

Changing perspectives

Thin section and ICP analysis of Neolithic pottery from the Åland Islands

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Abstract

The location of the Åland Islands in the Baltic Sea during the Neolithic period influenced its material culture and pottery traditions. This study challenges the focus on typology by examining the technical composition of the ceramic ware and its provenance. The methods used are ICP analysis (Inductively Coupled Plasma Analysis) and analysis of thin sections of the clay used. The study includes Early and Late Comb Ware, Jettböle I and II type of Swedish Pitted Ware and Kiukais Ware. Some sherds, interpreted as combining influences from both Comb and Pitted Wares, and representing the transition from one to the other, display a reinforcement of earlier pottery traditions. The thin section analysis indicates a local technological continuity in the pottery traditions visible in the preferred clay. A chronological difference in the choice and handling of the temper suggests different preferences within traditions. The ICP analysis indicates that some of the artefacts, for example, a clay figurine seems to be of non-Åland origin.

Keywords: ceramics, thin section analysis, ICP analysis, Neolithic, Åland

Introduction

The aim of this study is to investigate the composition of pottery and its change over time as well as the provenance of the clay used in Neolithic ceramics from the Åland Islands. The results are then compared with contemporary materials from the mid-eastern part of Sweden. Methods used are thin sections and ICP analysis on sherds. The material consists of samples from different pottery traditions on the Åland Islands, from the oldest Early Comb Ware (from ca. 5500 BC), through the Late Comb Ware and the Pitted Ware to the late Neolithic Kiukais Ware (up to ca. 1800 BC).

The Åland Islands consist of a cluster of islands located between mainland Finland and Sweden. The islands have been important in prehistoric as well as historic times for the movement and cultural contacts of people from the eastern and western parts of the Nordic countries. Earlier research on Neolithic pottery from the Åland Islands has to a high degree concentrated on similarities in style in pottery traditions from mainland Finland and Sweden. This study however does not focus on style but on the technical composition of the ceramics and its provenance. The results will be compared chronologically with the changes in style.

Neolithic ceramic record of the Åland Islands

The earliest settlements on the Åland Islands are found in the valley of Långbergsöda in the municipality of Saltvik. At the time, the Åland Islands consisted of only a few small islands far from the Finnish mainland and the sites can be characterized as temporary seasonal dwellings in a maritime environment. The ceramics from

these settlements are classified as older Early Comb Ware (Ka I:1). Dating of material from the sites has given values in between 5500 and 4350 cal BC (Hallgren 2008: 63; Helminen & Lucenius 2014: 6). The oldest dating from food crust on pottery is from Östra Jansmyra (Hallgren 2008: 63) in Långbergsöda. Ceramics defined as Typical (Ka II) as well as Late Comb Ware (III) occur on the Åland Islands but relatively few sites of this type are known and archaeologically investigated, except for the Late Comb Ware sites in Jomala municipality from which ceramics are included and analyzed in this study (see below). Comb Ware sites occur in the Finnish mainland dating from around 5200 BC and the Early Comb Ware represents the oldest pottery in the country together with the northern Säräisniemi 1 Ware (Leskinen & Pesonen 2009: 75–6; Halinen 2015: 56). Typologically and chronologically the Comb Ware during the Neolithic is divided into a number of subtypes, but the relevance of the traditional typological style sequences has been debated in later research (for a comprehensive discussion, see Nordqvist & Mökkönen 2015).

Pitted Ware appears on the Åland Islands around 3400/3300 BC (Stenbäck 2003). The Pitted Ware Culture is usually considered a distinct maritime hunter-gatherer culture that predominantly appears on sites in the eastern part of south and mid Sweden, although Pitted Ware is also found along the Swedish west coast and in Scania, and Denmark. On the Åland Islands the Pitted Ware phase has been labelled Jettböle I and II respectively, after the older and younger phase at the Jettböle site in the municipality of Jomala (see Cederhvarf 1912). The ceramics from the older Jettböle I phase have great similarities with the Säter/Fagervik III-style in Sweden and the younger Jettböle II-style with Säter/Fagervik IV (Meinander 1957).

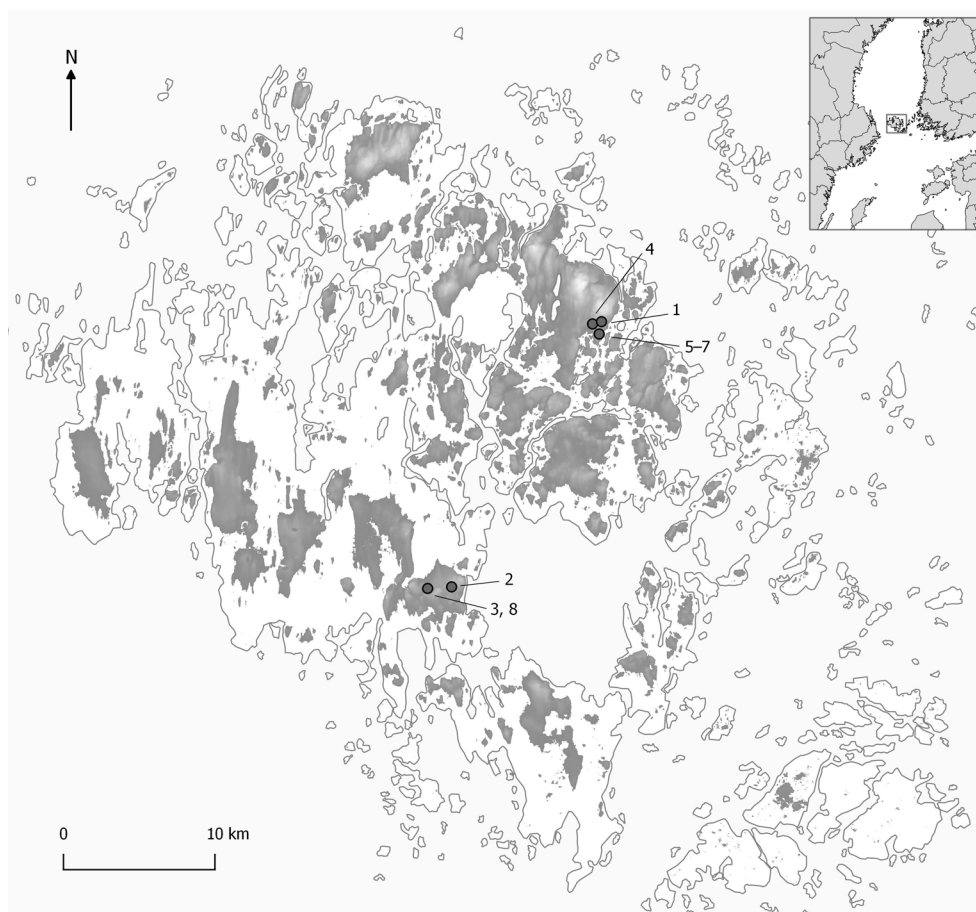


Figure 1. Map of the Åland Islands. Scale 1:500 000.

1. Sa 20.10 Vargstensslätten,
2. Jo 37.1 Stockmyra,
3. Jo 14.1 Jettböle Bergmanstorp,
4. Sa 20.7 Alkärr,
5. Sa 20.8 Glamilders,
6. Sa 20.8 Svinvallen,
7. Sa 20.8 Myrsbacka I,
8. Sa 14.1 Jettböle I and II.
(ÅLR/Museibyran 2015).

The contour indicates the Åland Islands today and the grey area indicates the height above sea level between 20 and 130 meters. Map: Lantmäteriverket 2013/ © EuroGeographics for the administrative boundaries. Layout Mikko Helminen.

During the late Neolithic, i.e. the period ca. 2300–1700 BC, a pottery style that traditionally is classified as Kiukais Ware appears on the Åland Islands. Kiukais Ware occurs along with Pitted Ware at Svinvallen in the village of Långbergsöda in Saltvik, where sites with solely pottery of Kiukais type also are found. The Kiukais Culture is a coastal tradition found in southern and southwestern Finland (Meinander 1954; Edgren 1993; Asplund 2008: 67; Halinen 2015: 68). Within the Finnish tradition of research the Kiukais tradition has partly been defined in a similar way as the Pitted Ware tradition in Sweden; as a continuation of the traditional maritime lifestyle in a progressively more Neolithic environment (see e.g., Halinen 2015: 68).

However, there are indications of cultivated plants within the Kiukais tradition in Finland (Leskinen & Pesonen 2009: 218), as well as

within the Pitted Ware tradition on the Åland Islands and on the Swedish mainland (Edenmo & Heimdahl 2012). A grain of barley, *hordeum nudum*, from the Pitted Ware site Glamilders, has been dated to 2880–2610 cal BC (Ua- 35045) (Possnert 2007; see also Engelman et al. 2004). The decoration of the Kiukais Ware and the vessel shapes have great similarities with some late Neolithic pottery identified in Sweden, in Uppland and along the coast of Norrland (see Holm et al. 1997; Holm 2006).

Material and aims of the study

The main question of this study is if there is a common tradition, technological or material, within the potter's craft between the Neolithic pottery traditions on the Åland Islands. If not: which factors vary? By comparing the results from

the Åland Islands with analysis performed on Neolithic ceramics from the mid-eastern part of Sweden, the aim is to broaden the perspective and understanding of the connections and contacts in the northwestern Baltic area during the Neolithic period. At present, there are no studies made on Neolithic ceramics from Finland within the area of this study, but this will be done at a later stage to make further comparisons possible. Some technological analyses are currently being done on Finnish Neolithic ceramics as new methods are introduced, and future projects are initiated (Holmqvist-Saukkonen 2012: 42).

25 sherds from seven different Neolithic sites on the Åland Islands were selected for this study. (Table 1). The method of selection was to choose samples representative of the majority of the material, i. e. not be deviant sherds. Based on traditional typology the sherds have been classified as Early (Ka I:1) and Late Comb Ware (Ka III), older (Jettböle I) and younger (Jettböle II) Pitted Ware and Kiukais Ware. Some of the sherds are difficult to classify and are interpreted as a mixed type of Comb Ware and Pitted Ware. This is especially noticeable at Jettböle Bergmanstorp, where some of the sherds have a typological similarity with Late Comb Ware, rather than Pitted Ware.

In addition to these 25 sherds this study includes another seven sherds from the Jettböle site. Thin section analysis was made on these sherds in 2003 by professor Anders Lindahl, Laboratory For Ceramic Research at the University of Lund, though the results have not yet been published. Two (2) of the seven sherds originated from Jettböle Bergmanstorp, two (2) from Jettböle I and three (3) from Jettböle II (see Stenbäck 2003: 215). ICP analysis has not been made on these

sherds but the results of the thin section analyses are an important contribution to this study.

The study of the ceramics from the Åland Islands thereby contains in total 32 sherds from 8 sites (Figure 1). These 25 plus 7 sherds have been selected as representing the common type of sherds, both in decoration (common features of decoration and traditional typology) and ware, found on the selected sites (see Figure 2a–c for photographs of the sherds). The selection of samples from each site has been made ocularly. The idea is to establish a basic understanding of the diversity or conformity of the ware and the craft used, as a starting point for the discussion of continuity or change in the represented pottery traditions.

In terms of style the pottery from Vargstensslätten has been classified as older Early Comb Ware (Ka I:1) (Väkeväinen 1975b; 1978) but the pottery is not entirely homogeneous. Ocular evaluation suggests the samples consists of two different types of ceramics, a very coarse grained black fabric tempered with quartz, and a finer red fabric tempered with rock. A previous diatom study of contemporary ceramics with a similar coarse-grained fabric from the nearby site Sa 20.2 Östra Jansmyra (not included in this study), concluded that the constitution of diatoms in the clay indicate that the vessels were made of *Ancylus* transgressional sediments or clay (see Haavisto-Hyvärinen & Kutvonen 2007), which supposedly was not available on the Åland Islands during the relevant period (Glückert 1978; Alhonen & Väkeväinen 1980: 745). Thus, the pottery was interpreted as imported to the islands from mainland Finland. Among the ceramics from Östra Jansmyra, clay with a content that indicated the use of a locally accessible plastic *gyttja* was observed. (Alhonen & Väkeväinen 1980: 74–5).

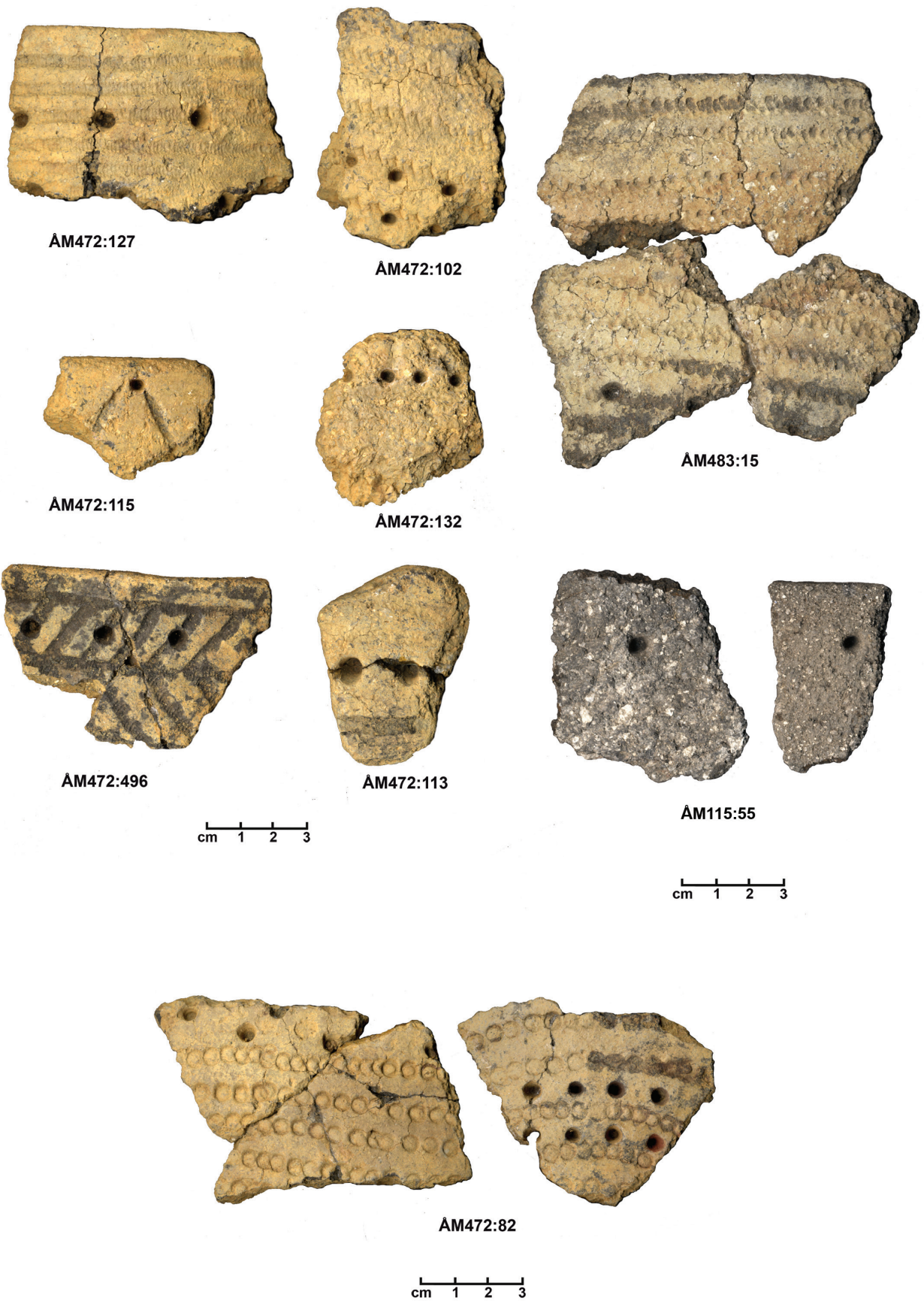


Figure 2a. The analyzed ceramics from the site 1. Vargstenslätten, Sa 20.10 (ÅM 115, 472, 483). Photo and adaption: Daniela Stenbäck.

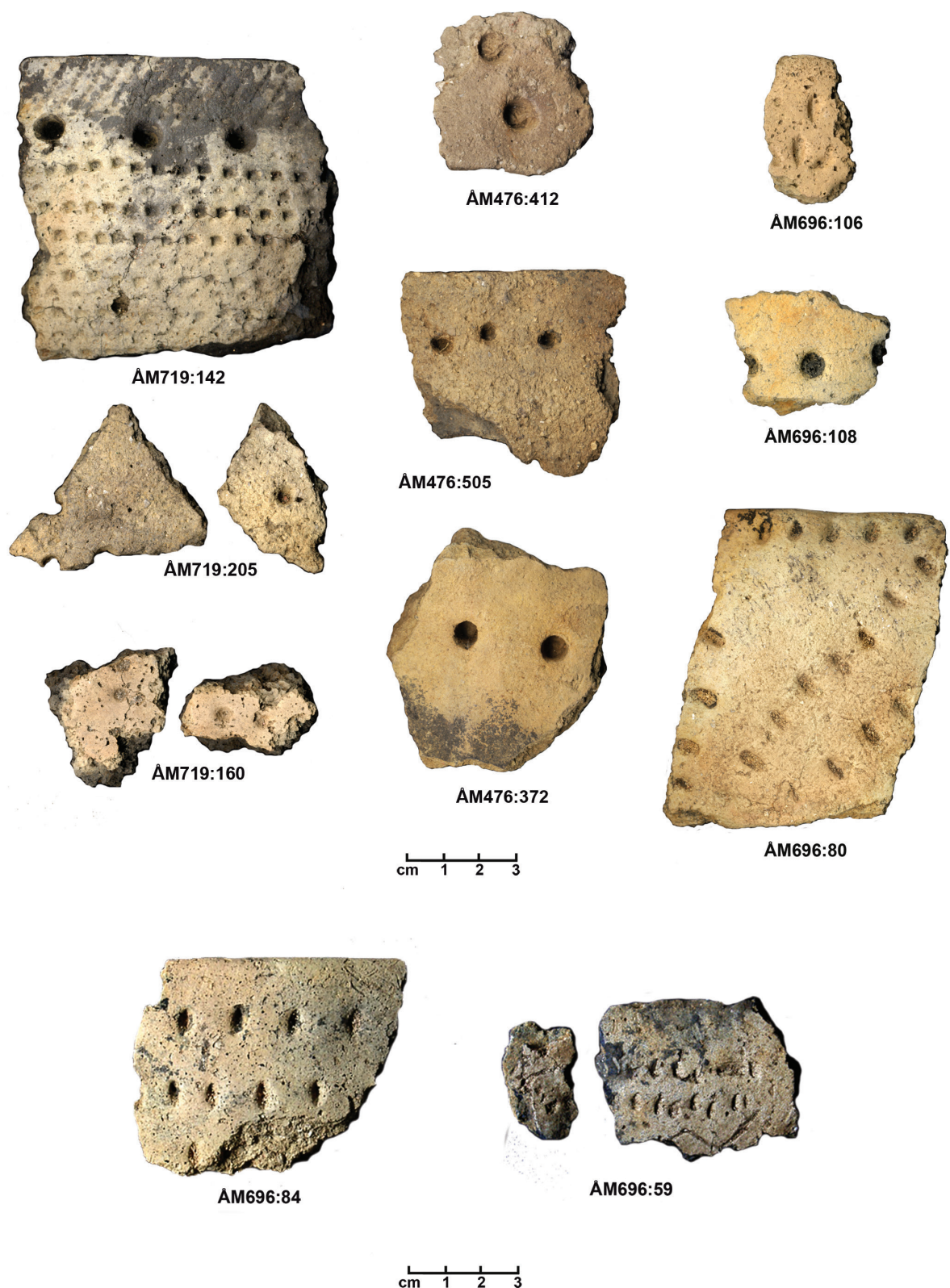


Figure 2b. The analyzed ceramics from the sites 2–4. Stockmyra, Jo 37.1 (ÅM 719), Alkärr, Sa 20.7 ÅM (476), Jettböle Bergmanstorp, Jo 14.1 (ÅM 696). Photo and adaption: Daniela Stenbäck.

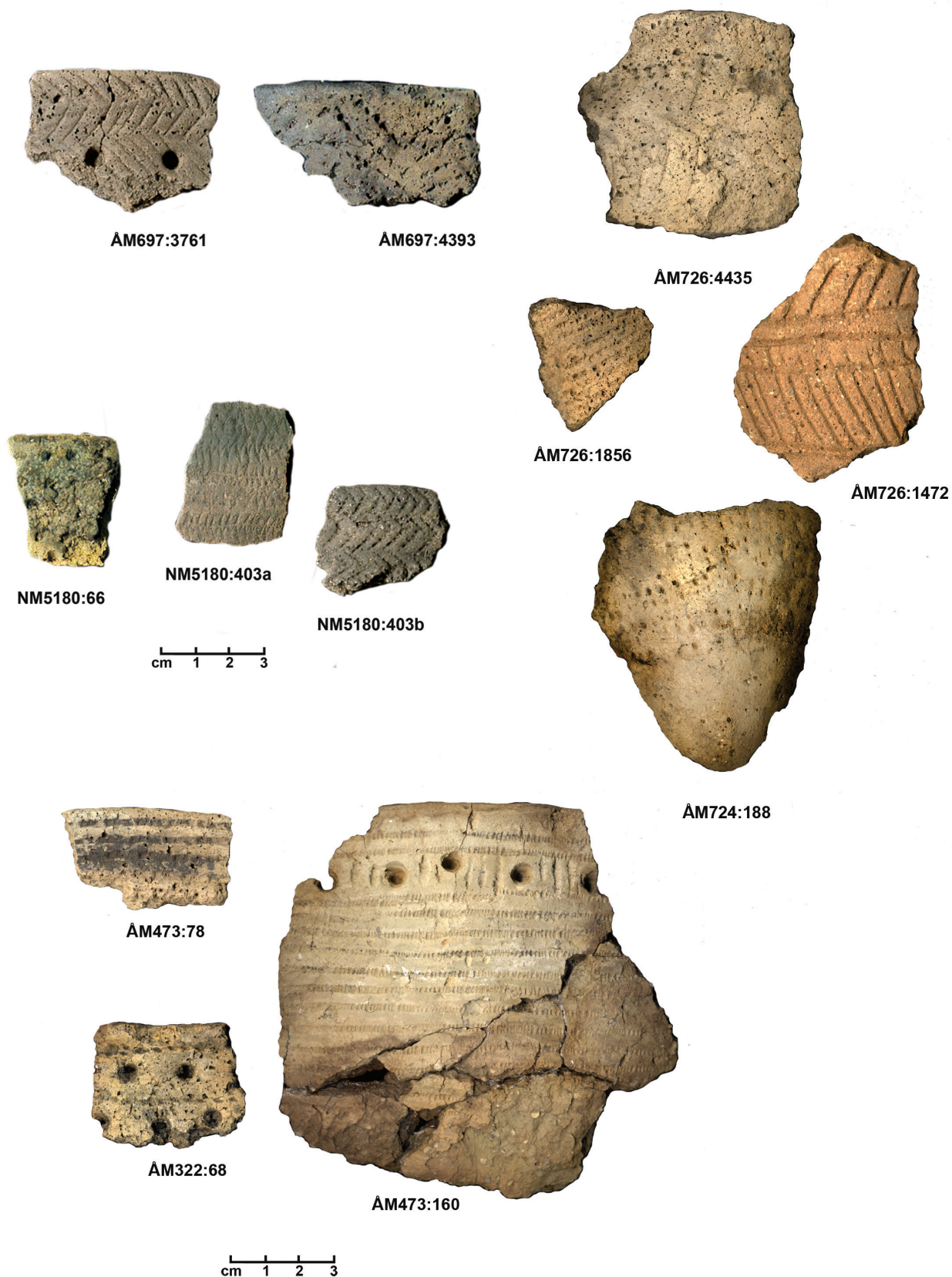


Figure 2c. The analyzed ceramics from the sites 5–8. Glamilders, Sa 20.8 (ÅM 724, 726), Svinvallen Sa 20.8 (ÅM 473), Myrsbacka, Sa 20.8 (ÅM 322), Jettböle I (ÅM 697) Jettböle II, Jo 14.1 (NM 5180). Photo and adaption: Daniela Stenbäck.

Only a few sites with Typical and Late Comb Ware have been found on the Åland Islands. One of them is Stockmyra site, investigated in the 1940's and in the beginning of this century. The ceramics have been classified as Typical Comb Ware (Ka II) by Dreijer (1947; 1979) but a later excavation indicated an element of Late Comb Ware (Ka III) among the sherds (Fagerholm-Sjöblom 2002). Typologically the ceramics from this site is distinct Comb Ware, and there is no indication of presence of Pitted Ware.

Jettböle Bergmanstorp is situated close to the famous Pitted Ware Jettböle site, but on a slightly higher level in the landscape, not far from the Stockmyra site. In the archaeological excavation at Bergmanstorp in 1999 older Pitted Ware, Late Comb Ware as well as ceramics that were difficult to classify were found. Some sherds were impossible to interpret typologically as being either Comb Ware or Pitted Ware. Based on this it has been suggested that Jettböle Bergmanstorp may represent an earlier phase of settlement and a typological transition or mixed phase between Comb and Pitted Ware (Stenbäck 2003). Four out of the five analyzed sherds from Bergmanstorp have been typologically classified as Comb Ware or similar to this type. The fifth sherd is difficult to classify.

Alkärr is, as the above-mentioned site Vargstens-slätten, situated within the Långbergsöda area, but on a significant lower level in the landscape. The ceramics from Alkärr has been classified partly as Late Comb Ware (Ka III) and partly as older Pitted Ware (Väkeväinen 1975a). Alkärr and the nearby Comb Ware site Tisdal together represent the succession between Comb- and Pitted Ware in the Långbergsöda area (Stenbäck 2003). Two of the analyzed sherds from Alkärr

have been typologically classified as Late Comb Ware or a mixed form of Comb and Pitted Ware, and one sherd as older Pitted Ware, although this sherd is typologically difficult to classify.

Compared to Alkärr, the site Glamilders is situated at a lower level in the landscape in the Långbergsöda area. The ceramic assemblage from Glamilders has principally been classified as younger Pitted Ware, but with some typological elements of older Pitted Ware. In this case, younger Pitted Ware relates to the Jettböle II phase on the Åland Islands or the Säter/Fagervik IV phase in Sweden (Meinander 1957; Stenbäck 2003). Three sherds and a fragment of a clay idol are included in the analysis (for discussion on clay idols, see Nuñez 1987).

Svinvallen and Myrsbacka are both situated just below Glamilders and the three sites form a chronological sequence; Pitted Ware during the Middle Neolithic, then to Kiukais Ware during late Neolithic and early Bronze Age. The assemblage from Svinvallen contains both younger Pitted Ware and Kiukais Ware, while Myrsbacka I and II contains Kiukais Ware and Bronze Age ceramics respectively (Meinander 1984).

The site of Jettböle I–II is situated just below Bergmanstorp and was investigated in the early 1900s by Björn Cederhvarf (1912). He divided the site into an upper, older part and a lower, younger part, referred to as Jettböle I and II respectively, based on differences in ceramic styles between the two areas. Cederhvarf excavated the Jettböle site at the same time as among others Oscar Almgren (1906; 1912) had found and investigated Pitted Ware settlements in Uppland and mid-eastern Sweden. The ceramics from Jettböle I and II were interpreted as having similarities with Säter/

Fagervik III and Säter/Fagervik IV respectively (Meinander 1957; Stenbäck 2003: 184). The Jettböle site, including Jettböle Bergmanstorp, was excavated in 1999–2000, and a number of ^{14}C dating confirm that the older Jettböle I phase can be dated to Middle Neolithic A (3300–2800 BC) and the Jettböle II phase to Middle Neolithic B (2800–2300 BC), referring to the periodization used in Sweden (Stenbäck 2003).

Methods

Two different methods for analyzing ceramics have been used in this study, thin section analysis and ICP analysis. It is a combination of microscopy of the fabric, which is used to determine the type of raw materials used in the ceramics, and ICP analysis, which is a method based on geochemistry where samples are analyzed by mass spectrometry. The ceramic terminology customary at The Laboratory for Ceramic Research at Lund University is used in this article (see e.g., Hulthén 1977).

Studies of Neolithic pottery has been dominated above all by questions on typologies and style, and these have in several respects formed the most important tools in the discussions on the cultural affiliations of the pottery traditions. At an early research stage, it was observed that both Comb Ware and Pitted Ware with a porous fabric originating from a temper rich in calcareous material existed. As a consequence, the quality of the fabric has been central in the discussions on both Early and Late Comb Ware as well as the Säter-/Fagervik sequences within the Pitted Ware tradition. (see e.g., Edenmo et al. 1997; Nordqvist & Mökkönen 2015). The Early Comb Ware (Ka I:1) generally lack calcareous material

temper while the Late Comb Ware (Ka III) has limestone or shell in the temper (see e.g., Edgren 1993; Leskinen & Pesonen 2009: 82). The aim of this study is primarily to investigate whether any changes in the production of pottery occurred from Comb Ware to Pitted Ware and Kiukais Ware on the Åland Islands. We know that the presence of calcareous material is a factor in a changing/variable craft, but it is also possible that the choice of clay and parts of the temper may have changed over time. Both choice of type of temper and the amount of temper can be related to the different types of wares.

To study the types of temper and clay, analysis by means of ceramic thin sections has been carried out. The thin section analysis was performed with slides of a total of 32 (25 plus 7 – see above) different sherds from the Åland Islands (Table 1) in a polarization microscope. During the analysis type of clay, type of temper and part of volume, largest grain, mineralogical composition and presence of any diatoms can be determined. Thin section analysis has been used in Scandinavia since the 1930s and it can be considered a well-established method for studying pottery (Bøe 1931; Hulthén 1977; Brorsson 2008b; Quinn 2013; for further discussion see Holmqvist–Saukkonen 2012). It is important to note that a thin section analysis is not only a petrographic analysis, it also covers the whole fabric, including vessel building technique and temper of other material than rocks, etc.

The thin section analysis has been combined with ICP analysis (ICP–MA/ES), in order to study if the pottery has been manufactured on the same site or not. ICP–MA/ES is a method which can be classified as instrumental geochemistry and it allowed us to determine the presence of 44

Table 1. Sites included in this study.

Site (prehistoric settlement)	Masl	¹⁴ C-datings	Ceramic style	Number of sherds	References
1. Vargstenslätten (Sa 20.10)	c 55	5310-4650 BC*	Early Comb	9	Väkeväinen 1978, Hallgren 2008: 63*
2. Stockmyra (Jo 37.1)	c 44		Late Comb	3	Drejier 1947, Fagerholm-Sjöblom 2002
3. Jettböle Bergmanstorp (Jo 14.1)	c 40	3550-2880 BC*	Late Comb / older Pitted Ware	3 + 2	Stenbäck 2003:181f*
4. Alkärr (Sa 20.7)	c 40		Late Comb / older Pitted Ware	3	Väkeväinen 1975
5. Glamilders (Sa 20.8)	c 35	2880-2610 BC*	Younger Pitted Ware	4	Meinander 1957, Vaara 2004*
6. Svinvallen (Sa 20.8)	c 32		Kiukais	2	Meinander 1984
7. Myrsbacka I (Sa 20.8)	c 32	2350-1940 BC*	Kiukais	1	Meinander 1984, Holm 2006:149*
8a. Jettböle I (Jo 14.1)	c 35	3360-2620 BC*	Older Pitted Ware	2	Cederhvarf 1912, Storå & Stenbäck 2001*
8b. Jettböle II (Jo 14.1)	c 30	2890-2200 BC*	Younger Pitted Ware	3	Cederhvarf 1912, Storå et al 2002*

non-organic elements, which were subsequently used to place the samples into distinct chemical groups. A minimum of 0.5 g of sample was ground into a fine powder and then dissolved in acid solution. The solution was then injected into excited argon plasma and when the atoms were targeted with massive energy, the electrons produced coloured rays, unique for every single element. The spectrum of atomic emission was measured subsequently with AES. From the 44 elements measured, 12 were used for data processing. The selection was based on previous experience of reliable discriminating elements in clay and pottery and chosen to include a wide cross-section of chemically different elements. These were the post-transition metals aluminium (Al), chromium (Cr), gallium (Ga), manganese (Mn) and vanadium (V), the alkaline earth metals calcium (Ca), magnesium (Mg), strontium (Sr), the lanthanides cerium (Ce) and lanthanum (La), the alkaline metal sodium (Na) and the transition metal cobalt (Co). The large amount of data was processed using the SPSS statistical software package for cluster analysis of the elemental dataset. Furthermore, the content of calcium (Ca) was determined, which can contribute to the discussion on possible use

of calcareous material as temper. The method is rather well established in European archaeology. Already in the 1990's Alan Vince, Lincoln, UK (e.g., Vince 1999), began to perform ICP analyses of Prehistoric and Historic pottery in Northern Europe and the method is today frequently used on pottery in several North European countries.

Thin section analysis

The results of the thin section analyses are presented according to the type of clay and the choice of temper material. This is because the aim is to examine the composition of fabrics within the traditionally pre-defined pottery types to enable comparisons, and initiate a discussion on ceramic technology with a changed perspective from typology to technology and its changes over time. (Figure 3).

Type of clay

The clays have according to the presence of silt and sand been divided into fine, medium coarse and coarse. All but one, a sherd from Alkärr (ÅM476:372), of the 32 analyzed sherds consists of sorted fine clay. A sorted fine clay has small

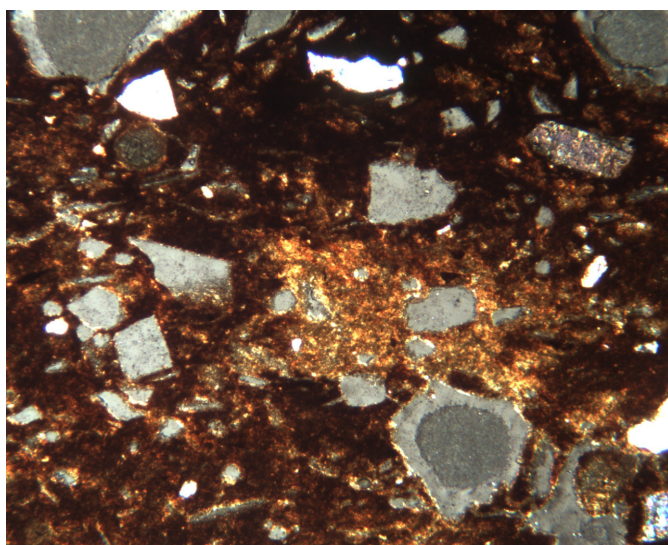
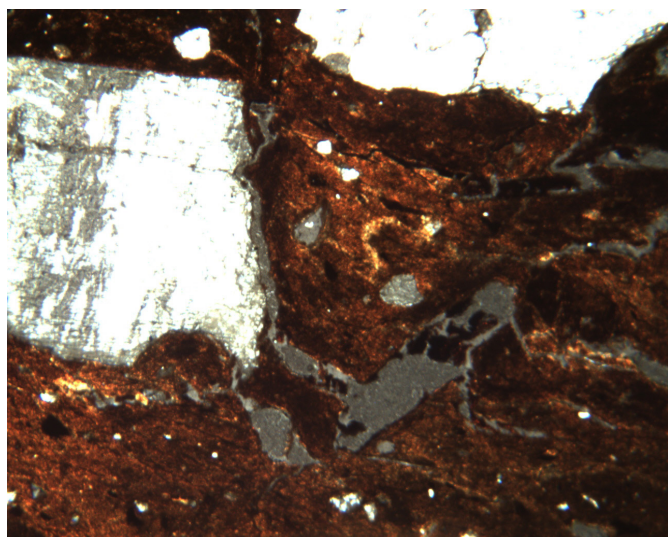
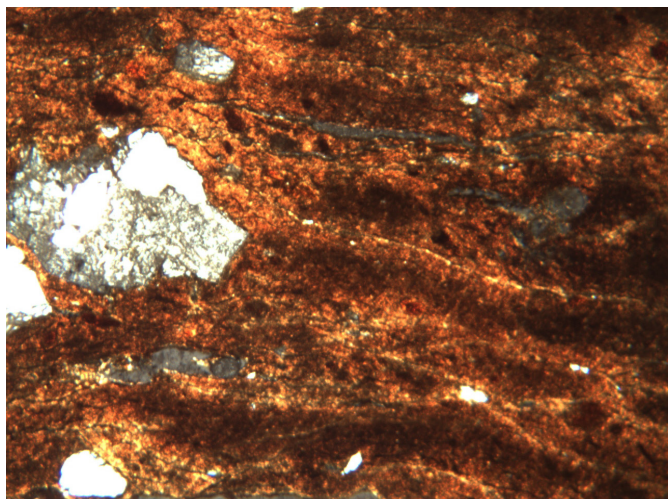


Figure 3. Thin sections. Photos taken in microscope, 40 x. Thin section 3 from Vargstenslätten (ÅM472:102) tempered with crushed quartz. Thin section 11 from Stockmyra (ÅM719:205) with quartz and limestone. Thin section 22 (the idol) from Glamilders (ÅM726:1856) only with limestone. Photo: Torbjörn Brorsson.

amounts or no silt at all. Of these 31 clays, all, except two from Alkärr (ÅM476:412, 505) and one from Jettböle Bergmanstorp (ÅM696:84), were very dense and lacked element of both silt and sand. Thus, it is worth noting that the same type of clay has been used on all sites, except Alkärr and Jettböle Bergmanstorp. The three deviating fine clays from Alkärr and Jettböle Bergmanstorp were silty, but still the quality of the clay was fine. The only sherd with a completely different fabric was a probable Pitted Ware sherd from Alkärr, number 18 (ÅM476:372). Even though the fabric appears to consist of a coarse sandy and silty, unsorted clay, calcareous material has been identified within the clay. The content of calcareous material may be natural. It can be determined that there is no difference in choice of clay between the different types of ceramics or between all the sites, except Alkärr (see below). (Table 2).

Tempering with crushed rock only – quartz

The fine clays have in 17 of the analyzed sherds been tempered with crushed quartz. In one of the thin sections from Jettböle II (NM5180:66) possible grains of diabase or gabbro have been observed, but this does not affect the interpretation of the provenance of the vessels. The maximum grain size varies between 1.5 and 4.5 mm, which indicates that the tempering has been handled in different ways and furthermore the temper has been sieved in several cases before it was added to the clay. The sieved temper consists of grains in the same hiatus, which is about 2.0 to 4.0 mm and no smaller grains have been identified. All nine analyzed Early Comb Ware sherds are found in this group of clay tempered with quartz. The same applies for two out of three sherds from Alkärr (ÅM476:412, 505) and three out of four from Jettböle Bergmanstorp (ÅM696:59, 80, 108),

Table 2. Results of thin section analysis from the Åland Islands. n.o. = not observed. X = presence. n.i.= no information. Samples 1–25 analyzed by Torbjörn Brorsson, samples J1-J7 by Anders Lindahl.

Thin section	ÅM	Find no.	Site	Sorted / Unsorted	Coarse / Medium / Fine	Silt	Sand	Iron oxide	Mica	Calcium	Diatoms	Organic matter	Calcium	Crushed rock	Grog	Sieved	Amount of temper (%)	Maximum grain (mm)	Notes
1	115	55	Vargstensläppen	Sorted	Fine			+	-		n.o.	x		x			18	4,0	Quartz, mica, sandstone
2	472	82	Vargstensläppen	Sorted	Fine			+	-		n.o.	x		x		x	11	3,5	Quartz, mica
3	472	102	Vargstensläppen	Sorted	Fine			+	-		n.o.			x		x	10	2,5	Quartz, mica
4	472	113	Vargstensläppen	Sorted	Fine			+	-		n.o.			x		x	13	3,0	Quartz, mica, sandstone
5	472	115	Vargstensläppen	Sorted	Fine			+	-		n.o.			x		x	15	3,0	Quartz, mica
6	472	127	Vargstensläppen	Sorted	Fine			+	-		n.o.			x		x	17	4,5	Quartz, mica
7	472	132	Vargstensläppen	Sorted	Fine			+	-		n.o.			x		x	15	3,0	Quartz, mica
8	472	496	Vargstensläppen	Sorted	Fine			+	-		n.o.	x		x			28	4,5	Quartz, mica
9	719	142	Stockmyra	Sorted	Fine			+	-		n.o.		x				12	2,5	
10	719	160	Stockmyra	Sorted	Fine			+	-		n.o.		x				10	2,5	Few grains of quartz
11	719	205	Stockmyra	Sorted	Fine			+	-		n.o.		x	x		x	10	1,5	Quartz
12	483	15	Vargstensläppen	Sorted	Fine			+	-		n.o.			x			26	4,5	Quartz, mica, sandstone
13	696	80	Jetböle Bergmanstorp	Sorted	Fine			+	-		n.o.			x		x	12	2,5	Quartz, mica
14	696	106	Jetböle Bergmanstorp	Sorted	Fine			+	-		n.o.		x		x		12	2,0	Few grains of quartz
15	696	108	Jetböle Bergmanstorp	Sorted	Fine			+	-		n.o.			x			20	2,0	Quartz, mica, sandstone
16	476	412	Ålkärr	Sorted	Fine	x		+	-		n.o.			x			17	4,0	Quartz. Few grains of lime
17	476	505	Ålkärr	Sorted	Fine	x		+	-		n.o.			x			15	1,5	Quartz
18	476	372	Ålkärr	Unsorted	Coarse	x	x	+	-		n.o.							1,5	Rich in calcium
19	724	188	Glamilders	Sorted	Fine			+	+		n.o.		x				22	1,5	Few grains of quartz
20	726	1472	Glamilders	Sorted	Fine			+	-		n.o.		x	x			17	2,0	Quartz. Low amount of calcium
21	726	4435	Glamilders	Sorted	Fine			+	-		n.o.		x				25	2,0	Few grains of quartz
22	726	1856	Glamilders	Sorted	Fine			+	-		n.o.	x	x				27	1,0	
23	473	78	Svinvallen	Sorted	Fine			+	-		n.o.		x				19	1,0	Few grains of quartz
24	473	160	Svinvallen	Sorted	Fine			+	-		n.o.			x		x	12	3,5	Quartz, mica
25	322	68	Myrsbacka	Sorted	Fine			+	+		n.o.		x				21	2,0	Few grains of quartz
J1	696	59	Jetböle Bergmanstorp	Sorted	Fine			+			n.o.			x			e.u.	3,0	
J2	696	84	Jetböle Bergmanstorp	Sorted	Fine	x		+			n.o.		x	x			e.u.	1,5	Quartz, sandstone. Quartz?
J3	697	3761	Jetböle I	Sorted	Fine			+			n.o.		x				e.u.	2,0	
J4	697	4393	Jetböle I	Sorted	Fine			+			n.o.		x				e.u.	2,0	
J5	5180	66	Jetböle II	Sorted	Fine			+			n.o.			x			e.u.	2,0	
J6	5180	403A	Jetböle II	Sorted	Fine			+			n.o.			x			e.u.	1,5	
J7	5180	403B	Jetböle II	Sorted	Fine			+			n.o.		x				e.u.	2,0	

as well as two out of three sherds from Jettböle II (NM5180:66, 403A). Noticeable is that the sherds from Alkärr and Jettböle Bergmanstorp have been interpreted as Late Comb Ware or a mixed form between Comb Ware and Pitted Ware. One sherd from Svinvallen belongs to the clays that have been tempered with quartz and this sherd belongs to the Kiukais culture. Further it can be verified that the sherds with the largest grain of rock are found in this group and eight out of nine sherds from Vargstensslätten have a largest grain size of 3.0 mm. The same is valid for one sherd from Alkärr, one from Jettböle Bergmanstorp as well as one from Svinvallen. The amount of temper in these 14 sherds varies between 10 and 28 % (percent in volume calculated under the microscope), which indicates a partially different fabric. The variation within the material from Vargstensslätten may have been related to the function of the vessels, or due to some other reason. Thin section number 2, 3 and 13 had the smallest amount of temper while thin section number 8 and 12 had the largest amount. Generally, it can be stated that the sherds belonging to vessels manufactured from clays tempered with crushed quartz contained large grain of temper, often larger than 3.0 mm in diameter.

Tempering solely with material rich in calcareous material

From all of the sites except the oldest in this study, Vargstensslätten and Alkärr, ceramics with tempering of calcareous material alone have been found. Two of the three analyzed sherds from Stockmyra (ÅM719:142, 160), determined as Late Comb Ware, are found in this group. Three out of four Pitted Ware sherds from Glamilders (ÅM724:188, ÅM726:4435, 1856), two Early Pitted Ware sherds from Jettböle I (ÅM697:3761, 4393), one of the three younger Pitted Ware sherds from

Jettböle II (ÅM403B) as well as the Kiukais Ware from Svinvallen and Myrsbacka (ÅM473:78, ÅM322:68), falls into the same group. One out of five sherds from Jettböle Bergmanstorp (ÅM696:106), that has been classified as Late Comb Ware, also contained temper rich in calcareous material. In this ceramics, small amounts of grog have also been identified. The use of grog occurs within the Comb Ware tradition on the Finnish mainland (Leskinen & Pesonen 2009: 170). The sherd from Jettböle Bergmanstorp was decorated with imprints of fingernails and the fabric was very porous.

Unlike the fabric with crushed rock, the grains of rock were not as large in the fabrics rich in calcareous material. Isolated grains of quartz, between 1.0 and 2.5 mm occurred. The largest grains (2.5 mm) were found in the Late Comb Ware from Stockmyra. A refinement in grain size is noticeable from the Early to the Late Comb Ware. Generally, the amount of temper was high; from 19 to 27 %, and it constitutes a large part of the fabric. In three sherds, however, the temper was between 10 and 12 %, and these sherds originated from Stockmyra (ÅM719:142, 160) and Jettböle Bergmanstorp (ÅM696:106).

It is interesting to conclude that the Late Comb Ware from Stockmyra contained temper of calcareous material, although in relatively low amounts. This is the earliest indication of clay tempered with calcareous material on the Åland Islands. The rest of the ceramics with high amounts of calcareous material temper have been interpreted as Pitted Ware and Kiukais Ware.

The analysis has not confirmed what type of material rich in calcareous material that has been added to the fine clays. However, the form of the

pores makes it unlikely to be bone, more probable the temper consists of limestone or possibly shell. The bedrock on the Åland Islands, as in other parts of the Baltic area, consists of quartz porphyritic rapakivi granite, Pyterlite and in the Långbergsöda area also Viborgite. The soil types represented are gravel/sand moraine, fine moraine, sand and clay. (Geological Survey of Finland (GTK); Haavisto-Hyvärinen & Kutvonen 2007). It has not at this stage been possible to use mineralogy to determine the provenance of the vessels.

The amount of grog in thin section 14 (ÅM696:106) from the sherd from Jettböle Bergmanstorp is so small that it does not influence the function of the vessel, nor is it likely to represent a different ware. Probably there were other reasons why the grog was added to the clay. The tempering could have had a symbolic function as a link to the past (Larsson 2009: 352).

Tempering with crushed quartz and material rich in calcium

One sherd from Stockmyra (ÅM719:205), one from Glamilders (ÅM726:1472) as well as one from Jettböle Bergmanstorp (ÅM696:84) are all very similar. These have been manufactured of fine clays tempered with crushed quartz and materials rich in calcareous material. The amount of temper in the sherds from Stockmyra and Glamilders are 10 and 17 % respectively and the largest grains of rock has been measured to 1.5 and 2.0 mm. The two sherds have been interpreted as Late Comb Ware and Younger Pitted Ware respectively. The sherd from Jettböle Bergmanstorp is interpreted as Late Comb Ware.

Naturally sandy/silty clay

One sherd from Alkärr (ÅM476:372) has been described as an unsorted sandy and silty coarse

clay. It means that no temper was added and that the clay was considered coarse enough for its purpose and this has been classified as natural sand/silt tempered. All the mineral grains in the fabric were rounded and the hiatus was rather equable. The calcareous material found in the clay indicates that the clay was probably naturally rich in calcareous material.

ICP analysis with the aim to determine the provenance of the ceramics

With the purpose to try to answer the question where the ceramics were manufactured ICP analysis has been performed on 25 sherds from the Åland Islands (Table 3). The method is based on determining the “chemical finger print” of the sherds and among other factors, a number of trace elements are important in determining where the clays and possible temper were collected. One trace element that is used for determination is calcium (Ca), which obstructs the interpretation. Calcareous material has been added to some of the clays and thus the analysis has been performed both with and without calcareous material, with the same result.

The ICP analysis is presented as a dendrogram, which is one of the best methods to understand and visualize the relationship between different samples (Figure 4). Two samples deviate significantly from the others, sherd 22 (ÅM726:1856); the idol from Glamilders, and sherd 20 (ÅM726:1472); a Pitted Ware sherd from the same site (ÅM726:1472, 1856). They fall into two entirely separate groups and they most likely have a different provenance than the Åland Islands. The other 23 sherds fall into different groups where the sherds from Jettböle Bergmanstorp, Glamilders,

Svinvallen and Stockmyra are found in the same group, while another group constitutes of four sherds that all come from Vargstensslätten. The distribution is generally large and the different groups are mixed. It seems impossible to determine if the sherds originate from vessels from specific sites of manufacture on the Åland Islands, because the method of analysis is not detailed enough. The sherds have been compared to material from Gotland, and the result is that the ceramics from the Åland Islands form its own groups without any similarities with contemporary pottery from Gotland (Brorsson 2015). The same method of analysis was used as on the Åland Islands material and one of the most significant results was that the samples from Gotland contained significantly higher amounts of natural calcium in the clays than the sherds found in The Åland Islands.

It can be stated that a large number of the analyzed sherds probably have an Ålandic origin, based on the large number of sherds with the same chemical composition (cf. Holmqvist- Saukkonen 2012: 33). The pots could of course have been made out of raw material from elsewhere, but according to the number of heterogeneous samples this seems unlikely. The homogenous material is interpreted as the remains of several Ålandic productions. Although this result is based on the assumption that the relatively large number of sherds analyzed that share the same chemical composition originate in the same region, it seems plausible to conclude this region as being the Åland Islands, representing a local craft tradition prevalent throughout the Neolithic, rather than import from neighboring regions. The homogenous character of the clay used, in relation to the differing styles in the ceramic assemblage studied from the Åland Islands, also

seem to support this assumption. Vessels and items of alternative provenance are most likely also present in the investigated material. The idol from Glamilders differs so significantly in clay composition, that it most probable has a non Ålandic origin, and the same goes for the Pitted Ware sherd number 20 (ÅM726:1472). The thin section analysis of the fabric in these sherds showed that they did not deviate from the other analyzed sherds from the Åland Islands, but the ICP analysis indicates another provenance. The craftsmanship is the same, which could suggest distinct relations between the Åland Islands and the Swedish mainland.

Changes over time in the ceramics from the Åland Islands

The analysis of the fabric indicates that the ceramic craft from the Early Comb Ware and up to the Kiukais Ware changed to a relatively significant degree (Tables 4 and 5). This period covers 3000 years and it is evident how the craft changed from using a fairly coarse fabric to a smother one, and with elements of new types of temper. However, a common feature during this time is distinguished and that is the choice of clay; sorted fine clays were used. This was also the case on the Swedish mainland during the early and middle Neolithic, following the Swedish classification of periods, i. e. 4000–2300 BC.

The Early Comb Ware was manufactured from clays tempered with crushed quartz of large grain size. The temper was sieved prior to it was added to the clay, as it was done within the Scandinavian Funnel Beaker tradition (Brorsson 2008b: table 18) which occurred in mid-eastern Sweden ca. 4000 – 3300 BC (Kihlstedt et al. 1997), i. e. it was

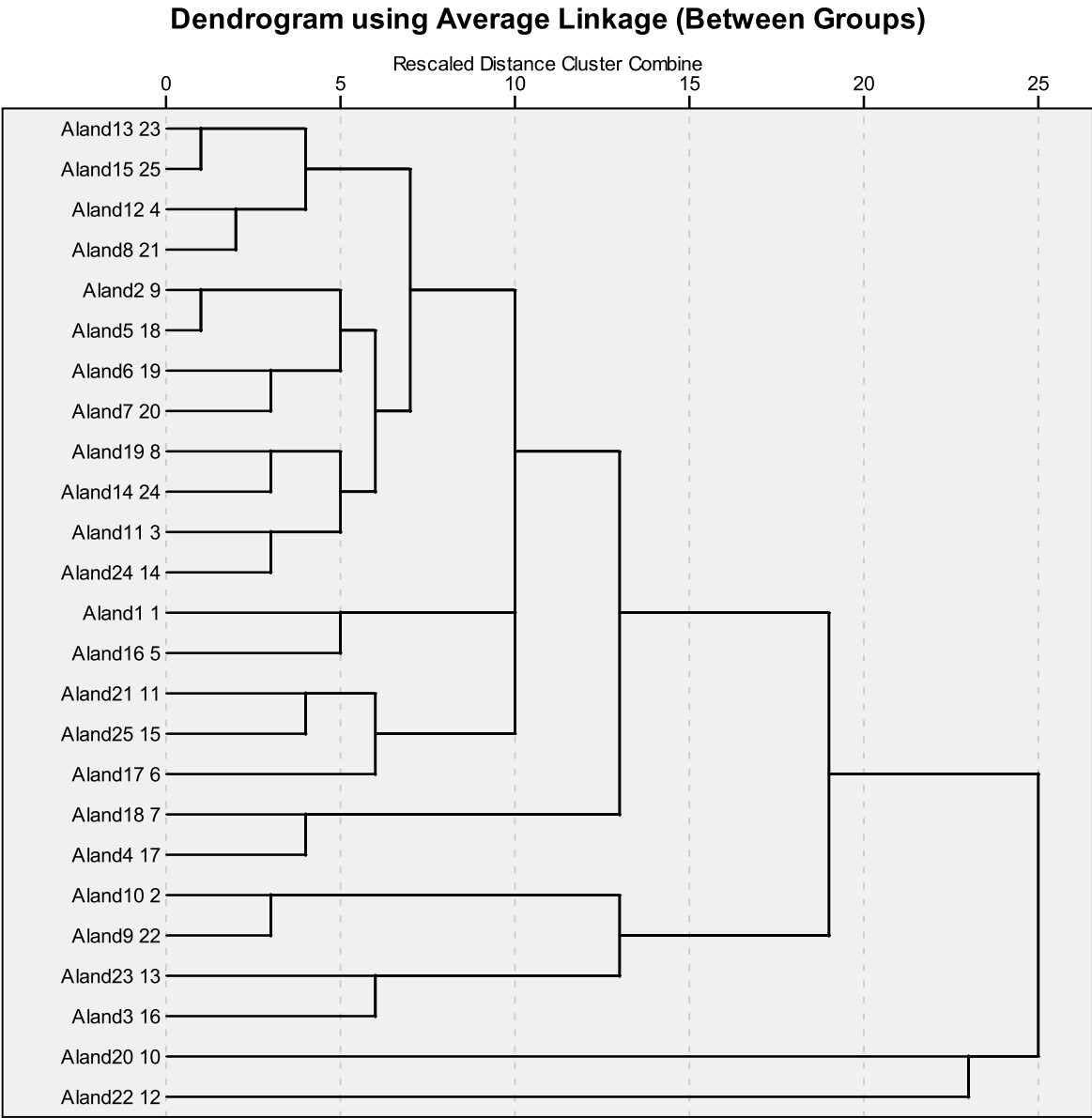


Figure 4. Dendrogram on the statistics based on ICP analysis of ceramic from the Åland Islands. The two samples at the bottom of the chart deviate significantly from the rest. Probably those two have not been manufactured on the Åland Islands. The numbers Åland 1–25 refer to the 25 analyzed sherds (compare Table 1).

Table 3. Results of the ICP analysis.

	Ag	Al	As	Ba	Be	Bi	Ca	Cd	Ce	Co	Cr	Cu	Fe	Ga	Ge	K	La	Li	Mg	Mn	Mo	Na
	ppm	%	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	%	ppm	ppm	%	ppm	ppm	%
Aland1	0,16	6,43	8	780	1,68	0,27	0,63	0,69	126,5	10,1	65	17,8	5,35	26,6	0,14	3,55	60,4	31,3	1,04	344	0,61	1,11
Aland2	0,08	8,33	7,9	730	3,78	0,35	1,2	0,14	128	20	101	44,7	5,73	27,1	0,13	2,82	73,3	66,3	1,53	675	0,81	1,53
Aland3	0,09	8,49	6,9	760	6,83	0,35	0,7	0,18	194	19,6	103	33,3	6,07	31,1	0,19	3,11	105	72,2	1,55	461	0,7	0,97
Aland4	0,07	8,29	2,9	810	4,6	0,22	0,82	0,13	141	13,6	79	29	4,16	23,8	0,12	3,19	83,8	56,8	1,2	347	0,35	1,51
Aland5	0,12	8,83	6,7	920	5,53	0,27	1,46	0,24	171	20,3	85	42,5	5,93	26,9	0,19	2,36	85,5	49	1,46	676	0,91	1,5
Aland6	0,07	8,44	5,4	670	5,03	0,57	0,6	0,17	151	13,8	75	22,3	4,61	26,4	0,21	3,81	77,2	74,4	1,22	404	0,52	1,24
Aland7	0,12	8,8	6,1	690	5,06	0,38	0,82	0,19	164,5	17,4	93	31,1	5,59	25,5	0,18	2,68	89,6	54,7	1,56	435	0,65	1,13
Aland8	0,12	8,24	4,4	770	3,63	0,22	1,75	0,13	110	17,5	63	27,1	5,9	23,3	0,17	2,68	54,6	54,9	1,48	687	0,7	1,51
Aland9	0,1	8,42	10,7	760	3,42	0,43	1,27	0,19	110,5	34,1	134	53,8	8,7	27,5	0,18	3,03	44,1	61,1	2,24	1390	1,29	1,94
Aland10	0,11	7,97	12,7	670	4,8	0,68	1,2	0,23	146	31,1	115	34,5	7,33	25,7	0,17	2,87	66,9	49,2	1,75	1630	1,11	0,93
Aland11	0,12	7,77	9,4	670	3,12	0,3	0,98	0,33	122	20,9	106	34,1	7,57	28,6	0,23	3,03	55,4	53,6	1,55	761	0,87	1,23
Aland12	0,06	7,96	12	680	5,16	0,23	1,6	0,16	119,5	17,2	74	25,6	7,59	21,2	0,16	2,41	57,2	49	1,44	619	1,08	1,5
Aland13	0,07	7,83	5	730	2,87	0,38	1,45	0,3	107,5	13	78	26,4	5,09	23,1	0,15	2,94	50,4	43	1,08	370	0,26	1,25
Aland14	0,11	8,58	5,2	870	4,11	0,46	1,64	1,01	131	19,1	104	61,6	6,08	27,5	0,21	2,88	62,6	60,1	1,64	511	0,42	0,92
Aland15	0,09	7,85	3,1	750	2,69	0,37	1,47	0,3	121,5	12,9	80	32,2	4,81	24	0,21	3,25	58,6	45,1	1,08	339	0,3	1,25
Aland16	0,11	7,32	4,9	860	6,68	0,52	0,66	0,52	141	8,1	56	24	5,48	23,7	0,21	4,22	67,2	21,7	0,65	596	0,54	1,24
Aland17	0,07	6,99	4,1	710	3,69	0,28	0,77	0,25	71,7	23,1	77	18,6	4,32	23,2	0,16	3,1	31	34,4	0,93	1110	0,59	1,25
Aland18	0,08	7,43	9,8	1000	7,77	0,2	0,97	0,44	180	11,8	55	16,2	3,97	20,7	0,25	2,56	85,3	31,3	0,88	334	0,55	1,46
Aland19	0,12	7,7	7,6	820	34,3	0,3	1,98	1,02	138	17,3	84	41,9	4,59	27,5	0,23	2,59	66,5	61,8	1,38	668	0,59	1,01
Aland20	0,12	7,67	8,6	1090	2,99	2,37	3,49	1,92	156,5	14,9	70	36,6	4,45	21,9	0,43	2,8	90,8	25,7	0,96	1120	0,51	1,09
Aland21	0,09	5,57	5,3	630	2,52	0,53	1	0,5	84,5	18,1	85	58	4,45	22,9	0,22	2,48	50	59,4	1,17	724	0,41	0,96
Aland22	0,14	7,88	4,5	1470	2,65	0,3	1,52	1,34	162,5	22	97	69,3	5,53	23,6	0,36	2,81	103,5	50,7	3,39	1420	0,53	0,87
Aland23	0,09	9,01	10,9	800	3,5	0,5	0,96	0,3	122	21,2	103	28,3	6,22	29,6	0,2	3,1	56,9	60,1	1,92	1120	0,5	0,89
Aland24	0,08	7,81	6	640	2,21	0,6	0,65	0,13	73,4	16,5	86	23,8	5,05	25,9	0,18	3,11	34	59,4	1,39	527	0,51	1,1
Aland25	0,09	6,95	5,4	670	4,12	0,33	0,71	0,43	121,5	21,1	109	46,1	5,24	23,7	0,2	2,65	62,3	64,5	1,49	724	0,54	0,85
	Nb	Ni	P	Pb	Rb	S	Sb	Sc	Se	Sn	Sr	Ta	Te	Th	Ti	Tl	U	V	W	Y	Zn	Zr
	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	ppm
Aland1	21,4	26,5	1120	70,7	185,5	0,06	0,61	11,5	1	3,4	118	1,92	<0,05	28	0,361	1,12	4,7	77	1,6	15,2	284	151
Aland2	17,4	50,1	1790	35,6	165,5	0,01	0,38	17,1	1	3,3	141	1,45	0,07	20,2	0,483	0,93	8,6	118	1,6	27,1	172	140,5
Aland3	23,5	49,7	2910	55,8	234	0,02	0,39	19,1	2	4,2	90,1	2,57	<0,05	29,8	0,479	1,21	8,1	116	1,8	38,8	195	157,5
Aland4	16,9	40,2	2010	36,9	200	0,02	0,17	12,3	1	4,2	249	1,7	<0,05	14,4	0,349	1,08	5,6	82	1,1	27,2	144	109
Aland5	18,5	47,6	3040	34,9	145	0,02	0,41	21,6	1	3,5	190,5	1,62	0,07	17,9	0,453	0,76	7,9	108	1,3	38,3	150	171,5
Aland6	20,9	33,8	1900	50,6	253	0,01	0,26	13,1	2	4	85,2	1,64	0,05	24,5	0,364	1,64	9,2	85	1,7	27,8	160	111
Aland7	19,3	43,2	1880	40,4	177,5	0,02	0,26	15,7	2	3,4	118	1,99	<0,05	21,1	0,442	0,98	7,4	113	1,5	30,6	182	139,5
Aland8	16,9	29,7	1670	28,4	164	0,01	0,31	16,6	1	2,8	167	1,45	<0,05	15,3	0,552	0,91	4,9	98	1,1	28,7	173	139
Aland9	19,6	72,6	1250	41,3	171	0,04	1,35	20,2	1	3,3	124,5	1,63	0,08	22,1	0,533	1,21	7,2	154	1,3	22,8	185	120,5
Aland10	18,1	50,6	1640	38,4	170,5	0,03	0,26	16,5	1	3,7	130	1,38	0,1	24,4	0,492	1,26	8	136	1,4	29,7	153	91,1
Aland11	19,7	46,9	4180	32,1	184,5	0,03	0,34	19,7	2	3,7	136,5	1,28	0,05	21,1	0,488	1,18	5,4	124	1,5	26,9	182	117
Aland12	15,5	28,7	1340	33,6	138,5	0,04	0,46	16,8	1	3,1	176	1,49	<0,05	18	0,456	1,03	6,5	127	1,2	28,9	126	102
Aland13	16,1	35,4	6810	28,3	188,5	0,01	0,64	14,5	1	3,4	147,5	1,22	<0,05	19,3	0,395	1,15	3,5	89	1,1	21	156	106,5
Aland14	22,5	48,9	7910	27,3	201	0,02	0,69	20,2	1	3,7	198	2,29	0,05	20	0,487	1,1	3,8	111	1,6	26,5	283	129
Aland15	19,3	34,6	6280	27,5	193,5	0,01	0,67	14,6	2	3,5	172	2,02	<0,05	19,6	0,401	1,19	4,5	84	1,1	23,7	166	102
Aland16	14,2	25,8	9400	40	239	0,01	0,26	13	3	4,4	136	1,29	<0,05	15,9	0,316	1,39	6,4	66	1,2	36,1	87	84,8

contemporaneous with Typical and Late Comb Ware. Already by the Late Comb Ware tradition the craft changed and now materials rich in calcareous materials were added to the clay. Of the three analyzed sherds from Stockmyra, two had temper with solely calcareous material while the third also had a small element of quartz. This implies that tempering with quartz was still in use, though less frequently. The amount of calcareous material at this stage was very low, usually 10 to 12 %.

The Early Pitted Ware from Jettböle I was solely tempered with calcareous material, which shows how thoroughly this type of temper manifested itself on the Åland Islands. The younger Pitted Ware from Jettböle II however was more mixed either with quartz or calcareous material which again indicates a change in the craft.

The younger Pitted Ware from Glamilders (Jettböle II style) is relatively homogeneous with a high amount of temper rich in calcareous material (usually more than 20 %), while quartz has only been found in one sherd. Hence it can be determined that both the older and the younger Pitted Ware contains a large amount of calcareous material (Jettböle I and II styles respectively), but ceramics tempered with quartz also exists.

Kiukais Ware from Svinvallen and Myrsbacka represents a more varied craft, with sherds either tempered with quartz or some material rich in calcareous material. In the three analyzed sherds, the different types of temper were not mixed. It is noticeable that the amount of calcareous material temper in two of the sherds is very high and similar to the Pitted Ware sherds. Overall there are significant technological similarities between Pitted and Kiukais Ware.

Eight sherds from Jettböle Bergmanstorp and Alkärr that were included in the analysis were determined as mixed forms between Comb and Pitted Ware. This analysis has been aimed at studying if the qualities of the fabrics can indicate anything about their cultural origin (Tables 2 and 5). First it can be noted that one of the sherds, number 18 (ÅM476:372), from Alkärr is very different from the other analyzed sherds. This sherd has been manufactured from coarse clay without any temper. The sherd has been classified as Pitted Ware. Sherd number 14 (ÅM696:106) from Jettböle Bergmanstorp has been tempered with a relatively small amount of calcareous material and this sherd has a resemblance with Stockmyra samples, although the sherd from Jettböle Bergmanstorp also contained grog. The sherd has been interpreted as Late Comb Ware.

The other four sherds from Alkärr and Jettböle Bergmanstorp are similar to the Early Comb Ware from Vargstenslätten. It is the element of temper solely containing quartz that places the sherds in this group. Sherd number 16 from Alkärr (ÅM476:412) most resembles the material from Vargstenslätten. The fabric in this sherd contained large grains of temper and it has been determined as possible Comb Ware. The other three sherds have similarities with Vargstenslätten, but they have a slightly finer temper. There was one sherd from Jettböle Bergmanstorp (ÅM696:84) tempered with both calcareous material and quartz, which can be seen as evidence for changing pottery craft tradition. The ceramics that represent mixed or transitional forms have been confirmed to have significant similarities with the Uskela Ware (see Vikkula 1981) within the Late Comb Ware tradition. The relationship in typology and craftsmanship between Uskela Ware in the

Table 4. Compilation of the thin section analysis.

Pottery	Site	Temper	Notes
Comb ceramics, early	Vargstenslätten	Quartz	Large grains, > 3.0 mm. High amount of temper.
Comb ceramics, late	Stockmyra	Calcium, (quartz)	Mainly lime/calcium temper. Low amount of temper. Small grains.
Comb ceramics, Pitted ware. Transition	Alkärr. Jettböle, Bergmanstorp	Quartz. Calcium. Natural	Either quarts or lime/calcium. Temper not mixed. Varying.
Pitted ware ceramics	Glamilders, Jettböle II, Jettböle II	Calcium, quartz	Mainly lime/calcium temper. High amount of temper.
Kiukais ceramics	Svinvallen. Myrsbacka	Calcium, quartz	Either quarts or lime/calcium. Temper not mixed. Varying.

Table 5. Mixed form sherds and their resemblance to specific ceramic groups.

Site	ÅM	Pottery	Temper	Resembles to	Notes
Jettböle, Bergmanstorp	696:80	Comb ceramics, Pitted ware. Transition	Quartz	Vargstenslätten, early Comb ceramics	Slightly finer than Vargstenslätten
Jettböle, Bergmanstorp	696:106	Comb ceramics, Pitted ware. Transition	Calcium (grog)	Stockmyra, late Comb ceramics	-
Jettböle, Bergmanstorp	696:108	Comb ceramics, Pitted ware. Transition	Quartz	Vargstenslätten, early Comb ceramics	Slightly finer than Vargstenslätten
Jettböle, Bergmanstorp	696:59:00	Comb ceramics, Pitted ware. Transition	Quartz	Vargstenslätten, early Comb ceramics	
Jettböle, Bergmanstorp	696:84	Comb ceramics, Pitted ware. Transition	Quartz, calcium	Stockmyra, Glamilders	
Alkärr	476:412	Comb ceramics?	Quartz	Vargstenslätten, early Comb ceramics	Same as Vargstenslätten
Alkärr	476:505	Comb ceramics, Pitted ware. Transition	Quartz	Vargstenslätten, early Comb ceramics	Slightly finer than Vargstenslätten
Alkärr	476:372	Pitted ware ceramics?	Natural	-	Own group

Finnish mainland and the Åland Islands needs to be further investigated. It is obvious that the ceramic material on the Åland Islands displays a wide range of variation during the Neolithic.

Comparison with Neolithic ceramics from mid-eastern Sweden

On the Swedish mainland and in the region of Uppsala the Neolithic ceramics was mainly manufactured from fine clays tempered with crushed granitic rock (Brorsson et al. 2007). Materials rich in calcareous material were also used while grog is attributed to the Battle Axe culture

(Larsson 2009: chapter 7 and 8). Within the analyzed Corded Ware material from Sweden, clay rich in calcareous material occur, but Corded Ware/Battle Axe Ware from the Åland Islands have not been analyzed and ceramics of this type only occurs as single sherds on Pitted Ware settlements on the Åland Islands (Stenbäck 2003: 82). However, grog was found in one of the sherds from Jettböle Bergmanstorp and its significance may also be symbolic, where the grog from an old pot was used as temper into a new one so that the the old pot was brought back into use again. Naturally tempered clays were also used within the Pitted Ware culture. At the Högmossen site in northern Uppland three out of 23 analyzed sherds

was ascribed to this group of ware (Brorsson et al. 2007: 420). It is worth noting that of around 100 analyzed Pitted Ware sherds from Mälardalen fewer than five were manufactured from coarse clays without adding extra temper. This analysis indicates that Pitted Ware on the Åland Islands was manufactured from the same type of raw material as the contemporary ceramics from Mälardalen.

The transition from Comb Ware to Pitted Ware on the Åland Islands took place around 3300 BC, i. e. at the transition between the Early and Middle Neolithic according to the Swedish periodization. It is about this time Pitted Ware on the Swedish mainland changed from Fagervik I and II into the Fagervik III phase (Larsson 2009: 224). Fagervik I is considered synonymous with the mid-Swedish Funnel Beaker culture. Analysis made on Funnel Beaker pottery from the site Bålmyren in Uppland Påljungshage and Östra Vrå in Södermanland have shown that the ceramics was mainly manufactured from fine clays tempered with crushed granitic rock with relatively large grains (Brorsson 2005; Brorsson et al. 2007: 420; Brorsson 2008a). Another important result was that the temper in several of these wares was sieved prior to adding it to the clay. Analyses of Funnel Beaker pottery have also been performed on sherds from the sites of Nävertorp and Mogetorp, along with additional sherds from Östra Vrå in Södermanland (Brorsson 2008b). The results indicate significantly larger variation in the pottery craft, where several different types of clays and both sieved and unsieved temper occurred. Despite this, it is possible to determine that the Funnel Beaker pottery in Mälardalen and Uppland was principally manufactured from sorted fine clays and tempered with relatively large grains of granite that had been sieved. The Funnel Beaker

pottery is younger, but technologically it is the same type of craftsmanship as in the Early Comb Ware from Vargstenslätten. In the assemblage from the site Nävertorp in Södermanland there were a few sherds with a possible connection to the Pitted Ware culture (Brorsson 2008b). The analysis showed that these two sherds had been tempered with bone or some other material rich in calcium as well as with crushed granite, and perhaps this is one of the earliest traces of limestone temper and the emerging Pitted Ware culture. The settlement at Nävertorp has been dated to 3800–3400 BC and it is possible that the temper rich in calcareous material appeared in the latter part of this period in Södermanland. On The Åland Islands this temper appeared at the transition between Early and Late Comb Ware. The phenomenon to temper the ceramics with material rich in calcareous material may thus be older on the Åland Islands than on the Swedish mainland.

Kiukais Ware is found on the Åland Islands in the Late Neolithic (Meinander 1984; Stenbäck 2003: 83) and it is partly contemporary with the Swedish Late Neolithic pottery. There are only a few analyses made of Late Neolithic pottery from the area around lake Mälaren, one is from the Norslunda site close to Arlanda in Sigtuna, Uppland (Brorsson 2009). Four sherds from Norslunda were analyzed and all of them had been manufactured from sorted fine clays tempered with crushed granitic rock and the fabric did not contain any material rich in calcareous material. Pitted Ware sherds from the same site were also studied and several of them did contain calcareous material, which indicate a variable craft between the Pitted Ware and the Late Neolithic pottery. From the Åland Islands, Kiukais Ware from the sites Svinvallen and Myrsbacka have been analyzed and two out

of the three sherds are very similar to the Late Neolithic pottery from Norslunda and indicate similarities in the pottery craft.

It can be determined that the Åland Islands and Mälardalen experienced the same change in the pottery craft from the Early to Late Neolithic. It is possible that the temper rich in calcareous material occurred a little earlier on the Åland Islands, but the analysis cannot confirm which region was first to abandon it. One of three sherds of the Late Neolithic Kiukais Ware on the Åland Islands has temper rich in calcareous material while none of the four analyzed Late Neolithic sherds from Norslunda contained calcareous material. This very vague basis may indicate that temper rich in calcareous material continued to be used a bit longer on the Åland Islands than on the Swedish mainland, but more of Late Neolithic materials from Sweden needs to be analyzed to confirm this hypothesis.

Conclusion

The thin section analysis of Early and Late Comb Ware, Pitted Ware and Kiukais Ware from the Åland Islands indicates continuity in the pottery craft and in the choice of clay during the entire Neolithic period, and it also indicates a technological similarity with pottery traditions on the Swedish mainland. The change in pottery style has been demonstrated earlier in the classification of the ceramics into traditional typologies. This study shows that it is possible to see differences also in the choice and handling of the temper in the ceramics. The change in preference of temper added to the vessels does not however occur at the same time as the typological shift between pottery traditions.

The Early Comb Ware vessels have a temper of rock and quartz which already in the Late Comb Ware parallels with the introduced limestone tempering. This introduction is earlier than what is confirmed on the Swedish mainland. Temper rich in calcareous material then occur in Pitted Ware on the Åland Islands, while in the Late Neolithic Kiukais Ware either one or the other is chosen but the materials are never mixed. The introduction of the temper rich in calcareous material that manifests itself in the Pitted Ware craft at Jettböle I-II and Glamilders are probably not introduced to the islands as a Pitted Ware innovation but arrived from the east.

The Early Comb Ware sherds that have a black outside and a fine polished/smoothed surface do not differ from the rest of the sherds analyzed. The treatment of the surface has raised questions why the surface almost looks like “asphalt”, but the analysis shows that this pottery is no different from the rest of the Early Comb Ware on the Åland Islands.

Provenance analysis (ICP-MA/ES) confirms that a local pottery craft most likely existed during the whole Neolithic period on the Åland Islands. This is also valid for the earliest Comb Ware, which doesn't display a different craft or a clay material with differing provenance as earlier research has suggested. This study neither confirms nor dismisses the occurrence of Ancyclus clay in the material. The aberrant ceramics that most likely is not manufactured on the Åland Islands is a fragment of an idol and a Pitted Ware sherd from Glamilders, while the rest of the analyzed Pitted Ware material is locally manufactured.

The communication and movements throughout the Baltic Sea are visible in the material culture

on the Åland Islands. Pots, clay idols and other types of artefacts with a provenance outside the Åland Islands are clear indications of existing contacts in different directions. The development of the ceramic technology and the fact that we can see influences from different traditions in unique vessels on the Åland Islands illustrate the spread of innovations and ideas in the Baltic region. The thin section analysis showed that a sherd from Alkärr determined as originating from an older Pitted Ware vessel had a divergent ware and if anything has a resemblance to ceramics from the Pitted Ware site Högmossen in Uppland. However, the result of the ICP analysis indicated that the sherd from Alkärr nevertheless probably has its provenance on the Åland Islands.

In this analysis, it has been suggested that the ceramics believed to represent mixed forms of Comb Ware and Pitted Ware display a reinforcement of the past and the earlier pottery traditions. At the site Jettböle Bergmanstorp grog from an older vessel has been mixed into the fabric of a new vessel. From this site and from the site Alkärr, vessels of Comb Ware resembling Uskela Ware have been found, made with temper and clay similar to the earliest Comb Ware found at Vargstensslätten. It is possible that we see traditional features being emphasized in the transition into new techniques.

The aim of this study is to contextualize the pottery traditions on the Åland Islands in a larger perspective. The study has shown that pottery was locally manufactured on the Åland Islands during the entire Neolithic period. The difficulties in classifying some of the ceramics into existing typologies and the local technological choices visible in the ceramics demonstrate this. Comparative studies of ceramic materials

from the Swedish mainland confirm contacts to the western shores of the Baltic sea, and there is evidence of a common ceramic technology during the period irrespective of typological traditions. To fully understand the communication and contacts in the Baltic Sea area and the relationship between the pottery traditions, further studies are necessary. Pottery from Neolithic sites in mainland Finland will be analyzed in order to broaden the perspective and make comparisons possible. The Kiukais Ware and the Late Comb Ware traditions on the Åland Islands have proven difficult to contextualize, and they have an important role in future discussions on ceramic technologies, typologies and as an intermediary to the understanding of the Neolithic in the Baltic Sea region.

Translation by Annica Cardell

Acknowledgements

The analyses in this project were funded by Svenska Litteratursällskapet i Finland and Berit Wallenbergs Stiftelse.

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