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Opaque glazed ware from *Satrianum* archeological site (Basilicata, southern Italy): ceramic bodies and glaze/decoration technologies

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***Abstract* – The present work is part of a PhD project entitled "Archaeometry of ceramic artefacts. Innovative tools and solutions for the knowledge, diagnostics and conservation of ceramic finds from archaeological contexts", concerning the study, the analysis and the application of innovative, effective and sustainable solutions for the knowledge of the archaeological heritage related to ceramic artefacts from medieval archaeological contexts in Basilicata, aimed at the compositional characterization of ceramic bodies and their coatings, including decorative elements when present. Here are reported the results from an archaeometrical investigation carried out on the opaque glazed ware from *Satrianum* archeological site. Raw materials provenance as well as bodies and glaze/decoration technologies have been investigated by integrating destructive and non-destructive techniques such as micro X-Ray fluorescence and micro Raman spectroscopy, and powder X-Ray diffraction.**

I. INTRODUCTION

This present work is part of a PhD project entitled "Archaeometry of ceramic artefacts. Innovative tools and solutions for the knowledge, diagnostics and conservation of ceramic finds from archaeological contexts", concerning the study and the application of innovative, effective and sustainable solutions for the knowledge of the archaeological heritage related to ceramic artefacts from medieval archaeological contexts in Basilicata, aimed at the compositional characterization of ceramic bodies and their glaze, including decorative elements when present. In the aforementioned project [1], ceramic fragments, and their glaze and decorations, from three archaeological sites in Basilicata (southern Italy) were analyzed: *Satrianum* (municipality of Tito-PZ), Santa Maria di Anglona (municipality of Tursi- MT) and from Castello di Moliterno (municipality of Moliterno- PZ). For convenience, since in many cases it was not possible to ascribe the attested ware to the canonical archaeological class due to the conditions of the glazes, it was decided to divide them using the ad-hoc macro-categories which account only of an autoptic criterion: i.e., unglazed ware; unglazed ware painted with red lines; opaque glazed ware; transparent glazed ware; graffita ware [1].

In the present work are reported the results of the archaeometrical investigation carried out on the opaque glazed ware from *Satrianum* archeological site. Raw materials provenance as well as bodies and glaze/decoration technologies have been investigated by integrating destructive and non-destructive techniques such as micro X-Ray fluorescence and micro Raman spectroscopy, and powder X-Ray diffraction.

II. THE ARCHEOLOGICAL SITE OF SATRIANUM

The *Satrianum* archaeological site stands on a hill that reaches almost 1000 m in height, in the municipality of Tito, in the province of Potenza, and was subjected to archaeological investigations starting in the 1970s [2]. Since 2000 it has been part of a multidisciplinary project directed by the School of Specialization in Archaeological Heritage of the University of Basilicata [3, 4, 5, 6].

The top of the hill is still occupied by the remains of the medieval settlement: a tower and two large villages along the southern and western slopes of the hill are preserved. The summit plateau, together with the square tower (seat of the civil authority) has returned the seat of ecclesiastical authority, an episcopal citadel - characterized by environments suitable for ecclesiastical life - and the monumental cathedral [5, 6, 7, 8, 9, 10]. During the 2006-2008 [7] and 2015 archaeological excavations - carried out by the School of Specialization in Archaeological Heritage, were found inside the episcope as well as near the cathedral some areas destined as throw. The archaeological investigations made it possible to recover a stratigraphic succession, characterized by layers of earth, rubble, lime lenses and finally, to close all this, by a thick

layer of collapse (sign of the definitive abandonment of the area [6] and returned a lot of ceramic fragments.

III. THE OPAQUE GLAZED WARE FROM S*ATRIANUM* SITE: CONSIDERATION ON THE CERAMIC BODIES

The ceramic bodies of thirty opaque glazed ware fragments, with the Courtesy of the Superintendence of Basilicata, have been characterized using powder X-ray diffraction. The comparison of mineralogical composition of the fragments with the clay sediments belonging to the Variegated Clay Group and to the Subappenine Clays formations sampled in Basilcata and with the mineralogical evolutionary trend as deduced from firing tests and the Tg-DTA curves [1] allowed to discriminate between local and imported artefacts, to assess the most probable raw material used in the opaque glazed ware production and the technology adopted by the workshops.

With the aid of the multivariate statistical analysis - using the PCA (Principal Component Analysis) method to extract factors and the abundances of mineralogical phases (wt%) normalized to quartz detected in the ceramic body as input variables - the opaque glazed ware from *Satrianum* can be divided into two different groups, exhibiting different mineralogical composition (*Fig.1*).

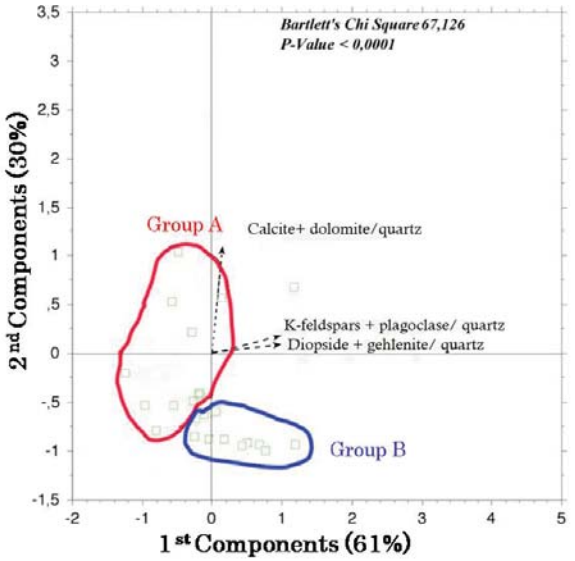

Fig.1 Output of the multivariate statistical analysis using PCA method to extract factors

The first group (Group A) include the opaque glazed ware subjected to firing temperatures between 800-900 °C and the raw material used for its production - as deduced from comparison with the evolutionary trend of mineralogical composition (data not shown) - likely came from the Argille Variegate Group formation outcropping both in the surrounding of the *Satrianum* as in the Rotondella ridge, southern of Tursi (PZ). For the second group (Group B), it is hypothesized firing in kilns at temperatures above 950 °C and the use of Subappenine Clays, as those of the type outcropping in the Tursi (PZ) area [1].

On this basis, a local production is suggested for the major part of the analyzed opaque glazed ware from *Satrianum.* Besides, different raw materials and/or technologies may account for the difference in mineralogical compositions observed.

IV. THE OPAQUE GLAZED WARE FROM S*ATRIANUM*: INTEGRATING INFORMATION FROM GLAZE/DECORATION AND CERAMIC BODY

Micro X-Ray fluorescence and micro Raman spectroscopy were used to characterized glaze and decorations from *Satrianum* opaque glazed ware and to understand the technology behind its production.

Opaque glazed ware decorated in brown and green attested at *Satrianum* in the layers of the third quarter of the XIV century has a lead-tin opaque glaze. As an example, is the mapping of elemental composition for a ceramic fragment pertaining to a bowl (TSM 8; *Fig. 2*) in which it can be observed the lead and tin glaze. Tin, that has been preserved only along the edge and under the decorations, is present in the mineralogical form of cassiterite (as deduced by powder X-Ray; data not shown). Relevant is the presence of a pseudo-engobe, consisting of calcium phosphate of organic origin (hydroxyapatite – the main constituent of the bones), probably made from animal bone dust. The pigment in the brown decorations contains manganese phases and the one from the green decoration copper phases.

Opaque glazed ware decorated in brown and green attested at *Satrianum* from the first half of the XIV century exhibit compositional characteristics of the ceramic body which suggest a local origin. The identification of the raw material used in this ware production is likely the clay deposits from the Subapennine Clays (sampled in Tursi locality). High firing temperatures are hypothesized for this type of ware. However, within this group of ware a special mention deserves the TSM11 sample - attested in the layers of the first decade of the XIV century and pertaining to a bowl - which has a ceramic body richer in calcite and therefore may have been fired at relatively lower temperatures and exhibits the presence of peculiar newly formed phases in the bright green and brown decorations (*Fig. 3*). This coupled to stylist consideration allows to hypothesize a non-local origin for it.

The glaze from the opaque ware decorated in brown, green and yellow, *e.g.* the TSM 4 sample pertaining to a jug, is also characterized by a lead-tin glaze. The composition of the ceramic body - rich in high temperature phases (gehlenite and diopside) - is also compatible with high firing temperatures and the use of Subappennine Clays (Tursi locality) as raw material. The brown

decorations is made of manganese and iron phase, jacobsite ($Mn^{2+}Fe^{3+}{}_2O_4$) whereas the yellow colored span within the brown lines at the jug belly contain well crystallized calcite (*Fig. 4*).

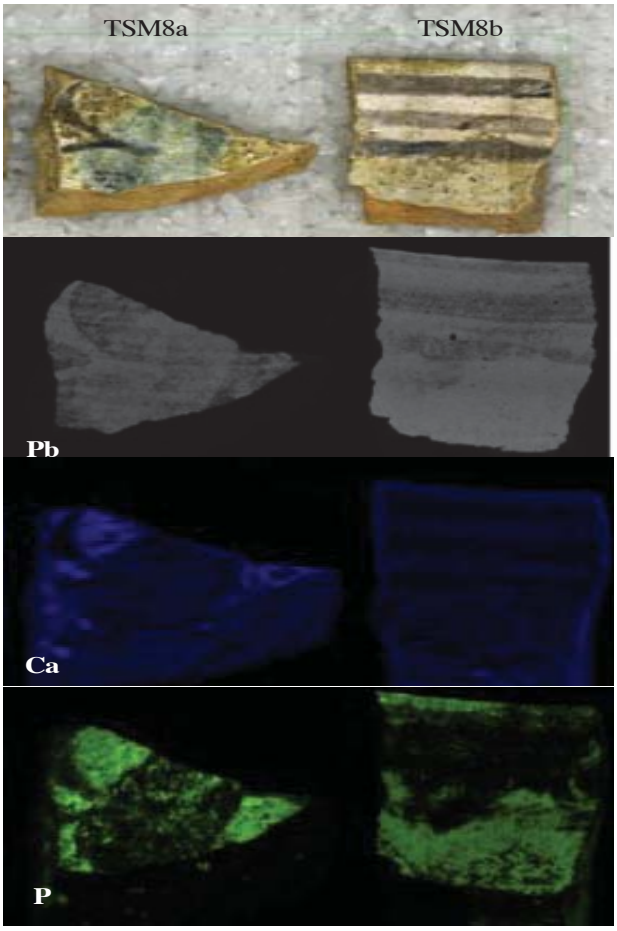

Fig. 2. Micro XRF mapping carried out with M4 Tornado from Bruker. TSM 8 sample pertaining to a bowl.

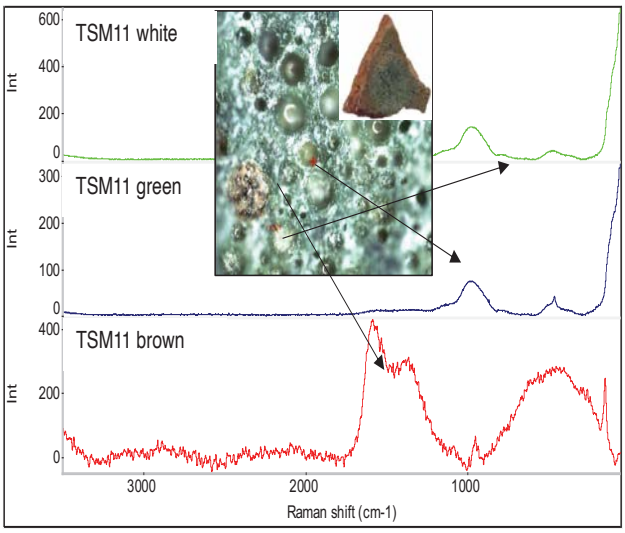

Fig. 3 Micro–Raman spectra of decorative elements from sample TSM11 pertaining to a bowl.

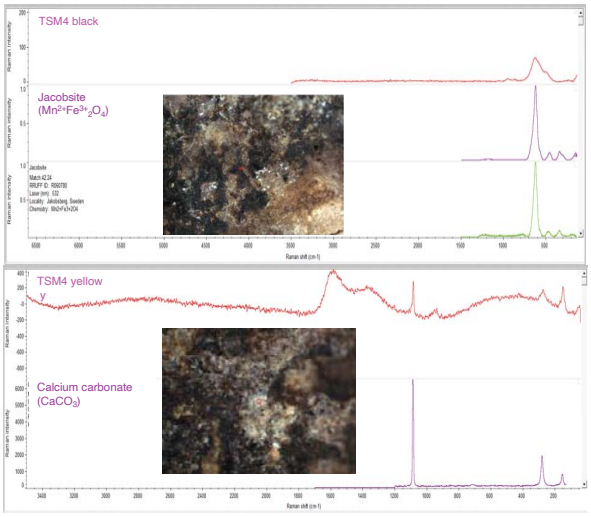

Fig. 4. Micro–Raman spectra of decorative elements from sample TSM4 pertaining to a jug

The mediaeval Satrianum archaeological escavation returned an opaque glazed ware fragment (TSM 25 sample) pertaining to an open shape, distinguished by a gold-colored glaze. The opaque glaze is rich in lead (with only traces of tin; *Fig. 5*). The golden yellow color is probably given by an arsenic sulphide, the orpiment (As2S3), typical of volcanic areas such as the Vesuvius area. Being the ceramic body compatible with a raw material such as Subapennine Clays (Tursi locality) and temperatures above 950 ° C, a local production is hypothesized.

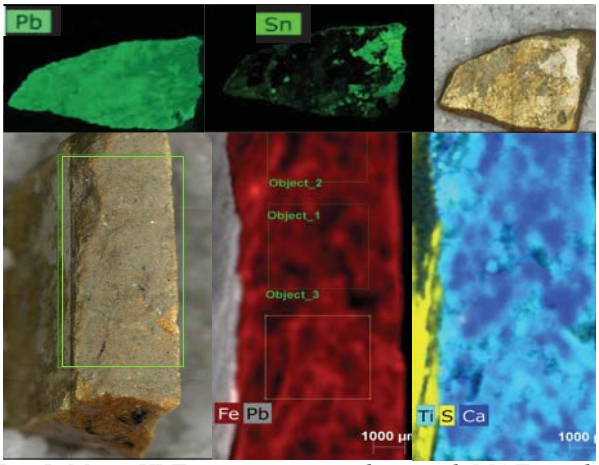

Fig. 5. Micro XRF mapping carried out with M4 Tornado from Bruker. TSM 25 sample pertaining to an open shape.

The fragment of a jug (TSM16 sample) characterized by a particular style that features analogy with Andalusian productions [6, 10], presents a green decoration in which, apart from Cu which notably characterizes green decoration in *Satrianum* opaque glazed ware, it has been identified in this decoration the Zn chromophore for the first time (*Fig. 6*). This, coupled to the ceramic body

compositional characteristics not compatible with local clays, suggests a non-local provenance.

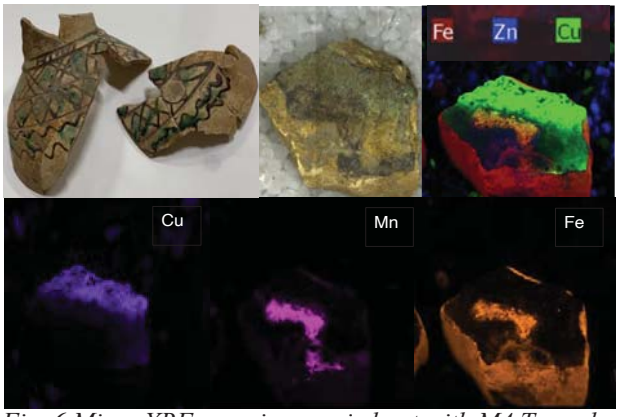

Fig. 6 Micro XRF mapping carried out with M4 Tornado from Bruker. TSM 25 sample pertaining to a jug

Opaque glazed ware decorated in green - a production decorated in green on a white background attested in the layers starting from the end of the XII century, which has green lines that follow the edges of the jugs and bowls - is characterized by the presence of a typical decoration with green globes inside the bowls or on the jugs. The compatibility of the compositional characteristics of the ceramic bodies with Subapennine Clays leads to the hypothesis that these artefacts come from local workshops. A provenance from shops located in the north of Apulia, where these deposits also outcrop, cannot be excluded [1].

In the opaque glazed ware from *Satrianum* another group (represented by the TSM 13 and 15 samples) has been identified which consists of bowls, attested in the archaeological layers starting from the first half of XIV century with a three-color decoration (brown, green and red) and the presence of an "S" in the center of the bowls. These, on the basis of archaeometrical data on ceramic body and glaze/decorations and of archaeological data (the wares are compared with those attested in the castle of Policoro [11]) may be the result of a local production and the use, as raw material, of the "clays" of the type of the Variegated Clays Group [1].

I. CONCLUSIONS

The integration of compositional information on the ceramic body of the opaque glazed ware from *Satrianum* with those resulting from the analysis of the glaze and decoration and based on stylistic considerations it can be observed that in the *Satrianum* site, starting from the end of the XIII century to the first half of the XIV century, a varied series of local productions, which however circulate in concomitance with imported productions are attested.

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