

# The byzantine fresco of Dormitio Virginis (12<sup>th</sup> century): Diagnosis and Intervention

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**Abstract** – This paper focuses on the microscopic and mineralogical characterization of the materials of a precious medieval fresco painting, a byzantine “Dormitio Virginis” in Sicily, discovered during a restoration work in a monastery located in the South of Italy. An exhaustive description of the original constituent has been obtained, enriching the knowledge on historical materials and techniques. Several techniques are used, such as optical and electron microscopy, X-ray fluorescence and X-ray diffraction, especially when the damage processes are the main concern. The experimental investigation, carried out on pigments and on binder, has allowed a better understanding of the original materials as well as of the remote techniques used to realize the artwork and of their state of conservation. The paintings are realized either by a fresco and lime coat and the analyses reveal the use of a simple color palette, based on natural earth, typical of the Byzantine pictorial tradition.

## I. INTRODUCTION

Byzantine monks, who settled in eastern Sicily after the conquest of Emperor Justinian, brought on the island figurative languages and architecture that influenced all the artistic future [1, 2]. An extraordinary example of Byzantine culture in Sicily is described by a beautiful pictorial artwork (12<sup>th</sup> century), inside the monastery of Santa Maria del Rogato in Alcara Li Fusi (Messina), representing the only fresco in Sicily of the “Dormitio Virginis” (Fig. 1). The figures and pictures are part of a theological program focused on the Virgin Mary: the dormitory Virginis, a sequence of Orthodox saints, and the Virgin that nurses the baby Jesus. The technical peculiarity that characterizes the fresco painting, together with its severe decay conditions (related to a cohesion loss of the preparatory layer and of the painting itself), make this artwork an exceptional case of study, finalized to the knowledge of the original materials and to project accurate intervention actions of

restoration. Additionally, this work can give a contribution for understanding the development of wall paintings in the Byzantine era, since written sources, in general, offer only ambiguous information about painting techniques, [3]. Moreover, much of the hitherto scientific research on Byzantine wall paintings has been focused on metropolitan monuments [4].

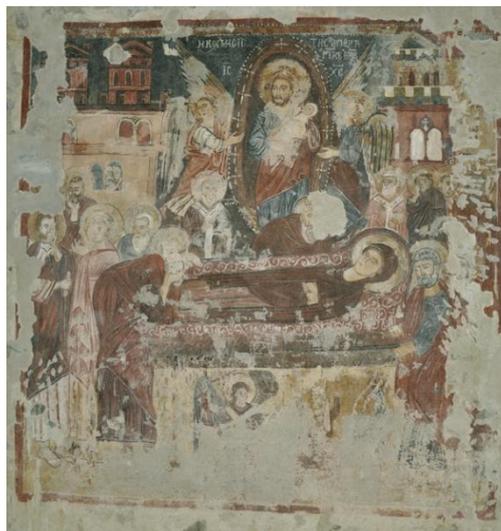


Fig. 1. a) The fresco of the Dormitio Virginis, after the restoration.

In addition, the study of the ancient renders and the characterization and mapping of degradation forms are of utmost importance to guarantee the conservation of such ancient monument and can give valuable information about its history and past interventions [5]. All these considerations are essential either to plan a correct conservative intervention providing, at the same time, precious elements for historians to trace the identity and the authorship of the work art.

In particular, this paper presents the chemical,

mineralogical and microstructural characterization of the internal renders of the Sicilian monastery. These investigations allow identifying the techniques and the materials used, and put them in relation to the different realization times or of restoration interventions as well. The samples collected are analyzed either as they are, in the form of micro-fragments, and in the form of cross-sections, depending on the scope and instrumental techniques. The micro-fragments allow the analysis of the paint surface composition, texture, and state of conservation; from the cross-sections it is possible to gather data about the number and paint layers stratigraphic succession, mortars and paint layers thickness and composition, pictorial technique, pigments physical and optical properties and, finally, its state of conservation.

## II. EXPERIMENTAL PROCEDURE

### A. General description of the work of art

The monastery of Santa Maria del Rogato, built around the 12<sup>th</sup> century, is an example of monastic Byzantine architecture. The monastery consists of the cells, where orthodox monks lived, and a small church with a single nave. Over the centuries, earthquakes and structural changes have affected the church, and few of the original architectural traces, testimonies of Byzantine figurative culture, are still preserved through frescoes. In addition, many of the existing frescoes are hidden from layers of plaster and lime. Actually, after the first restoration work, consisting in the removal of plaster and lime layers, four fresco portions emerged in the original masonry of the church, focused on the Virgin Mary. The main Marian subject is represented by the Dormitio Virginis in the south wall of the church, while on the opposite side is depicted the Madonna who nurses Jesus child. To the right of the scene depicting the Dormitio Virginis, some saints of the Orthodox Church are painted; between the saints, one can be recognizable as St. John the Baptist. On the opposite wall, similar scenes are presented but, unfortunately, it is not possible to understand how these saints were depicted because of the bad state of preservation. The technical aspects of the frescoes of Santa Maria del Rogato reveals technical peculiarities of the Eastern Methodological Tradition, like the presence of straw and charcoal in the plaster [6], and the crushing of the plaster called "politiones" [7]. This correspondence supports the hypothesis that the frescoes were realized by a Byzantine monk, coming from the Orient to dwell in the Sicilian Monastery.

### B. Sampling

The sampling is a crucial step that can influence the success of the characterization methodology. It is normally carried out using a small chisel or collecting fragments from high-degraded areas, and the location

must be documented before and after removal of the sample. In our case, we have collected only fragments or little samples, taken in different zones, generally in adjacent areas of losses (e.g., fractures and lack of adhesion). In particular, the samples are collected from: the main composition, that is the Dormitio Virginis (DV), the St. John the Baptist with other orthodox saints (S) and the Virgin with Jesus (VJ), as shown in Fig. 2.

From each area, the original materials consisted of two groups: i) micro-fragments of paint and preparatory layers; ii) fragments of rough plaster layer (*arriccio*), that is the under layer of plaster on which the drawing of the fresco is done. The presence of renders, more recent respect to the original paintings and partially covering the ancient frescoes, are investigated too.



Fig. 2. Sampling positions from: a) the Dormitio Virginis, DV; b) the St. John the Baptist and other orthodox saints, S; c) the Virginis with Jesus, VJ.

### C. Microstructural and mineralogical analysis

Once in laboratory, the first step is the careful observation of the collected samples using a stereo-zoom microscope (Leika S8APO), in order to identify particular features such as lime lumps or additives (fibers, inclusions, clays, charcoal, etc.) and, if necessary, to analyze the different stratigraphic layers. Then, the optical microscopy (OM) is coupled with other techniques for a qualitative identification of the different component of the mortars constituting the preparatory layer and the *arriccio* as well [3]. This analysis is conducted using X-ray fluorescence (XRF), X-ray

diffraction (XRD) and optical and scanning electron microscopy (OM and SEM, respectively). In particular, XRF is performed by means of X Spectro-Xepos III instrument and it is used to have information about elemental composition. The composition of the crystalline phases is determined with a PANalyticalXPertPRO diffractometer, equipped with Xcelerator detector and Cu X-ray source. The diffraction pattern is registered in the range of 5-70° 2Theta and 0.026° steps. Highscore Plus software is used for phase analysis.

SEM observations, performed on a Philips XL30CP with an Oxford INCA Energy 250 energy dispersive x-ray spectrometer (EDX), allow a further insight on the composition and morphology of the considered mortar samples. Particularly, it can be used to examine the textural interrelationships of the components and phases present that are too small to observe by optical microscopy, like salts, or organic/biological constituent. The EDX spectra allow the elemental analysis of the mortar components, and hence, complement the XRD analysis. Prior to SEM analysis, the samples are coated with a thin film of gold in a vacuum evaporation system.

As concerns painted samples, it is important to identify and characterize its constituents and features like, for example, the number and thickness of each layer, the type of pigments and their proportion. The micro-fragments of paint and preparatory layers are prepared as polished sections, examined by OM and SEM-EDX. The preparation of the polished cross-sections is conducted by impregnating the sample with an epoxy resin and cutting it perpendicularly to the layer. The polished surfaces are observed by means of the stereo-zoom microscope and by a fluorescence microscope Zeiss Imager A2 with a Leica DFC 350 FX digital camera, to assess the presence of biological material auto fluorescent. Optical observation of cross-sections enables the study of its layered structure together with the measurement of the thickness of each layer of paint, color, texture and pigment particle size. Afterwards, the cross-sections are analyzed by SEM-EDX used also for the mapping and the study of the pigments morphology.

### III. RESULTS AND DISCUSSION

#### A. Material characteristics of the arriccio and the preparatory layers

From optical and mineralogical results, the mortars related to the *arriccio* samples show essentially the same composition and microstructure, (Fig. 3), giving rise to the hypothesis that the application of the plaster was drafted in at the same time. In particular, the samples are composed by 30% of calcite (CaCO<sub>3</sub>, ICSD#980158258), coming from the binder and/or from aggregates, 65% of dolomite (CaMg(CO<sub>3</sub>)<sub>2</sub>, ICSD#980010404) and 5% of quartz (SiO<sub>2</sub>, ICSD#980039830). In addition, the mortars

present some shrinkage fissuring, and some pure lime lumps inside. This phenomenon can be explained by the lack of care in keeping the masonry wet during the setting. However poor quality lime, perhaps obtained by burning too marly limestone, therefore lacking in sufficient binding properties, may also be a contributing fact.



Fig. 3. Optical images of the *arriccio* of the fragments taken from: a) DV, b) S, c) VJ.

From the analyses of the preparatory layers, (Fig. 4), the **DV** and **S** samples appear clearly composed of the same components but with small variations in quantity due to sampling and different respect to **VJ**, both in the mineralogical and optical investigation. Actually, from XRD, the mortars referred to **DV** and **S** are composed by 51% of calcite, 34% of dolomite and 14% of quartz. While, as concerns **VJ** samples, they present a composition of 79% of calcite, 15% of magnesite and 6% of quartz. From the visual investigations, the preparatory layers from **DV** and **S** appear homogeneous, with pure lime lumps or some blades of straw distributed inside the plaster. On the contrary, in plaster of the **VJ** preparatory layer, some dark and sharp-cornered inclusions are distributed inside the entire sample. Such inclusions, separately analyzed by XRD, appeared composed by 51% muscovite (ICSD # 98-008-7845), 34% of quartz, 14% magnesioferrite (ICSD # 98-015-8447).



Fig. 4. Optical images of the preparatory layers of the fragments from: a) DV, b) SG, c) VJ.

The analysis of the pigments is mainly focused on the samples referred to the fresco of the Dormitio Virginis, because of the higher amount of collected fragments. In Figs. 5-8, the most representative fragments are reported, as observed by means of the stereomicroscope and optical microscope. In particular, in Fig. 5 it is shown a dark red pigment, from P3 sampling (**DV**), having a thickness of about 30 μm, composed by a mixture of a red with black spots inside, conferring a blood red tonality overall. SEM-EDX analysis in the pigment layer shows that, in addition to the presence of Ca, O and Si, (related to the phases recognized by XRD), different areas are characterized by specific elements such as Fe and O, or

C. These elements can be related to the presence of hematite ( $\text{Fe}_2\text{O}_3$ ) and C, associated to the use of natural red earth and to finely ground charcoal from vine pruning (black carbon inclusions), as well. In addition, under the pictorial film, a high content of binder in the plaster layer is observed, (Fig. 5d). This observation appears more evident in the stratigraphic section of P21 sample that presents, under the paint film, the compact plaster layer with a high lime content (Fig. 5e-f). This high binder content confirms that the preparatory layer has been realized by the method of "expolitiones", a technique inherited from the Roman tradition, called "polissage" or "politiones" in the Byzantine tradition [6-8]. This technique consists in the realization of a smooth plaster surface that improves the painted frescoes to reproduce approximately the surface of a precious marble. Actually, in the Byzantine method, such use of plastering had also the purpose to have an excess of lime on the surface and lengthen the plaster carbonation times to have more time to freshen up. In this regard, it can be useful to cite the archaeologist Didron, in relation to the Byzantine frescoes in the monastery of Esphigmenou, (Mount Athos, Greece): "Before drawing, the painter's master crushes the lime with a spatula", [9]. This practice was also possible thanks to the use of natural substances for the water retention, such as straw and coal, finely chopped, which were mixed in the plaster to reduce the drying time.

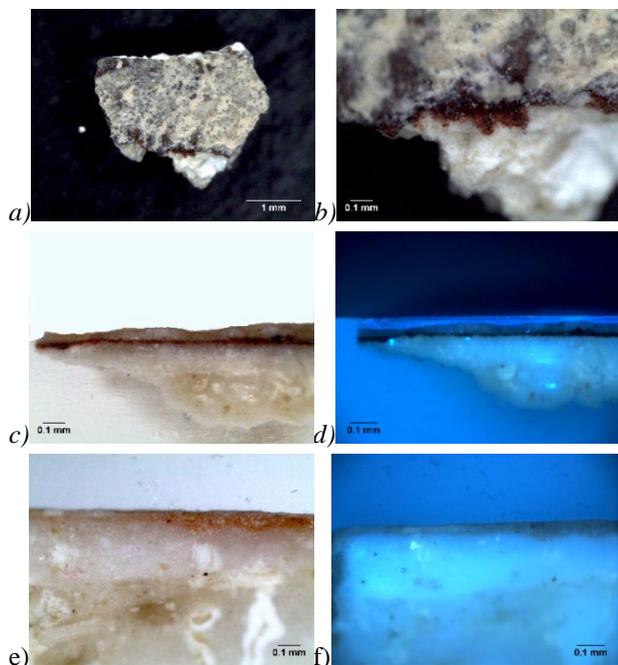


Fig. 5. Optical images of the P3 and P21 sampling, related to a red pigments: a-b) P3 bottom view; c-d) P3 cross section from stereo and from fluorescent optical microscope; e-f) P21 cross section from stereo and from fluorescent optical microscope

The connection with the Eastern tradition finds further confirmation in the analysis of P6 sample, taken from the black background behind the figure of Jesus Christ (Fig. 2a). In the Byzantine or Medieval pictorial cycles, black scenery generally has a shade that the human eye apparently sees as dark blue, also called *blue optic* or *Veneda*, an optical illusion originated by the combination of the charcoal of the plant fibers with the lime used as a binder [10, 11]. In addition, SEM observation on a stratigraphic section on P6 sample, (Fig. 7), supports the vegetal origin of the carbon black, since it visualizes the walls of the parenchymal cells of a fragment of vegetal fiber.

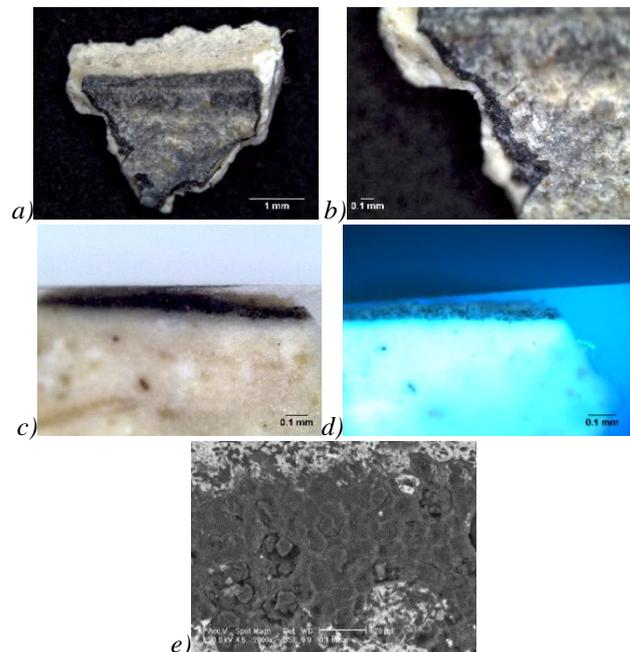
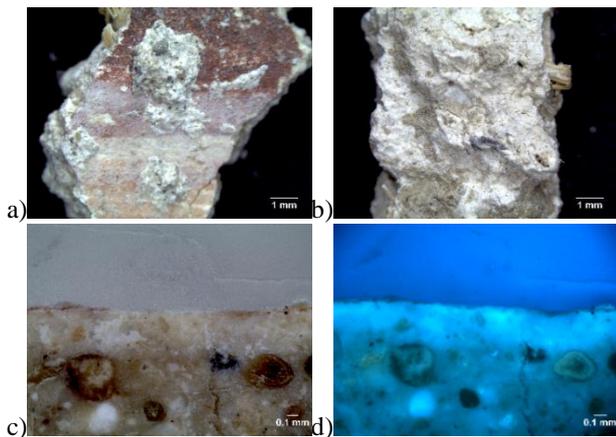


Fig. 6. Optical images of the P6 sampling, from DV, related to black pigment: a-b) bottom view, c-d) cross section from stereo and fluorescent optical microscope, respectively; e) SEM observation of the sample cross section

The P15 sample presents different chromatic layers: red, white and yellow (Fig. 8), characterized by a thickness  $< 20 \mu\text{m}$ . In particular, from EDX analysis, the red pigment is related to the presence of Fe and O, while the absence of Ti, Zn or Pb, allows establishing that the white pigment can be attributed to lime white. As concerns the yellow pigment, the presence of Fe reveals that it is a yellow ochre, composed by hydrated iron hydroxide, also confirmed by the XRD analysis.



*Fig. 8. Optical images of the P3 sampling, from DV, related to a several pigments, red, white and yellow: a) bottom view, b) backward view, c-d) cross section from stereo and from fluorescent optical microscope, respectively*

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