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INTERDISCIPLINARY STUDIES OF THE "VISTA DO DESTERRO" PAINTING: HISTORICAL APPROACH, ANALYSIS OF MATERIALS AND PRESERVATION/RESTORATION TECHNIQUES

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Abstract

Scientific methods of analysis are often used for investigation of artworks, and this is also the case of the painting entitled "Vista do Desterro", by Joseph Bruggemann, (1886) which is being restored at the Conservation-Restoration Atelier for Movable Cultural Heritage - ATECOR in Culture Foundation of Santa Catarina – FCC. This study used UV imaging methods, infrared spectroscopy (FTIR) analysis and energy-dispersive X-ray (SEM-EDS) analysis to identify the constituent materials of the referred artwork and previous interventions on it. All the analyses showed that drying oil was used as a binder, and a layer of terpenic varnish was also found. The possibly original pigments found were the following: lead white, natural sienna, brown ocher, synthetic ultramarine and yellow ocher. In addition, areas of at least two interventions were observed, where pigments barium sulfate (permanent white), titanium dioxide (titanium white) and traces of zinc oxide (zinc white) were detected; such pigments are typical of times later than that of the original painting. Finally, relining was identified, with use of glue based on vinyl substrate (standard PVA). This process was associated with the last intervention because of the date of this material. The chemical analysis of this artwork were crucial for the decisions about its restoration process, which also included an interdisciplinary team that joined forces to work on its historicity, supplemented by technical and conceptual analysis of the conservator-restorer responsible for restoration interventions.

Keywords: *Canvas paint; pigments; Art restoration; Art conservation; IR and EDS spectroscopy; UV light examination.*

Introduction

The use of scientific techniques of analysis applied to cultural heritage is gaining momentum around the world with recent studies [1-4], and the same has been happening in Brazil, with a wide and blended range of artworks that not only reveal their aesthetic beauty but are also usually attributed to cultures of a given people or ethnicity [5] and, thus, need to be

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preserved. Aging of such artworks begins at the time they are created and the physicochemical factors that contribute to these processes are varied e.g. temperature, light, relative humidity, pollution gases and even attacks by biological agents [6, 7]. The conservation of these artworks is a complex task that requires an interdisciplinary approach [8, 9].

The use of techniques for physicochemical analysis to identify constituent materials of artworks has a key role before any intervention process takes place, because the results of such analysis are extremely useful for making any decisions about the conservation or restoration of this material. In addition, as various pigments and binders were introduced at different times in history, each artwork or each restoration process can be dated precisely [10]. In Brazil, however, these types of analyses are not yet routine in conservation-restoration studios and research centers. At present, there is still very limited information available in our region about the materials and techniques used in movable heritage. Therefore, it is not yet possible to characterize and identify, from material aspects, the regional peculiarities and their evolutionary processes and, thus, understand the relationship between the artworks and the social, economic and cultural context where they were created.

The painting discussed in this study is titled *Vista do Desterro* (Fig. 1). It was painted by Joseph Bruggemann in 1866, and seeks to capture a panoramic view of the central area of the city of Nossa Senhora do Desterro, currently Florianópolis, located on the island of Santa Catarina, in southern Brazil [11-13]. The city of Desterro, as it was called back then, was also the capital of the province of Santa Catarina, which was part of the Brazilian Empire at the time (1822-1889). The painting is one of the most relevant artworks to the state of Santa Catarina. *Vista do Desterro* is one of the artistic productions that document the setting of one of the major urban centers of the province of Santa Catarina in the second half of the nineteenth century. It also illustrates and exemplifies the context of artistic production that existed in Brazil at that time, whose particular concern was that of portraying urban and natural landscapes.

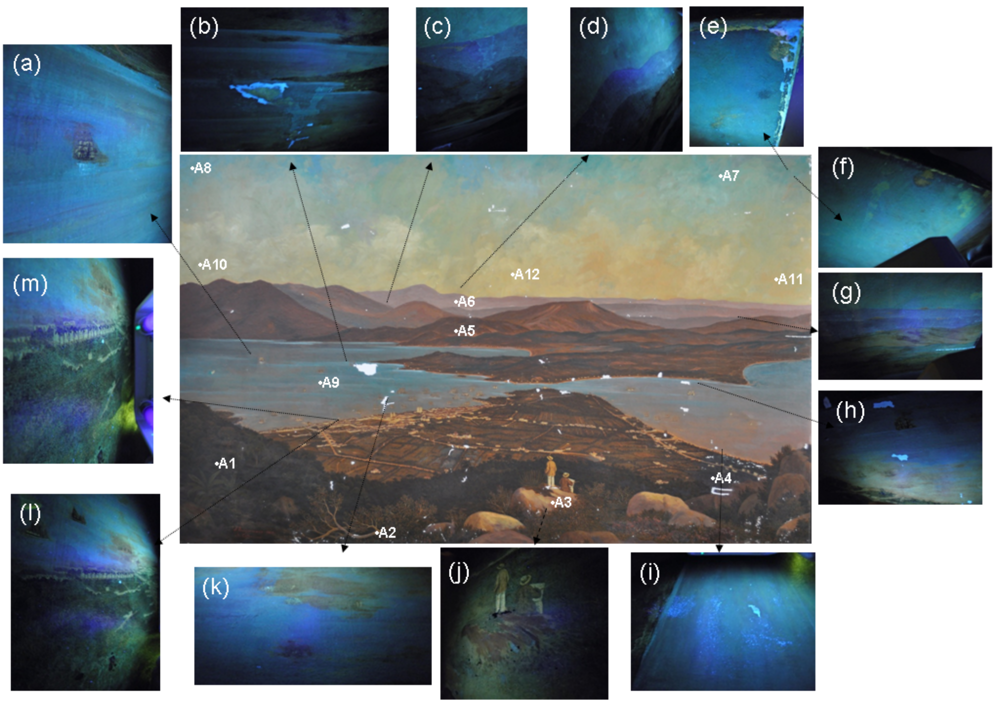

Fig. 1. Visible light photography showing the painting *Vista do Desterro* at the center, and UV photos revealing the interventions made

The painting *Vista do Desterro*, in addition to the artistic perspective of the nineteenth century it represents, is also linked to the production of historical knowledge in the context of urban iconographic sources, which allow us to understand the existing social representations of cities. This way, images are elements which support representations and discursive constructions that are associated with historical forms of perception and interpretation, as well as available languages and techniques, in addition to existing concepts and values [14, 15]. Paintings enable studies focusing on a range of issues related to social life of the period when they were produced.

This model for portraying landscape, as Brüggemann did, is the transposition of European practices and models prior to the emergence of aesthetics in the eighteenth century, where beauty exists in nature and is object of the senses, known and judged by the intellect, so that the artist assimilates the aesthetics of the picturesque and enjoys, as a spectator, the spectacle offered by nature [16-18].

Based on the iconographic, aesthetic and historical background of this artwork, interdisciplinary discussions were carefully held before any action or decision was made regarding conservation-restoration procedures for this physical and artistic representation, wherein Baldini believes that "matter is supportive of time", and can be very revealing [19].

The major concern which also motivated the development of an analysis and discussion of this artwork of Brüggemann's is due to the fact that mistakes were found in the restoration process of another artwork by this artist. The replica made by Brüggemann of another of his paintings, a maritime panoramic view of Desterro city (1866), was restored during the 1970s by the Department of National Historical and Artistic Heritage (DPHAN). Images that did not exist in the original painting were added, changing its original features [15]. Although that replica was made by the author himself, the additions reflected the weakness of the conservation and restoration approach towards his work.

Given the above, it should be noted that, since the second half of the nineteenth century, the painting Vista do Desterro, object of this study, has suffered a number of undocumented interventions and deterioration reactions of both the pictorial layer and the support, except for the last restoration intervention conducted in the Ateliê de Conservação-Restauração de Bens Culturais Móveis (Conservation-Restoration Studio for Movable Heritage/ATECOR) of Fundação Catarinense de Cultura (Culture Foundation of Santa Catarina/FCC), which has been duly discussed and documented. The main objective of this study is to show the results of analyses of the constituent materials of the work Vista do Desterro by infrared spectroscopy (FTIR), energy dispersive X-ray spectroscopy (EDS) microanalysis as well as ultraviolet light mapping. Another objective is to describe the restoration process of this painting. The development of this restoration work relied on an interdisciplinary team comprised of experts from different educational and training backgrounds, whose expertise was complementary to that of the other team members and crucial to the outcomes. The results were fundamental to guarantee the authenticity and legitimacy of this painting on canvas, which was invaluable to the cultural heritage of the state of Santa Catarina.

Materials and methods

Before any decision is made about an intervention process using conservation-restoration techniques, a detailed identification is required of the state of conservation and the constituent materials of the artwork in question. The collection of materials favored the representation of the painting as a whole and was performed by a conservator-restorer. The painting *Vista do Desterro* has been carefully mapped and observed by restorers and scientists for macroscopic detection of specific areas that are most appropriate for investigation by chemical and physicochemical methods. These areas represent the whole of the painting under study. Recently collected paint fragments were dried at 60°C in an oven to eliminate moisture before analyses were made. All materials and reagents used in the analyses in this study were obtained from commercial sources without previous purification.

Ultraviolet photography

Ultraviolet images were collected with a Sony DSLR 16.1 MP digital camera and a Ramsor hand lens coupled with a UV lamp (285nm). For data collection, the target areas were those that showed changes in the presence of UV radiation. The images were collected by the photo camera, which was always between 30 and 60cm far from the painting.

Infrared Spectroscopy

Infrared spectra of each sample were obtained on a Jasco 4100 FTIR spectrometer, in KBr pellets.

Energy-dispersive X-ray spectroscopy

The semi-quantitative study of the elements in each of the analyzed pigments was carried out using an energy-dispersive spectrometer coupled to a scanning electron microscope in a JEOL JSM-6390LV microscope at the Central Laboratory of Electron Microscopy at the Federal University of Santa Catarina (UFSC).

Conservation-Restoration Process

The procedures for the conservation and restoration of the painting *Vista do Desterro* were performed in accordance with the recommendations in heritage charters [20] and the theories by Cesare Brandi [21]. Prior to any intervention, the painting had to be mapped, and some steps were required for this purpose: photographic documentation, diagnosis of state of conservation and chemical analyses. After these steps, the following restoration procedures were performed: frame removal, emergency facing, consolidation of cracks, pictorial testimony of the oldest paint at the edges of the artwork, stretcher removal, flattening, cleaning, edge reinforcement, placement of new stretcher, flattening, pictorial reintegration, application of protective layer and, finally, placement of the canvas back to the frame.

Results and discussion

Ultraviolet photography

Ultraviolet photography is a fundamental analysis technique to identify the state of conservation of artwork because it shows recoating, oxidation of aged varnishes (presence of chromophores) and other materials that fluoresce in the presence of UV light [10, 22]. Figure 1 shows the photographs taken in the presence of UV light as well as the sites of sample collection for spectroscopic analysis.

Figure 1 shows several areas that have materials with fluorescent characteristics. Figure 1a and b show a darker and lighter blue region, typical of ultramarine pigments ($Na_{8-10}Al_6Si_6O_{24}S_{2-4}$) [10]. Figure 1c and d are extremely important, as they show that part of the mountain (further above) has been repainted at some point in the history of the painting, and one can clearly see that this mountain has fluorescent material. The two other parts are characteristic of older materials and use of non-fluorescent material such as red ocher ($Fe_2O_3 \cdot nH_2O$), for example, or sienna, which contain compounds made of silicates and aluminates. Figures 1e and f, just like figure 1a and b, show the presence of the same type of material, and the same color pigment reacts similarly to ultraviolet radiation. Figure 1g confirms, once again, over coating of the top of the mountain and the non-fluorescence of the material used in the other two parts. Figure 1h reveals the same bluish region present in other regions, such as figure 1i, and the underside of the painting shows, again, a non-fluorescent brown color, confirming the use of red ocher. In figure 1j, two different areas can be observed: one displaying the older non-fluorescent brown color and a possible area of reintegration. Finally, figure 1k, l and m show the same situation of the other parts, proving the use of the abovementioned materials.

FTIR and EDS analyses

Spectroscopic analyses helped to disclose some of the materials detected by ultraviolet light imaging, both in areas were interventions were identified and in older areas. All collected IR spectra of paint have bands ranging between 3530-3439cm^{-1}, typical of υO-H stretch, and bands at 2921-2926cm^{-1} on υC-H stretch 1734-1716cm^{-1}, attributable to υC = O stretches. This spectral profile proves that oil painting was the technique used both in original areas and areas of intervention [23].

Samples between A1 and A6 are associated with brown and ocher pigments, whereas the older, supposedly original samples were identified by FTIR (Fig. 2) in bands at 1080 and 1040cm^{-1}, which could be associated with a terpenic varnish, because it presents a considerable rate of aging, making these areas yellowish [24].

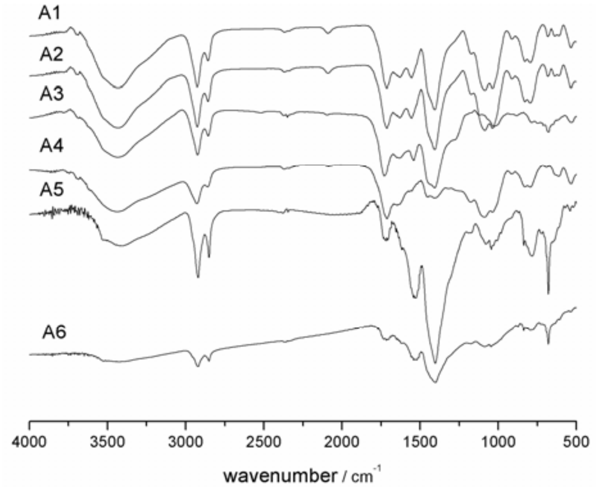

Fig. 2. Infrared spectra of brown and ochre areas

Such aging is related to the exhibition of the painting in unsuitable conditions of humidity, temperature and even pollutants such as gases, sulfates, nitrates, etc. and also the proximity to the marine environment in an atmosphere rich in chlorides, especially, which can sharply accelerate degradation of the varnish. It was also possible to identify the absence of bands in the varnish in samples A3 and A6 (the stone and the third layer of the mountain respectively – Figs.1c, d and j), which is evidence of the interventions observed by UV light, whereby only the presence of pure paint can be seen, without the subsequent application of a layer of varnish. The analysis of these layers by EDS (Fig. 3) was crucial to determine the pigments used, and in all older areas, lead white - $2PbCO_3 \cdot Pb(OH)_2$ - was identified as a basic compound of the coating primer used by the painter and elements such as Fe, Si and Al, typical of natural sienna, $Fe_2O_3 \cdot nH_2O$, Al_2O_3 and silicates, were identified in the pigment used in areas A1, A2 and A5, characterized as being possibly original.

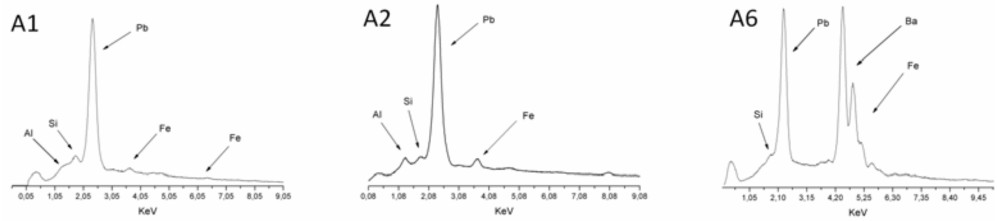

Fig. 3. EDX spectra of the brown and ocher pigments

Sample A6 (Fig. 1c) showed the absence of Al and also the presence of Ba and some traces of lead as a result of contamination with the older pigment. Thus, this intervention was characterized by the use of permanent white, $BaSO_4$, and also a brown pigment with the absence of Al, possibly ocher brown, $Fe_2O_3{\cdot}H_2O$ and clay [10], proving the intervention that was evidenced by ultraviolet imaging.

Samples A7, A8 and A9 refer to blue pigments which were also mixed with lead white when applied, at the FTIR spectra (Fig. 4) of the three samples. It is possible to notice a sharp signal at 1041cm^{-1} which refers to the υSi-O-Si stretch, characterizing the ultramarine blue pigment [24]. The absence of the band at 2341cm^{-1} was also noted, confirming that the pigments used are synthetic and consistent with the date of the nineteenth century [25]. Natural ultramarine blue was traditionally obtained from the mineral lapis lazuli with a complex process of selective extraction of blue particles, as reported in the literature [26]. On the other hand, it had already become available as a synthetic pigment by 1830 [27]. The FT-IR spectrum is used to differentiate between natural lapis lazuli and synthetic ultramarine. It was reported that the FT-IR spectra of natural ultramarine blue samples from Afghanistan showed a narrow at band 2341cm^{-1}, which was absent in the spectra of synthetic pigments.

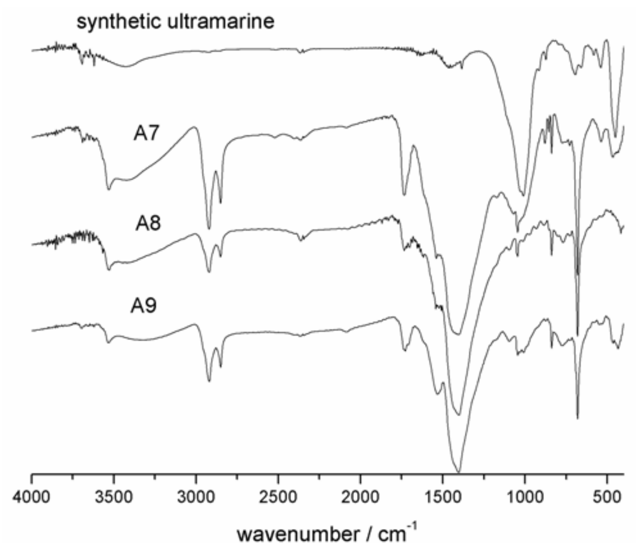

Fig. 4. Infrared spectra of the blue areas and synthetic ultramarine standard

EDS analysis (Fig. 5) shows, in both samples, the elements Na, Al, S and Si, confirming the pigment used - $Na_{8-10}Al_6Si_6O_{24}S_{2-4}$ - as revealed by FTIR and ultraviolet photography. However, Ti was identified in sample A8, and associated with the white pigment titanium oxide, TiO_2, which began to be used only in the twentieth century and, thus, characterizes an intervention area. It is a different base pigment from the one used in interventions in the areas of the brown pigment, so it can be concluded that the painting had two interventions, one perhaps back in the nineteenth century and the other in the twentieth century. Another method for verification of synthetic ultramarine is the ratio between Si and Al atoms which is between 0.60 - 0.80 [28]. In the semi quantitative analysis, the weight ratio Al/Si was 0.66, 0.59 and 0.81 for samples A7, A8 and A9, respectively. The values were at the upper and lower limits, and this may be due to the limitations of the technique; nevertheless, it is a simple and effective means of proving the use of this synthetic pigment.

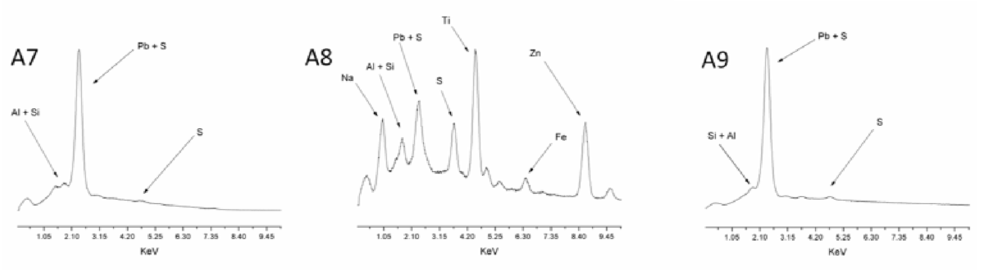

Fig. 5. EDX spectra of the blue areas

The yellow pigments present in the sky are characteristic of samples A10, A11 and A12. EDS spectra (Fig. 6) of sample A10 had the elements Al, Zn, Fe and Ti, featuring another intervention area, with the use of the pigments yellow ocher, titanium oxide and zinc white, possibly, since the absence of chrome rules out the possibility of zinc yellow and the typical IR bands (Fig. 7) showed only traces of terpenic varnish.

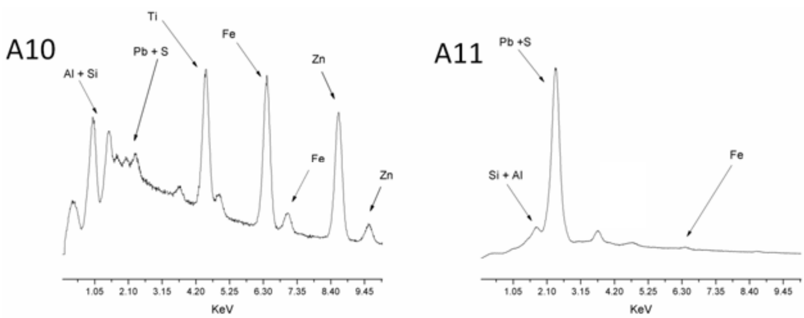

Fig. 6. EDX spectra of the yellow areas

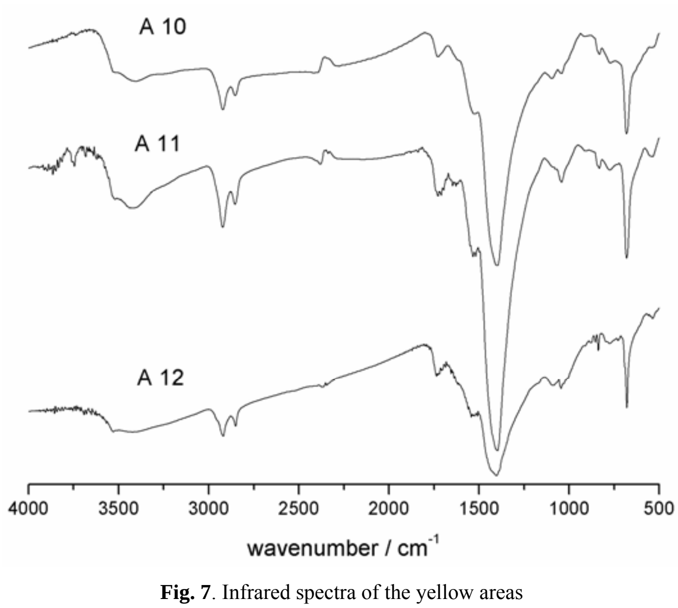

Fig. 7. Infrared spectra of the yellow areas

However, samples A11 and A2 have only the elements Pb, Fe and Si, characterizing possibly original areas, where the lead white pigment was used again. This is similar to the area represented by sample A8, a region located above A10, which can be characterized as a recoating, probably made around the same time, because of the similarity of materials used in both areas. Also, the presence of traces of ultramarine blue can be observed by EDS and the absence of lead perhaps signals; in this case, a total loss of the oldest pictorial layer and the need to recover it using other materials, as clarified in this study.

On the back of the painting, a process known as relining[1] was identified. It is an ancient and common restoration practice which strengthens the canvas with the original pictorial layer in areas with problems of degradation. The glue used in this process was collected, sample A13, and the result of FTIR (Fig. 8) showed mild features at 3379cm^{-1} referring to υOH and 1729cm^{-1} stretches assigned to υC = O.

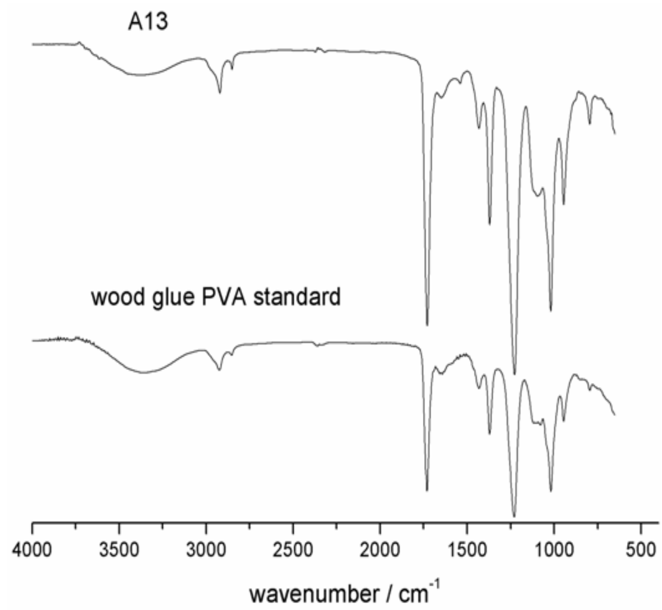

Fig. 8. Infrared spectra of the glue found in the relining process as well as of the standard PVA wood glue

These spectra were evidence that standard wood glue could have been used. To prove this, a standard of type of glue was used in this study, proving that the type of glue used in this case was really standard wood glue. This investigation proves the second intervention abovementioned, because this type of glue got into use around 1915; this intervention may be associated with the last intervention to the painting because of the same material found as the basis for the paints (titanium white) dates from that time, as well.

Table 1 summarizes the spectroscopic characterization and reports and materials identified in each analysis.

[1] The relining technique consists in adhering a new piece of fabric, preferably linen, to a work of art on canvas that is already degraded, i.e. torn or worn warp and woof, "threadbare", tears, cracks and other damage that can endanger the stability of the pictorial layer, representative of the artistic expression. Linen is the most frequently used fabric because its woof does not deform with time; cotton, for example, deforms with moisture because it is a more hygroscopic material. The fabric used for relining is stretched over a provisional stretcher, and an adhesive is applied on it (animal glue, resin and others). With a gun and a compressor, the adhesive is applied on the fabric and on the back of the original painting, i.e., on the two surfaces, which are then overlapped, enveloped and placed on a heated vacuum table for perfect adhesion.

Table 1. List of sampling points, principal FTIR bands, EDS analysis and type of material found

Sample	Description of material	Typical bands on infrared (cm^{-1})	Elements identified by EDS	Conclusions
A 1	Layer containing brown and ocher pigments	3439, 2926, 2855, 2091, 1716, 1403, 1086, 1037, 828, 793	Pb, Fe, Si, Al	Oil paint, terpenic varnish, lead white, ocher brown, sienna
A 2		3439, 2926, 2855, 2091, 1716, 1403, 1087, 1037, 828, 793	Pb, Fe, Si, Al	Oil paint, terpenic varnish, lead white, ocher brown, sienna
A 3		3439, 2926, 2855, 2091, 1716, 1403	-	Oil paint, absence of varnish, absence of bands 1080 and 1040cm^{-1}
A 4		3439, 2926, 2855, 1716, 1432, 1086, 1037, 828	-	Oil paint, terpenic varnish
A 5		3439, 2926, 2855, 1716, 1543, 1403, 1042, 781, 681	Pb, Fe, Si, Al	Oil paint, terpenic varnish, lead white, ocher brown, sienna
A 6		2926, 2855, 1716, 1716, 1543, 1060, 679	Pb, Fe, Si, Ba	Oil paint, absence of varnish, absence of bands 1080 and 1040cm^{-1}, lead and barium whites, ocher brown (sienna undetected)
A 7	Layer containing blue pigment	3530, 2921, 2851, 1734, 1532, 1405, 1070, 671	Pb, Na, Al, Si, S	Oil paint, terpenic varnish, lead white, synthetic ultramarine blue
A 8		3530, 2921, 2851, 1734, 1405, 1070, 671	Pb, Ti, Zn, Na, Al, Si, S	Oil paint, traces of terpenic varnish, lead white, titanium white, zinc white, synthetic ultramarine blue
A 9		3530, 2921, 2851, 1734, 1405, 1070, 671	Pb, Na, Al, Si, S	Oil paint, terpenic varnish, lead white, synthetic ultramarine blue
A 10	Layer containing yellow pigment	3408, 2921, 2851, 1731, 1527, 1405, 1037, 683	Al, Fe, Zn, Ti	Oil paint, traces of terpenic varnish, titanium white, zinc white, ocher yellow
A 11		3408, 2921, 2851, 1731, 1527, 1405, 1037, 683	Pb, Fe, Si	Oil paint, terpenic varnish, lead white, ocher yellow
A 12		3408, 2921, 2851, 1731, 1527, 1405, 1037, 683	-	Oil paint, terpenic varnish
A 13	Glue used for relining	3379, 2920, 2848, 1729, 1641, 1537, 1430, 1369, 1226, 1093, 1018, 941, 795	-	Comercial PVA wood glue

Restoration Process

This section reports the results and discussions on the restoration techniques used in the referred painting and previously described.

- **Photographic and textual documentation**: this was the first step performed before any intervention. It encompassed the photographic records and documentary research on the target painting. This enables the understanding of the context of this pictorial representation. Digital photographs were taken of the painting as a whole and the details of degradations, as technical document for intervention.
- **Diagnosis and analysis of the state of conservation**: thorough double-sided scrutiny of the painting was carried out to identify its state of conservation; degradations were described and visible damage was recorded on a diagnosis file – for example, color fading, dirt, cracking, loss of coating, bulging, recoating areas and previous interventions, tears and punctures, areas of infestation by insects or microorganisms, and chemical analysis. This procedure also included the identification of the origin of the painting, its dimensions, technical and historical data. To integrate the interdisciplinary areas involved in this step, various registration documents and types of records and registers were created, thus forming a *dossier* on the painting, along with the photographic documentation. IPHAN, in line with the Heritage Charters argues that "... the first step before an intervention should be knowledge of its history, the materials used and its physical state; a thorough diagnostic, followed by the decision about the type of action to be taken for the preservation of heritage" [29].

- **Frame removal:** the frame of the painting is made wood with golden paint and resin reliefs. The painting was placed on a protected surface and the frame was removed by detaching and releasing it from the painting for restoration purposes. The frame also received a mending intervention, mechanical cleaning (soft paint brushes and a vacuum cleaner) and chemical cleaning with xylene. In addition, some small missing portions were recovered with PVA resin and sawdust.
- **Emergency facing**: the edges and areas with damaged support were faced to avoid increasing the damage already observed in the painting. Such facing was done with Japanese tissue paper and adhesive carboxymethylcellulose diluted in deionized water at 5%. Because of the long fibers of this paper, the painting could be safely handled.
- **Consolidation of (flaking and detaching) cracks**: the paint was consolidated by procedures that occur at different times of restoration. After the Japanese paper was removed, the most critical points (with paint detachment) received adhesive application. In the case of permanent consolidation of detaching cracks, animal glue diluted in deionized water (1:1) was used as adhesive and was subsequently applied in heat treatment. Excess consolidant was removed from the surface with hot water.
- **Pictorial control of the original painting at the edges of the artwork:** a choice was made by the restoration team to leave a record of the original color on the edges and also to document the state of degradation of the pictorial layer and see the extent of missing portions and losses. Recoating was removed only by the edges as control, but when the frame is placed back on, these edges with the original paint will be hidden. This procedure of concealing recoating removal was done on purpose because otherwise it can interfere visually, modifying the aesthetics of pictorial representation. The advantage of this procedure is that it enabled recording the pictorial layer and also collection of samples of the original pigments that were used for chemical analysis. This step was decisive for the procedures that followed, as the analyses are fundamental to the understanding of the painting and its behavior over time.
- **Stretcher removal** - Before removing the frame and the frame, the paint layer was protected with emergency facing at the edges and in areas with damaged support, to avoid the damage incurred from expanding along the work of art. The painting was placed on a flat, protected surface and the frame was removed by detachment. Then the staples securing the canvas to the stretcher were removed. After completely loose, the canvas was suspended by several hands, releasing it from the stretcher.
- **Flattening**: as the relined original canvas had bubbles and was uneven, it was necessary to flatten its pictorial surface carefully on the heated table with the aid of a heated spatula and then put some light weights to keep the canvas flat to revive and solidify the relining adhesive again. This happened as expected by adding more intense heat (heated spatula) sporadically and moderate heat (heated table) on the whole painting.
- **Cleaning: Mechanical and chemical cleaning;** an artwork can be cleaned superficially or thoroughly, with two different methods: mechanical cleaning and chemical cleaning. Mechanical cleaning is superficial, done with a dry soft brush or a low suction vacuum cleaner. The intention with this type of cleaning is to remove light dust and all dirt particles deposited over time on the surface of the painting; it is what we call "dust of gravity." Deeper and more particular may be done with a scalpel to remove the excrement of insects or a thicker layer of dirt. Chemical cleaning is a method used to remove thick dust, fatty materials, waxes, resins, glues, recoating and damaged varnish added to the artwork. The painting was manually cleaned with cotton swab, scalpel, magnifying visor, using special illumination with cold light, protecting the back of the artwork and keeping the flatness of it during the mechanical cleaning by application manual effort that does not damage the surface of the artwork. Prior to chemical cleaning, tests were made not to affect the aesthetic appearance of the artwork. It is thus essential to carry out preliminary tests for evaluating and identifying damage to ensure the successful implementation of the procedure, thus maintaining the

structure and appearance of the artwork. Taking into consideration the results of the chemical analyses which identified the type of paint used, a choice was made for the use of deionized water when carrying out chemical cleaning.

- **Edge reinforcement**: edge reinforcement was used to protect the original edges, and also to reattach the painting to the new stretcher more easily. This reinforcement was made with strips of previously washed and dried linen. These tissues were attached to the original artwork with Beva® film (acrylic resin film) by means of heat treatment with a heated spatula. This film is a fully reversible product that can be removed in the future without affecting the integrity of the work.
- **Placement of new stretcher**: the painting received a new large stretcher, made of noble, lightweight wood (Spanish cedar), considering the most appropriate preservation methods [30]. This wood has been waxed with microcrystalline wax and treated with deltamethrin as a preventive treatment, reducing the risk of attack by wood-destroying insects. The work was secured with galvanized staples to prevent oxidation. Excess fabric used for edge reinforcement was rounded off by the back, skirting the edge, and then stuck by staples. Only after the recovery of the structure (support/volume), the volumetric restoration of the artwork could be viewed, this is critical for the final outcome.
- **Flattening**: the areas of the canvas with loss of original paint were filled with a flattening paste made with calcium carbonate ($CaCO_3$) diluted with 3.5% polyvinyl alcohol. Thus, the missing portion is recomposed by flattening the area up to the surrounding areas in order to enable chromatic reintegration, which is made with removable restoration pigments, in case of future intervention.
- **Chromatic reintegration**: reintegration was achieved with *tratteggio* painting techniques. The development of these techniques consisted in applying - only in areas with flattening paste - Maimeri gouache tempera paint, recommended for restoration of artworks, and avoiding the use of toxic products, thus preserving the temporal aspect of the artwork, the patina of time, as argued by Brandi [21], where the intent is to keep the "potential of the work in all its manifestation, without making false art or false history" [our translation]. The team sought to maintain awareness of the technique and the material that was used in the composition of the painting, because when patina is recovered or changed, the technique employed will guide the use of materials and products which do not alter the artwork in the future. Whether traditional materials and products or new technologies are used, the artwork will remain stable when using materials or products whose properties are similar to those of the original artwork. Upon reinstatement, the expression of authenticity of the matter cannot be influenced by retouching. The unity of the artwork has to be preserved without interrupting the reading of it.
- **Application of protective layer**: the application of varnish for aesthetic effect (brightness) or as a protective layer, usually on the canvas with oil paintings, coats of glossy or semi-gloss varnish, applied with a compressor to ensure homogeneity. This protection of the artwork shall meet the specific needs of each case, seeking maximum protection to the artwork by using compatible protective products that will not damage either the artwork or its appearance in the future. Although it is a common procedure to apply a protective layer, the team chose not to apply any layer of protection (wax or varnish) on the canvas or the reintegrations with paint - tempera. This decision was based on the chemical analysis, which showed the presence of terpenic varnish still present in the painting; thus, applying a new protective product could cause adverse reactions and damage the pictorial layer.

Conclusions

The present study made an analytical historical survey of the artwork *Vista do Desterro*, as well tests and chemical analysis for familiarization with the type of materials that make up the pictorial layers of the painting; the chemical agents responsible for its degradation were also identified. The expected result of this interdisciplinary research is the possibility to contribute to future restoration initiatives and assist in the preventive conservation of the painting, as well as identify, in an unprecedented way, pigments and chemical elements that make up this painting, thus ensuring its authenticity and materiality. In general, it could be observed that there are numerous interventions in different parts, with no clear and systematic correspondence between them. As a general conclusion, this comprehensive study found that the oldest polychrome, possibly the original one, contains lead white as a primer for the painting because it is being referenced in all analyses of the older layers. In addition to helping recovery and highlighting the materials that make up the referred artwork, this study demonstrated the importance of partnerships in various areas of scientific knowledge associated with interdisciplinary research.

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