi…

bundle of weeds or sticks was used for smoothing the surface. On the other hand, striation on the interior was most often horizontal or oblique, which most likely relates to practical considerations – it is easier and more effective to smooth the vessel's interior in such a way.

For early striated pottery, two subgroups can be distinguished: striated coarse-slipped and striated textile. Both are the result of local tradition merging with non-local pottery styles. Striated coarse-slipped means that a layer of clay, usually mixed with sand, was added over the surface of the striated vessel.[356] However, in one case at Krievu kalns such a layer was added on a smooth vessel, which was subsequently striated. This vessel stands out among the rest and can be considered unique. Such vessels are more common in Kurzeme, especially Krievu kalns, although they are also found on Lower Daugava living sites: Ķivutkalns and Vīnakalns hillforts as well as Laukskola settlement. Striated textile vessels are vessels exhibiting the use of both surface treatments. This subgroup is exclusively characteristic of Saaremaa, where it is represented at Asva hillfort, and the Lower Daugava living sites, where it occurs in the Ķivutkalns and Vīnakalns hillfort assemblages.

Late striated pottery is characteristic along the Daugava during the end of the Late Bronze Age and the Pre-Roman Iron Age, occurring at Daugmale hillfort and Kerkūzi I and Vilmaņi III settlements. This style later spread in present-day Lithuania during the Iron Age.

The morphology of striated pottery depends on the region: in Kurzeme and the Utena district more profiled and slightly profiled vessels are common, while in the Lower Daugava and Lake Lubāns areas barrel-shaped vessels are widespread. Rim diameter varies from 5 to 34 cm. The biconical profile form is characteristic of late striated pottery. Wall thickness of the vessels varies from 0.4 to 1.5 mm.

4.4.4.5. Asva Ware

Asva Ware is dated to the Late Bronze Age and is divided into two groups, fine and coarse ware, of which the latter is dominant (Fig. 39).

4.4.4.5.1. Fine ware

Fine ware is dated to the Late Bronze Age, as it has been found only in contexts dated to this period.[357] These vessels have smoothed or polished surfaces, and some are richly

[356]ANDREJS VASKS. Keramika epokhi pozdnej bronzi…, s. 41

[357] VALTER LANG. The Bronze and Early Iron Ages…, p. 129

ornamented.[358] Among all the analyzed sites, this type has been found only at Asva and Ridala hillforts and Lülle stone ship setting.

Valter Lang[359] argues that this type has been found at the Kurzeme stone ship settings and Ķivutkalns hillfort as well. However, the author has not found evidence of fine Asva Ware from the ship settings, as all of the sherds in these assemblages were coarse-grained and not polished. At Ķivutkalns hillfort and cemetery, two fragments of vessels with knobs have been found, which might thus belong to Asva fine ware; however, more detailed analysis is needed before making further interpretations.

Figure 39. Asva coarse and fine ware (TLÜ 3994, 3658:492). Photo: V. Visocka

In terms of morphology, these vessels are exclusively biconical with a flat bottom and tempered with sand or fine-grained granitic rock. They usually have knobs. The wall thickness is usually 0.55–1.1 cm. This type of ware is considered to have functioned as tableware. Such vessels are generally typical of the Lusatian Culture of Central Europe and Scandinavia.[360]

4.4.4.5.2. Coarse ware

The surface of coarse ware is usually smooth, striated, textile or all or two of these combined. Two thirds of such vessels are ornamented, mainly with pits in one or more rows.[361] Most of them are profiled, slightly profiled or barrel-shaped, and tempered with coarse granitic rock. The wall thickness of these vessels is 0.5–1.3 cm. This type of pottery

[358] UWE SPERLING. Aspekte des Wandels in der Bronzezeit…

[359] VALTER LANG. The Bronze and Early Iron Ages…

[360] Ibid., p. 128

[361] Ibid. p. 127

has been distinguished at Asva, Ridala and Brikuļi hillforts, and also in South-West Finland.[362]

4.4.4.6. Coarse-slipped pottery

Coarse-slipped, or early rusticated, pottery occurs commonly in small amounts in the western and southern parts, and is rare in central part of the Eastern Baltic. The characteristic feature is an additional clay layer tempered with fine sand or fine granitic rock temper, organics or dry clay lumps, which has been applied on the surface of the vessel. This layer has been added as a separate coating on the vessel wall by hand or using some kind of tool.[363] "This is applied in order to regularize and homogenize the surface by hiding any traces left by the roughing-out and/or the shaping operations […] also […] to create grainy surface […]. To diminish thermal spalling and cracking".[364]

Coarse-slipped pottery has been observed already in the Eneolithic of Central Europe (5th millennium BC), and subsequently evolved and was made by communities of the Lusatian, Únětice and Trzciniec archaeological cultures.[365] The chronology of Eastern Baltic coarse-slipped pottery can be divided into two groups: 1) early (1st millennium – 1st century BC), and 2) late (1st–12th century AD).[366] In the early phase, coarse-slipped pottery was common in the southern and western parts of the Eastern Baltic, while in the late phase it occurred in the whole region. Until the 5th century AD it was also common in present-day Lithuania, and occurs until the end of the 12th century in present-day Latvia.[367]

4.4.4.7. Textile-impressed pottery

Textile, or textile-impressed, pottery is one of the rarest types seen in the Eastern Baltic material. It is common in the northern and central parts of the Eastern Baltic. The texture of textile pottery, i.e. how it was created, is one of the most interesting aspects. Previously researchers thought that this kind of texture was created with a textile cloth, which is why it was so named. However, experimental research by Dumpe shows that this kind of

[362] VALTER LANG. The Bronze and Early Iron Ages…, p. 127

[363] ANDREJS VASKS. Keramika epokhi bronzi…, s. 51

[364] VALENTINE ROUX. Ceramics and Society…, pp. 99–100

[365] ANDREJS VASKS. Apmestās keramikas izplatība Latvijā…, 148. lpp

[366] Ibidem, 149–150.lpp; VYTAUTAS DAUGUDIS. Nekotorije dannije o proishozhdenii…, s. 66

[367] VYTAUTAS DAUGUDIS. Nekotorije dannije o proishozhdenii…, s. 66

texture is created using cord wrapped or knotted around a stick, obtaining various types of textures similar to cloth.[368]

Textile pottery has quite a wide chronology and distribution. Chronologically, it can be divided into two groups: 1) early and 2) late.[369] Early textile ceramics are dated to the Late Neolithic. Their distribution extends across a very wide region – from the Volga and Oka regions of central Russia, across the Lake Ladoga area and up to present-day Finland and further to the north-western part of the Baltic.[370] During the Early Bronze Age, textile pottery ceases to be used in the Eastern Baltic; however, it re-appears during the Late Bronze Age and continues until the 5th–6th century AD.[371]

4.5. Discussion and conclusions regarding pottery production and materials used

The obtained data shows that potters had access to good clay resources but mostly chose till clay, which is indicated by the sandy and impure clay paste observed in pottery thin sections, and the high Al_2O_3 and Fe_2O_3 and low CaO and MgO, which makes it highly plastic. The clays obtained in the field study generally have high levels of CaO, and thus, although usable for pottery production, were not used by ancient potters. Only one clay sample corresponds chemically and mineralogically to pottery from the archaeological site: this is KLG1 and Krievu kalns hillfort. It is also significant that Ķivutkalns sample KIV15 is not chemically similar to other samples from this living site; however, it could correspond to clays collected from the region, making it local or possibly imported from Asva or Narkūnai, as these clays also fall in the same group as clays from the Lower Daugava area.

The main tempering material was granitic rock, grog being used rarely, and observed in some cases in the Late Bronze Age pottery of Kurzeme and the Lower Daugava area (Klaņģukalns, Padure and Paplaka). One sample from Laukskola can be considered unique, since it was found to have quartzite temper. Some natural and accidental impurities were also distinguished in the material analyzed, namely iron compound and carbonate concretions as well as seed imprints. Overall, eight fabrics with various subgroups were distinguished. One

[368] BAIBA DUMPE. Agrās tekstilās keramikas…, 81. lpp

[369] AIVAR KRIISKA, MIKA LAVENTO, JÜRI PEETS. New AMS Dates of the Neolithic and Bronze Age Ceramics in Estonia. In: Estonian Journal of Archaeology, 2005, vol. 9(1), p. 6

[370] IEVA CIMERMANE. Latvijas tekstilā keramika un tās sakari ar Djakovas kultūras apgabalu. In: Arheoloģija un Etnogrāfija, nr. 8, Rīga, 1968. 54.lpp; KENNETH GUSTAVSSON. Otterböte: New Light on a Bronze Age site in Baltic. Stockholm, 1997, p. 77

[371] IEVA CIMERMANE. Latvijas tekstilā keramika…, 54–57. lpp

clay fabric, with iron compound concretions, is characteristic only of Kurzeme pottery, and this includes one sample from Mušiņas stone ship setting. This indicates that the vessel from Mušiņas was made from local clay, and thus can be considered locally made rather than imported. These fabrics are common on most of the sites, which indicates transmission of technological knowledge between Eastern Baltic communities. The most common clay paste used was coarse, rich in silt and sand. In all except a few cases, till clay was most likely used in pottery production, as the clay paste used was coarse and with natural impurities. There are no separate tendencies separating Early Bronze Age from Late Bronze Age pottery production in terms of fabrics, i.e. the main tendencies of fabric composition are represented in both periods. The Pre-Roman Iron Age pottery is tempered with coarser granitic rock than that of the Late Bronze Age.

All of the vessels were created without a potter's wheel and shaped using the hands, as indicated by fingerprints left on some of the vessels. The coiling method was used in pottery construction, using the U or N technique, where the former dominates during the Early Bronze Age, and the latter during the Late Bronze Age.

Regarding morphology, some regional and chronological tendencies are also seen. During the Early Bronze Age profiled vessels are more common than barrel-shaped vessels, whereas during the Late Bronze Age barrel-shaped vessels are common in the Lower Daugava and Lake Lubāns areas and on Saaremaa, slightly profiled and profiled vessels in the Kurzeme and profiled vessels in the Utena district. During the Pre-Roman Iron Age a new shape appears in the tradition of striated pottery, namely biconical vessels, which are common in the Upper Daugava area, whereas in Kurzeme a different tradition is seen: S-shaped vessels, with quite many early rusticated vessels in addition to striated vessels.

During the Early Bronze Age three types of wares existed: Lake Lubāns, Kvietiniai-Tojāti and Line-Incised wares, in addition to which some Post-Corded Ware is also distinguished. In the Late Bronze Age, striated and Asva Wares are distinguished, along with some subtypes and non-dominant wares, such as early rusticated, textile, striated coarse-slipped and striated textile. Lastly, during the Pre-Roman Iron Age late striated pottery is common in the Upper Daugava area, and striated and early rusticated pottery in Kurzeme. This indicates quite a slow pace of change in pottery production and in the aesthetic values of the inhabitants during the period from the Early Bronze Age to the Pre-Roman Iron Age.

5. SPATIAL DISTRIBUTION AND EVIDENCE OF POTTERY FUNCTION

This chapter addresses the function and meaning of the pottery, studied through the analysis of size, spatial distribution, use-alteration patterns and organic residue analysis. Not all sites have detailed data of spatial distribution, and so only a few sites will be analyzed in such a manner.

5.1. Pottery from living sites

5.1.1. Spatial distribution

Antilgė hillfort. Three trenches have been excavated on Antilgė hillfort, two of which relate to the Late Bronze Age. In trench 1, five features were distinguished, which are possibly traces of buildings.[372] Pits were observed in squares B2 (feature 1), A3 (feature 2), B4 (feature 3) and A2 (feature 4) as well as another feature, no. 5, located in B4 near feature 3.[373] The fill of feature 1 contained two striated pottery sherds, and feature 2 had another four.[374] Overall, 20 artefacts were uncovered in this trench, such as crucibles, bone tools, a grinding stone, etc., and 1107 pottery fragments.[375]

In trench 2, a large boulder without traces of use was found, which, in the opinion of Čivylitė, was exposed during habitation of the hillfort.[376] In this trench, 1020 pottery fragments, two bone tools and a grinding stone were uncovered.[377] The distribution of pottery shows that in trench 1 the highest amounts of pottery have been found near features 2 and 4, with less pottery in other areas, while in trench 2, with less pottery overall, the largest amounts are from squares B3 and C3 (Appendix IX).

Brikuļi hillfort. The main living and crafting activities were concentrated in the western and southern parts of the site (trenches III, IV, V, Va, X and XI) and the south-east of the hillfort (trenches XX, XVIII, XIX, XXIII and XXIV) near the palisades (Appendix X). From the distribution of the smooth and striated pottery, it is seen that it concentrates in three areas of the hillfort, particularly in trenches VIII, XVIII, XIX, XX, XXIII and XXIV, where

[372] AGNĖ ČIVILYTĖ. Antilgės piliakalnio (u.k. 3572)..., pp., 9

[373] Ibidem.

[374] Ibid. p. 10

[375] Ibid., p. 20, 47

[376] Ibid., p. 11

[377] Ibid., p. 13

8971 samples were found. This is also the largest area, with many features and structures, and therefore such a concentration was to be expected. More interesting is the much smaller area of trenches III, IV, V, Va and VI, where almost the same number of sherds – 8363 – were found. Lastly, mention should also be made of the area of trenches X, XI and XIV, where 2360 pottery fragments were found. In the rest of the trenches there was no intensive inhabitation, and therefore the number of sherds did not exceed 300.

Besides the pottery distribution, a variety of structures and features also indicate that quite intensive household activities took place in the area of trenches III, IV, V, Va and VI.[378] This area might be considered a food preparation zone, as in one of the buildings there was a high concentration of fish scales and animal bones, while in others, along with bone, there was an abundance of pottery sherds, together with various household tools, such as bone spikes and chisels and other artefacts – bone pins, an arrowhead, stone axe fragments, etc.[379] This does not mean that the area served only one function. The distribution of clay crucibles and moulds indicates that this area was used for bronze-casting as well.[380] Moreover, it shows that bronze-casting most likely took place in all of the living and crafting areas of the hillfort. In the surroundings of hearths in squares 3–4/e–f and 2–3/d–e (in trench IV), in addition to significant numbers of sherds, clay crucible fragments as well as a stone axe and a bone spike were recovered, while square 4/a, in addition to pottery and bone, also yielded a bronze razor.[381] Waste and household pits contained much less pottery than other features. The only exception in this area is a household pit in squares 1–3/a (trench Va), where, in addition to a strip of bronze sheet, an abrading stone and two bone spikes, 120 striated and smooth pottery sherds were recovered.[382] This is the only area with such a high concentration of pottery in buildings and hearths.

A building in trench XIX can be considered a very interesting feature: here, a pit was discovered (square 5–6/i–j), which contained a horse skull, a wild boar jaw, bones of elk,

[378] ANDREJS VASKS. Pārskats par izrakumiem Brikuļu apmetnē 1974. gadā. Rīga, 1974. In: Latvijas Vēstures Institūts Arheoloģisko materiālu krātuve (LVI AMK), Inv. Nr. VIAA: 312; ANDREJS VASKS. Izrakumi Brikuļu apmetnē 1977. gadā: pārskats I, II. Rīga, 1977. In: LVI AMK, Inv. Nr. VIAA: 373, 1–12. lpp

[379] ANDREJS VASKS. Pārskats par izrakumiem Brikuļu apmetnē 1974. gadā…, 6.–16. lpp; ANDREJS VASKS. Izrakumi Brikuļu apmetnē 1977. gadā…, 3.–12. lpp

[380] ANDREJS VASKS. Tīģeļi un lejamveidnes Brikuļu nocietinātajā apmetnē. In: Arheoloģija un Etnogrāfija 1994, nr. 27, 122. lpp

[381] ANDREJS VASKS. Pārskats par izrakumiem Brikuļu apmetnē 1974. gadā…, 11.–14. lpp

[382] ANDREJS VASKS. Izrakumi Brikuļu apmetnē 1977. gadā…, 3. lpp

beaver, cattle, ruminants, dog and domesticated pig, along with a small clay vessel, bone tools (a chisel and two spikes) as well as a clay crucible.[383] According to Vasks, this is quite an unusual find compared to others on the site, and the find of a whole horse skull and unbroken bones as well as tools indicates that this was a house offering.[384] Although such offerings are quite rare in present-day Latvia, they are not unique. A similar offering has been found at Asote hillfort, where, together with striated pottery, a dog skull and jaw were found as well as bones from cattle, horse, sheep and birds.[385]

Another interesting area with diverse structures and features is that of trenches X and XI, where various waste (?) and household pits were uncovered next to buildings, yet only small amounts of pottery and other artefacts, excluding crucibles, have been found inside or associated with these features, and these are in very fragmentary condition. Near this area, in squares 12/d–e – 2/c–e, is a sunken building (trenches XIV and XV), where, in addition to a few pottery sherds, the shaft of a bone pin and a piece of an antler tine with cut marks were found.[386] Lastly, a vessel was found in an ashy clay mound (13–15/b–c, trench XXIV); however, this find is difficult to interpret.

All the evidence described above suggests that the pottery at Brikuļi was mostly found in contexts associated with household activities – buildings and hearths. However, a few samples found in such contexts as an offering and a clay mound suggest that pottery was also used for some ritualistic purposes.

Kerkūzi I settlement. The main living and crafting activities took place in the north-western part of the settlement (trenches II–VIII). Clusters of hearths have been found in trench X. Interestingly, at Kerkūzi I sunken dwellings have also been found; however, these were almost devoid of pottery sherds.[387] Most of the hearths either did not contain any pottery or had less than 50 sherds.[388] Large amounts of pottery sherds have been found in trench II, squares 9–12/L-O, i.e. in the area of a building.

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[383] ANDREJS VASKS. Pārskats par izrakumiem Brikuļu apmetnē 1978.g. (I-II). Rīga, 1978. In: LVI AMK, Inv. Nr. VIAA: 379, 17. lpp

[384] ANDREJS VASKS. Brikuļu nocietinātā apmetne…, 27)

[385] ELVĪRA ŠNORE. Asotskoje Gorodishche…, ANDREJS VASKS. Brikuļu nocietinātā apmetne…, 27)

[386] ANDREJS VASKS.. Pārskats par izrakumiem Brikuļu apmetnē 1978.g…., 9.lpp

[387]ANDREJS VASKS. Pārskats par izrakumiem Kerkūzu apmetnē 1987. gadā. Rīga. In: LVI AMK, Inv. Nr. VIAA: 620

[388] ANDREJS VASKS. Pārskats par izrakumiem Kerkūzu I apmetnē 1985. gadā. Rīga. In: LVI AMK, Inv. Nr. VIAA: 551; ANDREJS VASKS. Pārskats par izrakumiem Kerkūzu I apmetnē 1986.g. Rīga. In: LVI AMK, Inv. nr. VIAA: 587; ANDREJS VASKS. Pārskats par izrakumiem Kerkūzu apmetnē 1987. gadā…

Krievu kalns hillfort. The main living and crafting areas concentrated near the defensive system in trenches I, II, III, IV and VI (Appendix XI).[389] Unfortunately, the extent of the buildings could not be clearly traced. The structures, such as palisades, hearths, post-holes and household pits, were mostly concentrated in trenches I, III–IV and VI–VIII, and thus most of the pottery is concentrated here.[390] Larger pottery concentrations were found in the hearths together with bones, i.e. in food preparation zones (?), with less pottery in the household pits. An exception is feature 3 (trench IV, square 2/B, layer 5), in which more than 200 sherds were discovered, and which can thus be regarded as a waste pit.[391]

Mention should be made of the hearth in square 2/B of trench I, where a horse jaw was found on stones, possibly identifiable as an offering.[392] This feature contained only 19 sherds, 12 of which were striated, while the rest were unidentifiable.[393] It is possible that these sherds come from a single vessel and thus could be associated with the horse jaw, constituting an offering, similarly to the examples from Asote and Brikuļi hillforts.

An almost entire miniature vessel was found in trench I, layer 2, and there was a whole pot (medium sized) *in situ* as well.[394] Unfortunately, the detailed context of these vessels is not known, as there were no indications of hearths, waste pits or other structures nearby, although an intensive cultural layer was distinguishable in the zone of these finds.

Ķivutkalns hillfort. The main living and crafting area concentrated in the north-eastern and south-western parts of the hillfort, where the buildings were distinguished, although the placement of hearths indicates that activities took place in the middle of the hillfort as well, i.e. in trenches I, V, VIII, XIII and X, part of VI and IX (Appendix XII). The amounts of recovered pottery sherds indicate that most of the pottery (ca. 4000–6000 sherds) was discovered in trenches V, VI, IX and XII. Large amounts of sherds (ca. 2000–3000) have been excavated in trenches I, II, III, VIII and X. The rest of the trenches yielded no more than

[389] ANDREJS VASKS et al. Krievu Kalns Hill-Fort, p. 83

[390] Ibidem, Fig. 3

[391] ANDREJS VASKS, AIJA VILKA. Pārskats par arheoloģiskās izpētes darbiem Skrundas Krievu kalna pilskalnā (Valsts aizsardzības Nr. 1263) 2013. gadā. Rīga, 2014. In: Latvijas Nacionālais Vēstures Muzejs Arheoloģijas departaments (LNVM AD), unregistered, 13. lpp

[392] ANDREJS VASKS, INGA DONIŅA. Pārskats par arheoloģiskās izpētes darbiem Skrundas Krievu kalna pilskalnā (Aizs. Nr. 1263) 2012. gadā. Rīga, 2013. In: LNVM AD, unregistered, 13. lpp

[393] Ibidem.

[394] Ibid. 10. lpp

500 sherds.[395] Based on the available data, it is seen that pottery intensity corresponds to structures such as buildings and hearths found in this area, thus indicating activities related to pottery, i.e., storage and cooking within the living site.

At least 20 hearths and 32 possible hearths were distinguished in the course of excavation.[396] The hearths have been described in great detail, permitting comparison of the main tendencies and the function of the hearths. It seems that hearths might have been used for waste, as large amounts of fish bone were found in nearly all of them, together with mammal bone, pottery sherds and various tools. Alternatively, these hearths were created on top of waste pits. At least some of the hearths can be considered multi-functional, as crucibles and bronze fragments have been found together with pottery, and bones have been recovered. Below, the most important hearths are described in detail.

Hearth 1, in trench VIII, can be considered a bronze-casting hearth, as crucibles and casting moulds for an arrow or axe as well as bronze were found in it. However, it also contained large amounts of pottery sherds and burnt and unburnt bones (cow, pig, sheep, beaver, bird and fish). Bone pins were also found in or near the hearth.[397]

Hearth 2 is located in trench I. It is also considered to be a bronze-casting hearth, as large quantities of crucibles and moulds were present. However, this hearth also contained large amounts of pottery sherds and animal bones, mostly from domestic stock. Fragments of a stone axe and bone pins were uncovered as well.[398]

Hearth 3 is located in trench I, adjoining hearth 2. On the surface of the hearth, casting moulds were uncovered, as well as a rich range of material, including pottery sherds. It is important to note that the pottery sherds had been pressed into the clay base of the hearth, which also contained large amounts of burnt clay. In cross section, the structure appears as a funnel shaped pit. Archaeologist J. Graudonis interprets this hearth as having been used for pottery firing, indicated by the sherds pressed into the clay, and the large amounts of clay found in it.[399]

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[395] JĀNIS GRAUDONIS. Ķivutkalna apmetne un kapulauks. Rīga, 1966-1967. Protokoli I-III. In: LVI AMK, Inv. Nr. Pd: 120, 173-1-2,5.

[396] JĀNIS GRAUDONIS. Nocietinātās apmetnes…, 14. lpp

[397] JĀNIS GRAUDONIS, JOLANTA DAIGA. Ķivutkalna apmetne. Pavardu protokoli. In: LVI AMK, Inv. Nr. Pd: 120-1, 2. lpp

[398] Ibidem, 3. lpp

[399] Ibid., 5. lpp

Hearth 6 is located in trench X. Near the hearth, large amounts of animal bones and pottery sherds were recovered, whereas the hearth itself yielded only some 20 sherds and two bones. A horse jaw was found outside the hearth. One of the layers consisted of large amounts of fish bone as well as a layer of charred grain. Several finds were obtained from the hearth: a bone pin, grinding stones, a whetstone and an antler.[400]

Hearth 19? (20) is located in trench V. This hearth stands out from the rest, as a grinding stone was found in the centre, covered with a layer of charred remains of food crops. Underneath was a fish bone layer as well as shell layer. In the surroundings of the hearth large amounts of potsherds and animal bones were uncovered, as well as bone tools, such as awls and needles.[401]

The finds of pottery near all of the hearths as well as the character of these hearths indicate that food was processed in most of them during the time of their use. The large amounts of pottery near and in the hearths indicate the presence of significant numbers of cooking vessels on the site, meaning that the site was inhabited by a large community.

Lagaža settlement. In the case of Lagaža only the distribution of Lake Lubāns type pottery is analyzed, as this type of pottery relates to the Early Bronze Age. It should be noted that such features as hearths were in many cases disturbed or partly destroyed due to agricultural activity, and thus their location on the plan is very approximate.

Due to some issues with the quality of the report, i.e. some coordinates are wrong, especially in trenches E and C, making it impossible to locate the finds, in this case the spatial distribution analysis itself is very approximate and serves only to give an insight into the Early Bronze Age pottery at this settlement. It is also important to note that Lake Lubāns type pottery was found in all of the layers distinguished and can only theoretically be associated with certain of the objects. This is a characteristic tendency on multi-horizon settlements.

The pottery was mostly found near structures, primarily hearths. The biggest concentration is seen in trench A, squares 1–2 A–D and 6–8 A–B, which also had layers of ash mixed with fish bone and calcined bone, possibly indicating a food preparation zone.[402] Another large concentration area is in trench B near a hearth in squares M–O 1–4 and K 1

[400] JĀNIS GRAUDONIS, JOLANTA DAIGA. Ķivutkalna apmetne. Pavardu protokoli. In: LVI AMK, Inv. Nr. Pd: 120-1, 9. lpp

[401] Ibid., 22. lpp

[402] ILZE LOZE. Pārskats par arheoloģiskajiem izrakumiem Lagažas apmetnē Balvu rajonā 1965. un 1966. gados. In: LVI AMK, Inv. Nr. VIAA: 186.

and 3–4.[403] On the other hand, trenches B, C, D and E do not share such a pattern, Lubāns pottery occurring only sparsely in these areas.

Mineikiškes hillfort. Overall, 144 structures were discovered on Mineikiškes hillfort, consisting of pits, posts, stake-holes and other structures. However, no hearths were distinguished in the excavated area (Appendix XIII).

Fifteen of these structures are posts of buildings, although the interrelationship between these structures is not obvious, and so it is not possible to distinguish the contours of the sunken buildings on this basis.[404] Structures 2 and 35, by their nature, can be considered household pits, while the purpose of the others is unknown.[405] Two systems of fortifications were also distinguished in the excavated area, in squares D–E 7–8 and A–E 8–4. The purpose of rectangular structure 48 is not clear: it could be a natural depression or the lowermost fill of a building feature.[406] The distribution of finds and structures indicates that the main living activities took place in the area A–C 3–6. It should be noted that two patches with concentrations of fish bone were distinguished in square C 5.

Pottery concentrations were observed in two areas: D 4–5 and B.[407] The pottery distribution shows interesting patterns, with concentrations in the areas D 1 and E 1-3, located near structure 48, which might indicate that this object is a building, as well as in square B 6, near the household pit (feature 35) and square A 7. The most significant is a large concentration of sherds in square E 8, where the fortification systems were uncovered**.** It is interesting that no large concentration of pottery is distinguished near the fish concentration zones, as this feature could be associated with food preparation zones or at least form part of activities relating to it.

Priednieki settlement. Priednieki settlement has partly been destroyed by sand quarrying, there being large sand deposits on this site. There were not many structures preserved that could relate to living and crafting activities: some post-holes, hearths and pits were discovered. The cultural layer of the settlement is poorly expressed, and seemingly not

[403] Ibidem; ILZE LOZE. Pārskats par arheoloģiskajiem izrakumiem Lagažas apmetnē 1968. gadā. Rīga, 1968. In: LVI AMK, Inv. Nr. VIAA: 768.

[404] KAROLIS MINKEVIČIUS. Mineikiškių piliakalnio (5705)…, pp. 8

[405] Ibid., VYTENIS PODĖNAS Mineikiškių piliakalnio (5705)…

[406] KAROLIS MINKEVIČIUS. Mineikiškių piliakalnio (5705), pp. 10

[407] Ibidem.

many activities took place in this area of the settlement.[408] The hearths contained only very small amounts of pottery (max. 140 sherds) or none at all. In the case of the possible household pits, the situation is similar.

An interesting find was made in pit 12/1–2 (trench I, layer 1), where, along with 133 potsherds, half of a pot together with a clay spoon were found in the fill of the pit.[409]

Vīnakalns hillfort. The main living and crafting activities took place in a semicircle near the hillfort's fortifications. The semicircle of the dark cultural layer indicates the location of buildings in the hillfort, and 19 hearths were discovered within them. Unfortunately, the excavation trenches are too large (four trenches covering the whole area of the hillfort) to estimate the intensity of pottery, and so this aspect will not be addressed.

Similarly as at Ķivutkalns, some of the hearths were possibly used as waste pits, since a mass of fish bone and shell together with various kinds of tools were discovered in some of them. A few hearths are especially interesting in the context of food preparation and pottery.

In hearth 4 large amounts of striated pottery as well as bones and pieces of amber were discovered. The most interesting element of this hearth is a limestone plate which was located next to the hearth and can be considered a possible (food) preparation zone.[410] Unfortunately the hearth had partly been destroyed by wartime trenches, and so further information is not available.

Hearth 8 was located in a craftsman's building and is considered to be a bronze-casting hearth, as it produced a relatively large number of crucibles and mould fragments. It also contained a large number of sherds and bones. Tools such as bone awls, whetstone fragments and an antler "staff" were also found in the hearth. The layers of the hearth consisted not only of ashes and sand but also of a mass of fish bone and shell.[411]

Especially interesting is hearth 12, in the middle of which there was a miniature vessel together with other sherds, bones and some artefacts.[412] It is hard to judge whether this

[408] ANDREJS VASKS. Pārskats par izrakumiem Priednieku apmetnē 2004. gadā. Rīga, 2006. In: LNVM AD, Inv. Nr. AA 861, 8. lpp

[409] ANDREJS VASKS. Pārskats par izrakumiem Priednieku apmetnē 2004. gadā… 7-8. lpp

[410] JĀNIS GRAUDONIS, JOLANTA DAIGA. Vīnakalna nocietinātā apmetne. Pavardu protokoli un plānu skices. Rīga, 1967. In: LVI AMK, Inv. Nr. Pd: 125-3, 7. lpp

[411] Ibidem, 15-19. lpp

[412] Ibid., 26. lpp

had some kind of ritualistic meaning, similar as at Brikuļi, or whether it was simply put there without any particular significance.

Overall, the spatial distribution of the pottery assemblages in their context shows a correlation between features and structures and the quantity of vessels found near them. Thus, more vessels have been found near features and structures, indicating their final placement and possible use in the context of the site.

5.1.2. Size and characteristics of the vessels and use-alteration patterns

Size and use-alteration patterns (in this case soot and food crust) are among the elements which can help determine the function of the vessels. Vessel size can be categorized into five groups: 1) miniature (4–6 cm diam.); 2) small (7–15 cm); 3) medium (15–20 cm); 4) large (20–25 cm) and 5) very large (25+ cm). The function of the miniature vessels is not clear: they could have been for medicinal plant infusions, for ritualistic purposes or made by children as teaching aids.[413] Small vessels could be considered cups or drinking vessels, the medium-sized ones for eating meals, the large vessels for cooking and very large examples for cooking and storage.

According to Vasks, miniature vessels were made from a single clay lump, with added sand or fine granitic rock temper.[414] However, there is a possibility that clay with high amounts of sand was used for miniature vessels, as it is often difficult to differentiate natural sand from sand intentionally added to clays.[415] It may be noted that in a few cases the temper size was quite large. For example, at Sokiškiai one miniature vessel was tempered with 5 mm and at Asva with 4 mm crushed granitic rock. Wall thickness varied from 0.5 to 1.5 mm. Miniature vessels generally have a smooth surface and are barrel-shaped, except for two vessels from Brikuļi and one from Ķivutkalns, which are profiled. Regarding use-alteration patterns, only one vessel, from Brikuļi, had soot on the outside, while the rest had no traces of use-alteration. The situation is similar with respect to the small vessels, only a few having soot, food crust being even rarer. Soot was distinguished on the outside of the vessels. Interestingly, one small vessel from Brikuļi had been deformed by fire, and may simply have been discarded. The morphology and characteristics of these vessels mainly depend on

[413] ANDREJS VASKS. Brikuļu nocietinātā apmetne…, 53. lpp; KATHRYN KAMP. Prehistoric Children Working and Playing: A Southwestern Case Study in Learning Ceramics. In: Journal of Anthropological Research, 2001, Vol. 57(4), pp. 427-450

[414] ANDREJS VASKS. Brikuļu nocietinātā apmetne…, 53. lpp

[415] JAMES STOLTMAN. The Role of Petrography…, p. 301

overall regional tendencies, the majority being striated, barrel-shaped or profiled. They are tempered with granitic rock, which has been sparsely or fairly densely added to the paste.

Approximately one third of all medium-sized vessels had use-alteration – either soot, food crust or both together. These vessels also follow the main characteristics of the overall tendencies. Temper has been added sparsely, fairly densely or densely to the clay paste. Regarding use-alteration patterns, a different situation is seen in the case of large vessels, such features being identified on more than a half of the vessels. Sooting on the outside of the upper body predominates; likewise very common is food crust and soot together. Of all the very large vessels, use-alteration patterns were distinguished on slightly under half. Mainly food crust, less commonly food crust and soot were identifiable on these vessels. Temper has been added semi-densely or densely to the clay paste.

By analysing the correlation between the wall thickness and diameter of the vessels, it is seen that, except for miniature vessels, wall thickness correlates with vessel diameter. As mentioned above, this is logical, as larger vessels need thicker walls in order to provide stability. However, it is important to bear in mind the idea of the vessel's function, i.e. the function intended when the vessel was made. We may assume that larger vessels were mostly made for storage, and thus will have thicker walls than those used for cooking.

5.1.3. Evaluation of spatial distribution and vessel function from use-alteration patterns

Overall, the pottery finds and their possible functions correlate with the contexts, as most of the vessels were found in the zones actively used for food preparation, such as hearths, buildings (for possible storage of dry and liquid substances) and waste pits, where broken vessels were put in some cases. Further, in several cases pottery has been found in seemingly ritualistic contexts, such as offerings together with animal bones, usually domestic and wild animals contributing to the diet of the prehistoric communities. This association with food gives a vessel a sacred meaning as a container which provides everyday meals as well as being used for feasting.

Soot and food crusts are the clearest indication of the function of a vessel, along with the context it has been found in. If there is correlation between use-alteration patterns, context and size of the vessels, then this can provide an important indication of the possible function of the vessels. However, as shown by the Brikuļi pottery, there is a positive correlation between vessels' use wear, their context and their size only in the case of large and very large pots, i.e. vessels with a diameter greater than 20 cm were used for storage and cooking. On the other hand, soot on small vessels and some of the miniature vessels indicates that the

contents of these vessels were heated before its use. It is probable that some kind of infusion, such as herb tea, was being heated before use.

5.2. Burial pottery

The burials of the Bronze and Pre-Roman Iron Age generally do not contain a lot of grave goods; only rarely are there items of bronze, bone or other materials. Pottery is one of these kinds of rare grave goods in stone cist, barrow and flat cemeteries.[416] A different situation is seen in the western part of the Eastern Baltic, where barrow graves contain urns used for cremated remains of the dead. Similarly, urns were used in stone ship settings as well.

5.2.1. Urns

Urns are common in barrow cemeteries in the western part of the Eastern Baltic and in stone ship settings in Kurzeme and Saaremaa, and one flat cemetery (Paveisininkai) is known which contains urn and cremation burials. A rich array of urns have been recovered from Ėgliškiai, Paveisininkai, Bašķi, Bīlavas and Mušiņas, with fewer examples from Lülle, Strīķi and Cīravas Dārznieki cemeteries.

5.2.1.1. Barrow cemeteries

Bašķi cemetery. A total of four urns have been found in barrow 1. Sherds from urns were found already in the sod. This is due to the ploughing that had affected the barrow, partly destroying it.[417] The urns were mainly found near the centre of the barrow.

Urn I had been partly destroyed; it was full of calcined bones and was thicker than the rest.[418] Urns II and IV were mixed together; both had been destroyed, and consequently were not fully reconstructable. These two urns were very similar. Urn III had been placed at some distance from the others, under a small stone. Unfortunately, it was very fragmentary and impossible to reconstruct.[419] Outside of the barrow, especially on its northern side, sherds together with bones as well as a striking stone were found.[420]

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[416] VALTER LANG. The Bronze and Early Iron Ages…; ANDREJS VASKS. No medniekiem un zvejniekiem…

[417] PĒTERIS STEPIŅŠ. Pārskats par izrakumiem Rucavas pagasta Bašķu kapenēs. 1938. In: LNVM AD, Inv. Nr. AA 175, 3.-4. lpp

[418] PĒTERIS STEPIŅŠ. Pārskats par izrakumiem Rucavas pagasta Bašķu kapenēs…, 4. lpp

[419] Ibid.

[420] Ibid.

Mainly small, unornamented sherds with a smooth or coarse-slipped surface have been found at Bašķi cemetery. The one reconstructable urn had a smooth surface and was profiled at the mouth. Some sherds had line incisions on the lip.

Dārznieki cemetery. The barrow had been partly destroyed by ploughing and by sand and clay quarrying. Only one whole urn was found in the area of the barrow, a discovery made by local people (Fig. 40). The urns with calcined bones had been placed on a stone structure and below it, and when this plate was removed another grave in a stone structure on a basal layer was found, consisting of calcined bones together with sherds.[421] This indicates a double burial. A few sherds were found in some other cremation graves, but it is impossible to say whether these were from urns or had been provided as grave goods.

Figure 40. Urn from Dārznieki cemetery (LNVM A 8848:2). Photo: V. Visocka.

The urn had a smooth surface, was unornamented and was wider in the middle; the upper body was not found but may have been similar to that of the urn from Bašķi cemetery. Soot has been found on the inside of the upper body of the vessel. Another vessel, possibly the urn below the first one, was coarse-slipped, with a strongly profiled shape. Soot was found on the inside of the vessel, indicating its use in household activities before becoming a burial urn.

Ėgliškiai cemetery. A total of nine barrows have been excavated at Ėgliškiai barrow cemetery, five of which are from the Late Bronze Age.

Barrow 1. One grave in this barrow had an urn. Grave 3 was found approximately 22 cm from the central grave and consisted of a structure made up of 13 stones, with five smaller stones in the centre. The bones were not in the urn, as it had been compressed and broken between the stones of the grave structure.[422]

[421] EDUARDS ŠTURMS. Ziņojums par izrakumiem Cīravas Dārzniekos. In: LNVM AD, Inv. Nr. AA 167, 1. lpp

[422] ELENA DANILAITĖ. Egliškių pilkapių, Kretingos raj., tyrinėjimai 1969 m. 1970. In: LII, Inv. No. 270, p. 5

Barrow 2. In this barrow three graves had urns. In the case of cremation burial 7 the urn had disintegrated, and only one sample remained.[423] Disturbed burial 5 was a cremation burial, on the south-eastern side of which a clay vessel had been put. The calcined bones and the vessel were at the same level. A stone had been placed on the vessel.[424] Cremated (double) burial 9 was located near burial 10 at a depth of 83 cm. The urns had been placed in stone structures. The cremated bones were put in the urns and flat stones placed on top of them.[425]

Barrow 5. In this barrow, six graves had urns. Cremation burial 1 was found at a depth of 10 cm. The grave consisted of a small stone structure, inside which there was an urn. According to Elena Grigalavičienė, the vessel was very fragile and was most likely unfired or under-fired.[426] Cremation burial 3 was 30 cm deep and consisted of an urn 30 cm in diameter. This urn had likewise been placed in a small stone structure.[427] Urn graves 4–7, too, had been placed in stone structures and topped with stone lids.

The vessels varied in style. Mainly smooth or polished vessels were found, and only in a few cases were coarse-slipped vessels used. The diameter of the vessels varied from 20 to 27 cm. In most cases the urns were markedly profiled in shape. One of the coarse-slipped vessels had a food crust on the inside of the middle of the body. One urn is particularly interesting: this is the urn of grave 13 in barrow 3, a round-based vessel with a double knob and incised line ornamentation. An unornamented vessel with a knob was also found in barrow 2, grave 6.[428]

Strīķi cemetery. This barrow was badly damaged. Only one urn (?) was found. A bronze neck-ring, a pin, an amber bead and a pottery vessel had been placed as grave goods on the subsoil in the centre of the barrow next to an inhumation grave (Fig. 41).[429] It is not known whether the pottery vessel was an urn or a grave good. In terms of its characteristics, this does seem more like an urn than a vessel.

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[423] ELENA GRIGALAVIČIENĖ. Egliškių pilkapių tyrinėjimai 1974 metais (Ėgliškiai II, Žalgirio apyl., Kretingos raj., kol. “Tarybų šalis”). 1974. In: LII, Inv. No. 590, p. 13

[424] Ibidem, pp. 17-18

[425] Ibid., p. 21

[426] ELENA GRIGALAVIČIENĖ. Egliškių pilkapių tyrinėjimai 1975 metais (Ėgliškiai II, Žalgirio apyl., Kretingos raj., kol. “Tarybų šalis”). 1975. In: LII, Inv. No. 591, p. 9

[427] Ibidem, pp. 9-10

[428] ELENA DANILAITĖ. Egliškių pilkapių, Kretingos raj., tyrinėjimai 1969 m…, pp. 12-14

[429] JĀNIS GRAUDONIS. Agro metālu periods…, 152. lpp

Other vessels have been found in Strīķi barrow grave as well. Considering the characteristics of each sherd, it seems that, apart from the urn, there were at least four more vessels in the barrow. Two of these have soot on the outside (one of which had a diameter of 8 cm). All of the vessels had a smooth surface, and the majority were without ornamentation. Ornamentation incised with the fingers is partially preserved on the neck of one vessel, while another has line incisions on the lip.

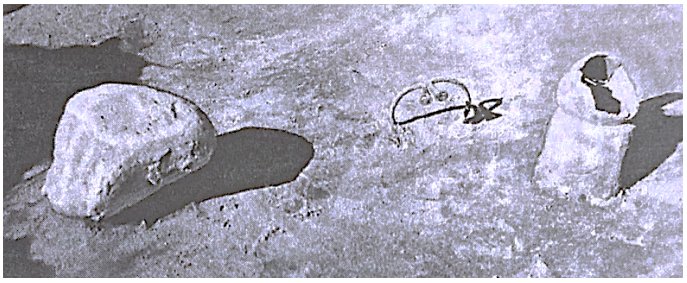

Figure 41. Burial urn and neck ring from Strīķi cemetery *in situ*. From: JĀNIS GRAUDONIS. Agro metālu periods…, 155. lpp

5.2.1.2. Flat cemeteries

The only flat cemetery with cremation burials in urns is Paveisininkai, which was established on a hillock. Three types of urn burials were discovered at Paveisininkai: graves simply dug into the soil, urns placed on top of stones and urns placed in stone structures.[430] Some of the urns on the stones had a stone "lid", for example in the case of burial 21.[431] Altogether, urns were found in 15 graves: 1, 3, 4, 5, 7, 11, 12, 13, 14, 15, 17 and 19–22.[432]

The urns found in this cemetery vary in size, shape and ornamentation. Most of the vessels are profiled, and most have an irregularly striated surface, in some cases striated coarse-slipped.[433] Ornamentation on the urns occurs mainly on the upper part of the neck, and only in one case (grave 13) is the whole vessel ornamented.[434] The vessels were 14–18 cm in diameter. Soot has been distinguished on the inside of one urn (grave 17).

5.2.1.3. Stone ship settings

Pottery and urns are characteristic of all the stone ship settings. In the Eastern Baltic there are various stone ship settings, the best known of which are Birznieki, Bīlavas, Mušiņas, Plintiņi and Lībe in Kurzeme and Lülle in Saaremaa. As the Kurzeme stone ship settings were excavated in the 19th century, for most of them there are no detailed

[430] PRANAS KULIKAUSKAS. Paveisininkų km. piliakalnio ir gyvenvietės (Kapčiamiesčio apyl., Lazdijų raj.) 1962 m. šukių ir radinių sąrašas. 1962. In: LII, Inv. No. 115, pp. 232-234

[431] Ibidem, p. 232

[432] Ibid., p. 238

[433] Ibid., pp. 238-241

[434] Ibid.

descriptions of the urns, the exceptions being Bīlavas and Mušiņas. However, even in these cases there are no precise reconstructions of the vessels. Moreover, during the Second World War the finds, except for those of Mušiņas, have been lost and are thus impossible to reconstruct.

In the stone ship settings of Kurzeme only urns with calcined bones in the middle of the "boat" were discovered.[435] These urns had been placed in multi-layered stone structures and covered with the stone lids. There were no other finds. The situation is different in the case of the Lülle stone ship setting, where bronze and iron artefacts were found in addition to urns.[436]

In terms of style, the stone ship setting pottery embodies local and non-local elements. For example, a reconstructable vessel from Mušiņas had non-local elements, such as the biconical shape, line-incised ornamentation on the neck as well as a knob, the only local element being striation on the surface. The situation is similar at Lülle: in addition to a non-local-style vessel of biconical shape with a polished surface and knob, a simple, coarse-grained, profiled, striated vessel was found. From Bīlavas there is a biconical vessel with a coarse-slipped surface, under which striation was visible, and with incised line ornamentation on the neck (Fig. 42).[437]

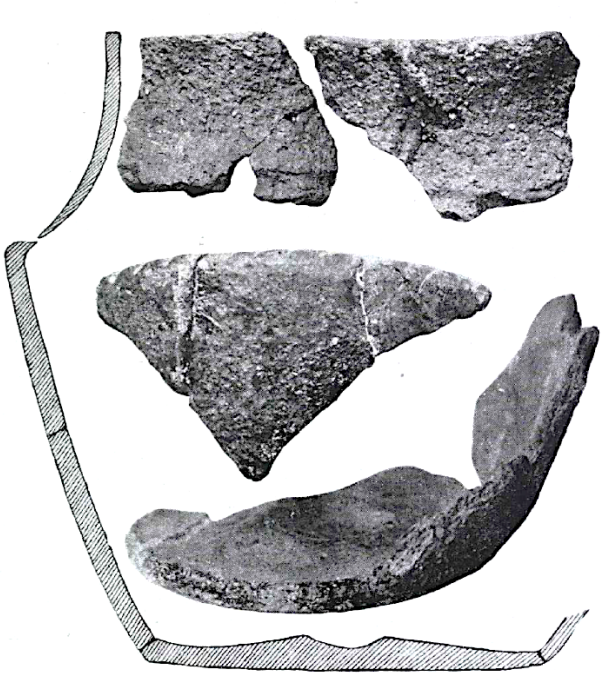

Figure 42. Vessel from Bīlavas stone ship setting. From: EDUARDS ŠTURMS. Die bronzezeitlichen Funde in Lettland…, Tafel V.

No clear traces of use-alteration patterns were distinguished, except

[435] EDUARDS ŠTURMS. Talsu novada aizvēsture. In: Talsu novads I. Talsi, 1935, 96. lpp

[436] VELLO LÕUGAS. Sõrve laevkalmed…

[437] EDUARDS ŠTURMS. Die Bronzezeitlichen funde in Lettland. In: Congressus secundus archaeologorum Balticorum Rigae, 19.-23.VIII.1930. Rigae, 1931, tafel V

for a sherd from Bīlavas excavated in the late 1990s by Vasks.[438] In this case, a small amount of food crust was identified on the inner surface of the vessel.

5.2.2. Pottery as grave goods

Pottery constituting grave goods is quite rare and its context in relation to the graves is in many cases unknown, especially with regard to barrow graves. Pottery found as grave goods is more common in the Lower Daugava region, where it has been found in Ķivutkalns flat and Reznes and Lipši barrow cemeteries, as well as in the Vidzeme region, namely at Buļļumuiža, and in the Early Bronze Age barrow cemetery of Pukuļi in Kurzeme.

In Buļļumuiža barrow cemetery pottery has been discovered in barrows 1, 3 and 4. In barrow 1, in the northern part of cist II, pottery sherds were found together with bronze artefacts.[439] Cist I of barrow 3 was covered with large stones and filled with sand and charcoal, under which there was a cover of small stones, on which pottery sherds and calcined bones were found.[440] In cist II of barrow 4 pottery sherds were found under the calcined bones.[441]

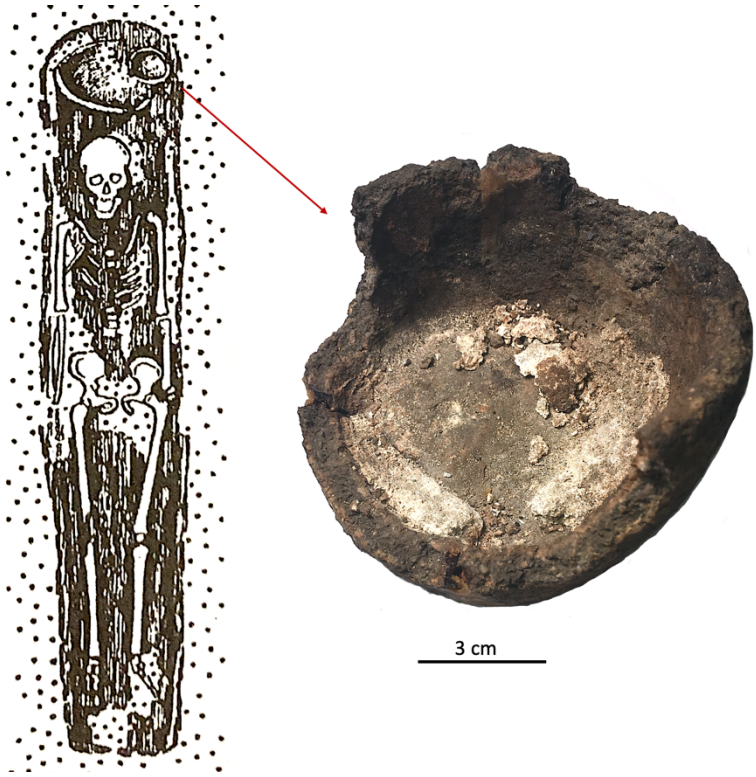

Figure 43. 204th grave of Ķivutkalns with vessel as a grave good. After RAISA DEŅISOVA et al. Kivutkalnskij mobilnjik (pottery – LNVM VI 120). Photo: V. Visocka.

The pottery was either smooth or striated, in one case textile with pit ornamentation forming a single row. It may be noted

[438] ANDREJS VASKS. Bīlavu "velna laivas"...

[439] EDUARDS ŠTURMS. Īss ziņojums par izrakumiem Limbažu pag. Buļļumuižas uzkalniņu kapā. 1929. In: LNVM AD, Inv. Nr. AA 37, 1. lpp

[440] VALDEMĀRS ĢINTERS. Pārskats par izrakumiem Limbažu pagasta Buļļu muižas kapenēs. 1930. In: LNVM AD, Inv. Nr. AA 38

[441] Ibidem.

that a small (9 cm diam.) smooth vessel with soot on the outside was found in the southern part (D section) of barrow 4. Small vessels have also been found at Reznes and Lipši cemeteries, the find from the latter having traces of soot on the outside, although the detailed association with the graves is not known. Both vessels were smooth, with no ornamentation. The only example of pottery as grave good associated with skeletal remains is Ķivutkalns burial 204, where a smooth vessel had been placed on the left side of the head of the deceased (Fig. 43). In the vessel, an unknown substance forming a white mass was discovered. A few sherds were discovered in other burials at Ķivutkalns as well, mostly striated or smooth, and in one case polished. A few Post-Corded Ware sherds were also discovered, indicating habitation during the Late Neolithic or Early Bronze Age. Vessel diameter ranges from 9 to 18 cm. The vessels are mostly barrel-shaped, with no use-alteration
patterns.

5.2.3. Evaluation of general trends in the burial pottery

The different characteristics of the cemeteries indicate different ideological tendencies among Eastern Baltic communities. The strongest similarities are seen among the barrow cemeteries in the western part of the Eastern Baltic, where urns are a characteristic element in the cemeteries. However, due to the lack of precise documentation (Paveisininkai, Strīķi, Bašķi, etc.), it is difficult to interpret the similarities among urn burial traditions. If we look at the urns themselves, some similarities are seen. For example, in the barrows of the western part of the Eastern Baltic, urns were made with a smooth surface. Some chronological differences are also seen, for example at Strīķi, which is considered to be a Pre-Roman Iron Age cemetery, line incision ornamentation is seen on the lip of some of the vessels. Such ornamentation is not seen on the Bronze Age urns, except for Bašķi. A different situation is seen in the case of flat cemeteries, as at Paveisininkai, where mostly urns with a striated surface are common. This indicates different socio-ideological tendencies. It is also notable that Paveisininkai is located in the south of Lithuania and might have been subject to different influences than the communities in the western part of the Eastern Baltic.

Urns are common in the stone ship settings as well. Very consistent similarities are observed between the structures of the stone ship settings of Kurzeme and Saaremaa and those of Gotland. Likewise similar, but at the same time showing different tendencies, are the urns found in these cemeteries. Here it is important to mention that no living sites dated to the Bronze or Pre-Roman Iron Age has so far been found on Gotland, and so it is impossible to determine the main tendencies of pottery craft and techno-stylistics of this region. However,

in terms of techno-stylistics, the Kurzeme and Saaremaa stone ship setting pottery shows very similar tendencies to the pottery found at Asva and Ridala, such as line incisions on the neck/shoulder of the vessel, knobs, biconical shapes, etc. This indicates the transmission of knowledge or transmission of the vessels themselves between Eastern Baltic communities.

Lastly, it is seen that, unlike the practice of burial in urns, the provision of pottery as a grave good next to the deceased is not a very common practice in the Eastern Baltic communities. Pottery is not an exception in this respect, as other artefacts were not added as grave goods in large amounts either. However, there are indications that pottery vessels were used in the burial rites.

5.3. Results of organic residue analysis

A total of 29 samples – seven food crust samples adhering to the vessel wall and 22 ceramic powder samples – on 25 sherds from Brikuļi, Ķivutkalns and Paplaka hillforts, Laukskola settlement and Bīlavas, Ķivutkalns and Reznes cemeteries were analyzed for organic, namely lipid, residues using GC-MS analysis. Sample selection was based on the location and type of site as well as surface treatment of the vessel.

There was sufficient lipid preservation, as indicated by previous analytical work (lipid concentration of 100µg g^{-1} in food crust or 5 µg g^{-1} in ceramic powder samples),[442] available in a total of 19 samples. Yet several of these had very high rates of either only resinous or most likely contamination-related lipid components present in the extracts, so that in the end it was not possible to further identify 14 samples (Table 5). The most prominent diagnostic biomarkers were either full or partial aquatic biomarkers: a full or partial combination of *ω*-(*o*-alkylphenyl) alkanoic acids (APAAs) with carbon atoms ranging from C16 to C20, formed during the heating of polyunsaturated fatty acids of aquatic organisms, together with one of the isoprenoid fatty acids (phytanic, pristanic, and 4,8,12-trimethyltridecanoic).[443] These indicate that lipids of aquatic origin (fish or aquatic animals) have been processed in those vessels.

Other more diagnostic biomarkers detected in several of the samples include various resinous/terpenoic compounds, such as (derivatives) of abietic acid and phenanthrenes,

[442] RICHARD EVERSHED. Experimental approaches to the interpretation of absorbed organic residues in archaeological ceramics. In: World Archaeology, 2008, vol. 40, pp. 26–47.

[443] F. HANSEL, MARK COPLEY, L. A. S. MADUREIRA, RICHARD EVERSHED. Thermally produced ω-(o-alkylphenyl)alkanoic acids provide evidence for the processing of marine products in archaeological pottery vessels. In: Tetrahedron Lett., 2004, vol. 45, pp. 2999-3002

indicating the presence of coniferous trees, or in one case also betulin and lupenol compounds, which relate to birch bark tar.[444]

Table 5. Results of organic residue analysis performed by Ester Oras.

Site	Inv. No.	Sample code	Observation
Ķivutkalns	LNVM VI 120	VV1	aquatic? + coniferous resins
Ķivutkalns	LNVM VI 120	VV2	aquatic + coniferous resin
Ķivutkalns	LNVM VI 120	VV3	aquatic? + coniferous resins
Ķivutkalns	LNVM VI 120	VV4	unknown
Ķivutkalns	LNVM VI 120	VV5	insufficient lipid preservation
Ķivutkalns	LNVM VI 120	VV6	aquatic? + coniferous resin, birch tar
Ķivutkalns	LNVM VI 120	VV7	aquatic + coniferous resin
Ķivutkalns	LNVM VI 120	VV8.1	insufficient lipid preservation
Ķivutkalns	LNVM VI 120	VV8.2	unknown
Ķivutkalns	LNVM VI 120	VV9	insufficient lipid preservation
Ķivutkalns	LNVM VI 120	VV10	unknown
Ķivutkalns	LNVM VI 120	VV11	unknown
Ķivutkalns	LNVM VI 120	VV12.1 (inner)	unknown
Ķivutkalns	LNVM VI 120	VV12.2 (cer)	aquatic + coniferous tree
Ķivutkalns	LNVM VI 120	VV12.3 (outer)	aquatic + coniferous tree
Laukskola	LNVM VI 128:8626	VV14.1	insufficient lipid preservation
Laukskola	LNVM VI 128:8626	VV14.2	coniferous tree, major peaks from resins
Reznes	LNVM VI 133:6	VV15.1	coniferous resin
Bīlavas	LNVM VI 325:4	VV16.1A	aquatic
Bīlavas	LNVM VI 325:4	VV16.1B	aquatic
Brikuļi	LNVM A12397:503	VV17	plant?
Brikuļi	LNVM A12379:568	VV18	insufficient lipid preservation
Brikuļi	LNVM A12468:185	VV19	poor baseline, low abundance
Brikuļi	LNVM A12405:431	VV20	insufficient lipid preservation
Brikuļi	LNVM A12379:515	VV21	aquatic?
Brikuļi	LNVM A12379:531	VV22	insufficient lipid preservation
Brikuļi	LNVM A12405:410	VV23	insufficient lipid preservation
Paplaka	LNVM A12438:13	VV24	unknown

In the case of Ķivutkalns, regardless of the different surface treatments (smooth or striated), the samples contained mostly residues relating to aquatic substances and additionally conifer resins, and in one case birch bark tar. Coniferous trees and resins have been distinguished in the Laukskola and Reznes samples as well. For most of the Brikuļi

[444] E. M. AVELING AND CARL HERON. Identification of birch bark tar at the Mesolithic site of Star Carr. In: Ancient Biomolecules, 1998, vol. 2, pp. 69–80

samples it was not possible to determine the residues, although in one sample very tentative hints of plant (?) with a range of n-alkanes (C16-21, 28, and unsaturated fatty acids) and partial aquatic biomarkers were distinguished. At Bīlavas only aquatic residues were distinguished.

A surprising result is the amount of conifer resin among all of the vessels. Knowing that there are also food remains left at least in some of these vessels, they are unlikely to have been used for tar/resin production. As an alternative explanation, the resins/tars might have been used as sealants to make the vessels stronger and more waterproof, or for repairing the vessels,[445] or else these resinous biomarkers might derive from the fuel used (firewood) during cooking. There are, however, quite clear indications of tar production in pottery vessels: for instance, one potsherd from Laukskola had a thick layer of tar, indicating this practice.[446]

5.4. Discussion and conclusions regarding pottery function based on the results of spatial and organic residue analysis and use-alteration patterns

The spatial distribution of pottery on all of the living sites shows a correlation with structures and features, such as houses and hearths, i.e. the highest pottery concentration is seen in the areas connected with food preparation and storage. Thus, in a way the spatial distribution reflects the function of the pottery. The vessel's use also relates to the size of the vessel: small vessels were most likely used as drinking cups, medium-sized vessels as serving ware, medium and large vessels for cooking and very large ones for storage. The soot on the bowls and small vessels might indicate the warming of drink and food before consumption. The role of the miniature vessels is not clear. Organic residue analysis shows that mostly aquatic residues together with conifer resins are present. This indicates high consumption of fish and resins used as sealants for the vessels analyzed. Analysis also shows that surface treatment and tempering had no major role in the actual function of the vessel.

Some interesting aspects of pottery use were revealed. For example, at Ķivutkalns a pottery firing hearth was found, where potsherds were used as a base together with stones. This indicates a secondary use of pottery vessels after they had ceased to serve their intended

[445] MANON BONDETTI, ALEXANDRE LUCQUINA, NIKOLAI SAVEL'EV, ANDRZEJ WEBERCDE, OLIVER CRAIG, PETER JORDAN. Resource processing, early pottery and the emergence of Kitoi culture in Cis-Baikal: Insights from lipid residue analysis of an Early Neolithic ceramic assemblage from the Gorelyi Les living site, Eastern Siberia. Archaeological Research in Asia, 2020, Vol. 24, p. 8

[446] VANDA VISOCKA et al. Between mighty hillforts…

function because of breakage. Interestingly, a socio-ideological function has been observed in the living-site material. At Asote and Brikuļi and presumably also Krievu kalns, pots have been placed in offerings together with animal bones. The burial pottery served a socio-ideological role in its clearest form, being used either as urns or in the burial rites, breaking and scattering it in the graves or in the surroundings of the cemetery. All of the urns, with a few exceptions, had been placed in stone "boxes" with a stone "lid" on top. Use-alteration features, such as soot, found on small vessels near the cemetery or in graves indicate some kind of ritualistic practice during burial rites. On the other hand, soot and food crust on some of the urns indicate that some vessels were primarily used in everyday life and only afterwards as urns. This is also seen in organic residue analysis, where an urn from Bīlavas contained aquatic residues, indicating household use before becoming an urn.

6. POTTERY IN THE NEARBY REGIONS

In order to understand regional tendencies and influences between regions, it is important to consider what kind of pottery is common in other nearby regions, such as Scandinavia (Sweden and Finland) and present-day Poland and Belarus.

6.1. Pottery in present-day Sweden

Vessels changed little from the Early Bronze Age to the Pre-Roman Iron Age, the main developments being the application of rustication on the pottery surface and changes in ornamentation. A new style that appeared during the Late Bronze Age was burnished fine ware.[447] In Sweden during the Late Bronze and Pre-Roman Iron Age the most common pottery style, distinguished on the basis of surface treatment, is rusticated (also known as coarse-slipped) ware, less common being smooth and burnished pottery, whereas, with some exceptions, striated and textile-impressed vessels are rare (Table 6). Hille Jaanusson divides rusticated ware into two types: 1) with an abundant sand admixture, creating a sandpaper-like surface and 2) thick and watery, creating a lumpy surface.[448] In some cases a striated surface is seen under the rustication, for example at the Otterböte and Skrävsta settlements.[449]

Table 6. Relative percentages of pottery surface treatments on the living sites in Sweden.[450]

Site	Location	No. of sherds	Surface treatment, %				
			Rusticated	Smooth	Burnished	Striated	Textile
Hallunda 13	Botkyrka Municipality, Stockholm County	12,452	79	19	2	0.2	0.1
Hallunda 69	-„-	36,583	77	19	4	0.1	0.1
Skrävsta	-„-	1525	66	22	12	–	–
Broby	Östra Göinge Municipality, Scania County	1850	59	32	5	5	0.2
Otterböte	Åland	6360	89	3	–	7	1
Darsgärde	Stockholms Lan	1200	0.5	31	0.4	64	4.5
Tuna	Södertälje Municipality, Stockholm County	59 (rims)	24	76	–	–	–

[447] THOMAS ERIKSSON. Pottery and feasting in Central Sweden. In: INA BERG (ed). Breaking the Mould: Challenging the Past through Pottery. Oxford, 2008, p. 48

[448] HILLE JAANUSSON. Hallunda. Stockholm, 1981, pp. 38–39

[449] Ibidem, pp. 50–53

[450] After HILLE JAANUSSON. Hallunda… pp. 51

A specific type of pottery is common in the area from Main Åland along the coast to the Öland and the Danish islands: the Otterböte type (Fig. 45). This type of pottery is characterized by fingerstreaks on the rusticated surface of the vessel: between two and four on the rim of the pot and vertical or inclined on the body.[451] The pottery has been made from fine clay with added crushed granitic rock temper. As the clay contains olivine, which is not common in Swedish clays but has been found in Central Europe, even more similar pottery in terms of petrographic and visual properties has been found in present-day Poland, and thus Kenneth Gustavsson interprets this kind of pottery as having its roots in the Lusatian Culture.[452]

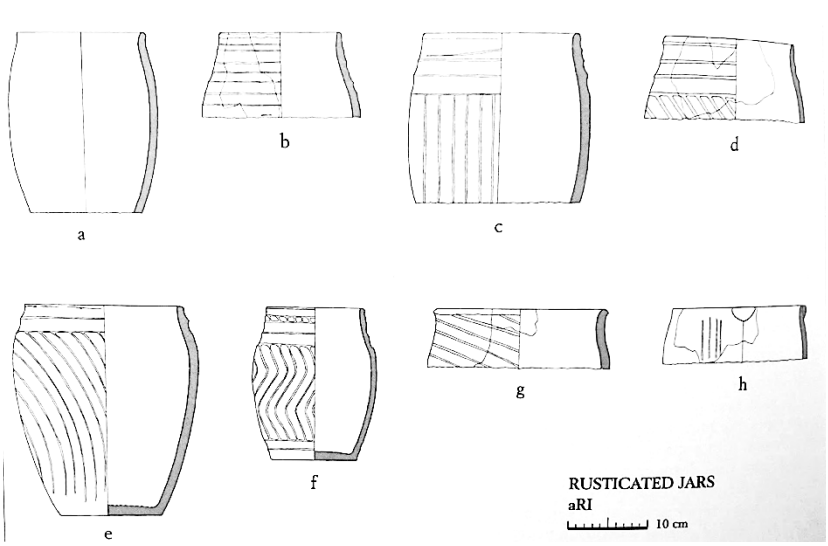

Figure 45. Otterböte type pottery. From: KENNETH GUSTAVSON. Otterböte: New Light on a Bronze Age Site in the Baltic. Stockholm, 1997, pp. 64

In terms of profile shape, the Scandinavian pottery is quite similar to that of the Eastern Baltic. Barrel-shaped and profiled shaped vessels are common. A variety of shapes occur in fine ware, where biconical or carinate vessels appear, just like in Asva fine ware.[453] Burnished vessels were most often used either as cups or bowls, i.e. tableware, whereas rusticated vessels are limited to cups.[454]

Ornamentation decreased during the Late Bronze Age in Sweden as well. However, a greater variety of ornamentation is seen in Swedish material. For example, the fine ware displays several kinds of geometric ornamentation. On the other hand, the most common

[451] KENNETH GUSTAVSSON. Multidisciplinary analyses on Bronze Age pottery from Otterböte, Åland. In: Proceedings of the VII Nordic Conference on the Application of Scientific Methods in Archaeology, Savonlinna, Finland, 7-11 September 1996. 1997, vol. 11, p. 196.

[452] Ibidem, p. 197

[453] Ibidem, pp. 52–56; HILLE JAANUSSON. Hallunda… pp. 66–94

[454] Ibid.

kinds of ornamentation on the coarse ware are undulating rims and pits. Unlike in the Eastern Baltic, fingernail imprints are seen as well.[455]

6.2. Pottery in present-day Finland

At the end of the Early Bronze Age, Kiukainen Culture pottery appeared in present-day Finland, characterized by a striated surface and pit decoration, with thick walls and a flat base, the vessels being barrel-shaped or S-profiled. At the end of the Early Bronze Age and during the Late Bronze Age Paimio type pottery was common, likewise characterized by a striated surface and pit ornamentation.[456]

Textile pottery is also found in small amounts in coastal Finland, and is more characteristic of inland regions of Finland and Karelia, where it is known as Sarsa-Tomitsa Ware.[457] Sometimes textile pottery is decorated with pit ornamentation, for example at the Ketohaka site in Salo and Niuskalan Polttolaitoksenkatu in Turku.[458] This pottery occurs starting from the end of the Early Bronze Age or the beginning of the Late Bronze Age. The temper is generally granitic rock, although in certain regions asbestos was used.[459]

Morby Ware occurs during the Pre-Roman Iron Age in Finland. It evolved from Paimio type pottery and is characterized by coarse temper, with a striated or textile surface, and is slightly profiled. This type of ceramics is always ornamented, mainly on the shoulder. The most typical ornamentation is the "cat's paw print", possibly made with a knot, leaf bud or cone.[460] Morby Ware is common in the coastal area of present-day Finland and is also found along the coast of present-day Estonia.[461]

6.3. Pottery in present-day Belarus

In Belarus a similar pottery tradition is seen as in territory of Lithuania and Latvia, namely striated pottery. Aleksandr Egoreychenko divides striated pottery into early striated

[455] THOMAS ERIKSSON. Kärl och social gestik. Keramik i Mälardalen 1500 BC–400 AD. Uppsala, 2009. pp. 140–151

[456] HENRIK ASPLUND. Kymittæ – Sites, centrality and long-term settlement change in the Kemiönsaari region in SW Finland. Turku, 2008, pp. 205–206

[457] Ibidem; MIKA LAVENTO. Textile Ceramics in Finland and on the Karelian Isthmus. Helsinki, 2001, pp. 25–27

[458] HENRIK ASPLUND. Kymittæ…, p. 206

[459] MIKA LAVENTO. Textile Ceramics in Finland and on the Karelian Isthmus. Helsinki, 2001, p. 47

[460] HENRIK ASPLUND. Kymittæ…, pp. 210–211

[461] Ibid., Fig. 101., p. 211

pottery, which relates to the Late Bronze and Pre-Roman Iron Age, and late striated pottery, which existed in the Early Iron Age (until the 5th century AD).[462] Early striated pottery is characteristic of the hillfort culture (*gorodische kultura*), as represented at the Late Bronze and Pre-Roman Iron Age hillforts. The vessels are usually barrel-shaped or slightly profiled, tempered with granitic rock and rarely have any ornamentation, which, if present, mainly consists of pits.[463] This pottery is widespread in north-western Belarus.[464]

East of the Early Striated Pottery Culture, another contemporaneous culture is represented: the Dnieper-Dvina Culture, which has a different kind of ceramics, namely smooth pottery, as characteristic element.[465]

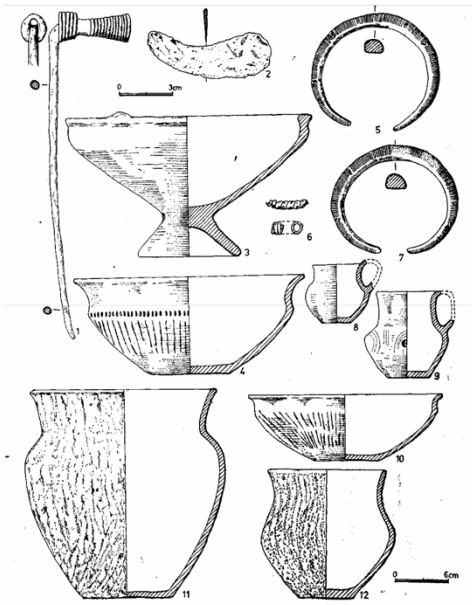

Figure 46. Early Lusatian ware. From: ALEKSANDER GARDAWSKI. Kultura łużycka…, p. 57

6.4. Pottery in present-day Poland

The Lusatian Culture is represented in the Bronze Age of present-day Poland (Fig. 46). This culture is distributed across a very wide region and differs in each part of it, something that also applies to pottery traditions, which differ between regions, especially with respect to fine ware. However, the dominant surface treatment in the Lusatian Culture material is rustication. Noteworthy are the fingerstreaked rusticated vessels, which also occur in Swedish material.[466] Sometimes textile pottery can also be found, but this is more likely to be an influence from other regions.[467] The forms of the vessels are usually profiled. The fine ware is usually biconical with a cylindrical neck, usually ornamented with line incisions or circles on the shoulder below the curve. Bowls are also common.[468]

[462] ALEKSANDR EGOREYCHENKO. Kultura rannei shtrihovannoij keramiki: harakterisktika i areal. In: BDU, 2001, Minsk, s. 37

[463] ALEKSANDR EGOREYCHENKO. Kultura rannei shtrihovannoij keramiki…

[464] Ibidem, s. 38

[465] Ibid.

[466] HILLE JAANUSSON. Hallunda…, pp. 56–57

[467] ALEKSANDER GARDAWSKI. Kultura łużycka na Górnym Śląskuiw Małopolsce zachodniej. In: Prahistoria Ziem Polskich, 1979, Tom IV, p. 58

[468] Ibidem.

Similarities between Eastern Baltic and Lusatian pottery should be investigated in the future, as the available information is too sparse for addressing this topic in the present study.

6.5. Discussion and conclusions regarding similarities between pottery styles of the Eastern Baltic and nearby regions

The obtained information indicates that seemingly most similar to the Eastern Baltic region is the pottery from the Belarus region, where the archaeological culture of striated pottery is widespread. This suggests a need for possible future studies of striated pottery in a wider region to obtain information for answering the questions: how similar is this pottery to the Eastern Baltic material and how does it differ technologically? Also interesting in this context is the Darsgärde settlement, where abundant amounts of striated pottery have been found; moreover, unlike in the rest of the Swedish material, striation is the dominant surface treatment type. It would be useful to find out more regarding this type of pottery: how similar or different is it in the context of the Eastern Baltic assemblages?

The Kiukainen and Paimio pottery types are also similar to those of the Eastern Baltic, especially to striated pottery ornamented with pits. It is difficult to interpret the possible influences between the regions due to the absence of a chronology for these pottery styles. It is known that the Kiukainen type emerged during the Early Bronze Age – but exactly when it became the typical style is not known to the author. According to the radiocarbon dates, the first striated pottery appeared as a separate style in the territory of the Eastern Baltic around the 14th–13th century cal BC, in the Early Bronze Age. Could these two styles have evolved at the same time without mutual influences, or was there transmission of knowledge between these two regions?

Regarding the non-local, namely rusticated, pottery, essentially two possibilities are seen: the Eastern Baltic potters were influenced either from Central Europe or from Scandinavia, namely present-day Sweden. Two types of rusticated pottery are seen: with a covering layer having either an admixture of sand or with a greater proportion of clay, creating vein-like impressions. This is also applicable to the Eastern Baltic material, as both styles are seen. Moreover, a combination of local (striation) and non-local (rustication) elements is seen in the material. Such pottery (striated rusticated) is observed in the Swedish material as well, which indicates transmission of knowledge between these two regions. Unfortunately, there is no detailed information regarding Lusatian rusticated pottery. Thus, we lack crucial information regarding the techno-stylistics of this kind of pottery, and

therefore it is impossible to compare the possible transmission of knowledge and similarities in traditions between pottery from different regions.

Regarding the textile pottery, it is important to note the textile pottery finds from Padure hillfort, which are the only such examples in the western part of the Eastern Baltic and might indicate either transmission of knowledge with the region of Finland or local contacts with Saaremaa, where textile pottery is also quite common. According to the obtained data, textile pottery in the Eastern Baltic is more common on the Lower Daugava and Lake Lubāns living sites, and, although present in rather small amounts, can still be considered more characteristic of these regions.

A similar situation is seen regarding Morby Ware, which is common in present-day Finland, and which, in addition to a striated surface, has textile impressions, which might indicate some influences between these regions during the Pre-Roman Iron Age.

7. DISCUSSION

Pottery production, function and meaning are strongly interconnected, i.e. vessels were built with the intention of a particular function, whether as cooking pots or burial urns. Pottery also indicates aesthetic values and technological capability. Thus, all aspects of pottery should be considered when dealing with its role in societies. In the material analyzed we can see not only every day practices but also technological growth and transfer of knowledge as well as influences between regions and pottery techno-function and socio-ideological function in the societies of the Eastern Baltic.

7.1. Change of pottery styles

Changes in pottery styles are connected with change in societies. When the values of societies change, their perception of material culture also changes, creating not only new tools and jewellery but also new kinds of pottery.

In the Early Bronze Age certain styles which had developed during the Late Neolithic (2900–1800 cal BC) continued to be used, namely Lubāns type and Post-Corded Ware. Both were made from sandy clay with granitic rock temper.[469] Unlike Post-Corded Ware, Lubāns type pottery is richly ornamented with a variety of motifs consisting of pits, combs and other types of impressions. Post-Corded Ware was ornamented with cord.

It is clear that Post-Corded Ware evolved from Corded Ware and at its culmination developed into other subtypes, such as Kvietiniai-Tojāti Ware at about 1400 cal BC. However, it is not clear from what pottery the Lubāns type evolved. Considering the rich ornamentation made using stamps and combs, it might have evolved from Comb Ware. It may be noted that Lubāns type pottery and likewise Corded Ware do not evolve into new styles but simply go out of existence. However, it is significant that sherds with cord ornamentation are still found in very small amounts on Late Bronze Age living sites. This could indicate continuation of the Post-Corded Ware tradition in a new, more symbolic and decorative aspect.

Striated pottery evolved from Narva Ware at about 1400 cal BC and during the Late Bronze Age became the dominant surface treatment in the region of Eastern Baltic.[470] This pottery was predominantly barrel-shaped in the northern and central parts and profiled in the

[469] GYTIS PILIČIAUSKAS. Virvelinės keramikos kultūra lietuvoje 2800–2400 cal BC. Vilnius, 2018, p. 148-155

[470] ANDREJS VASKS. Keramika epokhi bronzi… s. 110–115

western and southern parts of the Eastern Baltic. It did not evolve much during the Bronze Age but did change starting from Pre-Roman Iron Age, when Late Striated Pottery occurred in the south-eastern part of present-day Latvia and in eastern Lithuania. It was now made from clay with coarser but not densely added granitic rock temper, and the shape also changed to biconical. It is significant that in the western and southern parts of the Eastern Baltic during the Pre-Roman Iron Age pottery still followed the same major tendencies as during the Late Bronze Age.

As for minor and marginal styles of the Late Bronze Age, such as smooth, textile-impressed and coarse-slipped, due to the small numbers of vessels, it is impossible to assess the change in these pottery styles.

7.2. Pottery, influences and transmission of knowledge

In household and burial pottery not only different pottery-making practices but also influences from other regions can be distinguished, indicating trade and transfer of knowledge, including ideological values. According to *innovation theory*, pottery-making practices can be divided into three groups: 1) innovation from other regions, which includes imported vessels and vessels made by non-local potters; 2) local production – vessels made locally but with non-local elements and 3) tradition – local and non-local elements create a new style.[471]

Considering Early Bronze Age pottery from this perspective, Lubāns type pottery can be considered local; it was created and used exclusively, with a few exceptions, on the Lake Lubāns plain. However, it is difficult to distinguish from which style this pottery-making tradition arose. Lubāns Ware as a separate style began at the end of the Late Neolithic and continued in the Early Bronze Age. The ornamentation and style did not change during the transition from the Late Neolithic to the Early Bronze Age, indicating similar aesthetic values in these societies. It is significant that, alongside Lake Lubāns Ware, another style, namely the porous Abora Ware, was also common during the Neolithic, even more than Lubāns Ware, while Corded Ware was less common. This is particularly interesting, as the co-existence of local and non-local pottery is clearly seen, although it does not result in a new, merged style. Post-Corded Ware developed as a continuation of the

[471] THOMAS ERIKSSON. Pottery, transmission and innovation in Mälardalen. In: NILS ANFINSET, MELANIE WRIGGLESWORTH (eds). Local Societies in Bronze Age Northern Europe. London, 2012, p.

Corded Ware Culture and in the 14th century cal BC developed into a local tradition in the western part of the Eastern Baltic, namely Kvietiniai-Tojāti Ware.

Local and non-local elements are seen most clearly, with interaction between them, in the Late Bronze Age and Pre-Roman Iron Age material, where local striated pottery merged with non-local coarse-slipped and textile surface treatments, creating local striated coarse-slipped and striated textile types. Non-local elements are seen in the ornamentation of the vessels as well. Rusticated pottery originated in Central Europe, where it spread within the Únětice, Trzciniec and Lusatian culture areas. Rusticated and coarse-slipped vessels are common in Scandinavia as well, especially at the settlements of Otterböte, Broby and Hallunda.[472] In the Eastern Baltic region only a subtype, namely coarse-slipped (i.e. early rusticated) pottery, is common during Late Bronze Age. Small numbers of such vessels commonly occur in the western, northern, and south-eastern parts of the Eastern Baltic and along the lower reaches of River Daugava. It seems that inland pottery in Utena district does not share this trait. Starting from the Pre-Roman Iron Age, rusticated pottery appears in addition to coarse-slipped vessels, for example at Paplaka hillfort and Bašķi cemetery in Kurzeme. We may note the large amount of coarse-slipped pottery from the Dārznieki and Ėgliškiai cemeteries in the west and Paveisininkai in the south of the Eastern Baltic. Considering the chronology of the living sites, it seems that coarse-slipped pottery first appeared in the western part of the Eastern Baltic (Bīlavas stone ship setting, Padure and Krievu kalns hillforts). The regions of influence could be various. The Staldzene hoard indicates active trade and communication between the Kurzeme region and Scandinavia, which could indicate that coarse-slipped pottery was an influence from this region.[473] On the other hand, in the Lower Daugava area influences could have come from Central Europe, as the Ķivutkalns hoard, especially the tutulus, had its stylistic origins in the Lusatian Culture.[474]

Trade and communication between Scandinavia and the Eastern Baltic are also reflected in the occurrence of stone ship settings located in Kurzeme and Saaremaa, this tradition having its roots on Gotland, Scandinavia. Local and non-local elements appear on the pottery from these stone ship settings. For example, Mušiņas stone ship setting has a vessel with a striated surface, whereas the biconical shape, the line incision on its shoulder and the knob are non-local elements (in relation to Latvian and Lithuanian material) for the

[472] KENNET GUSTAVSSON. Otterböte…, HILLE JANUSSON. Halunda…, ANDREJS VASKS. Apmestās keramikas izplatība Latvijā. In: Arheoloģija un etnogrāfija, 1996, nr. 18, 148. lpp

[473] ANDREJS VASKS, ARMANDS VIJUPS. Staldzenes bronzas laikmeta depozīts. Rīga, 2004.

[474] BAIBA VASKA. Rotas un ornaments…

majority of Eastern Baltic living sites and burials. Similar pottery has been observed at Stenkyrka stone ship setting, Gotland, where the same kind of vessel but with a smooth surface has been found.[475] However, on Gotland no living sites dated to the Late Bronze Age or Pre-Roman Iron Age have been found; thus, it is impossible to know the tendencies of pottery in this region. In the context of pottery from living sites, we cannot ignore the striking similarities between the Asva and Ridala pottery and the pottery from the stone ship settings in Kurzeme. Asva pottery, especially the fine ware, shares the same biconical shape, line incisions and knobs as are found in stone ship setting pottery. This indicates local influences from Saaremaa.

During the Late Bronze Age textile pottery reappears in the archaeological material on Saaremaa, and to a lesser degree in the Lower Daugava area and on the Lake Lubāns plain. On Saaremaa, textile pottery is often combined with various other surface treatments, such as coarse-slipped and striated. On the other hand, in the Lower Daugava area (Ķivutkalns and Vīnakalns) only textile and textile striated have been found. Significant in this regard is Padure hillfort, which is the only living site in Kurzeme where textile pottery has been found, indicating trade and transmission of knowledge about this kind of pottery between regions. Interestingly, no textile pottery has been found in present-day Lithuania, indicating influences from different regions, namely those with rusticated pottery. The region with a dominance of textile pottery is the interior of present-day Finland and Karelia, for example the Sarsa and Tomitsa settlements. It could be that textile pottery influences come either from present-day Finland or from Asva hillfort, as active trade and contacts were most likely established between Saaremaa and the Lower Daugava area, the Lake Lubāns plain and possibly also Padure hillfort.

There are striking similarities between Asva coarse ware and vessels from Brikuļi. In stylistic terms, the rich but simple ornamentation indicates the presence of similar if not the same pottery ware on both sites. This has been distinguished in previous research by Lang and Sperling.[476] This could indicate a long-term relationship between these two communities, which resulted in similar material culture. As for Asva fine ware, it is considered to be locally created tableware common only at Asva.[477] This is indicated by the rich ornamentation and profile forms.

[475] UWE SPERLING. Aspekte des Wandels in der Bronzezeit…

[476] VALTER LANG. The Bronze and Early Iron Ages…; UWE SPERLING. Aspekte des Wandels in der Bronzezeit…

[477] UWE SPERLING. Aspekte des Wandels in der Bronzezeit…

In the Eastern Baltic as well as in Scandinavia ornamentation on pottery markedly decreased during the Late Bronze Age, and only a few vessels, except at Brikuļi and Asva, are ornamented. It seems that the perception of pottery changed in the Bronze Age communities. In ornamentation, influences and similarities from other regions, albeit just a few, are observed as well. One of the ornaments showing distant parallels in various regions is the plastic element consisting of a coil wound around the neck or shoulder of the vessel. In some cases these vessels had ornamentation in the form of finger impressions. Such ornamentation is observed at Asva, Krievu kalns, Ķivutkalns, Vīnakalns and Sokiškiai hillforts. However, such ornamentation is commonly seen in Scandinavian and Central European material as well. The fact that these kinds of ornamentation are found on sites with active bronze-working, which would thus also have been active trade centres, indicates the transfer of knowledge or transfer of pots from other regions. A further kind of ornamentation with its roots in other regions is another kind of plastic ornamentation: oval bumps. Such ornamentation has been found only in the Krievu kalns (Kurzeme), Ķivutkalns (Lower Daugava) and Asva (Saaremaa) assemblages – again, strong bronze-casting centres. These kinds of oval clay bumps have been found in Central European and Scandinavian material as well. Here, again, we can mention the Scandinavian hoards Staldzene and Tehumardi, which indicate relations with Scandinavia; thus, it is possible that these influences came from this region.[478] Mention should also be made of the Venta and Daugava waterways, which were used by locals and communities from other regions. In the case of Ķivutkalns, multi-regional influences are possible, indicated by the Ķivutkalns hoards and the intensive use of the River Daugava waterway by various communities.[479] Overall, most kinds of non-local ornamentation are seen in the regions near the large waterways and are less common inland, Sokiškiai being the only example of influences in ornamentation. Moreover, the inland pottery is far less ornamented, with a conservative adherence to local surface treatment practices.

Different pottery-making practices are seen in burial pottery. In the western and southern parts of the Eastern Baltic burial urns were common. These urns were either rusticated or smooth, almost like fine ware. It is interesting how different burial pottery is from the pottery on living sites, but it still follows similar tendencies across quite a large region. However, barrow graves with urn burials are found in the west, with flat graves in the

[478] UWE SPERLING. Aspekte des Wandels in der Bronzezeit…

[479] BAIBA VASKA. Rotas un ornaments…

south (Paveisininkai). Meanwhile, in the central part of the Eastern Baltic, practices were different – pottery was provided as a grave good for the deceased, indicating different ideological values and traditions in these two regions.

7.3. Techno-function and symbolic meaning of pottery

The function of ceramic vessels can undoubtedly be associated with food, its preparation, storage and serving, and with feasting.[480] Of course, pottery can be, and was, used for storing liquids and dry foods and as drinking cups. Having a crucial significance in meeting needs, they played not only a practical, but also a mental role in prehistoric societies.[481] James Skibo distinguishes three types of functions ceramic vessels can serve: techno-function, i.e., intended and actual use, as well as social and ideological function, both of which are applicable to traditions and aesthetic values of communities.[482]

Techno-function. According to Prudence M. Rice, several different variables must be considered when interpreting the function of vessels: shape, material, surface treatment and ornamentation, as well as clues such as use-alteration patterns (Table 7).

Table 7. Predicted archaeological correlates of vessel function.[483]

Functional category	Shape	Material	Surface treatment/orna-mentation	Clues	Wares/types of analyzed assemblages
Storage vessels	Restricted forms, orifice modified for pouring or closure; appendages for suspension or movement	Variable (possible concern for low porosity)	Variable for display or messages; slip or glaze to reduce permeability	Residues of stored goods in pores	Coarse-slipped, striated, Lubāns Ware, Kvietiniai-Tojāti Ware(?), Line-Incised Ware(?)
Cooking pots	Rounded, conical, globular	Coarse and porous, thin walls, thermal	Little to none; surface roughening for ease of handling	Patterns of exterior sooting or blackening; burnt contents	Striated, textile, coarse-slipped Lubāns Ware(?)

[480] THOMAS ERIKSSON. Pottery and feasting…, p. 49

[481] CLIVE ORTON, PAUL TYERS, ALAN VINCE. Pottery in archaeology. Cambridge, 1993, p. 227

[482] JAMES SKIBO. Pottery Function: A Use-Alteration Perspective. New York, 1992, pp. 33–34

[483] After PRUDENCE M. RICE. Pottery Analysis. A Source Book. Second edition. Chicago, 2015, p. 415. with authors additions

		shock resistant			
Food preparation (without heat)	Unrestricted forms, simple shapes	Emphasis on mechanical strength; relatively coarse, dense	Variable, generally low	Internal wear; abrasion or pitting	Striated, textile, Lubāns Ware
Serving	Unrestricted for easy access; often with handles; flat bases or supports for stability	May be fine	Generally high, for display or symbolic roles	Sizes correspond to individual servings or group size	Asva fine ware, miniature, small and medium-sized vessels (predominantly striated or smooth)
Transport	Convenient for stacking; handles; lightweight; restricted orifice	Emphasis on mechanical strength; dense, hard	Variable, generally low; slip or glaze to reduce permeability	Uniform size or multiple units of size; residues of contents	Not distinguished in the assemblages
Urns	Depending on the region	Mechanical strength	Depends on the region	Different shapes and sizes; secondary use is possible	Smooth pottery, coarse-slipped, Line-Incised Ware, striated and textile, in one case tableware (from cemeteries)

Rice argues that a vessel might have multiple uses not only during its life but also simultaneously, for example preparing food in a pot and then eating from it. Once a vessel can no longer perform its original role, in most cases the vessel or parts of it are recycled and used again for a different purpose. Thus, pottery function can be divided into primary and secondary use.[484] Rice distinguishes three basic types of vessel function: storage, cooking and transfer (serving and transport) vessels, each of which has different functional variables regarding morphology and use-alteration patterns (Table 7).

During the Bronze and Pre-Roman Iron Age in the Eastern Baltic vessels were most likely made only from two materials, wood and clay, as bronze was too much of a luxury

[484] PRUDENCE M. RICE. Pottery Analysis…, p. 414

material and too rare for making such objects. It is important to note that there are no remains of wooden vessels preserved from this period; however, such finds are known from Neolithic settlements, such as Sārnate.[485] The use of wooden vessels is even more likely considering that, except for miniature and very small vessels, no traces of classic tableware have been found on any living site in the Eastern Baltic, with the exception of Asva and Ridala hillforts, where fine ware bowls occur.

As potters build ceramic vessels based on their intended function, such technical properties as clay paste recipe (clay properties, temper type, size and amount), vessel size, shape and wall thickness as well as surface treatment were carefully chosen according to their potential use.[486] In this study, eight different fabrics were distinguished with different variations of grain size and density of temper added to the clay paste. Granitic rock temper was added to most of the vessels, sand or grog being added only in few cases. Granitic rock as well as sand were added to the temper in large amounts, whereas grog was added in sparse quantities. According to Rice, cooking vessels are coarse-textured, porous and tempered with materials that have low thermal expansion, such as grog or shell.[487] As mentioned above, shell is not common in Bronze and Pre-Roman Iron Age pottery. The addition of grog might indicate that these vessels were used as a cooking pots. However, it is important to stress that in the material analyzed granitic rock temper has always been added in addition to grog, indicating that adding grog temper had more of a symbolic than a functional role.

According to Daniel Santacreu, the most common practice among prehistoric communities is to use coarse vessels as cooking pots and fine vessels for storage or serving.[488] Coarse ware with abundant mineral content (natural or temper) improves vessels' endurance to thermal shock.[489] However, it is difficult to determine the function of vessels based solely on temper, as small cups and large vessels display similar tempering tendencies in the Eastern Baltic material, namely coarse temper. Usually, vessels with thin walls have

[485] BAIBA DUMPE. Trauki…, 493. lpp

[486] MICHAEL SCHIFFER, JAMES SKIBO, TAMARA BOELKE, MARK NEUPERT, MEREDITH ARONSON. New perspectives on experimental archaeology: Surface treatments and thermal response of the clay cooking pot. American Antiquity, 1994, vol. 59, p. 200

[487] PRUDENCE M. RICE. Pottery Analysis…, p. 424

[488] DANIEL SANTACREU. Materiality, Techniques and Society in Pottery production: the technological study of archaeological ceramics through paste analysis. Warsaw/Berlin, 2014, p. 148

[489] Ibidem, p. 152

better thermal efficiency – they heat up faster than those with thicker walls.[490] At the same time thick walls make pots significantly more durable against thermal shock. Kayla Bowen and Karen Harry note that there is no significant difference in the use of resources, such as fuel, between thin and thick-walled vessels,[491] which means that technically both thin- and thick-walled pots can be used for cooking. This seems to be the case for Eastern Baltic pots, where traces of cooking have been found on both large vessels (with thinner walls) and very large vessels (with thicker walls). Wall thickness can be quite relative, as it usually depends on the size of the vessel: in order for large vessels to be stable, thicker walls are necessary. In the case of Brikuļi hillfort, where it was possible to distinguish more or less precisely the location of the vessels in their context, it is seen that large vessels are the only ones which show a correspondence between use patterns and the context they have been found in: large vessels have been found near buildings and hearths and very large vessels with no soot or food crust occur near hearths. All of these traces show that pots above 20 cm in diameter were used as cooking and storage vessels.[492]

Miniature and small vessels might have been used as drinking cups. However, soot and food crust remains on some of these vessels indicate cooking practices. It is possible that the drink or other such substance was heated after it had gone cold. The use of the miniature vessels is also unclear, but soot traces on some of the vessels indicate a use involving heat. This indicates that they were actively used in everyday practices. It is possible that these vessels were used as cups for children. Even more interesting is that some of the miniature pots tend to replicate the larger vessels,[493] which might indicate some ideological meaning. Vasks suggests that miniature vessels served for preparing or making herb infusions.[494] None of the miniature vessels have been found in a context related to ideological or ritualistic activities, and therefore it is not possible to confirm or refute this possibility. Some researchers argue that miniature vessels were made by children in order to learn pottery

[490] KAYLA BOWEN, KAREN HARRY. Evaluating the Relationship between Ceramic Wall Thickness and Heating Effectiveness, Fuel Efficiency, and Thermal Shock Resistance. Midcontinental Journal of Archaeology, 2017, vol. 44, no. 3, p. 270; PRUDENCE M. RICE. Pottery Analysis…, p. 424

[491] Ibidem.

[492] VANDA VISOCKA. In a search of pottery function….

[493] ANDREJS VASKS. Brikuļu nocietinātā apmetne…, 54. lpp

[494] Ibid.

craft.[495] As for medium-sized pots, soot and food crust definitely indicate that they have been used in order to cook food, but it is hard to tell whether they were used for individual purposes or by the community overall. In the opinion of the author, large vessels were used to cook food for the whole community, and the medium-sized ones for smaller groups. This would explain the overall large number of medium-sized vessels.

It must be stressed that there was no indication that different vessel shapes correspond to some specific function. It is important to note that the same vessel shapes occur in different-sized vessels with different functions, and thus it is impossible to interpret the function based solely on this variation.[496] There is no correspondence to vessel shape and use-alteration patterns. A similar situation is seen with regard to surface treatments. Although striated pottery is considered to be more resistant to thermal shock than smooth pottery,[497] based on soot and food crust remnants both of these types have been used for cooking to a similar degree. Coarse-slipped and striated coarse-slipped vessels have also been identified in the assemblages analyzed, but these vessels generally have no use-alteration, with the exception of two vessels from Laukskola and Vīnakalns that have soot on the outside. It may be noted that these types of vessels are suitable for both cooking, as they are resistant to thermal shock, and also for storing liquids, due to the additional layer.[498] Coarse-slipped vessels could have also served the function of processing or storing non-food materials, such as tar. In several studies[499] organic residue analysis shows remains of such materials. Moreover, the vessel from Laukskola had a thick layer of tar on its interior surface. This indicates that these vessels were being used for storing tar or were coated with it, making them even more resistant to leakage of fluids.

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[495] For example, KATHRYN KAMP. Prehistoric Children Working and Playing…; LIDIJA BALJ. Minijaturne posude Vinčanske culture: Dečije igračke ili predmeti neke druge namene. In: Rad Muzeja Vojvodine, 2009, vol. 51, s. 23-34.

[496] PRUDENCE M. RICE. Pottery Analysis…, p. 421

[497] MICHAEL SCHIFFER et al. New perspectives on experimental archaeology…, p. 209

[498] Ibid.

[499] For example, CHRISTINA KARLSSON. Food Culture in Ritual and Profane Contexts: Organic residue analyses of vessels from two Bronze Age sites in Uppland, Sweden. Master 12 thesis. Stockholm, 2009; SVEN ISAKSSON. Vessels of Change: A long-term perspective on prehistoric pottery use in southern and eastern middle Sweden based on lipid residue analyses. In: Current Swedish Archaeology, 2009, vol. 17, pp. 131–149; VANDA VISOCKA. Švīkāts-apmests trauks Vīnakalna pilskalna keramikas kolekcijā. In: Latvijas Vēstures Institūta žurnāls, 2017, nr. 4(105), 5–24. lpp

Indications of secondary uses have also been identified in pottery assemblages. These include lacing holes for patching together broken vessels, so that they could continue in use, possibly for other purposes. The hearth on Ķivutkalns hillfort which was covered with additional sherds on its base also demonstrates a secondary use after the vessel had broken. This indicates that people were using all available material, even after it had served its function, i.e. they were recycling as much of their resources as possible.

Ideological function. Ideological or symbolic meaning has been observed in household as well as in burial pottery. The clearest indications of ideological function can be observed in the use of burial urns for cremated remains. According to Terje Oestigaard, "An urn as an object used for cremation remains is an ideologically transformed multi-vocal container with several functions, characteristics and properties […] it is transportable and thus represents alliances, relationships […] it is an object of economic status which may reflect social differentiation and hierarchies […] it is a charnel-house for the burnt bones, through which cosmological and religious ideas are expressed."[500] It may be noted that urns are characteristic only of Late Bronze Age societies in the western and southern parts of the Eastern Baltic, indicating the ideological and symbolic value of this kind of vessel for these communities.

In terms of function there are two types of urns: those which primarily served as urns, and household vessels used as urns.[501] Both kinds of urns have been identified in the Eastern Baltic material, as shown by use-alteration patterns as well as organic residue analysis. Primary urns (presumably those with no use-alteration) had different properties: they are smooth, profiled, fine-tempered vessels with thin walls, while secondary vessels have a coarse-slipped surface, are thick-walled and have coarse temper, i.e. they exhibit the characteristics of household pottery. Interestingly, between the urn burials there are also cremations buried without urns. It is possible that there were urns made from other materials, such as barks of trees. This is shown by the Pukuļi archaeological material, where remains of wood were found in barrow 11 under the calcined bones.[502] This might indicate social and ideological differentiation between individuals in these communities.

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[500] TERJE OESTIGAARD. Cremations as transformations: when the dual cultural hypothesis was cremated and carried away in urns. In: European Journal of Archaeology, 1999, vol. 2(3), p. 351

[501] Ibid.

[502] ANDREJS VASKS. Bronzas laikmeta kapulauks Pukuļos. In: Arheoloģija un etnogrāfija, 2000, Nr. 20, 98. lpp

Urns could have served as houses of the deceased, as a beginning of new life, which might be indicated by the fact that stones were used as lids, somewhat like a roof on top of the house. There is also a theory that urns served as a new skin or body of the cremated individual.[503] Cremations and ceramics both relate to fire, both being made with fire: an individual is reborn to a new life, and a vessel is created during the firing process. It is known that vessels serve an important role in food preparation, likewise related to fire, and preparation of food ensures the life of the community. Thus, the connection to food and death can be viewed as a symbolic transformation.[504] In the opinion of Oestigaard, during cremation individuals were also in a process of cooking, becoming part of the transformation "raw to cooked", just as the food in the ceramic vessels goes through this process.[505] At the same time, burial in a household vessel re-used for this purpose might also be a sign of individuality – being buried in your own property represents something more personal for the individual.

Pots as grave goods served an ideological and symbolical meaning. This is also connected with food as ritualistically given to the deceased for the afterlife. Only one such grave has been identified in the Eastern Baltic material: Ķivutkalns grave 204. A pointer to feasting as a burial rite is the occurrence of broken vessels outside and inside the barrow graves with traces of use-alteration patterns, indicating use during the funeral.

Regarding the ideological function of vessels on living sites, only in few cases can ritualistic aspects be observed, for example vessels in offerings at Asote, Brikuļi and Krievu kalns hillforts. In all of the cases animal bones were found in these offerings, indicating ritualistic aspects related to food and its preparation. In this respect Brikuļi is the clearest example among all those mentioned. The offering from this hillfort included several intact animal bones, including skulls, as well as bone tools. It is particularly interesting that wild and domestic animal remains were put in this offering. Moreover, elk, wild boar and beaver were the most hunted and utilised wild animals at the living site.[506] In their turn, cattle, sheep, goat, domesticated pig and also horse were the most common domestic animals found at Brikuļi.[507] The horse was more than ten years old, and the skull showed traces of the use of a

[503] JESSICA CEREZO-ROMÁN, ANNA WESSMAN, HOWARD WILLIAMS (eds). Cremation and the Archaeology of death. Oxford, 2017, p. 16

[504] TERJE OESTIGAARD. Cremations as transformations…, p. 359

[505] Ibidem.

[506] ANDREJS VASKS. Brikuļu nocietinātā apmetne…, 60. lpp

[507] Ibidem, 59. lpp

bridle.[508] Among these bones, dog was represented as well. Dogs indeed served an important role in obtaining food, especially when hunting, thereby gaining a specific social status.[509] The bones together with the small vessel might indicate a connection to food acquisition (through farming, animal husbandry and hunting), although more detailed investigation and re-evaluation of the osteological material is needed in order to draw further conclusions.[510] The reasoning behind putting a crucible in this offering is unclear; it stands out from the rest of the items in the offering. The vessel in this offering was a small one with smooth walls and line incision ornamentation. It also had soot traces on the outside, which might indicate that it had previously been used in everyday life and afterwards placed as an offering, as the bones had no traces of soot on them.

It may be noted that other ornamented vessels showed no clear pattern of having served a different function; based on the use-alteration patterns, they were used for all kinds of purposes, including storage and cooking. In the opinion of the author, this shows that the ornamentation was more related to aesthetic preference rather than symbolic meaning. An exception could be an ornamented vessel from Laukskola settlement, where a fish bone had been used to create the ornamentation. The only known ornamentation created using bones of aquatic animals is seen on pottery from Neolithic sites, such as Sārnate, Pūrciems, Piestiņa, etc., where potters used porpoise teeth to decorate vessels.[511] It should be added that most of the Neolithic sites with such ornamentation were located near the sea, and therefore the use of porpoise to ornament vessels might have had a deeper meaning, perhaps having to do with the relationship between food and pottery. It is known that fish and wild animals still had a major role in the diet of Late Bronze Age communities. For example, at Ķivutkalns 8% of all bones were from fish, most of which were found in large quantities in hearths, whereas wild animal bones constitute 6%.[512] As Laukskola settlement was located on the bank of the River Daugava, fishing most likely had a significant role in food provision. Thus, the ornamentation might have had a spiritual meaning, relating to the importance of fish

[508] Ibid., 27. lpp

[509] See DARCEY MOREY. Burying key evidence: The social bond between dogs and people. In: Journal of Archaeological Science, 2006, vol. 33(2), pp. 158–175

[510] Personal communication from zooarchaeologist Eduards Plankājs, May 28, 2021.

[511] VALDIS BĒRZIŅŠ, BAIBA DUMPE. Cūkdelfīnu zobu iespiedumi neolīta keramikas rotājumā. Latvijas Vēstures institūta žurnāls, 2016, nr. 1 (98), 5–27. lpp

[512] JĀNIS GRAUDOIS. Nocietinātās apmetnes…, 80–81. lpp

Summary and conclusions

The characteristics which pottery displays provide a meaningful insight into everyday life, such as the quality of execution of this craft, aesthetic values, ideology as well as transmission of knowledge and communication between prehistoric communities. In this thesis, various methods in pottery analysis were used to answer questions relating to pottery craft in the Eastern Baltic societies during the Bronze and Pre-Roman Iron Age. The results presented in this thesis cover different aspects of pottery production and its function as well as meaning in the prehistoric communities.

The obtained data on pottery production shows that pottery was made using good-quality till or purified till clay. Study of the clay beds showed that malleable till clay was available in the vicinity of the majority of living sites. In terms of clay chemistry, the potters used highly plastic clays. However, the clays obtained in the field study did not correspond to clays used in pottery production and so were not the ones used by ancient potters. Only in a few cases can we assume that the nearby clay resources identified in the surveys were used in pottery production. However, this is not always the case, as seen from the Narkūnai example: the hillfort was established on a good-quality till clay mound and in the surroundings there are several clay deposits; however, none of them are chemically similar to the pottery samples. Folklore material indicates that potters might have used waterways (rivers) to obtain good- quality clays. This might indicate different clay provision practices among Eastern Baltic prehistoric communities: either using nearby or on-site clays or walking distances of up to about 10 km or using waterways.

A wide variety of tempering materials were used in the production of the vessels: granitic rock (dominant), sand (minor), grog (rare), quartzite (rare) and possibly organic material (marginal). Various experiments and observations indicate that dung might also have been included as a tempering material. Petrographic and visual observations indicate that granitic rock temper dominated over all the other materials, where the rest of the tempering materials can be considered minor or even marginal. Eight fabrics with various subgroups were distinguished by petrographic analysis, which indicates the wide variety of paste recipes. It is significant that most of these recipes are represented on a range of sites, i.e., there are no fabrics characteristic of just one site, indicating the transmission of knowledge between Eastern Baltic communities. The recipes do not correspond to different time periods, i.e. the petrographic data shows that there are no striking differences between the Early Bronze Age pottery recipes and those of the beginning of the Pre-Roman Iron Age. However,

visual and statistical analysis shows that in the pottery from the end of the Pre-Roman Iron Age (from Vilmaņi III settlement) temper was added in smaller amounts but was much coarser than that of the Bronze Age vessels.

Vessel morphology does show chronological and regional differences. Thus, during the Early Bronze Age in the central part of the Eastern Baltic flat-based, profiled and barrel-shaped vessels and in the Lake Lubāns microregion round-based and flat-based profiled vessels were more common, whereas during the Late Bronze Age profiled vessels were preferred in the western and southern parts of the Eastern Baltic, while in the northern, central and eastern parts of the Eastern Baltic – barrel–shaped. It may be noted that on Saaremaa biconical vessels were also preferred among the fine wares. At the end of the Late Bronze and beginning of the Pre-Roman Iron Age a new shape enters the tradition of striated pottery, namely the biconical vessel. This shape, however, is only common at Upper Daugava sites, while in the rest of the region the previous tradition of vessel morphology continues.

During the Late Bronze Age ornamentation on the surface of the vessels decreases, indicating change in the societies and their perception of pottery. It seems that with the new luxurious material – bronze – there were other ways for societies to express themselves, leaving the decoration of pottery secondary. Now it served a more practical function, only rarely being ornamented. This, however, does not apply to Asva Ware or to burial urns, where ornamentation is seen on the surface of the vessels. The visual analysis shows that coastal pottery is more ornamented, with a variety of elements and motifs, than the pottery of the inland territory, indicating influences between regions.

Surface treatments and their subgroups as well as ornamentation show the clearest traces of the transmission of knowledge and contacts between prehistoric communities in the territory of the Eastern Baltic. Striated pottery can be considered as local in the Eastern Baltic. This type of surface treatment dominates in all of the Eastern Baltic region and occurs in a wide region: not just in the Eastern Baltic but also in present-day Belarus. It has been found in Scandinavia as well, even dominating at one site (Darsgärde). The Darsgärde example might indicate of strong influences from the Eastern Baltic region, as with the Paimio type in present-day Finland. Conversely, textile pottery, which is more common in the northern and less in the central part of the Eastern Baltic, was most likely an influence from present-day Finland, being dominant in the interior of Finland and Karelia. Significant in this regard are the finds of textile pottery from Padure hillfort, which is the only site in the western part of the Eastern Baltic where this kind of pottery has been found. This indicates

exceptional transmission of knowledge and communication between Padure and either Saaremaa or communities in present-day Finland.

The regions of influence are least clearly identifiable in the case of coarse-slipped pottery, as this is dominant in present-day Sweden and likewise in Central Europe. The radiocarbon datings show that coarse-slipped and striated coarse-slipped pottery first appeared in the western part of the Eastern Baltic. This surface treatment later appeared in the northern, central and eastern parts of the Eastern Baltic. Bearing in mind the presence of stone ship settings in Kurzeme and Saaremaa as well as the Staldzene and Tehumardi hoards, it is possible that these regions were influenced by Scandinavian groups travelling along the Venta river and to Saaremaa island. On the other hand, the Lower Daugava communities could have been influenced from Scandinavia via the waterway of the Daugava and from the Lusatian Culture of Central Europe, as indicated by the find of a tutulus at Ķivutkalns hillfort. It should be noted that on the inland assemblages from living sites, except Brikuļi, no coarse-slipped pottery has been found. Moreover, in the case of present-day Lithuania only striated and smooth vessels have been found. A different situation is seen in the cemetery material, where pottery seemingly follows different traditions.

Pottery function is analyzed in this study on the basis of spatial distribution, use-alteration patterns as well as organic residue analysis. The obtained data shows that pottery is generally associated with the structures and features found on the living sites: the highest pottery concentrations are seen in the areas connected with food preparation and storage, thus, reflecting the function of most of the pottery, namely cooking and storage. The clearest traces of tableware are seen in Asva Ware, where fine ware – bowls and cups – have been distinguished. The existence of coarse ware with small and medium-sized vessels, presumably for eating and drinking, indicates social differentiation, where fine ware was used by the elite while coarse ware was used by the rest of the community. Such social differentiation embodied in the pottery is not seen in the other regions of the Eastern Baltic, as only coarse ware is distinguished in the archaeological material. However, it is also possible that these fine ware vessels were used for special occasions such as feasting. Wooden vessels were possibly used as tableware as well in these communities, as such archaeological material is preserved from other periods. Organic residue analysis indicates that there is no correlation between surface treatment and the function of the vessel. Even more interestingly, in most of the vessels both fish and conifer residues were found together.

Use-alteration patterns such as soot and food crust were mostly seen on the large vessels, thus relating them to cooking. However, traces of food crusts and soot were also

distinguished on some small vessels and medium-sized pots, indicating heating or re-heating of food and liquids. The function of the miniature vessels is not clear: it is possible that they were either made by children, used as drinking cups by children or used for ritualistic purposes. Secondary use of broken vessels was also observed. Household pottery was used for socio-ideological purposes as well, which is indicated by the offerings found at some of the hillforts. Moreover, these offerings always consisted not only of a vessel, but also included animal bones – generally bones from domestic and hunted animals, as well as dog.

Burial pottery is most clearly seen as having served a socio-ideological role (meaning), being used either as urns or rarely as grave goods, or in burial rites, being broken and scattered in the graves or in the surroundings of the cemetery. This might indicate that a feast related to ritual was part of the burial rite among the Eastern Baltic communities on the sites where such vessels have been found. All of the urns, with a few exceptions, were put in stone "boxes" with a stone "lid" on top, indicating that the urn was meant to be a house for the deceased. Use-alteration patterns, such as soot, found on small vessels near the cemetery or in graves indicate some ritualistic practice during burial rites. The presence of soot and food crust on some of the urns indicates that some vessels were primarily used in everyday life and only afterwards as urns. This is also seen in organic residue analysis.

Overall, the obtained data gives an important insight into pottery production and its role in Eastern Baltic communities. Pottery was made with the intended function in mind, was used and re-used during its life and was even used in burial practices. This shows that indeed pottery and the craft of making it served a meaningful role in the prehistoric communities of the Eastern Baltic.

In future studies it would be important to compare Eastern Baltic pottery traditions to those of the nearby regions in order to understand and determine interregional transmission of knowledge. It would be especially beneficial to understand pottery traditions and their main tendencies in the Lusatian Culture in order to identify similarities to those of the Eastern Baltic region, if there are such. Remaining unexplained are the questions regarding inland pottery and coastal pottery: these seemingly show different influences, the inland areas being more conservative in terms of preferences regarding pottery construction and ornamentation. Considering this aspect, more inland sites should be investigated in the future.

Acknowledgements

Preparation of the PhD thesis was funded by: 1) the project "Social transformations in the Bronze Age societies of the Lower Daugava river", lzp-2018/2-0127; 2) the project "Subsistence strategies and the first demographic transition at the lake Lubāns wetland", lzp-2020/2-0032; 3) the project "Strengthening of the capacity of doctoral studies at the University of Latvia within framework of the new doctoral model", 8.2.2.0/20/I/006; 4) the Association for the Advancement of Baltic Studies Scholarship of Aina Birnitis and 5) the State Culture capital foundation projects "Refining the chronology of the Late Bronze and Pre-Roman Iron Age striated pottery by AMS ^{14}C dating", 2020-3KMA161, 2021-1-KMA047 and 2021-2-KMA069

The author is thankful to the National History Museum of Latvia, the Lithuanian National Museum, Tallinn University Archaeological Research Collection, University of Tartu Department of Archaeology, Institute of Latvian History Archaeological Repository, University of Latvia, Cēsis History and Art Museum, the Lithuanian Geological Survey and the Latvian Environment, Geology and Meteorology Centre as well as Estonian Geological Survey for permission to use their material, and to Artūrs Haferbergs, Valdis Bērziņš, Vytenis Podėnas, Baiba Dumpe, Alise Gunnarssone, Mārcis Kalniņš, Artis Kons, Anna Trubača-Boginska, Anna Batraga, Aija Ceriņa, Uwe Sperling, Ester Oras, Jonas Satkūnas, Gunita Zariņa, Jānis Ciglis, Silvija Tilko, Aigars Vāvere, Janta Meža and Ēriks Jēkabsons for their help, consultations and encouragement. And to supervisor Andrejs Vasks and scientific consultant Vija Hodireva for their encouragement and patience. And lastly, to my family for their support.

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4. Ava hillfort, TLÜ, AI 3307; AI 3658; AI 3799; AI 3994; AI 4366
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8. Buļļumuiža cemetery, LNVM AD, A 7406; A 9961; A 6395; A 63907; A 63908
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APPENDIXES

Appendix I. ^{14}C dates of the sites analyzed. Calibrated using OxCal 4.4.

INTCAL20. OxCal 4.4. Bronk Ramsey (2021), Atmospheric data from Reimer *et al.* (2020)

No.	Site	Material	Laboratory no.	^{14}C age (BP)	Cal (95.4%)	Reference
1.	Abora I settlement	Charcoal?	LE-641	6590±90	5704–5369 BC	Loze 1979
2.	Abora I settlement	Charcoal?	LE-671	3870±70	2565–2140 BC	Loze 1979
3.	Abora I settlement	Charcoal?	LE-749	3860±100	2580–2027 BC	Loze 1979
4.	Abora I settlement	Charcoal?	TA-394	3770±60	2451–1985 BC	Loze 1979
5.	Abora I settlement (striated pottery)	Food crust	Poz-131343	2515±30	786–543 BC	This study
6.	Antilgė hillfort	Charcoal	Ftmc-38-2	2461±52	761–415 BC	Podenas 2019
7.	Asote hillfort	Food crust	Poz-136323	2490±30	775–486 BC	This study
8.	Asva hillfort	Charcoal	TA-511	2585±50	832–544 BC	Lang 2007
9.	Asva hillfort	Charcoal	TA-81	2520±60	801–422 BC	Lang 2007
10.	Asva hillfort	Charcoal	Hela-3080	2502±30	779–524 BC	Sperling 2014
11.	Asva hillfort	Charcoal	Hela-3079	2505±30	780–540 BC	Sperling 2014
12.	Asva hillfort	Charcoal	Hela-3081	2536±30	796–546 BC	Sperling 2014
13.	Bašķi cemetery	Calcined bone	Hela-3851	2617±20	811–779 BC	Ciglis, Vasks 2017
14.	Bašķi cemetery	Calcined bone	Hela-3846	2531±21	789–551 BC	Ciglis, Vasks 2017
15.	Bīlavas stone ship setting	Calcined bone	Ua-42247	2726±39	975–806 BC	Wehlin 2013
16.	Bīlavas stone ship setting	Calcined bone	Ua-42246	3001±48	1401–1056 BC	Wehlin 2013
17.	Brikuļi hillfort	Charcoal	TA-750	2410±60	757–393 BC	Vasks 1994
18.	Brikuļi hillfort	Charcoal	LE-1767	2580±40	816–549 BC	Vasks 1994
19.	Brikuļi hillfort	Charcoal	LE-1768	1700±40	247–425 AD	Vasks 1994
20.	Brikuļi hillfort	Charcoal	LE-1769	2630±40	900–767 BC	Vasks 1994
21.	Brikuļi hillfort	Charcoal	LE-1770	6770±80	5835–5532 BC	Vasks 1994
22.	Brikuļi hillfort	Charcoal	LE-1771	3090±40	1441–1230 BC	Vasks 1994
23.	Buļļumuiža cemetery	Charcoal	Poz-80633	2725±35	968–807 BC	Ciglis, Vasks 2017
24.	Buļļumuiža cemetery	Calcined bone	Poz-80903	2495±35	779–481 BC	Ciglis, Vasks 2017
25.	Buļļumuiža cemetery	Calcined bone	Hela-3827	2430±32	750–404 BC	Ciglis, Vasks 2017
26.	Buļļumuiža	Calcined	Hela-3828	2447±33	754–410 BC	Ciglis,

	cemetery	bone				Vasks 2017
27.	Dārznieki cemetery	Calcined bone	Hela-0	2758±27	983–827 BC	Ciglis, Vasks 2017
28.	Dievukalns hillfort	Food crust	Poz-131344	1870±330	765 BC–772 AD	This study
29.	Dievukalns hillfort	Food crust	Poz-131345	2220±140	753 BC–76 AD	This study
30.	Dievukalns hillfort	Charcoal	Riga	2711±140	1260–477 BC	Zariņa 1982
31.	Egliškiai cemetery	Food crust	Poz-141373	2440±35	753–407 BC	This study
32.	Garniai I hillfort	Charcoal	Mams-29320	2521±24	786–546 BC	Podenas 2019
33.	Garniai I hillfort	Charcoal	Mams-29321	2498±23	773–543 BC	Podenas 2019
34.	Garniai I hillfort	Charcoal	Mams-29322	2492±23	772–541 BC	Podenas 2019
35.	Kaali settlement	Charcoal	Tln-288	2320±40	515–208 BC	Veski *et al.* 2004
36.	Kaali settlement	Charcoal?	?	2450±50	759-409 BC	Lang 2007
37.	Kaali settlement	Charcoal?	?	2435±50	756–403 BC	Lang 2007
38.	Kerkūzi I settlement	Food crust	Poz-136332	2410±30	743–399 BC	This study
39.	Ķivutkalns cemetery	Bone	Hela-1868	2555±40	807–544 BC	Vasks, Zariņa 2014
40.	Ķivutkalns cemetery	Bone	Hela-1864	2525±35	795–542 BC	Vasks, Zariņa 2014
41.	Ķivutkalns cemetery	Bone	Hela-3424	2515±52	797–425 BC	Vasks, Zariņa 2014
42.	Ķivutkalns cemetery	Bone	Hela-1867	2495±40	780–424 BC	Vasks, Zariņa 2014
43.	Ķivutkalns cemetery	Bone	Hela-1866	2490±40	778–423 BC	Vasks, Zariņa 2014
44.	Ķivutkalns cemetery	Bone	Hela-1865	2475±40	771–420 BC	Vasks, Zariņa 2014
45.	Ķivutkalns cemetery	Bone	Hela-3421	2448±54	760–408 BC	Vasks, Zariņa 2014
46.	Ķivutkalns cemetery	Bone	Hela-3422	2346±44	731–232 BC	Vasks, Zariņa 2014
47.	Ķivutkalns cemetery	Bone	Hela-3420	2316±53	715–202 BC	Vasks, Zariņa 2014

48.	Ķivutkalns cemetery	Bone	Hela-3423	2308±42	478–204 BC	Vasks, Zariņa 2014
49.	Ķivutkalns hillfort	Charcoal	Le-2032	2750±40	992–813 BC	Vasks, Zariņa 2014
50.	Ķivutkalns hillfort	Charcoal	TA-436	2675±60	983–771 BC	Vasks, Zariņa 2014
51.	Ķivutkalns hillfort	Charcoal	TA-438	2600±50	898–546 BC	Vasks, Zariņa 2014
52.	Ķivutkalns hillfort	Charcoal	TA-437	2500±70	792–416 BC	Vasks, Zariņa 2014
53.	Ķivutkalns hillfort	Bone	Hela-2675	2576±29	810–573 BC	Vasks, Zariņa 2014
54.	Ķivutkalns hillfort	Bone	Hela-2673	2543±27	796–550 BC	Vasks, Zariņa 2014
55.	Ķivutkalns hillfort	Bone	Hela-2674	2532±27	792–548 BC	Vasks, Zariņa 2014
56.	Ķivutkalns hillfort	Charcoal	Ri-220	2482±150	929–201 BC	Vasks, Zariņa 2014
57.	Ķivutkalns hillfort	Charcoal	Le-2030	2280±40	404–205 BC	Vasks, Zariņa 2014
58.	Ķivutkalns hillfort	Decayed wood	Le-2031	1920±40	11–221 AD	Vasks, Zariņa 2014
59.	Klosterkalns hillfort	Charcoal	Poz-141246	2985±35	1381–1056 BC	This study
60.	Koivukula hillfort	Charcoal	Tln-3359	2632±60	925–551 BC	Valk *et al.* 2012
61.	Krievu kalns hillfort	Charcoal	Tln-3519	2779±50	1048–816 BC	Doniņa *et al.* 2014
62.	Krievu kalns hillfort	Charcoal	Tln-3518	2507±60	794–420 BC	Doniņa *et al.* 2014
63.	Krievu kalns hillfort	Charcoal	Tln-3520	2454±45	759–412 BC	Doniņa *et al.* 2014
64.	Kvietiniai settlement	Charred barley	Poz-85276	3050±35	1411–1217 BC	Vengalis *et al.* 2020
65.	Kvietiniai settlement	Charred hazelnut shell	Poz-86015	3025±35	1399–1130 BC	Vengalis *et al.* 2020
66.	Kvietiniai	Charred	UBA-306000	3009±39	1391–1123	Vengalis *et*

	settlement	barley			BC	*al.* 2020
67.	Kvietiniai settlement	Food crust	FTMC-39-6	2930±39	1259–1011 BC	Vengalis *et al.* 2020
68.	Kvietiniai settlement	Charred hazelnut shell	Poz-86012	2800±35	1048–836 BC	Vengalis *et al.* 2020
69.	Kvietiniai settlement	Charred hazelnut shell	Poz-86013	2785±35	1014–832 BC	Vengalis *et al.* 2020
70.	Kvietiniai settlement	Charred hazelnut shell	Poz-86014	2755±35	1007–832 BC	Vengalis *et al.* 2020
71.	Kvietiniai settlement	Charcoal from urn	Poz-86016	2375±35	725–387 BC	Vengalis *et al.* 2020
72.	Lagaža settlement	Food crust	Poz-131338	3410±50	1879–1544 BC	This study
73.	Lagaža settlement	Charcoal?	TA-749	3685±80	2340–1782 BC	Loze 1979
74.	Lagaža settlement	Charcoal?	TA-396	3640±70	2268–1775 BC	Loze 1979
75.	Lagaže settlement	Charcoal?	LE-868	3240±70	1731–1321 BC	Loze 1979
76.	Laukskola settlement	Food crust	Poz-130291	2525±30	791–544 BC	Visocka *et al.* 2021
77.	Lulle stone ship setting	Calcined bone	Ua-42959	2525±30	791–544 BC	Wehlin 2013
78.	Lulle stone ship setting	Calcined bone	Ua-42960	2613±30	822–771 BC	Wehlin 2013
79.	Mineikiškes hillfort	Charcoal	Mams-33921	2528±25	790–547 BC	Podenas 2019
80.	Mūkukalns hillfort	Food crust	Poz-130292	2575±30	810–570 BC	This study
81.	Narkūnai hillfort	Charcoal	Mams-33922	2538±26	794–549 BC	Podenas 2019
82.	Padure hillfort	Charcoal	LE-6682	2890±100	1381–833 BC	Bērziņš *et al.* 2009
83.	Paplaka hillfort	Charcoal	TA-3151	2210±60	395–104 BC	Haferbergs 2018
84.	Paveisininkai cemetery	Calcined bone	Hela-2480	2528±30	793–544 BC	Piličiauskas *et al.* 2011
85.	Priednieki settlement	Charcoal	Tln-2982	2346±85	761–201 BC	Bērziņš *et al.* 2009
86.	Priednieki settlement	Charcoal	Tln-2981	2531±60	806–423 BC	Bērziņš *et al.* 2009
87.	Pukuļi cemetery	Charcoal	Poz-80631	7020±50	6010–5777 BC	Ciglis, Vasks 2017
88.	Pukuļi cemetery	Charcoal	Poz-80631	3230±35	1607–1421 BC	Ciglis, Vasks 2017
89.	Pukuļi cemetery	Calcined bone	Poz-80328	3225±30	1536–1425 BC	Ciglis, Vasks 2017

90.	Pukuļi cemetery	Calcined bone	Poz-77309	3130±35	1497–1294 BC	Ciglis, Vasks 2017
91.	Pukuļi cemetery	Calcined bone	Poz-80329	3190±30	1507–1415 BC	Ciglis, Vasks 2017
92.	Pukuļi cemetery	Calcined bone	Poz-80327	3145±30	1499–1311 BC	Ciglis, Vasks 2017
93.	Pukuļi cemetery	Charcoal	Poz-80630	3125±35	1496–1289 BC	Ciglis, Vasks 2017
94.	Pukuļi cemetery	Calcined bone	Poz-80897	2930±30	1222–1016 BC	Ciglis, Vasks 2017
95.	Reznes cemetery	Calcined bone	Hela-3555	2585±29	811–592 BC	Ciglis, Vasks 2017
96.	Reznes cemetery	Bone	Poz-101317	2900±40	1218–937 BC	Legzdiņa *et al.* 2020
97.	Reznes cemetery	Charcoal	Poz-118495	3055±35	1412–1222 BC	Legzdiņa *et al.* 2020
98.	Reznes cemetery	Bone	Poz-101195	2535±30	795–546 BC	Legzdiņa *et al.* 2020
99.	Reznes cemetery	Charcoal	Poz-118494	3085±35	1431–1236 BC	Legzdiņa *et al.* 2020
100.	Reznes cemetery	Horse tooth	Poz-111895	2935±30	1256–1017 BC	Legzdiņa *et al.* 2020
101.	Reznes cemetery	Bone	Poz-101193	2555±30	803–551 BC	Legzdiņa *et al.* 2020
102.	Reznes cemetery	Bone	Poz-111831	2835±35	1111–906 BC	Legzdiņa *et al.* 2020
103.	Reznes cemetery	Teeth	Poz-101194	2885±30	1200–936 BC	Legzdiņa *et al.* 2020
104.	Reznes cemetery	Bone	Poz-111833	2905±35	1218–998 BC	Legzdiņa *et al.* 2020
105.	Reznes cemetery	Partially calcined bone	Poz-111834	2935±35	1257–1016 BC	Legzdiņa *et al.* 2020
106.	Reznes cemetery	Unburned horse tooth	Poz-111894	2920±30	1214–1016 BC	Legzdiņa *et al.* 2020
107.	Reznes cemetery	Unburned horse tooth	Poz-118254	2935±30	1256–1017 BC	Legzdiņa *et al.* 2020
108.	Reznes cemetery	Calcined bone	Poz-112721	2795±30	1043–837 BC	Legzdiņa *et al.* 2020
109.	Reznes cemetery	Unburned horse tooth	Poz-118255	2850±35	1122–915 BC	Legzdiņa *et al.* 2020
110.	Reznes cemetery	Calcined bone	Poz-123125	3010±35	1389–1125 BC	Legzdiņa *et al.* 2020
111.	Reznes cemetery	Calcined bone	Poz-123126	3080±35	1426–1234 BC	Legzdiņa *et al.* 2020
112.	Reznes cemetery	Calcined bone	Poz-123127	3105±35	1445–1268 BC	Legzdiņa *et al.* 2020
113.	Sokiškiai hillfort	Charcoal	Mams-33923	2500±26	776–541 BC	Podenas 2019

114.	Vampenieši settlement	Charcoal	Poz-136331	3045±35	1412–1213 BC	This study
115.	Vilmaņi III bsettlement	Food crust	Poz-141430	1965±30	41 BC–126 AD	This study
116.	Vīnakalns hillfort	Food crust	Poz-130663	2480±30	772–476 BC	Visocka *et al.* 2021
117.	Vīnakalns hillfort	Food crust	Poz-130596	2510±30	786–541 BC	Visocka *et al.* 2021
118.	Vīnakalns hillfort	Food crust	Poz-130573	2520±30	789–544 BC	Visocka *et al.* 2021
119.	Žalioji settlement	Charcoal	Vs-2028	2470±50	770–416 BC	Piličiauskas *et al.* 2011

Appendix II. Description of the clays sampled and analyzed

No.	Code	Location	Munsell colour (raw, dry)	Munsell colour (fired 700°C)	Characteristics	Workability	Analysis conducted
Lower Daugava							
1.	DGM1	Daugmale hillfort riverbank slope	10 YR 6/5	7.5 YR 6/6	Silty, earthy plastic	Good	XRF, CP
	DGM2	Ploughed land near Daugmale hillfort	7.5 YR 5/4	7.5 YR 5/8	Sandy, sticky, plastic	Very good	XRF, CP
2.	DZI1	Steep bank of the Daugava in Dzintari	7.5 YR 5/6	5 YR 5/8	Plastic, sandy and micaceous	Good	XRF
	DZI2		7.5 YR 6/3	7.5 YR 6/6	Very sandy, calcareous	Medium	XRF, CP
3.	NAS1	Bank of Daugava facing Nāvessala Island	7.5 YR 5/6	7.5 YR 6/8	Sandy, plastic, some large dolomite inclusions (sorted out)	Good	XRF
4.	SAL2	Bank of Daugava near monument to Ako	10.5 YR 5/3	7.5 YR 6/6	Sandy, plastic, some large dolomite inclusions (sorted out)	Good	XRF
5.	SLD1	Near Saulesdārzs village	7.5 YR 5/5	7.5 YR 5/6	Very sandy, plastic	Good	XRF
	SLD2		7.5 YR 5/6	5 YR 5/8	Sandy, very plastic	Very good	XRF, CP

6.	SLKL1	Bank of Daugava near Saulkalne village	7.5 YR 6/2	10 YR 8/3	Purified by Daugava, sticky, plastic	Good	XRF, CP
No.	**Code**	**Location**	**Munsell colour (raw, dry)**	**Munsell colour (fired 700°C)**	**Characteristics**	**Workability**	**Analysis conducted**
7.	SRS1	Saurieši gypsum quarry	2.5 Y 7/1	10 YR 7/4	Plastic, large amount of gypsum impurities	Not suitable	XRF, CP
Kurzeme							
8.	JRN-M	In the seashore in Labrags village	2.5 Y 6/1	10 YR 6/4	Sticky, very plastic	Very good	XRF, CP
9.	UML	Near the sand quarry of Umuļi, near Keramika village	10 YR 6/4	7.5 YR 6/5	Sandy, partly plastic	Medium	XRF, CP
10.	RDS	Near Kuldīga radio station	-	-	Plastic, sticky	Good	-
11.	KL1,2	Near Klūdziņas farm, next to Klūgas forest	7.5 YR 6/4	7.5 YR 5/8	Fatty, very plastic	Very good	XRF, CP
12.	KLV-ST	In the quarry near Kalvene station	10 YR 7/4	7.5 YR 5/5	Sandy, plastic	Good	XRF, CP
Lake Lubāns							
13.	AB 4-5/E	In Abora I settlement	2.5 Y 5/2	10 YR 8/4	Fatty, plastic	Very good	CP
14.	VIL	ca. 3 km from Zvidze, near Vilkanči farm	10 YR 7/2	7.5 YR 7/4	Fatty, very plastic	Very good	-

15.	LIB	Ploughed field near Liberti farm	10 YR 6/6	7.5 YR 6/8	Fatty, very plastic	Very good	-
No.	**Code**	**Location**	**Munsell colour (raw, dry)**	**Munsell colour (fired 700°C)**	**Characteristics**	**Workability**	**Analysis conducted**
16.	ID-ZV	In Īdeņa village next to Zvejnieki farm	7.5 YR 6/4	7.5 YR 6/6	Sticky, sandy, very plastic	Good	-
17.	BAR	Barkava clay deposit	7.5 YR 4/3	7.5 YR 6/6	Fatty, sticky, very plastic	Very good	-
Utena district							
18.	NA-CL	Near Narkūnai hillfort	7.5 YR 5/5	5 YR 5/8	Sandy, plastic	Good	XRF, CP
19.	GA	On Garniai I hillfort	7.5 YR 4/6	7.5 YR 5/8	Sandy, sticky, plastic	Very good	-
20.	AN	ca. 1 km from Antilgė hillfort	2.5 Y 3/1	10 YR 6/8	Sandy, very plastic	Very good	CP
21.	SOK	ca. 2 km from Sokiškiai hillfort	10 YR 5/3	7.5 YR 6/8	Sandy, full of inclusions such as pebbles (sorted out), sticky, plastic	Good	CP
22.	MI	On Mineikiškės hillfort	10 YR 3/4	7.5 YR 5/8	Sandy, plastic	Good	-
23.	KE3	In Kernavė	10 YR 4/2	10 YR 7/6	Sandy with pebbles (sorted out), plastic	Good	CP
Saaremaa							
24.	AS-CL	On Asva hillfort	10 YR 5/2	7.5 YR 6/5	Sandy, sticky, plastic	Very good	XRF, CP

Appendix III. WD-XRF results of the analyzed clays. Median values from three measurements are represented.

No.	Sam-ple	SiO_2	Al_2O_3	Fe_2O_3	CaO	K_2O	P_2O_5	MgO	MnO	TiO_2	BaO	ZnO	ZrO_2	Rb_2O	SrO	V_2O_5	SO_3	La_2O_3	CeO_2	Sc_2O_3	Cr_2O_3	Na_2O	Cs_2O	MoO_3
Lower Daugava																								
1	DGM1	60.65	11.29	3.25	13.3	3.9	0.19	4.82	0.07	0.62	0.05	0	0.04	0	0.02	0	0.49	0	0	0	0	0.46	0	0
2	DGM2	67.67	16.61	5.22	0	5.42	0.11	2.32	0.09	0.87	0.03	0	0.04	0.01	0.01	0	0.11	0.04	0.05	0	0	0	0	0
3	DZI1	66.6	17.47	5.37	1.2	5.29	0.08	2.19	0.05	0.87	0.05	0	0.05	0.01	0.01	0.02	0	0	0.02	0	0	0.22	0.03	0
4	DZI2	52.37	12.59	4.57	17.29	4.33	0.06	5.71	0.07	0.79	0	0	0.04	0.01	0.02	0	1.11	0.03	0	0.01	0	0.72	0	0
5	NAS1	57.07	13.95	4.5	11.86	4.13	0.09	6.74	0.07	0.68	0	0	0.04	0.01	0.01	0	0.11	0	0	0	0	0.19	0	0
6	SAL2	59,37	12,05	3.39	13.98	4.03	0.15	5.09	0.06	0.62	0.05	0	0.04	0.01	0.02	0.01	0	0	0.06	0	0	0.78	0	0
7	SLD1	71.29	14.53	3.6	1.96	4.21	0	2.26	0.07	0.73	0.09	0	0.05	0.01	0.01	0.01	0.13	0.03	0	0	0.01	0.29	0	0
8	SLD2	66.33	16.88	5.38	1.48	5.2	0	2.53	0.03	0.82	0	0	0.05	0.01	0.01	0	0.16	0.04	0.02	0	0	0.53	0	0
9	SLKL1	38.66	13.85	5.29	24.99	4.36	0	11.21	0.09	0.54	0.04	0	0.01	0.01	0.01	0	0.32	0	0	0.01	0.03	0	0.03	0
10	SRS1	44.76	14.26	4.72	15.21	5.59	0.06	10.24	0.02	0.62	0.04	0.01	0.01	0.02	0.04	0.02	3.84	0	0	0	0	0.16	0	0
Kurzeme																								
11	KLG1	48.71	17.9	9.23	10.68	5.83	0.28	5.27	0.05	1.06	0	0.01	0.02	0.02	0.02	0	0.11	0.03	0	0.02	0	0.24	0	0
12	JRN-M	56,58	15.09	5.99	10.97	4.07	0.29	3.32	0.12	0.85	0.04	0.01	0.03	0.01	0.02	0	1.15	0.04	0.04	0	0	1.28	0	0
13	KLV-ST	62.04	13.79	4.95	9.08	4.18	0.12	3.65	0.12	0.78	0.08	0	0.04	0.01	0.02	0	0	0.06	0.04	0.03	0.01	0	0	0
14	UML	64.66	12.39	3.45	10.73	3.85	0.19	2.65	0.05	0.69	0	0.01	0.03	0.01	0.02	0	0.11	0.03	0	0	0	0.86	0	0
Utena																								
15	Na-	66.5	13.7	6.83	1.46	5.5	0	3.09	0.09	1.04	0.0	0	0.04	0.02	0.0	0	0.3	0	0.04	0	0	0.77	0	0

	CL1	1	5			3					5				1		2						
16	Na-CL2	67.42	11.53	4.44	5.47	4.65	0.37	4.02	0.06	0.81	0.08	0	0.05	0.01	0.01	0.03	0.05	0	0.04	0.02	0	0.53	0	0
Saaremaa																								
17	AS-CL1	52.04	18.59	12.64	3.09	4.54	0.18	3.62	0.13	0.93	0	0.02	0.02	0.02	0.02	0	0.46	0.03	0	0	1.66	1.66	0	0.1
Gotland																								
18	Go-CL1	53.83	18.43	7.05	8.05	4.92	0.41	4.49	0.06	0.86	0	0	0.02	0.02	0.02	0	1.01	0	0	0	0.01	0.42	0	0

Appendix IV. WD-XRF results of pottery samples. Median values from three measurements are represented.

No	Sample	SiO_2	Al_2O_3	Fe_2O_3	CaO	K_2O	P_2O_5	MgO	MnO	TiO_2	BaO	ZnO	ZrO_2	Rb_2O	SrO	V_2O_5	SO_3	La_2O_3	CeO_2	Sc_2O_3	Cr_2O_3	Na_2O	Cs_2O
Lower Daugava																							
Ķivutkalns																							
1	KIV11	53.89	15.96	10.53	2.78	4.2	7.7	2.17	0.16	0.86	0.18	0.05	0	0.01	0.02	0	0.23	0	0	0	0	0.92	0.06
2	KIV12	63.45	13.91	4.6	4.21	4.5	4.72	2.34	0.09	0.71	0.09	0.03	0	0.02	0.01	0.03	0.27	0.13	0	0.03	0	0.5	0
3	KIV14	57.11	15.77	7.73	3.04	5.13	4.17	2.17	0.18	0.64	0.28	0.08	0	0.01	0.03	0	0.5	0	0	0	0	1.29	0.08
4	KIV15	58.61	17.57	4.53	7.07	3.05	2.8	1.19	0.02	0.54	0.17	0.02	0	0	0.03	0	0.07	0.04	0.2	0	0	3.48	0
5	KIV16	65.63	13.84	6.8	2.53	3.57	2.95	1.92	0.29	0.59	0.29	0.08	0.03	0.01	0.02	0.04	0.31	0	0.12	0	0	0.58	0
6	KIV17	61.89	13.38	8.27	4.5	4.13	3.17	1.85	0.12	0.79	0.33	0.11	0.03	0	0.05	0	0.42	0	0	0	0	0	0
7	KIV18	51.53	11.37	5.34	8.69	4.87	13.52	2.12	0.31	0.64	0.23	0.07	0	0.01	0.03	0	0.42	0	0	0	0	0.31	0
8	KIV19	51.35	12.21	6.48	9.94	5.3	8.14	2.53	0.46	0.63	0.09	0.06	0	0.03	0.02	0.04	0.97	0.11	0	0	0	1.03	0
9	KIV20	52.51	13.78	8.18	6.63	4.75	8.59	2.56	0.04	0.75	0.47	0.15	0	0.02	0.03	0	0.73	0	0	0	0	0.19	0
10	KIV21	58.96	16.83	7.76	2.59	5.31	3.55	1.83	0.37	1.3	0	0.03	0.04	0.02	0.02	0	0.37	0.03	0.02	0	0	0.77	0
11	KIV-K41	43.3	11.29	12.1	7.78	4.61	15.69	1.62	0.87	0.98	0.15	0.08	0	0	0.05	0	0.15	0	0	0.04	0	0.35	0
12	KIV-K43	42.89	12.71	13.39	8.03	3.97	14.37	1.4	0.79	0.79	0.14	0.04	0	0	0.04	0	0.16	0	0	0	0	0	0
Laukskola																							
13	LK1	56.4	19.45	10.39	1.59	5.1	2.43	2.21	0.36	0.99	0.07	0.02	0.04	0.02	0.01	0	0.3	0	0.03	0	0	0.32	0
14	LK2	57.48	18.52	9.91	2.22	5.28	1.55	2.37	0.49	1.2	0.08	0.02	0.03	0.02	0.01	0.02	0.09	0	0	0	0	0.36	0
Lejasbitēni																							

15	LEJB1	53.67	20.42	11.47	1.09	5.48	1.4	2.61	0.56	1.17	0.13	0.05	0	0.02	0	0.03	0.15	0.05	0	0.03	0	0.8	0
Lipši																							
16	Li80	57.19	18.47	9.05	1.61	5.55	1.69	2.23	0.73	0.93	0.15	0.03	0.04	0.01	0	0	0.26	0	0	0	0	0.79	0
17	Li81	58.03	17.32	8.88	0.83	5.62	2.63	1.99	0.48	1.01	0.1	0.05	0	0.02	0	0	0.44	0	0	0	0	0.59	0
Reznes																							
18	RE 5/6	59.62	16.92	9.64	1.67	5.5	1.13	2.38	0.8	0.73	0.19	0.06	0	0.01	0.02	0.04	0.11	0.07	0	0	0	0.65	0
19	RE 6/10	55.5	19.29	9	2.17	5.64	3.15	2.19	0.52	1.17	0.21	0.06	0.04	0.02	0.02	0.02	0.22	0	0.02	0.01	0	0.63	0
Klaņģu-kalns																							
20	KL9	55.12	12.33	6.77	7.49	5.63	7.1	2.64	0.18	0.77	0.18	0.04	0	0.03	0.02	0	0.52	0	0	0.03	0	0.27	0
21	KL10	61.33	16.12	8.97	2.52	4.82	1.04	1.95	0.25	0.92	0.36	0.15	0	0.04	0.01	0.04	0	0	0	0	0	0.69	0
22	KL11	65.46	15.53	6.73	0.56	4.48	1.25	1.81	0.51	0.71	0.21	0.04	0	0.01	0.01	0	0.38	0.11	0	0	0	1.09	0
23	KL12	55.68	17.45	11.48	1.34	4.84	2.67	1.98	0.31	1.01	0.52	0.14	0.04	0.01	0.03	0	0.12	0	0	0	0	0.35	0
24	KL14	58.13	15.12	10.41	1.63	4.11	5.07	1.85	0.72	0.86	0.27	0.15	0	0	0.01	0	0.29	0	0	0	0	0.59	0.06
Vīnakalns																							
25	VK11	65.66	11.16	7.24	4.13	3.57	3.87	1.47	0.48	0.8	0.27	0.17	0.04	0.02	0.03	0	0.14	0.02	0	0	0	0.55	0
26	VK12	63.35	15.94	9.16	1.71	3.89	1.56	1.71	0.36	0.95	0	0.03	0.04	0.02	0.02	0	0.2	0.02	0	0.01	0	0	0
27	VK13	62.68	12.27	8.33	4.76	4.01	3.35	1.86	0.18	1.13	0.22	0.08	0.03	0.02	0.03	0	0.31	0	0	0.02	0	0.36	0

No	Sam-ple	SiO2	Al2O3	Fe2O3	CaO	K2O	P2O5	MgO	MnO	TiO2	BaO	ZnO	ZrO2	Rb2O	SrO	V2O5	SO3	La2O3	CeO2	Sc2O3	Cr2O3	Na2O	Cs2O	Nb2O	Pr2O3	Tb2O3
Kurzeme																										
Padure hillfort																										
1	BEL2	47.17	15.93	10.07	6.56	5.55	7.16	2.58	2.22	1.34	0.1	0.18	0.03	0.03	0.05	0	0.16	0	0	0	0	0.24	0	0	0	0
2	BEL5	41.05	15.68	14.53	5.31	4.63	13	2.04	1.46	0.94	0.29	0.03	0.05	0.03	0.03	0.04	0.17	0.05	0.06	0	0	0.19	0	0	0	0
3	BEL7	45.18	15.2	10.02	13.52	5.46	4.68	2.91	0.35	1.09	0.08	0.1	0.03	0.04	0.03	0	0.39	0	0.19	0.01	0	0.23	0	0	0	0
Priednieki settlement																										
4	ZR1	35.09	20.04	16.12	3.69	4.24	15.18	1.37	0.7	1.3	0.9	0.15	0.05	0.02	0.02	0	0.56	0	0	0.03	0	0	0	0	0	0
5	ZR2	59.42	18.83	8.88	0.58	5.41	1.69	2.59	0.18	1.12	0	0.05	0.04	0.03	0.01	0.05	0.09	0.05	0.05	0	0.01	0.59	0	0	0	0
6	ZR3	44.2	21.07	13.02	2.09	5.77	8	1.98	1.04	1.23	0	0.09	0.04	0.03	0.02	0	0.26	0	0	0	0.02	0.42	0	0	0	0
Bašķi cemetery																										
7	BAS1	52.22	19.79	16.34	0.61	4.5	1.96	1.49	0.14	1.1	0.08	0.06	0.03	0.03	0.01	0	0.52	0	0	0	0	0.45	0	0	0	0
Pukuļi cemetery																										
8	PUK1	53.59	21.3	11.77	0.4	6.31	0.56	2.98	0.17	1.25	0	0.02	0.01	0.03	0	0	0	0.04	0.04	0	0	0	0	0	0	0
Bīlavas stone ship setting																										
9	BIL6/c	58.58	19.53	8.68	0.32	5.54	1.12	2.2	0.24	0.96	0.15	0.04	0	0.02	0	0.03	0.19	0.07	0	0	0	0.91	0.07	0	0	0
Mušiņas stone ship setting																										
10	MUS1	55.37	20.85	11.49	0.64	4.45	0.9	2.12	0.22	0.91	0.16	0.05	0	0.02	0.01	0.05	0.53	0.06	0	0	0	0.72	0	0.05	0.07	0
11	MUS2	50.48	21.52	12.86	0.82	6.2	1.17	2.81	0.35	0.92	0.19	0.12	0.04	0.01	0.02	0.04	0.41	0.07	0	0.04	0	0.71	0	0	0	0
12	MUS3	45.61	19.54	18.24	2.52	5.46	1.82	2.82	0.69	1.56	0.14	0.13	0.04	0.04	0	0	0.6	0	0	0	0	0	0	0	0	0
Strīķi cemetery																										

13	STRI1	49.98	17.14	14.68	1.34	4.46	7.95	1.69	0	0.98	0.19	0.06	0	0	0.03	0	0.34	0	0	0	0	0.38	0	0	0	0
14	STRI2	42.38	19.18	18.96	1.86	5.44	6.92	1.74	0.08	1.12	0.19	0.11	0	0.03	0.01	0	0.6	0	0	0	0	0.56	0	0	0	0
15	STRI3	55.92	18.48	12.02	0	5.65	2.95	1.89	0	1.2	0.16	0.01	0	0.02	0	0.08	0.22	0	0	0.04	0	0	0	0.05	0	0
Tojāti settlement																										
16	TOJ1	56.39	18.3	9.18	0	6.3	2.72	3.58	0.11	0.99	0.25	0.11	0.03	0	0.02	0	0.34	0	0	0	0	0.27	0	0	0	0
17	TOJ2	47.38	22.17	10.47	0.44	6.95	4.55	3.41	1.28	1.04	0.1	0.09	0	0.02	0	0	0.62	0.06	0	0.02	0	0	0	0.56	0	0
Krievu kalns hillfort																										
18	KRI10	58.93	18.82	8.95	0.98	5.24	1.69	2.75	0.5	0.86	0.14	0.08	0.05	0.02	0.01	0	0.12	0	0	0	0	0.58	0	0	0	0
19	KRI11	52.29	19.25	11.01	2.13	5.48	4.14	3.44	0.27	0.96	0.11	0.11	0	0.02	0.03	0	0.13	0	0	0.02	0	0.23	0.02	0	0	0
20	KRI12	56.87	19.11	9.16	1.85	5.03	2.97	2.82	0.25	0.77	0.17	0.1	0.03	0.03	0.02	0.02	0.07	0.03	0	0	0	0.3	0	0	0	0
21	KRI13	53.43	19.68	11.34	1.49	5.1	3.92	2.41	0.66	0.91	0.14	0.11	0.07	0.02	0.01	0	0.16	0	0	0	0.02	0	0	0	0	0.01
22	KRI14	46.71	17.47	11.53	5.65	3.72	9.25	2.79	0.73	0.93	0.15	0.11	0.02	0.01	0.02	0.06	0.21	0	0	0	0	0.6	0	0	0	0
23	KRI15	55.51	17.44	12.47	1.7	4.66	2.56	2.35	1.48	0.98	0.14	0.07	0	0.02	0.01	0	0	0.02	0	0.02	0	0	0	0	0	0

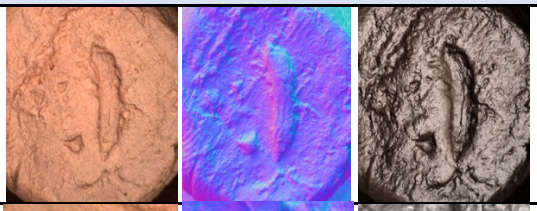
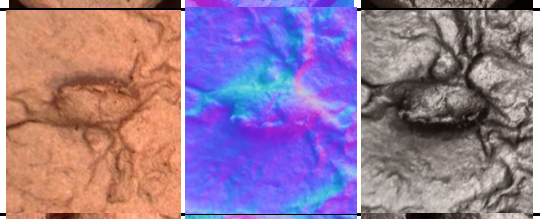
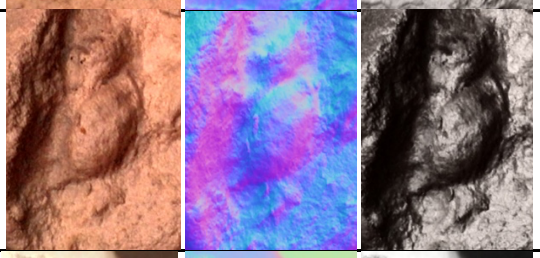
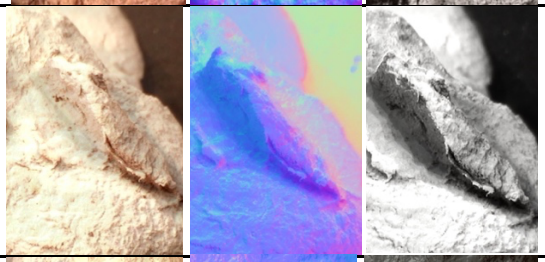
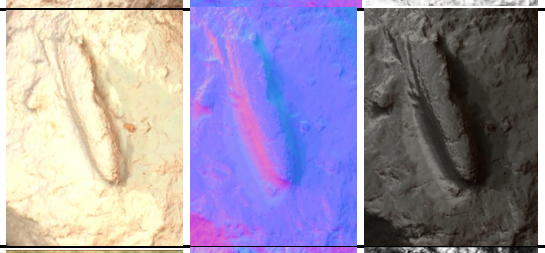
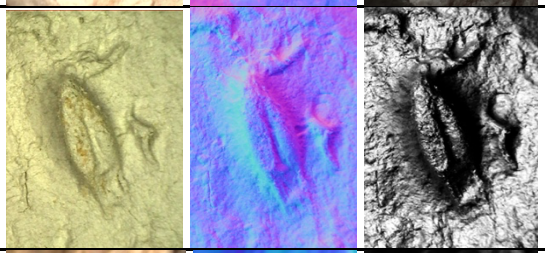
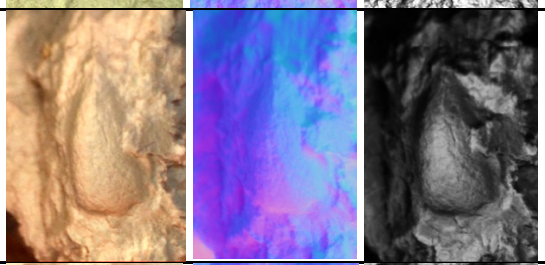
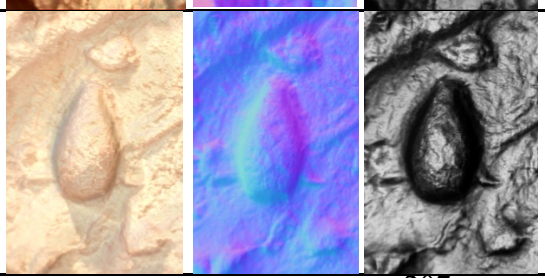
No	Sam-ple	SiO2	Al2O3	Fe2O3	CaO	K2O	P2O5	MgO	MnO	TiO2	BaO	ZnO	ZrO2	Rb2O	SrO	V2O5	SO3	La2O3	CeO2	Sc2O3	Cr2O3	Na2O
Lake Lubāns																						
Brikuļi hillfort																						
1	BRI1	49.67	14.66	8.69	9.81	5.03	6.84	2.36	0.34	1.1	0.19	0.06	0.03	0.03	0.04	0	0.18	0	0.04	0	0	0.52
2	BRI2	53.56	10.86	9.46	7.7	4.78	8.09	1.92	0.39	1	0.38	0.13	0.04	0.02	0.03	0	0.74	0	0	0	0.02	0.77
3	BRI3	46	10.51	11.17	12.86	5.45	8.5	1.67	0.26	1.38	0.33	0.07	0.04	0.04	0.03	0.03	0.88	0	0.08	0	0.03	0
Lagaža settlement																						
4	LAG1	52.83	13.13	7.9	7.89	4.27	9.33	1.18	0.11	1.37	0.59	0.07	0.02	0.01	0.05	0	0.21	0	0.08	0	0.03	0.85
5	LAG2	55.96	15.77	9.78	3.77	4.31	6.72	0.87	0.05	1.04	0.32	0.02	0.02	0.02	0.03	0.01	0.22	0.04	0.05	0.02	0.02	0.31
6	LAG3	52.47	15.81	8.15	6.18	4.68	7.7	1.71	0.06	1.34	0.24	0.03	0.03	0.01	0.04	0	0.6	0	0.05	0	0	0.45
7	LAG4	60.99	16.5	9.06	2.72	3.56	3.26	1.43	0.03	1.22	0.07	0.06	0.02	0.01	0.02	0	0.12	0	0.01	0	0	0.2
8	LAG5	44.7	17.98	7.39	7.44	2.93	15.42	0.57	0.07	1.34	0.54	0.03	0.03	0	0.05	0	0.55	0.03	0.3	0	0.01	0.21
9	LAG6	48.83	17.51	8.55	7.14	2.81	10.97	0.99	0.06	1.28	0.38	0.04	0.02	0	0	0.03	0.37	0	0.3	0.01	0.02	0.22

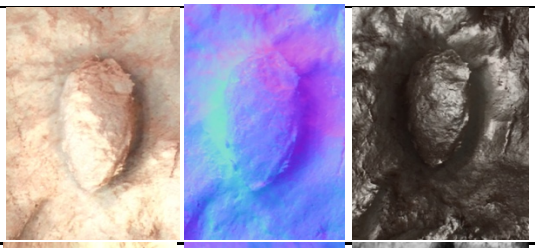
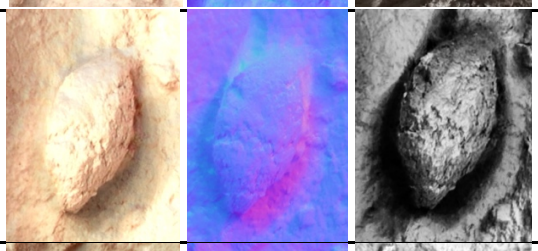
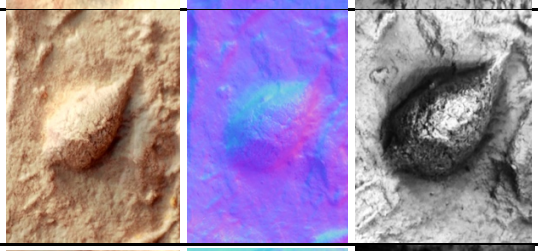
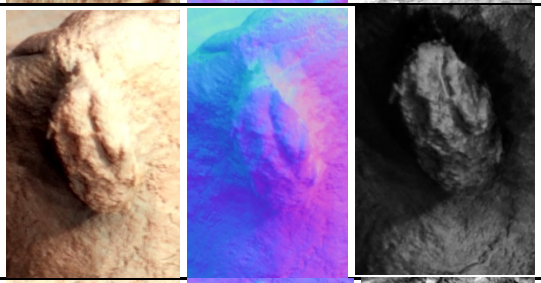
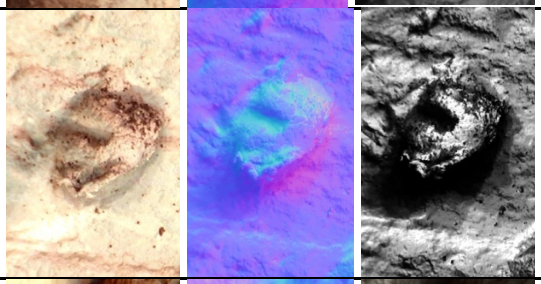
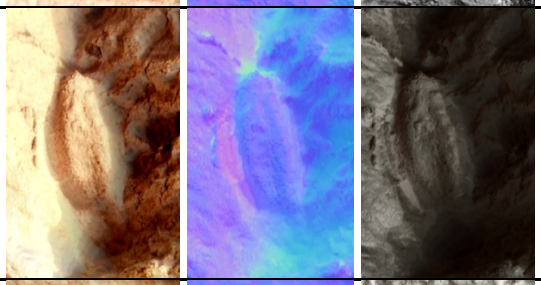
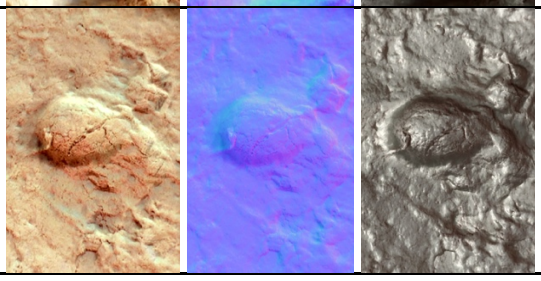
No	Sam-ple	SiO2	Al2O3	Fe2O3	CaO	K2O	P2O5	MgO	MnO	TiO2	BaO	ZnO	ZrO2	Rb2O	SrO	V2O5	SO3	La2O3	CeO2	Sc2O3	Na2O	Cs2O	RuO2
	Narkūnai hillfort																						
1	NA1	34.51	10.55	11.85	19.7	6.6	8.7	4.01	0.23	1.06	0.06	0.09	0	0	0.05	0	1.12	0	0	0	0	0	0
2	NA2	55.6	16.73	10.55	3.18	6.71	1.32	3.16	0	0.98	0.31	0.12	0	0.01	0.03	0.02	0.09	0	0	0	0.36	0	0.15
3	NA5	49.57	15.48	12.01	5.98	5.8	5.13	2.94	0.46	0.84	0.27	0.17	0	0.03	0.03	0.05	0.4	0	0	0.04	0	0.06	0
4	NA7	55.08	18.11	10.51	2.84	5.47	2.76	2.65	0.26	1.03	0.26	0.13	0	0.02	0.02	0.03	0.08	0.05	0	0	0	0	0
5	NA9	66.2	11.12	6.52	3.43	4.44	3.31	2.13	0.15	0.6	0.27	0.1	0	0	0.03	0.02	0.16	0	0	0	0.85	0	0
6	NA11	56.73	15.8	9.51	5.01	5.21	1.6	3.07	0.08	0.84	0.33	0.11	0	0	0.03	0.06	0.2	0.06	0	0	0.99	0	0
7	NA12	55.49	16.04	9.52	3.92	5.86	2.98	2.99	0	0.81	0.24	0.12	0	0.02	0.02	0.04	0.35	0	0	0	1.18	0	0
8	NA15	38.52	12.39	11.82	12.76	4.4	14.47	2.79	0.28	0.68	0.34	0.11	0	0.03	0.02	0	0.28	0	0	0.04	0.59	0	0
9	NA18	53.91	15.62	7.81	6.29	5.75	5.39	2.69	0.05	0.8	0.12	0.07	0	0.02	0.02	0	0.12	0	0	0	0.69	0.09	0

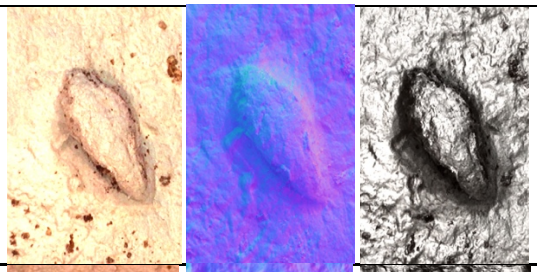
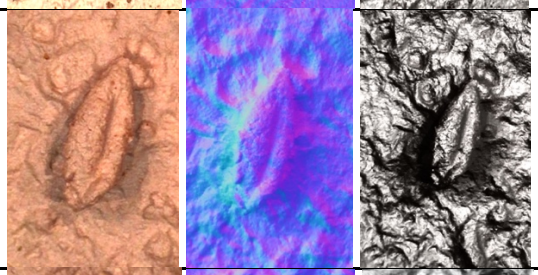
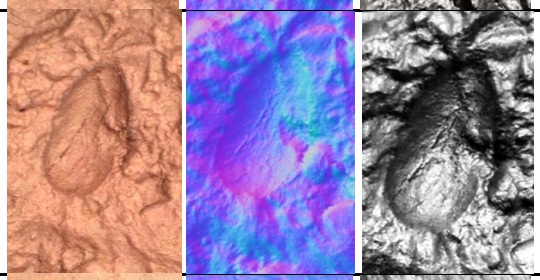
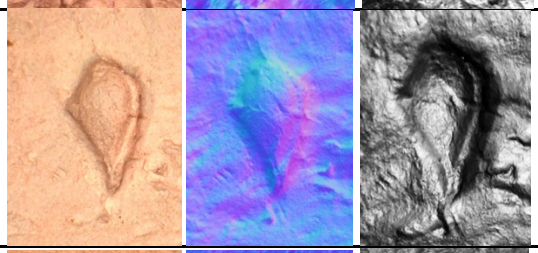
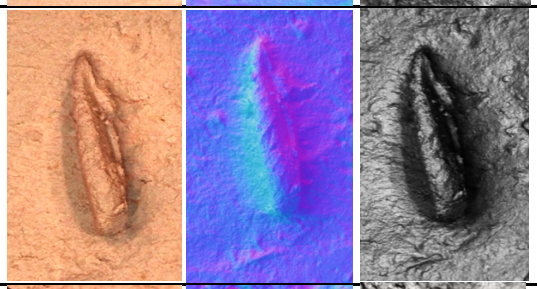
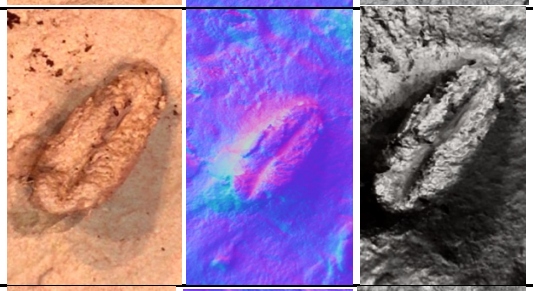
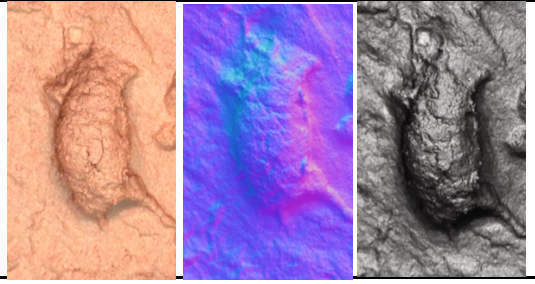
No	Sam-ple	SiO2	Al2O3	Fe2O3	CaO	K2O	P2O5	MgO	MnO	TiO2	BaO	ZnO	ZrO2	Rb2O	SrO	V2O5	SO3	La2O3	CeO2	Sc2O3	Na2O	Cs2O	Nb2O	Pr2O3	PbO
Saaremaa and Inland Estonia																									
Asva hillfort																									
1	AS4	56.39	18.08	8.15	3.21	5.3	1.22	3.56	0	0.86	0.23	0.08	0	0	0.03	0	0.25	0	0	0	2.42	0	0	0	0
2	AS5	37.7	13.45	13.56	9.66	6.28	11.76	3.93	0.06	0.74	0.38	0.15	0	0.03	0.03	0	0.67	0	0	0	0.84	0	0	0.13	0
3	AS6	42.16	11.54	10.14	13.91	4.48	9.02	4.45	0.07	0.71	0.25	0.1	0	0.03	0.03	0.07	1.31	0	0	0	1.2	0.06	0	0	0
4	AS12	48.35	13.65	9.31	12.6	4.7	5.27	3.26	0.06	0.81	0.23	0.1	0	0.02	0.04	0	0.12	0.07	0	0	0.81	0.09	0	0	0
5	AS14	48.36	14.38	10.59	8.19	5.84	6.45	3.21	0.04	0.86	0.18	0.1	0	0	0.04	0.04	0.33	0	0	0	0.46	0	0	0	0
6	AS17	50.23	12.45	10.75	7.92	5.99	6.12	3.42	0.06	0.82	0.21	0.06	0	0.03	0.03	0	0.44	0	0	0	0.83	0.06	0	0	0
7	AS18	49.9	15.01	11.57	7.54	5.47	3.97	3.34	0	0.88	0.25	0.11	0.03	0.06	0.06	0.03	0.34	0	0.09	0	0.51	0	0.04	0	0
8	AS19	40.26	13.48	14.35	12.5	4.34	8.05	3.16	0.03	0.6	0.31	0.19	0	0	0.07	0.07	0.49	0	0.25	0	0.71	0	0	0	0
9	AS20	51.55	16.07	9.15	11.13	4.36	1.17	3.38	0.05	0.86	0.24	0.11	0	0	0.03	0	0.25	0.16	0	0	0.47	0	0	0	0
Ridala hillfort																									
10	RID1	55.2	16.76	9.31	4.3	5.56	2.19	3.25	0.04	0.81	0.25	0.12	0	0	0.03	0.03	0.4	0.07	0	0	1.37	0.06	0	0	0
11	RID2	53.68	13.06	9.83	7.11	6.02	3.27	3.75	0.09	0.97	0.27	0.1	0	0.01	0.03	0.02	0.54	0	0	0.03	0.34	0.06	0	0	0
12	RID3	45.71	13.37	11.38	9.94	5.38	5.75	4.54	0.14	0.74	0.21	0.15	0	0.03	0.01	0.02	0.99	0	0	0	1.35	0	0	0	0
13	RID4	53.05	11.8	9.04	11.65	3.83	4.62	3.05	0.09	0.69	0.25	0.14	0	0.02	0.03	0	0.39	0	0	0	0.48	0.06	0	0	0

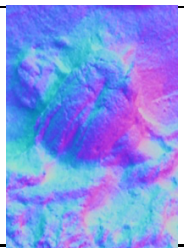
Lulle Sorve																								
14	LUL1	48.83	18.02	13.41	4.42	6.8	0.87	3.04	0.16	1.18	0.22	0.08	0	0.05	0.02	0.05	0.92	0	0	0	0.96	0	0	0	0
15	LUL2	48.51	20.1	12.74	3.53	6.34	1.12	3.37	0.37	1.01	0.1	0.26	0.01	0.03	0.01	0	1.15	0.11	0.15	0	0.33	0	0	0	0
16	LUL3	51.11	19.91	11.87	3.29	6.27	1.01	3.06	0.24	0.95	0.09	0.15	0	0.03	0.02	0	0.48	0.12	0	0	0.46	0.07	0	0	0
Koivuku-la																								
17	KOI1	56.87	17.26	9.69	3.51	5.29	1.63	2.42	0.22	0.94	0.26	0.05	0.05	0.03	0.03	0.03	0.13	0.08	0	0	0.75	0	0	0	0.03
18	KOI3	49.4	17.99	8.59	4.41	6.97	7.55	2.4	0.21	0.83	0.2	0.05	0	0.01	0.01	0.03	0.12	0	0	0.03	0.26	0.09	0.06	0	0.03
Soe																								
19	SOE1	47.23	24.91	12.84	2.97	5.23	1.72	1.66	0.25	1.24	0.17	0.1	0	0	0.02	0	0.23	0.13	0	0	0.68	0	0	0	0

Appendix V. Essential information on the analyzed seeds in pottery. By A. Ceriņa and J. Meža, RTI models: V. Visocka

No.	Site	Context/inv.no.	Species	RTI models
1	Brikuļi	A 12405:421	*Hordeum Vulgare* or *Avena* sp.	
2	Brikuļi	A 12405:460	-	
3	Brikuļi	A 12405:444	*Hordeum vulgare*	
4	Ķivutkalns	VI-5d-celtne_1	-	
5	Ķivutkalns	VI-5d-celtne_2	-	
6	Ķivutkalns	VI-5d-celtne_3	*Hordeum vulgare*	
7	Ķivutkalns	II-2	-	
8	Ķivutkalns	II-2-šķirsts	-	

9	Ķivutkalns	II-4_1	*Hordeum vulgare*	
10	Ķivutkalns	II-4_2	*Hordeum vulgare*	
11	Ķivutkalns	IV-1	-	
12	Ķivutkalns	IV-4	*Hordeum vulgare*	
13	Ķivutkalns	IV-6	-	
14	Ķivutkalns	V-7	*Hordeum vulgare*	
15	Ķivutkalns	VI-3	-	

16	Ķivutkalns	VI-4	*Hordeum vulgare*	
17	Vīnakalns	II-3_2	*Hordeum vulgare*	
18	Vīnakalns	II-3_3	*Hordeum vulgare*	
19	Vīnakalns	III-2	-	
20	Vīnakalns	III-2-1	*Avena* sp.	
21	Vīnakalns	III-2-2	*Hordeum vulgare*	
22	Vīnakalns	III-2-nogāze	*Hordeum vulgare*	

23	Vīnakalns	III-4	*Hordeum vulgare*			

No	Asva Inv. No.	Species
1	4366:455	*Triticum?*
2	4366:1915	-
3	4366:919-a	*Hordeum vulgare*
4	4366:1584	*Triticum*??
5	4366:919-b	*Triticum? Hordeum??*
6	4366:950-a	*Hordeum? Triticum??*
7	4366:950-b	*Panicum miliaceum??*
8	4366:287	*Hordeum*
9	4366:392	*Avena?*
10	4366:612	*Hordeum vulgare* ssp. *vulgare*
11	4366:1750	*Hordeum?*
12	4366:1703	Cereales (possibly *Hordeum?)*
13	4366:1579	-
14	4366:992	-
15	4366:1788	*Avena*
16	4366:1889	-
17	4366:1865	*Triticum???*
18	4366:1929	*Avena?*
19	4366:919-c	*Hordeum?*
20	4366:1189	Poaceae (Graminea)
21	4366:859	*Avena* sp.
22	4366:1788-a	*Avena* sp.
23	4366:1788-b	*Hordeum*
24	4366:1788-c	*Hordeum vulgare Gramineae*

Appendix VI. Table of results of petrographic analysis

NO.	CODE	SAMPLE INFORMATION			CLAY									TEMPER					FABRIC
		Inventory No.	Surface treatment	Wall thickness, cm	Coarseness	Degree of sorting	Silt	Fine sand	Sand	Mica	Iron oxides	Iron concretions	Carbonate concretions	Type	Volume, %	Max. grain size, mm	Max.avg. Size, mm	Homogeneity	
	ASVA																		
1	AS1	TLÜ, AI 3658: 693	Textile	0.85	fine	sorted	-	-	-	-	-	n	n	granite	12	3.6	2.58	+	**3.1.2.**
2	AS2	TLÜ, AI 3994: 951	Striated	0.75	fine	sorted	-	-	-	-	-	n	n	granite	17	4.05	2.43	+	**3.1.2.**
3	AS3	TLÜ, AI 3307: 259	Polished	0.6	coarse	unsorted	*	+	*	*	*	n	n	granite	8	1.5	1.17	+	**4.1.2.**
4	AS4	TLÜ, AI 4366: 1535	Smooth	0.65	medium	unsorted	*	*	*	-	-	n	n	granite	11	2.55	1.74	+	**6.1.2.**
5	AS5	TLÜ, AI 3994: 357	Striated	1	medium	medium	-	*	*	-	-	n	n	granite	17	3.75	2.58	+	**6.1.2.**
6	AS6	TLÜ, AI 3799: 387	Striated	0.95	fine	sorted	-	-	*	-	*	n	*	granite	5	4.05	1.89	+/-	**2.1**
7	AS7	TLÜ, AI 3658: 699	Striated	0.9	fine	sorted	-	-	*	*	*	n	n	granite	6	2.1	1.53	+/-	**3.1.1.**
8	AS8	TLÜ, AI 7065: 2663	Polished	0.6	fine	unsorted	-	*	*	*	+	n	n	granite	7	1.65	1.17	+	**3.2.1.**
9	AS9	TLÜ, AI 3994: 403	Polished	0.85	fine	unsorted	-	*	*	*	*	n	n	granite	15	1.95	1.41	+	**3.2.2.**
10	AS10	TLÜ, AI 4366: 1538	Smooth	0.7	fine	sorted	-	-	-	-	-	n	n	granite	12	6.6	2.52	+	**3.1.2.**
11	AS11	TLÜ, AI 4366: 1618	Polished	0.8	fine	sorted	-	-	*	*	*	n	n	granite	10	2.25	1.29	+	**3.1.1.**
12	AS12	TLÜ, AI 7065: 2476	Smooth	0.9	medium	medium	-	*	*	*	*	n	n	granite	15	2.4	1.83	+	**6.1.2.**
13	AS13	TLÜ, AI 3799: 421	Smooth	0.95	medium	medium	-	*	*	-	*	n	n	granite	8	3.6	2.13	+/-	**6.1.1.**
14	AS14	TLÜ, AI 7065: 2749	Striated	1	coarse	unsorted	*	*	*	*	*	n	n	granite	10	1.5	0.93	+/-	**4.1.2.**

15	AS15	TLÜ, AI 3658: 687	Polished	0.55	fine	sorted	-	-	-	-	-	n	n	granite	11	3.75	2.85	+	**3.1.2.**
16	AS16	TLÜ, AI 3994: 1470	Smooth	0.7	fine	unsorted	-	+	*	*	*	n	n	granite	13	2.1	1.71	+/-	**3.2.2.**
17	AS17	TLÜ, AI 3658: 561	Striated textile	1.2	medium	medium	*	-	*	-	-	n	n	granite	10	2.85	2.01	+	**6.1.1.**
18	AS18	TLÜ, AI 4366: 308	Polished	0.65	coarse	unsorted	+	+	+	-	-	n	n	sand	11	2.55	1.68	+/-	**4.2**
19	AS19	TLÜ, AI 7065: 2876	Striated	1	coarse	unsorted	*	+	+	*	*	n	n	granite	15	5.1	3.48	+/-	**4.1.1.**
20	AS20	TLÜ, AI 4012: 342	Polished	0.65	fine	unsorted	-	*	+	*	+	n	n	sand	9	1.5	1.08	+	**3.2.3.**
	ĶIVUTKALNS																		
21	KIV1	LNVM, VI 120	Striated	1.1	medium	unsorted	+	*	-	-	-	n	n	granite	32	5	2.5	+	**7.2.**
22	KIV2	LNVM, VI 120	Striated	1.1	coarse	unsorted	+	*	+	*	-	n	n	granite	17	3.8	2.8	+/-	**4.1.1.**
23	KIV3	LNVM, VI 120	Striated	0.95	coarse	unsorted	+	*	+	*	-	n	n	granite	25	2	1.5	+/-	**4.1.1.**
24	KIV4	LNVM, VI 120	Striated	0.8	coarse	unsorted	+	+	+	*	+	n	n	granite	23	3.5	2.8	+/-	**4.1.1.**
25	KIV5	LNVM, VI 120	Striated	1	medium	unsorted	+	*	-	-	-	n	n	granite	23	3	1.8	+	**7.2.**
26	KIV6	LNVM, VI 120	Striated	0.8	coarse	unsorted	+	+	+	*	-	n	n	granite	18	3	2.5	+/-	**4.1.1.**
27	KIV7	LNVM, VI 120	Textile	1	coarse	sorted	-	-	*	+	*	n	n	granite	30	5	2.9	+	**8.1.**
28	KIV8	LNVM, VI 120	Textile	1.3	coarse	unsorted	+	*	+	*	+	n	n	granite	13	2.9	2.4	+/-	**4.1.1.**
29	KIV9	LNVM, VI 120	Smooth	0.7	coarse	unsorted	+	+	+	*	+	n	n	granite	11	3.9	2.4	+/-	**4.1.1.**
30	KIV10	LNVM, VI 120	Smooth	1	coarse	unsorted	-	+	+	*	-	n	n	granite	13	4.1	2.1	+/-	**4.1.1.**
31	KIV11	LNVM, VI 120	Smooth	1	coarse	unsorted	-	+	+	*	-	n	n	granite	13	2.79	2.24	+/-	**4.1.1.**
32	KIV12	LNVM, VI 120	Striated	1.2	coarse	unsorted	+	+	+	-	-	n	n	granite	8	3.15	2	+/-	**4.1.2.**
33	KIV14	LNVM, VI 120	Striated	1.05	medium	unsorted	+	*	-	-	-	n	n	granite	15	3.3	2.34	+	**7.1.**
34	KIV15	LNVM, VI 120	Striated	1.3	medium	unsorted	+	*	-	-	-	n	n	granite	30	5.85	4.32	+	**7.2.**
35	KIV16	LNVM, VI 120	Smooth	0.7	coarse	unsorted	+	*	+	*	-	n	*	granite	10	3.9	2.01	+/-	**2.2**
36	KIV17	LNVM, VI 120	Striated	0.9	medium	unsorted	+	*	-	-	-	n	n	granite	30	3.75	2.88	+	**7.2.**
37	KIV18	LNVM, VI 120	Striated coarse-slipped	0.9	medium	unsorted	+	*	-	-	-	n	n	granite	30	6	2.4	+	**7.2.**
38	KIV19	LNVM, VI 120	Textile	1.2	coarse	unsorted	+	+	+	*	-	n	n	granite	15	4.8	3.21	+/-	**4.1.1.**
39	KIV20	LNVM, VI 120	Smooth	1.1	medium	unsorted	+	*	-	-	-	n	n	granite	15	4.2	2.88	+	**7.1.**

	NARKŪNAI																		
40	NA1	LNM, 1977, 2, 233	Striated	0.75	medium	medium	*	*	*	-	-	n	n	granite	18	3.75	2.64	+	**6.1.2.**
41	NA2	LNM, 1978, 2b, 165	Striated	0.9	medium	medium	*	-	*	-	*	n	n	granite	7	3.6	2.19	+/-	**6.1.1.**
42	NA3	LNM, 1978, 2b, 589	Striated	0.95	coarse	unsorted	+	+	-	*	-	n	n	granite	11	3.75	2.07	+/-	**4.1.1.**
43	NA4	LNM, 1977, 3, 2 obj.	Striated	0.7	medium	unsorted	+	-	*	*	*	n	n	granite	10	3.9	2.07	+/-	**6.1.1.**
44	NA5	LNM, 1978, 518	Striated	0.9	medium	medium	-	*	*	-	*	n	n	granite	7	3	1.8	+/-	**6.1.1.**
45	NA6	LNM, 1978, 2g, 199	Striated	0.85	fine	unsorted	-	*	*	-	-	n	n	granite	12	3.3	2.7	+	**3.2.2.**
46	NA7	LNM, 1978, 6, 184	Striated	1.05	fine	unsorted	-	*	*	-	*	n	n	granite	6	2.55	1.74	+/-	**3.2.1.**
47	NA8	LNM, 1978, 2y, 198	Striated	1.15	fine	unsorted	-	-	*	-	*	n	n	granite	8	3.6	2.04	+/-	**3.2.1.**
48	NA9	LNM, 1978, 6, 459	Striated	0.7	coarse	unsorted	+	+	+	-	-	n	n	granite	9	2.1	1.47	+/-	**4.1.2.**
49	NA10	LNM, 1978, 2b, 588	Striated	1	fine	unsorted	-	*	*	-	-	n	n	granite	10	4.5	2.16	+	**3.2.1.**
50	NA11	LNM, 1978, 2b, 384	Striated	1	medium	unsorted	*	*	*	-	*	n	n	granite	5	3.45	2.46	+/-	**6.1.1.**
51	NA12	LNM, 1978, 630	Striated	0.8	medium	medium	*	-	*	-	*	n	n	granite	12	4.35	2.07	+/-	**6.1.2.**
52	NA13	LNM, 1978, 2b, 581	Striated	0.75	fine	sorted	-	-	-	-	-	n	n	granite	15	3.3	1.98	+	**3.1.2.**
53	NA14	LNM, 1978, 2b, 568	Striated	0.85	medium	unsorted	+	*	-	-	-	n	n	granite	25	3.3	2.85	+	**7.2.**
54	NA15	LNM, 1978, 2b, 164	Smooth	0.55	medium	unsorted	+	-	*	*	+	n	n	granite	10	3.9	2.13	+/-	**6.1.1.**
55	NA16	LNM, 1978, 641	Striated	0.9	fine	unsorted	-	*	*	-	-	n	n	granite	20	3.9	2.97	+	**3.2.2.**
56	NA17	LNM, 1978, 549	Striated	0.8	medium	unsorted	-	+	*	*	*	n	n	granite	22	2.7	2.04	+/-	**6.1.2.**
57	NA18	LNM, 1978, 2a, 646	Striated	0.95	coarse	unsorted	*	+	*	-	*	n	n	granite	16	3.75	2.79	+/-	**4.1.1.**
	LAUKSKOLA																		
58	LK1	LNVM, VI 128:8626	Striated, fish bone orn.	0.85	medium	unsorted	*	*	*	*	-	n	n	granite	4.1	2	1.5	+	**6.1.1.**
59	LK2	LNVM, VI 128:8626	Striated	0.85	medium	unsorted	*	*	*	+	-	n	n	quartzite	15.6	3.2	2.74	+/-	**Loner**
	BĪLAVAS																		
60	BIL 6/c	LNVM VI 325:6	Coarse-slipped	0.85	medium	unsorted	*	*	*	*	*	n	n	granite	17	5.1	3.45	+	**7.2.**
	ABORA																		
61	AB2	LNVM VI 76: 5071	Lubāns Ware	0.7	coarse	unsorted	+	+	-	+	*	n	n	granite	15	3	1.38	+	**4.1.1.**

62	AB4	LNVM VI 76: 5074	Lubāns Ware	0.75	coarse	unsorted	*	+	+	*	*	n	n	granite	25	3.5	1.08	+/-	**4.1.1.**
63	AB7	LNVM VI 76:5106	Lubāns Ware	1	coarse	unsorted	+	+	*	*	-	n	n	granite	10	5.5	0.63	+	**4.1.2.**
64	AB8	LNVM VI 76:5108	Lubāns Ware	1	coarse	unsorted	+	*	+	-	*	n	n	granite	30	4.5	1.35	+/-	**4.1.1.**
65	AB10	LNVM VI 76:5109	Lubāns Ware	0.7	coarse	unsorted	+	+	*	+	*	n	n	granite	17	3.5	1.04	+	**4.1.1.**
	ĶIVUTKALNS C																		
66	KIV-K41	LNVM VI 120	Smooth	0.95	coarse	unsorted	+	*	*	*	-	n	n	granite	15	3	1.25	-	**4.1.1.**
67	KIV-K43	LNVM VI 120	Polished	0.7	coarse	unsorted	+	*	*	*	-	n	n	granite	6	1.5	0.52	-	**4.1.2.**
	LŪLLE																		
68	LUL1	TLŪ 4409:33	Polished	0.75	fine	unsorted	*	*	-	-	-	n	n	granite	5	2.85	0.83	+	**3.2.1.**
69	LUL3	TLŪ 4409:18	Striated	0.9	fine	unsorted	-	*	*	-	-	n	n	granite	11	3.3	1.15	+	**3.2.2.**
	MUŠIŅAS																		
70	MUS1	TŪ 1303	Smooth	1.05	medium	unsorted	*	-	*	-	-	n	n	granite	10	2.4	0.99	+	**6.1.1.**
71	MUS2	TŪ 1303:II:3	Coarse-slipped	1.15	medium	unsorted	*	-	*	-	+	n	n	granite	8	3	1,01	+	**6.1.1.**
72	MUS3	TŪ 1303:II:3	Striated	0.7	medium	medium	+	*	-	*	+	*	n	granite	8	2.25	0.77	+	**1.1.1.**
	RIDALA																		
73	RID1	TLŪ 4261:133	Smooth	0.8	medium	unsorted	-	*	*	-	-	n	n	granite	25	2.5	1.05	+	**6.1.2.**
74	RID2	TLŪ 4261: 685	Striated	0.95	fine	sorted	-	*	-	-	-	n	n	granite	17	0.92	0.77	+	**3.1.2.**
75	RID3	TLŪ 4261: 541	Striated	1	fine	unsorted	-	*	*	-	*	n	n	granite	12	2	1.39	+/-	**3.2.2.**
76	RID4	TLŪ 4261: 229	Smooth	0.75	medium	sorted	*	-	-	+	-	n	n	sand	17	1.26	0.63	+	**6.2.2.**
	PADURE																		
77	BEL1	LNVM A13517:138	Striated coarse-slipped	0.8	medium	unsorted	-	*	*	*	*	n	n	granite	15	2.7	2.1	+	**6.1.2.**
78	BEL2	LNVM A13673:162	Striated	1.15	fine	sorted	-	-	-	-	*	n	n	granite	4	4	2.4	+/-	**3.1.1.**
79	BEL3	LNVM A13517:153	Striated	1.05	medium	unsorted	-	*	*	-	*	n	n	granite	15	3	2.5	+	**6.1.2.**
80	BEL4	LNVM A13517:213	Striated	0.7	medium	unsorted	-	*	*	*	-	n	n	granite	30	6	1.5	-	**6.1.2.**
81	BEL5	LNVM A13291:104	Textile	0.6	medium	sorted	+	+	-	-	*	n	n	granite	4	2.3	1.6	-	**6.2.1.**
82	BEL6	LNVM A13673:88	Textile	0.8	medium	sorted	+	+	-	-	*	*	n	granite	4	3.4	1.2	+	**1.1.1.**
83	BEL7	LNVM A13517:177	Coarse-slipped	0.8	fine	sorted	-	*	-	-	-	n	n	granite	18	5	2.3	+/-	**3.1.2.**

84	BEL8	LNVM A13673:119	Coarse-slipped	0.95	fine	sorted	-	*	-	*	+	n	n	granite	10	3	2	+	**3.1.1.**
85	BEL9	LNVM A13291:101	Smooth	1.1	coarse	unsorted	*	*	+	*	+	n	n	granite	18	3.1	1.9	+/-	**4.1.1.**
86	BEL10	LNVM A13517:168	Smooth	0.9	medium	sorted	-	*	-	-	*	n	n	grog	10	2.8	1.9	+	**Loner**
	BRIKUĻI																		
87	BR1	LNVM A12405:394	Striated	0.9	medium	unsorted	*	*	-	-	-	n	n	granite	20	5.4	3.6	+	**7.2.**
88	BR2	LNVM A12379:522	Striated	1.1	medium	sorted	*	-	-	-	-	n	n	granite	13	6.3	4.2	+	**6.1.3.**
89	BR3	LNVM A12468:186	Striated	1.1	coarse	unsorted	*	*	*	-	*	n	n	granite	25	3.9	2.8	+	**8.2.**
90	BR4	LNVM A12405:423	Striated	0.9	medium	unsorted	*	+	-	-	-	n	n	granite	30	3.6	3.1	+/-	**7.2.**
91	BR5	LNVM A12468:80	Striated	0.95	medium	unsorted	-	*	+	-	-	n	n	granite	30	6	3	+	**7.2.**
92	BR6	LNVM A12405:329	Textile	0.85	medium	unsorted	*	+	-	-	-	n	n	granite	25	3.9	2.8	+	**7.2.**
93	BR7	LNVM A12405:393	Textile	1.1	medium	unsorted	*	+	-	-	+	n	n	granite	27	5.4	3.2	+	**7.2.**
94	BR8	LNVM A12468:180	Smooth	0.85	medium	unsorted	-	*	+	-	+	n	n	granite	8	3.3	2.3	+	**6.1.1.**
95	BR9	LNVM A12405:421	Smooth	1.1	medium	unsorted	-	+	*	-	*	n	n	granite	20	4.1	2.6	+	**6.1.2.**
	DIEVUKALNS																		
96	DK1	Unregistered	Striated	0.85	fine	sorted	+	-	-	-	*	n	n	granite	14	2.7	2.3	+/-	**3.1.2.**
97	DK2	Unregistered	Striated	1.15	coarse	unsorted	-	*	+	-	-	n	n	granite	40	5.4	3.2	+	**8.2.**
98	DK3	Unregistered	Striated	0.85	coarse	unsorted	-	*	+	-	-	n	n	granite	35	5.7	3.1	+	**8.2.**
99	DK4	Unregistered	Striated	1	medium	unsorted	-	*	*	*	*	n	n	granite	25	4.5	3.1	+	**7.2.**
100	DK5	Unregistered	Striated	1.2	coarse	unsorted	-	*	+	+	*	n	n	granite	30	5.7	3.7	+	**8.2.**
101	DK6	Unregistered	Smooth	0.8	fine	sorted	*	-	-	-	-	n	n	granite	10	1.9	1.4	+	**3.1.1.**
102	DK7	Unregistered	Smooth	1.1	coarse	unsorted	-	*	+	-	-	n	n	granite	30	3.6	3.2	+	**8.2.**
103	DK9	Unregistered	Textile	1.1	coarse	sorted	-	-	+	-	-	n	n	granite	32	4	3	+	**8.1.**
104	DK10	Unregistered	Textile	1.15	coarse	unsorted	*	*	+	-	-	n	n	granite	30	3.5	2.6	+	**8.2.**
	PAPLAKA																		
105	PAP1	LNVM A12438:14	Striated coarse-slipped	1	medium	unsorted	+	*	-	-	+	n	n	grog?	13	3	2.5	+/-	**5**
106	PAP2	LNVM A12438:14	Striated	1	coarse	unsorted	*	+	*	-	-	n	n	granite	18	2.5	1.9	+/-	**4.1.1.**
107	PAP3	LNVM A12438:14	Striated	0.5	fine	sorted	*	-	-	-	*	n	n	granite	5	1.7	1.2	-	**3.1.1.**

108	PAP4	LNVM A12438:13	Coarse-slipped	1	medium	unsorted	*	*	-	-	*	n	n	grog?	20	3.2	2.5	+	**5**
109	PAP5	LNVM A12438:18	Smooth	1.1	medium	unsorted	-	*	*	-	-	n	n	granite	8	2.7	2.2	+	**6.1.1.**
	KLAŅĢUKALNS																		
110	KL1	LNVM A9960:60c	Striated	0.75	medium	unsorted	*	+	-	-	-	n	n	granite	22	4.2	3.2	+	**7.2.**
111	KL2	LNVM A9960:27b	Striated	1	coarse	unsorted	+	+	*	-	*	n	n	grog	22	6.3	3.3	+	**Loner**
112	KL3	LNVM A9960:77	Striated	1.05	coarse	unsorted	*	+	*	*	-	n	n	granite	25	3.8	2.8	+	**4.1.1.**
113	KL4	LNVM A9960:84b	Textile	1.2	medium	unsorted	*	+	-	*	*	n	n	granite	10	3.2	2.9	+	**7.1.**
114	KL5	LNVM A9960:29	Textile	1.2	coarse	unsorted	*	+	+	-	*	n	n	granite	30	4.4	3	+	**8.2.**
115	KL6	LNVM A9960:60b	Smooth	1.1	coarse	unsorted	+	+	*	-	-	n	n	granite	18	3.6	3.1	+/-	**4.1.1.**
116	KL7	LNVM A9960:78	Smooth	0.9	medium	unsorted	*	+	*	-	-	n	n	granite	30	3.6	2.6	+	**7.2.**
	KRIEVU KALNS																		
117	KRI1	LNVM A13957:119	Striated coarse-slipped	0.9	medium	medium	+	*	-	-	*	*	n	granite	5	2.3	2	-	**1.1.1.**
118	KRI2	LNVM A13958:52	Striated	0.8	coarse	unsorted	*	*	*	-	*	n	n	granite	15	4	1.8	+/-	**4.1.1.**
119	KRI3	LNVM A13958:98	Striated	1.1	medium	unsorted	*	+	*	-	*	*	n	granite	10	3.8	3.2	+/-	**1.1.1.**
120	KRI4	LNVM A13957:59	Coarse-slipped	1.1	medium	medium	*	+	-	-	*	+	n	granite	5	3.5	1.8	-	**1.1.1.**
121	KRI5	LNVM A13957:119	Coarse-slipped	1.1	medium	medium	+	+	-	-	+	*	n	granite	8	4.5	2.6	-	**1.1.1.**
122	KRI6	LNVM A13958:26	Coarse-slipped	0.9	medium	unsorted	*	+	-	-	*	n	n	granite	15	3	1.8	+/-	**7.1.**
123	KRI7	LNVM A13958:116	Smooth	1.05	medium	unsorted	-	*	*	-	*	n	n	granite	13	4.1	2.6	+	**6.1.2.**
124	KRI8	LNVM A13958:21	Smooth	0.9	fine	sorted	-	-	-	-	*	*	n	granite	5	3	1.5	+	**1.2**
125	KRI9	LNVM A13958:95	Smooth	1.1	coarse	unsorted	*	+	*	*	*	n	n	granite	23	2.6	1.9	+	**4.1.1.**
126	KRI10	LNVM A13957:116	Striated	0.85	medium	unsorted	+	*	*	-	*	+	n	granite	13	4.5	2.64	+/-	**1.1.2.**
127	KRI11	LNVM A13958:94	Striated	0.9	medium	medium	-	*	+	+	*	+	n	granite	17	2.25	1.74	+	**1.1.2.**
128	KRI12	LNVM A13957:37	Smooth	1.55	coarse	unsorted	*	+	+	-	*	n	n	granite	20	5.1	1.29	+/-	**4.1.1.**
129	KRI13	LNVM A13957:117	Striated	1.3	fine	sorted	*	-	-	-	*	n	n	granite	10	3.9	2.88	-	**3.1.1.**
130	KRI14	LNVM A13957:23	Striated	1	coarse	unsorted	*	+	*	*	*	n	n	granite	5	1.8	1.47	-	**4.1.2.**
131	KRI15	LNVM A13957:24	Smooth	0.9	medium	medium	-	+	*	*	*	*	n	granite	15	5.7	3.27	+/-	**1.1.2.**
	VĪNAKALNS																		

132	VK1	LNVM VI 125	Striated	0.9	coarse	unsorted	+	+	*	*	-	n	n	granite	25	3.9	2.6	+	**4.1.1.**
133	VK2	LNVM VI 125	Striated	1	coarse	unsorted	-	*	+	-	-	n	n	granite	18	3.9	2.5	+	**8.2.**
134	VK3	LNVM VI 125	Striated	0.8	medium	unsorted	*	+	-	-	-	n	n	granite	15	3.6	2.9	+	**7.1.**
135	VK4	LNVM VI 125	Striated	0.95	coarse	unsorted	*	+	+	-	-	n	n	granite	20	3.6	2.6	+/-	**4.1.1.**
136	VK5	LNVM VI 125	Smooth	0.8	coarse	sorted	-	-	+	-	-	n	n	granite	25	2.5	2.3	+	**8.1.**
137	VK6	LNVM VI 125	Smooth	1	coarse	sorted	-	-	+	-	-	n	n	granite	20	3.9	2.7	+	**8.1.**
138	VK8	LNVM VI 125	Textile	1.8	medium	unsorted	+	*	-	-	-	n	n	granite	30	6	3.2	+	**7.2.**
139	VK10	LNVM VI 125	Textile	1.4	coarse	sorted	-	-	*	-	-	n	n	granite	30	2.7	2.5	+	**8.1.**
	KOIVUKULA																		
140	KOI1	TÜ 1915:209	Coarse-slipped	0.95	coarse	unsorted	+	+	*	*	-	n	n	granite	17	4.2	1.88	-	**4.1.1.**
141	KOI2	TÜ 1915:185	Smooth	1	coarse	unsorted	+	+	*	*	-	n	n	granite	13	2	1.37	-	**4.1.1.**
142	KOI3	TÜ 1915:196	Smooth	0.85	coarse	unsorted	*	+	+	-	*	n	n	granite	10	2.5	1.37	-	**4.1.2.**
	SOE																		
143	SOE1	TÜ 2672	Striated coarse-slipped	1	medium	sorted	+	-	-	+	-	n	n	granite	15	2.1	1.75	+	**6.2.1.**
	LEJASBITĒNI																		
144	LEJB1	LNVM A11847:532	Post-Corded Ware	0.6	medium	sorted	*	-	-	-	-	n	n	granite	8	1.75	0.87	-	**6.2.1.**
	LIPŠI																		
145	LI80	LNVM VI 185:199	Smooth	0.85	medium	unsorted	*	+	-	-	-	n	n	granite	13	2.85	1.34	+	**7.1.**
	TOJĀTI																		
146	TOJ1	LNVM A6329	Kvietiniai-Tojāti Ware	1	coarse	unsorted	+	+	+	-	-	n	n	granite	15	2.1	1,72	+	**4.1.1.**

Apendix VII. RTI models of different surface treatments

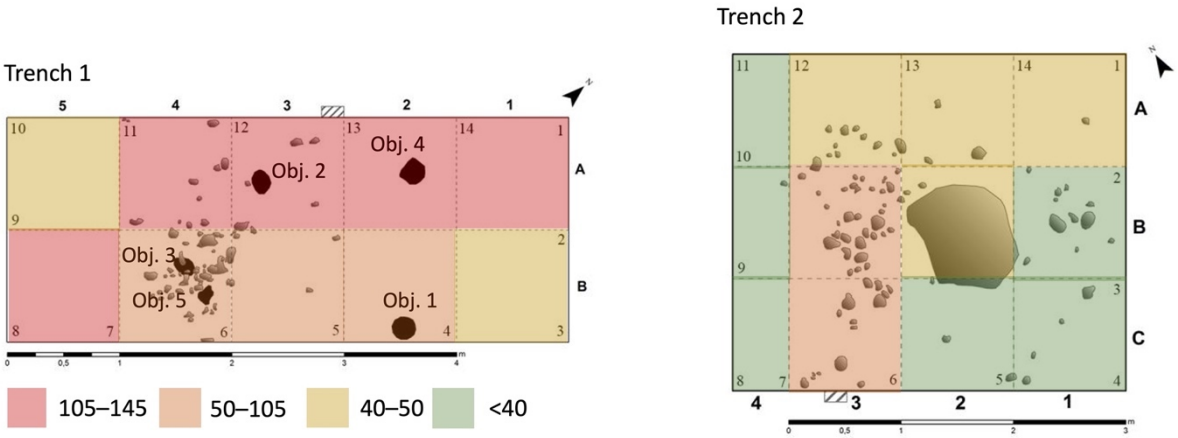
Striated (1, 2, 4, 5, 9), coarse-slipped (3, 6, 7), textile (8, 10). Krievu kalns LNVM A 13957, A 13958 (2, 6, 7), Vīnakalns LNVM VI 120 (1, 4, 8, 7, 10), Laukskola LNVM VI 128 (5, 9). Models: V. Visocka

Appendix VIII. Selection of different kinds of ornamentation seen on the pottery

(Asva, Krievu kalns, Laukskola and Klosterkalns assemblages). Photo: V. Visocka

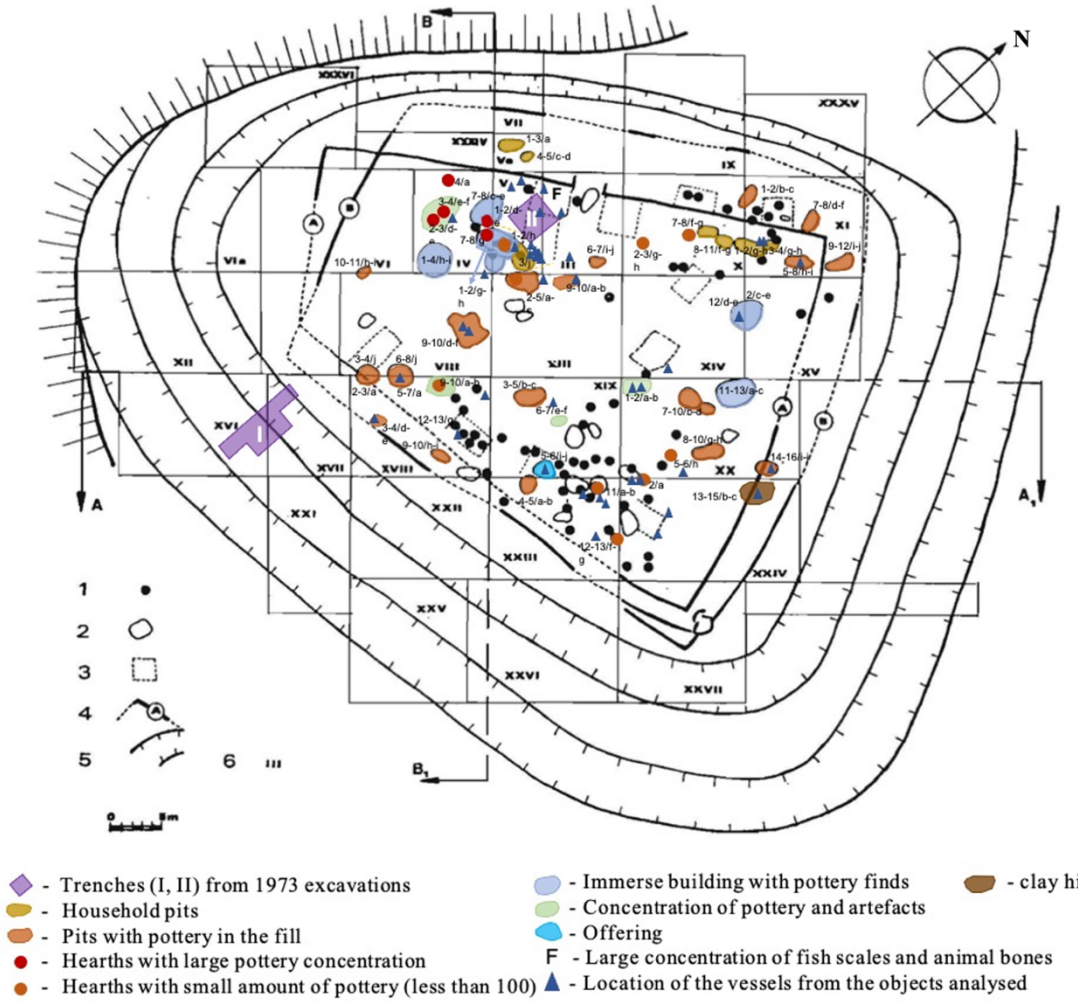
Appendix IX. Heat map of pottery finds on Antilgė hillfort

(After: ČIVILYTĖ AGNĖ. Antilgės piliakalnio…)



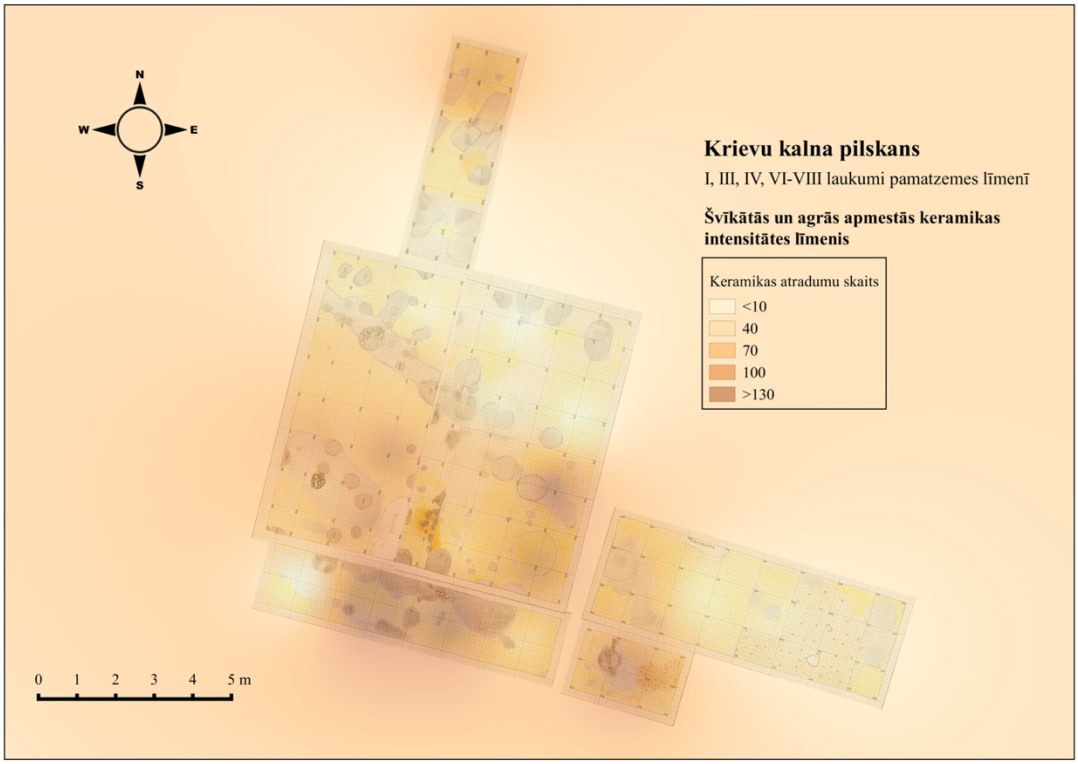
Appendix X. Pottery finds near structures on Brikuļi hillfort

(After archaeological research reports of A. Vasks)



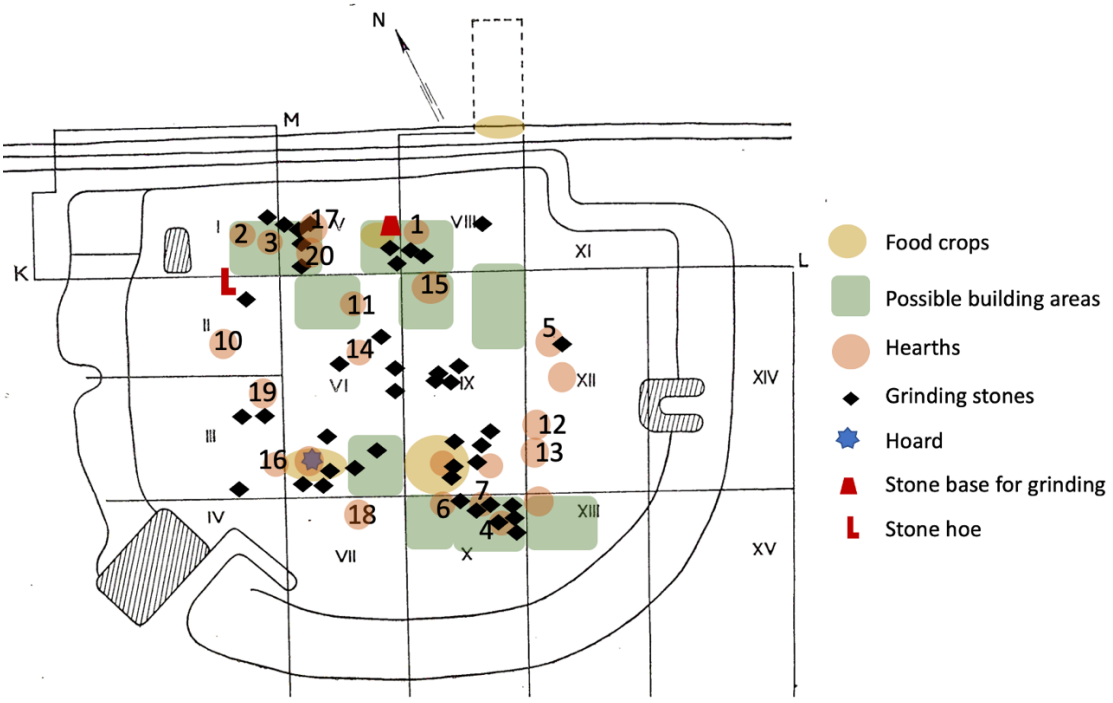
Appendix XI. Heat map of striated pottery distribution on Krievu kalns

(from: ARTŪRS HAFERBERGS. Celtniecība…)



Appendix XII. Plan of Ķivutkalns hillfort, including finds related to food preparation and hearths

(After JĀNIS GRAUDONIS, JOLANTA DAIGA. Ķivutkalna apmetne…)



Appendix XIII. Heat map of pottery on Mineikiškes hillfort

(After KAROLIS MINKEVIČIUS. Mineikiškių piliakalnio (5705)…,)