Pigment Analysis and Treatment of Four Dutch East India Company Vellum Charts

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ABSTRACT

In 2009, The National Library of Australia received, on semi-permanent loan, four Dutch East India (VOC) charts from the Kerry Stokes Collection. The four navigational charts came to light in the 1980s, through the auction house of Nico Israel of Amsterdam. Three of the charts were drawn or directed to be drawn in the 1730s by Isaac de Graaf, the official cartographer of the Vereenigde Oost-Indische Compagnie (VOC). The other was believed to have been drawn at a similar time in the cartographic workshops in Batavia, the centre of Dutch trade and exploration in the East.

Before commencing any treatment, photo microscopy was undertaken to help confirm the provenance of the charts. Each chart was examined under infrared (IR) and ultraviolet (UV) fluorescence light sources. Initial conclusions were made about the composition and date of pencil inscriptions and pigments. Further testing using X-ray fluorescence (XRF) spectroscopy was also performed.

The second part of the project was to undertake tape removal, humidification, flattening and mounting for permanent display. After much discussion it was decided to tension thread mount the charts. The method used was a combination of the State Library of New South Wales's mounting method for parchment maps, and Nicholas Pickwoad's 'reverse thread matt' technique and a little trial and error.

KEYWORDS

Dutch East India Company, vellum maps, pigments, tension mounting.

INTRODUCTION

The semi-permanent loan of four Dutch East India charts on vellum from the Kerry Stokes Collection presented a fabulous opportunity for the preservation staff of the National Library of Australia (NLA) to undertake a complex humidification and tension mounting treatment. Prior to undertaking any treatment, the charts were examined by light microscopy and other light sources, to enable conclusions to be drawn about the pigments, inks and the substrate itself. Further X-ray fluorescence (XRF) spectroscopy was undertaken on two of the four charts, thanks to assistance from the National Museum of Australia.

The four charts came to light in the 1980s, through the collector and publisher Nico Israel of Amsterdam. Three of the charts were drawn in 1735 by Isaac de Graaf (1667-1743), the official cartographer of the *Vereenigde Oost-Indische Compagnie* (VOC) from 1705-1743. The fourth chart was made a little earlier in the cartographic workshops of Batavia (now Jakarta) and is attributed to Paulus Paulusz. Batavia was the Dutch trade and exploration centre of the East. It was from here that the earliest European explorations to Australia were launched (Woods and Lewincamp 2009).

The Dutch East India Company was established in 1602 and quickly grew into one of the largest and most successful Asiatic companies before its demise in the early 1800's. The Dutch Government granted the VOC a monopoly of the trading route between the Cape of Good Hope and the Straits of Magellan. This enabled the VOC to control the trading routes which in turn gave them freedom to wage war, colonise territories and make treaties. Their successes enabled them to forcibly remove their competitors in the European market, thus monopolising the spice trade to Europe and taking over the majority of the shipping trade in Asian waters (Jacobs 1991).

At the end of the seventeenth century, trade and shipping had greatly expanded between Europe and Asia and the VOC lost its competitive advantage in the East. The fourth Anglo–Dutch War in 1780 and the collapse of the Old Dutch Republic forced management to hand the VOC over to a committee, effectively nationalising it (The National Archives of the Netherlands 2010).

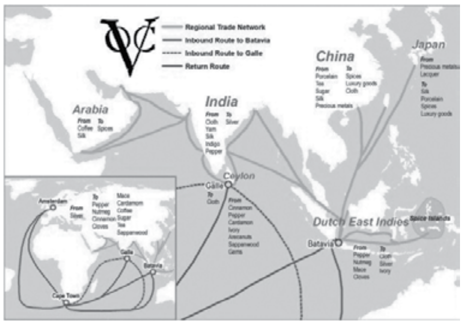

Figure 1: The Dutch East India Trade Routes (NLA 2010)

Perhaps fifty ships flying the VOC flag sailed into Australian waters before the HMAS Endeavour in 1770. Despite over 3,000 voyages to the East Indies, little remains of the working charts used aboard the VOC ships. Hand-drawn vellum charts used to plot courses are extremely rare and no such VOC charts are found in any other Australian public collections at this time. This collection of charts manufactured in the early 1700s is in amazing condition considering their journey to date (Dr M Woods 2009, pers.comm., 20th August 2009).

THE CHARTS

The four charts include two small scale charts of the Indian Ocean from the Cape of Good Hope to the Sunda Straits, one with track lines, a chart of the Java Sea and a detailed chart of the Netherlands ports, English coast and the Channel.

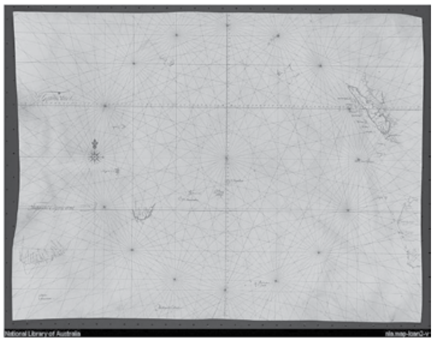

Figure 2: Chart 1 *From the Cape of Good Hope to the Sunda Straits* (Dimensions 710x940mm) (NLA collection MAP RM 4333 http://nla.gov.au/nla.map-vn4601303)

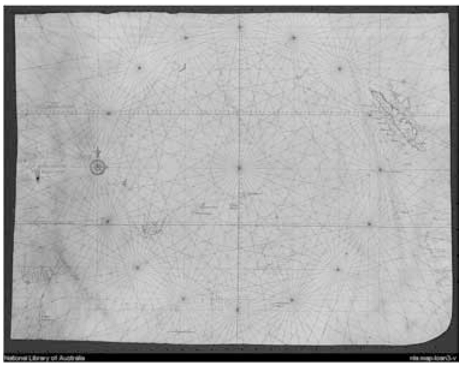

Figure 3: Chart 2 *From the Cape of Good Hope to the Sunda Straits (annotated with tracks of the ship Diemermeer)* (Dimensions 710x940mm) (NLA collection MAP RM 4332 http://nla.gov.au/nla.map-vn4601455)

Chart 2 (see Figure 3) is associated with a known voyage, evident in clear remnant pencil tracks relating to the ship *Diemermeer*, a heavily armed cargo vessel of about 850 ton capacity which sailed from Texel in the Netherlands to Ceylon, and Ceylon to Batavia in 1745-46. This chart includes not only the intended navigational points stipulated by de Graaf, but by virtue of the pencilled tracks, graphically demonstrates the difficulties in the period before chronometers were in use for navigators to accurately determine position across the Indian Ocean (Woods and Lewincamp 2009).

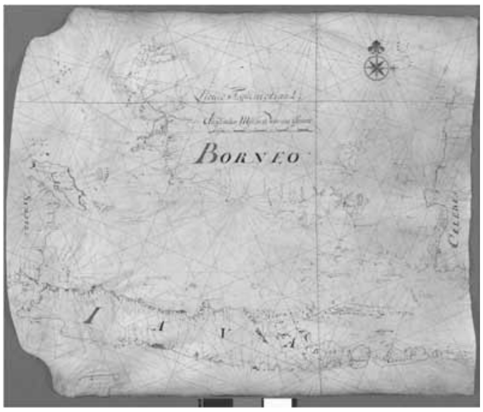

Figure 4: Chart 3 *Java Sea* – Borneo (Dimensions 820x680mm) (NLA collection MAP RM 4334 http://nla.gov.au/nla.map-vn4601792)

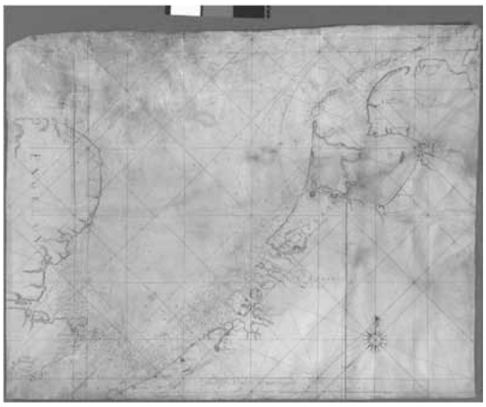

Figure 5: Chart 4 *North Sea* (Dimensions 730x915mm) (NLA collection MAP RM 4331 http://nla.gov.au/nla.map-vn4601670)

THE VELLUM

Vellum is a writing material made from animal skin that has been soaked, scraped and dried under tension. Vellum is a highly durable and flexible material, which can be easily rolled, making it ideal for ship charts. Traditionally, the term vellum referred to very fine skin made from calf, usually from young or foetal animals, whereas the term parchment does not indicate the type of animal used. Nowadays the terms parchment and vellum are almost interchangeable. For this project we will use the term vellum (Bloom 2001 pp. 25-6). Through observations under the microscope and with different light sources, the flesh and hair side of the chart substrate were identified. Hair follicles remaining after the scraping process were found on the verso side of the chart: *From the Cape of Good Hope to the Sunda Strait* (track marks). The presence of hair follicles can often provide a distinctive fibre pattern to enable conclusions about the type of animal used in manufacture (Ryder 1964). However the random hair follicles found on our skin did not provide any clear fibre pattern to assist with identification.

According to Leen Helmick, the Dutch map dealer, the charts were made from calf skin. This would be consistent with the size and colour pigmentation of the skins.

PIGMENT IDENTIFICATION

Identification of the pigments found on the charts was undertaken by non-destructive means, as it was considered unsuitable to do any microscopic sampling. Each chart was examined under visible, ultraviolet fluorescence (UV) and infrared (IR) light sources. Using the production dates of the charts, we were able to investigate and narrow down the possible pigments available to the cartographers at the time of manufacture. From the conservation literature six red, two green, four blue and four yellow pigments were found to be probable.

Red pigment

The red pigments were observed to be transparent under IR light. This result was then compared to characteristics of known samples of red pigments (vermilion, lead oxide, iron oxide and Realgar). Vermilion, a rich bright red pigment made from mercuric sulphide displays similar characteristics. According to Harley (1982, p.127), the Dutch produced and exported good quality vermilion in the eighteenth century.

XRF spectroscopy of the Java Sea chart confirmed our conclusions. The spectra displayed a very strong mercury peak consistent with the pigment vermillion.

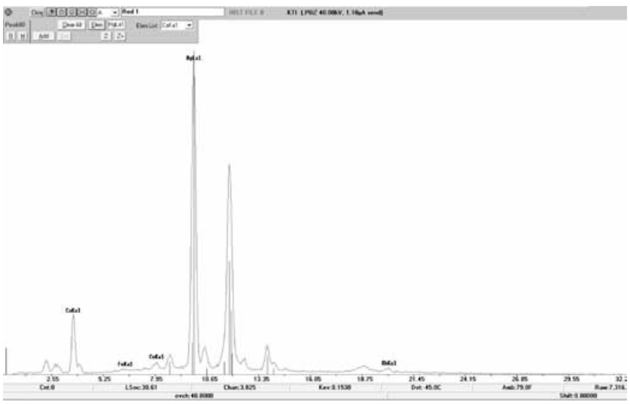

Figure 6: XRF spectra for red pigment on Java Sea Chart

Green pigment

The green pigments on each chart did not produce a clear result when observed under the different light sources. However XRF spectroscopy produced spectra with strong copper peaks. Both green pigment possibilities, malachite (copper carbonate) and verdigris (copper acetate) are produced from the mineral copper and unfortunately cannot be further identified by XRF. Verdigris often darkens and corrodes its substrate overtime. A slight 'burn' through of the green pigment was observed on the verso of the Java Sea chart. The initial conclusion from this observation was that the green pigment featured in the Java Sea chart was verdigris but without further testing for acetates this cannot be confirmed.

Chart No	Chart name	PIGMENTS									
		Red		Green		Blue		Yellow			
		IR	UV	IR	UV	IR	UV	IR	UV		
1	Indian Ocean	transparent	absorbs	-	-	transparent	absorbs	-	?		
2	Indian Ocean (tracks)	transparent	absorbs	-	-	transparent	absorbs	-	?		
Chart No	**Chart name**	**PIGMENTS**									
		Red		Green		Blue		Yellow		Purple	
		UV	XRF	UV	XRF	UV	XRF	UV	XRF	UV	XRF
3	Java Sea	absorbs	Mercury	-	Copper	absorbs	mercury	fluoresces	No clear spectra		No clear spectra
4	North Sea	absorbs	Mercury	-	Copper	absorbs	mercury	fluoresces	No clear spectra		No clear spectra

Table 1: Pigment observations under IR, UV light and XRF spectra results

Blue Pigment

The blue pigments on Java and North Sea Charts produced a strong copper spectrum with XRF spectroscopy concluding that the pigment is azurite. Azurite is a pigment of basic copper carbonate, occurring naturally in many parts of the world (Gettens and West Fitzhugh 1966).

Yellow Pigment

The yellow pigment on both the Java and North Sea charts fluoresced under ultraviolet light.

Different yellow pigment areas from both charts were analysed using XRF but unfortunately no clear peaks were visible, therefore it was concluded that the pigment was organic. The three yellow pigment possibilities were now gamboge, Indian yellow and saffron.

According to Isacco and Darrah (1993, p.474), Indian yellow fluoresces a brilliant yellow under ultraviolet light whereas other organic yellow pigments do not. Townsend (1993) disagrees with their statement and found that gamboge displays a weak yellow-gold fluorescence. Due to these conflicting articles pigment identification could not solely rely on ultraviolet observations.

Gamboge is very pH sensitive and known to turn orange-red in alkalis (Doerner 1962, p.67). Further investigation through spot testing was undertaken. A known sample of gamboge was spot tested using an alkaline solution of calcium hydroxide (pH 11); a positive test should have returned a bright orange colour change (A Wise 2010, pers. comm., 3rd May 2010) however this did not occur. The pH of the solution was increased to 13 resulting in a positive reaction. The alkaline spot test was tried on the yellow area of Java Sea. The chart result was less prominent than the known sample however a slight colour change was observed. Afterwards acetic acid was dropped onto the orange spot to return it to its original colour.

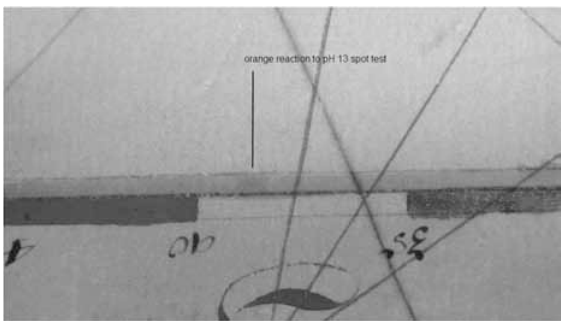

Figure 7: Positive gamboge test on Java Sea Chart

Gamboge is a bright yellow vegetable pigment made from the gum resin of evergreen *Garcinia* trees grown in south and south-east Asia. It was known to have been imported by the East India Company (British company in competition with the VOC) from 1615 onwards (Harley 1982, p.106).

Purple Pigments

Literature sources suggest purple pigments at this time were made from purple madder or by mixing other pigments together to obtain the correct hue. The mixtures were commonly red; vermilion (mercuric sulphide) or hematite (iron oxide), with blue; indigo, ultramarine or azurite (copper carbonate). The XRF spectra observed for the purple pigments found on both the Java and North Sea charts did not contain any strong peaks. Interestingly though there were small peaks of mercury, iron and copper. The initial conclusion was that these were due to contamination from surrounding pigments and ink and that purple was organic.

THE INSCRIPTIONS: PENCIL AND INKS

The pencil and ink inscriptions were observed under an infrared light source at the National Gallery of Australia. From conservation literature we understand that lead based media appears transparent whereas carbon absorbs the light. A strong dark line was characteristic on all charts therefore the pencil media was graphite (carbon).

The inks were believed to be iron-gall ink due to the characteristic brown colour and the manner in which it penetrated the vellum substrate. Under infrared light, inks that contain an iron component fade away and are difficult to see whereas carbon black inks are known to absorb the infrared and appear black (Khan and Lewincamp 2007). Fading away of the ink colour was observed on all four charts confirming the presence of iron rather than carbon black. Iron gall ink is made from oak tree galls, gum arabic and water.

To corroborate this result, inks were tested for Iron-(III)-ion, the stable iron ion, and the unstable Iron-(II)-ion using an indicator paper developed by the Netherlands Institute for Cultural Heritage (Neevel and Reissland 2005). All the inks tested were negative to Iron (II) ions. The negative result is probably due to the stable nature of the iron gall ink on vellum. Because vellum is limed during its manufacture, the environment is predominately alkaline reducing the acid hydrolysis and rate of oxidation in the inks of its surface (E Eusmen and Y Khan 2009, pers.comm., 3rd October). The theory was confirmed by the positive test of Iron (III) ions, the stable ion found in the iron gall ink complex.

TENSION MOUNTING TECHNIQUE

The charts displayed various degrees of planar distortion in the substrate. As a result the decision was made to undertake a humidification and tension mounting technique for storage and display. Preservation staff at the NLA had experience tension mounting smaller vellum documents but not large navigational charts. Dana Kahabka, Paper Conservator at the State Library of New South Wales (2007) developed an alternative to the well known reverse thread method developed by Nicholas Pickwoad for the successful housing of the Miranda Map (788x2145mm). The authors also returned to Pickwoad's article (1992) prior to taking on these epic treatments and therefore our method is influenced by both.

TREATMENT

No surface cleaning was undertaken on the charts as microscopic observations provided no evidence of surface dirt. The dirt appeared to be ingrained in the vellum fibre structure and any mechanical cleaning would have disturbed this. Moistened cotton swabs were rolled across the surface in what appeared to be the "dirty" areas but no change was observed so the method was abandoned.

The vellum substrates were all in a stable condition. The Java Sea Chart had three minor edge tears. These were repaired with wheat starch paste and Japanese tissue mends prior to humidification. There were areas of surface abrasion and minor staining particularly along the edges on all charts to varying degrees. The North Sea Chart showed signs of water damage.

Tape and Adhesive Removal

Three of the four charts had paper based adhesive tape on the verso. The paper layer was removed mechanically with moistened swabs. The adhesive layer was removed using a Toluene and Klucel G poultice.

A white wax-like adhesive on the Java Sea chart was removed from the verso to prevent further distortion during the humidification process. It had formed a rigid, cracked and brittle film over the surface that was causing unnecessary stress and strain on the skin. It was soluble in water and was removed using damp cotton swabs. The limited but uneven application of moisture to the substrate caused further distortions to the vellum that were released during humidification.

Humidification

The first chart was humidified on a rack in a metal tray with Perspex® lid above cool and then warm water. This method was abandoned as it produced uneven humidification. The water lost heat quickly requiring regular changing and when the chamber was opened the humidification was lost. We moved to a Gore-Tex® humidification package using damp blotting paper, which was easy to control and more gentle. Charts stayed in the package for two-three hours depending on the thickness of the skin.

Flattening

Both pressure and tension flattening techniques were tried in this project. The pressure method removed larger distortions in the charts but these were replaced with small tighter ones. The pressure was slowly reduced during the flattening process but this did not improve the outcome.

The charts were then flattened using a tension method. After humidification, bulldog clips were applied to the edges of the chart over a layer of Reemay® and blotting paper on each side. Rubber bands were secured onto the clips, they were pulled taut and pinned onto a large backing board. The chart was now suspended by the clips. Tyvek® was placed over the top of the chart to encourage slow drying and at regular intervals the pins were pulled out to keep it tight. As the chart dried the clips held it tight and flat.

Drying under tension proved to be more successful. The authors were able to reduce and often remove the vellum distortions. The Java Sea Chart was problematic however, due to the uneven thickness of the skin. When one problem area was flattened, the skin adjusted to cockle somewhere else. In the end, we compromised and accepted some small distortions. The chart was never going to be completely flat, as it had had a life as a working voyage chart.

Thread Preparation and Attachment

Barbour's three cord linen threads were cut and washed in warm, slightly soapy water to remove sizing. Once dry, one end was prepared by fanning the fibres to increase the surface area in contact with the chart. The fanned end was adhered to the chart with a 1:4 (w:v) paste of wheat starch in deionised water. The use of a strong diluted paste established an easily broken bond. Should the humidity levels fluctuate, the thread would release, preventing damage. The threads were attached at 10mm intervals around the edges, enabling the skin to be kept under control.

Mounting

Holes were punched in the backing board approximately 15 mm from the edges of the chart at 10mm intervals. The twisted threads are then pulled through holes in the backing board from recto to verso (see Figure 8).

Figure 8: Threads being pulled through to verso of the backing board

The threads were then slip knotted to a twisted thread circle (a length of thread that had been twisted and folded twice) on the reverse of the backing board. Once tied the threads were evenly tensioned and tightened. The excess thread was trimmed.

Figure 9: Thread circle

Two layers of Coreflute® build up were added to the backing board to lift the window mount above the thickness of the vellum. The chart mount packages were framed in custom made colonial style Fini frames™. The whole treatment was undertaken in a 24 hour controlled environment to ensure suitable conditions were sealed in the frame. Sheets of Art Sorb® conditioned to 55% relative humidity were also added to the frame package.

CONCLUSION

The XRF analysis of the pigments and ink on the charts drew together a number of conclusions. The authors were able to confirm the presence of certain pigments that were known trade articles of the Dutch East India Company and the surprising discovery of others that may not have been so common. Further investigation is still required to discover the composition of some pigments, such as the colour purple, but is not planned at this stage.

The treatment of the charts was a great learning experience for the preservation team at the NLA. Extensive testing of the waxy adhesive on the Java Sea chart was undertaken to find the best possible removal technique while being sensitive to the needs of the vellum substrate. The difficulties encountered during humidification and flattening resulted in an alteration of the treatment method that was not anticipated but produced a great result. Using the expertise and advise of other professionals to complete the 'reverse thread matt' technique allowed us to draw on the most appropriate aspects and adapt the treatment to suit the needs of these four navigational charts. The final outcome of the treatment was successful and the charts are now safely housed in their custom built colonial style frames.

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MATERIALS

Art Sorb® sheet form - Talas New York
Barbour three cord linen thread – Winterbottom Products Pty Ltd
Blotting paper – Australian Paper Shoalhaven Mill
Colonial frames – FINI Frames Melbourne
Coreflute® board – Archival Survival
Mount board (oversized) – Art & Archival Canberra
Mount cutting – Kim Morris, Art & Archival Canberra
Reemay® - University Products
Rubber bands, bull dog clips and cotton wool – general stationary supplier
Tyvek® - University Products, Archival Survival

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BIOGRAPHIES

Sophie Lewincamp received a Bachelor of Applied Science specialising in Conservation of Cultural Materials at the University of Canberra in 2004. In 2006, she was awarded the Harper-Inglis Conservation Fellowship at the Library of Congress, Washington DC. During her studies and afterwards, Sophie worked at many national institutions including the Australian War Memorial and the National Gallery of Australia. Sophie is currently on leave from her lab manager position at the NLA to undertake a research Masters in the historical and scientific analysis of the Middle Eastern Manuscript collection at the Baillieu Library, University of Melbourne.

Alexa McNaught-Reynolds received a Bachelor of Arts at the University of New England in 2005. She completed a Certificate IV in Museum Practice from the Canberra Institute of Technology in 2006 and a Master of Arts specialising in Conservation of Cultural Materials at the University of Melbourne in 2009. During her studies and afterwards, Alexa worked at many national institutions including the National Museum of Australia, National Archives of Australia, Australian War Memorial, and also in private practice at Art and Archival Pty Ltd and Endangered Heritage Pty Ltd. Alexa is currently working in the preservation department at the National Library of Australia.

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