Discoloration in Renaissance and Baroque Oil Paintings. Instructions for Painters, theoretical Concepts, and Scientific Data
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Figure Captions

A Proposal for the Classification of Painting Methods and Recipes

Fig. 1. Frontispiece of Willem Beurs, De groote wereld in 't kleen geschildert, Amsterdam 1692.

Fig. 2. Karel van Mander's instruction for depicting velvet drapery in the Grondt der edel vrij schilder-const, Haarlem 1604. f. 44r.

Painters’ Methods to Prevent Colour Changes Described in Sixteenth to Early Eighteenth Century Sources on Oil Painting Techniques

Fig. 1 Paulus van Somer’s remark on the discoloration caused by the oil medium. London, British Library, MS Sloane 2052, f. 94r.

Fig. 2 Frontispiece of volume II of El museo pictórico y la escala óptica, 2nd ed., Madrid 1795-97.

Fig. 3 Cross-section of paint reconstruction with coarse smalt particles in an oil medium.

Fig. 4
4.a Maarten van Heemskerck Drapers’ Altar (1546). Panel 260 x 122 cm. Frans Halsmuseum, Haarlem. Inv. no. 474. Mary’s clothes on the panel of the Annunciation are now a greyish beige colour. However, research that was carried out during the restoration showed that her mantle was originally blue and was painted with smalt. This striking discoloration is due to both the fact that the oil medium has darkened dramatically and that the smalt has lost its colour.

4.b A photo taken before restoration with raking light. The paint in the shadows has been applied with plenty of binding medium. Here, the layer of paint has darkened dramatically; it has a brown, fatty and greasy appearance.

4.c This detail taken before restoration, shows that Van Heemskerck had encountered the problem described by Palomino: the paint has dripped from a thickly-applied area beneath the mantle. Photo b and c: Conservation studio, Frans Halsmuseum.

Fig. 5 Drawing of a palette with pigments used for oil painting. Simon Eikelenberg Aantekeningen over schilderkunst (1679-1704). Alkmaar, Regionaal Archieven, acquisitions collection nos. 390-94, p. 394. Photo: Netherlands Institute for Cultural Heritage, Amsterdam.

Fig. 6
6.a Jan Davidsz de Heem, Festoon of Fruits and Flowers (signed: J. D. de Heem p.). Oil on canvas 64 x 60 cm. Rijksmuseum Amsterdam. Inv. no. SK-A-138.

6.b Cross-section (R 52/1) of highlight in the orange, normal light 400x.

6. 45 μm Highlight of orpiment, the degraded surface of this layer is well visible.

5. 6 μm Brownish layer, yellow lake, chalk and a little lead-white and black pigments.

4. c1 μm Thin strongly fluorescent medium layer.

3. 20 μm Orange layer; vermilion and yellow lake.

2. 24 μm Second ground layer; coarse lead-white, bone black and red earth.

1. 20 μm First ground layer; fine grained red earth, lead-white and some black pigment.
6. c
Cross-section (R 52/1) UV light 400x.

Fig. 7
Karel van Mander's instructions for the sinking in of smalt paint, *Gronde der edel vry schilder-coust*, Haarlem 1604, f. 50r.

Fig. 8

Fig. 9

Fig. 10
Frontispiece of José Hildago, *Principios para estudiar el nobilísimo y real arte de la pintura*, Madrid 1693.

Fig. 11

Fig. 12

**Discoloration or chiaroscuro? An interpretation of the dark areas in Raphael's *Transfiguration of Christ***

Fig. 1
Raphael *The transfiguration of Christ*. Panel 405 x 278 cm. Pinacoteca Vaticana, Rome. Inv.no.333. Photo: after the restoration of 1972-76.

Fig. 2

Fig. 3

Fig. 4

Fig. 5
Fra Bartolommeo, *The mystic marriage of St. Catherine (Pala Pitti)*. Panel 356 x 270 cm. Galleria Palatina di Palazzo Pitti, Florence. Inv. no.1912, n.208 (Inv.no.1890 n.8397).

Fig. 6

Fig. 7
Fra Bartolomeo *Madonna and child with st Anne and the patron saints of Florence (Pala della Signoria)*. Panel 465 x 308. Museo di San Marco, Florence, Inv. no. 1890 (n.1574).

Fig. 8
Fig. 9

Fig. 10

Fig. 11
Raphael, *The Holy Family with St Elizabeth, the Young S. John and Angels (Holy Family of Francis I)*, transferred from wood to canvas, 207 x 140 cm, Musée du Louvre, Paris, Inv. no. 1498.

Fig. 12
Raphael, *Cartoon for two apostles and hands*. Drawing black chalk and white heightening over pouncing 49.9 x 36.4 cm. Ashmolean Museum, Oxford. Inv. no. P II 568.

Fig. 13

Fig. 14
Raphael, *Cartoon for the face of an apostle*. Drawing black chalk over pouncing 37.5 x 27.8 cm. Chatsworth House, Chatsworth. Inv. no. 67.

Fig. 15

Fig. 16
Raphael, *Cartoon for the seated apostle at the left*. Drawing black chalk and charcoal (?) over pouncing 39.9 x 35 cm. British Museum, London. Inv. no. 1860-6-16-96.

Fig. 17
Raphael, *The transfiguration of Christ*. Detail of head of the seated apostle at the left.

Fig. 18

Fig. 19

Fig. 20

Fig. 21

Fig. 22
Raphael, *The transfiguration of Christ*. Detail of two apostles in blue at the left.

Fig. 23

Fig. 24
Anonymous, ink drawing of the lower half of the Transfiguration 38.4 x 47.9 cm. Musée du Louvre, Paris. Inv. no. 3955.

Fig. 25
Cornelis Cort after Raphael, *The transfiguration of Christ*. Engraving 54 x 37.7 cm.
Verdigris Glazes in Historical Oil Paintings: Recipes and Techniques

Fig. 1
The earliest description of the production process of verdigris in Montpellier is found in a relatively unknown manuscript by De Mayerne. London, British Library, MS Sloane 1990, f. 51r.

Fig. 2
Westphalian school, Last judgement (c.1500). Panel 149 x 175 cm. Rijksmuseum, Amsterdam. Inv.no. SK-A-2588.

Fig. 3
3a
Giovanni Antonio Pordenone, Judith holding the head of Holofernes. Canvas 103.5 x 86.5 cm. Rijksmuseum, Amsterdam. Inv.no. SK-A-3415.
3b
Detail of green curtain.
3c
Cross section (CR 10) from the green curtain, normal light 200x.
4. 25 \(\mu m\) Varnish layer, UV fluorescence.
3. 50 \(\mu m\) Local green glassy layer.
2. 50 \(\mu m\) Translucent green layer with copper green pigment (atacamite), lead-white and a few particles of lead-tin-yellow. no UV fluorescence.
1. 30 \(\mu m\) Grey layer with white, black and red particles.

Fig. 4
4a
South Netherlandish School, Triptych with scenes from the life of John the Baptist (dated 1557). Verso of the right wing, St. Barbara with the donor Berbel van de Noot. Oil on panel 194 x 87 cm. Rijksmuseum, Amsterdam. Inv.no. SK-A-2578.
4b
Cross section (CR2) from highlight of green dress of St. Barbara. normal light 200x.
6. 30 \(\mu m\) Three layers of varnish.
5. 25 \(\mu m\) Translucent light green layer with green particles, with on top brown discoloration.
4. 50 \(\mu m\) Green layer, azurite with lead-tin-yellow and lead-white.
3. 15 \(\mu m\) Green layer, azurite and little lead-tin-yellow and/or yellow ochre.
2. 10 \(\mu m\) Imprimatura of lead-white and charcoal.
1. 75 \(\mu m\) Ground layer of chalk and glue.
4c
EDX spectrum of layer 5. Besides copper, both calcium and lead are present.

Fig. 5

Fig. 6
Fig. 7
According to *Le Petit Peintre*, the colour of paint made of [basic] verdigris changed already after one month after application.
London, British Library, MS Sloane 2052, f. 90v.

Fig. 8
Fig. a, b

Fig. 9
9. a, b
Marco Marziale, *Christ and the Woman taken in Adultery* (c. 1505). Oil on canvas 130 x 166 cm. Bonnefantenmuseum, Maastricht. Inv. no. 3587.
9. b
Detail of head-dress of the adulterous woman.
9. c
Imprint of textile in green drapery.
Photo b and c: Lidwien Speleers, Stichting Restauratie Atelier Limburg, Maastricht.

Fig. 10
10a
South German School, *Saint Mauritius* (Second quart 16th Century). Oil on panel, 68 x 70 cm. Bonnefanten Museum, Maastricht. Inv. no. 3595.
10b
Detail of thickly applied viscous copper-green glaze, before restoration.
10c
Photo b and c: Stichting Restauratie Atelier Limburg, Maastricht.

Fig. 11
11 a
11b
Cross section (CR4) of green stola of woman at the left side of the painting, normal light 200x.
7. 4 μm Transparent green layer, no UV fluorescence (overpaint?).
6. 2 μm Thin brown layer, UV fluorescence (varnish?).
5. 6 μm Transparent green layer, no particles.
4. 60 μm Two green layers applied wet in wet, no green particles; lead-white, more lead-white in the upper layer, lower layer more yellowish, few black particles.
3. 8 μm Pale green layer with transparent particles and lead-white.
2. 1 μm Thin brown layer, with brown particles (isolation layer or pencil drawing?).
1. 90 μm White chalk glue ground.
11c
EDX spectrum of layer 5. Small amount of lead and calcium are present.

Fig. 12
12 a
Cornelis de Heem, *Still-life*. Canvas 153 x 166.5 cm. Rijksmuseum, Amsterdam. Inv. no. SK-A-564.
12b
Detail. Cornelis de Heem restricted the use of verdigris glaze, which today has a much more subdued dark green colour, to the bagpipe.

Fig. 13
Recipe in the *De Mayerne manuscript* that recommends varnishing the verdigris glaze as soon as possible. London, British Library, MS Sloane 2052, f. 6v.
Fig. 14
Recipe for glazing verdigris with aloe in the earliest copy (c. 1550) of Leonardo da Vinci's treatise on painting. Vatican Library, Codex Urbinas Latinus 1270, f. 60r.

Fig. 15
Lucas van Leyden, Triptych of the Last Judgement (1526/27). Oil on panel 209.5 x 84.8 cm. Stedelijk Museum de Lakenhal, Leiden. Inv. no. 244. Detail of the green garment of the sixth apostle of the central panel. The modelling of the garment was made with copper-green pigment and lead-white en lead-tin-yellow in various proportions. Photo: Netherlands Institute for Cultural Heritage, Amsterdam.

Fig. 16
16.a
School of Brescia (Moroni?), Portrait of a nobleman in armour (first half 16th Century). Oil on canvas 92.5 x 70 cm. Rijksmuseum Amsterdam. Inv.no. SK-A-3035.
16.b
Detail.
16.c
Cross-section of highlight in green costume, normal light 200x.
7. Thick glaze of dissolved verdigris.
6. Highlight of pure lead-white.
5. Green paint; verdigris and lead-white.
4. Underpainting of costume. Darker greyish layer; lead-white, carbon black, some red pigment.
3. Underpainting of costume. Warm greyish layer; lead-white, carbon black, some red pigment.
2. Second ground layer; lead-white and earth pigments.
1. Ground layer; lead-white and earth pigments.
16.d
Cross-section UV light 200x.

Fig. 17
17.a
17.b
Paint cross-section (R 51/3) from the green curtain, normal light 200x.
5. 26 µm Glaze of dissolved verdigris with a more brownish colour at the upper side.
4. 10 µm Darker green of verdigris and lead-white blended with previous layer.
3. 10 µm Light green; lead-white with verdigris.
2. 6 µm Second ground layer; carbon black, some iron oxide red, lead-white, chalk.
1. 10 µm Ground layer; lead-white, chalk, earth pigments, some carbon black.

Fig. 18
18.a
Frans Hals, Banquet of the Officers of the St. George Civic Guard (1616). Oil on canvas, 175 x 234 cm. Frans Halsmuseum, Haarlem. Inv. no. 1-109.
18.b
Detail from the curtain. Where the paint was protected by the frame, the verdigris glaze has been preserved. Photo: Conservation studio, Frans Halsmuseum.

Fig. 19
19.a
19.b
Detail of background with partial remains of original verdigris glaze (now brown). Underneath is the dark underpaint. Photo a and b: Conservation studio, Mauritshuis.
19. Cross section (1109/1) from the background, normal light 400x.
4. ≤ 24 µm Discoloured glaze of dissolved verdigris in an oil resin medium.
3. ≤ 10 µm Dark grey underpaint.
2. ≤ 6 µm Isolation layer, lead-white.
1. ≤ 48 µm Ground layer, chalk.

Fig. 20
Salomon van Ruysdael, *Landscape with dunes and carriage* (1631). Panel 56 x 86.4 cm. Scépmüvészeti Múzeum, Budapest. Inv.no. 515.

Fig. 21
Abraham Mignon, *Still-life with fruit and oysters*. Oil on canvas 60.5 x 75 cm. Rijksmuseum, Amsterdam. Inv. no. SK-C-187.

Fig. 22
22.a
Jan van Huysum, *Vase with flowers* (1722). Oil on panel, J. Paul Getty Museum. Inv.no. 82 PB.7O.
22.b
Dark green leaf on lower left side of vase painted with Prussian blue and Naples yellow. Photo: Joens Dik, University of Amsterdam.

**Indigo as a Pigment in Oil Painting Technique and the Problem of its Fading**

Fig. 1
1.a
Master of the Haarlem school (formerly attributed to Hendrik Pot), *Portrait of the St. Adrian Civic Guard*. Oil on canvas 214 x 276 cm. Frans Halsmuseum, Haarlem. Inv.no. 239.
1.b
Detail of faded sash.
1.c
At the top of the standard that was covered by the old frame, indigo paint has preserved its bright blue colour.
1.d
Detail of standard on the right. Where indigo paint was protected by the frame, the original blue has been preserved. Here the indigo paint was applied over the black costume. Due to the turbid medium effect, the faded indigo in this area appears bluer than the faded indigo paint that was applied over a light layer (1b). Photo b-d: Conservation studio, Frans Halsmuseum, Haarlem.
1.e
Cross-section (Pot 2) of faded sash (Fig. 1.b) normal light 500x.
3. 20µm Lead-white and indigo. The layer has faded up to 16-20µm beneath the paint surface.
2. 30µm Brown layer (imprimatura); lead-white, chalk, earth pigments.
1. < 220µm Ground layer, chalk, lead-white and a little brown earth pigment.
1.f
Cross-section (Pot 10) of unaltered indigo paint shielded from light by brown paint layer on top, normal light 500x.
6. 10µm Brown earth pigments and lead-white.
5. 12-18µm Lead-white and indigo.
4. 10µm Pale beige layer, lead-white, chalk, earth pigments.
3. 12µm Darker beige layer; lead-white, chalk, earth pigments.
2. 12µm Brown layer (imprimatura?); lead-white, chalk, earth pigments.
1. 160µm Ground layer, chalk, little brown earth pigment.

Fig. 2
2.a
Johannes Verspronck, *Regentesses of the St. Elisabeth’s Hospital* (signed and dated 1641). Oil on canvas 156.9 x 214.7 cm. Trustees of the St. Elisabeth’s Hospital, on loan to the Frans Halsmuseum, Haarlem. Inv. No. of 1 - 622.
2 b
Detail of tablecloth before restoration.

2 c
Right edge of the painting before restoration where indigo paint was covered by the frame.

2 d
Detail before restoration of original unvarnished selvedge shielded by the frame that indicates intensity of original dark green colour of the tablecloth.

2 e
Detail of tablecloth before restoration.

2 f

2 g
Cross-section (622/1) of green tablecloth, from area shielded by the frame, normal light 200x.

3. Varnish layer.

2. to 20µm
Yellow lake (weld), chalk (calcium substrate for weld), indigo, lead-white and some splintery particles.

1 to 60µm
Ground layer (applied in two layers, top layer slightly more pinkish); lead-white, chalk, little ochre, umber and manganese black.

2 h
Cross-section (622/1) UV light 200x.

Fig. 3
Chronological overview of pigments identified in paint samples by A. M. de Wild, Het natuurwetenschappelijk onderzoek van schilderijen, Den Haag 1928.

Fig. 4
*Indigofera tinctoria*, the main plant source for indigo. Fig. 54 of the first volume of Henricum van Rheed van Draakenstein, *Hortus indicus Malabaricus, continens regni Malabarici apud Indus celebrissimi omnis geritis plantas rariores per Henricum V an Rheed van Draakenstein*, 12 vols. Amsterdam (1678-1703).

Fig. 5
Woad plant (*Isatis tinctoria*) drawn by Simon Eikelenberg in his *Aantekeningen over Schilderkunst* (1679-1704), Almaar, Regionaal archief, acquisitions collection nos. 390-94.

Fig. 6

A. Tank for pure water.
B. Soaking tank.
C. Beating tank.
D. Settling tank where blue sediment precipitated in the bottom.
E. Taps through which liquid passed from one tank to the lower tank.
G. Cloth bags filled with indigo, hanging to drain.
H. Drying shed.

Fig. 7
Lumps of tropical indigo.

Fig. 8
DTMS spectrum of *I. tinctoria* L. from India (Kremer Pigmente). In the mass spectrum peaks 205, 234, 262 are markers for indigotin or indirubin.

Fig. 9
HPLC chromatogram of a solution of indigo pigment made from *Indigofera tinctoria* L. from India (Kremer Pigmente).

Fig. 10
EDX spectrum of *I. tinctoria* L. from India (Kremer Pigmente).
Fig. 11
a. Natural indigo from *I. tinctoria* (De Kat), normal light 200x.
b. Crossed polar 200x. Birefringent material indicates the presence of mineral matter.

Fig. 12
Indigo dye vat from Mexico with vat flower. Photo: Jesús López.

Fig. 13
EDX spectrum of wood indigo. Sample provided by Malla-Stina Tallgren, Helsinki.

Fig. 14.
Duerer Bouts The Entombment. Glae on canvas 90.2 x 74.3 cm. National Gallery, London. Inv. no. 664.

Fig. 15
15.a Frans Hals, *Officers and Sergeants of the St. George Civic Guard* (c. 1627). Oil on canvas 179 x 257.5 cm. Frans Halsmuseum, Haarlem. Inv. no. 110
15.b Detail of faded indigo blue sash.
15.c Cross-section (A 204/2) of blue sash from sitting man with yellowish coat middle foreground, normal light 200x.
8. 45μm Varnish.
7. 14μm Lead-white and indigo, degraded binding medium, the paint layer has faded.
6. 12μm Indigo and lead-white.
5. 6μm Lead-white and indigo.
4. 10μm Indigo and very little lead-white.
3. 10μm Lead-white and very little indigo.
2. 4μm Lead-white, yellow ochre and black pigment, binding medium rich layer.
1. Ground layer, lead-white and red earth pigment.
15.d Cross-section (A 204/2) UV light 200x.
15.e Cross-section (Ind.124) from blue square of standard just under rebate of the top frame, UV light 200x.
3.10-40μm Indigo and little lead-white, some red particles.
2. 24μm Yellow ochre, black pigment and lead-white (possibly two layers applied wet in wet. Lower layer appears more binding medium rich).
1. 120μm Ground layer; lead-white and red earth pigment.
15.f SEM EDX spectrum from indigo agglomerate in cross-section Ind.124 (15.e).

Fig. 16
16.a Frans Hals, *Officers and Sergeants of the St. Adrian Civic Guard* (c.1627). Oil on canvas 183 x 266.5 cm. Frans Halsmuseum, Haarlem. Inv.no.111.
16.b Detail of relatively well preserved blue sash.
16.c Cross-section (125/4) from blue sash, normal light 500x.
7. Varnish.
6. 20μm Indigo and lead-white, fading is visible up to 6-16μm beneath the paint surface.
5. 30μm Lead-white and indigo, probably two layers applied wet in wet.
4. <10μm Irregular layer; lead-white, black pigment. More binding medium rich than layer 3.
3. 4-14μm Lead-white and black pigment.
2. 4μm Brown binding medium, black pigment.
1. Incomplete Whitish ground; lead-white and very little red pigment.
Cross-section (A 202/1) from blue sash, normal light, oil immersion 400x.

6. 45 µm Varnish
5. 45 µm Indigo and lead-white, beneath the paint surface the layer has faded and exhibits strong fluorescence in UV light.
4. < 2µm Thin fluorescent layer (only visible in UV light).
3. 40µm Indigo and lead-white.
2. 16µm Several light greyish brown layers; lead-white, black pigment and ochre.
1. incomplete Whitish ground; lead-white and very little red pigment.

Cross-section (A 202/1) UV light 200x.

Cross-section (A 202/1) normal light, oil immersion 1000x. Along the topside of the big lump of lead-white the indigo has faded more severely.

SEM EDX spectrum from indigo agglomerate in cross-section 125/4 (16.c).

Frans Hals, Officers and Sergeants of the St. Adrian Civic Guard (c.1633). Oil on canvas 207 x 337 cm Frans Halsmuseum, Haarlem. Inv. no. 112.

Detail indigo blue sash of Captain Johan Schatter. For rendering the effect of warm reflections, Hals used the brown colour of the ground through thinly applied indigo layers.

c. Detail indigo blue sash of Captain Johan Schatter.
d. Cross-section (203/1b) from deep blue indigo paint at the left edge that was shielded from light by the frame and an layer of overpaint, normal light 200x.

7. 10µm Overpaint; red ochre, coarse black pigment, little white pigment.
6. 16µm Varnish.
5. 54µm Lead-white and indigo.
4. 2µm Thin binding medium rich layer.
3. 20µm Lead-white and little indigo.
2. 18µm Lead-white and fine back pigment.
1. Whitish ground layer.

Cross-section (126/7) from an exposed area of the blue sash at the left, normal light 100x.

7. 24µm Varnish
6. 25µm Indigo and lead-white.
5. 30µm Lead-white and indigo, two layers applied wet in wet.
4. <12µm Thin fluorescent layer of lead-white and little black pigment.
3. 24-64µm Ground layer; lead-white, dark brown pigment (umber?)
2. 12-45µm Ground layer; lead-white, dark brown pigment (umber?)
1. Glue and chalk?

Cross-section (126/7) UV light 500x.

Indigo paint at the far left side, which was partially shielded by light by the shadow of the frame, has a more intense blue colour.
Fig. 18
18. a
Frans Hals, *Officers and Sergeants of the St. George Civic Guard* (1639). Oil on canvas 218 x 421 cm. Frans Halsmuseum, Haarlem. Inv. no. 113.

18. b
Cross-section (A 201/1) normal light 200x.
7. 14μm Varnish layer.
6. 7μm Lumps of lead-white.
5. 8μm Lead-white and indigo.
4. 8μm Dark blue layer; indigo, lead-white (dark in UV).
3. 7μm Dark blue layer; indigo, lead-white (strong fluorescence in UV).
2. 13μm Dark blue layer; indigo, lead-white (dark in UV).
1. Ground; lead-white, ochre, dark brown pigment.

18. c Cross-section (A 201/1) UV light, 200x.

Fig. 19
19. a

19. b
Cross-section (355/1) of light blue skirt of woman at the right, normal light 500x.
2. 25μm Lead-white, indigo and few glass like particles. The paint layer has faded at the paint surface.
1. 100 μm Ground layer applied in three layers; lead-white, chalk and umber.

19. c
Cross-section (355/2) from thin shadow in green tablecloth, normal light 500x.
2. 25 μm Green layer; indigo, weld, little ochre, red pigment, chalk, few lumps of lead-white. Fading is visible at the paint surface. The faded part exhibits a stronger fluorescence in UV light.
1. Ground layer.

19. d
Cross-section (355/2) UV light 500x.

Fig. 20
20. a

20. b
Where the paint of the girls’ dress has been shielded by the frame the blue colour has been preserved.

20. c
Cross-section (70/4) of unfaded blue, normal light 200x.
3. 24μm Lead-white, indigo.
2. 4-40μm Irregular beige ground layer; lead-white, black pigment, red and brown earth pigments.
1. Incomplete Red ground layer; red earth.

20. d
Cross-section of faded blue (70/3) of the same brush-stroke, normal light 200x.
3. 20μm Lead-white and indigo, the layer has faded up to 10μm beneath the paint surface.
2. 50μm Beige ground layer; lead-white, black pigment, red and brown earth pigments.
1. Incomplete Red ground layer; red earth.

Fig. 21
21. a

21. b
Judith Leyster, *A game of tic-tac*. Detail of thin medium rich indigo layer over dark brown undercolour.

Fig. 22
22. a
Judith Leyster, *Merry couple*. Canvas 74.4 x 62.9 cm. Private Collection, The Netherlands.
22.b

Fig. 23
23.a
Jan Mienue Molenaar *The smell* (signed: IMR, the painting belongs to a series of five panels with the five senses, Inv. no. 572 is signed and dated: IMR1637). Oil on panel 19.5 x 24.3 cm. Royal Cabinet of Paintings Mauritshuis, The Hague. Inv. no. 575.
23.b
Detail of blue skirt.
23.c
Detail with un-faded blue that was shielded by the frame.

Fig. 24.a
Fig. 24.b
Pieter Fransz. de Grebber, *Triumphal procession with sacrificial bull*. Detail of blue flag.
Fig. 24.c
Cross-section (HTBS. 28. 17) of blue flag, normal light 200x.
3. 10-60 μm Light blue layer; indigo and lead-white. The layer has faded up to 5-20μm beneath the paint surface.
3. 15-30 μm Greysih blue layer; coarse white pigment, indigo, few brown and red particles.
2. 20-70 μm Beige ground layer; white pigment, transparent lumps (sand?), coarse brown ochre pigments, black pigment.
1. Incomplete Transparent (glue?) layer, exposing strong fluorescence in UV light.

Fig. 25
Frans Hals & Pieter Codde, *The company of Captain Reynier Rcaeland Lieutenant Cornelis Michiels Blauw* (*The meagre company*). Oil on canvas 207.3 x 427.5 cm. Rijksmuseum Amsterdam. Inv. no. C374. Detail with indigo sashes.

Fig. 26
26.a
Johanne ss Vermee r *Girl with a pearl earring*, (signed and dated) Oil on canvas 46.5 x 40 cm. Royal Cabinet of Paintings Mauritshuis, The Hague. Inv. no. 670.

26.b
Cross-section (1687/21) background, normal light 200x.
4 Varnish.
3. 20μm Translucent brownish green layer; indigo, yellow lake, chalk, lead-white, red and brown earth, little black pigment, weak fluorescence in UV, greyish yellow at the paint surface.
2. 10μm Black layer with bone black, possibly also charcoal black.
1. 100-200μm Ground; chalk, lead-white, little brown and red ochre, fine black pigment.

Fig. 27.
27.a
Pieter de Ring, *Still-life with golden goblet*. Oil on canvas 100 x 85 cm. Rijksmuseum, Amsterdam. Inv. no. A.335.

27.b
Cross-section (55/3) from highlight of blue tablecloth, normal light 400x.
5 Varnish.
4. 16μm Blue glaze of densely packed fine ultramarine, also silicates visible in UV light.
3. 36μm Ultramarine, coarse lead-white (particles measuring up to 30μm) and little indigo, more lead-white on top of the layer, pure lead-white paint of highlight applied wet in wet.
2. 10μm Indigo, lead-white.
1.80μm Ground layer; lead-white, red ochre, black pigment.
Cross-section (55/6) from shadow areas of blue tablecloth, normal light 400x.

6. Varnish
5. < 10µm Dark blue ultramarine glaze
4. 20µm Deep blue glaze of densely packed fine ultramarine, also silicates visible in UV light.
3. 10µm Ultramarine, indigo, lead-white.
2. 24µm Indigo, lead-white.
1. Incomplete Ground layer; lead-white, red ochre, black pigment.

Cross-section (55/6) UV light 400x.

Gerard van Honthorst, Portrait of Amalia van Solms and her daughters. Oil on canvas 383 x 205 cm. Oranjezaal, Koninklijk paleis Huis ten Bosch, The Hague. Inv. no. 31.

Detail of carpet with unfaded indigo paint that was shielded from light by the frame.

Original selvedge at the left indicating original colour of indigo paint.

Cross-section (31.ind.2) from unfaded blue, normal light 500x.

5. Varnish layer
4. 12-26µm Indigo and lead-white
3. 10µm Red glaze; red lake, some vermillion, glasslike particles (silicium, smalt?).
2. 10µm Vermilion
1. 70µm Ground layer with lead-white.

Cross-section (31.ind.4) from same brush stroke as (31.ind.2) faded blue, normal light 500x.

5. Varnish layer
4. 24µm Indigo, lead-white. The layer has faded up to 10-14µm beneath the paint surface.
3. 16µm Red glaze.
2. 20µm Vermilion
1. Incomplete Ground layer.

Cornelis Johnson, Portrait of a Dutch gentleman. Oil on canvas 92.5 x 73 cm. Dulwich Picture Gallery, London. Inv.no.1336.

Detail of background. Where protected by the frame, the blue colour has been preserved. As the picture has had two frames each covering the indigo paint to varying extent, today two strips of blue are visible in different intensity.

Cross-section from unfaded blue background from right edge under rebate of the frame, normal light, 500x.

4. 20µm Indigo, lead-white
3. Thin black layer, black pigments and ochre
2. Dark beige ground, lead-white, charcoal black, yellow ochre
1. Red ground, red and yellow earth pigments, lead-white, chalk.

Cross-section from faded area of blue background, normal light 500x.

4. 20µm Indigo, lead-white, almost the whole layer of 20µm has faded
3. Thin black layer, black pigments, ochre
2. Dark beige ground, lead-white, charcoal black, yellow ochre
1. Red ground, red and yellow earth pigments, lead-white, chalk.

Jan Steen, The sick woman. Oil on canvas 76 x 63.5 cm. Rijksmuseum Amsterdam. Inv. no. 230.
30.b
Detail during restoration of curtain of the box-bed.

30.c
Idem. Photo b and c: Conservation studio, Rijksmuseum Amsterdam.

30.d
Cross-section ([1745/4] from green curtain, oil immersion 200x.

2. 13μm
Indigo, little lead-white, chalk, one red particle, little charcoal black (of underdrawing?).

1. incomplete
Ground layer; chalk, umber, brown ochre.

Fig. 31
31.a
Peter Lely, *Elizabeth Murray, Duchess of Lauderdale* (c. 1648), Canvas 122 x 102. Victoria and Albert Museum, Ham House, Richmond. Detail of blue dress.

31.b

31.c
Cross-section (938/2) from highlight of indigo blue dress, normal light 200x.

5. 10μm
Varnish.

4. 20μm
Lead-white, indigo.

3. 55μm
Indigo, lead-white.

2. 30μm
Greyish brown ground; lead-white, charcoal black, yellow ochre.

1. Complete
Ground layer; chalk, yellow, brown ochre, black pigment.

Fig. 32
32.a.
Godfried Schalcken, *Self-Portrait*. Oil on canvas 61.3 x 49.8 cm. Fitzwilliam museum, Cambridge, Inv.no. 368.

32.b
Where the frame has protected the paint layer, the colour of the blue background is unchanged. As the picture has had two frames each covering the indigo paint to varying extent, today two strips of blue are visible in different intensity.

32.c
Cross-section (1216/3a) of faded paint area, normal light 200x.

This cross-section looks very similar to those taken from an unfaded paint area. Fading of indigo pigment may have taken place at the paint surface but chalking of the paint layer must account for most of the change in colour.

5. 20μm
Smalt, indigo, lead-white. In UV light is visible that the top paint layer is slightly lighter and more transparent, possibly due to fading of the indigo pigment.

4. c. 25μm
Smalt, indigo, lead-white.

3. 1 μm
Thin fluorescent layer of binding medium (only visible in UV).

2. 0-15μm
Smalt, indigo, lead-white.

1. Ground layer applied in various layer; lead-white, chalk, little umber.

32.d
Cross-section (1216/3a) UV light 200x.

Fig. 33

Fig. 34
Philip de la Champaigne, *La Vierge de douleur au pied de la croix*. Oil on canvas 178 x 125 cm. Musée du Louvre, Paris. Inv. no. 1129.

Fig. 35
Indigo cultivated at the English and French plantations in the West Indies. Hans Sloane, *Voyage to the islands Madera, Barbadoes, Nieves, Nieves, St. Christophers and Jamaica...* London (1707-25). The indigo plant at the left can be identified as the *I. suffruticosa* Mill. and the plant on the right as the *I. Glabra* L.

Fig. 36
Instructions for distinguishing indigo lumps of good quality and how to prepare them in order to make them permanent in oil in Wilhelm Beurs, *De groote warrelt in 't kloss Geschildert...*, Amsterdam 1692, p.16.
Fig. 37
Paint reconstructions of indigo pigment from *Indigofera tinctoria* (Kremer) extended with various quantities of lead-white (1:2, 1:4, 1:8, 1:16, 1:32, 1:64, 1:128).

Fig. 38

Fig. 39
Instructions on painting with indigo. André Félibien *Des principes de l'architecture, de la sculpture, de la peinture, et des autres arts qui en dépendent...* Paris 1676, p. 299.

Fig. 40
Paint reconstructions of natural indigo (Kremer) extended with lead-white (1:16) mixed with a variety of binding media. After light ageing no. 1 (see appendix).
40.a Purified linseed oil
40.b Glue
40.c Egg yolk

Fig. 41
Boiling of indigo oil paint in water secretes a brownish tincture.

Fig. 42
Ratio of indigorin and five other components in untreated and two types of boiled indigo using HPLC (254 nm).

Fig. 43
Paint reconstructions of indigo oil paint, used pure and extended with lead-white (1:16) after artificial light ageing (see appendix). In the samples the darker strip of blue visible has been protected from light. Especially after UV ageing there is a marked difference between synthetic indigo and natural indigo.
43.a Synthetic indigo, light ageing no. 1
43.b Natural indigo (Kremer), light ageing no. 1
43.c Synthetic indigo, light ageing no. 2
43.d Natural indigo (Kremer), light ageing no. 2
43.e Synthetic indigo, light ageing no. 2
43.f Natural indigo (Kremer), light ageing no. 2

Fig. 44
Instructions for depicting blue drapery and flowers with indigo in Wilhelm Beurs *De grote waereld in 't kleen geschildert...*, Amsterdam 1692, p. 40.

Fig. 45
45.a Abraham Bloemaert, *Adoration of The Magi*, canvas 168.5 x 193.5 cm. Centraal Museum, Utrecht. Inv. no. 2575.
45.b Detail of Mary's blue mantle during restoration. Today the ultramarine glaze is very worn due to abrasive cleaning methods in the past. Photo: Netherlands Institute for Cultural Heritage, Amsterdam.
45.c Cross-section (988/4) of greyish blue area of Mary's blue mantle, normal light 1000x.
5. Varnish.
4. 5-20µm Ultramarine and chalk.
3. c. 8µm Indigo and lead-white.
2. c. 50µm Ground layer; lead-white, little ochre and black pigment.
1. incomplete Ground layer; red earth.
45.d Cross-section (988/4) UV light 1000x.
Especially when examined in UV light it is evident that the ultramarine pigment contains high quantities of silicates.
Fig. 46
Laurent de la Hyre, Apparition de Jésus aux trois Marie. Oil on canvas 398 x 251 cm. Musée du Louvre. Inv.no. 5356.

Fig. 47
Nicolas Toussaint, Le Christ en croix, la Vierge, la Madeleine, saint Jean et saint Francais de Paule, Oil on canvas 422 x 292 cm. Musée du Louvre. Inv. no. 20007.

Fig. 48.
48.a
Bartolome d'Eyck (Master of the Annunciation of Aix), Mary Magdalen, reverse of the Isaiah (left wing of the altarpiece of the Annunciation). Fir panel 101.5 x 67.5 cm. Museum Boijmans Van Beuningen, Rotterdam. Inv. no. 2463.

48.b
Cross-section (1151) from red pattern painted on top of indigo blue background, normal light 200x.

5. Varnish.
4. 8μm Vermilion of red pattern.
3.15μm Indigo and lead-white.
2. 16μm Bone black with little lead-white.
1. Ground layer, gypsum.

Fig. 49
49.a
Jacob Jordens Triumph of Frederik Hendrik (signed and dated 1652). Oil on canvas 754 x 728 cm. Koninklijk Paleis Huis ten Bosch, The Hague. Inv. no. 32.

49.b
Detail of blue drapery. Photo: Lidwien Speleers.

Fig. 50

Fig. 51
Wybrand Hendriks after an anonymous master, Haarlem school, Officers and sergeant of the St.Adrian Civic Guard. Aquarel on paper 29.2 x 40.2 cm. Teylers Museum, Haarlem. Inv. no. W 46. Photo: Teylers Museum, Haarlem.

Fig. 52
Floor plan of the Oranjezaal Huis ten Bosch.
1. Pieter de Grebber, Triumphal procession (Fig. 24).
2. Gerard van Honthorst, Portrait of Amalia and her daughters (Fig. 28).
3. Jacob Jordens, Triumph (Fig. 49).

Fig. 53.
Van Somer’s advice to varnish indigo oil paint. London, British Library, MS Sloane 2052, f. 94r.