

The secret of black marker pens: Identification workflow with non-invasive hyperspectral and macro X-ray fluorescence imaging techniques

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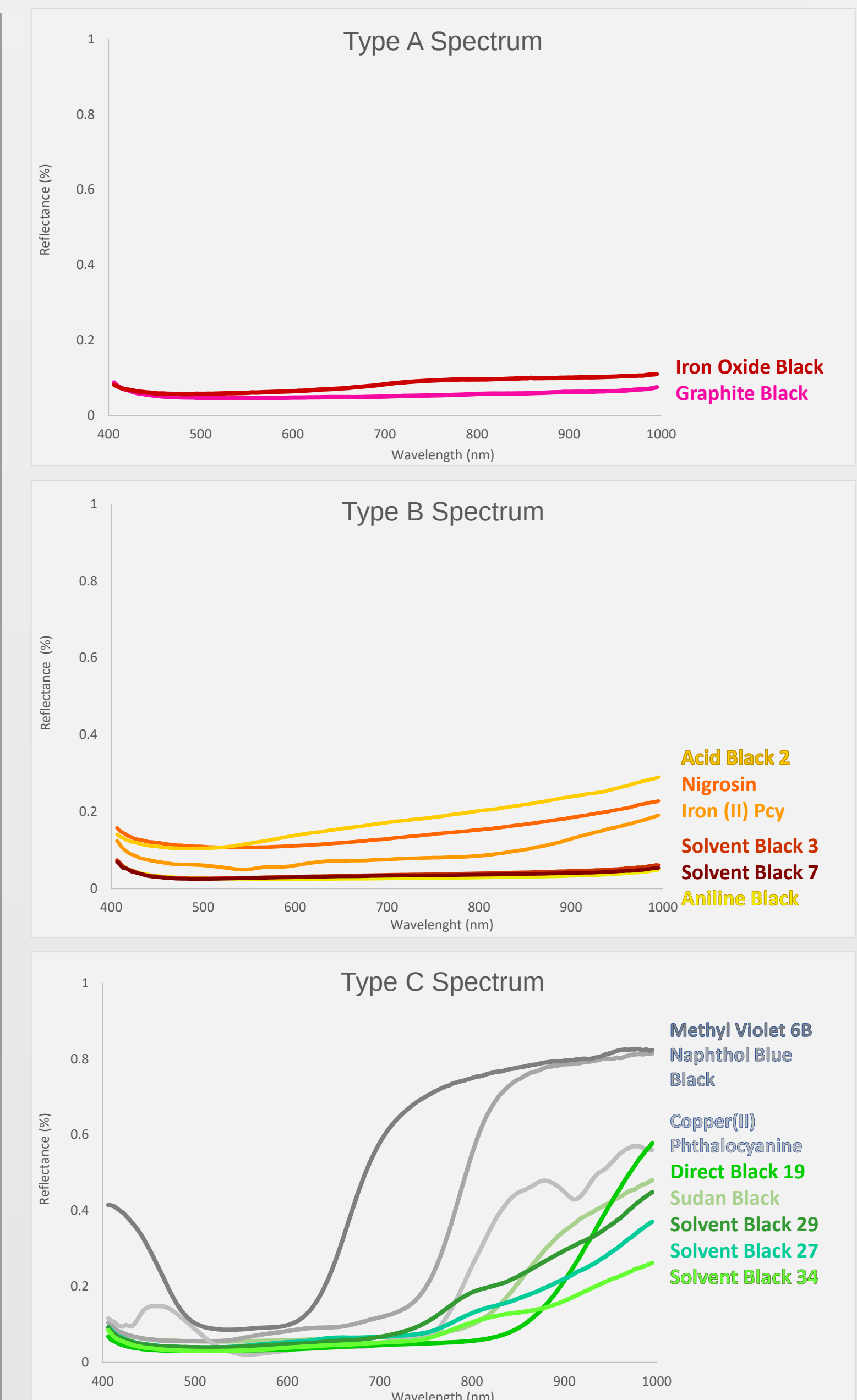
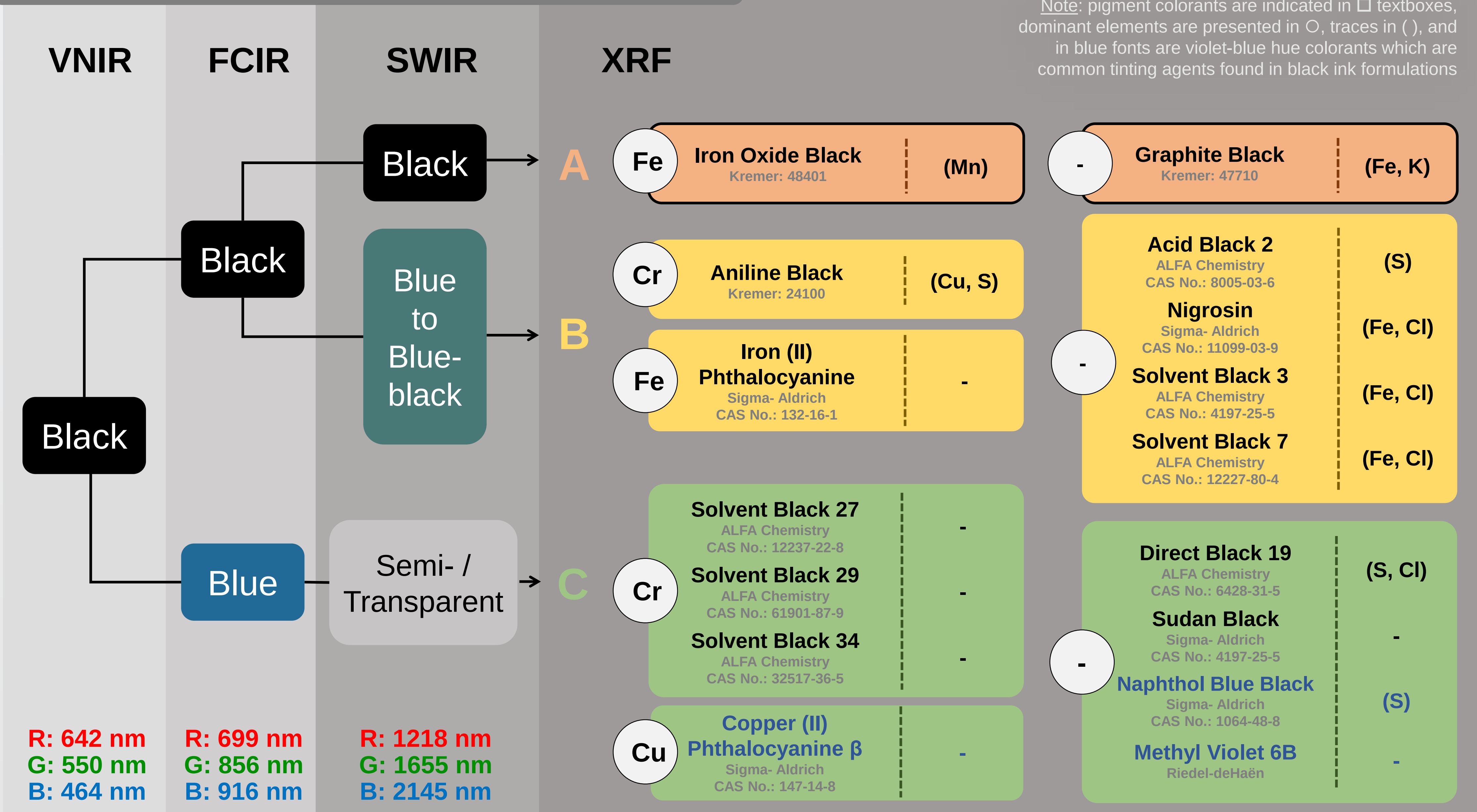
Background and Objectives

- Marker pens were popularized in the 1950s, a common and convenient writing stationery, widely used in artist drawings, illustrations, architectural plans and archival documents
- Blue and black inks are well-studied in the field of forensic science but the analytical methods usually involve sampling which is not always applicable to cultural heritage objects
- Media identification is fundamental in the development of preservation plans
- This study aims to establish a workflow by a combination of the non-invasive techniques - **hyperspectral imaging (HSI)** and **macro X-ray fluorescence (MA-XRF)** analysis to characterize and attempt to identify some of the commonly found **black colorants in marker pens and modern drawing inks**

Method

- 13 commonly occurring black colorants** in modern black inks were studied
- Dry pigments were mixed with gum arabic, dyes were dissolved in ethanol or water, then applied on off-white 130 gsm drawing paper
- HSI data was collected with **HySpex VNIR-1800** for the **visible to near infrared range 400-1000 nm** and **HySpex SWIR-384 short-wave infrared** from **930-2500 nm**
- False Colour (FC) images** were created with the VNIR images by adjusting the wavelength display channels (nm) : **R → 699, G → 856 and B → 916**
- XRF scan of the colorants was performed with the M6 Bruker Jetstream (Rh anode, 50 kV, 600 µA, air-path)
- A **flowchart** was developed based on the FCIR, SWIR images and elemental results of the colorants which could be **summarized into 3 categories**

Flowchart for the categorization of black colorants



Black ink artist sketches by Wu Guanzhong (1919 – 2010)		VNIR Image	FCIR Image	SWIR Image	Reflectance Spectrum VNIR	Ink - Type	XRF	Possible Assignment
D1 Paris, with doves (1989)						N1 - C	-	-
						N2 - C		Solvent Black 29
						N3 - A	-	Carbon Black
						N4 - C	-	-
						N5 - A	-	-
						N6 - B	-	Nigrosin
D2 Weeds in Lake Tai (2000)						N4 - C	-	-
						N5 - A	-	-
						N6 - B	-	Nigrosin
						N1 - C	-	-
						N2 - C		Solvent Black 29
						N3 - A	-	Carbon Black

Application and Results

- 2 black ink artist sketches (D1-2) from the Wu Guanzhong collection of the Hong Kong Museum of Art were scanned with HSI and XRF
- 3 distinctive inks are observed in each of the drawings, evidently in their FC images: inks N1-3 in D1 and inks N4-6 in D2
- Results would suggest **Category A – pigment based inks, Categories B and C – dye based inks**
- Following the flowchart, reflectance spectrum of each ink is compared with reference materials, and possible assignments are determined for **N2 – Solvent Black 29 (dye), N3 – carbon (graphite) black and N6 – Nigrosin (dye)**
- N3 is in fact a dark blue ink, this is replicated by a peak at around 500 nm and shoulder above 600 nm in its reflectance spectrum

Discussion and Future Work

- Imaging result provides insight to the artistic creative process of the artwork
- Analysis of a combination of FCIR and SWIR images has proved to be effective to differentiate between the various black inks present in an artwork
- The flowchart categorization of inks may help to evaluate the vulnerability of an artwork, to distinguish between black pigment and dye based inks, as the latter are more moisture sensitive and prone to fading and/or discoloration
- Some black dye colorants exhibit distinctive spectral features and/or elemental component which show potential for media identification
- Building a media reference library on colorants in their chemical forms, as well as commercial drawing inks and pens will aid material studies of the contemporary museum and archival collection
- Ink deterioration and fading, mixtures and concentrations are all factors which complicate ink identification, further study is required to investigate and verify their impacts on the categorization and identification flowchart

Selected References

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