

**Contribution to ceramics studies of the Alto Ribatejo
(Gruta do Cadaval and Anta 1 de Val da Laje, Tomar, Portugal)**

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Abstract

The research program on the later Prehistory of the Alto Ribatejo – TEMPOAR raised a crucial issue on the possible existence of two different cultural traditions in Neolithic and Chalcolithic of the region: the limestone and coastal area (e.g. caves, like Gruta do Cadaval) and the inland areas deposited with gneiss and schist (e.g. dolmens like Anta 1 de Val da Laje). The typologies of ceramics from these two sites are distinct. In this preliminary study, the author analyzed shards from these two sites dated from Neolithic to Roman time using attributes analysis, thin-section petrography, XRD and NAA, combining with multivariate data analysis. The objective was to examine the applicability of these techniques for ceramic provenance studies, assess intra- and inter-sites variation in mineralogical and chemical composition, in addition to determine whether some samples suggest the importation from outside. Results show that outliers from both sites probably were made from different raw materials by local potters, or imported from outside; except the outliers, there was technique inertia in each site in point view of ceramic raw materials. Mineralogically, the ceramics were enriched in quartz, micas, plagioclase and feldspars. The presence of calcite in some samples indicated a labor-intensive work of prehistoric potters. On the other hand, the results point to the use of different raw materials/ techniques, which could be expected since the archaeological sites studied are funerary contexts during a long period of time, and also because clay materials are variable from different regional geological contexts.

Keywords: Attributes Analysis, Compositional Analysis, Chemical Analysis, NAA, XRD, Thin-section Petrograph, REE, Cluster Analysis, Factor Analysis, Mineralogical Analysis, Multivariate Data Analysis.

Introduction

The “Alto Ribatejo” (North Ribatejo), a region of Central Portugal, is characterized by the merging of three different geo-morphological units: the limestone massif of Estremadura, to the west; the Miocene basin of the Tagus, with its quaternary terrace, to the south; and the granites and schist form the “Beiras”, to the east. CDV is a small cave in the Dogger limestone region of the Nabão River. VL1 is a passage grave with four layers. Lithic artifacts, ceramics, prestige objects and bones were uncovered both in these

two sites. However, there are huge differences between megalithic and caves sites found in this region. This kind of distinction could not be interpreted through chronological difference. In this region, it is believed that there existed two distinct traditions in the Neolithic and chalcolithic Alto Ribatejo. First, the megalithic context was observed in the east (such as the settlement of Maxial, on the opposite margin of Zezêre river) and in the southeast (like in Torres Novas/ Alcanena region). Second, there are various caves (like Lapa da Galiha, Gruta da Rexaldia, Necrópole das Lapas, etc.). The

possible existence of these two traditions were raised as a hot issue in the study of the prehistory of the Alto Ribatejo; artifacts found in this region were studied in details so they could provide some hints or information to answer this question and also to better understand better the prehistory of this region. Ceramic, as a ubiquitous and durable artifact, attracted many investigators.

This primary study on ceramic from this region centered on the composition features, combined several methods and expected to detect some traces that would contribute to comprehend some aspects of the prehistory of this region.

Methods

Both macroscopic analysis and microscopic analysis are used in this research. For macroscopic analysis, attribute analysis, which is used increasingly as a means to record a range of potentially relevant variables without making judgments a priori as to which variables are the most important for pattern recognition, is carried out. In 1968, Clarke provided us with the definition of attribute as: "a logically irreducible and independent variable within a specific frame of reference, [having] two or more states". Elizabeth S. Chilton defined "attribute" as one variable of a ceramic vessel, such as surface treatment, color, temper type, or rim shape. And an attribute state is one of many possible values or states for that variable, such as "quartz" "cord-marked" or "23mm". Thus each attribute has an infinite number of possible attribute states (Chilton, 1999). As every artifact, indeed every material object contains infinity of attributes or variables and therefore of possible systems networking these attributes and it is necessary to select the particular attributes we want to study (Clake, 1968). Usually, attribute has often been used to create typologies of pottery studies. The typology studies of these two sites have already been done by some scholars like Dr. Oosterbeek L. (1993). In this article, this method is borrowed not to do some typologies studies, but for general technique patterns of the bulk of ceramic shards. Attributes such as technological attributes (paste and temper, forming techniques, surface treatment and enhancement, firing) and morphological attributes (rim, wall, base, neck and collar) were analyzed in details.

Microscopic analysis is implemented to probe into the composition of the ceramic paste. Mineralogical analysis is carried out by means of XRD (X-ray diffraction) and Petrography

analysis; chemical compositional analysis is achieved by NAA (Neutron Activation Analysis). With these methods, we expect to obtain some comprehensive results concerned about the ceramic samples from this region.

Analysis and Results

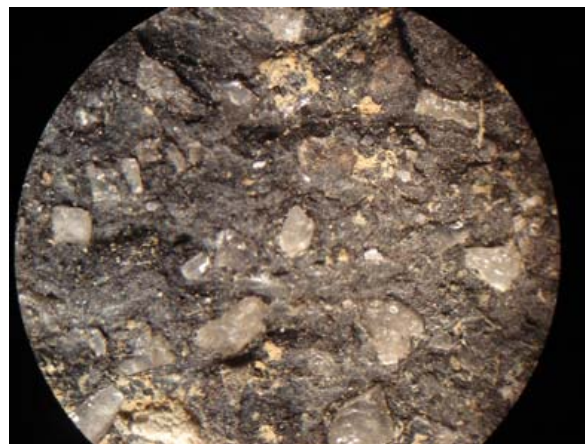


Fig. 1. Surface photo from binocular microscope (10*), by PENG Fuying

Macroscopic analysis

About 500 ceramic samples respectively from CDV (Gruta do Cadaval) and VL1 (Anta 1 do Val da Lage) were extracted from Prehistoric Centre of Politécnico do Tomar and studied at length. Among these samples, there are twelve complete vessels from VL1, and all of the rest samples are shards.

Most of the samples from the two sites have medium size rims (0.5-1cm), CDV have more samples have prodigious rims (>2cm), which could show that the ceramic in CDV is larger in size. Convex wall and simple rims dominate in all these samples. As to the shaping technique, in CDV, wheel is a more frequently used forming method, whereas in VL1, more samples are made by modeling, and sometimes the fingerprint is an evident indicator. Concerning the paste, through naked eye, mica and quartz can always be identified in these two sites. However mica played a more important role in VL1. The percentage of the samples with a mass of mica grains increase from 9.7% in CDV to 31.2% in VL1; and the percentage of the samples with mica augmented from 72.1% to 86.9%.

Mineralogical analysis

Thin-section analysis displays the existence of some common minerals, such as quartz, mica

and feldspars, grog is also observed in the ceramics as tempers.

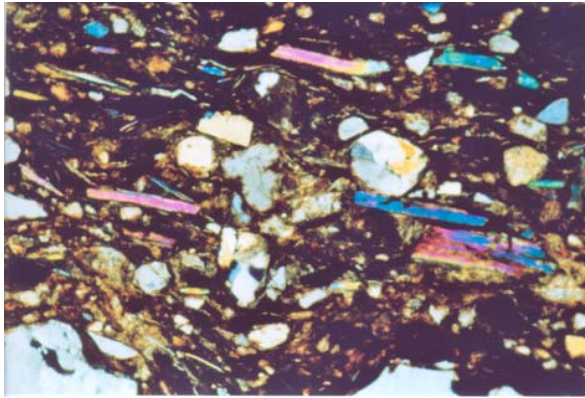


Fig. 2. A sample with quartz (white, light-yellow) and mica (elongated, pink and blue in colour) grains, photo taken from cross-polarized microscope with the magnification 10*6, by PENG Fuying.

X-Ray diffraction (XRD)

XRD confirmed the existence of some minerals like quartz, feldspars and micas. Some clay minerals were suspected to exist in some shards, which suggest probably they are fired at low temperature, perhaps below 500° or 600°, under which the clay minerals were transformed.

According to the mineralogical composition, some groups could be divided. Group 1 (CDV3, 18, 20) has abundance of calcite, while with scarce of quartz, which could be an indication of deliberate treatment; Group 2 (CDV13) is the only one with more feldspars than quartz; Group 3 is the biggest cluster which is characterized by the abundance of quartz, mica and feldspar succeeding based on the quantity. Some minerals, like anatase, magnetite-maghemite, amphibole and ilmenite occur in some samples. Judging from the richness in quartz, there is a great variability from samples to samples. Most of the samples without mica or trace micas are from

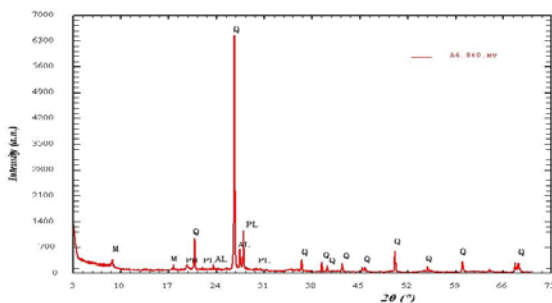


Fig. 3. One sample (VL 9) with both alkali-feldspar and feldspars, PL= plagioclase, AL= alkali-feldspar, PH= phyllosilicate, M= Mica.

CDV. This could explain the cluster when NAA is performed, vice versa. Through X-ray diffraction, we found that all of these samples were made of some raw materials with a lot of inclusions; there could be two explanations for this phenomenon. First, they were medium-quality ceramics with roughly the same clay-temper composition; second, they were higher-quality ceramics containing more clay and less temper, but calcium oxide, quartz, feldspar were added to low the fusing point. There was considerable quartz inside, since quartz has a large coefficient of expansion, these ceramics appear to be poorly suited for cooking vessels (Chilton, 1999). And as they were found in burials context, they were probably not to be used as cooking utensils (domestic pottery) Thus the second interpretation could be more reasonable.

Chemical analysis

Minor element analysis indicates the variations which can occur from one source of material to another. Minor element like Fe abundance can give information on variants in a group (Velde et Druc, 1999). In these two sites, some samples (CDV7, 16, 17, 20) have a very low level of Fe, which are below 3%; Fe contents of the ceramics from the same sites vary as they vary between the two sites, which suggest inter- and intra-sites difference in sources of materials or techniques.

Trace elements, especially the REE (Rare Earth Elements) analyses could provide a “fingerprint” for that particular source (Kingery W. David, 1998; Barnett K. William and Hoopes W. John, 1995).

7 outliers were extracted out according to Ce/Ce* anomaly (with a positive Ce/Ce*). Cluster analysis shows that samples from CDV and VL1 resemble more than the samples from the same sites; more clusters just with VL1 ceramic indicate that in CDV the ceramic is more diversified.

Factor analysis suggests that REE, Na₂O, Cr, As, Hf, U is the diagnostic chemical components, which also corresponds to K-means clusters analysis.

NAA is a very accurate and a highly sensitive method. It is a fingerprint to arrive some provenance studies. First, outlier are easily spotted, like from obvious Ce anomaly, three samples (CDV2, 11 and VL1) probably not locally made, but imported from other regions, as they were on a funerary contexts, the artifacts in

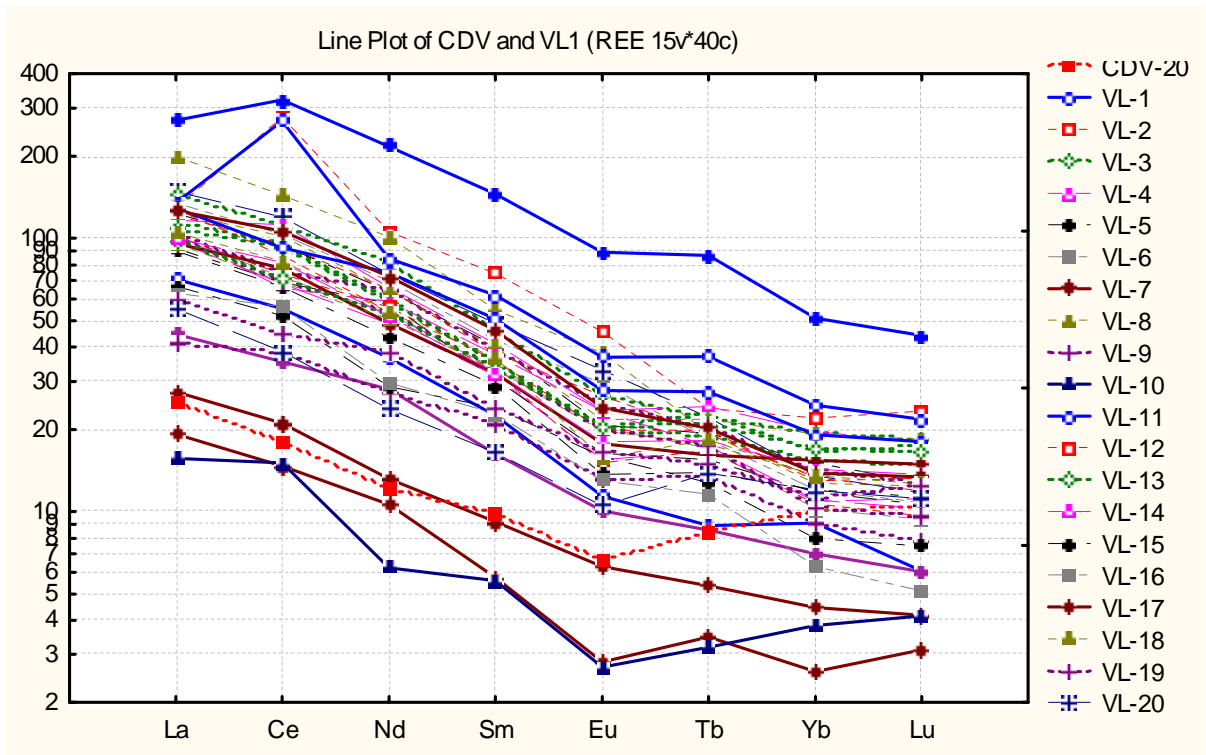


Fig. 4. REE patterns of samples from CDV and VL1.

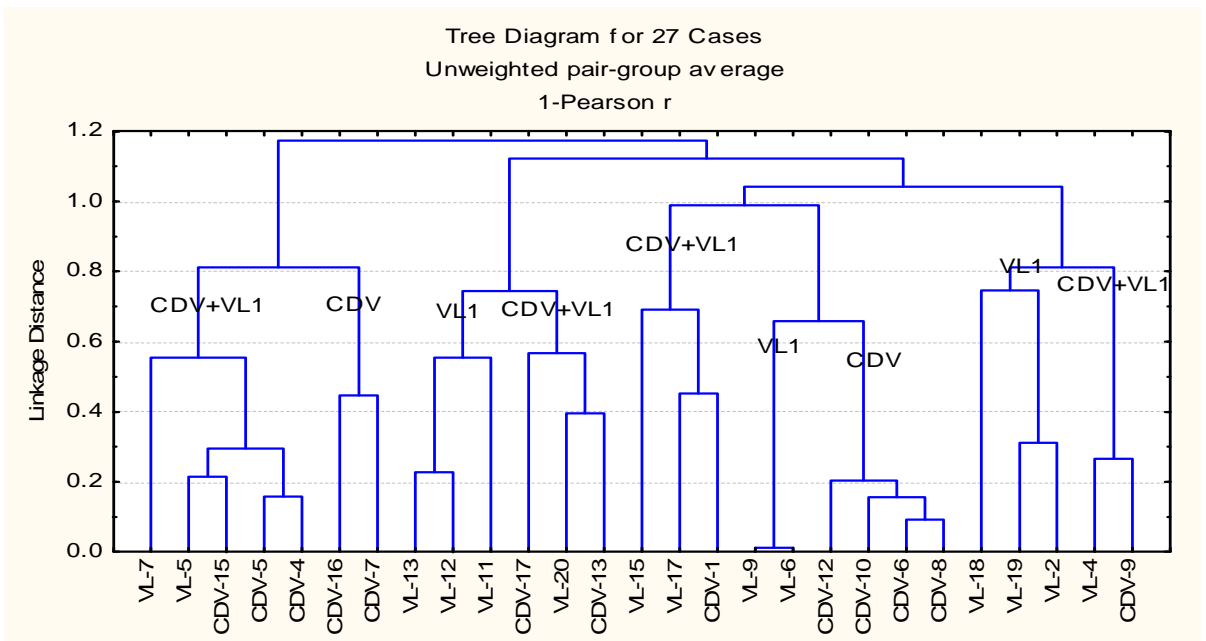


Fig. 5. Dendrogram of ceramic samples from CDV and VL1 based on their chemical contents.

burials could be from the around regions; or they are locally made from different clay materials.

Second, except for these three samples, other four samples (CDV14, 19, and VL10, 16) have a little positive Ce contents, which could separate them from the rest samples. Third, in both sites, there are several samples (CDV17, CDV20 and

VL10) have very low contents of almost all of the chemical elements. These varies point to the use of different raw materials/ techniques, which could be expected since the archaeological sites studied are funerary contexts during a long period of time, and also because clay materials are variable from different regional geological

contexts. However, there are some inherent disadvantages to provenance studies through NAA, as the chaîne opératoire such as the paste processes (tempers, colorants, water), subtractive processes (sifting, levigation, manual removal of some particle sizes) (Ciliberto Enrico, 2000; Arnold D.E, 2005); function (cooking, transporting, serving, prestige) and the effects of dragonesses are particularly critical when the related issues of ceramic production and exchange are considered. The chemical signature of a hypothetical vessel made in Area A and traded to Area B can be expected to become less A-like and more B-like the longer it resides in the ground at B (Stolmen, 2002; Rice, 1987; Ciliberto Enrico, 2000). What is more, it is too much expensive that prevents its wide spread use.

Conclusion and discussion

XRD and NAA were proved to be able to explain each other from different views and that both of them are powerful tools in compositional analysis in spite of their inherent limitation.

With these methods, some questions could be answered, meanwhile other questions were raised: the outliers were made from local potters with different raw materials or they were imported from other community?

As these two sites are in the same region and with similar chemical composition, what is the

clay procurement distance in this region? Or was there trade mechanism between these two communities? And as these ceramics were found in burials, were there any clues to that the prehistoric potters used different raw materials to make different kinds of pots based on their functions (domestic and prestige)? And what is more, how the potters chose the clays and temper and mixed them to enhance the workability of the paste? To further the study of the ceramic in this region, other methods, such as infrared spectrograph, can be applied to offset the disadvantages of XRD and NAA, thus complementary information can be obtained to provide a more comprehensive ideal of the ceramic; on the other hand, clay samples could be extracted from this region and processed in the laboratory for compositional analysis; and some data could be set up in order to offer a standard parameters; what is more, methods and concepts from other discipline, such as ethnology, anthropology could be borrowed to interpret the behavior behind the pottery industry; correlation to other artifacts found in these two sites, lithic, prestige artifacts, bone tools and other remains could provide a panorama vision about the people who lives thousands of years ago. In a word, this is a multi-discipline area, integration of different methods, perspectives and concepts can help to better understand the ceramic-making and prehistory in this region.

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