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The Conservation Treatment and Scientific Analysis of an 18th-Century Armenian Prayer Scroll

INTRODUCTION

Armenian Christianity has a rich tradition of contemplative prayer and religious instruction. Over the centuries, the community developed forms of personal devotion to address the desire for protection from physical and metaphysical danger. Amulets and talismans with Christian themes abound (Maranci and Meyer 2016). The *hmayil* is a typical example of an Armenian talisman in the form of a scroll. It was believed to protect the bearer, whether traveler, invalid, or other faithful in need. Traditionally, a prayer scroll would include Armenian religious iconography, as well as prayers, magical formulas, stories of healing, prayers against sickness, and protection against spells (Badmagharian 2016; Nersessian 1987). Early examples of *hmayil* were manuscripts; however, with the advent of movable type, printed scrolls became common from the 17th century onward (Avdoyan 2012).

The Library of Congress's African and Middle Eastern Division is home to one of the U.S.'s most extensive collections of Armenian research materials, including three Armenian prayer scrolls. All three scrolls were printed in Constantinople at approximately the same time. Although they contain very similar text and woodcut images, the palettes used for hand-coloring differ greatly (figs. 1–3).

Over the past 16 years, all three Armenian prayer scrolls have been treated by conservators at the Library of Congress. Since the initial condition of the scrolls upon accession varied considerably, an individual treatment approach was taken for each one. Hmayil Number 1 arrived in somewhat fragmented condition, and was reinforced, mended, and rehoused as separate panels following the original sequence. Hmayil Number 2 was in good condition and is still preserved in its original scroll format. This paper focuses on the recent conservation treatment of Hmayil Number 3, which was accessioned in severely compromised condition. The project was a collaborative one between book and paper conservators along with the Armenian specialist at the Library of Congress.

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DESCRIPTION

Acquired by the Library of Congress in 2012, Hmayil Number 3 was a gift from Michaux Burchard. It was printed in Constantinople in 1729, a time when these types of scrolls were very popular and readily available for purchase (Maranci and Meyer 2016). The text was printed, using movable Armenian type, by Astuatusatur Konstandupolsets'l, whose family had operated a printing house for 150 years (Sanjian 2012). The text appears as a single column running the length of the scroll, interspersed with woodcut illustrations of biblical stories and characters.

In its original form, the scroll would have been approximately 457 cm (15 ft.) long (fig. 4). More than 17 lengths of paper, each approximately 8.5-cm wide and 40-cm long, were glued together end to end. The scroll was printed on medium weight, cream-colored, handmade laid paper. Three different watermarks were identified, including several versions of the Tre Lune, a watermark with three crescent moons set side by side, often found in Venetian papers from the early 1700s made for Turkish export (fig. 5) (Ahmed 2016).

Like many other *hmayil*, Number 3 comprises a series of prayers, Gospel readings, and sermons. The text of the scroll is in classical Armenian, a written language in use from the 5th to the 19th centuries (Badmagharian 2016). In addition, as was customary, personal inscriptions in black ink were added to the printed text.

The decoration and iconography is also similar to that of traditional handwritten Armenian prayer scrolls, and is characterized by zoomorphic initials, side frames, and vignettes. Though incomplete in its present condition, the scroll has at least 30 illustrations of different provenance, most of which are signed "ԳՐ" (GR), the initials of Armenian artist and printer Grigor Marzuanetsi. In accordance with contemporary practice, Marzuanetsi used woodblock prints that were not his original works (Kouymjian 2015). For instance, the illustration "Tree of Life," which can be seen at the beginning of the scroll, was copied directly from the work of Christoffel van Sichem II, a well-known 17th-century Dutch artist whose woodcuts were used in the popular Dutch language Biblia Sacra. Marzuanetsi substituted his own initials, "GR,"

Fig. 1. Woodcut image from Hmayil Number 1, Constantinople, ca. 1725.

Fig. 3. Woodcut image from Hmayil Number 3, Constantinople, 1729.

Fig. 2. Woodcut image from Hmayil Number 2, Constantinople, ca. 1725.

Fig. 4. Hmayil Number 3 before treatment.

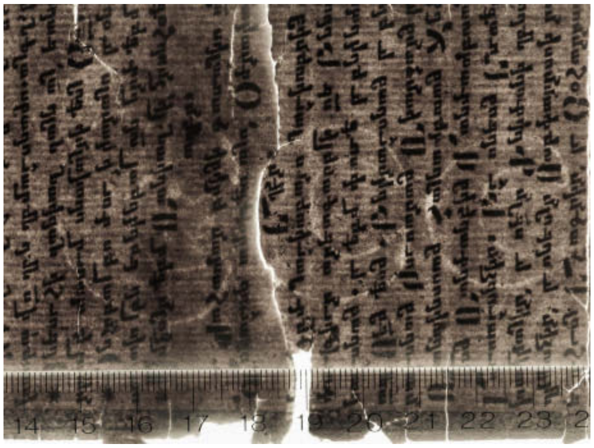

Fig. 5. Printed paper with Tre Lune watermark shown in transmitted light.

Fig. 7. The Tree of Life, Christoffel van Sichem II, The Morgan Library & Museum, PML 126380, p. 513. Note the monogram "CvS" in the lower left corner.

for van Sichem's "cVs" (figs. 6 and 7). All illustrations in the scroll were hand-colored, using shades of orange, red, green, pale brown, and yellow watercolor, and a metallic pigment.

CONDITION

Hmayil often suffer deterioration in serving their intended function, and Hmayil Number 3 was no exception. Many attempts to repair separating parts, using pieces of heavier weight laid paper, layers of coarsely woven cloth, and silk linings were apparent on Hmayil Number 3. During the treatment it became clear that paper patches were used at an early stage of the scroll's life, both because they were underneath the first fabric lining, and because many of the repair papers contained Tre Lune watermarks. Some repair papers also had drawings and inscriptions in various languages. Due to three centuries of unrolling and rolling, poor storage conditions and crude repairs, some text and imagery from the scroll had been lost.

Fig. 6. The Tree of Life, Grigor Marzuanetsi, Hymail Number 3 after treatment. Note the initials "ԳՐ" (GR) in the lower left corner.

When acquired by the library, the scroll was in 14 broken fragments of varying lengths, accompanied by a boxful of small "puzzle" pieces. The paper was very dirty and darkened overall, with considerable localized staining, especially along the edges. Medium to dark brown liquid stains appeared throughout the scroll. Amorphous black stains similar to mold damage were present throughout, particularly on the fabric backings. Intermittent, whitish, crumbly accretions were present on the surface of both text and illustrations.

Fig. 8. Section 7 before treatment, showing paper losses, creases, and tears through the image and text.

The paper was very worn, brittle, stiff, and full of breaks and tears. Numerous losses compromised the scroll's integrity (fig. 8). Across the width of the scroll, multiple repairs were stitched in blue, red, or undyed thread to reattach fragments—often in the wrong places (fig. 9).

On the verso, two layers of cloth linings once held sections together, but they no longer functioned well as backings. The crude wheat paste used to attach the paper patches and cloth linings had deteriorated significantly, contributing to the inflexibility of the scroll. The cloths had darkened with age, transferring discoloration to the scroll. The paper was delaminating from the linings. The scroll was severely tented and broken up, with numerous fragments folded back upon themselves or detaching.

The hand-coloring had changed considerably with age in some instances. While the oranges and reds were still vibrant, the yellow and brown colors appeared somewhat faded. The green colorant had sunk into the paper, turning it brown on the verso, in the manner of copper-containing pigments. Most areas of the metallic halos had darkened and lost their shine. Some particles had changed into black specks.

TREATMENT

When it arrived in the Conservation Division, the Hmayil Number 3 scroll was so fragile that it could not be served to researchers, or even handled for cataloging. Extensive

Fig. 9. Details of stitched repairs: (a) stitched repair in red thread, (b) stitched repair in undyed thread, and (c) two different images stitched together.

treatment was needed to enable access and for long-term preservation. Two senior conservators developed a phased approach to the project, but with the help and energy of two advanced conservation interns, the multiple steps required for conserving and mounting the scroll were completed within three months.

A number of decisions were required before practical work could commence. Given the size of the object and the labor-intensive treatment, a numbering system and a treatment protocol sequence were developed to make sure all the fragments and sections of the scroll could be tracked and would receive the same treatment.

After the condition and structure had been thoroughly documented, the cloth backings and stitching were removed mechanically and retained. Some well adhered paper repairs on the verso of the scroll remained in place at this stage. Local humidification with a steam pencil was used to facilitate opening creased fragments and smoothing curled edges. A soft brush and additive-free polyurethane sponges were used to reduce heavy accumulations of surface dirt and desiccated wheat paste.

WASHING

The solubility of all colorants was tested with deionized water, a mixture of 50% deionized water and 50% ethanol, and 100% ethanol. Testing demonstrated that the colorants were not immediately soluble in either water or ethanol, but immersion was not considered due to their slight friability. Capillary washing was selected to control the washing of the brittle, fragmented paper. Tek Wipe was chosen for its strong vertical capillary action and its ability to support small fragments during wet treatment (Molina and Hughes 2016). Since it can be rinsed and reused repeatedly, it was also a sustainable choice.

Following humidification in a Gore-Tex sandwich for about 30 minutes, fragments were washed face-up on a capillary unit of two Tek Wipe supports, using deionized water adjusted with a saturated calcium hydroxide solution to pH 7.5. Tek Wipe supports were changed three to four times, until no further discoloration emerged.

During each washing step, a dry sheet of Tek Wipe was placed directly on the fragments to draw out soluble discoloration from the front. Following the final wash, while the paper was still damp, paper seams were separated and remaining brown paper patches and residual adhesive on the verso were removed mechanically. Many of the paper patches were retained as historical components in the final housing of the scroll.

RECONSTRUCTION

After all the fragments had been washed, they were arranged according to the locations where they were first found, but placement of the large number of detached or misaligned fragments remained a challenge. Comparison of the scroll to the library's other two Armenian prayer scrolls proved a useful tool for assembly; many similarities in sequence were observed. In Hmayil Number 3, 27 of 30 images appeared to be better preserved in Number 1 or 2. A test tracing on polyester film demonstrated that the images were of identical size and detail, suggesting they were probably printed using the same woodblocks. Therefore, the two intact scrolls were used as references for piecing together the image puzzles of the third scroll (fig. 10). Despite the woodblock print similarities, Hmayil Number 1 and 2 were less useful in reassembling the fragmented text of Number 3. For these areas, pieces were realigned according to the edges of the paper, and with help from Tamara Ohanyan, a senior book conservator and Armenian language specialist at the Library of Congress.

PRIMARY LINING

Small groups of fragments of the scroll were assembled with a preliminary lining of lightweight kozo paper to provide a

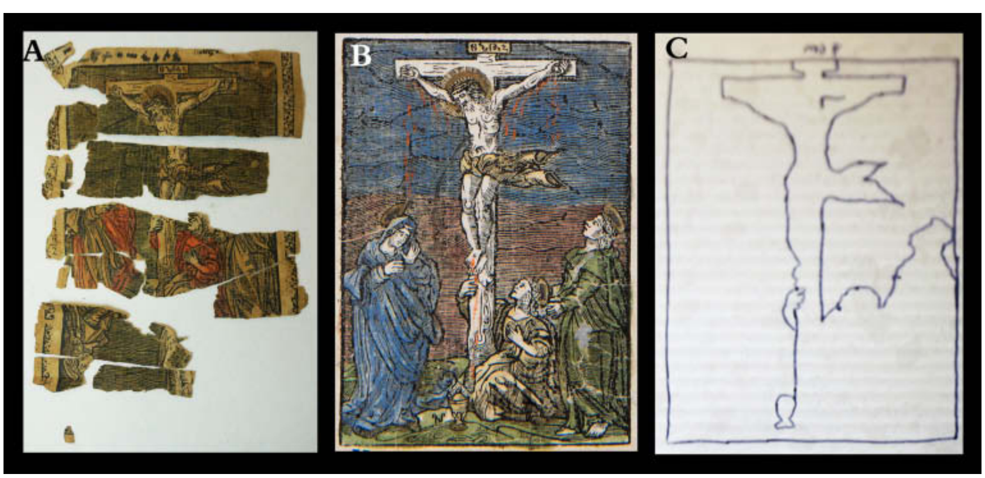

Fig. 10. Reconstruction of the fragmented image of the Crucifixion: (a) during treatment, photograph showing the fragmented condition of the Crucifixion, (b) a complete image of the Crucifixion scene in Hmayil Number 2, and (c) a tracing of the image on a piece of polyester film.

clearer interpretation of the final sequence of images and text pieces. Polyester film tracings of images from the other two scrolls were again important tools, making it possible to create accurate spacing in instances of substantial loss.

Prior to application of the first lining, fragments were humidified in Gore-Tex sandwiches. With the help of prepared tracings, they were transferred and aligned face-down on silicon-release polyester film over a light box. Strips of rayon paper[1] cut along the same grain direction as the scroll paper were placed along all four borders of the assembled fragments on the polyester film. A lightweight lining of RK1 paper was applied with dilute wheat starch paste to the assembled fragments, bordered with rayon paper. The lined assembly was placed between polyester web and thick felts to dry, with no weight on top. Use of the rayon paper strips reduced lateral shrinkage and ensured that the linings would dry flat (figs. 11 and 12).

To prepare the RK1 paper for use as the first lining and to impart an alkaline reserve, the RK1 paper was misted with a magnesium bicarbonate solution and allowed to dry. Research conducted at the library has indicated that magnesium bicarbonate can provide a moderate protective effect to counteract copper-green pigment degradation of paper.

SECONDARY LINING

On a scroll with less damage, losses might be filled individually with toned papers of similar thickness and weight, both to reestablish aesthetic unity and to achieve more consistent tension in the laminate structure. For Hmayil Number 3, the deterioration of the scroll as well as the large number of losses argued against individual fills. After discussion with the library's Armenian specialist, conservators decided to compensate for all losses with a uniformly toned second lining. Where the size of large losses could be determined accurately from the aforementioned tracings taken from Hmayil 1 and 2, spaces would be maintained in the reconstructed sequence of

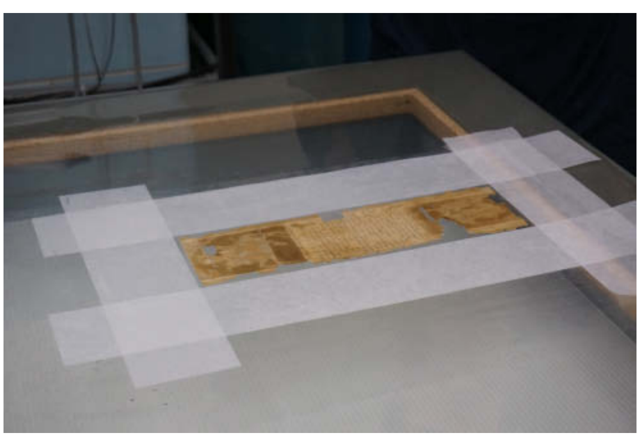

Fig. 11. Positioning four strips of rayon paper around the edges of the fragment.

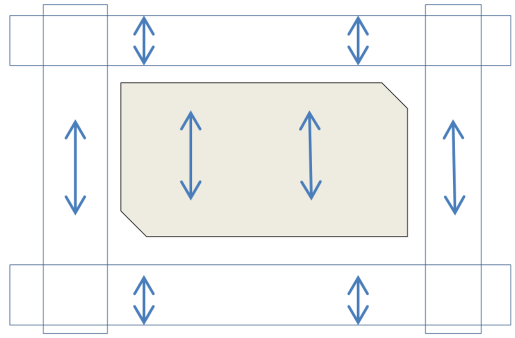

Fig. 12. Diagram showing the grain direction of the scroll fragment and the strips of rayon paper.

the text and images. It was also decided that Hmayil Number 3 would be mounted and housed flat, to help prevent future delamination of the scroll from its linings.

In preparation for the second lining, the scroll's original paper sections were identified during backing removal by overlaps in the papers and comparison to the other scrolls. A total of 17 sections were identified, some more complete than others (fig. 13). The small fragments lined with RK1 were joined together to reconstruct the original 17 sections.

For the secondary lining, a medium weight, handmade kozo tissue was chosen. Uda-gami has expansion characteristics and a laid finish similar to the paper of the scroll. It contains an alkaline buffer of Japanese clay, hakudo, which gives it a degree of opacity that is desirable for use as a fill paper. Uda-gami is also produced in a long format, well suited to the grain direction of the Armenian scroll paper. The dimensions of the secondary lining paper were determined by measuring a reassembled section. Aligning the Japanese fiber direction parallel to the grain direction of the scroll minimized curling upon drying (Nielsen and Priest 1997). To reduce the visual distraction of numerous losses, the lining paper was lightly toned on one side with acrylic paint applied by airbrush. As with the primary linings, the toned, secondary lining paper was sprayed on the verso with magnesium bicarbonate solution and left to air dry before use.

The fragment assemblies lined with RK1 were humidified and joined together face up to form the 17 original sections identified during backing removal. The RK1 lining margin along the bottom of the top fragment was retained, whilst the excess RK1 at the top of the adjoining fragment below was trimmed (fig. 14). For each assembly of RK1-lined fragments, the retained bottom margin was pasted out with dilute wheat starch paste, and the adjoining fragment positioned on the overlap and adhered into place.

Prior to application of the secondary lining, the assembled, humidified individual sections were placed face down onto a sheet of silicone-release polyester film with strips of moistened rayon paper along the sides, following the procedure

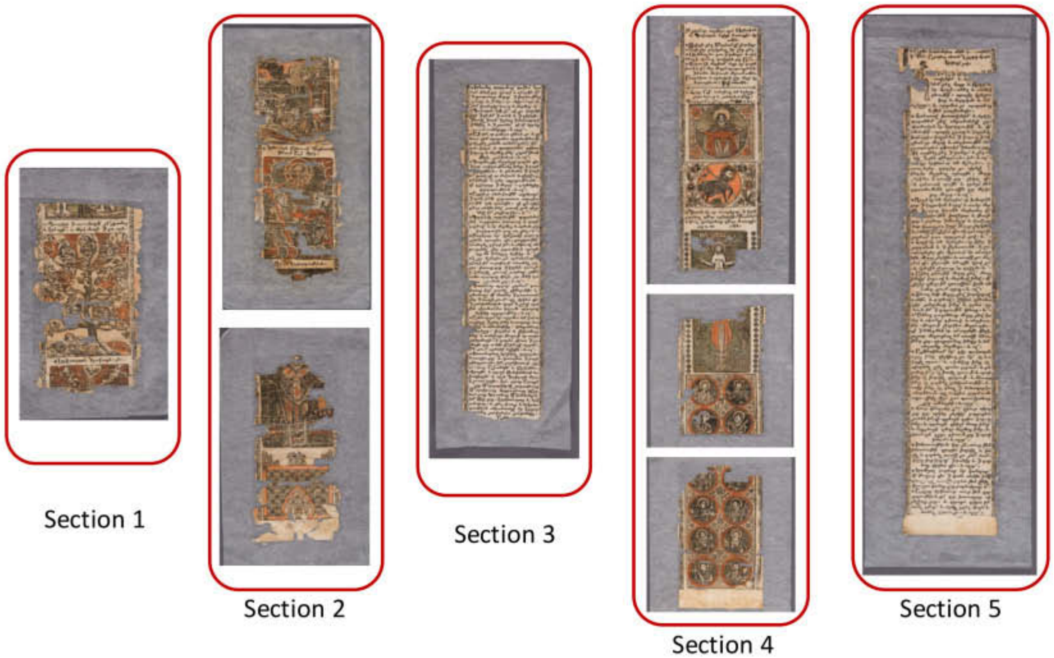

Fig. 13. Diagram showing the arrangement of the first five sections.

outlined for the first lining process. Dilute wheat starch paste was applied to the uda-gami paper which had been placed on a blotter to absorb excess moisture. The pasted lining paper was lifted on a stick and laid down at an angle onto the humidified assembled sections and brushed into place with a Japanese smoothing brush. Further melding of the secondary lining with the sections below was done by gently tapping with the ends of the Japanese smoothing brush bristles through a sheet of polyester web. At this stage, the uda-gami paper was pressed into the voids of the scroll losses from the back with a bone folder, to level the layers of the backing and original plane when seen from the front. The lined sections were sandwiched between polyester web and pressed between felts, weighted lightly with an acrylic sheet. When the lined sections were dry, the rayon strips were removed and the excess lining paper was trimmed.

A total of 42 linings was undertaken to both group the fragments together and to form cohesive images or segments of text into sections. After the final drying, a few of the linings had slight undulations along the edges, perhaps due to slightly imprecise positioning of the rayon paper. To reduce these undulations, the sections were humidified in Gore-Tex and friction dried between lightly moistened kozo paper of similar thickness, matching the grain direction of the scroll, brushing the layers of paper together, and drying them again between thick felts weighted lightly with an acrylic sheet (fig. 15).

REHOUSING

While the scroll sections are now stable, have an attractive appearance, and can be handled with care, they do not have the structural integrity to function again in a rolled format. As the Library of Congress Armenian Collections include a similar prayer scroll in its original rolled format, it was decided that the sections of Hmayil Number 3 would be mounted in custom-cut window mats, three sections per mat. The

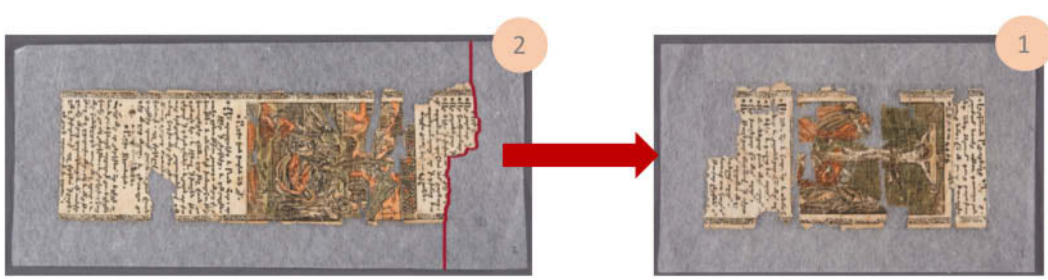

Fig. 14. Joining together the smaller lined fragments.

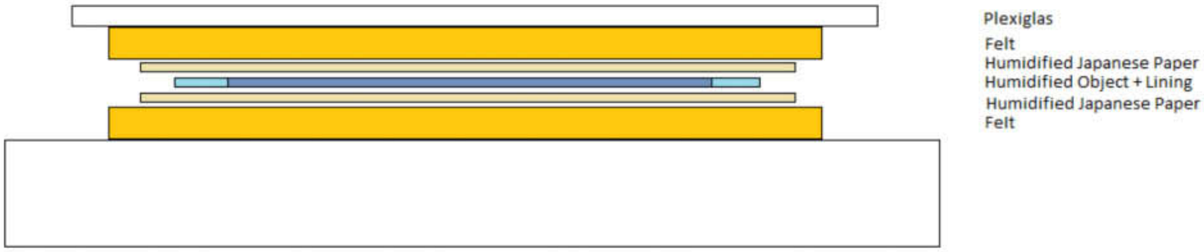

Fig. 15. Diagram showing the drying set up for the friction-drying stack.

mounting would allow for research use and facilitate digital reproduction. Three different mounting options were prepared for consideration, as seen in figure 16. The Armenian specialist and the conservators jointly chose the third option as the mounting template, because it shows the original sequence of the scroll while allowing readers to imagine areas that are missing.

Lined sections were placed into archival window mats made from museum mounting board and secured with small "half-moons" of polyester film adhered to the mounting boards with double-sided tape. This attachment allows easy mechanical removal of the sections. To protect the surface of the scroll and prevent the sections from lifting along with the window mats, a sheet of polyester film was placed within each mat and attached to the back mat with transparent tape along the upper edge. The lower edge of each polyester sheet was tucked into a channel of polyester film attached to the back mat.

The mounted sections, the historical components, and all the old repair materials were housed together in a custom box of archival corrugated board that is light enough to easily transport from shelf to reading room (fig. 17).

SCIENTIFIC ANALYSIS

Historical Armenian artists' materials and methods remain an area of interest in the cultural heritage community at large, and an area of research at the Library of Congress. As mentioned earlier, the individual palettes used to color the images of the three scrolls differ greatly. The completion of treatment of the three scrolls presented an opportunity for analysis to identify and compare the colorants used in 18th-century Armenian printed scrolls. Since the identification of colorants on the other two scrolls has not yet been completed, this paper will focus solely on Hmayil Number 3.

The colorants present on the scroll were analyzed using the noninvasive techniques of multispectral imaging and qualitative x-ray fluorescence (XRF) spectroscopy in the Preservation Research and Testing Division (PRTD) at the library.

Spectral imaging was conducted using PRTD's multispectral imaging system, supported with advanced image processing via principle component analysis and spectral curve analysis. The system is outfitted with a 50-megapixel monochrome camera with attached filter wheel, light panels

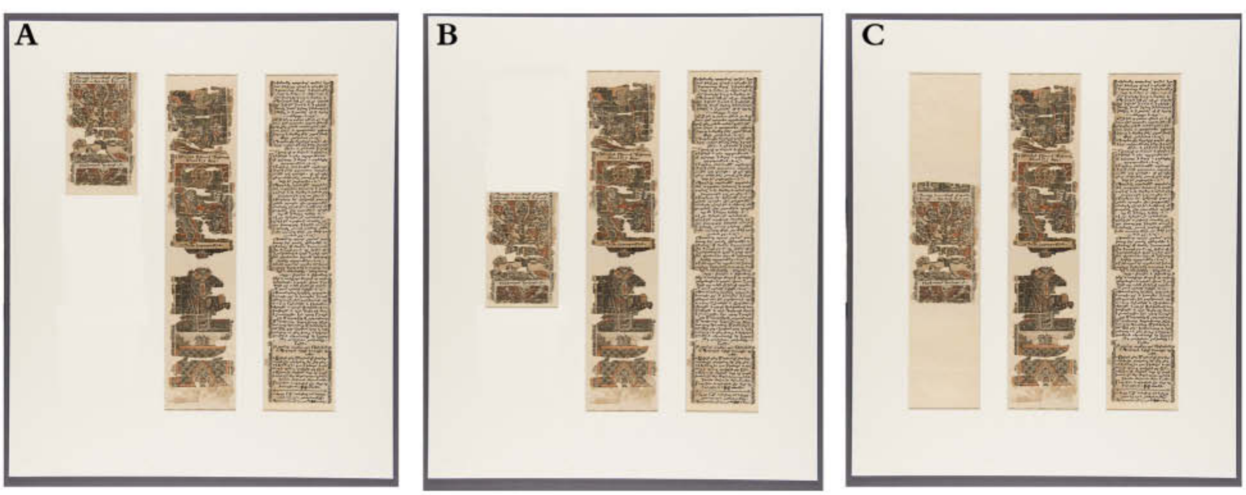

Fig. 16. Mounting options: (a) Option 1 was to trim any extra lining paper and align the sections along the top edge, (b) Option 2 was to trim away any extra lining paper and position the fragment in its original position with a custom-sized window, and (c) Option 3 was to leave the excess lining paper and keep the original section size to highlight the areas of loss.

Fig. 17. Rehousing: (a) custom storage box constructed for Hmayil Number 3, (b) four-flap enclosure for paper and thread used for previous repairs, and (c) custom storage box constructed for the textile backings used in the historic repairs.

containing LED illumination spanning 365 nm–940 nm, and integrated capture software. Each image sequence included 26 registered images. Further image processing was conducted via principle component analysis and spectral curve analysis using ImageJ and ENVI software. Principle component analysis, which was conducted by assigning a false color to areas that respond as spectrally similar, provided information on the distribution of the same pigments in the illustrations. Spectral curve analysis was used to identify different pigments by analyzing their spectral signatures and comparing to those of available reference samples in the form of spectral libraries.

XRF spectroscopy was conducted noninvasively with a Bruker Artax 400 spectrometer, which has a spot size of about 100 micrometers. The instrument is outfitted with a rhodium x-ray tube, polycapillary focusing optics, an integrated camera, and mapping capability.

ANALYSIS RESULTS AND DISCUSSION

Since each scroll's illustrations were colored using a limited palette, and many of the colorants appear on a single illustration, four sections were analyzed: (1) Section 4, Agnus Dei and Apostles images; (2) Section 6, Crucifixion and Deposition images; (3) Section 11, carpet design; (4) Section 13, horse armor (fig. 18). Analysis focused on the black ink, orange/reds, greens, yellows, and dark haloes. Measurements of the lined paper support were also taken for comparison.

ORANGE/RED

To the unaided eye there appears to be a difference in the red and orange pigments in various areas of the scrolls. For instance, the color of the sleeves of the Christ and the flowers appear red, and the color of the background of Agnus Dei

Fig. 18. Sections from Hmayil Number 3, Constantinople, 1729: (a) Section 4m, (b) Section 6, (c) Section 11, and (d) Section 13.

appears orange, as seen in figure 18a. With magnification of the image, redder areas appear to be an orange pigment on top of black print lines, which interfere with the eye's perception of that colorant. This conclusion was supported by principle component analysis, which shows that these areas are likely to be the same colorant, mixed with varying degrees of black print underneath. In addition, spectral curve analysis shows the similarity of the colorant in these areas (fig. 19).

XRF analysis of the orange/red areas reveals that this colorant contains major amounts of lead (Pb) with trace levels of cadmium and possibly also phosphorous (fig. 20). While phosphorus may arise from an organic medium used in the colorants, the finding of trace cadmium is unexpected and interesting. Rather than indicating the use of a modern red pigment, however, its consistent trace presence may possibly be linked to the lead ore used to manufacture the pigment used throughout the illustration. In addition, the lack of other detected elements, such as mercury expected in vermilion, suggests that a distinctive pigment was used throughout the scrolls examined.

YELLOW

The yellow colorant used throughout the scroll is dilute and faint. The spectral curve analysis of this yellow colorant, in comparison to reference samples, suggests that the yellow colorant is similar to gamboge or weld. XRF spectra show that this colorant contains only minor to trace elements, including aluminum, sulfur, potassium, minor to trace copper, and trace iron (fig. 21). These results generally suggest that the yellow areas contain an organic laked pigment.

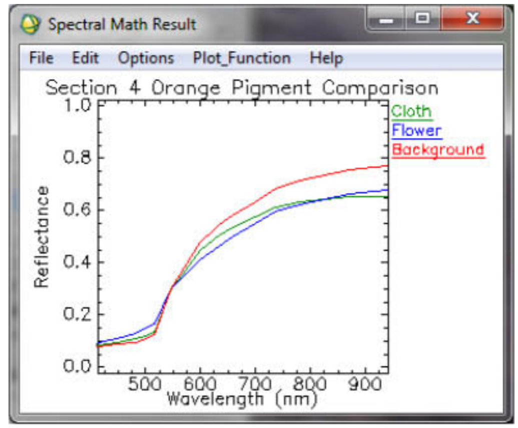

Fig. 19. Section 4: Curves plotted from spectral imaging data for red/orange pigment on the cloth of Christ's robe, the flower, and background.

Although it is possible that the trace elements arise from the source of the colorant as well as from mixed colorants. A yellow area in the cross of section 6 appears to have only minor variations of the above elemental make-up, suggesting a slightly different pigment mixture and/or contamination from nearby colorants.

GREEN

Various green areas were examined in the different sections. Under ultraviolet (UV) illumination, the green tends to absorb UV radiation, suggesting the presence of a heavy

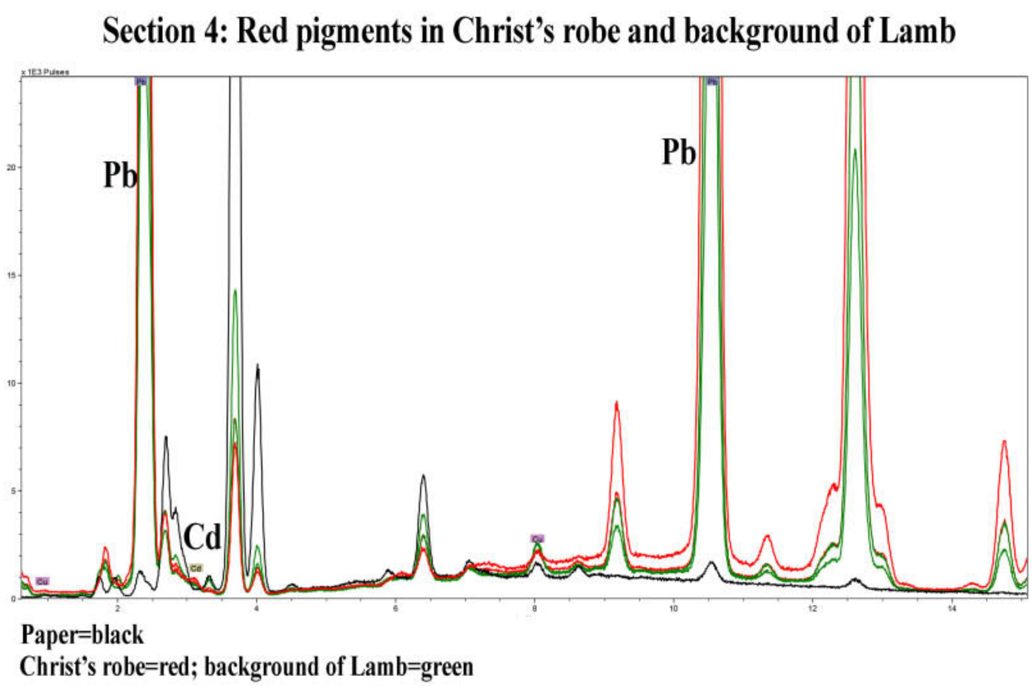

Fig. 20. XRF spectra comparison of the red/orange pigments on Christ's robe and the background of lamb.

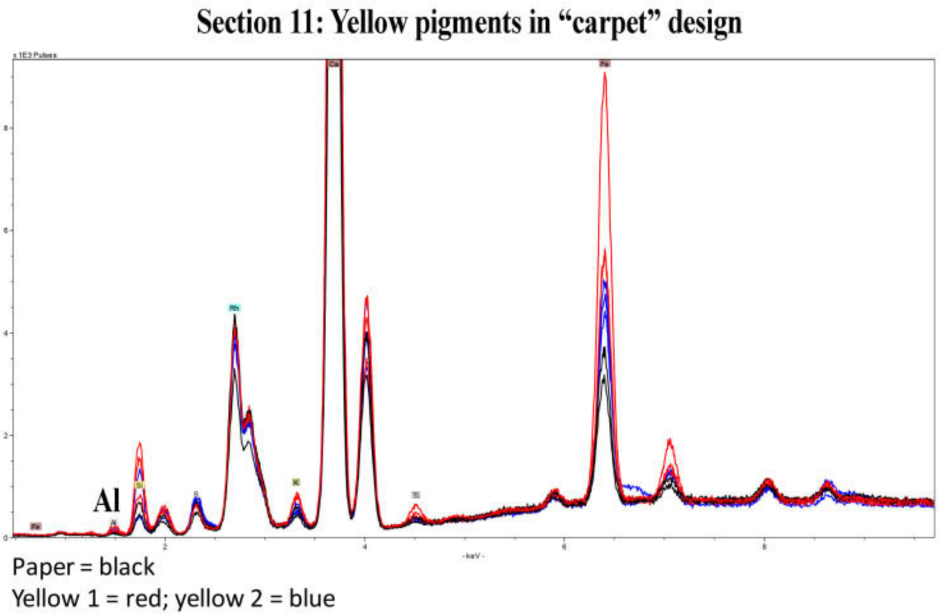

Fig. 21. XRF spectra of the yellow pigments on image of “carpet” design.

metal, which, in this case, is likely to be a copper-based pigment. In comparison to reference samples, spectral curve analysis of the green pigment also points to the organo-copper green pigment known as verdigris, mixed with a yellow colorant. XRF analysis also indicates the possibility of a mixture of copper-based green and yellow pigments for the green colors in some areas since spectra from selected areas show significant levels of copper, as well as sulfur and sometimes trace lead (fig. 22). In some green areas, minor to trace levels of iron, silicon, and possibly aluminum are also detected, possibly suggesting an admixture of a colorant such as yellow iron ochre. In particular, additional trace elements, including aluminum, potassium and iron, detected in the copper-green-colored areas of the sash and sleeve in the Christ figure in section 6 again may indicate that the copper-based green is mixed in these areas with an organic yellow pigment. This

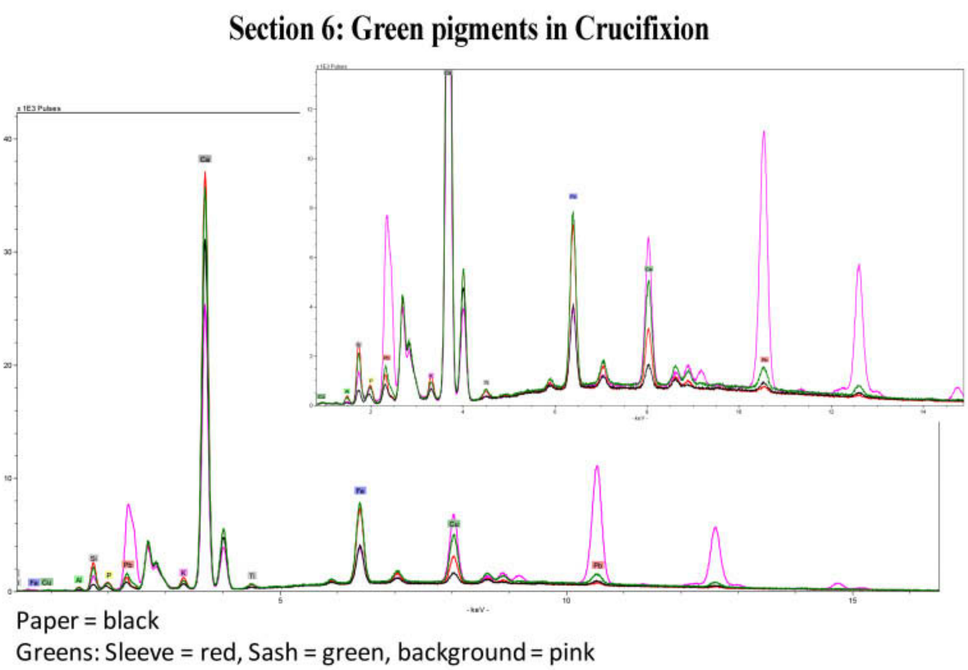

Fig. 22. XRF spectra of the green pigments in the Crucifixion.

is most apparent in comparison to the background green of the same print, which shows only the presence of copper with minor to trace lead. Overall, results for the main green colorant in the various areas are consistent with the use of an organo-copper pigment, such as verdigris, which is known to alter visibly over time to a darker, brownish green color, and was often mixed with yellow colorants to offset its original greenish blue hue.

HALOES

Although the halos appeared slightly different to the naked eye, XRF analysis of selected areas shows that, in all cases, an elemental signature for copper and zinc exists. This strongly suggests the use of so-called bronze powder. The presence of copper and zinc indicate that the pigment would more properly be termed "brass powder," although the distinction was not made historically. Additional minor to trace iron and silicon in some areas may indicate the presence of an additional pigment, applied, for instance, as a glaze or a type of bole, although none is visible. Very trace mercury in most of these areas may arise from a gilding method, although if that was the case, it is expected that mercury would be more significant.

CONCLUSION

Printed in early 18th-century Constantinople on Venetian paper, illustrated with Dutch woodcut images amongst Armenian text, Hmayil Number 3 is a unique representation of historical cultural exchange. Examination of the physical evidence uncovered the intertwined history behind its birth and life. Conservation treatment, which included Western and Eastern conservation materials and techniques, has greatly improved the condition of the scroll, making it safe for researchers to access and handle. XRF analysis with spectral imaging of the scroll indicates fairly consistent use of pigments across the scroll, including lead-containing red, organic yellow, organo-copper green, and a halo color identified as a bronze composition. The lessons learned from conserving this scroll and analyzing its colorants may inform future preservation of and research on similar scrolls.

ACKNOWLEDGMENTS

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NOTE

1. Rayon paper is a semisynthetic material made from cellulose, mostly wood-pulp, which undergoes chemical treatment to turn it into a soluble compound. Filaments are produced to create a synthetic fiber made from almost pure cellulose. Rayon paper comes in different thicknesses, it can be in very thin or heavier weight sheets, and it is smooth and translucent. Traditionally, rayon paper is most commonly used in conservation of Asian art as a facing material or used for friction drying and interleaving. As it originates from cellulose, rayon paper stretches when it is wet (Hare 1998).

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SOURCES OF MATERIALS

Golden Fluid Acrylic Colors
Dick Blick

RK-1 machine-made kozo paper roll
Paper Nao

Handmade uda-gami paper
Hiromi Paper, Inc.

Rayon paper; silicone-coated polyester film rolls
Talas

Tek Wipe
Polistini Conservation Material LLC

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