

Spectroscopic Analysis of Fabric Dyes from the 19th Century

Giovanna Beaulieu, Dr. Mary Kate Donais

In collaboration with the Saint Anselm College History Department and the Manchester Historic Association



Abstract

Preliminary instrumental measurements on test fabrics were completed in order to establish a protocol for analysis in anticipation of future work to be done on the Arnold L. Bossi Sample Book. First, using X-ray fluorescence (XRF) spectroscopy analysis, elements present in the test fabrics were identified. Next, using Raman spectroscopy, molecular characterization of the fabrics was performed. As a form of verification, spectra were then obtained via infrared (IR) spectroscopy.

Background

The 19th century was marked by the transition known as the Industrial Revolution. As a result, the dyeing and printing processes shifted from the use of naturally-occurring ingredients to the use of synthetic dyes. Thus, the dyeing and printing processes of the 19th century require a deeper understanding of chemistry.

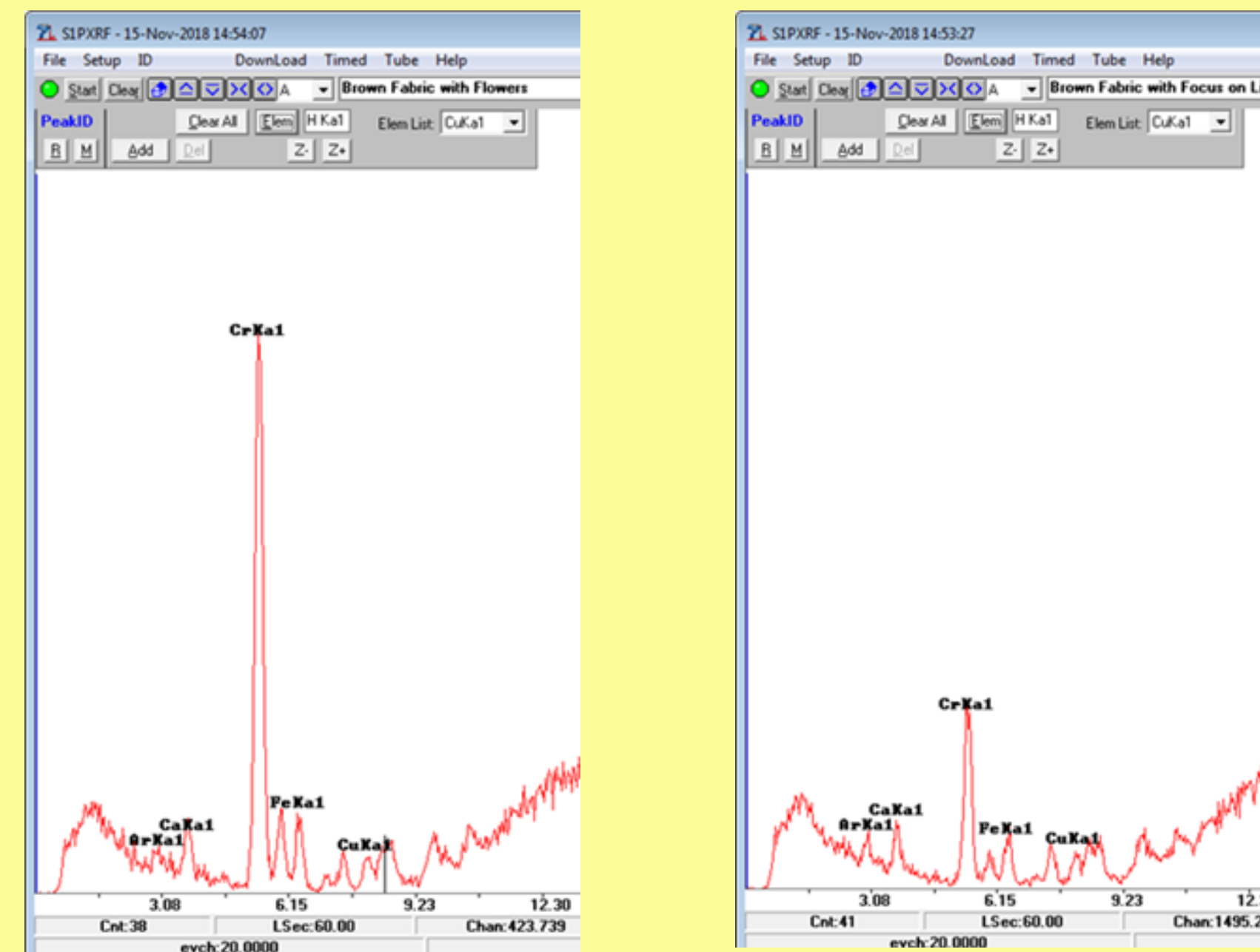
Methods

XRF spectra of seven fabrics from the 19th century were obtained with a Bruker Tracer III-V+ handheld XRF spectrometer secured to a stand. No preparation was required for this method of analysis as each fabric sample was placed directly on the instrument window. For all data collection, the x-ray tube voltage was 40kV and the current was 25 μ A. The total time of analysis for each spectrum was sixty seconds and the fabric samples were not moved throughout the entirety of the data collection. The collected data was analyzed via the Bruker S1PXRF software. Spectra of the seven fabrics from the 19th century were also obtained by way of Raman spectroscopy and IR spectroscopy analysis. For each analyses, a spectrum was obtained for the base color of the fabric and for every color used for detailing purposes.

Sample Fabric

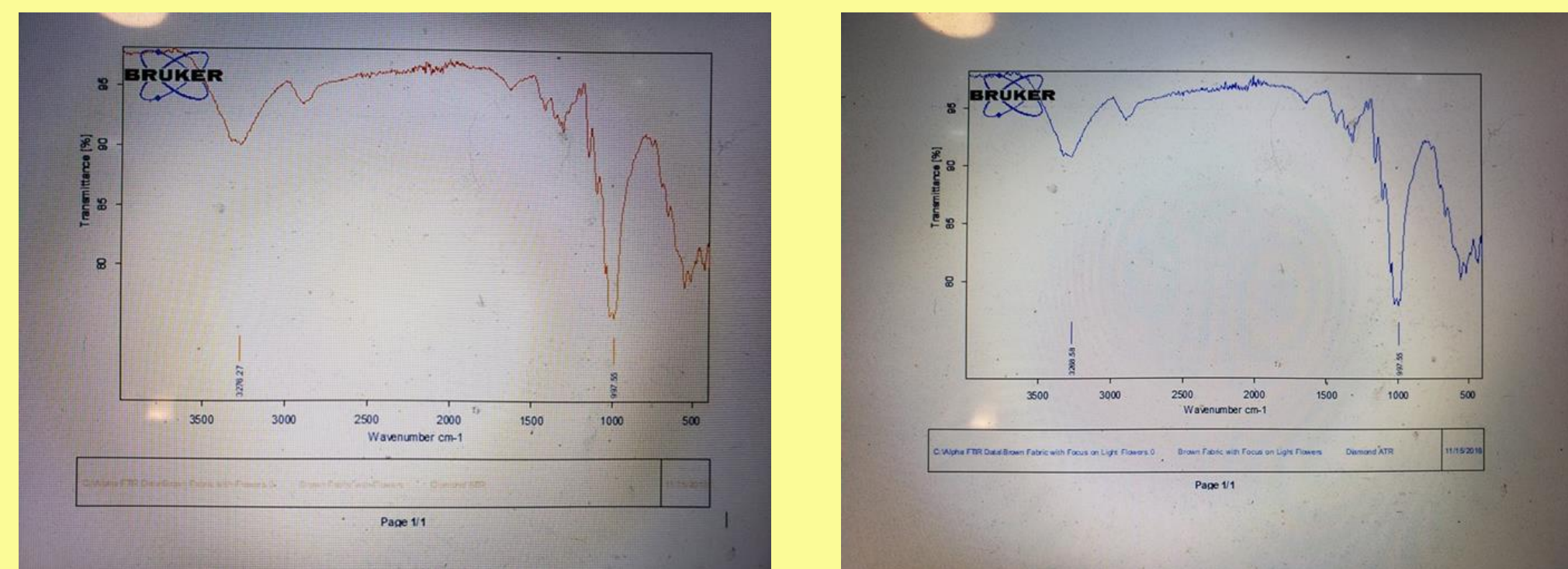


XRF Sample Spectra



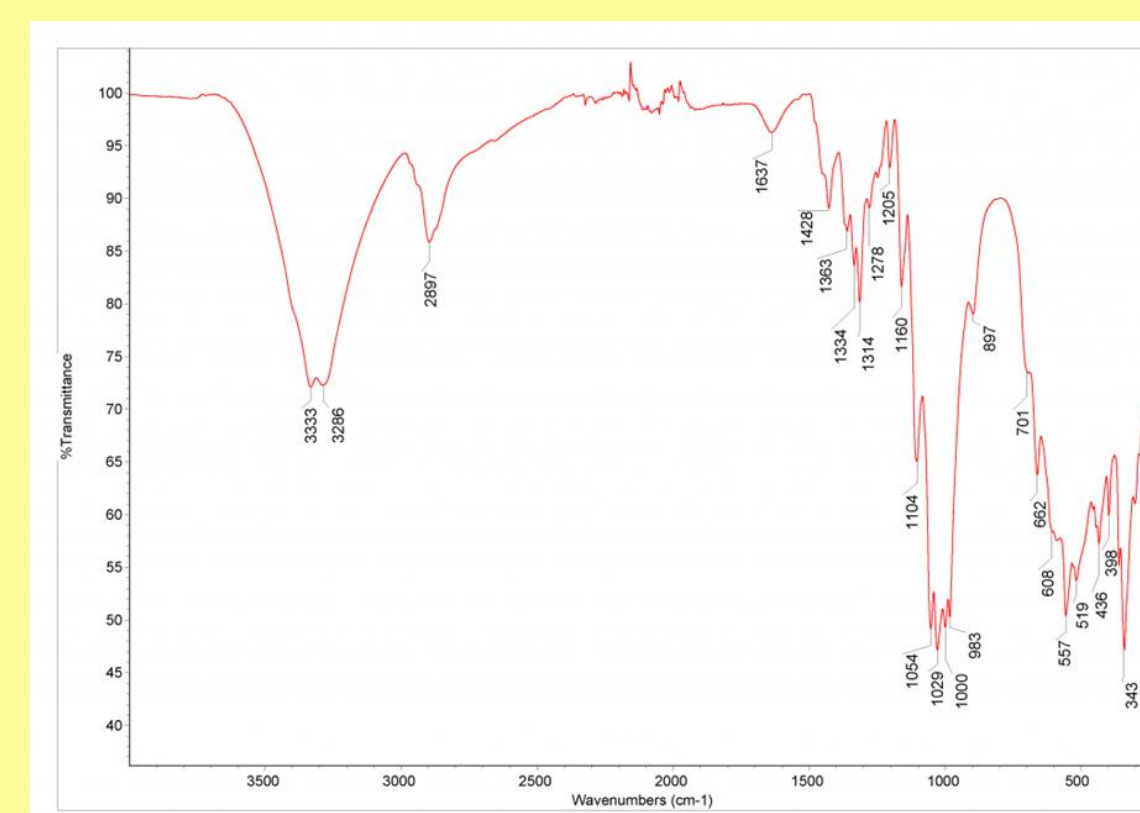
Brown Fabric with Focus on Base Color *Brown Fabric with Focus on Lighter Brown Flowers*

IR Sample Spectra

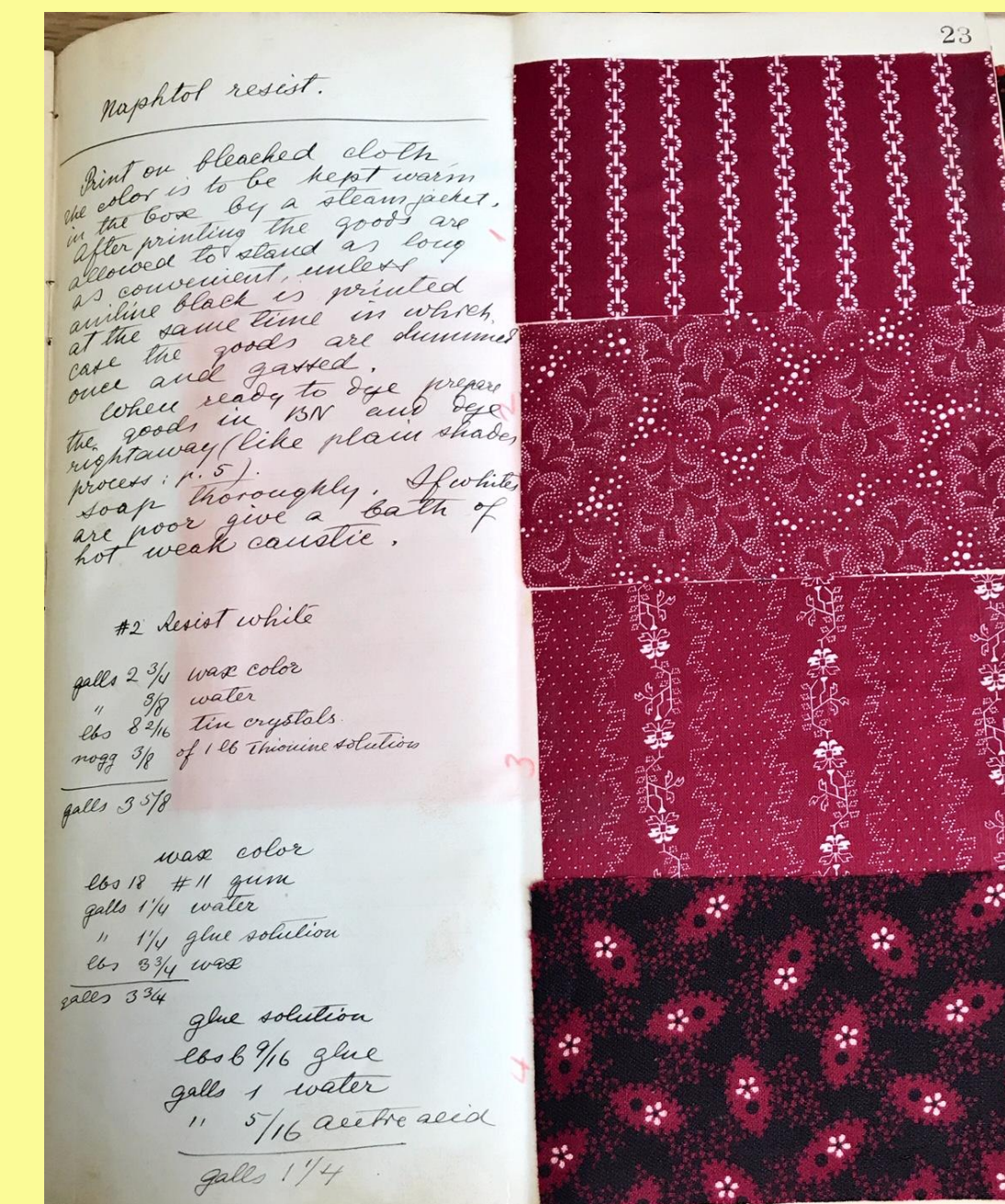


Brown Fabric with Focus on Base Color *Brown Fabric with Focus on Lighter Brown Flowers*

IR Spectrum for Cotton



Page from the Arnold L. Bossi Sample Book



Conclusions

- Element detected via XRF included Ca, Cr, Fe, Cu, Zn, As, and Sn
- No dyes were detected via Raman and IR spectroscopies
- IR analysis confirmed the fabrics are made of cotton
- Other methods or revised methods of organic molecular analysis will need to be explored such as surface enhanced Raman spectroscopy (SERS)
- Protocol for future researchers has been established for XRF analysis
- Future work would be to analyze fabrics from the Arnold L. Bossi Sample Book to
 - Identify dyes chemically and compare to the book's recipes
 - Explore chemical changes in dyes that have faded due to light exposure

Acknowledgements

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