Optical Microscopy Report

Ca. 1848 Zachary Taylor Banner Materials Analysis

For: Heritage Auctions
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Dallas, Texas 75219-3941

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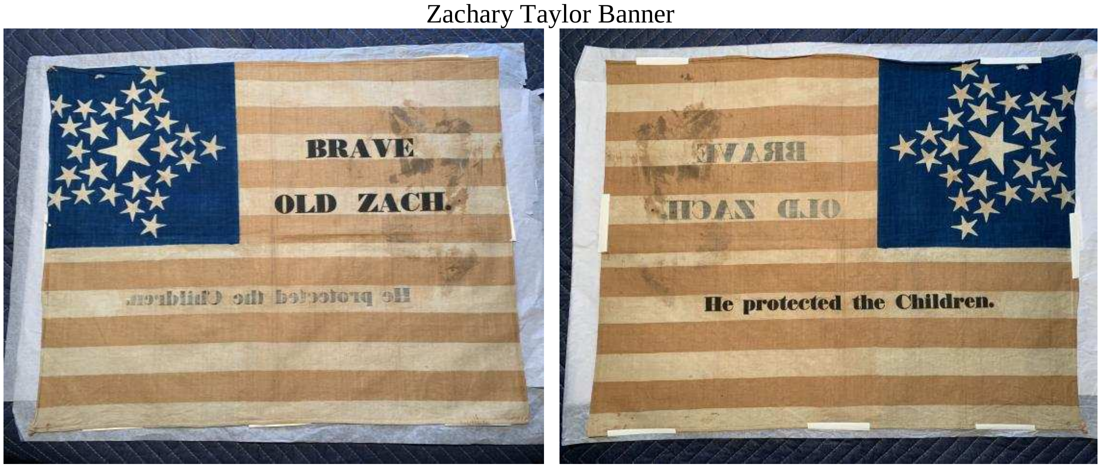
Zachary Taylor Banner



Purpose:

The goal of this project is to use cross-section and polarized light microscopy analysis techniques to investigate the nature and composition of the black paint on the banner. This analysis will contribute to a better understanding of the black lettering and how it may have changed or been altered over time.

Procedures:

The textile is remarkably intact, and there are no holes or tears adjacent to, or in, the black lettering. This made it slightly more difficult to sample because it was not appropriate to take a sample that would create a small hole in the woven textile. So, the fiber samples were removed from just one area of the front of the banner, after examining all the surfaces at 30X magnifications.

Small clumps of fibers were first examined with a 45X binocular microscope to locate fibers with attached black pigments suitable for cross-section and plane polarized light microscopy. One clump of painted fibers was selected and cast into a polyester resin cube for permanent mounting. The cube was ground and polished for cross-section microscopy analysis and photography. Individual fibers with attached black pigments were also permanently mounted on microscope slides for polarized light microscopy analysis. The sample preparation methods and analytical procedures are described in the reference section of this report.

The cast samples were analyzed with a Nikon Eclipse 80i epi-fluorescence microscope equipped with an EXFO X-Cite 120 Fluorescence Illumination System fiberoptic halogen light source and a polarizing light base using SPOT Advanced software (v. 5.1) for digital image capture and Adobe Photoshop CS for digital image management. Digital photographs of the best representative images are included in this report. Please note that the colors in the digital images are affected by the variability of color capture and color printing, and do not accurately represent the actual colors.

Cross-section Microscopy Analysis Results

Samples were taken from the bottom edge of the period at the end of "ZACH" for analysis.

The samples were examined in cross-section to better understand the context of the paint in relation to the textile support, and the individual black pigments and fibers were examined in plane polarized transmitted light to identify the pigments and fibers. Black pigments are particularly difficult to date as most carbon-based black pigments have been used since antiquity, and some pigments, like lampblack, are typically very tiny and rounded, and do not vary in size from eighteenth-century sources to 20th-century pigment production and processing.

Sample Locations
Flag 1. Black pigments mixed with fibers for plane polarized transmitted light.
Flag 2. Cross-sections of fibers with attached black layer.

Optical Microscopy Analysis

Fiber identification using polarized light microscopy confirms that the plain weave textile fibers are cotton, based on the typical twisting of the individual fibers and the moderate birefringence (refraction of light) observed in crossed polars.

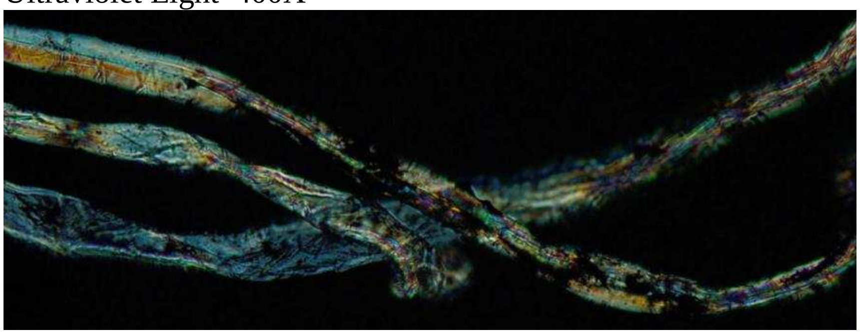
The black paint is comprised primarily of tiny rounded black particles, with a few larger sharp-edged black particles. All the black pigments are isotropic in crossed polars (these pigments are dark in crossed polars). This suggests the paint is comprised primarily of lampblack, with scattered charcoal black pigments. Both are ancient black pigments which are still in use.

The letters on both sides of the banner are printed or painted in the same way, with an opaque black paint that partially penetrated into the other side of the textile. The edges of the letters are crisp, with no halos around them (which would suggest that an oil binder component had seeped into the textile). Oil-bound paints typically leach into porous substrates, like textiles, so the absence of a discolored halo suggests that the paint does not contain oil.

When a clump of black pigments attached to the cotton fibers were exposed to water, the black paint partially dissolved and the pigments detached from the fibers. This phenomenon indicates that the paint is water-sensitive. Binding media characterization with biological fluorochrome stains indicated a positive reaction for the presence of carbohydrates with TTC. This reaction could indicate a starch sizing in the fibers, or the use of a natural gum, like gum Arabic or gum tragacanth, as a binder for the paint. No protein or oil reactions were observed with the fluorochromes FITC or DCF.

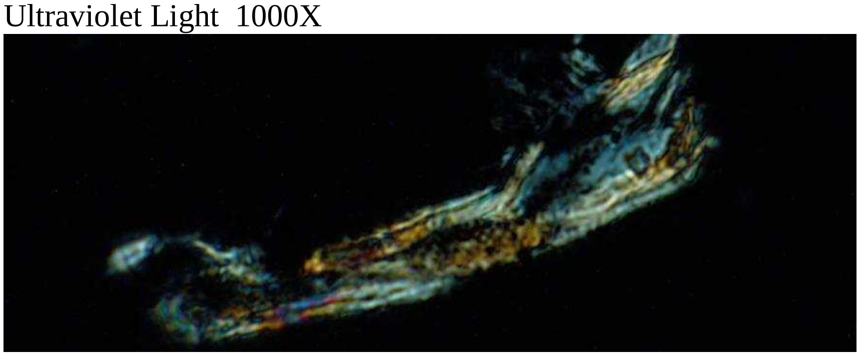
Flag 1a. Black pigments mixed with fibers for plane polarized transmitted light.
Pigments: primarily lampblack with a few charcoal black particles.
Fibers: degraded cotton.
Visible Light 400X

Ultraviolet Light 400X

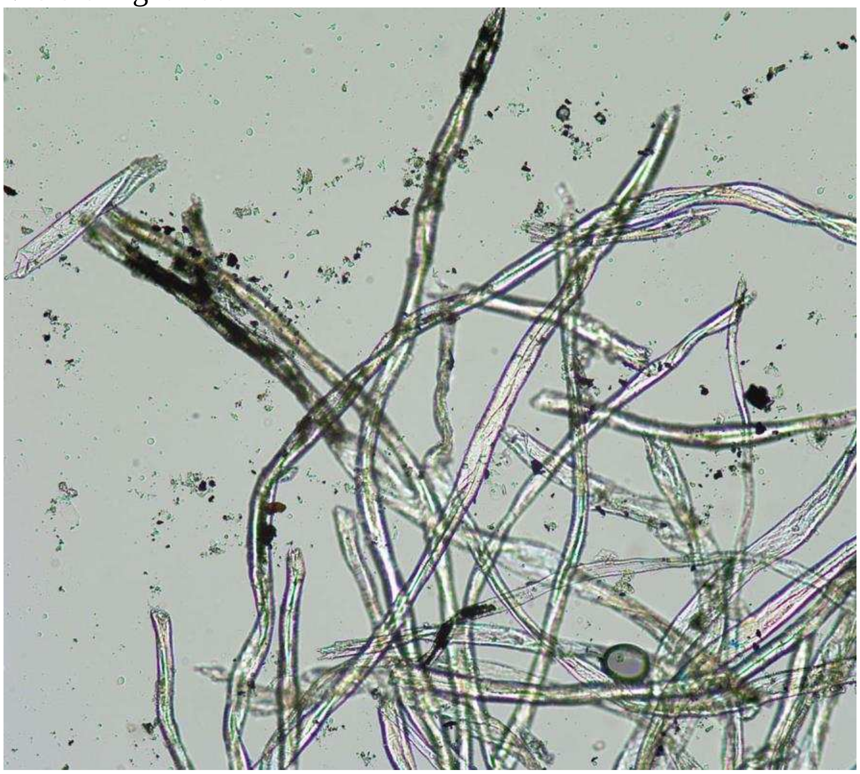


Flag 1a. Black pigments mixed with fibers for plane polarized transmitted light.
Pigments: primarily lampblack with a few charcoal black particles.
Fibers: degraded cotton.
Visible Light 1000X

Ultraviolet Light 1000X



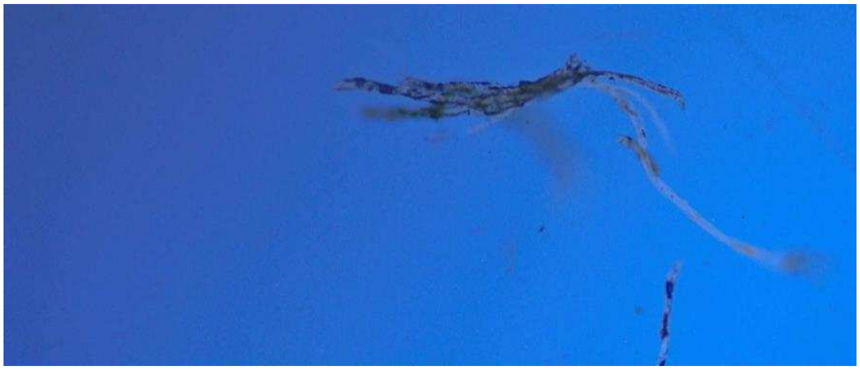
Flag 1b. Black pigments mixed with fibers for plane polarized transmitted light.
Fibers and black paint immersed in water to test paint solubility.
Black paint partially dissolved and pigments became disassociated on exposure to water.
Visible Light 400X



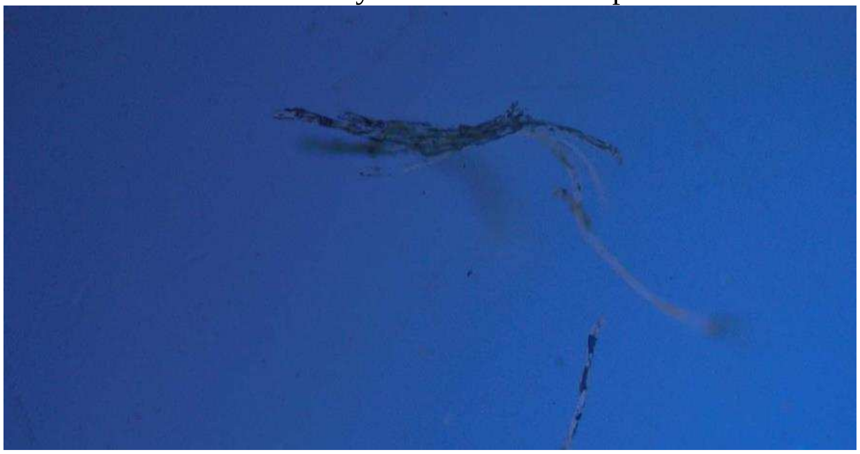
Visible Light 400X

Flag 2. Cross-sections of fibers with attached black print layer.
Visible Light 100X

Ultraviolet Light 100X
Paint is nonfluorescent.



UV Light & TTC for the presence of carbohydrates 100X
Weak + reaction for carbohydrates in the black paint.



Conclusion:

Analysis of the black paint used for the lettering confirms that it is composed of pigments consistent with nineteenth-century production. The inclusion of larger irregular charcoal black pigments suggests that it is not a finely ground, commercially produced paint more typical of twentieth-century manufacture.

The paints are water-sensitive, and seem to be bound with a carbohydrate material like a natural gum. There is no evidence of oil, or a synthetic binding media component, in the black paint. The use of a water-based paint for printing or stenciling would typically produce lettering with sharper edges than oil-based or emulsion paints.

This small optical microscopy analysis project indicates that the composition of the black paint used for the lettering is consistent with the nineteenth century. The fibers are cotton, and exhibit some evidence of age and degradation. But, paint and fiber analysis cannot conclusively determine the date of this black paint because the pigments and the methods for producing black hand-ground paints are still available today. This paint evidence must be considered in the context of all the other physical evidence to assess the date and condition of lettering on the banner.

Cross-section Preparation Procedures:

The samples were cast in mini-cubes of polyester resin (Excel Technologies, Inc., Enfield, CT). The resin was allowed to cure for 24 hours at room temperature and under ambient light. The cubes were then ground to expose the cross-sections, and dry polished with 400 and 600 grit wet-dry papers and Micro-Mesh polishing cloths, with grits from 1500 to 12,000.

The cast samples were analyzed and photographed using a Nikon Eclipse 80i epi-fluorescence microscope equipped with an EXFO X-Cite 120 Fluorescence Illumination System fiberoptic halogen light source and a polarizing light base using SPOT Advanced software (v. 4.6) for digital image capture and Adobe Photoshop CS for digital image management. The samples were photographed in reflected visible and ultraviolet light using a UV-2A filter with 330-380 nm excitation, 400 nm dichroic mirror and a 420 nm barrier filter and a B-2A filter with 450-490 excitation and a 520 nm barrier filter. Photographs were taken at 100X, 200X and 400X magnifications.

The following fluorescent and visible light stains were used for examination of the samples:

> Fluorescein isothiocyanate (FITC) 0.2% in anhydrous acetone. Positive reaction color is yellowish-green under the B-2A filter.
>
> Triphenyl tetrazolium chloride (TTC) 4.0% in ethanol to identify the presence of carbohydrates (starches, gums, sugars). Positive reaction color is dark red or brown under the UV filter.
>
> 2, 7 Dichlorofluorescein (DCF) 0.2% in ethanol to identify the presence of saturated and unsaturated lipids (oils). Positive reaction for saturated lipids is yellow and unsaturated lipids is pink under the UV filter.

Pigment Preparation

Pigments from individual paint layers were dispersed and crushed onto microscope slides with a scapel. These dispersed samples were permanently mounted under cover slips with Cargille MeltMount with a refractive index of 1.66. The samples were examined under plane polarized transmitted light and crossed polars (darkfield) at 400X and 1000X, and the unknown pigments were compared to standard pigment reference samples.

Information Provided by Ultraviolet Light Microscopy:

When viewed under visible light, cross-sections which contain ground, paint and varnish may often be difficult to interpret, particularly because clear finish layers look uniformly brown or tan. It may be impossible using only visible light to distinguish between multiple varnish layers. Illumination with ultraviolet light provides considerably more information about the layers present in a sample because different organic, and some inorganic, materials autofluoresce (or glow) with characteristic colors.

There are certain fluorescence colors which indicate the presence of specific types of materials. For example: shellac fluoresces orange (or yellow-orange) when exposed to ultraviolet light, while plant resin varnishes (typically amber, copal, sandarac and mastic) fluoresce bright white. Wax does not usually fluoresce; in fact, in the ultraviolet it tends to appear almost the same color as the polyester casting resin. In visible light wax appears as a somewhat translucent white layer. Paints and glaze layers which contain resins as part of the binding medium will also fluoresce under ultraviolet light at high magnifications. Other materials such as lead white, titanium white and hide glue also have a whitish autofluorescence.

There are other indicators which show that a surface has aged, such as cracks which extend through finish layers, accumulations of dirt between layers, and sometimes diminished fluorescence intensity, especially along the top edge of a surface which has been exposed to light and air for a long period of time.