Discovering Original Paints on a Bow-back Windsor Side Chair Using Cross-section Microscopy Analysis Techniques

Susan L. Buck, Ph.D., Conservator and Paint Analyst

Introduction:

Analysis of tiny samples, as small as a pinhead, can reveal surprising and important information about original paints and finishes, even from objects that were thoroughly stripped. A bow-back Windsor side chair owned by the Montpelier Foundation was examined and selectively sampled to identify, if possible, how it was originally painted. This chair has a Madison-family connection, but before it was acquired by Montpelier the surfaces had been stripped of virtually all of its early paints. It was hoped that analysis of tiny samples from the most protected areas of the chair show what it looked like when freshly painted.

Montpelier Bow-back Windsor Chair MF2013.16.1

Advantages of Fluorescence Cross-section Microscopy Analysis:

In reflect visible light, cross-sections which contain paints, shellacs and varnishes may often be difficult to interpret, as clear finish layers generally 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 reflected 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 clues that reveal 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.

Procedures:

By eye, the chair appeared to have been severely stripped and refinished with glossy clear coatings. But when the surfaces were examined with a 10X illuminated loupe (a Dermlite DL100 originally designed for dermatologists), it was possible to see trapped areas of early paint and degraded varnishes at protected areas of joinery and in the interstices of the bamboo turnings.

After examination at 10X, small samples were taken with a scalpel from four different protected areas in the bamboo turnings and at the edge of joins. At the lab the sample flakes were sorted under a binocular microscope at 40X and the best samples from each location were placed in a casting tray with polyester resin cubes for mounting. The cast sample cubes were ground with 400 and 600 grit sandpapers and polished with MicroMesh silica-embedded polishing cloths at grits from 1500 to 12,000 for cross-section microscopy analysis and photography.

The polished cross-sections 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. 4.6) for digital image capture and Adobe Photoshop CS for digital image management. Biological fluorochrome stains (FITC, TTC and DCF) were also used to characterize the organic binding media components in the individual paint layers.

After cross-section analysis, pigment particles were scraped from individual paint layers and dispersed on microscope slides for plane polarized transmitted light microscopy analysis. Digital photographs of the cross-sections and pigments provide important information about the comparative coating chronologies, but the colors in the digital images are affected by the variability of color printing and do not accurately represent the actual colors.

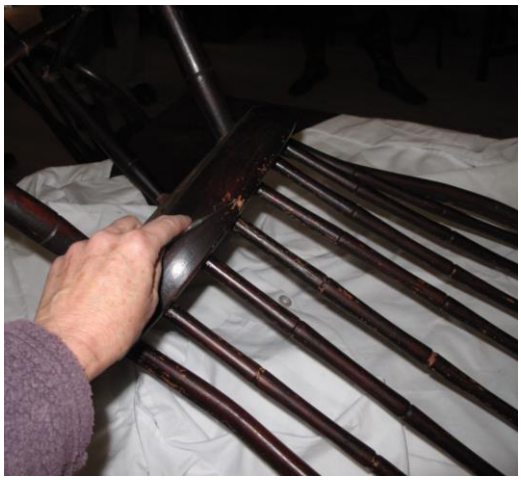
Bow-back Windsor Chair Sample Locations

1. At bamboo turning, back of spindle, at accumulation of early yellow and orange paint.
2. Top of spindle, near join with back, rear surface.
3. Back surface of seat.
4. At turning on side of PR front leg.

MF2013.16.1-1

MF2013.16.1-2

MF2013.16.1-3



MF2013.16.1-4

There is a remarkable amount of paint remaining trapped in protected crevices of this chair. It is possible to reconstruct the paint history to find eight generations of coatings. The original paint consists of a deep pink primer and a red-orange finish coat. Sample MF2013.16.1-1 provides the best example of this original paint treatment. The chair was then repainted with a coarsely ground deep yellow paint with a deeply cracked varnish coating. This deep yellow paint was found in samples MF2013.16.1-1 and

MF2013.16.1-4. The third paint layer (generation 3) is a deep red-brown paint, which is followed by a thin red paint in generation 4. The most recent coatings in generation 5 through 8 are translucent coatings: generations 5 and 7 are red-pigmented shellacs, and generations 6 and 8 are plant resin varnishes.

Binding media analysis with biological fluorochrome stains applied to the polished cross-sections shows that all of the paint layers contain oil components and the most recent pigmented shellacs and varnishes contain weak carbohydrate components, possibly natural gum additives. Polarized light microscopy analysis of the original red-orange finish coating shows that this paint is composed primarily of the traditional pigments red lead, with red ochre, white lead, and calcium carbonate. The second-generation yellow paint is composed of chrome yellow, yellow ochre and calcium carbonate. The presence of chrome yellow means that this repaint layer could not be earlier than about 1812, which is the first known reference for chrome yellow in the United States.

All of the paint layers on this chair are deeply cracked and disrupted, which suggests that each was exposed for a long stretch of time before being repainted. There is a proven tradition of repainting Windsor chairs, and the cross-sections show that each new paint color was quite different from the previous colors. The comparative paint stratigraphies for the four cross-sections are shown in the table below.

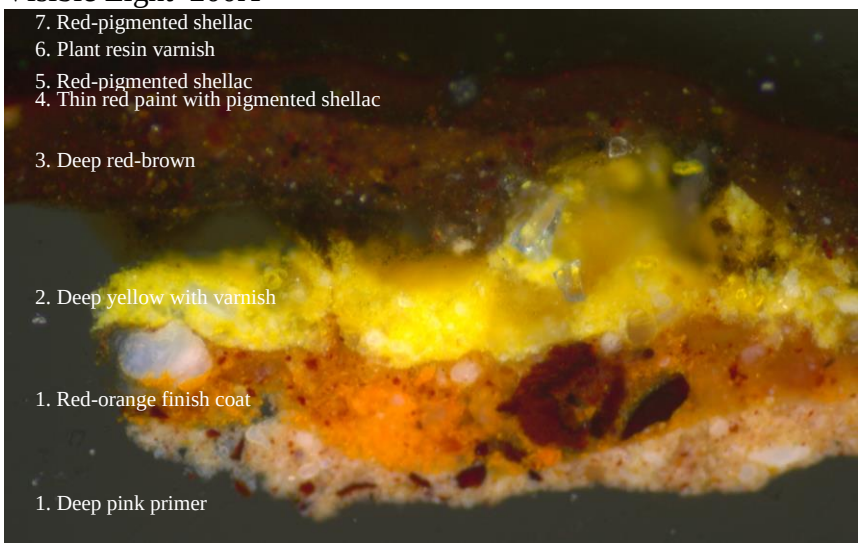
Bow-back Windsor Side Chair Surviving Paints and Finishes

Generation	**Layer**	**MF2013.16.1-1**	**MF2013.16.1-2**	**MF2013.16.1-3**	**MF2013.16.1-4**
8.	Pigmented varnish	--	x	--	--
7.	Red-pigmented shellac	x	x	--	x
6.	Plant resin varnish	x	x	--	x
5.	Pigmented shellac	x	--	--	x
4.	Thin red paint	x	--	--	--
3.	Red-brown paint	x	--	--	x
2. (After 1812)	Coarse yellow paint with plant resin varnish	x	--	--	x
1.	Red-orange finish coat on deep pink primer	x	x	x	x

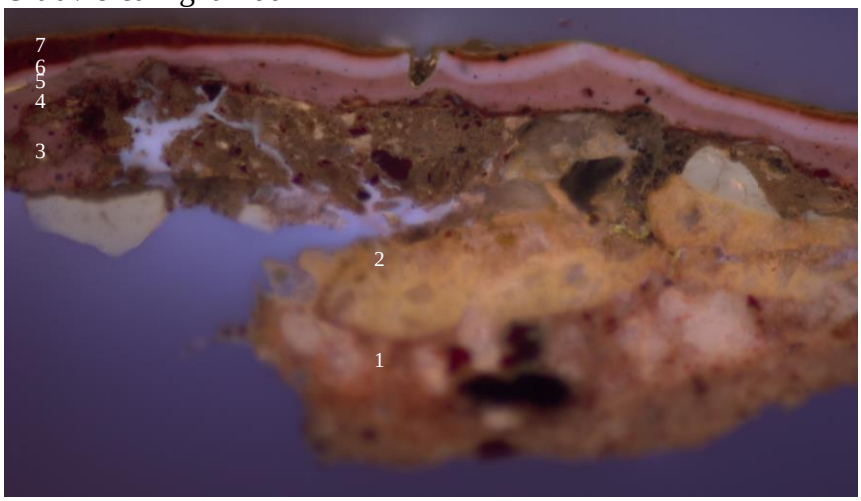
x= Layer is present; -- = Layer is missing

Sample MF2013.16.1-1. At bamboo turning, back of spindle, at accumulation of early yellow and orange paint.

Visible Light 200X

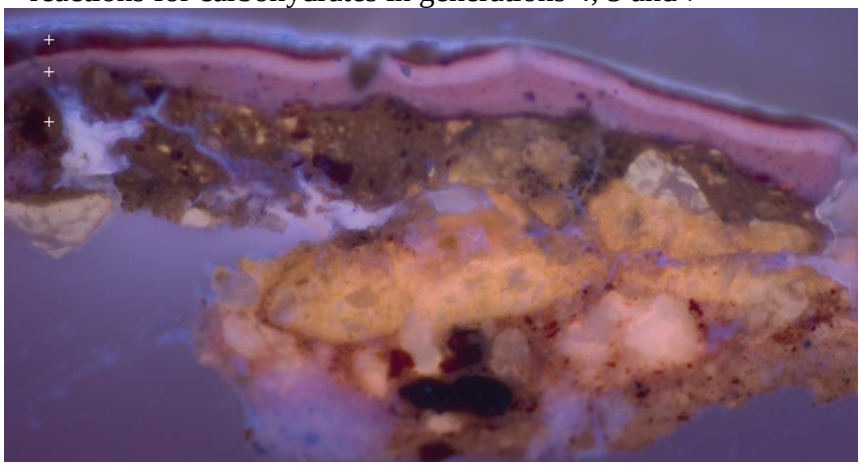


Ultraviolet Light 200X

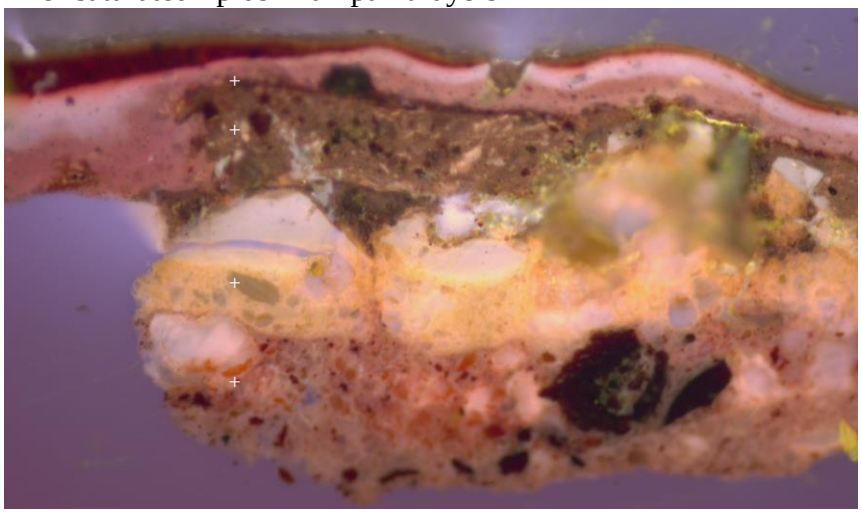


UV Light & TTC for carbohydrates 200X

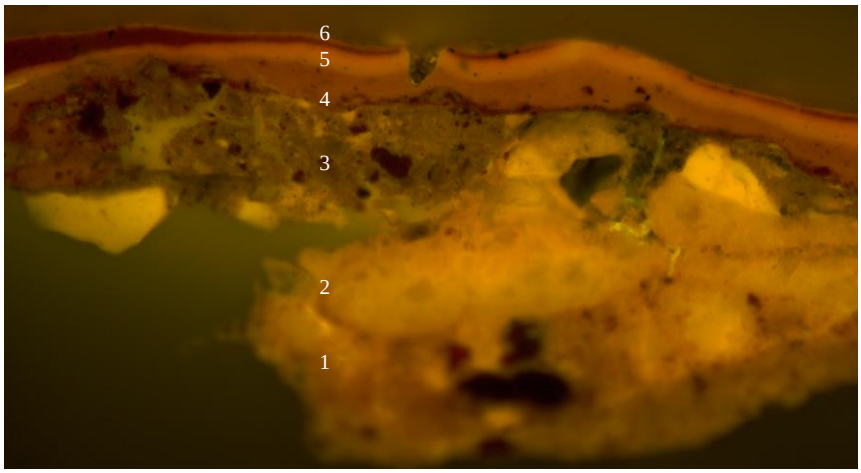
+ reactions for carbohydrates in generations 4, 5 and 7



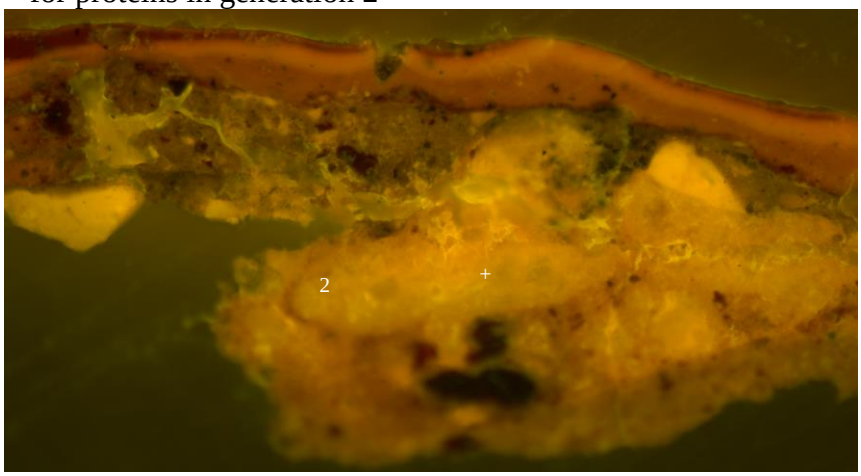
Sample MF2013.16.1-1. At bamboo turning, back of spindle, at accumulation of early yellow and orange paint.
UV Light & DCF for saturated and unsaturated lipids (oils) 200X
+ for saturated lipids in all paint layers



B-2A filter 200X

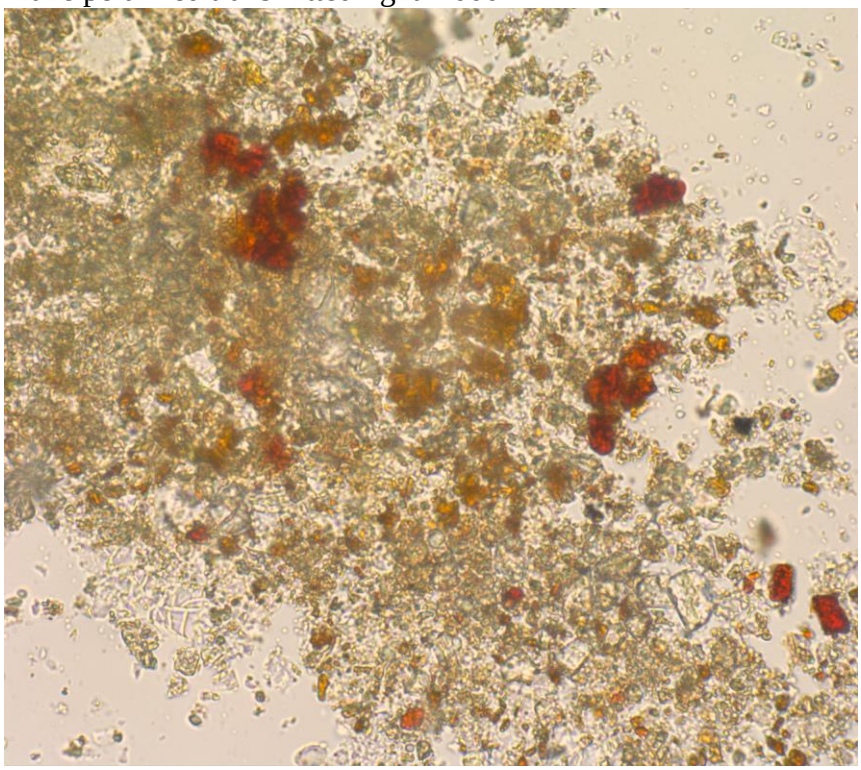


B-2A filter & FITC for proteins 200X
+ for proteins in generation 2

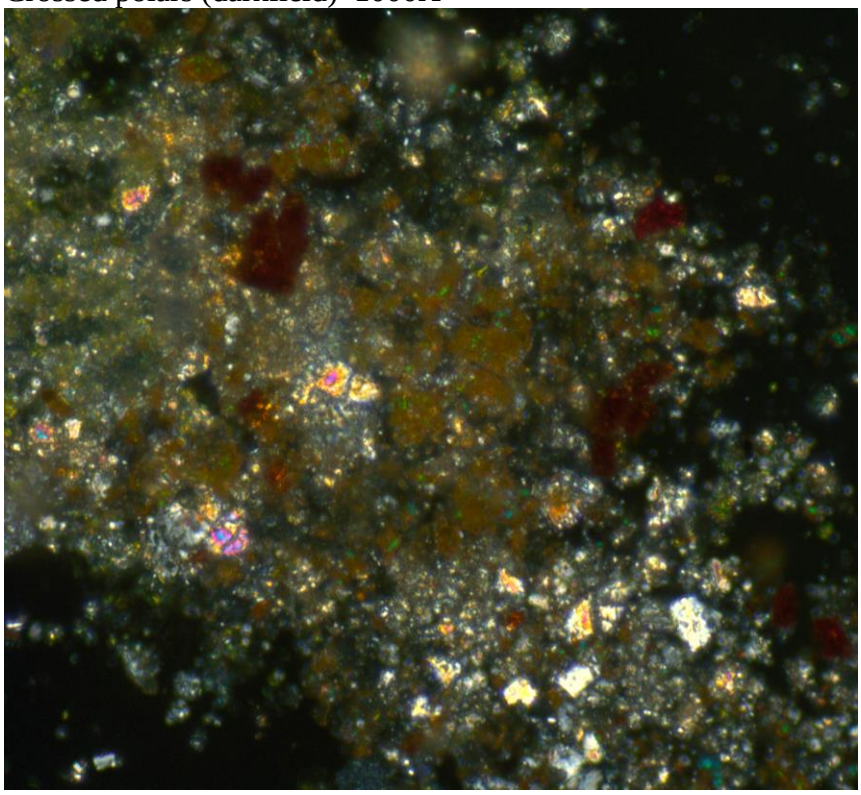


Sample MF2013.16.1-1. At bamboo turning, back of spindle, at accumulation of early yellow and orange paint. Pigments in the original orange paint layer: red lead, red ochre, white lead, calcium carbonate.

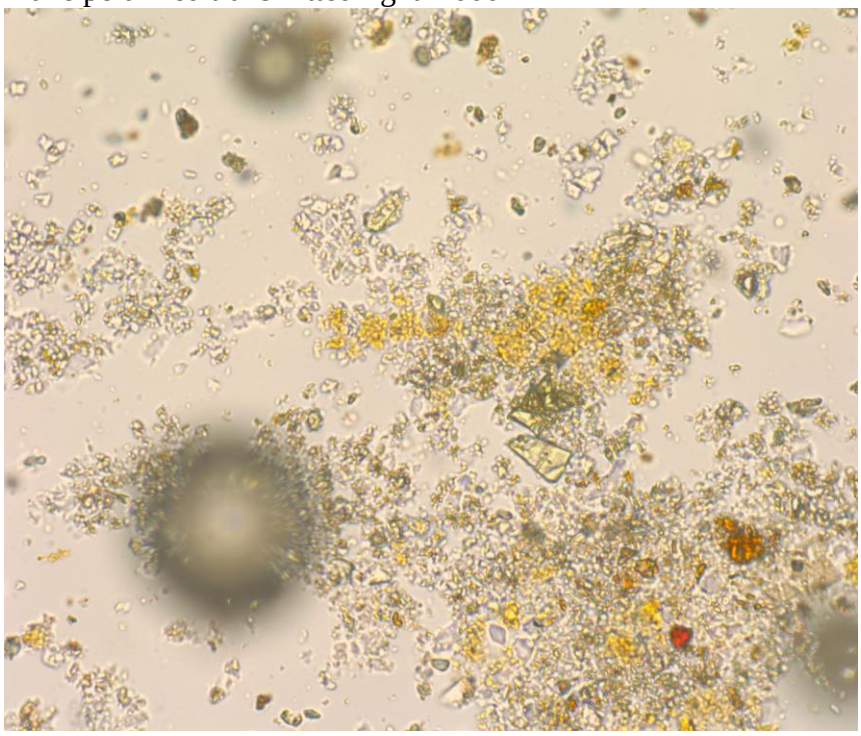
Plane polarized transmitted light 1000X



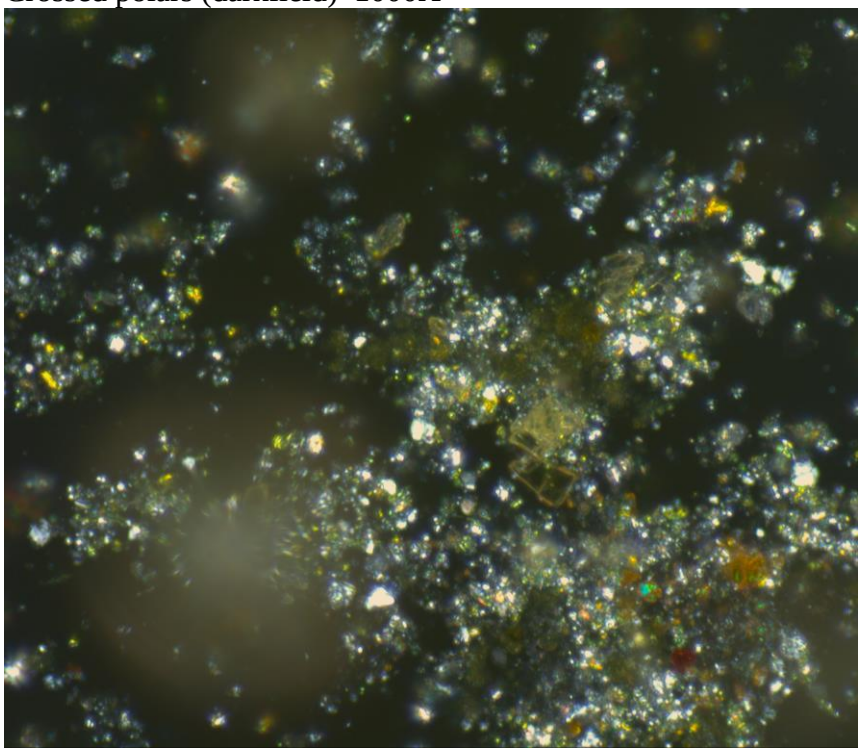
Crossed polars (darkfield) 1000X



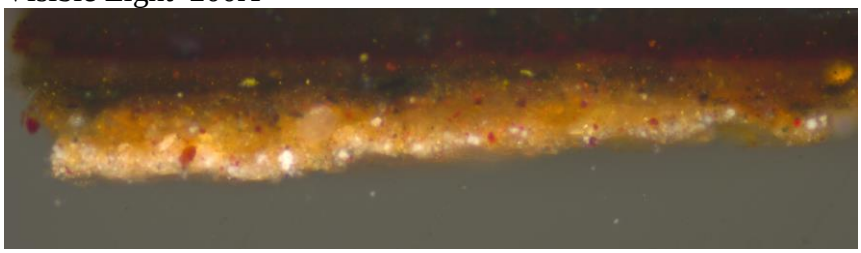
Sample MF2013.16.1-1. At bamboo turning, back of spindle, at accumulation of early yellow and orange paint. Pigments in the second-generation yellow paint layer: chrome yellow, yellow ochre, white lead, calcium carbonate.
Plane polarized transmitted light 1000X



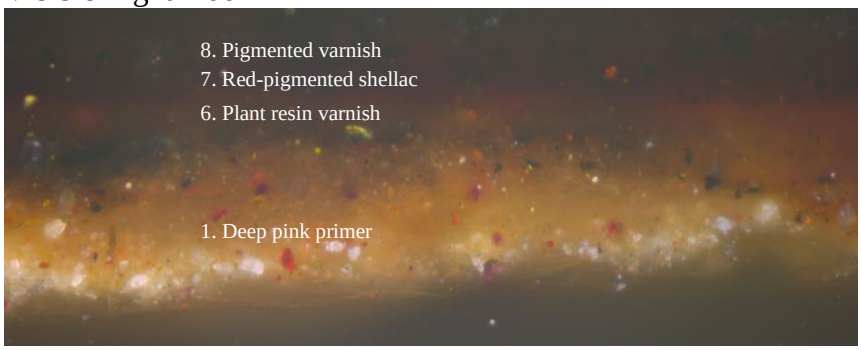
Crossed polars (darkfield) 1000X



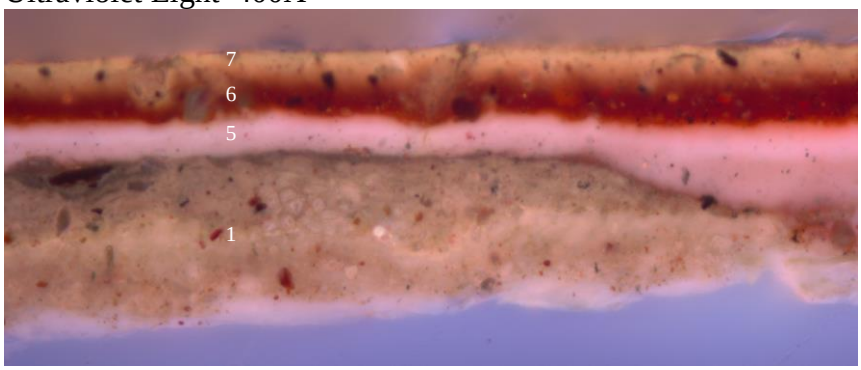
Sample MF2013.16.1-2. Top of spindle, near join with back, rear surface.
Visible Light 200X



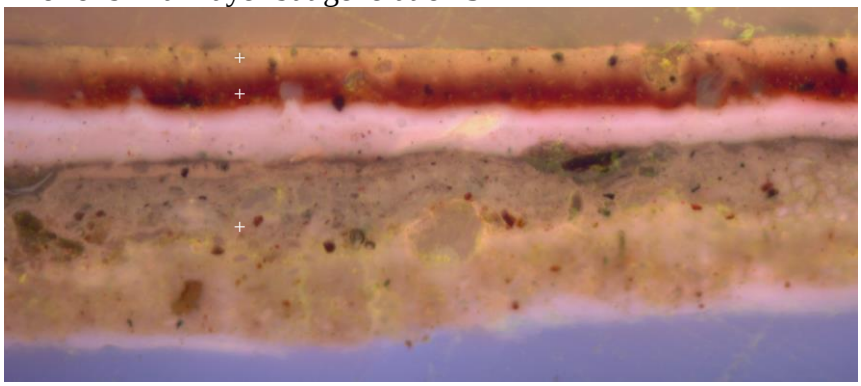
Visible Light 400X



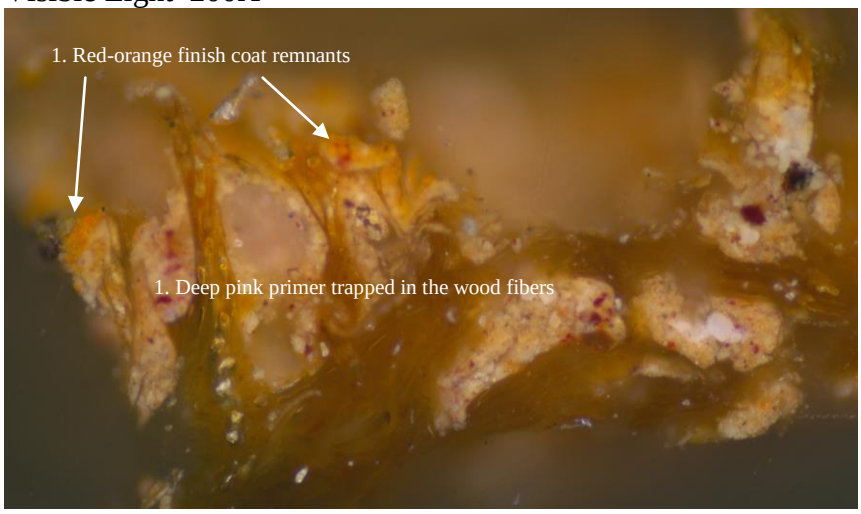
Ultraviolet Light 400X



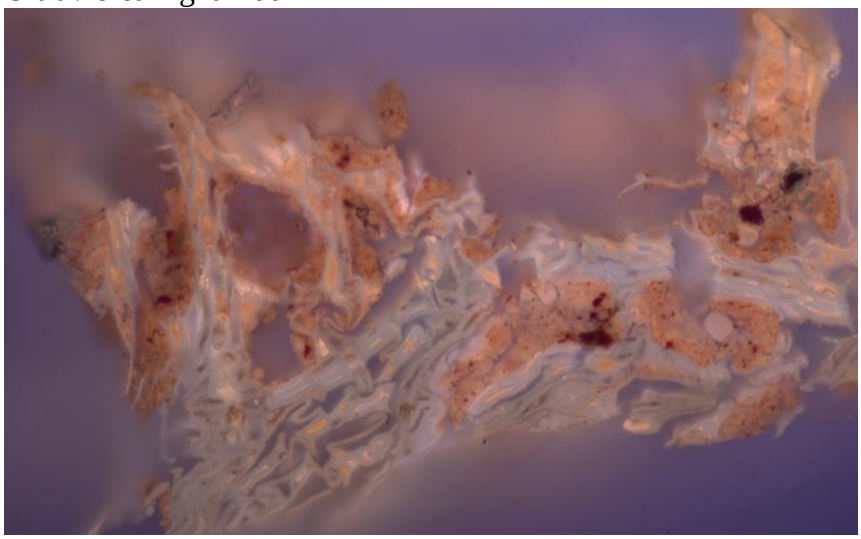
UV Light & DCF for saturated and unsaturated lipids 400X
+ for oils in all layer but generation 5



Sample MF2013.16.1-3. Back surface of seat.
Visible Light 200X



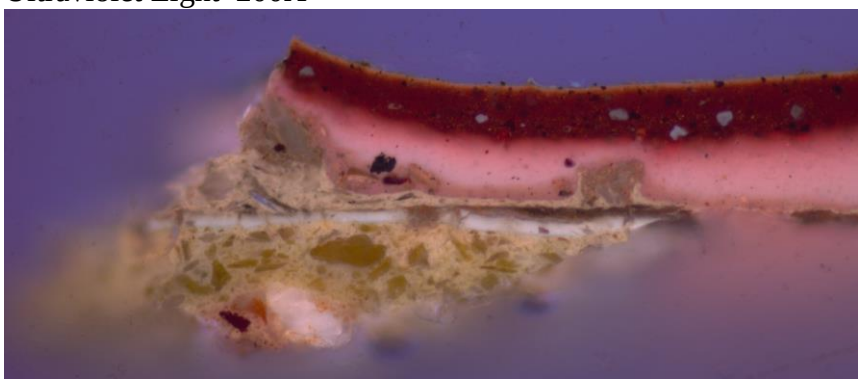
Ultraviolet Light 200X



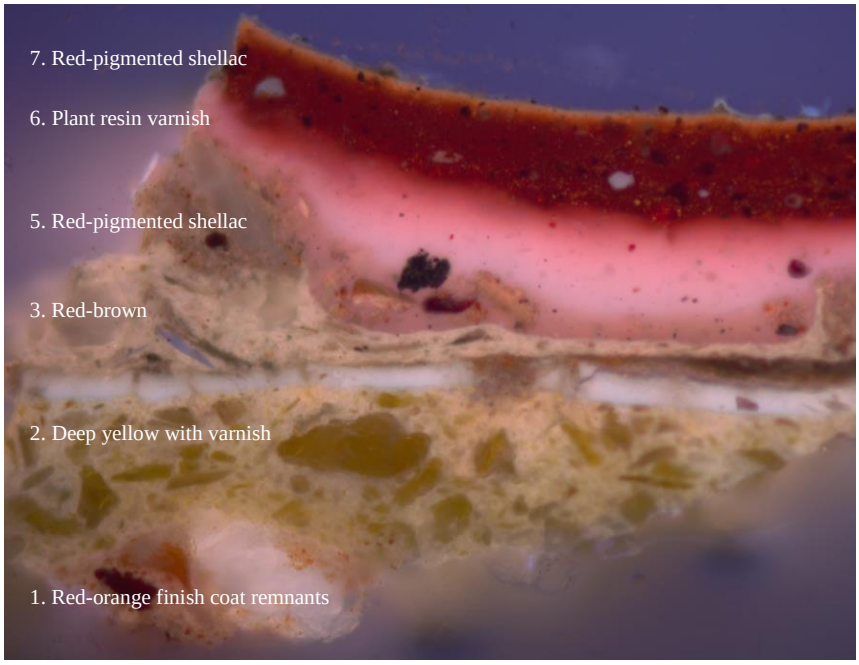
Sample MF2013.16.1-4. At turning on side of PR front leg.

Visible Light 200X

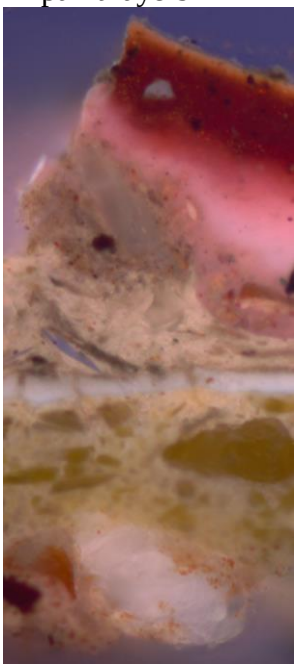
Ultraviolet Light 200X



Ultraviolet Light 400X



UV Light & DCF for lipids (oils) 400X
Weak + oil reactions in paint layers



Conclusion:

Only four tiny samples were needed to discover remarkably coherent paint sequences in two protected locations of the Montpelier bow-back Windsor side chair MF2013.16.1, with up to eight generations of coatings. The evidence suggests that this chair was originally painted with an oil-bound, bright red-orange paint on top of a deep pink base coat. The later coatings may have been applied to make the chair more stylish and/or to cover worn and dirty paint surfaces. Each time the chair was repainted, there was a significant color change. The original red-orange paint was painted over with glossy deep yellow, and then repainted again with deep red-brown oil paint. The fourth repaint was a thin red paint with shellac binder, followed by distinctive red-pigmented shellac. The chair was most recently recoated with varnish and pigmented shellac, before most of the coatings were mostly stripped away to expose bare wood. Fortunately, enough evidence remains to reconstruct the complete paint and finish history using a microscope originally intended for cell biology research.

MF2013.16.1-1. At bamboo turning, back of spindle, at accumulation of early yellow and orange paint.

Visible Light 200X UV Light 200X