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"SPOSALIZIO DI S. CATERINA" of Adriaen Isenbrant: Diagnostic Analyses of the Painting with the Aid of Restoration

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"SPOSALIZIO DI S. CATERINA" of Adriaen Isenbrant: Diagnostic Analyses of the Painting with the Aid of Restoration

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Abstract

This study investigates the conservation status, previous intervention, executive techniques and pigment materials of the painting “SPOSALIZIO DI S. CATERINA”, attributed to Adriaen Isenbrant back to 16th century. The analysis was carried out based on the combination of scientific examination and restoration exploration. The scientific examination includes both in-situ non-invasive techniques and laboratory micro-destructive techniques. Non-invasive examination consists of the application of ultraviolet fluorescence (UVF), infrared reflectography (IRR), infrared false color (IRFC) and energy dispersive X-ray fluorescence (ED-XRF), whereas micro-destructive analysis comprises optical microscope (OM). The obtained results revealed that the painting was in a relatively good condition with several times of previous restoration, it was painted with typical Flemish painting techniques and materials in 16^{th} century: a panel made of chestnut wood, a preparation layer composed of lead white colored in pale grey and brownish-orange, few of underdrawings and some pentimenti, with the palette composed of cinnabar and red ochre for red, verdigris or malachite for green, azurite for blue and yellow ocher for yellow. Moreover, this study provides an evidence that restoration, in particular during the cleaning of the painted surface and panel restoration process, is also acting as a very useful tool for painting investigation, being complementary with scientific examination, therefore it is of necessity to correctly and timely gather the information during the restoration process.

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Then I would like to thank the panel restorer Ms. Daniela Caldone for her detailed explanation to understand the panel and thank to Dr. Matteo Positano for his conducting of optical microscopy.

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1. Introduction

1.1. Aims and Research Questions

The object of this study is “SPOSALIZIO DI S. CATERINA”, a panel painting attributed to Adriaen Isenbrant back to 16th century, now conserved in Accademia Nazionale di San Luca in Rome (The images of the front and reverse painting are presenting in Fig.1). Though a study based on scientific examination including non-invasive and micro-invasive analyses, combined with restoration exploration, the aims of this thesis is to investigate thoroughly for the first time from ascertaining the conservation state, past interventions, to the characterization of the painting techniques and reconstruct the palette applied by the artist, finally to guide the restoration scientifically and contribute to a deeper understanding of the artist and his belonging school.

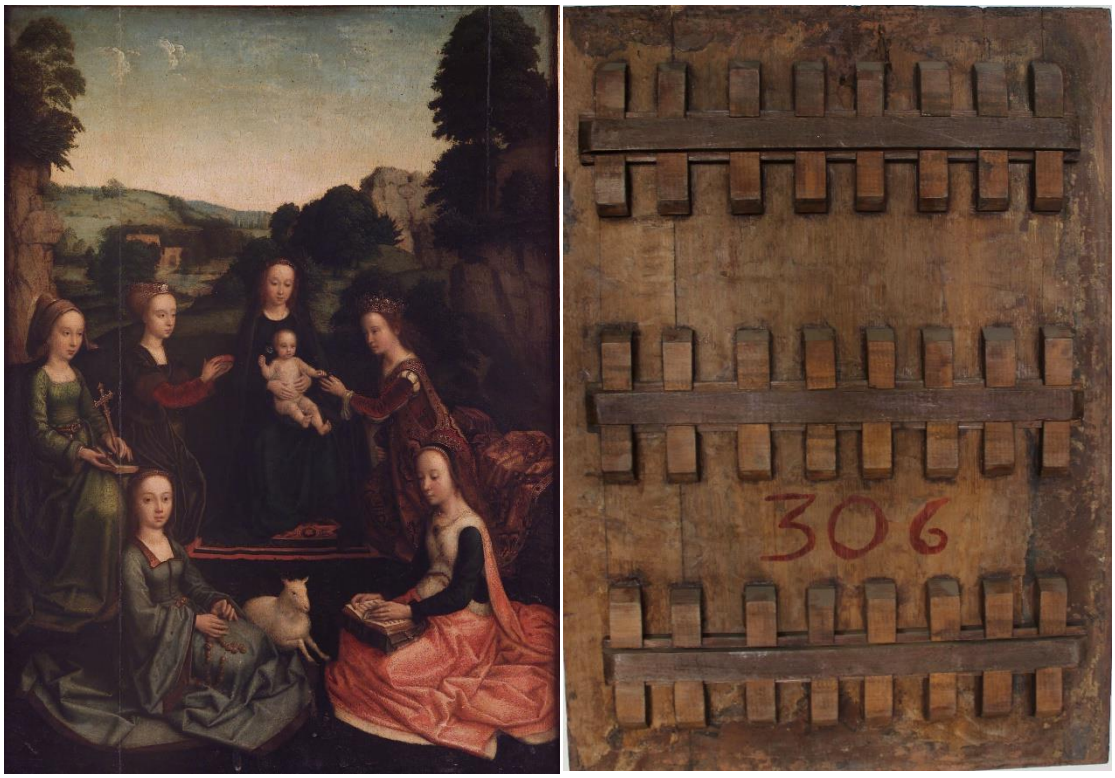

Fig.1 the painting "SPOSALIZIO DI S. CATERINA" from the front and reverse

The following research questions are important to reach the aims:

1. How is the condition of the painting? What kind of degradation was occurring and what are their most possible causes? Were there any previous interventions undergone and what kind of intervention, to what extent with what effects?
2. What is the stratigraphic structure of this painting?
3. How did the painter prepare the ground layer and with what purpose? Is there any underdrawing existing, and if there is, what technique was applied(e.g. free hand, cartoon pouncing, etc.)? Is there any pentimenti, from which what executive thoughts of the painter might be revealed?

4. What pigments were applied in Isenbrant's palette?
5. Does the restoration also play an important part in painting characterization and what specific information could be revealed?

To better achieve the aims, a comprehensive study process was taken as follow: Firstly, from an art history point of view, literature and archives were studied for understanding the broad context of the artist and the composition. Then, the scientific analysis of the painting was conducted by combining in-situ non-invasive techniques and laboratory micro-destructive techniques. Non-invasive examinations including ultraviolet fluorescence (UVF), infrared reflectography (IRR), infrared false color (IRFC) and energy dispersive X-ray fluorescence (ED-XRF), were applied in-situ for an overall examination of the painting in a simple and inexpensive way, the results from which could also help to determine suitable areas for further sophisticated analyses. Subsequently two microsamples collected from representative areas of the paintings were analyzed micro-destructively, by means of optical microscope (OM) operated on the cross sections. Moreover, restoration in particular during cleaning and panel restoration process, was processed as a complementary method to further investigate the painting.

1.2. Research Significance

Characterization of one panel painting executed by Isenbrant will set up a research paradigm for further studies. Other works of Isenbrant can be analyzed in a similar manner. With the accumulation of the results from individual scientific examination, a “fingerprint” style of the artist might be identified, which will not only contribute to understand the paintings attributed to Isenbrant, but also the art practices of the school he belonging to, the Flemish Primitives.

Even though Isenbrant’s oeuvre has already included nearly five hundred works (Wilson, 1995), the archaeometric analysis on his painting remains very limited and mainly restricted in infrared reflectography examination. Therefore, this study is of importance as it provides thoroughly the first insight into the artist's painting technique and materials, as well as going deeply to understand the painting’s condition and previous intervention. Moreover, with more and more technological knowledge accumulating though scientific analysis, it will allow comparisons not only among the other practices adopted by Isenbrant, but also between the paintings from his contemporary Flemish artists, which will greatly help art historians to access the attribution problem of Isenbrant, and improve the knowledge on the relationship between Isenbrant and his contemporary Flemish artists(e.g. were they from the same workshop? Were they sharing patterns? Were they master and disciple? Etc.). In addition, the identification of the technique and materials applied could also be served as a guide for the restorer to understand more deeply the deterioration processes occurred and to find out the most suitable intervention solutions.

1.3. Thesis Structure

The thesis is organized in five parts:

Part 1 presents a general overview of the thesis from the research aims, significance to the thesis structure.

Part 2 is from an art history point of view, providing the art historical context of the painting and focusing mainly on introducing the artist Adriane Isenbrant, by means of a brief review of related literature and archives.

Part 3 provides a detail description of the painting, including its subject and collection history, meanwhile it explains the experimental methodology and instuments setting conditions.

Part 4 discusses and interprets the results acquired from the analyses in three main aspects. The first aspect is focusing on the conservation status and previous interventions, the second aspect is regarding to the executive techniques, which consists of presenting the stratigraphic sequence of the painting, the preparatory layer, underdrawing and the pentiment in details. And the third aspect is to reconstruct the palette used by Isenbrant.

Part 5 presents an overall summarize of this study. Meanwhile, future perspectives are proposed for achieving a deeper understanding of Isenbrant's painting technique and for a better solution to the attribution issue.

2. Art historical Context and Literature Review

Starting from 15th century, with the economic dynamism and cultural vitality, a rapid development of fine art painting was occurred in Flanders region in order to cater to the civic and cultural demands of the growing bourgeoisie, especially in the flourishing cities such as Bruges and Ghent. This fine art school is known in art history as Flemish Primitives or Early Netherlandish paintings.

Flemish Primitives paintings have always been emulated by other artists, admired for their appeal to the eye and to the mind, and enthusiastically collected.(Hand & Wolff, 1986) It coincides with the early and high Italian Renaissance, the two kinds of significant paintings had indeed enjoyed a position of undisputed predominance among all the other schools.(Panofsky, 1966) However, distinct from Italian Renaissance, which was based on the rediscovery of art tradition and humanitarian ideals in classical Greek and Roman, and focused on natural science and human body anatomy for achieving subtle light and shadows, and depicting idealized human forms, the Flemish Primitives drew influence mainly from the Gothic style. Their subjects were typically referred to religious in nature, characterized by applying illusionism with a closely observed realism, as well as highlighting the details, the effect of light and the richness of colors.(Lai, 1997)

Adriaen Isenbrant was an artist active in sixteenth-century Bruges, belonging to Flemish Primitives school. Although his oeuvre has already included nearly five hundred works of many distinctly different styles with new attributions continue to be advance(Wilson, 1995) , very little about him were known with many confusions regarding to the attribution issues.

Limited archives evidence of Isenbrant prohibits a complete biography, however the archival research based on the minimal documents could also evoke some of the elusive artist's life fragments. Isenbrant was first mentioned in the record when he started to settle down in Bruges and was accepted as a master in Bruges painters' and saddle maker's guild in 1510. Throughout the period of 1516-1517 and 1547-1548 when Isenbrant worked as a *vinder* (minor official), as well as 1526-1527 and 1537-1538 as a *gouverneur* (financial officer), his name occurs quite often in Bruges archives, reveling us some private aspects of Isenbrant, for instance, he was married twice, he has three daughters with his second wife, and he died in Bruges shortly before 21th July, 1551.(Hand & Wolff, 1986)

According to Jean C. Wilson' s research, only four related civic documents constitute the records that are able to provide us a close view of Isenbrant's professional activities as an artist. Firstly, in 1520, Isenbrant was paid for the decoration of the Triumphal Entry of Charles V into Bruges. And the litigation records between the Bruges painters, Gerard David and Ambrosius Benson revealed that David had taken certain workshop patterns from Isenbrant's house at one time. Secondly, in 1534 the Bruges painter Jan van Eekele was ordered by the

city aldermen to complete and deliver several small panels that Isenbrant had commissioned him to paint. Thirdly, the records of litigation between the Bruges goldsmith's guild and Isenbrant in 1545 show us that Isenbrant was commissioned to paint a new banner for the guild, however in the process he ruined the old banner since he applied a pattern with punch mark. Lastly, Isenbrant may sell his paintings through a salesman that associated with both Antwerp and Bruges, whose name is Marc Bonnet, and Bonnet had once received painting from Isenbrant which were valued as 71.gr.(Wilson, 1995) This information is corresponding to a record revealing a fortuitous shift in 1511 that the artist's guild in Bruges was started to allowed their members to freely sell on the free market, which allowed a more prodigious output for artists, including Isenbrant.(Ainsworth, 1998)

Isenbrant's oeuvre was entirely a reconstruction by art historians, because there is no archive associated between Isenbrant and his extant work, nor even a single signed or monogramed painting was found. The research work for attribution was quite hard, not only because the considerably huge amount of paintings has already attributed to him without carefully considered and strictly examined, but also result from the complex situation that we have known from the archives that Isenbrant has his own workshop, from which Gerard David took his workshop patterns, and Isenbrant commissioned another painter Jan van Eekele to execute works for him, what's more he may sold his paintings from Bruges to Antwerp though Marc Bonnet. Regardless Isenbrant's puzzling professional activities, many art historians had made efforts to define his works.

Initially, when Isenbrant started to be paid attention to by connoisseurs, a description from Sanderus in his *De Brugensibus eruditionis fama claris bibri duo published* in Amsterdam in 1624 was widely accepted, which writes “Adrianus Isebrandus Brugensis, Gerardi Davidis pictoris Veteraquensis discipulus fuit, in nudis corporibus, et vultibus humanis delineandis egregius”, describing Isenbrant of Bruges as a disciple of the Flemish artist Gerard David and skilled in portraiture and the depiction of nude figures. (Hand & Wolff, 1986) Based on this description, connoisseurs have felt obliged to consider any painting that evinces Davidian characteristics as a possible work by Isenbrant. In 1847 Waagen received the initial grouping of three paintings that was attributed to Jan Mostaert at that time. Even though the possible incorrect attribution was conscious by Waagen, he still kept Mostaert as the painter of this grouping of works, thereafter the anonymous painter was known subsequently as the Waagen Mostaert or the Pseudo-Mostaert. In 1893, a stylistic basis of Mostaert’s paintings was established by Gustav Glück, contributed to the separation of Mostaert’s work from Waagen’s grouping. Meanwhile, documents related to Isenbrant was published by W.H. James Weale, including the citation that pointed out Isenbrant is a disciple of David. Hereafter, in 1902, it was Hulin de Loo that established an enduring link between the newly expanded oeuvre of the anonymous artist and the name “Adriaen Isenbrant”, which became the basis of our present knowledge of Isenbrant’s works. Following the earlier efforts, in 1905 Eberhard von Bodenhausen picked out thirty works by Isenbrant and twenty-three works from his workshop. Afterwards, with the effort of Max Friedländer, the amount of paintings that attributed to

Isenbrant was further refined and expanded to over one hundred and fifty in the 1930s and then again in the 1970s. (Wilson, 1995)(Hand & Wolff, 1986)More recently in 1995, Jean C. Wilson pointed out that previous discussions of Isenbrant's oeuvre were strongly relied on the principle of “disciple of David”, which however is not the characteristic only belongs to Isenbrant, therefore the oeuvre was probably comprised by paintings that from other artists in Bruges sharing the same “Davidian features”. Furthermore, a principal grouping method was proposed by Wilson based on the stylistic examination of works attributed to Isenbrant.(Wilson, 1995)

Notwithstanding that the works attributed to Isenbrant has been partially studied from icongrafic, stylistic and documental point of views, however only in very few cases scientific examination has been applied, among which infrared examination was most widely adopted. Firstly, infrared reflectography was applied to the painting THE ADORATION OF THE SHEPHERDS, revealing the underdrawing in the figures and architecture(Hand & Wolff, 1986) Latter in 1990, Jean C.Wilson analyzed the visual evidence of pouncing in works attributed to Isenbrant by infrared examination, combining with the documentary evidence, she illustrated that Isenbrant and his assistants may have used models to re-create popular compositions, as a result of the economic depression in Bruges and increasing demand of Flemish painting at that period.(Wilson, 1990). In THE FLIGHT INTO EGYPT, small pentimenti of composition was revealed by infrared reflectography, this information was used to link the painting to another triptych, CRUCIFIXION, attributed to Isenbrant collected in the Art Museum of Estonia, as the

underdrawing found in the landscapes from both the paintings are quite consistent.(“Sotheby’s Old Master Paintings Catalogue,” 2018) In A TRIPTYCH: THE ADORATION OF THE MAGI, infrared examination reveals again that pouncing was used to transfer the cartoon to the panel, particularly for the figures and their clothing. Moreover, dendrochronological analysis was also undertaken in this case, revealing the wood species of the central panel, and the earliest possible felling and use date, as well as the most likely use date were estimated by means of dating the youngest heartwood ring, indicating that the painting was composed in the middle years of Isenbrant’s career. (“Sotheby’s Old Master Paintings Catalogue,” 2015)

Despite the fact that Isenbrant’s oeuvre has already included considerable amount of works in various styles at the present, new attributions continue to be advanced, expending the already problematic body of works to even greater proportions.(Wilson, 1995) Hence, it is of urgency and necessity to reassess as much as possible of the paintings attributed to Isenbrant by means of combining the state-of-art scientific techniques with conventional art historical research approach, to build up a more reasonable and clearer attribution of this Flemish artist who has been always lacking of attention that deserves to be paid.

3. Materials and methods

3.1. Painting Description

The painting "SPOSALIZIO DI S. CATERINA" attributed to Adriaen Isenbrant back to 16th century is now conserved in Accademia Nazionale di San Luca in Rome. According to the archive from Accademia, it was received together with a group of painting painted during the 15th to 18th centuries as a legacy donated by an Italian painter, Domenico Pellegrini in 1838. (1759-1840). (Gardonio, Teixeira, Cipriani, Picardi, & Mariuz, 2013)

The painting depicts a recurrent ecclesiastical subject in Flemish paintings during the fifteenth and sixteenth centuries, which is showing that Virgin Mary and Baby Christ are seating on a low wall and surrounded by five Virgin Saints in a flowery garden. The Saints were able to be identified by their carrying symbols of their martyrdom: St. Catherine is holding a wedding ring from Baby Christ, incorporating the scene of the Mystic Marriage of St. Catherine. St. Barbara is holding a red circlet, from which Baby Christ may have just taken the ring, she is acting as a witness to the ceremony. St. Margaret is holding a golden cross. St. Agnes is seating on the ground with a ring and rosary closely next to a lamb. And St. Ursula is reading a book. Moreover, in this panel the artist paid a close attention to the details, from the dense group of grass and flowers in the foreground, to the blueish-toned hills in the distance, Virgin, Baby Christ and Saints were surrounded by a vast and lush landscape with rocks, trees, pastures, peaceful river and huts with chimney.

3.2. Scientific Examination

A multi-technique analytical approach was applied based on a wide non-invasive step followed by a micro-invasive step.

3.2.1. Non-invasive Approach

3.2.1.1. Imaging Diagnostic Techniques

Imaging diagnostic techniques are non-invasive in-situ methods that allow to make an overall examination of the painting while avoiding further movements in a simple and inexpensive way, which could also help to determine suitable areas for further sophisticated analyses. The settings for in-situ image diagnostic techniques are shown in Fig.2.

Fig.2 showing the settings for in-situ image diagnostic techniques

3.2.1.1.1. Ultraviolet Fluorescence (UVF)

The ultraviolet fluorescence is a method for revealing the conservation state and pervious intervention information of the painting as the surface of the painting will absorb ultraviolet radiation and then reflect some of the energy in visible light wavelengths, i.e. the fluorescence, which will be differing in intensity of the different age materials, generally, the older the fluorescent material, the stronger its fluorescence under ultraviolet.

The UVF examination process involves positioning two 380 nm ultraviolet lamp in front of the surface of the painting in a dark room. The photography was captured by a NIKON TD200 Digital Camera equipped with a 70 mm lens, with shutter speed of 15 seconds.

3.2.1.1.2. Infrared Reflectography (IRR)

Infrared reflectography was implemented in order to disclose the pentimenti and possible presence of infrared-absorbing material applied for underdrawings. IRR is quite easy to comprehend when compared with other types of scientific examinations, because it provides valuable overall information with directly comparison with the painting surface in visible light. From the early 1970s to the present, IRR was applied as the most important method in the scientific study of the Flemish paintings. (Faries, 2003)

In this case, the painting was illuminated by two bulb termo lamps emitting both visible and infrared lights. IRR photography was acquired by Sony DSC-F828 8MP Digital Camera with

90mm lens, a skylight (1b) 58mm filter was applied to modify the camera only detecting the spectrum between 900nm to 1100nm.

3.2.1.1.3. Infrared False Color (IRFC)

Infrared false color has been used as a supplementary technique of ED-XRF for identifying the pigments by differentiating materials in the resulting false color image since varying reflectance characteristics in the infrared band are captured and displayed as different colors. Although IRFC does not provide conclusive results, it is recognized as a valid tool for picturing an overview and orienting us for further point-specific ED-XRF examination.

The visible(RGB) and IRR photographs were taken under exactly the same conditions by Sony DSC-F828 8MP Digital Camera with 90mm lens, equipped with a skylight (1b) 58mm infrared filter and 100 nm band pass green and red filter. Photoshop was used as a digitally editing software, the infrared false color photography was acquired by overlaying the visible with the IRR pictures, the visible green and red channels become respectively the IRFC blue and green channels, and IRR image become The IRFC red channel.(Dulce María Aguilar-Téllez, José Luis Ruvalcaba-Sil & González-González, 2014) Fig.3 shows the approach of editing the VIS and IRR images to acquire IRFC image.

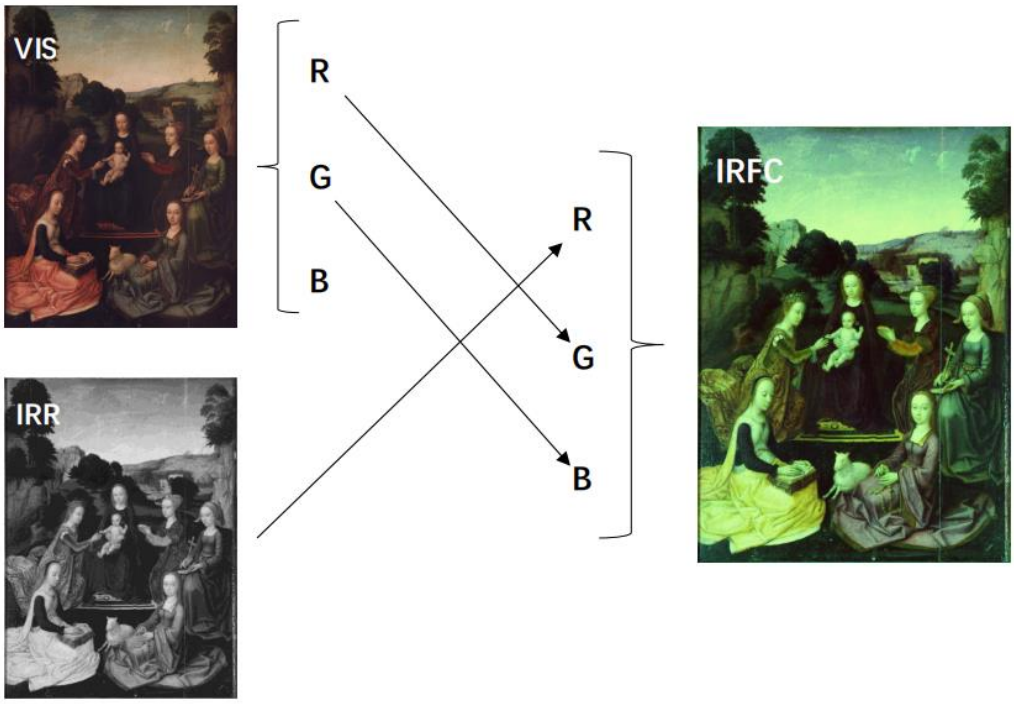

Fig.3. the approach of editing the VIS and IR images to acquire IRFC image by Photoshop.

3.2.1.2. Energy Dispersive X-ray Fluorescence (ED-XRF)

The energy dispersive X-ray fluorescence was applied as a fast in-situ non-invasive examination in order to understand the elemental composition of the pigments. 16 points were chosen and analyzed after the execution of UVF, IRR and IRFC examinations.

The ED-XRF spectrum were recorded by using Amptek Mini-X X-Ray tube system with Tungsten Golden anode(working voltage is 37kV and working current is 15 μ A) and an Amptek X-123 Silicon Drift Detector with a double laser point system. Photos of the mapping of the measurement points in ED-XRF on the painting and the acquisition of the spectra is presenting in Fig.4.

Fig.4.showing of the mapping of the measurement points in ED-XRF on the painting(a), and the acquisition of the spectra(b and c).

3.2.2. Micro-invasive Approach: Cross Sections and Optical Microscope (OM)

As a further scientific method of painting examination, optical microscope analysis on cross sections can reveal a precise information over a very tiny area of the painting, which is complementary to UVF and IRR examination whose images provide rather more general

information. For the stratigraphic study, two micro-samples chosen from the green dress of St. Margaret and the blue dress of St. Agnes near her rosary, were collected by Prof. Stefano Ridolfi from the painting, showing in the Fig.5.

The optical microscope analysis was conducted by Dr. Matteo Positano for studying the embedded cross-sections. The information of painting stratigraphy, including the layer sequence, thickness, particle color, size and texture were obtained by a Nikon Eclipse 50i pol optical microscope with Nikon D200 digital camera digital camera in visible light, and Nikon Eclipse E40 optical microscope with 50W mercury vapor lamps in UV light.

Fig.5 showing of the mapping of the micro-samples taken the painting(a), and the acquisition of the micro-samples(b and c).

3.3. Restoration: A Complementary Method for Characterization

By working in close collaboration with the restorers specializing in painting techniques, the restoration could also be regarded as a valuable approach for painting investigation, particularly during surface cleaning and panel restoration process, which is not only of immense help in orienting the scientific examination but also assisting in the understanding and interpretation of the results.

3.3.1. Surface Cleaning Combined with Portable Microscope

For study the painting, a “low-tech” method remains essential, microscopic examination still allows many other types of observation that are valid from both a technical and art history point of view. (Faries, 2003) In this study, A Veho VMS-004 Deluxe Microscope with 20x magnification was applied during the surface cleaning process conducted by Mr. Fabio Porzio. The process is presenting in Fig.6.

Fig.6 showing of the application of the microscope during the cleaning process

During the centuries, paintings become serious darkened as a consequence of accumulation of dirt, natural discoloration of vanish, as well as the deterioration of pigment and binding media occurring both on and beneath the surface. Conventionally, on the purpose of improving the desired aesthetic from the original painting, cleaning is the first step applied in a restoration work, with the aim of remove all the surface coating. Nevertheless, it is necessary to understand that cleaning is not only the most significant aspect of the overall conservation program(Colalucci, 1991), but it also can be an extremely valuable process working as a complementary tool of scientific examination which enables us to elucidate the painting technique. For instance, it could provide us deeper information regarding to the painting conditions: the paint losses, abrasions, the detail of the cracks and the craquelures. And it

worked as an aid for UVF examination, revealing the previous intervention. Moreover, it also helps for the determination of pentimenti and underdrawing as complementary of IRR, since a pure IRR image only consists of grey tones thus it is often very difficult to distinguish between underdrawing and pentimenti. Furthermore, the stratigraphic information will be also revealed when removing the retouching layer by layer near the crack or paint gaps, showing their characteristics, their relationships, and the role they may have had in the construction of the image, which can not be recognizable from the very limited number of cross sections(Manuel et al., 2015). All these data provide consequently a unique opportunity for studying the painting, however prone to disappear if they were not correctly gathered and recorded during the cleaning process.

A cleaning test on 8 zones selected basing on their varying conditions of previous interventions, pigment composition and the layer thickness was implemented(showing in Fig.7), with the objective of determining the most effective and suitable solvents and methods for removing the deteriorated varnishes and dirt, meanwhile preserving the underneath painting layers from solvent migration in different situations, as the same solvent may behave differently depending the way it is applied, the substances to be dissolved, the painting techniques and the pigment materials. After the test, the following solvents and methods were determined to be applied:

Fig.7. showing the cleaning test based on 8 zones

a. Pure acetone applied by cotton swab. Normally the first option for cleaning solvent is acetone, because pure acetone evaporates quickly, it is weak and less aggressive, making the cleaning efficiency relatively low thus suitable for performing a careful and controllable removal of only the surface layer, meanwhile it is one of the least toxic cleaning products with less harmful to the restorer.

b. A solvent composed of 20% dimetil and 80% acetone. When it comes to the area probably containing resin therefore difficult to clean by pure acetone, the chemical extraction effect of the 20% dimetil and 80% acetone solvent will work gently to remove the dirt and vanish, avoiding the risk of possible damage of the pigment layer underneath. It could be applied by rolling cotton swab, or by sticking a small piece of tissue containing the solvent to the surface with a contacting time of 30 seconds to guarantee maximum security both to the painting and to the restorer.

c. A solvent composed of 5% triammonium citrate and 95% water applied by cotton swab, for removing the extremely thick dirt layer and the repainted layer comes from the previous restoration.

d. Pure dimetilsofossido gel and 15% dimetil with 85% acetone solvent. First pure dimetilsofossido gel was applied by cotton swab, then washed by pure purified petrol after 1 minute in order to remove the gel and stop the chemical reaction. The advantages of applying dimetilsofossido gel is that its cleaning efficiency is a bit low, it works in a slow way and remains only on the surface of the painting instead of going though the other layers, and it is with less toxic to restorer as it is in gel. Then, 15% dimetil with 85% acetone, which is a relative weak solvent, was applied to refine the cleaning.

Notably, the magnifying glasses was used during the whole process, and a scalpel was applied when there is a need for further precisely cleaning of some small parts that were still remaining on the surface after applying the solvent. The old varnish, retouching, and the dirt covered on the surface was then removed square by square. A square was regarded as completely clean when there is no color appeared on the cotton swab which will also double checked with the portable microscope, an example is showing in Fig.8.

Fig.8. Image showing the microscopic photography taken from the sky for checking the cleaning condition after the primary cleaning. In this case micro-varnish was still remaining and some of them went into the craquelure, indicating the necessity of further cleaning.

3.3.2. Panel Restoration

With close cooperation with the skilled panel restorer Ms. Daniela Caldone, a standardized visual examination of the panel was implemented, after which the reverse panel was further observed by Veho VMS-004 Deluxe Microscope with 20x magnification and examined by

ultraviolet fluorescence(photos are shown in fig.9), with the aims of understanding the wood, current condition and previous intervention. Based on the results, a panel restoration strategy will be proposed.

Fig.9. Image showing the consultation and cooperation with the skilled restorers for understanding the wooden panel(a), and microscopic observation of the reverse panel(b)

4. Results and Discussion

4.1. Conservation Status and Previous Interventions

Before the present restoration was begun, the overall conservation statues both on the surface and the back of the panel were revealed by a visual examination first. Furtherly, close examination of the painting condition was also implemented with the aid of a microscope during the surface cleaning process, from which the types of deterioration can be classified into three groups according to its stratigraphy:

First, the alternation of the upmost protective layer. A dark, brownish, stained tone evened the colors due to the dirt covering and the decay of the varnish, which disfigures the image and disrupts the appreciation of the vivid scene, even leads a difficulty to identify the Saints since some of their wearing or carrying symbols of their martyrdom were covered and became invisible. One of the most considerable examples is of the ring of St. Agnes is shown in Fig.10

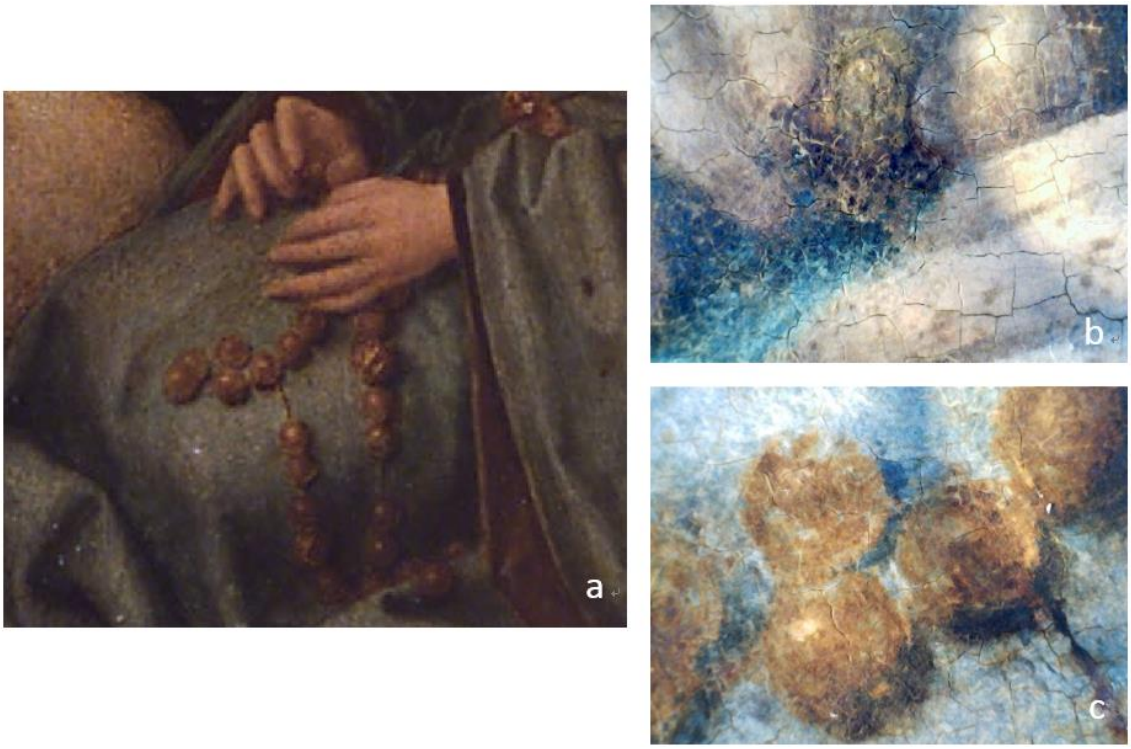

Fig.10. images showing the alternation of the holding ring of St. Agnes before(a) and after(b) surface cleaning. Typically in Flemish painting, St. Agnes is recognizable for her sheep and ring as a symbol signifying her own espousal to Christ. In this case, it was confusing at first since no ring was visible, nevertheless, after cleaning a vague ring appears in her right hand, which is surely different from a part of rosary (c).

Secondly, the deterioration of the paint layer, which can be divided by the possible causes into three types, is listed in the table.1. Some significant images are shown in Fig.11.

Table.1. There main types of deterioration on the paint layer and their phenomena.

Types	Deterioration Phenomena
Mechanical dominant deterioration	Craquelure due to the paint layers age and shrink Scratches resulting in a paint loss on the surface
Chemical dominant deterioration	Chromatic alteration of the pigment result from oxidation
Improper restoration induced deterioration	Irregular abrasions caused by excess friction or aggressive solvents during the previous improper cleaning

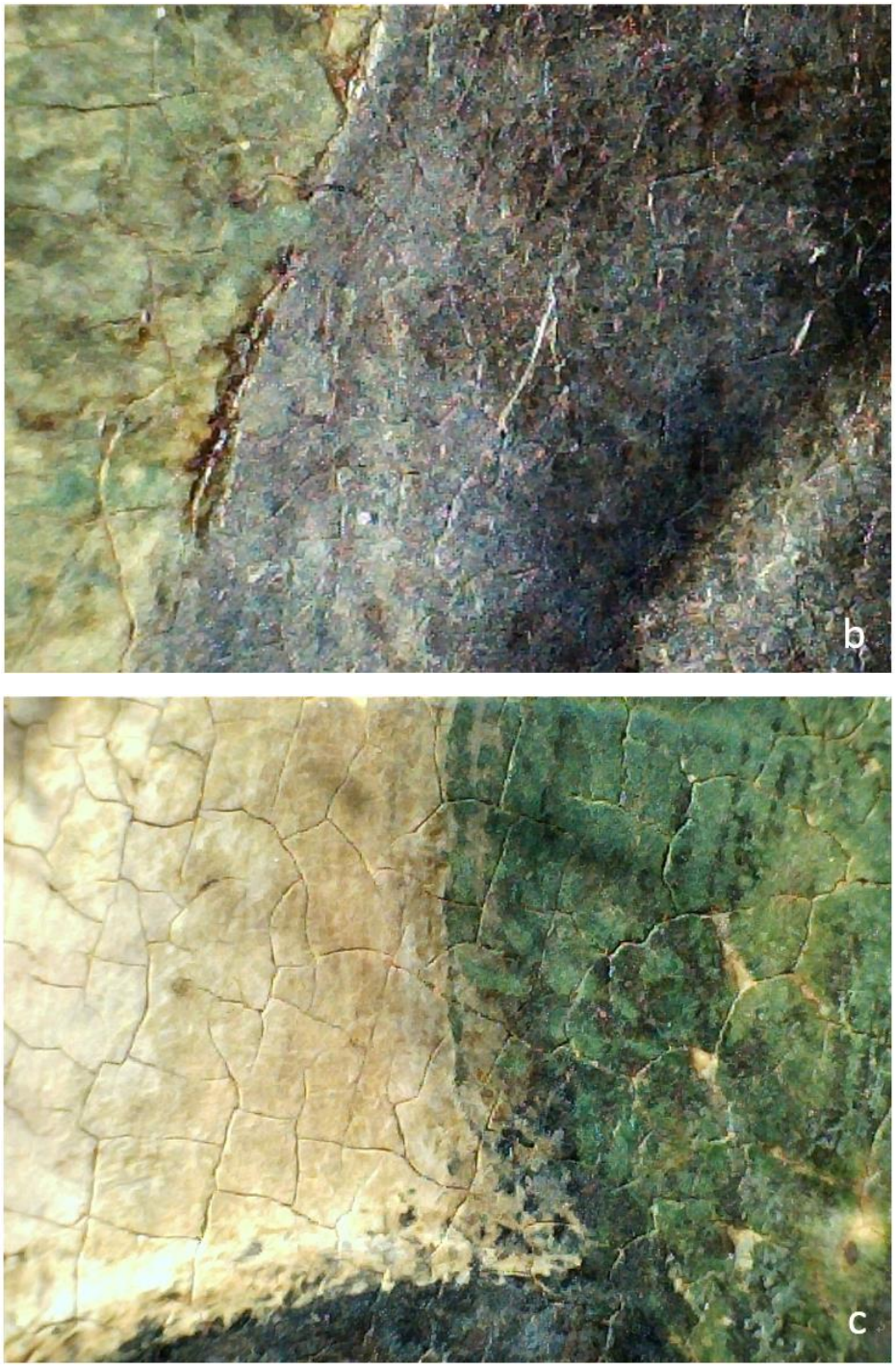

Fig. 11. Images showing the deterioration of the paint layer (a) Microscopic appearance of the craquelure on the face of St. Agnes (b) Microscopic appearance of the scratch on the dress of Virgin Mary (c) Microscopic appearance of the abrasion around the neck of St. Barbara

Thirdly, the panel itself was also carefully observed. In general, the panel is in a relatively good condition, as there is no considerable amount of deterioration among the whole painting although it was composed in the first half of 16th century. The reason probably results from the original material, which is recognized as chestnut wood by the experienced panel restorer in the standardized visual examination. Chestnut wood is a typical material applied in Flemish paintings, generally the chestnut wood used for panels is of high quality, therefore it is always relatively thin but strong enough as a support, preventing the painting from deformation and bio-attacks. The species of the panel also provides us a clue crucial for the confirmation of the origin of the painting.

Two vertical cracks were observed on the panel. The crack on the right is corresponding to the join between planks however became less glued and more separated during the centuries. The left one is a physical crack, rather than a natural occurring deterioration it was possibly resulting from once uncorrected restoration at the beginning of 20th, since the *parchettatura* (which is a wooden structure applied on the reverse panel for protecting the panel from nature curving deformation process and helping to keep the panel stay as flat as possible) was made much more thicker than the panel itself, therefore providing over-strong strength than needed, leading to a negative effect that became one of the main reasons of the formation of the existed left crack, and part of the reason of the right side panel planks separation, as the two cracks actually both coincide with the horizontal *parchettatura.*(see in Fig.12)

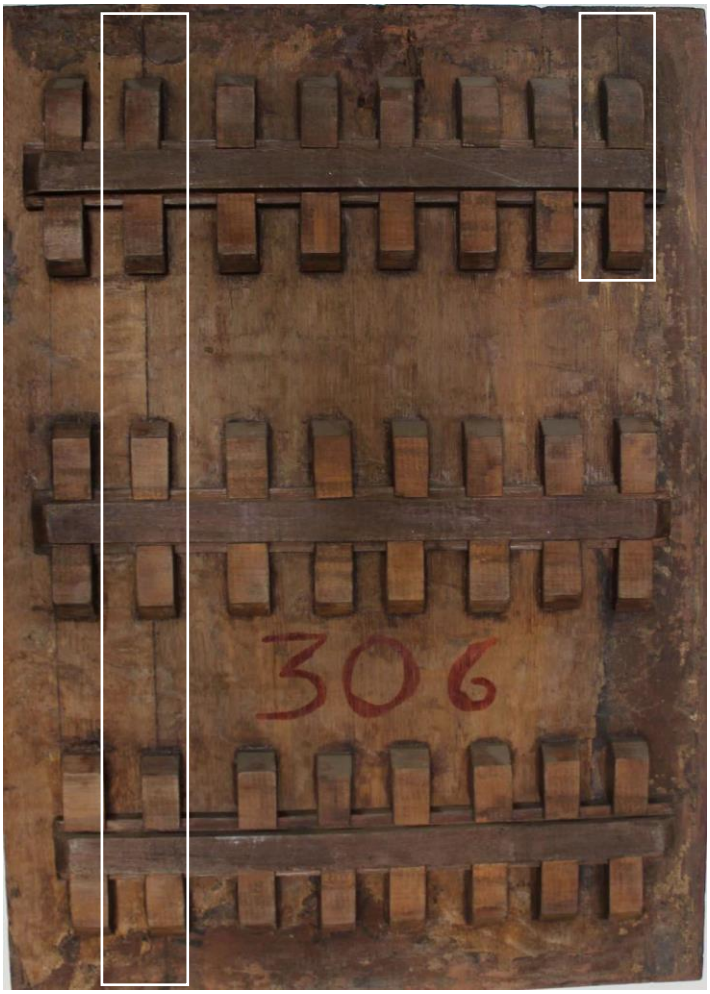

Fig. 12. Images showing the cracks are coinciding with the horizontal *parchettatura*

Based on the conservative state of the panel, it is crucially important to cooperate with the panel restorer to determine and implement the most suitable restoration strategy, which is: First, long triangular prisms made of the same wood species as the original panel will be applied along the vain vertically with glue to restore the two cracks. By means of triangular shape, the cracks will be glued by two surfaces, and supported by more strength compared with only one face glued. Second, since in the previous restoration *parchettatura* was applied

much more thicker than the actual need for conservation, it is necessary to reducing the thickness of the old *parchettatura* to the same thickness of the panel itself, in order to ensure the panel will only receive the same force as the force of its nature curving deformation, which could help to keep the panel stay as flat as possible during a long period. Lastly, when framing, polytetrafluoroethylene should be applied between the panel and the frame for two propose, one is to preserving a little space for securing every elements applied for protecting the panel are all slightly slidable, as well as the panel itself will not be completely fixed, in order to fit the possible future deformation. The other is to prevent the possible scratching between the painting surface and the frame.

The previous intervention information was obtained by UVF examination and partly revealed during the work of removal of the re-paintings. The varnish layer is not original since the presence of all the retouchings were found underneath the top varnish layer during cleaning, and it seems to be quite thin therefore the detected UVF appears to be influenced by the presence of the pigments. As the overall UVF images(showing in Fig.13) of both the front and back paintings appear in greenish and blueish respectively, it is evident that the varnish applied on the painting surface is from a natural origin, whereas the protective layer applied on the back is a synthetic product. The retouchings and overpaint have been observed in UVF image where the darker spots appear for the non-fluorescence characteristic of the younger material, since the organic media have not yet aged as much as the original materials and the used materials may differ from the original ones. The bright fluorescence spots on the back of

the panel were due to the spreading of the glue applied in previous restoration. In addition, the non-original varnish was distributed all over the painting surface including the frame border, indicating that the previous intervention was conducted thoroughly with taking out the painting from the frame.

Fig. 13. Images showing the UVF images (a)from the painting surface, showing also the overpaint and the two cracks (b)from the reverse panel.

It is of interest that in UVF image, two extensive dark zones were found on the top part of the painting covering the sky and on the middle bottom part of the painting covering the plants (showing in Fig.13a in white circle), seems to be overpainted from past interventions, and the fact is further confirmed during the surface cleaning exploration. After removing the varnish, a greenish pigment layer was found on a part of the sky, spreading into the unpainted panel edge, and a brownish pigment layer was also investigated spreading on the plants. The

purpose of this kind of intervention was revealed, as considerable amount of craquelures and abrasions were found under these pigment layers after cleaning, that is after retouching the craquelures and abrasions, another pigment layer was added by the previous restorer in order to make the surface of painting remain smooth.

In URF image, two dark vertical lines were clearly seen on the left and right sides of the painting (showing in Fig.13a in blue circle), resulting from the non-fluorescence nature of the retouching. As mentioned before, the left trace indicates the restoration for a physical crack result from deterioration, whereas the right trace is corresponding to the retouching of the join between planks. Moreover, the existence of several tones of dark around the right crack revealing us the intervention history from different periods, which was also investigated during the cleaning process, with the retouching removed layer by layer, 4 interventive layers has been discovered (the microscopic photography is showing in Fig.14). A greenish vanish layer was shown on the most top layer, under which some greyish older vanish spots were existing. Under the vanishes, there are two kinds of retouchings from different periods for filling the crack, the younger one appearing in white is made of gypsum and glue, whereas the yellowish older one is made of wax.

Fig.14. Microscopic photography showing the different intervention layers around the right crack

4.2. Executive Techniques

4.2.1. The Preparatory Layer

The existence of a preparation layer have been firstly revealed by ED-XRF analysis, most probably composed of lead white ($2PbCO_3 \cdot Pb(OH)_2$), characteristic by high counts of Pb presenting in every selected points even in dark areas. Moreover, two well-distinguishable colored preparation layers were exposed in the occasional gaps of paint loss zones after removing the dirt and discolored varnish layers, indicating lead white has been tinted with other pigments. A pale grey preparation layer was found spreading all over under the blue pigment layer of the sky, showing in Fig.15. And a brownish-orange preparatory layer was discovered applied more widely under the other parts of the paint which is also further

confirmed by optical microscope analysis(see in Fig.24 and Fig.25), evident examples are showing in the Fig.16.

Fig.15. Image showing the pale grey preparation layer exposed along the right crack after cleaning

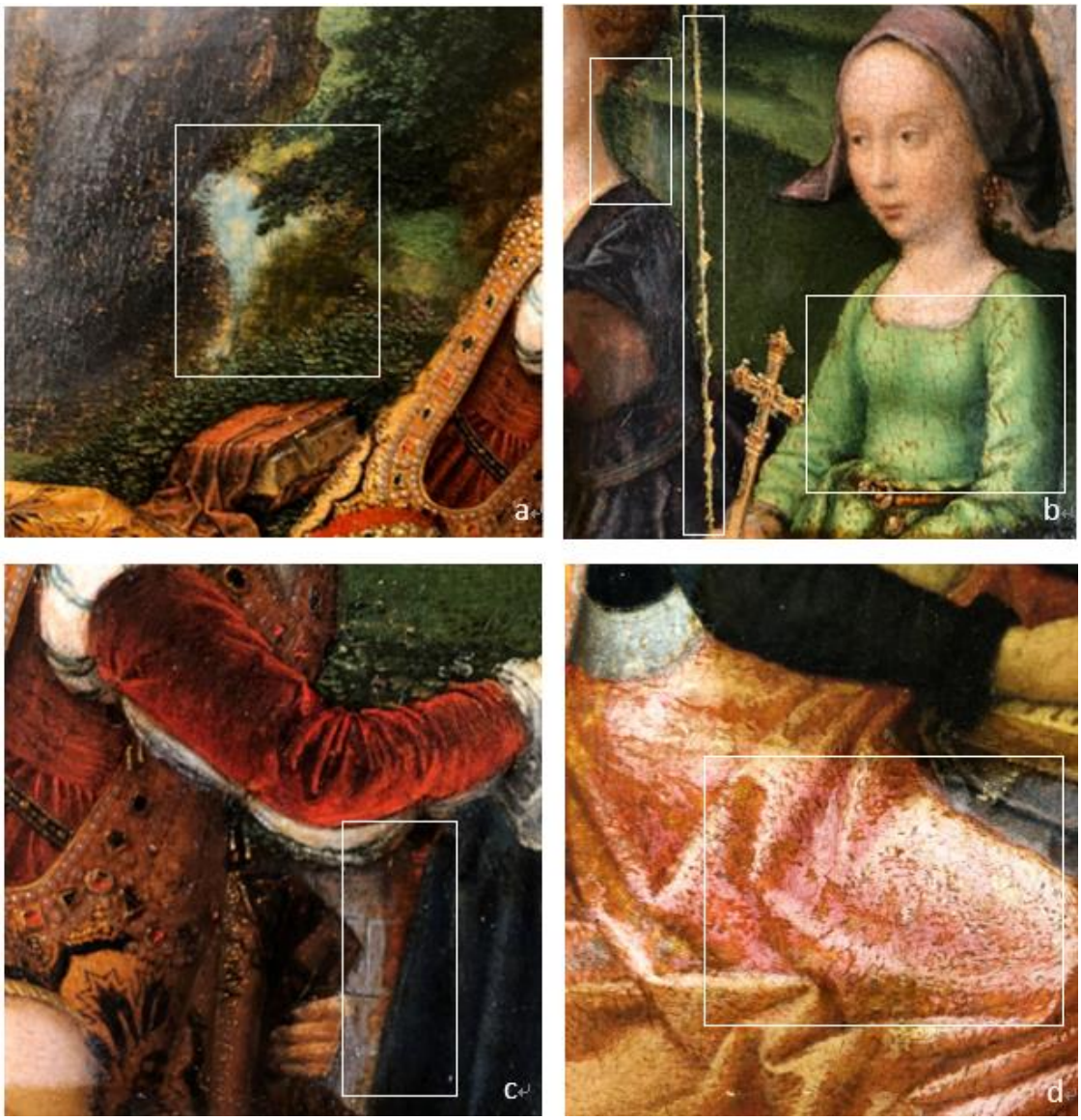

Fig. 16. Images showing the widely spreading brownish-orange preparatory layer during cleaning process (a) Brownish-orange preparatory layer showing in the background around the rock (b) Brownish-orange preparatory layer appearing near the neck of St. Catherine, along the right crack, and the in gap of paint loss on St. Margaret's green dress (c) Brownish-orange preparatory layer appearing under the paint of the wall between St. Catherine and Virgin Mary

These observations allow us to further understand the depicting technique of Isenbrant. Generally, the fundamental function of the preparatory layer is to isolate the ground, preventing it from absorbing medium from the layers of paint above and thus causing them to become lean and matt in appearance.(Billinge et al., 1997) Furthermore, the existence of two kinds of colored preparations indicates Isenbrant's deliberate choices in his composition, which might be expected to have some effect on the adjustment of hues and saturation of the color so as to determining the final chromatic quality of the paint. Noteworthy is that, regrading to the art history context, in the whole Europe there was a gradually transformation of preparatory layer from white dominant to colored. In Northern Europe, white or very light colored preparations actually remained popular until the end of the 16th century(Stols-Witlox, 2012), which however already adopted by Isenbrant in the first half of 16 century, showing his novel thoughts in painting execution techniques.

4.2.2. Underdrawing

The understanding of the underdrawing is mainly based on the evidence supplied by infarard reflectography and the electronic microscope applied during the cleaning process. Unexpectedly, only very limit amount of underdrawings were recognizable from IRR image:

The most detailed and impressive underdrawing IRR examination shows is on the dress of St. Ursula, consisting essentially groups of short, parallel hatching for depicting the shadow zones of the folds, showing in Fig.17.

Fig. 17. IRR image showing the underdrawing on the dres*s of St. Ursula*

What's more, in IRR image the eyes of all the figures and even the lamb are appearing only black spots in the central parts of each eye, forming a contrast when compared with the bigger and more detailed eyes under visible light, reveling the Isenbrant 's indications of the eyes design in underdrawing, that is, he only applied spots to define the position of the eyes, and then completed the composition by pigments as showing in Fig.18. Such an simple underdrawing cannot fail to play an essential part in Isenbrant's precise composition technique.

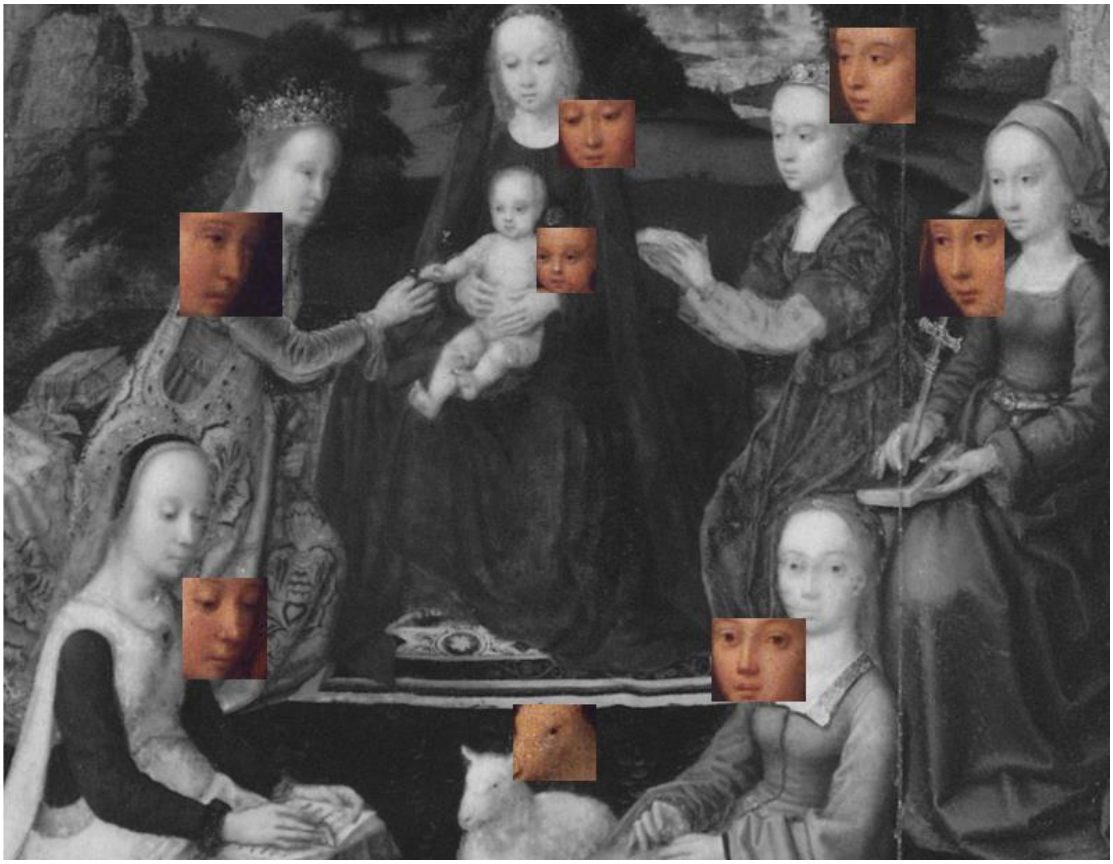

Fig. 18. Comparation of the eyes under IRR and visible light, showing the indications of the eyes design in underdrawing

The IRR images does not reveal an extensive underdrawing, which seems to be affected by the material used for the underdrawing, i.e. if an infrared-absorbing material such as carbon based black was not applied by the painter, it is impossible to reveal the underdrawing. However, during the cleaning process, no other underdrawing trace can be observed from the paint loss zones nor through the paint film where the paint is thin and had become translucent with age, indicating it is possible that the underdrawing was optional and not executed extensively by Isenbrant in this case.

4.2.3. Pentimenti

A great deal of alterations, i.e. the pentimenti, made to the figures and to the carefully arranged composition were revealed from IRR examination, as well as during surface cleaning process since the discolored varnish and dirt were removed from some of the paint layers that has become translucent during centuries, exposing the covered original composition.

One of the most considerable pentimenti was revealed on the face of St. Agnes from the IRR image, having to do with the direction of her whole face and gaze, showing in the Fig.19. In the preliminary scheme, St. Agnes was gazing down to the sheep and facing to the central of the scene, only showing half of her face with her eyes and nose. Her mouth was drawn on the very left of the face and her ear was very close to her right side hair. However Isenbrant made a quite perceptible displacement that he turned St. Agnes's face to a frontal view by repainting her new eyes, nose, mouth and enlarging her forehead as well as covering her previous drawn ear.

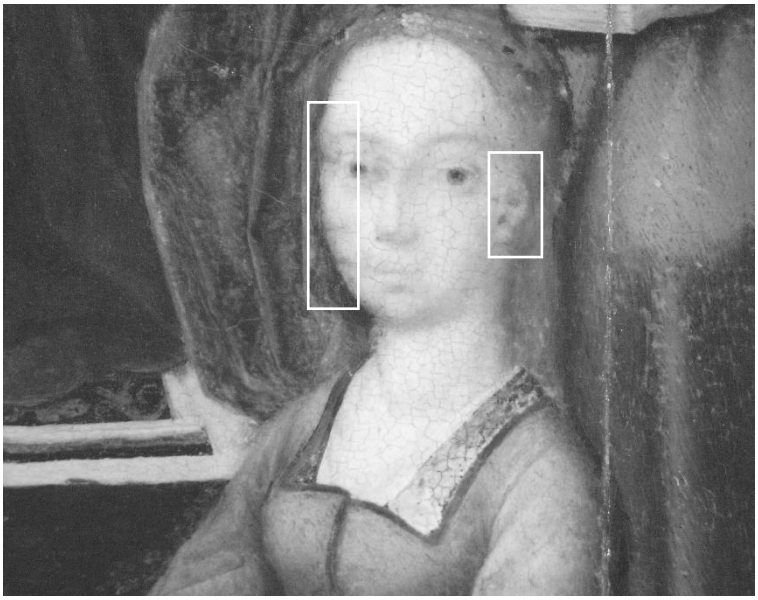

Fig.19. Image showing the pentimenti on the face of one St. Agnes

From IRR examination, a part of black counter was revealed on the forehead of St. Catherine, although it did not clearly indicate whether it is a pentimento or not, since the right side of the line are all appearing as dark grey in IRR image. However it became evident in the cleaning process that the black line found in IRR image is actually the original contour of St. Catherine's forehead, which Isenbrant did not follow in the finished painting. Instead, he enlarged the forehead a little bit by the pigment and make it overlapping on the tree from the landscape. Another interesting pentimento is from the St. Catherine's hair. IRR image shows evidently that there is a straight counter of the initial hair of St. Catherine, and the curly part seen in the visible light is almost absent, indicating the curly hair was probably added later. After cleaning, it became extremely clear that the curly hair was added by pigment afterwards above the tree in a very thin layer, and the tree underneath even became slightly visible as the thin pigment

layer was degraded during the centuries and became more translucent. The IRR examination result and the image after cleaning are showing in Fig.20.

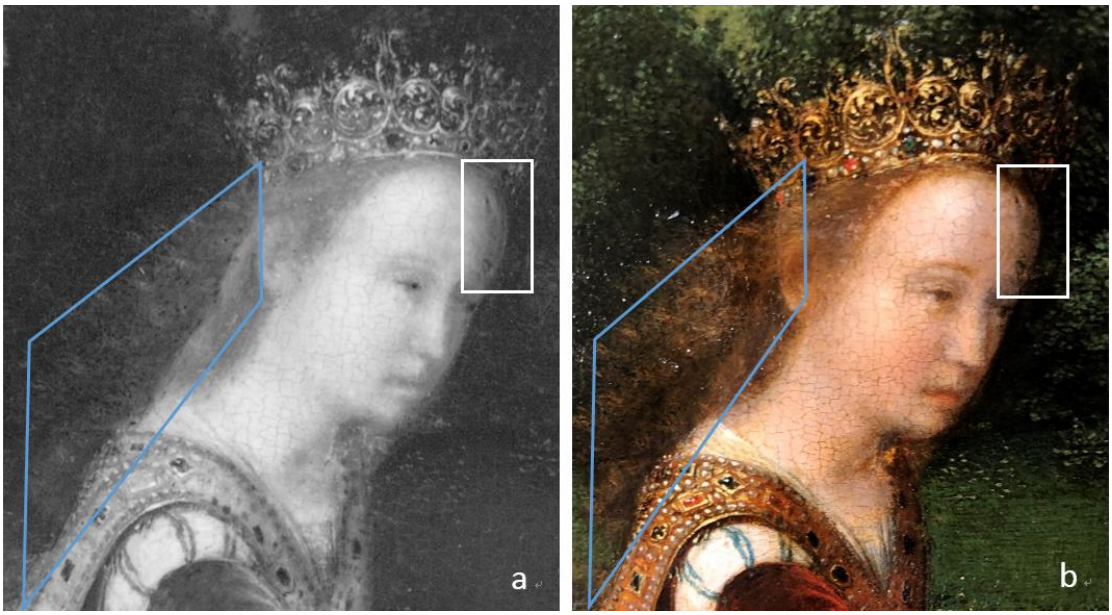

Fig.20. Images showing the pentimenti on St. Catherine's foreheand (in white circle) and her curly hairs(in blue circle) from IRR examination(a) and image after cleaning(b).

Two contour lines on the right side neck of St. Barbara were observed vaguely in IRR image. After cleaning, with the aid of microscope, it was clearly perceptible that the thin line on the left is actually the previous position of the contour, however another stronger line on the right side was added by the painter to widen the neck, which was also served as a part of shadow effect of the neck. Besides, the hairs of St. Barbara are of interest to us. From another very similar painting attributed to Isenbrant, we found some hairs remaining around the figure's neck, which is different from this painting seen in visible light before cleaning. By IRR examination, something confusing were found around the neck, seems to be a covered

pentimento. After cleaning, under the dirt, a brownish traces became visible. Two possibilities may occur here: first, Isenbrant changed his mind during composition and later covered the hairs by the landscape, which should be regarded as a pentimento. Secondly, the brownish traces may be made by the previous restorer on the propose of covering the abrasions, since this kind of restoration technique also found in other part of the painting as we mentioned before(see in Fig.13a). Notably that the IRR image also shows the ear of St. Barbara has been perceptibly enlarged. All these discussions based on IRR examination result and the image during cleaning are presenting in Fig.21.

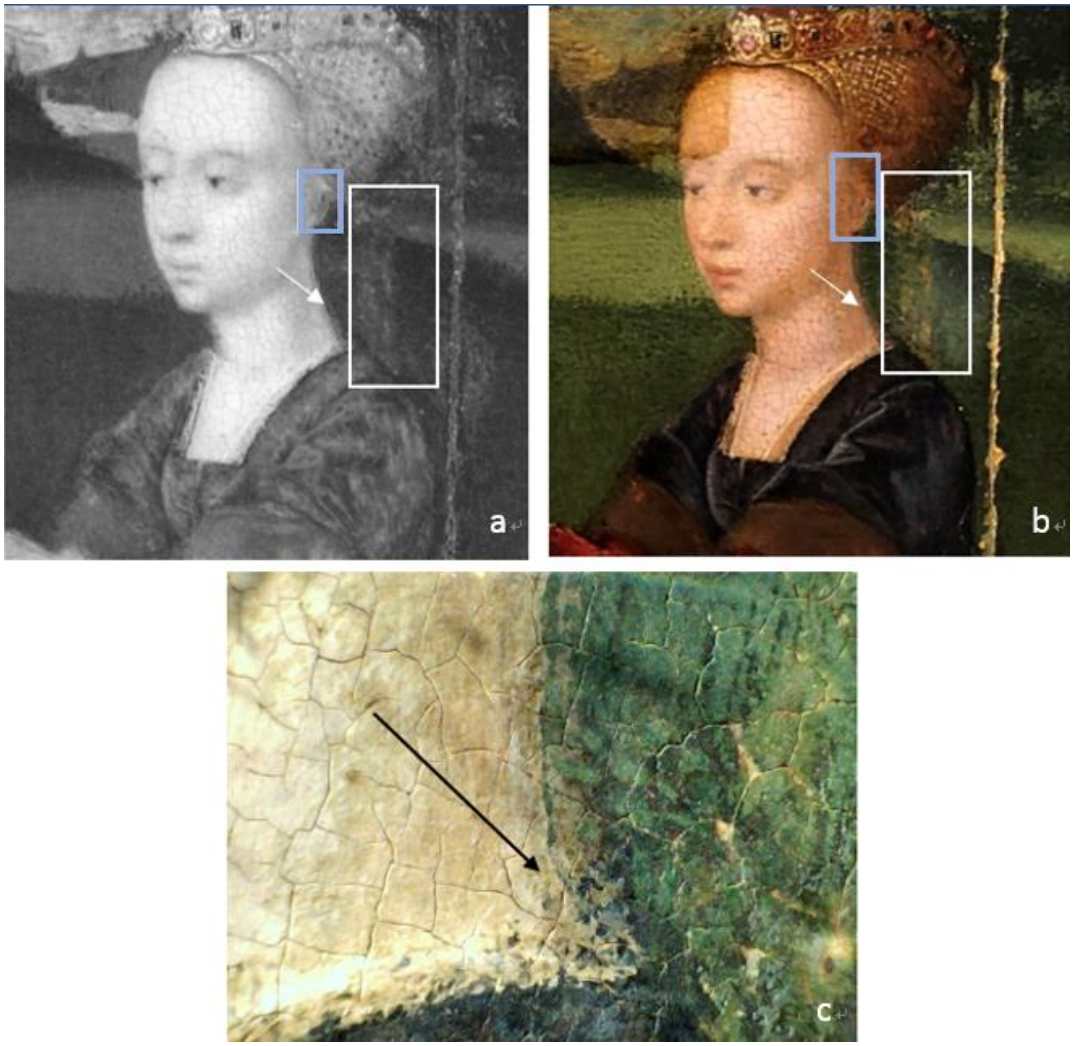

Fig.21. Images showing the pentimento of contour lines on the right side neck of St. Barbara(pointed by the arrows), the possible pentimento of her hair (in white circle) and her enlarged ear (in blue circle) from IRR examination(a), macro(b) and micro(c) photography after cleaning.

A second thought when Isenbrant was painting the headkerchief of St. Margaret was first shown from the IRR examination. Particularly, cleaning brought to a quite clear view that the drooping part of the headkerchief was drawn more wider before but then narrowed. The evident IRR image and after cleaning image are showing in Fig.22.

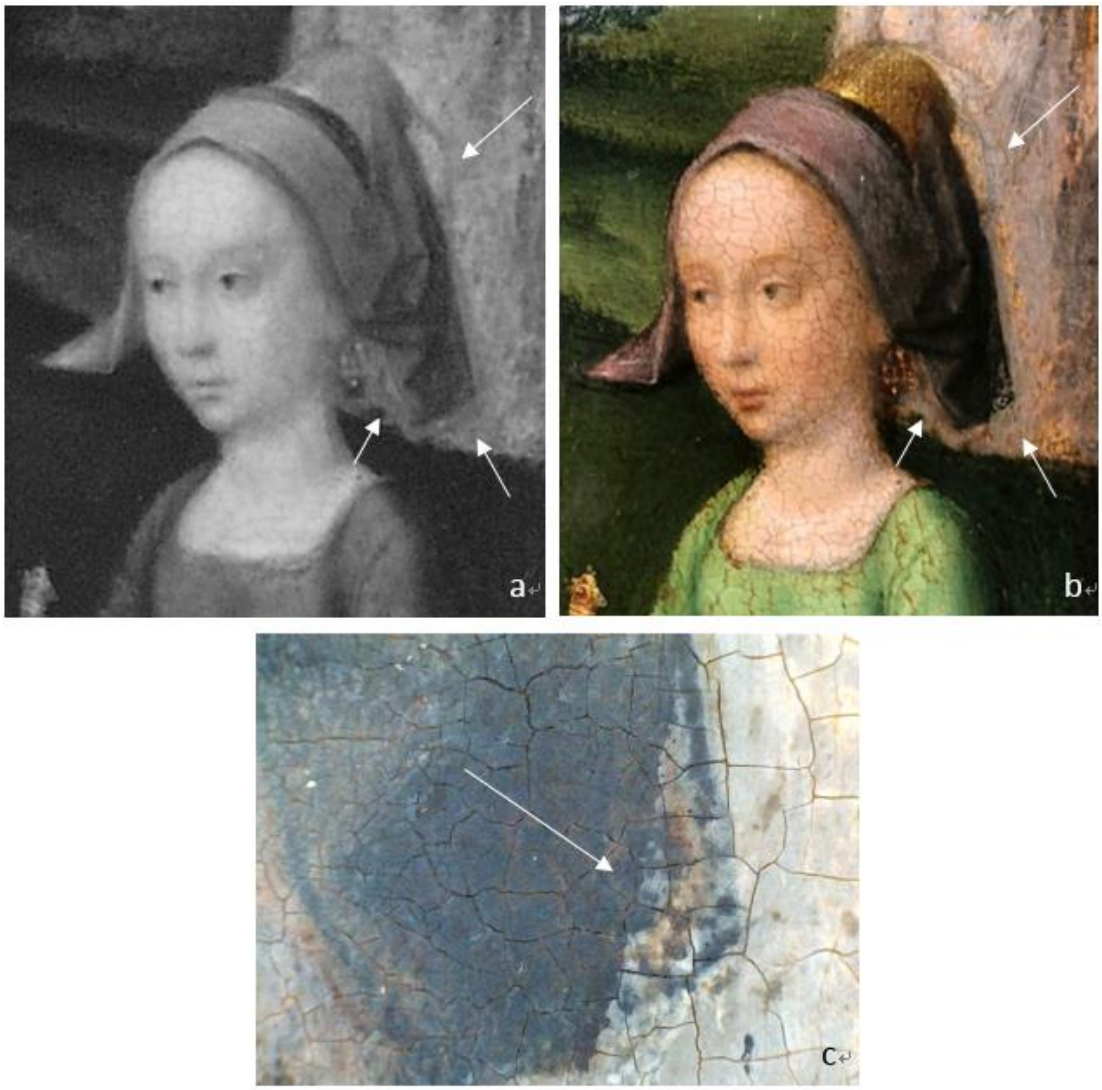

Fig.22. Images showing the pentimenti on the headkerchief of St. Margaret from IRR examination(a) and macro(b) and micro(c) photography after cleaning.

Moreover, cleaning exploration of the painting yields an additional pentimento on the left side rock although which was not so clear in IRR image, revealing Isenbrant extended outward the outline of the rock by applying pigment above the finished landscape to widen the rock(showing in Fig.23), showing his delicate care to the even tiny detail of the painting.

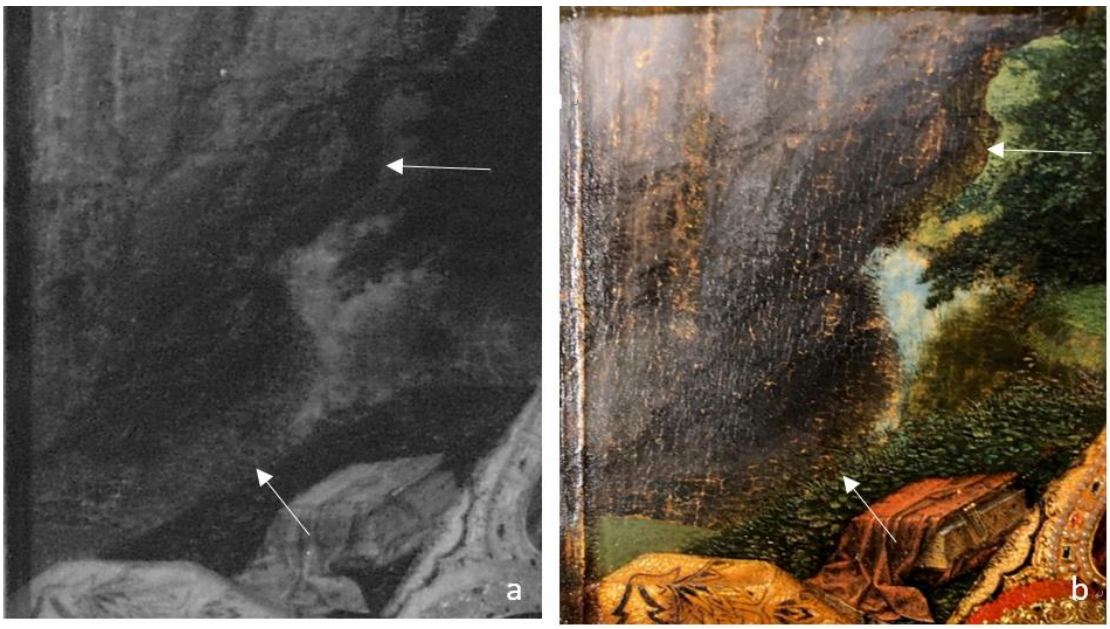

Fig.23. Images showing the pentimenti on the left side rock from IRR examination(a) and image after cleaning(b).

It is worth to mention that, from what we discussed above, the pentimenti were almost present in every figure and even in the landscape, revealing Isenbrant's continuously thinking and redesigning every detail of the painting to achieve his ideal work. Therefore, it seems to be illogical that in his composition of the most important figures of the whole painting, the Virgin Mary and Baby Christ, no pentimento was discovered at all, which possibly revealed us a crucial technique information of Isenbrant's execution, that is either he has been already very proficient in drawing Virgin Mary and Baby Christ with careful plan and meticulous preparation, thus no need for reconsidering and changing any element later. Or the figures were carefully copied by Isenbrant from a pre-existing pattern, however unfortunately, no

trace of copy in this case was found neither in the scientific examinations nor during the cleaning process.

4.2.4. Stratigraphy

Stratigraphy analysis of the two cross sections carried out by optical microscopy confirms the presence of a preparation layer, one or more paint layers depending on the sample, as well as several varnish protective layers. The images of the result are presenting in Fig.24 and Fig.25.

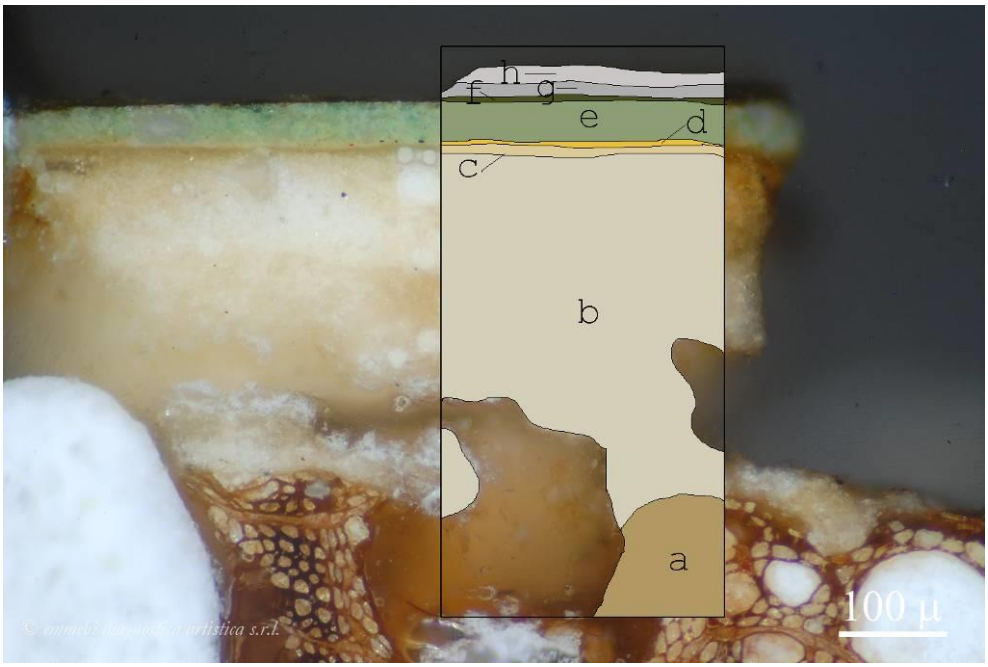

Fig.24 Photomicrograph showing the stratigraphic information of the micro-sample taken from the green dress of St. Margaret

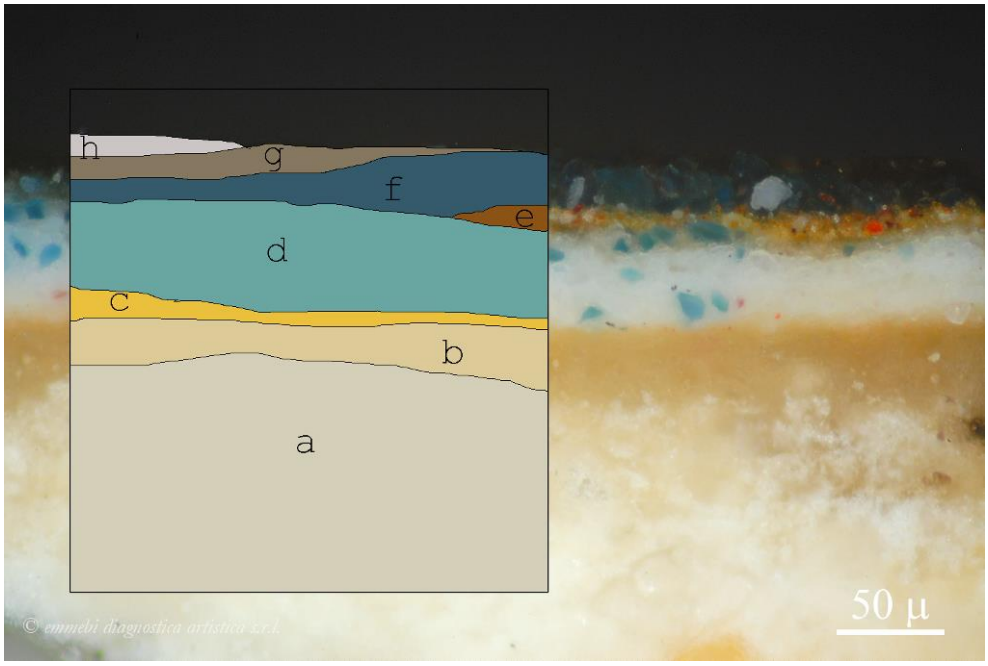

Fig.25 Photomicrograph showing the stratigraphic information of the micro-sample taken from the blue dress of St. Agnes near her rosary

Two cross sections show the same composition of the preparation layer by optical microscopic analysis, which is composed of a thick whitish layer(see in Fig. 24b and Fig.25a), a brownish layer(see in Fig.24c and Fig.25b) and a yellowish layer(see in Fig. 24d and Fig.25c) bottom up. This result is corresponding to the brownish-orange appearance of the preparatory layer that has been discovered in the occasional gaps of paint loss zones after cleaning as discussed before(see in Fig.16). It's worth noting that the rare presence of fine red and black particles appearing in the toppest of the preparation layer in both of the cross sections, could possibly be the traces of underdrawing.

Regrading to the paint layer, the analysis of a cross section taking from the green pigment which is verdigris or malachite according to ED-XRF analysis, is composed of a single 40 microns thick green pigment layer, including green, yellow and translucent particles with fine and very fine grains(see in Fig. 24e). Whereas three paint layers are revealed in the cross section taking from the blue pigment which is identified as azurite by ED-XRF. A 50 microns thick light blue layer is shown in the bottom of this paint layer, consisting of a white matrix and including some blue pigment particles from coarse to very fine(see in Fig.25d). Above the light blue layer, an orangish layer is present only on the right of the section with 10 to 15 micron thick, the color is obtained by mixing fine to very fine yellow pigment with red pigment(see in Fig.25e). This layer probably is result from the orangish pigment applied for depicting the rosary that right next to the blue sample. On the top of the paint layer, a thinner blue layer of about 20 microns consisting of particles of coarse to fine granulometry blue with very rare white and brown particles is shown(see in Fig.25f). The difference in thickness and color between the light blue and blue layers is presumably due to the fact that the light blue was obtained by dispersing fine particles of blue pigment in a white pigment matrix, therefore it is much more thicker than the upper blue. The existing of the two different hues of blue layers represents the repaintings, indicating that Isenbrant possibly applied light blue to paint the dress of St. Agnes at first, and then he covered it with a deeper blue pigment to achieve his ideal final chromatic appearance.

In the uppermost part of both of the samples, organic appearance layers with different degrees of fluorescent in ultraviolet light are presenting from the results of optical microscopic analysis, which seems to be the varnish coatings originated from different period. In the green sample, a brown organic appearance layer of about 10 microns is presenting over the paint layer with moderately fluorescent(see in Fig.24f), above which two layers of organic appearance with intense blueish and greenish fluorescent respectively are clearly found under the ultraviolet light(see in Fig.24g and 24h). Analogously, in the blue sample, a 10 microns brown layer of organic appearance, with almost non-fluorescent in ultraviolet light was observed on the top of the paint layer(see in Fig.25g), and above it, there is an another organic appearance layer with intense fluorescent in ultraviolet light(see in Fig.25h).

4.3. Pigment Material: Reconstruction of the Palette

Pigments were identified on the bases of an overall IRFC image (showing in Fig.26) and characteristic chemical elements gained from ED-XRF analysis performed on 16 points, as described in the Table.2. The pigments from the original Isenbrant's palette are all commonly applied in the 16th century Flemish painting, while the occasionally appearing chemical element belonging to modern materials (Zn) revealed us the previous retouching. The high counts of Pb presenting everywhere even in dark areas, corresponds to a lead white preparatory layer.

Fig.26. IRFC image of the painting

Table 2 ED-XRF results, expressed as counts per second.

Emission line	Ca Kα	Fe Kα	Cu Kα	Zn Kα	Hg Lα	Pb Lα
01_red	N:457	N:271	N:56	-	N:135	N:1038
02_red	G:53	G:89	G:79	G:56	G:179	N:7294
03_red	N:99	G:109	N:390	-	N:67	N:3359
04_green	G:36	N:117	N:8682	-	-	N:11623
05_green	N:61	N:73	N:20797	-	-	N:1716
06_green	G:82	N:59	N:12291	-	-	N::4067
07_green	N:56	N:363	N:36406	-	-	N:2648
08_blue	G:39	N:97	N:5426	-	-	N:10259
09_blue	N:66	N:307	N:21435	-	-	N:2509
10_blue	G:34	N:113	N:6767	-	-	N:4900
11_flesh	G:28	G:66	G:67	-	G:91	N:6371
12_underdrawing	N:220	N:51	G:116	N:53	N:80	N:6416
13_restoration	N:56	N:201	N:26527	-	-	N:2245
14_restoration	-	N:153	N:2181	N:469	-	N:6434
15_yellow	N:214	N:931	N:5027	-	-	N:9876
16_yellow	N:69	N:337	N:4539	-	-	N:2021

* N: Net area; G: Gross area

Only the main emission lines of each element are presenting.

Red pigment:

The red pigment was appeared in a yellowish tone in IRFC image thus preliminarily identified as cinnabar.(Moon, R, & Thirkettle, 1992) ED-XRF analyses based on 4 points from the dress of St. Ursula and the sleeve of St. Barbara in different hues, confirmed the identification owing to the presence of Hg as the predominant chemical element in all spectra for the identification

of cinnabar(HgS). However, the Kα(2.309 keV) and Kβ(2.465 KeV) peaks of the relatively low counts of S, as the characteristic element of cinnabar as well, were covered by the Mα(2.342 keV) and Mβ(2.444 keV) peaks of Pb, therefore can not be distinguished from the portable ED-XRF systems.(Diana, Gabrielli, & Ridolfi, 2007) The presence of lower peaks of Fe indicates Isenbrant probably mixed cinnabar with small amount of red ochre(Fe_2O_3) to improve color saturation. Light pink was achieved by mixing cinnabar with more lead white, characterized as high counts of Pb. The darker pink used to depict the shadow of the folds on the dress was possibly achieved by mixing cinnabar with a bit Cu based green or blue. Higher peaks of Ca and Fe can also be observed on the dark red from the sleeve of St. Barbara, revealing the use of an organic black pigment, based on Ca, and of burned ochre to achieve this dark tone.

Green pigment:

The green pigment points for ED-XRF analyses were chosen from the hill, the dress of St. Margaret, and the leaves of the left side tree, representing different tones of green from light to dark. The major chemical element in all spectra is Cu with higher or lower counts depending on the tonality of the green, which indicates that the green was accomplished by a Cu based pigment. Nevertheless, it is impossible to determine the green pigment only with ED-XRF examination, as Cu is the only characteristic element for not only a kind of Cu based green pigments. Even though, we are able to narrow all of the possibilities by its historical context, and it is most probably to be verdigris($Cu(CH_3COO)_2{\cdot}H_2O$) or malachite($Cu_2(CO_3)(OH)_2$). Unfortunately, IFRC photography does not help in this case for further identification. In the

selected points, Cu was always mixed with lead white with the characteristic element of Pb, the higher counts of Cu with lowers counts of Pb represents a darker tone of green, which also accompanied by higher counts of Ca that may result from an organic black pigment based on Ca, and Fe that may from brunt ochre in order to gain darker green.

Blue pigment:

The blue pigment for ED-XRF examination were selected from the sky, the dress of the Virgin Mary, as well as the dress of St. Agnes. High count number of Cu is present in every selected point, indicating the blue pigment applied is azurite($Cu_3(CO_3)_2(OH)_2$). It is also double confirmed because this pigment gives a purple response to IRFC photography. (Hayem-ghez, Ravaud, Boust, & Bastian, 2015)The different tonalities of blue showing different counts number of Cu mixed with other elements. More lighter the tonality, more lower the peak of Cu mixed with more higher peak of Pb, revealing the use of lead white to lighten the basic azurite color. The dark blue points showing not only high counts number of Cu with less counts number of Pb, but also revealing the presence of higher Ca and Fe counts, which probably indicates the use of an organic black pigment, based on Ca, and of burned ochre to achieve dark blue. Interestingly, high peak of Zn was discovered in one spectrum obtained from a point around the right side crack, , indicating the possible previous modern retouching using lithopone($ZnS \cdot BaSO_4$), which is a modern material discovered in 1870s and widely applied in restoration works. (Habashi, 2016)

Flesh tone:

The overall IRFC image shows all the flesh in the painting was appeared in a slightly yellowish hue homogeneously, revealing the presence of cinnabar.(Moon et al., 1992) Only one point of flesh color was selected from St. Agnes's forehead as a represent for ED-XRF examination. Besides the predominant chemical element Pb from lead white to lighten the flesh, the presence of Hg and Fe reveals the use of cinnabar and a bit of red ochre to color the lead white and obtain the pinkish tonalities of skin.

Yellow pigment

To investigate the yellow pigment, two points were selected from the rosary and the cross for ED-XRF analyses. The main element present is Fe, indicating the yellow pigment is yellow ocher($2Fe_2O_3 \bullet 3H_20$). It is also further confirmed by their green-yellow appearance in IRFC image.(Dulce María Aguilar-Téllez, José Luis Ruvalcaba-Sil & González-González, 2014) The existed high counts of Cu, which in this case possibly detected from the copper based blue and green pigment from the dresses of St. Agnes and St Margaret that applied under the yellow pigment layer, as the incident X-ray beam is able to penetrate several layers of the painting. The presence of Ca probably belongs to a black organic pigment used to darken the yellow however can not be identified more precisely by ED-XRF.

5. Conclusion and Future Perspectives

Through the combination of scientific examination with restoration exploration, preliminary results of the conservative state, the previous intervention, painting technique and the materials of palette was concluded.

Generally speaking, the panel was preserved in a relatively good condition. Nevertheless some degradation was also revealed: the paintings surface had been darkened as a consequence of accumulation of dirt and natural discoloration. Under the surface layer three kinds of deterioration were found in the paint layer, mechanical dominant deterioration of craquelure and scratches, chemical dominant deterioration of chromatic alteration of the pigment, as well as improper restoration induced abrasions. Besides, two vertical cracks were observed on the panel. One is corresponding to the join between two planks, the other is a physical crack, probably resulting from an uncorrected restoration at the beginning of 20th century. Moreover, based on the wood material, current condition and previous intervention, panel restoration strategies was proposed. The intervention information was obtained by UVF examination and during the work of removal of the re-paintings. Several varnish layers was revealed and the toppest one was examined as non-original, the retouchings and overpaint have been observed in UVF image where the darker spots appear. The bright fluorescence spots on the back of the panel were due to the spreading of the glue applied in previous

restoration. In addition, two extensive dark zones were found in UVF image which were retouchings for covering and smoothing the craquelures and abrasions underneath.

As for the executive techniques, optical microscope analysis reveals the stratigraphic information, indicating that the painting was painted with the sequence of a preparation layer, one or more paint layers depending on the sample, as well as several varnish coating layers originated from different periods interventions. The existence of a preparation layer composed of lead white have been firstly revealed by ED-XRF analysis. Moreover a pale grey and brownish-orange were shown during cleaning, indicating lead white was tinted with other pigments for helping to determine the final chromatic quality. Underdrawings were only revealed on the dress of St. Ursula as groups of short and parallel hatching for depicting the shadow zones of the folds, and on the eyes of each figures, appearing as tiny spots to define the position of the eyes. A great deal of pentimenti were revealed extensively under almost every figure and even the landscape, revealing Isenbrant's continuously thinking and redesigning every detail of the painting to achieve his ideal work. The fact that no pentimenti revealed from the most important element of the whole painting, Virgin Mary and the Baby Christ, may indicate that either Isenbrant has been already very proficient in drawing them, or the figures were carefully copied by Isenbrant from pre-existing patterns.

The palette applied was effectively characterized through IRFC and ED-XRF examination, which contains cinnabar and red ochre for red, verdigris or malachite for green, azurite for

blue and yellow ocher for yellow. In addition, the extensive presence of Pb reveals lead white was used for preparation layer. The occasionally appearing lithopone revealed the trace of previous retouching.

This study provides a vivid evidence that restoration, in particular during the surface cleaning and panel restoration process, was also acting as a very useful tool in painting investigation, being complementary with scientific examination. In this case, cleaning worked as an aid for UVF examination, showing the painting conditions and retouching history. And it helped for determining the pentimenti and underdrawing when collaborated with IRR examination. Furthermore, the stratigraphic information was also revealed when removing the retouching layer by layer near the crack or paint gaps. While panel restoration helped to understanding the wooden material, the degradation condition and its possible causes. Notably, it is necessary to record all these precise data in a timely manner, as they would be prone to disappear if they are not correctly and timely gathered during the restoration process.

It is expected that further scientific examinations with more wider range of state-of-art analytical methods on Isenbrant's paintings from other museums and galleries could be proceeded within an multidisciplinary context. With the accumulation of the data collected from future scientific analyses, the possible comparison study is becoming implementable, which will certainly further our understanding of the painting techniques and materials applied by Isenbrant, and provide better solutions for the attribution issue.

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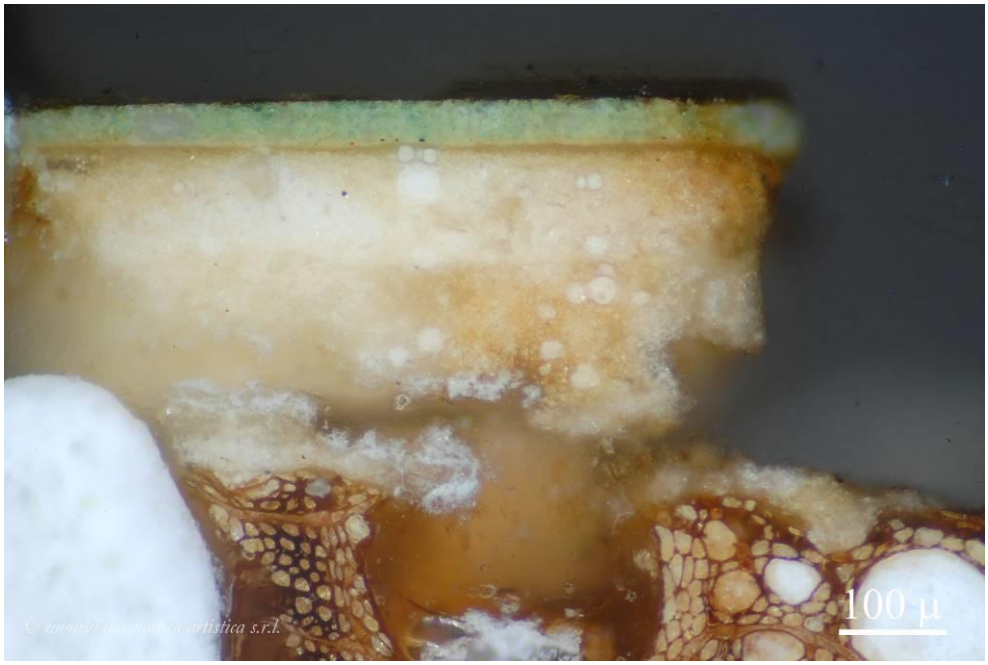
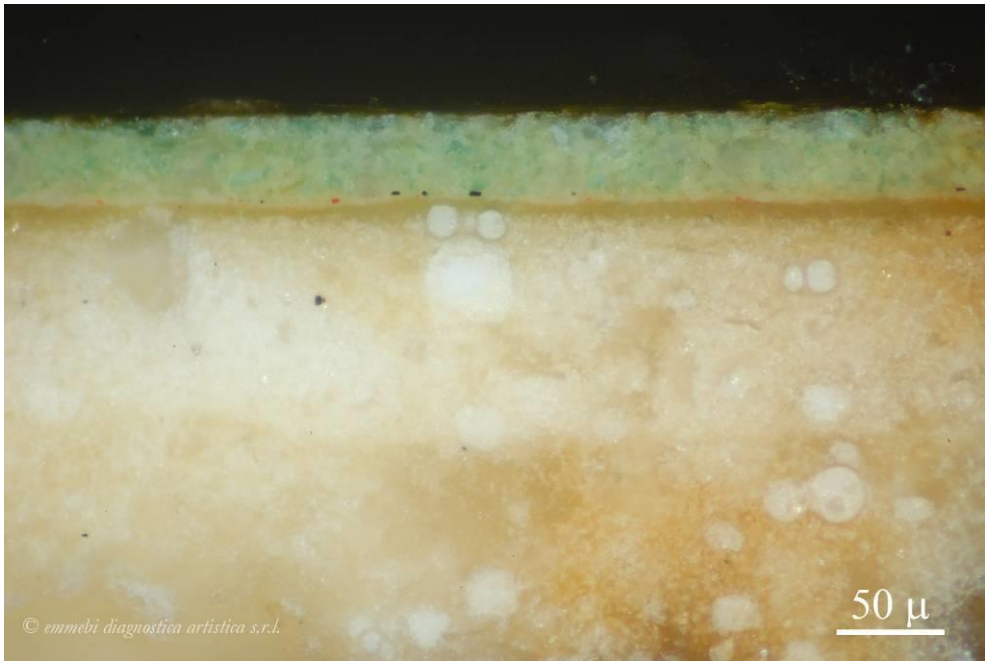
Appendix

Ⅰ. Optical Microscopy Images

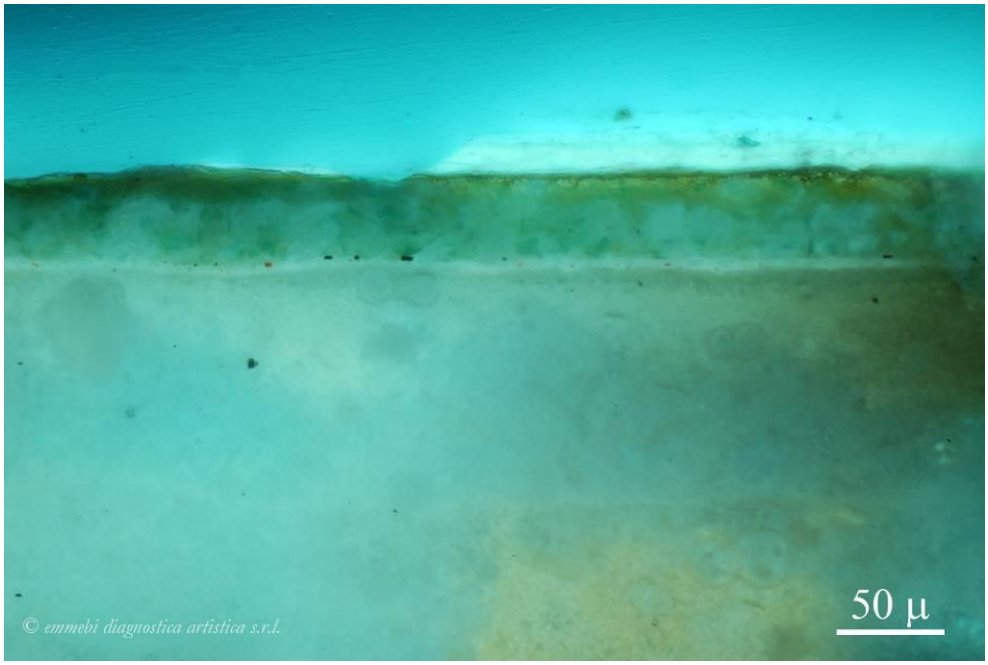
Green pigment:

Photograph performed with visvible light:



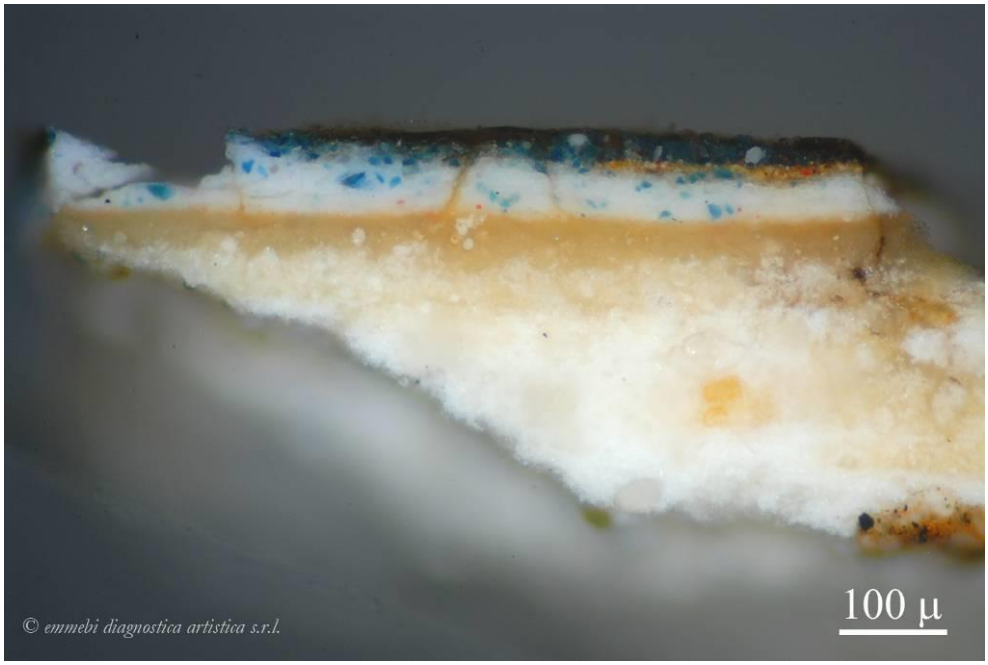


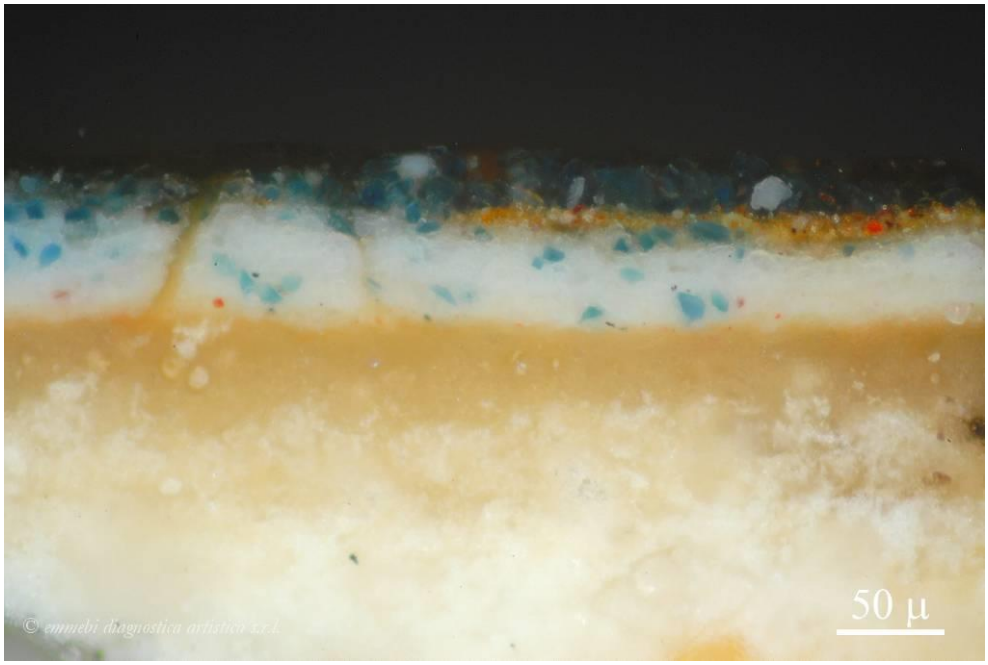
Photograph performed with ultraviolet light:



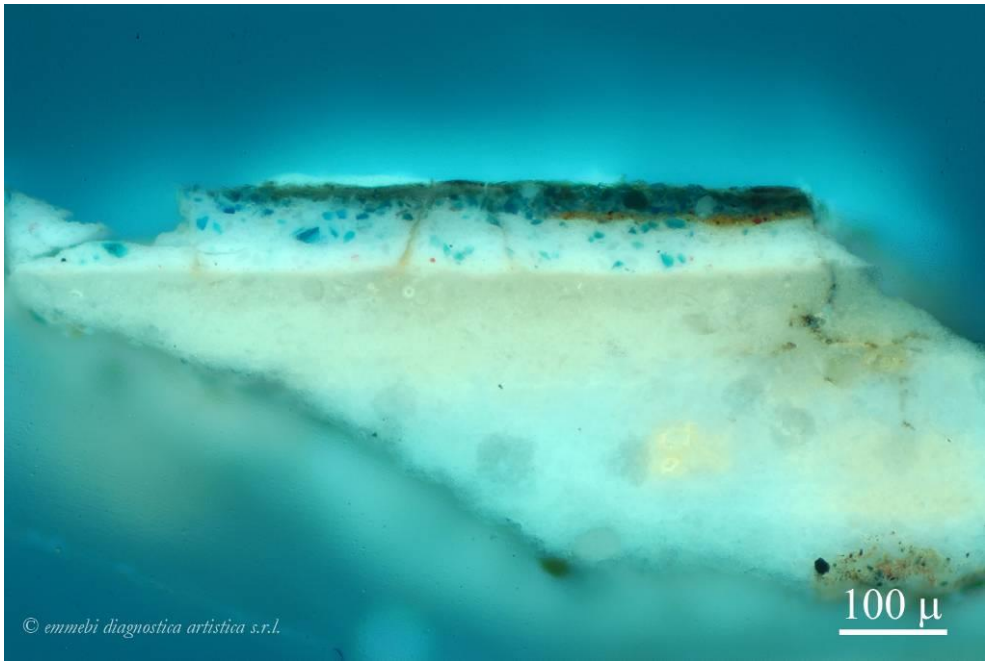
Blue pigment:

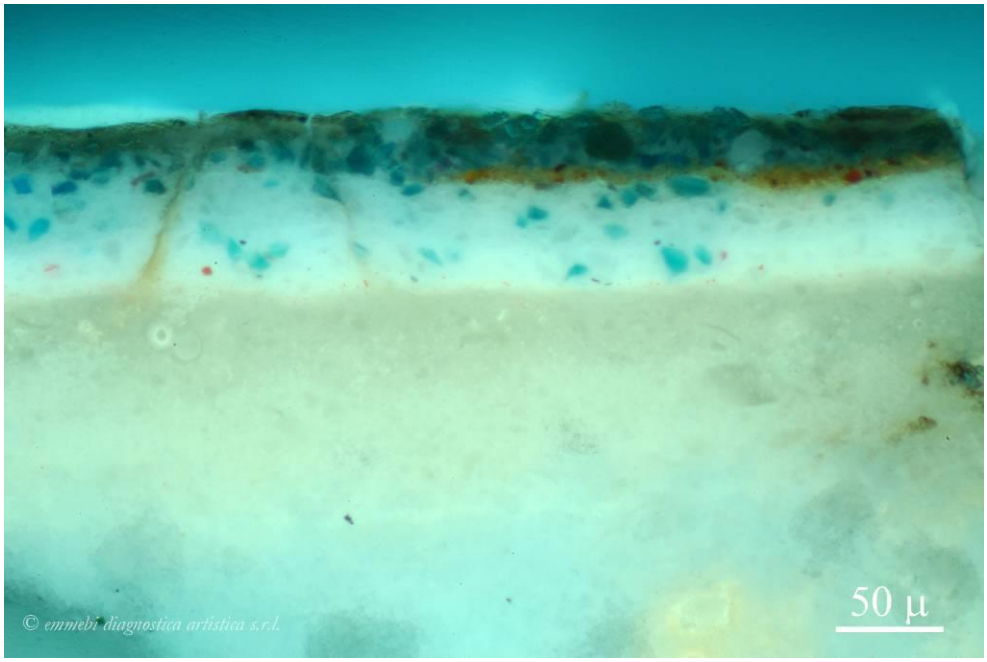
Photograph performed with visvible light:





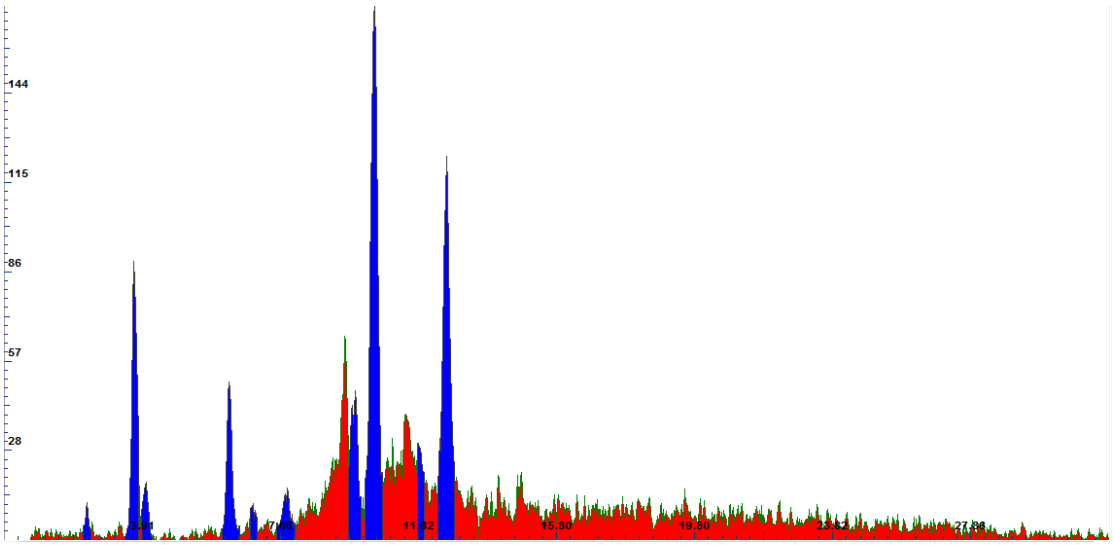
Photograph performed with ultraviolet light:



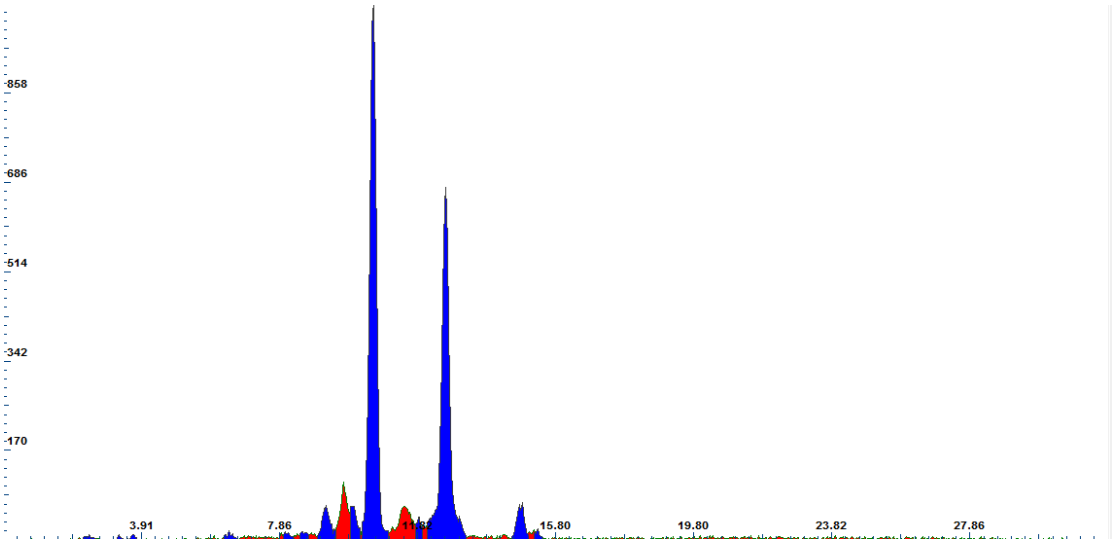

© emmebi diagnostica artistica s.r.l.
50 µ

Ⅱ. ED-XRF Results

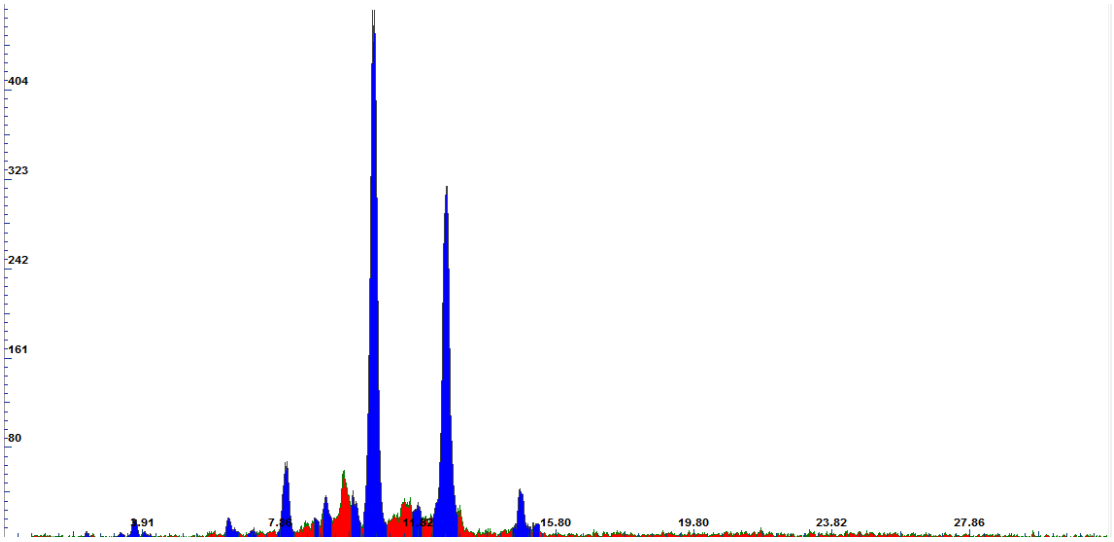
1 (Red)



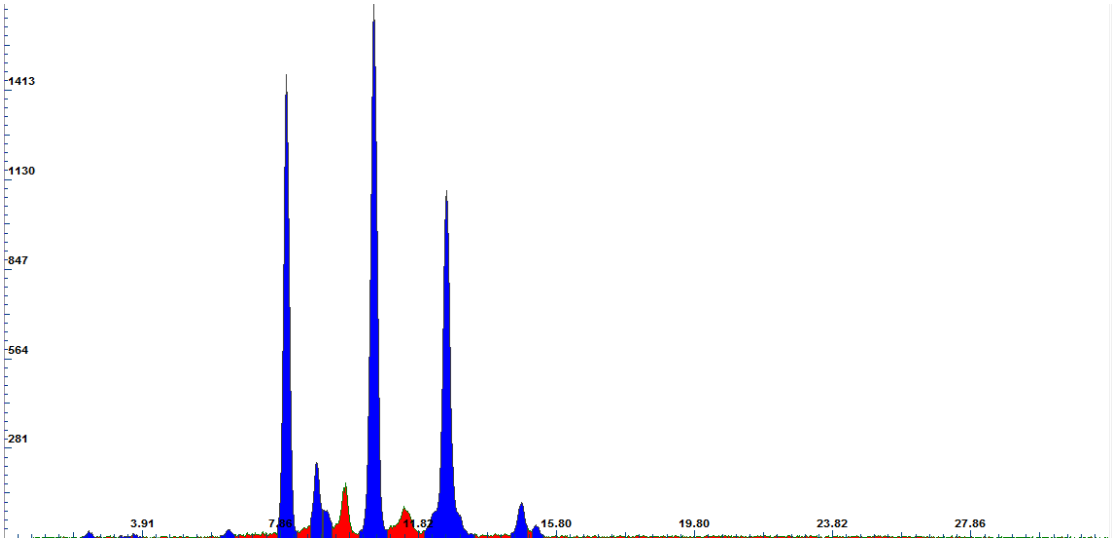
2 (Red)



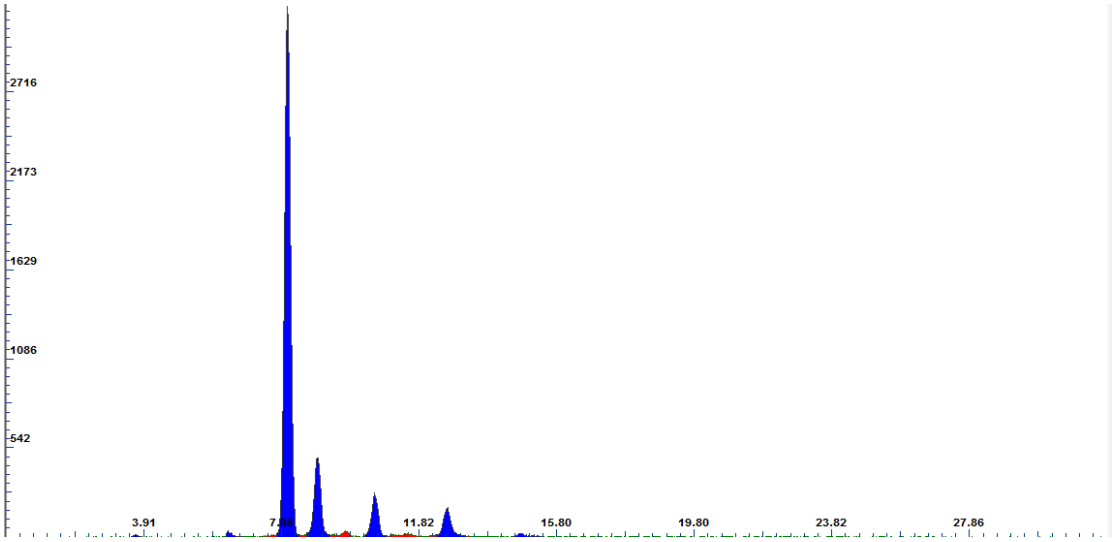
3 (Red)


404
323
242
161
80
3.91
15.80
19.80
23.82
27.86

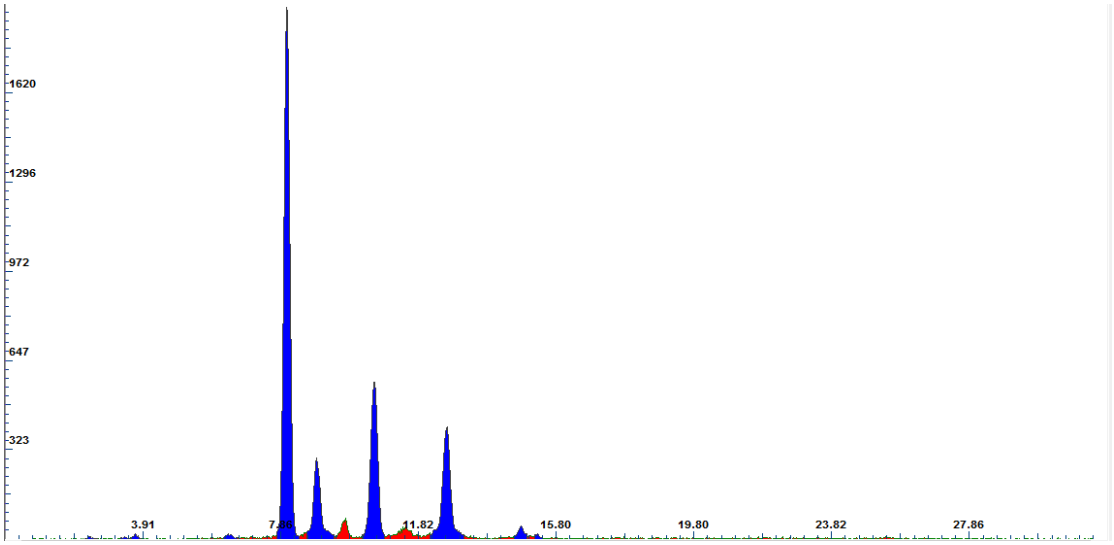
4 (Green)


1413
1130
847
564
281
3.91
15.80
19.80
23.82
27.86

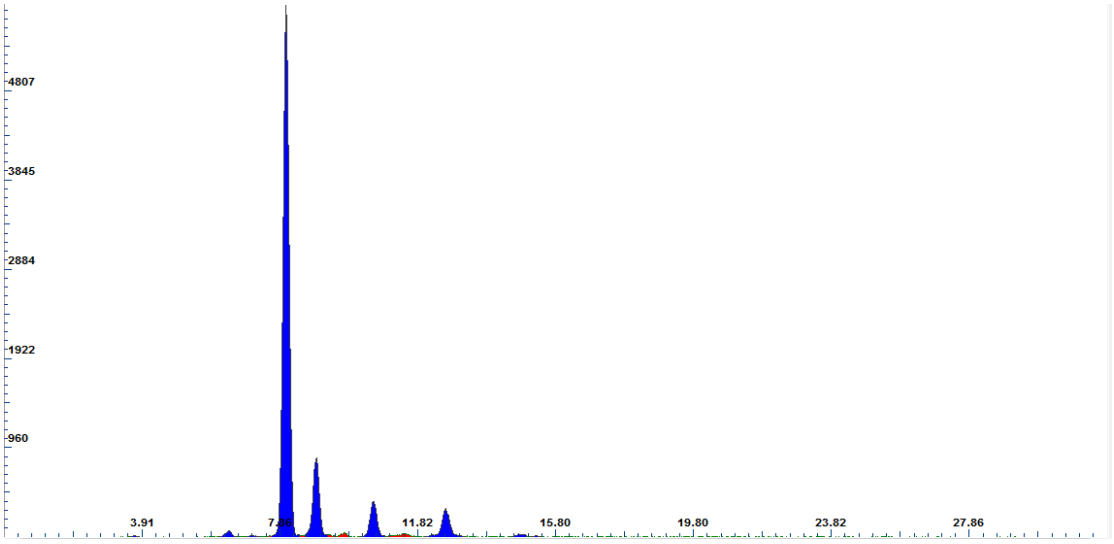
5 (Green)



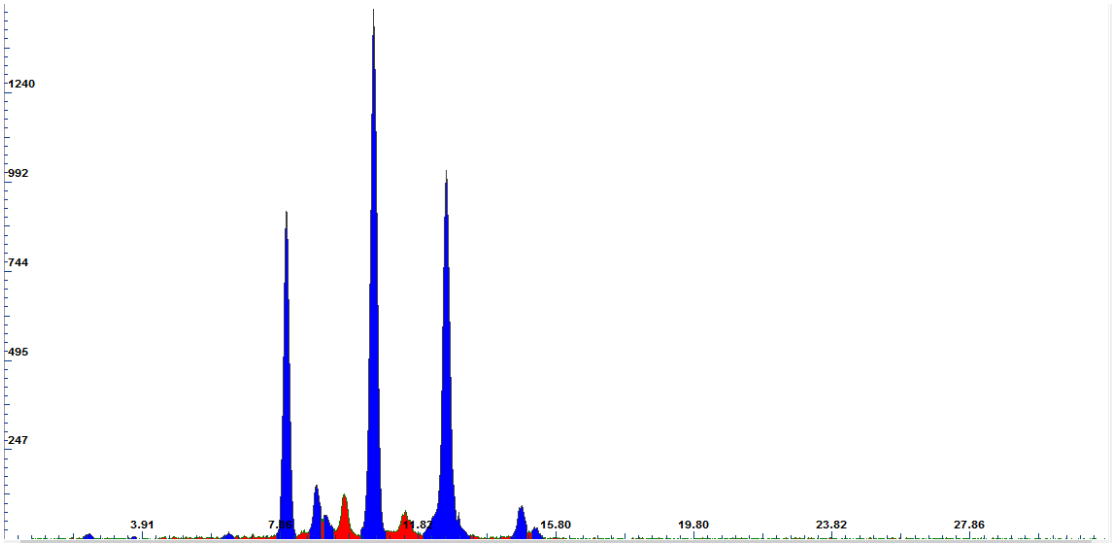
6 (Green)



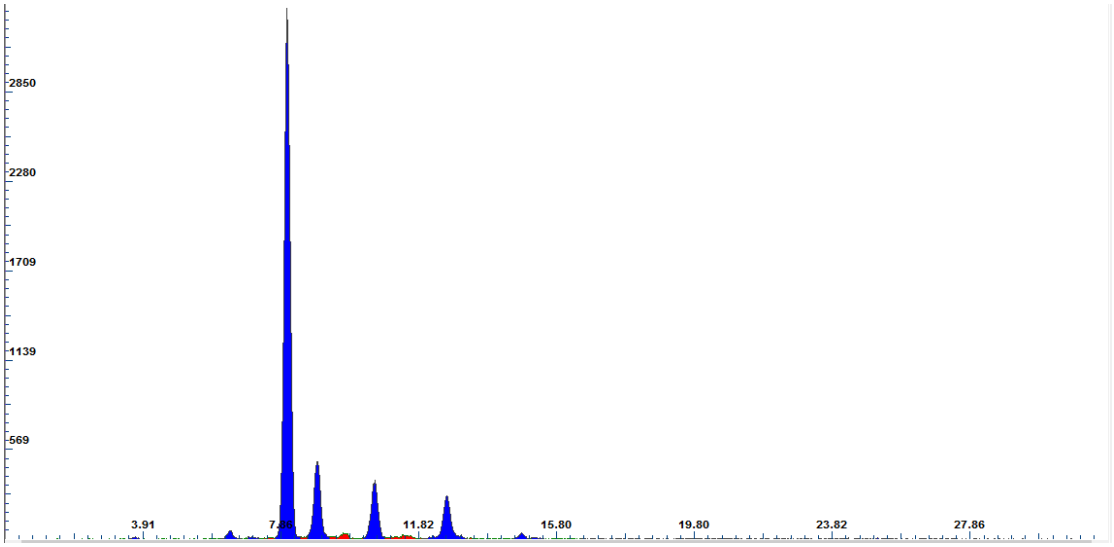
7 (Green)



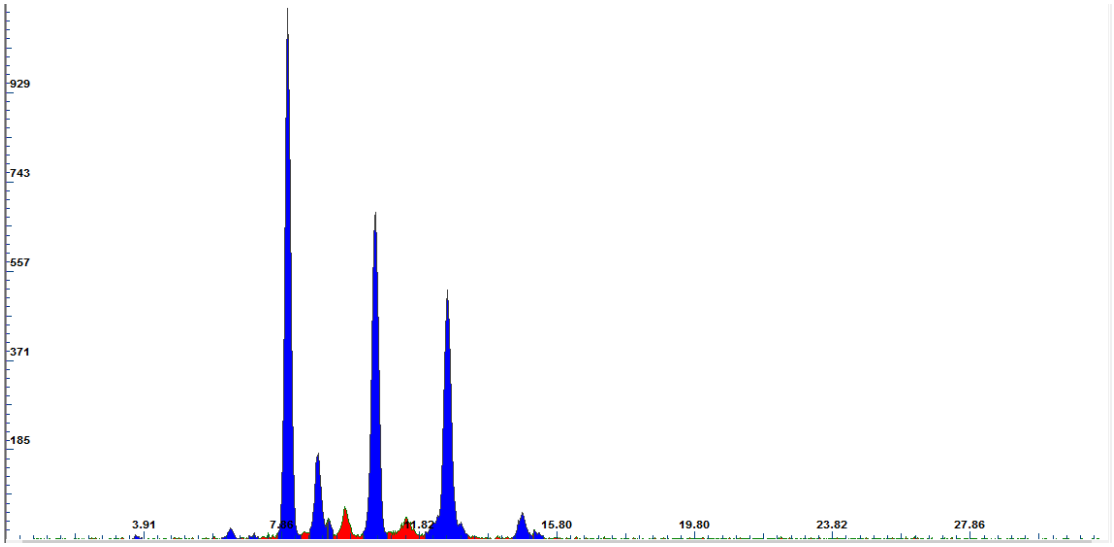
8 (Blue)



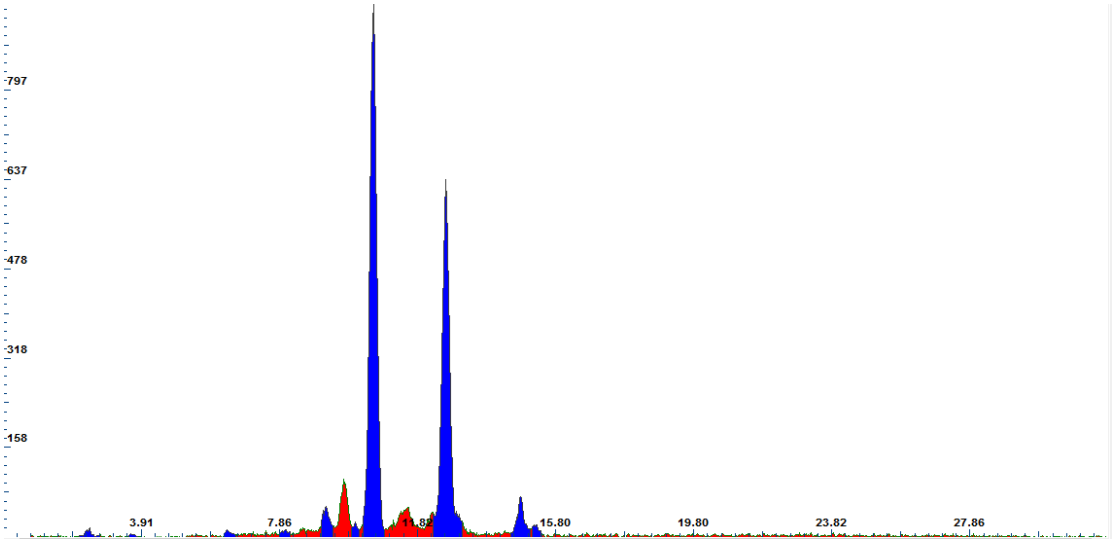
9 (Blue)



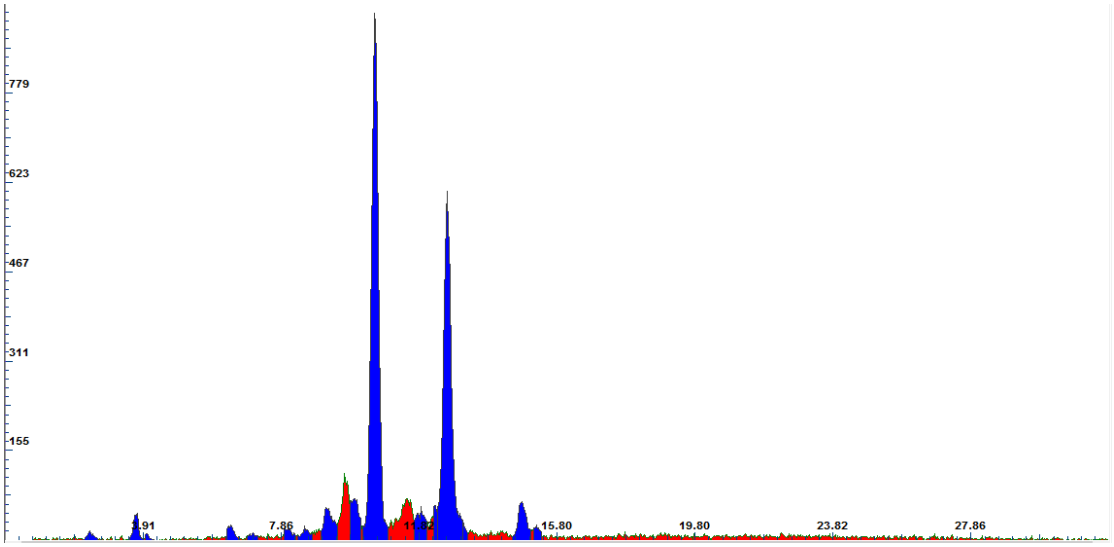
10 (Blue)



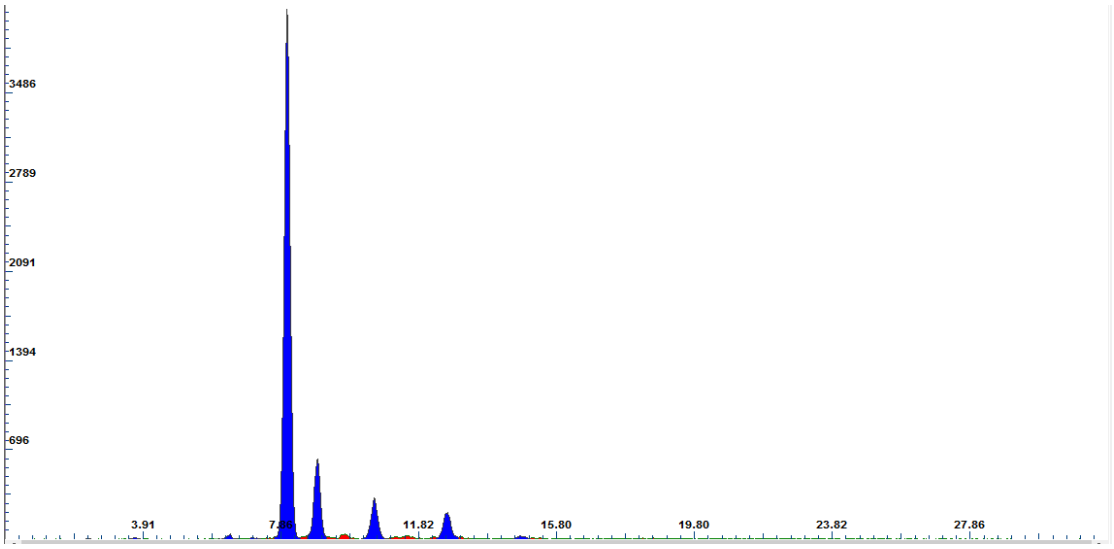
11 (Flesh)



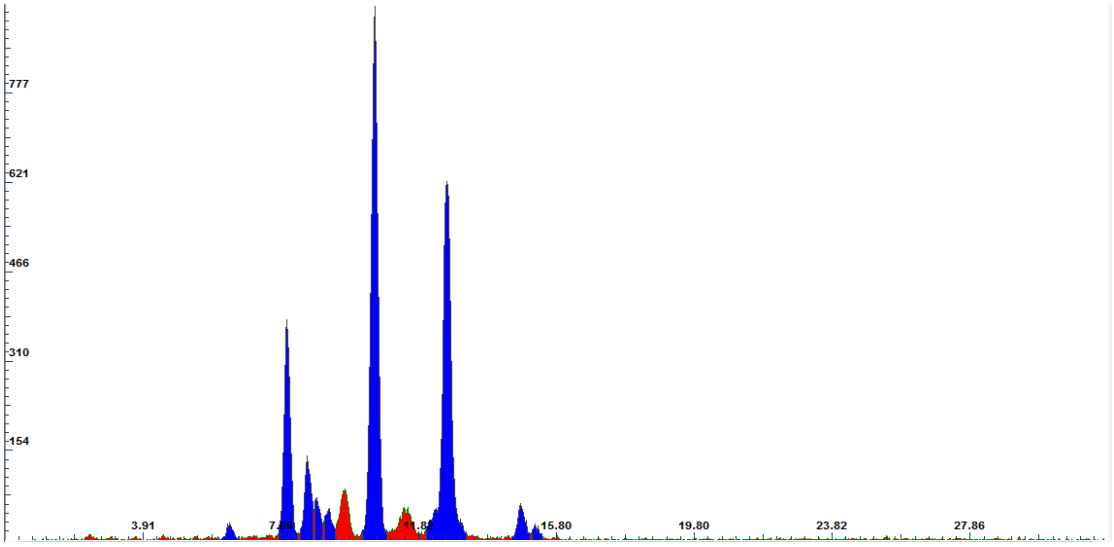
12 (Restoration-around dark red)



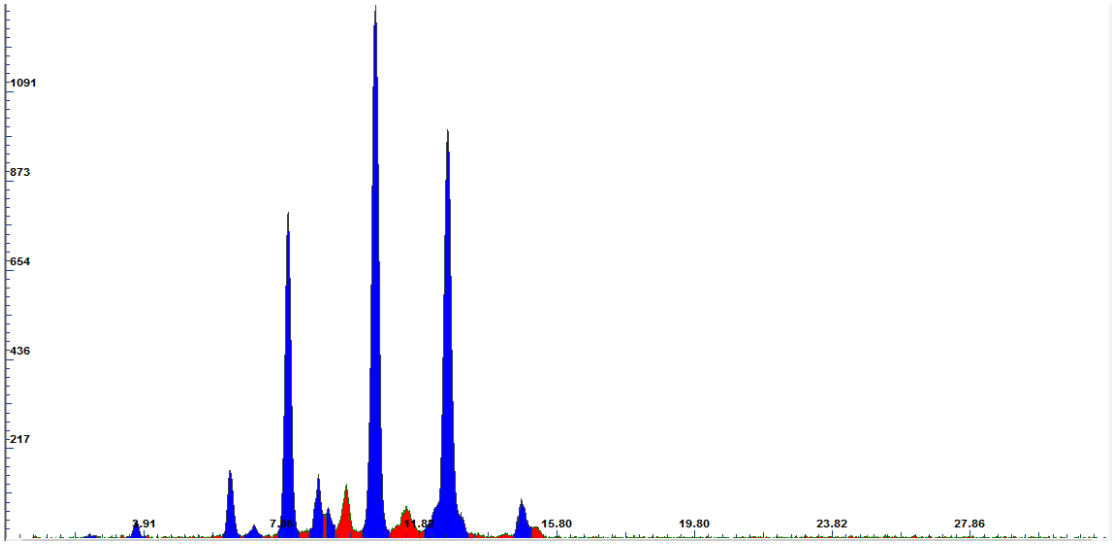
13 (Restoration-around dark green)



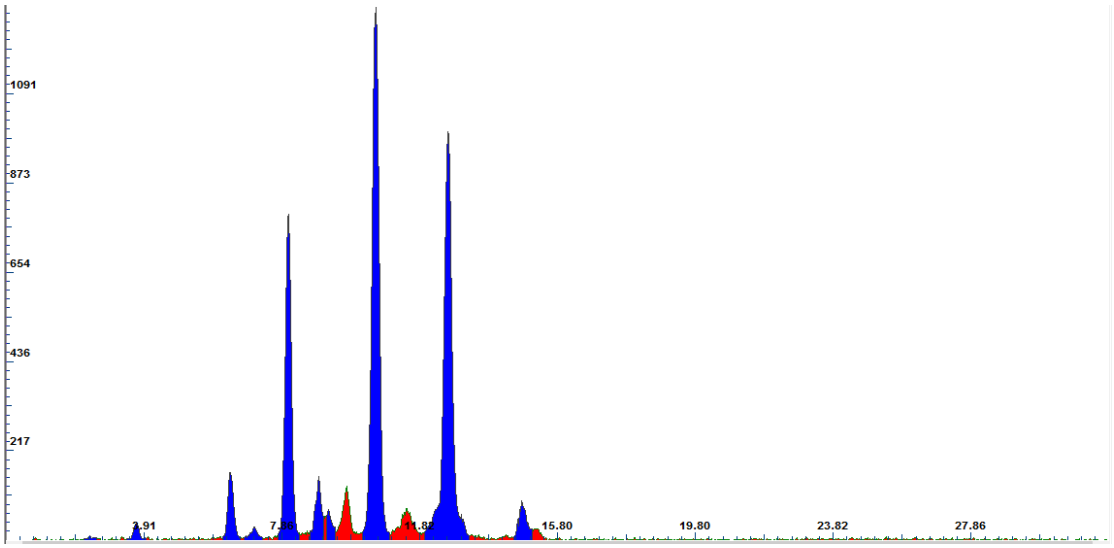
14 (Restoration-around blue)



15 (Yellow)



16 (Yellow)



Ⅲ. A summarized poster exhibited for public in Accademia Nazionale di San Luca

A self-report from an almost 500 years old Flemish painting

Un benvenuto a tutti! I am happy to see you here after my long sleeping for almost half of a millennium. Today I am going to share with you the process how I was getting to know myself with the help of scientific examination and restoration exploration.

Who am I?

- This is the most important question you people will ever ask yourselves, for me it is the same. By means of literature and archives study, the answer of this ultimate problem is revealed for me.
- My name is "SPOSALIZIO DI S. CATERINA", created by a painter Adriaen Isenbrant from Bruges in 16th century. An Italian painter Domenico Pellegrini brought me to Accademia Nazionale di San Luca since 1838, then I started to settle down here, so far already over one hundred and eighty years.

Where did I come from?

- After knowing I was created by Isenbrant, the next question I was eager to ask is how did Isenbrant create me, and how did the near half of a millennium change me. Scientific examination and restoration exploration answered my doubts by the following approaches:

Ultraviolet Fluorescence:
revealing my conservation state and pervious intervention information.

Infrared Reflectography:
disclosing my pentimenti and underdrawing.

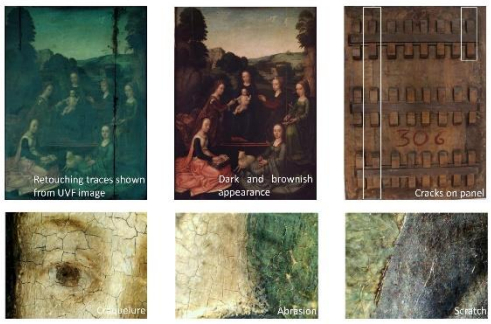
Infrared False Color:
working as a supplementary technique of ED-XRF for identifying the pigments.

Energy Dispersive X-ray Fluorescence:
understanding the elemental composition of the pigments.

Optical Microscope:
revealing the information of my stratigraphy, for this analysis I was cut a little bit.

Restoration:
helping in orienting the scientific examination, and assisting in the understanding and interpretation of the results.

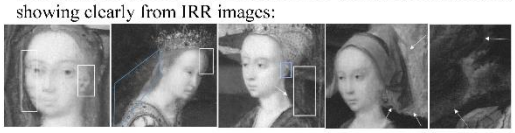
- Good news is that I was in a relatively good condition and took care by several times of past restoration, however as time went by, I still become aged and changed that you can find in the following images:



- Furthermore, I learnt that I was created layer by layer on a chestnut wood panel, bottom-up I have preparation layer composed of lead white colored in pale grey and brownish-orange, one or more paints layer, as well as several varnish layers, as you can see from my cross sections:

- And few of underdrawings were revealed in IRR images:

- Isenbrant also did some alternation on me during his composition, showing clearly from IRR images:



- Interesting to know from ED-XRF results, I was painted with typical Flemish painting materials in 16th century, my red pigment was from cinnabar and red ochre, green was from verdigris or malachite, blue was from azurite and yellow from yellow ochre!

Where am I going?

- With a deep understanding of myself, I see myself a brighter future. And thanks to the restorers, they cured me thoroughly:
  First my surface was cleaned, old varnish was removed and new varnish was applied. Now I look gorgeous from any angle. After that, retouching was conducted to repair my scars. Then my body, the panel, was also restored with a much more suitable protective structure, making sure that I will always be safe.
- From now on I will be exhibited and taken good care in Accademia Nazionale di San Luca. Although far from hometown, I am very glad to live here, waiting and welcoming visitors from all over the world!

Yang Zhou zhou.1876078@studenti.uniroma1.it