Rita de Castro Sousa Oliveira

Mestre em Conservação e Restauro, especialidade em Documentos Gráficos

The book of birds in Portuguese scriptoria: preservation and access

Dissertação para obtenção do Grau de Doutor em Conservação e Restauro do Património, Especialidade em Teoria, História e Técnicas.

Orientador: Prof. Doutora Maria João Seixas de Melo, FCT-UNL

Co-orientadores:
Prof. Doutora Maria Adelaide Miranda, FCSH-UNL
Doutor Marco Leona, Metropolitan Museum of Art

Júri:

Presidente: Prof. Doutora Maria Adelaide de Almeida Pedro de Jesus

Arguente(s): Prof. Doutor Andrew Beeby
Prof. Doutora Doris Oltrogge

Vogais: Prof. Doutor José Francisco Preto Meirinhos
Prof. Doutora Maria da Conceição Lopes Casanova

FACULDADE DE CIÊNCIAS E TECNOLOGIA
UNIVERSIDADE NOVA DE LISBOA

Dezembro 2016

The Book of Birds in Portuguese scriptoria: preservation and access

ACKNOWLEDGEMENTS

I would like to start by thanking Professor Maria João Melo, for introducing me to the fascinating subject of colour in medieval manuscript studies. Through our talks and debates, I have learned above all that critical thinking is one of the greatest assets you may have, not only in science, but also in life.

I would also like to thank my co-supervisors: Professor Adelaide Miranda, for her support and enthusiasm. She introduced me to the other side of illuminated manuscripts that mesmerized me: the intricate side of history and social context in middle Ages; and to Doctor Marco Leona, for receiving me in the Department of Scientific Research, from the MET. Working on such great institution and environment was a memorable experience.

This thesis would have not been possible without the contribution of a broad group of individuals and institutions:

Firstly, I would like to thank FCT-Fundação para a Ciência e a Tecnologia for allowing me to pursuit this work, through the grant SFRH/BD/76789/2011 as well as project PTDC/EAT-EAT/104930/2008.

I would like also to express my gratitude to the Biblioteca Nacional of Portugal, to the Arquivo Nacional da Torre do Tombo and, above all, to the Biblioteca Pública Municipal do Porto. The staff and directory from BPMP were very generous and supportive during this research. I would like to thank mostly Doctor Sílvio Costa and conservator Lucinda Oliveira.

From the DCR-UNL, I would like to start by acknowledging the work conducted by Ana Claro and Catarina Miguel. They were the pillars of a major component of this work. In addition, they were also, in a certain way, my mentors in different periods of my academic life. To Solange Muralha, your kindness and contribution to science will never be forgotten. To Professor Conceição Casanova, for her support with the Santa Cruz bookbindings. To the Photochemistry group, for always helping me when in need. To all of my teachers and colleagues, I thank you for the discussions, continuing learning and support. A special thank you to my sanity keepers: Vanessa, Diogo, Ana Isabel and Cristina. And, more recently, to Tatiana, Rita, Juliana and, above all, Paula. To Ana Maria, for all of my sudden inquiries kind-heartedly assisted. And, to all of the students that helped me improve my work along these years.

I would like to acknowledge the MOLAB team from the University of Perugia that in 2009 made the on-site investigation on the Santa Cruz Collection: Aldo Romani (team lider),

Alessia Daveri, Catia Clementi, Laura Cartechini and Valentina Manuali; and also to Costanza Miliani for organising the visit. Their work was a fundamental asset for this investigation.

To Professor João Lopes and Doctor Jorge Sarraguça for the productive discussions and development of the *mapping colour* tool. Without their contribution, this work would have not been possible.

From the MET, I would like to specially thank Federica Pozzi and Pablo Londero for their support.

From FCSH, I would like to thank the IEM, for their generous welcome in their group and for the knowledge exchange. A special thanks to Inês Correia, for our discussions on the implementation of the IDAP methodology.

From the School of Copenhagen, I would also like to thank Doctor René Larsen for kindly receiving me. To Doctor Dorte V.P. Sommer and Doctor Kathleen Mühlen Axelsson for teaching me the IDAP. And, to Cecil Krarup Andersen for thoughtfully receiving me in her home.

I would like to thank my friends and family. I could have not been through this work without your loving support. To Custódia, my pal and constant companion. And, last but not least, to my husband for being my inspiration every day.

RESUMO

Nesta tese, os *Livros das Aves* de Hugo de Folieto produzidos nos mosteiros Portugueses de São Mamede do Lorvão, Santa Maria de Alcobaça e Santa Cruz de Coimbra, foram estudados pela primeira vez através de uma abordagem interdisciplinar e holística. Esta investigação abriu portas para uma metodologia personalizada para o estudo da circulação de manuscritos, ao convergir história, codicologia, iconografia, cor – tanto molecular, como simbólica – análise textual e estado de conservação. Permitiu propor novas cronologias e estabelecer correlações entre cópias.

O scriptoria de Santa Cruz ainda não tinha sido alvo de um estudo aprofundado a nível material e técnico, como Alcobaça e Lorvão, que pudesse servir de apoio para a investigação sobre os Livros das Aves. Por esse motivo, os manuscritos de Santa Cruz foram sujeitos a um estudo detalhado sobre os seus materiais e técnicas de pintura, bem como sobre as suas encadernações. Uma vez que a coleção havia sido analisada previamente numa investigação MOLAB, o trabalho experimental desenvolvido nesta tese foi comparado com os dados MOLAB e as vantagens de uma abordagem *in situ* e de micro-amostragem foram discutidas. As três coleções foram comparadas, tendo-se estabelecido mais em pormenor a paleta do Românico, as suas singularidades e os seus principais problemas de degradação.

De modo a estudar o significado do uso destas cores, desenvolveu-se e aplicou-se nos três scriptoria uma ferramenta de *mapeamento de cor*. Conclui-se que como técnica complementar, esta poderia trazer novas perspetivas à história da arte, ao correlacionar padrões de cor com períodos históricos específicos.

Por último, desenvolveu-se uma nova metodologia para o estudo e caracterização de corantes em manuscritos iluminados, através da combinação de microespectrofluorimetria e SERS. Esta abordagem permitiu estabelecer que a goma laca foi usada para pintar vermelhos escuros e rosas em scriptoria Portugueses, durante o Românico.

Palavras-chave: manuscritos iluminados; Livro das Aves; Santa Cruz de Coimbra; mapeamento da cor; circulação de manuscritos; goma laca.

ABSTRACT

In this thesis, the *Books of Birds* from Hugh of Fouilloy produced in the Portuguese monasteries of São Mamede of Lorvão, Santa Maria of Alcobaça and Santa Cruz of Coimbra, were studied for the first time through an interdisciplinary and holistic approach. This investigation opened doors to a customized methodology for the study of manuscript circulation, by converging their history, codicology, iconography, colour – both molecular and symbolic – text analysis and conservation state. This allowed proposing new chronologies and correlations between each copy.

Santa Cruz still lacked a comprehensive study from a material and technical point of view, contrarily to Alcobaça and Lorvão, which could ultimately support the research on the Books of Birds. Therefore, the Santa Cruz manuscripts were subject of a detailed investigation on their painting materials and techniques, as well as its bindings, used in their production. Since the collection had been previously analysed in a MOLAB access, the experimental work developed in this thesis was compared with the MOLAB data and the advantages of an *in situ* and micro-sampling approach were discussed. The three collections were compared, which allowed establishing more in-depth the colour palette used in Romanesque manuscripts, their singularities and main degradation issues.

In order to study the meaning behind the usage of these colours, a *colour mapping* tool was developed and systematically applied in the three scriptoria. It was established that this complementary technique can bring new insights to art history, by correlating colour patterns to specific historical periods.

Finally, it was also developed a new methodology for the study and characterization of dyes in illuminated manuscripts, by combining microspectrofluorimetry and SERS for the first time. It allowed establishing that lac dye was used to paint dark reds and pinks in Portuguese scriptoria, during the Romanesque period.

Keywords: illuminated manuscripts; Book of Birds; Santa Cruz of Coimbra; colour mapping; circulation of manuscripts; lac dye.

PUBLICATIONS

As main author:

CASTRO, R.; CASANOVA, C.; OLIVEIRA, L.; MIRANDA, M.A. (2017). 'The Romanesque collection of Santa Cruz Abbey in Coimbra: Revisiting 12th c. and 16th c. monastic bookbindings', in Nataša Golob and Jedert Vodopivec (Eds.), *Bookbindings: theoretical approaches and practical solutions*. Turnhout: Brepols Publishers, in press.

CASTRO, R.; MELO, M.J.; MIRANDA, A. (2016) 'O De Avibus de Alcobaça – uma cópia de Clairvaux?', in Catarina F. Barreira (Coord.), *Luz, cor e ouro: estudos sobre manuscritos iluminados*. Lisboa: Biblioteca Nacional de Portugal (e-book).

CASTRO, R; MIRANDA, A; MELO, M.J. (2016). 'Interpreting lac dye in medieval written sources: new knowledge from reconstruction of recipes relating to illuminations in Portuguese manuscripts', in S. Eyb-Green, *et al.* (Eds.), *Sources on Art Technology: back to basics.* London: Archetype Publications, pp. 88-99.

CASTRO, R.; MELO, M. J.; MIRANDA, A. (2014). 'The Secrets Behind the Colour of The Book of Birds', in A. Miranda, A. Miguélez (Coord.), *Portuguese Studies on Medieval Illuminated Manuscripts*. Barcelona-Madrid: Brepols Publishers, pp. 31-55.

CASTRO, R.; POZZI, F.; LEONA, M.; MELO, M.J. (2014). 'Combining SERS and microspectrofluorimetry with historically accurate reconstructions for the characterization of lac dye paints in medieval manuscript illuminations', *Journal of Raman Spectroscopy* 45, 1172-1179.

As collaborator:

CAVERO, A.M.; MIRANDA, M.A.; MELO, M.J.; CASTRO, R.; CASANOVA, C. (2016). 'Beatus manuscripts under the microscope: the Alcobaça Beatus and the Iberian Cistercian tradition revisited', *Journal of Medieval Iberian Studies*, 8(2), 217-251.

MELO, M.J.; ARAÚJO, R.; CASTRO, R.; CASANOVA, C. (2016). 'Colour degradation in medieval manuscripts', *Microchemical Journal*, 124, 837-844.

CORREIA, N.; ROMÃO, T.; RICARDO, A.; MOTA, T.; MELO, M.J.; CASTRO, R.; CARVALHO, R.; MIRANDA, A. (2014). 'Design of an interactive experience with medieval illuminations: A journey into the beauty and meaning of medieval Portuguese manuscripts', *ACM Journal on Computing and Cultural Heritage*, 7(2), Article 13, 19 pages.

MELO, M.J.; CASTRO, R.; MIRANDA, A. (2014). 'Colour in medieval Portuguese manuscripts: Between beauty and meaning', in A. Sgamellotti, B. Brunetti, C. Miliani (eds.), *Science and art: The painted surface*. London: The Royal Society of Chemistry, pp. 170-192.

MELO, M.J.; MIRANDA, A.; MIGUEL, C.; CASTRO, R.; LEMOS, A.; MURALHA, V.S.F.; LOPES, J.A.; GONÇALVES, A.P. (2011). 'The colour of medieval Portuguese illumination: An interdisciplinary approach', *Revista de História da Arte*, FCSH-UNL, Nº1, Série W, 152-173

SYMBOLS AND NOTATIONS

λ_{abs}	absorption wavelength
λ_{em}	emission wavelength
λ_{exc}	excitation wavelength
μ-EDXRF	micro-Energy Dispersive X-ray Fluorescence spectroscopy
μ-FTIR	micro-Fourier Transform Infrared spectroscopy
μ-Raman	micro-Raman spectroscopy
ν	stretching vibration (asymmetric)
AFM	Atomic force microscopy
ALC	Alcobaça (normally associated to a MS number)
ANTT	Arquivo Nacional da Torre do Tombo (National Archives of Torre do Tombo)
ATR-FTIR	Attenuated Total Reflectance Fourier Transform Infrared spectroscopy
BNE	Biblioteca Nacional de España (National Library of Spain)
BNF	Bibliothèque Nationale de France (National Library of France)
BNP	Biblioteca Nacional de Portugal (National Library of Portugal)
BPMP	Biblioteca Pública Municipal do Porto (Municipal Library of Porto)
BMT	Bibliothèque Municipale de Troyes (Municipal Library of Troyes)
c.	century
CRSA	*Canonici Regulares Sancti Augustini* (Canons Regular of Saint Augustine)
DCR-FCT	Departamento de Conservação e Restauro – Faculdade de Ciências e Tecnologia
DSC	Differential Scanning Calorimetry
DUPDA	Digitised User-friendly Parchment Damage Atlas
EWS	Early Warning System
fol./fols.	folium or folia
FORS	Fiber Optics Reflectance spectroscopy
FT-Raman	Fourier Transform Raman spectroscopy
GC-MS	Gas chromatography-mass spectrometry
HF	Hydrofluoric acid

HPLC-DAD	High-Performance Liquid Chromatography with diode array detector
IDAP	Improved Damage Assessment of Parchment
Kα, Kβ, L…	Different energy x-ray levels associated to XRF spectral peaks
LKFK	Libro de komo se fazen as kores (The Book on how to make colours)
Lv	Lorvão (normally associated to a MS number)
MC	Mappae Clavicula
MET	Metropolitan Museum of Art
MHT	Micro Hot Table
Ms./Mss.	manuscript or manuscripts
NMR	Solid-state nuclear magnetic resonance
O. Cist.	Cistercian Order
OFM	*Ordo Fratrum Minorum* (Franciscan Order)
OFP	Order of Friars Preachers (Dominican Order)
OSB	*Ordo Sancti Benedicti* (Order of St. Benedict)
OSV	Order of St. Victor
PDAP	Parchment Damage Assessment Program
RAH	Real Academia de la Historia
SC	Santa Cruz (normally associated to a MS number)
Sec. Can.	Secular Canons
SERS	Surface-Enhanced Raman spectroscopy
Ts	Shrinkage Temperature
UV-Vis	ultraviolet-visible
v	verso (the back of a folio)
XMT	X-ray microtomography

TABLE OF CONTENTS

INDEX OF FIGURES

INTRODUCTION

CHAPTER I. THE ART OF PORTUGUESE ROMANESQUE ILLUMINATIONS

CHAPTER III. LAC DYE IN PORTUGUESE *SCRIPTORIA*

FINAL CONCLUSIONS

INDEX OF TABLES

INTRODUCTION

CHAPTER I. THE ART OF PORTUGUESE ROMANESQUE ILLUMINATIONS

CHAPTER II. THE PORTUGUESE BOOKS OF BIRDS

CHAPTER III. LAC DYE IN PORTUGUESE SCRIPTORIA

‘The art of the Middle Ages does not hold up a perfect “globed fruit”

but leads one in a walk along converting and diverging paths’

Marry Carruthers 2010: 190

INTRODUCTION

1.1. Preamble

Manuscripts are one of the most significant and privileged instruments of culture (Nascimento 2012: 269). They can carry languages, knowledge, technology, artistic value as well as signs of use that linger with time. As carriers of the memory of humankind, they are one of the richest and most precious cultural heritages of our civilization. Indubitably, its preservation is vital in order to defend our cultural legacy; as these illuminated manuscripts, beyond their intangible value, are also made of tangible materials, which can and will perish over time.

During Middle Ages, monasteries were fundamental in the perpetuation of literature as well as in the creation of art (Benton 2009: 1). The religious orders assumed the role of main cultural producers as well as intellectual centres while profound changes – in the political, religious, economic and demographic field – were taking place. These fragmentations swayed, in a crucial manner, the main artistic manifestations that developed in this new Western Europe that would later be known as Christendom (Rucquoi 2005: 299).

As these new religious orders embraced a new weight and significance in the cultural life of the Middle Ages – by transmitting knowledge through teaching, copying and producing intellectual and artistic work –, several dramatic reforms[1] within the Church were being held (Rucquoi 2005: 309). 'Among the most dramatic aspects of the movement of reform in the eleventh and twelfth centuries was the sheer number of new religious communities and forms of life and of men and women from all over Europe who were attracted to them' (Constable 1996: 44). As a consequence, both lay men and women started joining monastic orders in a vast number, or searching for new devotional spiritual practices at home (Dykema 2011: 98). As Linda Paterson (1998: 312) explains:

> 'In the late eleventh century the fire of reform flamed in the faithful of western Europe. Christians everywhere hungered for spiritual renewal through the purification of pilgrimage and crusade. They venerated the saints and holy relics, founded new parishes and monasteries, expressed their religious fervour and yearning for perfection in a profusion of Romanesque art and architecture (...)'.

[1] These reforms, which should not be mentioned as only a general 'reform', include a broad range of movements. Some say that it started in the 10th century with the attempts to return to the purity of monastic rule, and others say that it started around 1040 and 1070. However, these were mostly associated to the period between 1070 and 1100 with Popes Gregory VII and Urban II, who led to the suppression of the Hispanic liturgy, the persecution of the heresy and the adoption of the roman liturgy (Hamilton 2013: 8; Constable 1996: 4; Mattoso 1993: 552).

Within this process, books were the main vehicle for the dissemination of Christianity, mainly through the Bible. At that time, literature was, to a great extent, a literature for the Christian Church, written by and for the clergy. In the monastic library, the scribes were mainly copying the Sacred Scriptures, their commentaries, liturgical texts, Christian authors and abundant moralised, ascetic, mystical, hagiographic and monastic works (Rucquoi 2005: 317).

The monastic libraries, but above all their scriptoria, were the sustaining 'machinery' (Reynolds and Wilson 1991: 81) for the preservation and dissemination of ancient texts and Latin literature. Over the centuries, most of these testimonies and works of art were only accessible to a small number of people, remaining as secluded and secret objects.

Opening an illuminated medieval manuscript can be seen as disclosing a precious jewellery box: a world of vivid and bright colours is unveiled. Reminiscent of precious gemstones or stained glass, in medieval thought, these materials were highly valued due to their ability 'to embody or generate light' (Gage 2006: 20), which in turn made them possess an additional theological significance (Huxtable 2014). Consequently, medieval knowledge on technological art was considered an important skill, which was frequently seen as a craftsman secret artistry. During Middle Ages, various written sources on artistic technological information, in the form of manuals, treatises or recipe books, were made (Clarke 2001a). The presence of such sources in a scriptoria setting would influence tremendously the manuscript production. However, much of the knowledge behind and within colours has been lost throughout the centuries, namely their meaning in that particular social, religious and political context as well as their process of manufacture (i.e. by synthesis or purification).

Hence, this research aspires to bring an innovative approach and methodology of work to the study of illuminated manuscripts – particularly within the circulation of copies and/or models –, where social sciences and humanities as well as hard sciences are combined, in order to provide a holistic study that embraces both material and immaterial qualities of these works of art.

1.2. An overview of the state of the art for medieval manuscripts

Up until recent decades, research on medieval manuscripts was mainly carried out by literature sciences and art history. In the 1990s, the identification of colour materials and painting techniques in illuminated codices started to emerge, in a new research field established within conservation science. Regardless of its interest for social sciences and vice-versa, the dialogue between both research areas is still limited, although with some exceptions, that will be further discussed. As the exchange of knowledge is becoming increasingly and necessarily transdisciplinary over time, the tendency to develop more converging discourses will almost certainly define the next decades.

In the field of Conservation Science

The study of medieval manuscripts' materials within conservation science[2] has evolved tremendously within the last decades. In 2001, Mark Clarke made a review on this matter, stating that 'considering the large amount written about medieval manuscript decoration there have been surprisingly few analyses published' (Clarke 2001b: 3). Previous to this statement, the materials in medieval manuscripts were indeed rarely or inaccurately identified. The lack of suitable techniques and the undesirability to remove samples were two of the main reasons why the characterisation of pigments and dyes in illuminations were so difficult and uncommon. The first attempts to identify manuscript materials were from the late 18th century and were mainly based on visual assessment (Clarke 2001b: 5). As several researchers would later state, sole visual examination was an unfit and inaccurate method (Porter 1995; Clarke 2004a). While other unsuitable and deficient techniques such as micro-chemical tests were used, the development in the 1980s and 1990s of spectroscopic techniques, such as Raman spectroscopy, would revolutionize the way art works were analysed (Clarke 2001b: 6).

The increasing awareness of the scientific community for the preservation of this type of cultural heritage was boosted by the arising of new analytical techniques that allowed clear identification of painting materials. Raman spectroscopy was one of the first techniques that really opened the interest for the study of illuminations, due to its *in situ* applicability. As many museums, libraries and archives prohibit the removal of micro-samples, the advent of *in situ* analytical techniques opened a window for the characterisation of these cultural objects.

[2] Conservation science is broadly defined as a field that aims 'to quantitatively help in solving problems related to understanding the nature of ancient and art materials and processes, the interpretation of these materials with respect to human cultural history, and to aid in preservation and conservation of the objects for the future' (Artioli 2010: 1).

Some of the first published works on the identification of pigments in medieval illuminations began with the pioneering studies conducted by Robert Fuchs, Claude Coupry, Doris Oltrogge, Salvador Muñoz Viñas and Mark Clarke (Guineau *et al.* 1986; Viñas and Farrell 1992; Fuchs and Oltrogge 1994; Mrusek *et al.* 1995; Coupry 1999, 2011; Viñas and Farrell 1999; Oltrogge 2011; Clarke 2004b, 2011a). Their ground-breaking systematic interdisciplinary work allowed the identification of colorants at the molecular level as well as at their cultural context. Their contributions enabled to establish some of the most typical materials found, for example, in High Middle Ages French scriptoria (Guineau *et al.* 1986; Coupry 1999, 2011), in Renaissance Neapolitan manuscripts attributed to specific Italian miniature painters (Viñas and Farrell 1992, 1999) or in 7^{th}-11^{th} century Anglo-Saxon manuscripts (Clarke 2004b). The research group from Ghent University is also worth of mentioning as they were one of the first teams to attempt to correlate materials with specific scriptoria, through a multi-analytical approach, despite not having pursued a systematic line of research (Van Hooydonk *et al.* 1998; Wehling *et al.* 1999; Vandenabeele *et al.* 1999; Vandenabeele and Moens 2004; Deneckere *et al.* 2011).

Other researchers made significant contributions, in the 1990s, for the establishment of Raman and Fourier transform infrared (FTIR) spectroscopies as useful and informative analytical techniques for medieval illuminations (Porter 1992; Best *et al.* 1992, 1995; Clark 1995a, 1995b; Clark and Gibbs 1998; Burgio *et al.* 1997; Bruni *et al.* 1999). By the beginning of the 21^{st} century, these techniques were becoming more accepted and widespread. By this time, multi-analytical approaches begin to be used for illuminated manuscripts, in order to obtain complementary information. This was mainly possible because the improvement in some of these techniques and equipments allowed, for example, the use of smaller micro-samples – which was imperative for illuminations –, or the use of *in situ* applications. Hence, since the 2000s, a numerous amount of techniques such as X-ray diffraction (XRD), FTIR, X-ray fluorescence (XRF), Raman, Ultraviolet-visible spectroscopy (Uv-Vis), Laser-induced breakdown spectroscopy (LIBS), Hyper-Spectral imaging, Fiber optics reflectance spectroscopy (FORS), Particle-induced X-ray emission (PIXE) and Scanning electron microscope (SEM) started to be applied in manuscripts and in combination with each other (Scott *et al.* 2001; Melessanaki *et al.* 2001; Gilbert *et al.* 2003; Moura *et al.* 2007; Bruni *et al.* 2008; Burgio, Clark and Hark 2010; Picollo *et al.* 2011; Delaney *et al.* 2014).

The characterisation of dyes in illuminated manuscripts is known as one of the most challenging research areas. For many years, the majority of the already mentioned studies were

mainly associated to the identification of inorganic pigments[3]. Taking this into account, the pioneering work conducted by several researchers throughout these last two decades should be highlighted (Roger, Villela-Petit and Vandroy 2003; Schmidt and Trentelman 2009; Romani *et al.* 2010; Melo and Claro 2010; Melo *et al.* 2014; Aceto *et al.* 2012a, 2014 and 2015).

With the establishment of science conservation for illuminations, several researchers have published reviews, analytical protocols and *modus operandi* meant for the analysis of these specific works of art (Pessanha, Manso and Carvalho 2012; Aceto *et al.* 2011, 2012b; Melo *et al.* 2011; Doherty *et al.* 2013).

More recently, new research projects solely dedicated to this cultural heritage have emerged, such as the RICH project (Reflectance Imaging for Cultural Heritage)[4] coordinated by Lieve Watteeuw and Bruno Vandermeulen and the MINIARE project (Manuscript Illumination: Non-Invasive Analysis, Research and Expertise)[5] coordinated by Stella Panayotava and Stephen Elliot. Some of its team members, such as Paola Ricciardi and John Delaney, have done commendable work throughout these years on the development of non-invasive techniques for illuminations (Ricciardi *et al.* 2009; Ricciardi and Delaney 2011; Ricciardi *et al.* 2012; Ricciardi *et al.* 2013; Delaney *et al.* 2014).

Within the Portuguese context, since 2005, a team led by Maria João Melo (Conservation Scientist) and Adelaide Miranda (Art Historian) have embarked on a journey to unravel the lost knowledge within medieval technology and art (Melo *et al.* 2011; Miranda and Melo 2014; Melo, Castro and Miranda 2014). Their research has grown over the course of three funded projects where a systematic study on the history, materials and techniques of 12th and 13th centuries Portuguese medieval illuminations has been undertaken[6]. These projects had as focal studies three different scriptoria: São Mamede of Lorvão, Santa Cruz of Coimbra and Santa Maria of Alcobaça, which were the most important production centres during the Romanesque period in the recently formed Portugal. The three collections were studied under the framework of several PhD dissertations: Lorvão (Claro 2009; Correia 2014), Alcobaça (Miguel 2012) and

[3] With the exception from indigo that was already being molecularly identified through Raman spectroscopy in manuscripts since the 1990s (Porter 1992; Burgio, Clark and Gibbs 1999).
[4] For more information, please visit https://portablelightdome.wordpress.com/category/rich-illuminare/. Retrieved in September 2015.
[5] For more information, please visit http://www.miniare.org/Project.php. Retrieved in September 2015.
[6] *An interdisciplinary approach to the study of colour in Portuguese manuscript illumination*, POCTI/EAT/33782/2000; 2005-2007; *The identity of Portuguese medieval manuscript illumination in the European context*, PTDC/EAT/65445/2006; 2007-2009; *Colour in medieval illuminated manuscripts: between beauty and meaning*, PTDC/EAT-EAT/104930/2008.

Santa Cruz, which in 2009 was preliminarily studied under a MOLAB access[7], and now comprehensively assessed in this dissertation.

During these 10 years, a *modus operandi* for the analysis of illuminated manuscripts has been developed (Melo *et al.* 2011), where the advance of new *in situ* methodologies for the identification of historical colourants (Claro *et al.* 2009; Melo and Claro 2010; Claro *et al.* 2010; Castro *et al.* 2014; Melo *et al.* 2014; Melo *et al.* 2016b), research on paint binding media formulations (Miguel *et al.* 2012; Mas *et al.* 2014), study of degradation phenomena (Miguel *et al.* 2009; Muralha, Miguel and Melo 2012; Melo *et al.* 2016a) and the building of a database of references for colorants, binders and colour paints (Vitorino 2012; Miguel 2012; Melo and Miguel 2012; Miguel *et al.* 2014; Castro *et al.* 2014; Vitorino *et al.* 2015; Castro, Miranda and Melo 2016) have been carried out.

Overall, these studies have shown that the colorant materials used for medieval illuminations suffered several changes during the broad period of the Middle Ages (5th to 15th century), Table 1[8]. For instance, blues were not extensively used in earlier medieval manuscripts: 'Up until the tenth and eleventh centuries, many miniatures do not contain even a hint of blue, especially those produced in the British Isles and the Iberian Peninsula' (Pastoureau 2001: 40-41). During the Carolingian empire, blue becomes more present in medieval illuminations, particularly through the use of indigo, as seen in manuscripts such as the 8th-9th c. *Book of Kells* (Bioletti *et al.* 2009; Doherty *et al.* 2013) and the 8th c. Lindisfarne Gospels (Brown and Clark 2004). From the 10th century onwards, the presence of lapis lazuli becomes more frequent (Clarke 2004b; Baraldi *et al.* 2009; Nastova *et al.* 2013), with the exception of the 6th c. *Vienna Dioskurides*[9]. Azurite will be present during the entire Middle Ages, but its use in illuminations will be more frequent from the 14th century onwards, as a less expensive substitute for lapis lazuli, in admixtures of lapis lazuli, indigo, or by itself (Bruni *et al.* 2008; Ricciardi *et al.* 2009; Picollo *et al.* 2011; Lemos *et al.* 2014; Melo *et al.* 2014).

[7] MOLAB report from 2009: http://www.eu-artech.org/files/MEDMAN-UserReport.pdf. Retrieved in September 2015.
[8] This survey is important for a timeframe contextualisation of the materials that have been identified in illuminated manuscripts, but also vital for the understanding of the colour systems in Romanesque illuminations that will be presented ahead in this study.
[9] Although the authors believe that no retouching was made to the 6th c. *Vienna Dioskurides* manuscript (Aceto *et al.* 2012a), it is preferable to assume its presence with reservations or as an exceptional case.

Table 1. Colourants identified in European medieval manuscripts[10].

	6th	7th	8th	9th	10th	11th	12th	13th	14th	15th
Indigo	●		●	●	●	●	●	●		●
Lapis lazuli	●				●	●	●	●	●	●
Azurite							●	●	●	●
Vergaut	●	●	●	●			●	●		
Verdigris based		●	●	●	●	●	●	●	●	●
Basic copper sulphate										●
Malachite										●
Orpiment + azurite/lapis lazuli									●	
Lead tin yellow + azurite/indigo										●
Red lead	●	●	●	●	●	●	●	●	●	●
Vermilion	●			●	●	●	●	●	●	●
Red ochre	●	●	●		●		●		●	●
Lac dye							●	●		
Brazilwood										●
Red dyes (not specified)	●	●	●				●		●	●
Orpiment	●	●	●	●	●	●	●	●	●	●
Organic yellow		●	●				●	●	●	●
Lead tin yellow									●	●
Mosaic gold									●	●
Yellow Ochre	●	●	●					●	●	
Orchil dye			●	●						
Purple dye (not specified)	●		●	●						●
Carbon black			●	●	●	●	●			●
Grey (Carbon black/ indigo +lead white)		●					●	●		
Lead white	●	●	●	●	●	●	●	●	●	●
Gypsum			●	●		●	●	●	●	●
Chalk		●	●		●	●	●	●	●	●
Cassiterite (tin oxide)										●

[10] The survey was established from a set of 197 bound manuscripts, manuscript cuttings and single folios, based on the following published works: Aceto *et al.* 2010, 2012a, 2012b; Bersani *et al.* 2006; Best *et al.* 1995; Bicchieri *et al.* 2000, 2011; Bioletti *et al.* 2009; Brostoff *et al.* 2010; Brown and Clark 2004; Bruni *et al.* 1999; Burgio *et al.* 1997; Clark 1995b; Clarke 2004b; Coupry 1999, 2011; Delaney *et al.* 2014; Deneckere *et al.* 2011; Gilbert *et al.* 2003; Guineau *et al.* 1986; Lemos *et al.* 2014; Melo *et al.* 2011, 2014; Melo, Castro and Miranda 2013; Muralha *et al.* 2012; Picollo *et al.* 2011; Ricciardi *et al.* 2009, 2013; Scott *et al.* 2001; Trentelman *et al.* 2009; Viñas and Farell 1992, 1999.

The use of green pigments or mixtures in manuscript illumination suffered also changes throughout Middle Ages. For earlier codices, a predominant use of the mixture entitled *vergaut* made of indigo and orpiment has been documented for the dark greens (Clarke 2004b; Bioletti *et al.* 2009; Aceto *et al.* 2012a). This mixture tends to become superseded by green copper based pigments, in the Romanesque period. However, verdigris based pigments were already being used in earlier manuscripts (Clarke 2004b; Brown and Clark 2004; Doherty *et al.* 2013), and continued to be used as the prime source of green for the Romanesque period (Miguel 2012; Muralha *et al.* 2012; Ricciardi *et al.* 2013). Malachite, despite being known since Antiquity, only started to be widely used in the 15th century onwards as a likely substitute for the more unstable verdigris in medieval illuminations (Ricciardi *et al.* 2013; Melo *et al.* 2013). The use of sulphate coppers, such as posnjakite, brochantite, langite and antlerite have been also reported in Gothic and Renaissance illuminations (Gilbert *et al.* 2003; Melo *et al.* 2014). Moreover, mixtures of azurite or indigo and lead-tin yellow type II to produce green have been also reported for the same time period (Gilbert *et al.* 2003; Melo *et al.* 2014).

In the case of the reds and oranges, in the earlier medieval times, red lead was used as the main source of red for manuscript illumination (Brown and Clark 2004; Bioletti *et al.* 2009; Aceto *et al.* 2012a). The first evidences on the utilization of vermilion date to the 9th century (Coupry 1999; Clarke 2004b), with the exception once again from the 6th c. *Vienna Dioskurides*, which should be carefully considered as it is the only known example for such early period[11] (Aceto *et al.* 2012a). With time, the presence of vermilion becomes more dominant in relation to red lead (Baraldi *et al.* 2009). Red ochre was also used through the entire Middle Ages; however its presence in illuminations seems to be diminutive, as the use of vermilion becomes the main choice[12] (Clarke 2004b). Furthermore, organic reds have been also reported since earlier medieval times, but their characterisation has been a longstanding issue. These dye sources may be identity markers for a certain region, time frame or even scriptoria, however it is a territory still little explored. As already stated, very few studies have been able to identify organic dyes with some level of certainty, in medieval illuminated manuscripts. In this dissertation, lac dye will be established as the sole choice for dark reds in Portuguese Romanesque illuminations (Castro *et al.* 2014). On the other hand, in the 15th century brazilwood pigment lakes, with its characteristic bright pink colour as well as dark red glazes, will be identified in several French and Flemish books of hours (Roger, Villela-Petit and Vandroy 2003; Melo *et al.* 2014).

[11] The article in question, Aceto *et al.* 2012a, refers another 6th c. Codex named *Vienna Genesis*, but the conditions into which the manuscript was analysed are poorer as the folios were kept between polyacrylate sheets, making only possible to characterize the paints by FORS and XRF (the latter had also issues with the interference of the polymer, particularly with the lighter elements). Therefore, it was not considered for this survey.

[12] Red ochre was most likely considered a poorer choice, as the colour was not as vivid as vermilion.

The materials to produce yellows were probably the ones that suffered more changes throughout Middle Ages. In addition to orpiment as the preferable choice in earlier manuscripts, organic yellows were also used since early times (Clarke 2004b, 2011; Deneckere *et al.* 2011; Melo, Castro and Miranda 2014)[13]. Still the lack of analytical methodologies to characterize these paints and its frequent degradation constitutes a challenge for conservation science. With the beginning of the 14th century, other yellow pigments and dyes emerged, such as lead-tin yellow and mosaic gold (Bersani *et al.* 2006; Bicchieri *et al.* 2011; Melo *et al.* 2014). Yellow ochre, such as goethite, has been also reported throughout Middle Ages (Clarke 2004b; Bicchieri *et al.* 2011; Melo *et al.* 2014).

The use of purples, such as Tyrian purple, orchil and folium, has been reported in earlier medieval manuscripts[14]. However, this type of colour tends to wane during the Romanesque period[15], returning later during Gothic and Renaissance[16], with the orchil dye and its related litmus[17], for example. Nevertheless, the lack of knowledge that still exists regarding these dyes – particularly their molecular structures – and the challenges that they still currently pose, whether by their fading, their reconstruction through ancient or medieval technical treatises or the obstacles in analysing them, should be noted. In spite of this, the interest in these dyes has increased in the last few years, and for that reason, it is very likely that more information on the identification of these colorants may arise with the development of new advanced methods and use of historically accurate reconstructions.

Ultimately, the only colours that did not undergo any significant changes during Middle Ages were the black and white pigments, which were already known since Antiquity and remained unchanged.

---

[13] It is interesting to note that several studies refer the presence of a bright light yellow, but unfortunately its characterisation is still to be disclosed.

[14] Orchil was identified by means of fluorescence and Raman spectroscopy and in purple details of the 8th-9th c. *Book of Kells* (Romani *et al.* 2008; Bioletti *et al.* 2009). A mixture of orchil and folium is proposed for the 6th century *Codex Brixianus* by XRF, FORS and fluorescence spectroscopy (Aceto *et al.* 2014). Orchil dye was also identified in the 9th century *Bible de Théodulfe* through UV-Vis fluorescence combined with resonance Raman spectroscopy and confirmed by LC/QTOF-MS (Rosi *et al.* 2013). Please notice that some other studies have reported the identification of these dyes in earlier medieval manuscripts; however they were not considered here, since they were solely based on FORS.

[15] It was reported the presence of a purple in the 12th c. *Liber Floridus*, made of likely caput mortuum, a purple iron oxide mineral (Deneckere *et al.* 2011).

[16] The colour purple starts to be seen again in pen-flourished initials during the 14th and 15th centuries (Brown 1994: 97). The characterisation of purples has been mainly observed in works of art from 16th c. onwards. Orchil was identified by means of Raman spectroscopy in a *Map of Auvergne* from 1544 (Rosi *et al.* 2013). At the DCR-FCT-UNL, orchil identifications were also obtained by Raman spectroscopy in a 16th century Portuguese *Atlas of Fernão Vaz Dourado* (Melo *et al.* 2013; Melo *et al.* 2016b) and in a 17th century Portuguese *Commitment book* from Almada (Barrosa *et al.* n.d.).

[17] The main differences between the orchil dye and the litmus, both produced by the extraction of lichens from the *Roccella tinctoria*, is that the latter adds stronger alkaline solutions, such as $Ca(OH)_2$, K_2CO_3 or $CaSO_4$ (Cardon 2007: 489).

As for the binding media, 'the invisible component of the paint' (Melo *et al.* 2011: 160), it has been in medieval illuminations a less explored matter, mainly due to the analytical restrictions that most researchers face with the lack of analytical techniques that allow its identification without micro-sampling. FTIR has been the preferable analytical technique for its characterisation. It has been observed – within the few studies that have tried to identify the binder in colour paints – that the use of different binders has been also shifting in the course of the Middle Ages, particularly with the transition between proteinaceous to polysaccharide binders. In the Romanesque period, protein based binders have been systematically identified (Miguel *et al.* 2012), while 15th century illuminations have been associated more consistently with the use of polysaccharides, such as gum Arabic, or a mixture of both (Melo *et al.* 2014, Lemos *et al.* 2014), which is in agreement with the medieval treatises of that period (Kroustallis 2011; Clarke 2011b). The development of innovative analytical techniques in this area is bringing new perspectives for a crucial but much neglected issue for the preservation of colour (Nevin *et al.* 2007; Mazurek *et al.* 2008; Ricciardi *et al.* 2012; Miguel *et al.* 2012; Mas *et al.* 2014).

In the field of Art History

As already pointed out at the beginning of this state of the art, the social sciences and humanities field within the study of medieval manuscripts was much earlier developed then the conservation science domain. As a broad and vast research field, the background here presented will be mainly focused on the advances made on the study of Portuguese Romanesque manuscripts, but still by beginning to present a very brief contextualisation on the international perspective.

Research on medieval illumination, as systematic studies, dates back to the middle of the 19th century and beginning of the 20th century, where the interest in defining its origin, period styles and techniques started to emerge (Denis 1860; Middleton 1892; Quaile 1897; Bradley 1920; Herbert 1911). From 19th century forwards, library and museums' catalogues and exhibition books became increasingly recurrent, by presenting their collections and analysing their characteristics through style, provenance and date. In recent times, some studies have tried to offer comprehensive and wide-ranging surveys concerning the study of medieval illuminations (Robb 1973; Pächt 1986; Brown 1994; De Hamel 1997; Clemens and Graham 2007).

Regarding technical and material aspects on the production of manuscripts, fewer historians have explored this matter. Middleton was one of the firsts to present two chapters on the materials and technical processes of the illuminator (Middleton 1892: 224-256). Later, in

1956, Daniel V. Thompson made a broader and detailed study for medieval painting (Thompson 1956). More recently, further significant contributions explicitly for illuminated manuscripts have been published, such as the ones from Jonathan J.G. Alexander (Alexander 1992), Christopher de Hamel (De Hamel 1992 and 2001) and Mark Clarke (Clarke 2001a, 2011).

Within the study of bookbinding production – a research field with still much to explore – , major contributions have been made by some researchers, through the definition of typologies and structural properties within particular time periods and regions (Vezin 1973; Federici 1993; Clarkson 1993; Szirmai 1999; Lanoë 2008).

Overall, the references to Romanesque Portuguese manuscripts within an international context will be practically nonexistent, until the end of the 20th century. These studies will be fundamentally associated to individual manuscripts, such as the Lorvão's Apocalypse and Book of Birds (Clark 1999; Klein 2004; Cordonnier 2011).

Within the Portuguese context, illumination studies previous to the mid-80s were reduced to a small number of works that mostly sought to highlight individual artistic manuscripts (Martins 1963; Egry 1972). Since then, some pioneering effort has been undertaken by a group of researchers that marked the real commencement of the study of Portuguese Romanesque medieval manuscripts. It should be highlighted the major contributions done by Aires A. Nascimento, which has focused on so many fundamental topics, such as provenance, production, history and cataloguing within three of the most important monasteries of that time: São Mamede of Lorvão (Nascimento 2012b), Santa Cruz of Coimbra (Nascimento and Meirinhos 1997) and Santa Maria of Alcobaça (Nascimento and Diogo 1984; Nascimento 1992). His work along António D. Diogo on the study of the Alcobaça bookbindings was also paramount for the comprehension of the production specificities from that particular Portuguese scriptorium, as it was also noteworthy from an international point of view[18] (Nascimento and Diogo 1984). In one of his most recent works *Ler contra o tempo. Condições dos textos na cultura portuguesa (recolha de estudos em hora de vésperas)* from 2012, Nascimento gathers some of his most significant studies, where philology, codicology and Latin literature converge.

Art historian Adelaide Miranda has defined as well a turning point for the study of Romanesque illuminations in Portugal, particularly with her groundbreaking studies on the collections from Santa Maria of Alcobaça (Miranda 1984, 1996a) and Santa Cruz of Coimbra (Miranda 1996a, 1996b). Her numerous contributions have also been allied to the scientific coordination of exhibition catalogues (Miranda 1999a) and special issues on medieval illuminated manuscripts (Vieira da Silva and Miranda 2009; Miranda, Melo and Clarke 2011;

[18] Their work had a significant impact on the international bookbinding study from Szirmai 1999.

Miranda and Cavero 2014), having collaborated, in this last decade, with the Department of Conservation and Restoration from the Faculty of Sciences and Technology (DCR-FCT) in interdisciplinary projects for the study of Portuguese illuminations – as already described.

Other researchers have also contributed significantly for the study of 12th and 13th centuries Portuguese manuscripts, namely José Meirinhos (Meirinhos 1995; Nascimento and Meirinhos 1997; Meirinhos 2000), through his significant analysis on Santa Cruz's medieval collection; Horácio A. Peixeiro (Peixeiro 1998) and Ana de Oliveira Dias (Dias 2012) with studies around one of the most important and well-known Portuguese manuscript: Lorvão's Apocalypse; Maria Isabel Gonçalves (Gonçalves 1999) with the transcription and translation of the Portuguese Book of Birds, based on the São Mamede of Lorvão copy.

A group of researchers from the Institute of Medieval Studies (IEM, Instituto de Estudo Medievais), from FCSH-UNL, have also been very active on the study of 12th-13th century manuscripts in Portuguese collections. The recent and collective published works on Brepols and on the Invenire special number (Miranda and Cavero 2014; Guedes de Campos 2015) are the reflection of this new impetus to the study of book illumination in Portugal.

In the field of art technological sources

Research into written technological sources is a relatively young field of investigation that gathers art history, conservation science, but also other disciplines such as economics, social history, anthropology and aesthetics (Hermens 2012: 151). It plays a key role on the interdisciplinary approach of technical art history, to the extent that it can provide information about artists' materials and techniques, combining the preparation of 'reconstructions of historical recipes for a better understanding of the artistic process, the changes in appearance of the artwork, as well as for a correct interpretation of primary source material itself' (Hermens 2012: 162).

As this research field became more vital for art history and conservation science, several researchers decided to create the *Art and Technological Source Research* (ATSR) group in 2002. Four years later they were accepted as the 23rd working group from ICOM-CC. Their work has been focused on creating a forum of discussion where knowledge on sources for artists' materials and techniques are shared as well as systematic appropriate methodologies for this type of research. Throughout these years, they have shared their knowledge through a series of conference proceedings, where the actual research field is discussed, new sources of technological treatises are presented, and the application of reconstructions for the interpretation

of scientific data on artworks is explored (Clarke, Townsend and Stijnman 2005; Kroustallis *et al.* 2008; Hermens and Townsend 2009; Eyb-Green *et al.* 2012; Dubois *et al.* 2014).

Salvador Muñoz Viñas and Mark Clarke have reported some of the most recognized historical written sources for medieval painting techniques and materials (Viñas 1998; Clarke 2001a). Most of these treatises have been published in critical editions in English or Italian translations, such as the *Mappae Clavicula*, *Il Libro dell'Arte*, *De Arte Illuminandi*, the *Libro de komo se fazen as kores*, the *Segretti per Colori*, the *Schedula Diversarum Artium*, the Strasbourg manuscript, the Jehan Le Begue manuscripts, the 'Göttingen Model Book', just to name a few (Smith and Hawthorne 1974; Thompson 1954; Brunello 1992; Blondheim 1928; Merrifield 1967; Hawthorne and Smith 1979; Borradaile and Borradaile 1966; Lehmann-Haupt 1972). Some of these sources will be later explored in Chapter III.

In the field of Colour study

Finally, the study of colour, although 'still a relatively neglected aspect of the history of art' (Gage 1990: 518), is beginning to disclose itself as an individual field of research, that embraces a 'territory with ragged borders located somewhere between the sciences and the arts' (Brusatin 1991: 6).

John Gage and Michel Pastoureau have made paramount contributions in the past decades (Gage 1999a, 1999b, 2006; Pastoureau 1998, 2001, 2004, 2008, 2014). Both scholars believe that the study of colour in Western art needs to be developed along broadly anthropological lines (Gage 1990; Pastoureau 1989a). The complex nature of colour can be explained in the following manner:

> « La couleur n'est pas seulement un phénomène physique et perceptif; c'est aussi une construction culturelle complexe, rebelle à toute généralisation sinon à toute analyse, et qui met en jeu des problèmes nombreux et difficiles. C'est sans doute pourquoi, au sein des études médiévales, rares sont les travaux qui lui sont consacrés, et plus rares encore ceux qui envisagent avec prudence et pertinence son étude dans une perspective vraiment historique. (…) La couleur est d'abord un fait de société » (Pastoureau 2004: 113).

Taking into account the multifaceted cultural history behind colour meaning, few researchers have endeavour on the approach of its intricate analysis into medieval manuscripts (Bolman 1999; Pulliam 2013; Castro, Melo and Miranda 2014; Miranda and Melo 2014).

1.3. Research aims and methodology

This PhD project was carried out within the framework of the interdisciplinary project *'Colour in medieval illuminated manuscripts: between beauty and meaning'*. As part of an extensive and broad research investigation developed by several members of the project, this study aimed to sprout some of the branches that were designed and produced within the group[19] as well as bring new seeds to the investigation. By converging knowledge from both sides, this doctoral thesis was developed in order to open new possibilities of research, using the Book of Birds manuscripts produced in Portugal as main examples.

On this dissertation, three main objectives were established and, consequently, presented into three separate chapters – schematised in Fig. 1:

I. The study of the materials, techniques and state of conservation of the 12th-13th century illuminated manuscripts from the monastery from Santa Cruz of Coimbra;
II. The full and comparative assessment of the Portuguese Books of Birds;
III. The study of lac dye in medieval written sources and its presence in Romanesque Portuguese illuminations.

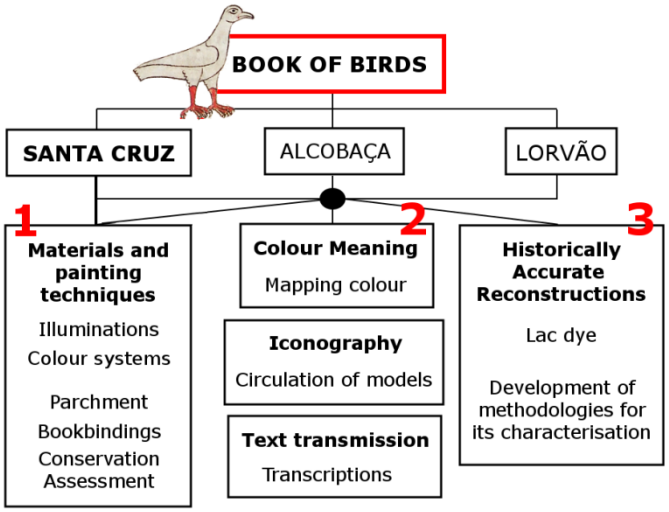


Figure 1. Scheme of the research design followed in this project.

The key aim of this thesis revolved around the study of three Portuguese manuscripts that contained a work called *De Avibus* (Book of Birds) from Hugh of Fouilloy – a 12th century text that was widely copied during the 12th and 13th centuries in Europe –, which were produced in the three monasteries of São Mamede of Lorvão, Santa Maria of Alcobaça and Santa Cruz of

[19] By this it is meant the work that was developed by all of the researchers that were involved on this project as well as on the previous two projects coordinated by Maria J. Melo and M. Adelaide Miranda – the names and references of each project are already mentioned in sub-chapter 1.2.

Coimbra. While Lorvão and Alcobaça scriptoria had been fully studied from a material and technical point of view in previous doctoral dissertations (Claro 2009 and Miguel 2012), Santa Cruz was still in need of a proper and comprehensive study, which could also ultimately support the study of the Books of Birds.

A MOLAB team from the University of Perugia, led by Aldo Romano, conducted an on-site investigation, during 2009, to the BPMP collection[20]. The results from that significant work were only preliminarily assessed on a brief report[21]. In 2011, a new on-site investigation was performed as part of the *Colour in medieval illuminated manuscript: Between beauty and meaning* project. The main goal of this operation was to examine more in-depth some of the manuscripts, by taking micro-samples that could allow laboratory analysis, and consequently, the application of more specific analytical techniques[22]. Therefore, on Chapter I, the experimental work developed in the second on-site investigation was compared with the MOLAB data in order to present the most complete interpretation of the painting materials used in Santa Cruz. A correlation between the monastery from Coimbra and the other two abbeys was also conducted.

Beyond the pictorial layer, this work also aimed to go further by studying the bookbindings and parchment support from Santa Cruz, from a conservation perspective, in order to assess its state of conservation, understand its archaeology, and sequentially, correlate each element with the whole, so that proper measures may be taken in a near future. The parchment evaluation was done according to the directives from the IDAP (Improved Damage Assessment of Parchment) methodology (Larsen 2007) and based on the application and adaption from Inês Correia approach[23] (Correia 2014). An assessment on the bookbinding typologies from Santa Cruz was conducted and their main conservation issues assessed. A prototype, based on the *De Avibus* manuscript SC 34, was also created in order to better understand its construction and present state of conservation.

Finally, in order to study the usage of colour during Middle Ages, a mapping tool was developed by João Lopes and Jorge Sarraguça and systematically applied during this thesis to the three Portuguese collections. This application was essential for the work developed by

[20] The manuscripts will be presented ahead in Chapter 2.2.
[21] MOLAB report from 2009: http://www.eu-artech.org/files/MEDMAN-UserReport.pdf. Retrieved in September 2015.
[22] The multi-analytical approach chosen for this task was based on previously published work, where the *modus operandi* for analysing medieval manuscripts was established within the DCR-FCT (Melo *et al.* 2011).
[23] Inês Correia was the first to apply the IDAP methodology into the Lorvão collection, based on a manuscript perspective (Correia 2014).

Maria João Melo and Adelaide Miranda[24] on their findings about the meaning behind the colour used in the three Portuguese scriptoria and how illuminated manuscripts worked under colour systems (Melo, Castro and Miranda 2014; Miranda and Melo 2014). Drawing on their approach, some specific considerations regarding the usage of colour, particularly in the Santa Cruz collection, were made.

In Chapter II, the main core of the investigation is presented as it tries to combine all of the methodologies developed in this dissertation into a unique approach for the study on the circulation of manuscripts. Taking into account the three copies from the Book of Birds, from distinct Portuguese scriptoria, this study aimed to correlate their materials, iconography, colour meaning and text, with regard to rectify chronologies, establish new associations between the three manuscripts within an international context, and ultimately, unravel the importance and uniqueness of these manuscripts for the history of art. Their state of conservation was also assessed, through the IDAP methodology.

From a broader scope, this project aimed to pose a number of essential questions: From the Portuguese *De Avibus* manuscripts, which copy served as example? Is it possible to establish a correlation between their painting materials with their production sites? Can other perspectives, such as codicology and text analysis, bring also new information on their circulation? Finally, on a wider intention, did the Book of Birds present deliberate colour meaning? And, did the illuminators assumed a passive or active role in the production of the copies?

The works *The medieval Book of Birds*: *Hugh of Fouilloy's Aviarium* by Willene B. Clark and *L'illustration du 'De Avibus' de Hugues de Fouilloy: Symbolisme Animal et Méthodes d'Enseignement au Moyen Âge* by Remy Cordonnier were fundamental sources for the elaboration of this study (Clark 1992; Cordonnier 2007).

Finally, Chapter III explores a particular issue within, not only the Books of Birds, but also with the Portuguese Romanesque manuscripts, in general. This research aspired to develop an analytical methodology that could be suitable for the identification of dyes in manuscript illuminations, already demonstrated in the state of the art as one of the most challenging obstacles for the characterisation of illuminated codices. This involved prepping historically accurate reconstructions, based on recipes described in medieval written sources. In addition of

[24] A global and comprehensive colour interpretation of the three main Portuguese scriptoria has been conducted by the two researchers, bringing new insights on its meaning through the mapping colour tool. These results will be soon fully presented and published.

aiming to recover a forgotten technology, it also aimed to create a solid database that could support and validate the interpretation of the results obtained from the applied analytical techniques. Surface-enhanced Raman spectroscopy (SERS) and microspectrofluorimetry were used here for the first time as complementary techniques to characterize lac dye paints. This work was partially conducted at the Department of Scientific Research of the Metropolitan Museum of Art (MET), where the main SERS analyses were made. The specificities within scriptoria were also assessed as well as the cultural significance behind the use of lac dye.

I. THE ART OF PORTUGUESE ROMANESQUE ILLUMINATIONS

I. THE ART OF PORTUGUESE ROMANESQUE ILLUMINATIONS

1. Introduction

During High Middle Ages, the territory which is now known as Portugal had a very different cultural scene. From the 4th to the 8th century, there were almost nonexistent traces of literary works (Mattoso 1969: 3) and the art that was produced during that period and that survived to the present day was primarily based on architecture, sculpture, ceramics and metals. The Suevi and the Visigoths that were settled in the north-western Peninsula were Arianists, which meant that they were not in favour of the representation of the sacred. With the Muslim occupation, in the 8th century, this absence of human figuration in a sacred context was also maintained (Melo *et al.* 2014: 172). However, this distaste for figurative art will have an end with the introduction of a new cultural and revolutionary era that would much appreciate images, and use them as vehicle of knowledge (Miranda 1996: 26-32; Rodrigues 1995: 201).

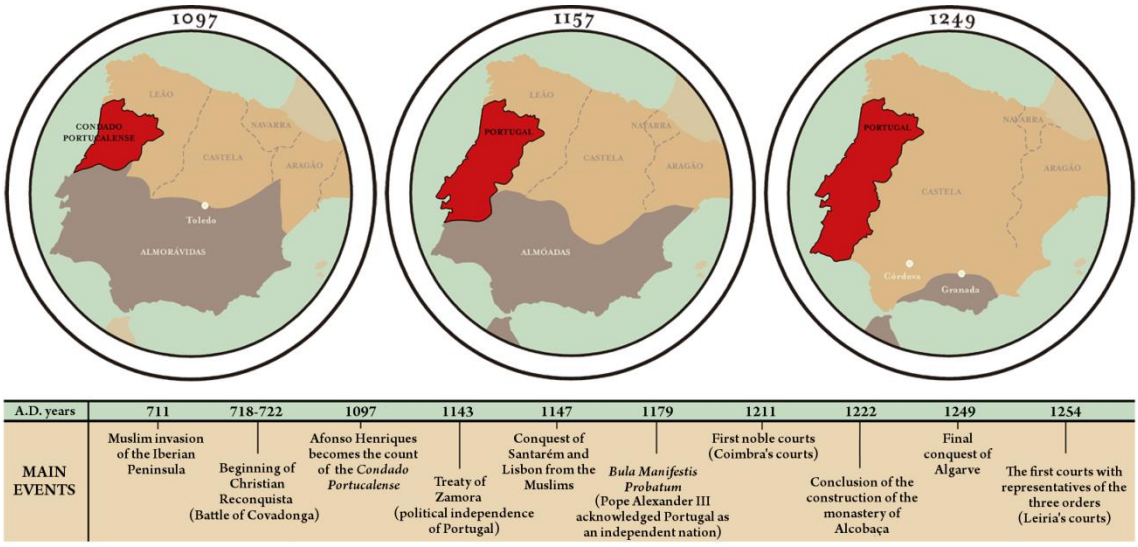


Figure 2. The formation of the Kingdom of Portugal during the Christian Reconquista[25].

With the Christian Reconquista, Fig. 2, after the Arab invasion to the Iberian Peninsula, Portugal faces one of its most important historical periods – its genesis – which also carried major reforms into its religious institutions. The presence of the Muslim communities bequeated the Visigoth rite to many small monasteries of family or seigniorial patronage, where it still subsisted often the tradition of the *regula mixta*. The second half of the 11th century was marked by French influence, with the dissemination and implementation of the reform by the Cluny monks (Emiliano 1997: 91). With the repossession of the lands, the Visigoth rite started to be

[25] Scheme adapted to English from the interactive panel (Correia 2014: 9-11) created in the framework of the funded project 'Colour in medieval illuminated manuscripts: between beauty and meaning' (PTDC/EAT-EAT/104930/2008).

replaced by the Roman rite as new monastic orders began also to emerge (Miranda 1984: 11-12). The significant cultural contribution given by the Visigoths and Muslims served as a melting pot for the artistic expressions that started to be developed during this turbulent period. It is within the monastic orders, linked to the very formation of Portugal as an independent kingdom, that the main cultural scene will be developed, as they become the main artistic producers and educational centres.

1.1. The three main Portuguese monasteries

During the Romanesque period, the three most important scriptoria from Portugal: São Mamede of Lorvão, Santa Cruz of Coimbra and Santa Maria of Alcobaça, were all located in the same region as strategic sites to control the Portuguese borders from the Muslim offensives, Fig. 3. The 12th century was one of the most unsettling periods in the North of Portugal, due to the Muslim threat and the inherent dispute for independence of the Christian kingdoms. The presence of these monasteries was not only vital for the community as educational and cultural centres, but also as peacekeepers and social stabilizers (Mattoso 1993).

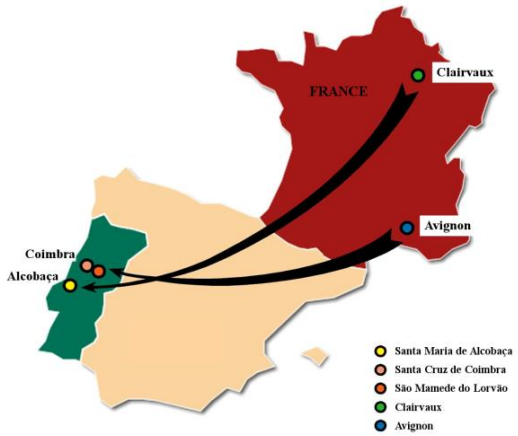


Figure 3. Map illustrating the Portuguese monasteries of São Mamede of Lorvão, Santa Cruz of Coimbra and Santa Maria of Alcobaça, with their related French motherhouses.

The foundation of the monastery of São Mamede of Lorvão is the most unclear; as there is little documentation on the date it was founded. This abbey situated in close proximity to Coimbra, near the main courses from the Mondego River, was most likely settled between 857 and 917[26] (Melo *et al.* 2011: 155). Before the arrival of the first Cluny monks, at the end of the 11th century, most monks in the Occident followed the system called *regula mixta*, also known

[26] Based on recent studies on the *Chartularium Laurbanense*, also known as the *Liber Testamentorum* from the Lorvão monastery, Aires Nascimento proposes the year of 857 for its foundation, based on the Count Hermenegildo, who according to the six historical events written in the back of the Cartulary, took Coimbra in 878; while Fernández Catón proposes 907 or 917, however more convinced on the latter (Mattoso 2009; Borges 2002).

as ‘mixed rules’. It adopted several behaviours based on, not only on rules that were given in a *codex regularum*, but also in local traditions (Borges 2002: 77-78). Therefore, in its primordial times, the Lorvão monastery was mainly dedicated to the Iberian monachism tradition[27] (Nascimento 2008: 95-96,102), having agreed to accept the St. Benedict Rule after 1085 (Mattoso 1997: 80-83; Borges 2002: 79; Miranda and Melo 2014: 5).

During the 12th century, the monastery lived what its thought to be its most dynamic period, with the increasing interest on the establishment of a written cultural expression, fed by the new Benedictine reform[28] (Meirinhos 2000: 1-3). It is believed that the monastery had its own scriptorium, regardless the reduced number of manuscripts that survived to the present day (Miranda *et al.* 2008: 229-230). Despite the small number of texts, some of these codices are considered as some of the most important testimonies of the cultural history from this newborn country. Unfortunately, only 18 manuscripts from that period have reached the present day; the collection, currently held at the National Archives of Torre do Tombo (Arquivo Nacional da Torre do Tombo, ANTT), is considered as ‘heterogeneous’ due to the variety of types of work, artistic styles and provenance (Melo *et al.* 2014: 172).

The scarcity of manuscripts is sometimes associated to the abrupt moment that took place in the 13th century, when the bishop of Coimbra, D. Pedro Soares, expelled the monks in order to allow the transformation of the monastery into a Cistercian female house, in 1206[29]. With the arrival of the nuns, the scriptorium most likely ceased its work[30]. This would explain why the production was not continued. The meagre number of existing manuscripts may be also due to the departure of the Benedictine monks, who may have taken with them part of the collection.

Christian medieval Coimbra was born in 1064, when the city was conquered by King Ferdinand I, called the Great (*Magno*), on July 9 of that year (Martins 2003: 105). Before 1130, the cultural centres in Portugal were the monasteries and the diocesan offices. The monasteries were still receiving the first new impetus of the introduction of the Cluny rules, but at the same

[27] This Iberian monachism was profoundly influenced by the ‘frutuosiano’ monasticism, led by St. Frutuoso, who wrote the *Regula Monachorum*, which had a more austere vision than of St. Isidore, but assuming its influence and also from other Patristics – also known as Church Fathers –, such as St. Benedict (Borges 2002: 79).

[28] Although still attached to the Iberian monasticism thought, the Lorvão monastery was already being influenced by the Rule of St. Benedict, through the growing interest in standardizing the use of liturgical and ritual texts under the authority of the Sacred Scriptures and the Patristics (Correia 2014: 69).

[29] Dona Teresa, daughter of the Portuguese King D. Sancho I, joined the monastery with her nuns, after the annulment of her marriage with King Alfonso IX of León. Though the first reference to the presence of the nuns dates from 1206, it was only in 1211 that the litigation between D. Teresa and the monastery ended. Only after that interference, which ended up involving pope Innocence III, it was possible to settle the queen and her nuns in the monastery with the status of the Cistercian Order (Vasconcelos e Sousa 2005: 117). It becomes to be called as the monastery of Santa Maria of Lorvão.

[30] ‘(…) from 1206, the date from which it starts to follow the feminine Cistercian, we believe it will no more have a scriptorium even though it continues to enrich its library’ (Melo *et al.* 2011: 149).

time, the importation of books and fresh concepts were starting to arrive from France. The diocesan offices organized their canonical services, collected books and taught young clerics how to adopt the new Roman liturgy, sustained by the religious reforms (Mattoso 1993: 262).

In June 28 from 1131, the monastery of Santa Cruz of Coimbra was founded, by several diocesan clergy in the company of Dom Telo, archdeacon from the Cathedral of Coimbra, who was considered the main head of this project (Gomes 2001-2002: 479). Around this year, D. Afonso Henriques abandons Guimarães, the former residence of the Counts of Portucale, and moves to Coimbra[31] (Mattoso 1993: 64). By settling there, the king was able to move more easily in the territory, increasing his authority above the stately nobility and endowing the city with the necessary structures. This allowed him to make political and economical decisions that he was not able to execute in the North. Moreover, it allowed him to have direct contact with the Mozarabic culture, leading to the preservation of important traditions that came from the Muslim world, such as the Visigoth liturgy and some popular mores, which were absent in the North (Martins 2003: 115-116; Mattoso 1993: 68).

The monastery, since its rise, relied on the support and donations from the royalty and nobility. D. Afonso Henriques becomes the most faithful protector of Santa Cruz. Consequently, the abbey starts to be the cultural centre for the court as well as one of the most active and influential cultural sites across the country (Miranda 1996b: 3; Mattoso 1993: 68-69).

The religious community that settled in the monastery followed the regular Canons of Saint Augustine through the guidelines of St. Ruf of Avignon[32], Fig. 3. The canons were related to Avignon, but also to Italy, where they travelled frequently, and to the Holy Land, where they tried to follow the example of their founder, S. Teotónio. The first reformists tried to return to the ideals of a primitive Church, giving priority to preaching[33]. This was their way to seek for the origins of Christianity. Without refusing the Roman Rite, they also introduced some habits and possibly legitimized indirectly some Mozarabic traditions, which lingered in the territory (Miranda 1996a: 62; Mattoso 1993: 262; Martins 2003: 143).

[31] These were also turbulent times in the political governance of Portugal, during the years of 1128-1139. Around 1130, D. Teresa surrendered to his son D. Afonso Henriques the County, after being defeated in S. Mamede. This was also what led him to move to Coimbra. The Battle of Ourique, in 1139, would be the turning point for D. Afonso Henriques as he starts to be claimed and also act as a king (Martins 2003: 189).

[32] According to Adelaide Miranda, the connection between Saint Ruf and its daughter abbeys was tenuous and would only represent the adoption of the same customs and an obedience visit every two years (Miranda 1996a: 61).

[33] Santa Cruz became known for hosting Saint Anthony of Padua in his youthful years – one of the greatest preachers of that time. The manuscripts from the library of the monastery were certainly fundamental for his development during those crucial years, as many will be later mentioned or cited in his sermons (Antunes 2006: 388-9).

According to Saul A. Gomes, the *armarium* from the monastery of Santa Cruz counted on the great effort from the Canons scribes. They copied manuscripts by sending the monks to St. Ruf of Avignon and Santiago de Compostela, but also by locally producing above all texts of liturgical nature as well as biblical, theological and historical subjects (Gomes 2001-2002: 481). The Santa Cruz scriptorium is one of the few examples where there are early records of its activity. A document from c. 1140 reports how Teresa Soares ordered a book of the *Moralia in Iob* for the price of 30 maravedís[34], for example (Nascimento and Meirinhos 1997: LXIX).

The collection of manuscripts that have survived to the present day is composed of 99 codices, preserved at the Public Library of Porto (Biblioteca Pública Municipal do Porto, BPMP) (Nascimento and Meirinhos 1997). However, the number of manuscripts that had their origin at the Santa Cruz scriptorium, is considered to be around 60 units (Gomes 2001-2002: 481). There are approximately nowadays 36 illuminated manuscripts, from which a significant number had its origin there, dating until the first quarter of the 13th century (Melo *et al.* 2011: 155).

It is believed that the implementation of the Cistercian Order in the Iberian Peninsula was tardy (Rucquoi 2000: 3). The first monastery in Portugal adopting their ideals was São João of Tarouca[35]. In 1153, the monastery of Santa Maria of Alcobaça was established – the 53rd daughter abbey from Clairvaux – as an agreement to develop the plan of expansion from the Cistercian Order[36] (Miranda 1984: 9). It is known that D. Afonso Henriques offered the lands to the Cistercians. According to Artur Nobre de Gusmão, the king was counting to have benefits with this settlement, as in one hand it would value the region and, on the other hand, it would also support his idea of forming an independent Portuguese Church (Nobre de Gusmão 1992: 43)[37].

The Cistercians adopted some of the concepts presented by the Rule of St. Benedict, particularly with the matter of the manual labour, to which the hours of liturgy had to be

[34] The earliest manuscript that survived to the present day is from 1139. However, there are no references of its scriptorium origin.
[35] There are some researchers that believe that the Monastery of Lafões may have adopted Cistercian ideals prior to Tarouca: 'Ainda que seja irrefutável que pertença a Tarouca o primeiro documento em que expressamente se faz menção da Ordem de Cister, bem como seja aceitável ter sido este o primeiro mosteiro cisterciense fundado em Portugal, certas ficam muitas dúvidas quanto ao lugar cronológico de Lafões no movimento cisterciense português' (Marques 1998: 44).
[36] This is also the year in which the mentor of the Cistercian Order, St. Bernard of Clairvaux, dies. «(…) au temps de saint Bernard : alors qu'à l'entrée du jeune novice à Cîteaux en 1112 n'existe que cette seule abbaye de moines blancs, l'ordre compte à la mort de l'abbé de Clairvaux, en 1153, environ 350 abbayes réparties dans toute la chrétienté latine» (Locatelli 1992: 103).
[37] In a broader spectrum 'A Cistercian monastery could be a marker of power and authority, and in some areas it was part of a push to colonise new lands, especially ones that had been recently converted' (Burton and Kerr 2011: 50).

reduced. With the admission of the lay brothers[38], the manual work starts to be their responsibility, by assuring the material life in the monastery (Miranda 1996a: 76-78).

The cultural role from the Cistercians is known to have been extremely important. Adelaide Miranda states that the *armarium* of Alcobaça was one of the most important libraries, in the early days of the monarchy, with the biggest projection in Portugal. Additionally, it could be equated as one of the most important Cistercian libraries in the monastic Europe (Miranda 1996a: 13). For José Mattoso, the importance of the library is well established by the numerous manuscripts they imported from their French associations as well as its scriptorium, where the monks copied many manuscripts since the 12th century. However, Mattoso adds that there are no known original works from that period and, that from the architectonical point of view, the construction of the abbey of Alcobaça was a representation of an imported foreign model (Mattoso 1993: 263). As a result, this abbey was most likely particularly faithful to its French influences. This will have important repercussions on their manuscript production, as it will be demonstrated ahead in Chapter II.

The Alcobaça scriptorium possessed a set of 456 manuscripts from the Middle Ages currently held at the Portuguese National Library (Biblioteca Nacional de Portugal, BNP), of which around 160 were illuminated and produced during the last quarter of the 12th century and first quarter of the 13th century (Nascimento 1992: 151; Melo *et al.* 2011: 156).

The profound changes observed in these Romanesque monasteries throughout the centuries and the lack of documentation has deprived the insight of knowing where and how their scriptoria worked and functioned. However, there are no doubts that they existed, taking into account the number of manuscripts that have survived to the present day (Nascimento 1992; Miranda 1999a).

The libraries from Alcobaça and Santa Cruz were enriched by their respective scriptoria, but also by the circulation of manuscripts between their affiliated monasteries, together with the donations made or given to the most prestigious and productive centres of that time (Melo *et al.* 2011: 148). It is also believed that between the canonical abbey and the Cistercian Abbey of Alcobaça, there were also traces of practice of exchange and loan (Gomes 2001-2002: 482). As for Lorvão's library, the latter exchanges would have not been so clear, since the monastery did not comprise an evident affiliation. There are, however, evidences that point out some connections between the scriptoria of Lorvão and Santa Cruz as well as the connection with the Cathedral of Coimbra. The monastery recruited its first scribes from the Diocese of Coimbra, for example (Cruz 1964: XIV). Despite its short time period connection, this episode may have

[38] The role of the lay brothers in the monastery will be further discussed ahead in Chapter II.

reinforced the bonds that existed between both monastic houses and may have perhaps provided some occasional exchanges between their scriptoria.

Throughout the history of these monasteries there are several evidences that there were existing connections and communications between them, whether by the circulation of common texts, or by the use of the same kind of iconographic models in their scriptoria (Miranda 1984: 182-191). The *De Avibus* Portuguese manuscripts, which will be later scrutinized in Chapter II, are a good example of this type of associations that may have existed at that time.

1.2. The collections from the three Portuguese scriptoria

As part of a larger-scale research, this investigation requires a broad contextualization on the three Portuguese scriptoria as they will contribute and impart significantly in this study[39].

As already mentioned, the monastery of Lorvão has currently a reduced collection of 18 manuscripts that have survived to the present day. Works based on the Sacred Scriptures, Latin Patristics, Hagiographies or Lectionaries, are some of the texts that seem to have mainly interested Lorvão's monks (Correia 2014: 70). The *Enarrationes in Psalmos* (1183) from Saint Augustine, the *Commentarium in Apocalypsin* (1189) from Beatus of Liébana and the *De Avibus* (1184) from Hugh of Fouilloy, are some of the earliest references of illuminated manuscripts in Portugal with colophon. The *Commentary on the Apocalypse* is considered to be one of the most unique produced manuscripts in Portugal, due to its rich iconographic program[40] (Melo, Castro and Miranda 2014: 172). The main focus of selection was given to the manuscripts dating from the Iberian monachism period, until de Cistercian period, which began in 1206.

Santa Cruz and Alcobaça monasteries shared some common interests concerning their library contents, such as the prevailing presence of works related to the Latin Patristics (Melo *et al.* 2011: 156), mainly through the authors St. Ambrose, St. Augustine, St. Jerome, St. Gregory and Beda (Miranda 1996a: 92). In the case of the Greek Patristics, Alcobaça tends to present more early Christian theologians such as Origen, St. John Chrysostom, St. Ephrem the Syrian, St. Cyprian, St. Athanasius of Alexandria, Eusebius of Caesarea and John of Damascus, while Santa Cruz only has Origen and Eusebius of Caesarea (Melo *et al.* 2011: 156). This taste for earlier Greek Christian writers in Alcobaça was incited by St. Bernard who esteemed their spiritual ideas based on asceticism (Miranda 1996a: 92; Melo *et al.* 2011: 156).

[39] In addition to the study of the three Books of Birds (Chapter II), the three scriptoria will be also addressed in the study of lac dye (Chapter III).
[40] The Beatus (the name commonly used to refer the *Commentary on the Apocalypse*), including the Alcobaça copy, were recently considered a Memory of the World by UNESCO.

Encyclopaedias were also present in both libraries with Saint Augustine's *De Doctrina Christiana*, Saint Isidore's *Ethimologies*, St. Bede's *De Rerum Naturam* and Hugh of Saint Victor's *Didascalicon*[41] (Melo *et al.* 2011: 157). Important 12th century theologians and homileticians, such as St. Bernard and Hugh of Saint Victor, were also present in both monasteries, with works such as *Sermones in Cantica Canticorum* (ALC 357), *Sermones* (SC 33), *De Sacramentis* (SC 16, ALC 156), *Tratactus in Expositione Ecclesiastis* (ALC 242), among others. Contrary to what expected, St. Bernard is not the most represented author in Alcobaça, even though his works spread rapidly through the library (Miranda 1996a: 97-98; Melo *et al.* 2011: 157). Hugh of Fouilloy, another 12th century author, less renowned compared to the other two writers, stands out also in the three Portuguese collections with his work *De Avibus*, and other texts that will be present in Santa Cruz, but chiefly in Alcobaça[42].

Hagiographies were also well represented in Alcobaça, though less present in Santa Cruz, while liturgical books – such as Psalters, Missals, Lectionaries and Sacramentaries – were quite significant in Alcobaça and Santa Cruz collections. Apart from these representative groups of codices, the bible was evidently an important manuscript for both libraries, when taking into consideration its magnitude and high quality execution. While in Santa Cruz, the only existing Bibles (i.e. SC 1, SC 2 and SC 3) solely gather the Old Testament, Alcobaça has both Old and New Testaments (i.e. ALC 427, ALC 158) represented in its *armarium* (Melo *et al.* 2011: 157).

Within the three scriptoria, a group of 38 manuscripts were selected from the monasteries of São Mamede of Lorvão (9), Santa Maria of Alcobaça (15) and Santa Cruz of Coimbra (14) held at the ANTT, BNP, and BPMP, respectively, as case studies in the framework of the aforementioned research projects started in 2005 at the DCR-FCT. The selection was made according to their chronology – which was settled between the 12th and 13th centuries, as part of the Romanesque period –, and on their artistic value, which was evaluated according to a certain type of ornamentation style within each scriptorium as well as by their chromatic properties. Also, in some cases, the choice was also made taking into account analogous texts in order to compare different scriptoria through the same work, such as the most evident *De Avibus*, but also through Lectionaries and Psalters present in the three collections and the *Ethymologies* from Santa Cruz and Alcobaça, for example.

A detailed list of the selected manuscripts, with the specified analysed folia, can be found in Appendix I.

[41] Saint Augustine's *De Doctrina Christiana* (SC 51), Saint Isidore's *Ethimologies* (SC 17, ALC 446), St. Bede's *De Rerum Naturam* (ALC 446) and Hugh of Saint Victor's *Didascalicon* (ALC 155).

[42] The work *De Claustro Animae is* represented in Santa Cruz ms. 48 (13th c.), however it is incomplete. The work was wrongly attributed to a Hugo Floriacensis (Nascimento and Meirinhos 1997: 236-237). As for Alcobaça, several works by Fouilloy, including the *De Claustro Animae*, are gathered in the ALC 238, which will be discussed further ahead in Chapter II.

1.3. Colour in Portuguese Romanesque illuminations

In Romanesque Portugal, the manifestation of colour in an artistic framework was mostly perceived through illuminated manuscripts, since it was the only painted form of art expression that has arrived to the present day, from this particular period in Portugal (Melo, Castro and Miranda 2014: 170).

Throughout these 10 years of research led by Maria João Melo and Adelaide Miranda, the materials and techniques applied in Portuguese Romanesque manuscripts have been unveiled and valued[43]. Although the country was geographically located in a periphery, artists were using precious materials that came from distant courses, travelling long distances through Arab and Jewish trade routes. It was also possible to acknowledge the privileged access that Portugal had, during that period, to the most advanced science and technology, due to the multi-cultural activity in the country (Melo, Castro and Miranda 2014: 171).

During the 12th and 13th centuries, illuminators used some of the best colorants available at that time, as seen in Fig. 4: vermilion, red lead – also known as *minium* –, orpiment, lac dye[44], lapis lazuli, indigo, green synthetic copper proteinate – named as *bottle green*[45] –, white lead, carbon and bone black. In a much more seldom presence, malachite, azurite and gold were also found in medieval illuminations[46]. In Appendix II, a table with all the pigments and dyes identified and the number of time they appear in the three collections for each manuscript are presented.

[43] The colour source and how it was used in middle Ages was perceived as meaningful qualities for artists when selecting their materials: 'The wealth and costliness of the colours and the authenticity of their use constitute the basis for the value and appreciation of the painting' (Brusatin 1991: 49); 'It was not only the source of the best raw materials of colour that was particularly valued by artists, but also their place of manufacture' (Gage 2006: 112).

[44] The presence of lac dye, previously to this study, was only identified in a micro-sample from Lorvão 5, fol. 6 in an infrared spectrum, through the characteristic bands from shellac. This will be further discussed in Chapter III.

[45] The name *bottle green* was termed by Adelaide Miranda, due to the characteristic shinny deep saturated green observed in the medieval green paints, much similar to a green glass bottle.

[46] These identifications have been mainly associated to the Lorvão scriptorium. From the 38 manuscripts, malachite was only detected in two folia from two manuscripts: *Book of Kalends* Lv. 17, fol. 169v, attributed to the 13th c. (Claro 2009: 67); azurite was detected in mixtures with lapis lazuli or indigo in the following manuscripts: Lv. 5, Lv. 15, Lv. 16, Lv. 17 and ALC 433 (Claro 2009: 94 and Miguel 2012); and gold was only found in two manuscripts: *The Creation,* fol. 95v from Lorvão 5 – applied directly to the parchment – and in the *Enarrationes in Psalmos,* Lorvão 50 – applied over a preparatory layer (Claro 2009). It is believed that the latter material was most likely avoided in Portuguese monastic scriptoria, in order to prevent the ostentation of wealth, as it would go against their believes. Pastoureau also refers the ethical issues behind its use: «L'or, en effet, pose un problème éthique. Lumière, il participe de l'échange avec le divin: c'est le bon or. Mais, matière, il exprime la richesse terrestre, le luxe, la cupidité: c'est une *vanitas*» (Pastoureau 2004: 146).

Figure 4. The Portuguese Romanesque palette. Although included, azurite, malachite and gold were seldom used (Design by Maria João Melo and Nuno Gonçalves).

Vermilion red was widely used in all of the manuscripts. It was applied as pure pigment in letterings and red paints, but also admixed with chalk or red lead – particularly in the Lorvão's Apocalypse – for more extensive painting. According to Miguel (2012: 121-123), this pigment was possibly brought from the Spanish mines of Almadén (Miguel *et al.* 2014). Dark reds, also commonly present in the illuminations, were made with lac dye, as it will be demonstrated in detail in Chapter III. Red lead was used as pure paint, or applied below other colours, such as dark reds, pinks or whites, to produce volume effects, known as *matiz*[47]. Orpiment was less often employed. It was mostly applied once again as pure pigment or in mixture with indigo, as *vergaut*[48]. An 'organic yellow'[49] was also found in all scriptoria, with more extent in Santa Cruz; however, its characterisation is still an ongoing project[50]. Lapis lazuli was the preference choice of blue for Portuguese Romanesque illumination. It was mostly used as pure paint, although it was found admixed with azurite – in rare occasions[51] – lead white for lightened shades or indigo for darkened colours. Dark blues were obtained by adding indigo to lapis lazuli or by using pure indigo. A deep saturated green, composed of a green synthetic

[47] *Matiz* is a term that signifies how colour was modelled in order to produce a sense of volume, through highlights of white or pale colours. Montpellier treatise has references to it and it is also discussed in Clarke 2011b: 191-192.
[48] Found in the ALC 249 manuscript from Alcobaça (Miguel 2012: 54) and in SC 1 and SC 43 from Santa Cruz as it will be presented hereinafter.
[49] This 'organic yellow' will be for now on described in inverted commas due to its unknow characterisation, since it is not certain that a yellow dye has been used.
[50] The study of the 'lost yellows' – name given by Mark Clarke in his article about the issues surrounding the identification of yellow organic colorants in medieval illuminations (Clarke 2011a) – is being currently studied by Paula Nabais in her PhD.
[51] Azurite appears in mixtures with lapis lazuli or indigo in the following manuscripts: Lv. 5, Lv. 15, Lv. 16, Lv. 17 and ALC 433 (Claro 2009: 94 and Miguel 2012).

copper proteinate[52], found ubiquitously in all manuscripts, was always applied as a single colour. The whites and highlights were applied with white lead, and the black colour, both carbon black and bone black, were employed. Pink and grey colours were consistently applied in Alcobaça manuscripts. These were obtained by adding lead white to red or black – or to dark blue indigo. Finally, there was a specific brown colour, found in six manuscripts from Alcobaça, whose characterisation still remains uncertain, as it might be a degraded organic colorant or a particular type of polysaccharide gum (Miranda *et al.* 2008; Miguel *et al.* 2009b; Melo *et al.* 2011; Muralha *et al.* 2012; Miguel 2012).

It is noteworthy to state that one of the main characteristics in medieval Romanesque painting is that pigments were mainly applied pure, which means that mixing pigments was not typical for this period. As Pastoureau (2001: 72) would mention: 'In the medieval conception of nature, the mixing, melding, fusing, or amalgamating of disparate elements were all viewed as infernal processes because they violated the natural order of things established by the Creator'[53], but above all it is believed that medieval illuminators were aware that mixing colours could lead to loss of luminosity[54].

Binding Media

The binding media in Portuguese Romanesque manuscripts has been consistently characterised has a proteinaceous binder (Melo *et al.* 2011: 160), which can be made of egg white, parchment glue or egg yolk. By means of chemometrics methodologies used to infrared spectra of medieval paint colours, Miguel *et al.* 2012 and Mas *et al.* 2014 were able to establish that parchment glue and egg white were often used separately or in mixtures of different proportions, while egg yolk seems to have been absent in the medieval paints, or in very minor amounts in a few of them. The use of mixtures or combinations of binders in medieval manuscripts was quite common, when looking at treatises from that period (Kroustallis 2011).

Painting Techniques within scriptoria

In each monastery, the painting technique, whether in the drawing or colour construction, revealed similarities as well as specificities within each scriptorium. They translated their cultural influences through style, ornamentation and colour.

[52] The manufacturing process of this green colour is still under study. The investigation started with Catarina Miguel (Miguel 2012) and it is being further developed by Juliana Buse in her PhD still ongoing.
[53] 'Colour-mixing had been little practised in antiquity for largely ideological reasons: nature should not be interfered with by man; mixture produced change, which was a bad thing' (Gage 2006: 8).
[54] Philip Ball describes precisely what happens when pigments are mixed: 'Each time a pigment is added to a blend, another chunk of the spectrum is subtracted from the reflected light. As a result, the colour gets duller and murkier' (Ball 2008: 44).

These monasteries seemingly integrated in their scriptoria a great knowledge from art technological treatises. Ranging from the traditional ancient *De Architectura* by Vitruvius (1st century BC) or the *Historia Naturallis* by Pliny the Elder (1st century), to the medieval compilation of *Mappae Clavicula* (9th-12th centuries) or the *De Diversis Artibus* (12th century) by Theophilus, for example. These two latter sources were most assumably present in Portuguese monasteries. There are references of a lost copy of the *Mappae Clavicula* on a document from 1218 in Santa Cruz of Coimbra. This copy was borrowed by Master Gil together with other scientific texts. The *Mappae Clavicula* was included in a miscellaneous volume with, for example, *Macer Floridus* by Otto of Meung and *Liber Lapidum* by Marbodus of Rennes[55] (Cruz and Afonso 2008: 12-13). It is also believed that the *On Diversis Artibus* was very likely present in Alcobaça, due to the painting technique used on the 13th century Alcobaça's *Etymology* (ALC. 446) where the technique to paint flesh in fol. 96v is closely related to the instructions given in Chapters 3-9 by Theophilus (Miguel 2012: 16-17).

In a considerable number of manuscripts, *matizes* and hightlights were used in order to express volumetric shapes and produce enhanced colour dimensions. This means that the colours were only mixed – mostly with lead white for pinks or light blues, for example – and then juxtaposed or applied side by side with pure paint colours. Blending colours in *degradé* (gradient) was not common at that time, therefore *matizes* were an optical illusion that illuminators used to give that impression. This particular technique was mainly observed in Alcobaça and more rarely in Lorvão – for example, in manuscripts such as ALC 249, 347, 412, 419, 446 and Lorvão 50, in Fig. 5.

The described style in Alcobaça came from an understandable influence: Clairvaux, the Mother Abbey. With St. Bernard's severe directives on image and colour[56], the Cistercian scriptorium of Clairvaux started to follow a monochromatic austerity, restricting the decoration to the major initials[57]. In Alcobaça, this austerity was also followed mainly in the initial manuscripts by restraining the decoration to initials and letters within a monochromatic atmosphere (Miranda 1984: 152). But later on, for example, in liturgical books, illuminators tend to used the *matizes* and highlights to create volume and exuberance (Melo *et al.* 2011:

[55] The description is as follows: 'Macer cum Lapidario et cum suis apendicijs et cum Mapa Clauicula ad aurum faciendum et cum [...] ad plantandas arbores et cum multjs experimentis' (Cruz 1964: 193).
[56] St. Bernard regarded colour as an impure useless luxury, a *vanitas*. He perceived colour as *turbidus*, *spissus* and *surdus*. Instead of bright or brilliant, he believed that colours were opaque, shadows for light. «La couleur n'éclaire pas, elle obscurcit, elle étend la part des ténèbres, elle est suffocante, elle est diabolique. Le beau, le clair, le divin, qui sont tous trois émergence hors des opacités, doivent donc se détourner de la couleur et, plus encore, *des* couleurs» (Pastoureau 2004: 138).
[57] «Le «Troisième style», enfin, celui que j'ai nommé le style monochrome, puisqu'il est fondé sur la monochromie des initiales peintes, peut indiscutablement être considéré comme un style bernardin. Il apparaît à Cîteaux et à Clairvaux dans les années quarante du XIIe s., mais sa meilleure période se situe pendant le troisième quart de ce siècle, donc après la mort de Bernard» (Zaluska 1992: 284).

164). Alcobaça tends to reflect a Byzantine influence, which is also present in manuscripts from the same period produced in Italy, Cataluña, Bourgogne and Champagne (Melo *et al.* 2011: 164).

Figure 5. Details on the painting techniques found in the collections from São Mamede of Lorvão (DGARQ-ANTT), Santa Maria of Alcobaça (BNP) and Santa Cruz of Coimbra (BPMP). From left to right, Lv. 44, fol. 17; Lv. 5, fol. 4; Lv. 16, fol. 71v; Lv. 13, fol. 6v; Lv. 50, fol. 1v; ALC 249, fol. 91v; ALC 347, fol. 3; ALC 412, fol. 10v; ALC 419, fol. 1v; ALC 446, fol. 96v; SC 1, fol. 37; SC 20, fol. 191; SC 20, fol. 144; SC 21, fol. 19; SC 34, fol. 94v.

As for the Lorvão scriptorium, the heterogeneity of the collection and its reduced number of manuscripts, does not allow a cohesive comprehension of its characteristic style and technique. Based on the scarce information available, it is possible to observe influences from the Iberian monachism, by giving emphasis to the drawing and use of strong pure colours in backgrounds, with Lorvão's Apocalypse as the quintessence of that style[58]. But, another type of style is also observed, as already mentioned, that is more related to the observed in Alcobaça. Lorvão manuscripts 12, 13, 15[59] and 17 embrace that new style, which for some art historians, may be related to a new palette – when the monastery became Cistercian in 1206 – or to the possibility that these manuscripts may have been produced, not in Lorvão, but in Alcobaça (Miranda and Melo 2014: 6).

On the following sub-chapter, it will be demonstrated that Santa Cruz style embraced a completely different practice, more focused on the use of pure colours through contrasting

[58] Due to the location of the monastery from São Mamede of Lorvão, still very influenced by the rich Mozarabic culture, the Apocalypse blended all of those influences. Some researchers say that the interest in reviving the *Commentary on the Apocalypse* in the 12th c. – the original text was written in the 8th c. and the most ancient surviving copies are from the 9th-10th centuries – was a foreshadowing of the dreadful times that were ahead for Christians in that territory (Miranda 1996a: 433).
[59] Lorvão 15 is thought to be most likely a production from the Alcobaça scriptorium, from an art history and musicology perspectives (Freire 2007: 437-456; Miranda 1999a: 230; Ferreira 2013).

polychromatic palettes in the background. The drawing assumes a prominent position within the painting, particularly with the usage of anthropomorphic and zoomorphic figures, which dominates its iconography – much more than in Alcobaça or Lorvão. The highlights are given in light and brilliant yellows, providing a sense of volumetry, which is different from the usage of the *matizes* seen in the other two monasteries.

2. Santa Cruz collection

A set of 14 representative manuscripts from the BPMP were selected for this study, based on their chronology – 12th to 13th century –, illumination style and texts: Santa Cruz 1, 2, 4, 11, 18, 20, 21, 27, 30, 34, 43, 58, 72.

In this chapter, the aesthetics and painting techniques in this collection will be presented, the characterisation of the materials and paint formulations will be discussed, and the state of conservation of the pictorial layers, the parchment support and the bookbindings from Santa Cruz will be assessed. The colour patterns and choice of palettes within the Santa Cruz scriptorium will be compared with the other Portuguese scriptoria through the colour mapping tool, taking into account the cultural meaning behind colour.

2.1. Illuminated Manuscripts from Santa Cruz

According to Adelaide Miranda, the Romanesque illuminations from Santa Cruz can be defined into three time periods: from 1139 to mid-12th century, from mid-12th century to late 12th century and first quarter of the 13th century (Miranda 1996a: 409).

1st Phase: 1139 to mid-12th century

Figure 6. From left to right, *Homiliarium* (BPMP, Santa Cruz 4, fol. 1, 1139), *Historia Ecclesiastica* and other texts (BPMP, Santa Cruz 30, fol. 1v, 1126-1175) and *De Genesi ad litteram imperfectus* and other texts (Santa Cruz 58, fol. 1v, 1139?).

From this initial period, there are three manuscripts that were chosen for this study: SC 4 (1139), 30 (1126-1175) and 58 (1139?), Fig. 6. They represent the oldest illuminated manuscripts from Portugal, as no prior examples have survived to the present day. These works embody archaic elements that disclose their strong influence from the Mozarabic world as well as reflections from Cluny (Miranda 1996a: 413).

The *Homiliarium*[60] of Santa Cruz (SC 4) from 1139 – also incorrectly known as *Liber comicum*[61] – contains texts from several Patristic authors such as St. Augustine, St. Bede, St. Ambrose, St. Gregory, and others (Nascimento and Meirinhos 1997: 28-67). There are some palaeographic and codicological elements that display the archaism of its production: the transitional Visigothic script[62] (Meirinhos 1995: 7), the pricking[63] that was done in the middle of the columns and the ruling that was marked with a hard dry stylus[64] (Miranda 1996b: 75).

According to Adelaide Miranda (1996a: 414), the Santa Cruz 4 discloses artistic influences from the Moissac and Limoges monasteries, particularly in some of its decorated initials, and above all, its zoomorphic elements, seen in Fig. 7. Two different ornamented features tend to emerge from the manuscript: one, which uses initials with symmetrical interlaced and braided knot patterns with strong coloured backgrounds (fols. 124, 166v); and the other, that represents zoomorphic and anthropomorphic figures in intricate drawings with the same strong coloured background (fols. 151v, 103v, 226 and 225v).

Figure 7. From left to right, several illuminations from the *Homiliarium* (BPMP, Santa Cruz 4, 1139), respectively: fols. 151v, 103v, 226, 225v, 124 and 166v.

[60] The *Homiliary* was a liturgical book that contained a selection of Patristic books (Miranda 1996b: 75).
[61] At the end of the manuscript in fol.328, it is possible to read: «Explicit Liber Comicum in Era MªCªLXXªVIIª» (Nascimento and Meirinhos 1997: 61).
[62] The Visigothic writing was the most common script in most Latin-Christian Iberian Peninsula since the 7th century to the 12th century. In Portugal, the scriptoria of the Cathedral of Braga and Coimbra were in the 11th century the main centres of Visigothic script, which was extended to the 12th century and influenced other close places, such as the Monastery of Santa Cruz (Meirinhos 1995: 7).
[63] The pricking is the marking of the folio or bifolium by a point or knife to guide ruling.
[64] During the Romanesque period, the pricking was normally done in the outer sides of the columns or simply absent. Moreover, during the 12th century, the dry point was replaced by lead, which did not leave such strong marks on the parchment (Jones 1946; Brown 1994: 111). The presence of lead in ruling has been reported in Alcobaça and Lorvão' manuscripts (Miguel 2012: 61 and Claro 2009: 89).

This manuscript is particularly interesting as it seems to reflect a period of transition between a style, on one hand, more devoted to the Carolingian and insular influence, namely with the use of the interlaced and braided knot patterns and the use of colour purple; on the other hand, with the beginning of the Romanesque period, through the figurative zoomorphic initials.

That sense of transition seems to be reflected also in the colours of the codex, which come across very heterogeneous. The purples, greens and yellows are quite assorted: some are lighter, some more concentrated or more bluish or reddish. In Fig. 8, an unfinished initial most likely made during two different periods is depicted, providing the opportunity to see some of the painting processes. It is likely that the main drawing with the interlaced knots and zoomorphic figure were done first, painted in yellow and purple on the inside and then the main text was written. The red line was used to delimitate the area for the background colour[65], and finally, the colours were applied, with the exception of the green that was not finished. It is evident that this background was painted after writing because delimitated spaces were left for that particular text.

Figure 8. BPMP, Santa Cruz 4, fol. 4 (1139).

It is viable to assume that if the manuscript was produced in Santa Cruz scriptorium this could serve as one of the possible explanations for the observed inconsistencies, since they could be still perfecting and experimenting different techniques. With this in mind, it is still in discussion if this codex was produced in this scriptorium (Miranda 1999b: 130).

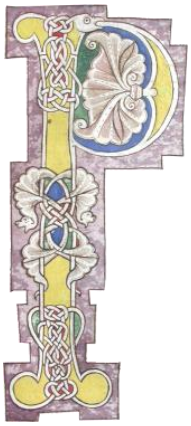


Figure 9. *Mazarine Bible*, BNF, Ms. Lat. 7, fol. 335 (11th-12th c.).

This manuscript has been related to the *Mazarine Bible*, Ms. Lat. 7 (Bibliothèque Nationale de France, BNF), due to the same kind of interlaced knots, scallops, zoomorphic features and colour[66] (Miranda 1996a: 414), Fig. 9. The exact provenance of the 11-12th century bible is unknown; still several art historians believed that it came from the Moissac scriptorium[67]. More

[65] One must take into account that this particular initial is not the most typically seen in this manuscript, since it uses a red ink to delineate the background drawing. Most initials had a black ink, as seen in Figure 7.

[66] This last feature will be discussed later on.

[67] According to Adelaide Miranda, authors such as Yolanta Zalouska and François Avril believe that the Mazarine bible is from the Moissac scriptorium. She also adds that Zalouska in her article about *La Bible Limousine de la Bibliothèque Mazarine a Paris* also refers that this type of illuminations came from the area of Aquitania and Limoges (Miranda 1996a: 414). On the other hand, Nascimento proposes that the SC 4 may have been produced in the Cathedral of Coimbra (Nascimento 2012a: 291).

connections have been also established not only with southwest France – the *Limoges Bible*, Ms. Lat. 8 (BNF); the *Homiliary*, Ms. Lat. 3783; Ms. Lat. 2241 –, but also with Spain – Bible San Juan de la Reña, Mss. 2[68], from the 11th century (Biblioteca Nacional de España, BNE) (Miranda 1996a: 414-415; Miranda 1999b: 131). The latter manuscript was produced in a church from Gerona that followed the regular Canons of Saint Augustine (Miranda 1999b: 131). On the other hand, the *Passionarium* Lorvão 16 dated from c. 1140 by Aires Nascimento, has been also related to the SC 4, due to the resemblance of their illuminations. The author proposes that the two manuscripts were produced in the monastery of São Mamede of Lorvão (Nascimento 2010: 23-24; Nascimento 2012b: 405).

The Santa Cruz 30 is from the 12th century and contains the *Historia Ecclesiastica* by Eusebius of Caesarea, *De Fide Catholica Contra Iudaeos* by Isidore of Seville, *De vida monacal* by an anonymous; the *Conferences 20, 8* by John Cassian and the *Bull of Canonization of St. Anthony* by Gregory IX (Nascimento and Meirinhos 1997: 164-168). The first 41 folia are written in transitional Visigothic script and the rest of the quire is written in a gothic script trying to imitate the previous writing. From folio 49 onwards the gothic script is assumed. This shows that the manuscript was produced in two moments: one from 1126-1175 (Miranda 1996b: 93), and the other from 1191[69] (Nascimento and Meirinhos 1997: 164-165).

Figure 10. BPMP, Santa Cruz 30, fol. 1v (12th c.).

The manuscript is very poor in terms of illuminations, since it only has one initial that could be related to Santa Cruz 4, however in a much more simplistic version, Fig. 10. It contains basic interlaced ropes with a zoomorphic figure on a yellow and dark red background. The following initials are simple letters in black and red. When it transitions for the later period, the initials look less archaic and are painted in blue.

The Santa Cruz 58 has several Patristic texts, such as *De Genesi ad Litteram* and *Questiones Evangeliorum* by Augustine of Hippo, the *Exameron* and *De paenitentia* by Pseudo-Ambrosius and the *Expositio in Lucae Evangelium* by Bede written in typical 12th century earlier gothic (Nascimento and Meirinhos 1997: 271-274; Meirinhos 1995: 13). It is known from the text *Vita Tellonis* that Presbyter Pedro Salomão from Santa Cruz remained exactly one

[68] In March 2015, F. de Assis Garcia and Ana Hernández presented a paper on 'Manuscripts Across Frontiers: The Transit of Influences Through Romanesque Aragón', in the Conference *Medieval Europe in Motion: Medieval Manuscripts in Motion*, where they connected several manuscripts, including the Mazarine bible Ms. Lat. 7 to the Bible of San Juan de la Peña.

[69] The manuscript presents a colophon in fol. 141 with the date 1191 (Nascimento and Meirinhos 1997: 165).

year in St. Ruf of Avignon, where he copied and then brought to Coimbra in 1139 a group of texts that are referred in this codex. Hence, it is very likely that it is the same manuscript, or at least a copy produced in Santa Cruz based on that copied codex from Avignon (Meirinhos 1995: 12). According to Miranda, the primitive collection from St. Ruf does not resemble with this set of earlier Romanesque manuscripts from Santa Cruz (Miranda 1996a: 420).

The manuscript contains several calligraphic initials mostly in red and yellow that remind Santa Cruz 4 for the interlaced knots and zoomorphic figures. In fol. 11, a decorated initial 'O' with a background painted in purple, red and green, is organized in intertwined knots that resemble a net. This initial served, according to Miranda, as inspiration for the illumination represented in fol. 205, from the *Bible* Santa Cruz 2, as seen in Fig. 11 (Miranda 1996a: 419).

Figure 11. Two illuminations from the BPMP, Santa Cruz 58, fol. 1, 1139? and Santa Cruz 2, fol. 205, beginning of the 13th c.

Finally, the *Ethimologies* by St. Isidore of Seville, Santa Cruz 17, written in gothic but still with Visigothic traces (Meirinhos 1995: 9), is also included in this group, due to its red and black titles and small initials, which remind the Mozarabic style. According to Miranda, the diagram of the tree of consanguinity from fol. 92v presents similarities with Hispanic manuscripts from the 10th century (Miranda 1996a: 421), such as the mss. Cod. 76 and Cod. 25(2) from the Real Academia de la Historia (RAH), seen in Fig. 12.

Figure 12. From left to right, several illuminations of the tree of consanguinity from the work *Etymologies* by Isidore of Seville from BPMP, Santa Cruz 17, fol. 92v, mid-12th century; RAH, Cod. 76, fol. 73v, 10th century and RAH, Cod. 25(2), fol. 146, 10th century.

To conclude, this set of illuminated manuscripts has several characteristics in common which allows them to be included in the primitive group from Santa Cruz of Coimbra. These collected works mark their own cultural time, by embodying past and present, from the Mozarabic culture that still persists until mid-12th century, and from the new fresh French influences that came from S. Ruf of Avignon and Southwest France (Miranda 1996a: 422).

2nd Phase: From mid-12th century to late 12th century

At this stage Coimbra was going through its most prosperous period, which led to the emergence of great artistic creations. This new phase is marked by the dead of S. Teotónio in 1162 and the production of Santa Cruz 43, which stands as a new direction in the scriptorium (Miranda 1996a: 423). This manuscript was written in 1165 by deacon and canon Pelagius Garsie[70] and contains the works *Collationes* and *De Institutis Coenobiorum* by Iohannes Cassianus (Nascimento and Meirinhos 1997: 221-223). According to Miranda (1996a: 424), it has a set of illuminations that transmit rigidity in the sense that it seems that the artists were only copying models without autonomy, Fig. 13. The interlaced knots are still present in the initial P from fol. 1 and the tangled stems and vegetable elements have not gain movement yet. Nevertheless the colour palette becomes more varied with a more pronounced presence of blue, which will be discussed later in the chapter.

Figure 13. From left to right, several illuminations from BPMP, Santa Cruz 43 (1165), fols. 1, 143v, 100, 225, 3 and 196.

The most emblematic mid-12th century manuscript from Santa Cruz is the *Bible* Santa Cruz 1, which includes only the Old Testament and a separated quire with the tables of concordance without text. It is believed that the latter tables were destined for another volume that would gather the New Testament (Miranda 1996b: 22; Nascimento and Meirinhos 1997: 5-

[70] The manuscript possesses a colophon in fol. 234v with the following inscription: 'Perscripto libro, sit laus et Gloria Christo. Per manus Pelagius Garsie diaconi, canonici Sancte Crucis colimbriensis monasterii vº kalendas decembris in Era MªCCªIIIª...' (Nascimento and Meirinhos 1997: 223).

6). This is the biggest codex in terms of dimensions (582x421) that was produced during this period in all of the three scriptoria, which means that its illuminations were an important asset. It is alleged to have been written in Santa Cruz – according to Miranda, the scribe shows to be inexperienced with this type of work –, but it may have been illuminated by an itinerant artist due to the high quality of the images that was aware of the Iberian tradition and of the local architectural culture[71] (Miranda 1996b: 24; 32). The ornamentation and the imaginary in this manuscript is a crossover between the French Northern illumination and the tradition of the peninsular bibles (Miranda 1996a: 425). In Fig. 14, a representative assembly of the imaginative and fantastic illuminations from this bible are depicted below.

Figure 14. From left to right, several illuminations from *Bible* BPMP, Santa Cruz 1 (12th c.), fols. 2, 43, 123 and 161v.

The *Salterium* Santa Cruz 27 from 1179[72] opens a new phase of production for liturgical books in Santa Cruz. In its sanctoral cycle, it is presented not only the liturgical saints from Southwest France, particularly the ones that followed S. Ruf of Avignon, but also local Portuguese saints. The decorated initials, but above all the

Figure 15. From left to right, two illuminations from the *Psaltery*, BPMP, Santa Cruz 27 (1179), fols. XV and 1.

[71] There are several evidences of Iberian models, such as the horseshoe arches, the resemblances on the representation of the evangelists to the Bible of León and the sarcophagus of S. Martinho de Dume, near Braga (Miranda 1996b: 32).

[72] The colophon also indicated the scribe, which was Fernandus: 'Fernandus scripsit istum psalterium, in mense iunii Era MªCCªXVIIª' (Nascimento and Meirinhos 1997: 155).

illumination of the Crucifixion (Fig. 15), denote the presence of a high quality artist that may have been hired from outside of the monastery (Miranda 1996a: 426; Miranda 1999b: 136). Moreover, its initial B also stands in the line of continuity seen in the Franco-Saxon illumination, which will have a strong acceptance for the Portuguese Romanesque artists. Both Santa Cruz, and above all Alcobaça, will use the *palmette* and the *rinceaux* ornamentation.

Two other manuscripts included in this study were also defined as works from this production phase in Santa Cruz: the *Evangeliarium* Santa Cruz 72, Fig. 22, and the *De Avibus* Santa Cruz 34. The first is called into question whether if it was produced in this scriptorium, due to its high quality painting technique that has no parallel with other manuscript from this time period in the Portuguese monastery (Miranda 1996b: 101). While, the second, although attributed to the 13th century, it will be demonstrated during this dissertation that this particular manuscript should be included as a production from the last quarter of the 12th century. This will be further developed in Chapter II.

As part of transitional works that start showing the elements that will be also present in the last phase in Santa Cruz scriptorium are two Legendaries with the description on the life of the saints: Santa Cruz 20 and Santa Cruz 21. The first contains the *Vita Sanctae Mariae Oigniacensis* by Jacques de Vitry, a hagiographic compilation: *Passiones Sanctorum* and also a fragment from the *De arrha animae* by Hugh of St. Victor, while the second begins with the *Passio sancti Felicis*, ending with the *Vita Hieronymi presbiteri* (Nascimento and Meirinhos 1997: 116-140). Both manuscripts have large dimensions, as they were most likely used for choir reading. Santa Cruz 20 has a historiated initial, in fol. 139, with a scribe dressed in a tunic, with a beard and without tonsure, seating on a chair with attached desk writing with two black inkhorns by his side, in Fig. 16. The decorated initials from both manuscripts remind two main different styles: one based on the type of initials found in *Bible* Santa Cruz 1; and the other influenced by Alcobaça. The first, uses the same kind of colour patterns seen in SC 1 with the zoomorphic motives (Fig. 16), while the second, tends to have more monochromatic backgrounds with big *palmettes* and *rinceaux* ornamentations, typical of the Portuguese Cistercian scriptorium (Figs. 17 and 18). Therefore, it is quite possible that several artists may have worked in these manuscripts, due to their varied styles, combining fantasy and realism, with an excellent knowledge on drawing and painting techniques (Miranda 1996a: 440). There has been found some parallelism between the two manuscripts and a group of Alcobaça manuscripts of legendaries, namely ALC 418, 419, 420, 421 and 422, which were dated as productions from the 1180's. According to Miranda, due to their similarities it is likely that the Santa Cruz codices were also produced shortly after them (Miranda 1996b: 104). In that sense, these manuscripts have been dated as productions from the beginning of the 13th century.

Figure 16. From left to right, several illuminations from *Legendarium* BPMP, Santa Cruz 20 (beginning of the 13th c.), fols. 139, 128v, 92 and 137v.

Figure 17. From left to right, several illuminations from *Legendarium* BPMP, Santa Cruz 20 (beginning of the 13th c.), fols. 197v, 211v, 229 and 191.

Figure 18. From left to right, several illuminations from *Legendarium* BPMP, Santa Cruz 21 (beginning of the 13th c.), fols. 108, 19, 214v and 249v.

Another example of an unfinished initial in the Santa Cruz scriptorium is given in Santa Cruz 20, fol. 49v, Fig. 19. In this case, the background in red was finished, but the body of the letter F was not finished, as it only contains a very light touch of yellow.

Figure 19. BPMP, Santa Cruz 20 (beginning of the 13th c.), fol. 49v.

The *Commentarium in Librus Regum*, Santa Cruz 11, by Rabanus Maurus, from the late 12th century and written by Johannes Michaeli, was also included to this set of manuscripts. Its decorated initials present the same type of ornament found in Alcobaça (Miranda 1996a: 441). It is also known for its unusual marginalia with several anthropomorphic figures, Fig. 20.

Figure 20. From left to right, several marginalia from BPMP, Santa Cruz 11 (late 12th c.), fols. 9v, 117, 18v, 88v and 32.

To conclude, this was the most opulent epoch for the Romanesque illumination in Portugal, manifested by the rich iconography from Santa Cruz, which was also privileged by the political and economic situation given by the advances in the *Reconquista*. These manuscripts reflect the openness of the scriptorium to a wide variety of artistic trends in the last quarter of the century. On one hand, they show influences from Alcobaça, which in turn also embody the style from the French Cistercian monasteries; on the other hand, the use of a particular set of colours, which will be discussed later, and its iconographic program mainly associated to the human figure and the animals, demonstrate a local creativity that departs from the more austere Cistercian style. By the end of the 12th century, the library of Santa Cruz already incorporated the fundamental texts necessary to guarantee the functioning of the monastic community (Miranda 1996a: 434; 1996b: 104).

3rd Phase: First quarter of the 13th century

In the first quarter of the 13th century, a change of paradigm for Santa Cruz monastery arises when it starts to lose its weight and influence within the royalty. The definitive moment was when King Afonso II of Portugal died in 1223 and was buried in the monastery of Santa Maria of Alcobaça, contrarily to its ancestors who favoured the regular Canons monastery. This resulted in a loss of privileges and donations, but also showed that there was an increase interest in the Cistercian order, which ultimately led to changes in the Santa Cruz scriptorium (Miranda 1996a: 435).

In this phase, another bible from Santa Cruz stands out, the Santa Cruz 2 (1201-1225), with the Old Testament and the Prophetic Books, which was also produced probably at the same time as the Santa Cruz 3, an analogous bible from the same monastery. There are very strong similarities in the text and illuminations between SC 2 and SC 1. The same kind of anthropomorphic and zoomorphic initials with coloured backgrounds surrounded by a frame are used, but the drawing is less elaborate and tends to be simplified, as seen in Fig. 21. Instead of a simple one colour frame, in this manuscript, the illuminator used predominantly a three-colour combination, finished with a white highlight.

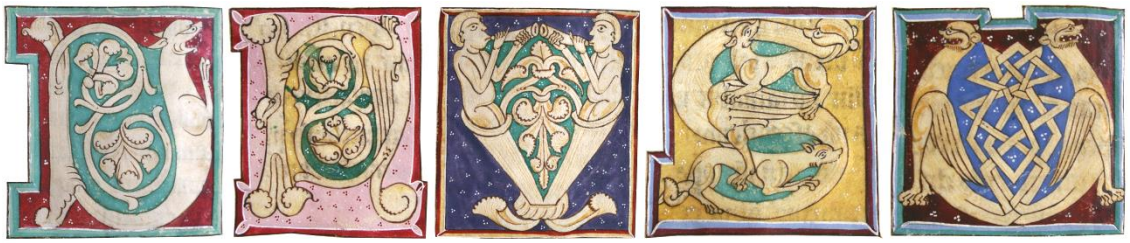


Figure 21. From left to right, several illuminations from *Bible* BPMP, Santa Cruz 2 (1201-1225), fols. 183v, 187, 175v and 172v.

De Antiquitate Judaica, Santa Cruz 18, by Flavius Josephus was produced in 1237 and copied by Martinus[73] (Nascimento and Meirinhos 1997: 113-115). The illuminations from this manuscript follow the *Evangeliarum* SC 72, according to Miranda (1996a: 441), but without the elegancy of the first, as depicted in Fig. 22. The Santa Cruz 6, produced between 1201 and 1225, has been also related to the SC 72 (Miranda 1999b: 162), Fig. 22.

Figure 22. Three similar illuminations from BPMP: Santa Cruz 72 (beg. 13th c.), fol. 2v; Santa Cruz 6 (beg. 13th c.), fol. 1 and Santa Cruz 18 (1237), fol. 3, from left to right.

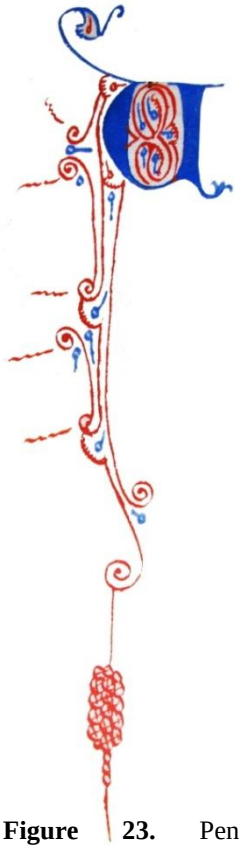


Figure 23. Pen flourished initial from BPMP, Santa Cruz 18 (1237), fol. 185v.

This period also represents a turning point in the Portuguese Romanesque illumination from the 13th century, as it starts to use pen flourished initials, mostly to small and medium initials, as seen in Fig. 23, which will appear in the 13th century onwards (Miranda 1996a: 441).

In conclusion, this last period in Santa Cruz is mostly characterised by the loss of creativity, as it tends to repeat previous models and simplify its drawings and ornamentations (Miranda 1999b: 142). The scriptorium of Santa Cruz is no longer the main producer of illuminated manuscripts, when compared to the Cistercian Alcobaça scriptorium. Moreover, the contact between both monasteries seems to be more frequent, as demonstrated by the repetition of models.

[73] The colophon from this manuscript states in fol. 284v: 'Martinus dives homo notauit hunc librum in honore sancte Marie et sancte Crucis. Prioratus domni Martini anno primo. Sub era MªCCªLXXªVª' (Nascimento and Meirinhos 1997: 115).

2.2 Colour in the Santa Cruz collection: materials and paint formulations

As already mentioned, a set of 14 manuscripts from Santa Cruz scriptorium were selected for the study of this collection. These were analysed in two different occasions:

1. In a MOLAB[74] on-site investigation in 2009, with *in situ* portable XRF, mid-FTIR reflectance, Raman[75], reflectance and UV-Vis emission – for emission and fluorescence lifetimes – spectroscopies.

2. In October 2011, a new on-site investigation at BPMP was undertaken under the framework of the project *Colour in medieval illuminated manuscripts: between beauty and meaning*[76] where magnified observations and photographs were performed *in situ* and a set of 63 micro-samples were taken from 5 manuscripts, including the Santa Cruz Book of Birds. These were afterwards analysed in the laboratory, by FTIR and Raman. Further analyses were performed to the lac paints, namely microspectrofluorimetry and SERS.

From the 14 manuscripts, a total of 66 folia were analysed, presented in Table 2. Details on the areas of analysis on each illumination and the experimental conditions followed for each technique can be found in Appendices III and IV, respectively.

Table 2. Manuscripts analysed from the Santa Cruz collection, its analysed folia and applied techniques. The manuscripts highlighted in gray were micro-sampled and analysed in the DCR laboratory, while the white ones were only analysed *in situ* during the MOLAB access.

Manuscript	Analysed folia	Total	Applied techniques
SC 1	2v, 3, 14v, 24, 65, 77, 173v, 185v, 260v, 226v, 338, 362v, 364v	13	XRF, Raman, mid-FTIR, FTIR, UV-Vis, fluorimetry (both MOLAB and DCR)
SC 2	46, 175v, 192v, 207v	4	Mid-FTIR, UV-Vis, fluorimetry
SC 4	1, 123v, 188v, 225v, 266, 317v, 329, 329v, 371	9	XRF, mid-FTIR, UV-Vis, fluorimetry
SC 11	18, 45, 117	3	XRF, mid-FTIR, fluorimetry
SC 17	1, 171	2	XRF, mid-FTIR, UV-Vis, fluorimetry
SC 18	3v	1	Mid-FTIR, UV-Vis, fluorimetry

[74] MOLAB stands for mobile laboratory that is equipped with portable instruments for *in situ* applications (For more information on their methodology, please see Miliani *et al.* 2010). It is now part of a joint collaboration with four Italian infrastructures: Centre SMAArt of the University of Perugia, CNR-ICVBC, Opificio delle Pietre Dure and Istituto Nazionale di Ottica Applicata. The team on this on-site investigation was, from the MOLAB group: Aldo Romani (team leader), Alessia Daveri, Catia Clementi, Laura Cartechini and Valentina Manuali; from the Portuguese group: Maria João Melo and Catarina Miguel.

[75] Raman spectroscopy data was very scarse (only used in Santa Cruz 1 and 20) and the obtained spectra had poor resolution, therefore these were not included in this study.

[76] The team that worked on this on-site investigation was: Maria João Melo, Adelaide Miranda, Catarina Miguel and Rita Castro.

SC 20	78, 86, 123, 123v, 139, 144, 162, 173v, 187v, 191, 197v, 199v	12	XRF, Raman, mid-FTIR, FTIR, UV-Vis, fluorimetry (both MOLAB and DCR), SERS
SC 21	2, 19, 207v, 262v	4	XRF, Raman, mid-FTIR, FTIR, UV-Vis, fluorimetry (both MOLAB and DCR), SERS
SC 27	1, 5, 15, 101v, 133	5	XRF, Raman, mid-FTIR, FTIR,
SC 30	1v	1	XRF, mid-FTIR, fluorimetry
SC 34	89, 89v, 93, 94v, 102, 103, 104, 104v, 107	9	Raman, mid-FTIR, FTIR
SC 43	1	1	XRF, mid-FTIR, UV-Vis, fluorimetry
SC 58	1	1	Mid-FTIR
SC 78	2v	1	Mid-FTIR

2.2.1. Colourants

The results on the analysis of the materials identified in Santa Cruz collection can be seen here and in Appendices II and V, where the main pigments and dyes for each manuscript are presented as well as their main analytical data.

In order to initially summarize, in Santa Cruz, lapis lazuli was used as the preferable choice for blue. To obtain lighter blue tones, the precious pigment was sometimes applied as if a watercolour in a very thin layer (SC 34, fol. 89v) or applied admixed with lead white (SC 1, 18 and 27). For darker blues, indigo was used admixed with lapis lazuli, as seen in Santa Cruz 20. In Santa Cruz 43, indigo with lead white was used to produce the blue paints. Red colours were made with vermilion, but particularly in Santa Cruz 20 a mixture of vermilion with lac dye was also used to create a contrasting palette. As for the dark reds and pinks, lac dye was identified by itself (SC 21) or with vermilion, as already mentioned. Greens were made with the synthetic copper proteinate and, additionally, in some cases, such as in Santa Cruz 1 and 43, a dark green was produced from indigo and orpiment. Yellow paints were prepared with orpiment (i.e. SC 4, tables of concordance from SC 1), which was less frequently used, or with an organic yellow – not yet fully characterised – that is ubiquitously present in most of Santa Cruz manuscripts. As for the rest of the palette, orange was limitedly used. In Santa Cruz 1, red lead was used in the tables of concordance as well as a not typical mixture of orpiment and vermilion. Furthermore, whites were obtained with lead white, however these were found more in mixtures with other colours, in order to produce lighter tonalities, blacks were prepared with carbon black as well as in carbon mixed black paints – a mixture of carbon black with iron-gall ink. As for extenders, Santa Cruz does not seem to have used this practice abundantly, as few examples of calcium

carbonate or gypsum were identified. Finally, in Santa Cruz, the use of a proteinaceous binder was also established. Below, in Fig. 24, several details from the colorants identified in Santa Cruz may be depicted.

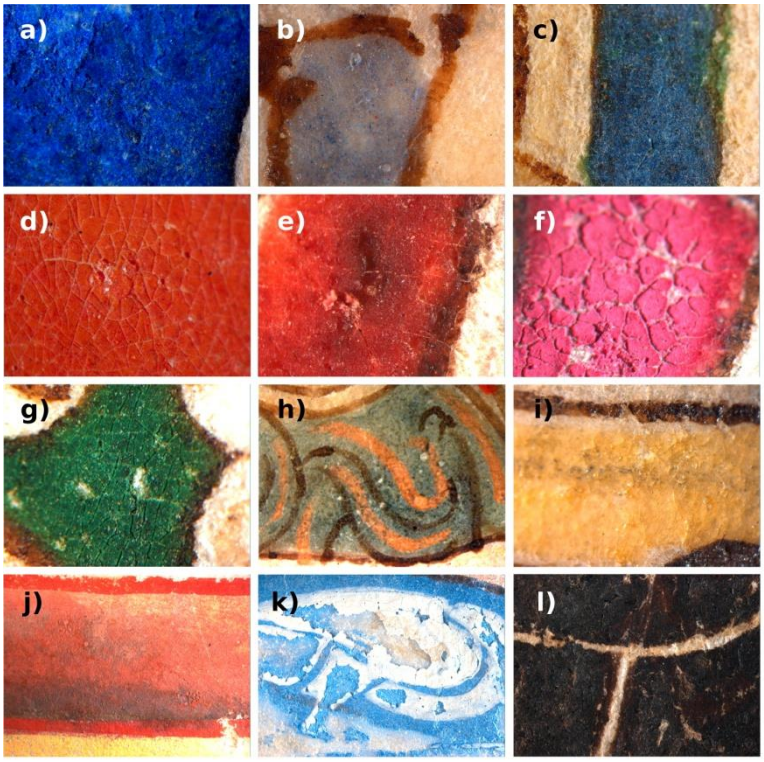


Figure 24. Several details from Santa Cruz palette: **a)** Lapis lazuli in SC 34, fol. 94; **b)** Diluted lapis lazuli in SC 34, fol. 89v; **c)** Lapis lazuli with indigo in SC 20, fol. 139; **d)** Vermilion in SC 27, fol. 15; **e)** Vermilion with lac dye in SC 20, fol. 78; **f)** Lac dye with calcium carbonate in SC 1, fol. 14v; **g)** Copper proteinate in SC 1, fol. 77; **h)** Indigo with orpiment (*vergaut*) in SC 1, fol. 3; **i)** 'Organic yellow' in SC 1, fol. 77; **j)** Red lead in SC 1, fol. 364v; **k)** Lead white in SC 27, fol. 1; **l)** Carbon mixed black, SC 34, fol. 104.

Binder

Infrared spectroscopy allowed the exclusive identification of a proteinaceous binder in Santa Cruz manuscripts. The protein fingerprint was mainly characterised by its polyamide absorption pattern: the amide I – CO stretching vibration – at 1651 cm^{-1}, the amide II – CN stretching and NH bending vibrations – at 1541 cm^{-1}, the CN bending at 1450 cm^{-1} and the OH and NH stretching absorption modes at 3400-3000 cm^{-1}. Moreover, other typical absorptions were also observed at the region of the 3000-2800 cm^{-1}, with the attributed asymmetric methyl stretching vibration at 2962 cm^{-1}, the asymmetric methylene stretching mode at 2935 cm^{-1}, and finally the symmetric methyl stretching absorption at 2875 cm^{-1} (Stuart 1997: 113-126; Miguel *et al.* 2012), Fig. 25a). Mid-FTIR reflectance did also showed signs from a proteinaceous material, as seen in Fig. 25b); however it could not be assigned for certain to a proteinaceous

binder, since the signal could be emerging from the underlying support. For that reason, in this case, FTIR was indispensable for a proper characterisation.

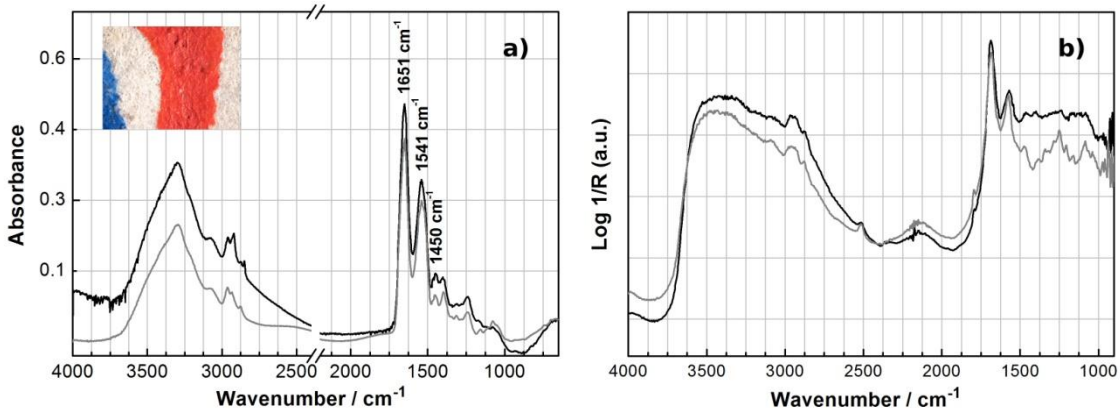


Figure 25. Transmittance infrared and MOLAB Mid-FTIR reflectance spectra, respectively, from: **a)** a red micro-sample from SC 34, fol. 89 (—) with an egg white reference (—), including an inset image detail from the area where the micro-sample was taken with 50x magnification; **b)** a red paint from SC 34, fol. 94v (—) with the parchment support from SC 34, fol. 107 (—).

Blue paints

Lapis lazuli ($Na_8[Al_6Si_6O_{24}]S_n$) was found in nine manuscripts from the collection[77]. The blue mineral was identified by FTIR, in Fig. 26a), through its aluminosilicate matrix – Al, Si-O_4 or TO_4 tetrahedra[78] –, where the strongest band is assigned to the T-O asymmetric stretching of the internal tetrahedra at 1007 cm^{-1}, with a shoulder at *circa* 1135 cm^{-1} associated to the T-O asymmetric stretching mode of linkages between the tetrahedra. Another band at 696 cm^{-1} is also observed, which is attributed to the T-O symmetric stretching mode. The bands at 1417 cm^{-1} and 877 cm^{-1} are associated to the presence of calcite, which is a typical mineral found associated with natural ultramarine (Miliani *et al.* 2008). The identification of lapis lazuli was also possible through mid-FTIR, Fig. 26b), by the presence of the asymmetric stretching of CO_2 entrapped in the sodalite β-cages at 2342 cm^{-1}, which is considered as a marker for natural ultramarine blue – as the synthetic version does not retain traces of CO_2 (Miliani *et al.* 2008; Miliani *et al.* 2010). Other bands have been also associated to the precious blue mineral, such as the broad inverted band around 1000 cm^{-1}, given by the *reststrahlen* effect[79], which is ascribed to the Al, Si-O asymmetric stretching vibration as well as the low, sometimes not perceptible, band at 2040 cm^{-1} from CO stretching mode (Miliani *et al.* 2008, Van der Snickt *et al.* 2011).

[77] The manuscripts are: SC 1, 2, 11, 18, 20, 21, 27, 34 and 72.

[78] Ultramarine pigments are made of feldspathoids of sodalite structure. The framework of alluminosilicate-sodalite $[Al_6Si_6O_{24}]^{6-}$ consists of alternating AlO_4 and SiO_4 tetrahedra – the TO_4 – which are cornered-linked in 4- and 6- membered rings to give cubo-octahedral cavities or sodalite β-cages (Miliani *et al.* 2008: 148).

[79] The *reststrahlen* effect is caused by a reflectance phenomenon where specular reflection depends on both the absorption index (*k*) and refractive index (*n*). Some materials, such as minerals, often present distorted spectral features, by the inversion of their bands, due to $k >> n$. (Miliani *et al.* 2010).

Mixtures with lead white were also identified by mid-FTIR, in SC 1, 18 and 27, through its characteristic distorted *reststrahlen* band of CO_3^{2-} at about 1400 cm^{-1}, Fig. 26c). Cerussite ($PbCO_3$) was detected by the $\nu_1+\nu_3$ and $\nu_3+\nu_4$ combination bands of carbonate at 2413 and 2040 cm^{-1} (Rosi *et al.* 2009).

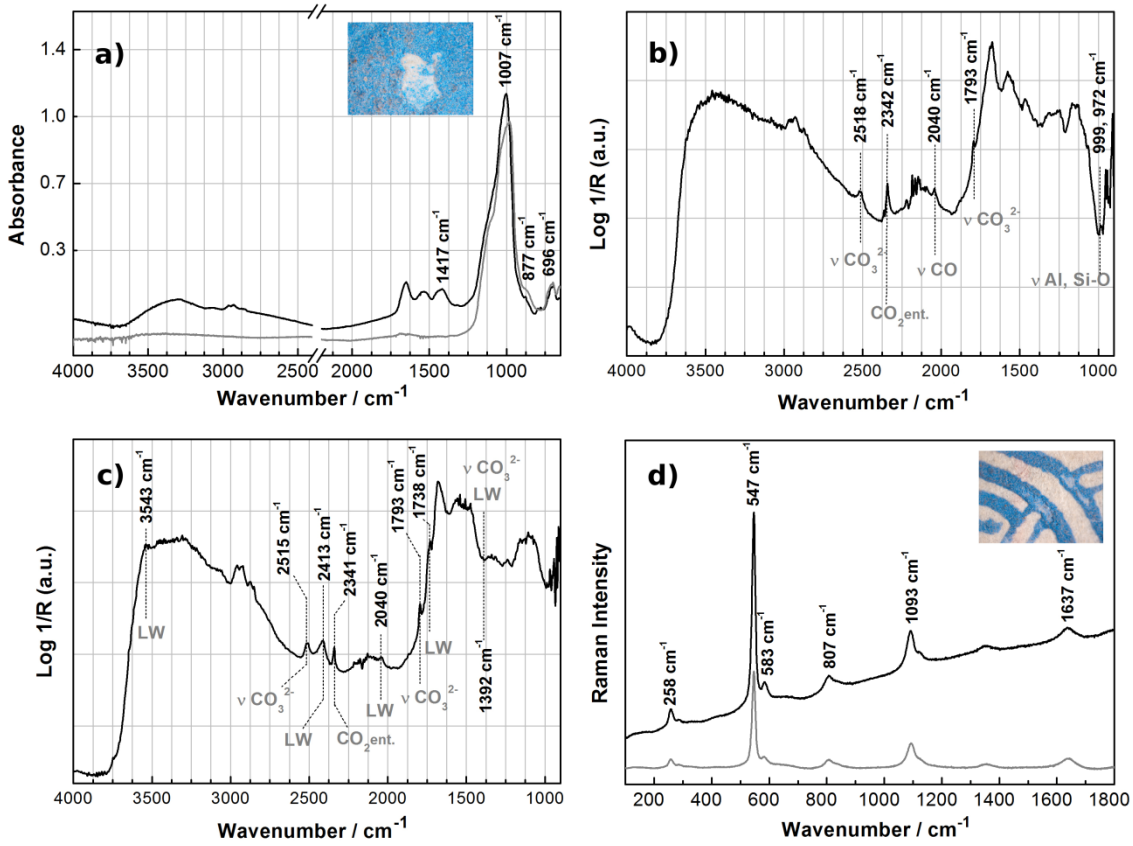


Figure 26. Several spectra of blue paints: **a)** Infrared spectrum of a blue micro-sample from SC 27, fol. 15 (—) with a lapis lazuli reference (—), including an inset image detail from the area where the micro-sample was taken with 40x magnification; **b)** MOLAB mid-FTIR reflectance spectrum of a blue paint from SC 1, fol. 364v; **c)** MOLAB mid-FTIR reflectance spectrum of a light blue paint from SC 1, fol. 364v; **d)** Raman spectrum of a blue micro-sample from SC 34, fol. 89 (—) with a lapis lazuli reference (—), including an inset image detail from the area where the micro-sample was taken with 25x magnification.

Additionally, Raman spectroscopy also clearly identified lapis lazuli through its characteristic bands at 258 cm^{-1} ascribed to the S_3^- bending mode, at 547 cm^{-1} due to symmetric stretching vibration and at 583, 1093, 1637 cm^{-1} that correspond to the overtones of the symmetric stretching of the S_3^- (Osticioli *et al.* 2009), Fig. 26d). UV-Vis reflectance spectra showed a reflectance maximum at around 464 nm and an apparent absorption maximum at circa 600 nm, which is in agreement with lapis lazuli (Aceto *et al.* 2012: 238), for details see Appendix V.

Darker blues were also used in at least four manuscripts[80], such as in Santa Cruz 20, where mixtures of lapis lazuli with indigo were used. This particular mixture was detected by Raman spectroscopy, Fig. 27a). Besides the typical bands from lapis lazuli – highlighted in a lighter blue –, indigo was identified through its characteristic bands observable in the region between the 1250-1700 cm^{-1} – highlighted in a darker blue. The spectral region between 1580 and 1700 cm^{-1} is normally ascribed to the stretching modes from C=C, C=CH and C=O, which are typical of indigoid molecules. Below this region, the bands at 1461, 1365, 1313 and 1255 cm^{-1} are primarily attributed to the in-plane bending of C-H and N-H bonds (Platania *et al.* 2015).

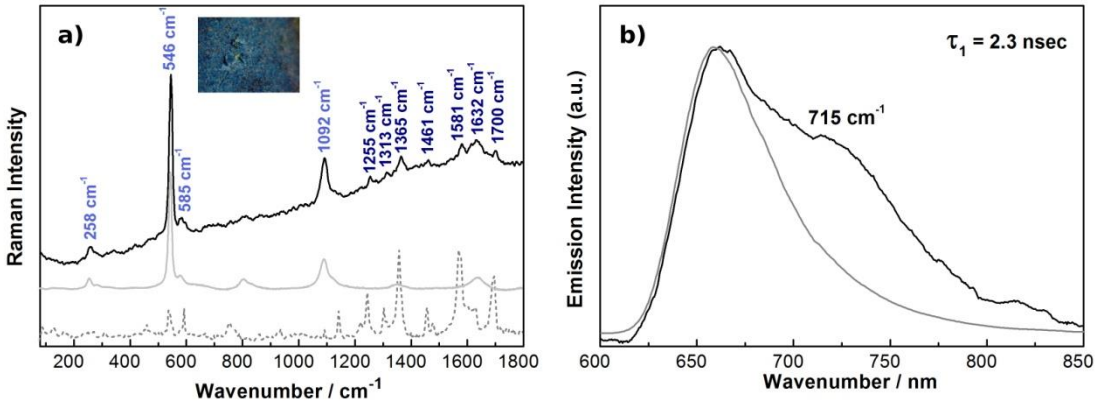


Figure 27. Several spectra of dark blue paints: **a)** Raman spectrum of a dark blue micro-sample from Santa Cruz 20, fol. 139 (—) with lapis lazuli (—) and indigo (---) references, including an inset image detail from the area where the micro-sample was taken with 63x magnification.; **b)** MOLAB emission spectra (λ_{exc} = 470 nm) *in situ* from blue paint from Santa Cruz 43, fol. 1 (—) with its parchment reference (—), including the lifetime decay fluorescence (τ) measurements from the blue paint.

The MOLAB fluorescence emission in Santa Cruz 43, shown in Fig. 27b), presents a maximum at circa 660 nm, which is attributed to the parchment support, and a shoulder at circa 720 nm, ascribed to indigo, with a fluorescence lifetime of 2.3 nsec. These results are in agreement with the data report by Romani *et al.* 2010, which refers the presence of a weak emission at about 730 nm in laboratory paint samples, which is due to the indigo dimer (Miliani, Romani and Favaro 1998), and a lifetime for indigo of 2.4 nsec (Romani *et al.* 2010). In addition to the fluorescence measurements, XRF and mid-FTIR reflectance were also carried out in this blue paint, showing no signs of any other blue pigment or dye and the presence of lead white. UV-Vis reflectance also showed an apparent absorption maximum at circa 670 nm, which is in agreement with the presence of indigo (Aceto *et al.* 2012: 238). Despite the absence of lapis lazuli, it should not be discarded its presence. These additional spectra can be seen in Appendix V.

[80] These manuscripts are SC 1, 20, 21 and 43. The identification was based on Raman and/or fluorimetry data. It is likely that SC 11 did also used indigo mixed with lapis lazuli, however the emission spectrum was not sufficiently clear since the signal was very weak (Appendix V, Fig. V.4.3.).

Red paints

Vermilion (α-HgS) was clearly identified as the main red pigment used in Santa Cruz, in 10 out of the 14 analysed manuscripts[81]. Its identification was established through Raman microscopy by its characteristic bands at 252 cm^{-1} and 282 cm^{-1} attributed to the bending vibrations of the S-Hg-S angle and at 342 cm^{-1} ascribed to the Hg-S stretching mode (Frost *et al.* 2002, 2010), seen in Fig. 28a). The presence of Hg was detected by XRF in most manuscripts, as for example in Santa Cruz 21, Fig. 28b). Sulphur (S) was not possible to clearly identify due to the mercury (Hg) interference. UV-Vis reflectance spectra presented the S-shaped feature with the inflection point around 600 nm, which is typical of the band-to-band electronic transition of mercury sulphide (Miliani *et al.* 2007: 852), see Appendix V for examples.

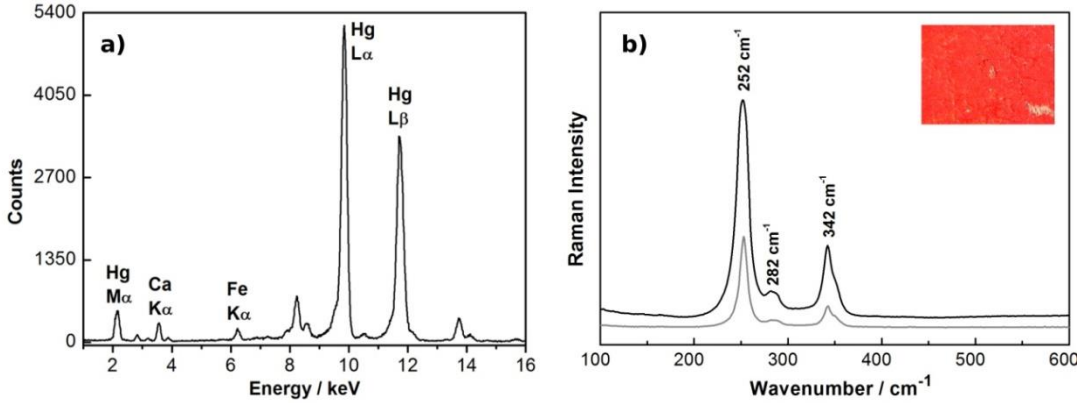


Figure 28. Several spectra of red paints: **a)** MOLAB XRF spectrum of a red paint from SC 21, fol. 262v; **b)** Raman spectrum of a red micro-sample from SC 21, fol. 207v (─) with a vermilion reference (─), including an inset image detail from the area where the micro-sample was taken with 50x magnification.

Another darker red was also found in several manuscripts. This red, contrarily to vermilion, did not show any sign of typical elements for red pigments by XRF and revealed a strong Raman fluorescence background. During this investigation, the organic red was molecularly identified as lac dye[82], through SERS technique by the identification of its main chromophore laccaic acid A, Fig. 29a). Additionally, in a rare occasion, in a sample from SC 1, the infrared spectrum presented clear indications of the presence of shellac – the resinous component associated to lac dye. Moreover, it was confirmed the use of calcium carbonate as filler, visible in Fig. 29b). The characterisation of lac dye in Santa Cruz was also complemented by the application of fluorimetry, both conducted by the MOLAB and the DCR equipment set, Fig. 29c) and d). It was established that lac dye displayed a consistent emission spectra for both instruments – taking into account the specificities used for each of them (such as the

[81] These manuscripts are: SC 1, 4, 11, 17, 20, 21, 27, 30, 34 and 43.
[82] The molecular characterisation by SERS was conducted to two manuscripts: SC 20 and 21. However, taking into account also the additional data acquired by FTIR and fluorimetry (both collected by the MOLAB team and by the microspectrofluorimetry from the DCR) it was also establish that lac dye was most likely used in SC 1, 2, 18 and 30.

instrumentation or the excitation wavelength) as well as the inherent differences found in each lac paint. To know more about this characterisation, please see Chapter III, where a deep portrayal of this particular colour in Portuguese Romanesque illuminations will be given.

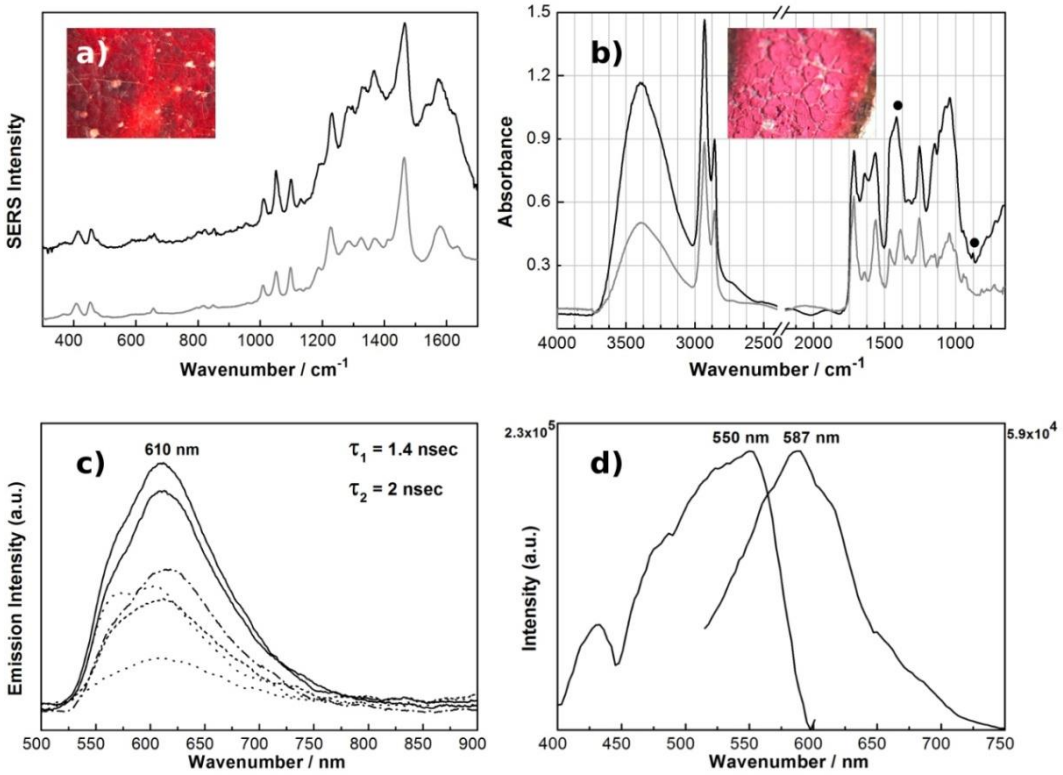


Figure 29. a) SERS spectra of a dark red micro-sample from SC 20, fol. 191 (─) and a laccaic acid A reference at pH=2 (—), including an inset image detail from the area where the micro-sample was taken with 25x magnification; **b)** Infrared spectra from a pink micro-sample from SC 1, fol. 14v (─) with $CaCO_3$ (●) and from a shellac reference (—), including an inset image detail from the area where the micro-sample was taken with 32x magnification.; **c)** MOLAB emission spectra (λ_{exc}=440 nm) from a dark red paint from SC 20, fols. 162v (─) and 173v (---); **d)** Excitation and emission spectra (λ_{exc}=490 nm) from a dark red micro-sample from SC 20, fol. 78.

Green paints

The colour green was mostly found to be from a synthetic copper green. By XRF, the presence of Cu (copper) and Zn (zinc) were identified in three manuscripts, suggesting that in order to produce this green, a copper brass alloy was most likely used, Fig 30a). However, the presence of zinc was not always established[83]. UV-Vis reflectance revealed a reflectance maximum at around 520 nm, which can be seen in several types of copper greens (Ricciardi *et al.* 2013: 3820). These spectra can be found in Appendix V.

With infrared spectroscopy, this particular green was characterised as a copper proteinate – a copper complex with a protein-based binder –, which is normally identified by a broad band at circa 1648 cm^{-1}, resulted from the collapse of the protein. This broad band tends to

[83] Cu and Zn were found in SC 1, 21 and 27, while Cu was identified by itself in SC 4, 11 and 20.

incorporate the amide I and II at circa 1653 and 1550 cm^{-1}, respectively, from the protein as well as the acetate absorption band at around 1635 cm^{-1}. Another evidence of the protein collapse is seen in the region of the O-H and N-H stretching bands, where the N-H absorption band at circa 3350 cm^{-1} tends to disappear as well as in the region of the C-H stretching modes around 3000-2840 cm^{-1}, where these C-H bonds have also a tendency to subside (Miguel 2012; Miguel 2009b), as seen in Fig. 30b). Moreover, in many of the samples analysed, calcium oxalate was also identified through its characteristic bands at 1321 cm^{-1} and 784 cm^{-1}. Mid-FTIR, also detected a predominant presence of calcium oxalate in most of the greens from Santa Cruz collection. More information on the degradation of this colour can be found ahead in sub-chapter 2.2.2. Colour degradation.

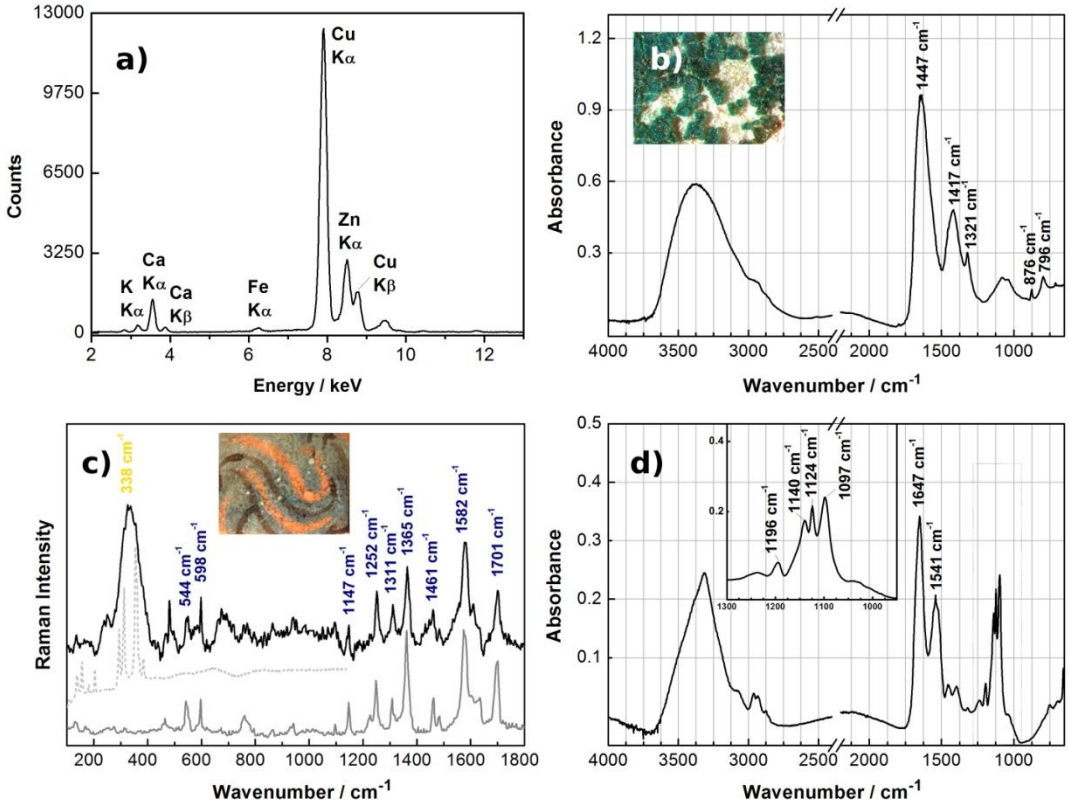


Figure 30. Several spectra of green paints: **a)** XRF spectrum of a green paint from SC 1, fol. 185v; **b)** Infrared spectrum of a green micro-sample taken from SC 1, fol. 24, including an inset image detail from the area where the micro-sample was taken with 63x magnification; **c)** Raman spectrum of a dark green sample from SC 1, fol. 3 with baseline correction (—) with indigo (—) and orpiment (---) references, including an inset image detail from the area where the micro-sample was taken with 50x magnification; **d)** Infrared spectrum of a dark green paint from SC 1, fol. 3, with an inset of the region between 1300-1000 cm^{-1}.

Most of the Raman measurements in the *bottle greens* exhibit a high fluorescent background, hindering the spectral feature from this particular compound. Most of the sporadic Raman data acquired was inconclusive, as the few acquired bands did not had any constancy,

and could not be attributed to already known copper greens, such as copper acetates, for example.

A dark green made of orpiment with indigo, known as *vergaut*, was also identified in Santa Cruz 1 by Raman microscopy. Indigo was characterised by its already described more intense bands at 544, 598, 1250, 1363, 1582 and 1701 cm^{-1}, seen in Fig. 30c). The broad band at 338 cm^{-1} was attributed to an orpiment-based solid phase pigment. This band was also reported on a medieval manuscript from Alcobaça – ALC 446 –, where it is believed that it may represent a degradation mechanism given by the reduction of orpiment or arsenate-based species (Muralha, Miguel and Melo 2012; Rochette *et al.* 2000).

The infrared spectrum also showed, in Fig. 30d), the following absorption bands at 1196, 1140 and 1124 cm^{-1}, which are likely ascribed to SO_4^{2-} ions in the structure (Jia *et al.* 2007). The presence of sulphates was also found by Mid-FTIR in SC 43 (consult Appendix V, Fig. V.11.2.c)) where a mixture of orpiment and indigo were used to produce *vergaut*.

Yellow paints

Two types of yellows were distinguished in Santa Cruz: orpiment (As_2S_3) and an 'organic yellow'. The first was less common[84]: it was detected As (arsenic) in the *Homiliarium* SC 4, Fig. 31a), for example, and in *Bible* SC 1 its use seems to be circumscribed to the tables of concordance. It was also identified in mixture with indigo, to create the well-known *vergaut* colour – already discussed in the previous colour. The yellow pigment was identified by Raman spectroscopy based on its characteristic bands at 136, 154 and 202 cm^{-1} assigned to the bending angle mode from S-As-S as well as the bands at 293, 311, 355, 359 and 383 cm^{-1} attributed to the anti-symmetric and symmetric As-S stretching vibrations (Forneris 1969; Frost, Martens and Kloprogge 2002). The Raman spectrum, from Fig. 31b), was acquired from an 'extemporaneous' sample[85] in the *Salterium* SC 27. When looking at the XRF spectra, from this particular folio, no traces of As were found – this can be seen in Appendix V, Fig. V.9.1. Consequently, its occurrence cannot be considered as premeditated.

[84] Orpiment was identified by Raman spectroscopy in SC 1 and 27. However, in the latter manuscript its origin is unknown. Moreover, XRF measurements also detected As in yellow paints from SC 4, while in SC 43, As was only detected in greenish paints, suggesting the use of *vergaut*.
[85] An 'extemporaneous' micro-sample is normally attributed to the type of sample that has not been taken directly from a specific colour paint, but was found normally above a colour layer or near it.

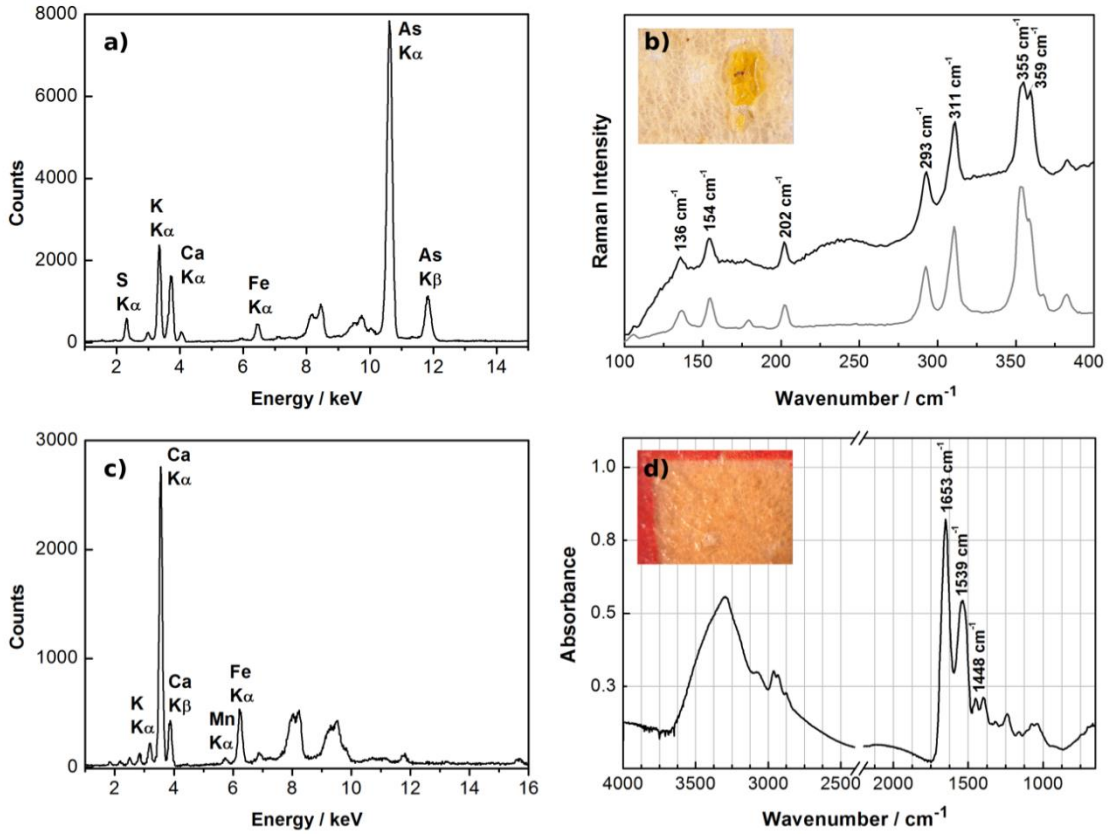


Figure 31. Several spectra of yellow paints: **a)** MOLAB XRF spectrum of a yellow from SC 4, fol. 122v; **b)** Raman spectrum of an 'extemporaneous' yellow found in SC 27, fol. 15 (—) with an orpiment reference (—), including an inset image detail from the area where the micro-sample was taken with 25x magnification; **c)** MOLAB XRF spectrum of a yellow from SC 21, fol. 262v; **d)** Infrared spectrum of a yellow paint from SC 21, fol. 83, including an inset image detail from the area where the micro-sample was taken with 50x magnification.

As for the other yellow paints, found in most of the manuscripts[86], no evidences of any inorganic or organic yellow dye were found. Through Raman spectroscopy it was not possible to obtain any information, due to the high fluorescence background signal. The XRF, depicted in Fig. 31c), detected the same elements normally found in the parchment support, with similar counts. The infrared analysis showed consistently a typical proteinaceous spectrum, Fig. 31d), with the characteristic absorption of amide I at 1653 cm^{-1} from the CO stretching band, the amide II at 1539 cm^{-1} from the CN stretching and NH bending modes, plus the CN bending band at 1450 cm^{-1} and the OH and NH stretching band modes at 3400-3000 cm^{-1} (Stuart 1997: 113-126; Miguel *et al.* 2012). Furthermore, no fluorescence emission was detected in these paints – the signal was very similar to the parchment. This absence of fluorescence may well, in one hand, indicate that a hypothetical yellow dye might be too degraded in order to be detected, or on the other hand, that no dye may have been used. In Fig. 32, the similarities between a yellow paint and a reconstruction of two layers of egg white applied on parchment can be observed. The egg white, when applied directly to parchment tends to saturate the natural colour

[86] This organic yellow was found in SC 1, 11, 17, 20, 21, 27, 30 and 34 (eight manuscripts).

from the support, highlighting the yellowish colour from the egg white and parchment. So, in addition to conferring glossiness to the surface, egg white can also emphasize the natural colour of the parchment.

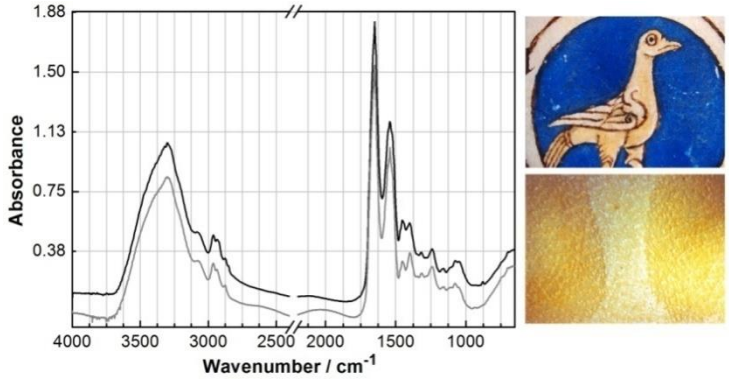


Figure 32. Infrared spectra of a yellow micro-sample taken from SC 34, fol. 94v (─) and of an egg white reconstruction[87] (—). On the right, on top a detail image from SC 34, fol. 94v in 7.1x magnification; on bottom a detail image from the egg white reconstruction in 7.1x magnification.

Orange and brown paints

The colour orange was seldom used in Santa Cruz. By Raman spectroscopy it was confirmed the presence of red lead, Pb_3O_4, also commonly known as *minium*, in the tables of concordance from Santa Cruz 1[88]. The identification was based on the characteristic Raman bands at 121 cm^{-1} and 549 cm^{-1}, which are attributed to the Pb-O stretching vibrations (Edwards *et al.* 1999, Miguel *et al.* 2009), Fig. 33a). Additionally, in the same paint, vermilion was also found, through its characteristic bands at 253, 289 and 343 cm^{-1} in order to produce reddish oranges. In another close area, in Fig. 33b), a different orange was also detected by Raman, which included the admixing of vermilion and orpiment.

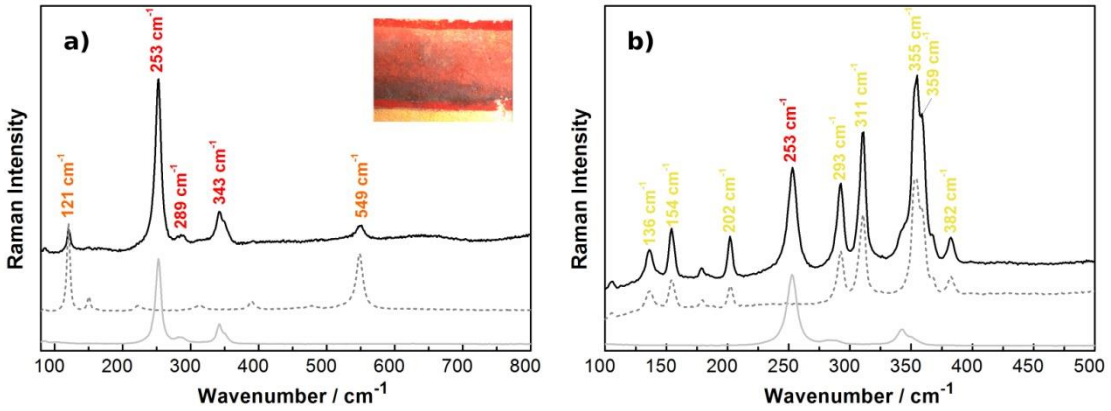


Figure 33. Several Raman spectra of orange paints: **a)** Raman spectrum of an orange from SC 1, fol. 364v (─) with a red lead (---) and vermilion (—) references, including an inset image detail from the area where the micro-sample was taken with 10x magnification; **b)** Raman spectrum of another orange from SC 1, fol. 364v (─) with a orpiment (---) and vermilion (—) references.

[87] This egg white was prepared according to the medieval treatise *De Clarea* (Thompson 1932: 19).
[88] It was confirmed molecularly in SC 1, however its use may have been also extended to SC 27.

As for the colour brown, it was only used in Santa Cruz 1, to paint the hair from some of the characters portrayed in the historiated initials. These were only analysed by XRF: Hg and Pb were always detected – a representative XRF spectrum can be seen in Appendix V, Fig. V.1.1. In order to produce these browns, it is likely that vermilion and red lead may have been used[89] possibly admixed with a carbon based black to darken the hue, which is not possible to detect by XRF.

Purple paints

Purple paints were also found in two manuscripts: SC 4 and 58, which are considered as some of the earliest produced codices in Santa Cruz. XRF analysis detected the typical elements also found in the parchment support, such as Ca, K, Fe, Mn and S, in relatable number of counts (this can be seen in detail in Appendix V.3.). By IR reflectance, Fig. 34a), in addition to the presence of calcite, given by the distorted reststrahlen band of CO_3^{2-} at 1415 cm^{-1} (Ricci *et al.* 2006), another broad inverted band at circa 1000 cm^{-1} was also found, in both manuscripts. This region is normally assigned to the Si-O stretching vibration, which could indicate the presence of silicates in the matrix of this paint. UV-Vis in apparent absorbance, Fig. 34b), showed an absorption maximum at 566 nm. Based only on this, it was not possible to correlate this information with a particular dye. Fluorimetry measurements were also conducted *in situ*, however no emission signal was detected in this particular purple.

Unfortunately, its identification will remain for now unknown, as no micro-samples were taken from these two codices, which would had allowed to a more detailed characterisation in the laboratory.

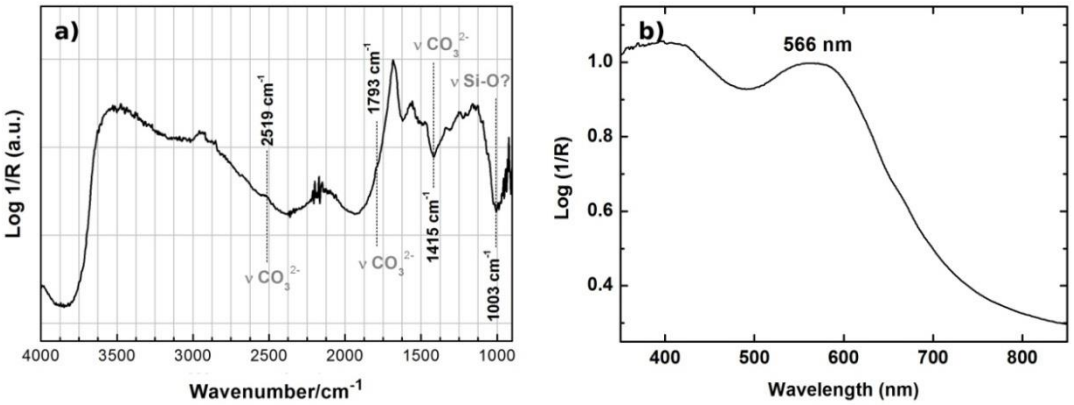


Figure 34. Several spectra of purple paints: **a)** MOLAB XRF spectrum of a purple paint (─) and the parchment support (┄) from SC 4, fol. 266; **b)** MOLAB Mid-FTIR reflectance spectrum of a purple paint from SC 58, fol. 1.

[89] This mixture was found, for example, in Lorvão's Apocalypse in its few brown paints, associated with an iron not identified compound (Claro 2009: 70-71).

White paints

To produce white colours, Santa Cruz scriptorium used lead white[90], $2PbCO_3.Pb(OH)_2$. It was mostly found mixed with other pigments to produce lighter tones for certain colours, as for example in light blues, already previously demonstrated in Fig. 26c). XRF detected the presence of lead – in Fig. 35a) –, while µ-FTIR allowed a clear identification through the characteristic intense broad stretching band of the CO_3^{2-} at circa 1402 cm^{-1}, and the sharp peak of the CO_3^{2-} bending mode at 681 cm^{-1} that indicates the presence of basic lead carbonate, plus the weak absorption band due to the OH stretching at circa 3533 cm^{-1} (Gettens 1993: 77), in Fig. 35b). A prominent broad band at 795 cm^{-1} was also detected. In this sample red lead and orpiment were also detected, taking this into account it is possible that this band may be related to an arsenic oxide. It has been reported an infrared absorption band on that same location for an oxidation product named arsenolite, As_2O_3 (White and Roy 1964: 1683-4), however most studies on orpiment do not mention this absorption. The identification of lead white was also made by mid-FTIR reflectance in SC 18, 27 and 43, which can be seen in Appendix V.

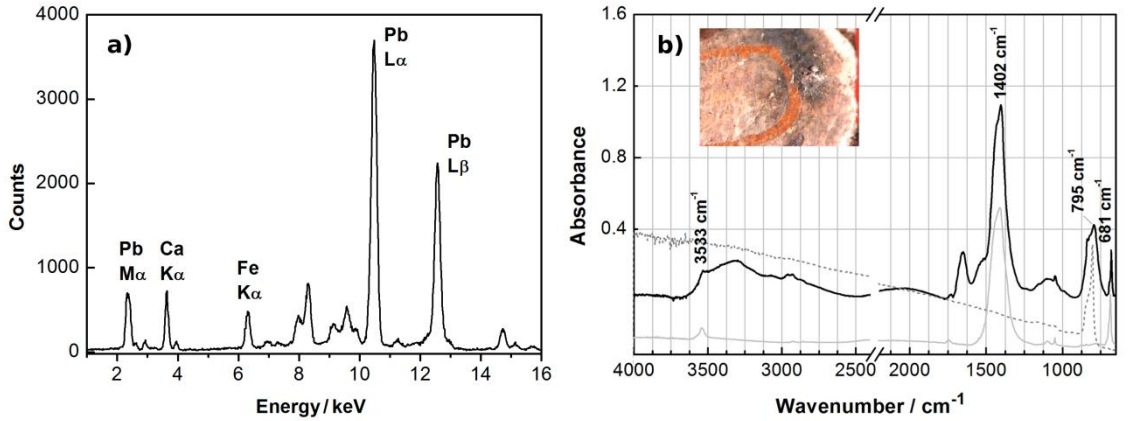


Figure 35. Spectra with evidences of lead white: **a)** MOLAB XRF spectrum of a light blue from SC 43, fol. 1; **b)** Infrared spectrum of a degraded white paint[91] from SC 1, fol. 364v (─) with lead white (—) and orpiment (---) references, including an inset image detail from the area where the micro-sample was taken with 40x magnification.

Black paints and ink

Black was mainly used as an ink[92], not as a paint. This is confirmed by the fact that the *Book of Birds* SC 34 is the only manuscript from Santa Cruz collection with black paints. From

[90] Lead white was molecularly identified in four manuscripts: SC 1, 18, 27 and 43. However, its presence may be more dominant in the collection, as several other manuscripts showed signs of Pb in light coloured paints.
[91] This degradation phenomenon will be later discussed, as on this micro-sample red lead and vermilion were also detected.
[92] The term ink is meant to include the ink used for writing as well as the ink used for drawing the contours of the illuminations.

all of the manuscripts analysed by XRF[93], all of them evidenced a higher Fe content in their black inks when compared to the parchment support, in Fig. 36a). The confirmation on the use of an iron-gall ink was achieved by Raman spectroscopy, in Fig. 36b), through its characteristic broad band with multiple peaks between 500-650 cm^{-1} which has been assigned to several stretching and in-plane bending ring C-C, the band at approximately 1326 cm^{-1} attributed to the C=C and C-O stretching vibrations and the in-plane bending from OH bond, at 1471 cm^{-1} ascribed to the sciss CH_2, the C=C stretching ring and at 1569 cm^{-1} assigned to the stretching mode from C=C ring (Bicchieri *et al.* 2013; Piantanida *et al.* 2013). The same sample was analysed by FTIR, seen in Fig. 36c), and a collapsed protein ascribed by the broad band at 1647 cm^{-1} from the stretching of the amides as well as calcium oxalate with its characteristic bands at 1323 and 787 cm^{-1} were identified. Calcium oxalate was also detected in five manuscripts by mid-FTIR reflectance. Its presence has been also reported in black inks by Bicchieri *et al.* 2013. This issue will be further discussed in the following section 2.2.2. Colour degradation.

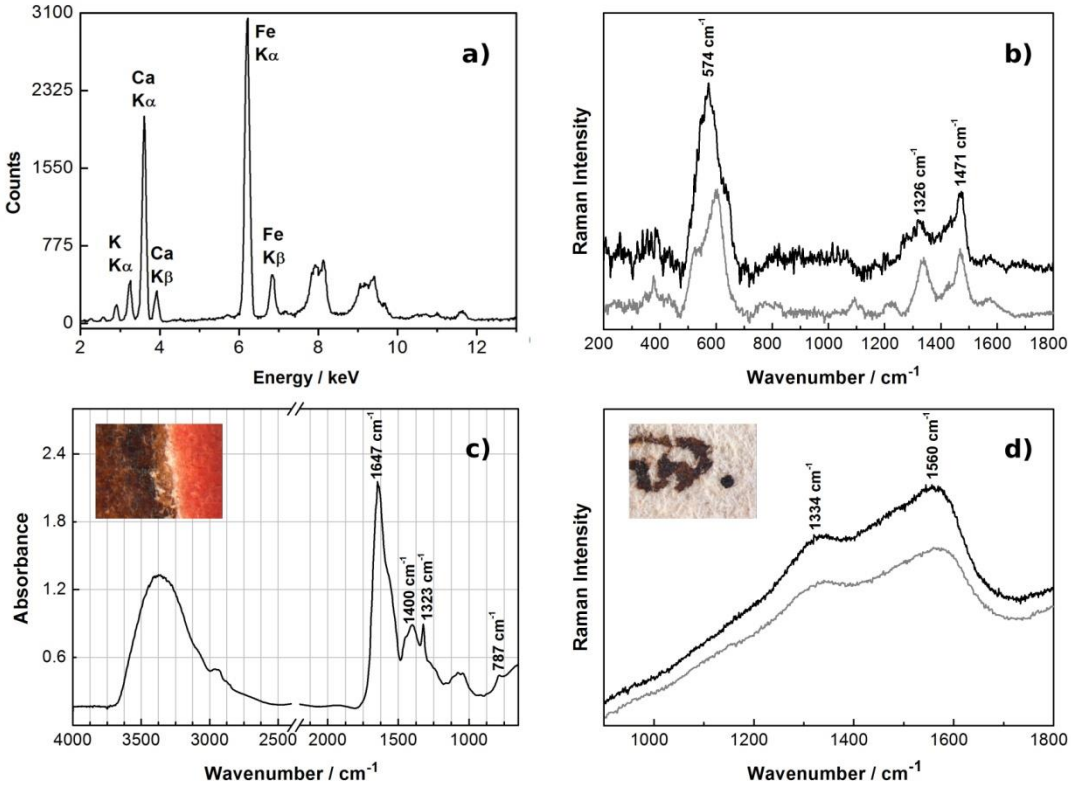


Figure 36. Several spectra of black paints: **a)** XRF spectrum of a black paint from SC 20, fol. 173v; **b)** Raman spectra of a black micro-sample from SC 20, fol. 78 with an iron-oak gall ink standard provided by Paula Nabais, at λ_{exc}=785 nm; **c)** Infrared spectrum of a black micro-sample from SC 20, fol. 78, including an inset image detail from the area where the micro-sample was taken with 50x magnification; **d)** Raman spectrum of a black micro-sample from SC 34, fol. 103 (—) with a carbon black reference (—), including an inset image detail from the area where the micro-sample was taken with 50x magnification.

[93] SC 1, 4, 17, 20, 21, 27, 30 and 43.

As for the SC 34, which contains actual black paints, from the three micro-samples taken from this particular codex, two of them did not show any signal by Raman microscopy, due to its high fluorescence. By FTIR one of them, SC 34, fol. 104, just revealed the fingerprint from the proteinaceous binder, while the other two showed signs of the collapse of the protein in different stages of degradation (SC 34, fols. 97 and 103). The high fluorescence from these two black paints may suggest the presence of organic acids, such as gallic or elagic acids, however the lack of XRF data does not allow a proper characterisation.

Raman spectroscopy allowed the identification of graphite, in SC 34 fol. 103, based on its characteristic broad doublet at *circa* 1560 cm^{-1} and 1334 cm^{-1}, also known as the G ('Graphite') and D ('Defect') bands, Fig. 36d). The first band has been reported as the C-C stretching vibrations of an ideal graphitic lattice vibration mode with E_{2g} symmetry, while the second band has been characterised as the disordered graphite constituent – it tends to grow more in relation to the G band with the increasing degree of disorder in the graphite structure – that corresponds to a graphitic lattice vibration with A_{1g} symmetry (Ferrari and Robertson 2000; Escribano *et al.* 2001; Sadezky *et al.* 2005). This particular sample was taken from an outlined drawing of a bird's paw. Taking this into account, it is probable that they were using not only iron-gall inks – taking into consideration that no carbon-based signal was achieved with two of the samples –, but also mixtures with carbon-based blacks to paint the black birds from SC 34, if considering this last sample.

Extenders

The use of fillers in the colour paints does not seem to have been a very widespread practice in Santa Cruz scriptorium, contrarily to Alcobaça. Although calcium carbonate was detected by mid-FTIR reflectance in most paints, due to its strong absorption coefficient, from the combination bands from the CO_3^{2-}: $\nu_1+\nu_4$ vibrations at 1793 cm^{-1}, the $\nu_1+\nu_3$ at 2515 cm^{-1} and the $2\nu_3$ at circa 2900 cm^{-1} (Rosi *el al.* 2009), its presence was not assigned as a filler, but as part of the parchment support. When comparing with transmittance infrared, calcium carbonate was normally observed in very small intensities, in order to be considered as a deliberate employment of filler[94].

Consequently, the only cases where an actual extender seems to have been used were in the deep dark reds made of lac dye, where calcium carbonate and gypsum were identified by FTIR, in Santa Cruz 1 and 21, respectively. The first example was already presented above in the lac paints, Fig. 29b). This subject will be further discussed in Chapter III.

[94] The use of paint reconstructions in parchment support were essential to acknowledge that the small amounts of calcium carbonate that were detected by FTIR could not be from the paint, but most likely from the surface of the parchment.

Varnishes

The use of varnish was very likely a common practice in Santa Cruz, judging by the appearance of some of the paints observed under the microscope. Many display a lustrous surface and in some cases even a heavy colourless craquelure above the coloured layer. By taking several 'extemporaneous' colourless samples found on top or near the paints, these displayed the fingerprint profile of a proteinaceous material. Moreover, some of the yellowish paints seen in the collection, attributed to the 'organic yellow', could be seen as well in some cases as a varnish applied directly to the parchment. These observations can be seen in Fig. 37.

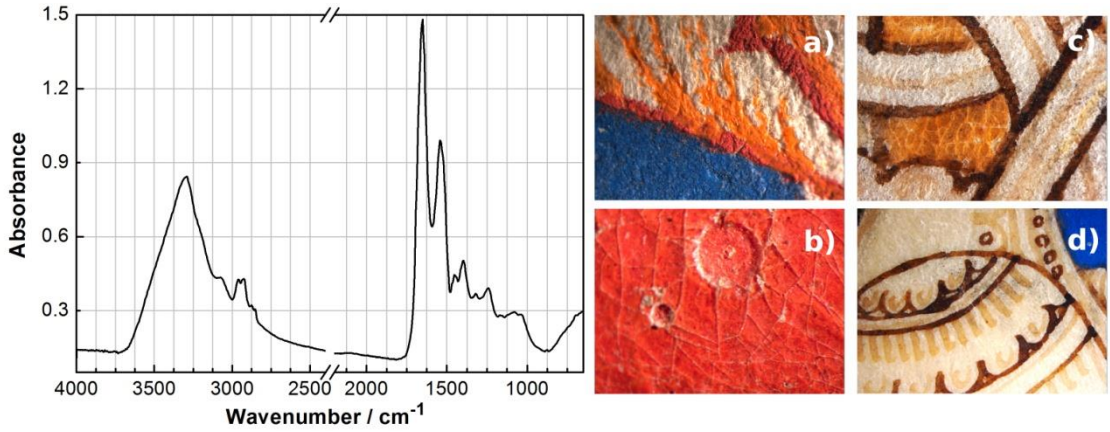


Figure 37. Infrared spectrum of an 'extemporaneous' micro-sample from SC 20, fol. 86. The detailed images on the right are from: **a)** SC 20 fol. 86, with an orange paint that presents a very glossy appearance; **b)** SC 27, fol. 15, with a red paint that presents a glossy and fragmented surface with signs of possibly dried bubbles; **c)** SC 1, fol. 24, with bright light yellows enhancing the drawing; **d)** SC 1, fol. 98, with the same bright light yellows that complement the drawing. The images were acquired in 10x, 20x, 25x and 63x magnifications.

2.2.2. Colour Degradation

In Santa Cruz collection, two major degradation issues surrounding colour were assessed: 1) within the pigments – defined by the loss of colour by colour alteration; 2) within the interaction of certain pigments with the binding media – led by the loss of colour by detachment. Some of these issues have been recently reviewed in an overall study on the most observed colour degradation phenomena in Portuguese Romanesque illuminations (Melo *et al.* 2016a).

The colour alteration on lead white and red lead in the *Bible* SC 1 is one of the most visual transformations of colour seen in the collection, Fig. 38. This phenomenon is characterised by the darkening of lead-containing pigments, which tend to generate black degradation products. These products have been identified in previous works as plattnerite (β-PbO_2) or galena (PbS) (Giovannoni, Matteini and Moles 1990; Burgio, Clark and Firth 2001; Miguel *et al.* 2009a; Muralha, Miguel and Melo 2012).

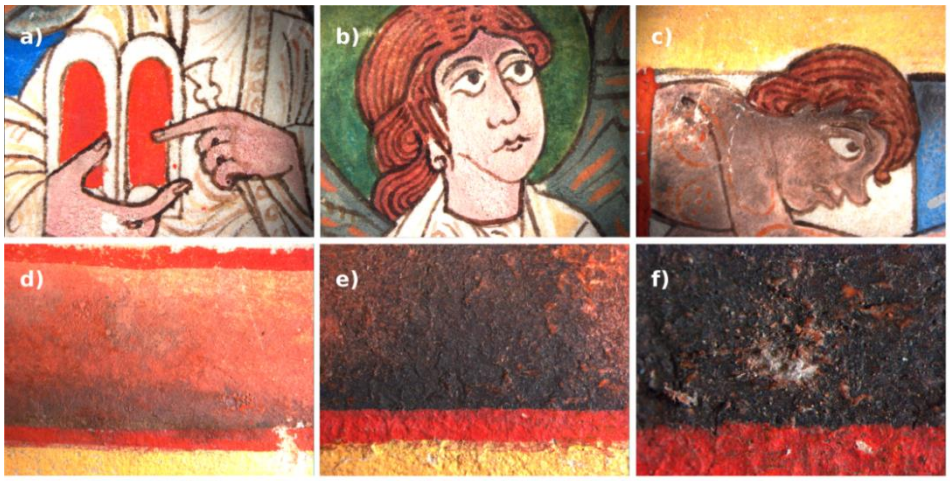


Figure 38. Several examples on the degradation of lead white: **a)** SC 1, fol. 14v, **b)** SC 1, fol. 14v, **c)** SC 1, 364v; and of red lead: **d)** SC 1, fol. 364v, **e)** SC 1, fol. 364v and **f)** SC 1, fol. 364v.

In Santa Cruz case, the main product identified by Raman spectroscopy was an arsenate broad band at about 812 cm^{-1}, attributed to the symmetric stretching ν_1 mode of the AsO_4^{3-} free ion that coincides with the anti-symmetric stretching ν_3 mode (Frost *et al.* 2003; Muralha, Miguel and Melo 2012). It is likely that galena may be also present – particularly in the lead white degradation, Fig. 39a), seen in the weak band at 433 cm^{-1} –, however the signal from vermilion and red lead pigments are much stronger, which may mask the other characteristic band from galena at circa 200 cm^{-1}, which is normally also weak (Miguel *et al.* 2009a).

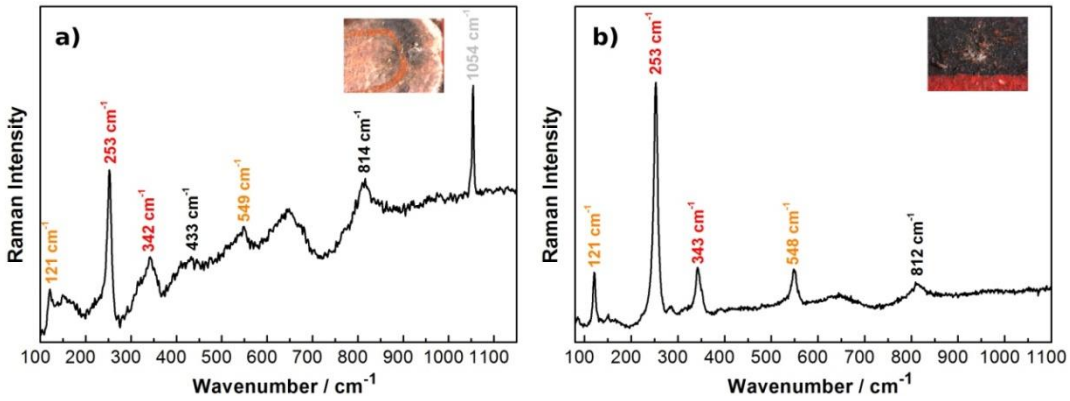


Figure 39. Raman spectra of lead pigment degradation: **a)** of a pink micro-sample from SC 1, fol. 364v, including an inset image detail from the area where the micro-sample was taken with 40x magnification; **b)** of a blackish orange micro-sample from SC 1, fol. 364v, including an inset image detail from the area where the micro-sample was taken with 50x magnification.

The presence of arsenate-based species, such as As_2O_3, seen by the band at 812 cm^{-1}, is an indication that orpiment, As_2S_3 – the only source of arsenic in the manuscript – is likely the responsible for the observed degradation. A proposed mechanism of degradation between red lead and orpiment was given by Miguel *et al.* 2009a, where the As_2O_3 was thought to be a product or a reaction intermediate. Moreover, Keune and Boon were the firsts to show that

arsenic from degraded pigments was transported in oil paintings, through a water-linked transport. The authors stated that arsenic was transported as arsenic trioxide in aqueous solution form, H_3AsO_3 (Keune and Boon 2011). More recently, this premise was supported by synchrotron-based X-ray micro-analyses where arsenite (As^{3+}, As_2O_3) and arsenate (As^{5+}) compounds, as main photo-degradation products from orpiment and realgar, are transported in the paint system by water, as water soluble compounds (Keune *et al.* 2015). It is quite likely that the same phenomenon could be occurring in medieval illuminations, as the binding media and parchment support are quite compatible materials for water transportation.

As for the source of sulphur, in addition to the orpiment, vermilion was also detected in these paints which could have also function as an intermediate for the mechanism of degradation, but it would be necessary more studies in order to attest that possible theory. Moreover, by mid-FTIR reflectance, both red lead and orpiment showed a broad inverted band at 1140 cm^{-1} assigned to the SO_4^{2-} vibration mode, in SC 1, 4 and 43[95]. According to Keune *et al.* 2015, the presence of sulphates below the predominant arsenic area was considered a significant aspect in the study of the degradation of arsenic sulphide pigments, as they detected different oxidation states, where sulphur was converted to several stable sulphur-species until reaching the sulphate (SO_4^{2-}) group. More studies will be needed to better determine these species and their role in the degradation mechanism.

As for the second most observed issue surrounding colour loss by detachment – which is considered more extended and frequent in Santa Cruz manuscripts compared to the colour alteration only found in one codex –, the so-called *bottle green* made from a copper proteinate complex has shown severe loss of cohesion and adhesion to the support, which can be seen in Fig. 40. While its colour seems unaffected, its binder has been extremely altered by the most likely protein chain scission and cross-linking, leading to a heavy craquelure pattern which in turn propitiates its physical breakdown and final loss.

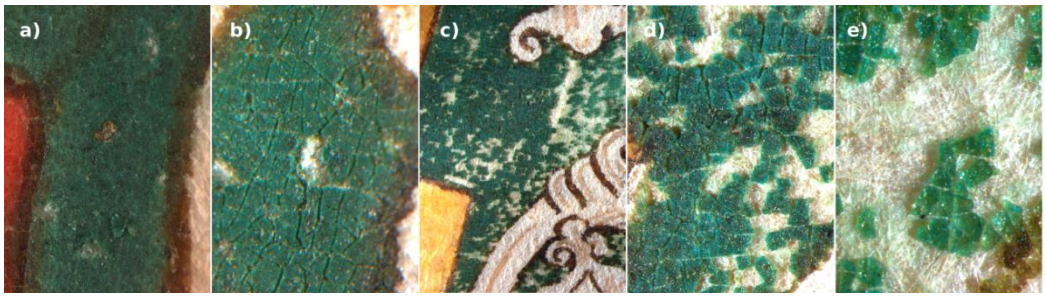


Figure 40. Detail images of *bottle green* with different stages of degradation: **a)** SC 20, fol. 86, **b)** SC 1, fol. 98; **c)** SC 1, fol. 24; **d)** SC 1, fol. 24; **e)** SC 1, fol. 24.

[95] In this particular manuscript, SC 43, orpiment was not molecularly identified. However, its presence is quite probable as As was detected by XRF, in a dark green paint, where indigo was detected too.

As already stated previously, this pigment showed in its infrared spectrum a broad band at about 1645 cm^{-1} that incorporated not only the amide I at 1653 cm^{-1}, but also the amide II at 1550 cm^{-1} ascribed to the collapse of the proteinaceous binder. Moreover, the broad band is most likely assigned also to the acetate absorption band at circa 1635 cm^{-1} from a verdigris-based pigment, which stands as the basis for the formation of a protein-copper complex (Miguel *et al.* 2009b). By looking at several infrared spectra of this synthetic copper proteinate, it has been establish some correlations between the degradation of the binder – i.e. the collapse of the two amides – and the state of conservation of the paint, Fig. 41. Likewise, changes in the C-H stretching absorption region 3000-2840 cm^{-1} are also observed, particularly with the disappearance of those bands, when severe collapse from the protein is also found in the amide region (Miguel 2012).

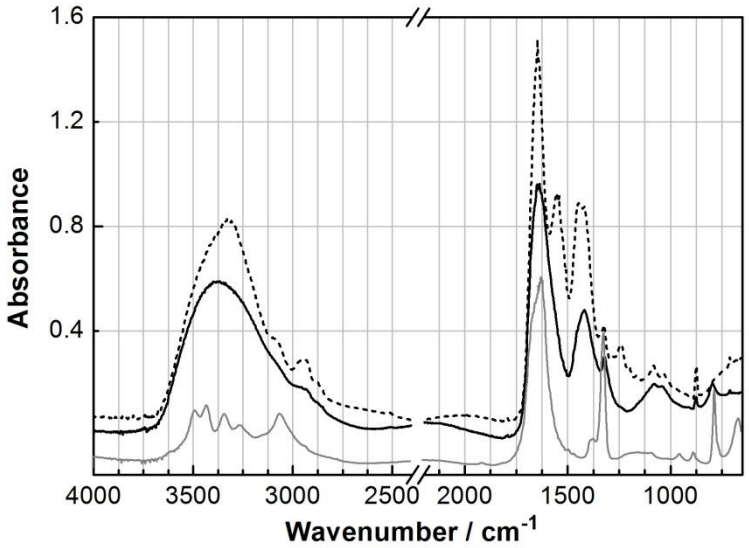


Figure 41. Infrared spectra of green copper proteinate paints from: SC 1, fol. 24 (─) and SC 34, fol. 107 (┈) with calcium oxalate monohydrate (whewellite) reference (—). The SC 1 represents the more degraded *bottle green*, while SC 34 presents the best preserved green paint in Santa Cruz collection (please notice that the band at about 1430 cm^{-1}, in SC 34 fol. 107, is more pronounced due to the presence of calcium carbonate).

Another factor is thought to be behind the green paint degradation and, consequently, the possible cause for the binder's deterioration: the ubiquitously present calcium oxalate ($CaC_2O_4.nH_2O$), identified by its absorption bands at 1323 and 784 cm^{-1}, both through FTIR and mid-FTIR – the latter band could not be detected by infrared reflectance. The other characteristic bands from calcium oxalate at about 1640 cm^{-1} and in the region ranging 3000-3600 cm^{-1} is overlapped by the protein absorption bands, therefore the identification of the specific kind of oxalate is difficult to assess (Monico *et al.* 2013). However, taking into account, their characteristic bands, it is likely that weddelite (dehydrated form) and/or whewellite (monohydrate form) may be present. In addition, both have been also reported in several works of art (Monico *et al.* 2013; Salvadó *et al.* 2009, 2013).

The infrared spectra with higher absorptions on the oxalate bands showed proportionally more alterations on the C-H absorption region and more complexed copper-proteinate bands (Melo *et al.* 2015). It is believed that the broadening of the copper-proteinate band is responsible for the loss of cohesion and adhesion of the *bottle greens* (Miguel 2012) and that the presence of calcium oxalates may be ascribed to the deterioration observed in the binding media.

The underlying principle behind the presence of oxalates is still under investigation. The pioneering work by Nati Salvadó has shown that calcium oxalates tend to be more close to the surface and between cracks, and that its presence is associated to the alteration of the binding media, particularly within the lipidic content (Salvadó *et al.* 2002, 2013). It is believed that these salts are formed from the reaction of mobile fatty acids with metals of pigments – such as copper and iron – or ground layers, like calcium, forming a metal coordinated paint system. Although consider as a stimulate for the reaction, the free fatty acids of the binders have not been proven absolutely indispensable for the activation of the mechanism for the formation of metal oxalates (Sotiropoulou *et al.* 2015). The source of oxalic acid has been also correlated with microbiological activity (Pinzari *et al.* 2010); however there have been several reports where microorganisms were not detected and where its origin is thought to come from an anthropic origin, formed by the degradation of organic materials (Colombini *et al.* 2002; Zoppi *et al.* 2010). Taking this into account, it is believed that the observed detachment and loss of cohesion of the green copper-proteinate paints from Santa Cruz is due to the proteinaceous binder degradation, which is activated by the reaction with the copper pigment, through a radical mechanism, leading in turn to extensive chain scission and cross-linking. The formation of calcium oxalate is one of the final products resulting from this chain reaction, through its interaction with the calcium present in the parchment support (Melo *et al.* 2015).

In addition to the green paints, calcium oxalates were also detected by infrared transmittance and reflectance in black paints and inks from five manuscripts from Santa Cruz. The presence of iron in several pigments has been referred as an important catalytic player in the process of formation of metal-complexes (work by Letizia Monico cited by Sotiropoulou *et al.* 2015). The presence of calcium oxalates in black inks has been also reported by Bicchieri *et al.* 2013. In the ATR-FTIR spectra of those fragments from the 7^{th}-8^{th} century showed as well the collapse of the two main bands of the protein, which is in agreement with the results presented here. Several problems of detachment and loss of pigment in the black birds from Santa Cruz 34 were also observed, which could be also related to this phenomenon, Fig. 42.

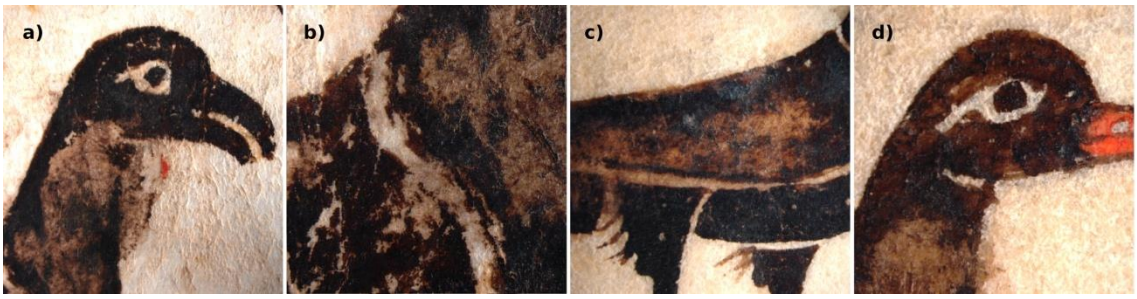


Figure 42. Detail images of black paint degradation in SC 34: **a)** fol. 97; **b)** fol. 97; **c)** fol. 104; **d)** fol. 104.

Finally, another less frequent issue within loss of colour by detachment was also observed with, particularly, lapis lazuli and lead white paints, Fig. 43. Flaking and loss of cohesion to the support may be explained by the low quantity of binder, normally associated to these two pigments – as shown previously in Figs. 26a) and 35b).

Figure 43. Detailed images of white and blue paints degradation in SC 27, fol. 1.

2.3. Parchment assessment

2.3.1. Parchment characterisation

For an overall introduction on the parchment and on the techniques used for its characterisation, consult Appendix VI.

On the characterisation of the parchment from Santa Cruz, the typical elements associated to this type of support were identified by XRF, namely Ca, K and Fe, with the less intense Cl, Mn and S, as seen in Appendix V.

By infrared spectroscopy, a sample taken from a glass-like layer[96] of the parchment was analysed, Fig. 44a). The characteristic bands of a proteinaceous material, such as collagen, were detected: at 1650 cm^{-1} the amide I; at 1543 cm^{-1} the amide II; at 1450 cm^{-1} the CN bending; and at 3400-3000 cm^{-1} the OH and NH stretching vibrations. Additionally, intense absorptions bands were also observed at the region of the 3000-2800 cm^{-1}, with the attributed asymmetric CH_3

[96] Glass-like layer was an expression created by IDAP to describe one of the typical signs of gelatinization. It can be very mild, with the presence of transparent and slightly discoloured fibres; to a very heavy and damaged state, where a layer of cracks and flakes starts to fall off.

stretching vibration at 2962 cm^{-1}, the asymmetric CH_2 stretching at 2935 cm^{-1}, and finally the symmetric CH_3 stretching absorption at 2875 cm^{-1} (Bicchieri *et al.* 2011; Odlyha *et al.* 2009; Miguel *et al.* 2012). An additional pronounced absorption band was found at 1035 cm^{-1}, which according to Bicchieri *et al.* 2013, can be attributed to the C-O-C stretching of the saccharide structure of the gelatine[97]. This is according to the authors, a sign of gelatinization of the parchment, which could be in agreement with the visual assessment of the glass-like layer. Nevertheless, the intensity of the CH bands should be noticed. Degradation of parchment has been reported to induce a reduction of the CH_2 and CH_3 stretching absorptions, which is not seen here (Della Gatta 2007: *et al.* 95).

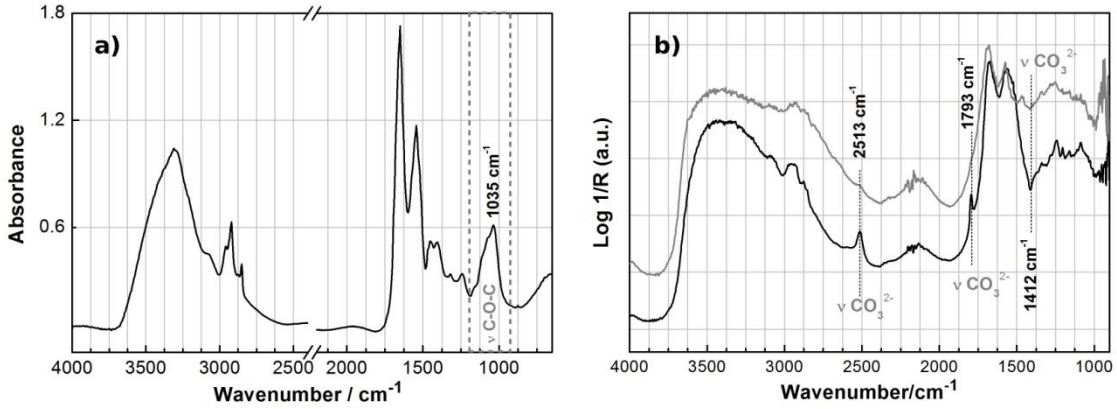


Figure 44. Several spectra from parchment: **a)** Infrared spectrum from SC 27, fol. 15; **b)** MOLAB Mid-FTIR reflectance spectrum of the flesh/recto side of the parchment from SC 17, fol. 1 (—) and of the grain/verso side of the parchment from SC 17, fol. 1 (—).

With mid-FTIR reflectance, calcite was detected by its elevated absorption bands at 1412, 1793 and 2513 cm^{-1}, in the flesh side of the parchment, Fig. 44b). Its presence may be explained by a finishing chalk treatment, which was typically rubbed onto the flesh side of the skin while it was still wet for posterior mounting to dry. This was supposed to give the parchment a smooth and white surface (Bicchieri *et al.* 2011: 268). On the other hand, the grain side of the parchment had a lower content of $CaCO_3$. According to Hiller *et al.* 2007, calcium carbonate may be indicative of a lime bath manufacture, where the calcite is embedded in the collagen matrix. It deposits on the fibril surface as well as in the gap and overlap regions of the collagen fibrils.

During the parchment surface analysis, residues of wax, most likely from candles, were found in two manuscripts from the collection by infrared and Raman spectroscopies in 'extemporaneous' samples. In Fig. 45a), the characteristic bands from a kind of paraffin wax were identified at 2920 and 2850 cm^{-1} by the CH stretching vibrations, at 1736 cm^{-1} by the C=O

[97] The same author refers two years previously that this band can be also a sign of the tannin source (Bicchieri *et al.* 2011: 270).

stretching absorption, at 1462 cm^{-1} by the CH bending, at 1173 cm^{-1} by the CO stretch of the ester group, and finally, at 721 cm^{-1} by the CH_2 rocking and wagging modes (Kühn 1960).

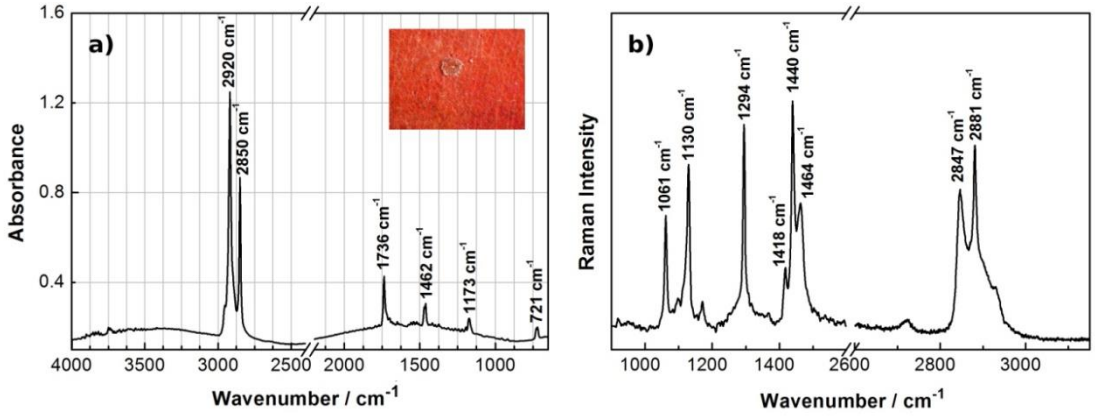


Figure 45. Several spectra of 'extemporaneous' samples of waxes: **a)** Infrared spectrum of an 'extemporaneous' micro-sample from SC 27, fol. 15, including an inset image detail from the area where the micro-sample was taken with 50x magnification; **b)** Raman spectrum of an 'extemporaneous' micro-sample from SC 20, fol. 144.

By Raman spectroscopy, in Fig. 45b), paraffin was also identified by several of its characteristic bands at 1061 cm^{-1} from the CC skeletal stretching, 1130 cm^{-1} from the CC stretching, 1294 and 1440 cm^{-1} from the CH_2 deformation, 1418 cm^{-1} from the CH_3 deformation and 1464 cm^{-1} from the CH_2 bending modes. Moreover, at the 3000-2700 cm^{-1} region, the peaks at 2847 and 2881 cm^{-1} are assigned to the symmetric and asymmetric CH_2 stretching vibrations, respectively (Zheng *et al.* 2006; Ó Faoláin *et al.* 2005).

2.3.2. State of conservation

The main goal of this part of the research was to assess the conservation condition of the parchment used in the manuscripts from the Santa Cruz collection. Under the guidelines developed by the IDAP methodology, a visual assessment of the damage in the parchment support was conducted, supported by colorimetric measurements and very sporadic analytical data. The general information about the applied methodology can be consulted in Appendix VI.

For the elaboration of this work, the PDAP and the DUPDA were used as fundamental tools. The PDAP was developed under a report that was divided into three parts: part 1) contained the general information about the parchment, including an overview of different types of damages and properties; part 2) enclosed the assessment of the properties and types of damage observed in *specific areas*[98]; part 3) involved micro-sampling of the specific areas for further analysis. According to the IDAP protocol, these analyses were mainly conducted

[98] These *specific areas* were normally around three different selections of areas, without ink or paint, which could represent distinct stages of deterioration. For more information, see Appendix VII.

through the microscopy, by observing the behaviour of the fibres in water and the measurement of the shrinkage temperature, Ts. In order to assist the user, a *helpfile* was created by IDAP with the definition of all the categories and the main observed pathologies in the parchment. While the two initial assessments were mainly visual, the third required micro-sampling, and for that reason it was limited to just an experiment in the School of Conservation, in Copenhagen[99].

In order to standardize the type of properties and damages observed in the parchment, IDAP established also specific vocabulary that was not used generically in graphic documents diagnosis. This allowed a better assessment of the specific issues surrounding this very singular material – this can be consulted in Appendix VI. Moreover, the visual categorisation of damage was divided into four levels: 1 - undamaged (●), 2 - slightly damaged (●), 3 - damaged (●) and 4 - heavily damaged (●)[100], also available in Appendix VI.

Some adaptations, though, had to be made to the PDAP approach, because the diagnosis was mostly designed for parchment bindings, detached folia or fragments. Therefore, it was not suitable for manuscripts. In collaboration with Inês Correia, the program was adapted to the required needs. Correia was the first to do a systematic and in-depth visual assessment of the Lorvão collection, focusing her approach on the damage from handling of each codex (Correia 2014). Over time, the procedure was simplified in order to make it more practical and feasible to apply to a manuscript, and ultimately, to a collection. Here, an even more simplified methodology was used by eliminating the three specific areas into just one overall observation. For more information on this, please consult Appendix VI.

From the 14 previously analysed manuscripts, nine were fully assessed – SC 4, 11, 17, 20, 21, 27, 30, 34 and 72 – and two additional – SC 54 and 68 – were also included due to their specific liturgical texts and primitive bindings, which will be discussed in the following sub-chapter. For more information on the approached methodology, please consult section VI.II from Appendix VI.

In Table 3, the distribution of the main damages found in the parchments from 11 assessed manuscripts is depicted. There were some common aspects that stood out: deformations, discolouration, surface contamination and mechanical damages. The deformations, which were visible in all of the parchments from the collection, are overall associated with the bad state of conservation of the bindings. The deficiency of the bookblock sewing and, in some cases, of the wooden boards is in most parts responsible for the lack of stability of the parchment – this will be further discussed in the next sub-chapter. The conditions

[99] The School of Conservation, in Copenhagen, was the headquarters of the IDAP program, led by René Larsen. In 2010, while receiving an IDAP training course, some preliminary applications of the methodology were conducted to three micro-samples taken from manuscript Santa Cruz 4.
[100] This colour system was based on the approach used by Inês Correia (Correia 2014: 163-4).

of the assessment – room temperature and RH (relative humidity) – may also explain the constant presence of deformations in all of the parchments, as it came from a controlled envirommment (the Casa Forte)[101] to an uncontrolled one (the assessment room). This may have led to fluctuations that directly contributed to the expansion and contraction of the parchment. On the other hand, the discolouration, surface contamination and mechanical damages are mostly related to the handling of the manuscript. These were mostly observed in the peripheral corners of the folia – the most handled specific area.

Table 3. Distribution in percentage of the different types of damage found in the parchment from Santa Cruz collection.

	SC 4	**SC 11**	**SC 17**	**SC 20**	**SC 21**	**SC 27**	**SC 30**	**SC 34**	**SC 54**	**SC 68**	**SC 72**
Deformations	100	100	100	100	100	100	100	100	100	100	100
Mechanical damage	55	47	46	85	71	77	37	66	100	100	95
Holes and losses[102]	30	19	35	28	29	37	17	21	60	45	23
Transparent areas	19	9	15	18	24	5	3	17	9	8	5
Surface contamination	100	74	52	93	100	100	60	100	100	100	100
Discolouration	100	91	100	100	93	100	63	100	100	100	95
Biodeterioration	2	6	4	0	3	0	11	28	3	0	0
Insects/rodents	4	4	13	3	1	3	6	14	11	8	9
Water damage	10	2	4	8	9	2	20	45	31	24	18
Glass-like layer	90	53	57	80	85	97	17	79	100	95	18
Calcite deposits	35	40	37	27	22	0	14	76	40	8	9
Previous interv./treatments	8	0	2	0	0	8	0	0	31	13	0
Text damage	45	0	33	22	13	65	14	55	94	97	9
Illumination damage	20	6	9	10	15	32	9	31	71	66	5
Overall categorisation of the damage	2	2	2	2	2	2	1	2	3	3	2

The glass-like layer showed also to be abundantly present in some of the manuscripts. This glassy surface is linked to slight gelatinisation, where the underlying fibre network is still visible through cracks in the vitreous layer (Della Gatta 2005: 648). Several degrees can be distinguished. In this case, glass-like pools around the hair holes from the grain side, fully or almost fully covered glass-like layers and glass-like layer cracks and flakes, in both sides, were the most detected – the latter was particularly seen in the areas were mechanical damage was also observed.

[101] For more information on the storage conditions of the manuscripts, please see ahead Chapter 2.2.4.
[102] This category was not present in the original IDAP approach. It was included in the mechanical damages and deformations – which were also shown together. To give a better notion of the physical damages in the parchment support, these three conditions were separated. Note that 'holes and losses' not only describe loss parchment, but also holes of manufacture that depending on their position may or not interfere with the stability of the support.

Some issues appear more allied to specific manuscripts. For example, biodeterioration was particularly observed in SC 34, through the presence of measles-like purple stains. These have migrated through several folia. A recent study has shown that among other bacterial species and fungi, halophilic microorganisms, such as the *Saccharopolyspora* species, may be responsible for the purple stain discoloration seen in ancient parchment (Piñar, Sterflinger and Pinzari 2015: 437). The microorganisms found in the Book of Birds from Santa Cruz were not identified, however it is important to establish in a near future that if these are still active or inactive, since they can continue to propagate. Colorimetric measurements were taken in order to monitor its presence. The continuous proliferation would not only alter even more the visual assessment of the parchment and, consequently, of the text and illuminations in it, but it would also change even more its surface, by leading to the weakening of the support and, subsequently, its loss. As for the other type of biodeterioration, it was found several lacunas made by xylophagous insects, only in the parchment near the wooden boards.

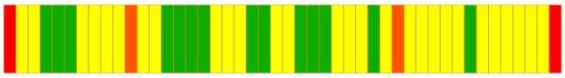
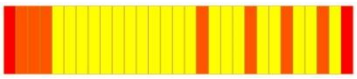
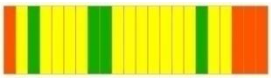
Text and illumination damage was mostly detected in manuscripts where more mechanical damages were observed, but also combined with a strong presence of glass-like layer. In some cases, for example, in SC 4, some of the red *rubrica* and other colour paints showed to be smudged, possibly from a combination of insufficient binding media and careless handling. Others evidenced detachment and other issues already discussed above in Chapter 2.2.2. The positioning of the illuminations was found to be crucial for its preservation. The ones that were more close to the fore edges or gutter were more susceptible to damage, due to the mechanical damages induced by handling and surface contaminations, such as dirt.

No clear correlation between the calcite deposits and the glass-like layer was established. These deposits are mostly associated to the manufacture process, as already established in Fig. 44. Nevertheless, in some cases, they were found concentrated in areas where water had been present or in previous treatments where adhesives and most likely humidification were applied, like in SC 34 and 54. These deposits seem to precipitate at the surface.

In Table 4, each analysed parchment is presented in the colours associated to the different degrees of damage. This analysis allowed establishing a non-pattern of degradation in each manuscript from a stratigraphic perspective, through an innovative codicological system created by Inês Correia (Correia 2014: 169). The only obvious pattern was that, in most cases, the parchments closer to the edges of the textblock were more degraded, when compared with the ones in the middle. However, variations were also observed through the bookblock showing that these changes were mostly associated to handling. It was possible to establish that in some cases, the most degraded parchments found in the middle of the textblock contained the beginning of a new text, for example, or full-size/significant illuminations. In some other cases,

the manufacture process, which was not always constant and regular, was also a reason of more or less deterioration.

Table 4. Distribution in percentage of the degree of damage found in the parchment from the Santa Cruz collection.

	Representative assessment of the textblock (designed by Inês Correia 2014: 169).
SC 4 (83 ff)	
SC 11 (47 ff)	
SC 17 (46 ff)	
SC 20 (60 ff)	
SC 21 (68 ff)	
SC 27 (60 ff)	
SC 30 (35 ff)	
SC 34 (29 ff)	
SC 54 (35 ff)	
SC 68 (38 ff)	
SC 72 (22 ff)	

Through colorimetric measurements, it was possible to establish not only the expected differences between the flesh and the grain side of the parchment, but also alterations in the different specific areas. For instance, the inferior corners of the folia showed more discolourations due to handling, while the upper head margin presented less colour alteration. This is in agreement with the colorimetric values that showed lower lightness L* in the inferior corners as well as a higher presence of red and yellow – the coordinates a* and b*, respectively. These measurements were made primarily for monitoring the medium- and long-term effect of these damages.

Furthermore, it should be noted that some of the parchment manuscripts were at some point trimmed – probably after changing the bookbinding. These are SC 11, 27 and 30. Taking

this into account, the damages seen in these codices, particularly on the exterior edges, may not reflect the authentic usage and passage of time.

As already mentioned above, two additional manuscripts from the collection – which were not molecularly analysed – were added to this assessment due to their contextualization. Santa Cruz 54 is a martyrology from the 12th-13th century with an early bookbinding and Santa Cruz 68 is a missal from the 13th century also with a primitive bookbinding[103]. In addition to both having early bindings, these two manuscripts share the same kind of function in the monastery: they were liturgical books. Correia along her research also noted that this particular type of codex suffered more handling than, for example, Patristic text books due to their important function for the liturgical rite (Correia 2014: 168). Accordingly, these two manuscripts displayed a categorisation of damage 3, which was the highest from the group.

On the contrary, Santa Cruz 30 was the only manuscript that exhibited a lower stage of deterioration, since most of its parchments from the textblock were still in good condition, displaying minor damages.

The final step in the IDAP program was to analise samples taken from specific areas that had already been visually assessed. A preliminary application was conducted at the School of Conservation, with samples taken from Santa Cruz 4[104]. Through microscope visualisation, it was possible to observe some of the most characteristic breakdown features of parchment fibres morphology, in Fig. 46. At the microscopic level, these fibres were overall characterised as stage 3 - damaged, due to the presence of 50% to 75% of deteriorated fibres[105]. The damage was mostly associated with flat fibres, splitting edges and curled 'pearl on a string' fibres. The result was in agreement with the visual macroscopic assessment.

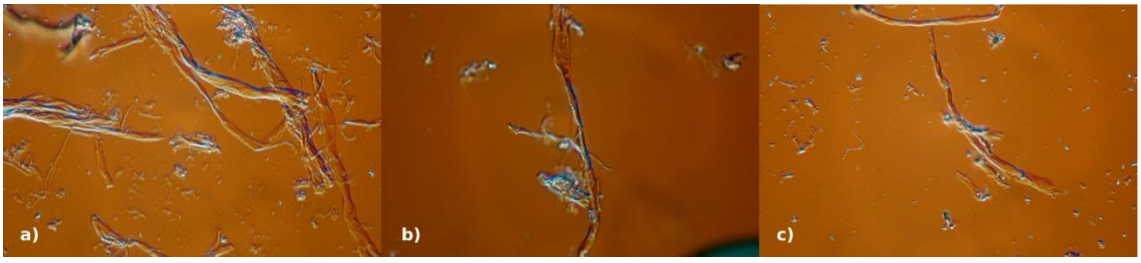


Figure 46. Observation of parchment fibres morphology from fol. 305, SC 4, by optical microscopy: **a)** several damaged fibres, at 160x magnification; **b)** partially flat fibre, at 300x magnification; **c)** 'pearl on a string' fibre with swollen and twisted areas, at 250x magnification.

[103] To know more about these bindings, please see the following section dedicated to the Santa Cruz bookbinding.
[104] These samples had approximately 200-300 μm^2 and were taken from areas where there were already preexisting lacunas.
[105] According to the IDAP categorisation for fibre damage: <30% of damaged fibres is considered undamaged (stage 1); 30% ≤ 50% of damaged fibres is some damage (stage 2); 50%≤75% of damaged fibres is damaged (stage 3); >75% of damaged fibres is heavy damage (stage 4).

The MHT (Micro Hot Table) technique was also applied in order to determine the T_s, shrinkage temperature, the hydrothermal stability of the parchment[106]. Through this method, three samples were analysed from fols. 1, 305 and 328. The samples reached a T_s between room temperature and < 45 ºC, which meant that they were between stages 4 and 2 of damage[107]. These were more or less in agreement with the visual macroscopic assessment – with a shift maximum of 1 stage of degradation. Ultimately the scarce number of samples and the amount of work and sampling that would be necessary to achieve relevant data led to the conclusion that this technique was not suitable for this particular study. Therefore, the visual macroscopic assessment was considered to be an adequate tool to obtain the overall evaluation of the parchment state of conservation.

Comparison with the Lorvão collection

When comparing the Santa Cruz assessment with the Lorvão collection (Correia 2014), it is possible to find similarities as well as disparities within the main types of damage. Surface contamination and discoloration were found to be the most common damage in both collections, as well as glass-like layer that was also found in a significant percentage. Differences were seen mostly in the deformations, which were not so prevailing in Lorvão. This might be connected to the fact that the Lorvão manuscript' bindings were restored in the 20th-21st century, presenting therefore more stable physical conditions. On the other side, calcite deposits were found to be very prominent in the Lorvão collection, which were though to be linked to the manufacture process (Correia 2014: 167). From a stratigraphic point of view, the damage is also presented in a non-uniformed pattern, as seen in Santa Cruz, Table 4.

2.4. Santa Cruz Bookbinding

Medieval bookbindings serve as guardians and protectors of knowledge. As Christopher Clarkson says: '[Bookbinding] demonstrated man's ingenuity in the creation of a complex and portable structure – the codex book. Moreover, the development of bookbinding is so full of informed variations and possibilities in both structure and choice of materials that it reflects a complete sociological and technological history from the first century to the present day' (Clarkson 1978: 34).

For many centuries, bookbinding structures were seen as replaceable or reusable for other purposes. According to J.A. Szirmai, 'Cast off like a worn-out garment, the construction of the old bookbinding' was for a long time completely overlooked and neglected (Szirmai 1996:

[106] To know more about the technique and applied equipment, see Axelsson *et al.* 2016.
[107] Also for the T_s, IDAP protocol has a damage scale: T_s > 50 ºC undamaged; T_s > 45 ºC and < 50 ºC slightly damaged; T_s > 40 ºC and < 45 ºC damaged; T_s < 40 ºC heavily damaged.

144). The author also adds that ‘many original bindings have already vanished: worn-out bindings have been replaced, but more often intact bindings have been needlessly renewed to the taste and fancy of fashion-conscious book-collectors’ (Szirmai 1989). This practice was extensively widespread from the Renaissance period onwards (Szirmai 1996: 144).

In these last decades, a paramount shift has evidenced the need to protect the whole codex, since they are not just ‘media of information transfer, but rather archaeological objects’ (Szirmai 1989). Bookbinding typologies and materials can unveil important local binding traditions, help recognize the technological culture in circulation among monasteries and set chronologies (Melo, Castro and Miranda 2014: 188). By studying their patterns and current conservation issues, better conservation decision-making can be made.

In Portugal, many of the original Romanesque bindings have unfortunately been lost, for the reasons mentioned above. From the three main Portuguese medieval collections, Alcobaça is presently the foremost monastery with original bindings from the 12th-13th centuries – for example, ALC 347, 358 and 426. These codices are known for their very robust and simple decoration, which was typical for that time (Szirmai 1998: 140-172). Two types of covering have been mainly found: 1) a parchment skin covering with a white heavy alum tawed leather overcover that forms an envelope type binding; 2) where the last covering material is substituted by a traditional brown leather, possibly vegetable tanned. The leather overcover fastened to an already fully or partially covered binding was most likely one of the reasons why so many of these codices survived to the present day (Nascimento and Diogo 1984: 15; Szirmai 1998: 165; Cavero *et al*. 2016; Melo, Castro and Miranda 2014: 188). On the other hand, the Cistercian monastery did not instil a radical change in its *armarium*, as what is thought to have been the case for Santa Cruz.

The Lorvão collection does not have any primitive bookbindings. According to Inês Correia, they were most likely altered during the 16th to 18th centuries, and then some were also restored in the 19th-20th century. Between 1999 and 2009, a systematic conservation intervention was conducted at the ANTT (Correia 2014: 124-125). They are, by far, the most detached bindings from what was most likely originally conceived in the Romanesque scriptorium.

Taking this into account, an assessment of the main binding typology found in Santa Cruz and its state of conservation will be subsequently presented and described.

2.4.1. The characterisation of the Santa Cruz typology

From the 99 codices from the collection, 71 are established as productions from the 12th and 13th centuries[108], even if without being able to certainly provide its origin. During 1995 and 1996 under the coordination of Aires A. Nascimento and José F. Meirinhos (1997), a crucial assessment of the Santa Cruz collection was conducted. In addition to the standard cataloguing of the manuscripts, a summarized and itemized description of the bindings for each codex was also presented. The survey methodology used by the group of four researchers that worked on the assessment, tried to standardize the main group of bindings found in the collection through categories, in order to maintain consistency and uniformity. These were mainly divided in five groups: 1) Original; 2) Primitive[109] – sometimes the word 'ancient' was also used; 3) 'Santa Cruz type'; 4) Restored; 5) Modern[110]. These will be described hereinafter.

This pioneering work of mandatory consultation was the main source for this further research. Some modifications and updates were made to the previous assessment. Firstly, no entirely 'original' bindings were identified. Those that were initially thought to be original by Aires and Meirinhos, were included in the primitive typology group[111]. Furthermore, the type 'modern' was also coupled to the 'restored' kind, since there were only two manuscripts under that description and the designation was considered defective, and consequently, abandoned. This analysis allowed gathering information on the main bookbinding typologies found in Santa Cruz, divided into three groups: primitive (16%), 'Santa Cruz type' (56%) and restored (28%). The survey allowed establishing that the so-called 'Santa Cruz type' bindings were the more predominant in the collection; and for that reason, more focus on this particular type of binding was given to this study. The information regarding the manuscripts that were included in each category can be seen in Appendix VII. In order to better understand its archaeology as well as contribute for a proper conservation decision making, a prototype was made according to the 'Santa Cruz type' based on the manuscript SC 34, *Book of Birds* (for a detailed description of this prototype, see Appendix VII).

[108] Some other manuscripts had also compilations of 12th and 13th century texts, but when these were in minority they were not included in this enumeration.
[109] Please notice that the category 'primitive' describes a type of bookbinding that is not entirely original. This means that although some of its elements may be considered as from the time those texts were made, there are some other elements that were altered or substitute along the way.
[110] From the Aires and Meirinhos study (1997), the manuscripts from 12th-13th century had the following types of bookbindings: 'Santa Cruz type' (56%), Restored (15%), Primitive (20%), Original (4%), Modern (3%) and Unknown (1%).
[111] There were two manuscripts that were catalogued as 'originals': Santa Cruz 24 and 54 – the latter had a question mark. By inspecting them it was possible to establish that they were not authentic bindings from the 12th-13th century, due to the presence of posterior metal bosses and clasps and evidences that the seam could not be original (some of the folia had been reinforced with tipped in parchment).

The classified 'primitive' bookbindings are the ones that include more elements that may be described as original or related from the Romanesque period. The SC 24 and 54 – previously classified as originals – were included in this group since they seemed to display several original elements, but with some modifications. These bindings include more than one kind of typology, but the main elements present some common features, which will be described ahead. It was interesting to notice that most of the texts present in this particular group were liturgical. From the 11 manuscripts, there were three Psalters, three Missals, one Epistolary, one Martyrology, one Evangeliary, and other two extremely used texts. This raised some questions: Were these manuscripts so ordinary, that they were not considered important enough to receive new bindings? Or was there another motive for them to have been left out? Taking into account their function, it is more likely that they were not changed because they were considered obsolete. In the monastic environment, liturgical books were often replaced or upgraded according to their daily life cult needs. This means that a lot of times, these codices were not used anymore, since they were outdated, which could explain their 'primitive' bindings. Fortunately, these manuscripts that were possibly left behind allowed theorizing about the book 'archaeology' of the Romanesque manuscripts from Santa Cruz.

The so-called 'Santa Cruz type' is a particular kind of binding that composes more than half of the collection, with 56% of the total. These bindings were, according to Nascimento and Meirinhos (1997: XIX-XX), made in the 16th century. Some of these codices have an index, like in Santa Cruz 1, written by a hand of that same period. Overall this operation into Santa Cruz's collection seems to have been a plan of action, due to its systematic and programmatic application. The reasons are not well established. In 1411, prior Afonso Dias describes a flood that destroyed many choir books and regal donation scriptures from the monastery (Nascimento and Meirinhos 1997: XVIII). There were not, however, any descriptions on this particular collection. Furthermore, the assessment from the parchment, previously presented, did not show any signs of such circumstances. During 1530 and around 1563, a typographic machine was installed in the monastery. Little is known on how the scriptorium, the *armarium* and the printing house were working with each other (Nascimento and Meirinhos 1997: XX). Judging by the look of the collection, it is more likely that they decided to substitute the bindings in order to homogenize their library. The use of *disiecta membra* – parchment fragments – from technical texts, such as law and medicine, was a common practice in Santa Cruz during their activity. This is, according to Nascimento and Meirinhos (1997: XVIII), an evidence that they were willing to destroy outdated works in order to preserve others. Whether they changed the bindings for aesthetic, functional or preservation reasons, it is clear that this operation was conducted to the most valued manuscripts. When comparing with the primitive bindings, it is explicable that may have tried to better preserve and/or cherish the texts that had only one copy

and that were culturally and religiously more notorious. Many of these manuscripts contained texts that were certainly important for the monastery, such as texts from earlier Patristic authors, like St. Augustine, St. Ambrose, St. Jerome as well as significant 12th century theologians, such as Hugh of St. Victor, Richard of St. Victor and St. Bernard of Clairvaux, just to name a few.

Finally, the 'restored' bindings constitute the group of manuscripts whose bindings were restored between the 'Santa Cruz type' period until the present day[112]. The designation is a bit redundant, if considering that all of the bindings were somehow changed. But in order to maintain some continuity with the work from Nascimento and Meirinhos 1997, the name was kept. These display different characteristics, whether in the decoration, material or technique that is too further away from the primitive bindings and unrelated from the 'Santa Cruz type'. Given their disconnection and assortment from the other manuscripts, they will not be described in detail, since these are less significant for this study given their more detached association with what were most likely the original Romanesque bindings from Santa Cruz.

Before an in-depth description of the different typologies it is crucial to mention that most of the bookbinding spines were restored in the 17th-18th centuries (Nascimento and Meirinhos 1997: xix) with spine linings in full fine brown leather with gold tooling decoration which was extended onto the board edges, fixed with glue and metal nails, Fig. 47a). Most of these spines were systematically substituted or, in some cases, such as in Santa Cruz 18 – a 'Santa Cruz type' binding – the 16th century binding was completely covered with the gold tooled brown leather, Fig. 47b). From that same period, some also evidenced reused written parchment transverse linings in the panels, between the sewing stations, as seen in the same codex. These spine reinforcements were, once again, most likely an institutional decision to standardize the collection. Taking this into account, there are no original and authentic Romanesque spines in the collection.

[112] Since the collection is at the BPMP very few manuscripts have been restored. The Santa Cruz 45 is one of the few codices that in the middle of the 20th century was altered. This led to the loss of some of its original elements and for that reason the library has been mainly focused on preventive measurements since then, which will be later described (Nascimento and Meirinhos 1997: xxii).

Figure 47. Details of Santa Cruz 18th century spines from: **a)** BPMP, Santa Cruz 58 (1139?); **b)** BPMP, Santa Cruz 18 (1237). Both belong to the 16th century 'Santa Cruz type' of bookbinding.

Primitive bindings

Eleven manuscripts were categorized as primitive. Although some present some variations, they share some common characteristics, which may define a typology. A separation between original and posterior elements in the book structure had to be made first in order to establish the archaeological features. In general, it was not found any original sewing structure. Nevertheless it should not be completely discarded, since some of the manuscripts did not display the necessary visibility in order to confirm this; whether because they had marks from previous stations or because they had traces of posterior parchments that were later introduced and sewn in the textblock – these were sewed in the original stations. Taking this into account, the information regarding the textblock and sewing technique should be considered carefully as it is not likely to be from the Romanesque period.

Figure 48. Binding details from the primitive manuscript BPMP, Santa Cruz 68, Missal, 13th century.

Overall, the textblock presented an inconsistent number of bifolia per quire – from 2 to 5 bifolia. Most of the endleaves seem nonexistent or, in other cases, latter additions. These posterior endleaves used old parchments from cast-off manuscripts with handwriting from the 15th century, for example, with the addition of a separately sewn endleaf quire, varying from one

or two bifolia to a stubbed leaf used as pastedown. The sewing was normally characterised by three to four split-strap cores in alum-tawed skin with pack sewing[113]. The sewing thread was white, non-dyed, probably from a vegetable source, such as flax or hemp. Depending on the size of the binding, the main sewing stations were equidistantly divided in the spine – with 6 to 7 cm between them. The endbands were normally approximately 5 to 6 cm to the nearest sewing station. These were made also with alum-tawed leather in a single strap-type support also with packed straight sewing. Overall, the sewing was made integrally from the head to the tail edge, with additional endbands at the primary wounds. According to Szirmai (1999: 151), the integral sewing with separate endband sewing has been more frequently encountered in 15-16th c. bindings, which is in agreement with the proposal that these seams are not original. All of the spine linings were from the already described 17th-18th century full brown leather with gold tooling decoration.

Figure 49. Binding detail from BPMP, Santa Cruz 54, Martyrology, 12-13th century.

It was within the boards and covering materials that it was possible to observe original evidences of Romanesque book structures. The wooden boards were 12 to 13 mm thick with a slight round profile. The lacing path from the board attachments was made with short entrance tunnels on the inner and outer face of the board in an inclined angle – the proposed attachment to the boards is presented ahead in Fig. 51. Most of them were difficult to access due to the presence of endleafs in parchment or thick leather covers, therefore it is only possible to propose what could be the typical kind of attachment board for the primitive Santa Cruz. The endbands were also attached in the same manner with the exception that the tunnels were cut in a 45º angle facing the interior face of the board. The white leather thongs were then fastened with wooden pegs or with iron nails. Two types of covering leather were identified: parchment or brown most likely vegetable-tanned leather with no decoration. Some of these skins were very thick. While in some cases, the leather seems to have been glued, in others, stitches were found as well as iron nails in order to fix the leather covering, as seen in Fig. 49. The corner turn-ins were sometimes square overlapping from the front or tongued.

The use of clasp straps in these bindings was also observed, with the exception of SC 68, from Fig. 48, that did not show any signs of it. As expected, none of them have survived intact. Most of them just display two simple cuts with remains from a leather strap hinged from the upper cover and attached to an iron nail. No information on the clasp was possible to obtain. Very simple metal bosses were also used, as seen in Fig. 48, in the centre of the covering.

[113] Please notice that most of the terminology used here is mostly based on the glossary created by the Ligatus project, which can be consulted at http://www.ligatus.org.uk/ (Retrieved in December 2015).

'Santa Cruz type' bindings

Forty manuscripts were included in this category. Since it was the most significant typology in the collection, a prototype was prepared in order to better understand the techniques used on the construction of the bookbinding (see Appendix VII).

Figure 50. Several binding details from different 'Santa Cruz type' of mss: BPMP, Santa Cruz 18, 58, 17 and 34.

While in the primitive bindings the number of bifolia per quire was assorted and irregular, in the 16th century 'Santa Cruz type' bindings, the quires are normally well organized in 4 bifolia. By looking at the spine, many displayed older sewing stations, Fig. 50. The number of split-strap cores in white tawed leather was sometimes adjusted with the rebinding. They tend to be more equally divided between each other, including the endbands, which are also applied at the same distance from the nearest sewing support. These varied between 3 to 5 split strap sewing supports, depending on the size of the manuscript. The sewing technique maintained very similar to the one already described for the primitive bindings. In most cases, an integral sewing was detected with packed straight sewing. The endbands become smaller in diameter with 5 mm, while the split straps of alum-tawed have an average of 15 mm. The spines are also characterised by the same 17th-18th century lining.

The wooden boards are most likely also from the 16th century period[114], due to their cut and state of condition. In addition to being thinner and narrow with 4 to 6 mm, the wood cut is unlike the one seen in the primitive bindings: it is more bevelled with a slight curve next to the spine. The split straps are also attached to the boards in a different manner. While in the

[114] A wood sample from the board from the manuscript SC 34 was taken for identification under the microscope. This exam was performed in the former Instituto dos Museus e Conservação (IMC) and through its structure they were able to propose that it was most likely a cedar wood, *Cedrus sp.*. Unfortunately, there are not many studies on the identification of the type of wood used for bookbindings. The only found reports on the use of cedar wood in bindings were linked to earlier Islamic, Coptic and Ethiopian book boards (Jacobs 2008: 14; Szirmai 1999: 26, 48). According to Nascimento and Diogo, it was likely that trees such as oak, chestnut and alder would have been the sources for wood in Portugal, but they also acknowledge that the choice of wood would have been conditioned to the available raw material (Nascimento and Diogo 1984: 29). Due to the lack of more examples, it is not possible to establish this as a characteristic feature from Santa Cruz.

primitive bindings, these were introduced in a carved tunnel, in the 'Santa Cruz type' they go over the board into an entry lacing-hole, without getting inside of the spine edge, and then finish in an exit lacing-hole. In order to illustrate the differences, Fig. 51 presents a proposal, in the form of diagrams, with the distinct observed techniques for both typologies. This type of attachment, from Fig. 51 D, is characteristic on 15-16th c. bindings (Szirmai 1999: 222-224).

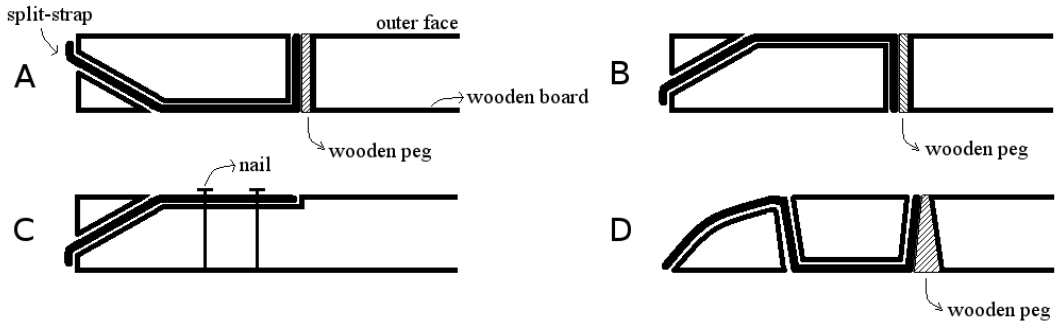


Figure 51. Proposed main types of board attachments found in Santa Cruz: A) Primitive bindings with split alum-tawed straps fixed with wooden pegs in the inner face of the board; B) Primitive bindings with split straps fixed with wooden pegs in the outer face of the board; C) Primitive bindings with split straps fixed with nails in the outer face of the board; D) 'Santa Cruz type' bindings with split straps fixed with wooden pegs in the inner face of the board (diagrams based on Szirmai 1999: 153 and 223).

The endbands were also attached through the upper side of the board in a 45º angle, Fig. 52, type C. Three variations were also detected in the disposition of the lacing paths: in most of the cases, the endbands were attached separately in a 45º angle (Fig. 53, type A), but occasionally, some were united to the nearest laced-in slips final entrance (Fig. 52, type B and C).

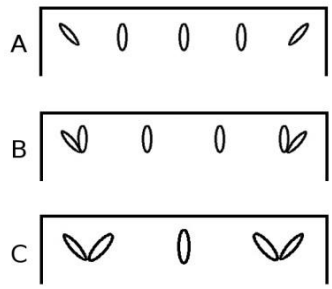


Figure 52. Different lacing paths found in 'Santa Cruz type'.

Only one type of covering leather was identified, made of brown vegetable-tanned leather decorated in blind tooling, as seen in Fig. 50. The skin was most of the times glued with an adhesive. In few exceptions, evidences of previous nails were also found in the edges of the turn-ins. The corners of the turn-ins were sometimes overlapped or slightly tongued and generally quite irregular. The blind tooling decoration with phytomorphic and geometric elements was the main characteristic that led to the acknowledgement of this typology, as seen in Fig. 53. This was most likely hand-made with individual metal tools. The main frame decoration was in some cases, found to be slight off-centre from the board. The main pattern is characterised by the presence of several simple flowers with six petals inside several triangles that suggest a main rhombus shape through triple lines. This is followed by a frame of interlaces and several triple lines that accentuates even more the framework composition. Some variations within this decoration were found, but the elements were always the same.

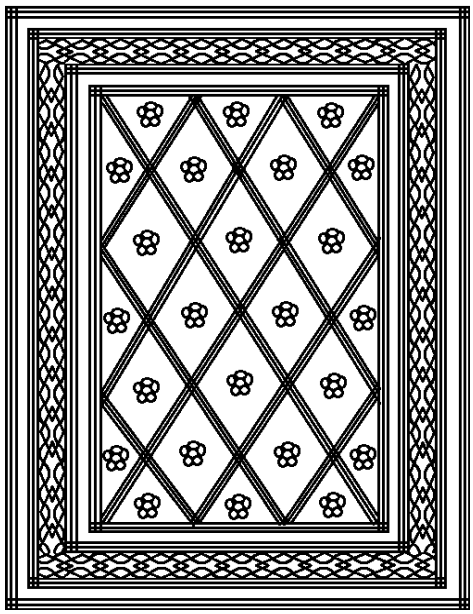


Figure 53. Scheme of the blind tooling decoration used in the 'Santa Cruz type' of binding. This particular motive was taken from BPMP, Santa Cruz 34.

Most of the bindings were furnished with fastenings[115], Fig. 50. The most used was the first one, with the little cross in the middle. This detail is most likely a reference and standing mark of the monastery – Santa Cruz, *Holy Cross* in English. No complete set was found, but some manuscripts, such as the SC 45, still preserved an entire leather strap, which showed how the system worked with a simple clasp, Fig. 54. These clasps were most likely made of brass. No signs of metal bosses to protect the leather covering were found in this type of binding, except in SC 1 (650x420 mm), which has marks from previous 5 bosses on each side.

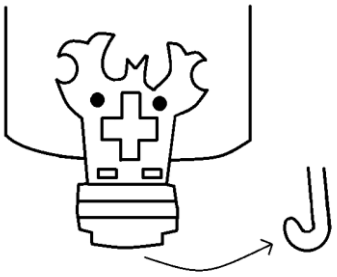


Figure 54. Drawing of the fastening found in BPMP, Santa Cruz 45.

Restored bindings

Twenty manuscripts showed different types of bindings when compared with the primitive and 'Santa Cruz type'. These differences were more related with the substitution of the coverings and implementation of 20th century materials, not necessarily with the sewing technique or board attachment, as seen in Fig. 55. These bookbindings will not be described in detailed as the others, since these are less significant for this study given their more detached association with what were most likely the original Romanesque bindings from Santa Cruz.

[115] Comparable models from the 15th and 16th centuries were found in Szirmai 1999: 255-259.

Figure 55. Binding details from BPMP, Santa Cruz 27, Psaltery, 1179.

2.4.2. The state of conservation

Much of the loss of the archaeological integrity of a book collection has been linked to the historical, cultural and intellectual mores of our society (Pickwoad 2000: 81-82). The collection from Santa Cruz and its state condition is directly related with its own function and purpose. All of the three described binding typologies display structural damages, which are fundamental for the archaeological functionality of the book, but as it will be demonstrated, not all of them are the same. The main observed damages found in the manuscripts selected for this study – with the additional SC 54 and 68 – can be seen in Appendix VII, Table VII.1.

Most manuscripts displayed the same types of damage. The sewing threads were generally broken in several areas of the textblock – normally where the split thongs or endbands were also broken. These ruptures were mainly linked to the loss of flexibility in the spine, but also to the quality of the leather straps. For example, in Santa Cruz 4, instead of white tawed leather they used vegetable-tanned leather thongs. These were broken in several pieces. The use of brown vegetable-tanned strap sewing supports was less common since it was known to be less durable (Szirmai 1999: 183-184), which is in agreement with the exposed case. Due to the large dimensions of this particular manuscript (440x290x7), they should have used larger and stronger thongs in alum tawed leather to ensure flexibility and strength to the binding.

The endbands were also, in most cases, broken or disconnected from the boards. Their vulnerable position in the edges of the spine made them more susceptible to physical damages. Furthermore, sometimes the wooden boards were also broken in the corners, causing the endbands to lose their support.

Leather tends to become hard and brittle, commonly due to the fluctuations in moisture content as a result of temperature and relative humidity changes, but also due to metal ions catalysis, which leads to the scission and reticulation of the polymer (Florian 2006: 42). Some of the split straps were, for example, so rigid and inflexible that when the wooden pegs from the board channels were lost, the thongs were unable to get back to their position within the lacing

path. These in turn created new tension areas, leading to the abrasion of the nearest parchment leaf. In other cases, such as the one from Santa Cruz 1, the pressure and stress from the thongs led to the fracture of the wooden board along the lacing paths. This was seen namely in the 'Santa Cruz type' of bindings.

Most of the manuscripts were in contact with xylophogous insects. Some of the primitive bindings, such as SC 68 and 74, and 'Santa Cruz type' bindings, such as SC 34, displayed extensive tunnelling which caused considerable damage to the wooden boards.

Figure 56. Detail from the upper side of the spine from BPMP, Santa Cruz 30.

The replacement of the spines was probably one of the worst later introduced elements, since in most bindings they are much deteriorated. The thin and weak vegetable-tanned leather used on the top of the leather covering edges is, in many cases, partially or completely missing, particularly in the joints of the manuscripts. In addition, the adhesive used to fix these linings was inappropriate as it weakened the underlying structure and, in some spines, seems to have also attracted insects, as seen in Fig. 56. Moreover, a beige coat on top of the leather was also observed in several manuscripts. Its nature is unknown; nevertheless it is unlikely a paint, since these stains go over the covering leather. It looks like an ageing process of an unknown material applied over the restored spine. In general, the covering leather displays also extensive abrasion due to handling. Most of them have partially missing skins in the edges and corners, but also sometimes in the region of the clasps. The lack of metal bosses in the 'Santa Cruz type' typology explains the heavily skin erosion seen in these manuscripts. Damage from xylophogous insects was also found in most codices, but their presence was not prolific. In the whole collection, only one book still displays an original leather strap from the 16th century, which was extremely dark, rigid and fragile.

The covering leather displays also, in general, extensive abrasion due to handling. Most of them have partially missing skins in the edges and corners, but also sometimes in the region of the metal clasps. The lack of bosses in the 'Santa Cruz type' typology explains the heavily erosion seen in these manuscripts. Damage from xylophogous insects was also found in most codices, but their presence was not prolific. Of all the collection, only one book showed to display still an original leather strap from the 16th century. It was extremely dark, rigid and fragile.

Finally, the fastening components were in many cases lost. It only remained the marks from it in the oxidized and stained leather. The primitive bindings display extensive corrosion in

the metals – which were probably made of iron –, while the 'Santa Cruz type' and restored bindings showed to be in better conservation state possibly due to their composition – most likely from brass given its colour.

When looking individually at the three types of bindings from the collection, it is clear that the one that presents more damages is the 'Santa Cruz type'. The board attachment is responsible for a significant part of the problems identified. The lacing technique, connecting the split straps sewing supports on the wooden board, creates more tension in to the spine, which over time tends to lead to the breakdown of the leather and to the fracture of the wood – two very common situations observed in 'Santa Cruz type'. This may justify the 17th-18th century early intervention on the spines that overtime increased the damages seen. Moreover, the lack of protective metal bosses also led to the covering loss. In 'primitive' and 'restored' bindings, this was less observed because a significant number of manuscripts had bosses.

Overall, this collection is in a concerning state of conservation, since most of the damages are constraining the functionality of the books. Many are not able to open properly anymore and each time they are handled they become more fragile and aggravate their current condition, through new tears in the seams and loss of material – namely from the wooden boards and from the leather covers. From this preliminary evaluation it was possible to assess that about 20% of the collection needs urgent remedial conservation treatment in order to avoid more losses, while around 30% could benefit from minor conservation treatments[116].

Preventive measurements from the library

In the last decades, the library has been trying to minimize the damage through a serious of preventive actions, which have at least decelerated and mitigated some of the degradation phenomena. In 2006, the collection was subjected to a nitrogen anoxia disinfestation, which allowed eradicating the damages caused by insects. The manuscripts started also to be stored in the horizontal, in individual acid-free cardboard boxes, to protect them against changes in humidity and temperature, dust, atmospheric pollutants and light. The collection was fully microfilmed in order to reduce to a necessary minimum the handling from readers. And, most importantly, two years ago the air conditioning system was substituted for an independent HVAC in the vault where the collection is kept acclimatized with a temperature that is set for 19 ºC ± 1 ºC and a relative humidity of 50% ± 1%[117].

[116] Need of urgent remedial conservation treatment: Santa Cruz 2, 4, 5, 8, 13, 14, 24, 30, 34, 35, 62 and 67; those that could benefit from minor conservation treatments: Santa Cruz 1, 3, 6, 7, 9, 11, 12, 17, 18, 26, 27, 40, 42, 48, 54, 56, 61, 68, 72, 77, 78, 79, 80, 90 and 91.
[117] Information given by the BPMP conservator Lucinda Oliveira.

3. The colour systems within Portuguese scriptoria – the Santa Cruz case

The study of the materials and techniques of the three Portuguese scriptoria[118] led to the development of a tool, named *colour mapping*. It was created to quantify the colour areas from each illumination, and ultimately from each manuscript. The key objective of this exhaustive survey was to assess the existence of specific colour systems related to Portuguese monasteries, by establishing what the most dominant colours were and if there were colour patterns in the Portuguese medieval collections. This aim to move towards the complex theme of the meaning of colour and its social and cultural significance has been developed and worked by Maria João Melo and Adelaide Miranda[119].

The core foundation for this work was based on quantifying the use of colour in each manuscript, and consequently, in each scriptoria. To achieve these goals, algorithms for digital image treatment were developed so that it would be possible to quantify colour, by acquiring automatically the colour areas in each illumination and process these data by computer image analysis. As the main central axis for this research, the mapping tool allowed not only to calculate the relative areas of the main existing colours in the manuscripts, but also by not being constrained to the molecular characterisation, it consented breaching new confrontations between Portuguese and other European manuscripts – whose in most cases still lack systematic studies on their materials. By opening the research field, the *colour mapping* allow to start evaluating the Portuguese state of the art of Romanesque illuminations on an European context, by comparing it with French manuscripts, where the more modern stylistic tendencies were coming from as well as with Spanish manuscripts, where the Iberian tradition converged with the Mozarabic heritage (Melo, Castro and Miranda 2014; Miranda and Melo 2014; Castro, Melo and Miranda 2014).

The computational tool used for accomplishing the *colour mapping* was developed with an in-house MATLAB code, by Prof. João Lopes and Dr. Jorge Sarraguça. More information about the experimental set-up can be seen in Appendix IV. The *colour mapping* analysis was performed in the three Portuguese Romanesque collections and the main data and basic information about the analysis can be found in Appendix VI.

---

[118] As already stated at the beginning of this work, the materials and painting techniques from the scriptoria of São Mamede of Lorvão and Santa Maria of Alcobaça were studied under the framework of two PhD investigations, namely by Ana Claro (Claro 2009) and Catarina Miguel (2012), which were fundamental references for the development of this research. Moreover, these studies were under the framework of the research projects coordinated by Maria João Melo and Adelaide Miranda: **ILUM 1:** POCTI/EAT/33782/2000; 2005-2007; **ILUM 2:** PTDC/EAT/65445/2006; 2007-2009; **ILUM 3:** PTDC/EAT-EAT/104930/2008.

[119] A summary of the results from this research have been gathered in the following publications: Melo, Castro and Miranda 2014; Miranda and Melo 2014. A more complete study on the meaning behind Portuguese Romanesque colour is being prepared for publication by both researchers.

Brief introduction to the cultural meaning behind the art of colour

In order to understand the discussion of the results that will be presented hereinafter, a brief contextualisation on the history and cultural meaning behind colours is given.

Hugh of St. Victor believed that Light was the most beautiful thing because it illuminated 'the colours of all things' (Cizewski 1987: 74). Nature's colours carried meaning, within invisible things, such as light – above all possessions –, and physical things, such as gems or precious stones, that were fundamentally God's creations. During Middle Ages, colour was considered as 'a secondary attribute of light' (Gage 1999a: 70). Consequently, it will be seen here that medieval artists were always seeking for the most luminous and brilliant materials as a constant pursuit for the Divine.

As already stated at the beginning of this investigation, colour can be seen as a stretch-out concept: 'the social and cultural meanings attached to color range widely, and while there are some meanings that are held across cultures and historical periods, color functions within semiotic codes that were developed by socio-cultural agents in response to the exigencies of specific times and places' (Feeser, Goggin and Tobin 2012). It is within these semiotic systems that some of the most profound notions on colours are perceived within a society. In addition to the importance behind linguistics, which not only convey different meanings within a specific time and place, but also carry permutable values in words, as expected from an evolving society; semiotic devices, such as national flags[120] and traffic signs, can be also seen as important symbols on the cultural perception of colour (Eco 1985).

According to Michel Pastoureau, during Classic Antiquity, a threefold system based on black, white and red subsisted in society and art. These three colours started to transition into a richer palette with the advent of Christianity. Yet, in the 12th century, there were still evidences of the powerful symbolic meaning behind these three colours (Pastoureau 2008: 39-42; Miranda and Melo 2014: 2).

Authors, such as Pliny the Elder or Vitruvius, claimed that the Ancient artists were more sober and restrained then the artists of their time. In Pliny's *Natural History*, the author states that the best painters from Classical times used deliberately a limited palette made of four colours: white, yellow, red and black (Croisille 1985). According to John Gage, Pliny was most likely sacrificing historical consistency[121] in order to promote a Roman ideal, connected to

[120] From another study quoted in Eco's work, it is stated that national flags from across the world – from a set of 137, in June 1970 – used only seven colours: red, blue, green, yellow, orange, black and white; and that the most common colour combination was red/white/blue (Weitman 1973: 341).

[121] Several studies have shown that the artists from Ancient Greece and Rome used a wider variety of colours, namely white, black, yellow, red, green, blue and purple. An interesting summary on the

austeritas. Several artists then tried to follow his ideal, like the 14th c. anonymous author from *De Arte Illuminandi* who attributed to Pliny the idea that there were three main colours: black, white and red, and that the others were 'intermediate'. (Gage 1999a: 29-38).

In late Antiquity, Christians gathered in catacombs to express their new religion, away from the pagan civilization. According to Brusatin (1991: 45), 'Christian colours – green, sky blue, white and violet – were the filters through which liturgical values were secretly passed and by which a communal ecclesial identity was silently expressed'.

Earlier Christians manifested already religious and social codes through their garments[122]. Monastic clothing had, for example, different colours associated to specific religious orders: black was, at the beginning of the 9th century, the preferable choice of colour for monks, who lived under the Rule of St. Benedict; while white was adopted, at the end of the 11th century, by the Cistercian monks[123], who appeared under a chromophobic movement (Pastoureau 2008: 65).

By about the year 1000, colour systems were also being introduced in liturgical vestments throughout Roman Christianity. Pope Innocent III – at that time still a cardinal – wrote in 1195 a treatise on the Mass. This rare testimony on the hierarchical adoption of colour within religious rituals brings interesting insights: white, a symbol of purity, was used for all celebrations devoted to Christ as well as the angels, virgins and confessors; red, the representation of the blood shed by and for Christ, was used for celebrations of the apostles and martyrs, and the Pentecost; while black was used during the Advent and Lent as well as in funeral masses and Holy Fridays (Pastoureau 2008: 39-40). Green was also described as an intermediate colour between white, black and red, which according to Pastoureau, made green the fourth colour of Christianity (Pastoureau 2014: 42). Still, blue was not even mentioned, not to add that this colour never really incorporated the liturgical code (Pastoureau 1989b: 220). This absence at the end of the 12th century can be considered rather strange, as at that time, blue was starting to become an important presence in all kinds of works of art – painting, stained-glass windows, and clothing, among others. Nevertheless, according to Pastoureau, the colour was 'absent from the system of liturgical colors, because this schema had been codified too early in history to assign a role to blue' (Pastoureau 2001: 40).

With the increasing interest in this new system of colours, green begins to stand out as one of the new symbols of Christianity. Guillaume d'Auvergne, bishop of Paris in the 13th century, believed that green was even more beautiful than red, since green was in the middle of

---

pigments and dyes used and found in Ancient Greece and Rome, comparing Pliny and Vitruvius texts, can be seen at Cabral 2001.

[122] It is important to highlight that some colours were very difficult at that time to dye in fabrics, such as white, green or black as Pastoureau demonstrates overall in his work Pastoureau 1998.

[123] The first Cistercian monks were known as the 'gray monks' – *monachi grisaei* (Pastoureau 2008: 65).

the colour axis, white and black (Gage 1999b: 71; Pastoureau 2014: 57). In the Islamic world, green was also considered a sacred colour, full of positive values (Pastoureau 2014: 49). It became the colour of the religion and of the Prophet. However, in this tendency, blue turquoise was also paired with green, as it also started to represent the colour of the new Islamic religion and community (Brusatin 1991: 46-48).

Blue, in Western culture, had for a long time little symbolic or aesthetic value. As Pastoureau would precisely note: 'For many centuries, blue was used in miniatures only rarely, and it is a deep shade[124] when it does appear. It is a secondary or peripheral color in manuscript illumination, devoid of symbolic meaning and contributing little, if anything, to the meaning of works of art. Up until the tenth and eleventh centuries, many miniatures do not contain even a hint of blue, especially those produced in the British Isles and the Iberian Peninsula' (Pastoureau 2001: 40-41).

According to Pastoureau, at the beginning of the 9th century, blue became more prominent in illuminations. It starts to be used in a wider range of positive associations. Interestingly, the French historian also mentions that 'Around the year 1000, most blues in manuscripts became clearer and less heavy', which consequently led to a change of paradigm as these blues begin to 'represent light and illumination' (Pastoureau 2001: 41). This blue was obviously a reference to lapis lazuli, which according to the data presented in Table 1 at the beginning of this study, showed that the precious blue mineral was starting to be used in the 10th-11th century. Thus, 'the beautiful pigment lapis lazuli, the carrier of the meaning of blue' became the ultimate symbol of virtue and spirituality (Melo, Castro and Miranda 2014: 182). In the 12th and 13th centuries, during the Romanesque period, the 'blue revolution' unfolds, becoming the prime social colour in Middle Ages (Pastoureau 1988: 9-19).

In the Romanesque Portuguese illuminated manuscripts context

It is within this religious, cultural and social context that the art of colour in Portuguese Romanesque illuminations will be developed. By looking at the materials found in the three collections, it is possible to conclude that they were quite similar between each other, with few exceptions, such as the mysterious purple and brown found in Santa Cruz and Alcobaça manuscripts, respectively; as well as the gold applied in Lorvão, which is absent in the other scriptoria.

With the *colour mapping* tool, it was possible to establish, what just by simple visual assessment was too difficult to perceive, that the main colours in Romanesque illuminations

[124] Michel Pastoureau was most likely referring this blue 'deep shade' as indigo. As summarized at the beginning of this study, in Table 1, indigo was the main blue identified in earlier middle ages.

were: red, blue and green, Fig. 57. Consequently, Maria João Melo and Adelaide Miranda were able to conclude that within the Portuguese scriptoria from the 12th and 13th centuries, a threefold colour system based on red, blue and green were instituted as the most dominant and symbolic presences in the only painted form of art expression that arrived to the present day from this particular period in Portugal (Melo, Castro and Miranda 2014: 183; Miranda and Melo 2014: 15). More detailed information on the results obtained for each scriptorium can be consulted in Appendix VIII.

Figure 57. Colour mapping of the distribution of the relative areas of the colours[125] found in the representative manuscripts from the monasteries of São Mamede of Lorvão, Santa Maria of Alcobaça and Santa Cruz of Coimbra (12th-13th centuries)[126].

The Santa Cruz case

Drawing from the methodology developed by Maria João Melo and Adelaida Miranda, this study focused on the analysis of several manuscripts from Santa Cruz. Despite its similarities, Santa Cruz colour palette stands out from the other two Portuguese collections, due to the unique presence of purple[127]. This colour had undoubtedly an important place also in Ancient and early Middle Ages societies. The shellfish purple, also known as Tyrian purple, was the most highly valued dyestuff in Antiquity due to its high-priced and arduous manufacture as well as its light-fastness and durability (Gage 2006: 148). Pliny even states that this colour was reserved only for the highest officers in the state. During early Middle Ages, authors such as Isidore of Seville were also fascinated by purple due to the way it embodied light (Gage 1999a: 25-27). The use of purple pages in illuminated manuscripts was introduced

[125] The results are represented in relative areas – i.e. average percentage –, in order to avoid adding to the evaluation the dimension of each manuscript. Therefore, instead of presenting the average of the areas analysed, the average was conducted to the ratio of colours in each manuscript, so that the data could be better interpreted.
[126] Some manuscripts were not considered in the representation, due to their unique palette – i.e. Apocalypse –, to their severe lost of pictorial layer which does not allow a proper analysis – i.e. Lorvão 16 –, or to their most likely non-association to the production of that monastery. Here are the manuscripts that were put aside: in Lorvão (Lv 3, 16 and 44) and in Alcobaça (Alc 405 and 433).
[127] A purple, not analysed, was also observed in ALC 402, fol. 237v. This unparalleled occurrence in Alcobaça cannot be seen as characteristic from this scriptorium.

in the production of prime and luxurious codices during the late Antiquity and early Christian periods. They were particularly used in Insular, Anglo-Saxon, Carolingian and Ottonian epochs, and were recovered during the Renaissance (Brown 1994: 104).

Due to the resemblance of the *Homiliarium*, Santa Cruz 4, with the *Passionarium*, Lorvão 16, and also the French *Mazarine* Bible, Ms. Lat. 7, a comparing analysis to the three manuscripts was conducted to their colour distribution. In addition, the *Homiliarium* from Alcobaça 412 was also included, since it had the same type of text and, most important, contained a colophon, which sets a precise date for its production: 1257.

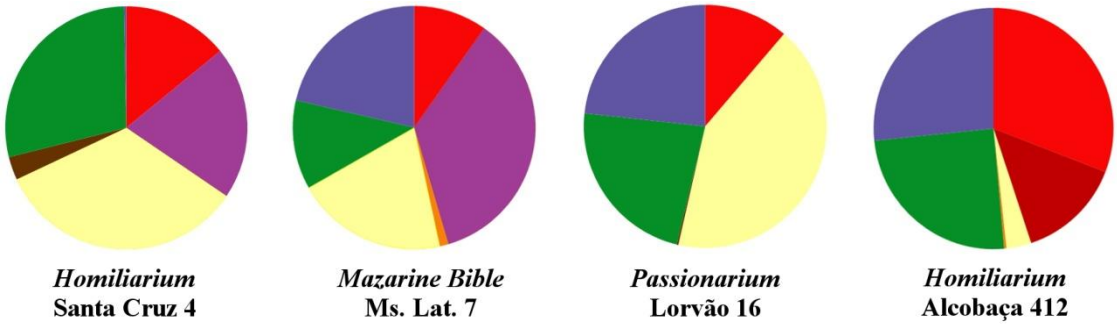


Figure 58. Colour mapping of the distribution of the relative areas of the colours found in the *Homilarium* BPMP, SC 4 (1139), *Mazarine Bible*, BNF, Ms. Lat. 7 (11th-12th c.), *Passionarium*, DGARQ-ANTT, Lv 16 (c. 1140) and *Homilarium* BNP, ALC 412 (1257).

In Fig. 58, the main results of this comparison are presented. While, SC 4 presents an almost absent presence of blue, the *Mazarine Bible* and the Lv 16 have a dominant presence of blue of about 20% each, and the ALC 412 only has 3% of yellow and a striking 45% of red (when including lac dye). Santa Cruz's *Homiliarium* still reflects more of the Carolingian influence, due to the presence of purple (20%), the extensive use of orpiment (34%) and the very meagre occurrence of blue (0.3%). On the other hand, the Alcobaça manuscript is more in line with the taste developed in the 12th to 13th century, whereas the other two manuscripts could be placed in between the other two. Deducting only from a colour perspective, SC 4 seems to be an older manuscript, when compared to the others, followed by the Ms. Lat. 7 and the Lv 16, which tend to use more blue and no purple, respectively, finishing with the ALC 412.

According to Gage, Bede stated that the purple gemstone amethyst was a symbol of Heaven and that the 'heavenly connotation of purple passed during the Middle Ages increasingly to blue' (Gage 1999b: 73). This seems to be in agreement with the observed, as blue seems to substitute purple.

Nevertheless, it is quite possible that the *Mazarine Bible* could have served as an example to the Santa Cruz's manuscript; however, the Lv 16 does not seem that could have served the

other way around based, once again, on the colour point of view. This is in agreement with the date c. 1140 proposed by Aires Nascimento (Nascimento 2012b: 464).

Another comparison was conducted between the same text, in this case the *Ethymologiae* by Isidore of Seville, with different manuscripts, namely Santa Cruz and Alcobaça compared with a Spanish manuscript. Fig. 59, contains the colour analysis between de Portuguese 12th c. *Etymologies* from Santa Cruz 17, the Spanish 10th c. *Etymologies* Cod. 76 from RAH, and the 13th c. *Etymologies* from Alcobaça 446. Here, a progression on the colour system from the Carolingian[128] to the Romanesque period can be observed.

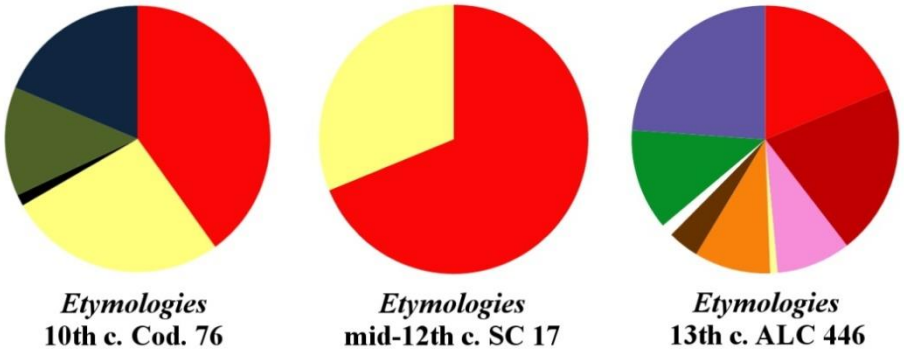


Figure 59. Colour mapping of the distribution of the relative areas of the colours found in the 10th c. *Etymologies* RAH, Cod. 76, mid-12th c. *Etymologies* BPMP, SC 17 and 13th c. *Etymologies* BNP, ALC 446.

Each manuscript has a unique palette that reflects the time of their production. Even without having the molecular characterisation of the Spanish 10th c. *Etymologies*, it is possible to establish that this manuscript contains what could be called one of the typical colour palettes of the Carolingian period. The red and yellow are the most dominant colours, while a dark green and dark blue – most likely *vergaut* and indigo, considering their period of production – stand as secondary colours. Black is also present, reminding the three folded colour system from classic Antiquity that Pastoureau referred.

The Santa Cruz manuscript has a reduced iconography with few illuminations in red and yellow. They seem to reflect the dominant colours brought from the Iberian tradition, but in a poorer and simpler version. According to Meirinhos, the Visigoth writing, late for the 12th-13th

[128] The lack of Portuguese examples from this period does not allow a deeper understanding on how colours were used in Portugal. Nevertheless, it should be highlighted the presence of fragments of manuscripts of most likely Hispanic origin in Portuguese territory that preserve the same type of palette – made of red/orange, yellow, dark blue, dark green and black – seen in Carolingian codices and that may have influenced the Portuguese artists of that time: the 'Actas do Concílio XIII de Toledo' from c. 950 (Arquivo Distrital de Bragança, FCSP, nº 206), the 'Actas di Concílio de Calcedónia de 451' from 967-1025 (Arquivo Distrital de Viseu, Perg. M. 51, nº 1) and the 'Cânone de Concordâncias Evangélicas' most likely from the 11th century (Arquivo Municipal Alfredo Pimenta, Pergaminho 413). More information on these fragments can be found in Miranda 1999a: 119-125.

century[129], suggests that the model used by the scribe was literally copied without an adaptation or that the scribe was accustomed to write in an old fashion manner (Meirinhos 2009: 1). Taking this into account, it is likely that this manuscript may have been copied from an older Iberian codex. As for the manuscript from Alcobaça, it presents a typical representation of the colour system established for this Portuguese scriptorium, with the dominant red, blue and green, followed by pink, orange and brown as secondary hues. The colour pink is considered as one of the colours associated to modernity. This hue will be later on the 14th and 15th centuries, one of the fashion colours for the aristocracy, as Pastoureau would point out (Pastoureau 1998: 40), both in clothing as well as in manuscripts, such as in Books of Hours[130] (Melo *et al.* 2014).

Finally, a last comparison with several manuscripts with colophon was made. The main aim of this analysis was to see if it was feasible to establish an evolution in the colour system during the beginning of the 12th century and mid-13th century at the Santa Cruz scriptorium.

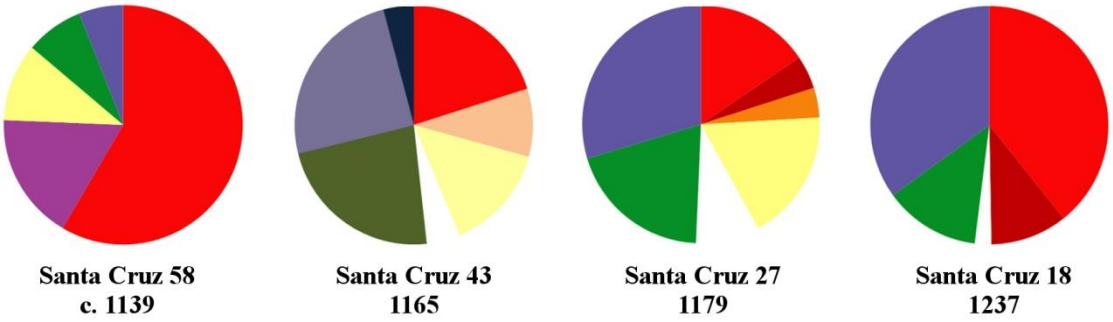


Figure 60. Colour mapping of the distribution of the relative areas of the colours found in several manuscripts from Santa Cruz collection with colophon: the BPMP, SC 58, c. 1139 – this is the only ms. without a colophon, but a very plausible date as previously discussed –; BPMP, SC 43, 1165; BPMP, SC 27, 1179 and BPMP, SC 18, 1237.

In Fig. 60, several changes can be depicted in the use and choice of colour. The purple is once again present in one of the most primitive manuscripts from Santa Cruz, SC 58, with almost 60% of red. The presence of the blue, with a representation of 6%, is from a particular illumination that raises questions on its possible posterior application. Then, the SC 43 features a palette composed of 23% of *vergaut* and about 30% of indigo blue[131], which are pigments more associated to the Carolingian period. SC 27 already shows a more typical colour system for the already well-established 12th century with the three dominant colours, but still with a

[129] The manuscript SC 17 was in the catalogue from BPMP establish as a production from the late 12th century or beginning of the 13th century (Nascimento and Meirinhos 1997: 110). Adelaide Miranda, on the other hand, established that the manuscript should be from the mid-12th century, based on its ruling and pricking (Miranda 1996b: 47).
[130] Note that the pink found in the Gothic period has been identified as brazilwood, not lac dye (Melo *et al.* 2014).
[131] As already mentioned in the molecular characterisation of the manuscripts from Santa Cruz, the lighter blue from SC 58 shows signs of indigo with lead white. The presence of lapis lazuli was not possible to establish.

strong influence from the Iberian tradition, brought by the 18% of yellow. Here, the *vergaut* was completely substituted by the so-called *bottle green*, in comparison with the previous manuscript. Then, finally, the SC 18, as a representation of the 13th century, presents 50% of red, 35% of blue, 13% of green and 2% of white. It is interesting to note that the proportion of lapis lazuli blue is always increasing with the evolution of time and that yellow tends also to lose importance. Moreover, lac dye could be also be seen as an interesting case, since its presence is only detected in the two last manuscripts. Its employment seems to start only in the last quarter of the 12th century.

5. Final remarks

From the study of the Santa Cruz collection it was possible to conclude that the monastery from Santa Cruz of Coimbra was able to bring to the present day some of the oldest testimonies of illuminated manuscripts from Portugal. This allowed a fortunate outlook on the beginning of the Romanesque period in Santa Cruz, by evidencing a clear period of transition in its scriptorium that is more palpable in comparison with the other two Portuguese monasteries: the strong archaic connection from the Mozarabic world seen in its earlier manuscripts is substituted by the more modern French influence. In the 13th century, this will reflect on the repetition of the same models, through the use of majestic initials with palmettes and rolled stems, found also in the Cistercian Alcobaça house. From an artistic point of view, the middle and late 12th century in Santa Cruz will characterise its golden period, through its colourful backgrounds, its animal imagery in the interior of historiated and inhabited initials, featured in fine drawings, rarely coloured and highlighted with glimpses of yellow.

The molecular analysis of the colour paints allowed to conclude that the palette used in Santa Cruz was very similar to the ones found in Alcobaça and Lorvão, with the exception of a not characterised purple colour found in SC 4 and SC 58 and the use of purer pigments – by the reduced use of extenders and fillers. The rest of the colour palette was based on lapis lazuli, indigo, vermilion, lac dye, synthetic green copper proteinate, *vergaut* (indigo+orpiment), organic yellow, orpiment, red lead, lead white and carbon black, which is in agreement with the previous studied collections.

In terms of *modus operandi*, it was interesting to have the opportunity to confront two different analytical approaches in the collection: *in situ* – through the MOLAB access – and micro-sampling. The first granted initial information scanning on various manuscripts, while the second allowed a more in-depth analysis of a more restricted group of codices.

The *in situ* analysis was carried out with portable instruments that were taken directly to the library, permitting an immediate examination directly on the manuscripts without removing

anything from the object. It allowed making a preliminary assessment, by giving substantial information on the composition of the main materials and their distribution. As presented by Miliani *et al.* 2007: 855: 'The great advantage of non-invasive methods is that no contact or sampling is necessary and therefore all the areas of the painting can be examined without any limitation'. However, some of these portable instruments have significant limitations, for example, in the restriction of spectral range given by the non invasive set-up. The XRF, for example, was not able to detect the Al, found in the blue lapis lazuli, due to its inability to detect elements with atomic number lower than 14.

Micro-sampling was carried out in selective and limited areas in previously chosen manuscripts. This decision was based on the information already obtained from the earlier methodology. The approach can be seen as less invasive if taking into account that a very small area can be the only altered spot[132], demanding also less handling. Moreover, it allows using more specific analytical techniques that provide additional information that would be difficult to obtain through current *in situ* methods. These can be carefully and patiently analysed in a laboratory setting, which means that better experimental conditions can be developed in order to extract more information from them.

The identification of certain compounds, particularly organic, is more easily achieved with certain techniques that require micro-sampling. For example, the proteinaceous binder used in Santa Cruz was only possible to confirm with certainty after micro-sampling, and consequently, infrared spectroscopy. As it will be seen in a more detailed description in Chapter III, micro-sampling was indispensable to identify molecularly lac dye[133]. Moreover, the use of fillers was also only possible to detect with the use of FTIR. On the other hand, without the *in situ* techniques a lot of the data would be disperse, as it would not have enough statistical validation. Techniques, such as XRF and mid-FTIR reflectance, were essential in order to understand what the main elements in the paints were and how the colours were constructed. Without this straightforward methodology, acquired on the spot, it would have not been possible to acquire so much information on the collection, since it would be too difficult to analyse all of those manuscripts through micro-sampling.

[132] As interestingly Jan Wouters claims, techniques called non-invasive or non-destructive (the latter was been nowadays mostly abandoned) should be also considered carefully. '(…) from a scientific point of view, any interaction between a material and an analytical vehicle, such as a beam of particles or electromagnetic radiation, is unlikely to leave that material unaltered after the interaction, especially when considered on the molecular level. This observation creates a distinction between object and material when discussing the destructive nature of an action such as sampling or analysis' (Wouters 2003: 61).

[133] It was noteworthy to state that samples that had been taken almost 10 years ago – in the specific case of the Lorvão samples –were used for the first time with new methodological approaches that allowed bringing new insights on these paints. Without them, it would have not been possible to molecularly identify lac dye in their scriptoria.

In this study it was possible to demonstrate that both methods were essential for the characterisation of the materials found in the illuminated manuscripts. While it is possible to obtain more data with the first approach as more areas can be examined; the second is more limited in number of analysis, yet broader as for analytical techniques. Consequently, both approaches can be really significant as they complement each other.

As for the overall state of conservation of the Santa Cruz collection, several problems regarding the pictorial layer, the parchment support and the bookbinding structure were detected. Within the colour paints, the most widespread concern was the detachment of some of the pigments, but above all the green synthetic copper proteinate. The presence of calcium oxalate was established as a product of degradation in the *bottle green* paints, but also in the black paints. While in Alcobaça the issue surrounding the deterioration of the green colours had been already connected to the presence of calcium oxalate (Miguel 2012: 84-104), black had never been found as also part of this phenomenon. Based on these experimental finds, it is possible to propose that the presence of calcium oxalate is connected to the degradation of the proteinaceous binder, which in turn is activated by the reaction with certain pigments that contain a high level of copper or iron. Therefore, it is unlikely that microbiological activity is behind the mechanism of formation of the calcium oxalate, otherwise most of the paints should also evidence the same problem. Moreover, arsenate-based species, such as As_2O_3, were detected in degraded paints that had orpiment admixed with lead-based pigments. Its presence is likely a product or a reaction intermediate, as previously proposed by Miguel *et al.* 2009a and corroborated here. Additionally, both red lead and orpiment revealed the presence of sulphates by mid-FTIR as well as in an infrared spectrum (Fig. 30d), which may be also a central degradation product for arsenic sulphide pigments, as proposed by Keune *et al.* 2015 for paintings.

The adapted IDAP approach for parchment in manuscript collection led to a full and effective assessment on the state of conservation of the collagenous support. The visual stratigraphic evaluation of the damage found in the textblock allowed establishing that the degradation was mostly related to handling and to the visualisation of specific texts within the book. It was also possible to conclude that the deformations found in all of the manuscripts were overall associated with the bad state of conservation of the bindings. The broken seams, split-thongs and endbands were responsible for the lack of stability of the support, creating deformations and mechanical damages; but also the wooden boards and the overly stress produced by the rigid split-strap cores were also accountable for the development of deformation and rigidity to the parchment.

This work presented also for the first time an extensive study on the bookbinding typologies found in Santa Cruz. It allowed establishing three main types of bindings for the 12th and 13th century manuscripts found in the collection: primitive; 'Santa Cruz type' and restored. Through the assessment of the collection, it was possible to identify primitive bindings that, although not untouched, still preserved some – of what is believed to be – original elements from the Romanesque period. The size and shape of the wooden boards and the board attachment were some of the primary clues that enabled its setting in the 12th-13th centuries. One of the interesting findings within these bindings was their liturgical purpose, which is probably behind the reason why these manuscripts were left as they were. The 'Santa Cruz type' was intervened in the 16th century most likely because these manuscripts were precious to the library, while the so-called primitive codices were just more common and easy to replace.

As for the *colour mapping*, based on the information presented here, the development of the tool and its implementation was very useful in establishing that the Portuguese Romanesque scriptoria functioned under a three-colour code: red, blue and green (Melo, Castro and Miranda 2014; Miranda and Melo 2014). It also allowed recognising that the older monasteries, Lorvão and Santa Cruz, featured a dominant presence of red – one of the colours that marked the late Antiquity and the earlier Middle Ages. For this reason, these scriptoria seem to have a deeper connection with the Iberian tradition, which is in agreement also with the historical background of these monasteries that were also geographically close to each other (Melo, Castro and Miranda 2014; Miranda and Melo 2014).

Drawing from those ideas, Santa Cruz was also target of a more in-depth analysis based on the importance of the colour purple, which was only found in the oldest surviving manuscripts. The study on the *Homiliarium* SC 4 suggested that purple was consequently substituted by blue, over time. The substantial use of indigo and *vergaut* as blue and green colours could be also seen as a sign of an ancient palette. Moreover, it was observed a more predominant presence of yellow in this scriptorium, which was attributed to its Iberian influence. And finally, through the dated manuscripts in the collection it was also possible to determine that lac dye started only to be used most likely in the last quarter of the 12th century. Alcobaça, on the other hand, has the most modern palette, due to its close contact with the French illumination from Clairvaux. Red, blue and green appear more equally distributed and additionally, pink starts to emerge as an important colour for the centuries that will follow.

II. THE PORTUGUESE BOOKS OF BIRDS

II. THE PORTUGUESE BOOKS OF BIRDS

1. Historical Context

As already introduced at the beginning of this dissertation, in the 12th century, Western moral though was under major transformations (Bejczy 2005: 1). The search for new teaching and preaching methods within clerical environment led to the arising of new educational treatises. By using theology as the main guiding line, the monastic clergy started exploring, in a more conspicuous way, the nature's representations and signs of the Creator as means of communication (Castro, Melo and Miranda 2014: 32). Romanesque philosophers and theologians, such as Hugh of St. Victor (1096-1141)[134], became aware of the need to study nature, as a necessity to understand men who inhabited it. This was also a way to look into themselves as well as to, through that knowledge, progress their path in comprehending the divine order and God itself (Chambel 2003: 5-6).

As a response to this new need to engage in a more intimate bond between men and God through nature, a group of treatises, named bestiaries, started emerging as instructional texts in the European monastic setting. These were works of symbolic-allegoric nature that used animals as models of behaviour. These bestiaries collected images of real and imaginary creatures accompanied by moralizing comments (Clark and McMunn 1989:1-2). These intended to stimulate the imagination between the real and the fantasy world, by presenting appealing illustrations that could be easily understood by illiterates, in order to comprehend more complex theological allusions (Carruthers 2008: 160, 307-309)[135]. Several types of bestiaries were disseminated through Europe, such as the *bestiarium latinum* or even the vernacular versions in archaic French of the *Bestiaire*[136].

This idea of perceiving God's creatures as teaching or studying tools to understand the scriptures was an entrenched thought for the 12th century theologians, as it may be seen in this quote from Hugh of St. Victor:

> 'For the whole sensible world is like a kind of book written by the finger of God — that is, created by divine power — and each particular creature is somewhat like a

[134] For Hugh of St. Victor, contemplating what God made was a way to recognize and understand what men needed to do. In *Didascalicon*, he writes 'All nature talks of God, all nature teaches man, all nature brings forth its reason, and thus in the whole universe nothing is unfruitful' (van't Spijker 2005: 78).

[135] According to Bobbi Dykema, using God's creatures to teach faith and morals was obvious to the men of the middle Ages, from a theocentric perspective, as they were inferior beings, when compared to humans. This, ultimately, asserted the humans' superiority and divine-authority over the natural world (Dykema 2011: 104-105).

[136] The main authors of the vernacular *Bestiaire* were Philippe de Thaon and Pierre Beauvais; from the *Bestiaire divin* was Guillaume le Clerc from Normandy; and from the *Bestiaire d'amours* was Richard de Fournival, with profane contents (Clark 2006: 114-116).

> figure, not invented by human decision, but instituted by the divine will to manifest the invisible things of God's wisdom. But in the same way that some illiterate, if he saw an open book, would notice the figures, but would not comprehend the letters, so also the stupid and 'animal man' who 'does not perceive the things of God' [1 Cor. 2:14], may see the outward appearance of these visible creatures, but does not understand the reason within. But one who is spiritual is 'able also to judge all things,' namely in that he considers the beauty of the works externally, [and] inwardly conceives how admirable is the wisdom of the Creator'[137].

The Book of Birds, known also by its most common Latin name *De Avibus*, appeared in this cultural context as a teaching text where *lectio*, *memoria* and *meditatio* were the main evocative aspirations (Castro, Melo and Miranda 2014: 32; Cordonnier 2007: 7). The main difference between the bestiaries and the *Aviarium* – one of the many names by which it is also known – is that instead of using all species of animal creatures, this book is entirely dedicated to birds.

In order to grasp the socio-cultural framework behind this work, before even talking about the text itself, it is important to be familiar with the background behind the actual writer.

1.1. Hugh of Fouilloy

The medieval writer Hugh of Fouilloy has long been little known, since for several centuries his work was commonly attributed to Hugh of St. Victor[138]. Only in recent decades a number of studies have come to credit his work and acknowledge him as a distinctive and original 12th century writer (De Clercq 1970; Clark 1992; Cordonnier 2007; Negri 2012).

Hugh of Fouilloy, of noble birth, was born about 1102, in the outskirts of Corbie, near Amiens[139]. It is believed that he was first educated at the Benedictine abbey of Corbie, which belonged to his family. He started his religious path as Benedictine at the priory of St. Laurent-au-Bois at Heilly – also near Amiens –, in the late 1120s (Cordonnier 2004: 48). In 1148, prior Ulric, which eventually became Fouilloy's predecessor, asked protection to Pope Eugene II, which led the monastery to come under Augustinian rule. The priory started to be well

[137] Hugh of Saint Victor, *De Tribus Diebus*, 12th century (quote taken from Cizewski 1987: 70).
[138] There are evidences showing that Hugh of Fouilloy was known in his days, such as biographical notes of the 13th century in the chronicles of William of Nangis and Aubry of Trois Fontaines, as well as references to his person in the great encyclopedia of Vincent of Beauvais (Clark 1992: 8). Yet, his name tended to perish, particularly in the 16th century, as his work was commonly attributed to Hugh of St. Victor, which made the prior of Saint-Laurent remain in the shadow for several centuries (Cordonnier 2007: 24).
[139] For a full and detailed description on Hugh of Fouilloy biography, see Rémy Cordonnier, *L'illustration du 'De Avibus' de Hugues de Fouilloy : Symbolisme Animal et Méthodes d'Enseignement au Moyen Âge*, Thèse pour le doctorat d'histoire de l'art. Lille: Université Charles de Gaulle, 2007.

established and grew, even founding a daughter house, St. Nicolas-de-Regny, in 1132, to which Fouilloy was sent as prior. By this time, Hugh of Fouilloy was probably seen as a notorious person in the monastic scene, as in 1149, he is elected abbot of an important Augustinian monastery, St. Denis at Rheims. However, he refused the offer, by saying that he was not worthy of such honor (Clark 1992: 7; Simons 1980: 216). In 1152, he became prior of St. Laurent, which was a much poorer house than St. Denis (Cordonnier 2007: 55-58). According to the obituary of St. Laurent-au-Bois, written in the end of the 12th century and used until the mid-13th century, Fouilloy died on September 7th. Several sources indicate 1172, 1173 and 1174 as the year of his death (Clark 1992: 5-6; Cordonnier 2007: 62)[140].

During his monastic life he wrote several works, of which the ones that are certainty assigned to him are, apart from *De avibus*, *De claustro animae*[141] – probably his most famous work[142] –, *De medicina animae, De nuptiis, De pastoribus et ovibus* and *De rota vera et falsa religionis.* Most of his work was written as educational and theological monastic texts and there are, unfortunately, no date evidences for what he wrote. Hugh of Fouilloy has been seen as a relentless defender of monastic discipline in an age of reform (Simons 2000: 1038). According to the estimates from Rémy Cordonnier, there are currently four hundred and sixty three manuscripts spread across the world with all of Fouilloy's works, where 64% belong to *De Claustro* and 28% to *De Avibus* (Cordonnier 2007: 23).

According to Willene B. Clark, Fouilloy may have written these texts out of necessity – due to his position as prior –, in order to solve the problems he was facing with his community. On a rare testament in a St. Laurent cartulary[143], Hugh of Fouilloy wrote about his life in St.

[140] As for Rémy Cordonnier, he believes that the prior may have died between 1172 and 1173, due to fact that in 1174, the charter of the Bishop of Amiens Thibaud Heilly was addressed to «à notre cher fils dans le Seigneur, Simon, prieur de Saint-Laurent» (meaning that they already had a substitute in 1174). Moreover, there was a papal bull from Alexander III that evidenced the last act on which Fouilloy appeared as prior of St. Laurent-au-Bois (Cordonnier 2007: 62).

[141] Also known as *The Cloister of the Soul*, in *De Claustro Animae* Fouilloy 'presents the cloister not only as an image of the soul, but also as a source of inspiration for moral reform. (…) In *De Claustro animae*, it is not only the cloister building, but foremost the communal life of the religious which serves as a model for the human soul.' (Laemers 2005: 123). Several studies have been conducted around this work. To name a few: Ivan Gobry, *Hugonis de Folieto: De Claustro Animae*, Thèse complémentaire pour le doctora ès Lettres, Paris: Faculté des Lettres et Sciences Humaines de l'Univeristé de Paris, 2 vol., 1965 ; Christiania Whitehead, 'Making a Cloister of the Soul in Medieval Religious Treatises', *Medium Aevum*, 67(1), 1998, pp. 1-29; Janice Pinder, 'Love and Reason from Hugh of Fouilloy to the *Abbaye du Saint Esprit*: Changes at the Top in the Medieval Cloister Allegory', *Parergon*, 27(1), 2010, 67-83; Franco Negri, *Per una Lettura del De Claustro Animae di Ugo di Fouilloy*, Dotorato di ricerca in Filologia Grega e Latina, Parma: Universitá degli Studi di Parma, 2012 .

[142] Most of the copies that have survived from Hugh of Fouilloy are from the work *De Claustro Animae*.

[143] The original cartulary was lost. The text is based on a copy from the beginning of the 13th century, held at Amiens, Bibliothèque de la Société des Antiquaires de Picardie, ms. 62, fol. 2r-2v, under the title: *Incipit prologus Hugonis in Carthalago* [sic] *cartarum ecclesie Beati Laurentii de Nemore.* For more information see: Walter Simons, « Deux témoins du mouvement canonial au XIIe siècle. Les prieurés de Saint-Laurent-au-Bois et Saint-Nicolas de Regny et leurs démêlés avec l'abbaye de Corbie », *Sacris Erudiri*, XXIV, 1980, 203-244.

Laurent, where he mentioned 'several efforts to solve disciplinary and administrative problems at both St. Laurent and St. Nicolas' (Clark 1992: 7). He also notes that he intended to solve these problems 'through proper documentation attested to by proper witnesses' (Clark 1992: 9).

As a writer, Hugh of Fouilloy may be seen as a secondary author from the Romanesque period, which remained in the shadow of his homonymous fellow Hugh of Saint Victor, without achieving the same recognition. But, even so, researchers such as Rémy Cordonnier and Mary Carruthers have shown how Fouilloy was more than just a simple writer, because of the way he constructed his moral and Christian thoughts through visual exegesis as few writers did at that time (Cordonnier 2012; Carruthers 2008, 2009). As Ivan Gobry would say « Hugues n'est pas professeur, mais Pasteur. Il laisse de côté les grandes vérités du Salut, déjà connues des moines… de là sa méthode allégorique »[144].

> « Si l'auteur du *De avibus* n'a pas le génie intellectuel d'un Hugues de Saint-Victor, ni l'art d'écrire d'un Bernard de Clairvaux, son travail, dans son apparente simplicité, offre le fruit de la réflexion bien terre-à-terre d'un chef de communauté qui devait assurer la *cura animarum* de son «troupeau». Ses textes se veulent instructifs, didactiques et relativement faciles d'accès. Destinés en priorité à un lectorat peu cultivé, ils ont plus trait aux questions éthiques qu'aux sujets théologiques. La spiritualité n'en est cependant pas absente, mais elle est toujours étroitement liée à une tropologie dont l'application des préceptes est présentée par l'auteur comme l'étape nécessaire à toute élévation. Son style est très coloré, il emploie de nombreuses métaphores et pratique l'allégorisme à outrance».[145]

Throughout this study, these issues around visual exegesis, moral preaching and allegorism, which appeared to have significance to the author, will be addressed in the following sub-chapters.

1.2. *De Avibus*

The Book of Birds was known under several tiles: *De Avibus, De Columba argentata, De tribus columbis, Liber avium, Ad Raineirium, Libellus ad Rainerum, De natura avium,* among others (Clark 1982: 63; Clark 1992: 1; Gonçalves 1999: 12). Nowadays, researchers have also shown preferences when it comes to name Fouilloy's treatise. For example, Willene B. Clark used the name *Aviarium,* Aviary and Book of Birds throughout her research (Clark 1982, 1992), while Rémy Cordonnier has used *Traité des oiseaux, Aviarium* and *De Avibus* (Cordonnier

[144] Quoted in Cordonnier 2007: 40 (originally written in *op. cit.* Gobry 1965).
[145] Cordonnier 2007: 62.

2007)[146]. In this study, the preferable used name will be *De Avibus* as one of the original Latin titles given at that period and Book of Birds as the modern adaptation for English, in order to simplify and standardize its name[147].

There are no indications at what point did Fouilloy wrote this unique work, while at the same time there is no surviving original manuscript. On one hand, the lack of documentation does not allow a proper dating; and on the other hand, the difficulty in evaluating the maturity of the author's writing, when compared to other works, is dubious[148]. Several researchers have tried to date it and changed their opinion through time, such as W. B. Clark[149] and R. Cordonnier[150]. Lately, the most adopted time frame for the Book of Birds is the third quarter of the 12th century (Castro, Melo and Miranda 2014: 32).

1.2.1. The structure

The structure of the *De Avibus* was kept quite faithful throughout the centuries, particularly during the late 12th century and throughout the 13th century, which was the period where they were most widely spread and copied (Castro, Melo and Miranda 2014: 35). Based on that information, it is believed that the oldest surviving copies must present a very similar fundamental structure and iconographic program to what is believed to be the original treatise (Cordonnier 2007: 68).

The text is divided in two parts:

1st part: It contains 37 chapters. It is considered the most creative part of the Book of Birds, as it gathers the most original contributions to the text and images – particularly the diagrams, such as the Dove and the Hawk, the Dove Diagram and the Three Doves Diagram, which will be later explored. This section is first highlighted by the prologue that begins by acknowledging the importance of the function and purpose of the images in the work. It displays mainly quotations from the Bible, with passages depicting doves, a hawk, a palm tree, a

[146] As already stated in the introduction, these two researchers will be the core sources for this investigation, since they were the ones that took the study of the Book of Birds further.
[147] It is recurrent to find in catalogues and inventories of libraries and archives the usage of several titles just to classify the *De Avibus* from Hugh of Fouilloy, which tends to misplace the researcher.
[148] It is believed that Hugh of Fouilloy may have used deliberately a simplistic writing style, since The Book of Birds was destined to an illiterate audience.
[149] In 1982, she places *De Avibus* sometime after 1152 (when the author was already a prior at St. Laurent-au-Bois) (Clark 1982: 63). Then, in 1992, she places the work of Hugh of Fouilloy in the late 1130s or the 1140s (Clark 1992: 9). This means that at that time, Fouilloy was probably prior of St. Nicolas-de-Regny.
[150] In 2004, Berlioz and Cordonnier place the work between 1130 and 1140, as Willene B. Clark (Berlioz and Cordonnier 2004: 73). However, over the years, Cordonnier begins to address a wider period, namely the second half or the third quarter of the 12th century (Cordonnier 2005, 2010, 2011).

turtledove and a Cedar. The dove is the main character in the first part of the book as most chapters will be connected to it.

2nd part: It contains 23 chapters, which includes an illustration and an individual chapter for each type of bird (e.g. Pelican, Raven, Swan, among others). Here the author tries to reinforce the lessons about God and the self awareness of being on a monastic community, by multiplying the allegories using real and hypothetical qualities for each individual bird (Clark 1982: 65).

1.2.2. The sources

In a conventional way, the sources of inspiration for *De Avibus* will reflect the clerical culture of the 12th century, by including the most important references of that period: the Bible, the Patristic authors and the Classic literature (Cordonnier 2007: 77). Of course, one could not forget the legacy behind the groundwork *Physiologus*.

The *Physiologus* had a major role on the genesis of the bestiaries, which in turn also influenced the creation of the Book of Birds. This literary Greek work may have been written in Alexandria in the 2nd century, while the Latin translation was in circulation by the 6th century, if not earlier (Hassig 1997: 5-6). Written by an anonymous writer, the *Physiologus* influenced incisively the global vision of the animal world in the Middle Ages, by presenting notions and beliefs related to real and fantastic animals, from which they extracted moralizing conclusions. As Clark and McMunn (1989: 2) would say: 'With its lively animal tales and compelling lessons, the Physiologus became a popular source of exempla and a favourite school-text in the Middle Ages'. According to Dines (2014: 2), it is known that in the 8th and 9th centuries, the *Physiologus* reached France, but little is known about its popularity during that time. Although Hugh of Fouilloy does not mention the work, it is evident how this source was a clear inherited influence, by mixing facts with imaginative concepts on his description of birds (Clark 1992: 10).

The Bestiary tradition was definitely present in Hugh of Fouilloy's work. Not only had it probably served as a structural model and occasional text source (Clark 1992: 4-5), his work was also later introduced on many versions of Bestiaries. Taking this into account, the *Bestiarium latinum* appeared in England at the end of the 11th century (Cordonnier 2007: 108). According to Clark, in the 9th century, there were already Latin bestiary texts that anticipated the Second-Family bestiary version, which included chapters from the *Etymologiae* of Isidore of Seville or the *Hexameron* of Saint Ambrose, such as the example of the manuscript Bern 318, made probably in northern France (Clark 2006: 10).

Fouilloy was, therefore, influenced by the *Physiologus* and the *Bestiarium* for different reasons. While the first tended to be more theological through the animal interpretation, the second opened the moral-ethical content, which made it more educational and didactic (Clark and McMunn 1989: 3).

The Book of Birds is full of insinuations and citations from the Bible, which was the most influential source during Middle Ages. The author uses both the Old Testament and the New Testament. According to Rémy Cordonnier, there are 110 biblical quotes, from which some of those passages are repeated several times[151]. The Gospel of St. Matthew and the Book of Job are also frequent references used by Fouilloy (Cordonnier 2007: 77)[152]. The author refers to the Scriptures mainly to explain a passage or to illustrate or corroborate one of his interpretations (Cordonnier 2007: 78). This is much more recurrent in the first part of the Book of Birds, than in the second part.

The second major reference for the French prior was the Patristic literature. His main influences were Rabanus Maurus, Isidore of Seville and St. Gregory the Great with the following works *Rerum naturis*, *Etymologiarium*, and *Moralia in Iob* and *Dialogos*, respectively. Also mentioned, though less frequently, were St. Jerome and Bede[153]. He may have been equally inspired by Cassiodorus, St. Ambrose and Origen[154]. The usage of these sources implied two types of information for Fouilloy. On one hand, purely factual information on the substance of his treatise – which were the birds –; and on the other hand, more technical information, related to the form of his book – which is the idealization of an exegetical textbook. He uses these sources through his personal observations, and therefore their contributions are always there to corroborate his personal interpretation. To conclude, the purpose of the author of The Book of Birds was primarily to create a theological book through animals, only with the pretext for exegetical practice (Cordonnier 2007: 80-81).

So even though Fouilloy knew the classics, these authors were not a key source of inspiration. In *The Personality of the animals* from Aelien and in *Natural History* from Pliny the Elder, the French writer obtained information about the natural habits of the birds. But as previously mentioned, the primacy was given to the Christian authors, who reinforced the idea that his treatise on birds was primarily a text that addressed theological issues and not facts of natural history (Cordonnier 2007: 82-83).

[151] Such is the case of the Psalm 67:14, which will be later discussed.
[152] Some less frequent sources are also used such as: *The Genesis*, *Song of the Songs*, *The Book of Leviticus*, *The Book of Jeremiah*, *The Book of Ezekiel*, *The Book of Isaac*, and others (Cordonnier 2007: 78).
[153] *Interpretation of Hebrew Names*, *Commentary on Matthew and Hebrew Questions on Genesis*, from St. Jerome; *Commentary on Tobit*, from Bede.
[154] *Exposition of the Psalms*, from Cassiodorus; *Hexameron*, from St. Ambrose and *Commentary on the Song of Songs*, from Origen.

1.2.3. The essence

The *De Avibus* uses birds as models of behaviour, such as *exempla* for Christian thought; each species was assigned with positive and negative characteristics – some of them even *oppositae qualitates* – in order to serve as example for a proper conduct in a monastic setting. The aim of Hugh of Fouilloy's work was given in a very clear manner as he said: 'Observe how the birds, which lack reason, by examples of perverse action teach educated men possessing the power of reason' (Clark 1992: 207).

According to Clark, the text was conceived specifically for a particular monastic community: the lay brothers (*conversi*)[155]. In the Prologue, Hugh of Fouilloy states to whom this text is dedicated. He introduces a man called Rainier, known as 'the Kindhearted', and calls him as his 'dearest friend':

> «Desiring to fulfill your wishes, dearest friend, I decided to paint the dove whose wings are silvered and the hinderparts of the back in pale gold, and by a picture to instruct the minds of simple folk, so that what the intellect of the simple folk could scarcely comprehend with the mind's eye, it might at least discern with the physical eye; and what their hearing could scarcely perceive, their sight might do so. I wish not only to paint the dove physically, but also to outline it verbally, so that by the text I may represent a picture; for instance, whom the simplicity of the picture would not please, at least the moral teaching of the text might do so»[156].

Clark considers the possibility that Rainer, a former noble *conversi* from the monastery where Fouilloy was a prior, may have had enough education to become a professor of lay-brothers – as it is known that particularly between Cistercians and, possibly among other religious Orders, there were lay-brother members that were literate teachers. The fact that Rainer had requested Fouilloy to write this book, suggests that he was probably a teacher as he would need a manual to support his teachings to his illiterate brothers. As an instructor, Rainer would have to translate and elucidate the moralizations and allegories to his simple-minded pupils (Clark 1982: 63). In several chapters from the Book of Birds, Hugh of Fouilloy refers for several times the role and the responsibilities of the teacher[157]. To draw the attention of the lay-

[155] The lay brothers were introduced in the monasteries in the 11th century to the 13th centuries, as a necessity to let them explore the land and livestock, allowing the monks to be free for their liturgical duties. These, in addition to the manual labour, had also to take vows of obedience and observe the rules of the religious order to which they were associated. Most of them were already adults when they were converted, often lacking education (Burton and Kerr 2011: 151-155; France 2012; Noell 2006: 253-257).
[156] Clark 1992: 117.
[157] For example, in the Cock chapter: ''The cock,' as the blessed Gregory said, 'receives intelligence so that he might first shatter the nighttime hours and then finally give out with a rousing call, because clearly

brothers, Fouilloy used images and diagrams[158] as a potential resource for religious instruction, as seen in the above mentioned prologue.

Additionally, the prologue is combined with an extremely interesting illustration – the first from the iconographic program –, which observed some variations along the years, though its main intention was preserved. On this scene, a dove – representing the clergy (*clericus*)[159] – and a hawk – representing the lay-brother or former knight (*miles*)[160] – are portrayed in a perch, facing each other, Fig. 61. The perch represents the monastic rule and the two characters seem to be having a conversation in the cloister, which is symbolized by the arches under them[161]. The dove starts the conversion by explaining the rules of this new life, which the hawk is about to embrace:

> 'See how the hawk and the dove sit on the same perch. I am from the clergy and you from the military. We come to conversion so that we may sit within the life of the Rule, as though on a perch; and so that you who were accustomed to seizing domestic fowl, now with the hand of good deeds may bring to conversion the wild ones, that is, laymen'[162].

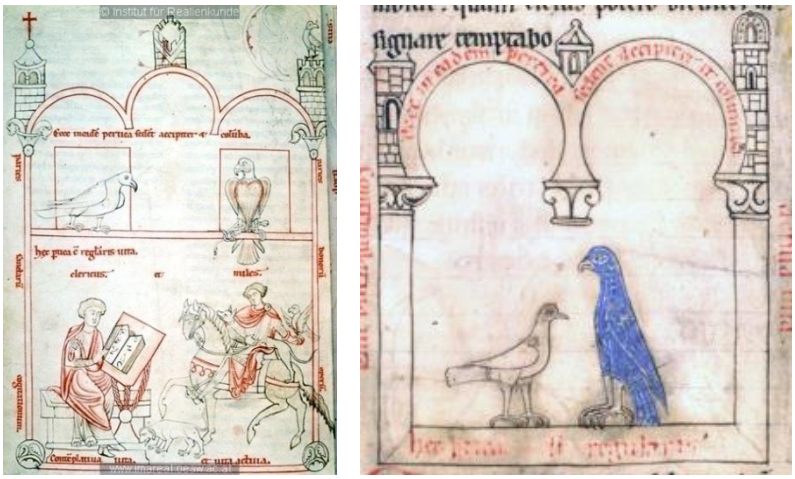


Figure 61. Representation of the Dove and the Hawk. Heiligenkreuz *De Avibus* (Heiligenkreuz Stiftsbibliothek, ms. 226, fol. 129v) and Lorvão *De Avibus* (DGARQ-ANTT, Lv 5, fol. 5), respectively[163].

---

every holy preacher first reflects upon the situation of his listeners, and then at length forms in his sermon an appropriate tone for teaching them. (…) Whence every teacher, so that he may instruct all in the one virtue of charity, should touch the hearts of his hearers with one principle, not with one and the same exhortation' (Clark 1992: 181, 183).

[158] It is believed that at least some of the diagrams seen in *De Avibus* were carefully designed by the author. This will be further discussed in the followings chapters.

[159] Clark proposes that the dove is also a representation of the author, as he being also a clergy man (Clark 1992: 13).

[160] In this case, the most obvious interpretation is that this *miles* is Rainer.

[161] These arches can also symbolize in a way a protective space, which can be subsequently associated with a birdcage as the author himself follows this analogy.

[162] Translation taken from Clark 1992: 119.

[163] The representations of the Dove and the Hawk are rarely portrayed with real human characters. The Heiligenkreuz illumination is considered as possibly the composition closest to the originally designed by

The particular focus on using exclusively birds may have been motivated by a metaphorical vision of the categories within the animal kingdom. That metaphor is built around a notion of hierarchy[164], where the terrestrial animals are considered inferior beings when compared to men and birds – to the extent that the latter are closer to the sky. Moreover, terrestrial animals will be seen also as substandard to men due to their lack of spiritual nature, as well as to birds due to their lack of capability to fly, which is an ability that allows them to be, once again, closer to spirituality (Cordonnier 2007: 74-75). This issue was also addressed in Fouilloy's *De medecina* and *De Claustro Animae*[165].

As for Jacques Voisenet, from all the animals' categories considered by the specialists from Middle Ages symbolism, the bird is the only animal that offers great richness or as he calls: '*signifiante*', through the description of certain parts of its body – e.g. wings and feathers –, of its production – e.g. eggs and pints – or of its environment – e.g. nest (Voisenet 2000: 139).

Nonetheless, one should not exclude the hypothesis that the author may have had intentions, at the beginning of his writing, on also using other kinds of animals, as on *De Avibus* he notes: 'But I shall try to provide information as briefly as I can about certain birds as well as animals which Holy Scripture cites by way of an example of conduct' (Clark 1992: 119).

2. The *De Avibus* 'migratory' journey

It is commonly assumed that *De Avibus* was a relative successful text widely spread and copied from the late 12th century to the mid-13th century throughout Europe, due to its doctrinal and didactic nature in the monastic cultural context. From a total of 129 known manuscripts[166], around 60 of them are completely or partially illuminated (Cordonnier 2011: 272), Fig. 62.

Hugh of Fouilloy. Subsequently, the illuminators started to represent solely the birds on the perch, as seen in the Lorvão representation.

[164] At the beginning of the 12th century, Philippe de Thaön will apply, for the first time, the designation of 'bestiary'. The work is divided in to three groups: 1st) dedicated to the animals on earth; 2nd) to the birds; and the 3rd) to the stones. In the first, he describes the animals that symbolize Jesus Christ and the Devil; in the second, he presents the birds referring the Savior and Men; and at last, in the third, he starts developing the issues surrounding the men, the divinity, the holy life and their heavenly rewards. It is evident that within this categorization, there is a hierarchy. It can be concluded that the birds that fly in the sky are connoted as the men that aspire to God (Chambel 2006: 9).

[165] «C'est Noé qui construit l'arche – c'est-à-dire: qui édifie l'âme; c'est lui qui place les animaux irraisonnables aux étages inférieurs, les hommes et les oiseaux à l'étage supérieur – entendez : il réprime les mouvements charnels, il place au-dessus les spirituels» in Hugh of Fouilloy's *De Claustro Animae*, quoted from Cordonnier 2007: 75.

[166] Rémy Cordonnier was able to establish that there were 128 known manuscripts (Cordonnier 2010a), yet with this investigation it was possible to identify a new copy from the Arsenal Library, Paris.

From this corpus, four of them are Portuguese[167]. To see a full list of the information on the 129 manuscripts, please see table from Appendix IX.

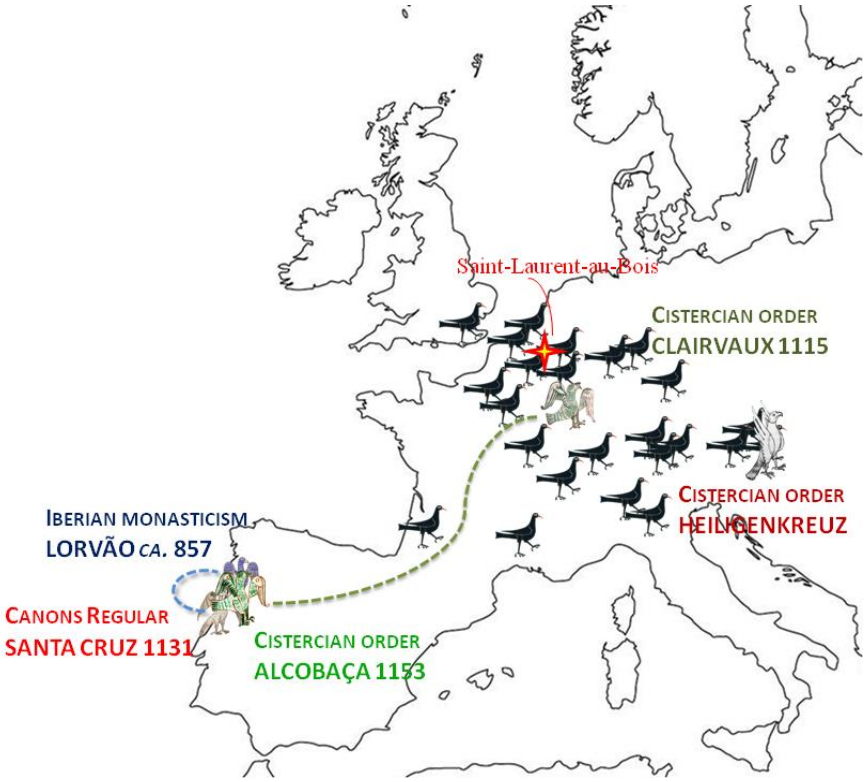


Figure 62. Possible sites of *De Avibus* productions[168] with dashed lines that represent the correlations within the Portuguese models.

It is established that «Chaque manuscrit a son histoire: il est copié par une ou plusieurs personnes à un endroit précis – voire dans une succession d'endroits. Il voyage, passe entre les mains de divers propriétaires; est lu, commenté, glosé, corrigé, recopié. Parfois, on vient de loin pour le voir et pour le copier (…)» (Tolan 2010: 167). In order to know the history of a manuscript, it is essential to understand its journey and its route, but there are still few studies exploring the networks involving the circulation of manuscripts during Middle Ages – particularly for the Franco-Iberian circuit – with the marginal exceptions from Diaz y Diaz and Aires Nascimento[169]. Reynolds and Wilson (1991: 97-98) describe for the Carolingian period, what could be also mirrored for the Romanesque epoch:

[167] For a more profound discussion on the Portuguese *De Avibus,* please see section 3. The Portuguese *De Avibus*.
[168] In reference to the work of Clark 1992: xviii.
[169] Manuel C. Diaz y Diaz, « La Circulation des Manuscrits dans la Péninsule Ibérique du VIIIe au XIe Siècle », in *Cahiers de Civilisation Médiévale*, 12 (47), 1969, 219-241 ; Manuel C. Diaz y Diaz, « La Circulation des Manuscrits dans la Péninsule Ibérique du VIIIe au XIe Siècle (suite et fin) », in *Cahiers de Civilisation Médiévale*, 12 (48), 1969, 283-392 ; Aires A. Nascimento, 'Concentração, Dispersão e Dependências na Circulação de Manuscritos em Portugal, nos Séculos XII e XIII', in *Coloquio sobre Circulacion de Codices y Escritos entre Europa y la Peninsula en los siglos VIII*-XIII. Actas 16-19 Septiembre 1982. Santiago de Compostela : Universidade de Santiago de Compostela, 1988, pp. 61-85;

> ‘The routes by which texts travelled as they progressed from place to place were naturally governed in part by geographical factors, as they moved along the valleys of the Loire or Rhine, but even more by the complex relationships that existed between institutions and the men who moved between them. There are so many gaps in our knowledge, and so many of the pieces in this puzzle have been irrevocably lost, that we can never hope to build up a convincing distribution map for the movements of texts in this period.’

The Book of Birds makes a good example on how manuscripts were circulated, while maintaining its content and iconography relatively faithful to the presumably original text. As in a more common sense, ‘the more widely a text was disseminated, the more derivative copies were produced, which in turn caused modifications in the text despite the best efforts of the copyists and users’ (Bourgain 2015: 151).

As Pascale Bourgain (2015: 150) would simply summarize:

> ‘Texts thus circulated through networks, either established through companionship from the days of one’s education, or through an institutional framework. (…) Shared culture, characterised by a knowledge of the same erudite language as well as a common foundation of texts and memories, created what Brian Stock refers as a ‘textual community’, which involves the circulation of common texts within locations and constituencies who were capable of communicating with each other. Religious orders, the habits of prayer communities, and the contact made through the practice of circulating mortuary rolls also favored this kind of exchange.’

It is unquestionable that the Book of Birds is a striking example of the networks of circulation that existed during Middle Ages. Taking into account the 129 known copies that reached to the present day, only 15 to 18 were produced at the end of the 12th century, whereas in the 13th century the production reached its highest peak with 66 to 69 manuscripts, as seen in Fig. 63. After this, the copying of the *De Avibus* started to decrease with 21 to 23 copies in the following century and 15 to 18 codices in the 15th century, which also seems to determine the end of its production.

Aires A. Nascimento, ‘Le Scriptorium d’Alcobaça: Identité et Corrélations’, *Lusitania Sacra*, 2ª série, 4, 1992, 149-162 ; Aires A. Nascimento, ‘Percursos do Livro na História da Cultura Portuguesa Medieval’, in *Ler Contra o Tempo. Condições do Textos na Cultura Portuguesa (Recolha de Estudos em Hora de Vésperas)*, Aires A. Nascimento (Ed.). Lisboa: Centro de Estudos Clássicos, Faculdade de Letras da Universidade de Lisboa, 2012, pp. 269-317.

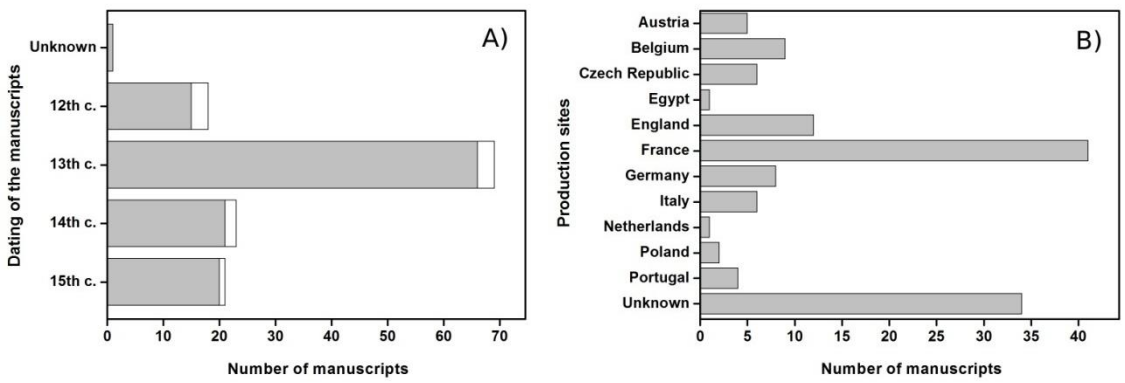


Figure 63. Number of *De Avibus* manuscripts that were produced A) in a specific century in gray (the copies that are possibly from that century, but are not completely established, are represented in white); B) in a specific country in gray. This information can be also consulted in Appendix IX, Table IX.1.

Geographically – while already considering the current borders and countries – the *De avibus* was mainly produced in France (at least 41), followed by England (12), Belgium (9), Germany (8), Italy and Czech Republic (6), Austria (5), Portugal (4), Poland (2) and, finally, Egypt and Netherlands (1), Fig. 63B). This demonstrated how this work had a wide geographic distribution.

France was, evidently, the nerve centre of the production of copies from the Book of Birds since the original text came from there. In England, the interest in Hugh of Fouilloy's work appears within a slightly different trend, largely related to the bestiaries and possibly a clerical background, and perhaps – as suggested by Clark – lay patrons (Clark 1992: 111). As for the rest of the countries, the production will be mainly associated to the monastic environment, which seems to have been the more interested in this text due to its nature. As a result, the main patrons of the *De Avibus* were the religious orders.

2.1. The Role of the Religious Orders

As essentially a monastic text, the Book of Birds was quite popular within that particular setting. In Fig. 64, the number of manuscripts attributed to a certain religious order is presented. From the 129 manuscripts, there are 55 unknown copies produced in an unidentified religious community, which means that 43% of the corpus cannot be represented. However, taking into account the rest of the collected works (57%), it seems that there were three institutions that invested more in this text: the Cistercians (26 to 30), the Benedictines (19 to 20) and the Augustinians (11). In outnumbered, there were the Dominicans (3 to 4), the Franciscans (2 to 4), the Victorines (2 to 3), and secular canons (2), which did not live under the Augustinian rule.

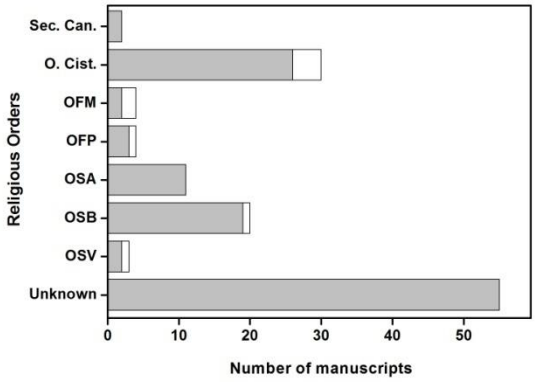


Figure 64. Number of *De Avibus* manuscripts that were produced in a specific religious order (in white, are represented the manuscripts that were most likely produced in that particular order, although not possible to state with certainty).

The highlight should be particularly given to the Cistercian Order, which was the main patron of *De Avibus*[170]. In addition to these 26 to 30 mentioned copies, according to Cordonnier, there were also two destroyed manuscripts during the Second World War, which belonged to the Cistercians abbeys of Trois-Fontaine and Cheminon, in France. Moreover, there are also evidences of other possible existing *De Avibus* in monastic libraries that are still presently functioning; however these still lack public catalogues to ensure public accessibility. Cordonnier reports, for example, the case of the possible Book of Birds in the Cistercian monastery of Beaubec (Cordonnier 2004: 2), which still needs to be confirmed. All of these references allow the conclusion that the Cistercian Order was probably the most interested community for Hugh of Fouilloy's text[171]. In addition, the manuscripts that are closer to what it is believed to be the original were also made in this institution, which also avows its importance in the context of this work.

One of the reasons for this dissemination within the Cistercian Order may be related to their donation system, where every time a new monastery was founded, the mother abbey was responsible for sending manuscripts to guarantee that there were enough texts for the practice of the *lectio divina*. This method of text transmission, created a certain uniformity within the Cistercian libraries (Cordonnier 2004: 4), which relates to the case of the Alcobaça copy, as it will be discussed ahead.

[170] It should be also highlighted that the interest in Hugh of Fouilloy's work was not based merely on the Book of Birds, as in most cases, contrarily to what is seen in other religious orders, the Cistercians were interested in several texts from Fouilloy. Therefore, the *De Avibus* appears frequently compiled with the *De Claustro animae*, *De Medecina Anime*, *De Rota*, *De Nuptiis* and *De Pastoribus* - from the most associated text to the less used (Cordonnier 2004: 3).

[171] If the manuscripts with known provenance are to be considered as the total, the Cistercian Order should represent approximately 40% of the entire religious communities of that time.

Although Augustinian[172], Hugh of Fouilloy's ideals appeared also in the same sphere as of Bernard of Clairvaux and the Cistercians (Cordonnier 2004: 7). His thoughts reflected the continuation of the religious reforms, through the return of the monastic purity supported by the *vita apostolica* (Clark 1982: 63), which was also expressed in St. Bernard's work (Constable 1991: 56). Therefore, it is possible to deduce that Hugh of Fouilloy and St. Bernard of Clairvaux shared the same values and motivations to write their treatises[173], which in turn may explain the impact of the *De Avibus* in the Cistercian Order.

One of the other most referred evidences of the connection between the Cistercians and Fouilloy's allegorical treatise on birds was the educational side of the text, mainly related to the lay brothers. Although there were *conversi* in many orders, the Cistercians were the ones that took the incorporation of lay brothers into a completely different level[174]. Since the Cistercians were largely dependent on agriculture and animal husbandry, the lay brothers became an essential community within the order. However there were clear distinctions between them and the white monks, which 'was not dependent on social status but on literacy. Monks could read; lay brothers could not' (Newman 2003: 185). In some monasteries, the lay brothers outnumbered the monks by 2:1 or even by 3:1 (France 2013: 85). In the second half of the 12th century, most orders that had lay brothers started experiencing difficulties with them (Constable 1996: 79-80), most likely due to their marginalized status[175]. This tendency to sideline lay brothers was probably responsible for the discipline problems they started having. According to Clark, at that time St. Laurent monastery also experienced the same crisis, when 'the canons began to indulge in personal luxuries' (Clark 1982: 63). This possibly explains the necessity of Fouilloy to write such a work, as a necessity to solve the issues from his priory. But is also justifies why this text was so popular at that time for other religious communities.

When looking at the dates of production of *De Avibus*, with an additional perspective, it is also possible to establish a relation between the increase of communities of lay brothers and the most prosperous period of dissemination, in the 13th century. On the other hand, the decrease of

[172] Hugh of Fouilloy's work found also followers in the Benedictine and Augustinian orders, most likely due to the author's contact with these religious communities, which could have led him to adopt ideas from both orders. Making the *De Avibus* a work of monastic interest overall.

[173] 'Bernard's presence, both in person and through the spread of his writings, made Cistercian life attractive to donors and potential monks (…). His writings present an interplay between scriptural exegesis and what he called the 'book of experience', and he encouraged his audiences to use their sensory and somatic knowledge as a starting point in their progression toward the divine' (Newman 2013: 31).

[174] It is within the Cistercians that the *Usus Conversorum* ('Use of the lay brothers'), a book of rules for the lay brothers, appeared. It was draft by Stephen Harding, most likely in the early 1120s and was introduced in the Cistercian law in 1202 (France 2012: 34-35; Noell 2006: 257).

[175] '(…) lay brothers were fed inadequately, alienated from the liturgy, and humiliated by having to wear badges of their low status, their beards. These cultural practices were constant reminders to *conversi* of their inferiority with respect to monks' (Noell 2006: 254).

production in the 14th century can be also explained by the recession observed in the Cistercian houses[176]. 'Had the lay-brotherhood maintained its earlier fervor and discipline, the Aviary, and perhaps also the Latin Bestiary, would almost certainly have remained in production alongside the vernacular Bestiarie' (Clark 1982: 71).

2.2. Circulation of Models

As already established, the *De Avibus* maintained its corpus with few changes in the course of its dissemination. Willene B. Clark, in 1992, created a classification for different models amongst the Book of Birds illustrated into six groups (Clark 1992: 40-89)[177]. According to Cordonnier, these groups represent the many variations seen in the text; nevertheless they also illustrate the same order and identical number of chapters coherently altered[178].

Within these six groups, there are two main models to which they all belong: Model A – closer to the original – and Model B – with clear differences in relation to the first. It is established that the Model A is the closest to what Hugh of Fouilloy created originally. Several examples from the main groups can be depicted in Fig. 65.

Model A is divided into two groups: the 'Heiligenkreuz group', which contains the manuscript that names the group that is considered the closest copy to the original[179] and the 'Paris group'. Clark divides the 'Heiligenkreuz group' copies into three subgroups: 1) Heiligenkreuz and Zwettl (very similar copies); 2) the Portuguese *De Avibus*, the Clairvaux copies and the Rome and Avignon Book of Birds; 3) the Yale I, Bordeaux and Cambrai manuscripts. These copies share very few changes in the text. These 'Paris group' copies were mostly made during the second quarter of the 13th century and produced in Paris, France. Their text is similar to the 'Heiligenkreuz group', although they present some elements associated to the Bestiaries (Clark 1992: 41-61)[180].

Besides, Model B collects three groups: 1) Ter Duinen, ii) Saint-Martin and iii) Aberdeen (Clark 1992: 61-85) – that contains copies that are more distant from the original. In this model, the Book of Birds is normally associated to the following treatises: *De medicina*, *De rota* and *De pastoribus* (Cordonnier 2007: 83-4). Its iconography is also distinct from the observed in

[176] As James France would state: 'Their inferiority vis-à-vis the monks in a servant-master relationship was a flaw which, together with economic, agrarian, demographic and cultural factors, contributed to their sharp decline in numbers in the fourteenth century' (France 2013: 85).
[177] At that time, Clark reported 57 illustrated manuscripts, yet nowadays there are more known copies, however these can be easily incorporated into the established categories.
[178] «Ces variantes n'affectent pas l'identité de l'œuvre, mais permettent d'éclairer l'histoire de sa transmission» (Cordonnier 2007 : 83).
[179] Vienna, Heiligenkreuz Stiftsbibliothek, Ms. 226. To see more information about the manuscript see Appendix II, table 1.
[180] Too see more detailed information on the *De Avibus*, please consult Appendix II, table 1.

Model A. Additionally there is also the so-called 'Independent manuscripts' whose originality and disparity does not allow an association with any specific group (Clark 1992: 85-89). In this particular assembly, lies the 14th century Portuguese manuscript that stands out for its unusual iconography and text.

Although not framed as a particular model, the *De bestiis et aliis rebus*[181] is a compilation of texts with related bestiary contents, which include the *De Avibus* from Hugh of Fouilloy. This particular bestiary version led to a series of contradictions and misjudgements throughout the years. First, there were issues behind its authorship[182], then some believed that the Book of Birds was not an independent work, but a specially made text for this particular book[183], and finally most researchers up until recently though that the *De bestiis* was a medieval collection from the 12th and/or 13th centuries[184]. As contrary to what was though, the *De bestiis* is a 16th century edited assemblage made by the canons of the Parisian abbey of St. Victor that had attached an *Opera Omnia*, by Hugh of Saint Victor. This compilation was made of four books: Book I, the 12th century *De Avibus* from Hugh of Fouilloy; Book II, a 'H'-bestiary text; Book III, a partial second-family bestiary with a lapidary; Book IV, an alphabetical glossary describing animals, which had been referenced in the previous texts (Clark 2006: 13; Cordonnier 2007: 112).

[181] See Francis J. Carmody, '*De Bestiis et Aliis Rebus* and the Latin Physiologus', *Speculum*, 13(2), 1938, 153-159.
[182] It was considered, for a long time, as an integral work of Hugh of St. Victor (Zink 1984: 60; Ribeiro 2004: 2). Then, J. P. Migne published all four books with a note attributing Book I to Hugh of Fouilloy. On a note, Migne refers : « L'auteur de cette compilation est incertain. Les Bénédictins attribuent le premier (livre) à Hugues de Foulois, le deuxième à Henri de Gand, le troisième et le quatrième à Guillaume Perrault. » (in *Patrologia Latina*, cixxv, cxviii) (*op. cit.* in Carmody 1938: 155).
[183] Gonçalves and Chambel suggested that the work was part of *De bestiis et aliis rebus* (Gonçalves 1999: 12; Chambel 2003: 195-6; 2006: 9).
[184] It is noteworthy to mention that several authors, including Clark that later corrected the date (Clark 2006), though that the *De bestiis et aliis rebus* was a medieval compilation from the 12th and/or 13th century (Clark 1992: 4; Hassig 1995: 7; Gonçalves 1999:12).

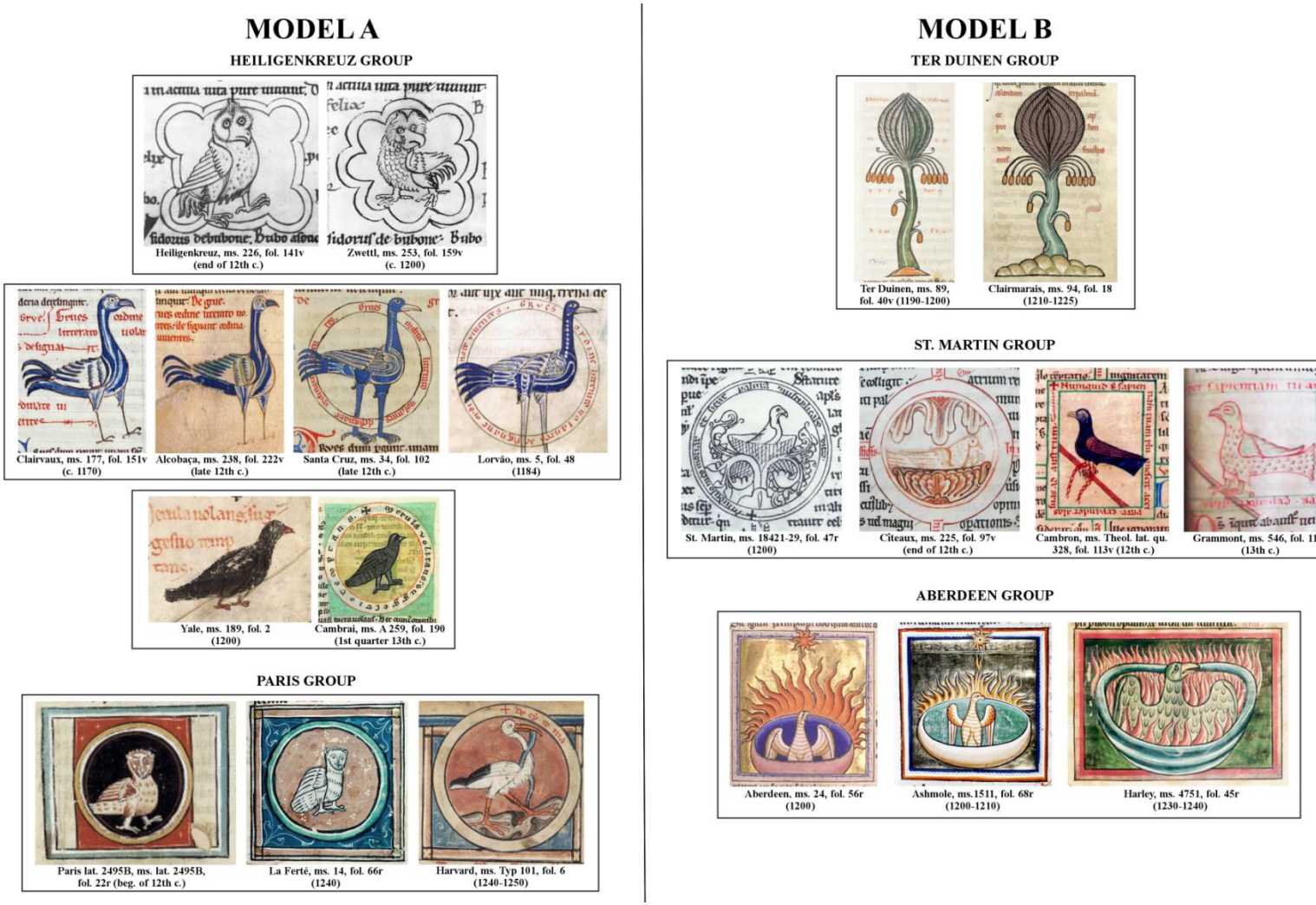


Figure 65. *C*irculation of models for the Book of Birds, according to Willene B. Clark (Clark 1992: 113), with some iconographic examples. For more information on each manuscript, please consult Appendix IX (most images were taken from the links shown in Appendix IX and some were provided by Rémy Cordonnier).

3. The Portuguese *De Avibus*

3.1. Historical considerations

Although bestiaries had an enormous popularity in England and France, there is no awareness of any copy produced in Portugal[185]. On the other hand, in the Portuguese monastic context of the end of the 12th century, there are three copies of the Book of Birds, which measure up to amongst the finest examples of the manuscripts found all over the world (Castro, Melo and Miranda 2014: 35). This work was produced in the scriptoria of the three most important monasteries of the Portuguese Romanesque, which were already described in the previous chapter: São Mamede of Lorvão[186], Santa Maria of Coimbra[187] and Santa Maria of Alcobaça[188]. Later, in the 14th century, a new copy from The Book of Birds was copied and translated in Portuguese[189,190], which confirms the popularity of Hugh of Fouilloy's work in Portugal.

The Portuguese *De Avibus* copies have attracted the interest of several researchers (Clark 1992: 44-49; Miranda *et al.* 2010; Cordonnier 2011; Melo *et al.* 2011; Castro, Melo and Miranda 2014). In addition to being some of Europe's best examples containing a practically complete iconographic program, they are also known for their dating and their correlation between other European copies.

The Lorvão manuscript has been known to be the oldest copy with two colophons (1183 and 1184). The corresponding colophon for the Book of Birds is from 1184. It indicates that in

[185] The production of bestiaries was mainly linked to the clerical world in opposition to the monastic environment, which is the main source of production in the Portuguese Romanesque. Therefore, this may be also an explanation for its absence in Portugal.

[186] Lisbon, Archives of Torre do Tombo, Monastery of São Mamede of Lorvão, Lv. 5. http://digitarq.dgarq.gov.pt/details?id=4381076.

[187] Porto, Municipal Library of Porto, Ms. 34. http://arquivodigital.cm-porto.pt/Conteudos/Conteudos_BPMP/SantaCruz%2034/SantaCruz%2034.htm.

[188] Lisbon, National Library of Portugal, ALC 238. http://purl.pt/24388.

[189] Brasilia, Central Library of the University of Brasilia, the manuscript does not have a number.

[190] The fourth Portuguese Book of Birds, written in archaic Portuguese, is from the 14th century and is currently in Brazil. From this manuscript there are only records of five birds in remaining fragments and a passage about the prophet Ezekiel. This manuscript was not incorporated in this study, since it belonged to a completely different historical and artistic background. Several researchers have analysed this work, namely: Pedro Azevedo, 'Uma versão Portuguesa da História Natural das Aves do séc. XIV', *Revista* Lusitana, 25, 1925, 128-147; Maria M. da Silva de Oliveira, 'O lexical e o simbólico no *Livro das Aves*', *Marginahlia*, Revista de Letras, nº3, 2008, 60-77; Rosa V. Mattos e Silva, Américo V.L.M. Filho, 'Fontes para o conhecimento da língua portuguesa de trezentos: os mais antigos manuscritos portugueses existentes no Brasil', *Série Estudos Medievais*, 2, 2009, 189-202; Maria Eurydice de Barros Ribeiro, 'O Livro da Aves. Fragmento de um manuscrito desaparecido', *I Seminário Brasileiro sobre Livro e História Editorial*, 8 a 11 de Novembro de 2004, Rio de Janeiro, 1-10; Maria Eurydice de Barros Ribeiro, 'A Imagem Documento. O Falcão: Tradição e Inovação no Livro das Aves', in *Anais Eletrônicos do IX Encontro Internacional de Estudos Medievais: O Ofício do Medievalista*, C.R. Bovo, L.D. Rust, M.S. da Cruz (Eds.). Cuiabá: ABREM, 2011, pp. 74-80 (Accessed in June 15 – Available in http:/abrem.org.br/copier.php?arquivo=Anais+IX+EIEM+2011.pdf).

addition to having been produced at that Portuguese monastery, it is also – at the European level – the oldest identified copy of the *De Avibus* with a specific dating. Both colophons state:

> 'Ad honorem dei et sancti Mametis in monasterio laurbanense est scribtus [sic] liber iste. In diebus Johannis abbatis FINITO LIBRO DONA DEN[IQUE] LARGIORA magistro. Era M.C.C.XXII' and 'Scriptus est liber este ad laudem et honorem Dei omnipotentis et sancti Mametis laurbanensis monasterii temporum regis Alfonsi, in diebus Johannis abbatis. Era M.CC.XXI'[191]

As for the other two Portuguese copies, from Santa Cruz and Alcobaça, they have been throughout the years established as productions from the 13th century (Clark 1992: 287-288, 305; Cepeda and Ferreira 1994: 164; Gonçalves 1999: 33-34; Nascimento and Meirinhos 1999: 199-203; Cordonnier 2007: annexe 1, pp. 100 and 107). However, there are several evidences that suggest that these manuscripts could have not been produced at such late period as it is claimed. By studying their colour, iconography, codicology and texts, this research aimed to bring new insights on the dating of these two Portuguese manuscripts, which will be further developed in these following sub-chapters.

3.2. Codicology

Codicology has been used as an essential complementary tool for the study of manuscripts. This discipline has shown to be imperative in order to contextualize the codex within time and space (Correia 2014: 22). Nascimento has been so far the only researcher that tried to establish the importance in studying the relationship between the different texts present in the three Portuguese *De Avibus* codices (Nascimento 2012b: 400-402).

As already mentioned, the Lorvão 5 was written in 1184. In addition to Fouilloy's text (fols. 4r-64r), it contains two additional chapters that were taken from St. Ambrose's *Hexameron* (fols. 15v-15r and fols. 17v-18r) as well as some excerpts from a bestiary (fols. 69v-73r) and from St. Isidore's *De creatione hominis* (fols. 73v-94v)[192]. These texts are also linked to compilations from bestiaries[193]. This manuscript is by far the smallest one with 210x137x43 mm. It was extensively trimmed in the edges. It contains 96 folia, 48 bifolia, 12 quires which are formed by four bifolia. The text is organized in one column and 21 lines. A scheme with the organization of the quires can be seen in Appendix X.

[191] Lorvão's *De Avibus*, fols. 67 and 90v, respectively.
[192] This numbering corresponds to the current organization of the folia, which was revised by Inês Correia during its restoration process in 2006 (Correia 2014: 137-8).
[193] According to W. B. Clark, both Second-family and 'Transitional' compilers used early sources, such as Isidore's *Etymologiae* and St. Ambrose's *Hexameron* to increase the animal population in their texts (Clark 2006: 12). The *Hexameron* was the only text that was found in Santa Cruz and Alcobaça (SC 58 and ALC 150). Only the SC 58 could have served as a reference for the Lorvão copy.

The binding was unfortunately modified in the 16th century and then restored in 2006, at the ANTT. The only original element from the archaeological structure of the codex is the 12 quires made of parchment. It contains a covering leather of vegetable tanned skin in oak wooden boards. The decoration in blind tooling is of neo-Mozarabic style. There are two fastenings in brass metal. The sewing was made in three hemp thongs with simple endbands (Correia 2014: xxi).

The Santa Cruz 34 manuscript is a compilation of different authors. It starts with the Spanish Petrus Alphonsus's *Dialogum contra iudeos*[194] (fols. 1r–73r), followed by the Anglo-Norman Gilbert Crispin from Westminster's *Disputatio judaei cum christiano* (fols. 73v–88v). During the 12th century, these two texts of anti-Jewish tract faced equivalent popularity and where often associated (Tolan 1993: 98). These are preceded by Hugh of Fouilloy's *De Avibus* (fols. 89r–110v) and by the anonymous *Vita Sancti Brendani*[195] (fols. 111r–117r). According to Nascimento, this text also followed a Hispanic tradition (Nascimento 2012b: 401). The last folium from this text also contains news from 1274[196]. Finally, in fol. 117v, there is an inventory of loaned books from the monastery[197], a well-known proverb[198] and the verses of a song[199].

There is no clear coherence on this text compilation since they approach quite distinct subject themes. According to Nascimento and Meirinhos (1997: 199), the textblock contains three hands: one from fols. 1-110; a second in fol. 73v and then another from fols. 111-117. Several annotations from that time and from a posterior period can be also found. The quires appear sometimes slightly trimmed – particularly on the upper edge. Despite sharing the same type of subject (only the two initial texts) and handwriting, the three texts from fols. 1-110 have different quire signatures: each gathering numeration begins a new count on each text. The last folium from Gilbert Crispin text finishes at the beginning of the first column and no other text was then preceded on that page. This may show that there was no clear continuity on this assemblage, since waste of space on a parchment leaf was obviously avoided due to their cost. The *De Avibus* seems to have parchment from another quality and also ends in the last folium at the beginning of the 2nd column with no continuity. The last text was more patently distinguished from the others by the different handwriting and ruling. Taking this information

[194] This text was written by Petrus Alfonsi in either 1108 or 1110 (Tolan 1993: 10).
[195] It was most likely written in the 10th century. It was, however, during the 13th century that this work was more copied (Selmer 1949: 178).
[196] *In era MªCCCªXIIª famis magna fuit in toto regno Portugalie taliter quod alqueire tritici ualeret XX solidos et uno milii XV solidos*.
[197] *Inventarium librorum Monasterii Sanctae Crucis*. 'In Era MªCCª<XLV> in mense decembrio' (Nascimento and Meirinhos 1997: 202).
[198] *Cum fueris feliz que sunt adversa caueto.* When thou shall be prosperous, avoid the things which are adverse (translation by Ross 1822: 66).
[199] Quem esta cantiga leea /se me deseja prazer / me ajude [sempre] a dizer / Tristis es anima mea.

into account, it seems that these texts were not deliberately prepared to be part of the same manuscript. The different codicological unities can be seen in Appendix X.

The present manuscript is 335x245x40 mm in dimension. It contains 117 folia, 15 quires with a folium later introduced in fol. 21. Moreover, fol. 88 was truncated. The text is organized in two columns in 34 (from fols. 1-110) to 35 (from fols. 111-117) lines. The binding, as described earlier in Chapter I, is currently made from a 'Santa Cruz type', which means that it is from the 16th century. Therefore, no original elements can be found, with the exception of the parchment quires.

The manuscript ALC 238 is also a compilation of different authors. It starts with St. Augustine's *Enchiridion ad Laurentium de fide et spe et caritate* (fols. 4r–34r) followed by his *De Continentia* (fols. 34r–45r). Pseudo-Gennadius Massiliensis is present with *De definitionibus ecclesiasticorum dogmatum* (fols. 45v–51r), preceded by the *Collectum Sancti Isidori de novae vitae institutione* (fols. 51r–53r). The text *De conflictu vitiorum et virtutum* by Ambrosius Autpertus (fols. 52–61v) is also present, followed by the *Sententiae Sancti Augustini* (fol. 56v[200]; fols. 61v–64v). Two texts from Richard of Saint Victor: *De potestate ligandi atque solvendi* (fols. 64v–74v) and *De triplici vicio mutabilitatis et constancia mentis* (fols. 74v–85r). Up until this part, there are quire signatures that go from i to x – in the middle there is an interruption from fols. 57r-61v between quires vii and viii.

Finally, four works by Hugh of Fouilloy are included: *De claustro animae* (fols. 86r–182r); *De medicina animae* (fols. 182r–193r); *De nuptiis libri duo* (fols. 193r–202v) and *De Avibus* (fols. 202v–227r). These open a new initiate a new numbering of quire signatures that beginning set off from i to xvii.

According to Nascimento (2012b: 401), the current manuscript is the result of the combination of two distinct autonomous units: fols. 1-85v and fols. 86-227. These may have been compiled together when the binding was substituted. This issue will be further explored in the molecular analysis of both parts.

The codex is currently 320x222x18 mm in dimension. It contains 227 folia, 30 quires organized in 4 bifolia. The text is organized in two columns between 35 to 36 lines. For more detailed information on the organization of the quires, please see Appendix X. The original binding was unfortunately lost, which led to the loss of the integrity of the organization of the texts. The current binding presents characteristics that point to the 18th century. It has pasteboard boards with a covering in light brown tanned leather with no decoration. The spine was later

[200] The text *Sententiae Sancti Augustini* is then interrupted by another version of the *De conflictu vitiorum et virtutum* by Ambrosius Autpertus. This was due to the introduction of a completely different quire that does not belong to this compilation. This alteration took place most likely when the binding was replaced.

restored during the 20th century with the application of a wide brown archival adhesive tape through the entire back. The sewing was done around four raised single cord bands. Only traces from an endband were found. Two cloth ties were used to close the book.

When comparing the three copies, the Lorvão manuscript possesses a sense of thematic purpose (Nascimento 2012b: 401), which is not present in the other two. While the Alcobaça copy gathers a collection of several texts from the same author, Santa Cruz does not. Moreover, while the Alcobaça manuscript assembles Patristic authors and 12th century theologians, collecting typical literature profusely copied in France; Santa Cruz also distinguishes itself by the Hispanic tradition texts, which diverge from the work by Fouilloy. In the Santa Cruz collection that has survived until present day, there are evidences of the presence of another text from Hugh of Fouilloy: *De claustro animae* (Santa Cruz 48), which is incorrectly attributed to a Hugo Floriacensis. This text is in between St. Isidore of Seville' *Sententiarum libri III* (also known as *De summo bono*) and *Synonimorum de lamentation animae peccatricis libri II* and Galland of Rigny's *Libellus proverbiorum*. Taking into consideration the presence of these authors in both scriptoria leads to the supposition that Santa Cruz library could have had in times other texts from Hugh of Fouilloy.

The lack of integrity on the book archaeology led to the loss of information that could have been vital to the challenging questions that this work tries to enlighten: Which manuscript served as reference for the copying of the Portuguese *De Avibus*? Is it possible to establish any connection between them and to other copies?

Alcobaça vs. Clairvaux

The Clairvaux manuscript (Ms. 177, Bibliothèque Municipale de Troyes)[201], most likely produced in the Clairvaux monastery[202] – the mother abbey from Alcobaça – has been subject to several comparisons with the Portuguese copy mostly based on iconography (Cordonnier 2011; Clark 1992: 44-49).

The Ms. 177 is 347x240 mm in dimension – which is comparably bigger than the Alcobaça copy. It contains 223 folia and the text is organized in two columns in 30 lines[203]. The binding is made of white leather covering without decoration in wooden boards. The latter has what looks like two dovetail keys on the inferior wooden board in order to stabilize a split. That

[201] The manuscript can be fully accessed at: https://www.bibliotheque-virtuelle-clairvaux.com/manuscrits/.

[202] Please notice that it has been pondered the hypothesis that this manuscript may have been produced in Portugal, due to its unsophisticated style (Clark 1992: 47-49).

[203] Unfortunately this manuscript was not personally accessed and no previous codicological published work has been found. Therefore there is some information that was no possible to acquire, such as the organization of the quires, for example.

particular board may have been a reutilized wood, due to the presence of several holes that do not seem to have any correlation with the binding. There are evidences of previous metal bosses and also marks of leather straps with two missing clasps. Based on the images from the bookbinding, it is also possible to see that they are made of white split-thongs fixed in a channel that goes to the outer face of the board – a technique widely used in the Romanesque period (Szirmai 1999: 153). The spine has a rounded tab which is also very common to this period, but apparently the endbands were lost. Based on the available information it is not possible to establish if the binding is original, however there are strong indications on that possibility based on some of the described elements. On the inferior endleaf there is following inscription: *Liber Sancte Marie Clarevallensis*. Recently the manuscript was establish as a production from around 1170, due to its connections with the Portuguese copies (Melo *et al.* 2011: 161).

A thorough bookbinding analysis could bring some interesting information whether if the Clairvaux manuscript has in anyway similarities to the Alcobaça Romanesque binding style. Some of the elements that were already described, such as the white leather covering and the lacing technique seem to be similar, but a more detailed analysis could bring foremost knowledge on the provenance of the manuscript.

One of the most interesting particularities between the two manuscripts is the presence of analogous texts, namely the several works by Hugh of Fouilloy. The *De claustro animae*, *De medicina animae*, *De nuptiis* and *De avibus* are in both copies in the same exact sequence. In ms. 177 Fouilloy' texts start at the beginning of the codex, whereas in ALC 238 is at the end. Nevertheless, the *De claustro animae* from Alcobaça has quire signatures that start from i to xvii, which indicate that these were intended to be at the beginning of the codex. Therefore, Fouilloy work was thought to be the first texts to feature on the manuscript, as in Clairvaux.

There are also other texts in common, besides Fouilloy's. Both *De potestate ligandi et solvendi* and *De triplici vitio mutabilitatis et constancia mentis* by Richard of St. Victor are present in both manuscripts. While in Alcobaça the quire signatures demonstrate that these texts were not intended to be in the same compilation, in Clairvaux the text sequence looks to be original as the quire signatures are also in accordance[204]. The Clairvaux manuscript has more texts by Richard of St. Victor as well as work by the Irish Pseudo-Cyprian. A complete table with the comparison between all of the texts present not only on the Portuguese copies, but also on the Clairvaux manuscript can be seen also in Appendix X.

[204] The last leaf signatures were partially erased and the numbering is difficult to see, but they are most likely sequential.

3.3. Iconography

It is established that there is a pictorial tradition in the *De Avibus* as several manuscripts that have survived till today contain illustrations that derive from the same iconography, thus confirming that there was most likely a full program of miniatures in the original manuscript (Clark 1992: 31)[205]. Taking this into account, it is possible to state that the typical iconographic program of the Book of Birds contains a total of 30 illuminations. In the first part of the text, there are seven illustrations: the Dove and the Hawk – part of the Prologue, it is sometimes represented also by two human figures –, the Dove Diagram, the Three Dove Diagram, the Hawk Diagram – which in some *De Avibus* is represented in the form of a simple miniature, without the diagram –, the Palm, the Turtledove Diagram – once again, it can be also represented only by a miniature – and, finally, the Cedar. These are considered the most original representations and it is believed that Hugh of Fouilloy had a direct influence in their designs, particularly in the Dove Diagram, which is intrinsically connected to the text. Finally, the second part of the text is portrayed with 23 illuminations from different birds, as follows: the Pelican represented with its chicks, the Nycticorax, the Raven, the Cock, the Ostrich, the Vulture, the Crane, the Kite, the Swallow, the Stork, the Blackbird, the Owl, the Jay, the Duck, the Goose, the Heron, the Caladrius, the Phoenix, the Partridge, the Quail, the Hoopoe, the Swan, the Peacock and the Eagle.

The iconographic program from the Portuguese *De Avibus* is considered as one of the most complete and faithful versions from the main iconographic tradition of the treatise (Cordonnier 2011: 274). The main similarities between the copies are found within the illuminations, although each contains certain variations. Moreover, it is also within the iconography that a pattern will start to unravel. Some pictures will openly expose the relations between certain copies, revealing new trails of insight on the transmission of these texts.

Between the three Portuguese manuscripts, the copy from Alcobaça is the only one that features a complete iconographic program with the 30 illustrations. The Santa Cruz manuscript was unfortunately truncated in the first folio that corresponded to the prologue. Therefore, two illuminations are missing: the Dove and the Hawk and the Dove Diagram. And, finally, the Lorvão copy does not contain the owl figure – it was most likely lost[206]– and adds a unique illustration of two Archers (fol. 5v).

[205] The program is best represented by the Heiligenkreuz manuscript, which includes all of the most common illustrations.
[206] The manuscript was damaged in that part of the text. The upper part of the folio has been lost – this is where the illumination was most likely placed.

Clark suggests that the addition of the Archers was merely a need to fill a blank space for the mise-en-page of the Dove Diagram (fol. 6), which required a whole page (Clark 1992: 45)[207]. Additionally, Cordonnier developed a more elaborate explanation. He suggests that the Archers are a reference to Psalm 91[208], 3-5: 'Surely he will save you from the fowler's snare and from the deadly pestilence. He will cover you with his feathers, and under his wings you will find refuge; his faithfulness will be your shield and rampart. You will not fear the terror of the night, nor the arrow that flies by day' (Cordonnier 2011: 274). Moreover, the faces from the archers were smeared. Cordonnier suggests that the nuns may have thought that the archers represented the Devil, because they were pointing their crossbows to the dove, depicted on fol. 6, which is positioned on the right side of the book page. They would be also probably familiarized with Psalm 91, making this theory more plausible.

In terms of style and drawing, these two Archers remind the Apocalypse Commentary from Lorvão (Lv 44, 1189, ANTT)[209] due to the way the bodies and the drapery are constructed and outlined, Fig. 66.

Figure 66. From left to right, the Two Archers (DGARQ-ANTT, Lv 5, fol. 5v), the Army of Heaven (DGARQ-ANTT, Lv 44, fol. 198) and the Four Horses (DGARQ-ANTT, Lv 44, fol. 108v).

[207] It is also believed that it might represent the knights that in the Heiligenkreuz manuscript were represented by the noble *miles* (Miranda 2010: 175). However, Rémy Cordonnier thinks that the aggressiveness of the knights, represented with two archers pointing at the Dove Diagram should unlikely represent the *miles* from the prologue as it does not translate the meaning behind the two scenes (Cordonnier 2011: 276).

[208] Please, notice that Cordonnier mentions Psalm 90, which is incorrectly attributed.

[209] There are other elements that suggest a similarity between those two manuscripts from Lorvão. For example, on the representation of the Christ in the Cedar illumination. His face is very similar to other faces represented in the Apocalypse, particularly in the eyes and face profile.

The prologue scene from the Lorvão manuscript is quite known for its architectural elements, Fig. 61. The Dove and the Hawk are seated in a perch framed by a horseshoe arc. This architectural element was typical from the Islamic culture and, at that time, Coimbra should have many buildings and constructions from that occupation period (Miranda *et al.* 2008: 237). This is a clear example where time and space are patent in the work of an illuminator[210].

With regard to the circulation of models defined by Willene B. Clark, it has been already stated that the Portuguese Book of Birds belonged to the Heiligenkreuz group. It is, however, possible to establish two sub-groups for the Portuguese copies, Fig. 67. In the first one, between the Lorvão and Santa Cruz manuscripts, the formal representation of the birds are very similar, by the way they are surrounded by two concentric circles as well as the use of blue. The second sub-group includes the codices from Alcobaça and Clairvaux. It is within these two manuscripts that the strongest correlation is exposed as there are not doubts that they were copied from one another[211], given that the drawings, the colours and the text are all very alike, as it will be demonstrated in this study. They distinguish themselves from the other sub-group due to the use of rectangular frames[212] or lack of any frameworks, the drawings of the birds and the predominant use of green, which will be also discussed further in the next sub-chapter.

Figure 67. From left to right, the Hawk as depicted in *De Avibus* (*on top*) Lorvão (DGARQ-ANTT, Lv. 5, fol. 16) and Santa Cruz (BPMP, SC 34, fol. 92); *bottom*) Alcobaça (BNP, ALC 238, fol. 206v) and Clairvaux (BMT, Ms. 177, fol. 139).

[210] 'Even where the artist is merely copying iconography, as in most Aviaries, there are nevertheless modifications which tend to result more from conscious choice than from unwitting changes or blunders. When a set of Aviary illustrations is compared with a known model or with the standard Aviary program, many of the pictures demonstrate beyond a doubt that the artist knowingly took liberties, garnishing the basic motifs with his own touches, adding or subtracting details, and changing decorative effects.' (Clark 1992: 93).

[211] Clark and Cordonnier also believe that these two manuscripts were copied from one another (Clark 1992: 47-48; Cordonnier 2011).

[212] There are some exceptions, where they use circular frames: the Three Doves Diagram, the Turtledove, the Raven, the Cock, the Vulture and the Swallow miniatures.

The representations of the birds from Lorvão are probably the more realistic and naturalist, followed by Santa Cruz, and finally, Alcobaça and Clairvaux, whose figuration is further from reality. While in Santa Cruz and Lorvão there are still stylistic differences between the same illustrations (for example, the Cedar from Lorvão represents a beardless and young Christ, while Santa Cruz contains a Byzantine Christ, Fig. 68), in Alcobaça and Clairvaux, the differences are less noticeable, as they stand as copies of each other. Nevertheless, the Clairvaux copy stands out for an inferior quality in the drawing. All representations from both Cistercian manuscripts, demonstrate how the illuminator was keen to fulfil to the letter the same iconographic program without imposing his personal touch. This explicit reverence and obedience suggest that the illuminator was probably following orders from above, possibly as a sign of respect to their mother abbey[213].

Figure 68. From left to right, the Christ from Lorvão (DGARQ-ANTT, Lv. 5, fol. 25), Santa Cruz (BPMP, SC 34, fol. 94v), Alcobaça (BNP, ALC 238, fol. 210) and Clairvaux (BMT, Ms. 177, fol. 142v).

There are iconographic elements from the Alcobaça manuscript that lead to think that it was copied after Clairvaux. Like, for instance, the representation of the eyes from the Nycticorax from Alcobaça (fol. 212v), Fig. 69. In this illumination the painter seems to have forgotten to draw the right eye from the bird or it did not understand the perspective that was being presented to him from the copy he was replicating.

Figure 69. From left to right, the Nycticorax from Alcobaça (BNP, ALC 238, fol. 212v) and Clairvaux (BMT, Ms. 177, fol. 145).

[213] Another possible interpretation is that the illuminator was not creative enough to think outside the box. 'In most Aviaries both artists and scribes sought to 'modernize' or at least personalize the copy, despite their allegiance to the standard' (Clark 1992: 92).

There are, however, other elements from the ALC 238 that connect with the Santa Cruz copy, complicating the plot. That is the case for the blue initial S (fol. 204) that resembles more with Santa Cruz (fol. 89), Fig. 70.

Figure 70. From left to right, the initial S from Alcobaça (BNP, ALC 238, fol. 204), Santa Cruz (BPMP, SC 34, fol. 89) and Clairvaux (BMT, Ms. 177, fol. 136).

Figure 71. From left to right, *top:* the Cock from Alcobaça (BNP, ALC 238, fol. 214), Clairvaux (BMT, Ms. 177, fol. 146v) and Santa Cruz (BPMP, SC 34, fol. 98); *bottom:* the Swallow from Alcobaça (BNP, ALC 238, fol. 219v), Clairvaux (BMT, Ms. 177, fol. 152) and Santa Cruz (BPMP, SC 34, fol. 103).

Moreover, the representation of the Cock and the Swallow from Alcobaça[214], Fig. 71, seem to have been painted over another illumination. As to what was observed for most birds, these two do not resemble at all to the Clairvaux ones. The two illustrations show erased drawings under the current paint: the Cock seems to have an extra concentric line inside, as shown in Clairvaux – that contains a double circular frame and whose size fits perfectly on the erased line –; and the Swallow still seems to have traces of another head that was precisely

[214] Cordonnier suggest that the two representations were most likely based on the other two Portuguese manuscripts, due to the characteristic beaming sun on the shoulder of the bird wing (Cordonnier 2011: 280-281).

positioned as the bird represented in the Clairvaux copy. The iconographic style of these two green birds represented in Alcobaça, seem more related to the birds found in Santa Cruz, specially the Swallow. It is strange why they decided to erase those two illustrations and start completely new ones.

Between Lorvão and Santa Cruz there is more thought and detail in the way the illuminations are made. While Lorvão uses a compass to acquire circular circumferences – some are a bit oval, not completely perfect circles –, Santa Cruz is a little less accurate, by marking those circumferences by hand. Therefore, Lorvão is probably the most well accomplished iconographic program, as it tends also to represent in a more accurate manner the birds – both in the drawing as well as in the colour use.

The iconography of Alcobaça and Clairvaux is considered by some researchers as relatively rudimentary and naïve by the way the birds are represented (Clark 1992: 48; Cordonnier 2011: 275). Cordonnier even suggests that the illuminations made in Alcobaça were possibly prepared by the actual scribe or by an untrained illuminator (Cordonnier 2011: 275), but that argument would make more sense if speaking about the Clairvaux copy. For this reason, Clark considers the hypothesis of that the Clairvaux manuscript may have been produced in Portugal, as it finds odd that such a copy would have been made in one of the most renowned monasteries of that time (Clark 1992: 47-49).

As the subject behind the images and the provenance of these *De Avibus* deepens, some other iconographic illustrations will be discussed ahead, given that colour plays a central role in their interpretation: it is the case of the Dove Diagram and the Three Dove Diagram.

3.4. Colour

3.4.1. Materiality

In order to study the colour from the Portuguese *De Avibus* as substance, the colour paints used in these manuscripts were characterised molecularly[215]. The *modus operandi* was similar to the one used and referred in Chapter I for the Santa Cruz collection – experimental conditions are found in Appendix IV. The information regarding the analysis of the three Books of Birds

[215] This molecular characterisation was conducted in several stages and periods. It should be acknowledge the projects in which part of this research was conducted as well as the work by Ana Claro and Catarina Miguel, who were the primary responsible for the acquisition of analytical data (μ-EDXRF, FTIR and Raman) carried out in the Lorvão and Alcobaça *De Avibus* (Claro 2009; Miguel 2012). As part of this investigation, microspectrofluorimetry and SERS were performed in both manuscripts. More recently, the ALC 238 was additionally characterised *in situ* by μ-EDXRF and FORS on a mission to BNP, in June 2015, where some additional micro-samples were also taken for infrared and Raman analysis – the investigation on the browns beneficiated particularly on this mission.

made in Portuguese scriptoria can be seen in Table 5. The areas of analysis on the three *De Avibus* can be seen in Appendix XII.

Table 5. Information on the analysis of the Portuguese *De Avibus* manuscripts.

Manuscript	Analysed folia	Total	Applied techniques
Lv 5	4, 5, 5v, 6, 6v, 7v, 16, 20v, 25, 33, 36v, 48, 49v, 50v, 54, 56v, 59v, 72v, 95v	19	µ-EDXRF, µ-Raman, µ-FTIR, microspectrofluorimetry, SERS
ALC 238	1v, 4, 4v, 33v, 34, 54, 76, 202v, 203, 203v, 206v, 210, 214, 220v, 224v, 225, 226v	17	µ-EDXRF, µ-Raman, µ-FTIR, FORS, microspectrofluorimetry, SERS
SC 34	89, 89v, 93, 94v, 102, 103, 104, 104v, 107	9	Raman, mid-FTIR, µ-FTIR

The colour palette used in the three Portuguese *De Avibus* is in agreement with the materials identified in the Romanesque illuminations described in the first chapter, Fig. 72. The binding medium was also characterised by infrared spectroscopy as a proteinaceous binder, which is in agreement with the three Portuguese scriptoria (Melo *et al.* 2011: 160; Miguel *et al.* 2012). The main representative spectra for each *De Avibus* copy can be seen in Appendix XIII.

Figure 72. The colour palette used in the Portuguese *De Avibus*. Each column is represented by a colour. The name of the colorant is presented as well as the colour designation used by Hugh of Fouilloy, which will be discussed later on this chapter.

The Lorvão manuscript has been described as the 'Blue Book' (Miranda *et al.* 2010: 178), due to the bountiful presence of lapis lazuli in its colour palette. In addition to the expensive blue stone, in some illuminations, small quantities of azurite and lead white were identified. Ana

Claro, during her doctoral research, tried to quantify the proportions of these three pigments, by a semi-quantitative analysis with µ-EDXRF. She was able to conclude that the lighter blues made with lead white had about 24% of white pigment, such as in fol. 5, while the deeper blues had only 1% of lead white, like in fol. 16. On the other hand, she was also able to establish that the presence of azurite was very low – below 1% – which could perhaps indicate an impurity (Claro 2009: 77). Given this idea, this less expensive blue mineral was not added to the main colour palette. As for Santa Cruz and Alcobaça, the blue paints are purer, without the above admixtures, with the exception of the latter where some Pb was found associated to the blue paints. Lapis lazuli was also used in large and small initials throughout the three texts.

Red vermilion was particularly highlighted in these manuscripts through the *rubrica* inscriptions surrounding the birds. It was also used for the initials, letterings and details from some of the illuminations, such as de Cedar, the Cock – apart from Alcobaça –, the Pelican and the Peacock. Vermilion is applied pure in Santa Cruz, while in Alcobaça calcium carbonate was used as filler and in Lorvão a small amount of lead white was normally added. Some of Alcobaça' pinks were made with the mixture of vermilion and lead white. This was particularly used on the birds' paws from fols. 222 and 223.

Lac dye was also identified in the dark reds from Lorvão and Alcobaça manuscripts – no evidences were found in Santa Cruz. While in Alcobaça lac was mainly used in small details and minor initials, in Lorvão the dye is profusely used in the Dove Diagram, as a central element, and on the initial D from fol. 4.

Green was extensively used in the birds from Alcobaça copy. Overall, the three manuscripts used the same type of synthetic copper proteinate, with the slight exception from the green found in the Palm Tree from Lorvão. By µ-FTIR, this paint in addition to the characteristic bands from the proteinaceous binder and the calcium oxalates, evidenced two bands at 3448 and 3342 cm^{-1} instead of the broad band from the OH stretching absorption region, Fig. 73. These could be assigned to the Cu-OH stretching bands that are normally associated with copper acetates (San Andrés *et al.* 2012). According to Miguel, the use of verdigris pigment could be the source for the copper proteinate (Miguel 2012: 97). These bands were also found in Alcobaça green paints, as also shown in Fig. 73. Therefore, it is possible that this particular paint may have suffered a different unknown type of process of degradation or manufacture[216].

[216] Please notice that this green was previously thought to be malachite. Claro (2009: 67-68) posed that hypothesis based on Raman data, but the spectra presented mainly fluorescence and the researcher even evidenced that in order to be malachite, it had to be somehow degraded. Taking into consideration this and the fact that the green mineral was not commonly used during this period, it should be discarded.

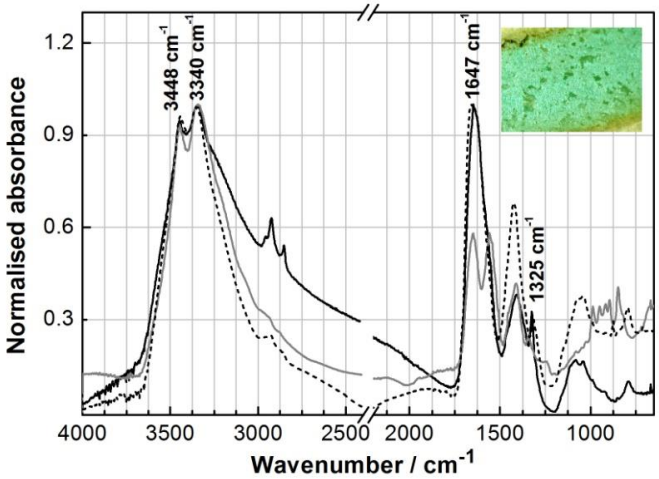


Figure 73. Normalised infrared spectra of the green paint from Lv 5, fol. 20v (─), including an inset image detail from the area where the micro-sample was taken with 20x magnification; compared with a green copper acetate reproduction with parchment glue (—) and a green paint from ALC 421, fol. 181 (---).

For the few faded yellows used in the Book of Birds – mainly of which had been applied in the Dove Diagram from Lorvão and Alcobaça copies – it was not possible to find a molecular signal that could be assigned to a colorant. In Alcobaça a significant amount of Cu was detected by µ-EDXRF. An exception was found in the blue initial S from ALC 238, where Hg and Cu traces were detected in the yellow details. This yellow was more saturated then the usual, which could be explained by the small mixture of vermilion. The three manuscripts displayed the typical signal from the proteinaceous binder by infrared spectroscopy. By Raman it was not possible to obtain any information once again, due to the high fluorescence background signal.

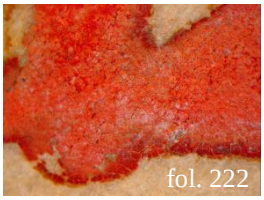
The Lorvão manuscript was distinctive by its application of red lead, uniquely in the zoomorphic initial D, fol. 4. To produce volume effect in the initial, layers of red lead combined with lac dye and lead white were used. This initial is considered as one of the most technical and complex illuminations from the three *De Avibus*.

The colour white, given by the white lead, was used exclusively in the Lorvão manuscript. It was applied as colour paint – i.e. as colour block – in birds such as the Stork, Caladrius and Swan to represent their natural colours; and also to highlight the feathers of some birds, such as the Doves, the Hawk, the Peacock, the Jackdaw and the Cock.

Several shades of brown were found in the Alcobaça manuscript and used to paint a significant number of birds as in opposition to using black – which was more used in the Santa Cruz and Lorvão[217] copies. Different compositions and states of conservation were detected according to its colour, as summarised in Table 6.

[217] In the Lorvão manuscript, brown was found and analysed in fols. 49v and 95v (the latter is not part of the *De Avibus*). Both presented similar XRF spectra, with Ca, Fe, K, Cu, Cl, S, P, (Mn), similar to the

Table 6. Main types of browns found in the Alcobaça *De Avibus* manuscript, with generic information on their main components, the state of degradation of the binder, the presence of calcium oxalate and the folia where each brown was used. The examples in gray are the ones that were only analysed by XRF.

			
Colour	**Red/reddish browns** 	**Light brown** 	**Browns** 
Main components	**HgS** ($CaCO_3$)	<< **Fe**	**Fe**
Binder	±Ok	Ok	Collapsed
Calcium oxalate	Medium presence	Not present	Present
Examples	Fols. 222, 225, 203, 212v, 223	Fols. 203v[c], 221v (not confirmed by XRF), 214[b], 226	Fols. 204, 213[a], 222, 223v, 204v, 208v, 219
Observations	There are also some mixtures where Fe > Hg in fols. 220v, 204v.	These light browns are similar to the 'organic' yellows found also in this manuscript.	These browns are similar to the writing ink, except the presence of Cu (nonexistent in the ink).

[a] This particular brown does not have Cu. Not only exhibits similarities with the writing ink, it also shows the same proportions of elements in the circled frame. It is therefore an indicative that it is likely that this specific bird – the Raven – was painted with the same material used for writing.
[b] The more darker circles in the bird are more similar to the writing ink (> Fe and no Cu).
[c] Some HgS particles were also detected in fol. 203v (but not in all samples). Moreover, Pb was also found in several areas by XRF, but it was not possible to identify its origin by FTIR and Raman spectroscopy.

Based on the XRF data, it was possible to establish different types of browns, according to their composition. Reddish browns found, for example, in the Dove and Hawk, Nycticorax and Blackbird from fols. 203, 212v and 220v, presented Hg, followed by Fe or Ca. Vermilion was confirmed by Raman in fols. 203v, 220v and 225. Lighter browns presented a low amount of Fe, in comparison with the darker browns. Both browns share the fact that they both have Cu in their composition, which is not present in the writing ink. Thus proving that the browns used to paint the birds we different from the ink used to write. When confronting the XRF counts from Hg(Lα) and Fe(Kα), in Fig. 75, clear distinction between the lighter browns and darker browns were found within the amount of iron present in the paints, while Hg appeared less frequently in more varied proportions.

light brown found in ALC 238. A micro-sample from fol. 95v showed the absorption bands typical of a proteinaceous binder.

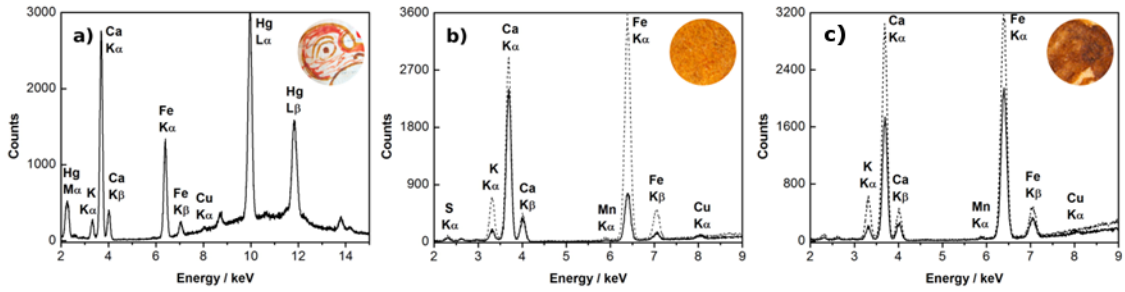


Figure 74. Several µ-EDXRF spectra from the brown paints found in the birds from ALC 238: **a)** reddish brown, Nycticorax, fol. 212v; **b)** yellowish brown, Dove Diagram, fol. 203v (—) with a writing ink, fol. 203 (‴); **c)** brown, Phoenix, fol. 223v (—) with a writing ink, fol. 214 (‴). Each spectrum includes an inset image detail from the nearby area where the analysis was performed with 7.1x magnification.

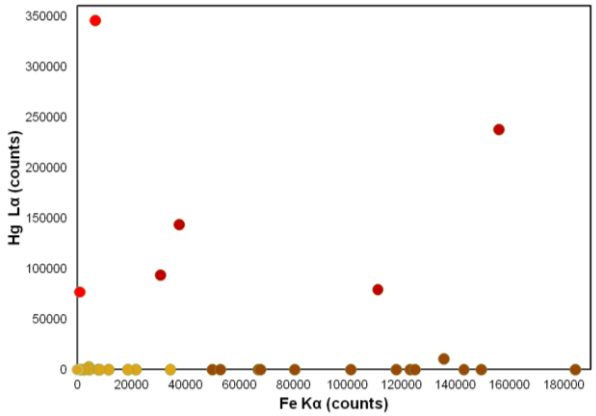


Figure 75. XRF counts measured for iron (Kα) and mercury (Lα) on brownish areas, showing how the different shades (already presented in Table 7) from the paints are related to those two elements.

With Raman spectroscopy, most of the samples showed high fluorescence, with the occasional identification of calcium carbonate in fols. 220v and 222. Infrared analysis provided additional information on these miscellaneous browns, as seen in Fig. 76. Dark browns that had higher levels of iron revealed frequently the presence of calcium oxalates, through the already described band at 1323 cm^{-1}, and possibly iron hydroxisulphates, from the region near 1100 and 1200 cm^{-1}, which can be ascribed to the stretching vibrations from ν_3 (SO_4^{2-})[218] (Powers *et al.* 1975; Bishop and Murad 2005). Moreover, a broad band at circa 1648 cm^{-1}, revealed a collapsed protein, as an additional sign of degradation, Fig. 76a). Based on the previous discussion in Chapter 2.2.2., it is most likely that the presence of iron may have function has a catalyser for the formation of oxalates and consequent protein degradation. This is corroborated by the fact that the lighter browns where iron was not the strongest element, presented a well defined proteinaceous profile, without calcium oxalate, Fig. 76b). As for the reddish paints,

[218] Similar spectra have been reported by Bicchieri *et al.* 2013 in Yemenite black inks from the 7^{th}-8^{th} century. That region in the infrared spectrum was considered by the authors a mixture of oxalates, which is unlikely as iron and copper oxalates do not have any absorption bands in that area. Nevertheless, in a Raman spectrum from another ink, in a lighter area of the sample, several compounds were identified: calcite, gypsum and different iron sulphates, in particular $Fe_2(SO_4)_3.9H_2O$ and $(Fe^{2+}/Fe^{3+})_n(SO_4)_m$. This latter identification is more in agreement with the hypothesis proposed in this study.

calcium carbonate was identified, for example in fol. 220v, Fig. 76c). This is in agreement with the Alcobaça scriptorium technique, where red vermilion paints were consistently admixed with calcium carbonate as an extender (Miguel 2012: 40). Calcium oxalate was only found in this particular paint, because Fe appeared as the main element – corroborating once again the central role performed by this element. Finally, in fol. 223v, in addition to the protein, a well defined cellulose pattern was found in the bands at 1161, 1113 and 1053 cm^{-1}, given by the C-O-C stretching vibrations from the pyranose ring skeletal (Yang *et al.* 2007: 1783). Its provenance is uncertain, but could be an important indicator for a vegetable dye or tanning.

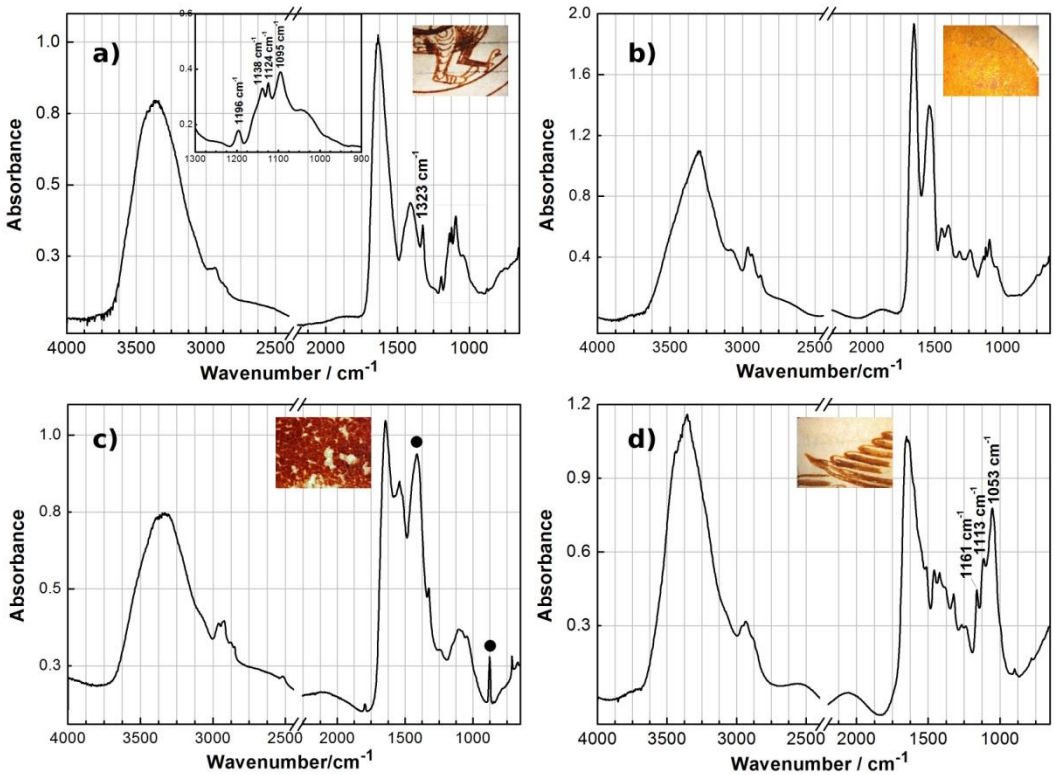


Figure 76. Several infrared spectra from the brown paints found in ALC 238: **a)** fol. 213 from a darker brown; **b)** fol. 203v from a lighter brown; **c)** fol. 220v from a brownish red (with $CaCO_3$ ●); **d)** fol. 223v from a darker brown with cellulose pattern. Each spectrum includes an inset image detail from area where the analysis was performed with 7.1x to 50x magnification.

Reflectance spectra showed only very occasionally a broad absorption band around 569 nm, which could not be assigned to any specific dye. Microspectrofluorimetry was conducted to all of the samples: no excitation and emission were detected[219]. In addition, SERS analysis was also unsuccessful, as no signal was obtained.

[219] The only exception was an 'extemporaneous' sample from fol. 203v found near the inner circle from the Dove Diagram. It presented an excitation maximum at 556 nm and the emission fluorescence around 607 nm, which can be found in lac dye. Since no other sample showed any signal, this was most likely an isolated paint drop.

Finally, the black colour, both as carbon black and bone black, were applied solely in the Lorvão and Santa Cruz copies, in the Ravens, Swallow (only in Lorvão) and Blackbirds. This colour, of particular shine, was achieved with the addition of wax, which was distinctly identified by infrared spectroscopy on a sample from the Swallow from Lorvão, as seen in Fig. 77. While in Lorvão the wax was separately identified within a sample, in Santa Cruz the wax was only detected by the increase of the CH stretching bands and the glossy appearance of the paint. Interestingly, both scriptoria used the same technique to highlight the blacks.

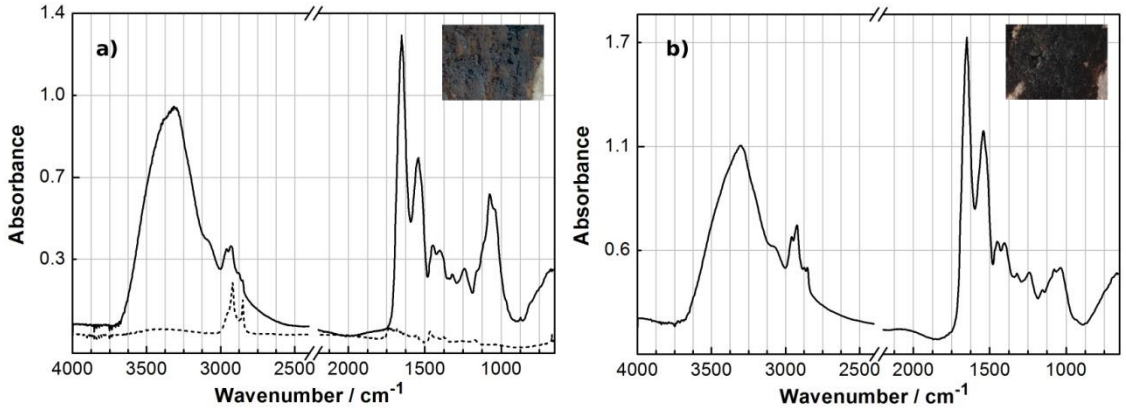


Figure 77. Black paints from the Portuguese *De Avibus*: **a)** Lv 5, fol. 50v (the two spectra are from the same sample, but the one in dashed lines is solely from the wax, which was separated from the black paint); **b)** SC 34, fol. 97. Each spectrum includes an inset image detail from the area where the analysis was performed with 7.1x magnification.

The mysteries within the Alcobaça copy

As previously referred in the codicology sub-chapter, the manuscript from Santa Maria of Alcobaça is assembled by two main codicological parts: fols. 1-85; fols. 86-227. In order to confirm this, several molecular analysis were conducted to the first part of the codex[220]. Additionally, the manuscript also posed another significant question, in this case, from an iconographic point-of-view: Were the Cock and Swallow later representations? Through the available analytical techniques, a clarification for this problem was sought.

Regarding the first enquiry, although most of the colour materials were identical and in agreement with the *De Avibus* palette, there were several details that allowed establishing that the two parts were made separately. The first was the use of vermilion and lead white to make all of the red paints in the texts; the second was the use of the colour orange – which is not present in the rest of the manuscript. This was made with vermilion and possibly lac dye[221]; the third was the composition of the writing ink which had more Fe than the one used in the *De*

[220] Please notice that the representative analytical data in Appendix XIII from the ALC 238 was divided in two parts in order to allow a clear distinction between both parts.
[221] It is not possible to confirm with certainty the presence of the lac since the emission and excitation signal from the microspectrofluorimetry was very low, due to the high presence of the red mineral. Nevertheless, the excitation maximum was 474 nm, which is in agreement with what is sometimes found in resinous lac (for more information, see Chapter III).

Avibus text and also presented Br; finally, the parchment composition was also different, since it contained Cu, which is not present in the 2nd codicological part.

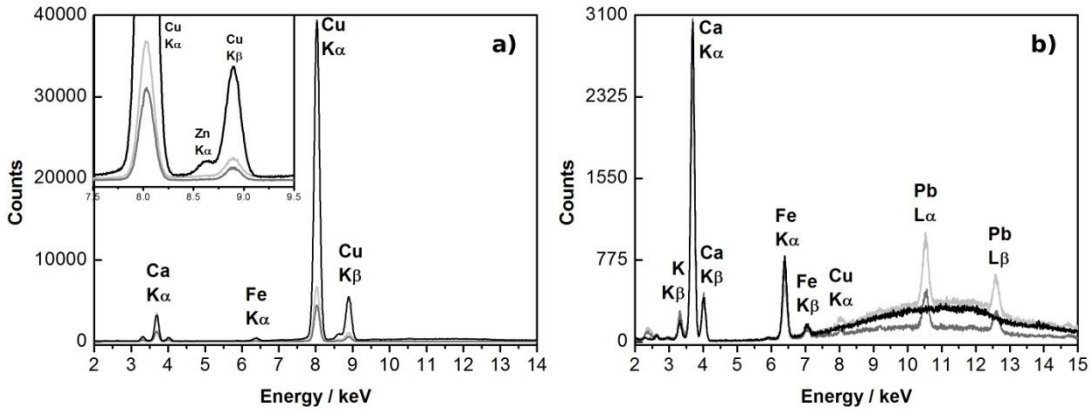


Figure 78. Several µ-EDXRF spectra from the green and black paints found in the Cock and Swallow from ALC 238: **a)** Green paints from the Cock, fol. 214 (—); Swallow, fol. 219v (—) and Owl, fol. 221 (—); **b)** Black outlines from the Cock, fol. 214 (—); Swallow, fol. 219v (—) in comparison with the brown circular outline from the Cock, fol. 214 (—).

As for the Cock and Swallow, by µ-EDXRF it was possible to confirm this supposition as the composition of the green and of the black outline was different from the rest of the manuscript. Both greens did not have any Zn in relation to Cu, which is the opposite of what was observed on the other greens from other birds, as seen in Fig. 78. The black outlines, from the Cock and Swallow, presented Cu and Pb in their composition, which were not present in the other brown outlines, as for example in the circular frame. While analysing the erased lines in the Cock miniature it was possible to confirm that the smaller circumference had the same composition of the other exterior line and that traces of most likely vermilion – due to the presence of Hg – were detected also in that area. Interestingly, the Clairvaux Cock was painted in red, as seen in Fig. 71, which could explain the presence of vermilion in that area. Taking these results into consideration it was possible to confirm that the Cock and the Swallow from Alcobaça were painted later on and that previous represented birds were painted according to the Clairvaux copy. Moreover, it was additionally noteworthy to find that the Crane from fol. 218v also revealed the same kind of green seen in the other two examples. By comparing it with the Clairvaux copy, it is possible to distinguish that the latter does not contain any green, which helps confirming that the green was also added later.

The question on why they decided to change these two particular birds and add that detail into the Crane remains a mystery. As some of the most familiar animals at that time, they could have decided to follow a more realistic interpretation of the well-known birds, but that was not the case. In addition they continue to use green, possibly to maintain the harmony on the rest of the work.

3.4.2. Immateriality

Mapping Colour

It is inarguable the relevancy of the *imago* in Hugh of Fouilloy's work[222]. But to what extent did the colour assume a definitive role? As a work that had such an enormous impact as a visual exegetical creation, colours should have been meaningful as well.

Through iconography it was established that the manuscripts of Lorvão and Santa Cruz had a connection as well as the Alcobaça and the Clairvaux. By applying the mapping colour system, it was also proven that the similarities between the style and drawing of the illuminations were not the only evidences that showed how related these copies were to each other. In Fig. 79, it is possible to observe how the colours were applied, in terms of areas, in the three Portuguese *De Avibus* as well as in the Clairvaux copy. Instantly, the association between the copies from Alcobaça and Clairvaux stands out, as they almost reveal the same colour pattern. As for the Lorvão and Santa Cruz, there are some similarities, but it was interesting to find that the blue and red colours were present in an almost identical amount, almost as if those two colours existed in contrast. Moreover, the green in Lorvão manuscript was in lower proportions when compared to Santa Cruz and then Alcobaça manuscripts (Melo *et al.* 2011: 166-165).

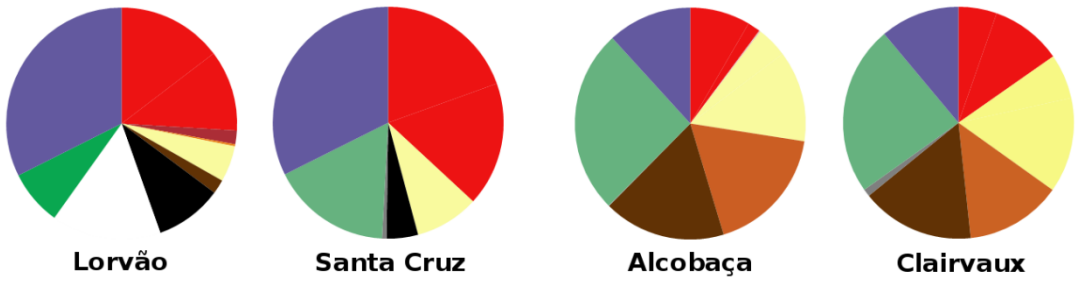


Figure 79. Distribution of the colours (in areas) on the *De Avibus* of Lorvão, Santa Cruz, Alcobaça and Clairvaux, respectively.

Through this colour mapping, new dating propositions started arising. Could the progression of blue in Santa Cruz and Lorvão mean that the Alcobaça copy was previously made due to its bountiful use of green? In other words, could the progression of blue – hence the regression of green – correspond to a change of paradigm, as blue was becoming the main colour in the medieval palette, taking for itself, the meaning of spiritual colour, as proposed by Michel Pastoreau[223], with his 'revolutionary' blue? This could mean that the Alcobaça copy was older than the other two Portuguese copies, contradicting what had been proposed over the

[222] 'For what Scripture means to the teachers, the picture means to simple folk' (Clark 1992: 119).
[223] 'This new blue, clear and luminous, is not associated with green (as it is in high medieval painting); instead, its partner is red.' (Pastoureau 2011: 41).

years: that the Alcobaça copy was made during the 13th century. This new hypothesis started to make even more sense when Patricia Stirnemann and Rémy Cordonnier proposed a new dating for the Clairvaux manuscript: c. 1170 (Melo *et al.* 2011: 167; Castro, Melo and Miranda 2014).

Colour through the words of Hugh of Fouilloy

The words from the author of *De Avibus* regarding colour can be considered as immaterial propriety, due to its sense of spiritual and allegoric allusion. Throughout time, the meaning behind the colour in the Book of Birds has raised attention amongst researchers, such as Friedrich Ohly and Remy Cordonnier (Ohly 2005; Cordonnier 2007: 195-201). There are a total of 122 references to colour in *De Avibus* – a fact that enhances the weight given to colour by the author (for more information, see Table XIV in Appendix XIV).

In the first part of the treatise, Fouilloy describes which colours are the most significant in the dove's composition. He starts by referring two meaningful colours that will constantly appear in the first section: silver (*deargentatae, argentum, argento vero*) and gold (*pallore auri, aurum, auro*). The words around the *pallidus* colour such as *pallor* should be read as yellow and *pallore auri* as yellow of gold or golden yellow. In chapter 5, the author depicts the dove's feet as being red (*rubeos*). After several forethoughts where he states that the feet of the dove represent the Church, he concludes that «the red of the feet is the blood of the martyrs», «wounded by the harshness of the land, that is, the cruelty of earthly things» (Clark 1992: 131). When referring the silvered wings, he mentions *candor* which is most likely allied to the bright white *candidus*, as a reference to brilliancy and lustre – values that may have had a different meaning at that time – as medieval men could perceive colours as attributes like shine or opacity. Moreover, by continuing to portray the colours present in the dove, he mentions that blue (*sapphirino*) was overspread in the wings, as a reminder of the precious stone, bright as the colour of the sky. White is also referred as *niveus* (snowy white) in combination with *sapphirino* as symbols of «purity of the flesh and the love of contemplation» (Clark 1992: 131). Continuing the dove's description, he then describes the eyes as being of the yellow colour *croceus*. Fouilloy sees the yellow eyes of the dove as a sign of matured reflection, as it reminds ripened fruit. References to the colours of a stormy sea (*maris*) and *nigro* (brilliant black) are also given. Most part of these colours will be summarized in the Dove Diagram.

In the second part of the text, Hugh of Fouilloy focuses more on the natural colours of the birds, giving primacy to white and black. Three types of whites are given: *candidus* (bright), *albus/album* (opaque) and *niveus* (snowy). These appear in chapters such as from the Blackbirds, Goose, the Heron, the Caladrius and Swan – some as opposite colour (e.g. blackbird) but most as the natural colour of the birds. As for black, several variations will be

described although they would probably mean the same type of black (e.g. *nigro/nigra, nigrescentibus, nigredinem, nigrescunt, nigredo*). The Raven has the highest number of references, followed by the Blackbird, the Swan and the Crane. Another word is given to gray/ash colour (*cinericium*/*cinericii*). The bird with the utmost amount of colour words is the Peacock with 13 references. These include colours that are not mentioned in anywhere else, such as the *colorem phoeniceum* – possibly a purple – (Bradley 2011: 82), *subrubeus* – a pink colour – and *viridis*[224] – a green colour.

Imago et colore *in the Portuguese manuscripts*

'The visual program of the Aviary is one of mnemonic and symbolic images, not pictorial narratives' (Clark 1992: 31). The evocative text from Fouilloy combined with these powerful images was most likely an inspiration for monastic illuminators. Some seem to have followed the author's guidelines, while others may have been drawn by their own creativity, influenced by their cultural and social environment. Taking into account the information obtained from the analysis of the materials and from Hugh of Fouilloy's meaning behind the colour, it was possible to observe some interesting details in the Portuguese copies.

For instance, the yellow *croceus* referred by the author was suitably applied in the eye of the Cock in Lorvão and Santa Cruz manuscripts, reminding the reflection of maturity in the eyes. This detail, seen in Fig. 80, as far as this study can tell, is unique to the Portuguese Books of Birds, and possibly to the majority of the European copies.

Figure 80. Detail from the Cock illumination: *on the left)* DGARQ-ANTT, Lv. 5, fol. 36v; *on the right)* BPMP, SC 34, fol. 98.

From an iconographic perspective, there are two illuminations that stand out for their ability to combine symbolism within *imago et colore*: the Dove Diagram and the Three Doves Diagram. These two examples, which are thought to be creations from the author itself, will be here further analysed.

[224] The other sole mention on green is given in the first part of the work, in Chapter 24, as *viridescat*.

The Dove Diagram

The Dove Diagram, represented in the first part of the text, is one of the most significant and better achieved schemas from the Book of Birds. By summing up and condensing the message – particularly from the first chapters – in one image, this diagram of mnemonic nature patents the importance and meaning of colour in the monastic world.

The representation is exposed by several inscriptions in rectangular and circular frames with a Dove in the centre of the scene, Fig. 81. In the main exterior border there is the quote from the Psalm 67:14: 'If you sleep among the midst of the lots, you shall be as the wings of a dove covered with silver, and the hinderparts of her back with the paleness of gold' [225] (Clark 1992: 11). This psalm is quoted five times during the first part of the work. The chant was most likely of common knowledge within the community of monks, since this was meant to be read continually during liturgies[226]. These psalms were themselves teaching methods through the use of repetition – something that can be related to the text[227].

The frame is then divided in the middle by a vertical axis. This visually suggests a cross, but it also symbolically implies the image of the dove through 'the yellow eye is the maturity of reason' and 'the red of the feet is the blood of the martyrs' (Clark 1992: 263), both positioned in the superior and inferior part of the diagram – head vs. feet. Overall, the eyes of the doves are never painted in yellow. There is, though, who proposes that the yellow eyes could be also suggested by the yellow circles that surround the inscriptions (Normore 2012: 23).

In the four peripheral medallions there is another psalm (47:7 and 8), which sentence is build along those four circles: 'Who will give me wings like a dove's? I shall both fly and rest. See how I have withdrawn in flight. I remained in solitude'[228]. Inside each circle there are inscriptions about colour symbolism linked to the dove. In the first circle: 'The silvery color (*color argenteus*) on the wings is the sermon of holy exhortation on the tongues of the teachers'; in the second circle: 'The gold colour (*color aureus*) on the hinderparts is the gift of eternal reward to come'; in the third circle: 'The celestial colour (*color aerius*) on the wings is the love of divine contemplation'; finally, in the last circle: 'The colour of the sea (*color maris*) in the rest of its body denotes distress in the carnal mind' [229].

[225] *Si dormiatis inter medios cleros penne columbe deargentate et posteriora dorsi eius in palore auri.*
[226] 'During religious celebration, readings would evoke fragments of sacred texts, and these, in turn, would serve as a model for even secular forms of expression. Once a text was read, contemplated, and internalized, it could be repeated to the less educated listener' (Bourgain 2015: 142).
[227] 'Hugh of Fouilloy's remarks point to an elementary pedagogy of making such compositional images as a technique for remembering' (Carruthers 2008: 309).
[228] *Quis dabit michi pennas sicut columbe ? Et uolabo et requiescam* (Ps. LV, 7). *Ecce elongaui fugiens et mansi in solitudine* (Ps. LV, 8).
[229] *Marinus igitur color in pectore columbe tribulationem designat in humana mente.* 'The sea color on the breast of the dove denotes distress in the human mind' (Clark 1992: 134-5).

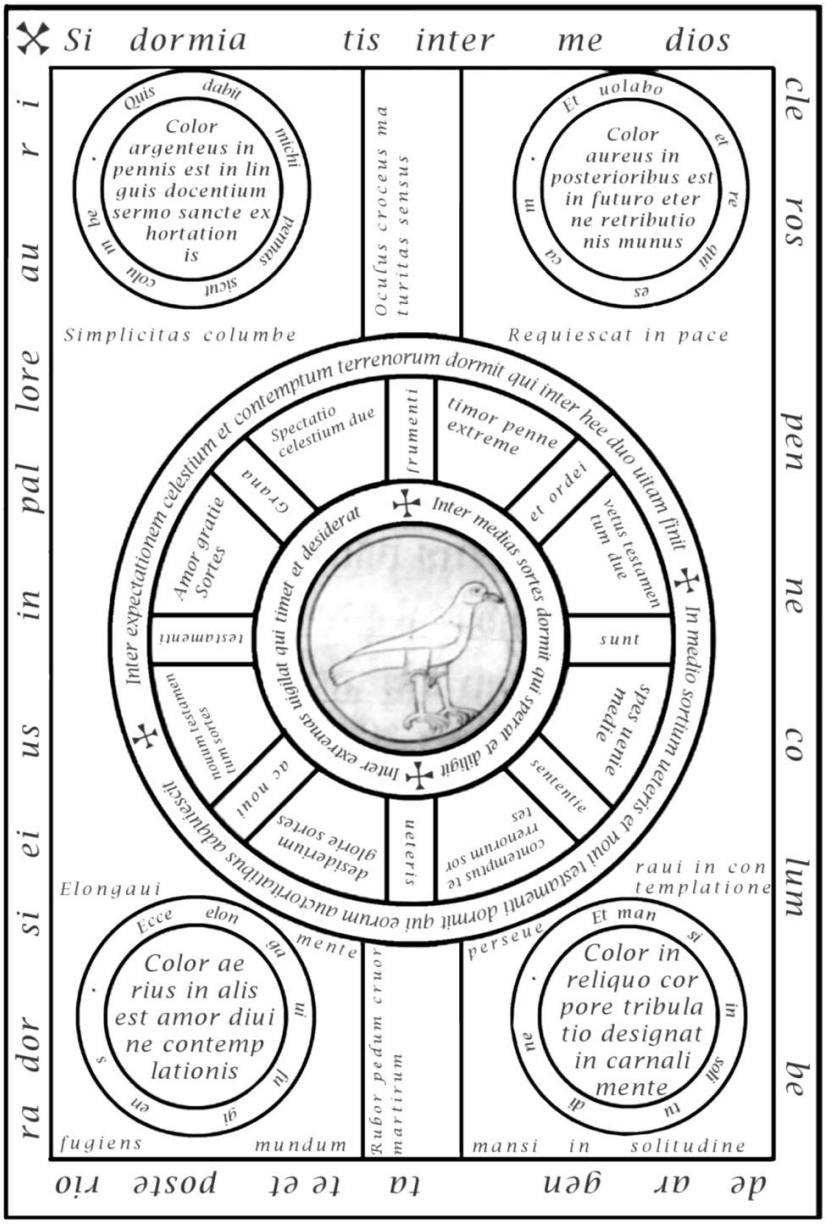


Figure 81. Schema from the Dove Diagram based on the Lorvão manuscript.[230]

According to Friedrich Ohly, colours do not have an intrinsic meaning, but rather a connection between two *res* (object/matter), which in turn confers meaning. For example, the feet from the dove signify the blood of the martyrs because they are red. Nevertheless, this association is only possible because blood is itself red. Likewise, saffron is a symbol of maturity because mature fruit, such as apples, can acquire similar colours to saffron. Christina Normore adds that 'The reader, like the dove, is caught in a constantly shifting labyrinth of meaning' (Normore 2012: 23).

[230] This schema is based on the representation developed by Remy Cordonnier.

The depiction of the dove itself is sometimes strongly associated to the text through the representation of colours that are mentioned in the diagram. Lorvão does not exhibit this connection, since it is represented without colour, with lead white highlights. Although it does not contain the colours blue, green and red, the Lorvão manuscript has the most spiritual colour of them all: white – as it will be demonstrated later on the Diagram of the Three Doves.

There are other European copies from *De Avibus* where the dove is represented with gold and silver leafs on their wings and back, such is the case from St. Omer, ms. 94, fol. 13v or Ter Duinen, Grootseminarie Brugge, ms. 89/54. This care from the illuminators in representing the gold and the silver from the dove started to appear mainly in the first half of the 13th century. Thus, these manuscripts have a greater symbolism when compared to the older copies that do not explicitly suggest visually the textual description from the dove.

Alcobaça is an interesting case, since the colours represented in the dove can be subtly interpreted as the colours mentioned in the four circles and inscriptions of the diagram. It is not possible to confirm if this was a conscience decision due to the location of the colours. The dove is mainly painted with blue *aerius* and in the back feathers there are several colours: yellow – which could substitute the *pallore auri*[231] –, green – which at that time could represent the *color maris*[232] –, and red – which should be on the feet, not in the back.

> 'In chromatic terms, as in every other formal respect, each painted dove is unique to its manuscript, produced, quite materially, by discrete voluntary artistic acts that are simultaneously, at least in their potential effects, hermeneutic interventions in the visual tradition' (Kumler and Lakey 2012: 10).

The Three Dove Diagram

The Three Dove Diagram is also one of the most allegorical images created by the author of the Book of Birds. Each dove presented in a vertical manner represents Noah, David and Jesus Christ[233], from bottom to top, Fig. 82. Cordonnier, in a throughout manner, explored several dimensions in this scheme: at the informative/descriptive, tropological, exegetical and symbolic grounds. The positioning and organization of the diagram follow an «organisation ternaire évolutive» (Cordonnier 2007: 190). The composition conveys the idea of rise and

[231] As it has been already mentioned, gold and silver were unusual in Portuguese Romanesque monasteries.

[232] Friedrich Ohly though that the colour *maris* was a gray colour (Kumler and Lakey 2012: 9). However, Remy Cordonnier brings a more interesting and more plausible perspective. For him, the colour *maris* is the green colour of the North sea, which is more in agreement with the green applied in the back of the Alcobaça dove.

[233] The Christ's Dove frame inscription: *Columba nivea est Sancti Spiritus gratia*; The David's Dove frame inscription: *Columba varia est Sancta Ecclesia*; The Noah's Dove: *Columba est anima nigra sed formosa*.

elevation, through contemplation. «Cette notion d'empilement ou de superposition appelle également une lecture ascendant plutôt que descendant» (Cordonnier 2007: 190), by going through the less important character – Noah – to the most spiritual and elevated one – Christ.

Colour assumes a significant role in this image. Following Hugh's text as well as the inscriptions around the illuminations, the dove represented below is painted in black or dark/dull colours (*nigra*), the middle is painted with several colours (*varia*) and the superior dove is pictured in white or colourless (*nivea*).

Notions of light, *lux*, and colour meaning during the 12th century are embedded in this particular image. The suggestion of a chromatic modulation is very interesting as it symbolizes a journey from darkness to light by converting 'the dove' into an enlightened spiritual being[234]. The meaning of these two central colours, white and black, demonstrates a dichotomy between a negative and positive value.

During Middle Ages, black was the symbol of sin but also of humility and austerity. At the opposite side, white was the colour of purity, innocence, glory, eternal life and lack of sin[235]. Noah's dove will carry a more positive vision as 'The dove of Noah is beautiful in action, black in tribulation. The dove is the soul, black but beautiful' (Clark 1992: 263). As a result, Fouilloy accentuates this idea of transitional state by symbolizing Noah as the humble sinner, in *nigra*, who seeks conversion within the Church. This way he begins his journey as a sinner in search for the Holy Spirit[236].

During this process of conversion/ascension, an intermediary stage subsists, represented by David's dove, which is presented with several intermediate colours: 'The Dove of David is covered in varicoloured attire by the manifold virtues. The parti-coloured dove is the Holy Church' (Clark 1992: 263). David thus represents the acquisition of virtues and ultimately the Church. These intermediate colours represent all the colours – red, blue, green…– that appear between darkness and light.

[234] According to Pastoureau «Si la couleur est une fraction de la lumière, elle participe ontologiquement du divin. Dieu est lumière» (Pastoureau 1989b: 205).
[235] The Benedictine monks, also known as the «black monks», wore black as a sign of respect, modesty and penitence. In opposition, the Cistercian monks, known as the «white monks», wore white. These differences lead to the famous discussion between Peter the Venerable of Cluny and St. Bernard of Clairvaux. Peter rebuked St. Bernard about the choice of colour for the Cistercians monks: as white was the colour of religious festivity, glory and resurrection, whereas black was the colour of humility (Pastoureau 1989b: 225; 1999: 114).
[236] According to Apponius, in *Commentary on the Song of Songs*, black meant ascension: *Nigra scilicet «ascendens» interpretatur hebraica lingua*. (Goldenberg 2003: 85).

Finally, the last step to ascension is represented by Christ's dove as 'The white dove is the grace of the Holy Spirit' (Clark 1992: 263). White, as Light, is hence represented as the ultimate step to purity and grace.

The Portuguese copies also reveal these notions of ascension by applying the darker tones (black, greyish blue[237] and brown) in Noah's dove, the colours of the Church (blue and green) in David's Dove and white tone or absence of colour in Christ's Dove. Moreover, it is believed that the most meaningful message was applied in the drawings as it will be described hereinafter.

These formal drawings applied to represent each dove are in fact in accordance with the symbology given by each dove. The Christ's Dove is drawn in a very simple manner in order to emphasize the idea of celestial purity; followed by David's Dove that starts revealing some details in the wings as a sign of an intermediate stage; and finally, Noah's Dove that is represented in a more detailed style with ornamented feathers in its whole body as a symbol of a converted man, who is still full of sins. It is proposed in this work that the excessive feathers represented in Noah's Dove, particularly in Lorvão manuscript, are a symbol of the sins that lack elevation.

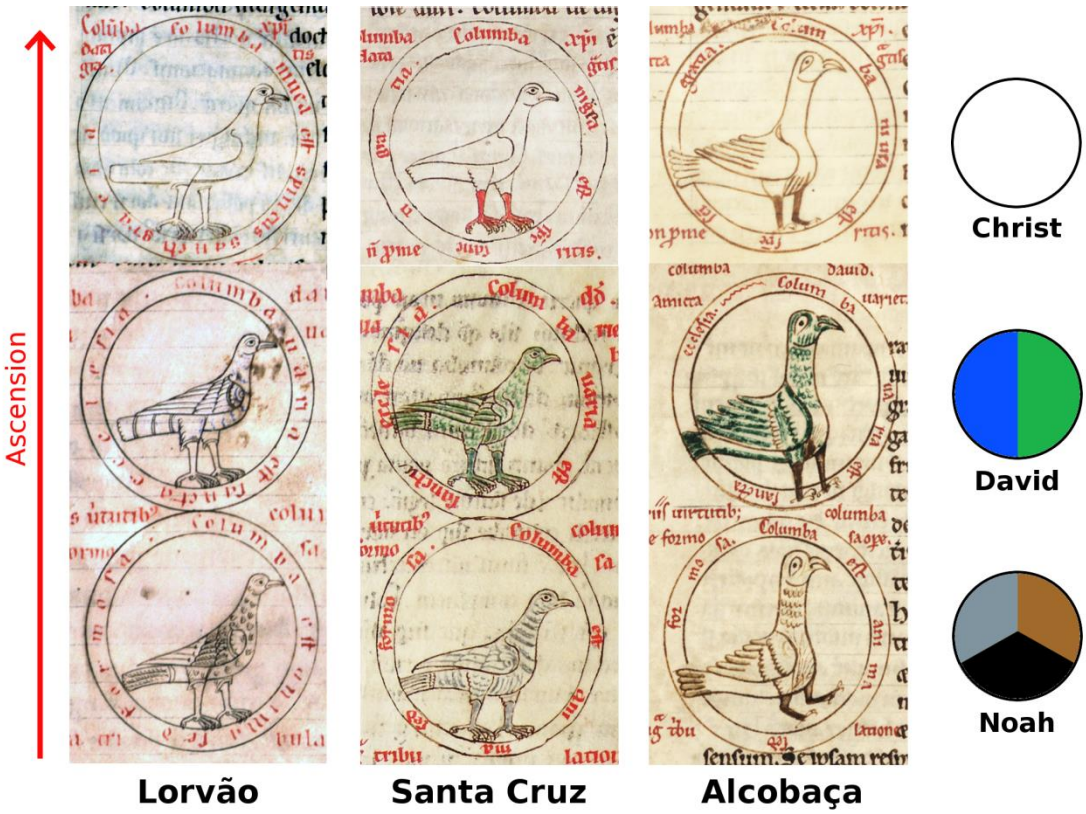


Figure 82. Scheme of the Portuguese Three Doves Diagram with a colour scheme beside.

[237] This colour was specifically made with lapis lazuli. The layer of paint is so thin that it assumes a more greyish tone.

3.5. Text analysis

In medieval text transmission, words or expressions were lost, misplaced or added from one copy to another, 'whether from physical damage, from the fallibility of scribes, or from the effects of deliberate interpolations' (Reynolds and Wilson 1991: 207).

In order to understand if the text from Hugh of Fouilloy had suffered major alterations between each copy and if it was possible to correlate them and see which copy served as basis for the other, a full and comparative study behind their texts was undertaken. Notwithstanding, the comparison could not be solely based on the three Portuguese manuscripts, as the perspective would be too constricted, in terms of chronology and production site. Therefore, the manuscripts from Clairvaux and Heiligenkreuz were also added to the analysis: the first, due to its already established connection between Alcobaça; the second, since it is considered to be one of the oldest copies and most likely closest to the original.

A complete transcription of all texts was carried out. In Appendix XV, the main transcription from the *De Avibus* from Alcobaça[238] is depicted. At the same time all of the disparities found in all of the other copies are also presented in the footnotes.

In order to assess the information, the deviations observed on the manuscripts needed to be classified into different categories. Four types of disparities were established: orthographic, omission, addition and syntax. The orthographic deviations were based on words whose spelling changed either by the addition, drop or exchange of letters – i.e. *peticionibus* vs. *petitionibus*; the occurrence of Latin declensions – i.e. *columbe* vs. *columbam* –; as well as completely different words – i.e. *salomonem* vs. *ierusalem*. The omission or addition of words, expressions or complete phrases were also established as different groups. And finally, the syntax was also added to categorize expressions or phrases that were written in a different order – i.e. *dei nostri est* vs. *dei est nostri*. Within these categorisations, not all of them had the same weight. For instance, a substantial number of orthographic deviations based on small changes in letters were not considered important, since they were in most of the times inconsistent[239]. Another deviation that was not included in the final interpretation was the words that were expuncted – this meant that the word had been identified as an error by the corrector; therefore when copying from that manuscript, the scribe did not use that same word because it was already known to be a mistake. Also, human errors such as repetition of the same word or syllables when exchanging lines were

[238] The Alcobaça *De Avibus* was chosen as main text, since it was considered to be the oldest manuscript between the Portuguese copies. This will be demonstrated ahead.
[239] Just to give an example, the word *hiemis* could be also presented as *hyemis*. In some manuscripts the same word could appear in both ways.

not considered. Taking these distinctions into account, only 414 deviations were considered for the comparison[240].

In order to simplify the analysis, a diagram with the established textual connections between copies was made, Fig. 83. Through this examination it was possible to form some considerations that will be presented hereinafter.

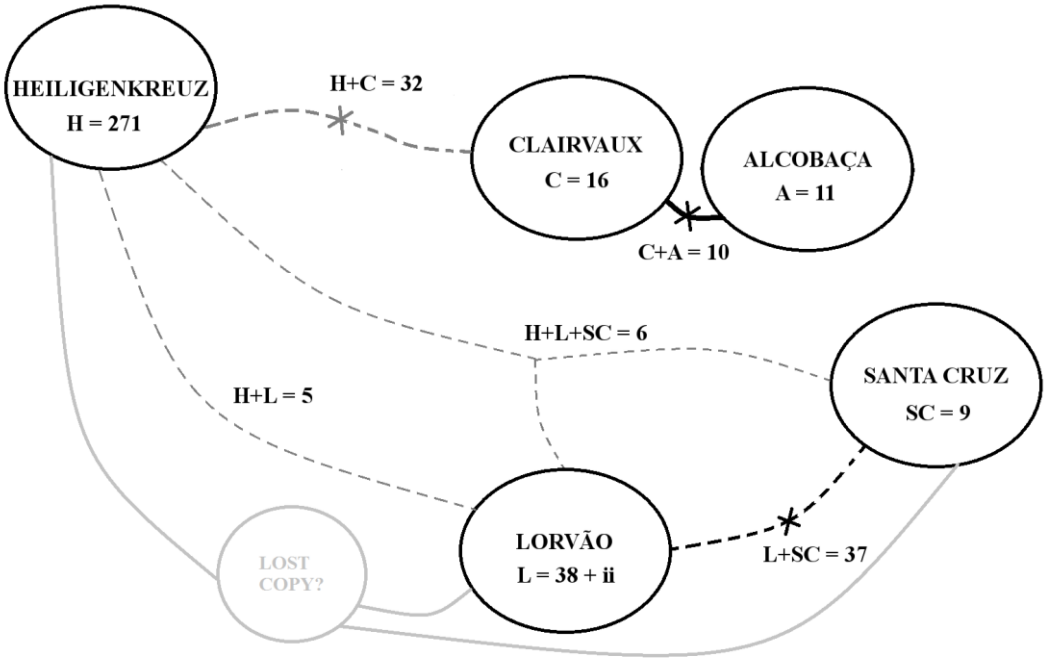


Figure 83. Diagram with the textual connections between the Heiligenkreuz, Clairvaux, Alcobaça, Santa Cruz and Lorvão copies. Each link is presented by the number of exclusive similarities found between the manuscripts (represented along the lines) as well as the number of unique disparities found within each copy (which is represented inside the circles). H is Heilingenkreuz, C is Clairvaux, A is Alcobaça, SC is Santa Cruz and L is Lorvão.

When comparing the five copies, it is clear that the Heiligenkreuz is by far the most distant one, since it contains 271 words and sentences that are completely different from the other four manuscripts. Within these differences many of them implied addition of words or phrases (32) as well as omissions (40). While the additions may represent the text that was lost through circulation, the omission may stand for the words and sentences that were added through copying. Syntax deviations (64) were also found to be very frequent in Heiligenkreuz when compared to the others. The rest of the discrepancies (135) were orthographic. Some examples on the type of deviation that was found within the five copies can be seen in Table 7.

[240] Please notice that all of the differences, despite not being considered, are given in Appendix XV.

Table 7. Several examples where all types of deviations are sequentially changed through copy in the five manuscripts.

Chapter	Heiligenkreuz	Clairvaux	Alcobaça	Lorvão	Santa Cruz
2nd prologue	*Pennas uirtutum*	*Penne uirtutum*	*Penne*	-	*Om.*
Chap. 22	*Firmus ligat*	*Firmiter conligat*	*Firmiter conligat*	*Firmiter colligat*	*Firmiter colligat*
Chap. 40	*Posse se sciunt*	*Posse se sciunt*	*Se posse sciunt*	*Se sciunt posse*	*Se sciunt posse*
Chap. 41	*Exortatione*	*Edificatione*	*Edificatione*	*Significatione*	*Significatione*
Chap. 45	*Carnes*	*Carnes*	*Carne*	*Carnem*	*Carnem*
Chap. 49	*Lucra*	*Luchrum*	*Lucrum*	*Lucrum*	*Lucrum*
Chap. 54	*Singularis*	*Singularis*	*Secularis*	*Singularia*	*Singularia*
Chap. 60	*Radiis*	*Radiis*	*Radios*	*Radio*	*Radio*

The Clairvaux manuscript has much less differences: only 16. Hence, it is more related with the Portuguese copies. Nevertheless, it maintains 32 words and sentences in common with Heiligenkreuz, by orthography (15), addition (10), syntax (4) and omission (3). Its connection to Alcobaça is not only evident in the codicology, iconography and colour, but also in the text. It was possible to establish that they are extremely similar. While in Clairvaux there are still variations associated to addition, syntax and omission, which can be explained by its correlation to an older copy; in Alcobaça the differences tend to be more orthographic. In fact, the distinctions between the Portuguese copies are more related to orthographic changes, which are harder to interpret. The 11 unique differences found in Alcobaça are plausibly human errors[241]. Between Clairvaux and Alcobaça, there were 10 similar variations that no other copy made.

Santa Cruz stands as the copy with less possibly human errors, as only 9 distinctions within the manuscript were found. No exclusive similarities between Alcobaça and Santa Cruz were established. Thus, the hypothesis that the Alcobaça manuscript could have served as copy for Santa Cruz is extremely unlikely.

The complexity on explaining the interrelationships between manuscripts tends to become much thornier when trying to contextualize the Santa Cruz and Lorvão copies. By comparing both, it was possible to establish a tie between them. It was found 37 analogous variations, mostly orthographic (24), followed by syntax (7) and omission (6). On the other hand, Lorvão presented 39 distinct words and sentences as well as two additional chapters. Despite most being orthographic (23), it was interesting to notice that 6 were by addition and 5 by omission, plus 5 by syntax. Taking this into account, it is very questionable to consider that the Lorvão manuscript served as copy to the Santa Cruz text, due to the added and omitted words, which should be equally present or absent in the SC 34.

[241] For example, instead of writing *infirmitate* the scribe from Alcobaça wrote *infinitate* (in chapter 49).

No correlation was found between the two Lorvão and Santa Cruz manuscripts and the Alcobaça copy. Some similar words were found between Heiligenkreuz and Lorvão, but these were merely orthographic. Santa Cruz also showed to have analogous words with the previous copies, but once again these were only slight changes within the letters.

So, who served as copy to the Santa Cruz and Lorvão manuscripts? It is most unlikely that the SC 34 served as reference to Lv. 5, despite the similarities, when considering other aspects, such as iconography. According to Clark, it was possible that the first Augustinian house in Portugal, Santa Cruz of Coimbra, was also the first to own a copy, nowadays lost, of Hugh's Augustinian text. 'It would be reasonable to assume that Santa Cruz was quick to acquire a new teaching text like the Aviary, and that the copy was made by a Santa Cruz canon in Paris or elsewhere in northern France' (Clark 1992: 47). Subsequently, this lost copy may have served as reference to the Lorvão monastery, due to their proximity. The text was then altered according to a more personalized manner with the inclusion of those two additional chapters. Shortly after, Santa Cruz may have prepared another copy, which is the currently known one. The similarities found between Heiligenkreuz, although thin, could be explained by the lost copy that would have had also connection to the Heiligenkreuz group.

3.6. State of conservation

It is possible to state that the worst case of degradation is when there is loss of material. In the particular case of manuscripts, is when there is loss of the parchment support. Santa Cruz lost one folium where the most iconic pictures from the *De Avibus* should be present: the Dove Diagram and the Dove and Hawk illuminations. Along its history it is likely that it may have been taken out for its presumable full page miniature, which could have been seen as a desirable one piece of art. This represents a tremendous lost for this cultural heritage. Moreover, it could contain the answer to some of the questions that have been made throughout this thesis.

The Lorvão copy suffered also from this calamity. But on this case, the fol. 55 was ripped out in more than one half of its page. On that now lost location, the illumination from the Owl should be represented. The causes that led to this incident are also unknown, but it may have not been for the same reason hypothetically given for the SC 34.

Past interventions had also a significant role on the current state of conservation of these manuscripts. While Santa Cruz stands out as the less touched codex – without addressing the binding –, Alcobaça and Lorvão were subjected to several interventions, specifically in the parchment support. The parchment from Lorvão was cleaned and rehydrated, and losses were infilled with paper (Correia 2014: cxiii). In the Alcobaça manuscript it should be highlighted the consolidations performed in fols. 63v and 64v, where thick, big and brownish pieces of

parchment were attached to the folium to cover tears. These were carelessly made. The adhesive taken from fol. 64v showed the presence of a proteinaceous profile with a strong absorption in the region around 1200-950 cm^{-1}. It presented the following vibrations: at 1151 cm^{-1} COC stretching, at 1117 cm^{-1} CC(CO) stretching, at 1072 cm^{-1} OH bending and CO stretching and finally at 1034 cm^{-1} CC(CO) stretching (Moura *et al.* 2007: 303). It was possible to suggest that this material was very similar to the Mexican mesquite gum[242], Fig. 84.

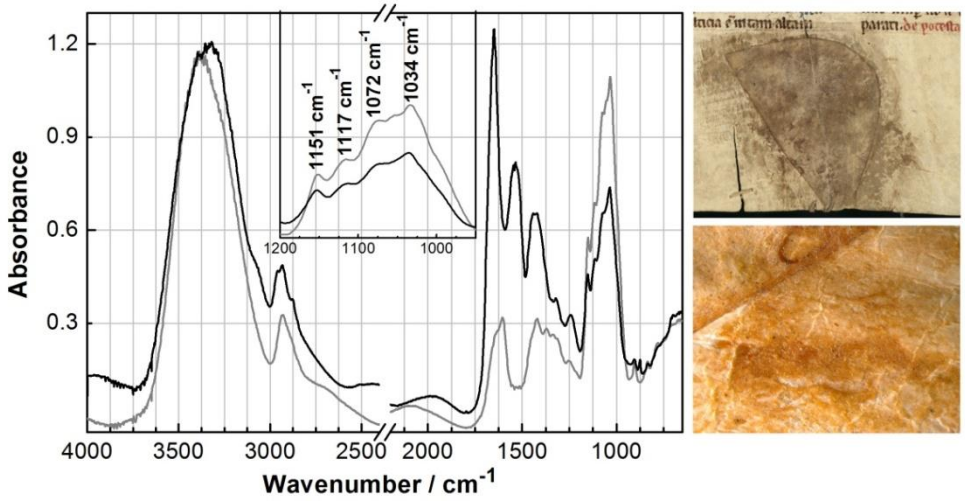


Figure 84. Infrared spectra of a brownish adhesive from ALC 238, fol. 64v (─) and Mexican mesquite gum (—). On the right, two details in different magnifications of the parchment patch (top: macroscopic scale; bottom: 12.5x magnification).

In order to establish the state of conservation of the parchment support from each manuscript, an IDAP approach was conducted, Tables 8 and 9. Through this assessment it was possible to establish that the three Books of Birds were on level 2 – slightly damaged. On one hand, the ones that were treated along these centuries showed more severe damages, particularly from handling. On the other hand, Santa Cruz presented many problems, such as surface contamination, deformation and mechanical damages that were much associated to the lack of intervention and above all to its current binding.

Overall, the illumination damage was very similar to the already described in Chapter II, for the Santa Cruz collection. The detachment of the bottle green was more visible in Alcobaça – due to its predominance. Calcium oxalates were found both in green and black paints. In ALC 238, several white precipitates were found on top of the paint layers, Fig. 85. These were identified as calcium oxalates, at the mono- and di-hydrate forms (based on Monico *et al.* 2013 information).

[242] A similar infrared spectrum was also acquired in one 'extemporaneous' micro-sample from fol. 203v, which is most likely a contamination.

Table 8. Distribution in percentage of the different types of damage found in the parchment from Santa Cruz collection.

	Santa Cruz 34	Lorvão 5[243]	Alcobaça 238
Deformations	100	83	93
Mechanical damage	66	58	70
Holes and losses[244]	21	25[245]	42
Transparent areas	17	54	45
Surface contamination	100	71	48
Discolouration	100	83	95
Microorganisms	28	0	32
Insects/rodents	14	0	5
Water damage	45	83	5
Glass-like layer	79	58	88
Calcite deposits	66	58	50
Previous interventions/treatments	0	100	12
Text damage	55	79	60
Illumination damage	31	46	27
Overall categorisation of the damage	2	2	2

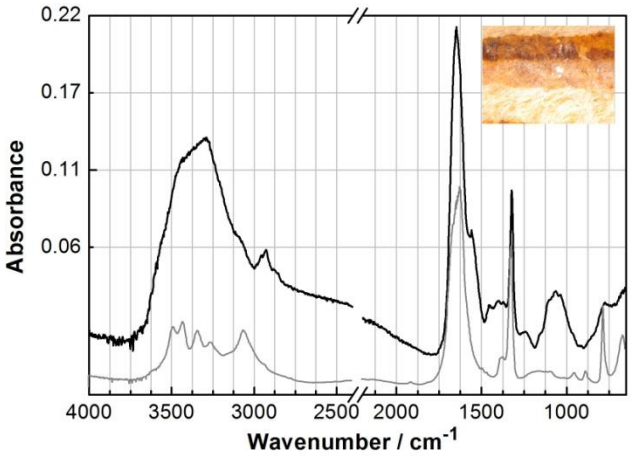


Figure 85. Infrared spectra of a white efflorescence found in an 'extemporaneous' sample close to a brown paint from ALC 238, fol. 221v (—) with calcium oxalate monohydrate (whewellite) reference (—), including an inset image detail from the area where the micro-sample was taken with 50x magnification.

Moreover, problems such as detachment, flaking and abrasion in the pictorial layer were also found to be associated to the position of the picture within the mise en page. The illuminations that were either too close to the spine or especially to the inferior corner of the folium, where the page was turned, were more susceptible to damage. This is why Santa Cruz

[243] Please notice that the assessment from the Lorvão manuscript was conducted by Inês Correia and that these results were taken from her PhD thesis (Correia 2014: 167).
[244] This category was not present in the original IDAP approach. It was included in the mechanical damages and deformations – which were also shown together. To give a better notion of the physical damages in the parchment support, these three conditions were separated. Note that 'holes and losses' not only describe loss parchment, but also holes of manufacture that depending on their position may or not interfere with the stability of the support.
[245] This category was added in this work by visual assessment of digital images.

presented more damage in its illuminations, when compared to Alcobaça, due to the positioning of its miniatures – many of its images are positioned in the extreme corners of the page.

Table 9. Distribution in percentage of the degree of damage found in the parchment from the three Portuguese Books of Birds[246].

	Representative assessment of the textblock (designed by Inês Correia 2014: 169).
SC 34 (29 ff)	
Lv 5 (24 ff)	
ALC 238 (60 ff)	

A correlation between the state of conservation of the parchment and the text was also established with the information from Table 9. For instance, in SC 34, the first folios present more damage – as expected from their proximity to the binding –, but the damage pattern is changed at the beginning of the *De Avibus* in fol. 89. From then on, more parchments are categorised in level 3. In Lv 5, the initial folia are also more damaged and then the folios around the Swallow, Swan and Blackbird and latter in St. Isidore's *De creatione hominis* are more damaged. Finally, in ALC 238, the damage pattern is even more dispersed, but also more consistent to the presence of more texts. In general, the beginning or end of certain texts such as St. Augustine's *De Continentia* or Richard of St. Victor's *De potestate ligandi atque solvendi*, tends to be connected with more parchments under level 3. With the beginning of the *De Avibus*, parchments are consistently in levels 3 or 4. Based on this information, the IDAP methodology not only made it possible to see what the most deteriorated folios were, but also allowed to distinguish what were the most visualised texts within the codices.

Regarding the bindings, the manuscript from Santa Cruz is currently heavily damaged, while the other two bookbindings were subjected to interventions in the 18th and 21th centuries. The 16th century codex structure is too weak. A significant part of the covering was lost and the seams are broken in several points, which may propitiate a future material loss, since there are already loose folios.

[246] Once again, the assessment from the Lorvão manuscript was conducted by Inês Correia (Correia 2014: 169).

4. Final remarks

The widespread dissemination of the Book of Birds through medieval Europe has shown its significance within the religious setting, as shown by the large found number of manuscripts produced in monastic scriptoria. This study was intended to disclose the route taken by the three Portuguese *De Avibus* from Santa Maria of Alcobaça, São Mamede of Lorvão and Santa Cruz of Coimbra.

In order to unveil their relationship, a new methodology of work within the circulation of copies was developed. A global assessment of these manuscripts was conducted through different perspectives: history, codicology, iconography, colour – by molecular characterisation and meaning –, text analysis and conservation. These distinct approaches were important in order to establish more precise connections, and ultimately, raise more questions on this matter.

Through this comparative study it was possible to determine that in the Heiligenkreuz group, there were two sub-groups within the Portuguese copies: Lorvão-Santa Cruz and Alcobaça-Clairvaux. Conversely, while it was established that the ALC 238 was a copy from Clairvaux; the same could not be said about SC 34 and Lv 5. Although they share parallelisms, either in the text and iconography, it was proven through the text that they had differences, which ruled out the possibility of them being a reference to each other. Taking into account the information from the text analysis, it was concluded that based on these two copies there must have been a fourth manuscript, most likely from the monastery of Santa Cruz of Coimbra, as supported by W.B. Clark.

Right from the beginning of this investigation, more precisely after the exchange of the dating from the Clairvaux manuscript to c. 1170 by Remy Cordonnier and Patricia Stirnemman, it became evident that the Portuguese manuscripts from Alcobaça and Santa Cruz needed revision. Taking also into account the dating from the Lorvão copy, 1184, it did not make sense to place these copies as productions from the 13th century. Therefore, with this research the ALC 238 and SC 34 were proposed as copies from the 1180-1190 (Castro, Melo and Miranda 2014: 37). Based on their iconography, text and colour use, these could not have more than 10 years of difference between them. While it is more likely that the Alcobaça copy was made prior to 1184, based on its straight link to Clairvaux; the Santa Cruz copy, based on iconography, may have been produced after the Lorvão *De Avibus*, through the fourth missing copy.

The molecular characterisation of the three copies showed that they used similar pigments, as already established when comparing the three scriptoria. However, some differences were detected, particularly in the usage of a brown paint in Alcobaça that is replaced

by carbon black in Lorvão and Santa Cruz, the lac dye only present in Lorvão and Alcobaça, and the use of red lead and lead white in Lorvão.

The brown colour, still not fully characterised, brough new information. The absence of an inorganic pigment – with the exception of vermilion, in some cases – led to think from the beginning that these paints were most likely made from an organic material. XRF showed that iron had an important influence in the final colour: >> Fe produced darker browns, while << Fe made lighter browns, closer to yellows, but no ochres or iron-based pigments were detected through Raman spectroscopy. Taking this into account, it is possible to suggest that these browns may have been specially formulated for this particular manuscript with similar materials used in iron-gall inks. This may be supported by the presence of sulphates in the infrared spectra, since these types of inks are normally prepared with iron sulphate. Based on medieval treatises it is very difficult to present examples, since brown was not seen at that time as a colour *per se*[247]. Moreover, since microspectrofluorimetry and SERS were inconclusive, more work will be necessary in order to obtain more answers.

Calcium oxalate was, once again, correlated to paints with high levels of iron, reinforcing the theory behind the important role of metallic elements in promoting and/or accelerating the process of degradation of the binder.

Still, in Alcobaça, the molecular analysis enabled to answer some questions that had been raised by codicology and art history: Was the manuscript produced all at the same time or were there any distinct time frame units between fols. 1-85v and fols. 86-227? On another note: were the Cock and Swallow erased and painted later on again?

Through the multi-analytical approach it was possible to verify that the manuscript was indeed painted during two separate events, due to differences in the paints. For instance, red was made by admixing vermilion with lead white; there was an orange – a colour that was not present in the *De Avibus* – made of vermilion and possibly lac dye; and the writing ink and parchment support had different compositions, in comparison with the other texts.

As for the Cock and Swallow, XRF showed that the green paint used did not had Zn in its composition, contrarily to what was found in the other greens. Moreover, there were also molecular evidences of previous illuminations, where both animals were painted with red vermilion, as in Clairvaux. Additionally, it was also found that the green paint used in the Crane – that was not present in the Ms. 177 – was also made of the same composition of the two previous mentioned birds.

[247] Brown was normally under the designation of red, *rubeus*, or yellow, *flavus* or *croceus*. Therefore, at that time, it was not encoded yet (Kristol 1980: 138).

Regarding their state of conservation, although all of the copies were evaluated as slightly damaged, in stage 2, some differences were found on each one of them. It should be highlighted the absence of the first folium from the *De Avibus* SC 34 and the teared folium in Lv 5, in fol. 55, which led to the loss of the owl figure. The IDAP approach was useful in order to evidence the importance of having a stable binding. Many of the issues found in Santa Cruz were associated to the bad state of conservation of its current bookbinding structure.

Finally, it was concluded that the Portuguese Books of Birds are some of the most interesting manuscripts for exploring colour meaning in the monastic Romanesque setting. When comparing the manuscripts that are considered to be the earliest ones – Heiligenkreuz and Zwettl[248] –, it seems that the interest in colour started with the Clairvaux and Portuguese manuscripts and then later at the beginning of the 13th century with other European copies, as the prior codices did not applied colour. Although it cannot be ascertain if the original work of Hugh of Fouilloy contained coloured images, it is believed after this research that it was most likely his intention, since its work is filled with meaningful remarks to paint and colour.

It seems that in time the information regarding colour will be transposed gradually to the manuscripts not only in the form of text – given by the author –, but also through the images – by the illuminators. This tendency will be carried out by the painters as ways of exploring the message from the Book of Birds and adding a new symbolic meaning to the work. Each illuminator – shaped by his own culture and provenance as well as individual/collective creativity – will exploit the wonderful imaginative possibilities given by Fouilloy to enhance the allegorical significance of his exegetical creation, through colour.

[248] Zwettl (Austria), Zwettl Stiftsbibliothek, Ms. 253, ca. 1200. The dating of this manuscript is also most likely in need of a revision.

III. LAC DYE IN PORTUGUESE SCRIPTORIA

III. LAC DYE IN PORTUGUESE SCRIPTORIA

1. Introduction

Lac is part of a resinous cocoon secreted by insects on twigs of branches of host trees, which incorporates also their bodies. This resin of animal origin is secreted by a petite parasite from the genus *Kerria* (Cardon 2007: 656; Melo 2009: 6-7). These insects are native to the countries of the southern and south-eastern Asia (Donkin 1977: 864; Cardon 2007: 656). There are several known species that differ greatly from one another in terms of colouring potential, as for example, *Kerria lacca*[249] – that is normally associated to India, but also present in Pakistan, southern China, Taiwan, Sri Lanka, Nepal, and other locations – and *Kerria chinensis* – mainly cultivated and collected in Bhutan, Assam, Myanmar, Thailand, Vietnam and southern China. The latter gives the best yield of lac dye since it tends to form more densely populated colonies (Cardon 2007: 656-660).

This resinous material is known as sticklac when in its raw state; however it can be also known under different names depending on the way it is treated[250]. The complex nature of lac is mostly due to the fact that it is composed of a resin – which normally represents 68% of the entire matter –, a dye – that only represents 10% – and other less representative constituents, such as wax, gluten, foreign bodies and impurities[251] (Bose, Sankaranarayanan, Sen Gupta 1963: 52). As a result, the main elements extracted from this substance are the red colouring dye named lac dye, which is made of laccaic acids A and B; laccaic acids C, D and E in minor quantities, Fig. 86; and the refined resin commonly known as shellac which – in addition to being a complex mixture of mono- and polyesters of hydroxyl aliphatic and sesquiterpenoid acids – also contains erythrolaccin, which is responsible for the yellowish orange hue that characterises the resin, Fig. 86 (Castro *et al.* 2014: 1172; Colombini, Bonaduce and Gautier 2003: 357; Kirby 2008: 90-91).

[249] Also known as *Laccifer lacca, Tachardia lacca, Coccus lacca, Lakshadia indica spp.*, and others.
[250] There are all sorts of commercial lac. Just to name a few: sticklac, seedlac, button lac, shellac, dewaxed decolourised lac, lac dye, lac wax and bleached lac. Sticklac allows better extractions of lac dye, since it is the less manipulated.
[251] These values may vary according to the species. In this case, it was based on the *Kerria lacca*, which is the specie that will be also used in this study.

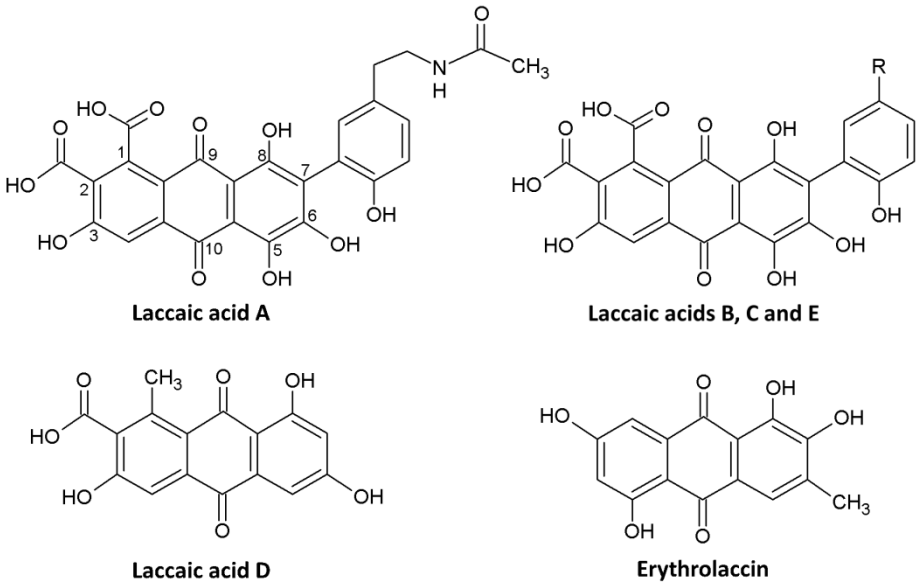


Figure 86. Chemical structures of laccaic acid A, laccaic acid B, C and E (B, R=CH_2CH_2OH; C, R=CH_2CHNH_2COOH; E, R=$CH_2CH_2NH_2$), laccaic acid D and erythrolaccin.

The word lac came, according to Donkin, most likely from the Cambodian word *le-ak* and later adapted in India, for Sanskrit as *lâkshâ* (Donkin 1977: 864). It was known since very early in India, given that it was mentioned in the *Atharvaveda* – one of the ancients Hindu holy texts, written about 1500 BC. The sacred text included a hymn praising the curative properties of *Laksha* (Book 5, Hymn 5): 'O gold-coloured, lovely, fiery (plant), with hairy stem, thou art the sister of the waters, O lâkshâ, the wind became thy very breath' (Bloomfield 1990: 21). As a medicinal plant, it was used to cure wounds and fractures, according to the *Atharvaveda*. Raw lac was considered a powerful healing substance 'perhaps, as in the case of kermes[252], by association between the colour of the dye and the colour of blood – perhaps also because of the adhesive properties of the resin that was thought to be able to draw the edges of a wound, whether internal or external, together' (Cardon 2007: 665). Along the centuries, other Indian texts started also referring not only its medicinal properties, but also its dyeing features, such as the 4th century BC *Ashtadhyayi* and the 3rd-2nd century *Samyutta Nikkayai* (Cardon 2007: 663). In China, lac was used on silk fabrics as early as the Han dynasty (206 BC – AD 220). One of the first documented evidences was written in *Wu Lu* by Chang Pho, in AD 320, where he describes lac dye from Indochina (Donkin 1977: 864).

As for the Mediterranean, this resinous material was also known since Antiquity. In Ktesias' *Indika* from the 5th century BC, the author refers 'a wild insect (…) that is found on trees which produce amber' (Donkin 1977: 864). This statement has been for several researchers

[252] Kermes (*Kermes vermilio*) is obtained from the eggs of the female insect that live in branches and trunk of the host oak tree. Its main constituent is the kermesic acid (Cardon 2007: 610-614).

interpreted as a reference for lac insects (Gopal and Srivastava 2008: 425; Cardon 2007: 664). In the 1st century AD text, *Periplus of the Erythraean Sea*, *lakkos* (lac) is also mentioned as an exported material from the northwest coast of India to Egypt, and then from there to the eastern Mediterranean (Cardon 2007: 664). Moreover, according to Donkin, Dioscorides and Bolus of Mendes, also known as Pseudo-Democritus, may have also alluded to lac (Donkin 1997: 864).

It is, though, with the Arabs that the commercialization of lac propagates around the Mediterranean, with the Muslim conquests. During 11th and 12th centuries, lac was one of the commodities traded in the Western Mediterranean (Cardon 2007: 664). The Geniza letters, also known as Cairo Geniza, which date broadly to the years 1000-1300 AD, have notable information on the history of local Jewish communities of Palestine and North Africa, and of their commercial relationship with Muslim communities from the Far East (Meri 2006: 282). These letters record several transactions of lac and how this resinous material was one of the staple Egyptian exports to the West during this period (Stillman 1973: 42). In the 11th century, Jewish traders from Egypt and Libya travelled to 'Nahrawara' (Anhilvarah) in Gujarat, India, to buy lac (Cardon 2007: 664). Al-Andalus was famous for its production and export of substances, such as saffron and *qirmiz* – the red dye kermes – but the Andalusi dyers preferred resort to the international trade for imported lac, brazilwood and indigo. At that time, *qirmiz* was the greatest opponent to lac, judging by one of the letters that asserted that the Sevillian *qirmiz* was 'superior to Indian lac (lakk)'. Interestingly, Alphonso X the Wise, in 1267, after regaining Murcia, demonstrated its weight and significance in the Iberian Peninsula society by restricting the use of lac dye, together with indigo, kermes and brazilwood, to its exclusive use in royal dyeworks (Cardon 2007: 664).

Several documents from the Egyptian trading house of Ibn 'Akwal indicated lac transactions during the early 11th century, and in the following century between Jewish partners in Almeria and North Africa (Constable 1994: 156-157; Stillman 1973: 43). It also seems that the market was very unstable and the prices varied a lot, as lac could cost 50 or 25 dinars per qinṭār, or it could be too expensive when in short supply: '*Lakk* is not on the market and has no price worth writing to you [merchant]'[253] (Stillman 1973: 42).

Some of the earliest Occidental documental descriptions of lac are, in fact, associated to Portugal, with the work *Coloquios dos simples, e drogas he cousas mediçinais da India* by the Portuguese physician Garcia de Orta, first published in April 1563, in Goa (Messinger-Ramos,

[253] According to Joseph Montville, the price of goods in medieval trade was mainly driven by the supply and demand. It was established that a merchant to make profit should go to a country where commodities were few and rare, in order to raise the prices. Furthermore, units of weight – such as the qinṭār –, volume, and money were not reliable around the Mediterranean, since Spain and Syria, for example, could operate in completely different scales. Therefore, it is nowadays difficult to establish how much it was worth some items in the medieval Mediterranean market (Montville 2011: 145-147).

Ramos and Marchant-Sauvagnargues 2004); and with the itinerary descriptions that Jan Huygen van Linschoten wrote after an expedition to Goa ordered by the King of Portugal, in 1596 (Burnell 2010).

In the conservation science field, lac dye has been mostly identified in historical textiles (Wouters 1985; Wouters and Verhecken 1989). Nonetheless, one exception is the work conducted at the National Gallery, in London, where several occurrences of lac dye in 13th to 17th century paintings, from Northern Europe and Italy, have been reported (Kirby 2008; Kirby 2012). The researchers developed an extraction method that enabled the detection of the lac chromophores by HPLC-DAD (Kirby and White 1996; Kirby, Spring and Higgitt 2005). Kirby was also able to propose that, in addition to the laccaic acids, the identification of erythrolaccin in lac paint could be recognized as a marker for the presence of shellac (Kirby 2008: 92).

Over the years, the characterisation of lake pigments and dyes in works of art has changed significantly with the advent of new analytical techniques, such as microspectrofluorimetry and SERS (Castro *et al.* 2014; Melo and Claro 2010; Claro *et al.* 2008; Leona 2009; Casadio *et al.* 2010). The development of improved sample pre-treatments, such as non-extractive gas-solid hydrolysis and mild extraction procedures has also allowed better characterisations (Pozzi *et al.* 2012; Pozzi 2012; Zhang and Laursen 2005).

Several studies showed the capacity of SERS to unambiguously identify the main chromophore of lac dye, laccaic acid A (Cañamares and Leona 2007; Leona 2009; Leona *et al.* 2011; Pozzi *et al.* 2012). On the other hand, microspectrofluorimetry had also taken groundwork steps in the characterisation of lac dye paints – particularly by providing information on the paint recipe used (Melo and Claro 2010).

In this chapter, the goal of this investigation was to identify and characterise the dark reds, carmine and pink colours found in Portuguese medieval paints. A first indication that lac dye could be the responsible for those hues was based on the results from a minute dark red sample from Lorvão monastery, by infrared analysis, Fig. 87. The infrared spectrum taken from the Dove Diagram of the Book of Birds, showed a similar fingerprint to shellac – the resinous part of the lac (Claro 2009: 80-81). Its main characteristic bands are observed at 2931 and 2858 cm^{-1} from the CH stretching absorption bands; at 1716 cm^{-1} from the C=O stretching vibrations; at 1637 cm^{-1} from the CO stretching vibrations; at 1560 cm^{-1} from the CN stretching and NH bending; at 1466 cm^{-1} from the C=C stretching aromatic rings; at 1387 cm^{-1} from the CH bending rings; at 1255 cm^{-1} and 1045 cm^{-1} from the C-O stretching carboxylic acids (Lang *et al.* 2003; Ortega-Avilés *et al.* 2005; Sarkar and Shrivastava 1997).

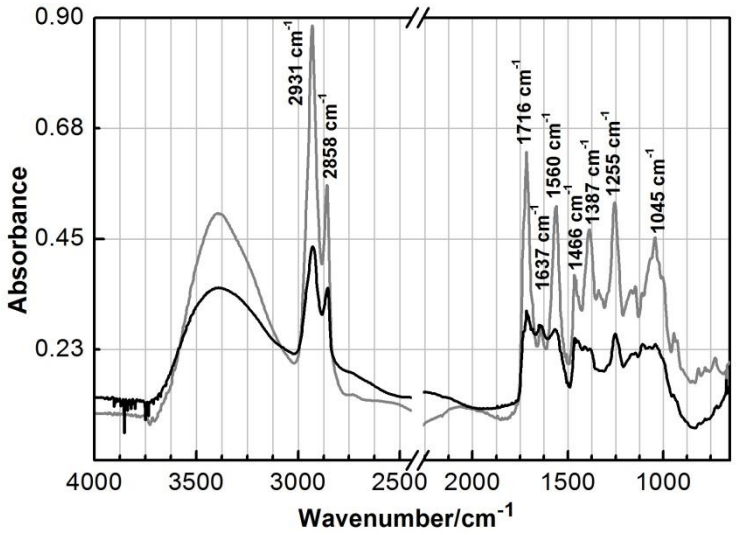


Figure 87. Infrared spectra of a dark red micro-sample from *Book of* Birds, Lv 5, fol. 6 (─) and a shellac standard at pH 9 (┄).

Because of the sample size restrictions and the difficulty in achieving an efficient extraction of the laccaic acids as a result of the resin crosslinking (Coelho *et al.* 2012; Sarkar and Shrivastava 2000) – even using the extraction method developed at the National Gallery – it was not possible to perform HPLC-DAD analysis to characterize the dye (Claro 2009: 80-81). On the other hand, there were also evidences that an organic chromophore was used in the Santa Cruz collection, based on the emission results obtained in the MOLAB access.

Taking all these factors into account, it became imperative to find alternative methods to unambiguously identify the dark reds found in medieval Portuguese collections. This exposed the need to study documentary sources and pigment recipes, in order to test analytical techniques and properly characterize the formulation of these paints. This type of approach for lac dye had been so far exploited by few researchers (Kirby 2008; Claro 2009; Melo and Claro 2010; Miguel *et al.* 2011).

2. Lac dye in medieval written technical sources

2.1. The sources for lac dye

During Middle Ages, lac dye was certainly an important colorant for artists, if considering the amount of recipes and references to lac that arrived to the present day in recipe books and treatises (Castro, Miranda and Melo 2016). As seen in Table 10, in eight of the most significant and known medieval treatises, fourteen recipes were collected, with knowledge from at least the 10th century up to the late 16th or 17th century. The transcription of all recipes in detail can be seen in Appendix XVI. There are few recipes expressly from the 12th and 13th

centuries, possibly due to the more limited number of treatises from this period. Though most of them are from a later period in relation to the Romanesque illuminations, these were also chosen in order to investigate whether the technology used over time showed an evolution.

Some artists showed reservations when it came to use lac, giving the impression that the process of manufacture or, perhaps, its application was too difficult to paint or to describe. The anonymous author from the 14th century *De Arte Illuminandi*, for instance, stated: 'Della lacca non mi curo e la lascio ai pittori'[254] (Brunello 1992: 83). Cennino Ceninni, on the other hand, as a painter, knew many recipes for lac, but advised people to buy it already made. According to the author of *Il Libro dell'arte*, there were several types of lac in the market, so artists should be careful to recognize the one that was of high quality, mentioning 'But take lacca which you work up from resin and is dry, lean, grainy so that it almost looks black and has a blood colour. This can only be good and perfect' (Broecke 2015: 69).

Table 10. Relevant information about the treatises and recipes.

Treatise	Translation/ Critical ed.	Information
Ms. of ibn Bādīs (c. 1025)	Levey (1962)	Its full title is 'Book of the Staff of the Scribes and Implements of the Discerning with a Description of the Line, the Pens, Soot Inks, Līq, Gall inks, Dying, and Details of Bookbinding', but for convenience it is usually mentioned under its author name, Muᶜizz ibn Bādīs (1007-1061), a prince and royal patron of the arts born in al-Manṣūtiyyah, near Qairawān (Levey 1962: 5-6, 30). This medieval Islamic bookmaking treatise focuses mainly on the preparation of inks, dyeing or tanning of leather and manufacture of glues and adhesives. *Lukk* (lac) is mentioned several times, particularly for making inks. The chosen recipe for this study is to make 'red ruby' from *lukk*.
Ms. Mappae Clavicula (12th c.)	Smith and Hawthorne (1974)	This source is a miscellaneous collection of recipes that started circulating most likely in the 9th c. It is known to have spread widely through monastic scriptoria networks (Kroustallis 2008: 35). The most complete copy is the Phillipps MS 3715 preserved at the Corning Museum of Glass, from the 12th century. Recipe 253 describes *De lacca* 'Lac, how it is worked for painting on wood or on a wall', which means that it was not explicitly for illuminations. According to Smith and Hawthorne, this recipe was already present in the Sélestat MS (the oldest surviving example), which means that this knowledge goes back at least to the 10th century (Smith and

[254] It was translated by Thompson as: 'I am not going into the subject of lac – I leave that to the painters' (Thompson 1956: 109).

		Hawthorne 1974: 13).
Ms. *O Libro de komo se fazen as kores (LKFK)* (15th c.)	Blondheim (1928) Strolovitch (2005 and 2010)	The *Libro de komo se fazen as kores* (LKFK) is a Judaeo-Portuguese medieval treatise in the art of illumination, written in Portuguese, with Hebrew alphabet, possibly from the 15th century[255]. The treatise is part of the MS De Rossi 945, preserved at the Biblioteca Palatina di Parma, Italy (Afonso 2010: 3-14). It contains one recipe for lac (*laka*), in chapter 13, 'para fazeres nobre karmen'. In the subsequent chapter, another recipe is described to make 'otro karmen' (another carmine), however in the latter the dye is not mentioned.
Ms. Le Begue (1431)	Merrifield (1967)	The Le Begue manuscript, dated 1431, was written by Jehan Le Begue, a secretary of the French Royal Chancellery that supervised the illumination of manuscripts. It contains also other texts, such as the *De diversis coloribus* from Alcherius that goes back to the period between 1382-1441 as well as copies of earlier material, such as Theophilus and Heraclius (Clarke 2009: 10). In *Experimenta de Coloribus* there are two recipes for lac: recipe 36 (*Lache crude*) and 37 (*gumam lache*). The latter was not included in our study. In *De diversis coloribus* from the 14th c., there is also the recipe 309 (*lache*).
Ms. Bolognese (15th c.)	Merrifield (1967)	The Bolognese manuscript, ms. 2861 della Biblioteca Universitaria di Bologna, was written in the 15th century. According to Merrifield, it is rather a book of recipes than a treatise. The recipes for lac are contained in the 5th chapter 'On the making of lakes, purples, and verzino in various manners' (Merrifield 1967: 433). It is the written source with more recipes for lac with a total of 5 recipes. The terminology used for lac changes from recipe to recipe: number 129 (*gomma de lacca cruda*), number 130 (*gummam lacce*), number 131 (*gumma lacce*), number B. 137 (*lacha cruda* or *grana*)[256] and number B. 140 (*gomma laquale*).
Ms. Strasbourg (15th c.)	Borradaile and Borradaile (1966) Neven (2011)	The Strasbourg manuscript is a well known recipe book from the 15th century. Unfortunately, the ms. was lost in the 1870 fire at the Strasbourg Library, but the text was preserved by means of a 19th century copy. The Borradaile edition is based on this transcription (Neven 2009: 65). This German source of North European illuminating techniques contains one recipe for lac (*lagga*): 'when you wish to make bright Paris red'.
Ms. Montpellier (15th c.)	Clarke (2011b)	The *Liber diversarum arcium*, part of the copy MS H 277, from the Bibliothèque Interuniversitaire, is also called Montpellier manuscript. It is a collection of recipes in Latin from approximately 1430, mainly for illuminating manuscripts and painting walls and wood, plus miscellaneous recipes for metallurgy, dying, glass decoration, etc. According to Clarke,

[255] The 15th century dating was proposed by the team of the University of Lisbon within the project 'As matérias da imagem'. Ivo Castro established, based on linguist analysis, that the first version could date from the 13th-14th centuries, and it is probable that some of the processes described reflect even older traditions (Castro 2010: 87-96).

[256] This recipe describes the use of 'laccha cruda ovẹro grana' to make lake. *Grana* (or grain) was at that time most likely kermes (Donkin 1977: 859). In the Montpellier ms., *grana* is specifically associated to kermes (Clarke 2011b: 179).

		part of its original treatise may have been written in c. 1300 and may have contained practices from North Europe (Clarke 2009: 11; Kroustallis 2011: 267-268). Recipe 1.9, chapter viii, is 'on the preparation and tempering of *lacca*'.
Ms. Paduan (late 16th c. – 17th c.)	Merrifield (1967)	Entitled 'Ricette per far ogni sorte di colori', from an unknown author, was written in Italy between the late 16th c. and 17th century. This later source, which is outside our period scope, brings new insights to the use of lac, namely with its new purpose for manufacturing varnishes. Recipe 90 'Per tirare il colore della gomma lacca che serve per li colori vivi' describes how to extract the colour from sticklac and ultimately make a varnish from it (Merrifield 1967: 686-687). Additionally, recipe 113 reports on 'Per far lacca finissma' (Merrifield 1967: 700-703).

2.2. Reproduction of lac dye paints

As already mentioned in the introduction of this dissertation, reconstructions can be used as an important ally in the study of, not only works of art, but also techniques and cultural mores of the society in which they operate. An interesting overview on the role of reconstructions in the conservation science field has been given by Spike Bucklow in his 'Housewife chemistry' article from 2013, where he states that 'Indeed, it might be fair to say that 'historical accuracy' is to technical art history what 'reversibility' is to conservation, and reversibility has been called a 'Holy Grail' and a 'utopian myth'', nevertheless reconstructions can offer 'flavours and insights when interpreted with knowledge of their limitations' (Bucklow 2013: 25). It is in this state of awareness that these recipe reproductions were approached. Three main objectives were underlined within this experience: 1) to emulate the processes behind each recipe and deconstruct its crucial steps; 2) create a database of reference materials to test suitable analytical techniques for dyes; 3) confront these sources with the dark reds found in Portuguese Romanesque illumination.

2.2.1. Challenges from missing or obscure information

Before getting into the discussion of the recipes, one should address the difficulties and questions posed by the interpretation of medieval written sources, and in particular, the recipes to make lac dye. Within missing or obscure information there were two main problematic axes: 1) translation and terminology; 2) lack of information or instructions.

The word *lacca* has caused several linguistic misinterpretations over time due to its resemblance to *lake*. D.V. Thompson also shared the same concerns: 'The word *lake* as applied to pigments derives from a material known as lacca from which lake pigments were prepared.

Curiously enough we have very little information about what was originally meant by *lacca.* We suppose that was the material that we now call lac**'** (Thompson 1956: 109)**.** It is now commonly accepted that *lacca* is a reference to lac – which is extracted from a resin secreted by insects – while *lake* does not mean expressly lac. Most lake recipes have common ingredients and procedures, making these instructions transposable for other red dyes, as mentioned in the Bolognese 130 recipe[257]. Therefore, assuming that all of these recipes were made specifically for lac should be approached carefully. Merrifield, for example, scrambled these concepts in recipe B. 137 by translating *lacca cruda* as 'crude lake', which means that if only looking at her translation, other dyes could be associated to the recipe.

In addition to this, there are recipes that have raised many questions concerning mistranslated or ambiguous instructions. For example, the word '*asado*' in the LKFK has been translated by Strolovitch (2010: 135) as 'fried meat'. On the other hand, Matos (2011: 166) has linked the original word to a Galician expression for a pot with two handles. Here it was decided to follow the latter version, since no rationale was found for the use of 'fried meat'. Furthermore, interpreting time specifications within the instructions can be a challenging exercise. For example, the Strasbourg recipe states: 'cook for half as long as one would boil a fish', while the Bolognese recipe 130 mentions: 'take gum lac, (…) into the urine and alum, continually mixing it over a slow fire for the space of 3 *misereres*'[258]. In these two cases, cooking and singing/praying were used to provide time in a clever way. These recipes were probably quicker to make, consequently less resin was normally extracted in the end.

While some treatises instruct what should be used to produce the final paint, some do not give any directions or give unforeseen guidelines. It would be expected that all of the recipes with alum would be prepared only with the precipitate formed. However, some recipes take the contrary position and use the solution (i.e. in the *Mappae Clavicula*). In some cases, where no information was given, the solutions were in most cases used, because they gave a more similar appearance to the glossy medieval lac paints.

Lastly, the absence of precise quantities for each ingredient made it more challenging to interpret the recipes, thus it is not possible to guarantee that the results obtained were the intention of the writers. Nevertheless, this is one of the limitations observed when trying to decode a medieval recipe. From the 14 recipes, only one provided all of the information – namely, the *Mappae Clavicula* manuscript –, eight supplied incomplete instructions, and five

[257] '(…) you may make lake in this way from various stones and of various kinds, namely, from that from which the crimson colour is made, from dragon's blood, from *grana*, from *vermiculis*, from *minio*, from *verzino*, and from the flowers of herbs' (Merrifield 1967: 448).
[258] *Miserere* is the Latin for 'have mercy'. It is part of the 51st psalm and takes around 2 minutes to read it slowly, which means that 3 *misereres* would take approximately 6 minutes. The use of *misereres* to count time was also a common practice in medieval cookery (Scully 2000: 112).

did not give any indication of quantities. Only through systematic and repeated reconstructions, changing the quantities of ingredients and following a coherent methodology was possible to have better insight into the presumed final product.

2.2.2. Key aspects of the recipes

A full description of each recipe can be found in Appendix XVI as well as tables with the main ingredients and quantities used and main observations for each recipe. From the 14 selected recipes, two main preparation methods were established: 1) the free lac dyes, where a simple extraction solution is used without mordant; 2) the alum-lac complexes, where lac dye is complexed with a metal ion, such as Al^{3+}, in the form of alum, forming a lake pigment, Fig. 88.

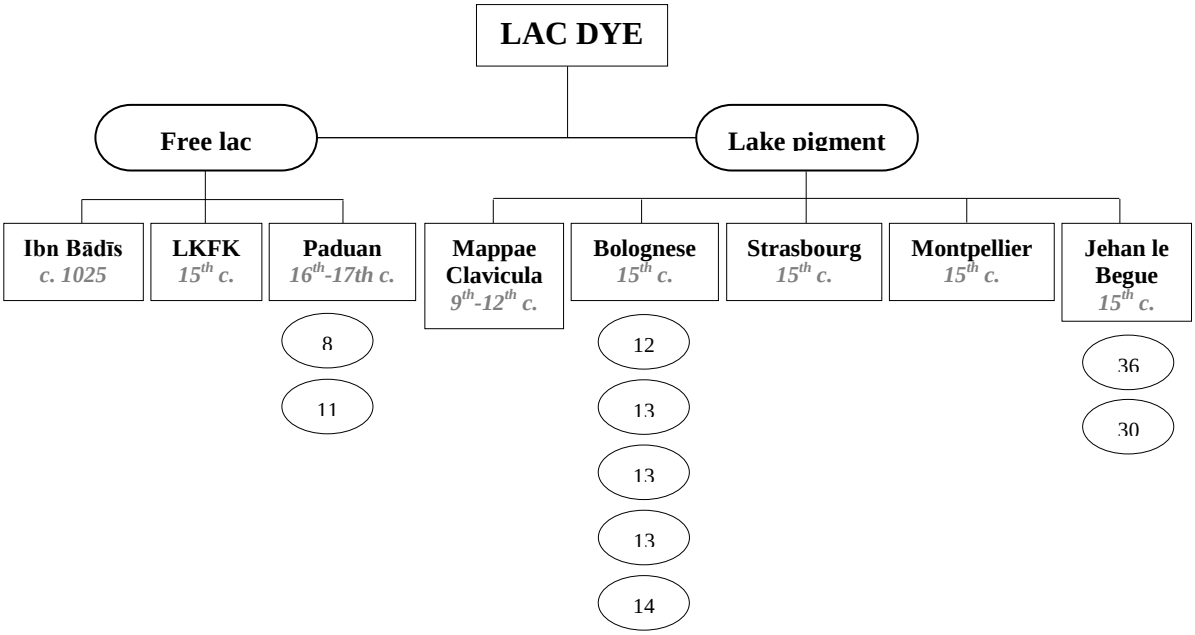


Figure 88. Scheme with the selected group of treatises and recipes.

In Fig. 89, the main chemical procedures in the recipes are depicted. In the first step, the sticklac is ground, in coarse or fine manner, when specified. Then, a basic solution is added – this can be in the form of a lye or urine, for example. Depending on the temperature of the extraction and pH used, less or more resin can be incorporated into the dye solution. In the third step, the mixture is filtered in order to remove the impurities of the lac and its residual resin. Some recipes can be complete at this point, such as the ibn Bādīs or Paduan 90; however, in most cases – 10 out of 14 recipes – there is a fourth procedure where alum is added. By introducing Al^{3+}, a precipitate is formed at the bottom of the recipient. In order to separate the liquid from the deposit formed, in the final step, sometimes a filtration step is described by removing the pigment through a linen bag, for example, or in other occasions it is just left to dry.

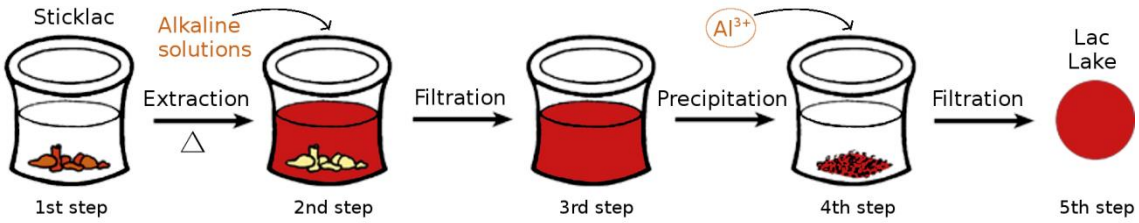


Figure 89. Scheme of the main steps for the reproduction of lac lake pigments. Image adapted from a design by Rita Carvalho.

The importance of pH in the extraction step

The extraction is a critical factor for all recipes. Lac dye changes its colour from orange to red or purple, depending on the pH of the solution. Laccaic acid A has three pKa values: 5.6, 7.0 and 9.8, which play an important role in the final hue (Claro 2009: 130–131). There are several factors and ingredients that can influence the pH. One of the most common extraction solutions is urine. The pH value of fresh urine is normally around 6, which means that the solution is close to a neutral pH. Several recipes, such as the LKFK manuscript, and the Bolognese manuscript 129 or 130, describe the use of old urine. Stale urine tends to develop higher pH values that can go up to 9, due to the hydrolysis of the urea that tends to produce ammonium and bicarbonate ions (Zhingang *et al.* 2008: 1023). Most recipes that add urine recommend boiling it until it is reduced to one third or one half of its initial quantity, such as the Mappae Clavicula and the Jehan Le Begue manuscripts (in Appendix XVI, these initial quantities are given). This practice can also raise the pH, but it should be done carefully; overly high temperatures should be avoided since this can darken the colour of the urine.

The addition of ingredients such as quicklime, ley of ashes – a source of OH^- ions from alkaline oxides, such as CaO, SiO_2, Al_2O_3, K_2O and Fe_2O_3, and others (Etiégnil *et al.* 1991) – and indirect sources of sodium carbonate and borax – present in the ibn Bādīs recipe – can also increase the pH, and some of them will also work as buffers by stabilizing the pH. Therefore, the most common extraction solutions for lac recipes are basic.

Alum ($AlK(SO_4)_2 \cdot 12H_2O$), a source of aluminium ions (Al^{3+}), acts as a Lewis acid and forms a metal-dye complex by converting the water-soluble dye into an insoluble pigment, commonly known as lake pigment. In order to precipitate, the extraction solution needs to be in the neutral to basic pH range (Clementi *et al.* 2008: 25; Kirby 2012: 157–158). In Fig. 90, the possible acid-base forms of laccaic acid A are shown, as well as two types of chelating sites in the molecule. Depending on the recipe, this factor can be more or less important, as some of the recipes do not require full precipitation.

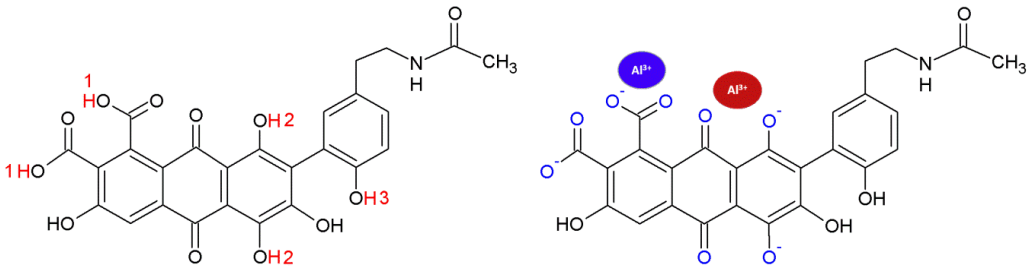


Figure 90. *Left*, in red, neutral form proposed for laccaic acid A: the more acidic protons are labelled as 1. *Right*, in blue and red, two types of chelating sites are shown as examples for the basic forms (there are 6 possibilities).

Alum *zucharino*, present in three recipes, also promotes the precipitation of the lake and provides the necessary means to produce paint at the same time by including egg white as binder. Alum *zucharino* is considered to be a mixture of ground alum heated with rose water, sugar and egg white (Clarke 2011b: 178). None of the sources explained how to do this ingredient. Therefore the followed recipe was based on the formula created by the British artist Nabil Ali who has been studying the recipes from the Montpellier ms.[259]. The following quantities were used: 2 roses, 2 g of alum, 10 g of brown sugar, 200 ml water and 25 g of egg white, final pH *c*.4.

The quantity of alum added in a solution is also important, since it influences the final colour of the paint as well as the pH. The more alum is added, the more pink/purple the colour tends to become, due to the acidification promoted by the inorganic salt as well as its white colour. In some of these reproductions, where there were none or scarce information about quantities, alum was carefully added just enough to produce reddish colours – pH around 6 –, since they were more similar to the medieval lac paints.

The presence of the resin: the luminous and glossy lac paints

The incorporation of the resin components in the final paint is essential to achieve the glossy appearance seen in the Portuguese medieval illuminations. As previously stated, this effect is closely related to temperature, pH, and also, extraction time.

It has been observed that heating above 60 ºC promotes the incorporation of the resin in the final solution, as mentioned in the LKFK recipe: 'the lac is melted'. Also, the use of basic extraction solutions, preferably above pH 8, tends to promote better dissolution of the resin. Moreover, the use of long extraction periods – at least one hour – can also contribute to a better dissolution of the shellac constituents. Consequently, it was observed that most recipes did incorporate, to a certain degree, these components in its final product, whether in the form of lac

[259] For more about Nabil Ali's work, please consult: http://nabilali.weebly.com/.

solution or pigment lake. The use of techniques, such as HPLC-DAD, FTIR and microspectrofluorimetry, which will be described hereinafter proved to be valuable for the identification of the incorporation of the shellac in the final paint (Kirby 2008: 91–92; Castro *et al.* 2014: 1177).

3. Development of a methodology for the characterisation of lac dye paints in medieval manuscript illuminations

For the study of lac dye paints, microspectrofluorimetry and SERS were tested, for the first time in this work, as complementary techniques and alternative methods to unambiguously identify the typical dark red colours found in medieval Portuguese illuminations. While SERS provides a conclusive molecular fingerprint for the main chromophore (Cañamares and Leona 2007), microspectrofluorimetry offers valuable information on the global paint formulation, i.e. the chromophore's environment (Melo and Claro 2010). In addition, the high sensitivity of microspectrofluorimetry enables to use the technique *in situ* with micrometer-level spatial resolution, unlike SERS on silver colloids that generally requires microsampling.

In this investigation, SERS was used for the first time in the analysis of lac dye reds from medieval illuminations. This procedure was conducted at the Scientific Department from the MET, where a solid and established methodology had been already developed for works of art (Leona 2009; Leona *et al.* 2011; Pozzi *et al.* 2012). The obtained data was then compared with microspectrofluorimetry results, thus enabling to validate the latter technique as a robust analytical tool for the detection of lac dye *in situ*. Other techniques, such as HPLC, FTIR, FORS, Raman and XRF were used as complementary techniques to characterize specificities in the reproductions or to identify the binder and fillers in the medieval paints.

The information about the experimental conditions can be found in Appendix IV, while the areas of analysis of the dark reds from Lorvão and Alcobaça[260] can be found in Appendix XVII. Representative analytical data from the molecularly characterised lac paints from the three collections can be found in Appendix XVIII[261].

3.1. Characterisation of lac dye reconstructions

In order to understand more about the reconstructions based on recipes of lac dye, the different components from the lac, namely the raw sticklac and the shellac, were analysed by microspectrofluorimetry. In the spectra of raw sticklac, seen in Fig. 91, both the resin and all the

[260] In order to avoid repetition, the dark red paints from Santa Cruz are represented in Appendix XVII with the rest of the paints.
[261] This is only represented by the dark red paints that were molecularly identified as lac dye.

lac chromophores are detected, whereas for shellac, the main contribution observed is that of the resin itselfol. The laccaic acid chromophores dominate the spectra for the raw material, and the excitation spectrum is characterised by a broad, unresolved band, with a maximum at 505 nm. Note that all of the excitation spectra showed a band at circa 420 nm that is an instrumental artefact, not emitting species. At 490 nm excitation, the emission spectrum of sticklac mainly displays features of the laccaic acids. The shellac resin's excitation spectrum displays a band at 463 nm, which compares well with the absorption spectrum published in literature for erythrolaccin, characterised by maxima at 264, 294 and 464 nm, of which only the latter can be detected with the microspectrofluorimetry instrumental setup (Kirby 2008: 93).

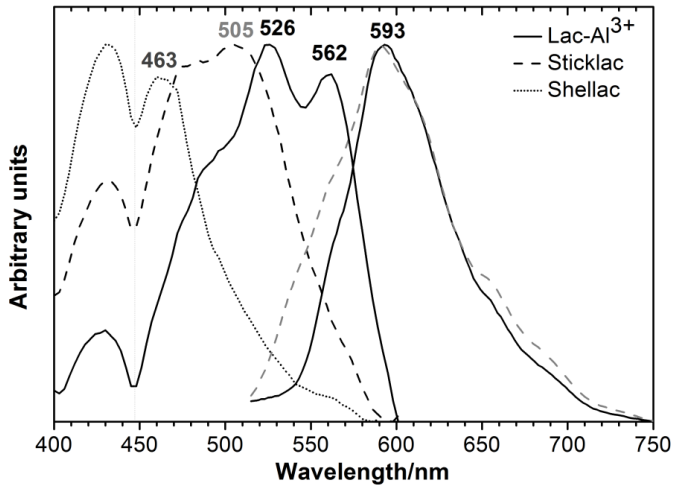


Figure 91. Normalized emission and excitation spectra of shellac, sticklac and Al^{3+}-lac complex.

On the other hand, the Al^{3+}-lac dye complex solution applied to filter paper, at pH=3.8, displayed well resolved spectral features, with a small Stokes shift, indicating that the same species was absorbing and emitting in the excited state. The relative intensities of the two emission bands may change according to the pH, and minor shifts may occur depending on the amount of alum present. Close to neutral and basic pH, the signal is lower and the band at 526 nm displays the highest intensity. With a higher amount of alum, the excitation spectrum tends to display more intensity, too. The emission spectrum, not so finely resolved, displays a maximum at 593 nm.

When looking at the reconstructions, several distinctions were found within the set of studied recipes through the multi-analytical approach used. Each technique was able to give different and complementary information. For the purpose of this work, these were separated between the most to the least observed type of reproduction to ease the interpretation: **type A** –

alum-lac complexes; **type B** –free lac reproductions (with resin incorporated)[262]; **type C** – alum-lac complexes with brazilwood.

In Fig. 92, type A is represented with the Mappae Clavicula recipe. In this case, the infrared spectrum shows mainly the proteinaceous binder, with prominent C-H stretching absorption bands from the resin, a very discreet shoulder at around 1715 cm^{-1} from the C=O also from the resinous matter and the beginning of a medium broad band in the region starting at 750 cm^{-1}, which may be attributed to Al-O vibrations, from the Al^{3+} complex (Clementi *et al.* 2008).

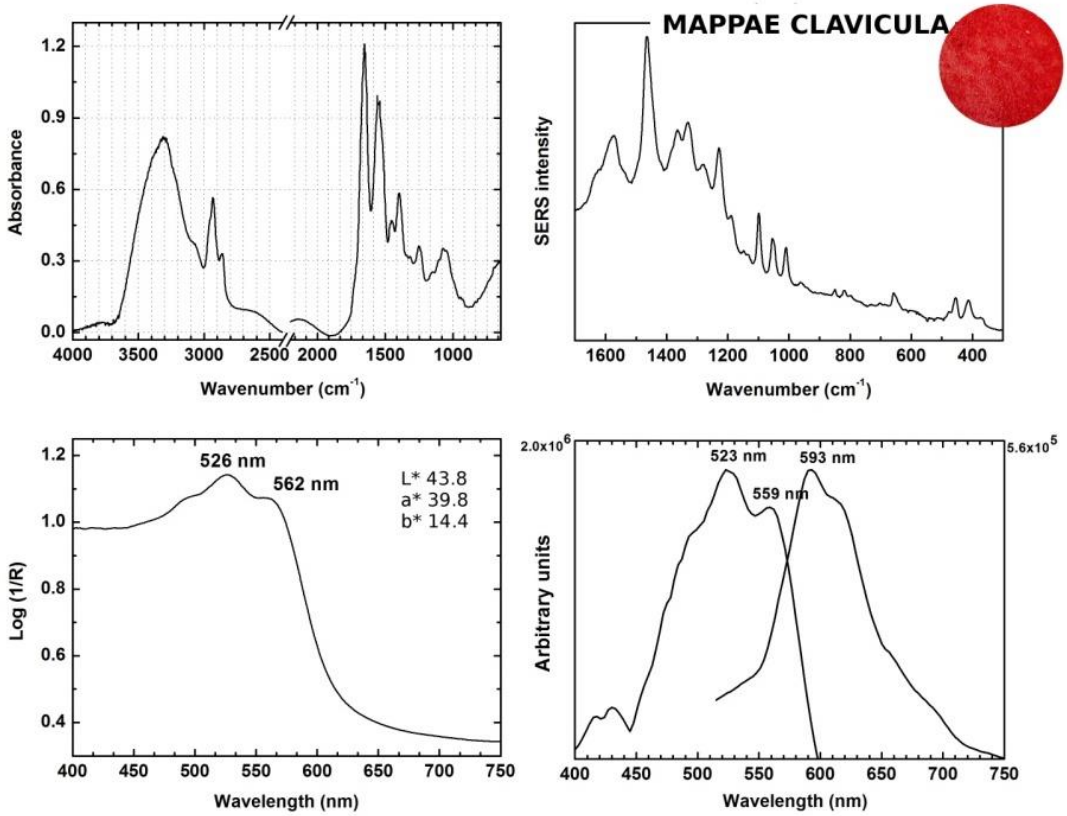


Figure 92. Representative analytical spectra (IV, SERS, FORS and microfluorimetry) from Mappae Clavicula: a **type A** reproduction.

The SERS spectrum shows a typical pattern of the main component of lac dye, i.e. laccaic acid A[263], with the most intense signals at circa 1578, 1464, 1368, 1326, 1287, 1227, 1188, 1098, 1052, 1010, 453 and 408 cm^{-1}. When analysing several reconstructions, it was observed

[262] As already discussed, in the key aspects of the recipes, the incorporation of the resin is not linked to the presence or absence of alum in the dye, which means that any type of reproductions can incorporate resin. In order to display the different analytical information found in these reproductions, type B will also discuss in detail the important role of the resin in the interpretation of the analytical data.

[263] It was verified through reference SERS spectra from laccaic acids A, B, C and E, collected from HPLC, that the similarity between the spectra of laccaic acid A and the commercial mixture indicates that SERS detects primarily the former compound, i.e. the main dye chromophore. This data can be found in Castro *et al.* 2014.

that the best spectra were obtained for lakes that were acquired in more acidic conditions. This is in agreement with Cañamares and Leona 2007, who found that the SERS intensity for lac dye increased when going from alkaline to acidic pHs. This is likely because of the increase in the resonance Raman effect combined with a lower electrostatic repulsion between laccaic acid and the negatively charged nanoparticle surface – capped by the citrate ions – at acidic pH. Within this group of lac lakes, minor shifts in wavenumber and slight changes in relative intensities were observed, which may be attributed to pH effects or to other components present in the matrix that may interfere with the SERS signal (Castro *et al.* 2014: 1176).

The FORS spectrum at UV-Vis displays two absorption bands at 526 and 562 nm, which are similar to the previously presented excitation spectrum of the Al^{3+}-lac dye complex solution analysed by microspectrofluorimetry, in Fig. 91. This is in agreement also with the excitation spectrum from the Mappae Clavicula, with minor shifts in the bands at 523 and 559 nm. In addition, the emission spectrum is also very similar to the one obtained for the Al^{3+}-lac dye complex, depicted in Fig. 91.

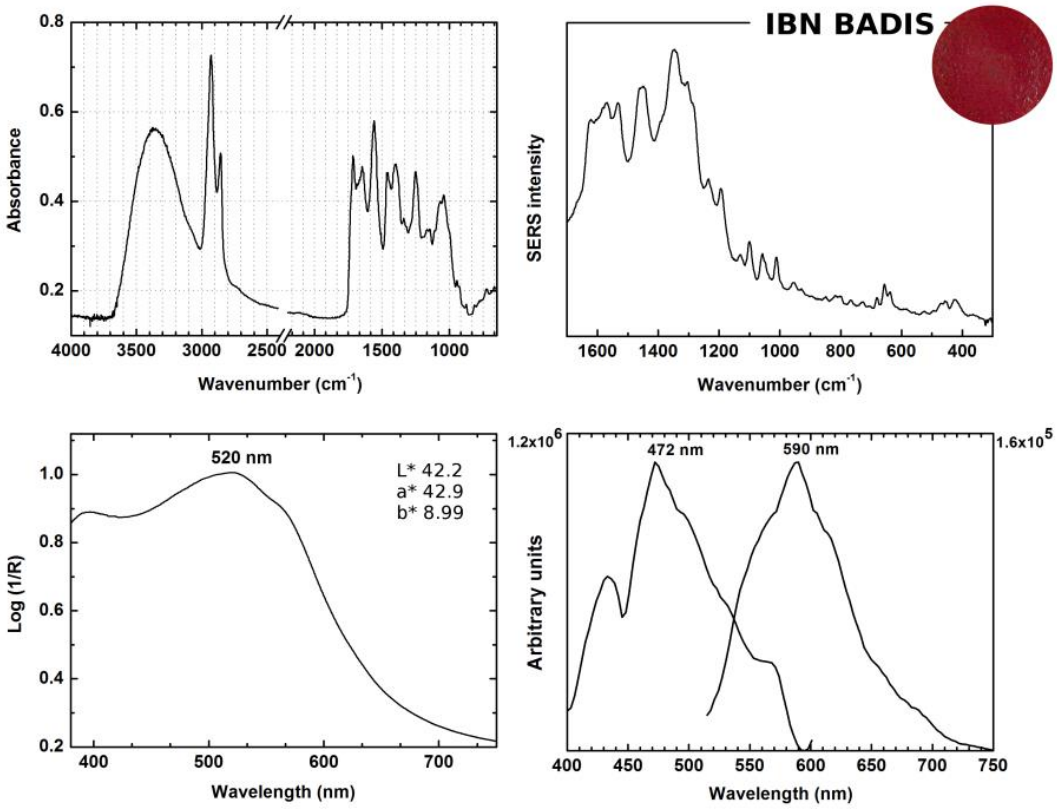


Figure 93. Representative analytical spectra (IV, SERS, FORS and microfluorimetry) from ibn Bādīs: a **type B** reproduction.

In Fig. 93, type B is represented with the ibn Bādīs recipe. Its infrared spectrum shows the typical bands of the shellac component, already described above in Fig 89. The SERS spectrum displayed intense signals at circa 1622, 1568, 1534, 1460, 1346, 1192, 1100, 1058 and

1010 cm^{-1}. Overall, a clear distinction was observed between the free lac reconstructions examined without hydrolysis and the lac dye-Al^{3+} complex analysed after the HF treatment. In the type A samples, the band at 1464 cm^{-1}, assigned to the C-C I ring stretching modes and to C_8-OH and C_5-OH bending modes, showed the highest intensity. While, the type B samples, displayed the highest intensity at 1340-50 cm^{-1}. According to the literature, this latter band is normally assigned to the deprotonation of the C_5-OH bending mode of carboxylic groups in the molecule (Cañamares and Leona 2007; Pozzi 2012: 36).

Furthermore, in the reflectance spectrum in apparent absorption, instead of two defined absorption bands, only one broad band at 520 nm is perceptible. This is likely due to the absence of the lac-Al^{3+} complex, but also to the saturation of the Ibn Bādīs reproduction paint, which is darker. With microspectrofluorimetry, the main band in the excitation spectrum is shifted toward lower wavelengths and is located at 472 nm. This may be ascribed to the absence of alum, but also to the presence of erythrolaccin – the yellow chromophore found in the resin. In order to confirm the presence of the yellow dye, HPLC-DAD was performed on the lac reproductions and it was possible to show that the Ibn Bādīs recipe did contain the marker of the resin, Fig. 94, just as stated in previous literature (Kirby 2008; Kirby, Spring and Higgitt 2005). Taking this into account, it was proposed in this work that the microspectrofluorimetry could be indirectly sensing the presence of the resin and indicating that the latter was incorporated in the final pigment (Castro *et al.* 2014: 1178).

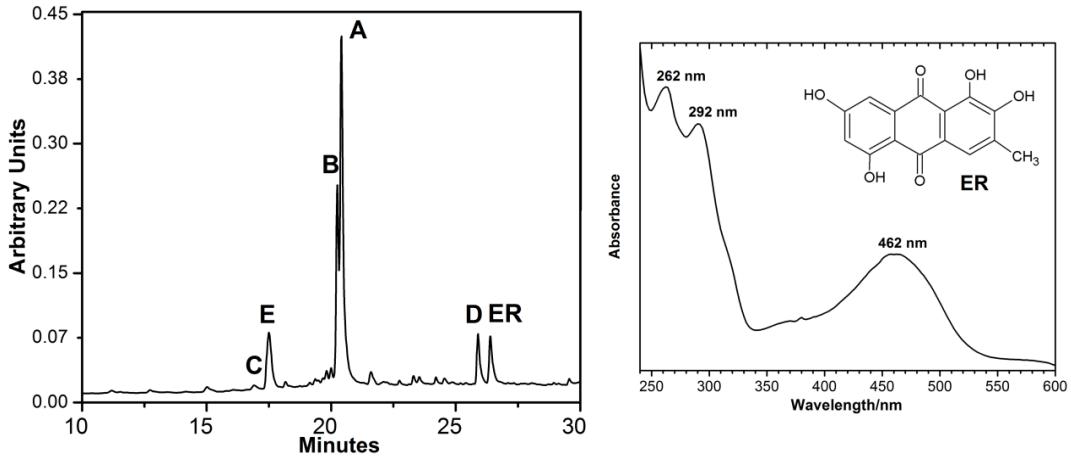


Figure 94. HPLC chromatogram acquired at 275 nm from the ibn Bādīs reconstruction, where the following compounds can be identified: A) laccaic acid A; B) laccaic acid B; C) laccaic acid C; E) laccaic acid E.; D) laccaic acid D; ER) Erythrolaccin. On the right, UV-Vis spectrum of the erythrolaccin.

Finally, in type C, another analytical data was also found, specifically for reproductions where in addition to the presence of lac dye with alum, brazilwood was also used. In Fig. 95, the infrared spectrum displayed medium C-H stretching absorption bands from the resin as well as the shoulder at around 1715 cm^{-1}, a broad medium band at around 1095 cm^{-1} possibly ascribed

to a sulphate band shifted by the presence of phosphate (Kirby, Spring and Higgitt 2005: 81), and finally, a broad band in the region starting at 750 cm^{-1}, which may be attributed to Al-O vibrations (Clementi *et al.* 2008: 30).

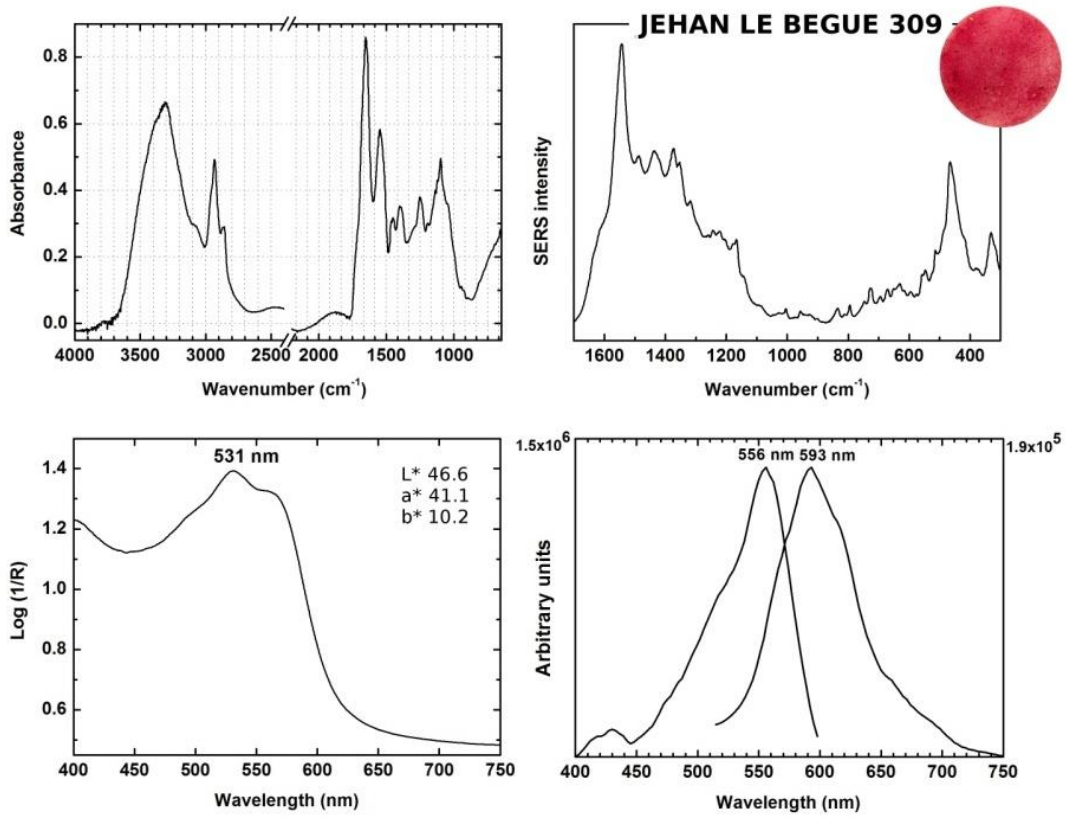


Figure 95. Representative analytical spectra (IV, SERS, FORS and microfluorimetry) from Jehan Le Begue 309: a **type C** reproduction.

With SERS, depending on the sample taken from the reconstruction paint, two completely different results were obtained. One was similar to the spectrum observed in type A reproductions with the characteristic bands from the laccaic acid A, while the other, seen in Fig. 95, is similar to the characteristic bands found in brazilwood, which can be observed at 1543 and 1490 cm^{-1} assigned to the C=C stretching vibrations, at 1375 cm^{-1} attributed to the C-O stretching and OCC and CH_2 bending modes, and at 465 cm^{-1} possibly from the ring deformation (Bruni, Guglielmi and Pozzi 2011: 1274).

The reflectance spectrum also revealed differences with a more pronounced band at 531 nm and a shoulder at 562 nm. The shift to higher wavelengths is in agreement with the brazilwood presence, which tends to present a single band at around 550-60 nm (Melo *et al.* 2014; Vitorino *et al.* 2015). The excitation spectrum also showed variations with a single band at 556 nm, which is also in agreement with brazilwood, while the emission band stayed similar to what is also normally found in lac dye paints (Melo *et al.* 2014; Vitorino *et al.* 2015).

In order to compare the results from the FORS and microspectrofluorimetry acquired for the main paint reconstructions, consult the following Table 11.

Table 11. Absorption, fluorescence excitation and emission maxima (average) for some of the main type of paint reconstructions.

	Type A			Type B		Type C	
	MC	**B129**	**Montpellier**	**IB**	**LKFK**	**JB 309**	**B 130**
λ_{abs}/nm	526, 562	526, 562	525, 562	528	530, 568	531	525, 560
λ_{exc}/nm	523, 557	526, 562	520	472	526	556	520, 556
λ_{em}/nm	593	593	590	589	563	593	593

Lac dye reconstructions in mixtures

Mixtures of lac dye with calcium carbonate, gypsum, lead white and vermilion were also tested, as they were too identified in medieval paints – as it will be demonstrated in the following sub-chapter. These were tested in all of the recipes; through the already referred multi-analytical approach. Differences between each mixture were assessed.

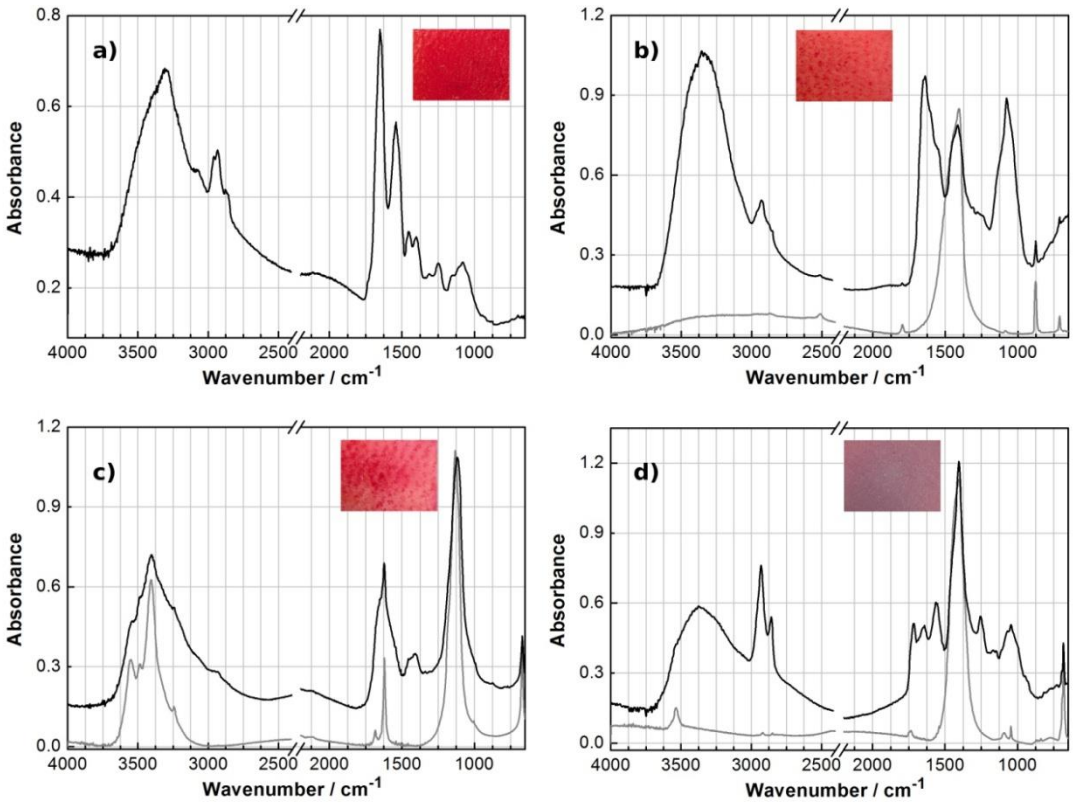


Figure 96. Representative analytical infrared spectra of several lac dye reproductions admixed with other pigments and fillers with egg white: **a)** Jehan le Begue 309 lac recipe with vermilion; **b)** Bolognese 131 lac recipe (─) with calcium carbonate and a reference from the latter (─); **c)** Mappae Clavicula lac recipe with gypsum (─) and a reference from the latter (─); **d)** ibn Bādīs lac recipe with lead white (─) and a reference from the latter (─). Each spectrum contains inset image details from each specific reconstruction with 16x magnification.

In Fig. 96, there are several examples of infrared spectra of lac dye recipes with different mixtures. In the spectrum presented in Fig. 96a), the pigment vermilion is not visible since it does not absorb in the 4000-650 cm^{-1} wavenumber region. Therefore, it is only possible to identify the absorptions from the proteinaceous material as well as some very minor details from the lac – with the C-H stretching absorption bands from the resin as well as the discreet shoulder at around 1715 cm^{-1}. Fig. 96b) contains calcium carbonate which can be characterised by it absorption band at 1432 cm^{-1} from the CO_3^{2-} stretching and by two sharp peaks of the CO_3^{2-} bending at 875 and 712 cm^{-1} (Andersen and Brečević 1991). In Fig. 96c), a Mappae Clavicula recipe was mixed with gypsum ($CaSO_4.2H_2O$). This is presented by the characteristic stretching OH bands at 3547, 3489 and 3404 cm^{-1} from the water groups and its respective bending OH vibrations at 1685 and 1622 cm^{-1}, followed by the sulphate anions SO_4^{2-} stretching broad band at 1119 cm^{-1}, and its associated bending band at 670 cm^{-1} (Mandal and Mandal 2002). Finally, Fig. 96d) is represented by an ibn Bādīs recipe with lead white. This was characterised by the weak absorption band due to the OH stretching at circa 3533 cm^{-1}, the intense broad stretching band of the CO_3^{2-} at circa 1402 cm^{-1}, and the sharp peak of the CO_3^{2-} bending mode at 681 cm^{-1} (Gettens 1993: 77).

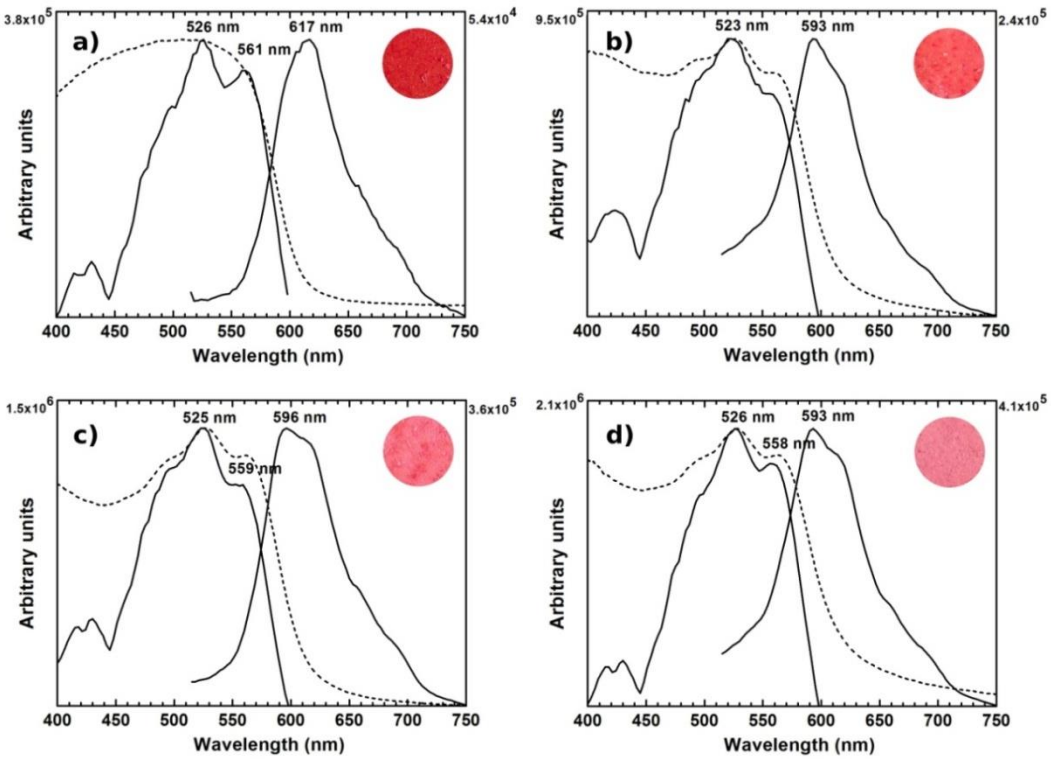


Figure 97. Apparent absorption (---), excitation and emission spectra from Mappae Clavicula reproduction admixed with other pigments and fillers with egg white: **a)** vermilion; **b)** calcium carbonate; **c)** gypsum; **d)** lead white. Each spectrum contains inset image details from each specific reconstruction with 16x magnification.

What was more interesting to observe were the apparent absorption, excitation and emission spectra from these mixtures, which revealed different spectra when compared to the recipes without mixtures. To serve as example, in Fig. 97 and Table 12, different mixtures from the recipe Mappae Clavicula – already presented in Fig. 91 – are depicted. For more information on the differences observed in each mixture for every recipe, please consult Table XVIIII.1. in Appendix XVIII.

Table 12. Absorption, fluorescence excitation and emission maxima (average) from the two main examples of type A and B of paint reconstructions.

	Type A					**Type B**				
	Mappae Clavicula					**Ibn Bādīs**				
	Without mixture	**Vermilion**	**Calcium carbonate**	**Gypsum**	**Lead white**	**Without mixture**	**Vermilion**	**Calcium carbonate**	**Gypsum**	**Lead white**
λ_{abs}/nm	526, 562	No clear band	527, 563	527, 562	528, 561	528	No clear band	530	526, 564	544
λ_{exc}/nm	523, 557	526, 561	523	525, 559	526, 558	472	472	475	475	472
λ_{em}/nm	593	617	593	596	593	589	617	589	587	589

The most noticeable difference was seen in mixtures with vermilion, Fig. 96a). These had great impact in the shape of the apparent absorption spectrum, by absorbing and saturating the signal from the lac. On the other hand, the excitation and emission fluorescence spectra lost considerable amount of signal – from 10^6 to 10^5. The excitation spectrum did not show many differences apart from the intensity and a minor ≈3 nm shift. However, the same could not be told about the emission spectrum that changed shape and shifted 24 nm. This was observed in general for every lac recipe with vermilion that assumed overall a maximum in the region of 615 nm.

Calcium carbonate allowed acquiring more defined apparent absorption spectra, most likely due to its less saturated colour, Fig. 96b). The main features in both emission and excitation spectra are maintained, though in the latter, the bands are not well resolved, due to the decrease in the second band at 559 nm. These displayed also less signal intensity, but on a smaller scale than with the vermilion. The mixture with gypsum showed an apparent absorption spectrum even better defined, but the excitation spectrum was not well resolved, Fig. 96c). The emission spectrum displayed a maximum shift at 596 nm. In general, most of the recipes did not show any significant change in the emission spectrum, besides the signal decrease. Finally, in Fig. 96d), the apparent absorption spectrum showed minor shift of 1 nm. When comparing with other recipes, it was observed in some cases, that lead white had an impact in the final spectrum by shifting the bands at higher wavelengths. This was particularly noticeable in reproductions of type B – the free lac dyes. The observed differences between the excitation and emission spectra were minute. From all of the pigments, lead white is the one that seems to less affect the signal intensity.

3.2. Characterisation of lac dye in Portuguese illuminated manuscripts

The dark reds, carmine and pink colours found in Portuguese 12th and 13th century illuminations were both used to paint illuminations as well as small initials, Fig. 98. These were applied as a single colour or as a *matiz* (layer by layer)[264]. In most cases, these paints were extremely glossy and translucent, although in some rarer occasions it had a more opaque surface.

Figure 98. Above, *De avibus* (DGARQ-ANTT, Lv. 5, fol. 4) from Lorvão monastery, Hagiographies (BPMP, SC 20, fol. 191) from Santa Cruz monastery and *Legendarium* (BNP, ALC 419, fol. 98) from Alcobaça monastery. Below, several examples of lac paint details found in the three scriptoria.

Complementary techniques

As already discussed at the beginning of this chapter, infrared spectroscopy was one of the first applied techniques that allowed suspecting the presence of lac dye in these paints. Moreover, it was mostly significant in establishing the type of mixtures used in the composition of the paints with the help also from Raman spectroscopy. For instance, pink colours were obtained by admixing the dye with lead white or with lead white and vermilion – this last combination was only found in a Alcobaça manuscript: ALC 347, Fig. 99a) and b); dark reds were sometimes obtained by admixing the organic colourant with vermilion – which was mostly identified in Santa Cruz illuminations, Fig. 99c) and d). In the Alcobaça scriptorium, the red dye was frequently mixed with gypsum in significant proportions as filler, Fig. 99e), while in Santa Cruz, gypsum was only found in minor quantities, in only one manuscript: SC 21. Calcium carbonate was mainly found in Lorvão and Santa Cruz scriptoria but its presence may be from the actual parchment support since it only occurs in small portions. The only case in which the intentional use of calcium as filler could be identified was in Bible SC 1 from Santa Cruz – as

[264] This *matiz* was normally made in combination with lead white and red lead, for example.

one of the strongest coloured pink paints found in Portuguese manuscripts, which also revealed characteristic bands normally associated to shellac, Fig. 99f). The observed effect from a more translucent to a more opaque surface was achieved through the composition: for glassy appearance, no fillers were used and a great amount of proteinaceous binder was found; for opaque paints, seen particularly in Alcobaça manuscripts, gypsum was admixed with the dye.

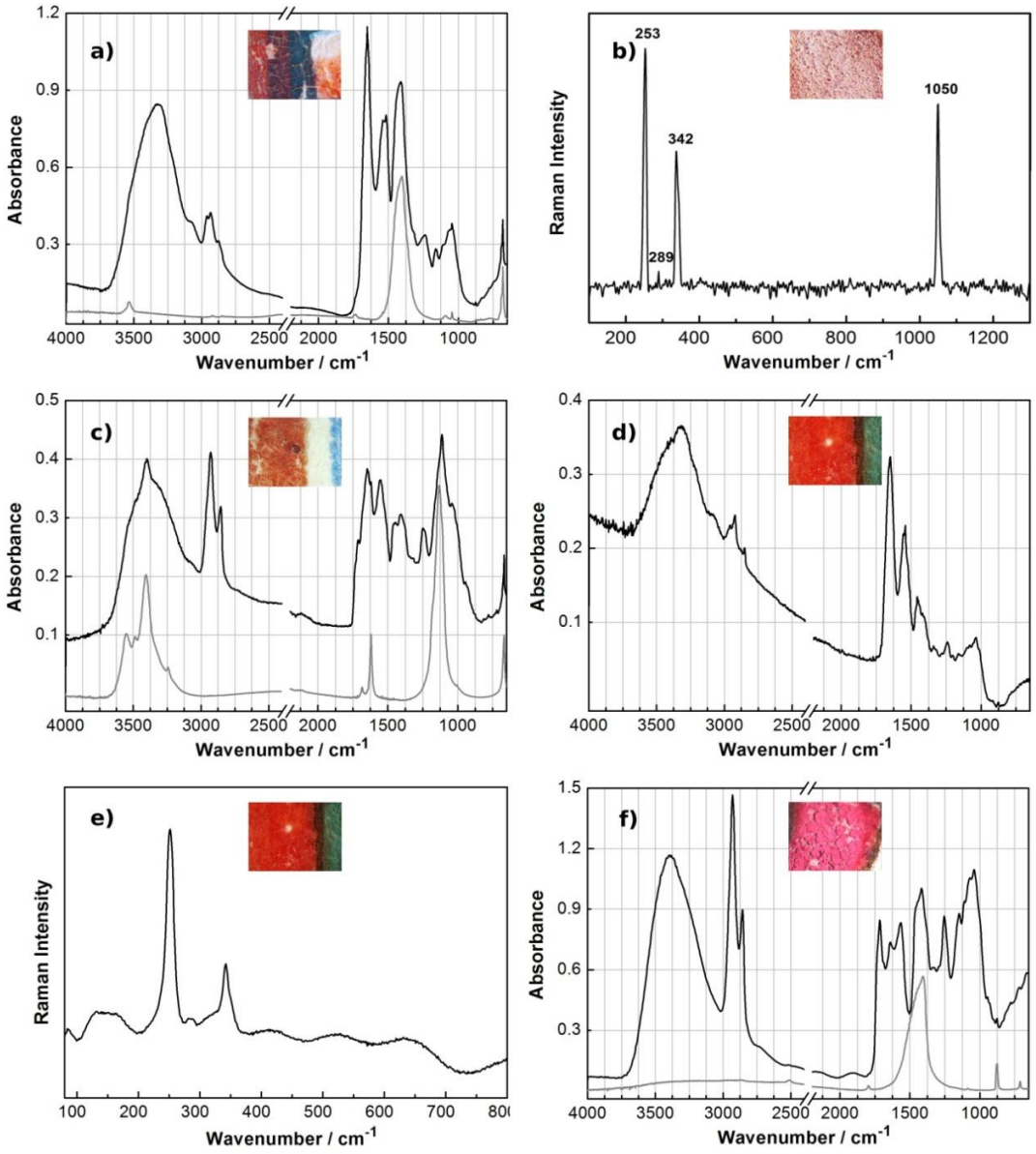


Figure 99. Representative infrared and Raman spectra from the dark reds and pink colours found in the three Portuguese scriptoria: **a)** infrared spectra from Lv 50, fol. 1v (─) with a lead white reference (┄); **b)** Raman spectrum from ALC 347, fol. 3 (with baseline correction); **c)** infrared spectra from ALC 238, fol. 206v (─) with gypsum reference (┄); **d)** infrared spectrum from SC 20, fol. 86; **e)** Raman spectrum from SC 20, fol. 86; **f)** infrared spectra from SC 1, fol. 14v (─) with calcium carbonate reference (┄)[265]. Each spectrum includes an inset image detail from the area where the micro-sample was taken with 40x, 63x, 50x, 63x, 32x magnifications, respectively.

[265] Please notice that the mss. Lv 50 and SC 1 were not subjected to any SERS analysis. Nevertheless, the infrared and microspectrofluorimetry data showed that these were very likely made of lac. Their emission and excitation maxima values can be seen in Appendix XVIII.

Surface Enhanced Raman Spectroscopy (SERS)

Surface Enhanced Raman Spectroscopy was for the first time used, as far as this study can tell, on 12th and 13th century's organic paints taken from illuminated manuscripts. When using the regular SERS procedure (Leona 2009), no clear signal from the dye was possible to obtain, due to the interference of the citrate ions capping the nanoparticles surface. Therefore, the HF pre-treatment – also used on the lake reconstructions – was necessary in order to acquire the identification of the dye. By doing this two step procedure, it allowed to confirm that the dark red used on Portuguese Romanesque illuminations was based on lac dye, Fig. 100.

The fact that SERS only worked after acidic treatment suggests that the historical paints from the manuscripts may have been all complexed with a metal ion; however, crosslinking of the resin may also have prevented the dye from being effectively mobilized in the paint sample without HF hydrolysis. It is, however, believed that alum may have been used in the historical samples since many infrared spectra showed a broad and declination band at the 750-650 cm^{-1} region – not completely resolved since it continues up to 400 cm^{-1} –, which is ascribed to the Al-O vibrations of aluminium in octahedral coordination, as seen in Fig. 99 (Clementi *et al.* 2008: 30). Overall, the SERS spectra of the historical samples are very similar to the lake reproductions spectra – type A –, revealing only slight variations in the 1580-1010 cm^{-1} region.

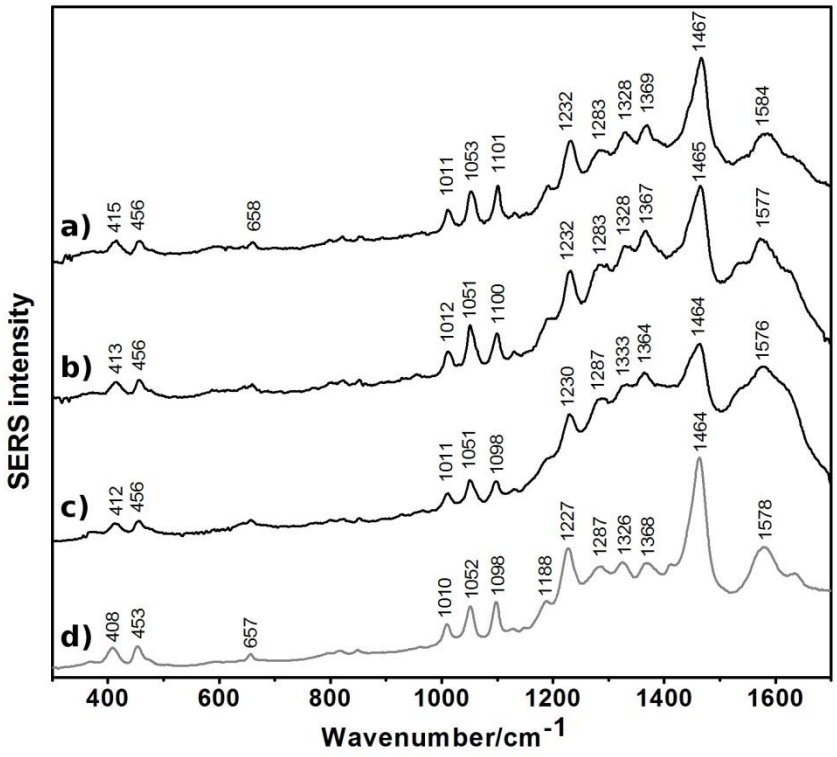


Figure 100. SERS spectra of the historical samples, at λ_{exc}=488 nm: **a)** Lorvão 5, fol. 6; **b)** Santa Cruz 20, fol. 191; **c)** Alcobaça 446, fol. 96v; **d)** laccaic acid A at pH=2 (—).

Microspectrofluorimetry

The emission and excitation maxima for the original medieval samples are displayed in Fig. 101 and Table 13. For more information on other manuscripts where dark reds were analysed by microspectrofluorimetry, please consult Table XVIII.2 in Appendix XVIII.

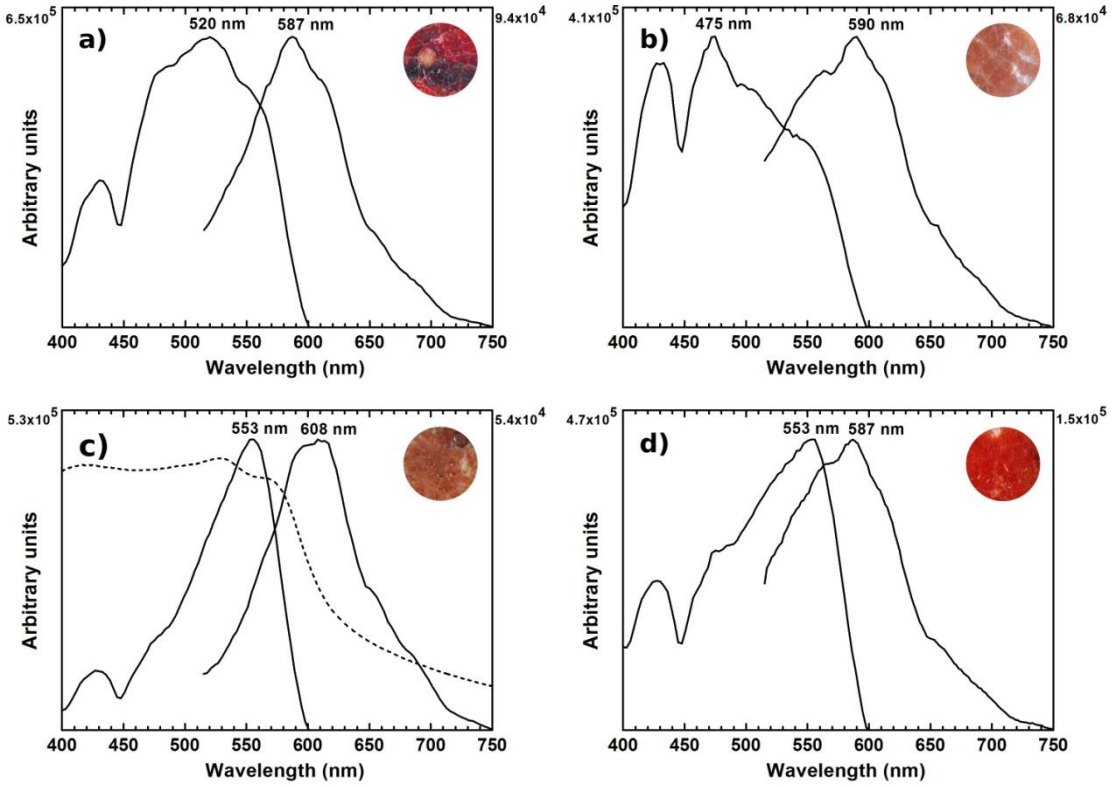


Figure 101. Excitation and emission spectra from several dark reds found in the three Portuguese scriptoria: **a)** Lorvão 5, fol. 73v; **b)** ALC 412, fol. 10v; **c)** ALC 238 fol. 206v, with the apparent absorption spectrum (---); **d)** SC 20, fol. 86. Each spectrum contains an inset image detail from the area where the micro-sample was taken.

Table 13. Fluorescence emission and excitation maxima of lac dye paints identified in each scriptoria.

	Lv 5	**ALC 238**	**ALC 249**	**ALC 412**	**ALC 419**	**ALC 421**	**ALC 446**	**SC 20**	**SC 21**
λ_{exc}/nm	523	553	556	475	553	472	478	553/472	523/472
λ_{em}/nm	587	608	590	590	590	591	593	587	590

The emission spectra show a band at 590±3 nm, which is detected consistently for the medieval paints. As observed in Fig. 101 and Table 13, more pronounced shifts are observed for the excitation spectra. Some of the original samples display a band at around 472 nm, particularly prominent in the Alcobaça samples, which, as discussed above, is likely due to the presence of higher amounts of resin; others present a band around 523 nm; and finally, there is a group of them that displays a band about 553 nm. The latter, compared to the reproductions,

was only observed in the Jehan Le Begue recipe, where more brazilwood was used[266]. Overall, when comparing these with the lac-Al^{3+}, sticklac and shellac spectra, it is possible to conclude that overall the medieval paints are composed of lac dye and shellac, in more or less concentration. Compared with the reconstructions, all A, B and C types of reproductions revealed similarities to the historical lac paints. In terms of signal intensity, more pronounced emissions were observed in samples from Lorvão (circa 2x), whereas spectra of Alcobaça and Santa Cruz samples were characterized by lower intensities.

No clear connections were established between the medieval paints that were mixed with pigments and the lac dye reproductions also with mixtures. The only similar effect was observed on the intensity of the signal that was normally lower, particularly when high proportions of vermilion and gypsum were used. The emission spectra were overall very similar between all of the historical paints, with the exception of the ALC 238 that presented a maxima emission around 608 nm. In some reconstructions, the presence of gypsum also led to a shift of wavelength, which could explain the deviation. In addition, the apparent absorption spectrum in fol. 206v from the Alcobaça *De Avibus* is in agreement with the obtained results for reproductions with or without gypsum, by displaying two bands at 529 and 568 nm. For more information on the mixtures, please see detailed results in Appendix XVIII.

Microspectrofluorimetry vs. MOLAB fluorimetry

When comparing both equipments, within the emission spectra, it was possible to detect differences in their maxima. While microspectrofluorimetry from the DCR presented mostly an emission maxima around 590 nm, the MOLAB fluorimetry showed predominantly an emission maxima around 610 nm, Fig. 102. The only exception was observed with Santa Cruz 20, fol. 197v, which presented a maxima at 614 nm.

The emission spectra from the microspectrofluorimetry were acquired exciting at 490 nm, while the MOLAB fluorimetry used an excitation at 440 nm. This behaviour suggests the presence of at least two fluorophores. This evidences the need of more studies on each component from the lac dye in order to understand better its performance.

[266] The Bolognese 130, for example, also a type C reproduction, displayed maxima values of 520 and 556 nm.

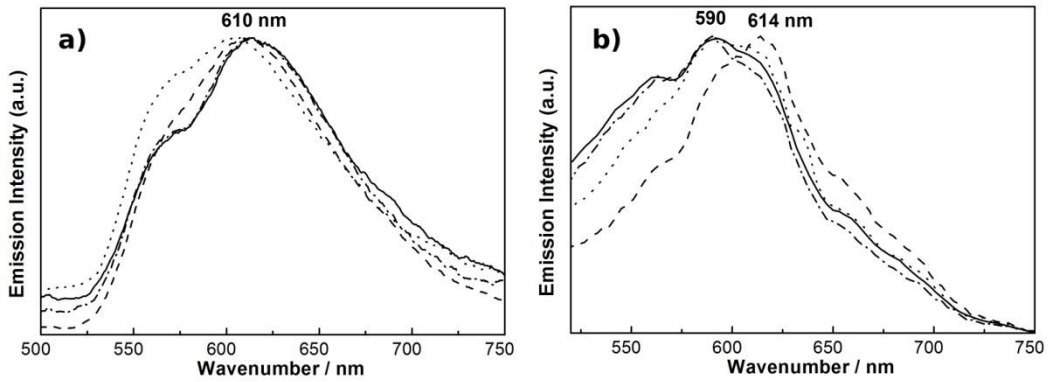


Figure 102. Normalised emission spectra from several dark reds found in Santa Cruz manuscripts: **a)** MOLAB emission spectra from SC 2, fol. 193 (—), SC 18, fol. 3v (-·-·), SC 20, fol. 139 (---), SC 21, fol. 19 (···); **b)** DCR microspectrofluorimetry emission spectra from SC 20, fols. 191 (—) and 197v (---), and SC 21, fols. 2 (···) and 19 (-·-·).

4. Final remarks

Reaching for past knowledge is the supreme goal when it comes to interpreting medieval written sources. The availability of historically accurate reconstructions proved to be crucial for this study, as it enabled to assemble a consistent spectral database of mock-ups prepared according to historical recipes, to be used for comparison in the analysis of samples from medieval illuminations. The interpretation of each recipe is subjected to some degree of subjectivity, but by reproducing a considerable number of recipes with different ingredients and instructions, the speculative risk was diminished by analysing and criticising each step. The colours and analytical characteristics found in Portuguese medieval illuminations were always established as the main goals, trying constantly to reach a similar product, through a critical and scientific observation. The comparison with paint reconstructions prepared in the lab shed new light on the fact that the colour shades observed in the medieval paints – pink, red and violet, to brownish hues – were mainly the result of the processing of the colorant as opposed to a result of degradation.

It was observed that the recipes that demanded more time of extraction, led to more incorporation of resin, which conferred more gloss to the final paint. Through microspectrofluorimetry this observation was also transposed to the medieval paints as they also seemed to incorporated significant amount of resin. Overall, when comparing historical samples with reconstructions, these appeared to be more related to the recipes from type A, when taking into account all of the applied analytical techniques.

It was also possible to sustain that brazilwood could not have been used in Portuguese Romanesque illuminations, not only because there were no analytical evidence for its usage –

with the exception of the excitation spectra from some of the medieval paints –, but also because it only began to be frequently mentioned in treatises from the 15th century onwards.

Within the group of reproduced treatises, the LKFK, the ibn Bādīs and the Mappae Clavicula manuscripts were considered particularly relevant for this study, because they share more connections with the Romanesque Portuguese monasteries in terms of origin, dating, and religious and social backgrounds. Nonetheless, it was the Mappae Clavicula recipe that showed more similarities with the medieval paints. Moreover, as already referred in Chapter I, this treatise was the only known manuscript that was most certainly present in the Santa Cruz library (Matos 2011: 135).

When looking solely to the treatises and recipes, there are some interesting facts that should be emphasised. Throughout the centuries, the choice of materials shows changes, from the use of plants to more modern ingredients such as crystals of tartar in the late 16th to the 17th century. Brazilwood, which became an extremely popular dye in the 15th century, started to be mixed with lac dye in order to make red paints. Alum *zucharino* appears only in the 15th century. Moreover, a particular prominent change can be observed in the Paduan manuscript, since it opened a new era for lac with the development of the purification of shellac. It also seems to indicate a lack of interest for the first time in the dye itself, as other red dyes become more important for miniature painting in Europe. This is in agreement with the reported occurrences of lac dye in paintings from the 13th to the 17th centuries in European paintings (Kirby, Spring and Higgitt 2005: 86-87; Kirby 2012: 169).

In this work, for the first time, lac dye was unequivocally identified in medieval illuminations. SERS proved to be an advantageous technique for the identification of dyes in illuminated manuscripts, because of the minute sample size required to analysis (10-20 μm). By having the unambiguous molecular fingerprint of the dye provided by SERS, it was possible to assess the microspectrofluorimetry results and validate this technique as a suitable analytical tool for the detection of lac dye *in situ*. While SERS provided unequivocal identification of laccaic acid A, microspectrofluorimetry described the chromophore in its environment. In this sense, these two techniques, combined in this study for the first time, can be seen as complementary.

In conclusion, this research was able to shed new light on the use of this historical dye. Its systematic application in Portuguese medieval manuscripts to obtain specifically dark red colours shows the importance of lac dye throughout the 12th and 13th centuries – much earlier than the arrival of the Portuguese explorer Vasco da Gama to India, in 1498. There is no evidence, to date, that lac dye was being used by medieval monasteries other than those cited in this work. Thus far, it has only been identified by SERS in a French polychrome wood sculpture

and in a Spanish crucifix, both dating to 1150-1200 (Leona 2009: 14760; Pozzi 2012: 105, 109). These three occurrences, in the Iberian Peninsula and Provence, corroborate the existence of an Arabic and Jewish trade network in the Al-Andalus and south-eastern France region during the Romanesque period. It is quite likely that more occurrences will be determined now that these techniques, particularly SERS, are being increasingly applied on cultural heritage.

As seen also throughout this dissertation, colour was perceived differently in medieval times, to the extent that brightness and opacity could be considered more significant than the actual hue (Gage 1999: 70). The ancient purple dye was, as already discussed in Chapter I, perceived as a brilliant colour (Bradley 2011: 82). Taking into consideration all of meaning behind the colour and the diminuishing use of purple in Romanesque manuscripts – as shown in the *colour mapping* data –, it is proposed here that the saturated red of lac was used to represent purple also as a luminous colour.

FINAL CONCLUSIONS

1.1. Major contributions

This dissertation embraced a holistic approach, by bridging innovative methodologies within the continuously expanding field of manuscript studies.

This thesis brought for the first time an exhaustive study on the Portuguese scriptorium of Santa Cruz of Coimbra. The colour paints were found to be in agreement with the already studied scriptoria from Santa Maria of Alcobaça and São Mamede of Lorvão and the bookbindings from the collection were also for the first time studied in detail. On the conservation level, this work aimed to bring awareness to the public, by having acknowledged the central issues within the manuscripts as well as having highlighted and valued this much unfamiliar cultural heritage to general society. It became clear that the bindings need exceptional vigilance.

From a broad spectrum, this work also posed very abstract questions regarding the relationship between medieval man and colour. It was possible to conclude that, on one hand, the importance of a colour was intrinsically correlated with its availability and knowledge on its process of manufacture. This was the case, for example, for lapis lazuli – it is likely that the commercial routes to Afeghanistan only started to arrive to medieval Europe around the 10th century, based on the analytical findings presented in Table 1. As moving to the 12th century, lapis lazuli starts to substitute indigo, as seen in the colour mapping analysis, due to its brightness. This leads to the second and most important intention behind the significance of colour: light. As previously discussed, the best coloring materials should embody light in order to please the medieval man as it made him feel closer to God, and for that reason, it is proposed in here that lac dye assumes that role with the disappearing of purple, as seen in Santa Cruz. This fading may have been related, once again, to its availability and process of manufacture, which made Tyrian purple, just as an example, too expensive. From these observations, it was also concluded that indeed pigments and dyes, as material things, related to the *significatio* of medieval illuminations.

By analysing the colour from the three Portuguese Romanesque illuminated manuscripts through the innovative mapping tool, it allowed Professors Maria João Melo and Adelaide Miranda conclude that, during Middle Ages, colour was perceive also through a semiotic system, where red, blue and green stood as the main axis for the coordination of hues. The Book of Birds case study allowed also establishing in this thesis that, in some cases, the illuminator did assume an active role in the interpretation of medieval texts. A clear example of that is the Dove Diagram that in the 13th century begins to be painted with silver and gold leaves.

On this note, this work contributed with the development, systematic application and analysis of the *colour mapping* tool to three collections of 12th and 13th centuries illuminated manuscripts with the combination of molecular characterisation. As shown here, when used as a complementary technique, it can bring new insights to art history by correlating colour patterns to specific periods in history. This, in turn, can be also used as a significant supplementary tool for dating manuscripts, as long as the period and style in question are well assessed.

With the Portuguese *De Avibus,* an innovative methodology for the study of circulation of manuscripts was developed for the first time, through the analysis of their history, codicology, iconography, colour – by molecular characterisation and meaning –, text analysis and state of conservation. It was possible to establish their relationships, their common and uncommon features as well as propose new datings for the Santa Cruz and Alcobaça copies. This research was also able to demonstrate that while Alcobaça came directly from the Clairvaux copy, Santa Cruz and Lorvão came most likely from another source. This suggests that an older fourth manuscript may have been most likely present in the Santa Cruz monastery, which had privileged contact with St. Ruf of Avignon. This means that two types of models – one from a Cistercian and another from a Regular Canons house – were circulating in Portugal during the 12th century.

Finally, a new methodology was also developed for the characterisation of dyes in illuminated manuscripts. Surface-enhanced Raman spectroscopy was used for the first time in combination with microspectrofluorimetry in order to identify lac dye in 12th and 13th century paints. A survey on lac recipes from medieval written technical sources was gathered also for the first time. These were used to test the methodology and to compare with the medieval paints. From this research, lac dye was unequivocally identified, but also specificities within each scriptoria were also detected, highlighting the importance of a multi-analytical approach in order to study the formulation of a paint. Lastly, this study also allowed confirming the existence of an Arabic and Jewish trade route in the Iberian Peninsula through the commercialization of this precious commodity.

1.2. Dissemination

Between the 18th and 19th centuries, Europe faced a new political and free-thinking mentality, which had extreme consequences for the cultural heritage. With the reforms inspired by the French Revolution, through liberalism, and the secularisation, several countries determined the dissolution of the religious orders, leading to the disappearance of abbeys,

convents and religious communities (De Mayer, Leplae and Schmiedl 2004: 18)[267]. With the extinction of these orders, the manuscripts that were held in the monasteries were, in the best scenario, moved to other libraries, archives and museums, while others were destroyed, sold or reused for indefinite reasons. However, despite these appalling repercussions, as Inês Correia reports, 'new custodial institutions gave them new possibilities as historic and artistic items, integrating them into their collections, describing them in inventories and displaying them through exhibitions and catalogues' (Correia 2011: 3).

As classical studies and newer disciplines, such as palaeography and codicology, began to emerge from the academic world (Correia 2011: 3), a new appreciation for the knowledge within this cultural heritage arrived. In addition to the historians, art historians also had a significant role in the dissemination of medieval manuscripts, as works of art, enhancing its merits beyond their documentary value. And, most recently, the conservation community – often coupled with conservators, restorers, chemists and physics, for example – embraced the study of their materiality.

Despite this widespread interest in medieval manuscripts from academia, the majority of the society is still distant and remains unaware of this heritage. Notwithstanding the efforts made by libraries, archives and museums to exhibit these 'fragile tridimensional objects that cannot be fully accessed', unlike easel paintings, since its display is normally provided with only two opened pages, this cultural inheritance stands as inaccessible for the general public, which cannot fully value the information and beauty within it (Correia *et al.* 2014: 2).

Throughout these centuries, the dissemination and access of knowledge, culture, technology and art through medieval manuscripts have experienced significant social, political, technological and cultural changes. Nevertheless, these changes have led to a greater engagement and openness to society, although still with limitations. Inspired by the crucial role assumed by monastic scriptoria in the dissemination of the European cultural heritage, this PhD also aimed to disseminate that wealth of knowledge and contribute for a better access to those manuscripts, both in their intangible aspects as well as in their materiality.

This dissemination was developed not only for the scientific community – in the form of peer-reviewed articles, oral and panel communications in national and international meetings –, but also for the general public. Consequently, an important part of sharing the knowledge obtained during these years was achieved through hands-on workshops, where participants from all age groups are invited to paint with the materials as similar as possible to the originally used

[267] In Portugal, the process began with the decree of expulsion of the Jesuits in 1759. However, the actual extinction of the religious orders happened only a century later, in 1834 (Giurgevich 2012: 271).

in the Romanesque period[268]. This allows them to be acquaintance with the art technology of that time, and above all, it also enables them to be in contact with a form of art that is for most part of the society still unknown.

Through this rewarding experience, new ways of approaching the audience were also developed within a multidisciplinary team, made by computer engineers, designers, illustrators, art historians, chemists, and conservators, by the development of an interactive installation (Correia *et al.* 2014). In the course of the knowledge gained in this investigation, it was possible to contribute for several of its contents, such as the interactive panel and the augmented book[269], as seen in Fig. 101. The latter was based on the manuscript *De Avibus* from Lorvão and the binding structure was inspired on the Romanesque technique found in Alcobaça scriptorium. Although not yet finished, the book has been filled with illuminations from reproductions from the Lv 5 with contributions from master students of History and Art Production Techniques, from DCR-FCT. This has enabled to have a more in-depth assessment on the techniques used by the artists.

Figure 103. On top left, creating the Dove and Hawk illumination from a Virtual scriptorium; On top right, lac dye information on the Interactive panel; On the bottom, the Augmented book.

[268] When working with children and untrained people, the toxic pigments are substituted by innocuous and safe colourants.
[269] For more information on these interactive elements, please see Correia *et al.* 2014.

1.3. Future directions

This work opened new perspectives regarding new lines of research.

For instance, some colour paints, such as the purple from Santa Cruz, the yellows in all of the collections and the browns from Alcobaça, still remain as mysteries. On the one hand, the same methodology developed in this thesis for dyes should be of great relevance for the study of the purple. On the other hand, the other two should be also researched, particularly through the making of historically accurate reconstructions that may lead in the future to the development of better and more sensitive experimental techniques.

It was possible to establish that calcium oxalate is an important marker for the binder degradation in Romanesque paints. Not only it was identified in Santa Cruz in green and black samples, it was also found isolated in the Book of Birds in brown paints. As a major degradation phenomenon in these manuscripts, it is imperative to find and understand what are the main chain reactions that are involved in this process, which are leading to the formation of the calcium oxalates. Knowing the mechanisms behind this issue, will certanly open new perspectives on how to preserve and intervene on these fragile paints. Additionally, as also seen, the role of sulphates on the degradation of lead-based pigments should be also explored.

Given the up to date preservation state of the Santa Cruz collection, its fruition is currently very limited. In order to increase the access to this vital cultural heritage it is imperative to find ways to stabilize its state of conservation, keeping its physical and archaeological integrity. As for future work, it would be tremendously essential to identify the materials used in the bindings' different typologies. This would most likely give more information on the production periods as well as provide the needed tools for future interventions.

The *mapping colour* tool would be also of great advantage for new studies on the circulation of copies. It should be opened to other European manuscript studies, by exploring different scriptoria. More correlations between manuscripts with colophon should be also assessed in order to develop more knowledge around the changes within the colour systems observed in illuminated manuscripts through time.

The Clairvaux *De Avibus* manuscript is currently the mysterious piece that still may provide some answers to the study of these Books of Birds. It could be of great importance to conduct a molecular analysis on its illuminations. Based on its colour palette, it could evidence if the manuscript could or not have been produced in Portugal. On the other hand, a codicology study could also provide information regarding the binding, for example. Taking into

consideration the typology from Alcobaça, this could also serve as an essential element for the location of its production.

Finally, regarding the approached methodology for lac dye, it is important to proceede more studies on this matter. On one hand, it is imperative to compare more types of historical dyes through microspectrofluorimetry as well as their influence when mixed with other pigments, in order to reinforce the advantages and capabilities of this technique for illuminated manuscripts – that has the great advantage of being *in situ*. On the other hand, on a more complex analysis, it will be also important to comprehend more about the influence of each component in the dye and its photo-degradation behavior – how it is translated into the excitation and emission spectra.

BIBLIOGRAPHY

ACETO, M.; AGOSTINO, A.; BOCCARELI, E.; CRIVELLO, F.; GARLANDA, A.C. (2010). 'Identification of copper carboxylates as degradation residues on an ancient manuscript', *Journal of Raman Spectroscopy*, 41(11), 1434-1440.

ACETO, M.; AGOSTINO, A.; GULMINI, M.; PELLIZZI, M.; BIANCO, V. (2011). 'A protocol for non-invasive analysis of miniature paintings', *Revista de História da Arte*, nº1, série W, 229-241.

ACETO, M.; AGOSTINO, A.; FENOGLIO, G.; BARALDI, P.; ZANNINI, P.; HOFMANN, C.; GAMILLSCHEG, E. (2012a). 'First analytical evidences of precious colourants on Mediterranean illuminated manuscripts', *Spectrochimica Acta - Part A*, 95, 235-245.

ACETO, M.; AGOSTINO, A.; FENOGLIO, G.; GULMINI, M.; BIANCO, V.; PELLIZZI, E. (2012b). 'Non invasive analysis of miniature paintings: proposal for an analytical protocol', *Spectrochimica Acta - Part A*, 91, 352-359.

ACETO, M.; IDONE, A.; AGOSTINO, A.; FENOGLIO, G.; GULMINI, M.; BARALDI, P.; CRIVELLO, F. (2014). 'Non-invasive investigation on a VI century purple codex from Brescia, Italy', *Spectrochimica Acta - Part A*, 117, 34-41.

ACETO, M.; ARRAIS, A.; MARSANO, F.; AGOSTINO, A.; FENOGLIO, G.; IDONE, A.; GULMINI, M. (2015). 'A diagnostic study on folium and orchil dyes with non-invasive and micro-destructive methods', *Spectrochimica Acta Part A*, 142, 159-168.

AFONSO, L.U. (2010). 'New developments in the study of *O livro de como se fazen as cores das tintas*', in L.U. Afonso (ed.), *The materials of the image: As matérias da imagem*. Lisboa: Cátedra de Estudos Sefarditas «Alberto Benveniste» da Universidade de Lisboa, pp. 3-27.

ALEXANDER, J.J.G. (1992). *Medieval illuminators and their methods of work*. New Haven and London: Yale University Press.

AMAT, A.; ROSI, F.; MILIANI, C.; SGAMELLOTTI, A.; FANTACCI, S. (2011). 'Theoretical and experimental investigation on the spectroscopic properties of indigo dye', *Journal of Molecular Structure*, 993, 43-51.

ANDERSON, F.A.; BREČEVIĆ, L. (1991). 'Infrared spectra of amourphous and crystalline calcium carbonate', *Acta Chemica Scandinavica*, 45, 1018-1024.

ANTUNES, J. (2006). 'A invulgar cultura literária de Frei António de Lisboa', in *Estudos em homenagem ao Prof. Doutor José Marques*, vol. 2, Departamento de História e de Estudos Políticos Internacionais (Org.). Porto: Faculdade de Letras da Universidade do Porto, pp. 387-394.

ARTIOLI, G. (Ed.) (2010). *Scientific methods and cultural heritage: An introduction to the application of materials science to archaeometry and conservation science*. New York: Oxford University Press.

AXELSSON, K.M.; LARSEN, R. and SOMMER, D.V.P. (2012). 'Dimensional studies of specific microscopic fibre structures in deteriorated parchment before and during shrinkage', *Journal of Cultural Heritage*, 13(2), 128-136.

AXELSSON, K.M.; LARSEN, R.; SOMMER, D.V.P. and MELIN, R. (2016). 'Degradation of collagen in parchment under the influence of heat-induced oxidation: Preliminary study of changes at macroscopic, microscopic, and molecular levels', *Studies in Conservation*, 61(1), 46-57.

BADEA, E.; DELLA GATTA, G.; BUDRUGRAC, P. (2011). 'Characterisation and evaluation of the environmental impact on historical parchments by differential scanning calorimetry', *Journal of Thermal Analysis and Calorimetry*, 104(2), 495-506.

BADEA, E.; MIU, L.; BUDRUGEAC, P.; GIURGINCA, M.; MAŠIĆ, A.; BADEA, N.; DELLA GATTA, G. (2008). 'Study of deterioration of historical parchments by various thermal analysis techniques, complemented by SEM, FTIR, UV-VIS-NIR and unilateral NMR investigations', *Journal of Thermal Analysis and Calorimetry*, 91(1), 17-27.

BALL, P. (2008). *Bright earth: the invention of colour*. [1st edition: 2001] London: Vintage Books.

BARALDI, P.; MOSCARDI, G.; BENSI, P.; ACETO, M.; TASSI, L. (2009). 'An investigation of the palette and techniques of some high medieval codices by Raman microscopy', *e-Preservation science*, 6, 163-168.

BARROSA, A.; CASTRO, R.; ARAÚJO, R.; CASANOVA, C. (n.d.). 'Study and conservation of two 17th century parochial manuscripts from Almada', in Care and conservation of manuscripts 16, April 2016, University of Copenhagen, *submitted*.

BEJCZY, I.P. (2005). 'Introduction', in István P. Bejczy and Richard G. Newhauser (Ed.), *Virtue and ethics in the twelfth century*. Leiden, Boston: Brill, pp. 1-10.

BENTON, J.A. (2009). *Materials, methods, and masterpieces of medieval art*. (Praeger series on the Middle Ages). Santa Barbara, California: ABC-CLIO.

BERLIOZ, J.; CORDONNIER, R. (2004). 'Le convers et les oiseaux. Monde animal, morale et milieu monastique: Le *De Avibus* d'Hugues de Fouilloy (XIIe siècle)', in *Homme-animal, histoires d'un face à face*. Catalogue de l'exposition de Strasbourg (Galerie Heitz, Musée Archéologique, Musée de l'ouvre Notre-Dame, Musée d'Art Modern et Contemporain, 7 avril-4 juillet 2004). Paris: Adam Biro – Strasbourg, Musées de Strasbourg, pp. 73-81, 125.

BERSANI, D.; LOTTICI, P.P.; VIGNALI, F.; ZANICHELLI, G. (2006). 'A study of medieval illuminated manuscripts by means of portable Raman equipments', *Journal of Raman Spectroscopy*, 37, 1012-1018.

BEST, S.P.; CLARK, R.J.H.; DANIELS, M.A.M.; PORTER, C.A.; WITHNALL, R. (1995). 'Identification by Raman microscopy and visible reflectance spectroscopy of pigments on an Icelandic manuscript', *Studies in Conservation*, 40(1), 31-40.

BEST, S.P.; CLARK, R.J.H.; WITHNALL, R. (1992). 'Non-destructive pigment analysis of artifacts by Raman microscopy', *Endeavour*, 16, 66-73.

BICCHIERI, M.; MONTI, M.; PIANTANIDA, G.; PINZARI, F.; SODO, A. (2011). 'Non-destructive spectroscopic characterization of parchment documents', *Vibrational Spectroscopy*, 55, 267-272.

BICCHIERI, M.; MONTI, M.; PIANTANIDA, G.; SODO, A. (2011). 'Illuminations: secrets, alchemy and conservation in three case studies', *Revista de História da Arte*, nº1, série w, 175-181.

___ (2013). 'Non-destructive spectroscopic investigation on historic Yemenite scriptorial fragments: evidence of different degradation and recipes for iron tannic inks', *Analytical Bioanalytical Chemistry*, 405, 2713-2721.

BICCHIERI, M.; NARDONE, M.; SODO, A. (2000). 'Application of micro-Raman spectroscopy to the study of an illuminated medieval manuscript', *Journal of Cultural Heritage*, 1, S277-S279.

BIOLETTI, S.; LEAHY, R.; FIELDS, J.; MEEHAN, B.; BLAU, W. (2009). 'The examination of the Book of Kells using micro-Raman spectroscopy', *Journal of Raman Spectroscopy*, 40(8), 1043-1049.

BISHOP, J.L. and MURAD, E. (2005), 'The visible and infrared spectral properties of jarosite and alunite', *American Mineralogist*, 90(7), 1100-1107.

BLONDHEIM, D.S. (1928). 'An old Portuguese work on manuscript illumination', *Jewish Quaterly Review*, 19(2), 97-135.

BLOOMFIELD, M. (1990). *Hymns of the Atharva-veda. Together with extracts from the ritual books and the commentaries.* M. Boomfield (trans.). (Sacred books of the East). New Delhi: Atlantic Publishers & Distributors.

BOLMAN, E.S. (1999). 'De Coloribus: the meaning of color in Beatus manuscripts', *Gesta*, 38(1), 22-34.

BORGES, N.C. (2002). *Arte monástica em Lorvão: sombras e realidade. Das origens a 1737*. Volume I. Textos Universitários de Ciências Sociais e Humanas. Lisboa: Fundação Calouste Gulbenkian, Fundação para a Ciência e a Tecnologia.

BORRADAILE, V. and BORRADAILE, R. (1966). *The Strasbourg manuscript: A medieval painters' handbook*. New York: Transatlantic Arts.

BOSE, P.K.; SANKARANARAYANAN, Y. and SEN GUPTA, S.C. (1963). *Chemistry of lac*. Namkum, India: Indian Lac Research Institute.

BOURGAIN, P. (2015). 'The circulation of texts in manuscript culture', in M. Johnston and M. Van Dussen (Eds.), *The medieval manuscript book: cultural approaches*. (Cambridge Studies in Medieval Literature). Cambridge: Cambridge University Press, pp. 140-159.

BOZEC, L.; VAN DER HEIDJDEN, G. and HORTON, M. (2007). 'Collagen Fibrils: Nanoscale Ropes', *Biophysical Journal*, 92, 70-75.

BRADLEY, J.W. (1920). *Illuminated manuscripts.* 2nd edition. London: Methuen & Co. Ltd.

BRADLEY, M. (2011). *Colour and meaning in Ancient Rome.* Cambridge: Cambridge University Press.

BROECKE, L. (2015). *Cennino Cennini's* Il libro dell'arte: *A new English translation and commentary with Italian transcription*. London: Archetype Publications.

BROSTOFF, L.B.; KHAN, Y.R.; OHANYAN, T.; HENGEMIHLE, F. (2010). 'Technical study of a fifteenth-century Armenian illuminated gospel from the Verin Noravank monastery', in C. Rozeik, A. Roy, D. Saunders (eds.), *IIC 2010 Istanbul Congress: Conservation and the eastern Mediterranean*. London: International Institute for Conservation of Historic and Artistic Works, pp. 62-68.

BROWN, M.P. (1994). *Understanding illuminated manuscripts: a guide to technical terms*. L.A., California: Getty Publications.

BROWN, K.L. and CLARK, R.J.H. (2004). 'The Lindisfarne Gospels and two other 8th Century Anglo-Saxon/Insular manuscripts: pigment identification by Raman microscopy', *Journal of Raman Spectroscopy*, 35(1), 4-12.

BRUNELLO, F. (1992). *De arte illuminandi e altri trattati sulla miniatura medievale*. 2nd edition. Vicenza: Neri Pozza Editore.

BRUNI, S.; CAGLIO, S.; GUGLIELMI, V.; POLDI, G. (2008). 'The joined use of N.I. spectroscopic analyses - FTIR, Raman, visible reflectance spectrometry and EDXRF - to study drawings and illuminated manuscripts', *Applied Physics A: Materials Science and Processing*, 92(1), 103-108.

BRUNI, S.; CARIATI, F.; CASADIO, F.; TONIOLO, L. (1999). 'Identification of pigments on a XV century illuminated parchment by Raman and FTIR microspectroscopies', *Spectrochimica Acta Part A: Molecular and Biomolecular Spectroscopy*, 55, 1371-1377.

BRUNI, S.; GUGLIELMI, V. and POZZI, F. (2011). 'Historical organic dyes: a surface-enhanced Raman scattering (SERS) spectral database on Ag Lee-Meisel colloids aggregated by $NaClO_4$', *Journal of Raman Spectroscopy*, 42, 1267-1281.

BRUSATIN, M. (1991). *A history of colors* [originally *Storia dei Colori*. Torino, 1983]. Boston & London: Shambhala Publications.

BUCKLOW, S. (2013), 'Housewife chemistry', in L. Wrapson, J. Rose, R. Miller and S. Bucklow (eds.), *Artists' Footsteps: The reconstruction of pigments and paintings*. London: Archetype Publications, pp. 17-28.

BUDRUGEAC, P., BADEA, E., DELLA GATA, G., MIU, L., COMĂNESCU, A. (2010). 'A DSC study of deterioration caused by environmental chemical pollutants to parchment, a collagen-based material', *Thermochimica Acta*, 500, 51-62.

BURGIO, L.; CLARK, R.J.H.; GIBBS, P.J. (1999). 'Pigment identification studies *in situ* of Javanese, Thai, Korean, Chinese and Uighur manuscripts by Raman microscopy', *Journal of Raman Spectroscopy*, 30(3), 181-184.

BURGIO, L.; CIOMARTAN, D.A.; CLARK, R.J.H. (1997). 'Raman microscopy study of the pigments on three illuminated mediaeval Latin manuscripts', *Journal of Raman Spectroscopy*, 28, 79-83.

BURGIO, L.; CLARK, R.J.H. and FIRTH, S. (2001). 'Raman spectroscopy as a means for the identification of plattnerite (PbO_2), of lead pigments and of their degradation products', *The Analyst*, 126, 222-227.

BURGIO, L.; CLARK, R.J.H. and HARK, R.R. (2010). 'Raman microscopy and X-ray fluorescence analysis of pigments on Medieval and Renaissance Italian manuscript cuttings', *PNAS*, 107(13), 5726-5731.

BURNELL, A.C. (2010). *Voyage of John Huyghen van Linschoten to the East Indies: from the old English translation of 1598.* Volume I. Farnahm, Surrey: Ashgate.

BURTON, J. and KERR, J. (2011). *The Cistercians in the Middle Ages*. Woodbridge: The Boydell Press.

CABRAL, J.M.P. (2001). 'História breve dos pigmentos: III – Das Artes Grega e Romana', *Boletim da Sociedade de Química,* série II, 82, 57-64.

CAÑAMARES, M.V. and LEONA, M. (2007). 'Surface-enhanced Raman scattering study of the red dye laccaic acid', *Journal of Raman Spectroscopy*, 38, 1259-1266.

CARDON, D. (2007). *Natural dyes. Sources, tradition, technology and science*. London: Archetype Publications.

CARRUTHERS, M. (2008). *The book of memory. A study of memory in medieval culture*. Cambridge: Cambridge University Press.

___ (2009). 'Mechanisms for the transmission of culture: The role of 'place' in the arts of memory', in Laura H. Hollengreen (ed.), *Translatio or the transmission of culture in the middle ages and the renaissance: modes and messages*. Turnhout: Brepols, pp. 1-26.

___ (2010). 'The concept of *ductus*, or, journeying through a work of art', in M. Carruthers (ed.), *Rhetoric beyond words: delight and persuasion in the arts of the middle ages*. Cambridge: Cambridge University Press, pp. 190-213.

CASADIO, F.; LEONA, M.; LOMBARDI, J.R.; VAN DUYNE, R. (2010). 'Identification of organic colorants in fibers, paints, and glazes by surface enhanced Raman spectroscopy', *Accounts of Chemical Research*, 43(6), 782-791.

CASTRO, I. (2010). 'Notas sobre a língua do Livro de como se fazen as cores (ms. Parma 1959)', in L.U. Afonso (ed.), *The materials of the image: as matérias da imagem*. Lisboa: Cátedra de Estudos Sefarditas «Alberto Benveniste» da Universidade de Lisboa, pp. 87-96.

CASTRO, R.; MELO, M.J. and MIRANDA, A. (2014). 'The secrets behind the colour of the Book of Birds', in A. Miranda and A. Miguélez (Coord.), *Portuguese studies on medieval illuminated manuscripts*. Barcelona-Madrid: Brepols Publishers, pp. 31-55.

CASTRO, R.; POZZI, F.; LEONA, M.; MELO, M.J. (2014). 'Combining SERS and microspectrofluorimetry with historically accurate reconstructions for the characterization of lac dye paints in medieval manuscript illuminations', *Journal of Raman Spectroscopy*, 45, 1172-1179.

CASTRO, R.; MIRANDA, A.; MELO, M.J. (2016). 'Interpreting lac dye in medieval written sources: new knowledge from the reconstructions of recipes relating to illuminations in Portuguese manuscripts', in S. Eyb-Green, J.H. Townsend, J.K. Atkinson, S. Kroustallis, K. Pilz, I. van Leeuwen (eds.), *Sources on Art Technology: back to basics*. London: Archetype Publications, pp. 88-99.

CAVERO, A.M.; MELO, M.J.; MIRANDA, .M.A.; CASTRO, R.; CASANOVA, C. (2016). 'Beatus manuscripts under the microscope: the Alcobaça Beatus and the Iberian Cistercian tradition revisited', *Journal of Medieval Iberian Studies*, 8(2), 217-251.

CEPEDA, I.V. and FERREIRA, T.A.S.D. (Eds.) (1994). *Inventários dos códices iluminados até 1500: Distrito de Lisboa*, Volume 1, Imprensa Nacional – Casa da Moeda.

CHAMBEL, P. (2003). *Os Animais na literatura clerical Portuguesa dos séculos XIII e XIV – presença e funções*. Dissertação de Doutoramento em História Medieval. Lisboa: FCSH-UNL.

___ (2006). 'A evolução do bestiário letrado medieval – uma síntese', Lisboa: IEM-FCSH-UNL. Accessed August 9, http://germanistik-portugal.org/iem/investigar/estudos/investigacao/bestiario-letrado-medieval

CIZEWSKI, W. (1987). 'Reading the world as scripture: Hugh of St Victor's *De Tribus Diebus*', *Florilegium*, 9, 65-88.

CLARK, W.B. (1982). 'The illustrated medieval Aviary and the lay-brotherhood', *Gesta*, 21(1), 63-74.

___ (1992). *The medieval Book of Birds*: *Hugh of Fouilloy's Aviarium* (Medieval and Renaissance texts and studies, 80). New-York: Binghampton.

___ (2006). *A Medieval Book of Beasts. The second-family bestiary: commentary, art, text and translation*. Woodbridge, Suffolk: The Boydell Press.

CLARK, W. B. and MCMUNN, M. T. (Eds.) (1989). *Beasts and birds of the middle ages. The bestiary and its legacy*, Philadelphia: University of Pennsylvania Press.

CLARK, Robin J.H. (1995a). 'Pigment identification on medieval manuscripts by Raman microscopy', *Journal of Molecular Structure*, 357, 417-428.

CLARK, R.J.H. (1995b). 'Raman microscopy: application to the identification of pigments on medieval manuscripts', *Chemical Society Reviews*, 24(3), 187-196.

CLARK, R.J.H. and GIBBS, P.J. (1998). 'Raman microscopy of a 13th-century illuminated text', *Analytical Chemistry*, 70, 99A-104A.

CLARKE, M. (2001a). *The art of all colours: mediaeval recipe books for painters and illuminators*, London: Archetype Publications.

___ (2001b). 'The analysis of medieval European manuscripts', *Reviews in Conservation*, 2, 3-17.

___ (2004a). '*Really* don't trust your eyes to identify manuscript pigments!', *Gazette du livre médiéval*, 44, 50-53.

___ (2004b).'Anglo-Saxon manuscript pigments', *Studies in Conservation*, 49(4), 231-244.

___ (2009). 'Codicological indicators of practical medieval artists' recipes', in *Sources and serendipity: testimonies of artists' practice*. E. Hermens and J.H. Townsend (Eds.). London: Archetype Publications, pp. 8-17.

___ (2011a). 'Colours versus colorants in art history: evaluating lost manuscript yellows', *Revista de História da Arte*, nº1, série W, 139-151.

___ (2011b). *Mediaeval painters' materials and techniques: The Montpellier 'Liber diversarum arcium'.* London: Archetype Publications.

CLARKE, M.; TOWNSEND, J.H.; STIJNMAN, A. (Eds.) (2005). *Art of the past: sources and reconstructions. Proceedings of the first symposium of the art technological source research study group.* London: Archetype Publications, Ltd. with the participation of ICN Amersterdam.

CLARKSON, C. (1978). 'The conservation of early books in codex form: a personal approach: part I', *The Paper Conservator*, 3(1), 33-50.

___ (1993). 'English monastic bookbinding in the twelfth century', in M. Maniaci and P.F. Munato (eds.), *Ancient and medieval book materials*. Vatican: Biblioteca Apostolica Vaticana, pp. 181-200.

CLARO, A. (2009). *An interdisciplinary approach to the study of colour in Portuguese manuscript illuminations'*. Ph.D. dissertation. Lisbon: Department of Conservation and Restoration. Universidade Nova de Lisboa.

CLARO, A.; MELO, M.J.; SCHÄFER, S.; SEIXAS DE MELO, J.S.; PINA, F., VAN DEN BERG, K.J.; BURNSTOCK, A. (2008). 'The use of microspectrofluorimetry for the characterization of lake pigments', *Talanta*, 74, 922-929.

CLARO, A.; MELO, M.J.; SEIXAS DE MELO, J.S.; VAN DEN BERG, K.J.; BURNSTOCK, A.; MONTAGUE, M.; NEWMAN, R. (2010). 'Identification of red colorants in Van Gogh paintings and Ancient Andean textiles cultural heritage by microspectrofluorimetry', *Journal of Cultural Heritage*, 11, 27-34.

CLEMENS, R. and GRAHAM, T. (2007). *Introduction to manuscript studies*. Ithaca, London: Cornell University Press.

CLEMENTI, C.; DOHERTY, B.; GENTILI, P.L.; MILIANI, C.; ROMANI, A.; BRUNETTI, B.G. and SGAMELOTTI, A. (2008), 'Vibrational and electronic properties of painting lakes', *Applied Physics A*, 92(1), 25-33.

COELHO, C.; NANABALA, R.; MÉNAGER, M.; COMMEREUC, S.; VERNEY, V. (2012). 'Molecular changes during natural biopolymer ageing – The case of shellac', *Polymer Degradation and Stability*, 97(6), 936-940.

COLOMBINI, M.P.; BONADUCE, I. and GAUTIER, G. (2003). 'Molecular pattern recognition of fresh and aged shellac', *Chromatographia*, 58(5), 357-364.

COLOMBINI, M.P.; MODUGNO, F.; FUOCO, R.; TOGNAZZI, A. (2002). 'A GC-MS study on the deterioration of lipidic paint binders', *Microchemical Journal*, 73, 175-185.

CONSTABLE, G. (1991). 'Renewal and reform in religious life: concepts and realities'. *Renaissance and renewal in the twelfth century*. R. B. Benson and G. Constable with C. D. Lanham (Eds.) (1st edition from 1982). Canada: Medieval Academy of America, pp. 37-67.

___ (1996). *The Reformation of the twelfth century*. Cambridge: Cambridge University Press.

CONSTABLE, O.R. (1994). *Trade and traders in Muslim Spain. The commercial realignment of the Iberian peninsula 900-1500*. Cambridge: Cambridge University Press.

CORDONNIER, R. (2004). 'Des oiseaux pour les moines blancs: réflexions sur la réception de l'Aviaire d'Hugues de Fouilloy chez les Cisterciens', *La Vie en Champagne*, 38, 3-12.

___ (2005). '*Haec pertica est regula*. Texte, image et mise en page dans l'*Aviarium* d'Hugues de Fouilloy', in B. Van den Abeele (ed.), *Bestiaires médiévaux. Nouvelles perspectives sur les manuscrits et les traditions textuelles*. Louvain-la-Neuve: Institut d'études médiévales (Textes, Études Congrès, 21), pp. 71-110.

___ (2007). *L'illustration du 'De Avibus' de Hugues de Fouilloy: symbolisme animal et méthodes d'enseignement au moyen âge,* Thèse pour le doctorat d'histoire de l'art. Lille: Université Charles de Gaulle.

___ (2010a). 'Un 128e exemplaire de l'*Aviarium* de Hugues de Fouilloy: Bruxelles, KBR, Ms. II 2313', *Revista Signum*, 11(1), 358-411.

___ (2010b). 'La plume dans l'*Aviarium* d'Hugues de Fouilloy: *sénéfiance*(s) d'une «propriété» aviaire', in Fabienne Pomel (ed.), *La corne et la plume dans les textes médiévaux*. Rennes: Presses Universitaires de Rennes, pp. 165-183.

___ (2011). 'Des interactions entre *scriptoria* Portugais au XIIe siècle', *Revista de História da Arte*, Série W, nº1, 272-283.

___ (2012). 'Dématérialisation? Rationalisation? Réflexion sur la représentation des animaux et autres créatures dans l'exégèse visuelle au Moyen Âge', in *Matérialité et immatérialité dans*

l'Église au Moyen Âge. Actes du colloque organisé par: Le Centre d'études médiévales de l'Université de Bucarest. Bucarest: Editura Universitãtii din Bucuresti.

CORREIA, I. (2011). 'Between material conservation and identity preservation – The (sacred) life of medieval liturgical books', in J. Bridgland *et al.* (eds.), *Preprints from the 16th ICOM-CC Triennial Conference, 19-23 September 2011*, Lisbon. Lisbon: International Council of Museums (ICOM), pp. 1-9.

___ (2014). *Estudo arqueológico* dos códices iluminados do fundo laurbanense. Tese de doutoramento em História da Arte Medieval. Lisboa: Faculdade de Ciências Sociais e Humanas da Universidade Nova de Lisboa.

CORREIA, N.; ROMÃO, T.; RICARDO, A.; MELO, M.J.; CASTRO, R.; CARVALHO, R.; MIRANDA, A. (2014). 'Design of an interactive experience with medieval illuminations: A journey into the beauty and meaning of medieval Portuguese manuscripts', *ACM Journal of Computing and Cultural Heritage*, 7(2), Article 13, 19 pages.

COUPRY, C. (1999). «Les pigments utilisés pour l'enluminure à Fécamp aux XIe et XIIe siècles», *Manuscrits et enluminures dans le monde normand (Xe -XVe siècles): Colloque de Cerisy-la-Salle*, Office Universitaire d'Études Normandes, Presses Universitairès de Caen, pp. 69-79.

___ (2011). «A la recherche des pigments», *Revista de História da Arte*, nº1, série W, 127-136.

CROISILLE, J.-M. (1985). *Pline l'Ancien*. *Histoire Naturelle*. Livre XXXV. J.-M. Croisille (trans.). Paris: Les Belles Letres.

CRUZ, A. (1964). *Santa Cruz de Coimbra na cultura Portuguesa da Idade Média*. Porto: Emp. Ind. Gráf. do Porto.

CRUZ, A.J. and AFONSO, L.U. (2008). 'On the date and contents of a Portuguese medieval technical book on illumination: O Livro de Como se Fazem as Cores', *The Medieval History Journal*, 11(1), 1-28.

DE CLERCQ, C. (1970). 'La nature et le sens du De Avibus d'Hugues de Fouilloy', in Albert Zimmermann, Rudolf Hoffmann (eds.), *Methoden in wissenschaft und kunst des mittelalters* (Miscellanea Medievaelia 7). Berlin: De Gruyter, pp. 279-302.

DE HAMEL, C. (1992). *Medieval craftsmen: scribes and illuminators*. London: British Museum Press.

___ (1997). *A history of illuminated manuscripts*. London: Phaidon Press.

___ (2001). *The British Library guide to manuscript illumination: history and techniques*. London: The British Library.

DE MAYER, J.; LEPLAE, S. and SCHMIEDL, J. (2004). 'Introduction', in J. de Mayer; S. Leplae and J. Schmiedl (eds.), *Religious institutes in Western Europe in the 19th and 20th centuries: Historiography, research and legal position*. Leuven: Leuven University Press, pp. 7-26.

DELANEY, J.K.; RICCIARDI, P.; GLINSMAN, L.D.; FACINI, M.; THOURY, M.; PALMER, M.; DE LA RIE, E.R. (2014). 'Use of imaging spectroscopy, fiber optic reflectance spectroscopy, and X-ray fluorescence to map and identify pigments in illuminated manuscripts', *Studies in Conservation*, 59(2), 91-101.

DELLA GATTA, G.; BADEA, E.; CECCARELLI, R.; USACHEVA, T.; MAŠIĆ, A.; COLUCCIA, S. (2005). 'Assessment of damage in old parchments by DSC and SEM', *Journal of Thermal Analysis and Calorimetry*, 82, 637-649.

DELLA GATTA, G.; BADEA, E.; MAŠIĆ, A.; CECCARELLI, R. (2007). 'Structural and termal stability of collagen within parchment: a mesoscopic and molecular approach', in R. Larsen (Ed.), *Improved Damage Assessment of Parchment (IDAP)*. IDAP EC Research report no. 18. European Commission. Luxembourg: Office for Official Publications of the European Communities, pp. 89-98.

DENECKERE, A.; DE REU, M.; MARTENS, M.P.J.; DE COENE, K; VEKEMANS, B.; VINCZE, L.; DE MAEYER, Ph.; VANDENABEELE, P.; MOENS, L. (2011). 'The use of a multi-method approach to identify the pigments in the 12th century manuscript Liber Floridus', *Spectrochimica Acta - Part A: Molecular and Biomolecular Spectroscopy*, 80 (1), 125-132.

DENIS, M.F. (1860). *Histoire de l'ornementation des manuscrits*. Lyon: Louis Perrin.

DIAS, A. de O. (2012). *Commentarium in Apocalypsin: O número e a forma geométrica na tradição simbólica das ilustrações do «Beato» de São Mamede de Lorvão*. Dissertaçao de mestrado em História Medieval. Lisboa: Universidade de Lisboa.

DINES, I. (2014). 'The Bestiary in British Library, Royal MS. 2 C. XII and its role in medieval education', eBLJ, Article 14, 1-22. Accessed August 10 http://www.bl.uk/eblj/2014articles/pdf/ebljarticle92014.pdf

DOHERTY, B.; DAVERI, A.; CLEMENTI, C.; ROMANI, A.; BIOLETTI, S.; BRUNETTI, B.; SGAMELLOTTI, A.; MILIANI, C. (2013). 'The Book of Kells: A non-invasive MOLAB investigation by complementary spectroscopic techniques', *Spectrochimica Acta - Part A*, 115, 330-336.

DONKIN, R.A. (1977). The insect dyes of Western and West-Central Asia', *Anthropos*, 72, 847-880.

DUBOIS, H.; TOWNSEND, J.H.; NADOLNY, J.; EYB-GREEN, S.; KROUSTALLIS, S.; NEVEN, S. (Eds.) (2014). *Making and transforming art: technology and interpretation. Proceedings of the fifth symposium of the ICOM-CC working group for art technological source research*. London: Archetype Publications.

DYKEMA, B. (2010). 'Preaching the Book of Creation: memory and moralization in medieval bestiaries', *Peregrinations*, 3(2), 96-121.

ECO, U. (1985). 'How culture conditions the colours we see', in Marshall Blonsky (Ed.), *On Signs*. Baltimore, Maryland: The Johns Hopkins University Press, pp. 157-175.

EDWARDS, H.G.M.; FARWELL, D.W.; NEWTON, E.M.; PEREZ, F.R. (1999). '*Minium*; FT-Raman non-destructive analysis applied to an historical controversy', *The Analyst*, 124, 1323-1326.

EDWARDS, H.G.M.; FARWELL, D.W.; NEWTON, E.M.; PEREZ, F.R.; VILLAR, S.J. (2001). 'Application of FT-Raman spectroscopy to the characterization of parchment and vellum, I; novel information for paleographic and historiated manuscript studies', *Spectrochimica Acta Part A*, 57(6), 1223-1234.

EDWARDS, H.G.M. and PEREZ, F.R. (2004). 'Application of FT-Raman spectroscopy to the characterization of parchment and vellum. II – Effect of biodeterioration and chemical deterioration on spectral interpretation', *Journal of Raman Spectroscopy*, 35(8-9), 754-760.

EGRY, A. de (1972). *Um estudo de o Apocalipse do Lorvão e a sua relação com as ilustrações medievais do Apocalipse*. Lisboa: Fundação Calouste Gulbenkian.

EMILIANO, A.H. de A. (1997). 'A língua notarial Latino-Bracarense e a Reforma Gregoriana', in Ivo Castro (ed.), *Actas do XII Encontro nacional da associação Portuguesa de linguística*, Braga-Guimarães 30 de Setembro a 2 de Outubro de 1996, Volume II. Lisboa: Associação Portuguesa de Linguística, pp. 91-110.

ESCRIBANO, R.; SLOAN, J.J.; SIDDIQUE, N.; SZE, N.; DUDEV, T. (2001). 'Raman spectroscopy of carbon-containing particles', *Vibrational Spectroscopy*, 26, 179-186.

ETIÉGNIL, J. and CAMPBELL, A.G. (1991). 'Physical and chemical characteristics of wood ash', *Bioresource Technology*, 37(2), 173-178.

EYB-GREEN, S.; TOWNSEND, J.H.; CLARKE, M.; NADOLNY, J.; KROUSTALLIS, S. (Eds.) (2012). *The artist's process: technology and interpretation*. *Proceedings of the fourth symposium of the art technological source research working group*. London: Archetype Publications.

FEDERICI, C. (1993). *La legatura medievale*. Milano: Istituto Centrale per la Patologia del Libro.

FEESER, A.; GOGGIN, M.D and TOBIN, B.F. (2012). 'Introduction: the value of color', in A. Feeser, M.D. Goggin and B.F. Tobin (eds.), *The materiality of color: The production, circulation, and application of dyes and pigments, 1400-1800'*. Burlington: Ashgate, pp. 1-10.

FERRARI, A.C. and ROBERTSON, J. (2000). 'Interpretation of Raman spectra of disordered and amorphous carbon', *Physical Review B*, 61(20), 14095-14106.

FERREIRA, M. (2013). 'Dating a fragment: a Cistercian litany and its historical context', in L. Scappaticci (ed.), '*Quod ore cantas corde credas': Studi in onore di Giacomo Baroffio Dahnk*. Rome: Libreria Editrice Vaticana, pp. 293-313.

FIDDYMENT, S.; HOLSINGER, B.; RUZZIER, C.; DEVINE, A.; BINOIS, A.; ALBARELLA, U.; FISCHER, R.; NICHOLS, E.; CURTIS, A.; CHEESE, E.; TEASDALE, M.D.; CHECKLEY-SCOTT, C.; MILNER, S.J.; RUDY, K.M.; JOHNSON, E.J.;

VNOUČEK, J.; GARRISON, M.; MCGRORY, S.; BRADLEY, D.G.; COLLINS, M.J. (2015). 'Animal origin of 13th-century uterine vellum revealed using noninvasive peptide fingerprinting', *Proceedings of the National Academy of Sciences*, 112(49), 15066-15071.

FLORIAN, M.-L.E. (2006). 'The mechanisms of deterioration in leather', in M. Kite and R. Thompson (eds.), *Conservation of leather and related materials*. Amsterdam: Elsevier, 36-57.

FORNERIS, R. (1969). 'The Infrared and Raman spectra of realgar and orpiment', *The American Mineralogist*, 54, 1062-1074.

FOULET, A. and SPEER, M.B. (1979). *On editing old French texts*, Kansas: Regents Press of Kansas.

FRANCE, J. (2012). *Separate but equal: Cistercian lay brothers 1120-1350*. Collegeville: Liturgical Press.

___ (2013). 'The Cistercian community', in Mette B. Bruun (ed.), *The Cambridge companion to the Cistercian Order*. Cambridge: Cambridge University Press, pp. 80-86.

FREIRE, F.G. (2007). 'El proceso de internacionalización de la miniatura en torno al año 1200 en la Península Ibérica: el antifonario de Las Huelgas Reales de Burgos', in *El monacato en los reinos de León y Castilla (siglos VII-XIII)*, pp. 437-456.

FROST, R.L.; MARTENS, W.N. and KLOPROGGE, J.T. (2002). 'Raman spectroscopy study of cinnabar (HgS), realgar (As_4S_4), and orpiment (As_sS_3) at 298 and 77K', *Neues Jahrbuch für Mineralogie – Monatshefte*, 2002(10), 469-480.

FROST, R.L.; MARTENS, W.N.; WILLIAMS, P.A.; KLOPROGGE, J.T. (2003). 'Raman spectroscopy study of vivianite arsenate minerals', *Journal of Raman Spectroscopy*, 34, 751-759.

FROST, R.L.; BAHFENNE, S. and KEEFFE, E.C. (2010). 'Raman spectroscopic study of the mineral gerstleyite $Na_2(Sb,As)_8S_{13}\cdot 2H_2O$ and comparison with some heavy-metal sulfides', *Journal of Raman Spectroscopy*, 41, 1779-1783.

FUCHS, R. and OLTROGGE, D. (1994). 'Colour material and painting technique in the Book of Kells', in F. O'Mahony (ed.), *The Book of Kells: Proceedings of a conference at Trinity College Dublin, 6-9 Sept. 1992*. Aldershot: Scolar Press for Trinity College Library Dublin, pp. 133-171.

GAGE, J. (1990). 'Colour in Wester art: an issue?', *The Art Bulletin*, 72(4), 518-541.

___ (1999a). *Colour and culture: practice and meaning from Antiquity to abstraction* [1st edition: 1993]. London: Thames and Hudson, Ltd.

___ (1999b). *Colour and meaning: art, science, and symbolism*. London: Thames and Hudson, Ltd.

___ (2006). *Color in art*. London: Thames and Hudson, Ltd.

GETTENS, R.J.; KÜHN, H. and CHASE, W.T. (1993). 'Lead white' in A. Roy (Ed.), *Artists' pigments – A handbook of their history and characteristics*. New York: Oxford University Press, vol. 2, pp. 67-81.

GHIONI, C.; HILLER, J.C.; KENNEDY, C.J.; ALIEV, A.E.; ODLYHA, M.; BOULTON, M.; WESS, T.J. (2005). 'Evidence of a distinct lipid fraction in historical parchments: a potencial role in degradation?', *Journal of Lipid Research*, 46, 2726-2734.

GILBERT, B.; DENOËL, S.; WEBER, G. and ALLART, D. (2003). 'Analysis of green copper pigments in illuminated manuscripts by micro-Raman spectroscopy', *The Analyst*, 128, 1213-1217.

GIOVANNONI, S.; MATTEINI, M.; MOLES, A. (1990). 'Studies and developments concerning the problema of altered lead pigments in wall painting', *Studies in Conservation*, 35(1), 21-25.

GIURGEVICH, L. (2012). 'Bibliotecas antigas. Um elemento para a história da ciência', *Ágora. Estudos clássicos em debate*, 14.1, 269-291.

GOLDENBERG, D.M. (2003). *The curse of ham: Race and slavery in early Judaism, Christianity, and Islam*. Princeton and Oxford: Princeton University Press.

GOMES, S.A. (2001-2002). '*In limine conscriptionis*: Documentos, chancelaria e cultura no mosteiro de Santa Cruz de Coimbra (séculos XII a XIV)', *Lusitania Sacra*, 2ª série, 13-14, 477-490.

GONÇALVES, M.I.R. (1999). *Livro das Aves. Edição do texto latino a partir dos manuscritos portugueses, tradução do latim e introdução por Maria Isabel Rebelo Gonçalves*. Lisboa: Edições Colibri.

GOPAL, L. and SRIVASTAVA, V.C. (Eds.) (2008). *History of agriculture in India (up to c.1200 AD)*. (History of Science, Philosophy and Culture in Indian Civilization, Volume V, Part 1). New Delhi: Concept: Project of History of Indian Science, Philosophy and Culture, Centre for Studies in Civilizations.

GUEDES DE CAMPO, F.M. (Coord.) (2015). 'Fiat Lux: Estudos sobre manuscritos iluminados em Portugal', *Invenire*, número especial, 2015.

GUINEAU, B.; COUPRY, C.; GOUSSET, M.T.; FORGERIT, J.P.; VEZIN, J. (1986). 'Identification de bleu de lapis-lazuli dans six manuscrits à peintures du xiie siècle provenant de l'abbaye de corbie', *Scriptorium*, 40, 157-171.

HAMILTON, S. (2013). *Church and people in the medieval West*. London: Routledge.

HAWTHORNE, J.G. and SMITH, C.S. (1979). *Theophilus: on divers arts: the foremost medieval treatise on painting, glassmaking and metalwork. Translated from the Latin with introduction and notes* [originally from 1963]. New York: Dover.

HENDERSON, J. (2013). *Ancient glass: an interdisciplinary exploration*. New York: Cambridge University Press.

HERBERT, J. A. (1911). *Illuminated manuscripts*. New York: G.P. Putnam's Sons and London: Methuen & Co. Ltd.

HERMENS, E. (2012). 'Technical art history: The synergy of art, conservation and science', in M. Rampley, T. Lenain, H. Locher, A. Pinotti, C. Schoell-Glass, K. Zijlmans (eds.), *Art history and visual studies in Europe: Transnational discourses and National frameworks*. Leiden: Brill, pp. 151-165.

HERMENS, E. and TOWNSEND, J.H. (Eds.) (2008). *Sources and serendipity: testimonies of artists' practice. Proceedings of the third symposium of the art technological source research working group*. London: Archetype Publications.

HILLER, J.C.; KENNEDY, C.J.; MAXWELL, C.A.; LAMMIE, D; WESS, T.J. (2007). 'Damage to parchment collagen measured by structural and biochemical analysis', in *Improved Damage Assessment of Parchment (IDAP)*. IDAP EC Research report no. 18. European Commission. Luxembourg: Office for Official Publications of the European Communities, pp. 99-104.

HUXTABLE, M.J. (2014). 'The relationship of light and colour in medieval thought and imagination', in K.P. Clark and S. Baccianti (eds.), *On light*. Oxford: Society for the Study of Medieval Languages and Literature, pp. 25-44.

JACOBS, D. (2008). 'Middle Eastern bookbinding – the Islamic book', in *Contributions to the symposium on the Care and conservation of middle Eastern manuscripts, the University of Melbourne, Australia, 26-27 November 2008*. Melbourne: Centre for Cultural Materials Conservation, The University of Melbourne, pp. 14-21.

JIA, Y.; XU, L.; WANG, X.; DEMOPOULOS, G.P. (2007). 'Infrared spectroscopic and X-ray diffraction characterization of the nature of adsorbed arsenate and ferrihydrite', *Geochimica et Cosmochimica Acta*, 71, 1643-1654.

JONES, L.W. (1946). 'Pricking manuscripts: The instruments and their significance', *Speculum*, 21(4), 389-403.

KENNEDY, C.J. and WESS, T. (2003). 'The structure of collagen within parchment – a review', *Restaurator*, 61-80.

KEUNE, K. and BOON, J.J. (2011). 'Can dispersed and migrated arsenic from degraded pigments in paintings be a marker for water-linked transport processes?', in J. Bridgland (ed.), *Preprints ICOM Committee for Conservation, 16th Triennial meeting, Lisbon, September 19-23*, pp. 1609, 1-7.

KEUNE, K.; MASS, J.; MEIRER, F.; POTTASCH, C.; VAN LOON, A.; HULL, A.; CHURCH, J.; POUYET, E.; COTTE, M.; MEHTA, A. (2015). 'Tracking the transformation and transport of arsenic sulfide pigments in paints: Synchrotron-based X-ray micro-analyses', *Journal of Analytical Atomic Spectrometry*, 30(3), 813-827.

KIRBY, J. (2008). 'Some aspects of medieval and renaissance lake pigment technology', in Jo Kirby (ed.), *Dyes in History and Archaeology 21: including papers presented at the 21st meeting, Avignon and Lauris, France, 2002*. London: Archetype Publications, pp. 89-108.

___ (2012). ‘Red Lake Pigments: Sources and Characterisation’, in M. del Egido and S. Kroustallis (eds.), *Fatto d’Archimia – Los Pigmentos Artificiales en las Técnicas Pictóricas*. Madrid: Ministerio de Educación, Cultura y Deporte. Villena Artes Gráficas, pp. 157–170.

KIRBY, J. and WHITE, R. (1996). ‘The identification of red lake pigment dyestuffs and discussion of their use’, *National Gallery Technical Bulletin*, 17, 56-80.

KIRBY, J.; SPRING, M. and HIGGITT, C. (2005). ‘The technology of red lake pigment manufacture: study of the dyestuff substrate’, *National Gallery Technical Bulletin*, 26, 71-87.

KLEIN, P.K. (2004). *Beato de Liébana: la ilustración de los manuscritos de Beato y el Apocalípsis de Lorvão*. Valência: Património Ediciones.

KRISTOL, A. (1980). ‘Color systems in Southern Italy: A case of regression’, *Language*, 56(1), 137-145.

KROUSTALLIS, S. (2008). ‘Los recetarios medievales de tecnología artística’, in S. Kroustallis, J.H. Townsend, E.C. Bruquetas, A. Stijnman; M.S.A. Moya (eds.), *Art technology: sources and methods*. *Proceedings of the second symposium of the art technological source research working group*. London: Archetype Publications, pp. 35-41.

KROUSTALLIS, S. (2011). ‘Binding media in medieval manuscript illumination: A source of research’, *Revista de História da Arte*, nº1, série 1, 113-125.

KROUSTALLIS, S.; TOWNSEND, J.H.; BRUQUETAS, E.C.; STIJNMAN, A.; MOYA, M.S.A. (Eds.) (2008). *Art technology: sources and methods*. *Proceedings of the second symposium of the art technological source research working group*. London: Archetype Publications.

KÜHN, Hermann (1960). ‘Detection and identification of waxes, including Punic wax, by Infra-red spectroscopy’, *Studies in Conservation*, 5(2), 71-81.

KUMLER, A.; LAKEY, C.R. (2012). ‘*Res et significatio:* The material sense of things in the Middle Ages’, *Gesta*, 51(1), 1-17.

LAEMERS, J.W.J. (2005). ‘*Claustrum animae:* The community as example for interior reform’, in István P. Bejczy and Richard G. Newhauser (eds.), *Virtue and ethics in the twelfth century*. Leiden, Boston: Brill, pp. 119-130.

LANG, P.L.; KEEFER, C.D.; JUENEMANN, J.C.; TRAN, K.V.; PETERS, S.M.; HUTH, N.M.; JOYAUX, A.G. (2003). ‘The infrared spectroscopy and energy dispersive X-ray analysis of paints removed from a painted, medieval sculpture of Saint Wolfgang’, *Microchemical Journal*, 74(1), 33-46.

LANOË, G. (Ed.) and GENEVIÈVE, G. (2008). *La reliure médievale. Pour une description normalisée. Actes du Colloque International (Paris, 22-24 Mai 2003) Organisée par l’Institut de Recherche et d’Histoire des Textes (CNRS)*. (Reliures Médiévales des Bibliothèques de France, Hors série). Turnhout: Brepols.

LARSEN, René (Ed.) (2002). *Microanalysis of parchment*, London: Archetype Publications.

___ (2003). 'Improved Damage Assessment of Parchment, IDAP: micro and non-destructive analysis and diagnosis for proper storage and treatment', in *Congres new approaches tot book and paper conservation*, pp. 74-78.

___ (2007). *Improved Damage Assessment of Parchment (IDAP)*. IDAP EC Research report no. 18. European Commission. Luxembourg: Office for Official Publications of the European Communities.

___ (2007b). 'Introduction to damage and damage assessment of parchment', in *Improved Damage Assessment of Parchment (IDAP)*. IDAP EC Research report no. 18. European Commission. Luxembourg: Office for Official Publications of the European Communities, pp. 17-21.

LEHMANN-HAUPT, H. (1972). *The Göttingen model book. A facsimile edition and translation of a fifteenth-century illuminator's manual*. Columbia: University of Missouri Press.

LEMOS, A.; ARAÚJO, R.; CASANOVA, C.; MELO, M.J.; MURALHA, V.S.F. (2014). 'Regards croisés des historiens de l'art et des chimistes sur deux livres d'heures de la Bibliothèque Nationale du Portugal, les mss IL15 et IL19', in A. Miranda and A. Miguélez (Coord.), *Portuguese studies on medieval illuminated manuscripts*. Barcelona-Madrid: Brepols Publishers, pp. 145-168.

LEONA, M. (2009). 'Microanalysis of organic pigments and glazes in polychrome works of art by surface-enhanced resonance Raman scattering', *Proceedings of the National Academy of Sciences of the United States of America*, 106(35), 14757-14762.

LEONA, M.; DECUZZI, P.; KUBIC, T.A.; GATES, G.; LOMBARDI, J.R. (2011). 'Nondestructive identification of natural and synthetic organic colorants in works of art by surface enhanced raman scattering', *Analytical Chemistry*, 83(11), 3990-3993.

LEVEY, M. (1962). 'Mediaeval Arabic bookmaking and its relation to early chemistry and pharmacology', *Transactions of the American Philosophical Society*, 52(4), 5-57.

LOCATELLI, R. (1992). *Bernard de Clairvaux. Histoire, mentalités, spiritualité. Colloque de Lyon-Cîteaux-Dijon*. (Sources Chrétiennes, 380). Paris: Les Éditions du Cerf.

MANDAL, P.K.; MANDAL, T.K. (2002). 'Anion water in gypsum ($CaSO_4.2H_2O$) and hemyhydrate ($CaSO_4.1/2H_2O$)', *Cement and Concrete Research*, 32, 313-316.

MARENGO, E.; MANFREDI, M.; ZERBINATI, O.; ROBOTTI, E.; MAZZUCCO, E.; GOSETTI, F.; BEARMAN, G.; FRANCE, F.; SHOR, P. (2011). 'Development of a technique based on multi-spectral imagining for monitoring the conservation of cultural heritage objects', *Analytica Chimica Acta*, 706(2), 229-237.

MARQUES, M.A. (1998). *Estudos sobre a Ordem de Cister em Portugal*. Lisboa: Edições Colibri.

MARTINS, A.A. (2003). *O mosteiro de Santa Cruz de Coimbra na Idade Média*. Coleccção Textos Universitários – 2. Lisboa: Centro de História da Universidade de Lisboa.

MARTINS, M. (1963). 'O Livro das Aves', *Broteria*, 77-5, 413-416.

MAS, S.; MIGUEL, C.; MELO, M.J.; LOPES, J.A.; DE JUAN, A. (2014). 'Screening and quantification of proteinaceous binders in medieval paints based on µ-Fourier transform infrared spectroscopy and multivariate curve resolution alternating least squares', *Chemometrics and Intelligent Laboratory Systems*, 134, 148-157.

MATOS, D. (2011). *The ms. Parma 1959 in the context of Portuguese Hebrew illumination*. Mestrado em Arte, Património e Teoria do Restauro. Lisboa: Universidade de Lisboa.

MATTOSO, J. (1969). *A cultura monástica em Portugal (711-1200)*. Lisboa: Arquivos de História da Cultura Portuguesa, Vol. III, nº 2.

___ (1993). *História de Portugal. 2º Volume – A monarquia feudal (1096-1480)*. Lisboa: Editorial Estampa.

___ (1997). *Religião e cultura na Idade Média Portuguesa*, Lisboa: Imprensa Nacional – Casa da Moeda.

___ (1999). 'O imaginário na iluminura medieval'. In *A iluminura em Portugal: identidade e influência (do séc. X ao XVI): catálogo da exposição*. Adelaide Miranda (Ed.). Lisboa: Ministério da Cultura - Biblioteca Nacional de Portugal, pp. 25-37.

___ (2009). 'Recensão: Nascimento, A.A. and Fernández Catón, J.M. (Eds.) (2008). *Liber Testamentorum Coenobii Laurbanensis (estudios)*', in *Medievalista*, 7. Lisboa: FCSH.

MAZUREK, M.; SCHILLING, G.; CHIAVARI, G.; HEGINBOTHAM, A. (2008). 'Antibody assay to characterize binding media in paint', in J. Bridgland (Ed.), *Diversity in heritage conservation: tradition, innovation and participation*. ICOM Committee for Conservation, 15th Triennial Conference, Vol. II, New Delhi: Allied Publishers Pvt. Ltd, pp. 849-856.

MEIRINHOS, J. (1995). *A escrita nos códices de Santa Cruz de Coimbra*. Porto: Biblioteca Pública Municipal do Porto.

___ (2000). 'A Filosofia no século XII. (2) Em Portugal: Os mosteiros e a cultura que vem da Europa', *Mirandum*, 10, 39-58.

___ (2009). 'O sistema das ciências num esquema do século XII no manuscrito 17 de Santa Cruz de Coimbra (Porto, BPM, Geral 21)', *Medievalista*, 5(7), 1-27.

MELESSANAKI, K.; PAPADAKIS, V.; BALAS, C.; ANGLOS, D. (2001). 'Laser induced breakdown spectroscopy and hyper-spectral imaging analysis of pigments on an illuminated manuscript', *Spectrochimica Acta Part B*, 56, 2337-2346.

MELO, M.J. (2009). 'History of natural dyes in the Ancient Mediterranean world', in T. Buchtold, R. Mussak (Eds.), *Handbook of natural colorants*. Chichester: John Wiley & Sons, pp. 3-20.

MELO, M.J.; ARAÚJO, R.; CASTRO, R. and CASANOVA, C. (2016a). 'Colour degradation in medieval manuscripts', *Microchemical Journal*, 124, 837-844.

MELO, M.J.; CASTRO, R. and MIRANDA, A. (2014). 'Colour in medieval Portuguese manuscripts: between beauty and meaning', in *Science and art: the painted surface*, A. Sgamellotti, B. Brunetti, C. Miliani (Ed.). London: Royal Society of Chemistry, pp. 170-192.

MELO, M.J.; CLARO, A. (2010). 'Bright light: microspectrofluorimetry for the characterization of lake pigments and dyes in works of art'. *Accounts of Chemical Research*, 43(6), 857-866.

MELO, M.J.; MIGUEL, C. (2012). 'The making of vermilion in medieval Europe: historically accurate reconstructions from *The Book on How to Make Colours*', in S. Kroustallis, M. Del Egido (eds.), *Fatto d'archimia – Los pigmentos artificiales en las técnicas pictóricas*. Madrid: Ministerio de Educación, Cultura y Deporte, pp.181-195.

MELO, M.J.; MIRANDA, M.A.; MIGUEL, C.; LEMOS, A.; CLARO, A.; CASTRO, R.; MURALHA; V.S.F.; LOPES, J.A.; GONÇALVES, A.P. (2011). 'The colour of medieval Portuguese illumination: an interdisciplinary approach', in M.A. Miranda, M.J. Melo and M. Clarke (eds.), *Medieval colours: between beauty and meaning, Revista de História da Arte*, Special issue nº1, Série W, 147-169.

MELO, M.J.; NABAIS, P.; GUIMARÃES, M.; ARAÚJO, R.; CASTRO, R.; OLIVEIRA, M.C.; WHITWORTH, I. (2016b). 'Organic dyes in illuminated manuscripts: a unique cultural and historic record', *Philosophical Transactions of the Royal Society A*, 374(2082): 20160050-20160069.

MELO, M.J.; OTERO, V.; VITORINO, T.; ARAÚJO, R.; MURALHA, V.S.F.; LEMOS, A.; PICOLLO, M. (2014). 'A spectroscopic study of brazilwood paints in medieval books of hours', *Applied Spectroscopy*, 68, 434-444.

MELO, M.J.; VILARIGUES, M.; MURALHA, V.S.F.; CASTRO, R. (2013). 'Mapping the colours of Fernão Vaz Dourado', in *Atlas Fernão Vaz Dourado*, Barcelona: M. Moleiro Editor S.A.

MERI, J.W. (2006). *Medieval Islamic civilization*: *an encyclopedia*. Volume 1. New York; London: Routledge. Taylor & Francis Group.

MERRIFIELD, M.P. (1967). *Medieval and renaissance treatises on the arts of painting: original texts with English translations* [originally published in 1849]. New York: Dover Publications Inc.

MESSINGER-RAMOS, S.; RAMOS, A. and MARCHAND-SAUVAGNARGUES, F.M.; and (trans.) (2004). *Garcia de Orta. Colloque des simples et des drogues de l'Inde* (1563) (Thesaurus). Arles: Actes Sud.

MIDDLETON, J. Henry (1892). *Illuminated manuscripts in classical and mediaeval times: their art and their techniques*. London: C.J. Clay & Sons, Cambridge University Press Warehouse.

MIGUEL, C. (2012). *Le vert et le rouge: a study on the materials, techniques and meaning of the green and red colours in medieval Portuguese illuminations*. Ph.D. dissertation. Lisbon: Department of Conservation and Restoration. Universidade Nova de Lisboa.

MIGUEL, C.; CLARO, A.; GONÇALVES, A. P.; MELO, M.J.; MURALHA, V.S.F. (2009a). 'A study on red lead degradation in the medieval manuscript, Lorvão Apocalypse (1189)'. *Journal of Raman Spectroscopy*, 40, 1966-1973.

MIGUEL, C.; CLARO, A.; MELO, M.J.; LOPES, J.A. (2009b). 'Green, blue, greenish blue or bluish green? Copper pigments in medieval Portuguese illuminations' in Hermens, E. and Townsend, J.H. (eds.), *Sources and serendipity – Testimonies of artists' practice*. London: Archetype Publications, pp. 33-38.

MIGUEL, C.; LOPES, J.A.; CLARKE, M.; MELO, M.J. (2012). 'Combining infrared spectroscopy with chemometrics analysis for the characterization of proteinaceous binders in medieval paints', *Chemometrics and Intelligent Laboratory Systems*, 119, 32-38.

MIGUEL, C.; MIRANDA, A.; LOPES, J.A., MELO, M.A.; CLARKE, M. (2011). 'A study in scarlet – vermilion red and colour paint formulations in medieval illuminations', in J. Bridgland (Ed.), *Preprints from the 16th ICOM-CC Triennial Conference, 19-23 September 2011, Lisbon*. Lisbon: International Council of Museums (ICOM), Paper 0107, 1-8.

MIGUEL, C.; PINTO, J.V.; MELO, M.J. (2014). 'The alchemy of red mercury sulphide: the production of vermilion for medieval art', *Dyes and Pigments*, 102, 210-217.

MILIANI, C.; DAVERI, A.; BRUNETTI, B.G.; SGAMELLOTTI, A. (2008). 'CO_2 entrapment in natural ultramarine blue', *Chemical Physics Letters*, 466, 148-151.

MILIANI, C.; ROMANI, A. and FAVARO, G. (1998). 'A spectrophotometric and fluorimetric study of some anthraquinoid and indigoid colorants used in artistic paintings', *Spectrochimica Acta Part A*, 54(4), 581-588.

MILIANI, C.; ROSI, F; BURNSTOCK, A.; BRUNETTI, B.G.; SGAMELLOTTI, A. (2007). 'Non-invasive in-situ investigations versus micro-sampling: a comparative study on a Renoirs painting', *Applied Physics A*, 89(4), 849-856.

MILIANI, C.; ROSI, F.; BRUNETTI, B.G. and SGAMELLOTTI, A. (2010). 'In situ noninvasive study of artworks: the MOLAB multitechnique approach', *Accounts of Chemical Research*, 43(6), 728-738.

MIRANDA, M.A. (1984). *A inicial iluminada Românica nos manuscritos Alcobacenses*. Dissertação de Mestrado em História de Arte, Lisboa: Faculdade de Ciências Sociais e Humanas da Universidade Nova de Lisboa.

___ (1996a). *A iluminura Românica em Santa Cruz de Coimbra e Santa Maria de Alcobaça.* Tese de doutoramento em História de Arte Medieval, Lisboa: Faculdade de Ciências Sociais e Humanas da Universidade Nova de Lisboa.

___ (1996b). *A iluminura de Santa Cruz no tempo de Santo António*. Lisboa: Edições Inapa.

___ (1999a). *A iluminura em Portugal: identidade e influência (do Séc. X ao XVI): Catálogo da Exposição*. Adelaide Miranda (Ed.). Lisboa: Ministério da Cultura - Biblioteca Nacional de Portugal.

___ (1999b). 'A iluminura Românica em Portugal', In A. Miranda (ed.), *A iluminura em Portugal: identidade e influência (do séc. X ao XVI): catálogo da exposição*. Lisboa: Ministério da Cultura - Biblioteca Nacional de Portugal, pp. 127-235.

MIRANDA, A.; LEMOS, A.; CLARO, A.; MIGUEL, C.; MELO, M.J. (2008). 'A cor na iluminura Portuguesa: uma abordagem interdisciplinar'. *Revista do Instituto de História da Arte*, nº 5, 228-245.

MIRANDA, A.; LEMOS, A.; MIGUEL, C.; MELO, M.J. (2010). '*On wings of blue*: the history, materials and techniques of the *Book of Birds* in Portuguese *scriptoria*', in L.U. Afonso (ed.), *The materials of the image, As matérias da imagem*. Lisboa: Cátedra de Estudos Sefarditas «Alberto Benveniste» da Universidade de Lisboa, pp. 171-184.

MIRANDA, A.; MELO, M.J. and CLARKE, M. (Eds.) (2011). *Medieval colours: between beauty and meaning*, Revista de História da Arte, Special issue nº1, Série W.

MIRANDA, A. and MELO, M.J. (2014). «Secrets et découvertes, en couleur, dans les manuscrits enluminés», in A. Miranda and A. Miguélez (Coord.), *Portuguese studies on medieval illuminated manuscripts*. Barcelona-Madrid: Brepols Publishers, pp. 1-30.

MONICO, L.; ROSI, F.; MILIANI, C.; DAVERI, A.; BRUNETTI, B.G. (2013). 'Non-invasive identification of metal-oxalate complexes on polychrome artwork surfaces by reflection mid-infrared spectroscopy', *Spectrochimica Acta Part A*, 116, 270-280.

MONTVILLE, J.V. (2011). *History as a prelude: Muslims and Jews in the Medieval Mediterranean*. Plymouth: Lexington Books.

MOURA, L.; MELO, M.J.; CASANOVA, C. and CLARO, A. (2007). 'A study on Portuguese manuscript illumination: The Charter of Vila Flor (Flower town), 1512', *Journal of Cultural Heritage*, 8(3), 299-306.

MRUSEK, R.; FUCHS, R.; OLTROGGE, D. (1995). 'Spectral windows on the past - a new reflectographic method for analysis of book illuminations and historical manuscripts', *Naturwissenschaften Aufsätze*, 82, 68-79.

MURALHA, V.S.F.; MIGUEL, C.; MELO, M.J. (2012). 'Micro-raman study of medieval Cistercian 12-13th century manuscripts: Santa Maria de Alcobaça, Portugal', *Journal of Raman Spectroscopy*, 43(11), 1737-1746.

NASCIMENTO, A.A. (1988). 'Concentração, dispersão e dependências na circulação de manuscritos em Portugal, nos séculos XII e XIII', in *Coloquio sobre circulación de codices y escritos entre Europa y la Peninsula en los siglos VIII-XIII*. Actas 16-19 Septiembre 1982. Santiago de Compostela: Universidade de Santiago de Compostela, pp. 61-85.

___ (1992). 'Le scriptorium d'Alcobaça: identité et corrélations', *Lusitania Sacra*, 2ª série, 4, 149-162.

___ (2008). ‘Mosteiro de Lorvão: a História possível dos seus tempos antigos’, in J. Fernández Catón (dir.), *Liber Testamentorum coenobii laurbanensis (estúdios)*. Léon: Centro de Estudios e Investigación «San Isidoro», pp. 81-156.

___ (2010). ‘O livro manuscrito: um mundo em aberto (em jeito de testemunho e de balanço)’, in José Meirinhos (coord.), *Colecção Conferências Universidade de Verão. Módulo: Textus. As fontes manuscritas medievais e no início da idade moderna*, nº 2. Porto: Universidade do Porto, pp. 1-29.

___ (2012a). ‘Percursos do livro na história da cultura Portuguesa medieval’, in *Ler contra o tempo. Condições dos textos na cultura portuguesa (recolha de estudos em hora de vésperas).* Lisboa: Centro de Estudos Clássicos, Faculdade de Letras da Universidade de Lisboa, pp. 269-317.

___ (2012b). ‘Tempos e livros medievos: os antigos códices de Lorvão – do esquecimento à recuperação de tradições’. *Ler contra o tempo. Condições dos textos na cultura portuguesa (recolha de estudos em hora de vésperas).* Lisboa: Centro de Estudos Clássicos, Faculdade de Letras da Universidade de Lisboa, pp. 389-410.

NASCIMENTO, A.A. and DIOGO, A.D. (1984). *A encadernação Portuguesa medieval: Alcobaça*. Lisboa: Imprensa Nacional – Casa da Moeda.

NASCIMENTO, A.A.; MEIRINHOS, J.F. (Eds.) (1997). *Catálogo dos códices da livraria de mão do Mosteiro de Santa Cruz de Coimbra na Biblioteca Pública Municipal do Porto*. Porto: Biblioteca Pública Municipal do Porto.

NASTOVA, I.; GRUPČE, O.; MINČEVA-ŠUKAROVA, B.; OZCATAL, M.; MOJSOSKA, L. (2013). ‘Spectroscopic analysis of pigments and inks in manuscripts: I. Byzantine and Post-Byzantine manuscripts (10th-18th century)’, *Vibrational Spectroscopy*, 68, 11-19.

NEGRI, F. (2006). ‘Il De claustro animae di Ugo di Fouilloy: vicende testuali’, *Aevum*, 80-2, 389-421.

___ (2012). *Per una lettura del De claustro animae di Ugo di Fouilloy*, Dotorato di ricerca in Filologia Grega e Latina, Parma: Universitá degli Studi di Parma.

NEVEN, S. (2009). ‘Comparative analysis of painting recipes: a new contribution to the study of the texts of the Strasbourg family’, in E. Hermens and J.H. Townsend (Eds.), *Sources and serendipity: testimonies of artists’ practice*. London: Archetype Publications, pp. 65-71.

NEVIN, A.; OSTICIOLI, I.; ANGLOS, D.; BURNSTOCK, A.; CATHER, S.; CASTELLUCCI, E. (2007). ‘Raman spectra of proteinaceous materials used in paintings: A multivariate analytical approach for classification and identification’, *Analytical Chemistry*, 79, 6143-6151.

NEWMAN, M.G. (2003). ‘Crucified by the virtues: monks, lay brothers, and women in thirteenth-century Cistercian saint’s lives’, in S. Farmer and C.B. Pasternack (Eds.), *Gender and difference in the middle ages*. Minneapolis: University of Minnesota Press.

___ (2013). ‘Foundation and twelfth century’, in Mette B. Bruun (ed.), *The Cambridge companion to the Cistercian Order*. Cambridge: Cambridge University Press, pp. 25-37.

NOBRE DE GUSMÃO, A. (1992). *A Real Abadia de Alcobaça*, Lisboa: Livros Horizonte.

NOELL, B. (2006). ‘Expectation and unrest among Cistercian lay brothers in the twelfth and thirteenth centuries’, *Journal of Medieval History*, 32, 253-274.

NORMORE, C. (2012). ‘Navigating the world of meaning’, *Gesta*, 51(1), 19-34.

Ó FAOLÁIN, E.; HUNTER, M.B.; BYRNE, J.M.; KELEHAN, P.; LAMBKIN, H.A.; BYRNE, H.J.; LYNG, F.M. (2005). ‘Raman spectroscopy evaluation of efficacy of current paraffin wax section dewaxing agents’, *Journal of Histochemistry & Cytochemistry*, 53(1), 121-129.

ODLYHA, M.; THEODORAKOPOULOS, C.; DE GROOT, J.; BOZEC, L.; HORTON, M. (2009). ‘Fourier transform infra-red spectroscopy (ATR/FTIR) and scanning probe microscopy of parchment’, *e-Preservation Science*, 6, 138-144.

OHLY, F. (2005). ‘Problems of medieval significs and Hugh of Folieto's “Dove Miniature”’, in Samuel Jaffe (ed.) and Kenneth Northcott (trans.), *Sensus spiritualis*: *Studies in medieval significs and the philology of culture*. Chicago: University of Chicago Press, pp. 68-135.

OLTROGGE, D. (2011). ‘Byzantine recipes and book illumination’, *Revista de História da Arte*, nº1, série W, 61-71.

ORNA, M.V. (2013). ‘Artists’ pigments in illuminated medieval manuscripts: tracing artistic influences and connections – A review’, in R.A. Armitage, J.H. Burton (eds.), *Archaeological Chemistry VIII*. Washington, DC: American Chemical Society, pp. 3-18.

ORTEGA-AVILÉS, M.; VANDENABEELE, P.; TENORIO, D.; MURILLO, G.; JIMÉNEZ-REYES, M.; GUTIÉRREZ, N. (2005). ‘Spectroscopic investigation of a ‘*Virgin of Sorrows*’ canvas painting: A multi-method approach’, *Analytica Chimica Acta*, 550, 164-172.

OSTICIOLI, I.; MENDES, N.F.C.; NEVIN, A.; GIL, F.P.S.C.; BECUCCI, M.; CASTELLUCI, E. (2009). ‘Analysis of natural and artificial ultramarine blue pigments using laser induced breakdown and pulsed Raman spectroscopy, statistical analysis and light microscopy’, *Spectrochimica Acta Part A*, 73, 525-531.

PÄCHT, O. (1986). *Book illumination in the middle ages: An introduction*. London: Harvey Miller Publishers.

PATERSON, L.M. (1998). *The world of the troubadours: medieval Occitan society, c. 1100-c.1300*. [1st published in 1993]. Cambridge: Cambridge University Press.

PATTEN, K.; GONZALEZ, L.; KENNEDY, C.; MILLS, D.; DAVIS, G.; WESS, T. (2013). ‘Is there evidence for change to collagen within parchment samples after exposure to an X-ray dose during high contrast X-ray microtomography? A multi technique investigation’, *Heritage Science*, 1, 1-9.

PASTOUREAU, Michel (1988). 'Du bleu au noir: Éthiques et pratiques de la couleur à la fin du Moyen Âge', *Médiévales*, 14, 9-21.

___ (1989a). *Couleurs, images, symboles: études d'histoire et d'anthropologie*. Paris: Le Léopard d'or.

___ (1989b). 'L'Eglise et la couleur, des origines à la Reforme', *Bibliothèque de l'école des chartes*, tome 147, 203-230.

___ (1998). *Jésus chez le teinturier: couleurs et teintures dans l'Occident médiéval*. Paris : Le Léopard d'or.

___ (1999). 'Les temps mis en couleurs: des couleurs liturgiques aux modes vestimentaires (XIIe-XIIIe siècles)', in *Bibliothèque de l'école des chartes*, 157 (1), 111-135.

___ (2001). *Blue. The history of a color* [originally *Bleu: Histoire d'une couleur*. Paris, 2000]. Princeton and Oxford: Princeton University Press.

___ (2004). *Une histoire symbolique du moyen âge Occidental*. Paris. Le Seuil.

___ (2008). *Black. The history of a color* [originally *Noir: Histoire d'une couleur*. Paris, 2008]. Princeton and Oxford: Princeton University Press.

___ (2014). *Green. The history of a color* [originally *Vert: Histoire d'une couleur*. Paris, 2013]. Princeton and Oxford: Princeton University Press.

PEIXEIRO, H.A. (1998). *Um olhar sobre a iluminura do Apocalipse de Lorvão*. Dissertação de provas públicas para professor coordenador. Tomar: Instituto Politécnico de Tomar, Escola Superior de Tecnologia, Departamento de Tecnologia e Artes Gráficas.

PESSANHA, S.; MANSO, M. and CARVALHO, M.L. (2012). 'Application of spectroscopic techniques to the study of illuminated manuscripts: A survey', *Spectrochimica Acta - Part B*, 71-72, 54-61.

PIANTANIDA, G.; MENART, E.; BICCHIERI, M.; STRLIČ, M. (2013). 'Classification of iron-based inks by means of micro-Raman spectroscopy and multivariate data analysis', *Journal of Raman Spectroscopy*, 44, 1299-1305.

PICKWOAD, N. (2000). 'Museums of the book', *Advances in Librarianship*, 24, 81-101.

PICOLLO, M.; ALDROVANDI, A.; MIGLIORI, A.; GIACOMELLI, S.; SCUDIERI, M. (2011). 'Non-invasive XRF and UV-VIS-NIR reflectance spectroscopic analysis of materials used by Beato Angelico in the manuscript *Graduale* n.558', *Revista de História da Arte*, nº1, serie W, 219-227.

PIÑAR, G.; STERFLINGER, K.; PINZARI, F. (2015). 'Unmasking the measles-like parchment discoloration: molecular and microanalytical approach', *Environmental Microbiology*, 17(2), 427-443.

PINDER, J. (2010). 'Love and reason from Hugh of Fouilloy to the *Abbaye du Saint Esprit*: Changes at the top in the medieval cloister allegory', *Parergon*, 27(1), 67-83.

PINZARI, F.; ZOTTI, M.; DE MICO, A.; CALVINI, P. (2010). 'Biodegradation of inorganic components in paper documents: Formation of calcium oxalate crystals as a consequence of *Aspergillus terreus* Thom growth', *International Biodeterioration & Biodegradation*, 64(4), 499-505.

PLATANIA, E.; LOFRUMENTO, C.; LOTTINI, E.; AZZARO, E.; RICCI, M.; BECUCCI, M. (2015). 'Tailored micro-extraction method for Raman/SERS detection of indigoids in ancient textiles', *Analytical and Bioanalytical Chemistry*, 407(21), 6505-6514.

POPESCU, C.; BUDRUGEAC, P.; WORTMANN, F.-J.; MIU, L.; DEMCO, D.E.; BAIAS, M. (2008). 'Assessment of collagen-based materials which are supports of cultural and historical objects', *Polymer Degradation and Stability*, 93(5), 976-982.

PORTER, C. (1992). 'Laser Raman spectroscopy: A tool for non-destructive pigment analysis of manuscripts', *The Paper Conservator*, 16, 93-7.

___ (1995). 'You can't tell a pigment by its color', in L.L. Brownrigg (Ed.), *Making The medieval book: techniques of production. Proceedings of the 4th conference of The seminar in the history of the book to 1500 Oxford, July 1992, Anderson*. Los Altos Hills, Calif.: Anderson-Lovelace; London: The Red Gull Press, pp. 111-116.

POZZI, F. (2012). *Development of innovative analytical procedures for the identification of organic colorants of interest in art and archaeology*, PhD dissertation. Milano: Università degli Studi di Milano.

POZZI, F.; LOMBARDI, J.R.; BRUNI, S.; LEONA, M. (2012). 'Sample treatment considerations in the analysis of organic colorants by surface-enhanced raman scattering', *Analytical Chemistry*, 84(8), 3751-3757.

POWERS, D.A.; ROSSMAN, G.R.; SCHUGAR, H.J.; GRAY, H.B. (1975). 'Magnetic behavior and infrared spectra of jarosite, basic iron sulfate, and their chromate analogs', *Journal of Solid State Chemistry*, 13(1-2), 1-13.

PULLIAM, H. (2013). 'Eyes of light: colour in the Lindisfarne Gospels', in J. Ashbee and J.M. Luxford (eds.), *Newcastle and Northumberland: Roman and medieval architecture and art*. (BAA Conference Transactions, 36). Leeds: Maney Publishing, pp. 54-72.

QUAILE, E. (1897). *Illuminated manuscripts: Their origin, history, and characteristics*. Liverpool: Henry Young & Sons.

REYNOLDS, L.D. and WILSON, N.G. (1991). *Scribes and scholars. A guide to the transmission of Greek and Latin literature*. 3rd edition (1st edition: 1968). Oxford: Oxford University Press.

RIBEIRO, M.E. de B. (2004). 'O Livro da Aves. Fragmento de um manuscrito desaparecido', *I Seminário Brasileiro sobre Livro e História Editorial*, 8 a 11 de Novembro de 2004, Rio de Janeiro, 1-10.

RICCI, C.; MILIANI, C.; BRUNETTI, B.G.; SGAMELLOTTI, A. (2006). 'Non-invasive identification of surface materials on marble artifacts with fiber optics mid-FTIR reflectance spectroscopy', *Talanta*, 69, 1221-1226.

RICCIARDI, P.; DELANEY, J.K. (2011). 'Combining visible and infrared imaging site specific, in-situ techniques for material identification and mapping', *Revista de História da Arte*, nº1, série W, 253-261.

RICCIARDI, P.; DELANEY, J.K.; FACINI, M.; ZEIBEL, J.G.; PICOLLO, M.; LOMAX, S.; LOEW, M. (2012). 'Near infrared reflectance imaging spectroscopy to map paint binders in situ on illuminated manuscripts', *Angewandte Chemie - International Edition*, 51(23), 5607-5610.

RICCIARDI, P.; DELANEY, J.K.; GLINSMAN, L.; THOURY, M.; FACINI, M.; DE LA RIE, E.R. (2009). 'Use of visible and Infrared reflectance and luminescence imaging spectroscopy to study illuminated manuscripts: pigment identification and visualization of underdrawings', *Proceedings of SPIE*, vol. 7391, pp. 7391006-1–7391006-12.

RICCIARDI, P.; PALLIPURATH, A. and ROSE, K. (2013). '"It's not easy being green": a spectroscopic study of green pigments used in illuminated manuscripts', *Analytical Methods*, 5(16), 3819-3824.

ROBB, D.M. (1973). *The art of the illuminated manuscript*. South Brunswick: A.S. Barnes.

ROCHETTE, E.A.; BOSTICK, B.C.; LI, G. and FENDORF, S. (2000). 'Kinetics of arsenate reduction by dissolved sulfide', *Environmental Science & Technology*, 34, 4714-4720.

RODRIGUES, J. (1995). 'A arquitectura Românica', in Paulo Pereira (Dir.), *História da Arte Portuguesa*. Volume I. Lisboa: Círculo de Leitores, pp. 183-263.

ROGER, P., VILLELA-PETIT, I. and VANDROY, S. (2003). 'Les laques de brésil dans l'enluminure médiévale: reconstitution à partir de recettes anciennes', *Studies in Conservation*, 48(3), 155-170.

ROMANI, A.; CLEMENTI, C.; MILIANI, C.; BRUNETTI, B.G.; SGAMELLOTTI, A.; FAVARO, G. (2008). 'Portable equipment for luminescence lifetime measurements on surface', *Applied Spectroscopy*, 62(12), 1395-1399.

ROMANI, A.; CLEMENTI, C.; MILIANI, C.; FAVARO, G. (2010). 'Fluorescence spectroscopy: A powerful technique for the noninvasive characterization of artwork', *Accounts of Chemical Research*, 43(6), 837-846.

ROSI, F.; CLEMENTI, C.; PAOLANTONI, M.; ROMANI, A.; PELLEGRINO, R.; BRUNETTI, B.G.; NOWIK, W.; MILIANI, C. (2013). 'Study of Raman scattering and luminescence properties of orchil dye for its nondestructive identification on artworks', *Journal of Raman Spectroscopy*, 44(10), 1451-1456.

ROSI, F.; DAVERI, A.; MILIANI, C.; VERRI, G.; BENEDETTI, P.; PIQUÉ, F.; BRUNETTI, B.G.; SGAMELLOTTI, A. (2009). 'Non-invasive identification of organic materials in wall

paintings by fiber optic reflectance infrared spectroscopy: a statistical multivariate approach', *Analytical and Bioanalytical Chemistry*, 395, 2097-2106.

ROSS, J. (1822). *Onomasia: or, Philadelphia Vocabulary: with the signs of quantity: comprising, sententiae puerile, catonis disticha, collections poeticae selectee, material medica, a sketch of mythology: with a very concise account of some of the heathen deities, heroes*. Philadelphia: Lydia R. Bailey.

RUCQUOI, A. (2000). «Les Cisterciens dans la Péninsule Ibérique», in *Unanimité et diversité Cisterciennes. Filiations-Réseaux-Relectures du XIIe au XVIIe Siècle*, CERCOR. Saint-Étienne : Publications de l'Université de Saint-Étienne, pp. 487-523.

___ (2005). 'Ordres religieux et histoire culturelle dans l'occident Médiéval', *Lusitania Sacra*, 2ª série, 17, 299-328.

SADEZKY, A.; MUCKENHUBER, H.; GROTHE, H.; NIESSNER, R.; PÖSCHL, U. (2005). 'Raman microspectroscopy of soot and related carbonaceous materials: spectral analysis and structural information', *Carbon*, 43, 1731-1742.

SALVADÓ, N.; BUTÍ, S.; ARANDA, M.A.G.; PRADELL, T. (2014). 'New insights on blue pigments used in 15th century paintings by Synchrotron Radiation-based micro-FTIR and XRD', *Analytical Methods*, 6, 3610-3621.

SALVADÓ, N.; BUTÍ, S.; NICHOLSON, J.; EMERICH, H.; LABRADOR, A.; PRADELL, T. (2009). 'Identification of reaction compounds in micrometric layers from gothic paintings using combined SR-XRD and SR-FTIR', *Talanta*, 79(2), 419-428.

SALVADÓ, N.; BUTÍ, S.; COTTE, M.; CINQUE, G.; PRADELL, T. (2013). 'Shades of green in 15th century paintings: combined microanalysis of the materials using synchrotron radiation XRD, FTIR and XRF', *Applied Physics A*, 111, 47-57.

SALVADÓ, N.; PRADELL, T.; PANTOS, E.; PAPIZ, M.Z.; MOLERA, J.; SECO, M.; VENDRELL-SAZ, M. (2002). 'Identification of copper-based green pigments in Jaume Huguet's Gothic altarpieces by Fourier transform infrared microspectroscopy and synchrotron radiation X-ray diffraction', *Journal of Synchrotron Radiation*, 9, 215-222.

SAN ANDRÉS, M.; DE LA ROJA, J.M.; SANTOS, S.; SANCHO, N. (2012). 'Patrones de identificación del verdigrís: elaboración a partir de la reproducción de recetas antiguas', in *Fatto d'Archimia. Los pigmentos artificiales en las técnicas pictóricas*, M. del Egido and S. Kroustallis (coord.). Madrid: Ministerio de Educación, Cultura y Deporte. Villena Artes Gráficas, pp. 235-258.

SARKAR, P.C. and SHRIVASTAVA, A.K. (1997). 'FTIR spectroscopy of lac resin and its derivatives', *Pigment & Resin Technology*, 26(6), 378-381.

___ (2000). 'FT-IR spectroscopic studies on degradation of lac resin – part II: ageing and UV irradiation', *Pigment & Resin Technology*, 29(2), 75-81.

SCHIMDT, C.M. and TRENTELMAN, K.A. (2009). '1064 nm dispersive Raman micro-spectroscopy for the in-situ identification of organic red colorants', *e-Preservation science*, 6, 10-21.

SCOTT, D.A.; KHANDEKAR, N.; SCHILLING, M. R.; TURNER, N.; TANIGUCHI, Y.; KHANJIAN, H. (2001). 'Technical examination of a fifteenth-century German illuminated manuscript on paper: A case study in the identification of materials', *Studies in Conservation*, 46(2), 93-108.

SCULLY, T. (2000). *Cuoco Napoletano: The Neapolitan recipe collection (New York, Pierpont Morgan Library, MS Bühler, 19): a critical edition and English translation*. Ann Arbor, Mich.: University of Michigan Press.

SELMER, C. (1949). 'A study of the Latin manuscripts of the *Navigatio Sancti Brendani*', *Scriptorium*, 3(2), 177-182.

SIMONS, Walter (1980). 'Deux témoins du mouvement canonial au XII^{e} siècle. Les prieurés de Saint-Laurent-au-Bois et Saint-Nicolas de Regny et leurs démêlés avec l'abbaye de Corbie', *Sacris Erudiri*, XXIV, 203-244.

___ (2000). 'Gobry (Ivan). *Le De claustro animae d'Hugues de Fouilloy', Revue belge de philologie et d'histoire*, 78 (3-4), 1037-1039.

SMITH, C.S. and HAWTHORNE, J.G. (1974). 'Mappae Clavicula: A little key to the world of medieval techniques'. *Transactions of the American Philosophical Society*, 64(4), 1-128.

SOTIROPOULOU, S.; PAPLIAKA, Z.E. and VACCARI, L. (2015). 'Micro FTIR imaging for the investigation of deteriorated organic binders in wall painting stratigraphies of different techniques and periods', *Microchemical Journal*, 124, 559-567

STILMANN, N.A. (1973). 'The eleventh century merchant house of Ibn 'Awkal (A Geniza study)', *Journal of the economic and social history of the orient*, 16(1), 15-88.

STRLIČ, M.; CIGIĆ, I.K.; RABIN, I.; KOLAR, J.; PIHLAR, B.; CASSAR, M. (2009). 'Autoxidation of lipids in parchment', *Polymer Degradation and Stability*, 94, 886-890.

STROLOVITCH, D.L. (2005). *Old Portuguese in Hebrew script: convention, contact, and convivência*. PhD dissertation. New York: Cornell University.

STROLOVITCH, D.L. (2010). 'Old Portuguese in Hebrew script: beyond *O livro de como se fazem as cores*', in L.U. Afonso (ed.), *The materials of the image: as matérias da imagem*. Lisboa: Cátedra de Estudos Sefarditas «Alberto Benveniste» da Universidade de Lisboa, pp. 29-43.

STUART, Barbara (1997). *Biological applications of Infrared spectroscopy*. New York: John Wiley & Sons.

SZIRMAI, J.A. (1989). 'Stop destroying ancient bindings', *Abbey Newsletter*, 13(5). Accessed 12 November, http://cool.conservation-us.org/byorg/abbey/an/an13/an13-5/an13-513.html.

___ 'The archaeology of bookbinding and book restoration', *Quaerendo*, 26(2), 144-164.

___ (1999). *The archaeology of medieval bookbinding*. Aldershot: Ashgate.

TANASI, M.T. (2002). 'Il deterioramento di natura chimica della pergamena', *Chimica e biologia applicate alla conservazione degli archivi*. Roma: Ministero per i beni e le attività culturali. Direzione generale per gli *archivi,* pp. 321-330.

THOMPSON, D.V. (1932). 'The *De Clarea* of the so-called Anonymous Bernensis', *Technical studies in the field of the fine arts*, 1, 8-81.

___ (1954). *The craftsman's handbook: 'Il Libro dell'Arte' by Cennino d'Andrea Cennini* [originally published in 1933]. New York: Dover Publications.

___ (1956). *The materials and techniques of medieval painting*. New York: Dover Publications.

TOLAN, J. (1993). *Petrus Alfonsi and his medieval readers*. Gainesville: University Press of Florida.

TRENTELMAN, K. and TURNER, N. (2009). 'Investigation of the painting materials and techniques of the late-15th century manuscript illuminator Jean Bourdichon', *Journal of Raman Spectroscopy*, 40(5), 577-584.

VAN DER SNICKT, G.; MILIANI, C.; JANSSENS, K.; BRUNETTI, B.G.; ROMANI, A.; ROSI, F.; WALTER, P.; CASTAING, J.; DE NOLF, W.; KLAASSEN, L.; LABARQUE, I.; WITTERMANN, R. (2011). 'Material analyses of 'Christ with singing and music-making Angels', a late 15th-C panel painting attributed to Hans Memling and assistants: Part I. Non-invasive *in situ* investigations', *Journal of Analytical Atomic Spectrometry*, 26, 2216-2229.

VAN HOOYDONK, G.; DE REU, M.; MOENS, L.; VAN AELST, J. and MILIS, L. (1998). 'A TXRF and Micro-Raman spectrometric reconstruction of palettes for distinguishing between scriptoria of related medieval manuscripts', *European Journal of Inorganic Chemistry*, 5, 639-644.

VAN'T SPIJKER, I. (2005). 'Hugh of Saint Victor's virtue: Ambivalence and gratuity', in I.P. Bejczy and R.G. Newhauser (eds.), *Virtue and ethics in the twelfth century*. Leiden, Boston: Brill, pp. 75-94.

VANDENABEELE, P.; MOENS, L. (2004). 'Pigment identification in illuminated manuscripts', in K. Janssens and R. Van Grieken (eds.), *Non-destructive microanalysis of cultural heritage materials*. Amsterdam: Elsevier, pp. 635-662.

VANDENABEELE, P.; WEHLING, B.; MOENS, L.; DEKEYZER, B.; CARDON, B.; VON BOHLEN, A. and KLOCKENKÄMPER, R. (1999). 'Pigment investigation of a late-medieval manuscript with total reflection X-ray fluorescence and micro-Raman spectroscopy', *The Analyst*, 124 (2), 169-172.

VASCONCELOS E SOUSA, B. de (2005). *Ordens religiosas em Portugal: das origens a Trento. Guia Histórico*. Lisboa: Livros Horizonte.

VEZIN, J. (1973). *Évolution des techniques de la reliure médiévale*. Paris: Bibliothèque National.

VIÑAS, S.M. and FARREL, E.F. (1992). 'Technical analysis of illuminated manuscripts from the Library at the University of Valencia, Spain', *Studies in Conservation*, 37, 99-103.

___ (1998). 'Original written sources for the history of mediaeval painting techniques and materials: A list of published texts', *Studies in Conservation*, 43, 114-124.

___ (1999). *The technical analysis of Renaissance illuminated manuscripts from the historical Library of the University of Valencia*, Valencia: HUAM-UPV.

VITORINO, T. (2012). *A closer look at brazilwood and its lake pigments*, Master dissertation. Lisbon: Department of conservation and restoration, Universidade Nova de Lisboa.

VITORINO, T.; MELO, M.J.; CARLYLE, L.; OTERO, V. (2015). 'New insights into brazilwood manufacture through the use of historically accurate reconstructions', *Studies in Conservation*, 61(5), 255-273.

VOISENET, J. (2000). *Bêtes et hommes dans le monde médiéval. Le bestiaire des clercs du V^e^ au XII^e^ siècle.* Turnhout, Belgium: Brepols Publishers.

WEITMAN, S.R. (1973). 'National flags: a sociological overview', *Semiotica*, 8(4), 328-367.

WEHLING, B.; VANDENABEELE, P.; MOENS, L.; KLOCKENKÄMPER, R.; VON BOHLEN, A.; VAN HOOYDONK, G.; DE REU, M. (1999). 'Investigation of pigments in medieval manuscripts by micro Raman spectroscopy and total reflection X-ray fluorescence spectrometry', *Mikrochimica Acta*, 130 (4), 253-260.

WHITE, W.B. and ROY, R. (1964). 'Infrared spectra-crystal structure correlations: II. Comparison of simple polymorphic minerals', *The American Mineralogist*, 49, 1670-1687.

WOODS, C.S. (2006). 'The conservation of parchment', in *Conservation of leather and related materials*, Marion Kite and Roy Thompson (Eds.). Oxford: Elsevier (Butterworth-Heinemann), pp. 200-224.

WOUTERS, J. (1985). 'High performance chromatography of anthraquinones: Analysis of plant and insect extracts and dyed textiles', *Studies in Conservation*, 30(3), 119-128.

___ (2003). 'Damage assessment approaches for organic materials in art: simple tests or sophisticated analyses?', in *Cultural heritage research: a Pan-European challenge*. Proceeding of the 5th EC conference, May 16-18. Cracow: European Communities, ICSC.

WOUTERS, J. and VERHECKEN, A. (1989). 'The coccid insect dyes: HPLC and computerized diode-array analysis of dyed yarns', *Studies in Conservation*, 34(4), 189-200.

ZALUSKA, Y. (1992). 'L'enluminure Cistercienne aux XII siècle', in *Bernard de Clairvaux. Histoire, mentalités, spiritualité: Colloque de Lyon-Cîteaux-Dijon* (Sources Chrétiennes, nº380). Paris : Les Éditions du Cerf, pp. 271-285.

ZHANG, X. and LAURSEN, R.A. (2005). 'Development of mild extraction methods for the analysis of natural dyes in textiles of historical interest using LC-diode array detector-MS', *Analytical Chemistry*, 77(7), 2022-2025.

ZHENG, M. and DU, W. (2006). 'Phase behavior, conformations, thermodynamic properties, and molecular motion of multicomponent paraffin waxes: A Raman spectroscopy study', *Vibrational Spectroscopy*, 40, 219-224.

ZHINGANG, L.; QINGLIANG, Z.; WANG, K.; LEE, D.; QIU, W. and WANG, J. (2008). 'Urea hydrolysis and recovery of nitrogen and phosphorous as MAP from stale human urine', *Journal of Environmental Sciences*, 20(8), 1018-1024.

ZINK, M. (1984). 'Le monde animal et ses représentations dans la littérature du moyen âge', *Actes de la société des historiens médiévistes de l'enseignement supérieur public. 15^{e} congrès, Toulouse*, 15(1), pp. 47-71.

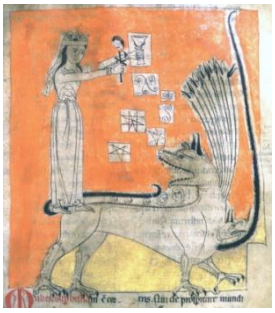
ZOPPI, A.; LOFRUMENTO, C.; MENDES, N.F.C.; CASTELLUCI, E.M. (2010). 'Metal oxalates in paints: a Raman investigation on the relative reactivities of different pigments to oxalic acid solutions', *Analytical and Bioanalytical Chemistry*, 397(2), 841-849.

APPENDIX I. Selected manuscripts from Lorvão, Alcobaça and Santa Cruz monasteries

Table I.1. Selected manuscripts from the Lorvão collection[1].

Manuscript title ref., dim. (mm), date	**Illumination detail**	**Analyzed folia**
Salterium Lorvão 3 160x130 12th century	 Lorvão 3, f.109v	1, 8v, 9v, 14v, 15, 16, 17v, 19, 19v, 23, 27, 35v, 36v, 43, 46, 46v, 51v, 54v, 59v, 71, 71v, 82v, 87v, 98v, 101, 107, 107v, 108, 109v, 110v, 113, 139v, 146, 149
De avibus by Hugh of Fouilloy Lorvão 5 220x70 1183-84	 Lorvão 5, f.5	4, 5, 5v, 6, 6v, 20v, 33, 36v, 59v, 50v, 54, 73, 95v
Lectionarium Sanctorale Lorvão 12 360x260 13th century	 Lorvão 12, f.50	6v, 7v, 8, 11, 17, 23, 30, 38v, 39, 50, 53v, 64, 94
Lectionarium Temporale Lorvão 13 420x280 13th century	 Lorvão 13, f.114	1v, 6v, 19v, 21v, 30, 35v, 39v, 44v, 63v, 73, 80v, 85, 92v, 114

[1] The general information about the Lorvão manuscripts was taken from the catalogue "Inventário dos Códices Iluminados até 1500: Distrito de Lisboa, Volume I" (Cepeda and Ferreira 1994: 65-72). Complete digital images of all the manuscripts can be accessed at http://digitarq.arquivos.pt/.

Gradual Lorvão 15 395x260 1201-1250	 Lorvão 15, f.38v	5v, 6, 11, 16, 26, 36v, 38v, 50, 125v, 154v, 167v
Passionarium Lorvão 16 380x250 c. 1140[2]	 Lorvão 16, f.71v	2v, 7v, 8, 11, 24v, 32, 34, 34v, 35v, 59v, 71v, 73, 126, 155, 161v, 165, 165v, 188
Book of Kalends Lorvão 17 290x210 mm 1st quarter of the 13th century	 Lorvão 17, f.169v	7v, 9, 9v, 34, 35, 74v, 162v, 169v, 230
Commentarium in Apocalypsis by Beato de Liébana (copied by Egas) Lorvão 44 345 x 245 1189	 Lorvão 44, f.43	43, 49, 115, 118, 136, 158, 177, 178v, 179, 185v
Enarrationes in Psalmos by Saint Augustine Lorvão 50 355x245 1183	 Lorvão 50, f.1v	1v, 17v, 34v, 64v, 173v, 196v, 197v, 248v

[2] The dating was recently rectified in Nascimento 2012b: 464.

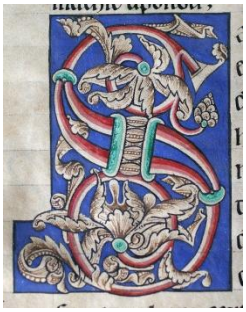
Table I.2. Selected manuscripts from the Alcobaça collection[3].

Manuscript title ref., dim. (mm), date	**Illumination detail**	**Analyzed folia**
Treaties, sentences and other texts (inc. *De Avibus*) by St. Augustine, Pseudo-Gennadius Massiliensis, Ambrosius Autpertus, Richard of St. Victor and Hugh of Fouilloy Alc. 238 320x222 Late 12th century[4]	 ALC 238, f.210	1v, 4, 4v, 33v, 34, 54, 76, 202v, 203, 203v, 206v, 210, 214, 220v, 224v, 225, 226v
Missal according to the Cistercian Rule Alc. 249 338x218 13th century	 ALC 249, f.91v	91v, 92, 109v, 124v, 125v, 125v
Sermones de verbis Domini*; *Sermones de verbis Apostoli by Saint Augustine Alc. 347 414x280 12th-13th century	 ALC 347, f.2	2, 57v
Sermones de Tempore*; *Setentiae by St. Bernard Alc. 358 409x268 12th century	 ALC 358, f.1	1, 36, 115v

[3] The general information about the Alcobaça manuscripts was taken from the catalogue "Inventário dos Códices Iluminados até 1500: Distrito de Lisboa, Volume I" (Cepeda and Ferreira 1994: 164-233). Complete digital images of most of the manuscripts can be accessed at http://purl.pt/index/geral/PT/index.html.

[4] The dating was established with the development of this thesis; also published in Castro, Melo and Miranda 2014.

Homiliae in Leviticum, Numerum, Josue et Judices by Origines (trans. by Rufinus Aquileiensis; copied by Friar Martinus of the Cist. Order) *Alc. 360* 391x265 13th century	 ALC 360, f.4v	1, 2, 3v, 4v, 10v, 11v
Tractatus de Evangelio Sancti Johannis by St. Augustine Alc. 402 437x315 12th-13th century	 ALC 402, f.227v	85v, 127v, 201v, 227v
Expositio in Leviticum by Radulphus Flaviacensis Alc. 405 432x295 12th-13th century	 ALC 405, f.3v	3v
Liber qui dicitur Angelus by Garnier de Rochefort (copied by Frater Egidius de Leirena); ***Summa Abel (Distinctiones)*** by Petrus Cantor Alc. 410 419x289 March 1219	 ALC 410, f.131	61, 61v, 111v, 131
Homiliarium (copied by Iohannes Pecatoris) Alc. 412 468x313 1257	 ALC 412, f.10v	10, 10v, 11v, 12

Legendarium cisterciense Alc. 419 436x285 12th-13th century	 ALC 419, f.1v	1v, 70, 92, 98, 98v
Legendarium cisterciense Alc. 421 435x293 12th-13th century	 ALC 421, f.181	159v, 181, 193v, 194, 198v, 202, 207v
Glossarium latinum*; *De arte grammatica by Papias; ***Liber interpretationes hebraicorum nominum*** by St. Jerome; ***Nomina regionum atque locorum de Actibus Apostolorum*** by Beda. ***De numeris*** by Raban Mauro; and others Alc. 426 370x260 12th-13th century	 ALC 426, f.251v	160v, 161, 251, 251v, 252
Bible mainly copied by Iohannes Pecatoris Alc. 427 485x333 12th-13th century	 ALC 427, f.115v	115v
Lectionarium Officii Cisterciense Alc. 433 460x329 1170-80 or 1201-1250[5]	 ALC 433, f.15	4v, 14, 15, 16, 16v, 17, 196

[5] The first dating is proposed by Miranda 1984 and the second is from Cepeda and Ferreira 1994. Catarina Miguel proposes (Miguel 2012) that the manuscript may be a compilation of two separate texts: one from the 12th century and the other from the 13th century, due to the presence of azurite in the latter.

Etymologiae; De natura rerum ad Sisebutum by St. Isidore of Seville Alc. 446 428x292 13th century	 ALC 446 f.96v	12v, 32v, 33, 33v, 96v, 97

Table I.3. Selected manuscripts from the Santa Cruz collection[6].

Manuscript title ref., dim. (mm), date	**Illumination detail**	**Analyzed folia**
Bible (Old Testament) Santa Cruz 1 582x421 1151-1200	 SC 1, f.14v	2v, 3, 14v, 24, 65, 77, 173v, 185v, 260v, 226v, 338, 362v, 364v
Bible (Old Testament and Prophetic Books) Santa Cruz 2 493x347 1201-1225	 SC 2, f.175v	46, 175v, 192v, 207v
Homiliarium Santa Cruz 4 424x291 1139 Oct. 25	 SC 4, f.317v	1, 123v, 188v, 225v, 266, 317v, 329, 329v, 371

[6] The general information about the Santa Cruz manuscripts was taken from the catalogue "Catálogo dos Códices da Livraria de Mão do Mosteiro de Santa Cruz de Coimbra na Biblioteca Pública Municipal do Porto" (Nascimento e Meirinhos 1997). Complete digital images of some of the manuscripts can be accessed at http://bibliotecas.cm-porto.pt/.

Commentarium in Librus Regum by Rabanus Maurus (copied by Johannes Michaeli) Santa Cruz 11 389x292 Late 12th century	 SC 11, f.117	18, 45, 117
Ethymologiae by Isidore of Seville Santa Cruz 17 411x293 Mid-12th century	 SC 17, f.1	1, 171
De Antiquitate Judaica by Flavius Josephus (copied by Martinus) Santa Cruz 18 395x280 1237	 SC 18, f.3v	3v
Legendarium Santa Cruz 20 460x280 Early 13th century	 SC 20, f.139	78, 86, 123, 123v, 139, 144, 162, 173v, 187v, 191, 197v, 199v
Legendarium Santa Cruz 21 371x246 Early 13th century	 SC 21, f.262v	2, 19, 207v, 262v

Salterium (copied by Fernandus) Santa Cruz 27 313x232 1179, June	 SC 27, f.1	1, 5, 15, 101v, 133
Historia ecclesiastica by Eusebius of Caesarea; ***De fide catholica contra Iudaeos*** by Isidore of Seville (copied by Fernandus Garsie) and other texts Santa Cruz 30 355x222 1126-1175	 SC 30, f.1v	1v
Dialogus contra judaeos by Petrus Alphonsi; ***Disputatio judei cum christiano*** by Gilbert Crispin of Westminster; ***De Avibus*** by Hugh of Fouilloy; and others Santa Cruz 34 332x243 Late 12th century	 SC 34, f.102	89, 89v, 93, 94v, 102, 103, 104, 104v, 107
Collationes; ***De Institutis Coenobiorum*** by Iohannes Cassianus (copied by Pelagius Garsie) Santa Cruz 43 310x217 1165 Nov. 27	 SC 43, f.1	1
De Genesi ad litteram; ***Quaestiones Evangeliorum*** by Augustine of Hippo; ***Hexameron. De paenitentia. Pastorale*** by Pseudo-Ambrosius. ***Expositio in Lucae Evangelium*** by Beda Santa Cruz 58 273x189 c.1139	 SC 58, f.1	1

Evangeliarium (contains only the Gospel's festivities) Santa Cruz 72 265x165 13th century (beg.)	 SC 72, f.2v	2v

APPENDIX II. Colour materials identified in the three Portuguese *scriptoria*

Table II.1. Pigments and dyes identified in the three Portuguese Romanesque collections from Lorvão, Alcobaça and Santa Cruz (Claro 2009; Miguel 2012 and results from this dissertation).

Mss	Date	Pigments and Dyes											
		HgS	Pb_3O_4	As_2O_3	Organic yellow	Lac dye	Indigo	Lapis Lazuli	Azurite	Cu proteinate	Malachite	Pb white	Carbon or bone black
Lv. 3	12th c.	X	X		X		X	X	X	X		X	X
Lv. 5	12th c.	X	X		X	X		X	X			X	X
Lv. 12	13th c.	X	X		X					X			X
Lv. 13	13th c.	X	X		X			X		X		X	X
Lv. 15	13th c.	X	X				X	X	X	X		X	X
Lv. 16	12th c.	X	X		X		X	X	X	X			X
Lv. 17	13th c.						X	X	X	X	X	X	
Lv. 44	12th c.	X	X	X									
Lv. 50	12th c.	X	X					X		X		X	X
ALC 238	12th c.	X			X	X		X		X		X	X
ALC 249	13th c.	X		X		X	X	X				X	X
ALC 347	12th- 13th c.	X						X		X		X	X
ALC 358	12th c.	X	X					X		X			
ALC 360	13th c.	X	X					X		X		X	X
ALC 402	12th- 13th c.	X	X					X		X			
ALC 405	12th- 13th c.	X						X					
ALC 410	13th c.	X	X	X				X				X	X

ALC 412	**13th c.**	**X**				**X**		**X**		**X**			
ALC 419	**12th- 13th c.**	**X**	**X**			**X**		**X**		**X**			
ALC 421	**12th- 13th c.**	**X**			**X**	**X**		**X**		**X**		**X**	**X**
ALC 426	**12th- 13th c.**	**X**						**X**		**X**		**X**	
ALC 427	**12th- 13th c.**		**X**		**X**		**X**	**X**				**X**	
ALC 433	**12th- 13th c.**	**X**	**X**					**X**	**X**	**X**			
ALC 446	**13th c.**	**X**	**X**	**X**		**X**		**X**		**X**		**X**	
SC 1	**12th c.**	**X**	**X**	**X**	**X**	**X**	**X**	**X**		**X**		**X**	
SC 2	**13th c.**							**X**					
SC 4	**12th c.**	**X**		**X**						**X**			
SC 11	**12th c.**	**X**			**X**			**X**		**X**		**X**	
SC 17	**12th- 13th c.**	**X**			**X**								
SC 18	**13th c.**							**X**				**X**	
SC 20	**13th c.**	**X**			**X**	**X**	**X**	**X**		**X**			**X**
SC 21	**13th c.**	**X**			**X**	**X**	**X**	**X**		**X**			
SC 27	**12th c.**	**X**		**X**	**X**			**X**		**X**		**X**	
SC 30	**12th c.**	**X**			**X**								
SC 34	**12th c.**	**X**			**X**			**X**		**X**			**X**
SC 43	**12th c.**	**X**					**X**					**X**	
SC 58	**12th c.**												
SC 72	**13th c.**							**X**					
Number of occurrences		**32**	**17**	**7**	**16**	**10**	**10**	**31**	**6**	**25**	**1**	**20**	**15**

APPENDIX III. Areas of analysis in the Santa Cruz collection

The black dots (●), black squares (□) and red dots (●) represent the areas where µ-EDXRF, µ-Raman and Mid-FTIR were performed *in situ*, while the red circles (○) correspond to the areas where a microsample was taken for additional analytical techniques, such as µ-FTIR and µ-Raman. Please notice that Santa Cruz 34 is represented in the *De Avibus* Appendix XIII.

Santa Cruz 1 – *Bible* (12th c.), BPMP

Figure III.1. Analysed areas in Santa Cruz 1, f. 2v.

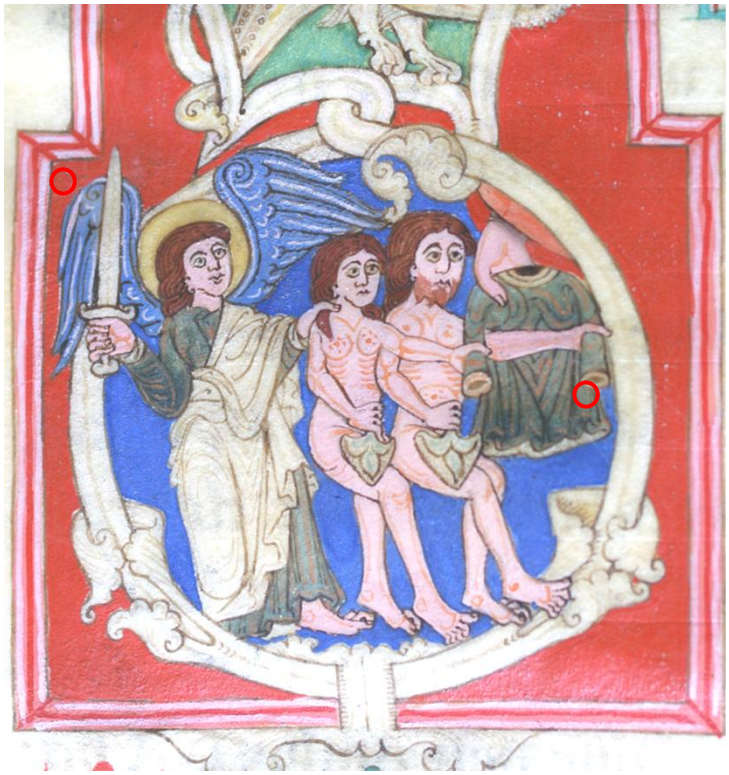


Figure III.2. Analysed areas in Santa Cruz 1, f. 3.

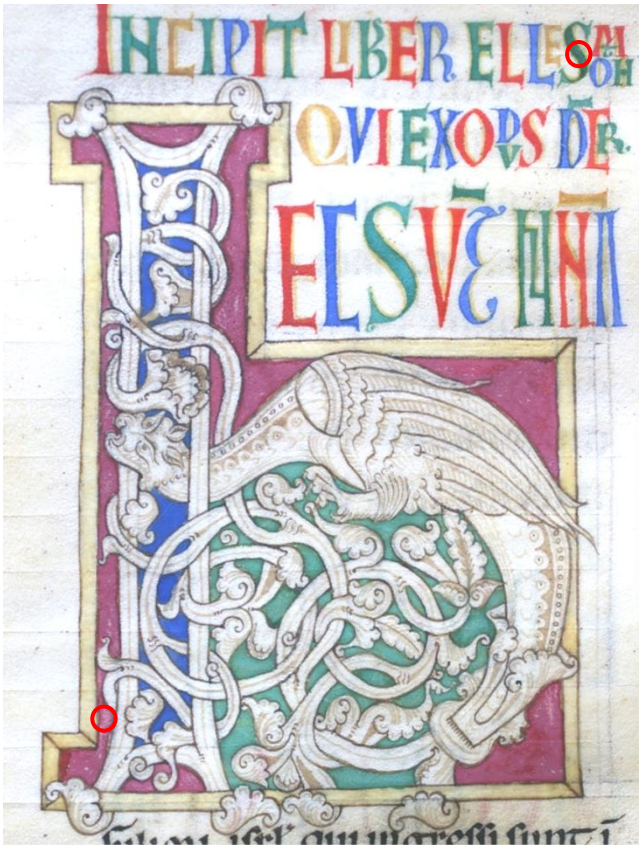


Figure III.3. Analysed areas in Santa Cruz 1, f. 14v.

Figure III.4. Analysed areas in Santa Cruz 1, f. 24.

Figure III.5. Analysed areas in Santa Cruz 1, f. 65.

Figure III.6. Analysed areas in Santa Cruz 1, f. 77.

Figure III.7. Analysed areas in Santa Cruz 1, f. 185v.

Figure III.8. Analysed areas in Santa Cruz 1, f. 206v.

Figure III.9. Analysed areas in Santa Cruz 1, f. 240v.

Figure III.10. Analysed areas in Santa Cruz 1, f. 313.

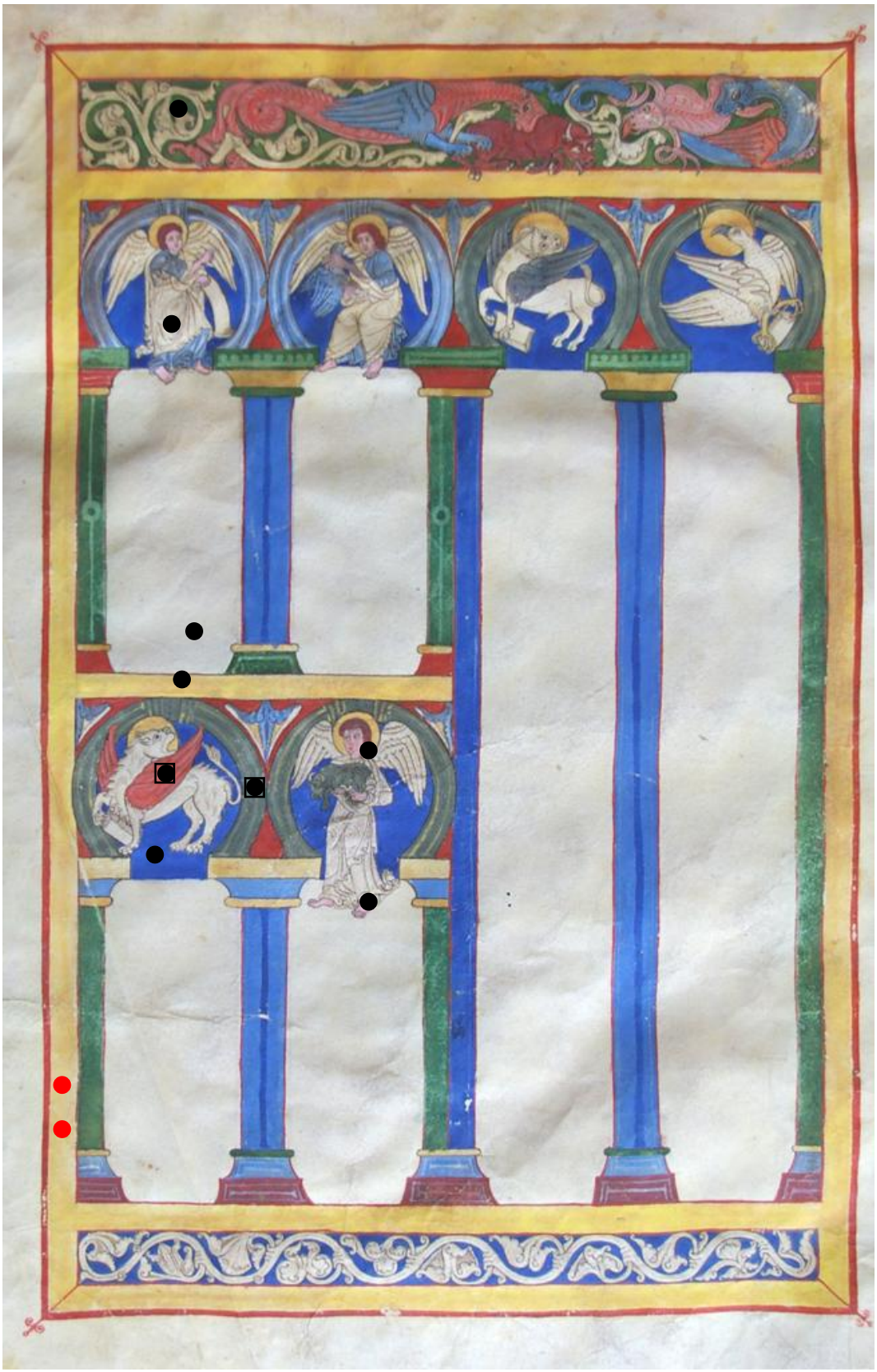


Figure III.11. Analysed areas in Santa Cruz 1, f. 362v.

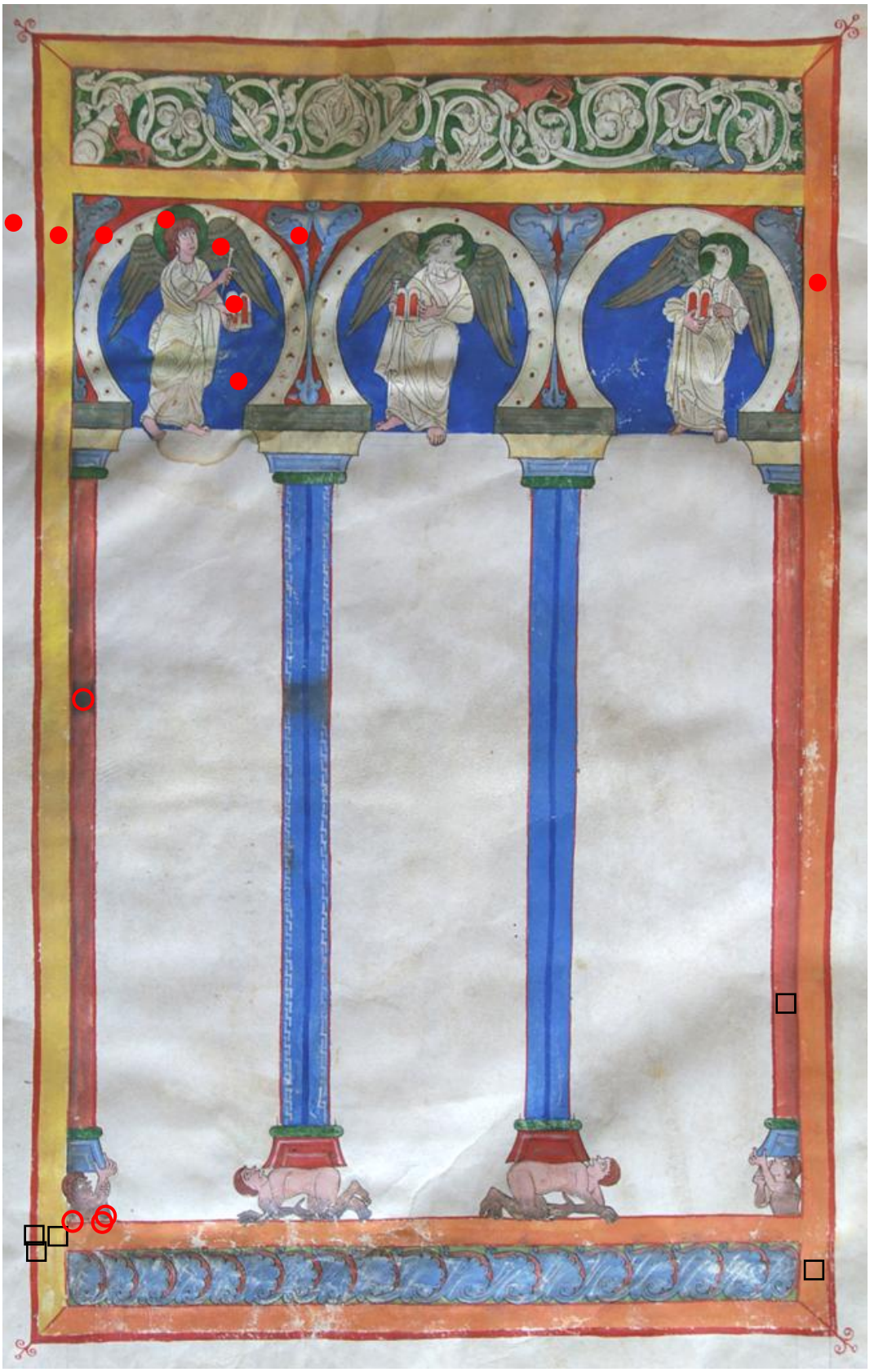


Figure III.12. Analysed areas in Santa Cruz 1, f. 364v.

Santa Cruz 2 – *Bible* (beginning of the 13th c.), BPMP

Figure III.13. Analysed areas in Santa Cruz 2, f. 175v.

Figure III.14. Analysed areas in Santa Cruz 2, f. 207v.

Santa Cruz 4 – *Homiliary* (1139), BPMP

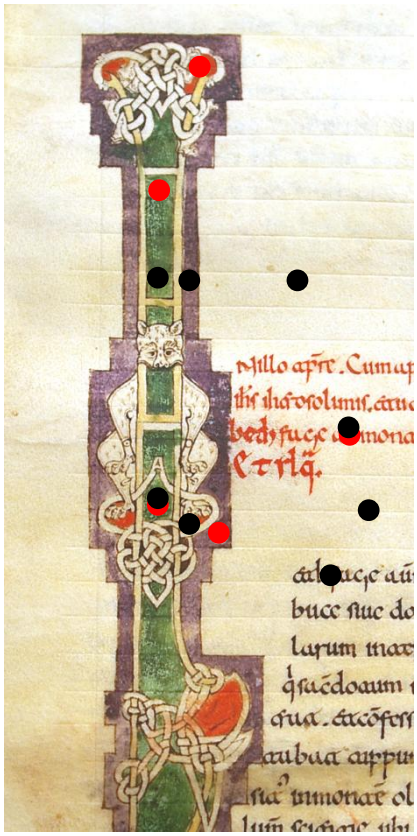


Figure III.15. Analysed areas in Santa Cruz 4, f. 1.

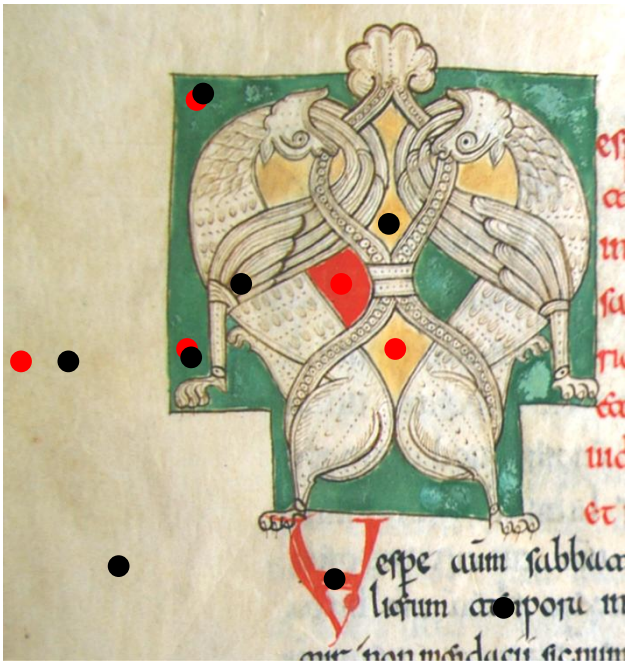


Figure III.16. Analysed areas in Santa Cruz 4, f. 122v.

Figure III.17. Analysed areas in Santa Cruz 4, f. 188v.

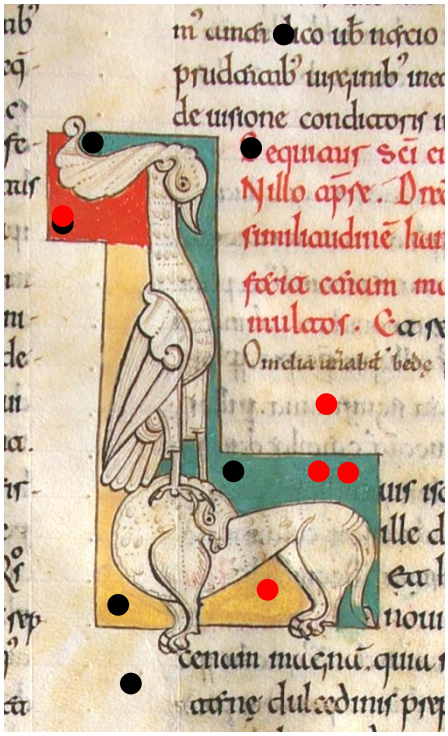


Figure III.18. Analysed areas in Santa Cruz 4, f. 225v.

Figure III.19. Analysed areas in Santa Cruz 4, f. 266.

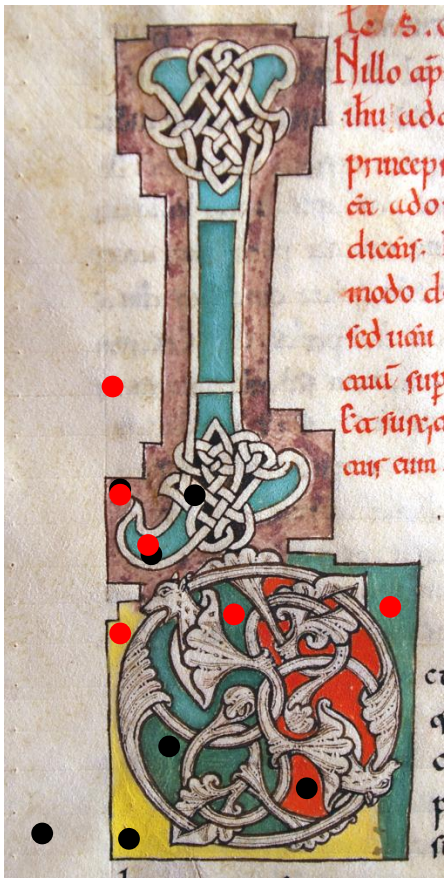


Figure III.20. Analysed areas in Santa Cruz 4, f. 317v.

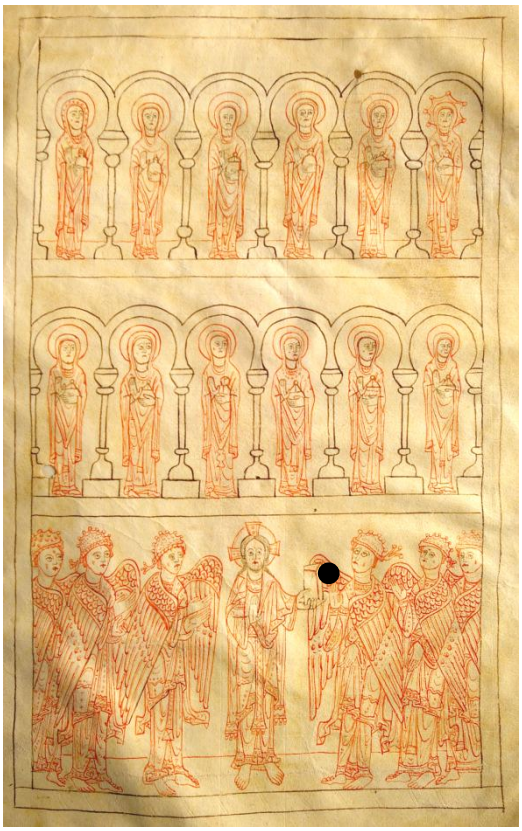


Figure III.21. Analysed areas in Santa Cruz 4, f. 329.

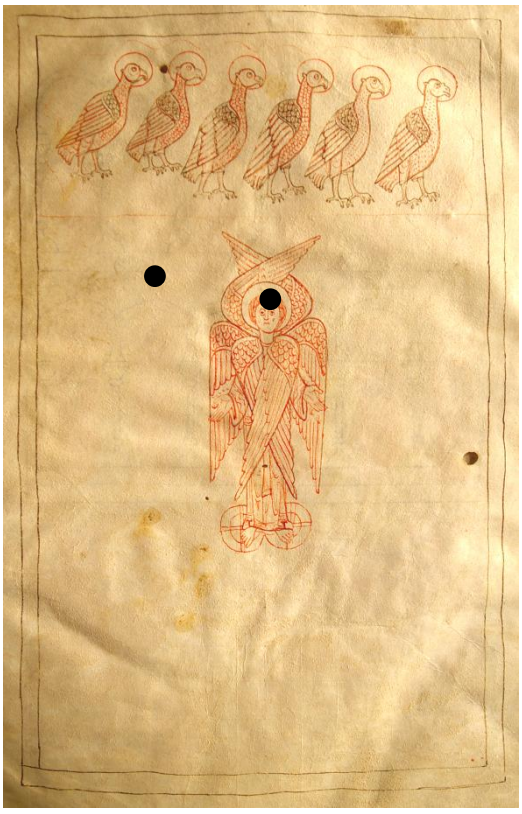


Figure III.22. Analysed areas in Santa Cruz 4, f. 329v.

Santa Cruz 11 – *Commentaria in libros IV Regum* by Rabanus Maurus (late 12th c.), BPMP

Figure III.23. Analysed areas in Santa Cruz 11, f. 18v.

Figure III.24. Analysed areas in Santa Cruz 11, f. 45.

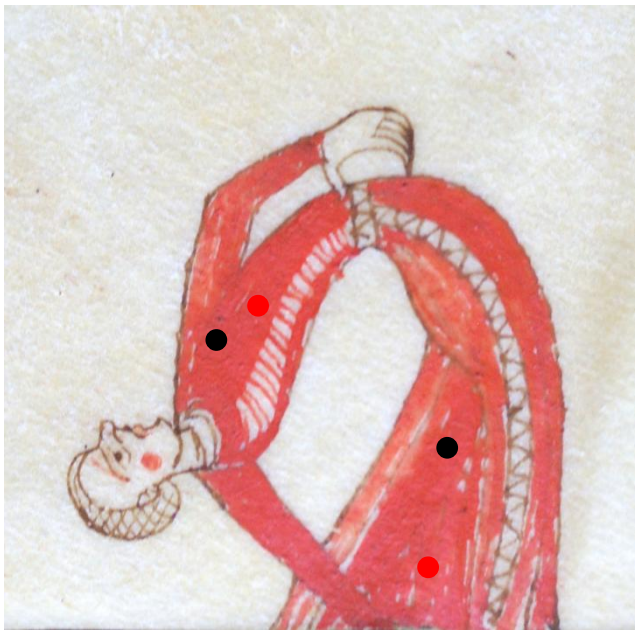


Figure III.25. Analysed areas in Santa Cruz 11, f. 117.

Santa Cruz 17 – *Etymologiarium* by Isidore of Seville (late 12th c. or early 13th c.), BPMP

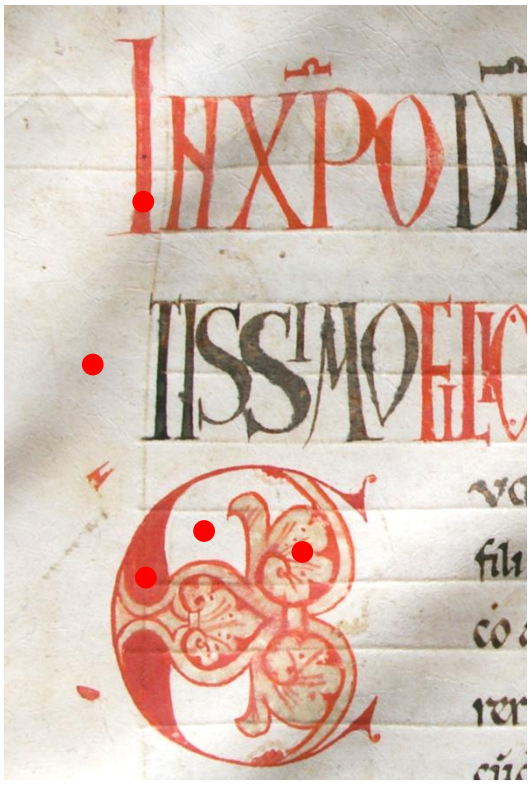


Figure III.26. Analysed areas in Santa Cruz 17, f. 1.

Figure III.27. Analysed areas in Santa Cruz 17, f. 171.

Santa Cruz 18 – *Antiquitates iudaicae* by Flavius Iosephus (1237), BPMP

Figure III.28. Analysed areas in Santa Cruz 18, f. 3v.

Santa Cruz 20 – *Vita Sanctae Mariae Oigniacensis* by Iacobus Vitriacensis | *Passiones Sanctorum* | *De arrha animae* (incomp.) by Hugo de Sancto Victore (end of the 13th c.), BPMP

Figure III.29. Analysed areas in Santa Cruz 20, f. 78.

Figure III.30. Analysed areas in Santa Cruz 20, f. 86.

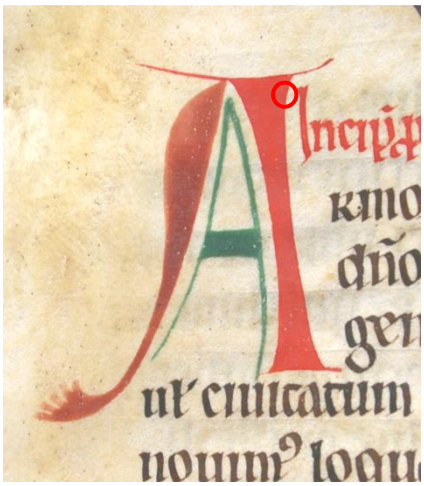


Figure III.31. Analysed areas in Santa Cruz 20, f. 123.

Figure III.32. Analysed areas in Santa Cruz 20, f. 123v.

Figure III.33. Analysed areas in Santa Cruz 20, f. 139.

Figure III.34. Analysed areas in Santa Cruz 20, f. 144.

Figure III.35. Analysed areas in Santa Cruz 20, f. 162.

Figure III.36. Analysed areas in Santa Cruz 20, f. 173v.

Figure III.37. Analysed areas in Santa Cruz 20, f. 187v.

Figure III.38. Analysed areas in Santa Cruz 20, f. 191.

Figure III.39. Analysed areas in Santa Cruz 20, f. 197v.

Figure III.40. Analysed areas in Santa Cruz 20, f. 199v.

Santa Cruz 21 – *Hagiography* (early 13th c.), BPMP

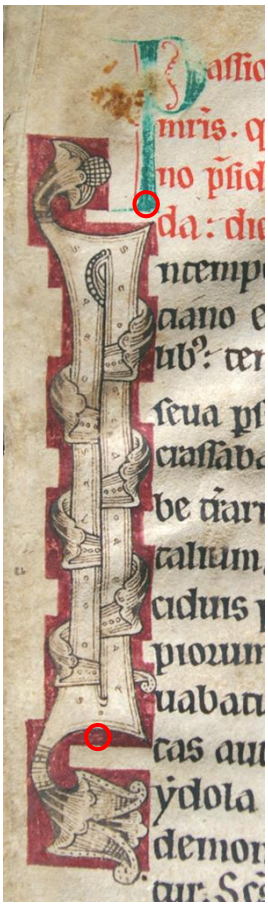


Figure III.41. Analysed areas in Santa Cruz 21, f. 2.

Figure III.42. Analysed areas in Santa Cruz 21, f. 19.

Figure III.43. Analysed areas in Santa Cruz 21, f. 83.

Figure III.44. Analysed areas in Santa Cruz 21, f. 207v.

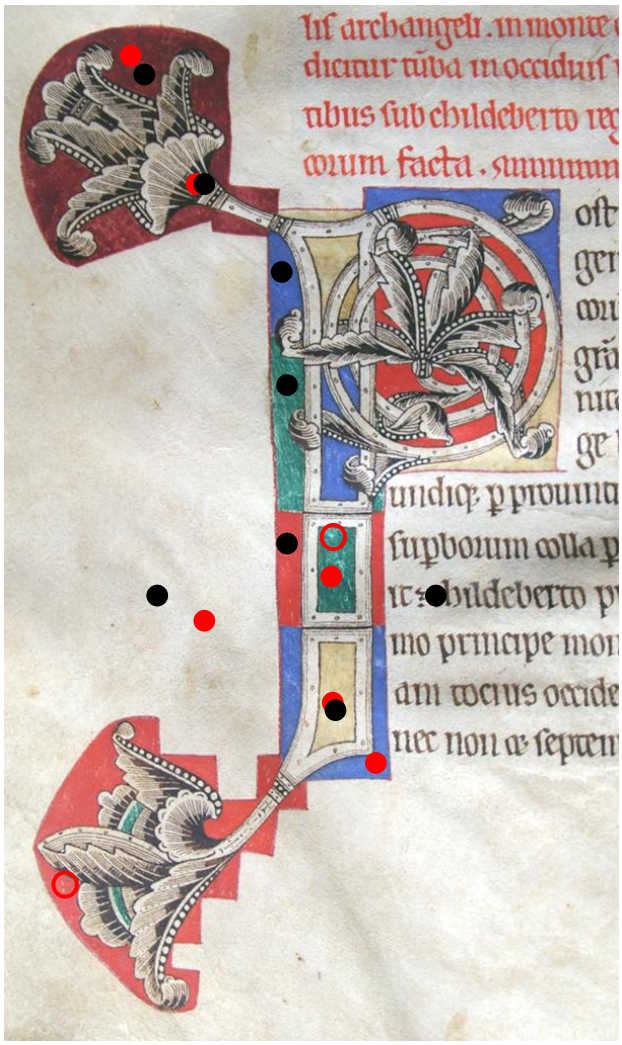


Figure III.45. Analysed areas in Santa Cruz 21, f. 262v.

Santa Cruz 27 – *Psalterium* (1179), BPMP

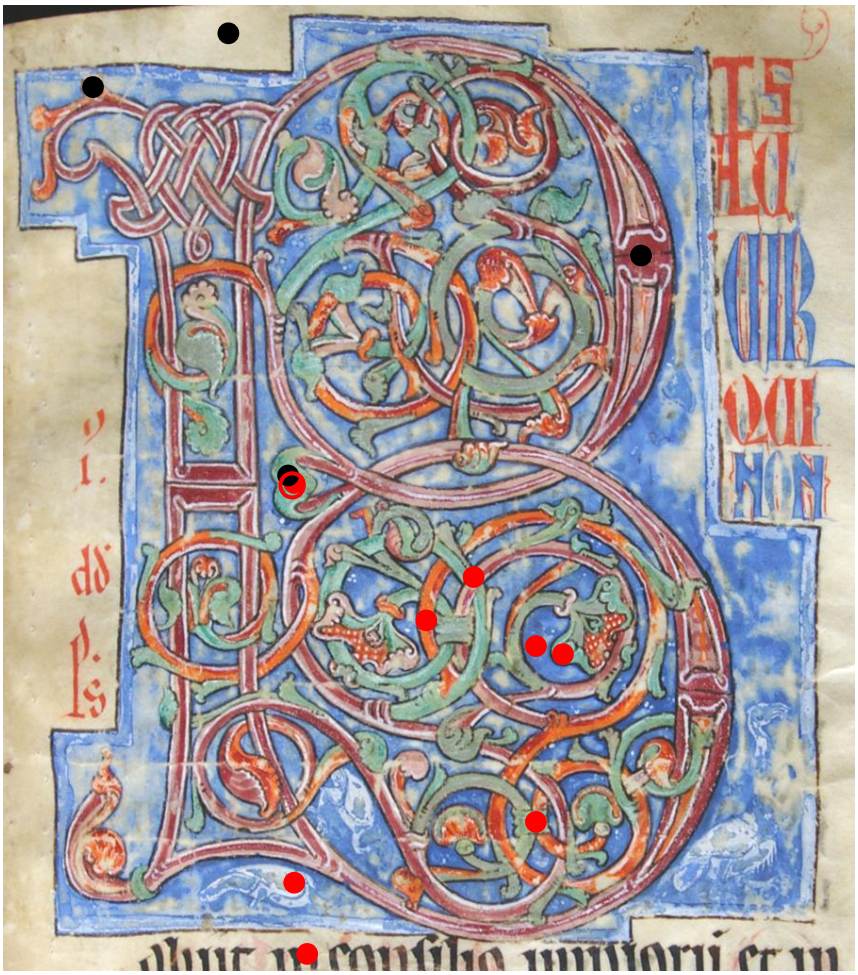


Figure III.46. Analysed areas in Santa Cruz 27, f. 1.

Figure III.47. Analysed areas in Santa Cruz 27, f. 15.

Figure III.48. Analysed areas in Santa Cruz 27, f. 101.

Santa Cruz 30 – *Historia ecclesiastica* by Eusebius Caesariensis | *De fide catholica contra Iudaeos* by Isidore of Seville | *De uita monachalis* by anonymous | *Conlationes* by Iohannes Cassianus (colophon of 1191 in the last text), BPMP

Figure III.49. Analysed areas in Santa Cruz 30, f. 1.

Santa Cruz 43 – *Collationes partum* (incompl.) and *De institutis coenobiorum* by Iohannes Cassianus (1165), BPMP

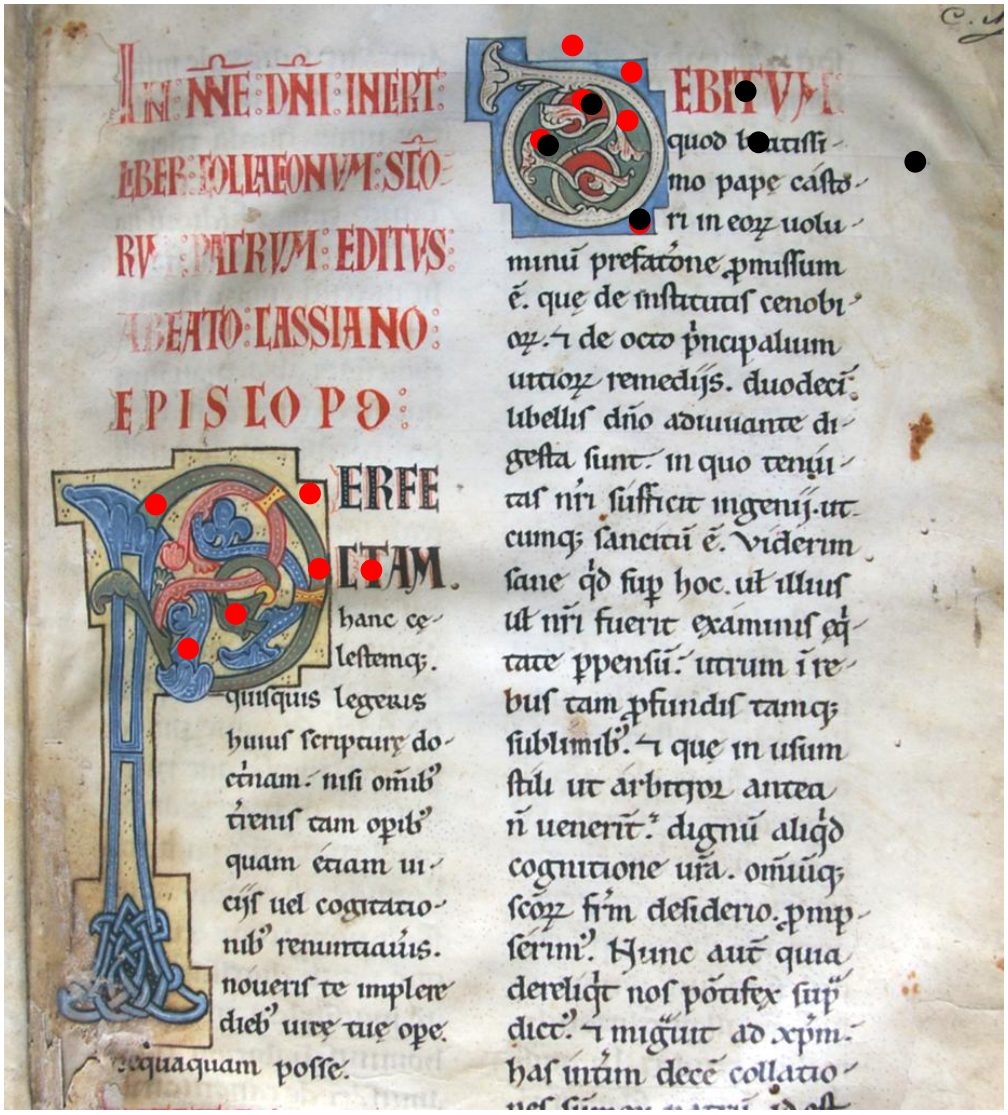


Figure III.50. Analysed areas in Santa Cruz 43, f. 1.

Santa Cruz 58 – *De Genesi ad litteram libri duodecim* and *Quaestiones Euangeliorum* by Augustinus Hipponensis | *Exameron* and *De paenitentia by* Ambrosius Mediolanensis | *Libellus de dignitate sacerdotale* by pseudo Ambrosius | *In Lucae evangelium exposition* by Beda (1139?), BPMP

Figure III.51. Analysed areas in Santa Cruz 58, f. 1.

Santa Cruz 72 – *Evangeliarium* (early 13th c.), BPMP

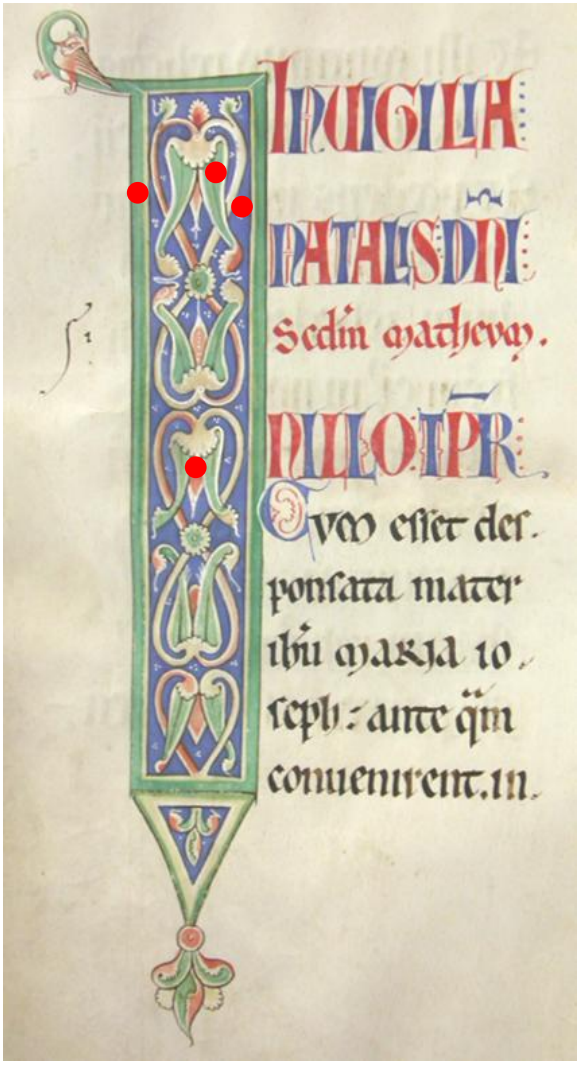


Figure X.52. Analysed areas in Santa Cruz 72, f. 2v.

APPENDIX IV. Experimental Conditions

IV.1. General Information

All reagents and solvents were of analytical grade. The medieval paint reconstructions and references used along the thesis were based on pigments and dyes from Sigma-Aldrich, Kremer, Maimeri and Vaz Pereira. Lac dye reconstructions are described elsewhere in Appendix XVI. Parchment was acquired from Musée du Parchemin et de l´Enluminure (Rouen, France) and used as binder as well as support.

Micro-sampling

Micro-sampling of the manuscripts was performed with a microchisel from Ted Pella microtools under a Leica KL 1500 LCD microscope, equipped with a 12x objective and a Leica Digilux digital camera, with external illumination via optical fibers. As for the micro-samples taken from the paint reconstructions, a tungsten needle was used. Micro-samples were typically of 20-50 μm in diameter and weight < 0.1 μg.

IV.2. DCR Instrumentation

IV.2.1. μ-EDXRF

Micro-EDXRF results were obtained using an ArtTAX spectrometer of Intax GmbH, with a low-power molybdenum (Mo) X-Ray tube attaining a microspot with a spatial resolution of circa 70 μm, an X-flash detector refrigerated by the Peltier effect (Sidrift), sustained by a mobile arm (providing a major freedom in choosing the spot of analysis). The accuracy of the incident beam position on the sample is achieved through three beams crossing diodes controlled by an integrated CCD camera; the characteristic X-rays emitted by the sample (at 40º) are detected by a silicon drift electro-thermally cooled detector with a resolution of 160eV at Mn-Kα. This apparatus allows for a simultaneous multi-element analysis in the element range from Mg (magnesium, atomic number 12) to U (uranium, atomic number 92).

The experimental parameters used were: 40kV of voltage, 300μA of intensity, for 120s, under Helium gas flux. Si, Mn, Cu and Pb standards were used as calibration standards in the beginning and at the end of the each day of data acquisition.

IV.2.2. μ-Raman

Raman microscopy was carried out using a Labram 300 Jobin Yvon spectrometer, equipped with a He-Ne laser of 17mW power operating at 632.8nm (red laser), and a 532nm diode laser of 50 mW power operating at 75% (green laser). Spectra were recorded as an extended scan. The laser beam was focused either with a 50× or a 100× Olympus objective lens. The laser power at the surface of the samples was between 4.3 and 0.17 mW.

IV.2.3. µ-FTIR

Infrared analyses were performed using a Nicolet Nexus spectrophotometer coupled to a Continuµm microscope (15x objective) with a MCT-A detector cooled by liquid nitrogen. The spectra were collected in transmission mode, in 50 µm areas resolution setting 4 cm^{-1} and 128 scans, using a Thermo diamond anvil compression cell. For some infrared spectra the system was purged with nitrogen prior to the data acquisition; for all infrared spectra the CO_2 absorption at circa 2400-2300 cm-1 was removed from the acquired spectra (4000- 650 cm^{-1}). To improve result robustness, more than one spectrum was acquired from different sample spots.

IV.2.4. Microspectrofluorimetry

Fluorescence excitation and emission spectra were recorded with a Jobin Yvon/Horiba SPEX Fluorog 3-2.2 spectrofluorometer. Fluorescence spectra were corrected for the wavelength response of the system. For microspectrofluorimetry analyses, the latter equipment was hyphenated to an Olympus BX51 M confocal microscope, with spatial resolution controlled with a multiple-pinhole turret, corresponding to a minimum 2 µm and maximum 60 µm spot, with 50x objective. Standard dichroic filters of 500 and 600 nm were used at 45° to collect the emission and excitation spectra, respectively. Emission spectra were acquired exciting at 490 nm and excitation spectra were recorded collecting the signal at 610 nm. Both type of spectra were acquired on a 30 µm spot (pinhole 8) and the following slits set: emission slits = 3 / 3 / 3 mm, and excitation slits = 5 / 3 / 0.8 mm. The optimization of the signal was performed for all pinhole apertures through mirror alignment in the optic pathway of the microscope, following the manufacturer's instructions. Spectra were collected after focusing on the sample (eye view) followed by signal intensity optimization (detector reading). Emission and excitation spectra were acquired on the same spot whenever possible. The paint reconstructions were mainly analyzed *in situ*, while the historical samples were analyzed in micro-samples. 5 spots per sample were measured to ensure reproducibility of the results.

IV.2.5. HPLC-DAD

HPLC-DAD analyses were carried out in an analytical Thermo Electron, FinniganTM Surveyor® HPLC-DAD system with a Thermo Electron, FinniganTM Surveyor® LC pump, Autosampler and PDA detector, and using a reversed-phase RP18 analytic column (Nucleosil C18, 250 x 4.6 mm, 300 Å - 5 µm) kept at controlled temperature (35ºC). Samples were injected into the column via a Rheodyne injector with a 25 µL loop. The elution gradient used at a flow rate of 1.7 mL/min consisted of A: HPLC-grade methanol and B: 0.3% (v/v) perchloric acid in Millipore ultrapure water. The gradient elution program was: 0-2 min, isocratic 7% A; 2-8 min,

linear gradient to 15% A; 8-25 min, linear gradient to 75% A; 25-27 min, linear gradient to 80% A; 27-29 min, linear to 100% A; and 29-40 min, isocratic 100% A.[40]

IV.2.6. UV-Vis

UV-Visible absorption spectra of the paint reconstructions and references in a 1-cm cuvette holder were recorded with a Cary 100 Bio spectrophotometer.

IV.2.7. FORS

The reflectance spectra were obtained with a reflectance spectrophotometer Ocean Optics in the region of 350-1050 nm through optical fibres. The analyses were obtained with 8 ms integration time, 15 scans and 15 box width.

IV.3. MOLAB Instrumentation

IV.3.1. XRF

The XRF equipment is made with a miniaturized X-ray generator EIS P/N 9910, equipped with a tungsten anode, and a SDD silicon drift detector (resolution of about 150 eV at 5.9 keV) cooled with a Peltier element. The instrument permits the detection of elements with Z higher than silicon (>14). The distance artwork-probe working distance is fixed at 2 cm. The beam diameter at the object surface is around 4 mm. The excitation parameters used were: current 0.01 mA, voltage 38 kV, acquisition time 120s. The X-ray source is a tungsten tube; thus all the spectra contain signals from the W source (8.1, 8.4, 9.5, 9.8, 10, 11.4 KeV). Also Ni (7.5 KeV) and Zr (15.7 and 17.7 KeV) are observed in all the spectra as interference from instrument materials.

IV.3.2. Reflectance Mid-FTIR

The spectrophotometer (JASCO VIR 9500) is equipped with a mid-infrared fibre optic sampling probe. The signal-to-noise ratio is very good in the range 900 to 4000 cm^{-1} with the exception of the 2050-2200 cm^{-1} region, and spectral resolution is of 4 cm^{-1}. The non-contact probe (4 mm diameter) is kept perpendicular to the painting surface (0°/0° geometry) at a distance of about 6 mm. Owing to the probe geometry, reflectance mid-FTIR spectra can present large distortions, both in band shape and absorption frequency, due to the presence of both specular and diffused components. Interpretation of spectra is possible through a wide specific database created *ad hoc*. The investigated spectral range was from 7000-900 cm^{-1} with a resolution of 4 cm^{-1} and 400 scans.

IV.3.3. Raman

The system was operated with a diode laser source at 785 nm. The Olympus micro-probe is equipped with an attenuator which allows for the laser power tuning at the surface. The back-scattered Raman light is collected (at 180°) by an optical fibre and led to a Czerny-Turner polychromator of about 100 mm of focal length and to a Peltier cooled CCD detector. The spectral range is from 250 to 2000 cm^{-1} with a maximum spectral resolution of 8 cm^{-1}. The measurement is contact-free with a spatial resolution of 0.1 mm^2, using a 20x objective and the output laser power was at the maximum 5mW.

IV.3.4. UV-Vis Fluorescence

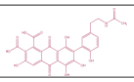
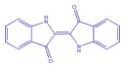
The portable fluorimeter has separate components: the light source (175W Cermax Xenon lamp) is focused on a H-10 Jobin Yvon UV-mono-chromator (linear dispersion 8 nm/mm) for selecting the excitation wavelength. A silica-fused fibre-optic cable directs the exciting light on the sample. The emitted light is convoyed by another fibre-optic cable to a high sensitivity (86 photons/counting, 2048 pixels, 200–1100 nm range) Avantes CCD spectrometer. A large number of short band-pass and long-pass filters, suitable to avoid scattered and higher harmonic excitation light, are also available to be used in online filter holders both in excitation and emission.

IV.3.5. Time resolved fluorescence

The instrument is composed by a pulsed source with interchangeable diodes and LEDs (two diodes, emitting at 375 and 650 nm, picosecond time scale, and one LED at 455 nm, nanosecond time scale), a photocathode detector working in the 350–850 nm range suitable for the detection of emissions of all organic colorants; a FluoroHub electronic device containing the TAC (time–amplitude converter) and a PC which fully controls the system of data acquisition and elaboration. A fibre optic sampling system, composed by a 400mm single silica fused fibres, transfers the excitation light to whichever point on a surface. A co-axial crown, constituted by 6 identical fibres, collects the emitted light from the surface and transmits the signal to the detector. A filter holder, positioned between the collecting fibres and the detector, allows the wavelength of the emitted light to be selected by choosing the appropriate band pass filter. This instrument allows a spatial resolution of about 12mm^2 and a time resolution of circa 0.4–0.5 ns or 0.1 ns using LEDs or laser diodes, respectively.

IV.4. Mapping colours tool

Table IV.4.1. The Atlas of Colour. Chemical formula, pigment name, proposed colour name and L*a*b* colour measurements. Historical paint reconstructions were made according to the molecular characterisation studied in the three Portuguese medieval manuscripts collections: Lorvão, Santa Cruz and Alcobaça (adaptation of the Table presented by Miguel 2001: 5).

						
						
HgS	Pb_3O_4	As_2S_3				
vermilion	red lead	orpiment	lac dye	Brazilwood	Brazilwood	indigo
vermilion red	**minium orange**	**orpiment yellow**	**lac carmine**	**Brazilwood rose**	**Brazilwood rose**	**indigo blue**
46, 47, 36	**60, 56, 60**	**80, 12, 68**	**30, 30, 13**	**45, 41, 1**	**61, 22, 5**	**22, 6, -5**
						
$Na_8[Al_6Si_6O_{24}]S_n$	$2CuCO_3.Cu(OH)_2$	synthetic green (copper green)	$CuCO_3.Cu(OH)_2$	$2PbCO_3.Pb(OH)_2$	$CaCO_3$	$Ca_3(PO_4)_2+C+MgSO_4$
lapis lazuli	azurite	*	malachite	white lead	white chalk	bone black
ultramarine blue	**azurite blue**	***bottle green***	**malachite green**	**white lead**	**white chalk**	**black**
47, 3, -35	**39, 4, -44**	**33, -27, 5**	**60, -30, 13**	**94, 0, 3**	**90, 3, 11**	**23, 1, 2**

* not yet fully characterized

A set of the most common colours found in Portuguese Romanesque illuminations was reproduced - the "pure" colours palette - and used in the colour mapping, seen in Table IV.4. The reproductions followed as accurately as possible the formulations identified in the framework of the analysis of the Lorvão, Sta. Cruz and Alcobaça collections. After being prepared, the paints were applied on parchment. The CIELAB parameters of the paints were measured and used to build a CIELAB colour palette that was used as calibration matrix on the algorithm. CIELAB of the parchment was also considered, as it is often present in the illuminations as background colour. The mapping of the regions occupied by the colours was obtained using an in-house built MATLAB function (MATLAB 7.11.0 R2010b). The steps involved in the mapping are as follows. After loading the image into the MATLAB workspace (in a RGB format), it is calibrated by automatically adjusting the gamma correction minimizing the difference between average colour chosen regions on the figure and the corresponding pure colours of the palette. The image is then converted to CIELAB format (3D data). CIELAB parameters for the "pure" colours palette (centroid of pure colour) are overlaid on the image and adjusted in the image through an optimization algorithm based on Kohonen neural network. This algorithm re-adjusts the position of the centroids of pure colours so that they fit optimally the image. Furthermore, the adjustment is achieved by approaching the centroids of pure colour (pure CIELAB) to actual values obtained image (CIELAB image). Within this step the disturbances in the CIELAB of images of different illuminations will be corrected. After the

optimization step of the centroids, each pixel of the image is analyzed and assigned to closest pure colour (using Euclidean distance). The CIELAB coordinates weigh all the same at this distance. The image pixels are then replaced by the "pure colour" assigned to them. In this way one can obtain a mask image. The pixels corresponding to the background (parchment) are then removed and the percentages of each colour present in miniature calculated.

IV.5. Lac dye methodology

IV.5.1. Colloid synthesis, SERS methodology and sample pre-treatments

Silver nanoparticles prepared by microwave-supported glucose reduction of silver sulphate with sodium citrate as capping agent were used as SERS substrate. A detailed description of the synthesis is reported elsewhere.[18]

SERS analysis was performed after deposition of 0.8 µL of the Ag colloid and 0.1 µL of 0.5 mol/L KNO_3 aqueous solution onto each micro-sample. Spectra were collected by focusing the laser beam onto the microaggregates which formed inside the dye-colloid droplet a few seconds after the deposition of the Ag nanoparticles and KNO_3. Several spectra were acquired continuously until the droplet dried out.

Three sorts of SERS procedures were used, according to the type of sample:

1 – For free lac reproductions (type A recipes), SERS analysis was performed directly on the micro-samples without any pre-treatment;

2 – For lac-alum reproductions (type B recipes), a non-extractive gas-solid hydrolysis pre-treatment was used, in which the micro-samples are exposed to hydrofluoric acid (HF) vapour in a closed microchamber for 5 minutes. This procedure aims to hydrolyze the dye-metal complex and increase the analyte adsorption on the nanosized metal substrate, thus enhancing the SERS signal.[21]

3 – For the historical samples, since it was possible to have the dye as free lac dye or as lac lake pigment, a two-step procedure was followed by analyzing the sample first without hydrolysis and then, after rinsing it with a water droplet, upon HF treatment.[21]

IV.5.2. SERS

SERS spectra was mainly performed in the MET and were acquired from silver colloid using a Bruker Senterra Raman instrument equipped with a charge-coupled device (CCD) detector and a 1800 rulings/mm holographic grating providing a resolution of 3-5 cm^{-1}. A 488 nm solid-state laser was employed as excitation source, with a power of about 0.5 mW at the sample. All spectra were obtained with a single integration of 30 s, focusing just below the surface of the colloid drop with an Olympus 20x LMPlanFL long working distance microscope objective.

IV.5.3. Other additional sample treatment

IV.5.3.1. For microspectrofluorimetry: Al^{3+}-lac complex applied on filter paper (500 µL of 10^{-3} mol/L lac dye solution in H_2O:MeOH 70:30 complexed with 20 µL of 1 mol/L $KAl(SO_4)_2.12H_2O$, at pH=3.8.

IV.5.3.2. For UV-Vis: Lac dye solutions in H_2O:MeOH 70:30 prepared to a concentration of 10^{-5} mol/L.

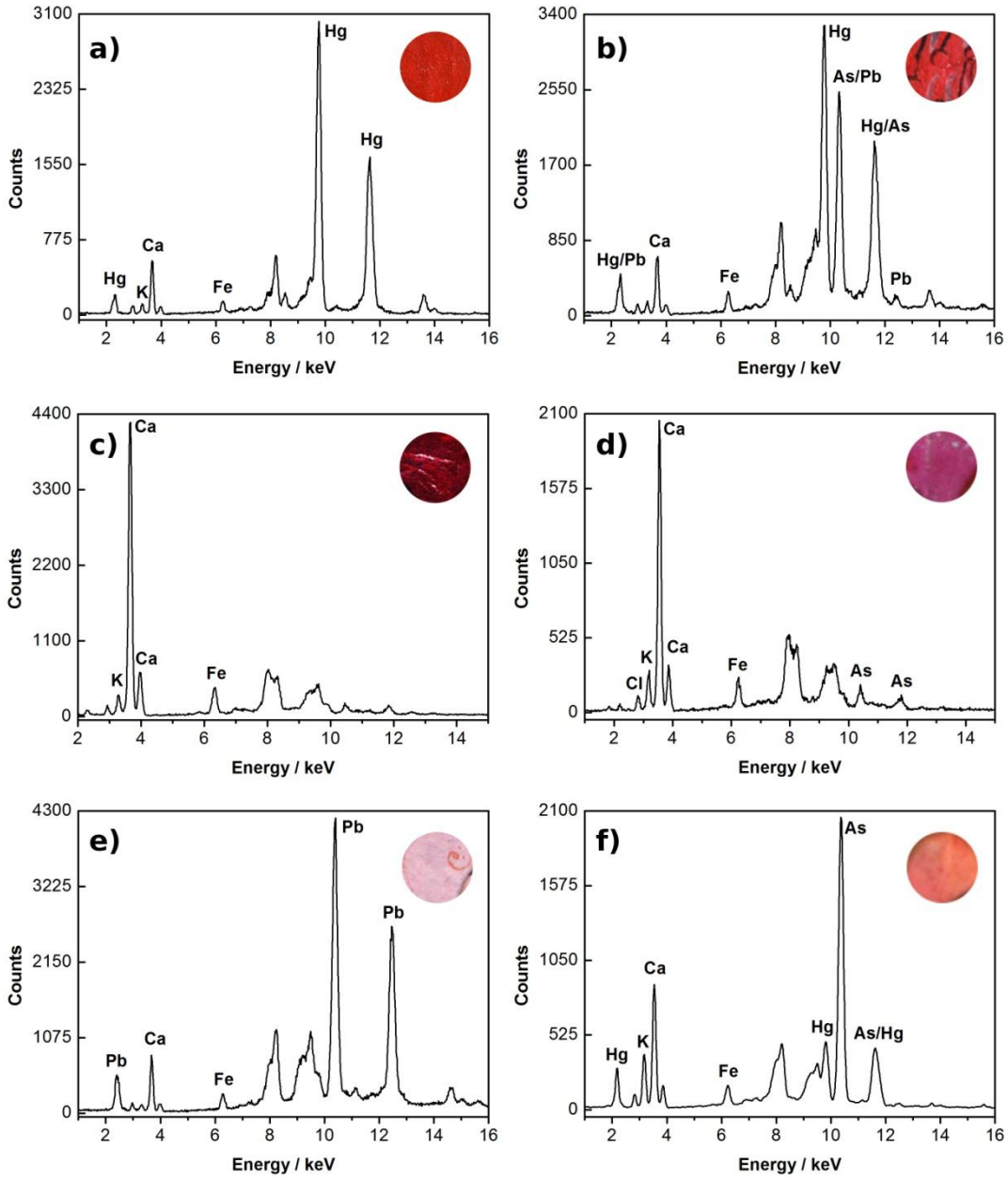
APPENDIX V. Representative analytical data from Santa Cruz collection

The main representative spectra acquired in Santa Cruz manuscripts, will be presented here. Each colour is represented by XRF, micro-Raman, micro-FTIR, mid-FTIR, fluorimetry (MOLAB) and SERS data, whenever performed.

Please notice that the data from Santa Cruz 34 will be in the Appendix XIII with the other Portuguese *Books of Birds*.

V.1. Santa Cruz 1

V.1.1. XRF



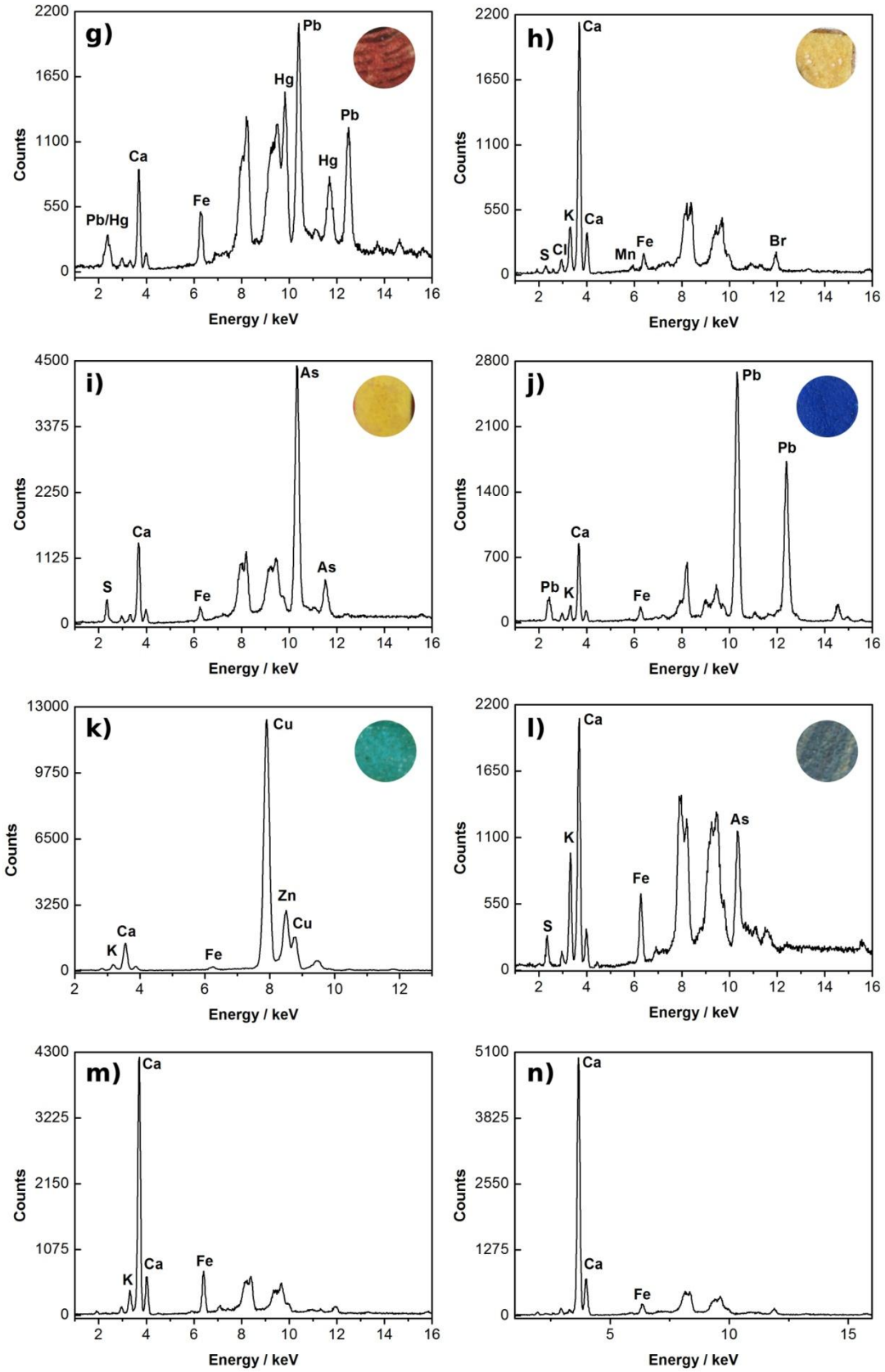


Figure V.1.1. Representative XRF spectra from Santa Cruz 1: **a)** red f. 206v; **b)** red f. 362v; **c)** dark red f. 240v; **d)** pink f. 185v; **e)** pink f. 362v; **f)** orange f. 185v; **g)** brown f. 362v; **h)** yellow f. 313; **i)** yellow f. 362v; **j)** blue f. 206v; **k)** green f. 185v; **l)** green f. 362v; **m)** black ink f. 313; **n)** parchment f. 240v.

V.1.2. Raman

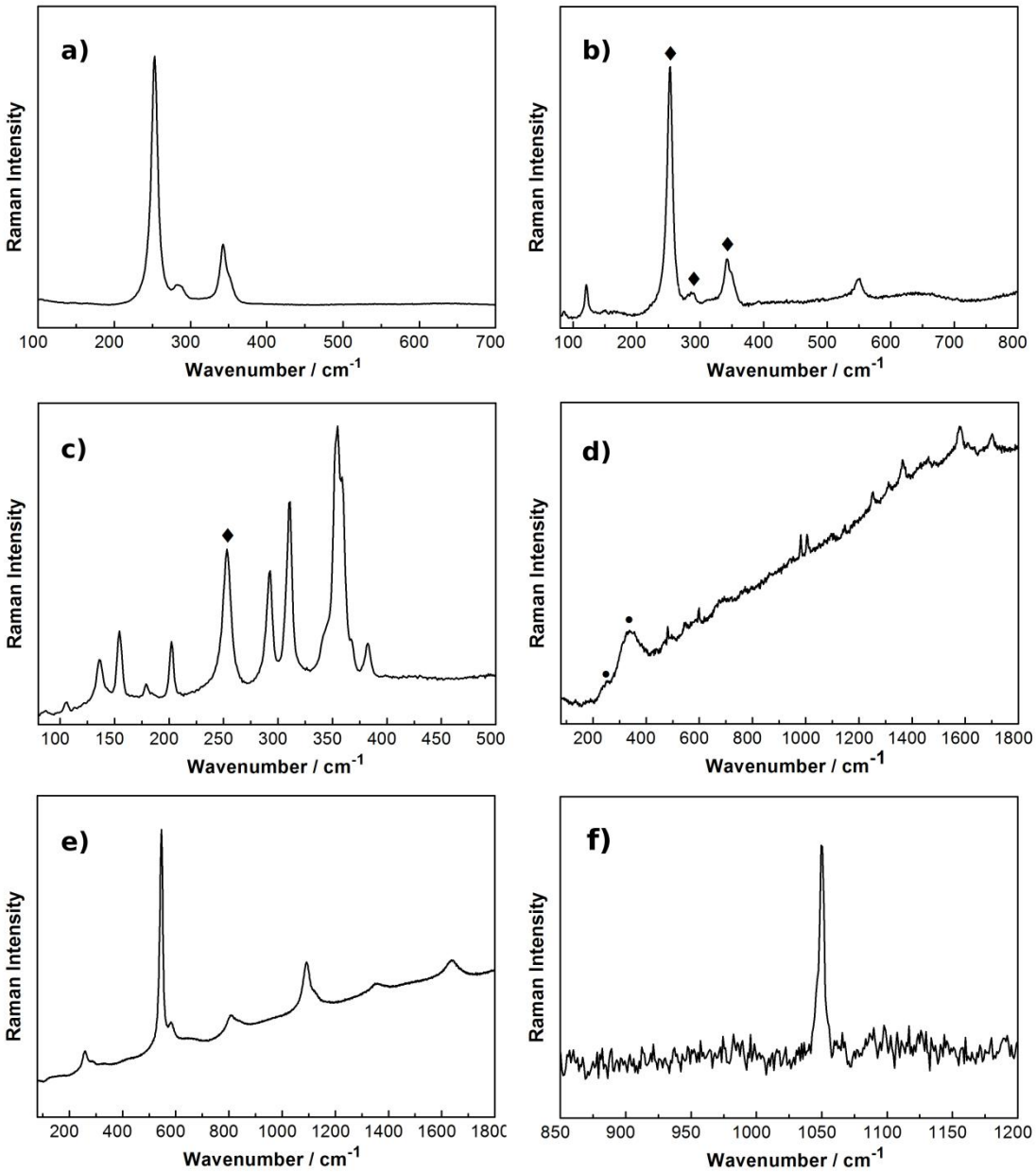


Figure V.1.2. Representative Raman spectra from Santa Cruz 1: **a)** red f. 86; **b)** orange f. 364v, with α-HgS (♦); **c)** yellowish orange f. 364v, α-HgS (♦); **d)** green *vergaut* f. 3, with As_2S_3 (●); **e)** blue f. 37.

V.1.3. Mid-FTIR reflectance

The assignments of the proteins (parchment and/or binder): amides I, II and III (1680, 1580, 1460 cm^{-1}) and combination band δ(N-H)+ν(N-H) (3080 cm^{-1}). This stands for all of the following spectra presented in this Appendix.

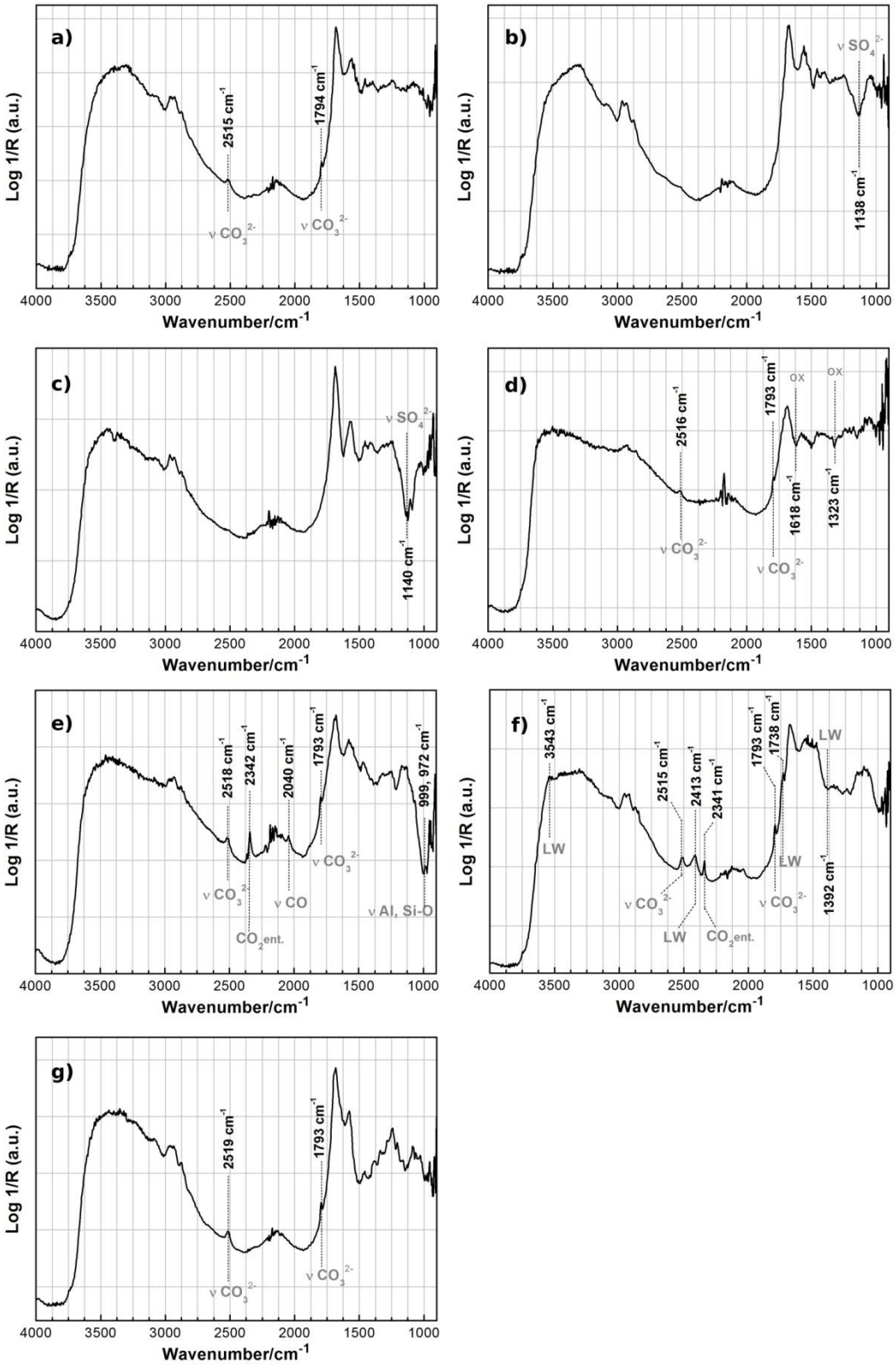


Figure V.1.3. Representative mid-FTIR reflectance spectra from Santa Cruz 1: **a)** red f. 364v; **b)** orange f. 364v; **c)** yellow f. 362v; **d)** green f. 364v; **e)** blue f. 364v; **f)** light blue f. 364v; **g)** parchment f. 364v.

V.1.4. FTIR

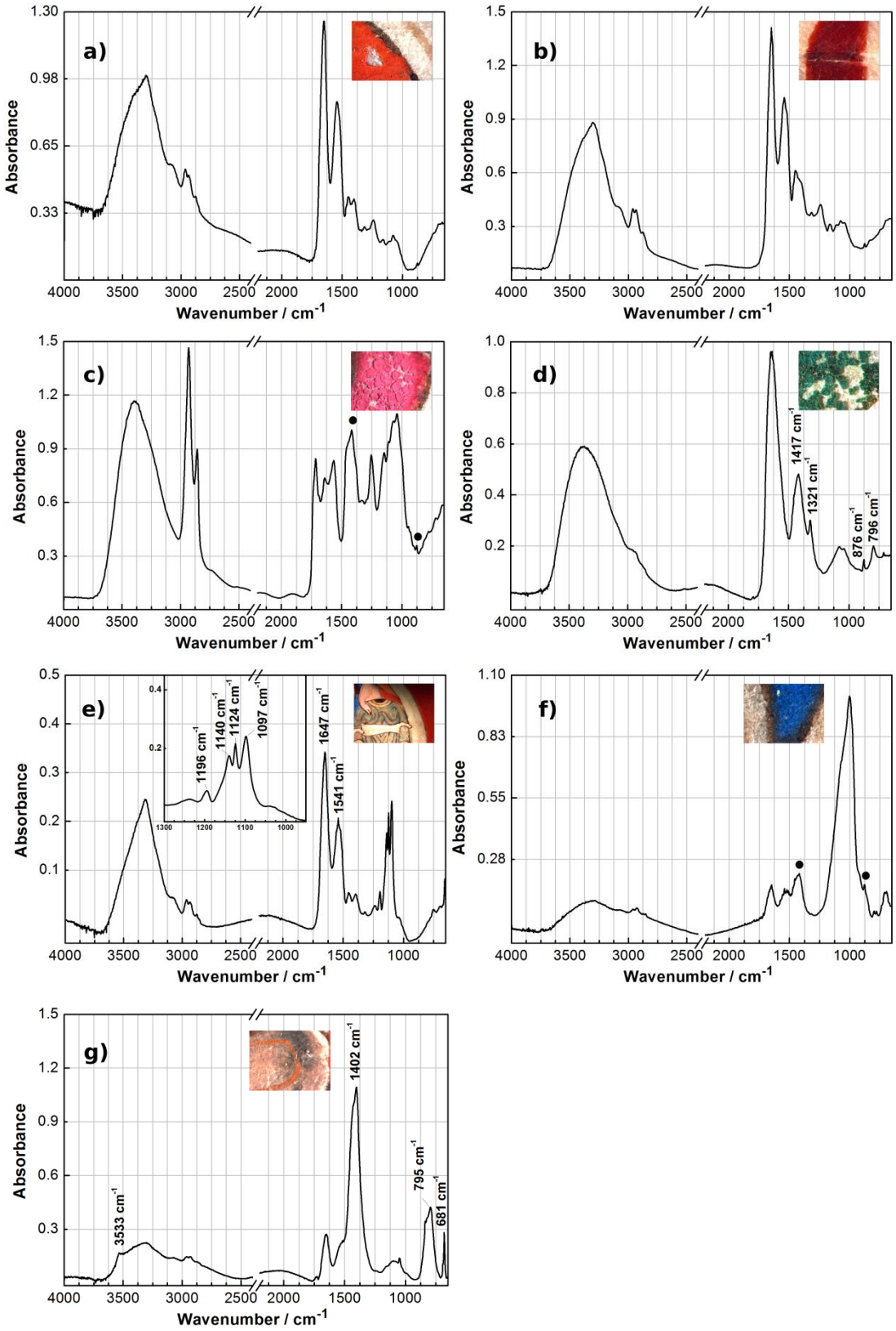


Figure V.1.4. Representative infrared spectra from Santa Cruz 1: **a)** red f. 364v; **b)** dark red f. 2v; **c)** pink f. 14v; **d)** green f. 24; **e)** dark green f. 3; **f)** blue f. 24 (● $CaCO_3$); **g)** white f. 364v.

V.1.5. Fluorimetry

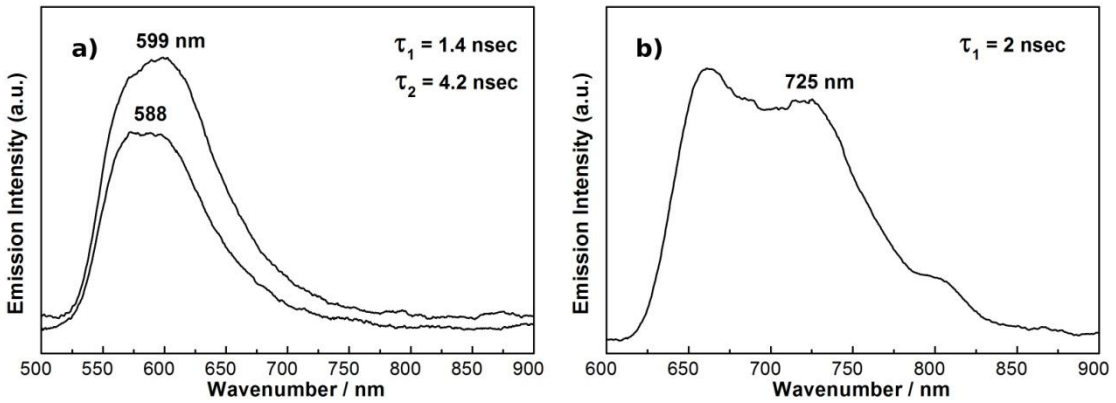


Figure V.1.5. Representative emission spectra (λ_{exc}=440 and 532 nm, respectively) from Santa Cruz 1: **a)** dark red f. 362v; **b)** dark green f. 362v.

V.2. Santa Cruz 2

V.2.1. Mid-FTIR reflectance

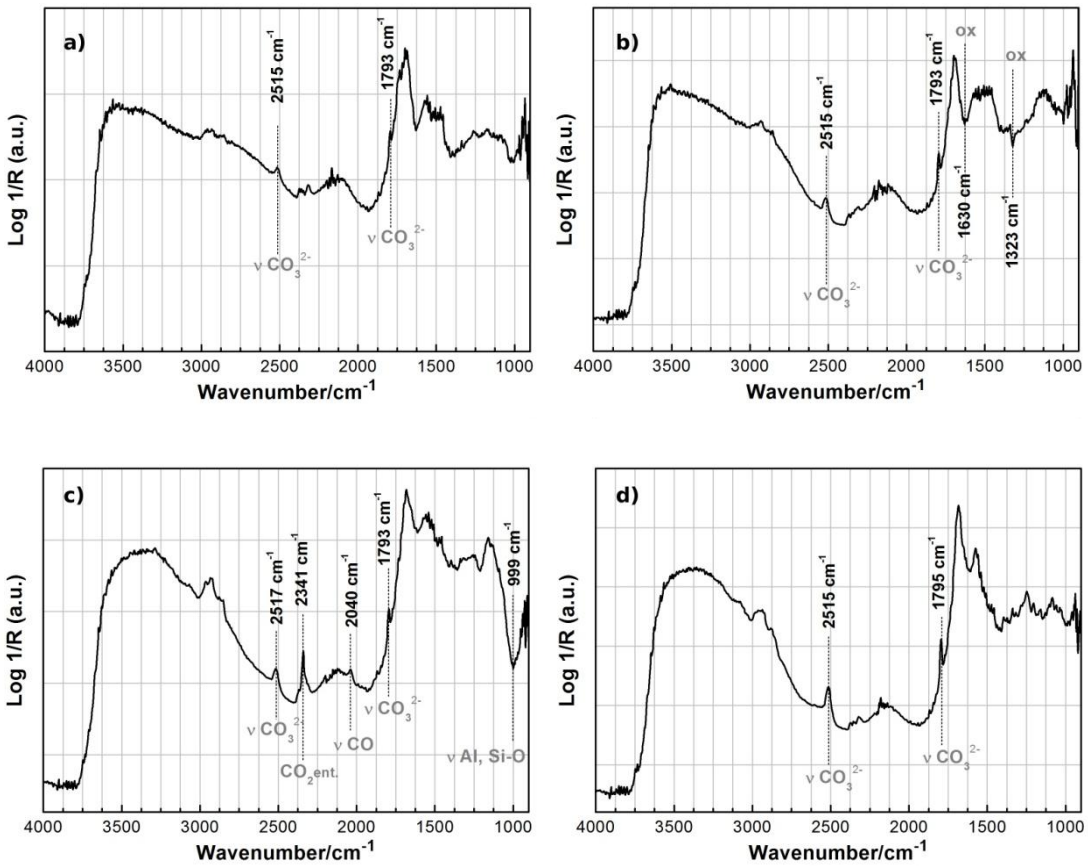


Figure V.2.1. Representative mid-FTIR reflectance spectra from Santa Cruz 2: **a)** dark red f. 207v; **b)** green f. 207v; **c)** blue f. 207v; **d)** parchment f. 207v.

V.2.2. Fluorimetry

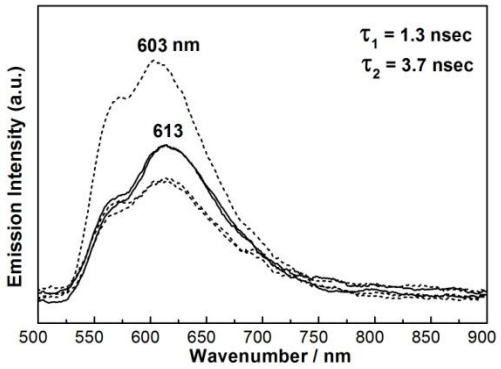
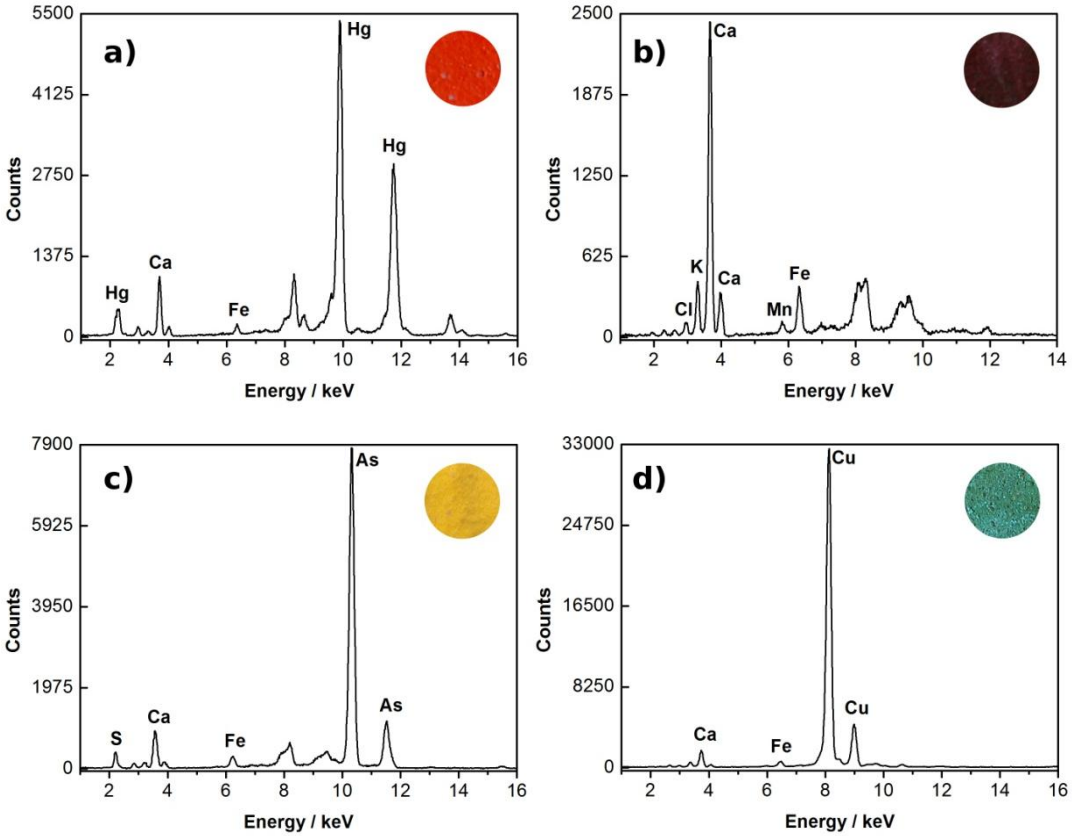


Figure V.2.2. Representative emission spectra (λ_{exc}=440 nm) from Santa Cruz 2: dark red ff. 193(─) and 207v (----).

V.3. Santa Cruz 4

V.3.1. XRF



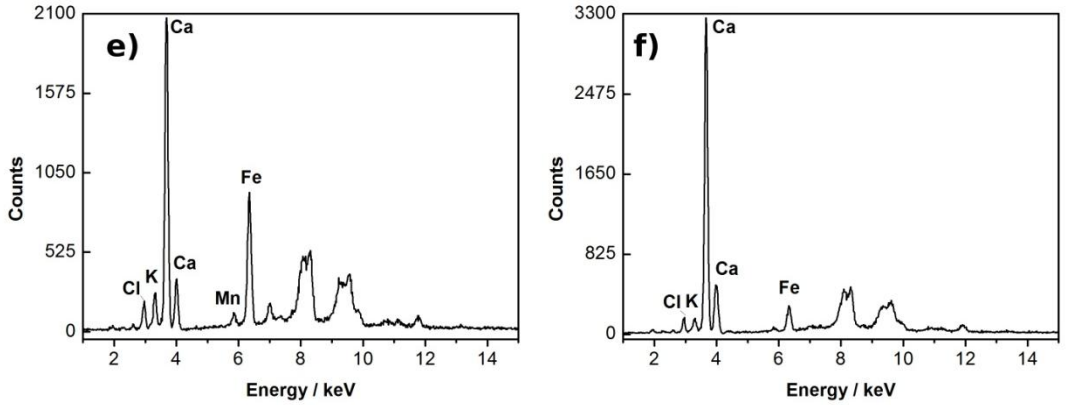
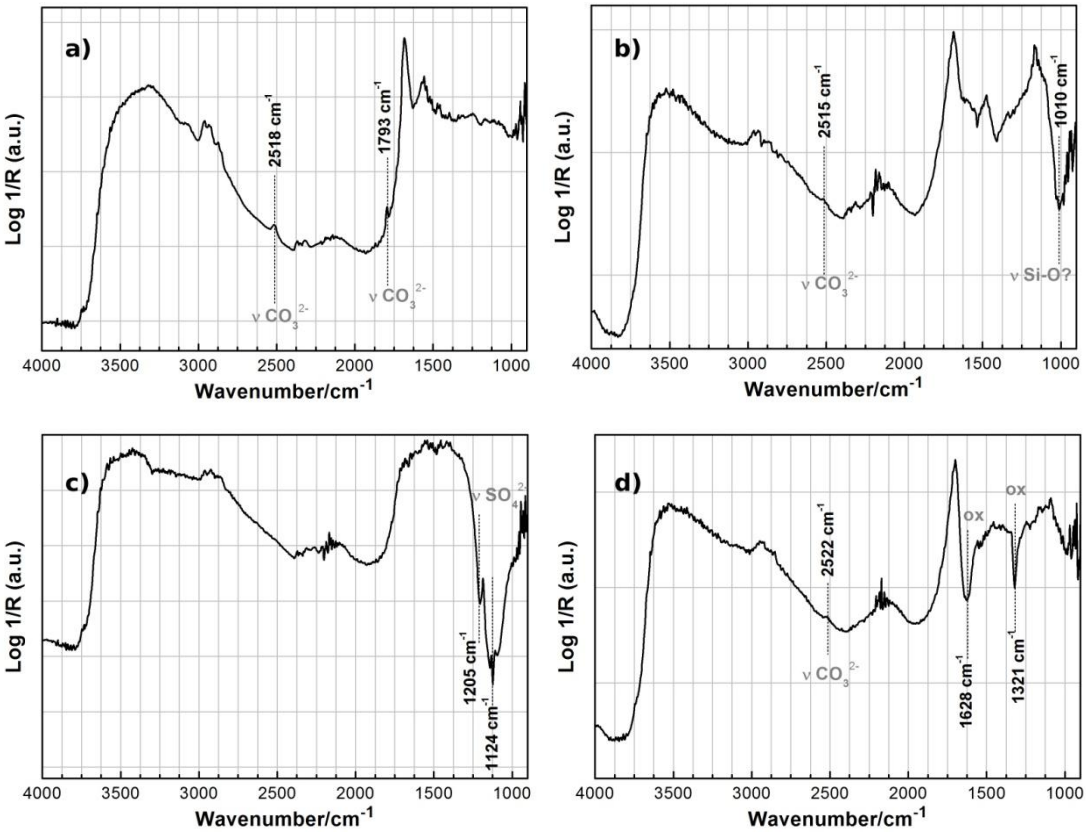


Figure V.3.1. Representative XRF spectra from Santa Cruz 4: **a)** red f. 225v; **b)** purple f. 266; **c)** yellow f. 317v; **d)** green f. 122v; **e)** black ink f. 122v; **f)** parchment f. 329v.

V.3.2. Mid-FTIR reflectance



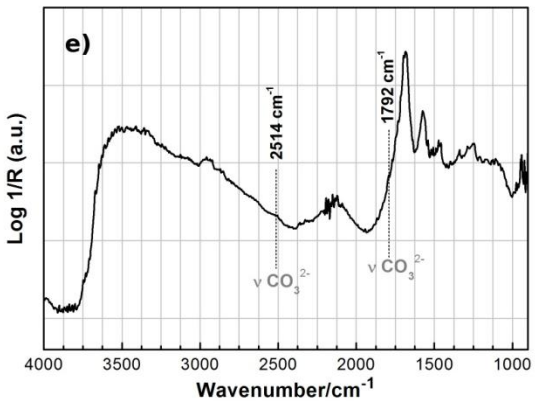
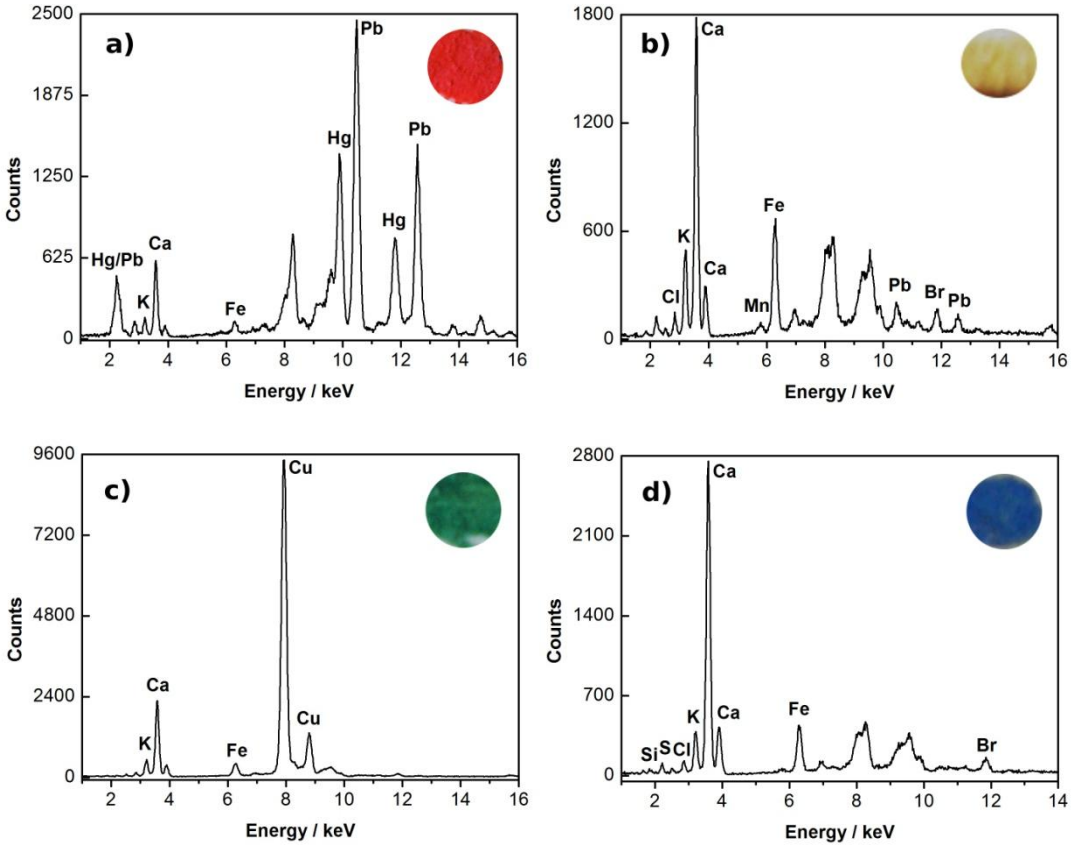


Figure V.3.2. Representative mid-FTIR reflectance spectra from Santa Cruz 4: **a)** red f. 123v; **b)** purple f. 1; **c)** yellow f. 123v; **d)** green f. 1; **e)** parchment f. 225v.

V.4. Santa Cruz 11

V.4.1. XRF



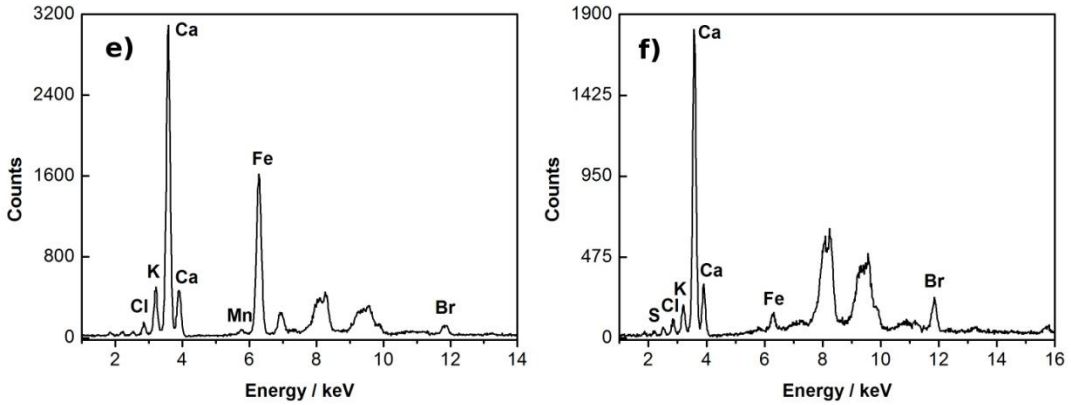


Figure V.4.1. Representative XRF spectra from Santa Cruz 11: **a)** red f. 117; **b)** yellow f. 45; **c)** green f. 45; **d)** blue f. 45; **e)** black ink f. 45; **f)** parchment f. 18v.

V.4.2. Mid-FTIR reflectance

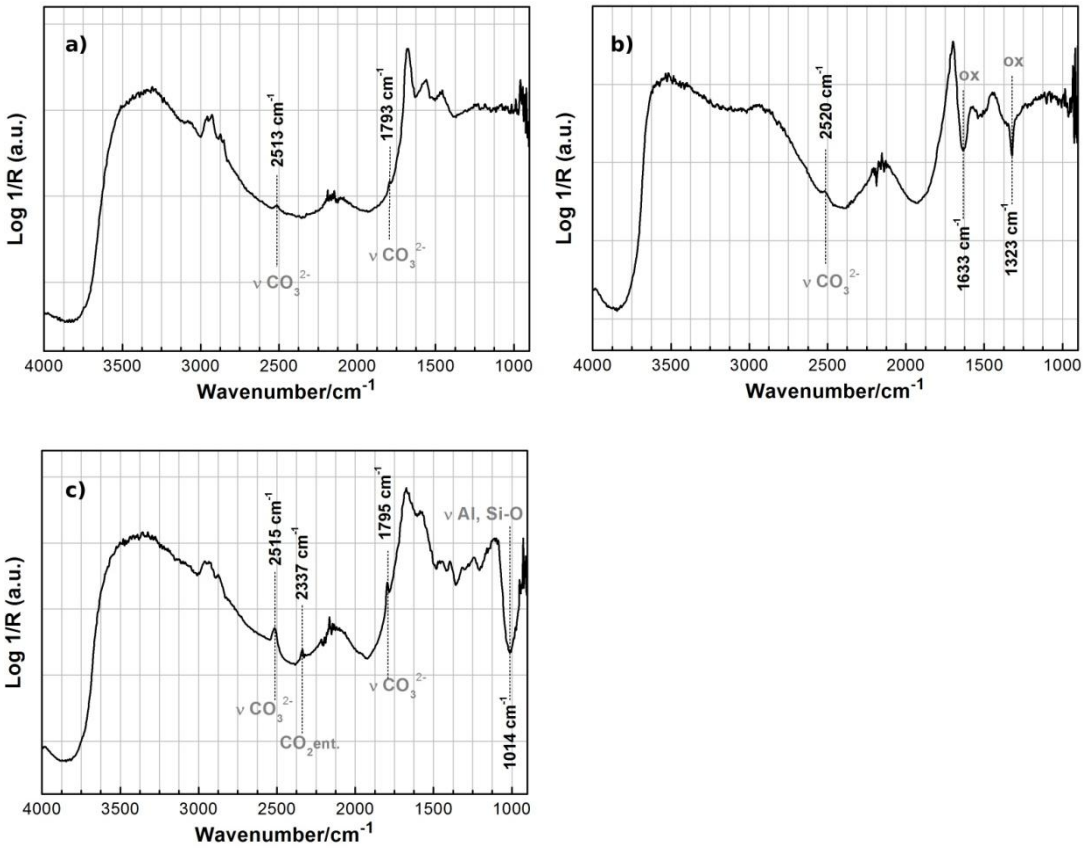


Figure V.4.2. Representative mid-FTIR reflectance spectra from Santa Cruz 11: **a)** red f. 117; **b)** green f. 45; **c)** blue f. 45.

V.4.3. Fluorimetry

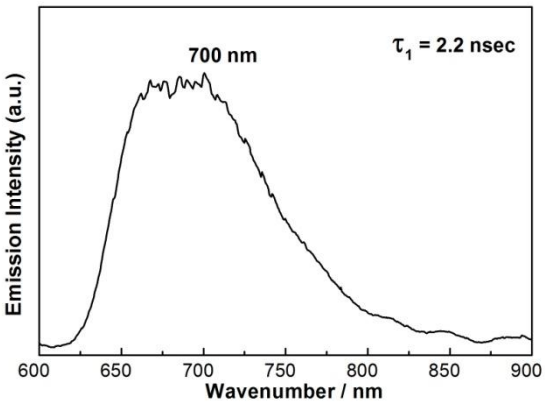


Figure V.4.3. Representative emission spectrum (λ_{exc}=470 nm) from Santa Cruz 11: blue f. 45.

V.5. Santa Cruz 17

V.5.1. XRF

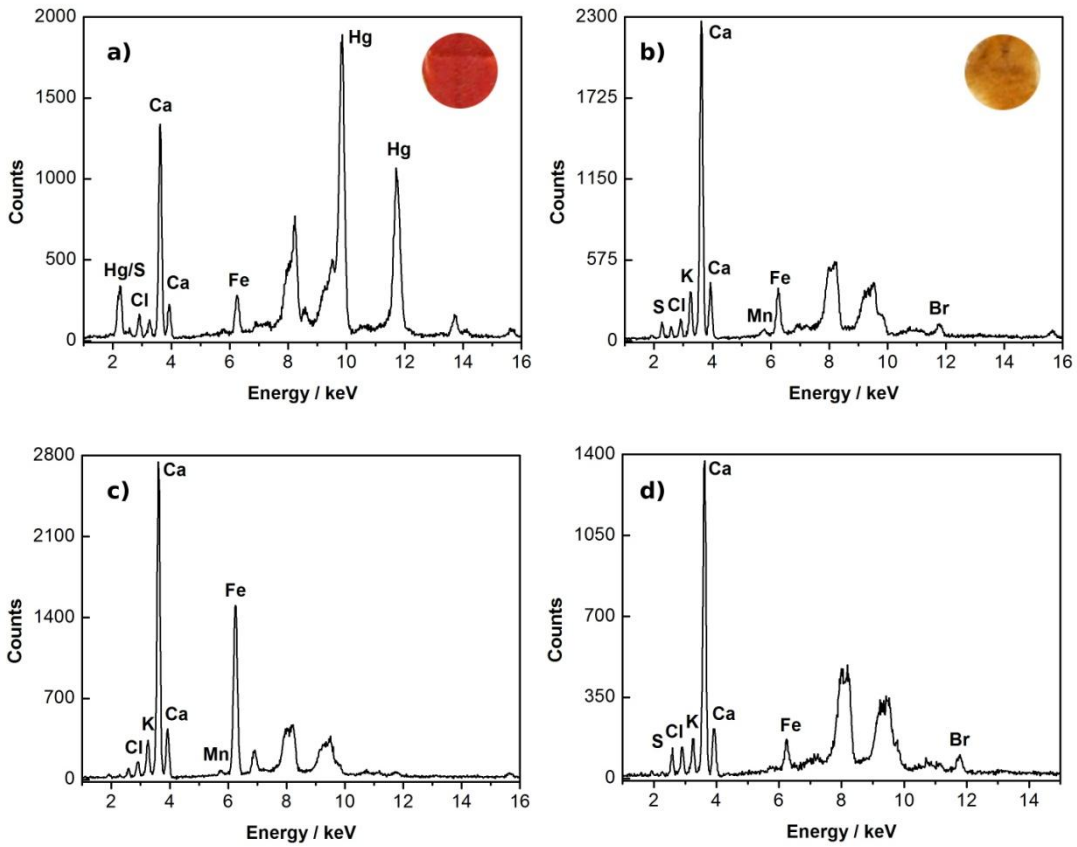


Figure V.5.1. Representative XRF spectra from Santa Cruz 17: **a)** red f. 171; **b)** yellow f. 171; **c)** black ink f. 171; **d)** parchment f. 171.

V.5.2. Mid-FTIR reflectance

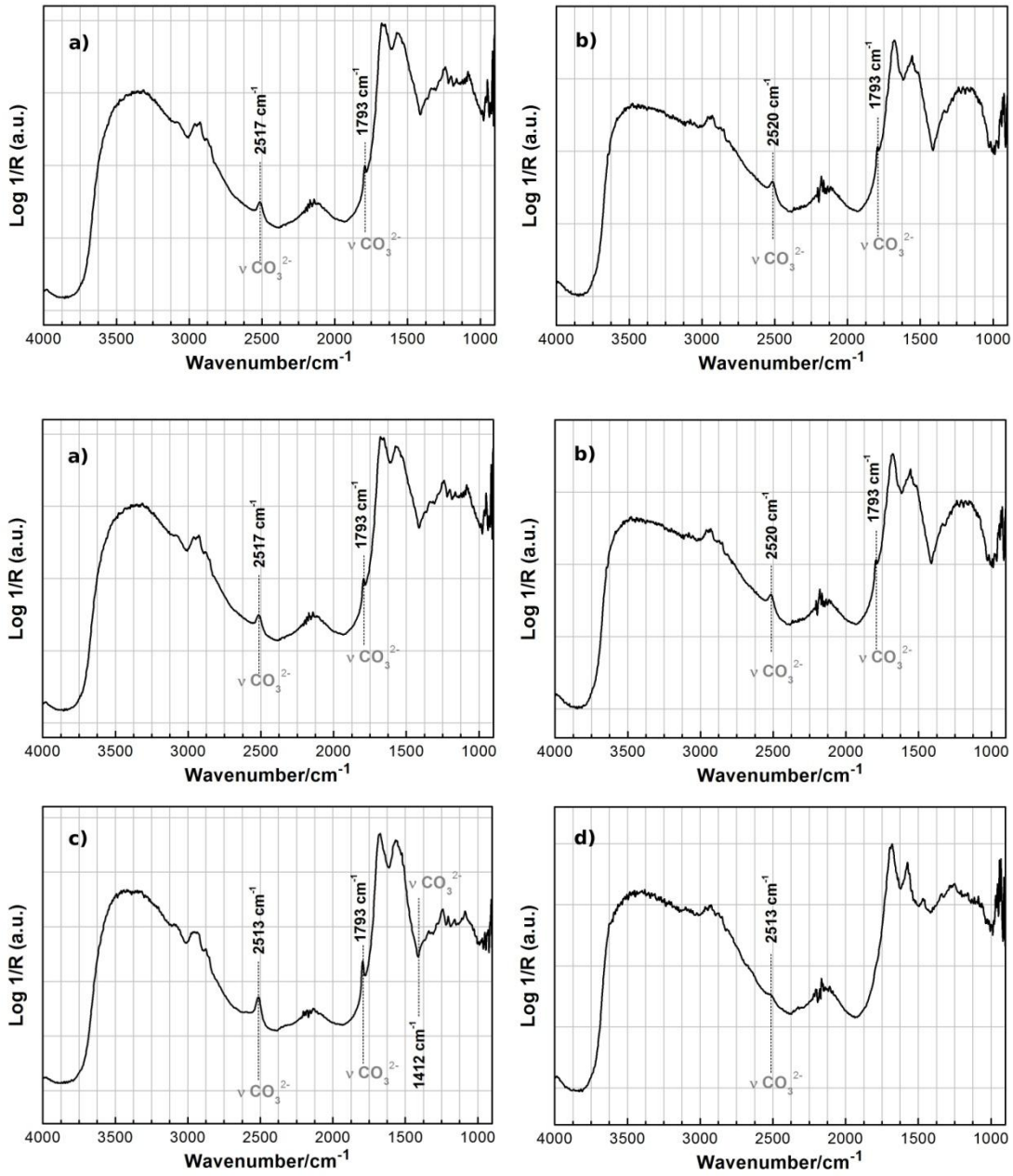


Figure V.5.2. Representative mid-FTIR reflectance spectra from Santa Cruz 17: **a)** red f. 1; **b)** yellow f. 1; **c)** parchment recto f. 1; **d)** parchment verso f. 1.

V.5.3. Fluorimetry

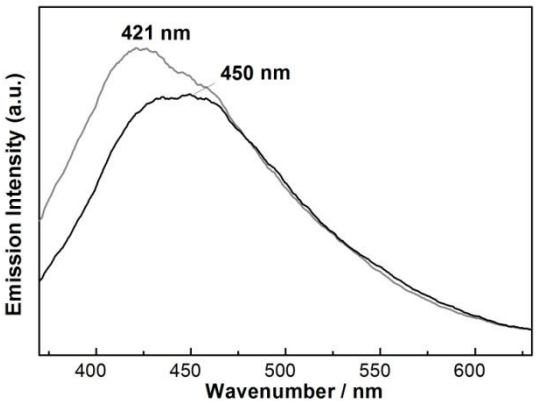
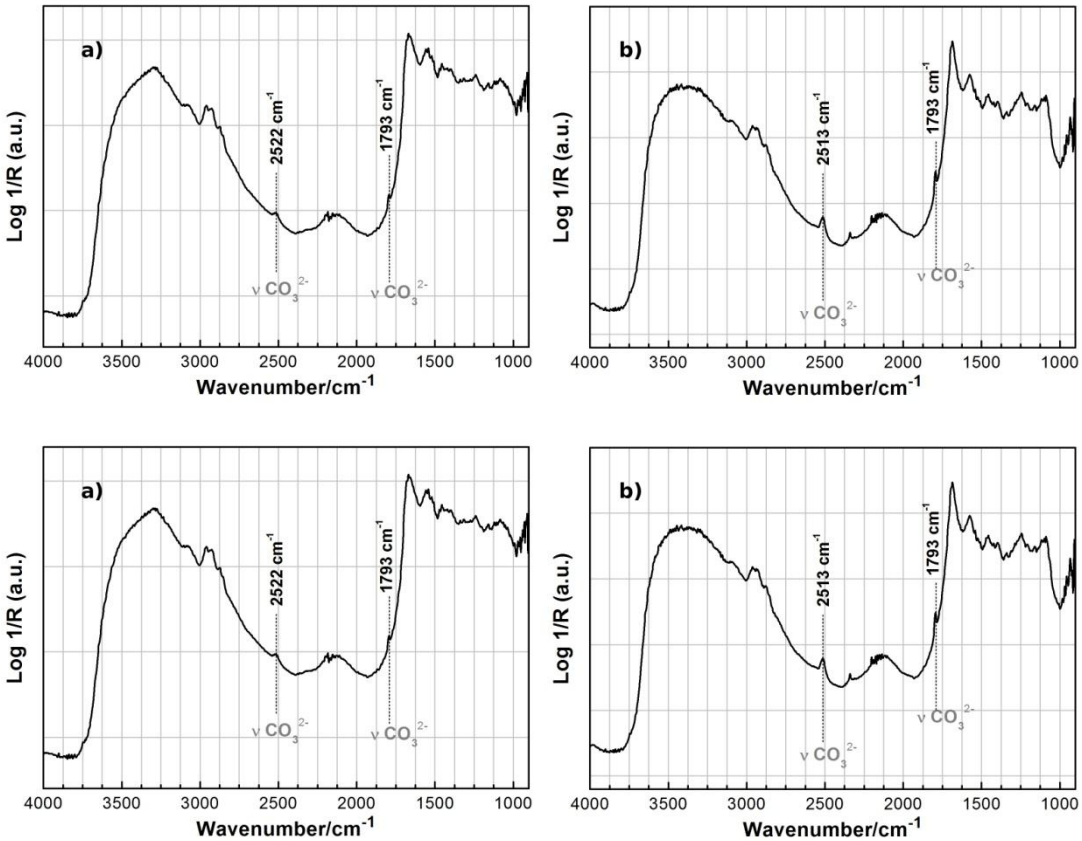


Figure V.5.3. Representative emission spectrum (λ_{exc}=333 nm) from Santa Cruz 17: yellow f. 1.

V.6. Santa Cruz 18

V.6.1. Mid-FTIR reflectance



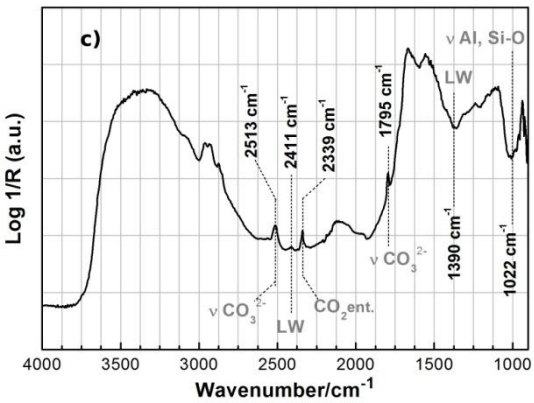


Figure V.6.1. Representative mid-FTIR reflectance spectra from Santa Cruz 18: **a)** red f. 3v; **b)** green f. 3v; **c)** blue f. 3v.

V.6.2. Fluorimetry

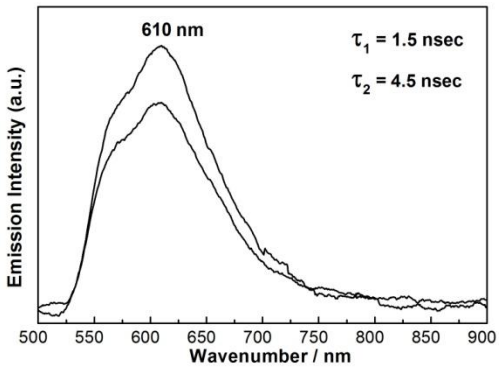
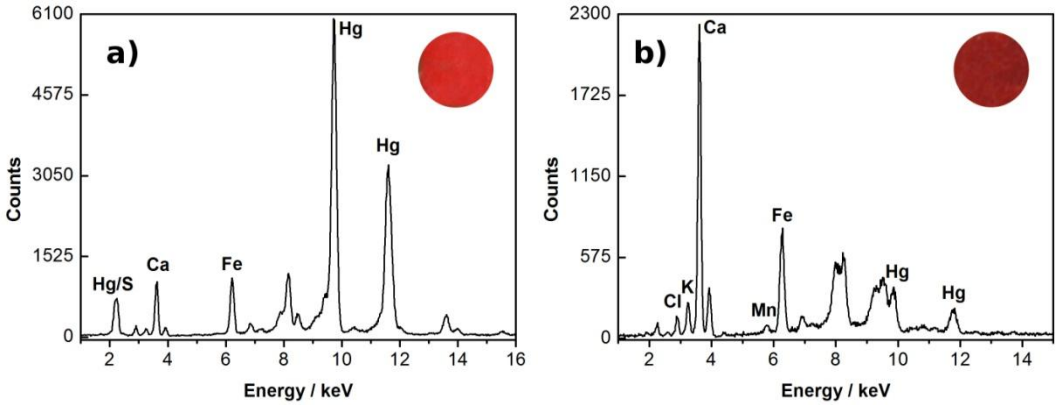


Figure V.5.3. Representative emission spectrum (λ_{exc}=440 nm) from Santa Cruz 18: dark red f. 3v.

V.7. Santa Cruz 20

V.7.1. XRF



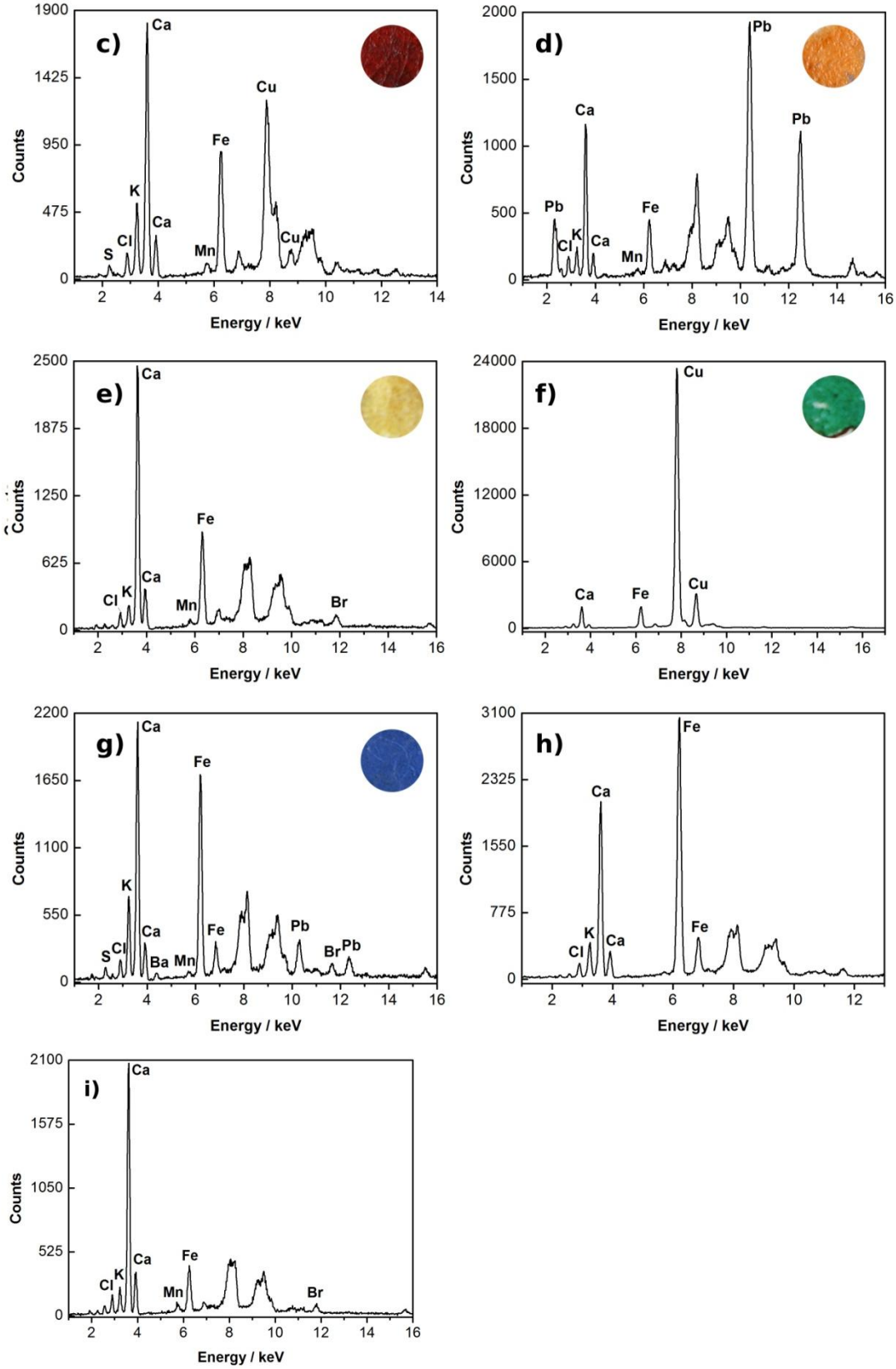


Figure V.7.1. Representative XRF spectra from Santa Cruz 20: **a)** red f. 173v; **b)** dark red f. 139; **c)** dark red f. 191; **d)** orange f. 191; **e)** yellow f. 162; **f)** green f. 173v; **g)** blue f. 173v; **h)** black ink f. 173v; **i)** parchment f. 191.

V.7.2. Raman and SERS

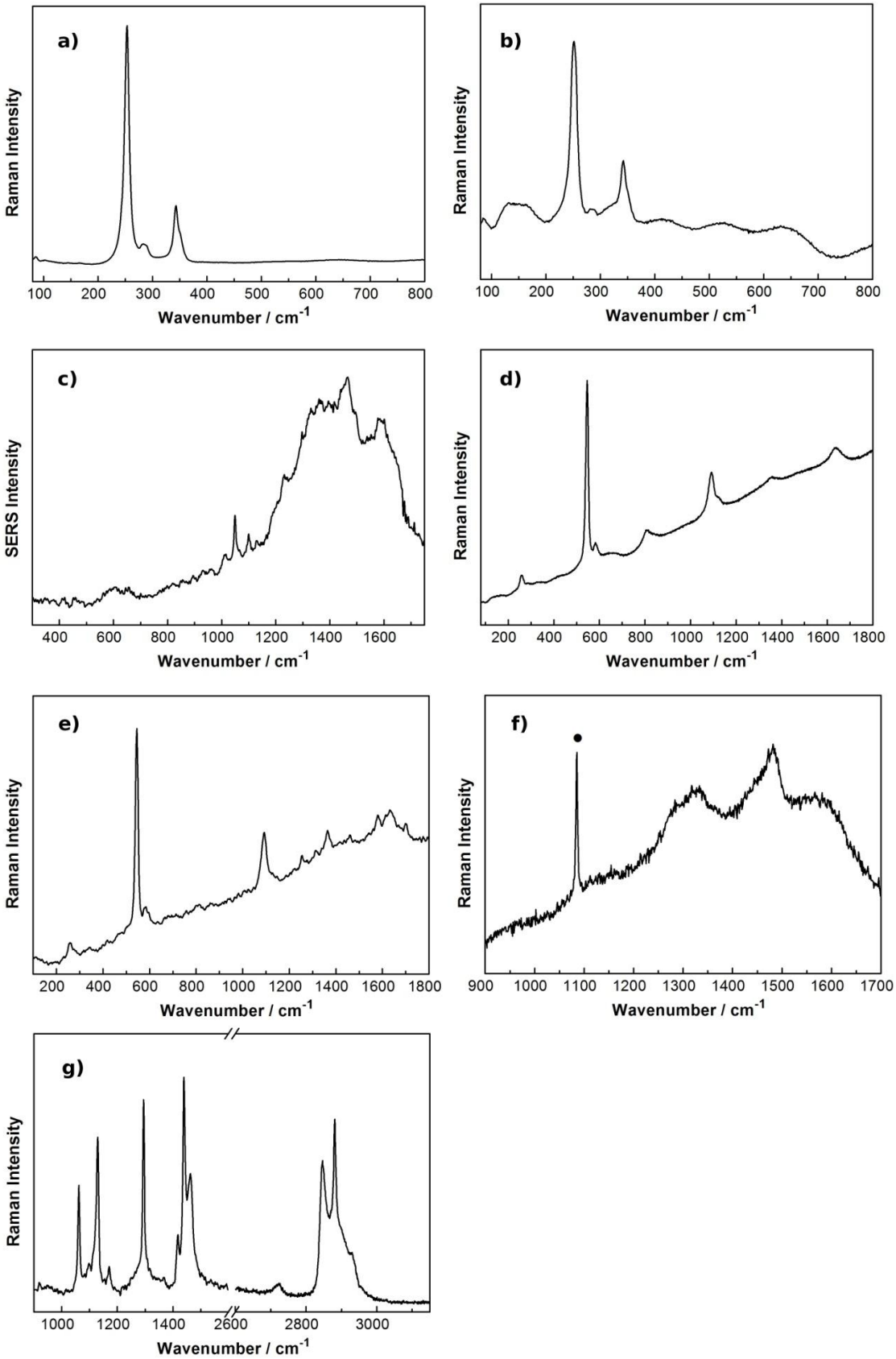


Figure V.7.2. Representative Raman and SERS spectra from Santa Cruz 20: **a)** red f. 123; **b)** dark red f. 86; **c)** dark red f. 86; **d)** blue f. 187v; **e)** dark blue f. 139; **f)** black ink f. 78, with $CaCO_3$ (●); **g)** extemporaneous paraffin f. 144.

V.7.3. Mid-FTIR reflectance

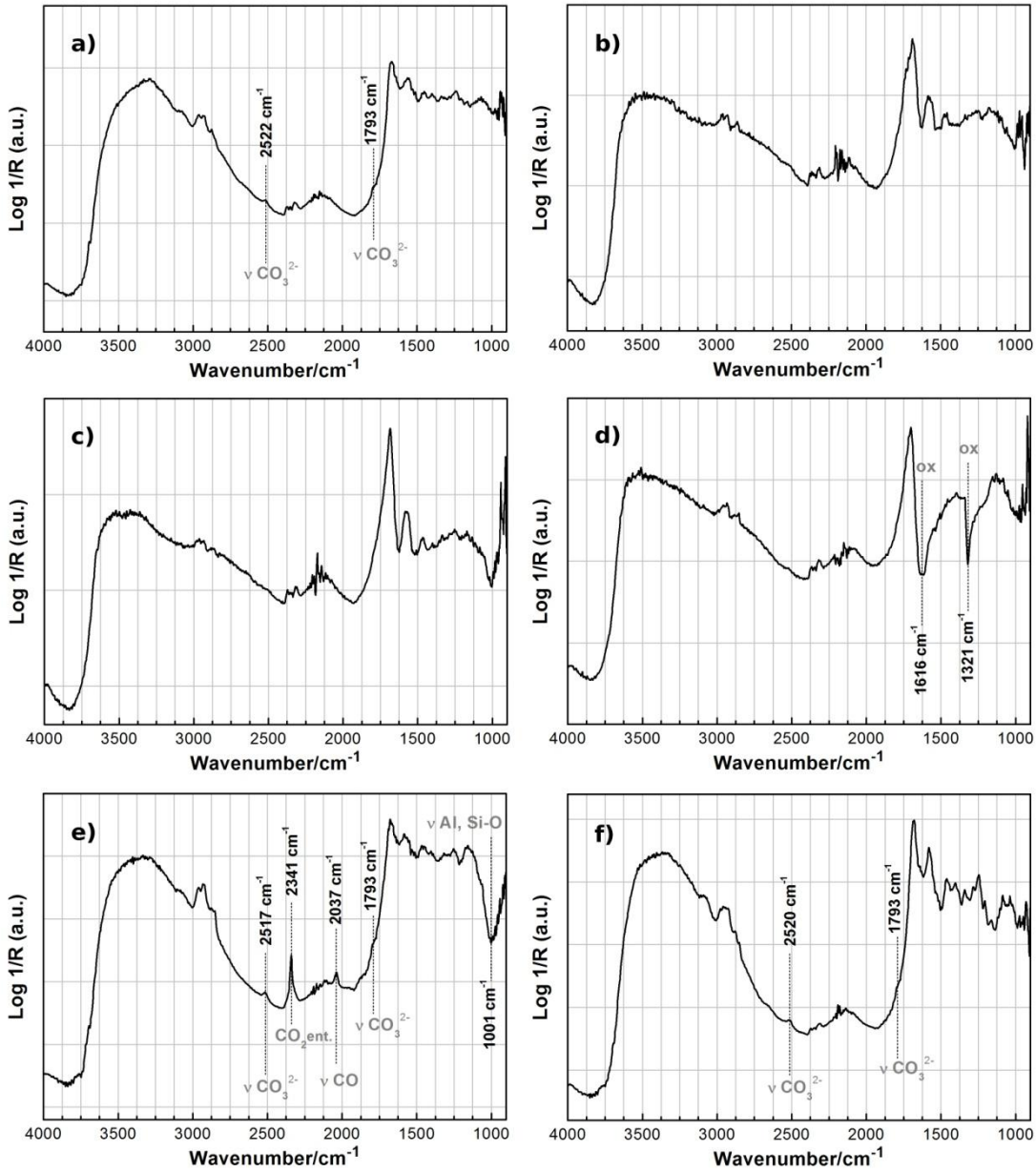


Figure V.7.3. Representative mid-FTIR reflectance spectra from Santa Cruz 20: **a)** red f. 173v; **b)** dark red f. 139; **c)** yellow f. 139; **d)** green f. 139; **e)** blue f. 162; **f)** parchment f. 162.

V.7.4. FTIR

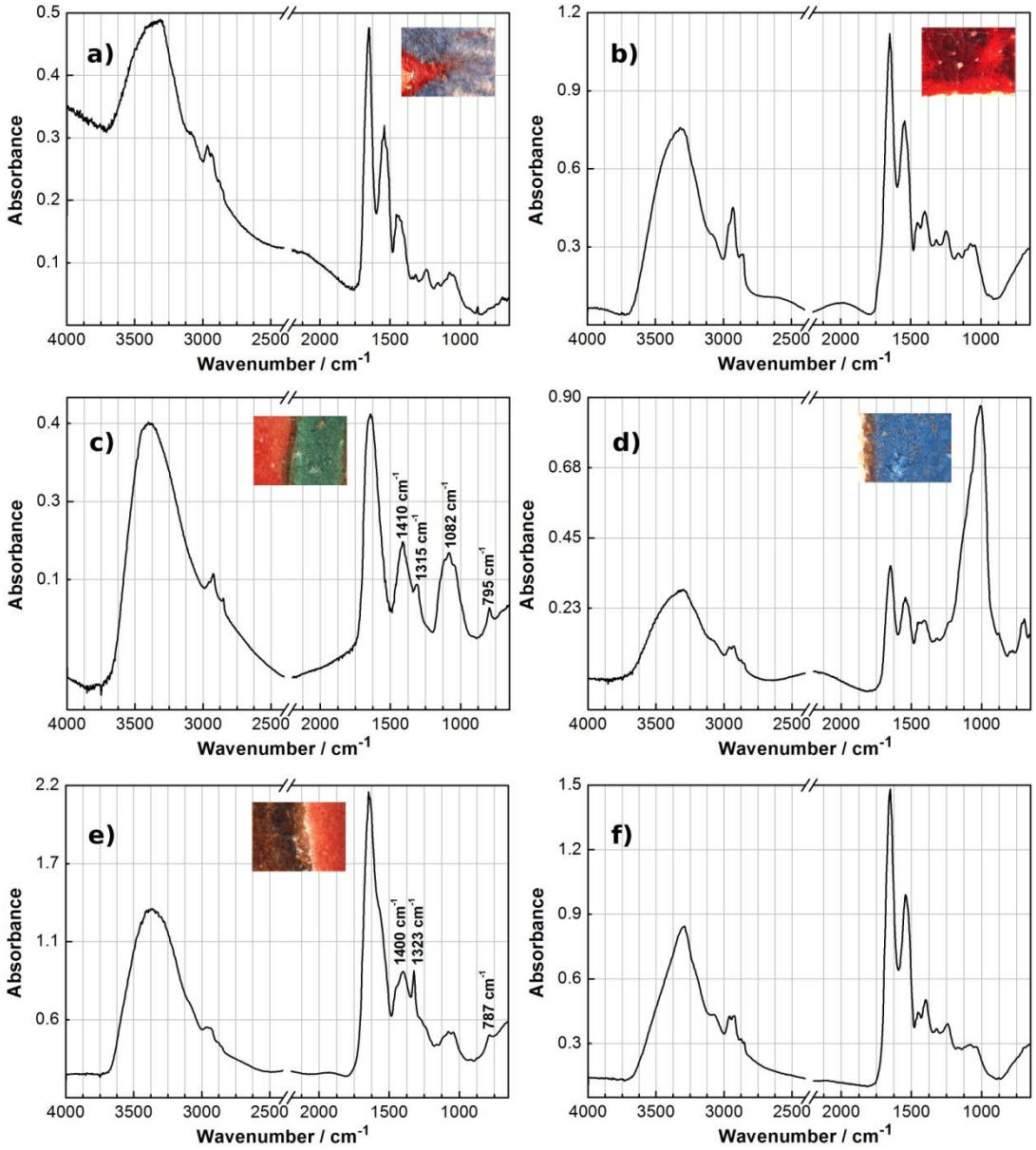


Figure V.7.4. Representative infrared spectra from Santa Cruz 20: **a)** red f. 199v; **b)** dark red f. 191; **c)** green f. 86; **d)** blue f. 78; **e)** black f.78; **f)** extemporaneous varnish f. 86.

V.7.5. Fluorimetry

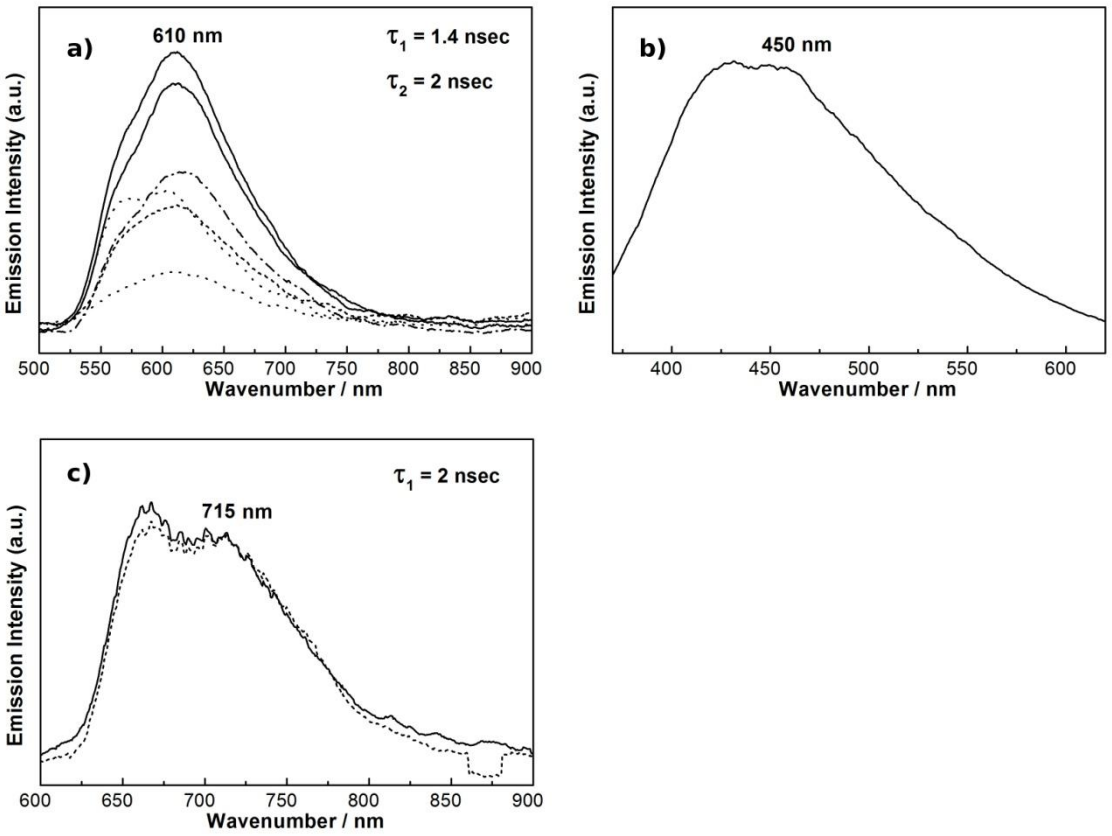
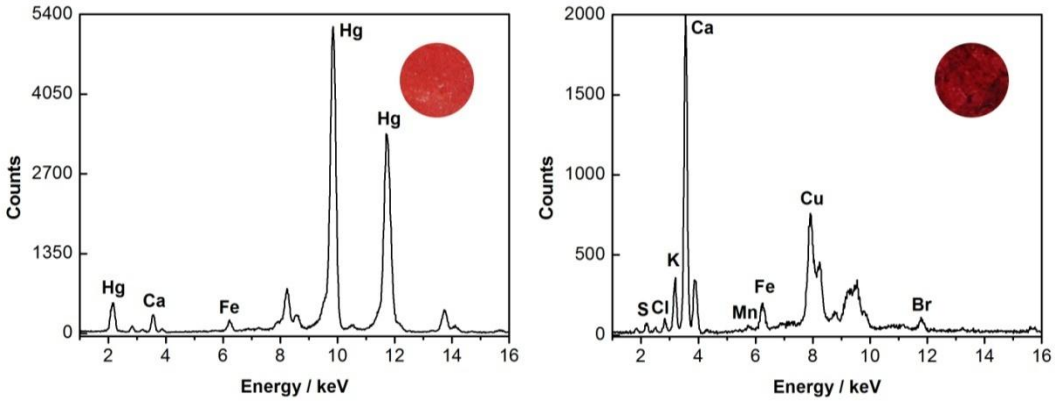


Figure V.7.5. Representative emission spectra (λ_{exc}=440, 333 and 470 nm, respectively) from Santa Cruz 20: dark red ff. 162v (—) and 173v (---); yellow f. 173v; blue ff. 139 (—), 162 (-·-) and 191 (···).

V.8. Santa Cruz 21

V.8.1. XRF



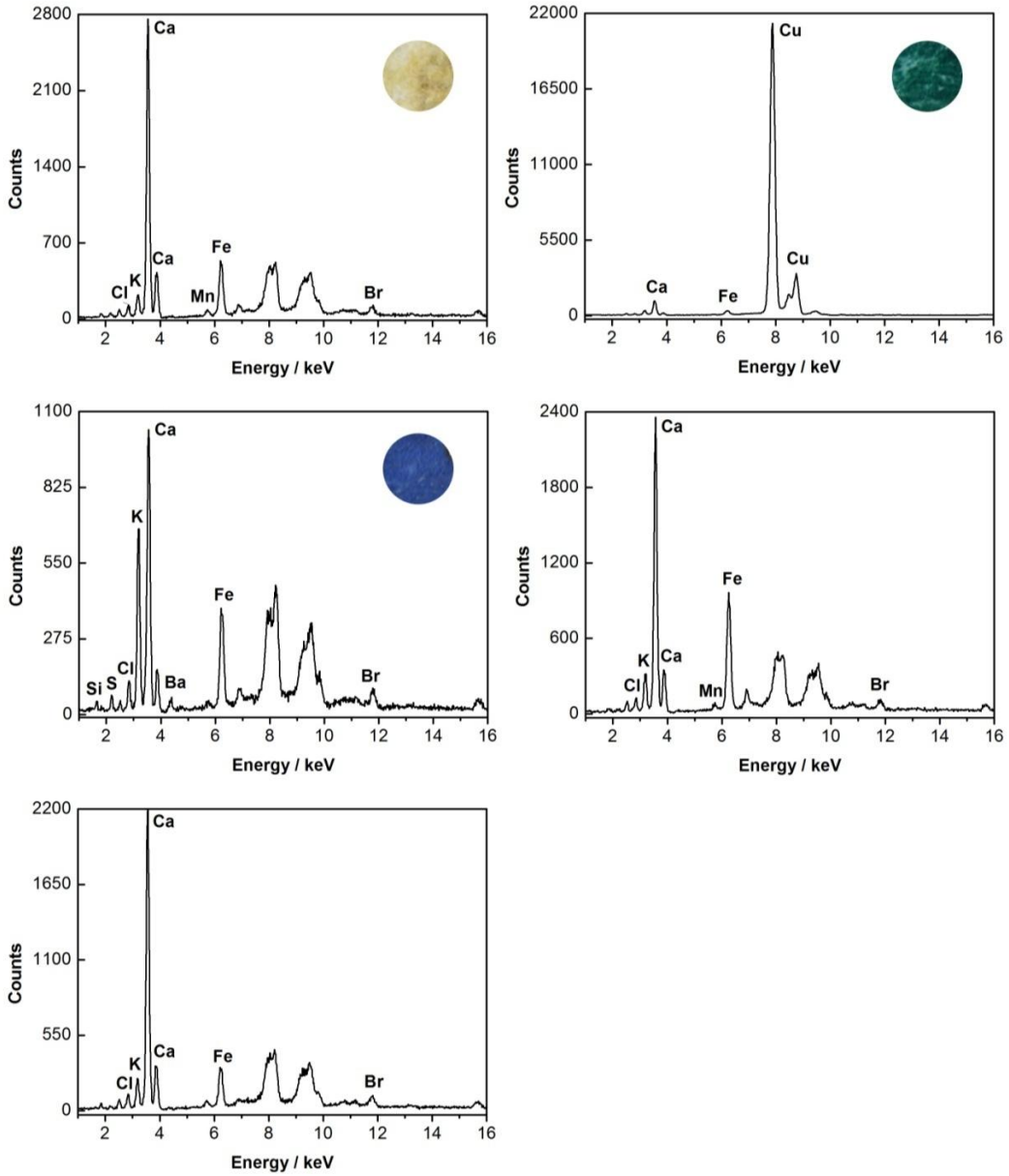


Figure V.8.1. Representative XRF spectra from Santa Cruz 21: **a)** red f. 262v; **b)** dark red f. 262v; **c)** yellow f. 262v; **d)** green f. 262v; **e)** blue f. 262v; **f)** black ink f. 262v; **g)** parchment f. 262v.

V.8.2. Raman

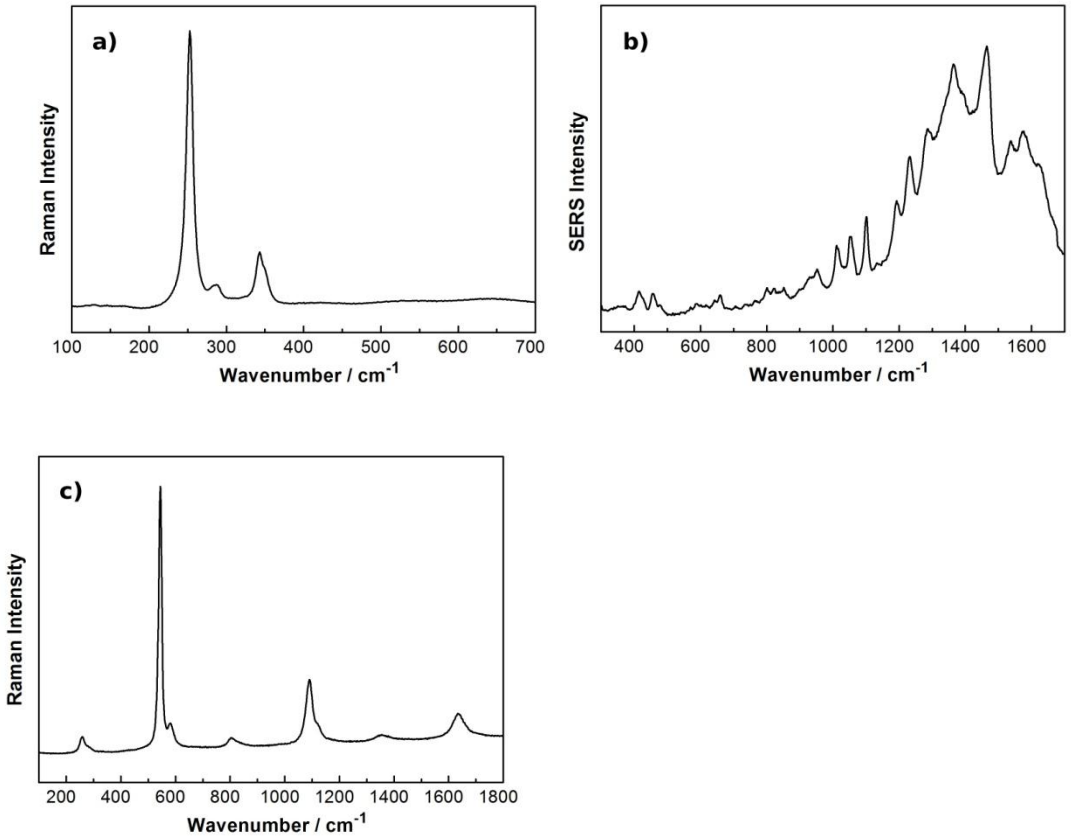


Figure V.8.2. Representative Raman and SERS spectra from Santa Cruz 21: **a)** red f. 262v; **b)** dark red f. 19; **c)** blue f. 207v.

V.8.3. Mid-FTIR reflectance

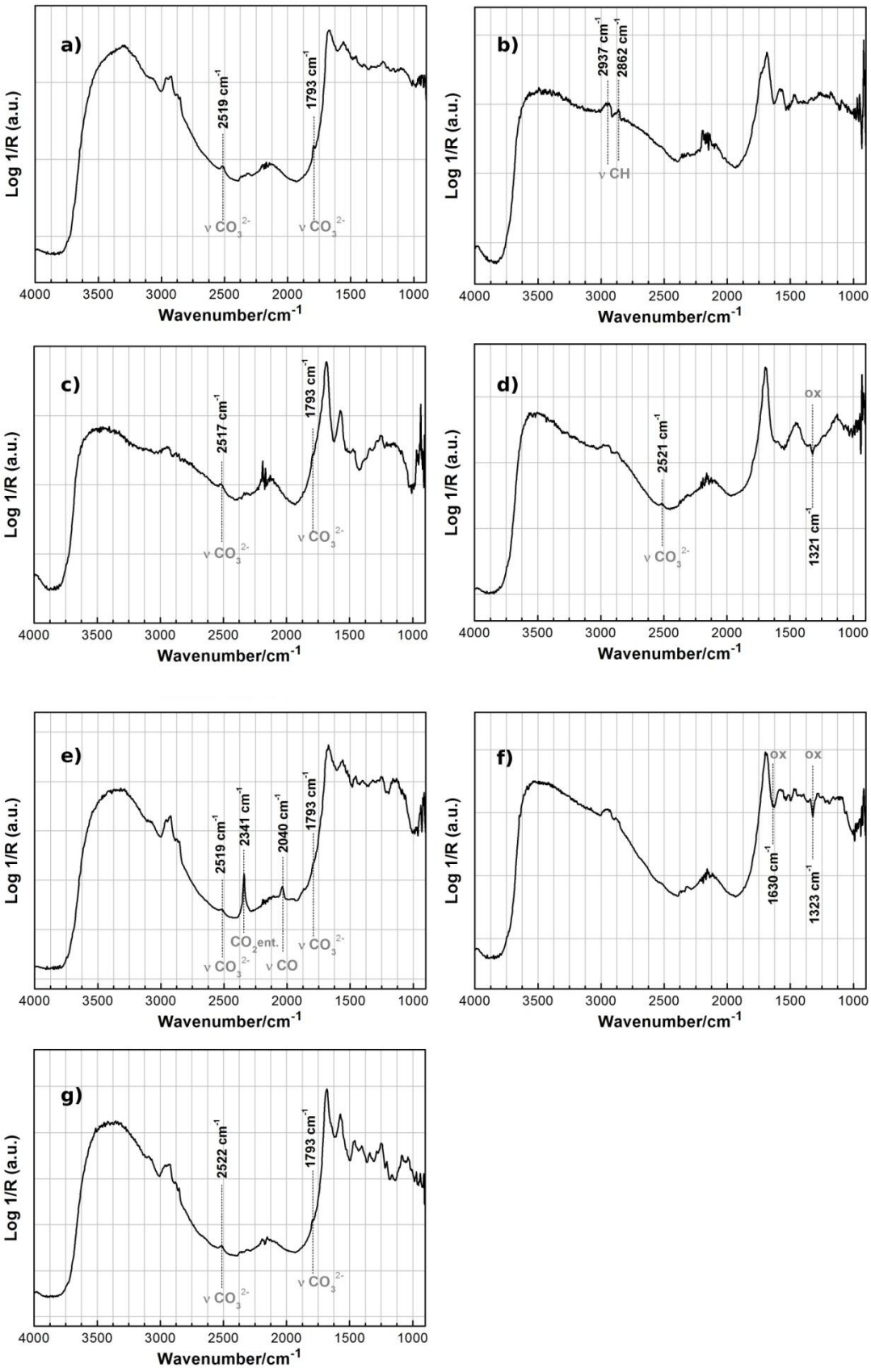


Figure V.8.3. Representative mid-FTIR reflectance spectra from Santa Cruz 21: **a)** red f. 262v; **b)** dark red f. 262v; **c)** yellow f. 262v; **d)** green f. 262v; **e)** blue f. 262v; **f)** black f. 262v; **g)** parchment f.262v.

V.8.4. FTIR

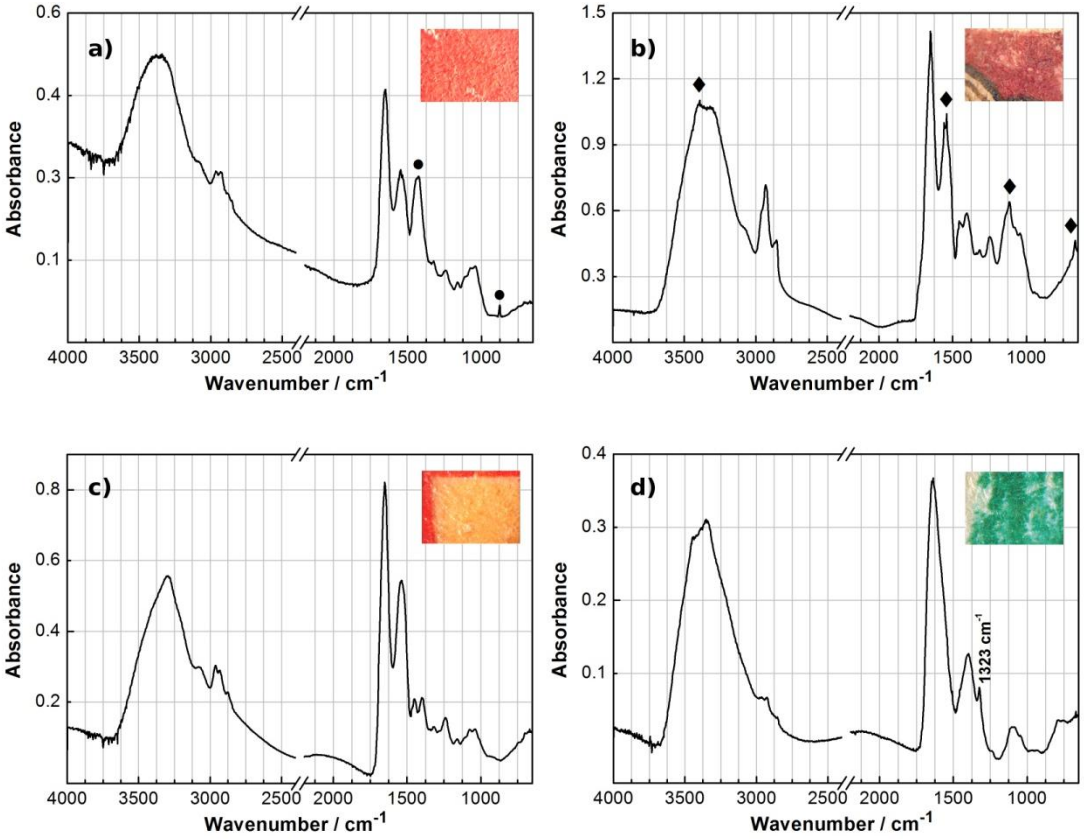


Figure V.8.4. Representative infrared spectra from Santa Cruz 21: **a)** red f. 262v; **b)** dark red f. 2; **c)** yellow f. 83; **d)** green f. 1.

V.8.5. Fluorimetry

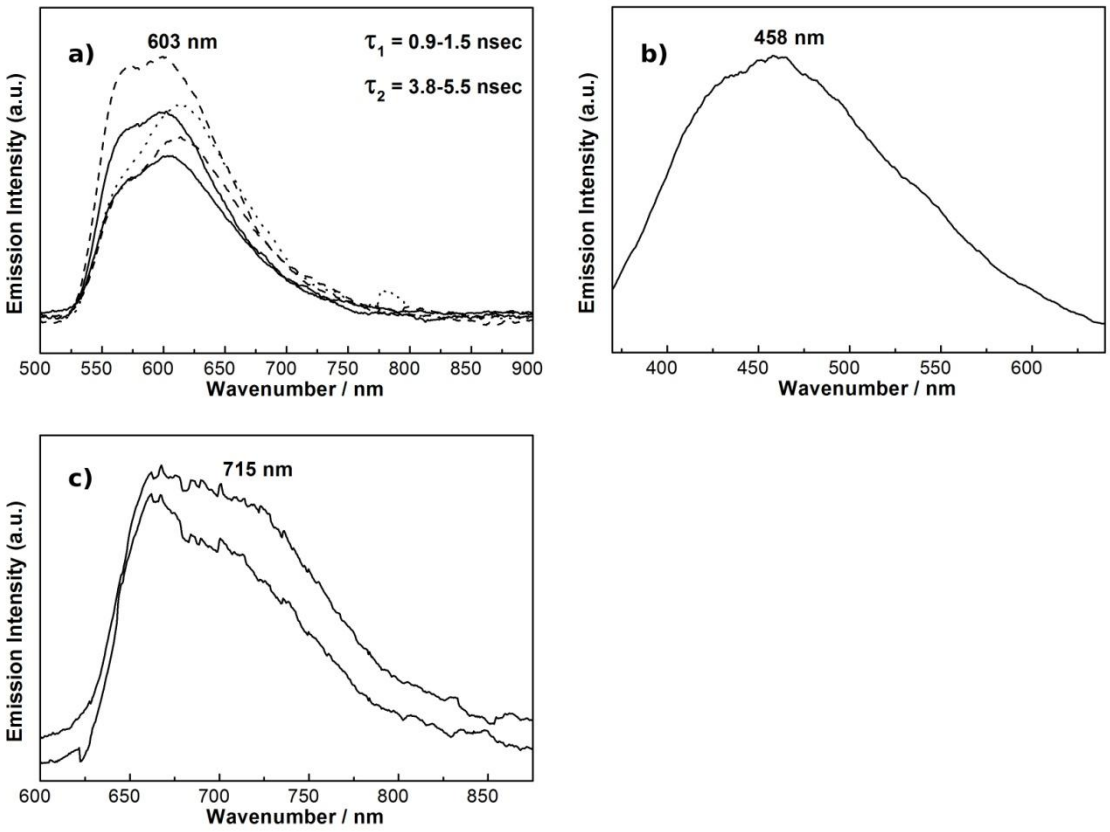


Figure V.8.5. Representative emission spectra (λ_{exc}=440, 333 and 470 nm, respectively) from Santa Cruz 21: dark red ff. 2 (▪▪▪), 19 (—) and 262v (---); yellow f. 262v; blue f. 262v.

V.9. Santa Cruz 27

V.9.1. XRF

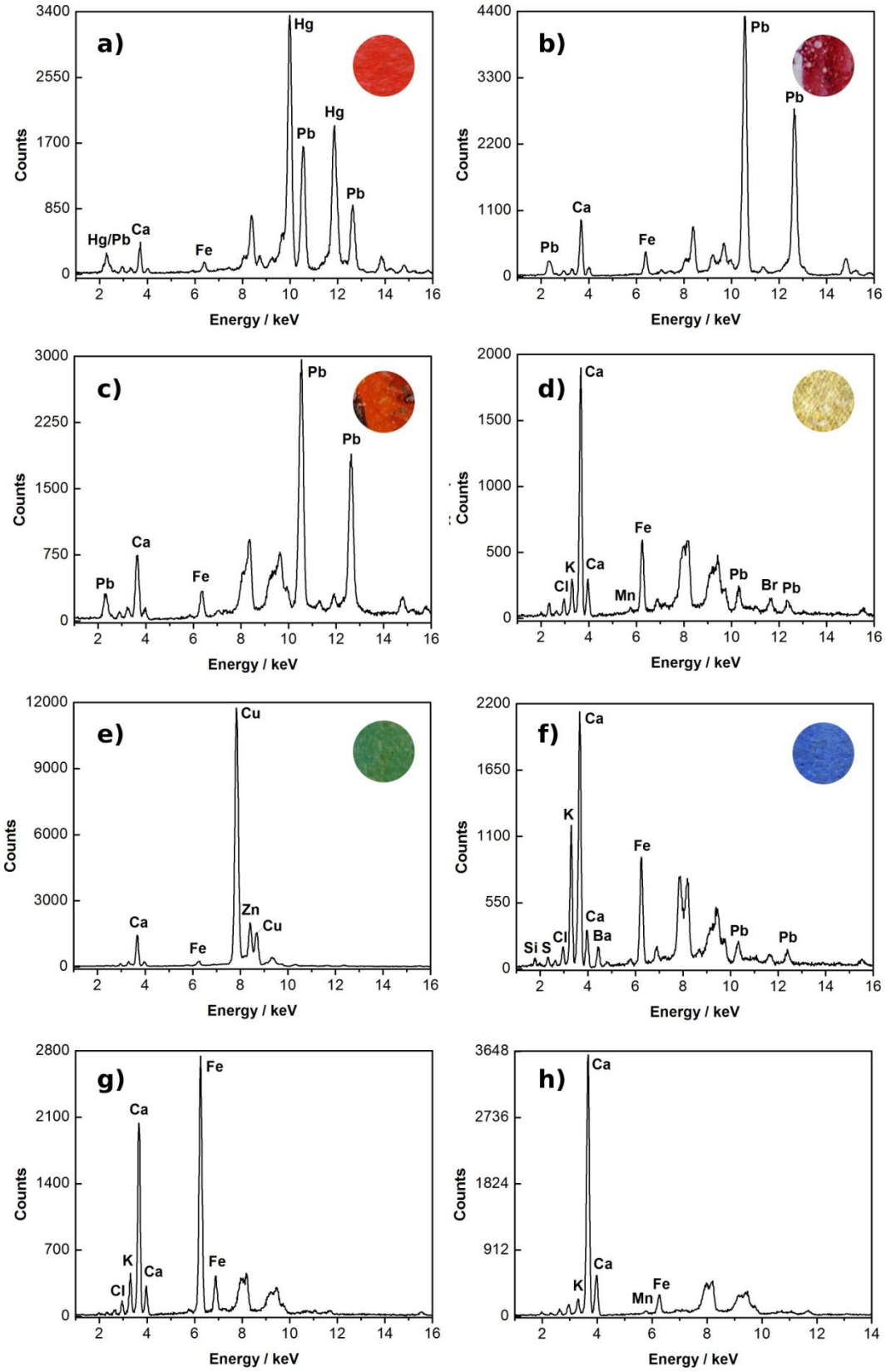


Figure V.9.1. Representative XRF spectra from Santa Cruz 27: **a)** red f. 15; **b)** dark red f. 1; **c)** orange f. 1; **d)** yellow f. 15; **e)** green f. 101; **f)** blue f. 15; **g)** black ink f. 101; **h)** parchment f. 101.

V.9.2. Raman

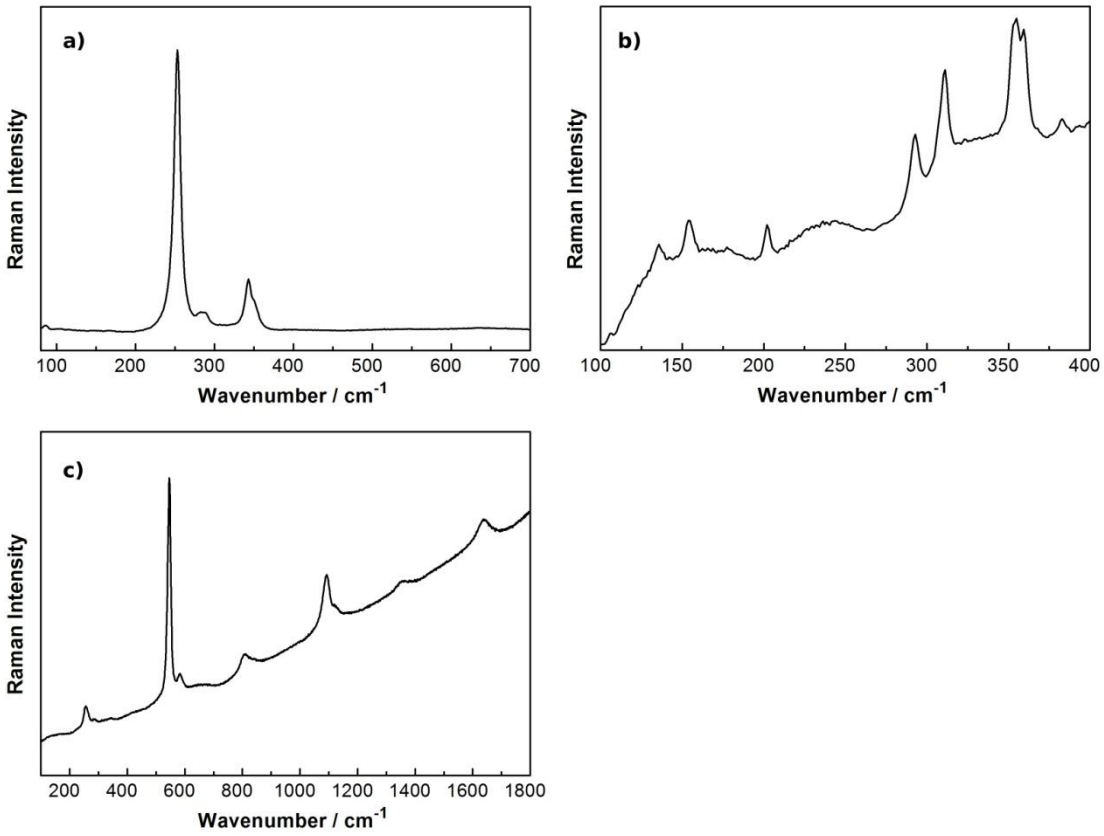
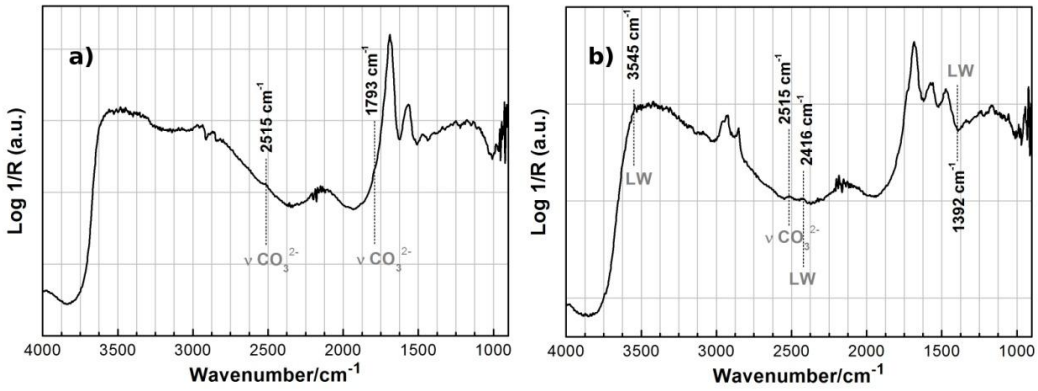


Figure V.9.2. Representative Raman spectra from Santa Cruz 27: **a)** red f. 5; **b)** extemporaneous yellow f. 15; **c)** blue f. 15.

V.9.3. Mid-FTIR reflectance



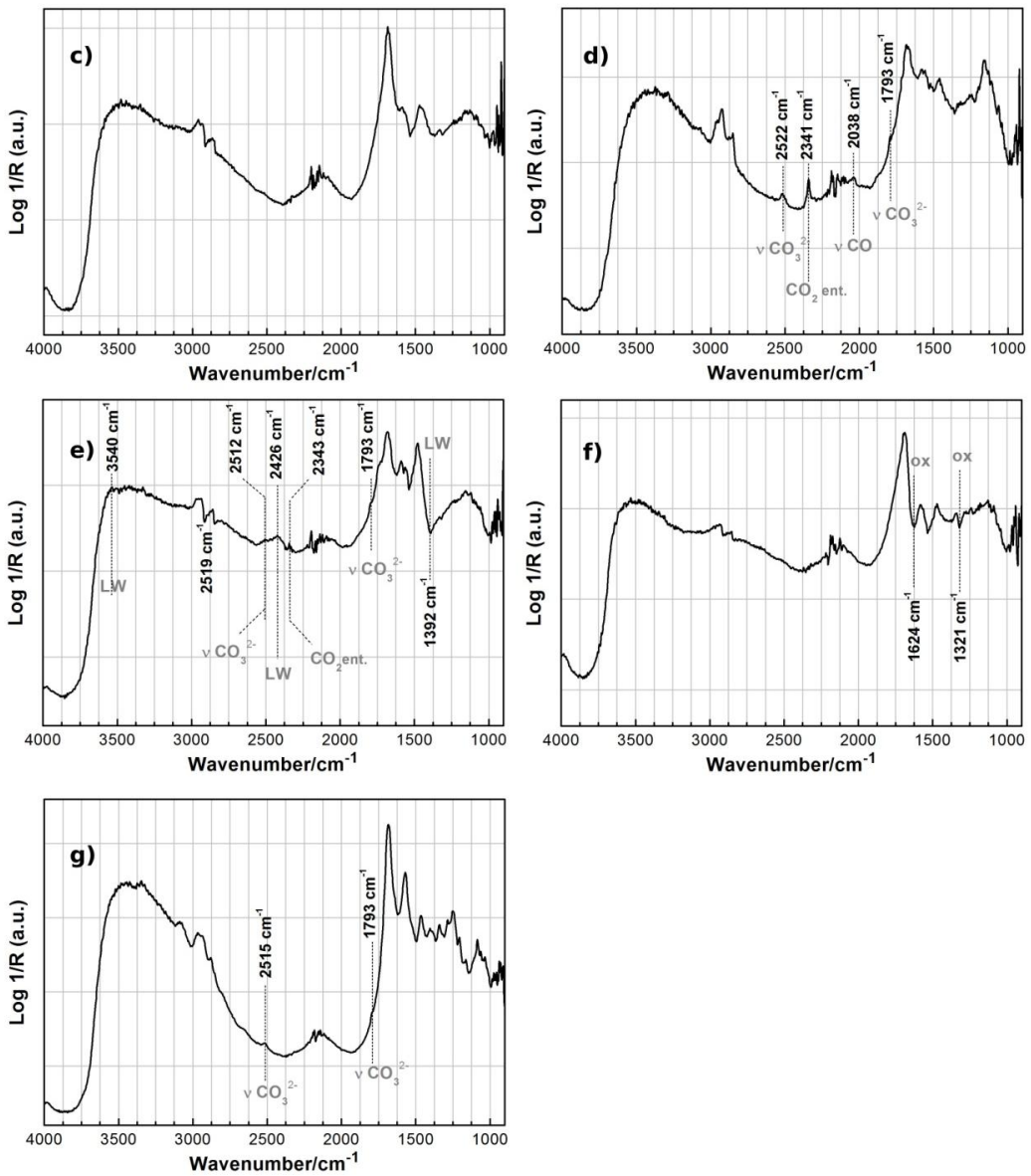
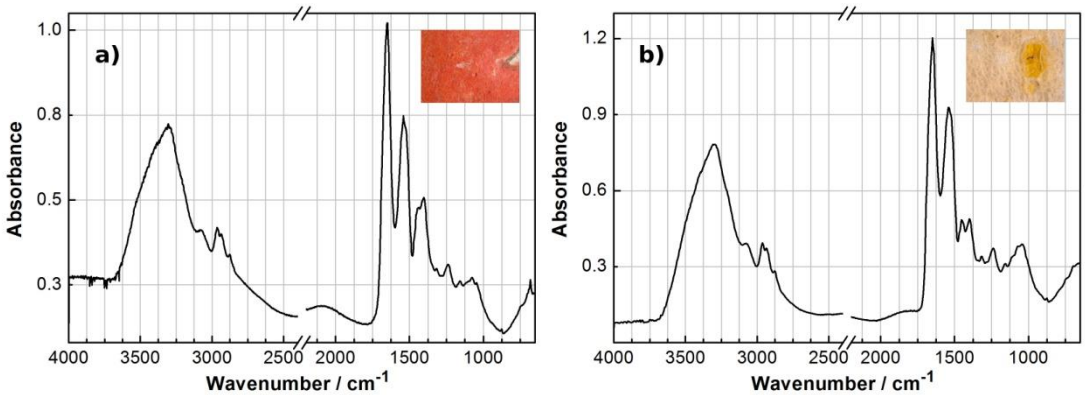


Figure V.9.3. Representative mid-FTIR reflectance spectra from Santa Cruz 27: **a)** red f. 15; **b)** orange f. 1; **c)** green f. 101; **d)** blue f. 1; **e)** white f. 1; **f)** black f. 1; **g)** parchment f. 15.

V.9.4. FTIR



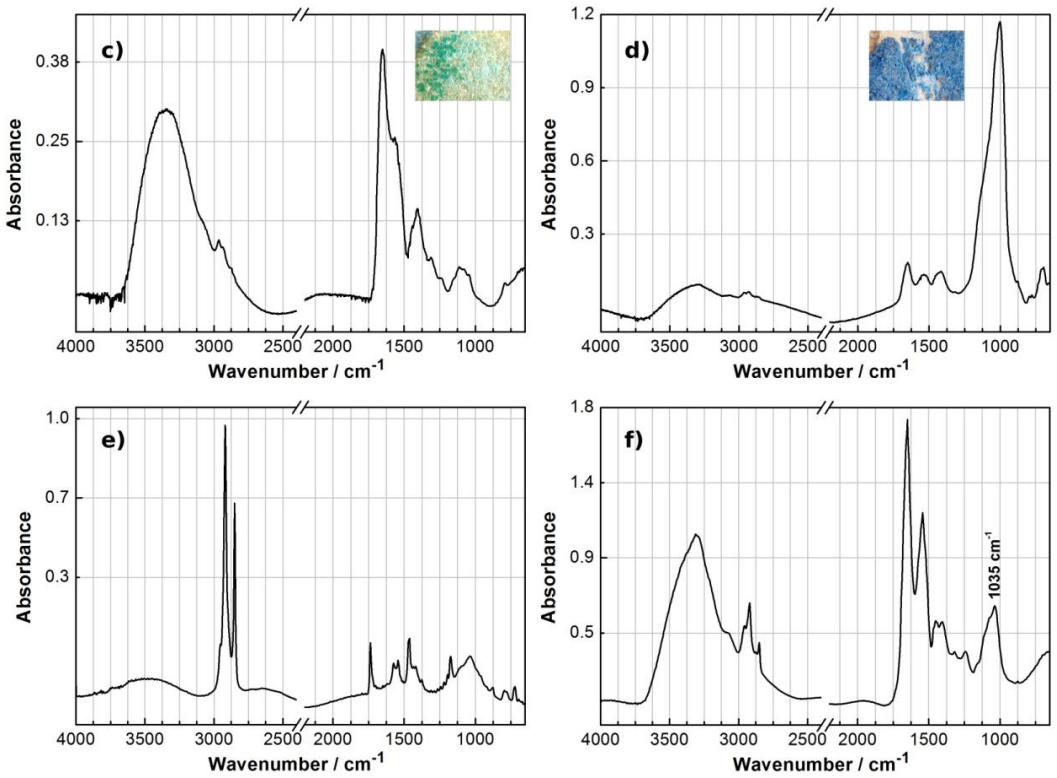
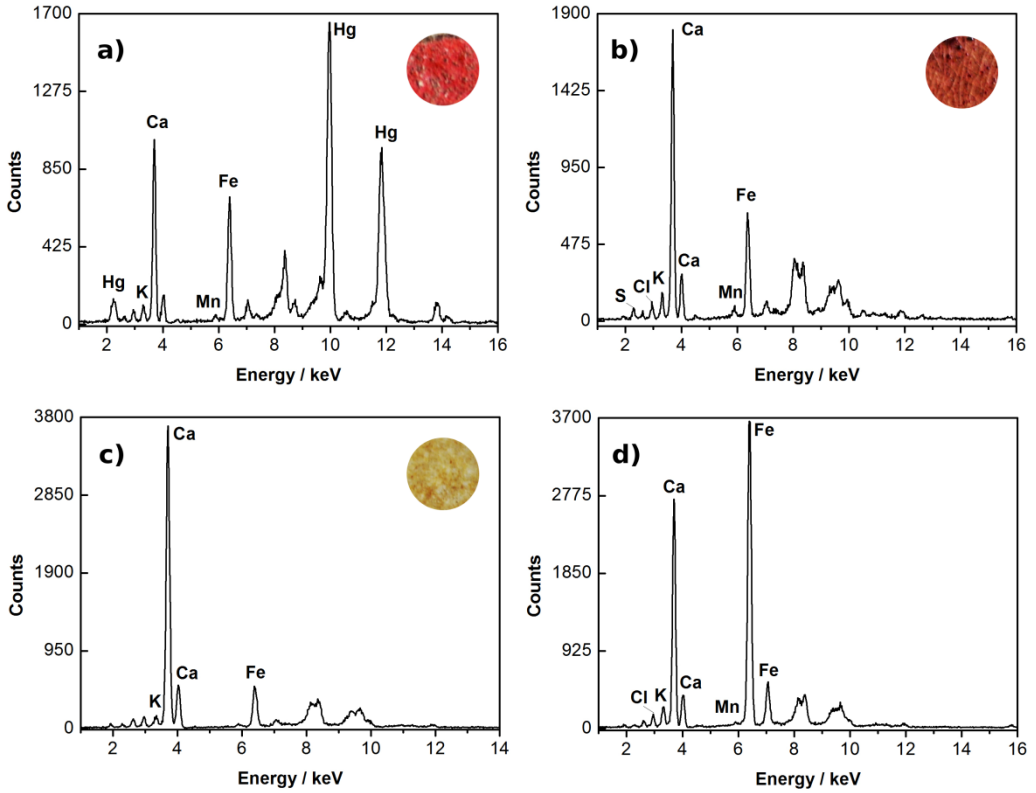


Figure V.9.4. Representative infrared spectra from Santa Cruz 27: **a)** red f. 15; **b)** yellow f. 15; **c)** green f. 1; **d)** blue f. 15; **e)** extemporaneous wax f. 15; **f)** parchment f. 15.

V.10. Santa Cruz 30

V.10.1. XRF



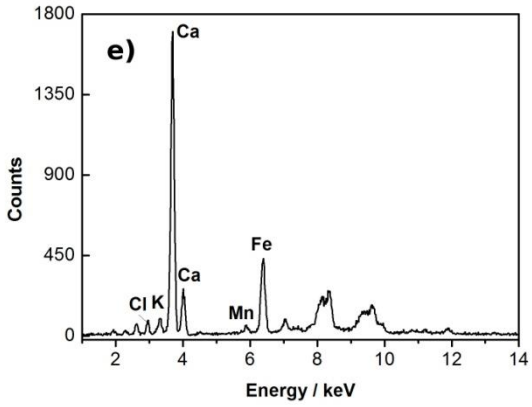


Figure V.10.1. Representative XRF spectra from Santa Cruz 30: **a)** red f. 1; **b)** dark red f. 1; **c)** yellow f. 1; **d)** black ink f. 1; **e)** parchment f. 1.

V.10.2. Mid-FTIR reflectance

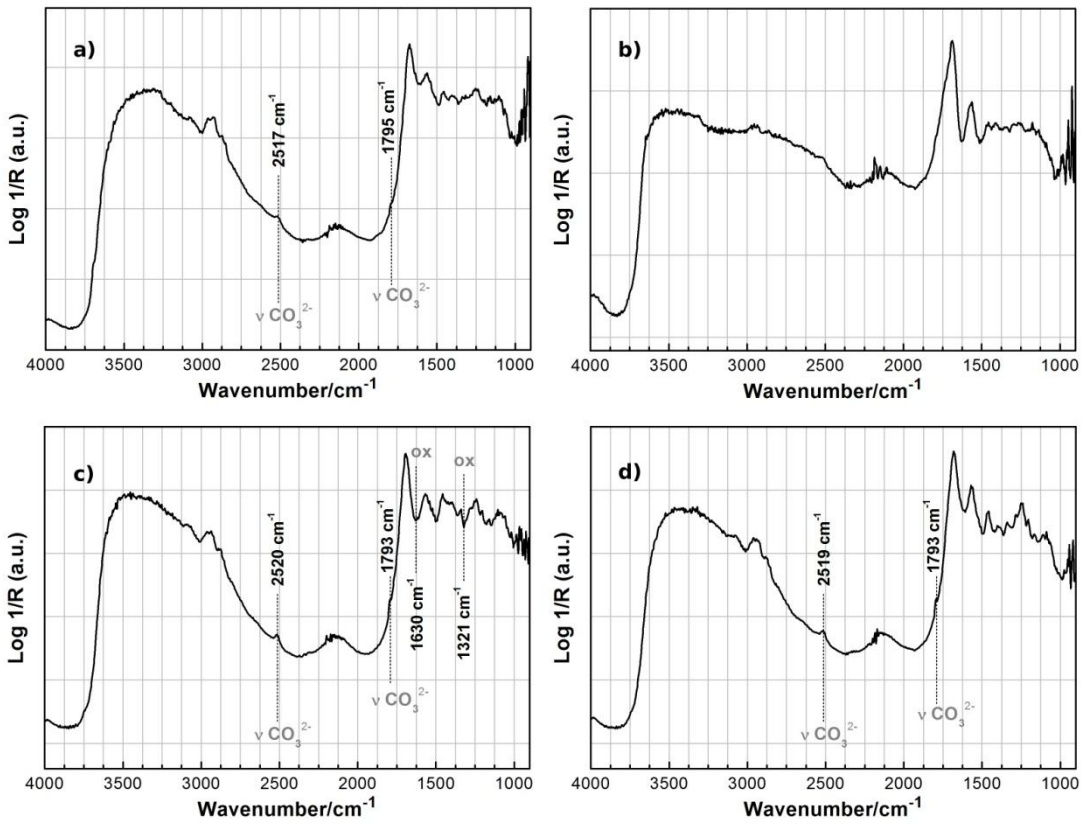


Figure V.10.1. Representative mid-FTIR reflectance spectra from Santa Cruz 30: **a)** red f. 1; **b)** dark red f. 1; **c)** black f. 1; **d)** parchment f. 1.

V.10.3. Fluorimetry

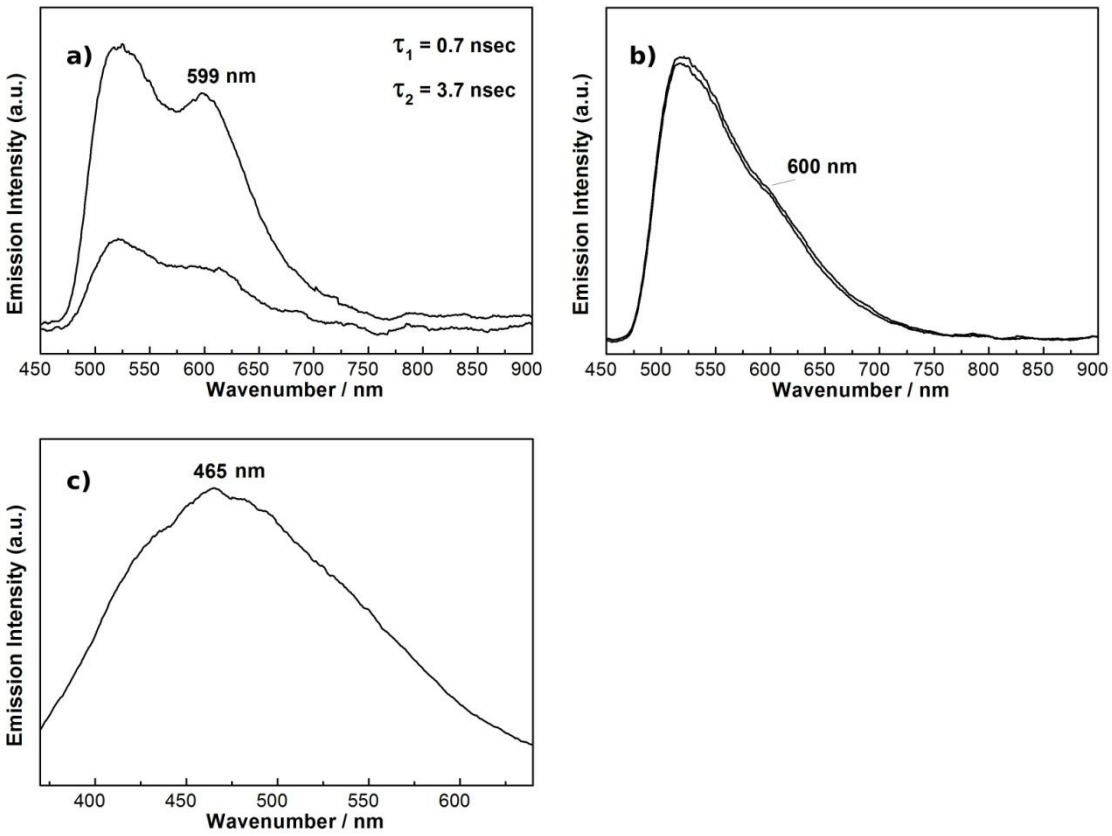
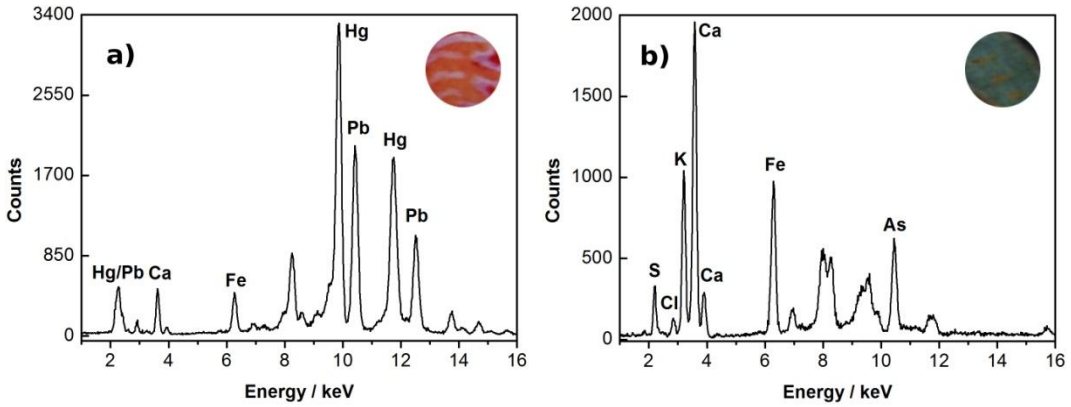


Figure V.10.3. Representative emission spectra (λ_{exc}=440 and 333 nm, respectively) from Santa Cruz 30: **a)** red f. 1; **b)** dark red f. 1; **c)** yellow f. 1.

V.11. Santa Cruz 43

V.11.1. XRF



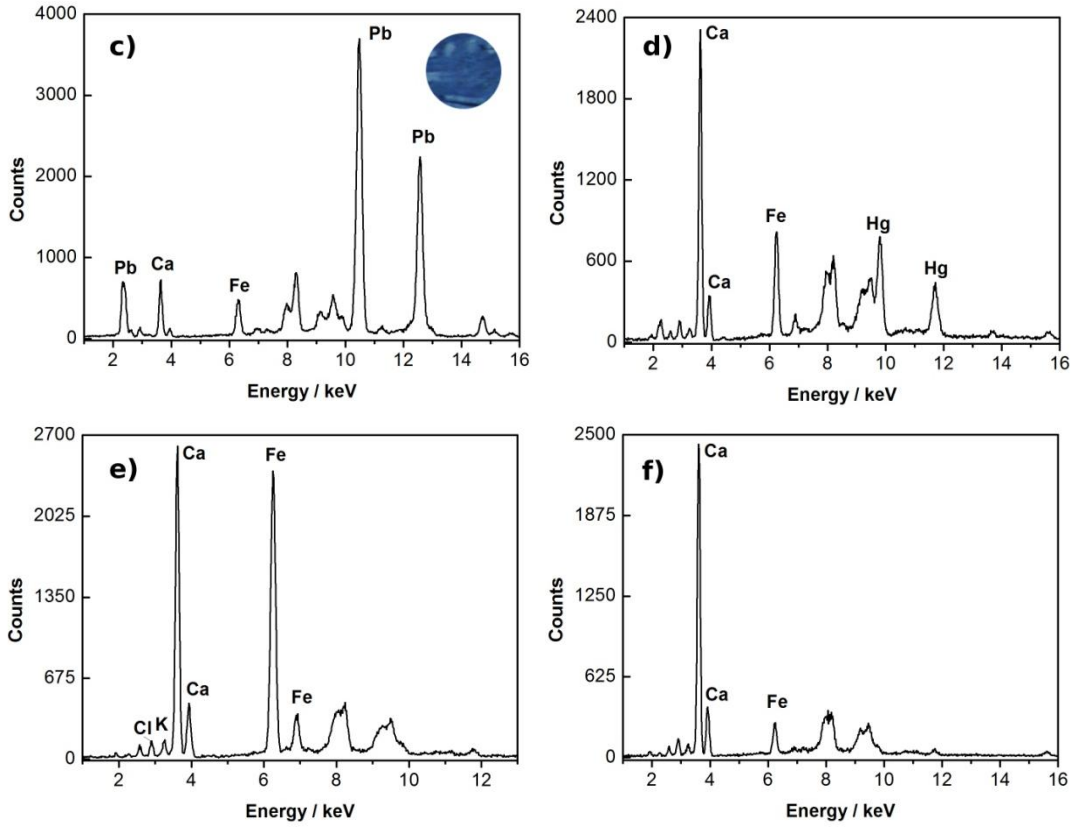
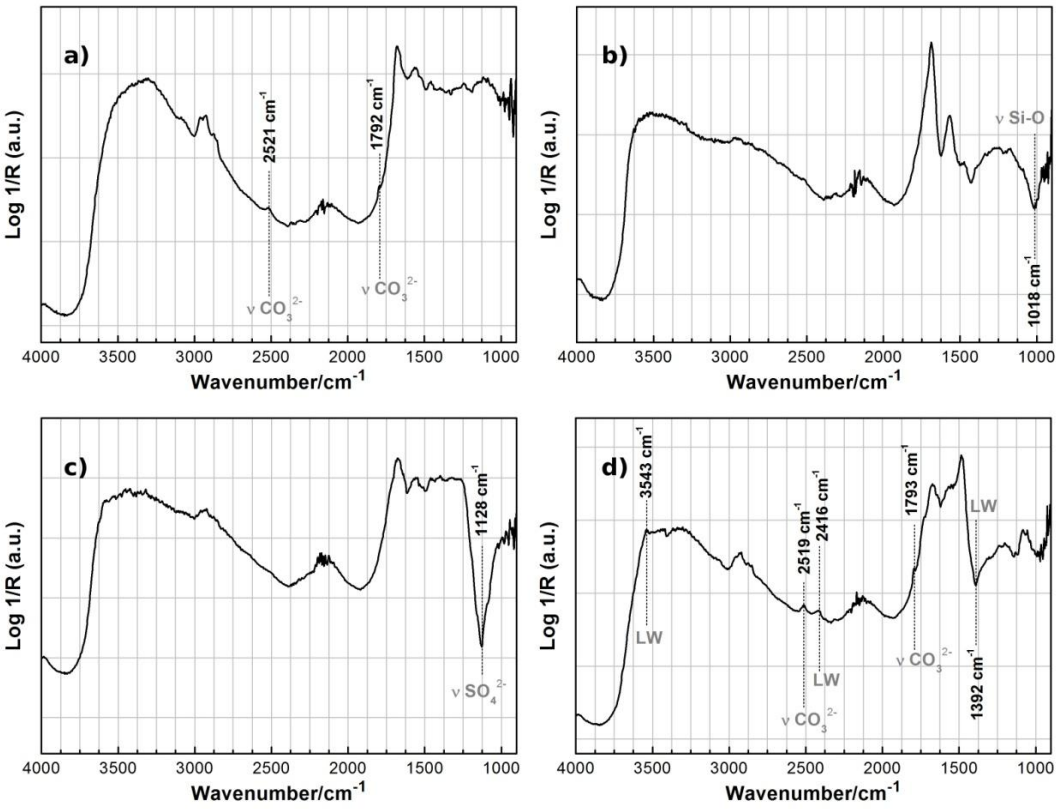


Figure V.11.1. Representative XRF spectra from Santa Cruz 43: **a)** red f. 1; **b)** green f. 1; **c)** blue f. 1; **d)** red ink f. 1; **e)** black ink f. 1; **f)** parchment f. 1.

V.11.2. Mid-FTIR reflectance



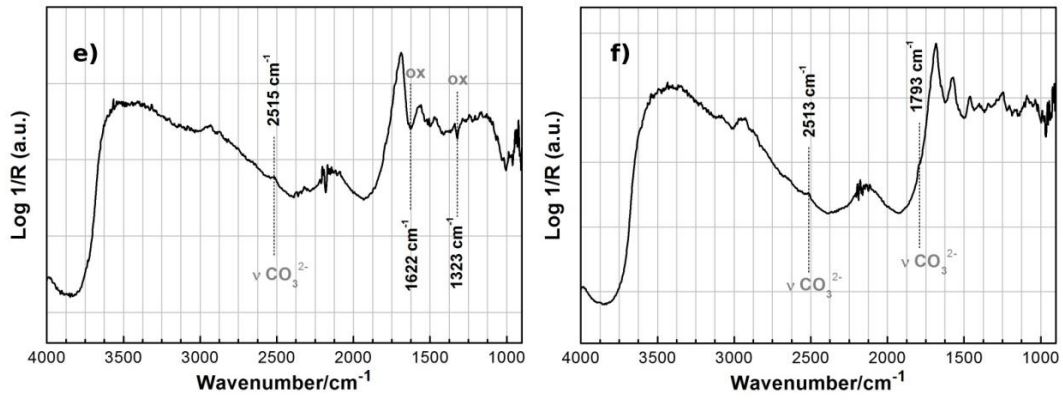


Figure V.11.2. Representative mid-FTIR reflectance spectra from Santa Cruz 43: **a)** red f. 1; **b)** yellow f. 1; **c)** dark green f. 1; **d)** blue f. 1; **e)** black f. 1; **f)** parchment f. 1.

V.11.3. Fluorimetry

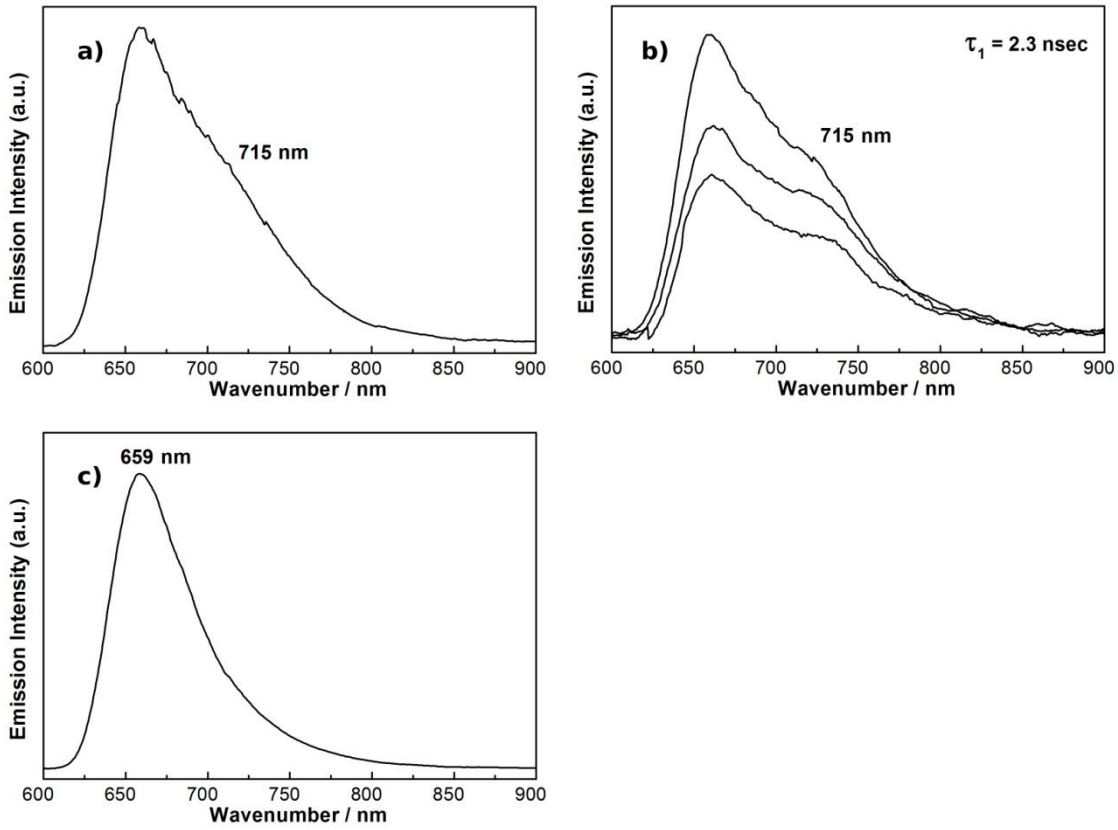


Figure V.11.3. Representative emission spectra (λ_{exc}=470 nm) from Santa Cruz 43: **a)** dark green f. 1; **b)** blue f. 1; **c)** parchment f. 1.

V.12. Santa Cruz 58

V.12.1. Mid-FTIR reflectance

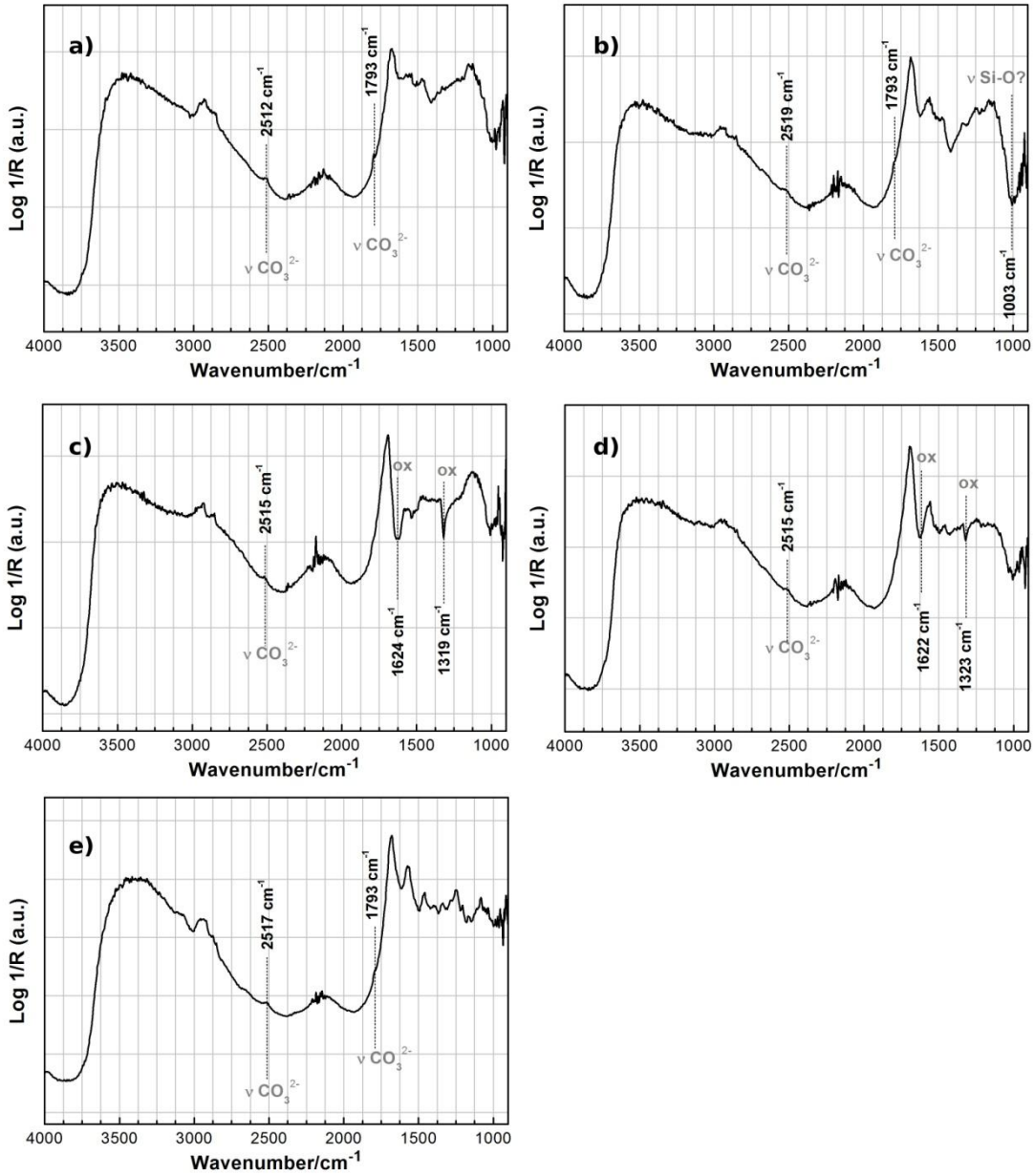


Figure V.12.1. Representative mid-FTIR reflectance spectra from Santa Cruz 58: **a)** red f. 1; **b)** purple f. 1; **c)** green f. 1; **d)** black f. 1; **e)** parchment f. 1.

V.13. Santa Cruz 72

V.13.1. Mid-FTIR reflectance

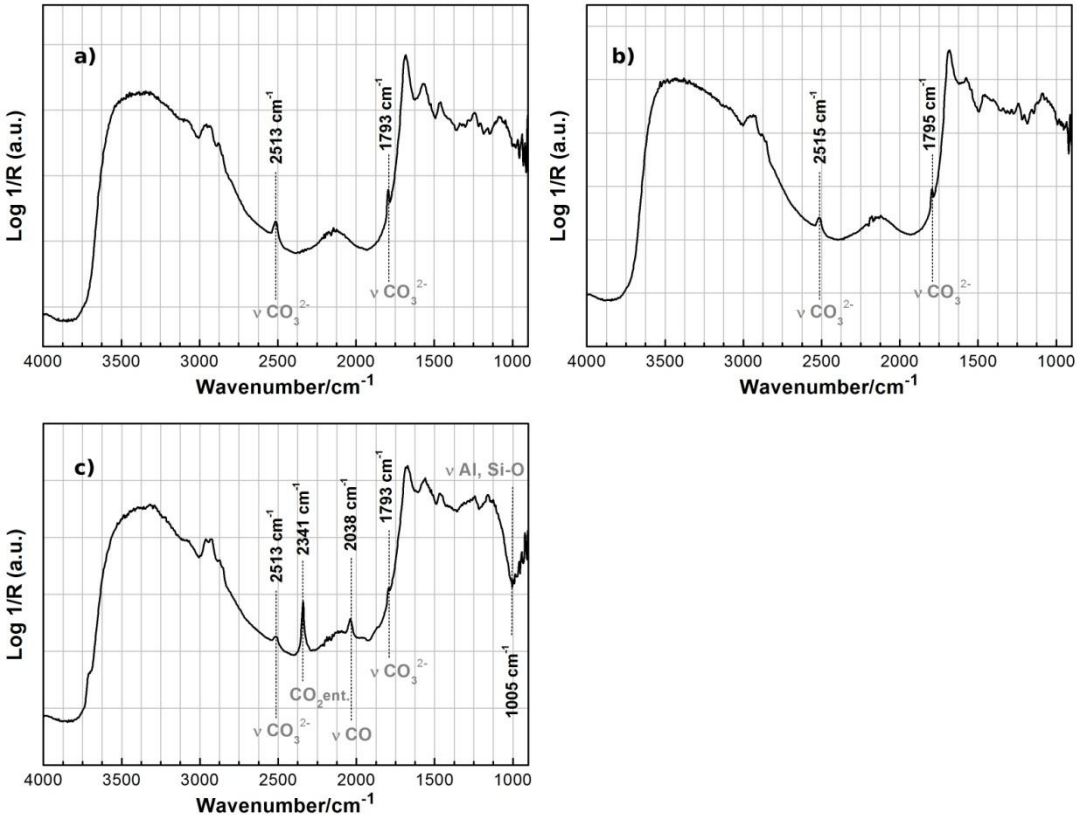


Figure V.13.1. Representative mid-FTIR reflectance spectra from Santa Cruz 72: **a)** red f. 2v; **b)** green f. 2v; **c)** blue f. 2v.

APPENDIX VI. IDAP methodology

VI.1. Parameters for the assessment

Table VI.1.1. Atlas of the main damages found in manuscript parchment.

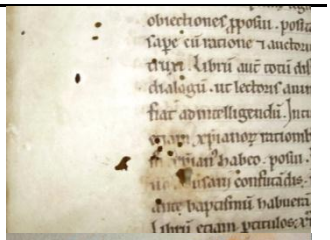
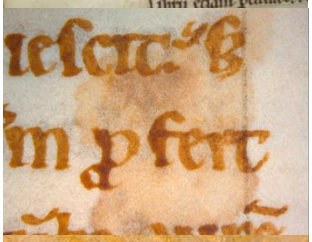
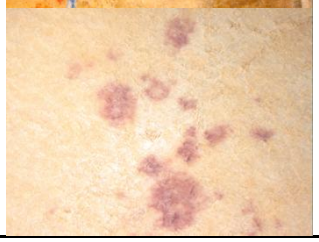
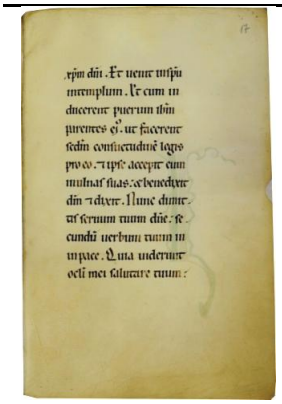
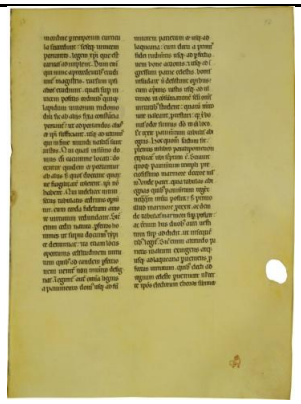
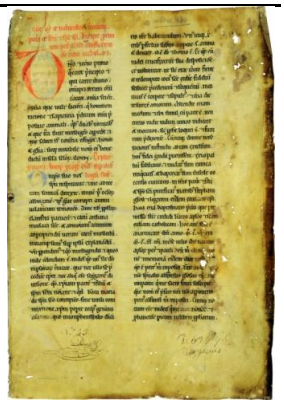
Type of damage	Examples	Type of damage	Examples
Deformations		Biodeterioration (insects / rodents)	
Mechanical damage		Water damage	
Holes and losses		Glass-like layer	
Transparent areas		Calcite deposits	
Surface contamination		Previous interventions /treatments	
Discolouration		Text damage	
Biodeterioration (microorganisms)		Illumination damage	

Table VI.1.2. Representation of the categorization of the damage in parchments.

Undamaged	Slightly damaged	Damaged	Heavily damaged
			
SC 72, f. 17	**SC 11, f. 97**	**SC 21, f. 5**	**SC 34 f. 1**
Good homogeneous condition. Natural yellowing of parchment.	Overall good condition, but with visible damage in small and limited areas, such as, for example, surface contamination, manufacture holes, creases.	Progression of the damage into a considerable amount of the support. Increasing presence of glass-like layer, tears, gaps, and others.	High homogeneous degree of damage, where the integrity of the support and its information is compromised.

VI.2. Representability

From the 14 previously analyzed manuscripts, nine manuscripts were fully assessed (SC 4, 11, 17, 20, 21, 27, 30, 34 and 72) and two additional manuscripts (SC 54 and 68) were also included.

Analyzing all of the parchment in each manuscript would be too time-consuming. In order to obtain representability, the assessment was performed whenever possible on the 1st and 5th-6th *folia* of each quire, if considering a 4 bifolia quire. This allowed the evaluation of half of the parchments – if considering that one bifolium contains 2 folia. Nevertheless, localized damages may reflect non-uniformed types of deterioration, which may be unique on each folium of a bifolium. Consequently, 25% of the support material was diagnosed through this methodology. The number of folia analysed can be seen in Table VI.2.

Table VI.2. Representability of the analyzed parchments.

	SC 4	**SC 11**	**SC 17**	**SC 20**	**SC 21**	**SC 27**	**SC 30**	**SC 34**	**SC 54**	**SC 68**	**SC 72**
Total number of folia	332	189	186	241	274	240	142	117	142	154	87
Total number of analysed folia	83	47	46	60	68	60	35	29	35	38	22

In order to make the implementation of the methodology more quick and effective, contrarily to the approach given by IDAP and performed by Inês Correia (Larsen 2003 and Correia 2014), the assessment was not done individually for three separate *specific areas*. According to IDAP, the examiner should choose three areas with different stages of conservation that could reflect the overall condition. This means that three specific evaluations had be performed, with the triple amount of data to interpret. Although it could give very detailed descriptions of the damage found in each parchment, it did not functioned from a practical point of view since it was too time consuming; and at the end, the gain information was not particularly significant for the evaluation. Therefore, the examination on this work was conducted on an overall assessment. Specific areas were only used to measure colorimetric values. These were constantly performed on the following locations (*a*, *b* and *c*) in order to maintain coherence, represented in Fig. VI.2.1.

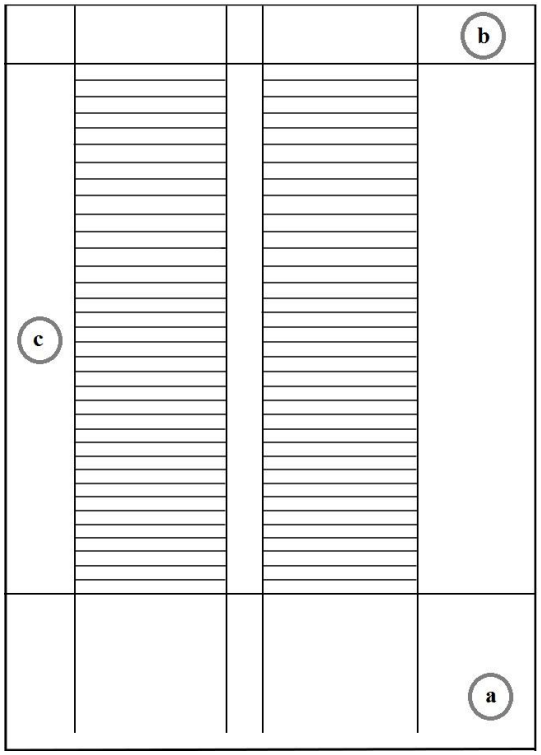


Figure VI.2.1. Specific areas (a, b and c) used for the colorimetric analysis.

VII.1. Construction of a prototype

The prototype was based on the manuscript SC 34, *De Avibus*. On one hand, this codex is based on the most common binding found in the Santa Cruz collection; and one the other hand, it is one of the most damaged books with additional importance for being one of the three Portuguese *Books of Birds*. The main goal was to gain knowledge on the techniques used of the construction of the bookbinding and from there establish what should be the main priorities for the stabilization of these manuscripts.

Figure VII.I.1. Bookbinding details from Santa Cruz 34.

Step-by-step

Materials: Heavy creamy paper imitating parchment from Casa Ferreira; flax thread; wax; alum tawed pig skin from J Hewit & Sons Ltd.; pine wooden boards; Archival BV Calf skin from J Hewit & Sons Ltd.; anilines; animal glue from rabbit skin; parchment from Musée du Parchemin, Rouillon.

The first step was to prepare the quires. Based on the SC 34, 15 gatherings were prepared with 34x23.5 cm, each with 4 bifolia. After folding all of the quires, these were left on the press machine for 24 hours. The holes for the seams were made with a small incision at the same distance, as seen in the sewing stations from SC 34. Then, three slit-thongs were prepared with the alum tawed skin with a cut only on the spin region (the edges were left uncut). In order to proceed with the sewing, an improvised sewing frame was constructed and the slit-thongs were fastened in the frame at a distance from each sewing station. The integral sewing was then conducted with a needle and flax thread that was rubbed on wax in order to ease the passage of the thread through the quires. See Figs. VII.1.1, VII.1.2 and VII.1.3. for more details on the steps.

Figure VII.1.1. Integral sewing scheme from SC 34 with separate sewing endbands (in broken lines).

Figures VII.1.2. and VII.1.3. Packed straight sewing of the textblock from the prototype in the improvised sewing frame and the

During this process, it was possible to conclude that the thickness of the used thread could have been somewhat greater to avoid so many turns in the packed straight sewing. After finishing the main seams from the textblock, the endbands were stitched separately, Fig. VII.I.3. The alum tawed white leather was cut with half of the diameter used for the main thongs. The technique was based on the model 'beed on the spine' from *Headbands: How to work them from* 1986[1].

The following step was to prepare the wooden boards. Since it was hard to find cedar planks, it was used pine because it was easier to arrange and was also found in some manuscripts from the collection. The boards were cut to required size and then they were polished and beveled with sandpaper according to the shape from SC 34. The lacing paths were drilled at the same distance found in the original binding and were also polished in order to receive the bands. The textblock was then attached to the wooden boards through the lacing channels. To fix the thongs and endbands to the boards, wooden wedges were added to the end hole and the excess of leather was cut. These steps can be seen in sequence from Fig. VII.I.4.

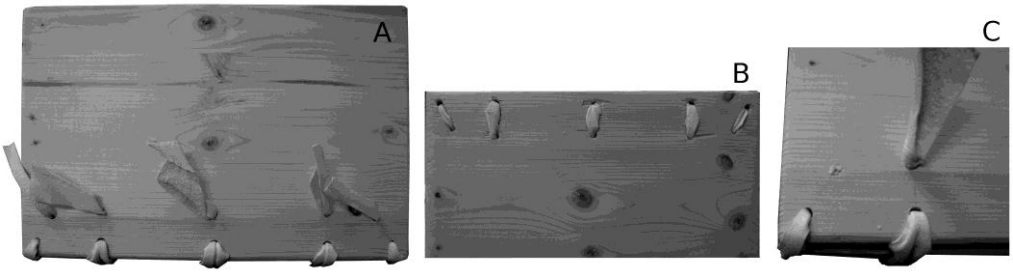


Figure VII.1.4. A) Exterior side of the board with attached slit-thongs; B) Interior side of the board; C) Detail of the wooden wedge and cut leather strip.

[1] GREENFIELD, J. and HILLS, J. (2005). *Headbands: How to work them*. [2nd revised ed.] New Castle, Delaware: Oak Knoll Press.

The leather covering made of calf skin was cut to the required size and then had to be dyed with anilines in order to achieve a brown colour. After that process, the edges were cut with a paring knife in order to achieve thinner corners. Four parchment transverse linings between the thongs were added with animal glue prepared with a concentration of 15%. Finally, the leather covering was applied with a more concentrated animal glue (40%). Subsequently, a long piece of cord was wrapped on each side of the sewing stations in order to keep the leather from pulling away while drying and also to enhance the bands in the spine. The book was then left to dry between heavy boards. On the following day, the parchment linings were glued to the boards and the endleafs were also attached with glue to the boards. No decoration or fastenings were added, since the main goal was to study the main core elements from the binding that could in the future be applied in interventive conservation treatments. The final result can be seen in Fig. VII.1.5.

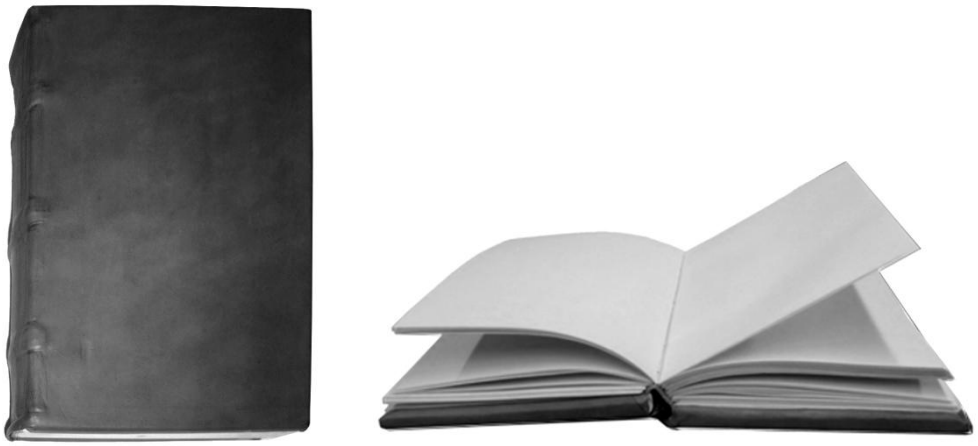


Figure VII.1.5. Final prototype from the manuscript Santa Cruz 34.

VII.2. State of conservation

Table VII.2. Main damages observed in the most significant elements from several manuscripts from Santa Cruz.

	Type of binding	Broken sewing	Broken thongs	Broken endbands	Board detachment	Loss of spine	Loss or broken wooden board	Loss of leather covering	Loss of clasps or bosses
SC 1	SCT	√	0	1	Right board	10%	broken	5%	10 bosses
SC 2	R	√	4	2	Attached to spine	0	0	25%	5 bosses & 2 clasps
SC 4	R	√	4	2	left board	90%	Broken and loss	60%	Non-existent
SC 11	SCT	√	3	2	Left board	99%	0	10%	0
SC 17	SCT	√	0	1	0	60%	0	20%	0
SC 18	SCT	0	3	2	0	10%	0	10%	2 clasps
SC 20	R	√	3	1	0	5%	0	20%	4 bosses
SC 21	SCT	0	0	1	0	5%	Lost 5%	10%	2 clasps
SC 27	R	√	3	2	0	15%	0	5%	0
SC 30	SCT	√	1	2	Some detachment	90%	5%	2%	0
SC 34	SCT	√	1	2	0	100%	5%	35%	0
SC 43	SCT	0	0	0	0	0	5%	8%	0
SC 54	P	√	4	2	0	75%	0	3%	8 bosses
SC 58	SCT	0	0	1	0	15%	0	5%	2 clasps
SC 68	P	√	0	2	0	35%	10%	5%	8 bosses
SC 72	R	0	0	2	0	25%	0	100%	0

SCT = 'Santa Cruz type'; P = Primitive; R = Restored.

APPENDIX VIII. Mapping colours data

This appendix contains all the information regarding the mapping colours analysis, including the number of manuscripts and illuminations analysed, as well as the main data acquired after the analysis.

VIII.1. Representability

Table VIII.1.1. Number of illuminations analysed by the mapping colours tool in Lorvão's collection.

Manuscript	Date	Folia	No. of illuminations	No. of analysed illuminations	% of analysis
Lorvão 3	12th c.	156	42	28	67
Lorvão 5	1184	96	34	34	100
Lorvão 12	13th c.	110	23	21	91
Lorvão 13	13th c.	126	32	20	63
Lorvão 15*	1201-1250	193	178	89	50
Lorvão 16	c. 1140	218	46	25	54
Lorvão 17*	1st q. of 13th c.	256	430	140	33
Lorvão 44	1189	219	64	63	98
Lorvão 50	1183	264	3	3	100
	TOTAL:	**1638**	**852**	**423**	**50**

* All of the illuminations are of reduced dimension except one, which was included in the group of analysed images.

Table VIII.1.2. Number of illuminations analysed by the mapping colours tool in Alcobaça's collection.

Manuscript	Date	Folia	No. of illuminations	No. of analysed illuminations	% of analysis
ALC 238	Late 12th c.	227	34	34	100
ALC 249*	13th c.	248	632	220	35
ALC 358	12th c.	117	76	40	53
ALC 402	12th-13th c.	340	157	80	51
ALC 405	12th-13th c.	206	15	15	100
ALC 410	1219	255	30	20	67
ALC 412	1257	221	110	58	53
ALC 419	12th-13th c.	189	38	38	100
ALC 421	12th-13th c.	246	52	52	100
ALC 426	12th-13th c.	259	36	29	81
ALC 427	12th-13th c.	168	33	28	85
ALC 433	1170-80 or 1201-1250	236	62	34	55
ALC 446	13th c.	220	34	27	79
	TOTAL:	**2932**	**1309**	**675**	**52**

* All of the illuminations are of reduced dimension except one, which was included in the group of analysed images.

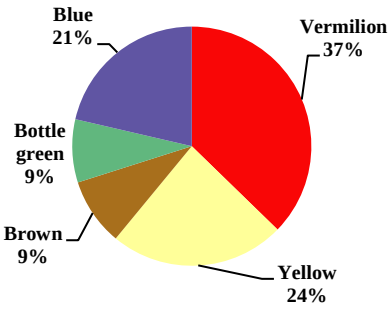
Table VIII.1.3. Number of illuminations analysed by the mapping colours tool in Santa Cruz's collection.

Manuscript	Date	Folia	No. of illuminations	No. of analysed illuminations	% of analysis
SC 1	1151-1200	366	73	40	55
SC 2	1201-1225	213	38	28	74
SC 4	1139	332	141	70	50
SC 11	Late 12th c.	189	5	5	100
SC 17	12th-13th c.	186	4	4	100
SC 18	1237	284	39	29	74
SC 20	Early 13th c.	238	37	37	100
SC 21	Early 13th c.	274	54	53	98
SC 27	1179	240	19	12	63

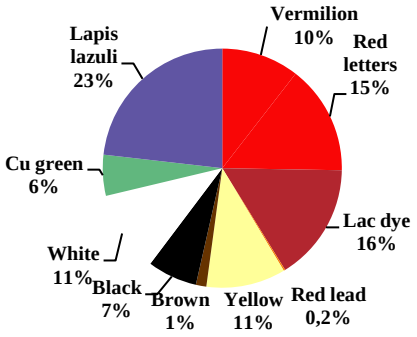
SC 30	1126-1175	142	5	5	100
SC 34	Late 12th c.	117	31	31	100
SC 43	1165	236	28	27	96
SC 58	1139?	272	13	13	100
	TOTAL:	**3089**	**487**	**354**	**73**

VIII.2. Mapping colours main results for each Portuguese monastery

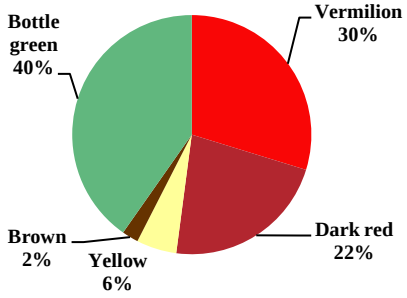
Table VIII.2.1. Mapping colours main results for each manuscript from Lorvão monastery.



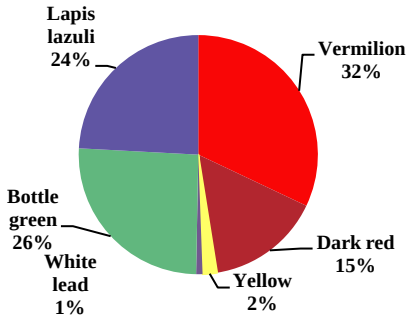
LORVÃO 3



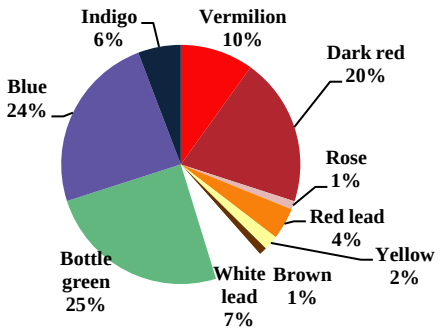
LORVÃO 5



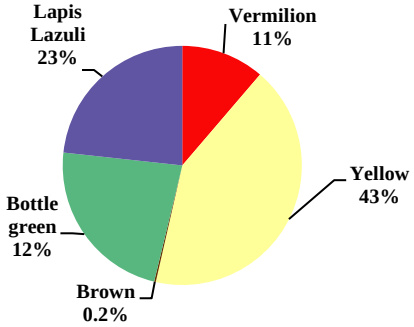
LORVÃO 12



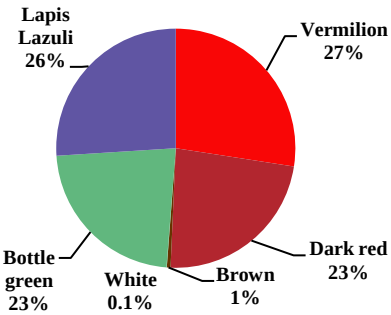
LORVÃO 13



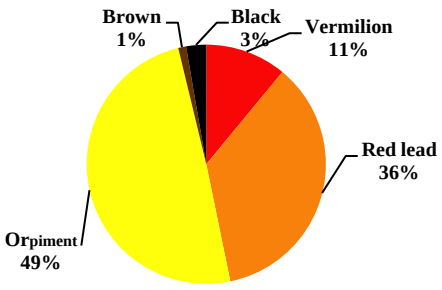
LORVÃO 15



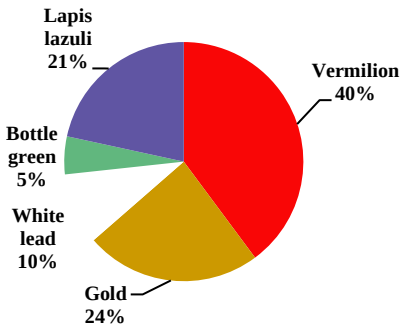
LORVÃO 16



LORVÃO 17

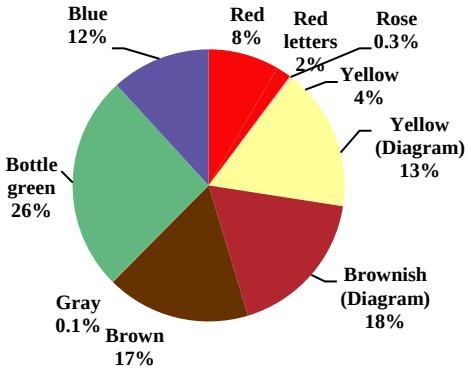


LORVÃO 44

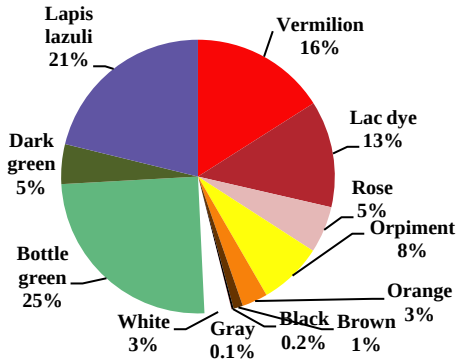


LORVÃO 50

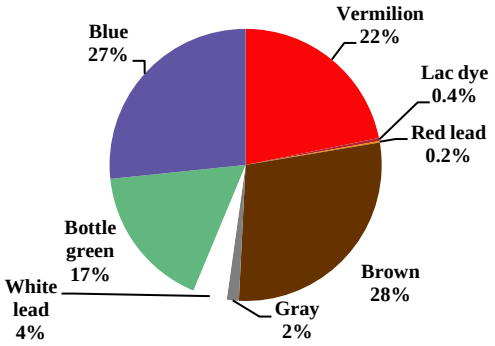
Table VIII.2.2. Mapping colours main results for each manuscript from Alcobaça.



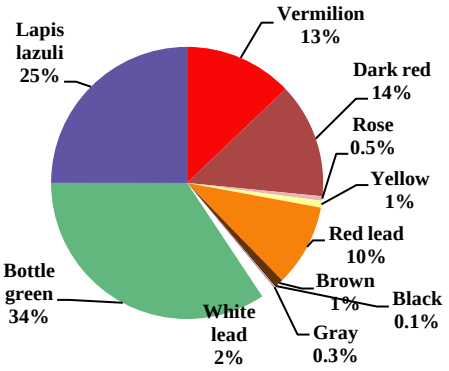
ALCOBAÇA 238



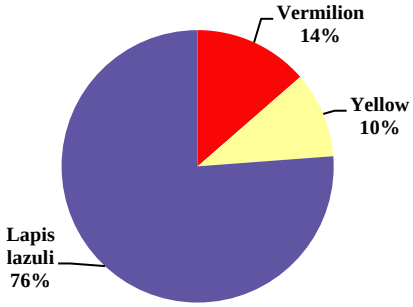
ALCOBAÇA 249



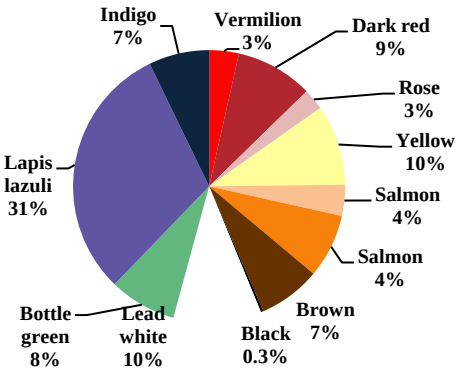
ALCOBAÇA 358



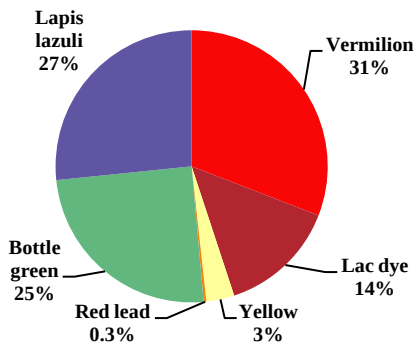
ALCOBAÇA 402



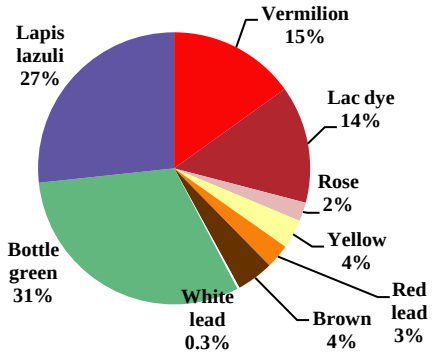
ALCOBAÇA 405



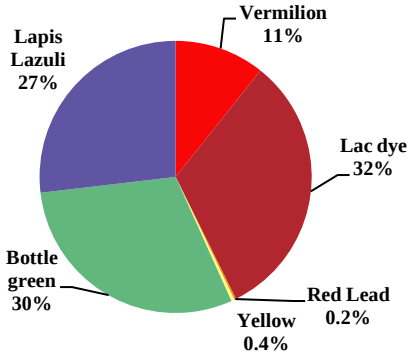
ALCOBAÇA 410



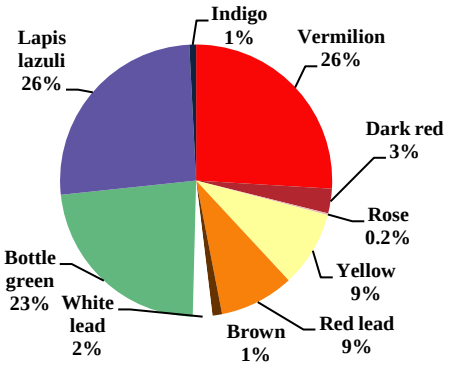
ALCOBAÇA 412



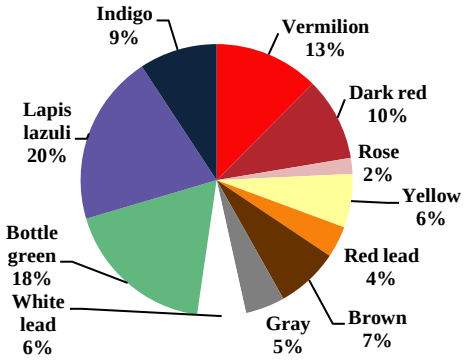
ALCOBAÇA 419



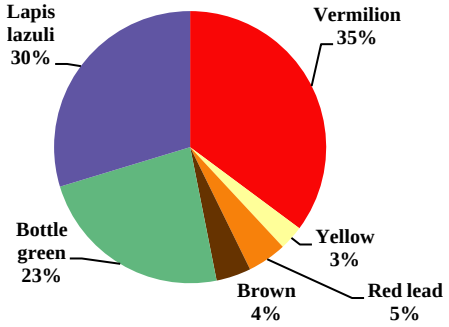
ALCOBAÇA 421



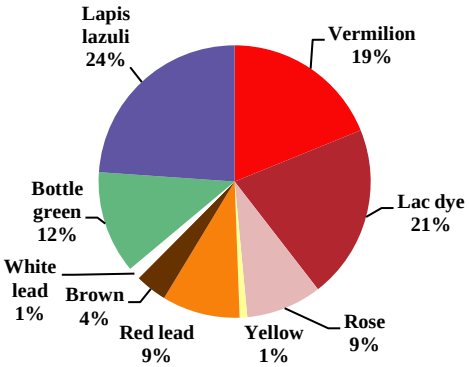
ALCOBAÇA 426



ALCOBAÇA 427

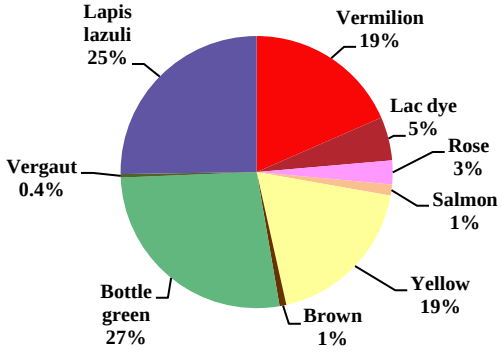


ALCOBAÇA 433

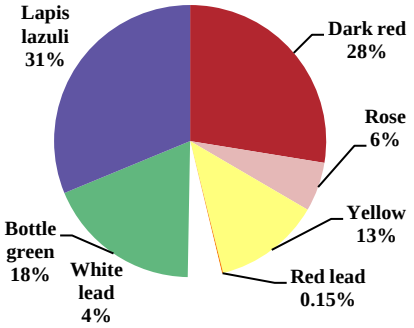


ALCOBAÇA 446

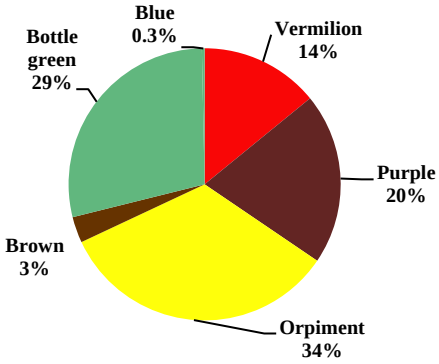
Table VIII.2.3. Mapping colours main results for each manuscript from Santa Cruz.



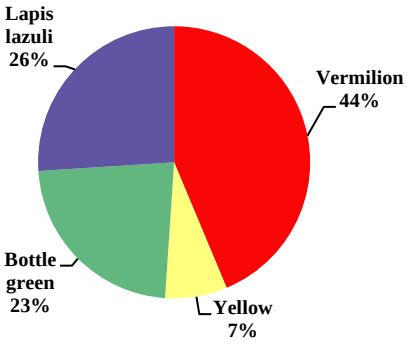
SANTA CRUZ 1



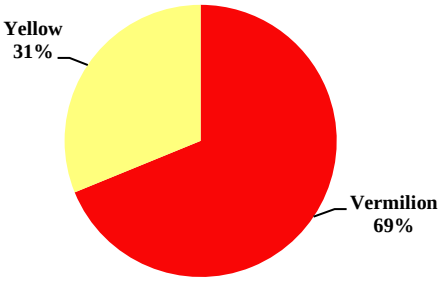
SANTA CRUZ 2



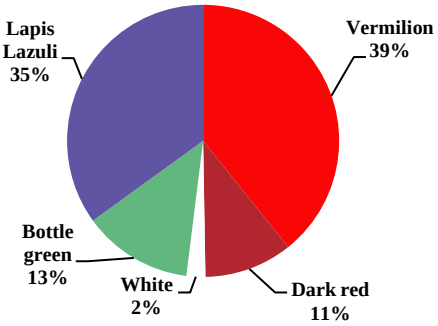
SANTA CRUZ 4



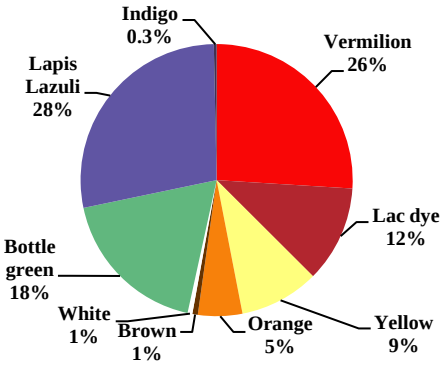
SANTA CRUZ 11



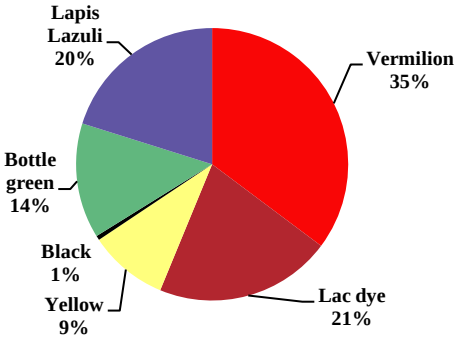
SANTA CRUZ 17



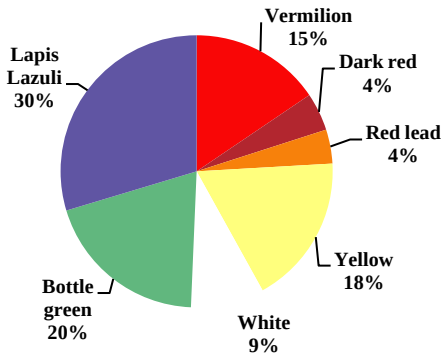
SANTA CRUZ 18



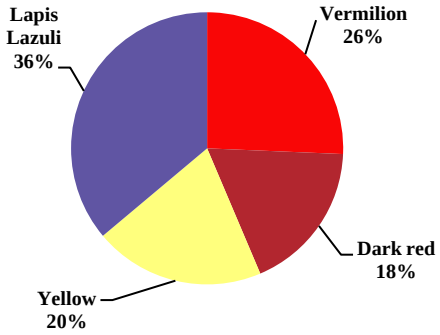
SANTA CRUZ 20



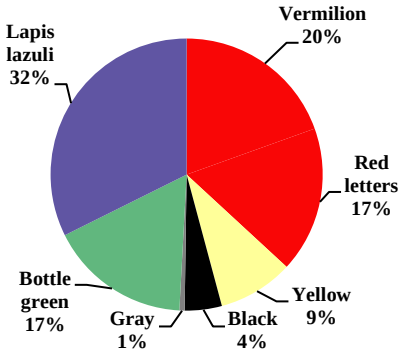
SANTA CRUZ 21



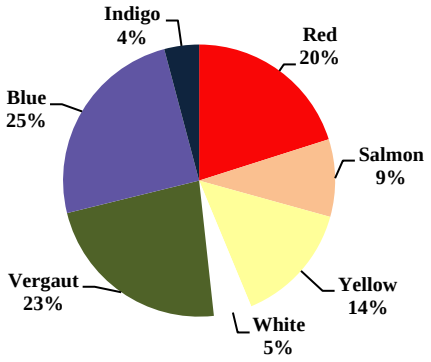
SANTA CRUZ 27



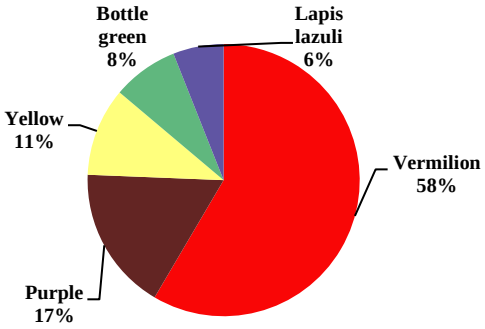
SANTA CRUZ 30



SANTA CRUZ 34



SANTA CRUZ 43



SANTA CRUZ 58

-

VIII.3. Summary of the main results

Table VIII.3.1. Relative colour areas (%) for each manuscript in the three Portuguese Romanesque collections.

	Vermilion	Lac dye	Carmine	Red lead	Orpiment	Yellow	Rose	Purple	Brown	Lapis Lazuli	Indigo	*Bottle green*	*Vergaut*	White	Gray	Black	Gold
Lv 3	37					35				23[a]		3				2	
Lv 5	25[b]	16		0.2		11			1	23		6[c]		11		7	
Lv 12	30		22			6			2			40					
Lv 13	32		15			2				24		26		1			
Lv 15	10		20	4		2	1		1	24	6	25		7			
Lv 16	11					43			0.2	23		23					
Lv 17	27		23						0.6	26		23		0.1			
Lv 44	11			36	49				1							3	
Lv 50			40							21		5		10			24
ALC 238	10[d]					17[e]	0.3		35[f]	12		26			0.1		
ALC 249	16	13		3	8		6		1	19		27	4	3	0.1	0.2	
ALC 358	20		0.4	0.2					27	29		21		2	1		
ALC 402	13		14	10		0.8	0.5		0.9	25		34		1.7	0.2	0.1	
ALC 405	14					10				76							
ALC 410	4		9	11		10	3		7	31	7	8		10		0.3	
ALC 412	31	14		0.3		3				27		25					

[a] Part of the blue consists of azurite.
[b] 10.5% of the red is from illuminations, while the rest is from the *rubrica* around them.
[c] As described in Chapter III, this green is not a copper proteinate, but is most likely a green copper acetate type.
[d] 8% of the red is from the illuminations, while the rest is from the *rubrica* around them.
[e] 13% of the yellow is from the Dove Diagram.
[f] 18% of the Brown is from the Dove Diagram.

ALC 419	15	14		3		4	2		4	27		31		0.3			
ALC 421	12	25		0.3		2	1.5			31		26		1.9	0.7		
ALC 426	26		3	9		9	0.2		1	26	1	23		2			
ALC 427	13		10	4		6	2		7	20	9	18		6	5		
ALC 433	35			5		3			4	30		23					
ALC 446	19	21		9		1	9		4	24		12		1			
SC 1	19	5		1		19	3		1	25		27	0.4				
SC 2			28	0.2		13	6			31		18		4			
SC 4	14				34			20	3	0.3		29					
SC 11	44					7				26		23					
SC 17	69					31											
SC 18	39			11						35		13		2			
SC 20	26	12		5		9			1	28	0.3	18		0.7			
SC 21	35	21				9				20		14				1	
SC 27	15		4	4		18				30		20		9			
SC 30	26		18			20						36					
SC 34	37[g]					9				32		17			1	4	
SC 43	20			9		14				25	4		23	5			
SC 58	58				17	11				6		8					

[g] 20% of the red is from illuminations, while the rest is from the *rubrica* around them.

APPENDIX IX. *DE AVIBUS* manuscripts

In order to assemble this list, Rémy Cordonnier (2007) and Willene B. Clark (1992) were the key sources of information, particularly for the origin, religious orders and iconographic programs. All major sources are indicated on the footnotes as well as websites where digital images are available (whenever possible). As for the column 'colours', the main information was obtained by visual assessment (mainly from digital photographs) or through Clark's data.

Table IX.1. List of *De Avibus* manuscripts **.**

	Current location/ Common designation	MS number	Dimensions (mm x mm)	Date	Origin	Religious Order	Iconographic programm	Colours
1	**Aberdeen**, University Library ***Aberdeen bestiary/aviary***[1]	24	302x210 (185x110/115)	1200 (13th c.)	England (perhaps Canterbury)	-	The Aviary text appears as part of a Second Family Bestiary section on birds. Several illustrations, but no Dove Diagram.	Gold, blue, red, rose, white, brown, orange, black, green, grey.
2	**Assisi**, Biblioteca Comunale ***Assisi Aviary***[2]	568	220x160	1301-1400	Assisi, St. Francis (Italy)	OFM	Unillustrated Aviary.	-
3	**Bamberg**, Staatsbibliothek ***Friar Kiliam's Aviary***[3]	Theol. 233	215x150	1469 (15th c.) (colophon)	Erfurt/Bamberg (Germany)	OFP	30 illustrations from the aviary. Many birds in circular frames with square outer borders, crude trilobe leaf forms in interstices.	Brown and red.
4	**Basel**, Öffentliche Bibliothek der Universität	B.VIII.29[4]	Unknown	ca. 1300 (14th c.)	-	OFP	Unillustrated Aviary.	-
5	**Berlin**, Staatsbibliothek und Preussischer	Theol. Lat. qu. 328[5]	250x200	12th c.	Cambron (France)	O. Cist.	Dove diagram, Hawk diagram and turtledove diagram.	Red, blue, green, brown.

[1] Clark 1992: 267-268. To see the ms.: http://www.abdn.ac.uk/bestiary/comment/1r.hti
[2] Cordonnier 2007: Annexe 1, p. 95.
http://www.internetculturale.it/jmms/iccuviewer/iccu.jsp?id=oai%3Awww.internetculturale.sbn.it%2FTeca%3A20%3ANT0000%3APG0213_ms.568&mode=all&teca=MagTeca+-+ICCU
[3] Clark 1992: 270; LEITSCHUH, Friedrich und Hans FISCHER: *Katalog der Handschriften der Königlichen Bibliothek zu Bamberg* (Bamberg, 1887-1912, 1966) : 823-825.
[4] Clark 1992: 312.
[5] Andreas Fingernagel, *Die Illuminierten Lateinischen Handschriften Süd-, West- und Nordeuropäischer Provenienz der Staatsbibliothek zu Berlin Preussischer Kulturbesitz*, Volume 1, Harrassowitz Verlag, p. 86-87.

	Kulturbesitz							
6	**Bordeaux**, Bibliothèque Municipale ***Bordeaux Aviary***[6]	995	235x160 (180x120)	End of the 12th c.	-	CRSA	Typical program with 30 illustrations.	Light blue, pale yellow, bright green.
7	**Bourges**, Bibliothèque Municipale ***Bourges Aviary***[7]	121 (101)	135x80 (105x60)	Middle 13th c.	Provenance: St. Sulpice (France) Production: unkown	OSB	Hawk diagram only.	Blue, red, brown.
8	**Brasilia**, Biblioteca Central da UnB (BCE) ***Da Silva Neto Aviary***[8]	-	302x220 (229x176)	14th c.	Production: Portugal; Provenance: no early provenance.	-	10 illustrations. Prologue min., 2 miniatures of Hawk on perch, Palm, Ostrich, Swallow, Stork, Nycticorax, Peacock, Eagle.	Blue, white, red, green, black.
9	**Bruges**, Bibliothèque Municipale	561[9]	Unknown	15th c.	Oudenburg, St. Pierre (Belgium)	OSB	Unillustrated Aviary.	-
10	**Bruges** Grootseminaire	506/131[10]	Unknown	1260-1270 (13th c.)	Oudenburg, St. Pierre (Belgium)	OSB	Unillustrated Aviary.	-
11	**Bruges** Grootseminaire ***Ter Duinen Aviary***[11]	89/54	338x225 (228x155)	1190-1200 (12th c.)	Ter Duinen (Belgium)	O. Cist.	Typical program with 30 illustrations.	Red, green, blue, beige, brown, grey, orange. With backgrounds in yellow and sometimes blue.
12	**Brussels**, Bibliothèque Royal de Belgique (BRB) ***St. Martin Aviary***[12]	18421-29 (3241)	290x205	1200 (13th c.)	Tournai, St. Martin (Belgium)	OSB	28 illustrations (without the prologue and the Three Doves Diagram)	Pen draw without colour

[6] Clark 1992: 270-271; Cordonnier 2007: Annexe 1: p. 96.
[7] Clark 1992: 271; http://www.enluminures.culture.fr/documentation/enlumine/fr/rechguidee_00.htm
[8] Clark 1992: 305-6.
[9] Cordonnier 2007: Annexe 1: p. 96.
[10] Cordonnier, *op. cit.*
[11] Clark 1992: 271-272; http://www.historischebronnenbrugge.be/index.php?option=com_album&Itemid=999&task=viewer&album_id=3
[12] Clark 1992: 273.

13	**Brussels**, BRB	2139-43 (1894)[13]	220x155	13th c.	Louvain, Val-St-Martin (Belgium)	CRSA	Unillustrated Aviary.	-
14	**Brussels**, BRB	531-39 (131)[14]	285x205	15th c.	Cologne, Great St. Martin (Germany)	OSB	Unillustrated Aviary.	-
15	**Brussels**, BRB ***BRB 8536 Aviary***[15]	8536-43	238x165	1250 (13th c.)	-	O. Cist.?	There is one illustration, with unfilled spaces left for 29 others.	Unknown
16	**Brussels**, BRB ***Aulne Aviary***[16]	II 1076 (1491)	312x230 (235x178)	Late 12th c.	Abbey of Aulne (Belgium)	O. Cist.	10 illustrations. Typical illustrations from part 1 and Pelican, the Palm and Cedar, Turtledove and Sparrow. No space for other pictures.	Line drawings with details in red and green.
17	**Brussels**, BRB	II 2313 (1487)[17]	295x210	Second half of the 15th c.	Production: Zwoelle (Netherlands)	-	It contains a Dove Diagram and also a the Hawk Diagram (without the representation of the hawk)	Red and yellow.
18	**Brussels**, BRB	II 952 (1207)[18]	220x152	13th c.	Cambron (France)	O. Cist.	Unillustrated Aviary.	-
19	**Cambrai**, Bibliothèque Municipale ***Cambrai Aviary***[19]	A 259 (249)	207x150 (160x100)	First quarter of 13th c.	Production: North France; Provenance: Abbey of St Louis near Noyen. (France)	OFM?	Typical program with 30 illustrations. Dove, hawk and turtledove diagrams. Some of the birds are painted in a circular frame.	Red, blue, dark green, blue green, beige, rust, brown, grey, gold and silver.
20	**Cambridge** (MA), Houghton Library ***Harvard Aviary***[20]	Typ 101	160x110/115 (110x80)	1240-1250 (13th c.)	Production: Paris; Provenance: unknown (France)	-	32 illustrations, 3 incomplete diagrams, frames for 2 miniatures and spaces for miniatures in text.	Rose, grey-blue, greenish-blue, red, green, beige, grey, black, brown, white, pale yellow.
21	**Cambridge**, Corpus Christi Collection[21]	164	(299x202) 115x81	13th c.	Production:England; It belonged to John Gunthorpe (†1498),	-	Unillustrated Aviary. 28 spaces were left to fill.	-

[13] J. Van Den Gheyn, S.J., *Catalogue des Manuscrits de la Bibliothèque Royale de Belgique*, Bruxelles : Henry Lamertin, Libraire-Éditeur, Tome III, 1903, p. 186.
[14] *Catalogue des Manuscrits de la Bibliothèque Royale de Belgique*, Bruxelles : Henry Lamertin, Libraire-Éditeur, Tome I, 1901, p. 64-6.
[15] Clark 1992: 272-3. It seems to have an illustration of a lay-brother dressed in grey with a white monk (hence the hypothesis of being from a Cistercian Order).
[16] Clark 1992: 274.
[17] Cordonnier 2010; *Catalogue des Manuscrits de la Bibliothèque Royale de Belgique*, Bruxelles : Henry Lamertin, Libraire-Éditeur, Tome II, 1902, p. 383-5.
[18] Catalogue des Manuscripts…, p.214-5.
[19] Clark 1992: 274-5. http://bvmm.irht.cnrs.fr/consult/consult.php?reproductionId=10089
[20] Clark 1992: 275-6. http://lms01.harvard.edu/F/59A3MX36IRKJLUTJNB664YRYQMVYBX1CFY46AJS6G5QXCJME9N-17916?func=find-c&=&CCL_TERM=sys%3D009547057&pds_handle=GUEST

					dean of Wells Cathedral.			
22	**Cambridge**, Gonville and Caius College ***Caius Aviary***[22]	372/621	235x165 (175x115)	1300 (14th c.)	Production: England; Provenance: Fr. John of Milham (14th c.); Fr. John Zouch, Provincial of the Franciscans in England, Bishop of Llandaff (d. 1423)	-	Second Family Bestiary. 28 illustrations, plus 2 marginalia. Illustrations not based on Aviary model.	Brown-rose, blue, red, grey, green and brown.
23	**Cambridge**, Pembroke College	258[23]	Unknown	13th c.	-	-	Diagrams partially drawn.	-
24	**Cambridge**, Peterhouse	259[24]	Unknown	13th c.	-	-	Diagrams partially drawn, spaces for all illustrations of Part 1.	-
25	**Cambridge**, Sidney Sussex College ***Sidney Sussex Aviary***[25]	100	290x210 (207x146)	1250 (13th c.)	Production: Paris; Provenance: bound at unknown date with 11th c. MS from Durham; given to the college by rector of Willingdale-Spain.	-	20 illustrations from the Aviary.	Mainly rose and blue, also red, pale orange, pale green, brown, grey, white and gold.
26	**Chalon-sur-Saône**, Bibliothèque Municipale ***La Ferté Aviary***[26]	14(11)	320x250 (250x185)	1240 (13th c.)	Production place: Paris. Provenance: La Ferté-sur-Grosne (France)	O. Cist.	19 illustrations from Part 2, ibis, Coot and 18 illustrations from the bestiary.	Mainly rose, red, blue, also green, brown, beige, grey, white and gold.
27	**Charleville**, Bibliothèque Municipale ***Signy Aviary***[27]	166B	305x208 (216x145)	End of 13th c.	Production: north France; Provenance: Abbey of Signy (France)	O. Cist.	It only contains the Dove Diagram without the inhabiting bird.	-
28	**Chicago**,	31.1[28]	255x172	14th c.	Admont (Austria)	OSB	With places for illustrations left blank.	-

[21] Clark 1992: 312. http://dms.stanford.edu/catalog/CCC164_keywords
[22] Clark 1992: 276-7.
[23] Clark 1992: 311.
[24] *Op. cit.*
[25] Clark 1992: 247-8.
[26] Clark 1992: 278-9. http://www.enluminures.culture.fr/public/mistral/enlumine_fr?ACTION=CHERCHER&FIELD_98=REF&VALUE_98=D-056318
[27] Clark 1992: 279.

	Newberry Library							
29	**Unknown location (Private collection)** ***Christie's Aviary***[29]	Christie's, 2 Dec. 1987, Lot 15)	110x76 (84x57)	1190 (12th c.)	Production: Probably north France or Flanders. Provenance: Unknown.	-	12 illustrations from the Aviary, probably originally line drawings, now fully colored.	Blue, red, green, dark grey-blue, minium, rose.
30	**Cracow**, Biblioteka Jagiellońska (BJ)	1383 (CC.VI.32)[30]	Unknown	15th c.	Třemešná? (Czech Republic)	-	-	-
31	**Cremona**, Biblioteca Statale Governativa ***Cremona Aviary***[31]	199	273x180 (193x132)	End of 12th c. – beg. of 13th c.	Production: Lombardy? Provenance: Cremona, Abbey of St. Augustine (Italy)	CRSA	28 illustrations from the Aviary.	Fully colored with gold.
32	**Dijon**, Bibliothèque Publique ***Cîteaux Aviary***[32]	225 (187)	335x225 (232x180)	End of the 12th c.	Production: Abbey of Cîteaux? Provenance: Abbey of Cîteaux (France)	O. Cist.	3 diagrams from the aviary. Dove, hawk and turtledove diagrams (only the last complete).	Red and blue initials. Red and brown in the turtledove diagram.
33	**Douai**, Bibliothèque Municipale ***Anchin Aviary***[33]	370	246x170 (185x142)	Beg. of the 13th c.	Production: north France, prob. Anchin Provenance: Abbey of Anchin (France)	OSB	3 diagrams from the aviary. Dove, hawk and turtledove diagrams.	Grey dove with gold and silver on wings, red Hawk, green and red turtledove.
34	**Dresden**, Sächs. Landesbibliothek	A 198[34]		13th c.	-	-	With places for illustrations left blank.	-
35	**Erlangen**, University Library[35]	St 589	Unknown	1450 (15th c.)	-	-	Unillustrated Aviary.	-
36	**Frankfurt**, SB	Barth. 167	170x120 (145x90)	Middle 13th c.	Production: North France. Provenance:	O. Cist.?	3 diagrams from the aviary. Dove, hawk and turtledove diagrams.	Yellow, green, red.

[28] Clark 1992: 311.
[29] Clark 1992: 310-1.
[30] Cordonnier 2007: Annexe 1, p.98.
[31] Clark 1992: 279-280.
[32] Clark 1992: 280-1; http://www.enluminures.culture.fr/public/mistral/enlumine_fr?ACTION=CHERCHER&FIELD_98=REF&VALUE_98=D-048800
[33] Clark 1992: 281. http://bvmm.irht.cnrs.fr/consult/consult.php?reproductionId=11053
[34] Clark 1992: 311.
[35] Clark 1992: 312.

	Frankfurt Aviary[36]				Cistercian ownership			
37	**Gdańsk**, Bibliotheka Gdańska	2224 (XV)[37]	Unknown	First half of the 15th c.	-	-	-	-
38	**Ghent**, University Library ***Grammont Aviary***[38]	546	275x190 (207x137)	13th c.	Provenance: Grammont, St. Adrien (Belgium)	OSB	2 incomplete diagrams (Dove, Turtledove), hawk on perch (intended for Hawk diagram).	Brown and green.
39	**Graz**, UB[39]	1545	Unknown	12th c. (f.1-94) and to 1300	Neuberg (Austria)	O. Cist.	-	-
40	**Heiligenkreuz**, SB ***Heiligenkreuz Aviary***[40]	226	261x175 (202x129)	End of the 12th c.	Production: Burgundy or Lorraine? (France) Provenance: Heiligenkreuz	O. Cist.	30 illustrations from the Aviary.	Line drawings in red and brown.
41	**Hohenfurt**, Knihohvna Klastera	69 Pp[41]	Unknown	15th c.	Vyssi Brod/Hœnfurt (Czech Republic)	O. Cist.	Unknown	-
42	**Klosterneuburg**, Stiftsbibliothek	795[42]	210x155	14th c.	Klosterneuburg (Austria)	CRSA	Unknown	-
43	**Klosterneuburg**, Stiftsbibliothek	929[43]	252x170	13th c.	Klosterneuburg (Austria)	CRSA	It contains at least the Dove Diagram.	-
44	**Kremsmünster**, Stiftsbibliothek	218[44]	Unknown	14th c.	-	OSB	Unillustrated Aviary.	-
45	**Kremsmünster**, Stiftsbibliothek	225[45]	Unknown	15th c.	-	OSB	Unillustrated Aviary.	-
46	**Lisbon**, Arquivo Nacional da Torre do Tombo	Lorvao 5	210x135 (171x91)	1184 (12th c.) *(colophon)*	Production: Abbey of St. Mamede of Lorvão (Portugal)	Iberian monasticism (OSB)	30 illustrations from the Aviary. Typical program, except the omission of the Hawk and turtledove diagrams.	Blue, red, white, green, dark red, black, yellow.

[36] Clark 1992: 281-2. http://sammlungen.ub.uni-frankfurt.de/msma/id/3584124
[37] Cordonnier 2007: Annexe 1, p. 98.
[38] Clark 1992: 282.
[39] Cordonnier 2007: Annexe 1, p. 100.
[40] Clark 1992: 283.
[41] Cordonnier 2007: Annexe 1, p. 100.
[42] Cordonnier 2007: Annexe 1, p. 100. http://www.ksbm.oeaw.ac.at/_scripts/php/newWin4msDescription.php?ID=1022
[43] Cordonnier 2007: Annexe 1, p. 100. http://www.ksbm.oeaw.ac.at/_scripts/php/newWin4msDescription.php?ID=1174
[44] Cordonnier 2007: Annexe 1, p. 100.
[45] Cordonnier 2007: Annexe 1, p. 100.

	Lorvão Aviary[46]							
47	**Lisbon**, Biblioteca Nacional de Portugal ***Alcobaça Aviary***[47]	ALC 238	318x218 (227x151)	Late 12th c.	Alcobaça (Portugal)	O. Cist.	30 illustrations from the Aviary. Typical program, except the omission of the Hawk and turtledove diagrams.	Green, red, brown, yellow, blue.
48	**London**, British Library	Add. 22401[48]	Unknown	14th c.	York Minster (England)	-	Unillustrated Aviary.	-
49	**London**, BL	Add. 24097[49]	Unknown	13th c.	Norwich? (England)	-	Unillustrated Aviary.	-
50	**London**, BL	Cotton Vitellius D. I[50]	Unknown	13th c.	-	-	-	-
51	**London**, BL ***Harley Aviary***[51]	Harley 4751	305x233 (200x140)	1230-1240 (13th c.)	South of England (England)	-	Second Family Bestiary. 106 illustrations none standard from the Aviary.	Rose, magenta, blue, orange red, green, olive green, mustard, silver.
52	**London**, BL ***Bardney Aviary***[52]	Roy. 10 A vii	232x173 (180x130)	2nd quarter of the 13th c.	Production: Bardney Abbey? Provenance: Bardney Abbey (England)	OSB	22 illustrations from the Aviary. Part 1: Only prolog. min., dove diagram (without text), turtledove diag.; Part 2: birds take odd forms, some resembling a falcon.	The birds and trees are drawn in brown.
53	**London**, BL ***Sloane Aviary***[53]	Sloane 278	267x187 (235x134)	1250-1260 (13th c.)	Production: Paris or French Flanders? (France) Provenance: Benedictine?	-	31 illustrations from the Aviary.	Rose and blue dominant, medium brown, red brown, mustard, orange red, grey.
54	**Los Angeles**, Getty	Ludwig XV,	191x142	End of the	Production: Region of	O. Cist.?	30 illustrations from the Aviary. Typical	Blue and rose

[46] Cepeda and Ferreira 1994: 65; http://digitarq.dgarq.gov.pt/details?id=4381076.
[47] Cepeda and Ferreira 1994: 164; http://purl.pt/24388.
[48] Clark 1992: 312.
[49] Clark 1992: 312. http://searcharchives.bl.uk/primo_library/libweb/action/display.do?tabs=detailsTab&ct=display&fn=search&doc=IAMS032-002031375&indx=1&recIds=IAMS032-002031375&recIdxs=0&elementId=0&renderMode=poppedOut&displayMode=full&frbrVersion=&dscnt=0&frbg=&scp.scps=scope%3A%28BL%29&tab=local&dstmp=1439399442065&srt=rank&mode=Basic&&dum=true&vl(freeText0)=Add.%20MS%2024097&vid=IAMS_VU2
[50] Cordonnier 2007: Annexe 1, p.101. http://www.mirabileweb.it/manuscript/london-british-library-cotton-vitellius-d-i-manuscript/100408
[51] Clark 1992: 288-9. http://www.bl.uk/catalogues/illuminatedmanuscripts/record.asp?MSID=8797
[52] Clark 1992: 289. http://www.bl.uk/catalogues/illuminatedmanuscripts/record.asp?MSID=5358&CollID=16&NStart=100107
[53] Clark 1992: 289-90.http://www.bl.uk/catalogues/illuminatedmanuscripts/record.asp?MSID=6512&CollID=9&NStart=278

	Museum (GM) ***Dyson Perrins Aviary***[54]	3	(135x94)	12th c.	St. Omer? Provenance: Possibly Cistercian.		Part 1 program.	dominant.
55	**Los Angeles**, GM ***Gloucester Aviary***[55]	Ludwig XV, 4	231x165 (150x112)	1277 (13th c.)	Production: Probably region of St. Omer; Provenance: Gloucester (England)	-	30 illustrations from the Aviary with typical Part 1 program.	Full color range: pink and green combinations, much green shading with grey; burnishing gold.
56	**Lüneburg**, Ratsbücherei	Theol. C20[56]	Unknown	14th c.	-	-	Unknown	
57	**Lüneburg**, Ratsbücherei	Theol. 4° 20[57]	Unknown	14th c.	-	-	Unillustrated Aviary.	-
58	**Melk**, SB ***Melk Aviary***[58]	Mell. 6	420x305 (314x252)	1200 (13th c.)	Production: South Germany? Provenance: Melk Abbey.	OSB	Two diagrams (Turtledove and Hawk).	Line drawings
59	**Montpellier**, BU Méd.	H 499[59]	150x110	13th-14th c.	Clairvaux (France)	O. Cist.	Unillustrated Aviary.	-
60	**Montpellier**, Soc. Archéol.	8[60]	273x185	12th-13th c.	-	-	26 illustrations.	Unknown
61	**Munich**, Bayerische Staatsbibliothek (BSB) ***Tegernsee Aviary***[61]	Clm 18368	290x220 (218x157)	14th c.	Production: South Germany; Provenance: Abbey of Tegernsee (Germany)	OSB	Dove diagram without the dove figure, turtledove diagram.	-
62	**Munich**, BSB	Clm 9649[62]	212x150	15th c.	Oberalteich (Germany)	OSB	Unillustrated Aviary.	-
63	**Munich**, BSB	Clm 11315	263x170	First half of	Production: South	CRSA	Dove and Turtledove diagrams, frame for	Line drawings

[54] Clark 1992: 290-2. http://www.getty.edu/art/gettyguide/artObjectDetails?artobj=1696&handle=book&pg=1
[55] Clark 1992: 292-3. http://www.getty.edu/art/gettyguide/artObjectDetails?artobj=1697&handle=book&pg=1
[56] Cordonnier 2007: Annexe 1, p. 101.
[57] Clark 1992: 312.
[58] Clark 1992: 293-4.
[59] Cordonnier 2007 : Annexe 1, p. 102. http://www.biu-montpellier.fr/florabium/jsp/nodoc.jsp?NODOC=2013_DOC_MON1_MBUM_73
[60] Cordonnier 2007 : Annexe 1, p. 102 ; *Catalogue général des bibliothèques publiques de France.* Tome I. Paris: Librairie Plon Les Petits-Fils de Plon et Nourrit, 1931, 199- 200.
[61] Clark 1992: 294-5. http://daten.digitale-sammlungen.de/~db/0000/bsb00008254/images/index.html?seite=0165&l=en
[62] http://daten.digitale-sammlungen.de/~db/0000/bsb00008215/images/index.html?seite=0116&l=en

	Polling Aviary[63]		(212x129)	the 13th c.	Germany; Provenance: Polling Abbey (Germany)		Hawk figure but no diagram.	
64	**Munich**, BSB ***Rohr Aviary***[64]	Clm 15407[65]	265x175 (206x112)	14th c.	Production: South Germany; Provenance: Abbey of Rohr (Germany)	CRSA	Dove diagram without the dove figure.	-
65	**Namur**, MGC ***Le Jardinet Aviary***[66]	48 B	295x215 (236x149)	After 1430 (15th c.) or 1424-1425	Production: ? Aulne Abbey after 1430 acquisition of Le Jardinet; Provenance: Abbey of Le Jardinet (France)	O. Cist.	Similar to the Aulne Aviary, omitting a inhabited initial (unillustrated).	Line drawings in brown.
66	**New Haven**, Yale University, Beinecke Library ***Yale Aviary***[67]	189	275x190 (145x219)	1200 (13th c.)	Production: north France; Provenance: Sir Thomas Phillips, MS. 3691	-	18 illustrations from the Aviary.	Blue, brown, grey.
67	**New Haven**, Yale University, Beinecke Library	851[68]	260x195	13th c.	-	-	With places for illustrations left blank.	
68	**New Haven**, Yale University, Beinecke Library	13[69]	237x180	2nd half of the 14th c.	Production: Italy	-	Unillustrated Aviary.	-
69	**Oxford**, Bodleian Library ***Ashmole Bestiary***[70]	Ashmole 1511	275x185 (186x112)	1200-1210 (13th c.)	Production: England, probably south; Provenance: unknown origin	-	29 illustrations from the Aviary.	Fully colored: red, blue, green, white, brown, gold, orange, yellow.
70	**Oxford**, Bodleian Library	Bodley 602	240x175 (181x102)	1240-1250 (13th c.)	Production: south England?; Provenance:	OFP?	18 illustrations from the Aviary. Only prologue min. is standard; omits	Magenta, orange, blue, grey, brown,

[63] Clark 1992: 294. http://daten.digitale-sammlungen.de/~db/0000/bsb00008253/images/index.html?seite=0017&l=en
[64] Clark 1992: 294.
[65] http://daten.digitale-sammlungen.de/~db/0000/bsb00008254/images/index.html?seite=0024&l=en
[66] Clark 1992: 295.
[67] Clark 1992: 295-6. http://brbl-dl.library.yale.edu/vufind/Search/Results?lookfor=%22Beinecke+MS+189%22&type=CallNumber
[68] http://brbl-dl.library.yale.edu/vufind/Record/3586828
[69] http://brbl-net.library.yale.edu/pre1600ms/docs/pre1600.ms013.htm
[70] Clark 1992: 196. http://treasures.bodleian.ox.ac.uk/The-Ashmole-Bestiary

	Bodley 602 Aviary[71]				Dominican?		diagrams except turtledove.	green, aqua, white.
71	**Oxford**, Bodleian Library ***Bodley Aviary***[72]	Bodley 764	298x195 (209x115)	1230-1340 (13th c.)	Production: South England; Provenance: unknown	-	7 non-Aviary miniatures for the Aviary chapters.	Light rose, blue, bright orange red, medium green, light brown, tan, mustard yellow, white, grey, gold.
72	**Oxford**, Bodleian Library ***Douce Aviary***[73]	Douce 151	243x180 (180x115)	14th c.	Production: England; Provenance: Francis Douce, early 19th c.	-	17 illustrations from the Aviary.	Light green, bright red, light brown, dark blue.
73	**Oxford**, Bodleian Library ***Lyell Aviary***[74]	Lyell 71	230x176 (170x130)	1300 (14th c.)	Production: Lombardy? Provenance: Italy	O. Cist. ?	10 illustrations from the Aviary. Knight and priest in prologue miniature.	Red, blue, pink, blue green, rose, grey, violet.
74	**Oxford**, Bodleian Library	Laud. Misc. 205[75]	Unknown	13th c.	-	-	Unillustrated Aviary.	-
75	**Oxford**, Bodleian Library	Rawl. G. 69[76]	Unknown	13th c.	-	-	With places for illustrations left blank.	-
76	**Oxford**, University College ***University College Aviary***[77]	120	238x153 (193x123)	15th c.	Production: England; Provenance: Nunnery?	-	17 illustrations from the Aviary. Most miniatures as in Ashmole Bestiary, with slight variations.	Red, white, blue, brown, green, light yellow.
77	**Padua**, BU	1542[78]	Unknown	13th c.	Padua (Italy)	OFM	Unknown	-
78	**Paris**, Arsenal Library	550 (625 T. L.)[79]	Unknown	13th c.	Paris (France)	CRSA	Unillustrated Aviary.	-

[71] Clark 1992: 197. http://bodley30.bodley.ox.ac.uk:8180/luna/servlet/view/all/what/MS.+Bodl.+602
[72] Clark 1992: 197-8. http://bodley30.bodley.ox.ac.uk:8180/luna/servlet/view/search;jsessionid=B3E33BA7076F5AA7DC95126B7C0E9335?QuickSearchA=QuickSearchA&q=Bodley+764&search=Search
[73] Clark 1992: 298. http://bodley30.bodley.ox.ac.uk:8180/luna/servlet/view/search?QuickSearchA=QuickSearchA&q=Douce+151&search=Search
[74] Clark 1992: 299. http://bodley30.bodley.ox.ac.uk:8180/luna/servlet/view/search?QuickSearchA=QuickSearchA&q=Lyell+71&search=Search
[75] Clark 1992: 312.
[76] Clark 1992: 311.
[77] Clark 1992: 299-300.
[78] Cordonnier 2007: Annexe 1, p. 104. http://cataloghistorici.bdi.sbn.it/file_viewer.php?IDIMG=9530&IDCAT=232&IDGRP=2320006&LEVEL=1&PADRE=2320001&PROV=INT#
[79] Clark 1992: 312.

79	**Paris**, Arsenal Library	1116[80]	210x150	13th c.	Provenance: St. Victor Abbey	OSV ?	Unillustrated Aviary.	-
80	**Paris**, Bibliothèque Nationale de France ***Notre Dame Aviary***[81]	fr. 24428	312x218 (240x150)	After 1260 (13th c.)	Production: Probably Paris; Provenance: Notre-Dame (France)	OFM ?	2 illustrations from the Aviary that also represent the moralizations: Palm and crucifixion, Cedar with monks beside tree.	Blue, rose, brown, beige, grey, gold.
81	**Paris**, BNF	lat. 2494[82]	250x155	Beginning of the 13th c.	Cerreto, St. Mary (Italy)	O. Cist.	With places for illustrations left blank.	-
82	**Paris**, BNF ***Avignon Aviary***[83]	lat. 2495	305x220 (228x169)	12th c.	Production: South France?; Provenance: given by Jean de Brogny, Bishop of Ostia to the monastery of St. Pierre-de-Luxembourg, Avignon.	-	30 illustrations typical from the Aviary.	Red, rose, light brown, blue, beige, bright yellow, green, white, gold and silver.
83	**Paris**, BNF ***Foucarmont Aviary***[84]	lat. 2495A	280x200 (193x129)	2nd quarter of the 13th c.	Production: Paris or north France; Provenance: Foucarmont Abbey (France)	O. Cist.	1 illustration from the Aviary: Nycticorax.	Blue, red, green, grey, black.
84	**Paris**, BNF ***Lat. 2496B Aviary***[85]	lat. 2495B	306x210 (235x158)	After 1230 (13th c.)	Production: probably Paris; Provenance: unknown	-	30 illustrations from the Aviary.	Red, rose, mauve, blue, green, deep yellow, black, white, silver.
85	**Paris**, BNF	lat. 2896[86]	185x130	13th c.	-	-	Unillustrated Aviary.	-
86	**Paris**, BNF	lat. 3638A[87]	200x140	13th c.	-	-	Unknown number of animal illustrations	Gold and other colours unidentified.

[80] *Catalogue des manuscrits de la Bibliothèque de l'Arsenal*, Paris, 1886, p. 289.
[81] Clark 1992: 300-1. http://visualiseur.bnf.fr/CadresFenetre?O=COMP-3&I=190&M=imageseule ; http://mandragore.bnf.fr/Search?q=fr.%2024428
[82] Clark 1992: 311-2. http://archivesetmanuscrits.bnf.fr/ead.html?id=FRBNFEAD000060309
[83] Clark 1992: 301-2. http://visualiseur.bnf.fr/CadresFenetre?O=COMP-2&I=2&M=imageseule
[84] Clark 1992: 302-3. http://mandragore.bnf.fr/ark:/12148/cgfbt162936h
[85] Clark 1992: 303-4. http://visualiseur.bnf.fr/CadresFenetre?O=COMP-1&I=24&M=imageseule
[86] Clark 1992: 312. *Catalogue général des manuscrits latins.* Tome III, 1952, p. 224-5.
[87] Cordonnier 2007: Annexe 1, p.106. *Catalogue général des manuscrits latins.* Tome VI, 1975, p. 412-3.

87	**Paris**, BNF	lat. 12321[88]	Unkonwn	13th c.	Saint-Germain-de-Près (France)	OSB	With places for illustrations left blank.	-
88	**Paris**, BNF ***St. Victor Aviary***[89]	lat. 14429	330x240 (237x165)	1250-1260 (13th c.)	Production: Probably Paris; Provenance: Abbey of St. Victor (France)	OSV	31 illustrations from the Aviary. Independent program: a single bird for the Dove Diagram.	Rose red and blue dominant, green, pink, beige, grey.
89	**Paris**, BNF	lat. 16492[90]	Unknown	13th-14th c.	Sorbonne (France)	-	Unillustrated Aviary.	-
90	**Paris**, BNF	lat. 14512[91]	Unknown	12th c.	Acquired by St-Victor in 1639 (France)	OSV	Unknown	-
91	**Paris**, Mazarine Library	179[92]	321x223	1240 (13th c.)	-	-	Frag. (ff.6v, 25 (?), 74)	-
92	**Paris**, Mazarine Library	740 (1040)[93]	246x171	13th c.	-	-	Unillustrated Aviary.	-
93	**Paris**, Mazarine Library	1029[94]	216x152	13th c.	Abbaye du Notre-Dame du Val (France)	O. Cist.	Unillustrated. Fragments of a bestiarie.	-
94	**Pise**, B. Cateriniana	55-29[95]	237x151	14th c.	Saint Catherine (Egypt)	OFP	Fragments from "*De Bubone*" and "*De gragulo*"	-
95	**Porto**, Biblioteca Pública Municipal do Porto ***St. Cruz Aviary***[96]	SC 34	330x238 (242x169)	Late 12th c.	Production: Coimbra, St Cruz; Provenance: Abbey of Santa Cruz (Portugal)	CRSA	28 illustrations. Prologue miniature and Dove diagram missing.	Blue, red, green, black, yellow, grey.
96	**Prague**, Univerzitni Knihovna	VI. F. 24[97]	Unknown	14th c.	Zlata Korun (Republic Czech)	O. Cist.	Unillustrated Aviary.	-
97	**Prague**, Národní	V A 7[98]	290x210	14th c.	Republic Czech	-	Unillustrated Aviary.	-

[88] Clark 1992: 312. *Inventaire des Manuscrits de Saint-Germain-des-Prés*, Paris, 1868, p. 47.
[89] Clark 1992: 304. http://mandragore.bnf.fr/Search?q=lat.%2014429
[90] Cordonnier 2007: Annexe 1, p. 106.
[91] Cordonnier 2007: Annexe 1, p. 106. *Inventaire des Manuscrits Latins de St. Victor conservés à la Bibliothèque Impèriale sous les numéros 14232-15175*. 1869, p. 20.
[92] Cordonnier 2007: Annexe 1, p. 106. http://www.calames.abes.fr/pub/mazarine.aspx#details?id=MAZA10346
[93] Cordonnier 2007: Annexe 1, p. 106. http://www.calames.abes.fr/pub/mazarine.aspx#details?id=MAZA13246
[94] Cordonnier 2007: Annexe 1, p. 106. http://www.calames.abes.fr/pub/mazarine.aspx#details?id=MAZA14480
[95] Cordonnier 2007: Annexe 1, p. 106. http://www.biblioteca-cateriniana.pisa.it/wp-content/uploads/2011/10/elencomss6.pdf
[96] Nascimento and Meirinhos 1997: 199-203; http://arquivodigital.cm-porto.pt/Conteudos/Conteudos_BPMP/SantaCruz%2034/SantaCruz%2034.htm.
[97] Clark 1992: 313.
http://v2.manuscriptorium.com/apps/main/index.php?request=show_record_num&param=11&client=&ats=1439457613&mode=&testMode=&sf_queryLine=avibus&qs_field=7
[98] Cordonnier 2007: Annexe 1, p. 108.
http://v2.manuscriptorium.com/apps/main/index.php?request=show_record_num&param=12&client=&ats=1439457790&mode=&testMode=&sf_queryLine=avibus&qs_field=7

	knihovna (NK)							
98	**Prague**, NK	VIII D 22 (Y. II. 5. N 65)[99]	293x215	14th c.	-	-	Unknown	-
99	**Reims**, Bibliothèque Municipale	880[100]	294x215	15th c.	Notre-Dame (France)	Secular canons	Unillustrated Aviary.	-
100	**Rome**, Casanatense ***Rome Aviary***[101]	444	318x213 (223x155)	1220-1230 (13th c.)	Production: Paris or north France; Provenance: Probably Abbey of Reims (France)	OSB?	28 illustrations from the Aviary, round framed or frameless. The prol. min. and the dove diag. are missing.	Red, brown, blue, green, black.
101	**Salzburg**, St. Peter SB	a.VIII.9[102]	Unknown	13th c.	-	-	Unillustrated Aviary.	-
102	**San Marino** (Cal.), HL	HM 627[103]	180×110 (145×85)	12th c.	Aulne (France)	OSB	Unillustrated Aviary.	-
103	**Seville**, BC Colombine	7-2-21[104]	Unknown	13th c.	-	-	Three incomplete illustrations of the dove.	Red line drawing.
104	**St. Omer**, Bibliothèque Municipale (BM)	86[105]	Unknown	13th c.	Clairmais (France)	O. Cist.	Unillustrated Aviary.	-
105	**St. Omer**, BM ***Clairmarais Aviary***[106]	94	344x240 (247x162)	1210-1225 (13th c.)	Production: Decorated probably at St. Omer; Provenance: Abbey of Clairmarais (France)	O. Cist.	30 illustrations from the Aviary.	Bright red, pink, orange, beige, blue, green, grey, brown, black, white.
106	**St. Omer**, BM	226[107]	Unknown	13th c.	St. Berlin (France)	OSB	Unillustrated Aviary.	-
107	**St. Petersburg**, BNR	lat. Q.v.I, 131	287x199 (216x127)	1200-1210 (13th c.)	Production: north of France? Douai?	-	26 illustrations from the Aviary (lost prologue miniature, 3 doves, blackbird,	Line drawings in red, blue, green,

[99] Cordonnier 2007: Annexe 1, p. 108. http://www.manuscriptorium.com/apps/index.php?direct=record&pid=RTRTR2-set20100113_73_236846#search
[100] Cordonnier 2007: Annexe 1, p. 108. http://ccfr.bnf.fr/portailccfr/jsp/portal/index.jsp?record=eadcgm:EADI:FRCGMBPF-514546101-01b.xml&action=opac_direct_view&only_main=false&success=/jsp/portal/index.jsp&profile=anonymous
[101] Clark 1992: 306-7.
[102] Cordonnier 2007: Annexe 1, p. 108.
[103] Clark 1992: 313. http://bancroft.berkeley.edu/digitalscriptorium/huntington/HM627.html
[104] Cordonnier 2007: Annexe 1, p. 108.
[105] Cordonnier 2007: Annexe 1, p. 108. http://bibliotheque-numerique.bibliotheque-agglo-stomer.fr/collection/533-initiales-c-et-a-ornees/?n=1
[106] Cordonnier 2007: Annexe 1, p. 108. http://bibliotheque-numerique.bibliotheque-agglo-stomer.fr/collection/652-recueil/
[107] Cordonnier 2007: Annexe 1: p. 108; http://ccfr.bnf.fr/portailccfr/jsp/index_view_direct_anonymous.jsp?record=eadcgm:EADC:D03010488

	Dubrowsky I Aviary[108]				Provenance: Coll. P. P. Dubrowsky.		owl).	with solid blue and green in Cedar and Palm; tarnished silver on Dove.
108	**St. Petersburg**, BNR ***Dubrowsky II Aviary***[109]	lat. Q.v.III, 1	229x161 (172x105)	1240-1250 (13th c.)	Production: Paris, based on style.	-	32 illustrations from the Aviary.	Rose, dark and medium grey-blue, also light brown, grey-green, grey, bright red, beige.
109	**Stuttgart**, WLB	Theol. et philos. 2º 26[110]	Unknown	15th c.	-	-	Unknown	-
110	**Trebon** (Czech), State Archive	A 18[111]		15th c.	Trebon (Republic Czech)	CRSA	Unillustrated Aviary.	-
111	**Troyes**, Bibliothèque Municipale (BM) ***Clairvaux Aviary***[112]	177	342x240 (239x169)	1160-1180	Production: Clairvaux ? Provenance: Abbey of Clairvaux (France)	O. Cist.	30 typical illustrations from the Aviary.	Blue, green, red, yellow, brown.
112	**Troyes**, BM	1761[113]	170x125	13th c.	Clairvaux (France)	O. Cist.	Unillustrated Aviary.	-
113	**Troyes**, BM	1875[114]	Unknown	13th c.	Bouhier (France)	-	Unillustrated Aviary.	-
114	**Valenciennes**, Bibliotèque Municipale ***St. Amand Aviary***[115]	101 (94)	350x230 (240x147)	After 1240 (13th c.)	St. Amand (France) Produced in Paris.	OSB	32 typical Aviary illustrations. Blue and rose backgrounds with rectangular frames.	Blue, rose, green, orange, white, black.
115	**Vatican**, Vatican	Vat. lat.	202x125	13th c.	-	-	Unillustrated Aviary.	-

[108] Clark 1992 : 284-5.
[109] Clark 1992 : 285-6.
[110] Cordonnier 2007: Annexe 1: p. 109.
[111] Cordonnier 2007: Annexe 1: p. 109.
[112] Clark 1992: 308. To consult the entire manuscript, see: https://www.bibliotheque-virtuelle-clairvaux.com/manuscrits/
[113] Clark 1992: 313. To consult the entire manuscript, see: https://www.bibliotheque-virtuelle-clairvaux.com/manuscrits/
[114] Clark 1992: 313. http://ccfr.bnf.fr/portailccfr/jsp/index_view_direct_anonymous.jsp?record=eadcgm:EADC:D02B11835
[115] Clark 1992: 309. http://www.enluminures.culture.fr/public/mistral/enlumine_fr?ACTION=CHERCHER&FIELD_98=REF&VALUE_98=D-080889

	Library	1047[116]						
116	**Vatican**, Vatican Library	Pal. lat. 1064[117]	Unknown	14th-15th c.	Schönau (Germany)	O. Cist.	Unillustrated Aviary.	-
117	**Vatican**, Vatican Library	Reg. lat. 221[118]	Unknown	13th c.	-	-	With places for illustrations left blank.	-
118	**Vatican**, Vatican Library	Ross. 22[119]	Unknown	15th c.	Archdeacon of Cambrai (France)	Secular canons	-	-
119	**Vatican**, Vatican Library	Ross. 378[120]	Unknown	14th c.	-	-	-	-
120	**Vatican**, Vatican Library	Reg. lat. 290[121]	Unknown	14th c.	-	-	With places for illustrations left blank.	-
121	**Vêndome**, BM ***Vêndome Aviary***[122]	156	220x162 (161x115)	First half of the 13th c.	Production: North France; Provenance: Abbey of L'Aumône.	O. Cist.?	3 diagrams: Dove and Hawk diagrams with birds at center; Turtledove diagram without bird.	-
122	**Vorau**, Stiftsbibl.	168(62)[123]	240x180	13th c.	-	O. Cist.	Unillustrated Aviary.	-
123	**Washington** (DC), Georgetown University Library de Ricci	12	Unknwon	-	-	-	Unillustrated Aviary.	-
124	**Wolfenbüttel**, Herzog August Bibliothek	129c[124]	Unknwon	13th c.	-	-	Unillustrated Aviary.	-
125	**Worcester**, Cathedral Chap. Library	Q 56[125]	Unknwon	15th c.	-	-	Unillustrated Aviary.	-
126	**Wroclaw**, BU	I F 281[126]	Unknown	15th c.	Heinrichau (Poland)	O. Cist.	-	-
127	**Wroclaw**, BU	I F 526[127]	Unknown	15th c.	Żagań Abbot	CRSA	-	-

[116] Clark 1992: 313. http://beta.worldcat.org/archivegrid/collection/data/76945403
[117] Clark 1992: 313. http://digi.ub.uni-heidelberg.de/diglit/bav_pal_lat_1064/0001/thumbs?sid=1724fe9664c72f230f9c8bc2d5cf928d#/current_page
[118] Clark 1992 : 312.
[119] Cordonnier 2007: Annexe 1, p. 110.
[120] Cordonnier 2007: Annexe 1, p. 110.
[121] Clark 1992 : 312. http://www.mss.vatlib.it/gui/console?service=shortDetail&id=53690
[122] Clark 1992 : 309-10. http://www.enluminures.culture.fr/public/mistral/enlumine_fr?ACTION=CHERCHER&FIELD_98=REF&VALUE_98=D-019620
[123] Clark 1992 : 312. http://www.vestigia.at/vorauer_katalog/codex_168.html
[124] Cordonnier 2007: Annexe 1, p. 110.
[125] Clark 1992 : 313.
[126] Cordonnier, Annexe 1, p.111. http://www.mirabileweb.it/manuscript/wroclaw-biblioteka-uniwersytecka-i-f-281/100425
[127] Cordonnier, Annexe 1, p.111. http://fama.irht.cnrs.fr/manuscrit/33210

128	**Znojmo**, SOA	304[128]	Unknown	15th c.	Bohemia (Republic Czech)	-	-	-
129	**Zwettl**, Stiftsbibliothek ***Zwettl Aviary***[129]	253	242x172 (202x133)	ca. 1200 (13th c.)	Zwettl (Austria)	O. Cist.	Typical aviary program with 30 illustrations. The text is missing in the dove diagram.	Line drawings in red and brown.

[128] Cordonnier, Annexe 1, p.111.
[129] Clark 1992: 310.

Lorvão 5

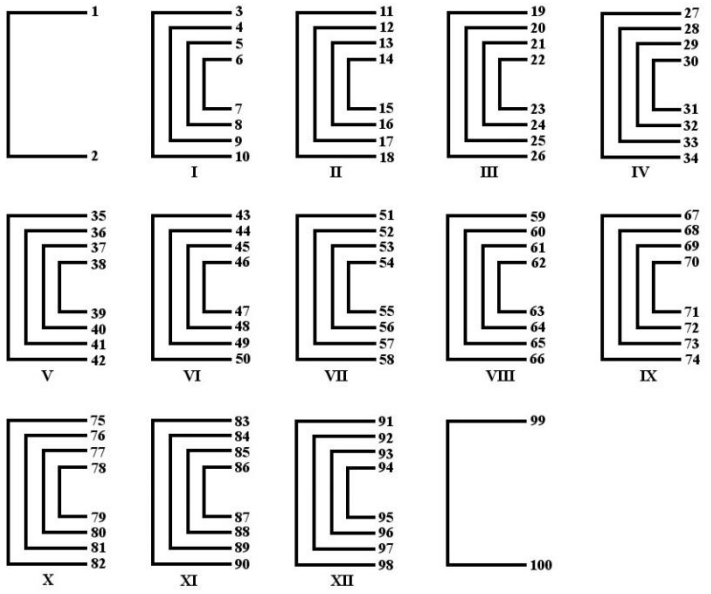


Figure X.1. Collation and foliation scheme from Lorvão 5[1].

Santa Cruz 34

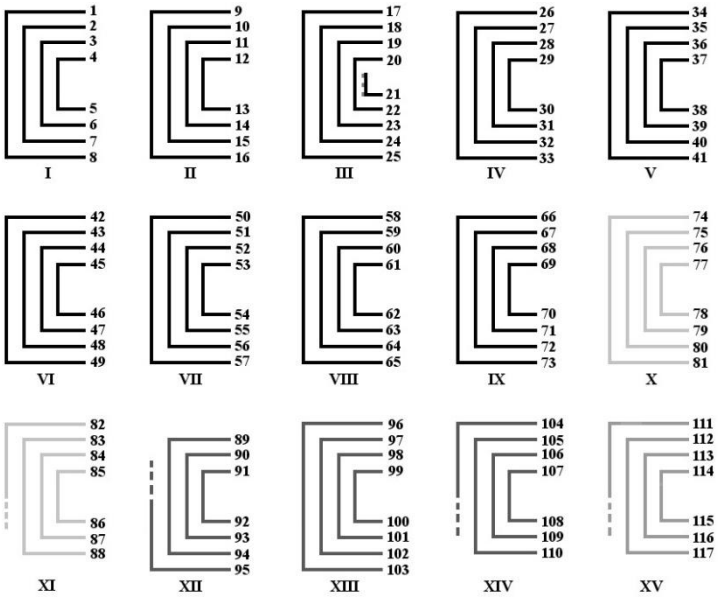


Figure X.2. Collation and foliation scheme from Santa Cruz 34. Folium 21 was glued to the 3rd quird, while the others that appear dashed were cut close to the spine. The black quires are part of the first codicological unity (i-ix), the ligher gray starts another (x-xi), the darker gray is part of the *De Avibus* unit (xii-xiv) and the gray is another separate unit (xv) included in the compilation.

[1] Information obtained by Inês Correia.

Alcobaça 238

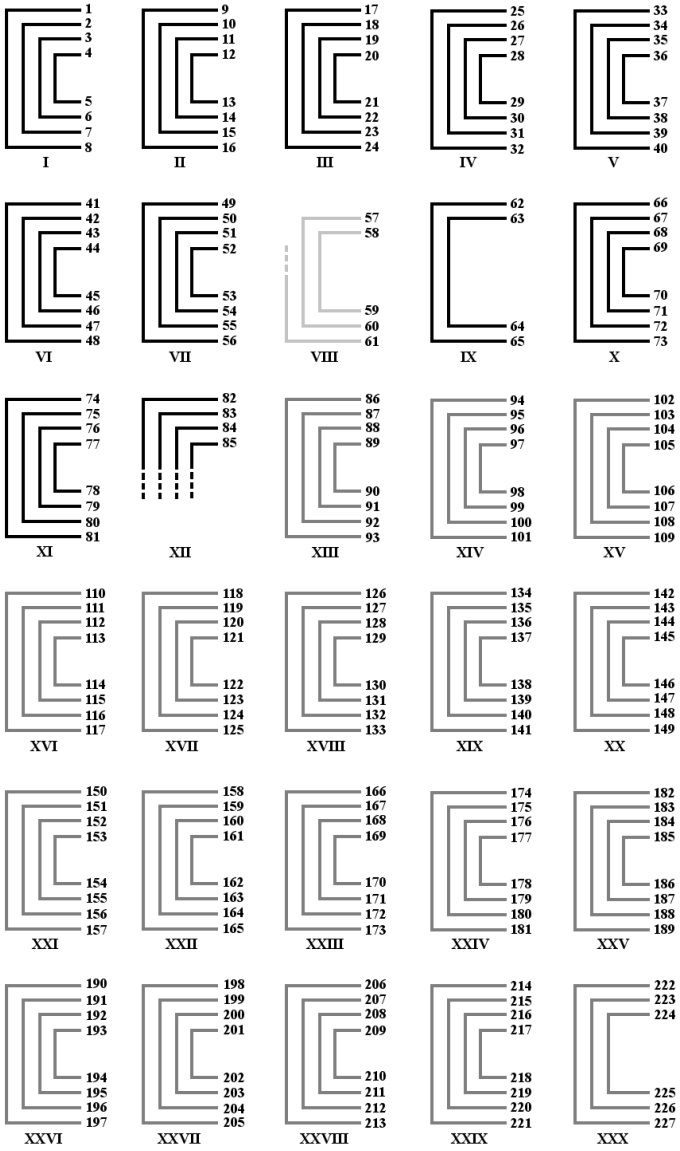


Figure X.3. Collation and foliation scheme from ALC 238. There are also two endleaves at the beginning and end of the textblock made of manual paper and a loose leaf at the start with the description of the works in the manuscript, written in 18th century handwritting. The black quires are part of the first codicological unity, the light gray is part of an additional quire and the darker gray is part of the second main unity that gathers the work by Hugh of Fouilloy.

Table X.1. Comparison between the different texts in each Portuguese *De Avibus* copy as well as in the Clairvaux manuscript. In light gray, the *De avibus* text; in darker gray, the other texts that are common between Alcobaça and Clairvaux.

Lorvão	Santa Cruz	Alcobaça	Clairvaux
De Avibus by Hugh of Fouilloy (ff. 4r-64r)	*Dialogum contra Iudeos* by Petrus Alphonsus (f. 1r 1st column – f. 73r 2nd column)	*Enchiridion ad Laurentium de fide et spe et caritate* by St. Augustine (f. 4r 2nd column – f. 34 1st column)	*De claustro animae* by Hugh of Fouilloy (f. 1r 1st column – f. 111r 2nd column)
Hexameron by St. Ambrose (ff. 15v-15r and ff. 17v-18r)	*Disputatio judaei cum christiano* by Gilbert Crispin from Westminster (f. 73v 1st column – f. 88v 1st column)	*De Continentia* by St. Augustine (f. 34r 1st column – f. 45r 2nd column)	*De medicina animae* by Hugh of Fouilloy (f. 111r 2nd column – f. 124r 2nd column)
excerpts from a bestiary (ff. 69v-73r)	*De Avibus* by Hugh of Fouilloy (f. 89r 1st column – f. 110v 2nd column)	*De definitionibus ecclesiasticorum dogmatum* by Pseudo-Gennadius Massiliensis (f. 45v 2nd column – f. 51r 1st column	*De nuptiis* by Hugh of Fouilloy (f. 124r 2nd column – 134v 2nd column)
De creatione hominis by St. Isidore (ff. 73v-94v)	*Vita Sancti Brendani* (f. 111r 1st column – f. 117r 2nd column)	*Collectum Sancti Isidori de novae vitae institutione* (f. 51r 1st column – f. 53r 2nd column)	*De Avibus* by Hugh of Fouilloy (f. 135r 1st column – f. 160v 1st column)
		De conflictu vitiorum et virtutum by Ambrosius Autpertus (f. 53r 2nd column – 61v)	*De templo salomonis ad litteram* by Richard of St. Victor (f. 160v 1st column – f. 171v 2nd column)
		Sententiae Sancti Augustini (f. 56v 2nd column; f. 61v 1st column – f. 64v 2nd column)	*De concordia temporum conregnantium in Juda* by Richard of St. Victor (f. 171v 2nd column – f. 175v 1st column).
		De potestate ligandi atque solvendi by Richard of St. Victor (f. 64v 2nd column – f. 74v 2nd column)	*De potestate ligandi atque solvendi* by Richard of St. Victor (f. 175v 1st column – f. 186v 1st column)
		De triplici vicio mutabilitatis et constancia mentis by Richard of St. Victor (f. 74v 2nd column – f. 85r 1st column)	*De triplici vicio mutabilitatis et inconstantia mentis* by Richard of St. Victor (f. 186v 1st column – f. 197v 1st column)
		De claustro animae by Hugh of Fouilloy (f. 86r 1st column – f. 182r 2nd column)	*Super exiit edictum* by Richard of St. Victor (f. 197v 2nd column – f. 201 1st column)
		De medicina animae by Hugh of Fouilloy (f. 182r 2nd column – f. 193r 2nd column)	*De tribus processionibus celebrioribus* by Richard of St. Victor (f. 201 1st column – f. 210 1st column)
		De nuptiis libri duo by Hugh of Fouilloy (f. 193r 2nd column – f. 202v 2nd column)	*De duocim abusivis* saeculi by Pseudo–Cyprian (f. 210 2nd column – f. 216v 2nd column)
		De Avibus by Hugh of Fouilloy (f. 202v 2nd column – f. 227r 2nd column).	*Liber de sacramentis* (f. 216v 2nd column – f. 223 2nd column)

APPENDIX XI. Iconographic Program from the three Portuguese *De Avibus*

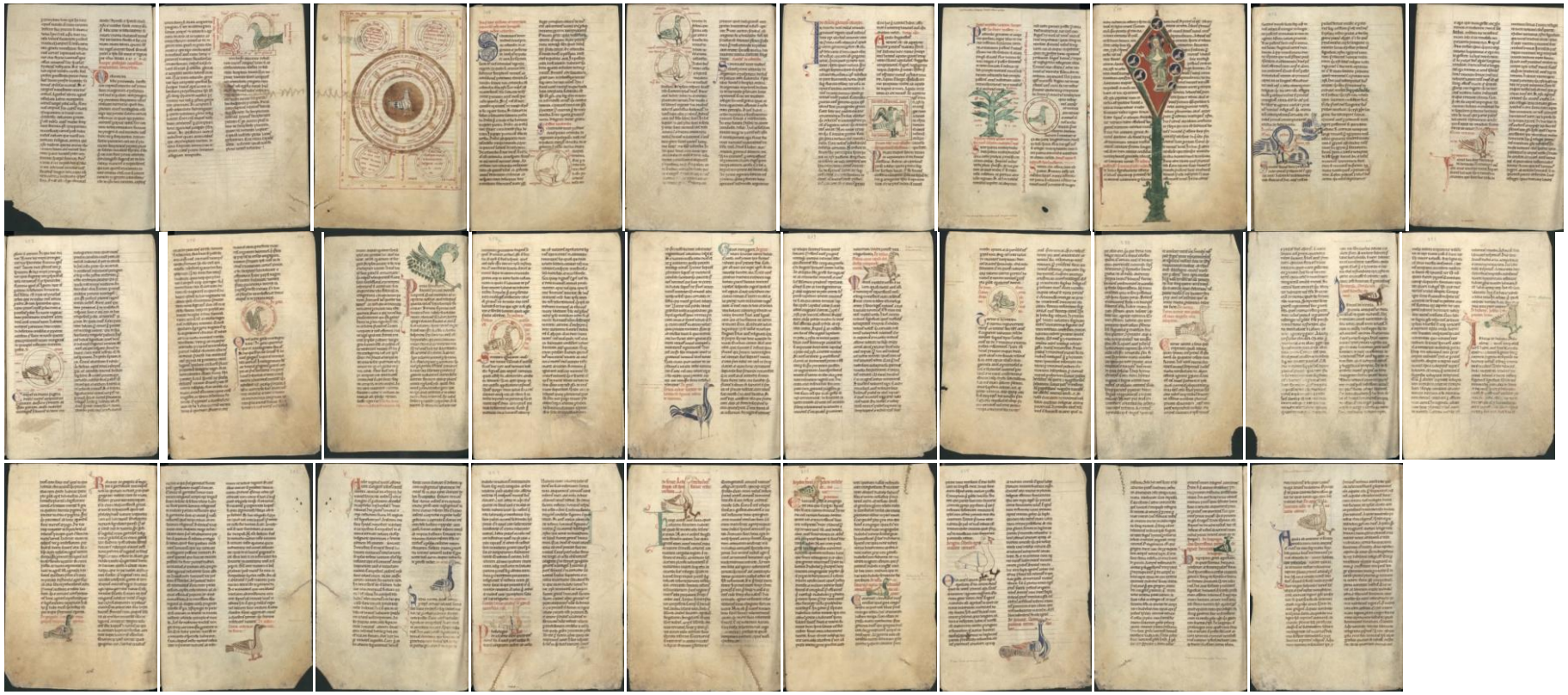


Figure XI.1. Iconographic program from the Alcobaça *De Avibus* (ALC 238, ff. 202v, 203, 203v, 204, 204v, 206v, 208v, 210, 212, 212v, 213, 214, 215v, 218, 218v, 219, 219v, 220, 220v, 221, 221v, 222, 222v, 223, 223v, 224, 224v, 225, 226v ©BNP).

Figure XI.2. Iconographic program from the Lorvão *De Avibus* (Lv 5, ff. 4, 5, 5v, 6, 6v, 7v, 8, 16, 20v, 21v, 25, 30v, 32, 33, 36v, 40, 46v, 48, 49v, 50v, 52v, 54, 56v, 58v, 59v, 60v, 61, 62v, 63v, 64v, 65v, 66v and 69 ©ANTT).

Figure XI.3. Iconographic program from the Santa Cruz *De Avibus* (SC 34, ff. 89, 89v, 92, 93, 93v, 94v, 96v, 97, 98, 99v, 101v, 102, 102v, 103, 104, 104v, 105, 106, 106v, 107, 107v, 108, 108v and 109v ©BPMP).

APPENDIX XII. Areas of analysis in the Portuguese *De Avibus*

The black dots (●), black squares (□), red dots (●) and red squares (□) represent the areas where µ-EDXRF, µ-Raman, Mid-FTIR and FORS were performed *in situ*, while the red circles (○) correspond to the areas where a microsample was taken for additional analytical techniques, such as µ-FTIR.

Lorvão 5 – *De Avibus* (1184), ANTT

Figure XII.1. Analysed areas in Lorvão 5, f. 4.

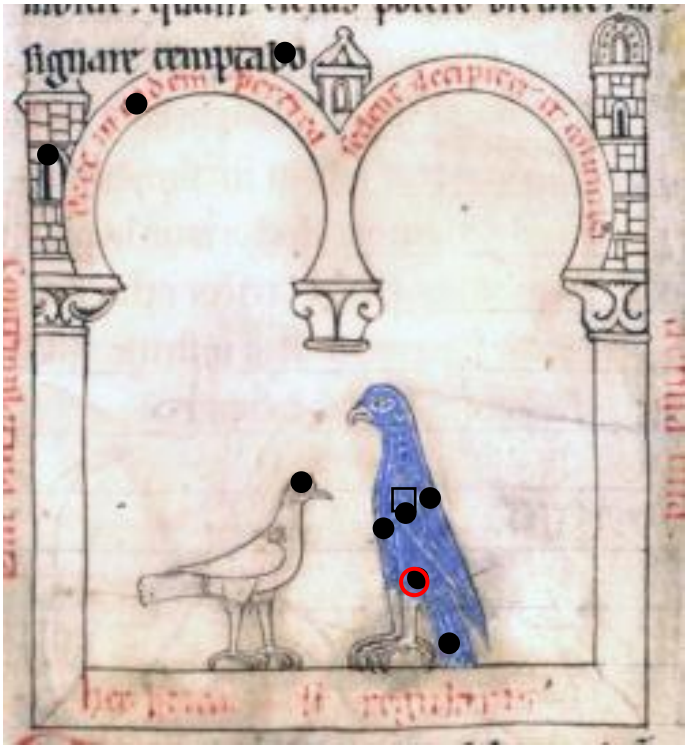


Figure XII.2. Analysed areas in Lorvão 5, f. 5.

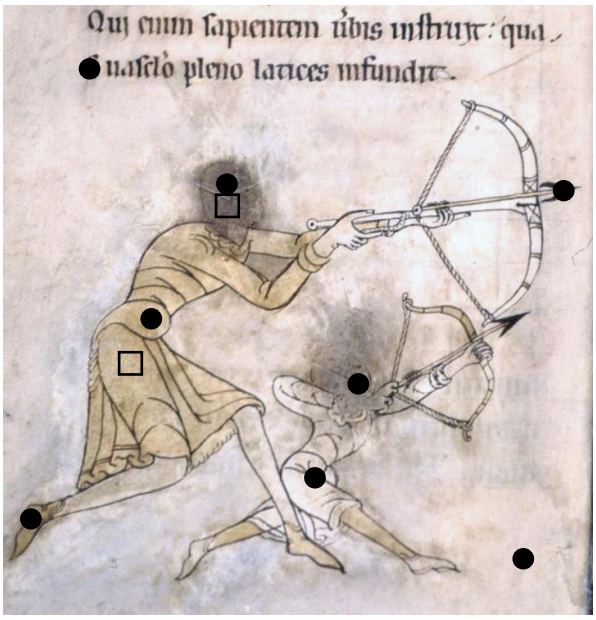


Figure XII.3. Analysed areas in Lorvão 5, f. 5v.

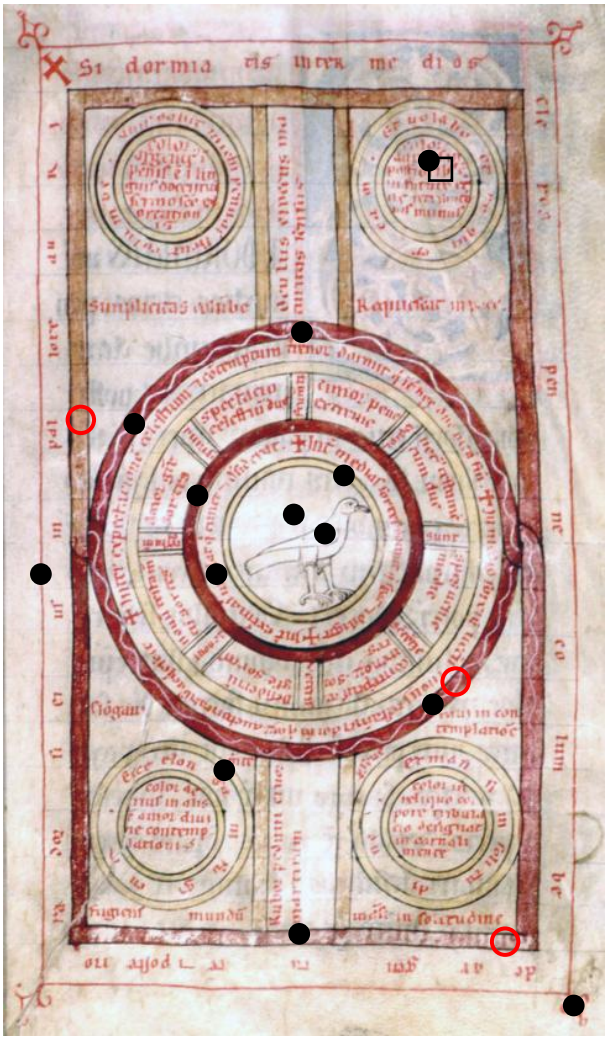


Figure XII.4. Analysed areas in Lorvão 5, f. 6.

Figure XII.5. Analysed areas in Lorvão 5, f. 6v.

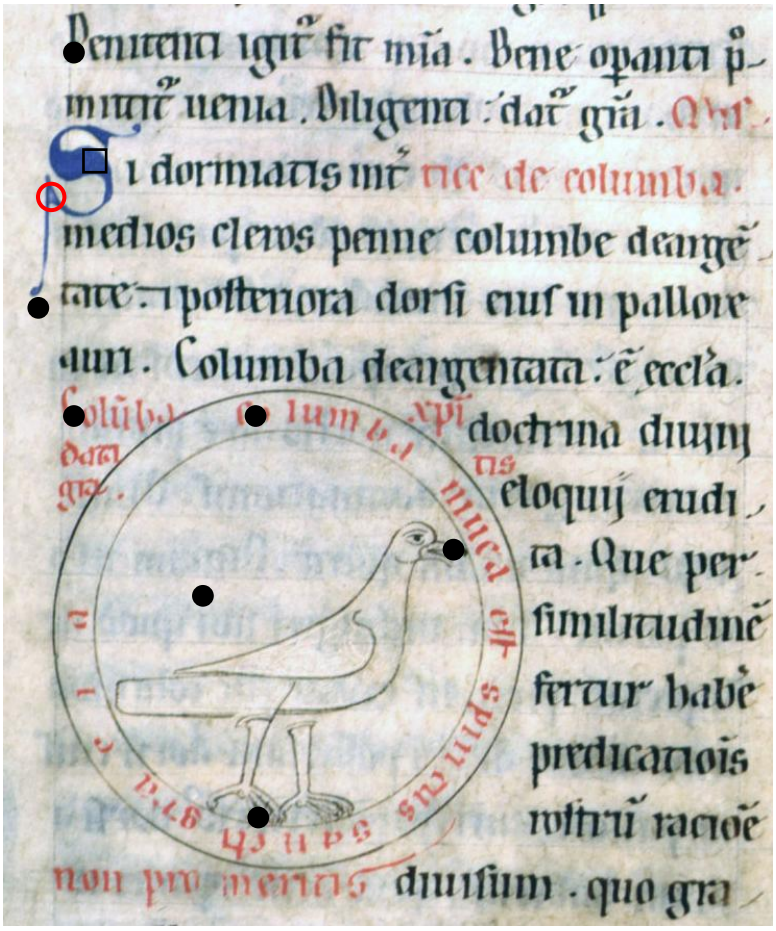


Figure XII.6. Analysed areas in Lorvão 5, f. 7v.

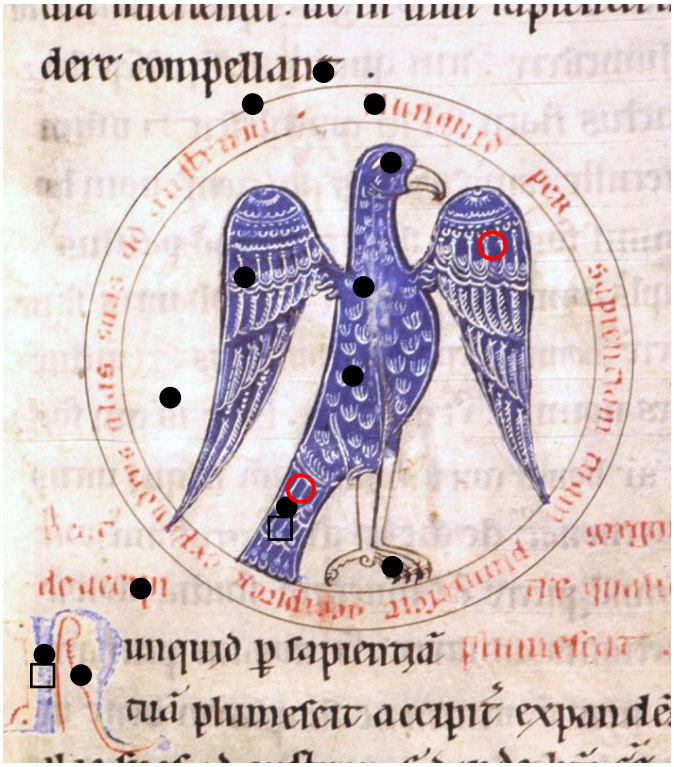


Figure XII.7. Analysed areas in Lorvão 5, f. 16.

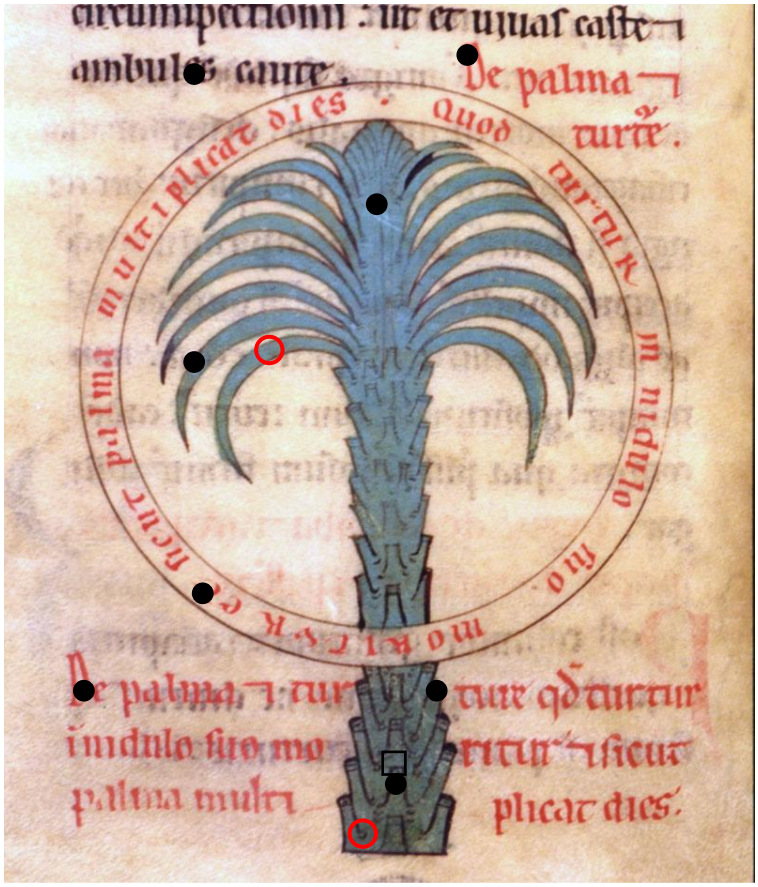


Figure XII.8. Analysed areas in Lorvão 5, f. 20v.

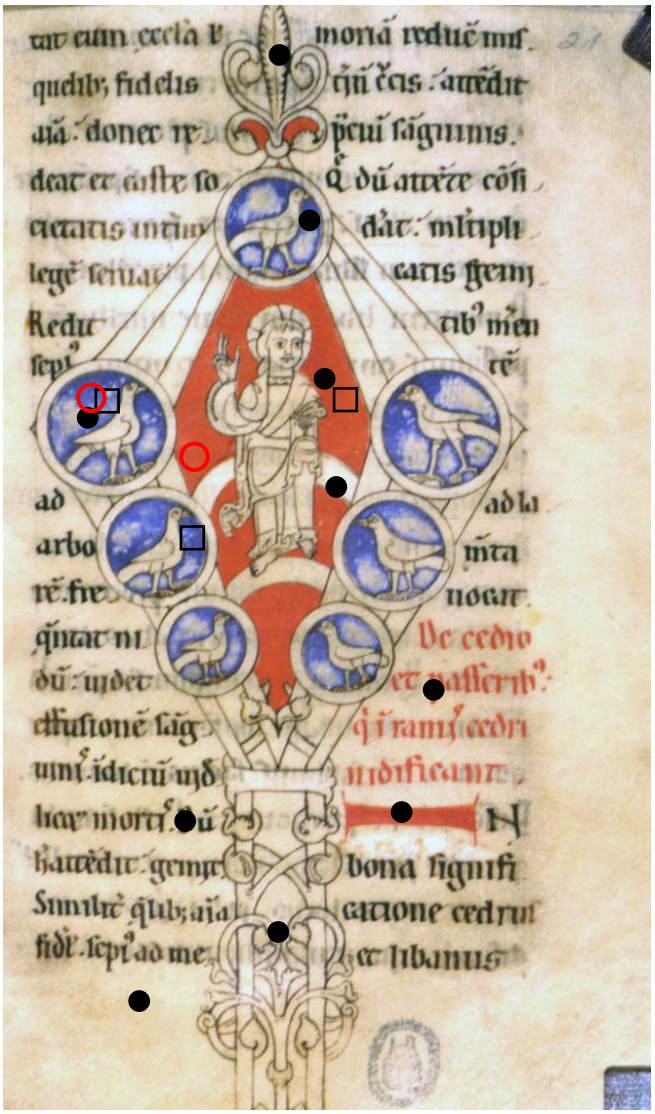


Figure XII.9. Analysed areas in Lorvão 5, f. 25.

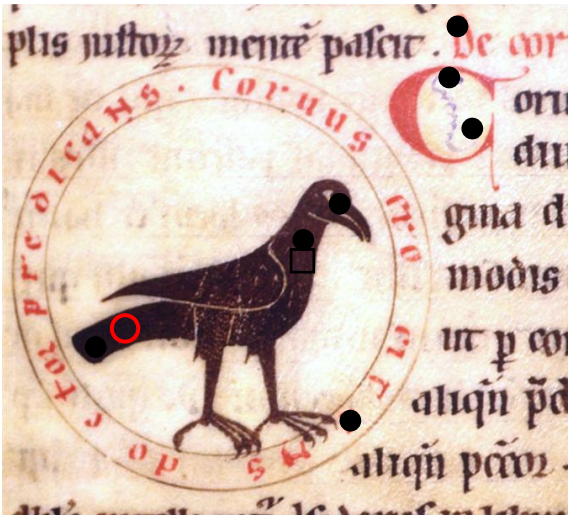


Figure XII.10. Analysed areas in Lorvão 5, f. 33.

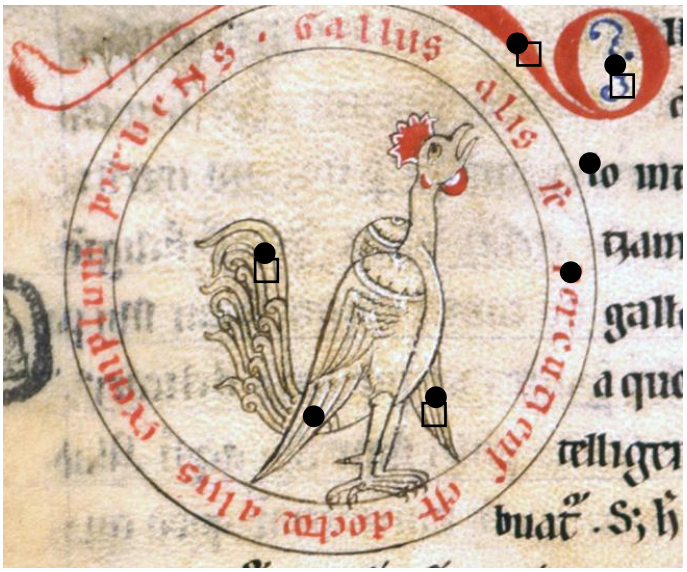


Figure XII.11. Analysed areas in Lorvão 5, f. 36v.

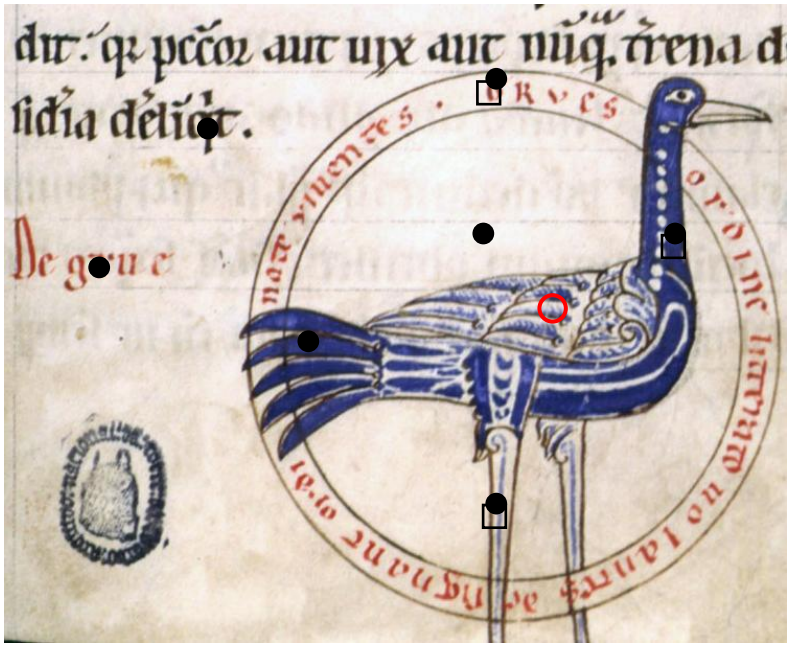


Figure XII.12. Analysed areas in Lorvão 5, f. 48.

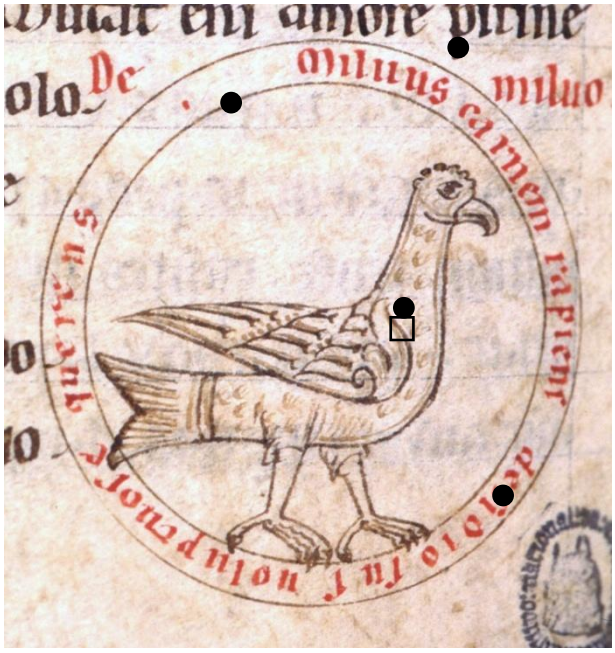
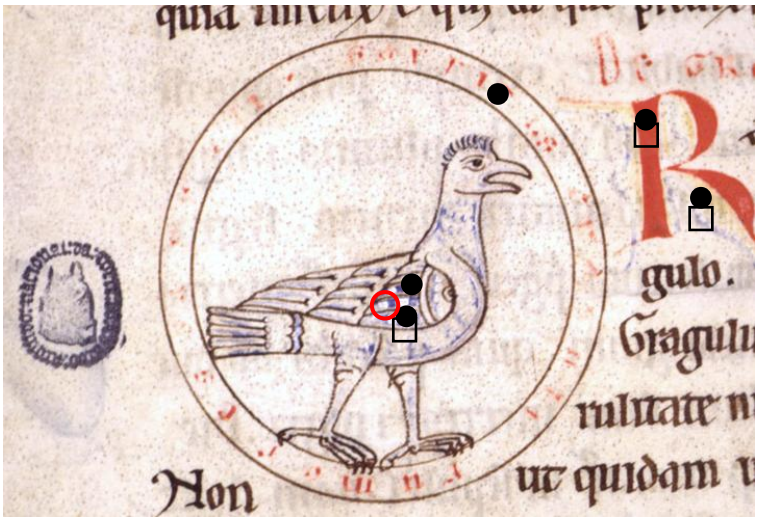


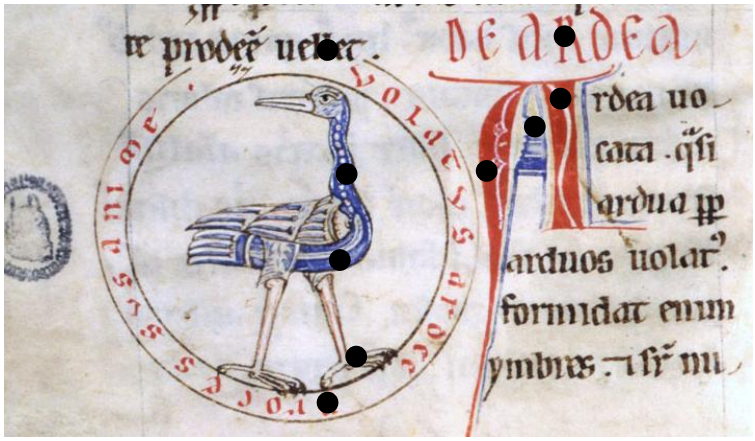
Figure XII.13. Analysed areas in Lorvão 5, f. 49v.

Figure XII.14. Analysed areas in Lorvão 5, f. 50v.

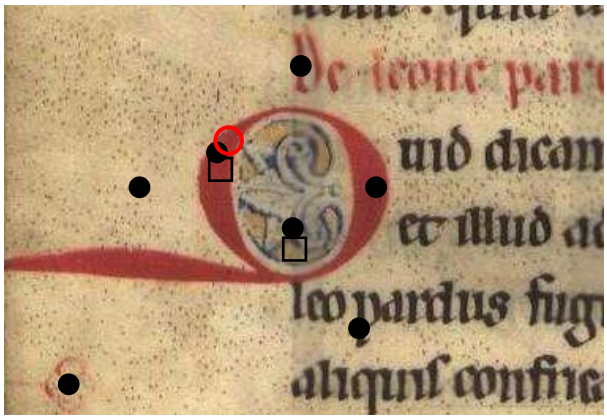
XII.15. Analysed areas in Lorvão 5, f. 54.



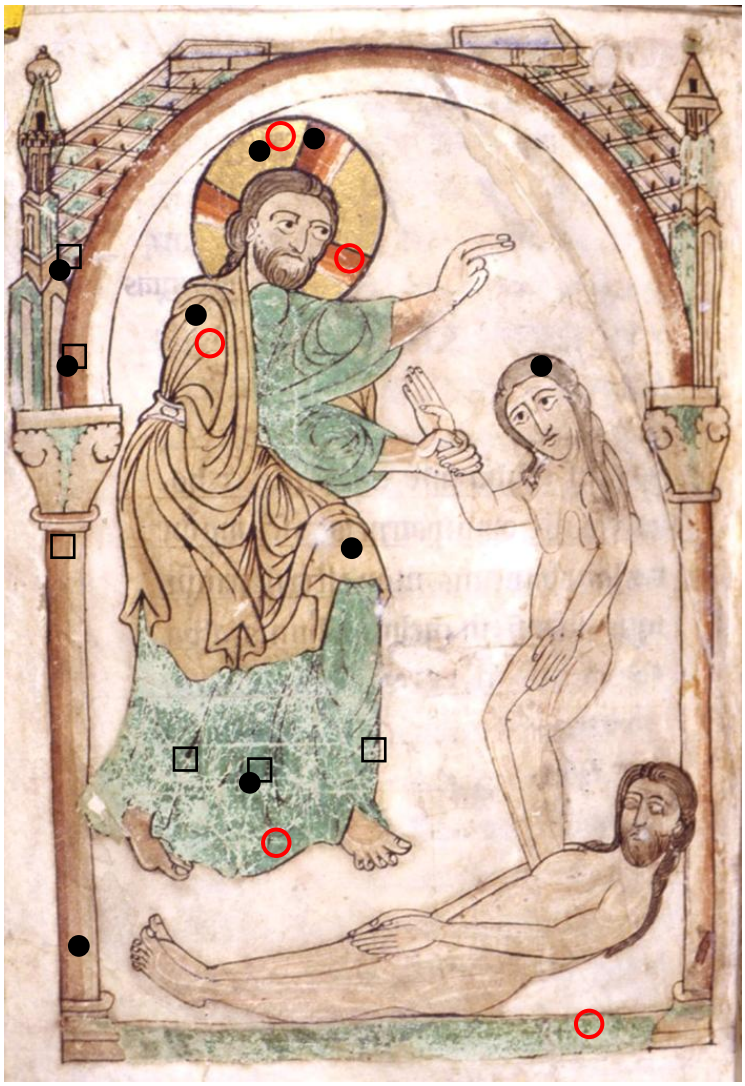
XII.16. Analysed areas in Lorvão 5, f. 56v.



XII.16. Analysed areas in Lorvão 5, f. 59v.



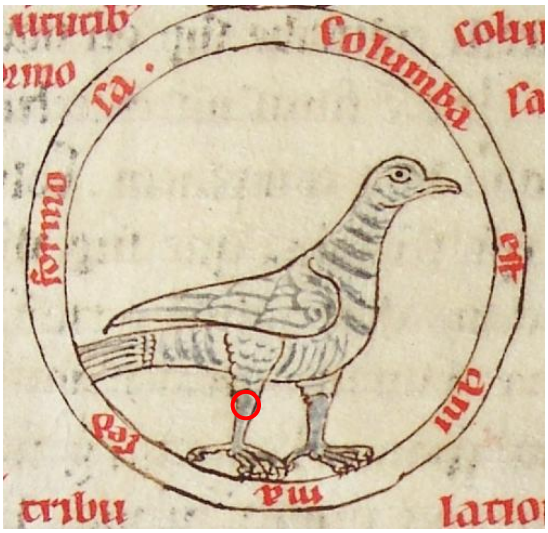
XII.17. Analysed areas in Lorvão 5, f. 72v.



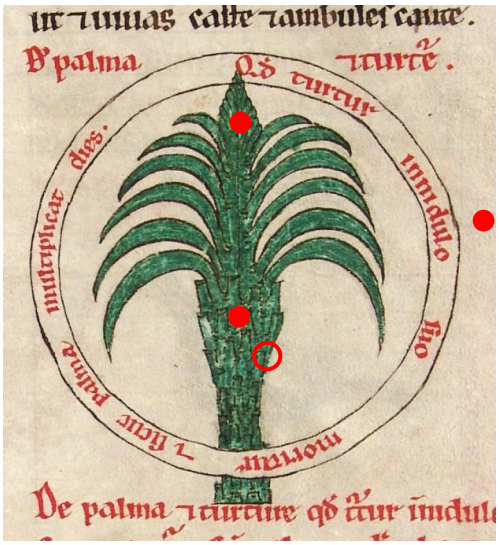
XII.18. Analysed areas in Lorvão 5, f. 95v.

Santa Cruz 34 – *De Avibus* (12th c.), BPMP

XII.19. Analysed areas in Santa Cruz 34, f. 89.

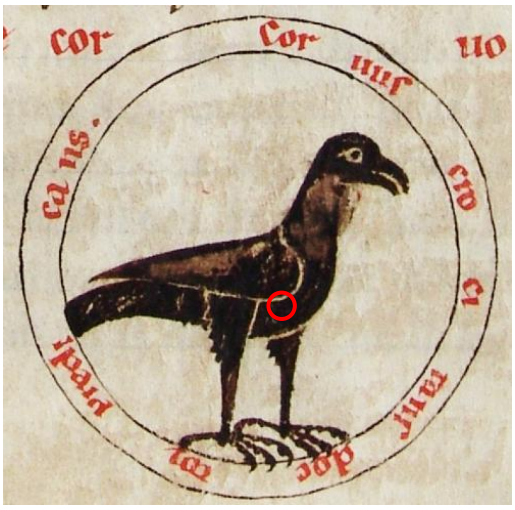


XII.20. Analysed areas in Santa Cruz 34, f. 89v.

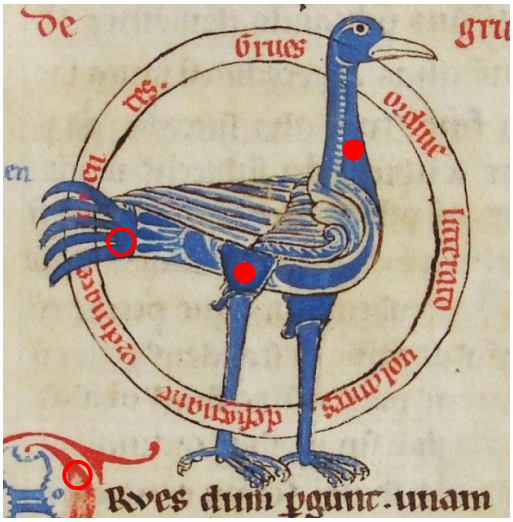


XII.21. Analysed areas in Santa Cruz 34, f. 93.

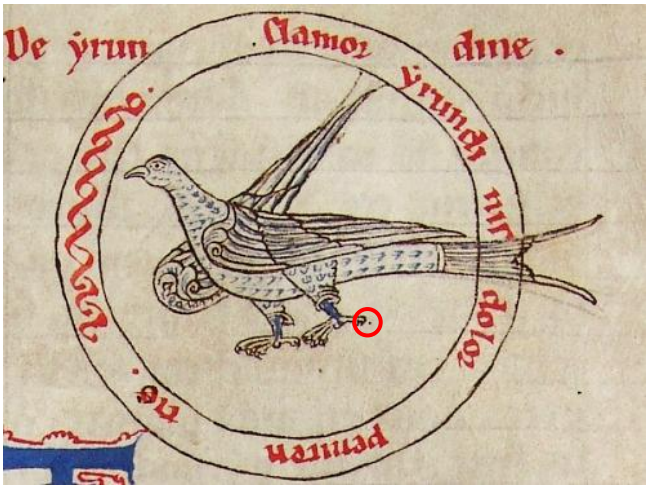
XII.22. Analysed areas in Santa Cruz 34, f. 94v.



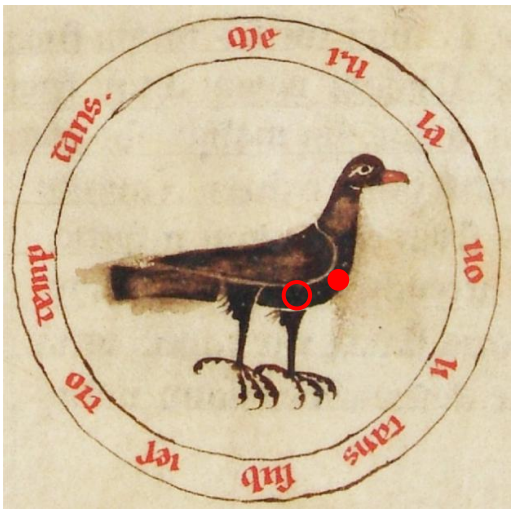
XII.23. Analysed areas in Santa Cruz 34, f. 97.



XII.24. Analysed areas in Santa Cruz 34, f. 102.

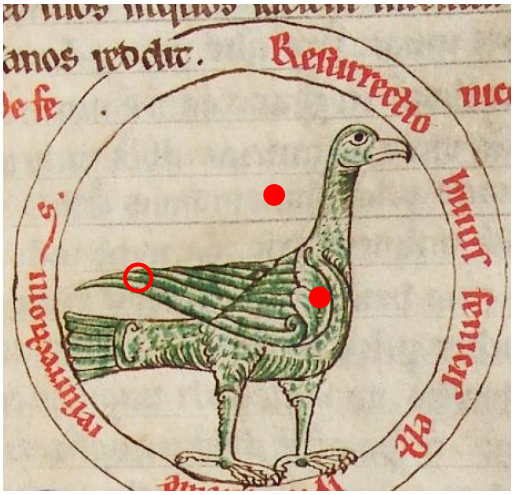


XII.25. Analysed areas in Santa Cruz 34, f. 103.



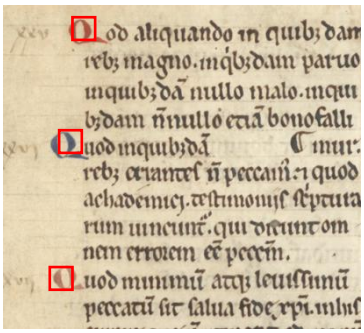
XII.26. Analysed areas in Santa Cruz 34, f. 104.

XII.27. Three areas where analysed by mid-FTIR in Santa Cruz 34, f. 104v, but the location is unknown.

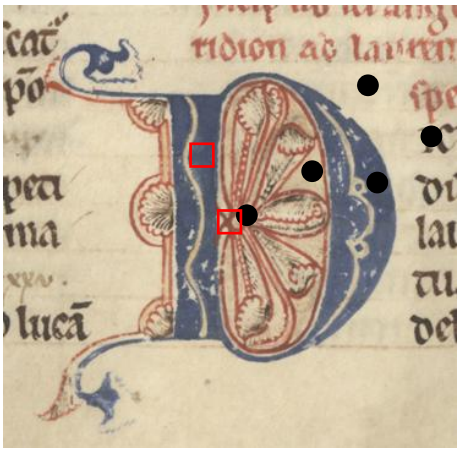


XII.28. Analysed areas in Santa Cruz 34, f. 107.

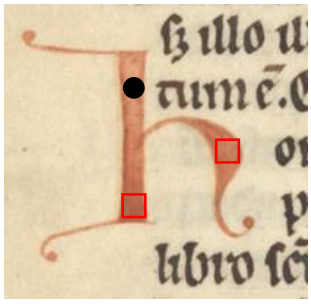
Alcobaça 238 – *De Avibus* (12th c.), BNP



XII.29. Analysed areas in Alcobaça 238, f. 1v.

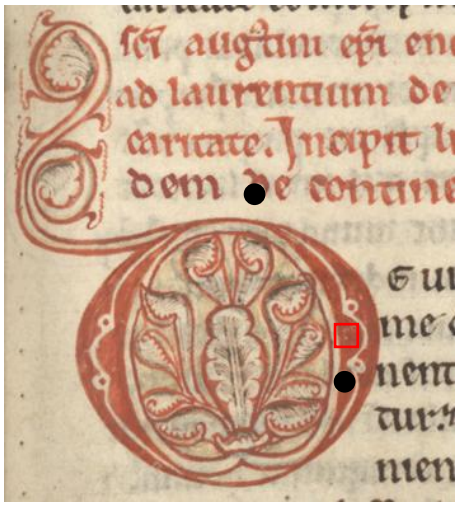


XII.30. Analysed areas in Alcobaça 238, f. 4.



XII.31. Analysed areas in Alcobaça 238, f. 4v.

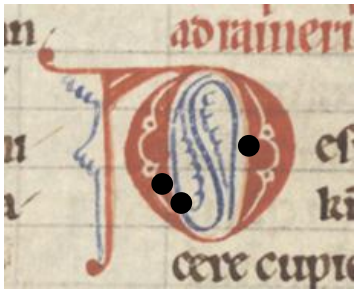
XII.32. Analysed areas in Alcobaça 238, f. 33v.



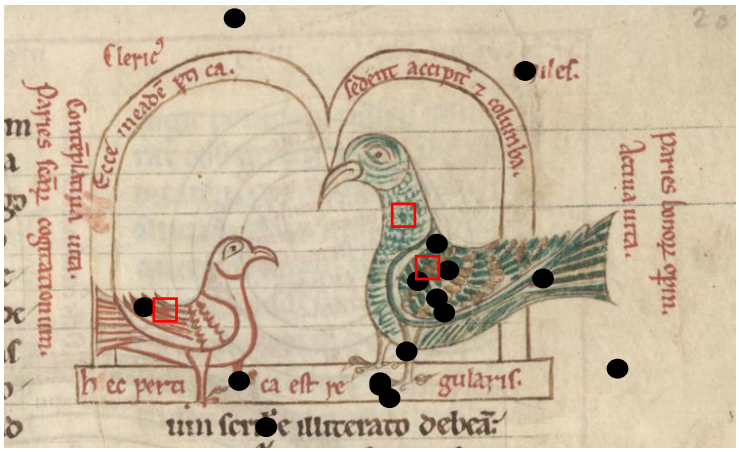
XII.33. Analysed areas in Alcobaça 238, f. 34.

XII.34. Analysed areas in Alcobaça 238, f. 54.

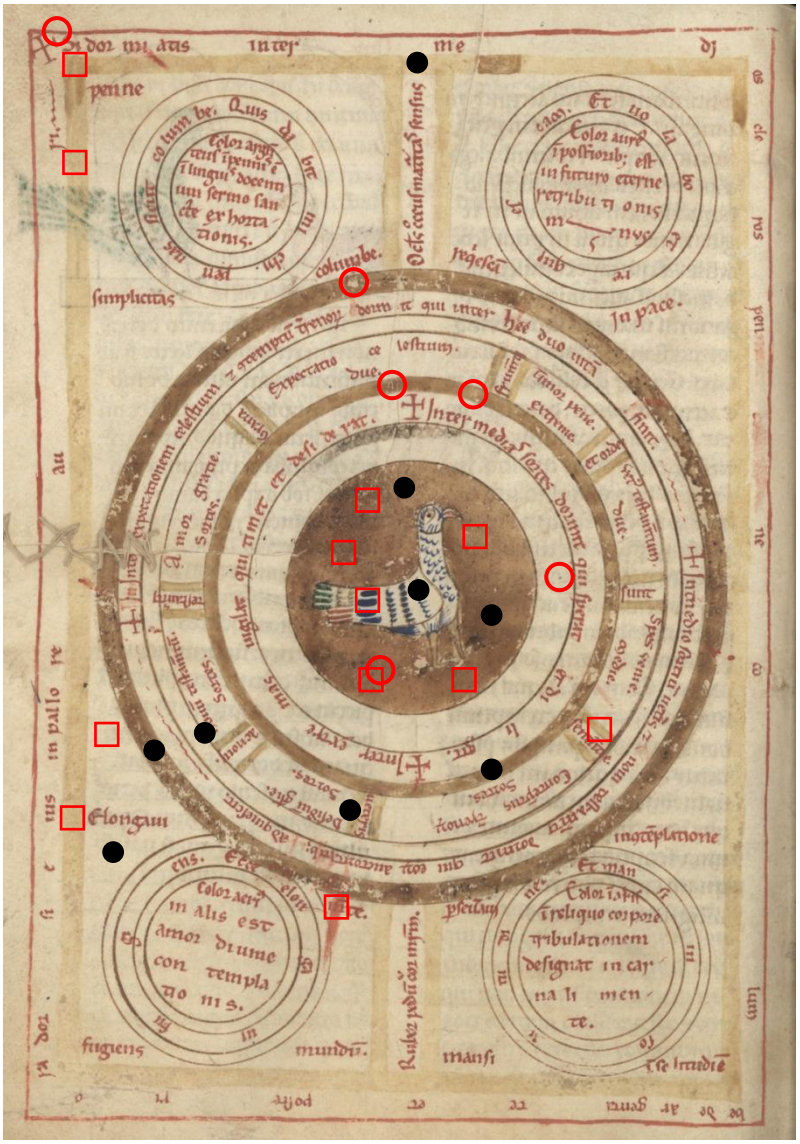
XII.35. Analysed areas in Alcobaça 238, f. 76.



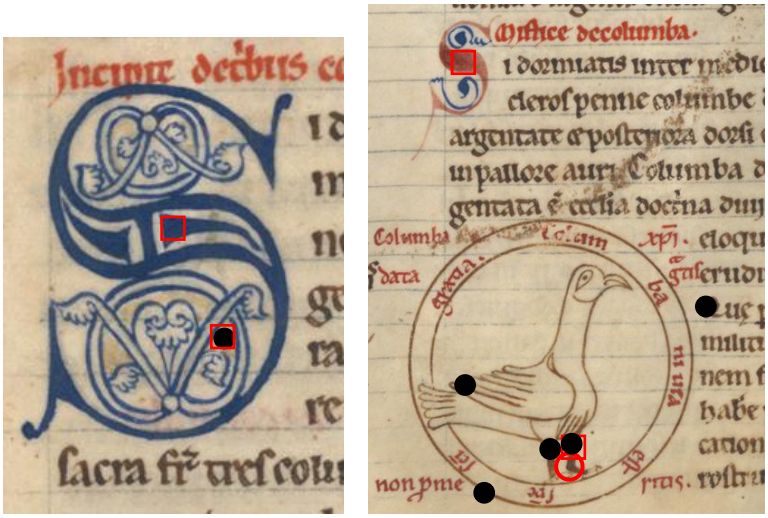
XII.36. Analysed areas in Alcobaça 238, f. 202v.



XII.37. Analysed areas in Alcobaça 238, f. 203.

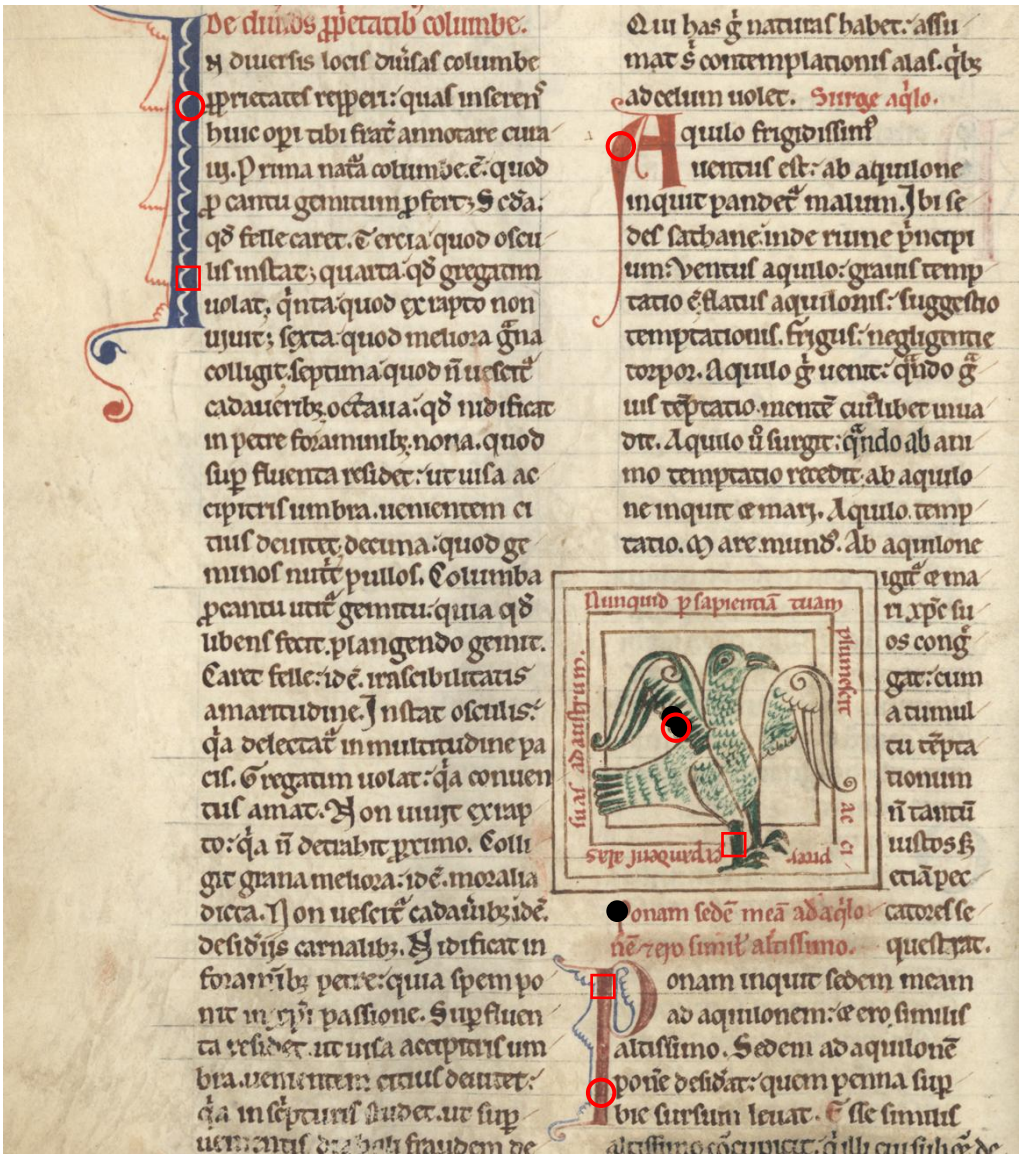


XII.38. Analysed areas in Alcobaça 238, f. 203v.

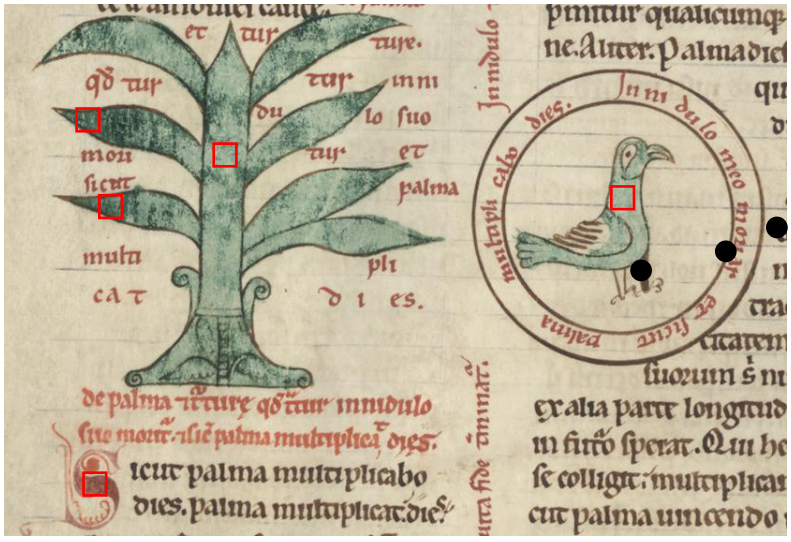


XII.39. Analysed areas in Alcobaça 238, f. 204.

XII.40. Analysed areas in Alcobaça 238, f. 204v.

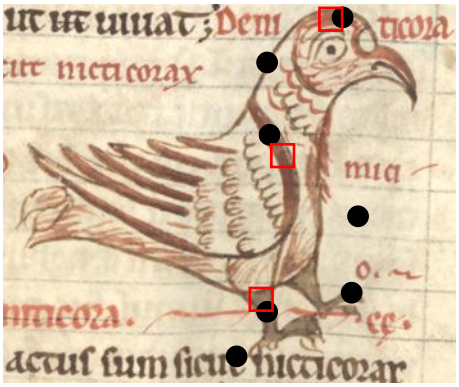


XII.41. Analysed areas in Alcobaça 238, f. 206v.

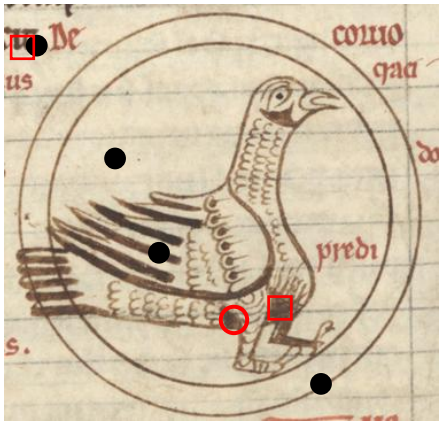


XII.42. Analysed areas in Alcobaça 238, f. 208v.

XII.43. Analysed areas in Alcobaça 238, f. 210.

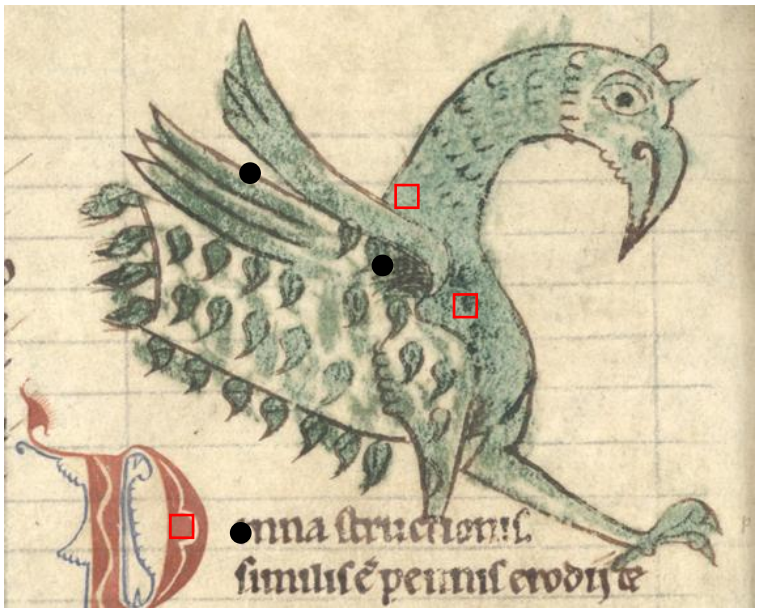


XII.44. Analysed areas in Alcobaça 238, f. 212v.



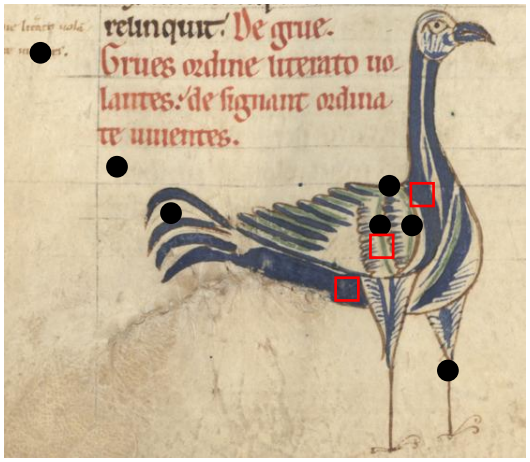
XII.45. Analysed areas in Alcobaça 238, f. 213.

XII.46. Analysed areas in Alcobaça 238, f. 214.

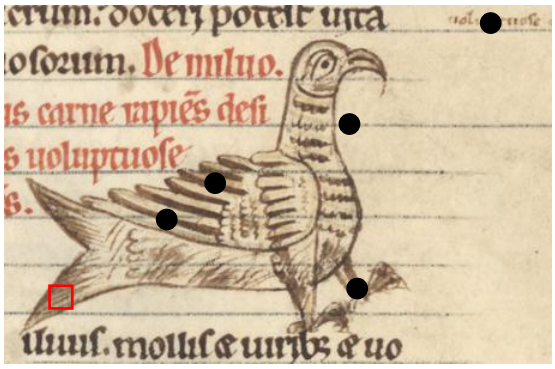


XII.47. Analysed areas in Alcobaça 238, f. 215v.

XII.48. Analysed areas in Alcobaça 238, f. 218.



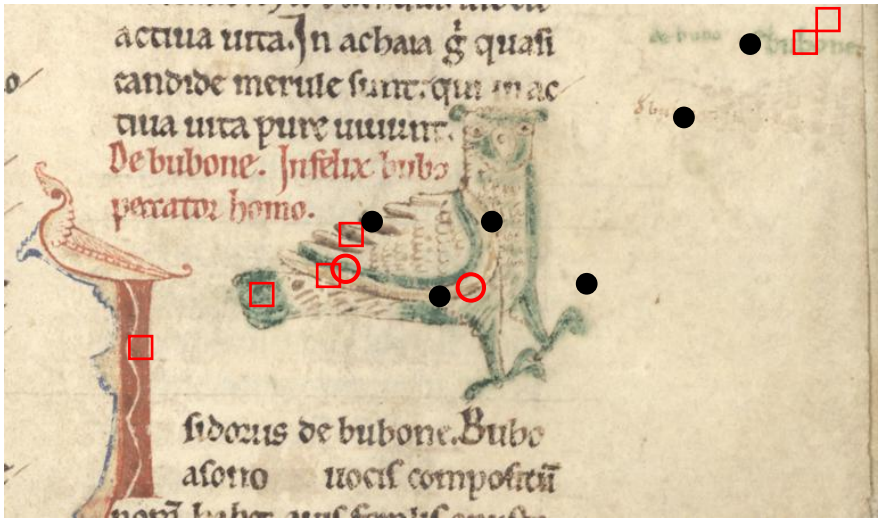
XII.49. Analysed areas in Alcobaça 238, f. 218v.



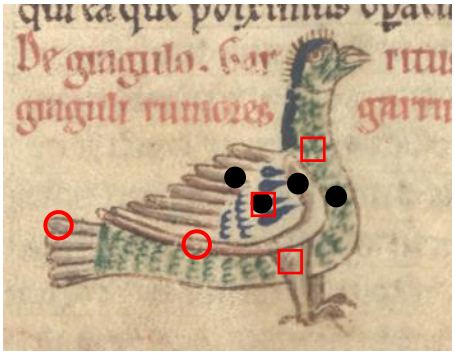
XII.50. Analysed areas in Alcobaça 238, f. 219.

XII.51. Analysed areas in Alcobaça 238, f. 219v.

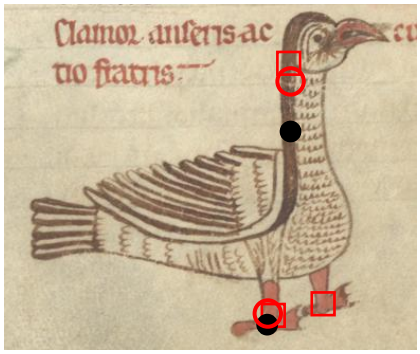
XII.52. Analysed areas in Alcobaça 238, f. 220v.



XII.53. Analysed areas in Alcobaça 238, f. 221.

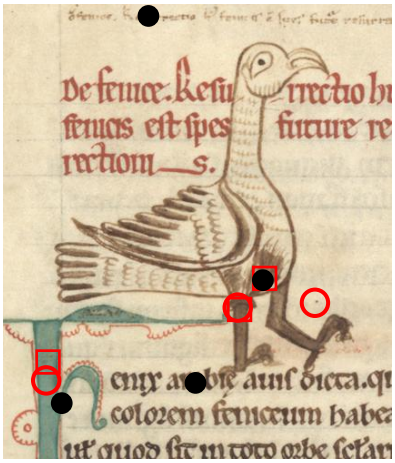


XII.54. Analysed areas in Alcobaça 238, f. 221v.



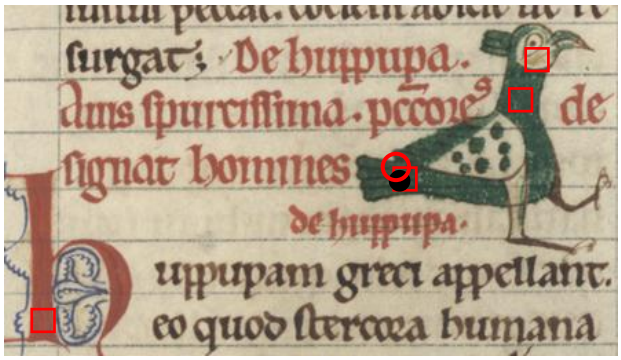
XII.55. Analysed areas in Alcobaça 238, f. 222.

XII.56. Analysed areas in Alcobaça 238, f. 223.



XII.57. Analysed areas in Alcobaça 238, f. 223v.

XII.58. Analysed areas in Alcobaça 238, f. 224.



XII.59. Analysed areas in Alcobaça 238, f. 224v.

XII.60. Analysed areas in Alcobaça 238, f. 225.

XII.61. Analysed areas in Alcobaça 238, f. 226v.

XIII.1. Santa Cruz 34

XIII.1.1. Raman

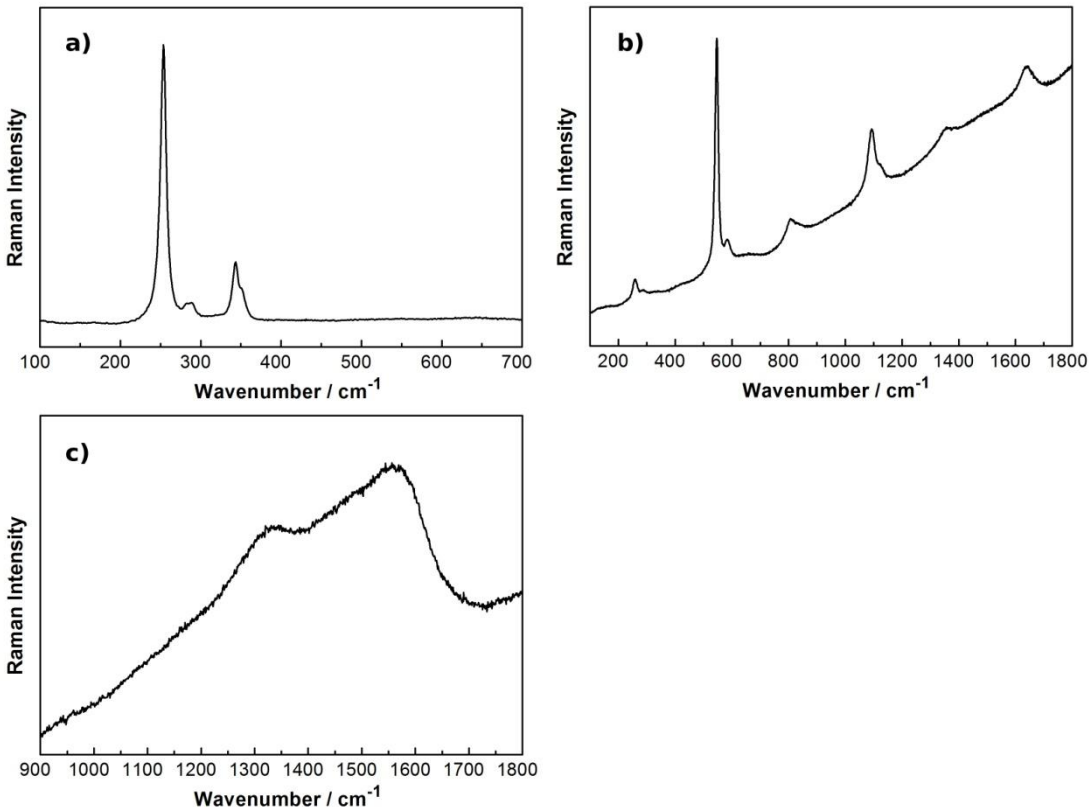
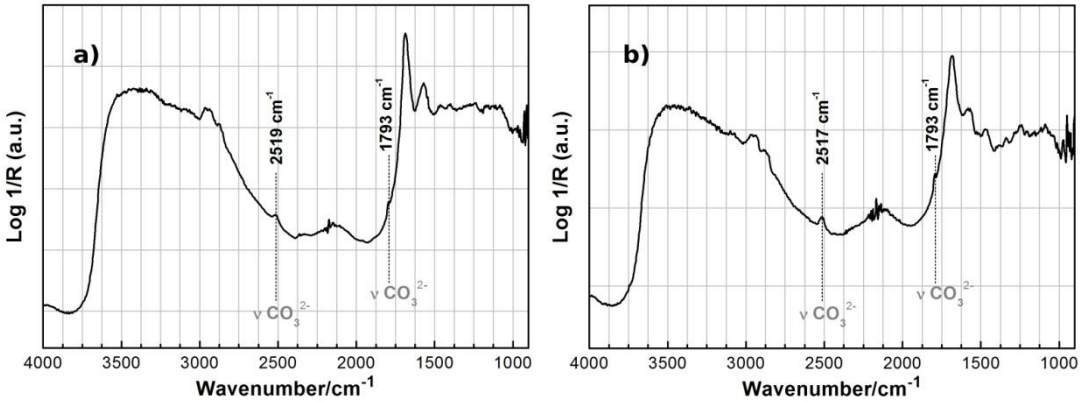


Figure XIII.1.1. Representative Raman spectra from Santa Cruz 34: **a)** red f. 94v; **b)** blue f. 89v; **c)** black f. 103;

XIII.1.2. Mid-FTIR

The assignments of the proteins (parchment and/or binder): amides I, II and III (1680, 1580, 1460 cm^{-1}) and combination band δ(N-H)+ν(N-H) (3080 cm^{-1}).



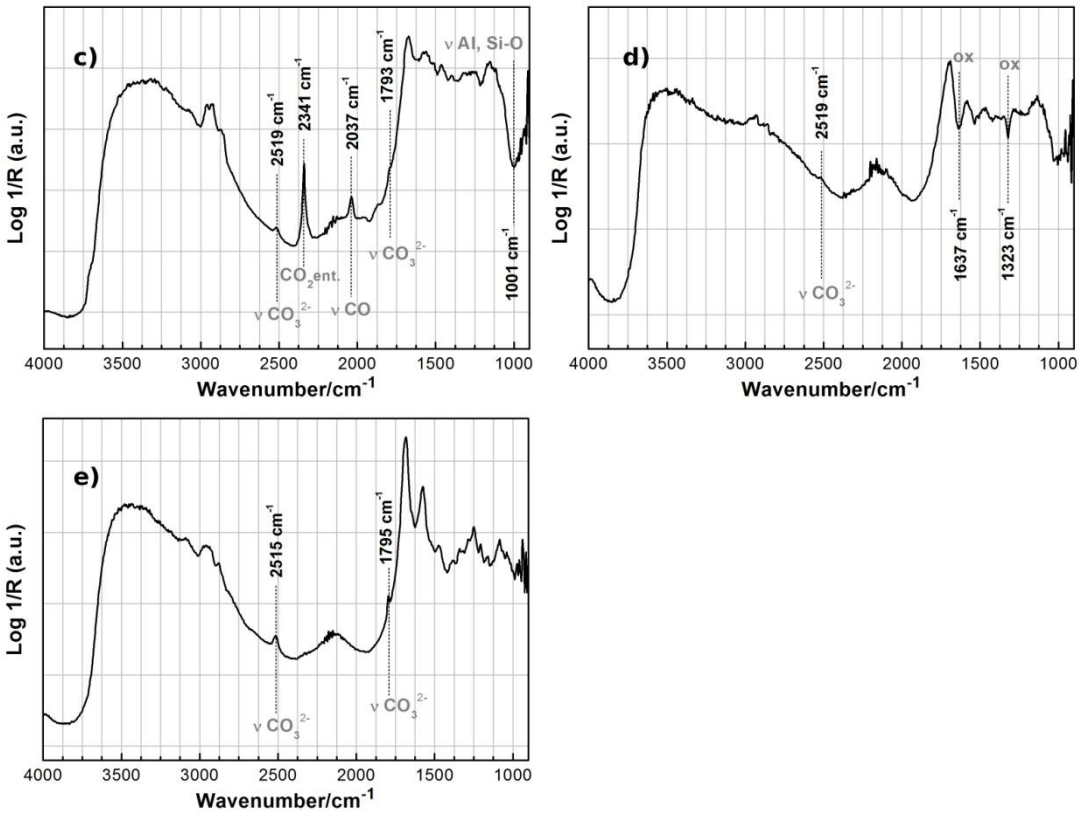
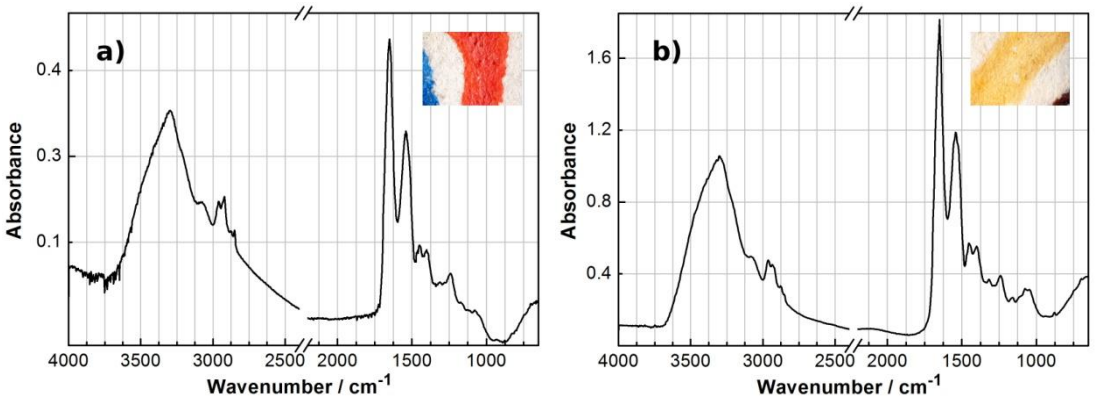


Figure XIII.1.2. Representative Mid-FTIR reflectance spectra from Santa Cruz 34: **a)** red f. 94v; **b)** green f. 107; **c)** blue f. 94v; **d)** black f. 104 (●); **e)** parchment, f. 107.

XIII.1.3. FTIR



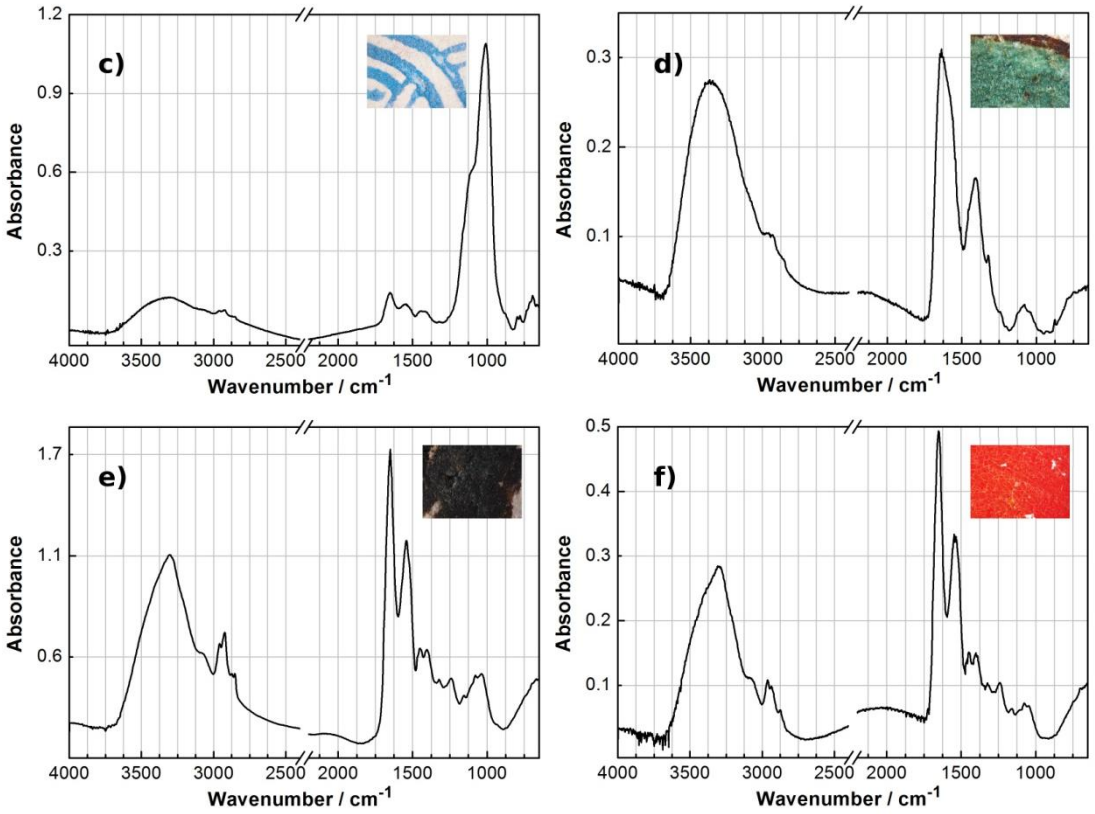
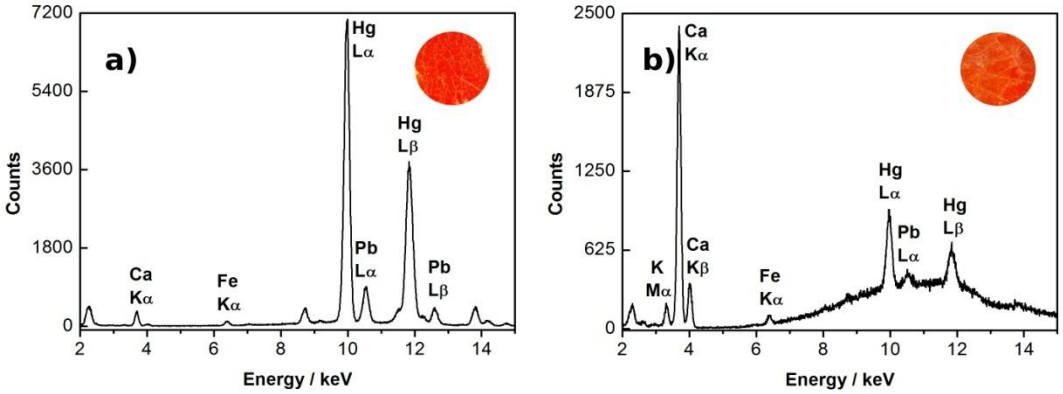


Figure XIII.1.3. Representative infrared spectra from Santa Cruz 34: **a)** red f. 89; **b)** yellow f. 94v; **c)** blue f. 89; **d)** green f. 93; **e)** black f. 97; **f)** varnish over red f. 94v.

XIII.2. Alcobaça 238

XIII.2.1. µ-EDXRF

1st main codicological unit



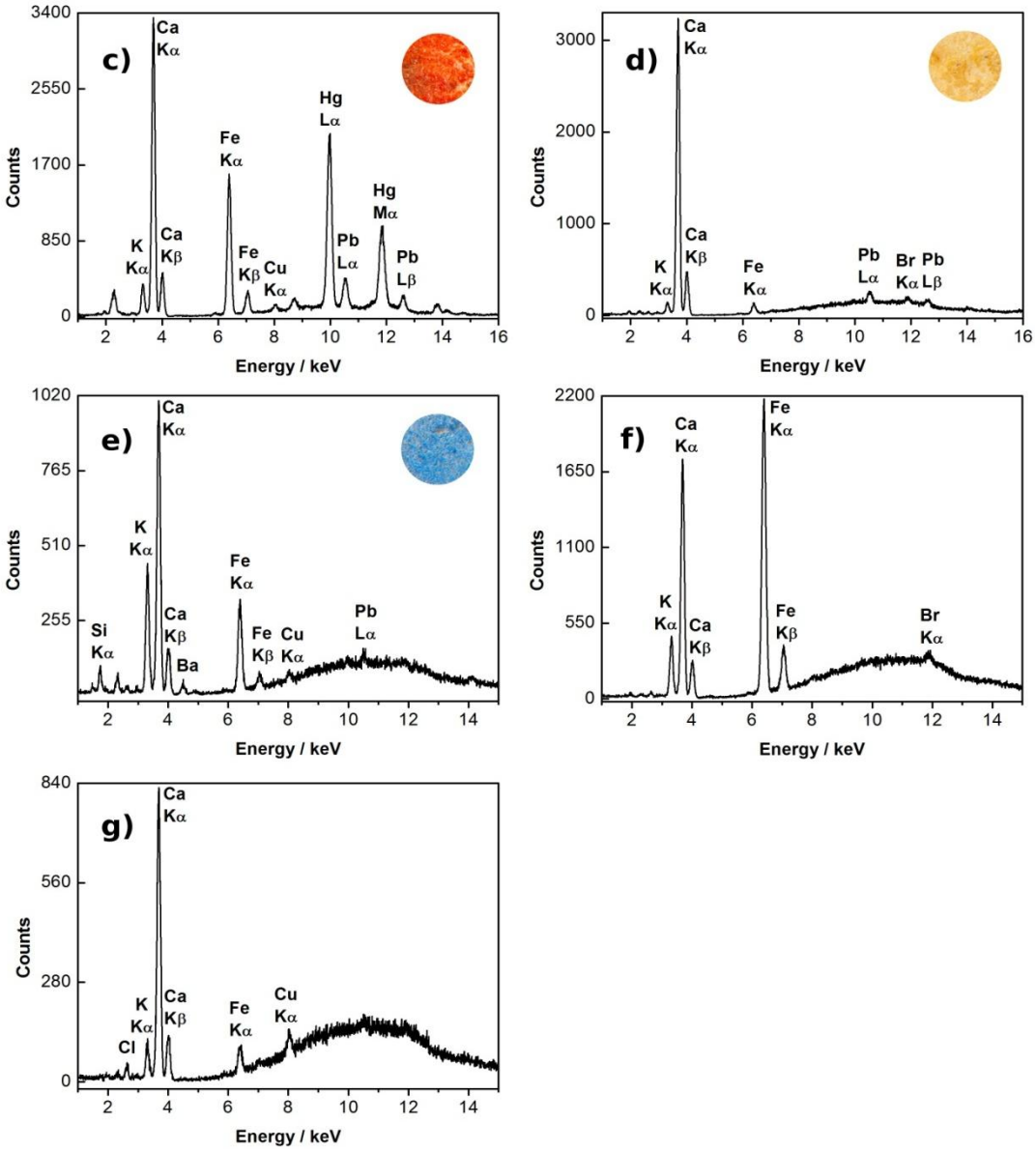
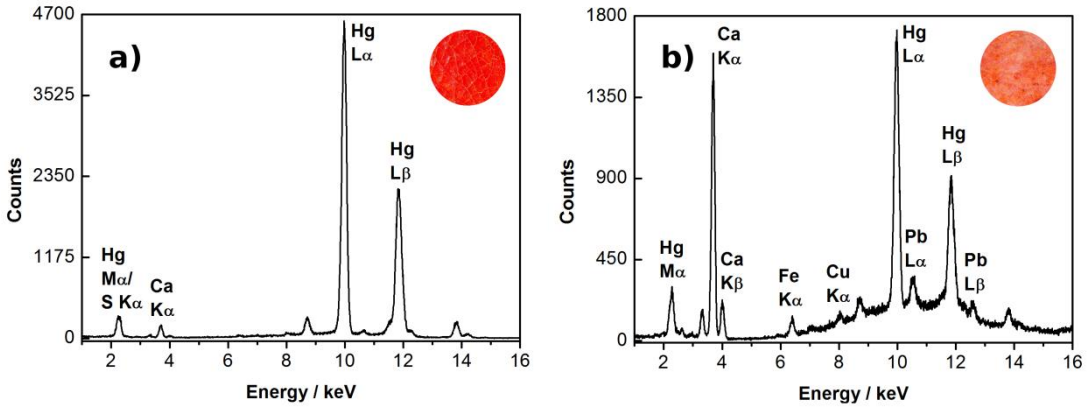
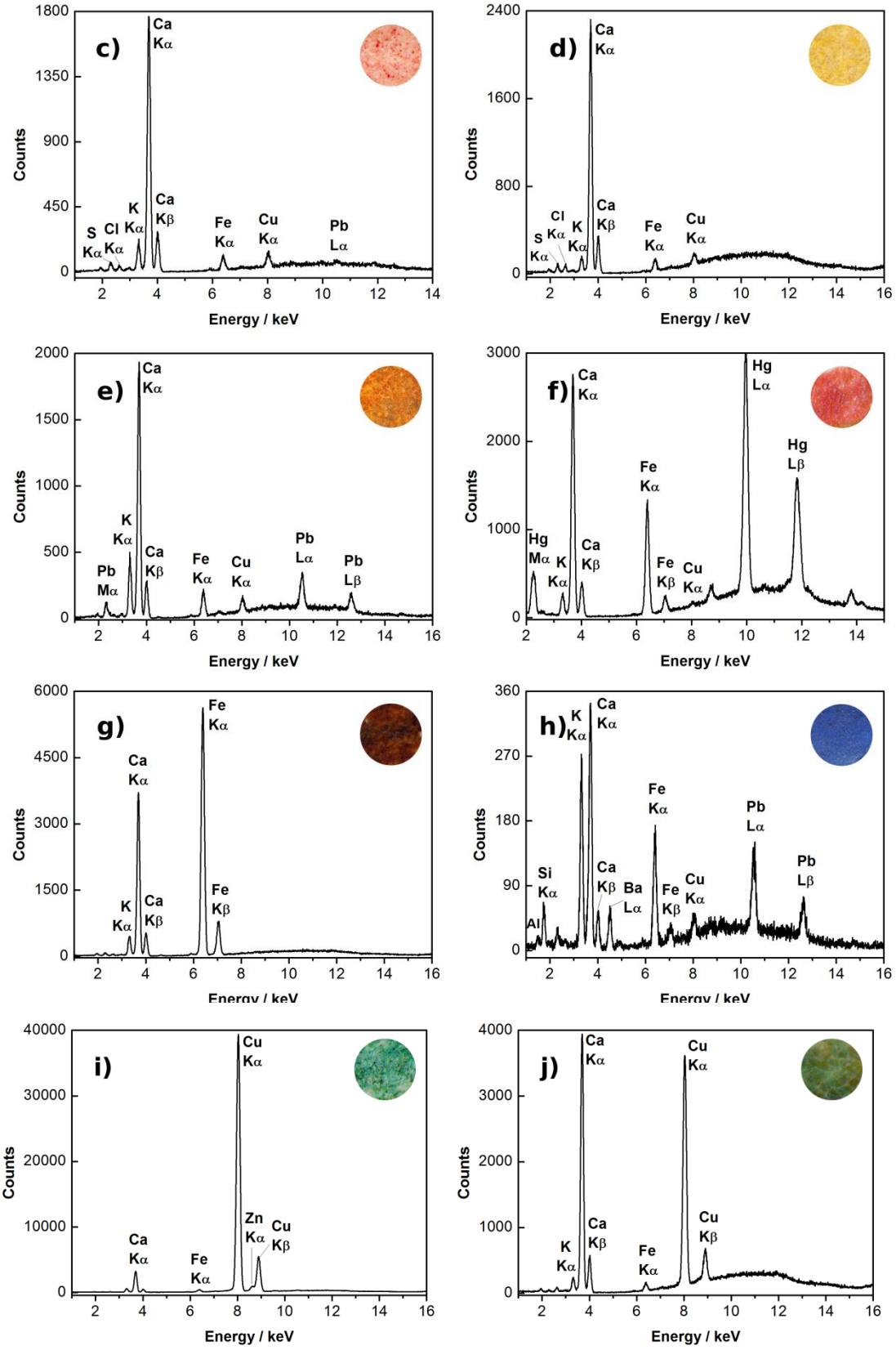


Figure XIII.2.1.1. Representative µ-EDXRF spectra from ALC 238: **a)** red f. 33v; **b)** glassy orange f. 4v; **c)** orange f. 76; **d)** yellow f. 33v; **e)** black ink f. 54; **f)** parchment f. 54.

2nd main codicological unit – De Avibus




c)
Counts
Energy / keV
S Kα
Cl Kα
K Kα
Ca Kα
Ca Kβ
Fe Kα
Cu Kα
Pb Lα
d)
Counts
Energy / keV
S Kα
Cl Kα
K Kα
Ca Kα
Ca Kβ
Fe Kα
Cu Kα
e)
Counts
Energy / keV
Pb Mα
K Kα
Ca Kα
Ca Kβ
Fe Kα
Cu Kα
Pb Lα
Pb Lβ
f)
Counts
Energy / keV
Hg Mα
K Kα
Ca Kα
Ca Kβ
Fe Kα
Fe Kβ
Cu Kα
Hg Lα
Hg Lβ
g)
Counts
Energy / keV
K Kα
Ca Kα
Ca Kβ
Fe Kα
Fe Kβ
h)
Counts
Energy / keV
Al
Si Kα
K Kα
Ca Kα
Ca Kβ
Ba Lα
Fe Kα
Fe Kβ
Cu Kα
Pb Lα
Pb Lβ
i)
Counts
Energy / keV
Ca Kα
Fe Kα
Zn Kα
Cu Kα
Cu Kβ
j)
Counts
Energy / keV
K Kα
Ca Kα
Ca Kβ
Fe Kα
Cu Kα
Cu Kβ

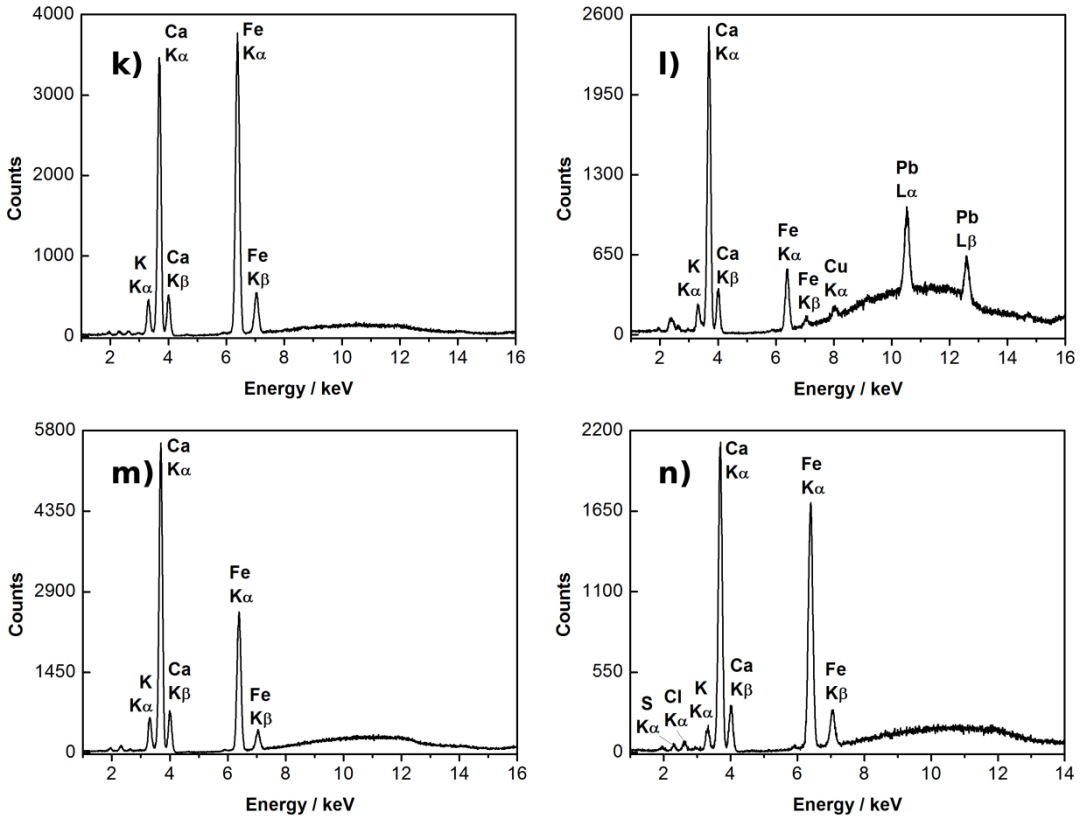
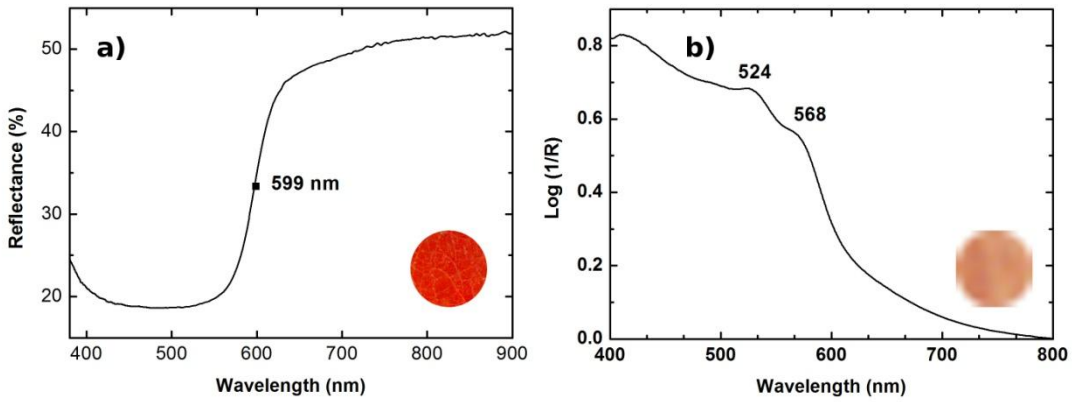


Figure XIII.2.1.2. Representative µ-EDXRF spectra from ALC 238: **a)** red f. 210; **b)** light red f. 223; **c)** rose f. 210; **d)** yellow f. 224; **e)** brown Dove Diagram f. 203v; **f)** brownish red f. 212v; **g)** brown f. 213; **h)** blue f. 210; **i)** green f. 221; **j)** green posterior f. 218v; **k)** brown drawing outline f. 213; **l)** black drawing outline f. 214; **m)** writing ink f. 203; **n)** parchment f. 224.

XIII.2.2. FORS Reflectance UV-Vis

1st main codicological unit



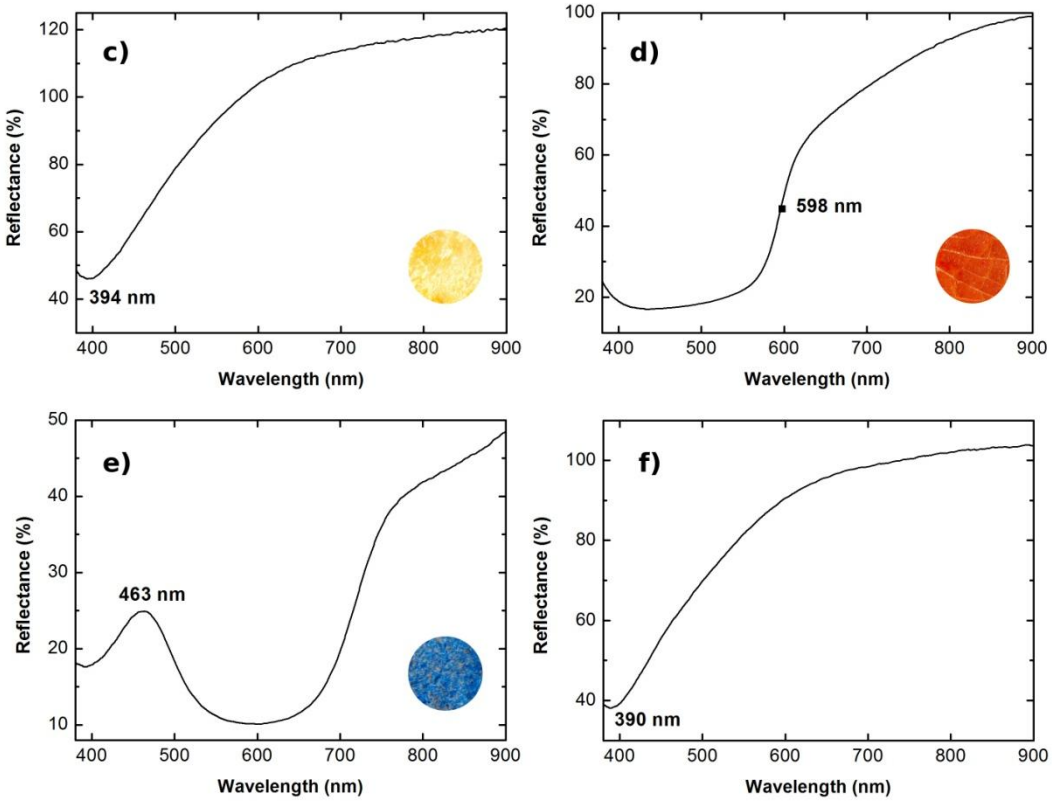
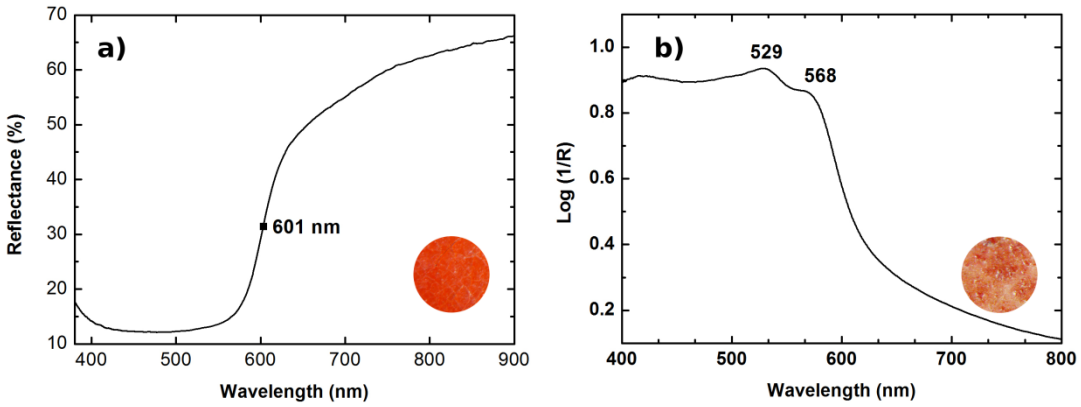


Figure XIII.2.2.1. Representative reflectance spectra from ALC 238: **a**) red f. 33v; **b)** rose f. 1v ; **c)** yellow f. 33v; **d)** orange f. 16v; **e)** blue f. 4; **f)** parchment f. 33v.

2nd main codicological unit – De Avibus



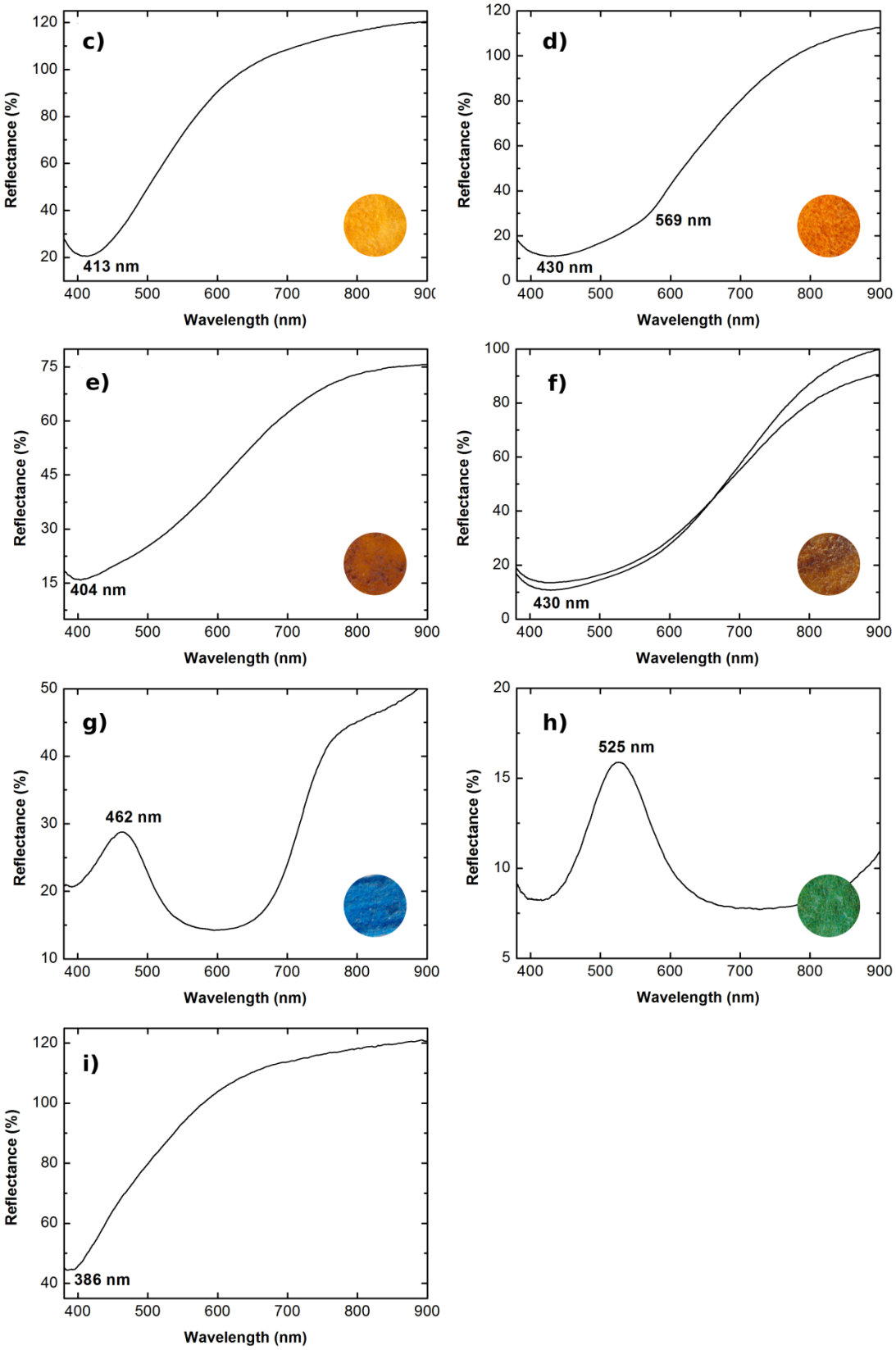


Figure XIII.2.2.2. Representative reflectance spectra from ALC 238: **a**) red f. 210; **b)** dark red f. 206v; **c)** yellow f. 203v; **d)** brown f. 203v; **e)** brown f. 204; **f)** brown f. 223v; **g)** blue f. 214; **h)** green f. 224v; **i)** parchment f. 203v.

XIII.2.3. Raman

1st main codicological unit

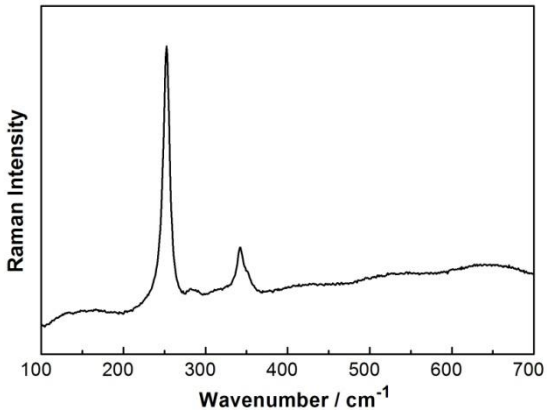


Figure XIII.2.3.1. Representative Raman spectra of the orange from ALC 238, f. 16v.

2nd main codicological unit – De Avibus

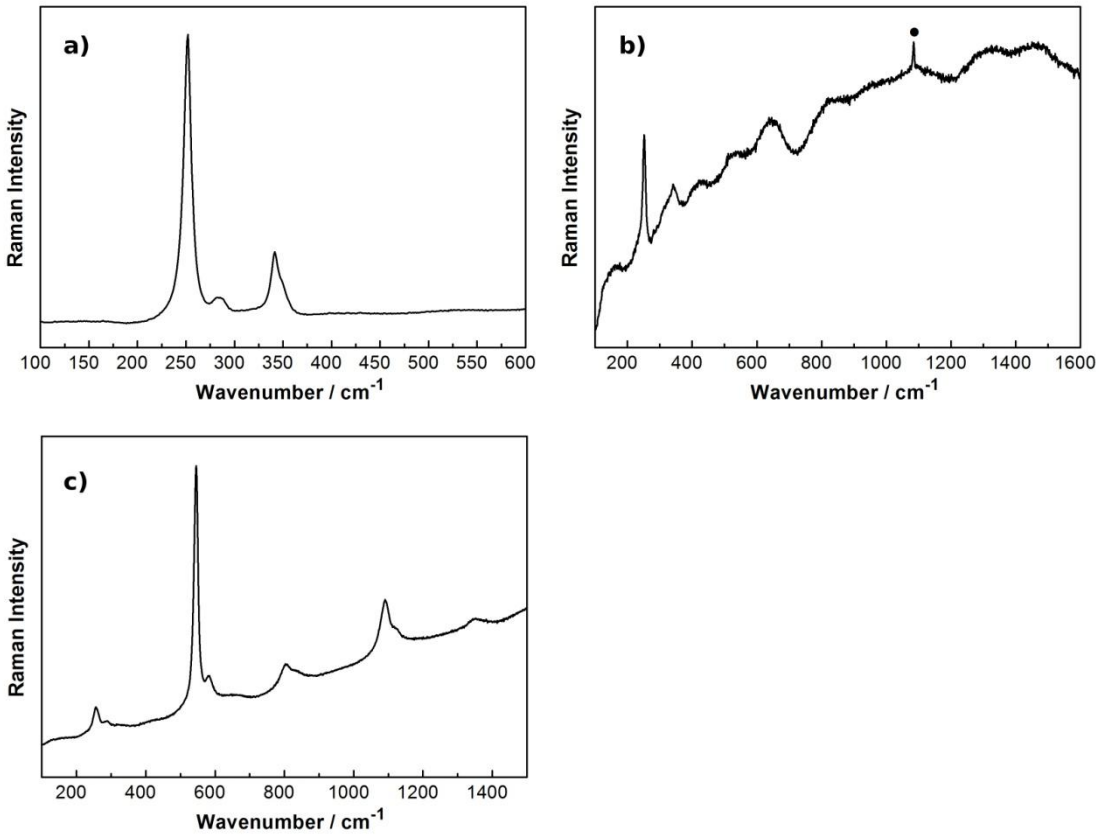


Figure XIII.2.3.2. Representative Raman spectra of the ALC 238: **a)** red, f. 210; **b)** brown, f. 220v (● calcium carbonate); **c)** blue, f. 210.

XIII.2.4. FTIR

1st main codicological unit

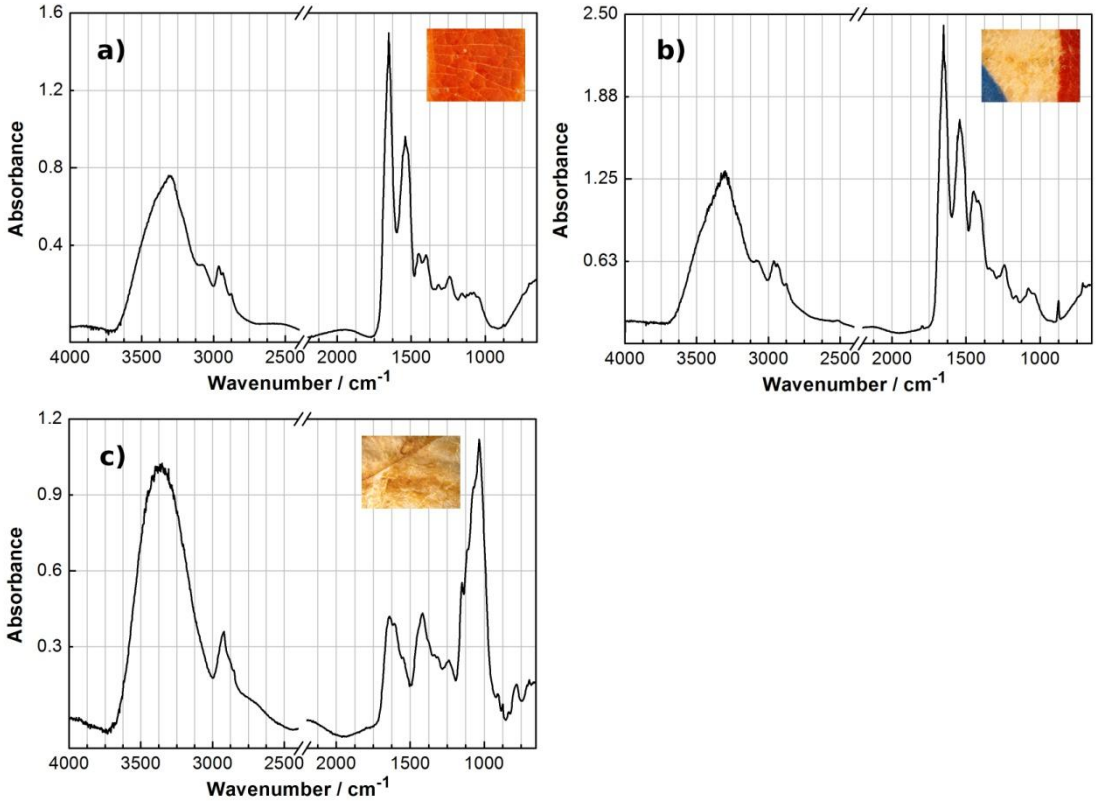
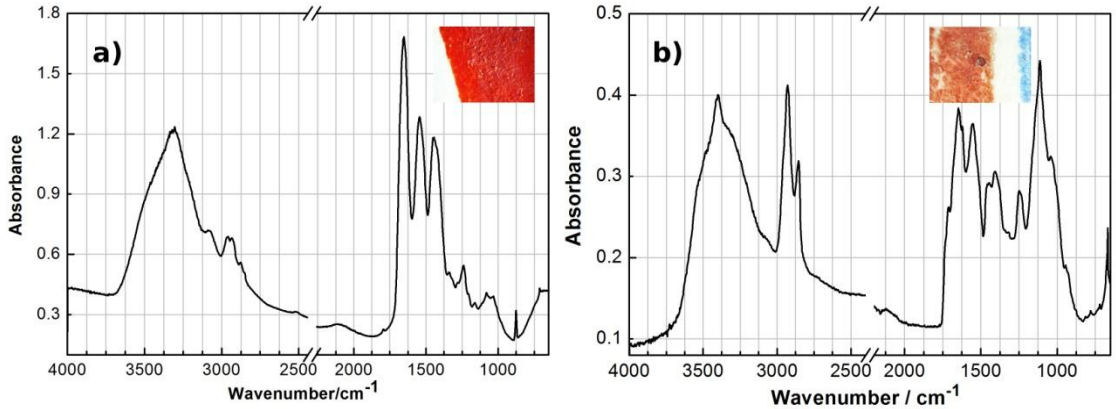


Figure XIII.2.4.1. Representative infrared spectra from ALC 238: **a)** orange f. 16v; **b)** yellow f. 33v; **c)** adhesive f. 64v.

2nd main codicological unit – De Avibus



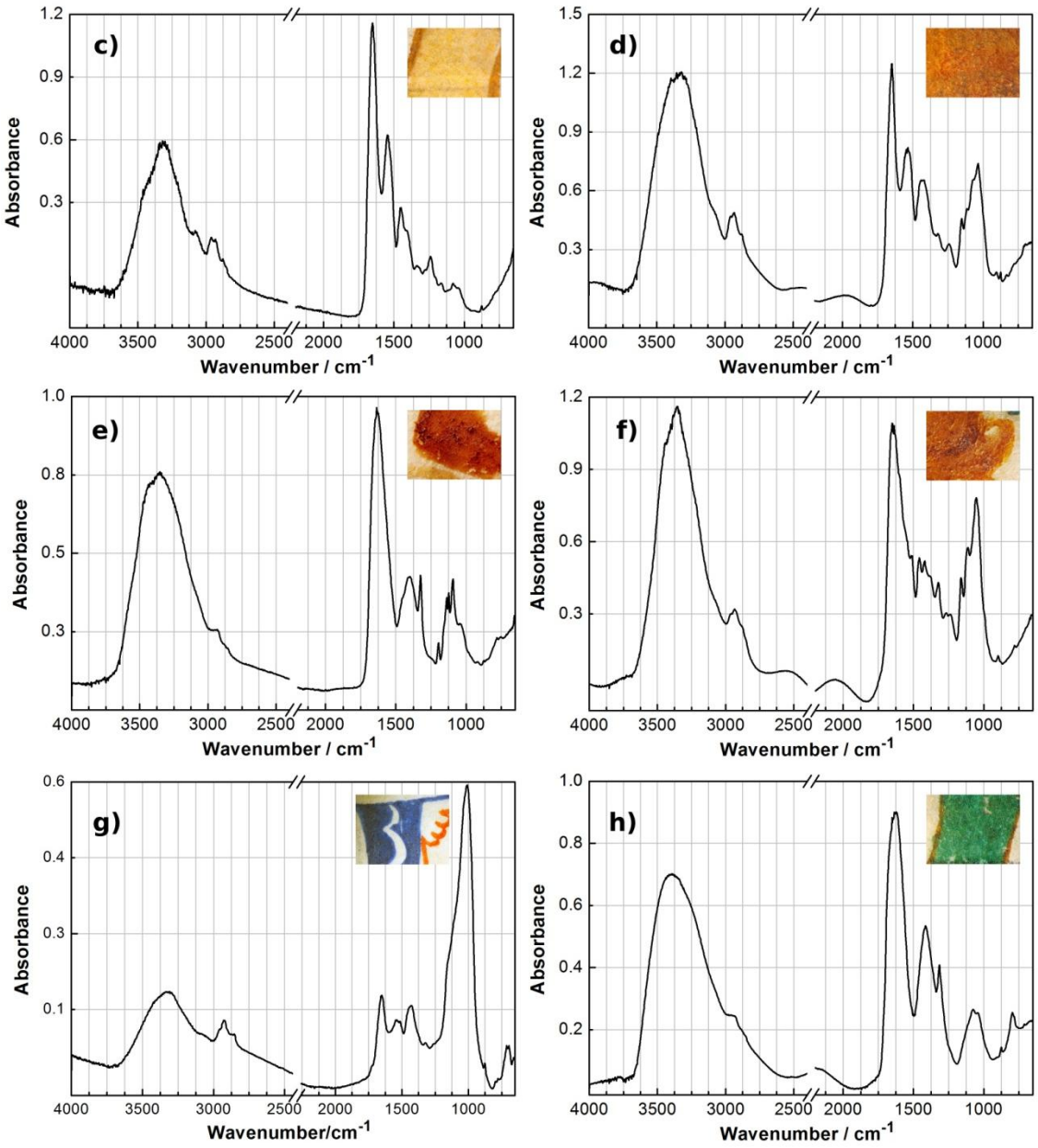
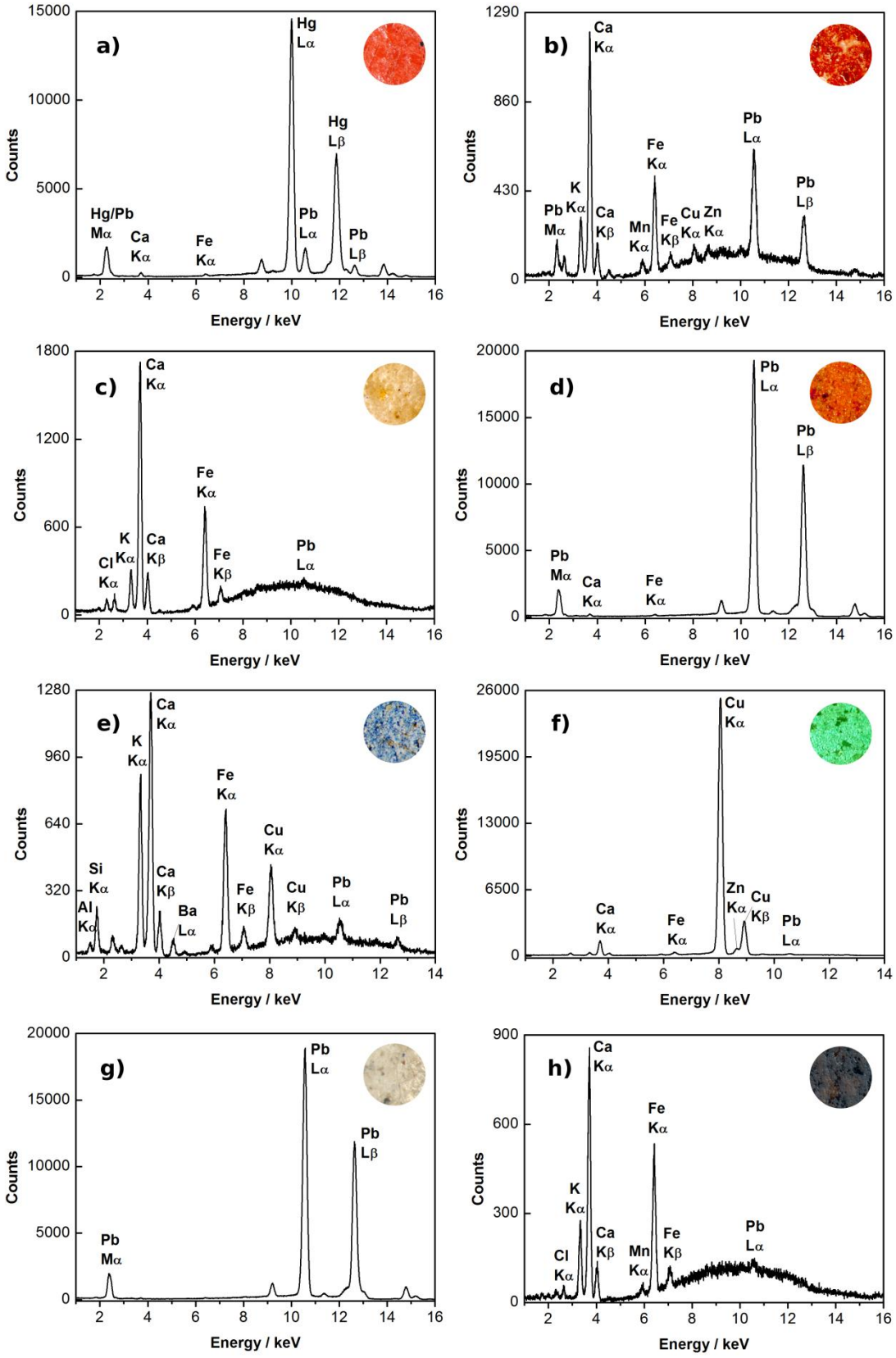


Figure XIII.2.4.2. Representative infrared spectra from ALC 238: **a)** red f. 206v ; **b)** dark red f. 206v ; **c)** yellow f. 224; **d)** brown Dove Diagram f. 203v; **e)** brown f. 204; **f)** brown f. 223v; **g)** blue f. 206v; **h)** green f. 224v.

XIII.3. Lorvão 5

XIII.3.1. µ-EDXRF



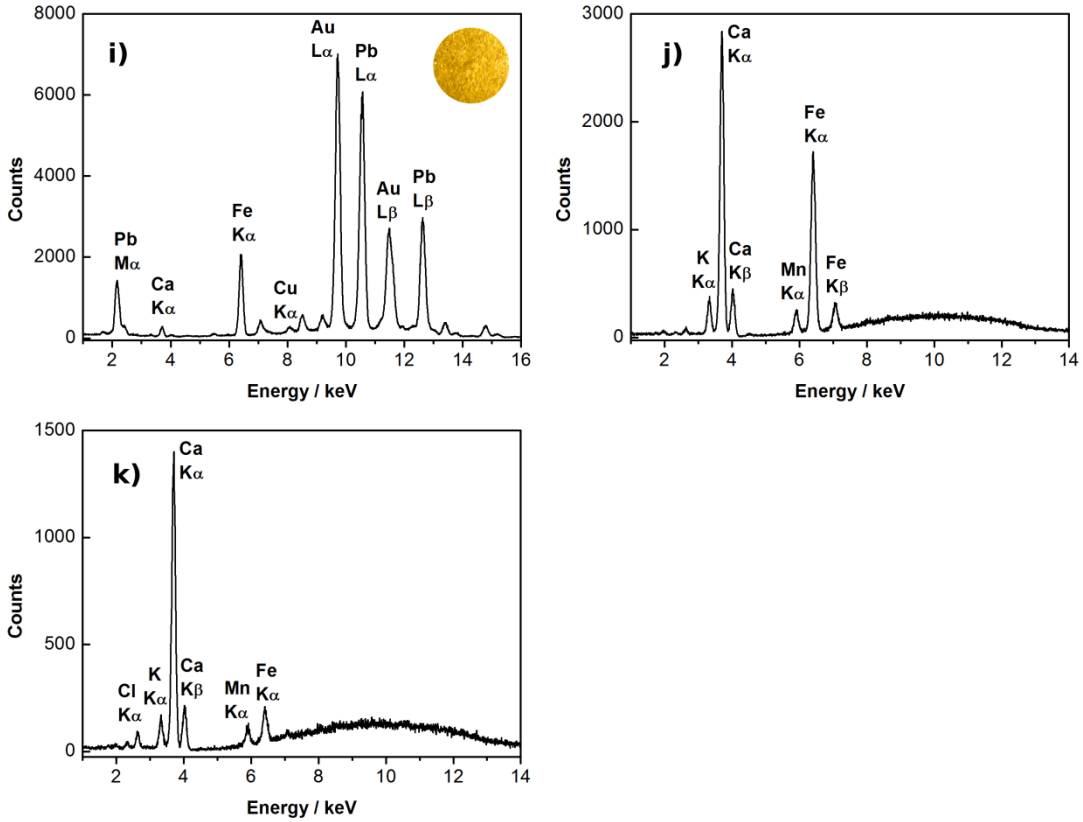
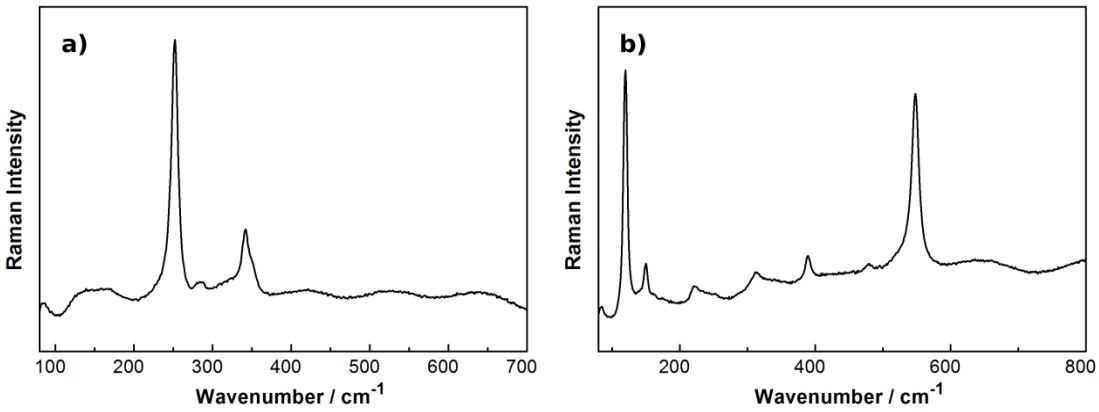


Figure XIII.3.1. Representative µ-EDXRF spectra from Lorvão 5: **a)** red f. 25; **b)** dark red f. 6; **c)** yellow f. 72v; **d)** orange f. 4; **e)** blue f. 16; **f)** green f. 20v; **g)** white f. 56v; **h)** black f. 50v; **i)** gold f. 95v; **j)** writing ink f. 25; **k)** parchment f. 25.

XIII.3.2. Raman



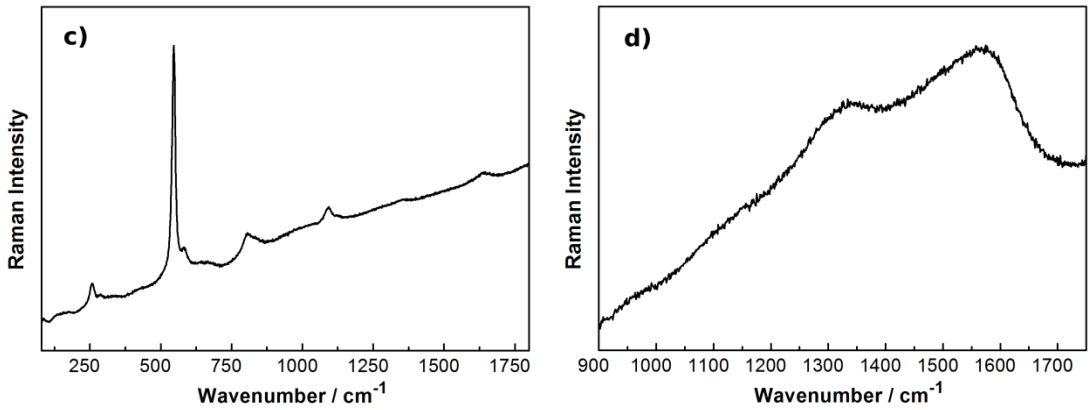
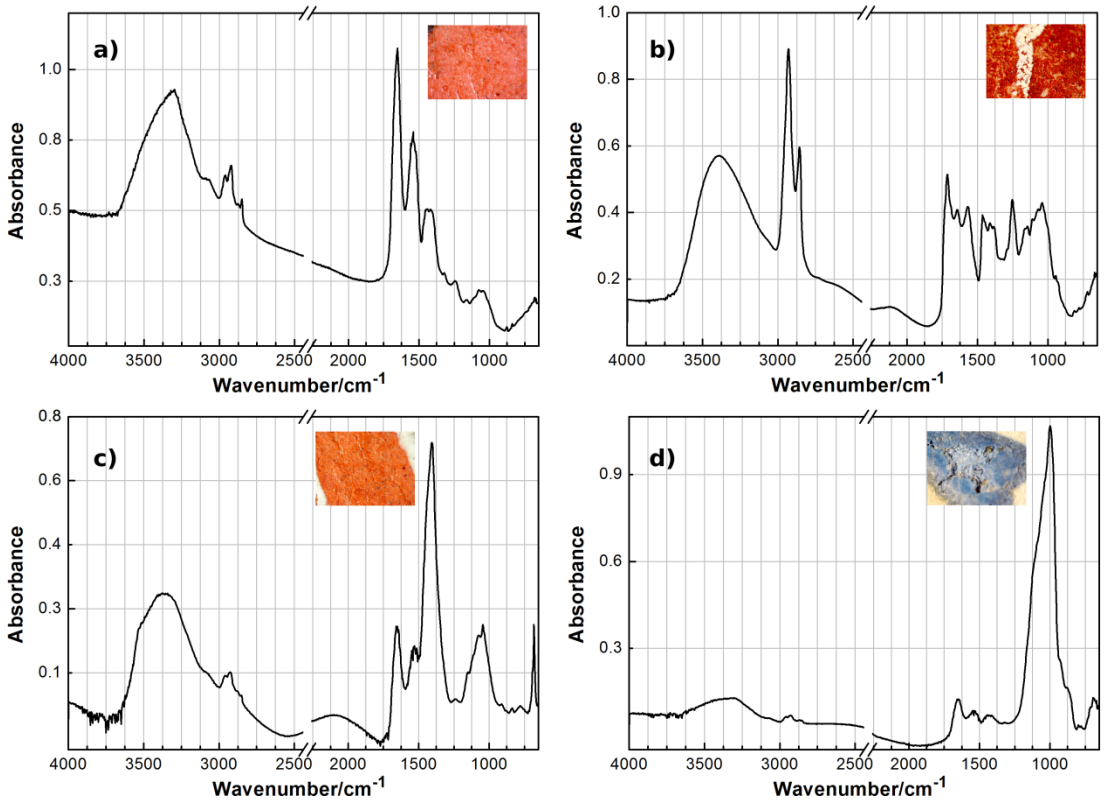


Figure XIII.3.2. Representative Raman spectra from Lorvão 5: **a)** red f. 6v; **b)** orange f. 4; **c)** blue f. 16; **d)** black f. 54.

XIII.3.3. FTIR



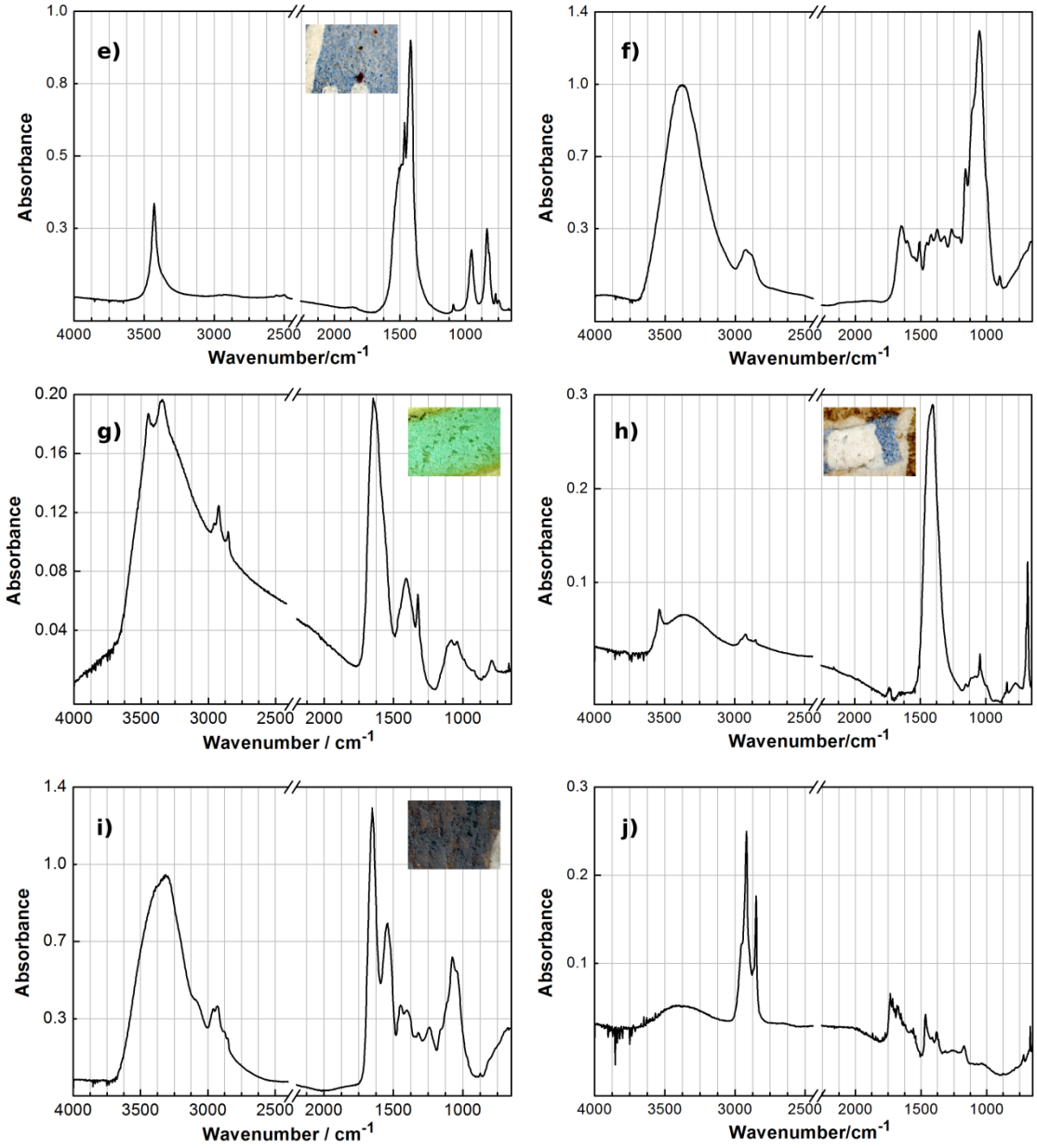


Figure XIII.3.3. Representative infrared spectra from Lorvão 5: **a)** red f. 25; **b)** dark red f. 6; **c)** orange f. 95v; **d)** blue f. 7v; **e)** blue f. 16; **f)** varnish above blue f. 16; **g)** green f. 20v; **h)** white f. 56v; **i)** black f. 50v; **j)** varnish above black f. 50v.

APPENDIX XIV. Colour terminology in Hugh of Fouilloy's *De Avibus*

Table XIV. Colour terminology used by Hugh of Fouilloy in the Book of Birds: words and frequency of use in the text and illuminations.

	Chapters																					
Colour words	1st part												2nd part									
	1st P	1	2	3	4	5	6	7	8	9	10	24	40	44	48	51	52	53	54	58	59	Σ
albus / album																1	2	1		1		5
argento			1		1																1	3
argentum				1	1		4														3	9
auro			1		1				1												1	4
aurum		1	1	1	2			2[i]													5	12
candidus/ candida								1 ii							4							5
candor[iii]							3											2				5
cinericium/ cinericii																1	2					3
color maris[iv]	1										1											2
croceus	1									2												3
deargentata	2	1	2	2	2	2	3		2													16
nigro[v]				2							1		8	2	4					3		20
niveus								2		1	1 vi									1		5
pallore auri	2	2	3	3	2			3 vii														15
pheniceum																			1			1
rubeos[viii]	1					3	1														1 ix	6
sapphirino								4[x]	1												1 xi	6
viridis / viridescat												1									1	2
TOTAL	7	4	8	9	9	5	11	12	4	3	3	1	8	2	8	2	4	3	1	5	13	122

[i] "Aureus"
[ii] "Candidis".
[iii] Also used as "candorem".
[iv] Also referred as "marinus color".
[v] Also mentioned as "nigredinem", "nigra", "nigram", nigrum", "nigredo", "nigrescunt", "nigri", "nigredine", "nigrescere", "nigrescant" and "nigrescentibus".
[vi] Here referred as "niveo".
[vii] "Pallore vero auri"; "pallor".
[viii] It also contains the variations "rubei" and "rubor".
[ix] "Subrubeus".
[x] "Sapphirinus".
[xi] "Sapphirinum".

APPENDIX XV. *De Avibus* transcriptions

The main transcription is from the *De Avibus* from Alcobaça (A). All of the disparities found in the copies of Heiligenkreuz (H), Clairvaux (C), Santa Cruz (SC) and Lorvão (L) are depicted on the footnotes. The organization of the text, such as the paragraphs, commas and periods, for example, are based on the transcription made by Clark (Clark 1992: 116-255). The transcriptions from Clark (1992) and Gonçalves (1999) were used as main references when needed. However, in order to maintain the text the most truthful as possible, no Latin adaptations or corrections were made to the words. The characters (letters) omitted by abbreviations in the original text from Alcobaça are shown in square brackets […], since it was considered important to include them, as some alterations between copies were likely due to misinterpretations. The symbols {…} and \ ... / mean that the text is illegible or that a correction or alteration was done to the text by the scribe, respectively. *Om.* stands for omitted.

1st Prologue

Incipit prologus[1] cuiusdam ad Rainerium conuersum[2].

Desiderii tui k[arissi]me peticionibus[3] satisfacere cupiens columbe[4] cuius penne sunt deargentate et posteriora dorsi eius in pallore auri pingere, et p[er] picturam simplicium m[en]tes edificare decreui, ut quod simplicium anim[us] intelligibili oculo cap[er]e uix poterat, saltem carnali discernat; et quod uix poterat auditus percipiat uisus. Nec tantum uolui columbam formando pingere s[ed][5] etia[m] dictando desc[ri]bere, ut p[er] scripturam demonstrem picturam; uel[6] cui n[on] placuerit simplicitas picture placeat saltem moralitas scripture. Tibi [i]g[itur] cui date sunt penne columbe, qui elongasti fugiens ut in solitudine maneres et requiesceres, qui non queris[7] dilationem in uoce coruina, cras cras, s[ed] contricionem in gemitu columbino, tibi inq[ua]m, non tantum ad p[re]sens columbam, sed etiam accipitrem pingam.

Ecce in eadem p[er]tica sedent accipit[er] \et/ columba. Ego enim de clero, tu de milicia[8]. Ad conuersionem uenim[us] ut in regulari uita quasi in p[er]tica sedeamus; et qui rap[er]e consueueras domesticas aues, nunc bone op[er]ationis manum[9] siluestres ad conuersionem trahas, id e[st] seculares.

Gemat [i]g[itur] colu[m]\ba/, gemat et accipiter; uocem doloris emittat. Uox enim columbe gemitus; uox accipitris questus. In p[ri]ncipio huius op[er]is iccirco[10] columbam preposui quia sp[iri]t[us] s[an]c[t]i[11] gra[tia] semp[er] p[re]paratur cuilibet penitenti nec nisi p[er] gra[tia]m p[er]uenitur ad ueniam. De accipitre u[ero] post columbam subiungitur, p[er] quem nobilium persone designantur. Cum eni[m] aliquis nobilium conuertit[ur], p[er] exemplum bone op[er]ationis paup[er]ib[us] presentatur. De quib[us]dam uero ta[m][12] uolucribus quam animalibus que ad exemplum morum diuina scriptura commemorat, quam citius[13] potero breuiter assignare temptabo.

[1] Incipit prologus + primi libri (H).
[2] *Om.* cuiusdam ad Rainerium conuersum (H, C).
[3] Peticionibus → Petitionibus (L).
[4] Columbe → Columbam (H).
[5] Sed → Set (L).
[6] Uel → Uelut (H).
[7] Queris → Requiris (H).
[8] Micilia → Militia (L).
[9] Manum → Manu (L, H).
[10] Iccirco → Idcirco (H).
[11] Sancti spiritus (H).
[12] Uero + non (C). The "n[on]" is expuncted.
[13] Citius → Cicius (H, L).

2nd Prologue[14]

1st Miniature: The Dove and the Hawk

Ecce in eade[m] p[er]tica sedent accipit[er] et columba.
Hec pertica est regularis[15].
Paries s[an]c[t]ar[um] cogitationum. Paries bonor[um] oper[um].
Cleric[us][16] miles[17].
Conte[m]platiua uita.[18] Actiua uita.

um[19] scrib[er]e illiterato debea[m], non miret[ur] diligens lector si, ad edificationem illit[er]ati, de subtilib[us] simplicia dicam. Nec imputet leuitati quod accipitre[m] uel columbam pingam, cum beatus iob et p[ro]ph[e]ta dauid hui[us] modi uolucres nobis relinquerint[20] ad doctrinam. {Quod enim} doctiorib[us][21] innuit scriptura hoc simplicibus pictura. Sicut enim sapiens delectat[ur] subtilitate sc[ri]pture, sic simplicium animus detinet[ur] simplicitate picture. Ego autem plus laboro ut simplicib[us] placeam, quam ut doctorib[us] loquar, et quasi[22] uasculo pleno latices infundam. Qui enim sapi\e[n]te[m] u[er]bis/ instruit, quasi uasc[u]lo pleno latices infundit.

2nd Miniature: The Dove Diagram

Exterior frame: Si dormiatis inter medios os cleros penne columbe deargentate et posteriora dorsi eius in palore auri.
Upper quadrants with respective circles: Penne[23], simplicitas[24] columbe. Quis dabit nichi pennas sicut columbe. Color arg[e]nteus i[n] pennis e[st] i[n] linguis docentium sermo sancte exhortationis[25]. / [26]Req[u]iesca[m][27] in pace. Et uolabo et requiescam. Color aure[us] i[n] post[er]iorib[us] est in futuro eterne retributionis munus.
Wheel rim and inner circles: In inter expectationem celestium et [co]ntemptu[m] t[er]renor[um] dormit qui inter hee duo[28] uita[m] finit. In medio sortiu[m] uet[er]is et noui testam[en]ti dormit qui eor[um] auctoritatib[us] adquiescit. / Inter medias sortes dormit qui sperat et diligit. / Inter extremas uigilat qui timet et desiderat.
Spokes: Grana frum[en]ti et ordei sunt sent[e]ntie ueteris ac noui testam[en]ti.
Between spokes with its corresponding phrases: Expectatio celestium - due sortes – Conte[m]ptus terrenor[um] / Timor penne – extreme sortes – Desid[er]iu[m] gl[or]ie / Vet[us] testam[en]tum – due sortes – Nouu[m] testam[en]tu[m] / Spes uenie – medie sortes – amor gratie.
Vertical bar: Rubor pedu[m] c[ru]or m[arti]r[u]m. Oc[u]l[u]s c[ro]ceus mat[ur]itas sensus.
Lower quadrants with respective circles: Elongaui m[en]te. Fugiens mundu[m][29]. Ecce elongaui fugiens. Color aeri[us] in alis est amor diuine contemplationis. / P[er]seu[er]aui in [co]nte[m]platione. Mansi i[n] solitudi[n]e[30]. Et mansi in solitudine. Color i[n]aris[31] i[n] reliquo corpore tribulationem[32] designat in carnali mente.

---

[14] Explicit prologus (H).
[15] Regularis + uita (H).
[16] Clericus + et (H).
[17] *Om.* Clericus miles (L).
[18] Uita + et (H).
[19] Um → Cum (L, H); Dum (C).
[20] Relinquerint → Reliquerunt (H, C).
[21] Doctioribus → Doctoribus (H, L).
[22] Quasi → Quare (L).
[23] *Om.* Penne (L); Penne + uirtutum (C); Pennas uirtutum (H).
[24] Simplicitas → Simplicitatis (H).
[25] Exhortationis → Exortationis (H).
[26] Uolabo desiderium (C); Uolabo desiderio (H).
[27] Requiescam → Requiescat (L).
[28] *Om.* Qui inter hee duo (H).
[29] *Om.* Elongaui mente. Fugiens mundum (H).
[30] *Om.* Perseueraui in contemplatione. Mansi in solitudine (H).
[31] Inaris → In (L); Maris (H).

1st Part

Incip[it] liber[33] cui[us]dam ad rainerium[34] conuersu[m] no[m]i[n]e[35] corde benign[m]. Incipit de t[ri]bus columbis.

Si dormiatis inter medios cleros penne columbe deargentate et posteriora dorsi ei[us] in pallore auri. In sc[ri]ptura sacra, fr[ater], tres columbas legendo repperi, ex quib[us], si attente consid[er]entur, simpliciu[m] mentes ad conu[er]sionem[36] poterunt edoceri: columba scilicet Noe, columba D[aui]d, columba ih[es]u Xpi. Noe requies, D[aui]d manu fortis, ih[e]c[us][37] Saluator int[erp[re]tatur. Peccatori aute[m] dicit[ur]: peccasti, quiesce. Si [er]g[o][38] uis e[ss]e Noe, quiesce a peccatis; ut Dauid e[ss]e possis, op[er]are fortia[39]. Si saluari desid[er]as, a Saluatore salutem postula. Diu[er]te, [i]g[itur], a malo, et[40] fac bonum, inquire pacem. Diu[er]te ad archa[m] Noe. P[re]liare cum Dauid p[re]lia domini. Inquire pacem cu[m] ih[es]u in ier[usa]l[e]m[41]. Diu[er]te ad quietem mentis, resiste temptationib[u]s, expecta patient[er][42] salutis beneficium.

De columba u[ero] Noe dicit[ur], Reu[er]sa est Columba ad uesp[er]am ferens in ore ramu[m] uirentis oliue. Ad archam Noe Columba reu[er]titur cum ad quiete[m] m[en]tis ab ext[er]iorib[us] anim[us] reuocatur. Reu[er]titur ad uesp[er]am cum, deficiente luce mundane felicitatis, uane gl[ori]e fugit pompam, timens ne inc[ur]rat obscuritate[m] noctis, id e[st], p[ro]funditatem p[er]petue dampnationis[43]. Oliuam gerit, quia mis[eri]c[or]diam querit. Oliuam in ore portat, dum indulg[er]i sibi quod deliq[ue]rat p[re]cib[u]s exorat.

De columba u[ero] david dicit[ur], et post[er]iora dorsi eius in pallore auri. In post[er]ioribus dorsi aurum habetur, q[u]ia bene op[er]anti in futuro uenia p[ro]mittit[ur]. Similit[er] et de saluatore legitur[44] cum in descenso columbe sup[er] um hec uox[45] audit[ur], Hic e[st] filius meus dilectus in quo michi bene complacui. Columba est sp[iri]t[us] s[an]c[t]i[10] gra[tia] que sup[er] ih[esu]m in iordane descendisse cernit[ur] q[u]ia cuilibet humili a peccatis mundato gra[tia] p[re]paratur. Penitenti [i]g[itur] fit misericordia; bene op[er]anti p[ro]mittit[ur] uenia; diligenti datur gratia[46].

Chapter 2 : Mistice[47] de columba.

Si dormiatis inter medios cleros penne columbe deargentate et posteriora dorsi eius in pallore auri. Columba deargentata e[st] eccl[es]ia, doct[ri]na diuini eloquii erudita, que p[er] similitudinem fert[ur] hab[er]e p[re]dicationis rostrum, ratione[48] diuisum quo grana colligat ordei et frum[en]ti, sententias[49] uidelicet[50] uet[er]is et noui testam[en]ti. Habet sinistrum oc[u]l[u]m et dextru[m][51] moralem et misticu[m] sensum. Seipsam respicit sinist[r]o, d[eu]m u[ero] contemplat[ur] dext[r]o. Duas alas habet, actiuam et contemplatiuam uitam. His duab[u]s alis sedens tegitur; his duabus uolans ad celestia subleuat[ur]. Uolam[us] cum m[en]t[e] excedim[us]; sedem[us] cum int[er] fr[at]es sobrii sum[us]. In his siquidem alis

---

[32] Tribulationem → Tribulatio (L).
[33] Liber → Libellus (H).
[34] Rainerium → Raynerium (C, SC).
[35] Nomine → Cognomine (H, C).
[36] Conuersionem → Perfectionem (H).
[37] Ihc → Ih[e]s[us] (H, SC).
[38] Ergo → Igitur (H).
[39] Fortia → Forcia (L).
[40] *Om.* et (H).
[41] Ih[e]r[usa]l[e]m (SC, L); Ier[usa]lem (C).
[42] Patienter → Pacienter (SC, L).
[43] Dampnationis → Damnationis (SC, L).
[44] Dicitur + legitur (C). The "dicit[ur]" is expuncted.
[45] Uox hec (SC, L).
[46] Gratia → Gracia (C).
[47] Mistice → Mystice (H).
[48] Ratione → Racione (L).
[49] Sententias → Sentencias (L).
[50] Uidelicet → Scilicet (H).
[51] Habet dextrum et sinistrum oculum (H).

pe[n]ne sunt inserte, penne[52] sunt doctores, alis recte actionis[53] et diuine contemplationis firmit]er] inherentes.
Cleros uero grece sortes uocam[us] latine. Due sortes, duo \su[n]t/ testam[en]ta. Inter quas sortes dormiunt qui auctoritatib[u]s uet[er]is et noui testamenti concordant et adquiesc[un]t.
Et post[er]iora dorsi ei[us] in pallore auri. Dorsum columbe illam partem corp[or]is e[ss]e dicunt cui radices alarum sese inuicem naturaliter coniungunt. Ibidem cor ponitur quod, dorso p[ro]ximu[m], auro p[er]petue beatitudinis in fut[ur]o op[er]ietur. Sicut aurum p[re]ciosius est argento sic et beatitudo fut[ur]i s[e]c[u]li p[re]ciosior est felicitate p[re]senti. Posteriora [i]g[itur] dorsi columbe in pallore auri erunt q[u]ia iusti in et[er]na beatitudine nimia claritate fulgebunt.

Chapter 3: Moraliter de columba.

3rd Miniature: The Three Doves
Columba Xpi[Christi] data g[ra]tis non p[ro] meritis (*inner frame:* Columba niuea[54] est sp[iri]t[us] s[an]c[t]i gratia). Columba David amicta uarietatib[us] uariis uirtutib[us] (*inner frame:* Columba uaria est sancta[55] ecclesia). Columba Noe formosa op[er]e nig[r]a t[r]ibulatione (*inner frame:* Columba est anima[56] sed formosa).

Si dormiatis inter medios cleros[57] penne columbe deargentate et posteriora dorsi ei[us] in pallore auri.
Columba e[st] quelibet[58] fidelis et simplex anima: deargentata in pennis declarata in uirtutib[u]s per famam bone opinionis. Que tot in cibum[59] colligit seminu[m] grana quot ad bene op[er]andum assumit[60] s[ibi] iustorum exempla. Duos habet oc[u]los, dextrum et sinistrum, memoriam scilicet et intellectum. In uno futura p[re]uidet, in altero transacta deflet[61]. Hos oc[u]los clauserunt in egyto[62] patres n[ost]ri, q[uonia]m n[on] intellexerunt op[er]a d[e]i, nec fuerunt memores multitudinis mise[ri]c[or]die eius.
Duas u[ero] habet alas amorem p[ro]ximi et amorem dei. Una extendit[ur] p[er] compassione[m] ad p[ro]ximum altera erigit[ur] p[er] contemplationem ad d[eu]m[63]. Ex his alis p[ro]cedunt penne id e[st] u[ir]tutes a[n]i[m]e. He penne argentea claritate resplendent q[ua]ndo, p[er] famam bone opinionis, audientib[u]s argenti more dulcem tinnitu[m] prebent.
Cleros uero grece sortes dicim[us] latine. Quatuor[64] aute[m] sunt sortes: timor et spes, amor et desid[er]ium. Sortes sunt q[u]ia pat[er]ne h[er]editatis locum nob[is] dist[ri]buunt. Timor et desiderium sortes sunt extreme; spes et amor medie. Timor animu[m] conturbat; desid[er]ium mente[m] cruciat, et nisi aliq[u]od medium int[er]uenerit, anim[us] a quiete recedit. Opportet[65] [i]g[itur] ut inter desid[er]ium[66] et timorem, spem ponam[us] et amorem. Spes enim timorem recreat, amor desid[er]ium temp[er]at. Inter spem [i]g[itur] et amorem, quasi inter medias, quiet[us] dormit, qui int[er] extremas, scilicet int[er] timorem et desid[er]ium uigilat et obstupescit. Si [i]g[itur] es columba u[e]l columbe penna dum times et desid[er]as inter extremas sortes uigilas, du[m] speras et digilis, int[er] medias quietus dormis.

[52] Penne + uero (H).
[53] Actionis → Accionis (L).
[54] Niuea → Nigra (SC). The \gr/ appear to be a correction.
[55] Sancta → Sanctu (SC). The \u/ is written in black.
[56] Anima + nigra (H, C).
[57] \Cleros/ medios (L). The "cleros" was posteriorly added.
[58] Quelibet + et (H).
[59] Cibum → Cybum (C).
[60] Assumit → Assummit (SC, L).
[61] Deflet → Defflet (L).
[62] Egyto → Egipto (SC, L); Egypto (H, C).
[63] All the copies use the abbreviation "dm". While Gonçalves states that the abbreviation stands for "deum", Clark refers "dominum". Here it was chosen the word "deum", which is also the selected translation used by Cordonnier in his thesis (2007).
[64] Quatuor → Quattuor (H).
[65] Opportet → Oportet (C, SC, L).
[66] Desiderium → Disiderium (SC).

Et post[er]iora dorsi ei[us] in pallore auri. In dorso solent onera[67] portari et per hec eadem possunt labores op[er]um[68] designari. Per posteriora u[ero] dorsi denotat[ur] expectatio p[re]mii. Post tolerantiam siq[u]idem p[re]sentium laborum, in futuro subsequi credim[us] iustis p[re]mia m[er]itorum. Reddet enim d[eu]s mercedem laborum s[an]c[t]orum[69] suoru[m], et deducit[70] eos in uia mirabili. Et hoc in pallore auri e[ss]e credimus qui p[re]ciosa e[st] in conspectu d[omi]ni mors s[an]c[t]orum eius. In pennis [i]g[itur] argentum, q[u]ia in linguis eloquium; in posterioribus u[er]o aurum, id e[st], post labores p[re]mium.

Chapter 4: Item de columba.

Si dormiatis inter medios cleros p[enne] c[olumbe] d[eargentate] et p[osteriora] d[orsi] ei[us] in p[allori] auri.
Columba deargentata e[st] absq[eu] felle malicia quelibet adhuc uiuens p[re]latoru[m] p[er]sona, q[eu] int[er] medios cleros dormit. Cleros grece latine sors[71], unde et cleronomia p[ro]p[ri]e uocatur hereditas que fit testam[en]to. Inde contigit ut \filli leui int[er]/ filios isr[ae]l n[on] haberent sotem[72], id e[st], h[er]e\ditatis/ partem, sed ex decimis uiuerent. Due sunt aute[m] hereditates[73], terrena uet[er]is tes[ta]m[en]ti et et[er]na noui. In medio [i]g[itur] istarum dormit qui in conte[m]ptu t[er]renorum et spe celestiu[m] uita[m] finit, dum nec nimis ardent[er] p[re]sentibus inhiat, et futura patienter expectat.
Et posteriora dorsi eius in pallore auri. Oculi eni[m] iustorum uidebunt regem in decore suo; tunc enim in posterioribus aurum[74] habebis cum apparuerit in fut[ur]o gl[ori]e[75] diuine maiestatis. Corone siquidem regum ex auro purissimo fabricant[ur], ex arg[e]nto uero monete fiunt, quib[u]s imagines[76] regum imp[r]imunt[ur]. In moneta notatur imitatio forme, in corona signum uictorie. Moneta siquidem diuini eloquii docet imitationem uite X[Christi], corona uero iuctorie post labores p[re]sentis s[e]c[u]li finem pugne. Ibi [i]g[itur] quasi in p[os]terioribus aurum, hic in pennis predicationis argentums quia cu[m] ad illa dona columba p[er]uen[er]it, ia[m] p[re]dicationis eloquio n[on] indigebit, sed in eo quod in ret[r]ibutione, in puritate p[er]fectionis sine fine uiuet.

Chapter 5: De pedibus columba[77].

Columba de qua hic agit[ur] rubeos pedes habere perhibetur. Hec columba e[st] eccl[es]ia, que pedes habuit quib[u]s totius mundi spatium[78] p[er]ambulauit. Pedes sunt m[a]r[tyr]es qui tot passib[u]s t[er]ram p[er]ambulant quot bonorum op[er]um exemplis uia[m] iusticie sequentib[u]s se demonstrant. Terram tangunt cum dignis increpationib[u]s[79] actus et uoluntates t[er]renas rep[re]hendunt. Sed[2] dum t[er]ra p[re]mitur asp[er]itate t[er]re, id e[st], t[er]renorum[80] crudelitate pedes uulnerantur, et sic pedes ecclesie rubei facti sunt, q[u]ia sanguinem suum p[ro] xpi[Christi] nomine m[arty]res effuderunt. Rubor [i]g[itur] pedum e[st] cruor m[arty]r[u]m.

Chapter 6: De pennis deargentatis[81].

Columba que pedes rubeos hab[er]e dicit[ur], pennas deargentatas habuisse u[er]bis p[ro]ph[e]ticis demonstrat[ur]. Penne, inq[ui]t d[avi]d, colu[m]be de arge[n]tate. Penne columbe de arge[n]tate su[n]t

[67] Onera → Honera (H).
[68] Operum labores (H).
[69] Sanctorum → Sanctis (H).
[70] Deducit → Deducet (H, C, L).
[71] Sors latine (SC, L).
[72] Sotem → Sortem (H, C, SC, L).
[73] Penne + hereditates (C). The "penne" is expuncted.
[74] Aurum in posterioribus (H).
[75] Glorie → Gloria (H, L).
[76] Imagines → Ymagines (H).
[77] De pedibus columba → De pennis argentatis (H). The titles were shuffled.
[78] Spatium → Spacium (SC, L).
[79] Increpationibus + et (C). The "et" is expuncted.
[80] Terrenorum + Cupiditate (C). The "cupiditate" is expuncted.
[81] De pennis argentatis → De pedibus columbe (H).

p[re]dicatores eccl[es]ie. Est aut[em] arge[n]tum diuinu[m] eloq[u]ium, tinnit[us] argenti dulcedo eloquii[82]. Color, candor. Candorem u[ero] argentum retinet, dum quilibet doctor mundiciam u[er]bis p[re]dicat, et mundicia[m] in se habet, dum quod docet diligit, et quod intus amat foris op[er]ibus ostendit. Hec sunt eloq[u]ia d[o]m[ini] casta, argentum igne examinatum. Eloquia d[omi]ni casta quia nulla sunt simulatione corrupta, nullo sunt semine cupiditatis imp[re]gnata[83]. Argentum examinatum igne[84] solidatum in qualibet p[er]turbatio[n]e. Candor [i]g[itur] argenteus in pennis e[st] in linguis docentium lene bla[n]dim[en]tum sermonis.

Chapter 7: De colore alarum.

Arum colorem sc[ri]ptum n[on] repp[er]i sed ex similitudine mat[er]ialis columbe potest assignari, ut si columbam pictam respicias, colorem mat[er]ialis columbe eam hab[er]e n[on] cont[ra]dicas. Alarum enim sup[er]ficies colore saph[i]rino[85] sup[er]fundit[ur], q[u]ia celi spetiem[86] anim[us] conte[m]plantis imitatur. Sed color saphirinus[87] candidis lineis distinguit[ur], ut saphirino[88] colori niueus misceatur. Color enim niueus safirino mixtus designat mundicia[m] carnis et amorem contemplationis.

Chapter 8: De p[o]st[er]iorib[us] dorsi colu[m]be.

Posteriora dorsi columbe deargentate p[ro]ph[et]a comemorat[89], et per ea[m] fine[m] uite p[re]sentis in quolibet homi[n]e moralit[er] demonstrat. In auro puritatem mentis in pallore uero auri designat mortificarionem carnis. Est enim pallor animi patientis[90] et mortificate carnis innatus color. Posteriora [i]g[itur][91] columbe deargentate in pallore auri erunt, dum puritas m[en]tis et mortification carnis finem cuiuslibet morientis obtinebunt[92]. Sed et ideo color aureus in post[er]iorib[u]s dorsi columbe[93] colori saphirino iungit[ur], q[u]ia contemplantis animum fut[ur]e beatitudinis gloria subsequet[ur]. Color [i]g[itur] aureus in p[os]teriorib[u]s designat et[er]ne ret[r]ibutionis munus.

Chapter 9: De oculis columbe.

Oculi tui columbarum. Columba sup[er] aquas sepissime sedere solet, ut cum uiderit umbram sup[er]uenientis accipit[ri]s fugiens declinet. Eccl[es]ia u[er]o sc[ri]pturis se munit, ut insidiantis diaboli fraudes euitare possit. Hec [i]g[itur] columba croceos oculos habet, q[u]ia eccl[es]ia matura consid[er]atione fut[ur]os casus attendit et p[ro]uidet. Color itaq[ue] croceus in oc[u]lis discretionem designat mature consid[er]ationis. Dum enim aliq[u]is quid agat uel q[u]id cogitet mature considerat, quasi croco spi[ri]tales oculos adornat. Habet enim crocus colorem maturi fructus. Croceus [i]g[itur] oculos est maturitas sensus.

Chapter 10: De colore reliqui corporis.

Color reliqui corporis imitatur colorem[94] turbati maris. Mare motu fluctuum seuiens ebullit; caro motu sensuu[m] ebulliens seuit. Mare pert[ur]bationib[u]s suis arenas mouet et subleuat; caro delectationib[u]s suis animi leuitatem pulsat. Mare t[er]minus suos egrediens aquis dulcib[u]s occurrit caro lasciuiens lac[r]imarum dulces riuulos obtundit. Mare diu[er]sis p[ro]cellaru[m] turbinib[u]s nauigantium cursos

[82] Eloquii → Uerbi (H).
[83] Impregnata → Inpregnata (H).
[84] Igne examinatum (SC, L).
[85] Saphirino colore (H).
[86] Spetiem → Speciem (C, L).
[87] Saphirinus → Saphyrinus (H).
[88] Saphirino → Saphiro (C). The correction is provided in superscript.
[89] Comemorat → Commemorat (H, C, SC, L).
[90] Patientis → Pacientis (SC, L).
[91] Igitur → Uero (H).
[92] Obtinebunt → Optinebunt (H).
[93] Columbe + columbe (L).
[94] Colorem + colorem (L).

impedit; caro p[ro]celosa recte uiuentium mores in p[ro]fundum mergit. Dum tantis mare te[m]pestatib[u]s agitat[ur] undar[um] collisione t[er]ra fluctib[u]s i[m]miscetur[95], et sic ex collisione maris et t[er]re colorem mixtum recipit mare. Similit[er] dum caro sugg[er]it et anim[us] non consentit quasi ex nigro et niueo quidam in corpore color efficit[ur], qui ex diu[er]sis fact[us] color medius appellat[ur][96]. Marinus [i]g[itur] color in pectore columbe t[r]ibulationem designat in humana mente.

Chapter 11: De diu[er]sis p[ro]p[r]ietatib[us] columbe.

In diuersis locis diu[er]sas columbe p[ro]prietates repperi, quas inserens huic op[er]i tibi frat[er] annotare[97] curaui. Prima nat[ur]a columbe e[st] quod p[ro] cantu gemitum p[ro]fert; s[e]c[un]da q[uo]d felle caret; tercia quod osculis instat; quarta q[uo]d gregatim uolat; q[u]inta q[uo]d ex rapto non uiuit; sexta quod meliora g[ra]na colligit; septima quod n[on] uescit]ur] cadauerib[u]s; octaua q[uo]d nidificat in petre foraminib[us]; nona quod sup[er] fluenta residet, ut uisa accipitris umbra uenientem citius deuitet[98]; decima quod geminos nut[r]it pullos.
Columba p[ro]cantu utit[ur] gemitu, quia q[uo]d libens fecit plangendo gemit. Caret felle, id e[st], irascibilitatis amaritudine. Instat osculis q[u]ia delectat[ur] in multitudine pacis. Gregatim uolat q[u]ia conuentus amat. Non uiuit ex rapto q[u]ia n[on] detrahit p[ro]ximo. Colligit grana meliora, id e[st], moralia dicta. Non uescit[ur] cadau[er[ib[us], id e[st], desid[er]iis carnalib[u]s[99]. Nidificat in forami[ni]b[u]s petre quia spem ponit in Xpi passione. Sup[er] fluenta residet, ut uisa accipitris umbra uenientem citius deuitet, q[u]ia in sc[ri]pturis studet ut sup[er]uenientis diaboli fraudem declinet. Geminos nut[r]it pullos, id e[st], amorem d[e]i et amore[m] \p[ro]ximi/. Qui has [i]g[itur] naturas habet assumat[100] s[ib]i contemplationis alas q[ui]b[u]s ad celum uolet.

Chapter 12: Surge aq[u]ilo[101].

4th Miniature: The Hawk
Nunquid[102] p[er] sapientia[m] tuam plumescit accipiter expandens alas suas ad austrum?[103]

Aquilo frigidissim[us][104] uentus est. Ab aquilone, inquit, pandet[ur] malum. Ibi sedes sathane inde ruine p[r]incipium. Ventus aquilo grauis temptatio e[st]. Flatus aquilonis suggestio temptationis. Frigus negligentie torpor. Aquilo [i]g[itur] uenit q[u]ando g[r]auis te[m]ptatio mente[m] cui[us]libet inuadit. Aquilo u[ero] surgit \q[u]ando ab/ animo temptatio recedit. Ab aquilone, inquit, et mari. Aquilo temptatio, mare mund[us]. Ab aquilone igit[ur] et mari Xpc suos cong[re]gat, cum a tumultu te[m]ptationum n[on] tantu[m] iustos, s[ed] etia[m] peccatores sequestrat.

Chapter 13: Ponam sede[m] mea[n] ad \aq[ui]lone[m] et erro simil[is] altissimo/.

Ponam, inquit, sedem meam ad aquilonem, et ero similis altissimo. Sedem ad aquilone[m] pon[er]e desid[er]at quem penna sup[er]bie sursum leuat. Esse similis \altissimo co[n]cupicit[105] q[u]i illi cui sube[ss]e de/bet p[er] arrogantie sp[iritu]m se equalem facit. Et ut plus dicam, n[on] tantu[m] se magistro suo equip[er]at, sed etiam illo meliorem e[ss]e putat. Cecidit diabolus cu[m] \se exaltare/ uoluit. Humiliat[ur] homo[106] cum se exaltare concupiscit.

---

[95] Immiscetur → Inmiscetur (H, SC).
[96] Appellatur → Apellatur (L).
[97] Annotare → Superannotare (H).
[98] Deuitet → Euitet (H).
[99] Carnalibus desideriis (C). Both words are represented with the following signal ″ at the beginning of the terms.
[100] Assumat → Assummat (L).
[101] Aquilo + et (C).
[102] Nunquid → Numquid (H, SC).
[103] H contains an additional vertical frame: Ponam sedem meam ad aquilonem et erosimilis altissimo.
[104] Frigidissimus → Fridissimus (SC, L).
[105] Concupicit → Concupiscit (H, C, SC, L).
[106] Homo → Humo (SC, L).

Chapter 14: Et[107] ueni, Auster[108].

Auster calidissim[u]s uentus e[st]. \D[eu]s inq[u]it ab/ austro ueniet. Ibi sedes altissimi, ibi dilectionis ardor, inde sinceritas u[er]itatis. Auster a serena regione p[ro]cedit, q[u]ia d[eu]s in serenitate morum requiescit. Ibi pascit, ibi cubat. Ibi quies mentis, ibi refectio contemplationis. Auster sp[iri]t[us] s[an]c[t]i[109] gra[tia]m designat, flatus austri benignitatem sp[iri]t[us] s[an]c[t]i, calor amor. Auster [i]g[itur] uenit quotiens[110] g[ra]tia sp[iri]t[us] s[an]c[t]i[111] mentem cuiuslibet accendit. Surgit quotiens a m[en]te gra[tia] recedit.

Chapter 15: ~~Ero simil[is] altissimo.~~[112]

D[eu]s, inquit, ab austro ueniet. Ab aquilone diabolus, ab austro d[eu]s. Ille ignorantie teneb[ra]s inhabitat; iste serenitatem caritis[113] amat. Frigus aquilonis poros c\a/rnis stringit; calor austri clausos ap[er]it. Q[uo]d enim frigus auaricie str[i]ngendo[114] retinet, ap[er]tis elemosine manib[u]s caritas larga p[re]bet. Penna siquidem uetus in infernum mergit, noua uero animu[m] ad celestia desid[er]anda sustollit. Peccata eni[m] grauant, ui[r]tutes u[ero] subleuant. [115]

Chapter 16: Beatus g[re]gori[us] de accipit[r]e[116] qualit[er] plumescat.

Nunquid[117] p[er] sapientiam tuam plumescit accipit[er], expandens alas suas ad austrum?
Unde beatus gregori[us], agrestib[u]s accipit[ri]b[u]s moris est ut flante austro alas expandant quatinus eoru[m] m[em]bra ad laxandam pennam uet[er]em uenti tepore concalescant. Cum u[ero] uentus deest, alis contra radium solis expansis atq[ue] p[er]cussis, tepentem s[ibi] auram faciunt sicq[ue] ap[er]tis poris, u[e]l uet[er]es exiliunt u[e]l noeu succrescunt. Quid e[st] [er]g[o] accipitrem in austro plumesc[er]e nisi quod unusq[ui]sq[ue] s[na]c[t]orum tactus flatu sp[iri]t[us] s[na]c[t]i concalescit, et usu[m] uetuste conu[er]sationis abiciens noui hominis formam sumit?
Quod paulus ap[osto]l[u]s ammonet[118], dicens, Expoliantes se[119] uet[er]em hominem cu[m] actib[u]s suis et induentes[120] nouum. Et rursum: licet his[121] qui foris e[st] n[oste]r homo corrumpat[ur], tam[en] is qui intus e[st] renouatur de die in diem. Uetustam aute[m] pennam p[ro]icere e[st] inuet[er]ata studia dolose actionis amitt[er]e; et nouam penna[m] sum[er]e e[st] mitem ac simplicem bene uiuendi sensum tenere.

---

[107] *Om.* Et (C).
[108] *Om.* Et ueni, Auster (H).
[109] Spiritus sancti → Spiritus dei (SC, L). Sancti spiritus (H).
[110] Quotiens → Quociens (L).
[111] Sancti spiritus (H).
[112] D[eu]s ab austro ueniet (C).
[113] Caritis → Caritatis (H, C, SC, L).
[114] Stringendo → Restringindo (C). The "res" is expuncted.
[115] Additional chapter in the L copy: De accipitre. Accipitres ferunt[ur] duram in eo adu[er]sus p[ro]p[r]ios fetus habere incleme[n]tia[m], q[uo]d ubi eos adu[er]terint temptare uolatus p[r]imordia nidis eiciunt suis, continuoq[eu] elimina[n]t ac si morent[ur], proculsant pennis, atq[eu] p[re]cipitant. U[er]berant alis, coguntq[eu] audere quod trepidant, nec ullum postea defer[re] his munus alimonie. Quid miru[m] tame[n] si rap[er]e assueti nutrire fastidiunt; Consideremus ad hoc eos e[ss]e generatos, ut etia[m] aues ad cauendu[m] formido exerceat. Nec passim curas relaxent s[ed]; p[er]ic[u]la p[re]donibus declinanda p[ro]spiciuunt. Deinde cum his nat[ur]a quedam p[re]dandi munus moleu[er]it magis t[er]renos pullos suos institu[er]e uident[ur] ad preda[m], qua[m] pastos abdicare compendiis. Cauent ne in ten[er]a etate pigrescant, ne soluantur deliciis ne marcescant ocio, ne discant cibos magis spectare quam querere, ne nature sue deponant uigorēm. Intermituntur studia nutriendi, ut in usus rapiendi audere compellant (L).
[116] Accipitre → Acciptre (SC).
[117] Nunquid → Numquit (H).
[118] Ammonet → Amonet (H).
[119] Se → Uos (H).
[120] Induentes → Inducentes (H).
[121] His → Is (H, C, SC, L).

Penna namq[ue] uet[er]is conu[er]sationis grauat, et pluma noue immutationis subleuat, ut ad uolandu[m][122] tanto leuiorem q[ua]nto nouiore[m] reddat.
Et benne ait, expandens alas suas ad austrum. Alas q[u]ippe n[ost]ras ad austrum expandere e[st] p[er] aduentum s[an]c[t]i sp[iri]t[us] n[ost]ras confitendo cogitationes aperire, ut iam n[on] libeat defendendo nos tegere, s[ed] acusando publicare. Tunc [er]g[o] accipit[er] plumescit cum ad austrum alas expanderit[123] q[u]ia tunc se un[us]quisq[ue] ui[r]tutum pennis induit cum s[an]c[t]o sp[irit]ui[124] cogitationes suas confitendo subst[er]nit. Qui enim fatendo uet[er]a n[on] detegit, noue uite op[er]a minime p[ro]ducit. Qui[125] nescit lugere quod grauat n[on] ualet p[ro]ferre q[uo]d subleuat; ipsa namq[ue] compunctionis[126] uis poros cordis ap[er]it, et plumas u[ir]tu tum fundit. Cumq[ue] se studiose mens de pigra uetustate redarguit, alacri nouitate iuuenescit. Dicat[ur] [er]g[o] beato iob, Numq[u]id per sapientia[m] tuam plumescit accipit[er] espandens alas suas ad austrum? Id e[st], nu[m]quid cuilibet electo tu intelligentiam contulisti, ut flante sp[irit]u s[an]c[t]o cogitationum alas expandat; quatin[u]s pond[er]a uetuste conu[er]sationis abiciat[127] et ui[r]tutum plumas in usum noui uolatus sumat; ut hinc uidelicet colligat[128] q[u]ia uigilantiam sensus in semetipso ex se ipso n[on][129] habet, qui hanc ex se confere aliis nequaq[ua]m ualet?[130]

Chapter 17: D[e] domestico et siluestre accipitre.[131]

Due sunt speties[132] accipit[r]is, domesticus scilicet et siluestris. Idem tam[en] s[ed] diu[er]sis temporib[u]s postest e[ss]e siluest[r]i set domesticus. Siluestris rap[er]e consueuit domesticas uolucres[133], et domestic[us] siluestres. Siluestris quas rapit continuo deuorat; domesticus captas d[omi]no suo relinquendas seruat. Porro d[omi]n[us] euis captaru[m] uolucrum uentres ap[er]it, et earu[m] corda accipitri in cibum tribuenda sumit. Interiora uentris cu[m] fimo eicit qui intus remanens putredinem carnium cum fetore gignit. Moralit[er] siluest[r]is accipiter captas uolucres et rapit et deuorat, q[u]ia quilibet p[er]u[er]sus actus et cogitationes simplicium n[on] cessat dissipare[134]. Domestic[us] uero accipit[er] est quilibet sp[ir]it[u]alis pater, qui tociens[135] siluestres uolucres rapit quociens s[e]c[u]lares ad conu[er]sionem predicando trahit. Captas occidit du[m] s[e]c[u]lares mundo mori p[er] carnis mortificationem querit[136]. D[omi]n[u]s aute[m] eius, id e[st], om[ni]p[oten]s d[eu]s uentres earum ap[er]it quia molliciem carnalium p[er] sc[r]ipturas increpando soluit. Corda u[ero] extrahit dum cogitationes s[e]c[u]larium p[er] confessionem manifestas fac[it]. Int[er]iora uentris cum fimo eicit q[ua]n[do] memoriam peccati[137] fetentem reddit. Ad mensam itaq[eu] d[omi]ni capte uolucres ueniunt, du[m] in corpus eccl[es]ie peccatores dentib[us][138] masticati sese conu[er]tunt.

---

[122] Uolandum → Uolatum (H).
[123] Expanderit → Expandit (H).
[124] Spiritui sancto (SC).
[125] Qui + enim (H).
[126] Compunctionis → Conpunctionis (H, SC).
[127] Abiciat → Abitiat (C).
[128] Sumat + colligat (C). The "sumat" is expuncted.
[129] *Om.* ipso (H).
[130] Another additional chapter in the L copy: De diuersitate auium. Inuenumus cornicis pedes uelut quibusdam digitis distantib[us] separatos atq[ue] diuisos, corui quoq[ue] ac pullor[um]. Alit[er] etiam formatos a natura pedes auium que carne uescunt[ur], quasi incuruos atq[ue] insinuatos, uelut ad p[re]dam paratos. Ea u[ero] que natandi habe[n]t usum et consuetudine[m] latos habent pedes et membrana quada[m] illos digitos pedum sibi copulatos atq[ue] conjunctos. In quo ammirabilis patet ratio nature, ut et illa ad uolandum, u[e]l ad rapiendu[m] usu accom[odo] fulciant[ur]. Et ista ad natanu[m] adjumenta habeant competentia quo melius possint aquis sup[er]natare et q[ua]si remis quibusdam pedibus suis membrane ullius extensione latioribus aquar[um] fluenta propulsent (L).
[131] *Om.* et (H).
[132] Speties → Species (C, L).
[133] Uolucres → Aues (H).
[134] Dissipare non cessat (H).
[135] Tociens → Totiens (SC).
[136] Querit → Cogit (H).
[137] Peccati + ~~peccati~~ (C).
[138] Doctorum + dentibus (H).

Chapter 18: Qualit[er] accipit[er] plumesc[er]e debeat.

Domesticis accipitrib[us] quo meli[us] plumescere debeant, munita ac tepentia requirunt[ur] loca. Loca munita s[un]t claustra in quib[us], dum siluest[r]is accipit[er] ponit[ur] it domesticus fiat, clausus tenet[ur]. Ibi ueteres pennas emittit et nouas assumit, quia quilibet claustralis q[ua]ndo p[r]istinis uiciis spoliatur noui hominis ui[r]tutib[u]s adornat[ur][139]. Nec inde extrahitur nisi prius eiectis ueterib[u]s pennis noue solident[ur]. S[ed] cum firmus in uolatu fuerit, eiectus foras ad manum uenit. Similit[er] si aliquis conu[er]sus de claust[r]o exeat, necesse e[st] ut ad manum bone op[er]ationis accedat; et inde emissus uolet ut ad desid[er]anda celestia toto ad nisu mentis seipsum leuet.

Chapter 19: Q[uo]d accipit[er] in manu sinistra[140] gestatur.

Accipit[er] in sinistra manu gestari solet, ut in dexteram ad aliquid capiendum emissus uolet. Leua inquit[141] eius sub capite meo, et dextera illius amplexabit[ur] me. Leua sunt bona temp[or]alia dextra[142] u[ero] sunt et[er]na. In leua [i]g[itur] sedet qui bonis temporalib[u]s p[re]sidet, in dexteram[143] u[ero] uolat qui toto affectu mentis et[er]na desiderat. Ibi accipiet[144] accipiter[145] columbam, id e[st], q[u]ilibet mutatus in melius s[an]c[t]i sp[iri]t[us] recipiet gra[tia]m.

Chapter 20: De p[er]tica accipitris.

Pertica accipitris designat nobis rectitudinem uite regularis, que a t[er]ra longe suspenditur q[u]ia a t[er]renis desid[er]iis hui[us] mundi uita[146] separatur. In hac p[er]tica ligatus sedet qui regularis uite statuta firmit[er] tenet. Duobus parietib[u]s inherere dicit[ur] a quib[u]s ex utraq[eu] parte sustentat[ur]. Duo parietes qui p[er]ticam sustentant[147] sunt actiua et contemplatiua uita, que pie uiuentium rectitudinem portant.

Chapter 21: De co[m]pedibus accipitris.

Quasi compedes in pedib[u]s accipit[er] habere consueuit, ne cum uoluerit exorta qualibet occasione euolare possit. Pedes accipitris quasi compedib[u]s[148] stringit qui timore iudicii et dolore supplicci mentis affectus p[re]mit. Et humiliauer[un]t, inquit, in compedib[u]s pedes eius. Pedes ioseph in compedib[u]s humiliat, qui ad memoriam reducens[149] p[re]sentem miseria[m] et et[er]nam pena[m], ne ad optata p[ro]grediant[ur], affectus animi ligat.

Chapter 22: De corrigia accipit[r]is.

Corrigia p[er] q[ua]m accipit[er] ligat[ur] in p[er]tica e[st] morticiatio carnis, p[er] q[ua]m quilibet conu[er]sus[150] tenetur in reg[u]lari uita. Corrigia quidem[151], que fit de corio mortui animalis, designat

[139] Adornatur → Adhornatur (L).
[140] Sinistra manu (H, C).
[141] Inquit → Inquid (H).
[142] Dextra → Dextera (H, SC, L).
[143] Dexteram → Dextera (H).
[144] Accipiet → Capiet (H).
[145] Accipiter → Accipieter (L).
[146] Uita → Longe (H).
[147] Qui perticam sustentant → Quibus pertica sustentatur (H).
[148] Compedibus → Conpedibus (SC).
[149] Reducens → Reducecens (SC).
[150] Conuersus quilibet (H).
[151] Quidem → Siquidem (H, SC, L).

mortificationem carnis. Non rumpit[er] hec corrigia s[ed] uoluit[ur][152] cum ad capiendu[m] aliq[ui]d accipit[er] impellitur. Similit[er] si quilibet frat[er] ad aliq[uo]d lucru[m] te[m]porale exeat, n[on] rumpit[ur] p[ro]positum, s[ed] cu[m] reu[er]titur eadem corrigia qua p[r]ius seipsum firmit[er] conligat[153]. Explic[it] de colu[m]ba et acipitre[154].

Chapter 23: Incipit de t[ur]ture et passere.

Post columbe gemitum et accipitris questum, rogas k[arissi]me ne diutius differam, s[ed] pla[n]ctum turturis et clamorem passeris t[ibi][155] ueloti[us][156] sc[r]ibam. Nec t[antu]m scribam, s[ed] etiam pinga[m] qualit[er] t[ur]tur heremi sec[re]tum diligat et passer solitarius in tecto clamare n[on] desinat, ut sub exemplo turturis teneas mu[n]diciam castitatis et sub exemplo passeris ames custodiam calide[157] circumspectionis, ut et uiuas caste et ambules caute.

5th Miniature: The Palm tree

De palma et turture[158] q[uod] turtur in nidulo suo moritur et sicut palma multiplicat dies[159].

Chapter 24: De palma et turture: q[uo]d turtur in nidulo suo moritur et sicut palma multiplicat dies. De palma et t[ur]ture q[uo]d t[ur]tur in nidulo suo morit[ur] et sic[ut] palma multiplicat dies.

6th Miniature: The Turtledove Diagram

Inner circle: In nidulo meo moriar et sicut palma multiplicabo dies.

Verticle frame: In nidulo suo morit[ur] cuius uita fide[160] t[er]minat[ur]. In nidulo turt[ur] nut[r]it pullos et ecc[le]tia in fide sp[iritu]ales filios[161].

Sicut palma multiplicabo dies. Palma multiplicat dies[162] quia tarde proficit priusq[ua]m in altum crescat. Silimit[er] iustus tarde[163] p[ro]ficit p[r]iusq[ua]m ad hoc p[er]ueniat ad quod tendit. Est enim iusti desid[er]ium ut p[er]ueniat ad celeste regnum. S[ed] ad hoc desid[er]iu[m] mundus impedit[164], ut ad optata nisi tarde p[er]uenire possit.

Palma dies multiplicat, nec tam[en] eam frigus hyemis u[e]l nimi[us] calor estatis impediunt quin semp[er] uiridescat[165]. Similit[er] iustus[166] semp[er] uiret, nec ab aliquo impeditur quin in p[ro]posito bone op[er]ationis perseueret. Frigus hiemis[167] e[st] torpor u[e]l negligentia refrigerate m[en]tis. Nimius calor estatis e[st] ardor libidinis u[e]l iracundie[168] fla[m]ma, seu incendium cupiditatis. Nec palma igit[ur] marcessit[169] frigore nec nimio estatis urit[ur] calore. Sic nec iustus p[re]mitur qualicumq[ue] temptatione.

Aliter. Palma dies multiplicat quia iustus dies antiq[u]os ad memoriam reducit et annos et[er]nos in m[en]te tractat. Paucitatem dierum suorum si[bi] nuntiat, et[170] ex alia parte longitudinem dierum in

[152] Uoluitur → Soluitur (H, C).
[153] Firmiter conligat → Firmiter colligat (SC, L); Firmus ligat (H).
[154] Acipitre → Accipitre (H, C, SC, L).
[155] *Om.* tibi (SC).
[156] Uelotius → Uelocius (H, SC, L).
[157] Calide → Callide (H, C, SC, L).
[158] These are presented as titles in SC and L, while the rest of the phrase is written in an inner circle.
[159] *Om.* De palma et turture quod turtur in nidulo suo moritur et sicut palma multiplicat dies (H).
[160] In + fide (H).
[161] In SC and L the words are organized around the circular frame, not in a verticle frame across the folio.
[162] Dies multiplicat (H, SC, L).
[163] Tarde → Tandem (H).
[164] Impedit → Impendit (L).
[165] Uiridescat → Uiridiscat (SC, L).
[166] Iustus → Intus (L).
[167] Hiemis → Hyemis (H, SC, L).
[168] Iracundie → Iracumdie (C).
[169] Marcessit → Marcescit (H, C).
[170] *Om.* et (SC, L).

fut[ur]o sperat. Qui hec igit[ur][171] int[ra] se colligit multiplicando dies sicut palma, uincendo mundum in altum crescit.

Chapter 25: Nidul[us] anime fidelis est fides passionis.

Statura tua assimilata est palme. Statura eccl[es]ie uel cui[us]libet fidelis anime assimilatur palme. In statura cui[us]libet hominis notat[ur] paruitas u[e]l magnitudo in membris p[er] lineamenta[172] corp[or]is. Habet aute[m] staturam palme iustus si aput[173] se modicus, aput d[eu]m magnus; in se humilis, coram deo sublimis. Hec palma e[st] xpc, cui assimilat[ur] iustus. Dum enim t[ri]bulationes quas passus e[st] xpc partitur, stature palme iustus assimilat[ur]. Vnde Ap[os]t[olu]s, Qui erunt participes t[ri]bulationum erunt participes et gl[ori]e. Qui igit[ur] membru[m] corporis e[st] que sunt capitis sentire debet.
Iam palma creuit in altum; iam cacumen illius[174] penetrauit celum. Ia[m] cum capite sunt capitis come, que sunt elate palmaru[m], id est, electe animar[um]. Adhuc stipes rugoso cortice, id est, eccl[es]ia ci[r]cumdata t[r]ibulationu[m] asp[er]itate, in t[er]ra figit[ur]; et rami, id est s[an]c[t]i, in eterna felicitate gl[ori]antur.

Chapter 26

Iustus ut palma florebit. Iustus plantat[ur], floret et fert fructum. Plantatur in domo d[omi]ni in atriis dom[us] d[e]i n[ost]ri. Domus d[e]i n[ost]ri e[st][175] dom[us] conu[er]sionis. Est aut[em] at[ri]um ante domu[m], ante domum siquidem conu[er]sionis e[st] atrium ren[un]tiationis[176]. Qui eni[m] mundo[177] renuntiat palmam uictorie qua mundu[m] uincit in at[ri]is dom[us] d[omi]ni plantat. Plantat[ur] [i]g[itur] in domo conu[er]sionis, floret p[er] famam bone opinionis, \fert fructu[m] recte[178] operationis[179]. S[ed] quorsum[180] figit radice[m]? Q[u]o[mod]o crescit? Quomodo/ roborat[ur]? Radicat[ur] p[er] fidem, c[re]scit p[er] spem, roborat[ur] p[er] caritate[m]. Mirum e[st] tam[en] q[uo]d de iustis dicit[ur]: Plantati in domo d[omi]ni, in atriis dom[us] dei n[ost]ri florebunt. Miru[m] est quod plantat[ur] in domo et florent[181] in at[r]io. S[ed] fortasse p[er] fide[m][182] plantat[ur][183] intus, p[er] exemplum boni op[er]is florent ext[er]ius, et sic p[er] famam bone opinionis foras exit odor floris. Uel alit[er], planta[n]tur[184] in domo, florent in at[r]io q[u]ia iusti plantat[ur] in p[re]senti eccl[es]ia et flore immarcessibili[185] florebunt in et[er]na uita. Ibi etiam cum flore recipient fructum, id est, cum mundicia carnis et anime future ret[ri]butionis p[re]mium.

Chapter 27: Nidulus t[ur]turis latet in arbore crucis[186].

Ascendam in palmam et apprehenda[m] fructus eius. Palma iuxta terram e[st] gracilis et asp[er]a, u[er]sus celum grossior et pulcra. Est [i]g[itur] ascensus difficilis s[ed] fructus dulcis. Minuit[ur] ascendentis labor dum sentit[ur] odor; difficultate[m] ascensus aufert dulcedo gustus. Palma e[st] xpc, fructus salus. Salus,

---

[171] Igitur hec (H).
[172] Lineamenta → Limamenta (L); liniamenta (SC, C).
[173] Aput → Apud (C, SC, L).
[174] Illius → Ipsius (L). The word \illius/ was later added on top of the ipsius.
[175] Dei est nostri (C).
[176] Renuntiationis → Renumtiationis (C).
[177] Mundo → Mundum (H).
[178] *Om.* recte (H).
[179] Operationis → Operacionis (L).
[180] Quorsum → Q\c/orsu^{u}m (L): An attemp to erase the "c" was made; additionally, a "u" was also superscripted on top of the other "u". Corsum (C). The "co" is expuncted with a "q" and an "o" supescripted on top of each other.
[181] Florent → Floret (H).
[182] Per fidem fortasse (H).
[183] Plantatur → Plantantur (H, C, SC, L).
[184] Plantantur → Plantatur (L).
[185] Immarcessibili → Immarcescibili (C); Inmarcessibili (H).
[186] *Om.* Nidulus turturis latet in arbore crucis (H).

inq[ui]t, p[o]p[u]li ego sum; gustate [er]g[o] et uidete q[uonia]m suauis e[st] d[omi]n[us]. Spes salutis in ligno e[st][187] crucis. Ascende [i]g[itur] in palma[m], id e[st], attende crucis uictoriam, p[er] scalam siq[u]idem crucis ascendes ad solium uictoris. Tolle et tu crucem tuam et sequere eum. Qui affligit carnem tollit crucem. Palma manu[m] uictoris ornat, et iustus palmam uictorie in manu bene op[er]ando portat. Tria dicunt[ur] e[ss]e de q[u]ibus iustus uictoria[m] debet acquirere[188]: mund[us], caro, diabolus. Iustus mundu[m] uincit dum eum cum suis oblectacionib[us][189] conte[m]pnit[190]. Carnem sup[er]at dum eam p[er] abstinentia[m] domat. Diabolo d[omi]natur et eum subicit dum eum a suis finib[u]s expellit. Palma[m] [i]g[itur] in manu gestat qui de his t[r]ibus bene op[er]ando t[r]iumphat.

Chapter 28: De turture.

Vox turturis audita e[st] in t[er]ra n[ost]ra. Vox t[ur]turis est dolor lese mentis. Vox t[ur]turis gemitum designat[191] cui[us]libet anime penitentis. Terra de qua hic[192] agit[ur] e[st] anim[us] qui t[er]rene fragilitatis occupationib[u]s irretitur. Est autem t[er]ra n[ost]ra et t[er]ra aliena. Terra aliena e[st] mens diaboli dominio subiugata. Unde, alieni insurrexerunt in[193] me, et fortes quesierunt a[n]i[m]am mea[m]. Terra aliena e[st] babilonia[194], t[er]ra n[ost]ra ier[usale]m. Babilonia[195] confusio, iherusalem uisio pacis int[er]pretat[ur]. Terram n[ost]ram alieni deuorant q[u]ando demones suis incursionib[u]s m[en]tem uastant. In babilonia tenem[ur][196] captiui, in iher[usa]l[e]m sum[us] liberi. Quom[od]o [i]g[itur] cantabim[us] canticum d[omi]ni in terra aliena? Terra e[ss]e n[ost]ra[197] dicit[ur] dum nichil in m[en]te n[ost]ra p[ro]p[r]i[um][198] repp[er]it[ur]. Terram nostram e[ss]e dicim[us] dum m[en]tem nostram cum magistro et f[rat]ib[u]s possidemus[199], ut anim[us] deo deuotus seruiat p[er] dilectione[m] fr[at]ib[u]s, p[er] co[m]passionem p[ro]ximo, p[er] modestia[m] sibi; et sic communis fiat. In t[er]ra [i]g[itur] n[ost]ra uox turturis audit[ur] du[m] in pacifica mente culpa cognoscit[ur]. Vox turturis audit[ur] dum ad penitentia[m] auris interior humiliter inclinat[ur].

Chapter 29: Item de turture.

Turtur secretum deserti diligit. Q[u]andoq[ue] tam[en] ad hortulos[200] paup[er]um et[201] agros cultoru[m] descendit, ut grana seminu[m] colligat unde uiuat. Turtur e[st] eccl[es]ia u[e]l quelibet fidelis a[n]i[m]a, secretum deserti solitudo claustri, grana seminu[m] sententie[202] doctorum, hortuli[203] u[e]l agri doctor[um] libri. Ex his anim[us] reficit[ur]; in his uita sp[iri]t[us], sic enim uiuit[ur], et in talib[u]s uita sp[iri]t[us] mei.

In locis tutissimis et in[204] delectabilib[u]s inuenit t[ur]tur sibi nidum[205] u[b]i reponat pullos suos. Inter ramos arboris condense nidu[m] collocat, oua ponit, unde suo temp[or]e p[ro]creent[ur] pulli. P[er] arborem intelligim[us] crucem, p[er] nidu[m] salutem, p[er] oua spem, p[er] pullos gemina[m] caritatem,

---

[187] *Om.* est (H).
[188] Acquirere → Aquirere (SC).
[189] Oblectacionibus → Oblectationibus (H, C, SC, L).
[190] Contempnit → Contemnit (SC, L).
[191] Designat gemitum (H).
[192] Hic → Hoc (SC). It has an "i" supercripted above the "o".
[193] In → Aduersum (H).
[194] Babilonia est (L).
[195] Babilonia → Babylonia (H).
[196] Tenemur → Tenentur (L).
[197] Nostra esse (H).
[198] Proprium → P[r]ium (SC).
[199] Possidemus → Presidemus (L).
[200] Hortulos → Ortulos (H).
[201] Et + ad (H, C).
[202] Sententie → Sentencie (L).
[203] Hortuli → Ortuli (H).
[204] *Om.* in (H).
[205] Nidum sibi (C).

amorem uidelicet d[e]i et p[ro]ximi. Queramus [i]g[itur] nidum t[ur]turis; queram[us] ouum in nido, nidum in arbore, id est, spem salutis in ligno crucis.
Notum etia[m] q[u]am plurib[u]s e[ss]e reor[206] naturam turturis e[ss]e tale[m] ut si semel socium amiserit, absq[ue] socio se[m]p[er] erit. Xpc e[st] spons[us] eccl[es]ie u[e]l cui[us]libet fidelis anime. Ascendit xpc in arborem crucis, undiq[ue] mundum cont[ra]xit. Ascendam, inquit, in palma[m], et om[n]ia traham ad me. Mortuus est xpc; expectat eum ecclesia, u[e]l quelibet fidelis anima, donec redeat, et caste societatis[207] int[er]im legem seruat. Redit sepius ad arborem, freque[n]tat nidum, uidet effusione[m] sanguinis, inditium[208] uidelicet mortis; dum hec attendit gemit. Similit[er] quelibet a[n]i[m]a fidelis sepius ad memoriam reducit mist[er]iu[m][209] crucis, attendit p[re]cium sanguinis. Que dum attente consid[er]at, multiplicatis gemitib[u]s me[n]te[m] ad lamenta uocat.

Chapter 30: De cedro et passerib[us] q[u]i in ramis cedri nidifica[n]t.

7th Miniature: The Cedar of Lebanon[210]

In bona significatione cedrus et liban[us][211] quandoq[ue] ponunt[ur], sic[ut] in canticis canticorum p[er] salomonem dicit[ur], Species ei[us] ut libani[212] electus ut cedri.
Liban[us] phenicis est mons, t[er]min[us] iudee cont[r]a septemt[r]ionem. Arbores illi[us] p[ro]ceritate, specie et robore ceterarum siluarum ligna p[re]cellunt. Per monte[m] libanu[m] sane intellig[er]e possum[us] eminentiam ui[r]tutum. Termin[us] e[st] uidee contra septemt[r]ionem, ne diabolus mentes uere co[n]fitentium intret p[er] temptationem[213]. Arbores illi[us] p[ro]ceritate, spetie et robore alias arbores precellunt \du[m]/ quelibet fideles anime p[ro]ceritate desid[er]ii[214], robore p[er]seuerantie alias antecedunt. P[er] cedrum intelligim[us] xpm. Hec e[st] cedrus alta libani, conformata ysopo, qui, cum e[ss]et sublimis, factus e[st] humilis. Passeres sunt p[re]dicatores. Pulli sunt hi q[u]i u[er]bo predicationes sunt p[ro]creati. Nidus q[u]i[e]te mentis locus. In hac [i]g[itur] cedro nidifica[n]t qui tranq[u]ille uiuendo de et[er]na beatitudine n[on] formidant[215].
Sunt cedri libani quas plantau[it] d[omi]n[u]s. Cedri libani sunt diuites h[uius] mundi. Passeres sunt cenobioru[m] rectores, pulli discipuli. Nidus officionaru[m] locus. In his cedris passeres nidificant q[u]ia rectores animarum in posessionibus[216] diuitum cenobia[217] locant. Ibi passeres clamare n[on] cessant ut s[ib]i a deo escam querant. A d[e]o s[ib]i escam[218] querunt qui u[er]bis diuini eloquii, q[u]asi cibo saciari uolunt. Die ac nocte clamitant q[u]ia[219] p[ro] suis benefactorib[u]s toto adnisu mentis d[eu]m rogant. In nido t[r]anquille m[en]tis pennas contemplationis nut[r]iunt q[u]ibus ad p[re]dictam cedrum q[u]am citius poterunt euolare contendunt. Circa ligna libani uolitant q[u]ia uitam seu mores uiroru[m] sublimiu[m][220] scire desid[er]ant. Ex his lignis libani salomon ferculu[m] fecisse legit[ur], q[u]ia eccl[es]ia de uiris sublimib[u]s et in fatigabilib[u]s edificatur.

Chapter 31

[206] Esse reor pluribus (H).
[207] Societatis + ut (H).
[208] Inditium → Indicium (H, SC, L).
[209] Misterium → Mysterium (H).
[210] The H version includes: Saturabuntur ligna campi et cedri libani quas plantauit illic passeres nidificabunt. Hec cedrus fuit comes Teubaldus.
[211] Libanus → Lybanus (H).
[212] Libani → Lybani (H).
[213] Temptationem → Tentationem (SC).
[214] Desiderii + specie castitatis (H).
[215] Formidant → Desperant (H).
[216] Posessionibus → Possessionibus (H, C, SC).
[217] Cenobia → Cenobium (SC, L).
[218] Escam sibi (SC, L).
[219] Quia → qui (H).
[220] *Om.* Sublimium (H).

Sunt cedri quas[221] plantauit d[omi]n[us]. Non plantauit in p[ro]p[r]ia uoluntate, n[on] dilatauit cupiditate. Omnis au[tem] plantatio q[ua]m n[on] plantauit pater meus celestis eradicabitur. Hi cedri libani sunt diuites sup[er]bi. In his nidificant herodii et accipitres, id est, raptores. Nidos co[m]ponunt q[u]ia in possessionib[us] diuitum raptores munitiones[222] construunt. Pulli sunt complices raptoru[m] seu minist[r]i. Hee uoluc[r]es in cedris ut rapiant latent, q[u]ia raptores nocendi potentia[m] a p[r]incipib[u]s p[er]u[er]sis habent[223]. S[ed] d[omi]n[u]s confringet cedros libani, id est, diuites mundi, quosdam p[er] penitentia[m], quosdam p[er] uindictam. P[er] penitentiam confringet q[u]ando sicut uitulum libani co[m]minuet. Comminuet tanq[u]am[224] uitulum libani[225] ad imitatione[m] uite X, ut fiat uitulus sacrificiis aptus, ut carnem mortificet et cum Xpo crucem portet. Per uindictam confringet alios, quia et[er]no igni reseruandos.

Predicta cedrus multu[m] succisa[226] p[ro]ficit, q[u]ia xpc morte p[ro]p[r]ia mundu[m] redemit. Nisi enim granu[m] frum[en]ti cadens in t[er]ra mortuum fu[er]it, ipsum solum manet. Si aute[m] mortuum fuerit multu[m] fructum affert. Cedrus [er]g[o] succidit[ur] du[m] xpc morit[ur], mors siquidem X multis p[ro]fuit. Descendit ad inferos; surg[e]ns a mortuis ascendens[227] ad celos, spem resurgendi morientib[u]s dedit. Q[u]id enim p[ro]dess[et] uiuere t[r]ibulationib[u]s concuti, ad extremu[m] mori, nisi sequeret[ur] spes resurgendi? Et q[u]id p[ro]de[ss]et resurrexisse, nisi constans e[ss]et hominem immortalem absq[ue] supplicio sine fine man[er]e? Similiter cum cedrus q[u]am plantauit d[omi]n[u]s succidit[ur], multu[m] p[ro]ficit q[u]ia ad et[er]ne beatitudinis edificiu[m] transfertur. Si au[tem] cedrus q[ua]m n[on] plantauit d[omi]n[u]s succisa fuerit, n[on] minime utilitatis erit, q[u]ia que nullu[m] fructum ferebat in Libano, id e[st], in s[e]c[u]lo, pondus edificii succisa sustinet in spi[ri]tali templo. Ita dico, si cedri sup[er]biam succidas p[er] penitentiam; si u[ero] p[er] uindictam succidas, gehenne incendiis illa[m] concremandam imp[er]petuu[m][228] seruas.

Chapter 32: De passere.

In d[omi]no confido quomo[do] dicitis a[n]i[m]e mee t[r]ansmigra in monte[m] sicut passer?

Sub passeris nomine designat[ur] instabilitas mentis in q[u]olibet homine. Est enim passer a\uis inco[n]sta[n]s et instabilis, et ideo designat mobilitatem me[n]/tis. Porro p[er] montem intelligim[us] elationis altitudinem. Quasi passer enim in mo[n]tem t[ra]nsmigrat, qui de ualle humilitatis mentem in sup[er]biam leuat.

Potest et aliter dici ut per passerem intelligam[us] quemlibet infidelem, mons uero sup[ra]dictus sit eminentia heretici sensus. Si q[u]is in hunc montem impingit nauem frangit. Quasi passer [i]g[itur] in hunc monte[m] transmigrat, q[u]i, humilitatem incarnationis xpi deserens, xpm d[eu]m et homine[m] e[ss]e negat. Hereticis itaq[ue] fidei repugna[n]tib[u]s p[ro]ph[et]a respondens dicit se n[on] discessurum a fide q[u]ia in d[omi]no confidit, non eni[m] in ui[r]tute sua confidit, nec in m[u]ltitudine diuitiarum suaru[m] gl[ori]atur.

Chapter 33: De nido passeris.

Passer inuenit sibi domu[m]. In domo pat[r]is mei mansiones multe sunt.

Passer qui de ramo in ramu[m] uolare nouerat, nunc de siluis ad domu[m] uolat. Sic multi q[u]i diu[er]sis s[e]c[u]li actib[u]s inherebant, n[un]c m[en]tem in domum n[on] manu facta[m], que in celis est, leuant. Passer qui uestiebat[ur] leuib[u]s plumis, id est, s[e]c[u]larib[u]s curis, n[un]c incedit pennat[us] ui[r]tutib[u]s et p[re]ceptis. Ascendit et nidu[m] ponit. Dat aute[m] d[eu]s unde fiat nidus. Verbum

[221] Quas + non (H).
[222] Munitiones → Municiones (L).
[223] Habent → Habeant (L).
[224] Tanquam → Sicut (H).
[225] Libani → Lilibani (SC). The "li" is repeated with the change of line.
[226] Succisa multum (H).
[227] Ascendens → Ascendit (H).
[228] Imperpetuum → In perpetuum (H, L); mperpertuum (SC). The "i" that should be at the beginning of the word seems to have been possibly erased.

siq[u]idem pat[r]is induit se feno[229] carnis, et sic in altum nidus ponit[ur], q[u]ia sup[ra] ang[e]licam creaturam humana collocat[ur]. Nidificat in foraminib[u]s[230] petre, q[uia] spem ponit in Xi passione. Pet[ra] eni[m] erat xpc. Hec e[st] alta cedrus libani, conformata ysopo; illic passeres nidificabunt.

Chapter 34: De calliditate passeris.

Vigilaui et factus sum sicut passer solitarius in tecto.
Locum manendi in domo fidei passer inuenit; et qui p[r]ius instabilis fuerat, ne ab \accipitre/ rapiat[ur] uigilare n[on] cessat. Sic a quolibet fideli agitat[ur][231], ne a diabolo captus[232] teneatur. Vigilat s[ib]i p[er] custodiam; uigilat p[ro]ximo p[er] doct[r]inam. In tecto passer habitat ut a t[er]renis longe fiat. In domo manet in tecto residet, qui fid[e]i firmitate[m] tenet de culmine ui[r]tutum subiectos docet. Ecce quomo[do] passer qui p[r]ius ad monte[m] p[er]fidie t[ra]nsmigrare consueu[er]at, nunc, pro u[er]itate fid[e]i uigilans, de excelsis clamat. Qui id[e]o dicit[ur] solitari[us], quia a terrenis desid[er]iis p[ro]cul sit remotus.

Chapter 35[233]

Anima n[ost]ra sicut passer erepta e[st] de laqueo uenantium[234]. La[queus] con[tribus][235] e[st], et nos liberati[236] sum[us].
Tenet anima similitudinem passeris, dum in his que agit utitur exemplo calliditatis. Dum eni[m] anima sepius seipsam consid[er]at, contingit q[ua]n[do]q[ue][237] ut, ex uisu[238] assidue consid[er]ationis, anim[us] callidior fiat, ut in uia positum uitet laqueu[m]. Sunt au[tem] tres laquei. Prim[us] laqueus uenantiu[m] e[st] fallax suggestio demonu[m]; s[e]c[un]d[u]s[239] subtilis deceptio hereticoru[m]; terci[us] dulcedo uite carnaliu[m]. Hii laquei ponunt[ur] in semita, in uia, in campo. Semita e[st] artior[240] uita[241] uia, lata uita[242], camp[us] spatiosa[243]. P[er] artam[244] et arduam religiosi; p[er] latam et rectam coniugati; p[er] spatiosam[245] et deuiam[246] uoluptuosi gradiunt[ur]. Laqueus passere[m] captum retinet dum diabolus mente[m] possidet, u[e]l dum dulcedo uite p[re]sentis placet, seu du[m] hereticus blandiciis deceptu[m] fouet. S[ed] laqueus rumpit[ur] et passer lib[er]atur si, abiectis carnalib[u]s desid[er]iis, anima ad d[eu]m conu[er]tat[ur]. Hoc aute[m] n[on] fit p[er] n[ost]ram potentiam, s[ed] p[er] gra[tia]m. Adiutorium, {enim, nostrum} in nomine domini.

Chapter 36: De p[re]cio passeris.

Iuxta seriem euang[e]lii, duo passeres asse ueneunt, et q[u]inq[ue] dipondio. Passeres sunt homines uagi et inconstantes. Dipondius ex duob[u]s assib[u]s constat, utru[m]q[ue] tam[en] parui pond[er]is e[st]. Asse [i]g[itur] et dipondio passeres uenduntur, dum p[ro] t[r]ansitoriis et temp[or]alibus[247] et[er]no igne

[229] Feno → Pheno (SC, L).
[230] Foraminibus → Forammibus (SC).
[231] Agitatur → Agitur (H).
[232] Captus → Raptus (H).
[233] De laqueo passeris (H, C).
[234] Uenantium → Uenatium (C).
[235] Contribus → Contritus (H).
[236] Liberati → Libarati (SC).
[237] Quandoque contigit (H).
[238] Uisu → Usu (H).
[239] Secundus → Secumdus (C).
[240] Artior → Arcior (SC, L).
[241] *Om.* uita (H).
[242] Uita → Uia (H).
[243] Spatiosa → Spaciosa (SC, L).
[244] Artam → Arctam (SC, L).
[245] Spatiosam → Spaciosam (L).
[246] Deuiam → Deuiosam (C). The "o" is expuncted.
[247] Temporalibus et transitoriis (C).

cruciandi peccatores diabolo subitiunt[ur][248]. Et tam[en] n[on] erit in obliuione coram domino un[us] ex illis, q[u]ia peccatorib[u]s semp[er] parata e[st] mi[sericordi]a redem[p]toris. Vos au[tem], inq[u]it, pluris illis[249] estis. Hoc de discipulis dixit. Sunt[250] iusti[251] maioris p[re]cii[252]. Dum enim iusti se et sua p[ro] d[omi]no in presenti s[e]c[u]lo t[r]ibuunt, in fut[ur]a beatitudine p[ro] t[r]ansitoriis et co[m]mutabilib[u]s et[er]na possidebunt.
Sunt quidam q[u]i duo[253] passeres coacte anima[m] et corpus int[er]pretant[ur], q[u]inq[ue] u[ero] passeres ad q[u]inq[ue] corp[or]is sens[us] referunt. Item n[on]ne duo passeres asse ueneunt? et un[us] ex illis n[on] cadet sup[er] t[er]ram absq[ue] patre meo[254]. Unde ieronim[us][255], Si parua, inq[u]it, animalia et uilia absq[ue] deo auctore n[on] decidunt, uos qui et[er]ni estis n[on] debetis timere quod absq[ue] p[ro]uidentia uiuatis. Nolite [er]g[o] tim[er]e eos qui occidunt corp[us][256], animam aut[em] n[on] possunt occidere.

Chapter 37: De inmolatio[n]e[257] passer[is].

Vox moysi p[re]cepit quod si quis a lepra mundatus fuerit offerat duos passeres equib[us][258] unum i[m]molet sacerdos in uase fictili sup[er] aq[u]as uiuas, alt[er]um u[ero] intingat in sanguine passeris immolati et eum in agrum lib[er]um uolare p[er]mittat. Duo passeres sunt corp[us] et anima, uas fictile fragilitas carnis moribunde, aque uiue scientia diuine sc[r]ipture que nob[is] p[re]stant potu[m] sp[ir]italem et ablutionem. Duos passeres offerim[us] cum corp[us] et a[n]i[m]am deo consecram[us]. Quod u[ero] un[us] passer immolabat[ur][259], retorto ad pennulas capite ita ut sanguis effund[er]etur nec tam[en] cap[ut] a collo abrump[er]etur, designat q[u]ia ita caro n[os]tra aff\ligen/da est p[er] abstinentia[m][260], ut n[on] penitus extinguat[ur] a uita. Q[uo]d u[er]o alt[er] passer liber in agrum auolare[261] p[er]mittit[ur] moralit[er] designat[ur], q[u]ia anima n[ost]ra concupiscentiis carnalib[us] edomitis pennis contemplationis ad celestia sit subleuanda.

2nd Part

Chapter 38: De pellicano

8th Miniature: The Pelican
Mors pellicani passio xpi.

Similis factus sum pellicano solitudinis.
Pellicanus e[st] egyptia auis, habitans in solitudine nili fluminis. Hec auis rostro pullos fertur[262] occid[er]e, et p[er] tres dies sup[er] eos flere. Post tres dies seipsam rostro p[er]cutit, et suo sanguine pullos asp[er]git. Et sic[263] quos prius occid[er]at, asp[er]so sanguine uiuicando[264] sanat. Mistice

[248] Subitiuntur → Subiciuntur (H, SC, L).
[249] *Om.* Illius (H).
[250] Sunt → Sed (L).
[251] Iusti → Isti (H).
[252] Precii → Pretii (H).
[253] Duo → Duos (H).
[254] Meo → Nostro (H).
[255] Ieronimus → Iheronimus (L).
[256] Corpus occidunt (C). The scribe added inverted comas to "corpus" to demonstrate the error.
[257] Inmolatione → Immolatione (C, L). In SC copy the "m" or "n" is absent due to the abbreviation: i[n/m]molatio[n]e.
[258] Equibus → A quibus (H); E[st] quibus (L).
[259] Immolabatur → Immolatur (L), "ab" are superscripted on top of the "la".
[260] Per abstinentiam est affligenda (H). Abstinentiam → Abstinenciam (L).
[261] Auolare → Aduolare (H).
[262] Fertur rostro pullos (H).
[263] Sic → Si (L).
[264] Uiuicando → Uiuificando (SC, L).

pellican[us] significat xpm, egyptus[265] mundum. Pellicanus habitat in solituine[266] q[u]ia xpc solus de ui[r]gine nasci dignatus e[st][267] sine uirili[268] copulatione. Est etiam solitudo pellicani quod immunis[269] e[st] a peccato uita xpi.
Hec auis rostro pullos suos accidit q[u]ia u[er]bo p[re]dicationis incredulos conu[er]tit. \Sup[er] pullos suos fle/re n[on] desinit, q[u]ia xpc cum resuscitaret lazarum mis[eri]c[or]dit[er] fleu[it]. Et sic p[ost] tres dies sanguine suos[270] pullos[271] uiuificat, q[u]ia xpc p[ro]p[r]io sanguine suo redemptos saluat. Moralit[er] aut[em] p[er] pellicanu[m] intelligere possumus n[on] quemlibet iustum, s[ed] a carnali uoluptate longe remotu[m]; p[er] egyptu[m] uita[m] n[ost]ram ignorantie tenebris inuolutam, Egyptus eni[m] tenebre int[er]p[re]tatur. In Egypto [i]g[itur] solitudinem facim[us] dum a curis et uoluptatib[us] s[e]c[u]li longe sumus. Sic et iustus in ciuitate solitudinem facit dum se immune[m], in q[ua]ntum humana natura patit[ur], a peccato custodit.
Rostro pellican[us] pullos suos occidit, q[u]ia iustus cogitationes et op[er]a que male gessit ore p[ro]p[r]io indicat et confundit, dicens, \Confitebor/ adu[er]sum me iniusticia[m] meam domino: et tu remisisti impietatem peccati mei. Sup[er] eos t[r]iduo deflet, quia q[u]icquid cogitatione, loquutione[272] et op[er]e male gesserit lac[r]imis deleri docet. Et sic pullos suos asp[er]sos[273] sanguine uiuificat dum carnis et sanguinis op[er]a minuit, et actus sp[ir]itales bene uiuendo seurat.
Hui[us] etia[m] uolucris natura talis dicit[ur] e[ss]e q[uo]d semp[er] afficit[ur] macie, et q[u]icquid glutit cito digerit, q[u]ia uenter eius nullum habet diu[er]ticulu[m] in quo retineat cibum. Non [i]g[itur] cib[us] ille corpus impinguat[274], sed tantum sustinet et confortat. Huic siquidem pellicano heremite uita fit simil[is], qui paruo pascit[ur], nec querit repletionem[275] uent[r]is, qui n[on] uiuit ut comedat, s[ed] comedit ut ~~ut~~ uiuat.

Chapter 39: De niticorace[276].

9th Miniature: The Night Raven
Sicut nicticorax in domicilio[277]. ~~De niticorace.~~

Factus sum sicut nicticorax[278] in domicilio.
Nicticorax e[st] auis que amat tenebras noctis. In parietinis[279] habitat, q[u]ia in ruinis maceriarum que sunt sine tecto domicilium seruat. Lucem refugit; in nocte uolitans cibos querit. Mistice nicticorax xpm significat qui noctis tenebras amat, quia n[on] uult mortem peccatoris, s[ed] ut conu[er]tat[ur] et uiuat. Ita eni[m] d[eu]s pat[er] dilexit mundum ut p[ro] rede[m]ptio[n]e mundi traderet morti[280] filium[281]. Quod aut[em] peccatores tenebre uocentur, ap[osto]l[u]s testat[ur], dicens, Fuistis aliq[u]ando tenebre n[un]c aute[m] lux in domino.
Habitat nicticorax in ruinis parietum, q[u]ia xpc nasci uoluit de pop[u]lo iudeorum. Non su[m], inquit, missus[282] nisi ad oues que p[er]ierunt dom[us] isr[ae]l. S[ed] xpc opp[r]imit[ur] a ruinis, q[u]ia occidit[ur]

[265] Egyptus → Egiptus (L).
[266] Solituine → Solitudine (H, C, SC, L).
[267] Dignatus est nasci (H).
[268] Uirili → Uiri (H).
[269] Immunis → Inmunis (SC).
[270] Suos → Suo (H, C).
[271] Pullos suos (SC, L).
[272] Loquutione → Locutione (H, SC, L).
[273] Aspersos → Asperso (H).
[274] Impinguat → Inpinguat (SC).
[275] Repletionem → Replecionem (L).
[276] Niticorace → Nicticorace (SC, L).
[277] Factus sum sicut nicticorax in domicilio (SC, L); Sicut nicticorax in domicilio, conuersus in occulto (H).
[278] Nicticorax → Niticorax (H, C, SC, L).
[279] Parietinis → Paritinis (L).
[280] Morti traderet (H).
[281] Filium morti (C). The scribe added inverted comas to "filium" to demonstrate the error.
[282] Missus, inquit (H).

a iud[e]is. Lucem refugit, quia uanam gl[or]iam detestat[ur] et odit. Cum enim leprosum mundaret[283], ut nob[is] exemplu[m] humilitatis daret ait leproso, Uide nemini dixeris. De hac luce dicit[ur], Auferet[ur] ab impiis lux sua, id e[st], p[re]sentis uite gl[ori]a. Ipse aute[m] e[st] lux inaccessibilis que illuminat om[n]em hominem. Lux [i]g[itur][284] refugit lucem, id e[st],[285] mundane gl[or]ie uanitate[m]. In nocte uolitans escas querit, quia peccatores in corpus eccl[esi]e p[re]dicando conu[er]tit.
Moralit[er] aute[m] nicticorax n[on] quemlibet iustum nobis innuit, s[ed] eum qui int[er] homines degens ab intuitu hominu[m] se in quantu[m] potuit abscondit. Luce[m] refugit, quia humane laudis gl[or]iam n[on] attendit. De qua luce dicitur, Nonne lux impii extinguetur nec splendebit flamma ignis eius? Lucem dicit p[re]sentis uite p[ro]sp[er]itatem. S[ed] lux impii extinguitur, quia fugitiue uite p[ro]sp[er]itas cu[m] ipsa terminat[ur]. Nec splendebit flamma ignis ei[us]. Ignem dicit te[m]p[or]alium desid[er]iorum feruorem. Cui[us] fla[m]ma est decor u[e]l potestas ext[er]ior, que de int[er]no eius ardore p[ro]cedit. S[ed] non splendebit, quia in die exitus om[n]is ext[er]ior decor et potestas p[er]ibit.
In nocte uigilat, dum peccatorum tenebras attendens eoru[m] errores uitat. Habitat in ruinis parietum, dum mundi defectum consid[er]at et expectat occasum. Escam in nocte querit, quia peccantiu[m] uitam recogitans de exemplis iustorum mentem pascit.

Chapter 40: De coruo.

10th Miniature: The Raven
Coruus cracitans[286] doctor predicans. De coruo.

Coruus in diuina pagina diu[er]sis modis accipitur, ut p[er] coruum aliq[ua]ndo p[re]dicator, aliq[ua]ndo peccator, aliq[ua]n[do] diabolus intelligat[ur]. Isidorus in libro ettimologiarum[287] dicit quod couus prius in cadau[er]ib[us] oculu[m] petit. Coruus est diabolus, quod[288] in cadau[er]ib[us] p[r]ius oc[u]l[u]m petit, q[u]ia in carnalib[us] intellectu[m] discretionis extinguit, et sic p[er] oc[u]l[u]m ext[ra]hit cerebrum. P[er] oc[u]l[u]m cerebrum extrahit, qui[289] extincto discretionis[290] intellectu sensum m[en]tis eu[er]tit.
Iterum p[er] coruu[m] quilibet peccator intelligit[ur] qui q[ua]si pecc[at]oru[m] plumis nigrescentib[us] uestit[ur]. Sunt aut[em] quidam peccatores q[u]i de mis[eri]c[or]dia d[e]i desp[er]ant. Sunt et alii qui adhoc[291] religiosoru[m] p[re]cib[us] adiuuent[ur] exorant. De quib[us] dicit[ur], corui pauerunt heliam. P[er] coruos [i]g[itur] peccatores intelligi uolunt, qui de sua substantia religiosos pascunt, illos eni[m] helias significat quos locus et habitus religionis occultat.
S[un]t aut[em] alii qui desp[er]ant, t[er]renis inhiant, cum intus deb[er]ent e[ss]e, foras spectant. De quib[us] sc[r]iptura dicit, coruus ad archam n[on] rediit, q[u]ia forsitan[292] aquis diluuii int[er]cept[us] p[er]iit; u[e]l cadau[er]ib[us] inuentis forsitan sup[er]sedit. Similit[er] peccator qui carnalib[us] desid[er]iis foras pascit[ur], q[uas]i coruus qui ad archam n[on] rediit, curis ext[er]iorib[us] detinet[ur].
S[ed] et in bona significatione coruus accipit[ur], ut p[er] coruu[m] q[u]ilibet doctus p[re]dicator intelligat[ur]. Unde p[er] beatum iob d[icitu]r, Quis p[re]parat coruo escam suam quando pulli eius ad d[eu]m clama[n]t uagantes, eo quod n[on] habeant cibos? Coruus, sicut ait beatus gregorius, e[st] quisq[ue] p[re]dicator doctus qui magna uoce clamat dum pecc[at]oru[m] suorum memoriam q[ua]si quandam[293] coloris nigredinem portat. Cui nascunt[ur] in fide discipuli, s[ed] fortasse adhuc consid[er]are infirmitate[m] suam[294] nesciunt, fortasse a peccatis p[re]t[er]itis[295] memoriam au[er]tunt, et p[er] hoc ea[m] q[ua]m sumi[296] oportet contra huius mundi gl[ori]am humilitatis nigredinem non ostendunt.

[283] Mundaret → Curaret (H).
[284] Igitur + Xpi (H).
[285] Id est + ueritas (H, C).
[286] Cracitans → Crocitans (H, C, SC, L).
[287] Ettimologiarum → Ethimologiarum (H, L); Ettimolagiarum (SC).
[288] Quod → Qui (H, C).
[289] Qui → Quia (H, L).
[290] Discretionis → Discrecionis (L).
[291] Adhoc → Adhuc + ut (H); Adhoc + ut (C, SC).
[292] Forsitan → Forsan (H).
[293] Quandam → Quendam (H).
[294] Suam → Propriam (H).

Hii uel[u]d ad accipiendas escas os ap[er]iunt cum doceri de secretis sublimib[us][297] querunt, s[ed] eis doctor suus ali\me[n]ta p[re]dicam[en]tor[um]/ sublimiu[m] tanto min[us] tribuit, q[ua]nto illos p[re]terita peccata[298] minus digne deflere cognoscit. Expectat quippe atq[ue] ammonet[299] ut a nitore uite p[re]sentis p[r]ius p[er] penitentie lamenta nigrescant, et tunc demum congrua p[re]dicationis subtilissime nut[r]im[en]ta p[er]cipiant. Coruus in pullis ora inhiantia respicit, s[ed] ante in eis pennaru[m] nigredine indui corpus querit, et discretus doctor int[er]na mysteria[300] eorum sensib[us] n[on] ministrat q[u]os adh[uc] ab h[oc] s[e]c[u]lo nequaq[ua]m se abiecisse consid[er]at. Et quo se a temp[or]ali gl[or]ia no[n] euacuant, eo a sp[irit]uali[301] refectione ieiunant. Eisq[ue][302] hiantib[us] in ore cibum reuocat dum ex ea intelligentia q[ua]m cep[er]it esurientib[us] discipulis alimenta uite loq[ue]ndo subministrat. Quos tanto ardenti[us] de sup[er]ioribus reficit, q[ua]nto uerius a mundi nitore nigrescere penitentie lam[en]tatione cognosc[it]. Pulli autem dum nigro se pennarum colore uestiunt de se etia[m] uolatum p[ro]mittunt, quia cum magis discipuli abiecta de se sentiunt, quo magis sese despicientes[303] affligunt, eo ampli[us] spem p[ro]uect[us] sui in altiora pollicent[ur]. Unde et curat doctor festinantius alere quos iam p[er] quedam indicia p[ro]uidet posse et[304] aliis p[ro]desse.

Que doctrine discretio dum caute a p[re]dicatore custodit[ur], ei diuinitus largior copia p[re]dicationis datur. Du[m] enim p[er] caritatem compati afflictis discipulis nouit, dum p[er] disc[re]tionem congruu[m] doctrine temp[us] intelligit, ipse n[on] solum p[ro] se, s[ed] etia[m] p[ro] eis quib[us] laboris sui studia impe[n]dit, maiora intelligentie munera p[er]cipit. Unde apte dicit[ur], Q[u]is p[re]parat coruo escam suam q[ua]ndo pulli eius ad d[eu]m clamant, uaga[n]tes eo quod n[on] habeant cibos? Cu[m] enim pulli ut sacientur clamant, coruo esca p[re]paratur, quia dum uerbum d[e]i boni auditores esuriunt, pro reficiendis eis maiora doctorib[us] intelligentie[305] dona t[r]ibuunt[ur].

Cuius pulli, id est, p[re]dicatores ex eo editi non in se p[re]sumunt, s[ed] in uiribus rede[m]ptoris sui. Unde bene d[icitu]r, quando pulli eius ad d[eu]m clamant, nichie[306] enim sua ui[r]tute se posse sciunt[307], et q[ua]muis animaru[m] lucra piis uocib[us] esuriant, ab illo tam[en] qui cuncta int[r]insecus op[er]atur hec fieri exoptant. Uera enim fide comp[re]hendunt, quia neq[ue] qui plantat e[st] aliquid[308], neq[ue] qui rigat, s[ed] q[u]i increm[en]tum dat. Quod uero dictum e[st], uagantes eo quod n[on] habeant cybos[309], in hac uagatione nil aliud qua[m] estuantium p[re]dicatorum uota signant[ur], qui du[m] in ecclesie sinum recipere pop[u]los ambiunt, magno ardore succensi, nunc ad hos, n[un]c ad illos colligendos[310] desid[er]ium mittunt. Quasi quedam q[u]ippe[311] p[ro]prie[312] uagatio e[st] ipsa cogitationis estuatio. Et uelud[313] ad loca uaria mutatis nutib[us] transeunt, dum p[ro] adunandis animab[us] in modos innum[er]os, in partes diu[er]sas esurienti m[en]te discurrunt.

Potest hec auctoritas alit[er] exponi[314], ut p[er] coruum intelligant[ur] quidam eccl[es]iaru[m] p[re]lati[315], pecc[at]oru[m] fuligine nigri. Qui non tantum escam suam sibi parant[316], s[ed] etia[m] p[re]para[n]t ut

---

[295] Preteritis peccatis (C).
[296] Sumi → Assumi (H); ~~Qua~~ssumi (C).
[297] Sublimibus + ~~credunt~~ (C). The word was completely strikethrough.
[298] Peccata preterita (H).
[299] Ammonet → Admonet (H).
[300] Mysteria → Misteria (SC, L).
[301] Spirituali → Spiritali (H, L).
[302] Eisque + in (SC).
[303] Despicientes → Despitientes (C).
[304] Posse et → Post se (H).
[305] Intelligentie → Intelligentia (L).
[306] Nichie → Nichil (H, C, SC, L).
[307] Posse se sciunt (H, C); Se sciunt posse (SC, L).
[308] Aliquid → Aliquit (L).
[309] Cybos → Cibos (H, C, L).
[310] Colligendos → Colligendo (H).
[311] Quippe quedam (C).
[312] *Om.* proprie (H).
[313] Uelud → Uelut (H, SC, L).
[314] Exponi → Exponit (L).
[315] Quidam ecclesiarum prelati intelligantur (H).
[316] Parant → P[re]parant (C). The additional "p" has a dot underneath it.

p[re] cet[er]is delicati[us] uiuant. Quoru[m] pulli s[un]t eorum discipuli, qui ad d[eu]m clamant et tam[en] m[ur]murat[317], quod eoru[m] magistri in cibum delicatiora sumant. Uagantes a claustris exeunt, et sic habundantia[m][318] uictualium s[ib]i querunt. Sunt et alii maiores corui, potestate maiores, dignitate sublimes[319], q[u]i q[ua]ndoq[ue] pop[u]los in eccl[es]iis congregant, ieiunia p[re]dicant; ipsi tam[en] in diebus ieiuniorum carnes edunt, et sic simplices scandalizant et offendunt. Inde pop[u]li uagantes mente dubitant utrum p[re]lati, qui ieiunia docent, ea pop[u]lis p[ro]desse credant.
Et hoc ad p[re]sens de coruo sufficiat, donec aliquis de eo potiora[320] dicat.

Chapter 41: De gallo.

11th Miniature: The Cock
Inner circle: Gallus alis se percutiens est doctor aliis exemplum prebens[321].

Quis dedit gallo intelligentiam?
De gallo queritur a quo ei intelligentia t[r]ibuat[ur]. S[ed] hec questio cito soluit[ur] si beatus gregori[us] loquens in moralib[us] audiat[ur]. Intelligentiam, sic[ut] ait beatus gregorius, gallus accipit ut p[r]ius nocturni temporis horas discutiat et tunc demu[m] uocem excitationis emittat, q[u]ia uidelicet s[an]c[tu]s quisq[ue] p[re]dicator p[r]ius in auditorib[us] suis qualite[m] uite consid[er]at, et tunc demum ad erudiendum congruam uocem p[re]dicationis format. Quasi enim horas noctis disc[er]nere e[st] peccatoru[m] uitam[322] diiudicare. Quasi horas noctis discern[er]e e[st] actionu[m] tenebras apta increpationis uoce corrip[er]e. Gallo itaq[ue] intelligentia desup[er] t[r]ibuit[ur], quia doctori u[er]itatis discre~~pa~~tionis uirtus ut nouerit quib[us] quid q[ua]ndo u[e]l quom[od]o inferat diuinitus ministrat[ur]. Non eni[m] una eademq[ue] cunctis exhortatio[323] conuenit, q[u]ia nec cunctos par morum qualitas astringit. Sepe aut[em] aliis officiunt qui aliis p[ro]sunt. Nam et plerumq[ue] herbe[324] que hec animalia reficiunt, alia occidunt; et lenis sibilus eq[u]os mitigat, catulos instigat; et medicamentu[m] quod hunc morbu[m] imminuit[325], alt[er]i uires iungit; et panis[326] qui uitam fortium[327] roborat, paruuloru[m] necat. Pro qualitate [i]g[itur] audientium formari debet sermo doctoru[m], ut et[328] ad sua singulis congruat et tam[en] a communis edificationis arte nu[m]quam recedat. Quid enim sunt intente m[en]tes[329] auditorum nisi quasi quedam in cithara tensiones strate cordarum? Q[ua]s tangendi artifex ut n[on] sibimetipsi dissimile canticu[m] faciant, dissimilit[er] pulsat, et icci[r]co corde consonam modulatione[m] reddunt, q[u]ia uno quidem plectro, s[ed] n[on][330] uno impulsu feriunt[ur]. Unde et doctor quisq[ue] ut in una cunctos uirtute caritatis edificet, ex una doctrina n[on] una eademq[ue] edificatione[331] tangere corda audientium deb[et].
Habemus u[ero] aliud quod de galli hui[us] intelligentia considerare debeamus, quia p[ro]fundiorib[us] \horis/ noctis ualentiores ac p[ro]ductiores edere cantus solet; cum u[ero] matutinum iam temp[us] appropinquat leniores ac minutiores omni[mod]o[332] uoces format. In quib[us] galli hui[us] intelligentia quid nobis innuat consid[er]ata p[re]dicatoru[m] discretio demonstrat, qui cum iniq[u]is adhuc[333]

[317] Murmurat → Murmurant (H, SC, L).
[318] Habundantiam → Habunciam (L).
[319] Sublimes → Sublimitate (SC).
[320] Potiora → Pociora (L).
[321] *Inner circle:* Intelligentia galli puidentia magistri. The upper phrase is also mentioned, but around the circle (C).
[322] Uitam → Merita (H).
[323] Exhortatio → Exortatio (H, SC, L).
[324] Herbe → Erbe (L).
[325] Imminuit → Immunit (C).
[326] Panis → Pannis (L).
[327] Fortium → Forcium (L).
[328] *Om.* et (H).
[329] Mentes → Mentis (L), with an "e" on top of the "i".
[330] *Om.* non (SC, L).
[331] Edificatione → Exortatione (H); Significatione (SC, L).
[332] Omnimodo → Omnino (L); Omnimo (SC).
[333] Adhuc iniquis (H).

mentib[us][334] p[re]dicant altis et magnis uocib[us] et[er]ni[335] iudicci timores[336] intimant, quia uidelicet[337] q[ua]si in p[ro]funde noctis tenebris clamant. Cu[m] uero iam auditoru[m] suoru[m] cordib[us] u[er]itatis luce[m] ade[ss]e cognoscunt, clamoris sui magnitudine[m] in lenitatem[338] dulcedinis u[er]tunt, et n[on] tam illa que sunt de penis t[er]ribilia quam ea que sunt blanda de p[re]miis p[ro]ferunt. Qui etia[m] minutis tunc uocib[us] cantant, q[u]ia p[ro]pinq[ua]nte mane subtilitate q[ua]dam queq[ue] de myst[er]iis[339] p[re]dicant, ut sequaces sui eo minutiora queq[ue] de celestib[us] audiant quo luci u[er]itatis appropinq[ua]nt.

Et quos dormientes longus galli clamor excitau[er]at, uigilantes succiosior delectat quatin[us] correcto cuilibet cognoscere de regno subitlit[er] dulcia libeat[340], q[u]i p[r]ius de iudicio adu[er]sa formidabat. Quod bene p[er] moysen exp[r]imitur cum ad p[er]ducendum exercitum tube clangere concisius iubentur. Scriptum na[m]q[ue] e[st], fac tibi duas tubas argenteas ductiles. Et paulo post, Cum concisus clangor increpuerit, mouebuntur castra[341]. P[er] duas eni[m] tubas exercitus ducit[ur], quia p[er] duo p[re]cepta caritatis ad p[ro]cinctum fid[e]i p[o]p[u]l[u]s uocatur. Que iccirco argentee fieri p[re]cipiunt[ur], ut p[re]dicatoru[m] u[er]ba lucis nitore pateant, et auditorum m[en]tem nulla sui obscuritate confundant. Iccirco aute[m] ductiles, q[u]ia necesse e[st] ut hii qui uentura[m] uitam p[re]dicant t[r]ibulationu[m][342] p[re]sentium tunsionib[us] crescant. Bene aute[m] dicit[ur], Cum [co]ncisus clangor increpuerit mouebunt[ur] castra, q[u]ia nimiru[m] p[re]dicationis sermo cum subtilius ac minutius agitur, auditorum corda [co]ntra temptationu[m] certamina ard[e]ntius excitant[ur].

Est aliud in gallo adhuc sollert[er] intuendu[m][343], quia cu[m] iam edere cantu[m] parat, p[r]ius alas excutit, et semetipsum feriens uigilantiorem reddit. Quod patenter cernim[us] si s[an]c[t]orum p[re]dicatorum uitam uigilant[er] uidem[us]. Ipsi q[u]ippe cum u[er]ba p[re]dicationis mouent p[r]ius se in s[an]c[t]is exercent actionib[us][344], ne in semetipsis torpentes op[er]e, alios excitent uoce. S[ed] ante se p[er] sublimia facta excutiunt, et tunc ad bene agendum alios sollicitos reddu[n]t. Prius cogitationu[m] alis semetip[s]os feriunt[345], quia q[u]icq[u]id in se inutiliter torpet sollicita inuestigatione depreh[e]ndunt, dist[r]icta a[n]i[m]adu[er]sione corrigunt. Prius sua punire fletib[us] curant, et tunc que aliorum sunt punienda denuntiant[346]. Prius [er]g[o] alis insonant, q[ua]m cant[us] emittant, q[u]ia a[n]teq[ua]m u[er]ba exhortationis p[ro]ferant, om[n]e quod locuturi sunt op[er]ib[us] clamant, et cum p[er]fecte in semetipsis uigilant t[un]c dormientes alios ad uigilas[347] uocant. S[ed] unde hec tanta doctori intelligentia, ut et sibi p[er]fecte uigilet et dormientes ad uigilias sub quib[us]dam clamoris p[ro]uectib[us] uocet; ut et peccatoru[m] tenebras caute pri[us][348] discutiat, et discrete p[ost]modum lucrem p[re]dicationis ostendat, ut singulis iuxta modum et temp[or]a congruat, et simul om[n]ib[us] que illos sequent[ur][349] ostendat? Unde ad tanta et tam subtilit[er] tendit[ur] nisi intrinsecus ab eo a quo e[st] condit[us] doceat[ur]? Quia [i]g[itur] laus tante intelligentie[350] n[on] p[re]dicatoris uirtus e[st], s[ed] auctoris[351], recte p[er] eundem[352] auctorem dicit[ur] u[e]l quis dedit gallo intelligentiam?, ac si diceret, Nisi ego qui doctorum mentes[353] q[ua]s mire ex nichilo condidi ad intelligenda que occulta sunt mirabilius instruxi.

---

[334] Mentibus + adhuc (L).
[335] Eterni → Eternis (L).
[336] Timores → Terrores (H).
[337] Uidelicet + et (H).
[338] Lenitatem → Leuitatem (H).
[339] Mysteriis → Misteriis (SC).
[340] Libeat → Liberat (H). It seems that the "r" is expuncted.
[341] *Om.* castra (H).
[342] Tribulationum → Tribulacionum (L).
[343] Est adhuc aliud in gallo intuendum sollerter (H).
[344] Actionibus exercent (H). Actionibus → Accionibus (L).
[345] *Om.* feriunt (H).
[346] Denuntiant → Denunciant (H, C, L).
[347] Uigilas → Uigilias (C, SC, L).
[348] Prius caute (H, C, SC, L).
[349] Sequentur → Sequantur (H).
[350] Intelligentie → Intelligencie (L).
[351] Auctoris → Actoris (L).
[352] Eundem → Eumdem (C).
[353] Mentes + quam (L).

Potest etiam de gallo dici quod sint quida[m] eccl[es]ie p[re]lati quib[us] a d[e]o intelligentia datur, nec tam[en] iuxta intelligentiam a d[e]o sibi datam aliquid op[er]antur. Non seipsos alis excitant, nec alios monent ad b[e]n[e] op[er]andum ut[354] surgant. Seipsos amant, et sic ocio et uoluptati uacant. Horas noctis sicut gallus n[on] annuntiant, q[u]ia[355] culpas delinquentiu[m] n[on] accusant. Confessionis et penitentie discretione[m] n[on] attendunt, s[ed] in adquirendis[356] reb[us] t[ra]nsitoriis intelligentiam a d[e]o sibi datam ponunt. Animaru[m] luc[ra] querere non nouer[unt], ea tam[en] que ad delectationem[357] carnis p[er]tineant tota m[en]te querunt.
Sunt et alii nimis simplices et illiterati, qui q[ua]si gallus sedent in p[er]tica regiminis, id e[st], in cathedra p[re]lationis. Locum occupant, et tam[en] officium diune legis ignorant. Sedent et tacent, seipsos pascunt, nec gregem s[ib]i commissu[m] ad pascua et[er]ne uiriditatis[358] ducunt. Et hic [i]g[itur], cui intelligentia dat[ur], nec p[o]p[u]lo u[er]bum dei p[re]dicat. Et hic qui tacet, quia nescit quid dicat.
Ut[er]q[ue] caueat ne quasi gallus de p[er]tica cadat. Filios suos heli sepe corripuit sed quia manu[m] correctionis n[on] adhibuit, fractis ceruicib[us] de sella cecidit. Antequam moreretur, mortem filiorum uidit[359] et archam domini ab allophilis captam fuisse cognouit.

Chapter 42: De strutione[360].

12th Miniature: The Ostrich
Strutio[361] in deserto, simulatio in [co]nu[er]so.

Penna structionis similis e[st] pennis erodii[362] et accipitris.
Quis erodium[363] u[e]l accipitrem nesciat aues reliquas quanta uolat[us] sui uelocitate t[ra]ncendat? Strutio u[ero][364] penne eoru[m] similitudi[n]em habe[n]t[365], s[ed] uolatus eorum celeritate[m] n[on] habet. A terra quippe elauari[366] n[on] ualet, et alas q[ua]si ad uolatum spetie tenus erigit, s[ed] tam[en] numq[ua]m se a t[er]ra uolando suspendit. Ita sunt nimiru[m] o[mne]s hypocrithe[367] qui dum bonorum uitam simulant, imitationem[368] s[an]c[t]e uisionis habent, s[ed] ueritatem s[an]c[t]e actionis n[on] habent. Habent q[u]ippe uolandi pennas p[er] speciem, s[ed] in t[er]ram[369] repunt p[er] actionem, q[u]ia alas p[er] figuram s[an]c[t]itatis extendunt, s[ed] curarum s[e]c[u]larium pondere p[re]grauati, nullatenus a terra subleuantur. Spetiem quoq[ue][370] phariseorum rep[ro]bans d[omi]n[u]s quasi strutionis pennam redarguit, que in op[er]e aliud exercuit, et in colore aliud ostendit, dicens, Ve uobis scribe et pharisei, hypocrite, ac si diceret, Subleuare uos uidetur speties penne, s[ed] in infimis uos dep[r]imit pond[us] uite. De hoc pond[er]e p[er] p[ro]ph[et]am dicit[ur], Filli hominu[m] usq[ue] quo graues corde?
Huius strutionis conu[er]surum se ypocrisim d[omi]n[u]s pollicet[ur] cum p[er] proph[et]am dicit, Glorificabit[371] me bestia agri, dracones et strutiones. Quid eni[m] draconu[m] nomine nisi in ap[er]to malitiose[372] mentes exp[r]imuntur, que p[er] t[er]ram semp[er] in infimis cogitationib[us] repunt? Quid u[er]o p[er] strutionis uocabulum nisi hii qui se bonos simulant designantur, qui s[an]c[t]itatis uitam,

[354] Ut ad bene operandum (H).
[355] Quia + quia (L).
[356] Adquirendis → Acquirendis (H, L).
[357] Delectationem → Delectacionem (L); Dilectionem (SC), an "e" is supercripted on top of the "i" from "di", and a "ta" is supercripted on top of the "tio".
[358] Uiriditatis → Ueritatis (H).
[359] Uidit → Audiuit (H).
[360] Strutione → Structione (L); Strucione (SC).
[361] Strutio → Structio (L).
[362] Erodii → Herodii (H, SC, L).
[363] Erodium → Herodium (H, SC, L).
[364] Uero → Non (L).
[365] Habent → Habet (H).
[366] Elauari → Eleuari (H, C, SC, L).
[367] Hypocrithe → Ypocrite (H); Hypocrite (SC, L).
[368] Imitationem → Imitacionem (L).
[369] Terram → Terra (H).
[370] Quoque → Namque (H).
[371] Glorificabit → Glorificant (H).
[372] Malitiose → Maliciose (L).

q[ua]si uolatus penna[m], p[er] spetiem retinent, s[ed] p[er] op[er]a non exercent. Glorificari itaq[ue] se d[omi]n[u]s a dracone[373] u[e]l strutione asserit, q[u]ia et ap[er]te malos et ficte bonos plerumq[ue] ad sua obseq[u]ia ex intima cogitatione conu[er]tit.

Habemus adhuc quod in consideratione structionis hui[us] de accipitre et erodio[374] attenti[us][375] p[er]pendamos. Accipitris q[u]ippe et herodii parua sunt corpora, s[ed] pennis densiorib[us] fulta, et iccirco cum celeritate[376] transuolant, q[u]ia eis parum inest quod aggraut, multu[m] q[uo]d leuat. At contra, strutio raris pennis induitur, et immani[377] corp[or]e grauat[ur], ut etsi uolare appetat, ipsa pennarum paucitas mole[m] tanti corp[or]is in aere n[on] suspendat. Bene [er]g[o] in erodio et accipitre electorum p[er]sona signat[ur][378] qui, quamdiu[379] in hac uita sunt, sine q[ua]ntu locumq[ue] culpe co\ntagio/ e[ss]e n[on] b[e]n[e][380] possunt. S[ed] cum parum eis[381] quid inest quod dep[r]imit, multa uirtus bone actionis suppetit, que illos in sup[er]na sustollit. At contra hypocrita etsi qua facit pauca que eleuent, p[er]petrat multa q[ue] grauant[382]. Neq[ue] eni[m] nulla bona agit hypocrita, s[ed] quib[us] ea ipsa dep[r]imat multa p[er]u[er]sa committit. Pauce [i]g[itur] penne corp[us] strutionis non subleuant, quia paruu[m][383] bonum hypocrite multitudo praue actionis grauat.

Hec q[u]oq[ue] ipsa strutionis penna ad pennas erodii et accipitris similitudinem coloris habet, uirtutis u[ero] similitudinem n[on] h[abe]t, illorum namq[ue] concluse et firmiores s[un]t, et uolatu aerem p[re]mere uirtute sue soliditatis possunt. At contra strutionis penne dissolute eo uolatum sumere[384] nequeunt, quo ab ipso que[m] p[re]mere debuerant aere[385] transcendunt[ur]. Quid [er]g[o] in his aspicim[us] nisi q[uo]d electorum ui[r]tutes solide euolant ut uentos humani fauoris p[re]mant? Hipocritaru[m][386] uero actio[387] q[ua]mlibet recta[388] uideat[ur] uolare n[on] sufficit, q[u]ia uidelicet fluxe ui[r]tutis pennam humane laudis aura p[er]transit.

S[ed] ecce unu[m][389] eundemq[ue] bonorum maloru[m]q[ue] habitum cernim[us], cum ipsam in electis ac rep[ro]bis p[ro]fessionis sp[eci]em uidem[us], unde n[os]tre intelligentie suppetat ut electos a rep[ro]bis, ut a falsis ueros comp[re]hendendo discernat p[ro]spicimus. Quod tam[en] citi[us] agnoscimus si intemerata i[n] memoria p[re]ceptoris n[ost]ri u[er]ba signam[us] cum[390] ait, Ex fructib[us] eorum cognoscetis eos. Neq[ue] eni[m] pensanda sunt que ostend[un]t in inimagine[391], s[ed] que seruant in actione.

Unde hic postq[ua]m spetiem strutionis hui[us] intulit, mox subiunxit facta, dicens, Que[392] derelinq[u]it in t[er]ra oua sua. Quid eni[m] p[er] oua nisi tenera adhuc p[ro]les exp[r]imit[ur] que diu fouenda e[st], u[t] ad uiuu[m] uolatile p[er]ducat[ur]. Oua quippe insensibilia sunt in semetipsis[393], s[ed] t[ame]n calefacta in uiuis uolatilib[us] conu[er]tunt[ur]. Ita nimiru[m] paruuli auditores ac filii: certum e[st] q[uo]d frigidi insensibilesq[ue] remaneant nisi doctoris sui sollicita exhortatione[394] calefiant. Ne [i]g[itur] derelicti in

[373] Dracone → Drachone (H, L).
[374] Erodio → Herodio (H, L).
[375] Attentius → Attencius (L).
[376] Celeritate → Sceleritate (SC).
[377] Immani → Inmani (SC).
[378] Signatur → Designatur (H).
[379] Quamdiu → Quandiu (L).
[380] *Om.* bene (H, C).
[381] Eis parum (H).
[382] Grauant → Grauent (H).
[383] Paruum → Paurum (C); Parum (SC, L).
[384] Sumere → Summere (L).
[385] Aere → Aerem (H).
[386] Hipocritarum → Hypocritarum (C).
[387] Actio → Accio (L).
[388] Recta + irecta (L).
[389] Cum + unum (H, C).
[390] Cum → Qui (H).
[391] Inimagine → Imagine (L, SC).
[392] Que → Qui (H).
[393] In semetipsis sunt (H).
[394] Exhortatione → Exortatione (H, SC).

sua insensibilitate torpescant, assidua doctorum uoce fouendi sunt quousq[ue] ualeant et p[er] intelligentiam uiuere et p[er] conte[m]plationem uolare.
Quia u[ero] ypocrite[395] qua[m]uis p[er]u[er]sa semp[er] op[er]ent[ur], loqui tam[en] recta n[on] desinunt, bene loq[ue]ndo aut[em] in fide uel conu[er]satione filios pariunt, s[ed] eos bene uiuendo nutrire n[on] possunt. Recte de hac strutione dicit[ur], que derelinquit in t[er]ra oua sua. Cura[m] na[m]q[ue] filiorum hypoc[r]ita negligit, qui[396] ex amore intimo reb[us] se exteriorib[us] subdit in quib[us] q[ua]nto magis extollitur, tanto min[us] de p[ro]lis sue defectu[397] cruciat[ur]. Oua [er]g[o] in t[er]ra dereliq[u]isse e[st] natos p[er] conu[er]sionem filios nequaq[ua]m a t[er]renis actib[us] int[er]posito exhortationis nido suspend[er]e. Oua in t[er]ra dereliq[u]isse e[st] nullum celestis uite filiis exemplum p[re]b[er]e. Quia eni[m] hypocrite p[er] caritatis uiscera n[on] calent, de corpore[398] p[ro]lis edite, id est, de ouorum suorum frigore nequaq[ua]m dolent. Et q[ua]nto se libentius t[er]renis actib[us] inserunt, tanto negligenti[us] eos q[u]os gen[er]ant ag[er]e t[er]rena p[er]mittunt.
S[ed] quia derelictos hypocritaru[m] filios sup[er]na cura n[on] deserit, n[on]nullos namq[ue] etia[m] ex talib[us] intima electione p[re]scitos largite gr[ati]e respectu[399] calefacit recte subiungit[ur]. Tu forsitan in puluere calefacies ea. Ac si dicat ut ego q[u]i illa in pulu[er]e calefacio, quia scilicet paruuloru[m] animas in medio peccantiu[m] positas amoris m[e]i igne succendo. Oua [er]g[o] d[omi]n[u]s in pulliere[400] derelicta calefacit, q[u]ia parrulorum animas p[re]dicatoru[m] suoru[m] sollicitudine destitutas, etia[m] in medio peccantiu[m] positas amoris sui igne succendit. Hinc e[st] enim quod plerosq[ue] cernim[us] et in medio pop[u]lorum uiuere, et tam[en] uitam torpentis pop[u]li n[on] tenere; hinc e[st] enim quod plerosq[ue] cernimus et malorum turbas n[on] fugere et t[ame]n sup[er]no ardore flagrare. Hinc e[st] q[uo]d plerosq[eu] cernim[us] ut ita dix[er]im, in frigore calere. Unde enim n[on]nulli, int[er] terrenoru[m] hominu[m] torpores positi, sup[er]ne spei desid[er]iis inardescunt; unde et int[er] frigida[401] corda succensi sunt, nisi q[u]ia om[n]ip[oten]s d[eu]s derelicta oua scit etiam in pulu[er]e calefacere; et frigoris p[r]istini insensibilitate discussa, p[er] sensum spiri[t]us uitalis[402] animare, ut nequaq[ua]m iacentia in infimis torpeant, s[ed] in uiuis uolatilib[us] u[er]sa, sese ad celestia contemplando, id e[st], uolando suspendant?
Notandum u[ero] e[st] quod in his u[er]bis n[on] solu[m] hypocritaru[m] actio p[er]u[er]sa rep[ro]batur, s[ed] bonoru[m] etia[m] magistroru[m] si qua \fortasse subrepserit[403] elatio premitur/. Na[m] cum de se d[omi]n[u]s dicit quod derelicta oua in pulu[er]e ipse calefacit, p[ro]fecto ap[er]te indicat quia ipse op[er]atur int[r]insecus p[er] u[er]ba doctoris; q[u]ia[404] et sine u[er]bis ullius hominis calefacit q[u]os uoluerit[405] in frigore pulu[er]is. Ac si ap[er]te doctorib[us] dicat[406], Ut sciatis q[u]ia ego sum qui p[er] uos loquentes op[er]or: ecce, cum[407] uoluero cordib[us] hominu[m] etiam sine uobis loquor. Humiliata [i]g[itur] cogitatione doctorum ad exp[r]im[en]dum hypoc[r]itam sermo conu[er]titur; et qua fatuitate torpeat adhuc sub strutionis facto pleni[us] indicatur.
Nam sequit[ur], Obliuiscit[ur] quoq[ue][408] q[uo]d pes conculcet \ea, aut bestia/ agri conterat[409]. Quid in pede nisi transit[us] op[er]ationis accipit[ur]? Quid in agro nisi mund[us] iste signat[ur]? De quo in euang[e]lio d[omi]n[u]s dicit, Ager aut[em] e[st] mund[us]. Quid in bestia nisi antiquus hostis exp[r]imit[ur], qui[410] huius mundi rapinis insidians humana cotidiae morte satiatur? De q[ua] p[er]

[395] Ypocrite → Hypocrite (C, SC, L).
[396] Qui → Quia (H).
[397] Defectu → De fructu (SC, L).
[398] Corpore → Torpore (H, C).
[399] Respectu → Respectum (SC, L).
[400] Pulliere → Puluere (H, C, SC, L).
[401] Frigida → Frida (SC, L).
[402] Uitalis spiritus (L).
[403] Subrepserit → Supreserit (C).
[404] Quia → Qui (SC).
[405] Uoluerit → Uoluit (H).
[406] Dicat doctoribus (H).
[407] Cum → Quos (H).
[408] *Om.* quoque (H).
[409] Conterat + ea (C). The "ea" is expuncted.
[410] Qui → Quia (H).

p[ro]p[het]am pollicente d[omi]no dicit[ur], Et mala bestia n[on] t[ra]nsibit p[er] eam. Strutio itaq[ue] oua sua deserens obliuiscitur quod pes conculcet ea, quia uidelicet hypoc[r]ite eos quos in conu[er]satione[411] filios gen[er]ant derelinquu[n]t, et om[n]ino n[on] curant ne aut exhortationis sollicitudine aut discipline custodia destitutos prauorum op[er]um exempla p[er]u[er]tant. Si eni[m] oua que gignunt diligerent, nimirum metuerent ne quis ea p[er]u[er]sa op[er]a demonstrando calcaret[412]. Obliuiscit[ur] etiam quod bestia agri conterat, q[u]ia nimiru[m] si diabolus, in hoc mundo seuiens, editos in bona conu[er]satione filios rapiat, hypocrita om[n]ino n[on] curat. Habent[413] [er]g[o] ueraces magist[r]i sup[er] discipulos suos timoris uiscera ex uirtute caritatis. Hypocrite aut[em] tanto minus commissis s[ib]i metuunt, quanto nec sibimetipsis q[uo]d timere debeant deprehendunt et quia obduratis cordib[us] uiuunt, ipsos etia[m] quos gen[er]ant filios nulla pietate[414] amoris agnoscunt.

Unde adhuc sub strutionis specie[415] dicit[ur], Duratur ad filios quasi n[on] sint sui. Que[m] enim caritatis gr[ati]a non infundit, p[ro]ximum suum etia[m] si ipse hunc deo genuit extraneum respicit[416]; ut p[ro]fecto sunt om[ne]s hypocrite. Quoru[m] uidelicet mentes dum semp[er] ext[er]iora appetunt intus insensibiles; fiunt et in cunctis que agunt dum sua semp[er] expetunt, erga affectum p[ro]ximi nulla caritatis compassione mollescunt et q[u]ia[417] caritatis uiscera nesciunt, eorum mens quanto p[er] mundi concupiscentiam in ext[er]iora resoluitur, tanto per affectionem suam int[er]ius obduratur. Et torpore insensibili frigescit int[r]insecus, q[u]ia amore da[m]pnabili molescit[418] foris; seq[ue] ipsa[m] consid[er]are n[on] ualet[419], q[u]ia cogitare se minime[420] studet. Cogitare u[ero] se[421] n[on] potest, q[u]ia tota[422] aput semetipsam n[on] est. Tota u[ero] e[ss]e aput semetipsam n[on] sufficit, quia per tot[423] concupiscentias rapitur, per[424] q[u]ot[425] a semetipsa speties dissipat[ur] et sparsa[426] in infimis iacet, que collecta si uellet ad summa consurgeret[427].

Unde iustorum mens, q[u]ia p[er] custodiam discipline a cunctoru[m] uisibilium fluxus appetitu constringit[ur], collecta aput semetipsam int[r]insecus integrat[ur]. Qualisq[ue] d[e]o u[e]l p[ro]ximo e[ss]e debeat plene se conspic[it], q[u]ia nichil suum ext[er]ius d[er]elinq[u]it. Et q[ua]nto ab ext[er]iorib[us] abstracta conpescit[ur][428] tanto aucta in infimis inflammat[ur]. Et quo magis ardet, eo ad dep[re]hendenda uicia[429] amplius lucet. Hinc e[st] eni[m] quod s[an]c[t]i uiri, du[m] se intra semetipsos colligunt, mira ac penetrabili acie occulta etiam aliena delicta dep[re]hendunt. Sequit[ur], Cum temp[us] fuerit in altu[m] alas erigit. Quid eni[m] alas huius structionis accipim[us] n[is]i p[re]ssas hoc temp[or]e quasi complicatas hypocrite cogitationes? Quas cum te[m]pus fu[er]it in altum eleuat, q[u]ia oportunitate comp[er]ta, eas sup[er]biendo manifestat. Alas in altum erig[er]e e[st] p[er] effrenata[m] sup[er]biam cogitationes ap[er]ire. Nunc aute[m] quia s[an]c[tu]m se simulat, quia in semetip[s]o st[r]ingit que cogitat, q[uas]i alas in corp[or]e p[er] humilitate[m] plicat. Eat [er]g[o] hypocrita et nunc suas laudes appetat, postmodum uitam p[ro]ximoru[m][430] p[re]mat, et q[ua]ndoq[ue] se in irrisione sui conditoris exerceat, ut quo elatiora semp[er] excogitat, eo se suppliciis at[r]otiorib[us] immergat.

---

[411] Conuersatione → Conuersacione (L).
[412] Calcaret → Calcarent (H). It seems to have a dot underneath the "n".
[413] Habent → Habeant (H).
[414] Pietate → Pietatis (H).
[415] Structionis sub spetie (H).
[416] Respicit → Respixit (H).
[417] Quia et (H).
[418] Dampnabili molescit → Dampnabili mollescit (H, C); Damnabili mollescit (SC, L).
[419] Ualet → Ualens (H).
[420] Minime + docet (C). The "docet" is expuncted.
[421] Se uero (L).
[422] Tota → Totam (L).
[423] Tot → Quot (H).
[424] Per + tot (L).
[425] Quot → Tot (H, C).
[426] Sparsa → Sponsa (SC, L).
[427] Consurgeret → Consurgent (H).
[428] Conpescitur → Compescitur (SC, L).
[429] Uicia → Uitia (SC).
[430] Proximorum → Xpiamorum (H).

Unde et subdit[ur], Obliuiscit[ur] quod pes conculcet ea et bestia agri conterat. Tunc oua pes calcat[431] et bestia agri cont[er]it cu[m] in t[er]ra deserunt[ur], quia uidelicet humana corda du[m] semp[er] t[er]rena cogitare, semp[er] que ima sunt ag[er]e appetunt. Ad cont[er]endum se agri bestie, id est, diabolo sternunt, ut cum diu infirma[432] cogitatione abiecta sunt, q[ua]ndoq[ue] eitam maiorum criminum p[er]petratione fragant[ur].
Sequit[ur], Durat[ur] ad filios[433] q[ua]si n[on] sint sui. Quasi n[on][434] suos respicit quos alit[er] uiu[er]e q[ua]m docuit ipsa dep[re]hendit, et durescente seuicia[435] t[er]rores admouet[436], seq[ue] in eorum cruciatib[us] exercet atq[ue] inuidie facib[us] inflammata in quib[us] n[on] laborauit ut possent uiuere, laborat ut debeant int[er]ire. Hypoc[r]ite [er]g[o], qui p[er] strutionem intelligit[ur], consuetudo talis e[ss]e p[er]hibet[ur] ut de nullo alio cura[m] habeat, s[ed] de his que agit in se gl[or]ietur, et sibi soli bonum quod agit p[re] cet[er]is ascribat[437].

Chapter 43: De uulture.

13th Miniature: The Vulture

Oculus uult[ur]is est[438] intentio rede[m]ptoris.
Semitam ignorauit auis, nec intuit[us] e[st] ea[m][439] oculus uult[ur]is.
Quis hoc loco auis nomine nisi ille signat[ur] qui corpus carneum quod assu[m]psit ascendendo ad ethera librauit? Qui apte quoq[ue][440] etiam uult[ur]is appellatione exp[r]imit[ur]. Uult[ur] quippe dum uolat si iacens cadauer conspicit ad esum se cadau[er]is deponit, ut[441] plerumq[ue] sic in morte capit[ur] dum ad mortuu[m] animal de summis uenit. Recte [er]g[o] mediator dei et hominu[m] redemptor n[oste]r uulturis appellatione signat[ur][442], qui manens in altitudine diuinitatis sue, quasi quodam uolatu sublimi, cadauer n[ost]re mortalitatis[443] conspexit in infimis, et sese de celestib[us] ad ima su[m]misit. Fieri quoq[ue][444] dignat[us] e[st]; p[ro]pt[er] nos h[om]o[445] et dum mortuu[m] animal petiit[446], mortem aput nos quia aput se erat i[m]mortalis inuenit.
S[ed] hui[us] uulturis oc[u]l[u]s fuit ipsa intentio n[ost]re resurrectionis, q[u]ia ipse ad triduum mortuus ab et[er]na nos morte liberauit. Ille eni[m] p[er]fidus iudee p[o]p[u]l[o]s mortalem uidit, s[ed] q[uo]d morte sua morte[m] n[ost]ram destrueret minime attendit. Conspexit q[u]idem uulturem, s[ed] oculos uulturis n[on] aspexit. Qui dum humilitatis eius uias, quib[us] non ad alta subleuant, consid[er]are noluit semitam auis ignorauit. Neq[ue] enim pensare studuit quod ei[us] nos humilitas leuaret ad celestia, et mortis eius intentio reformaret ad uitam. Semitam [i]g[itur] ignorauit aius, nec intuitus est oculos uulturis, q[u]ia et si uidit eu[m] que[m] in morte tenuit, uidere noluit q[ua]nta uite n[ost]re gl[ori]a de eius morte sequeretur. Unde ad crudelitate[m] quoq[ue] p[er]secutionis exarsit; u[er]ba uite p[er]cip[er]e renuit. P[re]dicatores regni celorum p[ro]hibendo, seuiendo, feriendo repulit[447]. Qui scilicet repulsi, iudeam ad q[ua]m missi fuerant deserentes in gentilitatis collectione disp[er]si s[un]t.
S[ed] et[448] natura uult[ur]is talis dicit[ur] e[ss]e[449], ut p[er] uulturem quisq[ue] peccator intelligi uideat[ur]. Uultur siquid[em] exercitum sequit[ur], ut mortuoru[m] cadau[er]ib[us] sacietur, q[u]ia

[431] Calcat → Conculcat (H).
[432] Infirma → Infima (H).
[433] Filios → Fililios (L).
[434] Non + de (C). The "de" is expuncted.
[435] Seuicia → Seuitia (SC, L).
[436] Admouet → Ammouet (SC, L).
[437] Ascribat → Asscribat (H).
[438] \est/ (SC).
[439] *Om.* eam (H, C).
[440] *Om.* quoque (H).
[441] Ut → Et (H, L, SC). It seems that the "e" on the SC copy was possibly corrected, but it is not clear.
[442] Appellatione signatur → Significatione appellatur (H).
[443] Mortatitatis nostre (H).
[444] Quoque → Quippe (H).
[445] Propter nos homo dignatus est (H).
[446] Petiit → Peciit (C).
[447] Repulit → reppulit (H, C).
[448] *Om.* et (H).
[449] Esse dicitur (H).

peccator p[ra]uos homines qui sunt in exercitu diaboli sequit[ur], ut p[ra]uos eorum mores imitetur[450]. Mortuoru[m] cadaurib[us] uescit[ur], quia carnalib[us] desid[er]iis que morte[m] gen[er]ant delectatur.
Uultur etia[m] pedib[us] libent[er] graditur, unde et a quib[us]dam gradipes appellat[ur], quia terrena peccator amat, et t[er]renis inhiat. Q[ua]n[do]q[ue] etiam uult[ur] in altum uolat, quia peccator mentem q[ua]ndoq[ue] ad celestia[451] leuat, s[ed] qua intentione hoc faciat, alter ignorat. Q[u]is enim intuet[ur] oculos uulturis, id est, intentione[m] cogitationis? Hoc eni[m] om[ni]p[o]t[ens] sibi reliquit, quod cogitationes hominu[m] solus nouit. Nota etiam quod uultur, ut ait ysidorus, a uolatu tardo nominetur. Tarde eni[m] cum uolare cep[er]it a t[er]ra recedit, quia peccator aut uix aut numq[ua]m t[er]rena desid[er]ia d[e]relinquint.

Chapter 44: De grue.

14th Miniature: The Crane

Grues ordine literato[452] uolantes, designant ordinate uiuentes[453].

Grues dum p[er]gunt unam secuntur ordine litt[er]ato. Excelsa aute[m] petunt, quo facilius uideant quas petant t[er]ras. Castigat au[tem] uoce que cogit agm[en]. At ubi rauces\cit/, succedit alia. Nocte aute[m] excubias diuidunt, et ordinem uigiliarum p[er] uices faciunt, tenentes lapillos suspensis digitis quib[us] so[m]nos arguat[454]. Quod cauendum erit, clamor indicat.
Etatem in illis color prodit, nam in senectute nigrecunt.
Grues cum de loco ad locum transuolant ordinem p[ro]cedendi uolando seruant. Illos aute[m] significant qui ad hoc student ut ordinate uiuant. Cum au[tem] ordinate uolando p[ro]cedunt, ex se litt[er]as in uolatu fingunt: illos aute[m] designat q[u]i in[455] se p[re]cepta scripture[456] bene uiuendo formant. Quedam earum alias antecedit, que clamare n[on] desinit, quia p[re]latus, qui p[r]imum locum regiminis obtinet, suos sequaces morib[us] et uita p[re]ire debet, ita tam[en] ut semp[er] clamet et uiam bone operationis sequacibu[us] suis p[re]dicando demonstret. Que aute[m] alias antecedit si[457] rauca facta fuerit, tunc alia succedit, q[u]ia p[re]latus si u[er]bum d[e]i subiectis, n[on] p[re]dicet[458] u[e]l p[re]dicare nesciat cum raucus fiat, necesse e[st] ut alius succedat.
Si aut[em] nox accesserit, illa que p[re]cedit cum aliis ad t[er]ram descendens locum quietis petit. Tunc simul o[mne]s ad custodiam sui uigilias ordinant, ut relique securius somni quiete[m] sumant[459]. Possum[us] aute[m] p[er] uigiles intellig[er]e quolibet[460] discretos fr[at]es qui co[m]munit[er] f[rat]ib[us] temp[or]alia p[ro]uid[e]nt, et de singulis specialit[er][461] curam hab[e]nt. Ad obsequia fr[atru]m p[ro] posse suo uigilant, ut ab eis incursus demonu[m] et accessus s[e]c[u]larium prudent[er] repellant[462]. Grues u[ero] que ad hoc eliguntur ut p[ro] aliis uigilent in pede a terra suspenso lapillum tenent, timentes ne si aliqua earum dormiat, lapsus a pede lapillus cadat. Si ante[463] cadat euigilans clamat. Lapis e[st] xpc pes mentis affectus. Sicut[464] enim aliq[u]is pedib[us] incedit, sic mens suis affectib[us] quasi pedib[us] ad optata[465] tendit. Si quis [i]g[itur] ad custodiam sui u[e]l fr[atru]m uigilet, lapillum in pede, id est, xpm in mente portet. Illud aute[m] summop[er]e caueat ne si impeccato[466] dormierit, lapillus a pede, id e[st], xpc

[450] Imitetur → Immitetur (SC, L).
[451] Ad celestia mente quandoque (H).
[452] Literato → Litterato (C, SC, L).
[453] A part of the word is also given in blue on the left side of the bird tail, since part of the rubrica is covered by the aforesaid tail.
[454] Arguat → Arguant (H).
[455] *Om.* in (C).
[456] Scripture percepta (H).
[457] Si + autem (H).
[458] Dei non predicet subiectis (H).
[459] Sumant → Summant (SC). The additional "m" is expuncted.
[460] Quolibet → Quoslibet (H, C, SC, L).
[461] Specialiter → Spiritaliter (H).
[462] Repellant → Reppellant (SC).
[463] Ante → Autem (H, SC, L).
[464] Sicut → Siquis (H, C).
[465] Optata → Obtata (L).
[466] Impeccato → In peccato (C, SC, L).

a mente recedat. Si aute[m] ceciderit, p[er] confessione[m] clamet, ut dormientes excitet, id est, fr[ate]s; tam p[ro] se q[ua]m pro eorum excessib[us] ad uigilantiam ci[r]cumspectionis inuitet.
Etatem in illis color p[ro]dit, nam in senectute nigrescunt. Hic enim color in senectute seni competit cum p[ro] peccatis plan\ge/[n]do gemit. Cum eni[m] que male gessit senex commemorat in senectute, colorem mutat. Mutat eni[m] amorem p[r]istine delectationis in dolorem [co]ntricionis.
Ecce qualit[er] p[er] naturam uolucrum doceri potest uita religiosorum.

Chapter 45: De miluo

15th Miniature: The Kite

Millius[467] carne[468] rapie[n]s desidiosus[469] uoluptuose[470] quere[n]s.

Miluus mollis et uirib[us] et uolatu quasi mollis auis, un[de] et nuncupat[ur]; rapacissim[um] tam[en] et semp[er] domesticis auib[us] insidiat[ur]. Sicut enim in livro ethimologiarum ysidori legit[ur], miluus a molli uolatu nominat[ur]. Est enim miliis mollis uirib[us]; illos autem miluus significat quos mollicies uoluptatis temptat. Cadau[er]ib[us] miluus uescit[ur], q[u]ia carnalib[us] desideriis uoluptuosi delectant[ur]. Circa coquinas et macella miluus assidue uolitat[471], ut siq[u]id crude carnis ab eis p[ro]iciatur foras uolocius rapiat. P[er] hoc eni[m] miluus eos nobis innuit quos cura ue[n]tris sollicitos reddit. Qui [i]g[itur] hui[us] modi sunt uoluptuosa querunt, macella frequentant et coquinis inhiant.
Miluus timidus e[st] in magnis, audax in minimis. Siluestres uolucres rap[er]e n[on] audet; domesticis aute[m][472] insidiari solet. Insidiat[ur] pullis ut illos rapiat, et quos incautos repperit[473] uelocius necat. Sic molles et uoluptuosi teneros pullos rapiunt, q[ui]a simpliciores et indiscretos suis morib[us] aptant et ad peru[er]sos us[us] p[ro]trahunt. Sup[er] eos lente uolando incautos decipiunt, dum eos blandis sermonib[us] adulando seducunt[474]. Ecce quom[od]o uolucres que ratione carent peritos homines et ratione utentes p[er] exe[m]pla p[er]u[er]se[475] op[er]ationis docent.

Chapter 46: De yrundine[476].

16th Miniature: The Swallow

Clamor yrundinis dolor penite[n]tis.

Turtur et hyrundo[477] et[478] ciconia cognouerunt temp[us] aduentus sui: Isr[ae]l aute[m] n[on] cognouit iudicium d[omi]ni.
De turture sup[er]ius dixim[us], restat aute[m] ut de yrundine et ciconia postea disseramus. Unde ysidorus, yrundo, inquit, dicta[479] quod cibos non sumat residens, s[ed] in aere capiat escas et edat. Garrula auis et p[er] tortuosos orbes et flexuosos circuitus p[er]uolans, et in nidis construendis educandisq[ue] fetib[us] sollertissima, habens etiam q[u]iddam p[re]scium quod lapsura deserat nec appetat culmina. Aliis quoq[ue] auib[us] n[on] impetit[ur], nec umq[ua]m p[re]da e[st]. Maria transuolat, ibiq[ue] yeme comorat[ur][480]. Custodit autem temp[or]a aduentus sui; nouit aute[m][481] q[ua]ndo ueniat, q[ua]ndo reu[er]tat[ur]. Nouit pia auis annuntiare aduentus sui testimonio ueris initium.

---

[467] Milius → Miluus (H, C, SC, L).
[468] Carne → Carnem (SC, L); carnes (H, C).
[469] Desidiosus → Desydiosus (C).
[470] Uoluptuose → Uoluptuosa (H, C).
[471] Uolitat → Uolat (SC, L).
[472] *Om.* autem (H).
[473] Repperit → Reppererit (C).
[474] Seducunt → Decipiunt (H).
[475] Peruerse → Praue (H).
[476] Yrundine → Hirundine (L).
[477] Hyrundo → Yrumdo (C); Hirundo (L).
[478] *Om.* et (H).
[479] Dicta → Dicata (C). The "a" is expuncted.
[480] Yeme comoratur → Yeme commoratur (C); Hyeme commoratur (H, SC, L).
[481] Autem → Etiam (H).

P[er] yru[n]dine[m] sicut auctoritas testatur, aliquando sup[er]bia mentis, aliq[ua]ndo contricio[482] cont[r]ibulati[483] cordis intelligit[ur]. Q[uo]d p[er] yrundinem sup[er]bia designet[ur], p[er] tobiam[484] dicit[ur]. Cum iactasset[485], inquit tobias, se[486] iuxta pariete[m] et obdormiss[et], contigit ut ex nido yrundinu[m] domienti illi calida stercora insiderent sup[er] oculos eius fieretq[ue] cecus. Unde beda sup[er] tobiam, Hyrundo[487] p[ro]pt[er] leuem uolatum[488] sup[er]biam cordis leuitatemq[ue] figurat, cui[us] immundicia[489] confestim excecat, nec eum uidere p[er]mittit qualis fuerit. Q[uo]d aute[m] p[er] yrundinem contricio cordis intelligi debeat p[ro]ph[et]a dicens demonstrat, Sicut pullus hyrundinis inquit sic clamabo. Intelligim[us] [i]g[itur] p[er] hyrundinem quemlibet discretum doctorem, p[er] yrundinis pullum clamantem discipulum, p[er] clamore[m] mentis contricionem. \Clamat pullus yrundinis du[m] querit a magistro u[er]bu[m] p[re]dicationis; clamat pullus yrundinis[490] du[m] p[er] confessione[m] magistro manifestat affectu[m] contrita[491] cordis/. Si nosti clamorem hyrundinis, nisi fallor, questum designat anime penitentis.

Hyrundo cibos residens n[on] sumit, s[ed] in aere quas capit escas edit, q[u]ia qui t[er]rena non diligit[492] remot[us] a t[er]renis celestia querit. Garrula auis e[ss]e dicitur, quia querulosis orationib[us] sepi[us] delectatur. P[er] flexuosos ci[r]cuitus p[er]uolat, ut ad diu[er]sa obedientie p[re]cepta mente[m] subiectus flectat. In nidis construendis educandisq[ue] fetib[us] solertissima. Nidum construit, quia in fide passionis xpi spem fixam ponit. Sollers in educandis fetib[us], id est, in docendis subiectis fr[atr]ib[us]. Habet etiam q[u]iddam p[re]scium quod deserat lapsura nec appetat culmina. Q[u]iddam[493] p[re]scium habent qui uere penitent, quod casum p[re]sentis s[e]c[u]li fugiant, et p[er]mansura sine fine querant. Hyrundo aliis auib[us] non impetit[ur], nec unq[ua]m[494] p[re]da est. Rapaces[495] aues nu[m]q[ua]m hyrundinem rapiunt, q[u]ia cont[r]iti corde nu[m]q[ua]m demonib[us] p[re]da fiunt. Hyrundo maria transuolat, quia qui uere penitet amaritudines et tumult[us] hui[us] mundi exire desid[er]at. Ibiq[ue] hyeme co[m]morat[ur], cum enim hyems[496] ingruit et frigus accedit, tunc iustus ad calorem caritatis t[ra]nsit. Ibiq[ue][497] pacient[er] expectat, donec frigus temptationis a mente recedat. Nouit pia auis annuntiare aduentus sui testimonio ueris initium[498]. Reuertit[ur] hyrundo post frigus hyemis, \ut annu[n]ciet[499] initiu[m] u[er]is. Similit[er] iust[us] post frigus nimie te[m]ptationis reu[er]tit[ur] ad te[m]p[er]atia[m] mod[er]ate m[en]tis, ut q[u]i frig[us] temptationis euaserat ad estate[m], id est, dilectionis amore[m] moderate p[er] ascens[us] boni op[er]is accedat. H[ec] e[st] [i]g[itur] nat[ur]a hyru[n]d[in]is, id e[st], a[n]i[m]e penitentis. Que semp[er] querit ueris initiu[m], q[u]ia in omnib[us] tenet discretionis et te[m]p[er]antie modu[m]/.

Ecce qualiter simplex auis eos instruit quos ab initio diuina p[ro]uidentia discretos facit.

Chapter 47: De ciconia

17th Miniature: The Stork

Pietas ciconie[500] circa pullos est amor magistri[501] circa discipulos.

---

[482] Contricio → Contritio (H, SC, L).
[483] Contribulati → Tribulati (H).
[484] Tobiam → Tobyam (H).
[485] Iactasset + se (H, C). The "se" is expuncted.
[486] *Om.* se (H).
[487] Hyrundo → Hyrumdo (C).
[488] Uolatum leuem (L).
[489] Immundicia → Inmunditia (SC).
[490] *Om.* clamat pullos yrundinis (SC, L).
[491] Contrita → Contriti (H, C, SC, L).
[492] Diligit → Diligunt (H).
[493] Quiddam + enim (H, C).
[494] Unquam → Umquam (H, C, L).
[495] Rapaces + uero (H).
[496] Hyems → Iemps (C).
[497] Ibique + frigus (H).
[498] Initium → Inicium (L).
[499] Annunciet → Annuntiet (H, C, SC).
[500] Ciconie → Cyconie (H).
[501] Magistri + erga (H).

Ciconie uocate a sono quo crepitant, quasi cicanie quem sonum oris potius e[ss]e q[ua]m uocis, q[u]ia quatiente[502] rostro eum[503] faciunt. Hee ueris nuntie, societatis comites, serpentiu[m] hostes, maria transuolant in asiam collecto agmine p[er]gunt. Cornices eas duces p[re]cedunt et ipse quasi exercitus p[ro]sequuntur[504]. Eximia illis circa filios pietas. Na[m] adeo nidos impensius fouent, ut assiduo incubitu plumas exuant. Quantum aute[m] temporis[505] impend[er]int in filiis[506] educandis, tantum et ipse inuice[m] a pullis suis allunt[ur].
Ciconie sonum oris p[ro] uoce quatiente rostro faciunt. Illos aute[m] p[re]tendunt qui cum fletu et stridore dentium quod male gesserunt ore p[ro]munt.
Hee sunt nuntie[507] ueris, quia cet[er]is demonstrant temp[er]antia[m] conu[er]se mentis. Societatis sunt comites[508], q[u]ia libenter habitant int[er] fr[ate]s.
Dicitur etia[m][509] de ciconia quod sit serpentib[us][510] inimica. Serpentes sunt p[er]uerse cogitationes siue p[er]uersi fr[at]es quos ciconia rostro p[er]cutit, dum iustus prauas cogitationes restringit u[e]l p[er]u[er]sos fr[ate]s pung[e]nti inuectione rep[re]hendit.
Maria transuolant, in asiam collecto agmine p[er]gunt. Asia interp[re]tatur eleuata. Maria [i]g[itur] transuolat et in asiam p[er]git qui spretis[511] mundi tumultib[us], ad altiora tendit.
Eximia illis circa filios pietas, ut assiduo incubitu sup[er] eos exuant plumas. Assiduo incubitu sup[er] pullos ciconie plumas exuunt, quia dum p[re]lati subiectos nutriunt sup[er]fluitatis et leuitatis a se plumas euellunt. Quantum aute[m] temporis[512] impend[er]int in fetib[us] educandis, tantu[m] et ipse inuicem a pullis suis[513] aluntur. Quantum pulli earum indigent, tamdiu ciconie eos[514] nutrire debent, quia in quantum indigent discipuli, tamdiu u[er]bo doct[r]ine debent[515] eos alere p[re]lati. Similiter[516] subiecti p[re]latos suis laborib[us] fouere debent, ut eis ministrent necessaria quib[us] egent.
Turt[ur] [i]g[itur] et hyrundo et ciconia illos rep[re]hendunt qui xpm in carne aduenisse n[on] credunt[517], iudicium d[omi]ni futurum n[on] p[er]timescunt.

Chapter 48: De merula

18th Miniature: The Blackbird
Merula uolitans subiestio[518] te[m]ptans.

Isidorus[519] de merula, Merula antiquit[us] medula uocabat[ur], eo quod modulet[ur]. Alii merulam aiunt uocitatam q[u]ia sola uolat, quasi mera uolans. H[ec] cum in om[n]ib[us] locis[520] nigra sit, in achaia[521] tam[en] candida est.
Merula e[st] auis parua s[ed] nigra. Illos autem innuit, quos peccati nigredo tingit. Merula dulcedine p[ro]prie uocis mentem mouet in affectum delectationis[522]. Illos aute[m] figurate demonstrat quos

[502] Quatiente → Quaciente (SC, L).
[503] Quia eum quatiente rostro (H).
[504] Prosequuntur → Prosecuntur (H, SC, L).
[505] Temporis → Tempus (H).
[506] Filiis → Fetibus (H).
[507] Nuntie → Nuncie (C, L).
[508] Comites sunt (H).
[509] Etiam → Enim (H).
[510] Serpentibus sit (H).
[511] Spretis → Sumptis (H).
[512] Temporis → Tempus (H).
[513] A pullis suis inuicem (H).
[514] *Om.* eos (H).
[515] Debent doctrine (H).
[516] Similiter + ~~p[re]lati~~ (C).
[517] Credunt + et (H, C).
[518] Subiestio → Suggestio (H, C).
[519] Isidorus → Isydorus (L); Isodorus (SC). A posterior "i" was drawn over the "o" (it does not seem to be a correction from that time).
[520] *Om.* nigra (H).
[521] Achaia → Acaya (L).

uoluptas carnis p[er] suggestione[m] temptat. De ea siquidem beatus gregori[us] in libro dialogorum scribit[523], Qualit[er] beato b[e]n[e]dicto uolitans occurrit, qualit[er] uir tantus, post discessum uoluc[r]is, temptat[us] fuerit ardore libidinis. Ait enim, Quadam u[ero] die dum solus e[ss]et beatus benedictus, temptator affuit. Nam nigra paruaq[ue] auis, que uulgo merula uocatur, circa eius faciem uolitare cepit eiusq[ue] uultui importune insist[er]e, ita ut capi manu poss[et] si hanc uir s[an]c[tu]s tenere uoluiss[et]. Sed signo crucis edito recessit auis tanta \a/[524] carnis temptatio aui eadem recedente secuta est quanta[m][525] uir s[an]c[tu]s nu[m]quam fuerat exp[er]tus. Quandam namq[ue] aliquando feminam uiderat quam malign[us] sp[iritu]s ante eius mentis oculos reduxit. Tantoq[ue] igne serui d[e]i animu[m] in spetie illi[us] accendit ut se eius in[526] pectore amoris flamma uix caperet, ut iam pene deserere heremum, uoluptate uictus, delib[er]aret. Cum subito sup[er]na gr[ati]a respectus ad semetipsum reuersus e[st], atq[ue] urticaru[m] et ueprium iuxta densa succrescere fructata conspitiens[527], exutus indumento quo indutus erat, nudum se in illis spinaru[m] aculeis et urticarum incendiis p[ro]iecit. Ibiq[ue] diu uolutatus toto ex eis corpore uulnerat[us] exiit, et p[er] cutis uulnera eduxit a corpore uuln[us] mentis, quia uoluptate[m] traxit i[n] dolorem. Merula [i]g[itur] uolitans e[st] suggestio uoluptate[528] temptans. Qui [i]g[itur] abicere cupiunt uoluptatem merule, oportet ut exemplo beati b[e]n[e]dicti transeant ad correctionem discipline, et sic delectationem mentis extrahant p[er] afflictionem carnis.

In regionib[us] achaie sunt, sicut ysidorus testat[ur], candide merule. Candida merula est uoluntas munda, Achaia u[ero] soror laborans int[er]pretat[ur]. Due sunt sorores, rachel et lia[529], actiua scilicet et contemplatiua uita. Lia laboriosa int[er]pretat[ur]. Actiua uita docet elemosinas impend[er]e, indiscretos docere, mundiciam castitatis habere, p[ro]priis manib[us] laborare. H[ic] e[st] labor actiue uite. Hec est soror laborans. Hec e[st] achaia[530], uidel[i]c[et] actiua uita. In achaia [i]g[itur] quasi candide merule sunt qui in actiua uita pure uiuunt.

Chapter 49: De bubone

19th Miniature: The Owl

Infelix bubo peccator homo.

Isidorus de bubone, Bubo a sono uocis compositu[m] nom[en] habet; auis feralis onusta quidem plumis, s[ed] graui[531] semp[er] detenta pigricia in sepulc[r]is die noctuq[ue] uersat[ur], et semp[er] commorans in cau[er]nis. Unde rabanus, bubo, inquit, in tenebris peccatoru[m] deditos, et lucem iusticie fugientes significat. Unde int[er] immunda animalia in leuitico deputat[ur], unde p[er] bubonem intellig[er]e possumus que[m]libet peccatorem.

Bubo a sono uocis dicitur, qui os ex habundantia cordis loquit[ur], nam quod cogitat mente p[ro]fert uoce. Auis feda e[ss]e dicit[ur], quia fimo eius locus in quo habitat co[m]maculat[ur], q[u]ia peccator illos cum quib[us] habitat exemplo p[er]u[er]si op[er]is dehonestat. Auis honusta plumis, id est, sup[er]fluitate carnis et leuitate mentis, s[ed] graui quidem[532] detenta pigritia detinetur inertia et pigritia[533] g[ra]ui, q[u]ia peccatores ad bene op[er]andu[m] sunt inertes et pigri. Die noctuq[ue] moratur in sepulchris[534], na[m] delectat[ur] peccato quod e[st] fetor humane carnis. Habitat etiam in cau[er]nis; nec p[er] confessionem exit foras, s[ed] lucem u[er]itatis odit.

---

[522] *Om.* Illos autem innuit, quos peccati nigredo tingit. Merula dulcedine proprie uocis mentem mouet in affectum delectationis (H).
[523] Scribit → Scripsit (H).
[524] A → Autem (H, SC, L).
[525] Quantam → Quanta (H).
[526] In eius (H, C).
[527] Fructata conspitiens → Fructeta conspiciens (H, SC).
[528] Suggestio uoluptate → Subiestio uoluptatem (SC).
[529] Lia → Lya (H, L).
[530] Achaia est (H).
[531] Graui → Grauis (H).
[532] Quidem graui (H).
[533] Pigritia → Pigricia (SC, L).
[534] Sepulchris → Sepulcris (L).

Ab aliis auib[us] uisus magnis earum clamorib[us] p[ro]ditur; magnis etia[m] incursionib[us] uexatur. Si enim pecc[at]or ad lucem cognitionis[535] ueniat, magnu[m] b[e]n[e] agentib[us] derisionis questum p[re]stat. Et cum in peccato dep[re]hensus ap[er]te[536] fu[er]it, ab aliis u[er]ba reprehensionis audit. Plumas euellunt et rostro lacerant, q[u]ia et[537] carnales actus peccatoris bene agentes reprehendunt et sup[er]fluitatem dampnant[538].
Infelix [er]g[o] bubo dicit[ur], q[u]ia in felix est qui ea que p[re]diximus op[er]atur.

Chapter 49: De gragulo

20th Miniature: The Jay
Garritus graguli[539] rumores garruli.

Rabanus de gragulo[540], Gragulus[541] a garrulitate nuncupat[ur], non ut quidam uolunt p[ro] eo quod gregatim uolent, cum sit manifestum ex uoce eos nuncupari. Est enim[542] loquacissimu[m] genus et uocib[us] importunu[m], quod u[e]l philosophoru[m] uanam loquacitatem uel hereticoru[m] u[er]bositatem noxiam significare potest.
Pot[est][543] et aliud dici de natura g[r]aguli. Gragulus enim garrulos designat et gulosos, qui enim gulositati student post cibum libent[er] rumores[544] referunt[545], et aures det[ra]ctioni prebent.
Gragulus in siluis degit; de una arbore in aliam garriendo transit, q[u]ia garrulus homo, de his cum quib[us] habitat, etiam turpia que de eis[546] nou[er]it aliis narrare n[on] cessat. Gragulus cum aliq[u]e[m] transire conspicit garrit, et cum[547] aliquos[548] occultos[549] repp[er]it, similiter agit, quia garrulus homo n[on] t[antu]m detrahit s[e]c[u]larib[us], s[ed] etiam eius quos religionis occultat locus.
Gragulus captus aliquando repositus claudit[ur] ut articulata u[er]ba loqui doceat[ur]. Similit[er] cum aliquis s[e]c[u]laris ad conu[er]sionem uen[er]it, u[er]ba religionis addiscit, ut lingua uolucris u[er]ba loquat[ur] hominis, ut qui inordinate loqui consueu[er]at, ordinate loqui hacterus[550] assuescat. Quandoq[ue] tam[en] euenit quod gragulus qui clausus tenebat[ur] euadit, et qui p[r]ius garrulus[551] fuerat, post egressionem magis clamat[552]. Eodem m[od]o garrulus homo cum uitam religionis accipit[553], uix lingua[m] suam deserit, s[ed] si forte relicto habitu foras exierit, bonum religionis in malam partem det[ra]hendo quasi garriendo u[er]tit.
Moneat [i]g[itur] nat[ur]a uolucris quis recipi debeat ad consortium[554] religionis. Discretus itaq[ue][555] doctor cum aliquem recip[er]e debet, saltem eum prius cohabitatione probet. A quodam u[ero] discreto et religioso didici quod sint quedam diu[er]sitates hominu[m] que uix ordinate in religione possunt detineri. Si aute[m] queras qui sint, ut euitari possint, hi[556] sunt pictores, medici, ioculatores, et quidam alii qui p[er] diu[er]sas regiones discurrere sunt assueti; huius modi homines uix possunt e[ss]e stabiles.

---

[535] Cognitionis → Cognicionis (L).
[536] Aperte deprehensus (H).
[537] *Om.* et (H).
[538] Dampnant → Damnant (SC, L).
[539] Graguli → Graculi (H).
[540] Gragulo → Gargulo (C). The "ar" are expuncted, with an extra signal of correction.
[541] Gragulus → Gargulus (C). The same problem seen in the previous case.
[542] *Om.* enim (H).
[543] Potest + adhuc (H).
[544] Rumores libenter (H).
[545] Referunt → Ferunt (H).
[546] Eis → His (H, L).
[547] *Om.* cum (H).
[548] Aliquos → Quos (H).
[549] *Om.* occultos (SC, L).
[550] Hacterus → Hactenus (H, C, L); Actenus (SC).
[551] Garrulus → Gragulus (C).
[552] Clamat → Clamabat (C). The "bat" is expuncted.
[553] Accipit → Arripit (H).
[554] Consortium → Consorcium (L).
[555] Itaque → Igitur (H).
[556] Hi → Hii (SC, L).

Ars pictoris ualde est delectabilis. Cum enim pictor eccl[es]iam, cap[itu]l[u]m, refectorium, u[e]l aliquas officinas pinxerit, ad aliud monast[er]ium, si ei concessum fu[er]it, rogatus ab aliquo causa pingendi transit. Op[er]a xpi pingit in pariete, s[ed] utinam ea[557] teneret in mente: uestiret colorib[us] exemplo et morib[us].
Ars u[er]o medicine multis indiget, et uix aut nunq[ua]m p[ro]prietate caret. Qui hanc exercet necesse[558] ut aromatib[us] et specieb[us] habundet. Cum aliquis eccl[es]ie uicinus infinitate[559] dep[r]imitur[560], medicus ad infirmum ut ueniat rogatur. Si aut[em] abbas[561] eum ire n[on] p[er]miserit, iram incurrit. Medicus q[ua]ndoq[ue] uidet q[uo]d ordinate eum uidere n[on] licet, tang[it] quod religioso tang[er]e n[on] conuenit. De incertis p[er] exp[er]imenta loquit[ur], s[ed] quia exp[eri]mentu[m] e[st][562] fallax, id[e]o sepe fallitur. S[ed] hoc religioso n[on] expedit[563] quod nisi uera loquat[ur]. Promittit eccl[es]ie sue lucrum[564] si eat ad infirmu[m], s[ed] tacet scandalum et anime sue dampnu[m][565]. Nosti forsitan frat[er][566] de monacho medico iusto nomine s[ed] utinam iusto op[er]atione qui in medicamine tres aureos absconderat, quid de eo beatus gregorius dicat. Qui licet ei in infirmitate sua seruierit, in correctione tam[en] ei[567] n[on] pep[er]cit. F[rat]es ante mortem ai loq[u]i p[ro]hibuit; post morte[m] u[er]o eum in sterquilinio[568] sepeliri iussit. Sic au[tem] e[st] absolutus e[st][569] post mortem. Pecunia tua tecum sit in p[er]ditionem[570].
S[ed] et[571] ioculatiores ante conu[er]sione[m] leues[572], cum ad conu[er]sionem ueniunt, sepius usi leuitate, leuit[er] recedunt. Illi u[ero] qui p[er] diu[er]sas regiones discurre[573] sunt[574] consueti, si tedio claustri fu[er]int aggrauati, citius a claustris exeunt, q[u]ia t[er]rarum diu[er]sitates norunt.

Chapter 50: De ansere

21st Miniature: The Goose
Clamor anseris accusatio fratris.

Anser uigilias noctis assiduitate clangoris testat[ur] nullu[m] autem animal ita odorem hominis sentit ut anser. Unde et clangore ei[us] gallorum ascensus in capitolio dep[re]hensus e[st]. Unde rabanus, Hec p[ro]uidos homines et erga custodiam suam b[e]n[e] uigilantes significare pot[est].
Anserum due sunt[575] speties domestice[576] uidelicet et campestres. Campestres in altum et ordinate uolant, illosq[ue] designant qui remoti a t[er]renis ordinem b[e]n[e] uiuendi seruant[577]. Domestice u[ero] in uicis simul habitant; multociens conclamant[578]; seipsas rostris lacerant. Illos significant qui et si conuent[us] amant, loquacitati tam[en] et detractioni uocant[579].

[557] Ea → Eam (L).
[558] Necesse + est (H).
[559] Infinitate → Infirmitate (H, C, SC, L).
[560] Deprimitur → Premitur (H).
[561] Abbas autem (L).
[562] Est experimentum (H).
[563] Expedit → Conuenit (H).
[564] Lucrum → Lucra (H); Luchrum (C).
[565] Dampnum → Damnum (SC, L).
[566] Frater → Super (H).
[567] Ei tamen (H).
[568] Sterquilinio → Sterquinio (C).
[569] *Om.* est (SC, L).
[570] Perditionem → Perdicionem (L).
[571] Et → etiam (H).
[572] Leues ante conuersionem (H).
[573] Discurre → Discurrere (C, SC, L).
[574] Sunt discurrere (H).
[575] *Om.* sunt (H).
[576] Domestice → Domesticie (C).
[577] Seruant → Diseruant (C).
[578] Conclamant → Comclamant (C).
[579] Uocant → Uacant (H, C).

Campestres[580] anseres om[ne]s sunt coloris cinericii, nec aliq[ua]m earum niueam seu uariam[581] uidi. In domesticis u[ero] n[on] solum habetur color cinericius, s[ed] etiam uarius, u[e]l albus. In campestrib[us] habet[ur] color cinerici[us], id est, in his qui a s[e]c[u]lo sunt remoti penitentie uilis habitus. Hii u[ero] qui in urbib[us] u[e]l in uicis habitant pulc[r]iocis coloris uestem portant.
Anser p[re] ceteris animalib[us] sup[er]uenientis hominis odorem sentit, quia discretus homo p[er] bonam u[e]l malam famam alios licet longe remotos cognoscit. Cum [i]g[itur] anser odorem sup[er]uenientis homi[ni]s sentit nocte, clamare n[on] desinit, q[ui]a cum negligentias ignorantie discretus f[rate]r in aliis uidet, clamare debet. In capitolio q[u]ondam roman[us][582] fuit clamor anseris; et in capitulo[583] cotidie p[ro]dest cum negligentias uiderit clamor discreti fr[atr]is. Clamor anseris, a capitolio[584] reppulit[585] hostem gallicum, a capitolio u[ero] clamor discreti fr[atr]is hostem reppulit[586] antiquu[m][587]. Clamor anseris urbem roma[m][588] ab impetu hostium[589] seruauit immunem; clamor discreti fr[atr]is ne turbet[ur] a p[er]u[er]sis custodit uitam co[m]munem. Forsitan diuina p[ro]uid[e]ntia naturas uolucru[m] nobis n[on] p[ro]poneret nisi eas in aliquo nobis forte p[ro]desse uellet.

Chapter 51: De ardea

22nd Miniature: The Heron
Volatus ardee processus anime[590].

Ardea uocata quasi ardua propt[er] arduos[591] uolatus formidat enim ymbres et sup[er] nubes euolat ut p[ro]cellas nubium sentire non possit. Cum aute[m] uolau[er]it significat tempestate[m]. Hanc multi tantalum[592] uocant. Unde rabanus, Hec auis potest significare animas electorum que, formidantes p[er]tubationem[593] huius s[e]c[u]li, ne forte p[ro]cellis p[er]secutionu[m] instigante diabolo inuoluant[ur], intentionem suam sup[er] om[n]ia temp[or]alia, ad serenitatem pat[r]ie celestis ubi assidue uultus d[e]i conspicit[ur] mentes suas eleuant.
Licet ardea in aq[u]is cibos[594] querat, in siluis tam[en] et in aliis arborib[us] nidum locat, q[u]ia iustus q[u]i reb[us] labentib[us] et transitoriis seipsum pascit, in uiris sublimib[us] spe[m] ponit: Et cuius caro sustentatur transitoriis[595] ei[us] anima delectatur eternis. Ardea pullos in nido rostro, defendere nitit[ur][596] ne ab aliis auib[us] rapiant[ur]. Eodem m[od]o iustus forti inuectione p[er]cutit quos p[er]u[er]sos ad decipiendum subiectos nouit.
Quedam u[ero] earum h[abe]nt colorem album, quedam cinericium ut[er]q[ue] tam[en] color in bonam partem ponit[ur], si p[er] album mundicia, p[er] cineritium penitentia designatur[597]; eiusdem enim generis sunt et qui penitent, et q[u]i munde uiuunt. Et color [i]g[itur] ardee et modus uite exemplum salutis dat religiosis.

Chapter 52: De caladrio

23rd Miniature: The Caladrius
Candor huius caladrii est mundicia xpi.

[580] Campestres → Capestres (H).
[581] Uariam seu niuea (H).
[582] Romanus + per (H).
[583] Capitulo → Capitolio (L).
[584] Capitolio + suo (C). The "suo" is expuncted.
[585] Repullit → Repulit (H, L).
[586] Reppulit → Repellit (H, L), Reppellit (SC).
[587] Antiquum → Antiqum (SC).
[588] Romam → Romanam (H, C).
[589] Hostum + hostium (L).
[590] *Om.* (A).
[591] Arduos → Altos (H).
[592] Tantalum → Tantulum (SC, L).
[593] Perturbationem → Perturbationes (H).
[594] Cibos in aquis (H).
[595] Transitoriis + et (H).
[596] Defendere nititur rostro (H).
[597] Designatur → Designetur (H).

Phisiologus de caladrio dicit[598] quod tot[us] albus sit. Cuius pars int[er]ior femoris caliginem aufert ab oc[u]lis. Natura etiam caladrii talis e[ss]e dicit[ur] ut si ad infirmum hominem aliquotiens[599] adducat[ur], utru[m] infirm[us] mori aut uiu[er]e debeat astantes certos reddat. Si enim faciem infirmi hominis respic[it] nec oc[u]los au[er]tit, s[ed] infirmi faciem diligent[er] consid[er]at, signum e[st] quod uiuat. Si aute[m] oculos au[er]tat[600] a facie infirmi hominis signum e[st] mortis.
P[er] caladriu[m] intelligim[us] xpm, qui uenit in mundum ut saluu[m] faceret genus humanum. Qui dicit[ur] e[ss]e niuei coloris, quia ab om[n]i peccato fuit immunis.
Cuius pars int[er]ior femoris tergit ab oc[u]lis obscuritate[m] caliginis. Per fermur p[ro]pagatio generis intelligit[ur]. Interior [i]g[itur] pars femoris e[st] incarnatio saluatoris. Int[er]ior siquidem et occulta incarnatio saluatoris. Int[er]ior siquidem et occulta incarnation saluatoris[601] fuit, que etiam diabolo latuit.
Uenit xpc in mundu[m] ut saluum faceret genus humanu[m]. Faciem suam a iudeis au[er]tit; gentiles respexit; iniquitates n[ost]ras sustinuit et qui peccatu[m] n[on] fecerat in ligno crucis peccata n[ost]ra portauit. S[ed] et cotidie p[re]dictus caladrius infirmitates n[ost]ras uisitat, m[en]tem p[er] confessionem[602] consid[er]at, et eos sanat quib[us] gra[tia]m penitendi pr[est]at. Ab illis [er]g[o][603] faciem au[er]tit quor[um] cor impenitens[604] nouit. Istos respuit, s[ed] illos in q[u]os facie[m] intendit sanos reddit.

Chapter 54: De fenice[605]

24th Miniature: The Fenix

Resurrectio hui[us] fenicis est spes future resurrectionis.

Fenix arabie auis dicta quod colorem feniceum habeat; u[e]l quod sit in toto orbe s[e]c[u]laris[606] et unica. Nam et arabes sing[u]larem fenicem uocant. Hec quingentis ultra annis uiuens, dum se uiderit senuisse collectis aromatum uirgulis rogum s[ib]i instruit, et conu[er]sa ad radium sol[is] alarum plausu uoluntariu[m] s[ib]i incendium nutrit sicq[ue] it[er]um de cinerib[us] suis resurgit. Unde rabanus, Fenix, inquit, potest significare resurrectionem[607] iustor[um] qui, aromatib[us] ui[r]tutum collectis, restaurationem p[r]ioris uigoris p[ost] morte[m] sibi preparant.
Fenix e[st] arabie auis. Arabia u[ero] interp[re]tatur campestris. Camp[us] e[st] hic mu[n]dus, Arabia s[e]c[u]laris uita, Arabes s[e]c[u]lares, Arabes fenicem appella[n]t[608] singularem. Singularis est quilibet iustus, a curis s[e]c[u]larib[us] omnino remotus.
Fenix p[er] quing[e]ntos annos uiu[er]e creditur, sicut sc[r]iptura testatur. Centenarius u[ero] numerus in annis moralit[er] designat t[er]minum p[er]fectionis. Quingentoru[m] annoru[m] numer[us] assignari potest quinq[ue] corp[or]is sensib[us]. Cum enim uisus deficit, p[r]imus centu[m] annoru[m] numerus transit. Cum deficit auditus, transit s[e]c[un]d[u]s. Cum u[ero] tres reliqui sensus, id est, gustus, odoratus et tactus deficiunt, tunc quingenti anni moralit[er] transacti sunt.
Cu[m] enim[609] morti fenix[610] appropinquat tunc diu[er]sas speties aromatu[m] parat. Aromata sunt bona op[er]a, diuerse species anime ui[r]tutes. Congeriem aromatum construit et se in mediis aromatu[m] specieb[us] componit. Hec tociens iustus agit, q[u]ociens ad memoria[m] bonorum op[er]u[m]

[598] Dicit de caladrio (H).
[599] Aliquotiens → Aliquociens (SC, L).
[600] Auertat oculos (H).
[601] *Om.* Interior siquidem et occulta incarnation saluatoris (H).
[602] Confessionem → Confesionem (L).
[603] Ergo → Uero (H).
[604] Impenitens → Inpenitens (SC, L).
[605] Fenice → Phenice (H).
[606] Secularis → Singularis (H, C); Singularia (SC, L).
[607] Resurrectionem → Resurrectio (H).
[608] Appellant → Uocant (H); Apellant (L).
[609] Enim → Uero (H).
[610] Fenix morti (H).

multitudinem[611] reducit. Ad radium solis alis ignem uoluntariu[m] excitat, q[u]ia mente[m] alis contemplationis excitatam iustus ardore s[an]c[t]i sp[iritu]s inflammat.
Sic [i]g[itur] fenix incenditur, s[ed] ex eius cinere fenix it[er]um p[ro]creat[ur]. Cum [er]g[o] fenix mortit[ur] et ex eius cin[er]e fenix it[er]um[612] nascit[ur], hoc exemplo agitur ut future ressurectionis u[er]itas a singulis fieri credatur[613]. Non est[614] [er]g[o] maius miraculum fides future resurrectionis quam ex cinere facta resurrect[i]o fenicis.
Ecce uolucrum[615] natura simplicib[us] ressurectionis argumentum prestat. Et quod scriptura predicat, opus nat[ur]e confirmat.

Chapter 55: De perdice

25th Miniature: The Partridge
Furtu[m] p[er]dicis insidie demonis. ~~De perdice.~~

Clamauit p[er]dix et congregauit oua que n[on] pep[er]it, faciens sibi n[on] cum iudicio diuicias. In medio eni[m] dierum suorum derelinquent[616] eas, et in nouissimis suis erit insipiens. Unde ysidorus, P[er]dix de uoce nom[en] h[abe]t auis dolosa adeo aute[m][617] fraudulenta, ut alt[er]ius oua diripiens foueat. S[ed] fraus[618] fructum n[on] habet, nam cum pulli p[ro]prie uocem genit[r]icis audierint, naturali quodam instintu[619] hanc que fouit[620] relinqunt[621], et ad eam[622] que genuit reuertunt[ur]. Unde rabanuns, Diabolus p[er] p[r]incipes hereticorum congregauit pop[u]los q[u]os n[on] pep[er]it, et deceptorum s[ib]i m[u]ltitudinem consociauit, quos postea dimisit; et om[n]ium iudicio stultissimus e[ss]e comp[ro]bat[ur].
Possumus [er]g[o] intellig[er]e diabolum p[er] p[er]dicem, p[er] ouum spem. P[er]dix uero cuis oua furatur[623] eccl[es]ia p[ro]cul dubio intelligit[ur]. In p[er]dice [i]g[itur] sc[r]iptura diabolum nobis innuit, qui[624] oua alt[er]ius p[er]dicis, id est, habentes spem salutis furat[ur]; fouet et nutrit. Furatur dum spem salutis eis subtrahit. Fouet occio[625], delectatione nutrit. Fouet t[er]renis desid[er]iis, nutrit carnalib[us] illecebris. Cum aut[em] pulli uocem p[ro]prie genit[r]icis audiunt, quodam nat[ur]ali instinctu eam recognoscunt. Similiter cum aliquis diabolo subiect[us] fu[er]it et uocem eccl[es]iastice[626] p[re]dicationis audit, ad eccl[es]iam quasi ad genit[r]icem p[ro]p[r]iam, relicto diabolo, transuolat, ut sub alis diuine p[ro]tectionis ult[er]ius in pace uiuat.
Ecce qualit[er] p[er]dix p[er]dit[627] oua que furat[ur] et congregat, qui n[on] e[st] mirum si quos male congregau[er]at diabolus iudicio u[er]itatis p[er]dat. In nouissimis [er]g[o] suis diabolus insipiens erit, quia in die iudicii eterna benedictione carebit, et tunc audiet p[er]dix cum p[er]ditis, id est, diabolus cum subiectis, Ite maledicti in ignem et[er]num qui p[re]paratus[628] diabolo et ang[e]lis eius. Ad hoc enim tendunt qui in hac uita diabolo seruiendo succumbunt[629].

Chapter 56: De cot[ur]nice

[611] Multitudinem + multitudinem (L).
[612] *Om.* Cum ergo fenix mortitur et ex eius cinere fenix iterum (H).
[613] Credatur → Creditur (SC, L).
[614] *Om.* est (SC, L).
[615] Uolucrum → Uoluchrum (L).
[616] Derelinquent → Derelinquet (H).
[617] Autem → Tamen (H).
[618] Fraus → Fraux (L).
[619] Instintu → Instinctu (H, C, L).
[620] Fouit → Foueat (H).
[621] Relinqunt → Relinquunt (H, C, SC, L).
[622] Eam → Eandem (H).
[623] Furatur → Furantur (SC, L).
[624] Qui → Quia (L).
[625] Occio → Otio (H); Ocio (SC, L).
[626] Ecclesiastice + p[er] (C). It may have been a mistake as the following word starts with "p" and begins on a different text line.
[627] Perdit → Perdidit (L).
[628] Preparatus + est (H, C, SC, L).
[629] Succumbunt → Subcumbunt (SC, L).

26th Miniature: The Quail

Coturnix maria transmea[n]s e[st] animal[630] labe[n]tia calcans.

Corturnices a sono uoces dictas constat[631], quas greci ortigias uocant eo quod uise fu[er]int p[r]imu[m] in ortigia insula. Hee aduenientes habent temp[or]a. Nam estate depulsa maria transmeant. Ortigometra dicit[ur] que gregem duc[it]; eam t[er]re p[ro]pinquante[m][632] accipit[er] uidens rapit. Ac p[ro]pterea cura est uni[er]sis ducem sollicitare g[e]n[er]is externi, p[er] quem caueant p[r]ima disc[r]imina. Sola hec auis sicut et h[om]o caducum patit[ur] morbum.

Cot[ur]nices aduenientes h[aben]t temp[or]a, nam maria transmeant estate depulsa. Calor estatis e[st] ardore caritatis. Frigus hyemis e[st] temptat[i]o refrigerate mentis. Ab amore [i]g[itur] p[ro]ximi, p[er] mare mundi hui[us][633], t[ra]nsmeat iustus ad amore[634] dei, ut in calida regione semp[er] maneat. Q[u]i semp[er] calore dilectionis in semetipso flagrat, ut uitet frigus hyemis, p[ro]cellas uidelicet et uentos imp[ro]uise temptationis.

Ortigometra d[icitu]r que gregem ducit; eam t[er]re p[ro]pinquantem accipit[er] uidens rapit. Terra sunt t[er]rena[635] desid[er]ia, Maria mundi p[er]icula; accipit[er] insidians diabolus p[er] suggestione[m] temptans[636]. P[ro]pinquante[m] [i]g[itur] t[er]re accipit[er] uidens rapit, quia eos qui terrena querunt diabolus secum trahit. Prelatus [i]g[itur] qui gregem antecedit diligent[er] p[ro]uideat q[ua] intentione terrena petat, utrum in suos usus ea redigat, u[e]l ad necessitatem fr[atru]m ea querat, ne accipiter, id est, diabolus, eum rapiat, qui p[ost]positis sp[irit]alib[us] terrenis inhiare n[on] cessat.

P[ro]pt[er]ea cura e[st] uniu[er]sis ducem sollicitare gen[er]is ext[er]ni, p[er] quem caueant prima disc[r]imina. Duo sunt gen[er]a hominu[m], bonoru[m] uidelicet[637] et malorum. Gen[er]is ext[er]ni sunt homines p[er]u[er]si. Iusti [i]g[itur] p[er]u[er]sos sibi p[re]ponunt[638] dum casus et euent[us] eorum diligent[er] attendunt. Dum h[ec] [i]g[itur] attente consid[er]ant prima peccandi disc[r]imina consid[er]ando uitant.

Hec auis sicut homo caducu[m] morbum, patit[ur][639] quia sp[ir]italis homo sicut et carnalis aliquotiens peccare p[er]hibet[ur]. ~~nec quociens.~~ Nec quotiens peccat morit[ur][640], q[u]ia ei penitendi gr[ati]a n[on] negat[ur]. Unde sc[r]iptum est, Septies in die cadit iustus, nec t[ame]n desinit e[ss]e iustus. Quociens enim iustus peccat, tociens adicit ut resurgat.

Chapter 57: De huppupa.

27th Miniature: The Hoopoe

Huppupa[641] auis spurcissima p[e]cc[at]ores designat homines.

Huppupam[642] greci appellant eo quod stercora humana consideat et fetenti pascat[ur] fimo. Auis spurcissima, cristis extantib[us] galeata, semp[er] in sepulc[r]is[643] et humano stercore co[m]morans. Unde rabanus, Hec auis scel[er]atos[644] peccatores significat, homines q[u]i sordib[us] p[e]cc[at]orum assidue delectant[ur]. Huppupa etiam luctum amare dicit[ur], quia s[e]c[u]li t[r]isticia mortem sp[iritu]s op[er]atur. P[ro]pt[er] quod oportet eum qui diligit d[eu]m semp[er] gaudere sine int[er]missione orare in om[n]ib[us] gr[ati]as ag[er]e, q[u]ia gaudium fructus e[st] sp[iritu]s.

---

[630] Anima (H, C).
[631] Constat → Constant (H).
[632] Propinquantem → Apropinquantem (H).
[633] *Om.* huius (SC, L).
[634] Amore → Amorem (H).
[635] Terrena sunt (H).
[636] Temptans → Tempta~~io~~nis (C). The letters "io" and "i" between the "nis" are expuncted.
[637] Uidelicet → Scilicet (H).
[638] Preponunt → Proponunt (H).
[639] Patitur morbum (H).
[640] Moritur → Momoritur (L). The additional "mo" is at the beginning of a different line.
[641] Huppupa → Hupupa (L).
[642] Huppupam → Hupuppam (H).
[643] Sepulcris → Sepulchris (H); Sepulchis (SC).
[644] Sceleratos → Celeratos (SC, L).

De huppupa e[tiam] phisiologus dicit[645] quod cum senuerit et uolare n[on] possit, filii eius ad eam ueniunt et pennas uetustissimas a corpore ipsius[646] euellunt, eamq[ue] fouere n[on] cessant donec it[er]um penne noue recrescant. Cibis sust[e]ntant, ut script[ur]a dicit, donec sicut antea su[m]ptis uirib[us] euolare possit. Exemplum [i]g[itur] p[er]u[er]sis hom[in]ib[us] t[r]ibuunt qui patres suos cum senuerint a domib[us] p[ro]priis expellunt: q[u]i eos c[um] deficiant sustentare renuunt q[u]i ipsos cum adhuc paruuli[647] e[ss]ent educaueruunt. Uideat [i]g[itur] homo rationabilis q[u]id pat[r]i u[e]l mat[r]i debeat, cu[m] irrationabilis creatura quod p[re]dixim[us], in necessitate cum senuerint parentib[us] reddat.

Chapter 58: De cigno

28th Miniature: The Swan

Albedo cigni simulatio conuersi.

Olor auis e[st] quam greci cignu[m] appellant. Olor autem dictus quod sit totus plumis alb[us][648]; null[us] enim meminit cignum nigrum. Olo[649] enim grece totum dicit[ur][650]. Cignus[651] a canendo est appellat[us], eo quod carminis dulcedinem modulatis uocib[us] fundit. Id[e]o aute[m] suauit[er] eum canere p[er]hibent[652], qui longum collum et inflexum habet, et necesse est eluctantem uocem p[er] longum et flexuosum it[er] uarias fundere[653] modulationes. Ferunt in hip[er]boreis[654] partib[us] p[re]cinentib[us] citharedis[655] olores plurimos aduolare apteq[ue] ad modum concin[er]e.

Cignus habet plumam[656] niueam, s[ed] carnem nig[ra]m. Moralit[er] color niuens in plumis designat effectum simulationis qua caro nigra tegit[ur], q[u]ia peccatu[m] carnis simulatione uelat[ur]. Cignus dum in flumine natat ceruicem capitis erectam gestat, q[u]ia sup[er]b[us] qui cum reb[us][657] trahit[ur] etiam labentium rerum possessione[658] ad tempus gl[ori]atur.

Ferunt in hip[er]boreis partib[us] p[re]cinentib[us] citharedis olores pl[ur]imos aduolare apteq[ue] ad modum concin[er]e, q[u]ia qui uoluptatib[us] totis desid[er]iis inhiant q[ua]si aduolantes uoluptuosis concordant. S[ed] et in extremis cum cignis[659] morit[ur], ualde dulcit[er] moriens canere p[er]hibet[ur]. Similit[er] cum[660] de hac uita sup[er]b[us] egredit[ur], adhuc dulcedine p[re]sentis s[e]c[u]li delectat[ur], et que male gessit ad memoria[m] moriens reducit.

Cu[m] u[ero] pluma niuea cign[us] exuit[ur] i[n] ueru positus ad ignem torret[ur]. Similit[er] cum diues sup[er]b[us] moriens exuit[ur], mundana gl[ori]a; descendens ad fla[m]mas inferni, cruciabit[ur] p[er] tormenta, et qui cibum querere consueuerat in imis, in abyssum[661] descendens, fit cib[us] ignis.

Chapter 59: De pauone

29th Miniature: The Peacock

Clamor pauonis terror doctoris.

Classis salomonis p[er] mare semel p[er] tres annos ibat in tharsis[662], deferens inde aurum et argentum, dentes helepha[n]torum[663], et simias et pauos.

---

[645] Dicit phisiologus (H).
[646] Ipsius → Eius (H).
[647] Paruuli → Pauuli (SC).
[648] Albus plumis (SC, L).
[649] Olo → Olon (H).
[650] Dicitur + latine (L). The "latine" is expuncted.
[651] Cignus + enim (H).
[652] *Om.* Perhibent (H). Perhibent → Quia (SC, L).
[653] Fundere → Reddere (H).
[654] Hiperboreis → Hyperboreis (H, L).
[655] Citharedis → Citharedys (L).
[656] Plumam habet (H).
[657] Rebus + transitoriis (H, C).
[658] Possessione → Possessiones (H); Posessione (L).
[659] Cignis → Cignus (H, C, SC, L).
[660] *Om.* cum (L).
[661] Abyssum → Abissum (L).
[662] Tharsis → Tarsis (L).

Tharsis int[er]pretat[ur] exploratio gaudii. Est aute[m] gaudium p[re]sentis s[e]c[u]li, e[st] et futuri. Gaudium p[re]sentis uite[664] fine claudit[ur], gaudium u[ero] fut[ur]e nequaq[ua]m fine t[er]minat[ur]. Gaudium presentis uite dolor et t[r]isticia sequit[ur], gaudium u[ero] fut[ur]e nec dolor nec tristicia subsequet[ur]. Gaudium p[re]sentis s[e]c[u]li e[st] honorib[us] sublimari, reb[us] transitoriis ad tempus p[er]frui, habundare parentu[m] copia et eorum delectari p[re]sentia. Cum aute[m][665] aliquis p[r]iuat[ur] honorib[us], spoliat[ur] reb[us], cum aliq[u]is amicorum morit[ur], tunc dolor sequitur. Hoc gaudium [i]g[itur] semp[er] dolorib[us] i[m]miscet[ur][666].

P[er] tres annos semel classis salomonis p[er] mare mittit[ur] in tharsis. Classis salomonis e[st] ui[r]tus confessionis. Hac classe p[er] hui[us] mundi mare uehimur, ne submergam[ur]. In tharsis [er]g[o] classis mittit[ur], que inde aurum et argentu[m], dentes helephantoru[m], simias et pauos deferre p[er]hibet[ur]. Aurum et argentum in tharsis e[ss]e dicit[ur], id est, uiri sap[ient]ia clari, eloq[ue]ntia p[er]iti, qui dum p[re]sentis s[e]c[u]li gaudium implorant[667] exquir[un]t, seipsos cognoscunt, et dum p[er] classem salomonis de tharsis ad salomonem[668] ueniunt, in pace eccl[es]ie p[er] confessione[m] puriores fiunt. De hoc auro purissimo fecit rex salomon scuta aurea. Scuta aurea sunt qui pure uiuunt et alios ab incursu diaboli defendunt. Ex p[re]dicto etiam argento fiunt tube argentee, id e[st], doctores eccl[es]ie.

Attulit etiam simias et pauos, id est, derisores et delicatos, ut qui in tharsis derisores et delicati fuerant in pace conu[er]sionis humiles existant. Attulit etiam classis salomonis dentes elephantoru[m][669], id e[st], detractiones[670] sup[er]borum. Dum eni[m] u[er]bis bonis op[er]ib[us] simplicium[671] detrahunt q[ua]si dentib[us] eorum ossa rodunt. Nota quod dentes elefantis[672] mat[er]ia fuint[673] eboris, et de mat[er]ia eboris fit trhon[us][674] salomonis. Qui enim ex rapina uiu[er]e consueuerant, subiecti u[ero] salomonis seipsos postea sedem parant.

P[er] tres annos semel classis salomonis ire consueuerat[675] in tharsis. Prim[us] annus moralit[er] est cogitatio, s[e]c[un]d[u]s loquutio[676], t[er]cius op[er]atio. Cum [i]g[itur] de his trib[us] simul confessio, agitur[677] quasi a seruis salomonis p[er] tres annos semel in tharsis itur.

S[ed] et iosaphath[678] rex iuda, sicut hystoria[679] dicit, classes in mari[680] fecit, que nauigarent in ophir[681] p[ro]pt[er] auru[m] et ire non potuerunt, quia confracte sunt in asiongaber. Iosaphath iudicans, uidas confessio int[er]pretat[ur]. Iosaphath aute[m] rex iuda[682] dicit[ur], q[u]ia indicium[683] confessioni d[omi]natur. Cum eni[m] peccator i[n] co[n]fessione seipsum iudicat, tunc rex iosaphath in iudea regnat. Ophir u[ero] herbosum int[er]pretat[ur]. Herbosa t[er]ra dicit[ur] que ab aliquo n[on] elaborat[ur], que uestit[ur] abundantia[684] graminis, ut moueat affectum delectationis. In hoc herboso[685] uoluptuosi sedent, desidiosi iacent. Sedent assiduitate[686], iacent dissolutione[687]. Hoc herbosum[688] e[st] hic mund[us],

---

[663] Helephantorum → Elefantorum (H); Elephantorum (C, L).
[664] *Om.* uite (L).
[665] *Om.* autem (H).
[666] Immiscetur → Inmiscetur (SC).
[667] Implorant + et (H, C).
[668] Salomonem → Ierusalem (H).
[669] Elephantorum → Elefantorum (C).
[670] Detractiones → Detractores (H).
[671] Simplicium → Simplium (L).
[672] Elefantis → Elephantis (SC, L).
[673] Fuint → Fiunt (H).
[674] Trhonus → Thronus (H, C, SC, L).
[675] Consuerat → Consuerant (H).
[676] Loquutio → Locutio (H, SC, L).
[677] Agitur simul confessio (H).
[678] Iosaphath → Iosaphat (H, SC, L).
[679] Hystoria → Historia (SC).
[680] Mari → Mare (SC, L).
[681] Ophir → Ophyr (H).
[682] Iuda + esse (H).
[683] *Om.* indicium (L).
[684] Abundantia → Habundantia (H, L).
[685] Herboso → Erboso (L).
[686] Set + assiduitate sedent (H).
[687] Dissolutione iacent (H).

st[er]i\lis/ et infecund[us]. In ophir [i]g[itur] classis iosaphath ire p[ro]pter aurum nitit[ur], ut dum mundi casus attendit[ur] m[en]tis puritas acquirat[ur]. S[ed] cum hoc agitur[689], in asiongaber classis iosaphath fracta fuisse p[er]hibetur. Gab[er]\sion/[690] a ieronimo dicit[ur] iuuenis siue fortis int[er]pretat[ur]. Non[691] [i]g[itur] mirum si classem confessionis frangat i[m]petus iuuentutis.

Q[uonia]m de premissis plura dixim[us], restat ut de pauone, de quo agere intendim[us], aliq[u]id p[ost]ea dicamus. Pauo, sicut ysidorus dicit, a sono uocis[692] accepit. Cum ex imp[ro]uiso enim[693] clamare cep[er]it, pauorem subitum audientib[us] incutit. Pauo [i]g[itur] a pauore dicit[ur], cum p[er] uocem eius pauor audientib[us] inferat[ur]. Pauo dum in tharsis habitat delicatos designat, cum u[ero] p[er] classem in iher[usa]l[e]m delatus fuerit, doctoru[m] p[re]dicantiu[m] figuram gerit. Duras habet carnes et putredini resistentes, que uix a coco[694] coquant[ur][695] foco, u[e]l a calore epatis coqui possunt in stomaco[696]. Tales sunt doctorum m[en]tes quas nec flamma cupiditatis exurit, nec calor libidinis accendit.

H[abe]t pauo uocem t[er]ribilem, incensu[m][697] simplicem, caput serpentinu[m], pectus saphirinum. Habet etia[m] in alis plumas aliquantulum rufas. Habet etiam caudam longam et, ut ita dicam, quasi oc[u]lis plenam. Habet pauo uocem t[er]ribilem q[ua]ndo p[re]dicator pecc[at]orib[us] minat[ur] inextinguibilem gehenne ignem. Simplicit[er] incedit quotiens in op[er]ib[us] suis humilitatem n[on] excedit. Habet caput serpentis dum caput mentis tenet[ur] sub custodia callide ci[r]cumspectionis. [698]Color rubrubeus in pennis amorem designat contemplationis. Longitudo caude longitudine[m] innuit future uite. Quod aute[m] quasi oc[u]los in cauda habet, ad hoc p[er]tinet, q[uo]d[699] un[us]quisq[ue] doctor p[re]uidet quod p[er]ic[u]l[u]m in fine singulis imminet[700]. Est in cauda color uiridis, ut initio conueniat finis. Varietas [i]g[itur][701] colorum designat diu[er]\sitate[m]/ ui[r]tutum.

Nota etiam q[uo]d pauo, dum laudat[ur], caudam erigat[702], q[u]ia p[re]latus quilibet adulantium laudib[us] p[er] uanam gl[ori]am mente[m] leuat[703]. Pennas in ordine ponit, q[ui]a quicq[u]id doctor agit se ordinate fecisse credit. Cum autem cauda erigit[ur], posteriora nudant[ur][704] et sic quod laudat[ur] in op[er]e deridet[ur] in elatione. Oportet [i]g[itur] ut pauo caudam submissam gerat ut quod doctor agit cum humilitate fiat.

Chapter 60: De aquila

30th Miniature: The Eagle

Iuuentus aq[u]ile renouatio anime.

Aquila ab acumine[705] oc[u]lorum uocata[706]; tanti enim contuit[us] e[ss]e dicit[ur] ut, cum sup[er] maria i[m]mobili penna ferat[ur] nec humanis pateat obtutib[us], de tanta su\blimitate pisciculos/[707] natare uideat, ac tormenti instar descendens raptam p[re]dam pennis ad litus p[er]t[ra]hat.

Nam et contra radiu[m] solis fert[ur] obtutu[m] n[on] flect[er]e, unde et pullos suos ungue suspensos radios[708] sol[is] obicit et quos uid[er]it immobilem ten[er]e aciem ut dignos g[e]n[er]e conseruat si quos

---

[688] Herbosum → Erbosum (L).
[689] Agitur hoc (H).
[690] Gabersion → Gaber sicut (H, C).
[691] Non + est (H, C).
[692] Uocis + nomen (H, C).
[693] Cum enim ex improuiso (H).
[694] Coco → Cocco (C).
[695] Coquantur → Coquatur (H).
[696] Stomaco → Stomacho (H, L).
[697] Incensum → Incessum (H, C, L).
[698] Color uero saphyrinus in pectore celeste desiderium designat in humana mente (H).
[699] Ut + quod (H).
[700] Imminet → Inminet (SC).
[701] Igitur → Ergo (SC, L).
[702] Erigat → Erigit (H).
[703] Leuat → Leuant (H).
[704] Nudantur → Nundantur (C). The additional "n" is expuncted.
[705] Acumine → Accumine (L).
[706] Aquila uocata ab acumine oculorum (H).
[707] Pisciculos → Pisculos (C).

u[ero] inflect[er]e obtutum quasi degen[er]es abicit. Unde beatus gregori[us], Aquile uocabulo in sc[r]iptura sacra[709] aliquando maligni sp[iritu]s, raptores animaru[m], aliquando p[re]sentis s[e]c[u]li potestates, aliq[ua]n[do] u[ero] u[e]l subtilissime s[an]c[t]orum intelligentie, u[e]l incarnat[us] d[omi]n[u]s ima scel[er]iter tranuolans[710] et mox summa repetens designat[ur].

Aq[u]ilarum nomine insidiatores sp[iritu]s exp[r]imunt[ur] ieremia[711] attestante, qui ait, uelociores[712] fuer[un]t p[er]sequutores[713] n[ost]ri aquilis celi. P[er]sequutores eni[m] n[ost]ri aquilis celi uelociores sunt, cum[714] contra nos maligni homines faciunt, ut ipsas etiam[715] aerias potestates inuentionib[us] malicie p[re]ire uideant[ur].

Aquile uocabulo potestas t[er]rena figurat[ur]. Unde et[716] p[er] iezechielem p[ro]ph[et]am dicit[ur], Aquila g[ra]ndis magnaru[m] alarum, longo menbrorum ductu, plena plumis et uarietate uenit ad libanu[m] et tulit medullam cedri et summitatem frondium ei[us] euulsit. Oua[717] uidelic[et] aquila q[u]is alius q[ua]m nabugodonosor[718] rex babilonis designat[ur], qui p[ro] imm[en]sitate[719] ex[er]citus magnaru[m] alarum, p[ro] diut[ur]nitate[720] temporu[m] longo m[em]brorum ductu, p[ro] multis u[ero] diuiciis[721] plenus plumis, p[ro] innumera autem t[er]rene gl[ori]e compositio[ne] plena uarietate desc[r]ibit[ur]? Que uenit ad libanum et tulit medulla[m] cedri et su[m]mitate[m] frondium eius euusilt, q[u]ia iudee celsitudinem petens nobilitate[m] regni ei[us], q[ua]si medullam cedri abstulit; et du[m] tenerrimam regum p[ro]lem a regni sui culmine captiuando sustulit, quasi summitate[m] frondium ei[us] euulsit.

Aq[u]ile uocabulo subtilis s[an]c[t]orum intelligentia exp[r]imit[ur]. Unde isdem p[ro]ph[et]a dum sub animaliu[m] sp[eci]e euangelistas quatuor se uidisse desc[r]iberet in eis quartum animal, id e[st], ioh[ann]em[722] significans, qui uolando terram, desereuit[723] q[u]ia p[er] subtilem intelligentiam int[er]na misteria u[er]bum uidendo penetrauit. Similit[er] qui adhuc t[er]rena m[en]te deser[un]t, uelut aquila cu[m] ioh[ann]e p[er] contemplatione[m] celestia querunt[724]. Item beatus g[re]gori[us] de aquila, Sicut aquila uolans ad escam. Moris quippe e[st] aquile ut inreu[er]berata acie radios solis aspiciat. S[ed] cum refectionis indigentia urget[ur], eandem oc[u]lorum aciem q[ua]m radiis[725] solis infix[er]at ad respectum cadaueris inclinat et q[ua]muis ad alta euolet, p[ro] sum[en]dis tam[en] carnib[us][726] t[er]ram petit. Sic uidelicet sic antiq[u]i patres fuerunt qui, in q[ua]ntum humanitatis infirmitas admittebat, creatoris lucem erecta m[en]te contemplati sunt. S[ed] incarnandu[m] h[un]c in mundi fine p[re]scientes, quasi a solis radiis ad t[er]ram oc[u]los deflexrunt[727], et q[ua]si de summis ad ima ueniunt, dum d[eu]m sup[er] om[n]ia, et homine[m] int[ra] om[n]ia agnoscunt. Que[m] p[ro] humano g[e]n[er]e, dum passuru[m] moritur[um]q[ue] conspiciunt, q[ua] scilicet morte semetipsos refici atq[ue] reformari ad uitam[728] nouerunt, q[uas]i more aq[u]ile p[ost] conte[m]platos solis radios in cadau[er]e escam quer[un]t.

---

[708] Radios → Radiis (H, C); Radio (SC, L).
[709] Sacra scriptura (H).
[710] Tranuolans → Transuolans (H, C, SC, L).
[711] Ieremia → Iheremia (H, L).
[712] Uelociores → Uelotiores (L).
[713] Persequutores → Persecutores (H, SC, L).
[714] Cum + tanta (H).
[715] *Om.* etiam (H).
[716] *Om.* et (H).
[717] Oua → Quia (H).
[718] Nabugodonosor → Nabuchodonosor (H); Nabucodonosor (SC, L).
[719] Immensitate → Inmensitate (SC).
[720] Diuturnitate → Diurnitate (L).
[721] Diuiciis → Diuitiis (L).
[722] Iohannem → Iohannes (H).
[723] Deseruit terram (H).
[724] Querunt → Petunt (H).
[725] Radiis → Radios (H).
[726] Carnibus → Carnalibus (L).
[727] Deflexrunt → Deflexerunt (H, C, SC, L).
[728] *Om.* ad uitam (H).

Aliter, Sicut aquila uolans ad escam. Aquila eni[m] alto ualde uolatu suspendit[ur], et adnisu p[re]peti ad ethera[729] librat[ur], s[ed] p[er] appetitum uentris t[er]ras expetit, seseq[ue] a sublimib[us] repente deorsum fundit. Sic sic humanu[m] genus in parente p[r]imo ad ima de sublimib[us] corruit, quod nimiru[m] conditionis[730] sue dignitas in r[atio]onis celsitudine q[uas]i in aeris lib[er]tate suspend[er]at. S[ed] q[u]ia cont[ra] p[re]ceptum cibum contigit p[er] uent[r]is concupiscentia[m], ad t[er]ras uenit; et q[uas]i p[ost] uolatum carnib[us] pascit[ur], q[u]ia illa lib[e]ra conte[m]plationis inspirac[u]la p[er]didit et deorsu[m] uoluptatib[us] corporeis letat[ur][731].
Item de aquila. Renouabit[ur] ut aq[u]ile[732] iuuent[us] tua. Solet dici de aquila, dum senectute p[re]mit[ur], quod rostrum illius aduncet[ur], ita ut summere cibum nequeat[733] s[ed] macie languescat. Ueniens ad petram rostrum acuit, et sic cibum[734] capiens it[er]um iuuenescit. Petra e[st] Xpc, aquila quilibet iustus qui ad petram rostrum acuit, dum seip[su]m Xpo p[er] bonam op[er]ationem conformem reddit. [735]

[729] Ethera → Hethera (SC).
[730] Conditionis → Condicionis (L).
[731] Lectatur → Delectatur (H).
[732] Aquile → Aquila (H).
[733] Nequeat → Nequeant (SC).
[734] Cimbum sic (H).
[735] Explicit liber auium (H).

APPENDIX XVI. Detailed description of the lac recipes

XVI.1. Lac dye recipes translations

Ms. of ibn Bādīs (*c.* 1025), Chapter 6
On the mixture of dyes, colors, and their preparation
Another color is red ruby from the *lukk*. How it is made. Description of how to dissolve the *lukk*. Ten ounces of *lukk* are broken up after it has been freed of its twigs. Then two dirhams of *ushnān* and two dirhams of *bauraq* are pounded very finely. Enough water is poured on to cover them. It is brought to the fire with the *lukk* until all of the redness of the *lukk* is brought out. It is removed from the fire. It is filtered, returned to the fire, and boiled until half of the *lukk* solution remains. It is then removed. Write with it. If it is desired that it remain dissolved, a piece of hard white sugar is added to it. If it is desired dry, it is placed in the shade protected from dust. When it is dry, it is removed and used for that which is desired. The *lukk* is broken into pieces and powdered like the crumbled chick pea. It is washed with water and put in a thick filter. The water is boiled vigorously. While it is in the filter, hot water is poured on it so that its color, red, will flow from the filter. The filtrate is boiled until it is decreased by two-thirds. Then dissolved gum is melted in it. Write with it. It comes out well (Levey 1962: 30).

Ms. *Mappae clavicula* (12th century), Recipe 253
Lac, how it is worked for painting on wood or on a wall
First grind lac and from it pick out the knobbly bits and impurities; then put it in a mill and grind it fine; then take the urine of a man or woman and first put it in a cauldron and let it boil until it is all reduced to a third. Continue always to take off the froth. Afterwards put in the lac and let it boil; then take very clean alum, and grind it and mix it in the above-mentioned lac. Then take a small cloth and keep on dipping it until a good color appears [on it]. Then put the liquid into little pots and work [with it]. Throw out the stone which forms in the liquid, because it is of no value. Into 5 pounds of lac put 5 oz. of alum and 10 pints of urine (Smith and Hawthorne 1974: 66).

Ms. *O Libro de komo se fazen as kores* (15th century), Chapter 13
In order to make fine carmine
In order to make fine carmine, take a large new pot that holds four açumbres of water, and fill it with human urine. And mix it for days, and make it very clear all the while so that it gives off foam. And once it is very clear and skimmed, take a large bowl and place rye-straw over it, and above the straw a linen cloth. And on the cloth place ashes of vine branches, two parts, and a third part quicklime, and place a pot underneath. And throw on the lye the strained urine that you strained through **fried meat** and continue straining it until the pot is full of this strained lye, in such a way that there are four *acumbres* of it there. And place it on the fire until only two fingers of it are left, and on the fire put another pot full of clear urine with the strained lye and heat both. And into the pot of clarified urine with the strained lye toss one pound of lac, and heat it gently, all the while stirring it with a slightly forked stick. And when the lac is melted, strain it with a linen bag, and place a basin underneath; whatever remains in the bag, place it in the pot of strained lye, which you have kept on the fire with gentle heat, until it is melted, stirring with a piece of wood. And then strain it separately with the bag containing the powder. Thus you can make carmine of two kinds, though first you must clarify the urine (Strolovitch 2005: 135).

Ms. Le Begue (1431), Recipe 36
To make lake
Take urine, and keep it for a long while, and afterwards make it boil until half of it is evaporated upon a slow and clear fire, skimming it continually, until it is perfectly purified. Then strain it

through a linen cloth, and put 4 lbs. of it into a glazed jar of the said urine, and 1 lb. of raw lac well ground, and add to it a sufficient quantity of *alumine zuccarino*, and put it by and keep it for use (Merrifield 1967: 62).

Ms. Le Begue (1431), Recipe 309

To make a very good lake

Take an ounce of lake, and rasp finely a little Brazil wood, put it into a clear vessel, then add to the Brazil wood some clean and clear beaten white of egg and a little alum water. Grind the lake with that water and dry it in the sun, and when you wish to use it, distemper it with this water, especially on parchment, and the more you grind it up with this Brazil wood water, the better it will be (Merrifield 1967: 294, 296).

Ms. Bolognese (15th century), Recipe 129

To make good lake

Take of urine as much as you like, and put it into a vase for the space of a week; then pour it into a pipkin and make it boil until no more scum arises. Then make it into a ley with strong ashes. Next take raw gum lac and pound it as small as panic, put it into a new glazed pipkin, and add to it some of the ley of urine, which must be quite clear, and mix it well with a stick; let the urine or ley be warm when it is poured upon the gum, and when it is well mixed, pour off gently the ley so coloured, and put it into a glazed jar. Then take *roche* alum in fine powder and mix it with water; then put some of this alum water into the shell containing the ley coloured with the lac, and when you see that it begins to froth, do not put any more. Then put that which has coagulated into a piece of linen like a strainer, hang it up high, and let the water run off; then take the drainings and put them back into the pipkin where the gum was still left, and mix it up well. Then pour it out, and repeat this another time, thus making 3 sorts of lake; the first best; the second not so good; and the third worst. And know that the ley must be poured very strong, made with urine, and baked ashes, and it must be poured very hot upon the powdered gum, putting the gum on a strainer or filter of linen; then pour the hot ley several times upon it; afterwards add the alum, and dry it; and also dry by itself what remains in the strainer, and it is done (Merrifield 1967: 446).

Ms. Bolognese (15th century), Recipe 130

To make lake as before in another manner

Take of gum lac 5 lbs., reduce it to powder and sift it through a close sieve; then take filtered urine, which has stood for 20 days, and place a small kettle on the fire, into which put the urine, and when you see the scum which floats upon the urine, remove it with a perforated ladle, and when the urine is well skimmed and warm, add 3 oz. of *roche* alum in powder, and make it boil again, and then again while it is still boiling take off the scum with the ladle, and when it is well skimmed and clear, take gum lac, sifted, and put it into the urine and alum, continually mixing it over a slow fire for the space of 3 *misereres*. Then take it off the fire and put it into a clean wooden powder, either rasped or pounded in a bronze mortar, and put it over the fire in a small glazed jar with a little water, and make the said *verzino* boil; afterwards strain it into a vase through a thin and close woolen cloth, and let it cool for one natural day; then take the urine with the alum which is in the before mentioned wooden bowl, and put into it this water which has been boiled with the *verzino* and then strain and mix it well together. Afterwards take 2 lbs. of *roche* alum, and put it into two metadelle of clear water, boil it, and afterwards put the alum water into the urine, and mix it well and let it settle for a day; strain it through a strainer and let it settle for another day. Then let it dry, and when nearly dry, cut it into pieces as you please, and let it dry hard. And observe, that you may make lake in this way from various stones and of various kinds, namely, from that from which the crimson colour is made, from dragon's blood, from *grana*, from *vermiculis*, from *minio*, from *verzino*, and from the flowers of herbs (Merrifield 1967: 446, 448).

Ms. Bolognese (15th century), Recipe 131

To make lake by another process

Take urine, pour it into a new glazed jar, and put it over the fire, make it boil well, and while it is boiling take off the scum which arises with a stick, and let it boil until one half is consumed. Afterwards, put the gum lac into the urine, and let it boil with a small quantity of gum Arabic, and a little alum *zucharino*, or *roche* alum. When it has boiled for the space of one hour, strain the liquor through a thin linen cloth, and let it settle in a glazed jar, and the lake will sink, that is, will go to the bottom. Then pour off the urine which remains upon the lake, taking care not to pour off the lake also, and let the lake dry by itself, and not by the fire, nor in the sun, and it will be good and perfect lake (Merrifield 1967: 448,450).

Ms. Bolognese (15th century), Recipe B.137

To make lake

Take one ounce of crude lake or *grana*, put it into a small pipkin, and pour on it sufficient urine or ley to cover the lake, and make it boil on a moderate fire for half an hour without smoke. When it boils keep mixing it, and when it has boiled take ½ oz. of *roche* alum, and ½ oz. of *sal gem*, and grind them well with ley, and put them into the jar before it has done boiling; then take the vessel from the fire immediately and let it cool. Next take a wash-hand basin and a *petito* of stale urine, or a strong ley, and throw the whole into the basin, and mix it together, and stir it very well with a stick, and put it for 15 days in a place free from dust, stirring it every evening and morning; at the end of a fortnight take a small linen bag and strain it, and put what you have remaining on a new and clean tile, and dry it directly in the shade, and you will have fine lake. Put it back into a box and cut it into pieces, &c (Merrifield 1967: 454).

Ms. Bolognese (15th century) Recipe B.140

To make lake in another manner

Take 1 lb. of gum [lac], and put it into very strong boiling ley, and let it dissolve; then take three glasses of tepid water in which 2 oz. of *roche* alum have been dissolved, but first put the water into a large shell, throw on it the boiled ley, and let it remain so for 2 days; then take a glass and take also that gum and water and ley, and strain it in a small woolen bag; let it run through and the lake will remain at the bottom (Merrifield 1967: 456).

Ms. Strasbourg (15th century)

Bright Paris Red

If you want to make beautiful and fine Paris red. First, you should make a lye from willow ashes. Take a species which is called '*lagga*' with which one dyes the leather. One should grind it into fine powder. One should heat the lye and pour the powder of the '*lagga*' into the hot lye and stir it all together and let it stand over night for pickling/(soaking). In the morning, one should put the colour on the fire and one should stir it without interruption. One should boil it half the time as one cooks a fish. Then one should put a *settin* of ice alum in the colour and one should stir it until it dissolves. After that take the colour from the fire and let it cool down. Filter the colour through a clean double-layer cloth. Wring the colour through it into a glazed vessel. Take the alum which should be finely ground and stir slowly the powder into the colour, stir it with a little spoon until the alum is quite well dissolved in the colour. Here note a sign; if the colour becomes thick as a warm wine and already beautiful red, then one should no longer add alum to it. (But) if the colour is thin fluid like water then one should add more alum into it and stir together until the colour becomes beautiful (and) thick. After that pour the colour all together into a bag whose form is identical to that of the bag (used) for the rose colour. Hang up the bag in the same way for draining over night until nothing drains out anymore. What drains from the bag is (light red) as light red wine. One should drain it away. But what remains in the bag is a beautiful and fine red. One should turn over the bag and put the colour on the stone and scrape the colour with a knife from the bag. Then put the colour in the wind and let it become

hard. Then keep it clean until one needs it. (This colour is called red of Paris, this is the most expensive one finds) (Neven 2011).

Ms. Montpellier (15th century), Recipe 1.9

On the preparation and tempering of lacca

We shall now proceed to the preparation of *lacca*. (…) Grind that well, then take two vessels and put in plenty of urine and boil it, and skim the urine well with a feather, and boil it, which urine shall be of a twelve year old boy drinking good wine; when, then, it shall be well skimmed, take a third part of the aforesaid urine, and then take *zucharino* alum and mix it in urine and pour it into the other [vessel] on the fire, and cook; we recommend cooking for a long time on the fire; when, then, it shall become good and red, take it from the fire and strain through a long linen bag, and again add cold urine with some divided alum [i.e. alum pieces], note: with the discharge is added [either one or ten ounces (?)] of gum Arabic, which thickens it (Clarke 2011: 108–9).

Ms. Paduan (late 16th–17th century), Recipe 90

To extract the colour of the gum lac, so that it will serve for bright colours

Pulverize coarsely the gum, and put it into a ley of rosewood or vinewood, which will extract its colour; you must then separate the water from the gum, and evaporate it carefully until it begins to thicken. You must then take it from the fire, and stir it with a silver spoon, and let it settle till the next morning, and when it is sufficiently thick, you must place it on a slab of marble, dry it and use it for giving a luster to the gum and to all colours. Observe that this colour mixed with white lead makes a beautiful flesh colour. The remainder of the gum lac must be washed in the ley until it has entirely lost its red colour; it will then do for melting with the other colours, as cinnabar, orpiment, and others, because the gum being passed through the ley, is clarified [or bleached], and all the impurities of the inside will pass off with the colour (Merrifield 1967: 686).

Ms. Paduan (late 16th–17th century), Recipe 113

To make very fine lake

Take ½ oz. of lac, half a drachm of crystals of tartar pulverized, and a *scudella* of hot water. First dissolve the tartar, then take the lac which has been ground, put it on a clean linen rag, and tie it into the form of a ball, and then cut off the superfluous part of the rag, and put the ball into the above-mentioned hot water, placing the *scudella* over some hot cinders, and leaving it there until the water becomes well coloured. When this is the case, take the ball from the water, and evaporate the water gently over the hot cinders until the colour is condensed at the bottom; it will then be done (Merrifield 1967: 700, 702).

XVI.2. Details from the recipes

Table XVI.2. Main ingredients and quantities used for each recipe.

Recipe	Lac (g)	Water (ml)	Urine (ml)	Lye (ml)	Alum zucharino (ml)	Alum (g)	Brazilwood (g)	Quicklime and ashes (2:1) (g)	Borax (g)	Sal gem (g)	Sodium carbonate (g)	Egg white (g)	Gum Arabic (g)	Tartar (g)
ibn Bādīs	5	50	-	-	-	-	-	-	0.1	-	0.1	-	-	-
MC	10	-	100	-	-	0.6	-	-	-	-	-	-	-	-
LKFK	10	-	150	-	-	-	-	2	-	-	-	-	-	-
JB 36	5	-	200	-	15	-	-	-	-	-	-	-	-	-
JB 309	0.25	10	-	-	-	0.1	0.1	-	-	-	-	3	-	-
Montpellier	5	-	200	-	30	-	-	-	-	-	-	-	-	-
Strasbourg	5	-	-	100	-	1	-	-	-	-	-	-	-	-
B 129	5	-	150	-	-	0.6	-	-	-	-	-	-	-	-
B 130	5	-	150	-	-	0.4	0.5	-	-	-	-	-	-	-
B 131	5	-	150	-	20	-	-	-	-	-	-	-	1	-
B B.137	5	-	-	100	-	0.4	-	-	-	0.4	-	-	-	-
B B.140	5	-	-	150	-	0.6	-	-	-	-	-	-	-	-
P 90	5	-	-	150	-	-	-	-	-	-	-	-	-	-
P 113	5	200	-	-	-	-	-	-	-	-	-	-	-	0.6

XVI.3. Main observations

Table XVI.3. Main colour coordinates (Lab* values) and important observations for the lac recipes.

Recipe/ result	Main ingredients/steps	Observations
Ibn Badis **L*** 42.2 **a*** 42.9 **b*** 9.0	*Lukk* (sticklac), *ushnān* (sodium carbonate), *bauraq* (borax) and water	*Ushnān*, a source of sodium carbonate, was made of plant ashes (Henderson 2013: 262; Levey 1962: 26) while *bauraq* could be also a source of sodium carbonate and/or borax (Levey 1962: 23). The quantities are described for each ingredient, except for water. By adding more or less water we can produce different colours, through pH variations. This is the easiest recipe to reproduce given that the steps, in addition to being simple, are well reported.
Mappae Clavicula **L*** 43.8 **a*** 39.8 **b*** 14.4	Lac, urine of a man or woman and alum	This is the only recipe with the indication for all of the ingredients; however the quantities for urine cannot be transposed to the small quantities of lac we use, so it needs adaptation. It also tells specifically that we are supposed to use the liquid to paint and "throw out the stone", which we think is the precipitate formed with the alum and possibly the uric acid compounds.
LKFK **L*** 35.3 **a*** 26.7 **b*** 25.3	Lac, human urine, rye-straw, ashes of vine branches and quicklime	So far we have not seen any purpose in using rye-straw during the filtration. The filtration step is also important to assure the neutral to basic extraction. Although the recipe does not give quantities, it refers proportions: "place ashes of vine branches, two parts, and a third part quicklime" (2:1).

		This is one of the most difficult recipes to interpret.
Jehan le Begue 36 **L*** 48.3 **a*** 42.8 **b*** 16.7	Raw lac, urine and alumine zuccarino	The step to filtrate the urine after evaporation is described, but then it does not mention filtration in the end after adding the raw lac. This might be a hidden detail from the recipe, since it may have been considered an obvious step.
Jehan le Begue 309 **L*** 42.2 **a*** 42.9 **b*** 9.0	Lake, brazilwood, white egg and alum water	We assumed that the so-called "lake" is lac dye in the form of a pigment lake. The mentioned brazilwood is "rasp[ed] finely", and then all the other ingredients are mixed and grinded together. No filtration step is stated, therefore we use the paint as it is (very small wood particles may be seen, although they do not interfere with the final colour).
Montpellier **L*** 51.1 **a*** 36.9 **b*** 18.8	*Lacca*, urine, *zucharino* alum and alum pieces	This recipe describes the use of two vessels. We believe that the two containers at the beginning are used to boil urine in order to increase the pH. Then only one of the vessels is used to extract the *lacca*. The second pot is used to "add cold urine" after straining the mixture with lac in order to increase the pH after the addition of alum which tends to acidify the solution (promoting more precipitation).
Strasbourg **L*** 35.9 **a*** 34.8 **b*** 12.1	Lac, hot lye and alum crystals	This recipe gives information on how to assess full precipitation of the lake with the addition of alum. It says to sprinkle alum into the solution until "colour has become as thick as a good mulled wine and is at the same time of a full red tint". The final solution is then filtered in a bag left hanging up overnight and then, the material inside the bag, is scraped and left to dry.
Bolognese 129 **L*** 48.6 **a*** 39.0 **b*** 19.2	Raw gum lac, stale urine (one week), ashes and roche alum	This recipe is quite exhaustive in the description of the details, though it does not mention quantities. One of the most interesting details is the one where they describe the precipitation of the lake: "take roche alum (...) when you see that it begins to froth, do not put any more".
Bolognese 130 **L*** 42.3 **a*** 42.9 **b*** 22.8	Gum lac, stale urine (20 days), brazilwood and roche alum	It is the only recipe that describes sifting the sticklac through a close sieve. Moreover, it adds alum to the urine prior to the sifted lac, which is an uncommon approach, since it tends to acidify the solution, making the conditions for precipitation a bit harder to achieve.
Bolognese 131 **L*** 45.9 **a*** 41.6 **b*** 20.3	Gum lac, urine, gum Arabic, alum zucharino or roche alum	The mentioning of the use of the precipitate is stated here: "strain the liquor through a thin linen cloth, and let it settle in a glazed jar, and the lake will sink, that is, will go to the bottom. Then pour off the urine which remains upon the lake, taking care not to pour off the lake also, and let the lake dry by itself".
Bolognese B.137 **L*** 38.3 **a*** 26.4 **b*** 2.3	Crude lake or grana, urine or ley, roche alum and sal gem	The recipe suggests that after adding and mixing in the fire all the ingredients, the solution should be removed from the heat and added stale urine or ley (basic solution), leaving it for 15 days. This promotes a more basic final pH.
Bolognese B.140 **L*** 38.8 **a*** 29.3 **b*** 0.0	Gum [lac], ley and roche alum	The mention of the use of the precipitate is also given in this recipe: "strain it in a small wollen bag; let it run through and the lake will remain at the bottom".

Paduan 90 **L*** 35.3 **a*** 21.9 **b*** 8.8	Gum and ley of rosewood or vinewood	The main purpose of this recipe is to extract lac in order to use it with other colours. The extraction in basic solution tends to produce purplish and lilac colours, which is in agreement with the description of its use with white lead to make "beautiful flesh colours".
Paduan 113 **L*** 52.6 **a*** 24.1 **b*** 6.5	Lac, crystals of tartar and water	A pink colour is achieved with the addition of crystals of tartar, which tend to acidify the final solution (pH 3). This material was not used during the Romanesque period. It became more typical in a later period, although normally still associated with alum in order to improve the precipitation of the dye (Cardon 2007: 12-13).

APPENDIX XVII. Areas of analysis of lac paints

The black dots (●), black squares (□) and red squares (□) represent the areas where µ-EDXRF, µ-Raman and FORS were performed *in situ*, while the red circles (○) correspond to the areas where a microsample was taken for additional analytical techniques, such as µ-FTIR, microspectrofluorimetry and SERS.

Lorvão 5 – *De Avibus* (1184), ANTT

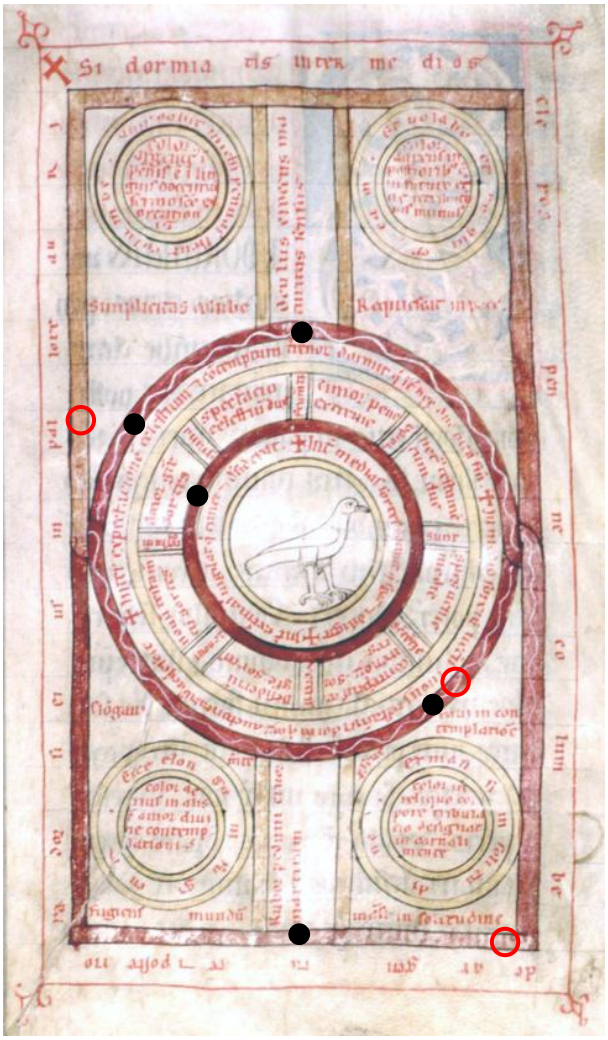


Figure XVII.1. Analysed areas in Lorvão 5, f. 6.

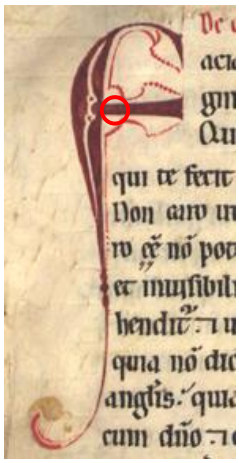


Figure XVII.2. Analysed areas in Lorvão 5, f. 73v.

Lorvão 12 – *Lectionarium Sanctorale* (13th c.), ANTT

Figure XVII.3. Analysed areas in Lorvão 12, f. 17.

Figure XVII.4. Analysed areas in Lorvão 12, f. 94.

Lorvão 13 – *Lectionarium Temporale* (13th c.), ANTT

Figure XVII.5. Analysed areas in Lorvão 13, f. 21v.

Figure XVII.6. Analysed areas in Lorvão 13, f. 30.

Figure XVII.7. Analysed areas in Lorvão 13, f. 44v.

Lorvão 15 – *Gradual* (1201-1250)

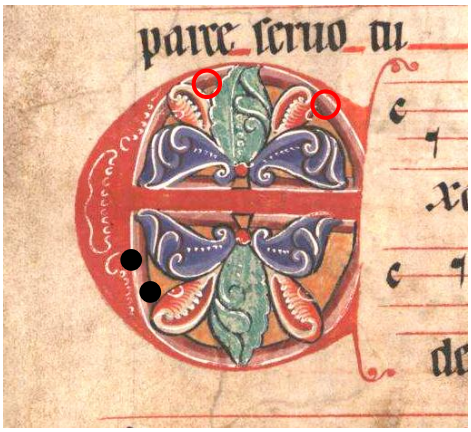


Figure XVII.8. Analysed areas in Lorvão 15, f. 26.

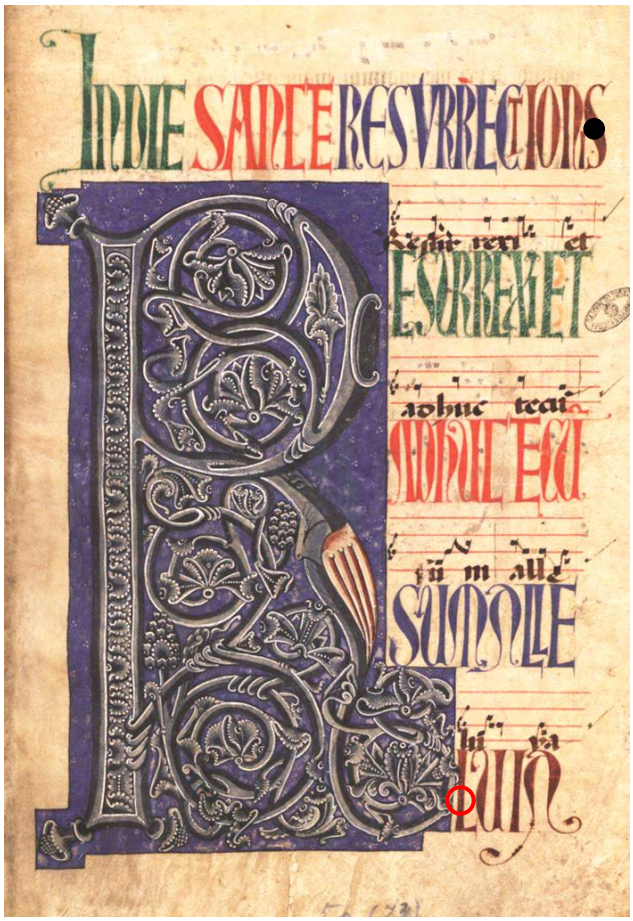


Figure XVII.9. Analysed areas in Lorvão 15, f. 50.

Lorvão 50 – *Enarrationes in Psalmos* by Saint Augustine (1183)

Figure XVII.10. Analysed areas in Lorvão 50, f. 1v.

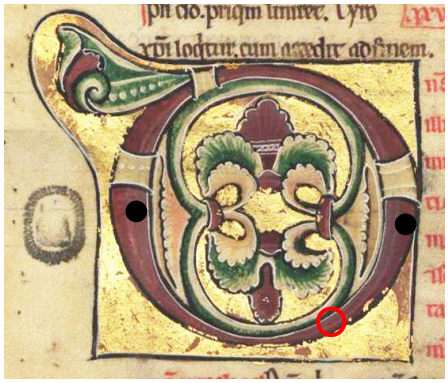


Figure XVII.11. Analysed areas in Lorvão 50, f. 64v.

Alcobaça 238 – *De Avibus* (12th c.), BNP

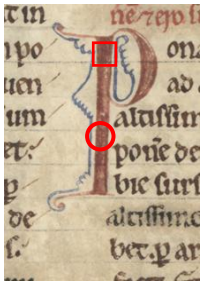


Figure XVII.12. Analysed areas in Alcobaça 238, f. 206v.

Figure XVII.13. Analyzed areas in Alcobaça 238, f. 210.

Alcobaça 249 – Missal according to the Cistercian Rule (13th c.), BNP

Figure XVII.14. Analysed areas in Alcobaça 249, f. 109v.

Alcobaça 347 – *Sermones de verbis Domini*; *Sermones de verbis Apostoli* by Saint Augustine (12th-13th c.), BNP

Figure XVII.15. Analysed areas in Alcobaça 347, f. 3.

Alcobaça 412 – *Homiliarium* (1257), BNP

Figure XVII.16. Analysed areas in Alcobaça 412, f. 10v.

Figure XVII.17. Analysed areas in Alcobaça 412, f. 12.

Alcobaça 419 – *Legendarium cisterciense* (12th-13th c.), BNP

Figure XVII.18. Analysed areas in Alcobaça 419, f. 98.

Alcobaça 421 – *Legendarium cisterciense* (12th-13th c.), BNP

Figure XVII.19. Analysed areas in Alcobaça 421, f. 193v.

Figure XVII.20. Analysed areas in Alcobaça 421, f. 202.

Alcobaça 446 – *Etymologiae*; *De natura rerum ad Sisebutum* by St. Isidore of Seville (13th c.), BNP

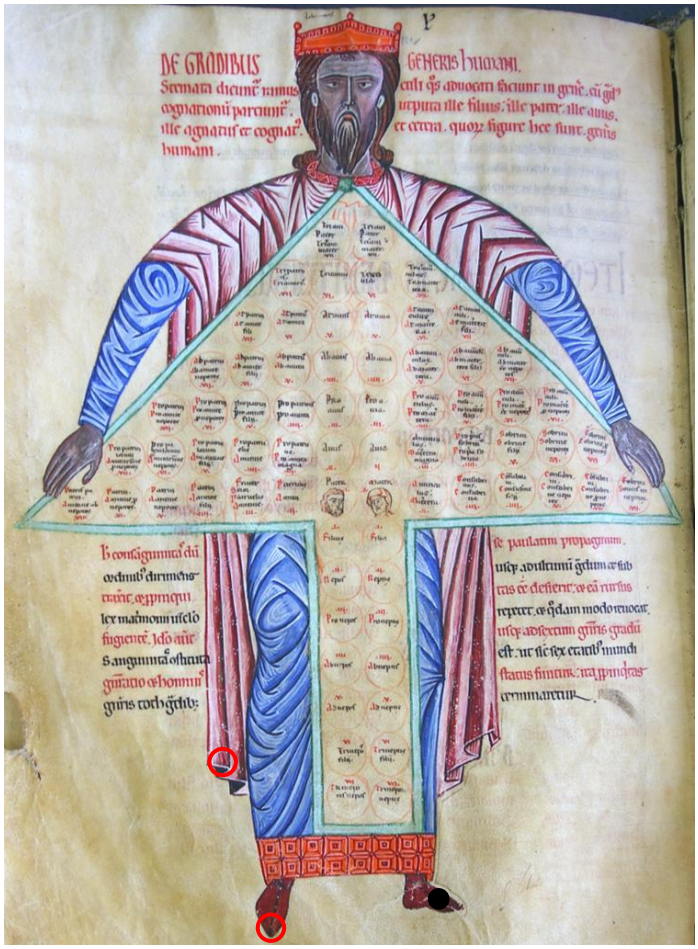


Figure XVII.21. Analysed areas in Alcobaça 446, f. 96v.

APPENDIX XVIII. Representative analytical data from lac dye

This appendix includes all the information from the dark reds that were molecularly confirmed as lac dye by SERS in the three Portuguese Romanesque collections.

XVIII.1. Lorvão

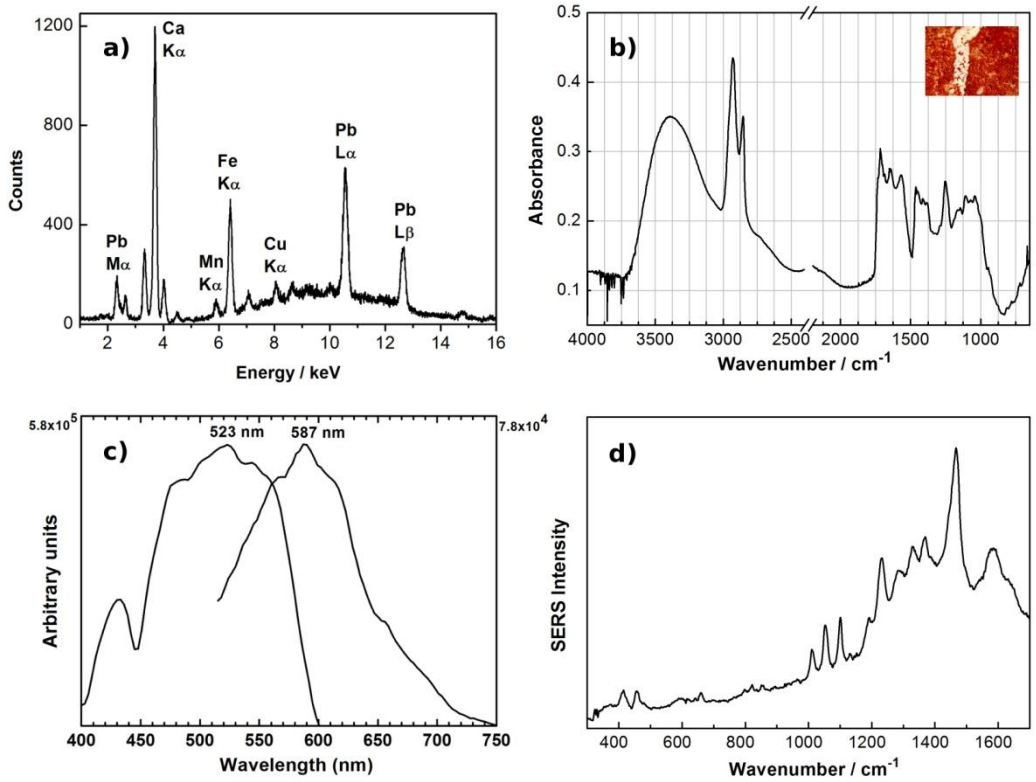
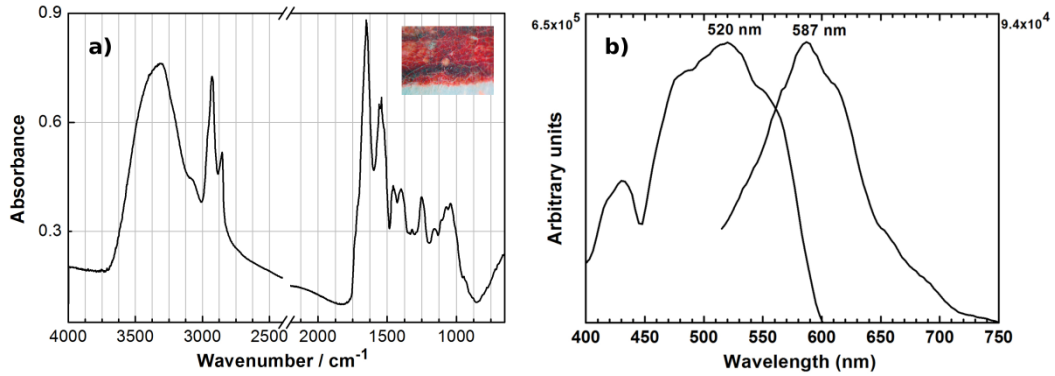


Figure XVIII.1.1. Several spectra of lac dye from Lorvão 5, f. 6: **a)** in µ-EDXRF; **b)** in infrared; **c)** in emission and excitation; **d)** in SER.



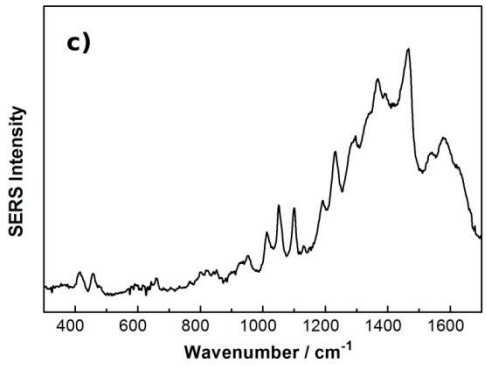


Figure XVIII.1.2. Several spectra of lac dye from Lorvão 5, f. 73v: **a)** in infrared; **b)** in emission and excitation; **c)** in SER.

XVIII.2. Alcobaça

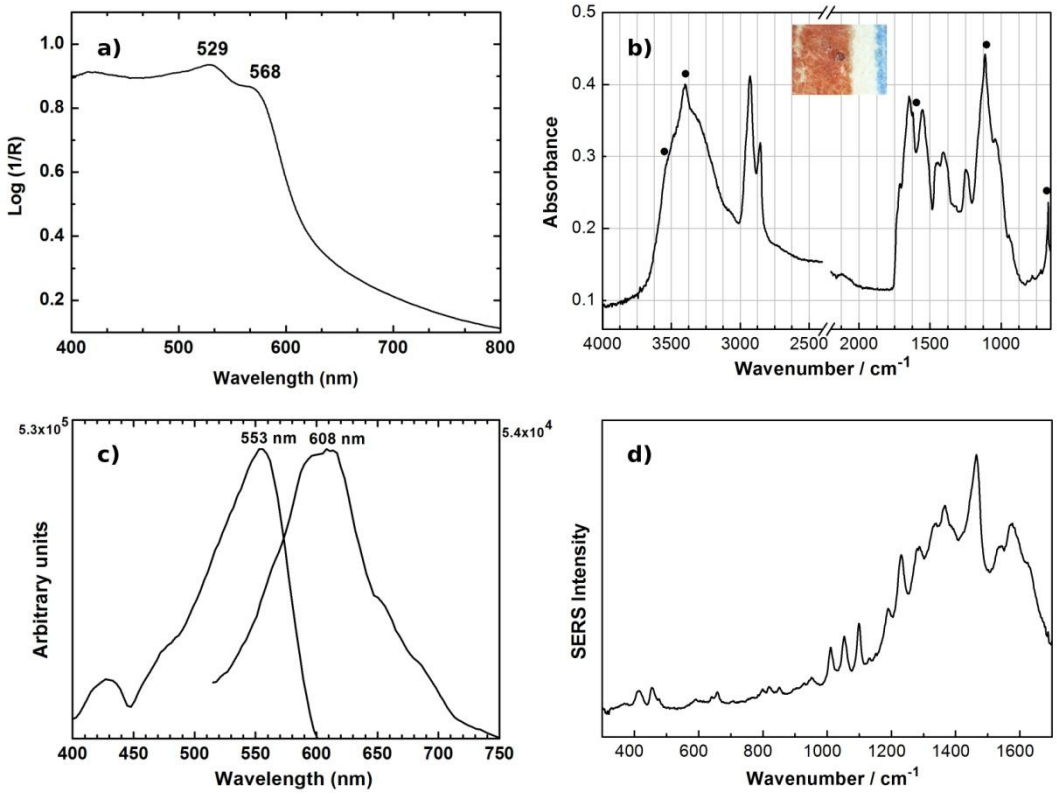


Figure XVIII.2.1. Several spectra of lac dye from Alcobaça 238, f. 206v: **a)** in apparent absorbance; **b)** in infrared (● gypsum); **c)** in emission and excitation; **d)** in SER.

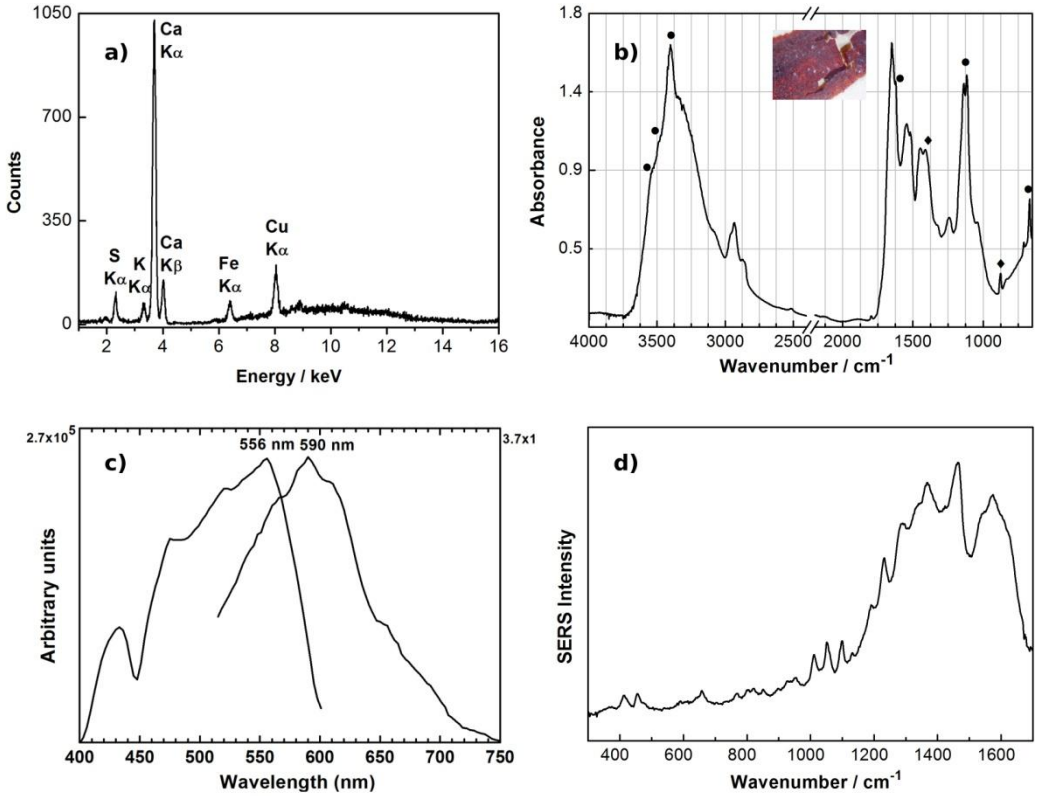


Figure XVIII.2.2. Several spectra of lac dye from Alcobaça 249, f. 109v: **a)** in µ-EDXRF; **b)** in infrared (● gypsum); **c)** in emission and excitation; **d)** in SER.

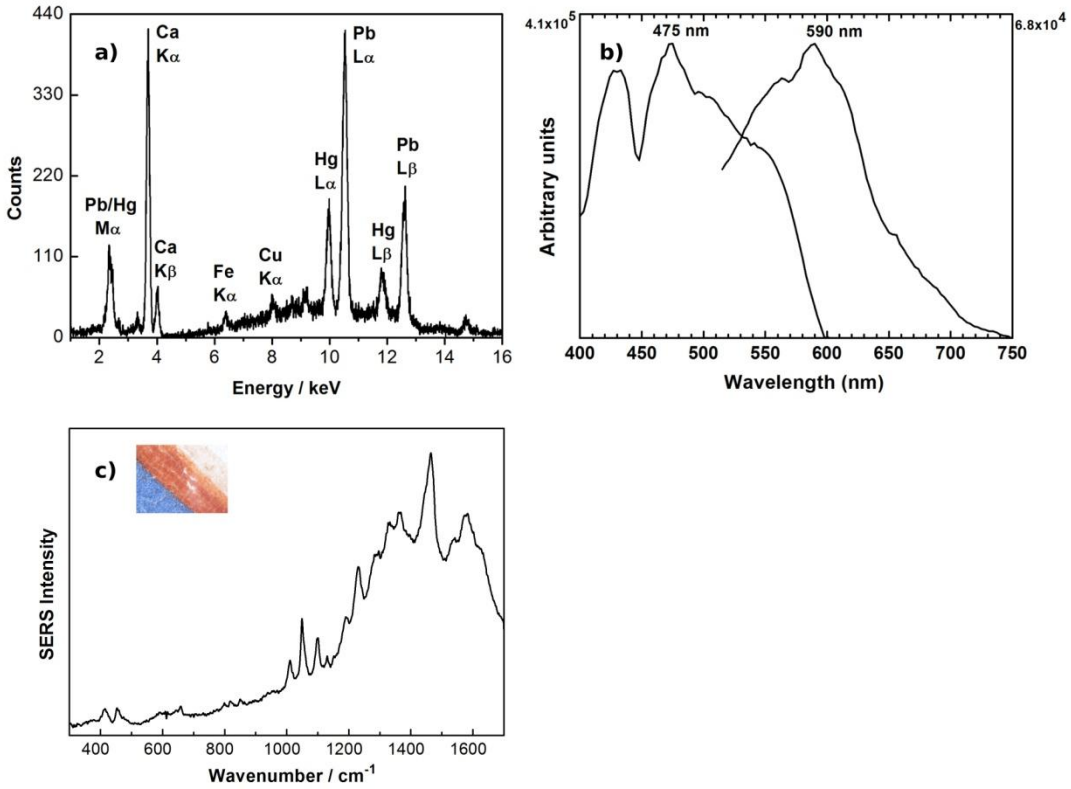


Figure XVIII.2.3. Several spectra of lac dye from Alcobaça 412, f. 10v: **a)** in µ-EDXRF; **b)** in emission and excitation; **c)** in SER.

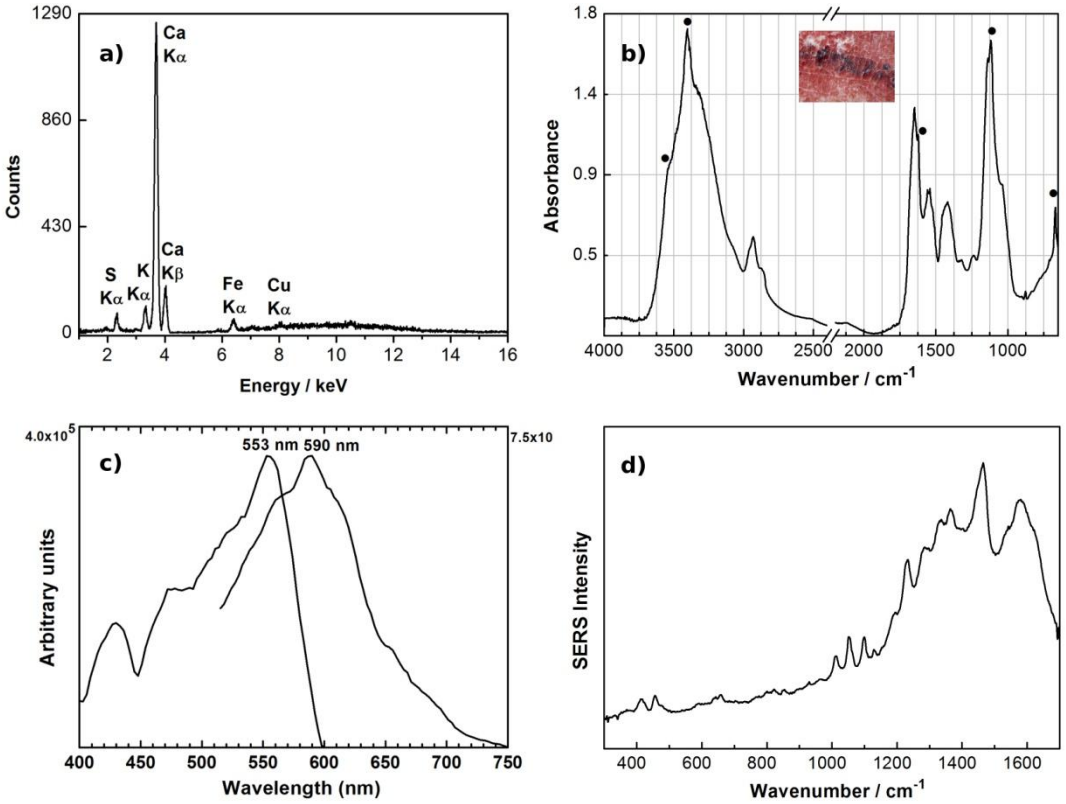


Figure XVIII.2.4. Several spectra of lac dye from Alcobaça 419, f. 98: **a)** in µ-EDXRF; **b)** in infrared (● gypsum); **c)** in emission and excitation; **d)** in SER.

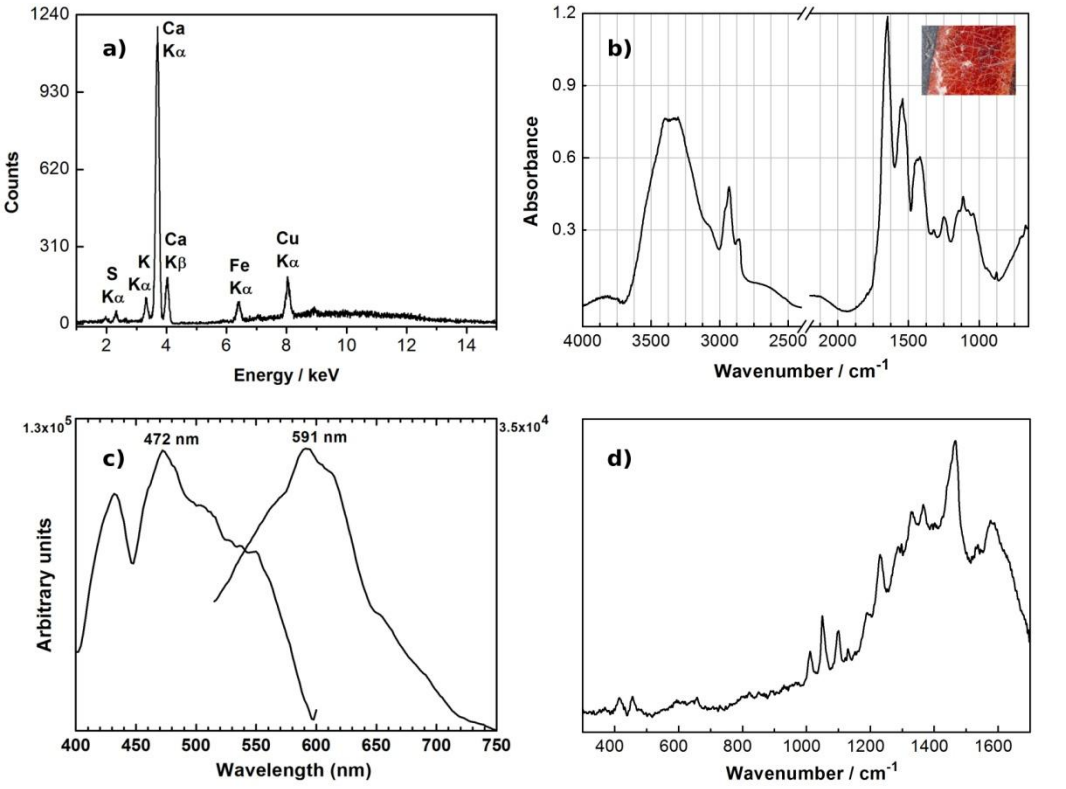


Figure XVIII.2.5. Several spectra of lac dye from Alcobaça 421, f. 202: **a)** in µ-EDXRF; **b)** in infrared; **c)** in emission and excitation; **d)** in SER.

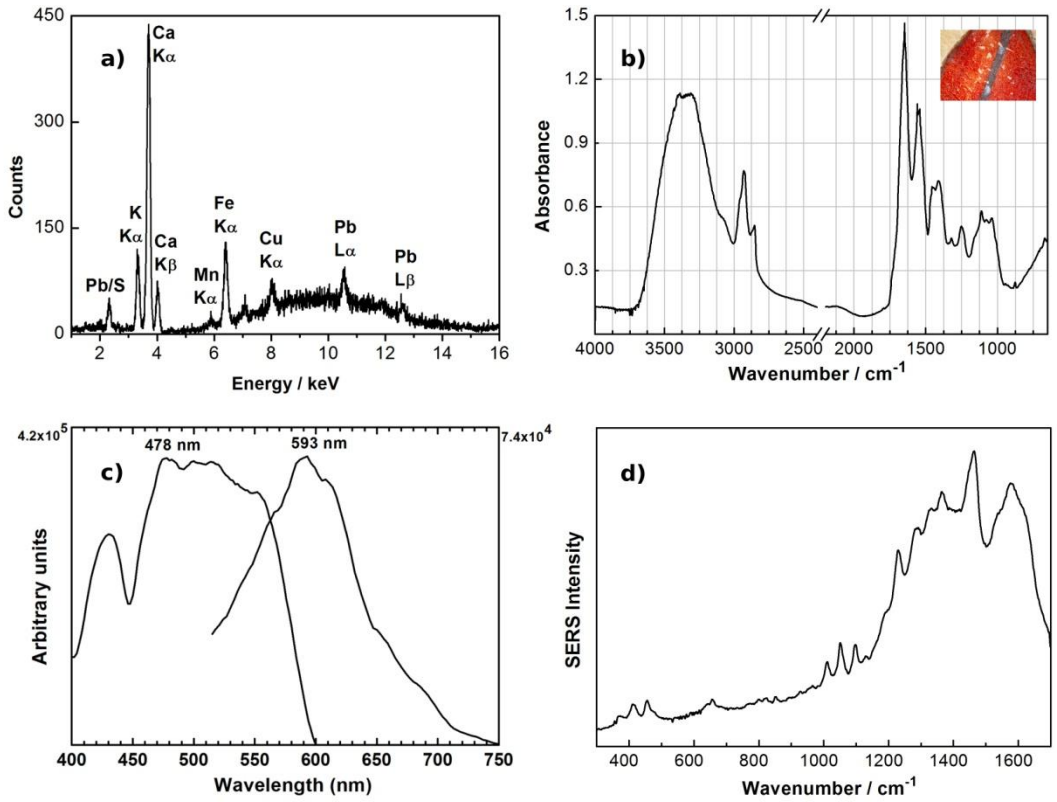
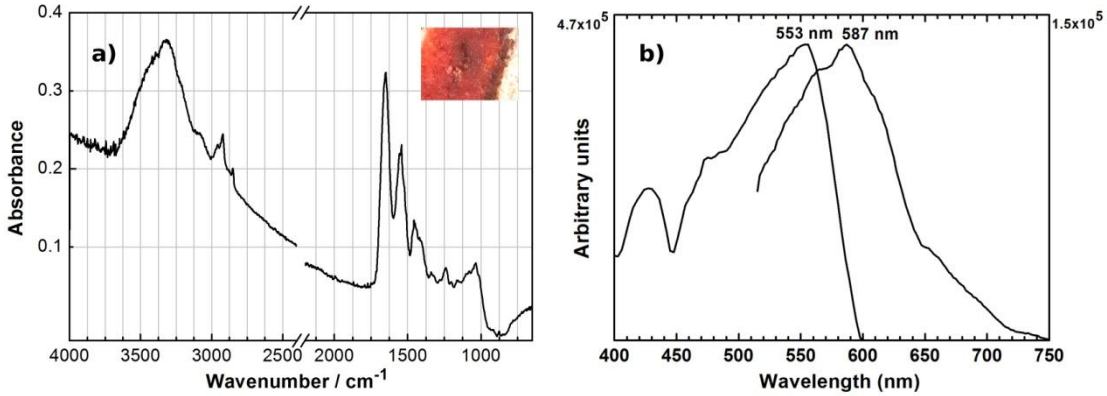


Figure XVIII.2.6. Several spectra of lac dye from Alcobaça 446, f. 96v: **a)** in µ-EDXRF; **b)** in infrared; **c)** in emission and excitation; **d)** in SER.

XVIII.3. Santa Cruz



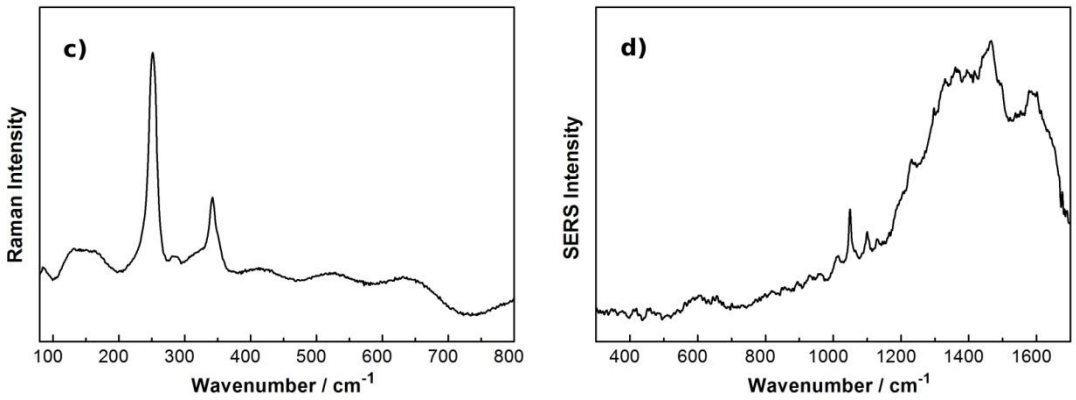


Figure XVIII.III.1. Several spectra of lac dye from Santa Cruz 20, f. 86: **a)** in infrared; **b)** in emission and excitation; **c)** in Raman; **d)** in SER.

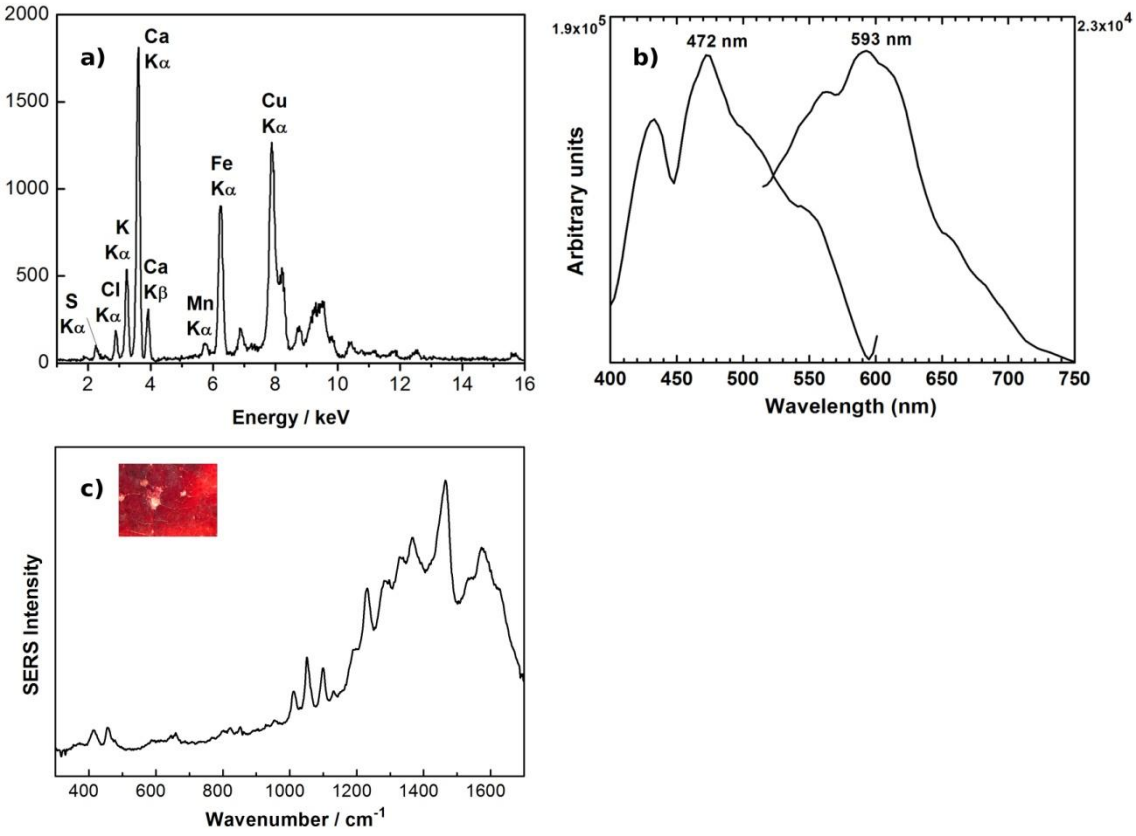


Figure XVIII.III.2. Several spectra of lac dye from Santa Cruz 20, f. 191: **a)** in μ-EDXRF; **b)** in emission and excitation; **c)** in SER.

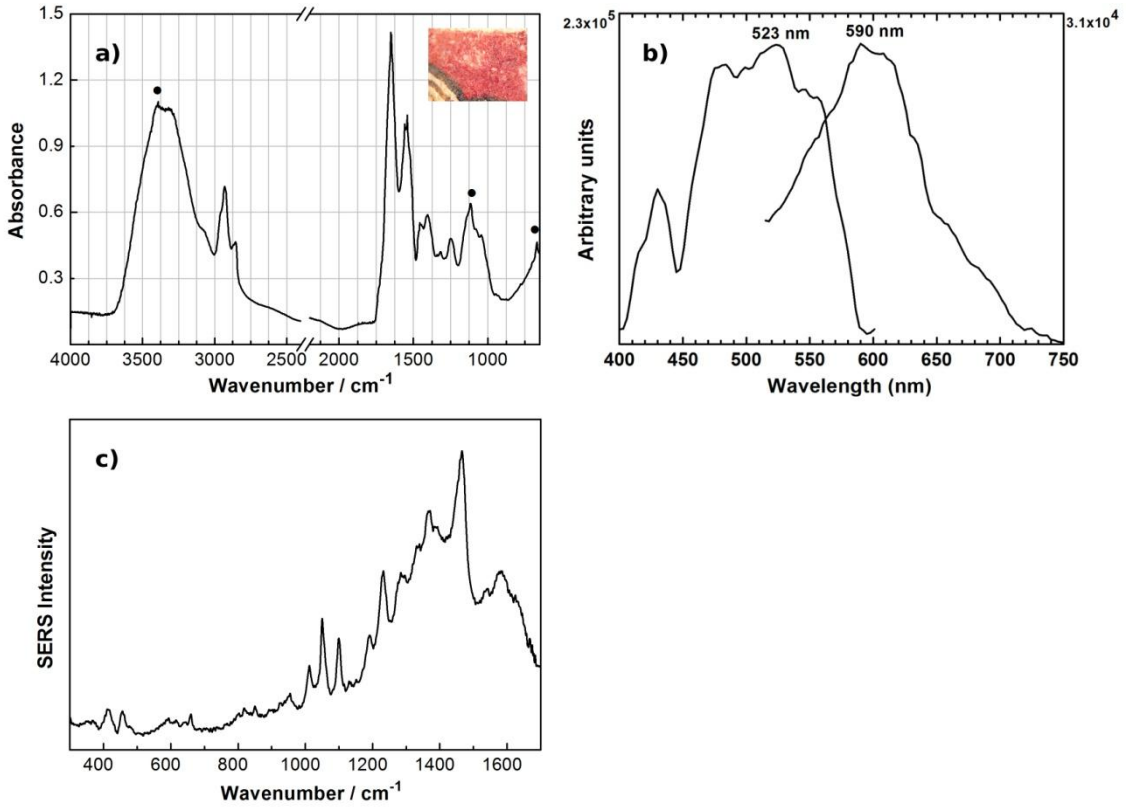


Figure XVIII.III.3. Several spectra of lac dye from Santa Cruz 21, f. 2: **a)** in infrared; **b)** in emission and excitation; **c)** in SER.

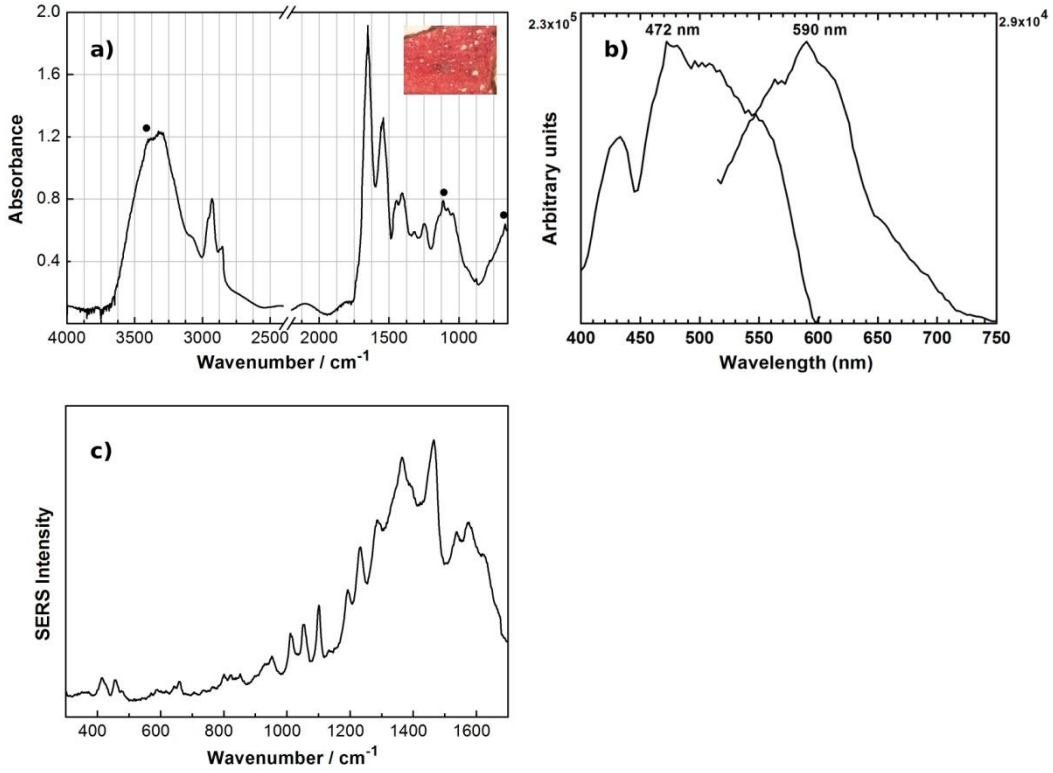


Figure XVIII.III.4. Several spectra of lac dye from Santa Cruz 21, f. 19: **a)** in infrared (● gypsum); **b)** in emission and excitation; **c)** in SER.

XVIII.4. Main results from FORS and microspectrofluorimetry

Table XVIII.4. Absorption, fluorescence excitation and emission maxima (average) from all of the paint recipes.

	Type A Mappae Clavicula					Type B Ibn Bādīs				
	Without mixture	**Vermilion**	**Calcium carbonate**	**Gypsum**	**Lead white**	**Without mixture**	**Vermilion**	**Calcium carbonate**	**Gypsum**	**Lead white**
λ_{abs}/nm	526, 562	n.s.	527, 563	527, 562	528, 561	528	n.s.	530	526, 564	544
λ_{exc}/nm	523, 557	526, 561	523	525, 559	526, 558	472	472	475	475	472
λ_{em}/nm	593	617	593	596	593	589	617	589	587	589
	Type A Bolognese 129					**Type B Book on how to make colours**				
	Without mixture	**Vermilion**	**Calcium carbonate**	**Gypsum**	**Lead white**	**Without mixture**	**Vermilion**	**Calcium carbonate**	**Gypsum**	**Lead white**
λ_{abs}/nm	526, 562	n.s.	527, 563	527, 562	528, 561	530, 568	n.s.	529, 569	531, 572	537
λ_{exc}/nm	526, 562	526, 561	526	526, 562	526, 562	526	523	526	526	529
λ_{em}/nm	593	617	593	590	617	563	587	587	587	593
	Type A Bolognese 131					**Type B Paduan 90**				
	Without mixture	**Vermilion**	**Calcium carbonate**	**Gypsum**	**Lead white**	**Without mixture**	**Vermilion**	**Calcium carbonate**	**Gypsum**	**Lead white**
λ_{abs}/nm	525, 562	525	526, 562	525, 562	526, 563	537	n.s.	530	533	540
λ_{exc}/nm	523, 556	526	526, 559	523	523	532	532	529	529	532
λ_{em}/nm	590	614	590	590	591	596, 614	599, 616	596	599, 611	614
	Type A Bolognese 137					**Type B Paduan 113**				
	Without mixture	**Vermilion**	**Calcium carbonate**	**Gypsum**	**Lead white**	**Without mixture**	**Vermilion**	**Calcium carbonate**	**Gypsum**	**Lead white**
λ_{abs}/nm	527, 562	525	527, 561	527, 561	529, 562	526, 561	n.s.	527, 563	526, 563	546
λ_{exc}/nm	484	514	454	499	496	520, 556	520, 556	520, 556	520, 553	520
λ_{em}/nm	590	617	593	590	593	587, 611	593, 614	587, 614	587, 614	593, 617
	Type A Bolognese 140					**Type C Bolognese 130**				
	Without mixture	**Vermilion**	**Calcium carbonate**	**Gypsum**	**Lead white**	**Without mixture**	**Vermilion**	**Calcium carbonate**	**Gypsum**	**Lead white**
λ_{abs}/nm	531, 569	527	529, 568	531, 569	529, 563	525, 560	522	526, 561	525, 561	525, 561
λ_{exc}/nm	517	523	523, 553	526	526, 556	520, 556	523, 562	523	526, 556	526, 556
λ_{em}/nm	614	617	596, 614	596, 617	596, 617	593	620	596	614	596
	Type A Strasbourg					**Type C Jehan le Begue 309**				
	Without mixture	**Vermilion**	**Calcium carbonate**	**Gypsum**	**Lead white**	**Without mixture**	**Vermilion**	**Calcium carbonate**	**Gypsum**	**Lead white**
λ_{abs}/nm	527, 565	525	527, 564	527, 564	527, 567	531	528	530	530	530
λ_{exc}/nm	472	472	472	472	475	556	559	556	556	556
λ_{em}/nm	590	611	596	595	614	593	614	593, 614	599, 611	596
	Type A Montpellier					**Type A Jehan le Begue 36**				
	Without mixture	**Vermilion**	**Calcium carbonate**	**Gypsum**	**Lead white**	**Without mixture**	**Vermilion**	**Calcium carbonate**	**Gypsum**	**Lead white**
λ_{abs}/nm	525, 562	523	526, 562	525, 562	526, 563	525, 562	522	527, 562	526, 564	527, 563
λ_{exc}/nm	520	520	523	523	520	523	523	523	484	523
λ_{em}/nm	590	590	593	593	614	590	596	598	593	593

n.s. – no clear band.

Table XVIII.2. Fluorescence excitation and emission maxima (average) for the dark reds found in the three Portuguese collections.

	Lv 5	**Lv 12**	**Lv 13**	**Lv 15**	**Lv 50**	**ALC 238**	**ALC 249**	**ALC 347**
	-	**-**	**$CaCO_3$**	**Pb white / gypsum**	**Pb white**	**gypsum**	**gypsum**	**Pb white**
λ_{exc}/nm	523	472	472/526	530/553	541	553	556	552
λ_{em}/nm	587	590	593/605	587	587	608	590	584
	ALC 412	**ALC 419**	**ALC 421**	**ALC 446**	**SC 1**	**SC 20**	**SC 21**	
	-	**gypsum**	**Pb white**	**gypsum**	**$CaCO_3$**	**HgS**	**gypsum**	
λ_{exc}/nm	474	553	472	475/520	475/548	472/553	472/523	
λ_{em}/nm	590	590	591	593	560/589/593	560/588/593	590	