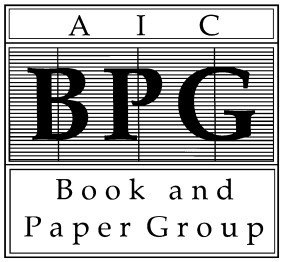

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Analysis of Varnish Patterns in Indian Oleographs at the Metropolitan Museum of Art Using UV Reflectance Photography

INTRODUCTION

The Metropolitan Museum of Art, New York, hosts a collection of more than 50 Hindu devotional prints dating from the 1880s through the 1940s. These chromolithographic prints on paper were once mass produced in India but today are extremely rare. The origins of Hindu devotional prints, called *god prints*, are deeply rooted in India's tradition of depicting deities and episodes from the epics and Puranas. These images played an important role in the country's cultural and historical development (Pinney 2004).

Even though chromolithographic printing presses were introduced in India in 1878, Indian publishers continued to send their drafts of god prints to European lithographic presses, where they could be printed in better quality (Pinney 2004). This practice encouraged European printmakers to take advantage by selling replications of Indian Hindu motives at prices that undercut the Indian publishers (Davis, Baron, and Narayan 2012; Relia 2014) (fig. 1A). One subgroup of chromolithographs, called *oleographs*, are characterized by the application of a shiny varnish over the printed surface. The glossy appearance is supposed to imitate oil paintings. This multifunctional varnish layer not only increased the aesthetic value of the prints by enhancing the color saturation but also provided physical protection (Marzio 1979; Johwari 2009; Twyman 2014).

One popular painter, whose images appeared as oleographs, was Ravi Varma (1848–1906). In his painting style, he introduced Western techniques of perspective, combining religious themes with European approaches in his renderings of historical and sacred mythological scenes (Chawla 2010). With his increasing popularity, Ravi Varma decided to make copies of his work to satisfy the high demand of patrons and admirers (Relia 2014). For that purpose, he made use of the chromolithographic printing process, but the mass production of oleographs resulted in severe damage to Varma's reputation as a serious painter. He was denounced by many as a "calendar artist." Nevertheless, his prints (see figs. 1B, 1C; fig. 2) laid the foundation for a growing interest in popular art and religious illustration, and his success encouraged many competitor presses (e.g., the Ravi Vaibhav Fine Art Lithograph Press) to set up their own ventures, trading on Varma's name and plagiarizing his prints (Relia 2014; Mahadevan 2016; Pinney 2018; Sarma 2019). In 1894, Ravi Varma and his brother Raja Varma opened the Ravi Varma Fine Art Lithographic Press in Bombay, India. This press moved several times due to social unrest in India, first to Ghatkopar (see figs. 1B, 1C) and one year later to Malavi (see fig. 2D). Financial difficulties led to the sale of the press in 1901, after which the press moved to Karla-Lonavla (see figs. 2E, 2F). There, in 1972, it was destroyed in a fire (Sharma and Chawla 1993; Chawla 2010).

The Metropolitan Museum of Art's collection of Indian lithographic prints includes 51 chromolithographs, of which 23 are varnished and thus considered oleographs. This study focuses on the examination of the varnish layers in the collection of 23 Indian oleographs. Looking at this layer using UV reflectance (UVR) imaging techniques offered a novel perspective and approach to analyzing historic varnish production and application methods on paper. Studying the varnish and identifying patterns could help distinguish originals by the Ravi Varma Press from copies, or prints published in Europe from those published in India. Individual oleographs were carefully selected for this study to demonstrate a variety of printing presses and dates of origin as represented in the collection of the Metropolitan Museum of Art. A comparative close-up examination using UVR was used to highlight material relations between the different prints based on their production characteristics.

OVERVIEW OF TECHNIQUES

As background to this preliminary study of the Metropolitan Museum of Art's collection of oleographs and different varnish patterns, an overview of techniques, technology, and

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Fig. 1. (A) *Radha*, India, ca. 1880–1900, 34.6 × 24.8 cm, printed in Italy, Reg. No. 135, purchase, gift of Mrs. William J. Calhoun, The Metropolitan Museum of Art, New York, 2013.9. (B) *Rama, Lakshmana, and Hanuman*, India, 1910–1915, 35.6 × 24.8 cm, Ravi Varma Udaya F. A. L Press Ghatkopar Bombay, Reg. No. 113, gift of Mark Baron and Elise Boisanté, The Metropolitan Museum of Art, New York, 2015.441.2. (C) *The Descent of the Ganges (Gangavatarana)*, India, ca. 1910–1920, 35.4 × 24.9 cm, Ravi Varma Udaya F. A. L Press Ghatkopar Bombay, purchase, Marie-Hélène Weill gift, 2016.483.

Fig. 2. (D) *Kali*, India, ca. 1910–1920, 50.8 × 36.2 cm, Ravi Varma Press Malavi-Lonavla, Reg. No. 68, purchase, gift of Mrs. William J. Calhoun, The Metropolitan Museum of Art, New York, 2013.17. (E) *Portrait of Maharajas*, India, 1910s, 35.6 × 25.1 cm, Ravi Varma Press Karla-Lonavla, Reg. No. 546, purchase, bequest of Nina Bunshaft, The Metropolitan Museum of Art, New York, 2014.91. (F) *Matsya Avatara* (Vishnu's Fish Avatar), India, undated, ca. 1900–1915, 35.2 × 25.4 cm, Ravi Varma Karla-Lonavla, Reg. No. 642, purchase, gift of Mrs. William J. Calhoun, The Metropolitan Museum of Art, New York, 2013.13.

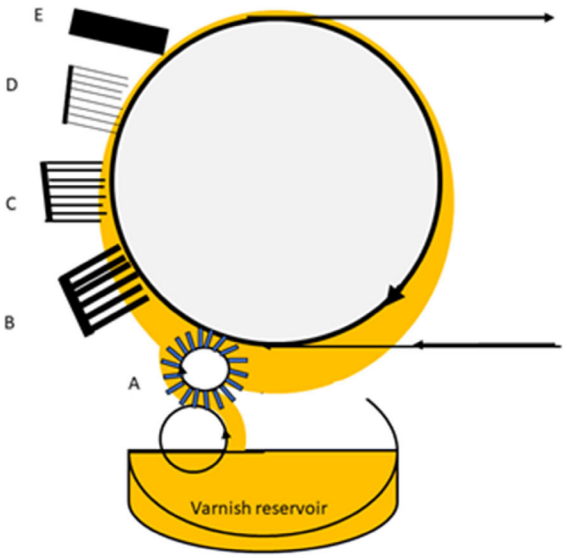

Fig. 3. Sketch illustrating ways of dispersing varnishing on the roll before final application (Mosier, Van der Reyden, and Baker 1992; Marchessault and Skaar 1967, 314). (A) Splatter brush. (B) Coarse brush. (C) Firm brush. (D) Light brushing with badger hairbrush. (E) Circulating bars.

tools for chromolithographic printmaking in India at the end of the 19th and beginning of the 20th centuries is provided, as well as an overview of varnishing technology, which was generally imported from Europe to India during this time (Chawla 2010).

Varnish could be applied either manually with a flat camel hair brush (Wyman & Sons 1882, 93) or by a varnishing machine. For mass reproduction, varnishing machines such as the machine by Messrs. Wm. Rawcliffe & Sons, of Radford's buildings, Parklane, Liverpool (Wyman & Sons 1882, 112), or "Newsum Varnishing machine" (Rhodes 1924, 264), were in use in England at the end of the 19th century. These machines applied varnish evenly by feeding the print into a system of rollers, one of which deposited varnish. Similar to the way printing machine functions, a large cylinder is placed above, but closely aligned to a composition roller, working in a pool of the varnish (fig. 3A). The sheets being fed by the grippers are carried between the cylinder and the roller. The literature describes several options for further smoothing the varnish on the roller before it is applied onto the paper. For example, several brushes of different sizes and refinement could be installed to further disperse the varnish once on the roller (see figs. 3B, 3C, 3D). This coating system was described in 1880 as highly effective but not very uniform. Brushes were later replaced by roll-circulating bars that lightly touched the paper surface (see fig. 3E). Another, later option was the use of a horizontal blade that thinned the varnish on the roll, creating a very even application (Mosier, Van der Reyden, and Baker 1992). In the 1880s in England, some sources recommend using the varnishing machine immediately after printing (Wyman & Sons 1882, 113), whereas others recommended maintaining a certain safety distance between the press and the varnishing location to reduce the risks associated with the preparation of the highly flammable varnish and inks. The storing and mixing of varnish at room temperatures, which could easily reach 90°F or above, sometimes produced flash fires that completely destroyed several presses.

Several common solvent-based varnishes were used to varnish lithographic prints toward the end of 19th century in Britain. Aqueous solutions were made of gums to coat the paper prior to varnish application. Without this coating, varnish when it was applied would penetrate the substrate and make it semitransparent. Alcoholic and turpentine varnish combinations were applied to achieve the glossy surface. The use of ethanol-based varnishes—for example, natural resins such as shellac (Twyman 2014)—required that the room and surface temperature of the print be warm and constant so that the ethanol and the water would evaporate simultaneously (Wyman & Sons 1882).

Spirit varnishes, such as combinations of gum sandarac, gum mastic, camphor, and alcohol, and turpentine varnishes, such as variations of Canada balsam, dammar gum, gum mastic, gum sandarac, and spirits of turpentine, were frequently used. Their advantages were a more suitable varnish color and a viscosity that allowed physical manipulation and fast drying (Wyman & Sons 1882, 113). To keep the brightness of colors and to simulate the appearance of a painting, the varnish needed to be as colorless as possible. This transparency could be achieved with oils, such as bleached linseed oil (Twyman 2014).

METHODS

UVR is a noninvasive imaging technique based on the reflection and absorption response of materials to sources of light in the UV region of the spectrum. Resulting images enable differentiation between materials with different responses. This photographic technique not only helps visualize the presence of substances of different chemical compositions when placed next to each other but can also enhance the visualization of characteristics such as distribution, thickness, and agglomeration of these substances on the surface of an object.

Because of its capability to enhance the visibility of certain characteristics of the surface of materials, UVR was chosen as a method to study the varnish patterns of oleographs in the collection of the Metropolitan Museum of Art. Scientific research must follow standardized procedures to achieve reliable and reproduceable results. Even though an attempt to establish general standards for multispectral imaging procedures for digital photography and conservation documentation has been done in the past (Frey et al. 2011), in reality, standards as carried out can vary even in a single

Fig. 4. Oleographs in normal light and under UVR (section in red frame in each print); UVR images are not modified; red frames (a–f) locate details of figures 5–10. (A) *Radha*, 2015.441.2. (B) *Rama, Lakshmana, and Hanuman*, 2013.9. (C) *Kali*, 2013.17. (D) *Portrait of Maharajas*, India, 2014.91. (E) *Matsya Avatara (Vishnu's Fish Avatar)*, 2013.13. (F) *The Descent of the Ganges (Gangavatarana)*, 2016.483.

institution and end up with different results. Accordingly, it is important to document procedures and techniques used.

The technical photography performed in this study followed the protocols established within the paper conservation department of the Metropolitan Museum of Art. A Nikon D90 (modified, infrared filter removed) and lens APO crystal lens UV-VIS-IR 60 mm (1:4 APO Macro lens) were used with PECA 900 (67-mm) and X-Night BP1 (72-mm) filters. All images were captured with the software Camera Pro 2 including the following color charts in each shot to provide standardized results: X-Rite Color checker Passport, and 99% and 5% Spectralon Diffuse Reflectance Standards. Additional steps included flat fielding and post-processing of images in Photoshop Lightroom and the Adobe Flat Field Plug-In. Detail images have been additionally adjusted in Photoshop by increasing the brightness/light exposure to further enhance the visibility of varnish patterns in the obtained UVR images. Adjustments are acknowledged in the captions.

RESULTS

Examination with UVR, without any adjustment of brightness, showed overall widely varying results. The majority of these oleographs showed a completely dark surface under UVR analysis. Examples of this state are represented in figures 4B and 4C. Only a few had moderate (see figs. 4A, 4E) to minor (see figs. 4D, 4F) visibility under UVR examination.

Adjustment of light exposure and brightness levels in Photoshop allowed a more accurate and detailed examination of varnish structures. Optical analyses of distinct samples of the 23 oleographs in the Metropolitan Museum's collection are represented in enlarged form. Figures 5–10 exemplify three different varnish patterns.

Pattern I. In pattern I, a systematic pattern of small grooves is visible (figs. 5, 6). Single grooves may vary in thickness and distinctness. Occasional dark dots are scattered over the

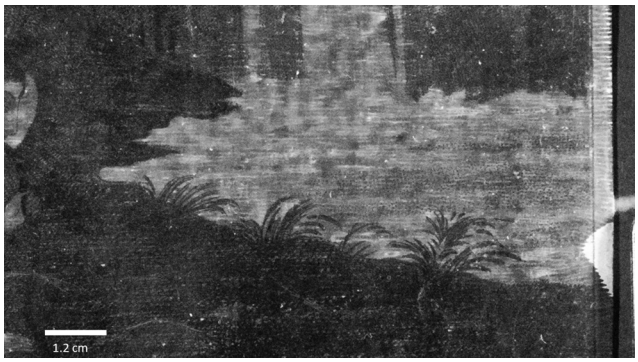

Fig. 5. Detail b: *Rama, Lakshmana, and Hanuman*, 2015.441.2; adjusted UVR detail-photo (see Fig. 4B).

Fig. 7. Detail d: *Portrait of Maharajas*, India, 2014.91; adjusted UVR detail-photo (see Fig. 4D).

surface (see fig. 6). Overall, the pattern can show a slightly mottled and uneven appearance. Irregularities along the margins can be observed in figure 5.

Pattern II: In pattern II, there are irregular distances between the grooves, and the distances are rougher and larger (figs. 7, 8) than in pattern I. The dimensions of the grooves differ considerably, ranging from 0.1 to 0.5 cm. The main varnish pattern can be seen to be vertical, but a blurred and indistinct secondary pattern that is horizontal can also be observed. Only very few dark spots of varnish accumulation are found (see fig. 7).

Pattern III. In pattern III, the varnish application is homogeneous (figs. 9, 10). The grooves are not visible in figure 9 or are barely visible in figure 10, even when digitally adjusted. On the surface, mostly scratches and past physical handling are visible. The light, soft grooves visible in figure 10 are similar in size to those in pattern I.

DISCUSSION

Although this study is focused primarily on the examination under UVR of varnish applied by machine, it should also be mentioned that in most cases the varnish application can also be visible to the naked eye. Thick and uneven varnish accumulations especially tend to discolor. At the same time, spots with less varnish (see fig. 6) create a mottled pattern and cannot necessarily be identified without further analysis.

Nonadjusted UVR images of oleographs displayed only very few visible parts of the printed image, whereas the margin still stayed visible to a certain degree on most prints under study. This difference can be explained by the presence of certain underlying colors or inks that obscure the appearance of the varnish if the varnish application is thin. The presence of inks containing chrome yellow and Prussian blue pigments was confirmed in the Metropolitan Museum's Indian oleographs under study.[1] Mock-ups were created to investigate possible interactions between the varnish and ink layers when observed with UVR. Experiments[2] showed that chrome yellow and Prussian blue appear differently under UVR, depending on the proportions of ink to water, viscosity, and general density when applied. Furthermore, they also showed that the thicker and denser the applied varnish, the fewer the characteristics of varnish details that are generally visible in UVR images (fig. 11).

Fig. 6. Detail f: *The Descent of the Ganges (Gangavatarana)*, 2016.483; adjusted UVR detail-photo (see Fig. 4F).

Fig. 8. Detail e: *Matsya Avatara (Vishnu's Fish Avatar)*, 2013.13; adjusted UVR detail-photo (see Fig. 4E).

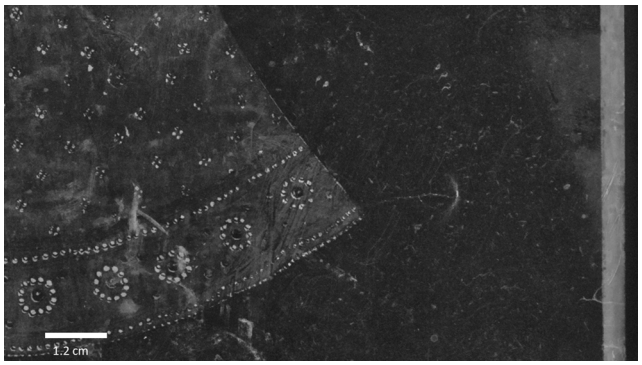

Fig. 9. Detail a: *Radha*, 2013.9; adjusted UVR detail-photo (see Fig. 4A).

To exclude these interactions from the current study, observations also focused on areas of the prints that did not contain any inks, such as the margins. Examples of applied varnish on margins studied with UVR showed a varying degree of darkening. This level of darkness was visually evaluated and ranked from level 1 (visible) to level 5 (invisible) (table 1).

Pattern I showed a more mottled general background pattern, including spotty, lighter areas, as well as darker spots. Although the darker spots could be identified as dust, dirt, or impurities in the varnish, the general light spottiness could be explained by the rather thinly applied varnish. Or, if ethanol evaporated too fast from the varnish composition, it could also leave behind water, which breaks the surface and results in a dull appearance (Wyman & Sons 1882), or creates a bubble in the varnish layer (Gottsegen 2006). It should be noted that air bubbles can also be introduced as a natural occurrence within the liquid varnish during application.

In figure 5, a specific uneven application of varnish could be observed in the margins. This unevenness was a result either of the paper expanding, causing deformations that prevented sufficient substrate to be in contact with the roller for the varnish to be applied, or of the varnish reservoir being depleted of medium. In this specific area of the margins, one can see how the varnish medium is accumulated on the roller at the moment of its application. Raised grooves that are visible represent differences in varnish surface topography on the roller that were transferred to the varnish by the brushes. More important, this flaw illustrates how the pattern in the background can be attributed to the actual roller structure, whereas the grooves represent imprints by the brush distributing the varnish on the roller.

Fig. 10. Detail c: *Kali*, 2013.17; adjusted UVR detail-photo (see Fig. 4C).

The use of a splatter brush for distribution of the varnish could produce the unevenness seen in pattern II. Pattern I, however, showed grooves, but they were much finer, indicating finer brushes. Evenly applied varnish suggests that the printed and varnished oleograph was produced in Europe, where the technology and equipment were able to produce this surface condition. Or evenly applied varnish might suggest that another tool—a blade not a brush—was used to distribute the varnish on the roller in a much finer way. In India, since most of the equipment, tools, and materials would have been imported from Europe, it can be assumed that similar techniques were used. Consequently, it is important that any interpretation of the appearance of the varnish as analyzed be informed by literature sources.

Today's provenance and literature research pertain to only a fraction of Hindu devotional prints that were initially printed. A complete catalog of prints, both physically or visually/digitally, is exceedingly difficult to collect, because it is unclear how many variations of one image were reproduced. Images were printed in numerous versions. For example, the image of *The Descent of the Ganges (Gangavatarana)* (Ravi Varma Udaya F. A. L Press Ghatkopar Bombay, 2016.483) can be found in several catalogues (Johwari 2009; Davis, Baron, Narayan 2012), but each has a different registration number, marking the lithographic stone from which it was printed.

However, most prints did not survive, given the poor quality of their materials and heavy handling in the past. They were a part of everyday life and used in religious practice. Furthermore, exposure to extreme environmental conditions, such as highest daily temperatures exceeding 31°C (87.8°F; 12-month moving average data from India, 1880–1920) (Muller et al. 2013) and high humidity in India, ultimately degraded the materials and attracted insects. Even dating the prints that survive is a challenge, since they were mass produced in large editions. Dates currently assigned are a range from one to several decades as a potential period of production. To illustrate complexities through a typical example of *Kali* (see fig. 4C), production is dated to a period ranging from ca. 1910 to 1920, but the Ravi Varma Press Malavi-Lonavala moved to Karla-Lonavla in 1901. Accordingly, the print must have been printed from an outdated lithographic stone, long after the press moved. This situation raises the question of how to handle dating in general when dealing with potential "reprints" of already mass-produced oleographs.

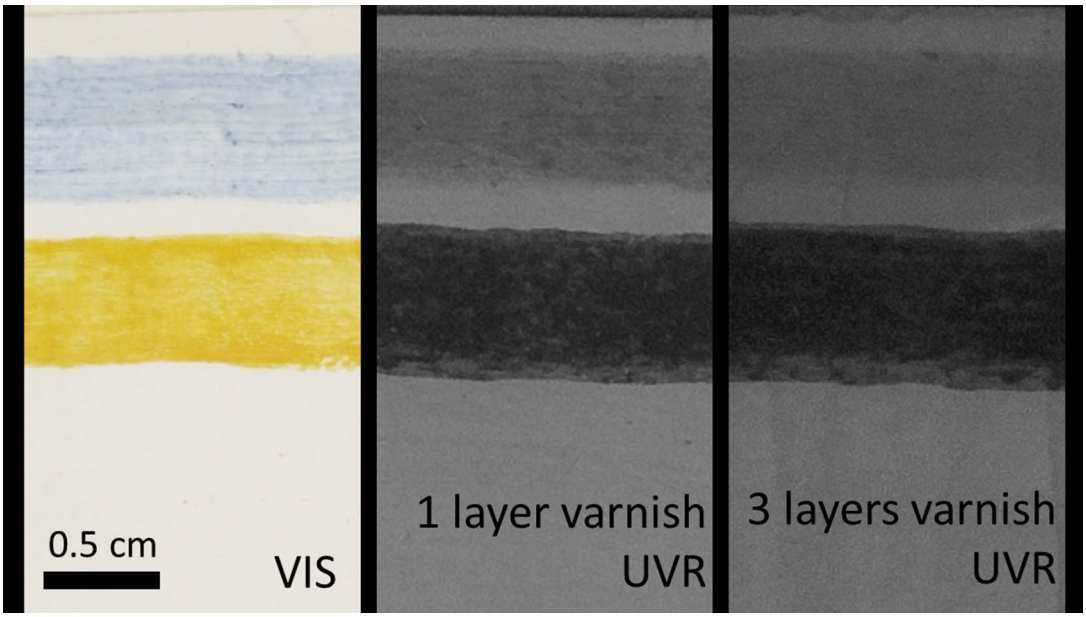

Fig. 11. Images in normal light (left) and unmodified UVR (middle and right) with chrome yellow (lower stroke) and Prussian blue (upper stroke), on coated paper, covered with one layer (middle) and three layers (right) of light shellac.

Based on the chronology of technical developments in varnishing/coating machinery, a compilation of data sets was established to cluster prints based on their varnish pattern (see table 1). The initial study included UVR analyses of all 23 oleographs of the Met's collection. Distinctive aspects of each include the decoded varnish patterns based on UVR analysis (adjusted and nonadjusted) and the representation of prints in literature and their challenges in provenance. Including only representative samples in this publication may circumscribe the results reported in this essay, but several issues complicated grouping the prints based on material characteristics. As already discussed, both dating and the origin of prints need to be interpreted with caution. Although varnish patterns can be distinguished and prints can be grouped by size, assignment on these bases to specific printing presses and dates was not possible. Observations suggest that although these patterns cannot yet be attributed to specific printing presses or dates of origin, they provide a way to explore the relation of these prints to technology and materials available in 19th- and 20th-century India.

CONCLUSION

Table 1 summarizes these findings. Although inconsistences of single data sets prevented a coherent grouping, based on

Accession number	Origin	Evaluation under in UVR (1 as visible – 5 as completely dark)	Grouping of Varnish pattern under adjusted UVR	Varnish orientation (horizontal/ vertical grooves)	Print size
2015.441.2	India, 1910–15, Ravi Varma Udaya F.A.L Press Ghatkopar Bombay	5	I	H	35.6 × 24.8 cm
2016.483	India, ca. 1910-20, Ravi Varma Udaya F.A.L Press Ghatkopar Bombay	1	I	H	35.4 × 24.9 cm,
2013.17	India, ca. 1910–20, Ravi Varma Press Malavi Lonavla	5	III	H	50.8 × 36.2 cm,
2013.13	India, Undated, ca. 1900–15, Ravi Varma Karla-Lonavla	4	III	V	35.2 × 25.4 cm,
2013.9	1880-1900, printed in Italy	2	II	-	34.6 × 24.8 cm
2014.91	Portrait of Maharajas, India, 1910s, Ravi Varma Press Karla-Lonavla	3	II	H	35.6 × 25.1 cm

Table 1

the reported characteristics of the three different varnish pattern groups, it can be concluded that appearance under UVR is connected with the characteristics of the roller, the way the varnish was distributed on the roller, its surface topography, and the consistency of the varnish itself. Even though the varnish patterns could be matched to historic varnishing techniques and machines, a connection between these patterns and specific dates or places of origin, or presses and formats, was not possible due to inconsistent results and the relatively small scope of the study.

The issue of dating and accurately locating the origin of prints raises the question of whether it is important to correctly date these mass-produced prints at all. What qualifies as an original Ravi Varma print, printed by a printing technician in thousands of editions, when compared with a reproduction of similar quality (Sarma 2019)? More research and analyses of oleographs are needed to establish a quantitative study. Perhaps the specific dating of a mass-produced oleograph is not relevant, so long as it can be contextualized within the practice of a printing press during its active existence. However, more research could potentially lead to a noninvasive identification method of "reprints" produced by individuals who were plagiarizing prints by Ravi Varma and the Ravi Varma Fine Art Lithographic Press.

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NOTES

1. Scientific analysis was carried out by the Department of Scientific Research at the Metropolitan Museum of Art, New York, to identify blue and yellow colorants in three Indian prints. XRF and Raman spectroscopy were used to confirm the presence of Prussian blue and chrome yellow in *The Descent of the Ganges (Gangavatarana)* (2016.483).
2. To create mock-ups for further investigation of color appearances below a varnish layer, a coating of kaolin bound in gum arabic was evenly applied on chromatography paper. Two parallel lines of chrome yellow and Prussian blue (applied by brush) were applied on top of the coating. Finally, one thin layer of commercially available light shellac (Kremer: order number 60440) was applied by transferring the varnish with a smooth glass roll evenly onto the paper.

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