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Microstructural characterization of prehispanic paintings

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Traditionally the archaeological samples analysis has been carried out by means of petrographic microscopy; however, techniques as scanning and transmission electron microscopy (SEM, TEM) and analytical techniques associated as Energy Dispersive X-Ray Spectroscopy (EDS) have shown their great potential that they have in the characterization of archaeological materials. In order to correlate the morphology and microstructure with their chemical elementary composition. In the last few years the study of prehispanic paintings has been extended due to several factors like the resistance to acids, solvents and biocorrosion, these have been not fully understood. The aim of this work is to show some studies about the prehispanic paintings, maya blue paint and red paint, found in several archaeological sites located in the southeast of Mexico.

The samples were analyzed in a SEM JEOL -5900LV equipped with Oxford microprobe for chemical elemental analysis by EDS, TEM JEM-2010 and JEM- 2010F equipped with STEM unit and EDS microprobe. Samples were grinnd and cleaned with an organic solvent in an ultrasonicated bath. A Fast Fourier Transform (FFT) from the TEM digital images was obtained, and mask was applied to some areas. A second FFT recovered the original image in which noise had been reduced.

The results obtained by SEM showed in both paintings, fiber-like structures of micrometers order as show in the figure 1. In other zones of the samples were identified irregular morphologies rich in C, O and Ca which they supported the fibers. The EDS analysis were identified the elements C, O, Na, Mg, Al, Si, Ca and Fe (Figure 2b). In early reports of Maya blue, Gettens [1] found 0.5 to 1.0 % impurities of Fe and 0.01 % of Mn and Cr. These last two elements did not identify them in any of the analyzed samples.

The results of the characterization by TEM and High Resolution Transmission Electron Microscopy (HREM) showed fiber crystalline structures in the nanoscopic level corresponding to palygorskite clay ($Mg_5(Si,Al)_8O_{20}(OH)_2 \cdot 8H_2O$) as show in the Figure 2a, the measurements of the atomic array of the clay and electron diffraction patterns confirms this results. In other laminar zones was identified the calcite phase ($CaCO_3$).

We in this study confirmed the hypothesis that affirms that organic colorants are encapsulated in the palygorskite pores, and probably also contribute to the final color [2,3,4]. In the future the development of natural pigments will allow the removal of elements strategically important as Pb, Cr and Cd from the paint industry.

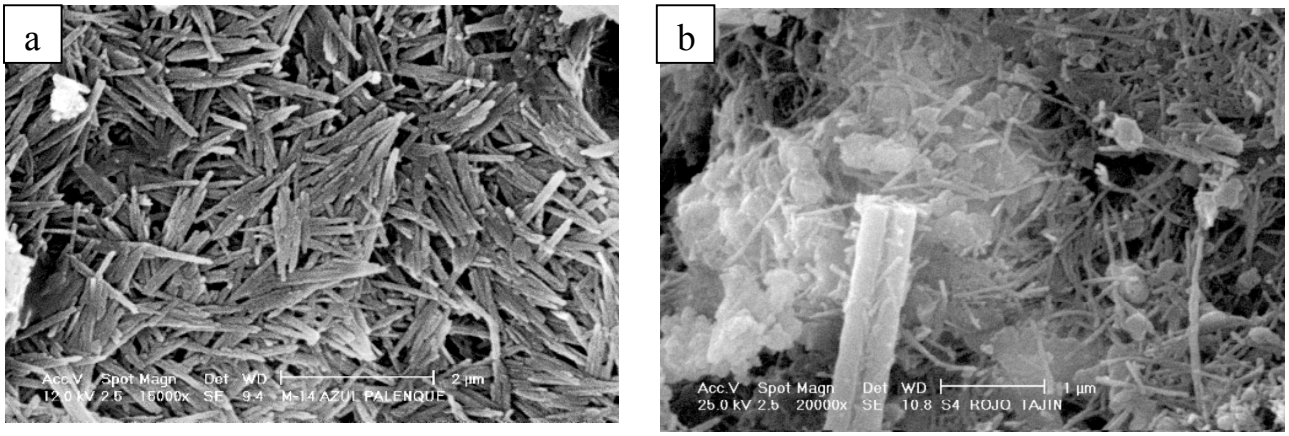

Figure 1.- a) SEM images of maya blue paint found in Palenque Chiapas, fibers of ~ 0.8 µm of long for 0.15 µm of wide are showing. b) SEM micrograph of red paint found in El Tajín Veracruz Mexico showing fibers grater size than 1 µm of length and 0.07 µm of width.

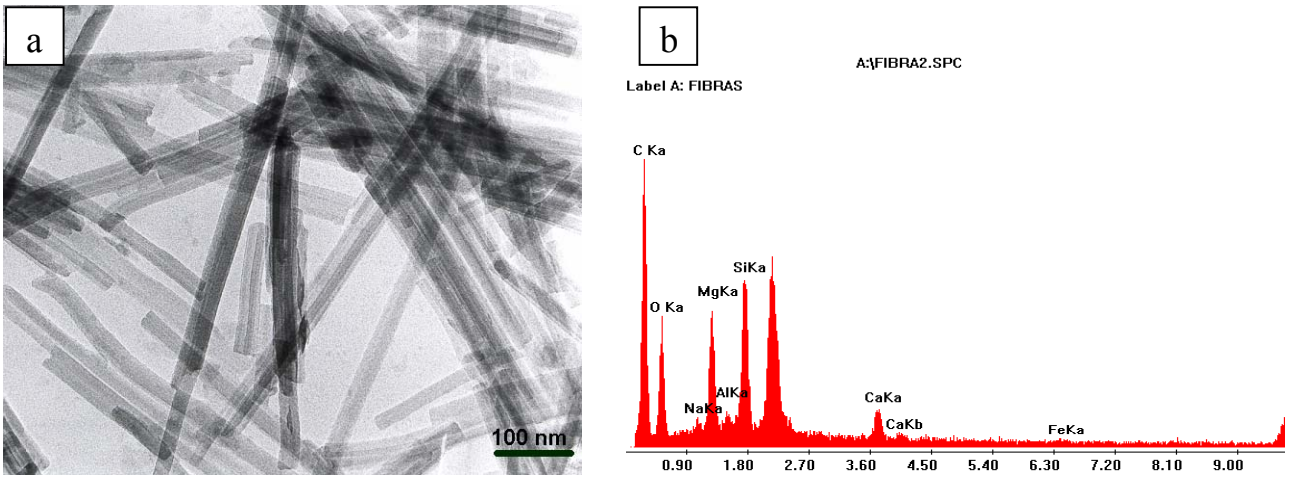

Figure 2.- a)TEM image show paligorskite crystals in the maya blue paint. b) EDS analysis of blue painting , the elements identified were C, O, Na, Mg, Al, Si, Ca and Fe.

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