Investigating Compositional Variability among Early Neolithic Ceramics from Korça Region, Albania

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In this study, Laser-Ablation ICP-MS and other archaeometric methods shed light on the technological and compositional variability of the ceramics from Podgori and Vashtëmi, two Early Neolithic settlements located in the Korça Plateau in Southeast Albania. The results are able to demonstrate clear differences in pottery manufacturing and raw material procurement. In addition, this study provides evidence for the location and chemical composition of the clays used by the Early Neolithic settlers of Vashtëmi. Previous research relied mostly in stylistic similarities and rough typological frequencies to conclude that Vashtëmi and Podgori belong to the same chronological sequence. The study presented here does not support this assumption. Fundamental differences in pottery quality and technology argue for a lack of association between the two settlements, even though the distance between them is less than 10 km. Future research needs to investigate whether this lack of relatedness is chronological or otherwise.

Introduction

The Korça region represents one of Southeast Europe's most important areas for the transition to farming. Its homonymic fertile plateau has been intensively occupied throughout the post-Mesolithic prehistoric periods, and it is regarded as a highly productive agricultural area today as well. The earliest Neolithic sites in Albania are found in this region. It has been argued previously that the early farmers preferentially settled in wetland environments, in areas not occupied by local hunter-gatherers.[1] This is a requirement that this region fulfills very well, as the earliest Neolithic sites in Albania are found here, with the Mesolithic being completely absent.

Due to the lack of resources and a deprivation of international academic cooperation, the Albanian archaeology of the late 20th century never moved beyond mere descriptive accounts and traditional stylistic comparisons. This study attempts to bring another dimension to the archaeological interpretations: the archaeometric investigation of ceramics and their technologies.

In Albanian prehistory, the Early Neolithic has an early phase represented by material culture from two sites in the Korça region – Vashtëmi and Podgori (Fig. 1). An important characteristic of this phase is the overwhelming abundance of monochrome pottery (mainly red-monochrome but also black/grey-monochrome), followed later by painted pottery and impressed pottery.

In a general macroscopic overview, the pottery assemblages from Podgori and Vashtëmi appear similar. For example, the frequencies of the ceramic types and the decorative styles are almost the same. Some visible differences are noted especially in the quality of the white-on-red pottery, where the white paint is smoother and

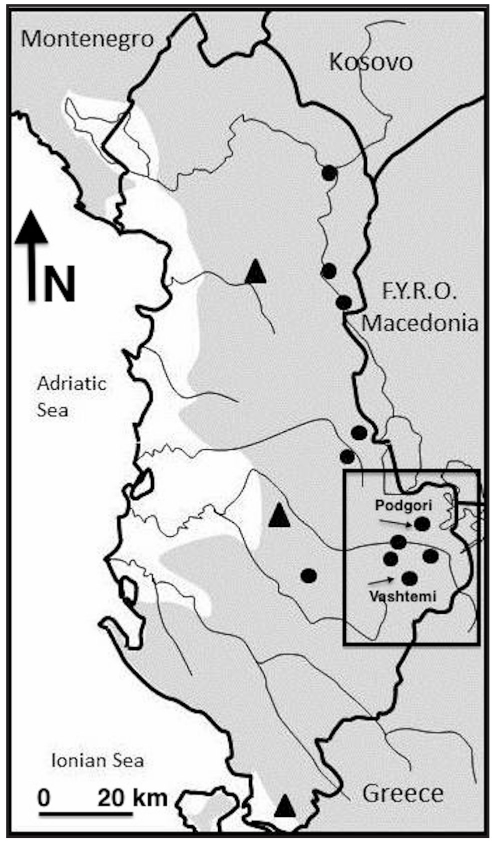

Figure 1: Map of Early Neolithic sites in Albania. Circles represent open-air sites; triangles represent cave sites. The rectangle in the SE, which is enlarged in Figure 2, is the focus of this study.

better-attached to the body of the pot in the Podgori ceramics than in Vashtëmi.[2] There is a need, therefore, to understand if such similarities and differences are indicative aspects of the relationship, or lack thereof, between the two settlements. I intend to explore this relationship by investigating the technological aspects of pottery production at both sites, through archaeometric techniques.

I propose to resolve a few issues that have not been determined by previous methods of stylistic comparison. An archaeometric analysis of the monochrome pottery of Vashtëmi and Podgori will determine the following: (1) the internal variation of monochrome clay composition within each site; (2) the differences in clay compositional variability between the two sites; and (3) the geological distribution of clay sources. The goal is to provide empirical data to make more accurate inferences on the settlement history of the region. The attainment of such information will permit prospective researchers to test hypotheses on the general processes of the Mesolithic-Neolithic transition.

I will be investigating the composition of the pottery clays through an elemental characterization instrument, in this case Laser Ablation Inductively Coupled Plasma Mass Spectrometry (LA-ICP-MS), and I will detect the presence or absence of calcareous materials through the use of an HCl acid test. The LA-ICP-MS data will be analyzed through multivariate statistical methods such as cluster analysis and principal component analysis, which will provide compositional groups and will test for clay sources. In addition, a visual inspection of pottery characteristics will reveal if there are qualitative differences in monochrome pottery technology between the two settlements.

<u>Background</u>

The Korça region consists of a large plateau located in the mountainous eastern part of the country, along the western shores of the lakes Ohrid, Prespa e Madhe and Prespa e Vogël, which are shared with the Republic of Macedonia and Greece. The geological composition of the surrounding mountains is diverse as well. The hills on the western part of the plateau are composed of molasse outcrops, while having serpentine boulders in the southwestern corner.[3] The southeast is dominated by higher elevations consisting of limestone, which serves as the bedrock of the three large lakes mentioned above. The southeast has a mixture of Neogene molasse and sporadic ophiolite outcrops.[4]

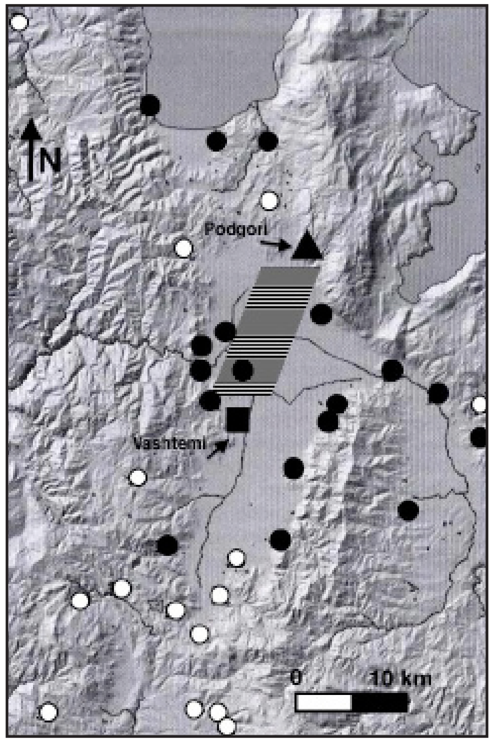

Figure 2: A distribution of pre and proto-historic sites in the Korça Region (after Aliu, 2006). Black circles are Neolithic and Chalcolithic sites, while white circles are Bronze and Iron Age sites. The striped parallelogram defines an approximated extent of the now drained, shallow Lake Maliq. Podgori and Vashtëmi are respectively located on the northeastern and southwestern corners of this lake.

Early Neolithic in the Korça Region

The Korça region represents the most intensely occupied area in Albania, especially during the Neolithic, Copper and Bronze Ages (Fig. 2).[5] Its archaeological investigation began in the sixties and the seventies, by Albanian archaeologists such as Frano Prendi, Muzafer Korkuti, Aleksandra Mano, etc.[6] The Neolithization of the territories within the contemporary borders of modern Albania is closely related to the first farming communities of Thessaly and Macedonia in Greece. This is not surprising, as geographical proximity played a major role in this process.

There are five Early Neolithic sites from this region: Vashtëmi, Podgori, Barç, Tren and Sovjan. The first two contain material that indicate a very early phase for this period, and will be the focus of this study. The chronological relationship between Vashtëmi and Podgori has never been clarified by their investigators. In fact, in some of their publications Vashtëmi is considered as a forerunner of Podgori.[7] Yet, in others, Podgori becomes the earliest date for agriculture in Albania, making Vashtëmi its antecessor.[8] The main features of each settlement and their respective pottery characteristics will be summarized in the following two sections.

Vashtëmi

Vashtëmi is located on the western edge of the Korça plateau and in the extreme south of Lake Maliq (Fig. 2). Adjacently to the west, there is a range of hills that contains sources of natural spring water which are still used today for irrigation by the local farmers. The Dunavec River runs in a south-to-north direction just a few hundred meters to the east, before draining into the much larger Devoll River only 2-3 km further north.

A short test excavation was conducted in 1973, following the discovery of the site by local farmers. Systematic excavation began in 1974, under the direction of Muzafer Korkuti, where an area of 225 m^2 was exposed Korkuti 1982.[9] It bears no signs of a long-lived settlement, although the stratigraphy revealed three consecutive occupational phases. This is attested by its material culture as well, which belongs exclusively to the Early Neolithic period. The entire cultural stratum reaches a maximal thickness of 150 cm.

The most abundant ceramic type is red monochrome, which comprises almost 80% of all the collected ceramic sherds by Korkuti's team.[10] The painted ceramics are the second most frequent decorative style, exhibited in two different types: white color on a red background and red color in white background. Impressed pottery was the next category of decorations, but was found in smaller amounts than the previous ones. Other types of decorations, such as Barbotine, incisions, and plastic additions are rarer and appear in the later stages of the settlement's life.

The overwhelming ceramic type – the monochrome – comes in a variety of colors as well. Korkuti divided it arbitrarily into two main categories, a red monochrome and a grey/black monochrome.[11] For most ceramics included in the red monochrome category, the surface exhibits a light red color. Other surface colors included in this category are brown, reddish brown, and, in smaller amounts, light brown. The second category, the grey/black monochrome, is found more often in the upper strata of the stratigraphy.

Podgori

Podgori is an open-air settlement, located in the northeastern extremity of the Korça Plateau and the southwestern slope Mali i Thatë. The settlement is situated not far from the modern village of the same name, at an elevation of 800 meters above sea level. It was inhabited from the Early Neolithic to the Bronze Age, but the use during the Early Neolithic is far more extensive than other periods.[12] It has a surface of approximately one hectare, and the Early Neolithic stratum reaches 3.2 meters in thickness. Systematic excavations were carried out in 1982, directed by Frano Prendi and Zhaneta Andrea. Since then, Podgori is considered as one of the biggest and most important Early Neolithic sites in Albania.[13]

As mentioned above, Podgori represents together with Vashtëmi the earliest Neolithic settlement in the plain of Korça and the earliest in Albania so far. The thick Early Neolithic layer represents seven occupational horizons, divided into three levels of development: Podgori Ia, Ib, and Ic. Podgori Ia has an abundance of very good quality Red Monochrome and White-on-Red pottery. Moreover, there are some types that are quite exquisite in their aesthetic beauty, such as the Red-on-White and Polychrome.[14] Impressed wares are found here as well, belonging to the two types also observed at Vashtëmi: the Adriatic Impresso and the local Devollite Impresso, with the former usually executed through fingernail impressions.[15]

There are some marked differences between Podgori and Vashtëmi, especially in the quantities of ritual objects and the abundance of raw material for lithic tools.[16] Yet, the Albanian archaeologists argue that the two sites belong to the same cultural sub-group and chronological phase due to the fact that pottery decorations and the respective typological frequencies are the same.[17] There are a few characteristics that are admitted as differences in pottery making between the two sites: (1) the monochrome pottery from Podgori is aesthetically of a better quality than in Vashtëmi; (2) the white paint is attached more firmly in the vessels in the Podgori samples, hinting to a better quality; and (3) in Podgori there is a polychrome variety of exquisite aesthetic quality, not found anywhere else in the Balkans during the same period.

Methods

In order compare the ceramic technology between the two settlements, two different, but complimentary, analytical techniques were employed. The analysis began with a simple HCl acid test, which is used to reveal the presence or absence of calcareous components in each ceramic sample. It is a simple method to understand if the clays or non-plastic inclusions come from different geologic compositions. LA-ICP-MS is used to further separate the samples into different compositional groups and to compare them with the five clay sources collected during the 2010 SANAP (Southern Albanian Neolithic Archaeological Project) excavation season.

One hundred fifty eight ceramic sherds were drawn from excavated layers on both sites. 104 sherds came from the 2010-2011 SANAP excavations in Vashtëmi. The selection procedure was geared to satisfy one main criterion – the detection of the widest range of compositional variation.

The 54 remaining sherds came from the 1982 excavation in Podgori and were chosen by Dr. Ilir Gjipali, the co-director of SANAP. Since Podgori contains material culture that extends beyond the Early Neolithic period and has multiple phases of habitation, we collected samples from the earliest strata only. This sample choice would allow us to make a better comparison with ceramic sherds from Vashtëmi.

During the 2010 SANAP excavation season, a total of five clay samples (500, 501, 502, 503, and F12k) were collected from sources around Vashtëmi, with the purpose of comparing their composition with our ceramic sherds. The clay is not used anymore for pottery making in the villages around Vashtëmi, but in some areas is still used as a building material (this information was obtained by the local construction companies).

HCl Acid Test

The hydrochloric acid test is used to detect calcareous materials within the clay-temper matrix. Calcite-based minerals have been used frequently in ceramic technology to achieve desirable vessel properties. In Early Neolithic pottery, limestone temper has been used to improve the adhesive aspect of the vessel wall in paint application.[18] Of the two most frequently used temper types in Early Neolithic (calcite and sand), only the calcite reacts with the HCl acid. The formula of this reaction is:

$CaCO_3(s) + 2\,HCl(aq) \rightarrow CaCl_2(aq) + CO_2(g) + H_2O(l)$

As a result of this reaction, the carbon dioxide (CO_2) and water (H_2O) exit the vessel as bubbles, and are visible by microscope or with the naked eye. Sample preparation involves the cutting of a piece of the sherd (the same to be used for LA-ICP-MS analysis) and applying a 10% HCl acid dilution on the freshly-exposed section. If the entire surface of the section is bubbling, then the clay comes from a calcareous parent rock. If we see bubbling only in the inclusions outside the clay matrix, then we are dealing with the use of limestone temper. If there are no bubbles, or only a few of the visible inclusions are reacting, then there are no calcareous minerals in the sample.

Laser Ablation ICP-MS

LA-ICP-MS is a minimally-destructive technique that exhibits high levels of accuracy, precision and sensitivity. The strength of LA-ICP-MS rests on the capability of the technique to do spot analysis on spatially segregated components from solid materials.[19] This capability allows for measuring only the elemental concentration of the clay matrix, by avoiding the temper particles and other non-clay inclusions. Consequently, by providing only the clay elemental concentrations, it allows for direct comparison with clay sources. As a result, this technique will tell us about (1) the location of the clay sources; and (2) the number of the types of clays used by the early farmers.

During the LA-ICP-MS analysis, a small laser beam removes about 5µm of material with every pass. Then, the ablated material is transported in the form of micro-particles through an argon flow into the plasma torch of the ICP-MS, which serves to ionize the atoms. In traditional LA-ICP-MS instruments, a group of cones pull out the ions into the mass spectrometer, which then counts the quantities of atoms according to mass and charge.[20]

Analysis and Results

A group of statistical analyses were used to make sense of the large multivariate data from the ICP-MS, as introduced by Neff[21] and his colleagues.[22] The entire data matrix contained 162 cases (samples) and 48 variables (element concentrations). To explore grouping tendencies within each assemblage, three statistical plotting techniques were used: (1) hierarchical cluster analysis dendrograms, (2) bivariate plots, and (3) principal components plots.

Macroscopic Overview of the Samples

The investigation of visible characteristics used for the cataloguing of the samples brought to light some significant differences between the two assemblages. First of all, it was very hard to pigeon-hole the surface colors into red and greyish black, the two main categories presented by Korkuti.[23] Ceramics from both sites came in a variety of colors, such as brown, light brown, orange, buff, etc. All these surface colors were encountered in both assemblages and no significant difference was detected in the frequencies of each color.

The most striking observation comes from the surface treatment. 55% of the Vashtëmi sherds had plain surfaces with no smoothness, no sheen, and no slip. From the Podgori assemblage, there were no sherds that fitted this description. A smooth surface with no sheen was catalogued as “burnished” (BU) in the inventory. 42% of the entire Vashtëmi sherds belonged to this category, whereas, again no sherds of this type where found in Podgori. The majority of the Podgori samples, about 82% of them, were noticed to have a sheen and smoothness. These were catalogued as "highly burnished" (HB). The rest of the Podgori samples (18%) had a surface treatment consisting of a thick slip, which gave the ceramic a constant color all the way through. Only 3% of such ceramics from Vashtëmi belonged to this category.

HCL Acid Test for Calcareous Components

The application of HCl acid on the samples began with the clay sources. From the five clay sources only two (500 and 502) reacted strongly with the HCl acid.

There was no uniform reaction noticed in the freshly exposed cross-sections from the samples from Vashtëmi. About 10% of the sherds reacted only in some specific spots, indicating a very weak presence of calcareous material in the clay matrix.

Podgori provided different results. 91% of the Podgori assemblage of sherds reacted in the surface. The effervescence bubbles were clearly visible in both the inner and outer surfaces of the sherds. Two sherds appeared to react with acid throughout the clay matrix. However they both had cracks in it where $CaCO_3$ could have been absorbed during post-deposition, as discussed by Vitelli.[24]

Compositional variability between Podgori and Vashtëmi

The first step of this analysis was to explore the overall variation in both sites simultaneously. To achieve the task a hierarchical cluster analysis was applied on the data, where the information is presented in a dendrogram. This analysis showed that Podgori exhibited much less compositional variation than Vashtëmi.

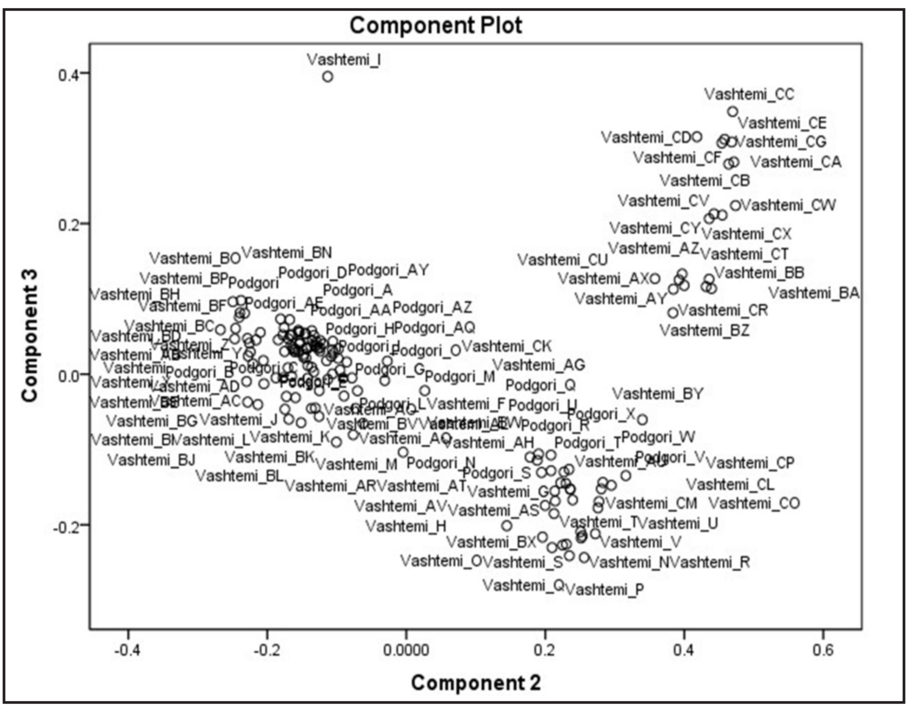

Figure 3: Q-Mode Principal Components plot.

Principal components analyses (PCA) were run on the data to test the validity of this initial difference between the two sites. This statistical technique can be performed in both modes: R-mode, focusing on variables; and Q-mode, focusing on the cases themselves.[25] In Figure 3 (Q-mode), a large group containing both Podgori and Vashtëmi samples covers almost half of the graphical space, while another distinct group consisting of only Vashtëmi samples is clustered in the top-right corner of the graph. To see which elements were responsible for this variation, an R-mode PCA was performed on the data. The results (Fig. 4) indicate for a stronger presence of rare-earth elements (REE) in the Vashtëmi samples. Other compositional components contributing to the separation of the groups are the elements iron, magnesium, silicon and aluminum. A combination of these elements was used to explore further the data (Fig. 5 and 6). Again, the compositional variability within the Vashtëmi assemblage is much higher, as the samples are plotted all over the place in the graph. In contrast, samples from Podgori display more compositional cohesion. After these initial analyses, the conclusion is apparent: there is little variation in the chemical composition of the Podgori ceramics, while the opposite is true for Vashtëmi.

Compositional groups within the Vashtëmi assemblage

All the sherds from Vashtëmi were analyzed together to determine compositional groups within the site. Initially, the raw data were explored through hierarchical cluster analysis.

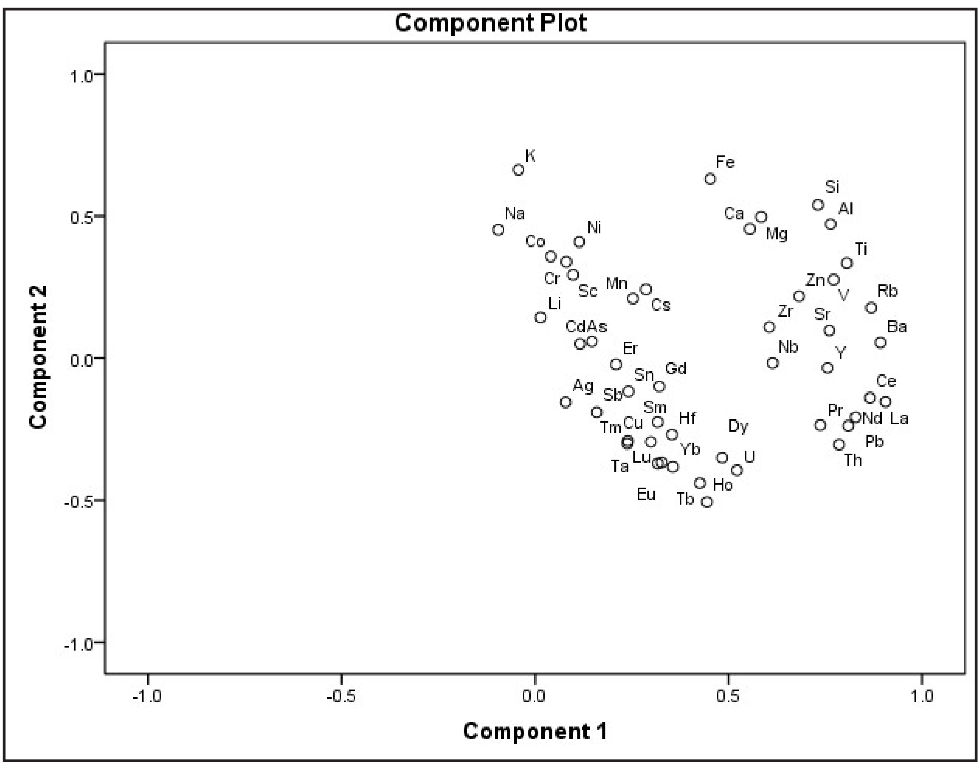

Figure 4: R-Mode Principal Components plot.

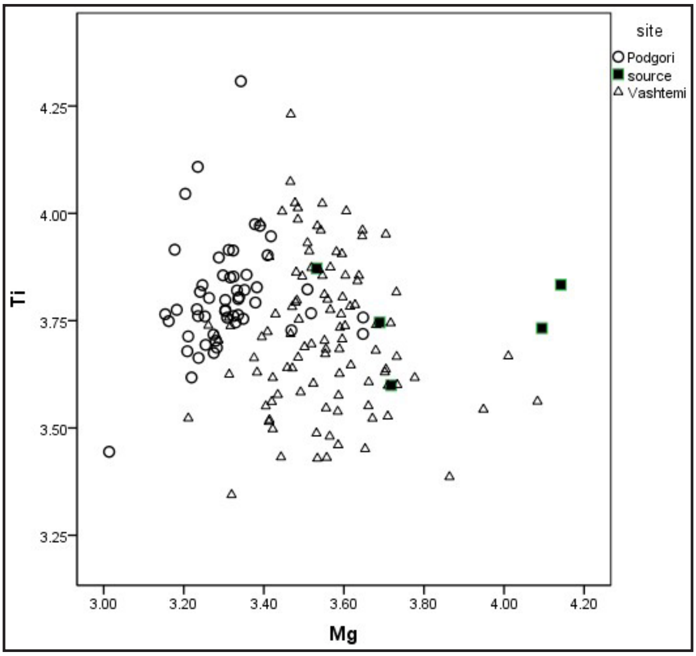

Figure 5: A bi-plot of the pooled variance of magnesium (Mg) and titanium (Ti)

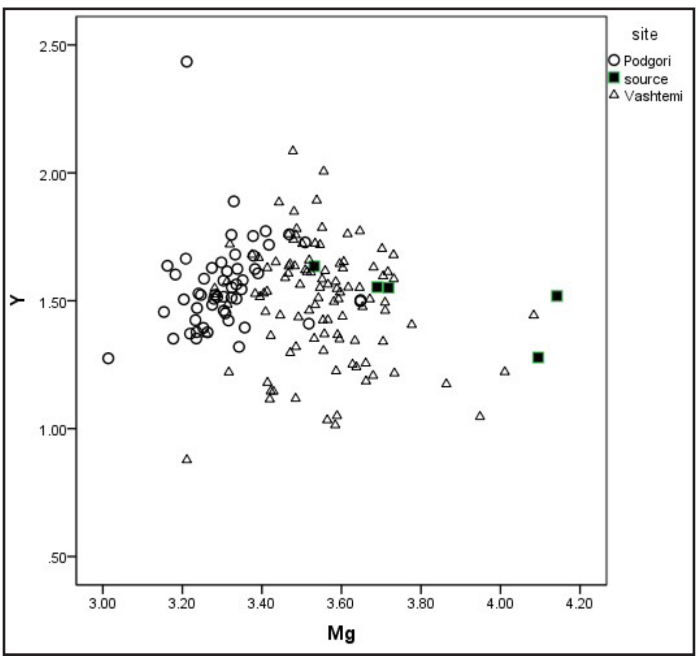

Figure 6: A bi-plot of the pooled variance of magnesium (Mg) and yttrium (Y)

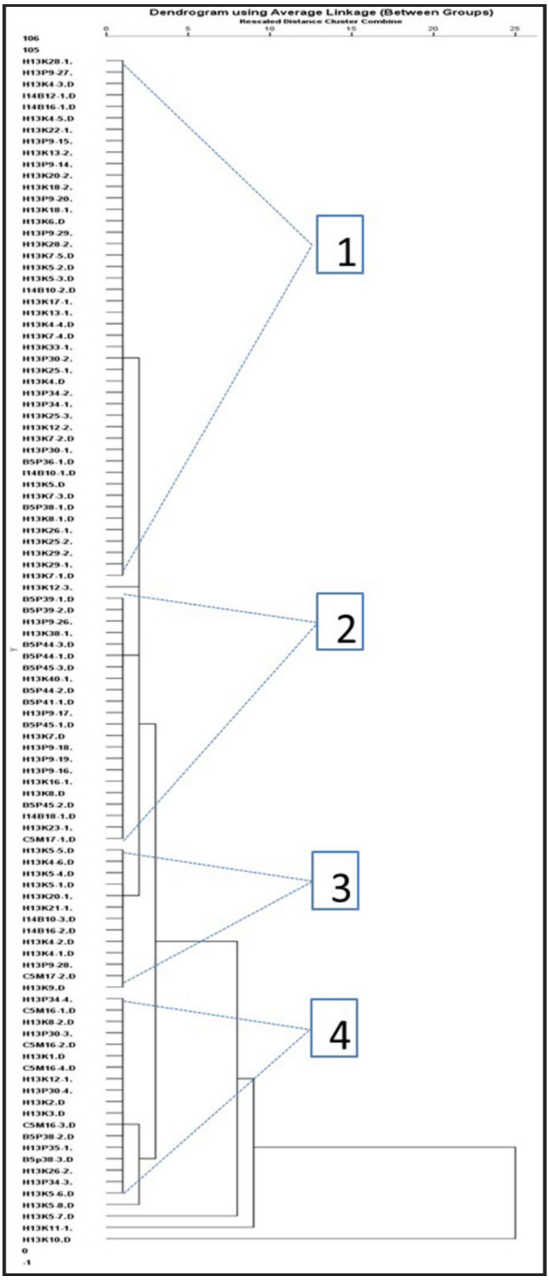

Figure 7: Cluster Analysis dendrogram of the Vashtëmi samples, indicating the existence of four major groups and a few outliers in the end (see bottom of the graph)

The samples were clustered into four subgroups (Fig. 7). The squared Euclidian distance between the subgroups 1, 2 and 3 is not very large, which could be interpreted as small variations within a single clay source. Subgroup 4, on the other hand, is separated further from these three subgroups. The presence of three outliers should be noted as well. They could be considered as "exotic" sherds, because their composition is different not only when considered within the compositional variation of Vashtëmi, but even when the Podgori samples are included.

The compositional differences between the subgroups were investigated through elemental bivariate plots. The only bivariate plot that revealed any significant difference between the subgroups was the Aluminum (Al) and Silicon (Si) (Fig. 8). The members of subgroup 4 exhibit smaller amounts of Aluminum and Silicon, especially when these two elements are combined.

Assigning clay sources to the sherds from Vashtëmi.

The data from the clay sources were merged with the data from Vashtëmi to detect if any of the clays would be compositionally similar to the sherds. This was performed only with the Vashtëmi group of data because the clay sources were collected in its surrounding areas. The analytical procedure was the same as in the analysis of the Vashtëmi data alone, except that five new cases (the 5 clay sources) were added to see in which groups would they fall.

Three clay sources, 501, 503 and F12k are positioned within the first cluster of the dendrogram (Fig. 9). The data was investigated further with bivariate plots.

Only clay sources F12k and 503 have been consistently within the main sample cluster in most of the bivariate plots, reaffirming the cluster analysis results. It could be implied that both of these clays come from the same geological foundation.

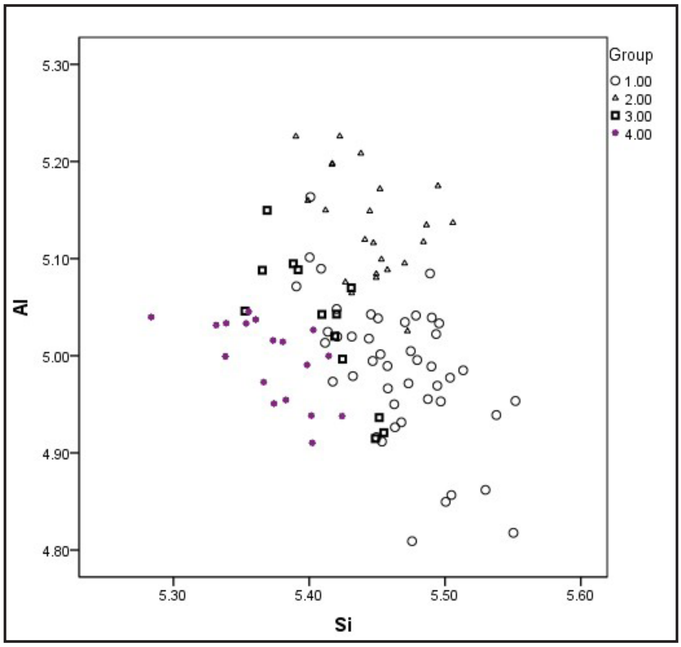

Figure 8: A bi-plot of the pooled variance of silicon (Si) and aluminum (Al), indicating that the major difference between group 4 and groups 1,2 and 3 is the smaller amounts of these two elements in group 4.

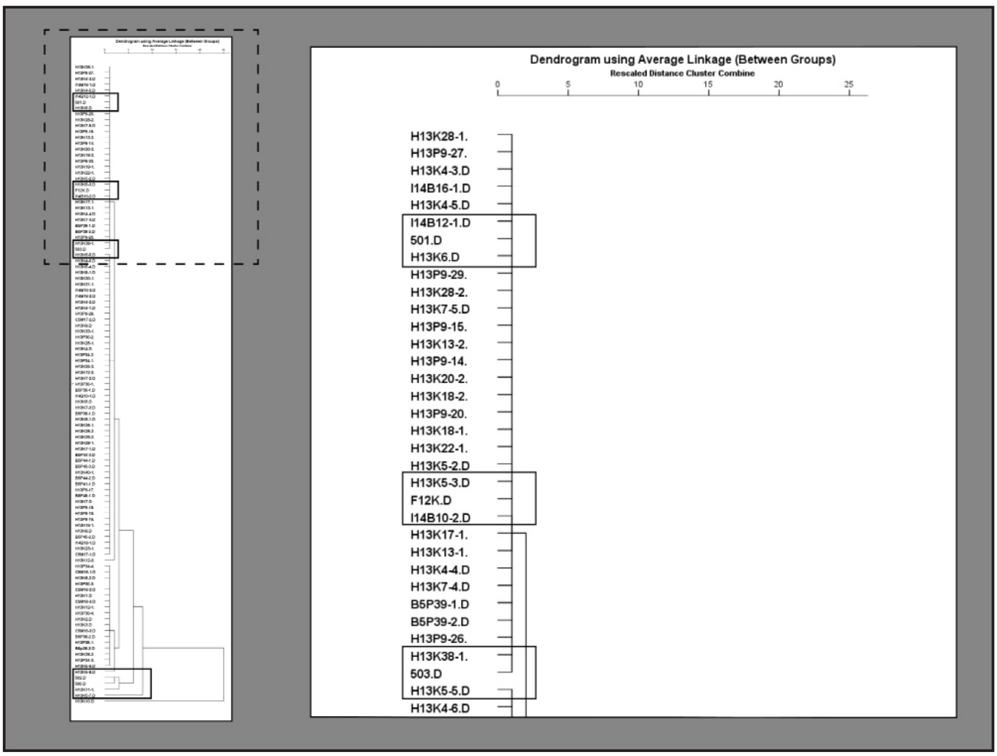

Figure 9: Cluster Analysis dendrogram of the Vashtëmi and the five sampled clay sources (500, 501, 502, 503 and F12k). Clay samples 501, 503 and F12k are located within the largest cluster of the Vashtëmi samples (the area is enlarged on the right), indicating their compositional similarity with most of the sherds from this site.

Discussion and Conclusion

The results of the LA-ICP-MS analysis demonstrate that at least two different clays were used for pottery-making at the Early Neolithic settlement of Vashtëmi. Clay of unknown chemical composition was used in the paste matrix of 'subgroup 4' ceramics. Subgroups 1, 2, and 3 are of similar enough composition to warrant their consideration as originating from the same clay source. A pooled variance of two elements, aluminum (Al) and silicon (Si) is responsible for the distinction between subgroups 1-3 and subgroup 4. There are two clay sources that display similarities with subgroups 1-3: sample 503 and sample F12k. The latter comes from a trench excavated during the 2010 SANAP season. Sample 503 was collected near the village of Maliq, about 6 km away from the site.

Ethnographic studies have revealed that in situations where transportation animals are not present, the artisans will not go further than 5-7 km to obtain clay for their craft.[26] Most of the clay sources are usually found at the lower end of this distance interval.[27] Therefore, it is reasonable to assume that sample 503 is less likely to be the clay source for the ceramics at Vashtëmi. We cannot rule out that clays 503 and F12k could be samples from the same geological population, which covers the entire southern area of the Korça Plateau and is drained exclusively by the Dunavec River.

The aesthetic characteristics of pottery are significantly different between the two sites. The quality of the monochrome pottery in Podgori is much higher. Most of the sherds in Podgori are either highly burnished or covered with a thick, shiny slip. In comparison, the majority of the monochrome sherds in Vashtëmi are plain or only slightly burnished.

In the HCl acid test, it was noticed that the Podgori sherds effervesced on their surface, but not within the clay matrix. Therefore, the depositional environment surrounding the site is highly calcareous, but the clay used for the ceramics is not. This was not the case for Vashtëmi, where neither the environment nor the clays were calcareous. The assumption of a lack of calcareous clays in the plateau cannot be supported, because we have two such calcareous sources, clays 500 and 502. In addition, the northeastern corner of the plateau - where Podgori is located - is made entirely of limestone.

The following points summarize the concluding remarks of this study:

- there are significant differences in ceramic technology between the two sites, such as the quality of the surface treatment and the variability in clay sources;

- the Podgori artisans were choosing non-calcareous clays and were more conservative in their choices, minimizing compositional variability;

- at least two different clays were used in the production of the monochrome pottery in Vashtëmi. The source of one of the clays was found within the spatial extent of the settlement.

Previous research relied mostly on stylistic similarities and rough typological frequencies to conclude that Vashtëmi and Podgori belong to the same cultural group. The results presented here do not support this assumption. Fundamental differences in pottery quality and technology argue for a lack of association between the two settlements, even though the distance between them is less than 10 km. Future research needs to investigate whether this lack of relatedness is chronological in nature, or due to other factors.

*Acknowledgments:

This study was made possible by the contribution of two generous grants: the IEMA Travel and Research Scholarship and the National Science Foundation grant (BCS-0971960, P.I. Susan Allen). I would like to thank the SANAP project dirsctors Dr. Susan Allen of the University of Cincinnati and Dr. Ilir Gjipali of the Albanian Institute of Archaeology for inviting me into their team. This study would have not been possible without the help and guidance of Dr. Hector Neff of the CSU Long Beach, who prepared the data for statistical analysis. I received enormous help from my advisors: Dr. Peter Biehl, Dr. Tina Thurston and Dr Sarunas Milisaukas, whose intellectual guidance created the framework of this study. I would like to thank as well Richard George, Ergys Hasa and Sami Hasa for their help with sample preparation. Lastly, big thanks to my wife Elvira Khasanova, whose moral and intellectual support kept me alive during those busy months.

Endnotes:

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2 Korkuti 1982
3 Xhomo A. Kodra, Z. Xhafa, and M. Shallo 2002
4 Xhomo A. Kodra, Z. Xhafa, and M. Shallo 2002; Fouache et al. 2010 (March),
5 see Aliu 2006 for a review
6 Cabanes 1998; Korkuti 1998
7 Prendi 1976; Korkuti 1982; Prendi 1982; Prendi and Andrea 1981
8 Andrea 1983; Prendi 1990; Korkuti 1995
9 Korkuti 1982
10 Korkuti 1982, 99
11 Korkuti 1982, 99-100
12 Prendi 1990
13 Andrea 1983; Korkuti and Prendi 1992
14 Andrea 1983
15 Prendi and Andrea 1981; Andrea 1983; Prendi 1990; Ceka and Korkuti 1993
16 Korkuti 1982
17 Prendi 1976; Korkuti 1982; Korkuti 1995
18 Vitelli 1993
19 Gratuze et al. 2001; Neff 2003
20 Pollard Bart, CM., Stern, B., Young, S.M.M., 2007
21 Neff 1994; Neff 2002
22 Cochrane and Neff 2006
23 Korkuti 1982; Korkuti 1995
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