Reducing the effects of discoloration and foxing from a watercolour drawing

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Introduction

An acquisition of watercolour drawings by local artist Ong Kim Seng was selected for display in the *Notable Acquisition Exhibition*, Singapore Art Museum (November 2009). From this collection, two of the watercolour drawings showed considerable evidence of foxing and discoloration, causing a visually disfiguring effect to the artworks. Due to the high levels of humidity in Singapore, cellulosic heritage materials are easily subjected to foxing (brownish spots)[i] and discoloration. Thus, they were identified for conservation treatment in order to reduce the brown spots and overall discoloration. The process of treating a watercolor drawing, *Tibetan Girl* (Accession no.: 2009-02249) is described in this article.

About the Artwork

The watercolor sketch was quickly executed by the artist when he met a Tibetan girl in Shannan, Tibet (Fig.1). According to the artist, the girl caught his attention from the rest during his journey across the Nepal and Tibet Highway in 1987. The chance encounter provided the inspiration for the sketch as he remembered that his subject was fair skinned and had a pleasant smiling face, unlike the other wind-swept faces he met during his trip[ii].

Condition of Artwork

Figure 1.Overall image of *The Tibetan Girl* before treatment

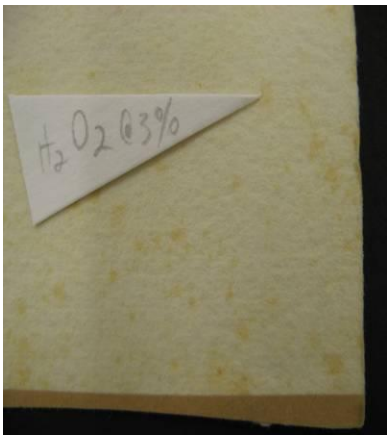


Figure 2.Bottom right corner of artwork (Recto) with foxing and water tape.

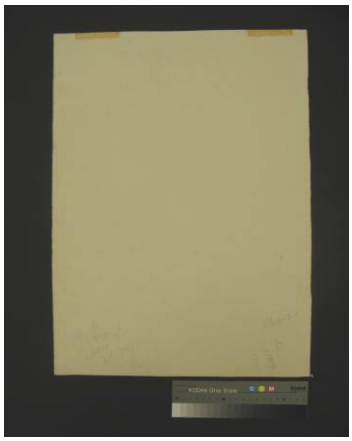


Figure 3.Shows the verso (back) of the artwork with tape stains at the top edge.

The overall condition of the artwork was slightly discolored with foxing spots scattered mostly around the top and bottom areas (Fig.2). Strips of brown water tape[iii] were found along the top and bottom edges. The verso[iv] of the artefact had tape stains in two sections at the top edge (Fig.3).

The watercolour media (e.g. pigments and binding materials) of the artwork was in good condition, with the red colour having a thicker paint layer.

Analysis of drawing before treatment

Spot Testing

Spot testing was carried out to determine if any of the colours would run or offset easily during a wet treatment with water and/or chemicals. It also provides an opportunity to observe any colour change of the artwork's materials. The test solutions used were: deionised water, ethanol solution (50%), calcium hydroxide (pH 8) and hydrogen peroxide solution (3% and 6%).

Figure 4.Image of artwork with small pieces of blotters that show the areas tested.

Figure 5.The red colour tested is more sensitive.

A tiny drop of solution was placed on an area that would be inconspicuous to the viewer (Fig.4). The pointed end of the blotter was then used to pick up any offset colors (Fig.5).

Solution / Color area	Deionised water	Ethanol solution (50%)	Calcium hydroxide solution (pH 8)	Hydrogen peroxide solution (3%)	Hydrogen peroxide solution (6%)
Red (Shirt area)	Offsets easily	Offsets easily	No significant colour change	No significant colour change	No significant colour change
Pink (Neck)	Slight offset	Slight offset	No significant colour change	No significant colour change	No significant colour change
Dark brown Hair (ear)	Offset	Offset	No significant colour change	No significant colour change	No significant colour change
Blue Hair (ear)	Offset	Offset	No significant colour change	No significant colour change	No significant colour change
Purple brown hair (forehead)	Offset	Offset	No significant colour change	No significant colour change	No significant colour change
Signature	Offset	Offset	No significant colour change	No significant colour change	No significant colour change

Table 1. Spot test results of various colors on the drawing.

The red water colour was found to offset more easily than the rest of the colours. However, the calcium hydroxide solution and hydrogen peroxide did not cause any noticeable colour change to any of the watercolors (Table 1).

Fibre Identification

The paper's fibres were analyzed in order to verify if the watercolor paper is made of cotton fibres. A sample was taken from the bottom right corner of the drawing. Part of this sample was tested with C-stain[v] to look at the colour change. Permanent slides were mounted with Meltmount[vi]. The fibres were stained with Toluidine blue for a better view of the fibres (Figs.6-8).

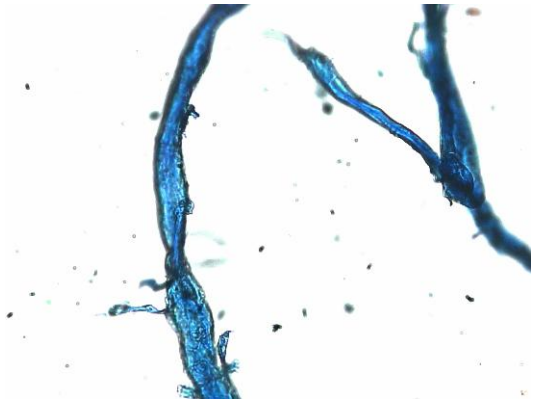


Figure 6. Picture of fibre taken at 40X

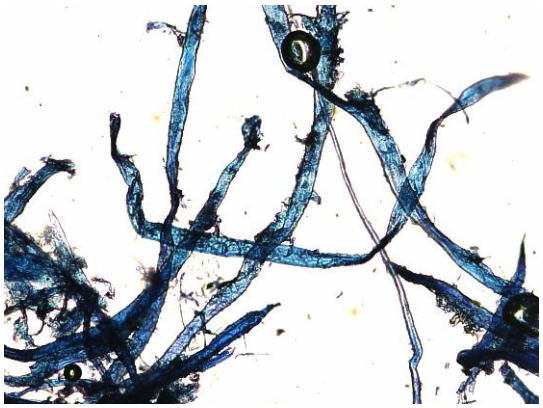


Figure 7.Picture of fibre taken at 10X

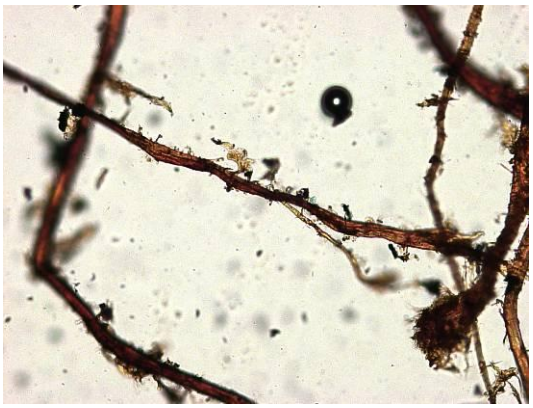


Figure 8. Picture of Fibre under C-stain

C -stain	Turned Reddish brown
Average Length	1.05 mm – 1.80 mm
Average Width	0.01 mm – 0.025 mm
Morphology	• Long twisted ribbon like fibres • Edges of fibres seem to have some thickening • Some thin cross markings observed

Table 2. Result of C-stain color, average length, average width and overall morphology of fibre.

The above characteristics fit the typical morphology of cotton fibres (Table 2).
The reddish brown color of C-stain indicates the presence of rag material; the characteristic twist is also a common feature in cotton fibres.

UV Examination

A UV lamp was shone on the drawing before treatment to see if there were any fluorescing areas before the treatment. Fluorescence can be used to gauge if there is any degradation by metal induced oxidation or fungi. Only the areas with foxing fluoresced under UV light (Fig.9). Since the fluorescence is not very strong, it is likely that the foxing has passed its stage of initial formation.[vii]

Figure 9.Bottom right area of artwork under UV–light before treatment, showing areas with foxing with mild fluorescence.

Figure 10.Bottom right area of artwork under UV–light after treatment

After the treatment, the areas with fluorescence remained with no decrement (Fig.10).

Colour spectrophotometer

A colour spectrophotometer[viii] was used to record the colour spectra of the foxing stains before and after the local bleaching of foxing spots (Fig.11). A target mask of 8mm in diameter was used to measure the foxing spots. A piece of Mylar was placed over the artefact and the exact spots to be measured were marked out (Fig.12). The spectral reflectance values obtained were converted to the CIELAB[ix] values using the Spectramagic NX program provided.

Figure 11.Image of spectrophotometer taking measurements on the artwork.

Figure 12.The Mylar sheet was placed over the artwork and areas to be measured were marked at T173, T174, and T175 respectively.

Figure 12.Image of the portable Spectrophotometer

Treatment: Reducing the level of discoloration and staining

Washing on suction table

Since the thicker paint layers are more sensitive to water, the paper was washed on a suction table (Fig.13). The suction table[x] creates a pulling force that prevents the water from drawing the colours outwards. A 50% ethanol solution was first sprayed onto the work with a compressor. The advantage of this tool is its ability to produce a fine mist of water that is dispersed evenly over the surface of the paper (Fig.14). This technique avoids the creation of big droplets of water that may cause the formation of tide marks. The next stage of the treatment involved spraying deionised water over the surface of the work on two separate occasions. Caution was taken not to spray too much on the image area. While the entire drawing was wet, the strips of the water tape on the sides were carefully lifted up and removed with a pair of forceps.

The artwork was left temporarily on the suction table to let it partially dry, before transferring it to a piece of felt[xi]. Following the completion of this treatment, the artwork was reassessed and no significant improvement to its visual appearance was recorded. Therefore, a series of bleaching options was evaluated for the next stage of treatment.

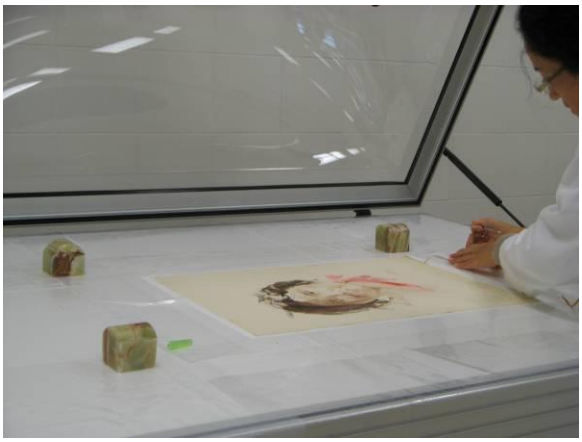


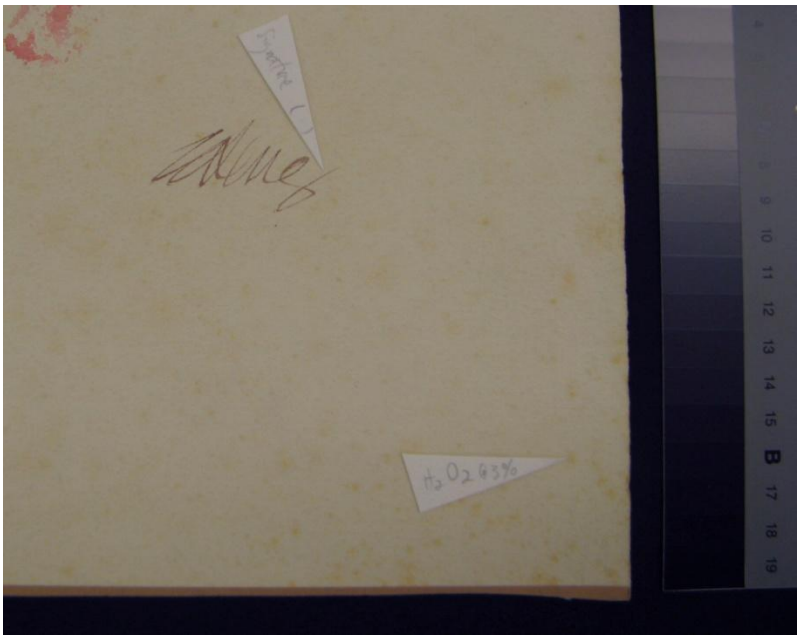
Figure 13.Image of drawing on suction table.

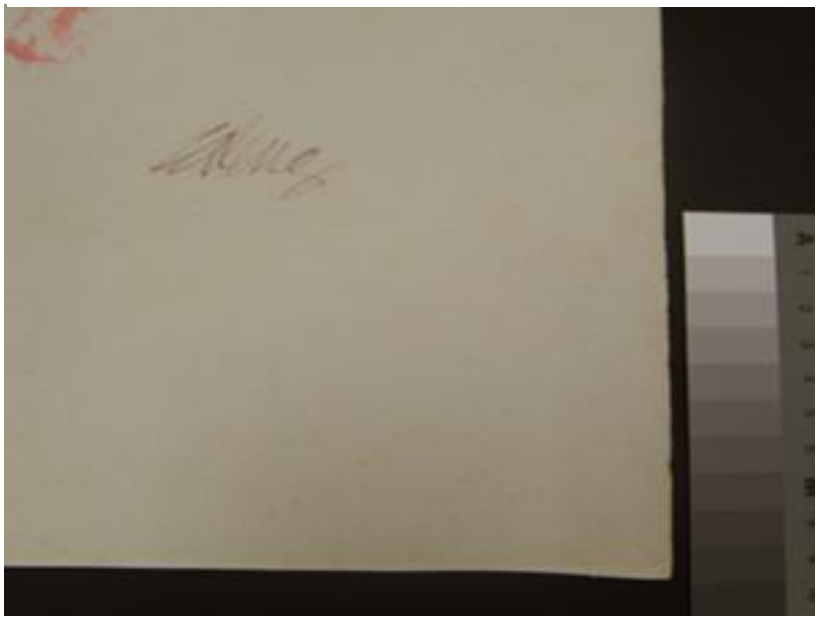
Figure 14.Image of artwork with a compressor spray tool releasing a fine mist of water.

Bleaching via Gortex

The drawing was placed face up in a tray. A thin layer of Gortex[xii], bigger than the artefact was placed over it. Then a thick blotter soaked with 6% hydrogen peroxide was placed on top of the Gortex and a sheet of Plexiglas was laid over the entire tray for 4 hours. The artwork was systematically checked every hour for any signs of bleeding in the colours.

The drawing presented marked improvements in its colour after the Gortex bleaching, with improvements in both brightness and whiteness.





Figures 15 and 16. The paper support of the artwork showed a significant improvement in its overall colour after the Gortex bleaching process..

Local bleaching on suction plate

Despite the visual improvements brought about by the Gortex bleaching process, there still remained a number of brown foxing spots. These required a localized bleaching treatment that specifically targeted the spots with 3% Hydrogen peroxide solution. This method of spot bleaching was undertaken with the aid of a suction disc that performs a similar function as the suction table (Fig.17).

Firstly, a piece of filter paper was placed on the suction disc, followed by the artwork. Strips of Mylar were then placed over the artwork to decrease the area size in order to increase the level of suction (Fig.18). Using a fine brush, drops of the hydrogen peroxide solution were dotted on areas with the foxing.

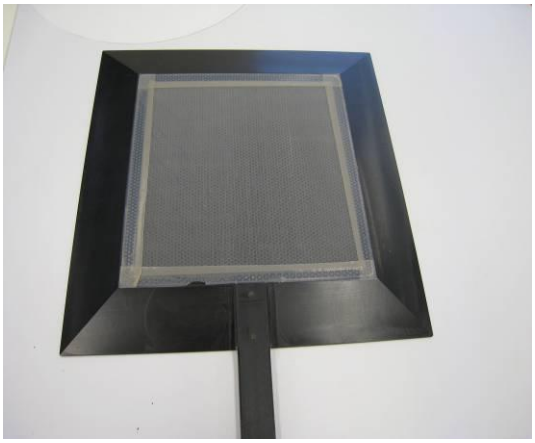


Figure 17.Image of suction disc.

Figure 18.Image of artwork on top of suction disc, sandwiched between the filter paper and sheet of Mylar on top.

Results – before and after treatment

In general, the treatment had contributed to the reduction of the paper's discoloured and yellow appearance. The disfiguring brown foxing spots were also successfully reduced in number and intensity (Figs.19 & 20).

Figures 19 and 20. The images highlight the condition before and after treatment.

Difference in L, a and b values, before and after the local spot bleaching.

	Target 172		Target 173		Target 174	
	Before	**After**	**Before**	**After**	**Before**	**After**
L	82.55	87.80	88.59	91.20	86.88	89.35
A	4.11	0.18	1.56	0.14	1.62	0.30
B	23.05	14.11	17.45	10.58	17.84	12.82

Table 3. The values of L, a and B measured before and after the treatment.

	L evaluation (ΔL)	**A evaluation (Δa)**	**B evaluation (Δb)**
T172	5.25 (lighter)	3.93 (less red)	8.94 (less yellow)
T173	2.61 (lighter)	1.42 (less red)	6.87 (less yellow)
T174	2.47 (lighter)	1.33 (less red)	5.02 (less yellow)
Average[xiii]	**3.44 lighter**	**2.23 less red**	**6.94 Less yellow**

Table 4. Evaluation of each the three targets 172, 173 and 174.

L represents the lightness, B represents the yellowness and A represents the redness of an area. The above data represents the change of these parameters after treatment.

On average, the three foxing spots examined, had all become lighter in appearance, with a marked reduction in their red and yellow colouration. The yellowness (b), had the greatest improvement, followed by lightness (L) and then redness (a). The visual improvements (lightened foxing spots lightened) had corresponded with the results obtained from the colour measurements.

Conclusion

Gortex bleaching seems to be an effective and safe method in reducing overall discoloration and light foxing spots for water sensitive media. Local bleaching was also successful with help of a suction plate and hydrogen peroxide solution. However, more in depth analysis can be done to compare the different bleaching methods with a range of solutions, and to observe any long term side effects on both the media and support.

Special thanks to my colleague Lee Siew Wah and former colleague Paula Carolina Leon Bravo for the some of the photos and treatment aide.

Notes

[i] Foxing – Rust colored spots that are either caused by mould growth or metal impurities within the paper.
[ii] Obtained through museumplus, artist provided information.
[iii] A water activated tape commonly used by local framers to mount artwork onto backing boards before framing.
[iv] Back of the artefact
[v] C-stain is a general stain used to differentiate the pulp types via the colour change observed in reference to a colour chart.
[vi] Cargille Meltmount with a refractive index of 1.662, a kind of thermoplastic for microscope slide mounting
[vii] http://www.reference-global.com/doi/abs/10.1515/REST.2000.85?cookieSet=1&journalCode=rest. The research shows that foxing under UV light shows heavy fluorescence at the initial stage of development. The luminescence decreases as the colour intensity increases.
[viii] Model no: Konia Minolta CM-2006d. It is an instrument that measures colour and translates it into numerical values that correlate to what the human eye perceives.
[ix] 1964 CIE 10º observer and D65 illuminant
[x] The suction table is equipment used for washing flat artefacts, connected to a vacuum pump that creates an adjustable constant suction across its surface.
[xi] The felt allows the wet artefact to dry flat, because it does not distort easily with high levels of moisture.
[xii] Gortex is used in conservation to evenly humidify objects with sensitive media or supports in a controlled way.
[xiii] Total values from T15 to T17 divided by 3.