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The Sant'Imbenia amphorae

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Abstract **– Recent excavation carried out at the Nuragic site of Sant'Imbenia (Alghero-Sardinia) brought to light a considerable number of transport amphorae. The archaeometric and archaeological study allowed us to trace the identikit of these vessels, on the basis of technological and typological aspects. The paper is concentrated on the amphorae found in the hut 47, because they clearly illustrate the diversified production of these vases.**

Keywords – Sant'Imbenia, Iron Age, amphorae, archaeometry, technology.

I. INTRODUCTION (E.G.)

The recent excavations in the Nuragic site of Sant'Imbenia (Alghero-Sardinia), located in the inner part of the Porto Conte bay (Fig. 1), allowed to highlight a considerable number of transport amphorae. A systematic study of these products, strictly connected to the stratigraphic context is necessary in order to reveal their 'identikit': provenance, production processes, typology and chronology. According to this aim the research has been based on the comparison and integration of archaeometric and archaeological data. This approach means that the production and the typology are two aspects playing the same role and having the equal relationship.

It deals with an essential premise for the study and the knowledge of a particular category of vessels, the transport amphorae (both local and imported), unknown to the Nuragic ceramic repertory. Our first aim is to define the technological and typological aspects: the final interest is to reconstruct a framework of the cultural, social and economic *milieu* in which many of these vessels were produced, presumably in order to export goods of the territory connected to Sant'Imbenia [1].

II. MATERIALS (E.G.)

At Sant'Imbenia we found a local amphorae group, followed by an important number of other 'local' products and importations (Iberian and mostly is represented by the Levantine amphorae, we have tried to recognize the typological and technological peculiarities of these central-western

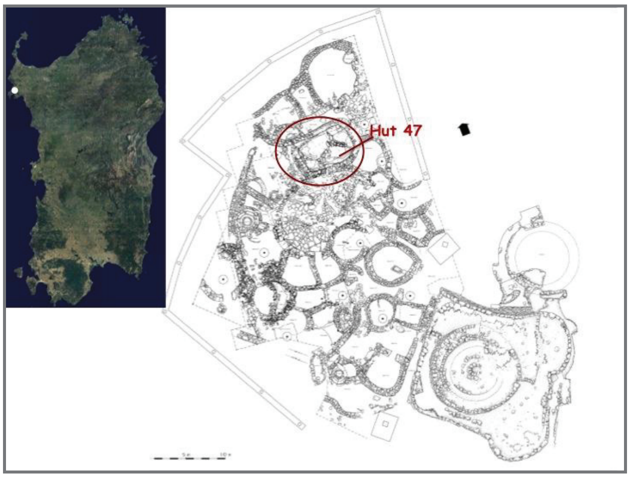

Fig. 1. Nuragic site of Sant'Imbenia
(Survey of L. Sanna).

Mediterranean products.

About the morphological aspects of the local/Sardinian amphorae we have identified two main typological "families", according to the absence or the presence of the neck (respectively Group 1 and Group 2) and related different sub-types and variants [1].

This paper aim to illustrate the study of the 'Sant'Imbenia amphorae' by the materials found in the hut 47 (Fig. 1), as they can clearly represent the typological and production variety of these transport vessels.

This hut is one of the ten rooms, both open (reserved to an artisanal activities) and close (shops) surrounding a central and open space (room 30), interpreted like a market place. The complex was realized according an 'urban' and coherent planning in the first Iron Age, modifying the previous private circular huts or single houses [2].

Respect to the other close rooms the hut 47 has been interpreted as 'representative hall' for dimensions, plan, architectural feature and building peculiarities; it is characterized by a stratigraphy related to life/use phases, dated from the 8th to the end of 7th/1st half of 6th centuries BC [3].

At the current status of the research we could reconstruct a sequence including four phases: 1) the recent abandon, suggested by thick layers of vegetal soil (from contemporary age to the end of the 6th BC);

2) the ancient abandon indicated by deposits of mud and

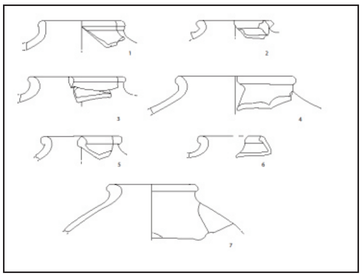

Fig. 2. The amphorae of hut 47 (numbers 2, 3, 4, 6, 7 local amphorae; numbers 1 and 5 other local.

collapsed stones (end 7th-first half of the 6th BC); 3) use and life activities (first half of the 8th-half of the 7th BC); 4) building activities related to the construction of the room 47 and the removal of previous rooms (before the half 8th BC).

The local transport amphora, connected to all the phases, were associated to Nuragic, Phoenician and Greek vessels. Among these amphorae the principal typological groups and some sub-types have been identified. The rims are distinguished and show various features (circular or sub-ovoid, vertical or differently inclined); the necks spreads to the shoulder, that is sloping (Fig. 2).

The imported amphorae, less represented, are related to the Carthaginian/North Africa area, as the comparison between the typological and archaeometric data. They did not appear in the early use/life level.

III. GEOLOGICAL SETTINGS (B. D.R.)

The geology of the area consists mainly of Mesozoic layers, which rest on quaternary deposits related to alluvial fans and/or flat braided channels, and wind dune fields of Würm age. The Triassic consists mainly of dolostones, dolomitic marls, chalk marls and clay with foraminifers. Only a couple of miles north of Nuraghe Sant'Imbenia the Triassic is characterized by continental facies, consisting of the typical red Buntsandstein sandstone. In particular, in the outskirts of the settlement, Triassic dolostones and sandstones outcrop with carbonatic cement. The Jurassic and the Cretaceous deposits consist of platform carbonates: mainly dolostones, limestones and marl. On the top, volcano-sedimentary successions and lacustrine deposits of the early Oligocene-Miocene outcrop [4].

IV. METHODS (B. D.R.)

We began by observing the samples under a Stereomicroscope (Leica ZOOM 2000) in order to identify the different treatments used to smooth the surfaces. We used a portable Minolta CM700d spectrophotometer to analyze the color of these pieces, both on the surface and in the matrix, and to calculate the L*, a* and b* coordinates. Due to the small size and curved surface of some samples, an illuminated area of just 3 mm in diameter was used. The measurements were performed by selecting CIE illuminant D65, which simulates daylight with a temperature color of 6504 K. We identified the mineral phases and ceramic texture by observing thin sections of ceramic fragments under an Olympus BX60 polarized optical microscope (POM) equipped with a digital microphotography camera (Olympus DP10). Non-plastic component and porosity contents were estimated visually using comparative charts (Munsell® Soil Color Charts, 1994). The mineralogical composition of the archaeological ceramics was determined using X -ray diffraction (XRD) analysis. A Philips PW1 710 diffractometer with automatic collimator was used. Working conditions were as follows: Cu Kα radiation emission (l = 1.5405Å), 40kV voltage, 40 mA current, explored area 3° to 60°2 θ, goniometric speed 0.05º 2θs-1The disoriented crystalline powder method was used. For this purpose, samples were previously reduced to powder in an agate mortar and sieved to obtain grains with a diameter of less than 0.053 mm. Data interpretation was performed using the XPowder software [5]. Bulk chemical analyses were performed by means of the wavelength dispersive X-ray fluorescence (XRF) technique, using a S4 Pioneer (Bruker AXS) spectrometer with a Rha node X-ray tube. 5 g per sample were finely ground and well mixed in an agate mortar before being pressed into an Al holder for disk preparation. Ten major and minor elements and eight trace elements were measured. The major and minor element contents are reported as wt.% oxide normalized to 100%, while trace elements are expressed in ppm, LOI-free. The analytical detection limits were: SiO2= 0.08%; Al2O3=0 .1%; TiO2= 0.01%; CaO = 0.01%; MgO =0 .07%; MnO = 0.01%; Na2O = 0.01%; K2O =0 .02%; Fe2O3= 0.01%; P2O5= 0.01%; Cr = 11p pm; Cu = 10 ppm; Zn = 15 ppm; Rb = 18 ppm;S r = 20 ppm; Y = 16 ppm; Zr = 15 ppm; Ba =2 40 ppm. The relative standard deviation was <1 % except for Y, Ba and Mn which presentv alues ranging from 3% to 4.8% (Niembro Bueno, 2009). ZAF correction was performed systematically [6]. The NCS DC 74301 (GSMS-1) standard [6] was applied. It is important to remember that we were unable to perform all the analytical techniques mentioned here on all the samples, due to the fact that in some cases we had only very small amounts of sample at our disposal.

V. DISCUSSIONS

A. *Archaeometric data* (B. D.R.)

Our results reveal that the amphorae are characterized by three different typologies (Fig. 3). The first, more abundant, is compatible with a local production which results relevant and specialized [7]; the second is compatible with another 'local' production [8] and the third one suggests an importation from different areas [9]. The three groups differ in the raw materials used and in the quantity of non-plastic component added.

The local potteries are homogeneous from the mineralogical and textural points of view. The main differences lie in the presence/absence of certain tempers and their grain size.

After the MOP observations, the local samples were divided into two groups (Fig. 4): the first has matrices with a black heart, medium birefringence, a 10-15% temper content and porosity values between 5 and 10%. Quartz, K-feldspar, muscovite, hematite and plagioclase were detected; also, there are pumice and ignimbrites, in relatively constant proportions and sizes, and fragments of metamorphic and sedimentary rocks; the second is characterized by matrices with low birefringence, a 15-20% grains content with a bimodal distribution and a porosity values range between 20-30%. We observed quartz, calcite, muscovite, rare feldspars, phyllites and litharenites. Imprints of straw and other plant remains were also detected.

Microscope observation showed that the amount of temper is generally higher in the first group. This seems to have been a deliberate technological choice on the part of the potters, as the wares had to withstand high thermal shocks. Other researches have shown that high temper concentrations minimize the risk of crack propagation although the strength of the finished ceramic is reduced substantially [10].

Based on the level of birefringence of the matrix and of some minerals, such as muscovite, as well as the presence of calcite, some samples could have been fired at temperatures of around 750ºC in an oxidizing atmosphere because of the risk of "lime blowing" (small spalls pushed out of the walls of the vessel), as the level etc. indicate. Generally, we observed that samples containing 5% or more of calcite, to which 10% of organic matter had been added [11], were fired in a reducing atmosphere. Under such conditions, Maggetti et al. [12] demonstrated that calcite can extend its stability up to 800-850ºC. Since the choice of crushed calcite grains was deliberate in order to reduce or eliminate the risk of spalling, if these temperatures were surpassed ceramics may have been quenched after firing [13]. It is also possible that seawater (the village is about 100 m far from the shoreline) was used to mould the clayey material, as sodium chloride acts as a melting agent and helps to produce more resistant ceramics [14]. In the wares in which they are present the calcite grains are generally darker and reaction rims may sometimes be observed, while muscovite, when observed, shows lower interference colours. Another aspect worth noting is the presence of partially vitrified matrices. These data suggest a firing temperature of around 900ºC.

X-ray diffraction (XRD) analyses show that all samples are rich in quartz and have varying phyllosilicate (muscovite) and feldspar content. Some of the samples of cooking ceramics are rich in calcite. The samples of two groups have a similar composition, although in the first some new silicate phases, gehlenite and diopside, start to appear. There is a number of samples in which gehlenite and/or diopside increased slightly, as did the content of the amorphous fraction (possibly an incipient vitrification of the matrix), while calcite content decreased. We also detected plagioclase and hematite.

In general, the use of calcite in ceramics production decreased significantly between the Late Bronze Age and the Early Iron Age. The opposite occurred with the amorphous fraction, which increased from very low percentages in the Late Bronze Age and the Early Iron Age samples, to higher percentages in the First Iron Age. This indicates a clear change in the preparation of raw materials during the Early Iron Ages. Moreover, the presence of mineral phases such as hematite and above all plagioclase indicates that potters used a clayey material that was different at least in part from the one used during the Late Bronze Age.

XRD results confirm expected firing temperatures suggested by optical microscopy observations. Temperatures were estimated on the basis of the mineralogical transformation that takes place in the ceramic when it is fired, and which is manifested in the presence of calcite and/or muscovite (around 750-850ºC) or new silicate phases (gehlenite and diopside) (more than 800-900ºC). However these temperature values must be used with caution because as Nuragic ceramics were not fired in kilns with an oxidizing atmosphere, but were open-fired in holes in the ground making, it is impossible for us to control their firing parameters (maximum temperature reached, heating rate, soaking time and firing atmosphere). The samples of the second group were fired at around 750-800ºC (or up to 850ºC under reducing conditions), as the presence of calcite and muscovite and the absence of new silicate phases suggest. By contrast, about half of the first group amphorae, was fired at higher temperatures, around or above 900ºC, as attested by the absence of carbonates and muscovite and the presence of gehlenite and diopside, albeit in small concentrations. The samples show different surface treatments: smoothing, burnishing or patinating; most samples show properly burnished patinas with well-covered, smooth, clean, impermeable surfaces. As regards the hue (a* and b*, coordinates of intensity and brightness of the color) of the ceramics, show a quite constant b* value, while a* varies from 5 to 20, depending on the intensity of the red colour on the surface. Almost of the sample are handmade.

About the imported pottery, we observed only one group, homogeneous from the mineralogical and textural points of view. As we observed in older studies [9], it is possible to conjecture a North African origin. The samples of this group are made both by hand and on the wheel.

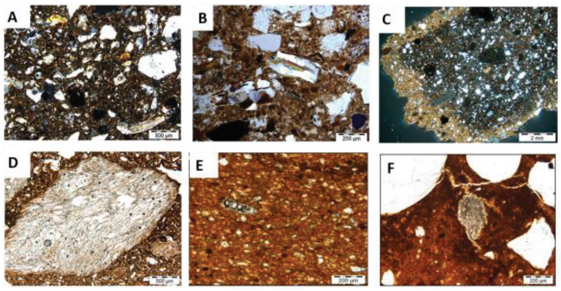

Fig. 3. MOP observations of the different types of clays and tempers.

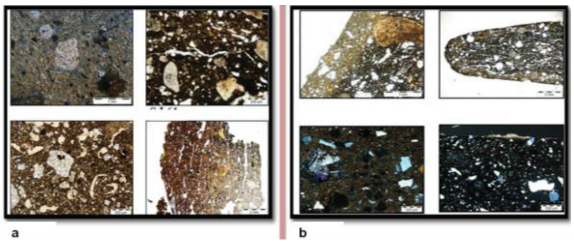

Fig. 4. MOP observations: a) samples of the group 1; b) samples of the group 2.

B. *General observations* (E.G.)

The context of the room 47, that confirms the general trend of the village, allows us to analyze the amphorae both about its production and the connected economic dynamics involving Sant'Imbenia and its territory.

As the first issue we can highlight the following aspects:

- the local amphorae of Sant'Imbenia are prevalent respect to the other 'local' and the importations;
- among the different productions identified at Sant'Imbenia the Iberian amphorae are absent (generally under-represented);
- respect to the typology defined about all the local amphorae the type with a short neck is present in our hut;
- the amphorae of the "Sant'Imbenia type" show direct comparisons with products found in Sardinia (particularly in Nuragic sites), in Iberian peninsula (both colonial and local settlements) and in North Africa (Utica and, in particular, Carthage);
- in the stratigraphic sequence the importations were uncovered in the most recent layers (related to latest use and to the abandon of the room); the local products were found to different life/use levels dated from the beginning of 8th century BC or just before the stratigraphic and the archaeometric data permitted to recognize the priority of a local amphora respect to a similar African product (Ramon T-3.1.1.2.) [16].

About the relationships between the local amphorae and the economic and social implications we can reconstruct a new framework of a Nuragic site during the First Iron Age.

The archaeological and technological study underlines the role of Sant'Imbenia and its area as an important 'experimental laboratory': in fact the data indicate that they represent one of the earliest centres of central-western Mediterranean where the transport amphorae were produced.

The local production of amphorae has a *raison d'être* in a social-economic structure involved in a complex surplus production and exchange system. Maybe in this *milieu* the wine played an important part, considered the vessels found at Sant'Imbenia related to the 'drinking kit', with amphorae, askoid jugs and cups [17].

The local production of transport amphorae at Sant'Imbenia is the sign of important social and economic changes occurred not only in this site, but also in the territory [18].

In fact, the comparison between the stratigraphic analysis and the archaeometric and typological data of the amphorae suggests the production of these products are strictly connected to the phase of the 'urbanistic' transformations of the site between the end of the 9th and the beginning of the 8t^{h} centuries BC [1].

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