

# Exterior assets and Properties of Frescoes on the Cement Resin

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**Abstract:** *Frescoes are known to be the most durable form of mural painting. The traditional technique, widely used throughout history, consists of applying water-dispersed pigments on a fresh lime plaster, which hardens through a carbonation reaction. At the beginning of the 20th century, Portland cement was used by some mural artists to obtain similar painting plaster. Although involving different setting mechanisms, cement-based frescoes show the same aspect and durability as lime-based frescoes. Following the invention of the Portland cement in the 19<sup>th</sup> century, some mural artists tried out a similar painting technique on cement plaster. Although the setting mechanisms of cement are different from those of lime, cement frescoes present the same aspect and durability as lime frescoes. Based on analyses of ancient frescoes and on laboratory reconstructions, this study brings new insights on the formation of a fresco surface.*

**Keywords:** *Fresco, cement, Surface, mural painting, plaster, pigment*

## 1.Introduction

Fresco is a mural painting technique that involves painting with water-based paint directly onto wet plaster so that the paint becomes an integral part of the plaster. Sir Edward Poynter. Paul and Apollos 1872. Tate. Developed in Italy from about the thirteenth century and fresco was perfected during the Renaissance. Abundant and frequent ancient frescoes have been systematically and precisely studied mainly for maintenance, preservation, and restoration purposes, yet the fundamental structures and processes taking place and occurrences on the fresco exterior side and on the surface are not fully understood. Two problems subjects are of particular interest: firstly, in what way can the surface assets of the fresco can be related to the artist's technique and the materials used? and more over again, what is the nature of the connections and relations among and amid the colors, dyes, pigments and the plaster?

The art term Fresco (Italian for 'fresh') describes the method of painting in which colour pigments are mixed solely with water (no binding agent used) and then applied directly onto freshly laid lime-plaster ground (surface). The surface is typically a *plastered wall or ceiling*. Various and several archaic and antique frescoes have been precisely and scientifically as well as logically studied mainly for the purpose of preservation, protection and restoration purposes, the underlying and basic methods taking place on the fresco exterior and surface are not fully spoken and stated. Most of the journalists and creators agree on the point of reality that the pigment connection to the surface remains and rests on mechanical influences and the impacts.

Fresco secco (“dry fresco”) is a process that dispenses with the complex preparation of the wall with wet plaster. Instead, dry, finished walls are soaked with limewater and painted while wet. The colours do not penetrate into the plaster but form a surface film, like any other paint. It is nevertheless doubtful and unsure how the colorants are end up and also were caught in the bounds of the plaster surrounded by. It is much easier than painting on dry plaster because paint sinks into dry plaster immediately. Painting on fresh plaster means that the artist can spread the paint much easier. Also, fresco is permanent because the paint joins with the plaster so that the colours will not rub off. Frescoes last for hundreds of years. For some of the writers, the carbonation response, and effects between lime along with carbon dioxide diffusing into the plaster induces the growth of calcite crystals above the pigments layer. For others, the pigments diffuse from the surface into the plaster during the setting. Furthermore, carbonation alone cannot explain the feasibility of the cement fresco procedure and practice since stick dressings and surface do not set all through and out of the carbonation but beyond and can be due to the hydration.

## 2.0 The methodology of an ancient frescoes on cement resin

### 2.1 The method of traditional frescoes: Cement Based tactic

(i) The cement-based **St Hippolyte fresco** (figure 1) was painted by the French muralist Henri Marret in 1936 on the tympanum of the St Hyppolite Church in Paris. It was painted *a fresco* on a grey cement plaster. It represents the martyrdom of St Lawrence and St Hippolytus.



**Figure 1** The investigated and examined frescos: (i) The St Hippolyte fresco

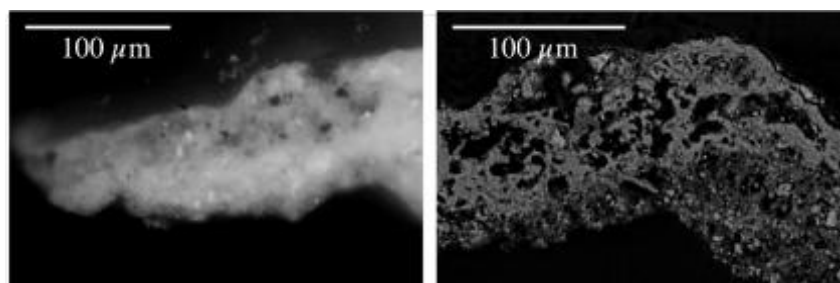
## 2.2 The reconstructions of the frescoes: Cement resin-based scheme

The Fresco refurbishments were implemented on 30x30 cm<sup>2</sup> mortar panels and were tested too. A cement plaster consisting of 4 volumes of sand, 1 volume of cement and 1 volume of tap water. The cement was a grey cement (CEM I), the sand had a grain size between 0 and 2 mm. The *intonaco* was applied on the concrete panels with a wooden spatula. The pigment was a red ochre containing hematite. It was dispersed either in pure water, or in lime water and applied on the *intonaco* with a brush. The *intonaco* was then either left untouched or immediately polished with a flexible spatula. The polishing consisted in several cycles of mechanical flattening of the plaster, with a total duration of about 20 minutes. The frescoes by Marret and the Roman fragments were first examined with the naked eye and carefully photographed, then micro-sampled with a scalpel blade n°12 and analyzed by X-Ray Diffraction (XRD), Optical Microscopy (OM) and Scanning Electron Microscopy (SEM) in the laboratory. The reconstructed frescoes underwent the same characterization process than the Marret frescoes.

## 3.0 Implementation And Results

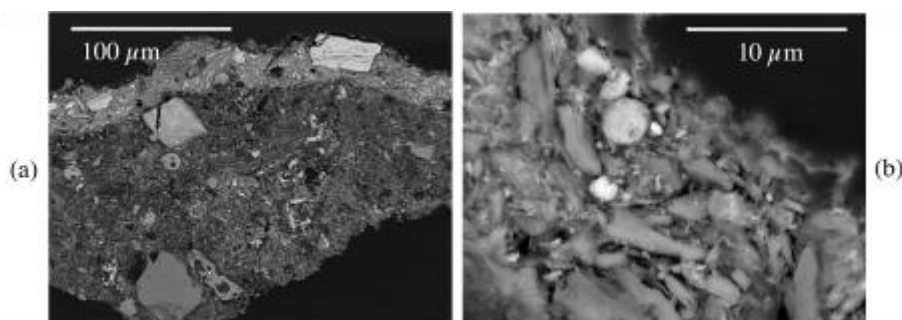
### 3.1 Characterization of ancient frescoes and polished sections

The St Hippolyte fresco presents a highly textured and rough surface, with many millimetrical fillers cropping out of the surface and traces of the spatula used to apply the plaster. The Fourqueux fresco is in general smoother than the St Hippolyte fresco, with a lowest density of fillers at the surface and maybe a superficial flattening of the plaster in some area. The Lero frescoes show a dense and shiny aspect, typical of the Roman technique. Concerning the composition of the cement *intonaco*, the cement plaster of St Hippolyte presents all the characteristics of a Portland cement mortar with ashes and quartz as fillers and coal as impurities. XRD analyses show the presence of gypsum in the bulk, which is necessary to regulate the setting of the cement. The polished sections of the Fourqueux fresco present a different microstructure, with a clear contrast in SEM between the pictorial layer and the *intonaco* and a more or less linear boundary between the two (figure 2). The surface of the fresco is highly porous.



**Figure 2** OM (left) and SEM (right) observation of a polished section from the Fourqueux fresco.

In the case of the cement fresco of St Hippolyte, SEM observations of polished sections reveal a high contrast between the surface and the bulk (figure 3a), but also a very specific microstructure of the pictorial layer, consisting of many oriented lamellar crystals (figure 3b).

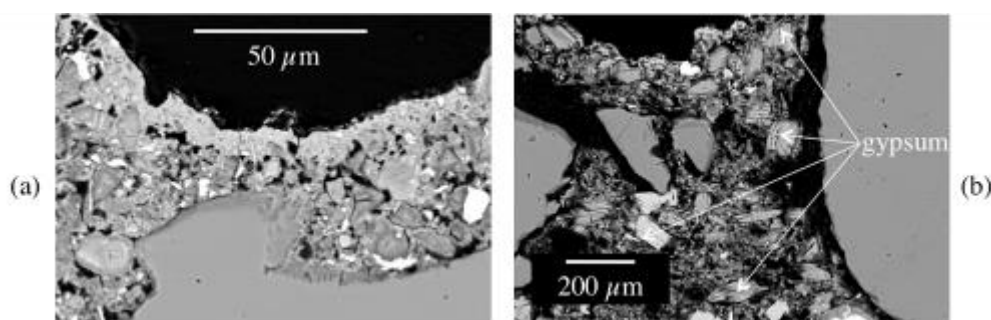


**Figure 3** SEM observations of polished sections from the St Hippolyte fresco.

XRD analyses identify these crystals as gypsum, a rather unexpected result. Gypsum can sometimes be found on mural paintings as an alteration product of calcium carbonate in contact with sulfur dioxide.<sup>9</sup> This hypothesis is in this case not satisfying: gypsum would not be strictly located in the pictorial layer. Marret never mentioned it in his writings, but he probably used gypsum as a binder for his pigments. The pictorial layer on the St Hippolyte fresco, with an average thickness of 2 micrometers against 40 to 60  $\mu\text{m}$  (for each fresco, the average thickness was calculated from a total of 50 measures on 5 polished sections), is thinner than that on the lime frescoes.

### 3.2 The use of cement

The first reconstruction on cement followed the traditional fresco technique. In term of general aspect, the result is similar to that of the St Hippolyte fresco, but in term of microstructure it is closer to the Fourqueux fresco: the pigments are dispersed in the first micrometers of the plaster, with a denser microstructure at the top surface (figure 4a). As expected, no gypsum is visible at the surface. On the contrary, the polished sections of the reconstruction with a gypsum solution as a binder are very similar to those of St Hippolyte (figure 4b).



**Figure 4** SEM observation of polished section from the cement reconstitution with (a) of without gypsum (b).

These results prove two things: firstly, it is possible to use the traditional fresco technique on cement, without resorting to the use of a mineral binder. Secondly, the gypsum found on the St Hippolyte fresco was indeed voluntarily used as a binder by Marret, for an unknown reason so far.



### 3.3 Cement behavior

The mechanisms of the cement fresco are the same as on lime: deposition of the pigments through both mechanical and diffusion effects. There is no need for a specific binder, although plaster of Paris was successfully used by Marret. The main difference from the lime fresco is that cement mortars tend to flocculate quickly, and the cement clusters block the penetration of the pigments into the plaster. This explains the thinness of the pictorial layers on cement, compared to the lime frescoes.

### 4. Conclusion

The cement fresco mechanisms are similar to those on lime, except that the pigments penetrate less deeply. The use of a mineral binder is unnecessary. The reason why Marret systematically used plaster of Paris as a binder for the St Hippolyte fresco is still unknown.

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