NOVA SCHOOL OF SCIENCE & TECHNOLOGY

DEPARTAMENT OF CONSERVATION AND RESTORATION

LANTERNA MAGICA

TECHNOLOGY AND PRESERVATION OF PAINTED GLASS SLIDES FOR PROJECTION WITH MAGIC LANTERNS

ÂNGELA BARROS SANTOS

Master in Conservation and Restoration

DOCTORATE IN CONSERVATION AND RESTORATION OF CULTURAL HERITAGE

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Lanterna Magica - Technology and Preservation of Painted Glass Slides for Projection with Magic Lanterns

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To Pedro, my family (old and new),
and those who believed in me.

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The fairest thing we can experience, is the mysterious. It is the fundamental emotion which stands at the cradle of true art and true science.

Albert Einstein, *The world as I see it* (1935)

ABSTRACT

Magic lantern is the term, deriving from the Latin *lanterna magica*, used to designate an early form of a slide projector in which transparent positive images depicted on glass slides (magic lantern slides) were projected onto a white surface such as a wall or screen. The invention of this apparatus in the mid-17th century allowed, for the first time, the projection of illuminated and magnified images to be viewed by collective audiences.

The materials and methods applied to produce painted magic lantern glass slides and specific conservation strategies remain an understudied field. As a result, their severe deterioration problems represent an aggravated challenge for conservation professionals. The present work was developed as the first systematic study on the materials and techniques used to produce painted magic lantern glass slides (entirely painted and coloured over printed outlines), bridging the gap between 18th- and 19th-century written and material sources while addressing preventive conservation and restoration challenges.

A literature review of 18th- and 19th-century written sources stating the materials and techniques applied in the magic lantern slide production was conducted, allowing for an overview of the types of glass support procured and the colour palette and binders available. The evolution of magic lantern instruments and illumination systems is also explored. Formulations of Winsor & Newton watercolours were investigated, revealing great complexity and individuality depending on the colourant used in each formulation.

The context of the use and impact of the magic lanterns in Portugal throughout time was briefly investigated, and two Portuguese collections of magic lantern slides held by the Portuguese Cinematheque – Museum of Cinema (CPMC) and the National Museum of Natural History and Science (MUHNAC) of the University of Lisbon were selected for the present study. These collections' characteristics are discussed, and the glass support and painting materials used in 48 of their slides, attributed to a European production of the 18th and 19th centuries, were studied by resorting to a multi-analytical approach.

The techniques of Energy Dispersive X-Ray Fluorescence spectrometry (EDXRF), Ultraviolet-Visible (UV-VIS) and Raman spectroscopies were applied *in situ,* and Fourier Transformed Infrared spectroscopy (FTIR) and Surface-enhanced Raman Spectroscopy (SERS) were carried out on micro-samples. EDXRF allied with semi-quantitative analysis by WinAxil program (making use of glass standards from Corning Museum of Glass (Corning, NY, USA) for validation) allowed the identification of four main glass compositional groups: potassium-rich, mixed-alkali, high-lime low-alkali, and synthetic soda-rich glass. These results, along with visual analysis, verified the preference for high-quality glass reported by historical documentation, and

the characteristics of each compositional group helped in the slides' attributions to certain regions and periods of production. By complementing EDXRF with UV-VIS, Raman, and FTIR spectroscopy, it was possible to identify several colourants, including yellow ochre, gamboge, red ochre, cochineal-based lakes, geranium lakes, vermilion, Prussian blue, ultramarine blue, copper-green, and carbon black, and fillers such as gypsum. Regarding these paints' binding components, FTIR detected terpenoid resins, namely mastic and shellac and the possible presence of oils. Finally, the SERS technique enabled the identification of carminic acid in a reddish micro-sample. These analyses verified the use of a reduced colour palette, the artist's preference for bright and pure colours, and simple mixtures to create different hues and gradients.

This material characterisation unveiled a strong correlation between the glass and painting materials identified in 18th- and 19th-century slides and those described by coeval written sources and enabled the development of a timeline comprising the evolution of glass procured and the colour palette used in the production of painted slides. It was also possible to find differences between manufacturers, countries, and periods, which may help attribute slides more precisely.

Finally, the conservation challenges faced by caretakers and conservation professionals were addressed. The state of preservation of more than 350 slides of interest from the Portuguese collections studied was assessed, and the most common damages were identified, some of them resorting to Optical Microscopy. This study demonstrated that the glass and the painting layers are the most fragile and damaged materials that compose these slides. Considering the material knowledge gathered and inputs from national and international institutions shared through a questionnaire, preventive conservation guidelines tailored to painted slide collections were developed to complement current conservation standards. As around 20 % of the slides studied are in poor or very poor conditions and need remedial or restoration actions, and no guidelines for these procedures on painted magic lantern slides were found by the author, this study also explored methods for cleaning painted surfaces and reassembling their glass support. However, a deep investigation regarding consolidation materials and methods for these transparent painting layers is fundamental.

This interdisciplinary research offers a valuable contribution to the understanding of painted magic lantern slides, aiming at increasing awareness and appreciation for these collections to ensure their long-term preservation and fruition by present and future generations.

Keywords: Magic lantern slides, Glass, Cold painting, Material characterisation, Conservation, Restoration, 18th century, 19th century.

RESUMO

Lanterna mágica é o termo, derivado do latim *lanterna magica*, utilizado para designar o primeiro projetor de diapositivos através do qual imagens positivas transparentes representadas em diapositivos de vidro (diapositivos de lanterna mágica) eram projetadas numa superfície branca, como uma parede ou um ecrã. A invenção deste instrumento ótico, em meados do século XVII, permitiu, pela primeira vez, a projeção de imagens iluminadas e ampliadas que podiam ser observadas por uma audiência coletiva.

Os materiais e métodos de produção de diapositivos de vidro pintados para lanternas mágicas e o desenvolvimento de estratégias de conservação continuam a ser um domínio pouco estudado. Como resultado, os problemas de deterioração mais severos representam um desafio agravado para os conservadores. O presente trabalho foi desenvolvido como o primeiro estudo sistemático sobre os materiais e técnicas utilizados na produção de diapositivos de vidro pintados para lanterna mágica (inteiramente pintados e coloridos sobre contornos impressos), criando uma ponte entre as fontes escritas e materiais dos séculos XVIII e XIX, ao mesmo tempo que aborda desafios de conservação preventiva e restauro.

Foi efetuada uma revisão bibliográfica de fontes escritas dos séculos XVIII e XIX que referem os materiais e técnicas aplicados na produção de diapositivos de lanterna mágica, permitindo uma visão geral dos tipos de suporte de vidro adquiridos e da paleta de cores e aglutinantes disponíveis na época. Foi também explorada a evolução dos instrumentos de lanterna mágica e dos sistemas de iluminação ao longo do tempo. As formulações das aguarelas Winsor & Newton foram investigadas, revelando grande complexidade e individualidade consoante o corante utilizado em cada formulação.

Foi feita uma breve investigação sobre o contexto da utilização e o impacto das lanternas mágicas em Portugal ao longo dos tempos e foram selecionadas para o presente estudo duas coleções portuguesas de diapositivos de lanterna mágica pertencentes à Cinemateca Portuguesa - Museu do Cinema (CPMC) e ao Museu Nacional de História Natural e da Ciência (MUHNAC) da Universidade de Lisboa. As características destas coleções são discutidas, e o suporte vítreo e os materiais de pintura utilizados em 48 dos seus diapositivos, atribuídos a uma produção europeia dos séculos XVIII e XIX, foram estudados com recurso a uma abordagem multi-analítica.

As técnicas de espectrometria de Fluorescência de Raios-X Dispersiva de Energia (EDXRF), e espectroscopias de Ultravioleta-Visível (UV-VIS) e Raman foram aplicadas *in situ* e a espetroscopia de Infravermelhos com Transformada de Fourier (FTIR) e a Espetroscopia Raman Amplificada por Superfície (SERS) foram efetuadas em micro-amostras. Aliando EDXRF à análise semi-quantitativa com o programa WinAxil (utilizando padrões de vidro do Corning

Museum of Glass (Corning, NY, EUA) para validação) foi possível a identificação de quatro grupos principais de composições vítreas: vidros ricos em potássio, alcalinos-mistos, com alto teor de cálcio e baixo teor de iões alcalinos e vidros ricos em soda sintética. Estes resultados permitiram verificar a preferência por vidros de grande qualidade, como relatado na documentação histórica, e cada grupo composicional pode ser associado a períodos e centros de produção específicos, fornecendo pistas cruciais para a atribuição destes diapositivos. Complementando a técnica de EDXRF com espetroscopia UV-VIS, Raman e FTIR, foi possível identificar vários colorantes, incluindo ocre amarelo, gamboge, ocre vermelho, lacas à base de cochonilha, lacas gerânio, vermelhão, azul da Prússia, azul ultramarino, verde de cobre e negro de carvão, e cargas como o gesso. Relativamente ao componente aglutinante destas pinturas, foram detetadas por FTIR resinas terpenóides, nomeadamente mástique e goma-laca, bem como a possível presença de óleos. Finalmente, a técnica de SERS permitiu a identificação de ácido carmínico numa amostra avermelhada. Estes resultados verificaram o uso de uma paleta de cor reduzida, a preferência dos artistas por cores vivas e puras, e a produção de misturas simples para a criação de diversos de tons e gradientes.

Esta caraterização material revelou uma forte correlação entre o vidro e materiais de pintura identificados nos diapositivos dos séculos XVIII e XIX e os materiais descritos nas fontes documentais da época, permitindo a elaboração de uma linha cronológica que abrange a evolução do vidro suporte e da paleta de cores utilizada na produção destes diapositivos pintados. Foi também possível encontrar diferenças entre fabricantes, países e períodos, o que permitirá auxiliar a atribuição de diapositivos com maior precisão.

Por fim, são abordados alguns desafios de conservação enfrentados pelos responsáveis por estas coleções e profissionais de conservação. Foi avaliado o estado de conservação de mais de 350 diapositivos pintados das coleções portuguesas estudadas e foram identificados os principais danos observados nestes objetos, alguns deles com recurso a Microscopia Ótica. Este estudo demonstrou que, dos materiais que constituem estes diapositivos, o vidro e as camadas de pintura são os materiais mais frágeis e danificados. Tendo em conta o conhecimento reunido do ponto de vista material, e informações prestadas por institucionais nacionais e internacionais através de um inquérito, foram elaboradas diretrizes de conservação preventiva adaptadas às coleções de diapositivos pintados, de forma a complementar as normas de conservação em vigor. Dado que cerca de 20 % dos diapositivos estudados se encontram em mau ou muito mau estado de preservação e necessitam de ações de conservação ou restauro, e não foram encontradas orientações para este tipo de procedimentos em diapositivos de lanterna mágica pintados, este estudo explorou também métodos de limpeza para estas pinturas e de união de fragmentos do vidro suporte. No entanto, considera-se fundamental uma investigação aprofundada sobre os materiais e métodos de consolidação destas camadas de pintura transparentes.

Esta investigação interdisciplinar oferece um contributo valioso para a compreensão dos diapositivos de lanterna mágica pintados, com o objetivo de aumentar a sensibilização e a apreciação por estas coleções para assegurar a sua preservação e fruição pelas gerações presentes e futuras.

Palavras-chave: Diapositivos de lanterna mágica, Vidro, Pintura a frio, Caracterização material, Conservação, Restauro, Século XVIII, Século XIX.

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SYMBOLS AND ABBREVIATIONS

#	Number
µ	Micro
µW	Microwatts
ΔE*	Total colour variation
A	Absorbance
Avg	Average
C&W	Carpenter & Westley
CPMC	*Cinemateca Portuguesa – Museu do Cinema* | Portuguese Cinematheque – Museum of Cinema
DCR	*Departamento de Conservação e Restauro* | Department of Conservation and Restoration
EDXRF	Energy Dispersive X-ray Fluorescence Spectrometry
FCT	*Faculdade de Ciências e Tecnologia* | NOVA School of Science and Technology
FTIR	Fourier Transform Infrared Spectroscopy
HLLA	High-lime low-alkali glass
Inv.	Inventory number/code
IPM	Integrated Pest Management
IR	Infrared
KR	Potassium-rich glass
MUHNAC	*Museu de História Natural e da Ciência* | Museum of Natural History and Science
MUL	*Museus da Universidade de Lisboa* | Museums of the University of Lisbon
OM	Optical Microscopy
Raman	Raman Spectroscopy
RH	Relative humidity
SERS	Surface-Enhanced Raman Spectroscopy
SS	Synthetic soda-rich glass
SP	State of preservation
T	Temperature
UV	Ultraviolet
VIS	Visible
VOCs	Volatile organic compounds
W&N	Winsor & Newton
wt%	Weight percent

INTRODUCTION

"What is more beautiful than light, which, although it has no colour in itself, nevertheless somehow colours, by illuminating, the colours of all things?"
Hugh of St Victor (1096-1141); PL 176, 820-821

Colourful images projected with light connect directly to our senses and emotions. They have been around, through *camera obscura* effects, possibly since prehistorical times (Rivers and Ingraham 2020, 24), and have played fundamental roles in our society for over three hundred years. Today, these are mainly presented through modern projectors at movie theatres, educational lectures, and dissemination.

Deriving from Latin, *lanterna magica*, the term magic lantern is commonly used to designate the early form of a slide projector. Through a light source, a mirror, and a magnifying lens, transparent positive images depicted on glass slides (magic lantern slides) were projected onto a white surface such as a wall or screen. The invention of this apparatus in the mid-17th century allowed, for the first time, the projection of illuminated and magnified images to be viewed by collective audiences.

Nowadays, we are constantly surrounded by colourful objects and images. To understand the impact these projections had in 17th-, 18th-, and early 19th-century society, we need to travel back in time and imagine a world where vibrant colour images were not accessible to everyone. Although colour has always been used to describe the world around us, coloured images were most accessible to middle and poor social classes in public spaces such as religious buildings (*e.g.,* through stained glass and wall and easel paintings). In the 17th and 18th centuries, only the wealthiest families could afford to own illuminated books, hand-painted engravings, early colour printings, miniature and easel paintings with expensive pigments, colourful house interiors and clothes dyed with the most vivid colours (Ball 2009).

The magic lantern allowed projectionists to bring vibrant transparent images carried through light to the walls of their living rooms, fairs in public squares, churches, theatres and academies (Balzer 1987; Frutos 2010). Suddenly, where there was darkness, it was also possible to have images painted with light. In these shows, frequently accompanied by narrations and music, lanternists explored the illusion of moving images by manipulating mechanical slides, leaving everyone in awe, from children to adults, independently of their social status (Bernardo 2009; Frutos 2010; Campagnoni 1996).

Following the popularity of magic lanterns, thousands of glass slides were produced, mainly during the 18th and 19th centuries, using painting, printing, and photography techniques with

transparent paints. Recently, the enormous heritage significance of these objects has been increasingly recognised. As a result, collections of glass slides held in museums, private and educational collections, libraries, and archives are gradually being studied to unveil the magic lantern's role and relevance in historical, social and cultural contexts worldwide (Kember 2019; San Segundo, Frutos, and Therón 2019). Sometimes accompanied by documentation such as catalogues, flyers, trade press, readings and written testimonies, the magic lantern glass slides should be perceived as material evidence reflecting the society of that period (San Segundo et al. 2019). In the last two decades, several projects have made extremely important contributions regarding the interpretation, digitisation and classification of collections of magic lantern slides (*e.g.,* the *A Million Pictures* project (AMP 2015-2018)). These recent developments have gradually made the slides more available to scholars and the general public.

Even though slide collections frequently have hundreds or even thousands of items, institutions can rarely prioritise these collections in terms of time or personnel since, according to Sarah Dellmann (2016), specialised knowledge of magic lantern slides is inaccessible to most curators, archivists and cataloguers. Furthermore, due to the absence of resources dedicated to these collections, institutions frequently lack high-resolution photographs and miss an inventory with complete and adequate identification, description and classification according to current metadata standards, which currently require combining information from multiple sources (*e.g.,* trade catalogues). Hampered by the scarcity of guidelines, these factors allied to improper packing of slides and uncontrolled environmental conditions when in storage or exhibition, constitute some of the main obstacles to their study and ultimately result in severe conservation problems, putting the integrity and future of these collections at stake (Dellmann 2016; San Segundo, Frutos, and Therón 2019).

Over the years, slides have been presented to the general public and digitally preserved as still, rigid, static images or simple animated image loops. However, when we look at a magic lantern slide as a form of artistic or social expression, we rapidly see much more than an image. In addition to the efforts to gradually catalogue and preserve the digital images represented in glass slides, there is an urgent need to look at these artefacts beyond their imagery. These objects have a material identity that goes far beyond their representations. Their intentional use included touch and movement during projections, from the horizontal sliding of 'panoramic' sliding motion to the animation of mechanical slides. These actions' sounds and movement speed as the sequences of images and stories were presented were also part of the experience of their use. In recent years, scholars and enthusiasts have been rediscovering these multisensorial experiences with glass slides as a central focus; their engaging performances have brought to life the original intention of these historical objects. Nevertheless, most performances, and even small demonstrations in museum exhibitions, resort to historical magic lantern slides, submitting them to handling, high intensities of light and often high fluctuations to elevated temperatures during the projections. In order to interpret, appreciate and preserve the materiality of magic lantern slides, we need to comprehend both intangible and material aspects of this cultural heritage.

The unparalleled beauty, vividness, detail and overall artistic value associated with slides entirely hand-painted and hand-painted over printed outlines, combined with their frequent incorporation into mechanical mountings, make them attractive to the general public and the

favoured choice to be projected. Despite that, no specific guidelines for preserving painted glass slides could be found at the beginning of the present research. Most of the studies refer to paintings on glass in general or to reverse glass painting, which does not accommodate some of the specificities of these slides (*e.g.,* slim thickness and transparency of the painting layers) (McKay 1993). The only work found to concern the degradation mechanisms and conservation of lantern slides with materials similar to the hand-painted slides was developed by Maud Shermer (2003), where the glass and paints of 20th-century printed magic lantern slides were examined.

Several authors have referred to the hand-painting techniques used to produce magic lantern slides over the years. However, only a few have investigated this question further. As the most relevant examples, Laurent Mannoni (1994) and Francisco Javier Frutos (2013) have explored the painting materials and techniques used to produce magic lantern slides from the 17th to the 19th century from a documental point of view, resorting to written sources from that period. On the other hand, to the extent of the author's knowledge, only one paper and two prior conference proceedings with chemical characterisation analysis of historical hand-painted slides were published as a result of an investigation by the University of Turin more than ten years ago (Scalarone et al. 2006; Ploeger, Scalarone, and Chiantore 2008; 2010). In the first proceeding, from 2006, the binding mediums of 16 glass slides (entirely painted and coloured photographs) from the 18th to the early 20th century were identified by Attenuated Total Reflection Fourier Transform Infrared (ATR-FTIR) spectroscopy and X-Ray Fluorescence (XRF) was used to detect the colourants' inorganic components. This study also included a set of paints for magic lantern slides analysed by the beforementioned techniques along with Pyrolysis-Gas Chromatography-Mass (Py-GC/MS). The later publications are analogues and further characterise the binders of two previous slides through Mid-Infrared Fibre Optic Reflectance (Mid-IR FORS) spectroscopy.

In this way, it is plausible to consider that the study of the materials and methods applied to produce hand-painted magic lantern glass slides and the development of conservation strategies has been neglected and remains an understudied field. As a result of the lack of in-depth knowledge and specific information on preserving these fragile objects, their severe deterioration problems represent an aggravated challenge for conservation professionals. These previous studies, where historical written sources and artefacts were analysed, paved the floor for the present investigation.

As part of the project MAGICA (*Magic lantern: Study, safeguard, uses, and reuses in 19th-century Portugal*, PTDC/ART-PER/1702/2021, www.magica-project.com) that started in January of 2022, this doctoral research aims to be the first systematic study on the production and preservation of the art of painting on glass for magic lanterns and impact the understanding, visibility, valorisation and future safeguarding of hand-painted glass slides in collections worldwide. In this regard, this work intends to: (a) shed light on the materials and techniques used to produce hand-painted magic lantern slides (entirely hand-painted and with printed outlines) from the 17th to the 19th century and realise if they can point to a specific time and place or can distinguish different glass makers and production centres by reviewing historical written sources and analysing original magic lantern slides (having Portuguese collections as case-studies), (b) establish a methodology for the analytical study of these collections, (c) recognise

the main conservation problems associated with these objects and identify if they are mainly associated with natural ageing or their exposure to aggressive conditions during projections, (d) develop preservation strategies to ensure their fruition by present and future generations. Although focused on specific Portuguese collections, this project also envisioned the comparison, connection, and relevance of the results obtained to other national and international collections.

In order to encompass the outcomes of this work, the present document is organised into five interrelated chapters. *Chapter 1* offers a summarised historical contextualisation of the subject. It presents the most relevant types of magic lantern instruments and their illumination systems and explains the evolution of the techniques applied to produce magic lantern glass slides. In addition, a critical review of literature from the 18th and 19th centuries on the glass and painting materials used for producing painted slides (entirely hand-painted and hand-coloured printed outlines) is presented. *Chapter 2* investigates the formulations of Winsor & Newton's watercolours advised for magic lantern glass painting by 19th-century literature studied in the first chapter of this work. This study is presented as a first step to understanding their complexity and advancing knowledge for the future production of historically accurate reconstructions to enable the study of their deterioration mechanisms. *Chapter 3* presents an overview of the Portuguese panorama and contextualises the national collections studied in this work and its magic lantern slides, giving particular attention to the slides that served as case studies for the development of this project. *Chapter 4* presents the multi-analytical methodology established to characterise historical slides and encompasses the material analysis of glass and paints from 18th- and 19th-century slides produced in European countries, along with the deterioration indicators uncovered. The evolution of the choice of materials employed throughout time and manufacturers and correlations between the materials and techniques described by historical literature and those identified in analytical studies are also explored. *Chapter 5* is dedicated to the conservation of collections of hand-painted slides, focusing on evaluating the current conditions of the Portuguese Cinematheque, assessing the state of preservation of the collections studied, and understanding the characteristics, conditions and conservation practices in other institutions that hold magic lantern slides. This chapter presents the preventive conservation guidelines applicable to all collections of hand-painted magic lantern slides developed to complement the general preventive conservation standards currently established. Restoration practices such as cleaning glass and painting and reassembling glass fragments are also explored in an attempt to find solutions to improve the current preservation practices. Finally, the main conclusions are presented along with remaining questions and suggestions for future work.

This is the first comprehensive study on hand-painted magic lantern glass slides, particularly in Portuguese collections. However, many relevant collections that could provide precious knowledge on producing these artefacts remain unstudied. This research intends to lay the foundation for understanding the production secrets behind such fascinatingly detailed, transparent and vividly colourful paintings that have been neglected until recently.



1

THE MAGIC LANTERN AND THE PRODUCTION OF GLASS SLIDES

"At this time, at the height of modernity, the strange couplet 'magic' and 'lantern' was at its most compelling, the word 'lantern' projected the rational illumination of knowledge, whereas the word 'magic' harked back to the psychological affects of deception, illusion and diabolical darkness."

Martyn Jolly (2017)

Studying cultural heritage objects implies understanding their origins, the intention of their creation and the purposes they served throughout time. In this sense, this chapter summarises the magic lantern's history and development as a projection instrument and a critical literature review focused on the 18th- and 19th-century production of painted glass slides.

1.1 The magic lantern invention, evolution and allure

Despite being simple to describe, the 'magic' or optical lantern emerged in the 17th century due to numerous studies in mathematics and physics, particularly from studies on light reflection on mirrors (catoptric) and refraction of light by different media (dioptric) (Mannoni 1994). Given the similarities of working principles, it is believed that it developed from the optical phenomena of *camera obscura* (Mannoni 1994). The *camera obscura* can be described as a cubic box with an orifice centred on one side, in which the exterior image, viewed through the hole, is reflected into the opposite interior face, inverted and reduced; whether in the case of the magic lantern, this concept was applied in reverse, considering it projected an image, which was placed inverted next to the hole, from the box to the exterior world, magnified (Robinson, Herbert, and Crangle 2001). However, the person responsible for inventing the magic lantern is not agreed upon between authors; the German Jesuit priest Athanasius Kircher (1602-1680) and the renowned Dutch scientist Christiaan Huygens are frequently referred to as the inventors (Mannoni 1991; Robinson, Herbert, and Crangle 2001; Frutos 2010). In his work from 1646, *Ars Magna Lucis et Umbrae* ("The Great Art of Light and Shadow"), Kircher described a primitive projection system with several elements that constituted a magic lantern, and its second edition (1671) included the first printed illustrations of this apparatus (Mannoni 1991; 1994). Possibly due to the popularity these figures gave to his work, Kircher is still mentioned as the magic lantern

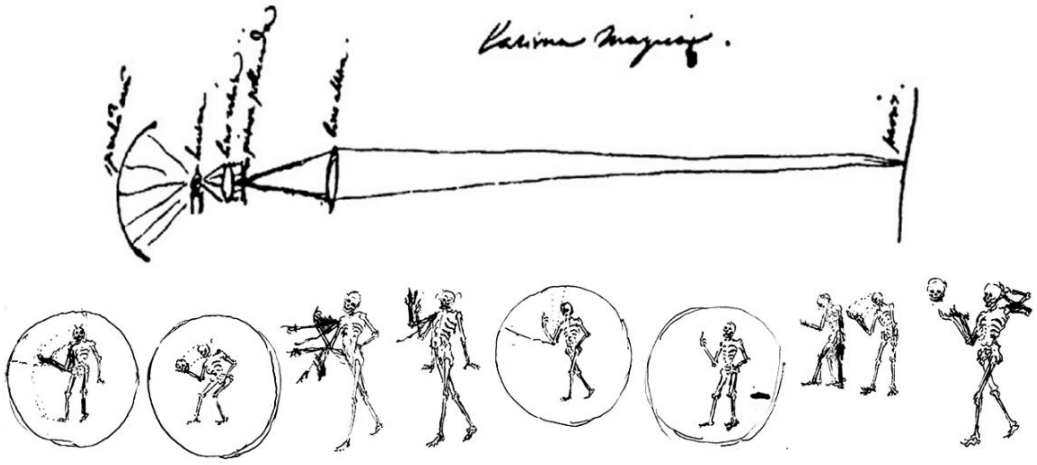


Figure 1.1 Set of drawings by Christiaan Huygens representing: a magic lantern (*laterna magica*), with the same configuration described by Huygens in a letter to Pierre Petit (December 11, 1664) (Société Hollandaise Des Sciences 1893, 5:161–62), with a concave mirror (*speculum cavum*), a lamp (*lucerna*), a vitreous lens (*lens vitrea*), a transparent image (*pictura pellucida*), another lens (*lens altera*) and a wall (*paries*) (1694); and skeleton figures illustrating animated glass slides showing the illusion of movement (1659). Bibliothèque nacionale de France (public domain) (Huygens 1916; 1950).

creator. Nonetheless, Huygens, astronomer, physicist and mathematician, has been increasingly recognised as the most probable magic lantern inventor (Robinson, Herbert, and Crangle 2001; Frutos 2010). In 1659, besides first sketching a magic lantern and describing its functioning, he already demonstrated illusions of movement created by slides by drawing a skeleton, removing its head to be projected in a fast sequence (**Figure 1.1**) (Mannoni 1991; 1994; Frutos 2010).

This instrument's history is rich, and its development unfolded for over two hundred years until its decline in the early 20th century. In a period marked by social, political, and religious instability, the baroque society found refuge in the allure of illusion in the most diverse expressions of art (Costa 1988). Since the beginning, projectionists have tried to fully explore the movement of the images projected, the abstraction, and the rapture of those who attended magic lantern shows (Bernardo 2009). As a result, the lanterns evolved from simple models to the most sophisticated instruments. These advances allowed for the creation of dissolving effects by juxtaposing complementary images (*Dissolving Views*) and other techniques that produced almost continuous moving images (*e.g.,* from day to night, winter to spring, and illusions such as snow falling or water running) (Costa 1988).

By projecting colourful, moving animated images in combination with recitations, music and audio performances, the magic lantern soon became one of the most extraordinary instruments and the most popular device for social communication, achieving its apogee during the 18th and 19th centuries, marking the beginning of the 'pre-cinema' period (Robinson, Herbert, and Crangle 2001; Frutos 2010). It was used to disseminate science, religion, and advertisement, illustrate lectures (*e.g.,* chemistry, astronomy, zoology, history, and art), and entertain children and adults with tales, adventures, burlesque animations, and occultism shows provided by itinerant lanternists, not only in large theatres and public squares but also in more intimate environments (Schlosser 1980; Balzer 1987; Campagnoni 1996; Frutos 2010).



Figure 1.2 Engraving capturing the audience's reactions at a Phantasmagoria show by *E.G.* Robertson in Paris (1845). Authored by A. Neuville and A. Jahandier *in* F. Marion "*L'Optique*" (1867). Public domain.

The Phantasmagoria was one of the most immersive and incredibly successful shows from late 18th and 19th centuries (**Figure 1.2**). Produced in pitch darkness, these sessions of pure terror convinced uneducated audiences of the appearance of supernatural and phantasmagorical figures by projecting the images on a white screen or column of smoke, behind which a magic lantern was placed, out of the audience's sight (Costa 1986; Heard 2005a; Cruz 2020). During these sessions, *e.g.,* wheel-mounted lanterns (phantascopes) were used to create effects of the gradual approach of the figures. Resorting to mechanical glass slides that gave the idea of moving figures, with music, scary sounds (such as of a glass harmonica), electrical shocks, light and shadow effects, real-size masked figures, incense, smoke, and other tricks, these shows became truly multisensorial and engaging, causing fear and disorientation to those who witnessed them (Robinson, Herbert, and Crangle 2001; Cruz 2020). Although phantasmagorias were performed in small spaces with oil lamps, the gaslight introduction allowed the development of illusion technologies inspired by these shows to enter the theatres contributing to the emergence of grand opera (Cruz 2020).

In the 19th century, the magic lantern was also associated with the Catholic Church not only for its use by missionaries for the evangelisation of indigenous people but also at the turn of the century, for being a tool for the propaganda of welfare concerns, fundraising, moral and religious instruction of poor-people, as well as for strategies against those who shared religious convictions different from the Pope in Rome (*e.g.* Freemasons, Socialists, Liberals, Jews, Protestants) (Robinson, Herbert, and Crangle 2001; Eifler 2010; Kessler and Lenk 2019). As an example, during the Siege of Paris (1870-71), magic lanterns were used for the first time to project microphotographs on glass (from about 0.8 mm, transported by carrier pigeons) containing news from the outside world to Paris (Robinson, Herbert, and Crangle 2001).

With the appearance and increasing popularity of the cinema from 1900 onwards, public and private magic lantern shows gradually began to disappear. However, in many countries, lanterns

continued being used in presentations, mainly as a teaching and information dissemination tool, for example, for scientific purposes (*e.g.,* medical lectures), religion (*e.g.,* the transmission of the Christian message), social action (*e.g.,* civic awareness and temperance sessions), and socio-cultural education (*e.g.,* dissemination of testimonies of travels and landscapes around the world), (Buddingh 2005; Heard 2005b). In the 20th century, the magic lantern use with the most significant impact was undoubtedly in advertising. It is possible to find countless coloured glass slides with commercial advertisements for a wide range of products, sales, religious publications, film premieres until around the 1930s and even messages for the audience before the cinema sessions (**Figure 1.3**) (Gillies 2005). In addition to advertising, the Magic Lantern remained present in the homes of many families as a form of entertainment as the continued production and marketing of toy lanterns accompanied sets of small slides with children's stories such as the ones produced by Disney (Schlosser 1980).

In the latter half of the century, magic lantern enthusiasts began collecting slides and using them again to illustrate lectures and private shows. As a result, The Magic Lantern Society of Great Britain was founded in 1977 and the Magic Lantern Society of the United States and Canada two years later. These groups were established to keep alive the art and science of projecting with magic lanterns, with the primary purpose of encouraging the organisation of exhibitions and shows of Magic Lantern equipment and lantern slides and known historically accurate methods of use; establishing a network of individuals and entities interested in the collection, conservation, restoration, exhibition and archiving of magic lanterns, lantern slides and related materials; facilitating and coordinating research, and stimulating publications related to these objects, as well as disseminating of knowledge within and outside the organisations (The Magic Lantern Society of GB, n.d.; Magic Lantern Society of US and Canada, n.d.).

Revivalist public performances in concert halls, galleries and museums have increased in recent decades. Additionally, new museums have been built, and more exhibitions related to the magic lantern have been held in countries including Belgium, Canada, England, France, Germany, Italy, Japan, the Netherlands, Portugal, Spain, Switzerland and the United States of America (Heard 2005c). The essence of the magic lantern has captivated contemporary artists worldwide to create projection works full of colour, light, shadow and movement, combining in their compositions materials as diverse as sand, plastic, metal, wood, fabric and stone (Davids 2005).



Figure 1.3 Examples of coloured slides shown before cinema sessions. (A) Advertisement slide to the Harley-Davidson motorcycle sold by Geo S. Burrows (US), ca.1920 from © 'de Luikerwaal' collection, Netherlands; (B) Public service announcement slide to "Prevent Forest Fires", ca. 1930-1931, from © Museums Victoria Collections, Australia; (C) Message slide "Everyone Has Taken Their Hat Off But You", ca.1915 from the © Museum of the Moving Image, New York; (D) Preview slide for the film "The Adventurer", ca.1917 from the © Museum of the Moving Image, New York. The credits of these images belong to the holding institutions mentioned.

1.1.1 Lanterns and illumination systems

The history of the magic lantern is intrinsically associated with the development of illumination systems, from candles to electric light. As it is possible to observe through the general scheme of a magic lantern presented in **Figure 1.4**, the illuminating power of the light source was of significant importance for the system, and most of the remaining components were to enhance, redirect and focus this light. As different light sources were invented and improved, mainly during the 19th century, new illumination systems were adapted to magic lanterns, and innovative models of magic lanterns arose. A summary overview of the most common types of magic lanterns and light sources, mainly found in 18th and 19th-century literature gathered by Robinson, Herbert and Crangle (2001), can be observed in **Figure 1.5**.

Early forms of lantern light sources included candles and oil lamps; as candles had a lower illumination power, oil lamps were much preferred. Over time, different oils were used, and besides the vegetal oils such as colza, in the second half of the 18th century, whale oils from Greenland and Sperm whales started to be used until the appearance of paraffin in 1860 (Robinson, Herbert, and Crangle 2001). Although information about the early stages of the magic lantern is limited, it is known that the reduced intensity of oil lamps only allowed for small projections (Balzer 1987). Nevertheless, improvements to the system, such as the invention of the Argand Oil Lamp and the addition of a piece of camphor to the oil (*e.g.,* Sperm oil), increased the steadiness of the flame and the brilliance and intensity of the light (Robinson, Herbert, and Crangle 2001). When paraffin became available, multiple-wick lamps were developed for magic lanterns (*e.g.,* Triplexicon, Phamphengos and Pentaphane), allowing for much stronger illumination power than any other oil lamp (Robinson, Herbert, and Crangle 2001). Nevertheless, authors such as Rintoul (1867, 48–49) preferred camphorated oils to paraffin (a brighter and steadier light) due to its risk of explosion when heated.

At the turn of the 19th century, the most innovative lantern designs identified were related to Phantasmagoria shows and toy lanterns, which were at the time powered by oil lamps and, therefore, apt for small projections. The Fantascope (1799) was a large lantern mounted on wheels

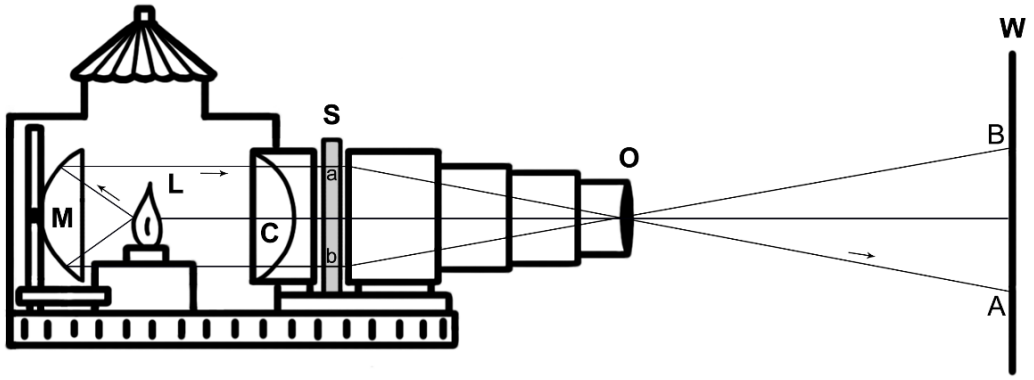


Figure 1.4 Scheme of the working principle of a magic lantern. Through small arrows (→) showing the light path, it is possible to observe that after its emission by a light source (L), it is reflected by a concave mirror (M) that forces the light through a condenser lens (C), lighting up the transparent image (ab) on the glass slide (S). Finally, this image (ab) goes through an adjustable objective lens (O) and is projected on a wall (W) as an inverted image (BA). Drawing by the author.

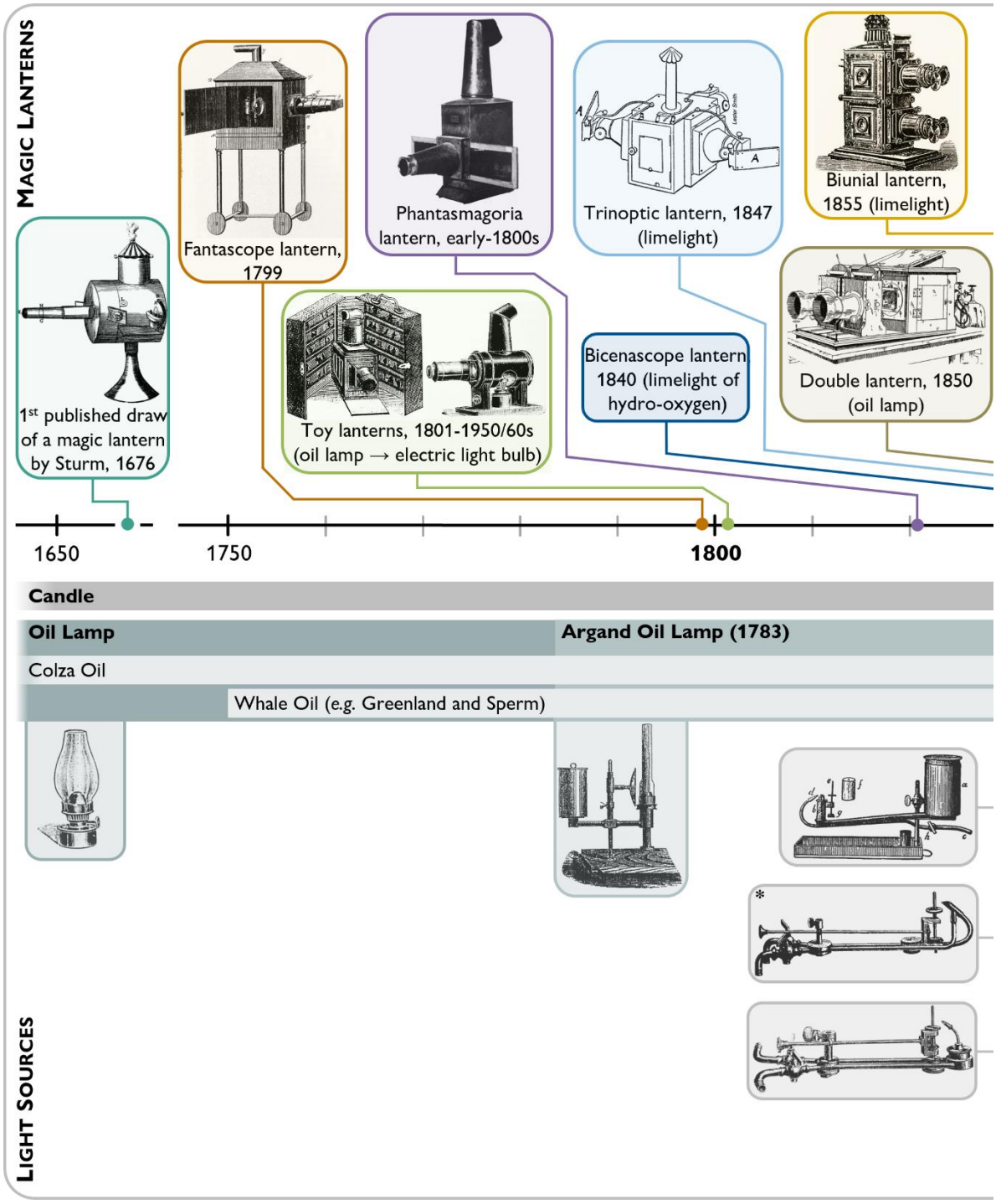


Figure 1.5 (Part A) Schematic summary overview based on the most common types of magic lanterns (top) and light sources (bottom) gathered from literature of the 18th to the 20th century by Robinson, Herbert and Crangle (2001). The set of figures shown are illustrative examples extracted from this publication, excepting figures marked with (*), collected from 'An Expert' [W.C. Hughes] (1893).

with accessories for special effects that allowed for the illusion of figures approaching and distancing, whether the later Phantasmagoria lantern was lightweight that could be attached to the projectionist belt and be operated hands-free to be easily moved towards and away from the screen (Robinson, Herbert, and Crangle 2001). Toy lantern was the name given to small lanterns intended for children's use, produced from the early 19th century to the mid-20th century and

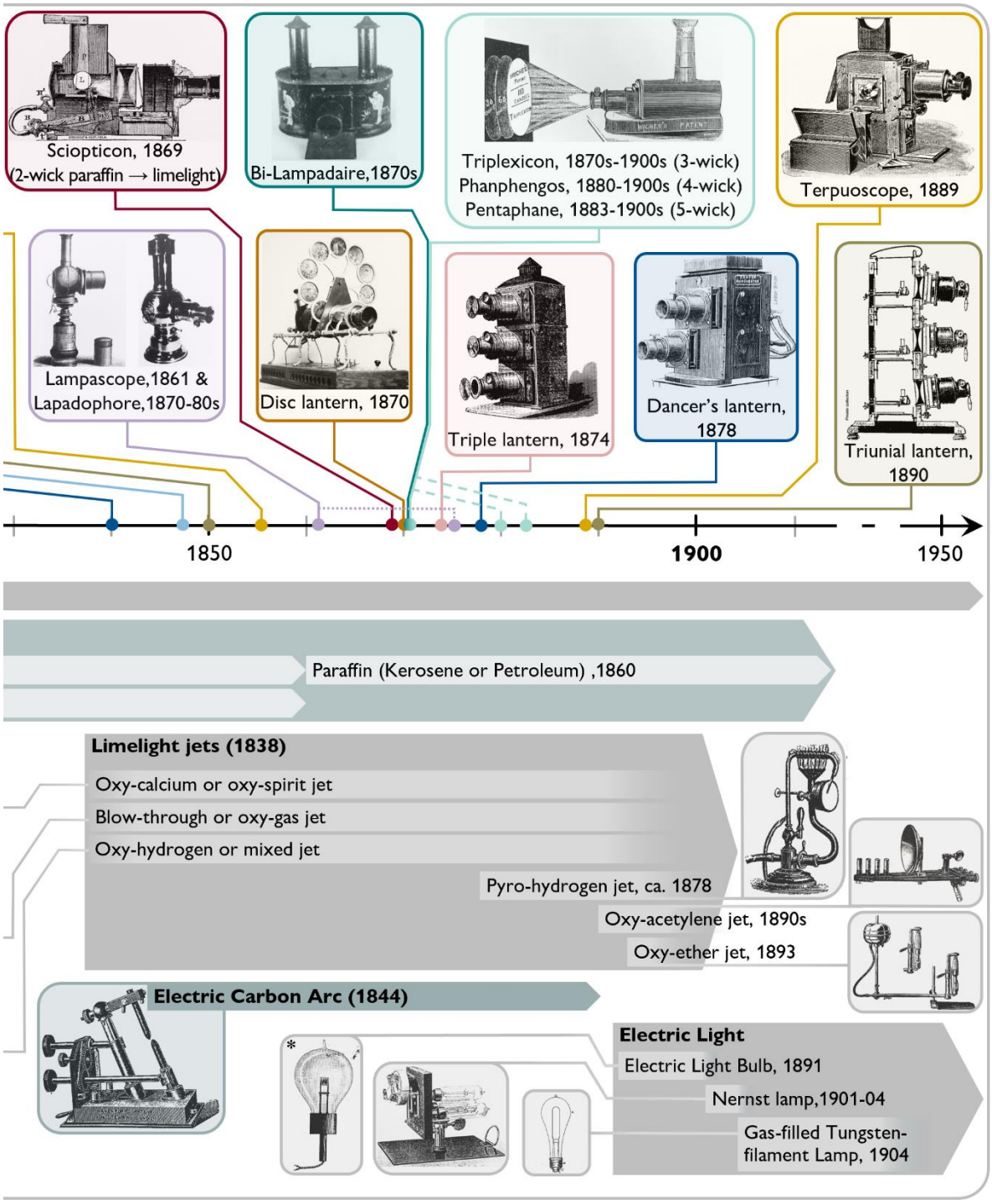


Figure 1.5 (Part B)

powered almost exclusively by oil lamps until the advent of electricity. Early models projected hand-painted glass slides until ca.1880, when chromolithographs replaced them, and, by the 1950s-60s, the lantern designs were already made of plastic and projected acetate slides in cardboard mounts (Robinson, Herbert, and Crangle 2001).

With the appearance of the limelight or Drummond light, adapted to magic lanterns in 1838,

the projection power improved considerably, allowing shows to reach larger audiences, significantly increasing its popularity (Balzer 1987; Robinson, Herbert, and Crangle 2001). The limelight is a very bright gas light that results from heating a piece of lime or calcium oxide with a gas flame of combined oxygen and hydrogen (Robinson, Herbert, and Crangle 2001). The emergence of this type of light stimulated the development of different variations of jet systems and the production of innovative magic lantern models. The oxy-calcium jet was the earliest form of limelight on magic lanterns, deriving directly from the Drummond light, and consisted of passing oxygen through a flame of a spirit or alcohol lamp that lightened a lime cylinder, resulting in a light output of 200-300 foot-candles, being suitable for small halls; nevertheless, it continued being used over the years when hydrogen gas was not available (Robinson, Herbert, and Crangle 2001). The blow-through, oxy-gas or safety jet uses pressured oxygen that passes through a gentle hydrogen flame touching a lime piece without previously mixing both gases, preventing accidents and almost achieving mixed jet light power ('An Expert' [W. C. Hughes] 1893). The oxy-hydrogen or mixed jet was the most powerful and brilliant limelight system as it had the hottest flame produced by mixing in a chamber both oxygen and hydrogen gas under pressure, which was directed to a piece of lime, emitting up to 1000 candles (Robinson, Herbert, and Crangle 2001). Pyro-hydrogen jet, first mentioned by Chadwick (1878), used a mixture of hydrogen gas and air that reached a disc of lime; although not comparable with the oxy-hydrogen or oxy-calcium light, it was superior to any oil light. The oxy-acetylene jet, developed around the 1890s, mixed acetylene gas with oxygen and was the least successful of the limelight jets as the light was feeble (maximum of 200 foot-candles) compared to other jets (Robinson, Herbert, and Crangle 2001). The oxy-ether jet appeared in 1893 and had a brief period of popularity as it required no fuel gas; however, it was a hazardous lamp as it passed oxygen through an ether reservoir (Robinson, Herbert, and Crangle 2001).

The increase in illumination power with improved paraffin lamps, limelight jets, and electric carbon arcs allowed for the development of lantern instruments with two and three objectives by placing two or three systems on top of each other, respectively, as the biunial, triple and triunial lanterns, instead of two separate lanterns side by side such as the double lantern powered by oil lamps (Robinson, Herbert, and Crangle 2001). The distinction between triple and triunial lanterns was that the first was a single system with three objectives, and the second was formed in two sections, consisting of a biunial and a single lantern, which could be attached or separated as whished (Robinson, Herbert, and Crangle 2001). It also enabled the development of three-objective lanterns that used a light limelight source, such as the Trinoptic lantern (Robinson, Herbert, and Crangle 2001).

The 19th century was, without doubt, the golden period of the magic lantern use and production of innovative instruments to accommodate different purposes (whether it was for big theatres, for lectures in small halls, more portable for travelling, or for instruction and amusement of children), and to create various transition effects, for example, the Disc Lantern which allowed for many images to be shown without the need for changing slides and the Terpuoscope where slides moved vertically instead of the more traditional horizontal sliding (Robinson, Herbert, and Crangle 2001). At this time, the magic lantern had attained a status as an educational tool and respect in the scientific sphere.

> *The magic lantern has always been one of the most popular instruments ever made. So popular has it been, that children by the thousand recognise its charms, while many of more mature years have a secret hankering after it, which they would fain leave unacknowledged: "For it is but a toy", think they, "and we have left toyland behind us since we reached man's estate". Let me sympathise with these feelings, and own for my part a weakness for pantomimes and fireworks, which weakness I have occasionally the opportunity of indulging, on the plea of taking my children out for a treat. But let me say at once that the magic lantern in now no toy, but is recognised as a valuable aid to education far and wide.*
>
> Thomas Cradock Hepworth (1889)

The late 19th century and early 20th century period was marked by the introduction of electric light systems in magic lanterns: first with the carbon-filament light bulb in 1891; the Nernst lamp, in 1901, which needed to be lit with a naked flame and had a three-filament of rare earth which provided the illumination of 1000 candles, nearly three times more efficient than the previous carbon-filament lamp; replaced in 1904 by the gas-filled Tungsten-filament lamp (Robinson, Herbert, and Crangle 2001).

Optician stores sold the most variety of magic lantern models and glass slides, separately or in sets inside wooden and card boxes, which could be accompanied by guidebooks with narration texts, brief descriptions, and instructions (**Figure 1.6**). The light in which magic lantern slides were projected strongly influenced how they were painted, and observed when projected so, the hue of the slides varied according to the type of lantern illumination and purpose (*e.g.,* painted with warmer hues for colder lights such as limelight, and painted in colder hues to be projected with warm lights such as oil lamps). A summary of the different light intensities is presented in *Appendix A.1.*



Figure 1.6 Example of a 19th-century crowded showroom where magic lanterns and slides of different sizes and qualities and shown while customers are watching a magic lantern show in the back room. Other displayed gods include stereoscopes and other scientific instruments, magicians' outfits, mechanical toys, and steam engines. Engraving of the W. Hagedorn's showroom in Berlin, by F. Wehl (ca.1890) (Robinson 2009).

1.2 Production of magic lantern slides: a review of methods and materials for painting glass slides

The magic lantern slide is the name used to designate positive and transparent images depicted on glass plates for projections with magic lantern instruments. Besides the lanterns, the production of glass slides had also evolved, and over time, three main techniques were used to produce them: hand painting, printing, and photography (**Figure 1.7**). With the projection lanterns and the production of slides increasing in popularity in the 18th and 19th centuries, various documents from this period include information on the different types of magic lanterns and how to operate them while also noting instructions on producing slides, providing invaluable information on their artistic and manufacturing practices (Frutos 2013).

The production methods used to represent the coloured figures on the glass slides drastically changed from *fired* to *cold paints* in the transition from the 17th century to the 18th century. Both Hertel (1716) and Nollet (1770) point out the production of earlier magic lantern slides with enamels fired at low temperatures (*fired paints*) as in the stained-glass tradition (**Figure 1.7-A**). They mention that although these were much more durable, it was difficult to find people who could do this type of work, it was very expensive, and the result was not as beautiful as those painted in watercolours or varnish colours (**Figure 1.7-B**) (Hertel 1716; Nollet 1770; Mannoni 1994). For those reasons, after choosing the glass plates for the support, the standard procedure was to paint the images by hand with watercolours, oils, and varnishes referred to as *cold paints*, which, when projected, revealed their magic by playing with the colours' transparency and light. In the second half of the 19th century, several manufacturers transitioned to printing techniques to create the images' outlines (*e.g.* copper-plate, **Figure 1.7-C**) and later the whole image with only printing processes (*e.g.* chromolithographs or transfer slides) (**Figure 1.7-D**) (Robinson, Herbert, and Crangle 2001; Frutos 2013). By the end of the century, most slides were produced by photographic methods that could also be hand-coloured (**Figure 1.7-E**) (Frutos 2013).

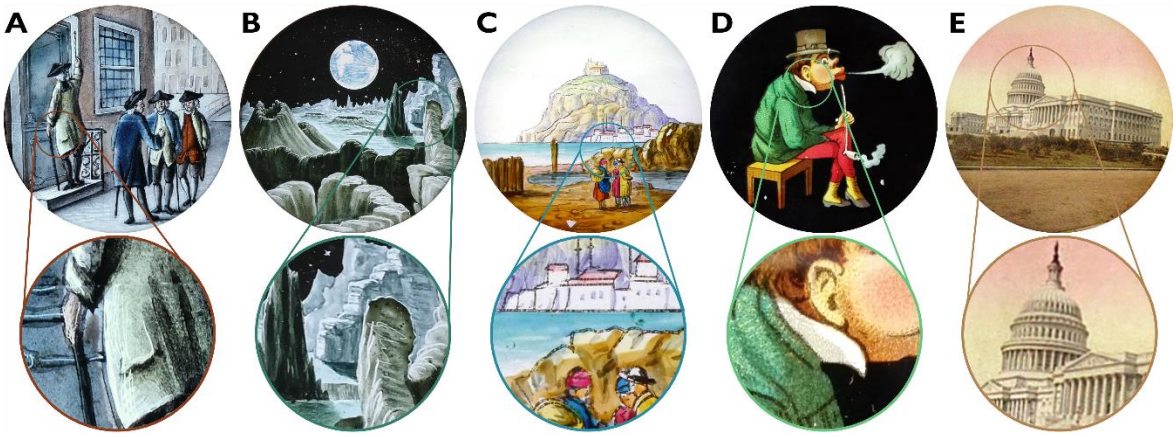


Figure 1.7 Slides produced with different depicting techniques: (A) hand-painted with *fired paints* (e.g using cobalt blue enamels), 18thc, Holand (CPMC-PC0001); (B) hand-painted, by Carpenter & Westley, 19thc, England (CPMC-PC3301/007); (C) hand-coloured printed outlines by Carpenter & Westley, ca. 1850-1875, England (CPMC-PC0189/009); (D) chromolithography, 1850-1899, England (CPMC-PC183); and (E) hand-coloured photography by T.H. McAllister, end of 19thc, United States of America (CPMC-PC0411/011). © Portuguese Cinematheque – Museum of Cinema, photos by the author.

Slides were composed of diverse materials. Besides the glass support and depicting materials (*e.g.,* paints and photographic emulsions), these objects frequently included paper, wood, and metal, which were applied to create different movement patterns and intricate mechanisms. The technique that produced the most magical and artistically valuable images was hand painting (**Figure 1.7-B**). Testimonies of the time enlighten us on the struggle of creating good-quality slides and the importance of mastering the technique and having the best quality materials. With the glass industry development by the end of the 18th century and the improvement of the painting techniques and materials, miniature masterpieces that required the skill of talented painters were created, bearing in mind that projections mercilessly magnified all details and imperfections (Schlosser 1980; Frutos 2013). According to 'An Expert' [W.C. Hughes] (1893), even though these miniature paintings required great mastery, this art was not as appreciated by the general public as painting on canvas and, as a result of the sale of poor-quality substitutes of painted slides, the compensation to real artists was not considered adequate.

Since hand painting was a slow and laborious process, this technique was unsurprisingly complemented and later replaced by faster and less expensive methods, especially with the beginning of the industrial revolution (Jailer 1987; Frutos 2013). Copper-plate printing was one of the first hybrid processes to produce large quantities of coloured outline slides (**Figure 1.7-C**). This process was adapted from ceramic decoration and extensively used by Philip Carpenter, who first described it in *Elements of Zoology* (1823) (Robinson, Herbert, and Crangle 2001). Briefly, this method involved engraving the outline on a copper plate (*e.g.*, by protecting the plate with varnish, etching, submerging the plate in acid so that only the etched lines corrode, cleaning the acid and removing the protective varnish), inking the plate with black enamel and wiping it so that the ink stayed only in the etched lines (Hecht 1980; Beattie 2013). Then, the copper plate was gently pressed onto a sheet of varnish/glue, which lifted the paint from the plate to be transferred to a sheet of glass (Hecht 1980; Robinson, Herbert, and Crangle 2001; Beattie 2013). Alternatively, the inked plate could be pressed directly on a glass covered with varnish/glue so the ink would stick to it (Hecht 1980). Finally, the glass was fired at low temperatures, carbonising the organic varnish/glue and permanently securing the enamel outline to the glass (Hecht 1980; Beattie 2013). Another variation was using a black colour mixed with varnish so that it would stick to the glass when dried without the need for fire (Frutos 2013). The copper-plate technique significantly contributed to the unprecedented dissemination of the magic lantern as an educative and recreational instrument economically available to all (Campagnoni 1996). Although it did not allow for the mass production of slides, as it still required much work from skilled painters, it enabled manufacturers to standardise their production and sell much cheaper outline slides to the public to be painted by amateurs (Roberts 2017).

> *"The accompanying outlines on glass will render the work exceedingly easy to the amateur. He will not require to trouble himself bout making out a correct outline – at all times a work of some difficulty – but will simply begin with the colours as they are laid out for him. In truth, he will find glass painting, on the outlines, almost as simple as print, or photographic colouring; and he will be able to produce, at less than one tenth the usual cost, a series of views and subjects for the magic lantern, which will often, on a long winter's evening, please both old and young."*
>
> A. N. Rintoul (1867)

Many producers used this technique until the 20th century, but other printing techniques, such as lithographic transfers, started being used after the late 1850s. In general, lithography consisted of drawing on limestone with a greasy material and covering it with acid so the stone would corrode non-greasy areas, leaving the motifs in relief for printing (Frutos 2013). Several colours could be combined in the same support by using a different limestone for each colour. In summary, the first chromolithographic transfers used oil colours printed on paper coated with a solution of starch, albumin and glycerin, covered with a water-soluble glue after printing, which was then moistened, applied on the glass and the paper removed (Hecht 1980; Frutos 2013). Around 1870, J. Barnard & Son started using enamel colours that needed firing after being applied to the glass, and in 1891, J. Theobald & Co also produced transparent lithographically printed papers by treating them with creosote oil and colophony resin (Hecht 1980).

Photography was the technique that allowed for the mass production of magic lantern slides with the advantage of showing authentic images from all corners of the globe, which could achieve more realism by colouring with watercolours, oils, and varnishes (**Figure 1.7-E**). Black outlines could also be photographically reproduced on a glass to be painted by amateurs (Robinson, Herbert, and Crangle 2001). The first commercially produced transparent photographs for magic lanterns were the *hyalotypes*, sold in 1850 by the brothers Wilhelm and Friedrich Langenheim (USA), using the *albumen-on-glass* technique invented by Abel Niépce de Saint-Victor in 1848 (Robinson, Herbert, and Crangle 2001). One year after, the *wet collodion* of Frederick S. Archer, a much faster and more sensitive method, started to be used for the mass production of slides (Robinson, Herbert, and Crangle 2001). Although *dry collodion* and the exclusively positive *carbon* process invented in 1855 were suitable for amateurs, it was with the introduction of the *gelatine dry plate* process in the late 1870s that amateur photography emerged for being a quick, more accessible to manipulate and cheaper despite its slightly inferior quality compared to *collodion* (Robinson, Herbert, and Crangle 2001).

Written documents are one of the most valuable sources of information for studying technical aspects of art production and understanding their evolution over time (Carlyle 1995; Nadolny et al. 2012). Although sources with instructions on producing lantern slides are known, the processes and materials used to manufacture historical hand-painted magic lantern slides for over two centuries are still understudied. The present work focuses on the glass and painting material components of slides entirely hand-painted and hand-coloured outline printed slides from the 18th and 19th centuries; therefore, it is essential to understand how these were produced.

With this in mind, a critical literature review focused on the material and techniques applied to these types of slides until the 19th century in Europe and North America was conducted to study its geographical and chronological evolution. Mannoni (1994) and Frutos (2010; 2013) have previously explored the production of slides based on historical literature, presenting an excellent foundation for developing the present work. This knowledge is fundamental to understanding these artefacts in terms of their materiality, allowing for an in-depth comprehension of the slides' historical, cultural and artistic impact. It also aids their analytical characterisation and the quest to unveil the key factors and mechanisms that lead to the degradation of historical slides. Subsequently, it can facilitate the development of better preventive and remedial conservation strategies to assure their access to future generations.

1.2.1 Written historical sources on painted magic lantern slides' production

The study of written historical sources documenting the production methods of magic lantern glass slides was conducted, considering documents written until the end of the 19th century in Europe and North America. Adding to the references compiled by Mannoni (1994) and Frutos (2010; 2013), the search was primarily performed on digitised archives in English, French, German, Italian, Portuguese, and Spanish. From the sources available to the public, different types of publications that informed on the glass support and painting materials used in producing magic lantern slides were included: manuscripts, treatises, books, catalogues or business periodicals and articles from magazines. Additionally, documents with instructions for colouring photographic slides were only included when there was an explicit indication that the listed materials and techniques could be applied or adapted to produce slides entirely hand-painted or hand-coloured on printed outlines. A total of 22 documents advising types of glass and materials applied to produce both hand-painted and hand-coloured outline slides were identified and can be consulted in **Table 1.1**.

Table 1.1 Consulted written sources on the production of painted slides, chronologically organised.

Author	Date	Title	Printer / Publisher	City
Hertel	1716	*Vollständige Anweisung zum Glasschleifen*	Rengerschen Buchhandlung	Halle
Wiedeburg	1735	*Einleitung zu den Mathematischen Wissenschaften*	Berlegtens Johann Meners	Jena
Denecke	1757	*Vollständiges Lehr-Gebäude der ganzen Optik*	David Iversen	Altona
Nollet	1770	*L'Art des Expériences*	-	Paris
-	17--	*Distribuiçam Das Partes Da Lanterna Magica*	-	Lisbon
Groom	1855	*The Art of Transparent Painting on Glass*	Winsor & Newton	London
Bielfeld	1855	*A Guide to Painting on Glass*	George Rowney & Co.	London
Whipple & Co.	1856	*Directions for the Graduation and Mixture of Colors*	M.J. Whipple & Co.	Boston
Winsor & Newton	1863	*Winsor & Newton's Trade Catalogue*	Winsor & Newton	London
Negretti & Zambra	1866	*The Magic Lantern, Dissolving Views, and Oxy-Hydrogen Microscope (…)*	Negretti & Zambra	London
Rintoul	1867	*Transparent Painting on Glass for the Magic Lantern in Water, Oil & Varnish Colours*	Brodie & Middleton	London
Urbino & Day	1873	*Art recreations: being a complete guide*	Shepard and Gill	Boston
"A Mere Phantom"	1874	*The Magic Lantern, How to Buy and How to Use it (…)*	Houlston and Sons	London
Middleton	1876	*Magic Lantern Dissolving View Painting*	Brodie & Middleton	London
Marcy	1877	*The Sciopticon Manual (…)*	James A. Moore	Philadelphia
Chadwick	1878	*The Magic Lantern Manual* (1st ed)	Frederick Warne & Co.	London
Molteni	1881	*Intructions Pratiques sur L'emploi des Appareils de Projection*	F. Aureau	Paris
Chadwick	1886	*The Magic Lantern Manual* (2nd ed)	Scovill Manufacturing Co.	New York
Hepworth	1889	*The Book of The Lantern*	Edward L. Wilson	New York
Underhill	1892	"Artistic Lantern Slides No. 1-2" in *The Optical Magic Lantern Journal and Photographic Enlarger*	-	London
"An Expert" [Hughes?]	1893	*The Art of Projection and Complete Magic Lantern Manual*	E.A. Beckett	London
Winsor & Newton	1896	*Winsor & Newton's Trade Catalogue*	Winsor & Newton	London

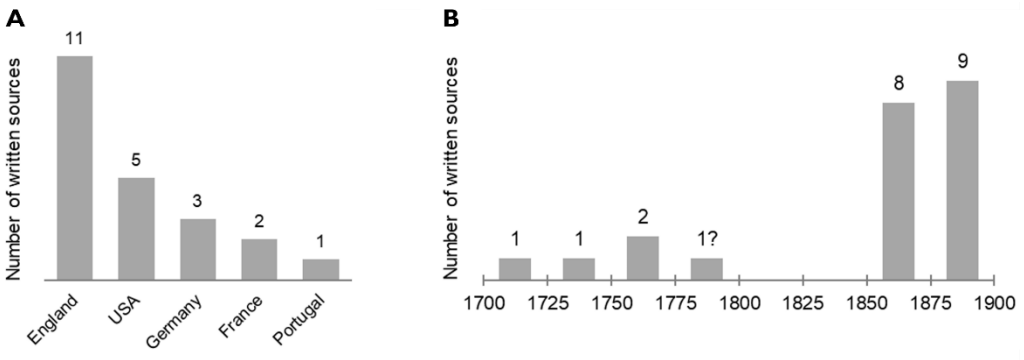


Figure 1.8 Geographical (A) and chronological (B) distribution of the 22 historical written sources consulted. Note: The source between 1775 and 1800 (with "?") corresponds to the one attributed to the end of 18th-century Lisbon.

As observed in **Figure 1.8-A**, most of the documents were produced in England, the United States of America (USA), Germany, and France, which was expected given that these countries were important centres of production of magic lanterns and glass slides. In particular, it should also be considered that there was an increased interest in rediscovering these documents in England and the USA, promoted by The Magic Lantern Society of the United Kingdom and the Magic Lantern Society of the United States and Canada.

Furthermore, most of the sources belong to the second half of the 19th century (**Figure 1.8-B**), which corresponds to the magic lantern apogee, with technological developments in both instrument and depiction techniques allowing its consolidation as a communication and entertainment medium and consequent mass production of glass slides and demand for painting instructions by students, amateurs, and private lecturers (Bielfeld 1855; Frutos 2010). Additionally, books published during this period had more printed copies and, therefore, can be more easily found than 18th-century ones.

The earliest documents in which instructions for magic lantern slide painting were identified are treatises from the 18th century that concern facts and principles mostly related to the construction of scientific instruments and the study of sciences such as mathematics, chemistry, and physics, in particular optics, written by academics possibly for dissemination and lecturing purposes (Hertel 1716; Wiedeburg 1735; Denecke 1757; Nollet 1770). The only exception is the bifolium loosened from a Portuguese manuscript containing information about the positioning of the magic lantern parts and colours to paint figures on the slides, from which the author and context information are currently unknown (Distribuiçam Das Partes Da Lanterna Magica 17--).

On the other hand, the books from the second half of the 19th century are predominantly handbooks and manuals. Several, written by artists, provide detailed information about different painting techniques, including painting on glass for magic lanterns, from the materials (*e.g.,* pallets, brushes, type of glass, colours, mediums) to the application processes step-by-step (Groom 1855; Bielfeld 1855; M J Whipple & Co. 1856; Rintoul 1867; Urbino and Day 1873; Middleton 1876). In some cases, these books were published by renowned manufacturers of artist's materials (*e.g.,* Winsor & Newton and George Rowney & Co.) and suppliers (*e.g.,* M. J. Whipple & Co.) and frequently included trade catalogues listing painting materials for magic lantern glass slides that were also considered (Groom 1855; M J Whipple & Co. 1856; Winsor &

Newton 1896). Another group of publications dedicated to explaining how to operate magic lanterns and related instruments was predominantly published by lecturers, lanternists and magic lantern and slides manufacturers and dealers, presenting the accessories available on the market (*e.g.,* types of lanterns, light sources, condensers, supports), and explaining how to paint glass slides (Chadwick 1878; 1886; Hepworth 1889; 'An Expert' [W. C. Hughes] 1893). Finally, a magazine article written by the artist Underhill (1892), specifically with instructions for magic lantern slide painting, was also found.

The production of hand-painted slides has been reported since the earliest documents reviewed for this research; they enlighten us on the difficulty of producing good quality glass slides without the complete mastery of the technique and the best quality materials (Hertel 1716; Wiedeburg 1735; Denecke 1757; Nollet 1770; 'Distribuiçam Das Partes Da Lanterna Magica' 17--; Bielfeld 1855; Groom 1855; M J Whipple & Co. 1856; Winsor & Newton 1863). Besides early references to painting with fired enamels, hand-painting with cold paints was the only technique explored by the literature until 1866, when Negretti & Zambra (1866), besides explaining how to paint slides for magic lanterns, also included recommendations for printing on glass and colouring photographic slides.

Although photography was the most used image production technique in the second half of the 19th century, some authors of this time, such as 'A Mere Phantom' (1874), argued that hand-painted slides should continue being produced for being more artistically interesting and appealing to the public than photographic ones. For specific purposes, photography could not aid, for example, in representing grotesque and comic figures or educational diagrams (*e.g.,* astronomical) ('A Mere Phantom' 1874). According to Chadwick (1878), even at the end of the 19th century, besides buying or producing transparent photographs on glass and colour them, lanternists and amateurs could easily buy clear glass plates to produce their slides from scratch or obtain outlines already printed on glass (with black varnish or fired enamel) to be painted and buy different types of frames and mechanical devices suitable for animated slides. In this way, books comprehending the hand-painting technique solely (without or with the aid of printed outlines) continued being published, *e.g.,* by Rintoul (1867), Urbino and Day (1873), 'A Mere Phantom' (1874), Middleton (1876), and Underhill (1892).

In addition to Negretti & Zambra (1866), the authors Marcy (1877), Molteni (1878), Chadwick (1886), Hepworth (1889), and 'An Expert', possibly Hughes (1893) also wrote instructions for hand-painting slides apart from those for colouring photographic slides. Finally, Winsor & Newton's *Trade Catalogue* from 1896 included painting materials specific for magic lantern glass painting without specifying the slides' production technique, which was interpreted as being transferable to all hand-painted slides.

1.2.2 Techniques for producing painted or coloured slides

During the 18th and 19th centuries, the production of hand-painted slides generally included four main stages: selecting and preparing the glass support, outlining and painting the image, and framing the slide (**Figure 1.9**). To produce the images, besides informing on the glass preparation, outlining and colour application, several authors advise choosing a place free of dust and

removing tiny fibres that stick to the paint with a small knife to avoid ruining the work when magnified (Groom 1855; M J Whipple & Co. 1856; Rintoul 1867; Chadwick 1886).

Another relevant aspect was the light source used when executing the paintings, as it should match the light colour temperature of the magic lantern light so that when the figures were projected, the colours would reflect the intended hues. It is possible that initially, all slides were painted with warm artificial light, such as oil lamps, so that the colours would match those projected under the same lights. After the appearance of lanterns illuminated with limelight (oxy-hydrogen or oxy-calcium light), around 1838, artists started referring slides should be painted under daylight or that the colours should be tested under this light, as it was considerably brighter and cooler (in terms of light colour temperature) than oil lamps (Middleton 1876; Scott 1891; Robinson, Herbert, and Crangle 2001, 284). Nevertheless, as lanterns used by amateurs and children continued having warm light sources, authors such as Groom (1855), Middleton (1876), and Chadwick (1886) stated explicitly in their manuals that daylight was not necessary and advised to paint under a strong artificial light source (*e.g.,* Argand gaslight, oil lamps or paraffin lamps with a green shade).

> *"It is much better (if the means of the exhibition permit) to procure a good-sized lantern, in which you can have a light such as the oxy-hydrogen or the oxy-calcium. These, being the nearest approach to daylight, will delineate with greater truth, and bring out the beauties (as also the imperfections, in any) of the picture. But if an oil lamp is used, the camphorated oil is the best to burn, as it is whiter and cleaner in burning than ordinary colza.*
>
> *If the picture is to be exhibited by the oxy-hydrogen light, the yellow tints must be kept down; but if an oil lamp is to be used in the lantern, the yellow tints in the slides, if* painted by daylight*, must be somewhat preponderate, as this colour, seen by the last-mentioned light, is not so observable as by the former."*
>
> Middleton (1876, 30)

Many authors emphasise the importance of carefully selecting good quality glass for the magic lantern slides to obtain the best result, with characteristics such as colourless, flat, very thin, uniform thickness, and perfectly free from any specks, veins, bubbles, and other flaws (Nollet 1770; Groom 1855; Bielfeld 1855; M J Whipple & Co. 1856; Negretti & Zambra 1866; Marcy 1877; Hepworth 1889; Underhill 1892). Before drawing or painting, the glass would be cut to the desired size and shape (*e.g.,* rectangular, square, or circular) and perfectly cleaned to remove dust and grease from the surface. Among the strategies used by the authors are rubbing the glass with ox-gall water on a piece of linen followed by turpentine (Bielfeld 1855); cleaning with a solution of water and ammonia (Negretti & Zambra 1866; Marcy 1877); cleaning with ox-gall to 'give the colours more bite', which possibly means to improve the colour adhesion to the surface by removing any grease and stains from the surface (Middleton 1876); and cleaning with *blanc d'Espagne* (possibly a whitewash), a product similarly advised to give a final polishing to the glass and increase paint adhesion (Molteni 1878). After the cleaning, other substances, such as weak solutions of gelatine in water, watercolour medium, solutions of sugar, and varnishes, could be used to coat the surface as a preparatory layer to enhance the glass transparency and the paints' adhesion (Hepworth 1889).

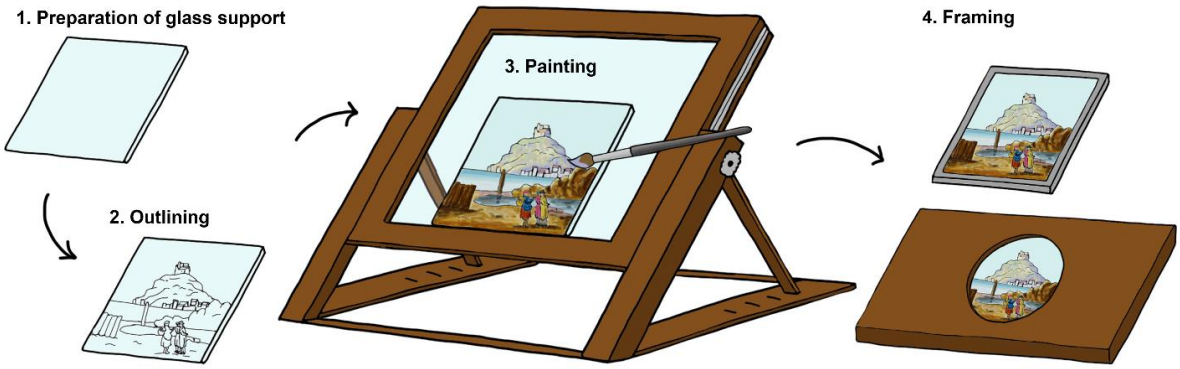


Figure 1.9 Main production stages of hand-painted magic lantern slides: (1) preparation of glass support, (2) outlining, (3) painting, and (4) framing. Drawings by the author.

After having the desired composition drawn on paper, the prepared glass was placed over a retouching desk (**Figure 1.9**) or an adapted easel for glass painting, with the drawing underneath, and the outlines or guidelines would be copied to the glass with a pencil, brush or lithographic pen with dark paint (*e.g.* brown and black), varnish colour, or watercolours matching the tone of each area depending on the desired effect (Hertel 1716; Groom 1855; M J Whipple & Co. 1856; Negretti & Zambra 1866; Middleton 1876; Chadwick 1886; 1878). Several options are presented regarding the outline: it could be done on the opposite side of the glass to keep the drawing steady during the painting process, and they would be rubbed off after the painting was completed (*e.g.* with a vinegar solution); they could be done on a different glass than the one on which the painting would be executed and, when finished, they would be attached with the paints facing inwards for protection; the outline could be done and receive the image directly over it; or be covered with a protective layer of varnish to assure it remained untouched during the colour's application (Hertel 1716; Groom 1855). If the glass slides were acquired already with the outlines printed, the process would start with the colour application (Chadwick 1878; 1886).

Regarding the painting method, it is advised to have a coloured illustration for reference. Most authors indicate that the background (*e.g.,* sky, clouds, and mountains) and distant elements should be painted first, using dimmed shades of colours, then the figures and finally, the details would be added with more concentrated colours (Groom 1855; M J Whipple & Co. 1856; Middleton 1876). In addition, the authors advised watercolours, oil, and varnish/spirit colours. According to Groom (1855), the first two were sometimes combined; watercolours created delicate and shiny effects, whereas the strength of the oils conferred intensity to certain parts of the painting that were intended to stand out. The figures would be painted with strong colours so these would remain visible when magnified under intense light (Urbino and Day 1873). After painting them, their surrounding background could be covered with opaque black oil paint or varnish paint to make them stand out, and needlepoints could be used to scratch details and write (Hertel 1716; Denecke 1757). The same scratching technique was used on slides covered in black paint to produce diagrams by drawing lines with sharp tools, giving the effect of white chalk on a blackboard (Negretti & Zambra 1866). Varnishes were applied at different stages, either between paint layers, mixed with the colourants, or as a final layer (Groom 1855). Some authors advise painting two slides simultaneously, alternating between them to give time for each layer to dry completely before applying the following layer of colour (Rintoul 1867). Others

advise using heat to fasten the drying process:

> *"When one coat of colour has been laid on, it should be quite dry before going over it with second tints; a gentle oven-heat answers well, observing that the heat be not so great as to blister the colours."*
>
> Negretti & Zambra (1866, 12)

> *"To facilitate the drying, heat may be applied, which is best done upon a small iron plate under which a gaslight or small Brunsen's burner is fixed."*
>
> Chadwick (1886, 116)

After the painting process was completed, another glass could be placed over the painted surface as an alternative to varnishing the painting or as an additional layer of protection. It is interesting to note that the limelight made such an impact due to its power as a projection light that, after its appearance in 1838, "artists who painted the slides predicted that their pictures would be ruined by such a light" (Chadwick 1878). A rim of glued/gummed paper was placed around the edge of the glass to keep this cover glass from touching the painting (Groom 1855; M J Whipple & Co. 1856). Furthermore, to prepare the glass to be safely handled and placed in the magic lantern to be projected, they would be framed using adhesive paper or wood with or without movement mechanisms (**Figure 1.9**) (Chadwick 1878). Some manufacturers employed papers with specific colours or patterns to characterise their ownership, and others marked the wooden frames with their company's information and logos (Schlosser 1980, 10).

To the extent of the author's understanding, these transparent paintings appear to descend from the stained-glass tradition, as implied by the reference to 17th-century or earlier slides painted with transparent low-fired enamels (Hertel 1716; Nollet 1770). As with stained glass, slides were observed in transparency, departing from reverse glass paintings that, even though use cold paints on glass, are opaque and were painted in reverse order (starting with details and finishing with the foreground) to be installed on walls (Fakuc 2007).

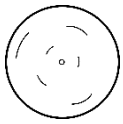
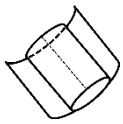
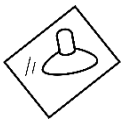
1.2.3 Materials advised

Glass support

The period of interest, from the mid-17th century to the end of the 19th century, has covered significant changes in the flat glass industry. Around half of the written sources consulted indicate preferred types of glass to make magic lantern slides with the desired quality, which appear to follow the developments in flat glass production (**Table 1.2**).

The earliest reference, by Hertel (1716), specifies thin 'discs' of pure glass, which can indicate the use of *crown* glass, one of the most predominantly used hand-blowing techniques to obtain transparent sheets of glass until the early 19th century, along with *broad* or *cylinder* glass. In a few words, the *crown* method created a circular panel or disc of glass by spinning an opened glass bubble in the pontil using centrifugal force and was greatly appreciated for its fire-finished surface (**Figure 1.10-A**) (Navarro 2003; Cable 2004). As the glass furthest away from the centre was flatter than the area surrounding the 'bullseye', it was probably the part used for the slides.

Table 1.2 Types of glass techniques advised by the written sources consulted for magic lantern slides.

Author	Date	Country	 *Crown*	 *Plate or Ground-Polished*	 *Broad or Cylinder*	 *Patent Plate*
Hertel	1716	Germany	●			
Denecke	1757	Germany		●		
Groom	1855	England	●	●	?	
Bielfeld	1855	England	●	●	?	
Whipple & Co.	1856	USA		●	?	
Negretti & Zambra	1866	England				●
'A Mere Phantom'	1874	England	●			●
Marcy	1877	USA		●		?
Hepworth	1889	USA		●		?
Underhill	1892	England				●

Note: (●) Identified by this term; (?) Not identified by this name but cannot be excluded. Drawings by the author.

On the other hand, the *cylinder* technique consisted of blowing a bubble and elongating it until a long cylinder was formed, which was then cut along its length, reheated, and opened into a sheet of glass, resulting in glass from 0.25 mm or less to 0.3 mm thickness (**Figure 1.10-B**) (Navarro 2003; Cable 2004). Often, these glass sheets have imperfections. For example, *crown* glass presented air bubbles with a concentric orientation and wavy surfaces, and the *cylinder* method resulted in glass with elongated bubbles, marks of flattening instruments, and rough surfaces (Navarro 2003).

Denecke (1757) refers to a glass that is poured, milled or rolled on tables and ground by glass manufacturers, suggesting the *plate* or *ground-polished* glass that should be homogeneous in thickness and with one smoother side (Hertel 1716; Denecke 1757). This flat glass production technique was developed in Saint-Gobain (France) at the end of the 17th century (ca. 1692) as a reinvention of the 1st-century AD Roman *cast (plate)* glass method, and it was produced by pouring and casting the molten glass from a special pot onto a flat polished metal table and passing a heavy metal roller on movable sidebars with the thickness of the intended glass plate (Navarro 2003; Cable 2004). This process resulted in a thick sheet of glass, which had to be ground and polished on both sides after annealing to reduce the thickness and remove the surface irregularities (Navarro 2003; Cable 2004; Dungworth 2011). Even though this technique produced high-quality flat glass, the long hand-polishing process made the *plate* glass more expensive than *crown* or *cylinder* glass (Dungworth 2011).

During the 19th century, both *crown* and *plate* glass were highly recommended. Groom (1855) and Bielfeld (1855) suggest both types of glass, and Groom adds that the flatted *crown* glass is suitable for common subjects, but the *plate* glass is better for refined executions. The latest is likewise mentioned by Whipple & Co (1856) as *plate* glass, by Marcy (1877) as *ground-polished* glass, and by Hepworth (1889) as a 'very finely-ground glass'. Hepworth (1889) emphasises that ground glass fine enough for making lantern slides, with no bubbles and other flaws, would be possibly difficult to find, and encourages the reader to grind and polish the glass themself, using

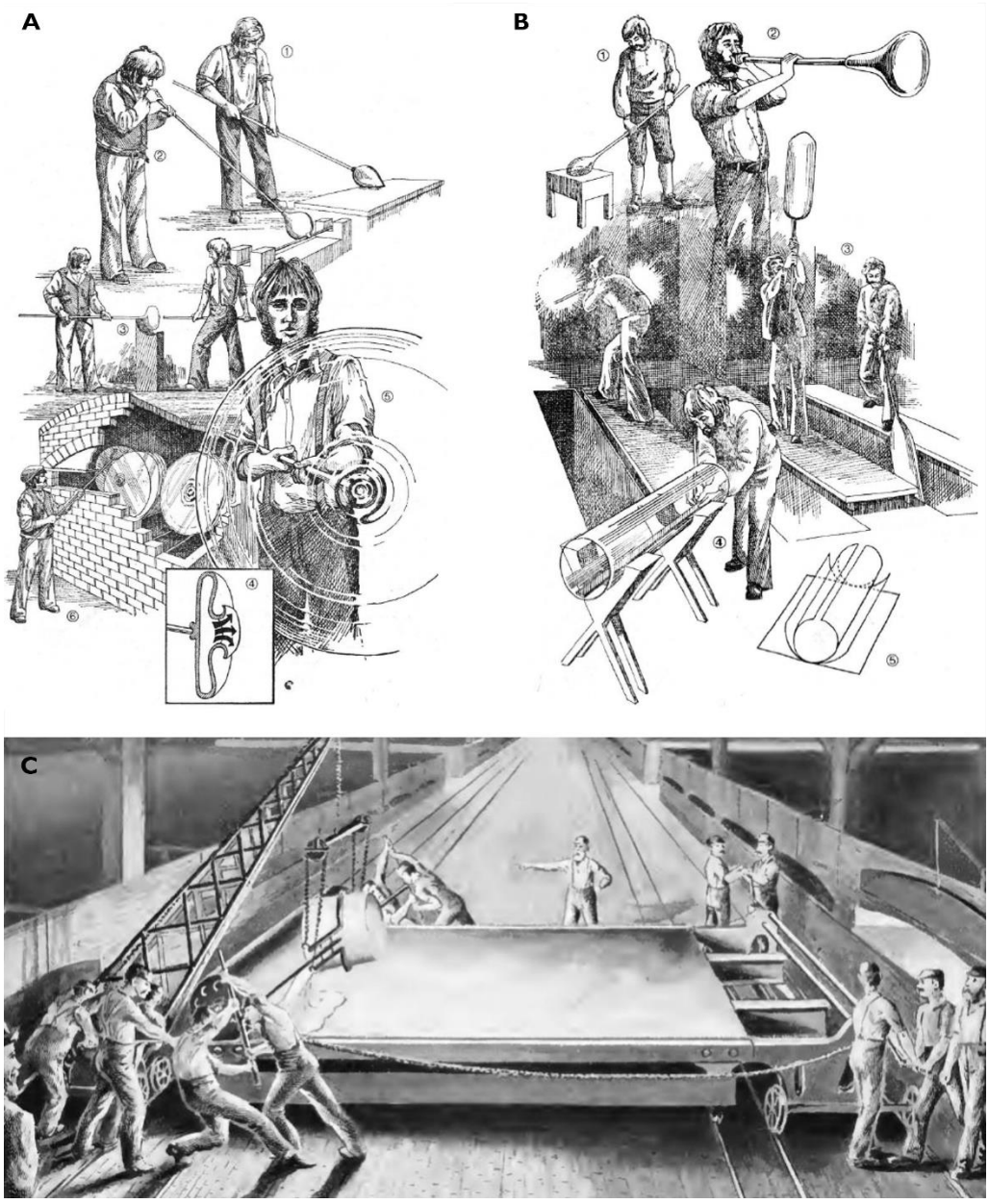


Figure 1.10 (A): *Crown glass* production technique. A bubble of glass is rolled onto a flat surface (1), blown (2), transferred to another pipe (3), opened, and flattened by spinning (4) resulting in a large disc (5), and annealed (6). © Dungworth (2011). (B): C*ylinder* or *broad* glass production technique. A bubble of glass is rolled onto a flat surface (1), blown (2), elongated to form a cylinder (3) which is then cut (4), open and flattened to form a large sheet (5) © Dungworth (2011). (C): *Cast plate* or *ground-polished plate* production technique. Representation of the first two steps where it is casted by pouring the molten glass onto a flat polished metal table and passing a heavy metal roller over the glass. After annealing in the chamber on the right of the image, the glass plate would then be ground polished on both sides. © Public Domain (Pittsburgh Plate Glass Co 1900).

flour and thin cream with water repeatedly until the glass is clear under transmitted light. Groom (1855) and Marcy (1877) also point out that the glass had a smooth and a rough side, explain how to distinguish them by drawing a fingernail over the surface, and indicate that the smoothest should be chosen to draw and paint to avoid irregularities. Although none of the authors explicitly mentioned *broad* or *cylinder* glass, after the improvements made from around the

1830s onwards, this production method gained strength; the resulting glass sheet tended to be rough on one or both sides, and when grinding and polishing processes were applied, it could similarly be referred to as *plate* glass (Cable 2008; Dungworth 2012; L. Brostoff et al. 2020). Considering this observation, the three references to *plate* glass from 1855 and 1856 could also point to the improved cylinder glass method.

In 1838, Chance patented a mechanised grinding method for *plate* glass (made with the *cylinder* technique) and improved the process by supporting the cold glass sheets on chamois leather, allowing the achievement of much thinner glass that became known as *patent plate* glass (Cable 2004; 2008). This type of glass was first mentioned by Negretti & Zambra (1866), and this technique was later suggested by 'A Mere Phantom' (1874), along with the *crown glass* (advised for most purposes) and by Underhill (1892). Given that *patent plate* glass became widely available in various thicknesses and qualities, Marcy (1877) and Hepworth (1889) could already be referring to this type of glass when mentioning *ground-polished* glass.

Insights into the glass composition are given mainly by earlier literature. The 18th-century authors Hertel (1716, 121), Denecke (1757, 265), and Nollet (1770, 3:345) advise the use of pure glass from France or Bohemia. Considering known compositions from that period and region, the authors could be indicating a potash-lime glass (*e.g.,* crystal or white/chalk glass) (Kunicki-Goldfinger et al. 2001). Chadwick (1886) states that the glass should not be 'too cold in tone', which may imply lower amounts of iron, an element responsible for giving green or blue-green tints to the glass, or other decolourising agents (Dungworth 2012).

Paints

The authors frequently listed the necessary painting materials, including various resinous and oil binding mediums and the best colourants for painting magic lantern glass slides, which can be consulted in **Table 1.3**.

Most authors mentioned using watercolours to paint on glass slides, given their brilliance and transparency, and their use goes from the beginning of the 18th century to the end of the 19th century. Several authors recommend mixing the watercolours with varnish before applying the paint; when watercolours were applied alone, it was frequently advised to coat the painting with a layer of clear varnish to protect it and prevent it from cracks when heated by the lantern (Groom 1855; Negretti & Zambra 1866; Middleton 1876). Gum water is only advised when watercolours are used or mixed with Indian ink (Middleton 1876).

> *The heat of a powerful limelight, such as would be used in a first-class exhibition, is considerable, and only varnish colours will stand the ordeal without detriment.*
>
> Scott (1891, 130)

Oil colours were usually not recommended during the 18th century. In his testimony, Hertel (1716) stated that he had tried to use oils but mentioned they would become dark and opaque in time, recommending using watercolours coated with varnish. The only source from the 18th century referring to the use of oil colours, the Portuguese manuscript, states they should be applied mixed with a thin varnish that should also be used to coat the painting at the end to give

Table 1.3 Binding medium components and colourants for painting magic lantern glass slides advised by written historical sources, chronologically distributed. §

Written Sources	1716 Hertel	1735 Wiedeburg	1757 Denecke	1770 Nollet	17-- Anon.	1855 Groom	1855 Bielfeld	1856 Whipple & Co.	1863 Winsor & Newton	1866 Negretti & Zambra	1867 Rintoul	1873 Urbino & Day	1874 "A Mere Phantom"	1876 Middleton	1877 Marcy	1878 Molteni	1886 Chadwick	1889 Hepworth	1892 Underhill	1893 "An Expert"	1896 Winsor & Newton
Resinous Binders																					
Gum Water	•		•											M	M				•		
Mastic Varnish	•	•	•	•		M	O			MT	•			•	•		•	•	•	•	
Sandarac Varnish	•	•	•	•												•		•			
Shellac/Lac Varnish				•		MT															
Copal Varnish				•			O					M?				•		•			•
Gum Anime				•																	
Varnish					MT		W	•	•				•		•	•					
(Japanners') Gold Size						M	O				•			•			•	•			•
Canada Balsam						•				•			•	•	•			•			•
Outside Varnish												•									
Opaque Black Varnish														•							
Water-colour Medium														M							
Megilp[1]																		•			•
Crystal Varnish																				•	
Solvents / Essences																					
Lavender Oil	•	•	•	•									•								
Spirits of Wine	•	•	•	•		•										•		•			
Turpentine	•	•				•	B	•		•	•	•	•	•	•	•	•	•	•	•	•
Ox-Gall						•	W		•	•			•	•		•	•	•			
Essence of Lemon										•											
Oil of Cloves															•						
Oils																					
Oil			•		•								•								
Boiled Oil					•															•	
[Pale] Drying Oil							O	•			•			•			•				
Almond Oil																				•	
Colourants																					
Carmine	W	W	W								BV		O	WV							O
Dragon's Blood	W	W																			
Florentine Lake	W	W	W																		
Pernambuco Wood			W																		
[Light/Thin] Red					O																
Crimson Lake						B	B		W		BV	O	O	WV	B		BV	B	W	O	O
Rose/Pink Madder Lake						B	O	•	W	W		O			B			B		O	O
Scarlet Lake							W			W	BV				B					O	
Madder Carmine								•													
Venetian Red											BV										
Alizarin Crimson																					O
Crimson Madder																					O
Geranium Lake																					O
Magenta																					O
Rembrandt's Madder																					O
Ruben's Madder																					O
Scarlet Madder																					O
Goma Guta/Gamboge	W	•	•		O	W	O		W	W	BV			WV					W		O
Saffron	W	•																			
[Berry Juice] Yellow			•																		
Yellow Lake					O		W	•				O			B		BV	B			O
Italian Pink						B	O		W				O		B			B		O	O
Gallstone						B			W												
Indian Yellow						B			W		BV			WV	B						O
Raw Sienna							O			W		O		WV				B	W		O

(continuation)

Written Sources	1716 Hertel	1735 Wiedeburg	1757 Denecke	1770 Nollet	17 -- Anon.	1855 Groom	1855 Bielfeld	1856 Whipple & Co.	1863 Winsor & Newton	1866 Negretti & Zambra	1867 Rintoul	1873 Urbino & Day	1874 "A Mere Phantom"	1876 Middleton	1877 Marcy	1878 Molteni	1886 Chadwick	1889 Hepworth	1892 Underhill	1893 "An Expert"	1896 Winsor & Newton
Aureolin									W												
Yellow Carmine																		B			O
Brown Pink																					O
Indigo	W	•	•			B			W		BV			?	B			B			O
Litmus	W	•																			
Ultramarine Blue	W	•			O																
Prussian Blue			•			B		•	W	W	BV		O	?	B		BV	B	W	O	O
Light Blue							W														
Chinese Blue							O														O
Payne's Gray																			W		
Verdigris	W		•		O					W											O
Green Lily			•																		
Light Green							W														
Dark Green							W														
Emerald Green												O									
French Veronese Green																					O
Olive Green																					O
Prussian Green																					O
Sap Green																					O
Viridian																					O
Mauve											BV										O
Purple lake															B					O	O
Purple Madder																		B			O
Violet Carmine																					O
Burnt Sienna						B	B	•	W	W	BV	O	O	WV	B		BV	B	W	O	O
Chinese Orange																		B			O
Raw Umber	W	•									BV			WV					W		
Brown from walnuts			•																		
Madder Brown						B		•	W	W					B			B			O
Vandyke Brown						B			W		BV	O		WV	B				W	O	O
Intense Brown							W														
Warm Brown							W														
Burnt Umber							O	•		W	BV			WV	B					O	
Asphalt								•		W											O
Sepia															B				W		
Bitumen																					O
Caledonian Brown																					O
Mummy																					O
Bone/Ivory Black	W	•	?		O						BV			WV				B		O	O
Lamp Black				V	O	B			W	W	BV	O		WV	B				W		O
Opaque Black					O		B														
Transparent Black							?										BV				
(Opaque) Blue-Black								•													
Neutral Tint																		B			O
Other Materials																					
Indian-Ink							W							L	•	L					
Prout's Brown Ink									L												
Sugar of Lead															D						•

§ Various historical material terms listed are ambiguous and possibly redundant, limiting their correspondence to specific materials (e.g., varnish and oil).

[1] A mixture of Mastic Varnish (Mastic resin dissolved in Turpentine) with Pale Drying Oil (Carlyle 2001).

Notes: (•) not specified; (M) mixed with colours; (T) applied on top; (W) watercolour; (O) oil colour; (B) both W and O; (V) varnish colour; (L) outlines; (D) drier; (?) possibly referred.

transparency and adhesion to the glass ('Distribuiçam Das Partes Da Lanterna Magica' 17--). Nevertheless, the 19th century was a period of changes in the production of painting materials, with alchemy giving place to chemistry and the discovery of new elements that triggered the development of different compounds and colourants (Harley 2001). Due to this period's significant improvements, new oil colours suitable for transparent glass painting were produced and started being advised in the second half of the 19th century by almost all authors (Bielfeld 1855; Groom 1855; M J Whipple & Co. 1856; Rintoul 1867; Urbino and Day 1873; 'A Mere Phantom' 1874; Marcy 1877; Molteni 1878; Chadwick 1878; 1886; Hepworth 1889; 'An Expert' [W. C. Hughes] 1893; Winsor & Newton 1896).

Besides being added to oil colours, oils were also used along with varnishes. More expressively than what is observed with the colourants, many authors mentioned using a varnish without attributing a name that could identify them. Nevertheless, it is possible to ascertain that the most used varnish throughout both centuries was by far the mastic varnish diluted with turpentine, which was also the most listed solvent, and/or with spirits of wine (alcohol), a varnish frequently used along with oil colours (Groom 1855; Urbino and Day 1873; Marcy 1877). Japanners' Gold Size, characterised as an oil-gum varnish, and Canada balsam are also much advised, followed by copal and sandarac varnishes. The latter, along with shellac varnish, appear to have been replaced during the 19th century.

Regarding solvents and essences, apart from turpentine, spirits of wine and ox-gall were often recommended in the 19th century. In opposition, lavender oil appears to have entered disuse during this period. Besides solvents and essences, oils were added to the varnishes, not only when oil colours were used but also with watercolours to improve the handling properties.

As mentioned, varnishes could be used as a preparation layer, applied between layers of colour, mixed with watercolours and oil colours, or on top of the painting. The intention was to enhance the colours' intensity and transparency, improve the paints' adhesion to the glass and protect the painting from, for example, cleaning, impacts, abrasion, and high temperature during the projections ('Distribuiçam Das Partes Da Lanterna Magica' 17--; Groom 1855; Frutos 2013). Varnish colours were first advised at the end of the 18th century by Nollet (1770). These were prepared by grinding the powder pigments with varnish (*e.g.* mastic or Canada balsam with turpentine), and during the 19th century, these colours were being sold already prepared. Besides being also mentioned by Rintoul (1867), Middleton (1876), Chadwick (1878; 1886) and Molteni (1878), most authors that suggested the oil colours advised mixing them with varnishes before applying the paint, which would give similar results in terms of transparency, adhesion, and shine, and would also accelerate the paints' drying time ('Distribuiçam Das Partes Da Lanterna Magica' 17--; Groom 1855; Bielfeld 1855; M J Whipple & Co. 1856; Rintoul 1867; Urbino and Day 1873; Middleton 1876; Marcy 1877; Molteni 1878; Chadwick 1878; 1886). The drying time of the oil paints was undoubtedly an issue they tried to overcome. Rintoul (1867) advised painting two slides simultaneously, alternating between layers of paint to allow them to dry before adding the next layer. Also, Chadwick (1878), who indicated all three types of paints were suitable, affirmed that watercolours were easy for amateurs to paint since less time was required for them to dry. Marcy (1877) also mentions that the sugar of lead could be added to the paints and the mastic varnish diluted with turpentine.

Several 19th-century authors indicated that both watercolours and oil colours should be obtained in tubes, and certain preferred Winsor & Newton's, one of the leading artists' colourmen worldwide by then (Groom 1855; M J Whipple & Co. 1856; Urbino and Day 1873; Hepworth 1889).

Regarding the colourants listed by the authors, summarised in **Table 1.3**, it is noteworthy that the number is limited comparing to those available due to the importance of transparency (Groom 1855). The majority are primary colours (yellows, pinks/reds, and blues), and the authors frequently mentioned that these should be mixed to produce the rest of the necessary hues ('A Mere Phantom' 1874). Furthermore, some authors only mentioned the type of paints and binding mediums that should be used and did not specify the colourants; additionally, others did not list some of the colourants with an identifiable term (*e.g.,* yellow lake, light blue and dark green), which increases the difficulty in ascertaining a trend in the choice of colourants over time.

In general, most of the colourants used were organic and transparent, and there was some consistency in the colour choice since the authors frequently referred to the same colourants. Regarding red and pink hues, cochineal lakes were by far the most mentioned and appeared to have been used throughout both centuries under the names of Carmine and Crimson Lake, followed by Rose or Pink Madder Lake. Various yellows were frequently advised; however, gamboge was the most listed, followed by Italian pink, an unidentified yellow lake, raw sienna and Indian yellow. Additionally, the 'yellow from berry juice' mentioned by Denecke (1757) may be related to Italian pink since this colourant was also extracted from berries. Blue colourants were the most consistent since mainly indigo and Prussian blue were preferred, the latter being the most used after it became available to artists (ca. 1724) (Coles 2018). Greens and purples were scarcely mentioned and, as stated by the authors, were frequently obtained by mixing primary colours (Groom 1855; M J Whipple & Co. 1856; Rintoul 1867; Frutos 2013). Nevertheless, the green Verdigris was mostly advised in the first half of the 19th century, and the purple lake was only in the second half. Burnt sienna was repeatedly advised as a valuable orange to be used by itself and to mix with other colourants. Nevertheless, since it is a semi-transparent colourant, authors often mention mixing a yellow lake with a red/pink colourant (Bielfeld 1855; M J Whipple & Co. 1856). Finally, various browns were listed, from lakes to earth pigments, Vandyke brown, madder brown, and burnt umber being the most common. Finally, as black colourants, lamp black, followed by bone/ivory black, were, without a doubt, the most frequently used.

Over time, changes in the colour palette can be perceived. The variety of advised colourants increased considerably from the mid-19th century onwards. Through Winsor & Newton's *Trade Catalogue* from the end of the century, it became clear that the advances in the pigment manufacturing industry continued to allow the development of new transparent colourants (Winsor & Newton 1896). A few colourants notably stopped being listed in this century, which was the case of the reds dragon's blood (a resinous colourant), Florentine Lake (a cochineal-based lake), and Pernambuco wood (known as brazilwood), the yellows saffron, gallstone and aureolin, the bluish-violet litmus and ultramarine blue, and the 'green lily' (that could mean green earth). It was interesting to notice that, in the 19th century, fewer green colourants were listed, increasing the references to mixtures to produce greens, and the opposite occurred with purples since more options became available (M J Whipple & Co. 1856). It should be noted that no white colourants

were listed since this was achieved by the absence of paint that allowed the light to pass through the glass (Groom 1855; Bielfeld 1855; M J Whipple & Co. 1856; Negretti & Zambra 1866). For background masks, opaque blacks were advised, and these, along with inks, were also indicated for outlines (Bielfeld 1855; M J Whipple & Co. 1856; Rintoul 1867).

1.3 Chapter conclusion

The magic lantern instrument and projection light sources evolved from the 17th to the 20th century. The purpose of its use influenced the choice of model and size of both magic lantern and glass slides, as well as the illumination system. In addition, the light source appears to have strongly influenced how slides were painted not only in terms of materials but also of colour temperature (as images intended to be projected with oil or electrical light were colder in tone to balance the warm light colour, in the same way as images for limelight projection were painted in warmer tones so it would balance the colder shade of this light).

Concerning the production of magic lantern glass slides entirely hand-painted and hand-coloured printed outlines, 22 written sources from 18th- and 19th-century Europe and the United States of America were found to have instructions on producing them. A significant part belonged to the 19th century, which coincided with the period when the magic lantern achieved higher popularity, and the demand for magic lantern slides considerably increased. It was possible to observe a tendency to transition the information on the production of slides from broad scientific treatises to specialised books over time.

The slides' production processes drastically changed from the mid-17th to the 18th century with the apparent transition from *fired paints* (*e.g.,* enamels) to *cold paints* (watercolours, oil colours and varnish colours) and from the 18th to the 19th century, it evolved with the development of the glass industry and painting materials manufacture during the Industrial Revolution. The quality of the glass and increased palette with refined transparent colourants and binding mediums allowed the production of slides with much higher quality that continued to amaze the public until our days.

Regarding the glass support, the importance of choosing the thinnest and most transparent glass sheets without imperfections became clear. This glass was mainly produced by the *crown*, *plate* or *ground-polished*, and later, the *patent plate* method. The macroscopic characteristics of the slides' chosen glass can help in attributions when allied with analytical methods since certain flat glass production centres used specific techniques and chemical compositions that changed over time. Since only a few sources indicated possible compositions, further research should be undertaken to uncover if slide manufacturers valued particular glass compositions. Changes in composition often depend on the manufacturing country; in this way, with a compositional references database, it can be possible to find correlations between chemical composition and production technique to attribute the glass support to a particular time and place, which can be crucial to pinpoint painted slides from unknown producers and further our knowledge regarding the magic lantern slides' manufacturers and their evolution over time.

Painting methods did not considerably change between authors, given that the variations observed appear to be mainly related to the image's composition and the choice of colourants and binding mediums. Watercolours mixed or protected with varnishes were the binding mediums preferred in the eighteenth century, and the nineteenth century saw increased references to oil colours. A list of around 70 transparent and semi-transparent colours was identified in historical literature. Even though some authors explained the painting processes in

a high degree of detail, it became clear that slide production was a specialised practice that required skills that were by no means easy for amateurs to master.

Identifying the materials and techniques applied to these slides contributes to their understanding and appreciation. Furthermore, the choice of painting materials, the use of heat during the painting process, the projection light source and the time of exposure have significant implications for the long-term preservation of these objects. In-depth knowledge of hand-painted slide production will aid the understanding of degradation mechanisms that lead to the conservation problems observed in these objects and help the development of better conservation practices (preventive, remedial and restoration).



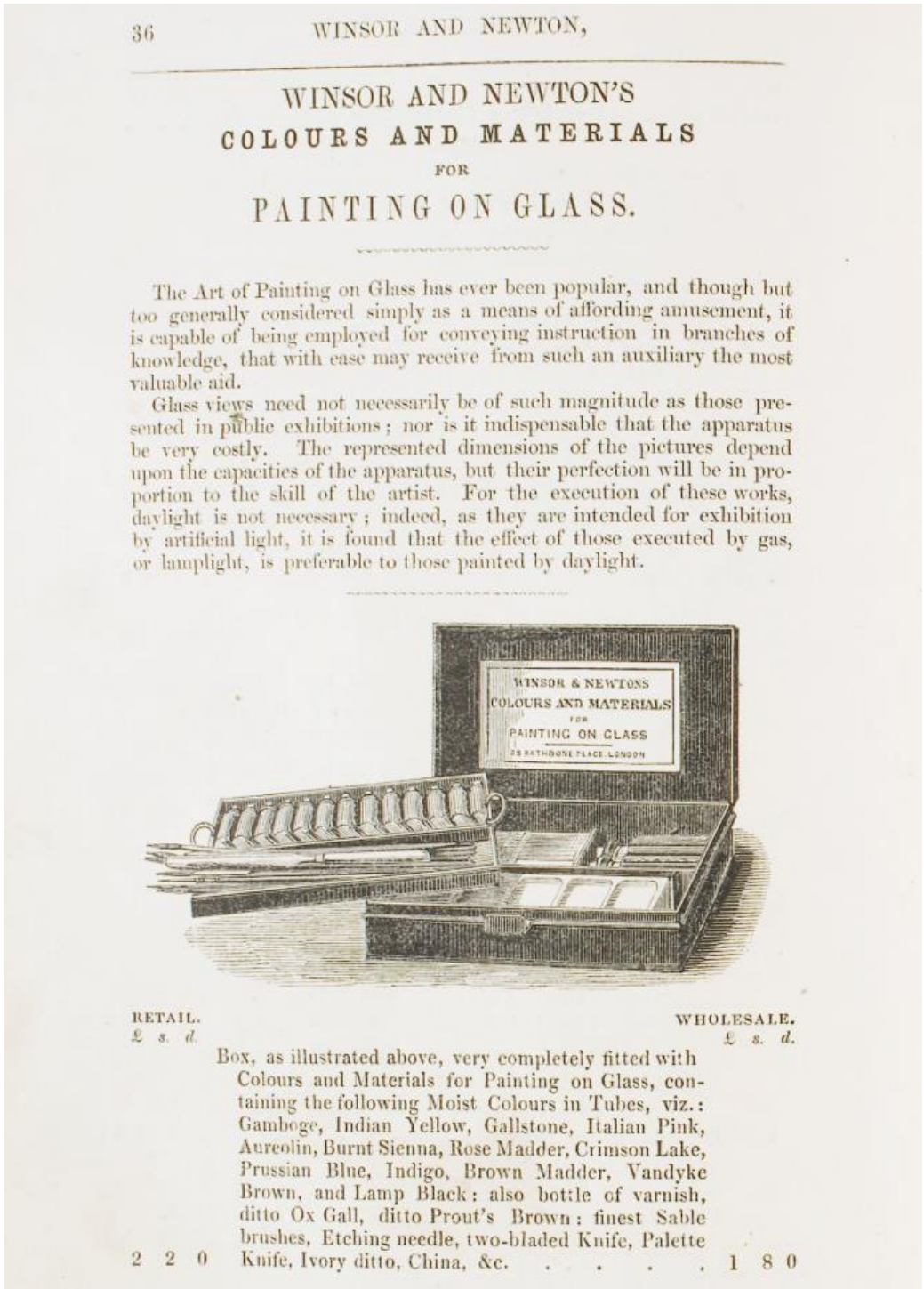
2

WINSOR & NEWTON'S WATERCOLOURS FOR MAGIC LANTERN GLASS PAINTING

> *The best colours for this purpose are WINSOR & NEWTON's, in Tubes.* […] *Particular attention is called to the great excellence of both the OIL AND WATER COLOURS of that house, which, for brilliancy, purity and permanence, are unrivalled.*
>
> Whipple & Co. (1856, 5–8)

The Winsor and Newton (W&N), founded in London in 1832 by William Winsor and Henry Charles Newton, was one of the leading artists' colourmen worldwide throughout the 19th century (Pavey and Staples 1984). One of the most significant improvements of the 19th century to the art of painting in watercolours, and consequently to the painting on glass slides, was the introduction of *moist colours* in 1835 through the addition of glycerine instead of honey, achieved by this company (Harley 1975; Pavey and Staples 1984).

The review focused on the production of painted magic lantern glass slides presented in the previous chapter, unveiled *The Art of Transparent Painting on Glass* by Groom (1855), published by W&N, as one of the most detailed instructional books on this art. In this source, the author lists the colours - gamboge, Indian yellow, gallstone, Italian pink, burnt sienna, madder lake, crimson lake, Prussian blue, indigo, madder brown, Vandyke brown, and lamp black - and gives preference to the use of watercolours in tubes by virtue of their "brilliancy and effect" (Groom 1855, 37–39). However, he also mentions their use as oil colours in tubes, except for gamboge (Groom 1855, 37). A few years later, a box with W&N moist watercolours in tubes and materials dedicated to painting on glass, shown in their 1863 Retail and Trade catalogues, became available for the first time. The description of the watercolours' use in **Figure 2.1** suggests that they were primarily intended for painting glass slides for magic lanterns, as "The represented dimensions of the picture depend on the capacities of the apparatus (…)" and "they are intended for exhibition by artificial light (...)". In 1896, another box, this time of "transparent oil colours for colouring magic lantern slides", was released (**Figure 2.2**), emphasising the prominence of the glass slides market at the time and W&N's continuous dedication to producing materials for this art until the end of the century (Winsor & Newton 1863; Vilarigues and Otero 2020).



36 WINSOR AND NEWTON,

WINSOR AND NEWTON'S
COLOURS AND MATERIALS
FOR
PAINTING ON GLASS.

The Art of Painting on Glass has ever been popular, and though but too generally considered simply as a means of affording amusement, it is capable of being employed for conveying instruction in branches of knowledge, that with ease may receive from such an auxiliary the most valuable aid.

Glass views need not necessarily be of such magnitude as those presented in public exhibitions; nor is it indispensable that the apparatus be very costly. The represented dimensions of the pictures depend upon the capacities of the apparatus, but their perfection will be in proportion to the skill of the artist. For the execution of these works, daylight is not necessary; indeed, as they are intended for exhibition by artificial light, it is found that the effect of those executed by gas, or lamplight, is preferable to those painted by daylight.

RETAIL. £ s. d.		WHOLESALE. £ s. d.
2 2 0	Box, as illustrated above, very completely fitted with Colours and Materials for Painting on Glass, containing the following Moist Colours in Tubes, viz.: Gamboge, Indian Yellow, Gallstone, Italian Pink, Aureolin, Burnt Sienna, Rose Madder, Crimson Lake, Prussian Blue, Indigo, Brown Madder, Vandyke Brown, and Lamp Black: also bottle of varnish, ditto Ox Gall, ditto Prout's Brown: finest Sable brushes, Etching needle, two-bladed Knife, Palette Knife, Ivory ditto, China, &c.	1 8 0

Figure 2.1 Page 36 of the *Winsor & Newton's Trade Catalogue* (1863) dedicated to the release of their first box of 'Winsor & Newton's Colours and Materials for Painting on Glass' with moist watercolours and other painting materials, suggesting that it was to paint magic lantern slides. Digital image available in the *W&N 19th-Century Archive Database*, ©Winsor & Newton (ColArt Fine Art & Graphics Ltd.).

W&N's moist watercolours were recommended for magic lantern glass painting by importers and dealers of artists' supplies, such as M. J. Whipple & Co (Boston). In their publications *Directions for the Graduations and Mixture of Colors, to which are added Directions for Transparent Painting on Glass* (1856) and *Illustrated Catalogue of Artists Materials* (c.1860), W&N's watercolours in tubes are referred to as the best for transparent painting on glass and their



88 WINSOR & NEWTON, Limited,

WINSOR AND NEWTON'S

TRANSPARENT OIL COLOURS

FOR COLOURING MAGIC LANTERN SLIDES, etc.,

IN TUBES.

Trade, 3s. per dozen. Retail, 4d. each.

Asphaltum	Gamboge	Mauve No. 2	Purple Lake
Bitumen	Indian Lake	Megilp	Raw Sienna
Brown Pink	Indigo	Mummy	Sap Green
Burnt Sienna	Italian Pink	Neutral Tint	Sugar of Lead
Caledonian Brown	Ivory Black	Olive Green	Vandyke Brown
Cassel Earth	Lamp Black	Olive Lake	Verdigris
Chinese Blue	Magenta	Prussian Blue	Yellow Lake
Crimson Lake	Mauve	Prussian Green	

Trade, 4s. per dozen. Retail, 6d. each.

Alizn. Crimson	Burnt Lake	Geranium Lake	Rubens' Madder
Brown Madder	Chinese Orange	Rembrandt's Madder	

Trade, 8s. per dozen. Retail, 1s. each.

Carmine No. 2	Pink Madder	Scarlet Madder
French Veronese Green	Purple Madder	Transparent Oxide of Chromium
Madder Lake	Rose Madder	Viridian

Trade, 12s. per dozen. Retail, 1s. 6d. each.

Burnt Carmine	Crimson Madder	Violet Carmine
Carmine	Madder Carmine	Yellow Carmine

OIL COLOUR MEDIUMS.

FOR MAGIC LANTERN SLIDES.

	Trade. 1oz. bottles. Per doz. s.	d.	2oz. round bottles. Per doz. s.	d.
Canada Balsam	4	0	8	0
Copal Varnish	4	0	8	0
Japan Gold Size	2	8	5	4
Spirits of Turpentine	2	0	3	4

Bottles of above to fit the Lantern Boxes, No. 1, Trade, 2s. 0d. per dozen; Retail, 3d. each. No. 2, Trade, 2s. 8d. per dozen; Retail, 4d. each.

Figure 2.2 Page 88 of the *Winsor & Newton's Trade Catalogue* (1896) dedicated to the presenting their sets of 'Transparent Oil Colours for Colouring Magic Lantern Slides' and 'Oil Colour Mediums for Magic Lantern Slides'. Digital image available in the *W&N 19th-Century Archive Database*, ©Winsor & Newton (ColArt Fine Art & Graphics Ltd.).

excellence in brilliance, purity, and permanence is emphasised. Following these findings, this chapter investigates the W&N 19th-century manufacture of watercolours for the first time to provide a better understanding of the complexity of materials used to paint magic lantern slides, advancing knowledge for the future production of historically accurate reconstructions to study their deterioration mechanisms.

2.1 Exploring Winsor & Newton 19th-Century Archive Database

The *W&N 19th-Century Archive Database* comprises digitised page-images of 85 manuscript books (MS) from 1834 to 1893 and a digital collection of 47 W&N trade and retail catalogues from 1835 to 1900[1] (Clarke and Carlyle 2005). It is considered one of the most remarkable and comprehensive historical archives of paint manufacturing processes available to researchers. Recently, its unique value as a primary documentary source of information on the philosophy and practices of this renowned artists' colourmen has been explored (amongst others: Woodcock 1995; Clarke 2008, 80; Carlyle et al. 2011; Otero 2018, 27).

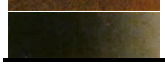
Of the 85 manuscripts, 20 primarily concern the manufacture of watercolours, corresponding to approximately 40 % of the database records, highlighting the high degree of production and pattern of experimentation invested by W&N in manufacturing watercolours. The records include process descriptions of watercolour formulations, usually dated, for cakes (32 %), moist for pans or tubes (24 %), and preparation of moist for tubes (25 %), and notes about the process and/or the quality of specific batches.

The number of database records regarding the pigment and the watercolour manufacture of the colours listed for painting on glass by Groom (1855) and in W&N's *Retail* and *Trade Catalogue* from 1863 may be consulted in **Table 2.1**.

Gamboge, crimson lake, and Prussian blue (highlighted in **Table 2.1**) were the colours selected to undertake this preliminary study of the W&N 19th-century manufacture of watercolours, as they were revealed to be the most recommended primary colours for magic lantern glass painting by 19th-century literature (*Subsection 1.2.3, Materials advised*), and positively identified in historical hand-painted glass slides (*Subsection 4.3, Magic paintings' molecular palette*).

[1] The *Winsor & Newton 19th-Century Archive Database* was designed by Leslie Carlyle and Mark Clarke. It was part of a Pilot Project within the *De Mayerne* programme (2002–2006) funded by the Nederlandse Organisatie voor Wettenschappelijk Onderzoek (NWO) from 2003 to 2005. The Database resulting from the Pilot Project named the Researcher's Edition was hosted in five locations: in the Netherlands, the Rijksbureau voor Kunsthistorische Documentatie (RKD); in the UK, The Hamilton Kerr Institute, University of Cambridge; The Conservation and Technology Department, Courtauld Institute of Art, University of London; and in Portugal, the Department of Conservation and Restoration, Faculty of Sciences and Technology, NOVA University of Lisbon. To the extent of the author knowledge, the only database currently functioning is the one hosted in Portugal. It was further developed at The Hamilton Kerr Institute (2006–2008) with the support of the Arts and Humanities Research Council (AHRC) through a Resource Enhancement Grant (Clarke and Carlyle 2005; Carlyle et al. 2011).

Table 2.1 Records from the W&N Database of the colours listed by Groom in *The Art of Transparent Painting on Glass* (1855) and W&N's Trade and Retail Catalogues from 1863 (database codes: 1863T, 1863R).

Appearance on paper [a]	Colours [b]	Pigment records [c]		Watercolour records [d]	
		Available	Inferred date	Available	Inferred date
	Aureolin	3	1862-82	43	1861-91
	Gallstone	0	-	24	1839-79
	Gamboge	25	1834-82	115	1834-90
	Indian Yellow	28	1833-73	114	1834-90
	Italian Pink	89	1837-82	58	1835-90
	Crimson Lake	243	1834-82	199	1839-89
	Madder Lake	36	1834-93	15	1836-82
	Rose Madder	53	1834-82	166	1835-90
	Indigo	15	1834-74	114	1838-90
	Prussian Blue	12	1834-93	137	1836-91
	Burnt Sienna	23	1834-93	134	1835-89
	Madder Brown / Brown Madder	79	1834-93	142	1838-90
	Vandyke Brown	14	1848-73	117	1839-90
	Lamp Black	6	1834-78	93	1838-89

[a] The colours presented are from charts of watercolours painted on paper from the *Specimen Tints of Winsor & Newton's Artists' Oil and Water Colours* (1882) held at the British Library, except for Gallstone, which is a suggestion based on other references from this pigment.

[b] The colours Aureolin, Rose Madder and Brown Madder are only listed in the W&N catalogues. Madder Lake and Madder Brown only appear in Groom (1855).

[c] Database search method: field "recipe name original" filled with the colour name, and "topics" with "pigment manufacture".

[d] Database search method: field "recipe name original" filled with the colour name, and "topics" with watercolour".

2.2 W&N 19th-century production of moist watercolours

Winsor & Newton introduced the world's first moist watercolours in their 1835's *Wholesale and Retail Catalogue*. As this catalogue states, instead of dipping a colour cake in water to dissolve it, the artists could now use the colours directly from the pans, as they "*always retain their moist state, so that the application of the smallest quantity of water brings of the colour*" (Pavey and Staples 1984, 24). This innovation consisted of adding glycerine instead of honey, allowing the colours to be easily rewetted, making them perfect for outdoor painting (Harley 1975). Moist watercolours, initially sold in porcelain pans, were also launched in collapsible metal tubes in 1846, following the example of oil tube colours (invented in 1841) (Carlyle 2001, 52; Barker 2004).

This preliminary research on the 19th-century production of W&N watercolours suited for transparent painting on glass focused on two manuscript books mainly dedicated to moist watercolour recipes, bearing the database codes *C1* and *M2*. These were selected due to their high volume of database records, 770 and 766, respectively, and their inferred date of ca. 1856 and ca.1872. These manuscripts cover the time between the publication of Groom's book (1855) and ten years after the release of the W&N *Catalogue* in 1863. Notably, the author of *C1* was Arthur Henry Newton, son of Henry Charles Newton, one of the founders of W&N.

Research on both manuscript books resulted in 59 production records [2] on the manufacture of moist watercolours of the selected colours: 14 for gamboge, 30 for crimson lake and 15 for Prussian blue. These production records correspond to a reduced number of recipes, namely four for gamboge, nine for crimson lake, and four for Prussian blue, further detailed below. According to these, the production process generally starts with grinding the pigment before mixing it with water, a binder solution, glycerine, and other additives. After being carefully homogenised, the paint was left to settle over a stone plate before being transferred to pots. To produce the moist watercolours in tubes, the type recommended for magic lantern glass painting by Groom (1855), W&N added more water to the moist watercolours before transferring them to the tubes to reduce the paint viscosity.

2.2.1 Moist watercolours: ingredients and recipes

The ingredients used in the W&N production records are frequently registered in the form of abbreviations, and their meaning is not always intuitive. As Clarke (2009) states, most of them were used by the manufacturer, possibly for convenience but also for maintaining some degree of confidentiality. A list of the W&N abbreviations, from original to modern terminology, of the ingredients used in the moist watercolours' recipes for gamboge, crimson lake and Prussian blue, identified in manuscript books *C1* and *M2*, is presented in **Table 2.2**.

[2] For clarity, a distinction has been made in this research between the terms database record and production record. A database record refers to data originated from the *Database*, whereas production records are manufacturing data from the actual W&N archive.

Table 2.2 W&N abbreviations, from original to modern terminology of the ingredients used in the moist watercolours of Gamboge, Crimson Lake and Prussian Blue, found in MS *C1* and *M2*.

W&N Original Name	Interpreted Name	Notes on the composition	Authority*
AcAc	Acetic Acid	-	URC 7PF05L01
Alb (Fluid)	Fluid Albumen	-	URC P4P132L01
Aq	Water	-	URC 7PF05L01
AR	Arrowroot	-	URC P1P112AL15
CP	Citrate Potash	Aqueous solution of potassium citrate with glycerine	URC X3P345L15
Cu PGA	Curdled Plain Gum Arabic	Aqueous solution of Gum Arabic with Fluid Albumen	URC C1P135L01
Cu PGS	Curdled Plain Gum Senegal	Aqueous solution of Gum Senegal with Fluid Albumen	URC P4P132L01
GL; GL (Pale) [a]	Glycerine, Pale Glycerine	-	URC P1P112AL15
GSI	Gum Senegal Isinglass	Aqueous solution of Gum Senegal with Isinglass	URC C1P783AL11
IsG	Isinglass	-	URC C1P783AL11
Jell GL	Jellied Glycerine	Glycerine heated with Arrowroot	URC P1P112AL15
Mst Comp[b], Transparent Mst Comp, TMC	Transparent Moist Composition	Aqueous solution of magnesium acetate	URC X6P514L01
Mur: Ammo; Sal Ammo	Muriate of Ammonium	Ammonium Chloride	URC P8P013AL01
Myrbane; Nitro-benzole	Mirbane	Nitrobenzene	URC M2P303B
OG	Ox Gall	-	URC 7PF05L01
PGA	Plain Gum Arabic	Aqueous solution of Gum Arabic	URC P4P131L15
PGS	Plain Gum Senegal	Aqueous solution of Gum Senegal	URC P4P131L01
Sol: Mur: Barytes	Solution of Muriate of Barytes	Aqueous solution of Barium Chloride	URC 3PP353L01
St Paste	Starch Paste	-	URC 7PF05L01
Thick OG	Thick Ox Gall	Boiled Ox Gall	URC A1P041L01
ΔL, Pure Spirits Wine	Alcohol	-	URC 7PF05L01

* Some abbreviations present in the recipes can be found in a database record identified with the Unique Recipe Code (URC) 7PF05L01.

[a] No recipes were found for Pale Glycerine in the database; it is assumed that the terms Pale Glycerine and Glycerine are synonyms.

[b] The term Mst Comp. was found in recipes for moist gamboge watercolours before ca.1854; from then on, the term used was Transparent Mst Comp.

Gamboge

As shown in Table 2.3, four different recipes for Gamboge moist watercolours were found. The colourant used in these recipes was gamboge, a yellow resinous gum usually extracted from *Garcinia* evergreen trees that grow in Southeast Asia (Harley 2001, 105–7). According to W&N production records from ca.1850, the natural brownish resin would be dissolved in alcohol and added to a solution of water and ammonia to precipitate in the form of yellow colour (URC 15P026).

Besides the colourant, the most common ingredients used to produce gamboge moist watercolours were water, glycerine, and magnesium acetate previously dissolved in water. It should be noted that none of the recipes calls for a binder. Given its resinous properties, gamboge functioned both as a pigment and a binder. The ingredients listed above are the exact components of the most representative recipe found, *G1*, with 10 out of 14 production records. The addition of water allowed for the easier dissolution/dispersion of all ingredients. Glycerine was probably

used as a moistening and plasticising agent, allowing the paint to stay wet for longer periods of time, be easily rewetted, and prevent cracking (Gettens and Stout 1966; Ormsby et al. 2005). The solution of magnesium acetate was considered "*the antidote to mouldiness*" (URC C1P044L01), as it can inhibit mould growth (Kycia et al. 2017). Almost all the recipes also contained acetic acid. In this case, it appears to have been added to prevent the alkaline action of the magnesium acetate solution by keeping the preparation somewhat acidic, as stated by W&N in the *M2* book (URC M2P242B).

Given the reduced number of production records and quantity of the ingredients used, *G2* and *G3* appear to be experimental recipes. In recipe *G3*, alcohol and ox gall were added in addition to the most common ingredients. These ingredients are frequently used as wetting agents. According to the commentary accompanying some recipes (URC C1P184 and M2P303B), alcohol was added to give richness to the solution and to prevent mouldiness. Although a small quantity was used, W&N noted that it turned the paint slightly greasy. Ox gall was added to counteract this effect since it works as a wetting agent that improves the flow of the watercolour by decreasing the surface tension and preventing the pigment agglomeration (Ormsby et al. 2005, 48). In recipe *G4*, W&N states that the oily ingredient nitrobenzene was added in an attempt to prevent the stored colour from becoming stained over time (URC M2P265B). Since it would also prevent mouldiness, they noted that when nitrobenzene was used, alcohol would not be required (URC M2P303B).

Table 2.3 W&N recipes for Gamboge moist watercolours found in MS *C1* and *M2*. The meaning of the abbreviations is given in Table 2.1.

Code	Production Records	Manufacturing Process			
		Colourant	Solvent	Glycerine	Other Additives
G1	10	Gamboge	Aq	GL	Transp. Mst Comp, AcAc
G2	2	Gamboge	Aq	GL	Transp. Mst Comp
G3	1	Gamboge	Aq	GL	Transp. Mst Comp, AcAc, ΔL, OG
G4	1	Gamboge	Aq	GL	Transp. Mst Comp, AcAc, Myrbane

Note: The ingredients' proportions are variable within the same recipe.

Crimson lake

Nine moist watercolour recipes were identified for Crimson Lake (**Table 2.4**). In general, these recipes had two main stages of preparation. First, the colourant[3] was mixed with potassium citrate dissolved in water and finely ground. An aqueous solution of gum Senegal would be

[3] For details on the manufacture of this specific colourant, please refer to the work by Vitorino *et al.* (2017).

added to this mixture (usually with thickening agents) and, after being adequately homogenised, left to dry on cold stones. The second step usually consisted of adding more potassium citrate solution together with a binder solution, acetic acid, and glycerine, which was again left to dry on cold stones to be subsequently stored.

Table 2.4 W&N recipes for Crimson Lake moist watercolours found in MS *C1* and *M2*. The meaning of the abbreviations is given in Table 2.1.

Code	Production Records	Manufacturing Recipes								
		Colourant	Solvent	Binder			Glycerine		Other Additives	
CL1	16	Crimson Lake	Aq	PGS	IsG		GL		CP	AcAc
CL2	2	Crimson Lake	Aq	PGS			GL		CP	AcAc
CL3	3	Crimson Lake	Aq	PGS		St Paste	GL		CP	AcAc	OG
CL4	2	Crimson Lake	Aq	PGS	Alb	St Paste	GL		CP	AcAc
CL5	1	Crimson Lake	Aq	PGS			GL	AR	CP	AcAc
CL6	1	Crimson Lake	Aq	PGS	IsG		GL		CP	
CL7	1	Crimson Lake	Aq	PGS	IsG	St Paste	GL		CP	AcAc
CL8	1	Crimson Lake	Aq	PGS	Alb	St Paste	GL		CP	AcAc	OG
CL9	1	Crimson Lake	Aq	PGS	Alb	St Paste	GL		OG	

Note: The ingredients' proportions are variable within the same recipe. The table does not account for two production records since they are incomplete.

The potassium citrate was added in the form of an aqueous solution with glycerine (CP), which was possibly meant to act as a buffering agent to counteract the acidic effect of the acetic acid. However, in this case, its function is unclear.

The most representative recipe identified is *CL1* (with 16 out of 30 production records), which included all of the materials mentioned above, the only difference being the addition of isinglass dissolved in hot water to the binder solution of gum Senegal. This method was also observed in recipes *CL6* and *CL7*. Since isinglass turns into gelatine when in contact with hot water, it was probably added to increase the viscosity and adhesive strength of the binder solution when compared to *CL2* (Gettens and Stout 1966, 30). According to W&N, starch was sometimes added along with the binder solution to prevent the gum from coagulating (URC 2CP1789). Other ingredients used as thickeners were albumen, which was used in recipes CL4, CL8, and CL9, and

arrowroot mixed with glycerine (*CL5*). Usually, only one of these ingredients was used at a time, except for recipes *CL4*, *CL7*, *CL8* and *CL9*, in which more than one was used. Finally, ox gall was added to *CL3*, *CL8* and *CL9*, probably to improve the flow of the watercolour, as mentioned above (Ormsby et al. 2005).

Prussian blue

Four recipes were identified for Prussian blue moist watercolours (**Table 2.5**). The colourant added was identified in the recipes as Chinese blue, being composed of ferrocyanide of iron ($Fe_4[Fe(CN)_6]_3$), according to the W&N declaration on pigment composition from 1892 (Otero 2018, 177–82).

The most representative recipe of this colour was *PB1,* described in nine out of the 15 production records. In general, two main steps were followed to prepare this colour. After grinding, the pigment was mixed with ammonium chloride dissolved in hot water (*PB1* and *PB2*). While hot, it would be dissolved in thick ox gall, and the binder solution of gum Arabic would be added. As observed in Crimson Lake recipes, starch would be added with the gum solution besides the albumen. After being well mixed, it would be left soaking for a few days. The second step usually consisted of adding more solution of gum Arabic with albumen and glycerine (with or without arrowroot). Finally, it was left to dry on cold stones to be stored in pots once dried.

Recipes *PB3* and *PB4* also appear to be experimental recipes. These recipes called for an aqueous solution of barium chloride instead of ammonium chloride; however, the intention behind adding these salts is unclear.

Table 2.5 W&N recipes for Prussian Blue moist watercolours found in MS *C1* and *M2*. The meaning of the abbreviations is given in Table 2.1.

Code	Production Records	Manufacturing Process								
		Colourant	Solvent	Binder		Glycerine			Other Additives	
PB1	9	Chinese Blue	Aq	PGA	Alb	St Paste	GL	AR	Thick OG	Mur: Ammo
PB2	3	Chinese Blue	Aq	PGA		St Paste	GL	AR	Thick OG	Mur: Ammo
PB3	1	Chinese Blue	Aq	PGA			GL			Mur: Barytes
PB4	1	Chinese Blue	Aq	PGA	Alb	St Paste	GL			Mur: Barytes

Note: The ingredients' proportions are variable within the same recipe. The table does not account for one production record since it is incomplete.

2.3 Chapter conclusion

The investigation of the *Winsor & Newton 19th-century Archive Database* provided invaluable access to the manufacturing process of their moist watercolours. This preliminary study revealed that W&N was particularly dedicated to producing watercolours. Their concern in producing high-quality materials is reflected in the constant experimentation of new combinations of ingredients that could enhance the performance of their products.

Two manuscript books were selected to investigate the production of moist watercolours for the colours previously identified on magic lantern glass slides. Four gamboge recipes, nine crimson lakes, and four Prussian blues were identified. Although only two manuscript books were explored in this first study, it was possible to determine the most relevant formulation for each colour that could have been commercially available. This preliminary research paves the way for an in-depth study of 19th-century W&N watercolour recipes in the future.

This work allowed for identifying which materials were used in these recipes and gaining insight into W&N's intentions when adding them. Notably, independently of the colour, glycerine was always present. The comparison between the recipes for the three colours revealed that even though the formulations used were relatively similar within the same colour production records, they were significantly different from colour to colour, which demonstrated that these formulations were adjusted according to what each pigment required. It was fascinating to notice that no gum was added to the gamboge, and even in the crimson lake and Prussian blue paints, different gums were used: gum Senegal and gum Arabic, respectively. Ormsby *et al.* (2005) have pointed out that gum Senegal was used for darker colours and gum Arabic for lighter, given their different natural colouration.

Nevertheless, a systematic study with reconstructions will be fundamental to fully understanding the role of each ingredient and the reasoning behind their choices. Reconstructions will also be crucial to determine if adding certain ingredients can influence the degradation of the magic lantern glass paintings. In the future, these may also be used as reference samples for further studies on degradation mechanisms and remedial conservation procedures for the development of sustainable preservation methodologies.



3

PORTUGUESE COLLECTIONS OF MAGIC LANTERN SLIDES

> *Um theatro não. Mas tenho a idéa d'uma sala, com projecções de lanterna magica, para ensinar a esta pobre gente as cidades d'esse mundo, e as cousas d'Africa, e um bocado de Historia.*
>
> Eça de Queirós (1901)

The magic lantern slide collections under study are introduced in this chapter. Although this work mainly focuses on the material characterisation and preservation of painted slides from Portuguese collections, it was considered appropriate to briefly explore the Portuguese context and the impact the magic lantern may have had on the country.

3.1 The Portuguese context: a brief overview

From early on, Portugal accompanied technological evolution that led to the creation of the Magic Lantern. In 1615, the Dominican Priest Filippe Nunes, in *A Arte da Pintura e Symmetria, e Perspectiva*, revealed to be aware of the technological developments in philosophical, literary and artistic fields. This work possibly presents the earliest account of a camera obscura with a lens by a Portuguese author (Bernardo 2009). The first Portuguese description of a magic lantern uncovered was written in 1698 on the first Lusitanian Encyclopaedia *Vocabulario Portuguez & Latino* by the priest D. Raphael Bluteau published by the University of Coimbra between 1712 and 1721, as an offering to King D. João V (Bluteau 1716; Bernardo 2009).

> *"Lanterna Magica. He hum engenho optico, que em huma parede branca repreſenta figuras tam monſtruoſas, que os que ignorão o artificio, imaginão que he obra feita com arte magica. He compoſto de hum eſpelho parabólico, que refleſte a luz de hũa velaſinha, a qual ſahe pelo buraquinho de hũ canudo, no fundo do qual eſtão muitos vidrinhos pintados, que na parede oppoſta refleſtem com mayor extenſaõ as extraordinárias, & medonhas figuras que tem. No seu livro intitulado, Deliciæ Mathematicæ, enſina Suventero a conſtrucção deſte optico inſtrumento; os Padres Kirker, & Keſtler da Companhia de Jeſus fazem menção delle; Rogerio Bacon Inglez foy o primeiro que deo algũa idea deſte curioſo invento."*
>
> Raphael Bluteau (1716, 5:38)

It is an important testimony to the philosophical-scientific thought of the time in Portugal, which shows that people knew about the creation of the magic lantern and its most popular shows, full of illusions and monstrous and extraordinary figures, from an early age.

At this time, the knowledge and developments in Portugal were controlled by the Jesuits, who dominated higher education through the Universities of Évora and Coimbra and by the Holy Office of the Inquisition (Bernardo 2009). On the other hand, for Portugal, the beginning of the 18th century was also marked by cultural renewal and the opening to foreign countries in search of new trends and attempts to reform education, which was reflected in the presence of Portuguese Jesuits with high education in areas such as philosophy, mathematics and physics, *e.g.* the priest Inácio Vieira, who in 1717 wrote *Tratado Da Catoptica e Tratado Da Dioptrica* (Mello and Leitão 2005; Vieira 1717). In this treatise, Vieira dedicated a short chapter, *Praxe 1ª. Da Laterna magica*, to constructing magic lanterns with instructions for producing glass lenses (Vieira 1717, 681–708). Although the magic lantern may have been known in the country at least since 1698, this work is perhaps the first Portuguese document exploring this projecting instrument's working principle and components and praising their usefulness.

In addition to this work, it is worth noting the small bifolium from a Portuguese manuscript dated from the 18th century, *Distribuiçam Das partes da Lanterna Magica* (Lisbon, Biblioteca Nacional de Portugal, MSS.6, n.38), where we can read, in addition to details on the positioning of the various components of a magic lantern, the recommended painting materials for producing figures on glass slides. Although very brief, the indications given by the author of this manuscript are in line with the directions given by European coeval literature, as discussed in *Chapter 1*, both in terms of the manipulation of the instrument and the methods used to produce images on glass for projections; nevertheless, slides of a Portuguese production are yet to be found.

> *"As Cores (para) as figuras são as ſeguintes.*
> *Negro não transparente (para) fazer corpo.*
> *Negro de fumo*
> *Negro transparente de osso*
> *Verde – Verde de cobre estilado, ouseja verde eterno.*
> *Azul ultramarino empouca quantida.*
> *Vermelho leve fino.*
> *Amarelho.*
> *Goma guta ou saldo santo. Estas vão temperadas com olio q ſe pode misturar com olio cozido (para) enxugar com vernis fino q ſe dará tambem ſobre apintura quando estiver enxuta (para) lhe acrescentar atransparencia e dar lhe ɛua tal ouqual ɛunião."*
> unknown, ('Distribuiçam Das Partes Da Lanterna Magica' *1700)*

Interested in putting an end to Portugal's lag in development compared to other European countries, Sebastião José de Carvalho e Melo (*Marquis of Pombal*), as minister of King D. José I (1750-1777), instituted economic, cultural, political, and philosophical reforms that changed the course of the country (Bernardo 2009). In this sense, the educational reforms stand out, with the creation of the new *Statutes of the University of Coimbra* of 1772, which indicate that the third year of the *Philosophical Course* would integrate the fundamental knowledge of *Experimental Physics*. Its program included, within the scope of the study of light, among other objects and

instruments used in optics, the invention and use of the magic lantern ('Livro III. Dos Cursos Das Sciencias Naturaes e Filosoficas' 1772; Nunes 2011).

Curiously enough, the earliest collection of hand-painted slides known in Portugal was acquired for the Physics Cabinet of the Royal College of Nobles of Lisbon (1761-1837) and transferred on the 3rd of February 1773 to the University of Coimbra, currently being held by the Science Museum of the University of Coimbra (MCUC) (**Figure 3.1**, **A**) (Pereira 2017). According to the inventory created in 1788 by Giovanni Antonio Dalla Bella (1726-1823), the first director of the Physics Laboratory of the University of Coimbra, among other scientific instruments, 52 magic lantern slides and three magic lantern projectors would have been held at the Physics Cabinet (Dalla Bella 1788; Carvalho 1978). Only 44 of these 18th-century slides remain in the MCUC, as well as 14 from the 19th century, acquired in 1840 (Ramires, Antunes, and Caldeira 2006, 25). It is noteworthy the existence of a set of 11 slides attributed to the 18th century, with unknown origin, currently held at the National Archive of Moving Images (ANIM) of the Portuguese Cinematheque – Museum of Cinema (CPMC), aesthetically similar to several 18th-century slides held by the MCUC (**Figure 3.1**).



Figure 3.1 Hand-painted magic lantern glass slides attributed to 18th-century Italy, held at different Portuguese institutions: (**A**) Science Museum of the University of Coimbra (inv. FIS.2070); (**B**) Portuguese Cinematheque – Museum of Cinema (inv. PC002-002). Another slide with a similar composition drawn in a different style, found at the Francois Binetruy collection can be consulted in *Appendix A.1*, **Figure A.1**.

In addition to the University of Coimbra, the use of projection lanterns as an instrument for teaching optics was documented by other Portuguese academies of science (*e.g.,* Polytechnic Academy of Porto (1836-1911), Polytechnic School of Lisbon (1837-1911), and Medical-Surgical Schools of Porto and Lisbon (1836-1911)) and served to educate young princes of the Portuguese monarchy (Felismino and Lourenço 2017).

Besides its use for educational purposes, it is known that the introduction of impactful entertainment shows marked the late 18th- and mainly the 19th-century Portuguese cultural life as the magic lantern travelled the country as a recreative object, entering noble and upper bourgeoisie houses carried by lanternists; nevertheless, no records have been found to date

suggesting when the first public show happened in the country using this device (Reis 2011). According to the testimony of Carl Israel Ruders, chaplain of the Swedish Legation to the Portuguese Court, in 1800, a public Magic Lantern show was offered to the people as part of the celebrations for the birth of Princess Maria Francisca Assis de Bragança, daughter of King D. João VI and Queen D. Carlota Joaquina (Costa 1988).

> *"No dia 22 de Abril (de 1800) os habitantes de Lisboa foram despertados às 5 da manhã pelas salvas de artilharia com que as fortalezas e os navios de guerra assinalaram alegremente o bom sucesso da princesa do Brasil, que dava à luz uma infanta. Na mesma noite, e nas duas seguintes, toda a cidade estava iluminada solenemente por ordem superior. (…) Entre as iluminações, a mais bela pareceu-me a do armazém dos negociantes de cereais, com as fachadas completamente cheias de luzes artisticamente dispostas. (…) Na Rua Augusta, havia uma tela transparente sobre a qual uma Lanterna Mágica projectava sombras chinesas representando diversos bonecos que ora se esmurravam em terríveis disputas ora se acariciavam e beijavam mutuamente, com grande gáudio do imenso povoléu que ali se amontoava para gozar o espectáculo. Por entre a multidão havia também muitas mulheres movendo-se e acotovelando-se para gozarem de todas estas belezas."*
>
> Alves Costa (1988)

In the 19th century, projection exhibitions such as phantasmagoria and theatrical-musical shows (*e.g., féeries* or the Portuguese *mágicas*) imported and adapted from other countries were portrayed in Portuguese theatres despite having comparably fewer conditions to perform them (Peliz 2022). As an example, the Portuguese public had the privilege of attending (*e.g.,* in Lisbon) phantasmagorias by Étienne-Gaspard Robertson (1763-1837), one of the pioneers and disseminators of these shows, whose passage through Portugal marked its introduction to the country (Reis 2011; Peliz 2022). Among relevant names of the time, it can also be highlighted the presence of Ellemberg and Marchand in theatres in Porto and Lisbon informed by local journals, *e.g., O Comércio do Porto* and *O Braz Tisana*. Among the music-theatrical genres in which magic lanterns were used, "mágica" was widely accepted on the Portuguese stages from 1840 to 1910, and this success has branched out to Brazil. These plays had a simple dramatic text with themes related to the wonderful, supernatural, and burlesque nature. They also included visual and sound effects, such as phantasmagoria, dance, and music. Although very little is known about the extension of the magic lanterns' use in the country, examples such as these demonstrate that important shows were presented in Portuguese rooms and theatres and testify to its presence and impact in 18th- and 19th-century society.

In 1875, a journal called *A Lanterna Mágica* (The Magic Lantern) was created by the caricaturist Rafael Bordalo Pinheiro (1846-1905) and written by Guilherme de Azevedo (1839-1882) and Guerra Junqueiro (1850-1923) under the collective pseudonym of Gil Vaz (**Figure 3.2**). The journal, filled with symbolic iconography, humorously commented on the main political, social, and cultural events of the week that marked Lisbon's current affairs, and comments on theatre performances were a current theme (Matos 2014).



Figure 3.2 Front cover of the 1st number of the *A Lanterna Mágica* journal, published in 1875. Cover by Rafael Bordalo Pinheiro (Gil Vaz 1875). Hemeroteca Municipal de Lisboa.

The mediatic popularism of the magic lantern in the pedagogy and entertainment of the European aristocracy spread into the 20th century, not leaving famous Portuguese writers and artists indifferent. Examples are the writer Eça de Queiroz (1845-1900), who, in the posthumous novel *A Cidade e as Serras* (1901), mentions the magic lantern as an important teaching tool and the artist José de Almada Negreiros (1893-1970) who, in 1929, produced six glass slides with a mixed technique (drawings photographed on glass and painted) which, together with a musical and literary component, make up the work *La Tragedia de Doña Ajada* (The Tragedy of Doña Ajada) (Eça de Queiroz 1901; Cinemateca Portuguesa 2017).

In recent years, there has been an effort to unveil this instrument's history in the country. The project MAGICA (*Magic Lantern: Study, Safeguard, Uses and Reuses in 19th-century Portugal*, PTDC/ART-PER/1702/2021, www.magica-project.com) is, since 2022, investigating not only the presence of renowned lanternists in Portugal and shows exhibited during the 19th century but also the role and significance of the magic lanterns in the context of the new theatrical and intellectual discourses of the late 19th century in the country that positioned themselves between the real and the unreal, the scientific knowledge and the mystical feeling.

The country has a wide variety of slide collections produced between the 18th and 20th centuries,

e.g., in England, France, Germany, Holland, Italy, and the United States of America. Although the Portuguese collections have not been systematically studied, it is possible to highlight the great diversity of typologies of glass slides that can be found throughout the country. From north to south of the country are listed a few Portuguese institutions that are known to currently hold collections of magic lanterns and glass slides (**Figure 3.3**):

1. Melgaço Museum of Cinema - Jean-Loup Passek, Melgaço, Viana do Castelo
2. Museum House of Vilar - The Moving Image, Lousada, Porto
3. Faculty of Engineering of the University of Porto (FEUP), Porto
4. Science Museum of the University of Coimbra (MCUC), Coimbra
5. Museum of the Moving Image (m|i|mo), Leiria
6. Portuguese Cinematheque - Museum of Cinema (CPMC), Lisbon
7. Maynense Museum of the Academy of Sciences of Lisbon (ACL), Lisbon
8. National Museum of Natural History and Science, University of Lisbon (MUHNAC), Lisbon
9. Faraday Museum, Museums of the University of Lisbon (MF-MUL), Lisbon.

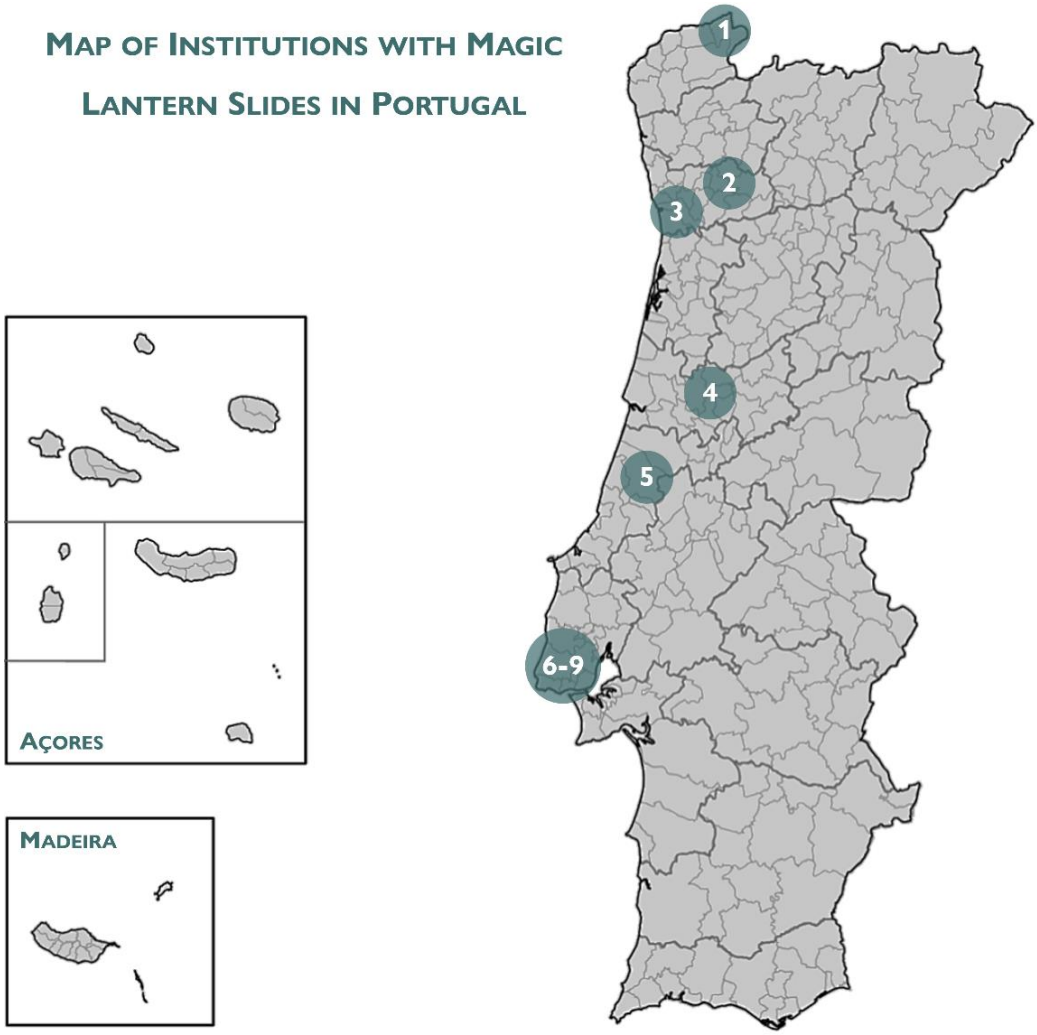


Figure 3.3 Known institutions holding collections of magic lanterns and glass slides throughout Portugal. The numbering follows the list of institutions given. (Background map adapted from ©Milenioscuro)

3.2 Studied collections

3.2.1 Portuguese Cinematheque - Museum of Cinema

The Portuguese Cinematheque - Museum of Cinema (CPMC) was founded in 1948 by one of the pioneers of European film libraries, Manuel Félix Ribeiro (1906-1982), as the national institution under the tutelage of the Minister of Culture and became autonomous in 1980. Its primary mission is to safeguard and disseminate the cinematographic heritage.

In 1956, the CPMC became a member of the International Federation of Film Archives (FIAF), which combines the efforts of the most important archives worldwide with over 150 affiliates from 77 countries. In the same year, it inaugurated its first room dedicated to the exhibition and two years later started having the Cinematheque programme activities in Foz Palace (Lisbon), the same place where, in 2007, the Junior Cinematheque was inaugurated. The project of the National Archive of the Moving Image (ANIM), transferred to the direction of the CPMC in 1981, was housed in 1996 on the outskirts of Lisbon, in Loures, which is now the base of all activities concerning the preservation, technical research, and collections' access, including the use of new technologies. This institution has played a decisive role in creating and developing the network of European institutions dedicated to preserving the European film heritage, being a co-founder of the European Association of Cinematheques in 1991 and participating in several programmes.

The CPMC holds the most extensive collection of magic lantern slides in the Portuguese territory, with more than 1300 objects. The majority is currently stored at the ANIM (Loures), and around 5 % is on display at the Junior Cinematheque (Foz Palace, Lisbon) (**Figure 3.4**).



Figure 3.4 Junior Cinematheque's exhibition room, dedicated to the pre-cinema period, with magic lantern instruments and glass slides (Foz Palace, Lisbon). © Photographed in 2021 by the author.

The slides were mostly produced between the 18th and 20th century by several countries and producers. According to their inventory information, the collection includes slides from England, France, Germany, Italy, Netherlands, Portugal, and the United States of America from renowned producers such as Carpenter & Westley, Ernst Plank, Hachette et Cie., Lapierre, W.E. & F. Newton/Newton & Co., T.H. McAllister, W.C. Hughes, York & Son, and others. The techniques used to produce the magic lantern slides were hand-painting, hand-coloured printed outlines (*e.g.,* lithography), chromolithography, photography, and hand-coloured photography. The distribution of slides from this collection according to their production technique can be seen in **Figure 3.5**, where the representativity of the 92 entirely painted slides and the 226 coloured printed outline slides is highlighted. Most slides were acquired by the institution at international auctions or donated by private owners through the years, and, for the great majority, little is known about their past before arriving at the CPMC.

The present work is focused on the entire group of hand-painted slides and hand-coloured printed outlines from this collection (322 slides), and their catalogue can be consulted in *Appendix A.2.1*. For the material characterisation study covered in *Chapter 4*, it was necessary to restrict the selection to 48 slides; nevertheless, the conservation of the whole group was addressed in *Chapter 5*.

Details of the classifications attributed to the entire group of slides of interest may also be observed in **Figure 3.5**. Following the classification by Barnes (1990), the most common types of movement mechanisms or formats identified in the CPMC collection are panorama slide, single slide, single slipping slide, and multiple slide. Various shapes of glass sheets are also comprised (*e.g.*, circular and square-shaped glasses). Regarding the subjects depicted, the great majority appear to have been used for entertainment purposes. According to the classification developed in *Linternauta* (San Segundo, Frutos, and Therón 2019), burlesque, tale, topical, romance, and adventure are the most common discursive genres. Examples of slides with different depiction techniques, movement mechanisms and discursive genres are presented in **Figure 3.6**.

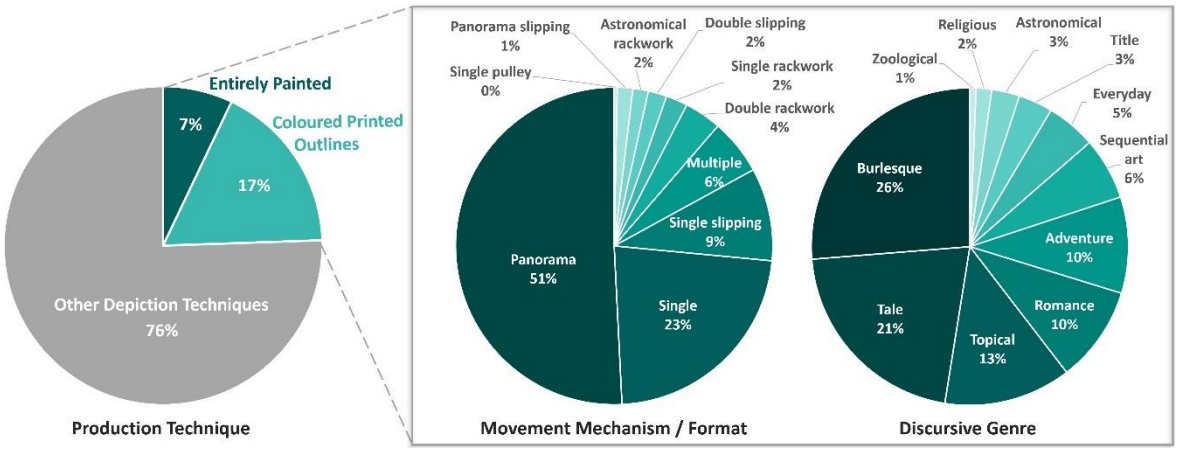


Figure 3.5 Overview of CPMC's collection of magic lantern glass slides: (left) percentage of slides entirely hand-painted and hand-coloured over printed outlines; (centre) distribution by movement mechanism or format, following the classification by Barnes (1990); (right) distribution by discursive genre, following the categories developed in Linternauta (San Segundo, Frutos, and Therón 2019).



Figure 3.6. Examples of slides with different depiction techniques, movement mechanisms and discursive genres identified in the CPMC collection: (**A**) Multiple slide, hand-painted, adventure genre, ca.1880, England, CPMC-PC0445/004; (**B**) Panorama slipping slide, hand-painted, topical genre, "Cape of Good Hope", by Carpenter & Westley, ca.1838-1900, England, CPMC-PC0003; (**C**) Panorama slide, hand-painted, religious genre, 18th century, Italy, CPMC-PC0002/011; (**D**) Astronomical rackwork slide, hand-painted, astronomical genre, by W.E. & F. Newton, 1850-58, England, CPMC-PC3301/001; (**E**) Single slide, coloured over printed outlines, tale genre, "Cinderella", ca.1850-1875, England, CPMC-PC0188/004; (**F**) Panorama slide, coloured over printed outlines, romance genre, "La Belle aux cheveux d'or", by Lapierre, ca. 1890, France, CPMC-PC0018/002; (**G**) Rackwork slide, hand-painted, title genre, early-19th century, Germany?, CPMC-PC0436/003.

3.2.2 National Museum of Natural History and Science

The National Museum of Natural History and Science (MUHNAC), from the Museums of the University of Lisbon (MUL), has existed since 2011 due to the unification of the National Museum of Natural History and the Science Museum of the University of Lisbon. It integrates its collections, the former buildings of the Polytechnic School (**Figure 3.7**), the Lisbon Botanical Garden, and the Ajuda Astronomical Observatory (since July 2012). The National Museum of Natural History, as designated in 1926, originates in the Royal Museum of Natural History and Botanical Garden, which was created in the 18th century in Ajuda (Lisbon). The Science Museum of the University of Lisbon was created in 1985, sharing the space of the Polytechnic Building with the National Museum of Natural History. In 2003, both Museums became autonomous from the Faculty of Sciences and are now supervised by the Rectorate of the University of Lisbon.

The MUHNAC-MUL collection has 50 slides (49 slides and a group of fragments) attributed to 19th-century English, French, and Germanic production from unknown and known manufacturers such as Lapierre and Ernst Plank. From these, 30 slides include hand-painting (eight entirely painted by hand and 22 coloured over printed outlines), which can be consulted in the catalogue presented in *Appendix A.2.2*, and the remaining 20 slides are chromolithographic (**Figure 3.8**). Unfortunately, none of the slides has a background history known by the museum.

Considering that during the material characterisation study (covered in *Chapter 4*), the museum was only aware of five hand-painted slides, those were the first to be studied on behalf of the master thesis in Conservation and Restoration of Beatriz Rodrigues (2018/2019), supervised by Professor Márcia Vilarigues and co-supervised by the author.

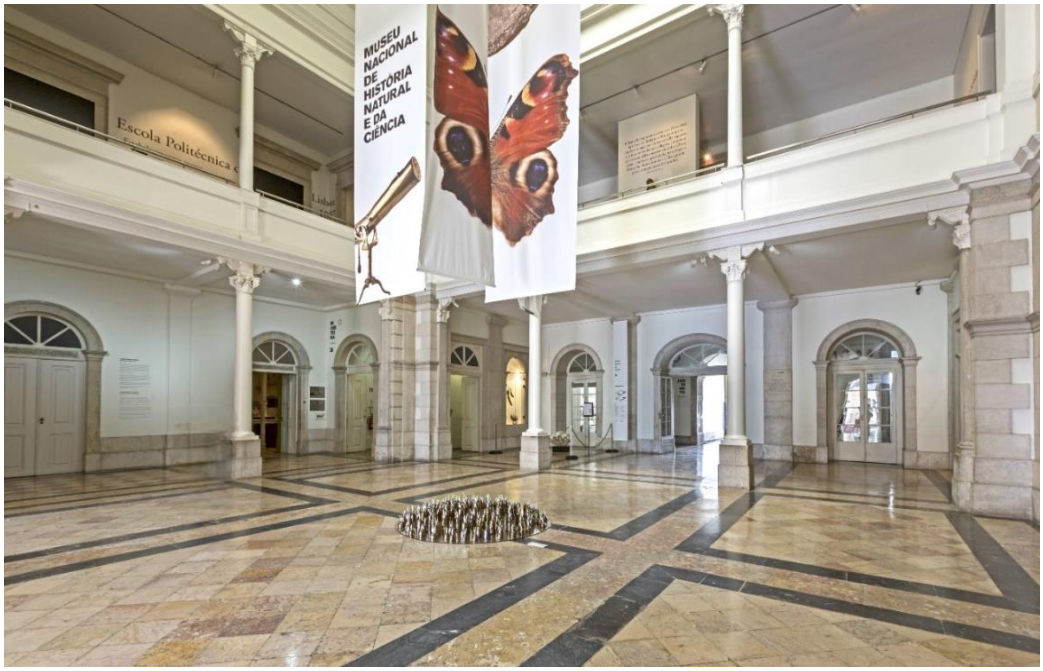


Figure 3.7 Installations of MUHNAC, in the former building of the Polytechnic School of Lisbon, where the collection of magic lantern slides is stored. © MUHNAC ULisboa (https://www.museus.ulisboa.pt).

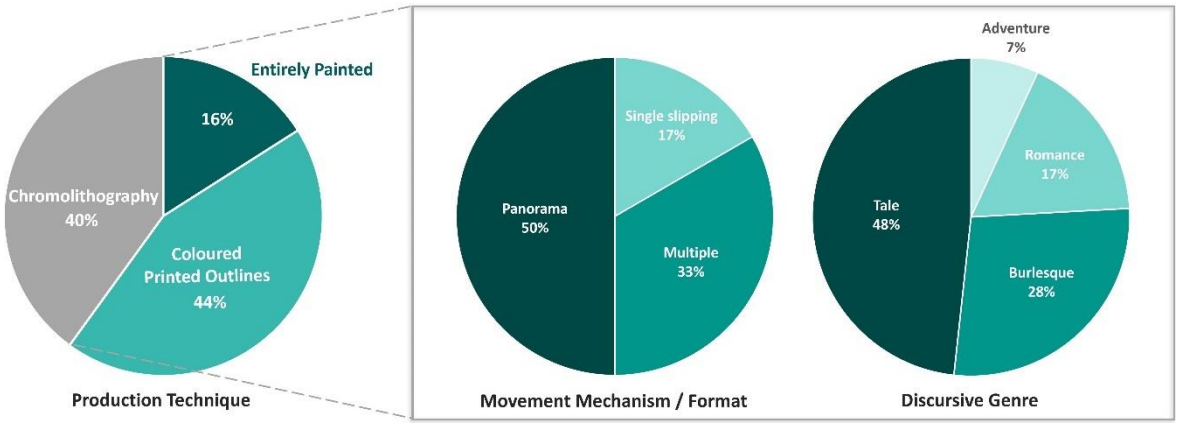


Figure 3.8 Overview of MUHNAC's collection of magic lantern glass slides: (left) percentage of slides entirely hand-painted and hand-coloured over printed outlines; (centre) distribution by movement mechanism or format, following the classification by Barnes (1990); (right) distribution by discursive genre, following the categories developed in *Linternauta* (San Segundo, Frutos, and Therón 2019).

Details of the classifications attributed to the entire group of slides of interest may also be observed in **Figure 3.8**. Following the classification by Barnes (1990), the most common types of movement mechanisms or formats identified in the MUHNAC collection are panorama slides, multiple slides, and single slipping slides. Regarding the subjects depicted, the great majority appear to have been used for entertainment purposes. According to the classification developed in *Linternauta* (San Segundo, Frutos, and Therón 2019), the most common discursive genres are tale, burlesque, romance, and adventure. Examples of slides with different depiction techniques, movement mechanisms and discursive genres are presented in **Figure 3.9**.

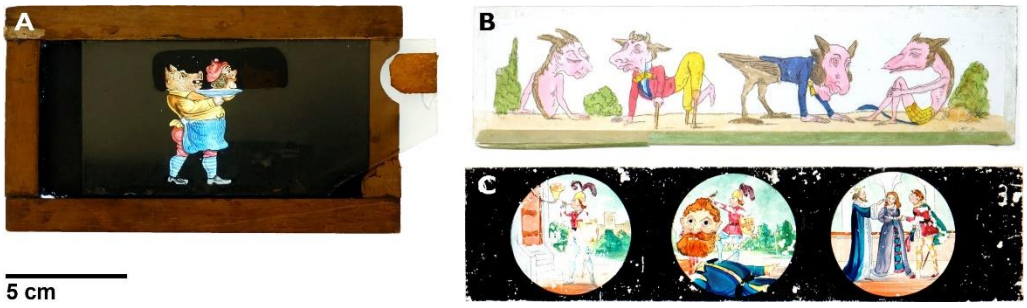


Figure 3.9 Examples of slides with different movement mechanisms, depiction techniques, and discursive genres identified in MUHNAC collection: (A) Single slipping slide, hand-painted, burlesque genre, 19th-century England, MUL-MUHNAC-UL000068; (B) Panorama slide, coloured over printed outlines, burlesque genre, by Lapierre, 19th-century France, MUL-MUHNAC-UL001209; (C) Multiple slide, coloured over printed outlines, tale genre, 19th-century, MUL-MUHNAC-UL025421.



4

MATERIAL CHARACTERISATION OF PAINTED GLASS SLIDES

Painting is a combination of light and shadow in close mixture with the diverse qualities of all the simple and complex colours.

Leonardo da Vinci

Painted magic lantern slides have been overlooked, especially from the execution techniques and constituent materials' point of view, consequently impacting its material preservation. The most extensive collection studied, owned by the Portuguese Cinematheque, exemplifies how diverse these collections can be and exposes the necessity for multidisciplinary approaches to improve its understanding.

Investigating the methods and materials helps place artworks in their historical context and propose attributions (*e.g.,* artist, time and place of production). The material study of these slides' technological aspects is a valuable complement to the archival, artistic and iconographic studies currently being undertaken within the framework of the project MAGICA and others that may be developed in the future. As previously stated, one of the main goals of this work was to identify analytical methodologies suitable for recognising the glass, pigments, and binders used in glass decoration and contributing to the in-depth comprehension of these fascinating objects. The aim was not only to start unveiling the relationship between the artefacts and the artists' or manufacturers' choice of materials but also to improve our ability to preserve them for future generations. The knowledge of their constituent materials is essential to establish the most suitable conditions for their preventive conservation in storage and display and approaches in remedial conservation and restoration works.

Although these artefacts are composite materials, commonly using glass, painting, wood, paper, and metal (**Figure 4.1**), only two are invariably present, being vital components of magic lantern slides (entirely painted and coloured over printed outlines): glass and painting materials. These materials were analysed from a physical and chemical point of view. The relationship between this information, the preservation challenges faced by holding institutions, and the different deterioration problems observed are further explored in *Chapter 5*.

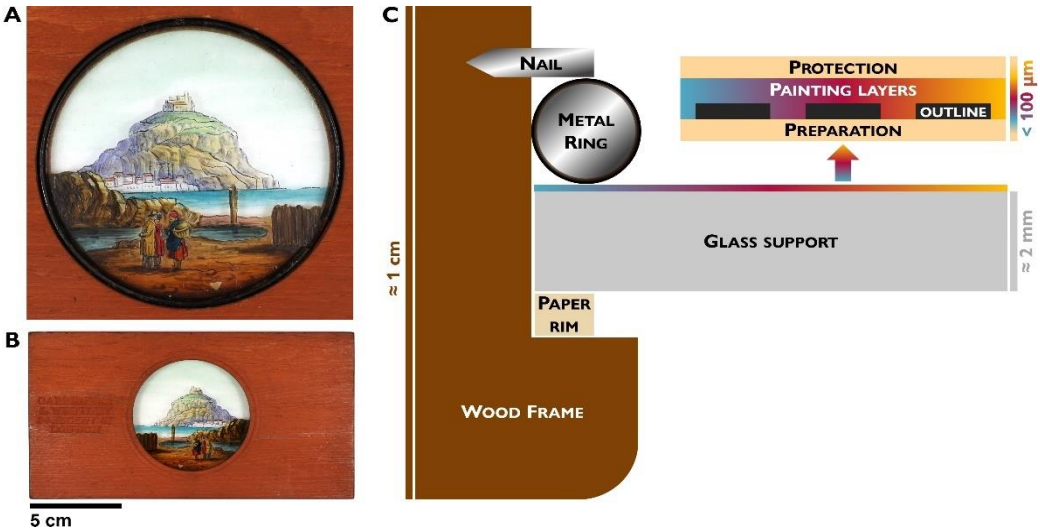


Figure 4.1 Example of a possible stratigraphy (C) based on descriptions found in historical written sources explored in *Chapter 1* and observations under the microscope, and structurally inspired by the typical single slide format used in CPMC-PC189/009 produced by Carpenter & Westley, England (ca.1838-1900), shown in detail from the painted side (A) and fully from the non-painted side (B).

4.1 Research design and methodology

When choosing the analytical methods to be used, the magic lantern slides' primary purpose of being projected and observed under magnification was considered, as well as their conservation needs. For that reason, a complementary multi-analytical methodology with *in-situ* analysis was favoured to keep the slides visually unaltered, and analyses requiring micro-samples were quantitatively restricted and confined to the paint areas with material loss (also named lacuna).

To the extent of the author's knowledge, only one paper and two prior conference proceedings regarding the characterisation of magic lantern slides were published resulting from an investigation by the University of Turin (Scalarone et al. 2006; Ploeger, Scalarone, and Chiantore 2008; 2010). The first proceeding, from 2006, identifies the binders of 16 glass slides (entirely painted and coloured photographs) from the 18th to the early 20th century by Attenuated Total Reflection Fourier Transform Infrared (ATR-FTIR) spectroscopy and X-Ray Fluorescence (XRF) spectrometry, used to detect the paints' inorganic components. Through ATR-FTIR, the authors mentioned that seven used gum Arabic and natural resins (with two having oil), three used natural resins and oil, two used only oil and three used animal glue. It was noted that oil was only found in slides from the 2nd half of the 19th and early 20th centuries. This technique also identified Prussian blue in one entirely painted slide. On the entirely painted slides, XRF detected the presence of copper in greens and blues, lead and iron in browns, organic blacks, and calcium and arsenic as frequent elements in the matrix. This study also included a palette/set of paints for magic lantern slides of the same period analysed by XRF, ART-FTIR and Pyrolysis-Gas Chromatography-Mass Spectrometry (Py-GC/MS), where the authors refer to the detection of gum Arabic, Prussian blue, cinnabar, and Hooker's Green (Prussian blue and Gamboge). The later publications, from 2008 and 2010, are analogues and characterise the binders of two previous slides through mid-Infrared Fibre Optic Reflectance spectroscopy (mid-IR FORS) and ATR-FTIR, showing that oil and gum binding materials were used along with a resin. It was proposed that gum was used as preparation and oil/resin paint or oil paints with the resin as a protective varnish layer.

In this project, a selection of slides was observed and photographed in detail using different light conditions and wavelengths, resorting to Ultraviolet-Induced Visible Fluorescence (UVIVF), stereomicroscopy and optical microscopy, and analysed by Energy Dispersive X-Ray Fluorescence spectrometry (EDXRF), Ultraviolet-Visible spectroscopy (UV-VIS), and micro-Raman spectroscopy (μ-Raman). Given their *in-situ* nature, these techniques were systematically applied to all the slides covering most of the colours. The results gathered with these techniques informed the restricted selection of areas in which Surface-Enhanced Raman Spectroscopy (SERS) and micro-Fourier Transform Infrared spectroscopy (μ-FTIR) were used, resorting to micro-sampling.

Examining cultural heritage artefacts usually resorts primarily to naked-eye observation under different light conditions (*e.g.*, reflected and transmitted light) and wavelengths (visible, infrared and ultraviolet) to help assess the object's conservation state and show details on the production techniques and past interventions (*e.g.*, overpaints and restorations), and photography helps to record the areas observed serving as documentation (Sandu, Joosten, and Leal 2015). UVIVF photography was carried out to examine the differences in the visible fluorescence of several painting materials applied to the glass, as it is an easy tool for institutions to use to identify the presence of certain materials.

Microscopy, whether of low- or high-magnification, is an imaging technique frequently used, *in situ* or using samples, to complement naked-eye observation. It is an essential tool in characterising materials (using different light conditions and wavelengths, and with the aid of, for example, polarizers), micro-sampling and monitoring many practical interventions (Sandu, Joosten, and Leal 2015). Microscopes are often equipped with a digital camera and connected to a computer that allows the manipulation of images and registration of information about the structure, size, shape, colour, thickness, dimensions, and other characteristics. Both low- and high-magnification microscopes (stereomicroscope and optical microscope, respectively) were equipped with a digital camera to examine and photograph the glass and paintings' morphology, techniques, and conservation issues.

EDXRF is one of the most used techniques for the elemental characterisation of cultural heritage objects. Given its *in-situ* nature, user-friendliness, and short acquisition times, it is often applied as a preliminary approach to the overall materials investigation. In the case of vitreous materials, the inability to detect elements lighter than Aluminium (below Z=13) constitutes a limitation; nevertheless, by using established glass standards for comparison, it is possible to circumvent this issue and achieve reliable semi-quantitative results of the composition of historical glass objects. This technique was selected to detect the elements in the glass matrix by directly analysing the glass support and to identify the elements present in each colour of the painting (**Figure 4.2**). These paint analyses are especially relevant when using a multi-analytical approach since these results can help narrow the hypothesis for each pigment and additive and aid in selecting samples for further analysis using, for instance, complementary molecular techniques to identify them.

UV-VIS spectroscopy has been widely used to identify colourants and binders in works of art, given its suitable characteristics for preliminary studies (*e.g.,* being used *in situ* and requiring short analysis times). This technique was used to recognise the colours observed through the electronic transitions responsible (**Figure 4.2**). Nevertheless, since it has a lower *fingerprinting* ability when compared to other molecular spectroscopic techniques (*e.g.,* Raman and FITR), UV-VIS is

frequently used to limit the number of analyses performed using more sophisticated techniques (Aceto et al. 2014).

Raman spectroscopy is often used to analyse cultural heritage objects *in situ,* and numerous studies demonstrate its strength for identifying both inorganic and organic materials (Robinet et al. 2006; Marucci et al. 2018). This technique was carried out directly on the magic lantern slides to identify the painting components at a molecular level through the vibrations of their bonds (**Figure 4.2**).

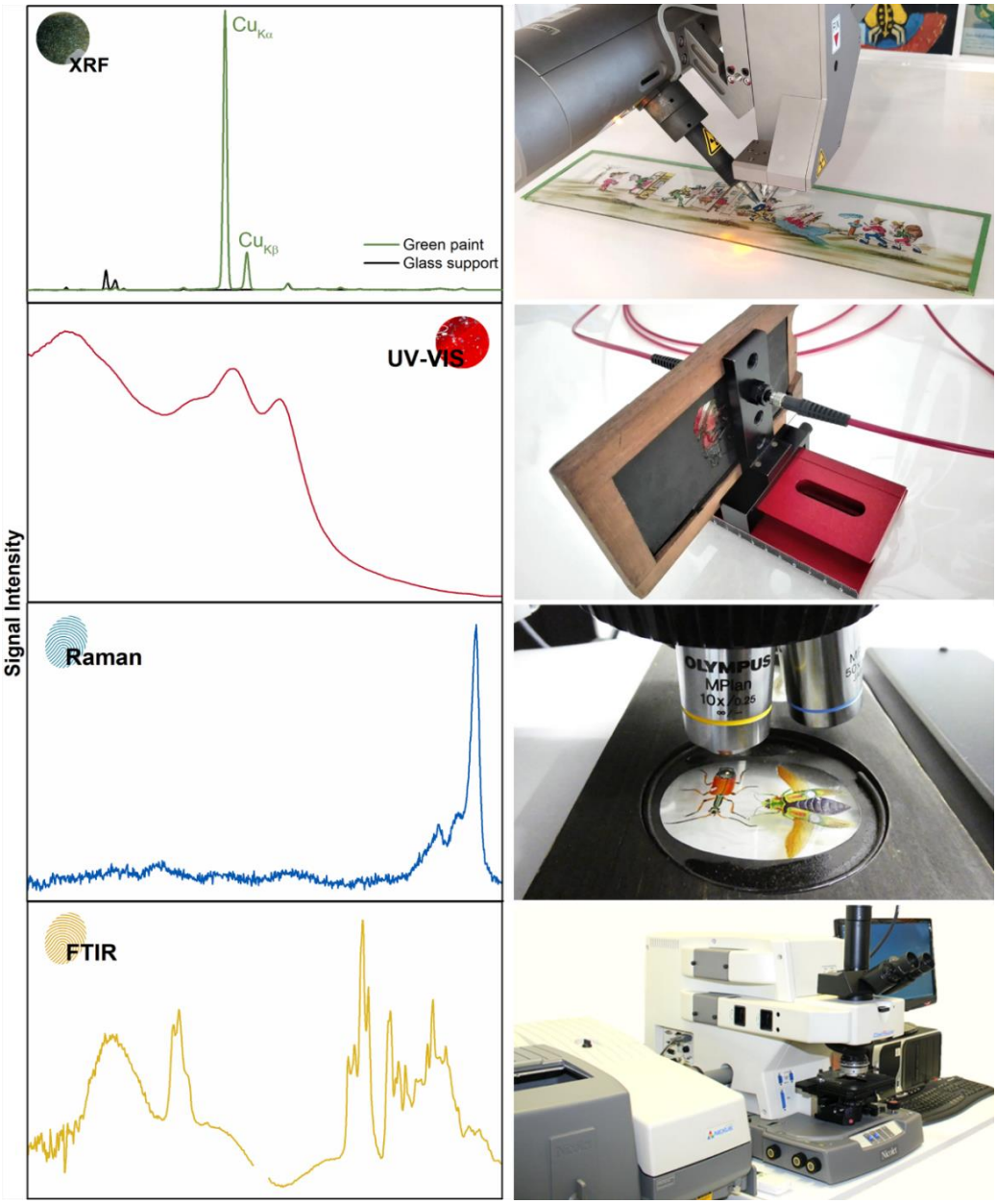


Figure 4.2 Examples of spectra obtained with different techniques and equipment used to analyse magic lantern slides. **EDXRF** spectrum of the green paint where the presence of copper (Cu) is visible by the peaks at 8 keV and 8.9 keV (CPMC-PC002/003). Its signal is much stronger than the glass support's spectrum. **UV-VIS** spectrum of the red colour where an anthraquinone chromophore of animal origin (such as cochineal) was identified through the absorption bands at 522 and 562 nm (MUL-MUHNAC-UL000065). **Raman** spectrum of the Prussian Blue pigment showing its characteristic bands at 2092, 2126 and 2155 cm^{-1} (CPMC-PC002/003). **FTIR** spectrum of Gamboge yellow by its characteristic molecular fingerprint (CPMC-PC3302/007).

Nevertheless, direct analyses of, for example, paint samples are sometimes compromised by the strong fluorescence of certain pigments and binders, which can mask the Raman signal (Pérez-Alonso, Castro, and Madariaga 2006). As a way of overcoming this issue, the same equipment has been increasingly used to perform SERS, an alternative or complementary method summarily based on the interaction of the colourant molecules with nano-structured substrates for the detection of an enhanced Raman signal; however, micro-sampling is needed (Osticioli et al. 2019). SERS was also performed on a selected micro-sample to identify the chromophore.

FITR spectroscopy is an established technique for characterising organic and inorganic materials in conservation science, giving information about characteristic molecular bonds' vibrations with high resolution, the main disadvantage being the need for sampling (Pérez-Alonso, Castro, and Madariaga 2006). This technique was performed on micro-samples collected from slides with paint loss to identify all paint components (colourants, binding mediums and additives) employed in these paintings, specificities of the paints' formulations, and deterioration or alteration products present (**Figure 4.2**). A portable ATR-FTIR was tested to avoid micro-sampling; however, the contact and pressure necessary to execute the analysis were unsafely high, considering the painting layers' brittleness and lack of adhesion to the glass support. For µ-FTIR analysis, the colour selection was restricted to damaged areas, and micro-sampling was carefully executed under a stereomicroscope, giving preference to already detached paint flakes. A few samples were mounted in resin, and the cross-sections were observed under a high-magnification microscope. The micro-sampling process and cross-section preparation are described in *Appendix A.3*.

Identifying materials with UV-VIS, Raman, SERS, or FTIR can rely on the assignment of the electronic transitions or molecular bond vibrations and comparison of its spectra with a spectral library of reference materials in databases or published scientific papers and books. Further information regarding the preparation of the slides for analysis, analytical instrumentation and experimental conditions are described in *Appendix A.3* and *Appendix A.4*.

4.1.1 Selection of slides for the material characterisation

The complexity of the analysis associated with these objects required the selection of a relatively small number of slides to be characterised from all the available slides listed in *Appendix A.2*. Therefore, the criteria for selecting representative artefacts were sequentially applied as follows:

- Production technique: slides entirely hand-painted or hand-coloured over printed outlines;
- Period of production: 18th and 19th century;
- Manufacturer or artist: most varied unknown and known manufacturers;
- Country of production: most varied proveniences;
- Number of colours: higher diversity of chromatic palettes;
- Typology/format: designed to be projected by different apparatus or on different structures (*e.g.,* mounted on wood/paper frames, with and without movement mechanisms, different sizes and formats such as panorama, square or circular) and with easy access to the glass and painting (with no protective glass or with mechanisms simple to disassemble);
- Subject: various discursive genres (*e.g.,* everyday, tale, burlesque, religious, adventure, topical, astronomical, title, among others).

A selection of 48 magic lantern slides from the collections encompassed by this project (*Chapter 3*) and VICARTE[4] is presented in **Figure 4.3**. From the CPMC, 40 slides were studied: 11 hand-painted slides from the second half of the 18th century attributed to Italy, one hand-painted and five hand-coloured over printed outlines by Carpenter & Westley (ca.1838-1900s) in England, two slides hand-painted by W.E. & F. Newton (ca.1850-1858) in England, six hand-painted and one hand-coloured over printed outlines from unknown producers from the 19th-century England, and 14 hand-coloured over printed outlines produced in France by Lapierre (ca.1860-1900s). From MUHNAC, five hand-painted slides from an unknown manufacturer attributed to the second half of 19th-century England were characterised, given that these were the only slides acknowledged by the institution at the time of selection.[5] Finally, from VICARTE were included two hand-painted slides produced in England by Philip Carpenter (ca.1822-1835) and W.E. & F. Newton (ca.1850-1858), and one hand-coloured over printed outlines by an unknown manufacturer, attributed to England.[6]

To access both sides of each glass sheet and painted surfaces, 12 single and double slipping slides and the three rackwork slides were disassembled. These were unmounted by temporarily removing small metallic nails and screws (*Appendix A.3*). Exceptionally, two slipping slides (CPMC-PC182 and CPMC-PC446) were analysed without disassembly, given the considerable risk of damaging the holding structures inserted in these objects, limiting the analysis's extent.

[4] VICARTE acquired three slides within the scope of the project with the Special Commendation Prize on *Mervyn Heard Award (2019)* by the Magic Lantern Society (*Technology and Preservation of Painted Glass Slides for Projection with Magic Lantern*s by Márcia Vilarigues, Ângela Santos, Vanessa Otero and Beatriz Rodrigues). Later other four were acquired within the framework of the MAGICA project (full catalogue in Appendix A.2.3).

[5] These five slides were studied within the framework of Beatriz Rodrigues's Master dissertation entitled "From Production to Preservation: Hand-Painted Magic Lantern Slides from the National Museum of Natural History and Science" (2019), supervised by Márcia Vilarigues and co-supervised by the author (Ângela Santos).

[6] These three slides were studied within the framework of MAGICA project and Margarida Gomes's Master dissertation entitled "Produção de Réplica de Diapositivos de Vidro para Espetáculos de Lanterna Mágica" (2022).

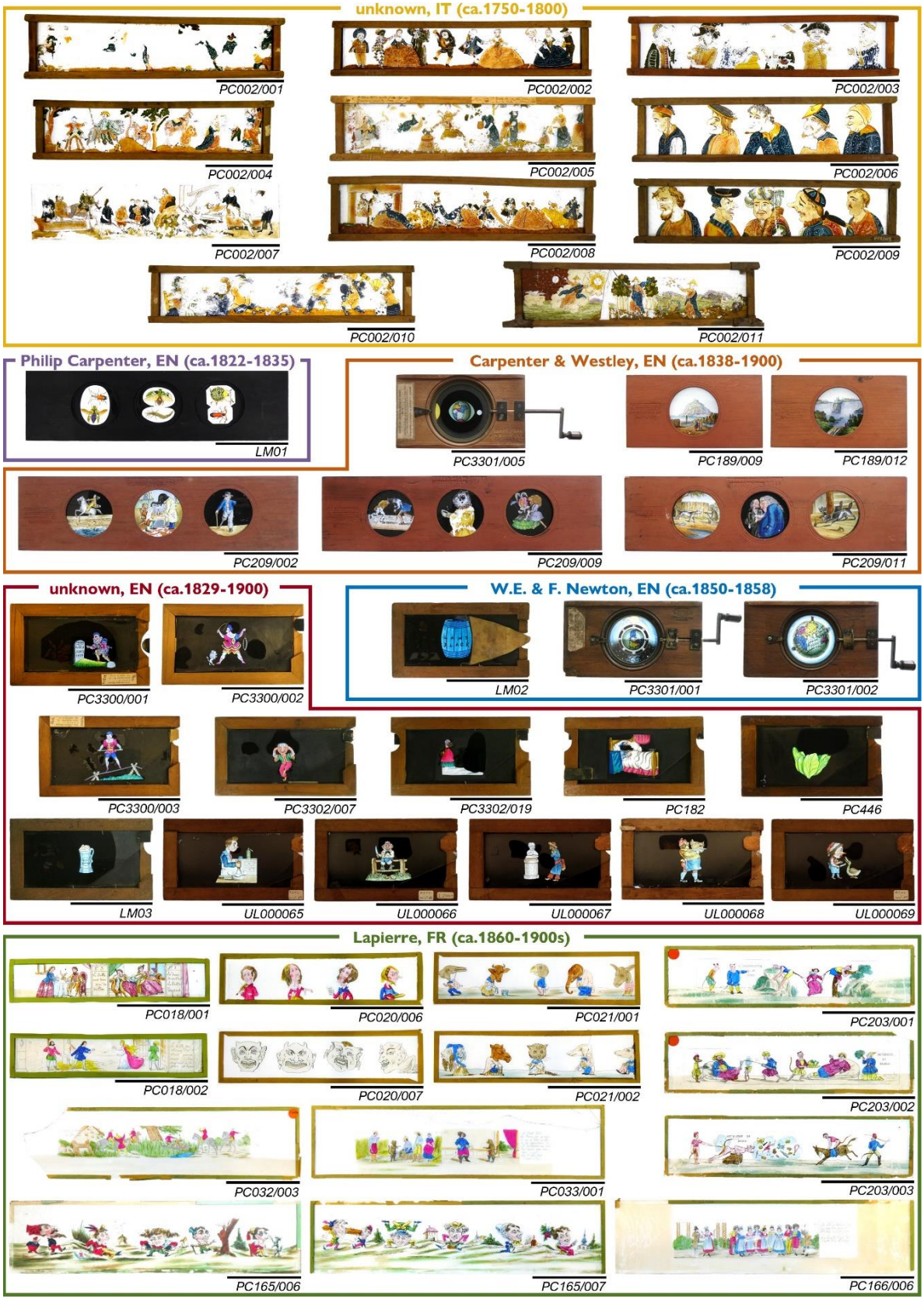


Figure 4.3 Magic lantern slides studied (48) grouped according to their attributed manufacturer, country and time of production. These slides are held by the Portuguese Cinematheque – Museum of Cinema (CPMC), the National Museum of Natural History and Science (MUHNAC) of the University of Lisbon, and the Research Unit VICARTE, and are attributed to Italy (IT), England (EN) and France (FR). The provided inventory numbers have the respective prefixes: CPMC-PC#, MUL-MUHNAC-UL#, and FCT.V.LM#. Scales: 10 cm.

4.2 A closer look at the glass support

Glass is commonly defined as a solid with a non-crystalline structure, and the lack of crystals allows it to be made transparent, one of the most valued characteristics (Dungworth 2019). The properties of different glass types are determined by their composition, which historically included quartz pebbles and silica (SiO_2) sand as the main glass network's former raw materials. Different alkaline oxides were added as fusing agents to decrease glass melting temperature and increase workability, which usually includes sodium (Na) and potassium (K) oxides, *e.g.,* natron (hydrated Na_2CO_3) and plant ashes (Na- or K-rich) (Navarro 2003). Nevertheless, since adding these materials compromised the glass's chemical durability, stabilising agents such as calcium, magnesium, and barium oxides were added (Navarro 2003). The raw materials could carry impurities, sometimes providing helpful information for provenance studies (Dungworth 2019).

From a historical point of view, the distinction between the objects' production centres and dates is fundamental. Holding institutions and collaborators stylistically attributed these magic lantern slides to specific places and periods of production. Nevertheless, most slides do not hold a production mark that can help in these attributions; therefore, the proposed period ranges were extensive in some cases, and the producers were unknown. Several slides also have multiple glass pieces, and it is often difficult to understand if they are all original since replacing broken, unpainted (or almost unpainted) glass sheets with new ones is a common practice.

Chemical analysis using EDXRF has proven to be a reliable source of information for identifying glass production centres and technologies following the relationships between them, the glassworks, and the diversity of formulations used throughout time (e.g., Rodrigues 2018). Furthermore, degradation studies on glass with different compositions revealed that besides the environmental conditions to which a glass object is exposed throughout its life, its chemical composition also influences its endurance (Kunicki-Goldfinger 2008). Therefore, analytical studies to uncover its history, composition, and preservation state heavily impact their interpretation, valorisation, and preservation. Considering various studies on glass formulations over time, a diagram for classifying glass compositional types produced in Europe during the 18th to the early 20th century is presented in **Figure 4.4**. This diagram is a guideline for classifying glass according to its chemical components (oxides). It should not be perceived as strict boundaries.

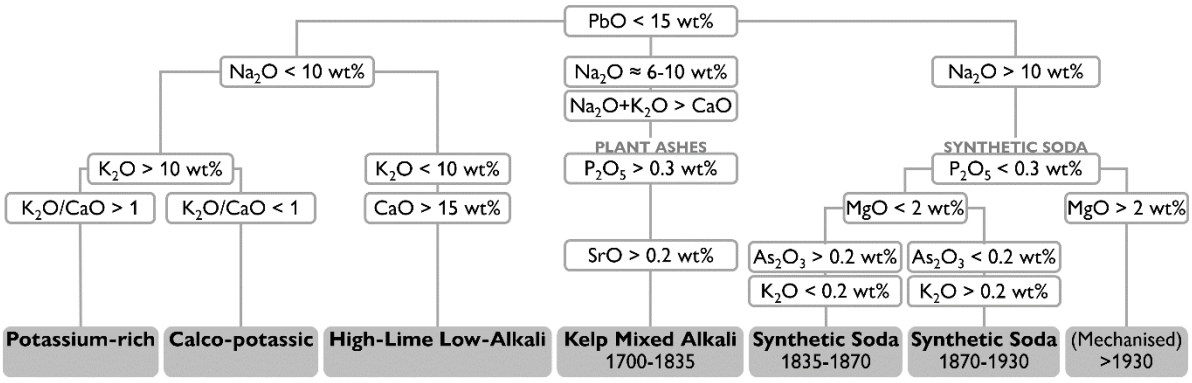


Figure 4.4 Diagram of the criteria used to classify the compositional type of glass based on the chemical components (oxides). For this diagram, previous classification studies by Schalm *et al*. (2007), Dungworth (2019), Girbal and Dungworth (2011), and Rodrigues (2018) were considered.

In recognition of the purposes of this study, the glass of 48 slides was visually and analytically characterised. Considering that 21 of these slides comprise more than one glass sheet, 74 glasses were studied[7]. The mapping of EDXRF analysis points for each glass is presented in *Appendix A.5*. The EDXRF instrumentation and experimental conditions are described in *Appendix A.4*

These analytical characterisation results were compared to glass compositions published for 18th- and 19th-century European glass (focusing primarily on flat and window glass production) to contribute more objectively with information on their chemical composition and elucidate the provenance of this group of glass slides. Furthermore, their chemical composition is presented and discussed with the proposed glass production technique typology to explore the relationship between the slides' stylistic characteristics, manufacturers, and glass production centres.

Data processing for the semi-quantification of the glass support

The semi-quantitative analysis was achieved with the WinAXIL program using spectra obtained from glass standards (A, B, C and D from Corning Museum of Glass (CMoG), Corning, NY, USA), under the same conditions, for validation (Brill 1999). The calculated error associated with SiO_2 and CaO is below 5 %. For SrO and BaO, the error is below 10 %. Regarding K_2O, MnO, Fe_2O_3, PbO, and SnO_2, the error varies between less than 5 % to 15 %. The error for CuO and ZnO varies between less than 5 % to 20 %, P_2O_5 is below 25 %, and TiO_2 is below 30 %. These errors are valid, assuming the glass surface was not significantly corroded. Given the limitations of the equipment and glass standards used, the range of quantities presented for light elements, such as sodium, magnesium, and aluminium, is merely indicative. The Na_2O and MgO concentrations were calculated using the "matrix by difference" method, which does not allow for separating these elements from other light elements that may exist in the glass, non-identifiable through this technique.

4.2.1 Glass chemical compositions

The semi-quantitative analytical results of the 74 glasses, presented in *Appendix A.6.1*, allowed the identification of four main compositional groups: potassium-rich (KR), mixed alkali (MA-k), high-lime low-alkali (HLLA), and soda-rich with synthetic soda (SS) glass (summarised in **Table 4.1**). The groups' definitions were made according to their compositional type and the information on the slides' manufacturer or production country. As observed in **Figure 4.4**, the glass classification considers the main constituents of historical glass compositions, which, besides silica (SiO_2), are dominated by the two types of alkali (K_2O and Na_2O), lime (CaO), and lead (PbO) in the lead-rich glass type.

The compositional groups identified in the magic lantern slides studied can be partially distinguished through their contents of potassium oxide (K_2O) and calcium oxide (CaO), which also correlates with the slides' production periods (**Figure 4.5**). This way, these main compositional groups are presented by chronological period (and by the most relevant glass production centres of that time).

[7] The fixed glass of slide CPMC-PC182 was not studied given the impossibility of accessing it.

Table 4.1 Elemental compositions of 74 sheets of glass support from 48 slides, grouped according to attribution and glass type following the criteria presented in Figure 4.4: potassium-rich (KR), high-lime low-alkali (HLLA), mixed alkali with kelp ash (MA-k) and synthetic soda (SS). The concentrations are given in weight percent (wt%). The minimum and maximum values presented for each group refer to the average composition of each glass (using six points of analysis) as shown in *Appendix A.6.1*, and the average of each group presented in this table considers the quantity of glass sheets in it (*e.g.*, 11 in the first group).

			Main Oxides										Minor Oxides								
Slides	**Type**		**Na_2O+MgO**	**Al_2O_3**	**SiO_2**	**SO_3**	**K_2O**	**CaO**	**MnO**	**Fe_2O_3**	**As_2O_5**	**PbO**	**P_2O_5**	**Cl**	**TiO_2**	**CuO**	**ZnO**	**Rb_2O**	**SrO**	**SnO_2**	**BaO**
unknown-IT	KR	min	BDL	1.67	68.83	0.11	12.25	7.33	0.013	0.08	0.064			0.09	0.010	0.002		0.007	0.006		
		max	2.31	1.96	72.00	0.29	19.18	11.48	0.043	0.30	0.572			0.26	0.024	0.004		0.026	0.011		
		avg-11	**~0.54**	**1.81**	**70.43**	**0.20**	**17.17**	**8.36**	**0.024**	**0.12**	**0.287**			**0.15**	**0.013**	**0.003**		**0.017**	**0.009**		
P. Carpenter	MA-k	min	8.63	0.01	67.50	0.11	2.62	11.40	0.041	0.49	BDL	0.060	0.95	0.20	0.072		n.d.		0.282		n.d.
PC3300/001-F,M		max	10.16	3.47	69.83	0.19	4.70	13.03	0.068	0.68	0.012	0.080	1.20	0.36	0.086		0.0132		0.390		0.060
		avg-5	**9.47**	**1.76**	**69.03**	**0.15**	**3.59**	**12.17**	**0.048**	**0.59**	**~0.007**	**0.069**	**1.03**	**0.31**	**0.081**		**~0.0062**		**0.323**		**~0.028**
C&W*	HLLA-a	min	5.54	0.42	72.00	0.20	0.20	12.87	0.258	0.19	0.127	0.060		BDL	0.034	BDL	BDL		0.020		BDL
		max	10.40	2.68	76.00	0.32	0.26	14.22	0.640	0.36	0.159	0.277		0.10	0.053	0.006	0.0035		0.025		0.052
		avg-11	**8.34**	**1.55**	**74.21**	**0.25**	**0.23**	**13.25**	**0.400**	**0.26**	**0.140**	**0.115**		**~0.06**	**0.045**	**~0.001**	**~0.0008**		**0.023**		**~0.008**
Newton	HLLA-b	min	5.89	0.43	72.00	0.20	0.19	9.15	0.009	0.21	0.167	n.d.	n.d.	n.d.	0.007	BDL	BDL		0.014		0.026
		max	12.85	3.07	76.50	0.32	0.81	13.85	0.392	0.38	0.597	0.057	0.65	0.07	0.043	0.0139	0.0185		0.042		0.340
		avg-6	**8.53**	**1.65**	**73.97**	**0.28**	**0.47**	**12.52**	**0.228**	**0.30**	**0.372**	**~0.019**	**~0.15**	**~0.03**	**0.035**	**~0.0052**	**~0.0071**		**0.023**		**0.139**
unknown-EN**	HLLA-c	min	4.08	0.07	72.33	0.19	0.18	11.58	BDL	0.10	BDL	n.d.	n.d.	BDL	0.030	BDL	BDL		0.011	n.d.	n.d.
		max	10.65	2.77	77.80	0.43	0.79	17.60	0.111	0.33	0.397	0.110	0.78	0.09	0.080	0.0076	0.0108		0.046	0.080	0.170
		avg-24	**6.84**	**1.07**	**74.89**	**0.30**	**0.35**	**15.27**	**~0.014**	**0.22**	**~0.055**	**~0.043**	**~0.06**	**~0.02**	**0.046**	**~0.0007**	**~0.0031**		**0.019**	**~0.027**	**~0.015**
Lapierre	HLLA-d	min	5.71	BDL	70.05	0.21	0.29	15.28	0.003	0.14	BDL	n.d.		BDL	0.036		0.0025		0.016		
		max	12.79	2.52	74.50	0.41	0.55	16.92	0.108	0.30	0.455	0.117		0.03	0.067		0.0041		0.029		
		avg-14	**8.53**	**~0.22**	**72.65**	**0.33**	**0.45**	**16.02**	**0.035**	**0.21**	**~0.073**	**~0.023**		**0.02**	**0.048**		**0.0033**		**0.019**		
PC3301/005-F,M	SS	min	19.77	0.09	60.70	0.19	0.21	10.45	0.007	0.17	0.037	BDL		BDL	0.031	BDL	0.0033		0.009	BDL	BDL
UL000068-M		max	23.92	2.8	66.33	0.24	0.58	12.55	0.014	0.20	0.665	0.035		0.05	0.032	0.0054	0.0756		0.011	0.05	0.100
		avg-3	**21.96**	**1.18**	**63.08**	**0.21**	**0.44**	**11.16**	**0.011**	**0.19**	**0.39**	**~0.022**		**~0.03**	**0.032**	**~0.0028**	**0.0279**		**0.010**	**~0.02**	**~0.057**

* Except for slide CPMC-PC3301/005, which has both fixed (F) and movable (M) glasses with a distinct composition (SS).

**Except the slide CPMC-PC3300/001 which has a MA-k composition, and the slide PC3301/005 and movable (M) glass from MUL-MUHNAC-UL000068 that are classified as SS.

BDL = below detection limit.; n.d. = not detected.; ~ = approximation considering n.d. and BDL values as zero.

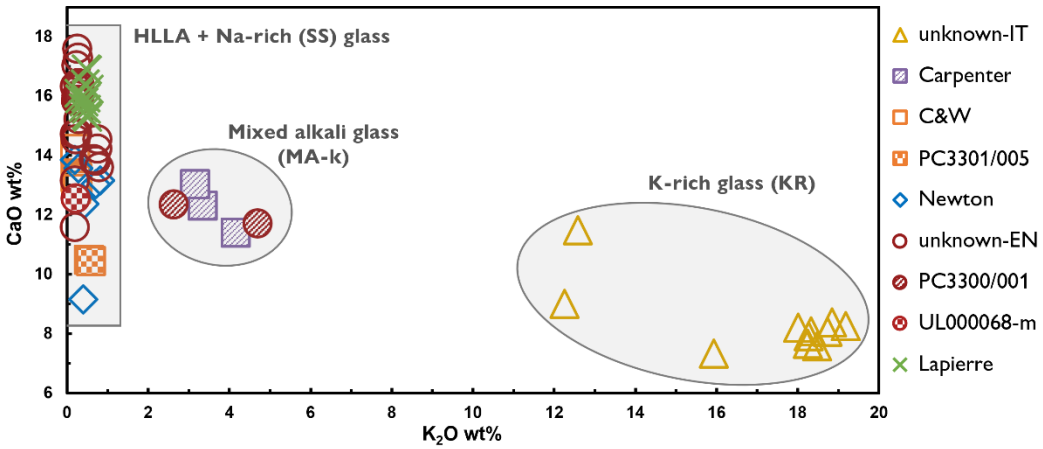


Figure 4.5 Scatter plot of the weight percent (wt%) concentrations of K_2O versus CaO showing a clear distinction between 18th-century potassium-rich (KR) glass, early 19th-century mixed alkali (MA-k) glass, second-half of 19th-century high-lime low-alkali (HLLA) and soda-rich (SS) glass. The composition classifications follow the criteria presented in Figure 4.4.

Potassium-rich glass

The 11 slides stylistically attributed to 18th-century Italy (CPMC-PC002/001-11) have potassium-rich or potassium-lime glass support. Although there is a lack of published studies regarding the composition of flat glass produced during this period to compare with the analytical results, their composition appears similar to three-dimensional objects of white or chalk glass produced in central Europe during the 17th and 18th centuries (Kunicki-Goldfinger et al. 2001; 2003; Rodrigues 2018, 94–97). These glasses are characterised by high quantities of K_2O (in most slides, between 18-19.2 wt% with only three with lower contents of 12-16 wt%) along with relatively high contents of CaO (7.3-8.4 wt% for the majority and even higher in two of the slides ~9-11.5 wt%). This amount of CaO was possibly introduced as chalk ($CaCO_3$) to compensate for the high K_2O content and stabilise the composition.

Additionally, these glass sheets contain more arsenic (As_2O_5) than manganese (MnO) as a decolourising agent and no lead (PbO). This central European white/chalk glass composition is also consistent with the indications of French or Bohemian glass in the 18th-century manuscript by Hertel (1716, 121), Denecke (1757, 265) and Nollet (1770, 3:345). Considering these slides are stylistically attributed to Italy, the glass could have been imported from central Europe or made in Italy following, *e.g.*, French glassmaking traditions as seen in previous centuries (Verità 2009).

Kelp-based Mixed Alkali glass

Five glass plates from two slides, one produced by Philip Carpenter (ca.1822-1835) (FCT.V.LM01) and the other by an unknown English manufacturer stylistically attributed to the second half of the 19th century (CPMC-PC3300/001), revealed a mixed alkali (MA) glass composition (**Table 4.1**). Compared to the other slides from the HLLA and SS groups, these glasses stand out for their higher contents of potassium (K_2O), strontium (SrO), iron (Fe_2O_3) and phosphorus (P_2O_5) oxides, lower calcium (CaO) relative to most HLLA glasses, and very low or absent arsenic oxide (As_2O_5) amounts (**Figure 4.6-A, B**). The higher quantities of Fe_2O_3 (~0.5-0.6 wt%) combined with low contents of MnO and low/no As_2O_5 as decolourising agents are the probable cause for these glasses' slight greenish tint. The presence of P_2O_5 between 1-1.2 wt% and the content of SrO above

0.2 wt% is indicative of a kelp glass, for which seaweed ash was used as a flux, giving a more variable content of K_2O oxide (Dungworth, Degryse, and Schneider 2009; Dungworth 2012; 2013). According to Dungworth (2012; 2013), this composition can be assigned to a period between the late-17th and early-19th century (ca.1835) of English production, when plant ashes were replaced by synthetic soda.

The chronology and production country proposed by these analyses for slide FCT.V.LM01 matched the attribution to the English producer Philip Carpenter and date of ca.1822-1835, pinpointed by the type of black-coloured wooden frame, trademarks on the frame and painted figures. On the other hand, slide CPMC-PC3300/001, although stylistically attributed to England, was thought to be from the second half of the 19th century (ca.1860). It is interesting to notice that an inscription with the year '1829' was painted on this slide. Considering that the chemical analyses suggested that the glass was produced before 1835, it strengthened the hypothesis that the inscribed year may be the year of the slide production, or it may have been painted between 1829 and 1835.

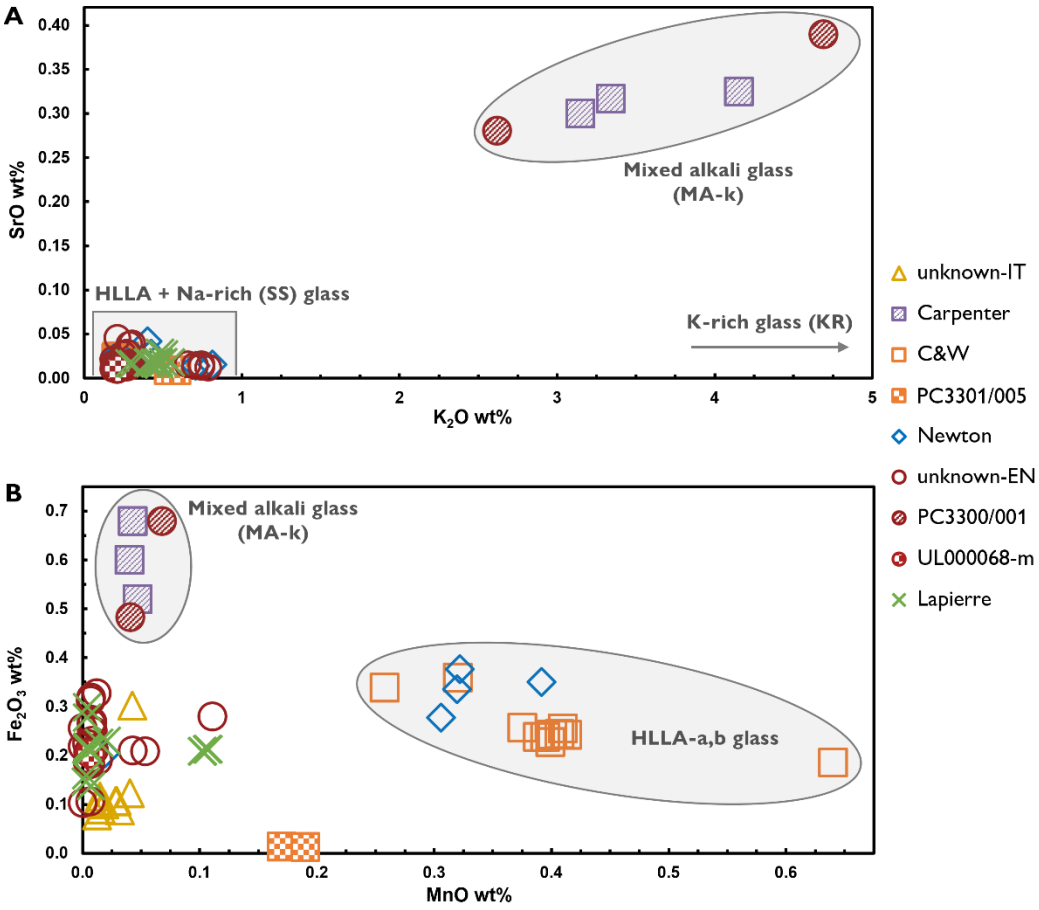


Figure 4.6 Scatter plot of the weight percent (wt%) concentrations of: (A) K_2O versus SrO, showing distinct contents between mixed alkali glass plates and the remaining 19th-century slides. (B) MnO versus Fe_2O_3, shows higher MnO content as a decolourising agent on glasses used by the 19th-century English slide manufacturers C&W and Newton. The composition classifications follow the criteria presented in Figure 4.4.

High-lime low-alkali glass

Almost all French and English slides from the 19th century fall into the high-lime low-alkali (HLLA) glass type characterised by the high contents of SiO_2 (70-78 wt%) and CaO (12-18 wt%) and low amounts of K_2O (0.2-0.8 wt%) and impurities.

These HLLA glasses are subdivided into four groups, considering the manufacturers of the slides and their compositional differences. For example, Newton slides (HLLA-b) differ from the others due to the lack of lead (PbO) and the use of higher contents of MnO and As_2O_5 as decolourising agents, possibly to compensate for higher amounts of Fe_2O_3. Also, Lapierre slides (HLLA-d) do not have copper (CuO) and barium (BaO) oxides and have more As_2O_5, possibly for the same reason as Newton's slides. Through the binary scatter plot of MnO versus Fe_2O_3 concentrations (presented in **Figure 4.6-B)**, it is possible to observe a clear separation of HLLA-c and -d from the other two groups of glasses used by the renowned English slides' producers C&W and Newton (HLLA-a and -b), given the higher content of MnO added as a decolourising agent.

Synthetic soda-rich glass

Another composition could be identified in both glasses from the slide CPMC-PC3301/005 produced by Carpenter & Westley (C&W) and a movable glass of slide MUL-MUHNAC-UL000068, stylistically attributed to 19th-century England. These three glasses can be classified as soda-rich, with a much higher content of light elements (Na_2O + MgO around 20 wt%) and lower SiO_2 than other HLLA glasses, with no PbO nor P_2O_5 detected, and low amounts of impurities (**Table 4.1**).

Although there is a significant error associated with the calculation of the light elements, the indication of high quantities of Na_2O, the absence of P_2O_5, and As_2O_5 above 0.2 wt% (possibly added as decolourant and fining agent) for the CPMC-PC3301/005 and below 0.2 wt% for MUL-MUHNAC-UL000068, points to a synthetic soda (SS) glass composition, respectively characteristic of the periods 1835-1870 and 1870-1930, according to Dungworth studies on English flat glass production (Dungworth 2012). Considering these analytical results and the threshold defined by the typology and the aesthetic characteristics of these slides, it can be proposed that the glass of MUL-MUHNAC-UL00068 was produced before 1900.

In the case of MUL-MUHNAC-UL000068, the date attribution based on the glass alone can be problematic, given the presence of two painted glasses with different compositions. It should be noted that the glass fixed within the wooden frame belongs to the HLLA-c compositional group. Some of the reasons to find different glass compositions within this slide could be a) if the movable glass had been broken and replaced at some point in history, or b) if the slide manufacturer was supplied by different glass producers or used glasses available in stock produced in different periods. However, this movable slide presents colourful and detailed painted motifs visually similar to those painted on the fixed glass. In this case, the analytical characterisation of the painting materials was fundamental to determine that both glasses were painted with the same materials, suggesting both are original parts and were painted after 1870, reinforcing the importance of using complementary analysis and crossing information.

Possible signs of glass deterioration

Glass deterioration mechanisms under typical environmental conditions are highly complex multi-phase systems and, besides the glass composition, depend on several other influencing factors such as varying temperature and relative humidity, nature and concentration of airborne pollutants (e.g., sulphur and formic acid) and particles, among others. In summary, corrosion may happen when glass is attacked by aqueous solutions or atmospheric water, and H^+ from the water enter the glass network and replaces alkali metal ions such as Na^+, leaching them and forming Na-rich films on the surface, prone to forming corrosion products (Brill 1999; Robinet et al. 2009).

In this way, one of the signs of glass deterioration that can be detected when analysing glass objects is the enrichment of the glass surface with Na^+ ions removed from the glass structure (A. Rodrigues 2018). Although the analytical methodology used in this study does not allow for the quantification of sodium content in the glass separately from other light elements, nor the stratigraphic analysis of the glass composition, by analysing both sides of each glass, it was possible to detect significant differences in the light elements' contents between the sides A and B of four glasses: movable glasses (M) of slides MUL-MUHNAC-UL000066 and UL000069; and glasses 3 and 2 respectively of slides CPMC-PC209/009 and PC209/011.

The glass that showed the most variation between the painted and non-painted sides (A and B, respectively) was the UL000066-M, with a standard deviation 9.05 concerning the Na_2O + MgO contents. Side B has contents of Na_2O + MgO between 3.9 and 5.7 wt%, while the painted side presents values between 18.9 and 24.6 wt%, possibly indicating glass deterioration. This side of the glass is less ventilated since it is in contact with the fixed glass of this slide, which particularly favours glass reactions with atmospheric water captured between both glass sheets. Variations in the other three cases are less intense (from 3.8 to 5.7), the sides with higher contents of light elements do not face another glass, and only in PC209/009-glass 3 does it hold the painting.

4.2.2 Technological evolution

With this selection of representative magic lantern glass slides, it was already possible to estimate periods of occurrence of the various groups of compositions identified. This estimation, based on publications concerning well-studied production centres' compositions (*e.g.,* 19th-century English window glass), allowed the suggestion of more accurate date ranges for the glass production of slides helped by the information of known manufacturers and stylistic characteristics of slides.

Regarding glass production techniques, 18th-century glasses appear to have been produced using the *crown* or *plate* technique, given that the tiny round-shaped bubbles are slightly tilted to the same side and have a homogeneous thickness (**Figure 4.7-A**). Since *plate* glass only allowed the production of sheets with a minimum of 6 mm at the time, and these glass slides are only around 2 mm thick, the use of the *crown* technique is more probable. In addition, the use of Central European *crown* potassium-rich glass to produce stained glass has also been reported (Caen 2009, 241; Dungworth 2012).

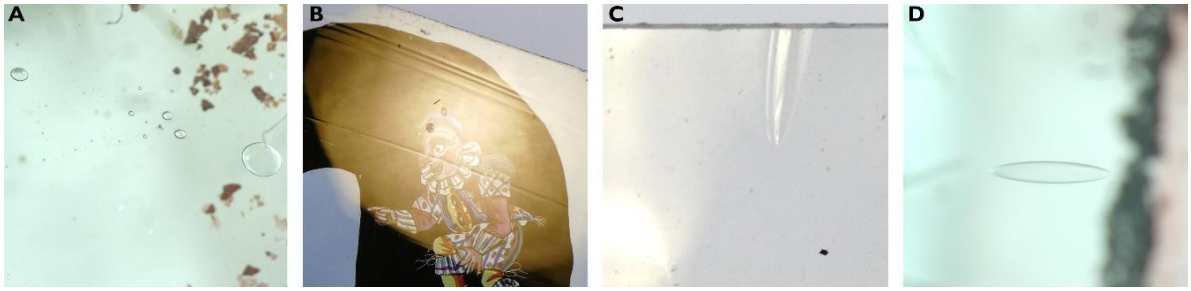


Figure 4.7 Bubbles and defects present on the glass support of magic lantern slides. (A) Round-shaped bubbles, possibly resulting from the *crown* technique, during the 18th century in central Europe (CPMC-PC002/004). (B) Concentric 'ripples' and 'fire-polished' surface characteristic of crown glass, produced in England in the early 19th century (CPMC-PC3300/001). Elongated bubbles typical of the cylinder technique, visible on (C), the English 19th-century slide (CPMC-PC3300/003), and on (D), the French 19th-century slide from Lapierre (CPMC-PC203/003).

On the 2 mm-thick movable glass from the slide CPMC-PC3300/001, it was possible to observe the presence of concentric 'ripples' on a 'fire-polished' surface, characteristic of the *crown* glass technique (**Figure 4.7-B**). It is also worth mentioning that kelp *crown* glass was produced in England until the early 19th century, which correlates with the composition's chronology (ca.1835) and the date inscription in the figure '1829' (Dungworth 2011; 2012).

Most glass plates of 19th-century slides from English and French producers appear to have been produced by *cylinder* techniques, given the elongated bubbles (**Figure 4.7-C, D**). In addition, the thickness of around 2 mm is frequently homogeneously distributed through the glass, and the surface is usually smooth on both sides, suggesting the use of *improved cylinder* techniques introduced around the 1830s (Dungworth 2012). It is worth mentioning that while France continued producing most flat glass with the *cylinder* technique throughout the 18th century, England used almost exclusively the *crown* method due to the taxation system by weight, which made *crown* glass more advantageous as it allowed for much thinner glass (Dungworth 2011).

Finally, by crossing the information gathered on the slides' chemical composition and production techniques, it was possible to design a chronological overview (**Figure 4.8**), informed by several authors' studies on flat glass production (e.g., Cable 2004; 2008; Caen 2009; Dungworth 2011; 2012; Nascimento 2014).

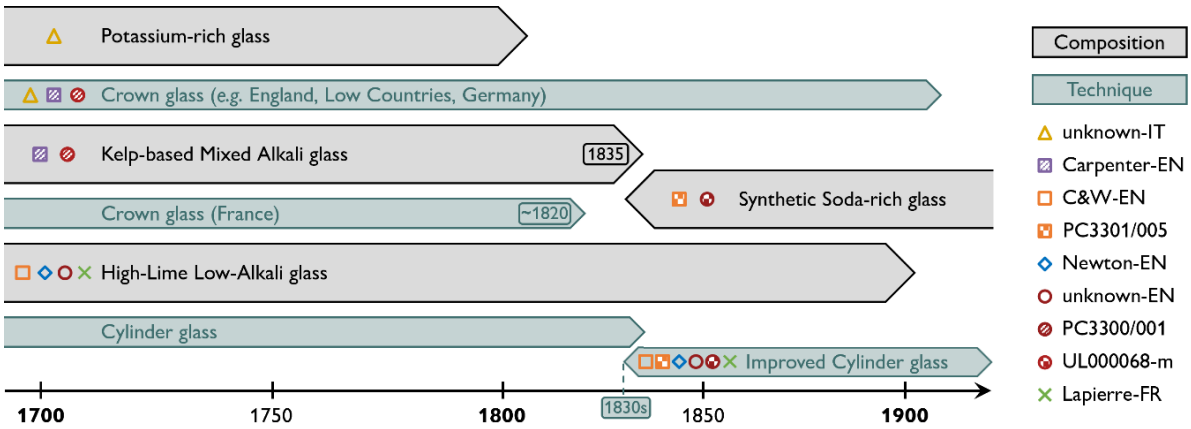


Figure 4.8 Chronological overview of the evolution of glass compositions and flat glass production techniques during the period of production of the studied painted glass slides (18th and 19th centuries). The symbols of the various groups of slides studied are distributed according to the suggested compositions and production techniques. Scheme inspired by Caen (2009).

4.3 Magic paintings' molecular palette and techniques

The art of painting magic lantern glass slides can be better appreciated and preserved if we deeply acknowledge its painting techniques and the materials chosen by the different painters and manufacturers. These paintings belong to a particularly interesting period to study due to the changes in the production of artists' materials fostered by alchemy, giving place to chemistry and the discovery of new elements that triggered the development of different compounds and colours (Harley 2001). The painter's colour palette rapidly reflected the increased production of new pigments.

Regarding the painting techniques, each manufacturer (known or unknown) had distinctive technical and aesthetical characteristics (**Figure 4.9**). For instance, Italian and English producers frequently combined different paints in subtle colour gradients and hues. In hand-painted Italian and English slides by unknown makers and those by Newton, the outlines were evident even in complex visual compositions. Strongly marked black printed outlines were also characteristic of Lapierre's slides; however, their designs appeared less complex for being painted with fewer colours (up to five) and very pure. In contrast, we can hardly see any painted outlines in Philip Carpenter's slides as they were made with the same colours as the figures. Even when they transitioned to printed outlines, already under Carpenter & Westley, they kept the black outlines thin and blended them with complex colour gradients.

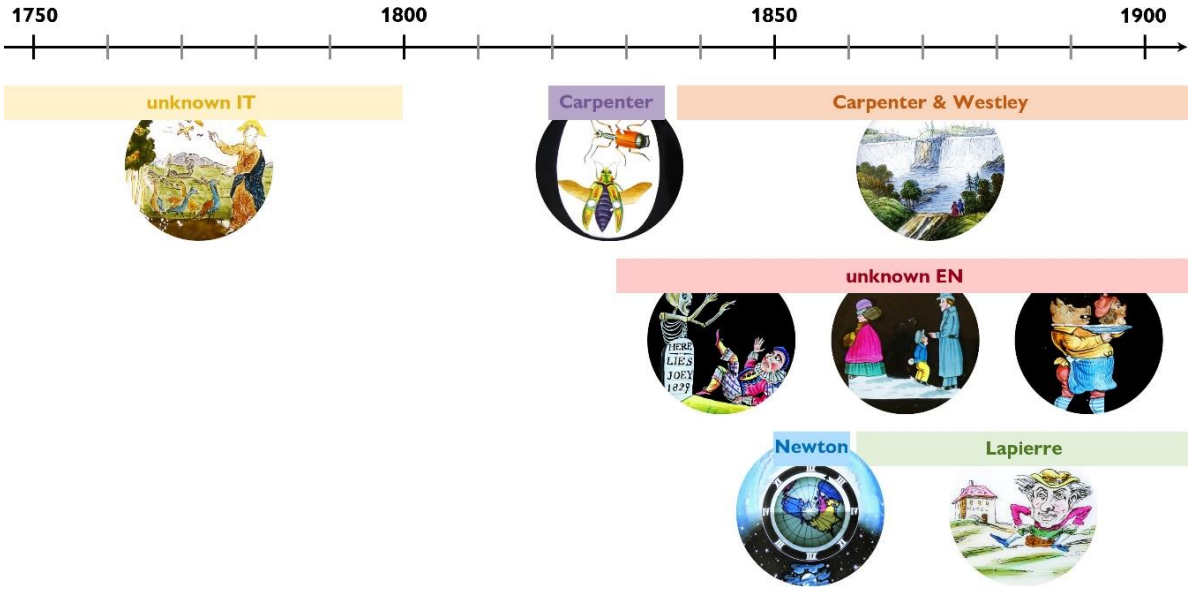


Figure 4.9 Details of slides from each group showing the various aesthetic characteristics distributed according to the production timeline suggested for the different sets of magic lantern slides analysed.

As identified in the literature review presented in *Section 1.2*, oil colours, watercolours, and varnishes were the preferred binding mediums. For that matter, one should bear in mind that besides their respective main components of drying oils, gums and natural resins, these complex mediums could include or be mixed with a variety of other components such as balsams (*e.g.,* turpentine and Canada balsam), solvents, glycerine (*e.g.,* in the case of W&N watercolours explored in *Chapter 2*) and many other additives. In the formulation of these paints, besides

binders and colourants, there may be other additives such as fillers (also known as extenders or inerts). These inert substances not only helped to increase volume, intensify, diffuse, or dilute the colours and improve certain properties (such as their mechanical resistance or optical properties) but also had the advantage of lowering the price of paints using dyes or pigments with high tinctorial power considering the lower amount of colourant necessary to their production (Gysau 2006; Eastaugh et al. 2008). These compounds can also be found in paints as bases or substrates of lake pigments. Examples of extenders used include calcium sulphate (gypsum), calcium carbonate (chalk), aluminium silicate (kaolin), and barium sulphate (Gysau 2006). Considering the extensive number of components that could be present in magic lantern glass paintings and the ageing of these materials, there was an increased complexity when analysing these objects.

4.3.1 Binding medium: the invisible component

The binder is the fundamental component responsible for maintaining the cohesion of the paint and creating adhesion between the paint and the glass support. Although often colourless and transparent, it may influence how colours are perceived and change over time and the overall stability of the paint. Written historical sources point to gums, oils and natural resins as the preferred binding materials for magic lantern glass paintings. Resins could be applied as a preparation layer, mixed with the colourants as a binder, or as a final protective layer to improve adhesion and optical properties such as transparency and shine, depending on their nature. Therefore, its characterisation is essential to comprehending the paint formulations used on lantern slides and the degradation problems already visible in some objects.

μ-FTIR analyses were performed on 53 micro-samples (five yellow, four brown, 16 red/pink, two purple, ten blue, six blue-green, six green, two black and two from areas of colourless binder) from 30 slides (indicated in *Appendix A.5*). As previously mentioned, the choice of slides and sampled areas was restricted. However, preference was given to yellow, red/pink and blue samples. These primary colours were chosen for being frequently intermixed to create other colours and being more prone to fading (organic yellows and reds/pinks). In addition, blue (identified in all these slides as Prussian blue by μ-Raman before sampling) was selected for its sharp C≡N stretching band at 2090 cm^{-1}, which does not overlap with the areas of characteristic bonds from oils, gums and natural resins, easing the binder's identification. μ-FTIR also identified several other colourants and additives mixed with the binder. Representative spectra of each group of slides are presented in *Appendix A.6.2,* and the respective μ-FTIR bond assignments are in *Appendix A.7*.

The infrared spectra generally showed complex fingerprints as all binders included natural resinous-based components. When more than one colour of the same slide was tested, the results pointed to the use of the same binder. Nevertheless, natural resins may mask the molecular fingerprint of other ingredients, such as oils or gums characteristic of oil paints and watercolours. The analysis identified two main binder components as terpenoid resins, possibly mastic and shellac, consistently advised by written sources revised in *Subsection 1.2.3* (**Figure 4.10**).

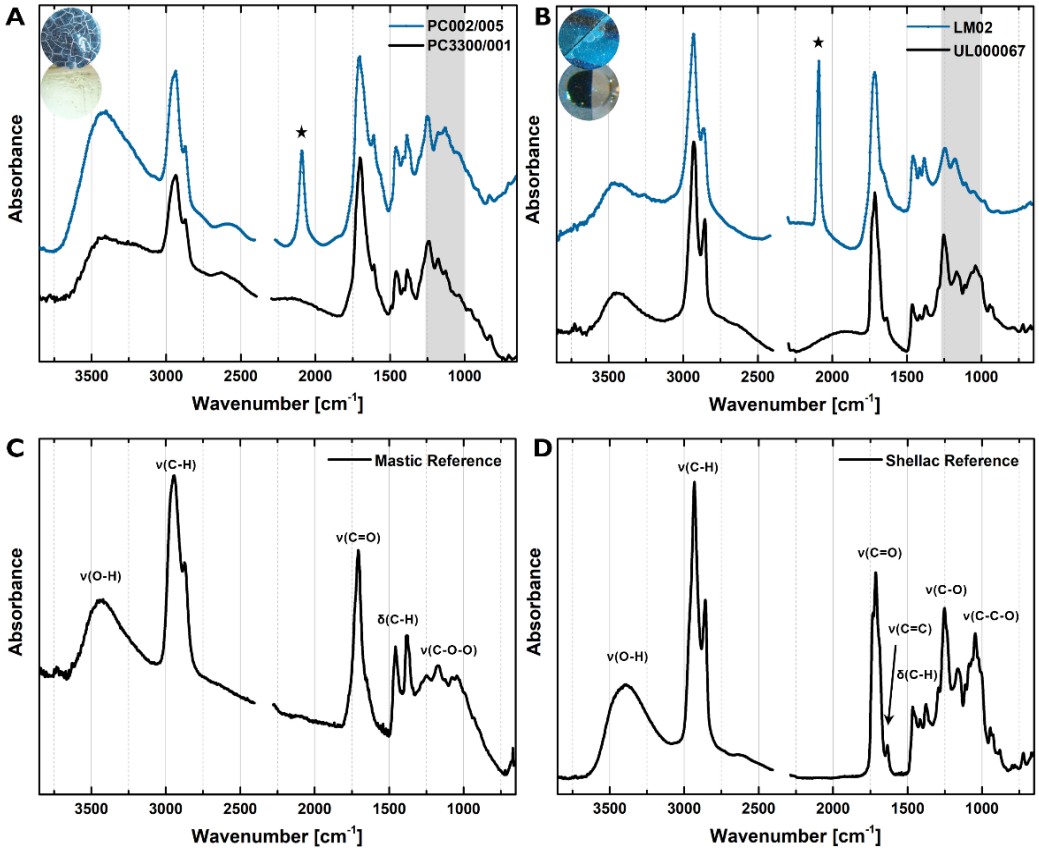


Figure 4.10 Infrared spectra of binders identified on magic lantern glass slides: (A) spectra of a blue and colourless paint area mainly composed of mastic resin, from slides PC002/005 and PC3300/001, respectively; (B) spectra from a blue and colourless paint area mainly composed of shellac resin, from slides LM02 and UL000067, respectively; (C) reference spectra of a mastic resin from DCR FCT-NOVA; (D) reference spectra of a shellac resin from DCR FCT-NOVA. The bands marked with (★), at 2090 cm^{-1}, are assigned to the Prussian blue pigment's ν(C≡N).

Mastic resin

Mastic resin appears to be the main binder component of slides produced in the 18th and 19th centuries by unknown producers from Italy and England and by Lapierre[8] from France, represented through the spectra in **Figure 4.10-A**. In the case of Lapierre slides, it was challenging to ascertain the binding medium used, given that only yellow and pink areas were analysed using μ-FTIR, and the fingerprint of their colourant, complexing agents, and fillers may influence the spectra interpretation. Nevertheless, these slides appear to have similar binder profiles. Notably, mastic constitutes the most advised varnish of 18th and 19th-century literature for magic lantern glass painting. Mastic is a pale-yellow natural resin produced by the *Pistacia Lentiscus* tree, soluble in ethanol but not in petroleum ethers, and used as a varnish for oil paintings (Carlyle 2001). When dissolved in turpentine with linseed oil, it formulates a painting medium called Megilp, also recommended for magic lantern painting by the end of the 19th century (Hepworth 1889; Winsor & Newton 1896; Carlyle 2001).

[8] Mastic resin was identified in slides: PC002/003, 5, 6, 9, 10; PC3300/001, 2, 3; PC3302/007, 19; PC182; PC018/001-2; PC203/002; PC033/001; and PC165/006-7.

The infrared analysis detected the presence of a terpenoid resin, such as mastic, displaying a strong band at ~2950 and a band at ~2870 cm^{-1} assigned to the C-H stretching vibrations, a broad O-H stretching band around 3450-3400 cm^{-1} and usually a weak and broad band occurring at ~2600 cm^{-1} due to the O-H vibrations (Derrick, Stulik, and Landry 1999; Zumbühl et al. 2017). It can be identified through the strong carbonyl (C=O) stretching band at ~1700 cm^{-1}, a C=C stretching shoulder at ~1649 cm^{-1}, the C-H bending bands at ~1457 and ~1385 cm^{-1}, and its fingerprint region (1300-600 cm^{-1}) presents the bands at ~1235-1245 cm^{-1} and ~1180 cm^{-1} assigned to the carboxylic and hydro-peroxide (COOH and COOOH) stretch vibrations (Derrick, Stulik, and Landry 1999; Azémard, Vieillescazes, and Ménager 2014; Ciofini et al. 2016; Zumbühl et al. 2017).

The slides' spectra (**Figure 4.10-A**), particularly those by Lapierre, also show a band at ~2935 cm^{-1}, broadening the mastic C-H stretching band at ~2950 cm^{-1}. In addition, they show the broadening of the carbonyl band to higher wavelengths, along with the broadening of the two C-H bending bands around 1456 and 1383 cm^{-1}, a third band at 1410 cm^{-1} (more intense in slide PC3300/001), as well as the bands at 1178, 1039 and 832 cm^{-1}. These characteristics may be indicative of a mixture of mastic resin with oil (Ciofini et al. 2016; Zumbühl et al. 2017). Furthermore, compared to the reference sample (**Figure 4.10-C**), there is a broadening of the absorption in the carbonyl stretching region and an increase of the bands around 3230 and 2600 cm^{-1}, which could be due to the formation of degradation products such as carboxylic acid groups (Ciofini et al. 2016). The increase in the intensity of the bands highlighted in grey in **Figure 4.10-A**, when compared to the bands assigned to the C-H bending, can also suggest the formation of oxidation products (Ciofini et al. 2016). These indications of binder degradation, accentuated in the 18th-century slides, are consistent with the failure of the paint's cohesion and adhesion to the glass substrate observed in these earlier slides at a macroscopic level as craquelure and paint loss (**Figure 4.11**). Although slides from 19th century England (represented by the spectrum of PC3300/001) appear to be in better condition, they also show molecular alterations consistent with the brittleness and lack of adhesion to the glass observed under the stereomicroscope.



Figure 4.11 Detail of the slide CPMC-PC002/010, showing severe microcracking and paint loss.

Shellac resin

Another terpenoid resin, possibly shellac, was identified as the main constituent of the binders from 19th-century slides produced by Carpenter & Westley and W.E. & F. Newton (represented by the spectrum of slide LM02), those by an unknown manufacturer held at MUHNAC (represented by the spectrum of slide UL000067), and possibly in one slide by Lapierre (**Figure 4.10-B**)[9]. Shellac is a yellow-brown resin excretion from the lac beetle insect *Laccifer lacca* that is usually prepared as spirit-varnish by dissolving it in alcohol, and it is sometimes mixed with oleoresins for elasticity and other resins such as mastic, sandarac, and Manilla copal (Carlyle 2001). Although it was only explicitly recommended by two of the revised written sources on slide painting, one was published by Winsor & Newton (Groom 1855). Also, many 19th-century authors who wrote about painting materials advised this varnish for its transparency, hardness, and durability (Carlyle 2001). During the 19th century, several methods were developed to decolourise shellac resin, for example, using charcoal or through chemical bleaching using chlorine (*e.g.,* by George Field, 1827), resulting in products commonly known as white lac varnish (Carlyle 2001; Veale et al. 1827; Sutherland 2010).

Shellac resin shows a broad O-H stretching band with a maximum absorbance of around 3430 cm^{-1}, and its C-H stretching profile bands fall around 2930 and 2857 cm^{-1} (Derrick, Stulik, and Landry 1999). It contains a strong C=O stretching band centred around 1715 cm^{-1} with shoulders at around 1735 and 1690 cm^{-1}, a small olefinic C=C stretching band around 1640-1635 cm^{-1}, C-H bending bands at around 1460, 1415 and 1380-1375 cm^{-1}, and several C-O stretching bands, in particular, at 1250-1240, 1163 and shoulder at 1140 cm^{-1}, a group of bands from the stretching of the C-C-O bonds at ~1045 cm^{-1} with shoulders at 1065 and 1006 cm^{-1}, the bands at 945, 927, 899, 796 and 780 cm^{-1}, and finally at around 722 cm^{-1} from the rocking of CH_2 bond (Derrick, Stulik, and Landry 1999; Ciofini et al. 2016; Zumbühl et al. 2017).

The two representative spectra presented in **Figure 4.10-B** are primarily distinguishable by their paintings' different states of preservation. In both groups, a decrease in the C-H stretching bands and an apparent increase in the carbonyl stretching region are noticed (when compared to the reference in **Figure 4.10-D**), possibly due to the presence of hydroxyl and carboxylic groups, which allied to a slight shift of the CH_3 bending band from ~1376 to higher wavenumbers (observed in LM02) may suggest structural deformations (Ciofini et al. 2016). Also evident in slide LM02, is the reduction of the C=C bond signal and C-C-O stretching of the alcoholic group centred at ~1045 cm^{-1}, possibly due to its cross-linking process (Ciofini et al. 2016). In several slides from Carpenter & Westley and W.E. & F. Newton, the brittleness and lack of adhesion to the glass surface are already a dramatic conservation problem.

These analyses allowed for a correlation between the slides and the written historical sources studied in *Subsection 1.2.3*. From the components identified, mastic varnish was the most advised binder throughout the 18th and 19th centuries, whether mentioned in combination with solvents, balsams, or oils. Late-18th and mid-19th centuries literature also advised shellac varnish,

[9] The slides in which shellac was identified are: PC189/009; PC209/002; LM02; PC3301/001-2; UL000066-69; and possibly PC166/006.

distinctively identified in 19th-century slides. It is worth noting that besides varnish colours, watercolours and oil paints were systematically recommended for magic lantern glass painting and, as observed from the preliminary study on the Winsor & Newton watercolours (*Chapter 2*), many more additives could be present in these paintings. Given the possible complexity of these mixtures, and considering that these natural resins may mask the molecular fingerprint of other components (*e.g.*, gums and oils), it is essential to complement this analytical μ-FTIR study with other molecular techniques, such as Gas Chromatography-Mass Spectrometry (GC-MS), to characterise further these paintings' binding mediums and additives.

4.3.2 Colourants' identification

Colour changes are expected in painted magic lantern slides, given their exposure to high temperatures and periods of intense light during projection shows. These may transform not only the original paint but also our perception of the colour palette, manufacturers' trademarks, and impact on the audience of that time. To increase our current knowledge, the colour of 46 magic lantern slides (excepting CPMC-PC209/009, /011) was observed under a stereomicroscope and examined using EDXRF, UV-VIS, and Raman techniques. In addition, μ-FTIR analyses were performed in several colours, favouring organic yellows and red/pink lakes to advance their identification. One pink sample (from CPMC-PC209/002) was also selected for SERS analysis to identify the chromophore. A summary of the results obtained, and representative spectra can be consulted in *Appendix A.6.2*.

White

In magic lantern slides, the white colour is obtained by the lack of pigment, which allows the projected light to pass through the colourless glass support, reflect on a white surface, and reach the audience's eyes almost undisturbed. Many artists used it to play with the light as part of the paintings by making the figures stand out from the background, drawing details, or writing with 'chalk white' lines by scratching methods (**Figure 4.12**). In this sense, white was considered a colour used in magic lantern glass painting without adding colourants, as pointed out in the historical literature (*Section 1.2*).

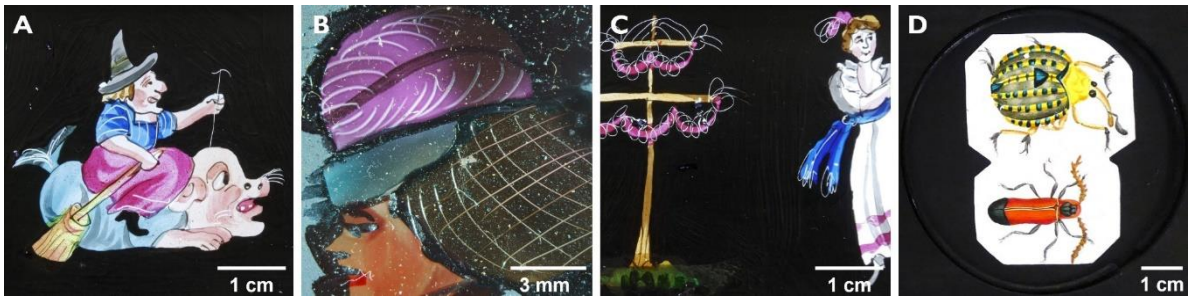


Figure 4.12 Details of 19th-century magic lantern glass slides displaying the use of colourless areas as part of the painting by applying scratching techniques to give shape and add details to the figures or by using large areas to make figures stand out. From CPMC collection: (**A**) PC3303/002, unknown, France; (**B**) PC3302/019, unknown, England; (**C**) PC3303/004, unknown, France. From VICARTE collection: (**D**) FCT.V.LM01, Philip Carpenter, ca.1820-1835, England.

Red and Pink

In 18th and 19th-century colour systems, red was already one of the three primary colours, along with yellow and blue, and can be observed in most magic lantern slides. In the set of objects analysed, hematite, a copper-based red pigment, an animal anthraquinone-based lake (probably from cochineal), eosin lakes (geranium lakes) and vermilion were identified in red and pink hues.

Red ochre (Hematite)

Red ochres are seen as the first red pigments used by humans. Even though this pigment was not advised for magic lantern glass painting in the studied literature, hematite (the reddish anhydrous iron oxide, α-Fe_2O_3) was identified in 18th-century slides to outline all the painting motifs, to colour elements (*e.g.,* musical instruments, hats, and hair), and to paint a large area of a night sky (**Figure 4.13-A**). The strong presence of iron (Fe), detected by EDXRF and its UV-VIS and Raman characteristic bands, allowed for the identification of this colourant (**Figure 4.13-B, C**).

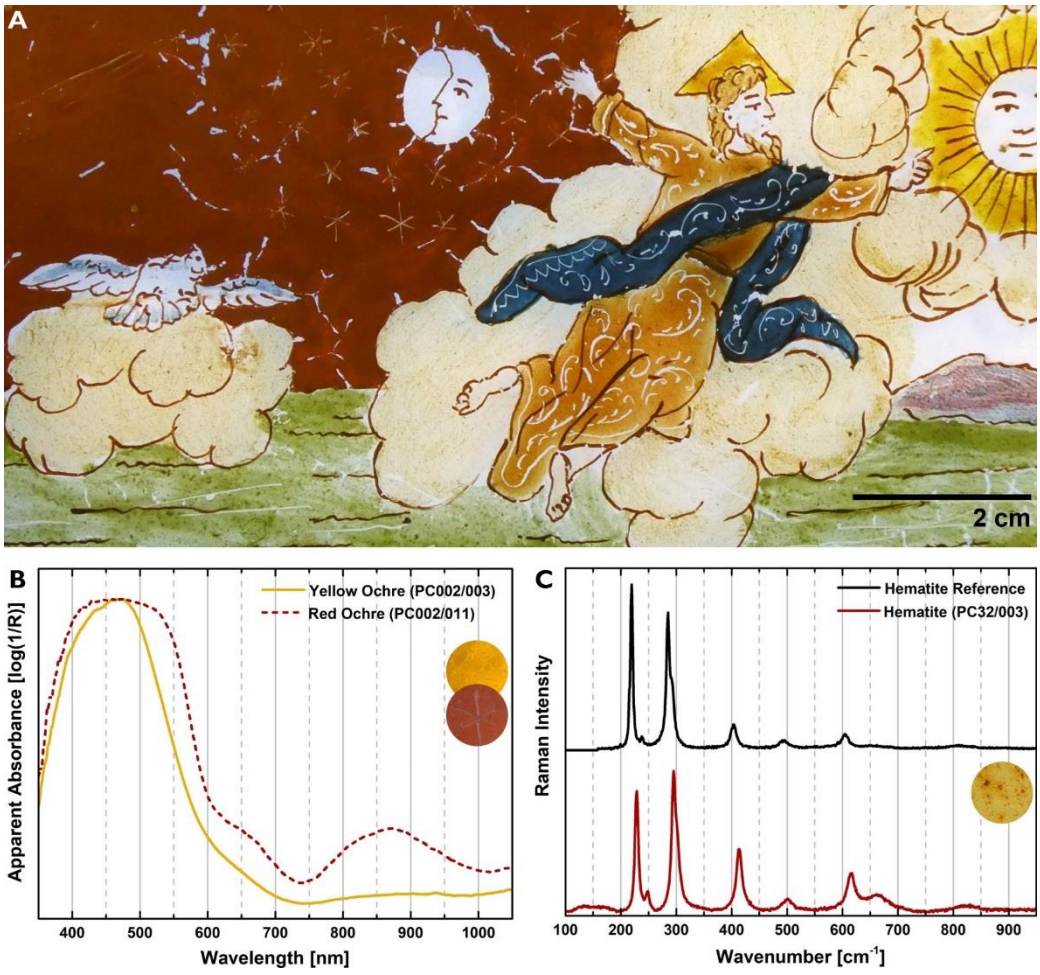


Figure 4.13 (A) Detail of the 18th-century magic lantern slide CPMC-PC002/011 attributed to Italy showing large areas painted with red iron oxide and the use of this colour for all the outlining. The yellow iron oxide paint is also visible in the triangular halo and sun. (B) UV-VIS apparent absorbance [log(1/R)] spectra of red and yellow iron oxides (α-Fe_2O_3 and α-FeOOH, respectively). (C) Representative Raman spectrum of hematite (α-Fe_2O_3).

Although slightly saturated, the UV-VIS spectrum shows four bands in the visible and near-IR regions (380-1050 nm) (**Figure 4.13-B**). The strong band of the electron pair transition $2(^6A_1)\rightarrow2(^4T_1)$, which exists at 530 nm for hematite, is the one with the most influence in the red colour observed (Torrent and Barrón 2002). The band at 440-450 nm and the weak absorption at around 660 nm are respectively attributed to $^6A_1\rightarrow{}^4E;{}^4A_1$ and $^6A_1\rightarrow{}^4T_2$ transitions, and the broad absorption band induced by the $^6A_1\rightarrow{}^4T_1$ transition is featured near 860 nm (Torrent and Barrón 2002; Cheilakou, Troullinos, and Koui 2014). The Raman spectra presented the characteristic bands of the Fe-O stretching vibrations at 228 and 498 cm^{-1} and the Fe-O bending bands at 247, 295, 413 and 617 cm^{-1} (**Figure 4.13-C**) (Legodi and de Waal 2007).

Cochineal lakes

Red dyes extracted from plants and insects have been precipitated with white inorganic substances as complexing agents (*e.g.,* based on aluminium (Al) and calcium (Ca)) to obtain an insoluble pigment with a red or pink hue since antiquity (Melo 2009). Red/pink lake pigments were considered essential for magic lantern glass painting, being present in every list of pigments mentioned by 18th and 19th-century authors. Cochineal-based lake pigments, such as Carmine and Crimson Lake, were the most advised and possibly the ones identified in five 18th-century slides, all 19th-century slides attributed to England, and four by Lapierre (CPMC-PC18/001, and CPMC-PC203/001-003); either alone or mixed with other pigments (*e.g.* Prussian blue to obtain purple, visible in the mid-right area of **Figure 4.13-A**).

Al and Ca were detected through EDXRF in red and pink lakes on slides LM02 (with Ca in the socks) and PC002/009 (only Ca). However, other paints may have higher Al contents than the glass support without being detected as Al is a very light element, and lower acquisition times were used for the paints. The UV-VIS spectra of these lakes (**Figure 4.14-A**) suggest the use of an anthraquinone lake of animal origin, considering its absorption shoulder at ~490 nm and strong bands at ~523-526 nm and ~562 nm (Kirby, Spring, and Higgitt 2007; Fonseca et al. 2019). Although these UV-VIS spectra may suggest the presence of aluminium carmine, detailed analyses by FTIR were essential to confirm this identification. Combining these results with the infrared analysis made it possible to identify, besides the resinous binder, gypsum ($CaSO_4{\bullet}2H_2O$) as the main filler in several red/pink colours10 (Figure 4.14-B) through its characteristic O-H stretching bands at 3405 cm^{-1}, at 1621 cm^{-1} from H_2O bending vibration and 1125 and 669 cm^{-1} respectively from the SO_4^{2-} stretching and bending vibrations (Montagner et al. 2013). A spectrum with features associated with the substrate, instead of one closer to that of carminic acid, supports the use of a lake pigment (Kirby, Spring, and Higgitt 2007). Variations in the UV-VIS and FTIR spectra of these red and pink lakes strongly indicate that different formulations were used in various slides (**Figure 4.14-A**).

It is worth mentioning that it was possible to match the infrared spectrum of the red paint from the slides held at MUHNAC (UL000065-69) with a Winsor & Newton (W&N) Crimson Lake oil paint tube from the 19th century characterised as a cochineal red lake paint where gypsum

[10] Gypsum was identified in slides: LM02; PC3300/002-3; PC3302/007; UL000065-69; PC18/001; PC203/002.

was added during pigment manufacture (**Figure 4.14-B**) (Vitorino et al. 2017). Investigation into the W&N 19th-century manufacturing processes for cochineal lake pigments has enabled the identification of the main infrared bands attributed to the W&N Crimson Lake pigment in the form of a complex of carminic acid with aluminium and calcium (Vitorino et al. 2017; Vitorino 2020). The bands identified by Vitorino in this complex, namely at 1569, 1465, 1411, 1309, 1288, and 1250 cm^{-1}, are observed in both historical paints (**Figure 4.14-B**). Their infrared spectra positively identified gypsum ($CaSO_4 \cdot 2H_2O$) through its characteristic bands and a terpenoid resin, possibly shellac, in the magic lantern slides (see *Subsection 4.3.1*). It is worth remembering that W&N published one of the manuals for painting on magic lantern glass slides, in which W&N's Crimson Lake was advised (see *Subsection 1.2.3*).

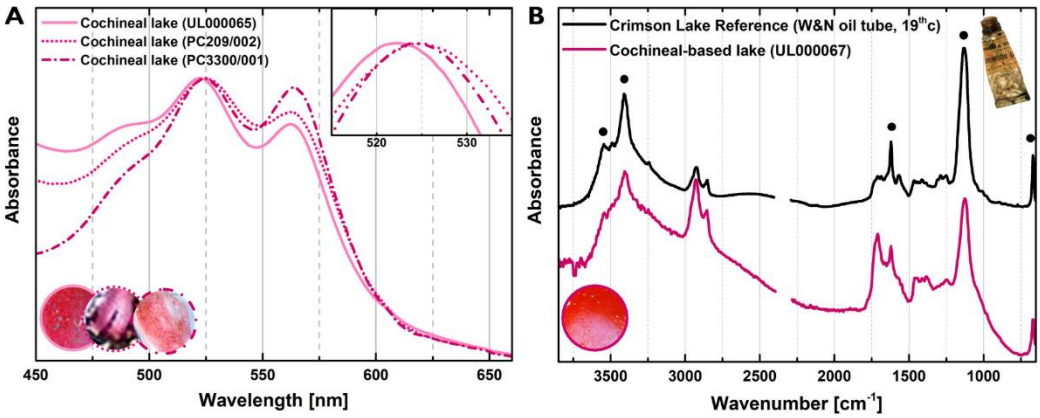


Figure 4.14 (A) UV-VIS absorbance spectra of animal anthraquinone-based lakes (possibly cochineal). (B) Infrared spectrum of an animal anthraquinone-based lake (possibly cochineal) with shellac resin and gypsum (●) from MUHNAC slides, compared to a reference of a Crimson Lake oil tube from the 19th-century by Winsor & Newton (W&N) (reference from DCR NOVA-FCT).

Even though UV-VIS and FTIR results suggest that cochineal-based lake pigments were used, it was necessary to resort to other methods to verify the presence of carminic acid ($C_{22}H_{22}O_{13}$), the primary chromophore of cochineals (*Dactylopius* spp.) (Cardon 2007). Surface-Enhanced Raman Spectroscopy (SERS) was the technique selected; nevertheless, the nature of the samples posed several challenges. The paint layers are thin and translucent, and the pigment is mixed in a resinous binder, meaning that a significant part of the micro-sample is resin. As the pink colourant is present in very low concentrations, it was necessary to use a larger sample to perform this analysis, compared to μ-FTIR. For these reasons, only one representative sample was selected to be analysed: an orange painting fragment consisting of a pink anthraquinone-based lake (thinly coated with an unidentified organic yellow) loosened from a severely flaking area of slide CPMC-PC209/002 (**Figure 4.15-A**).

Analysis of this sample by SERS, (undertaken following the method described in *Appendix A.4*, revealed a positive match with carminic acid references given the strong band at 1305 cm^{-1} and the bands around 1070, 1135, 1205, 1232 cm^{-1} (**Figure 4.15-B**) (Whitney, Casadio, and Van Duyne 2007; Pozzi, Lombardi, and Leona 2013; Choffel et al. 2022; Zhu et al. 2022). The main bands of the carminic acid detected can be assigned to the C-O-H bending vibrations and the O-H and C-H (between ~1070 and 1232 cm^{-1}) bonds (Osticioli et al. 2019; Zhu et al. 2022). Further optimisation of this process is needed to obtain spectra with improved band definition.

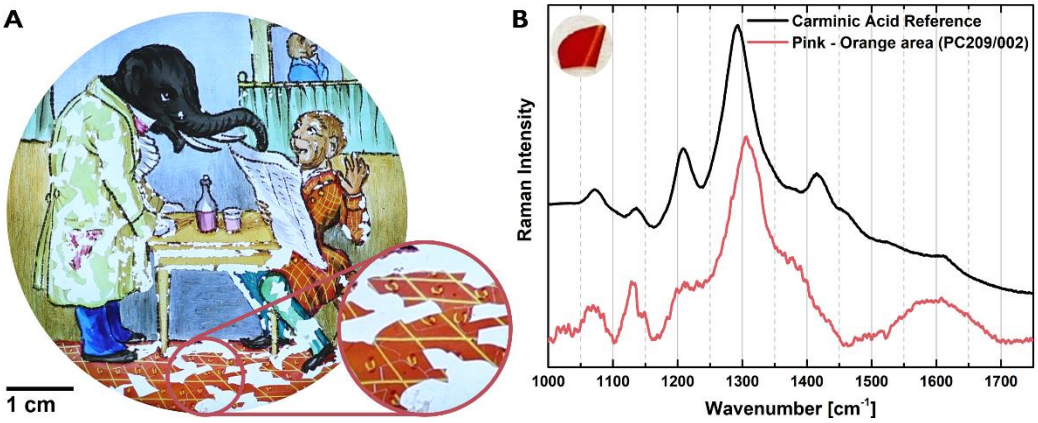


Figure 4.15 (A) Detail of slide CPMC-PC209/002 showing the pink in orange area from where the loosened paint sample belonged. (B) SERS spectra of the pink/orange sample made of a pink anthraquinone-based lake of animal origin (thinly coated with an unidentified organic yellow) compared to a reference spectrum of carminic acid from DCR NOVA-FCT.

Geranium lakes

A synthetic organic pink lake with eosin Y was identified as the main colourant in seven Lapierre slides analysed[11], from which it was possible to distinguish different formulations. Eosin Y (2',4',5',7'- tetrabromofluorescein, $C_{20}H_8Br_4O_5$) has been extensively used to produce lake pigments commonly known as geranium lakes (Eastaugh et al. 2008). This colourant was synthesised for the first time between 1871 and 1873, becoming commercially available in 1874, and its formulation typically included aluminium and lead ions as a complexing agent (e.g., in the form of $Al_2(SO_4)_3$, $AlCl_3$, $Pb(COOCH_3)_2$) (Cooksey 2018; Beltran et al. 2021). Given the vibrancy of these lakes, they rapidly became popular among artists and were included in the colour palette of great masters such as Vincent Van Gogh and Paul Gauguin (Beltran et al. 2021). It was also advised for slide painting, under the name of Geranium (Lake), by pigment makers such as J. Barnard & Son (1890) and Winsor & Newton (1896).

As eosin Y has an intense yellow-orange fluorescence under UV light, UVIVF photography was revealed to be insightful during the preliminary investigation. Under visible light, this lake had a bright pink colour, notoriously similar to slide PC166/006. However, under UV radiation, the characteristic fluorescence of this colourant was observed in the seven slides, with PC166/006 showing a dark red fluorescence, pointing to a different colourant (**Figure 4.16**).

EDXRF analysis of these pink areas detected higher bromine (Br) and lead (Pb) signals than the glass substrate; however, the presence of aluminium (Al), detected through its Kα and Kβ emission lines (respectively at 1.49 and 1.56 keV) may be masked by the Lα and Lβ emission lines of Br (respectively at 1.48 and 1.53 keV) (**Figure 4.17-A**).

This colourant was detected by UV-VIS through its characteristic absorption shape with a shoulder at ~500 and a maximum absorption at ~540 nm (Chieli et al. 2020); nevertheless, slight shifts to lower and higher wavelengths were observed (**Figure 4.17-B**). These shifts can be

[11] Eosin-based lakes were identified in eight slides from CPMC: PC18/002, PC20/006, PC21/001, PC32/003, PC33/001, and PC165/006-007. Slides PC20/007 and PC21/002 possibly contained eosin-based lakes similar to those used in the same set; however, due to the advanced fading, eosin could not be identified.



Figure 4.16 Detail of slides by Lapierre observed under normal (top) and Ultraviolet light (bottom): (A) slide CPMC-PC165/007 showing eosin's characteristic bright-orange fluorescence; and (B) slide CPMC-PC166/006 showing an eosin lake with a dark red fluorescence.

related to the complexing agent used and the synthesis method, and studies have shown that Al lakes have an absorbance maximum at ~535 nm and Pb lakes at ~652 nm, AlPb lakes being in the middle. In this way, it was already possible to distinguish two main groups of geranium lakes: the first with a band at lower wavelength (CPMC-PC18/002, PC20/006 and PC21/001) and the second with medium absorbance maximum (CPMC-PC33/001, PC165/006 and PC165/007). Additionally, slide CPMC-PC32/003 presented a higher absorbance maximum, and slide CPMC-PC166/006 presented an absorbance band similar to group B (538 nm) but with the shoulder band shifted to a higher wavelength (512 nm), suggesting possible molecular similarities between this colourant and these eosin lakes.

The Raman spectra show the typical bands of an eosin lake (**Figure 4.17-C**). The bands at 1468, 1502, 1563 and ~1620 cm^{-1} are possibly attributed to the C=C aromatic groups stretching vibration, the bands at 390, 575, ~715, 865 and 1288 cm^{-1} are associated with the xanthene dye skeletal vibrations (the last being a marker for Pb- and Al-lakes), and the bands at 620 and 700 cm^{-1} are probably related with the C-Br stretching vibrations (Beltran et al. 2021). From the beforementioned slides, the only pink with no Raman signal was PC166/006.

In this case, FTIR analyses are more suitable for distinguishing between Al- and Pb-based eosin lakes, given the similarities of the Raman spectra (Beltran et al. 2021). The infrared absorption bands of the first and second groups of slides are very similar (**Figure 4.17-D**). The strong bands at ~1550-60 and ~1450 cm^{-1} can be attributed to the stretching of the carboxylate group (C=O); and these are broad due to the overlapping with the smaller peaks from the C=C stretching vibrations of the aromatic group, which can be observed at ~1610, ~1600, ~1505 cm^{-1}, ~1460 cm^{-1} (Beltran et al. 2021). Another intense band is the one at ~1350 cm^{-1}, attributed to the ketone group interacting with the metallic ion of the complex, being responsible for the slight shifts related to the metal; the peak at ~1242 cm^{-1} can be attributed to the stretching of the ether (C-O-C), the bands at ~885 and ~711 cm^{-1} are from the skeletal vibrations, and the band at 716

cm^{-1} is attributed to the C-Br stretching vibration (Beltran et al. 2021). Additionally, infrared absorption bands from the stretching of the O-H group of the eosin lake overlap with the ones from the binder medium of the paint, and it is also possible to observe a band at ~1700 from the C=O stretching vibrations of the resinous binder; also, is noticeable the absence of the bands at ~1753 and 1212 cm^{-1}, corresponding to the C=O stretching of the colourless lactone form of eosin (Beltran et al. 2021). Notably, the shifts of the bands at ~1550-60, ~1450 and ~1350 cm^{-1}, resulting from differences in electronegativity of Al and Pb and a different anchoring position and coordination with the eosin, allow for the distinction of the complexing agent (Beltran et al. 2021). Shifts to higher wavenumbers suggest high amounts of Al are present in the paint (**Figure 4.17-D**) (Beltran et al. 2021; Delort 2023). Given the complementarity of the analytical techniques used, it is possible to suggest that these lakes were produced with both Al and Pb as complexing agents, considering the strong Pb signals detected through EDXRF analysis.

The pink from slide CPMC-PC166/066 showed a different fluorescence under UV light and was the only one with no signal on both EDXRF and Raman spectroscopies. Its UV-VIS spectrum showed a profile similar to eosin, with a maximum absorbance at 538 nm and a shoulder shifted to 512 nm; however, its FTIR spectrum revealed to be different from the other Geranium lakes, suggesting that another colourant, still to be identified, might have been used in this slide.

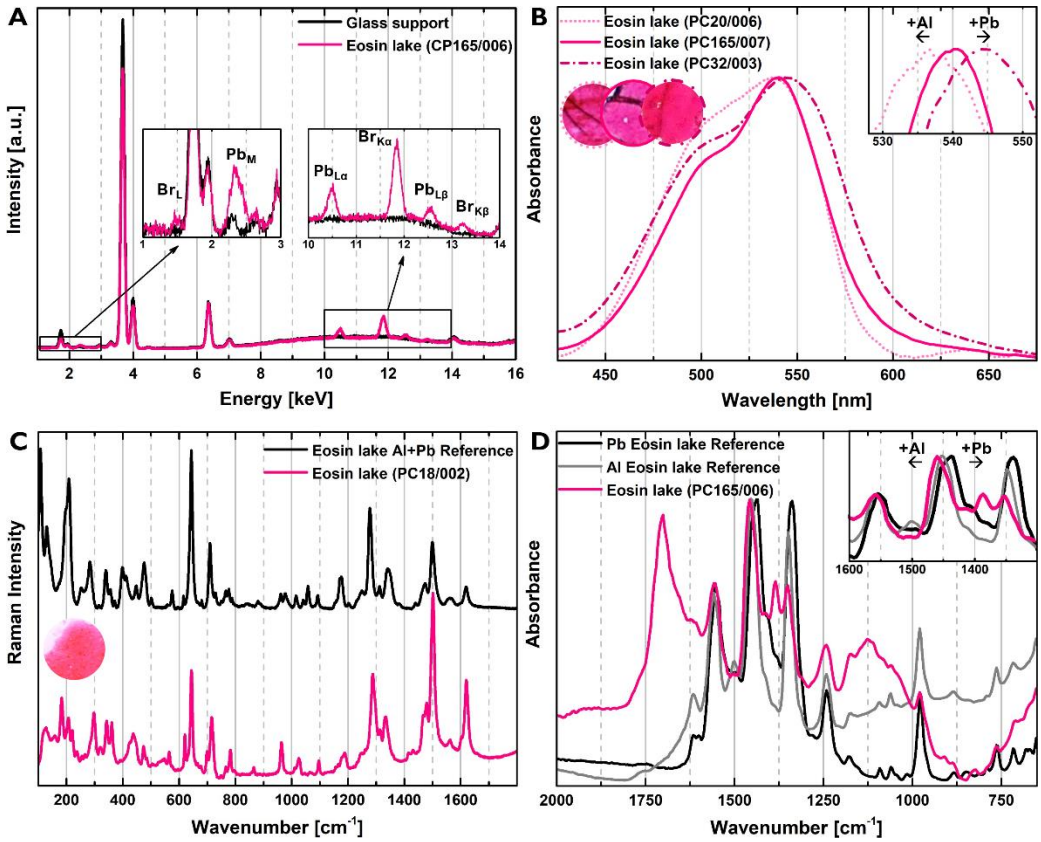


Figure 4.17 (**A**) EDXRF spectra comparison between the glass support and the eosin lakes. (**B**) UV-VIS spectra of eosin from the slides show slight shifts in wavelength, possibly related to the complexing agent and synthesis method. (**C**) Raman spectra of eosin from the slides compared to a reference by Delort (2023). (**D**) Infrared spectra representative of eosin lakes from the first two groups of slides distinguished through UV-VIS, compared with two references by Delort (2023).

The poor lightfastness of eosin pigments is a well-known problem, as many paintings authored by great artists at the end of the 19th century are fading. The light sensitivity of Geranium lakes was even notorious in short periods to painters such as Vang Gogh, who, in April 1889, in a letter to his brother Theo, wrote that "paintings fade like flowers" regarding these lakes (Chieli et al. 2020). The use and fading of this colourant have led to numerous scientific studies on its characterisation and degradation (*e.g.,* Anselmi *et al.* (2017), Centeno *et al.* (2017), Fielberg *et al.* (2017), Chieli *et al.* (2020), Sabatini *et al.* (2020), Beltran *et al.* (2021)). This high sensitivity to light in magic lantern slides is of great concern, considering that thin layers of colour were applied on a transparent glass support, and photochemical fading can occur from both sides of the glass. In terms of colour fading, it is fortunate that many magic lantern slides were kept in the dark for years. In the studied slides with eosin-based lakes, it is possible to observe this colour in both a good and poor state of conservation, as several slides were displayed under intense light conditions, while others were kept inside boxes (**Figure 4.18**).

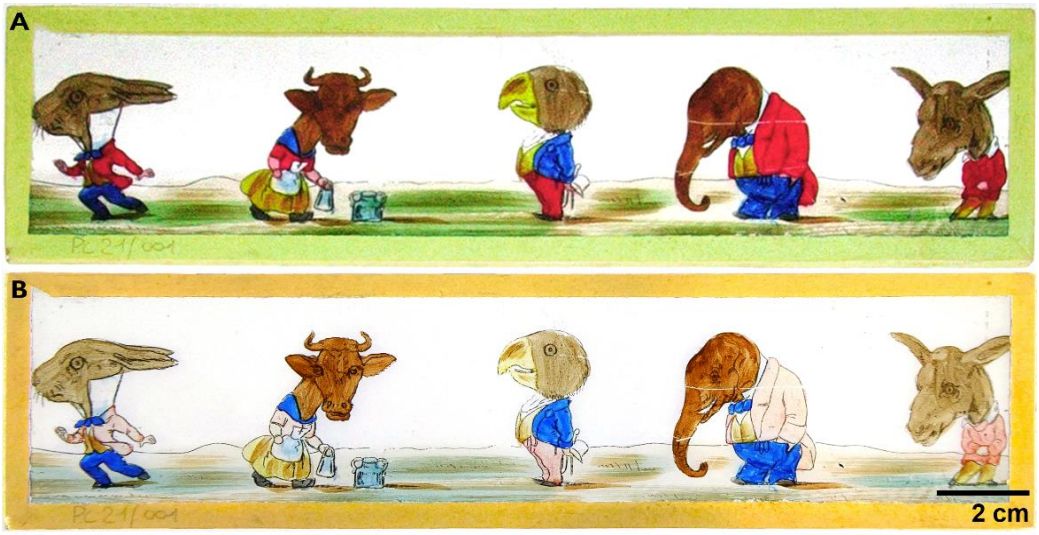


Figure 4.18 Magic lantern glass slide hand-coloured over printed outlines, from ca.1874-1900, produced by Lapierre (inv. CPMC-PC21/001), before (A) and after (B) two years in display under intense visible light conditions. Photography (A) by Teresa Parreira (ANIM-CPMC).

Vermilion

A fourth red colourant, vermilion, was identified in six 19th-century lantern slides studied, mixed with the animal anthraquinone- and eosin-based paints in red, pink, and orange colours (FCT.V.LM01-2, CPMC-PC189/009, CPMC-PC3300/001-2 and CPMC-PC18/002). This inorganic pigment, composed of mercuric sulphide (HgS), was used from prehistoric times to the 20th century and could be ground mineral cinnabar or be synthesised by two methods (dry and wet), which gave its particles different shapes (Getterns, Feller, and Chase 1993). Although vermilion was highly favoured for its bright red colour, it was not advised for magic lantern glass painting, possibly for being a semiconductor, which means that all visible light is absorbed by the pigment and its opaque black in transmittance (Getterns, Feller, and Chase 1993).

Using EDXRF, mercury (Hg) and sulphur (S), indicative of vermilion, were detected in two paintings, in addition to other elements associated with the pink lake. When analysing these under the microscope, a much smaller quantity of dark red particles dispersed in the lake was

observed, suggesting that a small quantity of this pigment was mixed in the paint (a formulation possibly sold by pigment manufacturers as scarlet, *e.g.*, by W&N), enabling the paint to remain transparent when projected. Raman analysis on these particles showed the bands at 254, 287, and 344 cm^{-1} from the HgS vibrations (**Figure 4.19**) (Frost, Martens, and Kloprogge 2002).

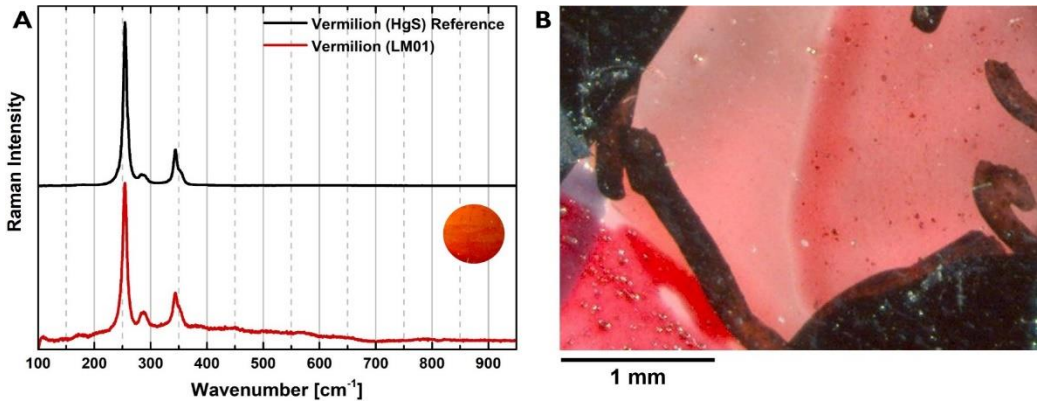


Figure 4.19 (A) Raman spectrum of the red colour of slide LM01 shows the characteristic signals of vermilion compared to a reference spectrum of vermilion from DCR NOVA-FCT. (B) Detail of slide CPMC-PC3300/002 showing a pink paint composed of an anthraquinone-based lake of animal origin (possibly cochineal) and vermilion particles under the microscope (10x original magnification).

Copper-based red

A red with a satin shine was detected in two 18th-century slides (CPMC-PC002/001 and /003), showing the copper's presence in EDXRF analysis. As UV-VIS and Raman spectra were inconclusive, this pigment remains unidentified. However, using copper salt as a substrate of a red lake pigment or a red copper oxide cuprite (Cu_2O) are possibilities that need further investigation (Kirby, Spring, and Higgitt 2007; Eastaugh et al. 2008).

Yellow

Yellow is one of the first colours humans use and one of the primary colours in the subtractive colour wheel used to produce many other hues. It has been used to replicate the sun's light, and it is considered the most luminous and brilliant colour in the spectrum, immediately capturing the attention of the human eye (Coles 2018). It is, therefore, not surprising that yellow was frequently applied to these paintings, being present in almost all the slides studied. Yellow ochre and gamboge were identified, along with other unidentified organic yellow lakes (**Figure 4.20**).

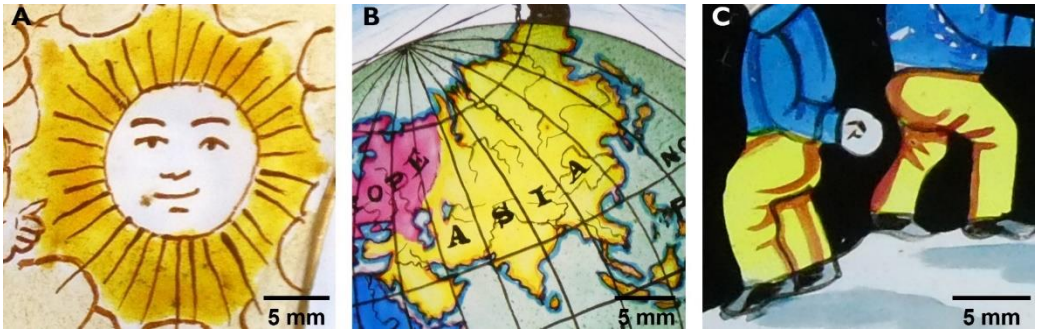


Figure 4.20 Details of magic lantern slides displaying various yellows: (A) yellow ochre, CPMC-PC002/011; (B) Gamboge, CPMC-PC3301/002; (C) Gamboge, CPMC-PC3302/019.

Yellow ochre

Yellow ochre is the most ancient yellow pigment known in artworks (Eastaugh et al. 2008). This natural pigment consists of a silica and clay matrix, with various hydrated forms of iron oxide as colourants, with goethite (α-FeOOH) being its predominant mineral (Eastaugh et al. 2008). Natural ochres are heterogeneous in particle size and composition, and their shades vary from yellows to reds and browns. Iron oxides were identified in yellows from the earliest magic lantern slides analysed, attributed to 18th-century Italy (CPMC-PC002/001-5,11), and in 19th-century slides produced by Philip Carpenter (FCT.V.LM01) and by Lapierre (CPMC-PC165/006) (*Appendix A.6.2-K*).

EDXRF detected iron (Fe) in these yellows. The UV-VIS analyses present the same four bands found on hematite since the same electronic transitions are responsible for the goethite yellow colour, the differences being the strong band of the electron pair transition $2(^6A_1)\rightarrow 2(^4T_1)$, which influences the most the colour range observed (from yellow to red), existing at 480 nm for goethite, and the broad absorption band induced by the $^6A_1\rightarrow ^4T_1$ transition featured around 910 nm for goethite (**Figure 4.13-B**) (Torrent and Barrón 2002; Cheilakou, Troullinos, and Koui 2014). The apparent absorption spectrum of the yellow ochre from 18th-century slides shows a slight shift of the goethite absorptions centred at 480 nm and 910 nm, respectively, towards higher and lower wavelengths, which may indicate a mixture with hematite (**Figure 4.13-B**).

Raman analyses also indicate that these yellow paints contain goethite and hematite as colourants (**Figure 4.21**). The bands at 227 and 502 cm^{-1} can be attributed to the Fe-O stretching, and the bands at 246, 412 and 617 to the Fe-O bending of hematite (Legodi and de Waal 2007). The strong band at 295 cm^{-1} is positioned between 292 and 299 cm^{-1}, respectively, characteristic of the bending of the Fe-O of hematite and the Fe-OH of goethite; also, the presence of the double peak at 227 and 246 cm^{-1} is characteristic of raw sienna, a yellow ochre containing a low percentage of hematite (Bikiaris et al. 1999; Legodi and de Waal 2007).

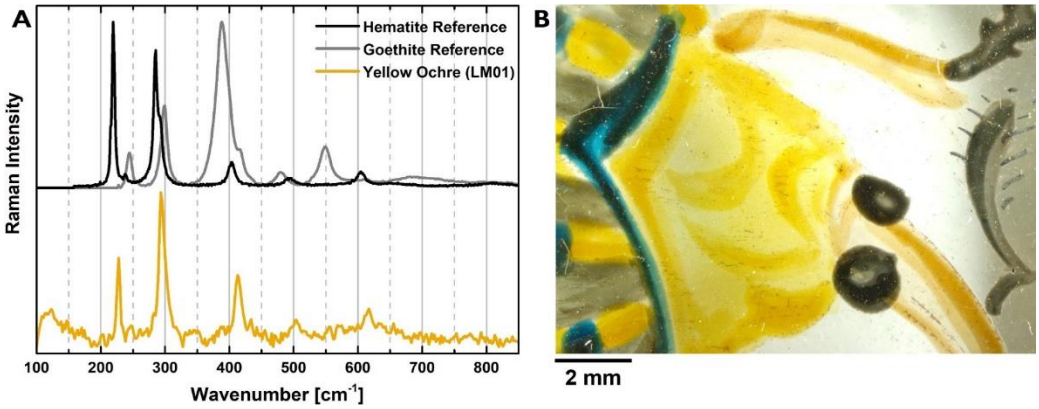


Figure 4.21 (A) Raman spectrum of the yellow colour of slide FCT.V.LM01 compared to the reference spectra of hematite and goethite from DCR NOVA-FCT. (B) Detail of slide LM01 showing the yellow hues of the area analysed by Raman under the microscope (10x original magnification).

Gamboge

Organic yellows appear to have been used in magic lantern slides throughout the 18th and 19th centuries, in some cases, along with yellow ochre. Gamboge, the most advised yellow colourant

for slide painting by historical literature, was the only organic yellow colourant identified in this selection of slides. Despite being present in the European artists' palette since the early 17th century, this yellow gum resin, extracted from *Garcinina* trees, was identified in 10 English 19th-century slides by P. Carpenter (only in the green), W.E. & F. Newton and unknown manufacturers, possibly produced after ca.1820 (*Appendix A.6.2 - B-H*) (Eastaugh et al. 2008; Coles 2018).

Gamboge was distinctively identified through its Raman characteristic bands at 1248 cm^{-1} due to the stretching of C-C, at 1330 and 1435 cm^{-1} from CH_2 bending vibrations, at 1594 cm^{-1} from C-C-H bond stretching, and at 1630 cm^{-1} due to C=C bond stretching (**Figure 4.22-A**) (Chaban et al. 2021). The infrared spectra of this yellow also presented the characteristic bands' profile in the C-H stretching region, its C=O stretching bands at 1737, 1694, 1634 and 1595, its skeletal and C-H bending bands at 1455, 1438 and 1333 cm^{-1}, and the bands of the C-O stretching vibrations at 1138, 1047 and 1020 cm^{-1} (**Figure 4.22-B**) (Chen, Zhou, and Sun 2016). This yellow resin was also identified in orange, brown and green colours of the same English 19th-century slides, except for P. Carpenter's, where it was only detected in green colour.

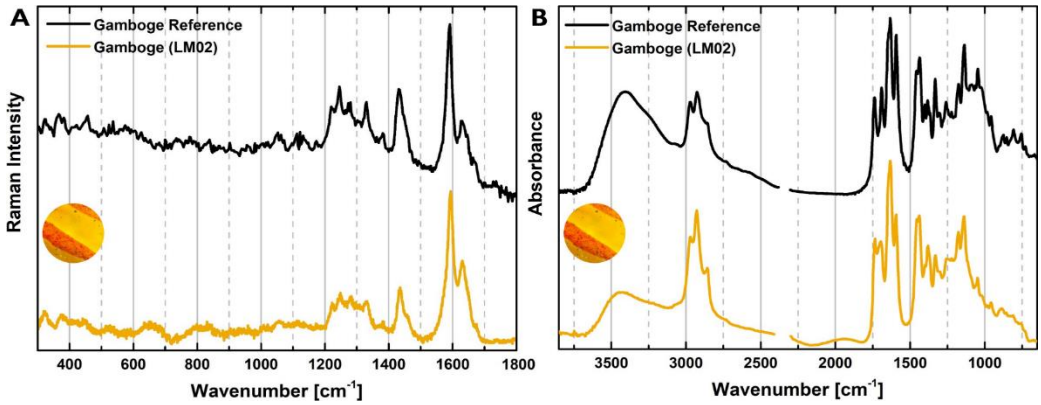


Figure 4.22 (A) Raman spectrum of Gamboge from slide FCT.V.LM02 compared to a reference spectrum from DCR NOVA-FCT. (B) FTIR spectra of Gamboge from slide FCT.V.LM02 compared to a reference spectrum from DCR NOVA-FCT.

Other organic yellows

As mentioned, other organic yellows were applied in magic lantern slides from the 19th century. Nevertheless, to the present moment, it was not possible to identify them. Analyses by EDXRF and Raman could not detect any signal in most of these paints. Furthermore, several factors are believed to make the interpretation of UV-VIS and µ-FTIR spectra difficult. UV-VIS analyses were performed in transmittance mode, and the intense yellow colours tended to saturate the spectra. In addition, the equipment used for UV-VIS analysis does not have a sufficient resolution in the ultraviolet region to distinguish weak peak variations under 400 nm, as organic yellow colours tend to be very similar in the visible region (Winter 1997). Another limitation is that these are transparent colours painted on glass, resulting in a spectral image that includes support and binder contribution. Natural terpenoid resins, identified as binders in these paints by µ-FTIR, also denote an increased difficulty in identifying organic yellow colourants as they are naturally yellowish and overlap with the pigments' UV-VIS bands. For instance, it was possible to observe the strong influence of the binder medium in the absorption region between 350-450 nm, as gamboge paints display a band at 390 nm and 425 nm when mixed with mastic or shellac,

respectively (**Figure 4.23-A**). This problem is also transferable to the μ-FTIR analysis, where it was only possible to discriminate the presence of mastic resin and gypsum, possibly applied as a filler (**Figure 4.23-B**). Overcoming these challenges will require testing other analytical techniques in these paints (*e.g.*, Microspectrofluorimetry and High-Performance Liquid Chromatography (HPLC) or Gas Chromatography (GC) combined with Mass Spectrometry (MS)).

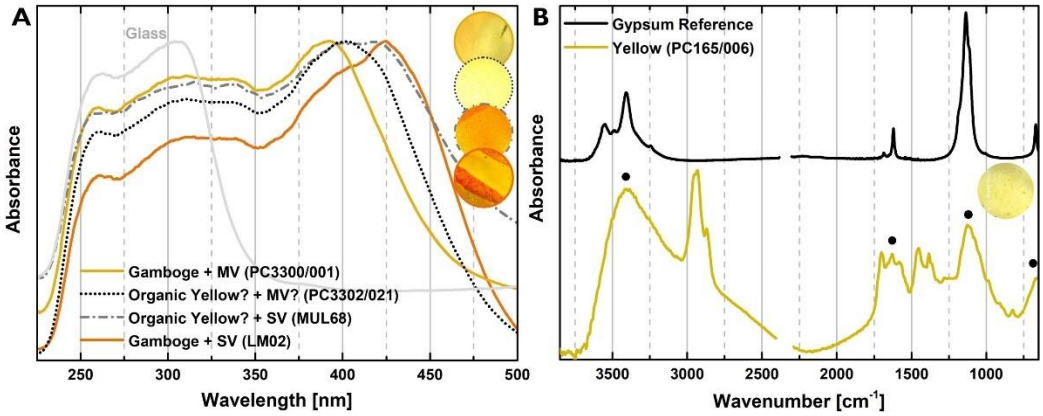


Figure 4.23 (A) UV-VIS absorbance spectra of gamboge with shellac (SV) and mastic (MV) varnishes and other unidentified organic yellows with SV and possibly MV. (B) FTIR spectrum of the yellow paint of slide CPMC-PC165/006 showing the contribution of a terpenoid resin, such as mastic, and gypsum ($CaSO_4 \cdot 2H_2O$) compared to a reference spectrum of gypsum (●) from DCR NOVA-FCT.

Blue

The presence of blue in all studied glass slides was not a surprise as it is a primary colour and was mentioned by all historical written sources consulted as an essential colour to paint these objects. The most recommended was Prussian blue, and the analyses confirmed the lantern slide painters' preference for this blue, as it was detected in all 18th- and 19th-century slides analysed. Prussian blue was identified in purples mixed with pink animal anthraquinone lakes, greens mixed with organic yellows such as gamboge or copper-green to achieve blue-green, as well as brown and black mixtures. Despite being only advised by 18th-century literature on lantern slide painting, ultramarine blue was only identified, mixed with Prussian blue, in one Carpenter & Westley (C&W) slide (CPMC-PC3301/005), on both blue and green colours (**Figure 4.24**).

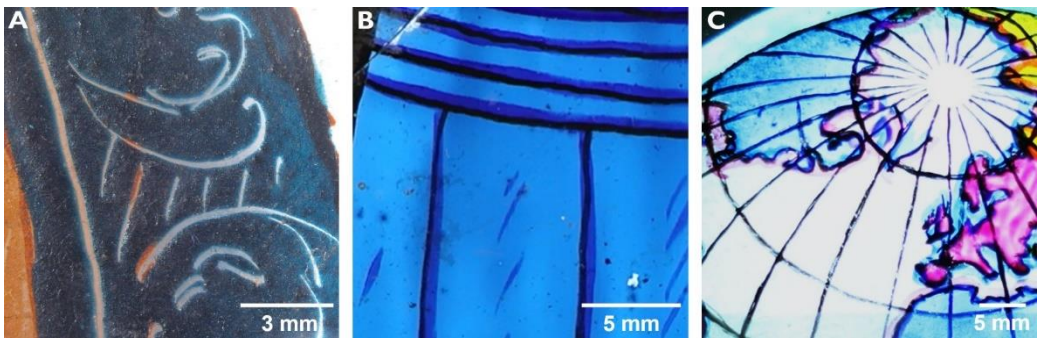


Figure 4.24 Details of magic lantern slides displaying various blues: (A) Prussian blue, CPMC-PC002/009; (B) Prussian blue, FCT.V.LM02; and (C) mixture of Prussian blue and Ultramarine blue, CPMC-PC3301/005.

Prussian blue

Prussian blue (or Chinese blue) pigment is characterised as a hydrated iron(III) hexacyanoferrate(II) complex, either soluble ($KFe^{III}[Fe^{II}(CN)_6]\bullet nH_2O$) or insoluble ($Fe^{III}_4[Fe^{II}(CN)_6]_3\bullet nH_2O$), that was discovered in 1704 or shortly after by the colour maker Johann Jacob Diesbach (Berrie 1997; Grandjean, Samain, and Long 2016).

EDXRF detected the intense presence of Fe in blue colours, pointing to the Prussian blue pigment. It was identified by UV-VIS spectroscopy through the absorbance minimum at around 475 nm and a broad absorption band at around 700 nm from the charge transfer between Fe^{2+} and Fe^{3+} (**Figure 4.25-A**); however, variations were observed in several Prussian blue pigments, possibly due to differences in the synthesis methods (Grandjean, Samain, and Long 2016). Raman allowed for Prussian blue identification through the bands corresponding respectively to the E_g and $1A_g$ mode of the ν(CN) stretching vibration of the Fe^{2+} and Fe^{3+} vibrational state are visible at ~2090 and ~2155 cm^{-1}, as well as the shoulder at ~2130 cm^{-1} from the CN^- stretching peak, the bands characteristic for Fe-CN-Fe bond deformation vibrations at 276 cm^{-1} and shoulders at 233 and 327 cm^{-1}, the band group representing all Fe-C stretching vibrations defined by a strong peak around 530 cm^{-1} and a second around 600 cm^{-1}; and in the spectral range where stretching vibrations of the triple CN bond occur (**Figure 4.25-B**) (Samain et al. 2013; Moretti and Gervais 2018). FTIR analyses of this pigment have shown its characteristic band at 2090 cm^{-1}, assigned to the stretching of the C N bond (**Figure 4.10-A, B**).

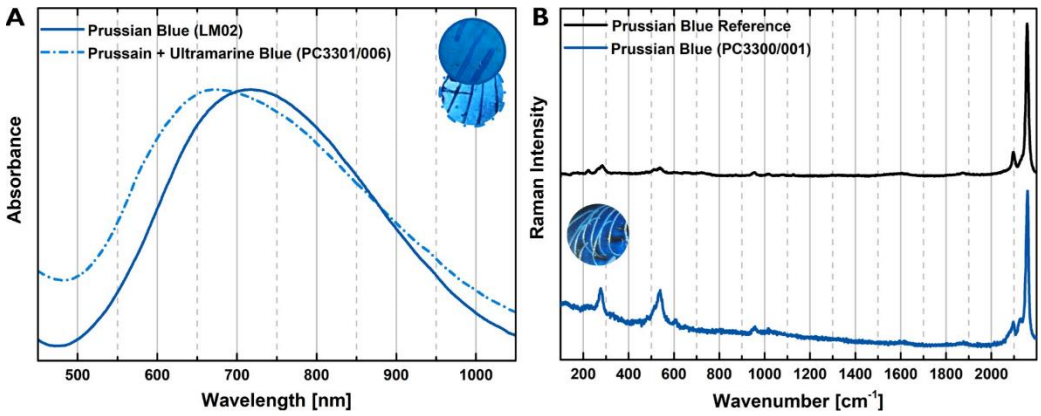


Figure 4.25 (A) UV-VIS spectra of Prussian blue compared to the paint made of a mixture of Prussian blue and Ultramarine blue identified on the historical slides. (B) Raman spectrum of Prussian blue from slide CPMC-PC3300/001 compared to a reference spectrum from DCR NOVA-FCT.

Ultramarine blue

Ultramarine from the semi-precious stone lapis lazuli, mainly composed of a mixture of the minerals lazurite and calcspar and iron pyrites, was used as pigment possibly since the 6th century as purified lazurite, $(Na,Ca)_8(AlSiO_4)_6(SO_4,S,Cl)_2$ (Plesters 1993). It is worth mentioning that according to its glass composition, this slide appears to have been produced after 1870. Given that around 1830, artificial ultramarine pigment with a similar composition ($Na_{6-10}Al_6Si_6O_{24}S_{2-4}$) started being manufactured, C&W was possibly using a synthetic ultramarine blue in this slide.

The presence of Ultramarine blue mixed with Prussian blue in the slide by C&W was detected

through the shifting of UV-Vis absorbance minimum to ~480 nm and the absorption band to ~670 nm from the charge transfer between S_2^- and S_3^- compared to Prussian blue spectra (**Figure 4.25-A**) (Berns and Imai 2002; Aceto et al. 2013). In the Raman spectra of this paint, besides the Prussian blue characteristic bands, the peaks of Ultramarine blue are mostly visible at ~255 and 545 cm^{-1} from the respective bending and stretching vibration of S_3^-, and at 1095 cm^{-1}, the first overtone of the S_3^- stretching vibration (**Figure 4.26**); however, it was not possible to confirm whether a natural or synthetic pigment was used (Osticioli et al. 2009).

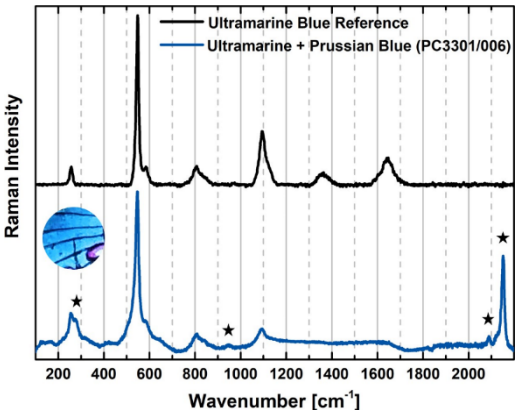


Figure 4.26 Raman spectrum of the blue paint made of Ultramarine blue and Prussian blue (★) from slide CPMC-PC3301/005 compared to a reference spectrum from DCR NOVA-FCT.

Green

The colour green has a chequered history as the green pigments available were relatively limited to malachite, green earth, and synthetic copper greens (such as Verdigris) for centuries, and an aversion to mixing different substances, such as yellow and blue pigments influenced the manufacture of greens (St Clair 2017; Coles 2018). Only by the late 18th century did new green pigments appear, namely the poisonous copper arsenic Scheele's Green, but it was not until the 19th century that the first greens made of mixtures were commercialised (St Clair 2017). The same tendency is observed regarding the colours to paint magic lantern slides in both written sources and analysed slides (**Figure 4.27**). Verdigris was the most advised green by 18th-century literature, and a synthetic copper-green was identified in slides of that time. Additionally, although green pigments were mentioned in the 19th century, most sources advised mixing yellow and blue to obtain the desired green hue, which agrees with the identification of Prussian Blue in all 19th-century slides mixed with yellows such as Gamboge.

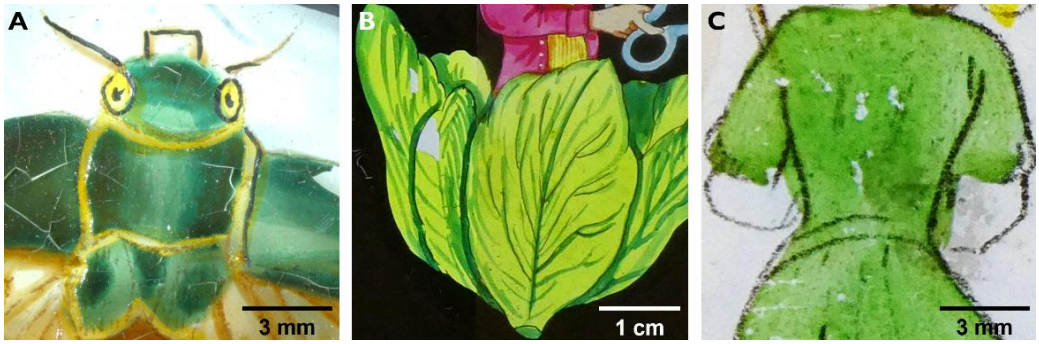


Figure 4.27 Details of 19thc. slides displaying greens: (**A**) Prussian blue and Gamboge, FCT.V.LM01; (**B**) Prussian blue and Gamboge, CPMC-PC446; (**C**) Prussian blue and unidentified yellow, CPMC-PC018/002.

Copper-green

Synthetic copper-based greens have been used since antiquity, being copper acetate (Verdigris) and copper resinate the most known pigments; however, copper sulphates, oxalates and chlorides have been identified in green paints, for example, atacamite ($Cu_2(OH)_3Cl$) (Buse, Otero, and Melo 2019). Whether these compounds resulted from pigment synthesis or paint degradation is often difficult to ascertain, particularly copper oxalates (Buse, Otero, and Melo 2019).

Verdigris is a bluish-green pigment constituted of copper(II) acetates produced from the reaction between copper and acetic acid, being the neutral and basic acetates ($Cu(CH_3COO)_2 \bullet H_2O$ and $Cu_x(CH_3COO)_y \bullet Cu(OH)_z \bullet nH_2O$, respectively) the most common compounds (Wiggins et al. 2019; Brostoff and Ryan 2020). On the other hand, copper resinate is a transparent green composed of mainly copper salts of resin acids (*e.g.,* $C_{19}H_{29}COOH$) that could be obtained by dissolving copper acetate or Verdigris in an acidic resin such as Venice turpentine, balsam or tree resin and oil-media (Kühn 1993; Paz, Rodriguez-Simón, and Manzano 2023). The natural formation of copper carboxylates when copper(II) is in contact with resinic and fatty acids (*e.g.* from oils) has been studied; the browning of the paint layer that contains copper pigments, such as Verdigris (that lack carbonate and hydroxo ligands), was found to be correlated with the ease of copper extraction by fatty and resinic acids (Kühn 1993; Gunn et al. 2002; Otero et al. 2014). Additionally, the investigation by Buse, Otero and Melo (2019) on synthetic copper-green pigment reconstructions from historical recipes of Verdigris has found three main groups of pigments based on the main resulting components of their formulation. In summary, the first group resulted in the formation of neutral copper acetate ($Cu(CH_3COO)_2 \bullet H_2O$), the second resulted in this acetate as the main compound with copper oxalate as minor (a compound commonly considered a degradation product), and the third resulting in a mixture of atacamite and copper acetate in which both components can be found as major or minor depending on the process.

In the Italian 18th-century slides, EDXRF analyses detected an intense copper (Cu) signal. The results by UV-VIS reflectance spectroscopy show an absorbance minimum between 565-575 nm and an absorption band around 675-680 nm, suggesting this green colour could be from a copper resinate compound (**Figure 4.28-C**) (Kühn 1993; Aceto et al. 2014). In blue-green painted areas, both the presence of Cu and Fe detected by EDXRF and the shifting of absorbance minimum to lower wavelengths (~470-475 nm) indicate a possible mixture of this copper-green pigment with Prussian blue, further identified in FTIR and Raman spectroscopies.

The infrared analysis of this green paint (**Figure 4.28-D**), besides the bands associated with the binding mediums (possibly mastic resin with oil) explored in *Subsection 4.3.1*, shows bands characteristic of the copper chloride atacamite, copper oxalate and possibly copper resinate. Atacamite ($Cu_2(OH)_3Cl$) was detected through the strong bands at 3340 and 3347 cm^{-1}, along with a set of weak intensity bands in the region between 800 and 1000 cm^{-1}, respectively assigned to the OH stretching and bending (Buse, Otero, and Melo 2019). Copper oxalate also appears to be present, given the broad band at ~1680 cm^{-1} and the small band at ~1325 cm^{-1} attributed to the stretching of the carboxyl group (COO^-), the shoulders slightly visible at ~1370 and ~820 cm^{-1}, respectively from the bending of the OCO and stretching of CC bonds (*Appendix A.7*) (Salvadó

et al. 2009; Monico et al. 2013; Buse, Otero, and Melo 2019). The strong band at 1608 cm^{-1} can be attributed to the stretching of the ionised carboxyl groups (COO^-), which can be produced by Verdigris or copper resinate since carboxylates can be formed when fatty acids or resinous material are in contact with copper(II) acetate or copper alloys; therefore, not being possible to unambiguously determine if they are a result of Verdigris degradation or from the original formulation of copper resinate (Kühn 1993; Gunn et al. 2002). The bands observed around 1400 and ~680 cm^{-1} can also be attributed to Verdigris (the last being only visible in a few spectra of this paint); nevertheless, if this was initially in this paint, it is heavily degraded as it already lost its OH and CH_3 structures (Kühn 1993; Platania et al. 2020; Paz, Rodriguez-Simón, and Manzano 2023). Additionally, several bands from the resinous binder could mask the presence of copper resinate and the other way around since, besides the band at 1608 cm^{-1}, the bands at 1700, 1457 and ~1241 cm^{-1} can be due to carboxylic acids as well as resin acids (Kühn 1993; Platania et al. 2020; Paz, Rodriguez-Simón, and Manzano 2023).

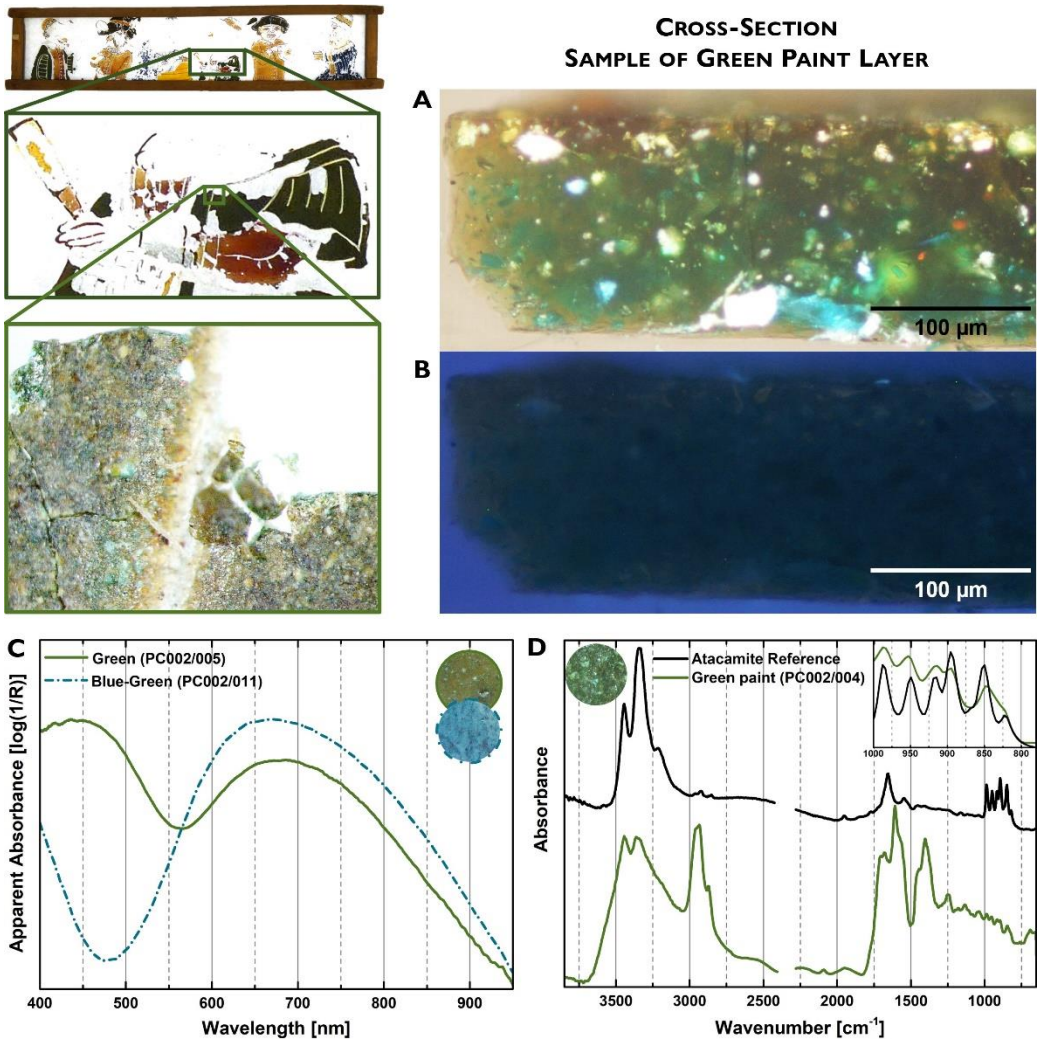


Figure 4.28 Copper-green paint from 18th-century slides with the sampling area from CPMC-PC002/003 presented on the top-left from which can be observed the sample cross-section under 200x original magnification, showing the paint layer stratigraphy exposed to: (A) visible light and (B) UV light. (C) UV-VIS apparent absorbance of copper-green and a blue-green mixture of copper-green with Prussian Blue. (D) Infrared spectra of copper-based green compared to the atacamite ($Cu_2(OH)_3Cl$) reference from DCR NOVA-FCT.

The green paint showed no signal in Raman except in a dark green mixture with carbon black, in which the identification of a copper compound was not conclusive. Raman analyses on this dark green area show bands at around 1300 and 1598 cm^{-1} from the carbon-black component and a band at 1442 cm^{-1}, which may be attributed to the CH_3 bending of copper oleates (**Figure 4.36-E**) (Platania et al. 2020).

When observing the green paint of these slides under the microscope, the colour difference between the area in contact with the glass (vivid bluish-green colour) and the top surface became notorious, showing a brown discolouration (**Figure 4.28-A**). Also, the lack of difference in fluorescence of these layers under UV light suggests that the resinous material is part of the paint and not applied on top (**Figure 4.28-B**). Notably, oil colours were usually not recommended during the 18th century, and in his testimony, Hertel (1716) stated that he had tried oil paints, but they would become dark and opaque in time, as observed in these slides. The discolouration of Verdigris from green to brown has been reported when studying artworks, and it is often less intense in areas not exposed to light (Kühn 1993). Since no materials were detected over the paint, the darkening is possibly related to the oxidation of its organic components and copper extraction and diffusion as fatty acid or resin carboxylic acid complexes (Kühn 1993; Gunn et al. 2002).

Given the combination of copper pigments and a binding medium with natural resinous components and possibly oils, it was expected to find metal soaps as their formation is part of the paint's drying process, being the extent of degradation complicated to estimate (Salvadó et al. 2009). However, these compounds have already formed protrusions that have extensively affected the paintings, which, along with the brown discolouration on the surface, suggests that this paint is already in an advanced degradation stage. It is relevant to emphasise that atacamite and copper oxalate can be products of the original paint formulation (Buse, Otero, and Melo 2019). Also, identifying Verdigris and differentiating it from copper resinate is challenging when paints are visibly degraded, and to determine the original nature of the copper pigment used, other complementary techniques are necessary (such as Gas Chromatography-Mass Spectrometry and FTIR with Synchrotron Radiation) (Kühn 1993; Paz, Rodriguez-Simón, and Manzano 2023).

Green mixtures

Only greens composed of mixtures of yellow and blue pigments were found in slides from the 19th century. In several cases, the yellow and blue pigment particle distribution was distinctively visible under magnification (**Figure 4.29-B**).

The UV-VIS absorbance spectra of these green paints show a band between 310-425 nm from the yellow paints (Gamboge or another unidentified organic yellow) and an absorbance minimum of around 450 nm along with a broad band around 680-690 nm from Prussian blue (**Figure 4.29-A**). When gamboge was used, the simultaneous presence of this pigment and Prussian blue could be identified in both FTIR and Raman spectroscopies (*Appendix A.6.2-B*, *F*, and *H*).

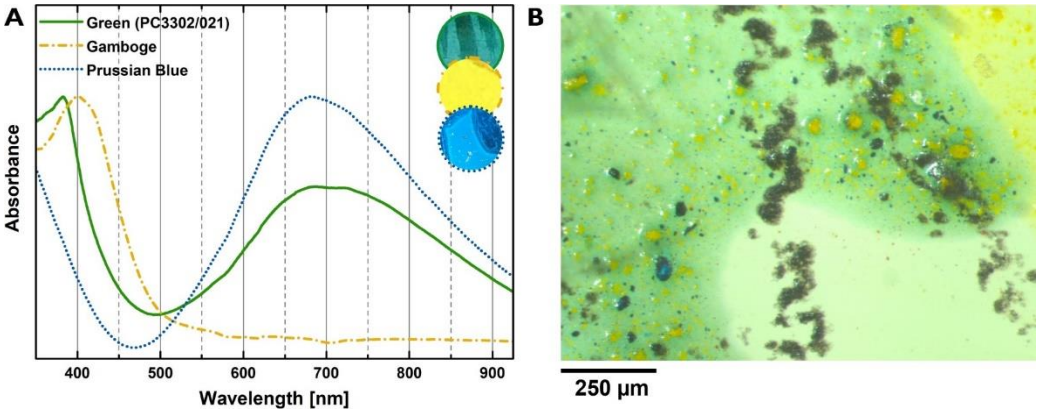


Figure 4.29 (A) UV-VIS absorbance spectra of the green paint obtained by mixing a yellow such as Gamboge with Prussian blue, each colour measured in different areas of the slide CPMC-PC3302/019. (B) Microphotograph of the green paint of slide CPMC-PC032/003 showing particles of organic yellow mixed with Prussian blue (100x original magnification).

Purple

Purple was viewed as a very particular colour for centuries. Since methods to obtain purple pigments were expensive, many cultures associated it with royalty and divinity, and only in the 19th century, with the introduction of new purples, did it become more common (St Clair 2017). Historical literature frequently mentions purple as one of the colours that should be obtained by mixing red or pink with blue. From 1867 onwards, the first purple colourants started being advised for magic lantern glass painting. This preference for mixtures was verified as all purple areas analysed revealed a mixture of the pink and blue used in the same slide (**Figure 4.30**).

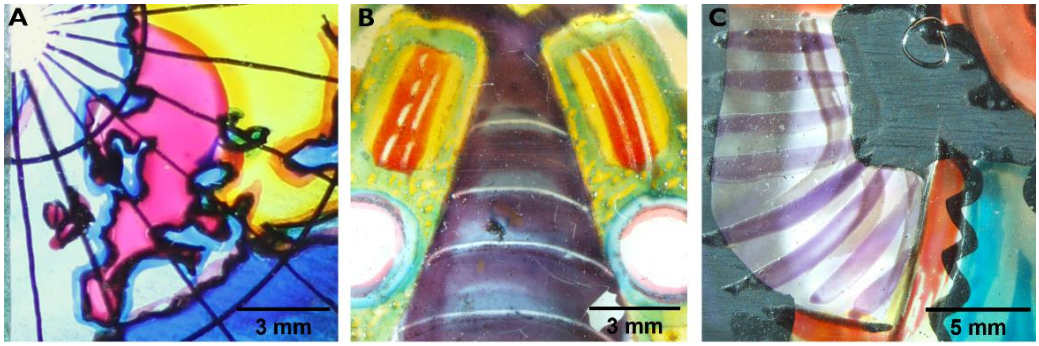


Figure 4.30 (A) Detail of CPMC-PC3301/001 showing a purple made by overlapping possibly a cochineal-based lake and Prussian Blue. (B) Detail of FCT.V.LM01 displaying a purple colour obtained by mixing possibly a cochineal-based lake with vermilion and Prussian blue. (C) Detail of CPMC-PC3302/007 showing a purple made by mixing a possibly cochineal-based lake with Prussian blue.

This mixture was detectable using UV-VIS spectroscopy, and the distribution of pink and blue particles was observed under magnification (**Figure 4.31**). Purple was achieved by overlapping these colours or applying previously mixed colours (**Figure 4.30** and **Figure 4.32**). The spectra of purple show bands at 525 and 566 nm with a shoulder at ~486 nm from an animal anthraquinone-based lake (possibly cochineal) and an absorbance minimum at ~450 nm along with a broad band around 680-690 nm from Prussian blue (**Figure 4.31**), previously identified. Prussian blue was also identified through both FTIR and Raman spectroscopies (*Appendix A.6.2-A*, *C*, *H*, and *I*).

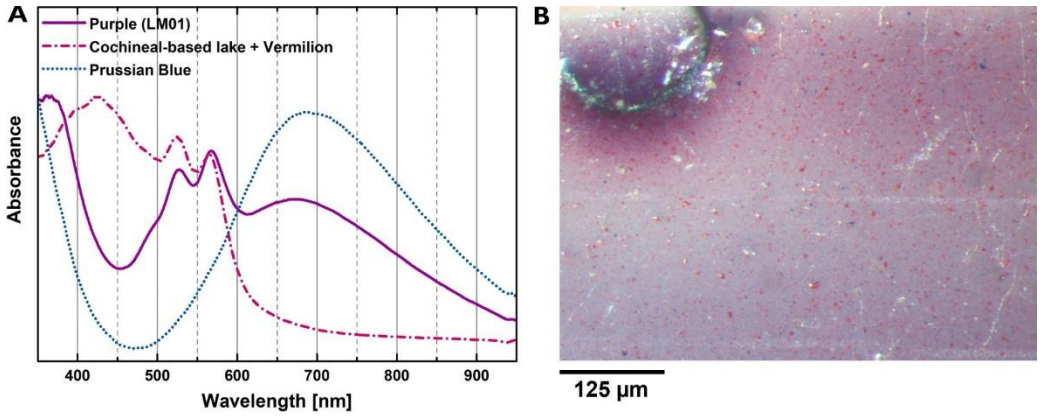


Figure 4.31 (A) UV-VIS absorbance spectra of the purple paint obtained by mixing a possible cochineal-based lake with vermilion and Prussian blue, each colour measured in different areas of slide FCT.V.LM01. (B) Microphotograph of the purple paint of slide CPMC-PC3302/007 showing particles of a cochineal-based lake mixed with Prussian blue (100x original magnification).

Orange

As the study of the written sources on magic lantern glass painting demonstrated, orange hues were frequently obtained by mixing yellow with red/pink. Given that only pigments transparent under transmitted light could be used, according to the literature, the artists' choices were limited to these mixtures and iron oxide pigments during the 18th and most of the 19th century. Besides mixtures found in 19th-century slides, an unidentified orange was present in 18th-century slides.

As expected, most of the oranges analysed were made by mixtures, given that the UV-VIS analyses clearly show the contribution of the various pigments. In the example of slide CPMC-PC3300/001 (**Figure 4.32-A**), the orange colour appears to have been obtained by mixing gamboge with a cochineal-based lake, previously identified, given the absorbance bands at 490, 524 and 563 nm (Fonseca et al. 2019). In this slide and FCT.V.LM02, the orange colour includes vermilion (HgS), identified through µ-Raman in orange and red/pink (see *Red and Pink*).

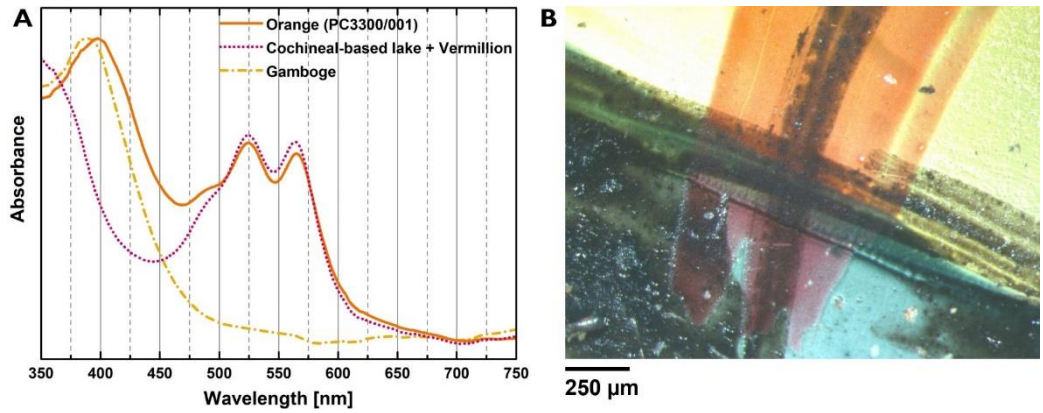


Figure 4.32 (A) UV-VIS absorbance spectra of the orange paint obtained by mixing yellow gamboge and a possible cochineal-based lake with vermilion (a formulation produced under the name of scarlet red, *e.g.*, by W&N), each colour measured in different areas of the slide CPMC-PC3300/001. (B) Microphotograph of the brushstroke detail from slide CPMC-PC3302/019 showing an orange hue obtained by juxtaposing the pink on top of the yellow paint (63x original magnification). In this detail, it is also possible to observe a purple colour where pink covers the blue paint.

Brown

Apart from the other colours, as St. Clair (2017) describes, brown does not appear in the rainbow nor on simple colour wheels. Instead of a hue, it is considered a shade since it results from darkening and greying yellows, oranges and impure reds or mixing yellows with reds and blues. Most advised browns for magic lantern slide painting were variations of iron oxide pigments (*e.g.,* raw umber, burnt umber and partially Vandyke brown), followed by madder brown. In the magic lantern slides studied, hematite and lepidocrocite were identified, sometimes with carbon-back and Prussian blue, as well as mixtures of red/pink, yellow and blue (**Figure 4.33**).

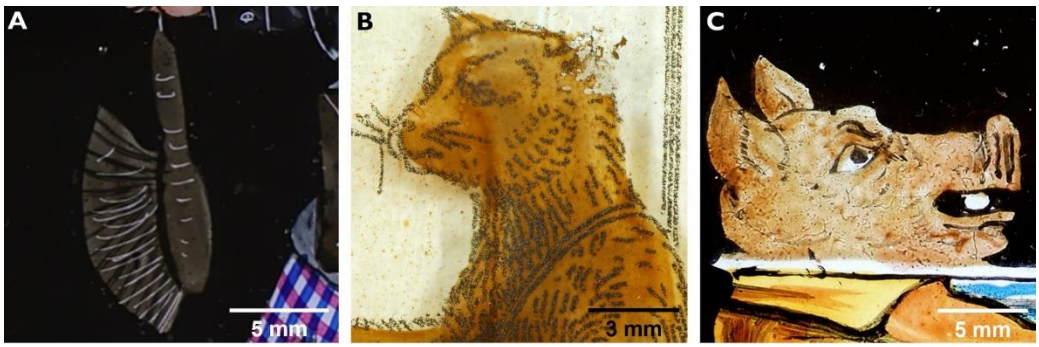


Figure 4.33 Details of magic lantern slides displaying various browns: (A) hematite, FCT.V.LM02 (B) hematite, CPMC-PC033/001; (C) Prussian blue with a possible cochineal-based lake and an unidentidied yellow, MUL-MUHNAC-UL000068.

Brown ochre (hematite and lepidocrocite)

EDXRF detected the presence of iron in brown areas of most of the slides analysed. Hematite (α-Fe_2O_3), goethite (α-FeOOH), and lepidocrocite (γ-FeOOH) were identified using Raman in browns of slides from 18th-century Italy and 19th-century Lapierre (*Subsection 4.3.2 - Red and Pink; Yellow* and *Appendix A.6.2 - A; L*, respectively). Lepidocrocite was detected through its strong Raman bands at 247 and 377 cm^{-1}, respectively assigned to the bending of Fe-O and the Fe-OH stretching vibrations, the bands at 344, 524 cm^{-1} due to the Fe-OH stretching, and at 646 cm^{-1} assigned to the Fe-O stretching (De Faria, Venâncio Silva, and De Oliveira 1997; Das and Hendry 2011). Hematite was also found in 19th-century slides, produced by Carpenter & Westley (CPMC-PC189/012), W.E. & F. Newton (FCT.V.LM02), by an unknown English manufacturer (FCT.V.LM03) and in most of the slides by Lapierre (*Appendix A.6.2 - J; K*). In Newton and Lapierre browns, Raman analysis detected that hematite was sometimes mixed with a carbon-based black or Prussian blue.

Brown mixtures

Apart from these, most 19th-century English slides appear to have brown hues obtained by mixing yellow, pink, and, in some cases, blue, as shown in **Figure 4.33-C** and **Figure 4.34**. The iron detected with EDXRF in most slides analysed can either be from earth pigments such as Vandyke brown or from Prussian blue present in the case of mixtures with, for instance, an organic yellow lake. In other cases, no signal could be detected by EDXRF, and neither Raman nor the UV-VIS spectra were clear, which may indicate an organic colourant or mixture of organic components. Examples of organic brown pigments from 18th- and 19th-century sources include madder brown, asphalt, and bitumen.

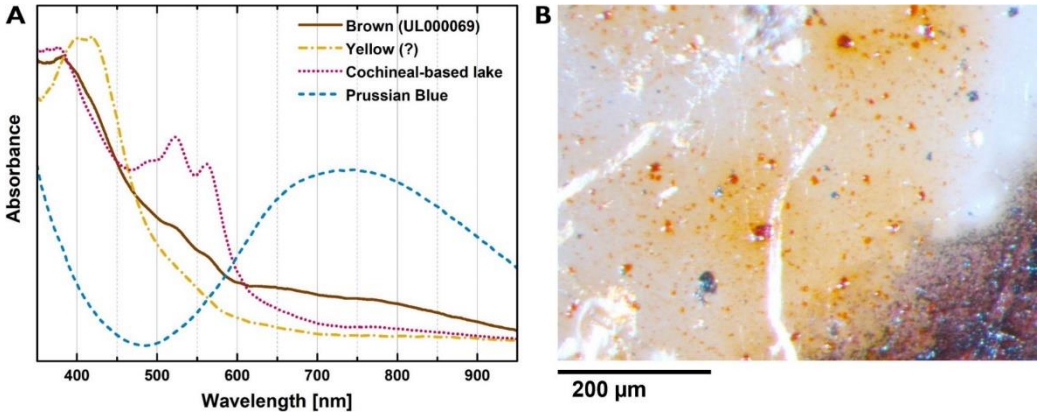


Figure 4.34 (A) UV-VIS absorbance spectra of the brown paint of MUL-MUHNAC-UL00069, possibly achieved by mixing yellow with an animal anthraquinone-based lake (possibly cochineal) and Prussian blue, identified in other areas of this painting. (B) Microphotograph of the brown paint of slide MUL-MUHNAC-UL00066 showing particles of yellow mixed with pink and possibly blue (80x original magnification).

Black

As light passing through the colourless glass support produces white, the total absence of projected light through magic lantern slides resulted in black. Therefore, opaque black colourants were applied to create the great majority of outlines (whether painted or printed) and these shadow effects by covering the entire background with these pigments, which helped the figures to stand out and allowed for the illusion of movement by covering some parts of the painting while revealing others (**Figure 4.35**). Transparent black was also used to colour figures in black and grey without obscuring the images (*e.g.,* the elephant in **Figure 4.36-A** and the shadow effect beneath the shoe in **Figure 4.36-B**). Written historical sources of both the 18th and 19th centuries mostly recommended the use of bone or ivory black and lamp black to paint on magic lantern glass slides, and those carbon-based blacks were possibly the ones applied to the slides studied. In addition, mixtures of carbon blacks and other colourants were detected (**Figure 4.36-C-E**).

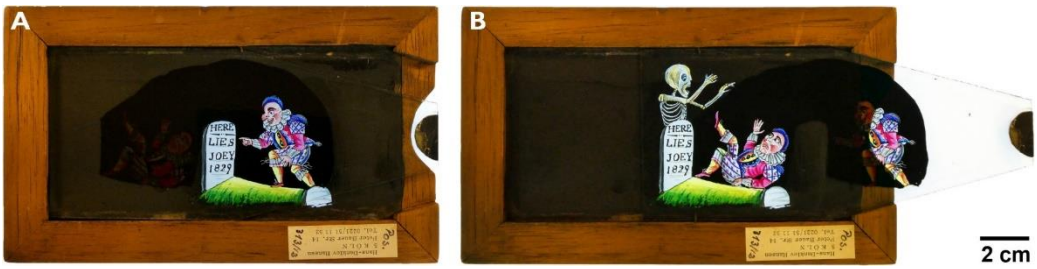


Figure 4.35 Example of the use of black paint in the background to help the figures stand out and create the illusion of movement by covering different parts of the figure when the slide is closed (A) and open (B) (inv. CPMC-PC3300/001).

Carbon-based black

The black colourant was identified through Raman spectroscopy as an amorphous carbon-based black pigment. The Raman spectra of these pigments (**Figure 4.36-D, E**) present two prominent characteristic bands between 1300-1600 cm^{-1} designated as G and D bands. The first consists of a narrow band at around 1580 cm^{-1} from crystalline carbon black 'graphite', known as G, and it is

assigned to the in-plane stretching vibration, corresponding to the zone centre E_{2g}; the second, known as D from the 'disordered' or microcrystalline graphite, consists of an additional band at around 1350 cm^{-1} and is assigned to a zone boundary graphite mode with A_{1g} symmetry (Tomasini et al. 2012). These bands are broad when in the presence of amorphous carbon, which is the case of the paints analysed. All of the black paints analysed presented a D band around ~1330 cm^{-1} and a G band around 1600 cm^{-1}.

In several of these black paints, calcium and phosphorous, among other elements, were detected by EDXRF. Additionally, in the Raman spectra of **Figure 4.36-D,** two very weak bands at 964 and 1090 cm^{-1} appear to be present (marked with ♦), and the first may be assigned to the phosphate-stretching mode of hydroxyapatite characteristic of carbon blacks of animal origin, such as bone or ivory black; nevertheless, given the low intensity of this signal, its identification could not be confirmed (Tomasini et al. 2012; Coccato et al. 2015).

In several slides, other colours, such as Prussian blue and copper-based green, were mixed with carbon black pigments, detected by Raman spectroscopy. However, in the case of copper-green, presented in **Figure 4.36-E**, it is uncertain whether the bands at ~1300, 1442 and 1595 cm^{-1} are assigned exclusively to copper compounds (as previously explored) or if a carbon black was mixed since this green is notably darker than other green areas of this slide.

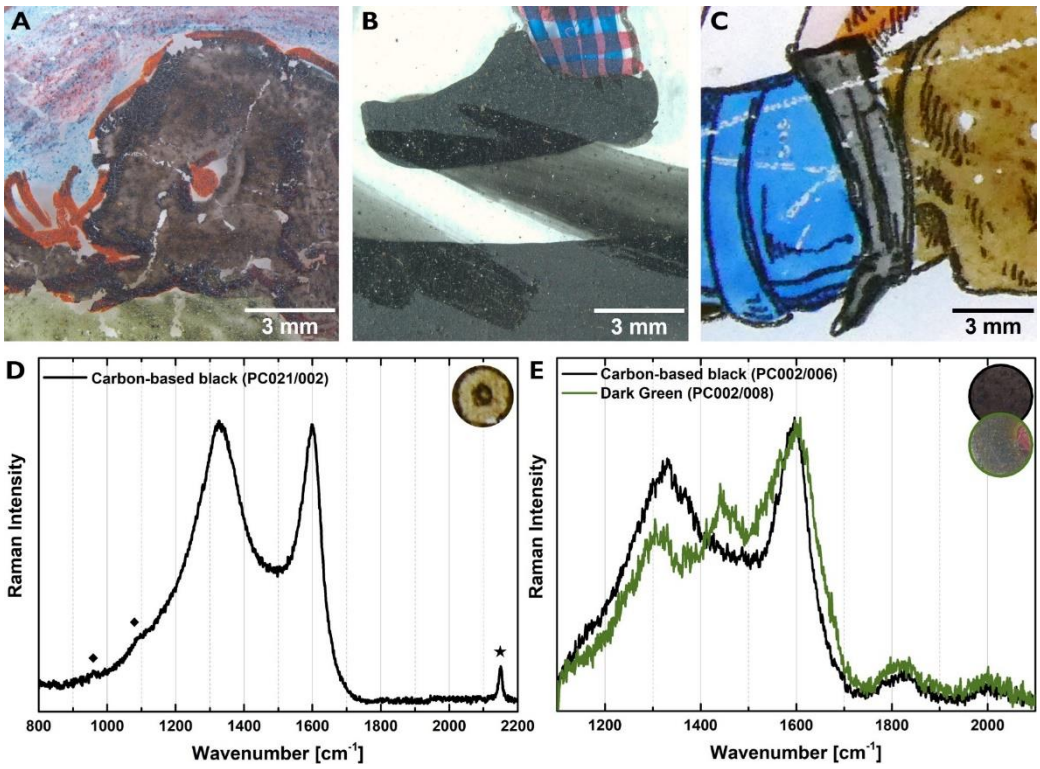


Figure 4.36 Details of slides displaying blacks and greys: (A) carbon-based black, CPMC-PC002/011; (B) carbon-based black (opaque black mask and transparent grey shadow), FCT.V.LM02; (C) mixture of carbon-based black with Prussian blue, CPMC-PC203/003. (D) Raman spectrum of a carbon-based black used for printed outlines. This black is possibly a bone or ivory black, given the additional very weak bands marked with (♦). The presence of Prussian blue could be detected through its characteristic band (★). (E) Raman spectra of carbon-based black compared to dark green from 18th-century slides.

Printed outlines

Several techniques and materials could be used to print outlines on glass sheets, as discussed in 1.2 Production of magic lantern slides: a review of methods and materials for painting glass slides. From the 21 slides with printed outlines studied, 15 were examined using EDXRF and/or Raman techniques. One slide was produced by Carpenter & Westley, two by unknown English producers and 12 by Lapierre.

In the Carpenter & Westley slide (CPMC-PC189/009), higher iron, barium, and possibly lead contents were detected compared to the glass support, even using a lower acquisition time (120s to 360s). Although it is uncertain if these contents can indicate the use of black enamel, according to the literature, in 1823, P. Carpenter adapted a transfer printing process for the outlines, the copper-plate printing technique, using black enamels for this process[12] (Beattie 2013).

Regarding the slides from unknown English manufacturers, both appear to have been produced with organic black paints. No signal was detected using EDXRF on the outline of slide CPMC-PC182, pointing to an organic paint. On slide FCT.V.LM03, EDXRF analysis detected higher contents of iron and lead compared to the glass support using the same acquisition time (360s), and Raman identified the presence of a carbon-based black.

All Lapierre slides from CPMC appear to have outlines primarily made of carbon-based black. In slides PC18/001-002, PC203/001-003, PC165/006-007 and PC166/006, EDXRF mostly detected higher contents of phosphorous, calcium, iron, copper, and zinc compared to the glass support using the same acquisition time (360s). These elements appear to be related to the mixture of other colourants with the organic black since Raman identified carbon-based black sometimes mixed with Prussian blue in slides PC203/003, PC033/001, PC165/006-007, PC020/007 and PC021/002 (**Figure 4.36-D**).

4.3.3 Colour palette evolution and manufacturers' choices

To colour the images projected by magic lanterns, artists resorted to subtractive colour mixing, and the figures observed resulted from the interaction of the light with the painting. With glass working as a colourless transparent support, the absence of painting allowed light to reflect the white colour of the projection screen to the audience. The opposite was achieved by blocking the passage of light to create dark areas within or around the painting, whether with black paint or shaped wooden frames. For this subtractive mixing system of colouring to work in projections, only transparent colourants could be used so that colours perceived by the audience would match the ones observed under reflected and transmitted light. Nonetheless, as demonstrated in the previous subsection, opaque pigments such as vermilion were also detected in historical slides besides the intended opaque black paints.

[12] The copper-plate printing process was tested and part of the outline of a 19th-century magic lantern slide was reconstructed in partnership with Ana Margarida Rocha (at the time PhD student from the Faculty of Fine Arts of the University of Porto (FBAUP) and VICARTE research unit) to compare the results obtained with the original slides studied. The details of the reconstruction process and results can be consulted in *Appendix A.8*.

The list of colours suitable for transparent painting was necessarily restricted when compared to the variety of colours commercially available in the 18th and 19th centuries. Additionally, the results obtained with the material characterisation of historical magic lantern glass slides unveiled a colour palette considerably less varied than expected from the literature. In this way, a small selection of colours produced many other hues, resorting to mixtures. Nevertheless, artists needed to keep in mind that each pigment absorbed a part of the available spectrum of visible light; therefore, for every colour added, more wavelengths were subtracted from the transmitted light (Ball 2009). Probably for this reason, preference was given to the brightest and purest colours, and mixtures were kept simple to avoid murkiness.

The preference for brighter and purer colours can be observed by studying the evolution of the colour palette used throughout the 18th and 19th centuries. It was possible to organise chronologically the colourants and mixtures identified in historical slides by crossing the date attribution information based on the producer marks of the frames and aesthetic characteristics, the glass support's production period, and the date of availability of the colourants identified. The development of this timeline allows for an overview of the colour palette evolution proposed for this group of slides (**Table 4.2**). As observed, significant changes in the colour palette occurred in the transition to the 19th century and the last third of the century. As previously discussed, improvements in oil and watercolours and the introduction of new colours influenced the palette suggested for the magic lantern slide painting by written historical sources and are correlated to the colourants identified on slides from the same period. Generally, the early 19th century shows a transition from inorganic yellows, reds and greens to organic colours or mixtures of organic and synthetic pigments. Throughout the century, the variety of colours and mixtures continued to increase.

Differences in the manufacturers' colour palettes and stylistic choices were also investigated. **Table 4.2** summarises the colours used in each slide organised by manufacturer and sets. Lapierre had the most concise colour palette, composed of primarily pure yellow, brown, pink, blue, green and black colours, and one shade of green made by yellow and blue paint. On the other hand, Italian and English producers frequently included oranges, reds and purples obtained by mixtures, considerably increasing the range of colours observed.

Concerning specific colourants used by known 19th-century producers, only P. Carpenter used ochre as a yellow colour. Interestingly, their slide also had a green made of gamboge and Prussian blue, indicating the possible use of an already prepared green formulation sold under the name of Hooker's green or Prussian green, introduced in the early 1800s (Eastaugh et al. 2008). As yellow, gamboge was only applied by W.E. & F. Newton. Other exclusive colourants were the ultramarine blue mixed with Prussian blue on Carpenter & Westley's slides and the pink eosin lake on slides by Lapierre. The case of the eosin lake is particularly interesting given that these Lapierre slides were aesthetically attributed to ca.1860-1900, and the identification of eosin shortened the date range to ca.1874-1900 due to the commercial availability of this pigment.

Table 4.2 Summary of results of the representative magic lantern slide sets organised according to their producer, country of production and date. The sets are identified from A to L, and the corresponding spectra can be found in *Appendix A.6.2*.

Representative Slide Sets	Unknown, IT	Carpenter, EN (LM01)	C&W, EN	C&W, EN (PC3301/005)	Newton, EN (LM02)	Newton, EN	Unknown, EN (PC3300/001)	Unknown, EN	Unknown, EN (MUHNAC)	Lapierre, FR	Lapierre, FR	Lapierre, FR (PC166/006)
	ca.1750-1800	ca.1822-1835	ca.1838-1900	ca.1838-1870	ca.1850-1858	ca.1850-1858	ca.1829-1835	ca.1860-1900	ca.1870-1900	ca.1860-1900	ca.1874-1900	ca.1860-1900
	A	B	C	D	E	F	G	H	I	J	K	L
Glass composition												
Potassium-rich (KR)	●											
Kelp-based mixed alkali (MA-k)		●					●					
High-lime low-alkali (HLLA)			●		●	●		●	●	●	●	●
Synthetic soda-rich (SS)				●				●	●			
Glass technique												
Crown	●						●					
Improved Cylinder			●	●				●	●	●	●	●
Binders												
Mastic resin	●						●	●		●	●	?
Shellac resin			●		●	●			●			
Oil	?						?					
Colourants												
Red ochre (hematite)	●											
Copper-based red-orange	●											
Anthraquinone lakes (cochineal)	●	?	●	●	●	●		●	●	●		
Cochineal lake? + vermilion		●	●		●		●	●				
Geranium lakes (eosin)											●	
Geranium lakes + vermilion											●	
Synthetic lake?												●
Yellow ochre	●	●									●	
Gamboge					●		●	●				
Yellow?	●		●	●		●			●	●	●	●
Prussian blue	●	●	●	●	●	●	●	●	●	●	●	●
Prussian blue + ultramarine blue				●								
Copper green	●											
Copper green + Prussian blue	●											
Copper green + Prussian blue + gamboge		●										
Prussian blue + gamboge					●	?	●	●				
Prussian blue + yellow?			●	●		●		●	●	●	●	●
Prussian blue + cochineal lake?	●		●					●	●			
Prussian blue + cochineal lake? + vermilion		●										
Ochre	●											
Ochre + cochineal lake + vermilion		●										
Gamboge + cochineal lake? + vermilion					●		●					
Yellow? + cochineal lake?			●					●	●			
Gamboge + cochineal lake?								●				
Ochre (hematite)	●		?	?	●			●		●	●	●
Unidentified	●	●					●	●				
Cochineal lake? + yellow?			●					●				
Cochineal lake? + gamboge								?				
Hematite + carbon black					●							
Prussian + carbon black									●			
Hematite + Prussian blue											●	
Carbon black	●	●	●		●	●	●	●	●	●	●	
Carbon black + Prussian blue	●									●	●	●
Carbon black + copper green	●											
Unidentified			●									

4.4 Chapter conclusion

This chapter set out to determine the composition of glass support and painting materials used to produce 18th- and 19th-century hand-painted magic lantern slides, understand their technological evolution, and give insight into their preservation state while testing the advantages and limitations of the applied multi-analytical methodology.

Analysing painted magic lantern glass slides was revealed to be more challenging than expected, primarily due to the chemical complexity and physical instability of these paintings. Nevertheless, despite including a relatively small number of slides, especially compared to the extensive 19th-century production reflected in the collections of many institutions, it allowed drawing a first systematic approach to their material characterisation that can be applied to other collections. EDXRF, UV-VIS, and Raman spectroscopies allowed for the acquisition of a vast number of analytical results in a relatively short time while *in situ*. As a result, the glass composition could be uncovered, and the complementary use of these techniques allowed the identification of most colourants applied in these paintings. Although FTIR and SER spectroscopies required micro-sampling, FTIR aided the identification of paint formulations by detecting colourants, binding mediums, and deterioration products, contributing to assessing the preservation condition of these slides, and SERS allowed for the definitive identification of cochineal-based pigments. This characterisation study has shown strong correlations between material analysis and aesthetic characteristics of 18th- and 19th-century slides and the historical research of written historical sources regarding production techniques and colour palettes used by artists and manufacturers developed in *Chapter 1*.

Analyses of the glass support have verified the preference for high-quality glass, as reported by historical documentation. The glass was generally very thin and transparent, with few bubbles and defects and low contents of impurities in their composition. The semi-quantification based on EDXRF analysis allowed for distinguishing four main compositional groups: potassium-rich, mixed alkali, high-lime low-alkali, and synthetic soda-rich glass. Each compositional group could be associated with specific production periods and regions, providing crucial clues for these slides' attributions.

This scientific approach also provided essential information on the binding mediums and colourants used in magic lantern slide paintings, demonstrating its similarities with the recommendations provided by historical literature. It showed a preference for bright and pure colours to avoid murkiness, which, coupled with the limited availability of transparent pigments, influenced the artists' choices and inspired the use of mixtures that created a multitude of hues and gradients. The analyses detected shellac and mastic resins and the possible presence of oils. Regarding the colourants, yellow ochre, gamboge, red ochre, cochineal-based lakes, geranium lakes, vermilion, Prussian blue, ultramarine blue, copper-green, and carbon black were identified. However, further investigation is necessary to uncover the complex composition of the binding mediums present in these paints, for example, resorting to pyrolysis-gas chromatography/mass spectrometry (Py-GC/MS), as well as several unidentified colourants. Synchrotron techniques need to be tested in paint cross-sections to verify if it is possible to analyse the binding medium and better understand these paintings' stratigraphy.

Microspectrofluorimetry can also be an invaluable tool to identify pigments and dyes as it does not require sampling and, within the framework of the MAGICA project, revealed possible, the identification of different recipe formulations for several pink paints resorting to a database and a chemometric approach.

Nevertheless, the results obtained regarding glass and painting materials align chronologically, and this investigation enlightens on how the technological evolution of the 19th century directly impacted the development of the art of painting glass slides. Higher-quality flat glass, along with the increase in synthetic pigments expanding the colour palette available to artists, and the introduction of printing techniques for the slides' outlines were of the most significance. The in-depth analysis of pigments used in these slides allowed us to visualise the evolution of their colour palette over time. Furthermore, it was possible to discern different manufacturers' unique artistic styles and preferences, from the complexity of Italian and English producers' compositions to Lapierre's concise yet vivid colour palette, each set of slides presenting its distinctive charm and artistic vision.

This study made it possible to attribute chronologies of production with more precision, emphasising the importance of complementing the aesthetical and documental attributions with analytical studies. Examples of this are slide CPMC-PC3300/001, initially attributed to the second half of the 19th century, which might have been produced before 1835 considering the glass support composition, and slide CPMC-PC165/007, initially attributed to ca.1860-1900, that saw its production range shortened to 1874-1900 due to the identification of eosin lake; a pigment that only became commercially available in 1874.

This investigation has also brought to light conservation problems and emphasised the fragility of these objects by exploring these questions from the material point of view. Examples are the presence of light-sensitive colourants in these slides (such as organic yellows and reds/pinks), the deterioration products detection such as carboxylates, and the severe brittleness of these paint layers brought to light when micro-sampling. The discovery of eosin-based lakes with such different states of deterioration (from intense colours to completely faded) highlights the importance of studying and preserving these historical artworks.



5

CONSERVATION CHALLENGES

> *The illumination of these exhibitions up to this period had been effected by means of oil lamps, which did not prove satisfactory in some of the larger rooms, and in 1837, Mr. Dancer, optician, now of Manchester, suggested to Mr. Smith the use of the "lime light", or, as it was then styled, the "Drummond light", which at that time was in the use for gas microscopes only.*
> *The artists who painted the slides predicted that their pictures would be ruined by such a light.*
>
> W. Chadwick (1878, 63–64)

Conservation describes "all measures and actions aimed at safeguarding tangible cultural heritage while ensuring its accessibility to present and future generations", respecting the significance and the physical properties of the cultural heritage item (ICOM-CC 2008). The various conservation measures and actions can be distinguished according to their objective by preventive conservation, remedial conservation, and restoration[13].

Preventive conservation designates indirect measures and actions undertaken without modifying the appearance and interfering with the materials and structures of the objects. These are carried out within the context or on the environment of the item or collection and aim to avoid and minimise future deterioration or loss (*e.g.,* registration, storage, handling, packing and transportation, security, environmental management, emergency planning, education of staff, public awareness, and legal compliance) (ICOM-CC 2008). Preventive conservation is recognised as the most effective means of promoting the long-term preservation of cultural property and considers the influence of the 10 deterioration agents (physical forces, criminal action, fire, water, pests, pollutants, light, incorrect temperature, incorrect relative humidity, and dissociation), a conceptual framework developed by the Canadian Conservation Institute (2017b).

Remedial conservation actions sometimes modify the appearance of objects and aim to mitigate current damaging processes or reinforce the structure of objects that are unstable or actively deteriorating at a rate that could be lost in a relatively short period (*e.g.,* disinfestation,

[13] Preventive conservation, remedial conservation and restoration were the terms adopted and described by the ICOM-CC at its 15th Triennial Conference in New Delhi on 22-26 September 2008 as the preferred nomenclature to characterise the various conservation actions.

desalination, stabilisation of corrosion, consolidation) (ICOM-CC 2008).

Finally, restoration activities are directly applied to an object to facilitate its appreciation, understanding and use when part of its significance or function was lost due to past alteration or deterioration, often altering its appearance while respecting the original material (*e.g.,* retouching, reassembling broken fragments, reshaping, filling losses) (ICOM-CC 2008).

Although these conservation measures and actions can be categorised in this way, sometimes they can serve more than one purpose, such as removing an old varnish, which can be both remedial conservation and restoration (ICOM-CC 2008).

Collections of magic lantern slides have been increasingly studied over the last decade; nevertheless, several factors are reported as significant obstacles to their preservation and availability worldwide. Among those is the lack of allocated resources, time and personnel dedicated to these objects, partly due to the inaccessibility of specialised knowledge on magic lantern slides to most curators, archivists, and cataloguers (Dellmann 2016). Regarding conservation instructions related to magic lantern glass slides, only preventive conservation, remedial conservation and restoration guidelines for photographic slides are currently available, and no specific directions for the preservation of hand-painted slides could be found (Preservation Self-Assessment Program (PSAP), n.d.; S. Clark 2009; Hill 2018). As it is understood, preventive conservation measures currently constitute the main obstacle to the study of these collections and ultimately result in severe conservation problems, putting the integrity and future of these collections at stake.

The present chapter addresses preventive conservation and restoration of magic lantern slide collections, aiming to help mitigate some of these factors. The initial section is dedicated to assessing collections conditions and practices, which was essential to develop preventive conservation guidelines for painted magic lantern glass slides, designed to complement general directions currently established for cultural heritage collections. The final section explores restoration challenges regarding cleaning and reassembling practices.

5.1 Assessment of collections conditions and practices

For an institution to effectively preserve its collections, it is essential to assess and monitor their condition to understand if the collection is deteriorating to adapt and implement new preventive and remedial measures and identify which objects should be prioritised when restoration interventions are needed (Keene 2002, 139). According to Keene (2002), to acquire a comprehensive view of the collections preservations, the three types of surveys needed include preventive conservation assessments (*e.g.,* institution policies, procedures, staff, space, resources), collections condition audits (categorisation of symptoms of damage to access the objects state of preservation), and curatorial assessments (*e.g.,* determine the importance of each object as part of the collection to set priorities for action or resources). The evaluation and monitoring should be based on clear definitions to allow the state of preservation to be compared over time and to other collections and institutions (Keene 2002, 139). Nevertheless, it is essential to keep in mind that evaluating the collection risk and attributing condition grades varies between evaluators and sometimes within the same person; therefore, to improve the results' reliability, definitions and parameters for decision-making should be as clear and precise as possible.

On the institution with the most extensive collection of slides studied, the Portuguese Cinematheque – Museum of Cinema (CPMC), a preventive conservation assessment focused on their spaces for storage and display was undertaken to identify the agents that can cause and accelerate these objects' deterioration. Given that this collection did not have high-definition photographs and an inventory file allowing the object documentation to be observed simultaneously with their pictures, a high-resolution photography campaign[14] and the catalogue presented in *Appendix A.2* were developed not only to inform the reader of this collection but also to aid the institution that is currently developing an improved database.

The CPMC and the National Museum of Natural History and Science (MUHNAC) collections were studied to determine which part of their collection represented magic lantern slides entirely hand-painted or painted over printed outlines, the slides' most common formats, movement mechanisms and types of constructions and compositive materials. Additionally, the state of preservation of slides of interest held by the CPMC and the MUHNAC was evaluated. The careful observation of these slides allowed for identifying the main deterioration problems.

Finally, a questionnaire to other national and international institutions holding magic lantern slides was undertaken to acknowledge the reality of other slide collections and their characteristics, for instance, the number of slides per institution, their depiction techniques and dates, common damages observed, and the conservation measures undertaken (preventive, remedial and restoration), and better understand the difficulties and the necessities that people responsible for these objects identified.

[14] The author is currently carrying out a campaign dedicated to registering high-resolution photographs of the CPMC collection of slides entirely hand-painted and coloured with printed outlines.

5.1.1 The Portuguese Cinematheque case study: addressing the collection's spaces

The CPMC collection is divided into two locations: the National Archive of Moving Images (ANIM) in Loures and the Foz Palace in Lisbon. Around 95 % of the CPMC collection of painted slides is in a storage room (along with almost all chromolithographic and photographic slides) at the ANIM facilities, which have been open since 1996 and were constructed with the purpose of archiving cinema collections. The permanent exhibition dedicated to the pre-cinema collection, which displays magic lantern instruments and slides, has been held by the Junior Cinematheque since 2007 at the Foz Palace, a historical building from the end-18th/early-19th century, that accommodates several services, including from the CPMC since 1958.

The approximate location of the storage and exhibition rooms, where the collection of magic lantern slides is distributed, within ANIM and Foz Palace buildings is presented in **Figure 5.1**. Considering the influence of the 10 deterioration agents recognised (physical forces, criminal action, fire, water, pests, pollutants, light, incorrect temperature, incorrect relative humidity, and dissociation), the ones related to environmental conditions were investigated in these rooms.



Figure 5.1 Approximate location of the storage and exhibition rooms that hold magic lantern slides within the ANIM and Foz Palace buildings. © Photographs of ANIM by Luis Pavão and Foz Palace by Manuel V. Botelho.

Environmental conditions in storage and exhibition rooms

Light and radiation, temperature and relative humidity conditions were evaluated in the storage and exhibition rooms. To better understand the impact of these factors on the slides, the light intensity and ultraviolet radiation were acquired using an ELSEC 764 Environmental Monitor, and the temperature and relative humidity were automatically registered every 2 hours during 8 and 12 months (at the exhibition and storage rooms, respectively), using dataloggers by Rotronic® Measurement Solutions, HL-1D / TL-1D (v2.0). An approximate mapping with the measurement locations is shown in **Figure 5.2**.

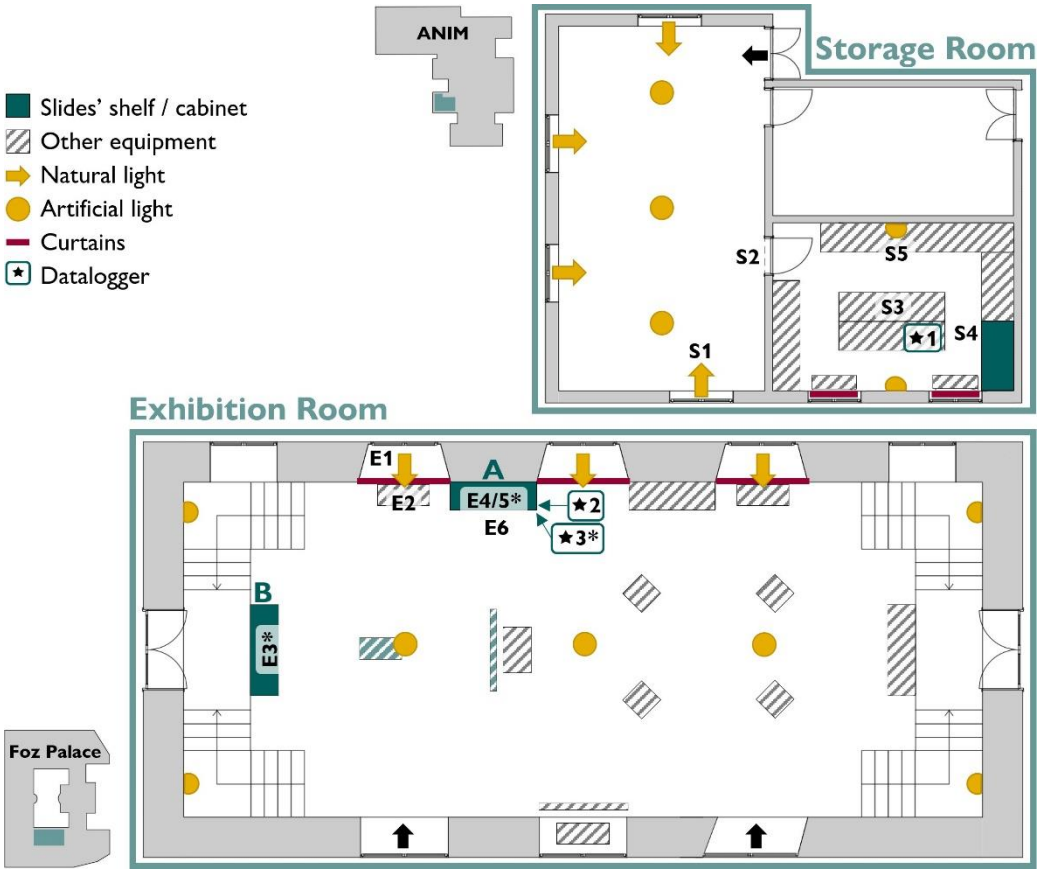


Figure 5.2 Mapping of the storage (S) and exhibition (E) rooms where the cabinets holding magic lantern slides are located. The light measurement locations are indicated through the codes **S** and **E**, and the dataloggers registering the temperature and relative humidity have the symbol ★. All measurements acquired inside closed cabinets are marked with *.

Light and Radiation

Although colourless glass, one of the main constituents of the magic lantern slides, is not usually affected by light exposure, these artefacts contain light-sensitive painting and frame materials (e.g., wood and coloured paper) prone to fading and discolouration. Both storage and exhibition rooms have curtains and UV filters on the windows, which protect the objects from natural light.

Natural light varies according to time of day, weather and season; nevertheless, measurements of the natural and artificial visible light and ultraviolet radiation in both storage and exhibition rooms (see **Table 5.1**) intend to give an insight into this factor's influence.

Table 5.1 Summary of visible (VIS) and ultraviolet (UV) light measurements in CPMC storage and exhibition rooms.

Storage Room			Exhibition Room		
Location code	VIS light (lux)	UV light (µW/lumen)	Location code	VIS light (lux)	UV light (µW/lumen)
S1	107	138	**E1**	39838	18
S2	75.9	47	**E2**	3588	4
S3	98.9	0	**E3***	11459	0
S4	29.9	0	**E4***	322	0
S5	607	30	**E5***	68.6	0
			E6	63.5	0

* Measurements acquired inside closed cabinets A and B.

In the part of the storage room where the slides are kept, the windows have blackout curtains, the artificial lights are mostly turned off and the slides are preserved in the dark inside conservation-grade card boxes. In this storage segment, objects on open shelves, such as the magic lantern projectors and illumination systems, are only occasionally exposed to approximate intensities between 30 and 100 lux (S3 and S4). In this area, there are two LED lamps on opposite walls pointing to the ceiling emitting around 600 lux and 30 µW/lumen of UV radiation (S5); nevertheless, as the lamps are covered with glass, the objects on the shelves directly in front of them only receive around 100 lux and no UV radiation (S3).

The neighbouring area, mainly dedicated to cataloguing, has translucent curtains to protect the objects from intense natural light. At the main desk (S1), the objects are exposed to around 110 lux and 140 µW/lumen of UV radiation; however, the light that enters the magic lanterns and slides' storage area when the door is open (S2) is significantly less intense (76 lux and 47 µW/lumen of UV radiation, measured at the door).

In the exhibition room, translucent curtains and UV protective filters are applied to the two windows that are kept with the wooden shutters open to allow for natural light; however, the lights from the ceiling and display cabinets are permanently turned on during the Junior Cinematheque opening hours (around 8 hours/day). The natural light that enters the room was measured without the curtain (E1) and with the curtain (E2) to understand their effectiveness in reducing the light intensity and UV radiation. The results revealed that the curtains are essential to protect the collection from natural light and radiation, reducing around 11x its intensity (from 39838 to 3588 lux) and 4.5x the UV radiation (from 18 to 4 µW/lumen).

Measurements outside (E6) and inside (E3-5*) of the two closed cabinets containing painted magic lantern slides revealed that although no UV radiation is received, the slides are exposed to highly damaging light from the lamps inside the cabinets. In 2021, several slides were returned to storage after around two years in the exhibition, severely damaged by light (**Figure 5.3**), and this study allowed for identifying the factors causing these damages.

Cabinet A (**Figure 5.3-A**) has two types of illumination systems, one behind the slides and the black paper that covers their non-painted areas (E4*) and another on top of the cabinet's front glass, pointing to the slides (E5*). The light behind the slides was revealed to be too intense, and the slides received around 320 lux. As can be observed by comparing **Figure 5.3-C** and **D**, the painting of slide CPMC-PC0508/001 suffered from fading, mainly visible in the yellow, brown and red paints, which, as discussed in *Subsection 4.3.2*, often contain organic colourants (*e.g.*,

gamboge, cochineal and eosin) that ideally should not be submitted to more than 50 lux (Bacharach 2016). Additionally, although the wooden frame's colour can vary slightly within the same set, besides the frame having a lighter colour than CPMC-PC0508/003, the wood surrounding the picture that was not covered by the black paper has an even lighter colour.

The light mounted inside cabinet B (**Figure 5.3-B**) is by far the most concerning as it exposes the objects to more than 11000 lux (E3*), more than 200x the intensity advised for light-sensitive materials such as the eosin-based lakes, commonly used by Lapierre to paint slides such as the CPMC-PC0020/007, severely damaged by these lights resulting in a colour loss on both the paper frame and painting, as shown in **Figure 5.3-E** and **F**.



Figure 5.3 Closed display cabinets (A) and (B) holding magic lantern slides in the exhibition room of Junior Cinematheque (Foz Palace, Lisbon). Slide CPMC-PC0508/003 (C), which was kept in storage, while slide PC0508/001 (D) from the same set was displayed in cabinet A, showing colour fading by light exposure. Slide CPMC-PC0020/007 before (E) and after (F) being displayed in cabinet B for around two years. © Photographs by the author (A-D and F) and Teresa Parreira (E).

Temperature

In the ANIM storage room area where the magic lantern slide collection is preserved, although it is an uncontrolled environment, the temperature (T) ranged between 16.9 ºC and 24.7 ºC over 12 months (**Figure 5.4-A**). These temperatures are adequate for this collection, given they stay in the advised range of 20 ± 5 ºC and, with minor daily fluctuations (max. of 1.3 ºC). It is worth noting these temperatures were measured in the room and not inside the boxes where the slides

are kept, meaning that fluctuations may be less notorious inside them.

The magic lantern and slides' exhibition room temperatures at the Junior Cinematheque ranged between 15.8 ºC and 25 ºC outside and between 15.4 ºC and 24.2 ºC inside cabinet A from November 2021 to July 2022 (**Figure 5.4-B, C**). Registered temperatures during these 8 months are within the advisable range; however, due to external factors, the measuring period of 12 months could not be completed, leaving the usually warmer months of August and September unmeasured. In this way, the possibility of the slides being exposed to temperatures above 25 ºC cannot be excluded. In this room, daily fluctuations were higher compared to the ANIM storage room, reaching a maximum variation of 2.6 ºC outside and 2.2 ºC inside the display cabinet A.

Although maintaining these moderate temperatures should keep the glass slides in good condition, the storage boxes and display cabinets should have adequate air ventilation. It was also noted that, inside the cabinet, the temperature was higher in the area closer to the light source mounted behind the slides. The fact that the surface behind the slides heats rapidly when the lights are turned on may result in higher temperatures and fluctuations in contact with the slides than those measured by the datalogger, which was placed in front of the slides near the cabinet's glass. Fluctuations can induce stress on the object due to the rapid expansion and contraction of certain materials, leading to several types of damage. For instance, higher temperatures may cause dehydration due to the consequent decrease of RH, accelerating the deterioration of the glass support and paints, and may increase the flexibility of natural resins, making them stickier and enabling them to hold dust easily.

Relative Humidity

The relative humidity (RH) and temperature are directly related, considering that when the temperature increases, the RH lowers and vice-versa. Considering the various materials frequently present in painted magic lantern glass slides, RH should be kept stable at around 45 %, avoiding daily fluctuations of more than 5 % (Brown et al. 2002). RH fluctuations are particularly damaging to both the organic and inorganic materials of slides.

Besides the average RH being around 53-56 % in the storage and exhibition rooms, slightly higher than advisable, it ranged between ~35 % and ~78 %. High fluctuations and RH of almost 80 % are concerning, given the risk of promoting glass and metal corrosion and causing stress in all materials. These high RH allied with temperatures of 25 ºC can encourage the growth of mould, create condensation between glass sheets and increase the reaction of glass with atmospheric water, leading to the leaching, dissolution and deposition of alkali salts on the glass surface, which may result in the detachment of the paint layer from the glass support (Clark and Zoitos 1992; Kunicki-Goldfinger 2008; Koob et al. 2018). In contrast, low RH may cause paint materials to shrink and crack and increase microcracking in unstable glass (Brown et al. 2002; Koob et al. 2018). Considering these results, measures should be taken to avoid extreme values.

Regarding fluctuations in RH, attention should also be paid to daily variations. In the storage room, the maximum daily variation was ~14 %, and it is expected to have less fluctuation inside the boxes where the slides are kept. In the exhibition room, these daily variations achieve 25 %, which are reduced to a maximum of ~15 % inside the display cabinet.

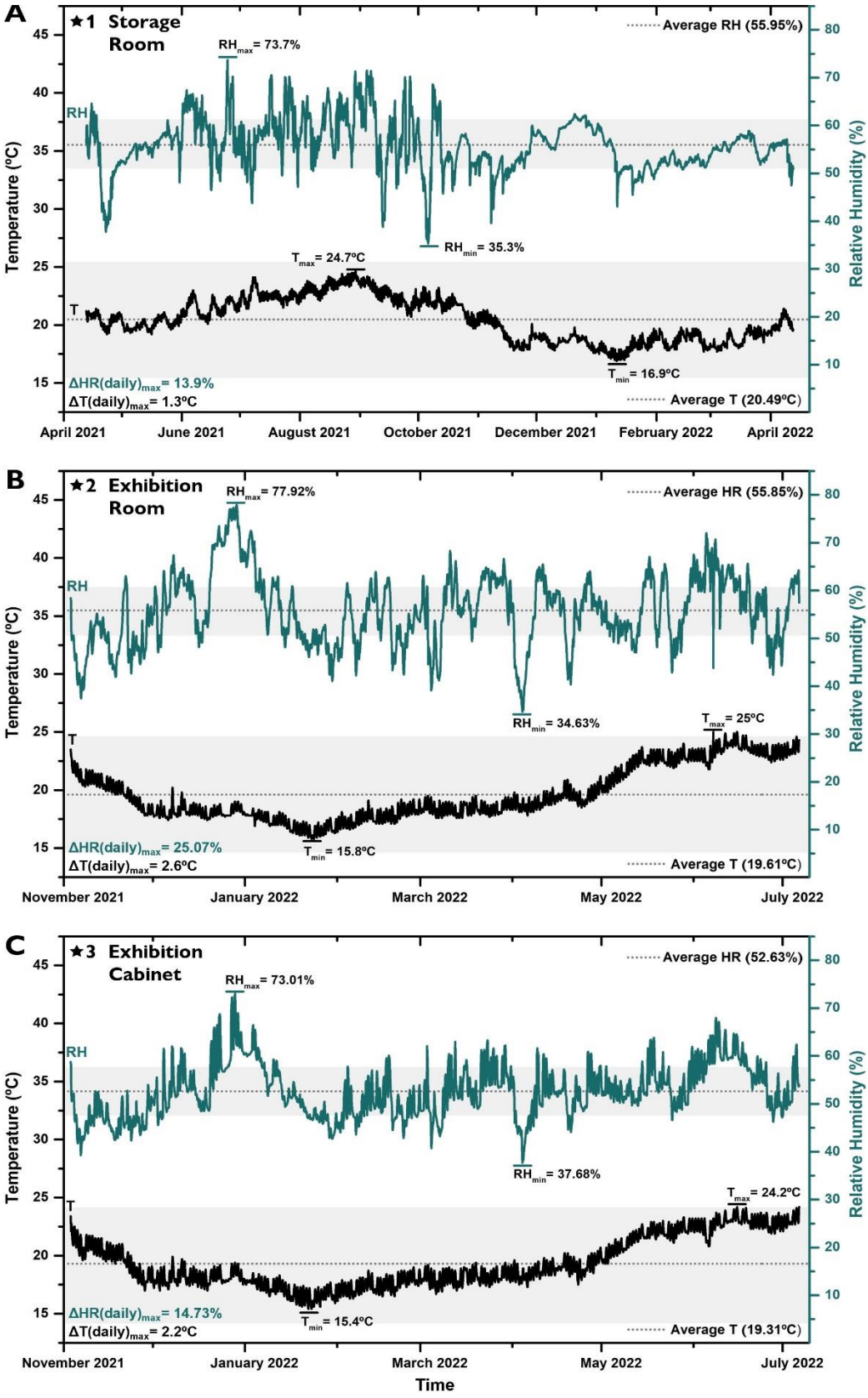


Figure 5.4 Collected data for the temperature (T) and relative humidity (RH) measured in the storage room (A) of ANIM for 12 months (21st April 2021 – 21st April 2022) and in the exhibition room (B) and display cabinet A (C) (Figure 5.3-A) of Junior Cinematheque for 8 months (3rd November 2021 – 6th July 2022). The grey range of ± 5 °C and ± 5 % represents the advised fluctuation limits for T and RH relative to the average values measured. The dataloggers (★) measuring locations are indicated in Figure 5.2.

5.1.2 Evaluation of the slides' state of preservation

Between 2019 and 2023, the state of preservation (SP) of 359 slides of interest (entirely painted and with printed outlines) from CPMC (322 slides), MUHNAC (30 slides) and VICARTE (seven slides) was assessed in collaboration with the conservation and restoration master student Beatriz Rodrigues. During the assessment, measurements and poor-resolution photographs[15] (for identification purposes only) were taken. The slides' evaluation of the apparent state of preservation was determined through careful macroscopic observation (*i.e.*, by the naked eye) of the slides to determine the overall condition of these collections. A classification was attributed to each material that generally composes these slides (glass, painting, wood, paper, and metal) as well as to the overall slide considering the relative condition of its materials according to the broadly applied condition grading (1-4), as follows (Keene 2002; Rodrigues 2018):

1. **Good** – object in good condition or stable, visibly undamaged.
2. **Fair** – object in fair condition or acceptable, damaged but stable, without the need for immediate action.
3. **Poor** – object in poor condition, probably unstable, and conservation action is desirable.
4. **Very poor** – object in very poor or unacceptable condition, severely weakened or highly unstable and actively deteriorating or affecting other objects, needing immediate action.

Several of these slides were analytically characterised, as observed in *Chapter 4*; therefore, the attributed state of preservation considered what was visible with the naked eye and what was observed with the analytical techniques (*e.g.,* stereomicroscopy and molecular spectroscopies). The deterioration problems or damages were documented according to the vocabulary widely used in condition reporting of cultural heritage, particularly in glass and painting conservation (*e.g.,* by Corning Museum of Glass and the Canadian Conservation Institute) (Canadian Conservation Institute 2017a; Davison 2003; Koob 2006).

The state of preservation assessment results of these 359 slides were compiled into a summary diagram (**Figure 5.5**). The grading attributed to each slide and its composing materials is shown in the catalogue (*Appendix A.2*). According to this evaluation, almost 80 % of the slides are in good or fair condition (SP1-2); nevertheless, almost 10 % are severely weakened and urgently need conservation actions. The entirely painted slides presented a higher percentage of slides in very poor condition (SP4) than those painted over printed outlines. However, this does not necessarily mean one technique is more susceptible to degradation. It is worth mentioning that 11 of these 15 entirely hand-painted slides in very poor condition were produced during the 18th century, and the remaining are from the 19th century. Factors such as the date of production, constituent materials, usage conditions, time of cumulative exposure to light (when projected, exhibited or stored), and the conditions in which the slides were kept over the years influence

[15] Photographs were taken in poor-resolution during the assessment just for object-information association purposes due to time and equipment limitations. A campaign to document all slides (entirely painted and with printed outlines) with high-resolution photographs is currently being undertaken by the author. The catalogue presented in *Appendix A.2* presents a mixture of poor- and high-resolution photographs and is being improved in parallel with the photographic campaign.

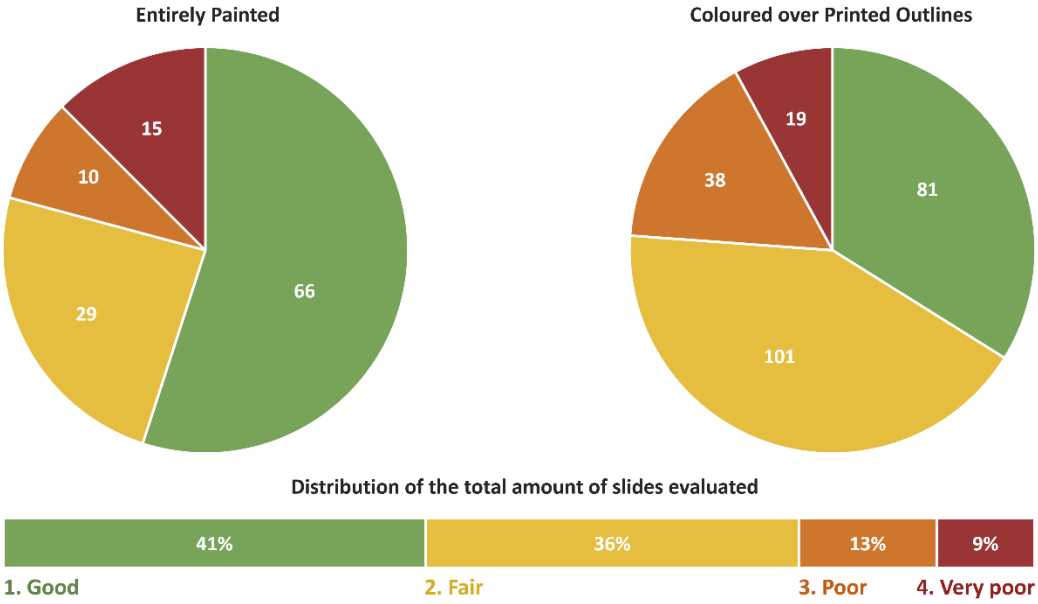


Figure 5.5. Overview of the apparent state of preservation (SP) of 359 slides, entirely hand-painted and hand-coloured over printed outlines, from the CPMC, MUHNAC and VICARTE collections, categorised on a scale from SP1-4 (from good to very poor condition).

the state they are today. This evaluation allowed us to determine that the painting was the most affected of the five types of materials individually assessed.

Regarding the 48 slides analytically characterised, eight are in good condition, 17 are in fair condition, eight are in poor condition, and 15 are in very poor condition. In terms of damages observed, the eight slides in good state of preservation (SP1) (from CPMC: PC020/006, PC189/012, PC182, PC3300/001, and PC3301/005; and from MUHNAC: UL000065-67) only presented thin layers of dust, and a few localised and minimal damages (*e.g.,* minor scratches in the wood or paint). The 17 slides in fair condition (SP2) appear stable while presenting a few damages, such as small, localised lacunas, mainly in the glass and paint, and tears of the paper frames. Slides CPMC-PC018/001 and PC033/001 were initially in poor condition; however, after a restoration intervention focused on the union of glass fragments, their state improved to a fair condition (restoration process described in *Subsection 5.3.2*). The eight slides found to be in poor state of preservation (SP3) (CPMC-PC018/002, PC020/007, PC021/001-2, PC032/003, PC166/006, PC446, PCPC3302/019) presented visible signs of paint deterioration that included cracks, flaking due to loss of paint adhesion to the glass support, lacunas and, in some cases, paint and paper discolouration and glass fissures and fractures.

The 11 slides from the 18th century (CPMC-PC002/001-011), the slide FCT.V.LM01 by Philip Carpenter from ca.1822-1835, and the slides CPMC-PC209/002, /009 and /011 by Carpenter & Westley from ca.1838-1900 were considered in very poor condition (SP4) for being unstable and in need of immediate action. These slides present damages visible to the naked eye, including paint cracks, flacking, lacunae, discolouration, and, in the worst cases, microcracking and powdering due to the failure of the paints' binder, resulting in the loss of paints' cohesion and adherence to the glass support possibly caused by its molecular alteration (*e.g.*, presence of carboxylates, known degradation products) detected using different analytical techniques, as discussed in *Subsection 4.3*. In several areas of slides CPMC-PC002/001-011, where the paint had

been lost, a thin layer of what appeared to be residue from the paint binder could be observed, with contour marks of paint craquelure. No cracking was found on the unpainted glass surface areas of these 15 slides. In the case of the 18th-century slides, further investigation on the glass support will be necessary to determine if, in addition to the failure of the paint binders, the microcracking in the paint and the loss of adhesion to the glass support may have been enhanced by possible glass deterioration.

Although primarily the slides classified as being in poor and very poor conditions have visible signs of physical and chemical deterioration, the material characterisation showed evidence of deterioration at the molecular level in various degrees in all the slides. Therefore, appropriate preventive conservation measures are necessary to reduce the progression of the degradation processes. It is also noteworthy that visual condition assessments have an inherent degree of subjectivity, not being greatly reliable and reproducible even when carried out by one person; however, they are still considered a vital method to understand the overall state of a collection and to support collection management decisions (Taylor 2011; 2014).

5.1.3 Common deterioration factors and damages

Evaluating the slides' state of preservation constituted an opportunity to recognise the most common deterioration factors and damages in these collections and assemble an illustrated glossary for these objects based on well-established nomenclature and descriptions of the materials that compose them (presented in *Appendix A.9.1*).

Magic lantern slides are composite artefacts by nature, combining several non-compatible materials in terms of conservation (glass, cold paints, wood, paper and metal). For instance, cold paints do not adhere well to vitreous surfaces, and glass does not follow any expansion or contraction movement of cold paint layers due to temperature fluctuations, causing the paint to crack and flake, ultimately resulting in paint loss. On the other hand, the glass may suffer from physical damage when confined in wooden frames, such as fracture due to the expansion of the wood in the presence of high humidity and chemical and structural alteration due to the emission of Volatile Organic Compounds (*e.g.*, formic acid, acetic acid, and formaldehyde); the wood is also hygroscopic, meaning it can absorb and retain water, which may promote the dissolution of the glass matrix in time (The National Trust 2006). Examples of common deterioration problems observed in the slides investigated are shown in **Figure 5.6**.

As expected, magic lantern slides present an assortment of damages possibly related to extensive handling, exposure to aggressive light conditions, extreme temperature, and relative humidity fluctuations during projections. Nevertheless, inadequate storage and display conditions can have an even more substantial impact on their deterioration, given that the time spent in these conditions is usually much higher.

Several of the most common structural damages, such as wear, tear and lacuna in the paper used in the frame or handle (**Figure 5.6-C**), fissures, fracture and lacuna in the glass (**Figure 5.6-D**), and scratches on the wooden frames and paint layers are possibly the result of excessive or careless handling. The abrasion of the paint in a preferential direction is often found, most probably due to the sliding movement of the slides during projections (**Figure 5.6-F**).

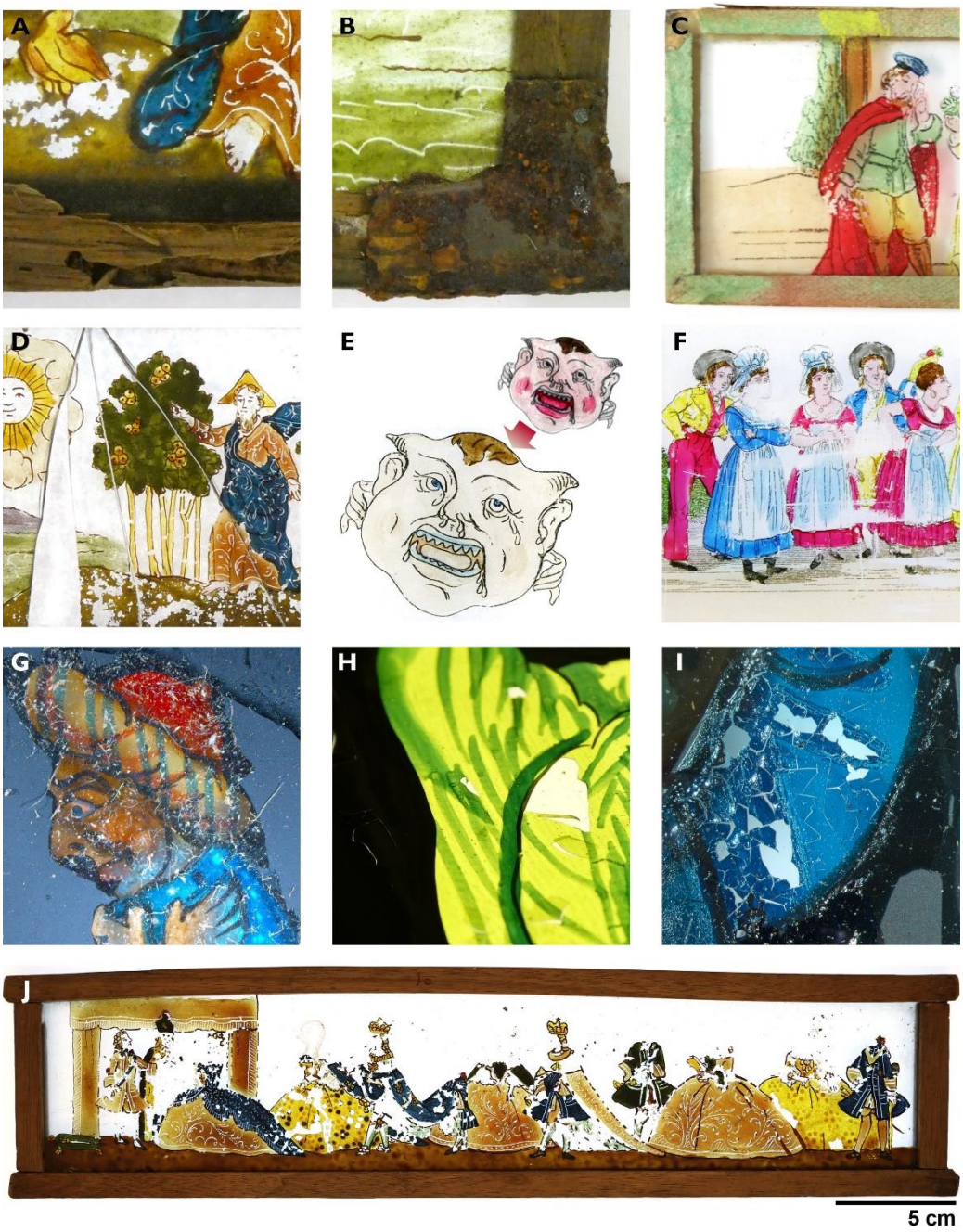


Figure 5.6. Examples of common damages observed in slides from CPMC and MUHNAC collections: (A) wood with insect damage and lacuna (PC002/011); (B) corrosion of the metal (PC002/011); (C) damages on the paper, such as wear, tear, lacuna, fading, and stains (PC017/006); (D) glass fissure, fractures and lacuna (PC002/011); (E) paint fading (PC020/007); (F) scratches and abrasion of the paint in preferential direction (PC166/006); (G) dust and grime on the surface (UL000067); (H) paint delamination and loss (PC0446); (I) paint cracking and flacking (PC3302/019); (J) wood distortion (PC002/008). © Photos CPMC by Ângela Santos and MUHNAC by Beatriz Rodrigues (2019)).

The slides' exposure to inadequate environmental conditions and lack of monitoring appears to be the origin of several common degradation problems: insect damage due to infestation on the wood (**Figure 5.6-A**), corrosion of the metallic parts (**Figure 5.6-B**), the presence of dust and grime over the surface of the slides (**Figure 5.6-G**), and wood distortion (**Figure 5.6-J**) and evidence of white spots on the glass support. These white spots are mainly observed on enclosed

glass surfaces (*i.e.*, between glasses overlaid without ventilation). They may be crystalline salts resulting from glass deterioration or fungi growth. This distinction often can only be made under a microscope.

As the condition assessment results pointed out, the paint is the most sensitive material due to its inherent properties and incompatibility with glass. The most frequently observed damages in the paintings were flacking, cracking, and loss (**Figure 5.6-H, I**), possibly caused by excessive exposure to light and high temperatures, which, besides causing the contraction and expansion of paint layers previously mentioned, accelerate the binders' deterioration. Additionally, their exposure to inadequate light conditions causes severe and irreversible fading (**Figure 5.6-E**) and discolouration, especially to light-sensitive colourants, in a short period.

Regarding the outlines printed onto the glass, these are frequently heterogeneous and have small lacunas. In several slides, the loss of colouring materials (*e.g.*, blue and pink paints) is only visible in areas adjacent to the outline part missing. Suppose a black glass enamel was applied to these slides. In that case, the outline detachment might be related to the enamel deterioration, incompatibility between the glass support and the enamel, or insufficient contact surface due to the small amount of enamel applied. Further investigation will be fundamental to determine the nature of the outline paints presenting conservation problems, which printing techniques and materials are more prone to loss, and the reasons behind their deterioration.

5.1.4 Surveying other national and international collections

An online questionnaire entitled "Conservation of Magic Lantern Hand-Painted Glass Slides" was designed with Google Forms as a qualitative research tool to understand the characteristics of different collections of magic lantern glass slides and how these are preserved in various institutions to understand the difficulties and acknowledge the necessities reported by the people responsible for these objects. This survey was developed within the framework of Beatriz Rodrigues's Master dissertation entitled "From Production to Preservation: Hand-Painted Magic Lantern Slides from the National Museum of Natural History and Science" (2019), supervised by Márcia Vilarigues and co-supervised by the author (Ângela Santos), and was available between 2019 and 2022 (https://goo.gl/forms/ofHmI7DZqMFNxokI2).[16]

At the beginning of 2019, the questionnaire was sent via email to 53 institutions known to have magic lantern slides from 11 countries (Australia, Canada, France, Germany, Italy, Netherlands, New Zealand, Portugal, Spain, the United Kingdom, and the United States of America). The institutions selected were mainly museums (43), but archives, universities and libraries were also included. In addition, an answer from a private collector was gathered since institutions were encouraged to share the link. The surveyed parties are listed in *Appendix A.9.2*.

[16] For further details about this questionnaire and full list of institutions to which the survey was sent, please consult Beatriz Rodrigues's Master dissertation entitled "From Production to Preservation: Hand-Painted Magic Lantern Slides from the National Museum of Natural History and Science" (2019).

Design

The first part of the online questionnaire addressed the characterisation of the institution and its collection of magic lantern slides. In this part were included questions concerning the existence of someone responsible for this collection, their professional training, the total number of slides held, dates of production, and the slides' depiction techniques, specifically if the collection contained hand-painted slides (either entirely painted or coloured over printed outlines/photographs).

Regarding the preventive conservation procedures undertaken, institutions were asked if the slides were inventoried or catalogued, digitised, and regularly monitored and if the environmental conditions were controlled in storage and display rooms. Questions about relative humidity (RH), temperature, light, and integrated pest management (IPM) programs were made on the topic of *Environmental conditions*. Storage and display conditions were addressed regarding types of equipment and protective materials, as well as the slide positioning (with indicative schemes) and organisation criteria.

The questionnaire also addresses the topics of previous remedial conservation procedures or restorations, the most common conservation problems observed in the slides (photographs of damages observed in slides were included to reduce ambiguity), and whether the historical slides are currently being used in recreations of magic lantern shows and demonstrations. Finally, it includes a field encouraging the caretakers to add further observations and contact the authors.

Results

Twenty answers from eight countries were obtained between February and April 2019. Fifteen of the answers were from museums (one from Canada, one from France, one from Germany, two from Italy, five from the Netherlands, two from Portugal, and three from the United Kingdom), two from archives (Australia and the United Kingdom), two from universities (United Kingdom), and one from a private collection (**Figure 5.7**).

Although the number of respondents is far from representative of the number of institutions that hold magic lantern glass slides, the authors present the results obtained as a brief insight into the reality of these collections. As disclaimed in the survey, only the participating parties' names are presented, and all the responses are anonymised and presented statistically.

Of the 20 entities that answered the survey, 19 have someone responsible for the magic lantern slides collection; however, only nine institutions have someone with professional training in the conservation field.

The number of magic lantern slides in each collection varies significantly from 50 to 50,000, totalling nearly 150000 slides surveyed. These collections hold slides from the 17th century (2 collections), the 18th century (11 collections), the 19th century (all 20 collections), and the 20th century (18 collections). Regarding depiction techniques, 16 have slides that are entirely hand-painted and coloured over printed outlines or photographs.

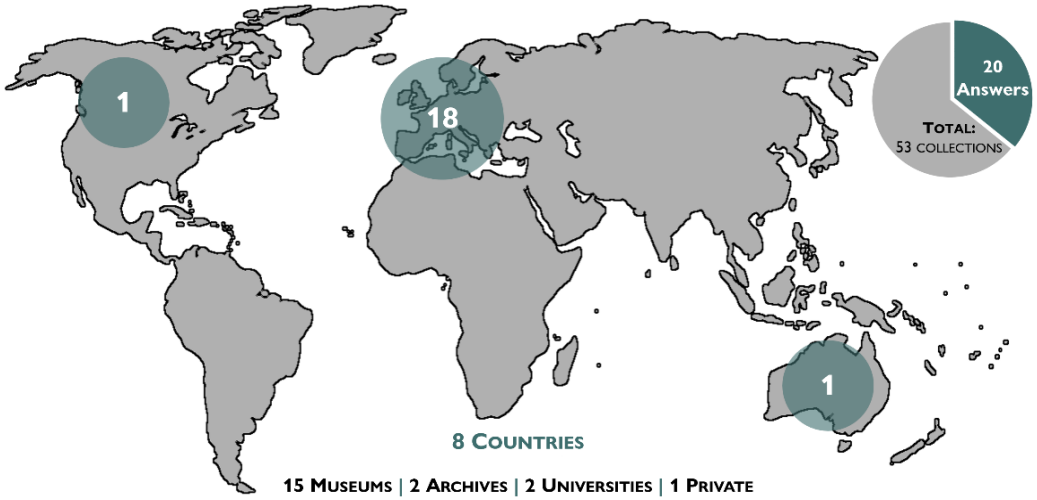


Figure 5.7 World map distribution of institutions and private collectors holding magic lantern slide collections participating in the survey.

Preventive conservation procedures

Concerning the preventive conservation procedures undertaken, 19 of these collections have their slides inventoried, and 18 have their slides digitised with the digital images kept in databases. These are essential steps to ensure clear identification and preservation of their imagery. They are also one of the best ways to reduce their handling and make them readily available for study.

Regular monitoring is most important to preventively guarantee the continued safety of cultural collections. It should concern factors such as temperature, relative humidity, light, pests, pollutants, equipment, and facilities. It also should include regular and individual monitoring of the objects themselves to detect alterations that may be occurring. Regardless of its significance, only 10 of these collections are regularly monitored, which may be related to the time management and personnel that this task requires.

Controlling environmental conditions in storage and exhibition rooms is an essential conservation measure. All 20 collections confirmed holding slides in storage, but only 13 controlled the environmental conditions in these rooms. Eleven institutions also have slides in exhibition rooms, of which nine can control the environment in these rooms. Furthermore, 12 surveyed institutions have implemented an Integrated Pest Management (IPM) program.

RH, temperature, and light conditions were similar in storage and display rooms within the same institution. Of the 20 collections, 12 registered RH values between 40-60 %, while two registered between 20-40 % (six did not answer). Regarding temperature, 18 reported temperatures between 10-25 ºC, of which almost 80 % were between 15-20 ºC (two did not answer). According to these results, these institutions appear to conserve their collections in favourable conditions, considering that the lower percentages of RH and temperature were indicated by institutions that hold photographic slides.

Light intensity in the 11 institutions' exhibition rooms ranges from <50 to 150 lux, but in the 20 storage rooms, light can reach 200 lux, which is exceptionally high considering the maximum of 50 lux recommended for these collections. The most common light sources these 11 exhibition

rooms used were LED (by six institutions), followed by fluorescent and incandescent (three did not answer). In storage, 13 of the 20 institutions referred to the use of fluorescent lights, followed by light emitting diode (LED) (five) and incandescent lights (two). In 14 of the 20 storage rooms and eight of the 11 exhibition rooms, ultraviolet (UV) radiation is avoided by using non-emitting or filtered lights along with the absence of windows or blockage of existing ones. These results demonstrate that light sources are chosen more carefully in display rooms than in storage; however, this might not be a problem if the collections are kept inside containers that protect them from light.

The furniture or equipment used to store or display magic lantern glass slides are frequently made of wood, metal, and glass. In storage areas, metal cabinets are more common, followed by wood cases and wood cabinets with glass windows, while in exhibition rooms, glass cases are the most common, followed by wood and glass cabinets. Only six of the 11 institutions can control the environment inside the exhibition furniture, keeping conditions similar to the rooms.

Of the 20 institutions, 16 confirmed that the magic lantern glass slides are not in direct contact with the storage or exhibition furniture, using mostly acid-free paper or card as a separator. Boxes and envelopes are frequently used to store glass slides and are commonly made of acid-free or neutral pH cards or paper. However, 4 of these institutions also use the original wood boxes to store them. These results have shown that one of the main concerns in these collections is the frequent use of wood furniture and boxes to keep the slides, given the amount of harmful volatile compounds that this material may release to the environment, especially if it lacks air circulation inside the container.

Regarding the position of slides in storage, 14 collections are kept vertically. This position may be dangerous if the pictorial layer is weakened. In terms of organisation criteria, the most common were size format and discursive genre, followed by depiction technique and producer or country of production.

The re-enactment of shows is common among magic lantern enthusiasts, private collectors, and institutions such as archives and museums. Eleven surveyed institutions have magic lantern shows, of which seven use original slides from their collections instead of replicas. The work developed to rediscover and re-enact these engaging performances has brought to life the original intention of these historical objects. However, submitting historical slides to heavy handling, intense light, and temperature during projections puts them at risk; therefore, more strategies should be pursued to produce replicas of original slides.

Remedial conservation procedures and final observations

Half of the 20 collections had slides that had undergone remedial conservation procedures and restorations. These interventions included overall cleaning (unpainted areas), consolidation of cracks and bonding of glass, removal of metal oxidations, application of protective coatings on the metallic parts, and replacement of screws in slides with complex movement mechanisms. The most common deterioration problems observed were the same as those identified in CPMC and MUHNAC collections, mentioned in *Subsection 5.1.3, Common deterioration factors and damages*.

Additional comments from the caretakers were considered highly relevant for this study. Many slides and the lack of time and personnel dedicated to these collections were pointed out as the main drivers for the non-application of conservation measures such as inventorying, digitisation, assessment of preservation state, and regular monitoring. Caretakers also shared their difficulty finding information on these collections, especially regarding preventive conservation, remedial conservation, and restoration. It is also worth mentioning that one institution, holding 20000 slides, revealed they could not answer the survey due to the lack of documentation on the collection and conservation measures undertaken.

5.2 Preventive conservation guidelines

The preventive conservation guidelines were developed considering three main aspects: technical studies, the questionnaire, and the literature review. Technical studies on CPMC and MUHNAC collections allowed, for example, the identification of the slides' compositive materials (from macro- to microscopic level), their state of preservation and main conservation problems, and types of constructions, which were essential to recommend suitable practices. The questionnaire intended to present an insight into their characteristics and conservation procedures undertaken by other institutions with the same type of collections to adapt the guidelines according to their necessities and difficulties, emphasising aspects that need more improvements. The literature review was mainly focused on magic lantern slides cataloguing and digital preservation and on the susceptibility of each material identified to propose the most appropriate conditions for these composite artefacts (*e.g.,* the detection of light-sensitive materials in the paintings influenced the light recommendations). These guidelines were designed as a complement of the general preventive conservation standards currently established for cultural heritage collections (*e.g.,* (Boylan 2004; 'Preventive Conservation Guidelines for Collections' 2018; Keene 2002; Koob 2006; Atkinson 2014; Brown et al. 2002; The National Trust 2006; Bacharach 2016; Duyck 2012)).

Heritage professionals recognise preventive conservation as the most effective means of promoting the long-term preservation of cultural property, and the primary goal of this work was the development of guidelines for the preventive conservation of magic lantern slides. The guidelines presented here are the first proposal and may be further developed in the future. These recommendations address inventory standards, appropriate environmental conditions, storage and exhibition materials, handling, and performative re-enactment shows. A summary of the guidelines can be consulted in **Table 5.2**, and further details are provided.

Table 5.2. Summary of preventive conservation guidelines recommended for painted magic lantern glass slides considering the different materials that may compose them.

Causes of damage	Recommendations	Additional notes
Temperature	~20 ± 5 °C	Avoid daily fluctuations >5 °C
Relative humidity	~45 ± 5 % RH	Avoid daily fluctuations >5 % RH
Light	~50 lux Use LED lamps, preferably with adequately tuned wavelengths	Avoid UV and IR radiation Reduce light levels Reduce exposure time
Fine particles and pests	Keep the collections and spaces clean. Install air pollution filters. Implement IPM.	Regular monitoring.
Storage and display	Use metal, glass, polyethene, polypropylene, cotton, linen, and other neutral pH materials. Avoid the contact of materials with the slides' painted surfaces. Allow ventilation between the slides and the storage/display materials, and each other. Allow ventilation inside storage and display equipment.	Use a layered storage system. Give preference to the horizontal disposition of the slides with the painting layer facing up.
Handling	Avoid handling as much as possible. Avoid any impact and vibrations.	Handle with very clean hands or use nitrile gloves.
Projection shows	Use replicas.	Intense temperature and light can damage the original slides.

It should be noted that photographic slides and slides made by chromolithographic processes on glass or acetate sheets were not addressed as they are outside the scope of this work. Although several preventive conservation measures are transferrable to all types of slides, specific environmental conditions proposed here may not be the most appropriate for these objects.

5.2.1 Recommendations for the collections' documentation and digital preservation

Establishing a detailed collection inventory with the attribution of a unique identifying number to each object (physically linked) is essential since it allows unambiguous identification of each object, reducing the risk of dissociation. General information about the object, background, and associated documentation should be stored in a digital database linked with the inventory number of each object. This inventory database should include entries for each slide that, for example, a) mention if it belongs to a series, b) contain information on the materials it is composed of (*e.g.,* glass, wood, paper), c) include manufacturing and depiction techniques, and d) contain a description with dimensions and type of construction or movement mechanism according to the classification defined by Barnes (1990), contain a classification in terms of discursive gender according to current metadata standards (*e.g.*, those defined by the research project "A Million Pictures" (AMP) and applied in online databases such as *Linternauta* and *LUCERNA – the Magic Lantern Web resource*) (Barnes 1990; 'LUCERNA – the Magic Lantern Web Resource' 2016; San Segundo, Frutos, and Therón 2019).

An evaluation of the conservation state, as comprehensive as possible, of the slides, including a rating based on the condition grading scale described in *Subsection 5.1.2, Evaluation of the slides' state of preservation* (Keene 2002) and high-quality digitisation (*e.g.,* by scanning or photographing) should also be present. Guidelines for the most appropriate ways to digitise magic lantern glass slides were also developed during the AMP project and published by Sabine Lenk *et al.* (2018). An excellent way to digitally preserve the slides, reduce the need to handle the original artefacts, and easily access them is by adding their digital images and all the information available to internal or online databases, as previously mentioned.

5.2.2 Environmental conditions

Controlling environmental conditions in storage, exhibition, and transportation is one of the most effective preventive conservation strategies to preserve and extend the artworks' lifetime. The most significant environmental factors contributing to the deterioration of magic lantern glass slides include temperature, relative humidity, light, dust accumulation, and insect and fungi activity. Implementing the collections' regular monitoring is imperative to avoid, detect, report, and treat potential damage and threats as soon as possible.

Hand-painted magic lantern glass slides are composite objects that frequently contain glass, paints and varnishes, wood, paper, and metal. Each of these materials reacts differently to environmental conditions, has distinct needs, and may contribute to the deterioration problems of the other materials. For instance, the contraction of painting materials due to low RH and

temperature may result in their cracking or detachment from the glass support since the glass does not behave the same way. Additionally, the materials can have undesired interactions with each other; for instance, glass deterioration can be promoted by the presence of hygroscopic materials like wood and paper, and copper-green organic pigments are more prone to deteriorate in the presence of natural resins (Coccato, Moens, and Vandenabeele 2017).

Due to the combination of such diverse materials, it is necessary to balance the most appropriate temperature, humidity and light conditions. The proposed conditions consider the lower and higher values recommended for each material composing painted magic lantern slides.

Temperature and relative humidity

Hand-painted glass slides should be stored and displayed in rooms where the temperature and relative humidity (% RH) are kept stable at 20 ± 5 ºC and 45 ± 5 % RH. However, more important than reaching the suggested values for temperature and RH, it is crucial to avoid fluctuations of more than 5 ºC and 5 % RH in 24 hours (Atkinson 2014; Brown et al. 2002). Both environmental factors are directly related, considering that when the temperature increases, the RH lowers and vice-versa. Fluctuations in either can induce stress on the object and lead to the rapid expansion and contraction of certain materials, causing damages observed in the collections, such as cracks, flaking, loss of adhesion of the paint layers, and the distortion, delamination or tears in the paper and wood (The National Trust 2006; Bacharach 2016).

Higher temperatures can accelerate the chemical deterioration of the painting materials, increase the flexibility of natural resins, and make them stickier. These temperatures will enable the paints to hold dust more easily, increase pest activity, and cause dehydration due to the consequent decrease of RH, which is especially dangerous to wood and paper. Higher RH can promote mould and fungi growth that damages the wood, paper, glass support and paint layers, and the corrosion of glass and metal. As observed in the collections, high RH is particularly dangerous in slides where two glasses are overlaid without ventilation, creating condensation between them, since it increases the reaction of glass with atmospheric water (which can lead to the detachment of the paint layer, briefly due to the leaching, dissolution and deposition of alkali salts on the glass surface) and fungi growth, enhancing its deterioration (D. E. Clark and Zoitos 1992; Kunicki-Goldfinger 2008; Koob et al. 2018; Corrêa Pinto et al. 2019). Too low temperature and/or RH may cause painting materials, wood, and paper to shrink and break and, in already deteriorated glass, it may increase microcracking (Bacharach 2016; 'Preventive Conservation Guidelines for Collections' 2018; Koob et al. 2018).

Light

Magic lantern glass slides should be stored in the dark. The recommended light level for displaying is around 50 lux; the light source, ideally artificial, should not produce any heat nor emit ultraviolet (UV) or infrared (IR) radiation (*e.g.,* Light Emitting Diode (LED) lamps), and the exposure time should be kept to a minimum (Bacharach 2016; 'Preventive Conservation Guidelines for Collections' 2018). These recommendations are based on the presence of light-sensitive materials such as wood, paper, organic binding media (*e.g.,* varnishes) and organic-based colourants (Bacharach 2016).

Exposure to natural and artificial light can damage the light-sensitive materials in hand-painted magic lantern slides, causing, for example, colour alteration and embrittlement of organic materials (**Figure 5.6-E**). Any heat produced can accelerate chemical deterioration processes and cause disintegration of these materials, particularly the thin paint layers.

Natural UV radiation can be removed by blocking natural light or installing UV filtering material over windows. Artificial light sources that do not emit UV and IR radiation or filtered-coated lamps should be used to eradicate these emissions inside the storage and exhibition areas. However, in cases where the transition to this lightning is not immediately possible, light sources should be kept away from the objects, and air circulation systems should be used to help control heat build-up (Bacharach 2016; Navarro 2003; Davison 2003; Keene 2002).

As light-emitting diode (LED) lamps are increasingly available in the market and have exciting properties such as low levels of heat, UV and IR emissions compared to other artificial light sources, these options have been preferred for museums. Studies by Lunz *et al.* (2017) have demonstrated that the possibility of tuning the spectra of LED lamps showed incredible advantages since the lighting solutions can be adapted according to the specific susceptibilities of certain light-sensitive materials to reduce significantly its photodegradation effect and consequently increase its lifetime.

Exposure time should be controlled by implementing object rotation plans to reduce cumulative light damage by defining which objects will be displayed and for how long. These object rotation plans should be developed considering that each slide should not be exhibited for longer than six months over five years at a maximum of 50 lux (i.e., 90,000 lux hours when exhibited for 10 hours a day) (Bacharach 2016). Suppose the maximum of 50 lux is exceeded. In that case, the exposure time must be proportionally reduced (*e.g.,* at 100 lux, it can be exhibited for a maximum of three months over five years). Installing motion detectors that only activate the light when visitors are close to the slides can also be an excellent strategy to reduce the light exposure time.

Fine particles and pest control

Particulate matter, such as dust and grime, is particularly damaging for magic lantern slides. The accumulation of these fine particles changes the visual appearance of the objects (**Figure 5.6-G**), blocks the passage of light when projected, interfering with its original purpose, and is abrasive. Abrasion is particularly dangerous in slides with movement mechanisms that can scratch the painting whenever the slide is manipulated. Depending on the particle composition, dust can lead to a slide's deterioration since it can be highly hygroscopic, adhere to the materials, promote mould and fungi development, and provide nutrients for insects that can severely damage the wood and paper materials (**Figure 5.6-A**). High RH (>65 %) can also promote the growth of mould, fungi and insects, and it must be avoided (Tétreault 2003; Bacharach 2016; 'Preventive Conservation Guidelines for Collections' 2018).

The presence of fine particles should be controlled to reduce its harmful effects, for example, by installing pollution filters in the ventilation and air conditioning systems and using high-efficiency particulate air (HEPA) vacuum cleaners. The collections and areas in which they are

stored and displayed should be kept clean, regularly maintained and monitored by Integrated Pest Management (IPM) (Bacharach 2016).

5.2.3 Storage and display

Magic lantern slide collections should be organised primarily according to their depiction technique and materials due to their different conservation needs. They must be stored and displayed with chemically stable and neutral materials to avoid releasing harmful substances that can accelerate deterioration. Metal (*e.g.*, steel), glass, polyethene, polypropylene, cotton, and linen are considered safe materials for museum collections. However, their compositions must be verified since there are manufacturing processes with coatings and additives that can be harmful. Nevertheless, the slides should never directly contact storage/exhibition furniture or other slides. A thin foil of polyethene foam can be used to separate the slides from the furniture. Pieces of thicker polyethene soft foam may be placed on some of the edges to allow ventilation between a slide and the furniture and between slides. Besides controlling the temperature, RH, light levels and pollutants in the storage and display rooms, these factors should also be controlled inside the storage and display cases. These cases must always allow ventilation to avoid the creation of condensation in the interior and increase, for example, glass deterioration, as discussed in the topic of *Temperature and relative humidity*.

Metal drawers or open shelves can be a good storage option to organise and protect the slides from environmental and physical risks (Duyck 2012). Soft-sliding metal drawers should be chosen to avoid vibrations that may damage weakened slides when opening or closing them. In an open shelf, a set of slides can be stored inside custom-made boxes adjusted to their dimensions, using, for instance, rigid polypropylene sheets or cards with neutral pH for the external structure and polyethene foam to build the interior. The box should have exterior holes, and the slides should be separated from the box and from each other to enable ventilation (**Figure 5.8**).

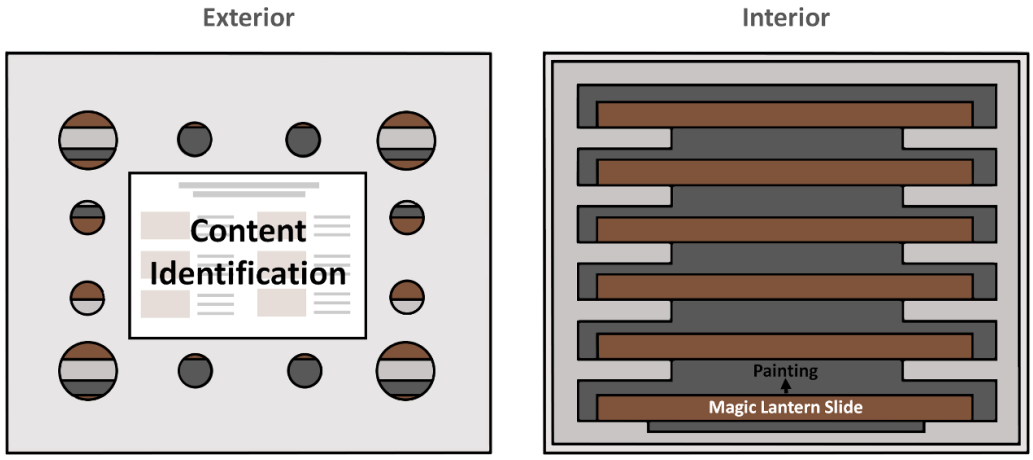


Figure 5.8 Example of a costume-made box to store magic lantern slides: (left) front view of the exterior, with holes to allow ventilation and brief information about its content to reduce handling; (right) front view of the interior, where the slides are in a horizontal position with the painting facing up, separated from each other and from the protective materials to allow ventilation.

Organising magic lantern slides according to their dimensions or type of construction is especially recommended when storing them in boxes. This criterion not only allows the optimisation of storage space but also organises the slides according to their purpose of use (*e.g.,* slides with 11x3 cm were used in "toy lanterns", and slides with 21x6 cm would have been used in big performances), which may be helpful for their study. However, it is imperative to find solutions so that none of the protective materials touches any painted surface to avoid physical damage, and the drawers or boxes have small openings to allow ventilation. A layered storage system, where each layer adds protection to the slides, is presented in **Figure 5.9**.

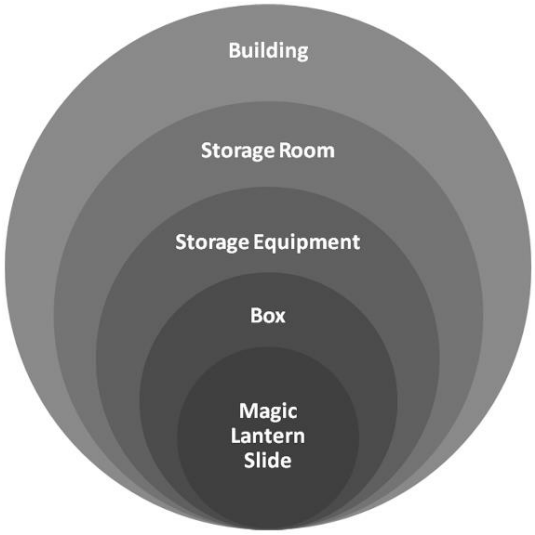


Figure 5.9. Scheme of a protective layered storage system for hand-painted magic lantern slide collections, adapted from (Boylan 2004).

Metal cabinets with see-through glass doors can be useful for exhibiting the slides. Depending on the conservation state of the slides, they can be stored and displayed in horizontal, angled or vertical positions. The horizontal distribution with the painting facing up is always preferred, particularly if the painting layer is weakened. The vertical position may cause fragments of severely weakened paint to detach from the glass and fall, as observed in the collections studied.

Wooden cases or other equipment should be avoided since wood (*e.g.,* oak and composite wood boards such as Medium Density Fibreboard (MDF), often found in more recent cases) emits Volatile Organic Compounds (VOC) (The National Trust 2006). Pollutants emitted by the wood, such as formic acid, acetic acid, and formaldehyde, are particularly damaging to the slides' glass support. These compounds can react with soda silicate glasses, leading to the formation of crystalline sodium formate at the surface, causing chemical and structural damage in the glass (Robinet et al. 2009).

5.2.4 Handling

Magic lantern slides can be physically damaged by incorrect handling: the glass support can fracture with pressure or impact (**Figure 5.6-D**); the wood frame is susceptible to scratches and dents; the paper frequently used as a frame or handle on slipping slides can suffer from wear and tear (**Figure 5.6-C**); and when exposed or in contact with a moving glass, the painting can easily suffer from abrasion (**Figure 5.6-F**), and if deteriorated, a slight impact can cause cracks and paint loss (**Figure 5.6-I**). Therefore, handling should be avoided as much as possible.

When necessary, the glass slides should be carefully handled (touching only unpainted areas) with the hands clean and dry at all times or using nitrile gloves to avoid the deposit of sweat and oil from the skin. Although cotton gloves are frequently used in museums and archives, they are not recommended since they can be too slippery to handle glass and cotton threads may get stuck on rough surfaces, for instance, if the slides have a weakened paper or wood frame (The National Trust 2006).

Each set of drawers or boxes in storage should present, on the most visible face, summarised information about the slides it contains (*e.g.,* inventory number and photograph of each slide) to reduce the need for handling (*e.g.*, **Figure 5.8**).

5.2.5 Strategies for demonstrative and recreative shows

It is a common practice to provide public projection shows with magic lantern slides to demonstrate how magic lanterns were operated and the original purpose of the slides, rekindling the magic lantern experience.

However, original slides should not be used in these situations, as their submission to intense light, temperature and handling during projections can be damaging. The use of replicas is recommended for this purpose. One of the goals of the project MAGICA is to develop strategies to produce high-quality replicas of original slides for projections easily. The first reconstruction of a magic lantern slide printed outline was undertaken in partnership with the artist Ana Margarida Rocha from VICARTE Research Unit and Faculty of Fine Arts - University of Porto (FBAUL) in 2019, and the printing process and results achieved are shown in *Appendix A.8 Reconstruction of printed outlines using the copper-plate printing technique*).

Notably, new LED illumination systems for installation on standard magic lantern projectors (*e.g.,* Celsun®) are available on the market. These LED Lime-Light systems are a better option to reduce the production of heat, UV, and IR radiation when compared to the original light sources (*e.g.,* limelight or incandescent bulbs). However, the light focused on the slides (~9000 lux) is far more intense than the original slides can be safely exposed to (50 lux); hence, replicas are always preferable. If their production cannot be afforded, other solutions of inferior quality may be explored, for instance, by photographing the original slides, printing them on acetate sheets with the exact dimensions, and enclosing them in card frames, as currently used by the Portuguese Cinematheque – Museum of Cinema (Lisbon). Supposing the use of originals cannot be avoided, the exposure time should be reduced, and rotation plans are imperative to reduce cumulative light damage, as explained in the topic *Light*.

5.3 Restoration: Cleaning and assembling fragments

As previously discussed, accretions (*e.g.*, dust and grime), cracking, flaking and delamination of paint layers, loss of paint, infestation by fungi, and breakage of the glass support are some of the most common conservation problems. Dust and grime, besides being a catalyst for further damage for being hygroscopic (attracting moisture and pests) and composed of abrasive particulates that scratch the paint (especially on slides with movement mechanisms), accretions are damages by themselves for drastically changing the slides' appearances, interfering with the projection by blocking light transmission and altering colours. Craquelure, delamination, and loss of paint appear to be mainly associated with the paint's shrinking and deterioration of the binding media, ultimately resulting in the complete loss of the imagery. The breakage of the glass support not only reduces the structural stability of the slides but often causes loss of paint along the break lines and has resulted in the loss of fragments by dissociation.

Several actions, such as cleaning, consolidation and assembly of fragments, are commonly taken to improve the condition of objects with these types of damage. However, almost no publications were found on remedial conservation and restoration procedures of painted magic lantern glass slides. As a first step, this subsection investigated cleaning practices undertaken on materials with similar characteristics, including reverse paintings on glass, unvarnished paintings and glass in general. Various cleaning systems that are widely available were tested and evaluated on magic lantern slides. Finally, two magic lantern slides with the glass support broken in ways that compromised their handling and increased the risk of dissociation were restored by cleaning non-painted areas and reassembling their glass fragments.

5.3.1 Overview of cleaning practices for paint layers

The primary goal of this overview was to identify widely available cleaning methods that could be used on painted magic lantern slides and select various for testing, considering cleaning efficacy, compatibility with the materials, and final appearance. For the cleaning test, two 19th-century English slides from VICARTE, bought for investigation purposes, were chosen (**Figure 5.10**). The slides were stable and in a fair state of preservation (SP2), having mostly dust. Slide FCT.V.LM.02, painted by W.E. & F. Newton, had the movable glass with one fracture and localised paint lacuna, and FCT.V.LM.03, painted over printed outlines by an unknown producer, had fungal hyphae and mycelia visible under the microscope. Their analytical study identified gamboge, Prussian blue, an animal-based lake (possibly cochineal), hematite, carbon black and terpenoid resins on both slides. Slide FCT.V.LM.03 also included an unidentified yellow lake.

Depending on their condition, decorations, and substances to remove, glass objects are typically mechanically cleaned with brushes and vacuum cleaners or chemically with materials including water, detergents, chelators, acids, and organic solvents (Davison 2003). For cold-painted glass, cleaning under the microscope with soft brushes can effectively remove loose dust (Koob 2006). Often, magic lantern slides present an adhered layer of dust and grime, possibly due to the paint layers' exposure to heat during projections. If the paint layer is stable, aqueous or solvent cleaning can be effective, following a close inspection to avoid flaking areas and testing in small, discreet areas to assess the effects of the cleaning system.

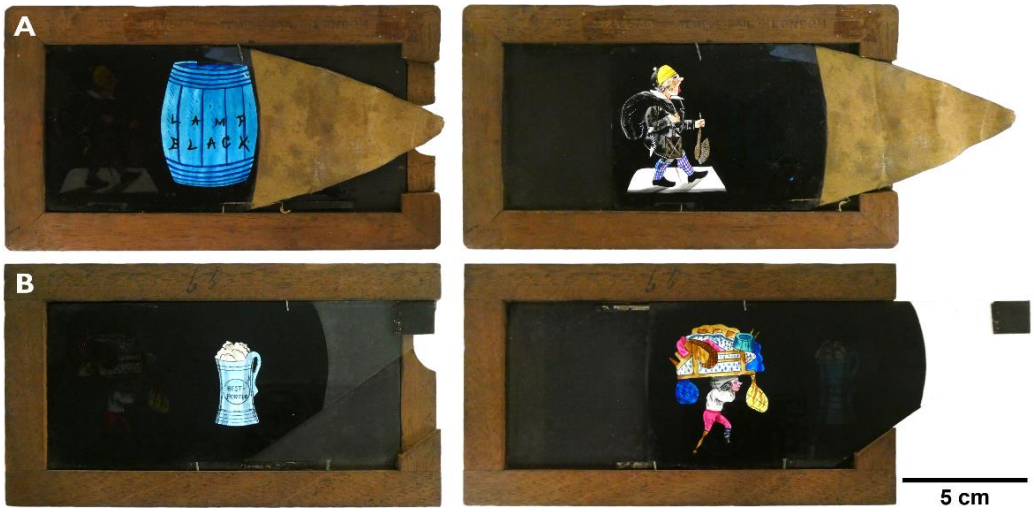


Figure 5.10 English magic lantern glass slides chosen for the cleaning tests, in closed (left) and opened (right) positions: (A) hand-painted by W.E. & F. Newton, ca.1852-1857 (FCT.V.LM.02) and (B) hand-painted over printed outlines by an unknown manufacturer, late 19th century (FCT.V.LM.03).

Mechanical dry-cleaning

Mechanical methods are frequently used to clean paintings and glass, such as soft brushes (*e.g.*, for glass objects and cold-painted glass), dust air blowers (*e.g.*, for optical glass), and vacuum cleaners (*e.g.*, for glass objects) (Davison 2003; Koob 2006; Fakuc 2007).

Only one publication was found that applied mechanical dry-cleaning methods to painted magic lantern slides. At the Hagley Museum and Library, soft brushes were used to remove loose dust and grime from the paint, and the results were successful (Wahl 2019) (**Figure 5.11**). In this case, although the slides were very dirty, the slides had two glasses overlayed with the painting facing inward, and most of the dust and grime was on the outer surface. Therefore, most accretions were cleaned from non-painted areas using a solution of ethanol and water, and soft brushes were only used to clean the paint, demonstrating that good results can be achieved by combining both methods.

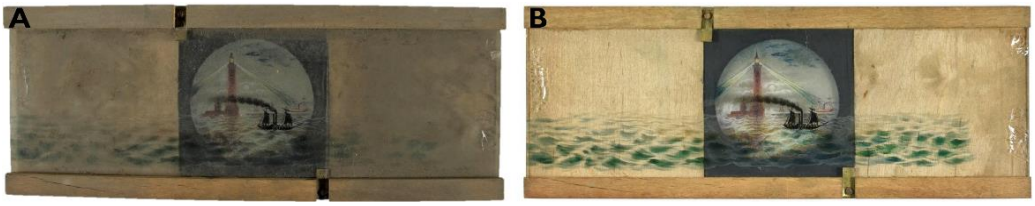


Figure 5.11 Restoration of a painted slide by Laura Wahl and Emma Gunuey at the Hagley Museum and Library: (A) before and (B) after treatment. © Hagley Museum and Library (Wahl 2019; 2020).

In 2019, Beatriz Rodrigues tested dust air blowers on a stable, entirely painted slide (without flaking areas) with very adhered dust, grime, and fungal residues (**Figure 5.12**). This method was tested for being considered less invasive than soft brushes; however, it was proven ineffective in removing adhered particles and fungal residues.

The third method, commonly used to clean unpainted glass objects, resorts to vacuum cleaners. To the extent of the author's knowledge, this method has not been tested on magic lantern slides; nevertheless, this method may not perform well on these paintings, given their fragility and general poor adhesion to the glass support.

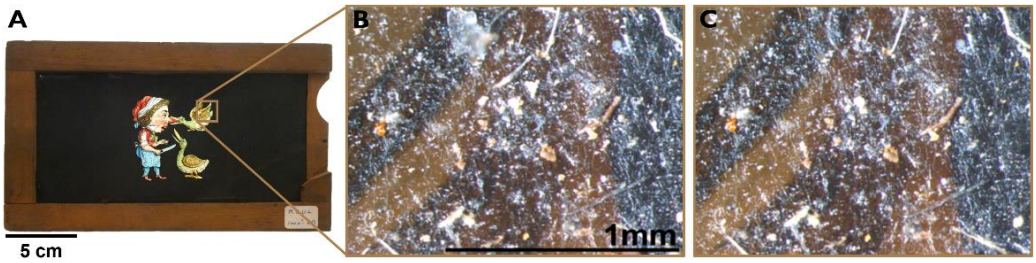


Figure 5.12 Results from the cleaning test using an air blower by Beatriz Rodrigues (2019), on slide MUHNAC-MUL-UL000069 (A), showing details from before (B) and after (C) the test.

Chemical cleaning

Chemical methods, such as water, detergents, organic solvents, chelators, acids, and petroleum distillates, are commonly used to clean glass and cold paintings. Besides focusing on cleaning efficacy, paint solubility, and the appearance of the paint after treatment, the search for chemical cleaning methods took into consideration the pH of the cleaning solutions, given the glass's susceptibility to deterioration under acidic conditions below a pH of 4 and alkaline conditions above a pH of 9 (Kunicki-Goldfinger 2008).

Besides water with or without detergents, one of the most frequently used solutions to clean glass is a 1:1 mixture of ethanol and deionised water applied with cotton swabs or paper towels (Davison 2003; Koob 2006). Hydrophilic solvents such as ethanol or acetone are also used to promote faster drying (Koob 2006).

For cold paints and low-fired enamels on glass, saliva and 1–5 % (w/v) triammonium citrate in deionised water, applied with swabs or brushes, are commonly used and reported as effective for their respective enzymatic and chelating actions, water is then used to remove remaining non-volatile compounds from the surface (Carlyle, Townsend, and Hackney 1990; Romão, Alarcão, and Viana 1990; Morrison et al. 2007; Kahrim et al. 2009; Sirett 2016; Migdol 2021). Petroleum distillates, such as white spirit, have also been successfully used to clean reverse glass paintings and as solvents in consolidants (Davison 2003; Bretz et al. 2008).

Chemical cleaning test: methodology

Considering their common use and availability in conservation laboratories, deionised water (W), 1:1 ethanol : deionised water (EW), natural saliva (S), 2.5 % (w/v) triammonium citrate in deionised water (TW), acetone (A), and white spirits (WS) were selected for testing. This selection only considered aqueous solutions with a pH between 4 and 9, given the glass's susceptibility to acidic and mostly alkaline conditions. The pH of each aqueous cleaning system was measured to confirm they were between 4 and 9: W 6.5, EW 7.6, S 6.5, and TW 6.2.

Cleaning tests were performed on the two previously mentioned slides (**Figure 5.10**). As mentioned, both were in fair condition, with dust and fungal evidence. W.E. & F. Newton's movable glass also had one fracture and flaking paint. All solvents were first applied to the larger areas of black background and blue paint on the first slide; then, the two most effective solutions were tested in yellow and pink areas on both slides (**Figure 5.13**). Areas of 5 x 5 mm black and blue and 3 x 3 mm yellow and pink surfaces were cleaned with small cotton swabs under the microscope (avoiding flacking areas). Saliva and triammonium citrate solutions were cleared

from the surface with deionised water after approximately 15 seconds. The L*a*b* coordinates of the areas tested were measured before and after the cleaning for comparison.

The pH measurement and colourimeter equipment and conditions are detailed in *Appendix A.4*. The detailed mapping of the cleaned and measured paint areas and the table of colourimetry results can be found in *Appendix A.9.3*.



Figure 5.13 Areas in which the solvents were tested from the glass slides presented in Figure 5.10: (A) FCT.V.LM.02 and (B) FCT.V.LM.03.

Cleaning results

The small cotton swabs effectively cleaned the paint surface, as the cotton fibres easily grabbed larger loose particles and fibres regardless of the solvent. Although very light pressure was applied, slight variations of strength and the presence of abrasive particles and cotton fibres sometimes scratched the paints. Microphotographs before and after cleaning with the different solutions of the black and blue painted areas of slide FCT.V.LM02 are given in **Figure 5.15**.

After cleaning with most of the solvents, the black and blue colours appeared more saturated, which was expected as particulate matter made bright colours appear duller (**Figure 5.15**). Although colourimetry results are merely indicative due to the difference between the measured area (⍉ 8 mm) and the areas cleaned, it verified this decrease in relative brightness (L*) (**Figure 5.14-A**). In terms of hue and chroma values (a*b*), they distanced from zero, meaning that the colours became more vivid (**Figure 5.14-B, C**). In **Figure 5.14**, the best results achieved by saliva and triammonium citrate are highlighted in green and the worst results by acetone in red.

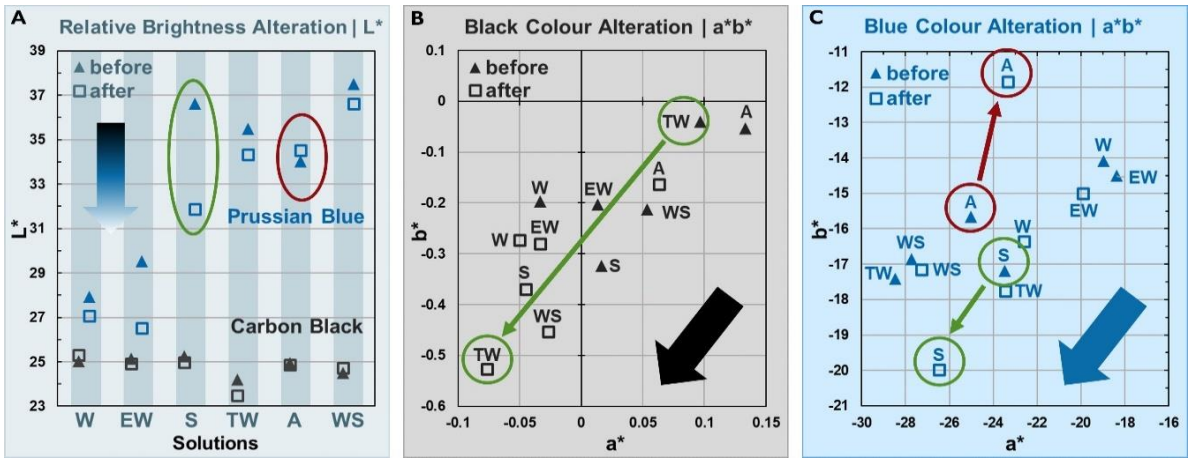


Figure 5.14 Colourimetry measurement averages of slide FCT.V.LM02 in black and blue colours, before and after cleaning: (A) Relative brightness alteration in both colours; (B) Black hue and chroma (a*b*) variations; (C) Blue hue and chroma (a*b*) variations. Large arrows represent the general tendency, and the best and worst results observed in these graphics are highlighted with green and red circles.

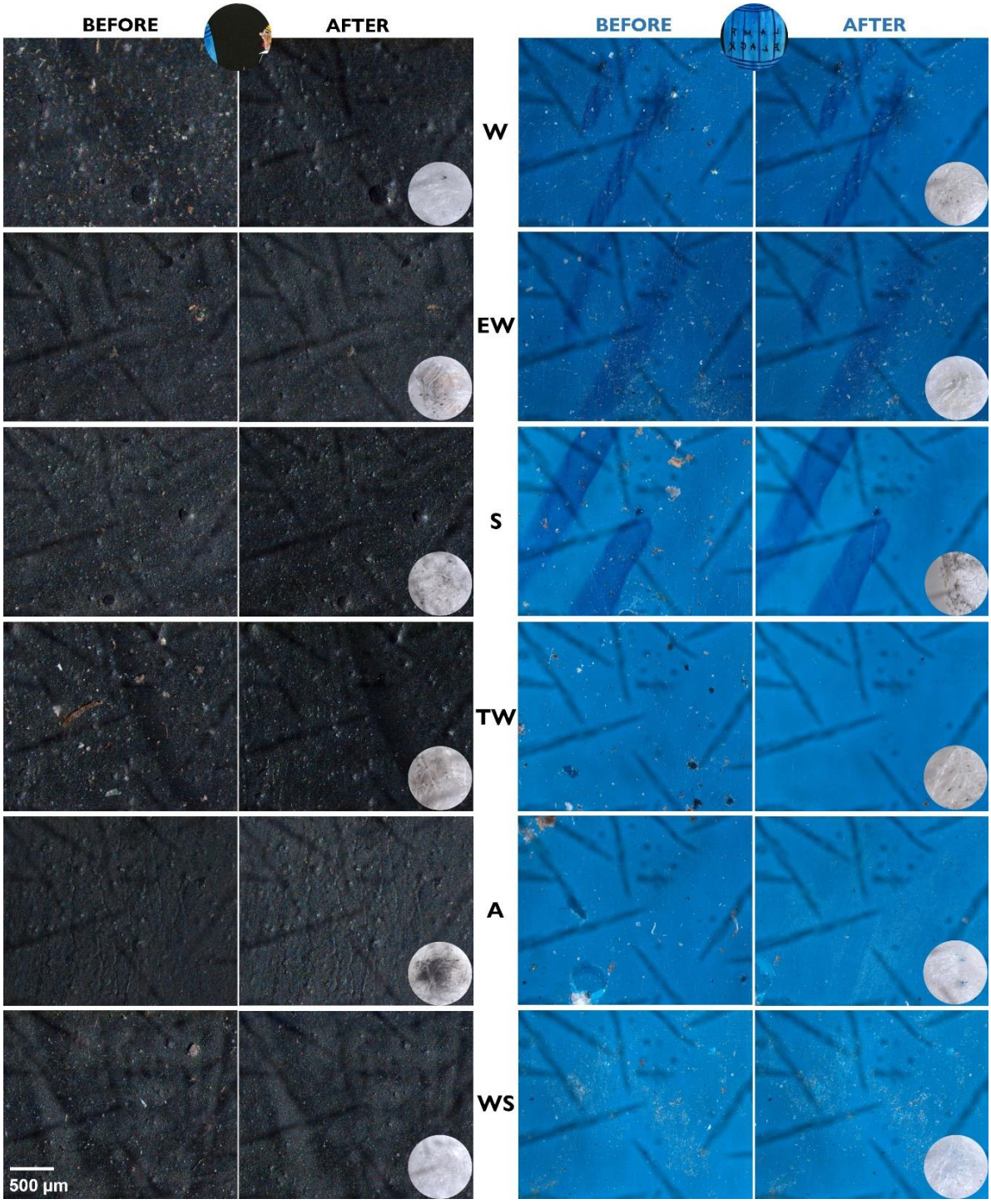


Figure 5.15 Microphotographs of the blue and black areas (under 50x magnification) from slide FCT.V.LM02 before and after cleaning with the different solutions (indicated by their code) and the respective cotton swabs after usage. The dark lines consistently present in all photographs are due to damage in the microscope lens.

The worst results were obtained using ethanol with water (EW), acetone (A) and white spirit (WS). Cleaning with these solvents was inefficient and solubilised the paints to varying degrees. This dissolution can be more prominently observed in the cotton swab of acetone on the black paint (**Figure 5.15**). Additionally, these solvents caused damages, including increased brittleness and a pitting and blanching effect due to light dispersion, leaving traces of the swab texture resulting from the paint dissolution.

Water (W), saliva (S) and triammonium citrate (TW) cleaned the coloured surface without dissolving the black and blue paints. Water removed loose dust and some of the grime on both colours; however, saliva and triammonium citrate solutions showed the best results by removing loose dust and adhered dirt, resulting in cleaner and glossier surfaces (**Figure 5.15**). Colourimetry results also highlighted the effectiveness of these two solutions (**Figure 5.14**).

Given their efficacy, saliva and triammonium citrate solutions were also applied to yellow and pink areas, with similarly excellent cleaning results (**Figure 5.16**). Besides removing dust and more adhered dirt, TW also appeared to have removed the fungi residues observed on the lower paint of the pink area cleaned.

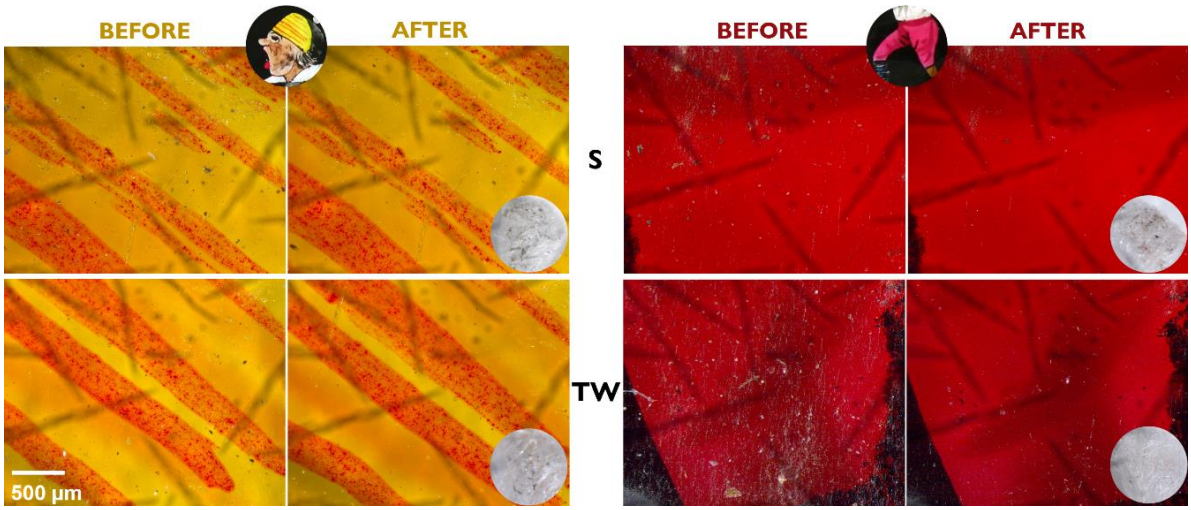


Figure 5.16 Microphotographs of the yellow and pink areas (under 50x magnification) from slides FCT.V.LM02 and LM03, before and after cleaning with saliva (S) and triammonium citrate (TW) solutions and the respective cotton swabs after usage. The dark lines consistently present in all photographs are due to damage in the microscope lens.

To test the efficacy of these solutions on areas affected by fungi, an area of slide FCT.V.LM03 with fungi white filaments (hyphae) and clusters (mycelium) was selected. Regarding these fungal residues, the TW solution appears to have performed better (**Figure 5.17**).

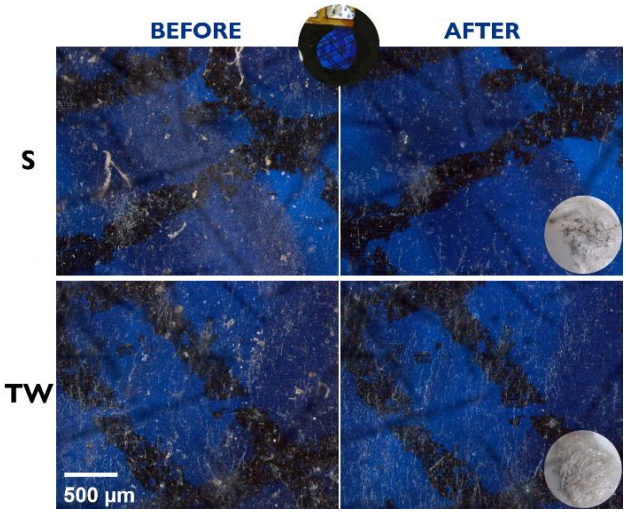


Figure 5.17 Microphotographs of the blue area (under 50x magnification) from slide FCT.V.LM03 before and after cleaning with saliva (S) and triammonium citrate (TW) solutions and the respective cotton swabs after usage. The dark lines consistently present in all photographs are due to damage in the microscope lens.

Assessed by also comparing the soiled cotton swabs after use, saliva appears most effective overall. However, triammonium citrate appears most effective in reducing fungal residues. In conservation practices, these solutions are sometimes applied more than once, meaning the results obtained could be improved by applying these solvents multiple times.

It is important to note that, while cleaning Newton's slide (FCT.V.LM02), a small area of the exposed outline, with no overlapping colour, proved to be water soluble, being effortlessly removed (**Figure 5.18**). This observation made evident that resin-based paints were used instead of the painting being entirely varnished at the end, confirming that only varnished surfaces can be safely cleaned with these aqueous solutions. It also emphasises the importance of cleaning under the microscope while carefully testing each colour to avoid damaging or removing any original material from the slides.



Figure 5.18 Microphotographs of an unvarnished area of the black outline from slide FCT.V.LM02 before and after cleaning with water. The dark lines consistently present in all photographs are due to damages inherent to the microscope lens.

5.3.2 Assembling fragmented glass support: challenges and options

When glass objects break, it is crucial to reassemble them as soon as possible. Although the restoration procedures and materials may vary according to the intention of storing or exhibiting the object, the risk of losing fragments increases over time. Also, handling fragmented glass is more complex and dangerous for the object and the caretaker, as glass often breaks into sharp-edged and pointy fragments, with a higher risk of further breakage and harm.

In glass conservation, choosing an adhesive is often a compromise as it rarely fulfils all the ideal specifications for compatibility, bond strength, durability, reversibility and aesthetics (Schuck, Fischer, and Schwahn 2019). Conservators commonly use two main adhesive types to reassemble glass: acrylic and epoxy resins. Solvent-based acrylic resins such as Paraloid® B-72 (PB-72) have been extensively recommended for remaining colourless and soluble after ageing, having moderate strength, adjustable consistency and fast setting time (Koob 2006). Epoxy resins stable to light-ageing, such as Hxtal® NYL-1, are also widely used in glass conservation, sacrificing reversibility when stronger structural bonds and unnoticeable repairs on clear colourless glass are desired since, in contract with PB-72, it does not leave a fine trail of air bubbles in the join line due of solvent loss (Koob 2006; Schuck, Fischer, and Schwahn 2019).

Magic lantern slides are composed of colourless flat glass sheets, one of the most unforgiving types of glass to repair. Besides commonly having sharp edges and smooth fracture lines, the glass breaks are frequently accompanied by tiny slivers and chips, which are particularly difficult to hide (Koob 2006). Also, tensions can be released when glass breaks and larger fragments might become slightly misaligned, especially in flat glass, making it no longer possible to reassemble its fragments perfectly.

Choosing the appropriate adhesive and method for assembling the studied magic lantern slides is particularly challenging as fractures often occur in painted areas of the glass support. As discussed in the previous subsection, these paintings can be dissolved by solvents commonly used to prepare PB-72, such as ethanol and acetone. On the other hand, epoxy resins have several disadvantages besides the limited reversibility, such as the very long setting times (e.g., Hxtal takes 48-96 hours to cure), the potential to yellow, especially when exposed to high light levels, and the significantly higher strength than glass, being more likely to break the glass in new areas than the bond to fail (Koob 2006). Additionally, epoxy resins have a very low viscosity for many hours, in contrast with the easily adjustable viscosity of PB-72 controlled by the amount of solvent (Koob 2006). Such low viscosity can be helpful in some instances; however, it can be problematic when break lines cross painted areas, as adhesives may irreversibly penetrate the paint layers, increase their transparency, and saturate their colours.

Treatment of two magic lantern slides

Eight CPMC slides selected to be characterised had their glass support broken. Two of these were entrusted to be restored, as their loose fragments were hampering the slides' handling and storage conditions (**Figure 5.19**). With this in mind, the primary goal of this intervention was to assemble the fragments to improve their physical stability, reducing the risk of harm to the caretaker when handling, wear of the fracture lines, further breakage, and dissociation of fragments.



Figure 5.19 Slides CPMC-PC0018/001 (**A**) and CPMC-PC0033/001 (**B**) before the restoration treatment.

Description of condition

Both slides were in poor condition, mostly due to the state of the glass support (*Appendix A.2.1*). In slide CPMC-PC0018/001, the glass support was fissured and fractured in six fragments, and glass and paint chips were found along the fracture lines. These physical damages happened in painted areas, resulting in paint loss along the fracture lines. Most of the fragments were held in place by the adhesive paper framing the slide; however, the paper was partially torn along the fracture line of one of the fragments, causing it to move and be suspended when the slide was handled. It was possible to observe dust all over the surface of the glass and paint and areas with dirt, flacking, abrasion, and loss of the pictorial layer. It was possible to observe small parts of the original adhesive paper underneath a new adhesive paper glued to the original in a previous intervention (*Appendix A.9.4*). A mapping of the main damages is shown in **Figure 5.20-A**.

Slide CPMC-PC0033/001 had its glass support broken into four fragments, and the fracture lines, fissures, and chips were in non-painted areas. Dust was all over the slide's surface, dirt, insect detritus on the glass, and a few lacunas/losses in the pictorial layer. Fading, discolouration, abrasion, and tear on the paper frame were also observed. A mapping of the main damages is shown in **Figure 5.20-B**.

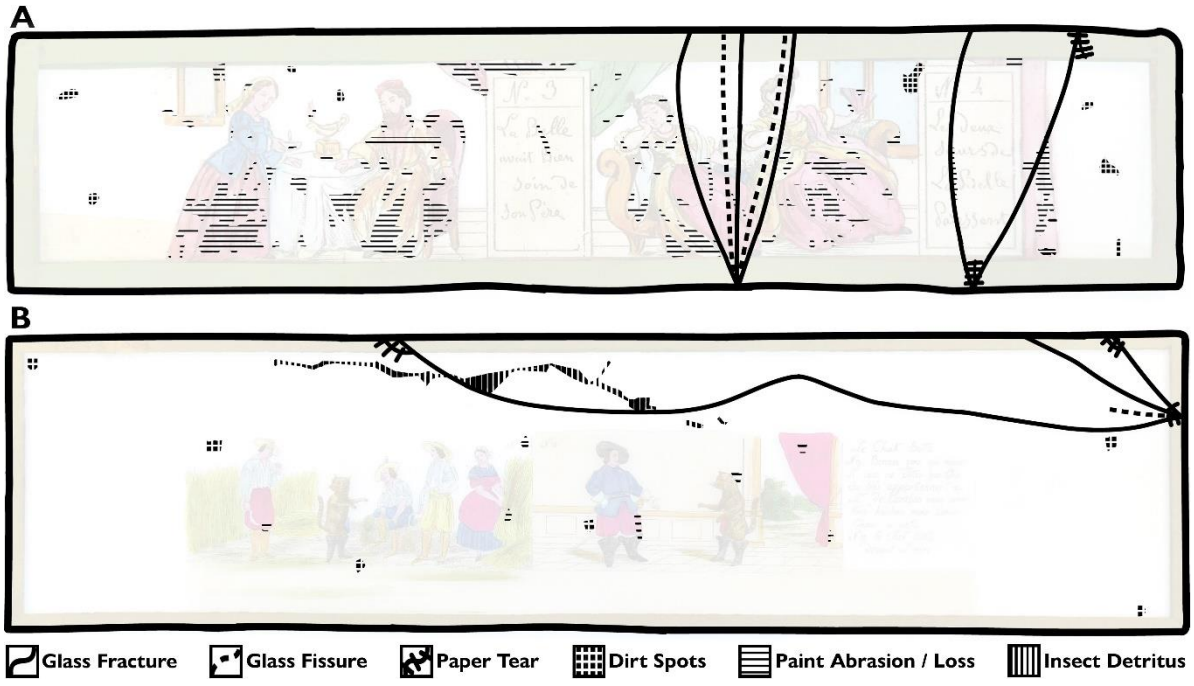


Figure 5.20 Mapping of main damages identified in slides CPMC-PC0018/001 (**A**) and CPMC-PC0033/001 (**B**).

Cleaning

Cleaning the fracture lines is essential for good adhesion between the glass and the adhesive. In the case of slide PC0018/001, the only fracture line exposed due to the tear of the paper frame was dry-cleaned using cotton swabs, given the risk of paint dissolution as this fracture occurred in a painted area. On the other hand, in slide PC0033/001, as all the fractures were safely distanced from the painting, a cotton swab with distilled water and ethanol (1:1) was used to clean the two exposed fracture lines.

This same water and ethanol solution was applied to all the glass areas without painting on both sides A (front, with painting) and B (back, without painting) of the slides, maintaining the cotton swab at a distance of 2-3 mm from the painting and paper frame. This chemical-cleaning method effortlessly removed all dirt spots on the glass and insect detritus on both slides. On slide PC0018/001, it also efficiently dissolved small excess parts of glue applied to glue a new paper frame over the original in a previous intervention. Regarding painted areas, these were left untouched.

Assembly of fragments

There are two commonly used methods of glass assembly: direct or piece-by-piece and by capillary action. In the first process, the glass is glued piece-by-piece, beginning with a single fragment and adding others to it one at a time after the first joint is set, starting with the largest piece or a large one from the edge of the object and, small pieces of tape can be used to keep the fragments in place while the adhesive is setting (Koob 2006). The second method requires temporarily joining all the fragments (*e.g.*, with tape, sticky wax or omega clamps) and injecting the adhesive along the breaks, where it will be drawn into the cracks by capillary action (Koob 2006).

Since the slides were intended to be stored after the restoration treatment and highly-strength structural bonds and unnoticeable repairs were unnecessary, PB-72 was selected to assemble the glass fragments. Additionally, although some fractures needed to be joined through the capillarity process, for which epoxy resins are usually more suitable due to their low viscosity, the fracture lines of PC0018/001 crossed painted areas, making PB-72 more advantageous for allowing a controlled and easily adjustable viscosity, ensuring the adhesive did not touch the paint.

PB-72 was prepared at 30 % in ethanol with around 3 % fumed silica (following the preparation instructions by (2006)). This percentage of adhesive allowed for the desired viscosity, and ethanol was chosen instead of the commonly used acetone for having a slower evaporation rate, better suited for the assembly by capillarity, and microspheres of fumed silica were added to reduce the formation of bubbles during the solvent evaporation (Koob 2006).

On both magic lantern slides, the fissures and fracture lines kept together by the green adhesive tape were injected with adhesive by capillary action from the non-painted side of the glass. The exposed fractures were assembled piece-by-piece by adding PB-72 only to the half of the fracture line closer to the non-painted side so that when the fragments were joined and pressed together, the adhesive would not overflow to the painted side. When settled, the excess of Paraloid was carefully removed with a rounded-tip scalpel blade to avoid adding amounts of solvent that could weaken the adhesive or damage the painting on the other side when close to it. Only after mechanically removing the excess adhesive were the areas surrounding the fracture and fissure lines cleaned carefully with the water and ethanol solution using small cotton swabs.

A small drop of adhesive was added underneath the green paper frame in areas where it was torn and lifted from the glass to reinforce the glass joint while assuring that handling would not further damage those weakened parts of the paper.

Before and after treatment photographs of the slides are presented in **Figure 5.21**, and details of the process can be found in *Appendix A.9.4*.



Figure 5.21 Slides CPMC-PC0018/001 (A) and CPMC-PC0033/001 (B) after the restoration treatment.

5.4 Chapter conclusion

This chapter addressed several conservation challenges faced by institutions holding painted magic lantern slides and conservation professionals. The collections of CPMC and MUHNAC were studied, and the state of preservation of painted slides and common damages was assessed. These and other national and international institutions holding magic lantern slides were surveyed to allow for an overall understanding of these collections' characteristics, conditions and conservation practices. With this knowledge, preventive conservation guidelines applicable to painted slide collections were developed to complement the current preventive conservation standards. Restoration practices such as cleaning glass and painting and reassembling glass fragments were also explored to improve the current preservation practices.

The environmental conditions of the CPMC storage and exhibition rooms with painted slides were investigated as a case study. This research showed that the parameter with the most problematic conditions is the light in the exhibition room. Not only are the illumination systems installed inadequate, but the light intensity is at dangerous levels for extended periods, resulting in devastating colour alterations in several slides. Considering the results, immediate actions should be taken to reduce light intensity and heat and avoid extreme relative humidity and temperature values in storage and exhibition rooms. These results are of significant importance in stimulating discussions and changes in this and other institutions and serve as an example to raise awareness of the fragility of this heritage.

The study of magic lantern collections of two Portuguese institutions (CPMC and MUHNAC), as well as the overview of 20 surveyed institutions around the globe, revealed that, even though slides entirely hand-painted and coloured printed outlines are present in small amounts when compared to slides with other depiction techniques (*e.g.,* chromolithography and photography), they have representativity in these collections. In the Portuguese collections studied, these slides represent between a quarter and more than half of the slides held, and 16 of the 20 institutions surveyed have these types of slides under their care.

The state of preservation of slides from CPMC and MUHNAC collections was assessed with careful macroscopic observation, revealing that almost 10 % are highly deteriorated and urgently need remedial conservation treatments. In 48 of these slides, a more precise assessment of the state of preservation was obtained by complementing the macroscopic observation with the analytical results of their material characterisation acquired in previous studies. Acknowledging what is happening at a microscopic and molecular level is fundamental. For instance, the 18th-century slides showed severe deterioration problems in the painting materials at the macro- and microscopic level (*e.g.,* paint loss, microcracking and discolouration). On the other hand, several of the 19th-century slides demonstrated that although no signs of degradation were observed with the naked eye, the presence of degradation products in the painting was analytically detected, emphasising the extreme importance of implementing preventive conservation measures, such as the control of the environmental conditions of temperature, relative humidity, and light.

The most common degradation problems found include overall dust and grime; fractures and lacunas in the glass support that, in some cases, resulted in the complete loss of the image

represented; painting deterioration, which frequently can be observed as fading, cracking, flacking, and lacunas; and fungi or insect damage in the wood frame, and wear and tear of the paper frame, that besides being a structural part of the slides, the frame may contain valuable information regarding the local and date of production, manufacturer and seller.

This study revealed that glass and painting are the most sensitive and damaged materials that usually constitute these artefacts. The general overview of slide care practices from national and international institutions holding magic lantern slides through the online survey was fundamental to understanding different collections contexts (*e.g.,* number of slides, slides' production periods, most common damages, and storage and display conditions). Caretakers from four institutions explicitly expressed concern about these collections due to the lack of personnel, dedicated time, and knowledge about magic lantern slide conservation. These problems consequently result, for example, in the absence of systematic cataloguing and digitisation, information about their state of preservation and monitoring, representing severe risks to the safeguard of these collections.

The preventive conservation guidelines presented specifically for painted magic lantern slide collections were developed to complement the general conservation standards for heritage collections. These recommendations intend to raise awareness and share more information about these objects to aid in the identification of degradation problems and factors that can be mitigated, as well as improve the routine care of these collections worldwide. These guidelines concern primary steps that should be considered when surveying a collection (*e.g.,* inventory, cataloguing, and digitisation), the environmental conditions recommended for its preservation (including temperature, RH, light, fine particles and pest control), storage and display conditions and materials, and handling. Other considerations regarding magic lantern demonstrations and recreations of shows while protecting original slides were also made available.

Despite its exploratory nature, the overview of cleaning practices for painted glass slides shows that the best method for cleaning stable and non-varnished paints appears to be using dry, soft brushes, and when the paintings are varnished or painted with varnish colours, solvents like saliva and triammonium citrate in water can be used. These solvents delivered the best results, leaving the colours more vibrant and shinier. Cotton swabs were efficient and easy to control regarding positioning and strength; however, the slight pressure applied in the presence of abrasive particles resulted in minor scratches on the paint surface. In the future, these solvents should be tested using soft brushes to compare the advantages and disadvantages of the swabs. The tests emphasised the importance of cleaning magic lantern slides under a microscope, even when using dry swabs or brushes, and every colour must be tested to ensure no paint will be damaged, given the presence of different colourants, binders, and resins. The areas with paint cracks and flacking layers cannot be cleaned without a previous consolidation. The cleaning tests performed in this work give a brief insight into these paints' susceptibility to solvents, allowing for discussions concerning the appropriate adhesives to reassemble fragmented glass support.

The need for further investigation on the materials used to produce painted slides, such as the binders and printed outlines, is acknowledged, as well as the improvement of conservation strategies, particularly concerning the most appropriate materials and procedures for cleaning, consolidation, and restoration.

Concluding Remarks

Magic lantern slides are fascinating artefacts that give a glimpse into the society of their time through their bright and transparent imagery and movement mechanisms. This investigation has contributed to a holistic understanding of this heritage, shedding light on its historical evolution, production technology, artistry, material science, and conservation challenges.

By reviewing written sources from the 18th and 19th centuries on magic lantern instruments and the production of glass slides, it was possible to understand the developments that occurred from the emergence of this communication medium to its decline. Not only did the type of lanterns and slides vary according to their purpose, but the colour temperature was also considered when painting (from colder to warmer tones) depending on the light source the magic lantern used, revealing a symbiotic relation between technology, purpose and artistic expression.

This research has identified marking periods of technological development in producing slides. In terms of depiction techniques, there was a transition from *fired paints* (*e.g.*, enamels) to *cold paints* (watercolours, oils and varnishes) from the mid-17th century to the 18th century; it was apparent the improvement in the quality of the materials and cold painting techniques in the 19th century; and by the mid-19th century onwards new complementary techniques such as outline printing were developed and the palette of transparent paints increased with the discovery of new colourants. For the support, only the thinnest and most transparent glass sheets without imperfections were procured, and several types of glass were used throughout time. The meticulous selection of the glass support and the painting materials elucidated the attention to detail and craftsmanship required to create lantern slides. To verify the survival of slides with *fired paints* from earlier periods, a slide from the CPMC collection (PC0001), attributed to the 18th century, showing characteristics similar to the stained-glass painting tradition, started to be analysed outside the scope of this thesis. In this preliminary analysis, the blue colour was revealed to be a lead-based glass enamel with cobalt as a colouring agent. In the future, it would be interesting to perform additional analytical studies on this and similar slides from other collections to understand this early magic lantern slide production technique and its evolution.

Besides the already established importance of the manual for painting glass slides for magic lanterns published by Winsor & Newton, it is now clear that, in the 19th century, they were continuously dedicated to producing quality painting materials for this art. Despite the exploratory nature of the investigation carried out on Winsor & Newton's production of moist watercolours (remarkably advised by other authors), it already gave an insight into the experimentation and dedication of this company and preferred formulations for the most advised primary colours (gamboge, crimson lake and Prussian blue), setting the stage for future

in-depth studies. Considering the invaluable knowledge provided by the *W&N 19th-Century Archive Database*, it would be important to study their formulations and produce historically accurate reconstructions of watercolours, oils and varnish paints based on their recipes to understand their behaviour in adverse environmental conditions by studying their degradation mechanisms. The degraded samples produced in the laboratory could also be used to investigate the different procedures and materials available and establish the best remedial and restoration options.

The material characterisation of 18th- and 19th-century slides from the Portuguese Cinematheque - Museum of Cinema and the National Museum of Natural History and Science (MUHNAC, from the University of Lisbon) significantly contributed to understanding the composition of the glass support and painting materials used in magic lantern slides and their technological advancements. With the multi-analytical approach applied, it was possible to semi-quantify the glass support with EDXRF analysis and distinguish them into four main compositional groups, and the complementary use of EDXRF, UV-VIS and Raman spectroscopies allowed the identification of most colourants applied in these paintings. FTIR aided the identification of paint formulations by detecting colourants, binding mediums, and deterioration products, contributing to assessing the preservation condition of these slides. Finally, SERS allowed for the definite identification of cochineal in red/pink lake pigments. These results verified the preference for high-quality glass, as reported by historical documentation, and distinguished groups of potassium-rich, mixed alkali, high-lime low-alkali (HLLA) and synthetic soda-rich glass, which could be associated with specific production periods and regions, providing crucial clues for these slides' attributions. The preference for bright and pure colours to avoid murkiness became evident, which, coupled with the limited availability of transparent pigments, influenced the artists' choices and inspired the use of mixtures that created a multitude of hues and gradients. The analyses detected shellac and mastic resins and the possible presence of oils. Regarding the colourants, red ochre, cochineal-based lakes, geranium lakes, vermilion, yellow ochre, gamboge, Prussian blue, ultramarine blue, copper-green, and carbon black were identified.

Concerning this methodology's advantages and limitations, EDXRF, UV-VIS, and Raman spectroscopies allowed for a large quantity of analysis in a short time while *in situ*. The semi-quantification of the glasses based on EDXRF analysis proved to be an invaluable tool for significant quantities of glass objects without sampling, the most challenging aspects of the quantification process being the absence of CMOG glass standards at the time, with a composition closer to HLLA glass for better calibration and validation, and the imprecision associated with light elements such as sodium and aluminium. UV-VIS and Raman spectroscopies were fundamental for identifying most colourants *in situ*. Raman spectroscopy made it possible to identify inorganic pigments and complexing agents; however, the fluorescence of complex mixtures of organic colourants and resins hampered their detection. Since it required micro-sampling, FTIR was never intended to be carried out as comprehensively as the remaining techniques. Although it needed minimal sample preparation, it was a delicate process given the miniature size, thickness, and fragility of painting layers and the presence of terpenoid resins that increased the spectra complexity and possibly masked other binders such

as gums and oils. SERS was fundamental in confirming the use of cochineal-based pigments; however, it demonstrated its impracticability in these miniature paintings, given the amount of sample needed for its execution without further optimisation.

Various aspects of material characterisation remain unanswered. To fully characterise the organic media present in these slides (which may include, *e.g.*, gums and oils) and understand their role in the painting process by understanding these paintings' stratigraphy resorting to cross-sections (*e.g.*, verifying if the binding mediums were applied as preparatory layers, as paint constituents and/or as protective layers), other analytical techniques should be explored, such as pyrolysis-gas chromatography/mass spectrometry (Py-GC/MS) and synchrotron radiation - Fourier transformed infrared spectroscopy (SR-FTIR). SR-FITR may also contribute to unveiling whether the altered copper-green was initially applied as Verdigris or copper resinate. Microspectrofluorimetry should also be tested to identify several organic yellow and brown colourants that remain to uncover.

This analytical study revealed strong correlations between the reviewed 18th- and 19th-century written sources and what is found on historical magic lantern glass slides, namely the glass quality, the colourants and binders identified and the painting techniques described. This investigation enlightens the impact of the 19th-century technological evolution on the development of magic lantern slide painting with higher-quality flat glass, the increase in synthetic pigments expanding the colour palette available to artists, and the introduction of printing techniques for the slides' outlines. This study made it possible to attribute chronologies of production with more precision, emphasising the importance of complementing the aesthetical and documental attributions with analytical studies. Additionally, differences in the artistic styles and colour palettes of several manufacturers could be distinguished. From intricate compositions and colour gradients of Italian and English producers to Lapierre's more concise and vibrant colour choices, each slide producer showcases its strategic and creative perspective. The continuous material characterisation of slides from known producers and determined date ranges will be fundamental to creating a spatial-temporal map that will provide knowledge on the manufacture evolution over time according to each producer and will be a valuable tool for the attribution of place and time of production of magic lantern glass slides of unknown provenance. Analysing more glass slides would also uncover if slide manufacturers preferred particular glass compositions and production techniques. This investigation also unveiled the existence of 18th-century slides carefully painted on high-quality thin glass while emphasizing the importance of implementing preventive conservation measures to safeguard these artefacts for future generations.

Two specific light-sensitive colours were identified in different stages of degradation paving the way for further research to deepen our understanding of their degradation mechanisms. The first is the copper-green detected on CPMC 18th-century slides, showing discolouration from green to brown, which was found to have a parallel in a good state of preservation in the Science Museum of the University of Coimbra (**Figure 3.1**). The other is the eosin-based lake found in severely faded slides due to exposure to extreme light conditions that belong to a set with slides that remain in good conditions. Both these case studies allow the comparison between well-preserved paints and deteriorated ones. The discovery of similar paints with such different states

of deterioration (from vivid colours to heavily darkened or faded) highlights the importance of studying and preserving these historical artworks.

With this in mind, the conservation challenges faced by those who have painted slides in their care were also addressed. Studying the environmental conditions of the CPMC slides' storage and exhibition rooms was most important as it showcases the urgent need for preventive conservation actions to install adequate illumination systems that reduce light exposure time and intensity and avoid extreme relative humidity and temperature values. This case study presentation encourages discussions and changes in this and other institutions that hold and display magic lantern slides. The most common degradation issues were identified by surveying slide collections and assessing the state of preservation of slides held in Portuguese collections, which allowed gathering an illustrated glossary of the damages found to help other professionals. Understanding the needs of the artefacts, caretakers and conservation professionals enabled the development of preventive conservation guidelines tailored to painted slide collections. These recommendations particularly considered the identification of light-sensitive materials during the analysis. Glass and painting were found to be the most fragile and damaged materials in these artefacts. Finally, given the need for efficient solutions to replicate original glass slides, the present work may help develop future proposals to protect historical slides while ensuring their fruition as a performative and educational moving artefact by present and coming generations.

Overall cleaning, consolidation of paint layers and union of glass fragments were considered the most necessary restoration treatments. Regarding cleaning, the overview of practices and cleaning tests performed on painted glass slides revealed that slides varnished or painted with varnish colours in stable conditions can be cleaned with saliva and 2.5 % triamonium citrate solutions. In contrast, non-varnished paints should be cleaned with dry and soft brushes. The tests emphasised the importance of testing all colours in small areas and cleaning magic lantern slides under a microscope. These techniques can be complemented with a solution of ethanol and water (1:1) by carefully applying it to the unpainted areas of the glass support using paper or cotton swabs, with excellent results. Further investigation on consolidation materials and methods to apply them on paint cracks and flacking layers is needed.

In conclusion, this thesis deepened our understanding of painted magic lantern slides, offering a valuable window into the world of early visual projection and artistic expression during the 18th and 19th centuries, and emphasised the interdisciplinary nature of conservation research. By bridging the realms of art history, materials science, and conservation practice, this study unveils a promising path for future investigation on these unique artefacts and hopes to increase awareness and foster collaboration between institutions, conservation professionals, and researchers to ensure the long-term preservation and appreciation of painted magic lantern slide collections.

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Chapter headings illustration

Magic lantern drawn by the author, inspired by the caricaturist Rafael Bordalo Pinheiro's small illustrations separating texts in the journal:
Vaz, Gil. 1875. *A Lanterna Magica* 1 (15 May). Lisbon: Typographia de Christovão Augusto Rodrigues.

APPENDIX

A.1 Magic lantern light sources and other collections

Table A.1 Summary of light intensity values found in literature and its correspondence to Lumens. This table was developed with information from diverse documental sources (Chadwick 1878; de Roo, n.d.; Robinson, Herbert, and Crangle 2001).

Light Sources	Candles	Lumens
Candle	1	12.57
Argand oil lamp	6-10	75.42 - 125.7
Paraffin single-wick	30	377.1
Paraffin double-wick	42-60	527.94 - 754.2
Paraffin triple-wick	110	1382.7
Paraffin four-wick	200	2514
Oxy-calcium jet	~150	1885.5
Blow-through jet	~200	~2514
Oxy-hydrogen / Mixed jet	430-1000	5405.1 - 12570
Pyro-hydrogen	10 - 150	125.7 - 1885.5
Oxy-acetylene	<200	<2514
Electric carbon-filament bulb	50-100	628.5 - 1257
Nernst three-filament lamp	1000	12570
Gas-filled Tungsten-filament lamp	>1000	>12570



Figure A.1 Panorama slide attributed to the second half of the 18th century, from the private collection of François Binétruy, with aesthetic features and painted composition similar to the slides from the Portuguese Cinematheque - Museum of Cinema (PC002/002) and Science Museum of the University of Coimbra (FIS.2070). © Collection of François Binétruy (https://collection-binetruy.com).

A.2 Catalogue of painted magic lantern slides studied

This appendix presents a catalogue with inventory information of all the painted magic lantern slides held by the Portuguese Cinematheque - Museum of Cinema (CPMC) and the National Museum of Natural History and Science (MUHNAC), organised by institution and production technique. The three slides acquired for this project, currently held by the VICARTE Research Unit, and studied in *Chapter 4* and *5* are also contemplated. This catalogue was compiled by gathering inventory information from holding institutions, photographing, measuring, and classifying the slides according to their format and discursive genre. The analytically studied slides are identified in the catalogue by the presence of an investigation code. A summary of the information regarding the individual state of preservation assessment was also included.

An overview of the number of slides of interest and state of preservation of each institution can be found in **Table A.2**, **Table A.3**, and **Table A.4**.

A.2.1 Portuguese Cinematheque - Museum of Cinema

Table A.2 Overview of the slides studied from the CPMC. © Photographs by the author.

		State of Preservation			
Slides	**Quantity**	**1 - Good**	**2 - Fair**	**3 - Poor**	**4 -Very poor**
Hand-painted	108	62	26	7	13
Coloured printed outlines	214	81	94	32	7
Total	322	143	120	39	20

Inventory Number **PC0001**
Investigation Code n/a



Title	-
Date	ca. 1750-1800
Producer	-
Origin	Netherlands (?)
Dimensions	47.4 x 9.1 x 0.9 cm
Format	Multiple slide
Discursive Genre	Everyday
Technique	Hand-painted (fire paints?)

State of Preservation
Overall: 1 - Good

Glass	Paint	Wood	Paper	Metal
1	1	2	-	-

Damages and observations:
It appears to be cylinder glass, painted with fire paints similar to stained glass.

Inventory Number **PC0002/001**
Investigation Code CP01



Title	-
Date	ca. 1750-1800
Producer	-
Origin	Italy (?)
Dimensions	39.5 x 9.9 x 0.7 cm
Format	Panorama slide
Discursive Genre	-
Technique	Hand-painted

State of Preservation
Overall: 4 – Very poor

Glass	Paint	Wood	Paper	Metal
1	4	2	4	-

Damages and observations:
Severe paint loss and flaking. Glass with small bubbles.

Inventory Number **PC0002/002**
Investigation Code CP02



Title	-
Date	ca. 1750-1800
Producer	-
Origin	Italy (?)
Dimensions	39.7 x 8.6 x 0.6 cm
Format	Panorama slide
Discursive Genre	Burlesque
Technique	Hand-painted

State of Preservation
Overall: 4 - Very poor

Glass	Paint	Wood	Paper	Metal
1	4	2	4	-

Damages and observations:
Paint loss, crackling, and discolouration.

Inventory Number **PC0002/003**
Investigation Code CP03



Title	-
Date	ca. 1750-1800
Producer	-
Origin	Italy (?)
Dimensions	39.7 x 8.9 x 0.7 cm
Format	Panorama slide
Discursive Genre	Burlesque
Technique	Hand-painted

State of Preservation
Overall: 4 - Very poor

Glass	Paint	Wood	Paper	Metal
1	4	2	-	-

Damages and observations:
Paint loss, flaking, and discolouration.

Inventory Number **PC0002/004**
Investigation Code CP04



Title	-
Date	ca. 1750-1800
Producer	-
Origin	Italy (?)
Dimensions	39.1 x 9.8 x 0.7 cm
Format	Panorama slide
Discursive Genre	Tale (?)
Technique	Hand-painted

State of Preservation
Overall: 4 - Very poor

Glass	Paint	Wood	Paper	Metal
2	4	3	4	-

Damages and observations:
Glass scratched, paint flaking and with abrasion.

Inventory Number **PC0002/005**
Investigation Code CP05



Title	-
Date	ca. 1750-1800
Producer	-
Origin	Italy (?)
Dimensions	39.6 x 9.6 x 1.2 cm
Format	Panorama slide
Discursive Genre	Everyday
Technique	Hand-painted

State of Preservation
Overall: 4 - Very poor

Glass	Paint	Wood	Paper	Metal
2	4	2	4	-

Damages and observations:
Wood distorted, paint losses and flaking, paper torn and yellowed.

Inventory Number **PC0002/006**
Investigation Code CP06



Title	-
Date	ca. 1750-1800
Producer	-
Origin	Italy (?)
Dimensions	39.2 x 9.7 x 0.8 cm
Format	Panorama slide
Discursive Genre	Burlesque
Technique	Hand-painted

State of Preservation
Overall: 4 - Very poor

Glass	Paint	Wood	Paper	Metal
1	4	2	-	-

Damages and observations:
Glass with small bubbles.

Inventory Number **PC0002/007**
Investigation Code CP07



Title	-
Date	ca. 1750-1800
Producer	-
Origin	Italy (?)
Dimensions	36.5 x 8 x 0.2 cm
Format	Panorama slide
Discursive Genre	Religious (?)
Technique	Hand-painted

State of Preservation
Overall: 4 - Very poor

Glass	Paint	Wood	Paper	Metal
2	4	-	-	-

Damages and observations:
Glass and paint horizontally scratched, paint loss and flaking.

Inventory Number **PC0002/008**
Investigation Code CP08



Title	-
Date	ca. 1750-1800
Producer	-
Origin	Italy (?)
Dimensions	39.5 x 9.4 x 0.8 cm
Format	Panorama slide
Discursive Genre	Burlesque (?)
Technique	Hand-painted

State of Preservation
Overall: 4 - Very poor

Glass	Paint	Wood	Paper	Metal
2	4	3	-	-

Damages and observations:
Glass scratched, paint flaking, retouching and distorted wood.

Inventory Number **PC0002/009**
Investigation Code CP09



Title	-
Date	ca. 1750-1800
Producer	-
Origin	Italy (?)
Dimensions	39.6 x 9.6 x 0.8 cm
Format	Panorama slide
Discursive Genre	Burlesque (?)
Technique	Hand-painted

State of Preservation
Overall: 4 - Very poor

Glass	Paint	Wood	Paper	Metal
3	4	3	-	-

Damages and observations:
Glass fractured and chipped, paint flaking and distorted wood.

Inventory Number **PC0002/010**
Investigation Code CP10



Title	-
Date	ca. 1750-1800
Producer	-
Origin	Italy (?)
Dimensions	39.7 x 8.6 x 0.7 cm
Format	Panorama slide
Discursive Genre	Everyday (?)
Technique	Hand-painted

State of Preservation
Overall: 4 - Very poor

Glass	Paint	Wood	Paper	Metal
1	4	2	-	-

Damages and observations:
Paint craquelure, flaking, and losses.

Inventory Number **PC0002/011**
Investigation Code CP11



Title	-
Date	ca. 1750-1800
Producer	-
Origin	Italy (?)
Dimensions	39.5 x 10 cm
Format	Panorama slide
Discursive Genre	Religious
Technique	Hand-painted

State of Preservation
Overall: 4 - Very poor

Glass	Paint	Wood	Paper	Metal
4	3	4	-	4

Damages and observations:
Glass fractured and fissured, paint flaking, wood infestation, and rusted metal.

Inventory Number **PC0003**
Investigation Code n/a



Title	*Cape of Good Hope*
Date	ca. 1875-1900
Producer	Carpenter & Westley
Origin	England
Dimensions	35 x 9.6 x 1.1 cm
Format	Panorama slipping slide
Discursive Genre	Topical
Technique	Hand-painted

State of Preservation
Overall: 1 - Good

Glass	Paint	Wood	Paper	Metal
1	1	1	-	-

Damages and observations:

Inventory Number **PC0011/001**
Investigation Code n/a



Title	*Le Tour de Monde en 80 jours*
Date	ca. 1890
Producer	Lapierre
Origin	France
Dimensions	19 x 4 cm
Format	Panorama slide
Discursive Genre	Tale
Technique	Coloured printed outlines

State of Preservation
Overall: 2 - Fair

Glass	Paint	Wood	Paper	Metal
1	2	-	2	-

Damages and observations:
Painting scratched.

Inventory Number **PC0011/002**
Investigation Code n/a



Title	*Le Tour de Monde en 80 jours*
Date	ca. 1890
Producer	Lapierre
Origin	France
Dimensions	19 x 4 cm
Format	Panorama slide
Discursive Genre	Tale
Technique	Coloured printed outlines

State of Preservation
Overall: 1 - Good

Glass	Paint	Wood	Paper	Metal
1	1	-	2	-

Damages and observations:

Inventory Number **PC0011/003**
Investigation Code n/a



Title	*Le Tour de Monde en 80 jours*
Date	ca. 1890
Producer	Lapierre
Origin	France
Dimensions	19 x 4 cm
Format	Panorama slide
Discursive Genre	Tale
Technique	Coloured printed outlines

State of Preservation
Overall: 1 - Good

Glass	Paint	Wood	Paper	Metal
1	1	-	2	-

Damages and observations:

Inventory Number **PC0011/004**
Investigation Code n/a



Title	*Le Tour de Monde en 80 jours*
Date	ca. 1890
Producer	Lapierre
Origin	France
Dimensions	19 x 4 cm
Format	Panorama slide
Discursive Genre	Tale
Technique	Coloured printed outlines

State of Preservation
Overall: 1 - Good

Glass	Paint	Wood	Paper	Metal
1	1	-	2	-

Damages and observations:

Inventory Number **PC0011/005**
Investigation Code n/a



Title	*Le Tour de Monde en 80 jours*
Date	ca. 1890
Producer	Lapierre
Origin	France
Dimensions	19 x 4 cm
Format	Panorama slide
Discursive Genre	Tale
Technique	Coloured printed outlines

State of Preservation
Overall: 1 - Good

Glass	Paint	Wood	Paper	Metal
1	1	-	2	-

Damages and observations:

Inventory Number **PC0011/006**
Investigation Code n/a



Title	*Le Tour de Monde en 80 jours*
Date	ca. 1890
Producer	Lapierre
Origin	France
Dimensions	19 x 4 cm
Format	Panorama slide
Discursive Genre	Tale
Technique	Coloured printed outlines

State of Preservation
Overall: 1 - Good

Glass	Paint	Wood	Paper	Metal
1	1	-	2	-

Damages and observations:

Inventory Number **PC0012/001**
Investigation Code n/a



Title	*La Fille de Madame Angot*
Date	ca. 1890
Producer	Lapierre
Origin	France
Dimensions	19 x 4 cm
Format	Panorama slide
Discursive Genre	Romance
Technique	Coloured printed outlines

State of Preservation
Overall: 1 - Good

Glass	Paint	Wood	Paper	Metal
1	1	-	1	-

Damages and observations:

Inventory Number **PC0012/002**
Investigation Code n/a



Title	*La Fille de Madame Angot*
Date	ca. 1890
Producer	Lapierre
Origin	France
Dimensions	19 x 4 cm
Format	Panorama slide
Discursive Genre	Romance
Technique	Coloured printed outlines

State of Preservation
Overall: 1 - Good

Glass	Paint	Wood	Paper	Metal
1	1	-	1	-

Damages and observations:

Inventory Number **PC0012/003**
Investigation Code n/a



Title	*La Fille de Madame Angot*
Date	ca. 1890
Producer	Lapierre
Origin	France
Dimensions	19 x 4 cm
Format	Panorama slide
Discursive Genre	Romance
Technique	Coloured printed outlines

State of Preservation
Overall: 1 - Good

Glass	Paint	Wood	Paper	Metal
1	1	-	2	-

Damages and observations:

Inventory Number **PC0012/004**
Investigation Code n/a



Title	*La Fille de Madame Angot*
Date	ca. 1890
Producer	Lapierre
Origin	France
Dimensions	19 x 4 cm
Format	Panorama slide
Discursive Genre	Romance
Technique	Coloured printed outlines

State of Preservation
Overall: 1 - Good

Glass	Paint	Wood	Paper	Metal
1	1	-	1	-

Damages and observations:

Inventory Number **PC0012/005**
Investigation Code n/a



Title	*La Fille de Madame Angot*
Date	ca. 1890
Producer	Lapierre
Origin	France
Dimensions	19 x 4 cm
Format	Panorama slide
Discursive Genre	Romance
Technique	Coloured printed outlines

State of Preservation
Overall: 1 - Good

Glass	Paint	Wood	Paper	Metal
1	1	-	2	-

Damages and observations:

Inventory Number **PC0012/006**
Investigation Code n/a



Title	*La Fille de Madame Angot*
Date	ca. 1890
Producer	Lapierre
Origin	France
Dimensions	19 x 4 cm
Format	Panorama slide
Discursive Genre	Romance
Technique	Coloured printed outlines

State of Preservation
Overall: 1 - Good

Glass	Paint	Wood	Paper	Metal
1	1	-	2	-

Damages and observations:

Inventory Number **PC0013/001**
Investigation Code n/a



Title	*Polichinelle*
Date	ca. 1890
Producer	Lapierre
Origin	France
Dimensions	20 x 6 cm
Format	Panorama slide
Discursive Genre	Tale
Technique	Coloured printed outlines

State of Preservation
Overall: 2 - Fair

Glass	Paint	Wood	Paper	Metal
2	1	-	2	-

Damages and observations:

Inventory Number **PC0013/002**
Investigation Code n/a



Title	*Polichinelle*
Date	ca. 1890
Producer	Lapierre
Origin	France
Dimensions	24 x 6 cm
Format	Panorama slide
Discursive Genre	Tale
Technique	Coloured printed outlines

State of Preservation
Overall: 1 - Good

Glass	Paint	Wood	Paper	Metal
1	1	-	2	-

Damages and observations:

Inventory Number **PC0013/003**
Investigation Code n/a



Title	*Polichinelle*
Date	ca. 1890
Producer	Lapierre
Origin	France
Dimensions	24 x 6 cm
Format	Panorama slide
Discursive Genre	Tale
Technique	Coloured printed outlines

State of Preservation
Overall: 1 - Good

Glass	Paint	Wood	Paper	Metal
1	1	-	2	-

Damages and observations:

Inventory Number **PC0013/004**
Investigation Code n/a



Title	*Polichinelle*
Date	ca. 1890
Producer	Lapierre
Origin	France
Dimensions	24 x 6 cm
Format	Panorama slide
Discursive Genre	Tale
Technique	Coloured printed outlines

State of Preservation
Overall: 1 - Good

Glass	Paint	Wood	Paper	Metal
1	1	-	2	-

Damages and observations:

Inventory Number **PC0013/005**
Investigation Code n/a



Title	*Polichinelle*
Date	ca. 1890
Producer	Lapierre
Origin	France
Dimensions	24 x 6 cm
Format	Panorama slide
Discursive Genre	Tale
Technique	Coloured printed outlines

State of Preservation
Overall: 2 - Fair

Glass	Paint	Wood	Paper	Metal
3	2	-	2	-

Damages and observations:
Glass fractured.

Inventory Number **PC0013/006**
Investigation Code n/a



Title	*Polichinelle*
Date	ca. 1890
Producer	Lapierre
Origin	France
Dimensions	24 x 6 cm
Format	Panorama slide
Discursive Genre	Tale
Technique	Coloured printed outlines

State of Preservation
Overall: 1 - Good

Glass	Paint	Wood	Paper	Metal
1	1	-	2	-

Damages and observations:

Inventory Number **PC0013/007**
Investigation Code n/a



Title	*Polichinelle*
Date	ca. 1890
Producer	Lapierre
Origin	France
Dimensions	24 x 6 cm
Format	Panorama slide
Discursive Genre	Tale
Technique	Coloured printed outlines

State of Preservation
Overall: 1 - Good

Glass	Paint	Wood	Paper	Metal
1	1	-	1	-

Damages and observations:

Inventory Number **PC0013/008**
Investigation Code n/a



Title	*Polichinelle*
Date	ca. 1890
Producer	Lapierre
Origin	France
Dimensions	24 x 6 cm
Format	Panorama slide
Discursive Genre	Tale
Technique	Coloured printed outlines

State of Preservation
Overall: 1 - Good

Glass	Paint	Wood	Paper	Metal
1	1	-	2	-

Damages and observations:

Inventory Number **PC0013/009**
Investigation Code n/a



Title	*Polichinelle*
Date	ca. 1890
Producer	Lapierre
Origin	France
Dimensions	24 x 6 cm
Format	Panorama slide
Discursive Genre	Tale
Technique	Coloured printed outlines

State of Preservation
Overall: 1 - Good

Glass	Paint	Wood	Paper	Metal
1	1	-	2	-

Damages and observations:

Inventory Number **PC0013/010**
Investigation Code n/a



Title	*Polichinelle*
Date	ca. 1890
Producer	Lapierre
Origin	France
Dimensions	24 x 6 cm
Format	Panorama slide
Discursive Genre	Tale
Technique	Coloured printed outlines

State of Preservation
Overall: 1 - Good

Glass	Paint	Wood	Paper	Metal
1	1	-	1	-

Damages and observations:

Inventory Number **PC0013/011**
Investigation Code n/a



Title	*Polichinelle*
Date	ca. 1890
Producer	Lapierre
Origin	France
Dimensions	24 x 6 cm
Format	Panorama slide
Discursive Genre	Tale
Technique	Coloured printed outlines

State of Preservation
Overall: 1 - Good

Glass	Paint	Wood	Paper	Metal
1	1	-	1	-

Damages and observations:

Inventory Number **PC0013/012**
Investigation Code n/a



Title	*Polichinelle*
Date	ca. 1890
Producer	Lapierre
Origin	France
Dimensions	24 x 6 cm
Format	Panorama slide
Discursive Genre	Tale
Technique	Coloured printed outlines

State of Preservation
Overall: 1 - Good

Glass	Paint	Wood	Paper	Metal
1	1	-	1	-

Damages and observations:

Inventory Number **PC0014/001**
Investigation Code n/a



Title	*La Chatte Blanche*, part 7-8
Date	ca. 1890
Producer	Lapierre
Origin	France
Dimensions	19 x 4 cm
Format	Panorama slide
Discursive Genre	Tale
Technique	Coloured printed outlines

State of Preservation
Overall: 1 - Good

Glass	Paint	Wood	Paper	Metal
1	1	-	2	-

Damages and observations:

Inventory Number **PC0014/002**
Investigation Code n/a



Title	*La Chatte Blanche*, part 10-12
Date	ca. 1890
Producer	Lapierre
Origin	France
Dimensions	19 x 4 cm
Format	Panorama slide
Discursive Genre	Tale
Technique	Coloured printed outlines

State of Preservation
Overall: 1 - Good

Glass	Paint	Wood	Paper	Metal
1	1	-	2	-

Damages and observations:

Inventory Number **PC0014/003**
Investigation Code n/a



Title	*La Chatte Blanche*, part 16-17
Date	ca. 1890
Producer	Lapierre
Origin	France
Dimensions	19 x 4 cm
Format	Panorama slide
Discursive Genre	Tale
Technique	Coloured printed outlines

State of Preservation
Overall: 1 - Good

Glass	Paint	Wood	Paper	Metal
1	1	-	2	-

Damages and observations:

Inventory Number **PC0015**
Investigation Code n/a



Title	-
Date	ca. 1890
Producer	Lapierre
Origin	France
Dimensions	19 x 4 cm
Format	Panorama slide
Discursive Genre	Tale
Technique	Coloured printed outlines

State of Preservation
Overall: 2 - Fair

Glass	Paint	Wood	Paper	Metal
1	2	-	2	-

Damages and observations:
Paint losses and scratches.

Inventory Number **PC0017/001**
Investigation Code n/a



Title	*La Belle e la Bête*, part 1-2
Date	ca. 1890
Producer	Lapierre
Origin	France
Dimensions	19 x 4 cm
Format	Panorama slide
Discursive Genre	Tale
Technique	Coloured printed outlines

State of Preservation
Overall: 2 - Fair

Glass	Paint	Wood	Paper	Metal
1	2	-	2	-

Damages and observations:

Inventory Number **PC0017/002**
Investigation Code n/a



Title	*La Belle e la Bête*, part 3-4
Date	ca. 1890
Producer	Lapierre
Origin	France
Dimensions	19 x 4 cm
Format	Panorama slide
Discursive Genre	Tale
Technique	Coloured printed outlines

State of Preservation
Overall: 3 - Poor

Glass	Paint	Wood	Paper	Metal
1	3	-	2	-

Damages and observations:

Inventory Number **PC0017/003**
Investigation Code n/a



Title	*La Belle e la Bête*, part 5-6
Date	ca. 1890
Producer	Lapierre
Origin	France
Dimensions	19 x 4 cm
Format	Panorama slide
Discursive Genre	Tale
Technique	Coloured printed outlines

State of Preservation
Overall: 2 - Fair

Glass	Paint	Wood	Paper	Metal
1	2	-	3	-

Damages and observations:

Inventory Number **PC0017/004**
Investigation Code n/a



Title	*La Belle e la Bête*, part 9-10
Date	ca. 1890
Producer	Lapierre
Origin	France
Dimensions	19 x 4 cm
Format	Panorama slide
Discursive Genre	Tale
Technique	Coloured printed outlines

State of Preservation
Overall: 2 - Fair

Glass	Paint	Wood	Paper	Metal
1	2	-	2	-

Damages and observations:

Inventory Number **PC0017/005**
Investigation Code n/a



Title	*La Belle e la Bête*, part 11-12
Date	ca. 1890
Producer	Lapierre
Origin	France
Dimensions	19 x 4 cm
Format	Panorama slide
Discursive Genre	Tale
Technique	Coloured printed outlines

State of Preservation
Overall: 2 - Fair

Glass	Paint	Wood	Paper	Metal
1	2	-	2	-

Damages and observations:

Inventory Number **PC0017/006**
Investigation Code n/a



Title	*La Belle e la Bête*, part 13-14
Date	ca. 1890
Producer	Lapierre
Origin	France
Dimensions	19 x 4 cm
Format	Panorama slide
Discursive Genre	Tale
Technique	Coloured printed outlines

State of Preservation
Overall: 2 - Fair

Glass	Paint	Wood	Paper	Metal
1	2	-	2	-

Damages and observations:

Inventory Number **PC0017/007**
Investigation Code n/a



Title	*La Belle e la Bête*, part 15-16
Date	ca. 1890
Producer	Lapierre
Origin	France
Dimensions	19 x 4 cm
Format	Panorama slide
Discursive Genre	Tale
Technique	Coloured printed outlines

State of Preservation
Overall: 3 - Poor

Glass	Paint	Wood	Paper	Metal
1	2	-	3	-

Damages and observations:

Inventory Number **PC0017/008**
Investigation Code n/a



Title	*La Belle e la Bête*, part 17-18
Date	ca. 1890
Producer	Lapierre
Origin	France
Dimensions	19 x 4 cm
Format	Panorama slide
Discursive Genre	Tale
Technique	Coloured printed outlines

State of Preservation
Overall: 3 - Poor

Glass	Paint	Wood	Paper	Metal
1	2	-	3	-

Damages and observations:

Inventory Number **PC0017/009**
Investigation Code n/a



Title	*La Belle e la Bête*, part 19-20
Date	ca. 1890
Producer	Lapierre
Origin	France
Dimensions	19 x 4 cm
Format	Panorama slide
Discursive Genre	Tale
Technique	Coloured printed outlines

State of Preservation
Overall: 3 - Poor

Glass	Paint	Wood	Paper	Metal
1	2	-	3	-

Damages and observations:
Painting loss and horizontal scratches.

Inventory Number **PC0018/001**
Investigation Code CP12



Title	*La Belle aux cheveux d'or (?)*
Date	ca. 1890
Producer	Lapierre
Origin	France
Dimensions	21.5 x 4.8 x 0.2 cm
Format	Panorama slide
Discursive Genre	Tale
Technique	Coloured printed outlines

State of Preservation
Overall: 3 - Poor

Glass	Paint	Wood	Paper	Metal
3	2	-	2	-

Restored: 2 – Fair
Damages and observations:
Glass fractured, paint loss and abrasion. Paper tore, not securing the glass fragments.

Inventory Number **PC0018/002**
Investigation Code CP13



Title	*La Belle aux cheveux d'or*
Date	ca. 1890
Producer	Lapierre
Origin	France
Dimensions	21.5 x 4.9 x 0.2 cm
Format	Panorama slide
Discursive Genre	Tale
Technique	Coloured printed outlines

State of Preservation
Overall: 3 - Poor

Glass	Paint	Wood	Paper	Metal
3	2	-	1	-

Damages and observations:
Glass fractured, paint loss, flaking and abrasion.

Inventory Number **PC0019/001**
Investigation Code n/a



Title	*Fables de La Fontaine*
Date	ca. 1890
Producer	Lapierre
Origin	France
Dimensions	21 x 5 cm
Format	Panorama slide
Discursive Genre	Tale
Technique	Coloured printed outlines

State of Preservation
Overall: 2 - Fair

Glass	Paint	Wood	Paper	Metal
1	2	-	1	-

Damages and observations:

Inventory Number **PC0019/002**
Investigation Code n/a



Title	*Fables de La Fontaine*
Date	ca. 1890
Producer	Lapierre
Origin	France
Dimensions	21 x 5 cm
Format	Panorama slide
Discursive Genre	Tale
Technique	Coloured printed outlines

State of Preservation
Overall: 2 - Fair

Glass	Paint	Wood	Paper	Metal
1	2	-	1	-

Damages and observations:

Inventory Number **PC0020/001**
Investigation Code n/a



Title	-
Date	ca. 1890
Producer	Lapierre
Origin	France
Dimensions	21.5 x 5.5 cm
Format	Panorama slide
Discursive Genre	Burlesque
Technique	Coloured printed outlines

State of Preservation
Overall: 1 - Good

Glass	Paint	Wood	Paper	Metal
1	1	-	2	-

Damages and observations:

Inventory Number **PC0020/002**
Investigation Code n/a



Title	-
Date	ca. 1890
Producer	Lapierre
Origin	France
Dimensions	21.5 x 5.5 cm
Format	Panorama slide
Discursive Genre	Burlesque
Technique	Coloured printed outlines

State of Preservation
Overall: 1 - Good

Glass	Paint	Wood	Paper	Metal
1	1	-	2	-

Damages and observations:

Inventory Number **PC0020/003**
Investigation Code n/a



Title	-
Date	ca. 1890
Producer	Lapierre
Origin	France
Dimensions	21.5 x 5.5 cm
Format	Panorama slide
Discursive Genre	Burlesque
Technique	Coloured printed outlines

State of Preservation
Overall: 1 - Good

Glass	Paint	Wood	Paper	Metal
1	1	-	1	-

Damages and observations:

Inventory Number **PC0020/004**
Investigation Code n/a



Title	-
Date	ca. 1890
Producer	Lapierre
Origin	France
Dimensions	21.5 x 5.5 cm
Format	Panorama slide
Discursive Genre	Burlesque
Technique	Coloured printed outlines

State of Preservation
Overall: 1 - Good

Glass	Paint	Wood	Paper	Metal
1	1	-	2	-

Damages and observations:

Inventory Number **PC0020/005**
Investigation Code n/a



Title	-
Date	ca. 1890
Producer	Lapierre
Origin	France
Dimensions	21.5 x 5.5 cm
Format	Panorama slide
Discursive Genre	Burlesque
Technique	Coloured printed outlines

State of Preservation
Overall: 1 - Good

Glass	Paint	Wood	Paper	Metal
1	1	-	2	-

Damages and observations:

Inventory Number **PC0020/006**
Investigation Code n/a



Title	-
Date	ca. 1890
Producer	Lapierre
Origin	France
Dimensions	21.5 x 5.5 cm
Format	Panorama slide
Discursive Genre	Burlesque
Technique	Coloured printed outlines

State of Preservation
Overall: 1 - Good

Glass	Paint	Wood	Paper	Metal
1	1	-	2	-

Damages and observations:

Inventory Number **PC0020/007**
Investigation Code n/a



Title	-
Date	ca. 1890
Producer	Lapierre
Origin	France
Dimensions	21.5 x 5.5 cm
Format	Panorama slide
Discursive Genre	Burlesque
Technique	Coloured printed outlines

State of Preservation
Overall: 3 - Poor

Glass	Paint	Wood	Paper	Metal
1	3	-	3	-

Damages and observations:
Severe paint and paper discolouration.

Inventory Number **PC0021/001**
Investigation Code n/a



Title	-
Date	ca. 1890
Producer	Lapierre
Origin	France
Dimensions	22 x 5.5 cm
Format	Panorama slide
Discursive Genre	Burlesque
Technique	Coloured printed outlines

State of Preservation
Overall: 3 - Poor

Glass	Paint	Wood	Paper	Metal
1	3	-	3	-

Damages and observations:
Paint abrasion and severe paint and paper discolouration.

Inventory Number **PC0021/002**
Investigation Code n/a



Title	-
Date	ca. 1890
Producer	Lapierre
Origin	France
Dimensions	22 x 5.5 cm
Format	Panorama slide
Discursive Genre	Burlesque
Technique	Coloured printed outlines

State of Preservation
Overall: 3 - Poor

Glass	Paint	Wood	Paper	Metal
3	3	-	3	-

Damages and observations:
Glass fractured and severe paint and paper discolouration.

Inventory Number **PC0022**
Investigation Code n/a



Title	-
Date	ca. 1890
Producer	Lapierre
Origin	France
Dimensions	22.5 x 5.5 cm
Format	Panorama slide
Discursive Genre	Zoological
Technique	Coloured printed outlines

State of Preservation
Overall: 1 - Good

Glass	Paint	Wood	Paper	Metal
1	1	-	2	-

Damages and observations:

Inventory Number **PC0023/001**
Investigation Code n/a



Title	*Riquet à la houpe*
Date	ca. 1890
Producer	Lapierre
Origin	France
Dimensions	21.5 x 5.5 cm
Format	Panorama slide
Discursive Genre	Romance
Technique	Coloured printed outlines

State of Preservation
Overall: 2 - Fair

Glass	Paint	Wood	Paper	Metal
1	2	-	1	-

Damages and observations:

Inventory Number **PC0023/002**
Investigation Code n/a



Title	*Riquet à la houpe*
Date	ca. 1890
Producer	Lapierre
Origin	France
Dimensions	21.5 x 5.5 cm
Format	Panorama slide
Discursive Genre	Romance
Technique	Coloured printed outlines

State of Preservation
Overall: 2 - Fair

Glass	Paint	Wood	Paper	Metal
1	2	-	1	-

Damages and observations:

Inventory Number **PC0023/003**
Investigation Code n/a



Title	*Riquet à la houpe*
Date	ca. 1890
Producer	Lapierre
Origin	France
Dimensions	21.5 x 5.5 cm
Format	Panorama slide
Discursive Genre	Romance
Technique	Coloured printed outlines

State of Preservation
Overall: 2 - Fair

Glass	Paint	Wood	Paper	Metal
1	2	-	1	-

Damages and observations:

Inventory Number **PC0023/004**
Investigation Code n/a



Title	*Riquet à la houpe*
Date	ca. 1890
Producer	Lapierre
Origin	France
Dimensions	21.5 x 5.5 cm
Format	Panorama slide
Discursive Genre	Romance
Technique	Coloured printed outlines

State of Preservation
Overall: 2 - Fair

Glass	Paint	Wood	Paper	Metal
1	2	-	1	-

Damages and observations:

Inventory Number **PC0023/005**
Investigation Code n/a



Title	*Riquet à la houpe*
Date	ca. 1890
Producer	Lapierre
Origin	France
Dimensions	21.5 x 5.5 cm
Format	Panorama slide
Discursive Genre	Romance
Technique	Coloured printed outlines

State of Preservation
Overall: 2 - Fair

Glass	Paint	Wood	Paper	Metal
1	2	-	1	-

Damages and observations:

Inventory Number **PC0023/006**
Investigation Code n/a



Title	*Riquet à la houpe*
Date	ca. 1890
Producer	Lapierre
Origin	France
Dimensions	21.5 x 5.5 cm
Format	Panorama slide
Discursive Genre	Romance
Technique	Coloured printed outlines

State of Preservation
Overall: 2 - Fair

Glass	Paint	Wood	Paper	Metal
1	2	-	1	-

Damages and observations:

Inventory Number **PC0023/007**
Investigation Code n/a



Title	*Riquet à la houpe*
Date	ca. 1890
Producer	Lapierre
Origin	France
Dimensions	21.5 x 5.5 cm
Format	Panorama slide
Discursive Genre	Romance
Technique	Coloured printed outlines

State of Preservation
Overall: 2 - Fair

Glass	Paint	Wood	Paper	Metal
1	2	-	1	-

Damages and observations:

Inventory Number **PC0023/008**
Investigation Code n/a



Title	*Riquet à la houpe*
Date	ca. 1890
Producer	Lapierre
Origin	France
Dimensions	21.5 x 5.5 cm
Format	Panorama slide
Discursive Genre	Romance
Technique	Coloured printed outlines

State of Preservation
Overall: 2 - Fair

Glass	Paint	Wood	Paper	Metal
1	2	-	1	-

Damages and observations:

Inventory Number **PC0024**
Investigation Code n/a



Title	*La Fille de Madame Angot*, part 5-6
Date	ca. 1890
Producer	Lapierre
Origin	France
Dimensions	21 x 5 cm
Format	Panorama slide
Discursive Genre	Romance
Technique	Coloured printed outlines

State of Preservation
Overall: 2 - Fair

Glass	Paint	Wood	Paper	Metal
2	1	-	3	-

Damages and observations:
Glass dirty, paper tore and detaching from the glass.

Inventory Number **PC0025**
Investigation Code n/a



Title	-
Date	ca. 1890
Producer	Lapierre
Origin	France
Dimensions	20 x 5.5 cm
Format	Panorama slide
Discursive Genre	Topical
Technique	Coloured printed outlines

State of Preservation
Overall: 2 - Fair

Glass	Paint	Wood	Paper	Metal
1	2	-	1	-

Damages and observations:

Inventory Number **PC0026**
Investigation Code n/a



Title	-
Date	ca. 1890
Producer	Lapierre
Origin	France
Dimensions	21 x 5.5 cm
Format	Panorama slide
Discursive Genre	Burlesque
Technique	Coloured printed outlines

State of Preservation
Overall: 2 - Fair

Glass	Paint	Wood	Paper	Metal
1	2	-	1	-

Damages and observations:

Inventory Number **PC0027**
Investigation Code n/a



Title	-
Date	Late 19th century
Producer	unknown
Origin	France
Dimensions	41 x 9.5 x 0.5 cm
Format	Panorama slide
Discursive Genre	Everyday
Technique	Hand-painted

State of Preservation
Overall: 3 - Poor

Glass	Paint	Wood	Paper	Metal
2	3	3	-	-

Damages and observations:
Glass with mould and dirty, and pink paint losses and flaking.

Inventory Number **PC0028/001**
Investigation Code n/a



Title	-
Date	Late 19th century
Producer	unknown
Origin	France
Dimensions	39.5 x 11 cm
Format	Panorama slide
Discursive Genre	Religious
Technique	Coloured printed outlines

State of Preservation
Overall: 3 - Poor

Glass	Paint	Wood	Paper	Metal
2	3	2	-	3

Damages and observations:

Inventory Number **PC0028/002**
Investigation Code n/a



Title	-
Date	Late 19th century
Producer	unknown
Origin	France
Dimensions	29 x 11 cm
Format	Panorama slide
Discursive Genre	Religious
Technique	Coloured printed outlines

State of Preservation
Overall: 3 - Poor

Glass	Paint	Wood	Paper	Metal
3	3	3	-	3

Damages and observations:

Inventory Number **PC0028/003**
Investigation Code n/a



Title	-
Date	Late 19th century
Producer	unknown
Origin	France
Dimensions	37.5 x 9.5 cm
Format	Panorama slide
Discursive Genre	Religious
Technique	Coloured printed outlines

State of Preservation
Overall: 3 - Poor

Glass	Paint	Wood	Paper	Metal
2	3	-	-	-

Damages and observations:

Inventory Number **PC0029/001**
Investigation Code n/a



Title	*Vues de Paris*
Date	ca. 1890
Producer	Lapierre
Origin	France
Dimensions	37.5 x 9.5 cm
Format	Panorama slide
Discursive Genre	Topical
Technique	Coloured printed outlines

State of Preservation
Overall: 2 - Fair

Glass	Paint	Wood	Paper	Metal
1	1	-	3	-

Damages and observations:

Inventory Number **PC0029/002**
Investigation Code n/a



Title	*Vues de Paris*
Date	ca. 1890
Producer	Lapierre
Origin	France
Dimensions	37.5 x 9.5 cm
Format	Panorama slide
Discursive Genre	Topical
Technique	Coloured printed outlines

State of Preservation
Overall: 2 - Fair

Glass	Paint	Wood	Paper	Metal
1	2	-	3	-

Damages and observations:

Inventory Number **PC0029/003**
Investigation Code n/a



Title	*Vues de Paris*
Date	ca. 1890
Producer	Lapierre
Origin	France
Dimensions	37.5 x 9.5 cm
Format	Panorama slide
Discursive Genre	Topical
Technique	Coloured printed outlines

State of Preservation
Overall: 2 - Fair

Glass	Paint	Wood	Paper	Metal
1	2	-	3	-

Damages and observations:

Inventory Number **PC0029/004**
Investigation Code n/a



Title	*Vues de Paris*
Date	ca. 1890
Producer	Lapierre
Origin	France
Dimensions	37.5 x 9.5 cm
Format	Panorama slide
Discursive Genre	Topical
Technique	Coloured printed outlines

State of Preservation
Overall: 2 - Fair

Glass	Paint	Wood	Paper	Metal
1	1	-	3	-

Damages and observations:

Inventory Number **PC0029/005**
Investigation Code n/a



Title	*Vues de Paris*
Date	ca. 1890
Producer	Lapierre
Origin	France
Dimensions	37.5 x 9.5 cm
Format	Panorama slide
Discursive Genre	Topical
Technique	Coloured printed outlines

State of Preservation
Overall: 2 - Fair

Glass	Paint	Wood	Paper	Metal
1	1	-	3	-

Damages and observations:

Inventory Number **PC0029/006**
Investigation Code n/a



Title	*Vues de Paris*
Date	ca. 1890
Producer	Lapierre
Origin	France
Dimensions	37.5 x 9.5 cm
Format	Panorama slide
Discursive Genre	Topical
Technique	Coloured printed outlines

State of Preservation
Overall: 2 - Fair

Glass	Paint	Wood	Paper	Metal
1	1	-	3	-

Damages and observations:

Inventory Number **PC0029/007**
Investigation Code n/a



Title	*Vues de Paris*
Date	ca. 1890
Producer	Lapierre
Origin	France
Dimensions	37.5 x 9.5 cm
Format	Panorama slide
Discursive Genre	Topical
Technique	Coloured printed outlines

State of Preservation
Overall: 2 - Fair

Glass	Paint	Wood	Paper	Metal
1	2	-	3	-

Damages and observations:

Inventory Number **PC0029/008**
Investigation Code n/a



Title	*Vues de Paris*
Date	ca. 1890
Producer	Lapierre
Origin	France
Dimensions	37.5 x 9.5 cm
Format	Panorama slide
Discursive Genre	Topical
Technique	Coloured printed outlines

State of Preservation
Overall: 2 - Fair

Glass	Paint	Wood	Paper	Metal
1	1	-	3	-

Damages and observations:

Inventory Number **PC0029/009**
Investigation Code n/a



Title	*Vues de Paris*
Date	ca. 1890
Producer	Lapierre
Origin	France
Dimensions	37.5 x 9.5 cm
Format	Panorama slide
Discursive Genre	Topical
Technique	Coloured printed outlines

State of Preservation
Overall: 2 - Fair

Glass	Paint	Wood	Paper	Metal
1	1	-	3	-

Damages and observations:

Inventory Number **PC0029/010**
Investigation Code n/a



Title	*Vues de Paris*
Date	ca. 1890
Producer	Lapierre
Origin	France
Dimensions	37.5 x 9.5 cm
Format	Panorama slide
Discursive Genre	Topical
Technique	Coloured printed outlines

State of Preservation
Overall: 2 - Fair

Glass	Paint	Wood	Paper	Metal
1	1	-	3	-

Damages and observations:

Inventory Number **PC0030/001**
Investigation Code n/a



Title	*La Fille de Madame Angot*
Date	ca. 1890
Producer	Lapierre
Origin	France
Dimensions	37.5 x 9.5 cm
Format	Panorama slide
Discursive Genre	Romance
Technique	Coloured printed outlines

State of Preservation
Overall: 2 - Fair

Glass	Paint	Wood	Paper	Metal
1	2	-	3	-

Damages and observations:

Inventory Number **PC0030/002**
Investigation Code n/a



Title	*La Fille de Madame Angot*
Date	ca. 1890
Producer	Lapierre
Origin	France
Dimensions	37.5 x 9.5 cm
Format	Panorama slide
Discursive Genre	Romance
Technique	Coloured printed outlines

State of Preservation
Overall: 2 - Fair

Glass	Paint	Wood	Paper	Metal
1	1	-	3	-

Damages and observations:

Inventory Number **PC0030/003**
Investigation Code n/a



Title	*La Fille de Madame Angot*
Date	ca. 1890
Producer	Lapierre
Origin	France
Dimensions	37.5 x 9.5 cm
Format	Panorama slide
Discursive Genre	Romance
Technique	Coloured printed outlines

State of Preservation
Overall: 2 - Fair

Glass	Paint	Wood	Paper	Metal
2	1	-	2	-

Damages and observations:

Inventory Number **PC0030/004**
Investigation Code n/a



Title	*La Fille de Madame Angot*
Date	ca. 1890
Producer	Lapierre
Origin	France
Dimensions	37.5 x 9.5 cm
Format	Panorama slide
Discursive Genre	Romance
Technique	Coloured printed outlines

State of Preservation
Overall: 2 - Fair

Glass	Paint	Wood	Paper	Metal
1	2	-	2	-

Damages and observations:

Inventory Number **PC0030/005**
Investigation Code n/a



Title	*La Fille de Madame Angot*
Date	ca. 1890
Producer	Lapierre
Origin	France
Dimensions	37.5 x 9.5 cm
Format	Panorama slide
Discursive Genre	Romance
Technique	Coloured printed outlines

State of Preservation
Overall: 2 - Fair

Glass	Paint	Wood	Paper	Metal
1	2	-	3	-

Damages and observations:

Inventory Number **PC0030/006**
Investigation Code n/a



Title	*La Fille de Madame Angot*
Date	ca. 1890
Producer	Lapierre
Origin	France
Dimensions	37.5 x 9.5 cm
Format	Panorama slide
Discursive Genre	Romance
Technique	Coloured printed outlines

State of Preservation
Overall: 3 - Poor

Glass	Paint	Wood	Paper	Metal
1	1	-	4	-

Damages and observations:
Paper frame tore and lifted from the glass.

Inventory Number **PC0031/001**
Investigation Code n/a



Title	*Le Tour du Monde en 80 Jours*
Date	ca. 1890
Producer	Lapierre
Origin	France
Dimensions	37.5 x 9.5 cm
Format	Panorama slide
Discursive Genre	Adventure
Technique	Coloured printed outlines

State of Preservation
Overall: 3 - Poor

Glass	Paint	Wood	Paper	Metal
3	2	-	3	-

Damages and observations:
Glass fractured and fissured, paint abrasion and paper lifted.

Inventory Number **PC0031/002**
Investigation Code n/a



Title	*Le Tour du Monde en 80 Jours*
Date	ca. 1890
Producer	Lapierre
Origin	France
Dimensions	37.5 x 9.5 cm
Format	Panorama slide
Discursive Genre	Adventure
Technique	Coloured printed outlines

State of Preservation
Overall: 2 - Fair

Glass	Paint	Wood	Paper	Metal
1	2	-	2	-

Damages and observations:

Inventory Number **PC0031/003**
Investigation Code n/a



Title	*Le Tour du Monde en 80 Jours*
Date	ca. 1890
Producer	Lapierre
Origin	France
Dimensions	37.5 x 9.5 cm
Format	Panorama slide
Discursive Genre	Adventure
Technique	Coloured printed outlines

State of Preservation
Overall: 2 - Fair

Glass	Paint	Wood	Paper	Metal
1	2	-	2	-

Damages and observations:

Inventory Number **PC0031/004**
Investigation Code n/a



Title	*Le Tour du Monde en 80 Jours*
Date	ca. 1890
Producer	Lapierre
Origin	France
Dimensions	37.5 x 9.5 cm
Format	Panorama slide
Discursive Genre	Adventure
Technique	Coloured printed outlines

State of Preservation
Overall: 2 - Fair

Glass	Paint	Wood	Paper	Metal
1	2	-	2	-

Damages and observations:

Inventory Number **PC0031/005**
Investigation Code n/a



Title	*Le Tour du Monde en 80 Jours*
Date	ca. 1890
Producer	Lapierre
Origin	France
Dimensions	37.5 x 9.5 cm
Format	Panorama slide
Discursive Genre	Adventure
Technique	Coloured printed outlines

State of Preservation
Overall: 2 - Fair

Glass	Paint	Wood	Paper	Metal
1	2	-	2	-

Damages and observations:

Inventory Number **PC0032/001**
Investigation Code n/a



Title	*Chasse au Lazo (mexique)*
Date	ca. 1890
Producer	Lapierre
Origin	France
Dimensions	37.5 x 9.5 cm
Format	Panorama slide
Discursive Genre	Everyday
Technique	Coloured printed outlines

State of Preservation
Overall: 2 - Fair

Glass	Paint	Wood	Paper	Metal
1	2	-	2	-

Damages and observations:

Inventory Number **PC0032/002**
Investigation Code n/a



Title	*Chasse a L'Ours / au Chamois*
Date	ca. 1890
Producer	Lapierre
Origin	France
Dimensions	37.5 x 9.5 cm
Format	Panorama slide
Discursive Genre	Everyday
Technique	Coloured printed outlines

State of Preservation
Overall: 3 - Poor

Glass	Paint	Wood	Paper	Metal
1	2	-	4	-

Damages and observations:
Paper frame tore and lifted.

Inventory Number **PC0032/003**
Investigation Code CP17



Title	*Chasse a Courre L'Hallali*
Date	ca. 1890
Producer	Lapierre
Origin	France
Dimensions	37.5 x 9.5 cm
Format	Panorama slide
Discursive Genre	Everyday
Technique	Coloured printed outlines

State of Preservation
Overall: 3 - Poor

Glass	Paint	Wood	Paper	Metal
2	2	-	4	-

Damages and observations:
Paper frame tore and lifted.

Inventory Number **PC0033/001**
Investigation Code CP18



Title	*Le Chat Botté*
Date	ca. 1890
Producer	Lapierre
Origin	France
Dimensions	37.5 x 9.5 cm
Format	Panorama slide
Discursive Genre	Tale
Technique	Coloured printed outlines

State of Preservation
Overall: 3 - Poor

Glass	Paint	Wood	Paper	Metal
3	1	-	2	-

Restored: 2 – Fair
Damages and observations:
Glass fractured and fissured, at risk of loss (before restoration).

Inventory Number **PC0033/002**
Investigation Code n/a



Title	*Le Chat Botté*
Date	ca. 1890
Producer	Lapierre
Origin	France
Dimensions	37.5 x 9.5 cm
Format	Panorama slide
Discursive Genre	Tale
Technique	Coloured printed outlines

State of Preservation
Overall: 1 - Good

Glass	Paint	Wood	Paper	Metal
1	1	-	1	-

Damages and observations:

Inventory Number **PC0034/001**
Investigation Code n/a



Title	*Le Petit chaperon Rouge*
Date	ca. 1890
Producer	Lapierre
Origin	France
Dimensions	38 x 10 cm
Format	Panorama slide
Discursive Genre	Tale
Technique	Coloured printed outlines

State of Preservation
Overall: 3 - Poor

Glass	Paint	Wood	Paper	Metal
3	1	-	2	-

Damages and observations:
Glass fissured.

Inventory Number **PC0034/002**
Investigation Code n/a



Title	*Le Petit chaperon Rouge*
Date	ca. 1890
Producer	Lapierre
Origin	France
Dimensions	38 x 10 cm
Format	Panorama slide
Discursive Genre	Tale
Technique	Coloured printed outlines

State of Preservation
Overall: 2 - Fair

Glass	Paint	Wood	Paper	Metal
1	2	-	2	-

Damages and observations:

Inventory Number **PC0034/003**
Investigation Code n/a



Title	*Le Petit chaperon Rouge*
Date	ca. 1890
Producer	Lapierre
Origin	France
Dimensions	38 x 10 cm
Format	Panorama slide
Discursive Genre	Tale
Technique	Coloured printed outlines

State of Preservation
Overall: 2 - Fair

Glass	Paint	Wood	Paper	Metal
1	2	-	2	-

Damages and observations:

Inventory Number **PC0034/004**
Investigation Code n/a



Title	*Le Petit chaperon Rouge*
Date	ca. 1890
Producer	Lapierre
Origin	France
Dimensions	38 x 10 cm
Format	Panorama slide
Discursive Genre	Tale
Technique	Coloured printed outlines

State of Preservation
Overall: 2 - Fair

Glass	Paint	Wood	Paper	Metal
1	2	-	2	-

Damages and observations:

Inventory Number **PC0034/005**
Investigation Code n/a



Title	*Le Petit chaperon Rouge*
Date	ca. 1890
Producer	Lapierre
Origin	France
Dimensions	38 x 10 cm
Format	Panorama slide
Discursive Genre	Tale
Technique	Coloured printed outlines

State of Preservation
Overall: 2 - Fair

Glass	Paint	Wood	Paper	Metal
1	2	-	3	-

Damages and observations:

Inventory Number **PC0034/006**
Investigation Code n/a



Title	*Le Petit chaperon Rouge*
Date	ca. 1890
Producer	Lapierre
Origin	France
Dimensions	38 x 10 cm
Format	Panorama slide
Discursive Genre	Tale
Technique	Coloured printed outlines

State of Preservation
Overall: 2 - Fair

Glass	Paint	Wood	Paper	Metal
1	2	-	2	-

Damages and observations:

Inventory Number **PC0108**
Investigation Code n/a



Title	-
Date	1850-1930
Producer	-
Origin	-
Dimensions	13 x 4 cm
Format	Panorama slipping slide?
Discursive Genre	?
Technique	Hand-painted

State of Preservation
Overall: 4 - Very poor

Glass	Paint	Wood	Paper	Metal
1	4	-	2	-

Damages and observations:
It appears to be a moving slide from which the fixed glass is missing.

Inventory Number **PC0109**
Investigation Code n/a



Title	-
Date	End 19th century
Producer	-
Origin	-
Dimensions	5 cm
Format	Single slide?
Discursive Genre	Burlesque?
Technique	Coloured printed outlines

State of Preservation
Overall: 2 - Fair

Glass	Paint	Wood	Paper	Metal
1	2	-	-	-

Damages and observations:

Inventory Number **PC0110**
Investigation Code n/a



Title	-
Date	End 19th century
Producer	-
Origin	-
Dimensions	5 cm ⌀
Format	Single slide?
Discursive Genre	Topical
Technique	Coloured printed outlines

State of Preservation
Overall: 2 - Fair

Glass	Paint	Wood	Paper	Metal
2	2	-	-	-

Damages and observations:

Inventory Number **PC0111**
Investigation Code n/a



Title	-
Date	End 19th century
Producer	-
Origin	-
Dimensions	5 cm ⌀
Format	Single slide?
Discursive Genre	Topical
Technique	Coloured printed outlines

State of Preservation
Overall: 3 - Poor

Glass	Paint	Wood	Paper	Metal
3	2	-	-	-

Damages and observations:

Inventory Number **PC0112**
Investigation Code n/a



Title	-
Date	End 19th century
Producer	-
Origin	-
Dimensions	6.5 cm ⌀
Format	Single slide?
Discursive Genre	Topical
Technique	Hand-painted

State of Preservation
Overall: 2 - Fair

Glass	Paint	Wood	Paper	Metal
1	2	-	-	-

Damages and observations:

Inventory Number **PC0113**
Investigation Code n/a



Title	-
Date	End 19th century
Producer	-
Origin	-
Dimensions	5 cm ⌀
Format	Single slide?
Discursive Genre	Topical
Technique	Coloured printed outlines

State of Preservation
Overall: 3 - Poor

Glass	Paint	Wood	Paper	Metal
3	2	-	-	-

Damages and observations:

Inventory Number **PC0165/001**
Investigation Code n/a



Title	-
Date	ca. 1890
Producer	Lapierre
Origin	France
Dimensions	38 x 10 cm
Format	Panorama slide
Discursive Genre	Burlesque?
Technique	Coloured printed outlines

State of Preservation
Overall: 2 - Fair

Glass	Paint	Wood	Paper	Metal
1	1	-	2	-

Damages and observations:

Inventory Number **PC0165/002**
Investigation Code n/a



Title	-
Date	ca. 1890
Producer	Lapierre
Origin	France
Dimensions	38 x 10 cm
Format	Panorama slide
Discursive Genre	Burlesque?
Technique	Coloured printed outlines

State of Preservation
Overall: 2 - Fair

Glass	Paint	Wood	Paper	Metal
1	2	-	2	-

Damages and observations:

Inventory Number **PC0165/003**
Investigation Code n/a



Title	-
Date	ca. 1890
Producer	Lapierre
Origin	France
Dimensions	38 x 10 cm
Format	Panorama slide
Discursive Genre	Burlesque?
Technique	Coloured printed outlines

State of Preservation
Overall: 2 - Fair

Glass	Paint	Wood	Paper	Metal
1	2	-	3	-

Damages and observations:

Inventory Number **PC0165/004**
Investigation Code n/a



Title	-
Date	ca. 1890
Producer	Lapierre
Origin	France
Dimensions	38 x 10 cm
Format	Panorama slide
Discursive Genre	Tale
Technique	Coloured printed outlines

State of Preservation
Overall: 2 - Fair

Glass	Paint	Wood	Paper	Metal
1	1	-	2	-

Damages and observations:
Elongated glass bubbles

Inventory Number **PC0165/005**
Investigation Code n/a



Title	-
Date	ca. 1890
Producer	Lapierre
Origin	France
Dimensions	38 x 10 cm
Format	Panorama slide
Discursive Genre	Burlesque?
Technique	Coloured printed outlines

State of Preservation
Overall: 2 - Fair

Glass	Paint	Wood	Paper	Metal
1	1	-	3	-

Damages and observations:
Elongated glass bubbles

Inventory Number **PC0165/006**
Investigation Code CP55



Title	-
Date	ca. 1890
Producer	Lapierre
Origin	France
Dimensions	38 x 10 cm
Format	Panorama slide
Discursive Genre	Burlesque
Technique	Coloured printed outlines

State of Preservation
Overall: 2 - Fair

Glass	Paint	Wood	Paper	Metal
1	2	-	3	-

Damages and observations:
Elongated glass bubbles

Inventory Number **PC0165/007**
Investigation Code CP19



Title	-
Date	ca. 1890
Producer	Lapierre
Origin	France
Dimensions	38 x 10 cm
Format	Panorama slide
Discursive Genre	Burlesque
Technique	Coloured printed outlines

State of Preservation
Overall: 2 - Fair

Glass	Paint	Wood	Paper	Metal
1	2	-	3	-

Damages and observations:
Elongated glass bubbles

Inventory Number **PC0165/008**
Investigation Code n/a



Title	-
Date	ca. 1890
Producer	Lapierre
Origin	France
Dimensions	38 x 10 cm
Format	Panorama slide
Discursive Genre	Burlesque?
Technique	Coloured printed outlines

State of Preservation
Overall: 2 - Fair

Glass	Paint	Wood	Paper	Metal
2	1	-	2	-

Damages and observations:
Elongated glass bubbles

Inventory Number **PC0166/001**
Investigation Code n/a



Title	*La Fille de Madame Angot*
Date	ca. 1890
Producer	Lapierre
Origin	France
Dimensions	38 x 10 cm
Format	Panorama slide
Discursive Genre	Romance
Technique	Coloured printed outlines

State of Preservation
Overall: 2 - Fair

Glass	Paint	Wood	Paper	Metal
1	2	-	2	-

Damages and observations:

Inventory Number **PC0166/002**
Investigation Code n/a



Title	*La Fille de Madame Angot*
Date	ca. 1890
Producer	Lapierre
Origin	France
Dimensions	38 x 10 cm
Format	Panorama slide
Discursive Genre	Romance
Technique	Coloured printed outlines

State of Preservation
Overall: 2 - Fair

Glass	Paint	Wood	Paper	Metal
1	1	-	2	-

Damages and observations:

Inventory Number **PC0166/003**
Investigation Code n/a



Title	*La Fille de Madame Angot*
Date	ca. 1890
Producer	Lapierre
Origin	France
Dimensions	38 x 10 cm
Format	Panorama slide
Discursive Genre	Romance
Technique	Coloured printed outlines

State of Preservation
Overall: 2 - Fair

Glass	Paint	Wood	Paper	Metal
1	2	-	3	-

Damages and observations:

Inventory Number **PC0166/004**
Investigation Code n/a



Title	*La Fille de Madame Angot*
Date	ca. 1890
Producer	Lapierre
Origin	France
Dimensions	38 x 10 cm
Format	Panorama slide
Discursive Genre	Romance
Technique	Coloured printed outlines

State of Preservation
Overall: 2 - Fair

Glass	Paint	Wood	Paper	Metal
1	2	-	2	-

Damages and observations:

Inventory Number **PC0166/005**
Investigation Code n/a



Title	*La Fille de Madame Angot*
Date	ca. 1890
Producer	Lapierre
Origin	France
Dimensions	38 x 10 cm
Format	Panorama slide
Discursive Genre	Romance
Technique	Coloured printed outlines

State of Preservation
Overall: 2 - Fair

Glass	Paint	Wood	Paper	Metal
1	1	-	2	-

Damages and observations:

Inventory Number **PC0166/006**
Investigation Code CP20



Title	*La Fille de Madame Angot*
Date	ca. 1890
Producer	Lapierre
Origin	France
Dimensions	38 x 10 cm
Format	Panorama slide
Discursive Genre	Romance
Technique	Coloured printed outlines

State of Preservation
Overall: 3 - Poor

Glass	Paint	Wood	Paper	Metal
1	3	-	3	-

Damages and observations:

Inventory Number **PC0167/001**
Investigation Code n/a



Title	*Histoire de Robinson*
Date	ca. 1890
Producer	Lapierre
Origin	France
Dimensions	24.5 x 6.5 cm
Format	Panorama slide
Discursive Genre	Adventure
Technique	Coloured printed outlines

State of Preservation
Overall: 1 - Good

Glass	Paint	Wood	Paper	Metal
1	1	-	2	-

Damages and observations:

Inventory Number **PC0167/002**
Investigation Code n/a



Title	*Histoire de Robinson*
Date	ca. 1890
Producer	Lapierre
Origin	France
Dimensions	24.5 x 6.5 cm
Format	Panorama slide
Discursive Genre	Adventure
Technique	Coloured printed outlines

State of Preservation
Overall: 1 - Good

Glass	Paint	Wood	Paper	Metal
1	1	-	2	-

Damages and observations:

Inventory Number **PC0167/003**
Investigation Code n/a



Title	*Histoire de Robinson*
Date	ca. 1890
Producer	Lapierre
Origin	France
Dimensions	24.5 x 6.5 cm
Format	Panorama slide
Discursive Genre	Adventure
Technique	Coloured printed outlines

State of Preservation
Overall: 1 - Good

Glass	Paint	Wood	Paper	Metal
1	1	-	2	-

Damages and observations:

Inventory Number **PC0167/004**
Investigation Code n/a



Title	*Histoire de Robinson*
Date	ca. 1890
Producer	Lapierre
Origin	France
Dimensions	24.5 x 6.5 cm
Format	Panorama slide
Discursive Genre	Adventure
Technique	Coloured printed outlines

State of Preservation
Overall: 1 - Good

Glass	Paint	Wood	Paper	Metal
1	1	-	2	-

Damages and observations:

Inventory Number **PC0167/005**
Investigation Code n/a



Title	*Histoire de Robinson*
Date	ca. 1890
Producer	Lapierre
Origin	France
Dimensions	24.5 x 6.5 cm
Format	Panorama slide
Discursive Genre	Adventure
Technique	Coloured printed outlines

State of Preservation
Overall: 1 - Good

Glass	Paint	Wood	Paper	Metal
1	1	-	2	-

Damages and observations:

Inventory Number **PC0167/006**
Investigation Code n/a



Title	*Histoire de Robinson*
Date	ca. 1890
Producer	Lapierre
Origin	France
Dimensions	24.5 x 6.5 cm
Format	Panorama slide
Discursive Genre	Adventure
Technique	Coloured printed outlines

State of Preservation
Overall: 1 - Good

Glass	Paint	Wood	Paper	Metal
1	1	-	2	-

Damages and observations:

Inventory Number **PC0168/001**

Investigation Code n/a



Title	*Les adieux de Petit Jacques à ses parents*
Date	ca. 1890
Producer	Lapierre
Origin	France
Dimensions	24 x 6 cm
Format	Panorama slide
Discursive Genre	Adventure
Technique	Coloured printed outlines

State of Preservation

Overall: 1 - Good

Glass	Paint	Wood	Paper	Metal
1	1	-	2	-

Damages and observations:

Inventory Number **PC0168/002**

Investigation Code n/a



Title	*Les adieux de Petit Jacques à ses parents*
Date	ca. 1890
Producer	Lapierre
Origin	France
Dimensions	24 x 6 cm
Format	Panorama slide
Discursive Genre	Adventure
Technique	Coloured printed outlines

State of Preservation

Overall: 1 - Good

Glass	Paint	Wood	Paper	Metal
1	1	-	2	-

Damages and observations:

Inventory Number **PC0168/003**

Investigation Code n/a



Title	*Les adieux de Petit Jacques à ses parents*
Date	ca. 1890
Producer	Lapierre
Origin	France
Dimensions	24 x 6 cm
Format	Panorama slide
Discursive Genre	Adventure
Technique	Coloured printed outlines

State of Preservation

Overall: 2 - Fair

Glass	Paint	Wood	Paper	Metal
1	1	-	3	-

Damages and observations:

Inventory Number **PC0168/004**

Investigation Code n/a



Title	*Les adieux de Petit Jacques à ses parents*
Date	ca. 1890
Producer	Lapierre
Origin	France
Dimensions	24 x 6 cm
Format	Panorama slide
Discursive Genre	Adventure
Technique	Coloured printed outlines

State of Preservation

Overall: 2 - Fair

Glass	Paint	Wood	Paper	Metal
1	1	-	3	-

Damages and observations:

Inventory Number **PC0168/005**

Investigation Code n/a



Title	*Les adieux de Petit Jacques à ses parents*
Date	ca. 1890
Producer	Lapierre
Origin	France
Dimensions	24 x 6 cm
Format	Panorama slide
Discursive Genre	Adventure
Technique	Coloured printed outlines

State of Preservation

Overall: 2 - Fair

Glass	Paint	Wood	Paper	Metal
1	1	-	3	-

Damages and observations:

Inventory Number **PC0168/006**
Investigation Code n/a



Title	*Les adieux de Petit Jacques à ses parents*
Date	ca. 1890
Producer	Lapierre
Origin	France
Dimensions	24 x 6 cm
Format	Panorama slide
Discursive Genre	Adventure
Technique	Coloured printed outlines

State of Preservation
Overall: 2 - Fair

Glass	Paint	Wood	Paper	Metal
1	1	-	3	-

Damages and observations:

Inventory Number **PC0169/001**
Investigation Code n/a



Title	*La Ferme*
Date	ca. 1890
Producer	Lapierre
Origin	France
Dimensions	23 x 6 cm
Format	Panorama slide
Discursive Genre	Autonomous
Technique	Coloured printed outlines

State of Preservation
Overall: 2 - Fair

Glass	Paint	Wood	Paper	Metal
1	1	-	3	-

Damages and observations:

Inventory Number **PC0169/002**
Investigation Code n/a



Title	*La Ferme*
Date	ca. 1890
Producer	Lapierre
Origin	France
Dimensions	23 x 6 cm
Format	Panorama slide
Discursive Genre	Autonomous
Technique	Coloured printed outlines

State of Preservation
Overall: 1 - Good

Glass	Paint	Wood	Paper	Metal
1	1	-	2	-

Damages and observations:

Inventory Number **PC0169/003**
Investigation Code n/a



Title	*La Ferme*
Date	ca. 1890
Producer	Lapierre
Origin	France
Dimensions	23 x 6 cm
Format	Panorama slide
Discursive Genre	Autonomous
Technique	Coloured printed outlines

State of Preservation
Overall: 2 - Fair

Glass	Paint	Wood	Paper	Metal
1	2	-	2	-

Damages and observations:
Fading of yellow and pink colours.

Inventory Number **PC0169/004**
Investigation Code n/a



Title	*La Ferme*
Date	ca. 1890
Producer	Lapierre
Origin	France
Dimensions	23 x 6 cm
Format	Panorama slide
Discursive Genre	Autonomous
Technique	Coloured printed outlines

State of Preservation
Overall: 1 - Good

Glass	Paint	Wood	Paper	Metal
1	1	-	2	-

Damages and observations:

Inventory Number **PC0169/005**
Investigation Code n/a



Title	*La Ferme*
Date	ca. 1890
Producer	Lapierre
Origin	France
Dimensions	23 x 6 cm
Format	Panorama slide
Discursive Genre	Autonomous
Technique	Coloured printed outlines

State of Preservation
Overall: 1 - Good

Glass	Paint	Wood	Paper	Metal
1	1	-	2	-

Damages and observations:

Inventory Number **PC0169/006**
Investigation Code n/a



Title	*La Ferme*
Date	ca. 1890
Producer	Lapierre
Origin	France
Dimensions	23 x 6 cm
Format	Panorama slide
Discursive Genre	Autonomous
Technique	Coloured printed outlines

State of Preservation
Overall: 1 - Good

Glass	Paint	Wood	Paper	Metal
1	1	-	1	-

Damages and observations:

Inventory Number **PC0169/007**
Investigation Code n/a



Title	*La Ferme*
Date	ca. 1890
Producer	Lapierre
Origin	France
Dimensions	23 x 6 cm
Format	Panorama slide
Discursive Genre	Autonomous
Technique	Coloured printed outlines

State of Preservation
Overall: 1 - Good

Glass	Paint	Wood	Paper	Metal
1	1	-	2	-

Damages and observations:

Inventory Number **PC0169/008**
Investigation Code n/a



Title	*La Ferme*
Date	ca. 1890
Producer	Lapierre
Origin	France
Dimensions	23 x 6 cm
Format	Panorama slide
Discursive Genre	Autonomous
Technique	Coloured printed outlines

State of Preservation
Overall: 1 - Good

Glass	Paint	Wood	Paper	Metal
1	1	-	2	-

Damages and observations:

Inventory Number **PC0169/009**
Investigation Code n/a



Title	*La Ferme*
Date	ca. 1890
Producer	Lapierre
Origin	France
Dimensions	23 x 6 cm
Format	Panorama slide
Discursive Genre	Autonomous
Technique	Coloured printed outlines

State of Preservation
Overall: 1 - Good

Glass	Paint	Wood	Paper	Metal
1	1	-	2	-

Damages and observations:

Inventory Number **PC0169/010**
Investigation Code n/a



Title	*La Ferme*
Date	ca. 1890
Producer	Lapierre
Origin	France
Dimensions	23 x 6 cm
Format	Panorama slide
Discursive Genre	Autonomous
Technique	Coloured printed outlines

State of Preservation
Overall: 2 - Fair

Glass	Paint	Wood	Paper	Metal
1	2	-	2	-

Damages and observations:

Inventory Number **PC0177**
Investigation Code n/a



Title	*Sailboats*
Date	End 19th century
Producer	unknown
Origin	-
Dimensions	32.5 x 7.5 cm
Format	Panorama slipping slide
Discursive Genre	Topical
Technique	Hand-painted

State of Preservation
Overall: 4 - Very poor

Glass	Paint	Wood	Paper	Metal
3	4	-	-	-

Damages and observations:

Inventory Number **PC0178**
Investigation Code n/a



Title	*Sea storm and lighthouse*
Date	End 19th century
Producer	unknown
Origin	-
Dimensions	33 x 7.5 cm
Format	Panorama slipping slide
Discursive Genre	Topical
Technique	Hand-painted

State of Preservation
Overall: 3 - Poor

Glass	Paint	Wood	Paper	Metal
3	3	-	-	-

Damages and observations:

Inventory Number **PC0182**
Investigation Code n/a



Title	*Snoring man eats rat*
Date	1850-1900
Producer	unknown
Origin	England
Dimensions	18.2 x 10.2 cm
Format	Double slipping slide
Discursive Genre	Burlesque
Technique	Coloured printed outlines

State of Preservation
Overall: 1 - Good

Glass	Paint	Wood	Paper	Metal
1	1	1	2	-

Damages and observations:

Inventory Number **PC0184**
Investigation Code n/a



Title	*Lady with umbrella*
Date	1850-1900
Producer	unknown
Origin	England
Dimensions	18 x 10 x 0.7 cm
Format	Single slipping slide
Discursive Genre	Burlesque
Technique	Hand-painted

State of Preservation
Overall: 1 - Good

Glass	Paint	Wood	Paper	Metal
1	1	1	2	1

Damages and observations:

Inventory Number **PC0185**
Investigation Code n/a



Title	*The Puzzling Twins*
Date	1850-1900
Producer	unknown
Origin	England
Dimensions	18 x 10.2 cm
Format	Single slipping slide
Discursive Genre	Burlesque
Technique	Hand-painted

State of Preservation
Overall: 1 - Good

Glass	Paint	Wood	Paper	Metal
1	1	1	2	1

Damages and observations:

Inventory Number **PC0186**
Investigation Code n/a



Title	
Date	1850-1900
Producer	unknown
Origin	England
Dimensions	18 x 10.2 cm
Format	Single slipping slide
Discursive Genre	Burlesque
Technique	Hand-painted

State of Preservation
Overall: 1 - Good

Glass	Paint	Wood	Paper	Metal
1	1	1	2	1

Damages and observations:

Inventory Number **PC0187**
Investigation Code n/a



Title	
Date	1850-1900
Producer	unknown
Origin	England
Dimensions	18 x 10.2 cm
Format	Single slipping slide
Discursive Genre	Burlesque
Technique	Coloured printed outlines

State of Preservation
Overall: 2 - Fair

Glass	Paint	Wood	Paper	Metal
1	2	2	-	2

Damages and observations:

Inventory Number **PC0188/001**
Investigation Code n/a



Title	*Cinderella*
Date	1850-1975
Producer	unknown
Origin	England
Dimensions	18 x 10 cm
Format	Single slide
Discursive Genre	Tale
Technique	Coloured printed outlines

State of Preservation
Overall: 1 - Good

Glass	Paint	Wood	Paper	Metal
1	1	2	-	2

Damages and observations:
Bleaching of the wood

Inventory Number **PC0188/002**
Investigation Code n/a



Title	*Cinderella*
Date	1850-1975
Producer	unknown
Origin	England
Dimensions	18 x 10 cm
Format	Single slide
Discursive Genre	Tale
Technique	Coloured printed outlines

State of Preservation
Overall: 2 - Fair

Glass	Paint	Wood	Paper	Metal
1	2	2	-	2

Damages and observations:
Bleaching of the wood

Inventory Number **PC0188/003**
Investigation Code n/a



Title	*Cinderella*
Date	1850-1975
Producer	unknown
Origin	England
Dimensions	18 x 10 cm
Format	Single slide
Discursive Genre	Tale
Technique	Coloured printed outlines

State of Preservation
Overall: 1 - Good

Glass	Paint	Wood	Paper	Metal
1	1	2	-	2

Damages and observations:

Inventory Number **PC0188/004**
Investigation Code n/a



Title	*Cinderella*
Date	1850-1975
Producer	unknown
Origin	England
Dimensions	18 x 10 cm
Format	Single slide
Discursive Genre	Tale
Technique	Coloured printed outlines

State of Preservation
Overall: 1 - Good

Glass	Paint	Wood	Paper	Metal
1	1	1	-	2

Damages and observations:

Inventory Number **PC0188/005**
Investigation Code n/a



Title	*Cinderella*
Date	1850-1975
Producer	unknown
Origin	England
Dimensions	18 x 10 cm
Format	Single slide
Discursive Genre	Tale
Technique	Coloured printed outlines

State of Preservation
Overall: 2 - Fair

Glass	Paint	Wood	Paper	Metal
1	2	2	-	2

Damages and observations:
Bleaching of the wood

Inventory Number **PC0188/006**
Investigation Code n/a



Title	*Cinderella*
Date	1850-1975
Producer	unknown
Origin	England
Dimensions	18 x 10 cm
Format	Single slide
Discursive Genre	Tale
Technique	Coloured printed outlines

State of Preservation
Overall: 1 - Good

Glass	Paint	Wood	Paper	Metal
1	1	1	-	2

Damages and observations:

Inventory Number **PC0188/007**
Investigation Code n/a



Title	*Cinderella*
Date	1850-1975
Producer	unknown
Origin	England
Dimensions	18 x 10 cm
Format	Single slide
Discursive Genre	Tale
Technique	Coloured printed outlines

State of Preservation
Overall: 1 - Good

Glass	Paint	Wood	Paper	Metal
1	1	1	-	2

Damages and observations:

Inventory Number **PC0188/008**
Investigation Code n/a



Title	*Cinderella*
Date	1850-1975
Producer	unknown
Origin	England
Dimensions	18 x 10 cm
Format	Single slide
Discursive Genre	Tale
Technique	Coloured printed outlines

State of Preservation
Overall: 1 - Good

Glass	Paint	Wood	Paper	Metal
1	1	2	-	2

Damages and observations:
Bleaching of the wood

Inventory Number **PC0189/001**
Investigation Code n/a



Title	*Waterloo Bridge*
Date	1850-1975
Producer	Carpenter & Westley
Origin	England
Dimensions	17.5 x 9.5 cm
Format	Single slide
Discursive Genre	Topical
Technique	Coloured printed outlines

State of Preservation
Overall: 1 - Good

Glass	Paint	Wood	Paper	Metal
1	1	1	-	1

Damages and observations:

Inventory Number **PC0189/002**
Investigation Code n/a



Title	*Southwark Bridge*
Date	1850-1975
Producer	Carpenter & Westley
Origin	England
Dimensions	17.5 x 9.5 cm
Format	Single slide
Discursive Genre	Topical
Technique	Coloured printed outlines

State of Preservation
Overall: 1 - Good

Glass	Paint	Wood	Paper	Metal
1	1	1	-	1

Damages and observations:

Inventory Number **PC0189/003**
Investigation Code n/a



Title	*St. Paul's Cathedral*
Date	1850-1975
Producer	Carpenter & Westley
Origin	England
Dimensions	17.5 x 9.5 cm
Format	Single slide
Discursive Genre	Topical
Technique	Coloured printed outlines

State of Preservation
Overall: 2 - Fair

Glass	Paint	Wood	Paper	Metal
1	2	1	-	1

Damages and observations:

Inventory Number **PC0189/004**
Investigation Code n/a



Title	*Westminster Abbey*
Date	1850-1975
Producer	Carpenter & Westley
Origin	England
Dimensions	17.5 x 9.5 cm
Format	Single slide
Discursive Genre	Topical
Technique	Coloured printed outlines

State of Preservation
Overall: 1 - Good

Glass	Paint	Wood	Paper	Metal
1	1	1	-	1

Damages and observations:

Inventory Number **PC0189/005**
Investigation Code n/a



Title	*Military Hospital Paris*
Date	1850-1975
Producer	Carpenter & Westley
Origin	England
Dimensions	17.5 x 9.5 cm
Format	Single slide
Discursive Genre	Topical
Technique	Coloured printed outlines

State of Preservation
Overall: 1 - Good

Glass	Paint	Wood	Paper	Metal
1	1	1	-	1

Damages and observations:

Inventory Number **PC0189/006**
Investigation Code n/a



Title	*Saint Peter's Square*
Date	1850-1975
Producer	Carpenter & Westley
Origin	England
Dimensions	17.5 x 9.5 cm
Format	Single slide
Discursive Genre	Topical
Technique	Coloured printed outlines

State of Preservation
Overall: 3 - Poor

Glass	Paint	Wood	Paper	Metal
1	3	1	-	2

Damages and observations:

Inventory Number **PC0189/007**
Investigation Code n/a



Title	*Melrose Abbey*
Date	1850-1975
Producer	Carpenter & Westley
Origin	England
Dimensions	17.5 x 9.5 cm
Format	Single slide
Discursive Genre	Topical
Technique	Coloured printed outlines

State of Preservation
Overall: 1 - Good

Glass	Paint	Wood	Paper	Metal
1	1	1	-	1

Damages and observations:

Inventory Number **PC0189/008**
Investigation Code n/a



Title	*Shakespeare's House*
Date	1850-1975
Producer	Carpenter & Westley
Origin	England
Dimensions	17.5 x 9.5 cm
Format	Single slide
Discursive Genre	Topical
Technique	Coloured printed outlines

State of Preservation
Overall: 1 - Good

Glass	Paint	Wood	Paper	Metal
1	1	1	-	2

Damages and observations:

Inventory Number **PC0189/009**
Investigation Code n/a



Title	*Mount St. Michael*
Date	1850-1975
Producer	Carpenter & Westley
Origin	England
Dimensions	17.5 x 9.5 cm
Format	Single slide
Discursive Genre	Topical
Technique	Coloured printed outlines

State of Preservation
Overall: 2 - Fair

Glass	Paint	Wood	Paper	Metal
1	2	1	-	2

Damages and observations:

Inventory Number **PC0189/010**
Investigation Code n/a



Title	*Isle of Staffa*
Date	1850-1975
Producer	Carpenter & Westley
Origin	England
Dimensions	17.5 x 9.5 cm
Format	Single slide
Discursive Genre	Topical
Technique	Coloured printed outlines

State of Preservation
Overall: 1 - Good

Glass	Paint	Wood	Paper	Metal
1	1	1	-	2

Damages and observations:

Inventory Number **PC0189/011**
Investigation Code n/a



Title	*Fingal's Cave*
Date	1850-1975
Producer	Carpenter & Westley
Origin	England
Dimensions	17.5 x 9.5 cm
Format	Single slide
Discursive Genre	Topical
Technique	Coloured printed outlines

State of Preservation
Overall: 1 - Good

Glass	Paint	Wood	Paper	Metal
1	1	1	-	2

Damages and observations:

Inventory Number **PC0189/012**
Investigation Code n/a



Title	*Falls of Niagara*
Date	1850-1975
Producer	Carpenter & Westley
Origin	England
Dimensions	17.5 x 9.5 cm
Format	Single slide
Discursive Genre	Topical
Technique	Coloured printed outlines

State of Preservation
Overall: 1 - Good

Glass	Paint	Wood	Paper	Metal
1	1	1	-	2

Damages and observations:

Inventory Number **PC0190**
Investigation Code n/a



Title	*Chapel of St. Helena*
Date	1850-1975
Producer	Carpenter & Westley
Origin	England
Dimensions	17.5 x 9.5 cm
Format	Single slide
Discursive Genre	Topical
Technique	Hand-painted

State of Preservation
Overall: 2 - Fair

Glass	Paint	Wood	Paper	Metal
1	1	2	-	2

Damages and observations:
Bleaching of the wood and possibly paint fading.

Inventory Number **PC0191**
Investigation Code n/a



Title	*Lanercost Priory*
Date	1850-1975
Producer	Carpenter & Westley
Origin	England
Dimensions	17.5 x 9.5 cm
Format	Single slide
Discursive Genre	Topical
Technique	Hand-painted

State of Preservation
Overall: 1 - Good

Glass	Paint	Wood	Paper	Metal
1	1	2	-	2

Damages and observations:
Bleaching of the wood.

Inventory Number **PC0192**
Investigation Code n/a



Title	*Veleiros junto aos glaciares*
Date	1850-1900
Producer	-
Origin	-
Dimensions	20.7 x 13 cm
Format	Double slipping slide
Discursive Genre	Topical
Technique	Hand-painted

State of Preservation
Overall: 3 - Poor

Glass	Paint	Wood	Paper	Metal
2	3	2	2	3

Damages and observations:

Inventory Number **PC0203/001**
Investigation Code n/a



Title	*Les Diableries, L'Escarpolette du Diable*
Date	ca. 1890
Producer	Lapierre
Origin	France
Dimensions	32.5 x 7.5 cm
Format	Panorama slide
Discursive Genre	Burlesque
Technique	Coloured printed outlines

State of Preservation
Overall: 2 - Fair

Glass	Paint	Wood	Paper	Metal
1	2	-	2	-

Damages and observations:

Inventory Number **PC0203/001**
Investigation Code n/a



Title	*Les Diableries, Interieur du Diable*
Date	ca. 1890
Producer	Lapierre
Origin	France
Dimensions	32.5 x 7.5 cm
Format	Panorama slide
Discursive Genre	Burlesque
Technique	Coloured printed outlines

State of Preservation
Overall: 2 - Fair

Glass	Paint	Wood	Paper	Metal
2	2	-	2	-

Damages and observations:

Inventory Number **PC0203/001**
Investigation Code n/a



Title	*Les Diableries, Artillerie du Diable*
Date	ca. 1890
Producer	Lapierre
Origin	France
Dimensions	32.5 x 7.5 cm
Format	Panorama slide
Discursive Genre	Burlesque
Technique	Coloured printed outlines

State of Preservation
Overall: 2 - Fair

Glass	Paint	Wood	Paper	Metal
1	2	-	2	-

Damages and observations:

Inventory Number **PC0204/001**
Investigation Code n/a



Title	*Les Fées*
Date	ca. 1890
Producer	Lapierre
Origin	France
Dimensions	27 x 7 cm
Format	Panorama slide
Discursive Genre	Tale
Technique	Coloured printed outlines

State of Preservation
Overall: 2 - Fair

Glass	Paint	Wood	Paper	Metal
1	2	-	3	-

Damages and observations:

Inventory Number **PC0204/002**
Investigation Code n/a



Title	*Les Fées*
Date	ca. 1890
Producer	Lapierre
Origin	France
Dimensions	27 x 7 cm
Format	Panorama slide
Discursive Genre	Tale
Technique	Coloured printed outlines

State of Preservation
Overall: 2 - Fair

Glass	Paint	Wood	Paper	Metal
1	2	-	3	-

Damages and observations:

Inventory Number **PC0204/003**
Investigation Code n/a



Title	*Les Fées*
Date	ca. 1890
Producer	Lapierre
Origin	France
Dimensions	23.5 x 7 cm
Format	Panorama slide
Discursive Genre	Tale
Technique	Coloured printed outlines

State of Preservation
Overall: 2 - Fair

Glass	Paint	Wood	Paper	Metal
2	2	-	3	-

Damages and observations:

Inventory Number **PC0204/004**
Investigation Code n/a



Title	*Les Fées*
Date	ca. 1890
Producer	Lapierre
Origin	France
Dimensions	26.3 x 7 cm
Format	Panorama slide
Discursive Genre	Tale
Technique	Coloured printed outlines

State of Preservation
Overall: 2 - Fair

Glass	Paint	Wood	Paper	Metal
2	2	-	3	-

Damages and observations:

Inventory Number **PC0205/001**
Investigation Code n/a



Title	*Le Juif Errant*
Date	ca. 1890
Producer	Lapierre
Origin	France
Dimensions	27 x 7 cm
Format	Panorama slide
Discursive Genre	Romance
Technique	Coloured printed outlines

State of Preservation
Overall: 3 - Poor

Glass	Paint	Wood	Paper	Metal
3	2	-	3	-

Damages and observations:

Inventory Number **PC0205/002**
Investigation Code n/a



Title	*Le Juif Errant*
Date	ca. 1890
Producer	Lapierre
Origin	France
Dimensions	27 x 7 cm
Format	Panorama slide
Discursive Genre	Romance
Technique	Coloured printed outlines

State of Preservation
Overall: 3 - Poor

Glass	Paint	Wood	Paper	Metal
1	2	-	3	-

Damages and observations:

Inventory Number **PC0206**
Investigation Code n/a



Title	*Le bon Roi Dagobert*
Date	ca. 1890
Producer	Lapierre
Origin	France
Dimensions	27 x 7 cm
Format	Panorama slide
Discursive Genre	Adventure
Technique	Coloured printed outlines

State of Preservation
Overall: 3 - Poor

Glass	Paint	Wood	Paper	Metal
3	2	-	2	-

Damages and observations:

Inventory Number **PC0207**
Investigation Code n/a



Title	*Malborough en guerre*
Date	ca. 1890
Producer	Lapierre
Origin	France
Dimensions	27 x 7 cm
Format	Panorama slide
Discursive Genre	Adventure
Technique	Coloured printed outlines

State of Preservation
Overall: 3 - Poor

Glass	Paint	Wood	Paper	Metal
1	2	-	3	-

Damages and observations:

Inventory Number **PC0208**
Investigation Code n/a



Title	*Mammalia N°9*
Date	ca. 1823?
Producer	Carpenter & Westley
Origin	England
Dimensions	36 x 9.5 cm
Format	Panorama slide
Discursive Genre	Zoological
Technique	Coloured printed outlines

State of Preservation
Overall: 3 - Poor

Glass	Paint	Wood	Paper	Metal
1	3	2	-	2

Damages and observations:

Inventory Number **PC0209/001**
Investigation Code n/a



Title	*Humorours copper plate slides*
Date	ca. 1823?
Producer	Carpenter & Westley
Origin	England
Dimensions	36 x 9.5 cm
Format	Multiple slide
Discursive Genre	Burlesque
Technique	Coloured printed outlines

State of Preservation
Overall: 2 - Fair

Glass	Paint	Wood	Paper	Metal
1	2	1	-	1

Damages and observations:

Inventory Number **PC0209/002**
Investigation Code n/a



Title	*Humorours copper plate slides*
Date	ca. 1823?
Producer	Carpenter & Westley
Origin	England
Dimensions	36 x 9.5 cm
Format	Multiple slide
Discursive Genre	Burlesque
Technique	Coloured printed outlines

State of Preservation
Overall: 4 - Very poor

Glass	Paint	Wood	Paper	Metal
1	4	2	-	3

Damages and observations:

Inventory Number **PC0209/003**
Investigation Code n/a



Title	*Humorours copper plate slides*
Date	ca. 1823?
Producer	Carpenter & Westley
Origin	England
Dimensions	36 x 9.5 cm
Format	Multiple slide
Discursive Genre	Burlesque
Technique	Coloured printed outlines

State of Preservation
Overall: 2 - Fair

Glass	Paint	Wood	Paper	Metal
1	2	1	-	2

Damages and observations:

Inventory Number **PC0209/004**
Investigation Code n/a



Title	*Humorours copper plate slides*
Date	ca. 1823?
Producer	Carpenter & Westley
Origin	England
Dimensions	36 x 9.5 cm
Format	Multiple slide
Discursive Genre	Burlesque
Technique	Coloured printed outlines

State of Preservation
Overall: 3 - Poor

Glass	Paint	Wood	Paper	Metal
1	3	1	-	1

Damages and observations:

Inventory Number **PC0209/005**
Investigation Code n/a



Title	*Humorours copper plate slides*
Date	ca. 1823?
Producer	Carpenter & Westley
Origin	England
Dimensions	36 x 9.5 cm
Format	Multiple slide
Discursive Genre	Burlesque
Technique	Coloured printed outlines

State of Preservation
Overall: 3 - Poor

Glass	Paint	Wood	Paper	Metal
1	3	1	-	1

Damages and observations:

Inventory Number **PC0209/006**
Investigation Code n/a



Title	*Humorours copper plate slides*
Date	ca. 1823?
Producer	Carpenter & Westley
Origin	England
Dimensions	36 x 9.5 cm
Format	Multiple slide
Discursive Genre	Burlesque
Technique	Coloured printed outlines

State of Preservation
Overall: 4 - Very poor

Glass	Paint	Wood	Paper	Metal
1	4	1	-	1

Damages and observations:

Inventory Number **PC0209/007**
Investigation Code n/a



Title	*Humorours copper plate slides*
Date	ca. 1823?
Producer	Carpenter & Westley
Origin	England
Dimensions	36 x 9.5 cm
Format	Multiple slide
Discursive Genre	Burlesque
Technique	Coloured printed outlines

State of Preservation
Overall: 4 - Very poor

Glass	Paint	Wood	Paper	Metal
1	4	3	-	2

Damages and observations:

Inventory Number **PC0209/008**
Investigation Code n/a



Title	*Humorours copper plate slides*
Date	ca. 1823?
Producer	Carpenter & Westley
Origin	England
Dimensions	36 x 9.5 cm
Format	Multiple slide
Discursive Genre	Burlesque
Technique	Coloured printed outlines

State of Preservation
Overall: 3 - Poor

Glass	Paint	Wood	Paper	Metal
1	3	1	-	2

Damages and observations:

Inventory Number **PC0209/009**
Investigation Code n/a



Title	*Humorours copper plate slides*
Date	ca. 1823?
Producer	Carpenter & Westley
Origin	England
Dimensions	36 x 9.5 cm
Format	Multiple slide
Discursive Genre	Burlesque
Technique	Coloured printed outlines

State of Preservation
Overall: 4 - Very poor

Glass	Paint	Wood	Paper	Metal
1	4	2	-	2

Damages and observations:

Inventory Number **PC0209/010**
Investigation Code n/a



Title	*Humorours copper plate slides*
Date	ca. 1823?
Producer	Carpenter & Westley
Origin	England
Dimensions	36 x 9.5 cm
Format	Multiple slide
Discursive Genre	Burlesque
Technique	Coloured printed outlines

State of Preservation
Overall: 3 - Poor

Glass	Paint	Wood	Paper	Metal
1	3	1	-	2

Damages and observations:

Inventory Number **PC0209/011**
Investigation Code n/a



Title	*Humorours copper plate slides*
Date	ca. 1823?
Producer	Carpenter & Westley
Origin	England
Dimensions	36 x 9.5 cm
Format	Multiple slide
Discursive Genre	Burlesque
Technique	Coloured printed outlines

State of Preservation
Overall: 4 - Very poor

Glass	Paint	Wood	Paper	Metal
1	4	3	-	2

Damages and observations:

Inventory Number **PC0209/012**
Investigation Code n/a



Title	*Humorours copper plate slides*
Date	ca. 1823?
Producer	Carpenter & Westley
Origin	England
Dimensions	36 x 9.5 cm
Format	Multiple slide
Discursive Genre	Burlesque
Technique	Coloured printed outlines

State of Preservation
Overall: 4 - Very poor

Glass	Paint	Wood	Paper	Metal
1	4	2	-	1

Damages and observations:

Inventory Number **PC0335/002,8,9**
Investigation Code n/a



Title	*Windmill*
Date	ca.1850-1900
Producer	-
Origin	France
Dimensions	8.2 x 8.2
Format	Standard / double rackwork slide
Discursive Genre	Topical
Technique	Coloured printed outlines

State of Preservation
Overall: 3 - Poor

Glass	Paint	Wood	Paper	Metal
3	3	-	2	-

Damages and observations:

Inventory Number **PC0335/003,14,15**
Investigation Code n/a



Title	*Hive with bees*
Date	ca.1850-1900
Producer	-
Origin	France
Dimensions	8.2 x 8.2
Format	Standard / double rackwork slide
Discursive Genre	Topical
Technique	Coloured printed outlines

State of Preservation
Overall: 2 - Fair

Glass	Paint	Wood	Paper	Metal
1	2	-	3	-

Damages and observations:

Inventory Number **PC0335/004,11**
Investigation Code n/a



Title	*Acrobat*
Date	ca.1850-1900
Producer	-
Origin	France
Dimensions	8.2 x 8.2
Format	Standard / double rackwork slide
Discursive Genre	Burlesque
Technique	Coloured printed outlines

State of Preservation
Overall: 2 - Fair

Glass	Paint	Wood	Paper	Metal
1	2	-	3	-

Damages and observations:
Is missing one glass

Inventory Number **PC0335/005,16,17**
Investigation Code n/a



Title	*Fontain with water*
Date	ca.1850-1900
Producer	-
Origin	France
Dimensions	8.2 x 8.2
Format	Standard / double rackwork slide
Discursive Genre	Topical
Technique	Coloured printed outlines

State of Preservation
Overall: 2 - Fair

Glass	Paint	Wood	Paper	Metal
2	2	-	2	-

Damages and observations:
Glass broken

Inventory Number **PC0335/006,12,13**
Investigation Code n/a



Title	*Aquarium with fish*
Date	ca.1850-1900
Producer	-
Origin	France
Dimensions	8.2 x 8.2
Format	Standard / double rackwork slide
Discursive Genre	Topical
Technique	Coloured printed outlines

State of Preservation
Overall: 2 - Fair

Glass	Paint	Wood	Paper	Metal
1	2	-	2	-

Damages and observations:

Inventory Number **PC0335/007,18,19**
Investigation Code n/a



Title	*Good night*
Date	ca.1850-1900
Producer	-
Origin	France
Dimensions	8.2 x 8.2
Format	Standard / double rackwork slide
Discursive Genre	Title
Technique	Coloured printed outlines

State of Preservation
Overall: 2 - Fair

Glass	Paint	Wood	Paper	Metal
1	2	-	2	-

Damages and observations:

Inventory Number **PC0445/001**
Investigation Code n/a



Title	*Polar expedition*
Date	ca. 1880
Producer	-
Origin	England
Dimensions	29.3 x 10.8 cm
Format	Multiple slide
Discursive Genre	Adventure
Technique	Hand-painted

State of Preservation
Overall: 2 - Fair

Glass	Paint	Wood	Paper	Metal
2	1	2	-	-

Damages and observations:

Inventory Number **PC0445/002**
Investigation Code n/a



Title	*Polar expedition*
Date	ca. 1880
Producer	-
Origin	England
Dimensions	29.2 x 10.4 cm
Format	Multiple slide
Discursive Genre	Adventure
Technique	Hand-painted

State of Preservation
Overall: 2 - Fair

Glass	Paint	Wood	Paper	Metal
2	1	2	-	-

Damages and observations:

Inventory Number **PC0445/003**
Investigation Code n/a



Title	*Polar expedition*
Date	ca. 1880
Producer	-
Origin	England
Dimensions	30.2 x 10.8 cm
Format	Multiple slide
Discursive Genre	Adventure
Technique	Hand-painted

State of Preservation
Overall: 2 - Fair

Glass	Paint	Wood	Paper	Metal
2	1	2	-	-

Damages and observations:

Inventory Number **PC0445/004**
Investigation Code n/a



Title	*Polar expedition*
Date	ca. 1880
Producer	-
Origin	England
Dimensions	29.6 x 11 cm
Format	Multiple slide
Discursive Genre	Adventure
Technique	Hand-painted

State of Preservation
Overall: 2 - Fair

Glass	Paint	Wood	Paper	Metal
2	1	2	-	-

Damages and observations:

Inventory Number **PC0445/005**
Investigation Code n/a



Title	*Polar expedition*
Date	ca. 1880
Producer	-
Origin	England
Dimensions	29 x 10.9 cm
Format	Multiple slide
Discursive Genre	Adventure
Technique	Hand-painted

State of Preservation
Overall: 2 - Fair

Glass	Paint	Wood	Paper	Metal
2	1	2	-	-

Damages and observations:

Inventory Number **PC0446**
Investigation Code n/a



Title	-
Date	1850-1900
Producer	-
Origin	England
Dimensions	17 x 10 cm
Format	Single slipping slide
Discursive Genre	Burlesque
Technique	Hand-painted

State of Preservation
Overall: 3 - Poor

Glass	Paint	Wood	Paper	Metal
1	3	1	2	2

Damages and observations:

Inventory Number **PC0449**
Investigation Code n/a



Title	-
Date	1850-1900
Producer	-
Origin	England
Dimensions	17.7 x 10.1 cm
Format	Single slipping slide
Discursive Genre	Burlesque
Technique	Hand-painted

State of Preservation
Overall: 1 - Good

Glass	Paint	Wood	Paper	Metal
1	1	1	2	1

Damages and observations:

Inventory Number **PC0450**
Investigation Code n/a



Title	*Snoring man eats rat*
Date	1850-1900
Producer	-
Origin	England
Dimensions	17.7 x 10 cm
Format	Single slipping slide
Discursive Genre	Burlesque
Technique	Hand-painted

State of Preservation
Overall: 1 - Good

Glass	Paint	Wood	Paper	Metal
1	1	1	1	-

Damages and observations:

Inventory Number **PC0451**
Investigation Code n/a



Title	-
Date	1850-1900
Producer	-
Origin	England
Dimensions	17.7 x 10 cm
Format	Single slipping slide
Discursive Genre	Burlesque
Technique	Hand-painted

State of Preservation
Overall: 1 - Good

Glass	Paint	Wood	Paper	Metal
1	1	1	1	2

Damages and observations:

Inventory Number **PC0452**
Investigation Code n/a



Title	-
Date	1850-1900
Producer	-
Origin	England
Dimensions	17.6 x 10.1 cm
Format	Single slipping slide
Discursive Genre	Burlesque
Technique	Hand-painted

State of Preservation
Overall: 1 - Good

Glass	Paint	Wood	Paper	Metal
1	1	2	2	2

Damages and observations:

Inventory Number **PC0463**
Investigation Code n/a



Title	*Nazareth*
Date	1875-1900
Producer	Carpenter & Westley
Origin	England
Dimensions	17.5 x 9.5 cm
Format	Single slide
Discursive Genre	Topical
Technique	Hand-painted

State of Preservation
Overall: 1 - Good

Glass	Paint	Wood	Paper	Metal
1	1	1	-	1

Damages and observations:

Inventory Number **PC0498/002,8,9**
Investigation Code n/a



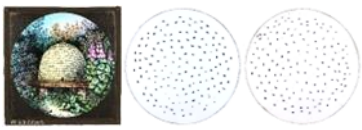
Title	*Windmill*
Date	ca.1850-1900
Producer	-
Origin	France
Dimensions	8.2 x 8.2
Format	Standard / double rackwork slide
Discursive Genre	Topical
Technique	Coloured printed outlines

State of Preservation
Overall: 2 - Fair

Glass	Paint	Wood	Paper	Metal
1	2	-	2	-

Damages and observations:

Inventory Number **PC0498/003,10,11**
Investigation Code n/a



Title	*Hive with bees*
Date	ca.1850-1900
Producer	-
Origin	France
Dimensions	8.2 x 8.2
Format	Standard / double rackwork slide
Discursive Genre	Topical
Technique	Coloured printed outlines

State of Preservation
Overall: 2 - Fair

Glass	Paint	Wood	Paper	Metal
1	2	-	2	-

Damages and observations:

Inventory Number **PC0498/004,12,13**
Investigation Code n/a



Title	*Acrobat*
Date	ca.1850-1900
Producer	-
Origin	France
Dimensions	8.2 x 8.2
Format	Standard / double rackwork slide
Discursive Genre	Burlesque
Technique	Coloured printed outlines

State of Preservation
Overall: 2 - Fair

Glass	Paint	Wood	Paper	Metal
1	2	-	2	-

Damages and observations:

Inventory Number **PC0498/005,14,15**
Investigation Code n/a



Title	*Fontain with water*
Date	ca.1850-1900
Producer	-
Origin	France
Dimensions	8.2 x 8.2
Format	Standard / double rackwork slide
Discursive Genre	Topical
Technique	Coloured printed outlines

State of Preservation
Overall: 2 - Fair

Glass	Paint	Wood	Paper	Metal
1	2	-	2	-

Damages and observations:

Inventory Number **PC0498/006,16,17**
Investigation Code n/a



Title	*Aquarium with fish*
Date	ca.1850-1900
Producer	-
Origin	France
Dimensions	8.2 x 8.2
Format	Standard / double rackwork slide
Discursive Genre	Topical
Technique	Coloured printed outlines

State of Preservation
Overall: 2 - Fair

Glass	Paint	Wood	Paper	Metal
1	2	-	2	-

Damages and observations:

Inventory Number **PC0498/007,18,19**
Investigation Code n/a



Title	*Bon Soir*
Date	ca.1850-1900
Producer	-
Origin	France
Dimensions	8.2 x 8.2
Format	Standard / double rackwork slide
Discursive Genre	Title
Technique	Coloured printed outlines

State of Preservation
Overall: 4 - Very poor

Glass	Paint	Wood	Paper	Metal
4	2	-	2	-

Damages and observations:
Standard glass heavily broken

Inventory Number **PC0507/001**
Investigation Code n/a



Title	*Rumple Stiltskin and his Bargain*
Date	1850-1875
Producer	-
Origin	England
Dimensions	17.6 x 11.5 cm
Format	Single slide
Discursive Genre	Tale
Technique	Hand-painted (photo mask)

State of Preservation
Overall: 1 - Good

Glass	Paint	Wood	Paper	Metal
1	1	1	2	-

Damages and observations:

Inventory Number **PC0507/002**
Investigation Code n/a



Title	*Rumple Stiltskin and his Bargain*
Date	1850-1875
Producer	-
Origin	England
Dimensions	17.6 x 11.5 cm
Format	Single slide
Discursive Genre	Tale
Technique	Hand-painted (photo mask)

State of Preservation
Overall: 1 - Good

Glass	Paint	Wood	Paper	Metal
1	1	1	1	-

Damages and observations:

Inventory Number **PC0507/003**

Investigation Code n/a



Title	*Rumple Stiltskin and his Bargain*
Date	1850-1875
Producer	-
Origin	England
Dimensions	17.6 x 11.5 cm
Format	Single slide
Discursive Genre	Tale
Technique	Hand-painted (photo mask)

State of Preservation

Overall: 1 - Good

Glass	Paint	Wood	Paper	Metal
1	1	1		-

Damages and observations:

Inventory Number **PC0507/004**

Investigation Code n/a



Title	*Rumple Stiltskin and his Bargain*
Date	1850-1875
Producer	-
Origin	England
Dimensions	17.6 x 11.5 cm
Format	Single slide
Discursive Genre	Tale
Technique	Hand-painted (photo mask)

State of Preservation

Overall: 1 - Good

Glass	Paint	Wood	Paper	Metal
1	1	1	2	-

Damages and observations:

Inventory Number **PC0507/005**

Investigation Code n/a



Title	*Rumple Stiltskin and his Bargain*
Date	1850-1875
Producer	-
Origin	England
Dimensions	17.6 x 11.5 cm
Format	Single slide
Discursive Genre	Tale
Technique	Hand-painted (photo mask)

State of Preservation

Overall: 1 - Good

Glass	Paint	Wood	Paper	Metal
1	1	1	2	-

Damages and observations:

Inventory Number **PC0507/006**

Investigation Code n/a



Title	*Rumple Stiltskin and his Bargain*
Date	1850-1875
Producer	-
Origin	England
Dimensions	17.6 x 11.5 cm
Format	Single slide
Discursive Genre	Tale
Technique	Hand-painted (photo mask)

State of Preservation

Overall: 3 - Poor

Glass	Paint	Wood	Paper	Metal
3	1	3	1	-

Damages and observations:

Inventory Number **PC0507/007**

Investigation Code n/a



Title	*Rumple Stiltskin and his Bargain*
Date	1850-1875
Producer	-
Origin	England
Dimensions	17.6 x 11.5 cm
Format	Single slide
Discursive Genre	Tale
Technique	Hand-painted (photo mask)

State of Preservation

Overall: 1 - Good

Glass	Paint	Wood	Paper	Metal
1	1	1	1	-

Damages and observations:

Inventory Number **PC0507/008**

Investigation Code n/a



Title	*Rumple Stiltskin and his Bargain*
Date	1850-1875
Producer	-
Origin	England
Dimensions	17.6 x 11.5 cm
Format	Single slide
Discursive Genre	Tale
Technique	Hand-painted (photo mask)

State of Preservation

Overall: 1 - Good

Glass	Paint	Wood	Paper	Metal
1	1	1	1	-

Damages and observations:

Inventory Number **PC0507/009**

Investigation Code n/a



Title	*Rumple Stiltskin and his Bargain*
Date	1850-1875
Producer	-
Origin	England
Dimensions	17.6 x 11.5 cm
Format	Single slide
Discursive Genre	Tale
Technique	Hand-painted (photo mask)

State of Preservation

Overall: 1 - Good

Glass	Paint	Wood	Paper	Metal
1	1	1	1	-

Damages and observations:

Inventory Number **PC0507/010**

Investigation Code n/a



Title	*Rumple Stiltskin and his Bargain*
Date	1850-1875
Producer	-
Origin	England
Dimensions	17.6 x 11.5 cm
Format	Single slide
Discursive Genre	Tale
Technique	Hand-painted (photo mask)

State of Preservation

Overall: 1 - Good

Glass	Paint	Wood	Paper	Metal
1	1	1	1	-

Damages and observations:

Inventory Number **PC0507/011**

Investigation Code n/a



Title	*Rumple Stiltskin and his Bargain*
Date	1850-1875
Producer	-
Origin	England
Dimensions	17.6 x 11.5 cm
Format	Single slide
Discursive Genre	Tale
Technique	Hand-painted (photo mask)

State of Preservation

Overall: 1 - Good

Glass	Paint	Wood	Paper	Metal
1	1	1	2	-

Damages and observations:

Inventory Number **PC0507/012**

Investigation Code n/a



Title	*Rumple Stiltskin and his Bargain*
Date	1850-1875
Producer	-
Origin	England
Dimensions	17.6 x 11.5 cm
Format	Single slide
Discursive Genre	Tale
Technique	Hand-painted (photo mask)

State of Preservation

Overall: 1 - Good

Glass	Paint	Wood	Paper	Metal
1	1	1	1	-

Damages and observations:

Inventory Number **PC0507/013**
Investigation Code n/a



Title	*Rumple Stiltskin and his Bargain*
Date	1850-1875
Producer	
Origin	England
Dimensions	17.6 x 11.5 cm
Format	Single slide
Discursive Genre	Tale
Technique	Coloured printed outlines

State of Preservation
Overall: 3 - Poor

Glass	Paint	Wood	Paper	Metal
2	1	3	2	-

Damages and observations:

Inventory Number **PC0508/001**
Investigation Code n/a



Title	*Quarreling*
Date	1850-1875
Producer	W.C. Hughes
Origin	England
Dimensions	17.7 x 10.8 cm
Format	Single slide
Discursive Genre	Sequential Art
Technique	Hand-painted

State of Preservation
Overall: 2 - Fair

Glass	Paint	Wood	Paper	Metal
1	2	2	-	-

Damages and observations:

Inventory Number **PC0508/002**
Investigation Code n/a



Title	*Quarreling*
Date	1850-1875
Producer	W.C. Hughes
Origin	England
Dimensions	17.7 x 10.8 cm
Format	Single slide
Discursive Genre	Sequential Art
Technique	Hand-painted

State of Preservation
Overall: 2 - Fair

Glass	Paint	Wood	Paper	Metal
1	2	2	-	-

Damages and observations:

Inventory Number **PC0508/003**
Investigation Code n/a



Title	*Quarreling*
Date	1850-1875
Producer	W.C. Hughes
Origin	England
Dimensions	17.7 x 10.8 cm
Format	Single slide
Discursive Genre	Sequential Art
Technique	Hand-painted

State of Preservation
Overall: 1 - Good

Glass	Paint	Wood	Paper	Metal
1	1	1	-	-

Damages and observations:

Inventory Number **PC0508/004**
Investigation Code n/a



Title	*Quarreling*
Date	1850-1875
Producer	W.C. Hughes
Origin	England
Dimensions	17.7 x 10.8 cm
Format	Single slide
Discursive Genre	Sequential Art
Technique	Hand-painted

State of Preservation
Overall: 2 - Fair

Glass	Paint	Wood	Paper	Metal
1	2	2	-	-

Damages and observations:

Inventory Number **PC0508/005**
Investigation Code n/a



Title	*Quarreling*
Date	1850-1875
Producer	W.C. Hughes
Origin	England
Dimensions	17.7 x 10.8 cm
Format	Single slide
Discursive Genre	Sequential Art
Technique	Hand-painted

State of Preservation
Overall: 2 - Fair

Glass	Paint	Wood	Paper	Metal
1	2	2	-	-

Damages and observations:

Inventory Number **PC0508/006**
Investigation Code n/a



Title	*Quarreling*
Date	1850-1875
Producer	W.C. Hughes
Origin	England
Dimensions	17.7 x 10.8 cm
Format	Single slide
Discursive Genre	Sequential Art
Technique	Hand-painted

State of Preservation
Overall: 2 - Fair

Glass	Paint	Wood	Paper	Metal
1	2	2	-	-

Damages and observations:

Inventory Number **PC0508/007**
Investigation Code n/a



Title	*Quarreling*
Date	1850-1875
Producer	W.C. Hughes
Origin	England
Dimensions	17.7 x 10.8 cm
Format	Single slide
Discursive Genre	Sequential Art
Technique	Hand-painted

State of Preservation
Overall: 2 - Fair

Glass	Paint	Wood	Paper	Metal
1	2	2	-	-

Damages and observations:

Inventory Number **PC0508/008**
Investigation Code n/a



Title	*Quarreling*
Date	1850-1875
Producer	W.C. Hughes
Origin	England
Dimensions	17.7 x 10.8 cm
Format	Single slide
Discursive Genre	Sequential Art
Technique	Hand-painted

State of Preservation
Overall: 2 - Fair

Glass	Paint	Wood	Paper	Metal
1	2	2	-	-

Damages and observations:

Inventory Number **PC0508/009**
Investigation Code n/a



Title	*Quarreling*
Date	1850-1875
Producer	W.C. Hughes
Origin	England
Dimensions	17.7 x 10.8 cm
Format	Single slide
Discursive Genre	Sequential Art
Technique	Hand-painted

State of Preservation
Overall: 2 - Fair

Glass	Paint	Wood	Paper	Metal
1	2	2	-	-

Damages and observations:

Inventory Number **PC0508/010**
Investigation Code n/a



Title	*Quarreling*
Date	1850-1875
Producer	W.C. Hughes
Origin	England
Dimensions	17.7 x 10.8 cm
Format	Single slide
Discursive Genre	Sequential Art
Technique	Hand-painted

State of Preservation
Overall: 2 - Fair

Glass	Paint	Wood	Paper	Metal
1	2	2	-	-

Damages and observations:

Inventory Number **PC0509/001**
Investigation Code n/a



Title	*Ye Elephant and Ye Tailor*
Date	1850-1875
Producer	-
Origin	England
Dimensions	17.6 x 10.7 cm
Format	Single slide
Discursive Genre	Title
Technique	Coloured printed outlines

State of Preservation
Overall: 1 - Good

Glass	Paint	Wood	Paper	Metal
1	1	1	-	-

Damages and observations:

Inventory Number **PC0509/002**
Investigation Code n/a



Title	*Ye Elephant and Ye Tailor*
Date	1850-1875
Producer	-
Origin	England
Dimensions	17.6 x 10.7 cm
Format	Single slide
Discursive Genre	Adventure
Technique	Coloured printed outlines

State of Preservation
Overall: 1 - Good

Glass	Paint	Wood	Paper	Metal
1	1	1	-	-

Damages and observations:

Inventory Number **PC0509/003**
Investigation Code n/a



Title	*Ye Elephant and Ye Tailor*
Date	1850-1875
Producer	-
Origin	England
Dimensions	17.6 x 10.7 cm
Format	Single slide
Discursive Genre	Adventure
Technique	Coloured printed outlines

State of Preservation
Overall: 1 - Good

Glass	Paint	Wood	Paper	Metal
1	1	1	-	-

Damages and observations:

Inventory Number **PC0509/004**
Investigation Code n/a



Title	*Ye Elephant and Ye Tailor*
Date	1850-1875
Producer	-
Origin	England
Dimensions	17.6 x 10.7 cm
Format	Single slide
Discursive Genre	Adventure
Technique	Coloured printed outlines

State of Preservation
Overall: 1 - Good

Glass	Paint	Wood	Paper	Metal
1	1	1	-	-

Damages and observations:

Inventory Number **PC0509/005**
Investigation Code n/a



Title	*Ye Elephant and Ye Tailor*
Date	1850-1875
Producer	-
Origin	England
Dimensions	17.6 x 10.7 cm
Format	Single slide
Discursive Genre	Adventure
Technique	Coloured printed outlines

State of Preservation
Overall: 1 - Good

Glass	Paint	Wood	Paper	Metal
1	1	1	-	-

Damages and observations:

Inventory Number **PC0509/006**
Investigation Code n/a



Title	*Ye Elephant and Ye Tailor*
Date	1850-1875
Producer	-
Origin	England
Dimensions	17.6 x 10.7 cm
Format	Single slide
Discursive Genre	Adventure
Technique	Coloured printed outlines

State of Preservation
Overall: 1 - Good

Glass	Paint	Wood	Paper	Metal
1	1	1	-	-

Damages and observations:

Inventory Number **PC0509/007**
Investigation Code n/a



Title	*Ye Elephant and Ye Tailor*
Date	1850-1875
Producer	-
Origin	England
Dimensions	17.6 x 10.7 cm
Format	Single slide
Discursive Genre	Adventure
Technique	Coloured printed outlines

State of Preservation
Overall: 1 - Good

Glass	Paint	Wood	Paper	Metal
1	1	1	-	-

Damages and observations:

Inventory Number **PC0509/008**
Investigation Code n/a



Title	*Ye Elephant and Ye Tailor*
Date	1850-1875
Producer	-
Origin	England
Dimensions	17.6 x 10.7 cm
Format	Single slide
Discursive Genre	Adventure
Technique	Coloured printed outlines

State of Preservation
Overall: 1 - Good

Glass	Paint	Wood	Paper	Metal
1	1	1	-	-

Damages and observations:

Inventory Number **PC0510/001**
Investigation Code n/a



Title	*The Sweep and Whitewasher*
Date	1850-1875
Producer	-
Origin	England
Dimensions	17.6 x 11.4 cm
Format	Single slide
Discursive Genre	Sequential Art
Technique	Coloured printed outlines

State of Preservation
Overall: 1 - Good

Glass	Paint	Wood	Paper	Metal
1	1	1	-	-

Damages and observations:

Inventory Number **PC0510/002**
Investigation Code n/a



Title	*The Sweep and Whitewasher*
Date	1850-1875
Producer	-
Origin	England
Dimensions	17.6 x 11.4 cm
Format	Single slide
Discursive Genre	Sequential Art
Technique	Coloured printed outlines

State of Preservation
Overall: 1 - Good

Glass	Paint	Wood	Paper	Metal
1	1	1	-	-

Damages and observations:

Inventory Number **PC0510/003**
Investigation Code n/a



Title	*The Sweep and Whitewasher*
Date	1850-1875
Producer	-
Origin	England
Dimensions	17.6 x 11.4 cm
Format	Single slide
Discursive Genre	Sequential Art
Technique	Coloured printed outlines

State of Preservation
Overall: 1 - Good

Glass	Paint	Wood	Paper	Metal
1	1	1	-	-

Damages and observations:

Inventory Number **PC0510/004**
Investigation Code n/a



Title	*The Sweep and Whitewasher*
Date	1850-1875
Producer	-
Origin	England
Dimensions	17.6 x 11.4 cm
Format	Single slide
Discursive Genre	Sequential Art
Technique	Coloured printed outlines

State of Preservation
Overall: 1 - Good

Glass	Paint	Wood	Paper	Metal
1	1	1	-	-

Damages and observations:

Inventory Number **PC0510/005**
Investigation Code n/a



Title	*The Sweep and Whitewasher*
Date	1850-1875
Producer	-
Origin	England
Dimensions	17.6 x 11.4 cm
Format	Single slide
Discursive Genre	Sequential Art
Technique	Coloured printed outlines

State of Preservation
Overall: 1 - Good

Glass	Paint	Wood	Paper	Metal
1	1	1	-	-

Damages and observations:

Inventory Number **PC0510/006**
Investigation Code n/a



Title	*The Sweep and Whitewasher*
Date	1850-1875
Producer	-
Origin	England
Dimensions	17.6 x 11.4 cm
Format	Single slide
Discursive Genre	Sequential Art
Technique	Coloured printed outlines

State of Preservation
Overall: 1 - Good

Glass	Paint	Wood	Paper	Metal
1	1	1	-	-

Damages and observations:

Inventory Number **PC0510/007**
Investigation Code n/a



Title	*The Sweep and Whitewasher*
Date	1850-1875
Producer	-
Origin	England
Dimensions	17.6 x 11.4 cm
Format	Single slide
Discursive Genre	Sequential Art
Technique	Coloured printed outlines

State of Preservation
Overall: 1 - Good

Glass	Paint	Wood	Paper	Metal
1	1	1	-	-

Damages and observations:

Inventory Number **PC0510/008**
Investigation Code n/a



Title	*The Sweep and Whitewasher*
Date	1850-1875
Producer	-
Origin	England
Dimensions	17.6 x 11.4 cm
Format	Single slide
Discursive Genre	Sequential Art
Technique	Coloured printed outlines

State of Preservation
Overall: 1 - Good

Glass	Paint	Wood	Paper	Metal
1	1	1	-	-

Damages and observations:

Inventory Number **PC0510/009**
Investigation Code n/a



Title	*The Sweep and Whitewasher*
Date	1850-1875
Producer	-
Origin	England
Dimensions	17.6 x 11.4 cm
Format	Single slide
Discursive Genre	Sequential Art
Technique	Coloured printed outlines

State of Preservation
Overall: 1 - Good

Glass	Paint	Wood	Paper	Metal
1	1	1	-	-

Damages and observations:

Inventory Number **PC0510/010**
Investigation Code n/a



Title	*The Sweep and Whitewasher*
Date	1850-1875
Producer	-
Origin	England
Dimensions	17.6 x 11.4 cm
Format	Single slide
Discursive Genre	Sequential Art
Technique	Coloured printed outlines

State of Preservation
Overall: 1 - Good

Glass	Paint	Wood	Paper	Metal
1	1	1	-	-

Damages and observations:

Inventory Number **PC0514/001**
Investigation Code n/a



Title	*Our Xmas Favourites*
Date	1850-1875
Producer	-
Origin	England
Dimensions	18.2 x 11.4 x 1 cm
Format	Single slipping slide
Discursive Genre	Burlesque
Technique	Hand-painted

State of Preservation
Overall: 1 - Good

Glass	Paint	Wood	Paper	Metal
1	1	1	2	2

Damages and observations:

Inventory Number **PC0514/002**
Investigation Code n/a



Title	*Our Xmas Favourites*
Date	1850-1875
Producer	-
Origin	England
Dimensions	23.1 x 11.4 x 1.3 cm
Format	Rackwork slide
Discursive Genre	Burlesque
Technique	Hand-painted

State of Preservation
Overall: 1 - Good

Glass	Paint	Wood	Paper	Metal
1	1	1	2	2

Damages and observations:

Inventory Number **PC0515/001**
Investigation Code n/a



Title	*Two in a Bed*
Date	1850-1875
Producer	-
Origin	England
Dimensions	17.8 x 10 x 1 cm
Format	Single slide
Discursive Genre	Burlesque
Technique	Hand-painted

State of Preservation
Overall: 1 - Good

Glass	Paint	Wood	Paper	Metal
1	1	1	-	2

Damages and observations:

Inventory Number **PC0515/002**
Investigation Code n/a



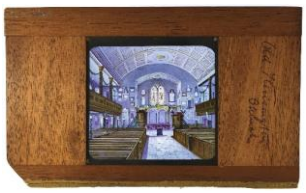
Title	*Two in a Bed*
Date	1850-1875
Producer	-
Origin	England
Dimensions	22.2 x 10 x 1.4 cm
Format	Rackwork slide
Discursive Genre	Burlesque
Technique	Hand-painted

State of Preservation
Overall: 1 - Good

Glass	Paint	Wood	Paper	Metal
1	1	1	-	2

Damages and observations:

Inventory Number **PC0523/001**
Investigation Code n/a



Title	*Old Kensington Church* (Dissolving view, part 1)
Date	1850-1875
Producer	17.7 x 11 x 1 cm
Origin	England
Dimensions	17.7 x 11 cm
Format	Single slide
Discursive Genre	Topical
Technique	Hand-painted

State of Preservation
Overall: 1 - Good

Glass	Paint	Wood	Paper	Metal
1	1	1	1	-

Damages and observations:

Inventory Number **PC0523/002**
Investigation Code n/a



Title	*Old Kensington Church* (Dissolving view, part 2)
Date	1850-1875
Producer	17.7 x 11 x 1 cm
Origin	England
Dimensions	17.7 x 11 cm
Format	Single slide
Discursive Genre	Topical
Technique	Hand-painted

State of Preservation
Overall: 1 - Good

Glass	Paint	Wood	Paper	Metal
1	1	1	1	-

Damages and observations:

Inventory Number **PC0525**
Investigation Code n/a



Title	*Ferry over the River Orontes*
Date	1850-1875
Producer	E.H. Wilkie, Late Royal Polytechnic
Origin	England
Dimensions	17.8 x 10.8 x 1 cm
Format	Single slide
Discursive Genre	Topical
Technique	Hand-painted

State of Preservation
Overall: 1 - Good

Glass	Paint	Wood	Paper	Metal
1	1	1	1	-

Damages and observations:

Inventory Number **PC0528**
Investigation Code n/a



Title	*Cairo*
Date	1850-1875
Producer	W.C. Hughes
Origin	England
Dimensions	17.6 x 11.3 x 1 cm
Format	Single slide
Discursive Genre	Topical
Technique	Hand-painted

State of Preservation
Overall: 1 - Good

Glass	Paint	Wood	Paper	Metal
1	1	1	1	-

Damages and observations:

Inventory Number **PC0529**
Investigation Code n/a



Title	*Cairo*
Date	1850-1875
Producer	W.C. Hughes
Origin	England
Dimensions	17.8 x 11.2 x 1 cm
Format	Single slide
Discursive Genre	Topical
Technique	Hand-painted

State of Preservation
Overall: 1 - Good

Glass	Paint	Wood	Paper	Metal
1	1	1	1	-

Damages and observations:

Inventory Number **PC0533**
Investigation Code n/a



Title	*Public Letter Writer Constantinople*
Date	1850-1875
Producer	-
Origin	England
Dimensions	17.9 x 11 x 1 cm
Format	Single slide
Discursive Genre	Topical
Technique	Hand-painted (Photo mask)

State of Preservation
Overall: 2 - Fair

Glass	Paint	Wood	Paper	Metal
1	2	2	1	-

Damages and observations:
Bleaching of the wood and possible paint fading

Inventory Number **PC0534**
Investigation Code n/a



Title	*Sultans Harem out for an Airing Turkey*
Date	1850-1875
Producer	-
Origin	England
Dimensions	17.8 x 11.2 x 1 cm
Format	Single slide
Discursive Genre	Topical
Technique	Hand-painted (Photo mask)

State of Preservation
Overall: 2 - Fair

Glass	Paint	Wood	Paper	Metal
1	2	2	1	-

Damages and observations:
Bleaching of the wood and possible paint fading

Inventory Number **PC0536/001**
Investigation Code n/a



Title	*Angel effect to Gettsmane* (Dissolving view – part 1)
Date	1850-1875
Producer	W.C. Hughes
Origin	England
Dimensions	17.8 x 11.4 x 1 cm
Format	Single slide
Discursive Genre	Religious
Technique	Hand-painted (Photo mask?)

State of Preservation
Overall: 1 - Good

Glass	Paint	Wood	Paper	Metal
1	1	1	1	-

Damages and observations:

Inventory Number **PC0536/002**
Investigation Code n/a



Title	*Sheppards Star effect* (Dissolving view – part 2)
Date	1850-1875
Producer	W.C. Hughes
Origin	England
Dimensions	17.8 x 11.4 x 1 cm
Format	Single slide
Discursive Genre	Religious
Technique	Hand-painted (Photo mask?)

State of Preservation
Overall: 1 - Good

Glass	Paint	Wood	Paper	Metal
1	1	1	1	-

Damages and observations:

Inventory Number **PC0536/003**
Investigation Code n/a



Title	*Angel effect for Crucifix* (Dissolving view – part 3)
Date	1850-1875
Producer	W.C. Hughes
Origin	England
Dimensions	17.8 x 11.4 x 1 cm
Format	Single slide
Discursive Genre	Religious
Technique	Hand-painted (Photo mask?)

State of Preservation
Overall: 1 - Good

Glass	Paint	Wood	Paper	Metal
1	1	1	1	-

Damages and observations:

Inventory Number **PC3300/001**
Investigation Code n/a



Title	*Here Lies Joey 1829*
Date	ca.1820-1835
Producer	-
Origin	England
Dimensions	17 x 10 cm
Format	Single slipping slide
Discursive Genre	Burlesque
Technique	Hand-painted

State of Preservation
Overall: 1 - Good

Glass	Paint	Wood	Paper	Metal
1	1	2	2	1

Damages and observations:

Inventory Number **PC3300/002**
Investigation Code n/a



Title	
Date	ca.1860
Producer	-
Origin	England
Dimensions	17 x 10 cm
Format	Single slipping slide
Discursive Genre	Burlesque
Technique	Hand-painted

State of Preservation
Overall: 2 - Fair

Glass	Paint	Wood	Paper	Metal
2	1	2	1	1

Damages and observations:

Inventory Number **PC3300/003**
Investigation Code n/a



Title	-
Date	ca.1860
Producer	-
Origin	England
Dimensions	17 x 10 cm
Format	Single slipping slide
Discursive Genre	Burlesque
Technique	Hand-painted

State of Preservation
Overall: 2 - Fair

Glass	Paint	Wood	Paper	Metal
2	2	1	1	1

Damages and observations:

Inventory Number **PC3300/004**
Investigation Code n/a



Title	-
Date	ca.1860
Producer	-
Origin	England
Dimensions	17 x 10 cm
Format	Single slipping slide
Discursive Genre	Burlesque
Technique	Title

State of Preservation
Overall: 1 - Good

Glass	Paint	Wood	Paper	Metal
1	1	1	2	-

Damages and observations:

Inventory Number **PC3301/001**
Investigation Code n/a



Title	-
Date	1850-1858
Producer	W.E. & F. Newton
Origin	England
Dimensions	24 x 10.5 cm
Format	Astronomical rackwork slide
Discursive Genre	Astronomical
Technique	Hand-painted

State of Preservation
Overall: 2 - Fair

Glass	Paint	Wood	Paper	Metal
1	1	2	2	2

Damages and observations:

Inventory Number **PC3301/002**
Investigation Code n/a



Title	
Date	1850-1858
Producer	W.E. & F. Newton
Origin	England
Dimensions	23.5 x 10.3 cm
Format	Astronomical rackwork slide
Discursive Genre	Astronomical
Technique	Hand-painted

State of Preservation
Overall: 2 - Fair

Glass	Paint	Wood	Paper	Metal
1	1	2	2	2

Damages and observations:

Inventory Number **PC3301/003**
Investigation Code n/a



Title	*The solar system*
Date	ca.1838-1900
Producer	Carpenter & Westley
Origin	England
Dimensions	26.5 x 10.6 cm
Format	Astronomical rackwork slide
Discursive Genre	Astronomical
Technique	Hand-painted

State of Preservation
Overall: 2 - Fair

Glass	Paint	Wood	Paper	Metal
2	1	1	1	1

Damages and observations:

Inventory Number **PC3301/004**
Investigation Code n/a



Title	-
Date	ca.1838-1900
Producer	Carpenter & Westley
Origin	England
Dimensions	26.5 x 10.5
Format	Astronomical rackwork slide
Discursive Genre	Astronomical
Technique	Hand-painted

State of Preservation
Overall: 3 - Poor

Glass	Paint	Wood	Paper	Metal
2	1	1	1	3

Damages and observations:

Inventory Number **PC3301/005**
Investigation Code n/a



Title	-
Date	ca.1838-1870
Producer	Carpenter & Westley
Origin	England
Dimensions	26 x 10.5 cm
Format	Astronomical rackwork slide
Discursive Genre	Astronomical
Technique	Hand-painted

State of Preservation
Overall: 1 - Good

Glass	Paint	Wood	Paper	Metal
1	1	1	-	1

Damages and observations:

Inventory Number **PC3301/006**
Investigation Code n/a



Title	-
Date	ca.1838-1900
Producer	Carpenter & Westley
Origin	England
Dimensions	17.5 x 9.5 cm
Format	Single slide
Discursive Genre	Astronomical
Technique	Hand-painted

State of Preservation
Overall: 1 - Good

Glass	Paint	Wood	Paper	Metal
1	1	1	-	2

Damages and observations:

Inventory Number **PC3301/007**
Investigation Code n/a



Title	-
Date	ca.1838-1900
Producer	Carpenter & Westley
Origin	England
Dimensions	17.5 x 9.5 cm
Format	Single slide
Discursive Genre	Astronomical
Technique	Hand-painted

State of Preservation
Overall: 1 - Good

Glass	Paint	Wood	Paper	Metal
1	1	2	-	?

Damages and observations:

Inventory Number **PC3301/008**
Investigation Code n/a



Title	-
Date	ca.1838-1900
Producer	Carpenter & Westley
Origin	England
Dimensions	17.5 x 9.5 cm
Format	Single slide
Discursive Genre	Astronomical
Technique	Hand-painted

State of Preservation
Overall: 3 - Poor

Glass	Paint	Wood	Paper	Metal
3	1	1	-	2

Damages and observations:

Inventory Number **PC3301/009**
Investigation Code n/a



Title	-
Date	ca.1838-1900
Producer	Carpenter & Westley
Origin	England
Dimensions	17.5 x 9.5 cm
Format	Single slide
Discursive Genre	Astronomical
Technique	Hand-painted

State of Preservation
Overall: 1 - Good

Glass	Paint	Wood	Paper	Metal
1	1	1	-	2

Damages and observations:

Inventory Number **PC3302/001**
Investigation Code n/a



Title	-
Date	ca.1860-1870
Producer	Newton & Co.
Origin	England
Dimensions	17 x 10 cm
Format	Double slipping slide
Discursive Genre	Burlesque
Technique	Hand-painted

State of Preservation
Overall: 1 - Good

Glass	Paint	Wood	Paper	Metal
1	1	1	-	2

Damages and observations:

Inventory Number **PC3302/002**
Investigation Code n/a



Title	-
Date	ca.1850-1900
Producer	Newton & Co.
Origin	England
Dimensions	17 x 10 cm
Format	Single slipping slide
Discursive Genre	Burlesque
Technique	Hand-painted

State of Preservation
Overall: 1 - Good

Glass	Paint	Wood	Paper	Metal
1	1	1	1	1

Damages and observations:

Inventory Number **PC3302/003**
Investigation Code n/a



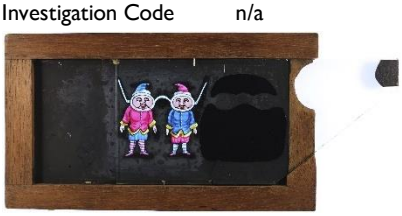
Title	-
Date	ca.1846-1860
Producer	Millikin & Lawley
Origin	England
Dimensions	17 x 10 cm
Format	Single slipping slide
Discursive Genre	Burlesque
Technique	Hand-painted

State of Preservation
Overall: 1 - Good

Glass	Paint	Wood	Paper	Metal
1	1	1	1	Nv

Damages and observations:

Inventory Number **PC3302/005**
Investigation Code n/a



Title	-
Date	ca.1850-1900
Producer	-
Origin	England
Dimensions	17 x 10 cm
Format	Single slipping slide
Discursive Genre	Burlesque
Technique	Hand-painted

State of Preservation
Overall: 2 - Fair

Glass	Paint	Wood	Paper	Metal
1	2	1	1	2

Damages and observations:

Inventory Number **PC3302/006**
Investigation Code n/a



Title	-
Date	ca.1850-1900
Producer	-
Origin	England
Dimensions	17 x 10 cm
Format	Single slipping slide
Discursive Genre	Burlesque
Technique	Hand-painted

State of Preservation
Overall: 1 - Good

Glass	Paint	Wood	Paper	Metal
1	1	1	2	2

Damages and observations:

Inventory Number **PC3302/007**
Investigation Code n/a



Title	-
Date	ca.1850-1900
Producer	-
Origin	England
Dimensions	17 x 10 cm
Format	Single slipping slide
Discursive Genre	Burlesque
Technique	Hand-painted

State of Preservation
Overall: 2 - Fair

Glass	Paint	Wood	Paper	Metal
1	2	1	2	11

Damages and observations:

Inventory Number **PC3302/008**
Investigation Code n/a



Title	-
Date	ca.1850-1900
Producer	-
Origin	England
Dimensions	17 x 10 cm
Format	Double slipping slide
Discursive Genre	Burlesque
Technique	Hand-painted

State of Preservation
Overall: 1 - Good

Glass	Paint	Wood	Paper	Metal
1	1	1	2	2

Damages and observations:

Inventory Number **PC3302/009**
Investigation Code n/a



Title	-
Date	ca.1850-1900
Producer	-
Origin	England
Dimensions	17 x 10 cm
Format	Single slipping slide
Discursive Genre	Burlesque
Technique	Hand-painted

State of Preservation
Overall: 1 - Good

Glass	Paint	Wood	Paper	Metal
1	1	1	2	2

Damages and observations:

Inventory Number **PC3302/010**
Investigation Code n/a



Title	-
Date	ca.1850-1900
Producer	-
Origin	England
Dimensions	17 x 10 cm
Format	Single slipping slide
Discursive Genre	Burlesque
Technique	Hand-painted

State of Preservation
Overall: 1 - Good

Glass	Paint	Wood	Paper	Metal
1	1	1	-	2

Damages and observations:

Inventory Number **PC3302/011**
Investigation Code n/a



Title	-
Date	ca.1850-1900
Producer	-
Origin	England
Dimensions	17 x 10 cm
Format	Single slipping slide
Discursive Genre	Burlesque
Technique	Hand-painted

State of Preservation
Overall: 2 - Fair

Glass	Paint	Wood	Paper	Metal
1	2	1	-	2

Damages and observations:

Inventory Number **PC3302/012**
Investigation Code n/a



Title	-
Date	ca.1850-1900
Producer	-
Origin	England
Dimensions	17 x 10 cm
Format	Single slipping slide
Discursive Genre	Burlesque
Technique	Hand-painted

State of Preservation
Overall: 1 - Good

Glass	Paint	Wood	Paper	Metal
1	1	1	1	-

Damages and observations:

Inventory Number **PC3302/013**
Investigation Code n/a



Title	-
Date	ca.1850-1900
Producer	-
Origin	England
Dimensions	17 x 10 cm
Format	Single slipping slide
Discursive Genre	Burlesque
Technique	Hand-painted

State of Preservation
Overall: 1 - Good

Glass	Paint	Wood	Paper	Metal
1	1	1	1	-

Damages and observations:

Inventory Number **PC3302/014**
Investigation Code n/a



Title	*Gute Nacht*
Date	ca.1850-1900
Producer	-
Origin	England
Dimensions	17 x 10 cm
Format	Single slipping slide
Discursive Genre	Title
Technique	Hand-painted

State of Preservation
Overall: 1 - Good

Glass	Paint	Wood	Paper	Metal
1	1	1	1	-

Damages and observations:

Inventory Number **PC3302/015**
Investigation Code n/a



Title	-
Date	ca.1850-1900
Producer	-
Origin	England
Dimensions	17 x 10 cm
Format	Single slipping slide
Discursive Genre	Burlesque
Technique	Hand-painted

State of Preservation
Overall: 1 - Good

Glass	Paint	Wood	Paper	Metal
1	1	1	1	-

Damages and observations:

Inventory Number **PC3302/016**
Investigation Code n/a



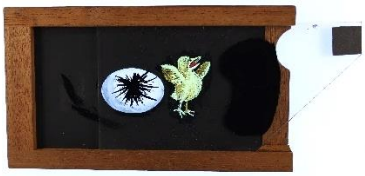
Title	-
Date	ca.1850-1900
Producer	-
Origin	England
Dimensions	17 x 10 cm
Format	Single slipping slide
Discursive Genre	Burlesque
Technique	Hand-painted

State of Preservation
Overall: 1 - Good

Glass	Paint	Wood	Paper	Metal
1	1	1	1	-

Damages and observations:

Inventory Number **PC3302/017**
Investigation Code n/a



Title	-
Date	ca.1850-1900
Producer	-
Origin	England
Dimensions	17 x 10 cm
Format	Single slipping slide
Discursive Genre	Burlesque
Technique	Hand-painted

State of Preservation
Overall: 1 - Good

Glass	Paint	Wood	Paper	Metal
1	1	1	1	-

Damages and observations:

Inventory Number **PC3302/018**
Investigation Code n/a



Title	-
Date	ca.1850-1900
Producer	-
Origin	England
Dimensions	17 x 10 cm
Format	Single slipping slide
Discursive Genre	Burlesque
Technique	Hand-painted

State of Preservation
Overall: 1 - Good

Glass	Paint	Wood	Paper	Metal
1	1	1	1	-

Damages and observations:

Inventory Number **PC3302/019**
Investigation Code n/a



Title	-
Date	ca.1850-1900
Producer	-
Origin	England
Dimensions	17 x 10 cm
Format	Double slipping slide
Discursive Genre	Burlesque
Technique	Hand-painted

State of Preservation
Overall: 3 - Poor

Glass	Paint	Wood	Paper	Metal
1	3	1	2	1

Damages and observations:

Inventory Number **PC3302/020**
Investigation Code n/a



Title	-
Date	ca.1850-1900
Producer	-
Origin	England
Dimensions	17 x 10 cm
Format	Single slipping slide
Discursive Genre	Burlesque
Technique	Hand-painted

State of Preservation
Overall: 1 - Good

Glass	Paint	Wood	Paper	Metal
1	1	1	2	1

Damages and observations:

Inventory Number **PC3302/021**
Investigation Code n/a



Title	-
Date	ca.1850-1900
Producer	-
Origin	England
Dimensions	17 x 10 cm
Format	Double slipping slide
Discursive Genre	Burlesque
Technique	Hand-painted

State of Preservation
Overall: 2 - Fair

Glass	Paint	Wood	Paper	Metal
1	2	1	2	-

Damages and observations:

Inventory Number **PC3303/001**
Investigation Code n/a



Title	-
Date	19th century
Producer	-
Origin	England
Dimensions	27.9 x 7.8 cm
Format	Panorama slide
Discursive Genre	Burlesque
Technique	Hand-painted

State of Preservation
Overall: 2 - Fair

Glass	Paint	Wood	Paper	Metal
1	2	1	-	-

Damages and observations:

Inventory Number **PC3303/002**
Investigation Code n/a



Title	-
Date	19th century
Producer	-
Origin	England
Dimensions	27.9 x 7.8 cm
Format	Panorama slide
Discursive Genre	Burlesque
Technique	Hand-painted

State of Preservation
Overall: 2 - Fair

Glass	Paint	Wood	Paper	Metal
1	2	1	-	-

Damages and observations:

Inventory Number **PC3303/003**
Investigation Code n/a



Title	-
Date	19th century
Producer	-
Origin	England
Dimensions	27.9 x 7.8 cm
Format	Panorama slide
Discursive Genre	Burlesque
Technique	Hand-painted

State of Preservation
Overall: 2 - Fair

Glass	Paint	Wood	Paper	Metal
1	2	1	-	-

Damages and observations:

Inventory Number **PC3303/004**
Investigation Code n/a



Title	-
Date	19th century
Producer	-
Origin	England
Dimensions	27.9 x 7.8 cm
Format	Panorama slide
Discursive Genre	Burlesque
Technique	Hand-painted

State of Preservation
Overall: 2 - Fair

Glass	Paint	Wood	Paper	Metal
1	2	1	-	-

Damages and observations:

Inventory Number **PC3303/005**
Investigation Code n/a



Title	-
Date	19th century
Producer	-
Origin	England
Dimensions	27.9 x 7.8 cm
Format	Panorama slide
Discursive Genre	Burlesque
Technique	Hand-painted

State of Preservation
Overall: 2 - Fair

Glass	Paint	Wood	Paper	Metal
1	2	1	-	-

Damages and observations:

A.2.2 National Museum of Natural History and Science

Table A.3 Overview of the slides studied from MUHNAC. © Photographs by Beatriz Rodrigues (UL000065-69) and Catarina Mateus.

		State of Preservation			
Slides	**Quantity**	**1 - Good**	**2 - Fair**	**3 - Poor**	**4 -Very poor**
Hand painted	8	3	2	2	1
Coloured printed outlines	22	0	4	6	12
Total	30	3	6	8	13

Inventory Number **UL000065**
Investigation Code n/a



Title	-
Date	ca.1870-1900
Producer	-
Origin	England
Dimensions	17.5 x 10.1 x 0.8 cm
Format	Single slipping slide
Discursive Genre	Burlesque
Technique	Hand-painted

State of Preservation
Overall: 1 - Good

Glass	Paint	Wood	Paper	Metal
1	1	1	3	2

Damages and observations:

Inventory Number **UL000066**
Investigation Code n/a



Title	-
Date	ca.1870-1900
Producer	-
Origin	England
Dimensions	17.5 x 10.1 x 0.8 cm
Format	Single slipping slide
Discursive Genre	Burlesque
Technique	Hand-painted

State of Preservation
Overall: 1 - Good

Glass	Paint	Wood	Paper	Metal
1	1	1	2	2

Damages and observations:

Inventory Number **UL000067**
Investigation Code n/a



Title	-
Date	ca.1870-1900
Producer	-
Origin	England
Dimensions	17.5 x 10.1 x 0.8 cm
Format	Single slipping slide
Discursive Genre	Burlesque
Technique	Hand-painted

State of Preservation
Overall: 1 - Good

Glass	Paint	Wood	Paper	Metal
1	1	1	2	2

Damages and observations:

Inventory Number **UL000068**
Investigation Code n/a



Title	-
Date	ca.1870-1900
Producer	-
Origin	England
Dimensions	17.5 x 10.1 x 0.8 cm
Format	Single slipping slide
Discursive Genre	Burlesque
Technique	Hand-painted

State of Preservation
Overall: 2 - Fair

Glass	Paint	Wood	Paper	Metal
2	1	2	2	2

Damages and observations:

Inventory Number **UL000069**
Investigation Code n/a



Title	-
Date	ca.1870-1900
Producer	-
Origin	England
Dimensions	17.5 x 10.1 x 0.8 cm
Format	Single slipping slide
Discursive Genre	Burlesque
Technique	Hand-painted

State of Preservation
Overall: 2 - Fair

Glass	Paint	Wood	Paper	Metal
2	1	1	3	2

Damages and observations:

Inventory Number **UL001208**
Investigation Code n/a



Title	-
Date	ca.1860-1900
Producer	Lapierre
Origin	France
Dimensions	23.5 x 6 cm
Format	Panorama slide
Discursive Genre	Burlesque?
Technique	Coloured printed outlines

State of Preservation
Overall: 3 - Poor

Glass	Paint	Wood	Paper	Metal
1	2	-	4	-

Damages and observations:

Inventory Number **UL001209**
Investigation Code n/a



Title	-
Date	ca.1860-1900
Producer	Lapierre
Origin	France
Dimensions	23.5 x 6 cm
Format	Panorama slide
Discursive Genre	Burlesque?
Technique	Coloured printed outlines

State of Preservation
Overall: 3 - Poor

Glass	Paint	Wood	Paper	Metal
2	1	-	4	-

Damages and observations:

Inventory Number **UL001210**
Investigation Code n/a



Title	-
Date	ca.1860-1900
Producer	Lapierre
Origin	France
Dimensions	18.5 x 8 cm
Format	Panorama slide
Discursive Genre	Romance
Technique	Coloured printed outlines

State of Preservation
Overall: 3 - Poor

Glass	Paint	Wood	Paper	Metal
2	3	-	-	-

Damages and observations:

Inventory Number **UL001211**
Investigation Code n/a



Title	-
Date	ca.1860-1900
Producer	Lapierre
Origin	France
Dimensions	20.5 x 6 cm
Format	Panorama slide
Discursive Genre	Romance
Technique	Coloured printed outlines

State of Preservation
Overall: 3 - Poor

Glass	Paint	Wood	Paper	Metal
2	2	-	4	-

Damages and observations:

Inventory Number **UL001212**
Investigation Code n/a



Title	-
Date	ca.1860-1900
Producer	Lapierre
Origin	France
Dimensions	23.3 x 6 cm
Format	Panorama slide
Discursive Genre	Romance
Technique	Coloured printed outlines

State of Preservation
Overall: 4 - Very poor

Glass	Paint	Wood	Paper	Metal
4	2	-	4	-

Damages and observations:

Inventory Number **UL001213**
Investigation Code n/a



Title	-
Date	ca.1860-1900
Producer	Lapierre
Origin	France
Dimensions	Max. 9.5 x 7 cm
Format	Panorama slide
Discursive Genre	?
Technique	Coloured printed outlines

State of Preservation
Overall: 4 - Very poor

Glass	Paint	Wood	Paper	Metal
2	2	-	4	-

Damages and observations:

Inventory Number **UL001214**
Investigation Code n/a



Title	-
Date	ca.1860-1900
Producer	Lapierre
Origin	France
Dimensions	23.3 x 6 cm
Format	Panorama slide
Discursive Genre	Romance
Technique	Coloured printed outlines

State of Preservation
Overall: 3 - Poor

Glass	Paint	Wood	Paper	Metal
2	2	-	3	-

Damages and observations:

Inventory Number **UL001215**
Investigation Code n/a



Title	-
Date	ca.1860-1900
Producer	Lapierre
Origin	France
Dimensions	23.5 x 6 cm
Format	Panorama slide
Discursive Genre	Romance
Technique	Coloured printed outlines

State of Preservation
Overall: 2 - Fair

Glass	Paint	Wood	Paper	Metal
1	2	-	-	-

Damages and observations:

Inventory Number **UL001216**
Investigation Code n/a



Title	-
Date	ca.1860-1900
Producer	Lapierre
Origin	France
Dimensions	23.7 x 6 cm
Format	Panorama slide
Discursive Genre	Tale
Technique	Coloured printed outlines

State of Preservation
Overall: 4 - Very poor

Glass	Paint	Wood	Paper	Metal
1	4	-	3	-

Damages and observations:

Inventory Number **UL001217**
Investigation Code n/a



Title	-
Date	ca.1860-1900
Producer	Lapierre
Origin	France
Dimensions	23.8 x 6 cm
Format	Panorama slide
Discursive Genre	Tale
Technique	Coloured printed outlines

State of Preservation
Overall: 2 - Fair

Glass	Paint	Wood	Paper	Metal
1	2	-	3	-

Damages and observations:

Inventory Number **UL001218**
Investigation Code n/a



Title	-
Date	ca.1860-1900
Producer	Lapierre
Origin	France
Dimensions	23.6 x 6 cm
Format	Panorama slide
Discursive Genre	Tale
Technique	Coloured printed outlines

State of Preservation
Overall: 2 - Fair

Glass	Paint	Wood	Paper	Metal
1	2	-	3	-

Damages and observations:

Inventory Number **UL001219**
Investigation Code n/a



Title	-
Date	ca.1860-1900
Producer	Lapierre
Origin	France
Dimensions	23.5 x 6 cm
Format	Panorama slide
Discursive Genre	Tale
Technique	Coloured printed outlines

State of Preservation
Overall: 4 - Very poor

Glass	Paint	Wood	Paper	Metal
4	3	-	4	-

Damages and observations:

Inventory Number **UL001220**
Investigation Code n/a



Title	-
Date	ca.1860-1900
Producer	Lapierre
Origin	France
Dimensions	23.6 x 6 cm
Format	Panorama slide
Discursive Genre	Tale
Technique	Coloured printed outlines

State of Preservation
Overall: 2 - Fair

Glass	Paint	Wood	Paper	Metal
1	2	-	-	-

Damages and observations:

Inventory Number **UL001221**
Investigation Code n/a



Title	-
Date	19th century
Producer	-
Origin	-
Dimensions	23.7 x 5 cm
Format	Panorama slide
Discursive Genre	Burlesque?
Technique	Hand-painted

State of Preservation
Overall: 4 - Very poor

Glass	Paint	Wood	Paper	Metal
1	4	-	-	-

Damages and observations:

Inventory Number **UL001222**
Investigation Code n/a



Title	-
Date	19th century
Producer	-
Origin	-
Dimensions	24 x 5 cm
Format	Panorama slide
Discursive Genre	Adventure
Technique	Hand-painted

State of Preservation
Overall: 3 - Poor

Glass	Paint	Wood	Paper	Metal
1	3	-	-	-

Damages and observations:

Inventory Number **UL025420**
Investigation Code n/a



Title	-
Date	19th century
Producer	-
Origin	-
Dimensions	23.5 x 5.7 cm
Format	Multiple slide
Discursive Genre	Tale
Technique	Coloured printed outlines

State of Preservation
Overall: 4 - Very poor

Glass	Paint	Wood	Paper	Metal
2	4	-	-	-

Damages and observations:

Inventory Number **UL025421**
Investigation Code n/a



Title	-
Date	19th century
Producer	-
Origin	-
Dimensions	23.2 x 5.6 cm
Format	Multiple slide
Discursive Genre	Tale
Technique	Coloured printed outlines

State of Preservation
Overall: 4 - Very poor

Glass	Paint	Wood	Paper	Metal
1	4	-	-	-

Damages and observations:

Inventory Number **UL025422**
Investigation Code n/a



Title	-
Date	19th century
Producer	-
Origin	-
Dimensions	23.2 x 5.5 cm
Format	Multiple slide
Discursive Genre	Tale
Technique	Coloured printed outlines

State of Preservation
Overall: 4 - Very poor

Glass	Paint	Wood	Paper	Metal
1	4	-	-	-

Damages and observations:

Inventory Number **UL025423**
Investigation Code n/a



Title	-
Date	19th century
Producer	-
Origin	-
Dimensions	22.5 x 5.5 cm
Format	Multiple slide
Discursive Genre	Tale
Technique	Coloured printed outlines

State of Preservation
Overall: 4 - Very poor

Glass	Paint	Wood	Paper	Metal
4	4	-	-	-

Damages and observations:

Inventory Number **UL025424**
Investigation Code n/a



Title	-
Date	19th century
Producer	-
Origin	-
Dimensions	23 x 5.5 cm
Format	Multiple slide
Discursive Genre	Tale
Technique	Coloured printed outlines

State of Preservation
Overall: 4 - Very poor

Glass	Paint	Wood	Paper	Metal
1	4	-	-	-

Damages and observations:

Inventory Number **UL025425**
Investigation Code n/a



Title	-
Date	19th century
Producer	-
Origin	-
Dimensions	23 x 5.5 cm
Format	Multiple slide
Discursive Genre	Tale
Technique	Coloured printed outlines

State of Preservation
Overall: 4 - Very poor

Glass	Paint	Wood	Paper	Metal
1	4	-	-	-

Damages and observations:

Inventory Number **UL025426**
Investigation Code n/a



Title	-
Date	19th century
Producer	-
Origin	-
Dimensions	23 x 5.5 cm
Format	Multiple slide
Discursive Genre	Tale
Technique	Coloured printed outlines

State of Preservation
Overall: 4 - Very poor

Glass	Paint	Wood	Paper	Metal
2	4	-	-	-

Damages and observations:

Inventory Number **UL025427**
Investigation Code n/a



Title	-
Date	19th century
Producer	-
Origin	-
Dimensions	23 x 5.5 cm
Format	Multiple slide
Discursive Genre	Tale
Technique	Coloured printed outlines

State of Preservation
Overall: 4 - Very poor

Glass	Paint	Wood	Paper	Metal
2	4	-	-	-

Damages and observations:

Inventory Number **UL025428**
Investigation Code n/a



Title	-
Date	19th century
Producer	-
Origin	-
Dimensions	23 x 5.5 cm
Format	Multiple slide
Discursive Genre	Tale
Technique	Coloured printed outlines

State of Preservation
Overall: 4 - Very poor

Glass	Paint	Wood	Paper	Metal
1	4	-	-	-

Damages and observations:

Inventory Number **UL025429**
Investigation Code n/a



Title	-
Date	19th century
Producer	-
Origin	-
Dimensions	23.8 x 5 cm
Format	Multiple slide
Discursive Genre	Adventure?
Technique	Hand-painted

State of Preservation
Overall: 3 - Poor

Glass	Paint	Wood	Paper	Metal
1	3	-	-	-

Damages and observations:

A.2.3 VICARTE Research Unit

Table A.4 Overview of the slides studied from VICARTE. © Photographs by the author.

		State of Preservation			
Slides	**Quantity**	**1 - Good**	**2 - Fair**	**3 - Poor**	**4 -Very poor**
Hand painted	4	1	1	1	1
Coloured printed outlines	3	0	3	0	0
Total	7	1	4	1	1

Inventory Number **LM01**
Investigation Code LM03



Title	*Insects N°2*
Date	ca.1822-1835
Producer	Philip Carpenter
Origin	England
Dimensions	35.3 x 9.5 x 0.9 cm
Format	Multiple slide
Discursive Genre	Zoological
Technique	Hand-painted

State of Preservation
Overall: 4 - Very poor

Glass	Paint	Wood	Paper	Metal
1	4	1	-	2

Damages and observations:

Inventory Number **LM02**
Investigation Code LM03



Title	*Lamp Black*
Date	1850-1858
Producer	W. E. & F. Newton
Origin	England
Dimensions	17.2 x 10.1 x 1.1 cm
Format	Single slipping slide
Discursive Genre	Burlesque
Technique	Hand-painted

State of Preservation
Overall: 2 - Fair

Glass	Paint	Wood	Paper	Metal
2	2	2	3	2

Damages and observations:

Inventory Number **LM03**
Investigation Code LM03



Title	*Best Porter*
Date	1850-1900
Producer	-
Origin	England
Dimensions	17.7 x 10.1 x 0.9 cm
Format	Single slipping slide
Discursive Genre	Burlesque
Technique	Coloured printed outlines

State of Preservation
Overall: 2 - Fair

Glass	Paint	Wood	Paper	Metal
2	2	1	1	3

Damages and observations:

Inventory Number **LM04**
Investigation Code n/a



Title	-
Date	19th century
Producer	-
Origin	-
Dimensions	19.5 x 10 cm
Format	Single lever slide
Discursive Genre	Burlesque
Technique	Hand-painted

State of Preservation
Overall: 3 - Poor

Glass	Paint	Wood	Paper	Metal
1	3	1	-	1

Damages and observations:

Inventory Number **LM05**
Investigation Code n/a



Title	-
Date	19th century
Producer	-
Origin	-
Dimensions	18.2 x 11.4 cm
Format	Single slide
Discursive Genre	Topical
Technique	Hand-painted

State of Preservation
Overall: 1 - Good

Glass	Paint	Wood	Paper	Metal
1	1	1	-	2

Damages and observations:

Inventory Number **LM06**
Investigation Code n/a



Title	-
Date	ca.1860-1900
Producer	Lapierre
Origin	France
Dimensions	33.5 x 8.5 cm
Format	Panorama slide
Discursive Genre	Burlesque
Technique	Coloured printed outlines

State of Preservation
Overall: 2 - Fair

Glass	Paint	Wood	Paper	Metal
1	2	-	3	-

Damages and observations:

Inventory Number **LM07**
Investigation Code n/a



Title	-
Date	ca.1860-1900
Producer	Lapierre
Origin	France
Dimensions	33.5 x 8.5 cm
Format	Panorama slide
Discursive Genre	Burlesque
Technique	Coloured printed outlines

State of Preservation
Overall: 2 - Fair

Glass	Paint	Wood	Paper	Metal
1	2	-	3	-

Damages and observations:

A.3 Preparation methods for the analysis

A.3.1 Disassembling magic lantern slides

Magic lantern slides with more than one glass sheet (21 slides) were temporarily dismounted by removing metallic nails, screws, or rims. Disassembling these slides allowed direct access to the painting and both sides of each glass (A and B), which was essential to analyse these materials. It is crucial to avoid having other materials in contact with the paint, so after disassembly, the glass sheets were placed horizontally with the painted side (side A) facing up.

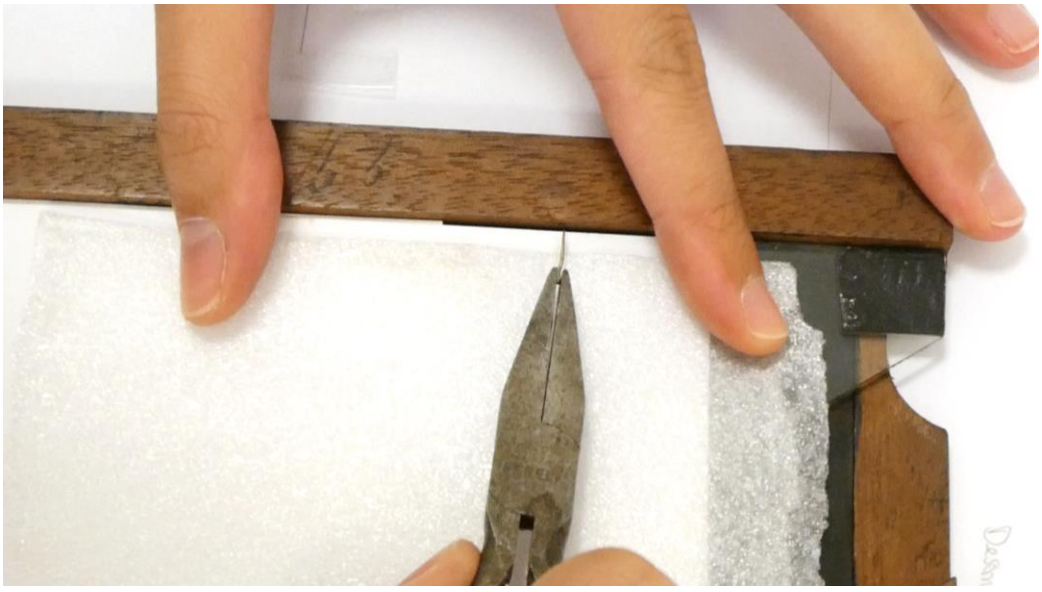


Figure A.2 Process of removing the nails from slide FCT.V.LM03 using a plier. Protective sheets of paper and thin foil of polyethylene foam were always used between the glass and the plier.

A.3.2 Code nomenclature guidelines for slide analyses

The sides of a slide are designated A and B, with side A holding the paint. In cases where the slide is composed of more than one glass sheet (*e.g.,* double slipping slide or triple slipping slide), only the fixed glass is considered. When referring to a single glass sheet, for example, when analysing the glass surface of a movable glass, the side holding the paint is named side A, independently of its positioning regarding the fixed glass sheet. If the glass sheet is only protective and does not hold any paint, its side A is the one in contact with the paint of the primary glass. In a multiple slide, each glass sheet should be numbered from left to right, with side A of the slide facing up. As some slides are more challenging to attribute codes for analysis, a scheme of the codes used for each slide was made when analysing it.

A.3.3 Micro-sampling of paint layers

Micro-sampling of paint layers was carried out using a micro-chisel from Ted Pella microtools under a Leica MZ16 stereomicroscope (7.1x to 115x zoom range) equipped with a Leica ICD digital camera and a fibre-optic light Leica system (Leica KI 1500 LCD). This procedure was mostly done between 50x and 100x magnification. Samples with their respective identifications were stored in concave microscope slides.

A.3.4 Preparation of resin-embedded cross-sections

A method for mounting micro samples in resin was developed considering the small size of this group of samples (maximum size of around 400 µm length and 150 µm thick). The result is an easy-to-handle cylindrical resin-embedded paint sample with the cross-section exposed and perfectly polished for observation under high-magnification microscopes and further analysis.

Under a stereomicroscope, the paint sample should be laid in the centre of a concave microscope slide, with the paint side previously in contact with the original glass support facing down. Then, as shown in **Figure A.3-A**, three drops of Tecnovit® resin should be added with a pipette, embedding all sides of the sample and carefully observing it under magnification. After the resin was cured, but not too hard (~15 min UV-light exposure), it was cut in a square shape with sides around 4-5 mm using a scalpel, keeping the sample in the middle. This way, a larger and thicker contact area is obtained to manipulate the sample easily. It should be noted that, in this case, the side of the resin with a slight curve will correspond to the side of the sample that was initially in contact with the original glass support.

The second part of the process consists of cutting the cover and pointy part of a micro-Eppendorf so that only the cylindrical portion is kept (**Figure A.3-B**). A double tape or a small portion of adhesive (*e.g.,* a fast-setting solvent-based adhesive such as Paraloid® B-72) should be placed in the centre of a flat microscope slide, and the embedded sample should be glued to it, using micro tweezers, this time with the cross-section side wanted for observation facing down (**Figure A.3-C**). At this point, the side of the sample corresponding to the area in contact with the original glass support should be marked for future reference. Once the sample is secured, the cylindrical portion of the Eppendorf should be placed on top and the join between the rim in contact with the glass should be sealed with adhesive (e.g., Paraloid® B-72) (**Figure A.3-C**).

After the sample and cylinder are secured in the desired position, the cylinder should be filled with the Tecnovit® resin and cured (~20 min UV-light exposure) (**Figure A.3-D**). Afterwards, the cylinder should be separated from the glass microscope slide and cut with a scalpel from top to bottom to remove it from the resin-embedded sample moulded inside (**Figure A.3-E**). Finally, the resinous cylinder should be carefully polished using Micro-Mesh™ Polishing Cloths under the stereomicroscope to remove the residual adhesive or tape and excess resin (**Figure A.3-F**), until the sample cross-section side is exposed and ready for examination (**Figure A.3-G**).

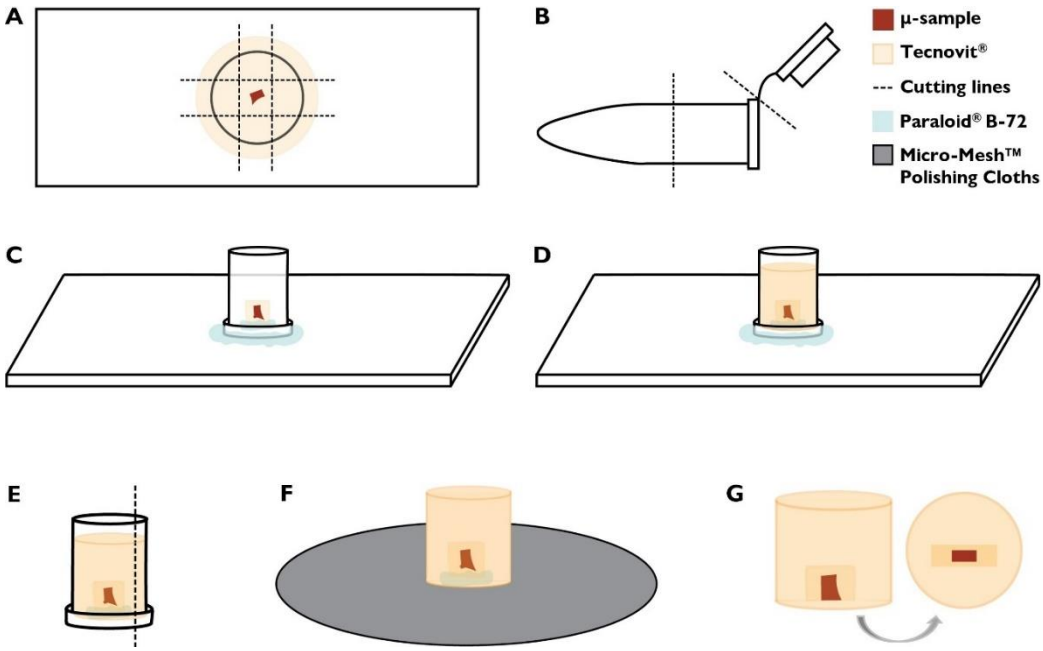


Figure A.3 Schematic representation of the process of preparing resin-embedded cross-sections according to the instructions described.

A.4 Instrumentation and data acquisition

Microscopy

Low-magnification microscope: Surface observation and sampling

The slides' surface examination, detailed photography, and paint sampling were conducted under a Leica MZ16 stereomicroscope equipped with a Leica ICD digital camera and a fibre-optic light Leica system (Leica KI 1500 LCD). Using a set of 10x ocular lenses and objectives ranging from 0.71x up to 11.5x magnification gives a total resolution between 7.1x and 115x.

High-magnification microscope: Paints' cross-section observation

Images of paint cross-sections were obtained using a Zeiss® Axioplan 2 IE microscope equipped with a transmitted and incident halogen light (tungsten light source, HAL 100), UV light (mercury light source, HBO 100 illuminator), and a digital camera Nikon® DXM1200F (using Nikon® ACT-1 microphotography software). Samples were analysed with 10x ocular lenses and 10x/20x/50x objective Epiplan lenses, giving a total optical magnification of 100x, 200x, and 500x, respectively. For the incident and transmitted light (normal light), the samples were analysed under crossed polars – polariser and analyser filters, and for UV light, the Zeiss filter set 2 (BP300-400, FT 395, LP 420) was used. The scales for all objectives were calibrated within the Nikon ACT-1 software.

Energy Dispersive X-Ray Fluorescence (EDXRF) Spectrometry

EDXRF analyses were performed directly on the objects using a portable ArtTAX 800 spectrometer from Bruker, equipped with a molybdenum (Mo) X-ray source (anode) and an electro-thermally Peltier-cooled XFlash® silicon drifted detector with a resolution of 170 eV. The accurate positioning system and focusing polycapillary X-ray mini lens enabled a small area of primary radiation (70 µm diameter) in the sample. The spectrometer was operated at 40 kV of voltage, 0.6 µA of intensity, and an acquisition time of 120-360 and 360 seconds for the paint and glass, respectively. Measurements were carried out in a helium atmosphere to allow the detection of low Z elements down to the aluminium (Al). Each material was examined in at least three areas. Regarding glass, both sides (A and B) were analysed, totalling six examined areas.

Data processing for the glass support

The semi-quantitative analysis was achieved with the WinAXIL program using spectra obtained from glass standards (A, B, C and D from Corning Museum of Glass (CMoG), Corning, NY, USA), under the same conditions, for validation. The calculated error associated with SiO_2, and CaO is below 5 %. For, SrO and BaO, the error is below 10 %. Regarding K_2O, MnO, Fe_2O_3, PbO, SnO_2 and, the error varies between less than 5 % to 15 %. The error for CuO and ZnO varies between less than 5 % to 20 %, for P_2O_5 is below 25 %, and for TiO_2 is below 30 %. These errors are valid, assuming the glass surface was not significantly corroded. The range of quantities presented for light elements, such as sodium, magnesium, and aluminium, is merely indicative given the equipment and glass standards limitations. The Na_2O and MgO concentrations were calculated with the "matrix by difference" method, which does not allow for separating these elements from other light elements that may exist in the glass.

Ultraviolet-Induced Visible Fluorescence (UVIVF) photography

The slides were irradiated with a Model UVL-56 hand-held Blak-Ray Lamp with 365 nm long wave UV light output. The visible fluorescence photography was captured by a Xiaomi Mi A3 48 Mp digital camera with a 1/2" image sensor behind a f/1.79 26 mm lens and by a Canon EOS R5 equipped with a Canon RF 24-70 mm f/2.8L IS USM lens inside a black Godox Ministudio box.

Ultraviolet-Visible Spectroscopy (UV-VIS)

Absorbance spectra

Most slides were analysed in absorbance mode using an AvaSpec-2048-SPU spectrophotometer equipped with the light source AvaLight-HAL Deuterium Halogen (Avantes). The AvaSoft software controlled the acquisition of the spectra directly on the objects in the 200–1100 nm range. The measurements used 10-50 ms integration time and 20-50 accumulations.

Reflectance spectra

The paint was too opaque to measure with the previous set-up on the set of 11 slides attributed to 18th-century Italy from the CPMC collection. In this case, reflectance spectra were acquired with an Ocean Optics MAYA 200 PRO spectrometer incorporating a dispersive fibre-optic single-beam with a 2048 linear silicon CCD array detector (Hamamatsu) and a halogen light source (Ocean Optics HL-200-HP 20 W), with an optical path covering the 360-2400 nm range. The measurements were performed in a geometry of 45 /45 (illumination/acquisition angles) configuration, giving a diameter of analysis of about 2 mm, with an integration time of 8 ms and an average of 15 scans. A Certified Spectralon® White Diffuse Reflectance Standard (99 %) was used for calibration. The spectra were acquired in reflectance; however, in this work, the spectra are presented as apparent absorbance, $A' = Log_{10}(1/R)$.

Raman Spectroscopy (μ-Raman)

Raman spectroscopy was carried out using a Labram 300 Jobin Yvon spectrometer with a 17 mW HeNe laser operating at 632.8 nm. Spectra were recorded as an extended scan. The laser beam was focused with a 50x Olympus objective lens, and the laser power at the surface of the samples was controlled using a set of neutral density filters varying between 0.6 and 2. All samples were analysed using 15 seconds of laser exposure time for 10 scans.

Surface-Enhanced Raman Spectroscopy (SERS)

Silver colloid synthesis and sample pre-treatments

Silver colloids for SERS were prepared by chemical reduction of silver nitrate with sodium citrate, following the synthetic protocol published by Lee and Meisel (1982). SERS analysis was performed after depositing around 0.8 μl of the Ag colloid and 0.1 μl of 0.5 mol l-1 KNO_3 aqueous solution onto each micro-sample.

Spectra collection

The spectra were collected using the Raman spectroscope previously described, using the same operating conditions, by focusing the laser beam onto the micro-aggregates that formed inside the paint-colloid droplet a few seconds after the deposition of the Ag nanoparticles and KNO_3. Spectra were acquired continuously until the droplet dried out.

Fourier Transform Infrared Spectroscopy (μ-FTIR)

Infrared analyses were conducted with a Nicolet Nexus bench spectrophotometer coupled to a Continuμm microscope (15x Objective) and an MCT-A detector cooled by liquid nitrogen. Micro-samples were previously compressed using a Thermo diamond anvil compression cell. The spectra were obtained in transmission mode, between 4000 and 650 cm^{-1}, with a resolution of 8 cm^{-1}, and 128 scans (in a few cases, 256 scans were used), and with a spot size of 50 x 50 microns. The spectra are shown as acquired, without corrections or further manipulations, except for removing the CO_2 absorption at ~2300-2400 cm^{-1}.

Relative Humidity and Temperature measurements

The relative humidity and temperature were measured and recorded with Rotronic HL-1D/TL-1D thermo-hygrometer devices. Measurements were automatically recorded every two hours in the Portuguese Cinematheque storage and display rooms. One device was placed on a shelf in the storage room (ANIM, Loures). Two devices were placed in the exhibition room (Cinematheque Junior, Foz Palace, Lisbon), one inside the main display cabinet and the other outside. The storage data was recorded between the 21st of April 2021 and the 21st of April 2022. The exhibition data was recorded between the 3rd of November 2021 and the 6th of July 2022.

Visible Light and UV Radiation measurements

The Visible light and Ultraviolet (UV) radiation were manually recorded using an ELSEC 764 UV+ Monitor in several areas of the Portuguese Cinematheque storage and display rooms. Measurements were undertaken in the storage room (ANIM, Loures) on the 21st of April 2021 and the display room (Cinematheque Junior, Foz Palace, Lisbon) on the 3rd of November 2021.

pH measurements

A Sartorius Docu-pH meter with a Hamilton electrode was used to measure the pH of each aqueous cleaning system used in the cleaning tests (*Subsection 5.3.1*).

Colourimetry

A Microflash portable colourimeter from DataColour International was used to measure the colour before and after cleaning (*Subsection 5.3.1*). The optical system uses diffuse illumination from a Xenon lamp over an 8 mm-diameter area using the D65 illuminant and CIE-Lab 10º observer settings. A bright white standard plate and a total black standard were used for calibration. The slides were measured three times, over filter paper, which provided a neutral white background. As the human eye perceives, colour may be represented in a three-dimensional system. The colour data are presented in the CIE-Lab system. In the Lab cartesian system, L^*, relative brightness, is represented by the z-axis, and its variations range from white ($L^*=100$) to black ($L^*=0$). The (a^*, b^*) pair represents the object's hue, the red/green y-axis plots a^* ranging from negative values (green) to positive (red), and the yellow/blue x-axis reports b^* going from negative (blue) to positive numbers (yellow). Total colour variation (ΔE^*) was calculated according to the expression $\Delta E^*=[(\Delta L^*)^2+(\Delta a^*)^2+(\Delta b^*)^2]^{1/2}$, where ΔL^*, Δa^* and Δb^* are the differences in the respective values before and after cleaning.

A.5 Mapping of the areas analysed



Figure A.4 Slide CPMC-PC0002/001: mapping areas of analyses by EDXRF and Raman spectroscopies, and micro-samples collection. In each glass, side **A** is the painted side.

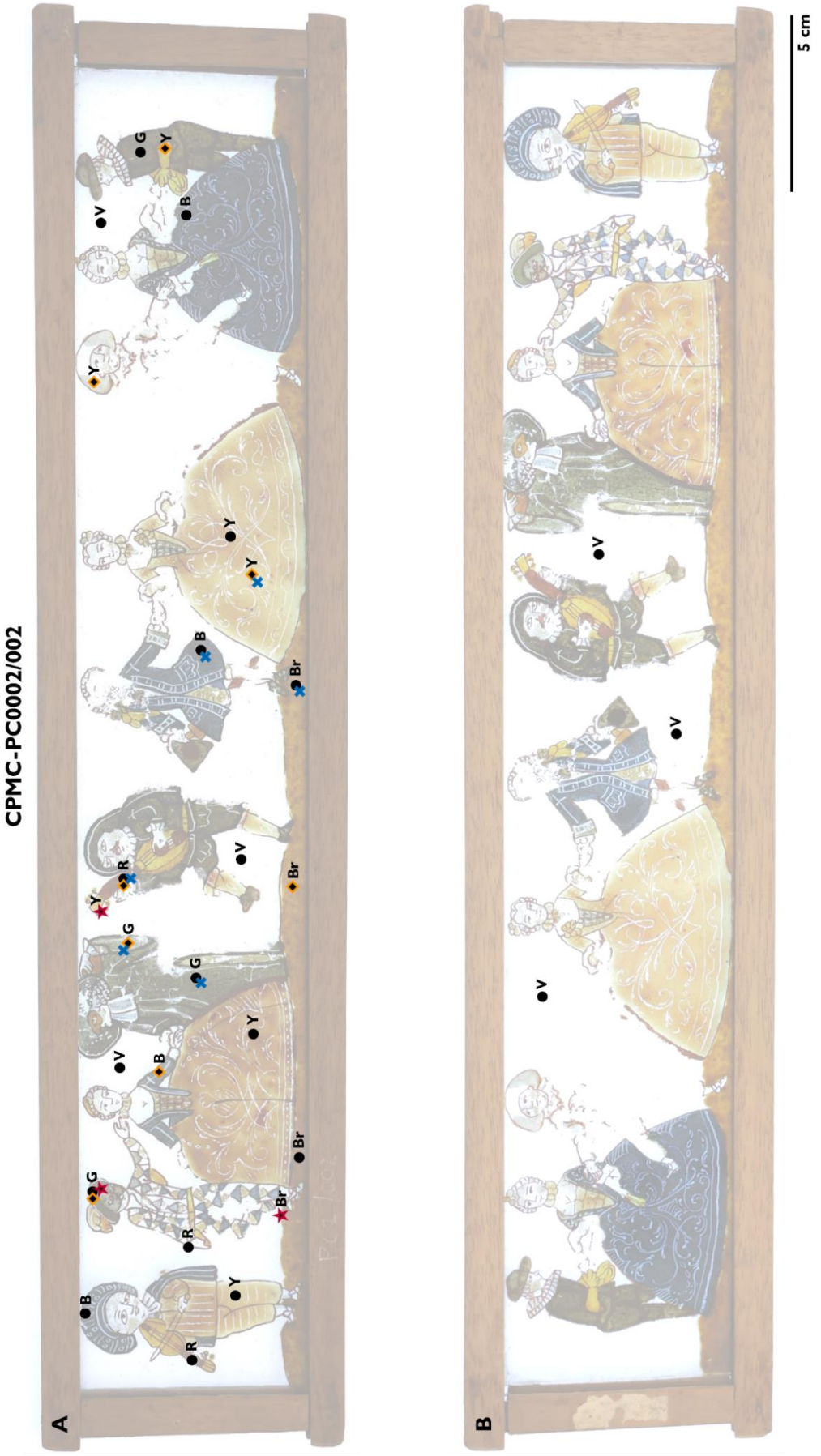


Figure A.5 Slide CPMC-PC0002/002: mapping areas of analyses by EDXRF, UV-VIS and Raman spectroscopies, and micro-samples collection. In each glass, side **A** is the painted side.

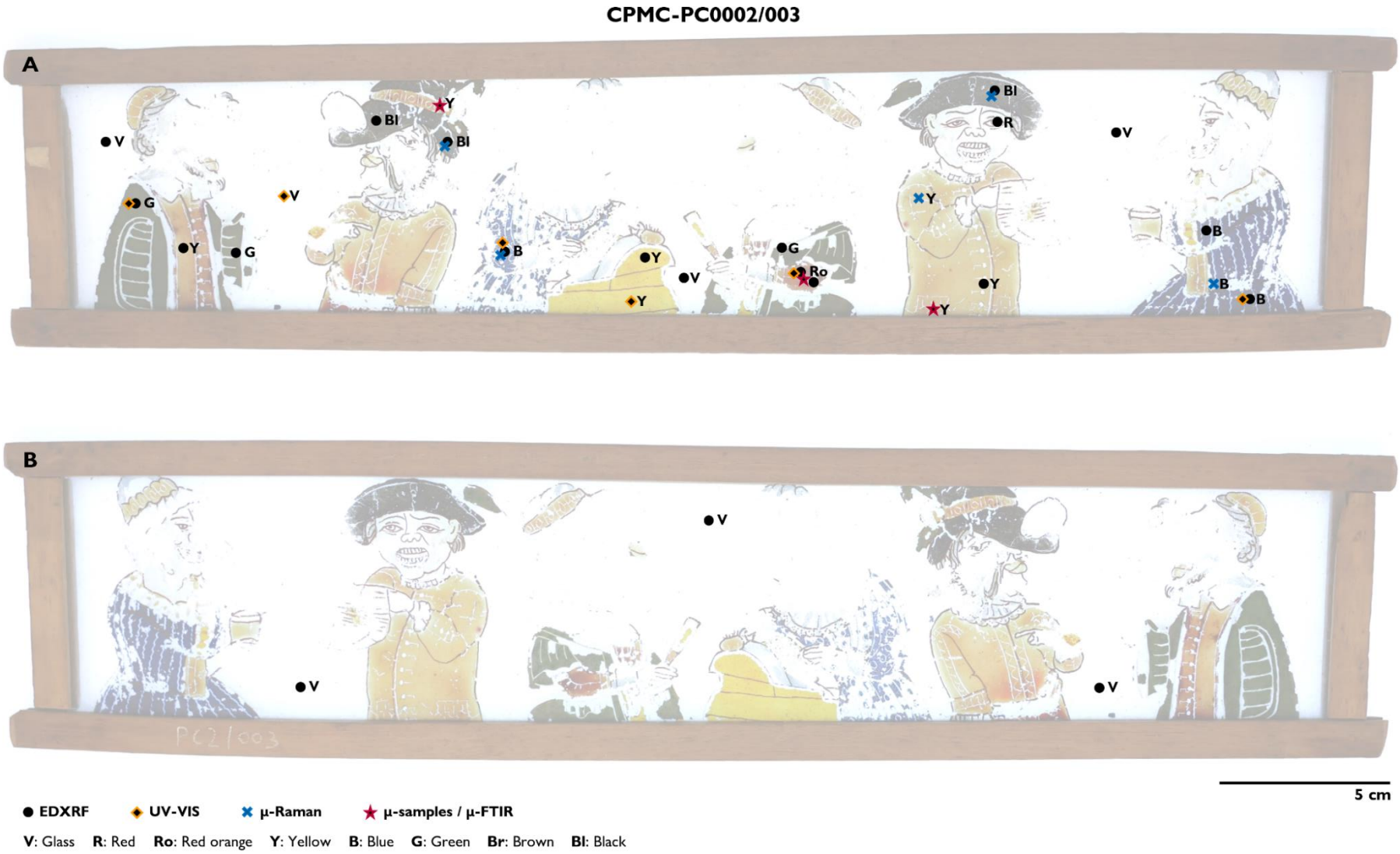


Figure A.6 Slide CPMC-PC0002/003: mapping areas of analyses by EDXRF, UV-VIS and Raman spectroscopies, and micro-samples collection. In each glass, side A is the painted side.

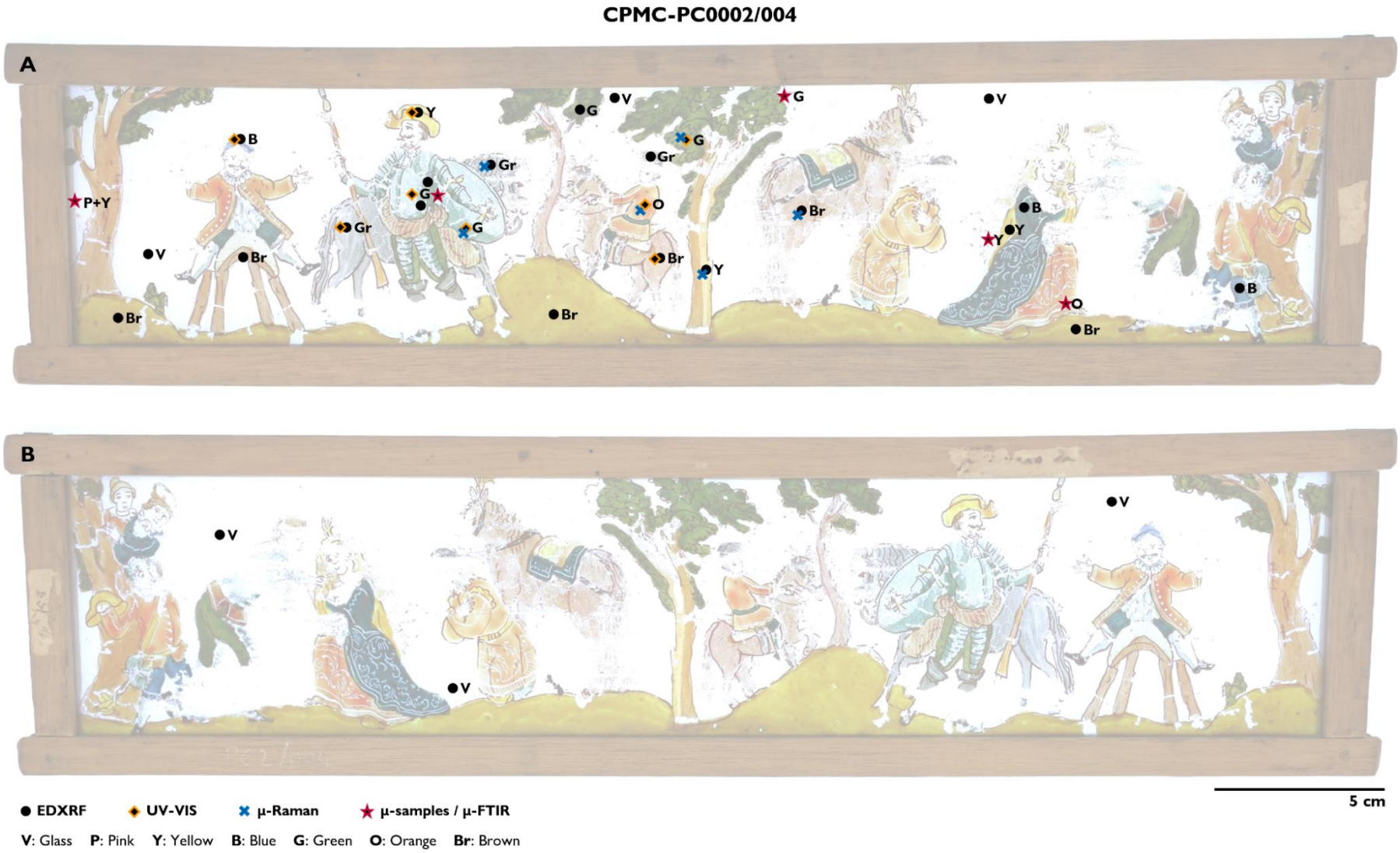


Figure A.7 Slide CPMC-PC0002/004: mapping areas of analyses by EDXRF, UV-VIS and Raman spectroscopies, and micro-samples collection. In each glass, side A is the painted side.

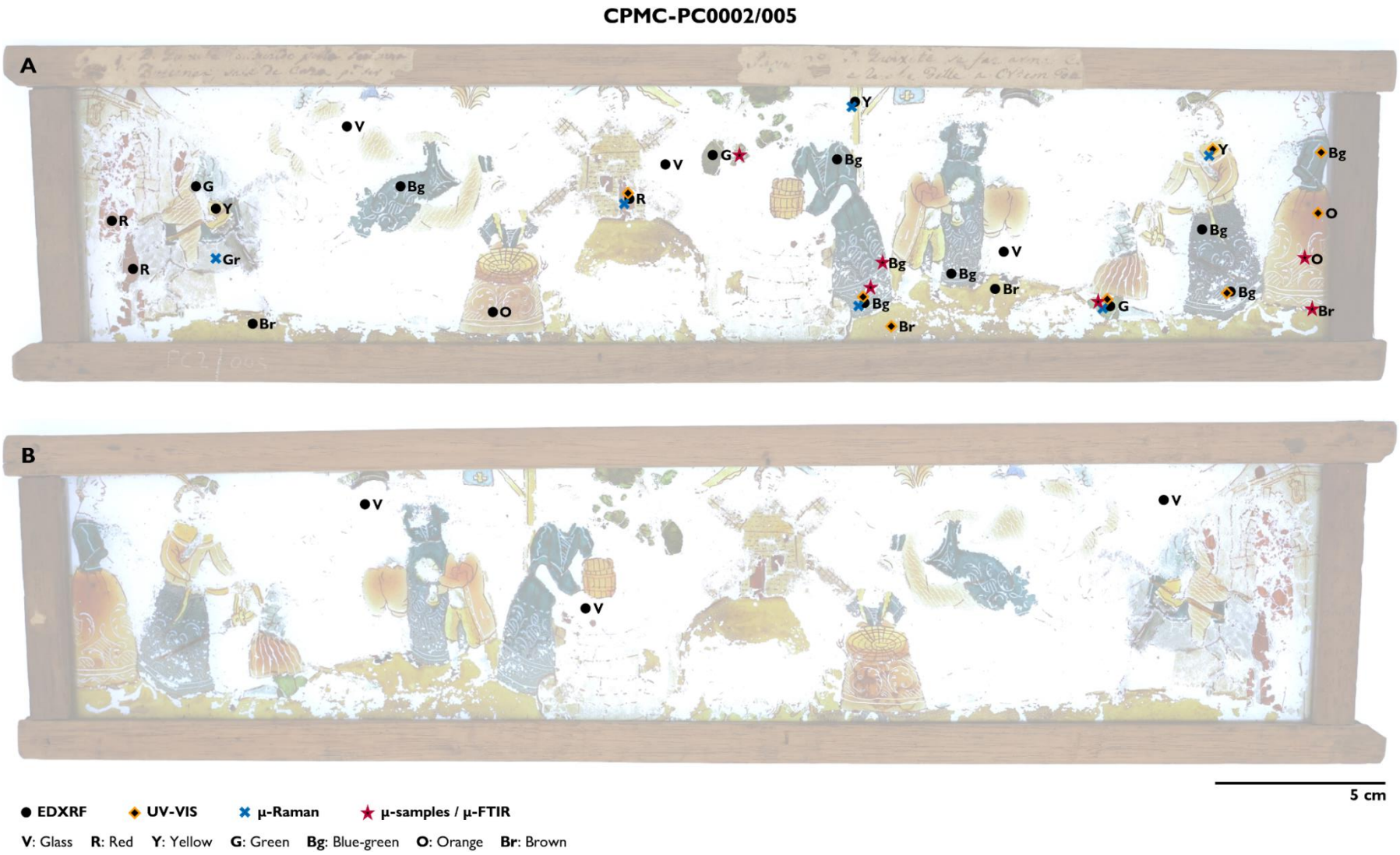


Figure A.8 Slide CPMC-PC0002/005: mapping areas of analyses by EDXRF, UV-VIS and Raman spectroscopies, and micro-samples collection. In each glass, side A is the painted side.

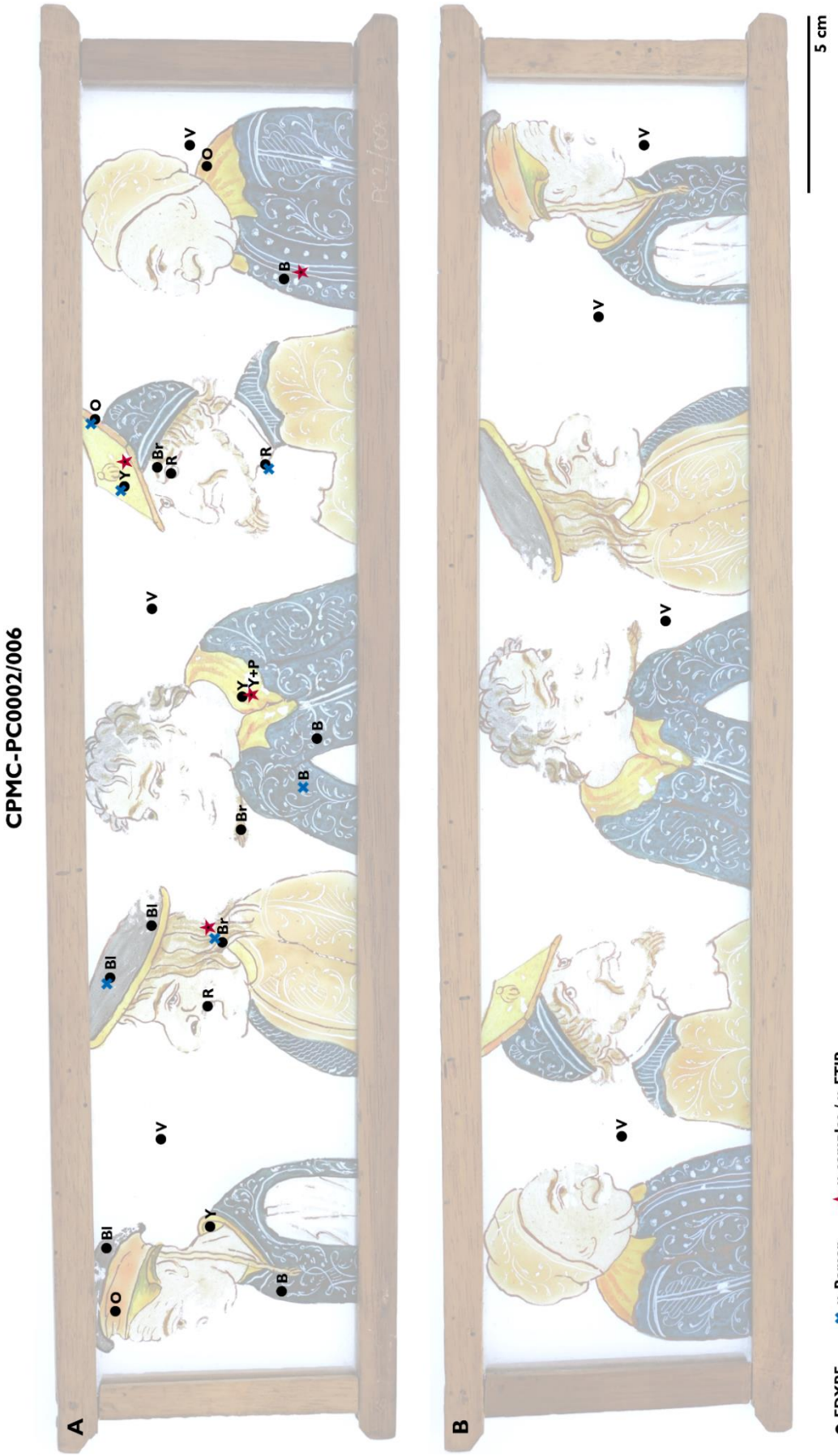


Figure A.9 Slide CPMC-PC0002/006: mapping areas of analyses by EDXRF and Raman spectroscopies, and micro-samples collection. In each glass, side **A** is the painted side.

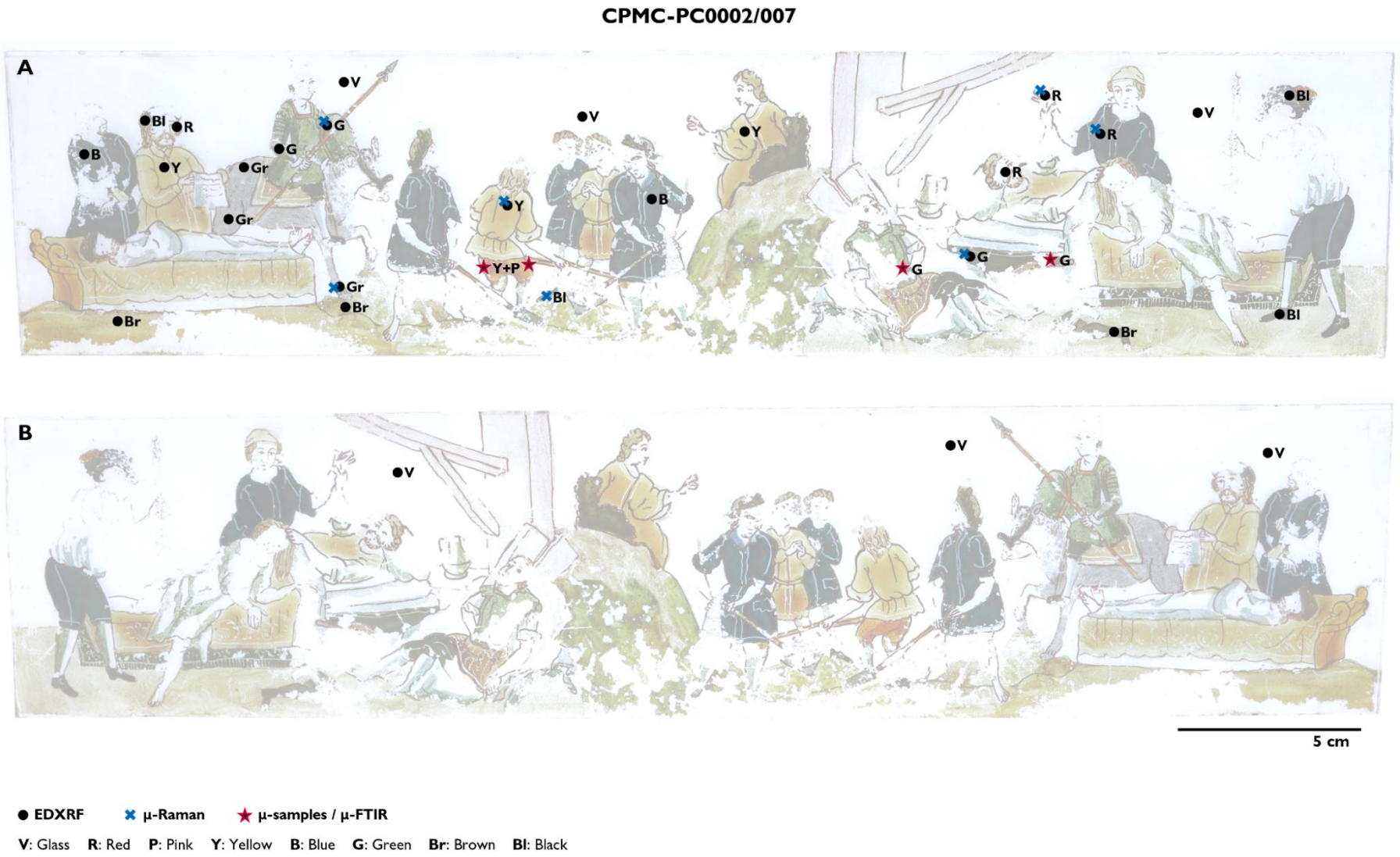


Figure A.10 Slide CPMC-PC0002/007: mapping areas of analyses by EDXRF and Raman spectroscopies, and micro-samples collection. In each glass, side A is the painted side.

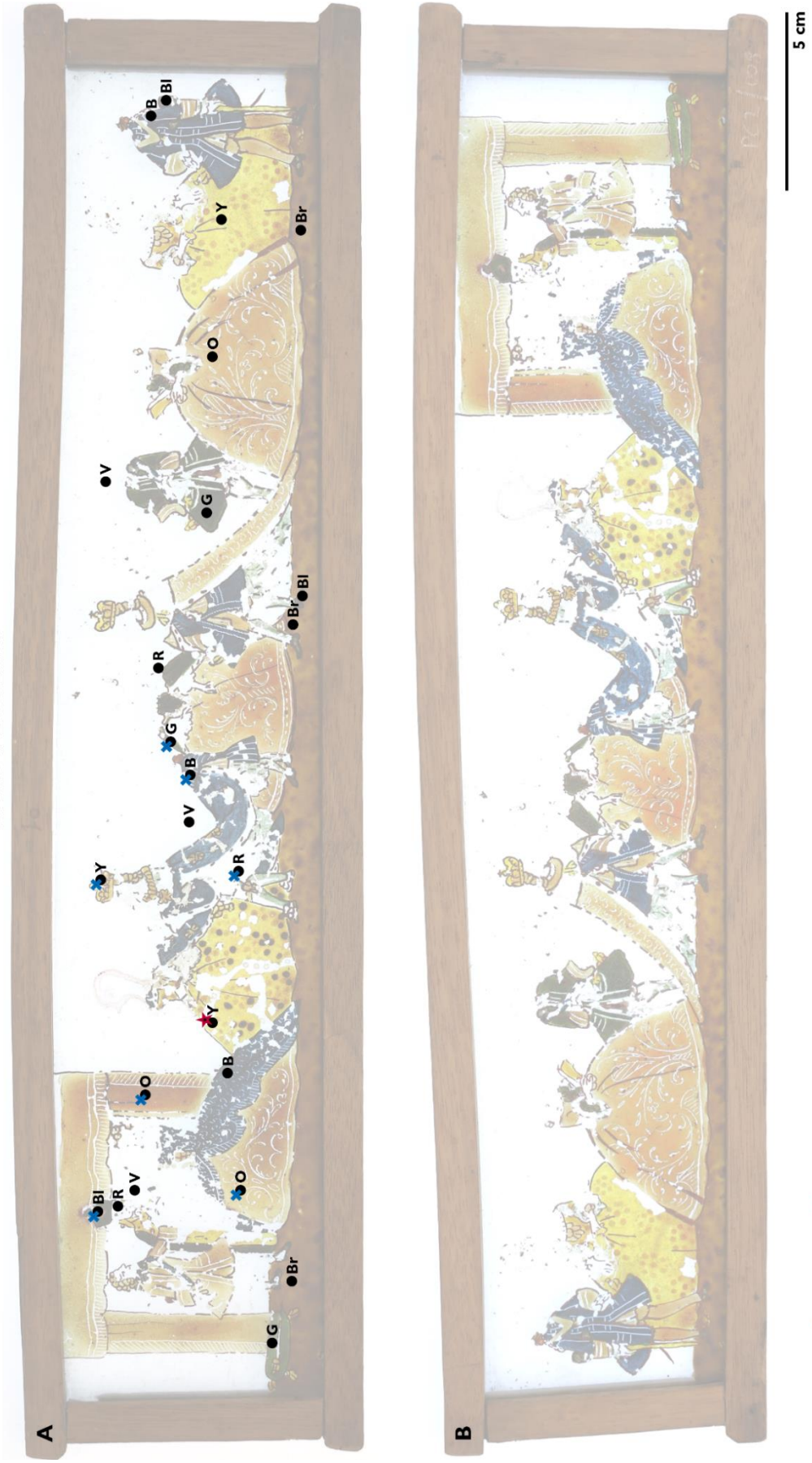


Figure A.11 Slide CPMC-PC0002/008: mapping areas of analyses by EDXRF and Raman spectroscopies, and micro-samples collection. In each glass, side **A** is the painted side.

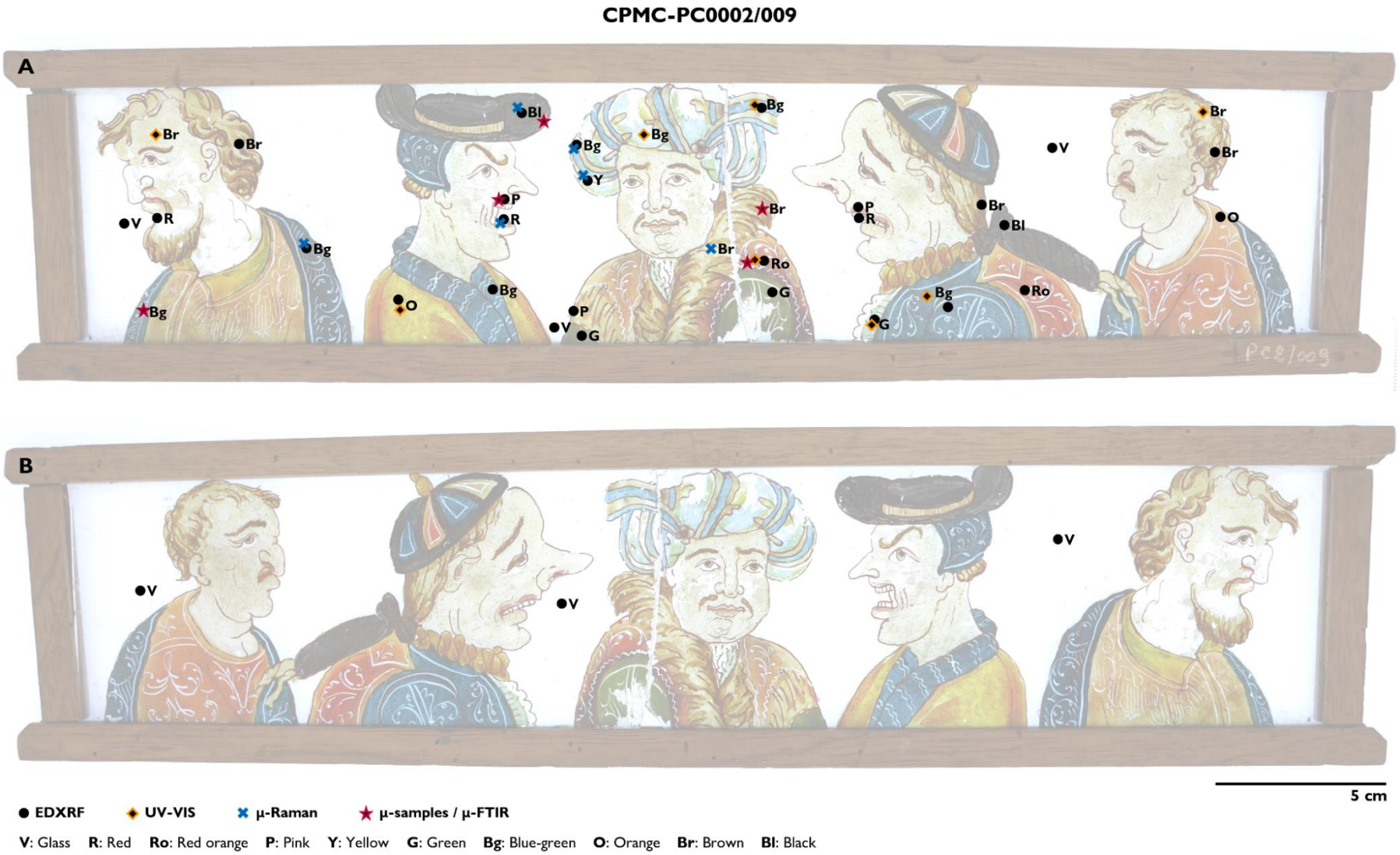


Figure A.12 Slide CPMC-PC0002/009: mapping areas of analyses by EDXRF, UV-VIS and Raman spectroscopies, and micro-samples collection. In each glass, side A is the painted side.

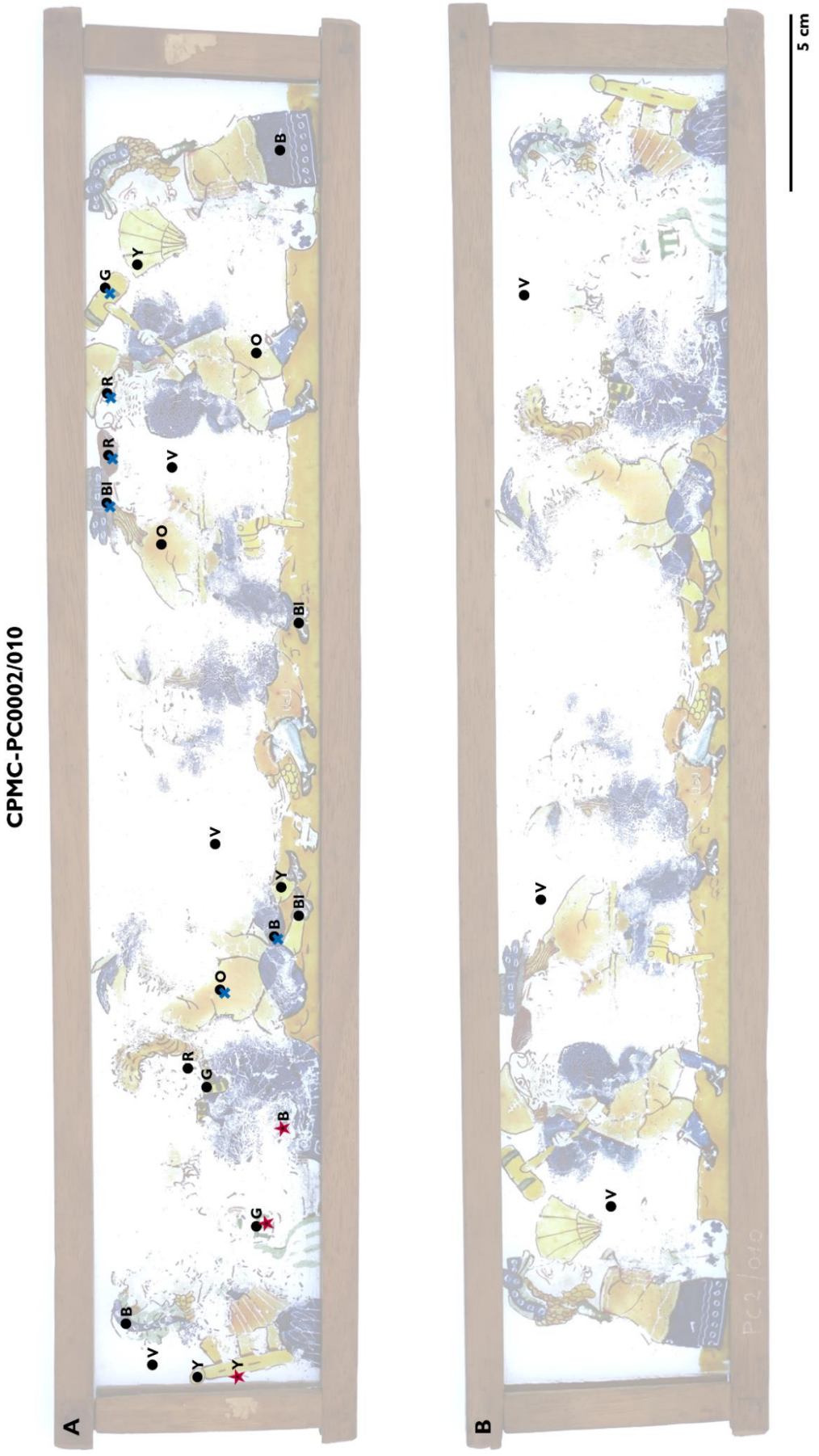


Figure A.13 Slide CPMC-PC0002/010: mapping areas of analyses by EDXRF and Raman spectroscopies, and micro-samples collection. In each glass, side **A** is the painted side.

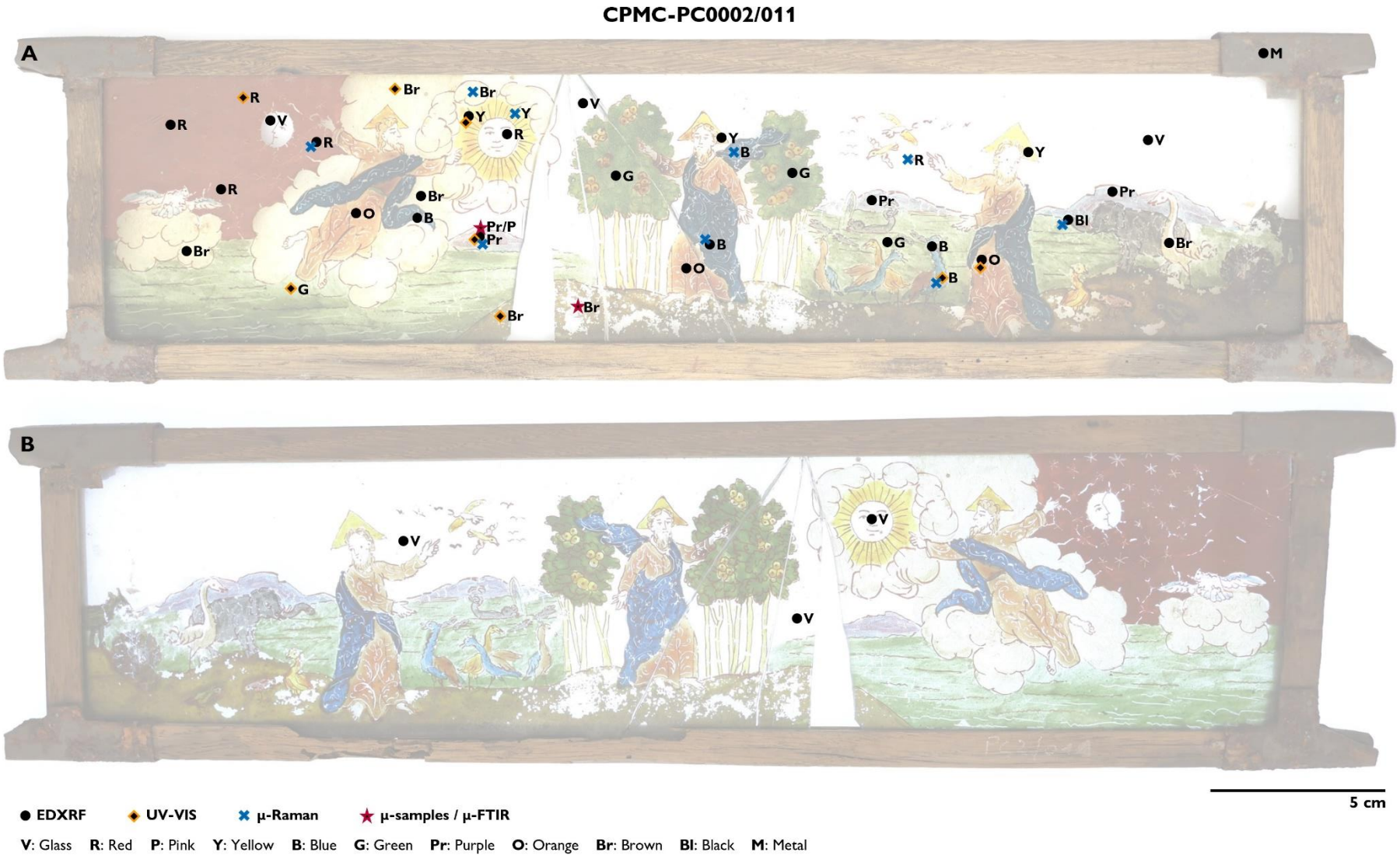


Figure A.14 Slide CPMC-PC0002/011: mapping areas of analyses by EDXRF, UV-VIS and Raman spectroscopies, and micro-samples collection. The painted side of each glass is identified as A.

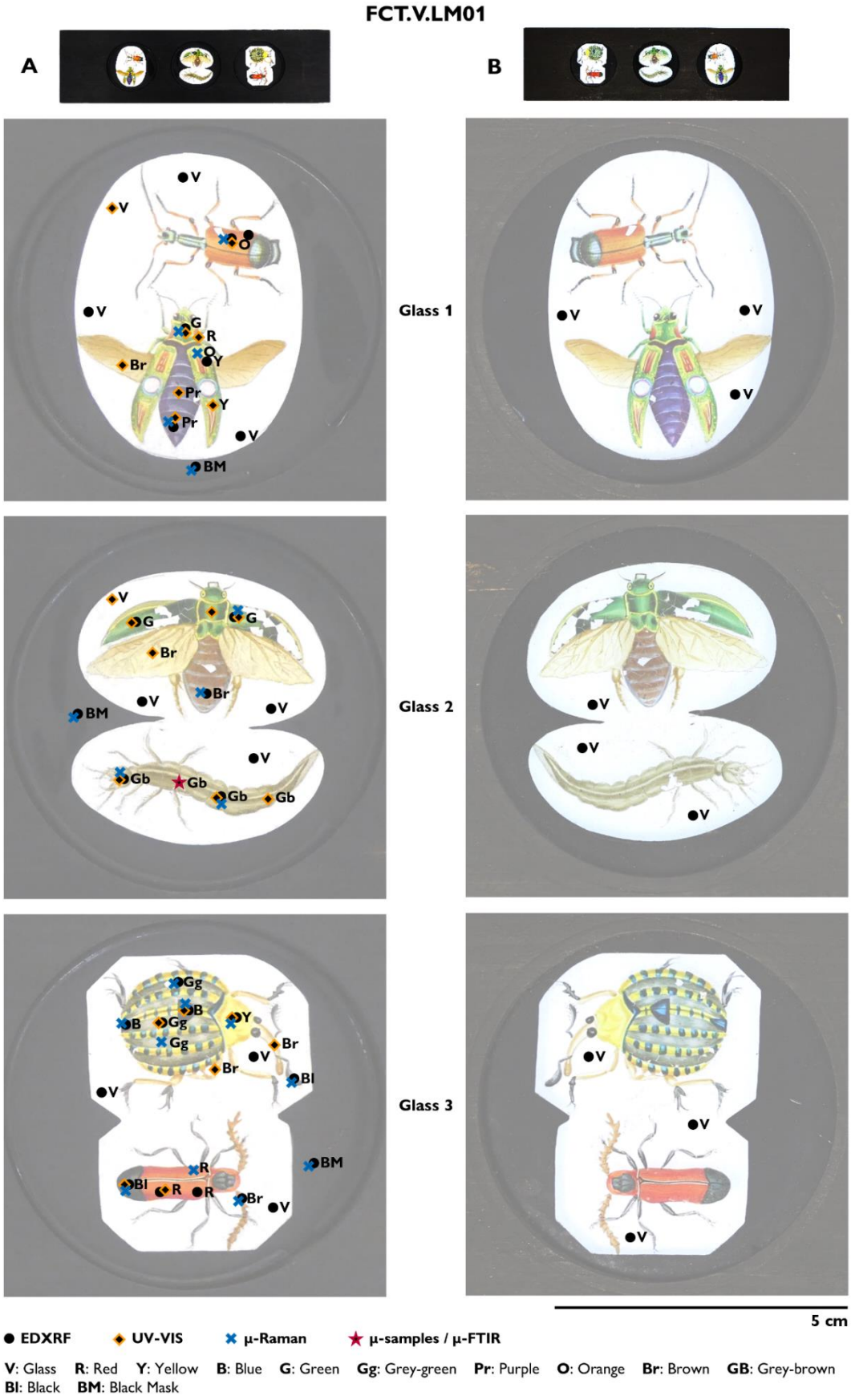


Figure A.15 Slide FCT.V.LM01 by P. Carpenter: mapping areas of analyses by EDXRF, UV-VIS and Raman spectroscopies, and micro-samples collection. The painted side of each glass is identified as A.

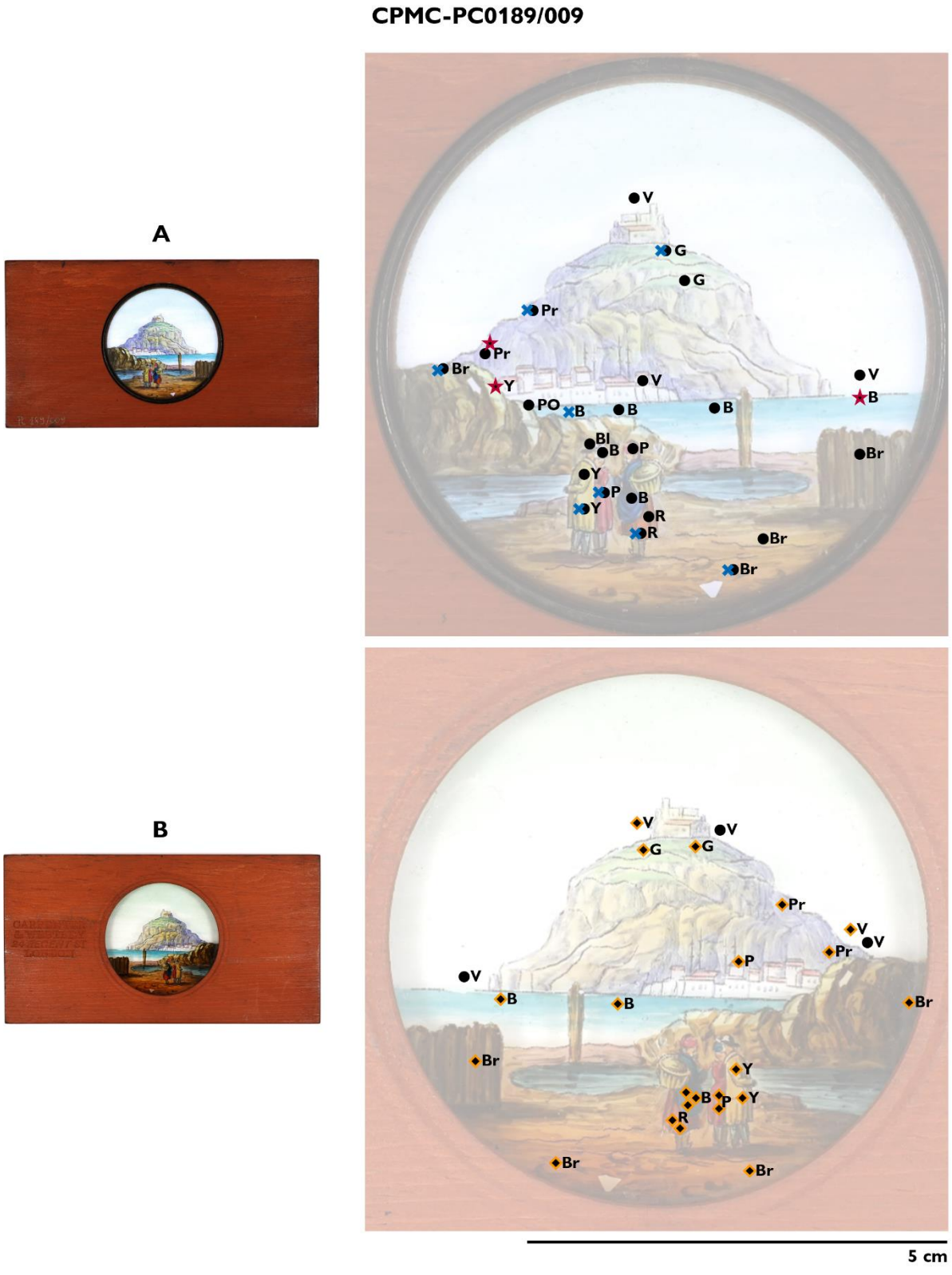


Figure A.16 Slide CPMC-PC0189/009 by C&W: mapping areas of analyses by EDXRF, UV-VIS and Raman spectroscopies, and micro-samples collection. The painted side of each glass is identified as A.

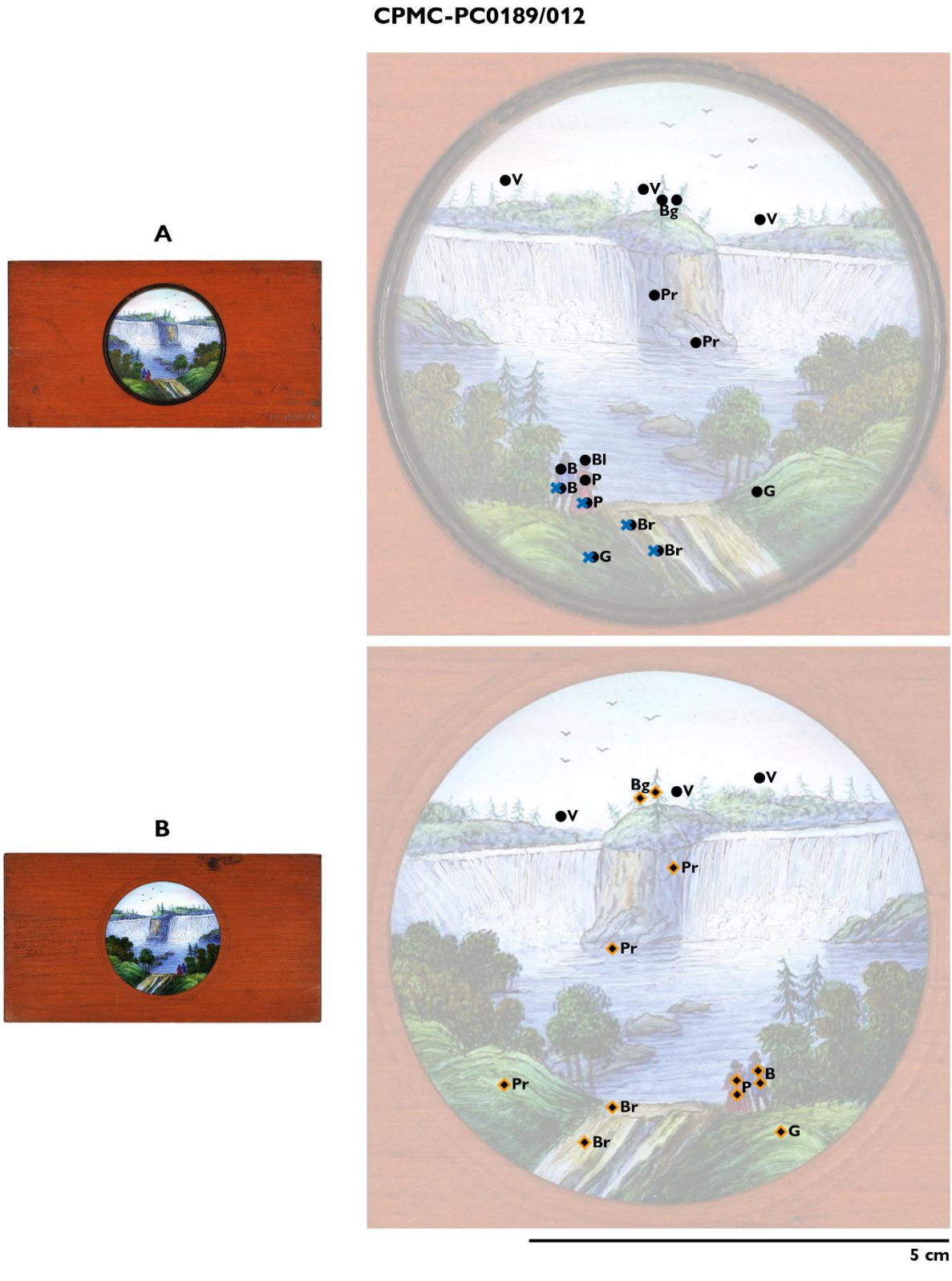


Figure A.17 Slide CPMC-PC0189/012 by C&W: mapping areas of analyses by EDXRF, UV-VIS and Raman spectroscopies. The painted side of each glass is identified as A.

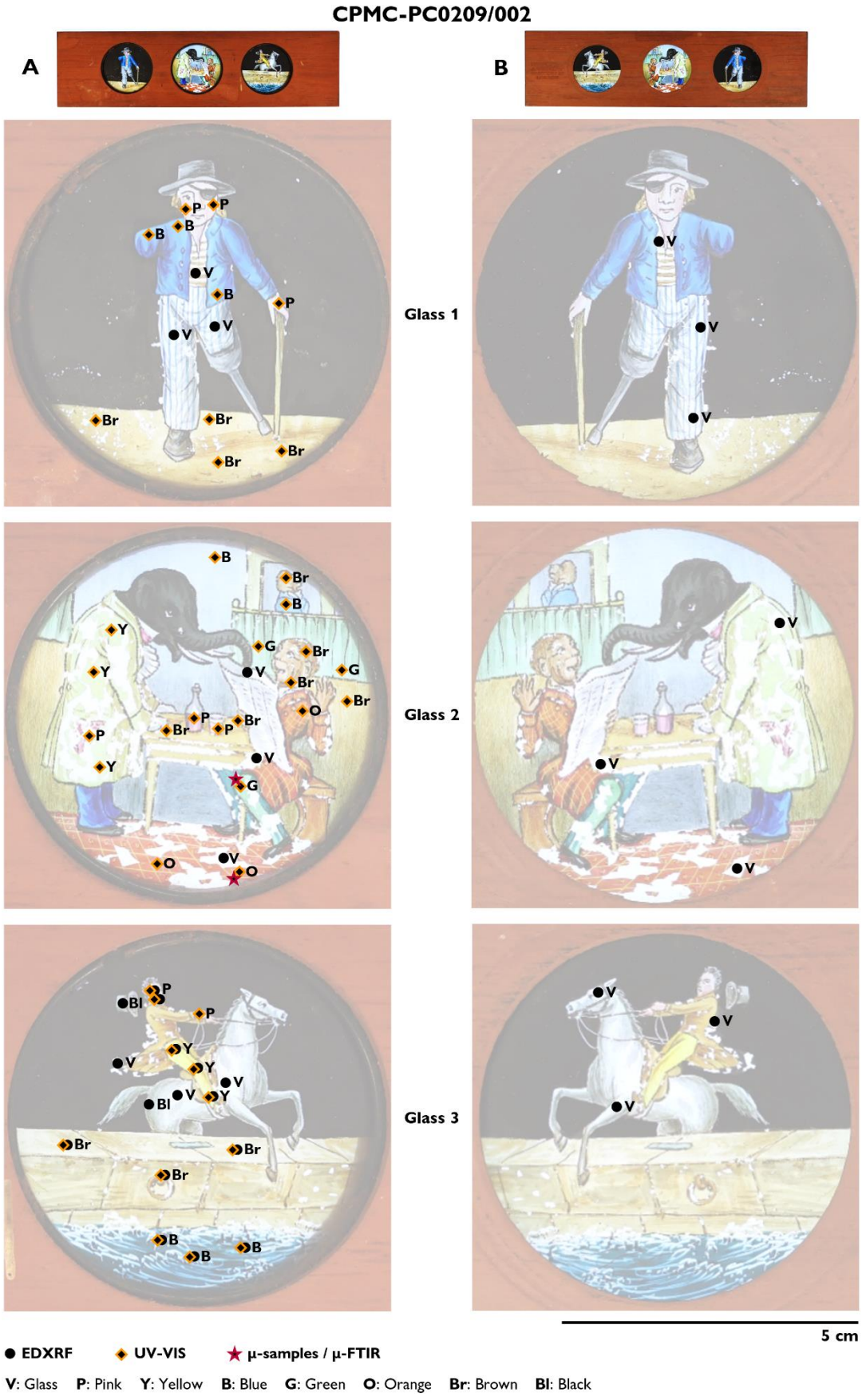


Figure A.18 Slide CPMC-PC0209/002 by C&W: mapping areas of analyses by EDXRF and UV-VIS spectroscopies, and micro-samples collection. The painted side of each glass is identified as A.

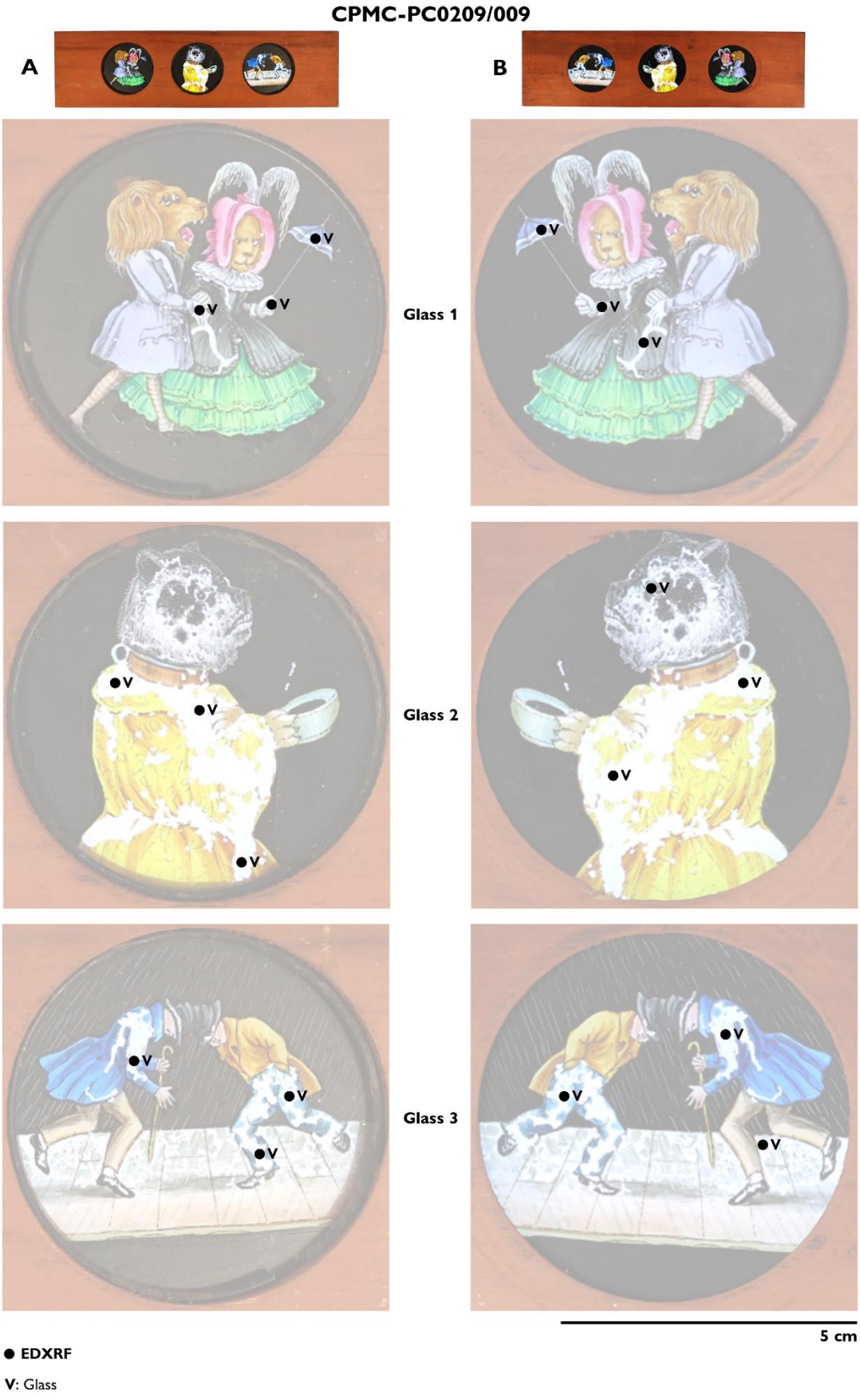


Figure A.19 Slide CPMC-PC0209/009 by C&W: mapping areas of analyses by EDXRF spectroscopy. The painted side of each glass is identified as A.

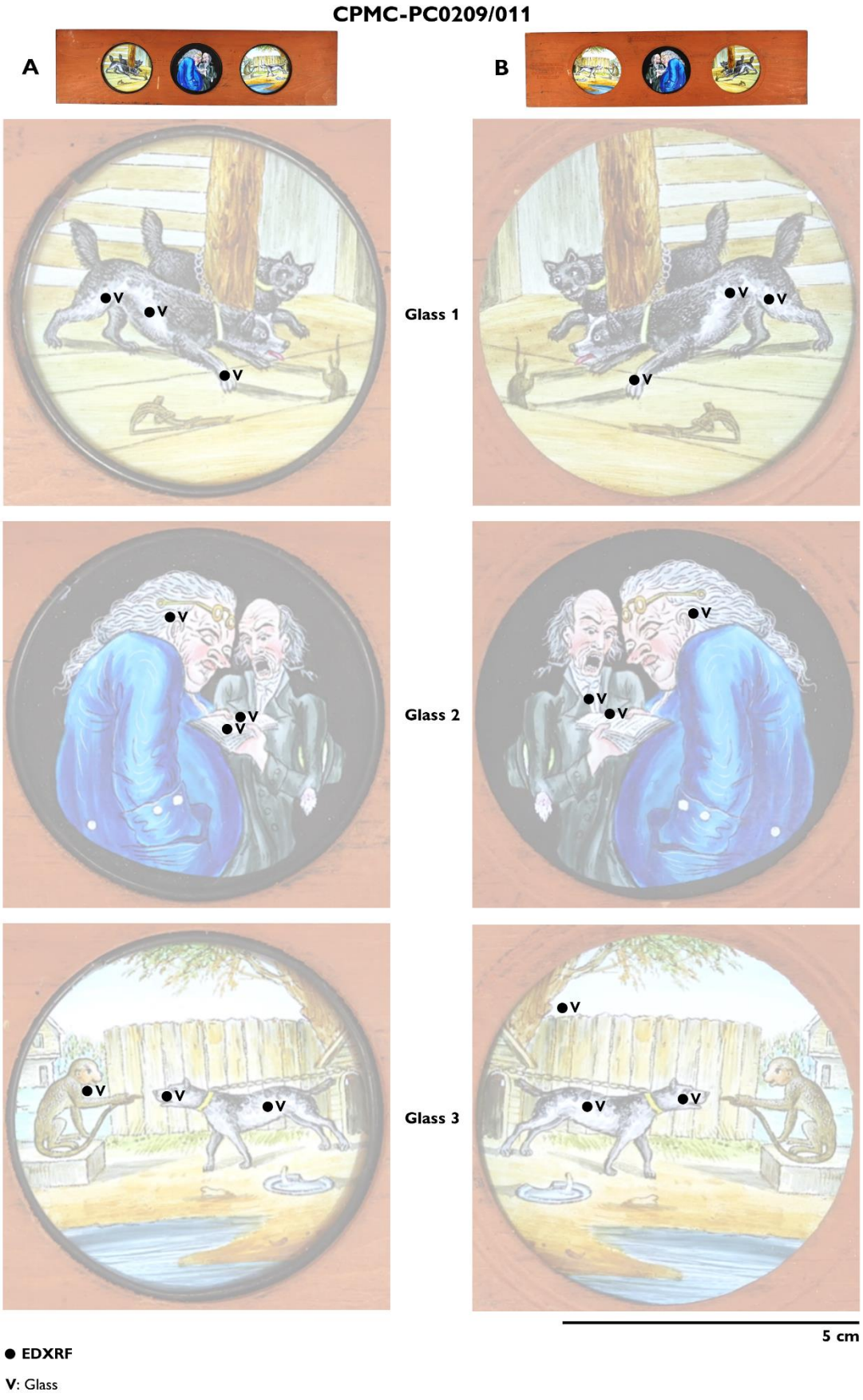


Figure A.20 Slide CPMC-PC0209/011 by C&W: mapping areas of analyses by EDXRF spectroscopy. The painted side of each glass is identified as A.

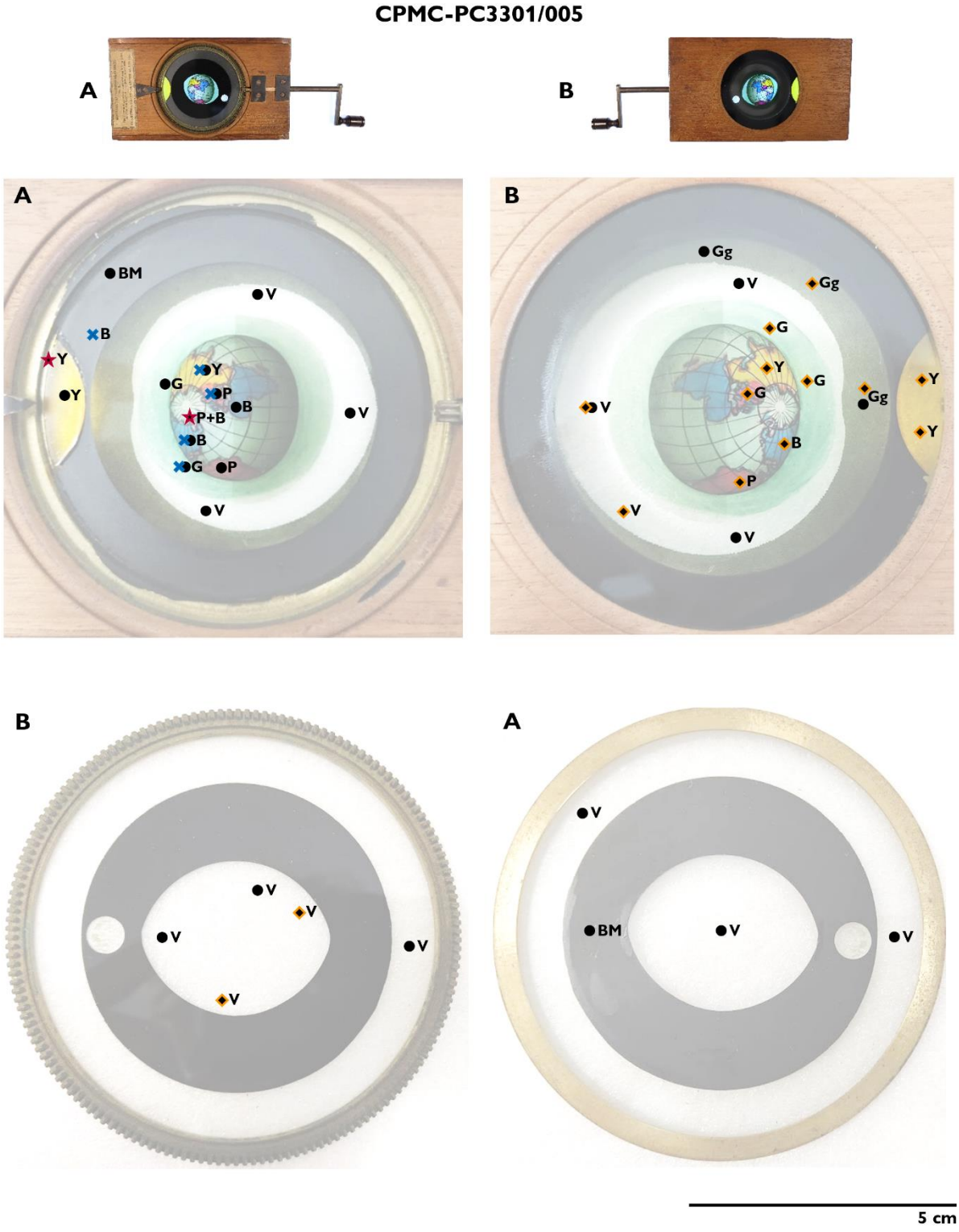


Figure A.21 Slide CPMC-PC3301/005 by C&W: mapping areas of analyses by EDXRF, UV-VIS and Raman spectroscopies, and micro-samples collection. The painted side of each glass is identified as A.

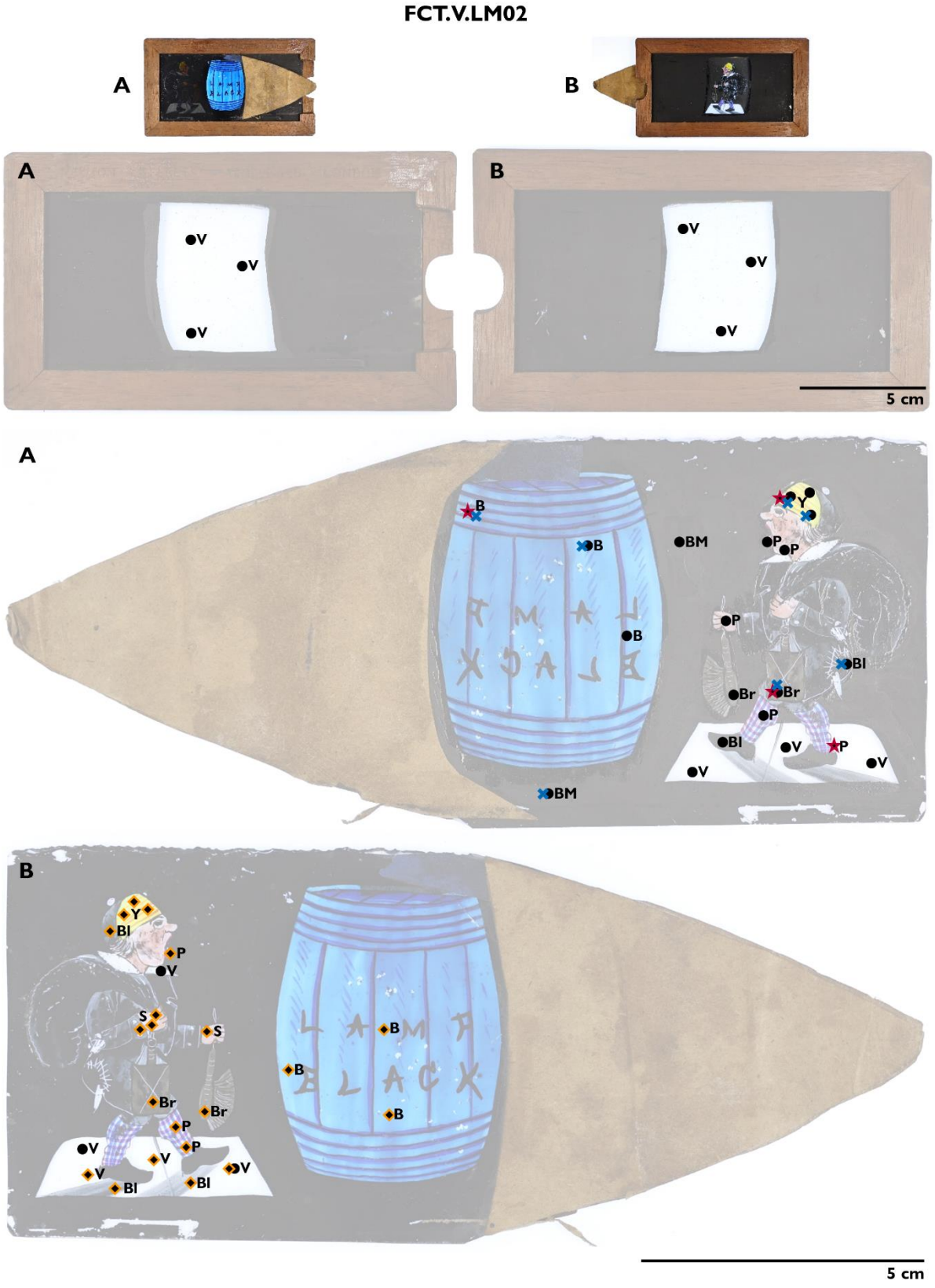


Figure A.22 Slide FCT.V.LM02 by W.E. & F. Newton: mapping areas of analyses by EDXRF, UV-VIS and Raman spectroscopies, and micro-samples collection. The painted side of each glass is identified as A.

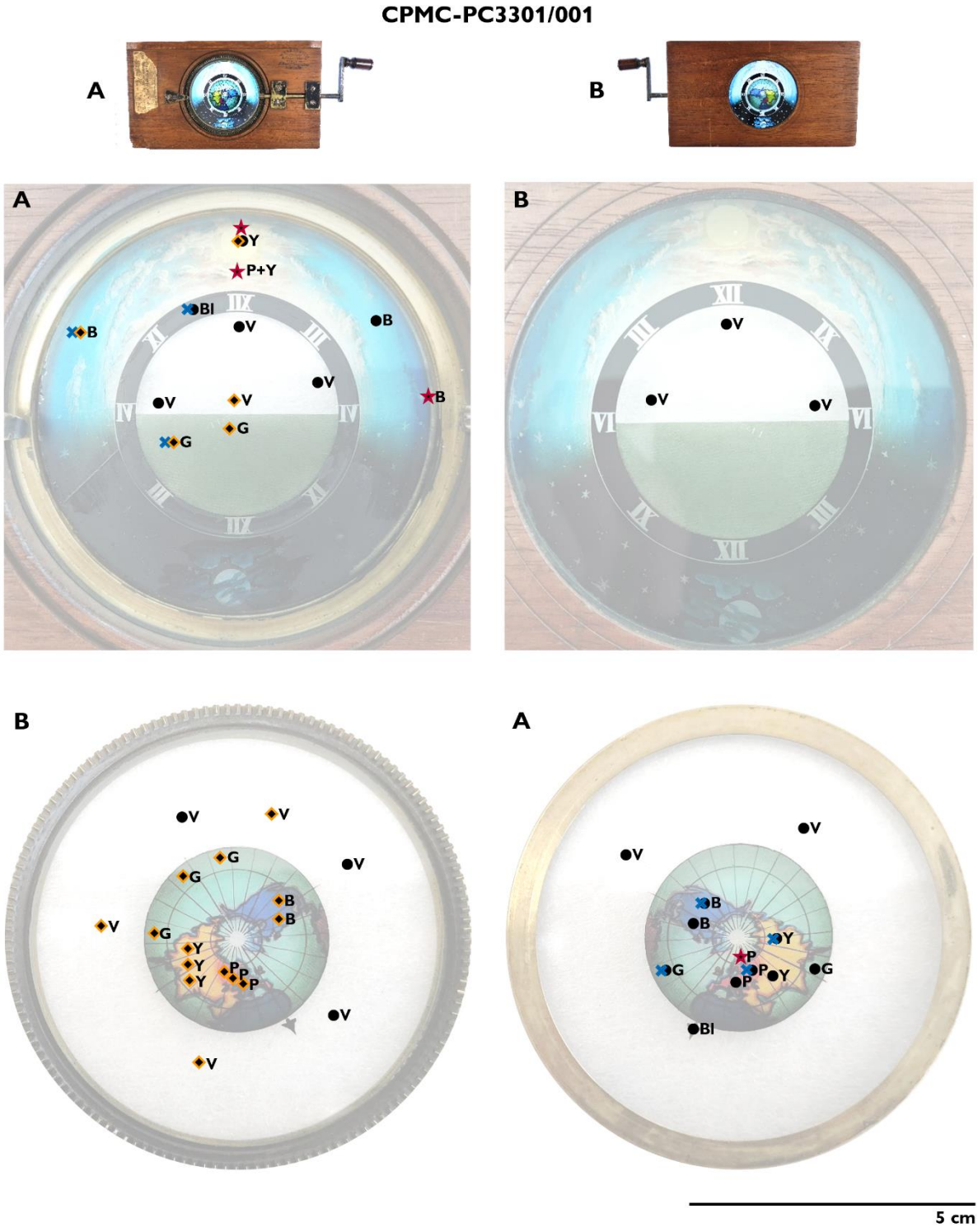


Figure A.23 Slide CPMC-PC3301/001 by W.E. & F. Newton: mapping areas of analyses by EDXRF, UV-VIS and Raman spectroscopies, and micro-samples collection. The painted side of each glass is identified as A.

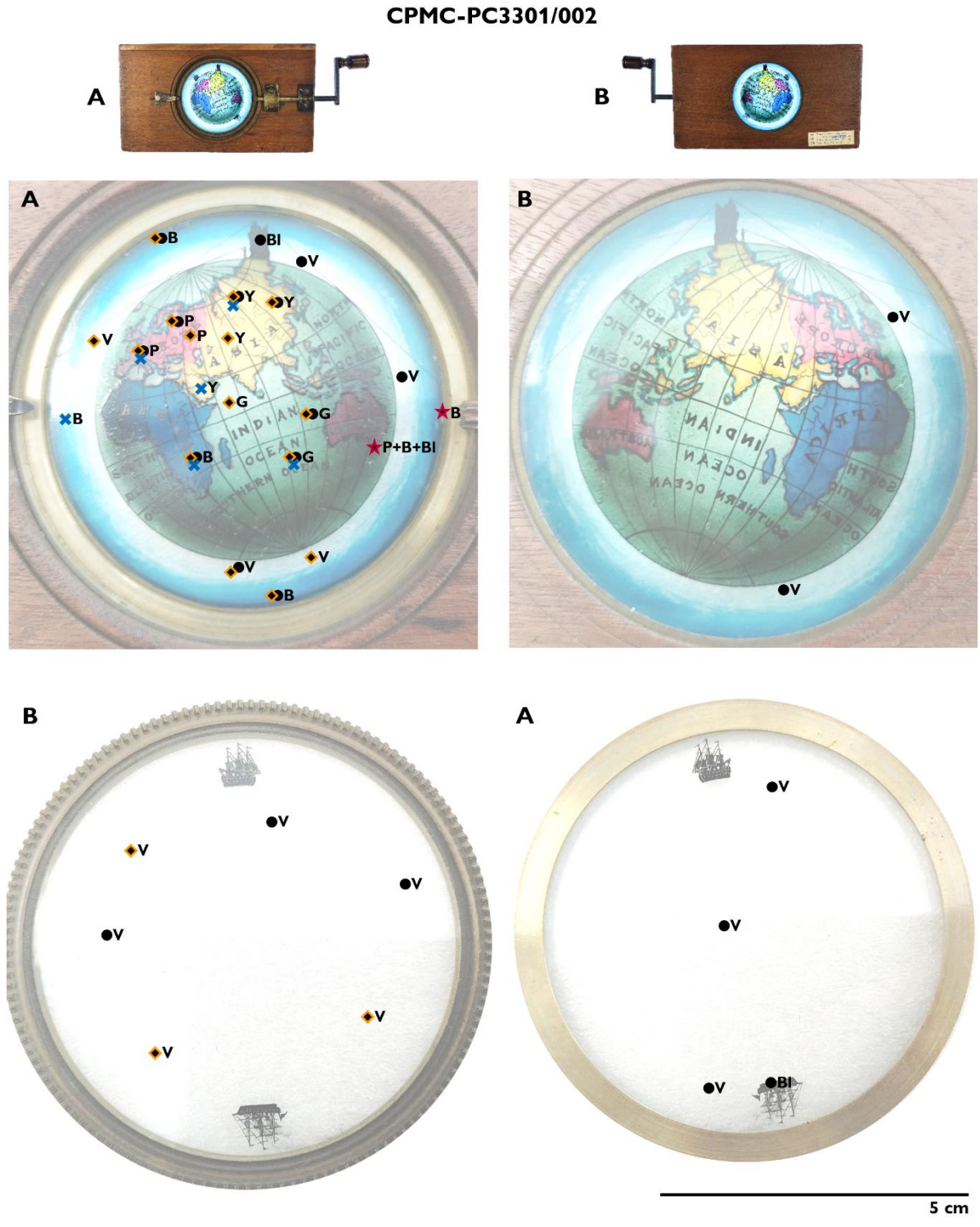


Figure A.24 Slide CPMC-PC3301/002 by W.E. & F. Newton: mapping areas of analyses by EDXRF, UV-VIS and Raman spectroscopies, and micro-samples collection. The painted side of each glass is identified as A.

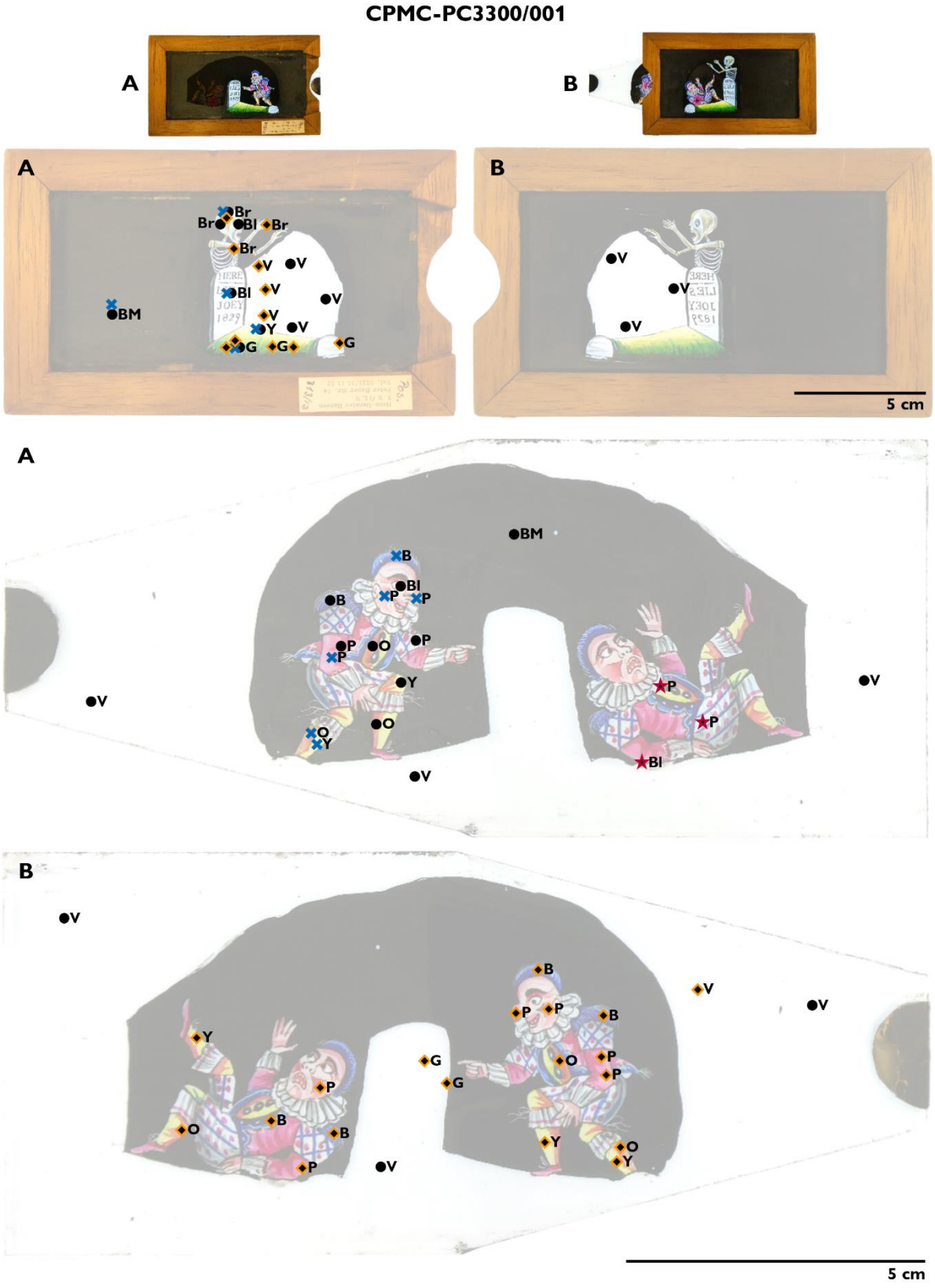


Figure A.25 Slide CPMC-PC3300/001: mapping areas of analyses by EDXRF, UV-VIS and Raman spectroscopies, and micro-samples collection. The painted side of each glass is identified as A.

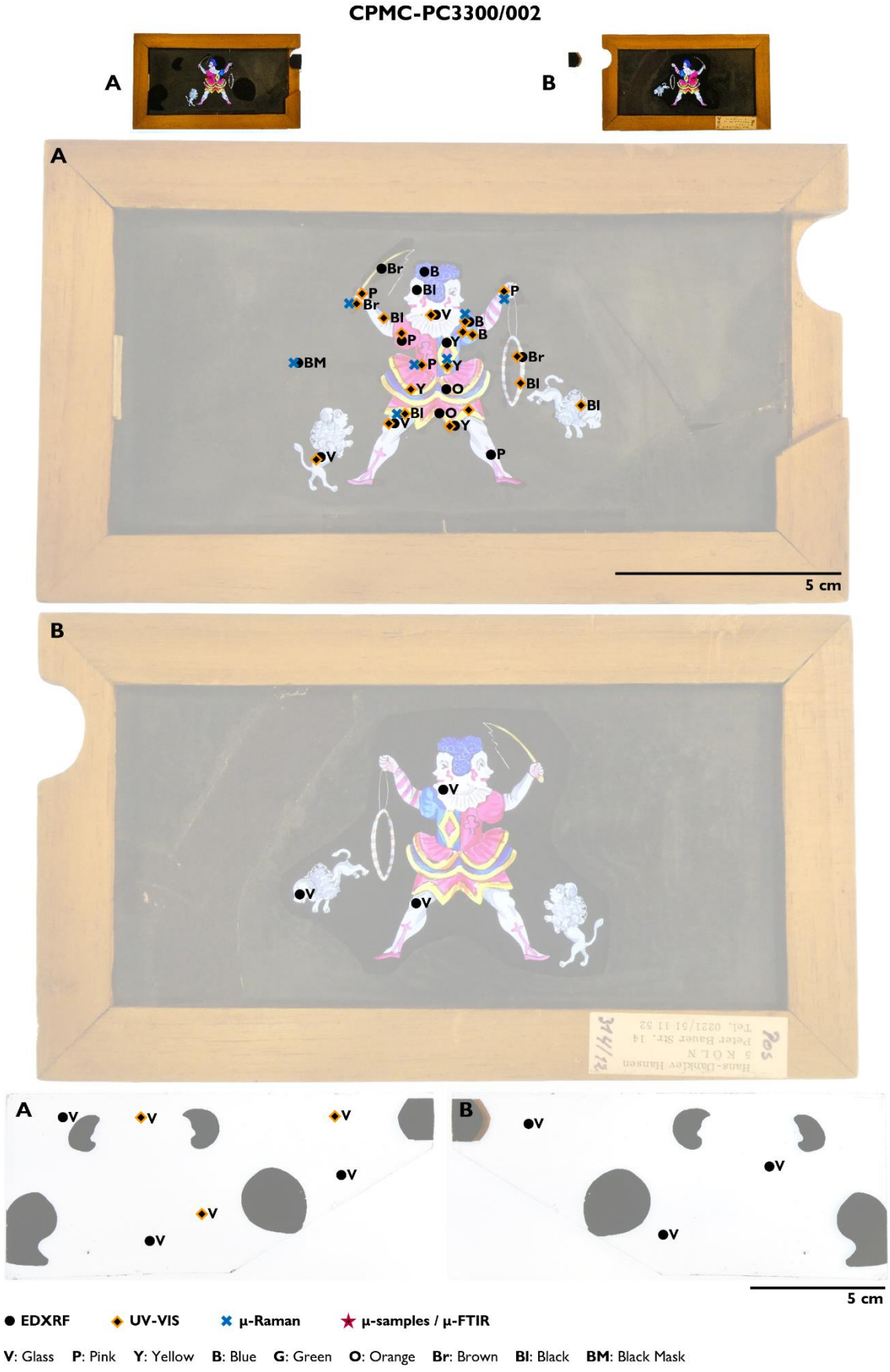


Figure A.26 Slide CPMC-PC3300/002: mapping areas of analyses by EDXRF, UV-VIS and Raman spectroscopies, and micro-samples collection. The painted side of each glass is identified as A.

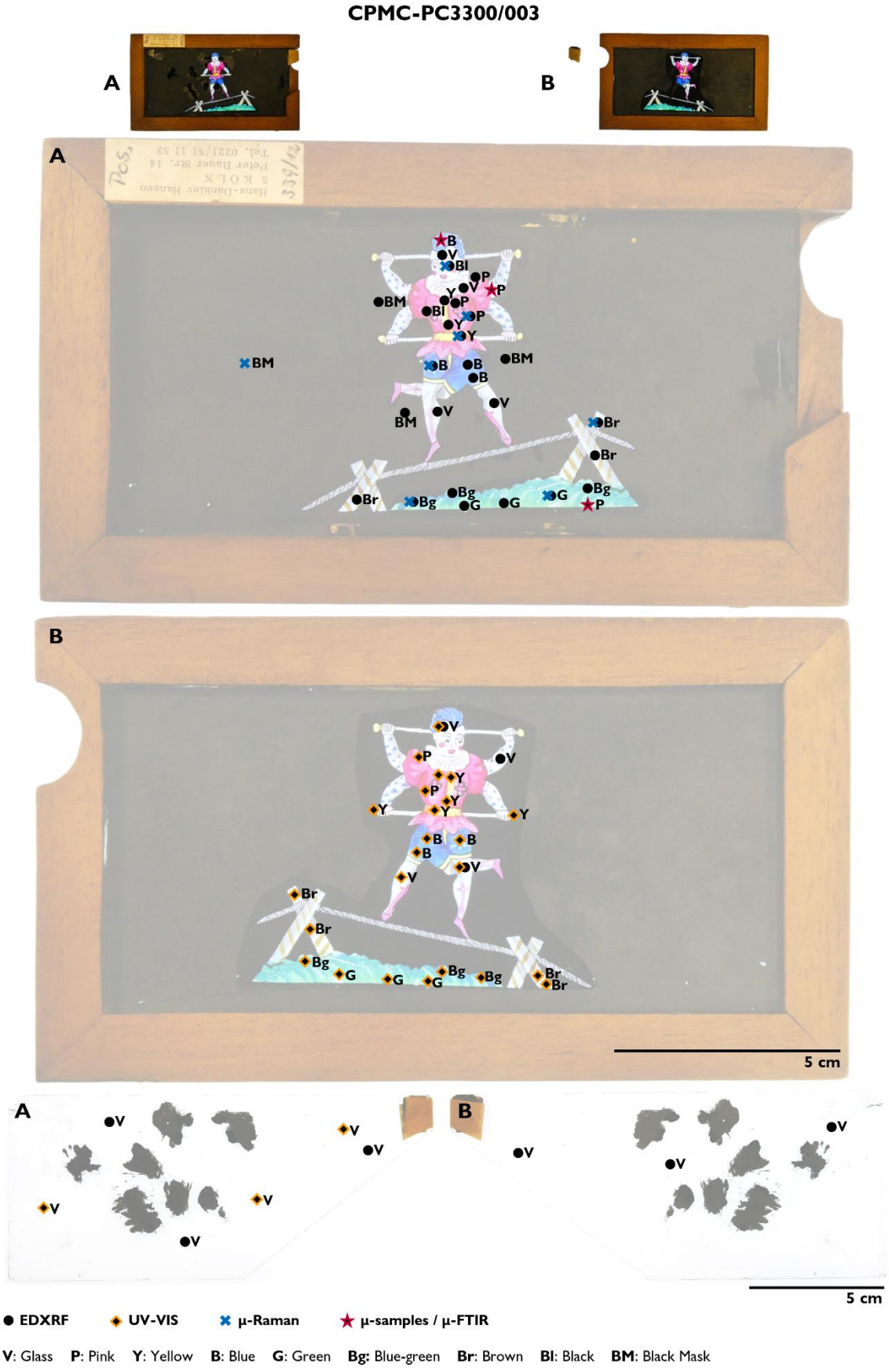


Figure A.27 Slide CPMC-PC3300/003: mapping areas of analyses by EDXRF, UV-VIS and Raman spectroscopies, and micro-samples collection. The painted side of each glass is identified as A.

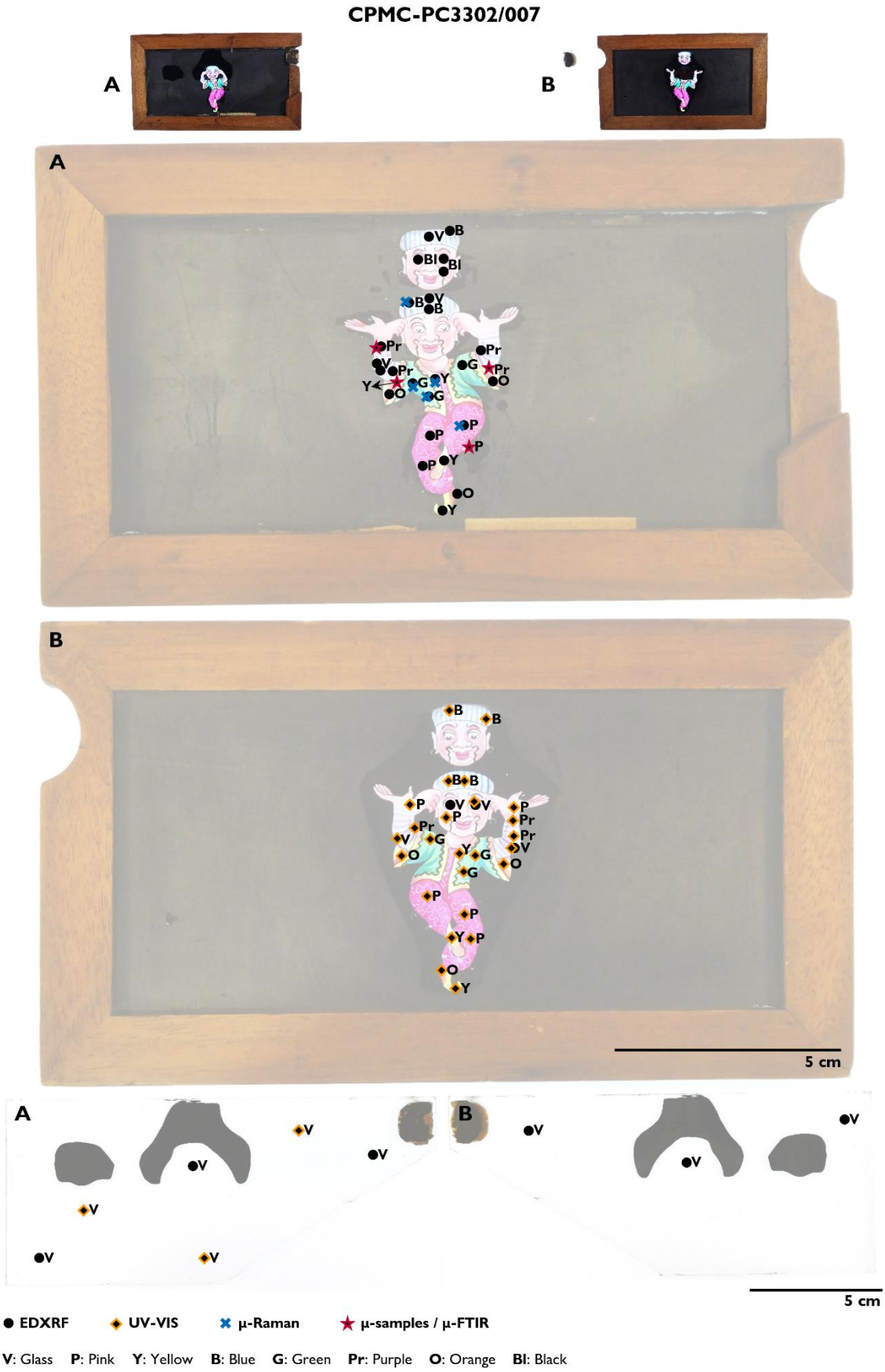


Figure A.28 Slide CPMC-PC3302/007: mapping areas of analyses by EDXRF, UV-VIS and Raman spectroscopies, and micro-samples collection. The painted side of each glass is identified as A.

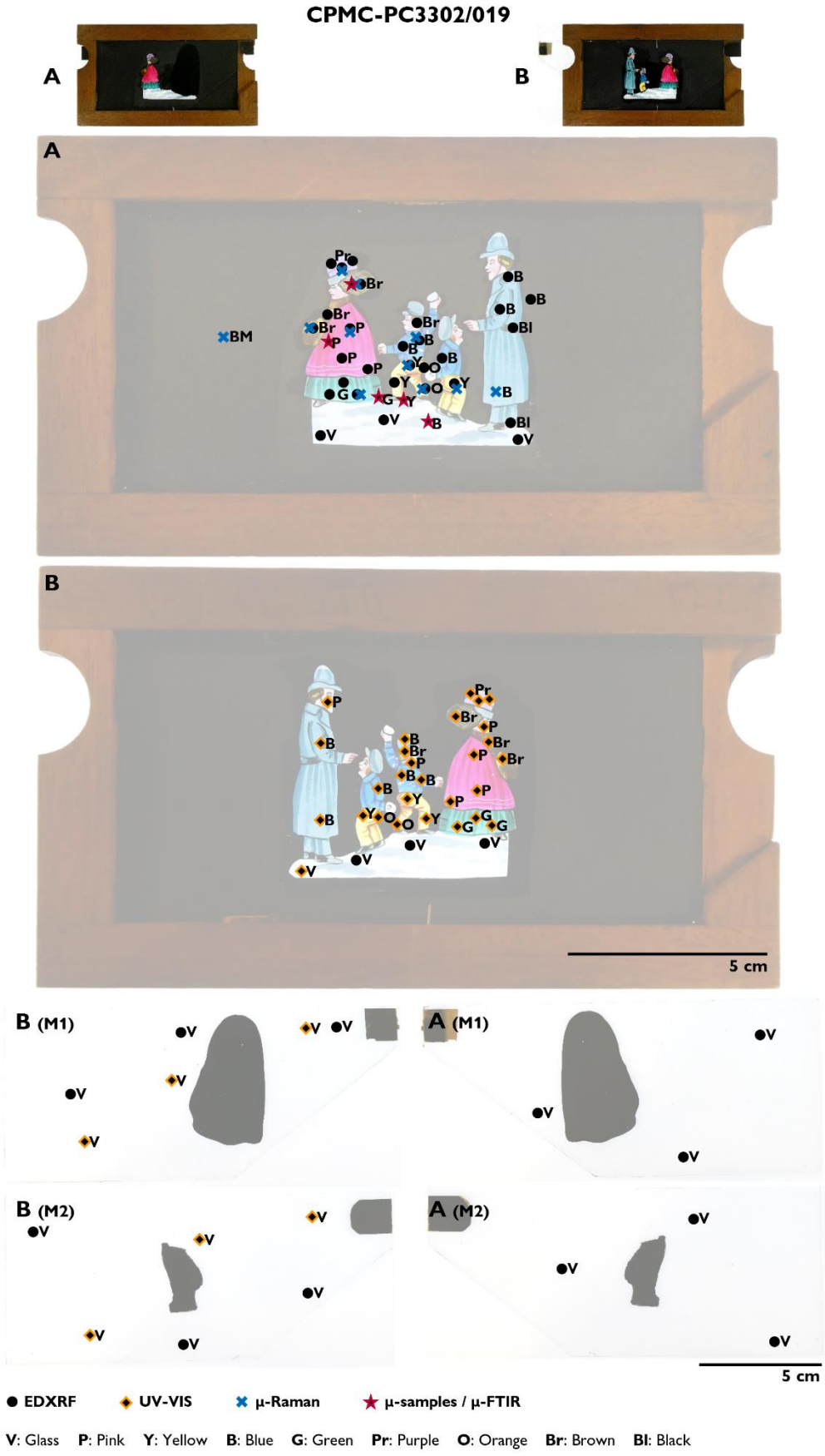


Figure A.29 Slide CPMC-PC3302/019: mapping areas of analyses by EDXRF, UV-VIS and Raman spectroscopies, and micro-samples collection. The painted side of each glass is identified as A.

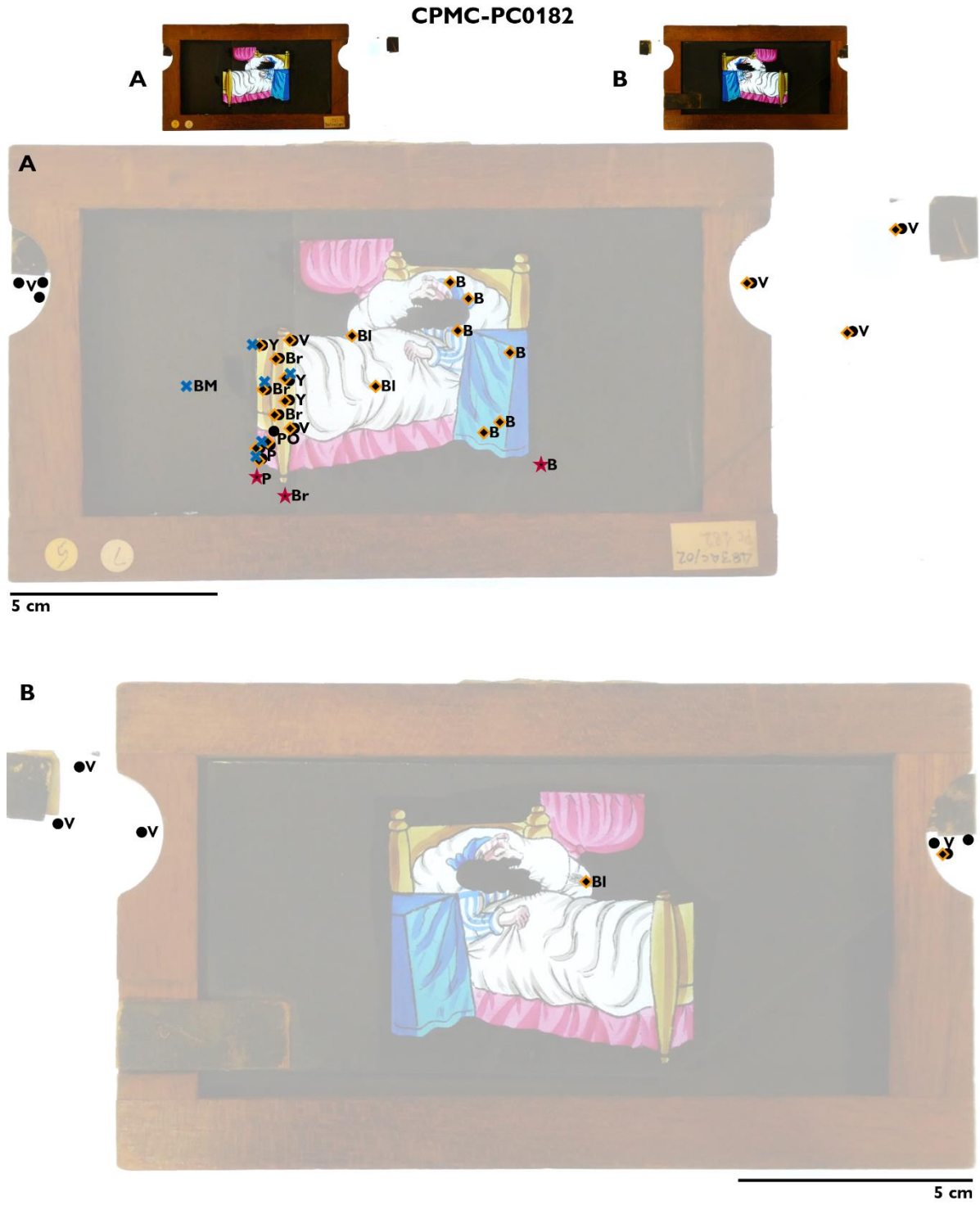


Figure A.30 Slide CPMC-PC0182: mapping areas of analyses by EDXRF, UV-VIS and Raman spectroscopies, and micro-samples collection. The painted side of each glass is identified as A.

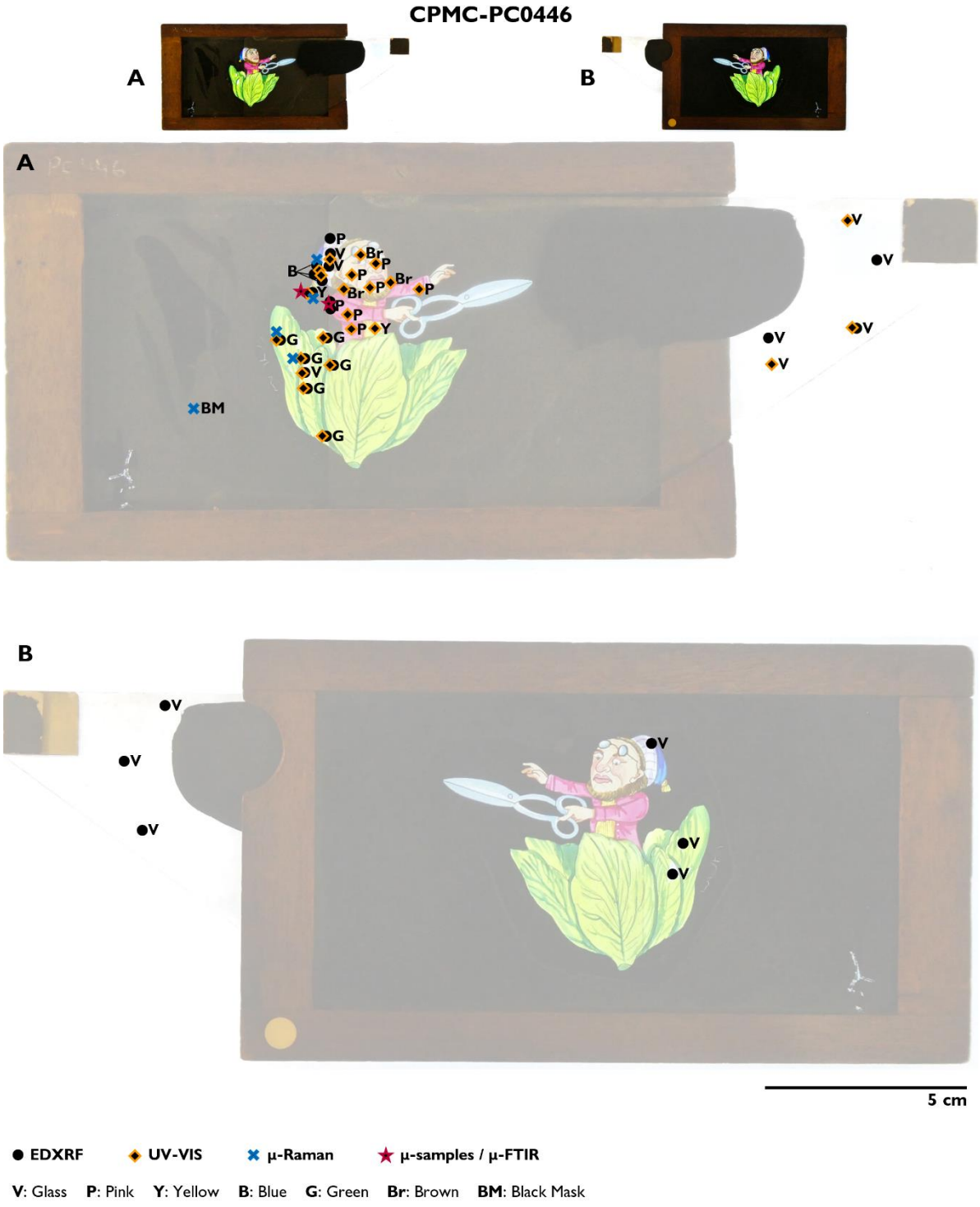


Figure A.31 Slide CPMC-PC0446: mapping areas of analyses by EDXRF, UV-VIS and Raman spectroscopies, and micro-samples collection. The painted side of each glass is identified as A.

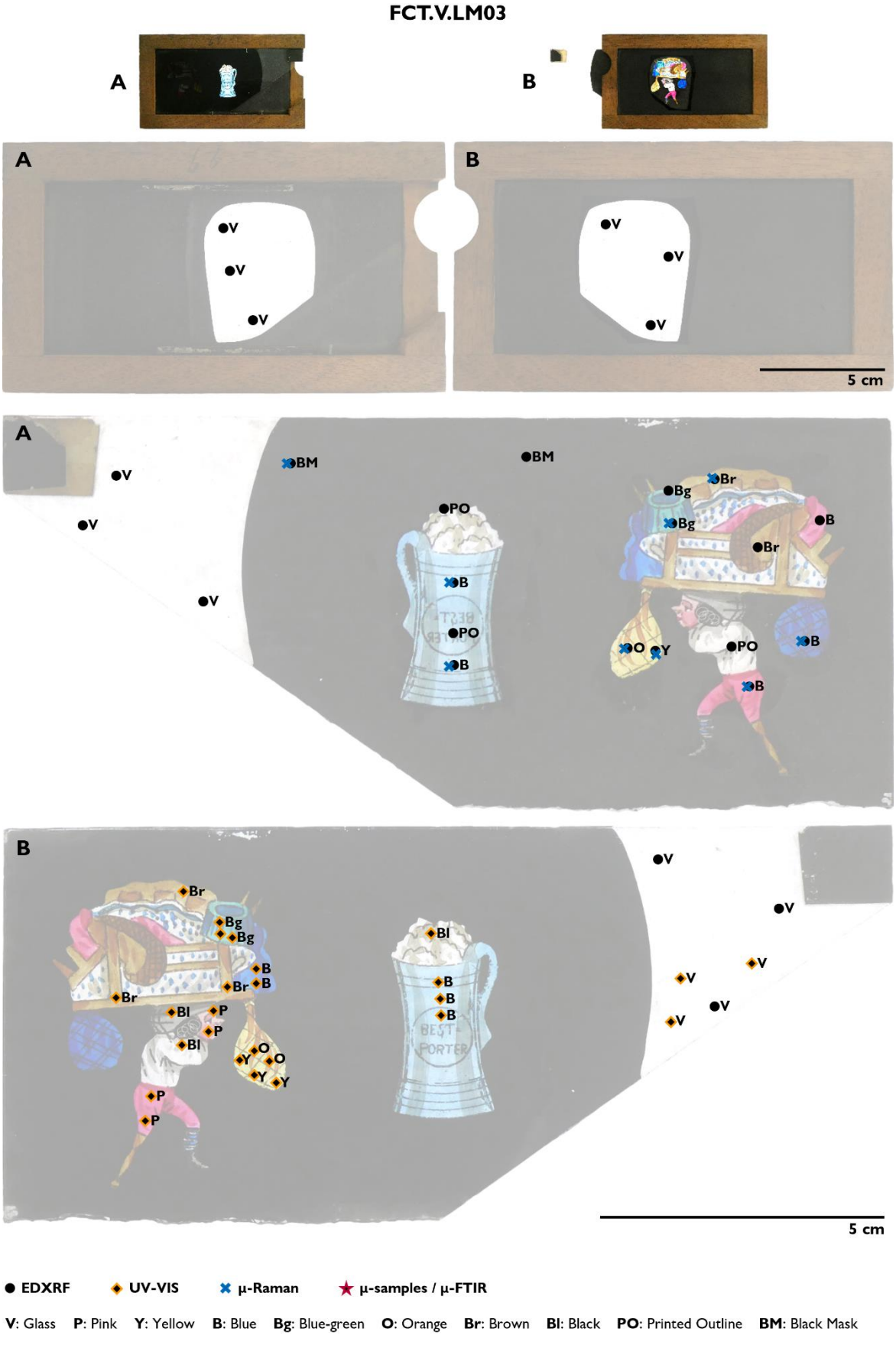


Figure A.32 Slide FCT.V.LM03: mapping areas of analyses by EDXRF, UV-VIS and Raman spectroscopies, and micro-samples collection. The painted side of each glass is identified as A.

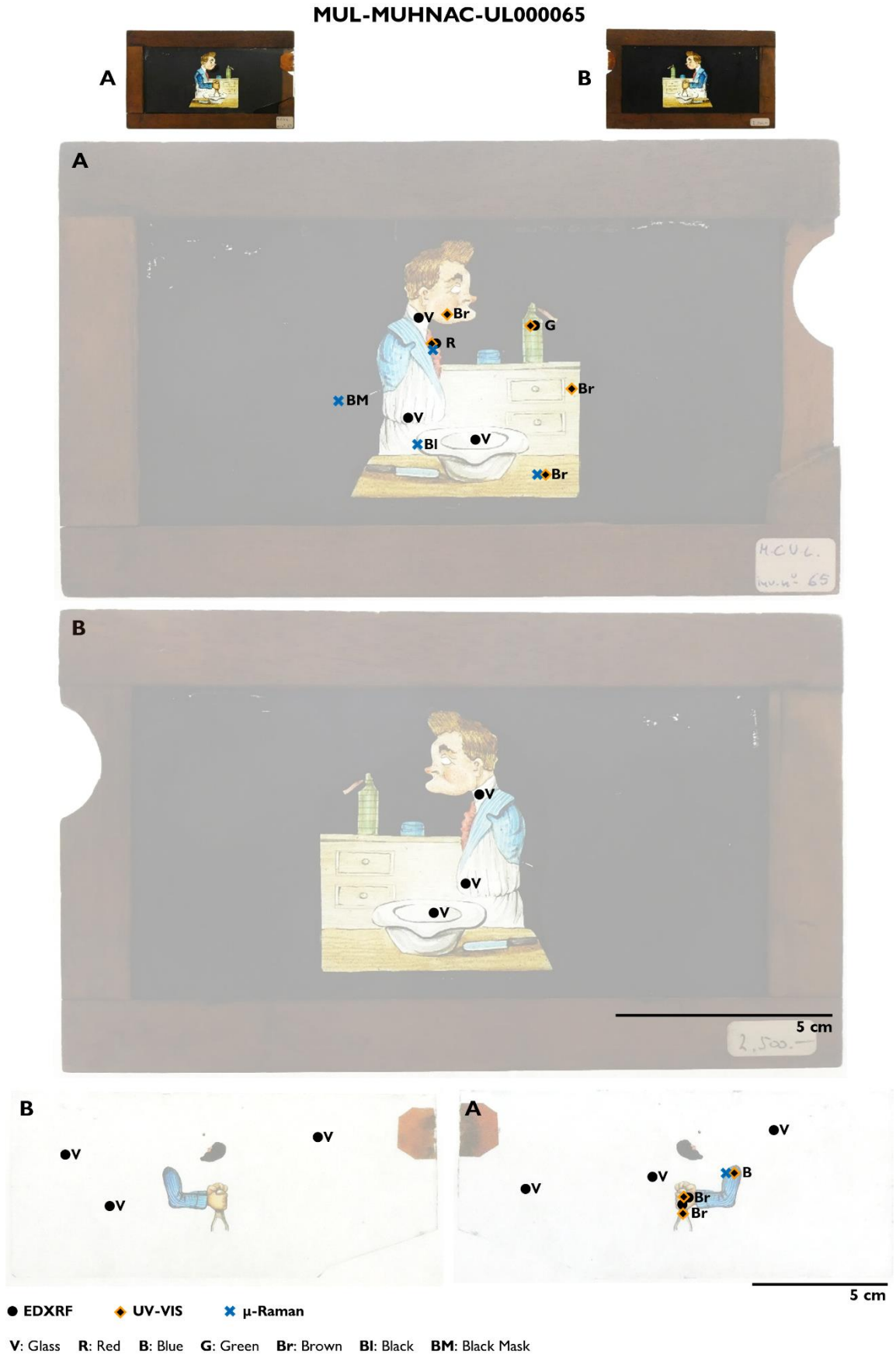


Figure A.33 Slide MUL-MUHNAC-UL000065: mapping areas of analyses by EDXRF, UV-VIS and Raman spectroscopies. The painted side of each glass is identified as A.

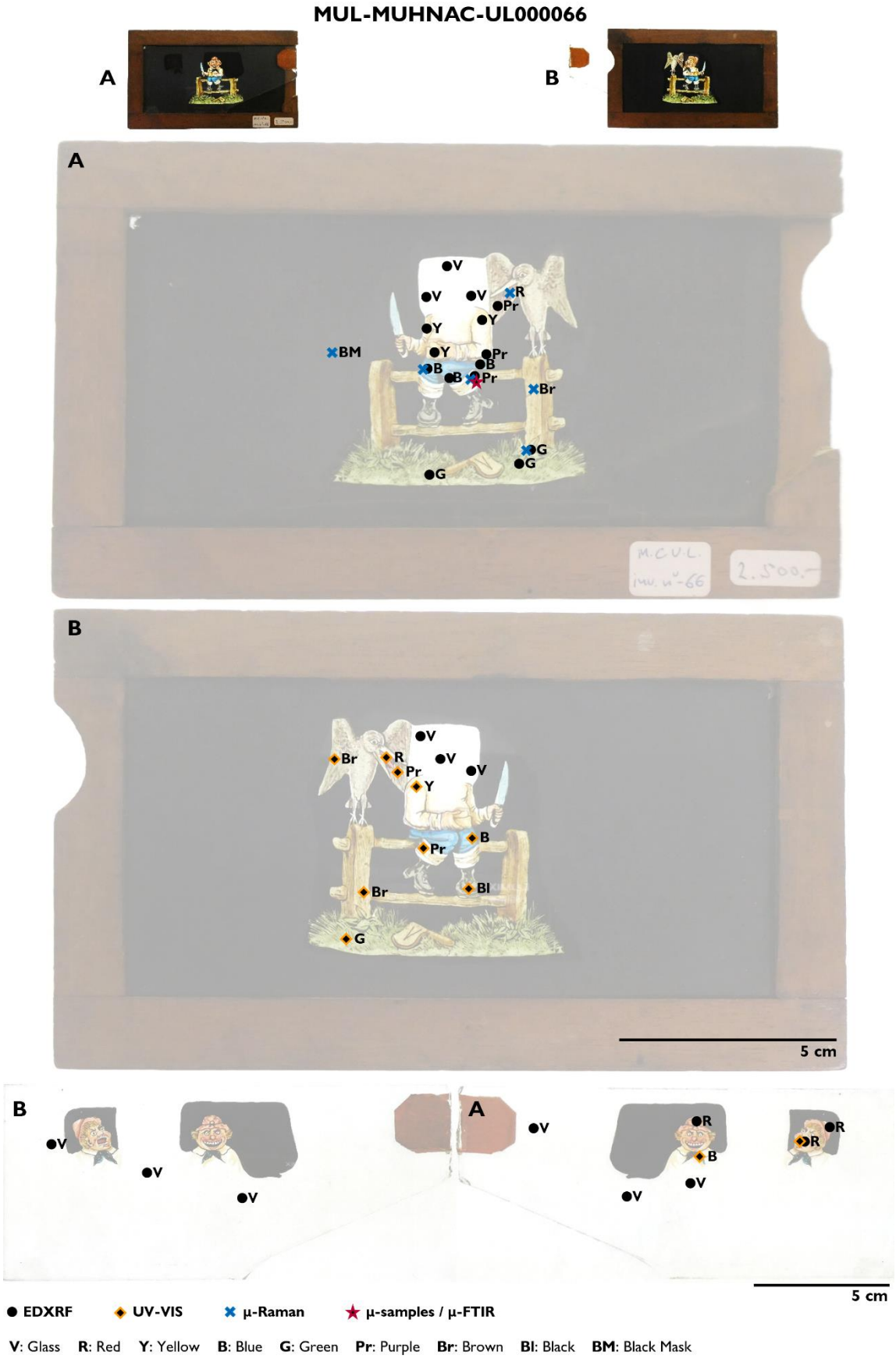


Figure A.34 Slide MUL-MUHNAC-UL000066: mapping areas of analyses by EDXRF, UV-VIS and Raman spectroscopies, and micro-samples collection. The painted side of each glass is identified as A.

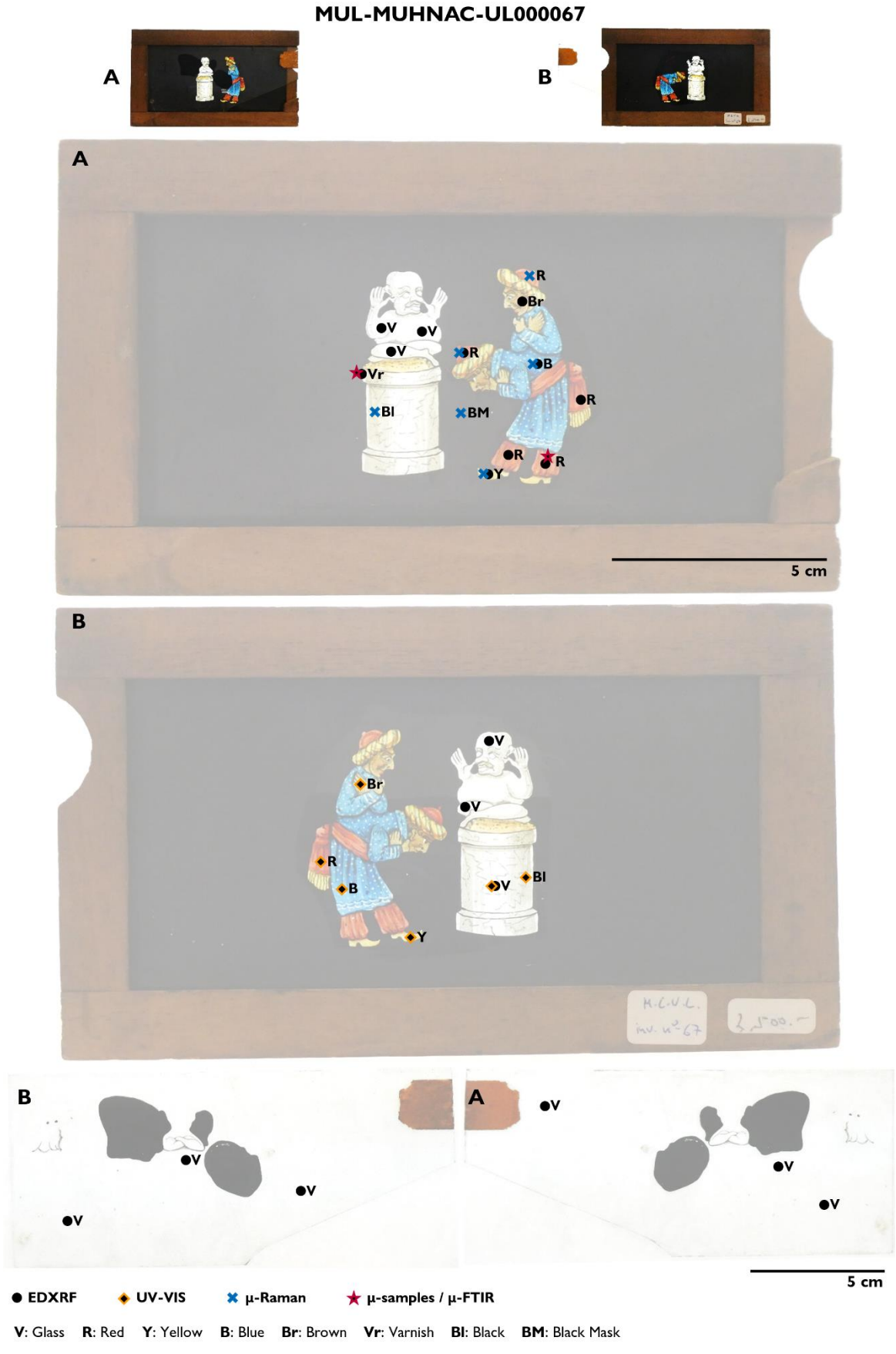


Figure A.35 Slide MUL-MUHNAC-UL000067: mapping areas of analyses by EDXRF, UV-VIS and Raman spectroscopies, and micro-samples collection. The painted side of each glass is identified as A.



Figure A.36 Slide MUL-MUHNAC-UL000068: mapping areas of analyses by EDXRF, UV-VIS and Raman spectroscopies, and micro-samples collection. The painted side of each glass is identified as A.

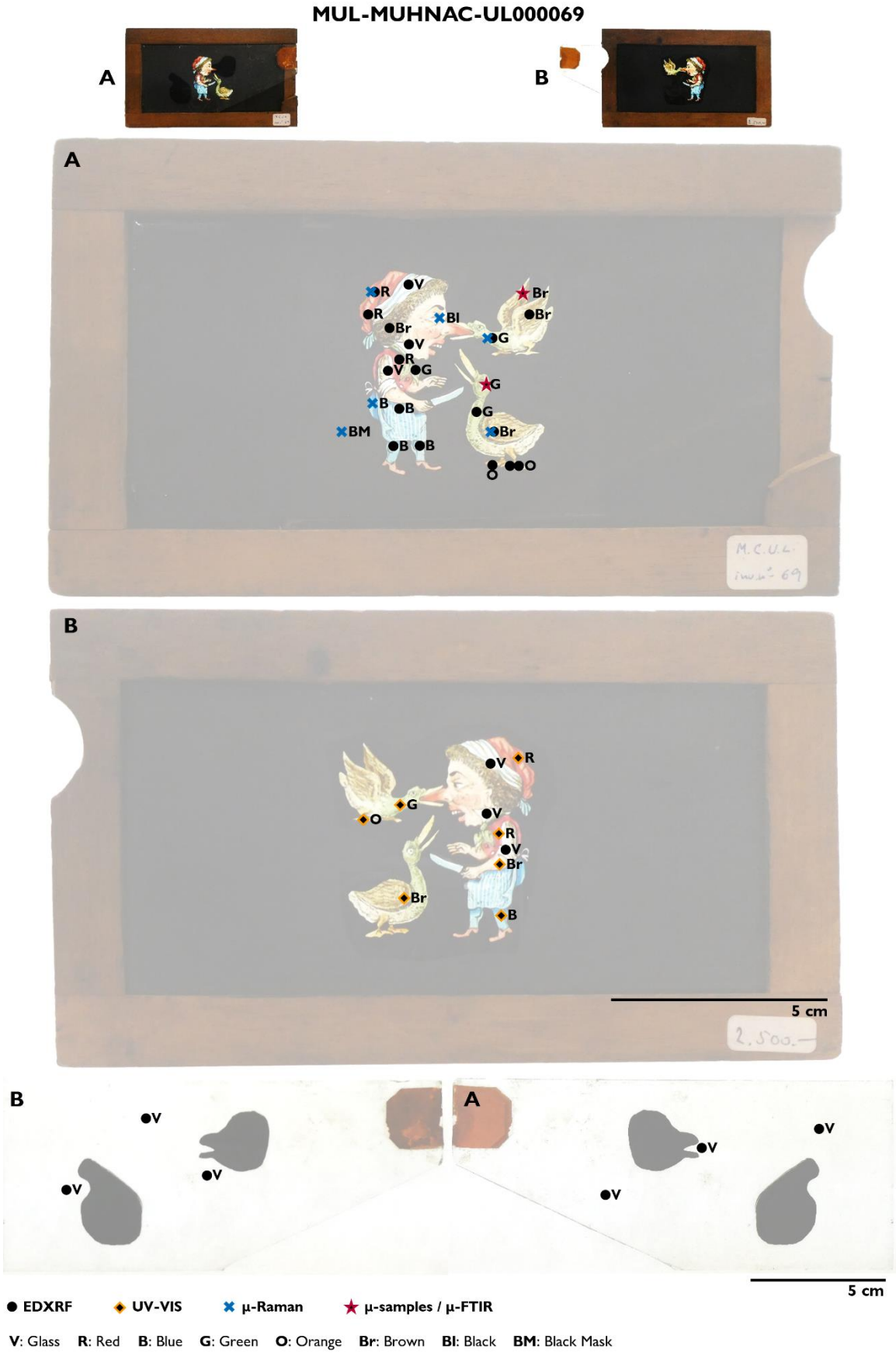


Figure A.37 Slide MUL-MUHNAC-UL000069: mapping areas of analyses by EDXRF, UV-VIS and Raman spectroscopies, and micro-samples collection. The painted side of each glass is identified as A.

CPMC-PC0018/001



Figure A.38 Slide CPMC-PC0018/001 by Lapierre: mapping areas of analyses by EDXRF, UV-VIS and Raman spectroscopies, and micro-samples collection. The painted side of each glass is identified as A.

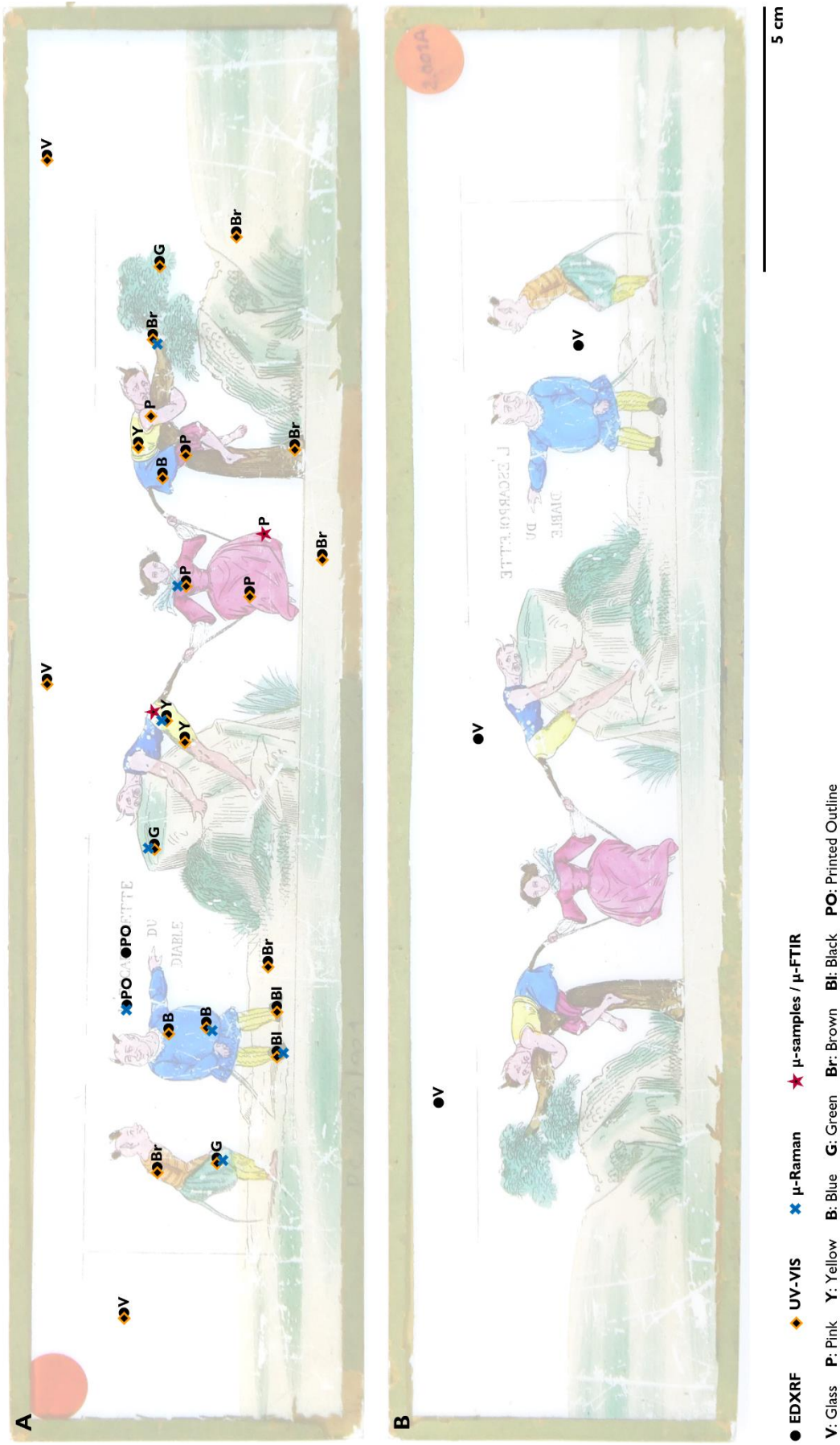


Figure A.39 Slide CPMC-PC0203/001 by Lapierre: mapping areas of analyses by EDXRF, UV-VIS and Raman spectroscopies, and micro-samples collection. The painted side of each glass is identified as A.

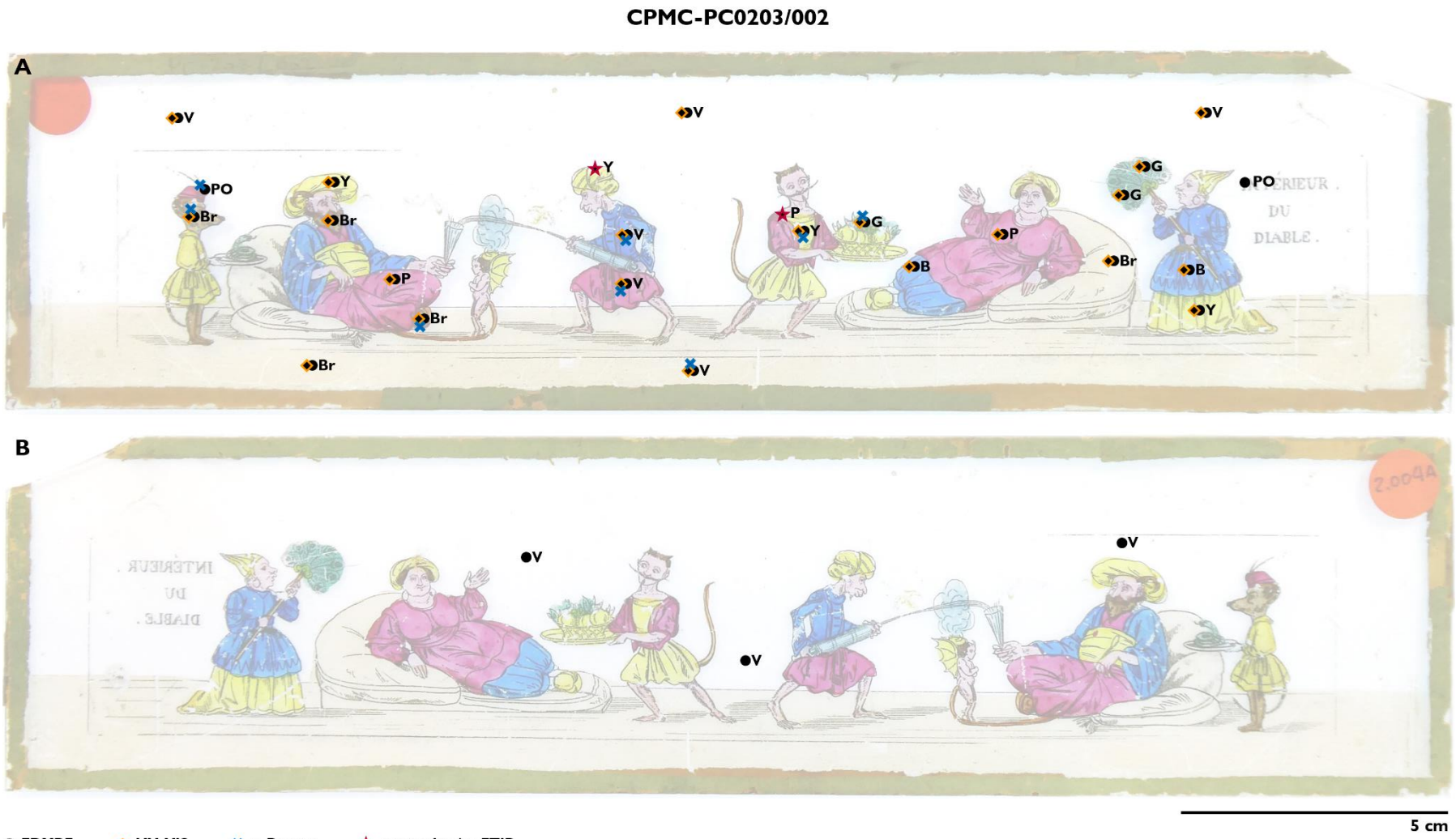


Figure A.40 Slide CPMC-PC0203/002 by Lapierre: mapping areas of analyses by EDXRF, UV-VIS and Raman spectroscopies, and micro-samples collection. The painted side of each glass is identified as A.



Figure A.41 Slide CPMC-PC0203/003 by Lapierre: mapping areas of analyses by EDXRF, UV-VIS and Raman spectroscopies, and micro-samples collection. The painted side of each glass is identified as A.

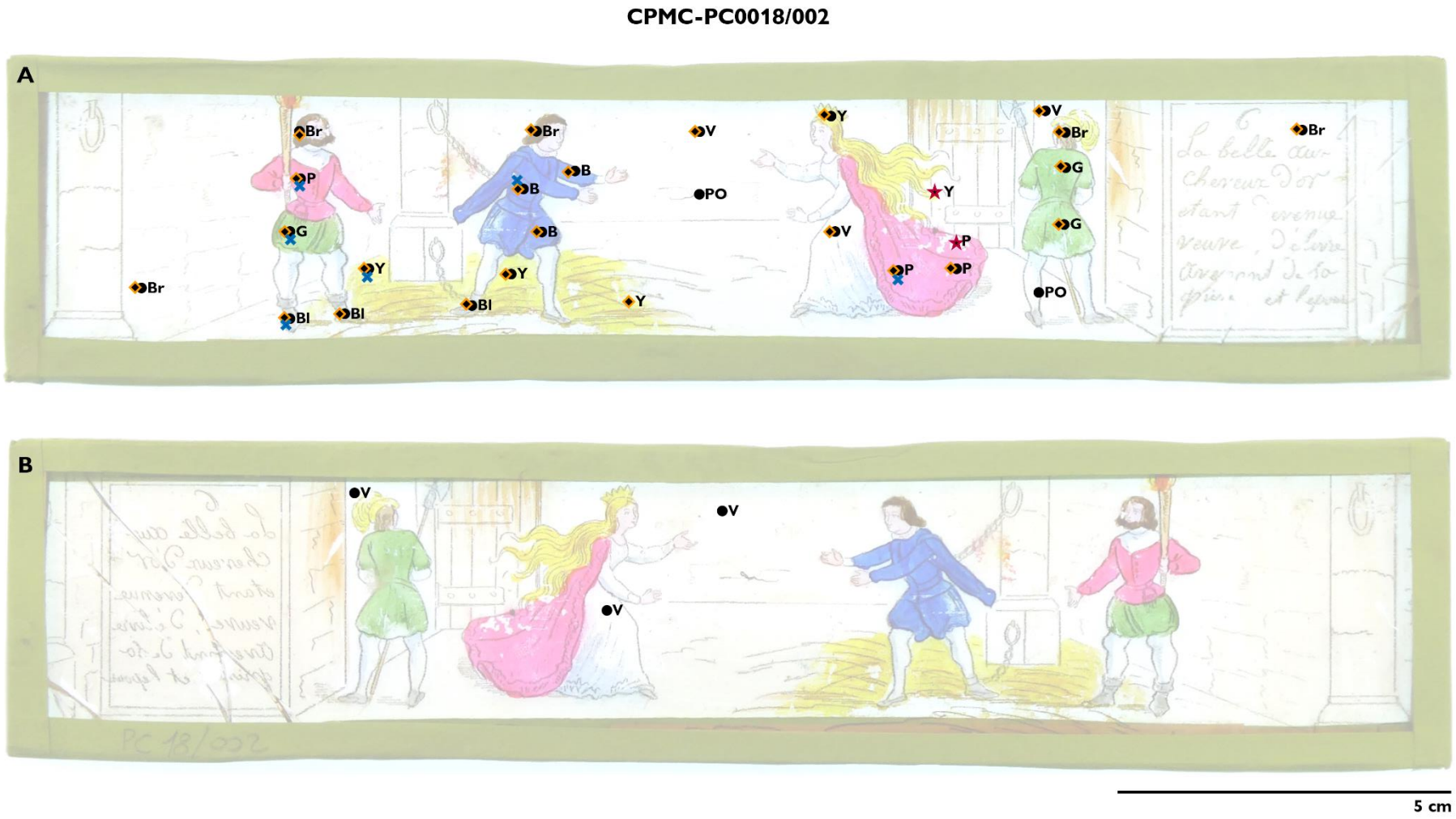


Figure A.42 Slide CPMC-PC0018/002 by Lapierre: mapping areas of analyses by EDXRF, UV-VIS and Raman spectroscopies, and micro-samples collection. The painted side of each glass is identified as A.

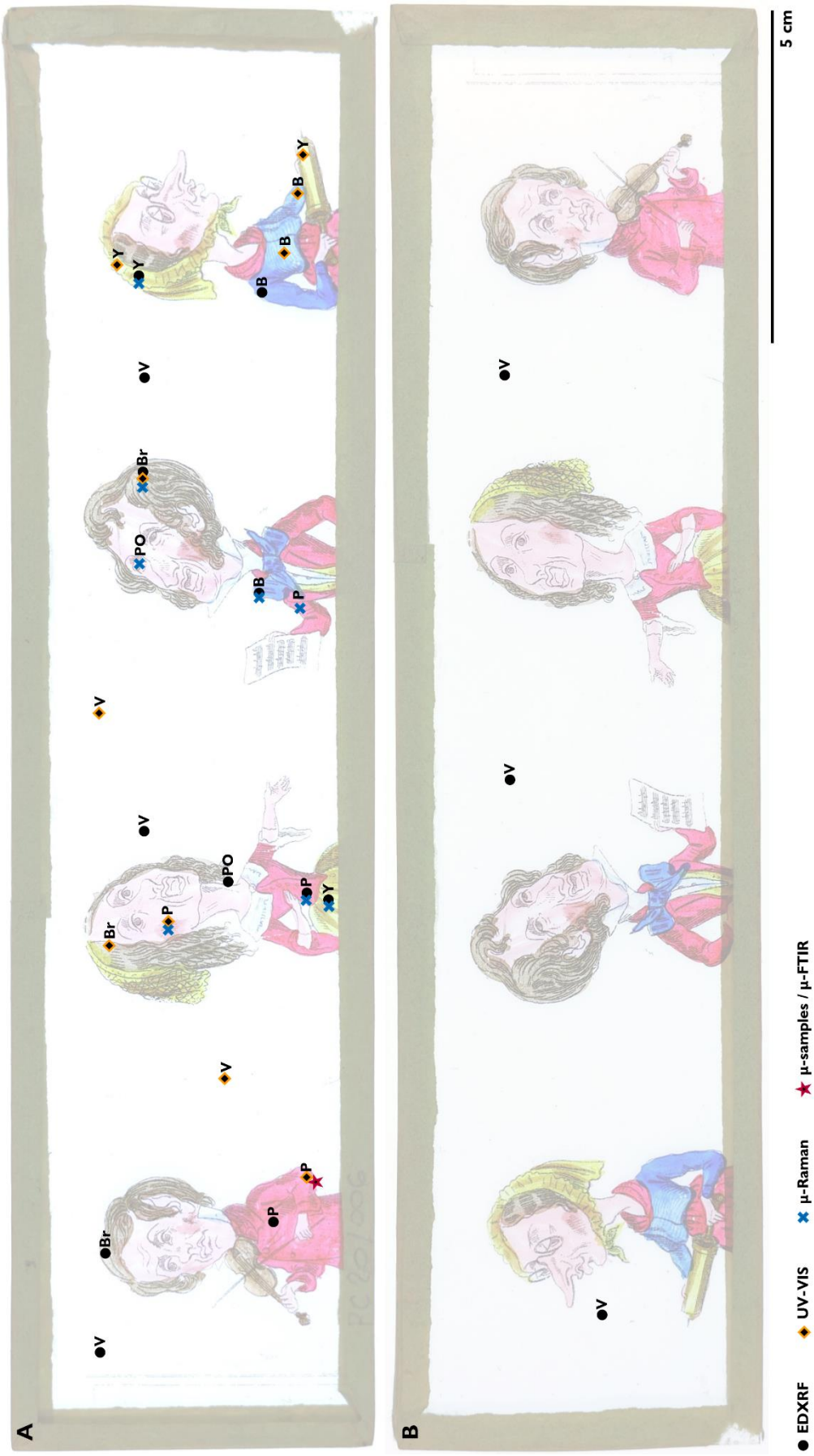


Figure A.43 Slide CPMC-PC0020/006 by Lapierre: mapping areas of analyses by EDXRF, UV-VIS and Raman spectroscopies, and micro-samples collection. The painted side of each glass is identified as A.

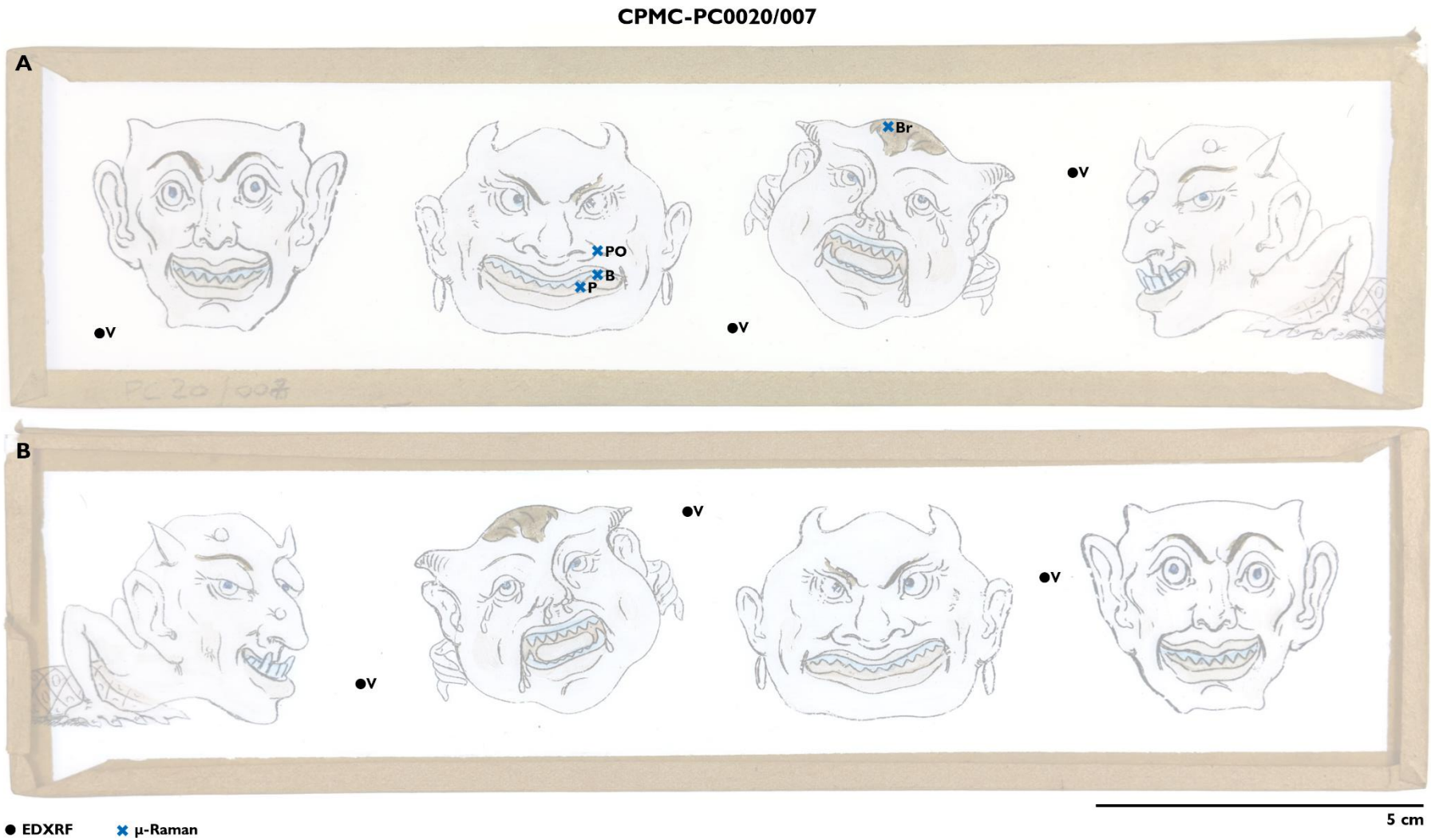


Figure A.44 Slide CPMC-PC00020/007 by Lapierre: mapping areas of analyses by EDXRF and Raman spectroscopies. The painted side of each glass is identified as A.

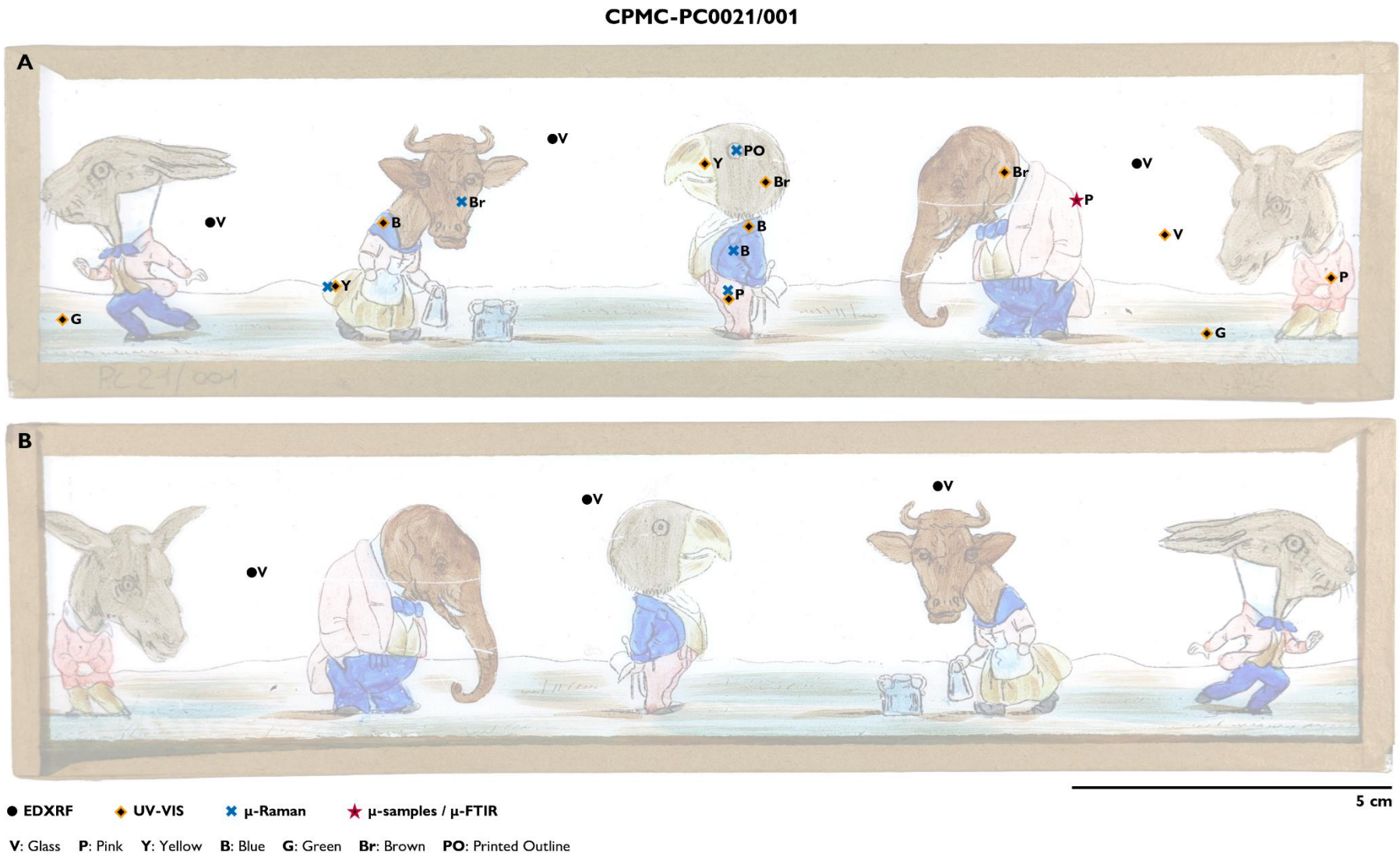


Figure A.45 Slide CPMC-PC0021/001 by Lapierre: mapping areas of analyses by EDXRF, UV-VIS and Raman spectroscopies, and micro-samples collection. The painted side of each glass is identified as A.

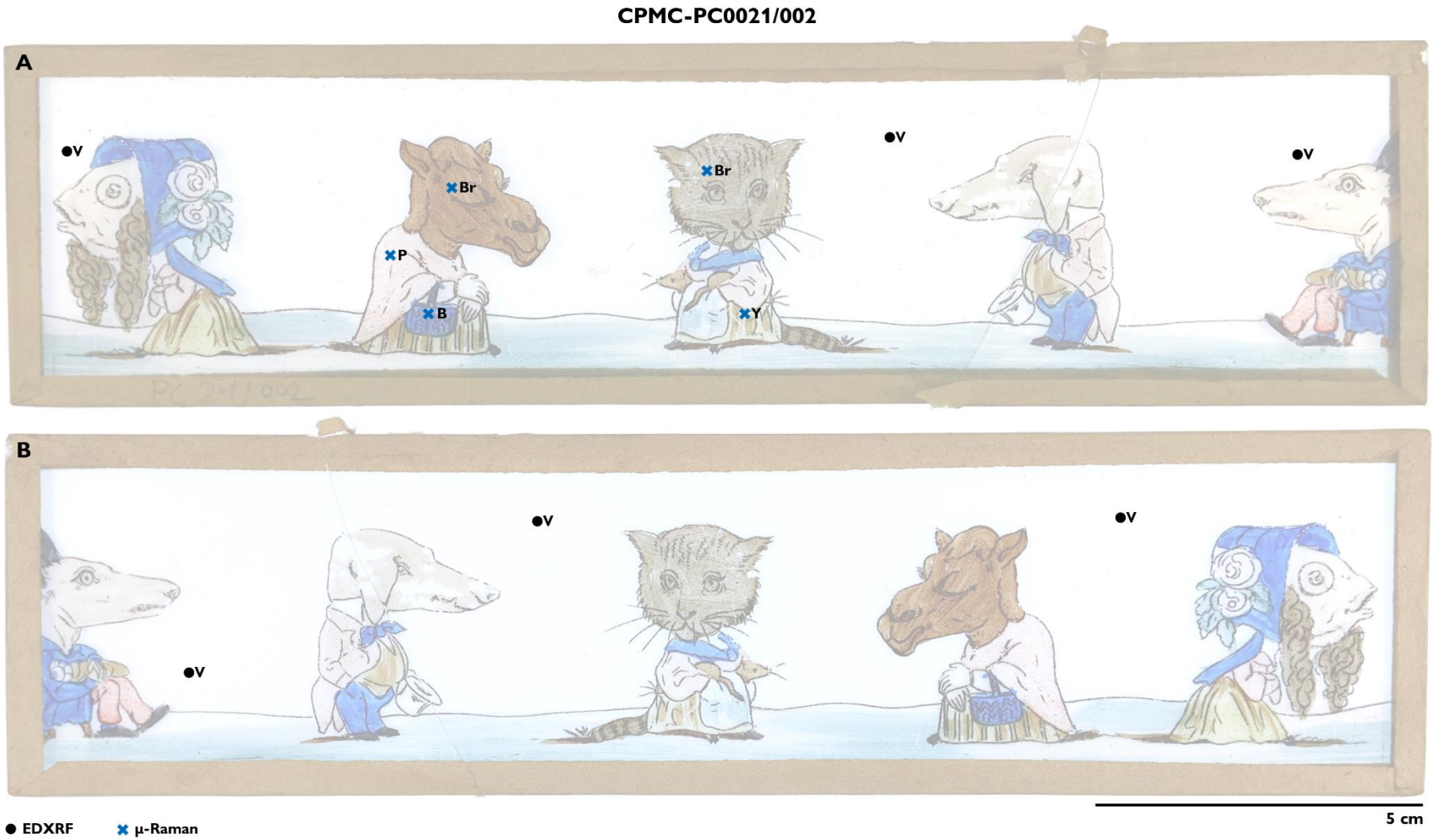


Figure A.46 Slide CPMC-PC0021/002 by Lapierre: mapping areas of analyses by EDXRF and Raman spectroscopies. The painted side of each glass is identified as A.

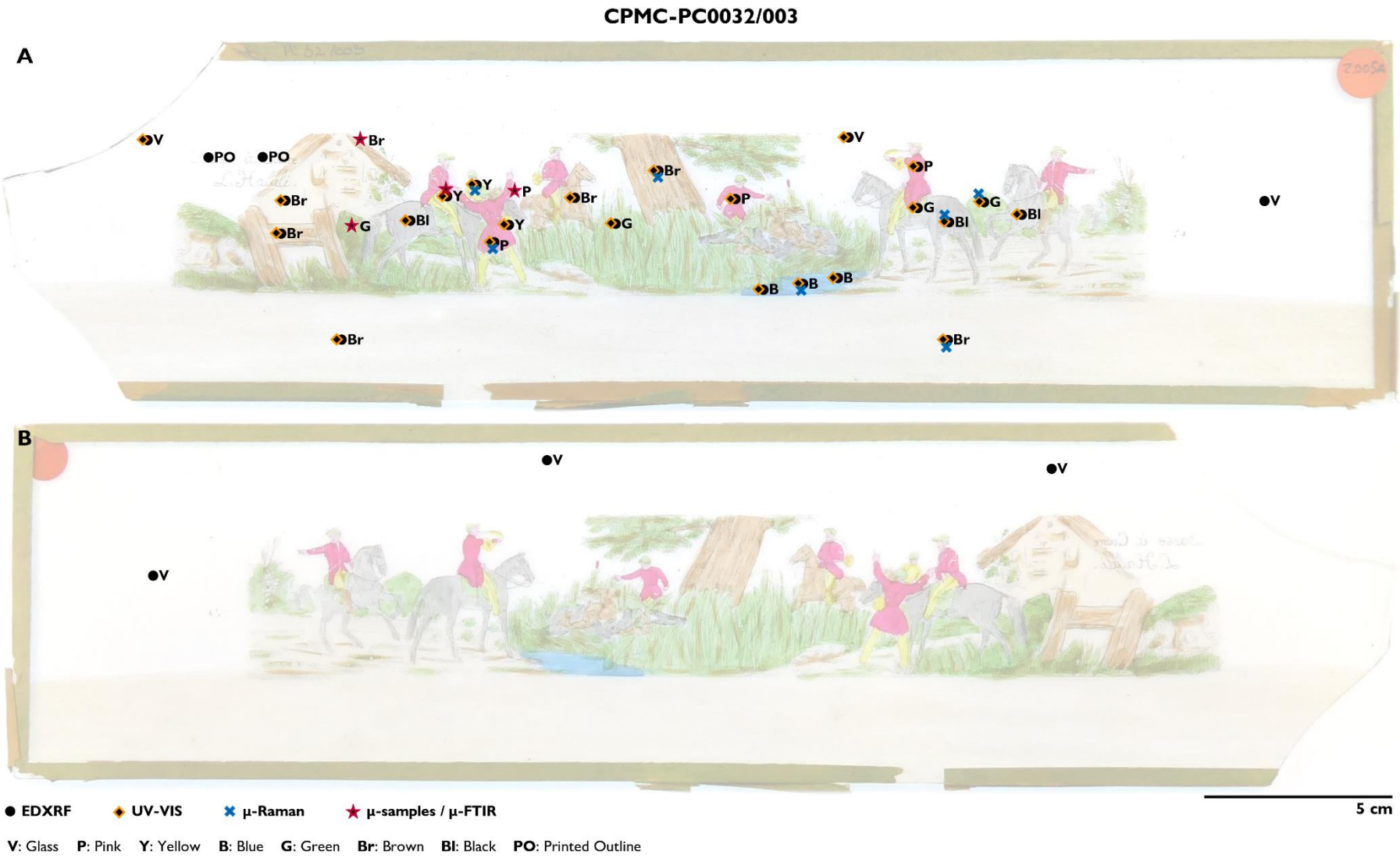


Figure A.47 Slide CPMC-PC0032/003 by Lapierre: mapping areas of analyses by EDXRF, UV-VIS and Raman spectroscopies, and micro-samples collection. The painted side of each glass is identified as A.

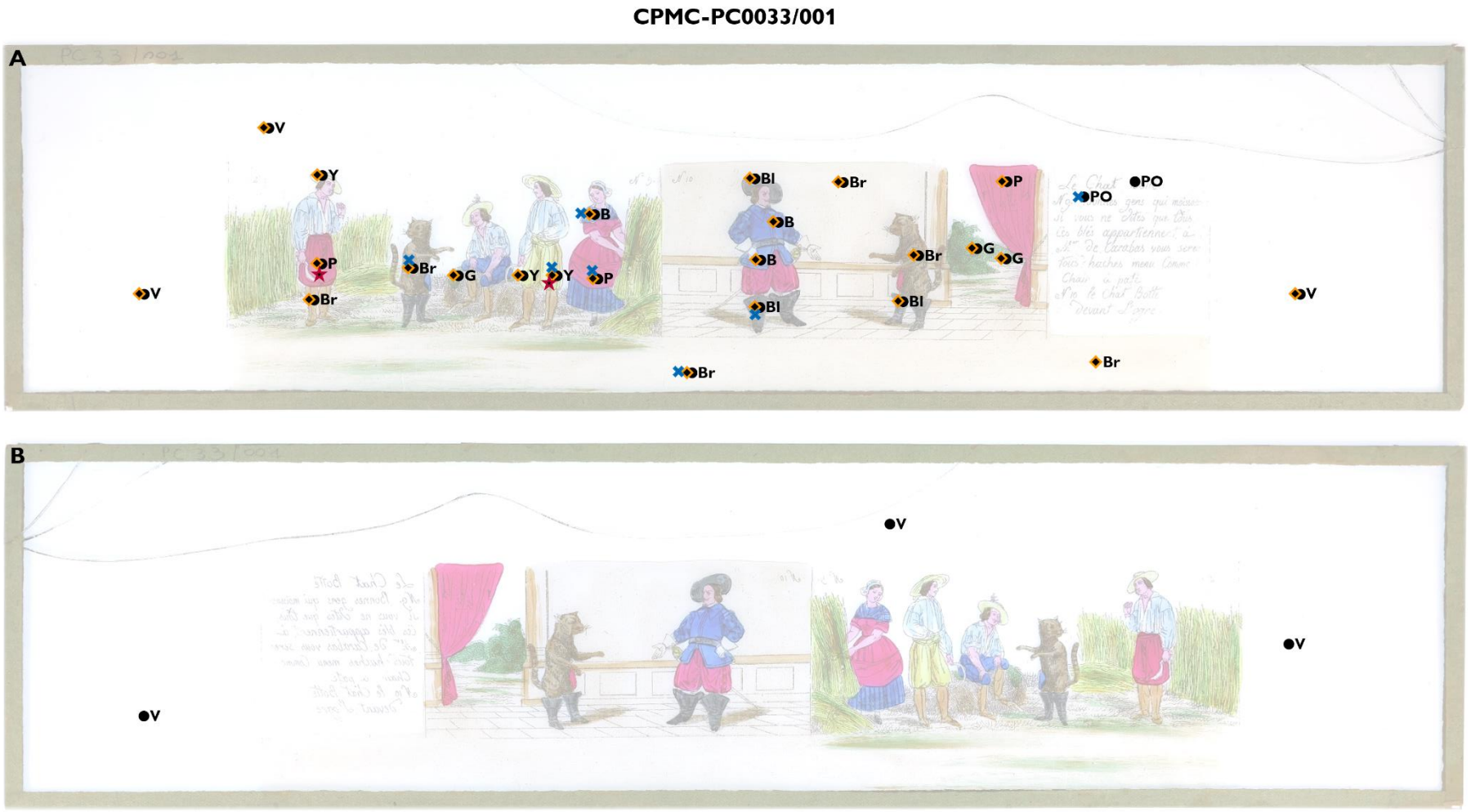


Figure A.48 Slide CPMC-PC0033/001 by Lapierre: mapping areas of analyses by EDXRF, UV-VIS and Raman spectroscopies, and micro-samples collection. The painted side of each glass is identified as A.

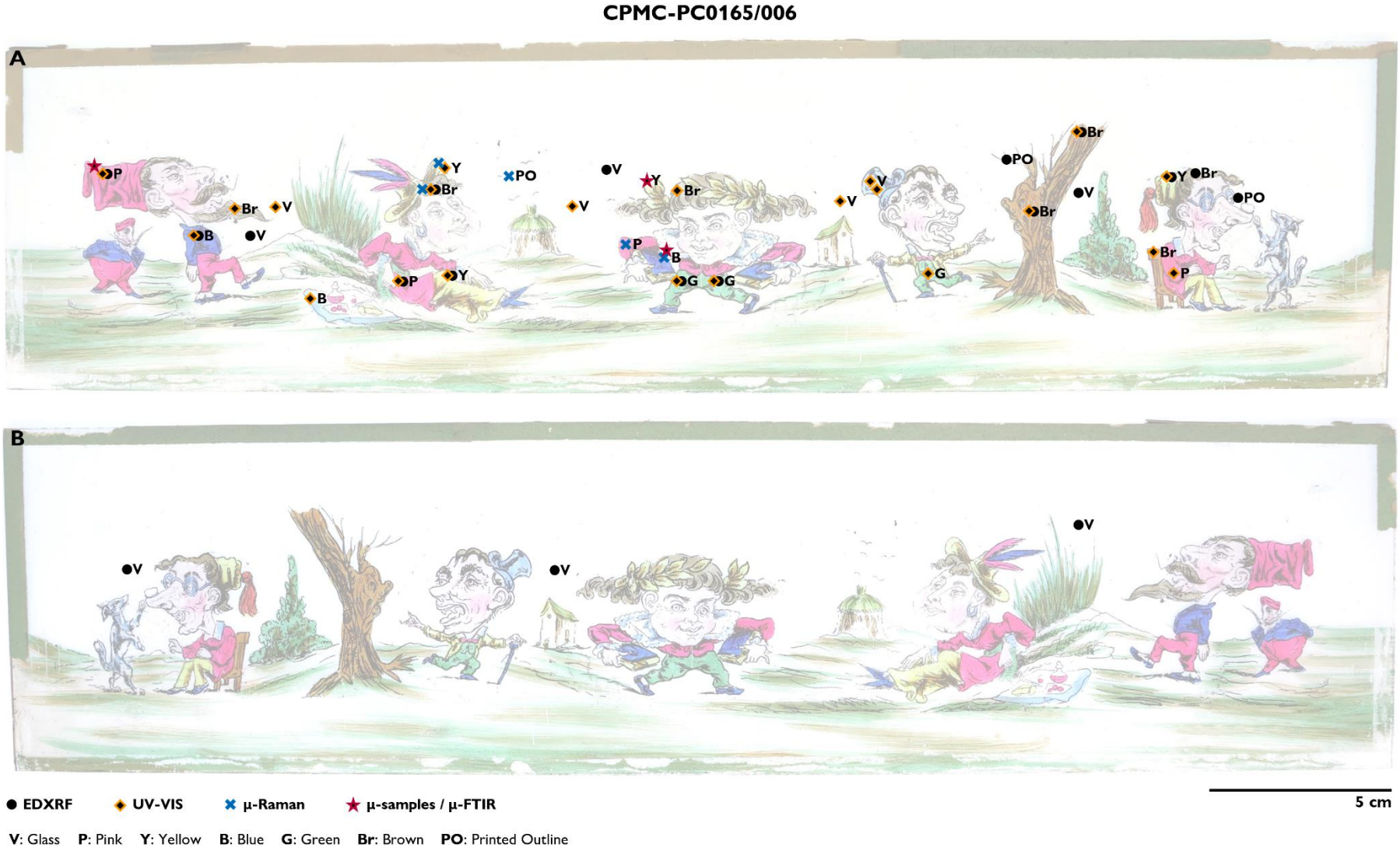


Figure A.49 Slide CPMC-PC0165/006 by Lapierre: mapping areas of analyses by EDXRF, UV-VIS and Raman spectroscopies, and micro-samples collection. The painted side of each glass is identified as A.

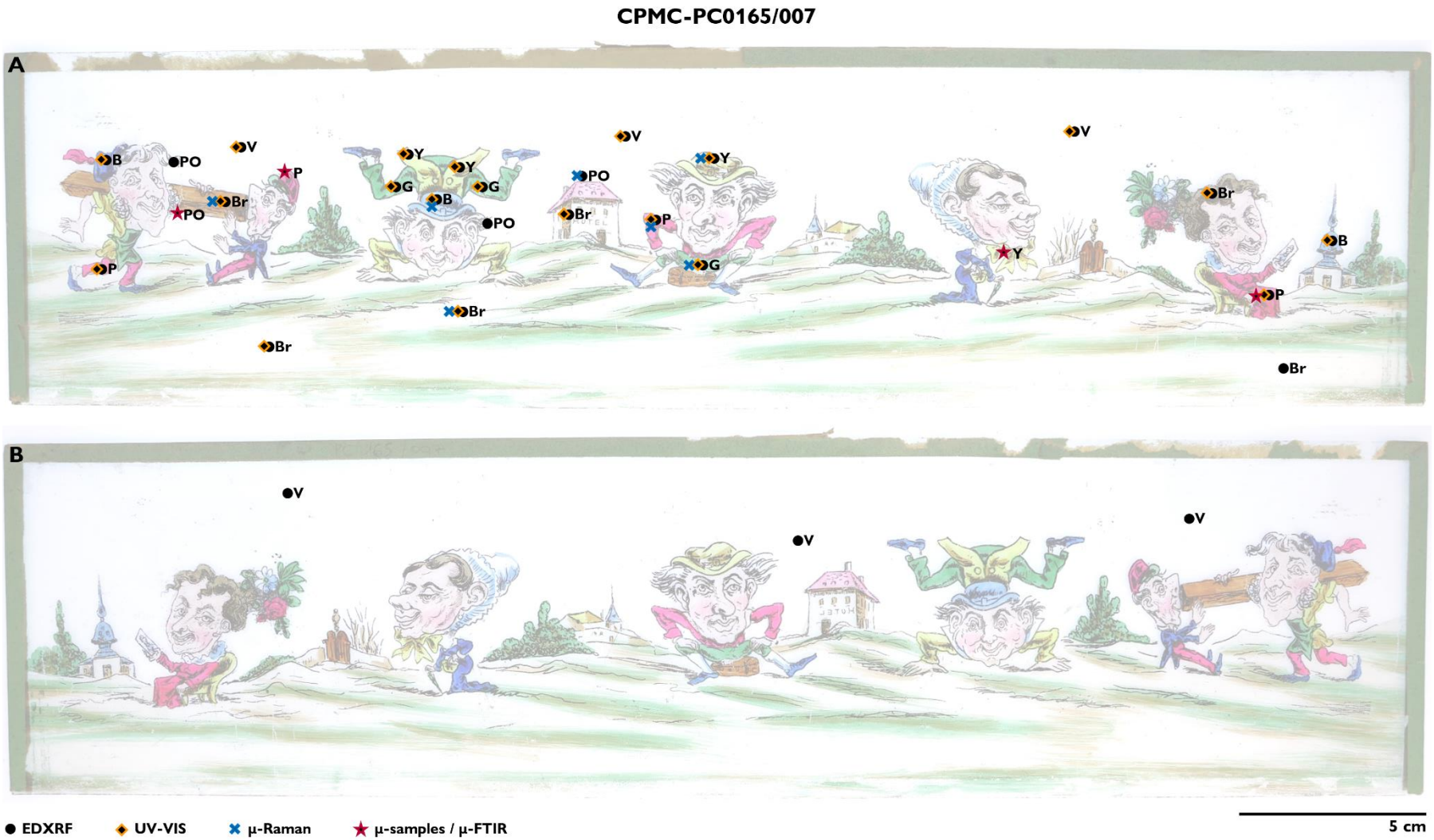


Figure A.50 Slide CPMC-PC0165/007 by Lapierre: mapping areas of analyses by EDXRF, UV-VIS and Raman spectroscopies, and micro-samples collection. The painted side of each glass is identified as A.



Figure A.51 Slide CPMC-PC0166/006 by Lapierre: mapping areas of analyses by EDXRF, UV-VIS and Raman spectroscopies, and micro-samples collection. The painted side of each glass is identified as A.

A.6 Material characterisation results

A.6.1 Glass support: semi-quantification results

Table A.5 Elemental compositions of 11 glasses classified as potassium-rich (KR), from 11 magic lantern slides attributed to the 18th century). The concentrations are given in weight percent (wt%). n.d. = not detected.

			Main Oxides										Minor Oxides				
Slide	Type		Na_2O+MgO	Al_2O_3	SiO_2	SO_3	K_2O	CaO	MnO	Fe_2O_3	As_2O_5	PbO	P_2O_5	Cl	TiO_2	CuO	ZnO	Rb_2O
PC002/001	**KR**	avg	n.d.	1.96	71.40	0.19	18.25	7.66	0.013	0.08	0.233			0.10	0.010	0.0039		0.026
CP01		stdev		0.11	0.55	0.02	0.35	0.11	0.000	0.00	0.005			0.01	0.00	0.0003		0.001
PC002/002	**KR**	avg	n.d.	1.82	71.17	0.25	18.48	7.57	0.014	0.11	0.194			0.10	0.011	0.0043		0.017
CP02		stdev		0.10	0.41	0.05	0.11	0.05	0.001	0.00	0.011			0.01	0.001	0.0005		0.000
PC002/003	**KR**	avg	n.d.	1.76	70.20	0.22	18.84	8.38	0.014	0.10	0.332			0.09	0.012	0.0040		0.020
CP03		stdev		0.15	0.45	0.05	0.29	0.04	0.000	0.00	0.008			0.00	0.001	0.0021		0.00
PC002/004	**KR**	avg	n.d.	1.82	70.67	0.26	18.74	8.07	0.032	0.09	0.228			0.14	0.010	0.0030		0.012
CP04		stdev		0.13	0.52	0.07	0.22	0.05	0.000	0.01	0.003			0.01	0.00	0.0003		0.000
PC002/005	**KR**	avg	n.d.	1.92	71.00	0.21	18.27	7.92	0.015	0.12	0.572			0.11	0.012	0.0043		0.013
CP05		stdev		0.18	0.00	0.04	0.16	0.04	0.000	0.00	0.022			0.01	0.001	0.0006		0.000
PC002/006	**KR**	avg	n.d.	1.76	70.00	0.16	19.18	8.25	0.040	0.12	0.204			0.11	0.014	0.0032		0.014
CP06		stdev		0.36	0.63	0.05	0.25	0.05	0.00	0.00	0.002			0.01	0.001	0.0005		0.000
PC002/007	**KR**	avg	0.13	1.82	70.17	0.29	18.01	8.20	0.028	0.11	0.452			0.13	0.013	0.0034		0.013
CP07		stdev	0.32	0.12	1.60	0.11	0.45	0.28	0.002	0.00	0.016			0.01	0.001	0.0004		0.000
PC002/008	**KR**	avg	2.31	1.82	68.83	0.17	15.94	7.33	0.043	0.30	0.260			0.24	0.024	0.0040		0.007
CP08		stdev	1.33	0.12	0.41	0.09	0.32	0.08	0.001	0.00	0.006			0.04	0.001	0.0012		0.000
PC002/009	**KR**	avg	1.46	1.67	72.00	0.11	12.25	9.00	0.015	0.09	0.164			0.23	0.011	0.0019		0.026
CP09		stdev	0.93	0.14	0.00	0.03	0.09	0.11	0.000	0.00	0.002			0.02	0.001	0.0003		0.000
PC002/010	**KR**	avg	0.18	1.88	69.17	0.14	18.33	8.08	0.029	0.11	0.458			0.12	0.012	0.0032		0.013
CP10		stdev	0.33	0.12	1.72	0.03	0.34	0.22	0.001	0.00	0.012			0.01	0.001	0.0005		0.000
PC002/011	**KR**	avg	1.86	1.73	70.17	0.16	12.58	11.48	0.018	0.10	0.064			0.26	0.011	0.0018		0.025
CP11		stdev	1.65	0.10	1.60	0.03	0.31	0.31	0.001	0.01	0.003			0.02	0.001	0.0002		0.001

Table A.6 Elemental compositions of five mixed alkali with kelp ash (MA-k) glasses, from two magic lantern slides of the early 19th century, produced in England by Philip Carpenter (FCT.V.LM01) and an unknown manufacturer (CPMC-PC3300/001). The concentrations are given in weight percent (wt%).

			Main Oxides										Minor Oxides								
Slide	**Type**		**Na_2O+MgO**	**Al_2O_3**	**SiO_2**	**SO_3**	**K_2O**	**CaO**	**MnO**	**Fe_2O_3**	**As_2O_5**	**PbO**	**P_2O_5**	**Cl**	**TiO_2**	**CuO**	**ZnO**	**Rb_2O**	**SrO**	**SnO_2**	**BaO**
FCT.V.LM01	**MA-k**	avg (1)	8.63	0.01-3.08	69.83	0.13	3.34	12.32	0.041	0.60	0.011	0.070	1.07	0.36	0.080		0.0130		0.317		0.060
LM01		stdev	0.01		0.01	0.00	0.00	0.00	0.000	0.00	0.000	0.000	0.00	0.00	0.000		0.0001		0.000		0.000
	**MA-k**	avg (2)	10.16	0.60-3.47	67.5	0.18	3.15	13.03	0.043	0.68	0.011	0.080	0.97	0.36	0.086		0.0132		0.300		0.040
		stdev	0.01		0.02	0.00	0.00	0.00	0.000	0.00	0.000	0.000	0.00	0.00	0.000		0.0002		0.000		0.000
	MA-k	avg (3)	9.45	0.57-3.08	69.33	0.15	4.15	11.40	0.047	0.52	0.012	0.060	0.95	0.33	0.072		0.0050		0.325		0.040
		stdev	0.01		0.01	0.00	0.00	0.00	0.000	0.00	0.000	0.000	0.00	0.00	0.000		0.0000		0.000		0.000
PC3300/001	**MA-k**	avg (F)	9.20	0.52-2.88	68.83	<0.11	4.70	11.72	0.041	0.49		0.062	1.20	0.32	0.085				0.390		
CP22		stdev	0.64		0.75		0.05	0.12	0.001	0.01		0.008	0.11	0.01	0.003				0.006		
	**MA-k**	avg (M)	9.94	0.50-2.85	69.67	0.19	2.63	12.37	0.068	0.68		0.072	0.97	0.20	0.083				0.282		
		stdev	0.73		0.52	0.03	0.03	0.19	0.001	0.02		0.008	0.05	0.01	0.002				0.005		

Table A.7 Elemental compositions of three soda-rich glass with synthetic soda (SS), possibly produced in England in the 19th century, from two magic lantern slides by Carpenter & Westley (CPMC-PC3301/005) and an unknown manufacturer (MUL-MUHNAC-UL000068). The concentrations are given in weight percent (wt%).

			Main Oxides										Minor Oxides								
Slide	**Type**		**Na_2O+MgO**	**Al_2O_3**	**SiO_2**	**SO_3**	**K_2O**	**CaO**	**MnO**	**Fe_2O_3**	**As_2O_5**	**PbO**	**P_2O_5**	**Cl**	**TiO_2**	**CuO**	**ZnO**	**Rb_2O**	**SrO**	**SnO_2**	**BaO**
PC3301/005	**SS**	avg (F)	22.18	0.48-2.8	62.22	0.24	0.54	10.48	0.014	0.17	0.665	0.030		0.05	0.032	0.0031	0.0033		0.009		0.100
CP34		stdev	1.39		0.01	0.00	0.00	0.00	0.000	0.00	0.000	0.000		0.00	0.000	0.0000	0.0000		0.000		0.000
	**SS**	avg (M)	23.92	0.47-2.62	60.70	0.21	0.58	10.45	0.013	0.19	0.470	0.035		0.04	0.031	0.0054	0.0756		0.009		0.070
		stdev	0.03		0.02	0.00	0.00	0.00	0.000	0.00	0.000	0.000		0.00	0.000	0.0000	0.0017		0.000		0.000
UL000068	**SS**	avg (M)	19.77	0.09-0.63	66.33	0.19	0.21	12.55	0.007	0.20	0.037				0.032		0.0048		0.011	0.05	
MUL04		stdev	2.25		1.63	0.01	0.01	0.50	0.000	0.01	0.002				0.002		0.0003		0.000	0.00	
																					

Table A.8 Elemental compositions of 17 high-lime low-alkali (HLLA) glasses, from eight magic lantern slides of the second half of the 19th century, produced in England by known manufacturers, Carpenter & Westley (ca.1838-1900) and W.E. & F. Newton (1852-1857). The concentrations are given in weight percent (wt%). n.d. = not detected.

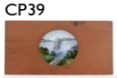
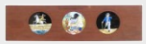
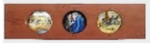
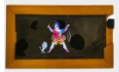
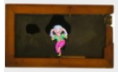
			Main Oxides										Minor Oxides								
Slide	**Type**		**Na_2O+MgO**	**Al_2O_3**	**SiO_2**	**SO_3**	**K_2O**	**CaO**	**MnO**	**Fe_2O_3**	**As_2O_5**	**PbO**	**P_2O_5**	**Cl**	**TiO_2**	**CuO**	**ZnO**	**Rb_2O**	**SrO**	**SnO_2**	**BaO**
PC189/009	**HLLA**	avg	9.90	0.45-2.65	73.33	0.24	0.21	12.87	0.320	0.36	0.140	0.092		n.d.	0.053	n.d.			0.022		
CP38		stdev	1.44		1.21	0.03	0.01	0.19	0.004	0.01	0.009	0.018			0.003				0.001		
																					
PC189/012	**HLLA**	avg	9.42	0.48-2.63	73.00	0.32	0.25	12.98	0.258	0.34	0.131	0.277		n.d.	0.045	0.0060			0.02		
CP39		stdev	4.26		2.97	0.04	0.01	0.86	0.021	0.03	0.008	0.023			0.002	0.0005			0.00		
																					
PC209/002	**HLLA**	avg (1)	8.94	0.45-2.62	74.00	0.21	0.22	12.98	0.399	0.23	0.134	0.080		0.06	0.042				0.023		
CP40		stdev	3.85		3.29	0.04	0.01	0.39	0.012	0.01	0.007	0.006		0.01	0.003				0.001		
	**HLLA**	avg (2)	6.34	0.42-2.47	76.00	0.25	0.26	13.18	0.375	0.26	0.152	0.123		0.07	0.049				0.022		
		stdev	2.01		1.67	0.06	0.01	0.13	0.003	0.00	0.007	0.014		0.01	0.001				0.001		
	HLLA	avg (3)	9.23	0.43-2.50	73.33	0.28	0.23	13.38	0.410	0.26	0.146	0.143		0.06	0.045				0.025		
		stdev	1.92		1.75	0.04	0.00	0.15	0.005	0.03	0.005	0.010		0.01	0.001				0.000		
PC209/009	**HLLA**	avg (1)	7.77	0.43-2.52	74.83	0.24	0.25	13.23	0.407	0.24	0.145	0.085		0.06	0.048				0.025		
CP41		stdev	2.00		1.72	0.03	0.03	0.14	0.005	0.00	0.004	0.010		0.01	0.003				0.001		
	**HLLA**	avg (2)	5.54	0.42-2.50	76.00	0.27	0.20	14.22	0.640	0.19	0.139	0.085		0.10	0.034				0.023		0.052
		stdev	0.91		0.63	0.04	0.01	0.15	0.009	0.00	0.013	0.010		0.01	0.003				0.001		0.034
	HLLA	avg (3)	7.96	0.45-2.65	74.83	0.30	0.22	13.17	0.391	0.24	0.127	0.108		0.06	0.044				0.022		n.d.
		stdev	5.76		5.38	0.08	0.01	0.31	0.007	0.00	0.005	0.010		0.00	0.001				0.001		
PC209/011	**HLLA**	avg (1)	10.4	0.44-2.58	72.00	0.23	0.24	13.36	0.388	0.24	0.159	0.100		0.08	0.043	0.0040	0.0035		0.022		0.033
CP42		stdev	3.44		3.00	0.03	0.01	0.22	0.005	0.00	0.007	0.019		0.01	0.002	0.0017	0.0011		0.000		0.006
	**HLLA**	avg (2)	9.25	0.50-2.68	73.20	0.20	0.22	13.16	0.401	0.24	0.136	0.060		0.08	0.047	0.0018	0.0029		0.024		n.d.
		stdev	4.84		3.96	0.04	0.02	0.38	0.012	0.01	0.003	0.010		0.01	0.004	0.0002	0.0001		0.001		
	HLLA	avg (3)	7.00	0.44-2.48	75.83	0.20	0.21	13.27	0.414	0.24	0.136	0.113		0.06	0.045	0.0031	0.0027		0.024		n.d.
		stdev	1.73		1.33	0.03	0.00	0.20	0.005	0.00	0.002	0.012		0.00	0.002	0.0004	0.0004		0.000		
FCT.V.LM02	**HLLA**	avg (F)	10.14	0.52-2.87	72.00	0.29	0.42	12.37	0.322	0.38	0.390	0.055	0.267	0.07	0.043	0.0021	0.0062		0.028		0.028
LM02		stdev	0.01		0.01	0.00	0.00	0.00	0.000	0.00	0.000	0.000	0.001	0.00	0.000	0.0000	0.0000		0.000		0.000
	**HLLA**	avg (M)	12.85	0.52-2.93	72.83	0.20	0.40	9.15	0.392	0.35	0.273	0.057	0.650	0.03	0.041	0.0078	0.0185		0.042		0.026
		stdev	0.01		0.01	0.00	0.00	0.00	0.00	0.00	0.000	0.000	0.001	0.00	0.000	0.0001	0.0003		0.001		0.000
PC3301/001	**HLLA**	avg (F)	9.03	0.53-3.07	72.67	0.32	0.71	13.03	0.009	0.21	0.595			n.d.	0.041	0.0076	0.0061		0.014		0.273
CP31		stdev	1.50		0.00	1.37	0.01	0.18	0.00	0.01	0.008				0.004	0.0106	0.0024		0.000		0.010
	**HLLA**	avg (M)	6.85	0.50-2.88	74.33	0.28	0.81	13.15	0.019	0.21	0.597			n.d.	0.040	n.d.	0.0053		0.016		0.340
		stdev	1.87		1.63	0.04	0.19	0.19	0.000	0.00	0.010				0.003		0.0011		0.001		0.006
PC3301/002	**HLLA**	avg (F)	6.41	0.43-2.53	75.50	0.32	0.28	13.57	0.306	0.28	0.209			0.04	0.043	0.0139	0.0066		0.018		0.112
CP32		stdev	1.39		1.38	0.09	0.20	0.15	0.140	0.04	0.196			0.01	0.003	0.0143	0.0036		0.001		0.117
	**HLLA**	avg (M)	5.89	0.43-2.55	76.50	0.26	0.19	13.85	0.319	0.34	0.167			0.04	0.037	n.d.	n.d.		0.022		0.053
		stdev	0.42		0.55	0.03	0.01	0.08	0.002	0.00	0.002			0.01	0.002				0.000		0.009

Table A.9 Elemental compositions of 24 high-lime low-alkali (HLLA) glasses, from 12 magic lantern slides of the second half of the 19th century, produced in England by unknown manufacturers. The concentrations are given in weight percent (wt%). n.d. = not detected; BDL = below the detection limit.

			Main Oxides										Minor Oxides								
Slide	**Type**		**Na_2O+MgO**	**Al_2O_3**	**SiO_2**	**SO_3**	**K_2O**	**CaO**	**MnO**	**Fe_2O_3**	**As_2O_5**	**PbO**	**P_2O_5**	**Cl**	**TiO_2**	**CuO**	**ZnO**	**Rb_2O**	**SrO**	**SnO_2**	**BaO**
PC3300/002	**HLLA**	avg (F)	4.08	0.42-2.45	75.67	0.38	0.30	16.35	0.010	0.21	n.d.	0.070		n.d.	0.043		0.0071		0.014		
CP23		stdev	0.96		0.52	0.02	0.01	0.10	0.000	0.00		0.006			0.003		0.0002		0.000		
	**HLLA**	avg (M)	5.57	0.40-2.40	74.50	0.42	0.19	16.33	0.007	0.11	0.192	0.110		n.d.	0.051		BDL		0.013		
		stdev	0.76		0.55	0.03	0.01	0.18	0.000	0.00	0.004	0.013			0.003				0.000		
PC3300/003	**HLLA**	avg (F)	7.23	0.44-2.48	76.00	0.22	0.19	13.16	0.111	0.28	0.125	0.086		0.08	0.046	0.0060			0.021		
CP24		stdev	0.41		0.71	0.04	0.01	0.09	0.001	0.00	0.003	0.005		0.00	0.002	0.0000			0.000		
	**HLLA**	avg (M)	5.98	0.40-2.27	75.00	0.34	0.22	15.83	0.053	0.21	<0.016	0.060		0.07	0.030	n.d.			0.012		
		stdev	0.61		0.63	0.03	0.01	0.14	0.001	0.00		0.011		0.01	0.003				0.000		
PC3302/007	**HLLA**	avg (F)	5.40	0.50-2.77	75.33	0.31	0.21	14.55	0.012	0.33	0.247	0.083		0.09	0.045				0.046		
CP26		stdev	1.71		0.82	0.04	0.01	0.16	0.001	0.01	0.005	0.015		0.01	0.002				0.001		
	**HLLA**	avg (M)	8.03	0.40-2.40	73.50	0.34	0.19	14.72	0.006	0.19	0.397	0.082		0.05	0.037				0.016		
		stdev	1.13		0.84	0.03	0.01	0.19	0.000	0.00	0.005	0.008		0.01	0.002				0.000		
PC3302/019	**HLLA**	avg (F)	5.27	0.42-2.43	75.17	0.34	0.29	16.07	n.d.	0.22		0.062		n.d.	0.033				0.038		
CP28		stdev	0.78		0.41	0.03	0.01	0.12		0.00		0.004			0.003				0.000		
	**HLLA**	avg (M1)	5.78	0.40-2.38	74.67	0.39	0.31	16.38	n.d.	0.26		0.058		n.d.	0.038				0.039		
		stdev	0.89		0.82	0.02	0.01	0.16		0.00		0.010			0.002				0.001		
	HLLA	avg (M2)	10.65	0.40-2.30	74.83	0.29	0.18	11.58	n.d.	0.10		0.067		0.04	0.042				0.011		
		stdev	0.89		0.75	0.03	0.01	0.12		0.00		0.010		0.00	0.002				0.000		
PC182	**HLLA**	avg (M1)	7.09	0.48-2.72	75.17	0.25	0.79	13.60	0.008	0.23		0.062		<0.03	0.054				0.012		0.040
CP29		stdev	0.79		0.75	0.05	0.02	0.06	0.000	0.00		0.004			0.005				0.000		0.007
	**HLLA**	avg (M2)	9.73	0.43-2.52	72.67	0.19	0.66	13.88	0.006	0.19		0.057		<0.02	0.053				0.016		<0.030
		stdev	0.93		0.82	0.02	0.02	0.18	0.000	0.00		0.005			0.002				0.000		
PC446	**HLLA**	avg (F)	7.44	0.48-2.67	75.00	0.24	0.70	13.82	0.007	0.18		0.060		<0.02	0.055				0.014		0.060
CP30		stdev	0.82		0.89	0.08	0.03	0.15	0.004	0.07		0.006			0.003				0.000		0.009
	**HLLA**	avg (M)	7.54	0.48-2.77	74.17	0.22	0.74	14.23	0.006	0.19		0.065		0.03	0.067				0.016		0.040
		stdev	1.27		1.17	0.06	0.02	0.38	0.001	0.01		0.005		0.01	0.003				0.001		0.009
FCT.V.LM03	**HLLA**	avg (F)	7.98	0.40-2.42	72.33	0.43	0.28	15.22	0.013	0.19	0.081	0.053	0.78	0.02	0.032	0.0076	0.0035		0.015		0.030
LM03		stdev	0.02		0.02	0.00	0.00	0.00	0.000	0.00	0.000	0.000	0.00	0.00	0.000	0.0000	0.0000		0.000		0.000
	**HLLA**	avg (M)	7.27	0.40-2.38	73.83	0.41	0.25	14.75	0.043	0.21	0.011	0.058	0.70	0.04	0.080	0.0024	0.0038		0.027		0.170
		stdev	0.01		0.01	0.00	0.00	0.00	0.001	0.00	0.000	0.000	0.00	0.00	0.001	0.0000	0.0000		0.000		0.002
UL000065	**HLLA**	avg (F)	6.91	0.07-0.53	74.33	0.30	0.27	17.30	0.008	0.25	0.053				0.041		0.0096		0.012	0.08	
MUL01		stdev	0.69		0.52	0.03	0.01	0.23	0.001	0.00	0.004				0.002		0.0004		0.000	0.00	
	**HLLA**	avg (M)	6.43	0.07-0.55	76.17	0.23	0.24	15.87	0.009	0.27	0.045				0.038		0.0066		0.013	0.06	
		stdev	0.97		0.75	0.03	0.01	0.18	0.001	0.00	0.003				0.006		0.0003		0.000	0.00	

(continued)

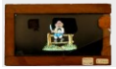
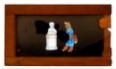
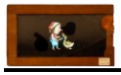
			Main Oxides									Minor Oxides								
Slide	**Type**		**Na_2O+MgO**	**Al_2O_3**	**SiO_2**	**SO_3**	**K_2O**	**CaO**	**MnO**	**Fe_2O_3**	**As_2O_5**	**PbO**	**P_2O_5**	**Cl**	**TiO_2**	**CuO**	**ZnO**	**Rb_2O**	**SrO**	**SnO_2**	**BaO**
UL000066	**HLLA**	avg (F)	4.98	0.09-0.68	75.83	0.28	0.25	17.60	0.005	0.21	0.057				0.043		0.0038		0.014	0.08	
MUL02		stdev	0.80		0.41	0.04	0.01	0.23	0.000	0.02	0.001				0.002		0.0001		0.000	0.00	
	**HLLA**	avg (M)	8.48	0.09-0.61	74.50	0.30	0.26	15.55	0.004	0.21	0.006				0.037		0.0036		0.028	0.07	
		stdev	6.99		5.07	0.06	0.03	1.77	0.000	0.03	0.000				0.006		0.0007		0.003	0.01	
UL000067	**HLLA**	avg (F)	6.68	0.10-0.70	75.83	0.23	0.23	16.02	0.009	0.25	0.006				0.036		0.0037		0.013	0.07	
MUL03		stdev	0.67		0.75	0.03	0.01	0.22	0.001	0.01	0.000				0.002		0.0002		0.000	0.00	
	**HLLA**	avg (M)	5.32	0.12-1.04	77.80	0.19	0.74	14.54	0.008	0.27	0.007				0.075		0.0105		0.013	0.06	
		stdev	0.89		0.84	0.03	0.01	0.05	0.000	0.00	0.000				0.001		0.0010		0.000	0.00	
UL000068	**HLLA**	avg (F)	7.46	0.11-0.78	74.67	0.31	0.28	15.88	0.007	0.32	0.019				0.048		0.0075		0.017	0.07	
MUL04		stdev	0.62		0.52	0.05	0.01	0.04	0.000	0.00	0.000				0.002		0.0005		0.000	0.00	
																					
UL000069	**HLLA**	avg (F)	6.36	0.10-0.68	75.67	0.29	0.29	16.25	0.007	0.31	0.045				0.044		0.0108		0.017	0.07	
MUL05		stdev	0.58		0.52	0.04	0.01	0.18	0.000	0.00	0.001				0.001		0.0008		0.001	0.00	
	**HLLA**	avg (M)	6.49	0.09-0.67	74.67	0.33	0.23	17.03	0.004	0.19	0.013				0.042		0.0035		0.013	0.08	
		stdev	3.81		2.66	0.05	0.02	1.12	0.000	0.01	0.001				0.005		0.0003		0.001	0.01	

Table A.10 Elemental compositions of 14 high-lime low-alkali (HLLA) glasses, from 14 magic lantern slides of the second half of the 19th century, produced in France by Lapierre (ca.1860-1900). The concentrations are given in weight percent (wt%). n.d. = not detected; BDL = below the detection limit.

			Main Oxides									Minor Oxides								
Slide	**Type**		**Na_2O+MgO**	**Al_2O_3**	**SiO_2**	**SO_3**	**K_2O**	**CaO**	**MnO**	**Fe_2O_3**	**As_2O_5**	**PbO**	**P_2O_5**	**Cl**	**TiO_2**	**CuO**	**ZnO**	**Rb_2O**	**SrO**	**SnO_2**	**BaO**
PC018/001	**HLLA**	avg	7.35	0.32-2.43	73.43	0.40	0.42	15.80	0.003	0.15	BDL	n.d.		n.d.	0.042		0.0028		0.018		
CP12		stdev	1.47		1.20	0.03	0.01	0.28	0.000	0.00					0.001		0.0004		0.001		
																					
PC018/002	**HLLA**	avg	6.23	0.33-2.47	74.25	0.37	0.40	15.60	0.003	0.16	0.2800	n.d.		n.d.	0.036		0.0027		0.018		
CP13		stdev	0.62		0.61	0.03	0.01	0.09	0.000	0.00	0.0000				0.002		0.0002		0.000		
																					
PC203/001	**HLLA**	avg	7.44	0.33-2.50	73.40	0.37	0.51	15.28	0.020	0.23	0.0250	0.102		<0.02	0.067		0.0041		0.027		
CP14		stdev	1.53		1.33	0.03	0.01	0.21	0.001	0.00	0.0034	0.010			0.002		0.0005		0.001		
																					
PC203/002	**HLLA**	avg	7.36	0.35-2.48	73.30	0.37	0.48	15.55	0.014	0.23	<0.0110	0.097		0.02	0.060		0.0034		0.029		
CP15		stdev	0.81		0.66	0.04	0.01	0.14	0.000	0.00		0.008		0.00	0.002		0.0002		0.000		
																					
PC203/003	**HLLA**	avg	8.08	0.37-2.48	72.45	0.41	0.48	15.35	0.007	0.14	0.4550	0.117		0.03	0.036		0.0025		0.016		
CP16		stdev	0.99		0.91	0.04	0.01	0.10	0.001	0.00	0.0084	0.018		0.01	0.001		0.0004		0.000		
																					

(continued)

			Main Oxides										Minor Oxides								
Slide	**Type**		**Na_2O+MgO**	**Al_2O_3**	**SiO_2**	**SO_3**	**K_2O**	**CaO**	**MnO**	**Fe_2O_3**	**As_2O_5**	**PbO**	**P_2O_5**	**Cl**	**TiO_2**	**CuO**	**ZnO**	**Rb_2O**	**SrO**	**SnO_2**	**BaO**
PC032/003	**HLLA**	avg	7.41	0.33-2.43	73.30	0.21	0.31	15.90	0.004	0.22	0.0950	n.d.		0.03	0.054		0.0038		0.016		
CP17		stdev	1.55		1.38	0.02	0.01	0.18	0.001	0.00	0.0031			0.01	0.002		0.0002		0.001		
PC033/001	**HLLA**	avg	8.46	0.37-2.52	71.98	0.23	0.29	16.10	0.004	0.21	0.1210	n.d.		<0.03	0.056		0.0037		0.017		
CP18		stdev	0.42		0.42	0.03	0.02	0.06	0.000	0.00	0.0012				0.001		0.0004		0.000		
PC165/006	**HLLA**	avg	7.01	0.33-2.43	72.42	0.40	0.50	16.88	0.004	0.28	BDL	n.d.		BDL	0.045		0.0034		0.018		
CP19		stdev	0.68		0.57	0.00	0.01	0.15	0.000	0.00					0.002		0.0004		0.000		
PC165/007	**HLLA**	avg	11.81	BDL	70.05	0.37	0.47	16.92	0.004	0.30	0.0050	n.d.		<0.02	0.045		0.0035		0.018		
CP55		stdev	2.83		2.55	0.02	0.02	0.23	0.000	0.00	0.0002				0.002		0.0003		0.000		
PC166/006	**HLLA**	avg	5.71	0.30-2.33	74.50	0.32	0.55	16.23	0.006	0.21	0.0100	n.d.		0.03	0.042		0.0031		0.018		
CP20		stdev	0.73		0.55	0.04	0.01	0.12	0.000	0.00	0.0003			0.01	0.001		0.0004		0.000		
PC021/002	**HLLA**	avg	8.73	BDL	73.82	0.28	0.45	16.42	0.107	0.21	0.0070	n.d.		<0.02	0.051		0.0030		0.018		
CP51		stdev	1.66		1.59	0.03	0.01	0.23	0.003	0.00	0.0003				0.001		0.0003		0.000		
PC021/001	**HLLA**	avg	12.47	BDL	70.45	0.27	0.46	15.95	0.103	0.21	0.0060	n.d.		<0.02	0.047		0.0032		0.017		
CP52		stdev	2.41		2.13	0.01	0.01	0.26	0.002	0.00	0.0002				0.002		0.0003		0.000		
PC020/006	**HLLA**	avg	12.79	BDL	70.13	0.29	0.47	15.93	0.102	0.21	0.0060	n.d.		<0.02	0.046		0.0034		0.017		
CP53		stdev	2.31		2.14	0.03	0.01	0.20	0.001	0.00	0.0004				0.003		0.0005		0.000		
PC020/007	**HLLA**	avg	8.60	BDL	73.68	0.29	0.45	16.42	0.108	0.21	0.0070	n.d.		<0.02	0.050		0.0030		0.018		
CP54		stdev	1.18		1.07	0.04	0.01	0.12	0.001	0.00	0.0003				0.001		0.0003		0.000		

A.6.2 Slides' representative spectra

A) Unknown, Italy (ca.1750-1800)



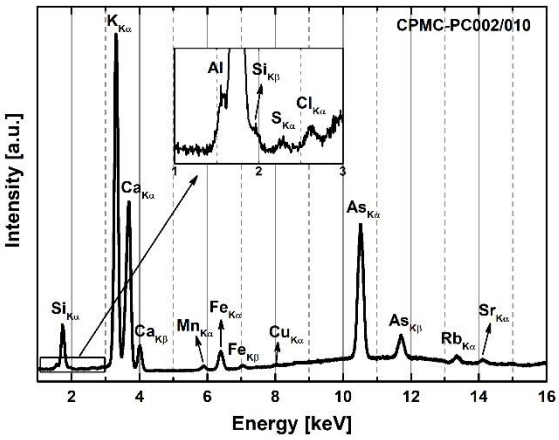
Glass

Semi-quantified as Potassium-rich glass

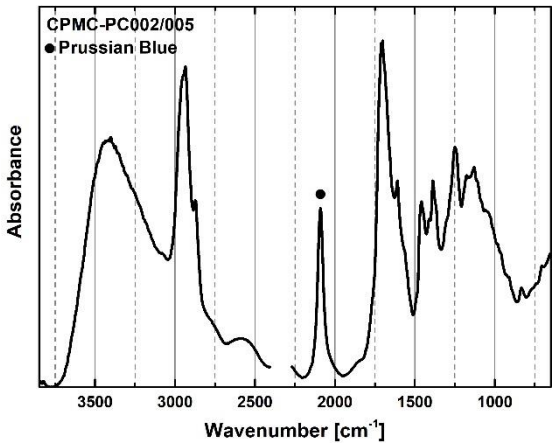
Binder

Identified as mastic resin

EDXRF



μ-FTIR

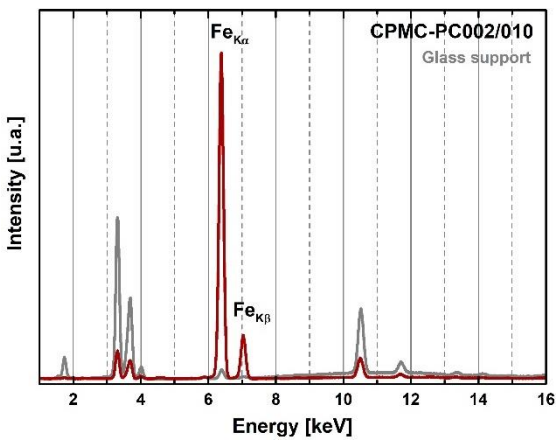




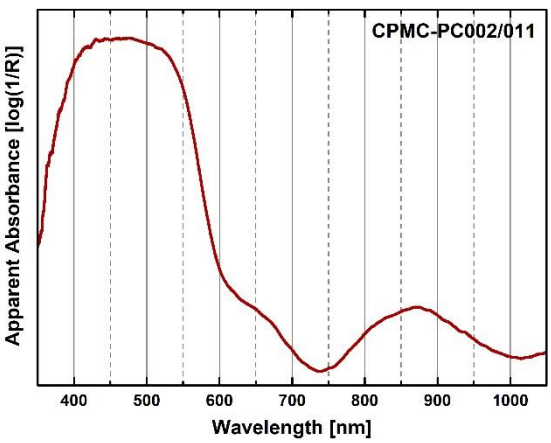
Red (also used as outline)

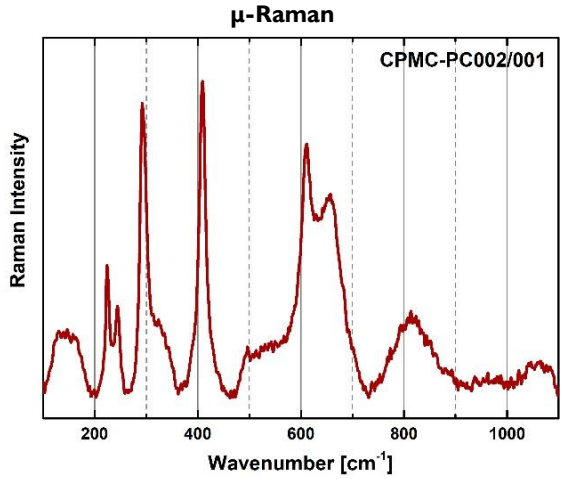
Identified as hematite

EDXRF



UV-VIS

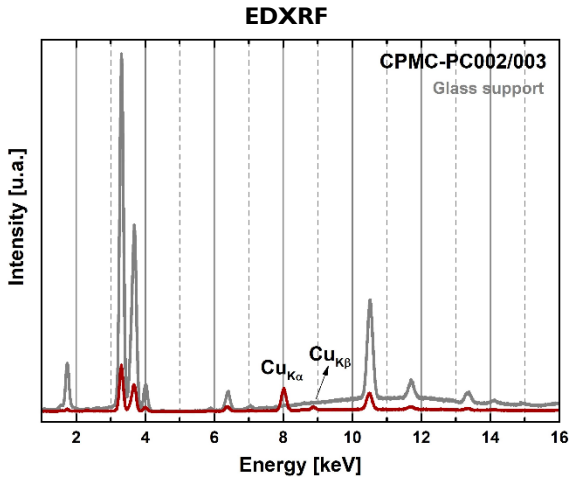


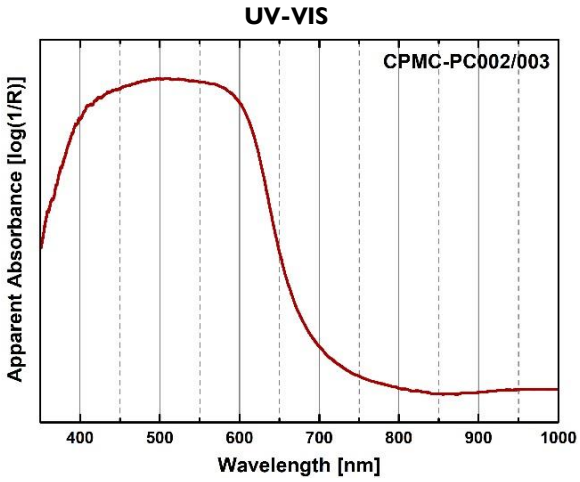


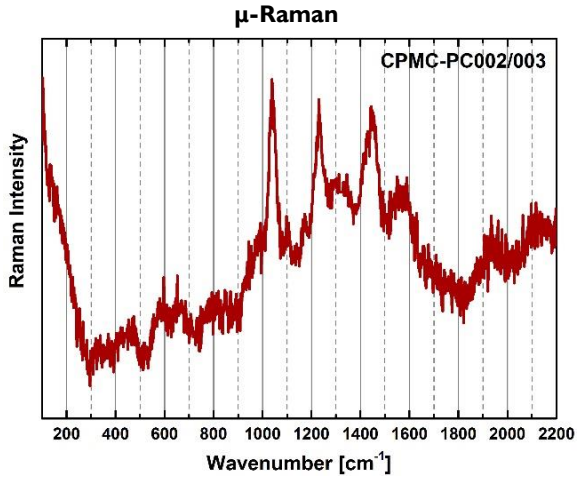


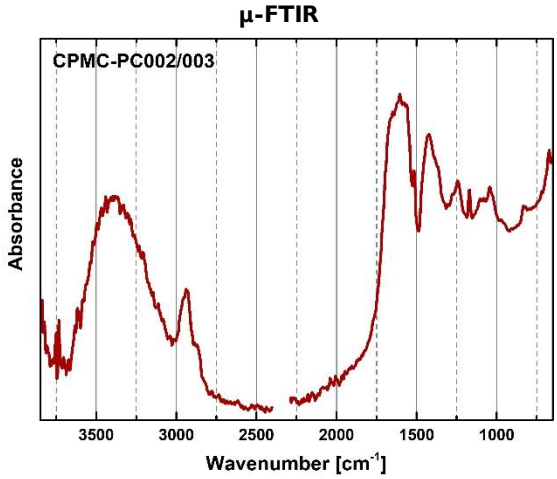
Red-orange

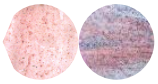
Colourant not identified, possibly a copper-based red







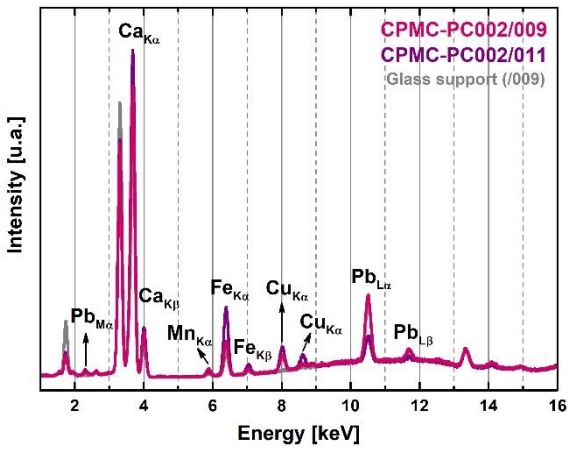




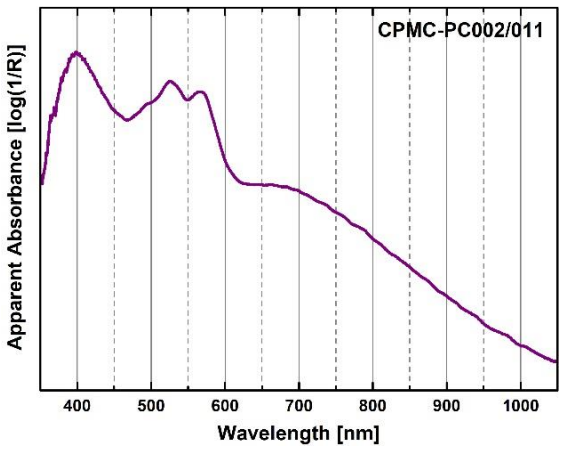
Pink and Purple

Identified as an animal anthraquinone lake (possibly cochineal) and Prussian blue

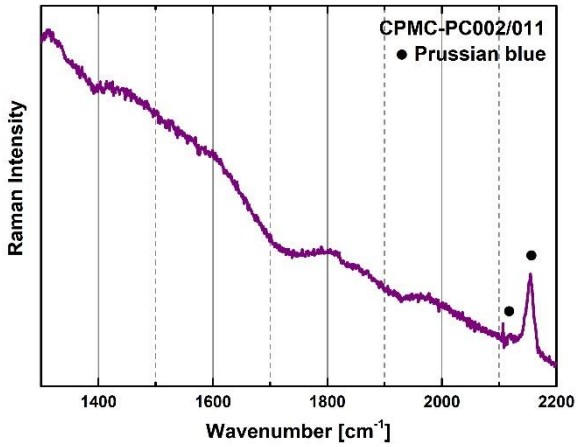
EDXRF



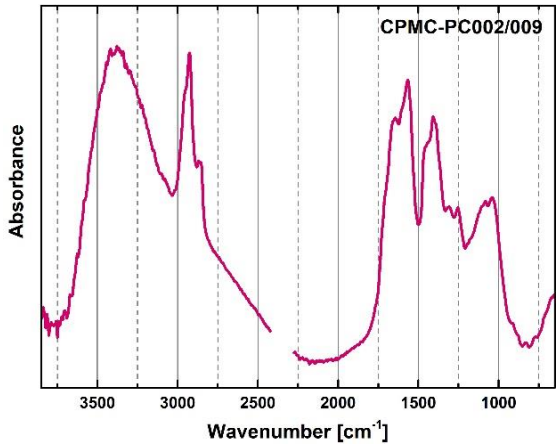
UV-VIS



μ-Raman



μ-FTIR

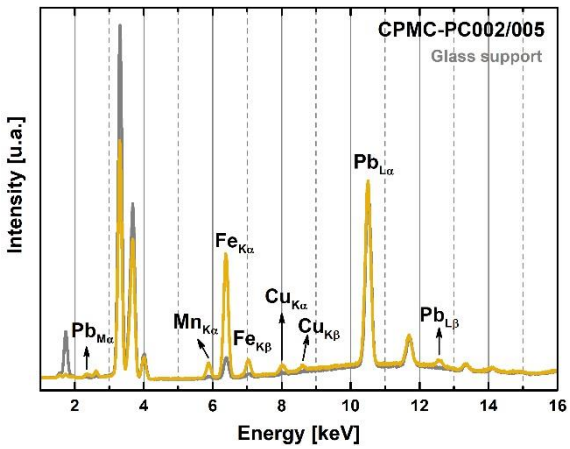




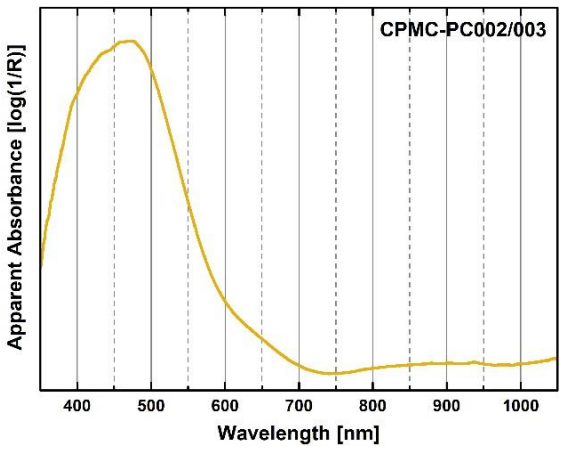
Yellow

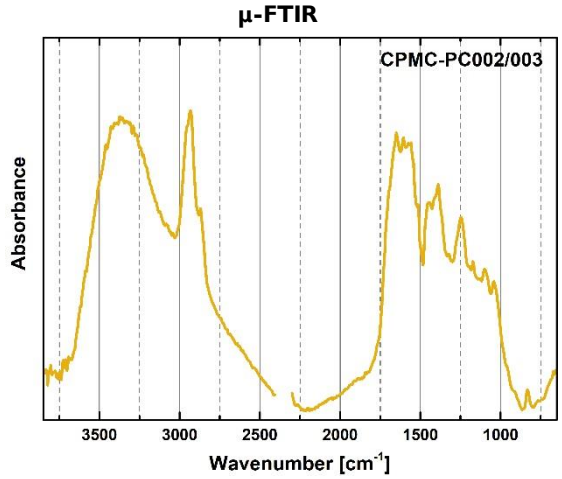
Identified as yellow ochre (with goethite and hematite)

EDXRF



UV-VIS

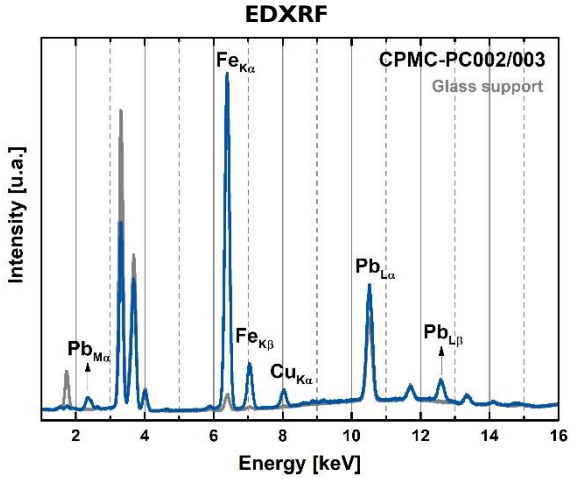


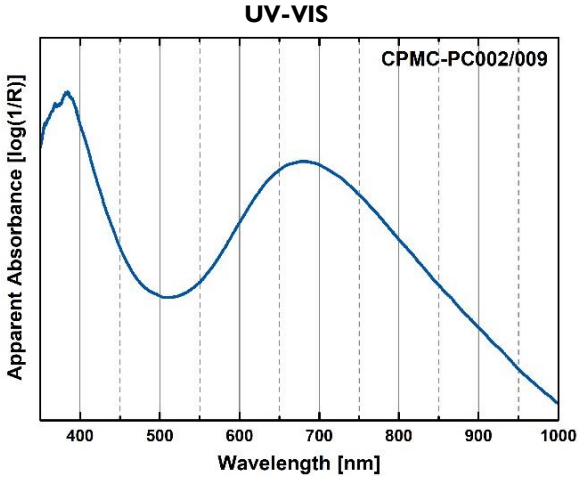


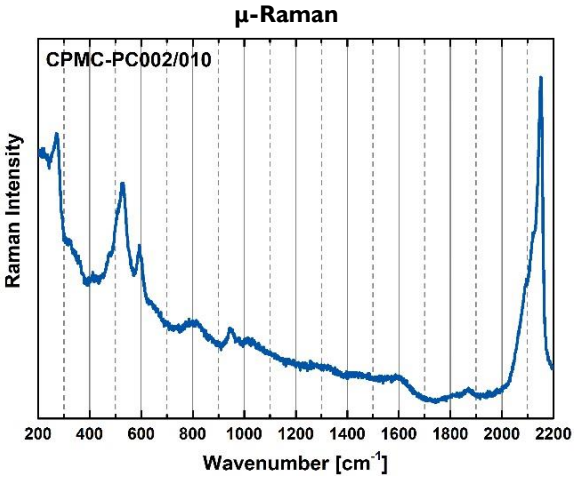


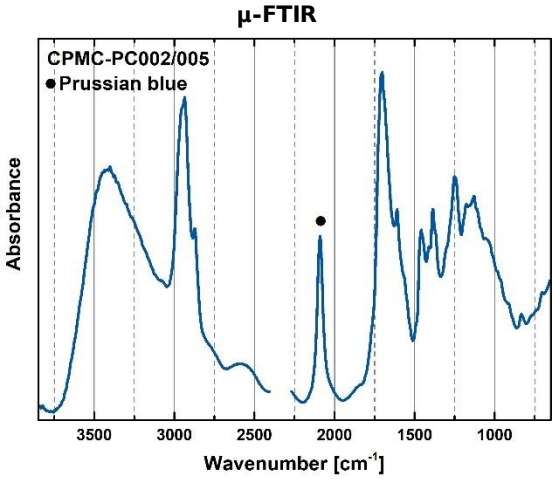
Blue

Identified as Prussian blue





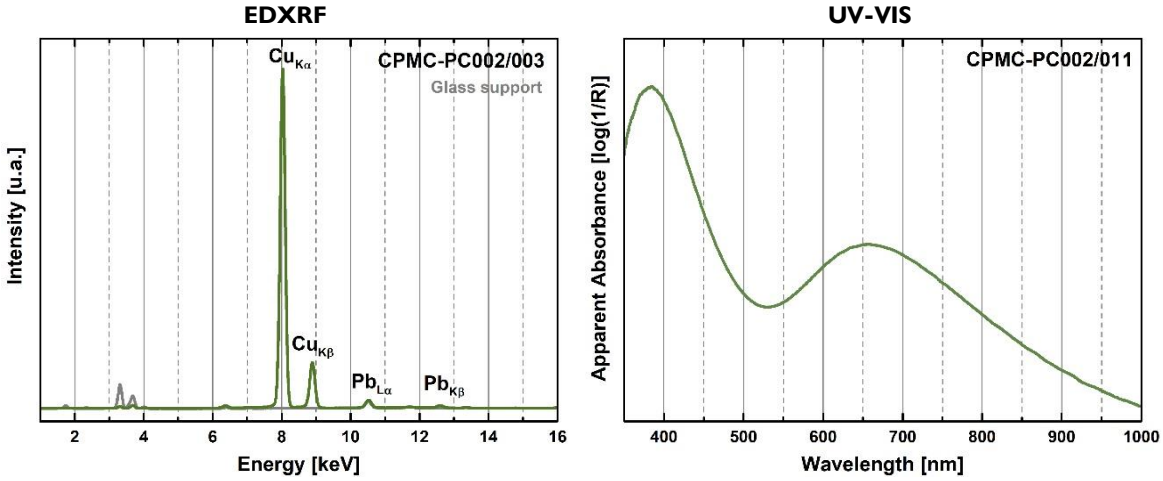


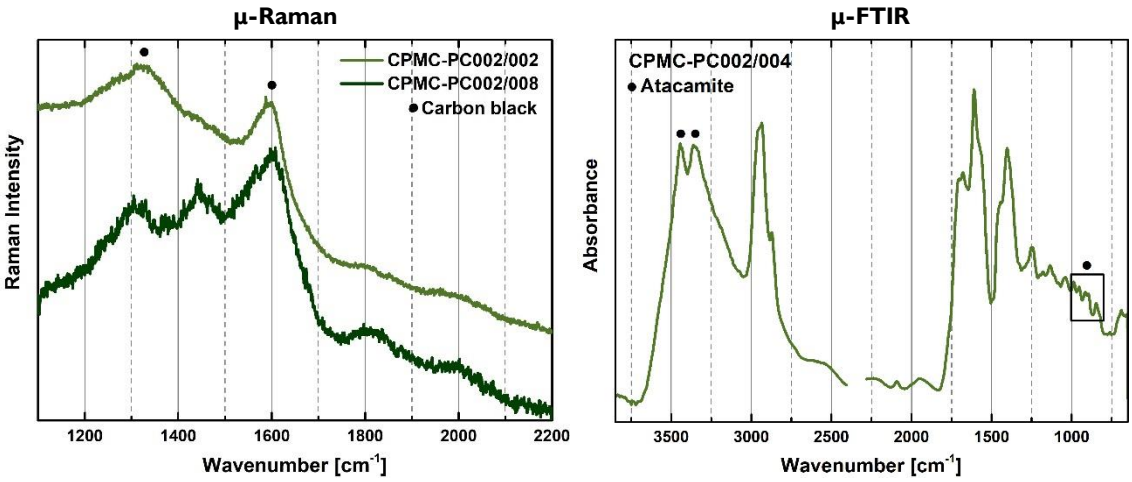




Green

Identified as copper-green

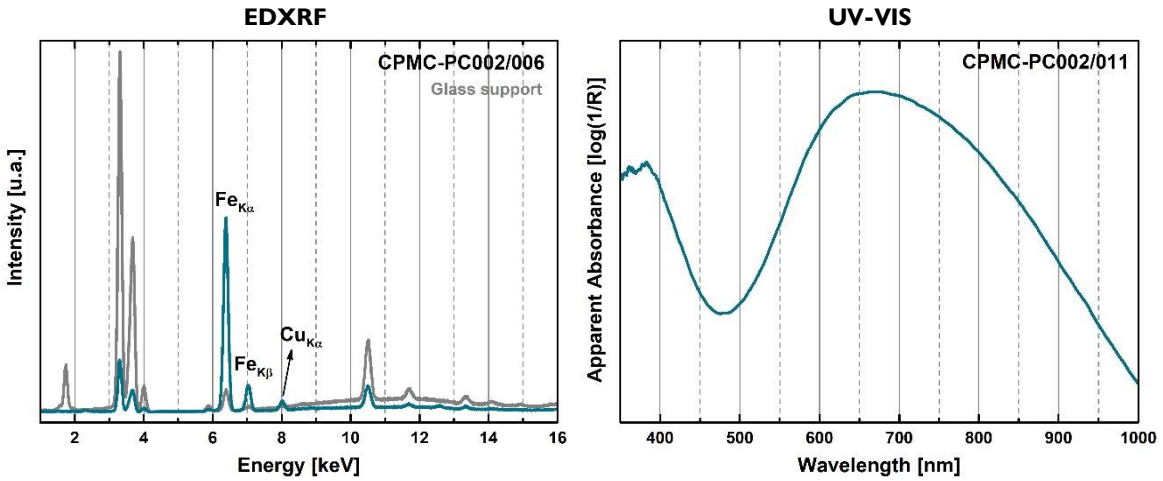


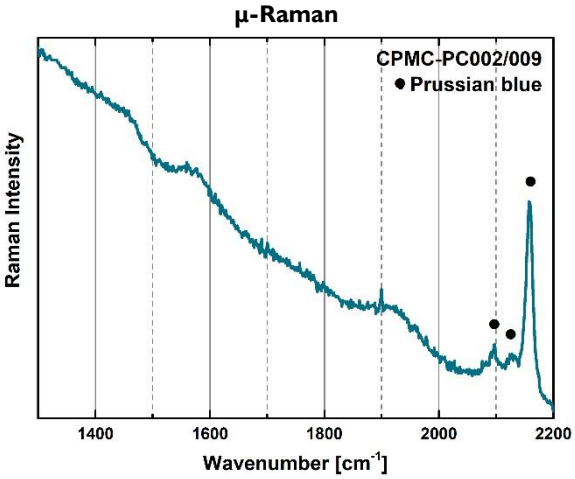


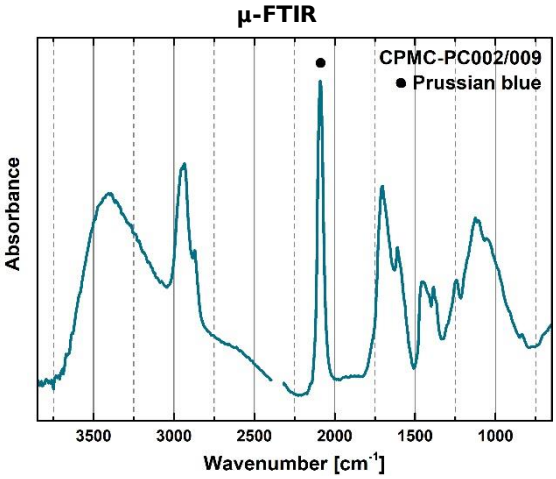


Blue green

Identified as Prussian blue and possibly copper-green



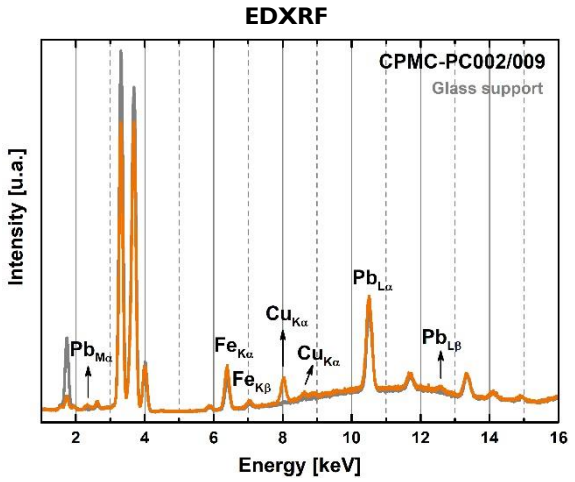


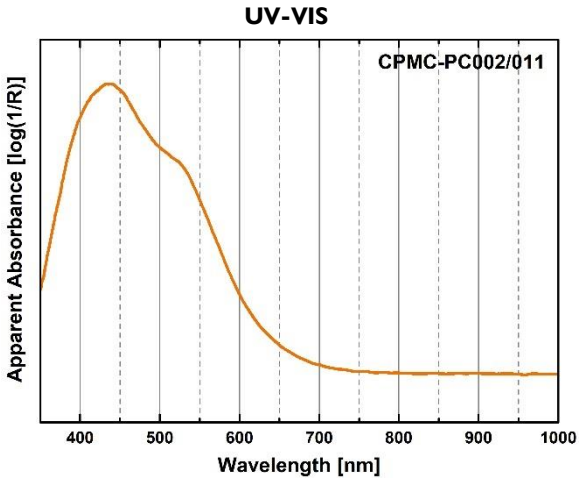




Orange

Colourant not identified

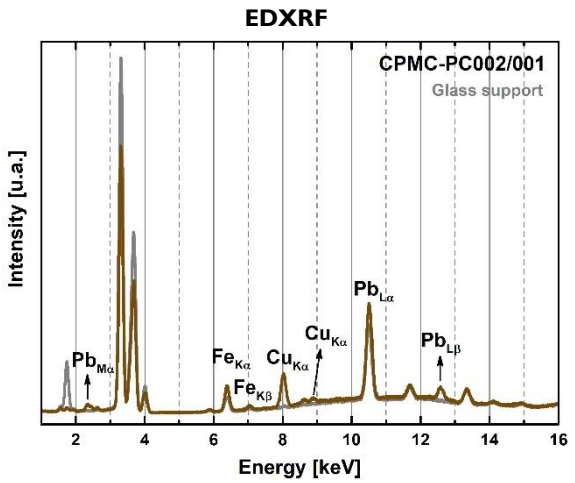


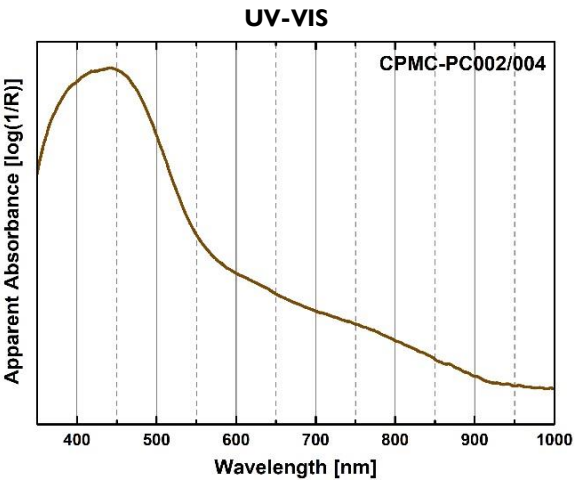


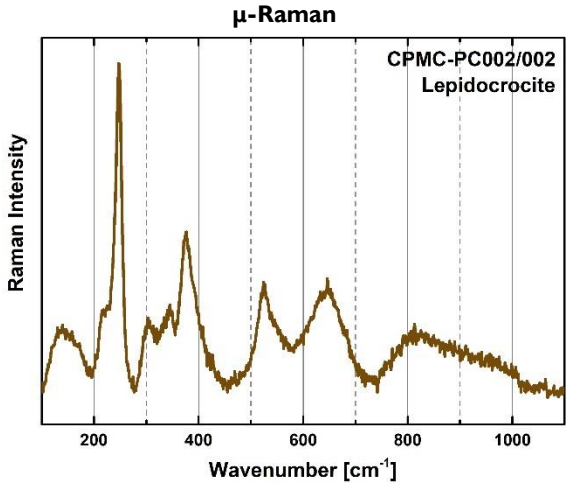


Brown

Colourant identified as brown ochre (with lepidocrocite)



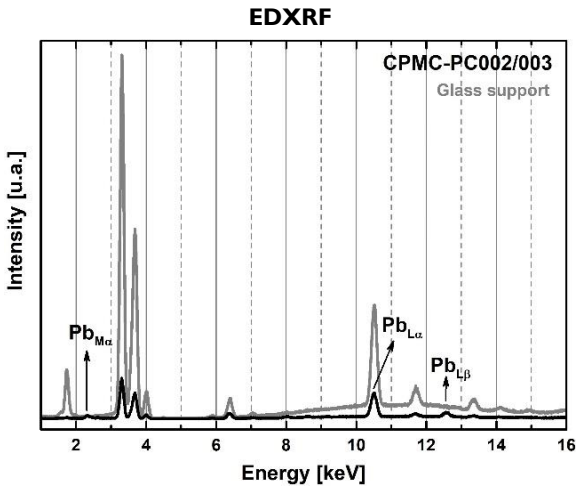


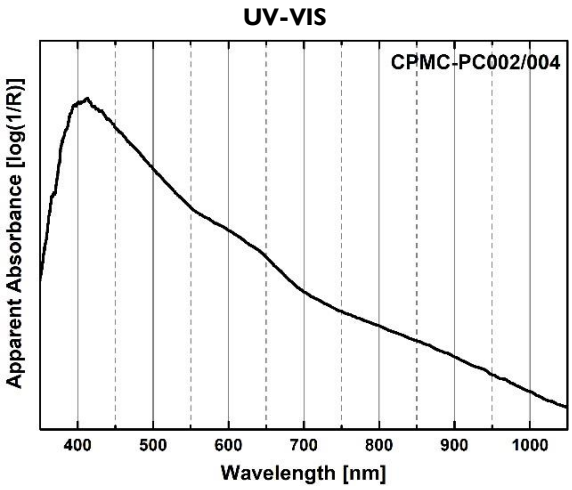


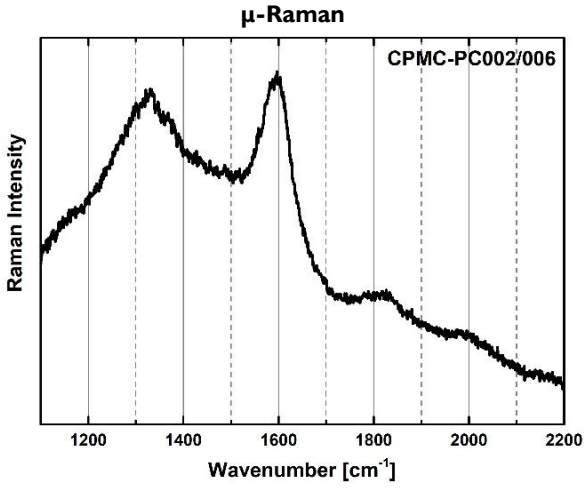


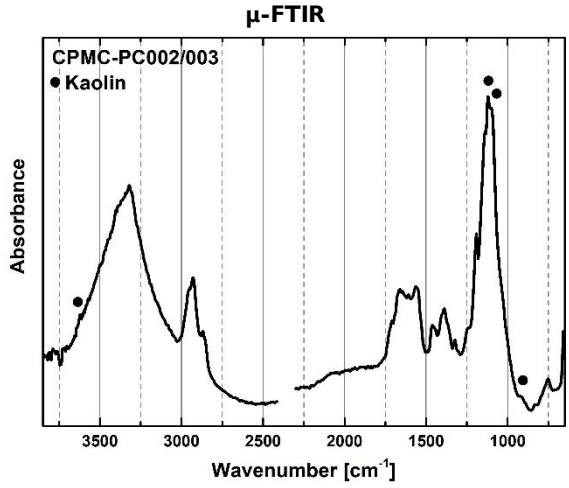
Black

Identified as carbon-based black









B) Philip Carpenter, England (ca.1822-1835)



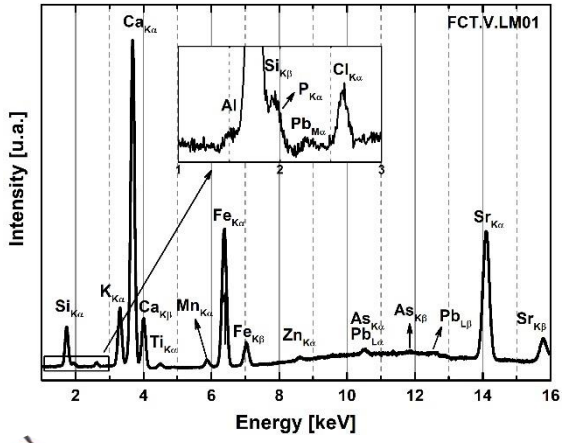
LM01

Scale: 10 cm

Glass

Semi-quantified as mixed alkali glass

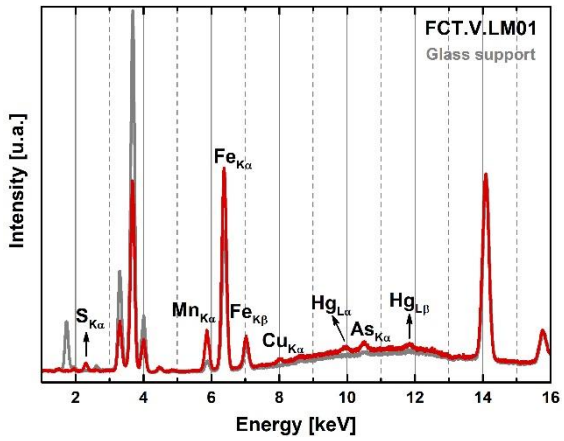
EDXRF



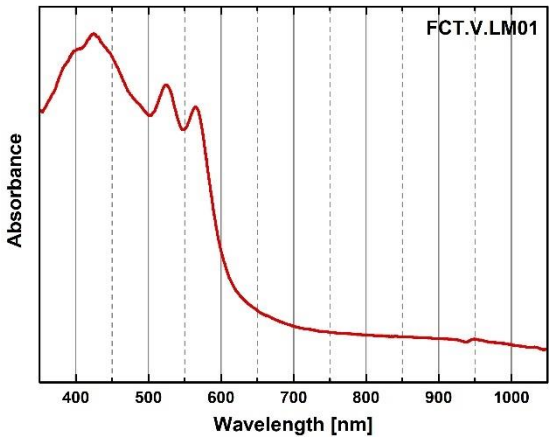
Red

Identified as vermilion, animal anthraquinone lake (possibly cochineal) and possibly yellow ochre

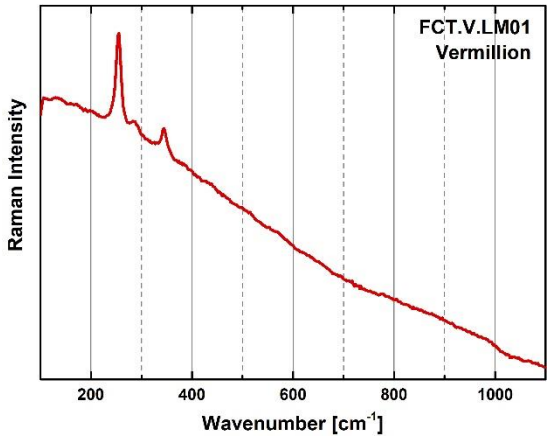
EDXRF



UV-VIS



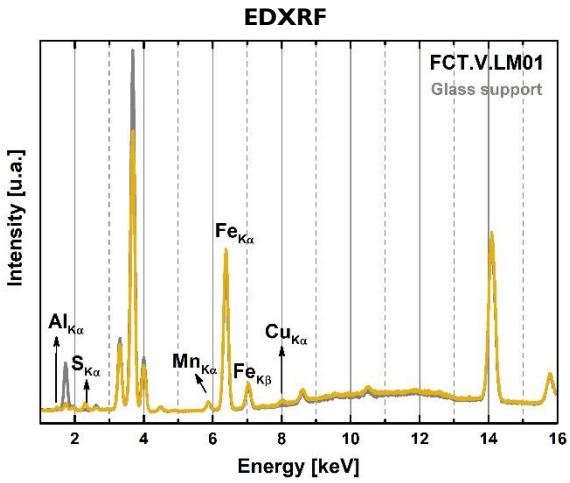
μ-Raman

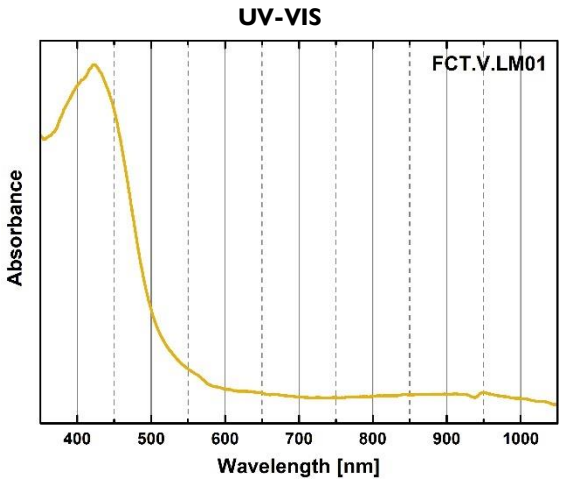


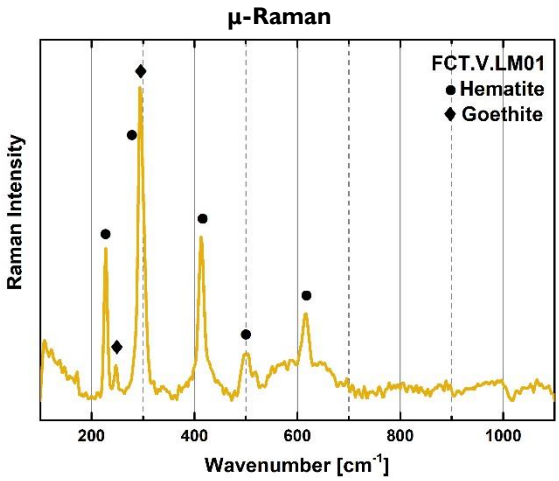


Yellow

Identified as yellow ochre (with goethite and hematite)



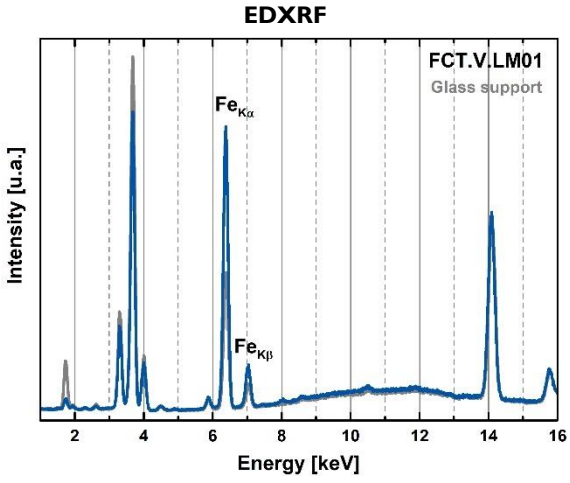


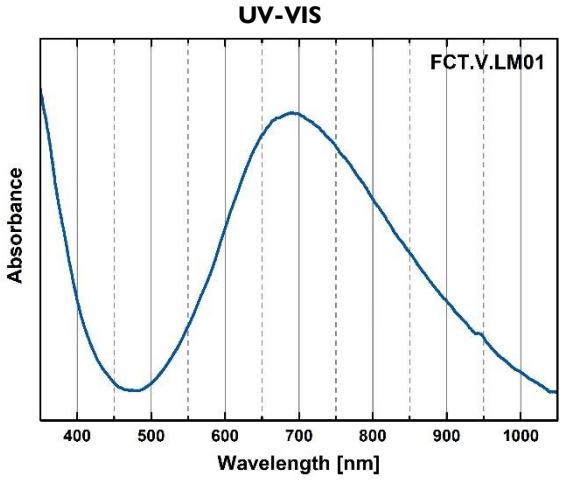


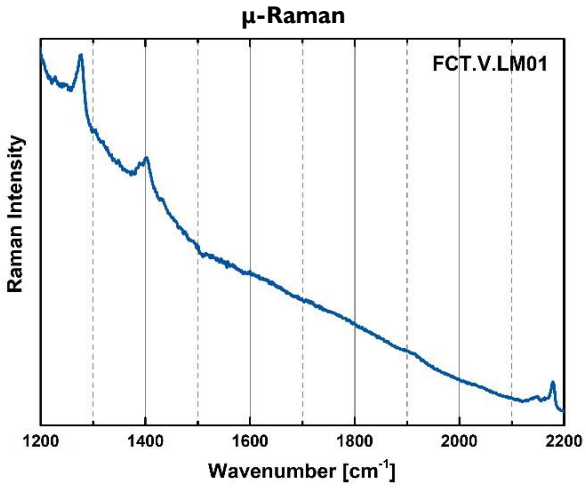


Blue

Identified as Prussian blue



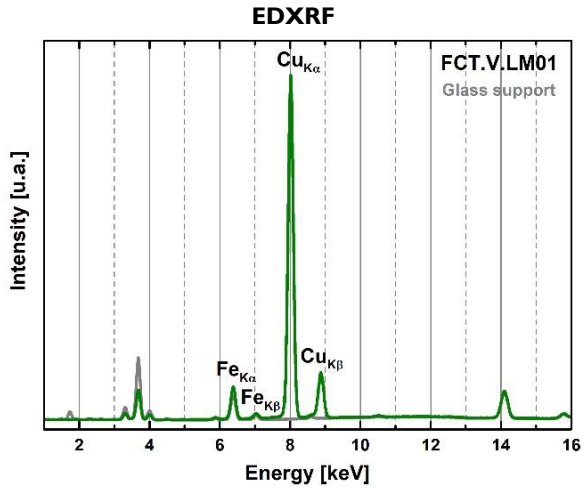


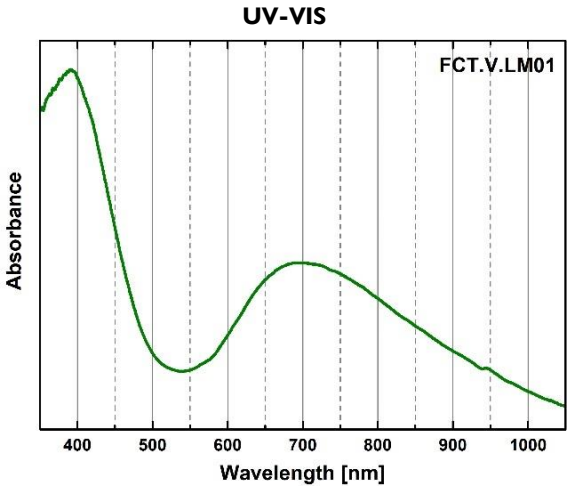


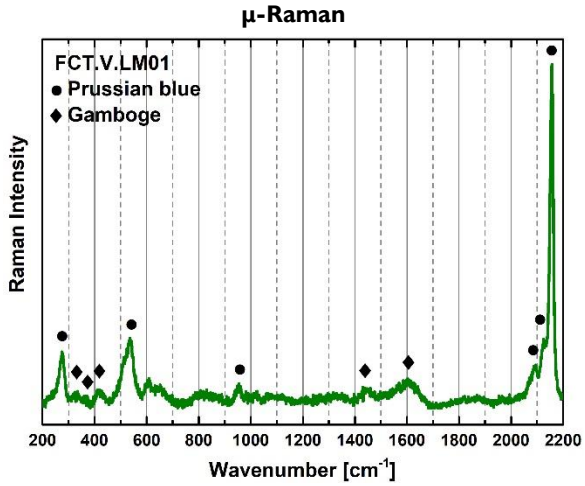


Green

Identified as copper-green, Prussian blue and gamboge





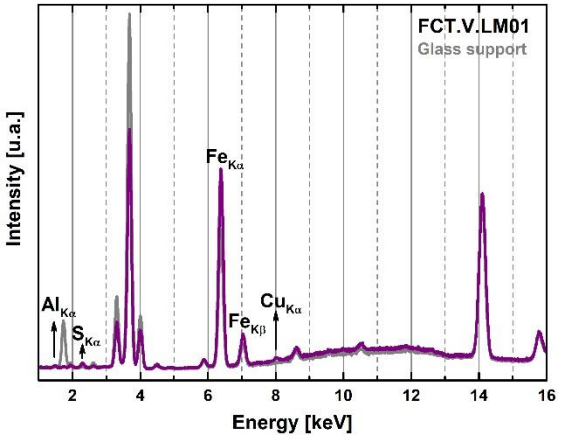




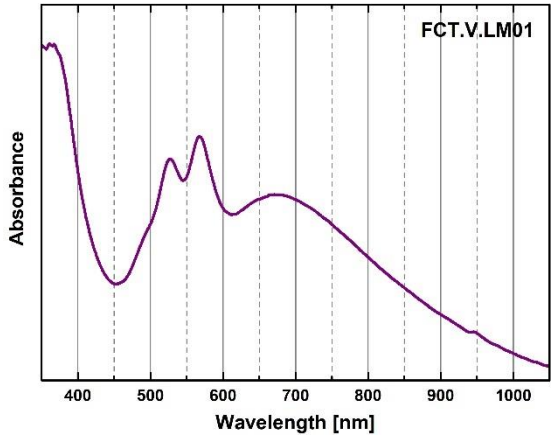
Purple

Identified as Prussian blue and an animal anthraquinone lake (possibly cochineal)

EDXRF



UV-VIS

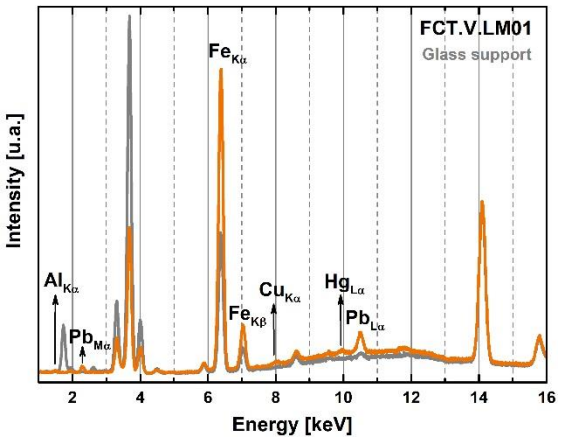




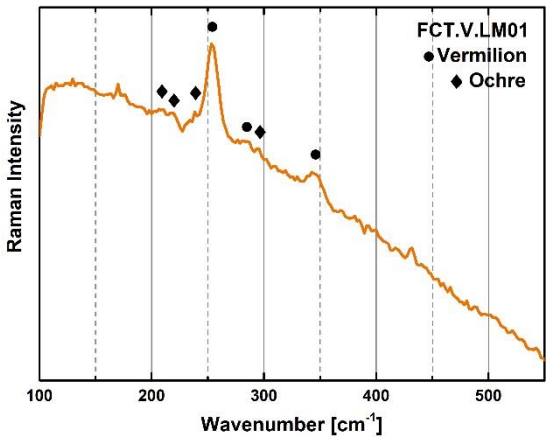
Orange

Identified as vermilion and possibly yellow ochre

EDXRF



μ-Raman

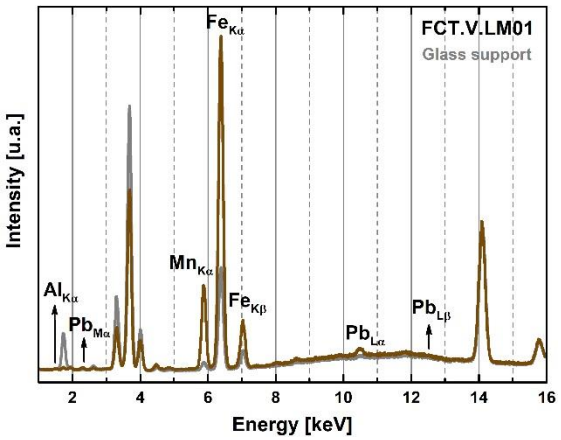




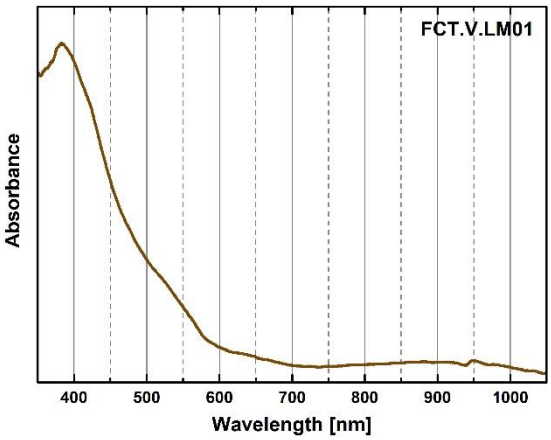
Brown

Possibly identified as an ochre

EDXRF



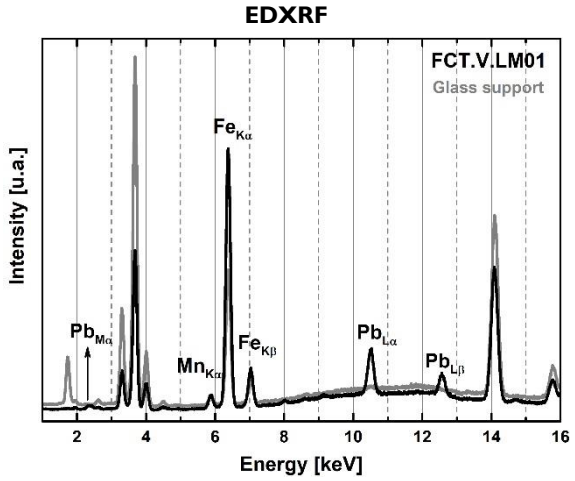
UV-VIS

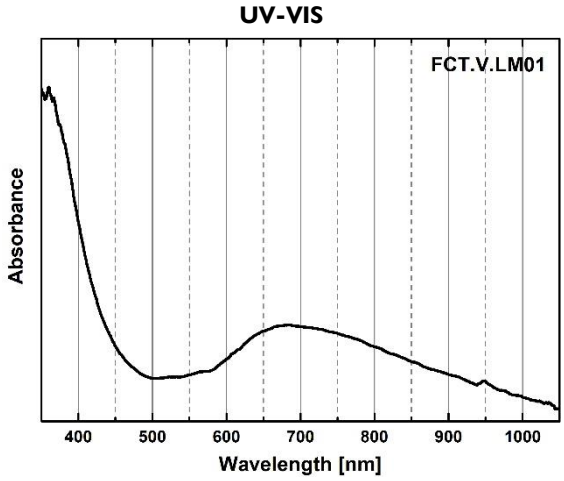




Black

Possibly identified as Prussian blue and carbon-black

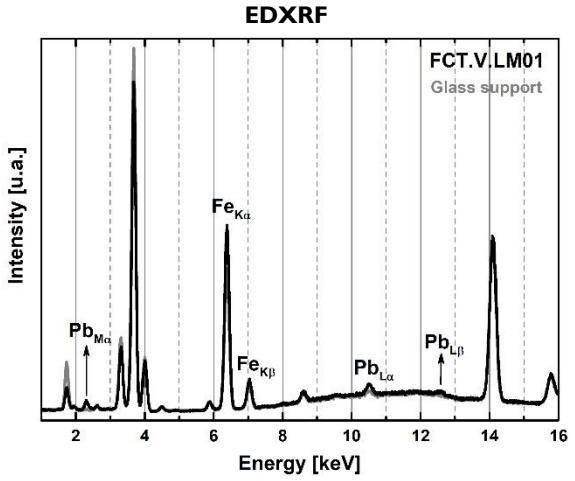


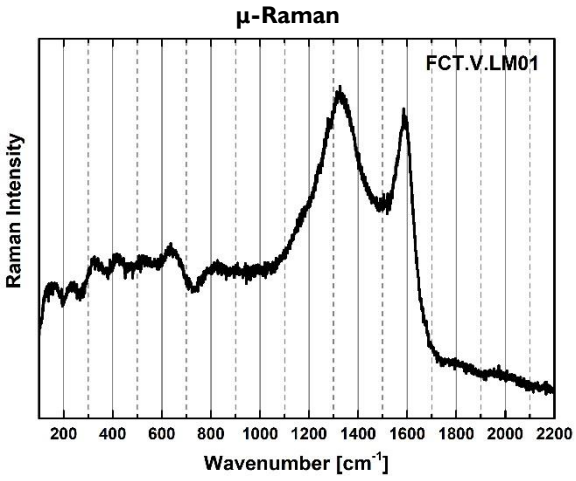




Black Mask

Identified as carbon-black





C) Carpenter & Westley, England (ca.1838-1900)



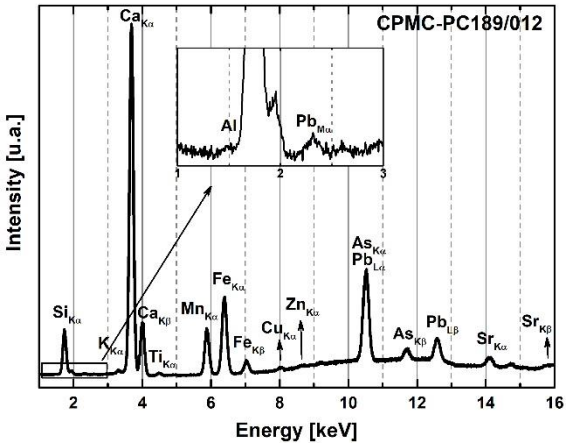
Glass

Semi-quantified as high-lime low-alkali glass

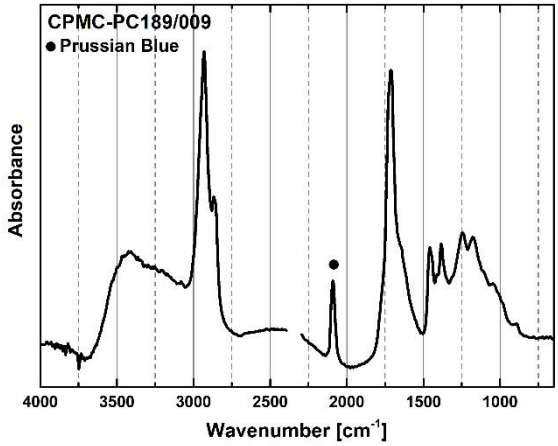
Binder

Identified as shellac resin

EDXRF



μ-FTIR

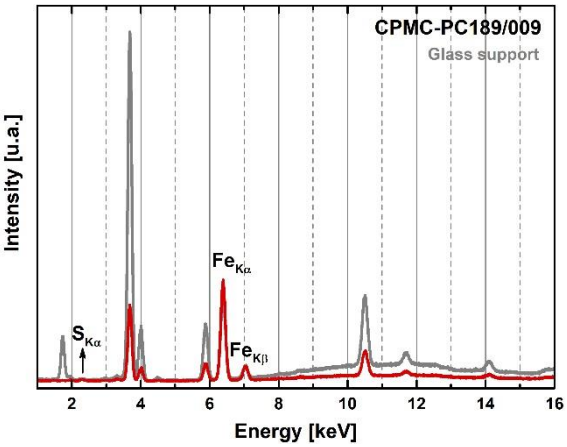




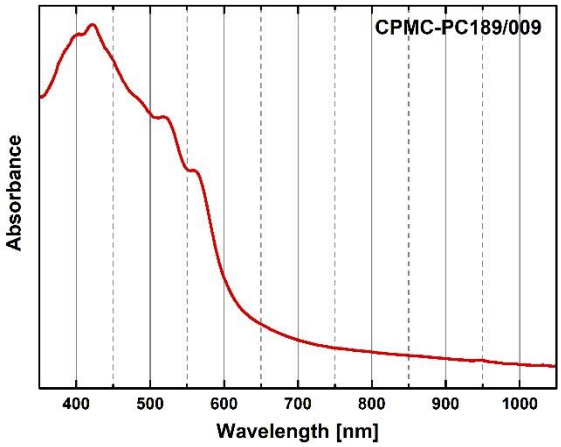
Red *(PC189/009)*

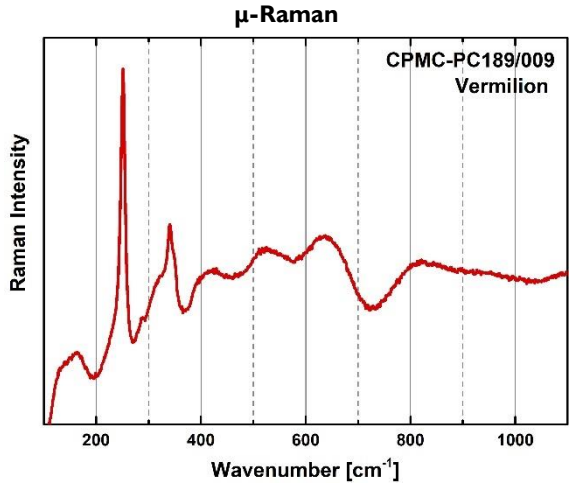
Identified as vermilion and animal anthraquinone lake (possibly cochineal)

EDXRF



UV-VIS

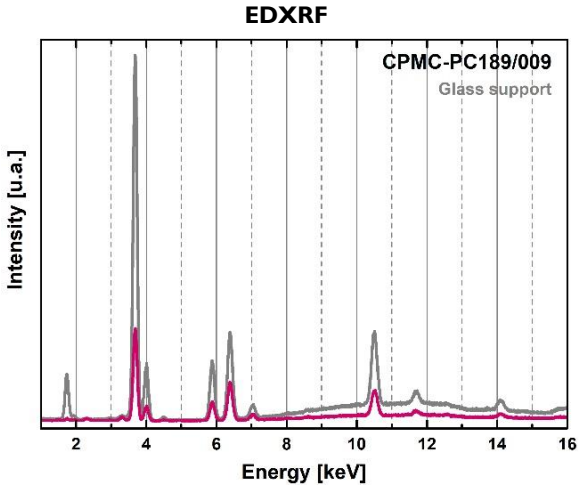


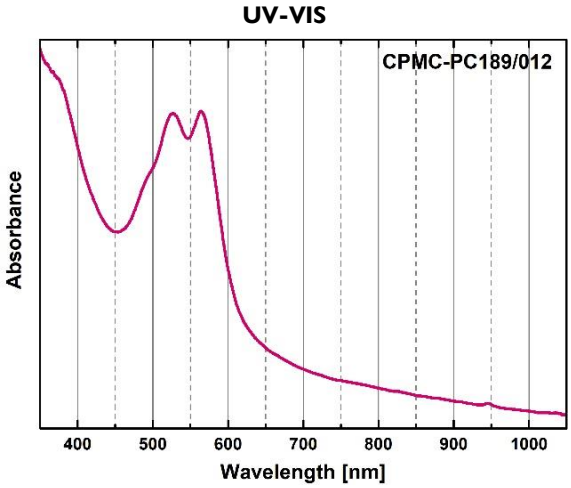


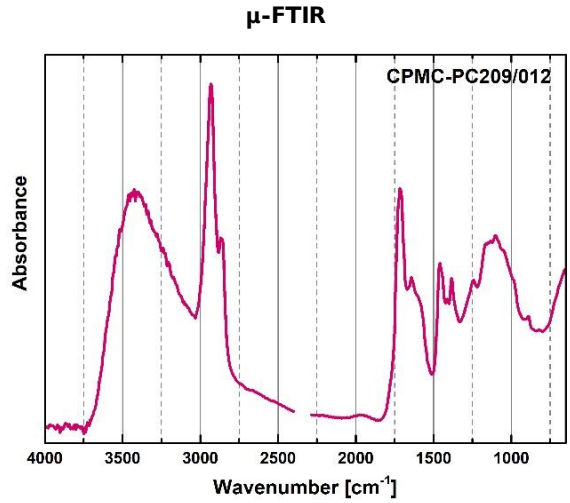


Pink

Identified as animal anthraquinone lake (possibly cochineal)





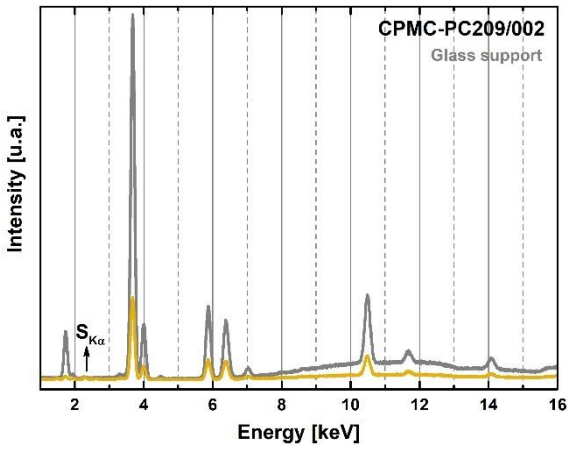




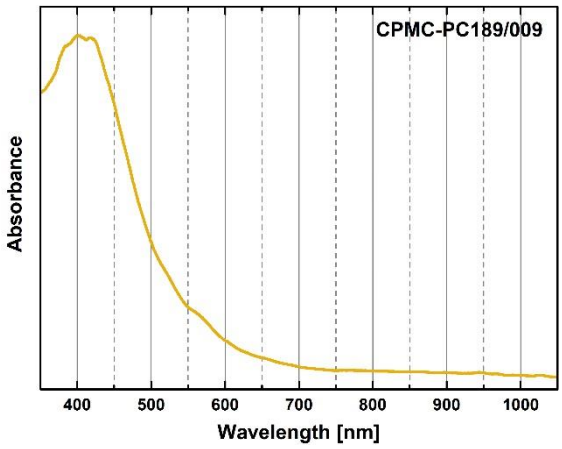
Yellow

Identified as an organic lake

EDXRF



UV-VIS

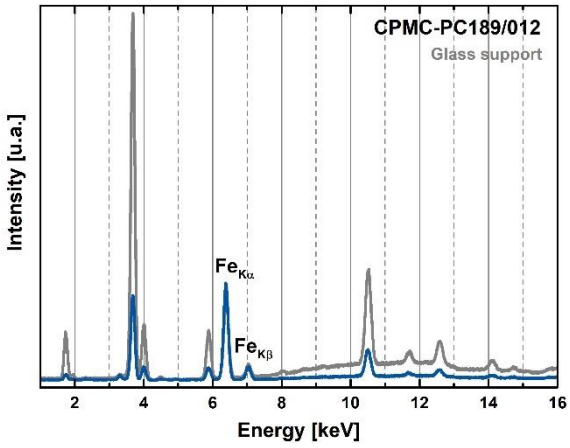




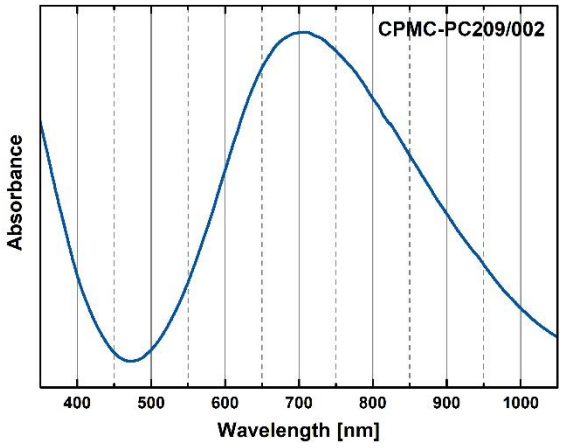
Blue

Identified as Prussian blue

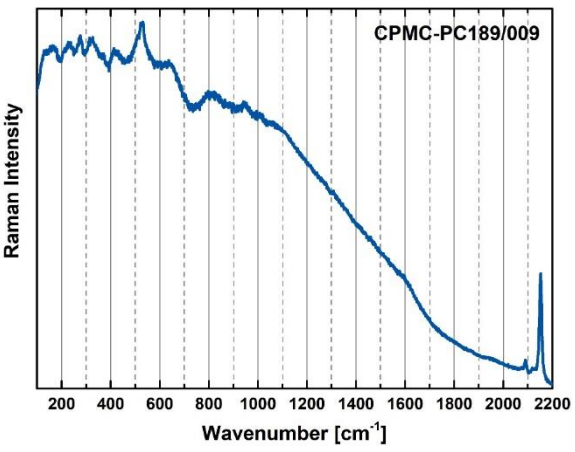
EDXRF



UV-VIS



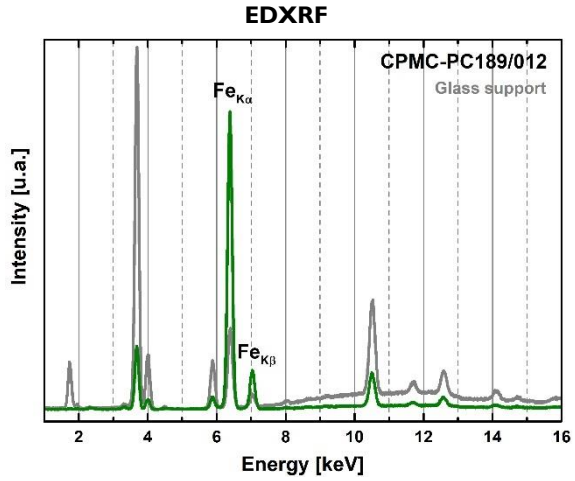
μ-Raman

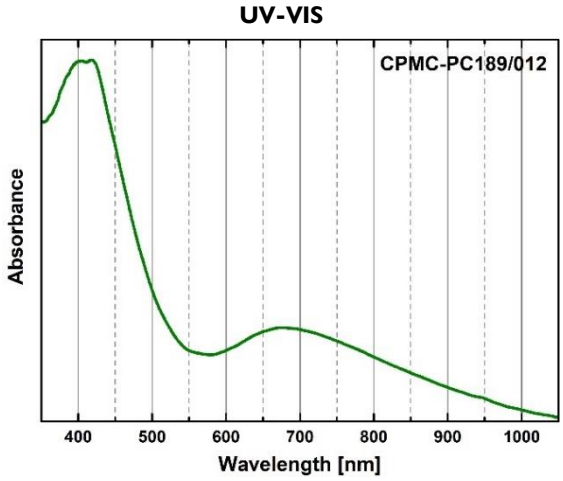


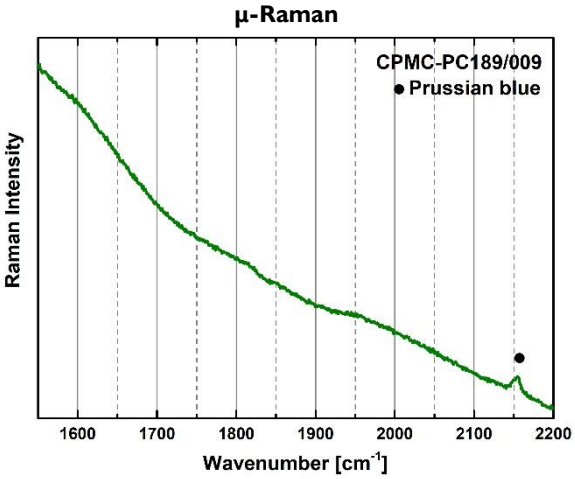


Green

Identified as Prussian blue and an organic yellow lake



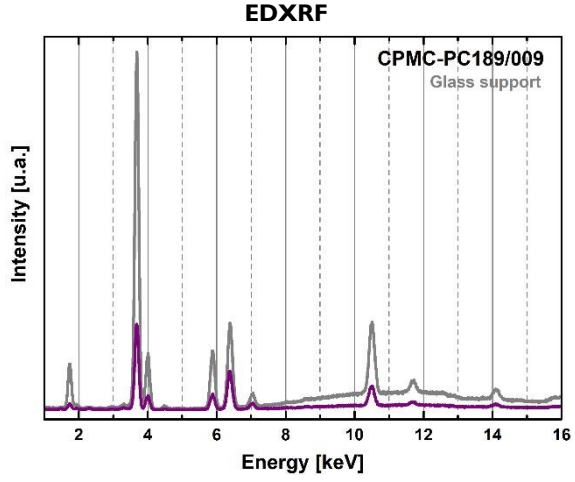


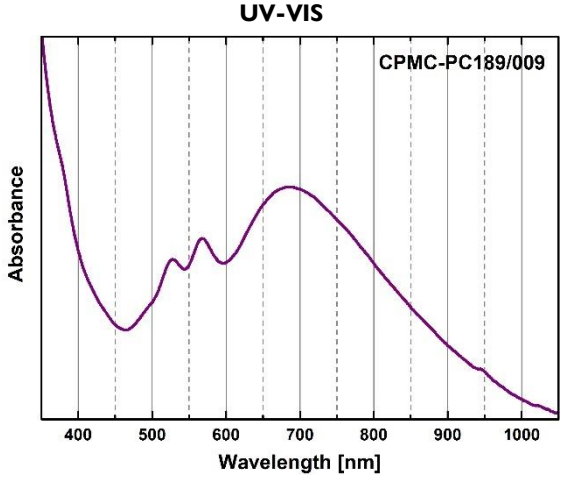


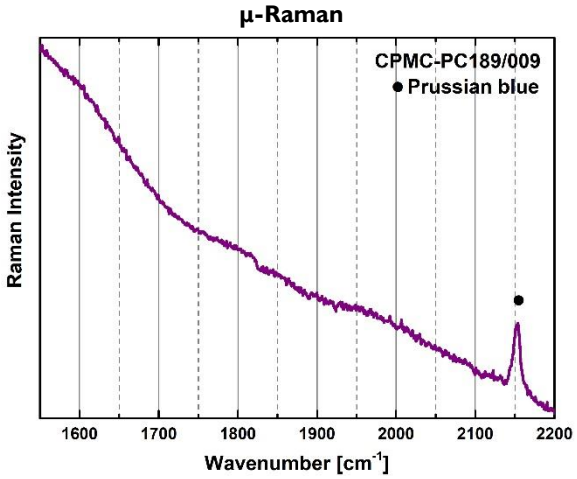


Purple *(PC189/009)*

Identified as animal anthraquinone lake (possibly cochineal) and Prussian blue



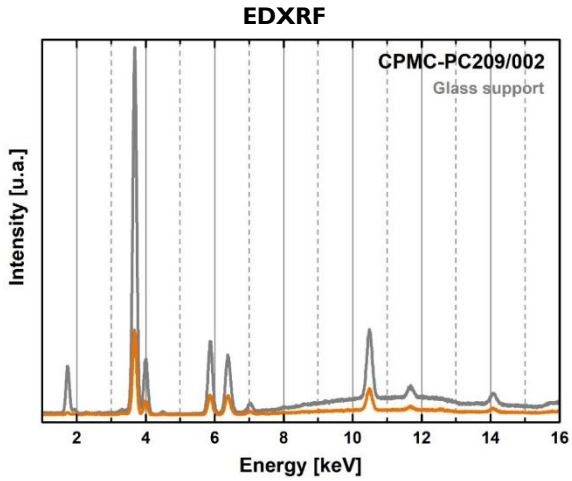


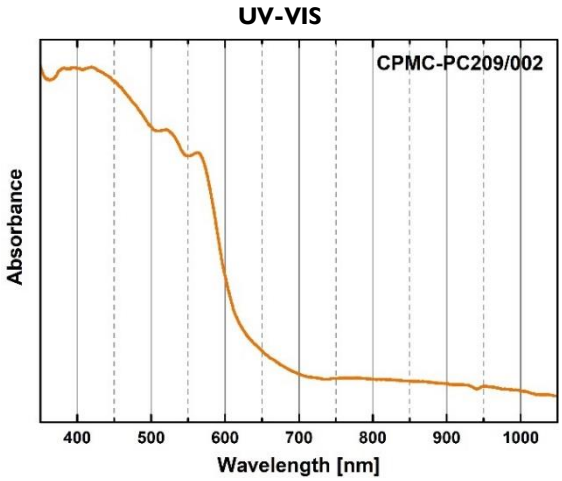


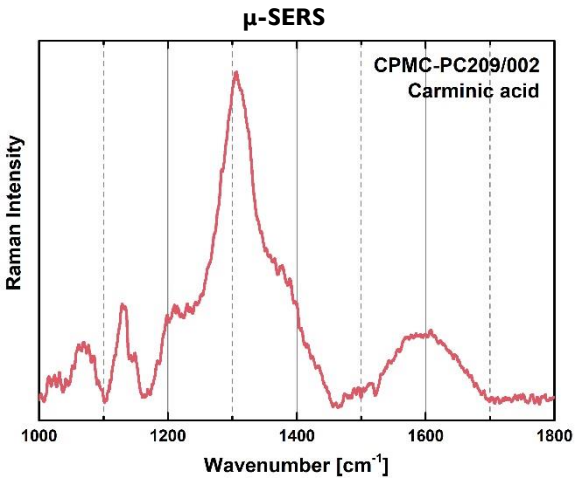


Orange

Identified as a pink cochineal-based lake and an organic yellow



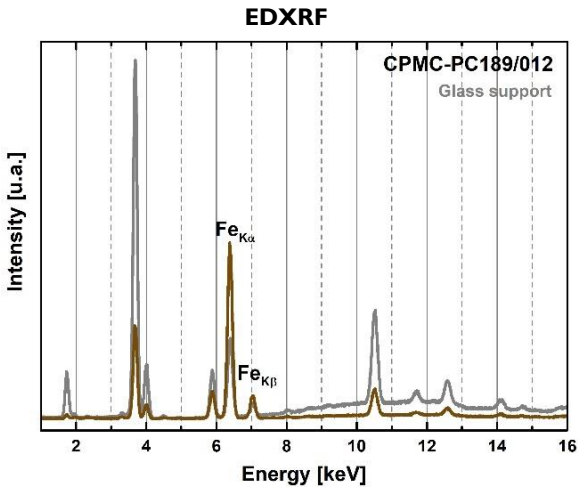


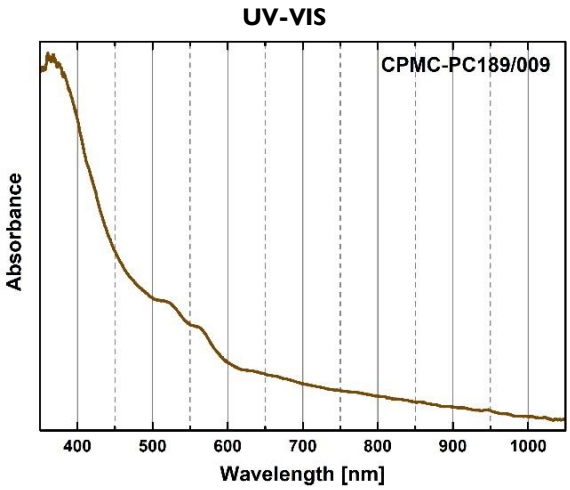


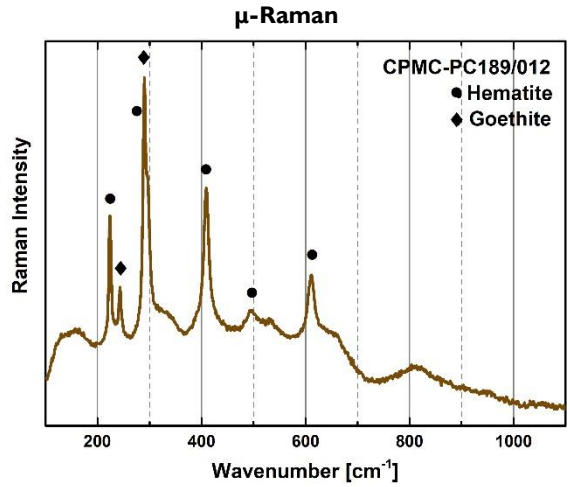


Brown

Identified as ochre and animal anthraquinone lake (possibly cochineal)



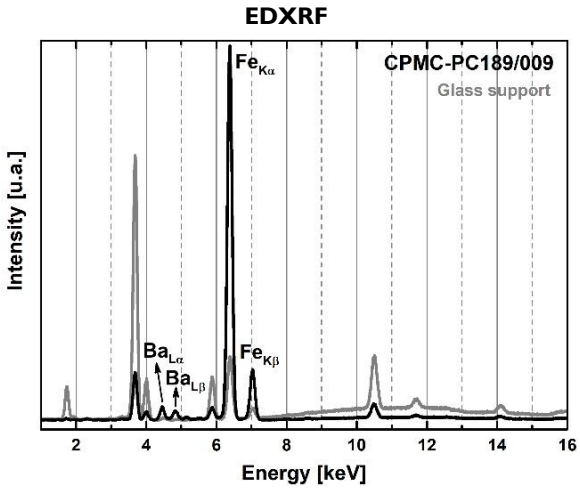






Black

Identified as an iron-based colourant



D) Carpenter & Westley, England (ca.1838-1870)

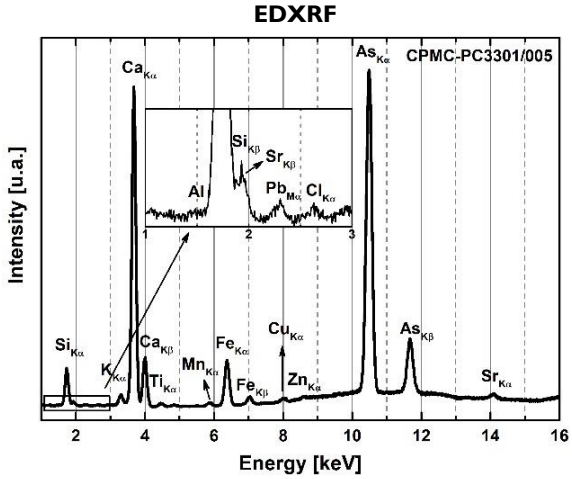


PC3301/005

Scale: 10 cm

Glass

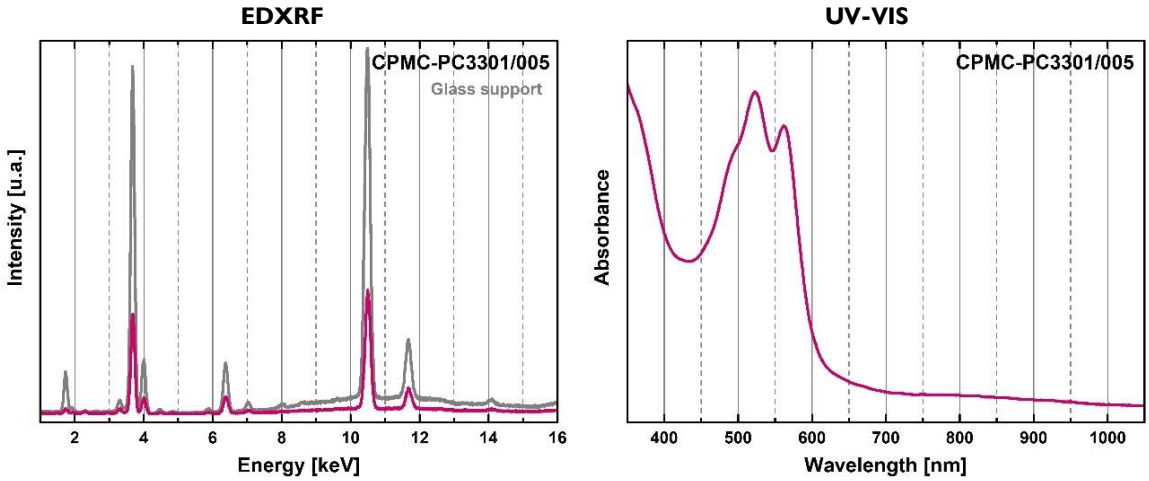
Semi-quantified as synthetic soda glass





Pink

Identified as an animal anthraquinone lake (possibly cochineal)

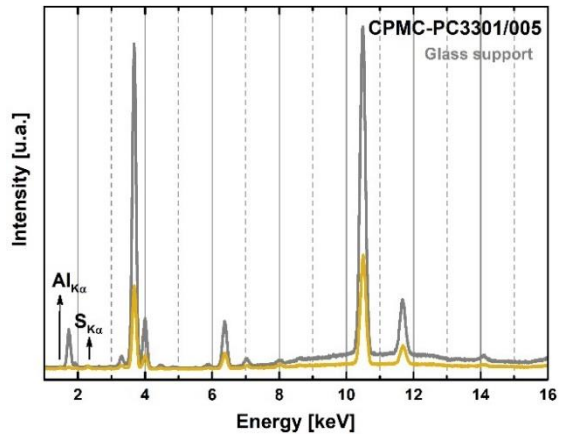




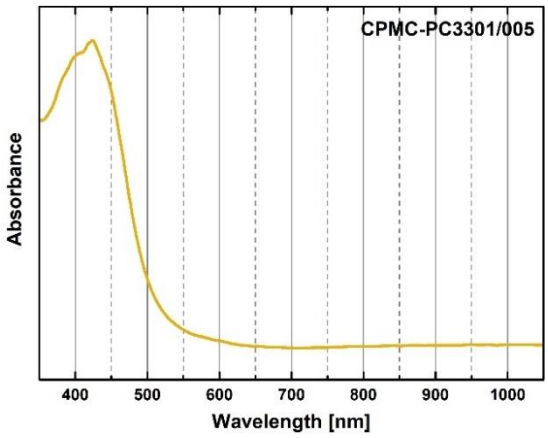
Yellow

Colourant not identified (possibly organic)

EDXRF



UV-VIS

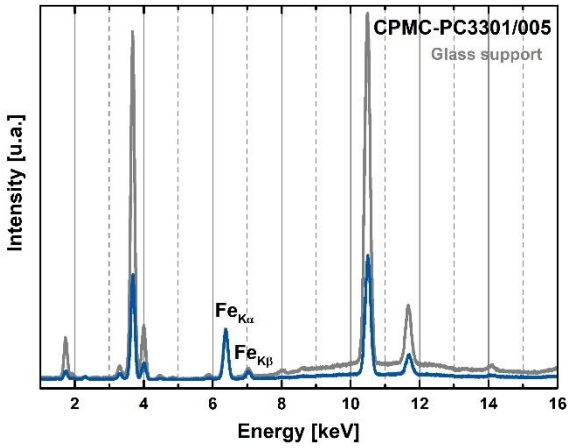




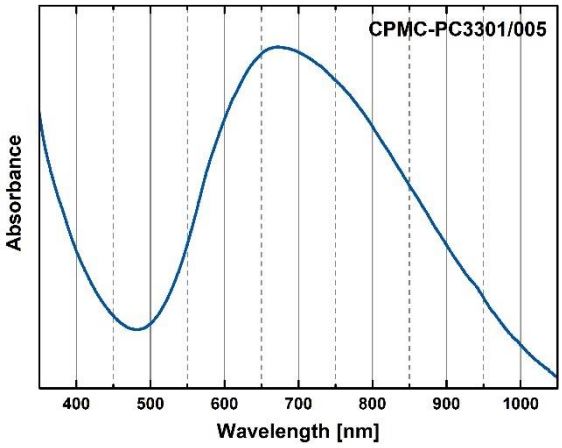
Blue

Identified as Prussian blue and ultramarine blue

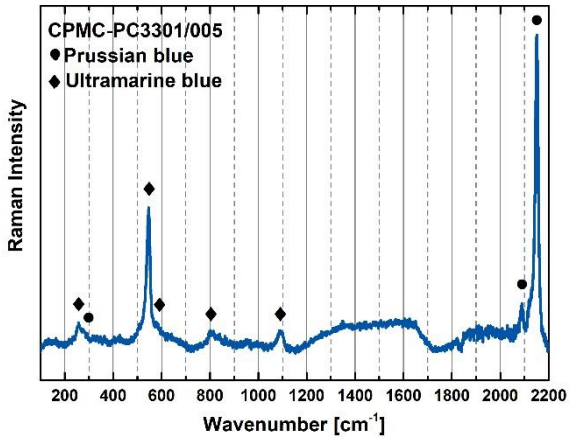
EDXRF



UV-VIS



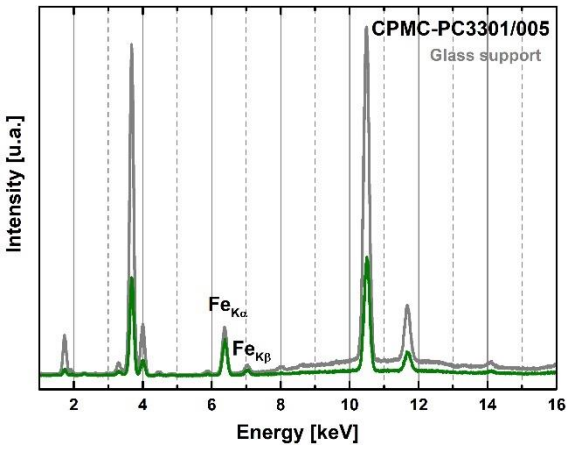
μ-Raman



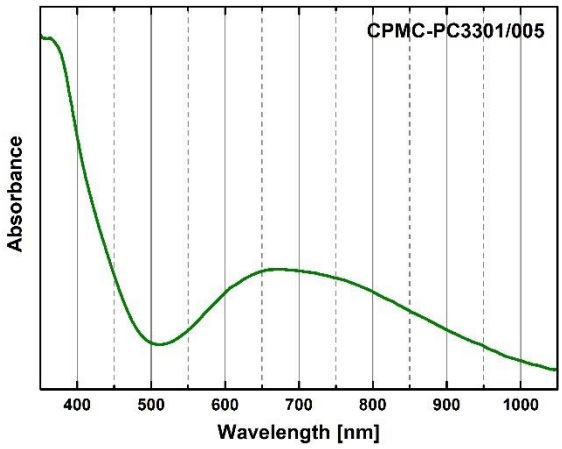
Green

Identified as Prussian blue, ultramarine blue and an unidentified yellow (possibly organic)

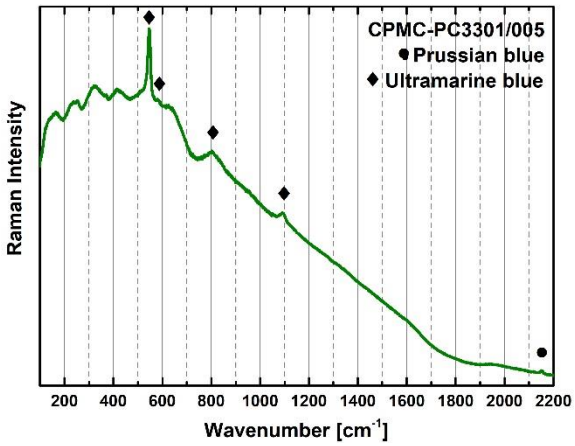
EDXRF



UV-VIS



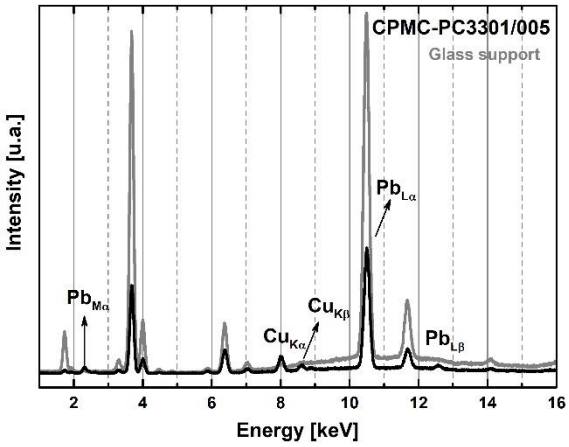
μ-Raman



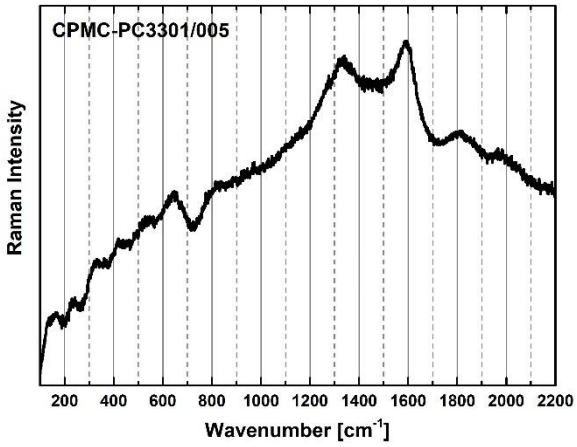
Black

Identified as carbon-black

EDXRF



μ-Raman



E) W.E. & F. Newton, England (1852-1857)



LM02

Scale: 10 cm

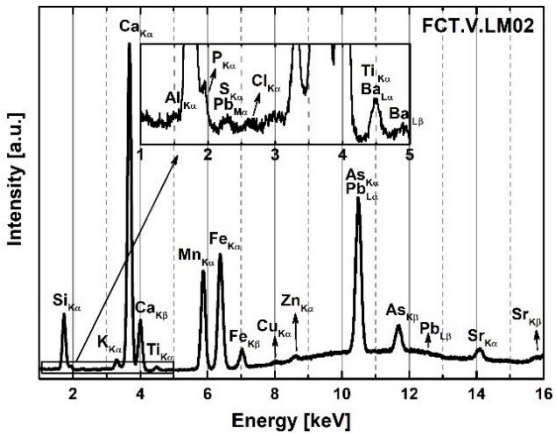
Glass

Semi-quantified as high-lime low-alkali glass

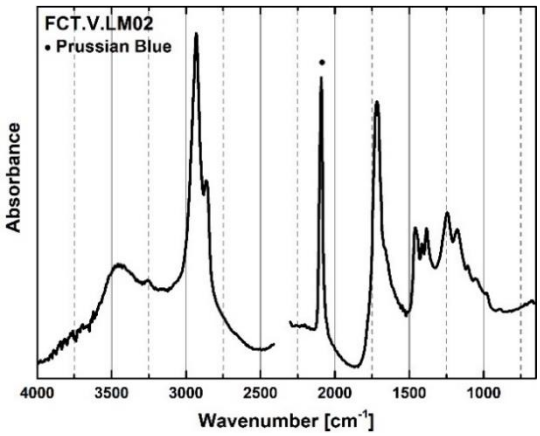
Binder

Identified as shellac resin

EDXRF



μ-FTIR

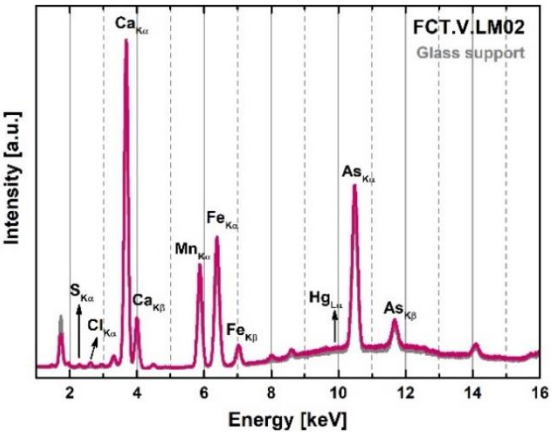




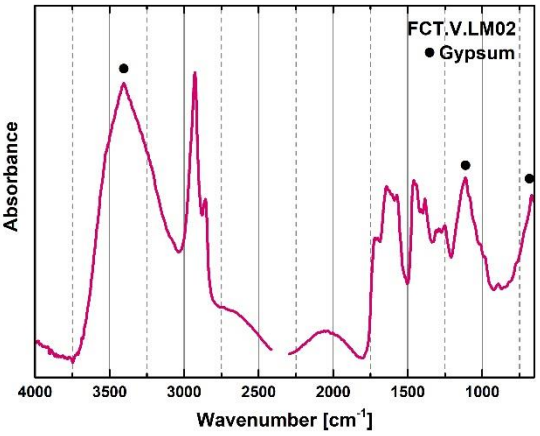
Pink *(socks)*

Identified as an animal anthraquinone lake (possibly cochineal) and vermilion

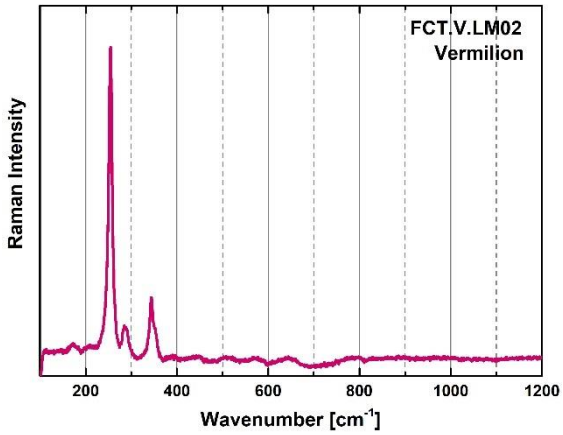
EDXRF



μ-FTIR



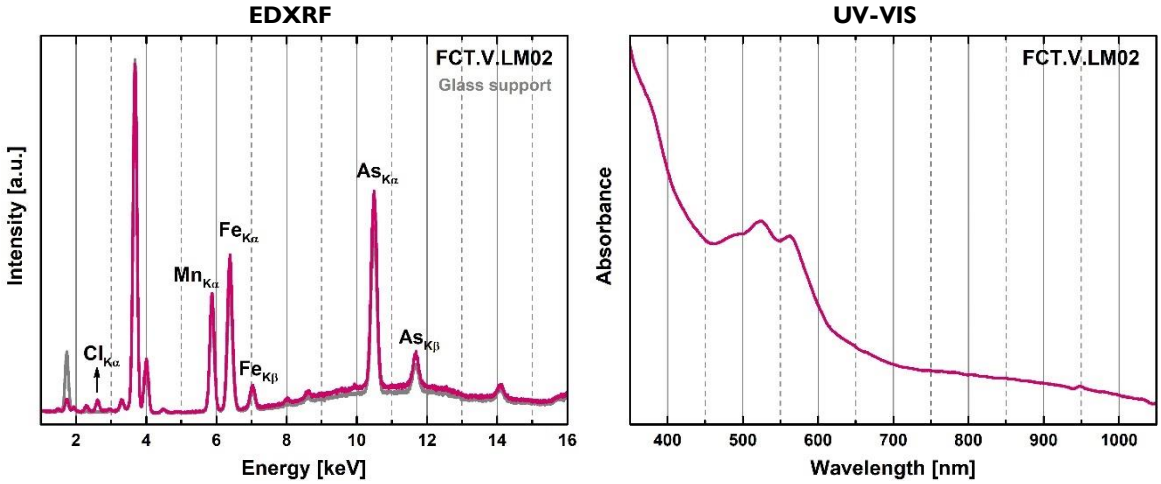
μ-Raman





***Pink** (lips)*

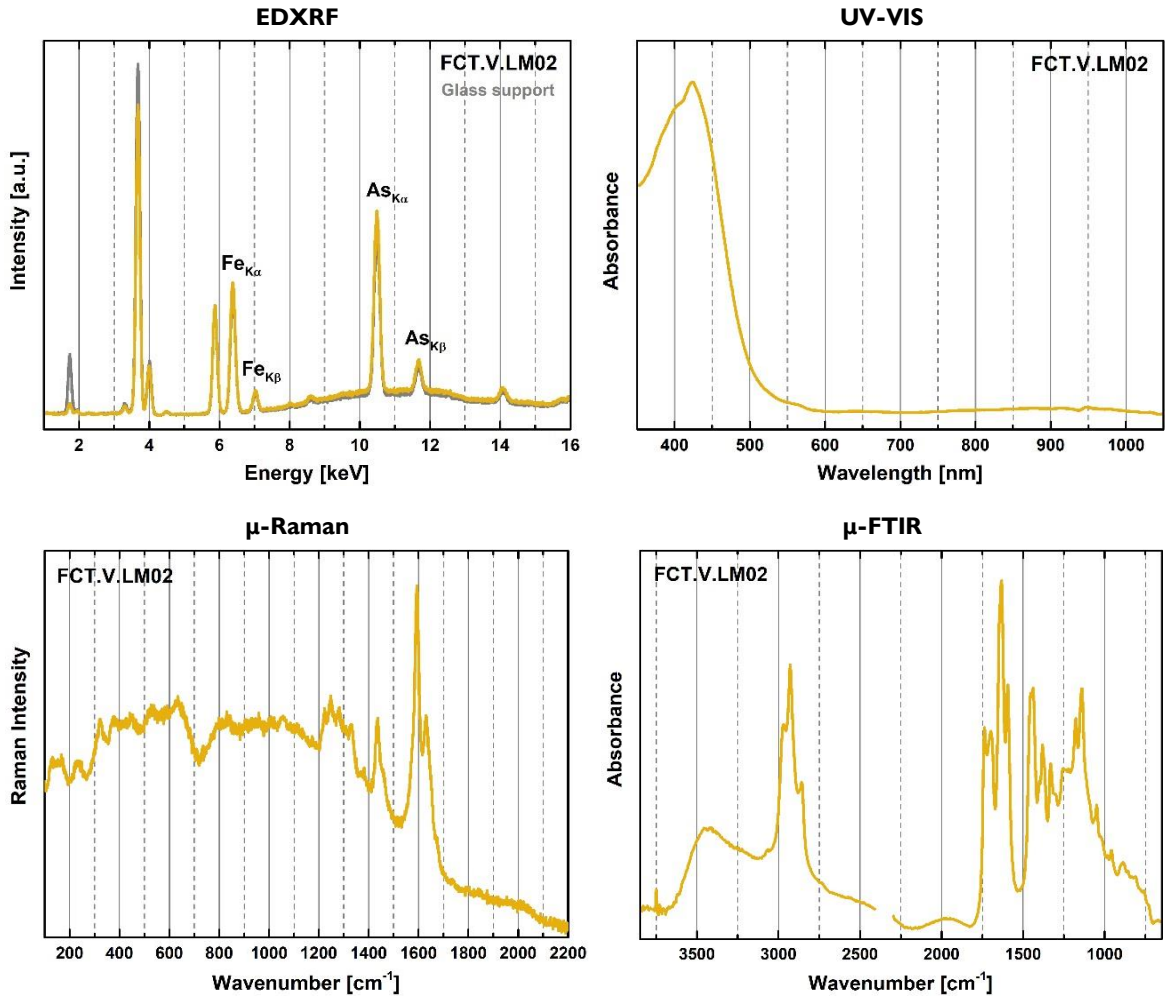
Identified as an animal anthraquinone lake (possibly cochineal)





Yellow

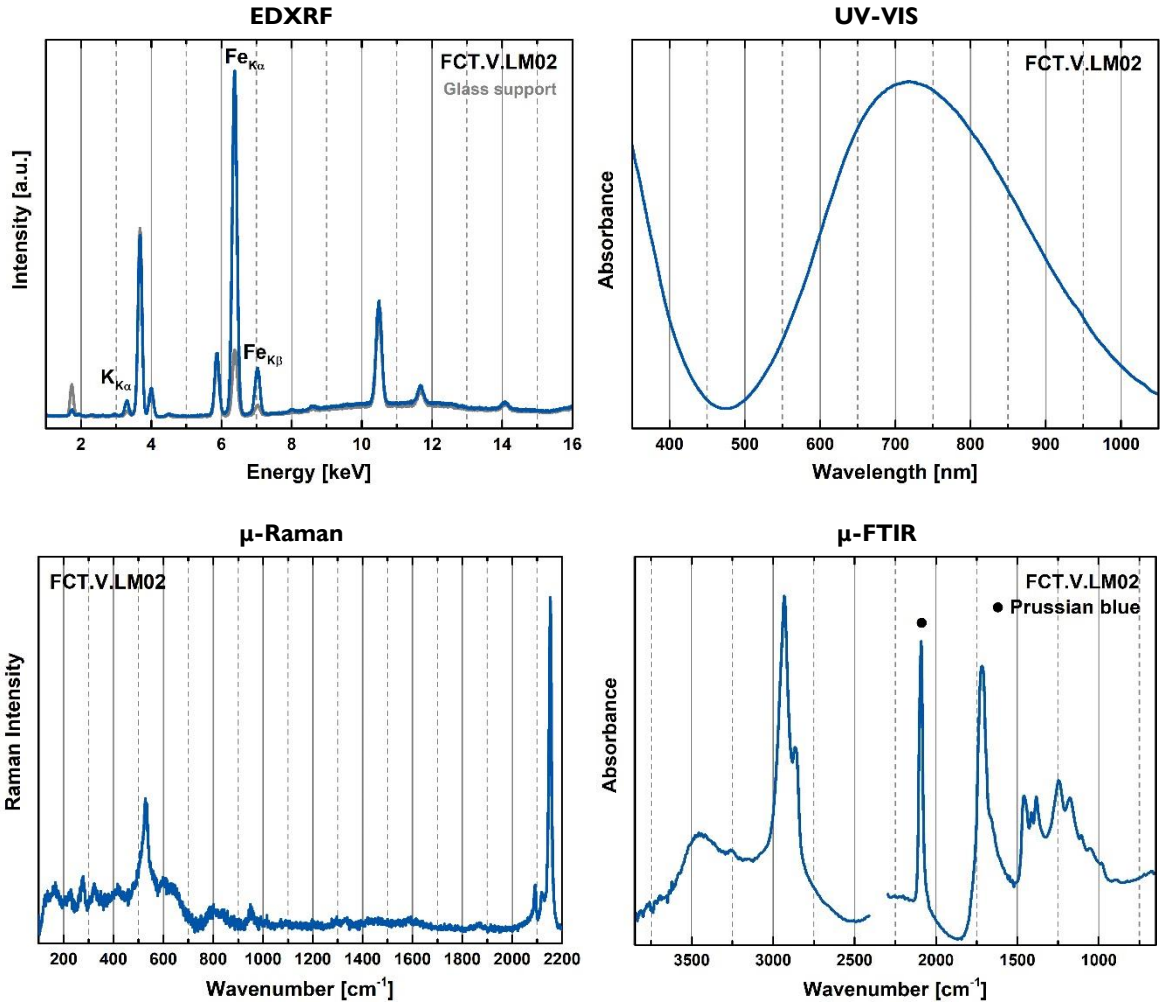
Identified as gamboge





Blue

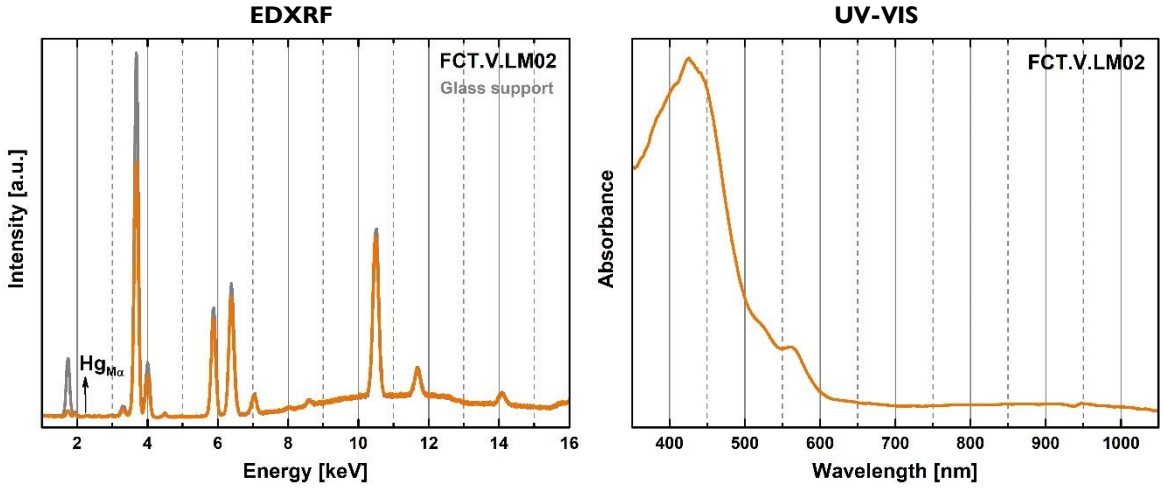
Identified as Prussian blue

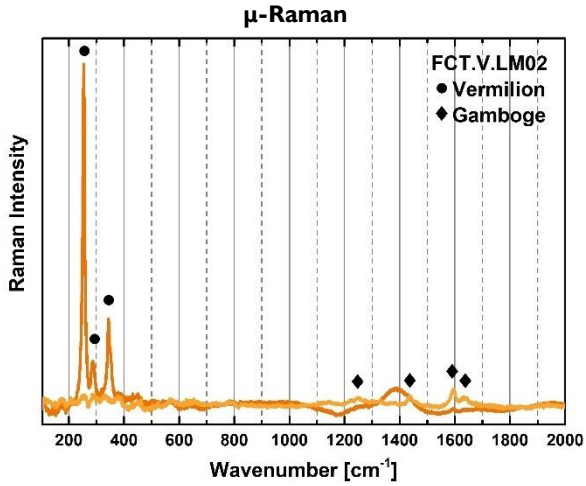




Orange

Identified as an animal anthraquinone lake (possibly cochineal) with vermilion and gamboge

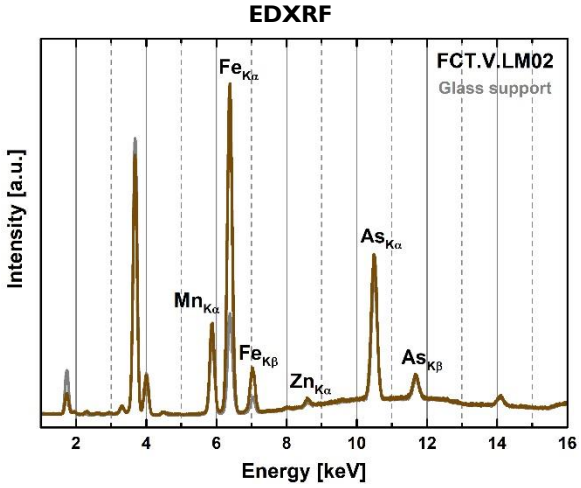


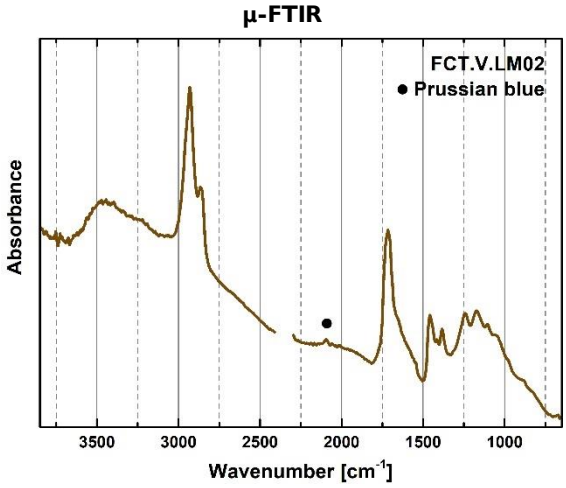


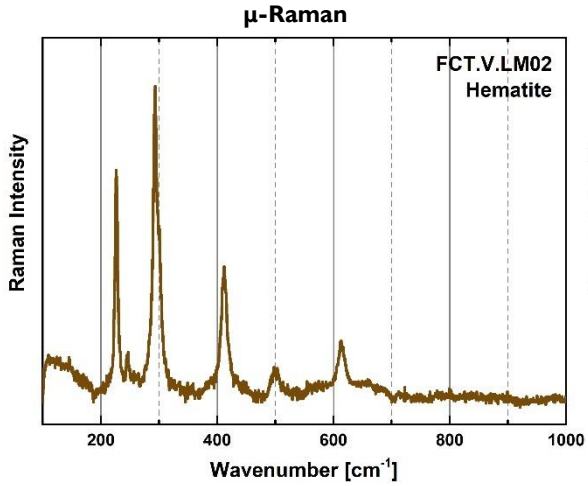


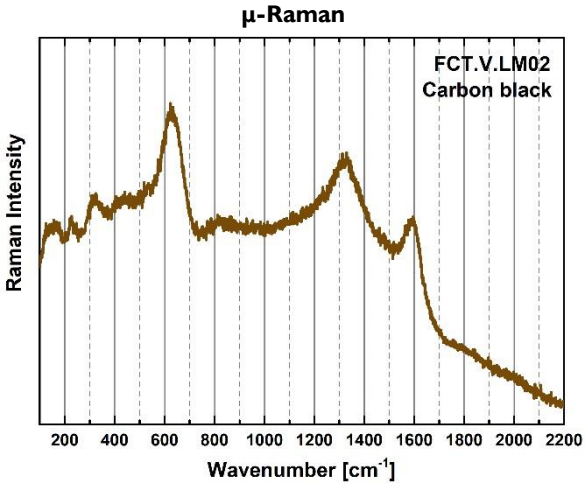
Brown

Identified as hematite, carbon black and possibly Prussian blue





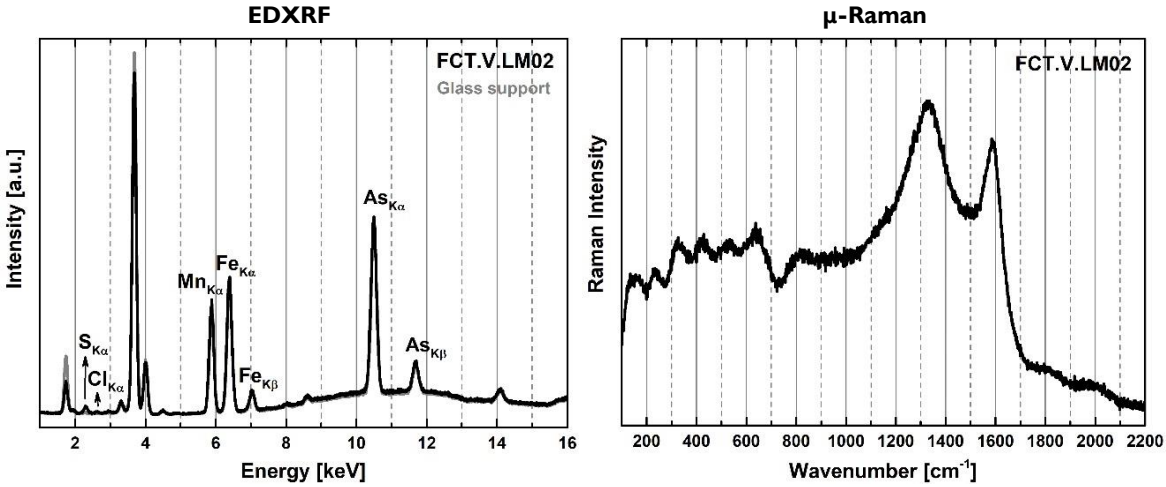






Black

Identified as carbon black



F) W.E. & F. Newton, England (1852-1857)


PC3301/001


PC3301/002

Scale: 10 cm

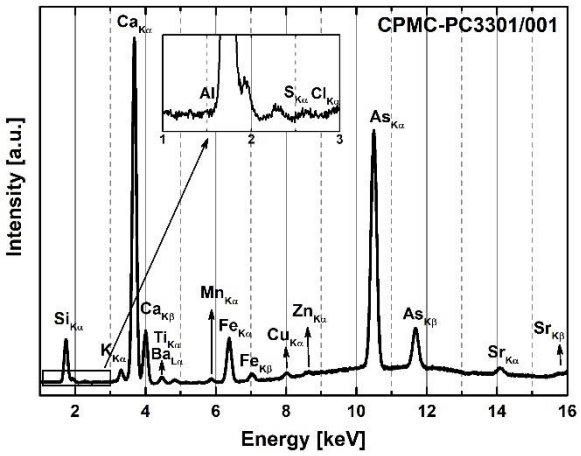
Glass

Semi-quantified as high-lime low-alkali glass

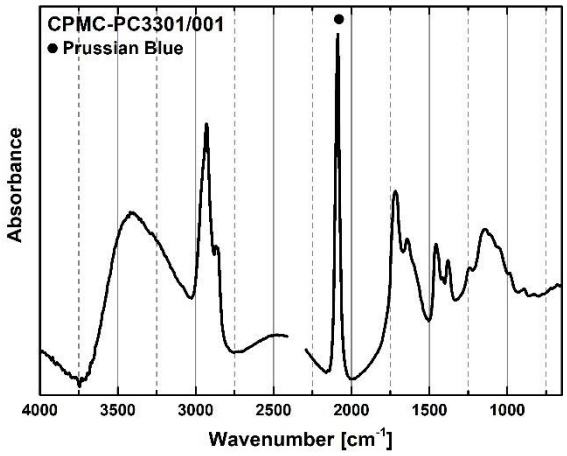
Binder

Identified as shellac resin

EDXRF



μ-FTIR

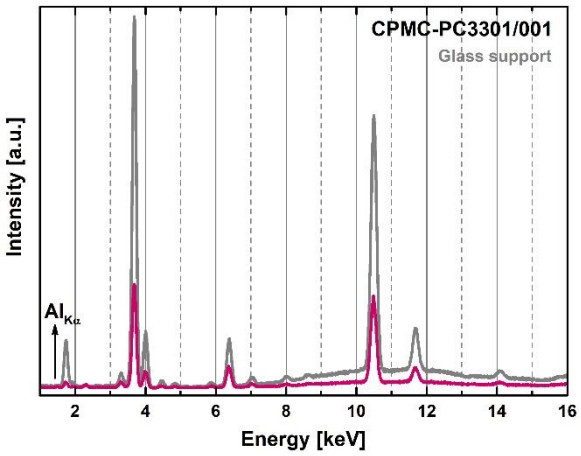




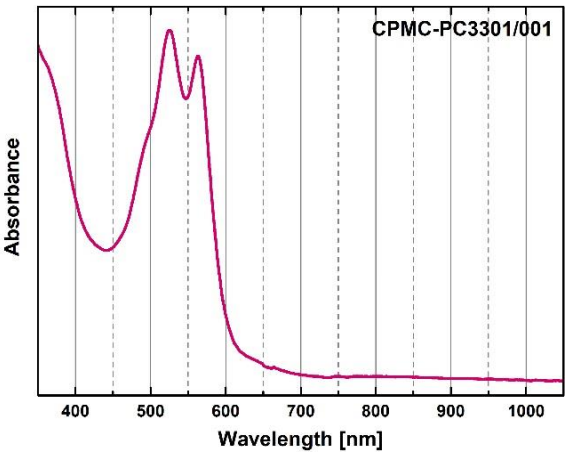
Pink

Identified as an animal anthraquinone lake (possibly cochineal)

EDXRF



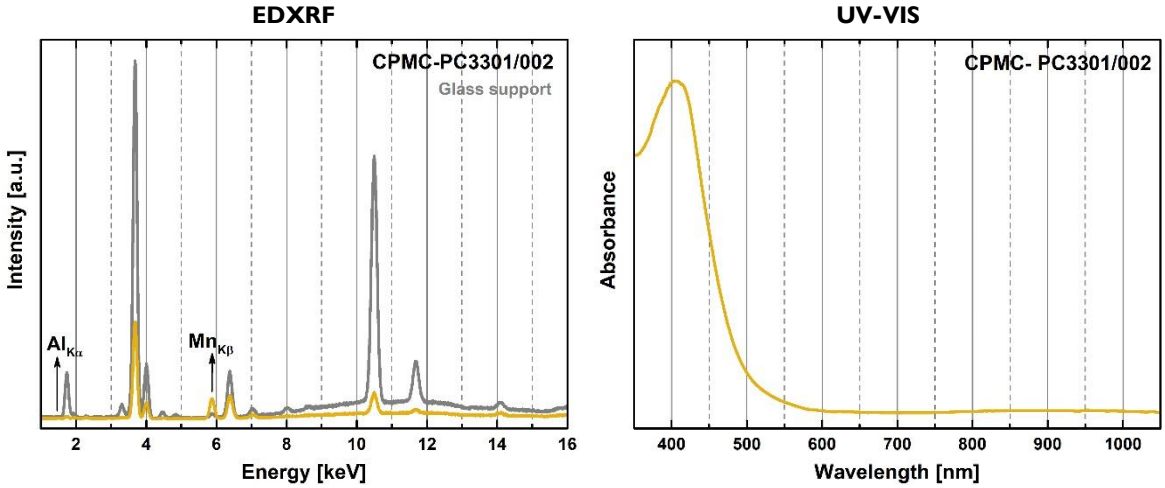
μ-FTIR

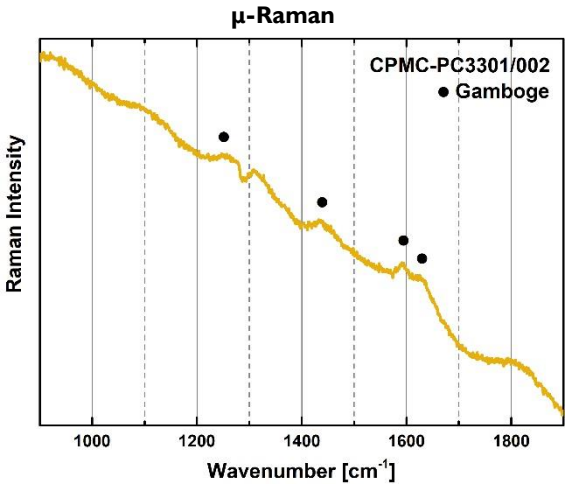




Yellow

Possibly identified as gamboge

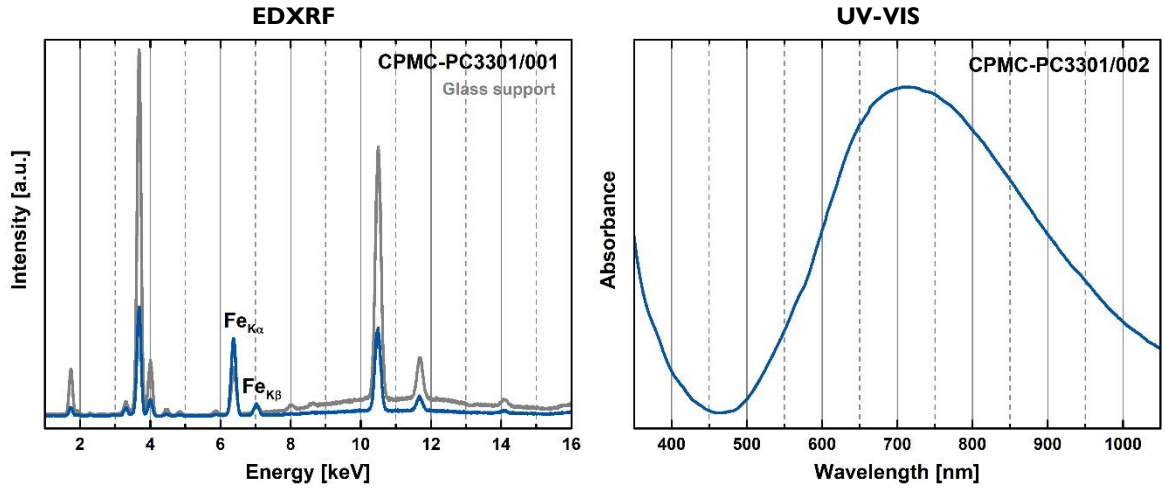


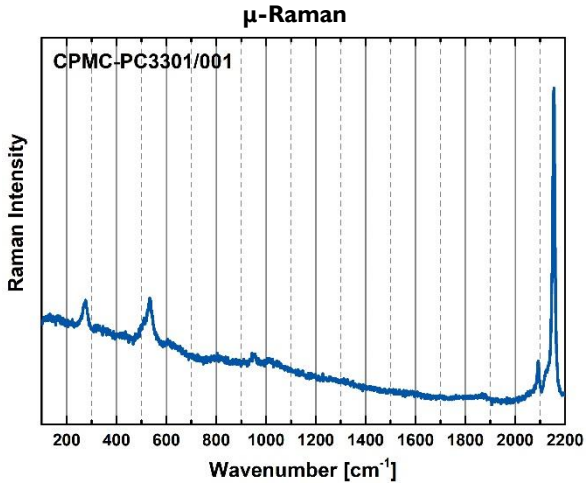


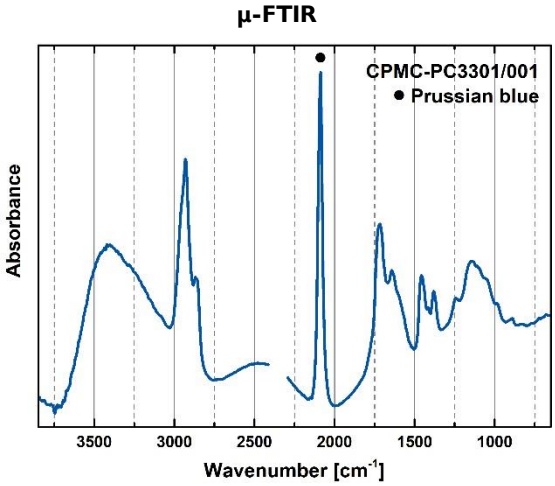


Blue

Identified as Prussian blue



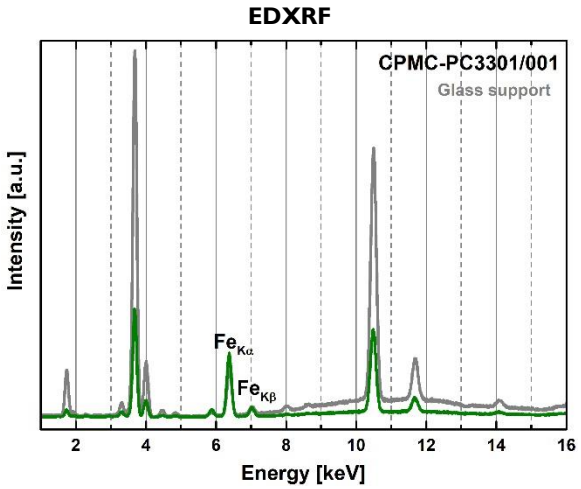


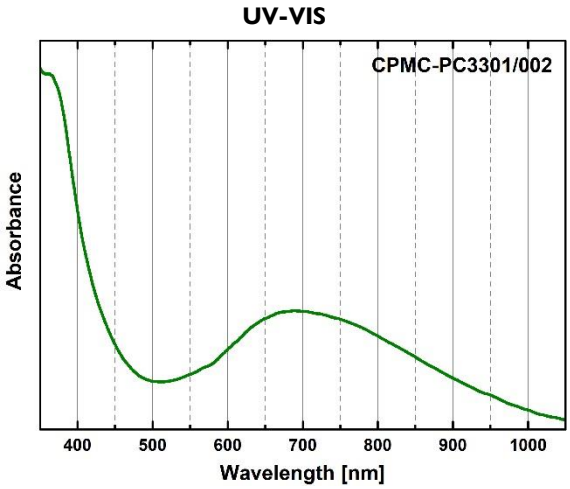


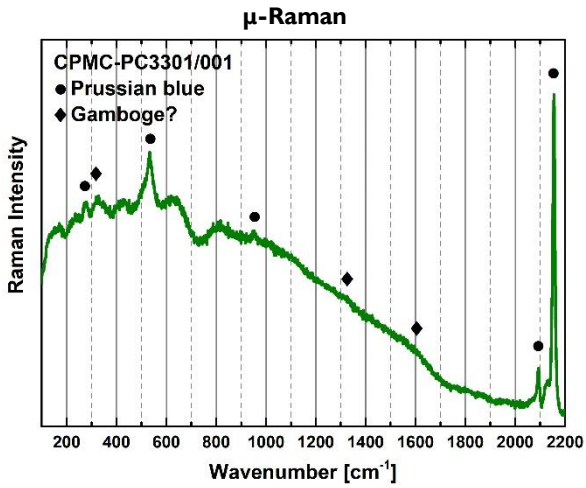


Green

Identified as Prussian blue and possibly gamboge



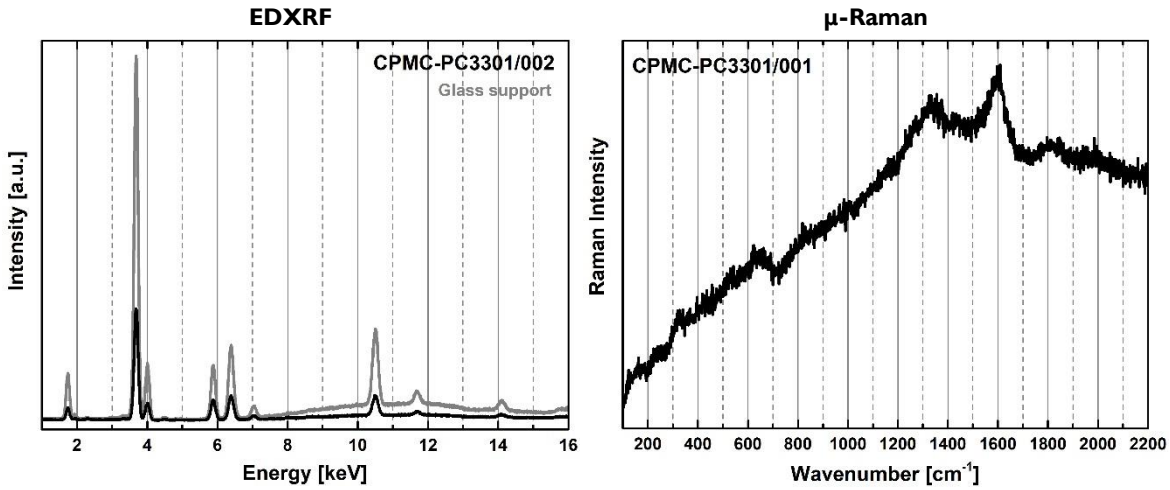






Black

Identified as carbon black



G) unknown, England (ca.1822-1835)



PC3300/001

Scale: 10 cm

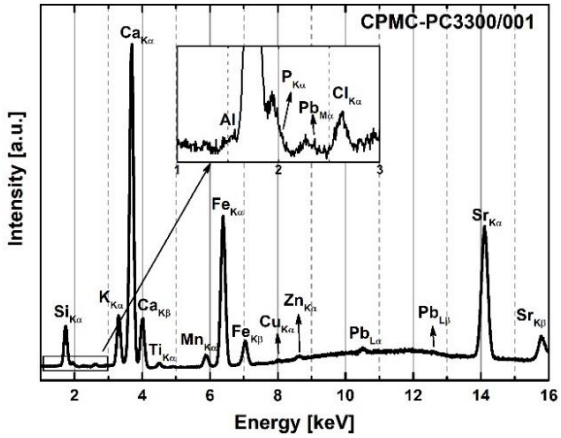
Glass

Semi-quantified as a kelp-based mixed-alkali glass

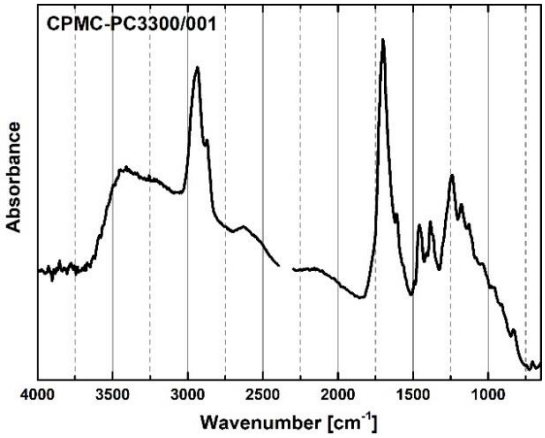
Binder

Identified as mastic resin

EDXRF



μ-FTIR

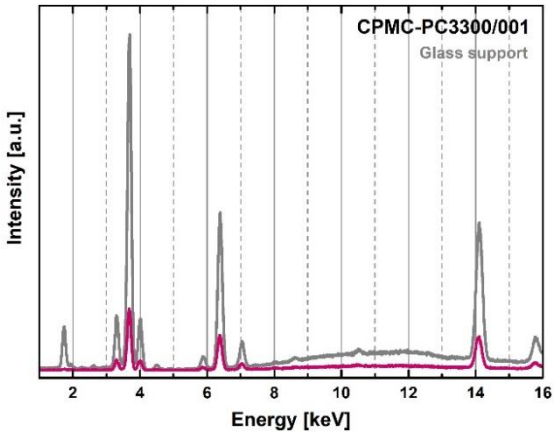




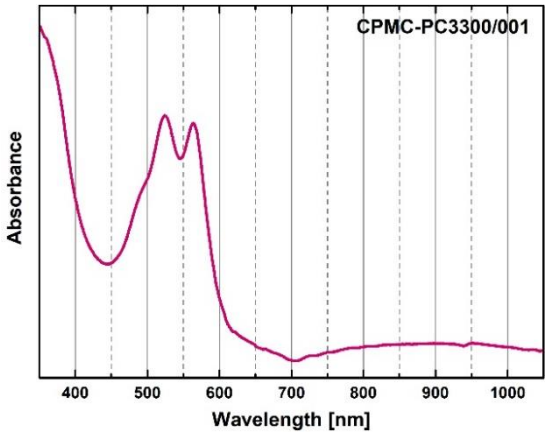
Pink

Identified as an animal anthraquinone lake (possibly cochineal) and vermilion

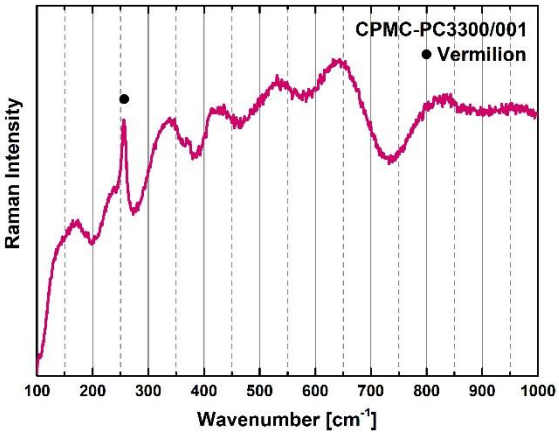
EDXRF



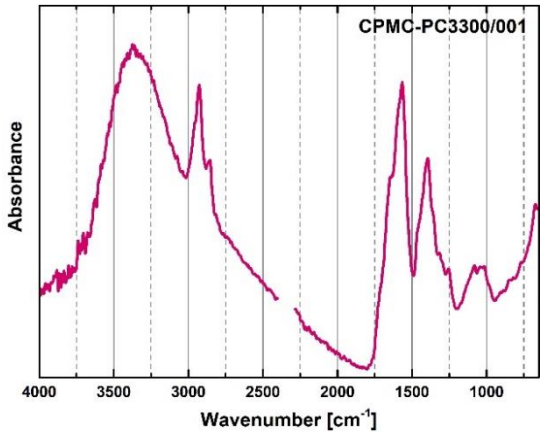
UV-VIS



μ-Raman



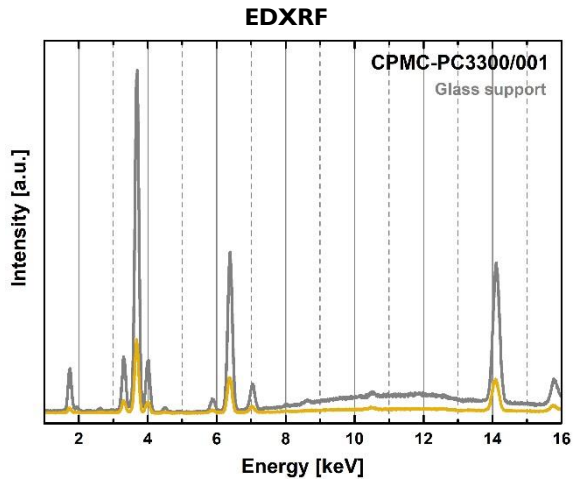
μ-FTIR

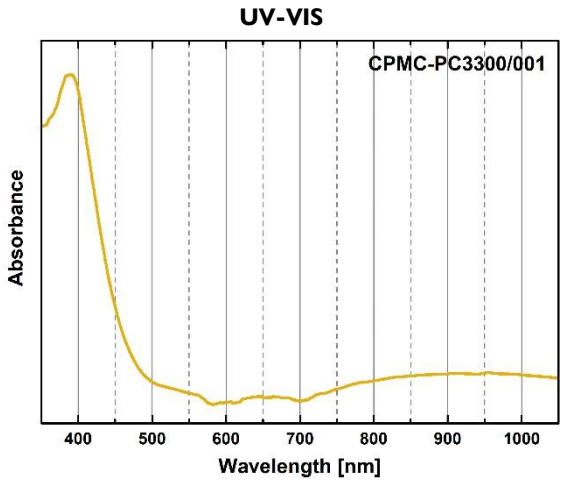


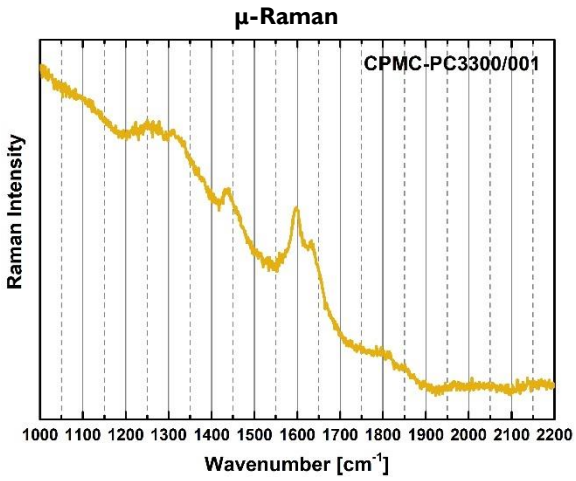


Yellow

Identified as gamboge



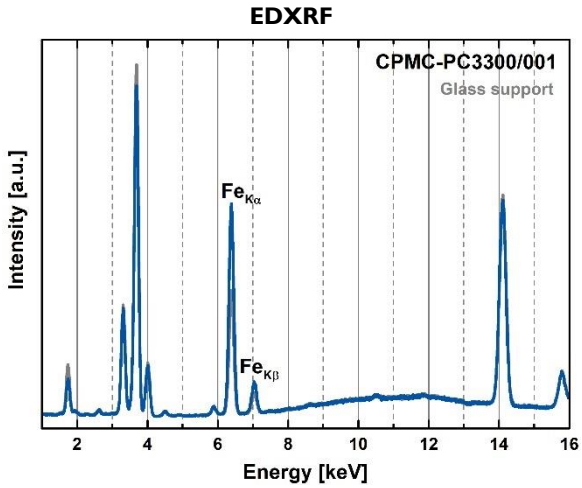


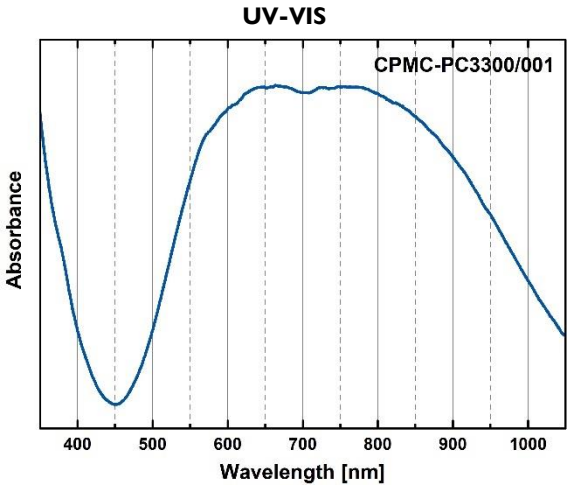


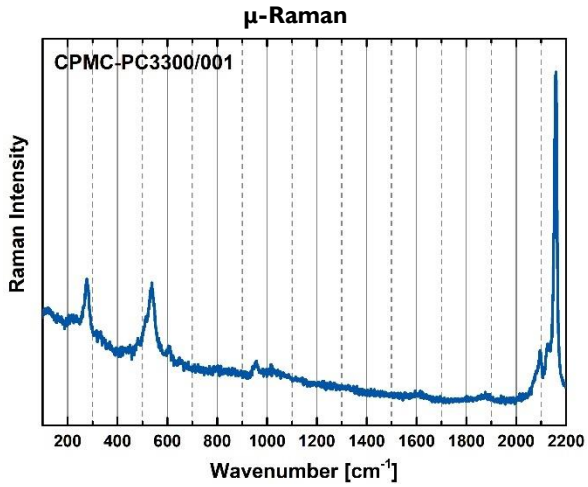


Blue

Identified as Prussian blue



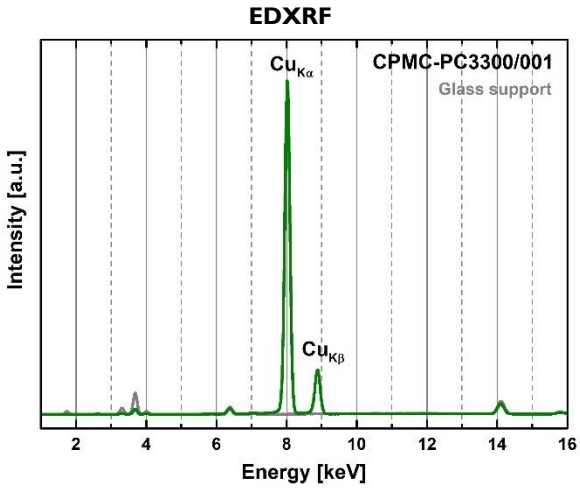


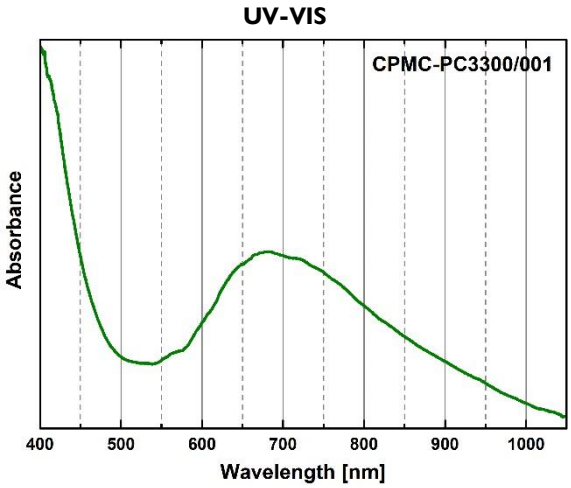


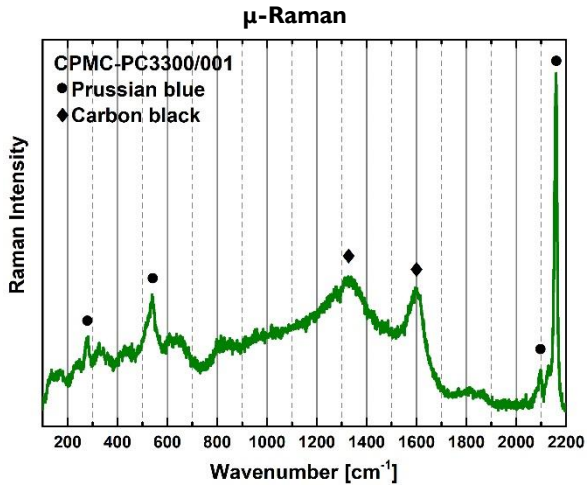


Green

Identified as copper green, Prussian blue and carbon black



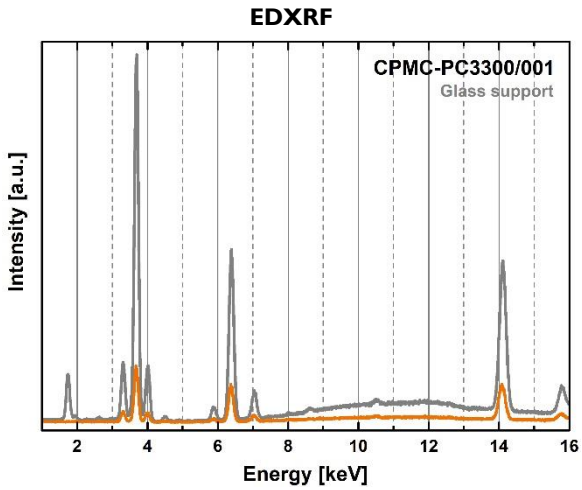


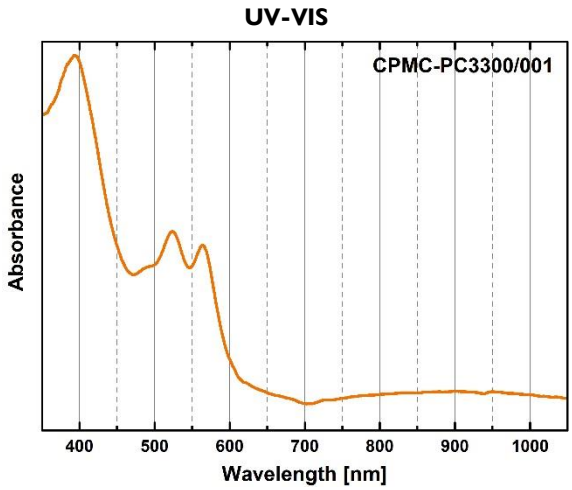


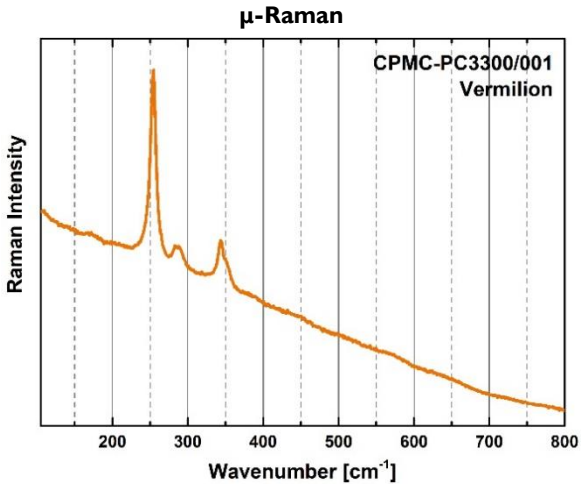


Orange

Identified as an animal anthraquinone lake (possibly cochineal) and vermilion



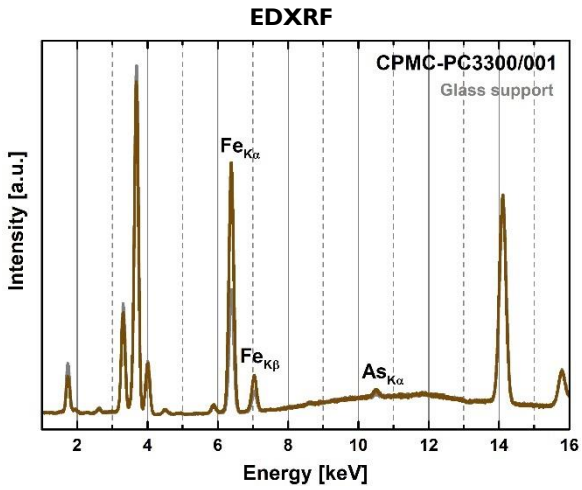






Brown

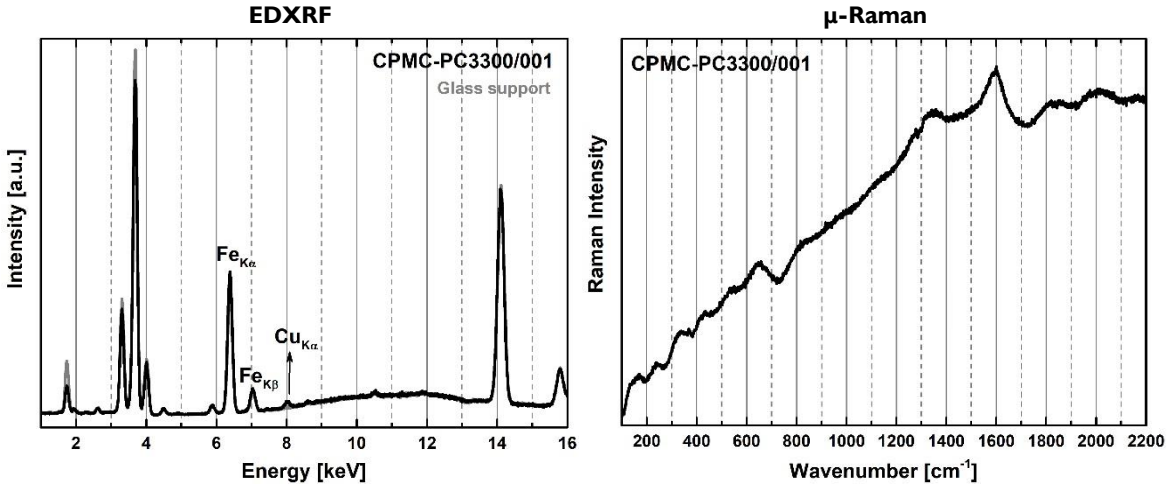
Not identified, possibly an earth pigment



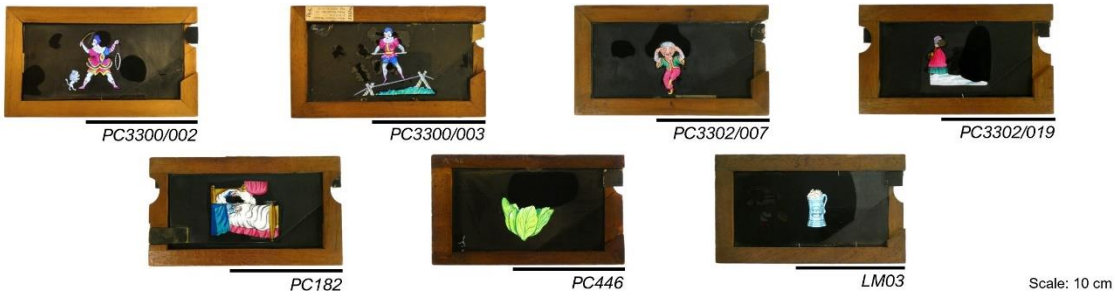


Black

Identified as carbon black



H) unknown, England (ca.1850-1900)



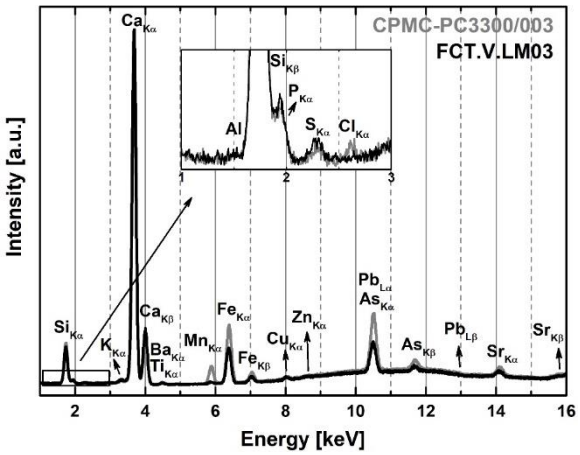
Glass

Semi-quantified as high-lime low-alkali glass

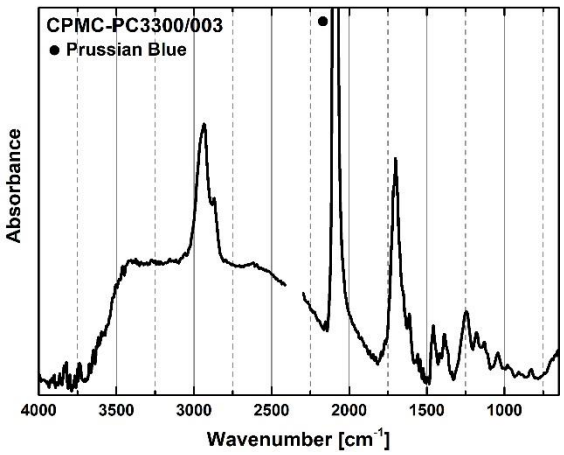
Binder

Possibly identified as mastic resin

EDXRF



μ-FTIR

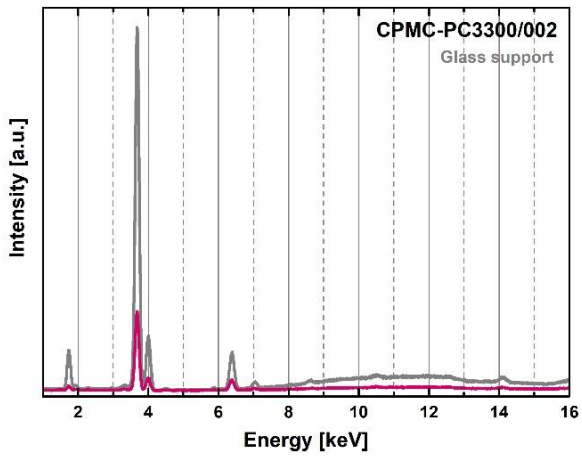




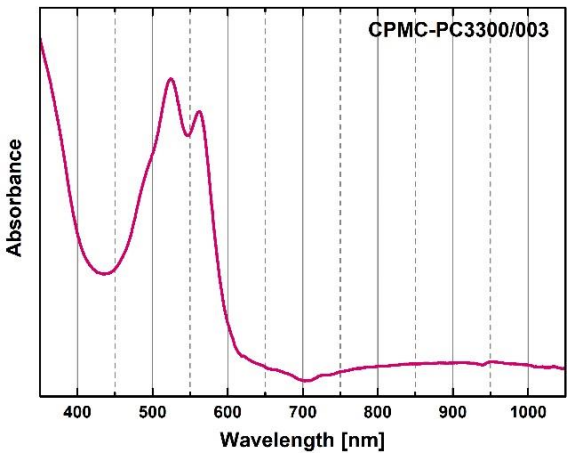
Pink

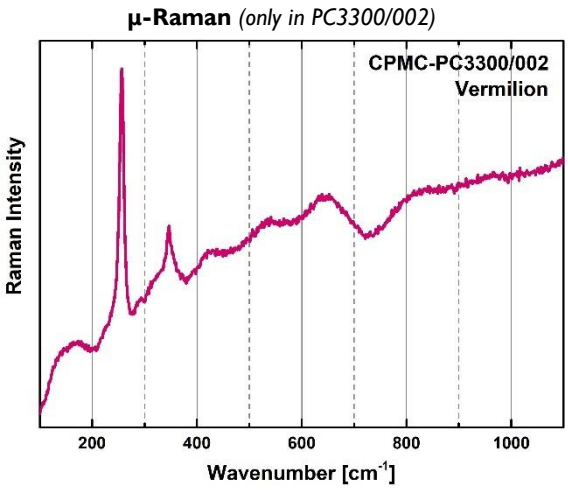
Identified as an animal anthraquinone lake (possibly cochineal) (with vermilion in PC3300/002)

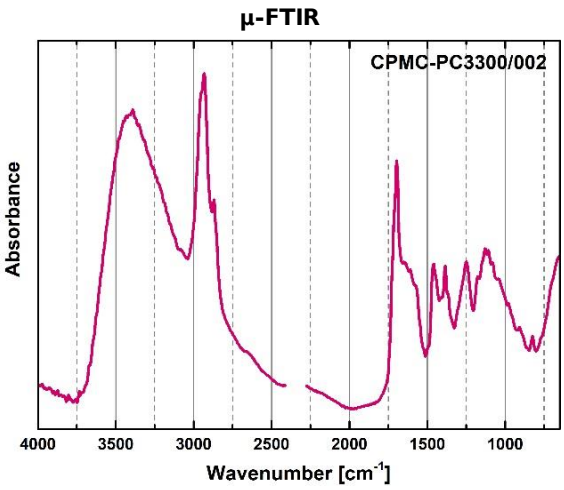
EDXRF



UV-VIS



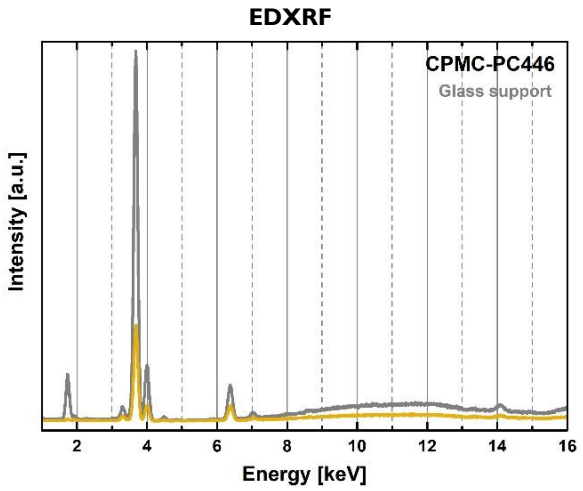


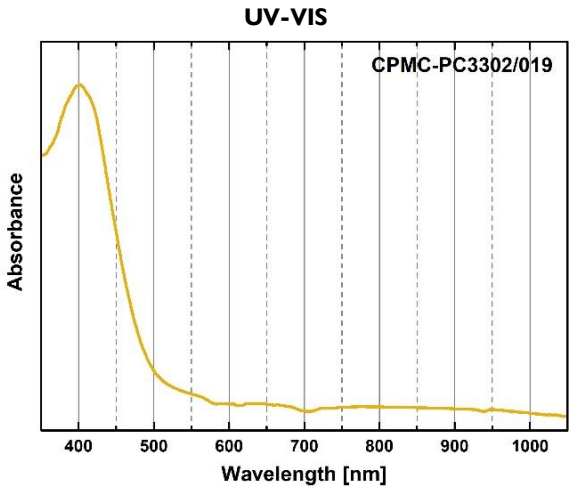


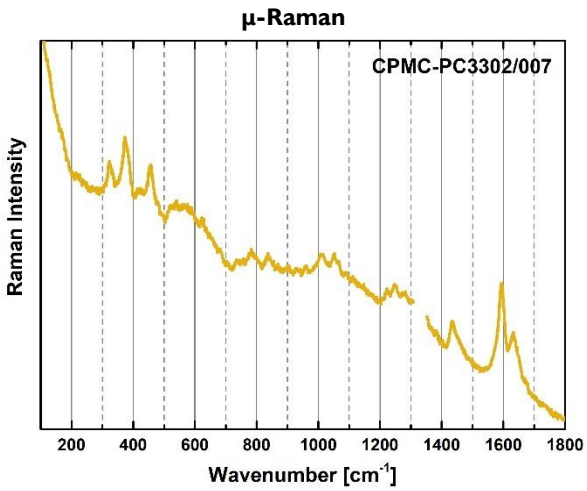


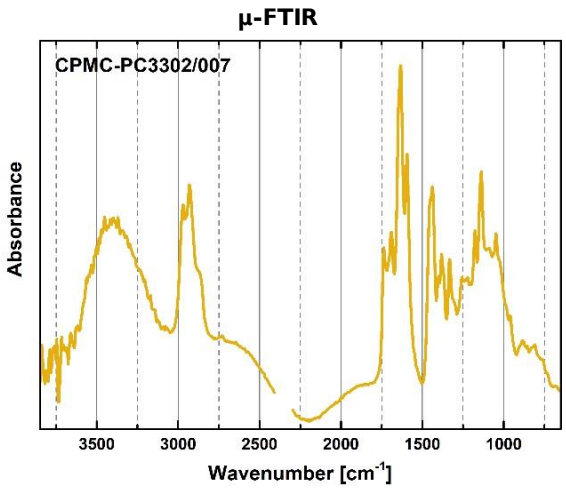
Yellow

Identified as gamboge





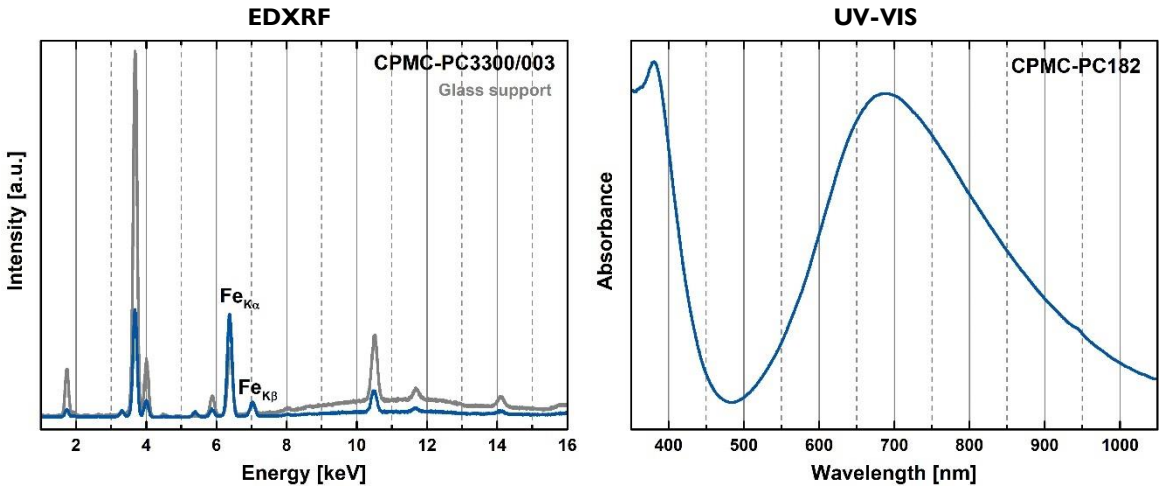


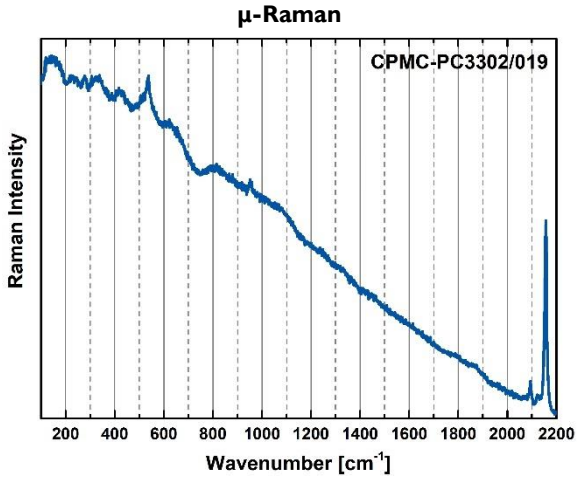




Blue

Identified as Prussian blue

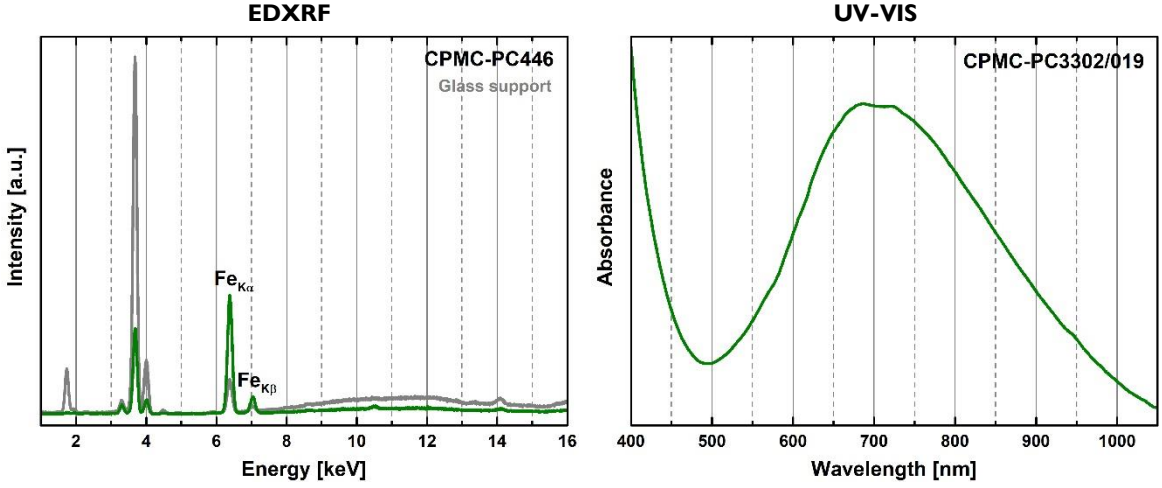


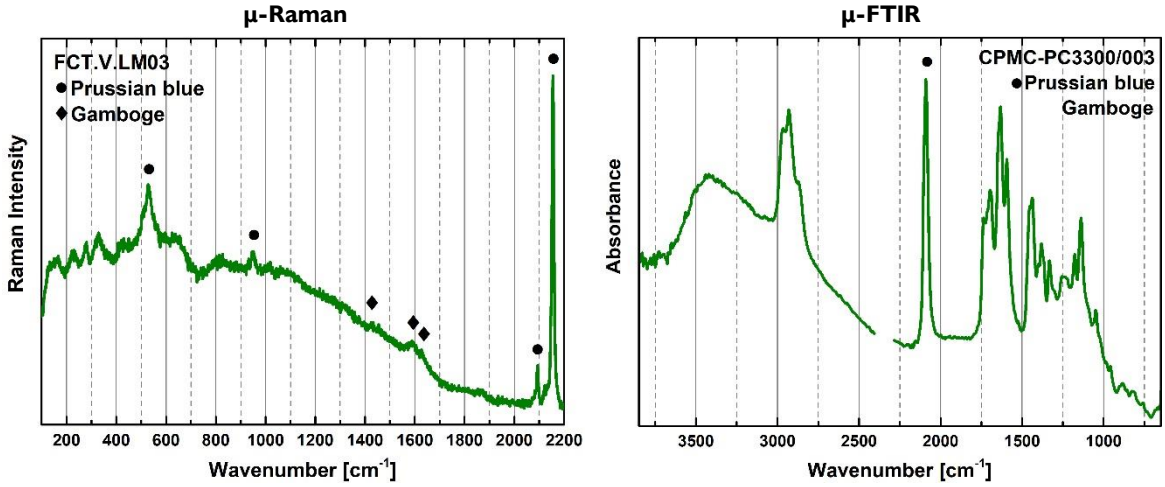




Green *(not present on PC3300/002 and PC182)*

Identified as Prussian blue and gamboge

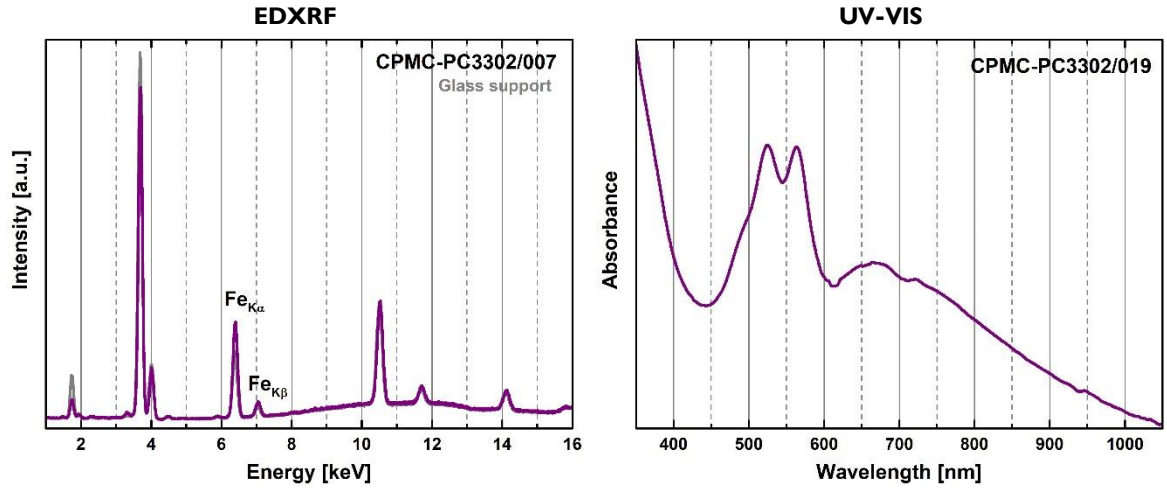


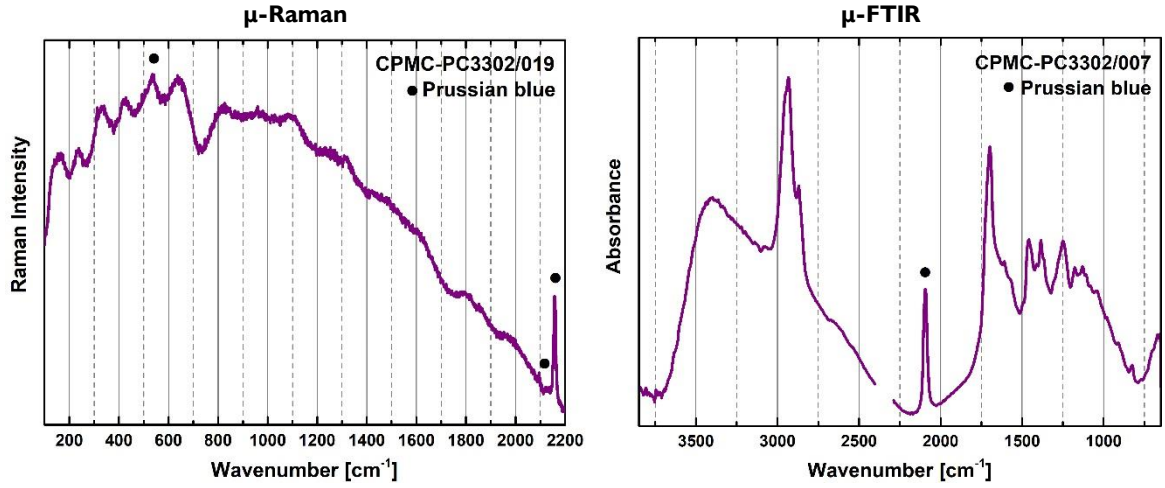




Purple *(only PC3302/007 and PC3302/019)*

Identified as Prussian blue and an animal anthraquinone lake (possibly cochineal)

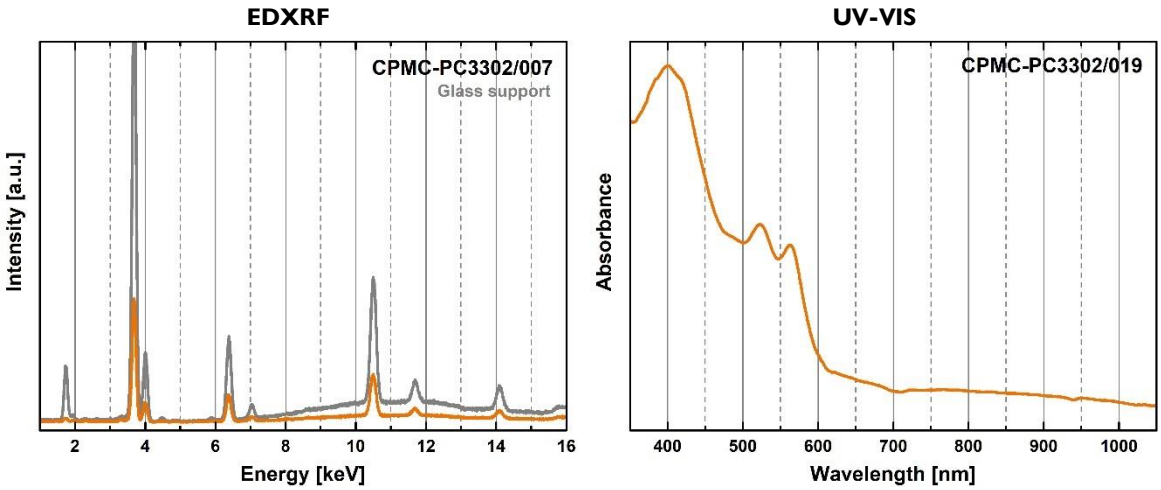






Orange *(PC3302/007, PC3302/019 and LM03)*

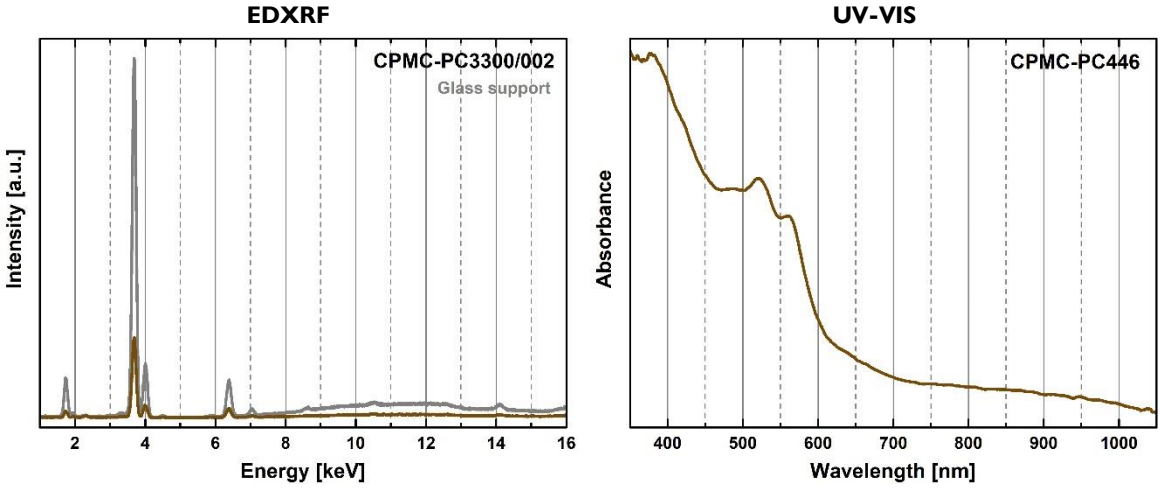
Identified as an animal anthraquinone lake (possibly cochineal) and an organic yellow (possibly gamboge)

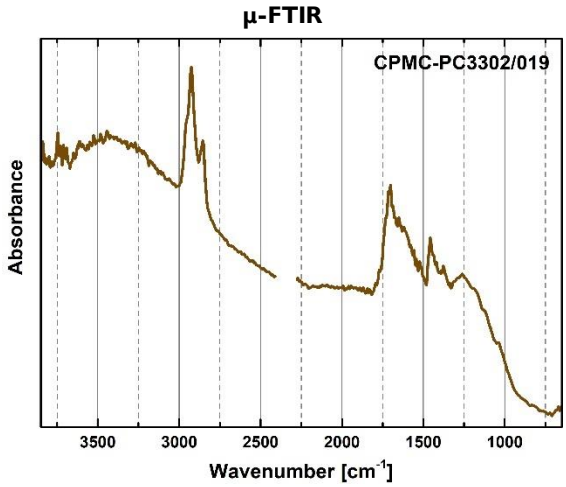




Brown

Identified as a mixture with an animal anthraquinone lake (possibly cochineal)



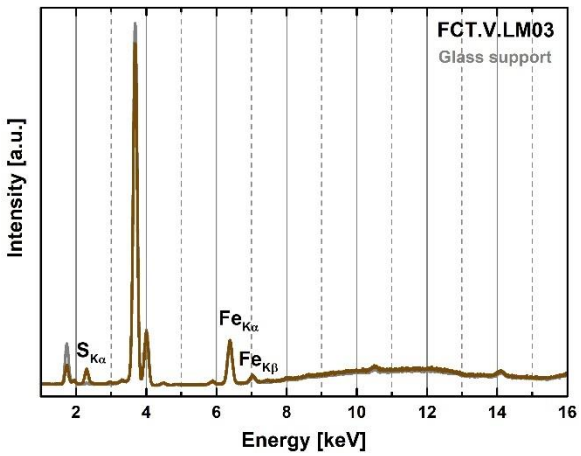




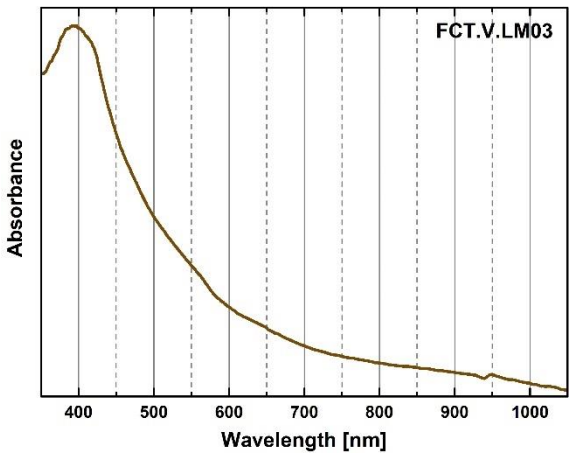
Brown *(LM03)*

Identified as an ochre (hematite)

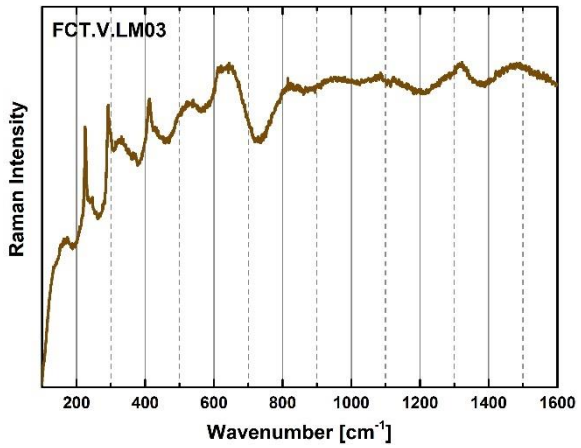
EDXRF



UV-VIS



μ-Raman

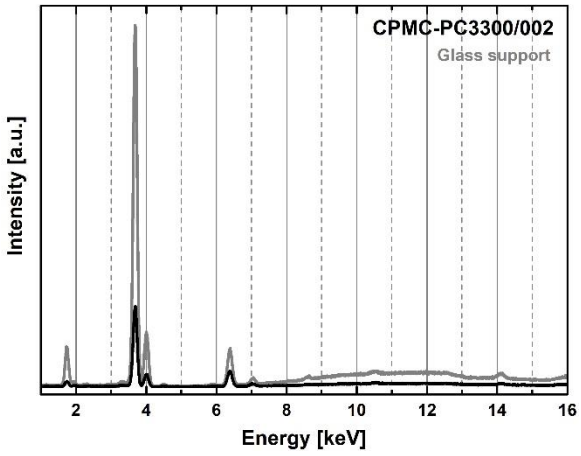




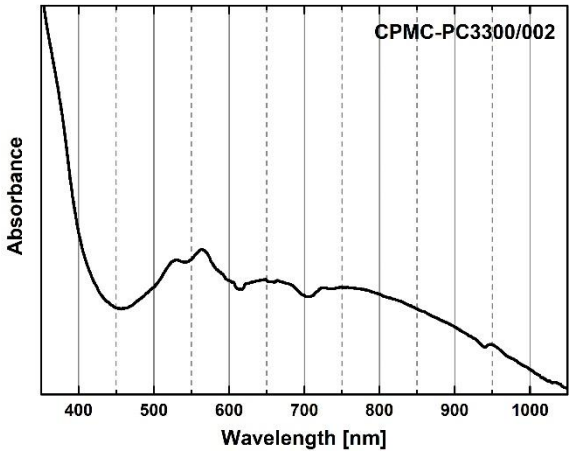
Black

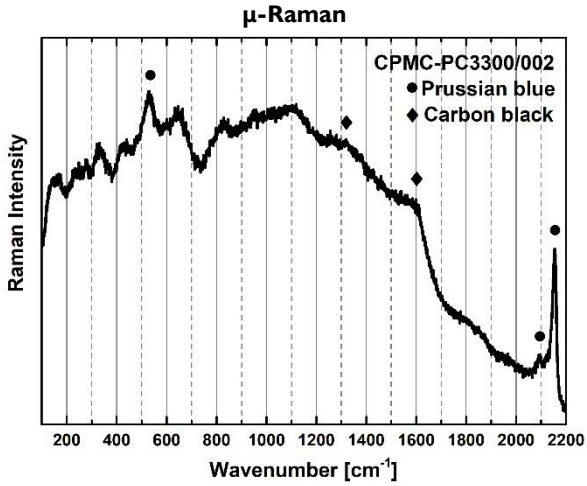
Identified as carbon black, Prussian blue and an animal anthraquinone lake (possibly cochineal)

EDXRF



UV-VIS

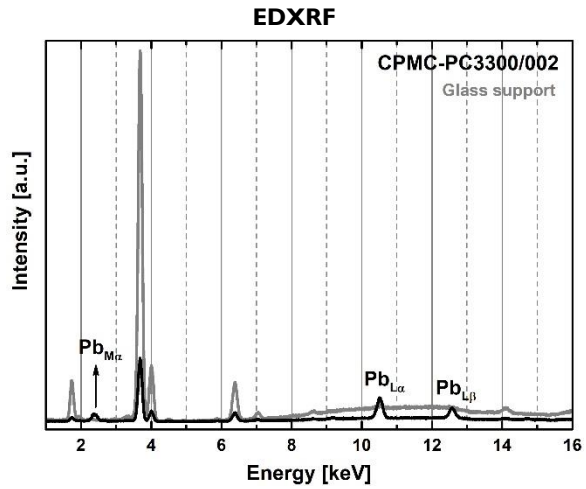


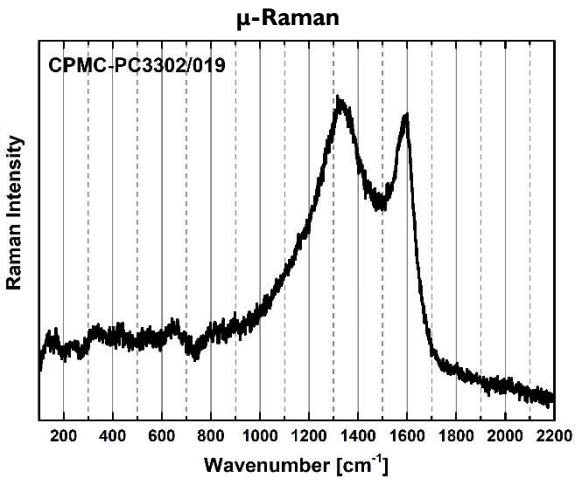




Black Mask

Identified as carbon black

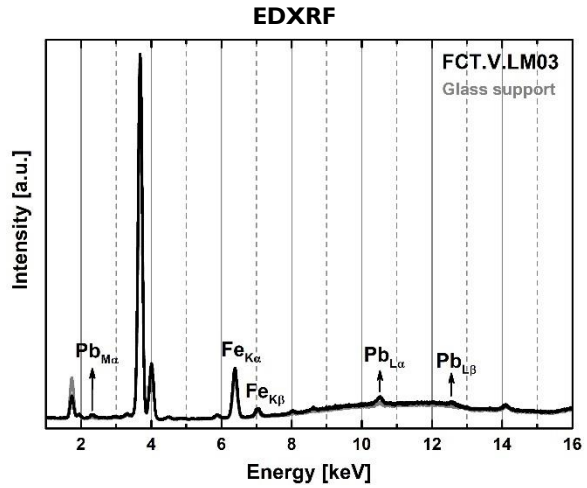






Printed Outline *(LM03)*

Colourant not identified



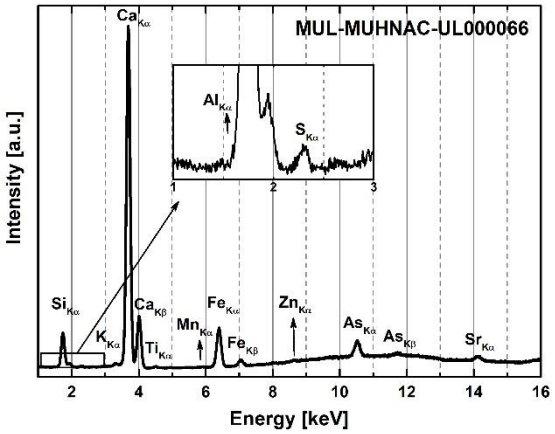
I) unknown, England (ca.1870-1900)



Glass

Semi-quantified as synthetic soda-rich glass

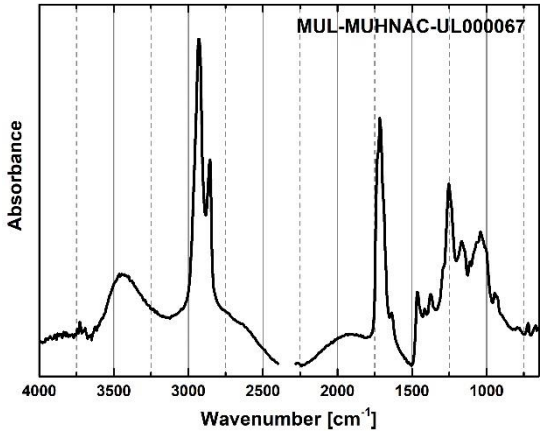
EDXRF



Binder

Identified as shellac resin

μ-FTIR

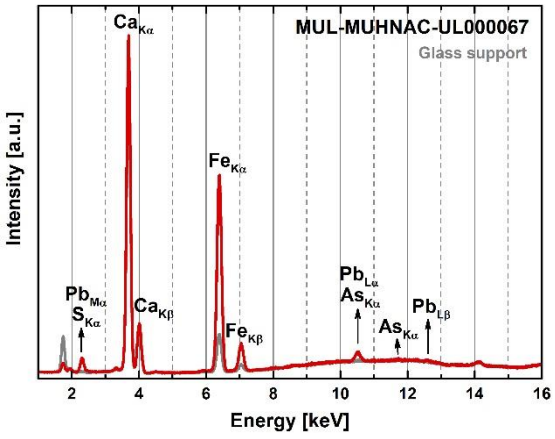




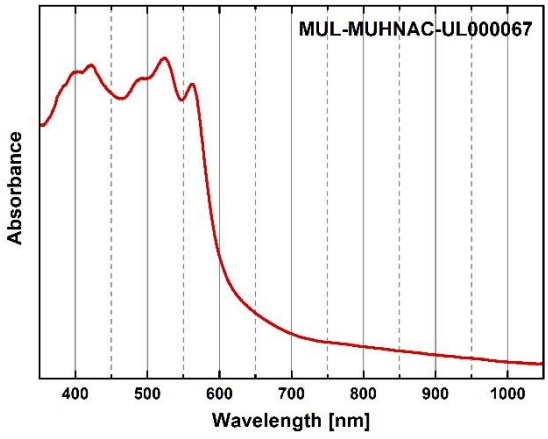
Red

Identified as an animal anthraquinone lake (possibly cochineal)

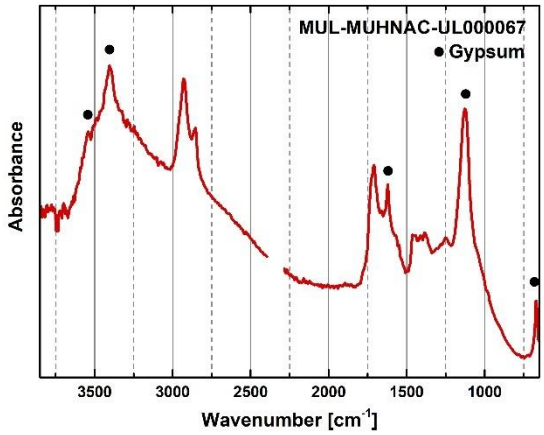
EDXRF



UV-VIS



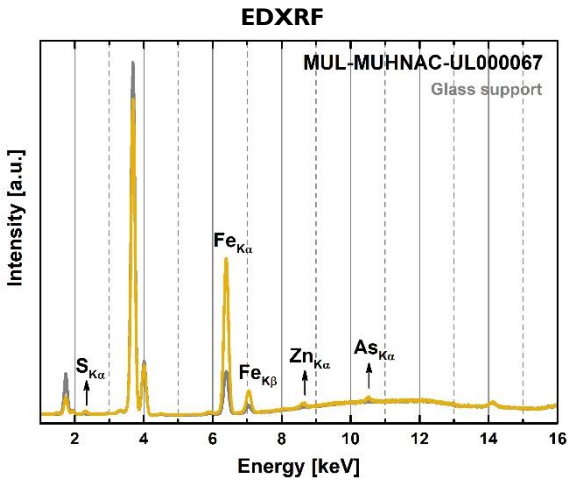
μ-FTIR

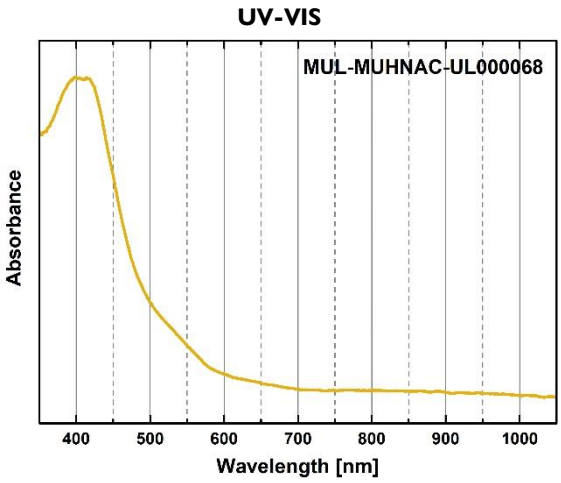


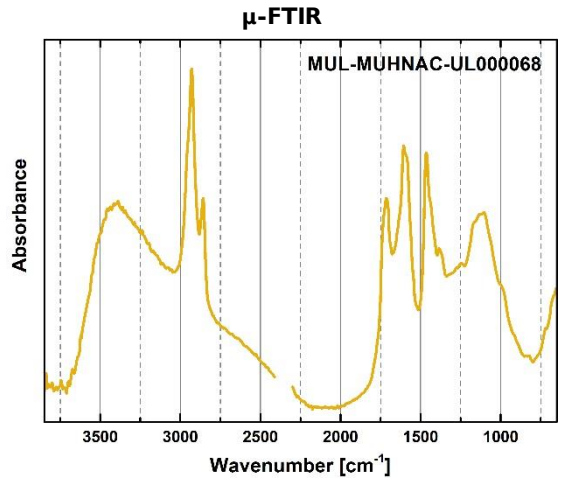


Yellow *(UL000067-68)*

Colourant not identified (possibly an earth pigment)



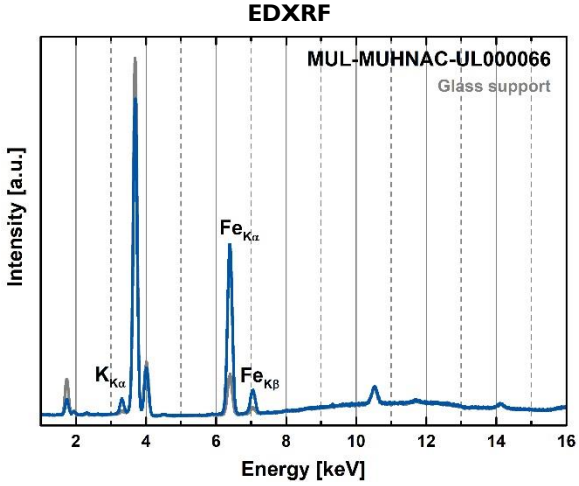


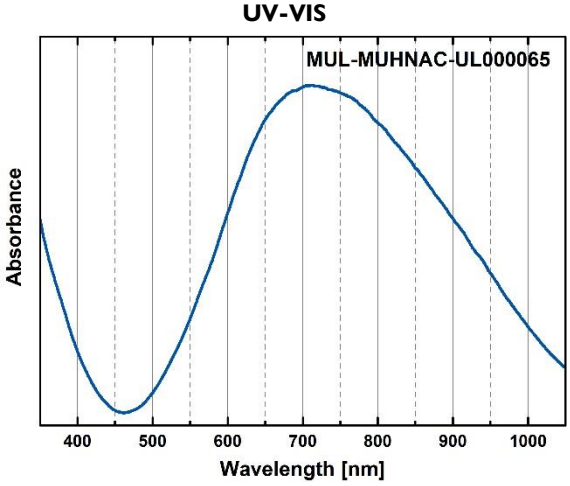


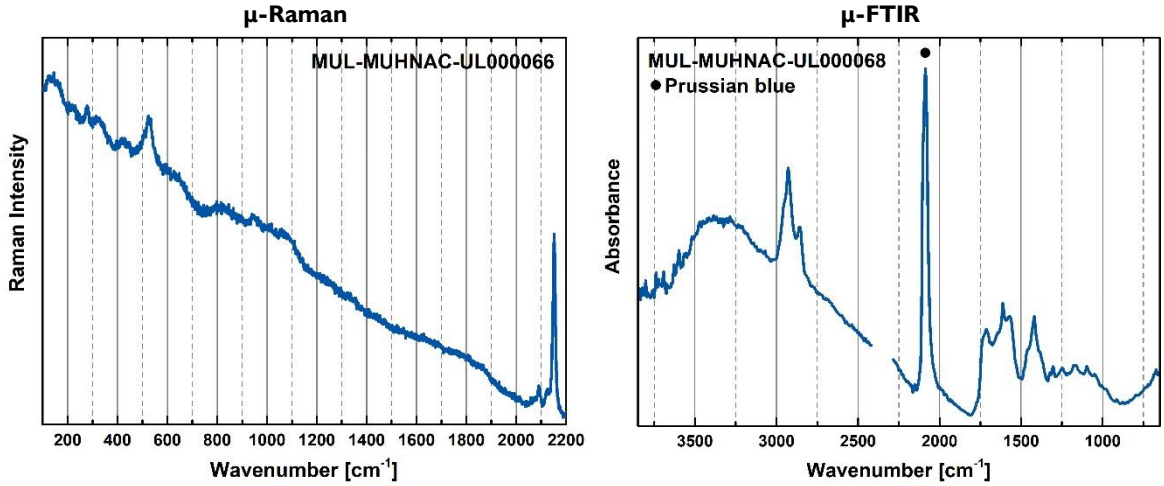


Blue

Identified as Prussian blue



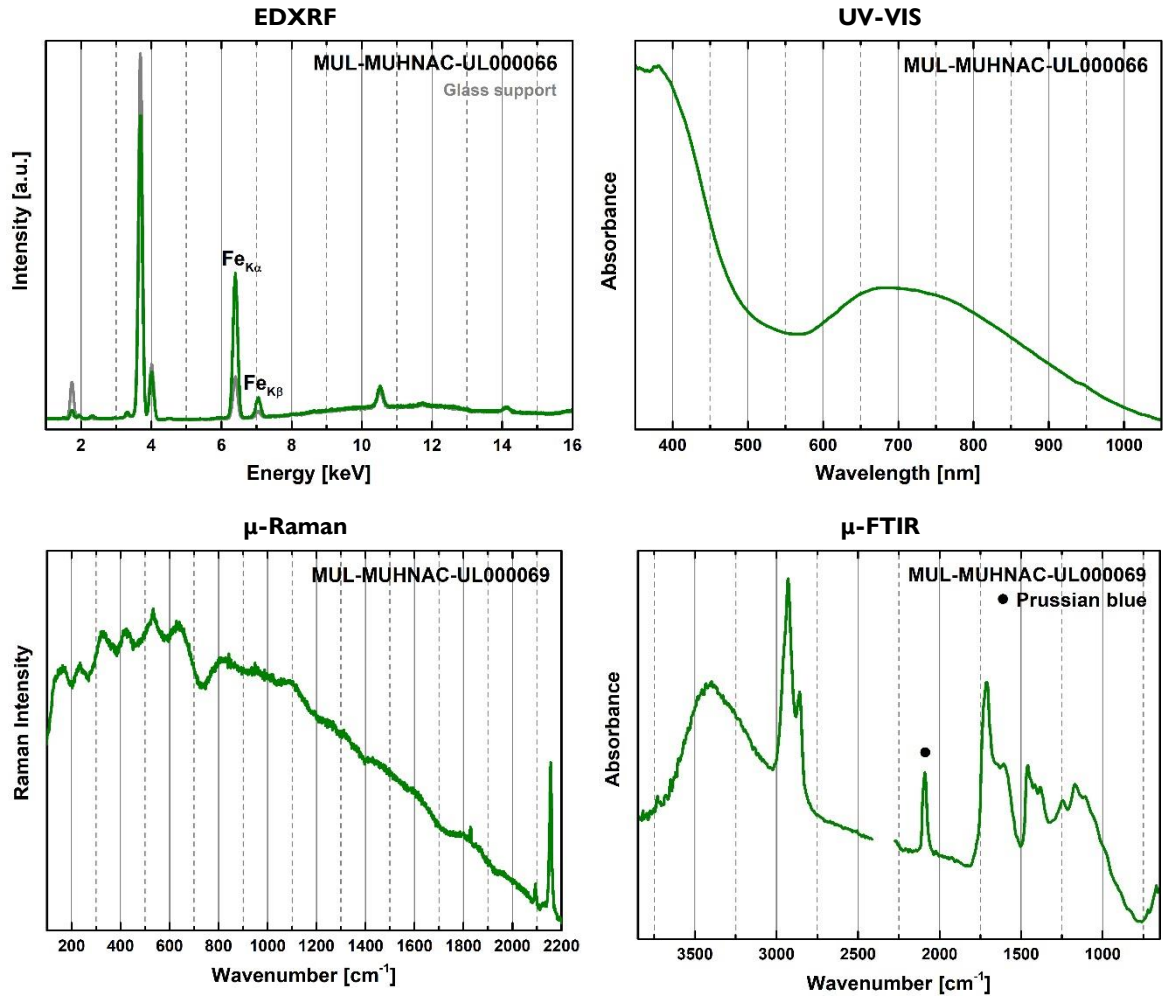






Green *(UL000065-66, 69)*

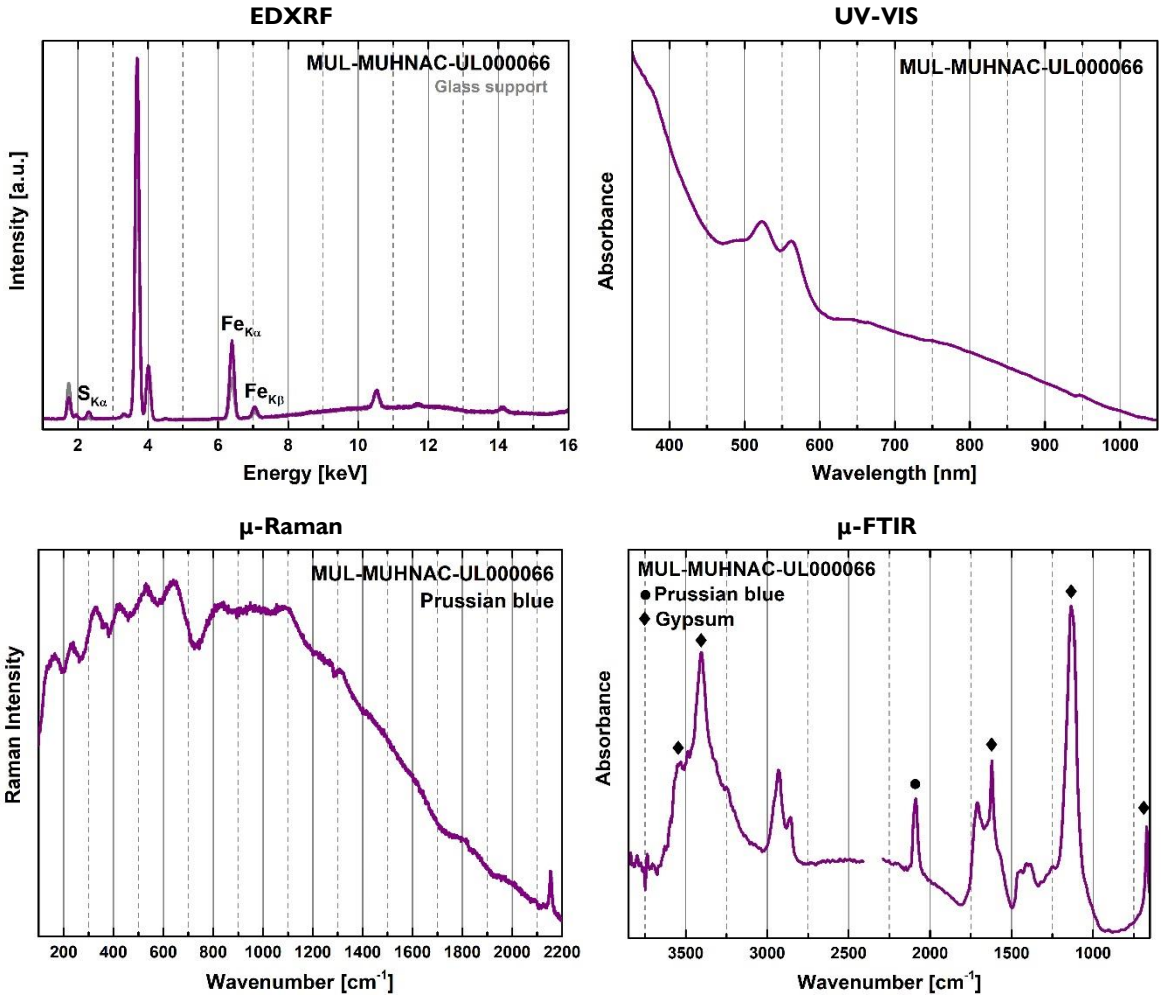
Identified as Prussian blue and possibly the unidentified yellow





Purple *(UL000066)*

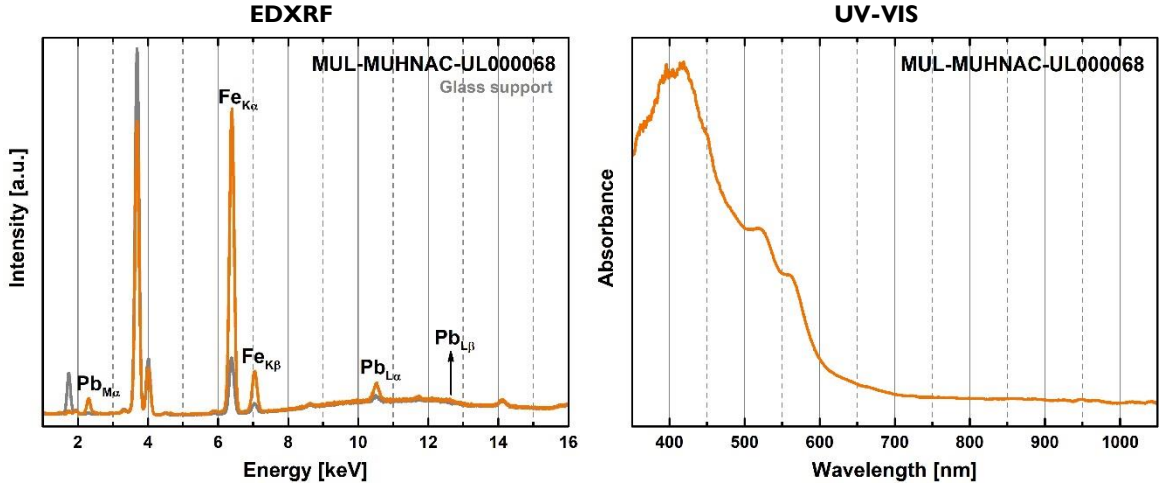
Identified as Prussian blue and an animal anthraquinone lake (possibly cochineal)





Orange *(UL000068-69)*

Identified as possibly the yellow earth pigment and an animal anthraquinone lake (possibly cochineal)

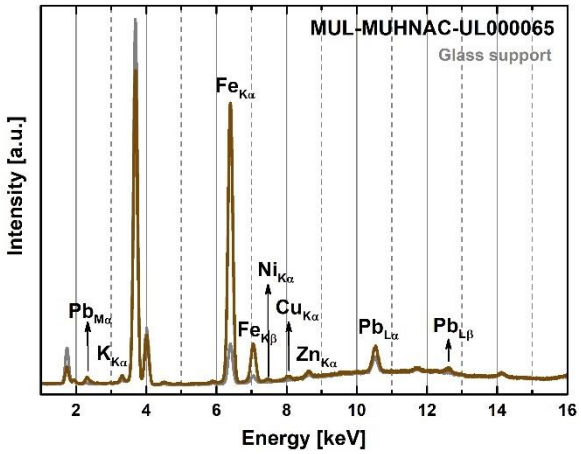




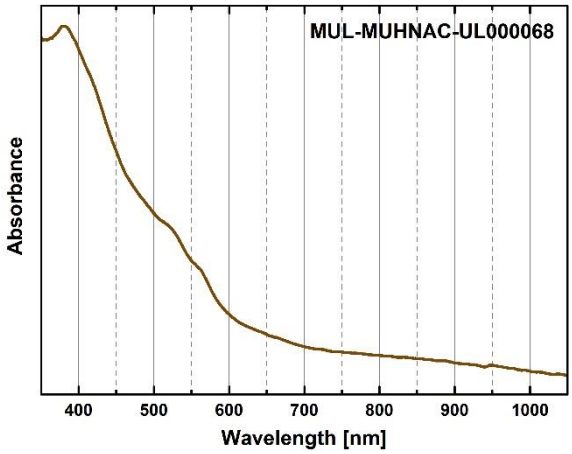
Brown

Identified as Prussian blue, an animal anthraquinone lake (possibly cochineal), carbon black and possibly yellow

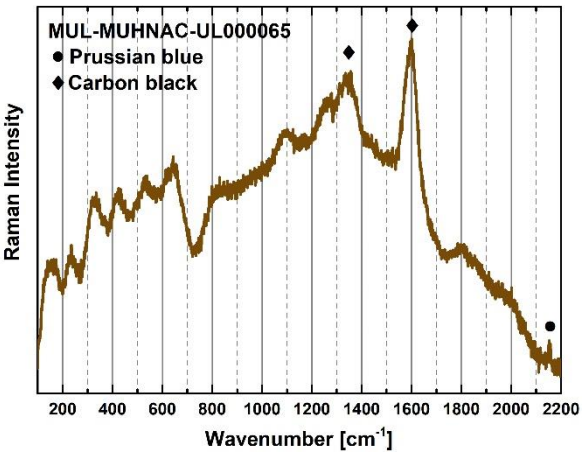
EDXRF



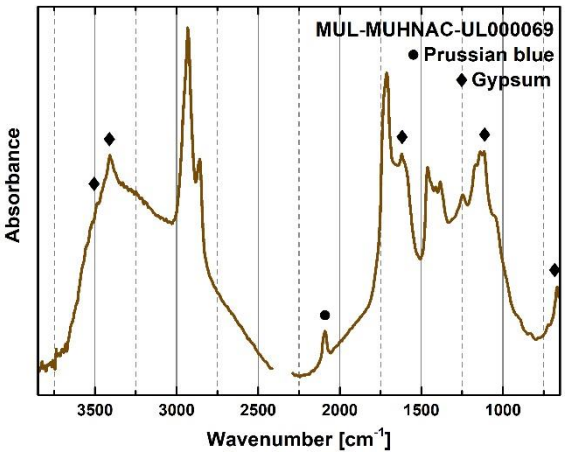
UV-VIS



μ-Raman



μ-FTIR

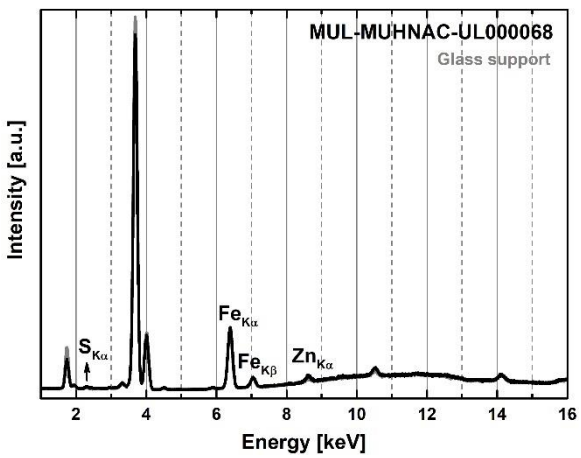




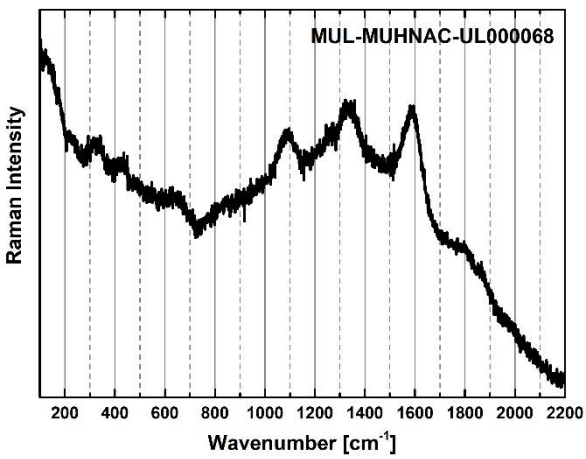
Black

Possibly identified as carbon black

EDXRF

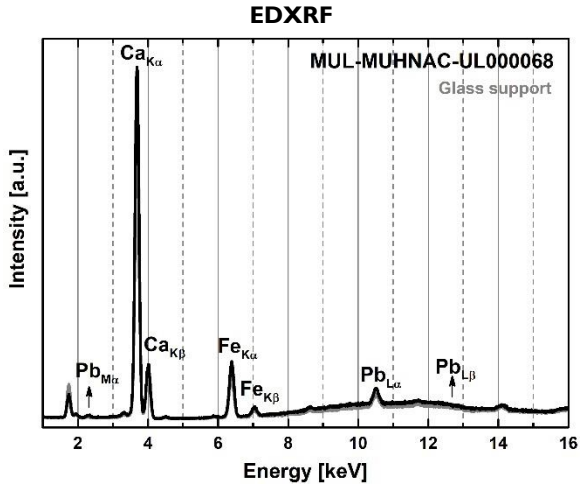


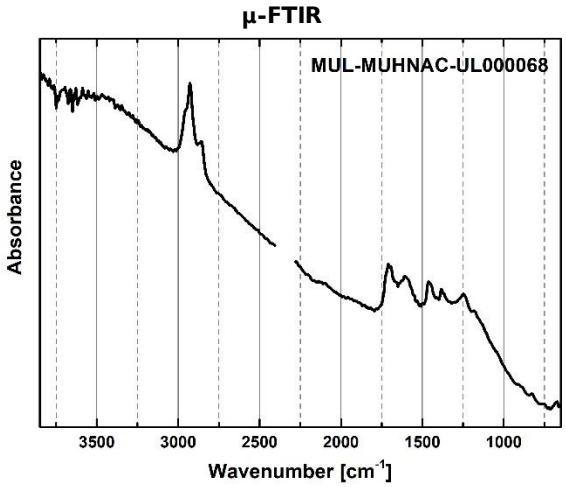
μ-Raman

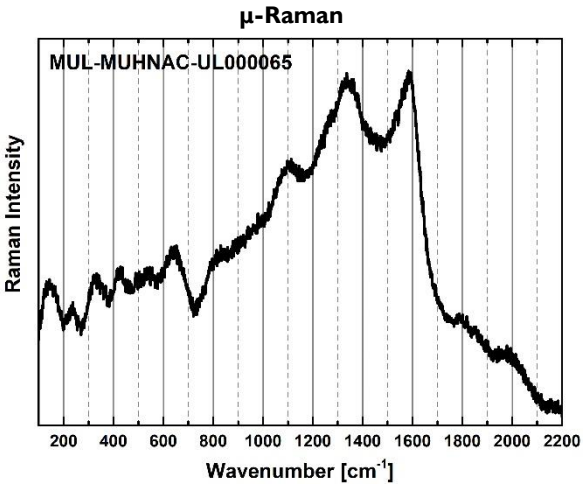


Black Mask

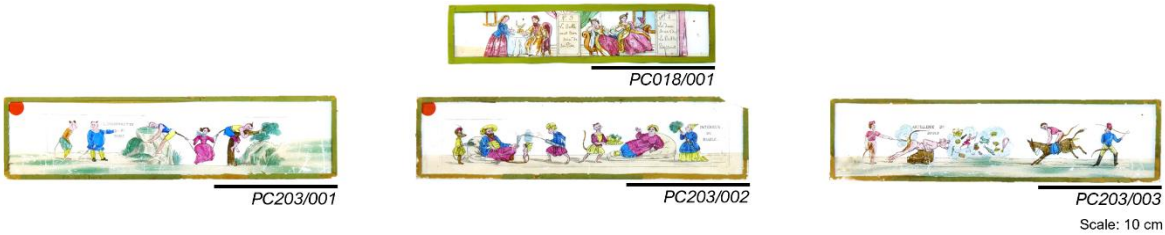
Identified as carbon black







J) Lapierre, France (ca.1860-1900)



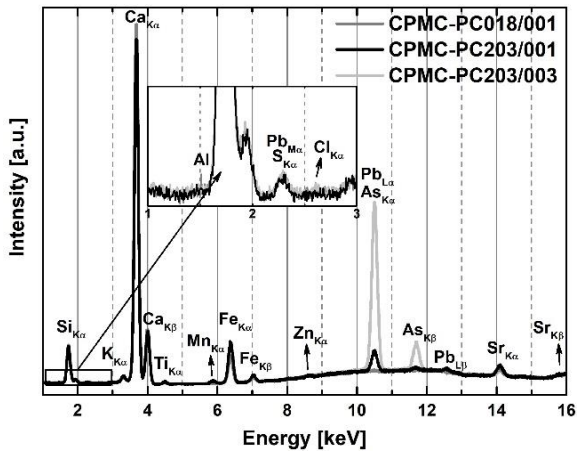
Glass

Semi-quantified as high-lime low alkali glass

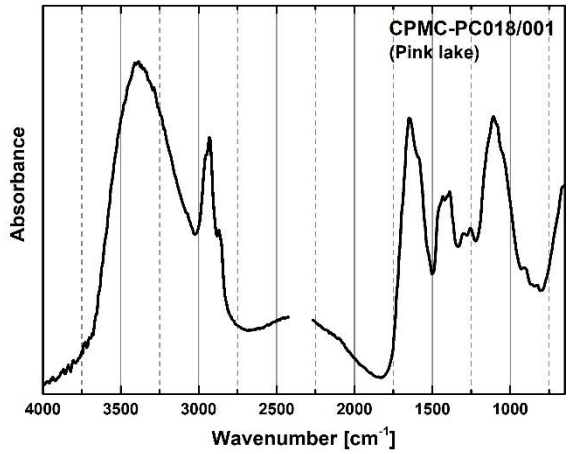
Binder

Possibly identified as mastic resin

EDXRF



μ-FTIR

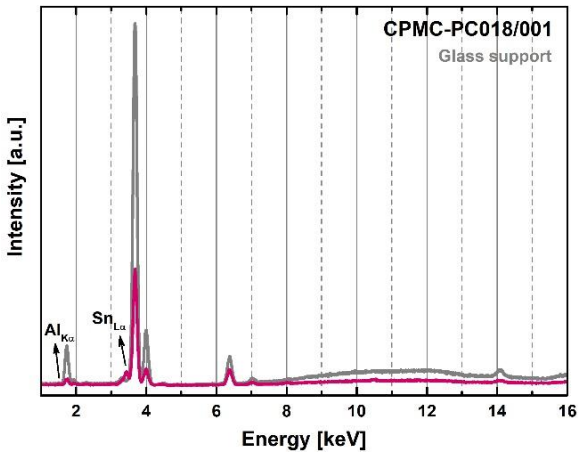




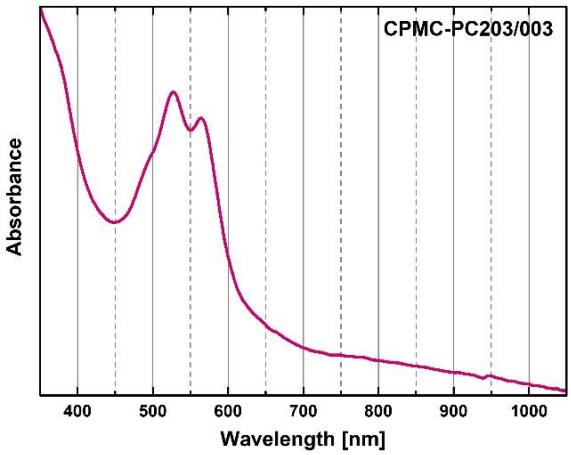
Pink

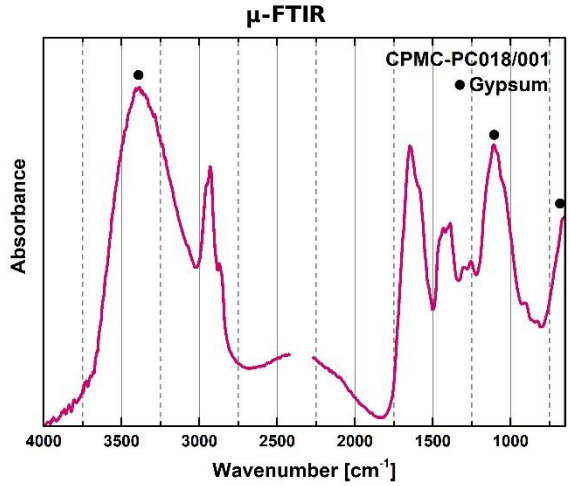
Identified as an animal anthraquinone lake (possibly cochineal)

EDXRF



UV-VIS

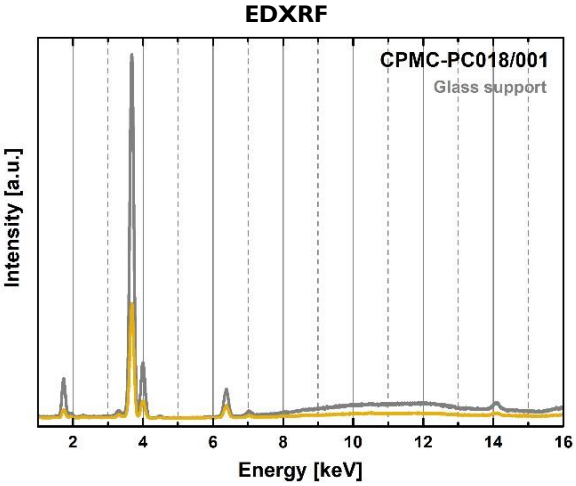


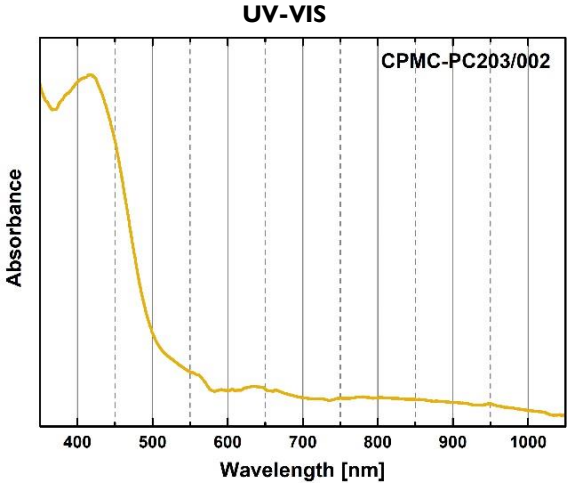




Yellow

Colourant not identified

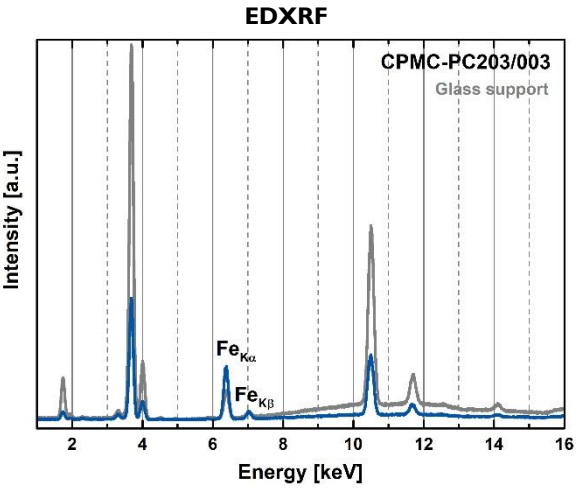


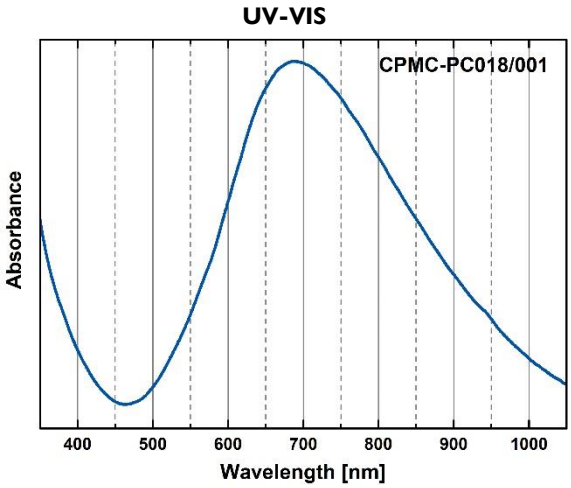


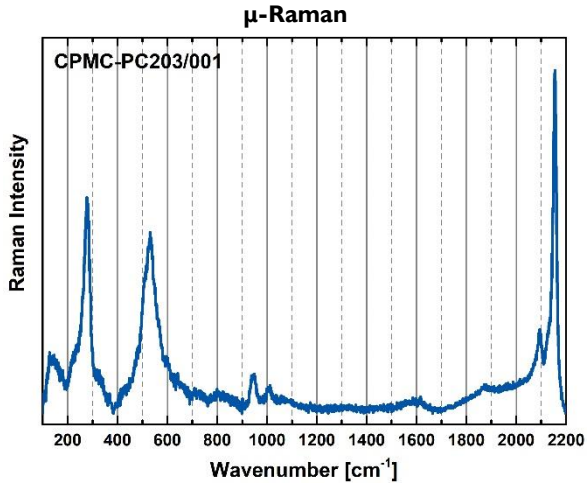


Blue

Identified as Prussian blue



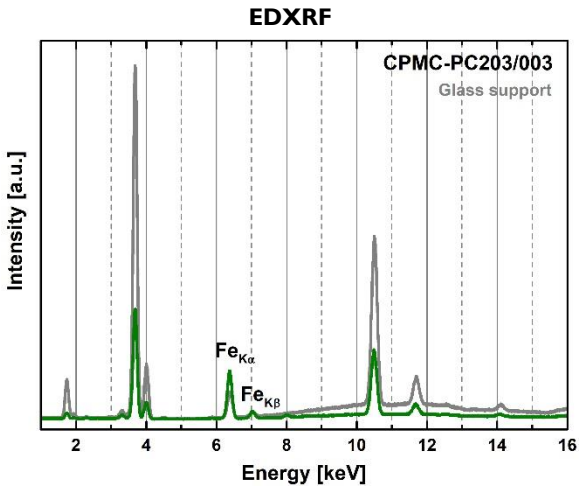


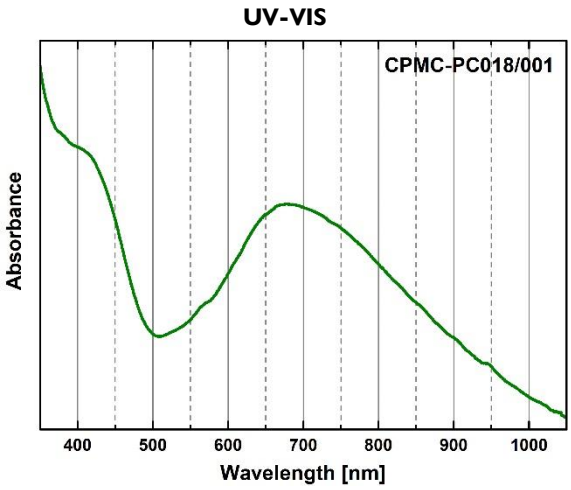


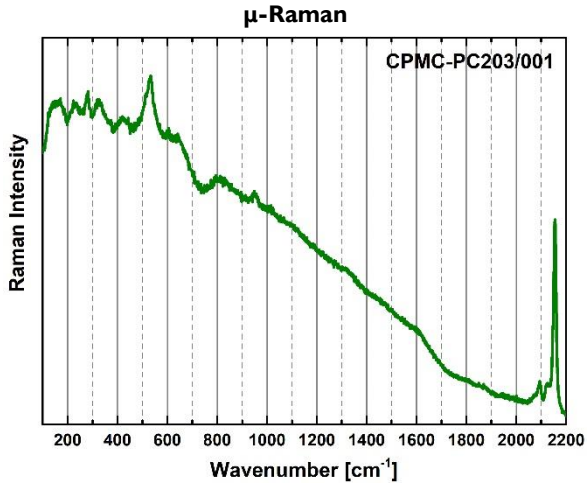


Green

Identified as Prussian blue and possibly yellow



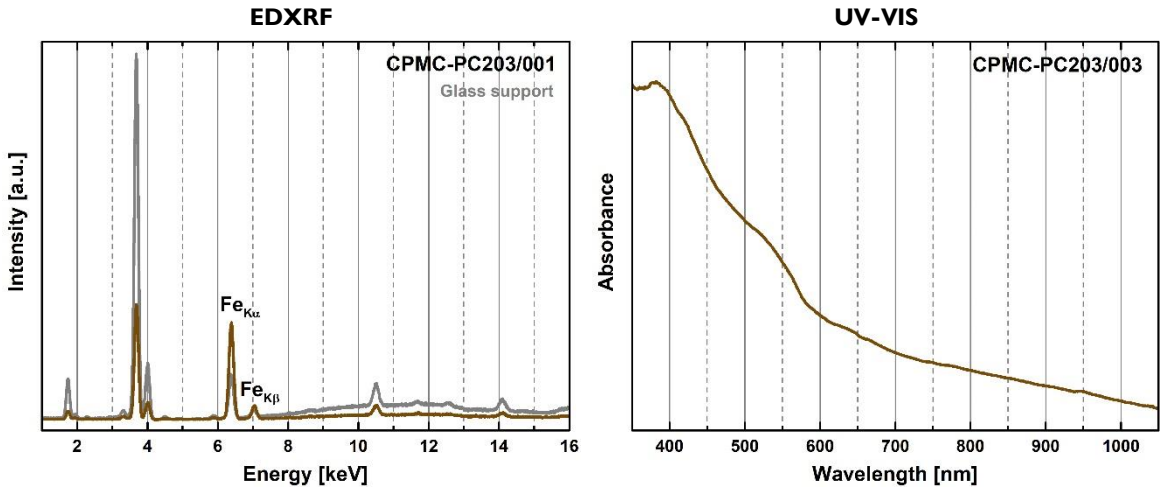


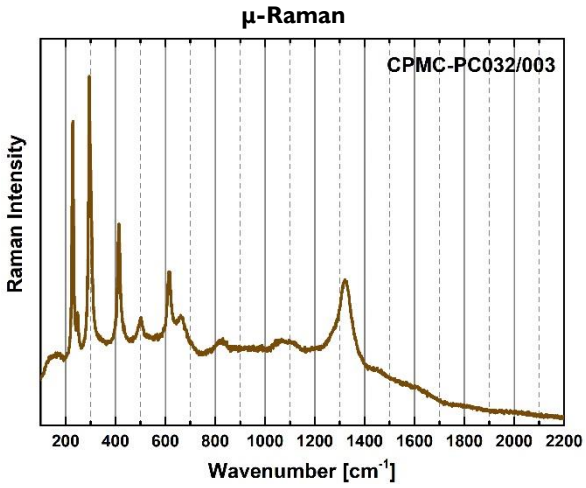




Brown

Identified as an ochre (hematite)

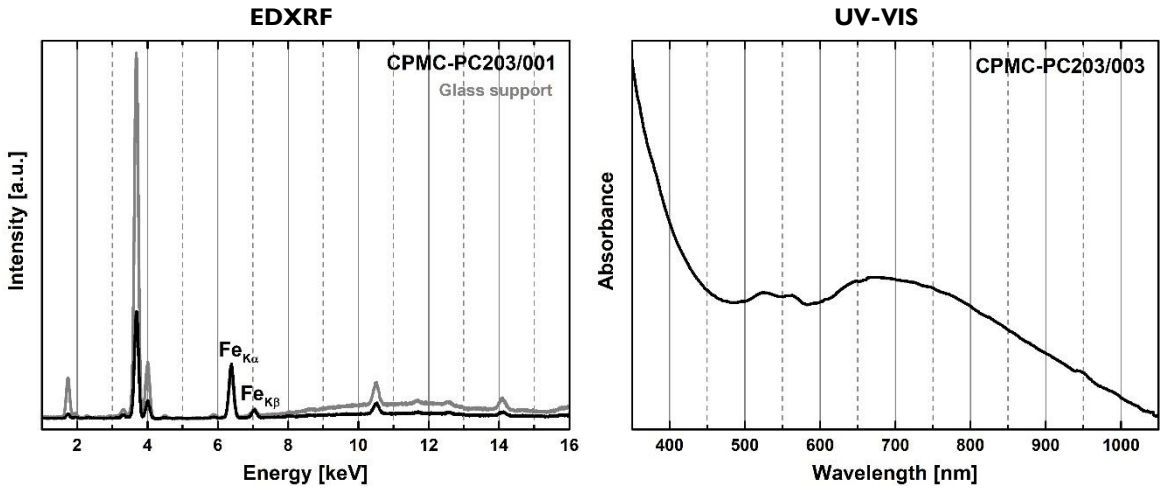


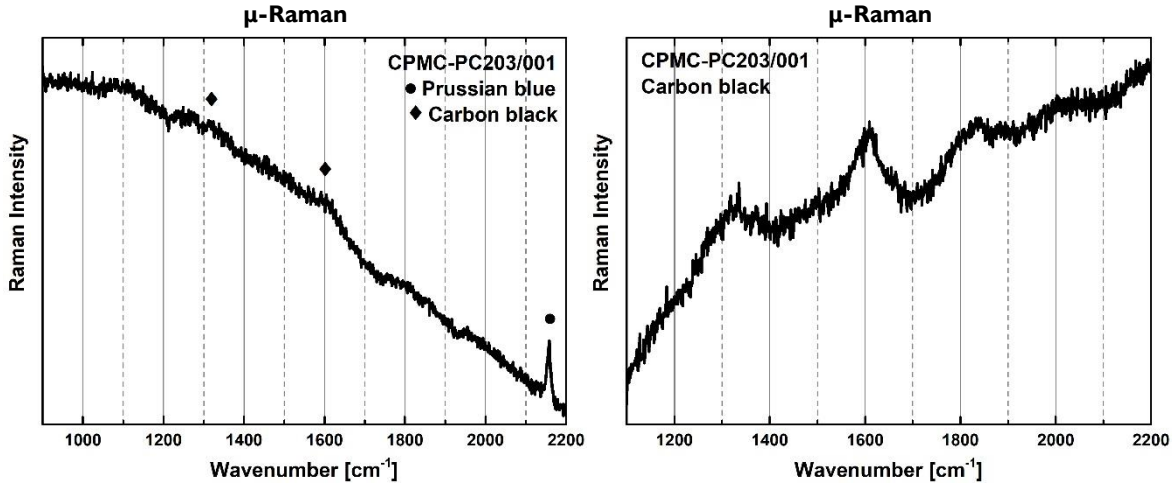




Black *(not present on PC203/002)*

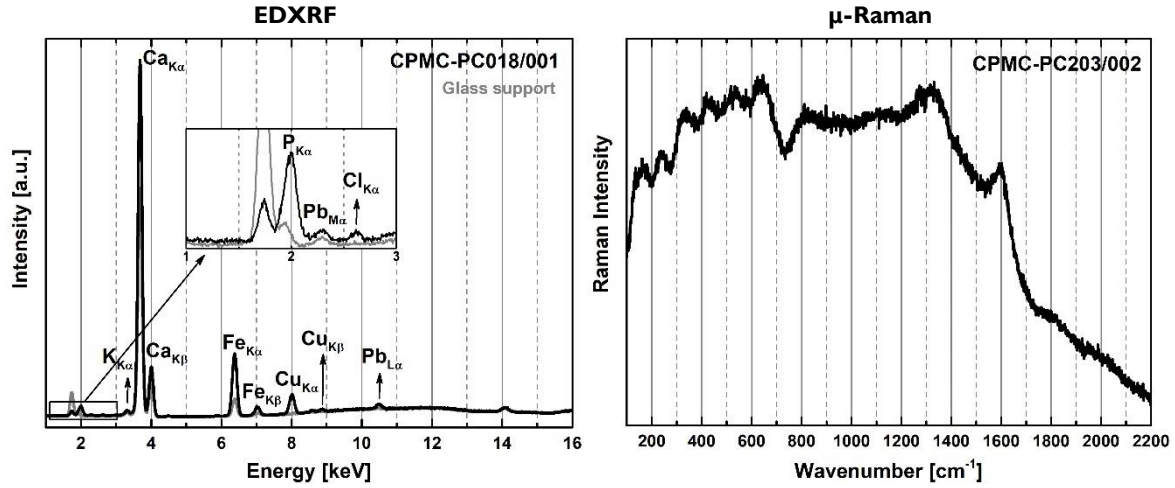
Identified as Prussian blue, carbon black and possibly an animal anthraquinone lake





BL ***Black*** *(Printed Outline)*

Identified as carbon black and other unidentified colourants



K) Lapierre, France (ca.1874-1900)



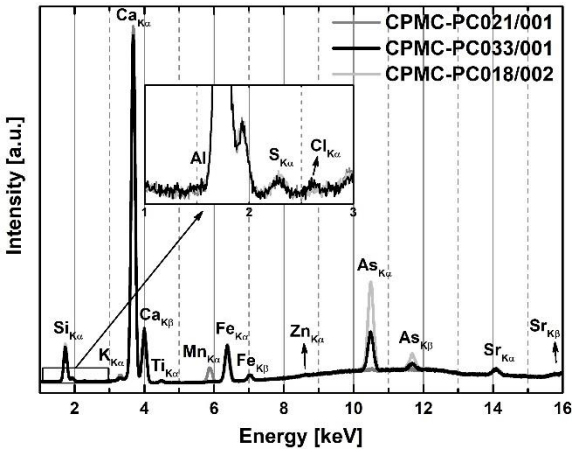
Glass

Semi-quantified as high-lime low alkali glass

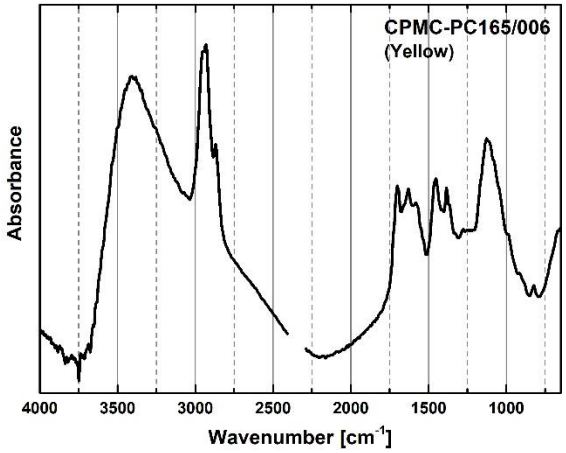
Binder

Possibly identified as mastic resin

EDXRF



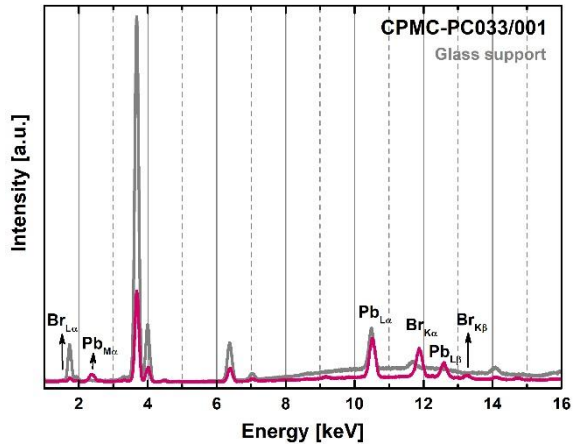
μ-FTIR



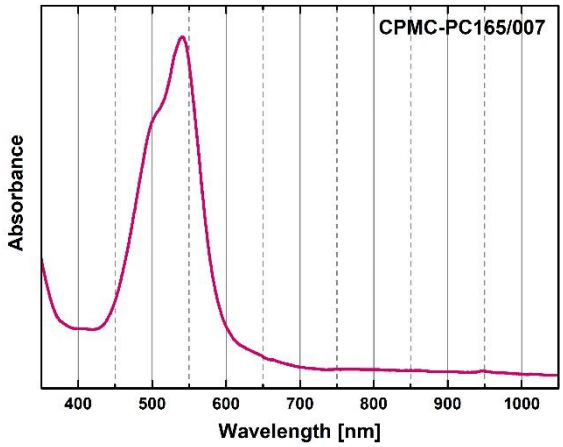
Pink

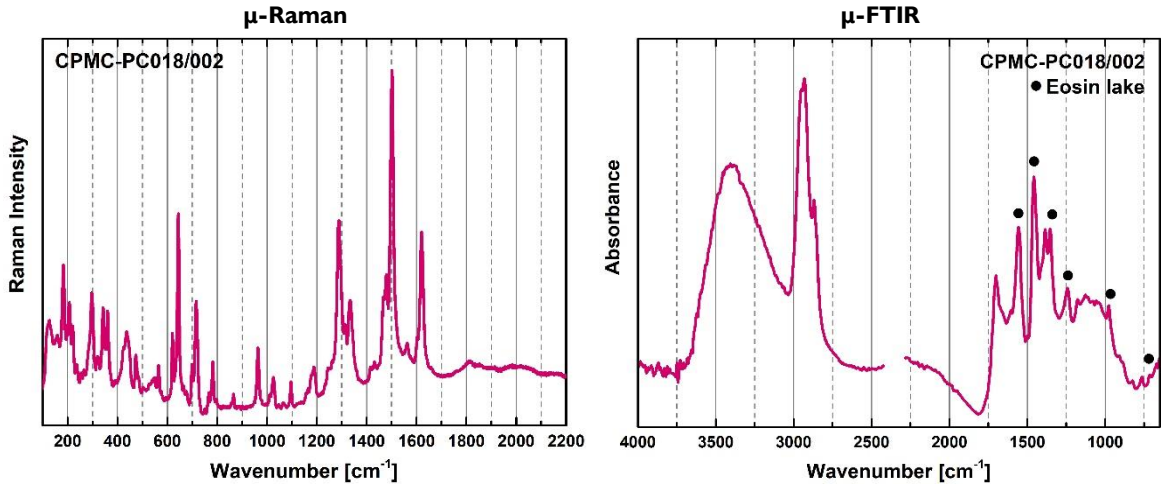
Identified as an eosin-based lake

EDXRF



UV-VIS

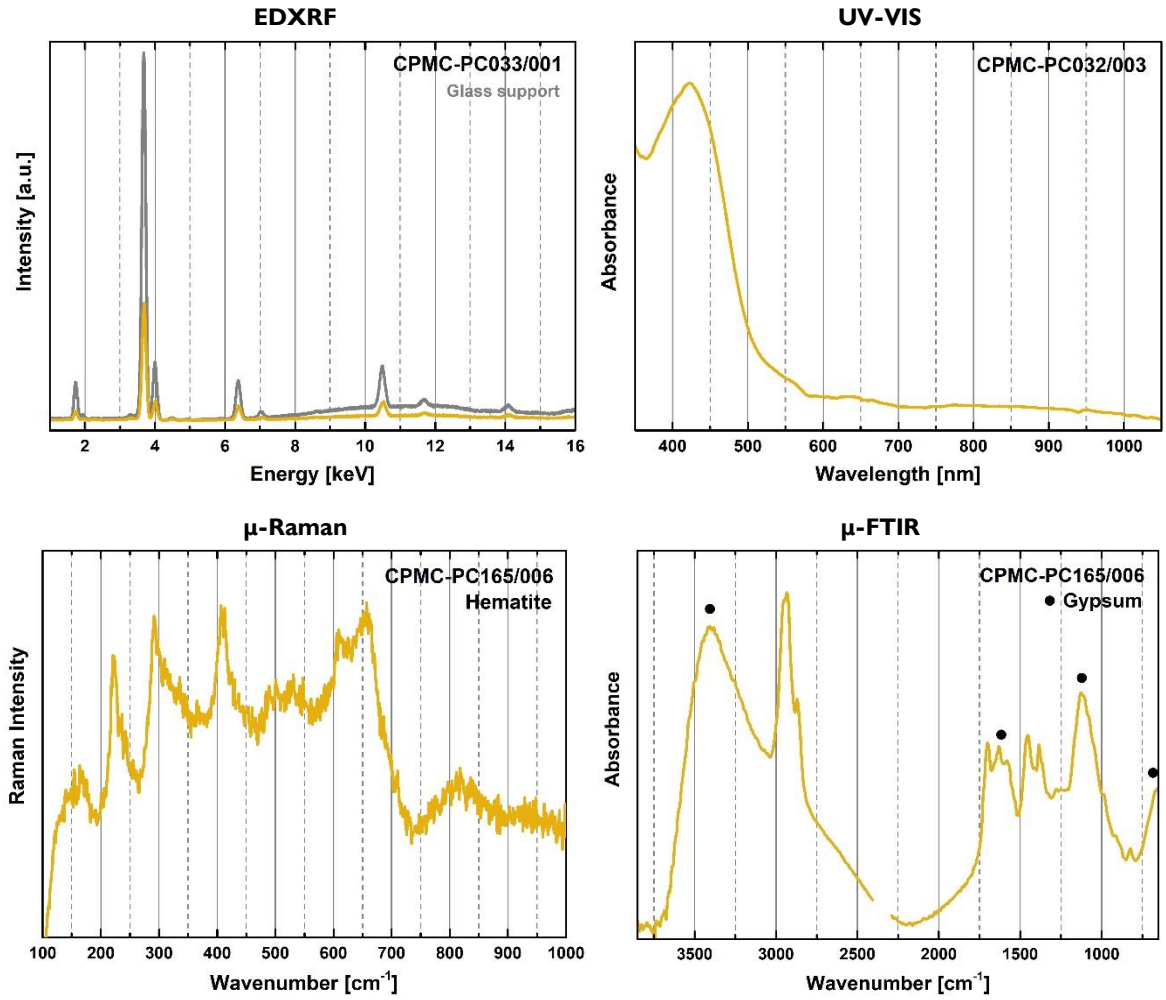






Yellow *(not present on PC020/007)*

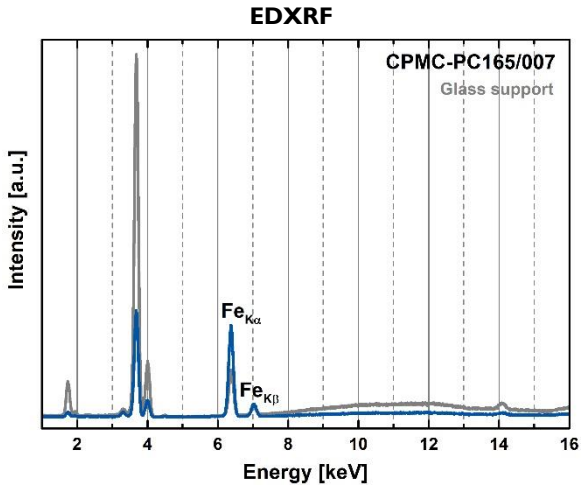
An unidentified yellow (possibly organic) and a yellow ochre (with hematite and gypsum) (PC165/006)

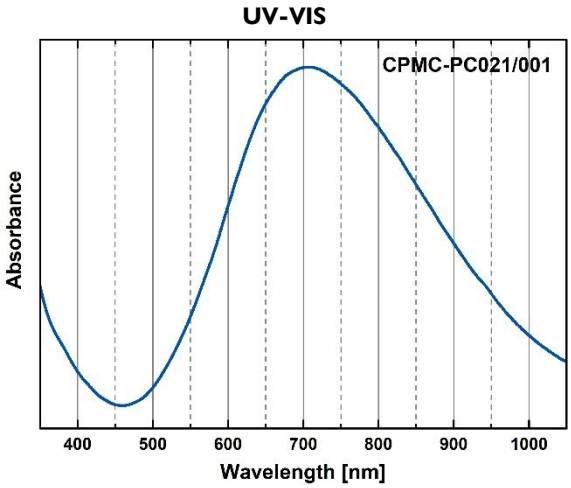


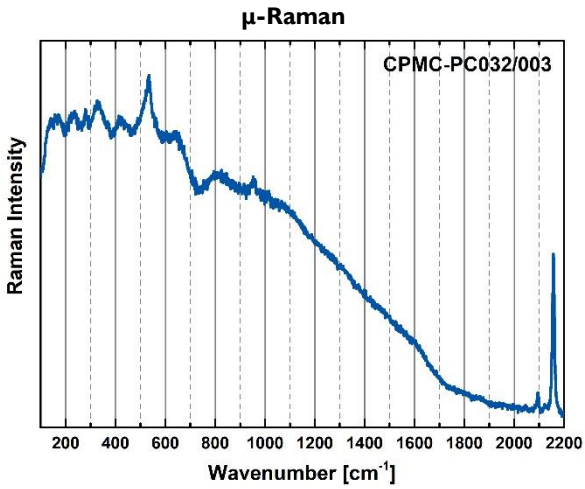


Blue

Identified as Prussian blue



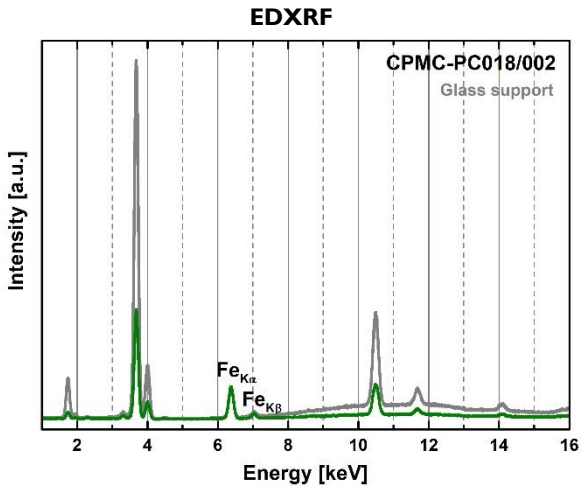


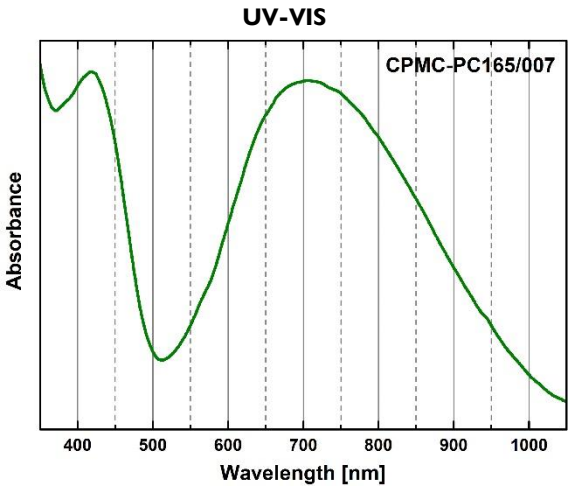


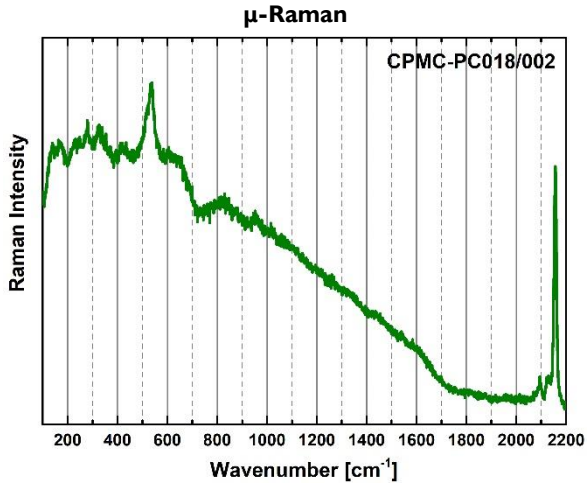


Green

Identified as Prussian blue and possibly yellow



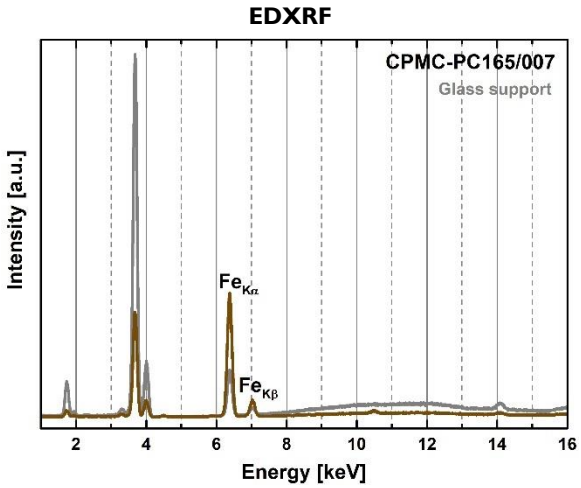


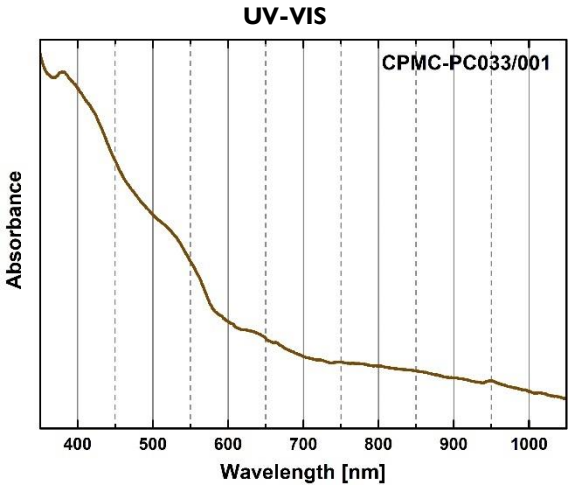


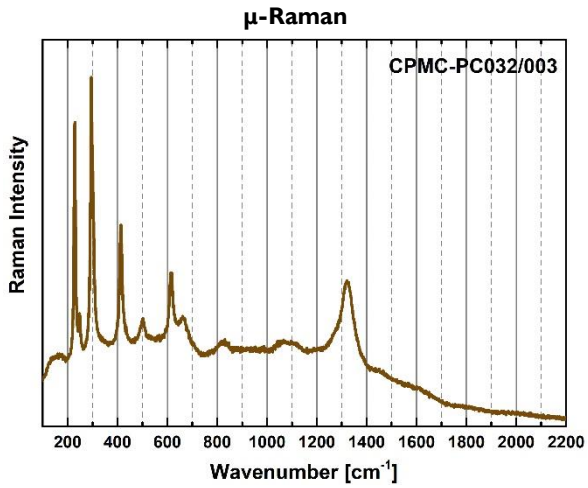


Brown

Identified as an ochre (hematite)



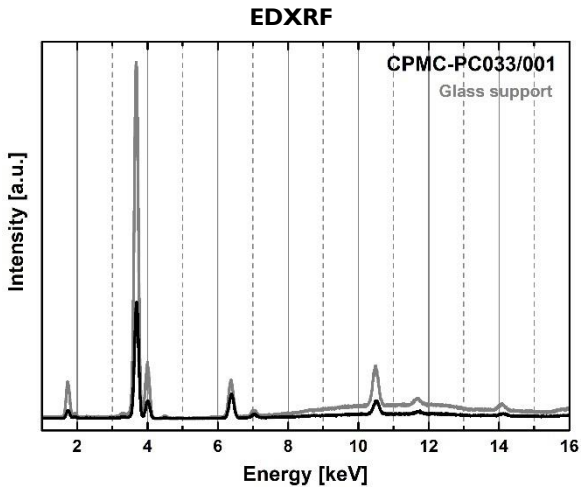


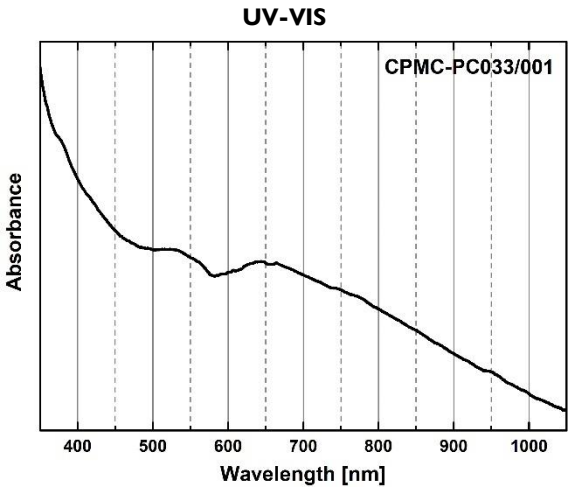


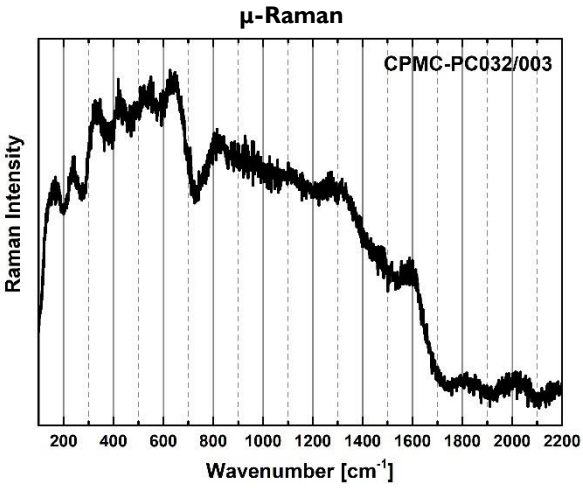


Black *(not present on PC020/006, PC021/002 and PC165/006-7)*

Possibly identified as carbon black



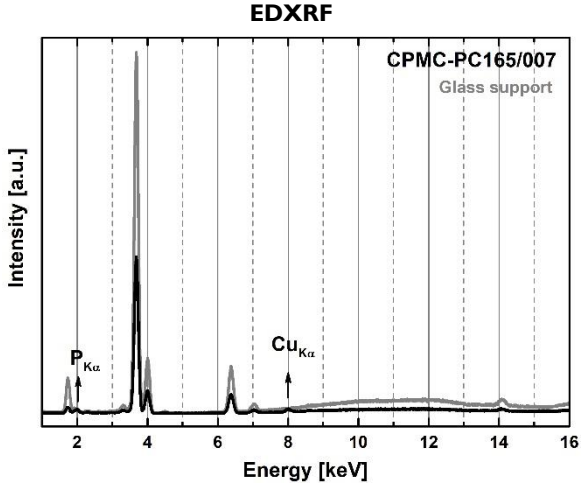


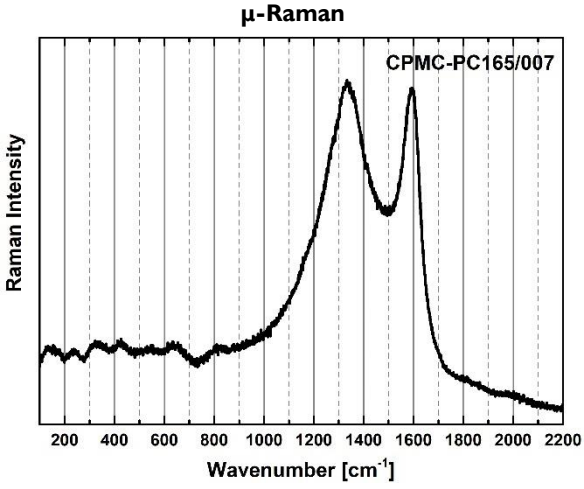




Black (Printed Outline)

Identified as carbon black





L) Lapierre, France (ca.1860-1900)



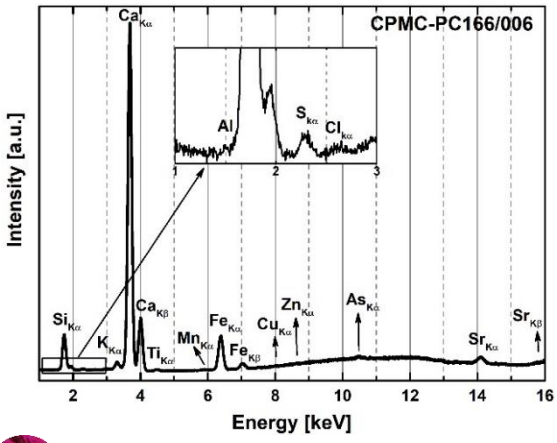
PC166/006

Scale: 10 cm

Glass

Semi-quantified as high-lime low alkali glass

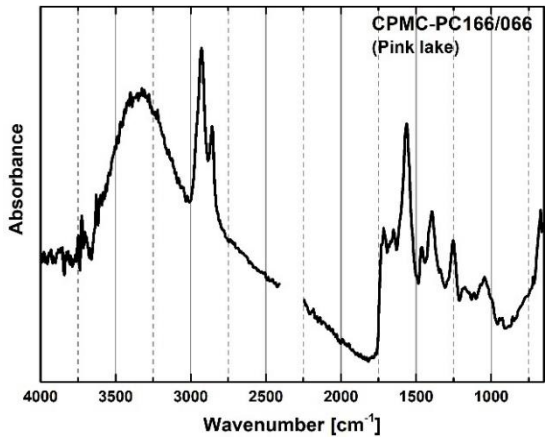
EDXRF



Binder

Possibly identified as shellac resin

μ-FTIR

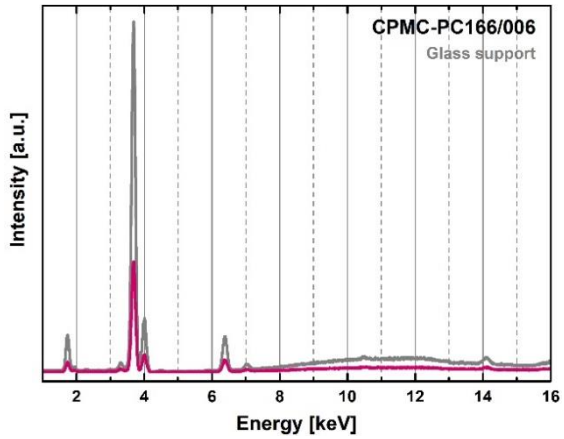




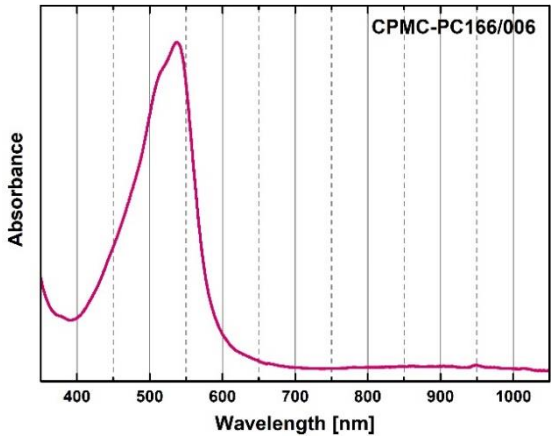
Pink

Colourant not identified

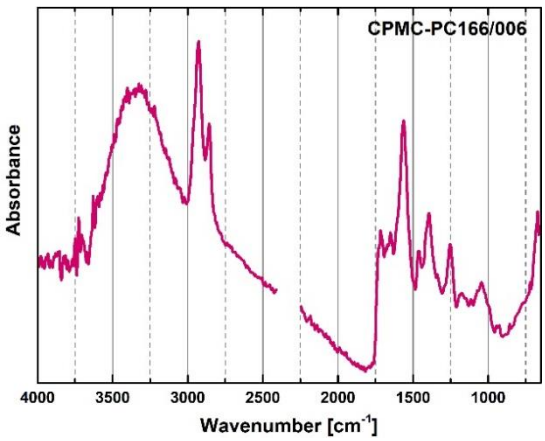
EDXRF



UV-VIS



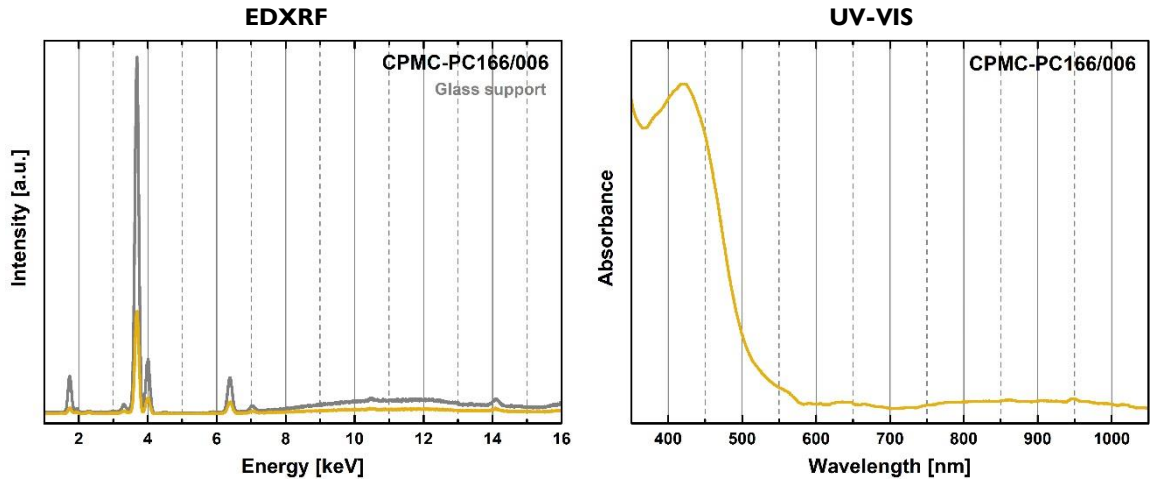
μ-FTIR





Yellow

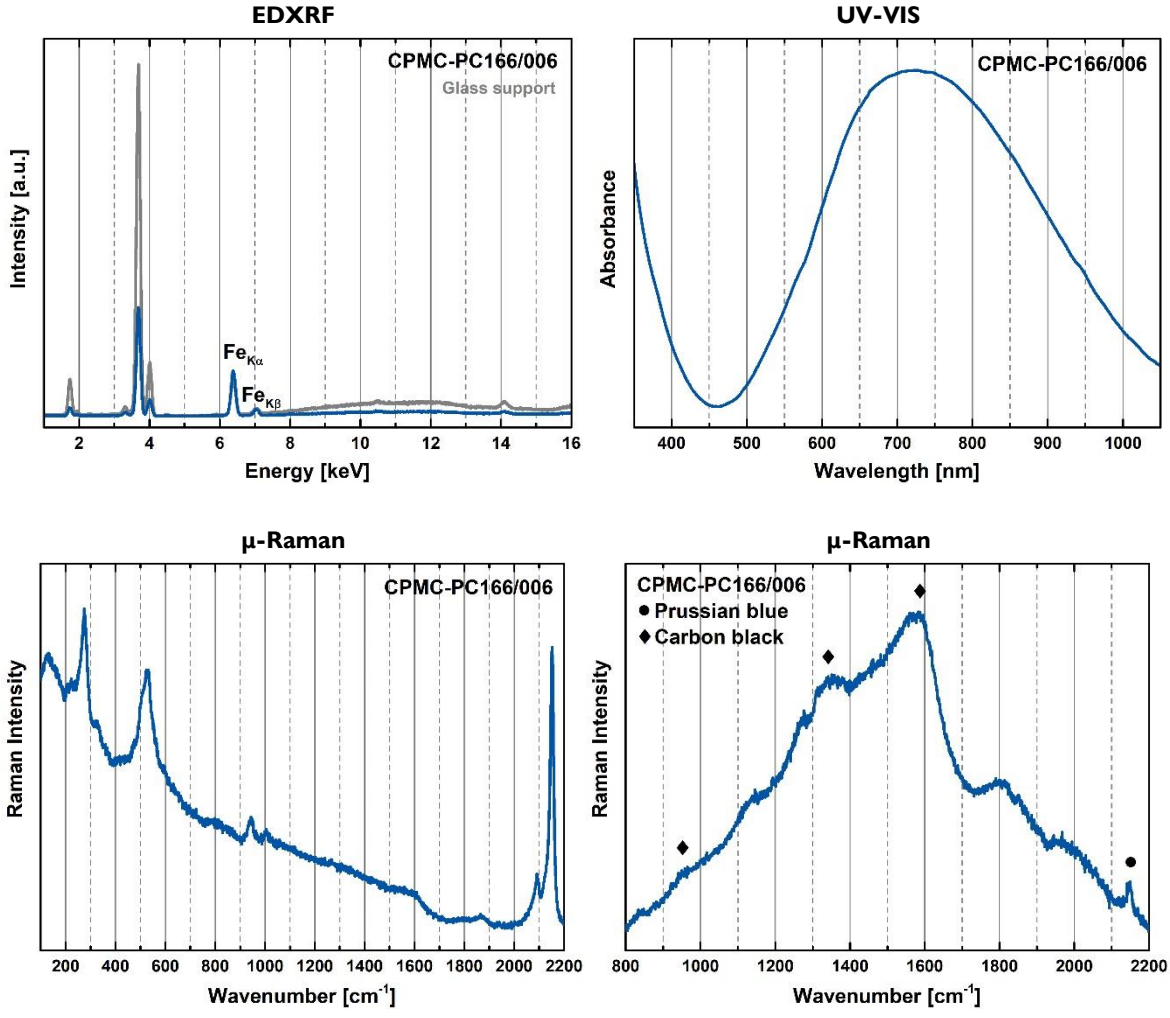
Colourant not identified





Blue

Identified as Prussian blue with carbon black

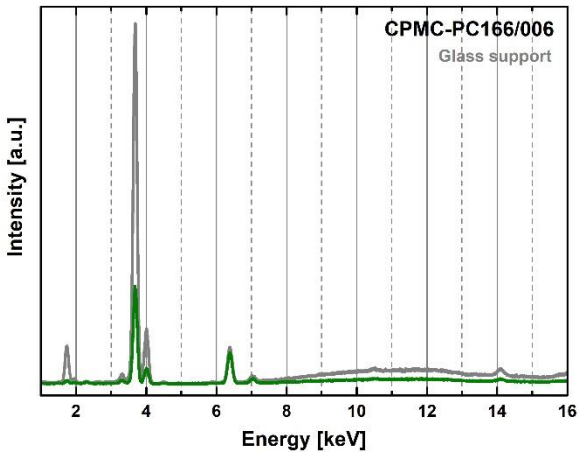




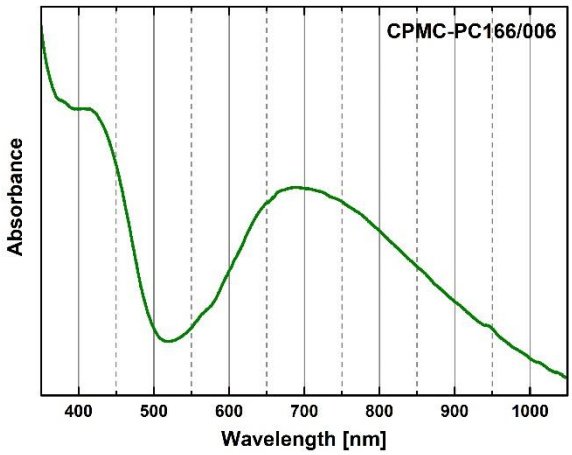
Green

Identified as Prussian blue and possibly yellow

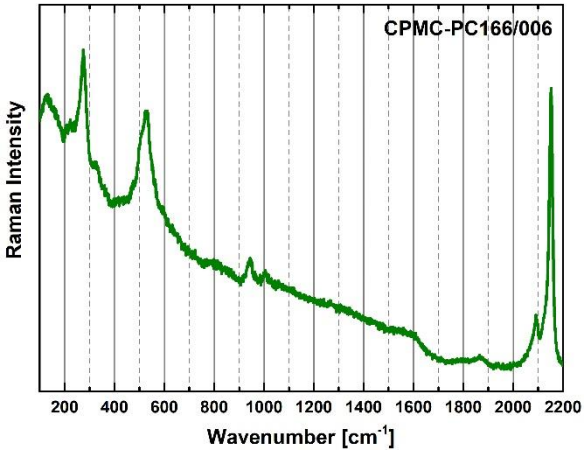
EDXRF



UV-VIS



μ-Raman

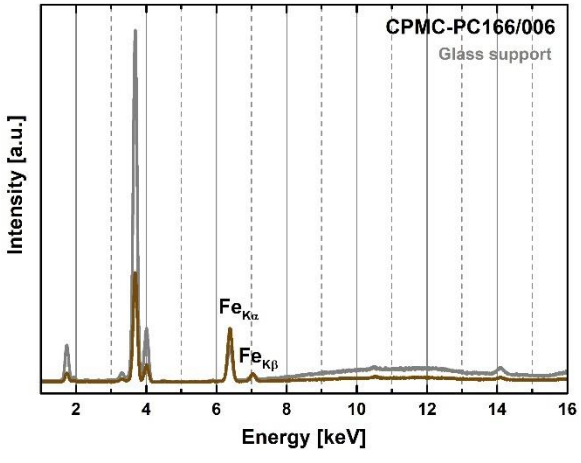




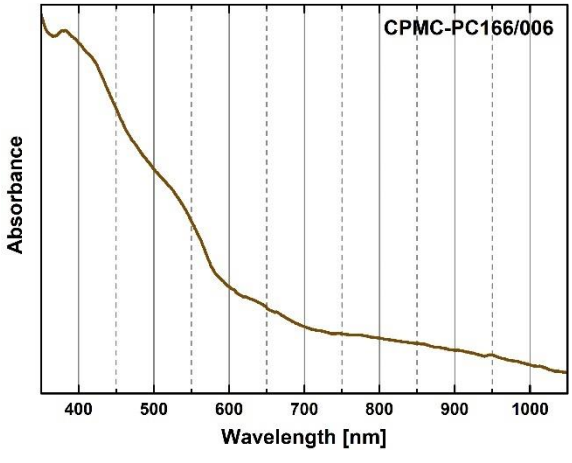
Brown

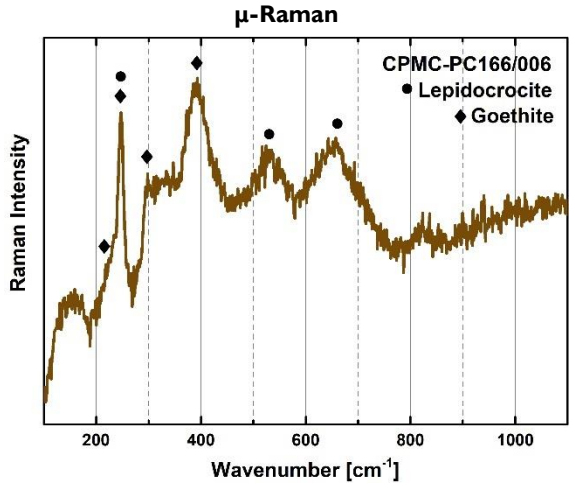
Colourant identified as an ochre

EDXRF



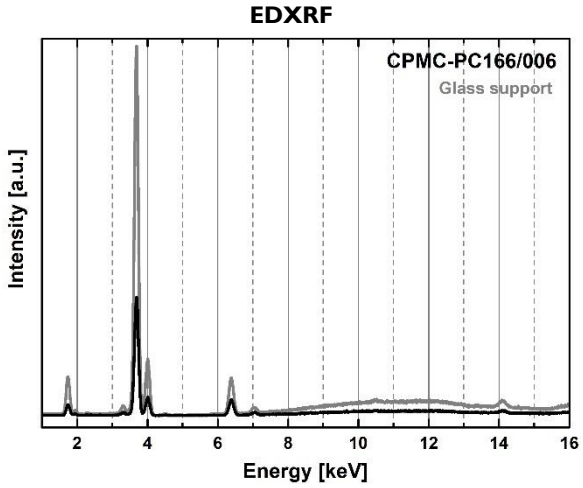
UV-VIS

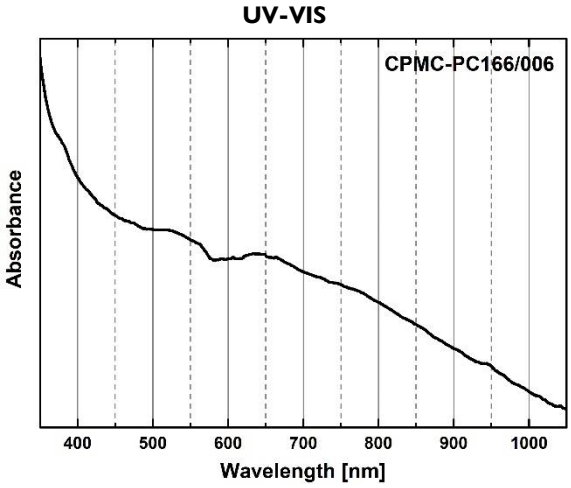


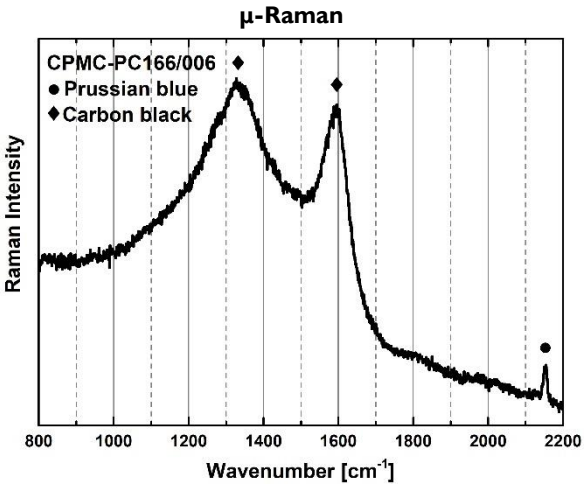


Black

Possibly identified as carbon black and Prussian blue







A.7 Spectral data of reference compounds

X-ray emission energies (EDXRF)

Table A.11 Photon energies in electron volts (keV), of the principal K-, L-, and M-shell emission lines of the elements detected. Data adapted from Kortright & Thompson (2001).

Element		Kα	Kβ	Lα	Lβ	Mα
$_{11}$Na	Sodium	1.041	1.071			
$_{12}$Mg	Magnesium	1.254	1.302			
$_{13}$Al	Aluminium	1.486	1.557			
$_{14}$Si	Silicon	1.740	1.836			
$_{15}$P	Phosphorous	2.014	2.139			
$_{16}$S	Sulfur	2.308	2.464			
$_{17}$Cl	Chlorine	2.622	2.816			
$_{18}$Ar	Argon	2.958	3.191			
$_{19}$K	Potassium	3.314	3.590			
$_{20}$Ca	Calcium	3.692	4.013			
$_{22}$Ti	Titanium	4.511	4.932			
$_{25}$Mn	Manganese	5.899	6.490			
$_{26}$Fe	Iron	6.404	7.058			
$_{28}$Ni	Nickel	7.478	8.265			
$_{29}$Cu	Copper	8.048	8.905			
$_{30}$Zn	Zinc	8.639	9.572			
$_{33}$As	Arsenic	10.544	11.726			
$_{35}$Br	Bromine	11.924	13.291	1.480	1.526	
$_{37}$Rb	Rubidium	13.395	14.961	1.694	1.752	
$_{38}$Sr	Strontium	14.165	15.836	1.807	1.872	
$_{50}$Sn	Tin			3.444	3.663	
$_{56}$Ba	Barium			4.466	4.828	
$_{80}$Hg	Mercury			9.989	11.823	2.195
$_{82}$Pb	Lead			10.552	12.614	2.346

Ultraviolet-Visible (UV-VIS) spectra

Table A.12 Main characteristic UV-VIS bands of reference compounds used to identify magic lantern slide materials.

Colourants	Bands (nm)	Assignment	Reference
Carminic Acid (Cochineal-based pigments) $C_{22}H_{22}O_{13}$	485-490$_{sh}$ 520-525, 550-565	 $n \rightarrow \pi^*$	(Fonseca et al. 2019)
Copper acetate (Verdigris) $Cu(CH_3COO)_2 \cdot Cu(OH)_2$	720		(Kühn 1993; Aceto et al. 2014)
Copper resinate $C_{19}H_{29}COOH$	675-695		(Kühn 1993; Aceto et al. 2014)
Eosin Y $C_{20}H_8Br_4O_5$	380-430$_{w}$ 500$_{sh}$ 540	 $\pi \rightarrow \pi^*$	(Chieli et al. 2020)
Goethite - Yellow ochre α-FeOOH + aluminosilicates	500 660 850-930$_{br}$	$2(^6A_1) \rightarrow 2(^4T_1)$ $^6A_1 \rightarrow {}^4T_2$ $^6A_1 \rightarrow {}^4T_1$	(Torrent and Barrón 2002; Cheilakou, Troullinos, and Koui 2014)
Hematite - Red ochre α-Fe_2O_3 + aluminosilicates	440-450 550 660 860	$^6A_1 \rightarrow {}^4E; {}^4A_1$ $2(^6A_1) \rightarrow 2(^4T_1)$ $^6A_1 \rightarrow {}^4T_2$ $^6A_1 \rightarrow {}^4T_1$	(Torrent and Barrón 2002; Cheilakou, Troullinos, and Koui 2014)
Prussian blue $Fe_4(Fe[CN]_6)_3$	680-720$_{br}$	Charge-transfer Fe^{2+}/Fe^{3+}	(Grandjean, Samain, and Long 2016)
Ultramarine blue $Na_{8-10}Al_6Si_6O_{24}S_{2-4}$	600$_{br}$ 400$_{vw}$	S_3^- S_2^-	(Berns and Imai 2002; Aceto et al. 2013)
Vermilion HgS	600	*Inflection point*	(Aceto et al. 2014)

Note: sh (shoulder), br (broad), w (weak), vw (very weak).

μ-Raman spectra of reference compounds

Table A.13 Main characteristic Raman (and SERS, for Carminic Acid*) bands of reference compounds used to identify magic lantern slides materials. *Identified through surface-enhanced Raman spectroscopy (SERS) technique.

Compounds	Bands (cm^{-1})	Assignment	Reference
Calcium carbonate (Chalk)	283_{w}	*lattice mode*	(Nakamoto 2009)
$CaCO_3$	714_{vw}	$\delta(CO_3^{2-})$	
	1088_{vs}	$\nu(CO_3^{2-})$	
Calcium sulphate dihydrate (Gypsum)	414, 493, 618, 670	$\delta(SO_4^{2-})$	(Chio, Sharma, and Muenow 2004; Prasad et al. 2005)
	1007	$\nu(SO_4^{2-})$	
$CaSO_4 \cdot 2H_2O$	3400, 3500	ν(OH)	
Carbon-based black (Ivory/Bone Black)	965_{vw}	$\nu(PO_4)$	(Tomasini et al. 2012)
	1358	C amorphous (D band)	
$C+Ca_3(PO_4)_2$	1593	C amorphous (G band)	
Carbon-based black (Lamp black), C	1357	C amorphous (D band)	(Tomasini et al. 2012)
	1585	C amorphous (G band)	
Carminic acid* (Cochineal)	461, 694, 801, 1068		(Cañamares et al. 2006; Zhu et al. 2022)
	$1232, 1428_{s}$	δ(CH)	
$C_{22}H_{22}O_{13}$	1297_{vs}, 1300, 1466	δ(C-O-H)	
	$1075, 1137, 1205_{s}$	δ(OH)	
	1619	ν(CC), δ(OH)/δ(CH)	
	1726	(C=O)	
Copper acetate (Verdigris)	1300, 1442, 1598	$\nu(COO^{-})$	(Platania et al. 2020)
$Cu(CH_3COO)_2 \cdot Cu(OH)_2$			
Eosin Y	1468, 1502, 1563, 1620	ν(C=C)	(Beltran et al. 2021)
$C_{20}H_8Br_4O_5$	390, 575, 715, 865, 1288	*xanthene skeletal*	
	620, 700	ν(C-Br)	
Gamboge	1001-1005	ν(C-C)/ν(CO)	(Vandenabeele et al. 2000; Chaban et al. 2021)
	1248	ν(C-C)	
	1330, 1436	$\delta(CH_2)$	
	1590-1601	ν(CHH)	
	1630	ν(C=C)	
	1740	ν(C=O)	
Goethite - Yellow ochre	227, 245	δ(Fe-O)	(Bikiaris et al. 1999; Legodi and de Waal 2007)
α-FeOOH + aluminosilicates	299	δ(Fe-OH)	
	389, 415, 477, 550,	ν(Fe-OH)	
	674	ν(Fe-O)	
Hematite - Red ochre	223, 240, 289, 403	δ(Fe-O)	(Legodi and de Waal 2007; Montagner et al. 2013)
α-Fe_2O_3 + aluminosilicates	495, 606	ν(Fe-O)	
Lepidocrocite - Brown ochre	245	δ(Fe-O)	(Bikiaris et al. 1999; Legodi and de Waal 2007; Das and Hendry 2011)
γ-FeOOH + aluminosilicates	284	δ(Fe-OH)	
	345, 374, 493_{sh}, 524	ν(Fe-OH)	
	650_{sh}	ν(Fe-O)	
Quartz	207, 265	(SiO)	(Montagner et al. 2013)
SiO_2	465	(Si-O-Si)	
Prussian blue	235_{sh}, 276, 327	δ(Fe-CN-Fe)	(Moretti and Gervais 2018)
$Fe_4(Fe[CN]_6)_3$	600, 535	ν(Fe-C)	
	2096, 2159	ν(C≡N)	
	2130	$\nu(CN^{-})$	
Ultramarine blue	255	$\delta(S_3^{-})$	(Rosi et al. 2004; l. Osticioli et al. 2009)
$Na_{8\text{-}10}Al_6Si_6O_{24}S_{2\text{-}4}$	548, 805, 1093	$\nu(S^{3-})$	
	584	$\nu(S^{3-}$ and $S^{2-})$	
Vermilion	254, 287	δ(S-Hg-S)	(Frost, Martens, and Kloprogge 2002)
HgS	344	ν(Hg-S)	

Note: vs (very strong), s (strong), w (weak), vw (very weak), sh (shoulder), br (broad), ν (stretching), δ (bending).

Infrared (μ-FTIR) Spectra of reference compounds

Table A.14 Main characteristic Infrared bands of reference compounds used to identify magic lantern slide materials.

Compounds	Bands (cm^{-1})	Assignment	Reference
Atacamite $Cu_2(OH)_3Cl$	3340, 3347 800-1000	ν(OH) δ(OH)	(Buse, Otero, and Melo 2019)
Calcium carbonate (Chalk) $CaCO_3$	1422 875 712	$\nu_{as}(CO_3^{2-})$ δ (O-C-O) $\delta_{as}(CO_3^{2-})$	(Derrick, Stulik, and Landry 1999)
Calcium sulphate dihydrate (Gypsum) $CaSO_4 \cdot 2H_2O$	3547, 3495, 3405 1685, 1621 1145_{vs}, 1117_{vs}, 1105_{vw} 669_{s}, 602	ν(OH) $\delta(H_2O)$ $\nu_{as}(SO_4^{2-})$ $\delta_{as}(SO_4^{2-})$	(Prasad et al. 2005; Montagner et al. 2013)
Carminic Acid (Cochineal) $C_{22}H_{22}O_{13}$	3423_{vs} 2917_{vw} 1716_{m}, 1617_{s} 1572_{vs} 1448_{vs} 1376_{s}, 1339_{s} 1083_{s} 1285_{sh}, 1255_{vs}, 1045_{s} 983_{w} 820_{w}, 768_{w}	ν(OH) $\nu(CH_3)$/ν(CH) ν(C=O) ν(CC)/δ(COH)/δ(CH) $\delta(CH_2)$ δ(CH)/δ(COH) ν(CO)/δ(COH) ν(CC)/ δ(COH) δ(CCC) γ(COH)	(Cañamares et al. 2006)
Copper acetate (Verdigris) $Cu(CH_3COO)_2 \cdot Cu(OH)_2$	3500-3400, 3367, 3272 2988, 2941 1602, 1560-95, 1421_{sh} 1445, 1048 1022-32, 673-86, 626	ν(OH) ν(CH) $\nu(COO^-)$ δ_{as}(CH)	(Silva et al. 2006; Buse, Otero, and Melo 2019; Platania et al. 2020; Paz, Rodriguez-Simón, and Manzano 2023)
Copper oxalates $CuC_2O_4 \cdot nH_2O$	1680, 1650 1362, 1320 820	$\nu_{as}(COO^-)$ $\nu_{s}(COO^-)$ δ(OCO)	(Salvadó et al. 2009; Monico et al. 2013; Buse, Otero, and Melo 2019)
Copper resinate $C_{19}H_{29}COOH$	3429-3396 2927-31, 2856-70 1694-1712, 1600-10 1460, 1380, 1230, 1166	ν(OH) ν(COOH) ν(C=O)	(Paz, Rodriguez-Simón, and Manzano 2023)
Eosin Y $C_{20}H_8Br_4O_5$	3431 1610, 1600, 1555, 1505, 1460 1753, 1624, 1212 1455, 1350 1240 885, 711 716	ν(OH) ν(C=C) ν(C=O) ν(C-O) ν(C-O-C) *skeletal* ν(C-Br)	(Sabatini et al. 2020; Beltran et al. 2021)
Gambogic Acid (Gamboge) $C_{38}H_{44}O_8$	3376 2927 1739, 1691, 1633, 1594 1456 1436, 1333 1260, 1138, 1046, 1020	ν(OH) ν(CH) ν(C=O) *skeletal*, δ(CH) δ(CH) ν(C-O)	(Chen, Zhou, and Sun 2016)
Goethite - Yellow ochre α-FeOOH + aluminosilicates	3129, 913, 800 894, 790, 623, 662, 547, 418	ν(OH)	(Montagner et al. 2013)

Ivory/Bone black $C+Ca_3(PO_4)_2$	2013 1087, 1038 962, 875 630, 604, 567 469	 $\nu_{as}(PO_4)^{3-}$ $\nu_s(PO_4)^{3-}$ $\delta_{as}(PO_4)^{3-}$ $\delta_s(PO_4)^{3-}$	(Derrick, Stulik, and Landry 1999; Daveri, Malagodi, and Vagnini 2018)
Kaolin $Al_2Si_2O_5(OH)_4$	3695, 3622 1117, 1040, 1011 935, 914	ν(OH) ν_{as}(Si-O-Si) (Si-O-Al) (Al-O-H)	(Montagner et al. 2013)
Linseed oil	3009, 2960_{sh}, 2927, 2856 1745 1654 1466, 1418, 1378 1238, 1164 1100 723	ν(CH) ν(C=O) ν(C=C) δ(CH) ν(C-O) ν(O-CH_2-C) γ(CH_2)+ ω(CH)=CH	(Ciofini et al. 2016)
Mastic resin	3440-3400 2950, 2870 2600_{sh} 1700-20 1649 1450-57, 1385 1235-1245 1180	ν(OH) ν(CH) ν(C=O) ν(C=C) δ(CH) ν(CC); ω, τ(CH); ν(COO) ω, τ(CH); ν(COO)	(Ciofini et al. 2016)
Prussian blue $Fe_4(Fe[CN]_6)_3$	2085_{vs}	ν(C≡N)	(Kahrim et al. 2009)
Quartz SiO_2	1117, 1164 799 782, 695	ν(Si-O-Si) ν(Si-O) δ(Si-O)	(Montagner et al. 2013)
Shellac resin	3440 2930, 2857 1715-22, 1730-40 1635, 1255 1464, 1380-1375 1415 1250,1163, 1140 1050, 1035, 1006 945, 927 723	ν(OH) ν(CH_2) ν(C=O) ν(C=C) δ(CH) δ(OH) ν(C-O-H) ν(C-O) / ν(CC) ω, τ(CH) / δ(OH) ω(CH_2)	(Ciofini et al. 2016; Chaban et al. 2021)
Ultramarine blue $Na_{8-10}Al_6Si_6O_{24}S_{2-4}$	1110-1088, 1016-1010 1093, 805 696 548	ν_{as}(Si-O-Si) ν(S^{3-}) δ(Si-O) ν(S^{3-}-S^{2-})	(Bruni et al. 1999; Derrick, Stulik, and Landry 1999)

Notes: δ (bending), γ (out of plane bending), ν (stretching), ω (rocking), τ (twisting), as (asymmetric), vs (very strong), s (strong), sh (shoulder).

A.8 Reconstruction of printed outlines using the copper-plate printing technique

The first reconstruction of part of a magic lantern slide was produced in 2019 in partnership with Ana Margarida Rocha (Faculty of Fine Arts - University of Porto (FBAUP) and VICARTE research unit) to test if the results were visually similar to those observed in magic lantern slides produced during the 19th century. An illustrated summary of the process can be found in **Figure A.52**.

According to the literature, in 1823, Philip Carpenter adapted a transfer printing process and started producing the first slides with printed outlines using the copper-plate technique, revolutionising the industry of magic lantern slides. The information gathered about this process, described in *Subsection 1.2.2*, was used to reconstruct a portion of slide CPMC-PC165/006 (by Lapierre), adapting to the materials and equipment available.

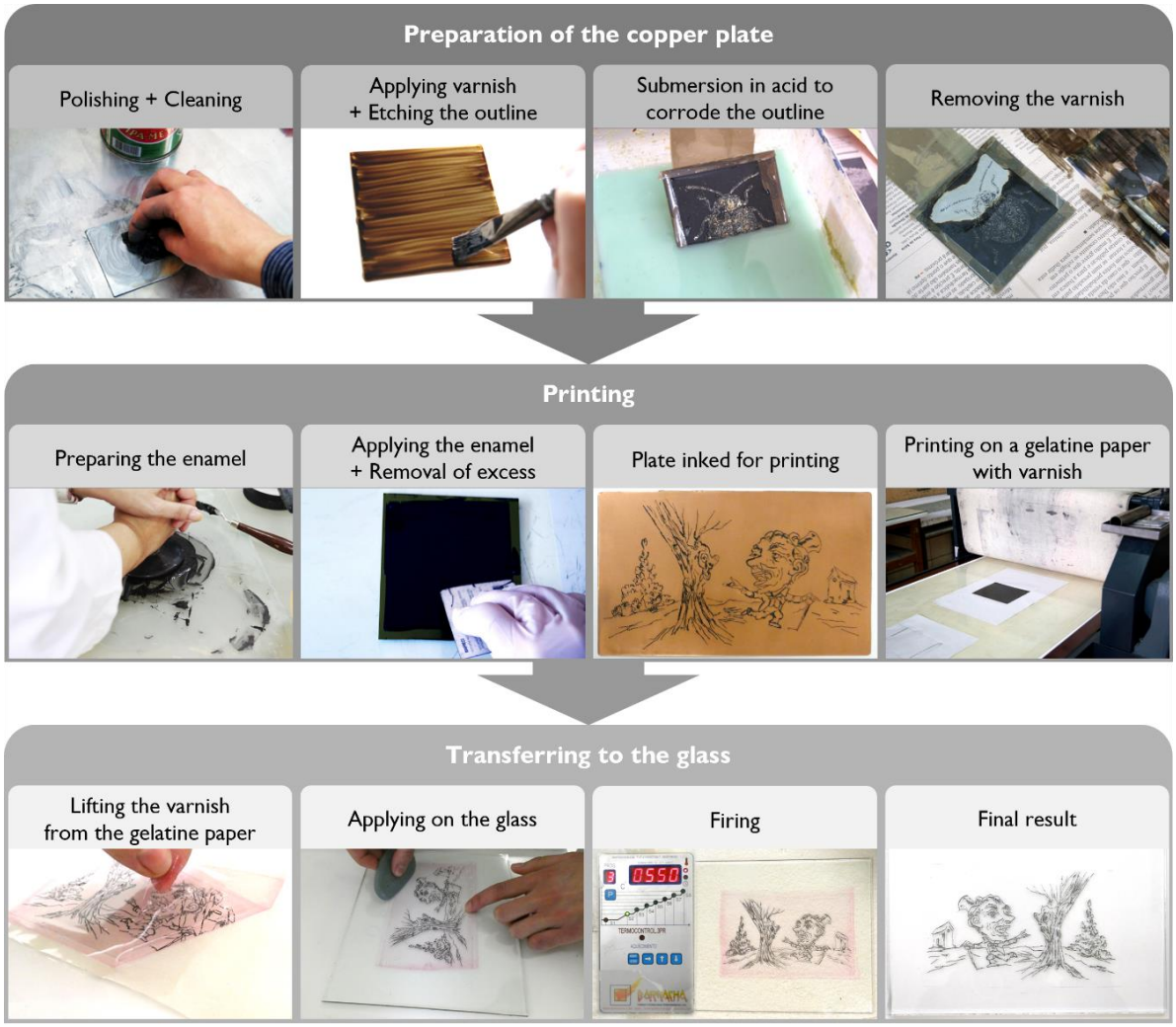


Figure A.52 Summary of the process of copper-plate printing on glass from preparing the copper plate to the final result. Several figures do not show the etching made for this reconstruction and are presented solely to illustrate the process. Ana Margarida Rocha executed and photographed the first two parts of this process. The third part was performed and photographed by the author.

The process started with the preparation of the copper plate. The flat metal plate was polished and cleaned to remove any grease from the surface. Then, the plate was protected with a varnish (in this case, the liquid etching ground varnish Charbonnel Lamour Black Satin Ground was used) and the outline was etched so that when submerging the plate in acid only the etched lines would corrode and leave an imprint of the drawing in the plate. To process the etching, the verse of the plate was protected with adhesive tape, and the plate was submerged for 30 minutes in an acidic solution prepared with copper sulphate, sodium chloride and water (500 g : 500 g : 5 l). After the cleaning the acid to stop the reaction, the protective varnish was removed with white spirit.

The second part of the process was printing the design onto a varnish layer. For this part, a black enamel paint was prepared with around 80 % pigment (Hans Barnstorf black enamel F4044) and 20 % oil medium (Charbonnel etching oil). The copper plate was then inked with this black enamel using a spatula and wiped so that the ink stayed only in the etched lines. On the calcographic press, the plate was placed on top of a sheet of gelatine paper previously prepared with a layer of varnish in the printing area (the varnish was tinted with a pink colourant for better observation of its placement), and the copper plate was then gently pressed onto the sheet with varnish, which lifted the paint from the plate.

The third and last part of the process consisted in transferring the outline to the glass sheet. To lift the varnish layer that contained the printed outline, the gelatine paper was submerged in water for a few minutes until the gelatine was dissolved to release it from the paper support. The outline could then be placed on top of a glass sheet in the desired position, which could be adjusted until the water between the varnish and the glass was removed. After its placement, the water and air bubbles between the varnish layer and the glass were removed to allow its adhesion to the surface. Finally, the glass was fired at a low temperature (550 ºC for 20 minutes, with a heating rate of 2 ºC/min), carbonising the organic varnish and permanently securing the enamel outline to the glass.

When comparing the result with slides by Carpenter & Westley (C&W) and by Lapierre, it was visibly more similar to C&W slides (**Figure A.53**). Additionally, according to the analyses preformed to these historical slides' outlines, C&W revealed to be possibly enamels while Lapierre contained carbon black and Prussian blue, detected with Raman spectroscopy.

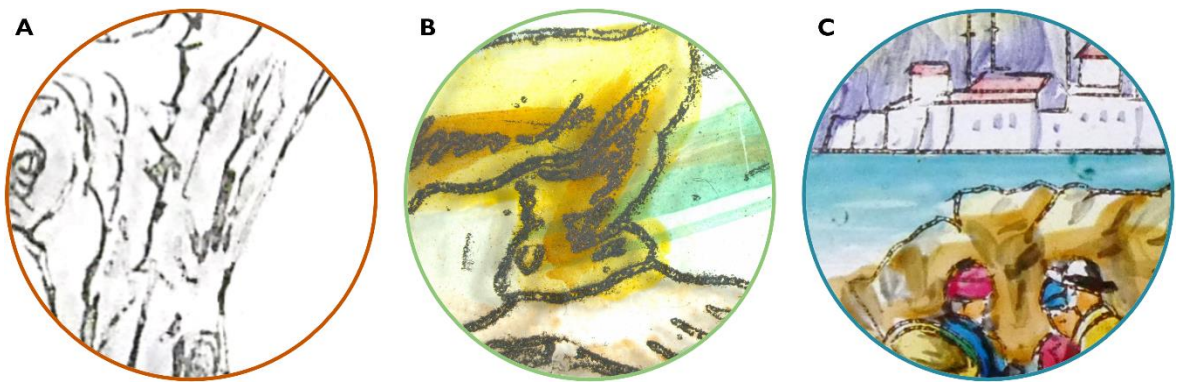


Figure A.53 Details of printed outlines from: (A) reconstruction using copper-plate printing technique; (B) original slide from Lapierre (CPMC-PC165/007); (C) original slide from Carpenter & Westley (CPMC-PC189/009).

The complete outline of an entire slide was later reconstructed by Ana Margarida Rocha, from VICARTE Research Unit and the Faculty of Fine Arts - University of Porto (FBAUP), using the same method, within the framework of the project MAGICA and Margarida Gomes' Master dissertation entitled "Produção de Réplica de Diapositivos de Vidro para Espetáculos de Lanterna Mágica" (2022) (**Figure A.54**).

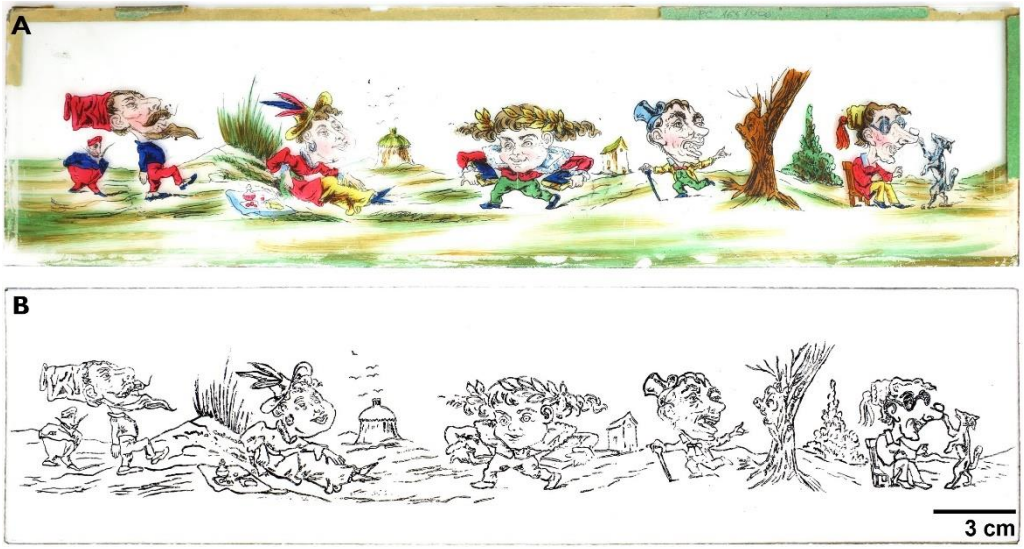


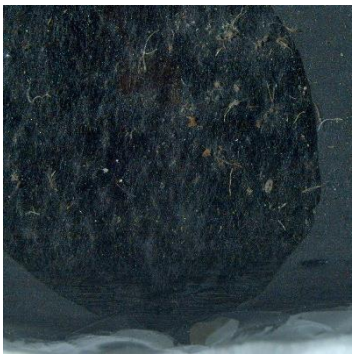
Figure A.54 Comparison between (A) the original lantern slide produced in ca.1874-1900 by Lapierre (CPMC-PC165/006) and (B) the reconstruction by Ana Margarida Rocha (VICARTE & FBAUP). © Photography (A) by the author and (B) by Margarida Gomes (2022).

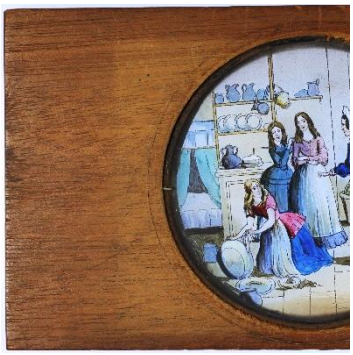
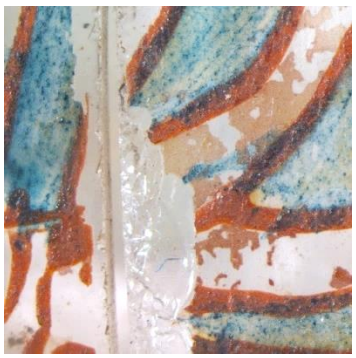
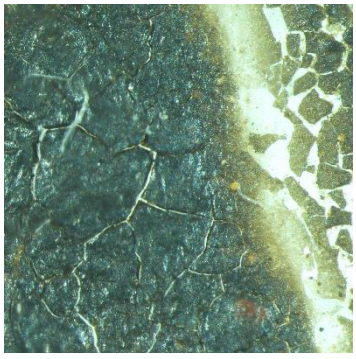
A.9 Conservation

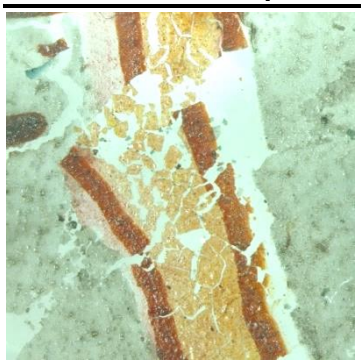
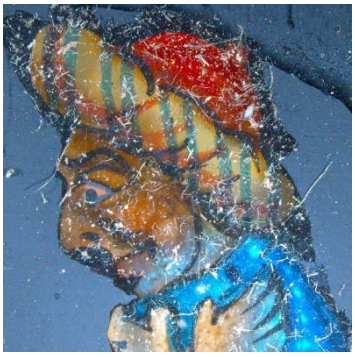
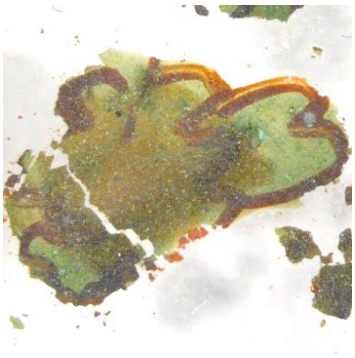
A.9.1 Illustrated glossary of damages (EN/PT)

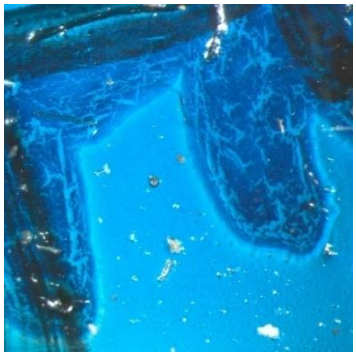
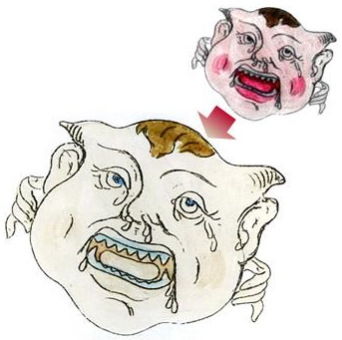
This glossary was developed by following the nomenclature widely used by heritage professionals to describe damages found on glass, painting, wood, paper, and metal, and were adapted to painted magic lantern slides (Canadian Conservation Institute 2017a; The Fine Arts Conservancy 2022; American Institute for Conservation (AIC) 2024). The damages presented are those identified by the author on studied magic lantern slides (entirely painted and coloured on printed outlines), and the possible existence of other damages should not be discarded. All the images illustrating the different types of damage are photographs of magic lantern slides captured with a digital camera or through the stereomicroscope setup. Photographs of slides from CPMC (inv. CPMC-PC#) and VICARTE (inv. FCT.V.LM#) are by the author, and the one from MUHNAC (inv. MUL-MUHNAC-UL#) is by Beatriz Rodrigues.

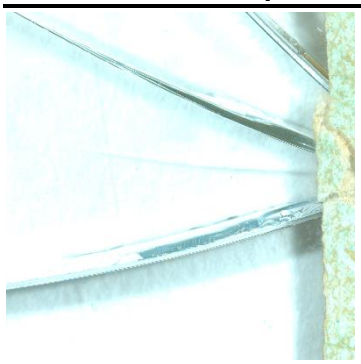
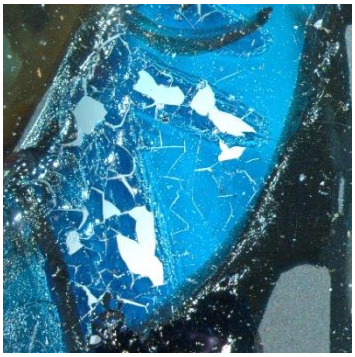
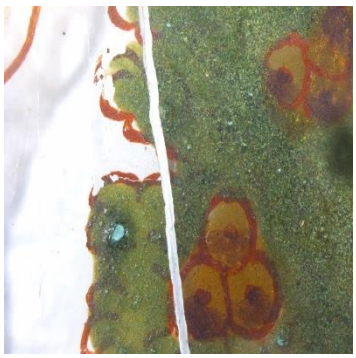
Table A.15 Illustrated glossary of damages identified on painted magic lantern slides held by the CPMC, MUHNAC and VICARTE. Note: Below the description are specified the slides' materials that can be affected by each damage.

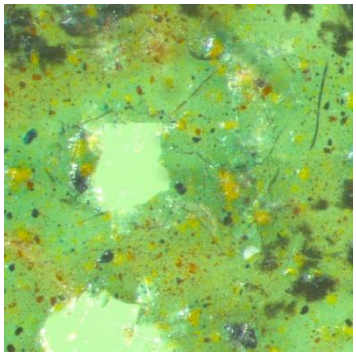
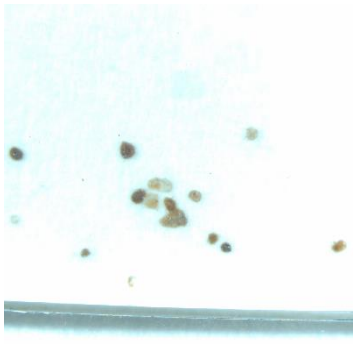
Illustrative Example	Damage	Description	Image Details
	**Abrasion** *Abrasão*	Damage to any material caused by friction, rubbing or over-cleaning with an abrasive product. *Danos em qualquer material causados por fricção, desgaste ou limpeza excessiva com um produto abrasivo.* (all materials)	CPMC-PC0166/006
	**Accretion** *Depósito*	An accumulation of foreign matter attached to the surface of the material that alters its original aesthetic, e.g., dirt, dust, mould, insect detritus, etc. *Acumulação de resíduos externos na superfície de qualquer material que alteram a sua estética original, por exemplo, sujidade, pó, bolor, detritos de insetos, etc.* (all materials)	FCT.V.LM03 Stereomicroscope (10x magnification)
	**Adhesive ageing** *Envelhecimento do adesivo*	Ageing signals of the adhesive applied to the paper handles or frames, such as yellowing, brittleness, cracks, and loss of adhesion, are caused over time by environmental or mechanical stresses. *Sinais de envelhecimento do adesivo aplicado às pegas ou molduras de papel, tal como amarelecimento, fragilidade, fissuras e perda de aderência, causados ao longo do tempo por tensões ambientais ou mecânicas.* (adhesive paper)	FCT.V.LM03 Stereomicroscope (10x magnification)

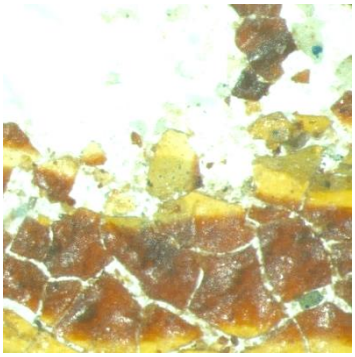
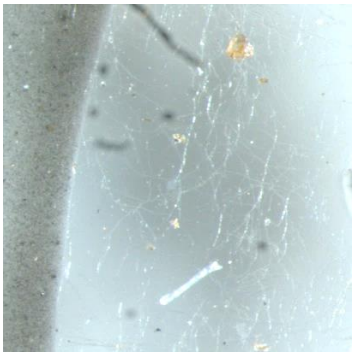
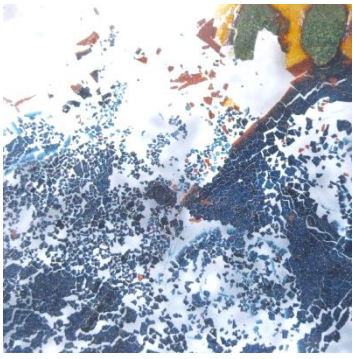
Illustrative Example	Damage	Description	Image Details
	**Adhesive tape** *Fita adesiva*	The adhesive of common tapes can contain acidic components that can irreversibly damage the materials to which their applied. Removing is sometimes impossible and may rip of original material. *Os adesivos das fitas comuns podem conter componentes ácidos que podem danificar irreversivelmente os materiais. A sua remoção é por vezes impossível e pode arrancar material original.* (all materials)	CPMC-PC3300/002
	**Bleaching** *Branqueamento*	Type of discolouration by bleaching of organic materials induced by the ultra-violet portion of the light spectrum, present mainly in natural and fluorescent light. *Tipo de descoloração por branqueamento dos materiais orgânicos induzido pela parte ultravioleta do espetro luminoso, presente principalmente na luz natural e fluorescente.* (wood | paper)	CPMC-PC188/001
	**Chip** *Esbeiçadela*	A small amount of material that breaks away accidentally as a result of mechanical action. Chips of glass and paint are commonly found across the glass fracture lines. *Uma pequena quantidade de material que se parte acidentalmente resultante de uma ação mecânica. As esbeiçadelas no vidro e tinta são comuns ao longo das linhas de fratura do vidro.* (glass | paint | wood)	CPMC-PC3300/002 Stereomicroscope (10x magnification)
	**Corrosion** *Corrosão*	Degradation of material from a chemical or electrolytic reaction generally applied to metal degradation (e.g., rust or copper corrosion). *Degradação de um material devido a uma reação química ou eletrolítica, geralmente aplicada à degradação de metais (por exemplo, ferrugem ou corrosão do cobre).* (metal | metal-based pigments)	CPMC-PC0001/011
	**Craquelure** *Craquelê*	Network of cracks/fissures that usually result from the embrittlement of paint due to age or mechanical stress of paints and varnishes. In the glass matrix, it is designated by crizzling. *Rede de fissuras que geralmente resulta da fragilização da tinta por envelhecimento ou esforço mecânico das tintas e vernizes. Quando na matriz do vidro, é designada por crizzling.* (paint | wood)	CPMC-PC0001/002 Stereomicroscope (25x magnification)

Illustrative Example	Damage	Description	Image Details
	**Deformation** *Deformação*	Change or alteration of the original shape of the painting or sections of the painting. It can occur due to environmental factors (e.g., light humidity, and temperature) or added materials. *Mudança ou alteração da forma original da pintura ou pequenas secções da mesma. Pode ocorrer devido a fatores ambientais (ex., luz, humidade e temperatura) ou materiais externos.* (paint)	CPMC-PC002/004 Stereomicroscope (25x magnification)
	**Delamination** *Delaminação*	Separation of the layers in an object or material composed of multiple layers is often due to the failure of an adhesive or binder from incorrect environmental conditions. *Separação das camadas de um objeto ou material composto por várias camadas, por vezes devido à falha de um adesivo ou ligante provocada por condições ambientais adversas.* (paint)	CPMC-PC0446
	**Dent** *Indentação*	A concave indentation or deformation on a surface caused by collision or pressure from another object. *Uma indentação côncava ou deformação numa superfície causada por colisão ou pressão de outro objeto.* (wood)	CPMC-PC0188/005
	**Dirt / Grime** *Sujidade*	Accumulated dust, grease, smoke and particulate matter through moisture or transfer during inappropriate handling (see accretion). It can become embedded and difficult or impossible to remove. *Acumulação de pó, gordura, fumos e partículas devido à humidade ou transferidas durante um manuseamento incorreto (ver depósito). Pode ficar incrustado e ser difícil ou impossível de remover.* (all materials)	MUL-MUHNAC-UL000067 Stereomicroscope (7.1x magnification)
	**Discolouration** *Descoloração*	Change in the colour of a material, often uneven, due to exposure to chemicals, light, or ageing. Fading, yellowing, staining, darkening, and bleaching are used to further refine this damage. *Alteração da cor de um material, geralmente irregular, devido à exposição a produtos químicos, luz ou envelhecimento. Desvanecer, amarelecer, manchar, escurecer e branquear são termos que refinam ainda mais estes danos.* (paint | wood | paper)	CPMC-PC0001/005 Stereomicroscope (10x magnification)

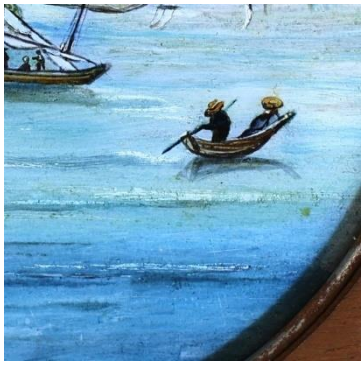
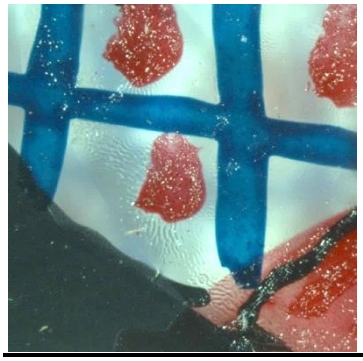
Illustrative Example	Damage	Description	Image Details
	**Distortion** *Distorção*	Change in the original shape of the wood due to concave or convex distortion parallel to the tree-stem axis. *Alteração da forma original da madeira devido a uma distorção côncava ou convexa paralela ao eixo do tronco da árvore.* (wood)	CPMC-PC0001/008
	**Drying cracks** *Craquelê de secagem*	Cracks occurring during the drying stage, usually wide and curved, with sloping edges and no cleavage, exposing paint layers below. *Fissuras que se formam durante a secagem, em geral largas e curvas, de bordos inclinados e sem clivagem, expondo camadas de tinta por baixo.* (paint)	CPMC-PC3302/019 Stereomicroscope (63x magnification)
	**Dust** *Poeiras*	Loose fine particles on the surface. *Partículas finas soltas na superfície.* (all materials)	FCT.V.LM03
	**Fading** *Desvanecimento*	Colours' loss of brightness and brilliance or diminishing of colour and tones, generally resulting from exposure to light, chemicals, pollutants or changes in pH. *Perda de vivacidade e brilho das cores ou diminuição da cor e tons, geralmente resultante da exposição à luz, químicos, poluentes ou alterações de pH.* (paint – pigments and dyes)	CPMC-PC020/007
	**Edge damage** *Dano na margem*	Damages in and confined to the edge of a sheet of paper, usually small tears or bends. *Danos na margem de uma folha de papel, geralmente pequenos rasgões ou dobras.* (paper)	FCT.V.LM02

Illustrative Example	Damage	Description	Image Details
	**Fissure** *Fissura*	Line of separation that still does not entirely section the material in fragments, visible by the naked eye or microscope (micro-fissure). *Linha de separação que ainda não divide completamente o material em fragmentos e que é visível a olho nu ou ao microscópio (microfissura).* (glass)	CPMC-PC0033/001 Stereomicroscope (10x magnification)
	**Flacking** *Descamação*	Detaching of pigment and binder clusters from the support occurring when a binder loses its adhesion and cohesion properties or has undergone physical stress. *Destacamento de porções de pigmento e aglutinante do suporte, que ocorre quando um ligante perde as suas propriedades adesão e coesão ou é submetido a uma tensão física.* (paint)	CPMC-PC3302/019 Stereomicroscope (25x magnification)
	**Fracture / Crack** *Fratura / Quebra*	A failure of materials resulting in cracks, crossing, and separating the material, caused by stress due to physical forces or incorrect environmental conditions. *Colapso de materiais que resulta em quebras, atravessando e separando o material, causada por tensões devido a forças físicas ou condições ambientais incorretas.* (glass | paint | wood)	CPMC-PC0001/011 Stereomicroscope (10x magnification)
	**Frame abrasion** *Abrasão por moldura*	Abrasion caused by the frame touching the painted surface, which can result in the paint detaching from the support and flacking. *Abrasão causada pelo contacto da moldura com a superfície pintada, o que pode provocar o destacamento da tinta do suporte e a sua deslocação.* (paint)	CPMC-PC3301/001
	**Frass** *Serrim*	A crumbly, sawdust-like chewed wood dropped by feeding animals or insects; generally associated with flight holes (see *insect damage*). *Madeira esfarelada, semelhante a serrim, mastigada por animais ou insetos que se alimentam; geralmente associada a buracos de saída (ver danos por inseto).* (wood)	CPMC-PC0209/002

Illustrative Example	Damage	Description	Image Details
	**Impact crackle** *Quebra por impacto*	Cracks in radiating circles or converging in an area of impact caused by a blow. *Fissuras em círculos radiantes ou convergentes numa zona de impacto provocada por uma pancada.* (paint | glass)	CPMC-PC0032/003 Stereomicroscope (100x magnification)
	**Insect damage** *Dano por inseto*	Physical damage caused destructive contact with insects. Signs may include tunnels, holes and insect detritus (see frass and infestation). *Muitas espécies de insetos alimentam-se de materiais orgânicos, causando danos. Os sinais podem incluir túneis, buracos e detritos de insetos (ver serrim e infestação).* (wood | paper)	CPMC-PC0209/002
	**Infestation** *Infestação*	An overrun and invasion, generally associated with insects, bacteria, or other micro-organisms such as mould. (all materials)	CPMC-PC0001/011
	**Flyspecks** *Dejetos de mosca*	Accretion of faeces by insects, often found as clusters of small circles. The matter is very acidic, and the damage caused by staining and deterioration can be irreversible. *Acumulação de fezes de insetos, muitas vezes na forma de grupos de pequenos círculos. A matéria é muito ácida e os danos causados pelas manchas e deterioração podem ser irreversíveis.* (all materials)	CPMC-PC0033/001 Stereomicroscope (10x magnification)
	**Insect detritus** *Detritos de inseto*	Debris and other waste left by insects, such as frass or other feeding remains, faecal matter (e.g., flyspecks), and insect remains. *Detritos e outros resíduos deixados por insetos, tais como restos de comida, excrementos (ex. dejetos de mosca), e cadáveres de insetos.* (all materials)	FCT.V.LM03 Stereomicroscope (100x magnification)

Illustrative Example	Damage	Description	Image Details
	**Lacuna / Loss** *Lacuna / Perda*	Part of material that is physically detached and missing, resulting in an empty space due to, e.g., fractures, flacking, abrasion, scratches etc. *Parte do material que está fisicamente destacada e em falta, resultando num espaço vazio devido a, por exemplo, fraturas, destacamento, abrasão, riscos, etc.* (all materials)	CPMC-PC0001/011
	**Loose / Detached paint** *Tinta destacada*	Areas of the paint layer that have lost adhesion and that, although still in place, are no longer firmly attached to the support. *Áreas da camada de tinta que perderam a adesão e que, apesar de se manterem no lugar, já não estão devidamente fixas ao suporte.* (paint)	CPMC-PC0001/001 Stereomicroscope (100x magnification)
	**Mould / Fungi** *Bolor / Fungos*	Fungi growth that invades organic materials in the presence of sufficient moisture, producing enzymes that degrade the host material; not easily detectable until mature. *Crescimento de fungos que invadem materiais na presença de humidade suficiente, produzindo enzimas que degradam o material hospedeiro; dificilmente detetável até estar desenvolvido.* (paint | wood | organic accretions on all materials)	FCT.V.LM03 Stereomicroscope (80x magnification)
	**Poor repainting** *Repintura indevida*	Repainting resulting from a poor repair by unskilled hands. *Repintura resultante de uma má reparação efetuada por mãos não qualificadas.* (paint)	CPMC-PC0001/008
	**Powdering** *Pulverização*	The condition of a material that can be easily reduced to a powder, e.g., pigment grains loosen in powder form due to damage in the paint's binder. *O estado de um material que pode ser facilmente reduzido a pó, por exemplo, grãos de pigmento soltos em forma de pó devido a danos no ligante da tinta.* (paint)	CPMC-PC0001/010 Stereomicroscope (10x magnification)

Illustrative Example	Damage	Description	Image Details
	**Printed outline failure** *Falha do contorno impresso*	Loss of printed outline and paint surrounding the outlined areas detached from the glass support, possibly due to the ageing of the printed paint or the materials' incompatibility. *Perda do contorno impresso e da tinta que envolve as áreas contornadas destacadas do suporte de vidro, possivelmente devido ao envelhecimento da tinta impressa ou à incompatibilidade dos materiais.* (paint)	CPMC-PC0209/007
	**Scratch** *Risco*	Physical surface damage, generally narrow and sharp-edged, that often involves material loss. *Danos físicos superficiais, geralmente estreitos e com arestas vivas, que envolvem frequentemente a perda de material.* (paint)	CPMC-PC3302/007 Stereomicroscope (63x magnification)
	**Split** *Rachadura*	A continuous break in the wood along the grain, caused by the contraction of a restraint material. Splits usually have the soft-edged appearance of a tear. *Rutura contínua na madeira ao longo do veio, causada pela contração de um material restrito. As rachaduras têm geralmente o aspeto suave de um rasgão.* (wood)	CPMC-PC0209/011
	**Stain** *Mancha*	A soiled or discoloured appearance caused by a foreign substance or uneven ageing. *Aspeto sujo ou manchado causado por uma substância estranha ou por um envelhecimento irregular.* (all materials)	CPMC-PC166/006
	**Tear** *Rasgão*	Physical damage which results in a linear or branched separation of the material into partially or entirely separate pieces, leaving irregular and soft fibrous edges. *Danos físicos que resultam numa separação linear ou ramificada do material em partes separadas parcial ou totalmente, deixando bordos fibrosos irregulares e macios.* (paper)	CPMC-PC0032/003

Illustrative Example	Damage	Description	Image Details
	**Tenting** *Levantamento*	Upward lifting of the paint layer, which has cracked into a pattern resembling the peaked tops of tents. *Levantamento ascendente da camada de tinta, que se fissurou num padrão que se assemelha a topos de tendas.* (paint)	CPMC-PC3302/019 Stereomicroscope (10x magnification)
	**Varnish ageing** *Envelhecimento do verniz*	Natural resin varnishes first turn golden in hue and then progressively darker with age, distorting the artist's original colours. *Os vernizes de resinas naturais começam por ter uma tonalidade dourada e escurecem progressivamente com a idade, distorcendo as cores originais do artista.* (paint)	FCT.V.LM05
	**Water damage** *Dano por água*	Staining or distortion on organic materials caused by contact with water and subsequently drying. *Manchas ou distorções em materiais orgânicos, causadas pelo contacto com a água e consequente secagem.* (paint | wood)	FCT.V.LM02
	**Wrinkles** *Enrugamento*	Furrows, ridges, or puckers that occur in a paint or varnish film during the drying process. *Estrias, saliências ou franzidos que ocorrem numa película de tinta ou verniz durante o processo de secagem.* (paint)	CPMC-PC3300/001 Stereomicroscope (25x magnification)

A.9.2 Questionnaire: List of surveyed parties

- Camera Obscura Museum zur Vorgeschichte des Films (Germany)
- Cinémathèque Française (France)
- Eye Filmmuseum (Netherlands)
- Manchester Museum (United Kingdom)
- Museo del Precinema - Collezione Minici Zotti (Italy)
- Museum De Lakenhal (Netherlands)
- Museum of the Moving Image (Portugal)
- Museum Sloten (Netherlands)
- National Museum of Natural History and Science (Portugal)
- National Science and Media Museum (United Kingdom)
- NFSA (Australia)
- O'Keefe Ranch (Canada)
- Private collection, anonymous (Europe)
- Rijksmuseum Amsterdam (Netherlands)
- Royal Albert Memorial Museum and Art Gallery, Exeter (United Kingdom)
- Screen Archive South East, School of Media, University of Brighton (United Kingdom)
- Speelgoedmuseum Deventer / Deventer Verhaal (Netherlands)
- The National Cinema Museum of Turin (Italy)
- University College London (United Kingdom)
- University of Sheffield (United Kingdom)

A.9.3 Cleaning test: mapping and colourimetry results

Areas cleaned and analysed

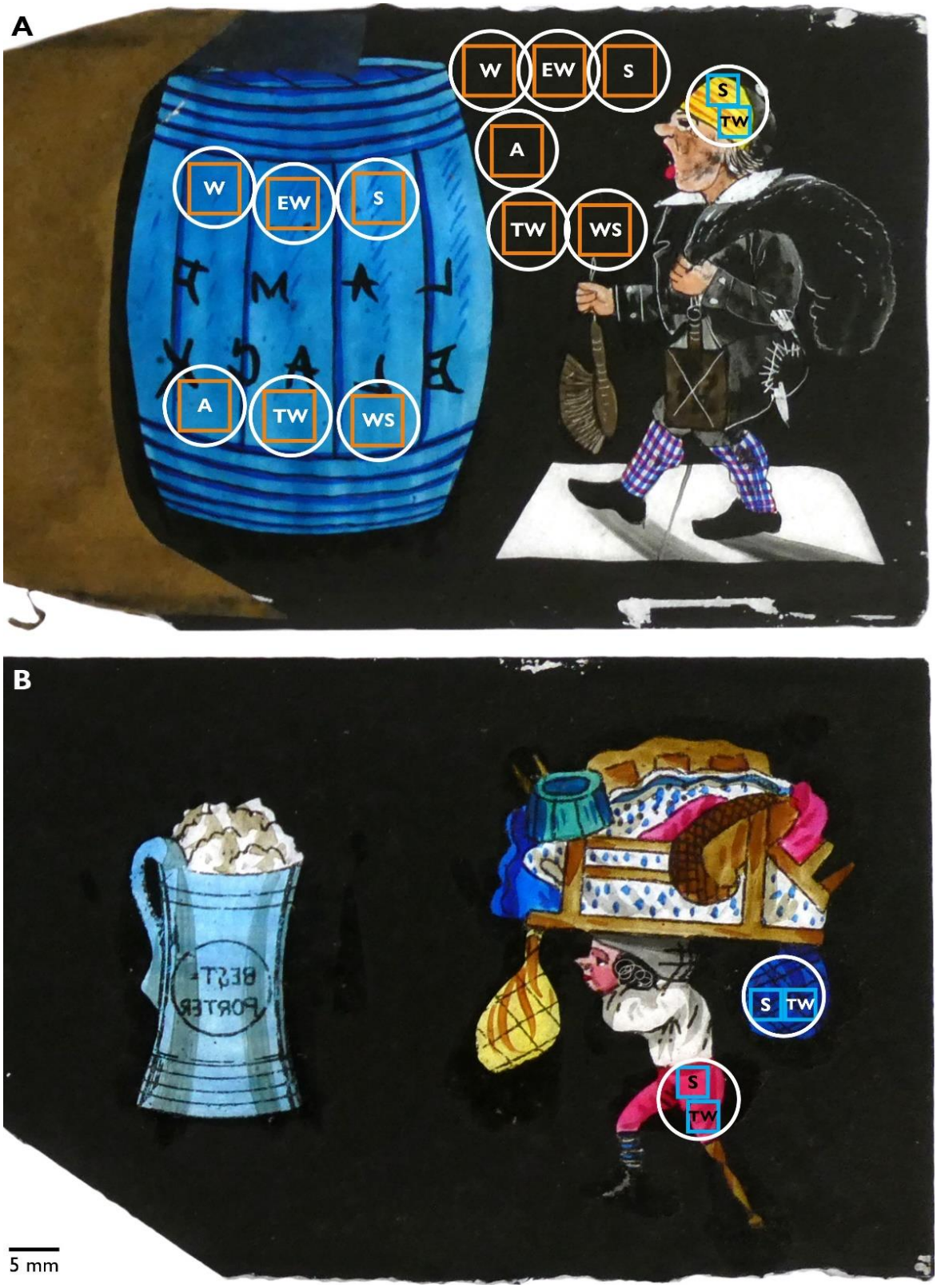


Figure A.55 Mapping of the areas cleaned (squares of 3 and 5 mm) and measured with the colourimetry analysis (circles of ⌀ 8 mm) on the slides FCT.V.LM02 (**A**) and FCT.V.LM03 (**B**) from VICARTE.

Colourimetry values before and after cleaning

Table A.16 Paints with black, blue, pink and yellow colours from slides FCT.V.LM02 and LM03, before and after cleaning with the solvents: water (W), ethanol and water (EW), saliva (S), triamonium citrate in water (TW), acetone (A), and white spirit (WS).

Slide	Colour	Solvent	Time	L*		a*		b*		ΔE*
				avg	stdev	avg	stdev	avg	stdev	
LM02	Black	W	Before	**25.02**	0.12	**-0.03**	0.03	**-0.20**	0.02	**-0.12**
			After	**24.99**	0.27	**-0.05**	0.04	**-0.27**	0.07	
		EW	Before	**25.11**	0.09	**0.01**	0.02	**-0.20**	0.02	**-0.61**
			After	**24.63**	0.26	**-0.03**	0.04	**-0.28**	0.11	
		S	Before	**25.23**	0.07	**0.02**	0.03	**-0.32**	0.03	**-0.39**
			After	**24.95**	0.00	**-0.05**	0.02	**-0.37**	0.01	
		TW	Before	**24.18**	0.07	**0.10**	0.03	**-0.04**	0.03	**-1.39**
			After	**23.45**	0.03	**-0.08**	0.04	**-0.53**	0.01	
		A	Before	**24.94**	0.03	**0.13**	0.01	**-0.05**	0.04	**-0.41**
			After	**24.71**	0.13	**0.06**	0.02	**-0.16**	0.05	
		WS	Before	**24.48**	0.13	**0.05**	0.04	**-0.21**	0.03	**-0.10**
			After	**24.70**	0.02	**-0.03**	0.02	**-0.45**	0.02	
LM02	Blue	W	Before	**27.93**	0.42	**-18.96**	0.26	**-14.09**	0.11	**-6.75**
			After	**27.06**	0.01	**-22.60**	0.51	**-16.36**	0.03	
		EW	Before	**29.52**	0.26	**-18.39**	0.92	**-14.51**	0.45	**-5.02**
			After	**26.52**	0.08	**-19.91**	0.06	**-15.00**	0.06	
		S	Before	**36.61**	2.63	**-23.48**	1.29	**-17.18**	0.23	**-10.57**
			After	**31.85**	0.63	**-26.48**	0.40	**-19.99**	0.02	
		TW	Before	**35.47**	0.99	**-28.47**	0.41	**-17.41**	0.10	**3.51**
			After	**34.30**	0.01	**-23.44**	4.58	**-17.76**	0.05	
		A	Before	**34.00**	1.02	**-25.02**	1.12	**-15.67**	0.54	**5.99**
			After	**34.50**	0.05	**-23.35**	0.02	**-11.85**	5.76	
		WS	Before	**37.48**	0.77	**-27.74**	1.95	**-16.86**	0.31	**-0.71**
			After	**36.60**	0.49	**-27.28**	0.04	**-17.15**	0.01	
LM02	Yellow	S+TW	Before	**59.62**	1.00	**23.10**	0.87	**74.89**	0.81	**6.59**
			After	**61.81**	0.02	**21.61**	0.01	**80.71**	0.02	
LM03	Pink	S+TW	Before	**32.14**	1.47	**49.91**	2.21	**13.73**	0.08	**-2.21**
			After	**29.85**	0.08	**48.90**	0.13	**14.82**	0.06	
LM03	Blue	S+TW	Before	**21.89**	0.24	**2.00**	0.33	**-13.59**	1.07	**-3.77**
			After	**20.61**	0.19	**2.13**	0.10	**-16.21**	0.37	

Note: Since the areas of yellow on LM02, and pink and blue on LM03 in which each solvent (S-saliva and TW-triamonium citrate in water) was applied were much smaller than the area measured in the colourimetry analysis (3 x 3 mm of ⌀ 8 mm), the results presented as S+TW refer to the total area before and after cleaning with both solvents (S+TW).

A.9.4 Additional photographic documentation of the restoration

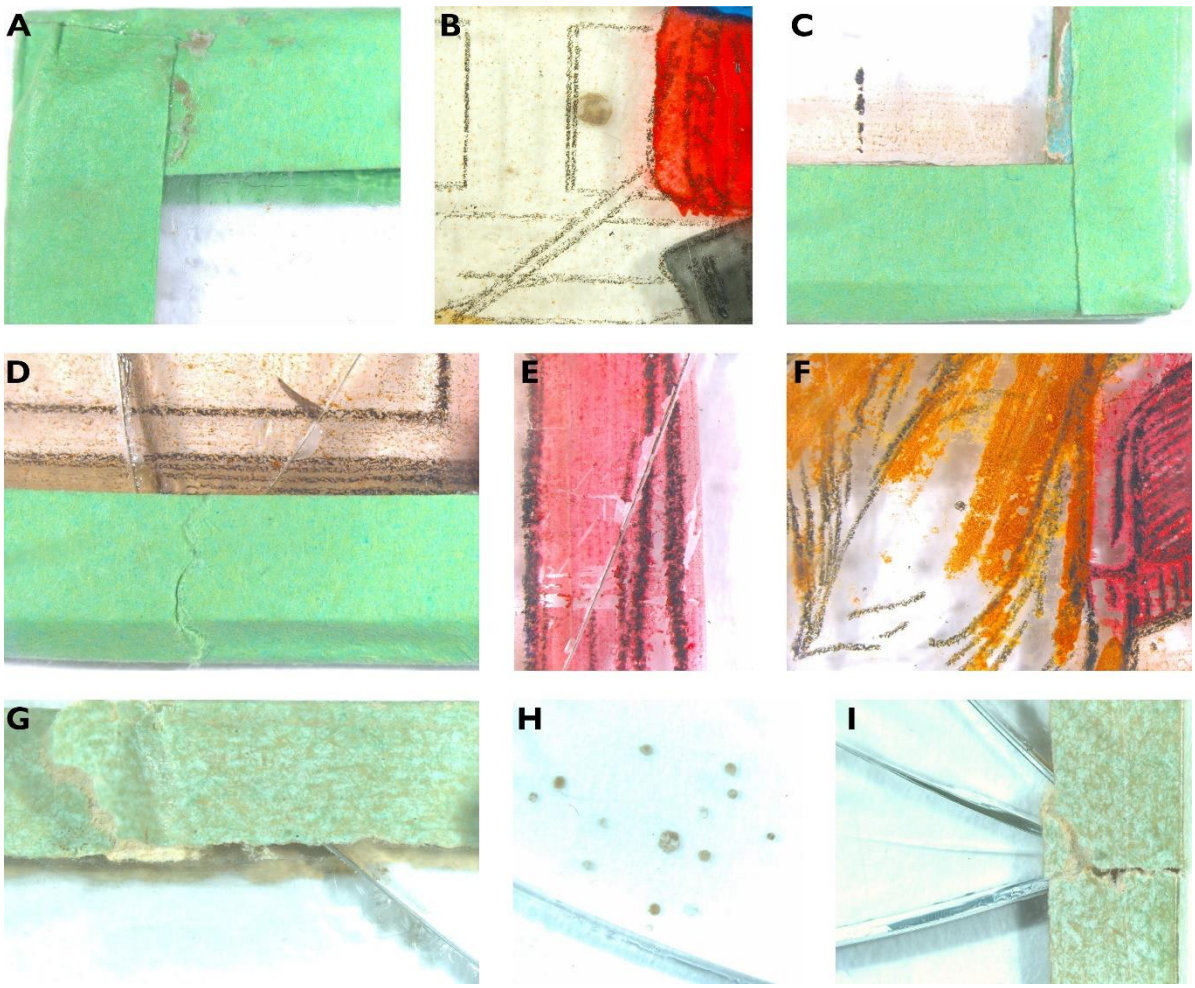


Figure A.56 Details of slides CPMC-PC0018/001 (**A-F**) and CPMC-PC0033/001 (**G-I**) photographed under the stereomicroscope (10x magnification): (**A**) Paper frame added in a previous intervention with adhesive over the paper and spreading over the glass support; (**B**) Example of a dirt spot on the opposite side of the painting; (**C**) Original paper frame visible under the paper added in a previous intervention; (**D**) Tear of the paper frame, glass fractures, and chips on the glass and painting; (**E**) Glass fractures, chips on the glass and painting, and paint scratches; (**F**)Abrasion and loss of painting; (**G**) Tear of the paper frame, glass fracture and chips; (**H**) Insect detritus and fracture on the glass; (**I**) Fractures and fissure on the glass and tear of the paper frame.



Figure A.57 Photographs captured during the restoration process: (**A**) Slide CPMC-PC0033/001 after cleaning the glass support, surrounded by materials used during the restoration, such as cotton swabs to clean, a needle to add the adhesive and a scalpel blade to remove the excess adhesive after it settled; (**B**) Fragment of CPMC-PC0033/001 before and after cleaning insect detritus from the glass; (**C**) Slide CPMC-PC0018/001 observed from the non-painted side after the injection of Paraloid® B-72 on fissure and fracture lines (before removing the excess adhesive).



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