

Plate 1 Follower of Quinten Massys, *Saint Luke painting the Virgin and Child* (NG 3902), c.1525. Oak, 113.7 × 34.9 cm.



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Front cover: Jan Gossaert, *The Adoration of the Kings*
(detail of Plate 65)

A double-sided panel by Stephan Lochner

Stephan Lochner is generally regarded as one of the most important German painters of the fifteenth century. He was the town painter in Cologne, and his presence there is well documented. An altarpiece by a 'Maister Steffan' was seen by Dürer on a visit to the city in 1520. Since the nineteenth century this has been identified as the altarpiece of the *Adoration of the Kings*, formerly in the Town Hall and now in Cologne Cathedral, and its painter has been assumed to be the Stephan Lochner documented as working at Cologne from 1442 to his death in 1451. A ref-

erence to his parents at Meersburg underlies the supposition that Lochner was originally from the area around Lake Constance.¹ A substantial body of work has been attributed to Lochner, including paintings dated 1445 (*Presentation in the Temple*, Lisbon, Calouste Gulbenkian Museum) and 1447 (*Presentation in the Temple*, Darmstadt, Hessisches Landesmuseum).

Attention has been drawn more recently to the insubstantial nature of the connection between the painter Dürer mentions and the *Adoration of the Kings*;² furthermore, no connections have

Plate 21 (below) Stephan Lochner, *Saints Matthew, Catherine of Alexandria and John the Evangelist* (NG 705). Oak, 68.6 × 58.5 cm.

Plate 22 (right) Stephan Lochner, *Saints Mark, Barbara and Luke*. Oak, 100.5 × 58 cm. Cologne, Wallraf-Richartz-Museum.



been traced between either the documented Lochner and the Meersburg area, or between the work attributed to Lochner and that of painters in the Lake Constance area.³ There is clearly a consistent body of work which can be related to the *Adoration of the Kings*, and the connections with the work of other Cologne painters are strong, but this work cannot be linked to Lochner with certainty; for the purposes of this article, however, the name of Lochner will be used, bearing in mind this *caveat*.

The National Gallery panel (NG 705) is painted on both sides with three full-length figures of saints (Plates 21 and 23). On the gilded side are Saints Matthew, Catherine of Alexandria and John the Evangelist, and on the reverse, Saints Jerome, Cordula(?) and Gregory the Great with a donor. The painting was first associated with Lochner in 1854 and has since then been regarded as part of the main body of work attributed to him.⁴ The National Gallery painting has a companion picture in the Wallraf-Richartz-Museum in Cologne,⁵ in which the other two evangelists are shown, together with Saints Barbara, Ambrosius, Cecilia(?) and Augustine (Plates 22 and 24). In the early nineteenth century the two panels were in the collection of the Boisserée brothers of Cologne, who were notable for the interest they, and a few others elsewhere in Germany, were taking in the work of so-called German 'Primitive' painters. The National Gallery's picture was exchanged with a fellow collector, Count Joseph Rechberg, and after a period in the Oettingen-Wallenstein collection, it was acquired by Prince Albert and presented to the Gallery in his memory in 1862 by Queen Victoria.⁶

The panel has been trimmed top and bottom – the original unpainted edges have been retained only at the sides.⁷ The Cologne picture, originally a single panel painted on both sides like the London picture, was split into two separate panels at some time between 1826 and 1840. The original front side is taller than the Gallery panel and includes carved wooden tracery top and bottom. Although these are not integral parts of the panel and are attached by modern fixings, traces of what appear to be original gilding and paint remain.⁸

The form of the original ensemble is uncertain. The paintings were probably the wings of a

triptych, with the donors on the outsides, but it has been suggested that the central panel might have been a carved shrine rather than a painted scene. There is a small triptych in the Bode Museum in Berlin from the early fifteenth century which included a relic or other image in a central panel surrounded by saints.⁹ This triptych has a base of tracery similar to the pattern of the Cologne panel, as well as arched tracery above. However, the *Crucifixion with the Virgin, Saint John the Evangelist and Seven Apostles* attributed to the Master of Saint Veronica (Cologne, Wallraf-Richartz-Museum) also includes similar carved tracery, and since this frames a painting which is either a single or a central panel, the possibility that the Lochner panels might have been shutters closing over a painted centre panel cannot be excluded. Perhaps the closest parallel for shutters with three saints are those in Munich, usually taken to be the outer faces of the shutters of Lochner's *Last Judgement* now in Frankfurt.

The oak panel of the National Gallery painting is constructed from three vertical boards, the joins reinforced with dowels. Dendrochronological examination has been carried out by Peter Klein of Hamburg University on both the London and the Cologne panels. He found that the wood is oak from the Netherlands/West Germany region and that one board in the London panel is from the same tree as a board in the Cologne panel. The most recent heartwood ring found on the London panel was formed in 1402; on the Cologne panel, however, the latest ring was formed in 1431. Since they are certainly a pair, this later date was used as the starting point for estimating the actual felling date and date of creation of both panels, a calculation which involves assumptions about the number of growth rings and storage time of the wood. Peter Klein has estimated that the earliest possible creation date for the two panels is 1440, adding a minimum number of growth rings and storage time to the earliest possible felling date. Using a median number for these factors gives a probable creation date of 1448. Dendrochronology of the *Presentation in the Temple* (Darmstadt), a painting dated 1447, gave an earliest felling date of 1431 and a likely felling date of 1441, a result which gives some justification for dating the two wing panels in the late 1440s.¹



Plate 23 Stephan Lochner, *Saints Jerome, Cordula(?), Gregory the Great and a Donor* (back of NG 705). Oak, 68.6 × 59.9 cm.

The London painting has a white chalk ground bound with glue;¹¹ this is standard in Northern European painting of the fifteenth century. A canvas of relatively fine weave was laid over the front of the panel before applying the ground.¹² Although the back of the panel is also painted with figures of saints, it is not prepared in the same way: there is no canvas layer beneath the chalk ground. Also, on the back there is a thin, medium-rich layer between the ground and paint consisting of black pigment bound in a proteinaceous medium (Plate 34).¹³ This is likely to be a uniform toning applied across the whole of the surface of the ground, rather than an undermodelling, since it occurs in all cross-sections taken, even from the plain white background. A similar layer was observed on the back of the companion wing in Cologne.¹⁴

The compositions on both front and back of the panel have been drawn on to the chalk ground using a thin paint applied with a brush (Fig. 10). The drawing is freehand and rapid. The figures are outlined, often using broken



Plate 24 Stephan Lochner, *Saints Ambrosius, Cecilia(?) and Augustine and a Donor*. Oak, 86 × 57.5 cm. Cologne, Wallraf-Richartz-Museum.

rather than continuous lines. The drawing of the faces is schematic: eyes are indicated by circles and noses and mouths by dashes. The drapery is drawn with a complex system of hatching and cross-hatching. Areas of cast shadow are also indicated with hatching, superimposed on the drawing for the figures. Although less drawing is observed on the reverse as a result of the poor state of preservation of this side of the panel, the style of underdrawing is essentially similar; the same schematic depiction of features can be seen in the face of Saint Gregory (Fig. 11).

The systematic use of cross-hatched underdrawing observed here has been found to be characteristic of a group of Lochner paintings and has not been noted in earlier Cologne paintings examined by others, or in *Saint Veronica with the Sudarium* (NG 687), a Cologne painting of about 1420 in the National Gallery attributed to the Master of Saint Veronica. The *Last Judgement* and the *Martyrdoms of the Apostles*, which have usually been regarded as early works of c.1435, show extensive cross-hatching, while



Fig. 10 Infra-red reflectogram mosaic detail showing Saint John the Evangelist.



Fig. 11 Infra-red reflectogram mosaic showing a detail of Saint Gregory the Great on the reverse.

in the Darmstadt *Presentation*, dated 1447, the cross-hatching is slightly less extensive and looser in appearance, closer to that seen on the National Gallery panel.¹⁵

Very few alterations were found in the underdrawing of the Gallery panel. The features of the faces are not painted exactly where they are drawn, but this is perhaps a result of the schematic drawing style rather than a series of conscious changes. The exception to this is the donor figure on the back, which may have been drawn further to the right. The contours of the figures on the front were then marked with incised lines to indicate the limits of the gilding. These lines are freehand and not followed exactly. The haloes were marked out using a pair of compasses to incise the outlines: the central hole for each can be located in the X-radiograph. On the back, incised lines have been used to rule the grid of the floor tiles.

The gilded decoration is refined and skilful with intricate punched haloes, relief-patterned brocade in the background, and metal leaf depicting gold and silver objects such as Saint Catherine's crown and sword. This is a feature

of German panel paintings of this period and many fifteenth-century German contracts contain detailed and specific descriptions of how the gilded areas should appear in the finished altarpiece, mentioning in particular whether the metal leaf should be burnished or matt.¹⁶ Different gilding techniques are used in adjacent areas on the present panel to achieve a variation in appearance. No gilding remains on the reverse, although there are fragments of gold leaf beneath original paint at the edges of areas which would have been gilded, such as the haloes, the palm held by Saint Cordula, Saint Gregory's papal tiara and the border of his cope.

The unburnished gold background behind the saints is decorated with a brocade pattern created by carving short grooves into the ground before application of the gold leaf. There are scattered splinter-like particles of charcoal black on the ground beneath the gold leaf, visible under the microscope where the gold leaf is abraded, and in one area, coinciding with a line in the design, the charcoal particles clearly form a dot – evidence that the design was transferred by pouncing through a drawing (Plate 25).¹⁷ The main outlines of the pattern were reinforced with lightly incised lines. The same pattern is found on brocades in other fifteenth-century paintings from Cologne, notably on the back of the wings of the *Adoration of the Kings* in Cologne Cathedral.¹⁸ The design, although elaborate, is a very close match; it cannot have been copied so accurately freehand directly from the Cologne altarpiece, or any other painting.¹⁹ Presumably a common drawing or tracing was used which was available in the workshop, and also more widely, since the pattern is found on a panel attributed to the Master of the Heisterbach Altar and on a painting attributed to a Cologne Master of around 1460, a follower of Lochner. Although the pattern is the same, differing techniques have been used. The curtain in the *Annunciation* on the wings of the Cologne altarpiece is applied relief brocade (*preßbrokat*); the drawing of the design must, in this case, have been used to make a mould.²⁰

The gold leaf is adhered to the ground with a yellowish translucent layer; this is visible with the stereomicroscope in some areas where the gold is worn and in cross-section (Plate 26). This mordant layer is unpigmented. It is too thin to be analysed by methods which could identify its

components precisely, but staining tests on a sample indicate that it is not proteinaceous.²¹

The smaller areas of metal leaf decoration, using mordant, such as the silver blade of Saint Catherine's sword (which is relatively untarnished), the gold hilt and the pommel, were applied after the figures were painted. The mordant is the same as that used for the brocade background. In a sample from the silver sword a small amount of lead-tin yellow was found, perhaps an indication that the mordant is oil-based, since lead-containing pigments have siccative properties.²² Silver leaf was also used for the blades on the broken wheel. Saint Catherine's crown is unburnished mordant-gilding, modelled with black paint and decorated with red and green jewels. The area of the crown was first underpainted with a pale pink opaque layer consisting of lead white and vermilion (Plate 27). This is not an adhesive for the gold; the same unpigmented mordant used in other areas was applied on top. A pink underlayer was deliberately used here to distinguish the crown from the halo surrounding it, but there is a similar layer beneath certain areas of painting, specifically the blue wings of the angel beside Saint Matthew's feet and the eagle in the bottom right corner.

The gold leaf on the haloes of the saints, angel and eagle is applied on a thin and streaky layer of red earth, and so is the flat strip of gold at the top of the panel, which would originally have been beneath carved tracery. The gold was then burnished and the haloes decorated with fine punching. The red earth layer is so thin that it was not possible to confirm whether it contains the clay-like components of a true bole, although this is suggested by the fact that it is present as the adhesive layer specifically in the areas which are burnished.

The paint on both the front and reverse is bound with linseed oil. The oil is heat bodied in the upper layer of red lake in Saint Catherine's cloak, the red lake glaze on Saint Jerome's robe, the green of Saint Matthew's cloak, and the fragments of green foliage on the back of the panel, and contains a small addition of pine resin. Both heat pre-treatment of the oil and the incorporation of resin would increase the transparency of the paint. The resin in the green paints is not in the form of true 'copper resinates' but simply an addition to the medium.²³

Front of the painting: *Saints Matthew, Catherine of Alexandria and John the Evangelist*

Saint Matthew's cloak is a distinctive apple-green colour. It is painted with a mixture of verdigris (copper acetate), lead-tin yellow and a little lead white; in a cross-section from a shadow there are two green layers, the upper layer being darker in colour (Plate 28).²⁴ In addition to verdigris, there is some copper chloride; only a small amount is present and it seems likely that this is a result of the method of manufacture of verdigris rather than a deliberate addition.²⁵ The green drapery is peppered with brown spots, more numerous in areas of shadow (Plate 29). The cross-section of the green shows that these spots are pits in the paint film and that the brown colour is due to dirt which has collected in the hole. One possible explanation, supported by the angular shape of the brown spots, is that large pigment particles have become dislodged from the paint leaving a hole. The green drapery on the front of the Cologne panel shows the same phenomenon. The greyish purple of Saint Matthew's robe consists of azurite, red lake and lead white.

The deep red paint of Saint Catherine's cloak has a peculiar lumpy texture, a result of the large size of the red lake particles in the upper paint layer. They are visible in cross-section embedded in a turbid whitish matrix which gives the paint more opacity than would be expected in a layer containing principally red lake (Plate 26). The opaque red underpaint is a mixture of vermilion, black and red lake, with lead white in lighter areas. The red lake is on an alumina substrate, and this is standard, but the composition of the matrix is unusual. EDX analysis indicates that the matrix contains zinc, sulphur, potassium, iron and a little lead (from a few particles of lead white). Elemental mapping of the red lake layer in the scanning electron microscope indicates that the zinc is associated with the sulphur, perhaps in the form of zinc sulphate, and that this compound is finely divided and scattered throughout the matrix. The most plausible explanation for finding zinc in the sample is that it is a component of a substance added to the oil medium as a drier. The Strasburg Manuscript, a German treatise on painting probably written in the sixteenth century, recommends adding zinc

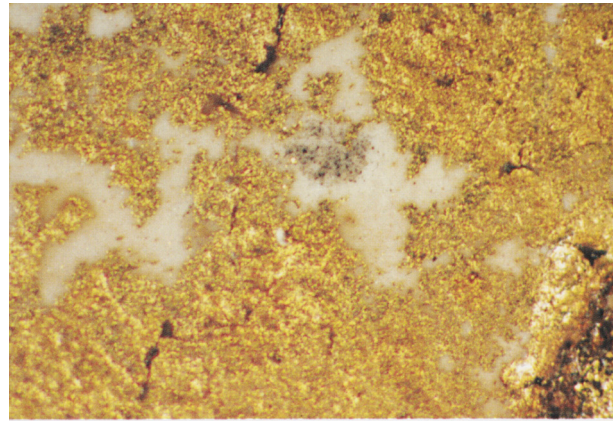


Plate 25 Photomicrograph of the gold background in *Saints Matthew, Catherine of Alexandria and John the Evangelist*. A charcoal 'dot' beneath the gold leaf is visible where the gold is worn.

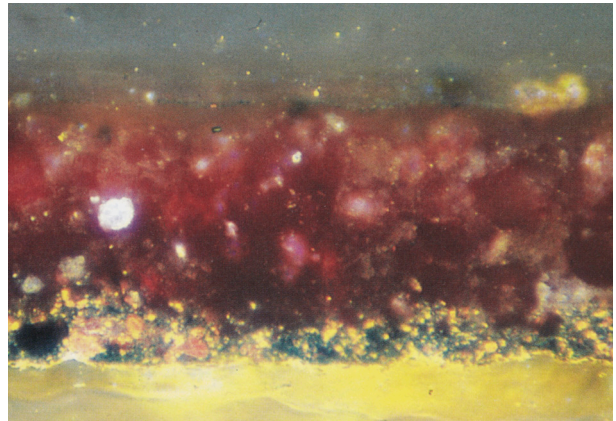


Plate 26 Cross-section of Saint Catherine's red drapery. A translucent yellow mordant and gold leaf are visible at the bottom of the cross-section since the sample is from the drapery where it overlaps the gold background. The red paint layer contains large particles of red lake in a whitish matrix, over a thin opaque layer of vermilion and black. The sample does not include the ground. Photographed at a magnification of 600 \times ; actual magnification 550 \times .

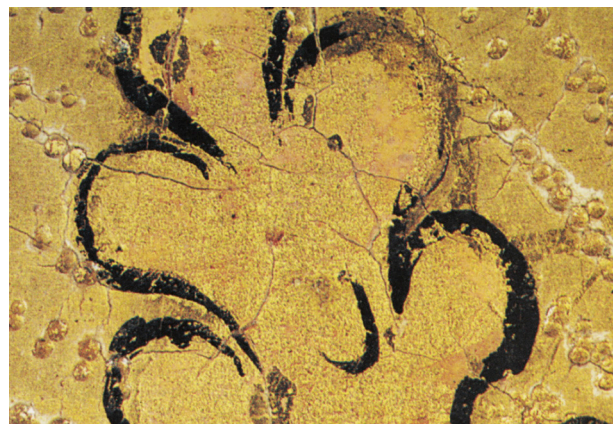


Plate 27 Photomicrograph of the top of Saint Catherine's crown showing a pink underlayer beneath mordant gilding.

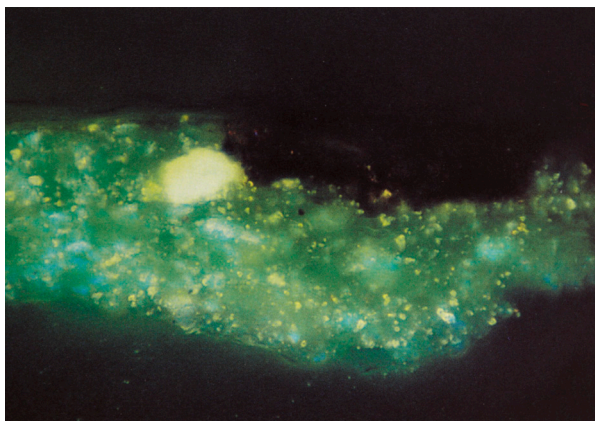


Plate 28 Cross-section of Saint Matthew's green drapery. The sample does not include the ground layer. The two green paint layers contain verdigris, lead-tin yellow and small amounts of lead white and copper chloride. A brown pit is visible in the uppermost layer. Photographed at a magnification of 480 \times ; actual magnification 440 \times .



Plate 29 Photomicrograph of Saint Matthew's green drapery. Brown pits are visible in the surface of the paint.

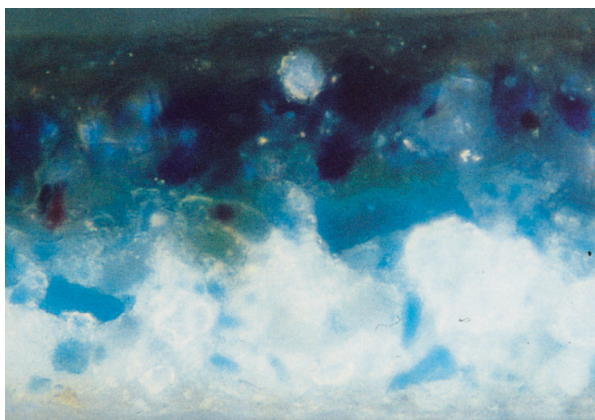


Plate 30 Cross-section of Saint Catherine's blue drapery. The upper blue layer consists of ultramarine and a small amount of lead white. The lighter blue underpaint is a mixture of azurite and lead white. No ground is present in this sample. Photographed at a magnification of 750 \times ; actual magnification 690 \times .

vitriol (zinc sulphate) to oil as a drier, but there are no other reports, so far, of it having been identified in paintings by technical analysis.²⁶ In fact, the zinc(II) ion has only mild siccative properties; copper, lead, manganese and iron are more effective driers, and even if zinc vitriol was used in the belief that it accelerated the drying of oils, it was probably impurities in it such as iron and manganese which actually had this effect.

The green lining lies on the red underpaint of the outside of Saint Catherine's cloak. It is darker in colour than Saint Matthew's cloak, but consists of a similar mixture of pigments and is pitted in the same way. Her bright blue dress has a greenish-blue underpaint of azurite mixed with lead white. The upper layer contains ultramarine, also mixed with lead white (Plate 30). It is uneven and lumpy and was clearly difficult to apply; the ultramarine is of large particle size, and would give the paint poor handling properties.²⁷

Saint John wears a white robe with purple shadows painted in azurite and red lake, applied with feathered hatched strokes. The red lining of his cloak is of a different hue to the red worn by Saint Catherine since there is no vermilion-containing underlayer; as with Saint Catherine, the lining is painted over the outside of the cloak, in this case white. It consists of a single layer of red lake and lead white and has the same appearance in cross-section as the red glazes in Saint Catherine's cloak. EDX analysis again revealed a zinc content, not present in samples from other colours, indicating that it is contained specifically in the red lake glazes. This is consistent with the proposal that it is present as a component of a siccative since red lake-containing oil paint is a poor drier.

The flesh tones consist of lead white tinted with small amounts of vermilion, red lake, yellow earth, azurite and lead-tin yellow, with black added in the shadows. The flesh-coloured paint is modelled only to a limited extent; instead, the features are drawn on, using opaque brick-red paint, and almost pure white highlights were then added. This technique is well illustrated in a detail of the face of the angel (Plate 31). The eyes have very large irises and round pupils which are not cut by the eyelids. The whites are achieved by allowing the basic flesh tone to show, with a single stroke of pure white paint

applied to each eye as a catchlight. The same brick-red paint outlines the hands and feet (Plate 32).

The blue wings, stole and bands across the robe of the small angel at Saint Matthew's feet are painted in ultramarine. It is noted above that the wings have a pale pink underpaint, left exposed in places as a mid-tone, while the highlights are small strokes of lead-tin yellow. The angel's white dress has purplish shadows consisting of azurite mixed with red lake. In the yellow-brown foreground yellow particles, large enough to be seen without magnification, give the paint a gritty texture (Plate 33). These are lumps of poorly dispersed yellow earth pigment.²⁸

Reverse of the painting: *Saints Jerome, Cordula(?), Gregory the Great and a Donor*

The paint on the back is very damaged, with large areas missing, exposing the wood of the panel. The most complete figure is that of the female saint (Saint Cordula?), while only the heads and shoulders of Saints Jerome and Gregory survive. The head of a donor figure is also preserved. Along the bottom edge of the panel are traces of paint which form a narrow dark red strip above which is a pale pink band about 16 mm wide with an underdrawn line marking its boundary with the tiled floor. At the extreme left edge some grey paint remains. There also seems to have been a strip of paint, pinkish in colour, from the level of Saint Jerome's shoulder to below where his feet should be. The saints are standing on a tiled floor, against a white background with two grey pillars behind them. The left pillar is considerably broader than the right. The X-radiograph shows that they are both square (rather than rounded) in section and intended to be stone (mortar courses show clearly). To either side of the right-hand pillar there are small areas of green which appear to be remains of foliage, and further traces of green paint were found near the left edge about half way down the figure of Jerome. By comparison with the Cologne wing, which presents a more complete image, although heavily restored,²⁹ it would seem that the three saints and the kneeling donor were in an architectural setting with a



Plate 31 Photomicrograph of the face of the angel beside Saint Matthew.

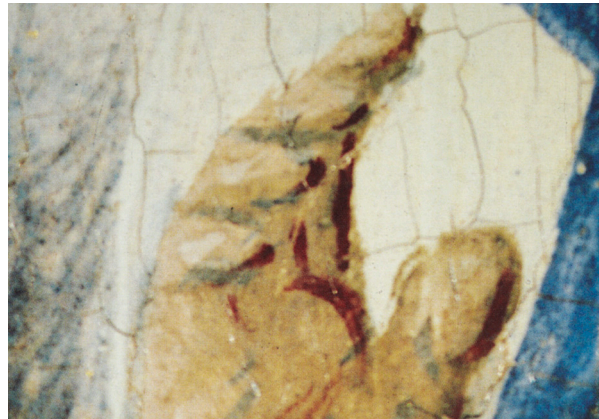


Plate 32 Photomicrograph of the hand of the angel beside Saint Matthew.

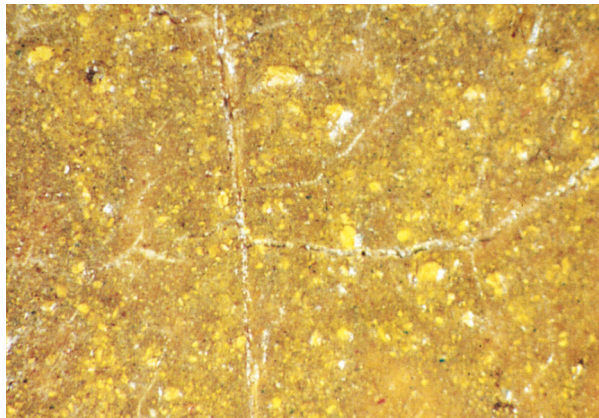


Plate 33 Photomicrograph of the brown foreground in *Saints Matthew, Catherine of Alexandria and John the Evangelist*. Large lumps of yellow pigment are visible.

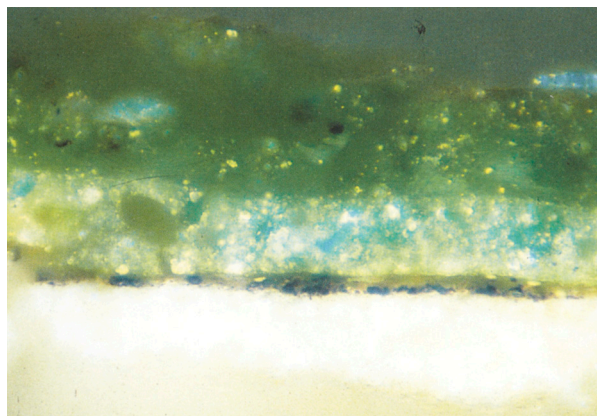


Plate 34 Cross-section of Saint Cordula's green drapery. The white chalk ground is covered by a thin medium-rich layer containing some black pigment. The two green paint layers are mixtures of verdigris, yellow earth, lead-tin yellow and lead white. Some blue-green particles of copper chloride are visible. Photographed at a magnification of 540×; actual magnification 495×.

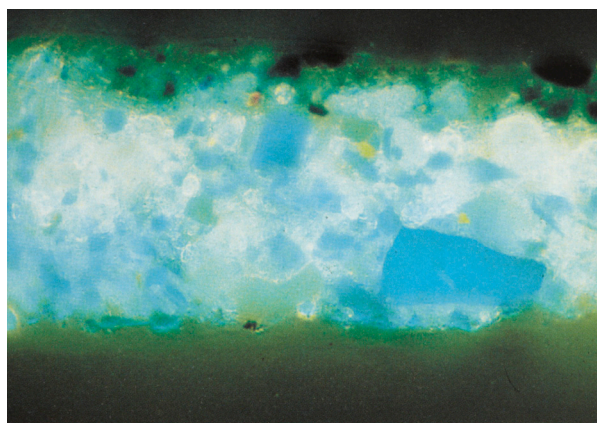


Plate 35 Cross-section of an area of shadow in Saint Gregory's blue drapery. A thin dark blue paint layer (lead white and indigo) lies over a lighter blue containing azurite and lead white. The sample does not include the ground. Photographed at a magnification of 1000×; actual magnification 550×.



Plate 36 Detail of Saint Gregory's head.

low wall behind them, over which can be seen some plants. The red and pink area at the bottom of the panel could be the remains of a plinth to match that on which the inscription is painted in the Cologne wing. The left edge may have been painted with a pink column inside a grey border to match the right edge of the Cologne picture.

The technique and materials of the remaining fragments of paint on the back of the panel show many similarities to the front. The paint of Saint Jerome's pinkish-red cloak has a similar texture to Saint Catherine's cloak, and contains large red lake particles in the upper layer. Again, in addition to aluminium from the substrate of the lake pigment, EDX analysis detected a small amount of zinc, together with a little iron and potassium. There is an opaque underlayer of lead white, red lake and some vermilion. HPLC analysis of the dyestuff in the red lake pigment indicated that it was extracted from the kermes insect.³⁰

Saint Cordula's dress has a more orange-red hue achieved by choosing an orange-red pigment, red lead (lead tetroxide), for the highlights of the drapery, rather than by combining red and yellow. The dress is underpainted with vermilion, and red lake glazes indicate the shadows. The lining of her cloak is more purple in colour; it is painted over the green of the cloak, in the same way as the linings of the cloaks on the front of the panel. The paint contains red lake and lead white mixed with azurite in lighter areas and the blue dyestuff indigo in shadows. As in other areas of red lake-containing paint, small but significant amounts of zinc were detected. The donor's purple robe was not sampled, but appears, from the surface, to be a similar mixture.

Cordula's green cloak has an opaque underlayer consisting of lead white, verdigris and yellow earth. Interestingly, the trace elements in the yellow earth are similar to those in the agglomerations of yellow earth noted in the foreground on the front of the panel, and are presumably related to the source of the pigment.³¹ The verdigris contains a small proportion of copper chloride,³² visible as more opaque and blue-green particles in a cross-section (Plate 34), pointing to another similarity in materials on the front and back. Unlike the front, the shadows of the cloak are modelled using thick green glazes, with black

added in the darkest areas, and there are no brown pits in the paint.

Saint Gregory's cope has a dull blue colour in sharp contrast to Saint Catherine's dress. A cross-section from an area of shadow (Plate 35) shows a light blue underlayer containing azurite and lead white covered by a darker greyish-blue layer of indigo and lead white.³³ The yellow patterns at his collar are lead-tin yellow.

In the flesh paint, lead white is tinted with a slightly different combination of pigments to that in the paint on the front of the panel. Saint Gregory's flesh contains small amounts of yellow, vermilion, red earth, black and azurite; Saint Cordula's rather pale face contains some vermilion and red lead, but only in small quantities. The features are drawn in the same way as on the front of the panel, however, with a dull brick-red paint consisting of red earth (Plate 36).

The white background behind the saints is unusual; the presence of small areas of foliage imply that there should be blue sky behind the saints, but a sample consisted of lead white alone. The floor tiles are pink and olive green: the pink (lead white and red earth) was painted first and a green glaze superimposed on alternate tiles. The green glaze contains verdigris mixed with some bone black; the rather brown hue is clearly intentional.

The technique of this painting by Lochner is firmly that of an artist living and working in Cologne, in spite of his possible origins in Southern Germany. Connections with Netherlandish painting have also been proposed, but in technique Lochner's paintings have more in common with earlier Cologne painters such as the Master of Saint Veronica and the Master of Saint Lawrence. The use of canvas beneath the ground and the extensive gilding in a variety of techniques are drawn from an earlier tradition. It is often quite clear why a particular method of gilding was chosen: burnished areas are water-gilded, relief patterns and small areas of decoration are mordant-gilded.

In their approach to the painting of faces earlier Cologne painters followed a method which had been in use for many decades, and which in the second half of the fifteenth century still appears to have been customary in nearby Westphalia, for example. This method involved

little modelling of the flesh, which appeared largely flat, and features such as the eyes were painted in an unvarying and formulaic manner employing black, white and dark red. The technique of painting the flesh in the National Gallery panel, using brick-red lines to delineate features, is a development of this systematic approach. A painting which called for a great many naked figures, the *Last Judgement* in Cologne (Wallraf-Richartz-Museum), shows the high degree of sophistication of which Lochner was capable. In that picture he uses a range of tones to suggest the three-dimensional qualities of human bodies, and white highlighting and a greyish shadowing method are prominent in modelling muscles and rounded limbs, rather than the earlier linear approach which made greater use of painted outlines.

Lochner's interest in colour is evident in his shutters of the *Martyrdoms of the Apostles* in Frankfurt, each made up of a number of small scenes. In these paintings, Lochner is extraordinarily inventive in the range of blues and reds he uses, and in the ways that he sets one colour against another. It has recently been observed that the underdrawing includes a great many colour notes,³⁴ in which the various hues of blue and red are distinguished by different signs, an indication of sophisticated planning of the colour relationships in this complex and ambitious work. Even in the simpler compositions of the London and Cologne panels, a particular concern for varying and balancing colours is evident. These variations in hue rely on the widest choice of available pigments, such as the use of red lead as well as vermilion and red lake, and the use of indigo as well as azurite and ultramarine. Where orange-red was required for the highlights on Saint Cordula's dress, the paint contains the orange-red pigment red lead. For the same reason, the deep blue pigment indigo was chosen for the dark blue shadows of Saint Gregory's cope, applied on a mid-tone underpaint of azurite. When a particular hue is repeated on the panels, the same pigment has been chosen: for example indigo was also found in the dull blue of Augustine's vestments on the reverse of the Cologne panel.³⁵

Cologne painting of the early fifteenth century is notable for its use of clear and bright colours; in this respect Lochner develops from an estab-

lished tradition. The choice of colours and juxtaposition of hues in his paintings are particularly imaginative; his skill in placing and contrasting such colours at key points within the compositions testifies to his outstanding abilities as a painter.

Notes and references

1. For Lochner's biography with references see M. Levey, *The German School*, National Gallery Catalogues, London 1959, pp. 59–60.
2. M. Wolfson, 'Hat Dürer das "Dombild" gesehen? Ein Beitrag zur Lochner-Forschung', in *Zeitschrift für Kunstgeschichte*, 49, 1986, pp. 229–35.
3. See F.G. Zehnder, *Stefan Lochner Meister zu Köln*, Wallraf-Richartz-Museum, Cologne 1993. In this publication, documents relating to Lochner are discussed in S.R. Fischer, 'Die Familie Lochner und der Bodenseeraum', pp. 5–8, and B. Konrad, 'Seeschwäbische Malerei von 1400 bis 1450 und ihre Beziehungen zu Köln', pp. 31–4.
4. See Levey, cited in note 1.
5. *Die Heiligen Markus, Barbara und Lukas* (WRM 68) and *Die Heiligen Ambrosius, Cäcilia(?) und Augustinus* (WRM 69). For a full discussion see F.G. Zehnder, *Altkölner Malerei*, Kataloge des Wallraf-Richartz-Museums XI, Cologne 1990, pp. 234–39. Also Zehnder, cited in note 3, p. 320, where both the Cologne panel and the National Gallery panel are discussed.
6. See Levey, cited in note 1, pp. 61–2.
7. The National Gallery panel measures 68.6(left)-68.4(right) x 59.6(top)-59.9 cm (bottom). The painted surface (front) measures 68.6(left)-68.4(right) x 58.5 cm.
8. The original front of the Cologne painting measures 100.5 x 58 cm, see Zehnder, cited in note 3, p. 320. See also C. Steinbüchel, 'Restaurierung eines Altarflügel von Stefan Lochner', in *Kölner Museums-Bulletin*, 1/1994, pp. 18–27, for information about the size and conservation history of the panels in Cologne. The authors are most grateful to Dr F.G. Zehnder and Mrs C. Steinbüchel for allowing them to examine the painting under the stereomicroscope in the Wallraf-Richartz-Museum conservation studio. Traces of red, blue and gold remain on the tracery. The blue pigment appears to be azurite suggesting that the tracery might be original and is certainly old. Information on the materials and layer structure of the paint on the Cologne panels can also be found in an appendix in Zehnder, cited in note 4, H. Kühn, 'Pigmentanalysen', pp. 610–12. The technique is also discussed, together with other paintings by Lochner, in H. Kühn, 'Technischer Bildaufbau und Farbmaterial im Werk Stefan Lochners', in Zehnder, cited in note 5, pp. 181–6, and in the context of fifteenth-century Cologne painting in H. Kühn, 'Malmaterial und Technischer Aufbau Alt Kölner Malerei', *Wallraf-Richartz-Jahrbuch*, LI, 1990, pp. 69–97.
9. Berlin, Bode Museum Inv 1627a. See R. Budde, *Köln und seine Maler 1300–1500*, Cologne 1986, No. 33, p. 214.
10. A report from Peter Klein dated 18 April 1995 is in the National Gallery files. The results of dendrochronology on paintings by Lochner are reported and the likely felling dates are discussed in detail in P. Klein, 'Dendrochronologische Untersuchungen an Gemäldetafeln von Stefan Lochner und Nachfolge' in Zehnder, cited in note 3, pp. 187–90.
11. Chalk ground (CaCO₃) identified by EDX.
12. The canvas has a thread count of 18 threads per cm. See pp. 21–4 in the general section in this *Bulletin* for a discussion of the preparation of panels in Early German paintings.
13. A cross-section from the reverse was stained with Amido Black 10B, a specific stain for proteins. The thin medium-rich layer on the ground containing some black pigment stained strongly indicating that the medium is proteinaceous. The layer was too thin to carry out analysis using a more specific method.
14. H. Kühn in Zehnder, cited in note 3, pp. 181–6. Kühn mentions that this type of layer is not found on other Cologne paintings.
15. Reflectograms of the National Gallery painting are reproduced and discussed in M. Faries, 'Stefan Lochners Unterzeichnungen: Erste Einsichten' in Zehnder, cited in note 3, pp. 169–80. The present discussion also includes the authors' observations. Reflectograms of the Frankfurt panels are reproduced in B. Brinkmann, 'Stefan Lochners Apostelmartyrien: Erste Ergebnisse', *Stefan Lochner*, symposium papers, forthcoming; the authors are grateful to Dr Brinkmann for making the text of this paper available and for discussing the reflectograms of the Frankfurt panels. The underdrawing in the altarpiece of the *Adoration of the Kings*, now in Cologne Cathedral, is discussed in W. Hansmann, 'Beobachtungen zum frühen Arbeits-stadium am Altar der Stadtpatrone von Stefan Lochner im Kölner Dom', *Zeitschrift für Kunsttechnologie und Konservierung*, Jahrgang 2/1988, Heft 1, pp. 96–106.
16. H. Huth, *Künstler und Werkstatt der Spätgotik*, Augsburg 1923 (4th edn Darmstadt 1981), pp. 110–12. A contract of 1453 for an altarpiece in a church in Innsbruck is published here. The contract states that burnished, not matt, gold is to be used for the background.
17. Black particles were also observed between the ground and gold leaf in the brocade background of the Cologne panel. See H. Kühn in Zehnder, cited in note 3.
18. The repetition of the pattern on a panel depicting the *Death of the Virgin* attributed to the Master of

- the Heisterbach Altar (Bayerische Staatsgemäldesammlungen, Bamberg), on the National Gallery and Cologne panels, the altar of the *Adoration of the Kings* in Cologne Cathedral and a painting attributed to a Cologne Master of around 1460 (WRM 85) is discussed in D. Levine, 'Stefan Lochner und Preßbrokat', Zehnder, cited in note 3, p. 144. It is not unusual to find the same pattern on paintings which are probably not from the same workshop, or not of similar date; see M. Roth and H. Westhoff, 'Beobachtungen zu Malerei und Fassung des Blaubeurer Hochaltars', *Flügelaltäre des Späten Mittelalters, Staatliche Museen Zu Berlin*, pp. 167–89. In this article a group of paintings from South Germany with identical brocade patterns, both applied relief brocade and painted brocade, is discussed.
19. The patterns were traced from a photograph of the National Gallery painting and a detail of the back of the wing of the altar of the *Adoration of the Kings* in Cologne Cathedral which is reproduced in C. Schulze-Senger, 'Der Altar der Stadtpatrone in der Hohen Domkirche zu Köln', *Zeitschrift für Kunsttechnologie und Konservierung*, Jahrgang 2/1988, Heft 1, pp. 87–95. The tracings, when overlaid, match exactly. The size of the pattern, estimated by scaling measurements from the reproductions, appears to be of the same order of magnitude. Levine reached similar conclusions, discussed in Levine, cited in note 18.
 20. A description of the manufacture of applied relief brocade can be found in B. Hecht, 'Betrachtungen über Pressbrokate, Rekonstruktionversuche unter besondere Berücksichtigung des sog. Tegernseer Manuskript', *Maltechnik/Restauro* 86 (1), 1980, pp. 22–49. See also the general section of this *Bulletin*, p. 33.
 21. A cross-section from Saint Catherine's crown was stained with Amido Black 10B, a specific stain for protein. There was no staining of the mordant layer, therefore a proteinaceous mordant can be ruled out.
 22. Lead-tin yellow was identified in the mordant layer by EDX analysis on a cross-section.
 23. The results of medium analysis are reported in the general section in this *Bulletin*, pp. 53–5.
 24. Lead-tin yellow 'type I' was identified by X-ray diffraction, in agreement with JCPDS file no.24–589. It has the composition Pb_2SnO_4 and is tetragonal in structure.
 25. Mapping of a cross-section by SEM–EDX indicated that some of the green pigment particles contain chlorine, and are therefore probably copper chloride. The low proportion seems to indicate that it is not a copper chloride pigment such as atacamite or calumetite deliberately added. It is more likely to be a secondary product resulting from the use of a traditional method of manufacture of verdigris, where copper plates coated in honey and common salt (sodium chloride) are exposed to acetic acid vapour. See, for example, recipe no.85, 'to make verdigris', in Mrs Merrifield's translation of the Bolognese MS, in *Original Treatises on the Arts of Painting*, Vol. II, 1849, p. 418. See also H. Kühn, 'Malmaterial und Technischer Aufbau Altkölnner Malerei', *Wallraf-Richartz-Jahrbuch*, LI, 1990, pp. 69–97, occurrences of copper chloride-containing verdigris in other early Cologne paintings are given here. Kühn also discusses similar recipes given in medieval treatises which could result in a small copper chloride content, see pp. 85–6.
 26. *The Strasburg Manuscript: a Medieval Painters' Handbook*, trans. V. and R. Borradaile, London 1966, pp. 54–5. (or E. Berger, *Quellen und Technik der Fresko-, Oel- und Tempera-Malerei des Mittelalters*, Munich 1897, pp. 169–70, para. 69–71.)
 27. See the section on Rogier van der Weyden in this *Bulletin*, p. 78, where the working properties of ultramarine-containing paint are discussed. The ultramarine particles in a sample from Saint Catherine's dress, measured under an optical microscope with a graticule eyepiece, were between 15 and 20 microns in size.
 28. EDX analysis on a large yellow particle indicated that it contains Fe (that is, probably iron oxide), Si, Al, Ti, some K, all elements associated with earth pigments. The Ti content is relatively high; it is usually found only in trace amounts.
 29. C. Steinbüchel, cited in note 8, pp. 18–27. The restoration of the original back of the wing is discussed and the painting is reproduced before retouching, indicating its actual state.
 30. The red lake in a sample from Saint Jerome's robe was analysed by HPLC. The result is reported in J. Kirby and R. White, 'The Identification of Red Lake Pigment Dyestuffs and a Discussion of their Use', *National Gallery Technical Bulletin*, 17, 1996, p. 72.
 31. Elements detected in the yellow earth pigment by EDX analysis were Fe, Si, Al, Ti and K. Again the titanium content was unusually high.
 32. Chlorine was detected in the copper-containing green pigment by EDX analysis. This indicates that, in addition to verdigris, the paint contains some copper chloride, probably a result of the method of manufacture, see note 25.
 33. The blue dyestuff indigo was identified by FTIR microscopy. It is used in Saint Gregory's cope to shadow the drapery, as described in *The Strasburg Manuscript*, cited in note 26, p. 57: 'Take light blue and mix with it a little lead white and shade on it with indigo...'
 34. B. Brinkmann, cited in note 15.
 35. Kühn, cited in note 8.