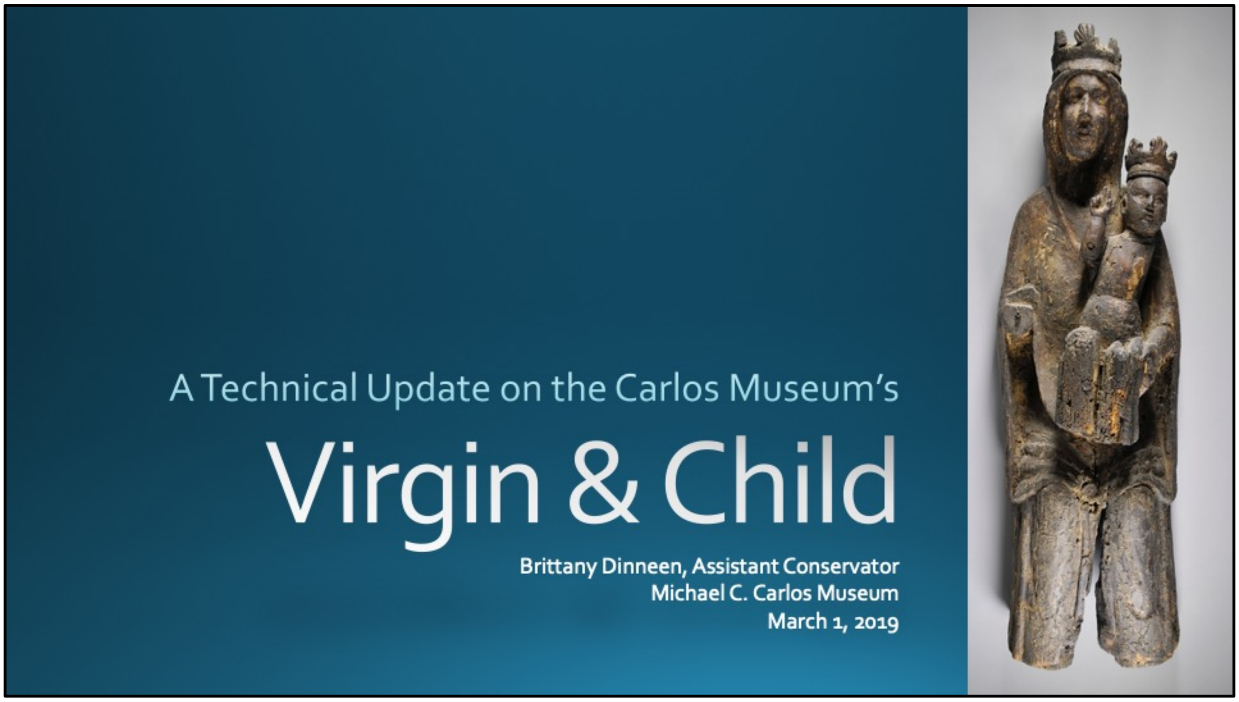


In 2015, the family of Thomas Lyman donated a Medieval wooden polychromed sculpture of the Virgin and Child to the Michael C. Carlos Museum. Prior to founding Emory's Art History department with two colleagues in 1977, Lyman had studied and lived in Paris with his family. At the time of the gift, Lyman's daughter recalled the sculpture in her father's house when she was a small girl and thought it might have been obtained from a Parisian art dealer. But beyond her recollections, no provenance survives. The Virgin & Child was thought to be of French origin, perhaps late 12th or early 13th century, based solely on stylistic attributes.

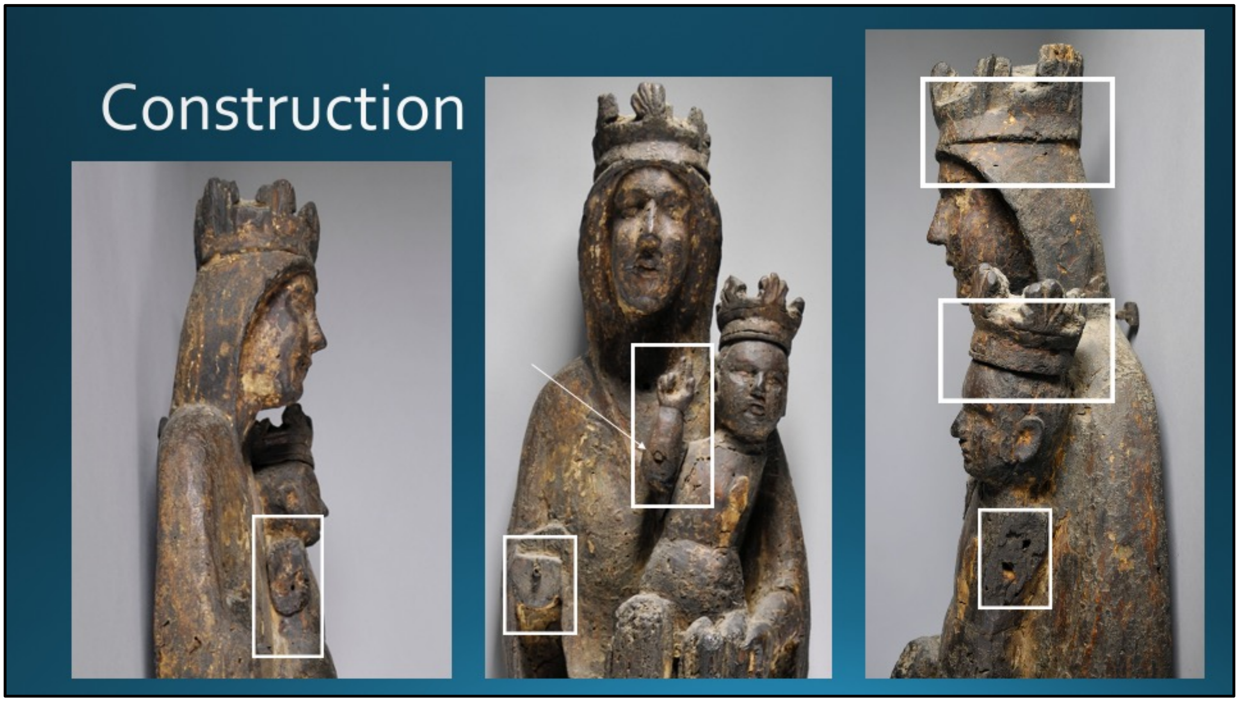
Background

Objectives

- Characterize and/or identify materials
  - Wood
  - Ground materials
  - Pigments
- Methods
  - Detailed visual analysis
  - Documentation
  - Microscopy
  - Instrumental analysis
- Reconstruct a representation of the polychromy

Nicole Corrigan, PhD Candidate in Art History, Emory University

As some of you may know, the museum has neither an official collection of medieval art, nor a curator of medieval art, but accepted the Virgin and Child to honor Lyman's contributions to the department, and Emory at large. Enter Emory PhD candidate and medieval art scholar Nicole Corrigan, who undertook a technical study of the Virgin and Child in partnership with Carlos conservators as a part of her Mellon Fellowship in Object-Based Curatorial Research. Our technical study combined a detailed visual analysis of the sculpture under both visible and ultraviolet light with microscopic and instrumental analytical techniques. Our goal was to characterize the wood, ground materials, and pigments present. Nicole wrote a paper detailing our methods and findings, which combined with her in-depth art historical analysis, helped us answer some of our research questions. She also traveled to Europe to investigate various comparanda, which ultimately resulted in a change in attribution to Northeastern Spain in the early 13th century.

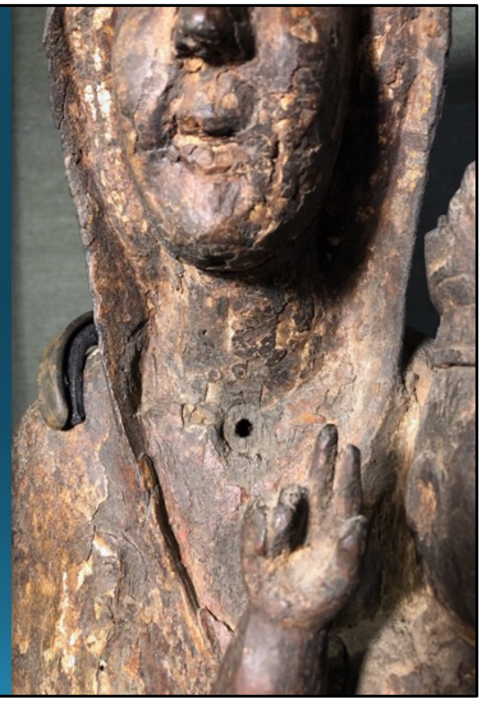


The sculpture is constructed almost entirely of one piece of wood. Exceptions to this are both the Virgin's and the Christ child's crowns, as well as his right shoulder and raised right arm. A front-facing perforation in Christ's right shoulder receives a dowel supporting the joint between the shoulder and raised arm. The arm arrived detached, but has since been re-joined with the dowel. The Virgin's right forearm has been lost, leaving behind a dowel that would have joined it to the body. Another piece that has evidently been lost is Christ's left arm. You can see two perforations that would likely have received dowels supporting the joint between Christ's shoulder and missing arm. How and what his arm would have held is not known with certainty, but a book would have been consistent with the Throne of Wisdom representation, as Nicole just described.

The USDA Forestry Products Lab analyzed a small chip we extracted from the rear, identifying the wood as a species of Poplar. Medieval wood sculpture was commonly carved from Poplar, which is a soft, lightweight, fine and uniform-grained hardwood. The tree is native to temperate areas in the Northern hemisphere.

Tool-marks visible in the rear show that it was roughly hollowed out, probably with a flat-headed adze, like that being used by the Medieval carpenter in the lefthand image, although narrower. The sculpture was hollowed out extensively in the drapery underneath the Virgin’s arms, as additional pieces of wood have been nailed over these gaps, apparently as reinforcement. The sculpture was not meant to be viewed in the round, and a metal hoop is affixed to the Virgin’s rear left neck supports Nicole’s assertion that the sculpture would have been hung.

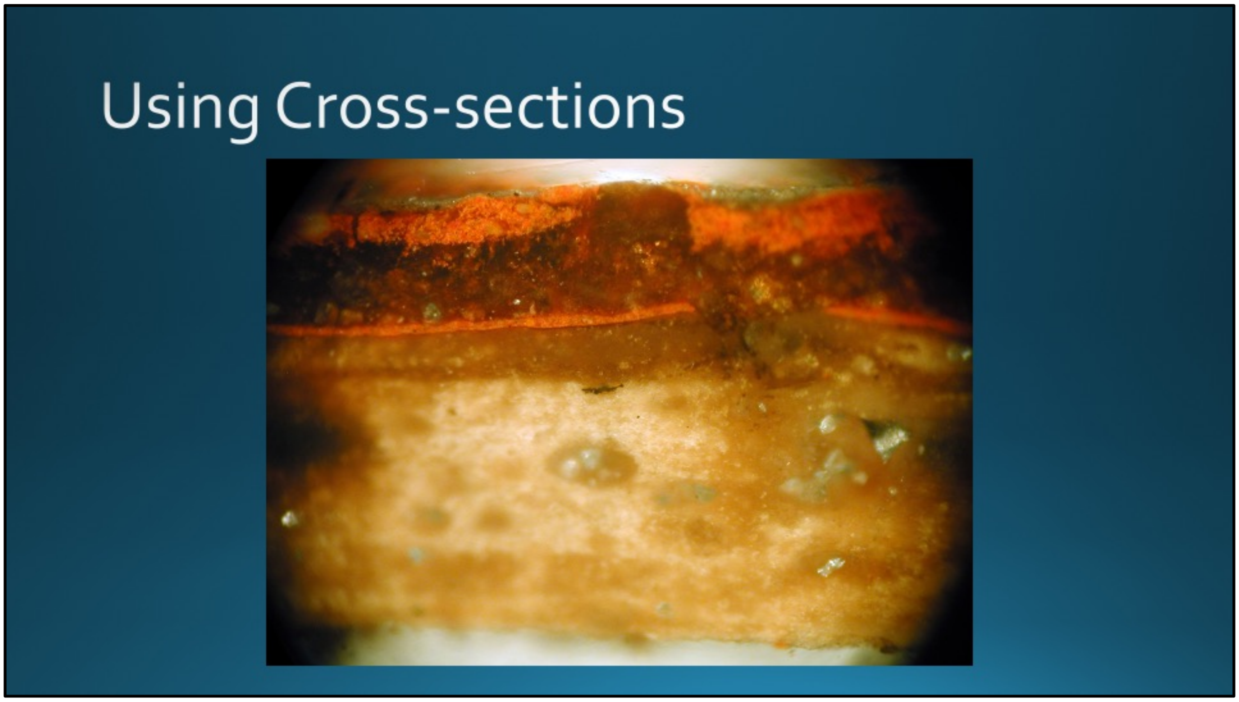
Brooch?



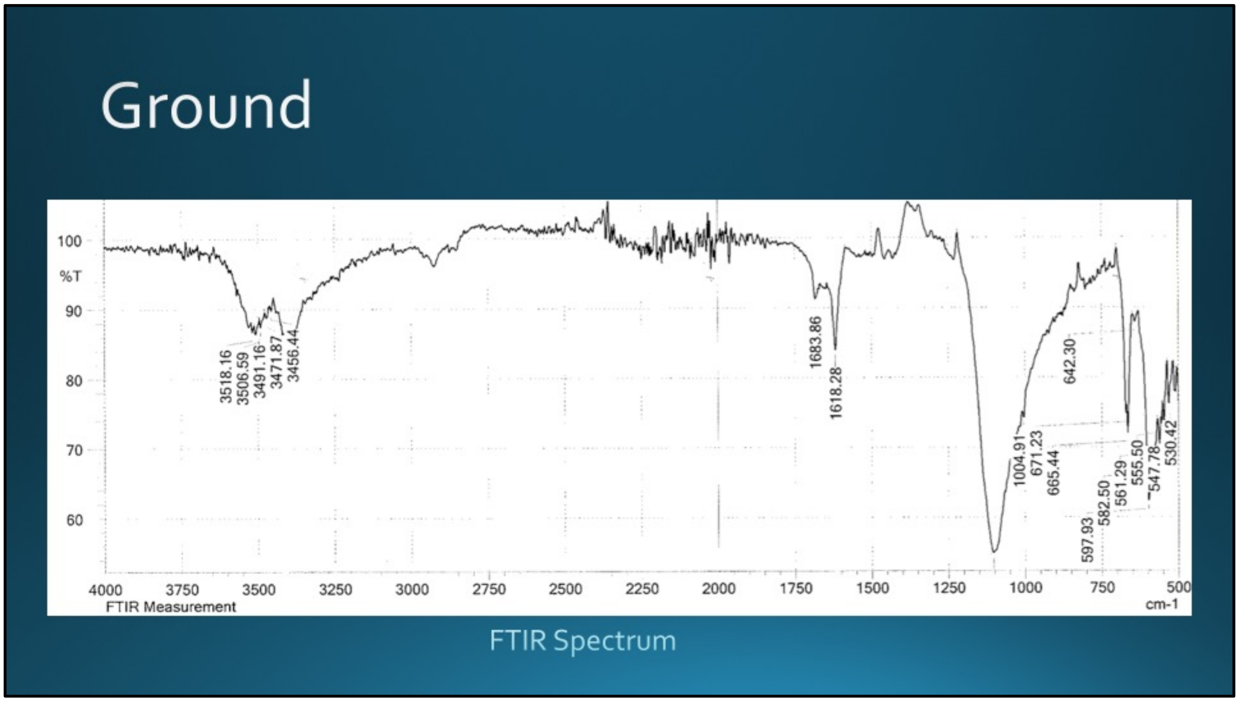
A hole drilled the base of the Virgin’s neck, above the neckline of her robe, suggests that something may have been attached, such as a brooch. To investigate this, we examined the sculpture under ultraviolet radiation, which often highlights differences in surface treatment that may not be apparent under visible light. The exam showed areas of absorption that looked like a dark patch compared to the surrounding wood, supporting the idea that there may once have been a metal attachment. We corroborated the difference in appearance with the use of an instrument called a handheld X-ray fluorescence spectrometer. When activated at the sample surface, the spectrometer emits a beam of very low-intensity x-rays. Over short period of time on the order of minutes, it detects the amount of energy fluoresced in response, characteristic energies which, again, are specific to a given element. The corresponding spectrum is then interpreted to determine which chemical elements are present. An advantage to this technique is that it is non-invasive and non-destructive, meaning we do not have to extract a sample from the surface. In our case, the spectrum showed a comparative increase in the signal for iron, compared to that of the wood, further supporting Nicole’s assertion that there may have been an iron brooch attachment.

The Virgin and Child sculpture has suffered significant losses especially in the crowns and bottom hems of the drapery. A vertical split runs up the center of the figure. This longitudinal cracking and smaller splits in the wood indicate that the sculpture has likely been exposed to prolonged shifts in relative humidity. You can see that it also hosted some wood-boring insects at one point in time; the exit holes have weakened the remaining wood where the insect activity was most present.

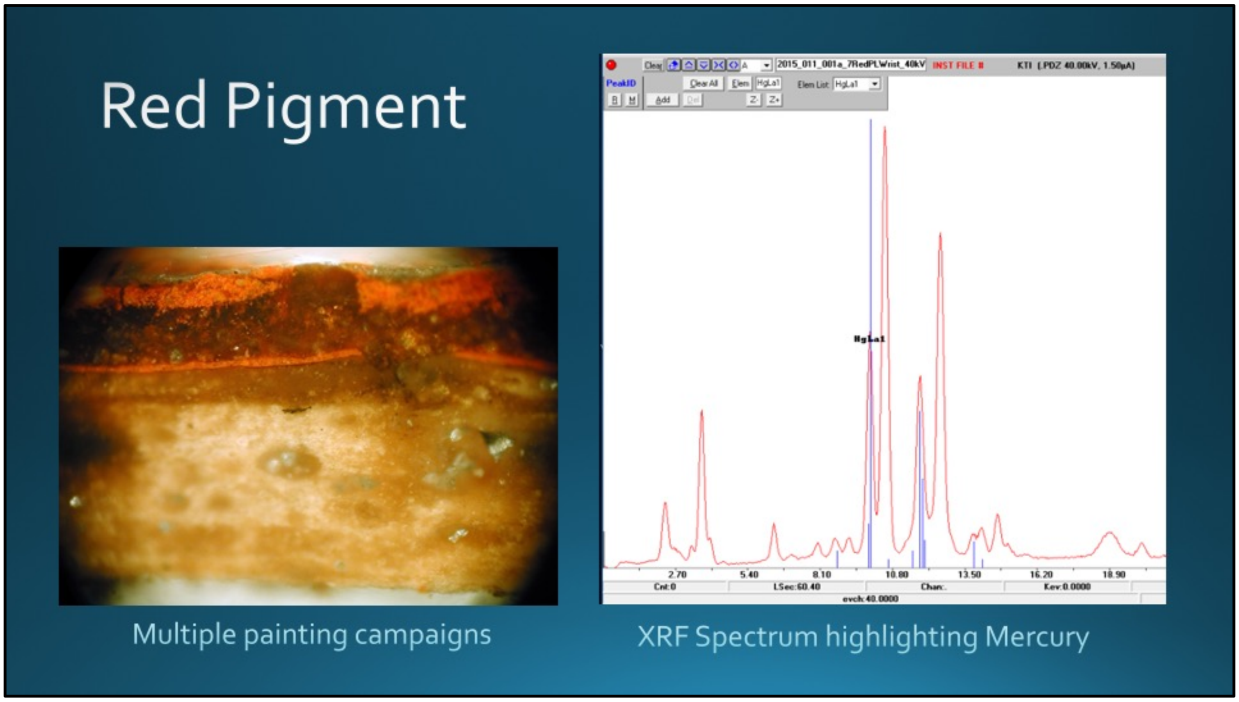
Of course, the most obvious loss, and the one that feels particularly devastating, is that of the polychromy. Small, isolated patches of color can still be seen along with slightly larger areas of exposed white ground. These patches of color are best glimpsed in more protected areas, like folds of drapery. You can see here patches of red and blue in the Virgin's robes, as well as some red on her lips. The overall surface appearance is dulled by a dark modern coating that has been liberally applied to the entire surface.



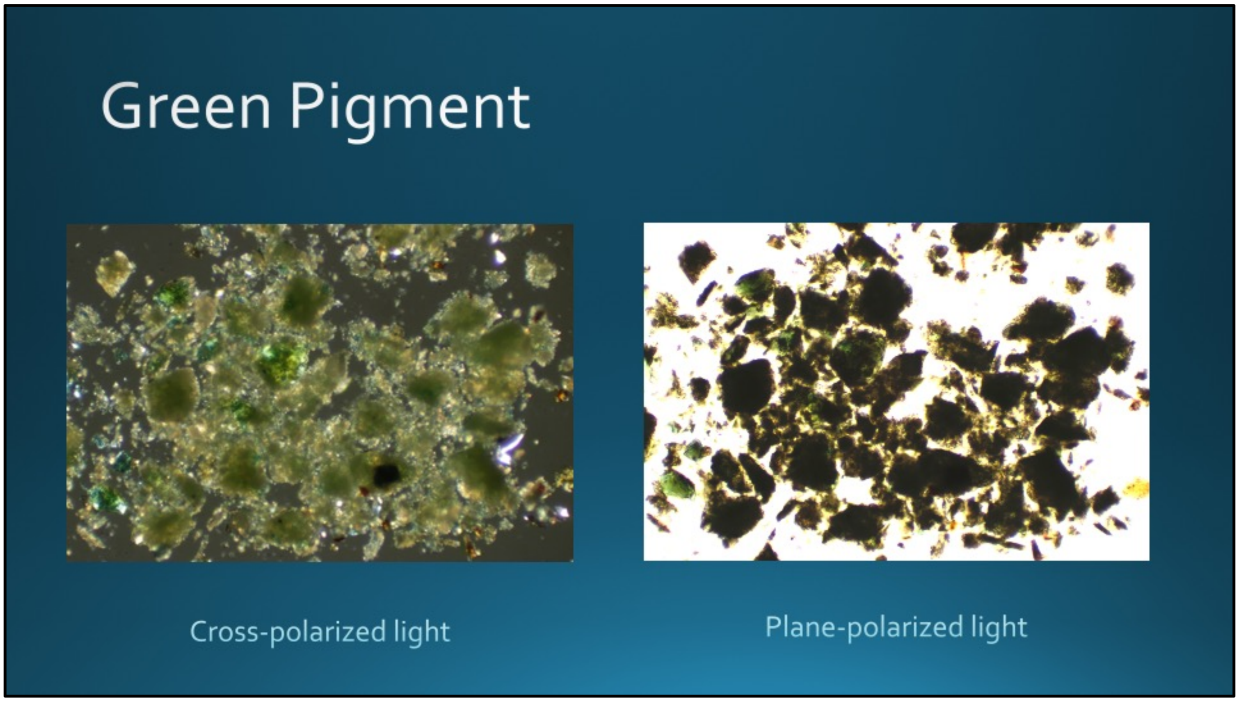
In order to help us examine the layered structure of the ground, paint, and coatings, we took three tiny cross-sections from inconspicuous areas along the edges of some of the paint islands. The cross-sections were then encased in a block of resin and cut and sanded to reveal the section's surface. In addition to the cross-sections, we took another set of dispersed samples of each color by scraping off a miniscule bit of paint with a small scalpel. I'll be sharing some of the images we captured through our microscope over the course of the presentation.



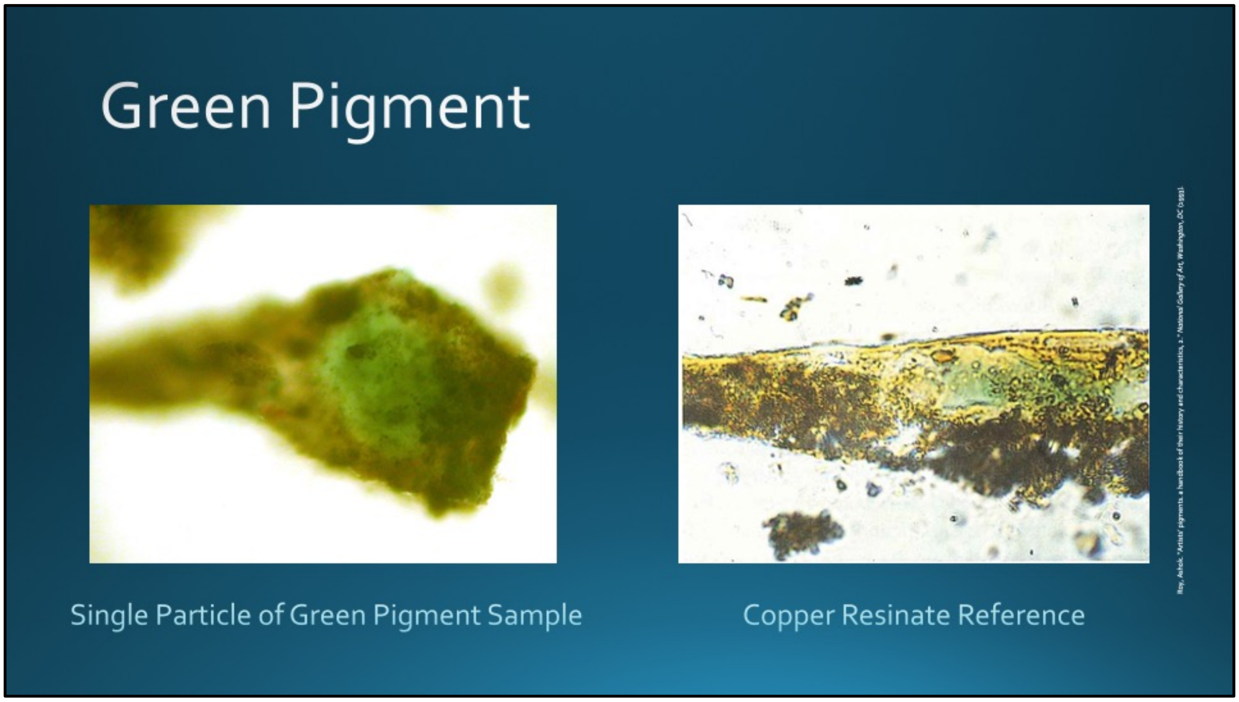
We'll start with the ground, which is a preparatory layer applied to the carved wood figure. Priming the color and the texture of the surface with a smooth, white layer promoted better adhesion of the paint. In Medieval wooden polychrome sculpture, the layer was typically comprised of calcium sulfate (gypsum), or calcium carbonate (chalk), mixed with animal glue. We analyzed a sample using Fourier Transform Infrared Radiation Spectroscopy, or FTIR, an instrument which emits a beam of infrared radiation at the sample and calculates how much energy it absorbs versus how much it transmits at successive wavelengths. The result is a fingerprint of sorts for the molecular bonds present. Keep in mind that these are mixed samples, but the spectrum shows characteristic IR absorption bands for sulfates at 1100 cm^{-1} along with two bands in the 3700 – 3200 cm^{-1} range, indicating a gypsum rather than chalk ground.



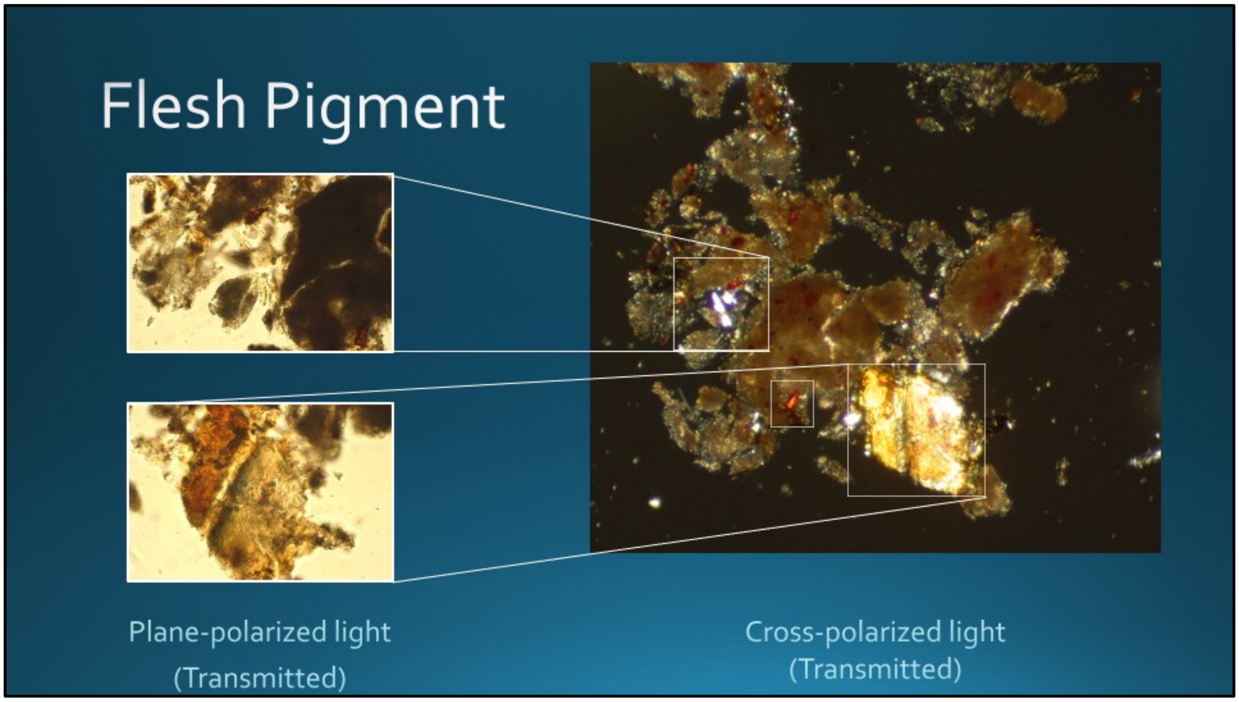
Another tool we used in the study was handheld X-ray fluorescence spectroscopy. This instrument focuses a beam of low-intensity x-rays at given substrate. The atomic structure of each element present, in turn, emits a signal at characteristic wavelengths that are then detected and displayed in a spectrum. Our spectrum shows us the unmistakable presence of mercury, in addition to other trace and secondary elements. In his early 12th century treatise *On Divers Art*, Theophilus discusses the use of cinnabar, or mercuric sulfide, as a red pigment in Medieval painting, even going so far as to explain how to react sulfur with mercury to manufacture the red colorant. The presence of mercuric sulfide, later referred to as vermilion, has been documented on numerous 12th century Medieval polychrome sculptures. In this particular cross-section, you can see two distinct layers of ground and red paint, which shows us that the sculpture was re-painted at least once. Overpaint is frequently seen on Medieval devotional sculpture, and we might suspect that owners, caretakers, and devotees would have been interested in preventing devotional images from looking decrepit and worn.



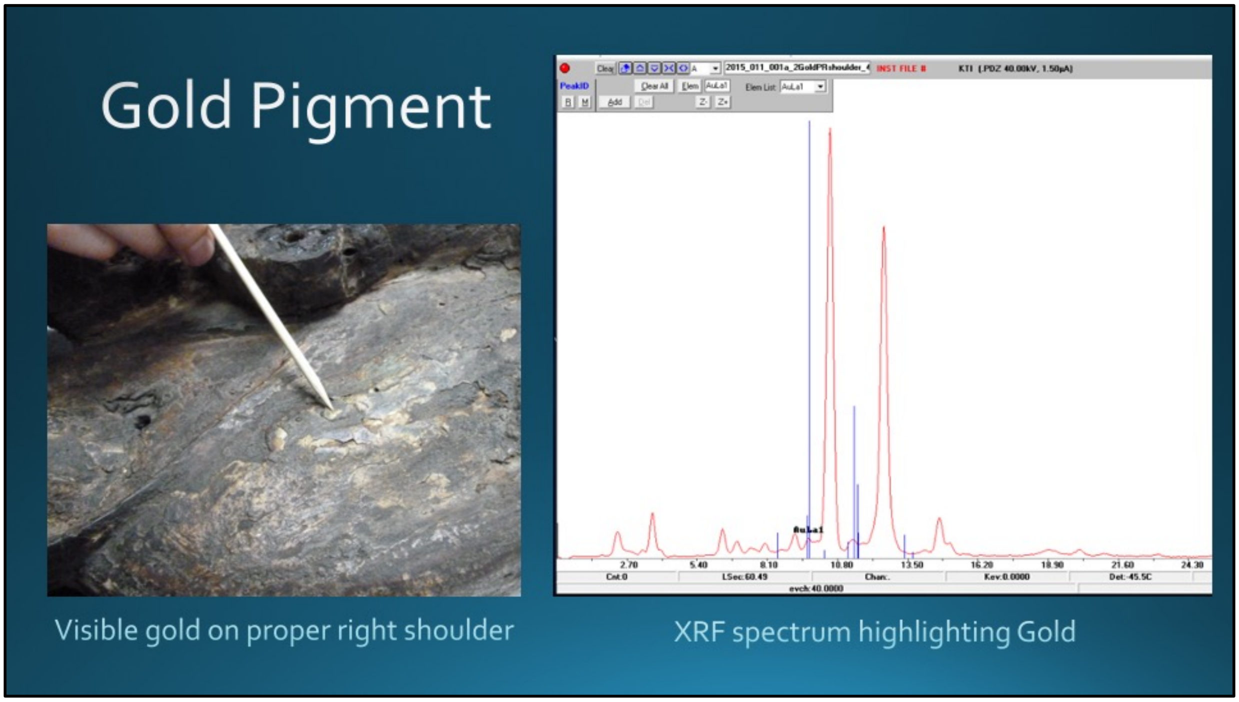
Christ's robes were inaccessible with the handheld XRF, so our analysis of the green paint relied strictly on examinations under polarized light microscopy (PLM). Examining a dispersed sample through transmitted light, as opposed to a cross-section under reflected light, allows us to manipulate the direction of the light wavelengths by crossing and uncrossing polarized light filters, in order to understand the crystallographic properties of the constituent pigment particles. The slightly blue-greenish shade, transparency, smeary nature of the colorant on large plate-like flakes accompanied by other small opaque clumps, and the way in which light is refracted through the materials when viewed through crossed polars gives us clues to the pigment's identity. Based on these observations, we can say with certainty that it is not an optical green created by a mixture of blue and yellow pigments.



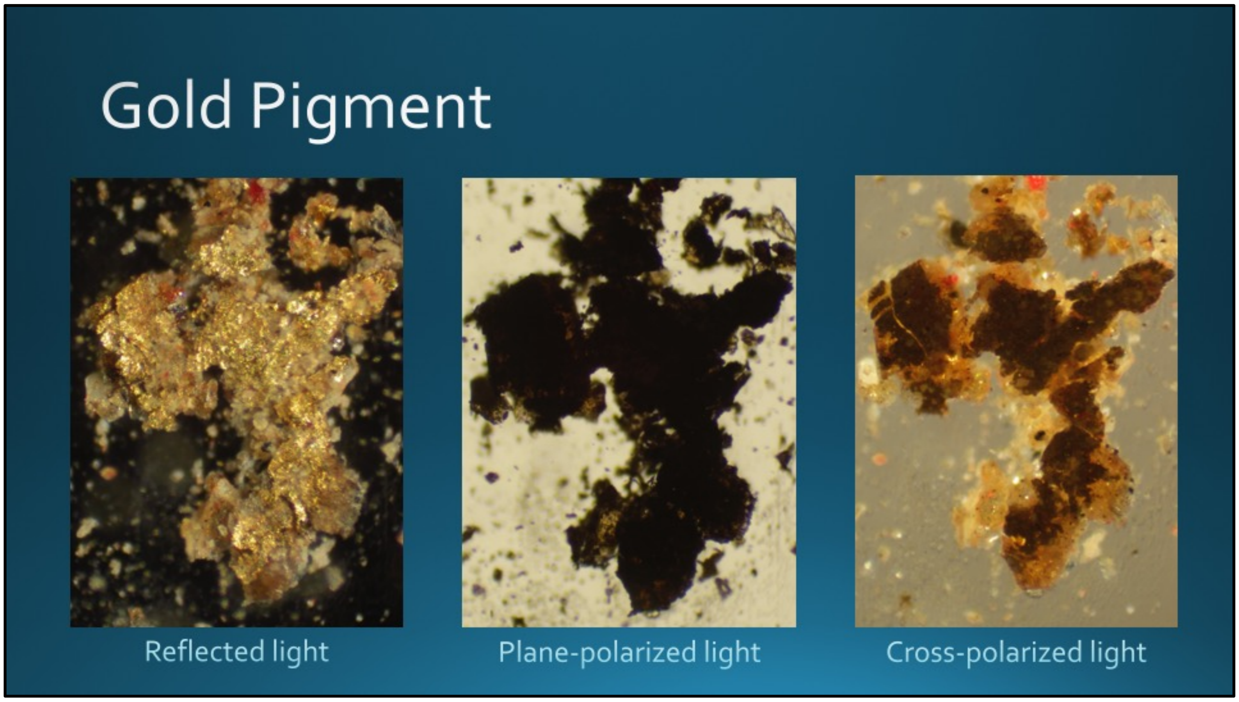
We can also eliminate other common Medieval green pigments described by Ceninni like terra-verte or earth greens and malachite which had an altogether different hue than that apparent here, and malachite, which has different optical properties under plane polarized light [lower RI than mounting medium, pleochroism]. The pigment on Christ's robe is likely a copper resinate, based on the presence of optically active fields of bluish-green on opaque, isotropic particles. Copper resinates, also misleadingly called copper green glazes, were manufactured by dissolving synthetically prepared mixed copper salts in Venice turpentine, balsam, or other resinous solution [Gettens & Stout, 1966]. Theophilus provides a specific set of instructions for preparing two types of mixed copper salts, Salt green and Spanish green. Both greens would be comprised primarily of copper acetates; some form of this copper salt mixture has been referred to as verdigris in historical texts as early as Vitruvius (First c. BC). [Eastaugh et al.2008]. According to Woudheysen-Keller (1995), proper dissolution of the salts in an oil or oil-resin "varnish," or binder, would have provided some degree of protection against oxidation and a resultant color shift.



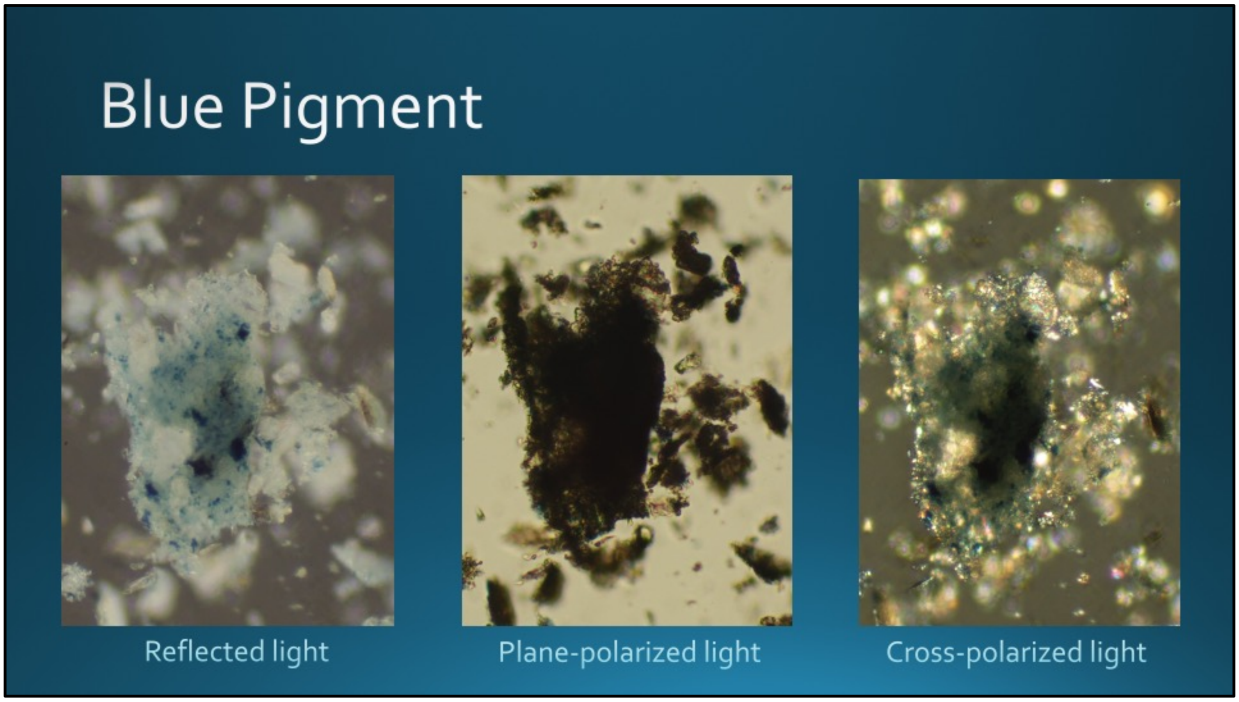
PLM also helped us resolve the identification of the flesh color components. Aside from the dark, isotropic, opaque fields that are probably the binder component, we can see at least three different types of particles. One is vermilion, as was identified on the red drapery. A second particle type is this small, transparent, colorless, prismatic particle with well-defined boundaries. A third type is this particle, which ranges in color from almost transparent yellow to brown-yellow, with a rough pitted surface. Both the transparent and yellow-brown particles exhibit high birefringence with interference colors when viewed under crossed polarized light. Based on these characteristics, lead carbonate hydroxide, or lead white, and lead oxide of the massicot type are excellent candidates. Their presence is consistent with Theophilus's description for making "flesh-colored paint," a combination of ceruse (or white lead), an altered yellowish-tan ceruse, and cinnabar.



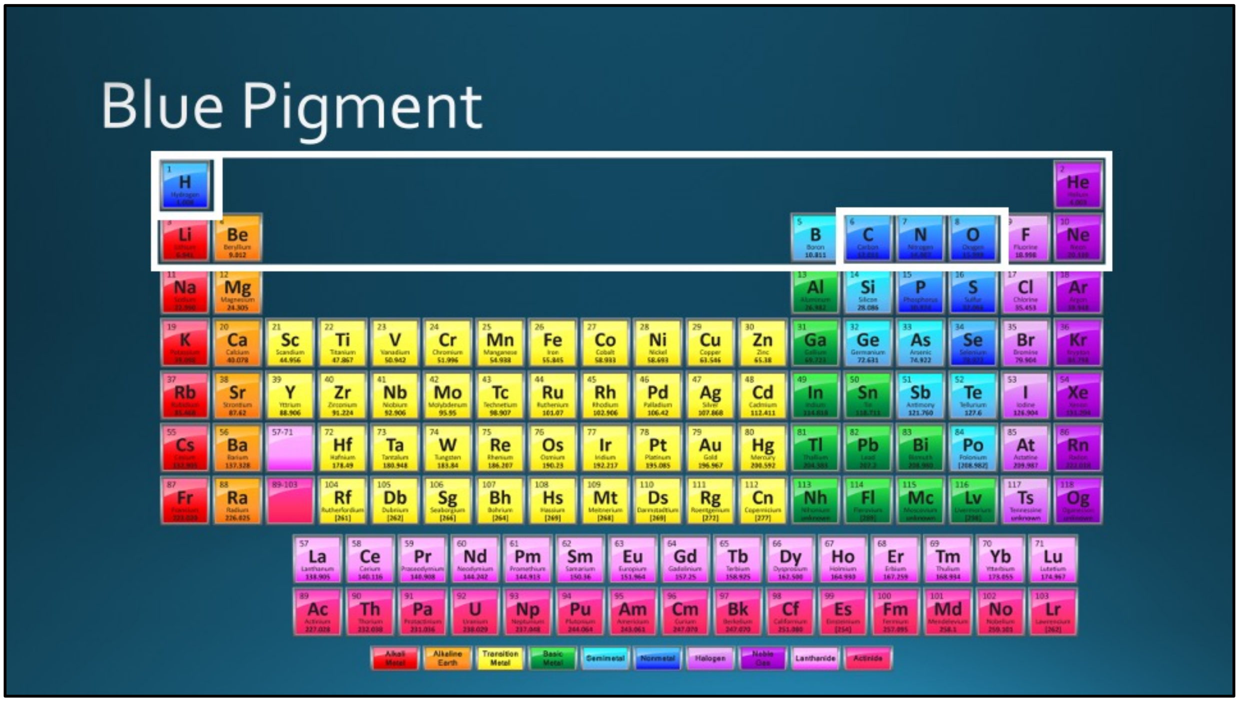
We also noted the presence of a lustrous yellow along the edges of the Virgin's mantle. The XRF spectrum showed a small, but unequivocal signal for gold. Theophilus describes the process of gilding with leaf over a layer of red bole, but he also describes milling gold to achieve a sort of powder that could be dispersed in a binder like any other pigment. So, too, does Thompson describe multiple application methods in his exhaustive study of Medieval painting materials and techniques.



Reflected light microscopy of the surface of a detached sample of the gold shows lustrous, yellow, flakey particles. With the transmitted light of PLM, however, the particles are completely opaque. Without a cross-section of the gold areas, however, it is difficult to determine the presence of bole underneath the gold. Evidence of bole would allow us to presume that the gold was applied as leaf, rather than as a powdered pigment dispersed in a binding medium.

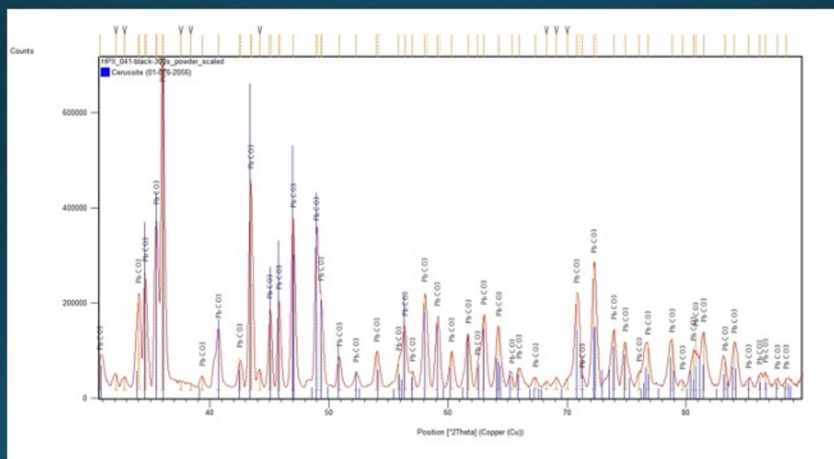


Identification of the blue colorant proved to be much more elusive. Examinations under microscopy in reflected light showed tiny blue particles on larger white fields. We could rule out a number of possible blue pigments based upon optical properties. Under plane polarized light, the blue particles appear dark and are thus isotropic. This means we can eliminate Azurite and Blue verditer. The Index of refraction is higher than the mounting medium, meaning we can also rule out Prussian blue, ultramarine, and cerulean blue.



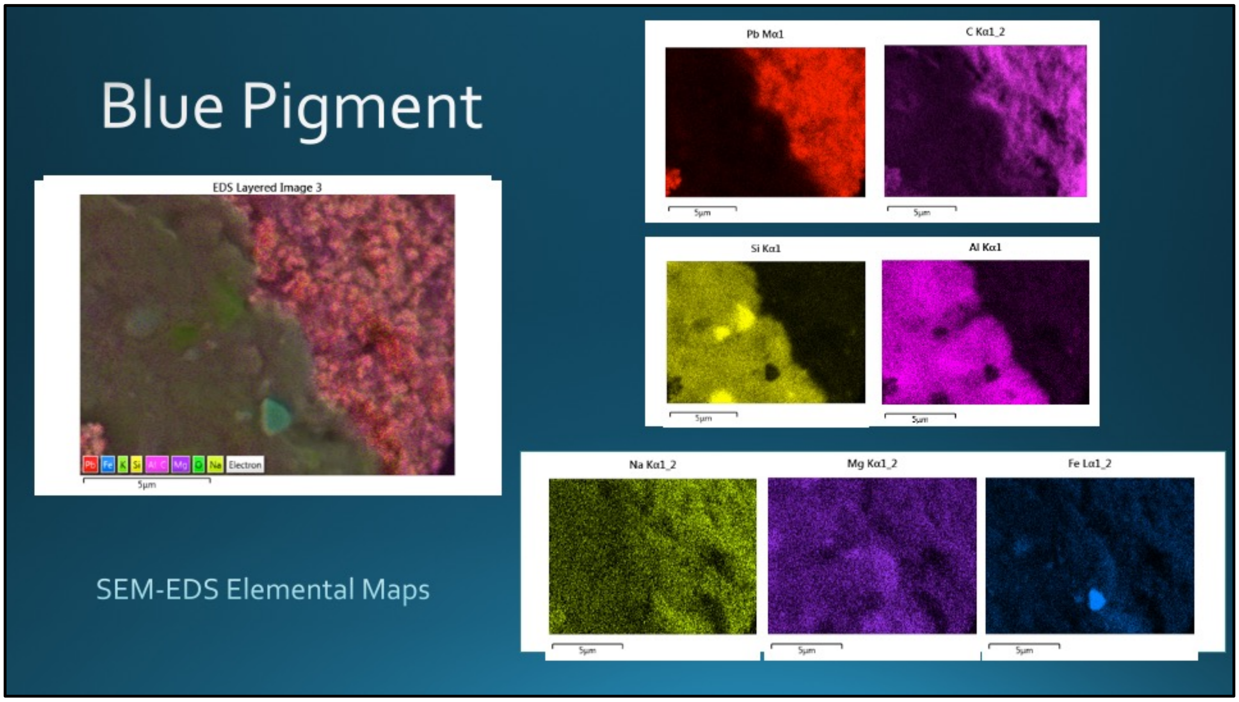
XRF analysis did not show any signals notably different than that of the ground, meaning that the major elements present in the blue pigment were likely all lower in mass than sodium. These lighter elements are undetectable by handheld XRF. So any organic blues comprised of carbon, hydrogen, oxygen, and nitrogen, including those that are manufactured by precipitation of a dye onto another particle, are undetectable with this instrument.

Blue Pigment



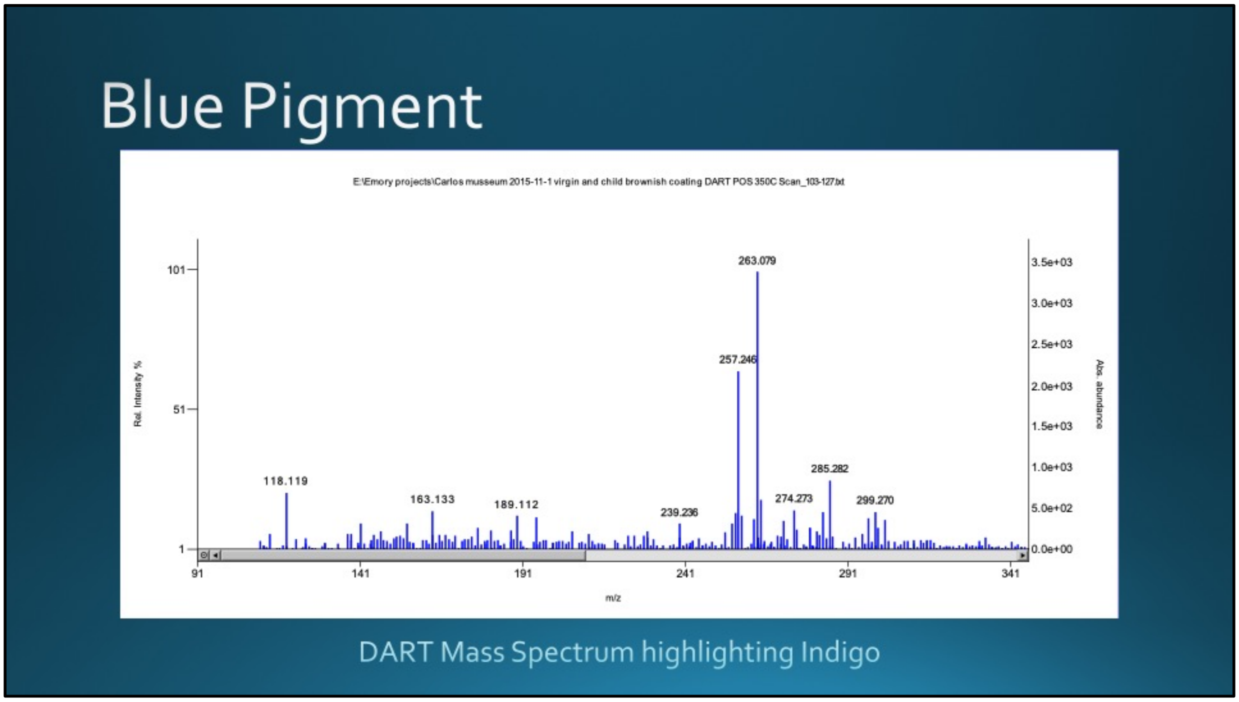
XRD spectrum highlighting Lead Carbonate (Lead white or cerussite)

We submitted a sample for analysis by x-ray diffraction (XRD), which emits a beam of x-rays at a single crystal, records the resultant pattern of diffracted rays, and uses software algorithms to provide potential matches. The pattern was almost entirely attributed to cerussite (the natural mineral form of lead carbonate, or lead white), suggesting that whatever was responsible for the blue was amorphous and not crystalline. It seems likely that the lead white was the basis for a precipitated blue. However, it is possible that the lead carbonate was mixed with the blue, used in the ground layer, and/ or added as a siccative in the paints or varnish layer. The evidence for an organic blue was mounting.



We sent a sample to the electron microscopy lab at the University of Georgia, which has a scanning electron microscope capable of incredibly high-resolution images on the micrometer scale, but more importantly for our purposes, can create elemental maps like this one with energy dispersive x-ray spectroscopy. The image is generated by a beam of electrons emitted at the sample, while a detector quantifies the signature elemental x-ray response of the constituent elements for identification. The elemental map produced here shows a clear presence of lead spatially associated with carbon, both of which are very localized, as well as oxygen. This lends further support to our XRD results. On the other side of the image, however, silicon and aluminum also share a very localized area, suggesting the presence of alumino-silicates. Calcium, sodium, magnesium, and iron were also detected.

Nicole's research showed the use of an alternative blue pigment used in 12th c. northeastern Spanish Romanesque frescoes, called aerinite. It is geologically rare and found in its natural form in only a handful of places on the planet, but one of those is the Spanish Pyrenees Mountains, specifically in the Huesca and Lerida provinces. Other references [Casa and Llopis 1992] consider that burnt aerinite gives the pigment a green-blue hue, and at least three frescoes utilizing aerinite as a green-blue pigment have been identified in Lerida and the nearby city of Zaragoza. Chemically, aerinite is an aluminosilicate with a carbonate group, a hydroxide group, and water, as well as calcium, sodium, two forms of iron, and magnesium. Based on the detection and spatial proximity of each these elements in the SEM-EDS results, we cannot rule out the presence of aerinite.



In an effort to exhaust all of our possibilities, we sent one final sample to Eastern Michigan University for analysis by DART (direct analysis in real-time) mass spectroscopy. This spectroscopic technique involves ionizing a low-molecular weight sample, that is, giving it a charge, then measures the masses of the constituent molecules. The mixture of molecular species will have a signature mass-based spectrum, to which reference spectra can be compared to aid with identification. Our sample showed an unmistakable match for the indigo dye, the largest, or base peak, of which is at 263.079. The indigo decomposition products indoxyl and aminobenzoic acid were detected, as well.

Our blue cross-section shows that there were at least two campaigns of blue paint: an earlier pigment that appears greenish-blue in reflected light, and a later application that features the much smaller dark blue particles in a white matrix. The heterogeneity of the repainted and recoated surface combined with the fact that only traces of paint remain, challenge our ability to conclusively identify all of the pigments. Combining the cross-section information with the results of our PLM, XRD, SEM-EDS, and DART-MS, we can say with certainty that some form of indigo was used at some point in the life of the sculpture, specifically the layer visible at the topmost surface of our sample. Our results suggest that the bottom-most paint layer could be aerinite, but follow-up analysis would be necessary to confirm this identification.

Identifying the pigments contributes much to our intellectual understanding of the sculpture's creation, even if we are left with lingering questions. However, we are ultimately interested in the aesthetic perception of the Virgin & Child as we consider how the sculpture might have been revered. We built a representative reconstruction of the polychromy through close examination and mapping of the paint islands on the surface of the sculpture. We present on the right a rendering of what we believe to have been the original polychromatic schema; hahed areas did not show any evidence of remaining paint, but are projected based on these and other comparanda explored by Nicole. We can now catch a glimpse of the glory that this Virgin & Child might have once conveyed for a devotee.

We can only speculate about how the Carlos Virgin & Child sculpture would have been perceived by the Medieval viewer. Knowing that the subject is undoubtedly religious, we can certainly infer some intent on the part of the artist was to invoke, inspire, and convey devotion. The Virgin & Child is valued for its sacred, historic, scientific, and at one time, aesthetic aspects. The technical study and conservation treatment of works of art demand that we consider their many values when making decisions about how and when to sample, analyze, clean, or reconstruct. Research in the name of any one of these values often informs the others, and indeed we have learned much about this Virgin & Child sculpture. As conservators and scholars, we must, however, continually balance our curiosity and our desire to intervene with respect and appreciation for the meaning given to the object by those who made and venerated it.

Thanks to:

- Renée Stein, Chief Conservator, Michael C. Carlos Museum
- Nicole Corrigan, PhD Candidate in Art History
- Jessica Betz Abel, Andrew W. Mellon Advanced Fellow in Object Conservation, Michael C. Carlos Museum
- Exhibition Co-Curators and Symposium Organizers Sarah Bogue, Kelin Michael, and Emma de Jong

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