SWISS CONSERVATION-RESTORATION CAMPUS

Scuola universitaria professionale della Svizzera italiana
SUPSI

Master-Thesis in Conservation-Restoration

An investigation into the use, composition, deterioration and conservation issues of smalt in 16th century wall paintings in Ticino

Fig 1: Direct light photograph showing a blue disc on the left that has always been exposed to the exterior environment, and a blue disc on the right that was covered by a mortar used to patch an adjacent wall many years ago. Triumphal arch, Exterior Chapel, Chiesa di San Nazario, Dino (TI).

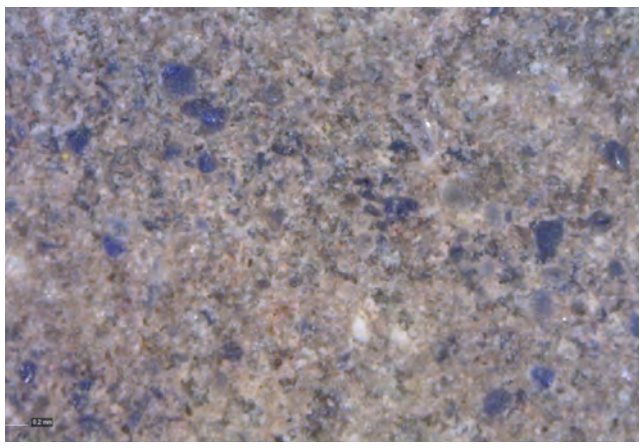

Fig 2: Microphotograph of smalt grains on a surface as seen with portable digital microscope (200x). *Madonna and Child with Saint Sebastian and Saint Rocco*, Oratorio di San Rocco, Ponte Capriasca (TI).

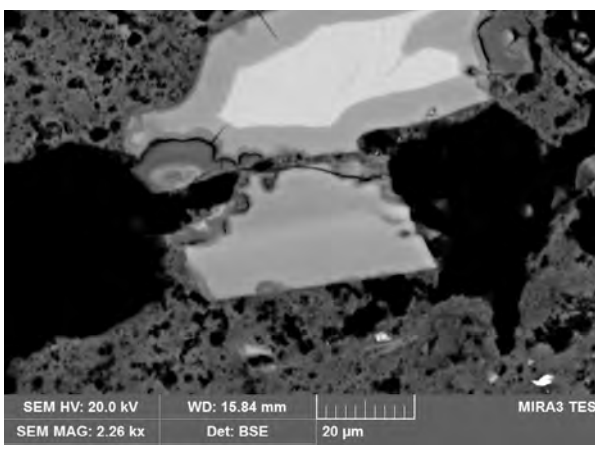

Fig. 3: Smalt grains as seen in SEM-BSE image (2.26 kx), demonstrating different deterioration phenomena. *Madonna and Child with Saint Sebastian and Saint Rocco,* Oratorio di San Rocco, Ponte Capriasca (TI).

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Abstract

Smalt is a blue cobalt-colored potash glass pigment that first came into use in 15th century Europe, and was in frequent use in wall paintings by the mid-16th century. The fact that it could be used in a variety of ways, including in affresco applications, made it an appealing and versatile material for many artists. It has long been known for its tendency to discolor in canvas paintings, however its deterioration behavior in wall paintings is less widely understood due to the fact that there are only a limited number of studies that provide comparative information.

Using information gathered from the historical and technical literature, and from archival sources, as well as from direct observation and investigation of four authentic wall paintings, this study attempts to look at the different uses of smalt, the complexity of its elemental composition, and signs and mechanisms of its deterioration on both macroscopic and microscopic levels. A comparative study of this type, with a narrowly defined time period (the first half of the 16th century), and a limited geographical area (Ticino), allows for the collection of data from a number of sources in a standardized way with clearly defined objectives so that it is possible to better compare the data and recognize trends and patterns.

The information gathered from the first part of the study was used to formulate questions and perform experiments related to the behavior of smalt in contact with water and different aqueous-based and alkaline substances with the aim of providing information that can potentially be useful in the conservation of this material in the future.

Investigation

Four examples of wall paintings from the first half of the 16th century in Ticino were chosen: the *Storie della Passione di Cristo* (Chiesa di Santa Maria degli Angeli, Lugano), the Exterior Chapel (Chiesa di San Nazario, Dino), the *Ultima Cena* (Chiesa di Sant`Ambrogio, Ponte Capriasca) and the *Madonna and Child with Saint Rocco and Saint Sebastian* (Oratorio di San Rocco, Ponte Capriasca). The paintings were investigated with different methods and techniques (direct light photography, Infrared False Color imaging (IRFC), portable digital microscope), to look at pigment application, mixtures and granulometry. The elemental composition of the pigment was studied using X-Ray Fluorescence (XRF). The deterioration phenomena associated with the pigment were explored on a macroscopic and microscopic level. To supplement this investigation, a set of microsamples from one of the case studies was investigated with the optical microscope (OM), and a Scanning Electron Microscope equipped with an Energy Dispersive X-Ray Spectrometer (SEM-EDXS).

A set of nine replicas was created (three sets of three different painting techniques) to look specifically at issues associated with the deterioration and conservation of smalt that were either unexplained or not sufficiently explored in the literature. One set of tiles was exposed to liquid water to simulate rising damp conditions, and another to high relative humidity. The Replica tiles were studied using direct light photography, portable digital microscope, and a spectrophotometer. Samples from the tiles were investigated with the optical microscope (OM), and a Scanning Electron Microscope equipped with an Energy Dispersive X-Ray Spectrometer (SEM-EDXS).

Replicas were then subjected to different treatments with aqueous-based and alkaline substances applied in poultices, that have been commonly used in the conservation of wall paintings in the past in order to look at the reactivity of the pure and applied pigment with these substances. The replicas were then examined after treatment as above to look at the effects of the different substances and contact times on the pigment.

Conclusions

From the literature it was possible to see that smalt was used in a wide variety of ways in examples of paintings outside this study, suggesting that this pigment was chosen by artists for its versatility and its tonal qualities, not only as a less costly substitute for other blue pigments. This was also true in the case studies. From observations of the paintings in Ticino it was possible to see that smalt was applied to create both large solid and textured areas of blue, as well as to create and define areas in clothing, accessories, and details in all of the paintings. Smalt was found in the case studies applied as a principal layer, as a base layer, and as a secondary layer, and found both pure and mixed with other pigments. A wide granulometric range was noted in the smalt found in the different paintings.

All of the examples of smalt found in the case study wall paintings contained cobalt (the element responsible for the blue color of smalt), as well as characteristic impurities associated with the cobalt ore at the beginning of the 16th century (arsenic, bismuth, and nickel). A series of criteria was defined for observing surfaces and individual grains in order to understand better the deterioration of the pigment on macroscopic and microscopic levels.

The results of the experiments demonstrated that, consistent with the literature about glass, smalt is reactive in contact with water (liquid and vapor) as well as with aqueous-based and alkaline substances applied in poultices. The experiments with exposure to water demonstrated that the pigment deteriorated in different ways (demonstrating both physical and elemental changes in the pigment grains) in contact with liquid water and vapor, a fact which is important in studying the deterioration of this pigment in wall paintings.

The extent of the interaction of the applied pigment with aqueous-based and alkaline treatments depended on contact time and the pH of the solution that the surface was in contact with. Many issues raised by the results will be pursued through further research to better define the contribution of different variables and the implications for the conservation of smalt used in wall paintings in the future.