

## **A DIAGNOSTIC ANALYSIS OF AN OUTDOOR FRESCO: THE CASE OF "SANTA MARIA DEI BATTUTI" OF THE CONEGLIANO CATHEDRAL**

Vasco Fassina<sup>2</sup>, Marta Mazza<sup>2</sup>, Ilaria Carocci<sup>1</sup>, Stefano Ridolfi<sup>1</sup>

<sup>1</sup> Ars Mensurae, Rome Italy. Email [stefano@arsmensurae.it](mailto:stefano@arsmensurae.it)

<sup>2</sup> Soprintendenza al Patrimonio Storico Artistico ed Etnoantropologico per la province di Ve, Pd, Bl e Tv. Email [vfassina@arti.beniculturali.it](mailto:vfassina@arti.beniculturali.it)

### **ABSTRACT**

*During recent decades, the Santa Maria dei Battuti facade of the Conegliano Cathedral, painted by Ludovico Pozzoferrato in the XVI century, has been subjected to frequent intervention works to slow down a sharp increase in the degradation processes. According to previous investigations carried out respectively in 1989 and 2003 preliminary to the last two conservation works it was found that a sulphating process of fresco paintings was taking place. In addition a widespread presence of whitening of the painting surface was observed. At the end of the work it was decided to make some periodic checks on the wall paintings surface in order to establish if the decay products were increasing.*

*In addition to the traditional laboratory analytical methods of analysis for the determination of soluble salts it was decided to map the gypsum presence on the wall paintings surface by using XRF spectroscopy. Making use of a transportable EDXRF system more than 350 analysis were carried out to check the full surface of the facade. Besides the degradation processes, the palette and painting techniques of the author were established. At the end of the scientific campaign, an up to now unique working protocol was established. The full facade was inspected and mapped out in all of its degradation processes. The result is a very powerful documentation of the state of the art of the fresco surface. This project was fulfilled with a strong synergy among scientists, art historians and restorers. Together with the results of the "Santa Maria dei Battuti" facade, in this memoir the working protocol established is explained.*

### **INTRODUCTION**

The diagnostic project we present in this memoir had the goal to verify the conservation state of the wall paintings after the restoration of 2003.

The control followed the criteria:

- General and detailed photographic documentation on the full area of the wall paintings to describe and register the present state.
- Photo comparison with the documentation collected immediately after the restoration operation.
- Mapping of the alteration with visual inspection.
- Measurement made with a portable XRF system, of the sulphur concentration in various parts of the surface. The presence of the sulphur can be a precise indication of a sulphating process originating from sulphur dioxide.
- Measurements using a portable XRF system, of the distribution concentration of barium ascribed to the consolidating treatment fulfilled with barium hydroxide.
- Measurement of water absorbance parameters on the surface of the wall.
- Stratigraphy studies of micro samples on the most significant pigments and comparison with the results of the non destructive measurements carried out with portable XRF.
- Soluble salts measurements in whitening surface areas.

### **THE FACADE OF THE DOME OF CONEGLIANO**

The Dome of Conegliano was built in successive stages starting from 1345 and modified up to the 60's of the XX century. It is an example of great complexity. The facade is, in fact,

replaced by an arcade corresponding to the building of two halls intended for the collective rituals of the confraternity of the "Battuti". The entire facade was decorated with a fresco by Lodovico Pozzoferrato in 1593 and represents the object of the present study.

The decoration is articulated within architectonic trompe d'oeil elements. Among the three light windows, nine figurative episodes, two of allegoric character and seven of biblical derivation, that seem to be read from right to left: Charity, Moses and the burning bush, Gideon and the marvel of the fleece, the withdrawal of the waters after the Flood, Salomon and the queen of Sheba, the Virgin Mary with the baby that appears to the Battuti while they sail with lucky wind, Jonathan and Achinaaz persecuted by Assalom's servants but saved by the household woman who hides them in the well, David and the procession of singers and players that accompany the Ark of the Covenant, Esther in front of Assuero. Under the three light windows seven monochromes dedicated to the story of Moses. In the low sections, alternated figures of Prophets and Sibyls are shown.

The figures and pictures are part of a theological programme composed by fellows of the School of the Battuti and focused on the Virgin Mary, most probably connected to the name of the church (Holy Mary of the Battuti). The compositional programme was already set in 1592 when the work was entrusted to the painter Giacomo Rota, and afterward only slightly changed by Pozzoferrato, who had already trained on monumental decorations in Treviso.

The entire composition is made with "buon fresco" with very large portions. Part of the degradation detected in 1989 is, as a matter of fact, attributed to the painting on dry plaster. Most of the evident degradations are, indeed, attributed to chemical, physical and biochemical attacks due to the weather and exposure to pollutants. The restoration has been devoted to the removal of Paraloid B72, that had been laid in an 1962 conservative intervention, and filled with dust and pollutants. For the removal of the Paraloid a very cautious procedure was applied; the problem was connected to the fact that the layer of oxalates was not uniformly originated from the organic stabilisers used in the previous restorations.

## **EXPERIMENTAL SET UP**

In the present work only some results are reported, in particular:

- measurements by portable EDXRF equipment,
- measurements of water absorption by using a Karsten tube
- measurements of barium stratigraphy with ESEM BSE.

Environmental Scanning Electron Microscopy (ESEM) associated with Energy Dispersive x-ray Spectrometry (EDS) was used to carry out the analysis on different painting layers with the aim to identify inorganic pigments as well as the presence of decay products, such as gypsum, or barium coming from the restoration treatment hydroxide barium-based.

As far as the EDXRF measurements are concerned more than 350 measurements have been made. This work is a unique example of use of a non destructive technique applied on an outdoor fresco to determine alteration phenomena which were impossible to establish with the usual destructive analytical methods. Simultaneously with the measurements on the altered areas, several measurements were fulfilled on color areas to determine the color sets of the painter and its painting technique. These kind of measurements, surely achieved in a non destructive manner, were made in situ (see Figure 1) availing of a portable EDXRF system composed of an air cooled x ray tube with an active spot of 1.5 mm and working with 35 kV high voltage and 0.2 mA current together with a Peltier cooled SDD (Silicon Drift Detector)

detector with an energy resolution of 150 eV at 5.9 keV. All together 193 measurements were achieved on color areas to determine the painting techniques and the pigments used by the painter, while 157 measurements were made to analyze the degradation areas.

In Figure 1 we report a moment of the measurements fulfilled in situ on a crane to reach the high frescos.

Most important for the results of the work, to optimize the assignment and choose significant points, the project was fulfilled by a restaurateur and by a physicist that together made the measurements. The results of the work is therefore a compendium of different abilities, a sum of complementary expertise coming from visual inspections and instrumentation results. To the classic survey produced by the visual inspection of a restaurateur all the EDXRF results were added composing a diagnostic survey on all of the painted surface.

In Figure 2 we show, as an example, the results on the section "Ester implores Serse" in which simultaneously are reported the visual data collected by a restaurateur (for example deposit, gap, adhesion defects etc.) and the EDXRF points on measurements.

## **RESULTS**

### **Measurements of Water Absorption by Using a Karsten Tube**

As far as absorption of water is concerned the capacity of the fresco surface to absorb water on unit surface was measured. The values obtained range from a minimum of 0.32 ml/cm<sup>2</sup> connected to the green yellow pigment of the fifth figure from left to a maximum of 1.17 ml/cm<sup>2</sup> of the dark red of the second violet monochrome from left, or 1.12 ml/cm<sup>2</sup> of the green pigment of the picture of the "Dreamer".

### **Measurements of Barium Stratigraphy with ESEM BSE**

The stratigraphic observations have given very interesting results as far as the barium is concerned. In some cases it is possible to observe that the barium used to consolidate has penetrated far beyond the pigment layer and it has reached the underlying plaster, while in other positions the barium has stopped at barely the pigment layer. In any case, in all the measurements the barium showed to have a very irregular distribution, it is not supposed, therefore, to guarantee a homogeneous consolidation.

More in specific, availing to a visual inspection, many critical areas showed a weakness in the adhesive property of the pigment layer. There is therefore a high danger of loss of the pigment layer because of the insufficient adhesion of the barium carbonate as a product of the reaction of the barium hydroxide used in the restoration.

### **Measurements by Portable EDXRF Equipment**

The facade paintings of the Virgin Mary of the Battuti have been painted with a fresco technique refined with dry finishing, organised from the start to use pigments not suitable with the fresco techniques.

The application of the plaster was made within irregular areas with an underlying drawing transposed with indirect incision (with the help of a "cartone"). As a matter of fact it is possible to find on the surface of the painting incisions cut with a point outlining the main figures.

The chemical elements found in the EDXRF measurement are: calcium, manganese, iron, nickel, copper, zinc, arsenic, lead, bismuth, strontium and tin.

A characteristic of these paintings is the lay of a colour base made in a fresco way and the better definition of details with a dry pigment, as an example with the yellow pigment (the tin lead yellow) to define the hair and dresses of the figures.

The pigments the painter used were the usual pigments for fresco painting (grounds, ochre and smalt), and the pigments for the dry layers (green or blue with copper base and tin lead yellow).

As far as the measurement of degradation is concerned, we find a high level of sulphur only in a limited and well defined number of points, where the presence of gypsum reaches a level of 40%. A part those points the level of gypsum is always lower then 10%.

The presence of barium, related to the previous restoration procedures, is seen in all the measurements, in a very inhomogeneous concentration.

## **CONCLUSIONS**

In this project an operative procedure for the analysis and conservative definition of outdoor frescos was tested. This test allowed the results to be well defined and complete on the full surface. Through an external session of work done with a portable EDXRF system a complete map of the wide surface of the frescos as been defined, both to analyse the painting technique of the author and to define the distribution of barium and sulphur, the former as a consequence of previous restoration and the latter as a consequence of the sulphating process.

The sample points were chosen by an interacting working group composed of a restaurateur and a physicist. The work was then ended with a diagnostic survey composed of the results of the EDXRF measurements and of the visual inspection of the restaurateur.

The SEM/EDS measurements were able to define the deepness of the barium in the pigment layer and plaster used in the last restoration.

The numerous non invasive EDXRF measurements and the few sampling SEM/EDS measurements allowed a comprehension of the problems the frescos of the Virgin Mary of the Battuti is existing in.

This procedure of work generated a very powerful tool to keep under control the degradation process of the fresco surfaces, reducing as much as possible the number of destructive samplings.

## **BIBLIOGRAPHY**

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*Figure 1: Part of the frescos and a lift necessary to work at the last level with an EDXRF instrument*

Tavola I - Ester supplica Serse



Legenda

	Deposito superficiale		Rigonfiamento		Difetto di adesione della pellicola pittorica
	Lacuna Mancanza		Abrasiono dell'intonaco		Punti di misura XRF - diagnostica
	Fratturazione o fessurazione		Abrasiono della pellicola pittorica		Punti di misura XRF - archeometria

Figure 2: Ester implores Serse, diagnostic survey

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