

VIS	UVL	IRRF	MBR Indigo Subtraction	XRF Major Peaks	Dyes/Fibers Indicated	Further Analysis
RED	Bright pink, orange	Golden yellow	Dark, weak	N/A	Madder ¹	FORS
PINK	Dull pink to violet, weak ²	Orange	Light, bright	N/A	Madder + indigo	FORS
	Bright pink, orange	Golden yellow	Dark, weak	N/A	Madder	FORS
ORANGE	Bright pink, orange	Golden to lemon yellow	Dark, weak	N/A	Madder ³	FORS
YELLOW	Pale yellow	Light yellow	Dark, weak	N/A	Yellow colorant ⁴	FORS
GREEN	Teal, weak ⁵	Salmon, pink	Light, bright	N/A	Indigo + yellow colorant	FORS
BLUE	Blue, dark, weak	Red	Very bright	N/A	Indigo	FORS
PURPLE	Violet, weak ⁶	Orange	Bright	N/A	Indigo + madder	FORS

VIS	UVL	IRRF	MBR Indigo Subtraction	XRF Major Peaks	Dyes/Fibers Indicated	Further Analysis
UNDYED	Light blue	Beige	Dark	N/A	Wool	FORS, optical microscopy
	Beige to dull brown	Bright	Very dark	N/A	Linen	FORS, optical microscopy
BROWN	Dark, weak	Orange-brown	Dark, weak	N/A	Tannin	FORS
	Light to medium blue	Red	Dark, weak	N/A	Undyed animal hair (e.g., goat)	FORS, optical microscopy
BLACK ⁷	Blue, dark, weak	Bright pink	Light, bright	N/A	Indigo	FORS
	Light to medium blue	Red	Dark, weak	N/A	Undyed animal hair	FORS, optical microscopy

Notes

1. Dyer et al 2018 offers information on identifying insect-based red dyes and suggests that visible induced visible luminescence (VIVL), in addition to UVL, can be a useful technique for characterizing red dyes. To date, no insect-based red dyes have been observed at the Kelsey Museum.
2. The intensity of the ultraviolet-induced visible luminescence (UVL) of pink dyes that also contain indigo depends on how much madder is present; these dyes may appear weakly violet or even bluish under UVL. The same is true for Indigo Subtraction (MBR Indigo) results for these dyes, which will appear brighter or weaker depending on the amount of indigo present.
3. Note that at the Kelsey, some orange yarns appear to be spun or double-dyed with yellow when examined under magnification. The yellow dye seems to slightly reduce the response of the madder during MSI so that the UVL and IRRFC results are not quite as bright or intense as madder alone.
4. Dyer et al 2018 identified yellow colorants with identical MSI behavior as weld.
5. Yellow colorants are less stable over time than indigo, which has the best lightfastness of any natural dye (Crews 1987). For this reason, green dyes in the Kelsey's collection tend to appear green-blue to the eye, and they show MSI behavior that is more similar to indigo than to yellow colorants like weld; at the Kelsey Museum, all examples of green were double-dyed.

6. The intensity of the UVL of purple dyes depends on how much indigo vs. madder is present; these dyes are likely to appear weakly violet or even bluish under UVL. The same is true for Indigo Subtraction results for these dyes, which will appear brighter or weaker depending on the amount of indigo present.

7. In the Kelsey's collection, yarns may appear black optically due to their placement next to contrasting colors; to date, however, all black yarns have been found to be either very dark blue (indigo) or undyed goat hair.

References

- Crews, Patricia Cox. 1987. "The Fading Rates of Some Natural Dyes." *Studies in Conservation* 32 (2): 65-72.
- Dyer, Joanne, Diego Tamburini, Elisabeth R. O'Connell, and Anna Harrison. 2018. "[A Multispectral Imaging Approach Integrated into the Study of Late Antique Textiles from Egypt](#)." Edited by Peter F. Biehl. *PLOS ONE* 13 (10): e0204699.