COLOURS OF THE WIND: INVESTIGATING THE USES AND MATERIALS OF A SELECTION OF FANS (18TH-19TH C.) USING MOBILE SPECTROSCOPIC TECHNIQUES (AQUITAINE MUSEUM, FRANCE).

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Introduction :

Fans are present in many museum collections yet almost no study focused on their materiality[1]. At first sight, fans may seem useful only for their refreshing effect, but throughout history, these precious objects have served a wide variety of purposes depending on their societal contexts. From being used by generals on battleground in Japan to their role among aristocratic women in European courts, and even as a means of spreading revolutionary ideas, fans have had a multitude of uses.

Our research focuses on 9 hand-fans (Fig.1) recently added to the collection of the Aquitaine Museum (Bordeaux, France). Only 4 are presented in this poster.

These 4 fans have been selected because they are presenting a high variety of materials and origins of productions:

- *Bergerades aux Agneaux*, 1855-1860, France, paint on paper and parchment, 27 x 50 cm, Aquitaine museum, Bordeaux, France (Fig.2).
- *Les terrasses Chinoises*, 1850-1860, Canton China, paint, textile and ivory on paper, 26.5 x 48,5 cm, Aquitaine Museum, Bordeaux, France (Fig.3.a-b).
- *Fleurs appliquées sur soie*, 1880-1885, France, textile, 27 x 49 cm, Aquitaine Museum, Bordeaux, France (Fig.5).
- *Les émeus*, 1890-1900, Japan, paint on paper, 22.7 x 42 cm, Aquitaine Museum, Bordeaux, France (Fig.6).

Fig.1. The 9 fans analysed in this study

Instrumentation

The complexity of these fragile objects led us to adopt a non-invasive methodology relaying solely on mobile spectroscopic techniques. This methodology developed in Archeosciences Bordeaux is particularly adapted when sampling is prohibited and when artworks are sensitive to light or to being handled [2,3].

The analyses have been conducted *in-situ* and in the laboratory using:

p-XRF, VIS&SWIR hyperspectral cameras, FORS, p-FTIR, LEDµSF and digital microscopes.

A specific palette of 46 pigments and mixtures was reproduced using Kremer pigments/dyes to constitute a database of reference spectra with all our mobile techniques (Fig.6).

Fig.6. The palette realised specifically for this study.

Results & discussion

Fig.2. Bergerades aux Agneaux, © Lysiane Gauthier

Fig. 2.2. SWIR Image in FC : R=1672nm; G=1489nm; B=1266nm

➢ Blue pigments

The VIS reflectance spectra allowed us to distinguish between a copper-based blue pigment (max reflectance around 450 nm) and a cobalt-based pigment (max absorbance around 585 nm), both mixed with lead white (Fig. 2.1) which explains the shift we observed compared to our reference data. The two bands present in the spectra of the copper-based blue at 545 nm and 600 nm can be attributed to the use of smalt. The p-XRF confirms the presence Co and Si. The cobalt blue pigment can be mapped and appears in red in the SWIR-FC image choosing characteristic bands [4] (Fig. 2.2).

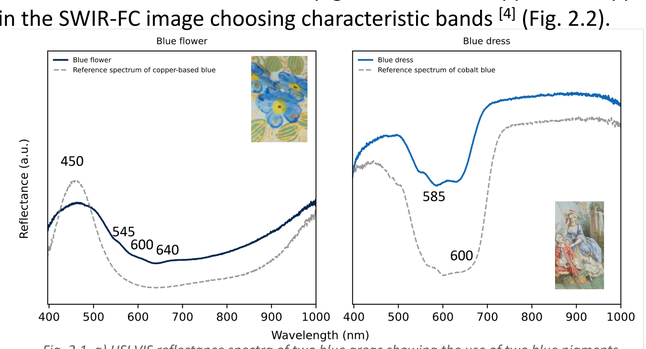

Fig. 2.1. a) HSI VIS reflectance spectra of two blue areas showing the use of two blue pigments.

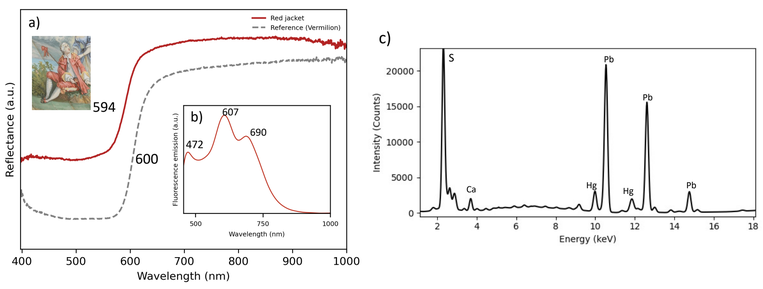

Fig. 2.3. a) HSI VIS reflectance spectra of the man in red on the fan compared to a reference spectra of vermilion; b) UV fluorescence spectrum for the same point on the fan, c) p-XRF spectrum for the same point.

➢ Red-dressed man

In the reflectance spectrum, the inflection point around 594 nm can be attributed to vermilion. This hypothesis is confirmed by the presence of Hg and S in the XRF spectrum and by the UV fluorescence emission at 607 nm. The fluorescence band at 690 nm may indicate the presence of chlorophyll *a* in case of a mixture of vermilion with a yellow dye (gamboge for example) [5].

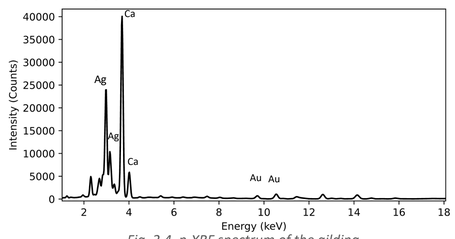

Fig. 2.4. p-XRF spectrum of the gilding

➢ Zwischgold technique used for frame gilding

A gold leaf (Au) remains on the sticks but seems to have disappeared in places, leaving a black layer. Ag is present in these black layers and can be attributed to the presence of the specific technique of the Zwischgold which consists of applying a gold leaf on top of a silver leaf [6].

Ca can be attributed to the mother-of-pearl stick on which the gilding is applied.

Fig.5. Fleurs appliquées sur soie , © Lysiane Gauthier

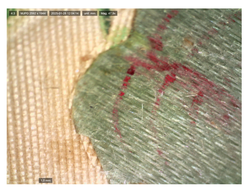

Fig.5.1. Dinolite® photography showing the two pieces of textile connected to each other at x47 magnification.

➢ Silk used for the fan leaf and the small applied flowers (5.1).

The SWIR reflectance spectra present the bands of the silk textile (1536 nm, 1575nm, 2205nm) (Fig.5.2).

The mapping of the repartition of the silk shows that silk was used both in the fan leaf and the flowers decorations (Fig.5.3).

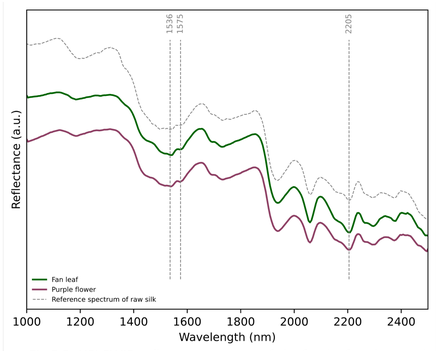

Fig.5.2. HSI SWIR reflectance spectra of the fan leaf and a purple flower compared to a HSI SWIR reflectance spectrum of silk

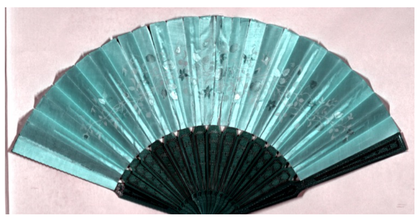

Fig.5.3. SWIR Image in FC with the characteristic bands of silk (R=2205nm ;G= 1575nm; B= 1536nm)

➢ A probable mixture of orpiment and copper-based pigment used as paint on the green fan's leaf:

The VIS reflectance spectra show the characteristic bands of orpiment (max absorbance around 420 nm) and a copper-based green pigment (max absorbance around 720nm) (Fig.5.4).

P-XRF analyses had confirmed the presence of As and Cu (Fig.5.5).

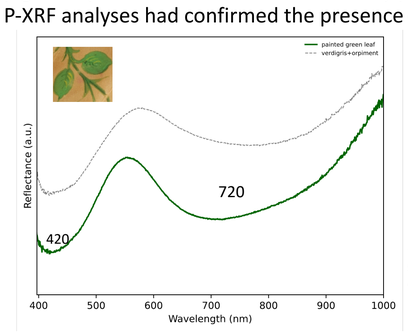

Fig.5.4. HSI VIS reflectance spectrum of the green leaves and a reference spectrum of orpiment mixed with a copper-based green

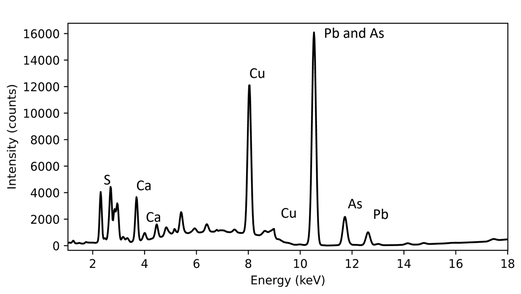

Fig.5.5. p-XRF spectrum of the green leaf

➢ The rich blue palette of the Chinese fan (Fig. 3.1):

For the blue of the sky, the presence of Fe and the flat reflectance spectrum with an absorbance maximum around 600 nm indicates the use of Prussian blue as suggested by the band at 2090 cm^{-1} in the FTIR spectrum.

Ultramarine blue has been used in the blue sea (Al identified by p-XRF and absorbance around 600 nm).

The reflectance spectrum of the blue of the wall looks like a synthetic copper-based pigment with a maximum absorbance around 640 nm, but no Cu was detected by XRF.

For the light blue of the kimonos, a first bath seems to have been done with Indigo and a second one with a yellow dye not identified yet[5].

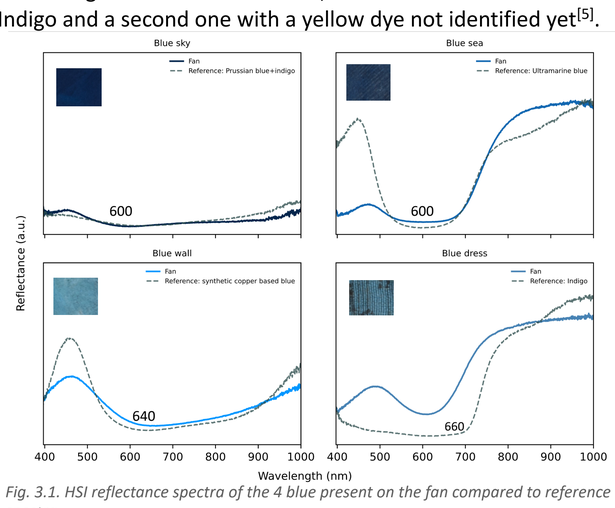

Fig. 3.1. HSI reflectance spectra of the 4 blue present on the fan compared to reference spectra.

Fig. 3.a and b Les terrasses Chinoises, side a and b © Lysiane Gauthier .

➢ The use of two different red on the two side of the fans for two similar decorations (Fig. 3 and 3.3).

Side A : The reflectance spectrum indicates a mixture between **red lead** (inflection point around 570 nm) and **indigo** (absorbance band at 660 nm). The elemental analysis shows a high concentration in Pb.

Side B : The pigment used is **vermilion** (inflexion point at 600 nm, presence of Hg and S in the p-XRF analysis and an emission band with the UV fluorescence around 617 nm).

➢ Restored areas (in rectangles in Fig. 3 and Fig. 3.2) are revealed using IRFC imaging and DinoLite® at high magnification. In the unrestored areas, paper's fibres are visible, whereas in the restored ones, they are not. IRFC imaging also reveals the use of a different pigment in the restored zone.

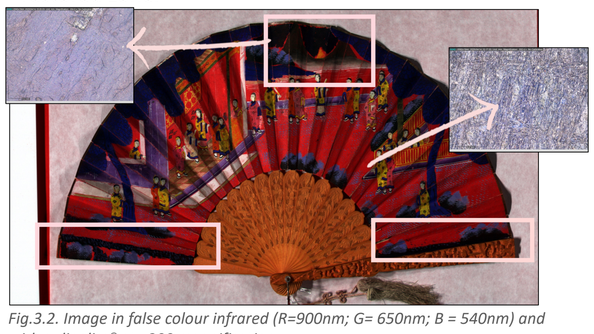

Fig.3.2. Image in false colour infrared (R=900nm; G= 650nm; B = 540nm) and with a dinolite® at x200 magnification

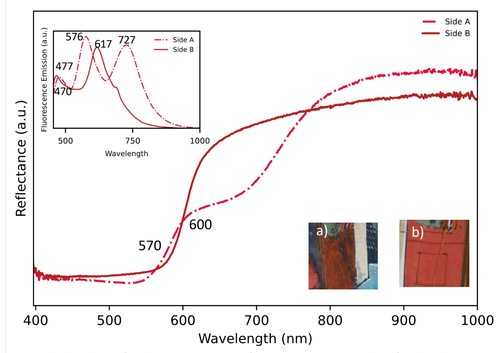

Fig.3.3. HSI reflectance and U.V fluorescence spectra for the two red area on each side of the fan

➢ The use of a grand variety of materials (Fig.3.4).

SWIR hyperspectral imaging advantage is to offer the possibility to map the different materials. We based our mapping on some specific protein bands of the textile (amide at 2059 nm and 2202 nm; C-H at 2290 nm). In this map :

- Textile parts appear purple,
- Paper appears grey, with a contribution from the copper-based green pigment, which appears yellow,
- Ivory heads turn black in the SWIR image.

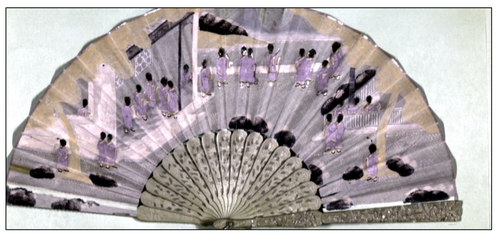

Fig.3.4. Image in false colour of the fan showing the different materials used. FC- R=2059nm; G=2202nm; B=2290 nm

➢ The probable use of synthetic dyes:

The reflectance spectra recorded in the orange zones present the bands of Orange II mixed with a chrome-based pigment (maybe chrome orange). The p-XRF confirms the presence of chrome.

In addition, Pb and Ca were detected and can be attributed to lead white to light the colour saturation of the orange dye and to the use of gofun, a calcium carbonate used as a preparatory layer, for the orange background (Fig.6.1).

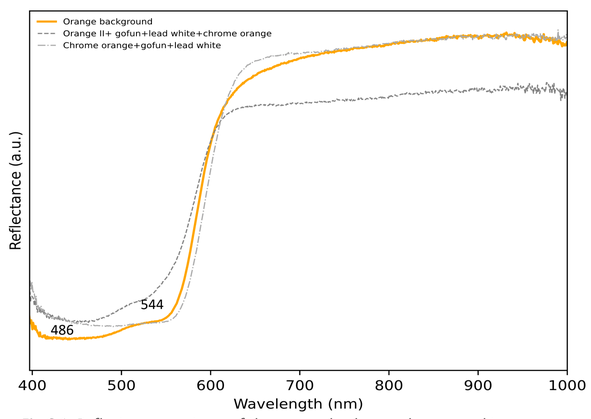

Fig.6.1. Reflectance spectrum of the orange background compared to some reference spectra of our database

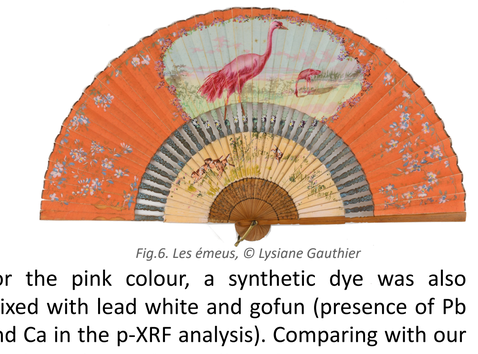

Fig.6. Les émeus, © Lysiane Gauthier

For the pink colour, a synthetic dye was also mixed with lead white and gofun (presence of Pb and Ca in the p-XRF analysis). Comparing with our database, it may be attributed to new coccine or acid fuchsin.

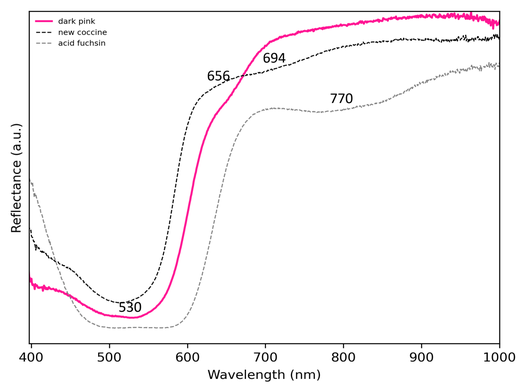

Fig.6.2. Reflectance spectrum of the pink bird compared to some reference spectra

Conclusions and perspectives:

- The analysis of this set of four fans revealed the use of a wide range of materials, both for colouring (dyes, natural and synthetic pigments), for supports (paper, textile, parchment) and a lot of combinations and mixtures.
- Some of these materials have been already identified, while others are still under analysis.
- Further experiments are necessary to increase the reference spectra of our database with others mixtures and to complete the interpretation of the data.
- This preliminary study opens the way for a broader investigation involving a larger number of fans to learn more of the richness of this type of objects and production depending of their provenance or century.

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