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THE CHARACTERISATION OF PIGMENTS OF AN EGYPTIAN ANTHROPOMORPHIC SARCOPHAGUS COVER OF THE LATE DYNASTIC PERIOD: A MULTI-ANALYTICAL STUDY.

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1. Introduction

Since ancient times, man has attributed symbolic meaning to colours, many of which have had different meanings depending on the civilisation. Throughout millennia, the charm of colours has always pushed Man to search for various natural materials to be used as pigments and/or dyes and, since antiquity, to produce colours synthetically. In ancient Egypt, where colour's symbolism was rigidly established, the tint was considered an indicator of a thing's essence rather than its appearance.
In this context, bearing in mind the high technical skills of Egyptians, it does not seem strange that what is considered the first synthetic pigment in history was Egyptian blue, whose production began around 3000 BC. This research aimed to characterise the colour palette employed for decorating the cover of an Egyptian anthropomorphic coffin attributed to the Late Period. The artefact, which is part of a private collection, was analysed by exploiting a multi-technique approach that employed Raman, scanning electron microscopy equipped with an X-ray fluorescence probe (SEM-EDXS), and total reflectance Fourier transform infrared spectroscopy (ATR/FTIR).

2. Results and Discussion

The first measurements were performed in situ directly on the artefact's surface. Blue-black, red, green, white, black and bright blue areas, which represented the entire colour palette of the coffin cover, were analysed through a BWTek i-Raman EX portable spectrometer equipped with a fibre optic probe and a 1064 nm Nd-YAG laser source. Despite the excitation in the near-infrared region, the collected spectra were mainly characterised by a very strong fluorescence signal, which was not surprising [1]. However, the peaks of calcite at 1086, 712 and 284 cm-1 and the bands at about 220, 290, 403 and 608 cm-1 attributable to red ochre were relieved by Raman spectra acquired respectively on the white and red area of the sarcophagus [1, 2]. Six micro-samples were then collected from the same points already investigated by Raman spectroscopy in order to verify the obtained results and deepen the analysis of the pigments through SEM-EDXS technique and ATR/FTIR spectroscopy.
After having observed the samples through a stereomicroscope to evaluate their hue from a microscopic perspective, they underwent morphologic and elemental semiquantitative analysis by a Hitachi TM 1000 scanning electron microscope equipped with an energy dispersive X-ray spectrometer (Oxford Instruments SwiftED). None of the SEM-EDX measurements required a coating application. All the samples appeared basically characterised by a relevant percentage of calcium, averaging in range from 65 to 80% in the coloured samples and reaching 90% in the white piece, and by the presence of silicon (5-15%), aluminium (averaging 1,5%), potassium (1-4%) and sulphur (2-5%). Then, for each sample, a chromophore element responsible for the colour was identified, namely copper for blue-black, bright blue and black samples, calcium for the white sample and iron for green and red samples.
Those results allowed hypothesising the presence of calcium carbonate in the white sample, red ochre in the red one, and green earth in the green one. The high percentage of copper was attributed to the employment of copper-based pigments in bright blue, blue-black and black fragments, the ones on black samples being quite surprising outcomes.
The subsequent ATR/FTIR measurements elucidated the presence of the characteristic bands of calcite (particularly abundant in the white sample) and the features of silicate minerals in all samples. Furthermore, white, green, and blue-black samples also exhibited peaks of calcium sulphate. Then, the presence of red ochre, previously evidenced by Raman spectroscopy, was confirmed, especially because of the bands ascribable to

iron oxide. In contrast, green earth, specifically the minerals celadonite and glauconite, were recognised in the FTIR spectrum of the green sample. Finally, the typical features of Egyptian blue (figure 1) were highlighted in the FTIR spectrum of the bright blue sample, whereas no evidence of anything came as far as the black pigment was concerned.

3. Conclusions

This study highlighted the usefulness of disposing of several complementary techniques. In fact, that multi-analytical approach allowed the characterisation of the entire colour palette, with the exception of the black pigments. Based on the high percentage of copper and the absence of any other element or Raman/IR features responsible for that dark colour, the contemporary presence of carbon black and Egyptian blue was hypothesised in black and blue-black samples. Further analyses will be performed to prove the latter conjecture. It is also worth noting that Raman in situ measurements enabled recognising some of the pigments in a totally non-destructive way. Finally, the identified colours were compatible with what is reported in the literature for analogous artefacts.

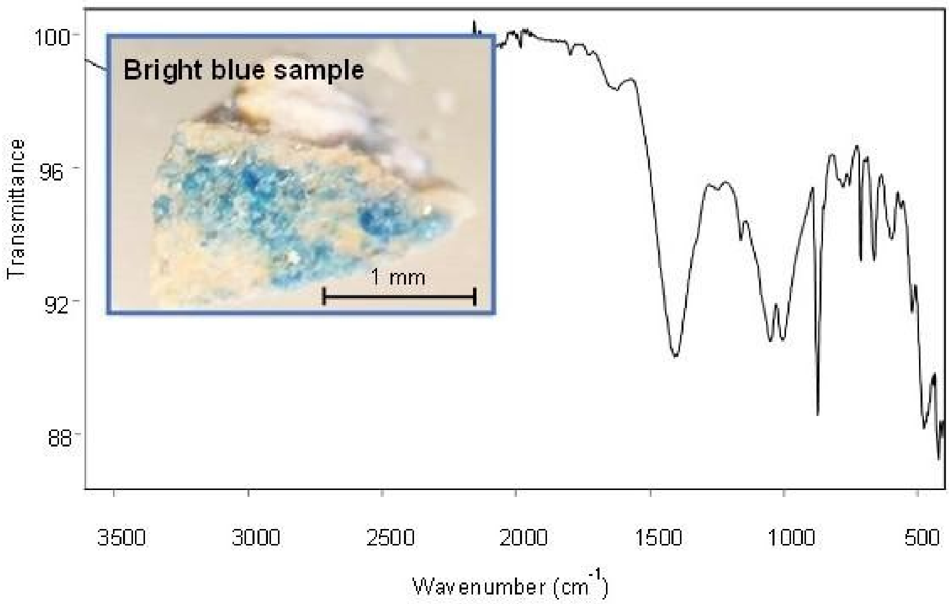

Fig.1 – ATR/FTIR spectrum of Egyptian blue obtained from the bright blue sample

References

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[2] S. Bruni et al. A non-destructive spectroscopic study of the decoration of archaeological pottery: From matt-painted bichrome ceramic sherds (southern Italy, VIII-VII B.C.) to an intact Etruscan cinerary urn. Spectrochim. Acta A Mol. Biomol. Spectrosc. (2018)