INTERNATIONAL JOURNAL OF CONSERVATION SCIENCE
ISSN: 2067-533X Volume 14, Issue 3, July-September 2023: 1221-1232 www.ijcs.ro
DOI: 10.36868/IJCS.2023.03.29

ANTÓNIO CARNEIRO'S PAINTING COLLECTION FROM THE MUNICIPALITY OF OPORTO. STUDY AND CONSERVATION IN THE 150th ANNIVERSARY OF THE PAINTER'S BIRTH

Carolina BARATA[1,2,*], Ana CABRAL[1], Maria AGUIAR[2], Laura CASTRO[2], Ana MACHADO[3], Ana CARDOSO[4,5], Sara VALADAS[4,5], Luís PIORRO[3]

[1] Municipality of Oporto, Division of Museums, Rua de Entre Quintas, nr. 219, 4050-240 Porto, Portugal
[2] CITAR, Rua Diogo Botelho, 1327, 4169-005 Porto, Portugal
[3] José de Figueiredo Laboratory, Rua das Janelas Verdes, nr. 37, 1249-018 Lisboa, Portugal
[4] HERCULES Laboratory, IN2PAST Associate Laboratory and ERIHS.pt – Institute for Advanced Studies and Research, Evora University, Largo Marquês de Marialva 8, 7000-809 Évora, Portugal
[5] City University Macau Chair on Sustainable Heritage – Institute for Advanced Studies and Research, Evora University, Rua Dom Augusto Eduardo Nunes 7, 7000-651 Évora, Portugal

Abstract

This paper presents a summary of the results obtained in the first approach ever made to the characterization of the materials and techniques used in the oil painting production by António Carneiro (1872–1930), one of the best portuguese painters in the transition from the 19th to the 20th centuries. A selection of ten oils on canvas belonging to the Municipality of Oporto were analysed using a set of non-invasive techniques: Infrared Reflectography, Ultraviolet Fluorescence Photography, X-ray Fluorescence Spectrometry, Fiber Optics Reflectance Spectroscopy and Fourier Transform Infrared Spectroscopy. The results obtained suggest the use of materials and techniques established in Europe at the turn of the century. The palette is composed of Pb, Zn, Hg, Cr, Cd, Cu, and Co-based pigments, associated with both traditional and recently introduced materials. The great missing element is Ti, associated with Titanium White, available on the market since 1918.

Keywords: *António Carneiro; XRF; FORS; FTIR; Easel Painting; Oil On Canvas; Symbolism; Turn of the 20th century*

Introduction

António Carneiro (1872–1930), considered the first Portuguese representative of the symbolist movement, is one of the most important artists in the history of Portuguese painting during the transition between the 19th and 20th centuries. He was a renowned artist during his lifetime, and he has received several national and international awards. He also taught at the Fine Arts Academy of Oporto, where he began his training at the age of 12 years old [1].

He had excellent drawing skills, and he left a vast number of sanguine, charcoal, paint wash, and graphite drawings, which not only served him as studies for paintings but assumed the category of works of art in their own right [1]. When painting with oils, he preferred canvas supports, but he also used wood. On cardboard and paper, he painted in watercolour and pastel.

His work is represented in the collections of several Portuguese institutions and private collectors. However, the largest number of paintings and drawings, along with documents, photographs, and personal objects, including some working instruments and artists' materials,

* Corresponding author: carolinabarata@cm-porto.pt; Tel: +351 226 057 000

are concentrated in António Carneiro's Studio, where the painter lived from 1925 to his death and which has belonged to the Municipality of Oporto (CMP) since 1971.

The studio opened as a museum in 1973. It has been closed since 2018 and is now being refurbished to reopen at the end of 2023.

Having practiced different artistic genres, some with a unique approach, António Carneiro's work, with a markedly intimate and uncluttered character, may be divided into four fundamental themes, according to Laura Castro's proposal [1]: symbols, portraits, family scenes, and landscapes, all of them present in the different stages of the painter's life, which is more easily divided by types and not by chronological order.

Although it has been the subject of numerous publications in the field of Art History throughout the 20th century and into the 21st century [1-6], there is no information available about the painter's creative process in terms of the techniques and materials used. The same happens with regard to the deterioration phenomena to which these materials were subjected. This lack of information, which places important constraints on the ability to inform the public on the artistic techniques and the conservation of the collections, is common to a large number of Portuguese artists of this period, excluding rare exceptions such as Francisco José de Resende [7], Silva Porto [8], Marques de Oliveira [9], Columbano Bordalo Pinheiro [10], Henrique Pousão [11] and Aurélia de Sousa [12].

With the objective of collecting information on the technique of this artist and, at the same time, contributing to the knowledge of Portuguese painting at the turn of the century, a first laboratory study was conducted, making use of the PT-MOLAB of the E-RIHS infrastructure, on a selection of ten oils on canvas from António Carneiro's Studio, produced between 1899 and 1929.

The ongoing laboratory study is part of a wider plan that also includes: the survey of the artist's personal documents in search of information related to the painting technique; the comparison between the supports (canvas, paper, and cardboard), the stretchers, and the frames used in the works with the ones available in the Oporto market at the time. The results obtained will be disseminated, namely through the exhibitions planned for the reopening of the Studio.

Experimental part

At CMP, there are 315 works, of which 39 are oil paintings on canvas and wood (datable from 1899 to 1929). The remaining 276 are sketches, drawings, and paintings on paper (graphite, charcoal, pencil, sanguine, ink wash, and watercolour).

From the 39 paintings belonging to CMP, 10 works have been selected for analysis, trying to cover this span of thirty years (1899–1929) and the 4 themes identified (Fig. 1).

Fig. 1. Selection of paintings analysed in this study by chronological order

In this case, chronology is important in order to understand if there were significant changes over time concerning methods and materials.

It was also intended to avoid paintings that have been restored. However, after close observation, it became evident that all 39 paintings underwent restoration campaigns.

In the case of 23 paintings, and based on statements and reports provided by restorers, it was possible to know that these works have been: relined or consolidated with wax resin; consolidated with acrylic emulsions; varnished with keton; and more recently, with acrylic resins. In some cases, it was retouched with oil colours. Glass slides with samples of these materials were prepared as references.

The analytical study was performed using Infrared (IR) Reflectography, Ultraviolet (UV) Fluorescence Photography, Energy Dispersive X-ray Fluorescence (EDXRF), Fiber Optics Reflectance Spectroscopy (FORS), External Reflection Fourier Transform Infrared Spectroscopy (ER-FTIR).

Sampling representative areas from paint and ground layers in order to guide in situ analysis was very difficult since paint layers are extremely thin and they are completely impregnated with the adhesives and varnishes that were applied during the restoration interventions. Also, there were practically no cracks or gaps through which samples could be collected. This impregnation would also influence the quality of the analytical results. The few collected samples were observed through Optical Microscopy (OM) as cross-sections.

A digital microscope was also used for surface observation.

OM

Five paint samples were mounted as cross-sections on epoxy resin *Metkon® Epocold* and examined with the optical microscope *Olympus® BX41*, under reflected light at 100x and 200x magnifications. Photographic records were taken with the *Dino-Eye AM7025X Edge Series 5MP Eyepiece Camera*.

Digital miscroscopy

A Dino-Lite digital microscope was used for capturing magnified images in order to illustrate: the structures of the supports, brushstroke direction, surface paint texture, the overlapping of paint layers, pictorial techniques such as wet-in-wet and wet-in-dry layering, distinguish original and non-original areas, and observe deterioration phenomena on the surface of the paintings.

IR Reflectography

IR reflectography was performed with a high-resolution APOLLO camera from OPUS Instruments. It was used to verify the presence of underdrawing and the respective technique used, whenever it existed, and assess the extent of any damage to the paint layers.

UV fluorescence photography

Photography of visible fluorescence with ultraviolet radiation was performed using a Nikon D2X camera equipped with an AF-S Nikkor 28–70mm 1:2.8D lens and compensation filters. Source of ultraviolet radiation: two towers of four mercury vapour lamps - Wood OSRAM lamps - SUPRATEC UV.

This method was used for the identification of areas where varnishes were used, their natural or synthetic characterization, and degree of deterioration, as well as for distinguishing non-original or retouched areas.

EDXRF (150 spectra)

X-ray fluorescence spectrometry was used for elemental characterization of the pigments using a portable Bruker Tracer 5i spectrometer equipped with an X-ray generator with a Rhodium anode and an X-Flash SDD detector. The experimental conditions applied were as follows: methods Spectrometer (40kV and 30μA) acquisitions of 60sec. The spectra obtained were interpreted with the ARTAX software.

FORS (80 spectra)

Fibre Optics Reflectance Spectroscopy (FORS) analysis in the UV-Vis-NIR region was performed using an i-Spec 25 portable spectrometer (BWTek) with a fibre optic probe with a tungsten halogen source (5W), a focal aperture of 5mm, an InGaAs sensor, and three detectors operating in the 400–2500nm spectral region. Analyses were performed using iSpec 4 software.

This method was used to corroborate the interpretation of the elemental analysis in the identification of pigments.

ER-FTIR (80 spectra)

For in-situ analyses, a Bruker ALPHA spectrometer with an external reflection module was used. The built-in video camera made it possible to control the analysis area with a diameter of 6mm. The IR spectra were acquired in the range of 4000-375cm^{-1}, with a spectral resolution of 4cm^{-1} and 128 scans. The OPUS 6.5 Bruker programme was used to process and treat the spectra.

Infrared spectroscopy was selected for the general characterization of the classes of binders and varnishes used and also of some pigments.

Results and discussion

Supports

António Carneiro used mainly very thin and dense canvases. Thin ground layers covering the entire surface of the fabric and pencil-marked clean cuts made with a blade indicate the use of pre-prepared industrial material (Fig. 2). Commercialization of ready-made supports started in the first half of the 19th century [13], and it was a well-acquainted practice during António Carneiro's lifetime, as demonstrated by portuguese contemporary painters such as Aurélia de Souza (1866–1922) [14, 15].

Fig. 2. Detail of painting edge showing pre-prepared industrial canvas

A few works are painted on thin and small-sized wooden panels.

There are some original strechers showing the stamps of its producers or sellers, such as *Araújo & Sobrinho*, a very well-known fine arts store from Oporto, founded in 1829, and *Galeria Jorge*, from Rio de Janeiro, Brazil (Fig. 3), reinforcing the interdependence between artist and suppliers and pointing out possible preferences for his material choices.

Fig. 3. Details of strechers showing the stamps of sellers/producers

Grounds

Ground layers are coloured white, and this is always visible through the paint surface, as the artist used few and thin paint layers over the commercial ground.

One cross-section from *Belinho lake* shows a sequence of two ground strata (Fig. 4): a thicker, more translucent bottom layer with opaque clusters, usually associated with the use of a Ca-based filler mixed with an opaque white pigment; over this first layer, a second one, thinner and opaque, generally consisting of a white pigment.

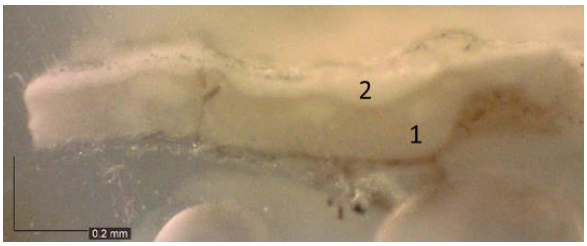

Fig. 4. Cross-section collected from one edge of *Belinho lake* oil on canvas, showing a white ground layer with two strata

When looking at the results of the elemental analysis, the elements detected in areas where the ground layer is exposed (Table 1) are consistent with those generally associated with paintings executed over commercial preparations of the same period.

Table 1. EDXRF spectra collected from the ten paintings

Spectra collected from exposed ground layers	
Life (left pannel)	Pb, Zn, Ca (Ba)
Life (right pannel)	Pb, Zn, Ca (Ba)
Grandmother	**Pb** (Ca)
Blue Porto	**Pb**, Zn, Ca (Ba)
Cláudio and Katherine	**Zn, Ca**, Ba, S
Spectra collected through the paint layers	
Selfportrait	**Pb**, Ca (Ba)
Wife	**Pb**, Ca, Ba
Cláudio varino	**Pb**, Ba (Ca)
Belinho lake	**Zn, Ba**, Pb, Ca
Camões Reading the Lusíadas to the Dominicans	**Pb, Zn**, Ca

Pb-based compounds are dominant, suggesting the use of lead white as the main material for the upper preparation stratum. Ca may be associated with a Ca-based filler, mixed with the white pigment, or constitute the main component of the lower stratum. The other detected elements are Zn and Ba, also common in the composition of pigments and extenders at the time [14, 15], usually associated with zinc white and barium sulphate, respectively. The elements that may be related to the ground layers that have been identified in the spectra collected through the paint layers lead to a similar interpretation.

These results related to the OM observation of the cross-section collected from *Belinho lake* suggest that this canvas was primarily covered by a thicker and transparent layer that could account for less opaque materials, such as Ca and Zn-based compounds, and then superimposed by a thinner and opaque final layer that could contain Pb-based pigments. The use of cheaper materials, such as Ca-based compounds, to inexpensively cover canvas fibres and the selection of a final whitish lead-based layer (pure or in mixture) were in accordance with many colormen's practices [16]. They would often use less expensive materials as base layers and reserve the more expensive ones for upper layers. The selection of lead-based white pigments for the final layer was common, as it provided a smooth and opaque finish with good light-

reflecting properties. Elemental analysis to be performed with Scanning Electron Microscopy coupled with Energy Dispersive Spectroscopy (SEM-EDS) may reveal the distribution of certain pigments or additives used by the painter, shedding light on his techniques and artistic choices.

When interpreting FTIR spectra, although the areas to be analysed have been previously cleaned with solvent solutions, in an attempt to remove the varnish films applied during the restoration interventions, it becomes clear that the presence of the adhesives and resins used does not allow them to reach the organic components of the paintings, as shown in Figs. 5 and 6.

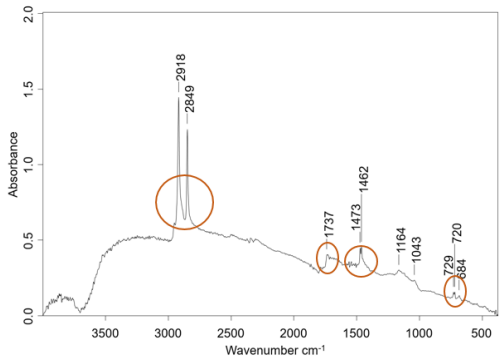

Fig. 5. FTIR spectrum collected from exposed ground area in *Life*

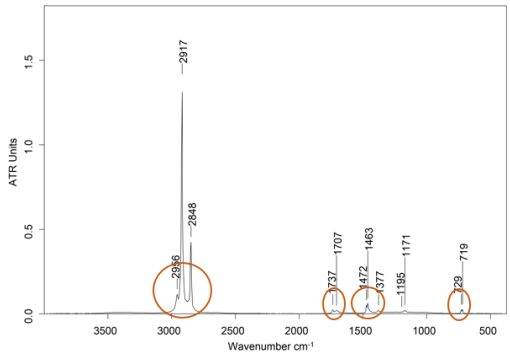

Fig. 6. FTIR spectrum of beeswax-resin reference

Even after cleaning the areas with solvent solutions, the presence of adhesives and resins used in previous restoration interventions can still interfere with the analysis of the organic components of the painting using FTIR spectroscopy. These materials overlap with or mask the signals of the organic components in the spectra, making their identification and characterization difficult or impossible.

Underdrawing

Detailed underdrawings, probably using graphite, are used in studies such as the one for *Life* (1899) (Fig. 7). In later studies, as in the case of *Camões Reading the Lusíadas to the Dominicans* (1926), where a more complex compositional organisation was required to place a large number of people within an architectural entourage, the artist found it useful to draw symmetrical lines divided in sub-multiple intervals to devise a harmonious distribution of the elements (Fig. 8). For that purpose, he combined the use of rulers with free-hand drawing, and only a few figures and parts of the architecture are detailed. The IR reflectography of the portrait of *Cláudio and Katherine* (1929) does not reveal any underdrawing. The picture under normal light shows brush outlines followed by free paint strokes directly applied over the ground (Fig. 9).

Paint layers

Paint layers are very thin, showing the white ground and the texture of the canvas underneath. The thinness of the paint layers appears to be intentional on the part of the artist, as it allows for greater control over the final appearance of the painting and also allows the texture of the canvas to show through. Additionally, using thin layers of paint can help prevent cracking and other damage to the painting over time, as thicker layers are more prone to shrinking.

Brush strokes are applied with great precision, and tones are mostly the result of mixing colours on the palette before applying them over the canvas, which is often visible to the naked eye. Fig. 10 shows a cross-section collected from a light brown area of *Life*, made of a mixture of white, red, and green pigments. This suggests that António Carneiro had a great level of

control and intentionality in the application of the paint. Overall, these characteristics suggest a high level of skill and expertise in painting techniques.

Fig. 7. IR Reflectography of the left panel of *Life* showing detailed underdrawing

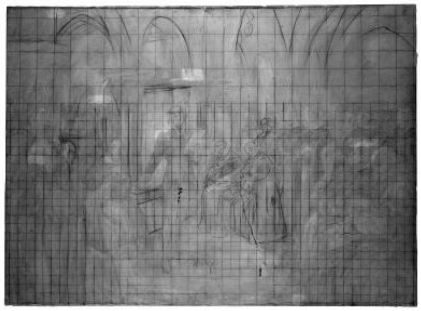

Fig. 8. IR Reflectography of *Camões Reading the Lusíadas to the Dominicans* showing a drawing grid

Fig. 9. Portrait of *Cláudio and Katherine*, showing paint strokes directly applied over the ground, with no underdrawing

Fig. 10. Cross-section collected from a light brown area of *Life*

When trying to identify the general classes of binding media and varnishes with FTIR, and as already pointed out in the case of grounds, spectra show mainly the characteristic absorption bands of the materials used in restoration interventions (Figs. 11 and 12).

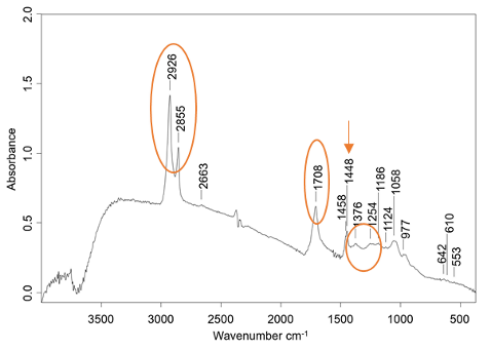

Fig. 11. FTIR spectrum from red area of the portrait of the wife

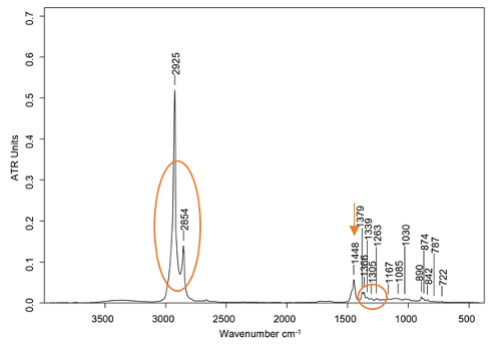

Fig. 12. FTIR spectrum of a ketone resin used as reference (© *Talens varnish 001*)

FORS spectra were useful to corroborate the interpretation of elemental analysis obtained through EDXRF. Examples are the identification of cobalt blue in a light blue area of *Belinho lake* and also in a violet area of the same painting (Figs. 13 and 14). This suggests the use of cobalt blue mixed with white and red pigments to obtain the violet hue. The correspondent EDXRF spectrum for the violet area shows Pb and Zn as major elements, minor peaks of Ca, Ba, Fe, and Co, and traces of Al and Si. (Rh and Ni are related to the constitution of the EDXRF equipment.) Pb and Zn should be related to the white pigments used in the white ground layers and probably mixed with a cobalt-based pigment to obtain the light blue hue. Fe suggests the use of a Fe-based red pigment to obtain the violet hue. Ca and Ba could be related to extenders, respectively a Ca-based filler and barite. Al could be associated with paint stabilisers, and Si with impurities associated with Ca-based fillers and Fe-based pigments. Further analysis will be necessary to confirm the exact pigments and techniques used by the artist.

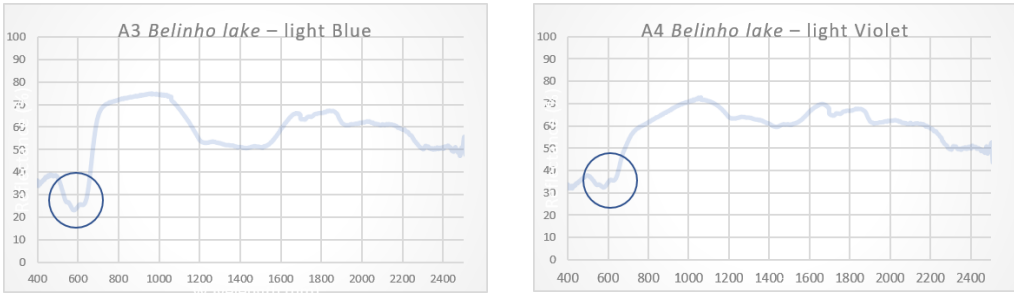

Fig. 13. FORS spectra of light blue and violet areas in *Belinho lake*

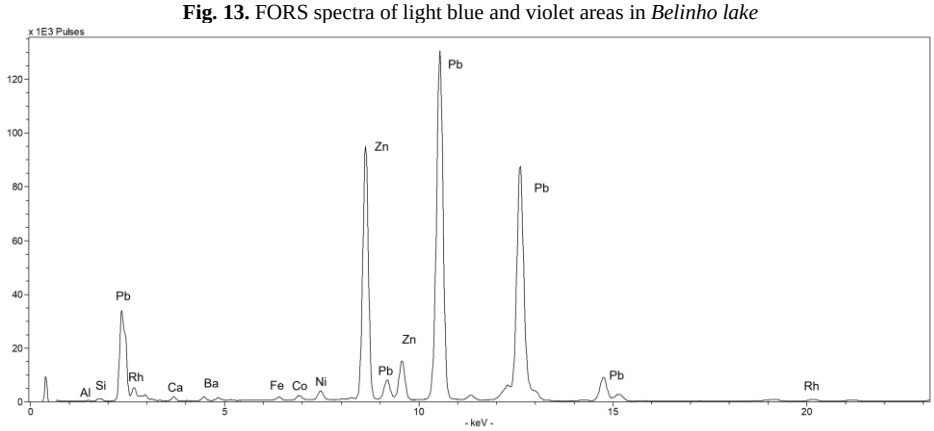

Fig. 14. Correspondent results obtained through EDXRF

After analysing each EDXRF spectrum individually and comparing the results for the group of 10 selected paintings, the evolution of António Carneiro's palette in this span of 30 years could be summarised in the following table (Fig. 15).

In flesh-tone areas, mixtures of Pb and Fe-based pigments appear to be the most frequent, followed by mixtures of Pb and Hg-based pigments in half of the works. Cd-based compounds are detected in one painting dating from 1929.

In yellow areas, Fe-based pigments appear in all works except *Porto Azul* (where no yellow pigments were used), followed by Cr-based pigments. A Cd-based yellow was clearly detected in *Belinho lake* (1923) in the yellow layers and as a component of the green areas, mixed with cobalt blue.

For red areas, Fe-based pigments are the most frequent ones, followed by Hg-based compounds. Again, Cd-based pigments were detected only in one painting, dating from 1929.

Concerning the blue colour, it is not present in more than half of the works analysed. Cu and Fe-based pigments appear in earlier works, although what might be interpreted as Prussian blue also appears in *Porto Azul* (1925). Cobalt blue was detected in two later works: *Belinho lake* (1923) and the portrait of *Cláudio and Katherine* (1929). Further analysis will be needed to clarify whether or not ultramarine blue has been used.

Fig. 15. Summary table of the interpretation of the XRF spectra collected from the chromatic layers

In green areas, Cr-based pigments are the most frequent, followed by Cu-based pigments. The detection of Cu associated with As in two works indicates the use of Emerald Green. Green is also the result of a mixture of Cd and Co-based pigments, as already mentioned in the case of *Belinho lake.*

For brown areas, the painter used mostly Fe-based pigments. Umber is suggested by the presence of Mn in one work. Browns are also the result of mixtures of red and green, as previously pointed out.

Finally, black areas are never pure black. Analytical results suggest C black in half of the paintings. In the other three works, the identification of P indicates the use of bone black.

Considering the historical period in which the activity of this artist has been developed, the possibility of using natural or synthetic organic pigments must also be considered. This is something to be further developed in future studies.

Summing up, this first study of António Carneiro's painting suggests that the artist was neither traditional nor avant-garde concerning his method of painting and the materials used. He was not an experimentalist, but he would use both traditional and new pigments available in the market at the time, such as Cd red, available in the market in 1910. These results are consistent with studies on Portuguese [11, 12] and other European painters of the same period [17]. The great missing pigment in the palette used for these 10 paintings is Titanium White, introduced on the market around 1916–1919 [18].

The valorization of António Carneiro's paintings is a very important activity, which will take into account both those from state and private collections. In the last years, a series of works [19-21] are known, which focus on modern methodologies of display, valorization and hoarding, which allows adequate protection even in the case of transfers or itineraries to other collections.

Conclusions

Following this first study, the next stage of the project should still include the use of laboratorial techniques in order to collect further analytical data on the painting techniques and materials. It will also be necessary to search for new approaches for collecting microsamples to be mounted as cross-sections and for the characterization of the binding media. Furthermore, there are some artist's materials, such as oil tubes, pallets, and a pastel box, that have been found among the painter's belongings and whose origin must be cleared.

In parallel, it will be essential to complement the knowledge of António Carneiro's creative process through the study of the numerous sets of sketches and drawings belonging to the Municipality of Oporto, as well as photographs. In this period, it is important to establish the link to that resource, which is often used and is more widely accepted and assumed than before.

It is expected to contribute to the enrichment of the exhibition contents to be presented to the general public as soon as the Studio reopens, namely through the understanding of the way in which the themes and the geographic and mental spaces that have marked the artist's path have had or not had implications in the evolution of his technique and in the selection of materials used for the execution of the works.

The connection to those spaces will also be made through the crossing between the characteristics of the supports and stretchers used by the artist and those that were available in fine art stores at the same time, namely in Oporto and Rio de Janeiro.

Through the publication of scientific articles, it is intended to contribute to the knowledge of Portuguese Painting at the turn of the 20th century and its comparison with other published studies.

In a future stage, the technical and material study will continue, expanding the analysis to a greater set of works and painting materials existing in the collection belonging to the CMP. The results of this project will have an impact on our knowledge of the artist's work and other collections in which he is represented.

In the medium-long term, by continuing the project that is now starting, it is expected to gather enough information to come to understand the integration of António Carneiro's work in the context of European and Brazilian artistic production of the same period.

Acknowledgments

This research was achieved with the collaboration of the Municipality of Oporto, CITAR, HERCULES Laboratory, and José de Figueiredo Laboratory. The analyses were performed in situ using portable equipment through the Mobile Laboratory of the ERIHS.PT infrastructure.

The team thanks private Photographer António Alves for the acquisition of general front and back photographs under normal light; Ana Sofia Simões and Susana Bessa (CMP) for all the support during the performance of the in-situ analysis; *Zenoficinas - Restauro, Molduras, Peritagens* for providing valuable information about the restoration processes undertaken in the 1980's and samples of some of the adhesives used as references in this study.

References

[1] L. Castro, **António Carneiro**, Edições Inapa, Lisboa, 2004.
[2] J. Brandão, *António Carneiro*, **Exposição de Homenagem ao Mestre Pintor António Carneiro**, Palácio da Bolsa, Porto, 1931.
[3] C. Ramos, **O Retrato na Obra de António Carneiro**, Escola Superior de Belas Artes, Porto, 1955.
[4] A. Candiago, **Antonio Carneiro Ilustratore di Dante**, Civilização, Porto, 1965.
[5] F. Azevedo, *Exposição Retrospetiva do Iº Centenário de António Carneiro*, **Colóquio e Artes, 12**, 1973.
[6] I. Silva, *Natureza e Símbolo em António Carneiro. Uma Aproximação à sua Pintura de Paisagem*, **MsC Thesis**, Faculdade de Ciências Sociais e Humanas, Universidade Nova de Lisboa, 1983.
[7] A.R. Veiga, *Técnicas de execução e fenómenos de degradação de pintura a óleo sobre suportes metálicos. Estudo sobre três pinturas a óleo sobre folha-de-Flandres da autoria de Francisco José Resende*, **MsC Thesis**, Escola das Artes, Universidade Católica Portuguesa, Porto, 2010.
[8] R.H. Silva, **Silva Porto**. **Exposição comemorativa do centenário da sua morte**. Instituto Português de Museus/ Museu Nacional de Soares dos Reis, Lisboa, 1993.
[9] A. Lopes, *A pintura a óleo sobre suportes celulósicos no séc. XIX: Estudo de três obras de João Marques de Oliveira*, **ECR, 4**, 2012, pp. 29-46.
[10] A.J. Cruz, *A pintura de Columbano segundo as suas caixas de tintas e pincéis*, **Conservar Património, 1**, 2005, pp. 5-19.
[11] A. Correia, M. Oliveira, R. Clark, M.I. Ribeiro, M.L. Duarte, *Characterization of Pousão Pigments and Extenders by Micro-X-ray Diffractometry and Infrared and Raman Microspectroscopy*, **Analytical Chemistry, 80**, 2008, pp. 1482-1492.
[12] M. Aguiar, A.J. Cruz, A. Calvo, J. Carballo, *Pintura em cartão no início do séc. XX em Portugal: Aurélia de Sousa, uma artista esquecida num tempo de mudanças técnicas*", **VIII Congreso Ibérico de Arqueometría**. Seminario de Arqueología y Etnología Turolense, Teruel, Espanha, pp. 113-122.
[13] A. Callen, **The art of Impressionism: Painting technique & making of Modernity**, New Haven and London, 2002, p. 59.
[14] M. Aguiar, *Os materiais e a técnica de pintura a óleo na obra de Aurélia de Souza e a sua relação com a Conservação*, **PhD Thesis,** Escola das Artes, Universidade Católica Portuguesa, Porto, 2013.
[15] D. Bomford et al., **Art in the making: Impressionism**, National Gallery, London, 1990, p. 46.
[16] A. Burnstock; K. Den Berg and J. House, *Painting techniques of Pierre-Auguste Renoir 1868-1919*, **Art Matters, 3**, 2005, pp. 47-65.
[17] I.C.A. Sandu (Ed.), *Understanding Munch and the art at the turn of the centuries between the museum and the laboratory*, **IJCS, 13**, Special Issue 1, 2022, pp. 1403-1704.
[18] E. Fitzhugh, **Artists´Pigments: A Handbook of Their History and Characteristics**, vol. 3, National Gallery of Art, Washington, 1997, p. 302.
[19] P. Spiridon, I. Sandu, *Muselife of the life of public*, **International Journal of Conservation Science, 7**(1), 2016, pp. 87-92.

[20] P. Spiridon, I. Sandu, L. Stratulat, *The conscious deterioration and degradation of the cultural heritage*, **International Journal of Conservation Science, 8**(1), 2017, pp. 81-88.
[21] I. Sandu, *Modern Aspects Regarding the Conservation of Cultural Heritage Artifacts*, **International Journal of Conservation Science, 13**(4), 2022, pp. 1187-1208

Received: February 05, 2023
Accepted: August 17, 2023