https://doi.org/10.2352/issn.2168-3204.2025.22.1.12

From invisible to visible: Scientific Imaging applied in drawings by Alberto da Veiga Guignard

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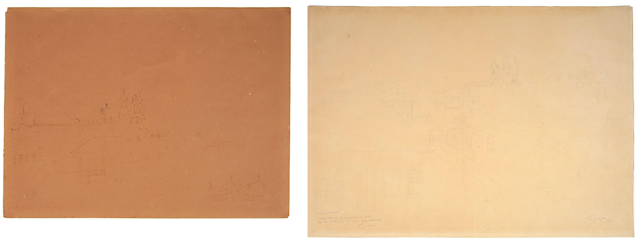
Abstract

Non-invasive scientific imaging is increasingly becoming an important research tool in the study of cultural heritage objects, combining sustainability and preservation in a responsible and conscious manner. The purpose of this study is to make a legibility by digital restoration of two drawings by Brazilian modernist artist Guignard, dated 1956 and 1958, respectively, one created with ink and pen nib, and the other presumably with graphite. Both drawings have likely suffered from photodegradation, with almost total loss of visibility due to fading and erasure of the drawn lines. Scientific photography techniques were employed, including infrared reflectance photography, visible light photography, ultraviolet fluorescence, Multispectral Imaging, transmitted light photography, raking light photography, and Reflectance Transformation Imaging (RTI). These techniques, used in combination, returned positive results, enhancing legibility and revealing traces and details that were no longer visible to the naked eye.

Motivation

The two drawings analyzed in this study were created by the artist Alberto da Veiga Guignard and depict landscapes of Ouro Preto, an important historical city in Minas Gerais, Brazil, which became the first Brazilian city to be included on the UNESCO World Heritage list in 1980. Both drawings show significant damage to visibility caused by the fading of the lines, possibly due to the effects of photodegradation [1].

The first work is titled "Paisagem de Ouro Preto", dated 1956, and listed as ink and pen nib on paper, with dimensions 22.5 x 30.1 cm. The second work is titled "Paisagem de Ouro Preto - Para Ângela", dated 1958, and possibly graphite on paper, with dimensions 34.3 x 48.3 cm. These drawings can be seen in Figures 1a and 1b, from left to right respectively.



***Figures 1a and 1b.** Drawings "Paisagem de Ouro Preto" (1956, left), and "Paisagem de Ouro Preto - Para Ângela" (1958, right), respectively. Photo: Alexandre Leão, Alexandre Costa, Larissa Oliveira.*

Born on January 23, 1896, in Nova Friburgo, a city in Rio de Janeiro state, Guignard spent much of his childhood and adult life in Europe with his family. He lived in Switzerland, France, Italy, Germany, and returned to Brazil in 1929, armed with solid artistic training, though by then all his family members had passed away [2]. He is now recognized as one of Brazil's greatest modernist artists and is also known for having taught and mentored many prominent artists who came after him [3].

The drawings studied here are part of the valuable public heritage and belong to the collection of MCG - Museu Casa Guignard, located in Ouro Preto. This museum is one of the seven state museums managed by Dimus - the Museum Directorate of the Secretariat of Culture and Tourism of Minas Gerais. The museum is housed in a building that was donated to the artist, though he never had the chance to live in it before his death [4].

Problem

The fading found in the drawings by Guignard is a common form of degradation that directly impacts their visibility, especially since most of his works date back to the 20th century [5]. These drawings, now entirely or partially invisible to the naked eye, hold significant artistic and monetary value in the Brazilian art market [6].

The drawings analyzed in this study – produced using pen and ink on paper (1956) and graphite on paper (1958), according to information from the digital inventory of the collection on the Tainacan platform [7] – stand out in the MCG collection precisely because of their remarkable loss of visibility. For this reason, they have been removed from display and are currently stored in the Technical Reserve at Dimus, located at Mineiro Museum in Belo Horizonte, Minas Gerais, Brazil.

Approach

The imaging procedures were made at iLab - Scientific Imaging Laboratory and PrismaLAB - Technical and Scientific Photography Laboratory, both located at the School of Fine Arts at the Federal University of Minas Gerais, Brazil. The drawings underwent various scientific imaging methodologies aimed at restoring their legibility. The photographic techniques used involved radiation with different wavelengths within the electromagnetic spectrum, such as ultraviolet, visible light, infrared, MSI - Multispectral Imaging, and different photographic methods for documenting works of art, such as reverse or transmitted light photography, raking light photography, and RTI - Reflectance Transformation Imaging [7].

Multispectral Imaging was generated by images obtained through Infrared Reflectance Photography, with three different IR sources: IR 850nm, IR 940nm, and halogen light. Visible light photography has been done with white, red (R), green (G), blue (B), and yellow lights, while ultraviolet fluorescence photography was done using three different light sources: UV 365nm fluorescent bulb, UV 365nm LED flashlight, and narrow band 395nm LED, as can be seen in Figures 2a and 2b.

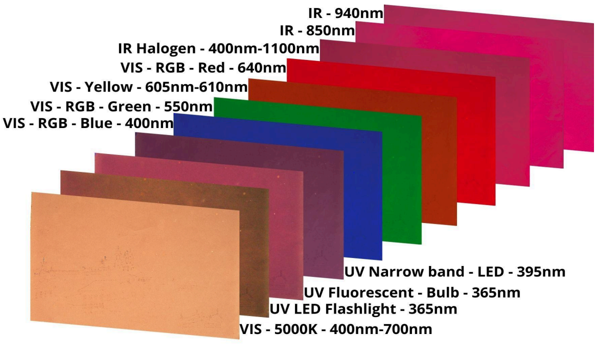


Figure 2a. *Schematic representation of an 11-strip multispectral image of the drawing "Paisagem de Ouro Preto" (1956). Photo without image processing. Photo: Alexandre Leão, Alexandre Costa, Larissa Oliveira.*

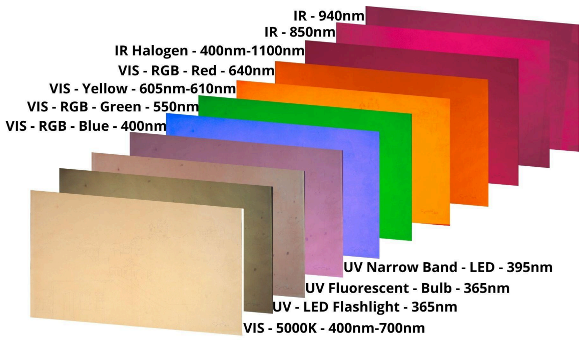


Figure 2b. *Schematic representation of an 11-strip multispectral image of the drawing "Paisagem de Ouro Preto- Para Ângela" (1958). Photo without image processing. Photo: Alexandre Leão, Alexandre Costa, Larissa Oliveira.*

The visible light, ultraviolet fluorescence, infrared reflectance, and reverse light photographs were taken using a Canon EOS Rebel T6 Digital Camera full spectrum, equipped with a Canon EF 24-70mm lens. The focal length was set to 50mm for the photographic recording of the 1956 work "Paisagem de Ouro Preto" and to 33mm for the 1958 work "Paisagem de Ouro Preto - Para Ângela."

The raking light and RTI photographs were taken using a Nikon D810 Digital Camera, with a Nikon AF Micro Nikkor 60mm lens, mounted on a photographic column. The drawings were individually placed on a gray cutting mat. A Nikon Speedlight SB-910 flash was used, triggered remotely via the Nikon ML-3 transmitter and the YongNuo digital YN622N II i-TTL wireless flash trigger transceiver.

For processing the images of visible light, ultraviolet fluorescence, and raking light photography, a "Basic Digital Image Processing" was adopted [8]. The images generated by all the techniques were initially processed using Raw Therapee (open source software), by white balance and exposure compensation adjustments. Some curves and tonal adjustments were applied in all images and saved in TIFF file format. The images were then edited using GIMP (another open source software), where they were cropped, the sharpness were enhanced, and they were converted to monochrome in TIFF 16 bit to be used to generate the MSI - Multispectral Imaging.

Before Multispectral Imaging procedures, it is essential to align the selected images through image registration. This is required due to the use of optical filters and the variation in illumination wavelengths, which demand refocusing the objective lens and it can result in image misalignment.

For Principal Component Analysis (PCA) the images need to be resized and realigned. And for this purpose, it was used the "Image Registration Manual – iLab" [9]. The Adobe Photoshop CS4 was the software used in this process. Then PCA (Principal Component Analysis) was performed using the free software ImageJ, the image stacking was done with the PCA plugin to generate the multispectral PCA images [10].

For transmitted light photography, as the lighting area on the table was smaller than the work "Paisagem de Ouro Preto - Para Ângela" (1958), it was photographed in three parts. These images were then merged in Adobe Photoshop CS4 using the Photomerge function, following the "Damage Map Manual" [11].

For the RTI - Reflectance Transformation Imaging, the drawings were placed on a gray cutting mat (Figure 3), with black reflective spheres positioned near the drawings.

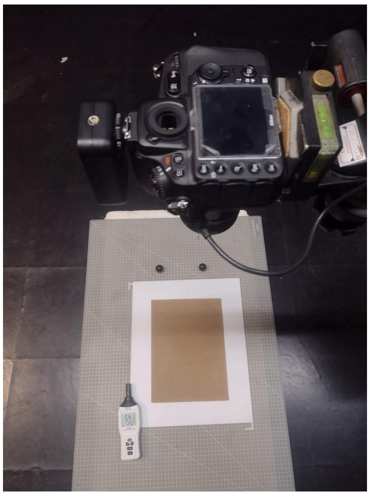


Figure 3. *A drawing placed on a gray cutting mat, with neutral paper, reflective spheres positioned near the drawing, and the camera set up. Photo: Larissa Oliveira.*

Measurements were taken with 12 markers on the floor, positioned at a distance equivalent to three times the diagonal of the drawings (37.5 cm and 55 cm, respectively), i.e., 112 cm from the work "Paisagem de Ouro Preto" (1956) and 165 cm from the work "Paisagem de Ouro Preto - Para Ângela" (1958). The Speedlight flash was positioned at different angles: 15º, 31º, 49º, and 65º [12]. In total, 49 images were generated for each drawing, 48 without a color chart and 1 with a color chart. The free software Relight was used for image processing. Initially, Raw Therapee was used to perform white balance adjustments on the 48 images of each drawing, generating JPEG files, which can be opened in RelightLab, functioning similarly to RTIBuilder. To view the file, the free software RTIViewer was used, applying filters to highlight details, such as *Specular Enhancement*, *Image Unsharp Masking*, *Static Multi Light*, and *Dynamic Multi Light*.

Results

The results obtained successfully recovered the drawings, restoring their visibility and retrieving details that had disappeared or were never seen with such precision.

Worth noting that all the techniques contributed to the recovery of the image of both drawings; however, the most significant results were achieved by combining the 11 images generated through visible light photography, UV fluorescence, and IR reflectance, creating the MSI.

By transforming the generated images into monochrome, the drawings stood out in some way – either through the delineation of their lines in dark or white tones, or by highlighting the relief left by the fine tip used by the artist.

The Multispectral Imaging showed details clearly on each drawing, emphasizing the path of their lines in dark or white tones, and other times through the visualization of relief present in the drawings.
After stacking the images in ImageJ, PCA - Principal Component Analysis was generated, some images offered a better reading of the drawings. A series of 11 PCA images were created, in which each image from different techniques/wavelength was placed in the first order before the stacking process. For a more detailed analysis, only four PCA images were chosen.
For example, analyzing Figure 4a, in PCA image “Guignard_1956_01-White_var4” (left side of the figure), the lines of the drawings became more legible and darker, allowing us to see the fine details of the window grilles. Meanwhile, in PCA “Guignard_1956_06-UVF365_var5” (right side of the figure), the lines stood out in white, making it easier to visualize the contours of the Inconfidência Museum (formerly the House of Council and Jail of Ouro Preto).

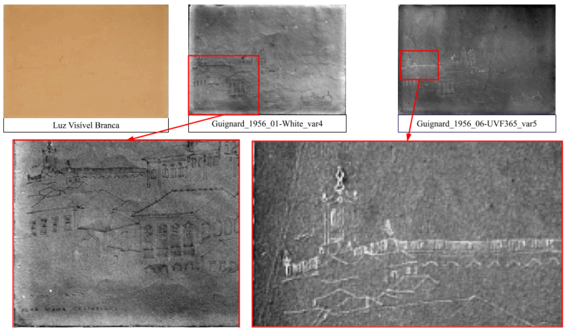


Figure 4a. *Details of PCA images generated from the work “Paisagem de Ouro Preto”, de 1956. Photo: Alexandre Leão, Alexandre Costa, Larissa Oliveira.*

Looking at Figure 4b, in the upper left corner of PCA image “Guignard_1958_06-UVF365_var5” (lower left side of the figure), small palm trees (highlighted with yellow circles) are visible – a characteristic feature of Guignard’s works. In this same PCA image, some construction details are easily visible, such as the columns supporting a townhouse. In PCA image “Guignard_1958_09-IR850_var6” (right side of the figure), zooming in it is possible to read the inscription “mais alto” (which means higher) with an arrow drawn by the artist, indicating the tips of building roofs.

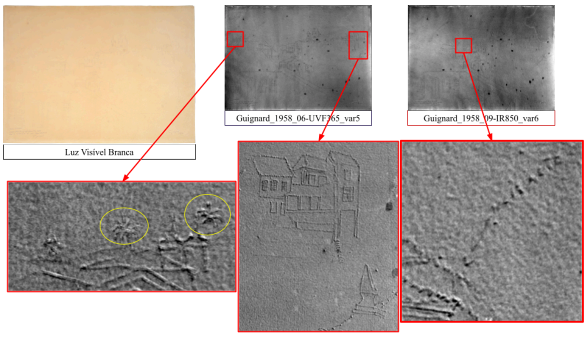
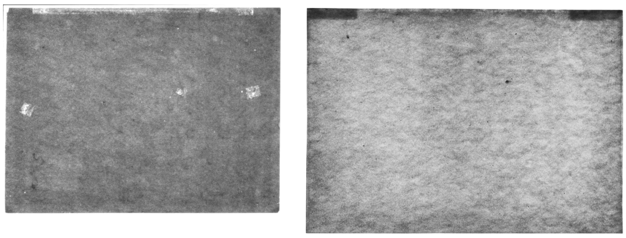


Figure 4b. *Details of PCA images generated from the work “Paisagem de Ouro Preto - Para Ângela”, de 1958. Photo: Alexandre Leão, Alexandre Costa, Larissa Oliveira.*

The reverse light photographs allowed the visualization of areas with differences in paper weight and the presence of adhesives, for example (Figures 5a and 5b).



Figures 5a and 5b. *A monochromatic image of the reverse light photograph of the drawings 'Ouro Preto Landscape' (1956, on the left) and 'Ouro Preto Landscape - For Ângela' (1958, on the right), respectively. Photo: Alexandre Leã, Alexandre Costa, Larissa Oliveira.*

The raking light photographs revealed the support deformations, creases, and marks. The grooves caused by the drawing materials are also evident in both artworks, making visible some drawings previously imperceptible.
The lines forming the church in the central part of the artwork became more prominent, as shown in the Figure 6a, just like the lines representing the buildings. It is possible to see this clearly in the lower left corner of the piece, according to the same figure.

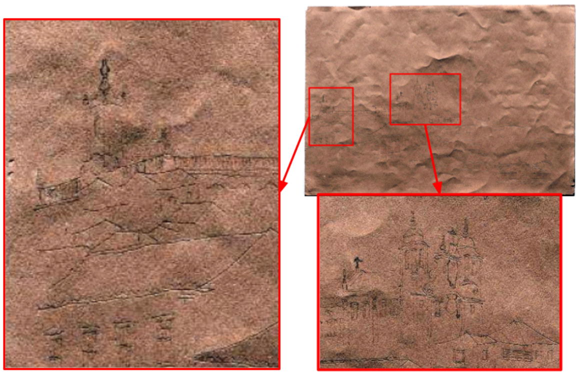


Figure 6a. *Details visible in the raking light photograph of the work "Paisagem de Ouro Preto", from 1956. Photo: Alexandre Leão, Alexandre Costa, Larissa Oliveira.*

In the drawing "Paisagem de Ouro Preto - Para Ângela" (1958), there is a mark in the upper right corner that is invisible to the naked eye, but after the use of some techniques – such as raking light photography – it became evident as it is shown in Figure 6b. The same happened with the artist's signature.

Figure 6b. *Details visible in the raking -light photograph of the work "Paisagem de Ouro Preto - Para Ângela", from 1958. Photo:Alexandre Leão, Alexandre Costa, Larissa Oliveira.*

The RTI allowed us to see some invisible details and even some that were barely perceptible. In the drawing "Paisagem de Ouro Preto" from 1956, by applying the *Specular Enhancement* filter with Diffuse Color at 0%, Specularity at 66%, and Highlight Size at 1%, it became possible to read the previously illegible dedication "Para Mania Jelihovsky," which is marked as point 01 in Figure 7a.
Using the same filter, we could also highlight almost imperceptible drawings under visible light, such as the one marked at point 02. Additionally, the artist's signature, shown at point 03, became visible with Diffuse Color at 0%, Specularity at 100%, and Highlight Size at 9%.

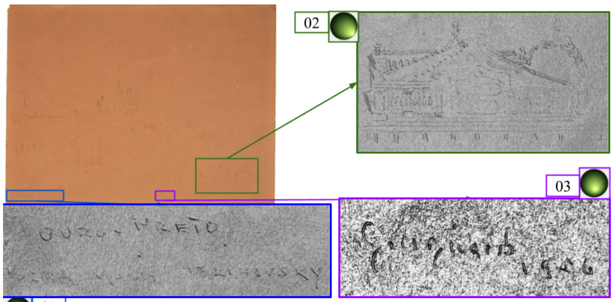


Figure 7a. *RTI details of the drawing "Paisagem de Ouro Preto", from 1956, with different filters. Photo: Alexandre Leão, Alexandre Costa, Larissa Oliveira.*

In the work "Paisagem de Ouro Preto - Para Ângela" from 1958, the application of the Specular Enhancement filter at point 01 in Figure 7b, with Diffuse Color at 0%, Specularity at 100%, and Highlight Size at 42%, revealed small palm trees – so characteristic of Guignard's works. At point 02 in the same figure, the filter helped to slightly highlight the lines of the church drawing, with Diffuse Color at 0%, Specularity at 69%, and Highlight Size at 66%.

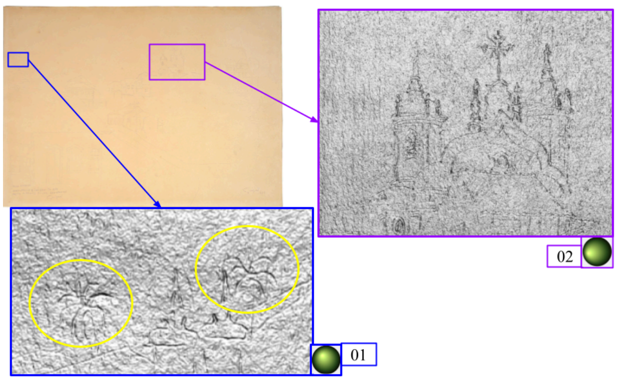


Figure 7b. *RTI details of the drawing "Paisagem de Ouro Preto - Para Ângela", from 1958, with different filters. Photo: Alexandre Leão, Alexandre Costa, Larissa Oliveira.*

The brightness, sharpness, contrast and many other enhancements were used by Photoshop CS4 to improve the visibility of the drawings generated by PCA, like the Figures 8a and 8b.

Figure 8a. *Visible Light (left) and PCA image (right) of the drawing "Paisagem de Ouro Preto" (1956). Photo: Alexandre Leão and Alexandre Costa (left), Larissa Oliveira (right).*

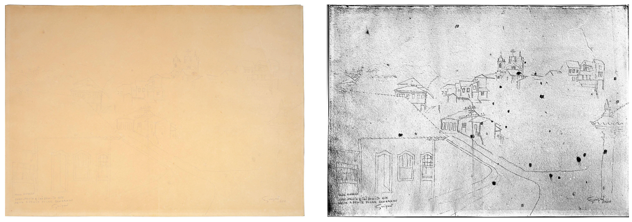


Figure 8b. *Visible Light (left) and PCA image (right) of the drawing "Paisagem de Ouro Preto - Para Ângela" (1958). Photo: Alexandre Leão and Alexandre Costa (left), Larissa Oliveira (right)..*

Conclusion

Scientific Imaging is crucial for the proper recording of works of art and can be used to restore the visibility of deteriorated pieces, as demonstrated in this work.
Details like the small palm tree drawings that are so common in Guignard's works, and illegible inscriptions that are barely visible to the naked eye – such as his signature on the 1956 drawing – are important details that help identify and authenticate the artist's works, as they are part of his creative process. The degradation process of these drawings is currently irreversible, which makes them harder to be read. However, by using scientific photography techniques, we can partially restore the function of these drawings, allowing us to more easily see the landscapes created by the artist.
Paper-based artworks are susceptible to fading due to intrinsic degradation, but the artist's intention remains marked in such a way that, depending on the material and technique used, it is possible to recover the work even after the fading, using such techniques. The generated images made the drawings visible mainly by the use of Multispectral imaging.
The Casa Guignard Museum has now the possibility of showing to the audience the original drawing in company of the Multispectral image. The public now has the opportunity to really understand the picture, and the cultural heritage professionals are able to study them.

Acknowledgments

FAPEMIG - Foundation for Research Support of the State of Minas Gerais, APQ-00237-22, Financial Support.

iLAB – Scientific Imaging Laboratory, PrismaLAB - Technical-Scientific Photography Laboratory, School of Fine Arts at UFMG – Federal University of Minas Gerais, Brazil; Cecor – Center for Conservation and Restoration.

To all the professionals at Museu Casa Guignard and the Museums Directorate of Minas Gerais, Brazil.

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