

CONSERVATION STATE OF MURAL PAINTINGS FROM A HISTORIC HOUSE IN FLORIANÓPOLIS-SC, BRAZIL. A MULTIDISCIPLINARY APPROACH

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Abstract

The scientific approach to conservation and monitoring of mural paintings executed in a historic house with an eclectic style of the twentieth century, located in Florianópolis, Santa Catarina, Brazil, is an example of interdisciplinary collaboration between conservators, historians, and scientists in planning and development actions for preventive maintenance as well as interventions of restoration. The mural paintings are recognized worldwide as an architectural element and property, which records the representations of the cultural landscape of an age. In this context, the painting technique found in this house and its state of conservation were investigated by evaluation of pigmented surfaces and then by optical and spectroscopic (IR and EDX) techniques. These results were crucial for the record of the characteristic painting present in this building, showing a period marked by intense urban renewal in Brazilian cities.

Keywords: *Mural paintings; pigments; infrared spectroscopy; EDX*

Introduction

A number of historic buildings located at the center and in the quarters of Florianópolis, State of Santa Catarina, Brazil, exhibit mural and decorative paintings that are associated to their historic past, generally based on the life style of the population of that time, linked to the European immigration current and to the urban transformation processes of the late nineteenth century and the beginning of the twentieth century. In particular, a historic house of the 1920's, located at the center of Florianópolis, exhibits unique characteristics in its interior, revealing decorative mural paintings in all the internal dependencies of the house. These paintings have suffered a lot of influence and degradation, for the house has been built on an island, where salinity and the sea air interfere with the conservation of the constructive materials. Another aggravating aspect is the layers of re-paintings that cover the original mural paintings. This building has been built to deepen our researches and analyses, taking into account that it in no

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historic moment has suffered restoration intervention, thus, keeping its original characteristics. Therefore, the objective of this work is to carry out a historic survey of this historic house, deepening the chemical tests and analyses for knowledge of the type of materials that make up the pictoric layers of the mural paintings, also elucidating the chemical agents responsible for its degradation. The expected result from this multidisciplinary research is the possibility of contributing in the future restoration actions and helping in its preventive conservation, besides identifying in an unheard-of way the chemical elements that make up these mural paintings of the Island of Santa Catarina.

Historic Aspects about the Mato Grosso Quarter

The end of the nineteenth century was a period of search for changes in the urban structure of the city of Florianópolis. This process has brought about significant changes in the Luso-Brazilian colonial style present in its town planning and constructive format of the building. The search for remodeling the city was a process that has involved the demolition of houses considered unhealthy, the construction of public buildings, opening and paving of streets and avenues, gardening of squares, installation of the first networks of piped water, electric power, and sewers [1].

The eclectic style that has started to be adopted in many constructions was one of the marks of the period, inserted in a context of search for urban and social remodeling and modernization.

In the city of Florianópolis, a significant symbolic element of the process was the reform, between 1895 and 1898, of the seat of the State government, a colonial historic house of the eighteenth century, which has been gifted with neo-classic eclectic lines and decorative elements, transformed, this way, in a monument to the aesthetic, cultural, and political conceptions of the elite that took on the State government in the newly-installed republican regime and that would seek to remodel the city [2]. As one of the main buildings of the city in that period, its new architectural style would end up influencing the options made in the aesthetic format of the constructions that would be built later on in the region.

The current Visconde de Ouro Preto Street, where is located the historic house broached in this text, had been previously denominated as Rua Áurea, which used to prolong itself up to Largo Municipal, currently Getúlio Vargas Square [3].

Getúlio Vargas Square is located in one of the paths, existing from the eighteenth century, which used to link the first occupation center of the town, the current Praça XV de Novembro, to Forte São Luiz, and later on have served as an orientation axis to occupation by residential ranches of the wealthiest classes of the population, which have been progressively dismembered into glebes at the end of the nineteenth century, appearing this way the Mato Grosso quarter [4].

The constructions with an eclectic style have progressively started forming part of the central urban area of Florianópolis, configuring themselves as one of the elements of the new urban order desired for the town between late nineteenth century and beginning of the twentieth century, with a highlight for those existing at Rua Visconde de Ouro Preto. The current photo of the historic building built in the old Mato Grosso quarter, currently the center of Florianópolis, is presented in Figure 1.



Fig. 1. Eclectic historic house of the 1920's, the object of study of this work.

Architectural Style

The importance of this urban set, of the old Mato Grosso quarter, is based on the expression of the architectural units that make it up, a testimonial of the successive phases of the history of architecture. It counts on a mix of different styles of architecture, such as the Luso-Brazilian architecture of the colonial period, eclectic architecture, art nouveau-influenced architecture, and rationalistic and modernistic architecture. The presence of Germans in this quarter has also been reflected on architecture. The different forms of living, materialized in these buildings, express, among others, the evolution in the technical knowledge, the socio-cultural evolution of the community and the influences of imported fads, besides the imposition of the various codes of Town Postures.

The first buildings were ground-level houses or *sobrados* (houses of two or three stories) with a rather stripped architecture, situated in the alignment of the street, presenting roof edges that only later on would be replaced by the platbands and receive adornments. One can quote as examples some buildings located at Rua Visconde de Ouro Preto, Rua Dom Joaquim, Praça Getúlio Vargas, Rua Almirante Alvim, and Largo Benjamim Constant.

Later on appeared the high-basement houses, which have gradually released themselves from the side limits of the lot. The entrance through the side façade generally occurs through a veranda, allowing space for the garden. The high-basement houses, when located on corners, presented the façade in a rounded vertex or broken corner.

The transition moment that the world goes through with the turn of the century and the search for a new balance inside art has also expressed itself in architecture. Thus, eclecticism is

present as a testimonial of this transition in search of new values. In this sense, the ornamentation of the façades already presents some elements of the new styles that may come, such as the “art nouveau” and the “art deco”. The geometrization of lines and the use of the colored stained-glass windows can already be observed.

With the implantation of the architecture of the twentieth century, the buildings start being isolatedly located at the center of lots, releasing themselves from the alignment of the thoroughfares and allowing the appearance of a varied range of architectural trends. Immigration has also contributed to the import of new techniques and new adaptations of style and program.

One highlights then the volume of the building, with the valuation of the differentiated façade plans. Besides the cover in various levels, it releases the conventional standards in two or four waters.

The release of the rigid architectural parties starts. The rationalistic influence, with little complex programs, will mark the middle-class residences. Also in relation to the immigration architecture, one has at Rua Alves de Brito a concentration of cottages located on corners, architectural examples of rare occurrence in the city. The cottages are ground-level buildings with small dimensions, typical of the middle class, with two-water roofs, the finishing of which occurs through lambrequins, with a frontal generally worked gable and a side entrance.

On the whole, some education-linked buildings are still inserted. The current Town Hall, the old School for Learning Craftsmen, is a monumental building, with eclectic characteristics of the twentieth century. The Silveira de Souza Primary School, just like the previous one, also presents characteristics of eclecticism, and both have a “U”-shaped floor plan, traditionally utilized in the school architecture of the time.

On the basis of this overview of the evolution of architectural styles present at the built units of the set, the unique character of this region is made evident, which reunites buildings of several historic periods.

The importance of the Mato Grosso quarter is made evident, therefore through the different moments of architecture history present in the set. This way, the region constitutes itself, by means of its buildings, in an important document representing the urban development of the city of Florianópolis, considering also its condition of capital of State characterized by the cultural and ethnical diversity[4].”

Mural Paintings

As history and architecture go together, the mural painting is an important constructive element that forms part of the architectural patrimony and reflects the cultural identity of a people. The importance of conserving and restoring this patrimony asset are ways of preserving the traits of our ancestral memory. The mural paintings show stratigraphically our cultural heritage and the sedimentation of the elements that have been passed on to us by the generations that have colonized Brazil, besides valuing the culture and the territory in which it is inserted. As defines the Letter from Krakow (2000)[6]:

"Chaque communauté, s'appuyant sur sa mémoire collective et la conscience de son passé, est responsable de l'identification comme de la gestion de son patrimoine. ... Les éléments individuels de ce patrimoine, sont porteurs de valeurs qui peuvent changer avec le temps. Cette variabilité des valeurs identifiables dans les monuments fonde la spécificité du patrimoine, "au cas par cas", au cours de l'histoire." (CHARTRE DE CRACOVIE-2000)

The images revealed by the probing into the walls of the historic building under study demonstrate the pictoric representation that transmits an aesthetic taste and time trend. They reveal signs of each generation and its historic time. They are panels full of meanings, which many times are covered by ink layers (later re-paintings), hiding, thus, part of the history and of the cultural identity of a people. For the monuments are the "... historic construction, which contains in itself, in each one of its constituting parts, some of the history of its formation or building and only constitutes itself as a patrimony asset, only acquire sense and value if apprehended in the dynamics of historic time and space"[6]. The mural paintings are the final product of the stratigraphic accumulation of the constructive elements and of the inter-relations established with the social and natural milieu.

According to the *Convention pour la Sauvegarde du Patrimoine Culturel Immatériel* (2003), the (material and immaterial) cultural patrimony is transmitted from generation to generation; and permanently recreated by the communities and social groups by virtue of their milieu, their inter-relation with nature and history, revealing the identity and the historic and patrimony continuity, contributing to the valuation, the respect to the cultural diversity, and to human creativity [8].

Therefore, the mural paintings are the historic testimonial, as well as the cultural representation that forms part of a people's identity. And the pictoric techniques of execution of the mural paintings are characterized as hereditary techniques, for they transmit the continuity of a "savoir-faire" (know-how).

In the case of the mural paintings of the Florianópolis Historic House, hidden by several layers of monocromatic paintings, the probings have revealed the profusion of colors and the geometric composition of the decorative bars, which make evident a very common historic practice between 1920's and 1940's at the houses that existed on the Island of Santa Catarina, where the chromatic tones and the geometric motives used to form a decoration standard in the houses of families with a higher social level. These mural paintings did utilize the graphic and symbolic representation model from the peoples who have emigrated from Europe and settled here.

The aesthetic tradition of decorating all the internal walls of the buildings and making decorative friezes on the external walls of the verandas is an immaterial patrimony and an execution of the pictoric technique that has traveled overseas. This tradition that has arrived here has had a new interpretation on adapting to the materials found at the place, creating a new mural painting technique: the "pigmented whitewash".

On the decorative tradition of this time it was common to mix several differentiated styles in the aesthetic composition of the paintings. It is the case of the mural paintings of the Historic House, where on the bottom we have a strip of one meter (on average) with the technique of the "Trompe-l'oeil"¹, in brownish tones, imitating wood, utilizing as fixation vehicle the oil, which gives a glossy, smooth aspect different from the upper part, which completes the rest of the wall with the technique of the "pigmented whitewash", where this innovative technique gives an aspect of traditional afresco, with a light velvety touch, different from the "escaiola", utilized at the traditional kitchens to give impermeabilization.

Due to this profusion of technical relations mentioned, besides the cultural aspects that form part of these mural paintings, one considers that these mural paintings are the historic testimonial, as well as a cultural representation that forms part of the identity of the people who has adopted this territory to fixate themselves and turn it into their new home. These emigrants

¹ **Trompe-l'oeil**: expression from the French language that means "to deceive the eyes", an artistic technique very often used in the pictoric techniques, which utilizes perspective tricks to create an optical illusion of objects or shapes that do not really exist.

have left us an aesthetic and pictoric treasury to be unveiled in the laboratory researches and analyses, which reveal the hereditary techniques of these symbolic representations, brought and transmitted by the European emigrants who have fixated themselves here, characterizing, thus, a cultural patrimony – as a living and evolutive expression, which has crystallized itself on the wall of our houses, cathedrals, churches, palaces, and residences, making up, thus, the historic patrimony of the cities and their cultural landscape. They reinforce the cultural identity of this place, stimulating and making evident the historic, religious, and cultural values, linked to the human value of the territory.

Thus, this research means to contribute to the valuation, conservation, and restoration of the mural paintings existing in Santa Catarina through the knowledge about the techniques utilized in the execution of the paintings, generating a source of technical-scientific information to help in the restoration intervention methods; aiming at a multidisciplinary bias linked to the values of society, valuation of the patrimony, inter-relation of the territory, and cultural memory.

The mural paintings existing in the inner part of the historic house have been found from stratigraphic windows described in the experimental part and the result after pickling is presented in Figure 2, where A, B, and C represent the places of pigment collection for analysis.

A serious problem observed during the work of removal of the re-paintings was the presence of insoluble salts, a pathology related to the geographic position of the building in order to help the works of removal of these salts, samples were also collected for analysis of infrared spectroscopy and EDX; Figure 2 shows the formation of salts on the oldest painting.



Fig. 2. (a) Mural paintings found at the historic house after pickling of the most recent ink layers; where **A** is the trace of green painting found in the ornament above, **B** and **C** is the ochre and dark brown color respectively (b) traces of soluble salts found during the process.

Experimental

Before making any decision in the intervention process by using conservation and/or restorations techniques, it takes a detailed identification about the state of conservation of the work in question. Every mural painting found at the historic house has been carefully mapped and observed by restorers and scientists for detecting macroscopy of the specific areas, which

are more appropriate to be investigated by chemical and physical-chemical methodologies, being that these areas represent the whole of mural painting. Stratigraphic windows contain 4 cm² have been opened for identification of the oldest layer and fragments, in powder, of the painting presented in Figure 2; A, B, and C representing the green, ochre, and brown colors, respectively, have been collected, cleaned from the selected areas and analyzed by infrared spectroscopy – FT-IR, and by X-rays by utilizing dispersive energy spectrometry for semi-quantitative analysis of the elements present in the samples. Samples of plaster have been submitted to qualitative chemical analysis with silver nitrate (AgNO₃) and barium chloride (BaCl₂) for identification of the chloride and sulfate ions respectively according to the protocol published by the ICCROM [5]. The newly-collected painting fragments have been dried at 60°C in a greenhouse for elimination of humidity before carrying out the analyses. All the materials utilized in this work have been obtained from commercial sources with previous purification.

Results and Discussion

Opening of the Stratigraphic Windows

The result of the opening of the stratigraphic windows is presented in Figure 3. One observes five distinct layers, being the 1st, 2nd, and 3rd ones related to more recent later re-paintings, in the 4th layer one observes the oldest painting, which is found in all parts of the historic house, once the last one refers to the preparation layer.

The first three layers have been identified at the place with the help of solvents [14] and both are acrylic resin-based, probably of commercial source, taking into account that they are more recent re-paintings. The fourth layer, older, has been utilized for more detailed analysis of painting technique by utilizing instrumental methods.



Fig. 3. Stratigraphic windows referring to the five layers found at the historic house under study

Painting Technique

The techniques utilized in the mural paintings were evaluated with the intention of clarifying the materials utilized in the most representative colors of the mural painting.

Organoleptically, the paintings have faded parts with many marks of time, presenting dirt and punctual crackled regions. The analyzed samples correspond to fragments of the colors presented in Figure 3, A, B, and C representing the green, ochre, and brown colors respectively. The infrared spectrum of the three samples is presented in Figure 4.

In the A and C infrared spectrum one observes bands in the region of $3600\text{-}3200\text{cm}^{-1}$ that can be attributed to $\nu_{\text{O-H}}$ distensions, $2800\text{-}2500\text{cm}^{-1}$ related to $\nu_{\text{C=C}}$ distensions, in connected systems, still both present distensions in the region of $1600\text{-}1400\text{cm}^{-1}$ related to $\nu_{\text{C=O}}$ distensions and, lastly, both present a band in 1110cm^{-1} attributed to $\nu_{\text{C-O}}$, a similar spectrum is published by Rusak and collaborators [9] who correlate these bands found with oil-based inks. Sample C still presents other characteristic bands between $1466\text{-}1402\text{cm}^{-1}$, $1110\text{-}1020\text{cm}^{-1}$ which can be attributed to the type of pigment utilized, and it can be characteristic of hydration waters respectively [14] or still of a protection layer [10] that could be applied on the brown-pigmented layer, considering that this one was the most inferior, present in the mural painting of the historic house.

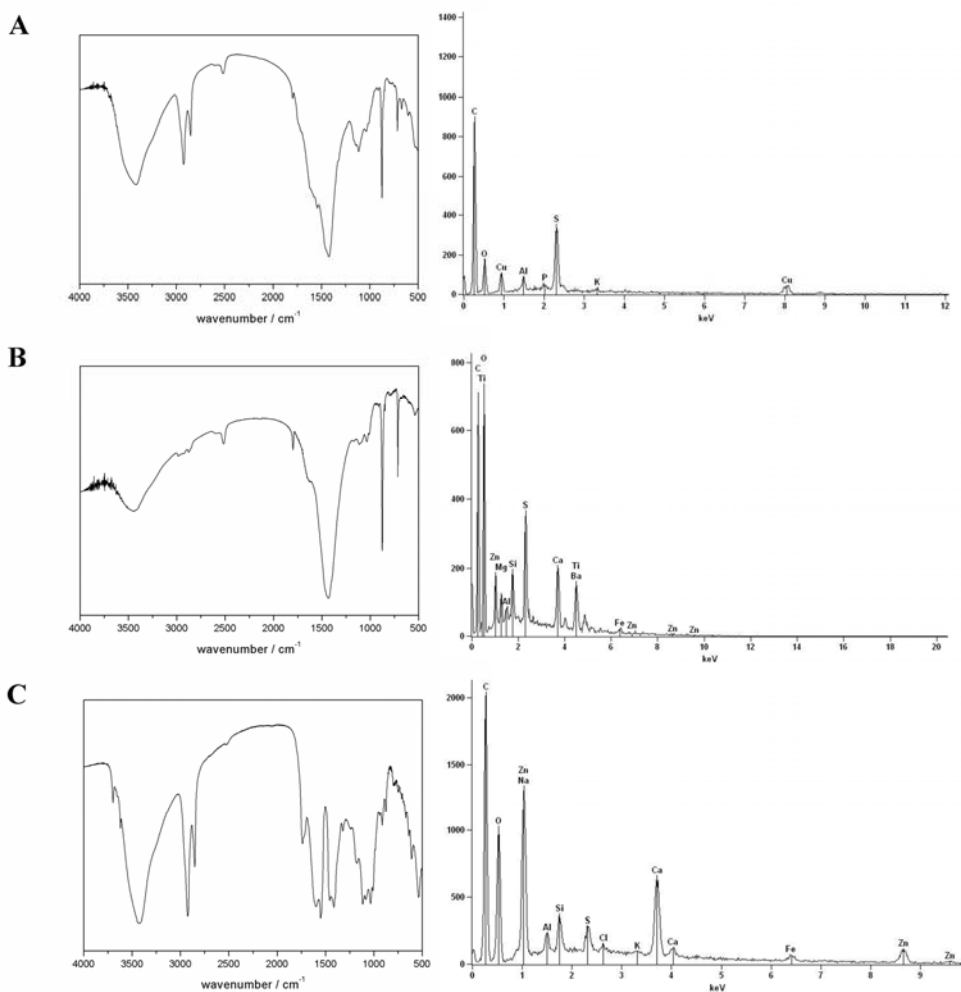


Fig. 4. EDX spectra collected from fragments of green, ochre, and brown colors, respectively, where in sample A the following representative elements have been detected: Cu, S, K, and O, in sample B: Fe, Zn, Ba, Mg, S, and O and, in sample C: Fe, Ca, K, S, Zn, Na, O, Cl. Infrared spectra of the fragments of colors were collected, where: A, B, and C represent the green, ochre, and brown colors, respectively.

As to spectrum B, it presents many differences in relation to the two others previously discussed. The bands in the region of $2500\text{-}2800\text{cm}^{-1}$ are suppressed, as well as those present in 1100cm^{-1} in fragments A and B, showing that another painting technique has been utilized. However, there are two very similar bands in spectra A and C: 1490cm^{-1} and 3500cm^{-1} , revealing that this ochre tone can have come from the dilution of the brown tonality also utilized in the mural painting, or still that a mix of pigments can also be utilized and that it contains pigments existing in painting A.

More information about the type of pigment utilized has been possible by means of X-ray spectrometry analysis with a dispersive energy analyzer. The spectra are presented in Figure 4.

First, one observes the presence of Cu in the green pigment existing in the ornaments present in the mural painting, a characteristic element present in numerous pigments of this coloration [11]; observing the infrared spectroscopy data, where one observes waves in 3400 , 1500 , and 1095cm^{-1} and this one has also presented release of CO_2 when in the presence of hydrochloric acid, which can suggest that this pigment contains carbonates [5] and the presence of the copper atom in the structure leads us to the conclusion that it deals with a malaquita that presents itself in the $\text{CuCO}_3\cdot\text{Cu}(\text{OH})_2$ structure and was utilized as pigment very often at the time the historic house was built[12].

The EDX analysis of pigments B and C has presented some similarities, like the presence of Fe and Zn, and sample B has presented Ba. The experimental evidences reveal that the brown color comes from a clay mineral with the $\text{Fe}_2\text{O}_3\cdot\text{H}_2\text{O}$ chemical composition. According to Stuart and collaborators [14], the presence of barium can be associated to a binary mix of minerals for dilution of the brown ink, giving rise to ochre, the lithopone [14], BaSO_4 can have been utilized in this dilution, considering the evidence of presence of barium and sulfur in considerable amounts. These instrumental chemical analysis are describe on literature, where are utilizing for identification pigments in amount of cultural heritage [15-17].

Identification of Chemical Pathologies in the Plaster

In the process of cleaning and withdrawal of the re-painting applied on the mural painting, one has come across a pathological problem of chemical origin which is the formation of insoluble salts in the plaster and between the original layers of the mural painting and the other more recent ones applied on them. A detailed analysis of the type of salt, that is, identification of ions that form part of these compounds is fundamental, having in mind that the identification of this pathology directly helps the conservers-restorers who at some moment will carry out the works at the historic house. Soon after being collected, the salt was qualitatively analyzed at the laboratory by the precipitation method detailed in the experimental part. The result of the analysis is presented in Figure 5.

Turbidity is observed in both analyses in both test tubes, when compared to the white one. This phenomenon results from the precipitation of the chloride and sulfate ions present in the analyzed plaster. The accumulation of salts in the plaster and between the layers has as its main origin the geographic localization of the building; first, for being located on an island and at less than 20km from the sea, an accumulation of chloride ions, Cl^- , is eminent, and also, being on a street with a great flow of vehicles, the deposition of sulfate, SO_4^{2-} , is also favored at the building. For identification of the complete chemical pathology, the samples have been submitted to dispersive energy X-ray spectrometry, the spectrum with all the elements found in the sample of analyzed salts is presented in Figure 5.

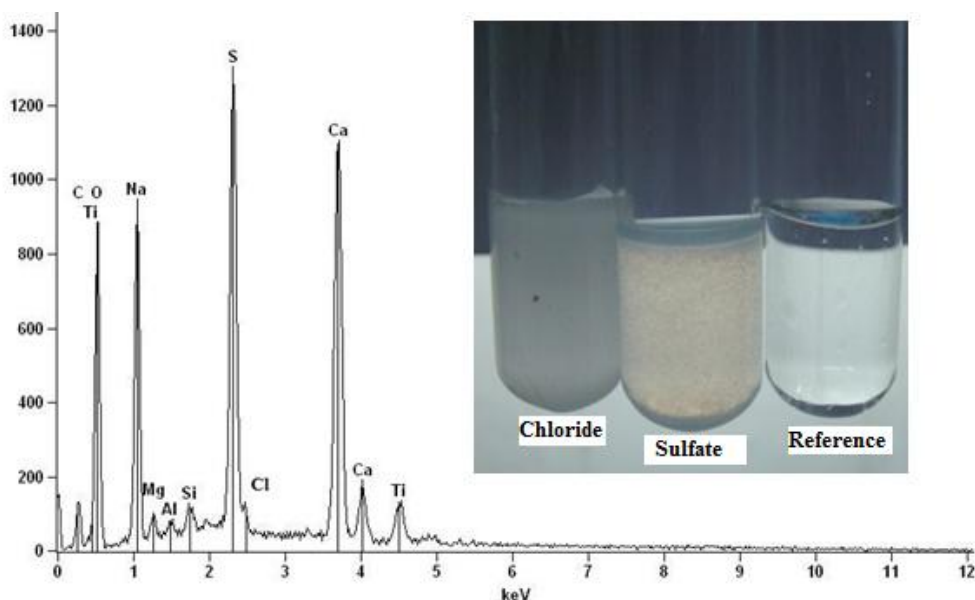


Fig. 5. EDX spectrum of the collected samples of salts, the detected elements Ca, Na, S, and Cl are directly linked in the formation of chloride and sodium and calcium sulfate in the plaster of the historic house and between the painting layers, confirming the results of the qualitative analysis of chloride and sulfate in the plaster of the historic house studied in this work.

It is reported that the presence of sulfate can lead to irreversible damages to the historic constructions, in the presence of humidity it can dilute and withdraw the ink layers present in the mural paintings and they can also serve as nutrients for some micro-organisms. As to chloride, it serves as electrolyte for oxidation/reduction reactions that may occur with some types of ink, resulting in fading and modifications on the pictoric layer [14-18]. The identification of these salts in this building, specifically, is of great importance, for it alerts about the preventive preservation of the mural paintings not only of this one, but also of other historic buildings present at the center of Florianópolis.

Conclusions

The buildings with an eclectic style represent an important element of the architectural historic process of the Brazilian cities. Adopted in Brazil with greater intensity between the end of the nineteenth century and the beginning of the twentieth century, it has represented a shape linked to urban change, with intense influence in the construction of the cities.

The eclectic architectural style was contemporary of urbanism, a science that encompassed sanitary measures with the aim of qualifying life in the cities. From this perspective of change, it has concentrated itself in its buildings, both in its internal configurations and in façades, architectural elements of high symbolic content and marked influence of its applicative technique.

Therefore, this research has operated in the domain of conservation and restoration in mural paintings, as an essential condition to the elaboration of a durable and sustainable preservation policy of this patrimony. Operating through the enlargement of knowledge on the

techniques utilized in the execution of the paintings and the intervention methods, in an interdisciplinary way, concentrating its studies in the technical knowledge on the materials that make up the paintings, like a source of technical-scientific information that will help future intervention and restoration processes. Besides contributing to valuation and making evident the integrated assets that make up the patrimony architecture, it demonstrates the importance of the partnerships in various areas of scientific knowledge associated to multidisciplinary researches.

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References

- [1] H.R. de Araújo, *A invenção do litoral: Reformas urbanas e reajustamento social em Florianópolis na Primeira República*, **Dissertação (Mestre) - Curso de História**, Departamento de História, Pontifícia Universidade Católica de São Paulo, São Paulo, 1989, p. 214.
- [2] H.R. de Araújo, **Fronteiras internas: urbanização e saúde pública em Florianópolis nos anos 20**, Letras Contemporâneas, Florianópolis. 1999, pp. 102-113.
- [3] O.R. Cabral, **Nossa Senhora do Desterro**, vol. I, Lunardelli, Florianópolis, 1979.
- [4] S.A. Araújo, **Serviço do Patrimônio Histórico e Artístico do Município de Florianópolis**, Arquivo do Instituto de Planejamento Urbano(IPUF), Florianópolis 2007.
- [5] B. Ernesto, **Conservation of Architectural Heritage, Historic Structures and Materials. ARC Laboratory Handbook**, Vol. III, Salts, ICCROM, Rome, 1999.
- [6] * * *, **Charte de Cracovie**, «Convention pour Conservation et Restauration du Patrimoine Construit», Comité Scientifique de la Conférence Internationale de Cracovie, 2000, <http://www.unesco.org> (accessed on 16 January 2013)
- [7] F. Luís Fernando de Oliveira, M. André Manuel Paes, C., Sofia Barroso, *Experiência do Minho*, Sesión nº 3 de Arqueologia de la Arquitectura, del IV **Congreso de Arqueologia Peninsular**, Universidade de Algarvo, Portugal, 2004, p. 173.
- [8] * * *, **Convention pour la Sauvegarde du Patrimoine Culturel Immatériel**, UNESCO, Paris, 2003, <http://www.unesco.org>. (accessed on 9 January 9 2013)
- [9] D.A. Rusak, L.M. Brown, S.D. Martin, *Classification of vegetable oils by principal component analysis of FTIR spectra*, **Journal of Chemical Education**, **80**(5), 2003, pp. 541-543.
- [10] M.R. Derrick, D. Stulik, J.M. Landry, **Infrared Spectroscopy in Conservation Science**, Getty Conservation Institute, Los Angeles, 1999.
- [11] K Hemachandran, A.R. Chetal, *X-Ray K-Absorption Study of Copper in Malachite Mineral*, **Physica Status Solidi**, **136**, 1986, pp. 181-185.
- [12] M. Bacci, F.R. Baldini, R. Linari. *A colour analysis of the Brancacci Chapel frescoes*, **Applied Spectroscopy**, **45**, 1991, pp. 26-31.
- [13] C.A. Santos, *O Eclesiástico Historicista em Pelotas: 1870-1931*, **Anais do 20º Encontro da Associação Nacional de Pesquisadores em Artes Plásticas**, ANPAP, Rio de Janeiro, 2011.
- [14] S.H. Barbara, **Analytical Techniques in Materials Conservation**, John Wiley & Sons, Chichester, England, 2007.

- [15] S. Bianchin, M. Favaro, P.A. Vigato, G. Botticelli, G. Germani, S. Botticelli, *The scientific approach to the restoration and monitoring of mural paintings at S. Girolamo Chapel - SS. Annunziata Church in Florence*, **Journal of Cultural Heritage**, **10**(3), 2009, pp. 379-387.
- [16] M. Gil, M.L. Carvalho, A. Seruya, I. Ribeiro, P. Alves, A. Guilherme, A. Cavaco, J. Mirao, A. Candeias, *Pigment characterization and state of conservation of an 18th century fresco in the Convent of S. Antonio dos Capuchos (Estremoz)*, **X-ray Spectrometry**, **37**(4), 2008, pp. 328-337.
- [17] S. Wei, M. Schreiner, H. Guo, Q. Ma, *Scientific Investigation of the Materials in a Chinese Ming Dynasty Wall Painting*, **International Journal of Conservation Science**, **1**(2), 2010, pp. 99-112.
- [18] K. Cornelis, H.S. Cornelius Jr., **Manual of Mineralogy** (20th ed.), John Wiley & Sons, New York, 1985.
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