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Experimental and Innovative:
Matisse Paintings from the Wertheim Collection

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I. Abstract

Henri Matisse was one of the great pioneers of modern European painting. His body of work from 1913-17 has been referred to as his most experimental and innovative due to his use of a subdued palette that included the use of black, and a varied working technique comprised of complicated layering due to compositional revisions (D'Alessandro & Elderfield 2010). Two of his paintings from the Fogg Museum's Wertheim Collection, *Geraniums*, 1915 and *Still-Life with Apples*, 1916, were subject to a technical analysis in order to understand the materials, development, and structure of these significant works and to determine whether or not they displayed the characteristics of the 1913-17 period. With the aid of Infrared reflectography (IRR), Infrared digital photography (IRDP), and X-radiography it was concluded that *Geraniums* had slight variations from its contour underdrawing while *Still-Life with Apples* had significant compositional revisions. X-ray Fluorescence (XRF), Fourier Transform Infrared Microspectroscopy (FTIR), and Scanning Electron Microscopy Energy Dispersive Spectrometer (SEM-EDS) identified a limited, subdued palette for *Still-Life with Apples* and a diverse, bright palette for *Geraniums*. Cross-section analysis with Reflected Light Microscopy (RLM) supported by examination of the painting under magnification revealed complicated paint stratification in both works as well as striking changes in color combinations. A water-soluble red paint containing carbohydrate inclusions was identified in *Geraniums* in cross-section analysis and FTIR. The carbohydrate component may have been an additive in the paint, however further analysis is necessary to identify its function. The construction sequence of both paintings was hypothesized using digital image manipulation in order to visualize the various stages of the paintings as Matisse may have created them. Based on the technical analysis with support from archival information, it was concluded that *Still-Life with Apples* displayed characteristics of the 1913-17 period and *Geraniums* did not exhibit the same characteristics as *Still-Life with Apples*, and with supportive archival information from Bernheim-Jeune, dates to approximately 1910.

Both paintings had non-original synthetic varnishes noted in the conservation files and identified with FTIR analysis. Varnish removal was proposed due to the poor aging of the synthetic varnishes, which had altered the original aesthetics and surface quality of the paintings.

Treatment of *Geraniums* involved removing the non-original synthetic varnish and returning it to a more original state. While solubility testing was performed on *Still-Life with Apples* and testing confirmed that brush strokes and more accurate colors would be revealed, curators decided not to proceed with this treatment due to the dramatic change that would occur to the appearance. A second treatment option was chosen including slightly reducing the varnishes with TS-28, filling and inpainting abrasions along the perimeter of the painting, and toning the painted border to match Matisse's original color. Further conversations with curators are necessary to identify whether or not the date of *Geraniums* will be changed based upon the collected data and archival information.

II. Introduction

In June of 2008 the Harvard Art Museums in Cambridge, Massachusetts, closed its doors to the public in order to remove its collections in preparation for the renovation and reconstruction of the 81 year old building. One of the Museums' most important groups of objects is the Maurice Wertheim Collection, which contained Impressionist and Post-Impressionist paintings, drawings, and sculptures ranging from 1860-1930. The body of artwork was originally bequeathed in 1950 to the Fogg Museum with three stipulations: the collection was to remain a single entity, it was to be placed on permanent exhibition, and was to be made available for the use of Mrs. Wertheim for as long as she was alive and still resided at their New York residence on East 70th Street (O'Brian, 1988). Ultimately the works remained in New York from 1950 until 1974 when Mrs. Cecile Wertheim passed away (O'Brian, 1988). However, during the summer months when she vacated the townhouse, or when the works were loaned to other museums for exhibitions, the artworks were on display in Cambridge (O'Brian, 1988). This meant the artwork was traveling quite frequently during this short time span and was not on continuous permanent view at the Fogg Museum until 1974. However, from that time on, none of the paintings have been off view for more than three months at a time, which has never permitted a focused technical examination of their materials and techniques.

This paper will focus on the research and treatment of two particular paintings from this collection: *Geraniums*, 1915 and *Still-Life with Apples*, 1916, both by Henri Matisse. What makes this opportunity for research on these paintings so enticing is the very narrow range of dates between the two, which correspond to a particularly experimental time period in Matisse's career. Historian Alfred J. Barr wrote about the work from this period as having "a power of invention and an austerity of style scarcely equaled at any other time in Matisse's career, setting it apart as a period of radical invention." (D'Alessandro & Elderfield 2010). Except for the recent 2010 publication by the Art Institute of Chicago and Museum of Modern Art, New York entitled *Matisse: Radical Invention, 1913-17*, very little has been published about the materials and methods used by Matisse during this time.

The goal of the project was to understand the characteristics of Matisse's 1913-17 period in an effort to define whether or not *Geraniums* and *Still-Life with Apples* fit within this period. Historical research and materials analysis guided a technical examination to better understand Matisse's materials and working methods as exhibited in *Geraniums* and *Still-Life with Apples*. Through materials identification and understanding Matisse's technique, various stages of the paintings were recreated with digital image manipulation. Overlapping with the technical research, a proposal was submitted to remove the synthetic varnishes present on both paintings.

III. 1913-17 Period

a. Historical Relevance

Looking at the entirety of Matisse's career in the timeline seen in figure xx, the 1913-17 period correlates with World War 1. In the beginning of 1913 Matisse returns to France from his

Figure 1. Timeline of Matisse's career.

extended trip to Morocco and leaves for Nice at the end of the period in 1917. During the period Matisse works mostly at his Issy studio in Paris, France. With the suspension of the spring and fall salons, and the art markets retracting, there were no longer the same opportunities for public displays of new work for Matisse. This also meant that Matisse had fewer interactions with fellow artists and dealers, relationships which fostered his early work. The influence of the war most likely limited Matisse's access to artist's materials, which ultimately may have affected the number of works he produced during this period as well as his method of production.

b. Characteristics

One of the distinguishing characteristics of the 1913-17 period is Matisse's use of a subdued palette (D'Alessandro & Elderfield 2010). Blues, grays, and black become the main characters in his palette. The use of black in a large portion of a composition is new to Matisse. He refers to the use of black as a force, used as a ballast to simplify the construction as well as a color of light, not dark and compares its luminosity to other colors used at this time (D'Alessandro & Elderfield 2010).

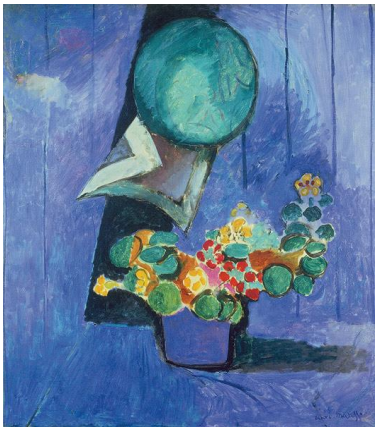

Figure 2. *Flowers and Ceramic Plate*, 1913. Oil on canvas, 37 ¾ x 33". Städel Museum, Frankfurt am Main.

Figure 3. *Goldfish and Palette*, 1914. Oil on canvas, 57 3/4 x 44 1/4". The Museum of Modern Art, NY.

The other distinguishing characteristic of the 1913-17 period is the constant compositional reworking that occurs on the same support (D'Alessandro & Elderfield 2010). A primary example is *Bathers by a River*, of which there are early photographs documenting the various stages of the painting. Revisions during this period include multiple changes to a composition as well as dramatic changes in color. There are few related sketches for many of the 1913-1917 paintings, which supports the idea of Matisse working and reworking his ideas out on the final canvas, rather than pre-planning with preliminary sketches. In an interview with Matisse from 1908 he describes revisions as:

> *A new combination of colors will succeed the first…I am forced to transpose until finally my picture may seem completely changed. One change causes another, and yet another, because the entire arrangement of my picture is expressive: the place occupied by the figures, the empty spaces around them, the proportions, all of that has its share.*

Figure 4. *Bathers by a River*, 1909-1910, 1913, 1916-17 . Oil on canvas, 102 ½ x 154 3/16". The Art Institute of Chicago.

Figure 5. *Bathers by a River* photographed in progress, 1913. The Art Institute of Chicago.

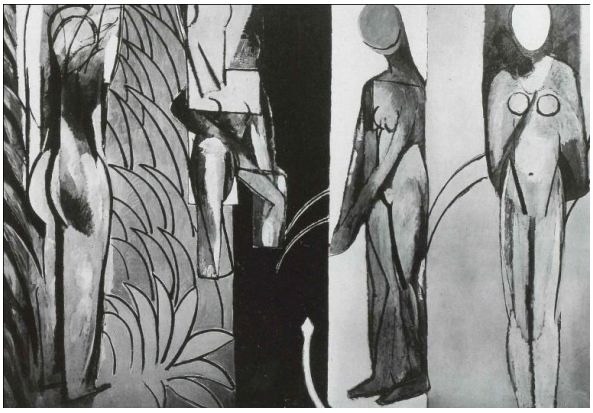

Figure 6. *Bathers by a River* photographed in Fifth State, 1916. The Art Institute of Chicago.

IV. Still-Life with Apples, 1916

a. Background and Related Paintings

Figure 7. *Still-Life with Apples* under normal illumination. Oil on panel, 12 15/16 x 16 3/16".

Figure 8. Back of *Still-Life with Apples* under normal illumination.

Still-Life with Apples is an oil (est.) painted on a mahogany panel (est.) approximately 12 15/16" H x 16 3/16 in W and ¼" in diameter (Figure 7 and 8). The panel was most likely commercially prepared (est.) and the ground contains lead white, barium sulphate, and linseed oil (est). The panel, ground, and paint layers are all in good condition. For the full Condition Report see Appendix.

Figure 9. *Still-life with lemon*, 1917. Oil on panel, 10 ¼ x 13 ¼". The Barnes Foundation.

A comparable work was identified in the Barnes Collection entitled *Still-Life with Lemons* (Figure 9) and dates to 1917. This painting is also an oil on panel of approximately the same size. When compared to other works from Matisse's career *Still-Life with Apples* resembles several other works (Figures 10, 11, 12) from the 1913-17 period in both subject matter and palette.

Figure 10. *Woman on a high stool* (*Germaine Raynal*), 1914. Oil on canvas, 57 7/8 x 37 5/8". Museum of Modern Art, NY.

Figure 11. *Gourds*, 1915-16 (dated on painting 1916). Oil on canvas, 25 5/8 x 31 7/8". The Museum of Modern Art, NY.

Figure 12. *Apples*, 1916. Oil on canvas, 46 x 35". The Art Institute of Chicago.

b. Technical Analysis

Some indications of a contour line drawing are visible in the IRDP of *Still-Life with Apples* (Figure 13) in the left apple and the front edge of the table, which indicates a previous change in the angle of the table edge.

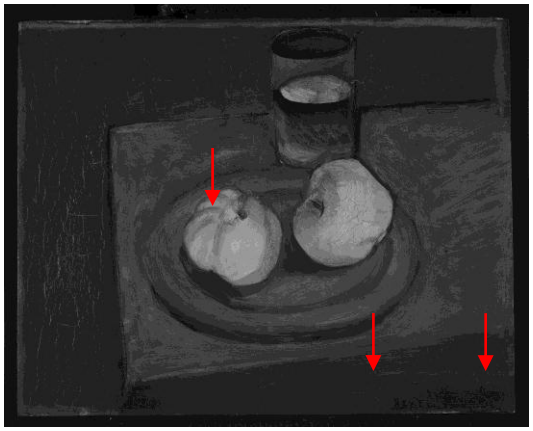

Figure 13. Infrared digital photograph of *Still-Life with Apples*. Some underdrawing is visible in the left apple and table edge.

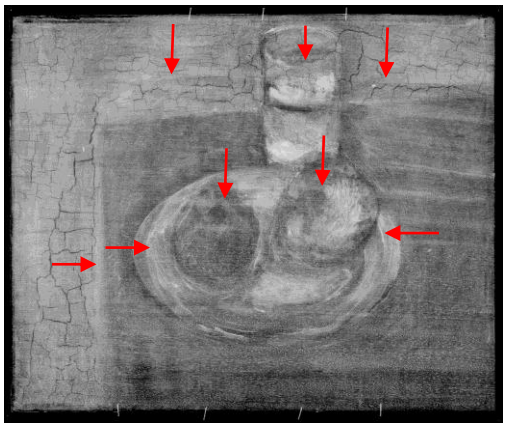

Figure 14. X-radiograph of *Still-Life with Apples*. Multiple compositional changes are visible.

However looking at the x-radiograph (Figure 14) allows for a great deal of insight into the compositional revisions. Changes seen in the x-radiograph include a widening of the mouth of the glass, altering all three angles of the table top, shifts in perspective of the apples, and a smaller perimeter of the plate. It is possible that the changes between the shifts in perspective of the apples is directly related to the change made in the perimeter of the plate.

Indications of compositional revisions are also visible through dramatic changes in color detected throughout the painting under magnification, which are confirmed by the layer structure detected in cross-sections taken from these same areas. Numbers in cross-sections correlate to paint layers and letters correspond to possible varnish layers.

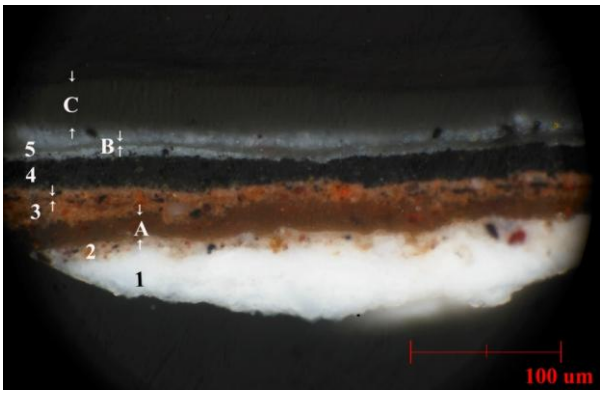

Figure 15. Cross-section 1 of *Still-Life with Apples*.

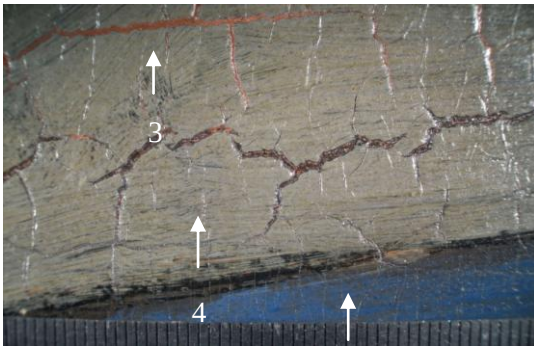

Figure 16. Macrograph 1 of *Still-Life with Apples*. Changes in color are visible through crack apertures.

Looking at cross-section 1 (Figure 15) and macrograph 1 (Figure 16) layers 3, 4, and 5 can be correlated. Layer 4, visible through the apertures of the cracks, indicates the previous extension of the top table edge, which Matisse changed by covering with layer 5's light gray paint.

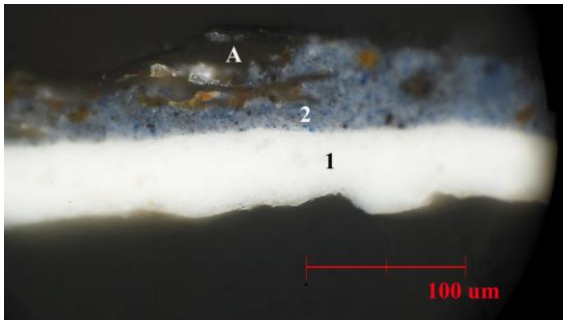

Figure 17. Cross-section 2. Some underdrawing is visible in the left apple and table edge.

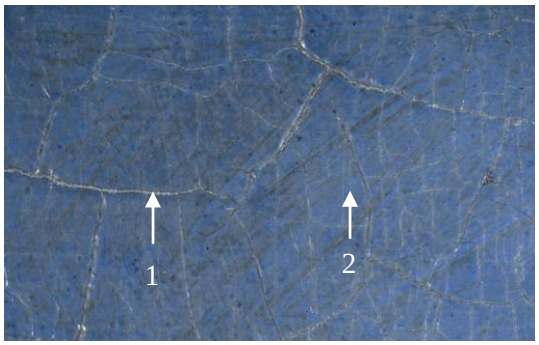

Figure 18. Macrograph 2. Ground and paint layer 2 are visible.

Cross-section 2 (Figure 17) and macrograph 2 (Figure 18) show that no changes had been made to the color of the table top. The ground is visible in the crack apertures, layer 1, in the macrograph with only blue paint, layer 2, applied on top.

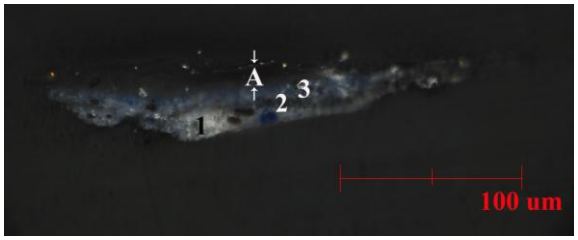

Figure 19. Cross-section 3. Some underdrawing is visible in the left apple and table edge.

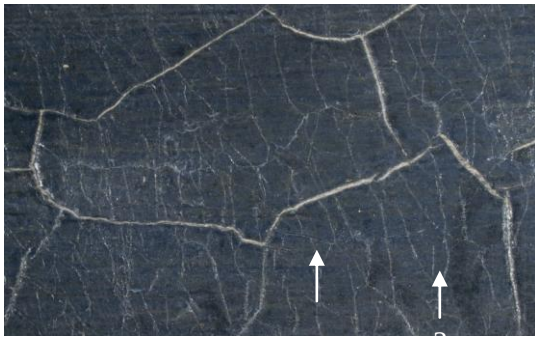

Figure 20. Macrograph 3. Multiple compositional changes are visible.

Cross-section 3 (Figure 19) and macrograph 3 (Figure 20) are comparable to cross-section 2 and macrograph 2 in that no major color changes or compositional revisions are present. The ground, layer 1, is visible through the crack apertures and the uppermost paint layer, layer 3, is visible on top. Ultimately, multiple layers of paint in the cross-sections indicate compositional changes or shifts in color schemes.

Pigment analysis for *Still-Life with Apples* identified a rather limited palette including the use of cadmium red, chrome green and cadmium yellow, ultramarine blue, bone black, and lead white (Figure 21). This information was based on analytical data collected from cross-sectional analysis with RLM and Raman spectroscopy, and sample analysis using FTIR, as well as in-situ XRF (See Appendix for full results).

Figure 21. Palette of *Still-Life with Apples.* From left to right: cadmium red, chrome green and cadmium yellow, ultramarine blue, bone black, and lead white.

By surveying and combining all the information collected including the altered composition seen in the x-radiograph, noting shifts in color under magnification, and adding pigment identification and paint structure, an approximation of what the painting may have looked like during its construction was created. Based on color measurements taken in Adobe Photoshop, these images represent just a few possible states in the process of Matisse's revisions. Although the actual progression of the painting is unclear and could only be understood from further cross-section analysis, it is likely that these color composites represent how the painting developed.

Figure 22. Color composite 1 of *Still-Life with Apples*. Changes in apples cores, shapes of apples, glass, plate, and table.

Figure 23. Color composite 2 of *Still-Life with Apples*. Final placement of plate, apples, and glass. Changes to table.

Color composite 1 (Figure 22) shows a change in background color, a shift in perspective of the apple cores and a shape change in the left apple, a wider mouth of the glass, and a smaller plate. The back of the table top is extended and angles of the table are straight. From here it is possible that the perspectives of the apples, perimeter of the plate, and the mouth of the glass were placed in their final states as seen in color composite 2 (Figure 23). From here the last addition of paint may have been the gray background, seen in the final state (Figure 24). A quote from Matisse in 1908 provides insight into his technique:

Figure 24. Final state of *Still-Life with Apples*.

> *Both harmonies and dissonances of color can produce very pleasurable effects. Often when I settle down to work I begin by noting my immediate and superficial color sensations. Perhaps I might be satisfied momentarily with a work finished at one sitting but I would soon get bored looking at it; therefore, I prefer to continue working on it so that later I may recognize it was a work of my mind.*

c. Treatment

Figure 25. Oblique specular digital photograph of *Still-Life with Apples*. Plastic-like quality of surface coatings.

Figure 26. UVA induced visible fluorescence digital photograph of *Still-Life with Apples*. Characteristic bluish fluorescence of a synthetic varnish.

Still-Life with Apples has gone through a significant amount of treatment, most of which involved altering the surface coatings. Viewing the painting in oblique specular light showed the dull, plastic-like quality of the surface coatings (Figure 25). The brush strokes were lost and the original colors appeared quite yellow and gray due to the poor aging characteristics of the surface coatings. Reading through the conservation file provided a great deal of insight into what lay on the surface of the painting. The most recent treatment occurred in the mid 80's and involved reducing a natural resin varnish and adding 4-5 brush and spray applications of Winton's Picture Varnish and Soluvar Matte Varnish. Viewing the UVA induced visible fluorescence image (Figure 26), a characteristic bluish fluorescence indicative of a synthetic varnish was observed. The surface coating appeared to be quite uneven under the fluorescence, most notable in the lower right corner. FTIR analysis of the surface coating identified both a synthetic and natural resin varnish.

Revisiting cross-section 1, more about the surface coatings could be understood. In figure 27 layer C corresponds to the later additions of synthetic varnishes in the 80's, which is quite thick and yellowed, while layer B corresponds to the natural resin varnish which is thinner and yellowed. This cross-section also provides insight into a painted border that runs around the perimeter of the painting. This material corresponds to the uppermost paint layer in layer 5. Looking at the cross-section more closely we can see a clear interface between the lower layer of paint, which is Matisse's original layer of paint, and the subsequent natural resin varnish layer (Figure 28). This interface indicates that the lower paint layer had time to dry and form a film before the natural resin varnish was applied. An SEM image of the same area identifies the two paint layers of similar color in paint layer 5 appear quite different from one another (Figure 29). Although the two contain similar materials, the lower layer of paint, Matisse's original, has a higher pigment content and smaller pigment

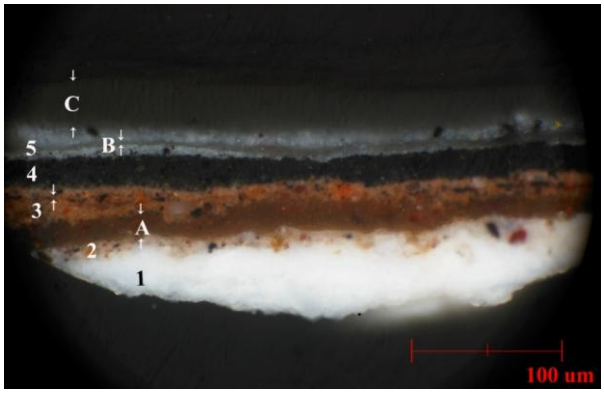

Figure 27. Cross-section 1 of *Still-Life with Apples*. Layer C corresponds to the synthetic varnishes and Layer B corresponds to the natural resin varnish.

particles as compared to the subsequent layer, the painted border, which has lower pigment content and larger pigment particles.

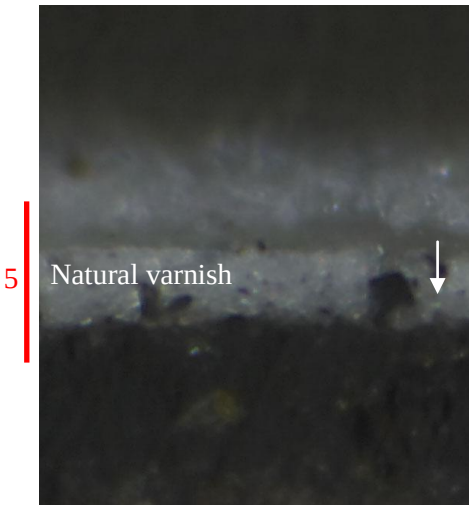

Figure 28. Magnified section of cross-section 1. Interface between Matisse's original paint layer and the natural resin varnish.

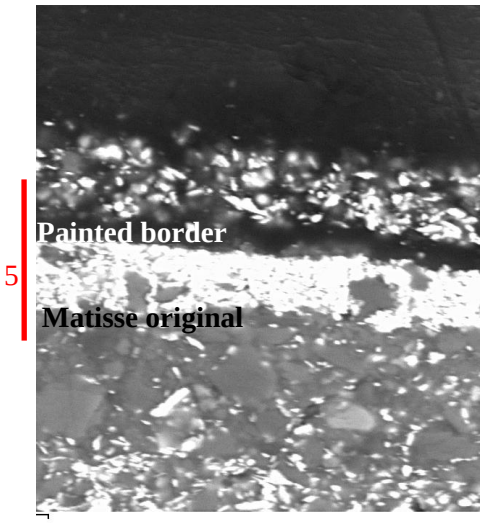

Figure 29. SEM image of cross-section 1. Matisse's original paint is different from the painted border.

Viewing macrographs of the painted border further confirms that this material is not original to the painting (Figures 30 and 31). In two different areas of the border along the top of the painting, it is easy to distinguish that the painted border has been applied in one continuous stroke, the color of which does not match the surrounding area, and Matisse's brush strokes are mimicked on top of this stroke. In a third macrograph of the painted border along the bottom of the painting (Figure 32), again the painted border does not match the surrounding area and is one continuous stroke of paint.

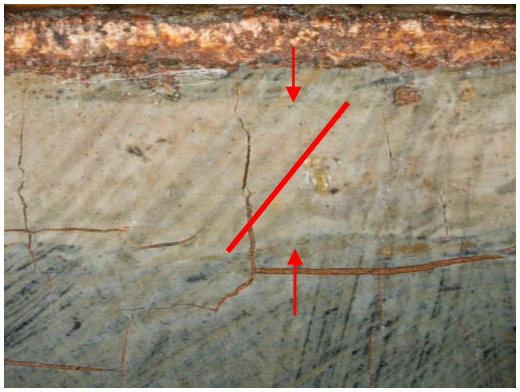

Figure 30. Macrograph 4 of *Still-Life with Apples*. Painted border at top edge showing incorrect color match and mimicking of Matisse's brushstrokes.

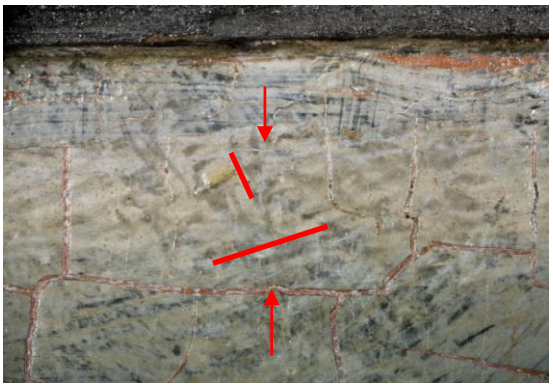

Figure 31. Macrograph 5 of *Still-Life with Apples.* Painted border at top edge showing incorrect color match and mimicking of Matisse's brushstrokes.

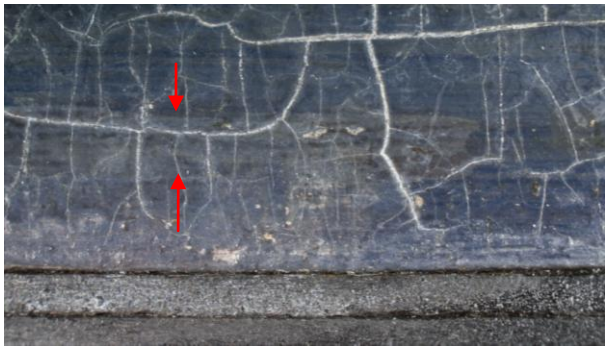

Figure 32. Macrograph 6 of *Still-Life with Apples*. Painted border at bottom edge showing incorrect color match and mimicking of Matisse's brushstrokes.

Figure 33. Detail of x-radiograph of *Still-Life with Apples*. Abrasions from a previous frame rabbit are visible around the perimeter of the painting.

More insight into why this painted border was added can be collected from revisiting the x-radiograph (Figure 33). The painted border correlates directly with previous abrasions that occurred when the paint was still slightly wet, most likely from contact with a previous frame rabbet.

Looking into the provenance of the painting French art dealer Paul Guillaume owned *Still-Life with Apples* as early as 1925 and likely acquired it directly from Matisse. *Still-Life with Apples* is pictured in Guillaume's dining room circa 1930 (Figure 34).

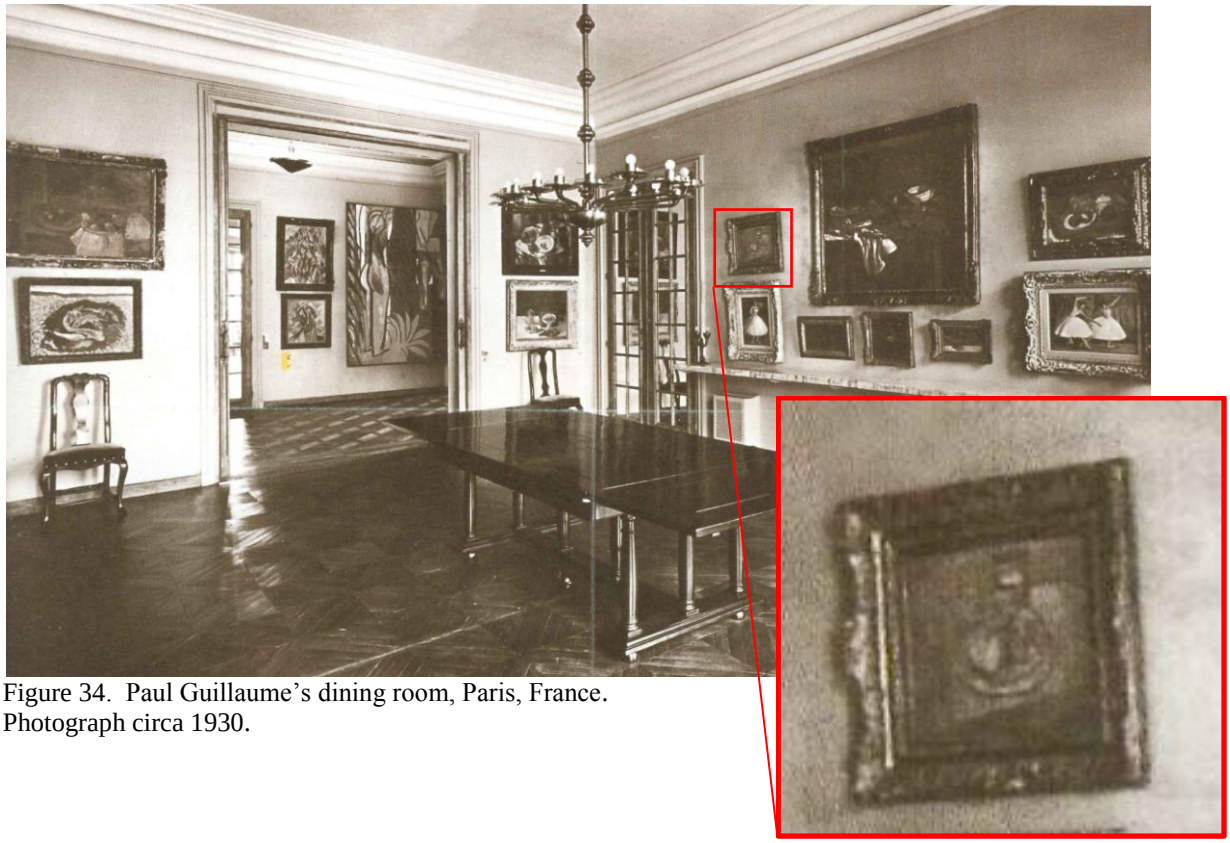

Figure 34. Paul Guillaume's dining room, Paris, France. Photograph circa 1930.

It is possible that Guillaume added the natural resin varnish, a popular trend with dealers at that time, and restored the early frame abrasions within 10 years or so after the painting was completed. This would explain the presence of drying cracks through the original paint and added border.

Figure 35 and 36. Cleaning tests of varnish removal showing enhancement of colors on *Still-Life with Apples.*

Ultimately it was proposed to remove the natural and synthetic varnishes, as well as the painted border since they are not original to the painting as identified by analysis. The natural resin varnish has been compromised by a previous cleaning attempt and is no longer a uniform coating. Removing the natural and synthetic varnishes and painted border would enhance the intended colors and textures of the painting (Figure 35 and 36). A cleaning approximation of the painting is seen in Figure 38, based on color calculations taken in Photoshop of cleaning tests.

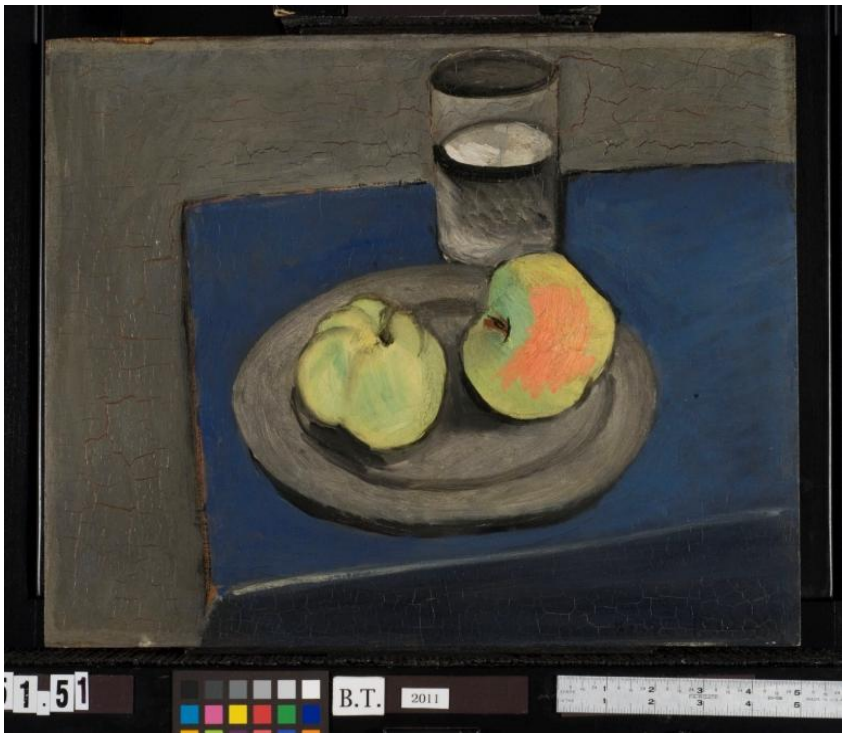

Figure 37. *Still-life with Apples* before treatment.

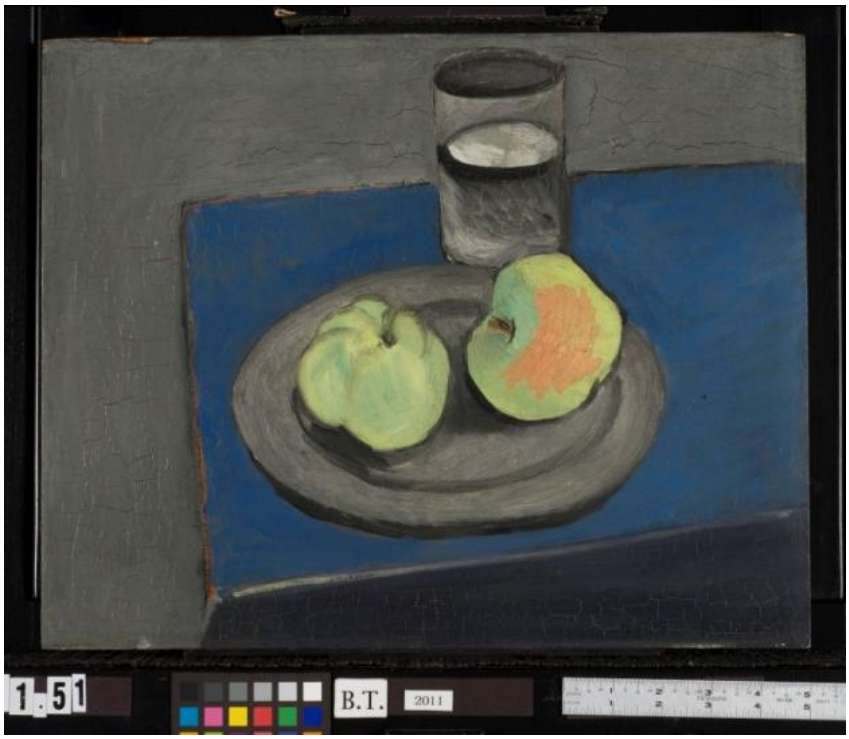

Figure 38. Cleaning approximation of *Still-life with Apples*. Synthetic and natural resin varnishes, and painted border have been digitally removed.

However, curators of the collection decided not to proceed with this treatment option and a second option was chosen. After the varnish was slightly reduced with TS-28, abrasions at the top and bottom of the panel were filled with Modostuc. Fills and cleaning tests were locally varnished with mastic. Fills were then inpainted using Gamblin Conservation Colors. The entire painted border was toned to match the surrounding areas using Gamblin Conservation Colors.

Figure 39. *Still-life with Apples* before treatment.

Figure 40. *Still-life with Apples* after treatment.

V. Geraniums, 1915

a. Background and Related Paintings

Figure 41. *Geraniums* under normal illumination. Oil on canvas, 24 3/16 x 19 13/16”

Figure 42. Back of *Geraniums* under normal illumination.

Geraniums is an oil painting on commercially prepared canvas and is dated to 1915 based on the curatorial file (Figure 41 and 42.). The support, ground, and paint are all in good condition. For the full Condition Report see Appendix. Beyond the obvious difference of the support, a visual difference is immediately noted when comparing this painting to the previous *Still-Life with Apples*. This visual difference includes color palette and painting technique.

Similar works to this painting all date from around 1910 and have related subject matter, ornate patterning, and bright palette (Figures 43, 44, and 45).

Figure 43. *Still-Life with Blue Tablecloth*, 1909. Oil on canvas, 34 5/8 x 46 ½”. The State Hermitage Museum, St. Petersburg.

Figure 44. *Still-Life with Geraniums*, 1910. Oil on canvas, 36 5/8 x 45 ¼”. Munich, Neue Staats Galerie.

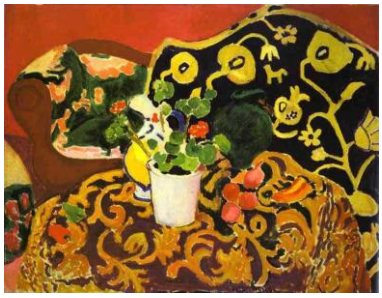

Figure 45. *Spanish Still-Life*, 1910-11. Oil on canvas, 35 x 45 5/8”. The State Hermitage Museum, St. Petersburg.

b. Technical Analysis

Figure 46. Infrared digital photograph of *Geraniums.* Some underdrawing is visible throughout.

Figure 47. X-radiograph of *Geraniums.* No compositional revisions are visible.

Viewing the infrared digital photograph shows the relatively unchanged composition originally constructed by Matisse (Figure 46). Comparing this to the x-radiograph confirms that no major changes had been made to the composition on the canvas support (Figure 47). Since the application of paint for this painting, was significantly different from *Still-Life with Apples*, a great deal of the fluid black paint used by Matisse to construct a loose contour of the composition was visible under magnification in normal light (Figure 48 and 49).

Figure 48. Macrograph 1 of underdrawing visible in geranium blossoms.

Figure 49. Macrograph 2 of underdrawing visible in flower in background wallpaper.

This technique of sketching the composition in a fluid black paint and continuing on with the painting process with little to no changes being made to the composition is typical of Matisse's technique early in his career. Since no compositional changes were found in *Geraniums*, it is possible that Matisse had developed the composition in provisional drawings or sketches which is another characteristic of his early technique. A documented underdrawing of *The Pink Studio*, taken before Matisse began to block in the composition with paint suggests what (Figure 50 and 51) *Geraniums* may have looked like when it was first applied to the canvas.

Figure 50. Photograph of *The Pink Studio* in progress, 1911. Bibliothèque Nationale, Paris.

Figure 51. *The Pink Studio*, 1911. Oil on canvas, 70 5/8 x 7' 3". Pushkin Museum of Fine Arts, Moscow.

This information began to support the idea that *Geraniums* could possibly be from an earlier date than 1915. Various points came together when curatorial fellow Elizabeth Rudy found a different date and title listed for Geraniums with this reference image in Bernheim-Jeune's published catalogue of Matisse archives (figure 52). The date of the reference image is unknown. Bernheim-Jeune was Matisse's main dealer in Paris for most of his career and kept fairly accurate records of the works coming through their gallery at the time, which included photographing all of the works.

Figure 52. *Pot of Geraniums, 1910.*
Info from Bernheim-Jeune Archival Catalogue.
Date of reference image unknown.

The paint structure of *Geraniums* is not unlike that of *Still-Life with Apples*, in that there are multiple layers of paint and dramatic changes in color. However it is much easier to view the paint structure under magnification in *Geraniums* due to the different technique utilized by Matisse in his paint application in *Geraniums*. Matisse allows his layering process to be visible in each subsequent layer of paint. The same paint structure is further confirmed in cross-sections. Again in cross-sections, the numbers correspond to paint layers and letters to possible varnish layers.

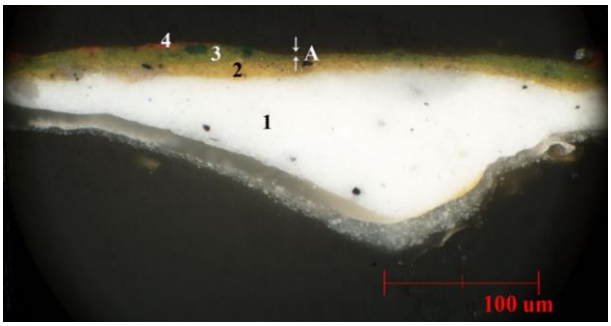

Figure 53. Cross-section 2 of *Geraniums*. Clear layering of paint structure.

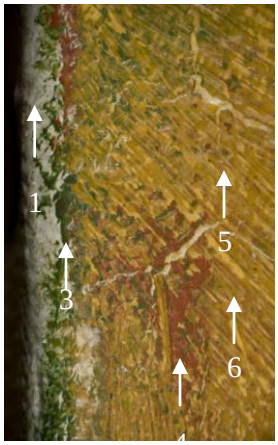

Figure 54. Macrograph 2 of *Geraniums*. Multiple changes in color are visible.

Cross-section 2 (Figure 53) and macrograph 2 (Figure 54) are from the foreground of the painting which is comprised of a variety of earth colors. Layers 1, 3, and 4 can be correlated. In addition to the 3 paint layers seen in the cross-section, there are two additional yellow paint layers, 5 and 6, visible in the macrograph.

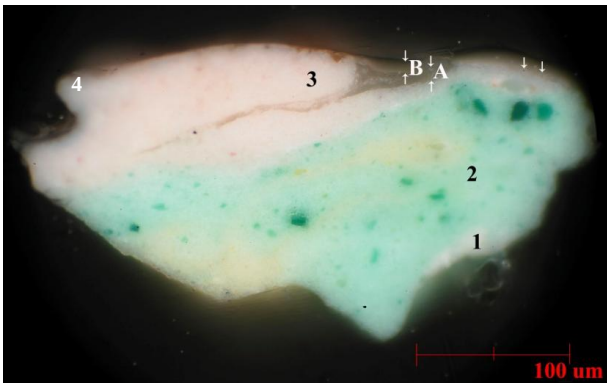

Figure 55. Cross-section 3 of *Geraniums*. Clear layering of paint structure.

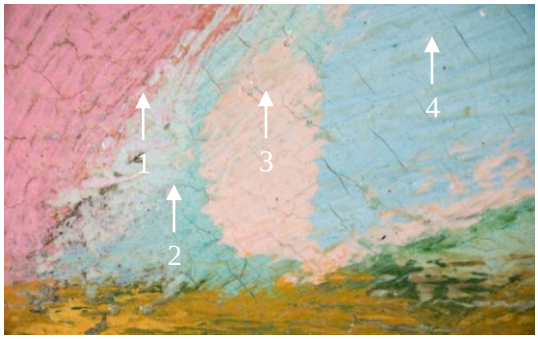

Figure 56. Macrograph 3 of *Geraniums*. Multiple color changes are visible due to Matisse's application of paint.

Paint layers in cross-section 3 (Figure 55) and macrograph 3 (Figure 56), taken from the background, correlate directly with one another. It is easy to distinguish what paint layer came first in the macrograph due to Matisse's application of paint and his allowance of underlying colors to periodically show through subsequent layers.

Pigment analysis for *Geraniums* identified a bright extensive palette including the use of lithipone and lead white in the ground, vermillion, venetian red, yellow ochre, viridian/chrome green, terre verte, cobalt blue, Prussian blue, ultramarine blue, cobalt violet, bone black, and lead white (Figure 57). This information was based on analytical data collected from cross-sectional analysis with RLM and Raman Spectroscopy, and sample analysis using FTIR, as well as in-situ XRF analysis (See Appendix for full results).

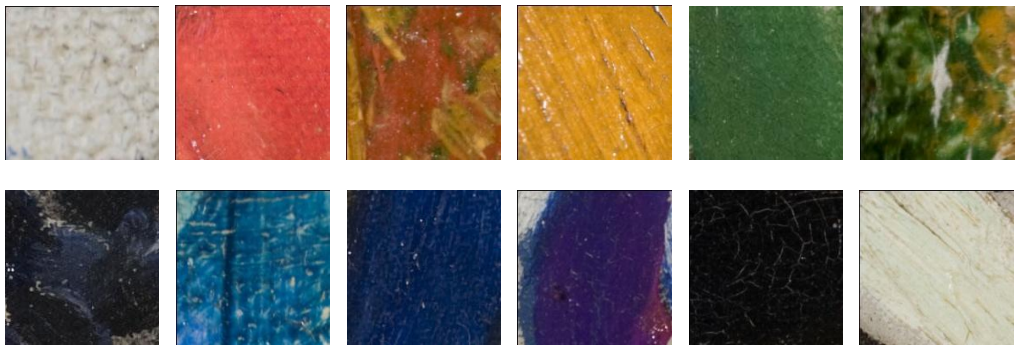

Figure 57. Palette for *Geraniums*. From left to right: ground containing lithipone and lead white, vermillion, venetian red, yellow ochre, viridian/chrome green, terre verte, cobalt blue, Prussian blue, ultramarine blue, cobalt violet, bone black, and lead white..

By surveying and combining all the information collected including the altered composition seen in the x-radiograph, noting shifts in color under magnification, and adding pigment identification and paint structure, an approximation of what the painting may have looked like during its construction was created. Based on color measurements taken in Adobe Photoshop, these images represent just a few possible states in the process of Matisse's revisions. Although the actual progression of the painting is unclear and could only be understood from further cross-section analysis, it is likely that these color composites represent how the painting developed.

Figure 58. Color composite 1 of *Geraniums*. Initial application of contour line drawing and subject's color.

Figure 59. Color composite 2 of *Geraniums*. First color combination for foreground and background.

Figure 60. Color composite 2 of *Geraniums*. Second color combination for foreground and background. Note complementary colors.

Figure 61. Color composite 4 of *Geraniums*. Third color combination for foreground and background.

Figure 62. Color composite 5 of *Geraniums*. Final color in background and foregeround.

Figure 63. Final state of *Geraniums*. Addition of yellow ochre accent in table top is last addition.

The first color composite shows (Figure 58) an early state of the painting, with a fluid contour line drawing followed by the initial addition of color to the main design elements in the background and pot of geraniums. Color composite 2 (Figure 59) shows an initial color combination for the table top and background. Color composite 3 (Figure 60) has another possible color combination for the table top and background. Note the use of complementary colors in this version. Color composite 4 (Figure 61) may have been closer to a final state, as the final background color has been added and another new color has also been added to the table top. In color composite 5 (Figure 62) the final foreground color has been chosen, with only the additional accent in the upper left edge of the table added in the final state (Figure 63). Here color seems to be the driving force for Matisse, rather than reconstruction of the composition as seen previously in *Still-Life with Apples*. In 1908 Matisse writes of color and harmony:

> *It is necessary, that the various elements that I use be so balanced that they do not destroy one another. To do this I must organize my ideas; the relation between tones must be so established that they will sustain one another. A new combination of colors will succeed the first one and will give more completely my interpretation. I am forced to transpose until finally my picture may seem completely changed when, after successive modifications, the red has succeeded the green as the dominant color.*

c. Treatment

Geraniums has been through a few treatments, the most recent of which involved a spray application of PVA varnish. Viewing the painting in oblique specular light (figure 64) showed the dull, plastic-like quality of the surface coating. The brush strokes were lost and the original colors appeared slightly yellow and gray due to the poor aging characteristics of the PVA varnish. Viewing the UVA induced visible fluorescence image, Figure 65, a characteristic bluish fluorescence indicative of a synthetic varnish was observed. FTIR analysis of the surface coating confirmed a PVA and no other materials were present on the

Figure 65. UVA induced visible fluorescence digital photograph of *Geraniums*. Characteristic bluish fluorescence of a synthetic varnish.

surface. Revisiting cross-section 2 (Figure 66) further confirms the presence of the spray-applied PVA varnish. This information identified that the varnish was not original to the painting, which most likely meant the painting was not intended to be varnished. The PVA varnish was removed using toluene. During treatment images show just how subtly the colors had been yellowed by the varnish (Figure 67). Before and after treatment images reveal only a slight change in colors from the varnish removal, which is most noticeable in the blue in the background. Curators were impressed with the subtle improvement of the colors and the revelation of previously hidden brushstrokes on the surface (Figure 69).

Figure 64. Oblique specular digital photograph of *Geraniums*. Plastic-like quality of surface coating.

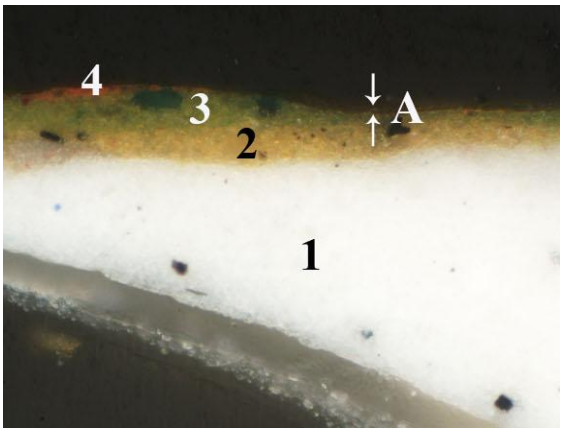

Figure 66. Magnification of cross-section 1 of *Geraniums*. Layer A is the thin PVA varnish.

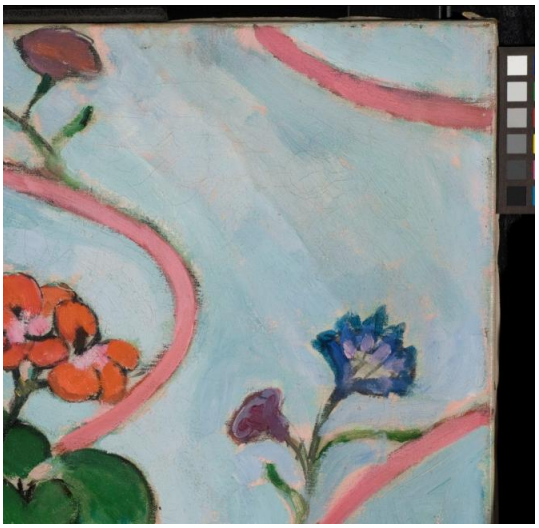

Figure 67. During cleaning detail of *Geraniums*

Figure 68. *Geraniums* before treatment.

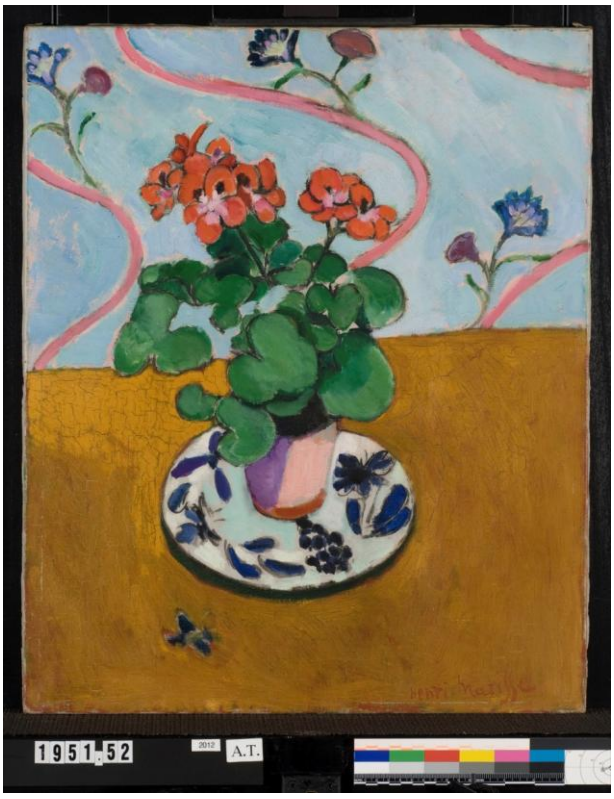

Figure 69. *Geraniums* after treatment.

VI. Conclusion

The technical analysis for *Still-Life with Apples* identified a subdued, limited palette, dramatic revisions to the composition, as well as overall color shifts. These characteristics unquestionably match the 1913-17 period. The technical analysis for *Geraniums* identified a diverse palette, no slight shifts to the composition, and dramatic color shifts. Because these characteristics do not match what was found in *Still-Life with Apples*, it is clear that *Geraniums* does not belong in the 1913-17 period. Treatment of *Geraniums* involved removing the unoriginal synthetic varnish and returning it to a more original state. While solubility testing has been performed on *Still-Life with Apples* and testing confirmed that brush strokes and more accurate colors would be revealed, curators decided not to proceed with this treatment. A second treatment option was chosen including slightly reducing the varnishes with TS-28, filling and inpainting abrasions along the perimeter of the painting, and toning the painted border to match Matisse's original color. Further conversations with curators are necessary to identify whether or not the date of *Geraniums* will be changed based upon the collected data and archival information. What began as an exploration of the 1913-17 period defining these two works, soon became two separate journeys. In the end great insight into both Matisse's early work, as well as his innovative and experimental period were gained.

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X. Appendix

a. Analytical Results for *Still-Life with Apples*, 1916

Figure 71. Sampling sites for analysis on *Still-Life with Apples*.

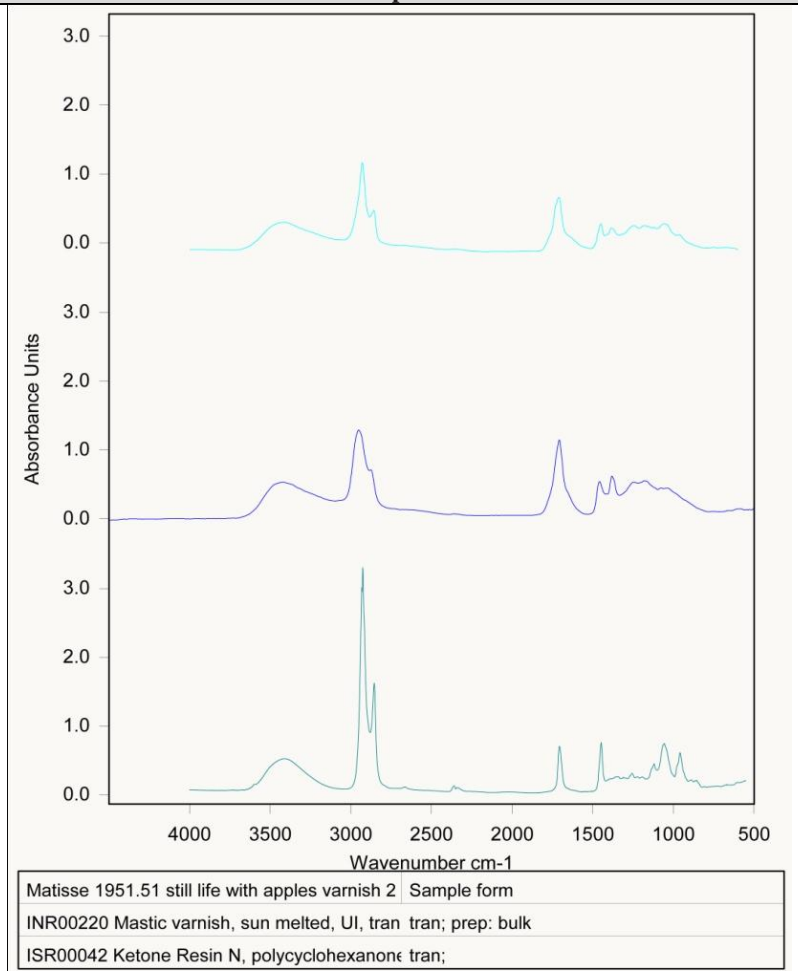
Figure 70 Table 1 Analysis of Samples and Cross-sections

***Still-Life with Apples,* 1916**

Analytical Methods:
1- Scanning Electron Microscopy (SEM)
2- Raman Spectromicroscopy
3- Fourier Transform Infrared Spectroscopy (FT-IR)

Note: Pigments identified by Raman Spectromicroscopy and FTIR are positive identification, whereas the pigments identified by other techniques are inferred from the elemental data.

Sample		Color	Material Identification	FTIR Spectrum
*1 Varnish		Yellow/brown	Synthetic resin (ketonic)[3] Natural resin (dammar)[3]	
**2 Varnish		Yellow/brown	Synthetic resin (ketonic)[3] Natural resin (dammar)[3]	



Analytical Methods:
1- Scanning Electron Microscopy (SEM)
2- Raman Spectromicroscopy
3- Fourier Transform Infrared Spectroscopy (FT-IR)

Note: Pigments identified by Raman Spectromicroscopy and FTIR are positive identification, whereas the pigments identified by other techniques are inferred from the elemental data.

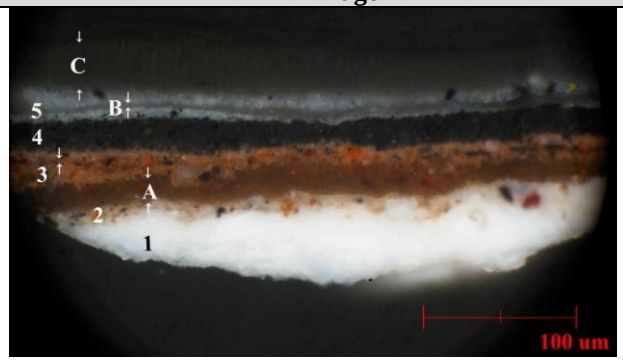
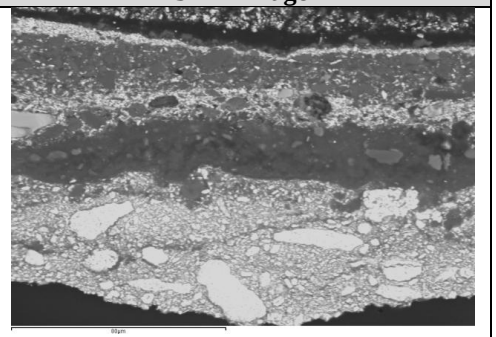
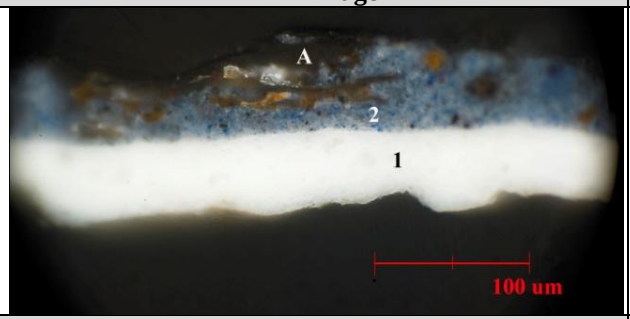
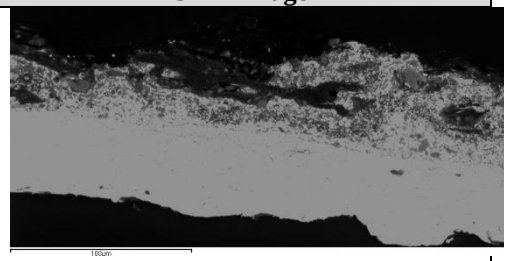
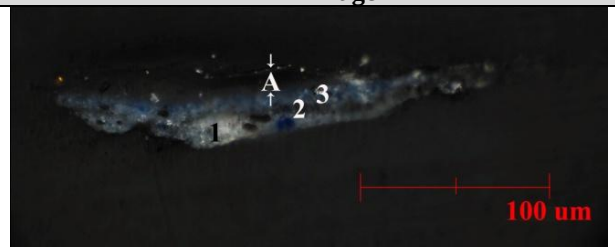
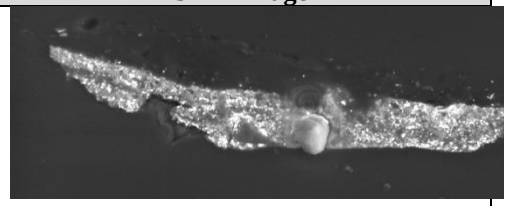
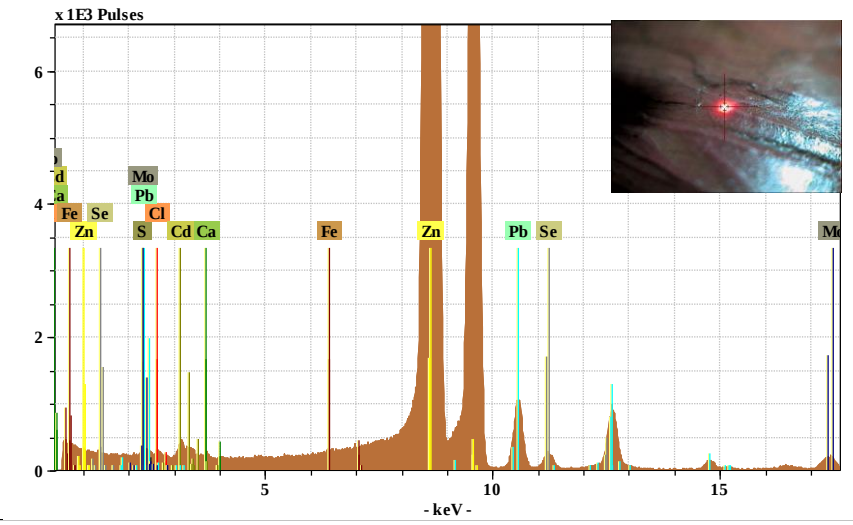
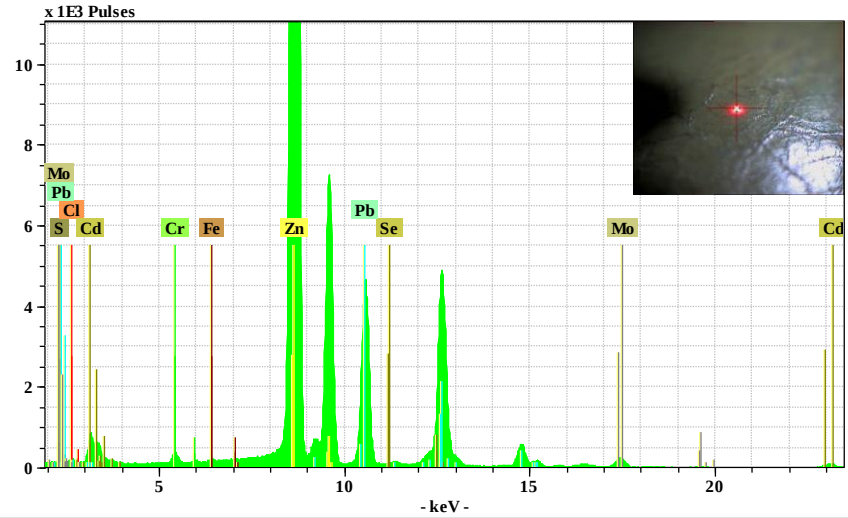
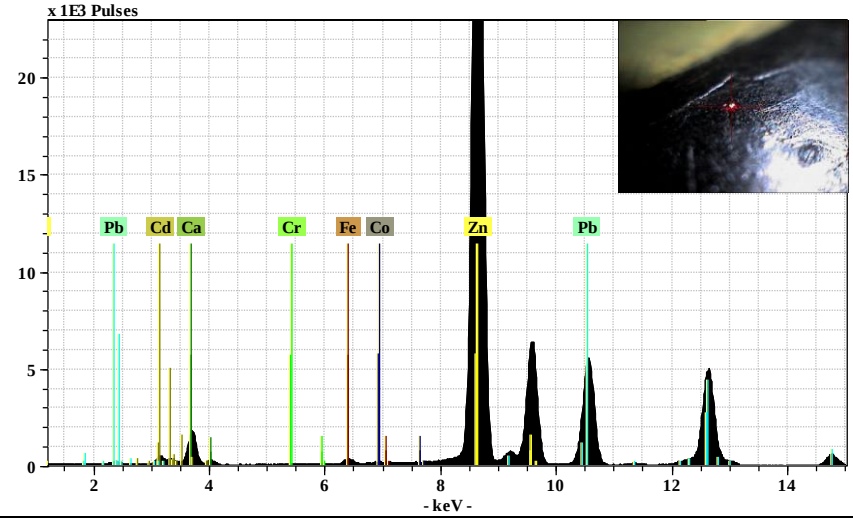
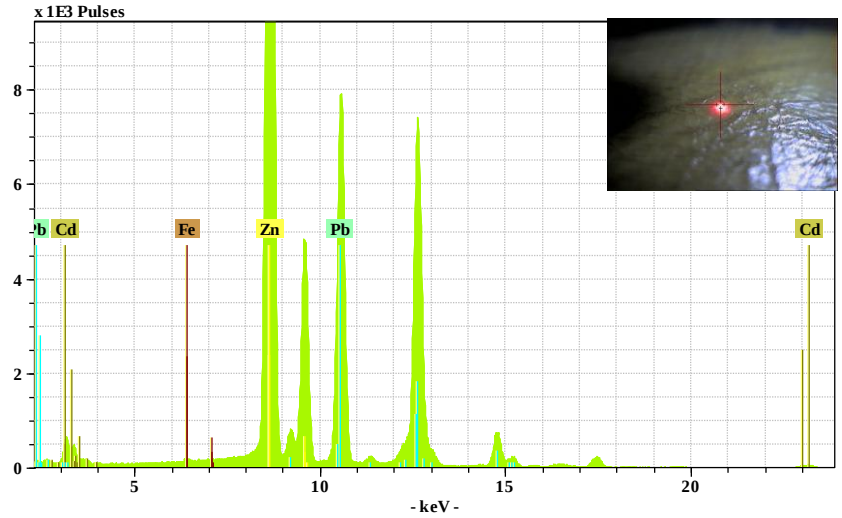
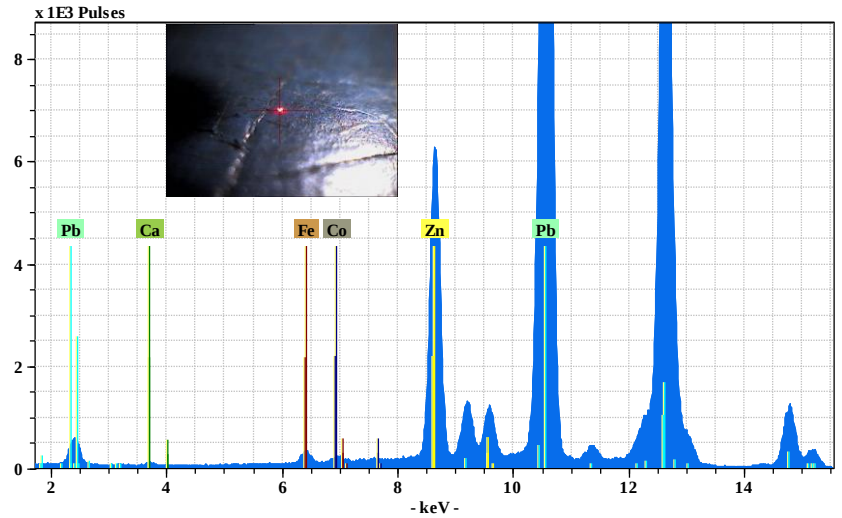
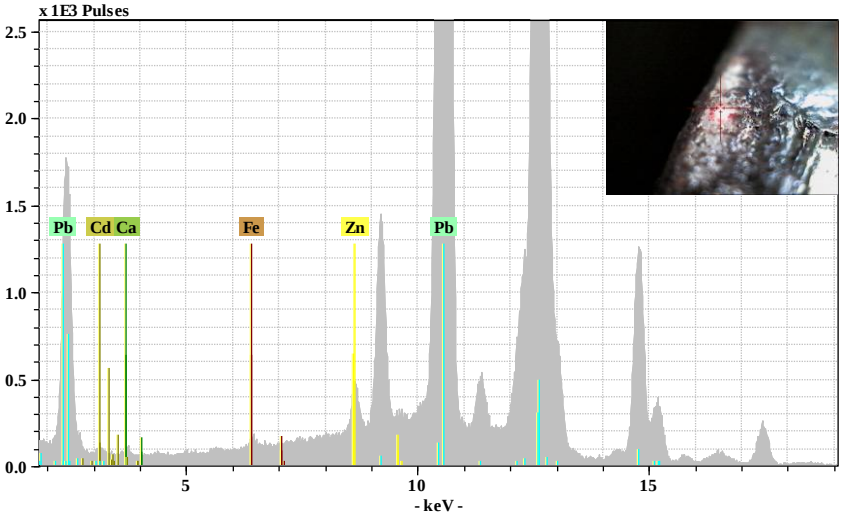
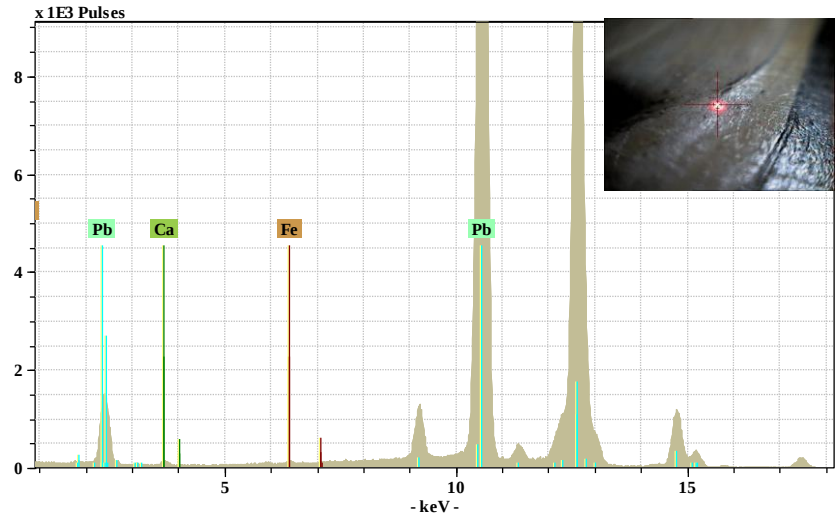
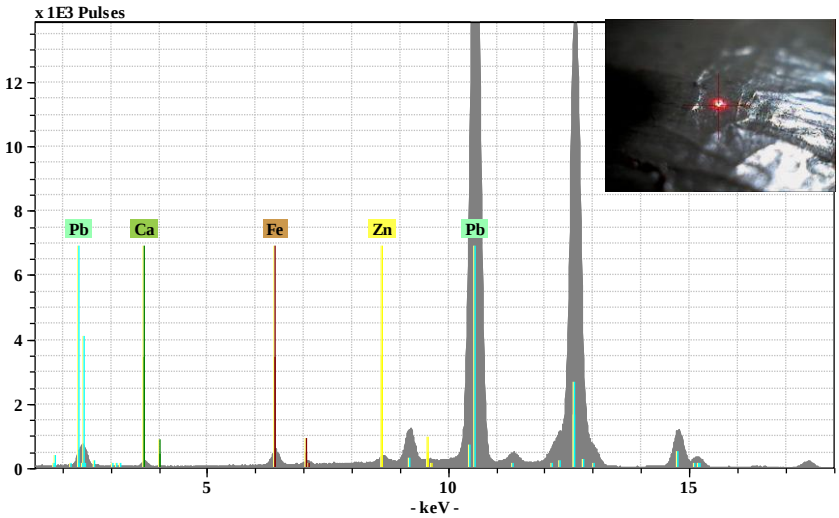
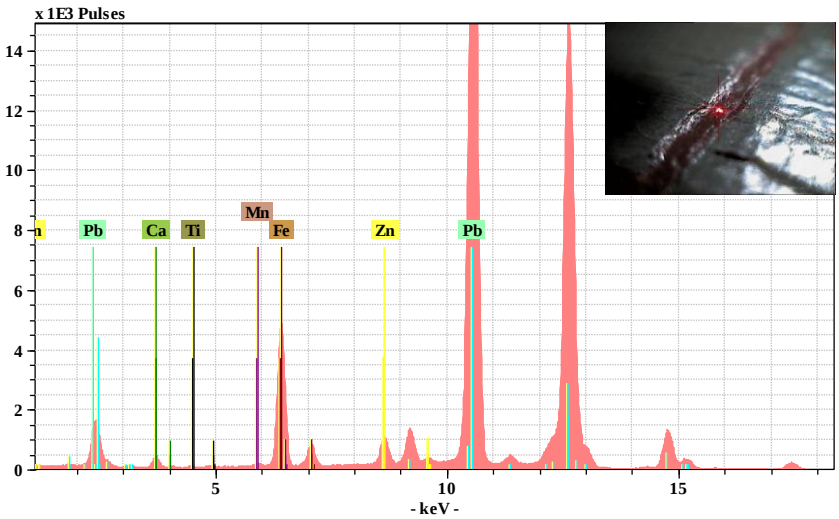
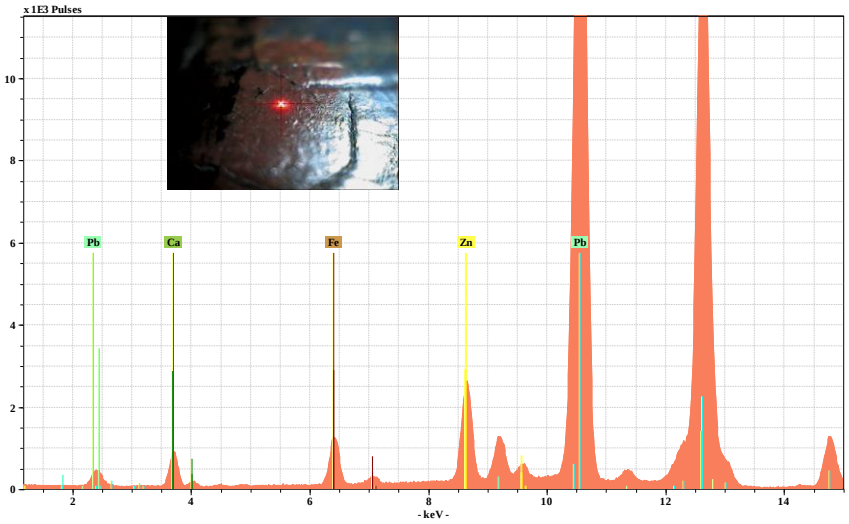
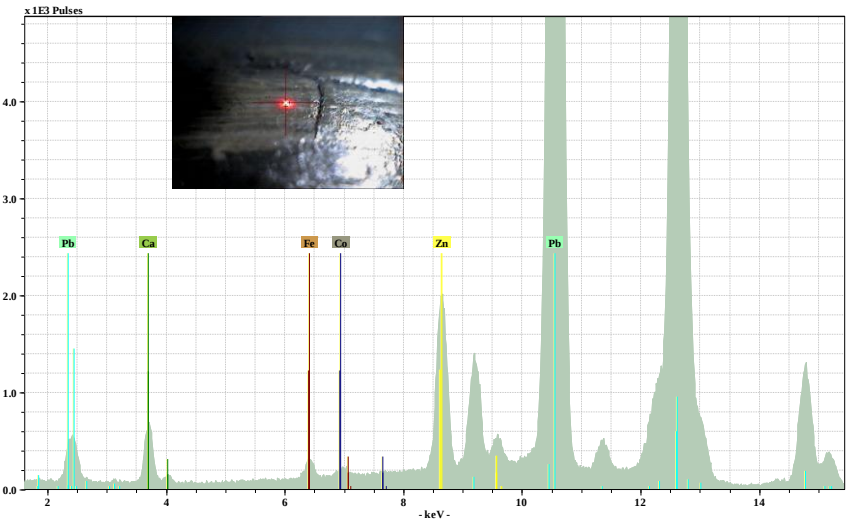
Sample	Layer	Color	Material Identification	RLM Image	SEM Image
1 Cross-section	C	Yellow/brown	Synthetic resin (ketonic) *,***		
	B	Brown	Natural resin*, **		
	5	Gray	Lead white[1] Zinc white[1] Bone black[1]		
	4	Black	Bone black[1] Ultramarine[1]		
	3	Pink	Hematite[1,3] Bone black[1]		
	A	Pink	Hematite[1]		
	2	Pink	Hematite[1], Lead white[1]		
	1	White	Lead white[1, 2] Barium sulfate[2]		
Sample	**Layer**	**Color**	**Material Identification**	**RLM Image**	**SEM Image**
2 Cross-section	A	Yellow/brown	Synthetic resin (ketonic) *,*** Natural resin (dammar) *, **		
	2	Blue	Ultramarine Blue[1, 2] Bone black[1]		
	1	White	Lead white[1]		
Sample	**Layer**	**Color**	**Material Identification**	**RLM Image**	**SEM Image**
3 Cross-section	A	Yellow/brown	Synthetic resin (ketonic) Natural resin (dammar) (See above)*, **		
	3	Blue	Ultramarine blue[1] Bone black[1]		
	2	Black	Bone black[1]		
	1	White	Lead white[1]		

Figure 72	**Table 2 Analysis of Pigments with XRF**		
***Still-Life with Apples,* 1916**			
Sample	**Color**	**Material Id**	**Image and Spectrum**
1	Orange/pink (in right apple)	Cadmium red Zinc white (Zn, Pb, Cd, Se, trace Ca, Cl, S/Pb/Mo)	
2	Green (in right apple)	Chrome green Zinc white (Zn, Pb, Cd, Cr, Fe, trace Cl, Pb/S/Mo)	
3	Black (next to right apple)	Bone black Zinc white (Zn, Pb, Ca, Fe, Cd, trace Cr, Co)	

Sample	Color	Material Id	Image and Spectrum
4	Yellow (in right apple)	Cadmium yellow Zinc white (Zn, Pb, Cd, trace Fe)	
5	Blue	Ultramarine Lead white (Pb, Zn, Fe, Co, trace Ca)	
6	Ground/gray (ground in foreground)	Lead white (Pb, Zn, Fe, Ca,Cd)	

Sample	Color	Material Id	Image and Spectrum
7	White (in glass)	Lead white (Pb, Fe, trace Ca)	
8	Gray (in background)	Lead white Bone black (Pb, Fe, Zn, Ca)	
9	Salmon/red (in crack in background gray)	Hematite Lead white (Pb, Fe, Zn, Ca, Mn, trace Ti)	

Sample	Color	Material Id	Image and Spectrum
10	Salmon/red (in lower left corner of table top)	Hematite Lead white (Pb, Zn, Fe, Ca)	
11	White (streak in lower left corner of table top)	Lead white Zinc white (Pb, Zn, Ca, Fe, trace Co)	

b. Analytical Results for *Geraniums*, 1915

Figure 74. Sampling sites for analysis on *Geraniums*.

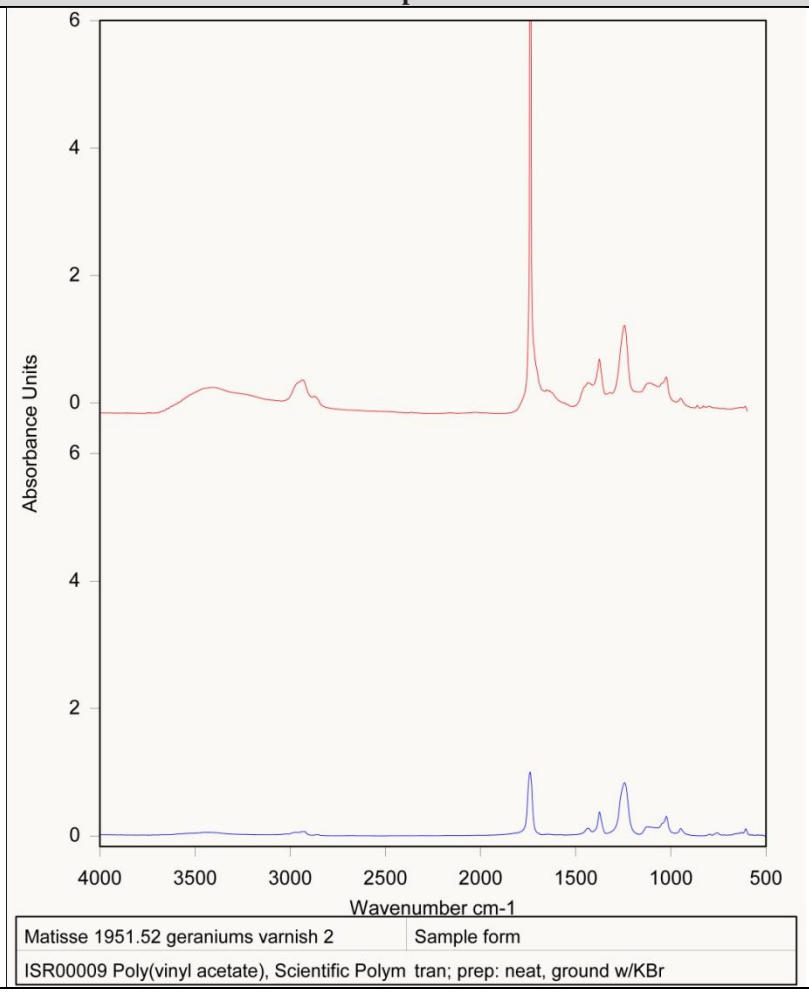
Figure 73 **Table 3 Analysis of Samples and Cross-sections**

***Geraniums*, 1915**

Analytical Methods:
1- Scanning Electron Microscopy (SEM)
2- Raman Spectromicroscopy
3- Fourier Transform Infrared Spectroscopy (FT-IR)

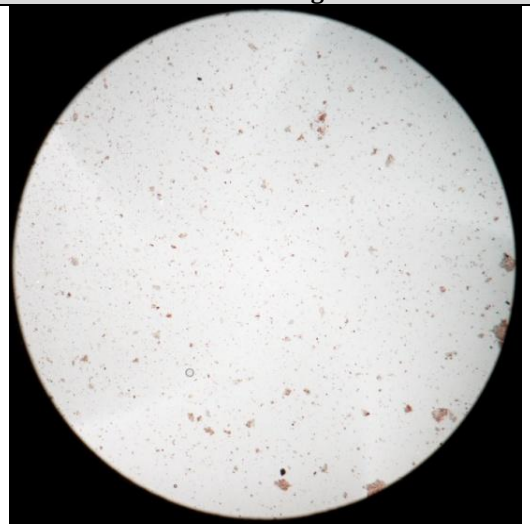
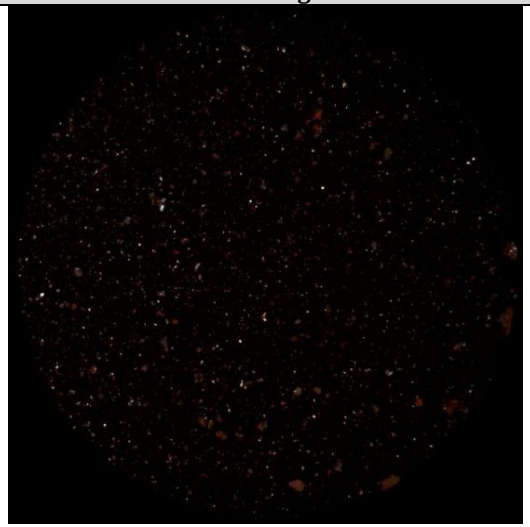
Note: Pigments identified by Raman Spectromicroscopy and FTIR are positive identification, whereas the pigments identified by other techniques are inferred from the elemental data.

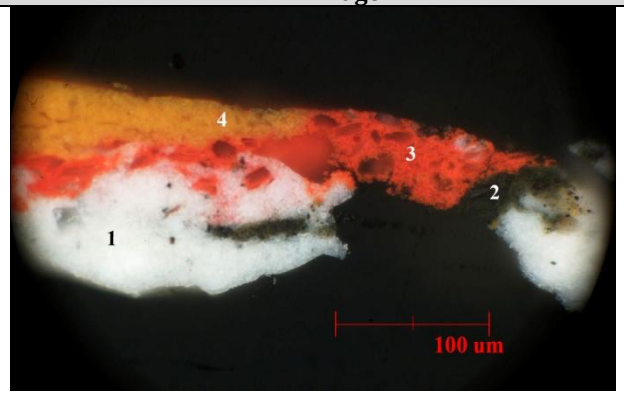
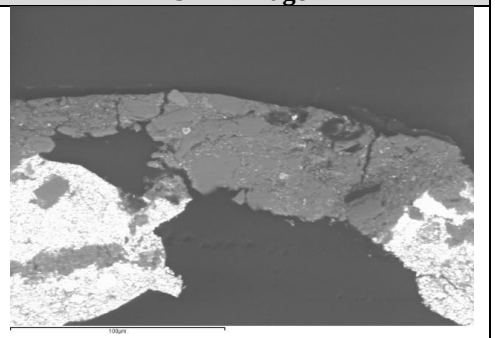
Sample		Color	Material Identification	.FTIR Spectrum
*1 Varnish		Yellow/gray	PVA[3]	
**2 Varnish		Yellow/gray	PVA[3]	



Analytical Methods:
1- Scanning Electron Microscopy (SEM)
2- Raman Spectromicroscopy
3- Fourier Transform Infrared Spectroscopy (FT-IR)

Note: Pigments identified by Raman Spectromicroscopy and FTIR are positive identification, whereas the pigments identified by other techniques are inferred from the elemental data.

Sample		Color	Material Identification	PLM Image	XPL Image
1 Pigment		Red	Carbohydrate[3] Hematite[3]	 400x	

Sample	Layer	Color	Material Identification	RLM Image	SEM Image
1 Cross-section	4	Yellow	Yellow ochre[1] Lead white[1] Zinc white[1]		
	3	Red	Hematite[2,3] Venetian red[1] Lead white[1]		
	2	Green	Terre verte[1] Bone black[1] Lead white[1] Zinc white[1]		
	1	White	Lithapone[1, 2] Lead white[1]		

Analytical Methods:
1- Scanning Electron Microscopy (SEM)
2- Raman Spectromicroscopy
3- Fourier Transform Infrared Spectroscopy (FT-IR)

Note: Pigments identified by Raman Spectromicroscopy and FTIR are positive identification, whereas the pigments identified by other techniques are inferred from the elemental data.

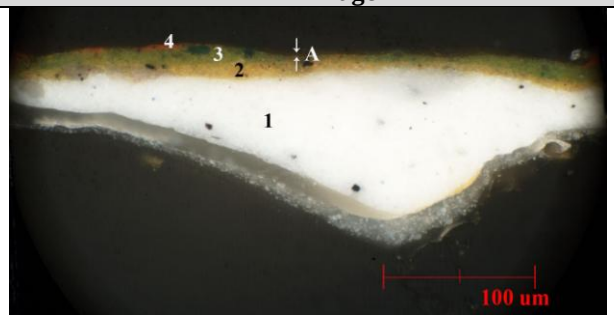
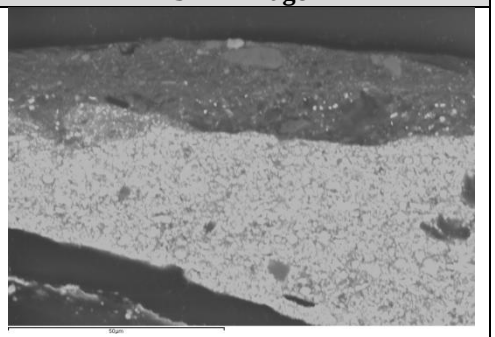
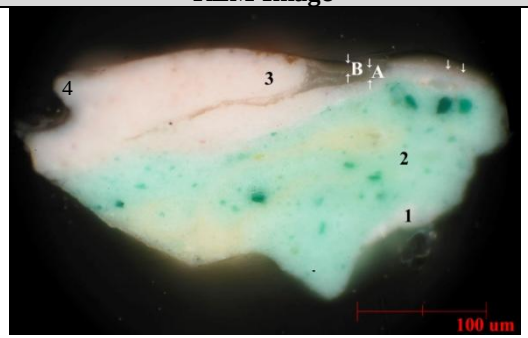
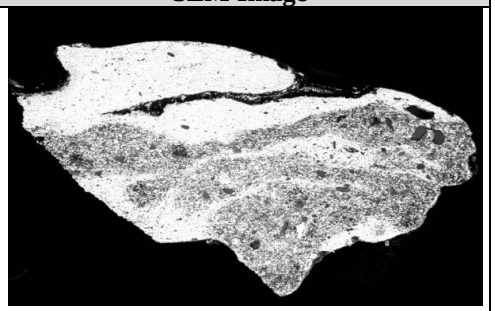
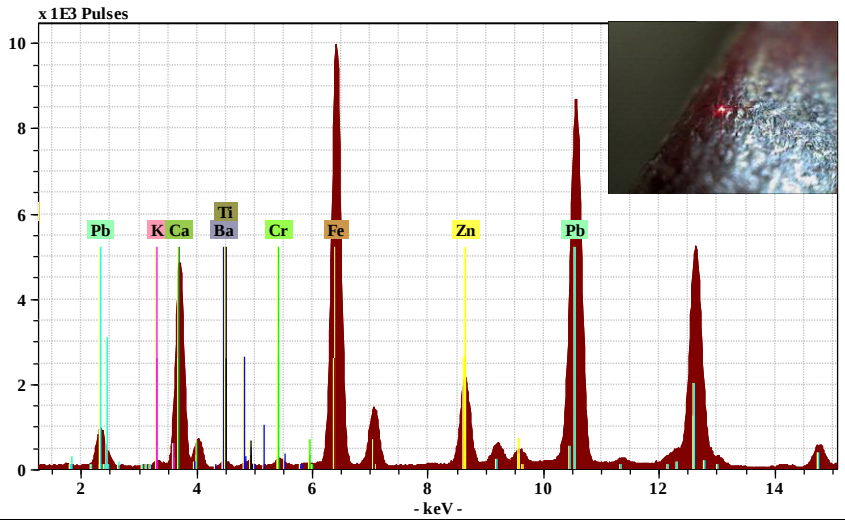
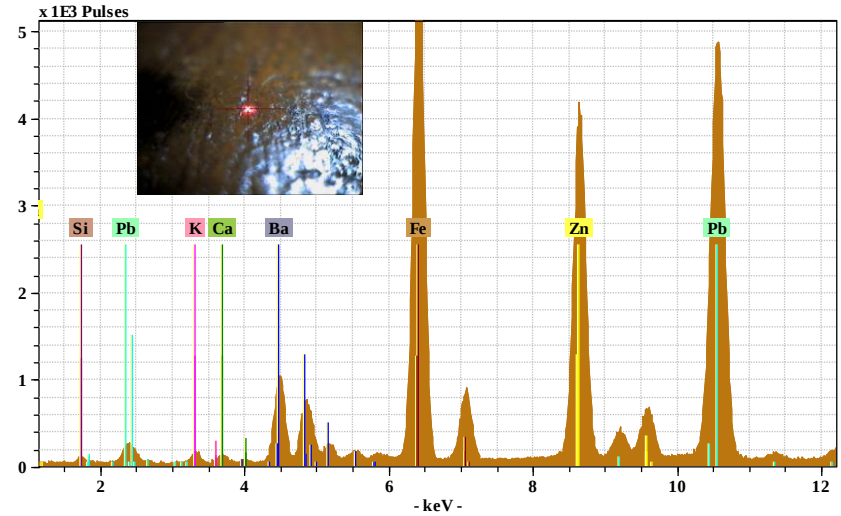
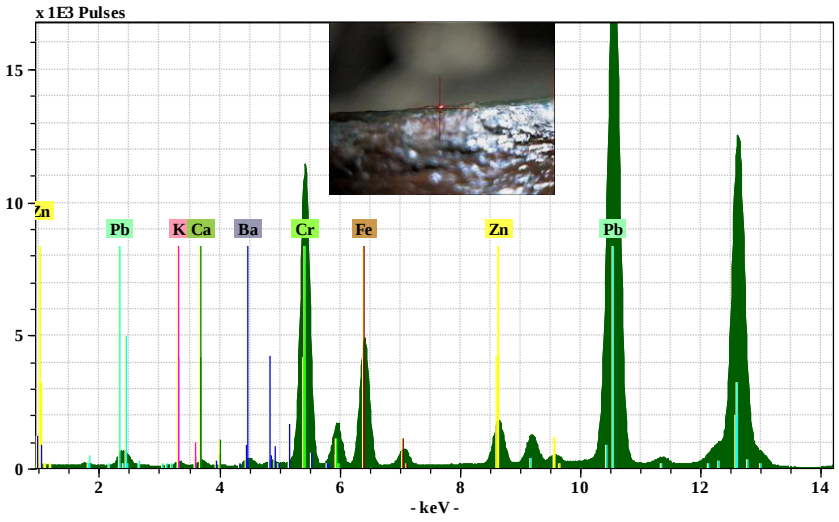
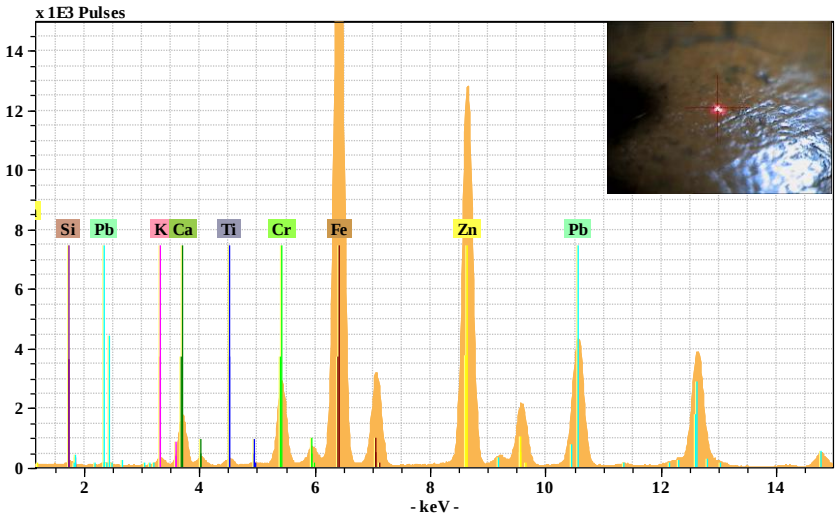
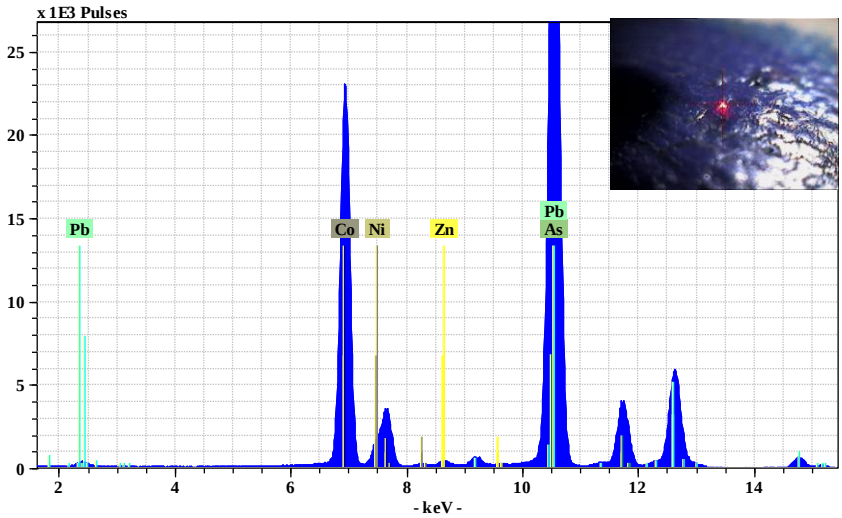
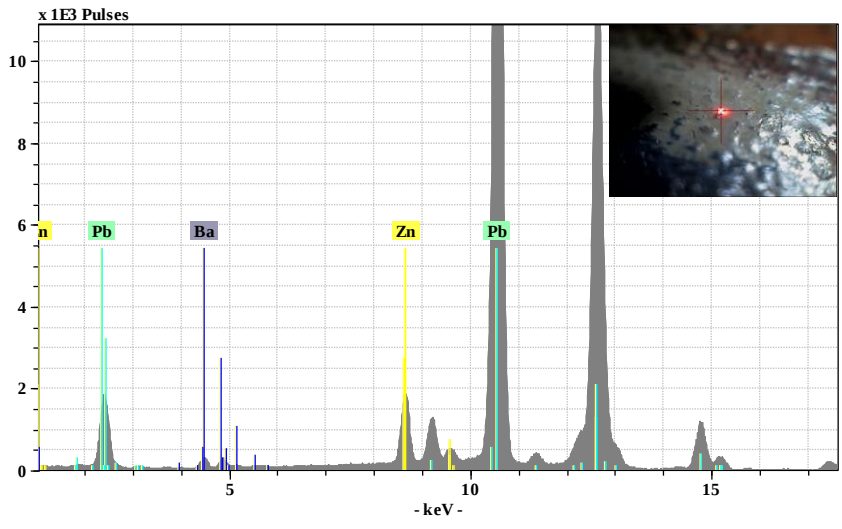
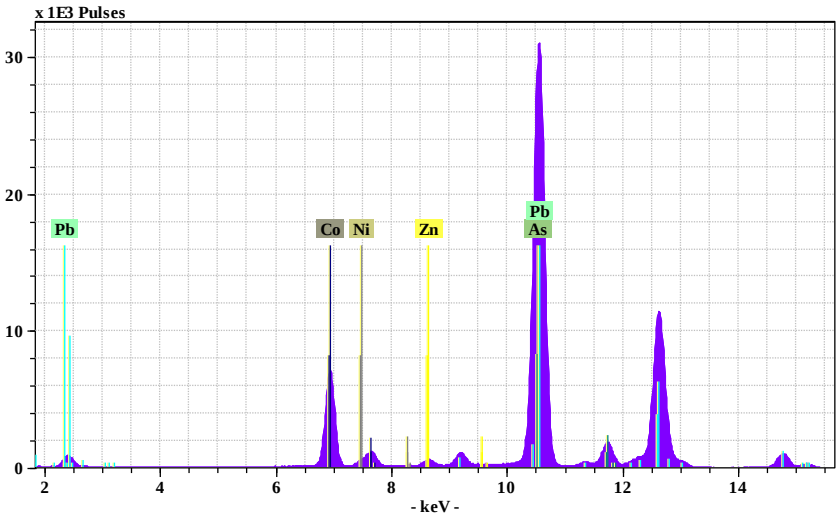
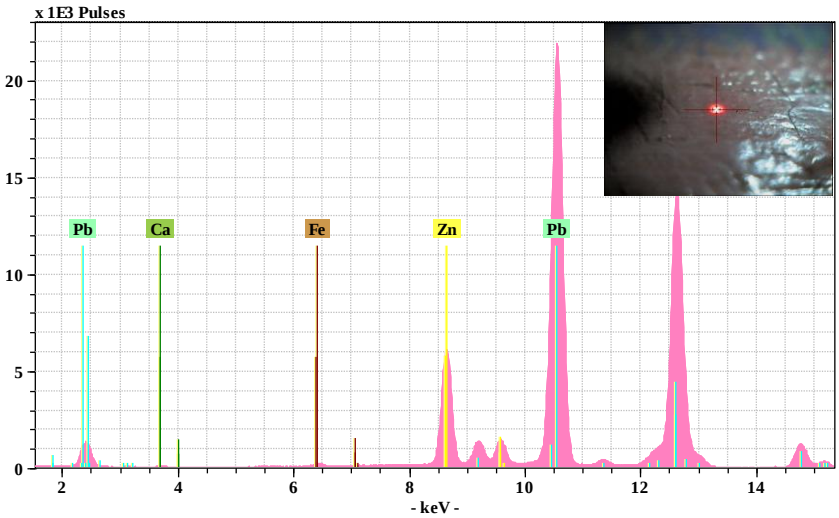
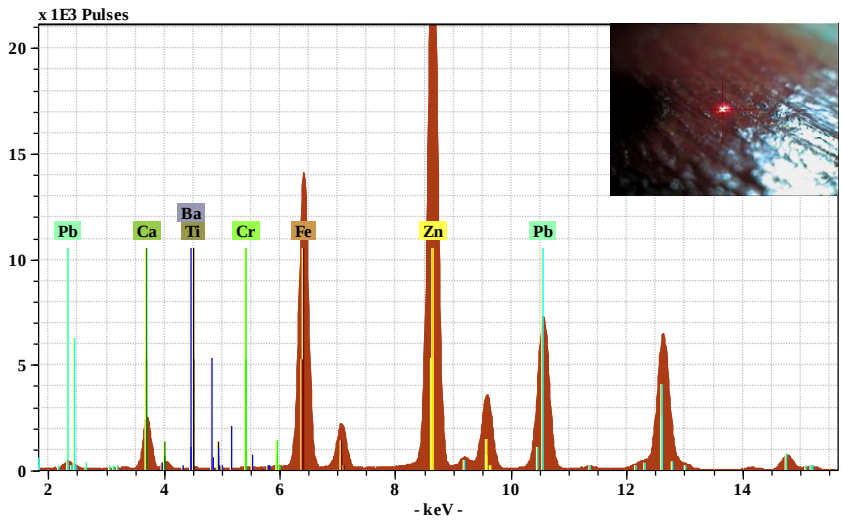
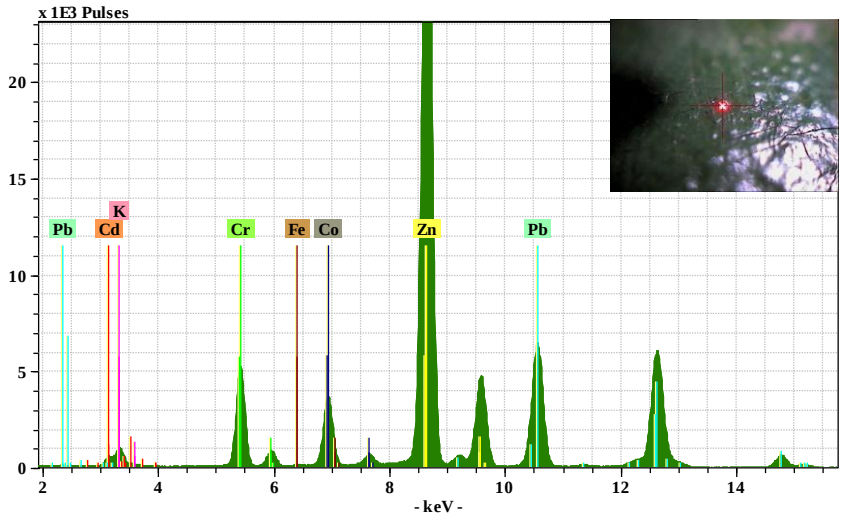
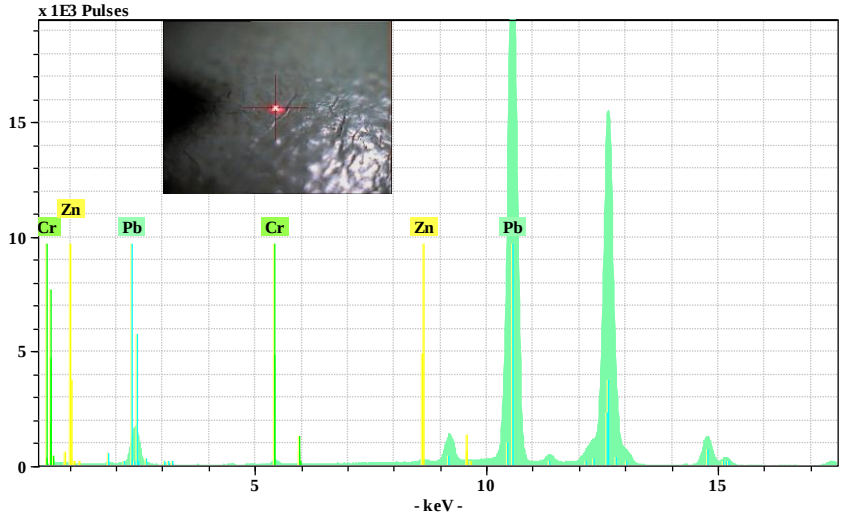
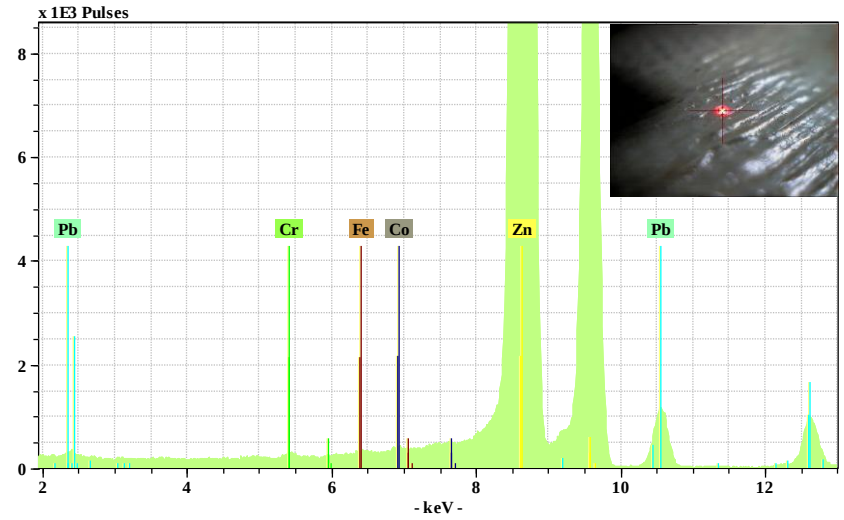
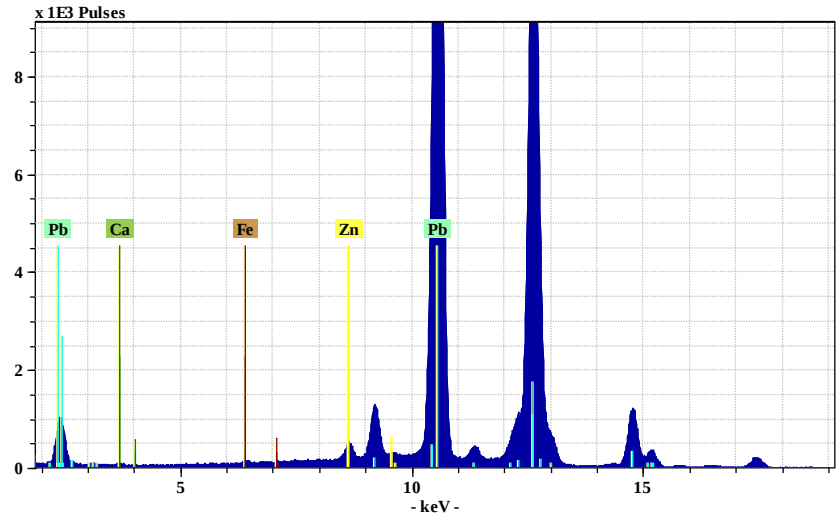
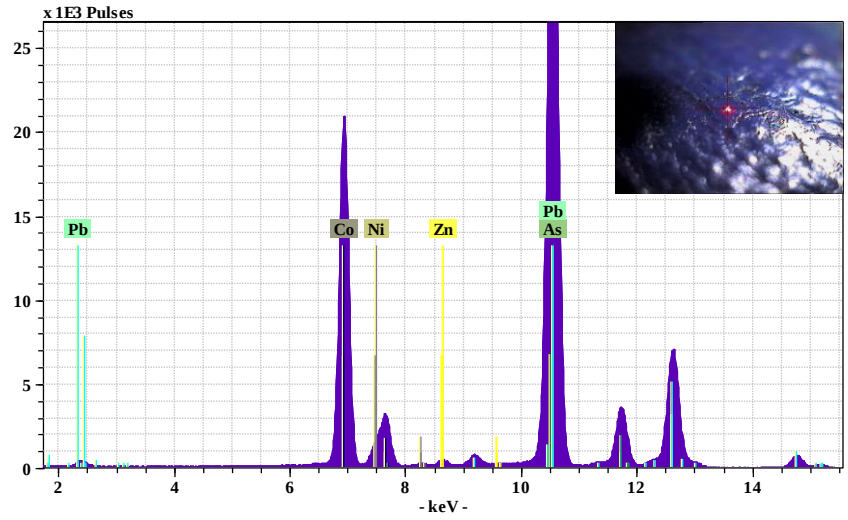
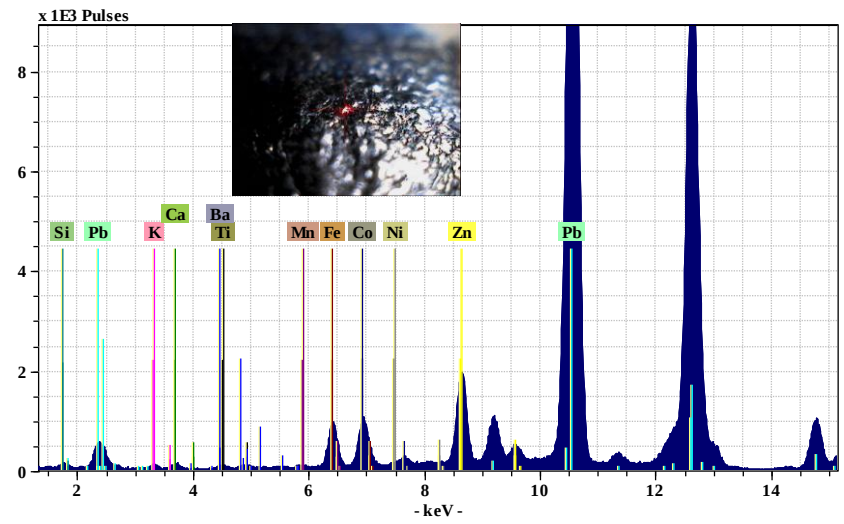
Sample	Layer	Color	Material Identification	RLM Image	SEM Image
2 Cross-section	A	Yellow/gray	PVA*, **		
	4	Red	Hematite[2,3] Venetian red[1] Lead white[1]		
	3	Green	Terre verte[1] Bone black[1] Lead white[1] Zinc white[1]		
	2	Yellow	Yellow ochre[1] Lead white[1] Zinc white[1]		
	1	White	Lithapone[1, 2] Lead white[1]		
Sample	**Layer**	**Color**	**Material Identification**	**RLM Image**	**SEM Image**
3 Cross-section	B	Yellow/gray	PVA*, **		
	A	Clear	-		
	4	Blue	Cobalt blue[1]		
	3	Pink	Venetian red[1]		
	2	Green	Chrome green[1] Zinc white[1]		
	1	White	Lithapone[1, 2] Lead white[1]		

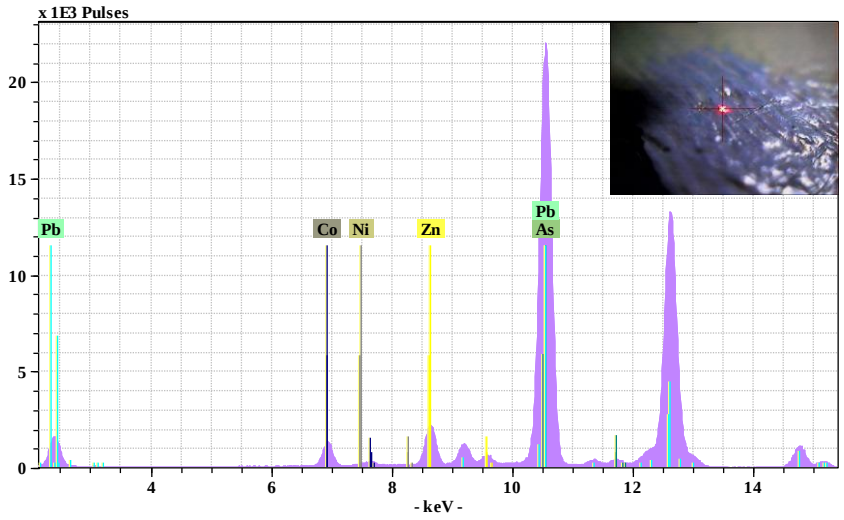
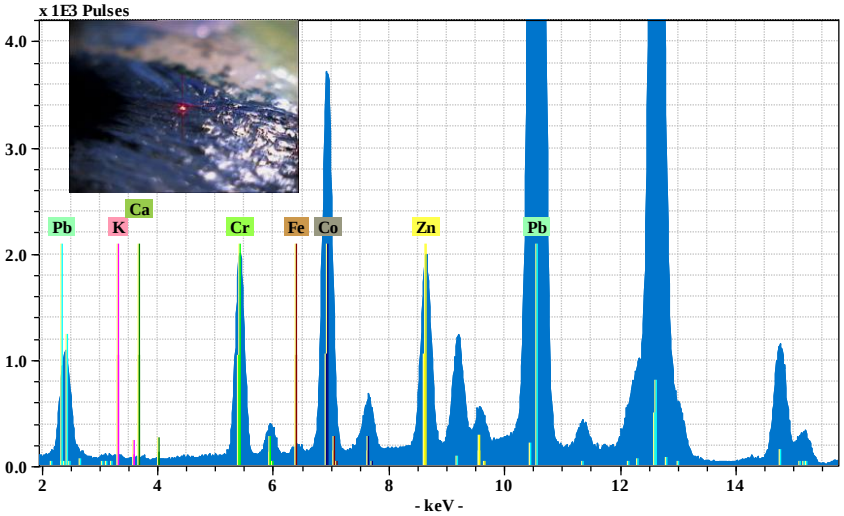
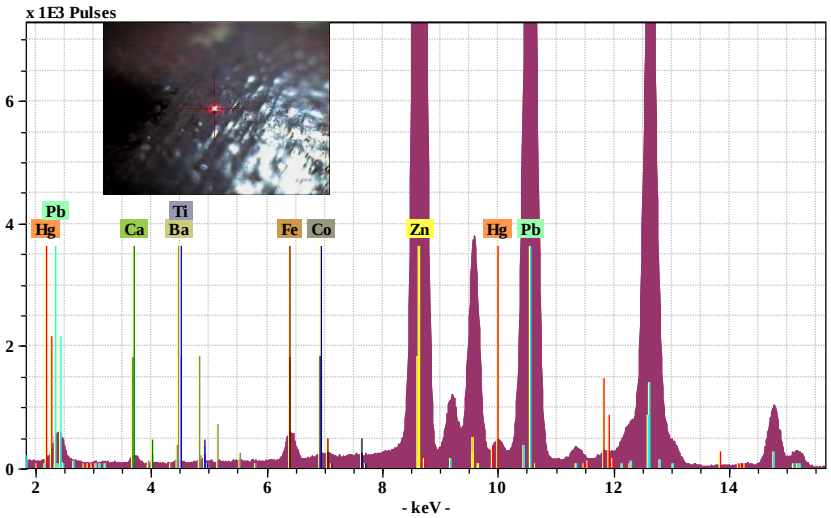
Figure 75	**Table 4 Analysis of Pigments with XRF**		
***Geraniums*, 1915**			
Sample	**Color**	**Material Id**	**Image and Spectrum**
1	Red (in foreground, near left edge)	Venetian red Lead white (Fe, Pb, Ca, Zn Trace Cr, Ti, Ba, K)	
2	Yellow/orange (in foreground near left edge)	Yellow ochre Lead white Zinc White (Fe, Pb, Zn, Ba, K, Ca, Si)	
3	Green (in foreground near left edge)	Chrome green Lead white (Pb, Cr, Fe, Zn, Ba, trace K, Ca,)	

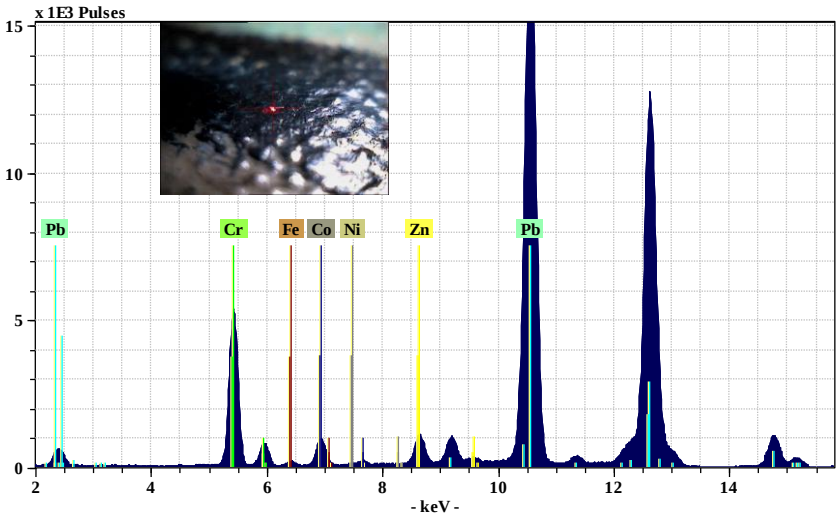
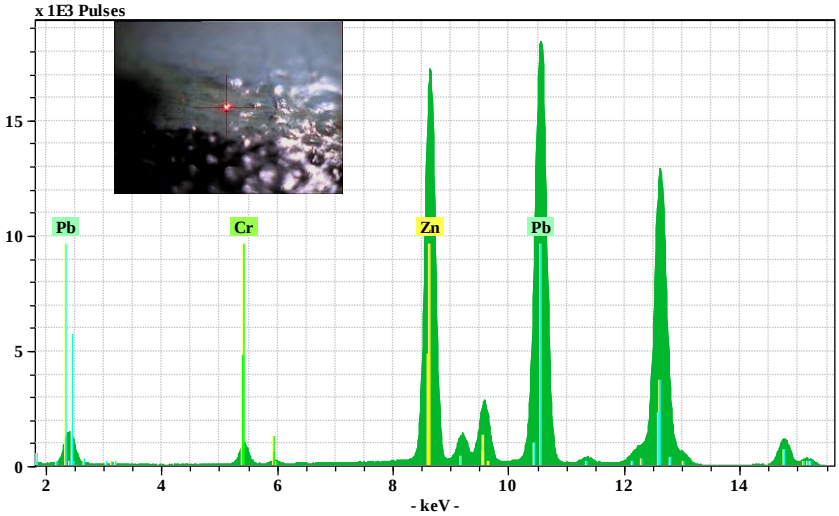
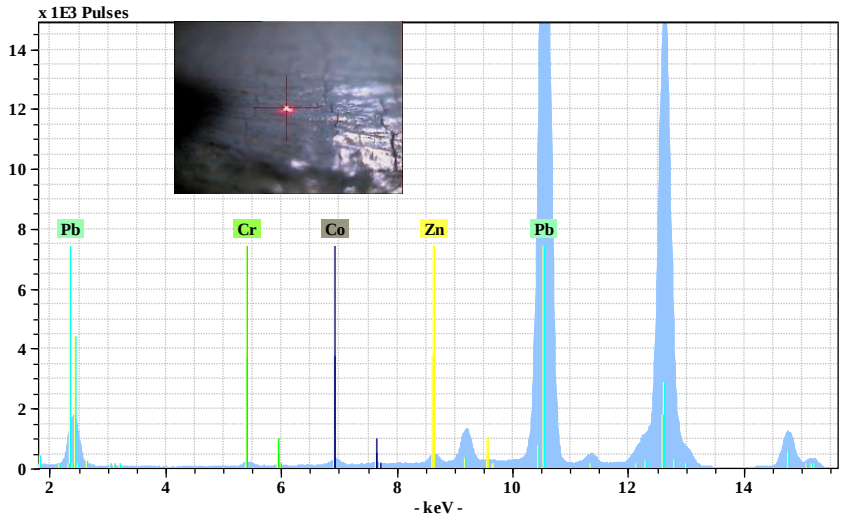
Sample	Color	Material Id	Image and Spectrum
4	Yellow (bright highlight in upper left corner of foreground)	Yellow ochre Zinc white (Fe, Zn, Pb, Cr, Ca, Ti, K, trace Si)	
5	Bright blue (blue flower in plate)	Cobalt violet Lead white (Pb, As, Co, Zn, trace Ni)	
6	Ground/white (ground in plate)	Lead white Lithopone (Pb, Zn, Ba)	

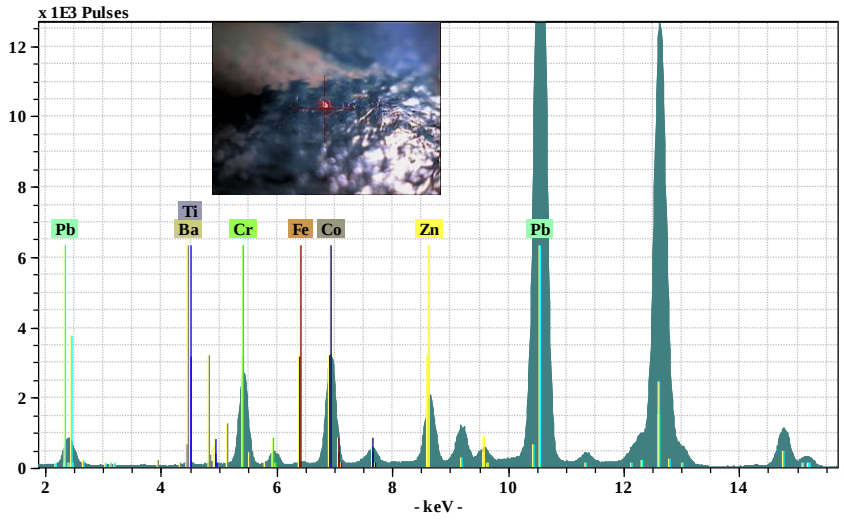
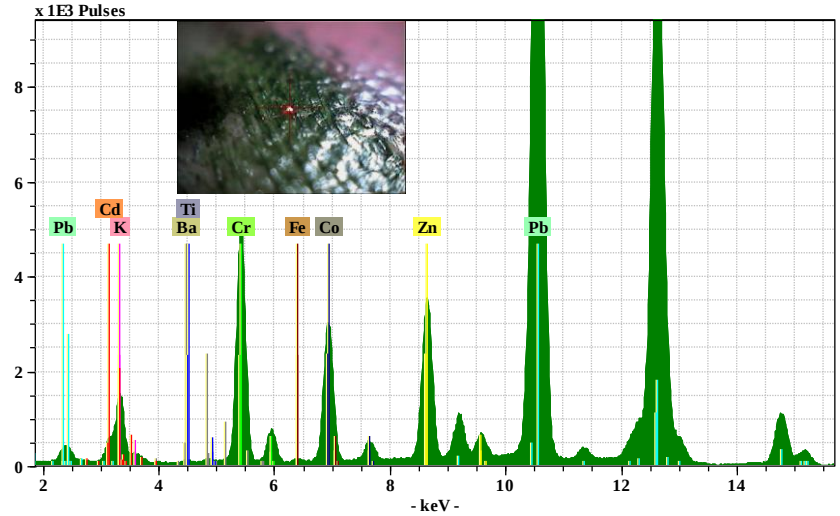
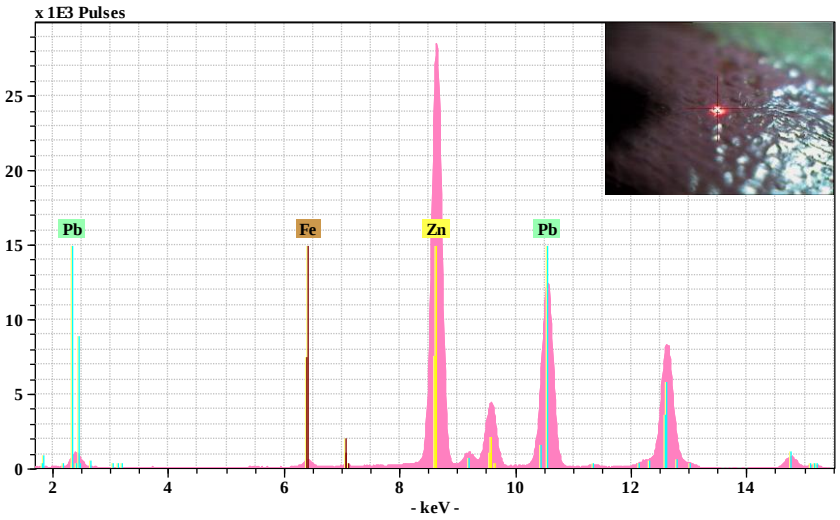
Sample	Color	Material Id	Image and Spectrum
7	Violet (in flowerpot)	Cobalt violet Lead white (Pb, As, Co, Ni, Zn)	
8	Pink (in flowerpot)	Hematite Lead white (Pb, Zn, trace Fe, Ca)	
9	Red (in flowerpot)	Hematite Zinc white (Zn, Fe, Pb, Ca, trace Cr, Ba, Ti)	

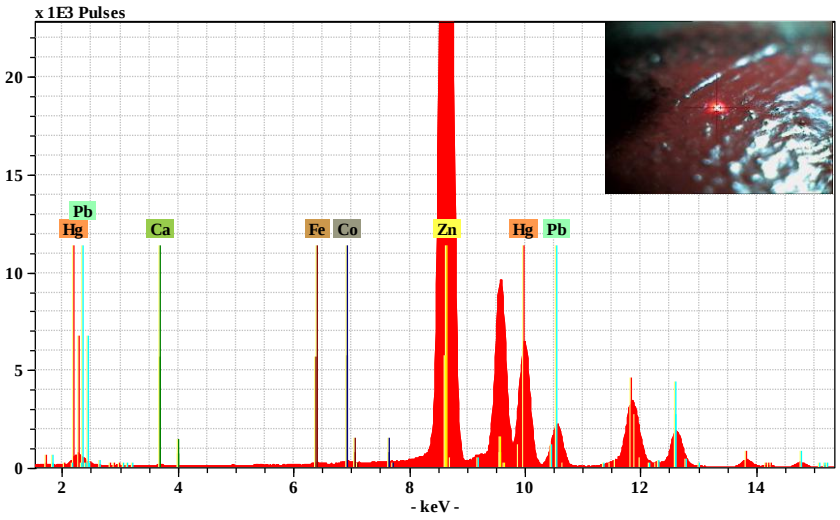
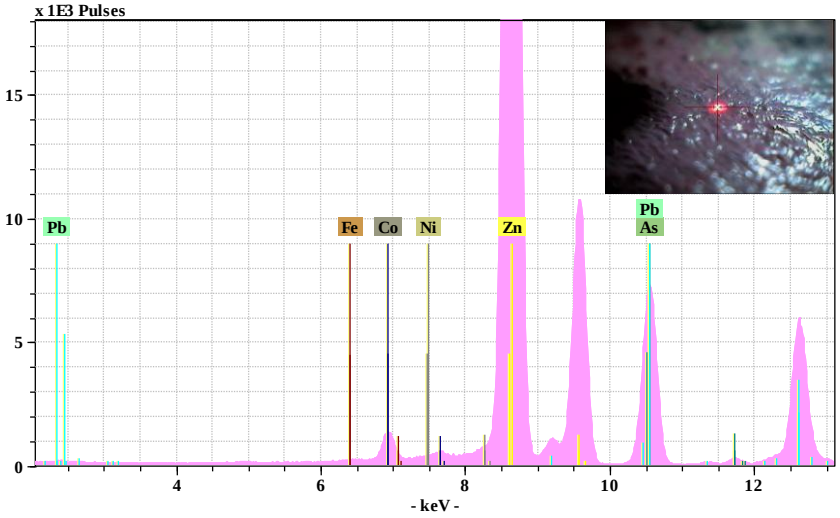
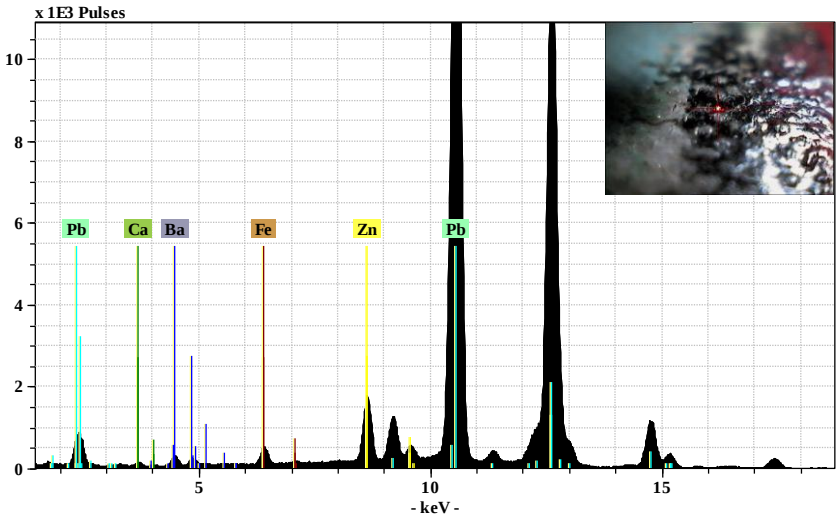
Sample	Color	Material Id	Image and Spectrum
10	Green (in leaf)	Chrome/veridian green Zinc white (Zn, Pb, Cr, Co, K, trace Cd, Fe)	
11	Blue/green (in plate)	Chrome/veridian green Lead white (Pb, Zn, Cr)	
12	Light blue/green (in plate)	Chrome/veridian green Zinc white (Zn, Pb, trace Co, Cr, Fe)	

Sample	Color	Material Id	Image and Spectrum
13	Blue (blue flower, middle tone, in plate)	Ultramarine blue Lead white (Pb, Zn, Fe trace Ca)	
14	Purple (purple/blue flower in plate)	Cobalt violet Lead white (Pb, As, Co, Ni, Zn)	
15	Dark blue (dark blue flower in plate)	Cobalt blue Lead white (Pb, Zn, Co, Fe, trace Mn, K, Ca, Si, Ti/Ba, Ni)	

Sample	Color	Material Id	Image and Spectrum
16	Bright purple (upper left flower in background)	Cobalt violet (Pb, As, Zn, Co, trace Ni)	
17	Bright blue (upper left flower, in background)	Cobalt blue Lead white (Pb, Co, Cr, Zn, Fe, trace K, Ca)	
18	Purple/red (central flower in background)	Vermillion Zinc white Lead white (Pb, Zn, Fe, Hg, Ca, Co, trace Ba/Ti)	

Sample	Color	Material Id	Image and Spectrum
19	Dark blue (dark blue flower in background)	Cobalt blue Lead white (Pb, Cr, Zn, Co, Fe, trace Ni)	
20	Green (in background next to geranium on the right)	Chrome/veridian green Lead white Zinc white (Pb, Zn, Cr)	
21	Light blue (in background)	Cobalt blue Lead white (Pb, Zn, Co, Cr)	

Sample	Color	Material Id	Image and Spectrum
22	Blue (flower on right, in background)	Cobalt blue Lead white (Pb, Co, Cr, Zn, Fe trace Ba, Ti)	
23	Green (stem in blue flower at right, in background)	Chrome/veridian green Lead white (Pb, Cr, Zn, Co, K, Cd, Fe, trace Ba/Ti)	
24	Pink (ribbon in background)	Hematite Zinc white (Zn, Pb, Fe)	

Sample	Color	Material Id	Image and Spectrum
25	Red (geranium)	Vermillion Zinc white (Zn, Hg, Pb, trace Ca, Fe, Co)	
26	Bright pink (in geranium)	Cobalt violet Zinc white (Zn, Pb, As, Co, trace Ni, Fe)	
27	Black (underdrawing)	Bone black (Pb, Zn, Fe, Ba, Ca)	

Sample	Color	Material Id	Image and Spectrum
28	Yellow/green	Chrome/veridian green Zinc white (Zn, Pb, Cr, Fe, Co, Ni Trace Ca)