Approaching the study of rock "monuments". The archaeological site of Pietralba (Upper Tiber Valley, Arezzo, Italy)

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Abstract A multidisciplinary investigation of some open-air manufactured rocky blocks (both of Proto-historic and Medieval Age) found in the archaeological site of Pietralba (Arezzo, Italy) was performed. The Pietralba blocks display different typologies: a rectangular tub, an L-shaped tub, a throne, and a pyramid. Their study has been approached from the geo-morphologic, mineralogical and chemical standpoint with the threefold purpose of selecting how to better preserve the exposed surfaces from the atmospheric agents, of shedding light on their enigmatic use and, as a consequence, of developing a study-method never applied so far in this field. Even though rock Bmonuments^ are largely widespread and constitute a very intriguing issue, just few studies have been carried out on such artefacts and they have never produced univocal and definitive outcomes regarding their use and age. Samples collected from the tubs were analysed in order to identify the mineralogical and chemical inorganic composition, as well as the possible presence of organic components.

Keywords: Rock monuments, Tubs, Multidisciplinary approach, Preservation, Upper Tiber Valley, Middle ages,

Introduction

The archaeological complex of Pietralba is located within an oak copse along a steep slope on the right side of the deeply incised valley of the Tignana Creek (a short tributary of the Tiber River) in the municipality of Pieve S.Stefano (Upper Tiber Valley, Arezzo, Tuscany - Fig. 1). This site is characterized by the occurrence of a number of "puzzling" lithic artefacts carved in the rocks outcropping in this area.

Similar manufactured rocks, whose chronology and function are hardly detectable, are widespread throughout the Italian territory. These stone "monuments" are generally described as tubs s.l. and are usually situated, grouped or isolated, in secluded places, sometimes quite inaccessible and far away from any man-made environment, or they are close to ancient churches and castles. The category of the so-called tubs actually includes a lot of different structures, which were probably devoted to different functions as well. This term usually indicates a manufactured rock displaying at least one cavity (but often more) not less than 1 m wide and ranging from a few cm to 2-3 m deep (Arcà and Fossati, 1995).
Tubs can be essentially grouped into three main typologies: single tubs, multiple tubs, beds (or thrones) (Battistini, 2011). Single tubs exhibit a flat bottom surrounded by edges along their entire perimeter and are more or less equipped with a drain hole. Multiple tubs are usually composed of two adjacent cavities, generally of different size, quadrangular or circular in shape, placed at different heights and communicating through a hole or a groove. Beds (or thrones) are similar to tubs, except for having one side open. The difference between beds and thrones consists in the greater length (exceeding one meter) of beds.
Even though rock "monuments" are largely widespread (Battistini, 2011) and constitute a very intriguing issue, very few studies have been carried out on such artefacts and have never produced univocal and definitive outcomes regarding their use and age. However several hypotheses have been put forward. The most credited ones concern uses as water places or for tanning.
According to the results of a previous study (Moroni Lanfredini and Laurenzi, 2011), the rock artefacts of Pietralba are to be divided into two chronologically and spatially separated groups. In the present work we are mainly dealing with the more recent couple (two tubs) of structures, which can most probably be attributed to the Medieval Age due to both technological evidence (Giardino, 2011) and the pottery retrieved nearby (Cipriani, 2011).
To shed light on the "mysterious" use of the manufactured rocky blocks of Pietralba, an archaeometric multi-analytical investigation was performed.
Plant resins, natural waxes and lipids of animal and vegetal origin are often encountered in artefacts from the archaeological sites. The difficulty in identifying them is due not only to the complexity of the chemical composition of these natural substances and their mixtures but also to the changes in the chemical composition due to human activities such as heating or mixing materials, in order to modify their properties in view of a specific use. Moreover, degradation from ageing under the influence of different taphonomic circumstances induces further changes in the composition of the original materials.

Identifying the molecular composition is essential in order to establish the natural substances present in the sample and to understand the alteration processes that have modified the original composition of the samples.
The main aim of this paper is to illustrate the results of this archaeometric investigation since our research represents the first study of ancient objects such as “tubs” obtained by using innovative chemical methodologies.

Geomorphological setting

The slopes of the Tignana creek, where the archeological site of Pietralba is located, are made of Lower Miocene sandstone and mudstone (Cervarola Fm, Tuscan Units, Fig.2), originated from an articulated geomorphological evolution reasonably occurred during the Quaternary. Both erosive and depositional processes which shaped this area are recorded by different landforms. A first order erosive process is represented by the deep fluvial incision of the Tignana Creek made after a diversion of an original course directed to SSW (Benvenuti, 2011). The evidence for this former river is represented by the overall NNE-SSW trending direction of the Tignana valley upstream the Pietralba site and by a small beheaded alluvial fan near San Pietro in Palazzi (Fig. 2) originally fed by this river (Benvenuti et al., 2013). The river diversion toward SW was possibly determined by the activity of normal faults such as that crossing the Tignana valley downstream the site (Fig. 2) that attracted the Tignana toward the Tiber River.
The progressive deepening of the post-diversion valley reach is testified by the remnants of four terraces (T1-T4, Fig. 3) which interrupt the steep inclination of the slope.
These terraces mark successive stages of development of progressively narrower alluvial plains of the diverted Tignana up to the present entrenched valley becoming wider downstream (Fig. 4). The occurrence of Early Bronze Age artefacts (sites of Migliara and Molino del Magni, Fig. 2) (Gennusa and Moroni Lanfredini, 2011) on this lowermost alluvial plain indicates that about 4,000 years ago the Tignana valley had reached the present morphology (Fig. 4), so that the valley incision recorded by T1-4 had occurred well before and presumably during the late Quaternary (Benvenuti et al., 2013). Besides the fluvial shaping, the slopes including the Pietralba site are characterized by diffuse landslides which evidently developed throughout the progressive valley incision. With the deepening of the valley and the steepening of the flanking slopes, gravitative phenomena became a significant component of the surface processes occurring in this specific physical setting. Among

possible different types of landslides (Figs. 1-2), rockfalls, proven by isolated large sandstone boulders, affected the slopes below terrace T4, and determined the condition for the human use of the site.

The Pietralba archaeological site

The archaeological complex of Pietralba appears intimately connected with the surrounding natural landscape both for its setting along a steep slope inside a copse (Fig. 5) and because blocks of sandstone, in which monuments were carved, were a basic part of local landscape. Like most of the evidence of this kind from other regions of Central (Emilia-Romagna, Marches, Tuscany, Lazio), Southern (Campania, Calabria, Lucania) and insular (Sardinia, Sicily) Italy (Battistini, 2011), these are surface monuments and, therefore, cannot be referred to a definite archaeological context. In addition, no archive and/or oral tradition document is available. As a consequence, their chronological and functional attribution is still a matter of debate and investigation.

State of the art

Pietralba, from its discovery, has been the object of a number of chrono-functional hypotheses which alternatively considered the archaeological complex as an Umbro-Piceno sacrifice/cult/votive place, or, more concretely, as a craft productive area of indefinite chronology (from Proto-history to the Medieval Age) (Moroni Lanfredini & Laurenzi, 2011). In an attempt to hold back this proliferation of sometimes imaginative ideas, in 2010, a multidisciplinary project was undertaken in order to elucidate, as far as possible, both the chronology and the function of these monuments. An outcome of this research was the publication of a volume (Moroni Lanfredini & Laurenzi, 2011), containing several studies approaching the issue of Pietralba and of similar Upper Tiber Valley contexts, from different standpoints (geo-morphological, technological, archaeological, archaeo-astronomic). At the same time, also preliminary mineralogical and bio-chemical analyses (Santo et al., 2010; Santo et al., 2011a and 2011b) were carried out, aimed at characterizing the rock lithology and at possibly discovering organic substances as a result of the activity (ies) carried out at the site.

Artefact description

The complex of Pietralba is composed of four structures which are seemingly unrelated to each other (Fig. 5). These have been named using the traditional terminology relating to their hypothetical function or to the natural morphology of the “housing” rock (rectangular tub, L-shaped tub, throne, and pyramid).

The “rectangular tub” (Fig. 6) consists of a large rock block roughly quadrangular, 5 m long and 2 m wide. The tub was carved in the upper face of this rock, perhaps artificially levelled, with its longer edges parallel to the slope. The tub capacity is modest as the excavated part is few decimetres deep. On the shorter side below a rectangular recess 8 cm wide and 8 cm deep was opened, probably used for housing a removable wooden or terracotta lock-gate. The same side shows a central cut opening into a small ditch which descends downwards.

The “L-shaped tub” (Figs. 6, 7) is located 4 m below the rectangular tub and was carved in a rock of about 5.80 m x 4.20 m. This structure shows a very singular typology consisting of a narrow L-shaped ditch, about 40 cm deep, which is open at both its ends (west and north). Here the bottom of the rock was intentionally cut in order to obtain a sort of steep slide. It is likely that the ditch end(s) could be locked by means of wooden or terracotta mobile parts. Although no continuity or real contiguity has been observed, a functional connection between the rectangular tub and the L-shaped tub, by mobile and /or perishable structures, cannot be excluded.

A cluster of three sandstone blocks (throne, pyramid and small pyramid) is positioned about 40 m below along the slope. The rock “housing” the so-called “throne” (Fig. 8) is the largest one (around 4.20 m long and 3. 20 m wide), and has a roughly pentagonal shape. The denomination of throne is due to its chair – like morphology. On the top of the rock there is a circular artificial cavity.

The rock known as “pyramid” shows a natural pyramidal morphology (Fig. 9) with an equilateral triangle base measuring about 3 x 3 m. The eastern face, roughly triangular, bears two identical aligned circular cavities intentionally positioned 2 m from the ground. These cavities are reminiscent of two eyes. Owing to this feature and to the pyramidal morphology, the rock looks like an anthropomorphic figure.

The last block (small pyramid) has a pyramidal shape too, but it does not seemingly display any trace of human intervention.

Despite they are highly weathered, the tub, the L-shaped tub, the throne and the pyramid show still clearly visible manufacturing signs. Technological investigation (Giardino, 2011) has led to assume that these artefacts do not seem to be either functionally or chronologically coeval. Manufacturing traces suggest that the upper group (rectangular tub and L-shaped tub) is probably younger than the lower one.

Grooves visible on the surface of the rectangular and L-shaped tubs are distinctive of the use of hard and robust implements, such as picks and chisels, and indicate a fully historical age perhaps, Medieval or even post-Medieval; although re-manufacturing processes obliterating traces connected to previous uses cannot be ruled out.

Both artefacts below (throne and pyramid) are affected by a completely different, even if not less complicated, interpretative problem. The “eyes” of the pyramid, in particular, have preserved no tool sign which could be explained with the use of stone, horn or wooden implements. Moreover the general conformation of the rock, showing a flat triangular shape, and the central position of the “eyes” seem to mirror the purpose of representing a schematic human face. Such an object is conceptually much nearer to the ideology of prehistoric Megalithism than to the classic and Medieval world.

During some surveys in the surroundings a number of pottery shards scattered on the ground surface close to the rectangular and the L-shaped tubs were retrieved. These are mainly composed of vascular elements displaying features typical of the lower medieval period full phase, as most of them date back to the XI – XIII century A.D.

Sampling and Analytical Methods

The manufactured blocks of the archaeological site of Pietralba appear highly weathered; they are almost completely covered by moss and lichens and have been subject to exfoliation and flaking. In order to obtain unaltered rock samples we used a micro corer and we collected samples in different areas of the structure (Figs. 7-9). In each sample different portions were distinguished, corresponding to the different depth. In addition to those from the carved blocks, we collected rock samples also from unworked blocks of similar lithology, occurring in the site.

In order to characterize these samples, mineralogical, chemical and biological composition was obtained.

Mineralogy and whole rock major element analyses

The mineralogical composition was determined on the rock powders of each sample by means of a Philips PW 1050/37 diffractometer with acquisition system X’Pert PRO Philips, operating at 40 KV, 20 mA, with Cu anode and graphite monochromator, investigated range 2θ□5-70° (detection limit 4%).

The abundance of major elements was obtained by combined wet chemical techniques [Na_2O, MgO, FeO and loss on ignition (LOI)] and X-ray fluorescence by using a Philips PW 1400 wave length dispersive spectrometer with Rh anode. The correction for the matrix effect was made according to the method of □Franzini et al. (1972). In particular, the content of Na_2O and MgO was obtained by atomic absorption spectrometry (AAS) after solubilized samples through an acid attack with HCl and HF; ferrous oxide FeO was measured by titration; total volatile components (H_2O+ and CO_2) were determined as loss on ignition (LOI) at 950°C on powder dried at 110° C.

Whole rock mineralogical and major element analyses were carried out at the Department of Earth Sciences (University of Florence).

The rock samples were successively analyzed by the Fourier Transform Infrared Spectroscopy (FT-IR) and by the Gas Chromatography-Mass Spectrometry (GC-MS) and High-Performance Liquid Chromatography with Diode-Array Detection (HPLC-DAD) in order to biologically characterize them. Analyses were performed at the Department of Chemistry and Industrial Chemistry (University of Pisa).

Several samples, collected in different position and depth of the tubs, were analyzed and compared, with the aim of observing the possible differences between the surface in use and the rest of the object under study. In this way, we tried to identify any possible residue related to the use of the tub in the past.

FT-IR analyses

The rectangular and L-shaped tub rock samples were dried at 40° C for 48 hours and successively the powder obtained from the external layer was investigated via infrared spectroscopy (FT-IR) after extraction in two different classes, with different polarity , of organic solvents (chloroform en - propanol), in order to solubilize the organic substances possibly present in a selective manner.

The samples were placed in two vials and in each vial was added a different solvent; then, they were allowed to extract for 48 hours. At this point, 50 drops of solvent were taken and were left to evaporate under a hood. Once evaporated KBr was added and was prepared the tablet to be analyzed by the FT-IR spectrometer.

GC-MS analyses

The collected samples were also subjected to a previous published analytical procedure based on gas chromatography- mass spectrometry (GC-MS) (Andreotti et al, 2006) for the identification of acyl-lipids, waxes, resinous materials in the same microsample. Samples (1-5 mg) were subjected to saponification with 10% hydroalcoholic KOH. Neutral organic components were extracted with n-hexane and, after acidification, the acidic organic components were extracted from the residual solution with diethyl ether. Aliquots of both the extracts were derivatised with N,O-Bis(trimethyl)-silyl-trifluoroacetamide (BSTFA) containing 1% trimethylchlorosilane (Sigma) using isooctane as a solvent. 2µl were analysed by GC-MS using hexadecane and tridecanoic acid as internal standards.

The Agilent Technology was made up of 6890N gas chromatograph coupled with a 5973 single quadrupole mass spectrometer equipped with PTV injector. The mass spectrometer was operated in the EI positive mode (70 eV). MS: T transfer line: 280 °C; T ion source: 230 °C; T quadrupole: 150 °C. GC: HP-5MS fused silica capillary column (J&W Scientific, Agilent Technologies), deactivated silica pre-column; carrier gas: constant flow mode (He, purity 99.995%) at 1.2ml/min. GC conditions: T init. = 80°C, 2 min isothermal, 10°C/min up to 200°C, 4 min isothermal, 6°C/min up to 280°C, 40 min isothermal.

HPLC-DAD analyses

The sample (ca. 2 mg) was subjected to the extraction by solution of methanol: water (1:1) in a glass vial for 60 minutes at 60°C in an ultrasonic bath; the supernatant is collected and stored and then purified on a Nylon filter (4 mm syringe filter,0.45µm PTFE, Alltech, Italy) and dried under nitrogen flow and then dissolved in 100 µL of solution water:acetonitrile (1:1); a 20µL aliquot is injected into the chromatographic system.

A HPLC consisting of a PU-2089 Quaternary Gradient Pump with degasser (Jasco International Co., Japan), equipped with a 20µm Rheodyne Model7125 injection valve and coupled to a spectrophotometric diode array detector MD-2010 (Jasco International Co., Japan) was used. The data were processed by ChromNav® software. The chromatographic separation was performed on an analytical reverse phase C-18 column (Wakosil II 5C18RS, 5µm, 250 mm×4.6 mm, SGE International, Australia) connected to a C-18 pre-column (1mm Opti-Guard C18, Optimize Technologies Inc., Oregon, US).The eluents were: A, acetonitrile with 0.1% trifluoroacetic acid; B, water with 0.1% trifluoroacetic acid. The programme was: from 15% A and 85 % B, hold for 5 minutes, then to 50 % A and 50 % B in 25 minutes; from 50 % A and 50 % B to 70 % A and 30 % B in 10 minutes. Conditioning took 10 minutes; the cleaning step was achieved with 100% A for 10 minutes. The flow rate was 1 mL/min. The detection wavelength was set at 275 nm and 254 nm the acquisition of DAD spectra was achieved in the range 200-650 nm, 4 nm steps.

Results

Mineralogical and geochemical analyses performed on the rocks collected in the Pietralba archaeological site show strong similarities among the samples from the different artefacts and the unworked blocks. They are mainly characterized by quartz and feldspar (K-feldspar and plagioclase) and subordinate amounts of calcite and phyllosilicates. This kind of rock can be classified as sandstone. The average composition expressed in % of the major element oxides is shown in Table 1.

Chemical analysis was performed to find embedded organic materials in the samples. The FT-IR analyses obtained on different samples from the rectangular tub (extraction in chloroform) have shown the presence of organic substances of lipid nature (fatty acid and esters; Fig. 10). On the contrary, soluble organic substances were not detected in n-propanol and were completely absent in the L-shaped tub samples.

Gas chromatography coupled with mass spectrometry (GC-MS) and High-Performance Liquid Chromatography with Diode-Array Detection (HPLC-DAD) was also applied. In order to avoid environmental contaminant, the samples were taken through core from deeper layers. Despite these precautions, all the analyzed samples present similar chromatographic profiles (Figs. 11-12).

In the chromatograms obtained by GC-MS (Fig. 11) it was identified the presence of linear fatty acids with C12 to C18 carbon atoms. The most abundant being palmitic (hexadecanoic acid, C16:0) and stearic acids (octadecanoic, C18:0). The presence of odd chain length fatty acids and cholesterol indicates that animal fats are present in the samples. Moreover, odd-branched (C15 and C17) fatty acids suggest that the animal lipids have undergone bacterial degradation.

The general chromatographic (GC-MS) pattern and the fatty acid profile suggest the occurrence both of animal (fatty acids with odd carbon atoms, cholesterol) and plant (fatty acids with even carbon atoms, β-sitosterol) origin.

With the aim to detect the presence of possible compounds with low volatility and high polarity, which are not easily detectable by GC-MS analysis, the technique of HPLC-DAD has also been used. In figure 12 are present chromatographic profiles registered for all the analyzed samples collected from the tubs (rectangular and L-shaped). It is evident that the obtained profiles are very similar to one another and it is not possible to observe significant differences.

Discussion

The rock "monuments" of Pietralba can be distinguished into two different groups located along the slope at a distance of about 40 m. This spatial distribution could be in itself indicative of a different function and a different age of these structures. Such an hypothesis is supported by the pyramid configuration, which is strictly reminiscent of similar monuments belonging to the megalithic world, and by the technological study outcomes (Giardino, 2011). Hence, according to the available data, the lower couple of “monuments” (throne and pyramid) could exhibit an older, probably pre-proto-historic, age which does not contrast with the astronomical calculations (Nocentini, 2011). If this interpretation is correct, the two groups of structures not only do not share the chronology but neither do they share the function, as the pyramid in particular is most probably to be connected to the cult/ritual sphere rather than to a productive activity.

Broaching the present study we were mainly interested in defining the economic role of the tubs whose ergonomic characteristics (as well as their probable chronology) seem to be indicative of a specific productive use of the site during the Medieval Age, at least according to the most reliable hypothesis.

The Pietralba rock is made of sandstone resulting from rockfall along the slopes which actually subtend thick sandstone and mudstone strata (Fig. 2) This relatively weak lithotype displays mechanical characteristics (workability, degree of compaction, wear resistance) making it ideal to be worked upon in order to obtain tanks.

The tubs are located very close to each other and just below the oldest terrace T4 (Fig. 3) on the steepest portion of the slope characterized by numerous large sandstone blocks; their working was most probably complementary. The presence of conduits, openings and artificial blocks suggest a function involving the use of a liquid phase, e.g. water or other liquids deriving from the organic material treatment. However, due to the small depth (a few decimeters) of the rectangular tub and the limited availability of water at short distances, it is believed that only small amounts of material were used. The position of the rectangular and L-shaped tubs, along the slope gradient, suggests the need to exploit gravity to drain any kind of extract. The lack of connection between the two structures could probably be remedied trough mobile structures such as wooden gutters..

In the L-shaped tub, the narrow channel with its sharp turn towards the valley suggests a more marked drainage function: the 90° elbow may indicate a filter or block action for foreign material suspended in the solution which could be collected at this channel point and then eliminated from the production cycle.

Generally, with just some exceptions, the function of this type of artefacts remains difficult to interpret and several hypotheses have been proposed in the literature, such as: small water troughs, olive and/or grape presses (Quilici, 1988; Masi, 2005; Micati and Tonelli, 2008), tanks for the tanning of hides and skins or the extraction of tannin (Cherici,1990). Regarding Pietralba tubs, it is difficult to imagine their use as crushers or presses relating to olive oil or wine production, in an environment completely unsuitable for this kind of cultivation. At the same time, we can exclude a proto-industrial use aimed at the production of tannin, given the small depth of the tubs.

Alternatively, Pietralba tubs could be used in the production of woad, a blue-indigo pigment, derived from the Isatis tinctoria, a biennal herbaceous plant. This industry was particularly active in the Tiber Valley from the late Middle Ages to the Renaissance. In theory, the characteristics of the Pietralba tubs could be suitable for the first stages of the woad processing (Benvenuti et al., 2011). According to this hypothesis the L-shaped tub could be used to shred the leaves and to collect the liquid produced at the end of the channel. At the same time the shredded leaves could be placed into the rectangular tub and be mixed with water and/or urine which could then be collected and reused. Unfortunately we have no tangible proofs of the performing of a similar productive activity in the Pietralba tanks as a prerequisite for this would be the proximity in the area of Isatis tinctoria ancient crops. Such a possibility can not be obviously excluded a priori, even though no fossil pollen of Isatis tinctoria was identified during the palynological study (Mariotti Lippi, Gonnelli, 2011). In any case, even if the tubs of Pietralba were involved in the productive chain of the woad, the idea of a veritable industrial production is nearly untenable, given the extent of the complex and the limited capacity of the tubs themselves. It is more likely that this production was of a local household level, probably prior to the full development of the industry of woad in the Upper Tiber Valley.

We used different innovative chemical methodologies in order to shed light among the various hypotheses through the identification of organic substances possibly present on the rock samples collected from the tubs.

The Fourier transformed infrared spectroscopy was useful for providing initial hypotheses about the substances present. The FT-IR analyses revealed the presence of organic substances of oily nature (Fig. 12) on different samples from the rectangular tub. These preliminary analyses of the organic residues provided a fingerprint and general information on the nature of organic material. Successively, the Pietralba rock samples were analyzed by gas chromatography–mass spectrometry; in all the analyzed samples the patterns did not reveal the terpenic compounds, thus, the presence of a vegetable resin was ruled out (Langenheim, 2003); the organic residues examined showed a very similar fatty acid profile, with a dominance of saturated, even carbon number fatty acids and in particular of palmitic and stearic acids.

The composition of fatty acids could be ascribed to a mixture of animal and vegetable lipids at a quite low concentration. Since the tub is in open air and due to the low amount of the identified compounds, their presence can be ascribed more to an environmental contamination than to their effective past use in the tub. On the basis of the observed lipid profile, it is not possible to say whether a vegetal-origin lipid material had been added to the mixture or not.

Unfortunately, the HPLC-DAD analysis has not produced significant results. There were no significant differences between samples taken at different points of the object under study.

The multidisciplinary study carried out on Pietralba allowed us to realistically assume, for the two tubs, a chronological framework, the Medieval Age, and a function most probably correlated to a craft productive activity. Unfortunately, we failed in the attempt to define, through detecting the worked material, its specific function in detail, since chemical analyses did not produce clear results.

It is worth specifying that proposing a functional interpretation connected to a specific chronology, does not automatically mean that Pietralba played only this role and that its history was limited to this "brief" lapse of time. We are not able and we do not want to reject, a priori, diverging opinions and theories, even though they are beyond our pragmatic approach. For many of the rock monuments scattered throughout Italy, traces of their holy/therapeutic/miraculistic significance remained in the oral tradition (Battistini and Nocentini, 2011; Battistini and Battistini, 2011).

Regarding Pietralba tubs no information concerning its possible past cult and/or ritual function is available from either oral memory or written sources. Perhaps we can add also this negative evidence to support the prevailing economic function of this site.

Our multidisciplinary study on Pietralba has highlighted the existing difficulties in analyzing the particular problem of rock structures from the standpoint of the methodological approach, on the one hand, and of the interpretative model, on the other hand. Both the method and the model can not be generalized. Every find constitutes a separate case to be examined in a multidisciplinary way with consideration of all variables involved. There are solid signs to believe that most rock tubs had a complex and articulated history, not always chronologically circumscribed and connected to a single specific function. Hence also the chronological issue must be considered from this "enlarged" perspective. Being able to identify a possible chronology does not necessarily mean defining the whole time span in which a given structure was functionally active.

Concluding remarks

The FT-IR preliminary analyses, obtained on different samples from the rectangular tub, have shown the presence of organic substances of an oily nature (fatty acid and esters). However, in all the analyzed samples the GC-MS patterns did not reveal the terpenic compounds, thus, ruling out the presence of a vegetable resin. Since the different samples showed a very similar chemical profile, we are inclined to interpret these results as due to an environmental pollution rather than to an anthropic activity. Nevertheless the possible use of the tub(s) for maceration or beating of cortex or berries, acorns and/or leaves of oak or chestnut should not be ruled out. A number of environmental characteristics, such as the topographic position far from any important water sources, the ground morphology and the vegetable cover most probably dominated by oaks such as presently, as well as the ergonomic features of the tubs which display a limited containing capacity, suggest the presence of a manufacturing cycle carried out at a household level and based on local products connected to the resources being present at the site. Interestingly, for instance, the practice of soaking acorns in rock tubs, in order to rid them of worms (known as "ghiandantatico") for feeding pigs, seems to be documented in the Upper Tiber valley since the Longobard period (Ubaldi Nucci, 1997).

In conclusion, we believe that our study is useful for demonstrating that the historical framing (at least in the broad sense) and the enhancing of very particular and "difficult" monuments like the so-called "rock tubs" is possible, when using a correct multidisciplinary approach. Actually this type of artefacts, since apparently indecipherable, is, most of the time, unfairly confined to the "second division" in the "league" of archaeological heritage.

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Captions

Fig. 1 – Pietralba. Location of the archaeological site.

Fig. 2 – Geological map of the Montedoglio-Tignana Creek area with location of the Pietralba site (modified after Moroni Lanfredini and Laurenzi, 2011)

Fig. 3 – Aerial view of the study area from Google EarthTM with annotated topography and the location of the rocky blocks discussed in the text. The steep slopes flanking the Tignana channel are mantled by several landslides (symbols as in Fig. 2). T1-T4 are the remnants of terraced surfaces marking the progressive incision of the Tignana Creek.

Fig. 4 – Hypothetical evolution of the Tignana Creek valley during the Quaternary (not to scale). The progressive river downcutting left the terraced surfaces T1-T4 determining the subsequence development of steep slopes prone to landsliding.

Fig. 5 – Pietralba. Section and planimetry of the area where the lithic “monuments” are located.

Fig. 6 – Pietralba. Overview of the rectangular and L tubs. In the rectangular tub are reported the micro core areas of sampling.

Fig. 7 – Pietralba. The L-shaped tub. Manufacturing traces are clearly visible on the bottom. The micro core areas of sampling are reported in the magnification of the squared area.

Fig. 8 – Pietralba. The throne.

Fig. 9 – Pietralba. The Pyramid.

Fig.10 – Infrared spectra (4000-450 cm-1 obtained on one sample collected in the rectangular tub. The numbered peaks are typical of organic substances of lipid nature (fatty acid and esters).

Fig. 11- Total ion current chromatograms of samples a) A (rectangular tub), b) B (rectangular tub), c) C and d) E (L-shaped tub); (IS1 = hexadecane, IS2 = tridecanoic acid). The acidic

species are present as TMS-derivatives. Cx:y: linear monocarboxylic acid with x carbon atoms and y-insaturations; *: phthalate contamination.

Fig. 12 - HPLC chromatograms at 254 nm of samples a) A (rectangular tub), b) B (rectangular tub) , c) C and d) E (L-shaped tub) extract.