HELENA PINHEIRO DE MELO*
Centro de Investigação em Ciência
e Tecnologia das Artes (CITAR)
Universidade Católica Portuguesa
Porto, Portugal
manahelena@gmail.com
JANA SANYOVA
Institut Royal du Patrimoine Artistique (IRPA/KIK)
Bruxelles, Belgique
jana.sanyova@kikirpa.be
ANTÓNIO JOÃO CRUZ
Departamento de Arte, Conservação e Restauro
Escola Superior de Tecnologia de Tomar
Instituto Politécnico de Tomar
Tomar, Portugal
ajccruz@gmail.com
*Author for correspondence

AN UNUSUAL GLAZING TECHNIQUE ON A PORTUGUESE PANEL PAINTING FROM THE SECOND HALF OF THE 16TH CENTURY: MATERIALS, TECHNIQUE AND RECONSTRUCTIONS

Keywords: 16th century, Portuguese, oil painting, glazing, red lakes, rheology, reconstruction

ABSTRACT

A regular dotted pattern, suggesting the imprint of a cloth, was found on the red glazes of three panel paintings from the second half of the 16th century, attributed to the Portuguese painter Francisco João (active 1562–1595). The materials and stratigraphy of the red glazes were analysed in one of these paintings using OM, µ-FTIR, SEM-EDX and HPLC. The original glazes were prepared with cochineal and madder lakes bound in an oil-based medium. Based on that information and on research on historical treatises of the period, reconstructions were made using a cochineal lake and different oil-based binding media to which resins, driers and fillers were added. Different formulations gave similar results to the original imprint, reflecting the diversity of approaches to the glazing technique found in historical sources.

RÉSUMÉ

Un motif en pointillé, suggérant l'imprimé d'un tissu, a été trouvé sur les glacis rouges de trois panneaux peints de la seconde moitié du XVI[e] siècle, attribués au peintre portugais Francisco João (actif de 1562 à 1595). Les matériaux et la stratigraphie des glacis rouges ont été analysés sur une de ces peintures à l'aide de la microscopie optique, la microspectroscopie infrarouge à transformée de Fourier, la microscopie électronique à balayage couplée à la spectrométrie de rayons X à dispersion d'énergie et la chromatographie en phase liquide haute performance. Les glacis originaux avaient été préparés avec de la laque de cochenille liées dans un médium à l'huile. En se basant sur ces informations et en menant des recherches dans les traités historiques de cette période, des reconstitutions ont été effectuées avec de la laque de

INTRODUCTION

In the context of a scientific program that aims at identifying the materials and techniques of the workshop of Francisco João, the most productive artist working in the region of Évora, Southern Portugal, between 1562 and 1595, three panel paintings, from a group of 50 panels studied, were found to exhibit a regular dotted pattern on their red-glazed draperies, suggesting the imprint of the weave of a cloth. The panel depicting the *Assumption of the Virgin*, with a painted surface of 269 cm high by 214 cm wide, was selected for the study of this glazing technique (Figure 1). It is part of a single panel altarpiece located in the church of Beringel, a village close to the city of Beja. This paper discusses this particular glazing technique based on research in historical painting treatises that mention the use of cloth for glazing. The red-glazed areas of the original painting were analysed in terms of the materials present, the build-up of paint layers and the technique of applying the glaze. Based on that information and on recent studies on the glazing technique, practical reconstructions were made.

ON THE GLAZING TECHNIQUES

Glazing with a cloth

In oil painting, a glaze could be defined as a translucent, medium-rich paint layer usually applied on top of an opaque underlayer with the aim of broadening the variety of hues possible to obtain with a limited range of pigments and give colours more depth and saturation. On this subject, Armenini (1587), Filipe Nunes (1615), De Mayerne (1620) and the anonymous author of *The art of painting in oyle by the life* (1664) mention that a cloth with cotton wool inside could be used to 'work' the glaze (Table 1). Armenini and the anonymous author of *The art of painting*… specify that the glaze should be first laid with a brush and rubbed or patted afterwards with a textile pad (Table 1). Nunes and De Mayerne are not so clear on this aspect and the possibility of a direct application of the glaze with the cloth has to be considered (Table 1). Historical sources further indicate that a linen or cotton textile could be used and a few describe its texture as soft or loose (Table 1).

Evidence of this practice was found on paintings made in Northern and Southern Europe from the 15th to the 17th centuries, in areas glazed in

cochenille et de garance et différents liants à base d'huile, auxquels des résines, des siccatifs et des matières de charge ont été ajoutés. Différentes formulations ont donné des résultats similaires à l'imprimé d'origine, reflétant la diversité des approches de la technique du glacis selon les sources historiques.

RESUMEN

Se encontró un diseño regular de puntos, que imitaba la impresión de una tela, en las veladuras rojas de tres pinturas sobre paneles de la segunda mitad del siglo XVI, atribuidos al pintor portugués Francisco João (activo en 1562–1595). Se analizaron los materiales y estratigrafía de las veladuras rojas en uno de estos cuadros por medio de microscopía óptica, µ-FTIR, MEB-EDX y HPLC. Las veladuras originales se prepararon con cochinilla y laca de garanza preparados en un medio a base de aceite. Basándose en esa información y en investigaciones de tratados históricos de la época, se hicieron varias reconstrucciones utilizando una laca de cochinilla y diferentes medios a base de aceite a los que se añadieron resinas, secantes y cargas. Se obtuvieron resultados parecidos a la impresión original a partir de diferentes formulaciones, lo que reflejaba la diversidad de acercamientos en la técnica de veladuras encontrada en fuentes históricas.

Figure 1
Assumption of the Virgin (painted surface: 269 × 214 cm), attrib. Francisco João (active 1562–1595), Church of Beringel, Beja, Portugal (© IMC)

green, red and blue (Table 2). According to the written sources, this method was employed to hide visible brushstrokes, to make the colour uniform and to create an even film (Table 1). The use of a dry brush (Nunes) or the palm of a hand (Armenini) was also mentioned as capable of achieving the same effect (Table 1). De Mayerne further indicates that this technique made it possible to highlight and darken the glaze (Table 1).

Table 1
Red glazes according to treatises that mention the use of a cloth (16th–17th centuries)

Treatise	Drier	Binding medium	Technique	Reference
Armenini (1587)	Varnish made of mastic, walnut oil and alum	Oil + little comon varnish	Veil the sketch evenly with a large brush of miniver; next pat it either with the palm of your hand or with a little wad of cotton wool covered with linen, so that the colour is uniform without any sign of a brushstroke. And if it does not turn out to one's satisfaction, one returns after it is dry to repaint with the mixture and pat in the prescribed way.	Olsweski 1977
Filipe Nunes (1615)	Burned ground glass Minium Oil with litharge (boiled or not)	Oil	Apply the glaze after the undermodelling is dry. Take a soft linen cloth and put a bit of cotton wool inside it, and then make a sort of brush in a way that the cotton stays inside the cloth and does not touch the painting, and with that spread the verdigris and you will see the lights in light green and the darks in dark green. The same is also done with red laque. You can also spread the paint with a brush, the paint must be a bit lean, and then with a large brush you can blend the glaze so that it stays evenly united.	Ventura 1982
De Mayerne (1620–1646)	Burned alum Ground glass, (burned or not) Minium White copperas Several recipes of heat-bodied oil and litharge, minium or glass. Water is sometimes added while heating	Linseed oil	There are two ways of glazing, either with the brush or with a loose rag with cotton wool inside it, and then over the glazing, you can highlight or darken it.	Berger 1901
The art of painting by the life (1664)	-	-	Apply the glaze after the undermodelling is dry. Apply a thin glaze layer. Rub it all over with a little lawn stuffed with cotton to make your lake lye even.	van Eikema Hommes 2004

Binding media of red glazes

Painting treatises not only suggested practical methods for handling the paint but also gave advice on the nature of the binding medium, the importance of using a drier when working with red lakes and the thickness and consistency of glaze layers. Several treatments were

proposed to increase the viscosity of the oil, its drying rate, or both, such as leaving it to the sun or heating it, sometimes in the presence of water or additives such as litharge, minium, lead white or ground glass. Written sources often recommended using these prepolimerized oils in small quantities. De Mayerne prescribed the addition of a few drops of these oils to the ground colours (Berger 1901, 270) and Nunes advised dipping the brush in them (Ventura 1982, 103). Minium, ground glass, white copperas and burned alum could also be directly mixed with the red lake to help it dry (Table 1).

Table 2
Paintings with glazes blotted with a cloth

School	Author	Painting	Glaze	Reference
German	Workshop of the Master of the Life of the Virgin	*The Mass of St. Hubert*, ca. 1480–1485 National Gallery, London (NG 253)	red	Campbell et al. 1997
Flemish	Quinten Massys (ca. 1465–1530)	*The Virgin and Child Enthroned with Four Angels* National Gallery, London (NG 6282)	red	Dunkerton 2008
	Anonymous, Antwerp	Antwerp altarpiece, ca. 1520 Oxburgh Hall, Norfolk	green	Woudhuysen-Keller 1995
	Anonymous, Antwerp	Antwerp altarpiece, ca. 1520–1525 Wallraf-Richartz-Museum, Köln (WRM 439/440)	green red	Wadum 2002
Netherlandish	Gerrit Dou (1613–1675)	*Kitchen made at a Window* Kunsthistorisches Museum, Vienna	blue	Wadum 2002
		The Young Mother, 1658 Mauritshuis, The Hague		
Italian	Marco Marziale (active ca. 1492–1507)	*Christ and the Woman Taken in Adultery*, ca. 1505 Bonnefantenmuseum, Maastricht (Inv. 3587)	green	van Eikema Hommes 2004
	Raphael (1483–1520)	*Saint John the Baptist Preaching*, ca. 1505 National Gallery, London (NG 6480)	red	Roy et al. 2004
	Altobello Melone (ca. 1490–before 1543)	*Christ Carrying the Cross*, ca. 1515 National Gallery, London (NG 6546)	red	Dunkerton et al. 1999
	Benvenuto Tisi, Il Garofalo (ca. 1476–1559)	*The Vision of Saint Augustine*, ca. 1518–1525 National Gallery,London (NG 81)	red blue	Dunkerton et al. 2002
	Marco Palmezzano (1460–1539)	*Mystic Marriage of Saint Catherine*, 1537 Private collection	green	Woudhuysen-Keller 1995

Painting treatises showed opposite preferences about the viscosity of red glazes. Nunes stated that the red glaze should be lean (‘*rala*’) and, when describing several methods to treat the oil with litharge, he highlighted that care should be taken to prevent the oil from thickening (Ventura 1982, 103). Although not directly related to the technique of glazing with a cloth, De Mayerne observed that red lakes should be bound in thick oil to compensate for their lack of body, or else that they should

be mixed with little oil and ground 'as thick as butter'(Berger 1901, 128–130, 232, 250).

Armenini considered that the addition of a little mastic oil varnish to the binding medium of all glazing colours would act as a drier and increase the saturation of these layers (Olszwesky 1977, 275). He also focused on the importance of applying a final varnish to enliven and, as underlined by De Mayerne as well, preserve the colours (Olszwesky 1977, 278; Berger 1901, 268). The resin could therefore be mixed with the colours or applied in the final varnishing stage. Yet, varnishing paintings was not a universal practice and, although he provides several varnish recipes, Nunes, for instance, did not assign particular relevance to this operation.

The diversity of approaches to glazing displayed in historical sources coincides with the results of binding media analyses of red glazes from 16th century European paintings where raw oils, heat-bodied oils and sometimes resin were identified (Campbell et al. 1997, Higgitt and White 2005).

ANALYTICAL METHODS

The painting surface was examined in situ with a magnifying lens (5×). Digital photographs of the surface were taken with a Sony Cibershot-DSC-H9.

Two samples were collected from red-glazed areas. The sample cross-sections, embedded in a resin, were studied with optical microscopy (OM) in reflection mode, under incident light and ultraviolet radiation, using an Axioplan polarization microscope (Carl Zeiss) with magnifications up to 1000×. Subsequently, the samples were gold coated and studied through scanning electron microscopy with energy dispersive X-ray spectrometer (SEM-EDX) on a JEOL JSM6300 microscope (15 kV) with X-ray detectors Pentafet Si(Li) and BSE (Tetra) both from Oxford Instruments.

Fourier transform infrared microscopy (μ-FTIR) was used to identify the main class of binding medium. The material removed from each layer was compressed into a diamond cell and analysed in transmission mode with a Hyperion 3000 spectrometer coupled to a microscope with a Mercury Cadmium Telluride (MCT) detector. The absorption spectrum, between 4000 and 600 cm^{-1}, was collected over 64 scans.

The red lake dyestuffs were analysed with high-performance liquid chromatography (HPLC) using a Spectra-SYSTEM from ThermoScientific. It consisted of a P1000XR pump, an AS3000 autosampler equipped with a 20 mL loop and a UV6000 UV-Vis DAD detector equipped with a 50 mm detector cell. The analytical column was an Alltima RP C18, 5 mm, 250 × 4.6 mm (Altech, Lokeren-Belgium). The eluents were: (A) MeOH, (B) 5 percent ACN in water, (C) 0.1 percent TFA in water; (D) ACN. The flow rate was 1 μL/min. The elution program was with column-switching at 5 min with a gradient as follows: 0-15 min: 90B, 10C; 15-55 min: 15A, 60B, 10C, 15D; 55-64.5 min: 45A, 10C, 45D; 64.5-70 min: 90D, 10C.

RECONSTRUCTIONS

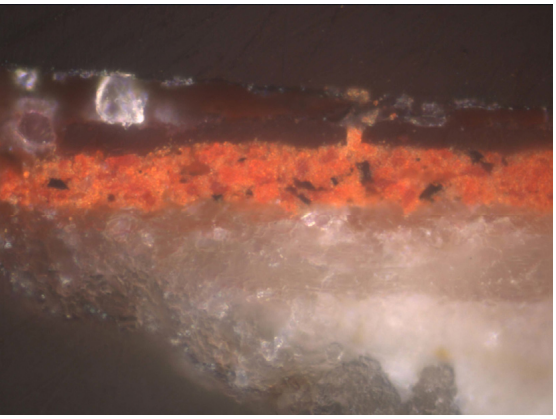
Multiplex panels were given a sizing layer of warm animal glue diluted at eight percent in water. Commercial gesso was bound in a ten percent animal glue solution and made into a paste that was spread with a spatula over the sized panels. The surface of the ground was polished and an isolation layer made of raw linseed oil was brushed on the surface. Two thin layers of lead white bound in linseed oil were then brushed over the ground.

Several binding media formulations were tested based on six ingredients (Table 3–4):

- binding medium: linseed or walnut oil, raw, sun-thickened with litharge or heat-bodied with litharge and water (100°C)
- pigment: lake made of cochineal on alumina
- diluent: spirit of turpentine
- drier: powdered glass rich in lead or heat-bodied oil with litharge at 150°C
- resin: mastic or colophony, in the form of an oil varnish
- filler: natural calcium carbonate.

Table 3
Organic media of reconstructed red glazes

	Details of preparation	Source
Binding medium	Raw cold-pressed linseed oil (L) or walnut oil (W)	
	Boiled linseed oil in water with litharge (BLW) Raw cold-pressed linseed oil + litharge (97/3 w/w); the double amount of water to oil (2:1) is added. The litharge is ground with a little bit of oil before adding the rest of the oil and water. The mixture is heated for 2 hours under continuous stirring. The prepared oil is left to cool.	Garcia. 1990
	Boiled walnut oil in water with litharge (BWW): substitute linseed by walnut oil in recipe BLW.	
	Sun- thickened linseed oil (SL) or walnut oil (SW) The raw oils were added 4% litharge and exposed to the sun in a glass container covered with glass for 8 weeks. Each mixture of oil with litharge was stirred daily.	
Drier	Boiled linseed oil with litharge (BL) Raw cold-pressed linseed oil + litharge (97/3 w/w) The litharge was ground on the slab with a little bit of oil and added to the rest of the oil. This was heated to 150°C for 2 hours under continuous stirring. The prepared oil was left to cool.	Viguerie et al. 2008
	Boiled walnut oil with litharge (BW): substitute linseed by walnut oil in recipe BL.	
Varnish	Mastic oil varnish (MOV) Mastic + walnut oil (1/1 v/v) The resin was added to the oil and the mixture gently heated until dissolution of the resin. The varnish was filtered to eliminate impurities.	Armenini. 1587 Olszweski. 1977
	Colophony oil varnish (COV) Colophony + linseed oil (1/1 v/v) The resin was added to the oil and the mixture gently heated until dissolution of the resin. The varnish was filtered to eliminate impurities.	Marciana Manuscript 16th c. Merrifield. 1999



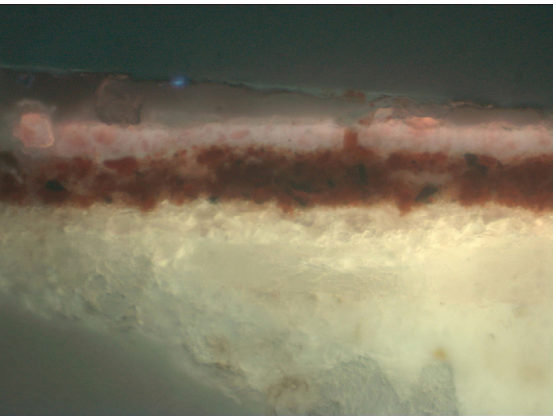


Figure 2
Imprint of the weave of a cloth in a red glaze over a red underlayer

Figure 3
Cross section from red drapery under visible light (1000 ×)

Figure 4
Cross section from red drapery under UV (1000 ×)

The organic components of the binding media were mixed on a glass slab and the pigment added afterwards and bound with a glass muller. Two types of linen cloth with an open and dense weave were selected to blot the glazes, following two application methods. In one method, the paint was brushed on the surface and then tapped with the textile; in the other method, the cloth was tapped on the slab to pick the paint and then tapped directly over the painting surface.

Observations of the surface aspect and colour of the red glazes were made with the naked eye under incident and ranking light immediately after application and checked daily to detect any changes. The drying of the glazes was assessed by the tackiness of the surface to the light pressing of a fingertip.

RESULTS AND DISCUSSION

Original glazing technique

The glaze was evenly laid on top of an undermodelling of the draperies. Different hues were obtained depending on whether an opaque red paint or a pink colour was used as underlayer. The red undermodelling was achieved with a mixture of a similar tonal range made of cinnabar, red lake, lead-tin yellow and a little carbon black (Figures 2–4). The pink garments were modelled over a thin layer made of lead white, red lake and a little azurite and carbon black. The folds were then highlighted with a pink to almost white layer of paint made of lead white and red lake while the deepest shadows were graphically painted with a diluted red lake (Figures 5–6). Evidence of the imprint of a woven fabric was visible to the naked eye on the red glazes of the draperies of three of the almost life-size figures of the apostles. The imprint was extremely regular and covered large areas of paint (Figure 5). The cloth imprinting was done with great care and overlapping of the imprint of red lake over adjacent painted motives was only detected in minute areas.

Analysis with µ-FTIR showed the presence of an oil-based medium and lead soaps. The red lake dyestuffs were identified by HPLC as cochineal and madder. By SEM-EDX, a high aluminium content suggested the presence of alumina in the substrate; small amounts of calcium carbonate, silica and sometimes sodium containing substances adsorbed on the alumina were found.

Glaze reconstructions

The binding media formulations, details of application and general results are presented in Tables 4–5 and Figure 7. Similar results were obtained with different formulations. When the pattern was not preserved, the use of the textile helped to create a uniform layer, hiding eventual brushmarks. This suggests that this method may have been used more often than has been supposed.

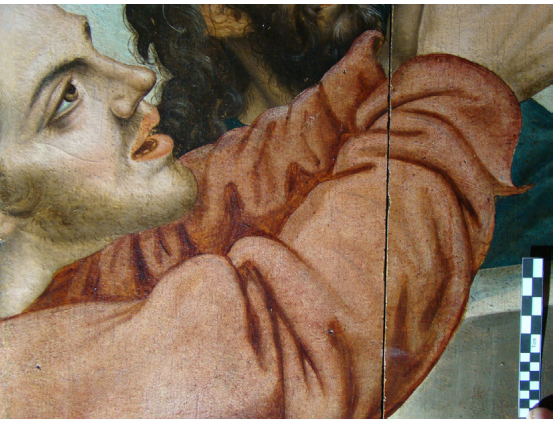


Figure 5
Area of blotted glaze in the draperies of Saint John

Figure 6
Imprint of the weave of a cloth in a red glaze over a pink underlayer

The cloth with a density of 18 × 17 threads/cm^2 produced an imprint close to the original (Figure 8). Collecting the paint from the slab with the linen pad used up much more paint than when the patting was done after first brushing the paint onto the surface. The first method worked by adding paint, whereas the second subtracted paint that was already applied, thus creating different imprints. In the first method, saturation of the textile with varnish or gum before picking up paint limited the wasted paint absorbed by the cloth. Although in practice the repeated patting simultaneously both added and subtracted paint, resulting in similar patterns in both cases, it was observed that the patting of the glazed surface gave a closer result to the original than the direct application of paint with the pad. In this last case, however, the imprint was less dependent on the glaze rheology and a pattern was more easily created. This pattern was more textured and therefore matte. The spreading of a final varnish would, in all cases, be a solution to problems with a lack of surface brilliance.

Figure 7
Reconstruction panels

The working properties of the paint were dependent on the rheological properties of the binding medium. These could be partly controlled by the type of oil, resin or diluent used and their relative proportion in the mixture (Table 4). The medium ‘recipe’ favourable to the textile imprint might, however, have a negative impact on important characteristics of the final glaze such as its brilliance, saturation and colour. Thus, the addition of turpentine, accelerated the drying rate of the paint, which helped to retain the pattern but lent a matte appearance to the surface, creating the need for later varnishing. On the contrary, the addition of resin not only increased the brilliance and saturation of the glaze but also created a stiffer paste, capable of fixing the imprint. This was particularly true with colophony since mastic gave a satin appearance to the surface as a result of faster drying. Still, the sticky consistency of the resin/oil varnishes had the disadvantage of easily picking up small fibres from the textile. Heat-bodied oils prepared according to the recipes in Table 3 imparted more brilliance to the glaze. The brown colour of those that were heated with litharge directly over the fire, did not appear, to the naked eye, to affect the colour of the glaze. However, if the imprinted pattern was to be preserved, the heat-bodied oils should not be used pure but added

in small quantities to the raw oils, as indicated in written sources. The difficulty in keeping the imprinted pattern when using heat-bodied oils could only be counteracted by an acceleration of the drying rate with the addition of spirit of turpentine, by the formulation of a thick paint with a high pigment concentration, by the addition of a resin or by significantly increasing the lapse of time between the brushing and the patting. The use of driers such as litharge treated oils or powdered glass did not appear to significantly affect the drying rate of the paint, although the small scale of the reconstitutions did not permit a sound conclusion on this aspect.

Figure 8
Reconstruction 1:1 of a detail of St. John's tunic. Paint: (walnut oil / turpentine, 1/1 v/v) + red lake (3+1 v/v)

The rheological properties of the paint were also significantly dependent on the addition of any filler such as the pigment, glass or chalk (Table 5). The proportion of three parts medium to one part pigment or a mixture of pigment and glass or chalk gave the best results, provided that a ratio filler/pigment lower than 3:1 was respected. The glass and chalk had a similar behaviour, slightly decreasing the paint saturation and giving it a pinker hue. This effect could be reduced by decreasing the amount of medium thus simultaneously creating a more viscous paint. In fact, these dry powders, even when added in small quantities to the red lake, imparted a creamy consistency to the paint, giving it more body and making it easier to work with, while simultaneously preserving the imprint of the textile. In doing so, they had the advantage of not interfering with the brilliance of the final glaze or imparting too dark a colour, which would happen if the rise in viscosity was only achieved with a high pigment concentration, as suggested by De Mayerne. Furthermore, these cheap and easily available materials would enable economic use of the expensive red lake. In addition to all these benefits, and according to the texts, glass would act a drier of the red lake as well.

CONCLUSION

In search of the glazing technique used by Francisco João in red glazed areas, it was found that paint with opposite rheological properties, apparently in a contradictory way, would keep the imprinted pattern. A lean paint, as suggested by Nunes, could be used as long as turpentine was added to the mixture to increase its drying rate. A stiffer paint, with the addition of a little resin oil varnish, indicated by Armenini as a drying agent, would also be suitable and would simultaneously preserve the glaze brilliance without need of further varnishing. Finally, a viscous paint with a high pigment concentration, as suggested by De Mayerne, but better even, with the addition of a filler such as ground glass, mentioned in the written sources as a drier for red lakes, would work as well. A transparent filler such as ground glass or chalk would furthermore maintain the satin appearance of the glaze and enable a better control of its colour saturation without interfering with the paint viscosity. A proportion of three parts medium to one part pigment or a mixture of pigment and glass or chalk gave the best results, provided that a ratio filler/pigment lower than 3:1 was respected.

Table 4

Reconstructed red glazes: binding medium manipulation

Binder	Preparation details	Textile	Application Details	Observations			
				Wet layer		Dry layer	
				Pattern	Surface appearance	Pattern	Surface appearance
L or W	Raw linseed oil + cochineal lake (1:1, v/v)	T1a	Brushmarks visible, good spreading Patting after 30 min	+	Satin	+	Matte
		T2a		+		+	
		T1b	Several applications of paint necessary to cover surface Uses more paint than patting after brushing	+	Matte	+	Matte
		T2b		+		+	
	Raw linseed oil + cochineal lake (3:1, v/v)	T1a	Brushmarks visible, good spreading Patting after 30 min, repeated after 6 h	–	Satin	+	Pattern + after 6h00 Satin/matte
		T2a		–		+	
		T1b	Several applications of paint necessary to cover surface Uses more paint than patting after brushing	+	Satin	+	Matte
		T2b		+		+	
	Raw linseed oil + cochineal lake (8:1, v/v)	T1a	No brushmarks visible Patting after 30 min.	–	Glossy	–	Satin
		T1b		+	Satin	+	Satin/matte
	Walnut oil + cochineal lake (10:1, v/v)	T1a	No brushmarks visible. Difficult to adhere to underlayer. Patting after 30 min	–	Glossy	–	Satin
		T2a		–		–	Dripping of paint
	Walnut oil + cochineal lake (4:1 v/v)	T1a	No brushmarks visible Patting after 30 min	–	Glossy	–	Satin/matte
		T2a		–		–	
SL or SW	Sun-thickened linseed oil + cochineal lake (2:1 v/v)	T1a	No brushmarks visible Patting after 30 min, repeated after 2 h	–	Glossy	+	Pattern + after 2h00 Satin
		T2a		–		+	
	Sun-thickened walnut oil + cochineal lake (10:1, v/v)	T1a	No brushmarks visible Patting after 30 min, repeated after 2 h	–	Very glossy	–	Satin
		T2a		–		–	Dripping of paint
BLW or BWW	BLW + cochineal lake (2:1 v/v)	T1a	No brushmarks visible Patting after 30 min	–	Very glossy	–	Glossy
		T2a		–		–	
	BLW + cochineal lake (8:1 v/v)	T1a	No brushmarks visible. Difficult to adhere to underlayer: repeated brushing necessary Patting after 30 min	–	Glossy	–	Glossy
		T1b		+		+	
	BWW + cochineal lake (8:1 v/v)	T1a		–	Glossy	–	Satin
		T2a		–		–	
L + BL or W + BW	(Linseed oil + BL 3:1 v/v) + cochineal lake (8:1 v/v)	T1a	No brushmarks, good spreading T1a: patting after 30 min	–	Glossy	–	Satin
		T1b		+		+	
	(Linseed oil + BL 3:1 v/v) + cochineal lake (3:1 v/v)	T2a	Brushmarks visible, good spreading Patting after 30 min	+/–	Glossy	+/–	Satin
	(Linseed oil + BL 3:1 v/v) + cochineal lake (1:1 v/v)	T2a		+		+	Satin/matte
	(Linseed oil + BL (1:1 v/v)) + cochineal lake (3:1 v/v)	T1a	Brushmarks slightly visible, good spreading Patting after 30 min Patting after 2h00 where no pattern obs.	–	Glossy	–	Satin
		T2a		–		–	
	(Linseed oil + BL 1:1 v/v) + cochineal lake (1:1 v/v)	T1a		+		+	Satin/matte
		T2a		+		+	
	(Linseed oil + BL 1:3 v/v) + cochineal lake (3:1 v/v)	T2a	No brushmarks, good spreading Patting after 30 min, repeated after 2 h	–	Glossy	+/–	Pattern + after 2h00 Dripping of paint
		T3a		–		–	Satin/matte
	(Linseed oil + BL 1:3 v/v) + cochineal lake (1:1 v/v)	T1a	Brushmarks slightly visible, good spreading Patting after 30 min	+	Glossy	+	Matte
		T2a		+		+	
	BL + cochineal lake (2/1 v/v)	T2a	No brushmarks, good spreading Patting after 30 min, repeated after 2 h	–	Glossy	–	Glossy
		T2b		–		–	
	(Walnut oil + BW 3:1 v/v) + cochineal lake (3:1 v/v)	T1a	Brushmarks slightly visible, good spreading Patting after 30 min, repeated after 6 h	–	Glossy	+	Matte
		T2a		–		+	Pattern + after 6h00
	(Walnut oil + BW 1:1 v/v) + cochineal lake (3:1 v/v)	T1a		–		–	Matte
		T2a		–		–	
	(Walnut oil + BW 1:3, v/v) + cochineal lake (3:1 v/v)	T1a		–	Glossy	–	Satin/matte
		T2a		–		–	

Binder	Preparation details	Textile	Application Details	Observations			
				Wet layer		Dry layer	
				Pattern	Surface appearance	Pattern	Surface appearance
L + Turpentine	(L + turpentine 3:1, v/v) + cochineal lake (8:1 v/v)	T1a	No brushmarks visible, good spreading	–	Satin	–	Satin
		T1b	T1a: patting after 30 min	+		+	
	(L + turpentine 3:1 v/v) + cochineal lake (2:1 v/v)	T1a	Brushmarks visible, good spreading	+	Satin	+	Satin
		T2a	Patting after 30 min	+		+	
	(L + turpentine 1:1 v/v) + cochineal lake (2:1 v/v)	T1a		+	Satin	+	Matte
		T2a		+		+	
	(L+ turpentine 1:3 v/v) + cochineal lake (2:1 v/v)	T1a	Brushmarks visible. Dries very quickly	+	Satin	+	Matte
		T2a	Patting has to be done in 5-10 min, before drying of the glaze	+		+	
BLW + Turpentine	(BLW + turpentine 3:1 v/v) + cochineal lake (2:1 v/v)	T1a	No brushmarks visible, good spreading	+/–	Glossy	+/–	Satin
		T2a	Patting after 30 min	+/–		+/–	
	(BLW + turpentine 1:1 v/v) + cochineal lake (2:1 v/v)	T1a	Brushmarks visible, good spreading	+	Satin	+	Satin/matte
		T2a	Patting after 30 min	+		+	
	(BLW + turpentine 1:3 v/v) + cochineal lake (2:1 v/v)	T1a	Brushmarks visible. Dries very quickly	+	Matte	+	Matte
		T2a	Patting has to be done in 5-10 min, before drying of the glaze	+		+	
BLW + COV	(BLW + COV 3:1 v/v) + cochineal lake (2:1 v/v)	T1a	No brushmarks visible, good spreading	–	Glossy Saturation increases with increase of varnish in the mixture	–	Glossy
		T2a	Patting after 30 min	–		–	
	(BLW + COV 1:1 v/v) + cochineal lake (2:1 v/v)	T1a	No brushmarks visible. Sticky paint	–		–	Glossy/satin Saturation increases with increase of varnish in the mixture
		T2a	Patting after 30 min. Some fibres from the textile get easily trapped in the glaze paint, especially when only varnish is used as the binding medium	–		–	
	(BLW + COV 1:3, v/v) + cochineal lake (2:1 v/v)	T1a		+		+	
		T2a		+		+	
	COV + cochineal lake (2/1 v/v)	T1a		+		+	
		T2a		+		+	
BWW + MOV	(BWW + MOV 3:1 v/v) + cochineal lake (2:1 v/v)	T1a	No brushmarks visible, good spreading	+	Satin	+	Satin
		T2a	Patting after 30 min.	+		+	
	(BWW + MOV 1:1 v/v) + cochineal lake (2:1 v/v)	T1a	Brushmarks visible, good spreading	+		+	
		T2a	Patting after 30 min	+		+	
	(BWW + MOV 1:3 v/v) + cochineal lake (2:1 v/v)	T1a		+		+	
		T2a		+–		+	
	MOV + cochineal lake (2:1 v/v)	T1a	Brushmarks visible, good spreading	+/–	Satin	+	Satin Pattern+ after 5h00
		T2a	Patting after 30 min, repeated after 5 h Some fibres trapped in paint	+/–		+	
	MOV + cochineal lake (4:1 v/v)	T1a	No brushmarks visible, good spreading	+/–		+	
		T2a	Patting after 30 min, repeated after 5 h	+/–		+	
BLW or L + Turpentine + COV	(BLW + turpentine + COV 2:1:1 v/v/v) + cochineal lake (8:1 v/v)	T1a	No brushmarks visible, good spreading	–	Glossy	–	Satin
		T1b	T1a: patting after 30 min	+		+	
	(L + turpentine + COV 2:1:1 v/v/v) + cochineal lake (8:1 v/v)	T1a		–	Glossy	–	Satin/glossy
		T1b		+		+	

Notes:

For the abbreviations used in the first two columns and other details, see Table 3.

T1: textile density 10x10 threads/cm^2; T2: Textile density 18x17 threads /cm^2

a: paint applied with a brush followed by tapping with a cloth

b: textile picks the paint on the slab and directly blots it on the surface

+: textile pattern clearly imprinted on the surface; – : textile pattern not imprinted on the surface

Table 5

Reconstructed red glazes: addition of fillers

Binder and Filler	Preparation details	Textile	Application Details	Observations			
				Wet layer		Dry layer	
				Pattern	Surface appearance	Pattern	Surface appearance
L + Chalk	L + (chalk + cochineal lake 1:3 v/v) (3:1 v/v)	T2a	Brushmarks visible, good spreading Patting after 30 min	+	Glossy Growing saturation with decrea-sing L	+	Satin
	L + (chalk + cochineal lake 1:3 v/v) (1:1 v/v)	T2a		+		+	
	L + (chalk + cochineal lake 1:3 v/v) (1:3 v/v)	T2a	Brushmarks visible, good spreading Patting after 30 min. Dries quite fast	+		+	Satin/matte
	L + (chalk + cochineal lake 1:1 v/v) (3:1 v/v)	T2a	Brushmarks visible, good spreading Slightly pasty paint Patting after 30 min	+	Glossy Growing saturation with decrea-sing L Chalk slightly decreases saturation giving the paint a more pink hue	+	Satin
	L + (chalk + cochineal lake 1:1 v/v) (1:1 v/v)	T2a		+		+	
	L + (chalk + cochineal lake 1:1 v/v) (1:3 v/v)	T2a	Brushmarks visible, good spreading Patting after 30 min. Dries quite fast	+		+	Satin/matte
	L + (chalk + cochineal lake 3:1 v/v) (3:1 v/v)	T2a	Brushmarks visible, good spreading Slightly pasty paint Patting after 30 min	–		–	Satin
	L + (chalk + cochineal lake 3:1 v/v) (1:1 v/v)	T2a		+		+	
	L + (chalk + cochineal lake 3:1 v/v) (1:3 v/v)	T2a	Brushmarks visible. Thick, pasty paint Patting after 30 min	+		+	Matte
BWW + Chalk	BWW + (chalk + cochineal lake 1:3 v/v) (3:1 v/v)	T2a	Brushmarks visible, good spreading Patting after 30 min	+/–	Glossy Growing saturation with decrea-sing BWW Chalk slightly decreases saturation giving the paint a more pink hue	+/–	Satin/glossy
	BWW + (chalk + cochineal lake 1:3 v/v) (1:1 v/v)	T2a		+/–		+/–	
	BWW + (chalk + cochineal lake 1:1 v/v) (3:1 v/v)	T2a	Brushmarks visible, good spreading Slightly pasty paint. Patting after 30 min	+/–		+/–	
	BWW + (chalk + cochineal lake 1:1 v/v) (1:1 v/v)	T2a		+		+	
	BWW + (chalk + cochineal lake 3:1 v/v) (3:1 v/v)	T2a	No brushmarks visible, good spreading Slightly pasty paint. Patting after 30 min	–		–	
	BWW + (chalk + cochineal lake 3:1 v/v) (1:1 v/v)	T2a	Brushmarks visible, good spreading Slightly pasty paint. Patting after 30 min	–		–	
L + BL + Chalk	(L + BL 3:1 v/v) + (chalk + cochineal lake 3:1 v/v) (3:1 v/v)	T2a	Brushmarks slightly visible, good spreading Patting after 30 min	+/–	Glossy Chalk slightly decreases saturation giving the paint a more pink hue	+/–	Satin/glossy
	(L + BL 3:1 v/v) + (chalk + cochineal lake 3:1 v/v) (1:1 v/v)	T2a		+		+	
	(L + BL 3:1 v/v) + (chalk + cochineal lake 3:1 v/v) (1:3 v/v)	T2a	Brushmarks visible, good spreading Thick, pasty paint Patting after 30 min	+		+	Satin
L + COV + Chalk	(L + COV 3:1 v/v) + (chalk+ coch. lake 3:1 v/v) (3:1 v/v)	T2a	Brushmarks visible, good spreading Patting after 30 min	+	Glossy. Chalk slightly decreases saturation giving the paint a more pink hue	+	Satin/glossy
	(L + COV 3:1 v/v) + (chalk+ coch. lake 3:1 v/v) (1:1 v/v)	T2a		+		+	
	(L + COV 3:1 v/v) + (chalk+ coch. lake 3:1 v/v) (1:3 v/v)	T2a		+	Satin	+	Satin/matte

Binder and Filler	Preparation details	Textile	Application Details	Observations			
				Wet layer		Dry layer	
				Pattern	Surface appearance	Pattern	Surface appearance
L + Glass	L + (glass + cochineal lake 1:3 v/v) (3:1 v/v)	T2a	Brushmarks visible, good spreading Patting after 30 min	+	Glossy Growing saturation with decrea-sing L Glass slightly decreases saturation giving the paint a more pink hue	+	Satin/matte
	L + (glass + cochineal lake 1:3 v/v) (1:1 v/v)	T2a		+		+	
	L + (glass + cochineal lake 1:3 v/v) (1:3 v/v)	T2a		+		+	Matte
	L + (glass + cochineal lake 1:1 v/v) (3:1 v/v)	T2a	No brushmarks visible, good spreading Slightly pasty paint. Patting after 30 min	+		+	Satin
	L + (glass + cochineal lake 1:1 v/v) (1:1 v/v)	T2a	Visible brushmarks, good spreading Slightly pasty paint. Patting after 30 min.	+		+	Satin/matte
	L + (glass + cochineal lake 1:1 v/v) (1:3 v/v)	T2a	Visible brushmarks, good spreading Pasty paint. Dries fast. Patting after 5 min	+		+	Matte
	L + (glass + cochineal lake 3:1 v/v) (3:1 v/v)	T2a	No brushmarks visible. Slightly pasty paint. Patting after 30 min, repeated after 2 h	–		–	Satin
	L + (glass + cochineal lake 3:1 v/v) (1:1 v/v)	T2a	Visible brushmarks, good spreading Pasty paint. Patting after 30 min	+		+	
	L + (glass + cochineal lake 3:1 v/v) (1:3 v/v)	T2a	Visible brushmarks. Thick, pasty paint. Dries fast. Patting after 5 min	+		+	Matte
BWW + Glass	BWW + (glass + cochineal lake 1:3 v/v) (3:1 v/v)	T2a	No brushmarks visible, good spreading Slightly pasty paint Patting after 30 min	–	Glossy	–	Satin
	BWW + (glass + cochineal lake 1:1 v/v) (3:1 v/v)	T2a		–		–	
	BWW + (glass/cochineal lake 3:1 v/v) (3:1 v/v)	T2a		–		–	

Notes:
For the abbreviations used in the first two columns and other details, see Table 3.
T1: textile density 10 x 10 threads/cm^2; T2: Textile density 18 x 17 threads /cm^2
a: paint applied with a brush followed by tapping with a cloth
b: textile picks the paint on the slab and directly blots it on the surface
+: textile pattern clearly imprinted on the surface; – : textile pattern not imprinted on the surface

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MATERIALS LIST

Lead white; animal glue
Le Lion
Rue Laeken 55, 1000 Brussels, Belgium

Cold-pressed linseed oil
Emile Noël S.A.S.
30130 Pont-Saint-Esprit, France

Cold-pressed walnut oil (73550); cochineal lake (42100); chalk from Champagne (58000); Chios mastic resin (60050)
Kremer Pigmente
Hauptstrasse 41-47, 88317 Aichstetten, Germany

Linen cloth
Casa dos Panos
Rua Fanqueiros 45, 1100–226 Lisbon, Portugal

Colophony resin; turpentine rectified (Talens 032); calcium sulphate
Casa Ferreira
Rua Rosa 185, 1200–384 Lisbon, Portugal

Powdered glass rich in lead PR-O
Ceramista
Caldas-da-Rainha, Portugal