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NEW PERSPECTIVES ON FLEMISH ILLUMINATION

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Black as Ink. Materials and Techniques in Fifteenth-Century Flemish Grisaille Illuminations by Jan de Tavernier, Willem Vrelant and Dreux Jehan

Lieve Watteeuw and Marina Van Bos

ABSTRACT: The grisaille illuminations examined for this study were all created between 1458 and c. 1480, in the geographical area around Brussels, Bruges, Ghent, Lille and Valenciennes, towns under Burgundian rule. They are observed, compared and analysed with non-destructive XRF equipment. In part I of the essay we compare the results of the technical and laboratory investigations of miniatures by Jan de Tavernier and his associates, created c. 1458–1460; followed in part II by data from grisaille miniatures attributed to two illuminators who also worked for Philip the Good: Willem Vrelant and the Master of the Girart de Roussillon (Dreux Jehan). These findings are compared in part III to those from miniatures by two lesser illuminators painting in grisaille: the Master of the Golden Fleece of Vienna and Copenhagen and the Master of the Grisailles Fleurdelisées. The study reveals that the palette of the ‘grisaille illuminators’ was almost as varied as that of the illuminators in color. They achieved their range of tones from their range of pigments and inks and by mixing pigments with inks with great subtlety. Jan de Tavernier (in volume I of the *Croniques and the Conquestes the Charlemagne*) and the Master of the Grisailles Fleurdelisées employed the same type of iron-gall ink containing iron, copper and zinc as the scribes of their respective manuscripts. Dreux Jehan also created his figures with iron gall inks. But some illuminators preferred to work in other materials: they painted the outlines of the

figures and architecture in carbon black ink, as found in the miniatures by the assistants of Jan de Tavernier, by Willem Vrelant and by Vrelant’s follower, the Master of the *Vraie Cronicque d’Escosse*. To enrich the grey shades in the washes, the illuminators added colored materials like vermilion, minium or organic components. In all the illuminations, the subtle differences between shades of black were obtained by using different iron gall inks sometimes alone or in combination with carbon based inks or lead white.

Introduction

Grisaille comes from the Old French word *gris*, which is probably derived from the Frankish word *gris* and is related to the Old High German word *greis*.¹ By the middle of the fifteenth century the color grey had become almost as highly esteemed as the color black. The impact of grey on princely dress codes, panel painting and book illumination greatly increased.² Although fifteenth-century grisailles on panel and on parchment have been studied *in extenso* during the last few decades, there has not been an in-depth laboratory study on the use of materials in grisaille illuminations.³ Recent evolutions in analytical equipment allow observation and non-destructive analysis of the materials used in illuminated manuscripts.⁴ The components

Willem Vrelant, *Shipyards*, Bruges, before 1468.
Brussels, Royal Library of Belgium (ms. 10777),
Leonardo Bruni, *Première Guerre Punique* (French translation by Jean Lebègue), fol. 37v.

of the illuminator's brushstrokes, carefully applied with a fine hair brush, can be observed with the binocular microscope and determined with the XRF ArtTax module.⁵ Non-destructive pigment identification sheds light on the illuminator's palette. Bringing these findings together with the stylistic and historical evidence creates a new understanding of the workshop practice of illuminators.

Grisaille was evidently an inexpensive form of painting, as lead white or ceruse (*cerosa*, *cerussa*), chalk, lime white, carbon black and iron gall ink could very easily be purchased or prepared. The illuminator did not have to acquire any rare and so costly materials.⁶ But *less is more*, and the restriction to white, grey and black meant that this highly fashionable style focused attention on the illuminators' outstanding artistic skills.



III. 15.1 Jan de Tavernier, *Court and Market*, c. 1458. Brussels, Royal Library of Belgium (ms. 9066), *Conquestes et croniques de Charlemaine*, fol. 11r.

The grisailles examined for this study were all created between 1458 and ca 1480, in the geographical area around Brussels, Bruges, Ghent, Lille and Valenciennes, towns under Burgundian rule. In part I of the essay we compare the results of the technical and laboratory investigations of miniatures by Jan de Tavernier and his associates, created c. 1458–1460 (ill. 15.1); followed in part II by data from grisaille miniatures attributed to two illuminators who also worked for Philip the Good: Willem Vrelant and the Master of the Girart de Roussillon (Dreux Jehan). These findings are compared in part III to those from miniatures by two lesser illuminators painting in grisaille: the Master of the Golden Fleece of Vienna and Copenhagen and the Master of the Grisailles Fleurdelisées.

The main aim of this study is to identify the materials and techniques used by the grisaille illuminators and to discover whether there is a shared and continuing tradition in the methods of a group of 'Flemish' illuminators.⁷ We are very grateful to the curator and staff for their assistance.⁸

Methodology for assessing grisaille materials and techniques *in situ*

The methodology to determine the grisaille and semi-grisaille materials and techniques of six Flemish illuminators' workshops is founded on empirical data established by three processes: the first is a conservation-examination of the physical and material characteristics of the illumination both with the naked eye and through microscopic observations under low and high magnification;⁹ the second is technical imaging with the use of macrographs, high resolution digital images, with natural, ambient, raking and transmitted light;¹⁰ the third is non-destructive XRF-analysis for inorganic materials to provide elemental analytical data.¹¹ The examination and technical imaging stages of the research guided the selection of the measuring spots for the non-destructive XRF analyses. When reference is made to an XRF measurement, the data are mentioned by folio in the table at the end of the essay.

Components of iron gall and carbon inks used in grisaille illuminations

The key components of materials for grisailles are a range of black inks, applied with a brush like paint. Inks were used to write the text on the parchment (with a quill), to delineate the contours of the figures (with a brush) and, with the addition of more medium, as a 'wash' in different shades. XRF analysis reveals the elements iron, copper, zinc, lead, which all create 'non-colors': black and different monochrome tints of grey.¹² To define the subtle differences in composition of the inks and the ink based washes, clusters of measuring spots were analyzed to reveal the combinations of ink components.

The major source for the black color in grisaille illumination is iron gall ink.¹³ It is made from tannins, vitriol, gum arabic and water. The color varies from black to a very dark brown for the text,¹⁴ with different hues of grey for the washes. Based on the composition of the inks in the manuscripts investigated with XRF, three types of iron gall ink were distinguished: Type I, ink with iron and copper (Fe/Cu); Type II, ink which contains not only copper and iron but also zinc (Cu/Fe/Zn) and Type III which contains only iron (Fe).¹⁵ In what follows, the type of iron gall ink that has been detected will be referred to between brackets.

Carbon black is the second basic black in illuminations. Carbon black ink is made of lampblack or by burning resinous woods or bones, powdering them and mixing the material with water-soluble natural polymers such as gum or gelatin (vine black, ivory black, lamp black, known in Latin as *atramentum*). The color is cool black to dark grey. It can be used with fine brushes to create and detail figures.¹⁶ With the addition of more medium, carbon black can be used to 'wash' subsequent grey layers on the parchment; applied in washes it appears fine and even in tone.¹⁷ Carbon ink is chemically inert and is more stable than iron-gall ink. It is important to note that carbon cannot be detected with XRF, so that the apparent absence of a mineral in a dark black spot undoubtedly indi-

cates the use of carbon black. The use of carbon based ink for writing is very unusual in the fifteenth century, but carbon black drawing inks and carbon black in oil are commonly used materials in fifteenth century panel paintings.

In the studied grisaille illuminations, only lead white and probably egg-shell white and lime white were found as white pigments to prepare the parchment and, for lead white, to highlight details.¹⁸ For some artists, the color of the parchment, often enhanced by the preparation, plays an important role in the pictorial composition when left unpainted to act as a form of white.

PART I

Materials in grisailles painted by Jan de Tavernier in the *Conquestes et croniques de Charlemaine*

Detailed examination of the materials and the techniques used for the grisaille miniatures in the famous *Conquestes et croniques de Charlemaine*, a manuscript originally in two volumes, illuminated around 1458, reveals how Jan de Tavernier (Oudenaarde, d. after 1460) and his workshop used a limited range of materials and colors (KBR, ms. 9066, 9067 and 9068; ill. 15.2).¹⁹ The accounts of the Burgundian dukes of March 29 1460 reveal the high payments for these *ymaiges de blanc et de noir*, more than 300 small and half page miniatures for the two volumes of the *Croniques*.²⁰ Examination of three grisaille miniatures, KBR, ms. 9066, fol. 111r and KBR, ms. 9067, fol. 141r and fol. 198, produced measurements revealing distinct sources for the essential blacks. The first illumination, the large miniature at the beginning of the dedicatory prologue to the first volume (KBR, ms. 9066 fol. 111v) is the well-known scene of court and market created by Jan de Tavernier with a razor-sharp sense of detail, and with a developed sense of perspective.²¹ It shows a busy market day, a great fifteenth-century snapshot of urban activity flourishing around the Burgundian court.

How did the illuminator realize this large illumination? Tavernier composed the narrative scene



III. 15.2 Jan de Tavernier, *City Gate with Market*, c. 1458.

Brussels, Royal Library of Belgium (ms. 9066), *Conquestes et croniques de Charlemaine*, fol. 11r, detail.

on top of an extremely thin layer of medium rich ink – a ‘wash’ on the parchment. Dynamic strokes with brushes of varying thickness were used to complete the shadows, the modeling of the walls, windows and roofs and the subtle effects of the horses, their riders and the architecture. The vibrant line is characteristic of Jan de Tavernier. Deploying a bird’s eye view, he created a single lively scene of the busy street and the interiors.

The initial overall wash consists of a very thin iron gall ink (Ink Type II, containing iron (Fe), copper (Cu) and a small amount of zinc (Zn), XRF 4, 5, 8), mixed with some lead white, and probably also an organic color to give the wash a warmer tint. The small ink particles are visible in the images with transmitted light. The wash layer is

brushed on in different directions, as described earlier in the fifteenth century in Cennini’s *Libro dell’arte*: a wash for sheep parchment should be prepared by putting water in a nutshell and adding two or more drops of ink (Cennini does not specify the constituents of the ink); the wash should then be applied almost dry with a good sized soft bristle brush.²²

After the wash, Jan de Tavernier employed a dark iron gall ink (Ink Type II: Fe/Cu/Zn) to establish the image. With some preliminary sketching, the contours of the figures were outlined in black (XRF 7). Although the composition of the miniature seems perfectly balanced, some changes (*pentimenti*) are noticeable. The macro-research shows on the left a first outline of Philip the Good. In this



III. 15.3 Jan de Tavernier; *The Croniques et Conquestes de Charlemaigne Presented and Handed over by Jean de Créquy, Seigneur de Canaples to Philip the Good*, c. 1458. Brussels, Royal Library of Belgium (ms. 9066), *Conquestes et croniques de Charlemaigne*, fol. 11r; detail.

first position, the upright figure of the Duke is only seen in the dark wall of the building in the left. In the final position at right: the *Croniques et Conquestes* are presented and handed over by Jean de Créquy, seigneur de Canaples (1429–1473) to Philip the Good (ill. 15.3).²³ Remarkably, the ink used by the scribe of the codex, David Aubert (c. 1435–after 1480) is similar in basic composition (Ink type II, XRF 2) to the ink used in the grey surface wash and for delineating the subject. As the scribe's quill was broad, it laid more ink than the fine brush of the illuminator, resulting in the deposits of ink turning brittle and powdery, as is clearly visible with transmitted light. In the miniature a pen, not a brush, was used to draw in a black ink some details like the amulets and prayer beads in the shop under the gate (image with transmitted light, no XRF measurement).

After the painting of the figures with ink applied with the tip of a brush onto the primary wash, a second wash was used of a little tinted ink for the darker shades, applied with an almost dry brush. The pink incarnation of the pronounced cheekbones and the lips was created with touches of paint containing vermilion and lead white, as in full color illumination (XRF 9). The brushstrokes in the soft pink colors are virtually invisible to the naked eye but nuances of tone and texture are created on the surface by dots and short grey lines. Finally the illuminator added the highlights with lead white mixed with a medium, most probably gum arabic. Larger areas of white were painted with brushes of varying thickness in liquid and opaque layers (XRF 6).

Different tints for the grisaille illuminations in the second volume of the *Croniques* attributed to the associates of Jan de Tavernier

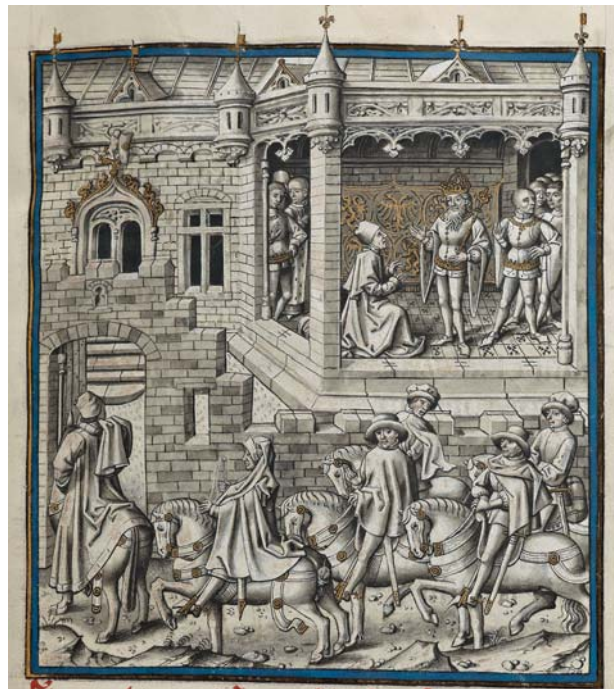
From the colophon of 1458 in KBR, ms. 9068, fol. 297v, and the payment of March 1460 when the first volume was completed and the second volume (KBR, ms. 9067 and Ms 9068) had yet to be illuminated, we know that illuminating both parts of the *Croniques* probably took perhaps around two years to complete.²⁴ The illumination of the second

volume is not only distinctive in style but different in both techniques and materials.

We compared the results from the first volume with two miniatures in the second volume (KBR, ms. 9067, fol. 14r and fol. 198r), attributed to Jan Tavernier and his workshop. In the first half page illumination in semi-grisaille (fol. 14r), a papal emissary reports to Charlemagne in his palace, while horsemen move towards the gateway in the foreground (ill. 15.4). The 'line' of this miniature is less subtle in comparison with the related composition of the famous frontispiece in the first volume, presumably by Tavernier's own hand.

Any differences in effect, in technique and palette take on a special significance as the second volume was illuminated in a distinct phase, after the first volume, and apparently not by Tavernier himself but by his associates.

On fol. 14, the most important material utilized for the wash is a medium-rich iron gall ink different to that used in the first volume (KBR, ms. 9066,



III. 15.4 Collaborators of Jan de Tavernier, A Papal Emissary Reports to Charlemagne in his Palace, while Horsemen Move towards the Gateway in the Foreground, c. 1458. Brussels, Royal Library of Belgium (ms. 9067), *Conquestes et croniques de Charlemaine*, fol. 14r, detail.

fol. 11): here the ink, containing only iron and copper (Ink Type 1), is mixed with very small amount of lead white (XRF 6 and 8). This wash was again applied as an extremely thin layer, spread over the surface within the frame of the miniature. Although to the human eye the color looks the same as in the first volume, it emerged that this wash is different, containing only minor amounts of lead white (compare with KBR, ms. 9066, XRF 4). A second wash of lead white, darkened with drops of ink (Ink Type 1) was applied for contrasts and shading (XRF 7). For the colors of the semi-grisaille

in the second volume, Tavernier's associates probably used minium or red lead, not vermilion as in the first volume, fol. 11, and most probably an organic color for obtaining the brownish shade in the wash. On the left the stairs of the Palace, the horseman's garments are shaded with matte red, probably minium (XRF 11 and 12: coat), perhaps suggesting the red evening sun. A further distinctive feature is the use of shell gold, absent from the miniatures of the first volume. The delicate detailing possible with this precious metal is evident in the horses' trappings and the knights' adornments.



III. 15.5 Collaborators of Jan de Tavernier, *A Papal Emissary Reports to Charlemagne in his Palace*, after 1458. Brussels, Royal Library of Belgium (ms. 9067), *Conquestes et croniques de Charlemaine*, fol. 14r; detail.



III. 15.6 Collaborators of Jan de Tavernier, *Charlemagne's Army Preparing to Cross the Gironde*, after 1458. Brussels, Royal Library of Belgium (ms. 9067), *Conquestes et croniques de Charlemaine*, fol. 117r, detail.

The half page miniature on fol. 198 of Charlemagne's army preparing to cross the Gironde reveals a third range of techniques and materials, perhaps the result of another collaborator working with Jan de Tavernier to accomplish the 33 miniatures for this first part of the second volume (ill. 15.5).²⁵ The overall grey-brownish background wash has a different composition from that on fol. 14 (Ink Type 1). In this grey wash only iron is found (Ink Type III). The light beige tint is mainly composed of a wash containing iron and probably a reddish brown organic pigment (not detectable by XRF; see XRF 5, 8 and 9, the slightly browner and darker color between the figures). The black lines of the drawing, however, contain only a very small amount of iron which indicates the use of a paint based on carbon to execute the figures (XRF 4), and not an iron gall ink as in the two previous examples. The wash is applied leaving areas in reserve so

that the small strip of white at the horizon has no added material apart from the preparation, leaving just the natural parchment color visible (XRF 3, under the trees). The white heightening for the sky and the touches to create the highlights, on the other hand, consist of a layer of pure thick lead white (XRF 2).

This comparative technical study confirms the deductions of Canon Dehaisnes in 1882²⁶ and more recently of Verroken and Vanwijnsberghe that the workshop of Jan de Tavernier in Oudenaarde around 1460 depended on extensive collaboration with apprentices and assistants.²⁷ The contributions by distinct hands are confirmed by their use of different materials as well as different techniques. From the readily accessible materials available for painting in grisaille, the assistants had the liberty to choose the ones each found most congenial.



III. 15.7 Willem Vrelant, *Visitation*.
Brussels, Royal Library of Belgium (ms. IV 145), *Book of Hours*, fol. 75v.

PART 2

Materials in the grisaille illuminations attributed to Willem Vrelant and his followers

In order to reveal how other illuminators created ‘images in black and white’, we examined five more grisaille miniatures by different artists in various manuscripts in the Manuscript Department of the Royal Library of Belgium. These manuscripts have in common that they were all illuminated for Burgundian patrons, whose taste for grisaille was well established, and for the international art-market, where grisailles were appreciated on panel as well as on parchment.

The Bruges illuminator Willem Vrelant (fl. 1450–1481) was painting for a small Book of Hours (KBR, ms IV 145, around 1470) with four illuminations in semi-grisailles. The general practice was first to cover or ‘wash’ the area of the miniature with iron gall ink mixed with some lead white (Ink Type 1).²⁸ In the miniature of the *Visitation* (fol. 75v), we can observe that the thin wash is painted unevenly (see image with transmitted light [ill. 15.7]). Only occasionally, as for the rock is a different ink wash used, one containing zinc (Ink Type II, XRF 17). Evidently executed with quills and brushes of different thicknesses, the contour lines of the figures and the landscape were probably drawn in carbon black (comparison of XRF 11 and 12 with XRF 10: the hand and the outline of the hand give the same results with XRF analysis). Highlights were added with fine brush strokes of lead white, followed by ocher, touches of vermilion (XRF 4 and 10) and lead-tin yellow for the delicate detailing of the Virgin’s hair (XRF 14).²⁹ Shell gold was used to shape the roofs and trunks of the trees (XRF 19); pure gold leaf was used for the halo (XRF 1).

In the *Première Guerre Punique* (KBR, ms. 10777, Leonardo Bruni, *De primo bello punico*, in the French translation of Jean Lebègue), also illuminated by Willem Vrelant, a large variation of grey tonalities is visible in the half page miniatures.³⁰ On the examined folio’s areas are left in reserve by the wash which is of Ink Type 1, containing iron and



III. 15.8 Willem Vrelant, *The Translator Jean Lebègue in his Study*.

Brussels, Royal Library of Belgium (ms. 10777),
Leonardo Bruni, *Première Guerre Punique*
(French translation by Jean Lebègue), fol. 9r.

copper (XRF 4), heightened with lead white and gold (ill. 15.8). The sky of the miniature is finished with a bright blue azurite (XRF 2). For the final highlights, shell gold as well as silver was used for painting the window grille and the clouds (XRF 5, 3).

A skillful follower of the style of Willem Vrelant, known as the Master of the *Vraie Cronicque d’Escosse*, executed around 1480 a *Breviary* now fragmentary but still with 21 miniatures, some in semi-grisaille (KBR, ms. II 5646; ill. 15.9).³¹ On fol. 13, with the depiction of the *Assumption of the Virgin*, the illuminator imitated Vrelant’s technique: the surface wash was done with lead white mixed with ink containing copper and iron (XRF 5, Ink Type 1: Cu/Fe). This ink is clearly different from the writing ink (XRF 7, Ink Type II: Fe/Cu/Zn).³² The contour lines of the Virgin, the clouds and the angels were painted in a black carbon ink (XRF 4) and the highlighting was mainly done by applying fine hatching in shell gold. On the image of *Pentecost* (fol. 17), the grisaille is heightened only with shell gold, gold leaf and, in the lower part, with fine discrete lines drawn with a thin quill in azurite and an organic red for the geometrical floor tiles.



III. 15.9 Master of the *Vraie Cronique d'Escoce*, *Virgin with Four Angels*, c. 1480. Brussels, Royal Library of Belgium (ms. II 5646), *Breviary*, fol. 13r.

Dreux Jehan or the Master of the Girart de Roussillon and the grisaille illuminations in the *Cy nous dit*

At the beginning of the manuscript of the *Composition de la Sainte Écriture* or *Cy nous dit* (KBR, ms. 9017) made for Philip the Good, there is a prominent half-page image of the anonymous author or the scribe, David Aubert, sitting behind his writing desk in his study (fol. 38v; ill. 15.10).³³ The writer's

heavy figure is placed at the center of a square room, the position of his hands creating the central point of the elaborate perspective.

The Master of the Girart de Roussillon, often identified with Dreux Jehan (fl. 1448–1467, Brussels and Bruges), created this semi-grisaille in 1462. For painting the image a little lead white was mixed with iron gall ink (Ink Type 1: Cu/Fe), and used as a basic wash within the miniature frame. The direc-



III. 15.10 Master of the Girart de Roussillon,
David Aubert behind his Writing Desk, c. 1460.
Brussels, Royal Library of Belgium (Ms. 9017),
Composition de la Sainte Écriture or Cy nous dit, fol. 38v.

tions of the semi-dry large brush strokes are clearly visible with transmitted light, when the particles of the iron gall ink can be detected. The overall grey color is composed of applied shades of the same type of ink containing different amounts of iron and copper (Ink Type 1: Cu/Fe) mixed with lead white (XRF 2 and 3, measurements inside the cupboard and in the background). The highlights were applied with extremely thin accurate brush strokes either in lead white, for the filigree work on the side of the writing desk, in silver, for the bars of the windows (XRF 6), or in gold, for the book clasps (XRF 7).

PART 3

Grisailles by two illuminators for a text by Jean Miélot: the Master of the Golden Fleece of Vienna and Copenhagen and the Master of the Grisailles Fleurdelisées

The *Traité des quatre dernières choses* (KBR, ms. 9048), Jean Miélot's translation of Gerard van Vliederhoven's *Cordiale de quattuor novissimis* was executed after 1472 because in the colophon Miélot is described as 'jadiz (formerly) chanoine de St-Pierre a Lille', a position he ceased to hold in

that year, probably because of his death; the *ex libris* of Charles de Croÿ shows that it was completed by 1486.³⁴ The text of the manuscript was written in an ink of Type II, as measured on fol. 90 (Fe/Cu/Zn, XRF 9), the same type of ink as found in David Aubert's *Croniques the Charlemaigne, Part 1 and II* (see above). Most probably, this type of ink was common for decades in the scriptoria of the Southern Netherlands. The first volume of the *Chroniques de Hainaut*, completed in 1448, was also written with an ink containing zinc, by Jacotin du Bois and perhaps Jean Wauquelin.³⁵

It is likely that Miélot himself had decided the content of the five miniatures that introduce the text's five sections, since similar subjects appear in the copy that entered the library of Philip the Good (KBR, ms. 11129).³⁶ In this copy, however, the miniatures are in semi-grisaille. They were executed by two artists: the Master of the Golden Fleece of Vienna and Copenhagen³⁷ and the Master of the Grisailles Fleurdelisées.³⁸ The two artists were not only different in style: they also used different materials to create their grisaille illuminations.

The wash for the frontispiece depicting the scribe's study (fol. 1), attributed to the Master of the Golden Fleece of Vienna and Copenhagen, was probably made with carbon ink, as the XRF spectra do not reveal a high iron or copper content (ill. 15.11). Moreover some red vermilion was added to give the wash a slightly purple shade (XRF 1 and 2). The limited colors added to the semi-grisaille are azurite for the curtain (XRF 3), vermilion for creating the browns of the wooden chair (XRF 5) and shell gold for heightening (XRF 4).

In the second miniature examined, on fol. 90 at the start of the third chapter, attributed to the Master of the Grisailles Fleurdelisées, the contour lines of the human figures, their demon tormenters and the cityscape were executed in a different ink from that in the first miniature (here Ink Type II: Fe/Cu/Zn, XRF 6; ill. 15.12) To complete the landscape setting, two dominant colors were added in different tones. The surface was completed in a wash of ink and lead white (with no reserve for the



III. 15.11 Master of the Golden Fleece of Vienna and Copenhagen, *Jean Miélot behind his Writing Desk*, after 1472. Brussels, Royal Library of Belgium (Ms. 9048), Gerard van Vliederhoven, *Traité des quatre dernières choses* (French translation by Jean Miélot), fol. 1r.



III. 15.12 Master of the Grisailles Fleurdelisées, *Human Figures and their Demon Tormenters*, after 1472. Brussels, Royal Library of Belgium (Ms. 9048), Gerard van Vliederhoven, *Traité des quatre dernières choses* (French translation by Jean Miélot), fol. 90r.

sky) on which layers of azurite and lead white were applied in different shades (XRF 8). The other dominant color in the semi-grisaille is a copper green, also used in washes of varying intensity for the rendering of the grass and the foliage (XRF 3 and 4). Finally gold was used for highlighting and hatching (XRF 1 and 2).

Conclusions

Through empirical data we can conclude that in all in this study the analyzed Flemish manuscripts of the third quarter of the fifteenth century, the inks used by the scribes contain iron, copper and zinc. The analyses of the composition of the ink strengthen the findings from other forms of research that scribes were not isolated craftsman preparing their daily materials in secret but, on the contrary, worked in a well-integrated network of book producers. The presence of zinc, from the vitriol used to manufacture the iron gall ink, suggests that the

vitriol probably came from the Harz mountains, a rich mining area in Saxony. Without the complex networks of international trade, basic materials could not have been obtained.

Examining the materials used for both the grisaille illuminations and the text in the same manuscripts reveals significant data. Jan de Tavernier (in volume 1 of the *Croniques and the Conquestes the Charlemagne*) and the Master of the Grisailles Fleurdelisées employed the same type of iron-gall ink containing iron, copper and zinc as the scribes of their respective manuscripts. Dreux Jehan also created his figures with iron gall inks. But some illuminators preferred to work in other materials: they painted the outlines of the figures and architecture in carbon black ink, as found in the miniatures by the assistants of Jan de Tavernier, by Willem Vrelant and by Vrelant's follower, the Master of the *Vraie Cronicque d'Escosse*. To enrich the grey shades in the washes, the illuminators added colored materials like vermilion (Tavernier in volume 1 of the *Croniques*), minium (the assistants of Tavernier in volume II of the *Croniques*) or organic components (Tavernier himself in the first volume of the *Croniques* and the Master of the *Vraie Cronicque d'Escosse* in the Breviary). In all the illuminations we found that subtle differences between shades of black were obtained by using different iron gall inks sometimes alone or in combination with carbon based inks or lead white. For Jan de Tavernier, the difference in style between himself and his collaborators was confirmed by the different materials employed in the first and second volumes of the *Croniques*, bearing out the codicological and archival evidence.

In conclusion, we have discovered that the palette of the 'grisaille illuminators' was almost as varied as that of the illuminators in color. They achieved their range of tones from their range of pigments and inks and by mixing pigments with inks with great subtlety. As important for the final result was the use of a variety of quills and brushes. The application of tinted washes on parchment relates to the common medieval practice of

producing independent drawings on tinted parchment and paper.

We should also observe that grisaille illuminations seldom functioned in isolation in the *mise en page*. Whether by Tavernier, Dreux Jehan, Vrelant or the followers of Vrelant, the miniatures would not have the same strength without the border decoration, the red and black lettering and the large colorful *fleuronné* capitals letters. Borders and text were sometimes also decorated in grisaille and sometimes in full color. The sharp contrast between the cool grisaille images and the exuberant border illumination increases the strong visual appeal that made Flemish illumination so renowned.

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	Ca	Fe	Cu	Zn	Ag	Au	Hg	Pb	Sn
<i>Chroniques et Conquestes, part I, folio 2 (KBR 9066)</i>									
Ink 2	11963	25681	15710	5907				1179	
Background next to dog 4	6106	9419	7930	4142				70496	
Background next to dog 5	5842	1123	718	256				148511	
Foot, white 6		755	690					533079	
Foot, black line 7	2980	1951	1856	993				202494	
Background next to foot 8	2237	2657	4256	1984				220722	
Incarnation 9		1471	1417				74036	314868	
<i>Chroniques et Conquestes, part II (KBR 9067)</i>									
Fol.14 crown gold 5	3734	2609	3014			100191		4285	
Fol.14 background 6	5884	1070	918					4916	
Fol.14 architecture grey 7	3879	1059	272					79329	
Fol.14 border 8	7073	661	312					2987	
Fol.14 stairs 11	840	7581	6650	3665				196116	
Fol.14 coat 12								290249	
Fol.198 sky 2	985							269364	
Fol.198 background 3	5988	278							
Fol.198 black lines 4	6827	576						863	
Fol.198 background 5	6218	449						2962	
Fol.198 background 8	1064	130						717	
Fol.198 background- 9	1018	119							
<i>Book of Hours, folio 75v (KBR IV 145)</i>									
Nimbus 1	934	1381	6673			325629		76733	
Incarnation cheek 4			1320				16968	539497	
Incarnation hand 10	1226	1759	671				13139	389483	
Incarnation contour 11	549	1391	705				3144	387140	
Incarnation contour 12	1098	1436	1163				12041	593412	
Hair virgin 14	1669	66967	1292				9859	200231	335
Rock 17	4650	4047	625	672				120120	
Tree 19	3052	4204	2032			82788		159901	
<i>Premier Guerre Punique (KBR 10777)</i>									
Sky 2	1954	9303	1328818					4357	
Cloud in the sky 3		8662	1305307		1429				
Background 4	745	1906	2381					320662	
Window bar 5	1184	515				26154		254121	

	Ca	Fe	Cu	Zn	Ag	Au	Hg	Pb	Sn
<i>Book of Hours, folio 13 (KBR II 5646)</i>									
Contour line 4								47429	
Background 5	598	93	205					6755	
Ink 7	1303	1165	326	2100					
<i>Composition de la Sainte Ecriture, folio 38r (KBR 9017)</i>									
Wardrobe 2	2374	720	3936					339281	
Background 3	9455	1191	570					60851	
Window bar 6	1369		1305		1814			628767	
Book clasp 7	6531	581	1314			10434		169956	
<i>Traité des quatre dernières choses (KBR 9048)</i>									
Fol.1 background 1	1095	94	144				211	6051	
Fol.1 background 2	732	152	397				61	22152	
Fol.1 library curtain 3	814	270	38515					10104	
Fol.1 book 4			1115			30205		20360	
Fol.1 chair 5	483	146	1466				8097	14992	
Fol.90 crown 1	326	177	363			1622		19576	
Fol.90 crown 2	278	200	282			16838		12205	
Fol.90 grass/foilage 3	289	837	18614	1685				23428	
Fol.90 grass/foilage 4	300	1110	18536	1796				17563	
Fol.90 contour line 6	529	1580	1003	2153				9875	
Fol.90 sky 8	201		31930					32892	
Fol.90 ink 9	1278	2804	1058	2448					

Table : XRF analysis results. The values given in this table are computed peak areas with no real quantitative value and which are only used for relative comparisons. For calcium (Ca), iron (Fe), copper (Cu), zinc (Zn), silver (Ag) and tin (Sn), the intensity of the $K\alpha$ peak is measured; for gold (Au), mercury (Hg) and lead (Pb) the intensity of the $L\alpha_1$ peak is measured.

NOTES

- 1 Littré 1873–1874: 1939; see: <http://www.littre.org/definition/gris>, 25/12/2013.
- 2 Pastoureau 2008: 109; see also the essay of Anne Dubois in this volume.
- 3 On the definition of grisaille painting in the Low Countries in the fifteenth century, see: Liefinck 1970: 237–242; Houston 1973; Osterom-Renger 1983: 145–173; Borchert 2009: 13; Bergeon Langle & Curie 2009: vol. 1, 50; and the essay by Anne Dubois in this volume.
- 4 The results of the technical examination and analyses of Italian Renaissance drawings by the Department of Conservation and Scientific Research at the British Museum, published in 2010, constitute a benchmark for the study of the 'monochrome' materials used by Italian draftsmen around 1500. As some drawing materials are shared with or inspired by illuminators' practice, the study was highly relevant for this research. See: Ambers, Higgitt & Saunders 2010.
- 5 ArtTax equipment (Bruker AXS Microanalysis, Germany) with a Rhodium tube and a built-in color CCD camera was used (figure 1). For the experiments an energy of 50 kV, a current of 500 µA and a Mo 25µm filter were used, during 120 seconds. Light elements (atomic number lower than 11) cannot be detected and only the elements themselves are identified (no molecular information).
- 6 Lime white could be obtained by fine grinding of eggshells. Chalk (calcium carbonate) was obtained from chalk beds all over Europe; grinded, washed and transported in vats. It was used in parchment preparation and could be used with a binder as a paint. See: Roy 1993: 283–285. Lead white was an important material for white in grisaille painting, although this essay does not deal with pigments in depth. Theophrastus, Pliny and Vitruvius all described the preparation of lead white from metallic lead and vinegar. This involved casting metallic lead as thin 'buckles', which were stacked up and covered with a mixture of decaying dung and spent tanner's bark, to supply the carbon dioxide, and left for six to fourteen weeks, by which time the blue-grey lead had corroded to white lead. The pots were then taken to a separating table where scraping and pounding removed the white lead from the buckles. The powder was then dried. See: Gettens, Kühn & Chasen 1986: 67–81.
- 7 Complementary to this research is the related publication on inks: Van Bos & Watteeuw 2014: 365–381.
- 8 All the studied illuminations are in the manuscript collection of the Royal Library of Belgium and were analyzed with the laboratory equipment in the storage area.
- 9 Zeiss binocular microscope, Reading Room, Manuscript Department, Royal Library, Brussels.
- 10 Camera, Phase One, 80 million pixels, photography by Bruno Vandermeulen, KU Leuven.
- 11 X-ray Fluorescence (XRF) is an 'elemental' analysis technique revealing the chemical elements (not molecules or compounds!) present in the analyzed area. Elements with atomic number higher than K are identified. No information on organic compounds. Equipment: Art-tax, Bruker AXS Microanalysis, Germany. See also: Ambers, Higgitt & Saunders 2010: 62–63.
- 12 Calcium (Ca) is present in all XRF measurements as chalk is a main component of the parchment preparation. See: Gettens, Fitzhugh & Feller 1986: 203–223.
- 13 For iron gall ink, see: Zerdouan Bat-Yehouda 1983; Sistach & Espadler 1993: 485–490; Wunderlich 1994: 414–42; Krekel 1999: 54–58; Wouters & Banik, 2000: 141–148; Brown 2002; Stijnman 2004: 14–17; Reissland & Ligterink, 2011 (<http://ink-corrosion.org>).
- 14 The color of iron gall ink can shift in time.
- 15 Considerable amounts of zinc were found in the iron gall ink (Ink Type II) of the fourteenth-century Macclesfield Psalter, Fitzwilliam Museum Cambridge (2008) and in some Italian renaissance drawings studied at the British Museum (2010). See: Bucklow 2008 (www.eu-artech.org/files/REPORT%20FITZWILLIAM%202.doc); Ambers, Higgitt & Saunders 2010: 57–75.
- 16 For carbon black, see: Gettens & Stout 1966; Schramm & Hering 1988: 70–71; Winter 1983: 49–66.
- 17 For washes, see: Verre, Tanimoto & Higgitt 2010: 58–59.
- 18 For white pigments, see: Schramm & Hering 1988: 28; 33 and 34. Shell white and gypsum would not be detected by XRF, as the identifying component calcium is also used in the preparation of parchment.
- 19 Brussels, KBR, ms. 9066, David Aubert, *Conquestes et croniques de Charlemagne*, Southern Netherlands, 1458–1460. Bibliographic orientation: Dehaines 1882; Indesteghe 1966: 336–39; Bousmanne 1997a: 104–105; Johan 2004: 2–93; Verroken 2006b; LDB-IV 2009: 153–155, Watteeuw 2011: 229–232.
- 20 Brussels, KBR, ms. 9067, *Conquestes et croniques de Charlemaine*, Southern Netherlands, 1458–1460, Volume II, miniatures by associates of Jan de Tavernier. On Jan de Tavernier, see: Dehaines 1882; Winkler 1925; Delaissée 1959; Dogaer 1987; Brinkmann 1996; Vanwijnsberghe 2001; Brussels 2002; Johan 2004; Verroken 2006b; Vanwijnsberghe & Verroken 2011 and the essay by Dominique Vanwijnsberghe and Erik Verroken in this volume.
- 20 Barrois 1830: 243–244; LDB-IV 2009: 148; Paviot 2009: 413–446.
- 21 Brussels–Paris 2011: 229–232, n° 39–40.
- 22 Cennini 2002: 6–7 and 9*Grind all these things (components) up well on the porphyry slab with well or spring or river water; and grind them as much as ever you can stand grinding them, For they can never be done too much; because the more you grind them, the more perfect tint it becomes... Running your hand lightly, with the brush about half dry, first in one direction and then in the other. And put on three or four coats of it in this way or five, until you see that the paper is tinted evenly. And wait long enough between one coat and the next for each coat to dry.*
- 23 The Duke is identified by his arms and badges; the presenter of the book can be identified as Jean v de Créquy because, like Philip the Good, he wears the chain of the Golden Fleece. Créquy was one of the first knights of the Order in 1430. See: Johan 2004.
- 24 The payment to Jan de Tavernier is known by a Ducal Ordinance of 29 March 1460, provided by Maistre Jehan Scarreel (*secrétaire et garde de nostre Espargne*) ...*Et Jehan le Tavernier, sur ce qu'il lui puet et pourra estre deu par nous tant a cause de certaines histoires en noir et blanc que de nostre commandement et ordonnance il a faictes ou premier volume du livre de charlemaine qui est presentement porté par-devers nous, comme de celles qu'il doit faire ou second volume dudit livre de Charlemaine, I escut*; (Lille, Archives Départementales du Nord, cc, v 2037, mementos de Philippe le Bon, no. 62694). See: Paviot 2009: 154.
- 25 Volume II of the *Croniques* is now bound in two volumes: KBR, ms. 9067 and 9068.
- 26 Dehaines 1882: 20–38.
- 27 See the essay by Dominique Vanwijnsberghe and Erik Verroken in this volume.
- 28 Brussels, KBR, ms. IV 145, *Book of Hours, use of Rome*, around 1470, 14 color miniatures, 4 miniatures in grisaille, all attributed to Willem Vrelant. See: Cockshaw 1986: 42–48; Bousmanne 1997a: 14, 238–239; Brinkmann 1997: 62; Brussels–Paris 2011: 239, 249–250.
- 29 Contour line XRF 3 gives no result; contour line of the hand (XRF 11 and 12) shows no difference from the measurement of the hand itself (XRF 10).
- 30 Brussels, KBR, ms. 10777, Leonardo Bruni d'Arezzo, *La première guerre punique, traduction française de Jean I Le Bègue*. See: Lyna & Pantens 1989 : vol. 1, 330–333; Bousmanne 1997a: 233–234.
- 31 Brussels, KBR, ms. II 5646, *Breviary, prayers*, c. 1480, attributed to the *Maitre de la vraie cronique decosse*. See: Cockshaw 1986: 46–47; Dogaer 1987: 105; Lyna & Pantens 1989 : vol. 1, 338–342; Bousmanne 1997a: 236–237.
- 32 In measurements XRF 5 and 7 titanium was also found, which could indicate a twentieth-century intervention or retouching.

33 Brussels, KBR, ms. 9017, *Composition of the Holy Scripture*. See: Cockshaw 1986: no. 14: 29; Lyna & Pantens 1989: no. 286; Brussels-Paris 2011: no. 23: 188–201.

34 Brussels, KBR, ms 9048, *Traité des quatre dernières choses*. See: Lyna & Pantens 1989, no 307; Hans-Collas & Schandel 2009: 164; Brussels-Paris 2011: 373; LDB I 2000: 302–304; Wijsman 2011.

35 Brussels, KBR, ms. 9242, *Chroniques de Hainaut*. See: Wouters & Banik 2000: 141–148.

36 LDB I: 302–4; Brussels-Paris 2011, no. 41.

37 The Master of the Golden Fleece of Vienna and Copenhagen worked for patrons at the Burgundian court, including Louis de Gruuthuse. His surviving oeuvre consists of c. 15 manuscripts. See: Brussels-Paris 2011: 379–381; Hans-Collas & Schandel 2009: 157–163.

38 The Maitre aux grisailles fleurdelisées was an illuminator active in Lille in the 1460s and 1470s, working for Jean de Wavrin, Louis de Gruuthuse and other leading patrons. See: Hans-Collas & Schandel 2009: 164–173; Brussels-Paris 2011: 372–374.