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CHARACTERIZATION OF SOME TEXTILE ARTIFACTS FROM PLOPIS WOODEN CHURCH – PART OF UNESCO WORLD HERITAGE SITES

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Abstract: *Churches are often similar to art museums, having numerous collections of frescoes, icons, liturgical books, old furniture and various textile pieces, some of them even from the 15th to the 19th century timeframe. Due to their great historical significance, some of these churches became part of UNESCO World Heritage Sites. The Plopis Wooden Church from Sisesti village (Maramures county, Romania) is an example of such sites.*
Generally, the textiles found in churches have a role in retaining the humidy from the environment and preventing proper ventilation, contributing to an increase in the moisture content of wood, which can lead to the development of mold. With that in mind, the regular shaking and airing of fabrics, carpets, and any other textile found inside churches, especially wooden ones, is indicated. Consequently, the identification of the fibrous composition of historic textiles and the processes involved in their aging are essential because long-term conservation of such textiles is influenced by these factors. This information facilitates the development of adequate conservation strategies. The chemical composition of fibers greatly impacts their properties. The main requirement for a technique to be suitable for characterizing historic textiles is that the said technique is non-destructive, or micro-destructive, at most. Thus, for the present study, the assessment of a texile fragment – 'Adam and Eve' fabric from Plopis Wooden Church, that is believed to be roughly the same age as the church – was performed via scanning electron microscopy (SEM) and energy-dispersive X-ray spectroscopy (EDS).

Key words: *textiles, heritage, fibers, SEM, EDS.*

1. INTRODUCTION

The 'Saint Archangels' Plopis Wooden Church from Sisesti village (Maramures county), Romania, was built during 1796 and 1798 [1]. The church is part of UNESCO World Heritage Sites since 1990. The Plopis church was built from oak wood, with many unique features. The church has had many repairs which were meant to preserve it, and the last major restoration was carried out at the beginning of the 1990s. The passing of time had an impact especially upon the frescoes that were painted in 1811, which nowadays are present only in the southern part of the nave [2].

The comprehension of the function, context, and role of a historically valuable object are essential information that may impact its conservation process [3]. Moreover, for textiles in this category, the identification of the fibrous composition and aging processes and mechanisms are important for their long-time conservation.

2. MATERIALS AND METHODS

2.1. Materials

The textile fabric has its origin in the 'Saint Archangels' Plopis Wooden Church. More specifically, it was taken from the western part of the nave, in the area where the choir is situated. The fabric is a long and friable strip of approximately 150 cm, with a film-like layer on one of its sides. The role the fabric had within the Church was not yet identified.

For a precise assessment of the fabric and due to its heterogeneity, two different areas of interest were selected (Fig. 1).

***Fig. 1**. Photographs of the entire textile fabric (**a**) and the areas from which the two samples were selected (**b** – area 1 and **c** – area 2)*

2.2. Methods

A scanning electron microscope (Quanta 200, FEI) was used in conjunction with an energy-dispersive X-ray spectroscopy detector (Element, EDAX-AMETEK). The SEM analysis was carried out at accelerating voltages between 10 – 15 kV. The EDS analysis was performed in mapping mode at 15 kV accelerating voltage and 2000× magnification, for both samples.

For both analyzes, the samples were placed on aluminum specimen stubs covered with conductive adhesive carbon tape. The samples did not require additional metal coating and were used as they were.

3. RESULTS AND DISCUSSION

3.1. SEM results

All SEM results were obtained as longitudinal views of the samples placed horizontally, without tilting.

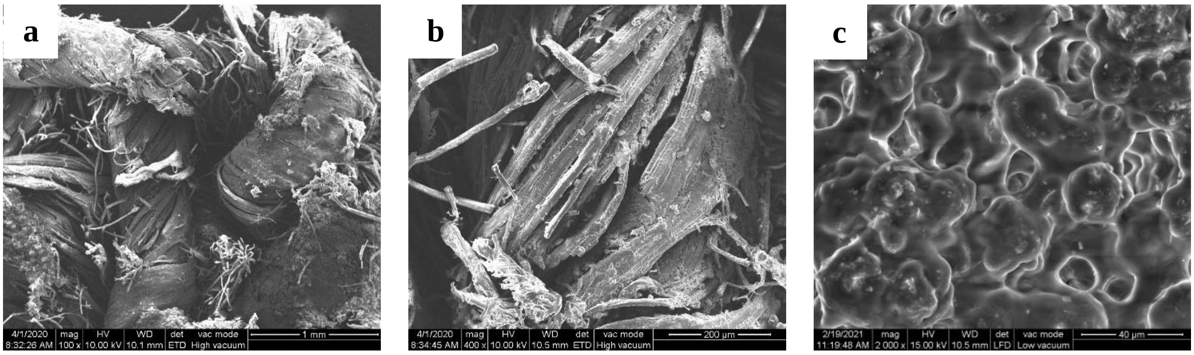

Fig. 2*. SEM micrographs of sample 1 at 100× **(a)**, 400× (**b**), and 2000× magnification (**c**)*

The first sample has been selected from an area which presented both the textile fabric, as well as a film that was present at its surface. The SEM micrographs from Fig. 2 (a, b) show the fibers twisting into a thread and the film on its surface. The mean diameter of the threads is approx. 610 μm, whilst the diameters of individual fibers range between 10 and 20 μm, corresponding to linen fibers, according to literature [4]. The fibers have a linen/ hemp appearance (the distinction between these two types of fiber cannot be made via SEM) [5]. The film partially covering the surface of the threads has a granular appearance, as in Fig. 2 (c).

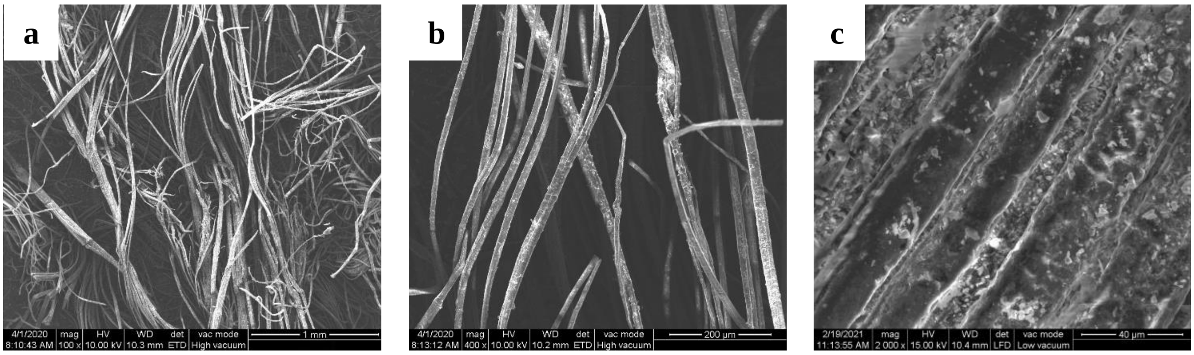

Fig. 3*. SEM micrographs of sample 2 at 100× **(a)**, 400× (**b**), and 2000× magnification (**c**)*

The second sample has been selected to emphasize the textile fibers, not the surface film. The similarity of the fibers'appearance to linen/ hemp fibers was observed in more detail in longitudinal view, especially the smooth surface pattern with bamboo-like cross-marking nodes. The high degradation state of the sample was noticed as well, with longitudinal splits of the fibers and the scuffing of the cross-marking nodes.

3.2. EDS results

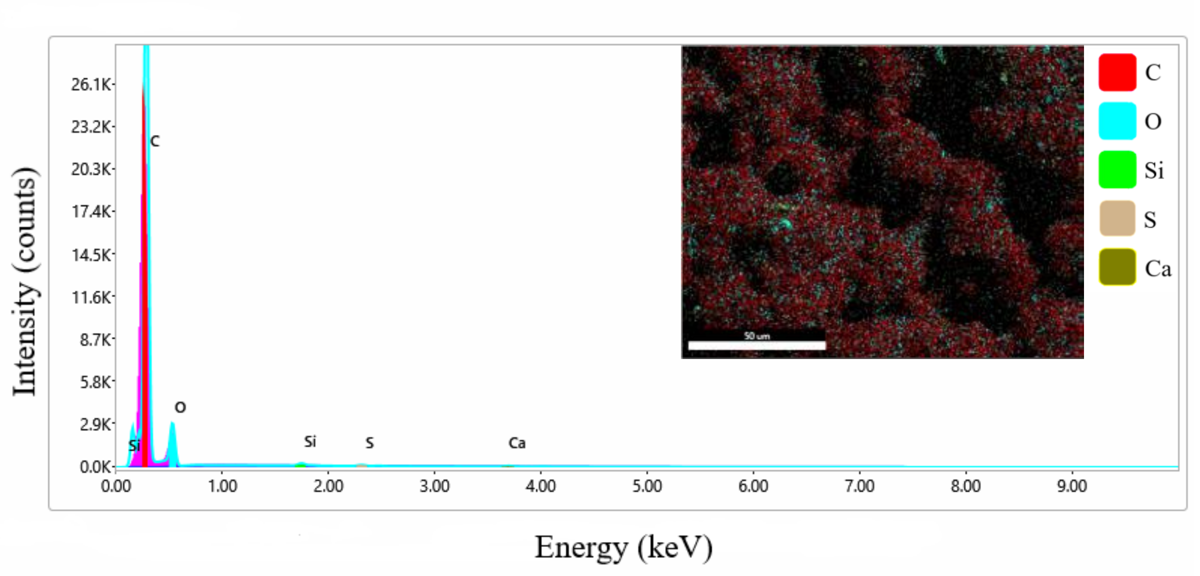

Fig. 4. *EDS map and spectrum for sample 1*

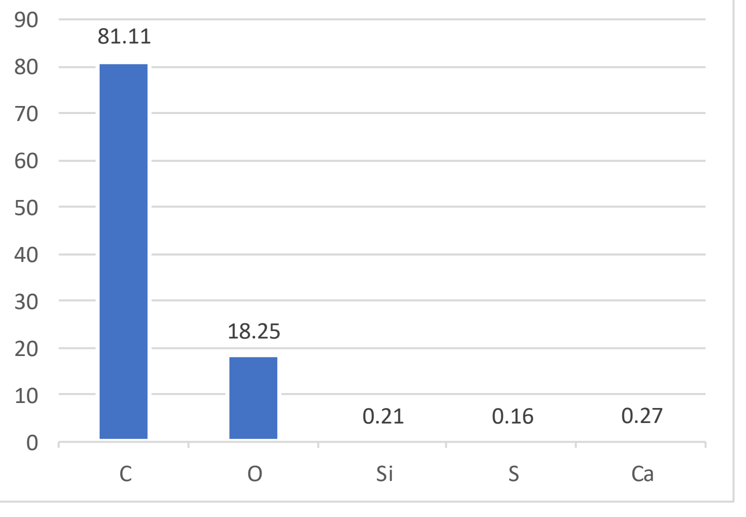

Fig. 5. *EDS elemental quantification for sample 1 (wt%)*

The area that was mapped is the same as in Fig. 2 (c). The high carbon and oxygen content indicate that the film covering the fabric may be some type of natural polysaccharide-based adhesive [6]. The other elements are, most likely, impurities (oxides, salts), due to their insignificant proportions (< 1%), when compared to carbon and oxygen.

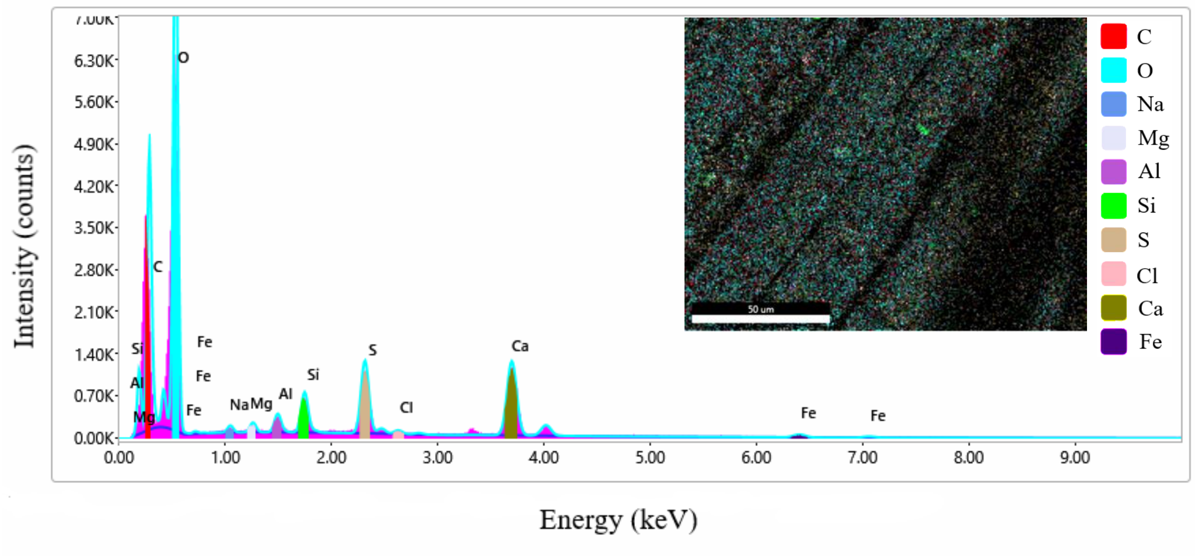

Fig. 6. *EDS map and spectrum for sample 2*

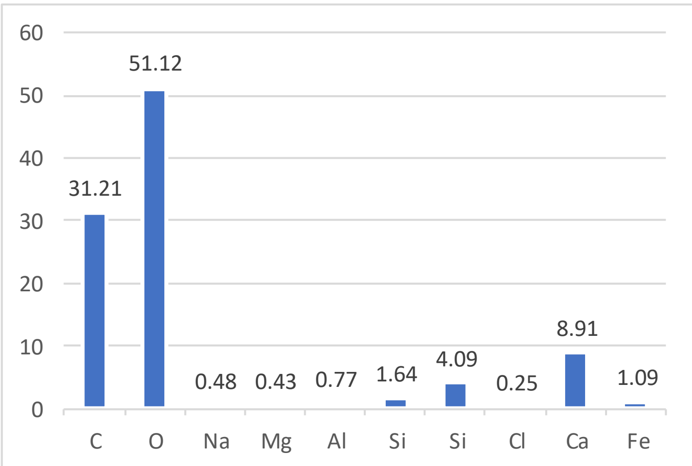

Fig. 7. *EDS elemental quantification for sample 2 (wt%)*

The area that was mapped is the same as in Fig. 3 (c). Similar to sample 1, the analysis revealed the presence of multiple elements, besides the expected carbon and oxygen inherent to the fibers, which are mostly composed of cellulose (72.5–81%) and, in a lesser proportion, of hemi-cellulose (14.5–20%) [7]. The many other chemical elements may be present on the sample due to finishing treatments that may have been applied to the textile fabric (i.e., mordanting, dyeing) [8]. Additionally, impurities may also influence the chemical composition.

4. CONCLUSIONS

Following the analyzes that were performed on the samples, the cellulosic nature of the fibers was identified, even though the exact type of fiber could not be determined due to the similar microscopic appearance of linen and hemp. The advanced state of degradation of the fabric was highlighted and, while it was certainly caused by the old age of the textile artifact, it may also have been accelerated by the salts and oxides that were applied during the finishing processes.

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