Production and ceramic technology at the Late Bronze Age site of Alassa-Pano Mandilaris (Cyprus - Kouris Valley)
First things first: understanding the nature of the raw material(s) and their source(s)
Jacobs, Ariane; Makarona, Christina; Nys, Karin; Claeys, Philippe

Published in:
The Transmission of Technical Knowledge in the Production of Ancient Mediterranean Pottery

Publication date:
2015

Citation for published version (APA):
Walter Gauss – Gudrun Klebinder-Gauss – Constance von Rüden (eds.)

THE TRANSMISSION OF TECHNICAL KNOWLEDGE IN THE PRODUCTION OF ANCIENT MEDITERRANEAN POTTERY

Proceedings of the International Conference at the Austrian Archaeological Institute at Athens
23rd–25th November 2012

Österreichisches Archäologisches Institut
Sonderschriften Band 54
Das Österreichische Archäologische Institut ist eine Forschungseinrichtung des Bundesministeriums für Wissenschaft und Forschung

Umschlagbild: Töpfer auf Siphnos (Foto K.-V. von Eickstedt)

Bibliografische Information der Deutschen Bibliothek
Die Deutsche Bibliothek verzeichnet diese Publikation in der Deutschen Nationalbibliografie; detaillierte bibliografische Daten sind im Internet über <http://dnb.ddb.de> abrufbar.

Bibliographic information published by Die Deutsche Bibliothek
Die Deutsche Bibliothek lists this publication in the Deutsche Nationalbibliografie; detailed bibliographic data is available in the Internet at <http://dnb.ddb.de>

Alle Rechte vorbehalten
ISSN 1998-8931
ISBN 978-3-900305-78-9
Copyright © 2015 by Österreichisches Archäologisches Institut Wien
Redaktion: Jennifer Palinkas, Eva Diana Breitfeld-von Eickstedt, Barbara Beck-Brandt
Umschlaggestaltung: Büro Pani; Andrea Sulzgruber
Satz und Layout: Andrea Sulzgruber
Gesamtherstellung: Holzhausen Druck GmbH
# CONTENT

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Introduction</td>
<td>7</td>
</tr>
<tr>
<td>Walter Gauß – Gudrun Klebinder-Gauß – Constance von Rüden</td>
<td></td>
</tr>
<tr>
<td>Skill And Learning Networks</td>
<td>17</td>
</tr>
<tr>
<td>Ina Berg</td>
<td></td>
</tr>
<tr>
<td>Approaching Ancient Techniques. From Technology to Bodily Learning and Skill</td>
<td>35</td>
</tr>
<tr>
<td>Constance von Rüden</td>
<td></td>
</tr>
<tr>
<td>Making Pots in a Transcultural Perspective: The Impact of Moving Potters on the Transmission of Technical Knowledge</td>
<td>51</td>
</tr>
<tr>
<td>In the Footsteps of the Philistine Potters. Tracking the Dissemination of Technical Knowledge in the Production of Twelfth Century B.C. Aegean-Style Pottery to the Coastal Southern Levant</td>
<td></td>
</tr>
<tr>
<td>Ann E. Killebrew</td>
<td>63</td>
</tr>
<tr>
<td>Mobility in the Bronze Age Aegean: The Case of Aeginetan Potters</td>
<td></td>
</tr>
<tr>
<td>Bartłomiej Lis – Štěpán Rückl – Maria Choleva</td>
<td>77</td>
</tr>
<tr>
<td>An Aeginetan Potters’ Workshop in Athens?</td>
<td></td>
</tr>
<tr>
<td>Gudrun Klebinder-Gauß – Sara Strack</td>
<td>97</td>
</tr>
<tr>
<td>Winners, Losers, and Survivors of Roman Imperialism. A Case Study from the Northern Peloponnese</td>
<td></td>
</tr>
<tr>
<td>Conor P. Trainor – Peter J. Stone</td>
<td>115</td>
</tr>
<tr>
<td>The Italo-Mycenaean Connection. Some Considerations on the Technological Transfer in the Field of Pottery Production</td>
<td></td>
</tr>
<tr>
<td>Elisabetta Borgna – Sara T. Levi</td>
<td>139</td>
</tr>
<tr>
<td>Technological Innovations in Pottery. Examples from Celtic ‘Princely’ Sites (6th to 5th Century B.C.) in Continental Europe</td>
<td></td>
</tr>
<tr>
<td>Ines Balzer</td>
<td></td>
</tr>
<tr>
<td>Technical Change in Social Context</td>
<td>165</td>
</tr>
<tr>
<td>The Spreading of the Potter’s Wheel in the Ancient Mediterranean. A Social Context-Dependent Phenomenon</td>
<td></td>
</tr>
<tr>
<td>Valentine Roux – Caroline Jeffra</td>
<td>183</td>
</tr>
<tr>
<td>Pottery Production during the Third and Second Millennium B.C. in Western Syria. The Development of Ceramic Technology as a Result of the Rise of Qatna as a Regional Capital</td>
<td></td>
</tr>
<tr>
<td>Marco Iamoni</td>
<td></td>
</tr>
</tbody>
</table>
Ceramic Technology in Rapid Transition. The Evidence from Settlement Deposits of the Shaft Grave Era at Tsoungiza (Corinthia) .......................................................... 207
Jeremy B. Rutter

Some Reflections on Ceramic Technology Transfer at Bronze Age Kastri on Kythera, Kolonna on Aegina, and Lerna in the Argolid .................................................. 225
Michael Lindblom – Walter Gauß – Evangelia Kiriatzi

Wheelmade Pottery and Socioeconomic Changes in Indigenous Mediterranean Gaul Societies during the Early Iron Age .................................................. 239
Anne-Marie Curé

Between Transfer and Interaction: Phoenician Pottery Technology on the Iberian Peninsula .......................................................... 257
Dirk Paul Mielke

TECHNICAL CHOICES AS SOCIAL CHOICES

Roads, Markets, Migrants. The Historical Trajectory of a Male Hausa Pottery Tradition in Southern Niger .......................................................... 277
Olivier Gosselain

Production and Ceramic Technology at the Late Bronze Age Site of Alassa-Pano Mandilaris (Cyprus-Kouris Valley). First Things First: Understanding the Nature of the Raw Material(s) and Other Source(s) .......................................................... 297
Ariane Jacobs – Christina Makarona – Karin Nys – Philippe Claeys

The Production and Distribution of Early Greek-Style Cooking Wares in Areas of Cultural Contact: The Case of Southern Italy and Sicily .......................... 311
Alessandro Quercia

THE ART OF FIRING: KILN TECHNOLOGY AND FIRING PRACTISE

Kiln Construction and Use in Greece. Communicating Technical Knowledge ............... 333
Ian Whitbread – David Dawson

A Closer Look at Updraft Pottery Kiln Constructions Based on Middle Helladic to Iron Age Examples in the Aegean .......................................................... 351
Susanne Prillwitz – Anno Hein

Addresses of Contributors .......................................................... 367
PRODUCTION AND CERAMIC TECHNOLOGY AT THE LATE BRONZE AGE SITE OF ALASSA-PANO MANDILARIS (CYPRUS-KOURIS VALLEY)

FIRST THINGS FIRST: UNDERSTANDING THE NATURE OF THE RAW MATERIAL(S) AND THEIR SOURCE(S)

ABSTRACT
A number of studies have focused on Plain Ware ceramics from Alassa-Pano Mandilaris, a site dating from Late Cypriot (LC) IIC to LC IIIA, and have especially considered their wide fabric variation, with six macroscopic types and eight petrographic fabric groups identified. More samples have been examined here (Black Slip, Coarse Cooking, and White Painted Wheelmade III) in order to characterize production and ceramic technology. A total of twelve petrographic fabric groups were identified and the combination of petrography with lead (Pb) isotope analysis suggested that most could have been made with local raw materials. New preliminary strontium (Sr) isotopic results identify two distinct groups that explain the nature and source(s) of the raw materials in more detail. This result is crucial for understanding local ceramic technology because it targets the very first steps of the operational chain: the selection and procurement of raw materials, and their sources. This paper will investigate: a) to what degree the local environment (including natural variability and/or the use of different clay sources) played a role in the distinction of the twelve fabric groups and b) whether the new grouping corresponds with distinct productions or ceramic traditions.

INTRODUCTION
Local and regional variations of coarse wares, such as Plain Wares and Coarse Cooking pots, have recently begun to receive more attention. Besides the exchange and trade of copper and valuable objects, utilitarian goods are indeed an important category: their production and circulation provides information about settlement systems, interaction(s) between sites, and particular socioeconomic and political questions.

The local pottery from Alassa-Pano Mandilaris, located in the Kouris Valley, is an excellent case study because the ceramics offer a view from a settlement close to the important administrative seat at Alassa-Paliotaverna located 500 m to the north. This type of center or urban site usually has a distinct socioeconomic administration; the three ashlar buildings with store-rooms indeed suggest that an elite oversaw the collection and storage of agricultural products.

---

3 In this paper we use the term White Painted Wheelmade III (hereafter WPWM III) to designate fine ware wheel-made vessels with matt-painted decoration of the Aegean/Mycenaean type as well as the group of locally-made examples that differ from the Greek mainland (e.g., Kling 1989; Steel 1998, 286).
4 Renson et al. 2013.
6 See also Webb 2002, 132.
7 Negbi 2005.
8 Hadjisavvas 2000, 393–396.
for staple finance and ceremonial feasting\(^9\). Therefore, we have examined the Alassa pottery according to the different steps of the \textit{chaîne opératoire}: the raw materials and their preparation, and the forming, firing, and finishing methods\(^10\). In this study, we will characterize local and regional techniques in the production of domestic pottery. By examining the local production and ceramic technology, we wish to understand the social organization at the site and define whether pottery production was an administered activity in a centralized or decentralized organization\(^11\). A detailed analysis of Plain Ware pottery, which represents the bulk of the material, has demonstrated that the observed paste variability can partly be explained by the use of distinct technologies: for example, the use of sand temper for large-sized vessels that correspond with Plain Ware Type I vessels (see tab. 1), the selection of noncalcareous clays for the production of Plain White Wheelmade II\(^12\) (hereafter PWWM II) vessels, and the use of mudstone temper in some other vessels of Type V\(^13\). However, the examination of more samples, such as Coarse Cooking, Black Slip, and WPWM III, has increased the number of fabric groups to twelve, making it necessary to consider the raw materials and their sources in more detail. Our aim is to understand whether we can relate the large number of fabric groups to several workshops using different clay sources, or if these fabrics represent natural variability in the raw material sources\(^14\). This question deserves further attention because it has been argued that »potters are even aware of variations in natural deposits and will therefore select that portion having the most appropriate properties and the least variation«\(^15\). In this regard, we must consider whether control over resources played a role in the preference or accessibility of clays, or if other social or technological factors affected paste variability as described by D. E. Arnold\(^16\). He defined specific environmental and procurement variables to explain paste variability, which are related to particular technological and social factors, such as territorial matters (control over resources and restricted access) and ceramic-inherent properties (intended use, shape, and size of vessels). We will consider some of these aspects in this paper\(^17\).

---

\(^9\) Keswani 2009, 114.
\(^10\) Jacobs 2009.
\(^11\) We will elaborate on this particular research question and provide a model of pottery production, distribution, and consumption in a Ph. D. thesis in preparation by Ariane Jacobs.
\(^12\) P. Åström defined canonical PWWM II as a technologically superior ware of the LC IIC–LC IIIA period. The Swedish Cyprus Excavation’s classification for Plain Ware pottery is still in use today, although it is somewhat outdated: Plain White Handmade, Plain White Wheelmade I and II, Pithos, and Red Wheelmade (Åström 1972, 225–266).
\(^13\) Jacobs 2009; Jacobs – Borgers (forthcoming).
\(^14\) Another possible explanation for twelve distinct fabrics might be that there is a shift over time and that fabrics correspond with particular periods or phases. The ceramics under study have in general been dated to the LC IIC and LC IIIA periods, but most belong to the LC IIIA phase (Hadjisavvas 1991, 177). Only with a chronological or stratigraphical refinement of the assemblage can definite conclusions be made. Consequently, it is necessary to take into account that chronological factors might have played a role (see also \textit{infra}).
\(^15\) Rye 1981, 16 f.
\(^16\) Arnold 2000.
\(^17\) Arnold 2000, but see also Tite 1999, 215 f.
<table>
<thead>
<tr>
<th>Sample</th>
<th>Ware</th>
<th>Type</th>
<th>Fabric</th>
<th>Description</th>
<th>Comments</th>
<th>Provenance</th>
</tr>
</thead>
<tbody>
<tr>
<td>AL 17</td>
<td>Plain</td>
<td>I</td>
<td>A</td>
<td>Calcareaeous, coarse, sand temper</td>
<td>Chert bearing</td>
<td>Local&lt;5 km</td>
</tr>
<tr>
<td>AL 13</td>
<td>WPWM III</td>
<td>II</td>
<td>C</td>
<td>Calcareaeous</td>
<td></td>
<td>Local&lt;5 km</td>
</tr>
<tr>
<td>AL 2</td>
<td>Plain</td>
<td>II</td>
<td>D</td>
<td>Calcareaeous, fine</td>
<td></td>
<td>Local&lt;5 km</td>
</tr>
<tr>
<td>AL 22</td>
<td>Plain</td>
<td>IV</td>
<td>D</td>
<td>Calcareaeous, fine</td>
<td></td>
<td>Local&lt;5 km</td>
</tr>
<tr>
<td>AL 30</td>
<td>Plain</td>
<td>IV</td>
<td>D</td>
<td>Calcareaeous, fine</td>
<td></td>
<td>Local&lt;5 km</td>
</tr>
<tr>
<td>AL 31</td>
<td>PWWM II</td>
<td>III</td>
<td>F</td>
<td>Noncalcareaeous, mudstone temper</td>
<td>Chert bearing, Diffused calcite</td>
<td>Local&lt;10 km</td>
</tr>
<tr>
<td>AL 20</td>
<td>Black Slip</td>
<td>II</td>
<td>G</td>
<td>Calcareaeous</td>
<td></td>
<td>Local&lt;5 km</td>
</tr>
<tr>
<td>AL 32</td>
<td>Plain</td>
<td>II</td>
<td>N</td>
<td>Noncalcareaeous</td>
<td>Coarse micrite inclusions</td>
<td>Local&lt;10 km</td>
</tr>
<tr>
<td>AL 23</td>
<td>PWWM II</td>
<td>III</td>
<td>N</td>
<td>Noncalcareaeous</td>
<td>Significant micrite inclusions</td>
<td>Local&lt;10 km</td>
</tr>
<tr>
<td>AL 1</td>
<td>Plain</td>
<td>IV</td>
<td>P</td>
<td>Calcareaeous, organic temper</td>
<td></td>
<td>Local&lt;5 km</td>
</tr>
<tr>
<td>AL 21</td>
<td>Plain</td>
<td>I</td>
<td>A</td>
<td>Calcareaeous, coarse, sand temper</td>
<td>Chert bearing</td>
<td>Local&lt;10 km</td>
</tr>
<tr>
<td>AL 33</td>
<td>Plain</td>
<td>I</td>
<td>B</td>
<td>Noncalcareaeous, coarse, sand temper</td>
<td></td>
<td>Local&lt;10 km</td>
</tr>
<tr>
<td>AL 11</td>
<td>Coarse Cooking</td>
<td>-</td>
<td>L</td>
<td>Noncalcareaeous</td>
<td>Chert bearing</td>
<td>Local&lt;10 km</td>
</tr>
<tr>
<td>AL 12</td>
<td>Coarse Cooking</td>
<td>-</td>
<td>L</td>
<td>Noncalcareaeous</td>
<td>Chert bearing</td>
<td>Local&lt;10 km</td>
</tr>
<tr>
<td>AL 15</td>
<td>WPWM III</td>
<td>II</td>
<td>N</td>
<td>Noncalcareaeous</td>
<td></td>
<td>Local&lt;10 km</td>
</tr>
<tr>
<td>AL 23</td>
<td>Plain</td>
<td>II</td>
<td>N</td>
<td>Noncalcareaeous</td>
<td></td>
<td>Local&lt;10 km</td>
</tr>
<tr>
<td>AL 28</td>
<td>PWWM II</td>
<td>III</td>
<td>N¹</td>
<td>Noncalcareaeous</td>
<td></td>
<td>Local&lt;10 km</td>
</tr>
<tr>
<td>AL 26</td>
<td>PWWM II</td>
<td>III</td>
<td>O</td>
<td>Noncalcareaeous</td>
<td></td>
<td>Local&lt;10 km</td>
</tr>
<tr>
<td>AL 18</td>
<td>Plain</td>
<td>V</td>
<td>E</td>
<td>Calcareaeous, mudstone temper</td>
<td>Chert bearing</td>
<td>Regional&lt;25 km</td>
</tr>
<tr>
<td>AL 19</td>
<td>Plain</td>
<td>V</td>
<td>E</td>
<td>Calcareaeous, mudstone temper</td>
<td>Chert bearing</td>
<td>Local&lt;10 km</td>
</tr>
<tr>
<td>AL 14</td>
<td>WPWM III</td>
<td>II</td>
<td>G</td>
<td>Calcareaeous</td>
<td></td>
<td>Island (?)</td>
</tr>
<tr>
<td>AL 16</td>
<td>WPWM III</td>
<td>Very fine</td>
<td>I</td>
<td>Calcareaeous, very fine</td>
<td></td>
<td>Island (?)</td>
</tr>
<tr>
<td>AL 35</td>
<td>WPWM III</td>
<td>Very fine</td>
<td>I</td>
<td>Calcareaeous, very fine</td>
<td></td>
<td>Island (?)</td>
</tr>
</tbody>
</table>
DATASET

The Plain Wares under discussion have been extensively described elsewhere\(^{18}\) and therefore it is sufficient to refer to the sample numbers and the associated shapes and types (I–V)\(^{19}\). However, the petrographic fabric groups have been slightly altered to include the new samples and to make larger fabric groups that focus on the main components (see tab. 1, clay matrix, recipe, and comments)\(^{20}\). We briefly describe these new samples and their fabric groups as well as the provenance of the samples\(^{21}\) before presenting the new combined grouping (tab. 1; see Isotopic Grouping below).

CLAY RECIPES AND PETROGRAPHIC FABRICS

The petrographic fabric grouping is based on similarities in clay matrix, inclusions, and voids\(^{22}\). From this grouping it is clear that large Plain Ware vessels of Type I have been sand-tempered and were made from both calcareous and noncalcareous clays (Fabric A and B). Likewise, the medium- and small-sized open and closed shapes of Type II were made from untempered calcareous and noncalcareous clays (Fabric D and N). Type III consists of PWWM II vessels exclusively made from fine noncalcareous clays (Fabric F, N, and O). Type IV was macroscopically categorized as a separate category but only one sample (AL 7; Fabric P) has evidence for organic temper whereas the other samples were grouped with Type II samples (Fabric D). Finally, Type V vessels with mudstone temper are grouped together in Fabric E\(^{23}\). Two Coarse Cooking samples come from cooking jugs with a globular body and V-shaped neck, rounded rim, rounded base, and one vertical handle. This very common type of cooking pot is also attested at Kalavassos-Ayios Dhimitrios, Hala Sultan Tekke, and Enkomi\(^{24}\). Both samples were grouped in Fabric L, which is a micaceous clay full of coarse igneous fragments. The five WPWM III samples refer to vessels belonging to the major group of fine and decorated ceramics at Alassa. The fine fabric samples (AL 16, 35) form a distinct Fabric I with a very fine calcareous matrix unlike other Alassa samples. Three other WPWM III samples (AL 13–15) were grouped under three fabric groups. Fabric C (AL 13) and Fabric G (AL 14) both have a calcareous clay matrix but the latter also includes a Black Slip sample. The third fabric, Fabric N (AL 15), has a noncalcareous clay matrix and illustrates an overlap with other Plain Ware and PWWM II samples (AL 23, 28, 32). Finally, one Black Slip\(^{25}\) sample (AL 20) was examined and grouped in Fabric G along with other Plain Ware and WPWM III samples. This example indicates that similar raw materials were used to produce different pottery wares and vessel types\(^{26}\), which suggests a high degree of interaction between the potters and/or workshops.

---

\(^{18}\) Jacobs 2009; Jacobs – Borgers (forthcoming).

\(^{19}\) For further reading on the types, see Jacobs 2009. Type VI is not included in this paper because it is used to group random fragments from rare fabrics, mostly red-firing fabrics.

\(^{20}\) Ariane Jacobs’s Ph. D. thesis will present a description of all the samples and petrographic fabric groups.

\(^{21}\) Renson et al. 2013.


\(^{23}\) See also Jacobs – Borgers (forthcoming).

\(^{24}\) Spagnoli 2010, 105 tab. 5.1.

\(^{25}\) Black/Red Slip wares are less often found at the site and refer to jugs with the handle attached below the rim. The fabric is comparable with Plain Ware fabric, although it is finer and well mixed and characterized by many black inclusions. The fabric is finished with a matt dark brown, black, or occasionally red slip, which flakes in a distinct way.

\(^{26}\) Jones 1986, 343.
LOCAL PRODUCTION AT Alassa

There is no direct evidence of pottery production at Alassa, but the presence of misfired sherds and local traits in the production of WPWM III vessels (e.g., strainer jugs) clearly demonstrate that pottery production was practiced at or near the site. Moreover, a comparison of geological samples collected at Alassa with the ceramic samples under discussion indicates that most of them are compatible with the Pakhna formations and the nearby Troodos Ophiliote, based on Pb isotope composition analysis. The combination of petrographic, Pb isotope, and the new Sr isotope analyses allows further interpretation of these clay sources and the high number of local domestic fabrics in connection with specific strategies, such as the selection or procurement of the raw materials.

METHODOLOGY

Archaeometry has always aspired to link ceramic products with raw materials. To this end, comparisons of the elemental compositions of sherds and clays have been used, but this approach is considered inconclusive due to the very nature of the materials being compared (postburial alterations of ceramics, variability of clay sources). Petrography has been more recently employed to overcome these issues, but this technique too entails risks (subjectivity of the researcher, non-distinctive lithologies in sherds or clays that lead to generic conclusions). Recently, therefore, more precise geochemical techniques like Pb isotopes have been considered.

The Pb isotopic signature of Cyprus was proven to be distinctive enough to verify local production of the Alassa assemblage. However, the different formations themselves were not well differentiated, allowing only for a vague hypothesis about clay sources. The combination of Pb with a second isotopic system could offer an extra layer of resolution. Since Pb is mostly related to the silicate fraction of a rock, sediment, or ceramic, the second isotopic system should represent the carbonate fraction as well. Consequently, the Sr system was chosen as the new isotopic dimension (fig. 1).

It should also be noted that isotopes not only track geographical provenance, but also (and most importantly) trace geological processes. Hence, they should not be treated as elemental

28 See also Renson et al. (in press); Hadjisavvas also proposed that the fine WPWM III variants were imported from other traditional LC centers (Hadjisavvas 1991, 179).
29 Renson et al. 2013.
30 Renson et al. 2013.
2 a) Combined isotopic plot of $^{206}\text{Pb}/^{204}\text{Pb} - ^{87}\text{Sr}/^{86}\text{Sr}$ ratios for the sherds of the Alassa assemblage. The data points have been color-coded according to petrographic fabric. b) Combined isotopic plot of $^{206}\text{Pb}/^{204}\text{Pb} - ^{87}\text{Sr}/^{86}\text{Sr}$ ratios for the Alassa sherds and locally available materials (© A. Jacobs – Ch. Makarona – K. Nys – Ph. Claeys)
data – using statistical methods to create control clusters or fields – but should be more diligently examined to reveal mixes, weathering, and sedimentological processes (for example, considering the isotopic composition of alluvial sediments along the course of a river and its surrounding lithology).

The isotopic ratios ($^{87}\text{Sr}/^{86}\text{Sr}$, $^{206}\text{Pb}/^{204}\text{Pb}$, $^{207}\text{Pb}/^{204}\text{Pb}$, and $^{208}\text{Pb}/^{204}\text{Pb}$) were measured using a Multi-Collector-Inductively Coupled Plasma-Mass Spectrometer (MC-ICP-MS) for better precision. The procedure is described elsewhere$^{32}$; the data regarding the Pb isotopic compositions for this study were obtained from the relevant literature$^{33}$. The Sr isotopic measurements for the raw material formations have already been published$^{34}$, while the data concerning the sherds will be included in a forthcoming publication$^{35}$.

**ISOTOPIC GROUPING**

First, we would like to emphasize that we present here only preliminary results that are part of ongoing research on the Kouris Valley environment. The current examination of ceramic samples from Episkopi-Bamboulia, located 10 km south of Alassa will lead to a more in-depth analysis of the river valley context.

The isotopic signatures of the 24 sherds from the Alassa assemblage are compared in table 1 (see isotope grouping) and figure 2 a.

The $^{87}\text{Sr}/^{86}\text{Sr}$ isotopic ratio is reported versus the previous Pb ratios of $^{206}\text{Pb}/^{204}\text{Pb}$. We use the $^{206}\text{Pb}/^{204}\text{Pb}$ values, but all three Pb isotopic dimensions were investigated and results accord with those presented here. Comparison of the isotopic compositions of the sherds yields some interesting results. Two groups clearly stand out: Group A, made up of 11 sherds, 8 of which belong to various calcareous fabrics, and Group B, made up of 8 sherds, 7 of which belong to noncalcareous fabrics. Five sherds were previously identified as outliers$^{36}$ and Sr isotopes confirm this result for three samples (AL 16, 18, 35); this result will be discussed in detail below.

Group A, which can be referred to as the calcareous group, contains 3 sherds that were assigned to noncalcareous petrographic fabrics (tab. 1: displaced AL 31, 32, 25). However, a close inspection of the petrographic descriptions can explain the higher Sr isotopic values of the sherds. All displaced sherds exhibit higher micritic calcite content than the rest of the corresponding fabrics$^{37}$: AL 31 contained diffused calcite, while AL 32 and AL 25 contained micrite inclusions$^{38}$. In a mixture of two materials with different Sr content and isotopic compositions, the Sr signature of the end product will be shifted toward the more Sr-rich component$^{39}$. Micritic calcite has a much higher Sr concentration than silicates or clay minerals; therefore, it can shift the signature of the noncalcareous sherds to higher values$^{40}$. Noncalcareous Group B also contains one misplaced sherd, AL 21, which belongs to calcareous Fabric A. This fabric is coarse and characterized by a wide assortment of moderately- to poorly-sorted inclusions (schists, epidote, zoisite, serpentine, micrite, chert, and microfossils). Thus, it is highly likely that the sam-

---

$^{32}$ Renson et al. 2011; Makarona et al. 2012.
$^{33}$ Renson et al. 2013.
$^{34}$ Makarona et al. 2012.
$^{35}$ In this paper, we concentrate solely on the results concerning Alassa-Pano Mandilaris, while our future research will focus on the broader geological and LBA landscape of Cyprus, when full isotopic measurement results will be provided.
$^{36}$ Renson et al. 2013.
$^{37}$ A calcareous clay is defined as having at least 15 % CaO and a noncalcareous clay is defined as having between 0–2 % CaO (Maniatis 2009, 6), which means that noncalcareous clays can contain some micritic or calcite inclusions, as in the above-mentioned specimens.
$^{38}$ In tab. 1, we provide only a very brief description of the clay matrix and coarse inclusions; Jacobs – Borgers (forthcoming), provides a more detailed mineralogical description and it is also the subject of further examination.
$^{39}$ Faure – Mensing 2005.
$^{40}$ Faure – Mensing 2005, 113–143 tab. 1.
ple fraction chosen for analysis was not representative of the clay matrix; rather, it contained a significant amount of inclusions with lower Sr isotopic ratios, as is expected for igneous rocks. The above grouping shows that it is reasonable to make a distinction between two different isotopic groups that correspond to distinct clay sources. The two sources exhibit some internal variability, which can be related to the natural variability of the raw material sources and preparation methods (sand and organic temper). At the same time, however, the two groups are physically separated from each other (at a distance much higher than analytical error), indicating the exploitation of two distinct clay sources around the site. In order to investigate the nature of these two sources, it is necessary to examine not only the sherds, but also the available raw materials.

**GEOLOGICAL INVESTIGATION**

The local geology of Alassa is shown in figure 1 b; geological samples were collected in the Pakhna formation and the river sediments of the Kouris and Limnatis rivers. The complicated tapestry of igneous formations in the Troodos Ophiolite is shown here in simplified form. Before Troodos started rising above the surface of the sea, a silicate-rich cover developed on parts of the submerged lavas. The silica turned into bedded chert, and the weathering of the lavas created bentonitic clays, which are collectively known as the Perapedhi formation. The Moni melange also includes bentonitic clays, mixed with an assortment of lithologies (siliceous sandstones, mudstones, and serpentinites). Sedimentation of carbonates began with the Lefkara formation, made up of zones of intermixed marls and chalks. The lower horizons of Lefkara are characterized by the presence of chert nodules. The Pakhna formation follows; it contains, once again, marls, chalks, and calcareous sandstones. Finally, the weathering and mixing of all these components leads to the gravels, sands, and clays of the Pleistocene terrace deposits and the Holocene alluvial covers.

The isotopic fields of the local formations discussed above are compared to the signatures of the sherds in figure 2 b. It must be kept in mind that in the creation of a clay bed from those raw materials, two different types of processes will take place: the chemical and physical weathering of the parent rock(s) and the mixing of different types of lithologies. Both processes will influence the isotopic ratios of the resulting clay materials. Identifying these effects can help us identify the nature of a clay source.

Chemical weathering will result in the loss of radiogenic isotopes ($^{206}$Pb and $^{87}$Sr), leading to lower isotopic ratios. This process is represented by line I in figure 2 b and accounts for the strikingly lower isotopic values of the fresh river sediments compared to their parent materials. Yet, mixing processes cannot be represented by straight lines in this type of diagram. Rather, we must use curves (specifically hyperbolas) with their curvature dependent on the relationship between the Sr and Pb concentrations of the mixing components (end members). Therefore, we have calculated on figure 2 b the hyperbolas corresponding to the mixing of carbonate materials with either igneous materials from the Troodos (line II) or with material from the Perapedhi formation (line III).

The above remarks will help us to explain the nature of the two different clay sources corresponding to Groups A and B. The calcareous source for Group A corresponds to the bulk carbonate isotopic composition of the Lefkara and Pakhna formations. Group B corresponds to a noncalcareous clay with lower Sr and Pb isotopic values. Earlier isotopic studies link the
non-calcareous sherds with either bentonite clays from the Perapedhi formation or weathering products of the Troodos lithologies (gabbrros, intrusive, plutonic or mantle rocks). The addition of the Sr data, however, partly disproves this hypothesis because there is no complete correspondence with either of the proposed sources. Instead, we propose that the source for Group B should be found among noncalcareous alluvial deposits and not necessarily a pure bentonitic or igneous clay outcrop. A strong noncalcareous character in alluvial material could appear in areas of the valley close to the interface of the Troodos and Perapedhi formations, where influence from the marl bedrock would still be minimal.

Another clue for the location of the two clay sources is the nature of the inclusions present in the different fabric groups. Both groups contain igneous inclusions: inclusions in Group A are finer and less frequent, while Group B has coarser and more dominant inclusions. The difference can be attributed to the distances between the two clay sources and the Troodos: coarser inclusions are found closer to the mountain range and finer ones are weathered and transported at lower altitudes. One final consideration is the presence of chert inclusions in both groups, namely in Fabrics A, B, and L. On closer inspection, it is clear that chert is related to sand-tempered and coarser fabrics. The bedded cherts of the Perapedhi formation would be more resistant to weathering; the source of the chert inclusions is more likely to be the small nodules interlaid in the Lefkara chalks.

CLAY SOURCES

It can be argued that the clay source for Group A should be located relatively close to the site of Alassa. Even though the Pakhna formation is more dominant, the use of cherty sands could mean the location is close to the interface between the Pakhna and Lefkara formations, along either the Kouris or Limnatis rivers, about 5 km north of the site. The clay source for Group B should be located at higher altitudes, at the interface between the Troodos, the Perapedhi outcrop, and the Lefkara carbonates, 10 km north of the site along the Kouris river. Thus, access to the clay sources differs. The first source (Group A) is situated close to the site and was used for the production of various pottery wares including Plain Wares of Types I, II, and IV, as well as WPWM III and Black Slip wares. The majority of the domestic pottery wares were thus made with raw materials from this first source and the internal heterogeneity in Group A, interpreted as natural variability in raw material sources, might be related to the easy procurement and subsequent different preparations of these materials by one or more workshops.

The second source (Group B) is located much further from the site in terrain more rugged than the more easily accessible calcareous source. The raw materials corresponding with this source were used for Plain Wares of Types I and II, as well as WPWM III. However, Plain Wares of Type III (or PWWM II) and Coarse Cooking pots were exclusively made with materials from the second source, which suggests a particular preference for the production of these wares. Indeed, PWWM II and Coarse Cooking pots represent vessels with specific properties. PWWM II belongs to a category of fine Plain Ware vessels, with aesthetic features such as a pale slip and decorated ridges or grooves in the neck or base. PWWM II was used for making a limited number of consumption vessels including bowls, jugs, and kraters, which are very comparable with PWWM II pottery from other sites. Cooking pots are more common but require care in manufacturing: they need to withstand a number of stresses, including thermal stress and rapid changes in temperature, and they need to exhibit a certain degree of strength. For both these classes of vessel, it can be argued that they represent a controlled production, perhaps involving specialists who accessed more restricted sources. This argument, however,

---

47 Jacobs 2009, 93, 98 f.
cannot apply to the production of Plain Ware Type I and II vessels made with materials from this second clay source: perhaps they are products of a competing workshop.

OUTLIERS

On a final note, mention should be made of the group of outlier sherds. The different displacements of the mudstone-tempered sherds belonging to Plain Type V, AL 18, and AL 19 have already been attributed to different sources of mudstone. Indeed, our analysis confirms that the mudstone used in sample AL 19 is related to the Perapedhi formation. The higher Sr isotopic values for sherd AL 18 accord with measurements for the Mamonia and Kannaviou formations (not plotted here for reasons of clarity). Because the Moni melange occurs where the Kannaviou formation rests at the south of Troodos, the correspondence of sherd AL 18 with the Moni isotopic field is to be expected. Sherds AL 16 and AL 35 also plot in the direction of the Mamonia Terrane signature and thus could be considered imported material from the Palaepaphos area. Finally, sherd AL 14 was already categorized as an outlier because of its highly altered Pb isotopic composition.

UNDERSTANDING PASTE VARIABILITY AT ALASSA-PANO MANDILARIS

Chronological Factors

Despite the absence of a detailed chronological classification for the ceramic assemblage, we propose that the use of the two main clay sources is not related to a chronological factor, such as a change in resource use over time. We have observed that PWWM II and Coarse Cooking pots were made with raw materials from the second source and both these vessel types were used during the entire period. Thus, we believe that both sources were used during the entire period and that the use of raw materials from the more restricted source (Group B) is part of a ceramic tradition of producing PWWM II and Coarse Cooking vessels in noncalcareous clays. Only an examination of a larger set of samples and material from other sites can shed more light on this particular matter. However, we do not exclude the possibility that the natural variability within each source might be due to temporal factors, but at this time we cannot provide answers to this question.

Geological Variability

The results from the isotopic grouping demonstrate that isotopic compositions in combination with petrographic fabric groups can clarify paste variability by the identification here of two main clay sources. This approach also accounts for the associated natural variability within these sources, partly enhanced by specific preparation techniques, such as the sand and mudstone temper in Plain Ware Types I and V respectively. This combined methodology has helped identify two distinct production units at Alassa: both are linked to the local geology but exhibit unique characteristics, and they are well separated. These results can explain the local scale of Alassa ceramic production, but can be even more valuable when compared to similar assemblages from different sites on Cyprus. Moreover, it has become clear that nonlocal types of domestic pottery were imported to Alassa, such as some of the Plain Ware Type V vessels with mudstone temper and fine WPWM III vessels. Further characterization of the Kouris Valley could identify the presence of geological and/or geographic subsystems and their relation to community units.

49 Renson et al. (in press).
50 Renson et al. (in press).
51 See above note 14.
52 Arnold 2000, 333.
Technical Choices

At the outset of this paper we sought to understand the relevance of the new grouping in relation to the clay sources and to translate these results into specific strategies or technological/technical choices, such as the procurement and selection of raw materials. In fact, this goal is difficult because a number of factors play a role, such as chronological and geological variables. Nevertheless, the identification of two main types of clay sources has shown that the first source included a large range of easily accessible calcareous clays spread over its area that were available to the local potters. The potters used these clays to produce multiple domestic and consumption wares, including Plain Wares, Black Slip, and WPWM III wares. The wares used similar raw materials and had similarities of forming and firing\(^{53}\), suggesting that they were produced in sets through community practices that shared similar technological traditions\(^{54}\). A few Plain Ware Types stand out, such as Type I with sand temper (Fabric A) and Type IV subtype with organic temper (Fabric P), reflecting specific productions that require further investigation into their production sequence as well as a quantitative approach to relate them to standardized, specialized, or homologous productions.

The second source seems to be more restricted because it is located at a distance of 10 km and contains noncalcareous clays or bentonitic clays. The procurement of these clays required more effort and energy, especially if we presume that pottery production took place at or very near the settlement (see »Local Production at Alassa« above). In the case of the cooking pots, the use of noncalcareous and micaceous clays full of igneous rocks is part of an early tradition of using such clays for making a well-performing cooking pot\(^{55}\). Similarly, bentonitic clays allow vessels with thin walls, such as in the production of PWWM II vessels\(^{56}\). We therefore propose that noncalcareous clays were selected to make these particular types of vessels, intended for a specific use and to satisfy a specific market. The fact that vessel types similar to the products from the first clay source were also produced with these noncalcareous materials demonstrates the existence of potters or workshop(s) following different traditions.

However, it is difficult to speculate exactly how both these sources operated in the LC period; therefore, we will continue this discussion when the complete study of local ceramic technology has been completed. In addition, determining the scale of production, distribution, and consumption patterns will also help in understanding these particular matters.

CONCLUSION

To conclude, the preliminary results presented in this paper, although part of ongoing research, open a discussion of ceramic technology of domestic goods by focusing on the first step in the production sequence: understanding the nature of the raw materials and their sources in a specific region. More remains to be added to this discussion, but, as mentioned in the title, we first want to establish the first things – namely, a better understanding of the local environment of Alassa. The results of the combined petrographic and isotope analysis have shown that the Allassa potters used raw materials from two main sources demonstrating some internal variability as a consequence of the natural environment and possible temporal factors. Second, each source was most probably exploited by a different group of potters, each working with different types of clay(s); in some cases, the production was generated by the demand for a specific product (PWWM II and Coarse Cooking pots). We need to consider other technological choices – such

\(^{53}\) The characterization of the technological choices related to the preparation (sand, organic, and mudstone temper), but also the forming, firing, and finishing, is the subject of further analysis. Through personal examination, we have observed that all of the wares and vessels occur in both hand- and wheelmade versions and were fired in a similar way.

\(^{54}\) See also Crewe 2007, 129; Crewe – Knappett 2012, 178.

\(^{55}\) Dikomitou – Martinón-Torres 2012.

\(^{56}\) Vaughan 1991, 351.
as the forming, firing, and finishing practices—before we can fully understand local ceramic technology and the organization of production. However, the preliminary results presented here have given insight into an LC IIC–LC IIIA production community by characterizing the local environment and the clay sources. This fingerprint or geological signature provides a useful tool for investigating the economic principles of the production and circulation of utilitarian goods in an effort to deconstruct existing socioeconomic models such as hierarchies, heterarchies, or redistribution models \(^{57}\), and to build instead a case based on domestic pottery.

**ACKNOWLEDGEMENTS**

First, we wish to thank the organizing committee of this conference for creating a welcoming and friendly environment and for giving young scholars, including the first two authors, the opportunity to participate and present results of ongoing research. We also wish to thank Dr. Sophocles Hadjisavvas for granting permission to examine the ceramics from Alassa and publish some preliminary results. The research leading to these results has received funding from the European Union, Seventh Framework Programme (FP7/2007–2013) under grant agreement n°265010. The authors would like to express their gratitude to the personnel of U.L.B. and UGent that assisted in the analytical procedure. Finally, we thank Dr. Virginie Renson for reading preliminary drafts and giving useful feedback.

**BIBLIOGRAPHY**

Crewe 2007 L. Crewe, Early Enkomi. Regionalism, Trade and Society at the Beginning of the Late Bronze Age on Cyprus, BARIntSer 1706 (Oxford 2007).
Crewe 2009 L. Crewe, Regionalism and the First Appearance of Plain White Handmade Ware in the Middle Cypriot Bronze Age, in: Hein 2009, 79–90.

\(^{57}\) A basic tripartite and hierarchical model was first proposed by Catling 1962. This model was subsequently reworked and adjusted by Keswani (as well as e.g., Hadjisavvas 2000; Knapp 2008; Webb 2002) who proposed heterarchical relations (Keswani 1993; Keswani 1996) as well as a possible redistribution model at Kalavassos (Keswani [forthcoming]). Elaboration and variants on these basic models have been extensively discussed by many scholars, such as Knapp (Knapp 2008, 131–153. 391–469).


Keswani 2013  P. Keswani, Olive Production, Storage and Political Economy at Late Bronze Age Kalavasos, Cyprus, in: Jacobs – Cosyns (forthcoming).


Kling (forthcoming)  P. Keswani, Olive Production, Storage and Political Economy at Late Bronze Age Kalavasos, Cyprus, in: Jacobs – Cosyns (forthcoming).


Negbi 2005  O. Negbi, Urbanism on Late Bronze Age Cyprus: LC II in Retrospect, BASOR 337, 2005, 1–45.

Pilides 2000  D. Pilides, Pithoi of the Late Bronze Age in Cyprus. Types from the Major Sites of the Period (Nicosia 2000).


