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Editorial

New Insights into the Assessment of Archaeological Crystalline Structures

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New analytical approaches and tools have become essential for safeguarding archaeological assets, given the accelerated degradation caused by diagenetic alteration or exposure to the atmosphere [1–10]. Non-destructive techniques, together with chemometric tools, are increasingly dominant in this field of investigation [11–22]. Various materials can be found in an archaeological context, such as metals, pigments, glasses, stones, ceramics, or plasters, making their preservation challenging under a single conservation plan [23–35].

This Special Issue on "Archaeological Crystalline Materials" encompasses eight papers that study the physical–chemical properties of archaeological materials and their changes in lattice parameters and crystalline domains.

An analytical methodology to explore the manufacture of glass tesserae from a Roman domus is presented by Gomez-Laserna et al. [36]. Their paper focuses on the important role of supply and production strategies of the Taormina workshop (Italy). Specifically, their methodology, which was based on the combination of X-ray fluorescence (EDXRF) and Raman spectroscopy, allowed them to inspect the raw materials used by the craftsmen. Chemometric tools revealed different kinds of tesserae, with one group being compatible with the geochemistry of local carbonatic/dolomitic materials and another showing a more complex pattern, which was attributed to a non-local material, suggesting that there was a network of commercial contacts wider than the local market.

Several contributions examined mortars and plasters that were used to decorate walls and their respective manufacturing techniques [37–39]. Tévar et al. [37] employed the non-invasive high-resolution macroscopy (NIHRM) technique combined with colorimetric analysis to examine the microstratigraphic phases of mortars and the grain sizes of the aggregates, the distribution, and the sphericity index. The authors focused their study on the walls from the Roman villa of Noheda (Spain), being able to establish the production technology of mortars, and the pictorial surface. Lee et al. [38] conducted morphological analysis to identify the materials used in the wall plasters from a Korean tomb. Specifically, they investigated the processing conditions for the plaster components and the utilization of oyster shells in the Goa-ri Tomb plaster, identifying key techniques used for mural creation in the Great Gaya period.

Rong et al. [39] examined the detrimental effects of sodium sulphate on tomb murals in Jiangx and proposed an in situ consolidation and desalination protocol using barium hydroxide nanoparticles in combination with a phosphoric acid system. Another consolidation treatment was suggested by Valentini et al. [40], involving new non-functionalized SiO_2 nanoparticles, which were applied to Pietraforte, a Florentine sandstone. The silicate-based consolidating agent, dispersed in an aqueous medium, was tested on the façade of San Lorenzo Church (Florence) and analyzed to evaluate the behavior of Pietraforte against environmental humidity before and after treatment. This analysis involved textural and physical analyses as well as specific tests to assess the effectiveness of consolidation.

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Depending on the geological provenance of certain minerals, the presence of trace elements varies greatly, making it valuable to reconstruct their original composition. This is the case with cinnabar mineral. Several isotopic studies have been conducted to determine the provenance of cinnabar pigments. Pérez-Diez et al. [41] proposed a new non-invasive spectroscopic methodology based on the use of portable Raman and EDXRF instruments, which allows to reveal mineralogical differences between the cinnabar ores at different locations of the Almadén mining park, the main cinnabar source during Roman times. This work demonstrated the need for an in situ screening of the mineralogy of the mining area to extract the best mineral specimens and to achieve representative isotopic results in the laboratory. Moreover, their article described how canonical discriminant analysis (CDA) and principal component analysis (PCA) on the spectroscopic data allowed to reveal similarities and differences among the cinnabar mineral samples from Almadén and the Pompeian cinnabar pigment. Pocostales et al. [42] examined the geochemical processes occurring on the surface during the formation of stucco, focusing on the development of a film composed of an amorphous gel-like stratum and a micro-crystalline stratum. The study conducted with polarized optical microscopy, scanning electron microscopy, and Fourier transform infrared spectroscopy, demonstrates how the surface becomes more crystalline over time.

Finally, Lee et al. [43] examined the characteristics of minerals, such as malachite, present in murals, via optical microscopy (OM), X-ray powder diffraction (XRD), and scanning electron microscopy (SEM) with energy dispersion. The article describes different chemical components, microstructures, and mineral crystallizations across various layers.

In conclusion, the present Special Issue on "Archaeological Crystalline Materials" shows a representative overview on the new analytical approaches for the study and conservation of archaeological crystalline materials. This Special Issue highlights the need to develop non-invasive methodologies that allow us to obtain information on the origin of crystalline materials, as well as their potential transformations. Furthermore, the development of new conservation materials is a hot topic [44–52]. However, these novel materials will need to be formulated with respect to the original mineralogical structure and composition of archaeological crystalline materials whilst keeping the environment and operators' health in mind.

Conflicts of Interest: The authors declare no conflict of interest.

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