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PIXE TECHNIQUE APPLIED TO ALMEIDA JÚNIOR MATERIALS

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ABSTRACT

The Institute of Physics University of São Paulo in collaboration with the Pinacoteca do Estado of the State of São Paulo has a project to develop a data bank with information about the elementary composition of pigments of paintings and materials of its collection for future application as conservation and restoration as well as authenticity,. The project is beginning with the materials (palette, paint box and paint tubes) belonging to the painter Almeida Jr.. Twenty-three spots on the palette were chosen with determined colors, and also the paint tubes present in the paint box. The PIXE (Particle Induced X-ray Emission) analysis of the spectra enabled to conclude that the red colors have predominant Hg and S suggesting Vermellion and the white one are consisted of Pb (Lead White). The analyzed tubes of same colors confirm the elements pigment present in the palette.

1. INTRODUCTION

The Ion Beam Analysis Material Laboratory (Laboratório de Análise de Materiais por Feixes Iônicos – LAMFI) of the Institute of Physics University of São Paulo has installed an external proton beam device for PIXE [1]. This structure is being used in the non-destructive analysis of ceramics, artifacts, paintings and biological tissues, which are not compatible with the high vacuum of the PIXE chamber [2].

The elemental composition of the pigment found on a palette, tubes, and paint box belong to the Brazilian painter Almeida Jr. (1850-1899) were analyzed with PIXE. These materials (shown in figs. 1 and 2) are from the Pinacoteca of State of São Paulo.

The PIXE analyses were done on twenty-three spots of different colors on the palette as shown in Fig 1, and on two tubes with red and white pigments.

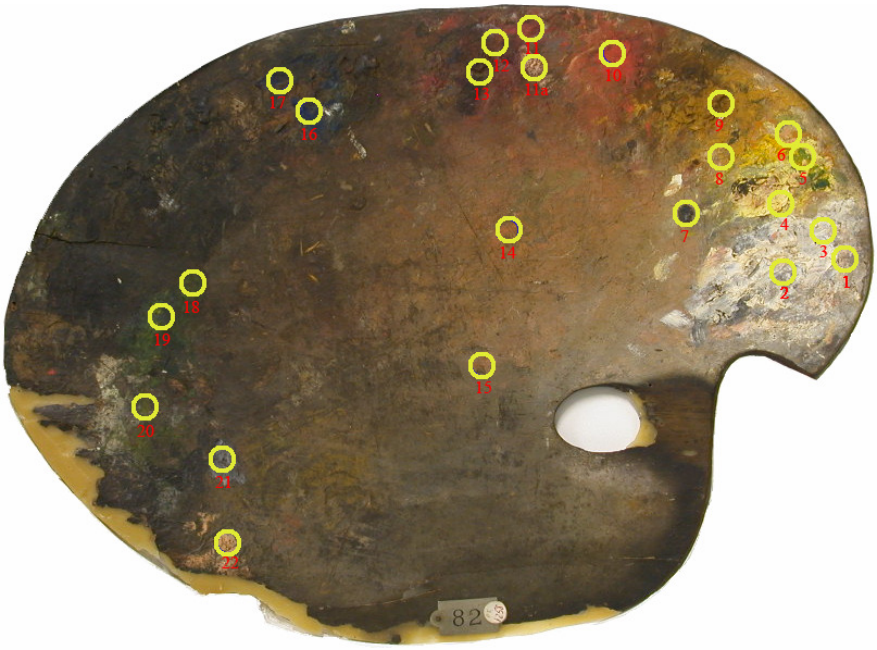

Figure 1. Palette with characteristic points chosen for analysis.

Figure 2. Paint box of wood with metallic division inside.

2. RESULTS

All spectra shown in this work are normalized to the proton induced fluorescence of the K line of Ar which is present in the air between the sample and the exit window of the beam line. In fig. 3 are shown the spectra corresponding to the white color of point 3 on the pallet and the white from the paint tube. The two spectra shown in this figure are similar except for

a visible difference in the Ca, Ti, Ba and Fe peaks. Similarly in fig. 4 we have the spectra corresponding to the red of the point 10 and the red tube and this figure shows a large difference between the two spectra. This difference is due to the fact that a thin layer of red paint over the tube was analyzed. When irradiated, protons penetrated the paint layer hitting the casing of the tube giving a typical spectrum of metal elements (Sn, Fe, Zn and Pb) together with the elements of the red pigment. On the other hand the white tube had a very thick layer of white paint shielding it from the protons. The hypothesis for the presence of Ca, Ti and some Fe in both cases can be due to the contact of all tubes inside the paint box, as you can see in fig. 2.

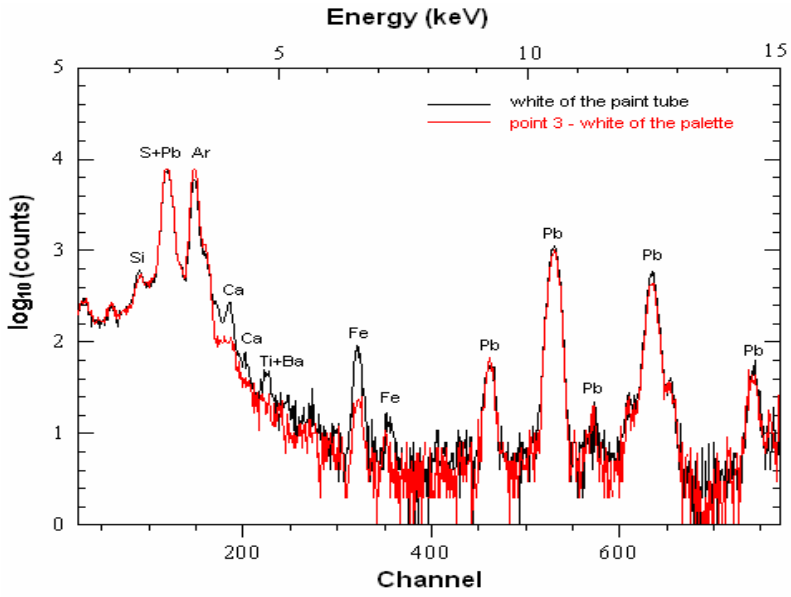

Figure 3. Spectra of the paint tube and of point 3 (white) of the palette.

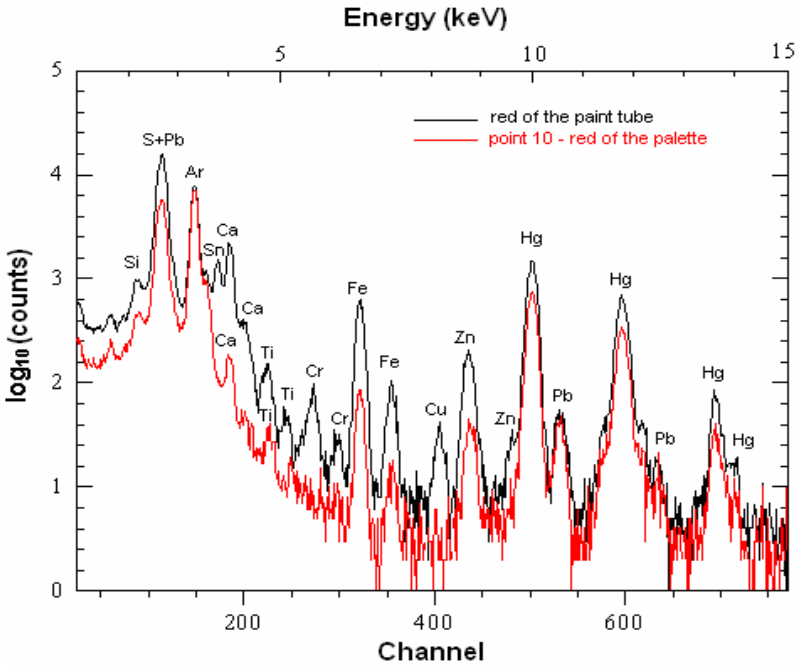

Figure 4. Spectra of red of the paint tube and point 10 (red) of the palette.

In the red paint spectra (fig. 4) the similarities are fewer but the differences besides Ca, Ti, Ba and Fe are mainly associated with the elements present on tube casing, like the Sn and Cu (the paints were analyzed without being removed from the tubes). Elements such as Fe, Zn and Pb can be also associated with the tube casing. Cr appears almost only in red pigment on the tube. In the figure 5 it is possible to see the comparison of the spectra of the red paint on the tube and other part without paint. In these spectra it is possible notice that the Zn and Fe are mostly present in the paint and much less on the casing, the latter has almost no Cr. This element is present in various pigments of yellow and green colors [3] and could also be mixed with the red vermellion pigment.

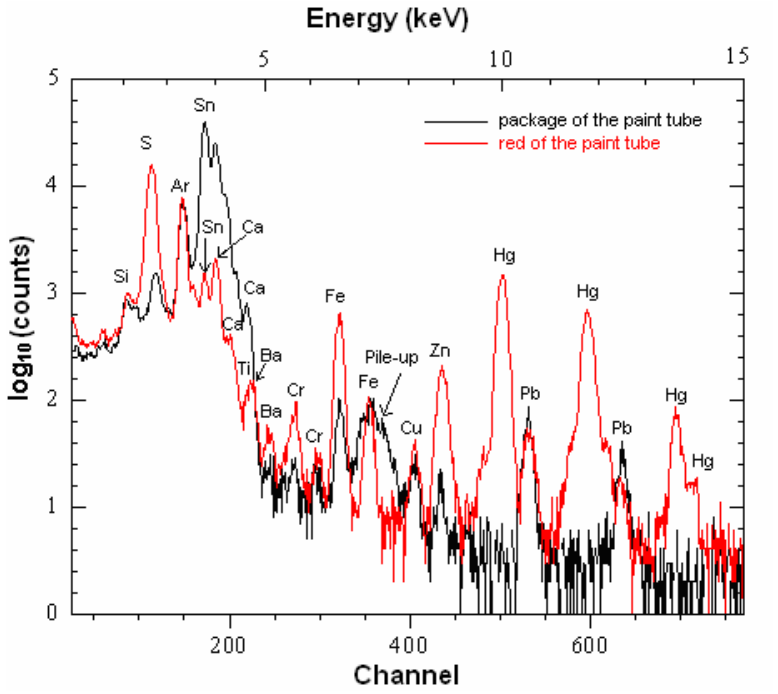

Figure 5: Spectra of red of paint tube and of the casing (metallic) of the tube.

The large presence of S, Pb and Hg characterize the pigment lead white and vermellion, respectively as can see in figure 6 and 7. The other elements came probably from the tube casing and some mixtures of other pigments, for example: chrome yellow and chrome green.

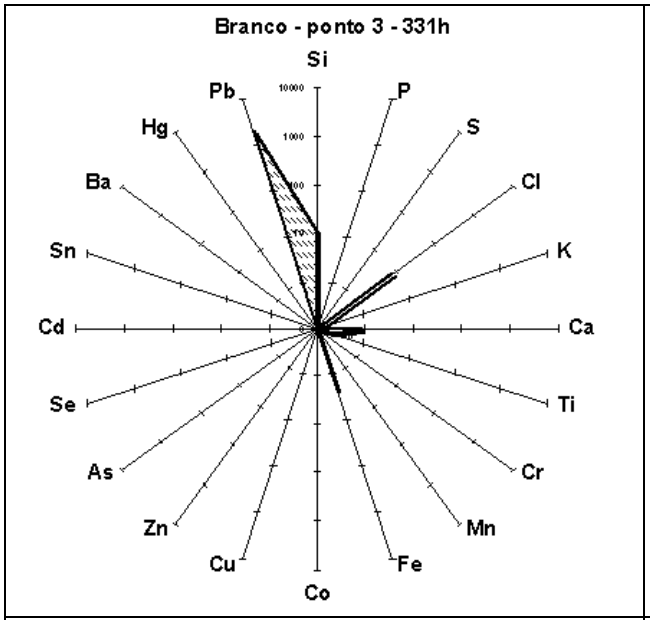

Figure 7: Sun ray plot of white pigment of the point 3 on the palette.

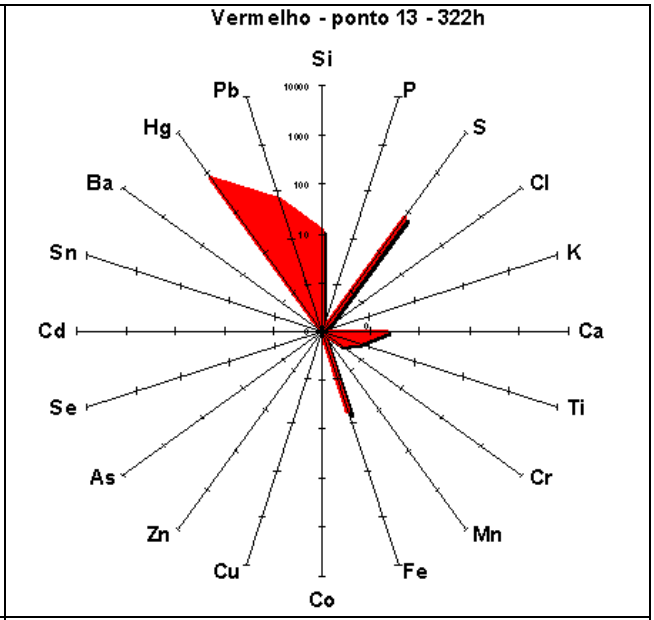

Figure 8: Sun ray plot of red pigment of the point 13 on the palette.

The data analysis of these results is underway to characterize the pigments used by the painter Almeida Jr.

3. CONCLUSIONS

The PIXE technique can be used in the elemental analysis of a pigment in a non-destructive manner. Due to the nature of the analyzed material and of peculiarities of the PIXE technique, the analysis realized in this case is semi-quantitative. The spectra analysis allowed us to conclude that the red color present on the palette and in the tubes is composed with Hg and S (vermillion) (red pigment utilized since the antiquity until the present). The white one suggest the lead white ($2PbCO_3 \cdot Pb(OH)_2$).

The obtained results also allowed to conclude that for the analyzed tubes from white and red colors, the pigments of the same colors present in the palette are the same which are present in the paint tubes.

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