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Interrogating Ebony: the case of imitation

Wood identification and color technological research on 17th-century Flemish cabinets containing ebony (imitation)

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Abstract

In the 17th-century, Antwerp was a major European trade center for luxury goods. Among these goods were elaborately crafted cabinets, often adorned with high-value materials and decorative techniques such as silver, silk, panel paintings, ivory, tortoiseshell, and ebony. Ebony is a rare, expensive, exotic black wood, used for veneer and moldings. However, historical records indicate that cabinetmakers also employed imitation techniques to replicate the appearance of ebony. This thesis investigates the materials and methods used in these imitations, aiming to uncover craft practices that remain obscure today. A mixed-methods approach was employed, combining historical research with scientific analysis on a selection of 17th-century Flemish cabinets, including wood identification through optical microscopy and scanning electron microscopy (SEM), as well as chemical characterization using portable X-ray fluorescence (pXRF) and SEM-EDX.

Analysis confirmed a variable presence of ebony imitation across the examined objects. Visual inspection proved useful for identifying imitation in veneers and moldings. In three cabinets, *Pyrus sp.* was presumably identified in place of *Diospyros sp.*. For analyzing color technology, XRF measurements on the cabinets and mockups, based on contemporary written sources, yielded promising overlap, but gaps remained. The study is limited by analytical constraints, which suggest that the results represent only a partial view of the broader practice of ebony imitation in 17th-century Flanders. Nevertheless, further investigation is required to fully understand the scope and techniques of this early form of material substitution, including expanded XRF reference measurements on both ebony and endemic wood species.



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Preface

Flemish cabinets represent a distinctive furniture type that appears in various forms. Their defining characteristic is a wooden box with drawers, typically veneered and decorated with costly and exotic materials. The Flemish cabinet is the outcome of a stylistic evolution influenced by both time and geography. Produced in 17th-century Flanders, these cabinets were traded mainly in Antwerp, where they were sold locally, exported or made on demand.¹

The materials found on such cabinets are highly diverse. A general overview includes: metals such as gilded silver, brass, and iron. Animal materials such as bone, ivory, tortoiseshell, and mother-of-pearl. Stone materials including marble and agate. Mixed media such as paintings, embroidery (stump work) and lacquer work. And a variety of woods, most notably ebony.

Among these, ebony is the characteristic material used for veneers and moldings. Imported from tropical regions, ebony was valued for its deep natural black tone, which contributed to its prestige. However, due to its rarity and excessive cost, it is believed that cabinetmakers often sought to imitate ebony by employing less rare materials and enhancing them through various staining or finishing techniques.



Figure 1: Cabinet with embroidery (stump work). A classical example of a Flemish cabinet featuring two doors that enclose the internal structure. Inside, decorations can be found on both the doors and drawers. The drawers are arranged around a central smaller door. This cabinet is thought to be veneered with ebony, the black material that frames the embroidery. Inv. 0071, Royal Museum of Art and History, Brussels © F. Hermesen

¹ In literature the nouns Flemish and Antwerp cabinets are used for the same subject. Antwerp was the trade center in 17th century southern Netherlands with its harbor. For this thesis, the noun Flemish cabinet will be used because the production did not only occur in Antwerp but also in Brussels and other Flemish regions. Van Meenen (2024) uses the same term, but De Boeck (2024) uses Antwerp.

In the first part of this thesis, a comprehensive overview of the historical and material context of the use of ebony and its imitation on Flemish cabinets is provided. This is followed by a state-of-the-art review of contemporary research conducted on this topic. The subsequent section outlines the detailed methodology, explaining the analytical techniques and approaches applied.

The fourth part presents the results of the wood identification analyses conducted on seven cabinets, alongside the pXRF and SEM-EDX findings related to possible coloring techniques. These results are then integrated into the broader art-historical and material-technical context, offering valuable insights for art historians, conservators, and scientists. The effectiveness and limitations of the employed analytical methods are also discussed.

This research was primarily supported by the University of Antwerp, with the collaboration of the Antwerp X-ray Imaging and Spectroscopy (AXIS) laboratory and the Wood Research Lab of the Royal Museum for Central Africa. To ensure wider accessibility, the full study and its results will be made publicly available through the University of Antwerp library.

Beyond revealing a potentially overlooked craft practice of 17th-century cabinetmakers, this research aims to demonstrate the analytical approaches capable of uncovering such historical techniques. It contributes to a better understanding of these objects and their material context within the heritage sector. The interdisciplinary nature of this project, combining expertise from different fields and specialists, highlights the importance of collaboration in addressing complex art-technological questions.

1 Historical context

1.1 Stylistic evolution of cabinets and it's use of ebony

To understand the story of the Flemish cabinet, a short summary of it's stylistic evolution is given, as the development is a result from a rich cross-pollination between different regions. This exchange led to numerous cross-references and stylistic influences, giving the cabinet a complex and layered character. In the following text, the main evolutionary lines are outlined to provide insight into the cabinet's origins and clarify the significance of ebony in its stylistic and technical evolution.

Southern Europe

For the beginning of cabinet's evolution (1480-1700), the mark is set at the hembra, a Catalan bride's dowry-chest from around 1480 with Moorish origins that pioneered the integration of drawers in furniture design.² This innovation evolved into the vargueño (also called bargueño or escritorio), a Spanish travel desk that gained widespread popularity from the 1500s Spain.³ The vargueño featured modest exteriors with simple metal fittings, while concealing richly carved and polychromed interiors behind a distinctive fall-front panel that doubled as a writing surface, see Figure 2. As a result, its main purpose was transportation and storage.⁴ Throughout the mid 16th-century Italian cities like Florence emerged as



Figure 2: *Vargueño on stand, possibly Salamanca, Spain, ca. 1630*
© V&A

influential cabinetmaking centers, and as a result of a more cross-pollination within the guilds, the Italians incorporated bone, ivory and mother of pearl.⁵ These craftsmen elevated cabinets further beyond functional storage, incorporating decorative inlay with urns, trophies and grotesques. This evolution gave cabinets, besides storage, a function for display and prestige, which reflected their owners' wealth, taste, and social standing.⁶ In cities such as Mantua and Naples, a trend arose during the mid-16th century toward the more extensive use of ebony in combination with engraved ivory. Cubitt notes, for instance, that a room in the Ducal Palace of Mantua was decorated with ebony and ivory panels crafted by

² Monique Riccardi-Cubitt, *The art of the cabinet : including a chronological guide to styles* (: Thames and Hudson London, 1992). 33.

³ Reinier Baarsen and Amsterdam Rijksmuseum, *17de-eeuwse kabinetten*, Rijksmuseum-dossiers (Waanders ; Rijksmuseum, 2000); Baarsen and Rijksmuseum, *17de-eeuwse kabinetten*. 4.

⁴ Riccardi-Cubitt, *The art of the cabinet : including a chronological guide to styles*. 36.

⁵ Riccardi-Cubitt, *The art of the cabinet : including a chronological guide to styles*. 40.

⁶ Riccardi-Cubitt, *The art of the cabinet : including a chronological guide to styles*. 40, 36-37.

Francesco Capriani in 1566.⁷ In Naples (Spain), the art of (colored) inlay got revived by the arrival of Dutch and German craftsmen. Different cabinets and a cupboard were ordered, which consisted of ebony, ivory engravings, and colored inlay, as one illustrated in Figure 3. The primary use of ivory in combination with ebony declined by the 1620s and shifted to more precious materials, such as turtle shell, stones, and gilded bronzes.⁸



Figure 3: **A** Spanish cabinet with ebony and ivory, presumably produced by the Flemish cabinetmaker Jacobo Fiamengo and Giovanni Battista De Curtis (engraver), ca 1600 in Naples © V&A. **B** On the right an Augsburg cabinet ca. 1627 – 1630, BK-NM-7325 © Rijksmuseum Amsterdam

Augsburg

In the footsteps of Southern Europe, Germany (Augsburg and Nuremberg) became one of the leading cabinetmaking centers in Europe from the 15th century until the early 17th century.⁹ In 1568, the city of Augsburg counted 130 independent cabinet makers. At first, these compact, table-mounted pieces retained structural similarities to Spanish predecessors, drop fronts or double doors concealing multiple small drawers, but featured exteriors richly adorned with marquetry in native European woods arranged in colorful and architectural designs.¹⁰ From the latter half of the 16th century onward, the use of ebony became increasingly prominent.¹¹ Augsburg's influence across Europe is evident from the contract that Lorenzo Duca (a presumable Flemish cabinetmaker situated in Naples) and Teodoro de Voghel (a presumable Dutch ivory engraver/cabinetmaker) made for two cupboards for the sacristy of Certosa. Lorenzo left for Augsburg to work on the cupboards, the woods, and the coloring, which were different from those in Naples, and could only be produced in Augsburg.¹²

⁷ Riccardi-Cubitt, *The art of the cabinet : including a chronological guide to styles*. 49.

⁸ GIUSEPPE BERETTI, "FURTHER INVESTIGATIONS INTO THE MANNERIST NEAPOLITAN CABINET, 1575-1621," *Furniture History* 55 (2019): 27–49, JSTOR Arts & Sciences XI Collection, <https://doi.org/10.2307/45252968>. 27-49.

⁹ Baarsen and Rijksmuseum, *17de-eeuwse kabinetten*. 5. - Riccardi-Cubitt, *The art of the cabinet : including a chronological guide to styles*. 39, 43.

¹⁰ Riccardi-Cubitt, *The art of the cabinet : including a chronological guide to styles*. 42-43.

¹¹ Riccardi-Cubitt, *The art of the cabinet : including a chronological guide to styles*. 79-80.

¹² BERETTI, "FURTHER INVESTIGATIONS INTO THE MANNERIST NEAPOLITAN CABINET, 1575-1621." 30.

Antwerp

Antwerp emerged in the late 15th century as a leading trading hub for goods across Flanders and Europe. Its strategically located port facilitated global commerce, transforming Antwerp into one of Western Europe's foremost metropolises.¹³ The city became a vibrant center where artists and craftsmen from diverse backgrounds settled and worked within the local guilds. Part of this flourishing period can be explained, as Vermeulen (2003) notes, by the reorganization of artistic workshops, a process of rationalization and standardization that allowed artworks to become commodities traded throughout Europe.¹⁴ The years between 1540 and 1565 can be regarded as Antwerp's golden age. During this time, artistic production became increasingly specialized and oriented toward export markets.

However, Antwerp's prosperity began to wane after 1563, when the English cloth trade shifted from Antwerp to Emden, removing one of the city's main economic foundations.¹⁵ This was followed by the Dutch Revolt, sparked by the iconoclastic riots of 1566 and followed by the Spanish suppression which led to a significant economic decline (Figure 4). A series of emigration waves after 1566 caused a major loss of skilled artisans and merchants. By the 1590s, this outflow began to stabilize, and in the following decade, Antwerp slowly regained its footing. Despite the city's economic isolation due to the closure of the River Scheldt, the production of luxury goods remained strong. The local art market adapted by focusing on high-end, artisanal products made for an elite clientele.¹⁶ In 1609, the signing of the Twelve Years' Truce between Spain and the Dutch Republic restored a degree of stability. This period of peace allowed Antwerp to revive its international trade connections and once again attract skilled craftsmen to the city (Figure 4).



Figure 4: **A** *The wharf of Antwerp*, by Sebastiaan Vranckx, 1616-1618. A illustration of busy quay where many goods are being transported. © The Phoebus Foundation. **B** *The tragic oppression of the Netherlands*, anonymous, 1569. A detail of the engraving showing the oppressor Alva (Spanish) with the Devil. © National museum of the Netherlands

¹³ Baarsen and Rijksmuseum, *17de-eeuwse kabinetten*. 23.

¹⁴ Filip Vermeulen, *Painting for the Market : Commercialization of Art in Antwerp's Golden Age*, Studies in European Urban History (1100-1800); 2 (Brepols, 2003), WorldCat. 34.

¹⁵ Vermeulen, *Painting for the Market : Commercialization of Art in Antwerp's Golden Age*. 56.

Jan Van der Stock and Hans Devisscher, *Antwerpen, verhaal van een metropool, 16de-17de eeuw : Antwerpen, Hessenhuis, 25 juni-10 oktober 1993* (Snoeck-Ducaju & zoon, 1993), WorldCat. 18.

¹⁶ Christine Göttler et al., *Trading Values in Early Modern Antwerp: An Introduction* (Brill, 2014), WorldCat, <https://research.rug.nl/en/publications/f68efb78-02b3-49c7-a733-e5fe965e4d56>. 474.

The influence of Spanish and German production centers on Antwerp is evident, with inventories mentioning both Spanish and Augsburg cabinets. In the final decades of the 16th century, Fabri (1991) documents several entries referring to “Spanish” ebony cabinets.¹⁷ Antwerp itself also housed craftsmen who produced cabinets, likely adopting trends from neighboring regions while developing its own cabinet style.¹⁸ By the end of the 16th century, claims of specialization within the guilds appear. In Amsterdam, the first known ébéniste, David Stafmaecker, settled in 1590.¹⁹ While in Antwerp, the earliest specialized ebony workers began settling between 1600 and 1605.²⁰

¹⁷ Ria Fabri, *De 17de-eeuwse Antwerpse kunstkast : typologische en historische aspecten* (Paleis der Academiën Brussel, 1991). 21-24.

¹⁸ In Madrid, there are entries that mention escritorios des Flandes. See Fabri, *De 17de-eeuwse Antwerpse kunstkast : typologische en historische aspecten*. 24.

¹⁹ Th. H. Lunsingh Scheurleer, “Het Amsterdamse St.-Jozefsgilde, in het bijzonder met betrekking tot de meubelmakers,” *Historia; maandschrift voor geschiedenis en kunstgeschiedenis*, n.d. 36.

²⁰ Fabri, *De 17de-eeuwse Antwerpse kunstkast : typologische en historische aspecten*. 112-113.

1.2 Flemish cabinet production

Flemish cabinets are not the work of a single craftsman but the result of collaboration among several specialists. The production of a cabinet could begin with a customer's request. The customer could either commission an ebony worker directly, who operated his own workshop, or place an order through a merchant. These merchants, in turn, employed multiple ebony workers who could be assigned specific tasks.²¹ Before 1600, cabinets were made by carpenters, while the decorative inlays were executed by inlayers belonging to the carpenters' guild. With the arrival of the first ebony workers in Antwerp around 1600, these artisans were incorporated into the carpenters' guild.²² By 1621, their craft had evolved into a distinct specialization of ebony workers within the guild. A distinction was made between ebony workers who produced frames, who fell into Saint-Luke's guild, and those who made cabinets, the carpenters' guild.²³ Although both groups employed similar techniques, their end products differed. Figure 5 depicts a 17th-century workshop of frame makers. The characteristic decorations found on Flemish cabinets: such as silver mounts, embroidery, paintings, and other embellishments, were created by additional craftsmen specializing in those materials.

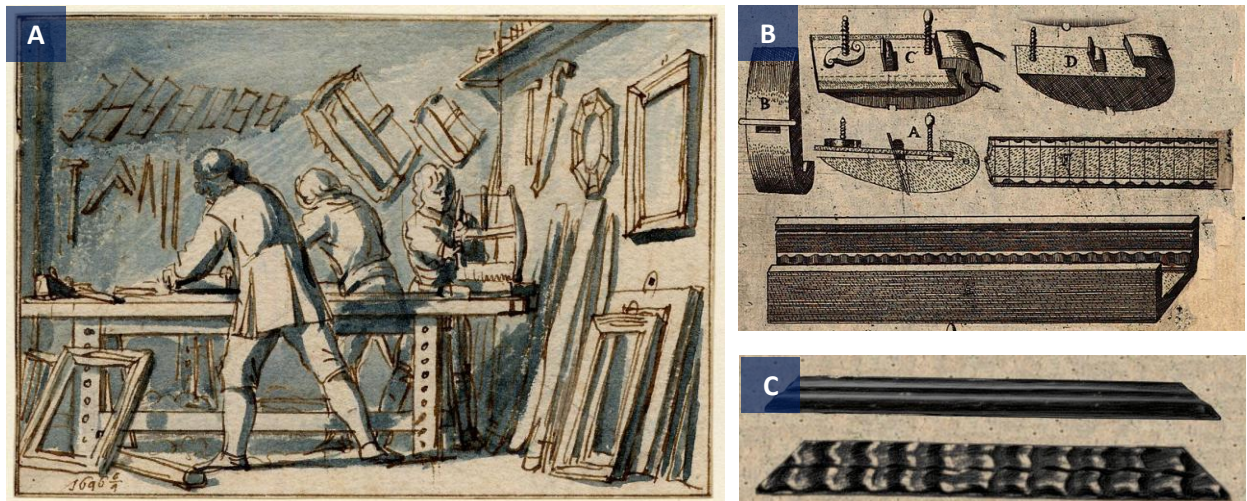


Figure 5: In figure A, is a frameworker workshop depicted, attributed to the Haarlem painter Salomon de Bray (1597-1664) © The Trustees of the British Museum. In figure B is a first known depiction (copper engraving) of the machine that made the rippled moldings, Rutger Kasemann – Flammleistenhobel 1630 © Wikimedia. In figure C is the upper molding straight, representing a simpler wave form molding, based on a molding from cabinet IV.0071 in the Royal museum of Art and History Brussels. The lower molding is a rippled molding, based on a molding from cabinet AV.7024 in the MAS -Antwerp © Edited by F. Hermesen

²¹ Fabri, *De 17de-eeuwse Antwerpse kunstkast : typologische en historische aspecten*. 115-116

²² Fabri, *De 17de-eeuwse Antwerpse kunstkast : typologische en historische aspecten*. 114-115.

²³ Fabri, *De 17de-eeuwse Antwerpse kunstkast : typologische en historische aspecten*. 114-116

The ebony worker was responsible for constructing the cabinet's main frame and decorating it with veneer and moldings.²⁴ Ebony was imported in large beams, which the craftsmen had to saw into thin sheets of veneer.²⁵ It is generally believed that this was done using hand saws, producing veneer with a thickness of approximately 1 to 2 millimeters.²⁶ However, the literature on this subject remains vague, as water/wind and man-powered sawing machines were already in use by the early 17th century.²⁷ The use of ebony veneer allowed craftsmen to economize on costly material while maintaining the same luxurious appearance. The moldings were produced either by hand or with the aid of machines. It is thought that the first machines for molding originated in Germany and gradually spread across Europe.²⁸ On Flemish cabinets, as well as on other 17th-century examples, these moldings appear in a wide variety of forms: some are simple and straight, while others are rippled or more elaborate. Although they could be made by hand, evidence suggests that by the mid 17th-century, workshop machinery capable of producing moldings had become increasingly common. Figure 5 depicts one of the earliest known representations of such a device.

After the veneer was sawn and the moldings produced, both were glued onto the cabinet frame using animal protein-based adhesive. Somewhere between the construction and the finished product, decorative media crafted by other specialists: such as embroidery, metalwork, or miniature paintings, were added to complete the cabinet.²⁹

²⁴ Fabri, *De 17de-eeuwse Antwerpse kunstkast : typologische en historische aspecten*. 114-116

²⁵ The exact techniques employed by ébénistes are not always clearly documented. Inventories from the Forchondt' workshop record the purchase of ebony wood in pounds (Catherine Schepens, "CC-1043_kabinetten_overige productie_grondstoffen," 2025.). In Amsterdam, a specific guild branch of sawyers existed for cutting planks, but there is no explicit mention of veneer production. Piena suggests, that carpenters may have cut the veneer themselves. See Paul van Duin et al., *Vierde Nederlandse symposium hout- en meubelrestauratie : 12 oktober 1999 Amsterdam* (Stichting Ebenist ; Rijksmuseum ; VeRes, 2001), WorldCat. 14. Fabri also does not directly address the practice of veneer cutting by ébénistes, but she does note that tortoiseshell was cut by the ébénistes themselves. See Fabri, *De 17de-eeuwse Antwerpse kunstkast : typologische en historische aspecten*. 29.

²⁶ Vadim Van Meenen, "Identificatie van Ebbenhout (Diospyros) En Andere Tropische Zwarte Houtsoorten Op 17de -Eeuwse Vlaamse Kabinetten" (Universiteit Antwerpen, 2024). 23.

²⁷ Cornelis Van Vuuren, *Groot volkomen moolenboek, of Naauwkeurig ontwerp van allerhande tot nog toe bekende soorten van moolens met haare gronden en opstellen, en al het geene verder daar toe behoort, ten dienste der oeffenaaren ... geteekent door Leendert Van Natrus ... Jacob Polly ... en Cornelis Van Vuuren, en zeer naauwkeurig in het kooper gebragt door Jan Punt ..* (J. Covens en C. Mortier, 1736), WorldCat.6.

Duin et al., *Vierde Nederlandse symposium hout- en meubelrestauratie : 12 oktober 1999 Amsterdam*. 19.

²⁸ Dirk Wendelen, "Robbellijsten" (Universiteit Antwerpen, 1992). 26-28

²⁹ It is only possible that the decorative media were added before the moldings, as these media lie underneath the moldings. At what exact stage the other craftsmen were involved in the production process is not always clear.

1.3 Flemish cabinet appearance

An Antwerp cabinet can be divided into separate groups, differentiating by their size, materiality and execution. A cabinet can contain two or one door that encloses its inner structure. There are always several different drawers that most of the time are situated around a central smaller door(s). These drawers and doors are decorated with costly and exotic materials. In all cases, the cabinet is veneered and has moldings. Most of the time these are executed in black veneer and moldings, presumably ebony, but also appear in other types of wood, or other material like turtle shell (veneer).³⁰

In Figure 6, a small table cabinet is depicted with embroidery (Stump-work). In this case there is no smaller central door, but a central drawer. The cabinet is decorated with presumably ebony veneer and moldings. The drawers can be enclosed with a lid. Most of the (smaller) cabinets also have handles for transport.



Figure 6: Small table cabinet with embroidery (Stump work). 1: central drawer, 2: One of moldings on the drawer, 3: Piece of ebony veneer, 4: Hinge on top of the cabinet, 5: Lid that can enclose the cabinet. © Collection DIVA, Antwerp (S58/66). Photographs by F. Hermsen

³⁰ See Fabri (1991) or De Boeck (2024) for a better understanding of the different kinds of cabinets.

In Figure 8, a characteristic example of a Flemish table cabinet can be observed. This type of cabinet can be more precisely defined compared to other forms. In this case, small paintings are mounted on the drawer fronts and inner doors, bordered by ebony moldings and veneer. The two side doors open to reveal a series of drawers, while in the central section a smaller door provides access to additional, even smaller drawers hidden behind it. A defining feature of this group is the profiled lid at the top. Frequently, the interior also includes a mirror flanked by two decorative media, such as paintings in this example. In Figure 7, a drawing of a similar cabinet is presented. Although the overall concept remains consistent, variations can be found in dimensions and the number of drawers. On the exterior of the side doors, the ébénistes created visual interest by arranging the moldings into geometric compositions, sometimes L-shaped and other times rectangular, demonstrating both craftsmanship and aesthetic refinement.



Figure 7: cabinet on stand with paintings. 1: Central smaller door where more smaller drawers are present, 2: profiled top, 3: mirror in upper lid with paintings besides © Collection City Antwerp (Sm.0774.1-3), MAS. Edited by F. Hermesen

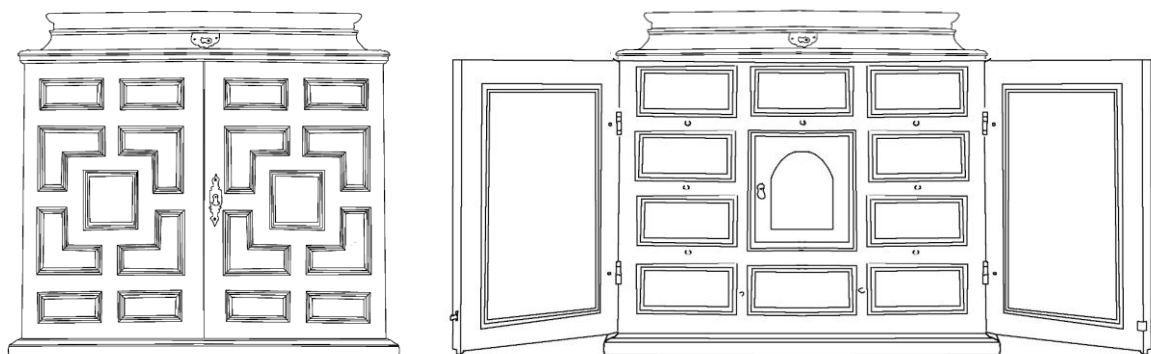


Figure 8: Simplified drawing of a Flemish table cabinet, group IV. On the left is an enclosed cabinet featuring geometrical forms created with moldings. The lid is visible on top. On the right is an open cabinet displaying various drawers arranged around a smaller central door. © Drawing based on cabinet out of the collection of the Royal Museum of Art and History in Brussels (IV.71). Edited by F. Hermesen

In Figure 9, there are no doors or lids enclosing the drawers. Instead, the drawers themselves are richly ornamented with gilded brass, tortoise shell, various tropical woods, and rippled ebony moldings. The cabinet is bordered with alternating bands of bone and ebony, creating a refined contrast. At its center, two small doors open to reveal a mirrored chamber. Within this chamber, the *ébénistes* experimented with the use of mirrors. Such a central mirrored space, or “*perspectiefje*”, clarifies the intended function of these cabinets. Beyond their practical use as storage furniture, the painted and decorated drawers and doors conveyed narratives. These cabinets were therefore not merely static objects but acted as miniature stages, visual theatres designed to engage and captivate their audience.³¹

The cabinets presented here represent only a selection of the wide variety that existed. The intention was to illustrate the defining characteristics of these Flemish cabinets. As shown, there is significant variation in scale, materials, and execution. Nevertheless, one recurring and central element is ebony. A material that forms the focus of the following chapters.



Figure 9: cabinet on stand with *perspectiefje*. 1: perspective, 2: L-shaped inlay, 3: gilded brass garniture, 4: ebony rippled molding, 5: turtle shell cabochon, 6: band with ebony and bone © Collection M Leuven (M/51). Edited by F. Hermsen

³¹ Nadia Baadj, *10 Collaborative Craftsmanship and Chimeric Creation in Seventeenth-Century Antwerp Art Cabinets* (2016), 270–96, https://doi.org/10.1163/9789004325760_012. 275-280.

1.4 The fashion of black

Black is a fascinating and complex color. In the textile industry from the 1500s onward, black became a popular and prestigious color during the 16th and 17th centuries, where it was favored among the upper classes.³² This preference is clearly reflected in contemporary portraiture, where noblemen and women are frequently depicted in striking black garments contrasted by white collars and gold jewelry.³³ The allure of black lies in its rarity and the difficulty of achieving it: producing a deep, colorfast black dye was technically challenging since natural black dyes were often unstable or faded quickly, dyers had to combine red and blue dyes to create a deep blue-black tone. This dyeing method not only required skill but also came at a high cost, making black textiles a symbol of wealth, status, and refinement. Thus, wearing black was not only a fashion statement but also a visible marker of prestige.³⁴ This same trend extended into the world of interior furnishings. As shown in archival inventories and research by Thiel and de Bruyn, black (ebony) frames were more frequently listed than those made from oak, bone, or white moldings.³⁵



Figure 10: *The Cabinet of Art Lovers* by Jan Siberechts (1661–1672). This painting provides insight into the material culture and interior aesthetics of the 17th-century Netherlands. **A:** The cabinet features multiple drawers and appears to combine ivory and ebony, utilizing their contrasting tones to create a striking visual effect. **B:** A gilded picture frame suggests the presence of luxury materials beyond black, supporting the notion of a rich and varied interior palette. **C:** A typical black frame, reflecting the broader trend of dark-toned frames commonly found in inventories of the time. **D:** The checkerboard black-and-white tile floor, a hallmark of Baroque interior design. © Collection Rau for UNICEF

³² Natalia Ortega Saez, "Relation Between Historical Recipes and Current Preservation State of Black Dyed Wool: Recipe Based Research in North Western Europe, 1680-1850" (2018). 59-60.

³³ Marieke de Winkel, "The Artist as Couturier : The 'portrayal' of Clothing in the Golden Age," *Dutch Portraits / Royal Picture Gallery Mauritshuis, The Hague ... Rudi Ekkart et Quentin Buvelot.*, 2007, WorldCat. 71.

³⁴ Natalia Ortega Saez, *Zwarter Dan Zwart? Historische Recepten, Ingrediënten En Verfpcedures Gebruikt Bij Het Zwartverven van Textiel in de Zuidelijke Nederlanden, circa 1500-1850*, 13 2019. 7-11.

³⁵ P. J. J. van Thiel and C. J. de Bruyn Kops, *Prijst de lijst : de Hollandse schilderijlijst in de zeventiende eeuw* (Rijksmuseum ; Staatsuitgeverij, 1984). 42-44.

In Figure 11 we see this vividly expressed: black and white garments, checkered tile floors, black frames, and a cabinet in the corner, all exemplify this dramatic visual dynamic. Yet, it is not merely black and white, the space is enlivened by gilded frames, ornate wall decorations, and decorative capitals on columns. The result is a carefully orchestrated visual language in which black plays a deliberate role. In this context, ebony emerged as the quintessential luxury material, symbolizing wealth and artistic sophistication.³⁶ But ebony did not stand alone: materials such as tortoiseshell, mother of pearl, and gilded ornamentation contributed to the luxurious visual culture of the 17th-century Netherlands.³⁷

Clair obscure – Chiaroscuro – Reflexie-const

The interplay between dark and light can create visually stronger and richer effects. This technique, known as *clair-obscure* or *chiaroscuro*, was developed in the 15th–16th century. Although primarily associated with painting, it also applies to three-dimensional works. Van Binnebeke (2018) introduces the Dutch term *reflexie-const*, the Northern equivalent describing the same manipulation of light–dark contrasts. He traces its application in sculpture back to the late 15th century and demonstrates that the concept surpasses strict *chiaroscuro* by involving a broader palette of contrasting colors. By showing that this principle is present not only in engravings and paintings but also in sculptural practices, Van Binnebeke establishes a more comprehensive understanding of the technique. One example he discusses is a 16th-century tomb combining polychromed alabaster with black marble.³⁸ In this context, the use of black wood in combination with ivory or bone on cabinets can be interpreted within the same visual logic. The strong contrasts enrich the depictions on drawers and doors, enhancing their spatial and aesthetic depth.

³⁶ Riccardi-Cubitt, *The art of the cabinet : including a chronological guide to styles*. 49.

³⁷ *In contrast to some interpretations that the blackest color was in all cases strived (in furniture) for the Netherlands during the 17th century. Hovinger and Klusener found out that the furniture left in collections were during the 19th century altered to be black, to resemble ebony. By wood identification they could point out indications that the furniture was more diverse in color tones.*

³⁸ Emile van Binnebeke, “Chiaroscuro Als Ästhetisches Prinzip,” in *Kunst Und Theorie Des Helldunkels 1300–1550*, ed. Claudia Lehmann et al. (De Gruyter, 2018), <https://doi.org/10.1515/9783110547320-014>. 13-14, 17.

1.5 Ebony and its color

Ebony is widely known as a black wood species. However, contrary to what many objects and interpretations suggest, ebony is not necessarily entirely black. It naturally exhibits a range of color variations, a fact already noted by authors in the 17th and 18th centuries. The 18th century French writer and cabinetmaker Roubo described several types of ebony - ébène vert, ébène rouge, and ébène noir - not all of which were uniformly black.³⁹ However, these color-based distinctions do not necessarily indicate distinct species.⁴⁰ A single ebony species can produce wood with varying colors, and thus color cannot be used for species identification.

"Ebony has the flaw of sometimes being streaked with reddish veins, especially the kind that comes from the Isle of Mauritius, which reduces its value, since the beauty of this wood lies in its perfectly black and glossy color."⁴¹

Of the 761 known species in the genus *Diospyros*, around 40 species are recorded as producing blackish heartwood.⁴² This number may be an underestimation. By going further in detail, even species known for producing blackwood, do not always do so. The formation of black heartwood is influenced by fungal or microbial invasion, making it a life-dependent process.⁴³ As a result, ebony can display a wide spectrum of colors: ranging from greenish, orangey, and grey to purple hues, black streaks, or a uniform black.⁴⁴ This natural variation is sometimes visible on cabinets. For example, a 17th-century cabinet from Oudenaarde in Figure 11, shows noticeable color variation in its ebony molding.⁴⁵



Figure 11: A 17th century cabinet with lacquer work. The drawers were examined and showed on separate locations color variations. In figure B a drawer is depicted, with in figure C detail viewed from the side of the drawer. Collection Museum Oudenaarde © T. Nijs. Edited by F. Hermsen

³⁹ André-Jacob Roubo, *L'Art Du Menuisier Ébéniste. Troisième Section de La Troisième Partie de l'Art Menuisier* (Paris: Académie des Sciences, 1774). 775.

⁴⁰ Van Meenen, "Identificatie van Ebbenhout (*Diospyros*) En Andere Tropische Zwarte Houtsoorten Op 17de -Eeuwse Vlaamse Kabinetten." 66.

Nina Dijkstra, "Black and Shining, and Pleasing to the Eye, Black Chemical Stains on Dutch 17th Century Ebony Furniture" (Universiteit van Amsterdam, 2024). 11.

⁴¹ Roubo, *L'Art Du Menuisier Ébéniste. Troisième Section de La Troisième Partie de l'Art Menuisier*. 774. *L'Ebene a le défaut d'être quelquefois tachée de veines rousâtres, fur-tout celle qui vient de l'Ifle Maurice, ce qui en diminue la valeur, puisque la beauté de ce bois confitte dans fa couleur parfaitement noire & luifante.*

⁴² Mehrdad Jahanbanifard et al., "Description and Evolution of Wood Anatomical Characters in the Ebony Wood Genus *Diospyros* and Its Close Relatives (Ebenaceae): A First Step towards Combatting Illegal Logging," *IAWA Journal* (Leiden, The Netherlands) 41, no. 4 (2020): 577–619, <https://doi.org/10.1163/22941932-bja10040>. 578.

⁴³ W.E. Hillis and P. Soenardi, "Formation of Ebony and Streaked Woods," *IAWA Journal* (Leiden, The Netherlands) 15, no. 4 (1994): 425–37, <https://doi.org/10.1163/22941932-90001378>. 435.

⁴⁴ Hillis and Soenardi, "Formation of Ebony and Streaked Woods." 427.

⁴⁵ *An examined loose molding from the same cabinet was found to be uniformly black and showed heavy in contrast to an endemic specie like pear. This indicated no straightforward evidence of diospyros.* However, it remains uncertain whether a stain was applied in this case.

1.6 Ebony imitation

One critical question is whether blackened wood was intentionally produced as an ebony imitation or whether its appearance should be understood as a stylistic or artistic preference of the period. As discussed in the stylistic evolution, wood coloring was already practiced before ebony became fashionable. Inlayers used various coloring techniques to create figurative scenes or to achieve hues that differed from the wood's natural color. For 17th-century cabinets, however, the term ebony imitation is justified. These cabinets functioned not only as artworks but also as investments, created in a period marked by discovery, global trade, and a fascination with exotic materials. It was presumably only when issues such as limited supply and high costs arose that woodworkers turned to imitation techniques. Guild regulations explicitly forbidding such practices further indicate that ebony possessed economic and symbolic value beyond its aesthetic qualities. This supports the interpretation that blackened wood on Flemish cabinets was not merely a stylistic choice but a deliberate attempt to emulate ebony. For this reason, the term ebony imitation is used throughout this thesis.

1.6.1 Ebony imitation 17th century cabinets

As mentioned, Augsburg was a major center in cabinet production before and during the rise of Antwerp. To distinguish a cabinet produced in Augsburg from the rest of the German region and Europe, the cabinets were stamped with a pinecone mark, representing Augsburg. From 1625, the word EBEN was added beside the pine mark, to make clear that ebony was used. This ensured the buyers of purchasing a cabinet with legit ebony.⁴⁶ The initial reason was that other cities besides Augsburg produced cabinets, like Munich, where ebonized pear wood was used instead of ebony.⁴⁷ In reality, the lack or presence of the mark doesn't prove whether ebony was used or not.⁴⁸ Antwerp had the same problem with craftsmen who were (secretly) using ebonized wood instead of ebony. In 1621, an ordinance was carried out that all pieces which used Spanish wood (an ebony substitute) should be stamped with an S.⁴⁹ This stamp has not been found today. In contrast to Augsburg, where the stamp ensured price guarantee, the case of Antwerp meant the opposite. In 1652, a text cites that the ebony worker Luycas Castiels (Antwerp) had to pay six pounds as fine because he had used ebony substitutes in combination with ebony.⁵⁰ A same practice was noted for the ebony worker Andris Mons, an archival text mentions that the manufactured cabinet's top contains pearwood (1656).⁵¹

In Antwerp 1661, a petition was filed complaining that cabinets marketed as "ebony cabinets" were not actually made from ebony. Instead, these pieces were partially constructed from ebony substitutes that had been treated and polished to replicate ebony's appearance. As a result, the petition requested that these woods should no longer be used and if used, should be kept in their original, natural color.⁵²

⁴⁶ Baarsen and Rijksmuseum, *17de-eeuwse kabinetten*. 15.

⁴⁷ Riccardi-Cubitt, *The art of the cabinet : including a chronological guide to styles*. 49.

⁴⁸ In the study of George Manginis, "An Augsburg Cabinet at the Benaki Museum," *Μουσείο Μπενάκη Supplement*, 2023. 163, he showed an ebonized cabinet which doesn't have the stamp EBEN. Cabinet (IV.820) in the collection of the Royal Museum of art and history in Brussels, was found with the seal of Augsburg and EBEN, but the cabinet showed clear use of ebonized wood.

⁴⁹ Fabri, *De 17de-eeuwse Antwerpse kunstkast : typologische en historische aspecten*. 40.

⁵⁰ Schepens, "CC-1043_kabinetten_overige productie_grondstoffen." Ref 68. Inventory archive 1043_f127r.

⁵¹ Schepens, "CC-1043_kabinetten_overige productie_grondstoffen." Ref 173. Inventory archive 1043_f156r.

⁵² Fabri, *De 17de-eeuwse Antwerpse kunstkast : typologische en historische aspecten*. 40.

1.6.2 Reasons for ebony imitation

The primary motivation for imitating ebony was likely economic. According to Fabri, an ebony substitute could be purchased for one-sixth the price of genuine ebony in 1620.⁵³ Another reason could be that imitation was necessitated by supply shortages (which is linked with its price), although literature does not directly support this theory. Brouard (1963) demonstrates that ebony prices fluctuated dramatically with market availability, with prices falling during periods of abundant supply. This pattern is evident in 1650, when an oversupply of ebony led the Dutch to restrict harvesting to 400 ebony trees annually on Mauritius.⁵⁴ A third possible reason for its use was ebony's high density, which made creating rippled moldings difficult to execute.⁵⁵ Given the limited information available, it appears that ebony imitation could have been employed as a cost-saving measure, a solution to supply shortages or because of its material properties. It remains unclear whether craftsmen used these substitutes openly with client knowledge or discreetly.⁵⁶

⁵³ Fabri, *De 17de-eeuwse Antwerpse kunstkast : typologische en historische aspecten*. 40.

⁵⁴ N. R. Brouard, *A History of Woods and Forests in Mauritius* (J.E. Félix, I.S.O., Govt. Printer, 1963), WorldCat. 1-9.

⁵⁵ Iskander Breebaart et al., "Pressed Baleen and Fan-Shaped Ripple Mouldings by Herman Doomer," in *Reproduction and Reconstruction in Furniture Conservation: Proceedings: Eleventh International Symposium on Wood and Furniture Conservation, Stichting Ebenist, Amsterdam, 9-10 November 2012* (Stichting Ebenist, 2013), 20201001-00147879, pp. 62–74, 87, AATA. 66-67.

⁵⁶ In an inventory described by Fabri, A cabinet with Spanish wood was sold for a considerably lower price compared to a cabinet made from ebony. There are thus sometimes suggestions that buyers knew a cabinet was made from an ebony substitute. Fabri, *De 17de-eeuwse Antwerpse kunstkast : typologische en historische aspecten*. 203.

1.7 Substrates

When searching inventories for furniture made from ebony (imitation), such as cabinets and frames, various descriptions appear that reveal the complexity of material identification on historical sources on the subject of ebony. Terms are found ranging from ebony, specified ebony, black wood, (black) painted wood, imitation ebony, Spanish wood, pear wood and baleen. Research by scholars such as Fabri and Thiel demonstrates that these inventory descriptions are far from consistent. Several important caveats must therefore be considered when interpreting these sources. A description of "ebony" does not necessarily indicate that genuine ebony species were used, as imitations or substitute species could have been employed. Similarly, the term "black wood" is particularly ambiguous and could refer to virtually any darkened material as well as an ebony species. These terminological inconsistencies highlights the need for careful analysis when analyzing these historical sources.

1.7.1 Wood

For the following subsections, the mentioned woods were selected on the basis of texts which mentions explicitly the use of a specific wood for ebony imitation. Specific coloring techniques will be given in the 1.8.

Pear

A wood type that is consistently referenced in literature, not only in historical documents, but also in analyzed wood samples.⁵⁷ It appears to be the holy grail for ebony imitation. It would have been chosen for its similar fine grain and coloring abilities. In some rare cases, this wood turns black.⁵⁸

Spanish wood

Ria Fabri mentions that (black-painted) Spanish wood was in 17th century Antwerp a wood type for ebony imitation. She gives two options of tree species: *Taxus baccata* (yew tree) or *Morus* sp. ("verfmoerbezieboom").⁵⁹ Duverger (1984) mentions the same of a black Spanish wooden cabinet.⁶⁰ De Boeck (2024) found different records that relate to Spanish wood. She found nine records of Spanish wood, two records of black Spanish wood, one record of red Spanish wood.⁶¹ There are thus suggestions that Spanish wood was used as an ebony substitute. Although it also could suggest that the stated records mention cabinets that contain a black ebony wood species supplied by the Spanish and for this reason was called Spanish wood. Otherwise, a cabinet in Spanish style could mislead readers that the record

⁵⁷ The use of pearwood can be found in different standard works and specified literature. Some examples are: Fabri, *De 17de-eeuwse Antwerpse kunstkast : typologische en historische aspecten*. 40. - Hans Michaelsen and Ralf Buchholz, *Vom Färben des Holzes Holzbeizen von der Antike bis in die Gegenwart: Literatur, Geschichte, Technologie, Rekonstruktion, 2000 Rezepturen*, 2 ed (Michael Imhof Verlag, 2009), WorldCat. 79. – Mechthild Baumeister, *A Seventeenth-Century Parisian Ebony Cabinet Restored by Herter Brothers*, Wooden Artifacts Group Postprints 2005, ed. Mechthild Baumeister and Stephanie Rabourdin-Auffret (2005), <http://www.wag-aic.org>. 7.

⁵⁸ Fabri, *De 17de-eeuwse Antwerpse kunstkast : typologische en historische aspecten*. 40.

⁵⁹ Fabri, *De 17de-eeuwse Antwerpse kunstkast : typologische en historische aspecten*. 39-40. Duin et al., *Vierde Nederlandse symposium hout- en meubelrestauratie : 12 oktober 1999 Amsterdam*. 4. J. 1. Wassink and H. W. van Klaveren, *Houtaanduidingen Antiek, Oud, Ouderwets, in Onbruik of soms nog wel eens gebruikt*, Bos en hout berichten, no. 7 (1989), WorldCat. 4.

⁶⁰ Kim De Boeck, "Materiaal-Technisch Onderzoek Naar de Constructie van (Kunst)Kabinetten Vervaardigd in de Zuidelijke Nederlanden Tijdens de 17e En 18e Eeuw" (Universiteit Antwerpen, 2024). 60.

⁶¹ De Boeck, "Antwerpse Kabinetten Ontbloot." 36.

doesn't state Spanish wood but in reality a black wooden cabinet from Spain. The yew tree is a conifer, out of the taxus family. This tree grows in Europe, North Africa and southwest Asia. Its wood was used for furniture from the middle ages, and went almost extinct in Europe.⁶²

Tropical woods

In the research conducted by Hoving and Klusener (2013) on an ebony furniture collection of the Tropenmuseum, several wood samples previously thought as ebony turned out different. Out of the 44 items once thought to be ebony or calamander, only 14 turned out to be wholly or partially composed of these species. The analyses revealed the presence of a wide range of other wood types, including: red sandalwood (*Pterocarpus santalinus*), padouk (*Pterocarpus indicus*), Indian rosewood (*Dalbergia latifolia*), East Indian satinwood (*Chloroxylon swietenia*), oelin (*Eusideroxylon zwageri*), teak (*Tectona grandis*), nangka (*Artocarpus* sp.), tandjoeng (*Mimusops elengi*), and gerongang (*Cratoxylum* sp.), most of which are endemic to Southeast Asia. Red sandalwood, however, originates from southern India. Interestingly, the objects made from red sandalwood were found to be covered with a black finish. This is a striking result, since red sandalwood itself was already considered a costly and prestigious material, raising the question of why such an expensive wood would be concealed beneath a blackened surface.⁶³ Fabri also mentions that green ebony (*Bignonia leucoxylon*) was used as a cheaper alternative for ebony.⁶⁴

⁶² Benham et al., *Taxus Baccata in Europe: Distribution, Habitat, Usage and Threats* (n.d.).

⁶³ Dave van Gompel et al., *Furniture from the Netherlands East Indies 1600-1900 : A Historical Perspective Based on the Collection of the Tropenmuseum* (KIT Publishers, 2013), WorldCat. 77-80.

⁶⁴ Fabri, *De 17de-eeuwse Antwerpse kunstkast : typologische en historische aspecten*. 39-40.

1.7.2 Baleen

In the Boijmans Van Beuningen Museum stands a cabinet featuring black, figured drawer fronts. At first glance, these appear to be carved from ebony. However, all the drawer fronts are nearly identical, suggesting a different technique and material. This cabinet was made by the Dutch ébéniste Herman Doomer (1595-1650). Remarkably, not only do we know the maker, but the black material used is a substance derived from one of the largest animals in the world: the whale.



Figure 12: Cabinet in ebony and baleen by Herman Doomer, 17th century © Museum Boijmans Van Beuningen

The Netherlands began whale hunting from the 17th century to the end of the 18th century. The initial reason for hunting whales was their oil. Besides the oil, baleen was harvested. Baleen whales do not have teeth, they use baleen instead to act as a filter in the mouth of the whale. It traps small organisms like fish and krill, which the whale feeds on.⁶⁵ The size of a baleen plate varies per species and between individuals, but the dimensions vary between 12-55 centimeters wide and a length of 0,2 to 5 meters.⁶⁶ Lyall Watson describes that the color varies between whale species, the Greenland whale has plates that are dark olive grey in contrast to the North Atlantic whale, which are dark grey to black.⁶⁷

The baleen was first considered a byproduct and was in the beginning used as building material.⁶⁸ The Noordsche Compagnie asked Johannes Osborn, an ivory and horn worker, to investigate if the baleen could be used for a more valuable purpose. In 1618 Osborn was granted a patent by the Dutch State-General to prepare baleen, which the last patent ending in 1630.⁶⁹ H. A. Rooswinckel was granted an octroi to process baleen for broader uses: planing and decorative function for furniture and other purposes. Again, the link with ebony was stated within the octroi.⁷⁰ Once it is potential was discovered for

⁶⁵ Marloes Rijkelijkhuisen, *Handleiding voor de determinatie van harde dierlijke materialen : bot, gewei, ivoor, hoorn, schildpad, balein en hoef* (Amsterdam University Press Amsterdam, 2008). 73.

⁶⁶ Rijkelijkhuisen, *Handleiding voor de determinatie van harde dierlijke materialen : bot, gewei, ivoor, hoorn, schildpad, balein en hoef*. 77.

⁶⁷ L. Watson, *Sea Guide to Whales of the World* (Dutton, 1981), <https://books.google.be/books?id=MAwXAQAAIAAJ>. 70,72.

⁶⁸ Hacquebord and Vroom 1988, pp. 52–53)

⁶⁹ S. Muller, 'John Osborn', in: *Oud Holland* 33 (1915), pp. 206-207.

⁷⁰ Scheurleer, "Het Amsterdamse St.-Jozefsgilde, in het bijzonder met betrekking tot de meubelmakers." 37.

other crafts, the prices rose. The baleen was shipped and processed in Amsterdam. Where it was mainly used for corset strips, as they were stiff, thermoplastic and durable. The trade was big enough that specialized craftsmen were solely focused on processing the baleen.

Baleen is a hard, black and thermoplastic material. Iskander Breebaart and Gert van Gerven tested this and came to the result that the baleen does not necessarily need a black finish to imitate the ebony.⁷¹ Osborn incorporated the technique to make various medallions and reliefs by pressing heated baleen into metal molds.⁷² Some of the pressed baleen were painted black. The octroi given to Osborn and Rooswinckel also issues that the baleen was allowed to be used like it was an ebony species or a similar wood.⁷³ Which is known to have been the case on frames and cabinets.⁷⁴ In 1641 Doomer and his son were granted the patent of making pressed Baleen. There is a possibility that Doomer knew Osborn and incorporated his technique into his cabinets.⁷⁵ Various ébénistes in Amsterdam have used baleen as a veneer for frames. Besides veneered and pressed, it was also planed. The work of Thiel and Bruyn Kops on inventories of the 17th century frames, shows 50 references of baleen veneered frames in contrast to 260 references of ebony veneered frames.⁷⁶ In present day, different frames with pressed baleen can be found in different institutions, but on cabinets it remains scarce.⁷⁷

The use of baleen by Antwerp ébénistes remains unclear. Fabri does not mention it in her work, and evidence for its application is limited. In a rare case, Posson identified a keratinous material on a 17th-century Calvary cross. She suggests that the object was likely produced by ébénistes and tentatively proposes baleen as a possible material. However, this identification was not confirmed analytically, and therefore remains unproven.⁷⁸ In contrast to Amsterdam, Antwerp didn't have direct access to baleen and were mainly reliable on trading to access the baleen. After Osborn's and Doomer's death with the combination of the bankruptcy in 1645 of the Noordsche Compagnie, the use of baleen in veneer and pressed form declined.⁷⁹

⁷¹ Breebaart et al., "Pressed Baleen and Fan-Shaped Ripple Mouldings by Herman Doomer." 72.

⁷² In addition to the overview given by: Van Thiel (1969), Van Zuiden (1915), S. Muller (1915) and N. Roever, *Johannes Osborn, In: Oud Holland Pressed baleen and fan-shaped ripple mouldings by Herman Doomer 73 5 (1887), pp. 309-312, there is the portrait of Amalia von Solms the collection of Institut Néerlandais, Paris and the portrait of Frederik Hendrik in the Statens Museum for Kunst, Copenhagen.*

⁷³ Thiel and Bruyn Kops, *Prijst de lijst : de Hollandse schilderijlijst in de zeventiende eeuw.* 43.

⁷⁴ (Lootsma 1937, pp. 165–167; Muller 1915; van Thiel 1969; van Thiel and de Bruyn Kops 1984)

⁷⁵ Nationaal Archief Den Haag, Staten van Holland, Inventaris nr. 1599. See also: P.J. van Thiel, 'Hollandse lijsten van balein, Bekends en onbekends over Jan Osborn en zijn octrooi'. In: Zadoks-Josephus Jitta e.a. (eds.), *Miscellanea I.Q. van Regteren Altena, Amsterdam, 1969, pp. 104-110.* G. Doorman, *Octrooien voor de uitvindingen in de Nederlanden uit de 16e-18e eeuw. Met besprekingen van enkele onderwerpen uit de geschiedenis der techniek, Den Haag, 1940.* J.G. van Dillen, *Bronnen tot de geschiedenis van het bedrijfsleven en het gildenwezen van Amsterdam, II, Den Haag, 1933, No 1035, 936, 929, 928, 680.* 16 See Van Dillen, o

⁷⁶ Thiel and Bruyn Kops, *Prijst de lijst : de Hollandse schilderijlijst in de zeventiende eeuw.* 42-43.

⁷⁷ Thiel and Bruyn Kops, *Prijst de lijst : de Hollandse schilderijlijst in de zeventiende eeuw.* 158. And also complementary description in H. E. van Gelder and S. MULLER, "JOHANNES OSBORN," *Oud Holland*, n.d.

⁷⁸ Nathalie Posson, *Dossier Calvariekruis Carolus Borromeuskerk, Vooronderzoek En Restauratie-Behandeling* (Antwerpen, 2023). 32-36.

⁷⁹ Thiel and Bruyn Kops, *Prijst de lijst : de Hollandse schilderijlijst in de zeventiende eeuw.* 159.

1.8 Ebonizing

Ebonizing is a process aimed at altering the outer surface of a material to give it the appearance of black ebony.⁸⁰ There are several techniques to achieve this effect. For this thesis, a distinction is made between chemical staining, pigments, and carbonizing. With chemical staining, a chemical reaction is induced that causes the wood fibers themselves to turn black. This creates a darkened layer in the upper part of the wood, while preserving the visibility of the natural wood grain. The application of pigments will result in a black surface layer, which requires the use of a binding medium, pigments and a solvent. This technique can obscure or even completely conceal the wood grain. Finally, carbonizing involves heating the wood until the surface becomes charred, producing a blackened appearance that should resemble ebony.⁸¹ In the following chapter a closer look will be taken in ebonizing, but before explaining this, a brief introduction is given about the context of historical ebonizing recipes.

1.8.1 Historical ebonizing recipes

As described earlier, ebony imitation was a restricted practice among *ébénistes* affiliated with guilds. It is possible that for that reason, no recipes or practical guidelines written by *ébénistes* have been found. Nevertheless, numerous historical recipes for creating ebony imitations appear in secret or magic books. This type of book gained popularity from the 16th to the 18th century. These works emerged within the context of Renaissance humanistic science, which aimed to understand and document nature's processes through observation and practical experimentation. The titles of these books often include the word "Secrets": the recipes describe (scientific) mechanisms that were not fully understood at the time, and sometimes remain obscure today.⁸² On the other hand, as G. Long argues, the contents of these books were not necessarily secret to the public. Instead, they often served as compilations of existing knowledge from various crafts.⁸³ A single book can contain over 300 recipes on a wide range of topics: from curing headaches, making ink, preparing dyes and ointments, to brewing love potions. Which results in a sort of encyclopedic overview.

One of the early and well-known authors of such a book was Alessio Piemontese. His book: "*I Secreti del Reverendo Donno*", was first published in Venice (1555) and then in Antwerp (1558), with reprints continuing as late as 1755.⁸⁴ One of the recipes in his book describes how to make an ebony imitation, that is indistinguishable from real ebony.⁸⁵ This shows that ebony imitation was already practiced at the

⁸⁰ The definition of the term "ebonizing" is somewhat ambiguous. According to the Merriam-Webster Dictionary, it refers to the act of staining wood black in order to resemble ebony. Merriam-Webster.com Dictionary, s.v. "ebonize," accessed August 19, 2025, <https://www.merriam-webster.com/dictionary/ebonize>. For this instance, the term ebonizing will be used not only to address a dye or a chemical stain but also carbonizing.

⁸¹ It is important to note that black dyes also exist. Unlike chemical stains, dyes are already colored substances that are absorbed directly into the wood fibers. This technique produces a black tone by penetration rather than chemical alteration. However, this procedure falls outside the scope of the present thesis.

⁸² William Eamon, *Books of Secrets and Vernacular Knowledge* (2022), 216–22, https://doi.org/10.1007/978-3-319-31069-5_240. 1-5.

⁸³ Pamela O. Long, "The Openness of Knowledge: An Ideal and Its Context in 16th-Century Writings on Mining and Metallurgy," in *The History of Science in a World of Readers* (Max-Planck-Gesellschaft zur Förderung der Wissenschaften, 2019), <https://doi.org/10.34663/9783945561430-02>. 321.

⁸⁴ Society for the Diffusion of Useful Knowledge (Great Britain) and G. Long, *The Biographical Dictionary of the Society for the Diffusion of Useful Knowledge*– (Longman, Brown, Green, and Longmans, 1842).), 827.

⁸⁵ G. Ruscelli, *De Secreten van [...] Alexis Piemontois, Inhoudende Seer Excellente En[de] Wel Gheapprobeerde Remedien, Teghen Veelderhande Cranckheden, Wonden, En[de] Andere Accidenten*. (by Ian van Waesberghen, 1571), <https://books.google.be/books?id=AYRbAAAAQAAJ>. 101-102

end of the 16th century and seen as a valuable craft. In the Netherlands, Carel Baten (1540–1617) was a town physician whose works primarily dealt with medical treatments and remedies.⁸⁶ He included the same recipe for imitation in his “Secreetboek van vele diverse en heerlijke kunsten”.⁸⁷ In reality, it is not uncommon to find authors copying recipes from one another, sometimes without citation.

These kind of books were used by both intellectuals and ordinary people, often for practical and everyday purposes. However, they also attracted readers such as artists, alchemists, and early investors, people willing to dedicate time and resources in pursuit of professional or financial gain.⁸⁸ Their practical and accessible knowledge appealed to a wide audience and covered a broad spectrum of crafts, making them an important emerging source of knowledge in the development of early modern science.

For this thesis, seven historical recipes originating from such books were used, ranging from the 17th to the 18th century. These recipes differ in authorship, region, and formulation. In result, these recipes offer valuable insights, but they must be examined critically concerning their authorship, origin and target audience. Even if a book is dated to a certain region and period, this does not necessarily mean that the recipe itself originates from that specific historical or geographical context.

⁸⁶ Klaas Hoogendoorn, *Bibliography of the Exact Sciences in the Low Countries from ca. 1470 to the Golden Age (1700)* (Brill, 2018), WorldCat. 83-85.

⁸⁷ Carel Baten, *Secreet-boeck van vele diversche en heerlicke consten in veelderleye materien : met veel remedien teghen de innerlijcke en uytterlijcke gebreken der menschen : wt Latijnsche, Francoische, Hooghduytsche ende Nederduytsche autheuren vergardert* (Voor loost Hartgersz, boeckverkooper ..., 1650), WorldCat. 192.

⁸⁸ Eamon, *Books of Secrets and Vernacular Knowledge*. tells that both households as intellects use the secret books, in contrast to Pamela O. Long, “The Openness of Knowledge: An Ideal and Its Context in 16th-Century Writings on Mining and Metallurgy.” Who discusses that even investors and patrons were the aim public.

1.8.2 Chemical staining

Chemical staining is a process in which a chemical reaction takes place within the wood itself. By applying a chemical stain, the upper layer of the wood can be darkened to a deep black. An essential advantage of this method is that the wood grain remains visible. Therefore, if a substrate with a grain pattern similar to ebony is selected, a convincing imitation can be achieved. The appearance of a chemical stain depends on both the composition of the solution and the characteristics of the wood. Different solutions produce different shades of black, and the success of the staining process varies among wood species because the concentration and distribution of chemical elements differ not only between species but also between individual specimens of the same species (as will be further discussed). Among the historical techniques for ebony imitation, chemical staining appears to be the most frequently used. Of the seven historical recipes analyzed, five rely primarily on chemical staining.

The chemical part of chemical staining

Chemical staining is a coloring process that relies on tannins that are naturally present in wood. These tannins can react with a metallic salt, causing the wood surface to turn blue/black. The tannins are a group of different organic acids: tannic acid (contains Quercitannic acid and Gallo tannic acid), gallic acid and ellagic acid.⁸⁹ The tannins are polyphenols that have hydroxyl groups in ortho positions. These groups in the tannin molecules can chelate when they are exposed to metal ions like Fe^+ and Cu^+ . When this process occurs, the pH level drops due to the deprotonation of hydrogen. The higher the tannin concentration in the wood, the darker it can get on its own.⁹⁰

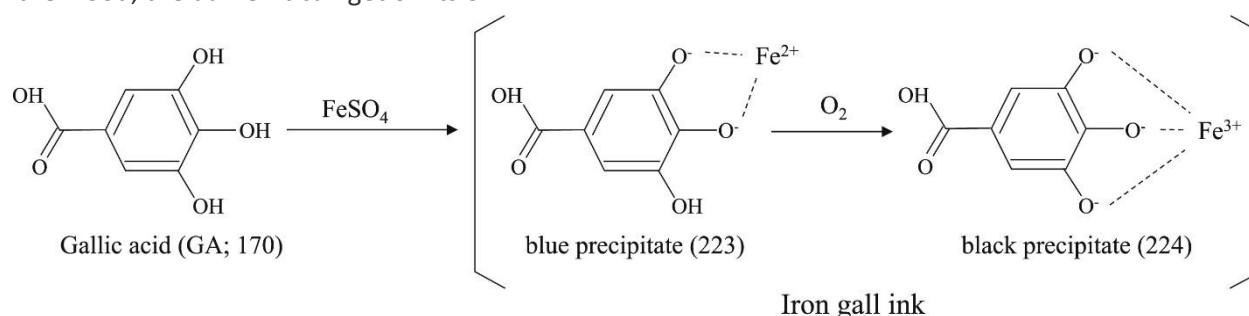


Figure 13: An overall formula for the reaction of gallic acid and iron (II) sulfate (FeSO_4), the major component of iron gall ink. © Hsu et al. (2020)

The anion is the negative counterpart of the salt and will behave as a proton acceptor. Two (or three) hydrogen atoms from the tannic acid will bind to the anion and the cation will take its place. When exposed to air, the Fe(II) polyphenol complexes oxidizes to Fe(III) , as this is more stable and will turn into

⁸⁹ Tree's produce tannins to defend themselves against biological infestation as organisms avoid the tannins because they disrupt their digestive processes. The amount of tannins in the tree differs between species, oak tree's by example have a high tannin concentration (with low insect infestation). The tannin concentration can also differ between individuals; some individuals were more prone to be attacked in a certain region and thus developed more tannins in their lifetime. Also, the age of a tree can determine how much tannins are present. At last, the polyphenols concentration of tannins differs also on the location of the tree. Annual shoots would have a higher content of tannins compared to 6–12-year-old branches of the same tree. See S Yu Shubkin et al., "Comparative Content of Biologically Active Substances in Wood Species of the North of the Forest Steppe on the Example of Lipetsk Region," *IOP Conference Series: Earth and Environmental Science* 677, no. 2 (2021): 022018, <https://doi.org/10.1088/1755-1315/677/2/022018>. 2.

⁹⁰ If a wood specie does not contain enough tannins or if a darker black is desired, some recipes mention to use gallnuts or tea to increase its tannin concentration.

a darker black. This exact chemical reaction is still not exactly defined, but Figure 13 shows its result.⁹¹ The speed of this autooxidation and the quantity depend on the anion. With Fe(II)sulfate, the autooxidation is slower, and fewer Fe(III) complexes are formed. With Fe(III)acetate, darker colors can be achieved as Fe(III) is already present. In result, Fe(II)chloride and Fe(III)acetate will result in darker black tones compared to Fe(II)Sulfate and Fe(II)Gluconate.⁹² Inorganic phosphate can act as a catalyst, speeding up the reaction when used with acetic acid. Phosphate is naturally present in vinegar and blocks the crystallization of iron, which would otherwise slow down the reaction.⁹³ Alum ($KAl(SO_4)_2 \cdot 12H_2O$) can be added to a staining solution to increase the concentration of the anion SO_4 . An excess of acid is necessary to ensure effective staining, as maintaining a sufficiently high hydrogen ion concentration (low pH) is required for the chemical reaction to proceed. If the solution is applied, only the upper layer of the wood will be stained. This is shown by Canevari et al. (2016), who found that an iron-based stain penetrated the wood to a depth of 1,0 to 1,5 millimeters when analyzed with an optical microscope. When analyzed with SEM-EDX, iron content was measured up to 0,70 millimeter, with the highest concentration in the first 0,30 millimeter.⁹⁴

Chemically staining ebony

As discussed earlier, ebony is not always completely black. In the 17th century, the Dutch naturalist Rumphius also observed that not all ebony species were jet black. To achieve a deeper black tone in objects, he described a method for enhancing ebony's color by staining and polishing it.⁹⁵ Fabri found suggestions in historical sources that ebony was colored by craftsmen.⁹⁶

*"... that worked ebony often has a dull color and no shine, but must acquire it through staining and polishing. The staining is done with the best ink, in which some boil shavings of sappanwood and a bit of alum, to give the blackness a more lustrous purplish sheen. After applying this once or twice, or even three times, the wood must be polished - first with hard brushes, then with soft ones, and finally with a woolen cloth and a bit of wax."*⁹⁷

⁹¹ Yu-Ting Hsu et al., "Insights into the Chemistry and Structure of Iron Gall Ink Based on 'Two-Step' Bamboo Nib-Spray/Mass Spectrometry," *International Journal of Mass Spectrometry* 451 (May 2020): 116325, <https://doi.org/10.1016/j.ijms.2020.116325>. 1, 3.

⁹² Robert Q. Thompson, "Iron Acetate Solution Prepared from Steel Wool and Vinegar for Ebonizing Wood," *Journal of Wood Science* 69, no. 1 (2023): 7, <https://doi.org/10.1186/s10086-023-02079-0>. 2.

⁹³ Thompson, "Iron Acetate Solution Prepared from Steel Wool and Vinegar for Ebonizing Wood." 7.

⁹⁴ Claudio Canevari et al., "Chemical Characterization of Wood Samples Colored with Iron Inks: Insights into the Ancient Techniques of Wood Coloring," *Wood Science and Technology* 50, no. 5 (2016): 1057–70, <https://doi.org/10.1007/s00226-016-0832-2>. 1067.

⁹⁵ Georg Eberhard Rumpf et al., *Het amboinsch kruid-boek : dat is, beschryving van de meest bekende boomen, heesters, kruiden, land- en water-planten, die men in Amboina, en de omleggende vind* (1750), WorldCat. 5.

⁹⁶ Fabri, *De 17de-eeuwse Antwerpse kunstkast : typologische en historische aspecten*. 39.

⁹⁷ Rumpf et al., *Het amboinsch kruid-boek : dat is, beschryving van de meest bekende boomen, heesters, kruiden, land- en water-planten, die men in Amboina, en de omleggende vind*. 5. *dat bet verfch-gewerkte Ebbenbout een dootze koleur , en geen glans beeft, maar den zelve verkrygen moet met aanftryken en polyften. Het aanftryken gefchiet met de befte inkt , daar in zommige de fpaanders van Sappanbout en wat Aluyn koken , om de fwartigheit met een purpere glans te meer luifter te geven: dit zoo twee a driemaal aangefctreken zynde , moet men 't bout polyften, - eerft met barde, daar na met zachte boenders , en ten laat- ften met een wollen lap, en een weinig was. 5.*

Example of a historical chemical staining recipe

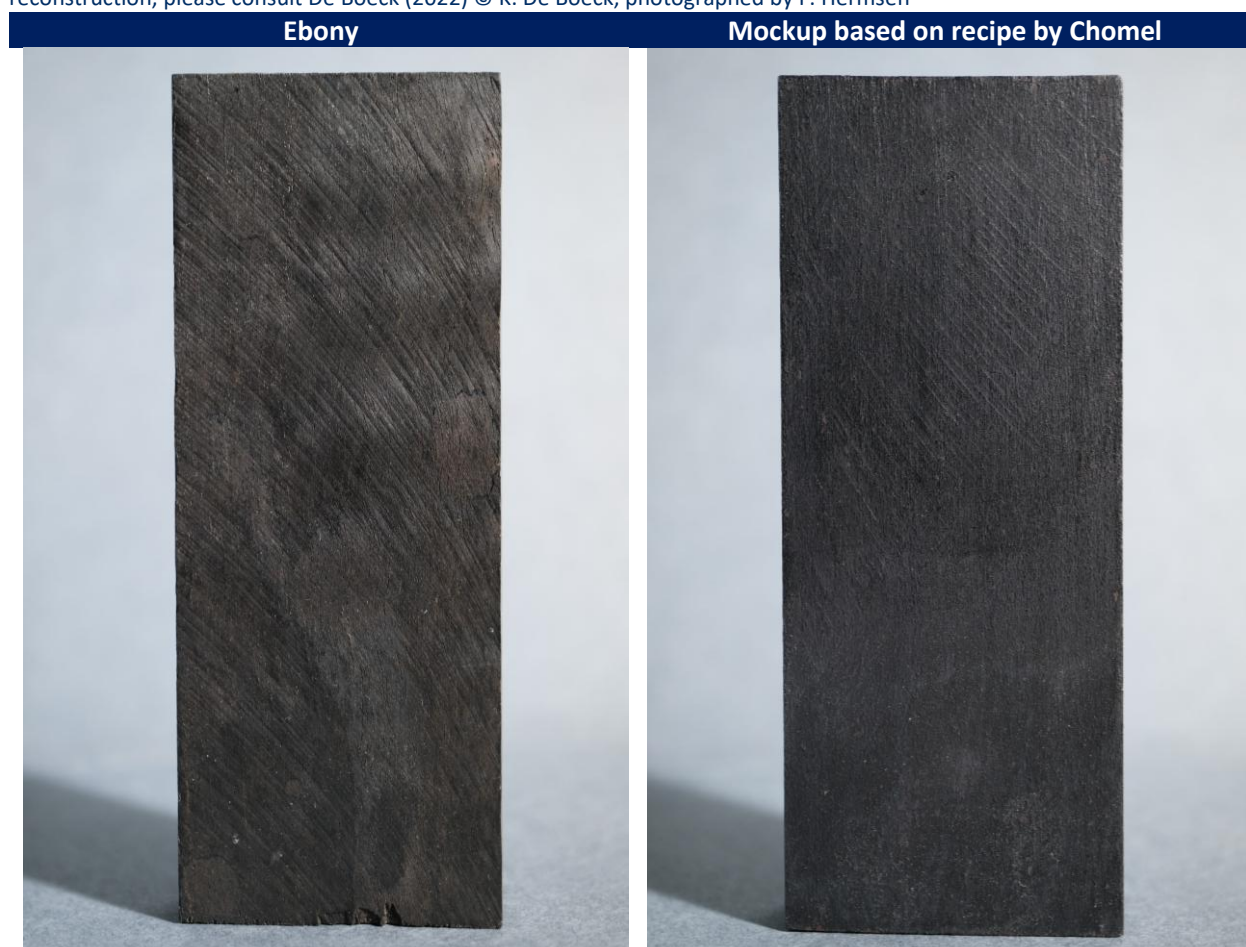
Table 1 presents a recipe described by Chomel in 1778. Although 17th-century staining recipes also exist, this particular example was chosen because it was reconstructed by De Boeck (2022), allowing the results to be verified. To execute the recipe, one begins by selecting a recommended wood species. The surface is first smoothed with horsetail and then cleaned with a cloth. Next, gallnuts, logwood, vitriol and verdigris are ground in the required proportions. These ingredients are placed in a pot with either vinegar or water, boiled, and subsequently strained. The warm mixture is applied to the wood three or four times, allowing each coat to dry completely before the next is applied.

The inclusion of gallnuts and logwood increases the tannin content, thereby enhancing the depth of the black color, as these components will function as dyes. Vitriol and verdigris act as proton donor and acceptor within the staining reaction. De Boeck (2022) prepared two variations of the recipe: one using water and one using vinegar. Because vinegar can act as an additional proton acceptor, the resulting mock-ups were noticeably darker than those produced with water. By varying the number of applied layers, the intensity of the black could be controlled. See Table 2 for the result of the mockup, using vinegar. This achieves very convincing results compared to the ebony mockup.

Table 1: Recipe of Chomel in Algemeen huishoudelijk-, natuur-, Zede kundig- en konst-woordenboek ..., Volume 2 (1778), p 1155. On the left you have the literal transcribed text in Dutch. On the right you have a translated version in English.

Original text	Free English translation
Om het Ebben-hout natebootzen <i>Het hout dat men hiertoe wilt gebruiken, moet vast, glad en zonder adren zijn; dienende dus hier toe best het hout van appel-boomen, peer bomen, cornoelje, haag-boeke, hulst, enz, en het zelve moet voor het verwen de gedaante gegeven zijn, die het zal hebben, en met paardestaart en een lap wel glad gepolijst worden.</i> <i>Nog anders: Neemt vier oncen beste galnoten, en één once campechie-hout; een-vierde once vitriool, en een half once Spaansch groen; alles klein gemaakt zijn de, doet het zaamen in een nieuwe pot, met wat water of azijn, en kookt het wel, daar na warm doorgezigt zijnde, bestrijkt het hout hier mede warm, drie of meermaalen, na dat het telkens droog geworden is; zo zal het zeer zwart worden.</i>	To Imitate Ebony Wood The wood you want to use for this must be firm, smooth, and free of visible grain. The best woods for this purpose are apple, pear, dogwood, hornbeam, holly, and similar types. The wood must first be shaped into its final form, and then polished very smoothly with horsetail (equisetum) and a cloth before dyeing. Another method: Take four ounces of the best gallnuts, one ounce of logwood, a quarter-ounce of vitriol, and half an ounce of verdigris. Crush everything into small pieces and put it together in a new pot with some water or vinegar. Boil it well. Afterward, strain it while still warm, and brush the warm mixture onto the wood three or more times, allowing it to dry between each coat. By doing this, the wood will become very black.

Table 2: Results of the mockup (plum) made by De Boeck (2022) on the right. Compared to genuine ebony on the left. For the reconstruction, please consult De Boeck (2022) © K. De Boeck, photographed by F. Hermsen



1.8.3 Pigments

The use of pigments is a well-established practice in painting on wooden substrates like panels and wooden statues. Black pigments can be produced from various sources, often derived from burned organic or mineral materials. In contrast to chemical staining, the application of a pigmented paint layer, which requires a pigment, a binder, and a solvent, typically obscures the wood grain, making the substrate's natural structure less visible. An advantage of this method is that the color can be applied more easily and uniformly, whereas staining and carbonizing generally require preparation of the wooden surface. The following subsection provides a brief overview of black pigments, commonly used binders, and a relevant historical recipe.

Pigment use

Lamp black is a standard pigment used for black paint, it originates from burned wood. Besides this, pigments such as ivory black and bone black also exist, which are burned animal materials like bones and ivory. There is a difference between these carbon blacks, as their weight and structure differ. Bone black has a content (up to 80%) of calcium phosphate, 20 % carbon, and calcium carbonate. The pigments can be used in oil or in gesso. Besides this, other blackish pigments existed, such as bistre, asphalt, and vine black.⁹⁸ Michaelsen (2009) mentions that on nine German cabinets this technique has been found to imitate ebony. On one cabinet, a black-brown glaze was found, made of asphalt mixed with linseed oil, and applied over a preparatory glue layer. Seven other South German cabinets were examined, which showed the use of treated pear wood with asphalt or mummy brown. At last, a cabinet made in Thuringia showed the use of lampblack in combination with a water-based medium.⁹⁹

Example of a historical recipe – To imitate ebony, LeBrun (1635)

In 1635, the painter Pierre Lebrun describes, in a Brussels manuscript, a compilation of marvelous recipes for painting, including one for making ebony wood (Table 3). First, lamp black, ink, and a bit of glue. This was all stirred. Instead of glue, vinegar could also be used. The solution should be applied three or four times, and once it is totally dry, the wood needs to be polished. In the end, a wax cloth or wax was applied to create a smooth finish.¹⁰⁰ This recipe is not fully pigment-based, as iron-gall ink combined with vinegar can also be used to stain wood. But in this rapid sequence, it is rather a pigment-based recipe. In ink, a binder such as gum Arabic is present. By analyzing the result of the recipe, the use of wax made the sample glossy. The grain is less evident than in the other two techniques, indicating a drawback for imitation, as shown in Table 4.

⁹⁸ E.B.F Pey and Ernst Homburg, *Een kabinet vol kleur : de collectie schildersmaterialen van de Amsterdamse verfhandelaar Michiel Hafkenscheid (1772-1846)* (Vantilt, 2018), WorldCat. 224-229.

⁹⁹ Michaelsen and Buchholz, *Vom Färben des Holzes Holzbeizen von der Antike bis in die Gegenwart: Literatur, Geschichte, Technologie, Rekonstruktion, 2000 Rezepturen*. 80-81.

¹⁰⁰ Lebrun, *Receuil des essais des merveilles de la peinture*, 1635. Recept: Pour contrefaire le bois d'ebene

Table 3: Recipe of Pierre Lebrun in Recueil des essais des merveilles de la peinture (1635), page 818. On the left you have the literal transcribed text in French. On the right you have a translated version in English.

Original text	Free English translation
Pour contrefaire le bois d'ebene <i>Pour contrefaire le bois d'ebene, on prend de noir de fumée avec de l'ancre, et un peu de colle meslée dedans, aucuns y mettent du vinaigre au lieu de la dite colle, puis on passe par dessus les moulures trois ou 4 fois avec la dite com position ; après on les frottes avec un chiffre ou jonq pour les polir, cela estant fait on les frottes avec un linge ciré ou avec un morceau de cire, pour les rendre luisantes comme ebene, s'il y a quelques taches, on les fait en aller avec des joncs à force de frotter.</i>	To Imitate Ebony Wood To imitate ebony, take lampblack mixed with ink and a little glue. Some people use vinegar instead of the glue. Then brush this mixture over the moldings three or four times. After that, rub them with a burnisher or a piece of rush to polish them. When this is done, rub them with a waxed cloth or a bit of wax to make them shine like ebony. If there are any spots or blemishes, remove them by rubbing hard with rushes

Table 4: Results of the mockup (pear) made by De Boeck (2022) on the right. Compared to genuine ebony on the left. For the reconstruction, please consult De Boeck (2022) ©K. De Boeck, photographed by F. Hermesen



1.8.4 Carbonizing

Carbonizing is a technique capable of producing a black color throughout the wooden substrate. To the author's knowledge, this method has not been identified on any 17th-century European cabinet. Nevertheless, it is included in this thesis because some historical recipes for ebony imitation explicitly describe carbonizing procedures.

Example of a historical recipe - How to Make Wood Look Like Ebony, as if it had grown that way. Carel Baten (1694)

In this recipe (Table 5), Baten instructs the craftsman to boil the wood in oil together with sulfur and vitriol.¹⁰¹ The process corresponds to the production of certain historical black pigments in which organic material is heated or burned to achieve carbonization. As a result, this method does not merely color the surface, as is the case with staining or pigmented coatings, but can blacken the entire cross-section of the wood. Baten warns against boiling the wood for too long, as this would cause the material to become brittle. This observation is confirmed in the reproduced mock-up, which is noticeably more brittle than the others when sawn. Whether this technique is suitable for ebony imitation remains uncertain. The results are shown in Table 6.

Meiler (2000) also reconstructed a carbonizing recipe, from 1262. He concluded that the use of oil improves the aesthetic appearance of the treated wood. However, similar to Batens' description, the resulting material became brittle and uniformly black throughout. An additional finding by Meiler was that, due to the high oil content, the treated wood could no longer be glued effectively, rendering the technique impractical for joinery or veneering.¹⁰²

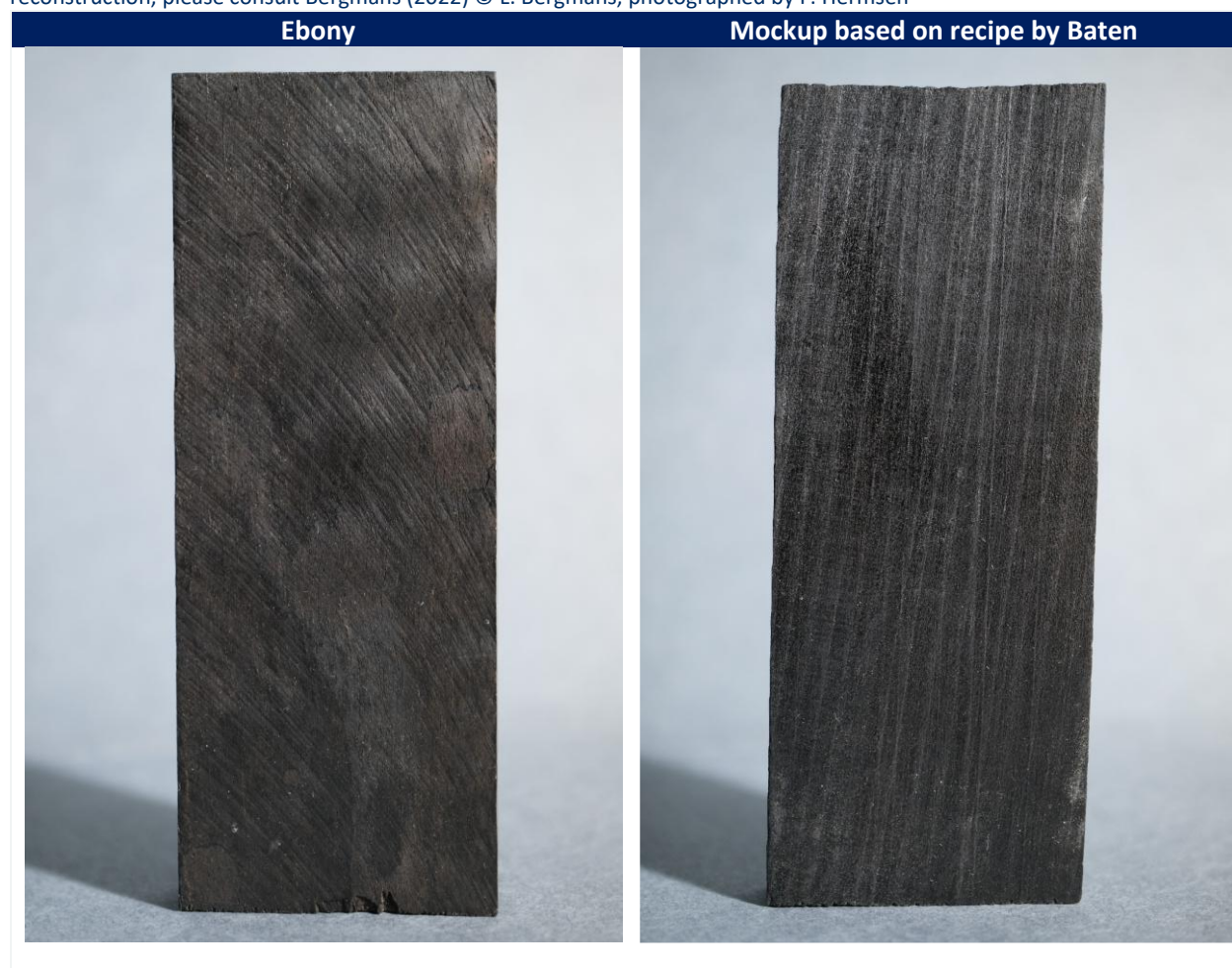
¹⁰¹ Baten, *Secreet-boeck van vele diverse en heerlicke consten in veelderleye materien : met weel remedien teghen de innerlijcke en uytterlijcke gebreken der menschen : wt Latijnsche, Francoische, Hooghduytsche ende Nederduytsche autheuren vergardert.*: Om Ebbenhout te maken, gelijk oft alsoo gewassen ware.

¹⁰² Josef A. Meiler, "Holzarten zur imitation von ebenholz" (Institut für Restaurierung und Baudenkmalpflege der Fachhochschule Hildesheim / Holzminden, 2000). 92.

Table 5: Recipe of Carel Baten in *Het secrete-boeck vol heerlijke konsten* (1694), page 202. On the left you have the literal transcribed text in dutch. On the right you have a translated version in English.

Original text	Free English translation
<i>Om Ebbenhout te maken, gelijk oft alsoo gewassen ware</i> <i>Alle hout dat hart, klaer, en wichtigh is, kan tot forme van Ebben-hout gemaekt worden, gelijck als Esschen hout, Ceder-hout, Moerbesi-hout, ofte Pock-hout, op dese maniere:</i> <i>Neemt eenige stucken deses houts, legtse te weycke drie ofte vier dagen langh, in Aluyn-water, stellet op een warme plaetse, op dattet altijt magh warm blijven: daer naer soo ziedet in Olie, daer in dat een hasenoot groot Vitriols en Solfers gesmeten is, een ure langh ofte weynigh min, want hoe datmen 't langer ziedet, hoe dattet zwarter worden sal, dan</i> <i>al te lange en is ook niet goet, mits dattet daer door brandigh, en al te kort-brekigh worden soude, want ist van passe gezoden, soo sal 't uytnemende swart wesen.</i>	How to Make Wood Look Like Ebony, as if it had grown that way Any wood that is firm, sound, and heavy can be made to resemble ebony, such as ash, cedar, mulberry, or pockwood, by using the following method: Take some pieces of this wood and soak them for three or four days in alum-water, placing them somewhere warm so that they stay warm the whole time. After that, boil them in oil into which you have thrown a hazelnut-sized piece of vitriol and sulfur. Boil the wood for about an hour, or a little less. The longer you boil it, the blacker it will become. But boiling it for too long is not good, because then the wood may become scorched and brittle. When it has been boiled just the right amount, it will be exceedingly black.

Table 6: Results of the mockup (apple) made by Bergmans (2022) on the right. Compared to genuine ebony on the left. For the reconstruction, please consult Bergmans (2022) © L. Bergmans, photographed by F. Hermesen



2 State of the Art

In this chapter, contemporary research concerning 17th-century (Flemish) cabinets, their wood types, and ebony imitation will be discussed. This thesis is situated within the FED-tWIN HOME-AGE project (2019–2025) led by Prof. Vincent Cattersel, under which several students from the University of Antwerp have conducted research on 17th-century Flemish cabinets. These include both bachelor's and master's theses by De Boeck (2022, 2024), Bergmans (2022), Nijs (2024), and Van Meenen (2024). In addition, related studies from other institutions contribute to this field, such as Dijkstra (2024, University of Amsterdam), Meiler (2000, Hornemann Institute), and Herzinger (2025, Hildesheim University of Applied Sciences). While some of the results have already been introduced in the previous chapter, this chapter focuses specifically on the studies in their total context that are dedicated to the topic. The following section presents in-depth, targeted research that provides a broader and more systematic understanding of the materials and techniques used in 17th-century cabinetmaking. The State of the Art is divided into three main sections:

- Ebony and imitation substrates in 17th-century cabinets, which include both analytical and archival research
- Coloration and imitation of ebony, focusing on analytical measurements of color and staining techniques
- Reproductions of historical recipes, addressing reconstructions of ebony imitation and varnish preparation.

These three sections are followed by a comparative overview that integrates historical findings with material evidence from the State of the Art to establish expectations for the analytical results of this study. Finally, the chapter concludes with a discussion of the identified lacunae, leading into the problem statement and the relevance of the chosen research topic.

2.1 Ebony and woods on 17th-century cabinets

Vadim Van Meenen – 2024 “Tracing the roots of Antwerp’s black gold” Identification of ebony (*Diospyros*) and other tropical black wood species on 17th century Flemish cabinets

Van Meenen conducted research on identifying ebony in 17th-century Flemish cabinets. His aim was to determine the wood species, specifically below the general classification of “ebony.” To achieve this, he employed a combination of Scanning Electron Microscopy (SEM) and Direct Analysis in Real Time Time-of-Flight Mass Spectrometry (DART-TOFMS). Fifteen cabinets from Belgian and Dutch museums were sampled. Using SEM, he first examined whether the wood anatomy corresponded to that of *Diospyros* sp. (the ebony genus). Next, DART-TOFMS analyses were carried out to attempt species-level identification. The results showed that two samples could be confirmed as *Diospyros*, although the exact species could not be determined. A third sample was identified as *Dalbergia melanoxylon* (African blackwood). The remaining samples could not be conclusively identified, primarily due to the lack of suitable reference

spectra in databases. Another possible explanation for these inconclusive results is historical contamination or alteration, which may have affected the DART readings.¹⁰³

Despite the analytical limitations, Van Meenen demonstrates through historical and modern literature that the geographic origin of ebony was broader than traditionally assumed. In the 16th century, Flemish cabinetmakers initially acquired ebony through Portuguese trade networks, sourcing from the East and West Indies. In the 17th century, this shifted to Dutch trade, with ebony being imported from regions such as Mauritius and Santo Domingo. Additionally, Van Meenen provides an overview of African and Asian regions associated with ebony production. He also emphasizes that historical sources must be critically examined with regard to taxonomic nomenclature. Historical descriptions of tree species are often problematic due to inconsistencies in terminology, geographic misunderstandings, and the changing meaning of names over time and across authors. Therefore, historical accounts of wood species require careful interpretation.¹⁰⁴

Kim De Boeck – 2024 “Antwerp Cabinets Uncovered” Material-technical research into the construction and materials of (art) cabinets produced in the Southern Netherlands during the 17th and 18th centuries

De Boeck conducted a literature review and material research on 17th-century Flemish cabinets. In her review, she analyzed the work of Fabri, Duverger, Van Herck, and Denucé. From these authors, she gathered information regarding construction techniques, wood species, and joinery. These researchers transcribed 17th- and 18th-century inventories and trade documents: such as letters, invoices, delivery notes, and other archival sources. Her research demonstrated that historical sources mention a wide variety of woods used in cabinetmaking. Out of the literature review, ebony appeared most frequently, with 114 references. The second most common term was “herthout” (49 references), which is thought to be a synonym for hardwood, such as oak and walnut. Cabinets made of (painted) Spanish wood were mentioned 11 times. In total, she recorded 30 different types or names of woods. Her findings also indicate a peak in historical sources referring to cabinets between 1640 and 1650, suggesting a bloom in cabinet production.¹⁰⁵

She also examined online metadata from 28 cabinets. Of these, 46% mentioned ebony, sometimes in combination with other materials, 39% mentioned ebony veneer, and 32% referred to ebonized wood. The remaining entries described blackened wood, oak, limewood, or pine. This diversity and ambiguity show how difficult it is to determine which wood type was actually meant and whether the author correctly identified the material. It is also often unclear whether the described wood refers to the veneer or the carcass.¹⁰⁶

In her conclusion, De Boeck suggests that herthout should be understood differently from inlay wood or joinery wood. She indicates that the term likely refers to oak or walnut, rather than an ebony species. She also stresses that online metadata should be approached critically, as wood may have been painted black

¹⁰³ Van Meenen, “Identificatie van Ebenhout (Diospyros) En Andere Tropische Zwarte Houtsoorten Op 17de -Eeuwse Vlaamse Kabinetten.” 81-86.

¹⁰⁴ Van Meenen, “Identificatie van Ebenhout (Diospyros) En Andere Tropische Zwarte Houtsoorten Op 17de -Eeuwse Vlaamse Kabinetten.” 85-87.

¹⁰⁵ De Boeck, “Antwerpse Kabinetten Ontbloot.” 35-37, 47-49.

¹⁰⁶ De Boeck, “Antwerpse Kabinetten Ontbloot.” 38-39.

and material identification is often uncertain, an observation she also applies to the historical written sources.¹⁰⁷

Josef A. Meiler's - 2000 "Wood Species for the Imitation of Ebony" Historical Source Texts and Practical Implementations

As part of Josef Meiler's research, he conducted a comprehensive literature review in which he identified 88 sources discussing ebony imitation, dating from the 16th to the 20th century. For the 16th century, he found references to three types used as substitutes for ebony: boxwood (*Buxus*), cedar, and mulberry. For the 17th century, he identified nine additional wood types: pear, apple, olive, service tree (*Sorbus* species), cherry, elm, cedar, walnut, holly, and maple (in addition to those already mentioned for the 16th century).¹⁰⁸

Across the complete dataset of wood types documented between the 16th and 20th centuries, pear wood appeared most frequently (28.9%), followed by boxwood (10.9%) and oak (5.9%). In total, Meiler recorded 35 wood species historically used to imitate ebony. He notes that boxwood represents the earliest documented ebony substitute, with references dating back to 1262. Furthermore, Meiler provides descriptive notes on each wood type mentioned.¹⁰⁹

He emphasizes that compiling such an overview is complex, as many historical authors appear to have copied recipes from one another, leading to potential distortions in the data. He also points out that his overview is not exhaustive, since not all available sources could be included. In addition, historical wood names often contain topographical or regional references, which may cause confusion, as a single name might denote different wood species or vice versa. Meiler concludes that the broad range of identified species suggests that information on wood types in these historical sources must be approached critically.¹¹⁰

In addition to his literature review, Meiler conducted wood identification analyses on 16th- to 20th-century objects and produced reconstructions (the state of the art of which is discussed below). In total, 42 samples were taken from 25 objects. He also incorporated previously available data from the Rijksmuseum in Amsterdam and the Department of Wood Biology in Hamburg. The samples measured between 1 and 3 millimeters in size, and sections were prepared either by hand or using a microtome, depending on their dimensions, with a thickness of 20 µm. Wood identification was performed using a transmitted light microscope with magnifications of 100×, 200×, and 400×. For further methodological details, see Meiler's thesis.¹¹¹

Among these, one object dated to the 16th century and six to the 17th century. The imitation on the 16th-century object was identified as olive (*Olea europaea*). Of the 17th-century objects, a cabinet (1630–1640) and a frame (1652) were identified as belonging to the *Maloideae* subfamily (within *Rosaceae*, which includes fruitwoods). Another frame (1657) was also identified as *Maloideae*, but contained spruce as

¹⁰⁷ De Boeck, "Antwerpse Kabinetten Ontbloot." 47-48.

¹⁰⁸ Meiler, "Holzarten zur imitation von ebenholz." 32-33.

¹⁰⁹ Meiler, "Holzarten zur imitation von ebenholz." 36-49.

¹¹⁰ Meiler, "Holzarten zur imitation von ebenholz." 85-86.

¹¹¹ Meiler, "Holzarten zur imitation von ebenholz." 103-106.

well. A pulpit from 1681 contained logwood, while another late-17th-century frame contained *Aspidosperma* sp. Finally, a cabinet from the same period was again identified as *Maloideae*.¹¹²

Interestingly, his results show a predominance of pome fruitwoods, which aligns with their frequent mention in historical sources. The identification of olive wood also corresponds to his literature findings, suggesting that its use was not time-specific: the analyzed sample comes from a 16th-century object, whereas its first written description dates a century later. The identification of logwood is particularly noteworthy, as this wood species was primarily known for its use in textile dyeing. Although not mentioned in the analyzed literature until 1834, its presence here demonstrates an earlier application. Meiler further explains that the use of *Aspidosperma* sp. can be linked to its historical role as a substitute for boxwood, while the presence of spruce relates to earlier descriptions of coniferous “cedar” wood by H. J. Wecker in 1559.¹¹³

Although Meiler continues his analysis with earlier objects beyond the selected timeframe, his results illustrate the interpretative strength of combining historical and analytical data. He concludes that no definitive statements can be made regarding chronological trends in the use of specific woods for ebony imitation, as the available data are not suitable for quantitative analysis. However, he does observe that woods from the *Maloideae* family appear to have been preferred for ebony imitation.

¹¹² Meiler, “Holzarten zur imitation von ebenholz.” 111, 116, 118-119.

¹¹³ Meiler, “Holzarten zur imitation von ebenholz.” 120-122.

2.2 Measurements on coloring techniques

Nina Dijkstra – 2024 “Black and shining, and pleasing to the eye” Black chemical stains on Dutch 17th-century ebony furniture

Research conducted by Dijkstra provides evidence that ebony was stained in the 17th-century Northern Netherlands. A notable case study involves the Doomer cabinet (BK-2020-1), dated 1632 and housed in the Rijksmuseum. During its restoration, visual and analytical observations revealed clear indications of staining. While the back of a molding displayed natural ebony hues, these variations were absent on the visible front, suggesting a superficial treatment to create a more uniform appearance. XRF measurements taken from the molding confirmed the presence of iron and sulfur, indicative of iron-based staining. However, the spectra were not consistent across the object, implying that the stain was applied locally. Further supporting the theory of historical staining, the stain was detected on hidden construction wood, suggesting it occurred during the original production rather than during later restorations.¹¹⁴

Of the 50 measurements conducted across ten objects (including the Doomer cabinet and reference materials), nine measurements from five objects pointed toward the application of an iron stain. On a sixth object, copper sulfate was identified as the staining agent. Like the Doomer cabinet, the inconsistent presence of metals across measurement sites further supports the hypothesis of non-uniform, localized application. Additional staining tests on ebony reference samples demonstrated that while iron staining could produce a visually uniform black surface, subtle hue variations remained visible. Moreover, in all visually analyzed objects, the wood grain remained discernible, indicating that the stains did not obscure the wood's natural grain. Despite these findings, the study acknowledged key limitations, particularly the natural presence of iron in the reference ebony, which complicates the interpretation of results. However, the combination of elevated sulfur content alongside metal traces provided strong indications of artificial staining.¹¹⁵

Quirin Amadeus Herzinger - 2025 “An Originally Black Cabinet from the 17th Century” Reconstruction Attempts of Its Coloration

The master's thesis by Herzinger examines a (mid-) 17th-century stained cabinet from Augsburg. The interior of the cabinet is stained black, while on the exterior, the stain has largely disappeared. Herzinger notes that the black-stained veneer was likely intended to imitate ebony. The veneer is made of pearwood and measures up to 5 millimeters in thickness. The moldings were produced using the same type of machine discussed in the introduction.¹¹⁶

FTIR-FPA analysis revealed that the binding medium is protein-based, and significant amounts of wax were also detected. This suggests that the binder could have been egg white, casein, or animal glue. Based on additional solubility tests, animal glue was most likely used. The detected wax may have been applied to provide a glossy finish and serve as an isolating layer, functioning similarly to a varnish.¹¹⁷ The pXRF

¹¹⁴ Dijkstra, “Black and Shining, and Pleasing to the Eye, Black Chemical Stains on Dutch 17th Century Ebony Furniture.” 6-9.

¹¹⁵ Dijkstra, “Black and Shining, and Pleasing to the Eye, Black Chemical Stains on Dutch 17th Century Ebony Furniture.” 51.

¹¹⁶ Quirin Amadeus Herzinger Herzinger, “Rekonstruktionsversuche der Farbigkeit” (HAWK Hochschule für angewandte Wissenschaft und Kunst Hildesheim, 2025). 2.

¹¹⁷ Herzinger, “Rekonstruktionsversuche der Farbigkeit.” 15-17.

analysis detected small amounts of iron, potassium, aluminum, and sulfur. According to Herzinger, this may indicate the presence of an iron oxide pigment, an iron-containing additive, or an iron-based stain.¹¹⁸

2.3 Reproduction of historical recipes

Kim De Boeck – 2022 “Paint It Black” Methods for the Imitation of Ebony in the Southern Netherlands during the 17th and 18th Centuries

De Boeck completed her bachelor’s thesis on the reproduction of ebonizing recipes. In addition, she carried out pXRF analyses on cabinet ID.76 (see attachments). The results were not conclusive, which can be attributed to the variation in measurement location, including veneer, moldings, the back panel, and painted drawer fronts. In all cases, iron was detected. The measurements on the back panel showed the greatest variety of elements: sulfur, silicon, aluminum, potassium, calcium, and iron. No spectra were given.¹¹⁹

Furthermore, De Boeck identified seven historical recipes originating from the Southern Netherlands, published in the 17th and 18th centuries, which describe methods for painting wood black or imitating ebony. No manuscripts written by ebony workers themselves were found. In addition, she traced 35 recipes from German, French, and English sources. From these, she selected four recipes for reproduction, based on geographic origin, time period, presence of iron, availability of materials, and coloring method.¹²⁰

Her database allowed for a distinction between recipes describing the general blackening of wood and those specifically intended to imitate ebony. This resulted in 33 recipes for ebony imitation and 18 for coloring wood black. The sources also mentioned a wide range of wood substrates, 15 in total, including apple, walnut, and mulberry. Pearwood appeared most frequently, being mentioned in ten recipes.¹²¹

Five recipes were reconstructed and tested on four different wood types: pear, cherry, apple, and plum. The reconstructions were compared to ebony using the HART evolution tool. De Boeck notes that interpreting historical recipes can be challenging, and that not all reconstructions successfully imitated ebony, partly due to these interpretative difficulties. The two most successful results differed not only in wood substrate but also in coloring technique: one used paint, while the other employed a stain. This demonstrates that multiple approaches can effectively imitate ebony. De Boeck also highlights that the main differences between recipes lie in their degree of finishing, such as the use of horsetail, ivory dust, or beeswax.¹²²

¹¹⁸ Herzinger, “Rekonstruktionsversuche der Farbigkeit.” 15.

¹¹⁹ Kim De Boeck, “Ebbenhoutimitatiemethoden in de Zuidelijke Nederlanden tijdens de 17e en 18e eeuw” (Universiteit Antwerpen, 2022). 9-12.

¹²⁰ De Boeck, “Ebbenhoutimitatiemethoden in de Zuidelijke Nederlanden tijdens de 17e en 18e eeuw.” 13-18.

¹²¹ De Boeck, “Ebbenhoutimitatiemethoden in de Zuidelijke Nederlanden tijdens de 17e en 18e eeuw.” 14-19.

¹²² De Boeck, “Ebbenhoutimitatiemethoden in de Zuidelijke Nederlanden tijdens de 17e en 18e eeuw.” 33-37.

Luna Bergmans – 2022 “Putting Black on White” Ebony Imitations in the Netherlands during the 17th and 18th Centuries

Bergmans also completed her bachelor’s thesis on the reproduction of ebonizing recipes. In addition, she conducted pXRF analyses on a cabinet from the Royal Museum of Art and History in Brussels (inv. 820). The results of five measurements consistently showed the presence of calcium, silicon, sulfur, potassium, and aluminum. In some measurements, magnesium, iron, zinc, and phosphorus were also detected. No spectra were provided.¹²³

Bergmans identified four historical recipes originating from the Southern Netherlands, published in the 17th and 18th centuries, which describe methods for painting wood black or imitating ebony. No manuscripts written by ebony workers themselves were found. The four recipes were reconstructed and tested on four different wood species: pear, cherry, apple, and plum. The reconstructions were compared to genuine ebony using the HART evolution tool. Three of the four recipes produced satisfactory visual results when compared to real ebony.¹²⁴

Bergmans notes that although the four recipes use largely similar ingredients, the specific methods of preparation and application strongly influence the outcome. She further clarifies that while many of the elemental components detected in the XRF analyses correspond to those in the recipes, not all elements can be explained by them. The results demonstrate that variations between recipes have a greater impact on the final appearance than the type of wood substrate used. In other words, minimal differences were observed between the various wood species, whereas more pronounced differences were found between the recipes themselves.¹²⁵

Tjabbe Nijs – 2024 “(Im)perfect Polishing” A Comparative Material-Technical Study of Historical Polishing Techniques from the Southern Netherlands during the 17th and 18th Centuries

Nijs conducted research on 17th- and 18th-century polishing techniques. For his study, he reproduced an 18th-century varnish recipe composed of ethanol, sandarac, and turpentine. To reconstruct historical polishing techniques, he analyzed 47 recipes drawn from fifteen publications dating from the 17th and 18th centuries, originating from the Netherlands, Germany, France, and the United Kingdom. From these recipes, he identified 19 different polishing materials, ranging from flour to tin oxide. For the practical reconstructions, Nijs selected pear veneer, which he stained with an ethanol-based colorant to imitate ebony. He produced five mock-ups using different materials and techniques, which were subsequently analyzed using the HART evaluation tool and gloss measurements. Nijs notes that all mock-ups were successful to some degree, although certain materials were no longer available today, which imposed limitations on the reconstructions.¹²⁶

The results showed that the mock-ups exhibited lower reflectance values compared to the cabinet (inv. 820) from the Royal Museum of Art and History. The use of coarse materials resulted in a matte finish, while finer materials produced a glossier surface. Nijs concludes that while reproductions can yield

¹²³ Luna Bergmans, “Ebbenhoutimitaties Binnen de 17de En 18e Eeuw in de Nederlanden.” (Universiteit Antwerpen, 2022). 8, 13.

¹²⁴ Bergmans, “Ebbenhoutimitaties Binnen de 17de En 18e Eeuw in de Nederlanden.” 9-12, 18.

¹²⁵ Bergmans, “Ebbenhoutimitaties Binnen de 17de En 18e Eeuw in de Nederlanden.” 18-23.

¹²⁶ Tjabbe Nijs, “(Im)perfect polijsten Een comparatief materiaaltechnisch onderzoek naar historische polijsttechnieken uit de Zuidelijke Nederlanden tijdens de 17e en 18e eeuw.” (Universiteit Antwerpen, 2023). 7-17.

successful results, they have inherent limitations. The condition and appearance of historical reference objects, such as the cabinet, may have changed over time, influencing comparisons. Beyond issues of interpretation and material availability, Nijs emphasizes that the execution of historical recipes requires considerable skill and tacit knowledge that cannot be fully derived from the written sources. He further notes that numerous parameters, such as drying time, pressure, movement, and stroke direction, can significantly influence the outcome. The main reason for discussing this thesis, alongside the others, is to highlight that while reproduction and comparison with historical objects can be informative, such methods are inherently limited and must be interpreted with caution.¹²⁷

Josef A. Meiler's - 2000 "Wood Species for the Imitation of Ebony" Historical Source Texts and Practical Implementations

In addition to his historical research and wood identification, Meiler experimented with wood imitation by reproducing six historical recipes on oak, boxwood, and cedar. The choice of these wood species was based on their differing anatomical, physical, and mechanical properties. The recipes, dating from the 16th to the 19th centuries, were derived from a study by Prof. Michaelsen, who analyzed 350 staining recipes and identified repetitions, thereby extracting six fundamental recipes. These recipes involved boiling and staining processes similar to those described by Kim De Boeck and Luna Bergmans, although none used pigments. The results showed that two of the six reproduced recipes yielded satisfactory outcomes in terms of color and efficiency.¹²⁸

In subsequent experiments, Meiler stained 20 different wood species to evaluate which were most suitable for achieving a convincing ebony imitation. The results indicated that boxwood was the most successful, followed by balsa, apple, and maple. Interestingly, the frequency with which wood types were mentioned in historical sources did not correspond to the quality of the imitation. Oak, for example, could be easily distinguished from ebony due to its ring-porous structure, whereas lesser-known species such as service tree (*Sorbus* sp.) provided more convincing results. Among the softwoods, the outcomes were inconsistent; yew performed better than cedar. Meiler concluded that, although many wood species can visually approximate the appearance of ebony, oak and mulberry are less suitable due to their distinct porosity. He further emphasized that the degree of finishing plays a crucial role: surface treatment can significantly enhance the imitation, meaning that the success of the reproduction depends not only on staining but also on material choice and physical properties. However, he also noted that the distinctions between effective and ineffective imitations remain subtle.¹²⁹

Quirin Amadeus Herzinger - 2025 "An Originally Black Cabinet from the 17th Century" Reconstruction Attempts of Its Coloration

For the reconstructions, Herzinger selected historical recipes dating from the Middle Ages to the late 17th century. The selection criteria included the use of animal glue as a binding agent, a production method without submersion, black colorants containing iron (in combination with vitriol and/or alum), application by brush, and the use of glue or wax as a coating. Based on these criteria, four recipes were chosen from

¹²⁷ Nijs, "(Im)perfect polijsten Een comparatief materiaaltechnisch onderzoek naar historische polijsttechnieken uit de Zuidelijke Nederlanden tijdens de 17e en 18e eeuw." 27-28.

¹²⁸ Meiler, "Holzarten zur imitation von ebenholz." 87-98.

¹²⁹ Nijs, "(Im)perfect polijsten Een comparatief materiaaltechnisch onderzoek naar historische polijsttechnieken uit de Zuidelijke Nederlanden tijdens de 17e en 18e eeuw." 99-102.

a total of 113 recipes originating from 27 sources.¹³⁰ The recipes were reproduced on pear wood and tested both with and without preliminary glue impregnation and with and without finish coating.¹³¹

The results showed that all four recipes successfully produced a convincing ebony imitation. Herzinger evaluated the visual, color, and gloss characteristics of the mock-ups before and after artificial ageing. While all recipes could imitate ebony, none achieved a perfect optical match. After artificial ageing, the gloss of the uncoated mock-ups remained largely unaffected, whereas those with a final coating showed noticeable changes. Interestingly, one recipe darkened further after ageing, suggesting that oxidation processes were not fully completed during the pre-ageing phase.¹³²

Solubility tests revealed that, after artificial ageing, the coatings on the mock-ups became water-soluble. However, the damaged layers could be reworked to regain their original appearance. In terms of color measurements, three of the four recipes were deemed suitable for ebony imitation, as the color shifts after ageing were minimal, small enough to allow for potential use in contexts. Herzinger also noted that glue impregnation prior to staining yielded superior results, while the inclusion of tin salts produced a greyish hue, undesirable for ebony imitation.¹³³

Gloss measurements showed that the mock-ups initially exhibited a silk-matte to medium gloss, except for one example that had a higher gloss level. This exception was attributed to the use of a black wax containing oil residues. Following artificial ageing, most samples displayed a reduction in gloss. In conclusion, Herzinger recommends using one of the recipes, and using instead wax, a microcrystalline wax as the most appropriate for restoration work aiming to imitate ebony.¹³⁴

¹³⁰ Keep in mind that a source like recipe book can contain different recipes with the same result.

¹³¹ Herzinger, "Rekonstruktionsversuche der Farbigkeit." 18-23.

¹³² Herzinger, "Rekonstruktionsversuche der Farbigkeit." 56-61.

¹³³ Herzinger, "Rekonstruktionsversuche der Farbigkeit." 56-61.

¹³⁴ Herzinger, "Rekonstruktionsversuche der Farbigkeit." 62-71.

2.4 An overview of historical material used for ebony imitation

The examined literature reveals a wide variety of materials and techniques used to imitate ebony. The following two tables provide an overview of the substrates and coloring techniques identified in historical sources. Table 7 presents an overview of possible substrates used for ebony imitation. No distinction is made between species, as some genera contain only one species while others include over seventy. Moreover, historical documents rarely specify the species used. In contrast to Van Meenen's research, this overview focuses primarily on European materials, as endemic wood types are thought to have been the main substitutes for ebony. The geographical term "Europe" is applied here, since although the cabinets were produced in Flanders, wood could have been imported, and sources may vary in regional attribution.

The information presented in Table 8 derives from both the author's own research and the studies discussed in the State-of-the-Art chapter. Where possible, only 16th- and 17th-century sources were included, although De Boeck's work also draws on 18th-century references. In total, fourteen different substrates were identified. This list is not exhaustive, as not all available historical sources could be examined. However, the recurrence of materials across multiple sources strengthens the reliability of these findings. The table demonstrates the considerable diversity of wood types that may have been used for imitation purposes. The frequency with which certain woods are mentioned has not been quantified here, though such analysis could yield interesting insights, as shown by Herzinger and De Boeck.

Table 8 summarizes the materials used in four main categories of ebonizing: chemical staining, pigment based, carbonizing, and finishing. Each material is accompanied by an elemental description, followed by an explanation of its specific function in the technique. The final column cites the corresponding source(s). The table is not exhaustive, as additional materials were likely used, and some recipes combine several techniques, an aspect not represented in the scheme. The primary function of this table is to serve as an interpretative tool for the analytical findings that will follow later in this thesis. It may also help link future results to those obtained in previous research.

Table 7: The table is organized into three columns on the left, listing the substrates by family, genus, and common name. The same structure is applied to baleen. The region column indicates the geographical origin of each material, which is predominantly European, except for logwood, a tropical species. On the right, the corresponding source is provided. This table is not exhaustive but serves to illustrate which materials might be expected if samples are analyzed.

Substrate for ebony imitation 16 th - 17 th century				
Family	Genus	Common name	Region	Source
Rosaceae	<i>Pyrus sp.</i>	Pear	Endemic (Europe)	See context
	<i>Prunus sp.</i>	Prune, cherry	Endemic (Europe)	See Meiler and De Boeck
	<i>Malus sp.</i>	Apple	Endemic (Europe)	See Meiler and De Boeck
	<i>Sorbus sp.</i>	Rowan	Endemic (Europe)	See Meiler and De Boeck
Taxaceae	<i>Taxus sp.</i>	Conifer	Endemic (Europe) <i>Possible Spanish wood</i>	See Meiler and De Boeck
Buxaceae	<i>Buxus sp.</i>	Boxwood	Endemic (Europe)	See Meiler and De Boeck
Pinaceae	<i>Cedrus sp.</i>	Conifer	Endemic (Europe)	See Meiler and De Boeck
Moraceae	<i>Morus sp.</i>	Mulberry	Endemic (Europe) <i>Possible Spanish wood</i>	See Meiler and De Boeck
Oleaceae	<i>Oleae sp.</i>	Olive	Endemic (Europe)	See Herzinger
Ulmaceae	<i>Ulmus sp.</i>	Elm	Endemic (Europe)	See Herzinger
Aquifoliaceae	<i>Ilex sp.</i>	Holly	Endemic (Europe)	See Herzinger
Sapindaceae	<i>Acer sp.</i>	Maple	Endemic (Europe)	See Herzinger
Fabaceae	<i>Haematoxylum sp.</i>	Logwood	<u>Tropical wood species</u>	See Meiler and De Boeck
Infraorder	Parvorder	Common name	Region	Source
Cetaceae	<i>Mysticeti</i>	Baleen	Hunted around Iceland, used in Northern Netherlands (Amsterdam)	See context

Table 8: Overview of materials used in various coloring techniques. The table lists the common name of each material, its elemental composition, and its specific application in coloring techniques. The fourth column provides the corresponding source. This table is not exhaustive but illustrates which materials may be encountered in analytical results.

Color technique to imitate ebony			
Material	Elemental	Explanation	Source
Chemical staining			
Gallnuts	Tannins	To produce a deeper stain	See context
Logwood	Tannins	To produce a deeper stain	See Herzinger
Iron sulfate	FeSO ₄	Cation + anion	See context
Vitriol	Fe(II)SO ₄ , ZnSO ₄ or Cu(II)SO ₄	Cation + anion	See context
Iron gall ink	Fe(II)SO ₄	Cation + anion	See context
Copper acetate	Cu ₂ Al(AsO ₄)(OH) ₄ ·4(H ₂ O)	Cation + anion	See context
Verdigris	Copper holding (formula depends on type)	Cation + anion	See context
Tin salt	Sn(II)Cl ₂	Cation + anion	See Herzinger
White whine/vinegar	CH ₃ COOH	Anion	See context
Lye	NaOH	Anion	See Herzinger
Solfer	S	Anion	See context
Nitric acid	HNO ₃	Anion	See Herzinger
Alum	KAl(SO ₄) ₂ ·12H ₂ O	Anion	See context, Herzinger, Bergmans and De Boeck
Pigment based			
Indigo	C ₁₆ H ₁₀ N ₂ O ₂	Dye	See Herzinger
Water	H ₂ O	Solvent	See Herzinger
Iron gall ink	Fe(II)SO ₄	Solvent (and dye)	See Herzinger
Lamp black	Carbon based molecule	Pigment	See Herzinger
Soot	Carbon based molecule	Pigment	See Herzinger
Bone black	C, PO ₄	Pigment	See Herzinger
Asphalt	Carbon based molecule	Pigment	See Herzinger
Animal glue	Carbon based molecule	Binder	See Herzinger
Gum Arabic	Carbon based molecule	Binder	See Herzinger
Egg	Carbon based molecule	Binder	See Herzinger
Casein	Carbon based molecule	Binder	See Herzinger
Potash lye	KOH	As a degreasing agent	See Herzinger
Carbonized			
Linseed oil	Carbon based molecule	Boiling medium	See context
Finishing			
Bee wax	Carbon based molecule	Coating	See Nijs and Herzinger
Animal glue	Carbon based molecule	Coating	See Nijs and Herzinger
Bleached wax	C, [NH ₄] ₂ CO ₃ , KOH	Coating	See Nijs and Herzinger
Tin oxide	SnO	Polishing	See Nijs
Tripoli	SiO ₂	Polishing	See Nijs
Flour	Carbon based molecule	Polishing	See Nijs
Chalk	Ca	Polishing	See Nijs
Charcoal	Carbon based molecule	Polishing	See Nijs
Pumice stone	SiO ₂ , Al ₂ O ₃ , + others in lower concentrations	Polishing	See Nijs
Horsetail and other grinding materials	Carbon based molecule	Polishing	See Nijs

2.5 Research question and relevance

The reviewed literature revealed a wide range of wood species and coloring techniques used to imitate ebony. Van Meenen demonstrated the potential of ebony identification to better understand historical trade, while Dijkstra showed how XRF analysis can uncover chemical staining on ebony. Meiler identified a variety of wood types used to imitate ebony in 16th- and 17th-century German cabinets. Herzinger demonstrated that, through various analytical and reconstruction techniques, a close approximation of the original materials could be achieved. Dijkstra, De Boeck, Bergmans, Nijs, and Herzinger further showed that reproducing historical recipes can yield convincing results that imitate ebony, which can be analyzed (XRF) and compared with historical material.

Together with the context, these studies provide strong indications that ebony imitation can occur on Flemish cabinets. However, this leads to a lacuna in contemporary research: although historical sources mention the imitation of ebony in 17th-century Flemish cabinetmaking, no comprehensive study has yet confirmed this practice through material analysis. As a result, both the imitation substrates and the coloring techniques remain largely unknown. This gap gives rise to the following main research question:

How were stained non-black wood species used to imitate ebony in selected 17th-century Flemish cabinets, and can these materials be reliably identified during minimally intrusive examination?

From this central question, the following sub-questions arise:

- **In which decorative areas in 17th-century Flemish cabinets is ebony imitation employed, and does its placement relate to the use of imitation?**
- **To what extent was *Pyrus sp.* used as a wood for ebony imitation in 17th-century Antwerp cabinets, and how does this compare with contemporary descriptions?**
- **Which staining techniques were employed to create ebony-like surfaces on 17th-century Antwerp cabinets, and how do the analytical results correspond with contemporary written sources?**

It is important to note that this study focuses exclusively on chemical staining techniques and excludes pigmented and carbonization-based coloring methods, as including these would exceed the scope and timeframe of this research. The methodological approach used to answer these questions will be discussed in the following chapter.

This research is relevant for the following reasons. It addresses a historical question by verifying whether ebony imitation was indeed applied to Flemish cabinets, as suggested by archival sources. It provides a deeper material–technical understanding of the examined objects, which may inform future restoration practices and improve preventive conservation strategies. The findings may also assist in authenticity assessments and in linking specific craftsmen to particular techniques. Finally, by demonstrating that historical ebony imitations could successfully replicate the visual qualities of real ebony, this study challenges the notion of inferiority associated with imitations. It encourages the use of sustainable alternatives in modern restoration and woodworking, considering the ethical and ecological implications of using real ebony today.

3 Methodology

This chapter outlines the research methodology. The study is divided into three steps, the results of which collectively contribute to answering the central research question. These three steps include a literature review with a historical study (already given), a material-technical study of wood species, and a material-technical study of the stains. Figure 14 presents a general overview of the methodology. This thesis was grammatically corrected using ChatGPT and Grammarly.

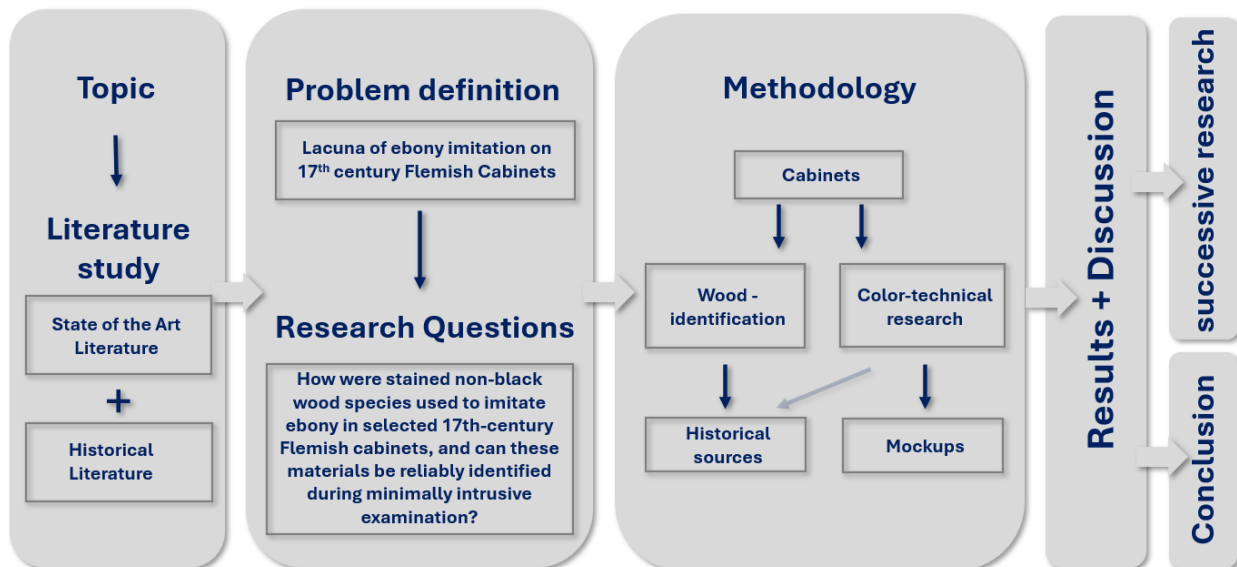


Figure 14: Overview of the used methodology

3.1 Selection of literature

The work of Ria Fabri serves as the starting point for the historical study within this thesis. Fabri refers to several primary sources related to ebony imitation in 17th-century Antwerp. However, a potential drawback of this approach is that her research may not include all relevant information on ebony imitation, which could lead to a distorted view or a lack of broader context.

To partially compensate for this limitation, Catherine Schepens's research is also used. In the academic year 2024–2025, she is conducting her master's thesis on ebony workers in 17th-century Antwerp and Brussels employed by the Forchondt family business. Schepens has compiled a dataset containing references to ebony workers from the Forchondt account book.¹³⁵ Although this account book covers only six years (1650–1655) and focuses solely on the Forchondt family, it highlights the valuable information still undiscovered in the archives beyond Fabri's work.¹³⁶ In addition to the works of Fabri and Schepens, several reference works dealing with ebony imitation are also used.

Most of the used literature can be classified as secondary sources, with the exception of the database by Schepens, which serves as a primary source. Recipe collections generally function as secondary sources as well, since the information they contain was often copied, derived from craftsmen, or transmitted from other texts. Realistically, writings produced directly by craftsmen are rare. Therefore, recipes and historical archival sources, such as the Forchondt records, serve as the primary reference points for this study.

The selection of contemporary literature was based on keywords such as ebony imitation, (chemical) staining, 17th-century cabinets, Flemish cabinets, and ebony. Several theses and reports were obtained directly from the authors or their supervisors. The German-language literature was translated using DeepL. Some of these documents were scanned rather than original digital copies, which made certain passages difficult to interpret. The reader should be aware that, as I do not master German, I relied on computer-assisted translation, which may have introduced ambiguities in interpretation.

¹³⁵ Cashbook with inventory number 1043

¹³⁶ It is not feasible to search the archives of the ebony workers within the cabinetmakers' guild for references to ebony imitations and simultaneously conduct a material-technical study within the time constraints of this master's thesis. Therefore, reference sources such as Fabri and Schepens are used.

3.2 Selection of cabinets

3.2.1 Selection criteria

The selection is based on the following criteria: each cabinet must be a 17th-century Flemish cabinet, composed of historically blackened veneer and/or blackened moldings. If imitations are found and there is reason to believe they are original, the cabinet in question is included in the selection.

Table 9: This table outlines the criteria used to select the cabinets.

Selection criteria	
Stands	It is often difficult to prove whether a lower section (stand) is original. Over time, these lower parts were frequently replaced or added. ¹³⁷ For this reason, the lower sections are not included in the selection.
Period and region	The selection of cabinets is limited to the 17th century, a period during which Antwerp flourished as a trading city in Europe and the cabinet trade prospered. Since it is not always clear when and where a specific type of cabinet was produced, stylistic features are used as indicators, pointed out by Fabri.
Style	Preferably, table cabinets from group IV were selected in order to place the results within a more specific art-historical and stylistic framework, and in line with the work of De Boeck. However, due to limited research time and the small number of known cabinets featuring ebony imitation, an expansion to both smaller and larger models is possible.
Backside	The blackened backs of the selected cabinets were not intended to imitate ebony. It is possible that the same coloring method was used as in the imitation of ebony, however, this aspect is not investigated in this thesis, which focuses specifically on veneer and moldings.
Restorations	Wood identification of restoration materials falls outside the scope of this research. All efforts have been made to avoid sampling from reconstructed or restored areas. However, this exclusion represents a critical challenge in the methodology, as varying degrees of past interventions may have occurred. Firstly, it is possible that some veneers or moldings were stained or recolored during previous conservation treatments. Secondly, certain restored areas may be visually indistinguishable from original components, making it difficult to ensure complete exclusion of later additions. To mitigate this issue, a multi-step approach was employed. Initially, each object was visually examined under both normal and UV light to identify obvious restorations. During analysis, pXRF results from different areas of the same cabinet were compared to detect anomalies. Finally, SEM-EDX results from the physical samples were cross-referenced with the corresponding pXRF spectra. If these results align, there is a strong indication that the sampled material is original. In cases where discrepancies are observed, results are interpreted with caution.

¹³⁷ Fabri, *De 17de-eeuwse Antwerpse kunstkast : typologische en historische aspecten*. 65, 70, 90, 94,

3.2.2 Cabinets

For the material-technical study, seven cabinets will be examined.¹³⁸ The selection of these cabinets is presented in Table 10. This selection is based on information from museum institutions, where the presence of ebony imitation or blackened wood was either explicitly mentioned or communicated orally. The cabinets were identified using the following search terms: ebony imitation, blackened wood, and ebonized wood.¹³⁹ The platforms used for this purpose include DAMS Antwerp (City of Antwerp Collection), BALaT (KIK-IRPA), and Erfgoedplus.¹⁴⁰ An in-situ analysis will be conducted to determine whether a cabinet contains historically blackened wood. This will be assessed according to the following criteria: at least four distinct locations must be visible where color variations are present in the veneer and/or moldings. These areas must not be located on restored parts. Archival material may serve as supplementary evidence to support the identification. Research was performed on cabinets in the following museum institutions: the Royal Museum of Art and History (Brussels), M Leuven (Leuven), Plantin-Moretus Museum (Antwerp), Snijders & Rockox House (Antwerp), DIVA (Antwerp), MAS (Antwerp), and the Depot Luchtbal (Antwerp).

¹³⁸ Seven cabinets were selected for analysis for the following reason: the aim is to conduct high-quality research on wood identification and stain analysis. This thesis will assess the effectiveness of this methodological approach, which can then serve as a basis for future quantitative research. This strategy ensures a more balanced relationship between time investment and research quality.

¹³⁹ For the selection the terms were used in Dutch: “ebben imitatie”, “gezwart hout” en “geëboniseerd hout”.

¹⁴⁰ See attachments for an overview of the used websites.

Table 10: Each cabinet is assigned its own ID (on the basis of the HOMEAGE database), in addition to the museum's inventory number. The cabinets are categorized into groups (see section 1.1). All cabinets were analyzed for wood identification and color-technology.

Researched cabinets				
Object ID	Cabinet	Group	Researched	Institution
ID.4		<u>Group IV</u>	- Wood sample (SEM + EDX) - pXRF	<i>Snijders & Rockox museum</i>
ID.20		<u>Group III</u>	- Wood sample (SEM + EDX) - pXRF	<i>Museum aan de stroom (MAS)</i>
ID.55		<u>Group IV</u>	- Wood sample (SEM + EDX) - pXRF	<i>City collection Antwerp</i>
ID.76		<u>Group IV</u>	- Wood sample (SEM + EDX) - pXRF	<i>Royal museum of art & history Brussels</i>
ID.92		<u>Group VIII</u>	- Wood sample (SEM + EDX) - pXRF	<i>Plantin-Moretus Museum</i>
ID.625		<u>Group III</u>	- Archival material - pXRF	<i>DIVA</i>
ID.637		<u>Group II</u>	- Wood sample (SEM + EDX)	<i>M Leuven</i>

3.3 Material-technical research - wood

3.3.1 Sampling methodology

Before sampling is conducted, each institution is consulted to determine whether prior wood identification research has been carried out, and if samples are already available, and whether restoration reports, registration forms, or publications exist. This helps prevent unnecessary damage to the cabinets and ensures that samples are only taken when necessary. A specific procedure was followed for the sample collection, as detailed in section 10.1. This procedure serves to justify the choice of sampling location and to carry out sampling systematically. Depending on the location and type of sample, different tools were used, including a micro chisel, a Japanese knife, a plane, and a scalpel. The aimed sample size was 1–2 mm³. After sampling, each sample was carefully stored in an acid-free paper envelope to prevent contamination.¹⁴¹

3.3.2 Optical microscope

For the analysis of the samples and the coupes, an Olympus BX41 microscope was used. This microscope allows observations under reflected, transmitted, ultraviolet, polarized, and visible light. The cross-section was mounted on a microscope slide using Euparal and diascopically examined. The anatomical characteristics of the wood were then analyzed based on the IAWA list of microscopic features for both hardwood and softwood. For final genus identification, this information was combined with the IAWA database.

3.3.3 Scanning electron microscope (SEM)

For the identification of small samples where optical microscopy does not provide sufficient detail, a scanning electron microscope (SEM) is used. The Phenom Pure G6 SEM is employed for this purpose, operating at an accelerating voltage of 15 kV with the BSD full detector and beam intensity of image. The anatomical characteristics of wood are analyzed according to the IAWA list of microscopic features for both hardwood and softwood. For final species identification, this information is cross-referenced with the IAWA database.

Scanning Electron Microscopy (SEM) is a high-resolution imaging technique that utilizes a focused beam of electrons to examine the surface morphology and microstructure of materials. Unlike optical microscopy, which relies on visible light and has limited resolving power, SEM can achieve a magnification of 8000x, allowing for detailed visualization of microanatomical structures at the nanometer to micrometer scale.¹⁴² In SEM, a finely focused electron beam is spread across the surface of the sample. As the beam interacts with the sample, it generates several types of signals, including secondary electrons, backscattered electrons, and characteristic X-rays. The most commonly used signal for imaging is the secondary electron emission, which provides high-resolution topographical information about the surface

¹⁴¹ The sampling procedure followed the methodology outlined by Van Meenen's thesis. This was done to ensure that potential results in future research remain comparable. Vadim Van Meenen, "Identificatie van ebbenhout (Diospyros) en andere tropische zwarte houtsoorten op 17de -eeuwse Vlaamse kabinetten" (Master Universiteit Antwerpen, 2024). p15.

¹⁴² Angela Balzano et al., "Scanning Electron Microscopy Protocol for Studying Anatomy of Highly Degraded Waterlogged Archaeological Wood," *Forests* 13, no. 2 (2022), <https://doi.org/10.3390/f13020161>. 8.

being examined. These signals are detected and converted into grayscale images that reveal surface morphology with significant depth of field and contrast.¹⁴³

3.3.1 SEM - Wood identification

Peter Gasson emphasized that context is crucial in the process of wood identification. Questions such as What is it? Where is it from? Is it an endangered species? can all guide the identification process.¹⁴⁴ Given the vast number of wood species, these contextual considerations can help narrow down possibilities and facilitate more efficient identification. In this study, wood identification began with a focus on the genera *Diospyros sp.* and *Pyrus sp.*, as these were the most likely candidates based on prior knowledge and initial results. A comparative list of anatomical features was compiled for species from both genera. These features, visible in the transverse, radial, and tangential planes of the wood, served as reference points. While certain characteristics, such as the presence of prismatic crystals, may not differ significantly between genera, they can still aid in the identification.¹⁴⁵

The Genus level is different from the species level. Many studies show how difficult it is to differentiate wood samples by species, especially *Diospyros sp.* The reason is that the difference in morphological elements of wood species is relatively small, in contrast to identifying wood on a genus level.¹⁴⁶ The identification follows the same route. For this reason, it is not the goal to identify the wood on species level as genus level is sufficient enough, because *Diospyros sp.* will highlight the use of ebony, *Taxus sp.* of yew tree and *Pyrus sp.* of pear wood.

If the veneer and moldings are indeed made of ebony, and we assume the species then belongs to the *Diospyros* genus, we could expect the following anatomical characteristics based on the paper of Jahanbanifard et al (2020). The intervessel pit arrangements are mostly alternate, and the shape is polygonal. The horizontal length of the intervessel pits is mostly 3-7µm, but in rare cases reaches 10µm. The genus *Pyrus* has helical thickening in the vessel elements, which *Diospyros sp.* does not have. The diameter of the vessel lumina is for *Pyrus sp.* mostly smaller than the *Diospyros sp.* (<= 50µm for *Pyrus sp.*). Deposits in vessel heartwood are rather found in *Diospyros sp.* than in *Pyrus sp.*. The axial parenchyma indicates possibly both species but should rule out other genera like *Populus*. The ray width is a controversial method to differentiate the genera. *Diospyros sp.* can have a ray width from one to three, where one is most of the time present and multi ray width rarely present. *Pyrus sp.*, in contrast, has mostly a multi-ray width, where one could sometimes have a one-ray width.¹⁴⁷ As a result, *Diospyros*

¹⁴³ Joseph I. Goldstein et al., *Scanning Electron Microscopy and X-Ray Microanalysis*, 4th ed. 2018, 1 online resource (XXIII, 550 p. 546 illus., 409 illus. in color.) online resource. (Springer, 2018), WorldCat, <https://doi.org/10.1007/978-1-4939-6676-9>. VII

¹⁴⁴ Peter Gasson, "How Precise Can Wood Identification Be? Wood Anatomy's Role in Support of the Legal Timber Trade, Especially Cites:," *IAWA Journal* 32 (January 2011): 137–54, <https://doi.org/10.1163/22941932-90000049>. 137.

¹⁴⁵ Ideally, wood samples are sectioned along all three anatomical planes (transverse, radial, and tangential) then dehydrated and mounted onto an SEM stub. This standard preparation greatly enhances the clarity of the wood's anatomical structures. However, due to the exceedingly small size, fragility, and layered structure of the samples, cutting clean cross-sections was not feasible. This led to several limitations: Surface irregularity (The uncut surfaces were not perfectly flat, complicating visual analysis) Contaminants (Residues of glue and varnish obstructed parts of the surface, hiding anatomical features) Limited orientations (Most samples were oriented tangentially, leaving the transverse and radial planes, both critical for identification, largely unexamined) On the positive side, the samples were already dry due to centuries of semi-controlled storage conditions, so additional drying was unnecessary.

¹⁴⁶ Gasson, "How Precise Can Wood Identification Be? Wood Anatomy's Role in Support of the Legal Timber Trade, Especially Cites:" 137.

¹⁴⁷ Jahanbanifard et al., "Description and Evolution of Wood Anatomical Characters in the Ebony Wood Genus *Diospyros* and Its Close Relatives (Ebenaceae): A First Step towards Combatting Illegal Logging." 578-618.

Inside Wood. 2004-onwards. Published on the Internet. <http://insidewood.lib.ncsu.edu/search> [29/07/2025]

sp. and *Pyrus sp.* both have prismatic crystals, and their sizes were measured to check whether they would yield the same results as Van Meenen (2024).¹⁴⁸

However, identifying such small samples remains challenging, as these features are not unique to and can be found in other genera as well. Moreover, certain anatomical traits, such as the presence of prismatic crystals, may not be uniformly distributed throughout the wood, meaning one area might display more crystals than another. Therefore, wood identification must rely solely on the presence of diagnostic features, not on their absence.¹⁴⁹ A critical caveat must be acknowledged. For instance, if a sample exhibits a ray width of three cells (something not typically seen in *Diospyros sp.*) this does not automatically mean the wood belongs to *Pyrus sp.*. The aim of the analysis was not to pinpoint specific species, but to distinguish ebony samples from other types of wood. As such, the results should be interpreted as informed approximations rather than definitive conclusions.

¹⁴⁸ Van Meenen, "Identificatie van Ebenhout (Diospyros) En Andere Tropische Zwarte Houtsoorten Op 17de -Eeuwse Vlaamse Kabinetten." 79.

¹⁴⁹ IAWA Committee, "IAWA List of Microscopic Features for Hardwood Identification : With an Appendix on Non-Anatomical Information," 2009, WorldCat, <http://publikationen.ub.uni-frankfurt.de/frontdoor/index/index/docId/10925>. 225.

3.4 Material-technical research - color technology

3.4.1 Portable X-Ray Fluorescence

Portable X-ray fluorescence (pXRF) is a non-invasive chemical analytical technique used to determine the elemental composition of materials. The device used for this research is the Olympus InnovX Delta, equipped with a 4 W, 40 kV X-ray tube and a Ta/Au excitation source (anode). The analysis mode is set to Geochem, enabling detection of all elements heavier than silicon (Si). It is important to note that this instrument does not detect light elements (i.e., those lighter than Si). Consequently, any staining techniques involving light elements will not appear in the spectrograms and may go undetected using this method.

Each measurement beam is set to 60 seconds to capture both lower- and higher-energy ranges. The resulting spectra are processed using bAxil software. For interpretation, the detected elements are categorized as trace, minor, and major elements. Based on the mock-up results, the following thresholds were defined in Table 11. These thresholds are self-defined, as the study by Dijkstra does not disclose the basis for her classification of trace, minor and major elements. But the method originates from her. While setting these parameters introduces a degree of subjectivity, since an element falling just below a threshold may still be significant (like an element with 399 counts). A flexible margin of interpretation was maintained to avoid misclassification. This categorization helps structure the data interpretation and its reuse.

Table 11: presents the defined thresholds for both the low-energy and high-energy spectra. The left column outlines the margin ranges used for the low-energy spectrum, while the right column presents those for the high-energy spectrum. For detailed results, please refer to the attachments.

	Low-energy spectrum	High-energy spectrum
Trace elements	< 400 counts/s	< 10 counts/s
Minor elements	400 - 800 counts/s	10 - 50 counts/s
Major elements	> 800 counts/s	> 50 counts/s

Six historical cabinets were selected for pXRF analysis. Before measurement, a thorough visual inspection was conducted to avoid restoration, nail locations, or other potential contaminants. This was done by following the procedure listed in the attachments. Each cabinet underwent seven pXRF measurements: ideally, three on the moldings and three on the veneer, and the area from which a physical sample was taken for further analysis. By comparing the seven spectra and filtering out outliers, readings possibly affected by restoration materials or metal interference (e.g., nails) can be excluded. However, pXRF has a key limitation: it cannot distinguish between layers. Therefore, an underlying nail or other material could produce elevated readings of certain elements (e.g., iron), skewing interpretation. Additionally, wood may naturally contain elements that are not related to staining or surface treatments. To address these limitations and support a more accurate understanding, scanning electron microscopy with energy-dispersive X-ray spectroscopy (SEM-EDX) was also employed for analysis of the physical samples.

3.4.2 SEM-EDX

Scanning Electron Microscopy with Energy Dispersive X-ray Spectroscopy (SEM-EDX) is a widely utilized analytical technique in heritage science for the microstructural and elemental characterization of cultural heritage materials. This integrated approach combines high-resolution imaging capabilities with qualitative and semi-quantitative elemental analysis.¹⁵⁰ EDX analysis has already proven valuable for detecting inorganic elements present in wood stains, as shown by Dijkstra (2024).¹⁵¹ The technique exhibits sensitivity limitations for light elements (atomic numbers below Sodium (Na-11), meaning that crucial organic components cannot be detected through EDX analysis.¹⁵² But it is more sensitive than pXRF. The analysis was applied to both an ebony sample (from the mockup, last page of the attachments) and six cabinet samples. Accelerating voltages of 15-20 kV were employed for optimal heavy element detection and adequate beam penetration. Analysis was conducted using a backscattered electron detector (BED-C) under low-vacuum conditions at 30 Pa atmospheric pressure to minimize charging effects. All samples received carbon coating for electrical conductivity, with working distances optimized between 11.1-12.3 mm based on sample dimensions.

¹⁵⁰ Goldstein et al., *Scanning Electron Microscopy and X-Ray Microanalysis*.

¹⁵¹ Dijkstra, "Black and Shining, and Pleasing to the Eye, Black Chemical Stains on Dutch 17th Century Ebony Furniture." 31.

¹⁵² Kirsty High and Kirsty Penkman, *Analytical Methods for Assessing Preservation in Waterlogged Archaeological Wood: Their Importance for Site Management Decisions*, June 13, 2020. 23.

3.4.1 Mockups

In addition to the cabinet samples, seven test panels created by De Boeck and Bergmans will be analyzed using portable X-ray fluorescence (pXRF) and optical microscopy. De Boeck and Bergmans originally produced 32 samples based on nine historical recipes. Two recipes were excluded from further testing because they did not yield a sufficiently black finish. From the remaining seven recipes, the best-performing sample was selected for each panel.¹⁵³ Each test panel will undergo three pXRF measurements and be examined under an optical microscope for depth of staining. These panels, which replicate historical recipes for ebonizing wood, will serve as a reference database. By comparing the pXRF data of the cabinets with those of the test panels, it will be possible to identify similarities with the historical staining recipes, following the methodology of Dijkstra (2024). However, in contrast to Dijkstra's approach, no foam backing was used during analysis. Instead, the mock-ups were held vertically in place using a clamp. As a result, the XRF measurements were taken with air behind the sample rather than foam, reducing the risk of detecting extraneous elements such as calcium or iron originating from the support material.

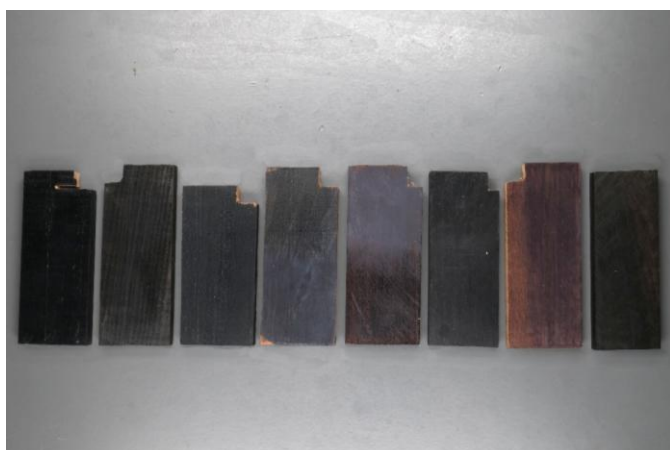


Figure 15: Overview of the Mock-Ups. A detailed list of the specific mock-ups and the recipes used can be found in the appendix. The mock-up on the far right serves as a reference piece made from genuine ebony.

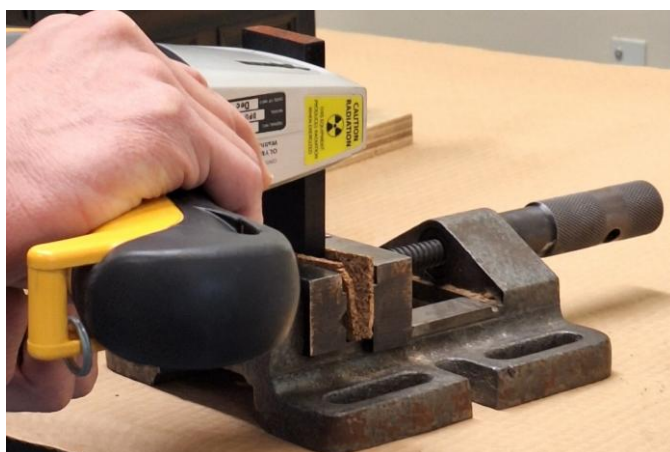


Figure 16: Technique Used to Analyze the Mock-Ups: Instead of placing the mock-up flat on the table, it was positioned vertically during analysis. This method simplifies the interpretation of the spectra by minimizing background interference and improving measurement consistency.

¹⁵³ If desired, the results of this thesis can be consulted through Prof. Vincent Cattersel (University of Antwerp), as they have not been published.

4 Results

4.1 Visual inspection on cabinets

All seven cabinets displayed varying levels of damage that revealed ebonized wood with underlying yellowish wood. These damaged areas occurred in various locations: the moldings, veneer, and the structural framework. On veneered surfaces, it was more difficult to distinguish distinct layers that might indicate ebonizing techniques. Consequently, photographs were taken of all cabinets at locations where indicators of ebony imitation were visible, see Figure 17 and attachments.

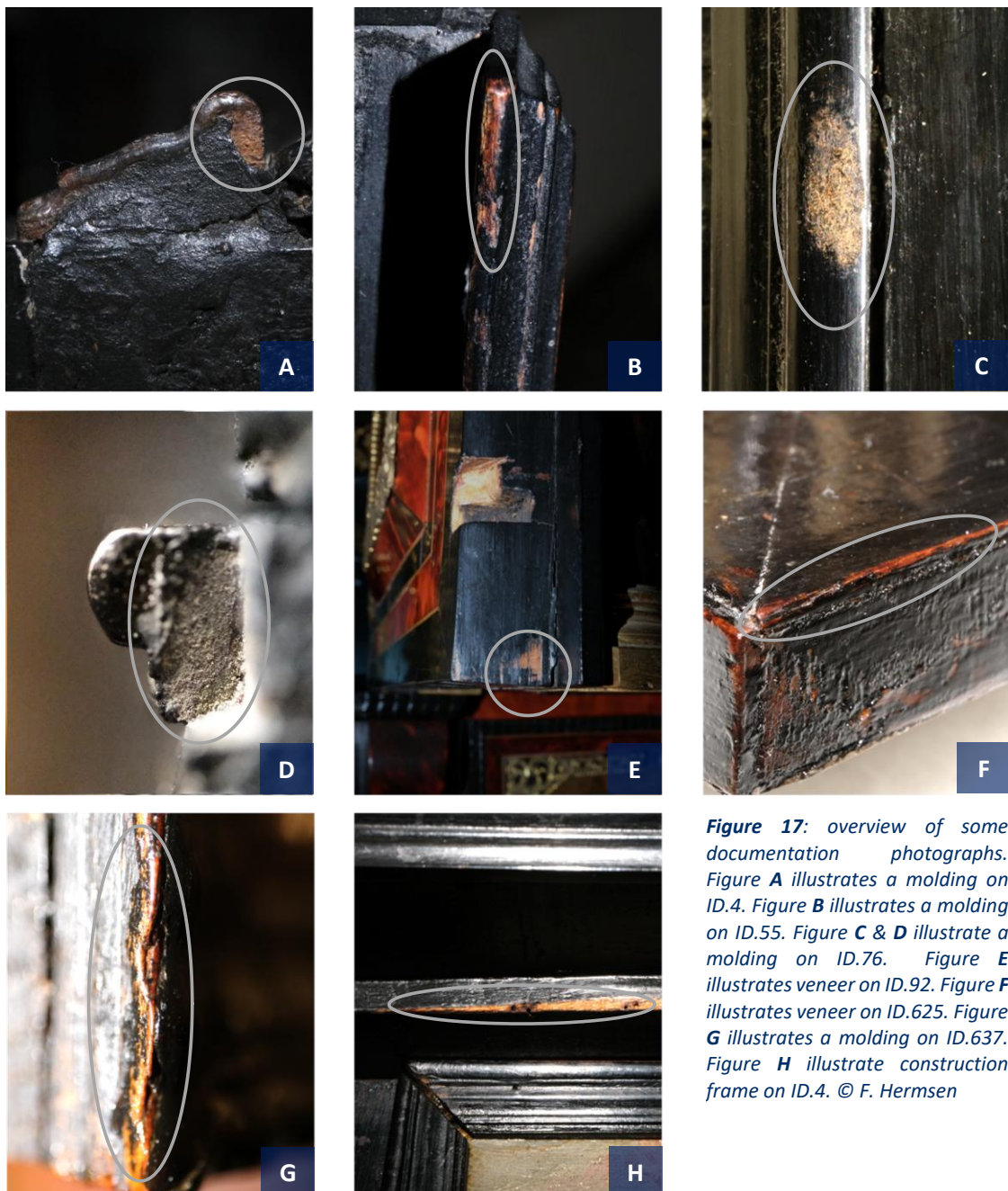


Figure 17: overview of some documentation photographs. Figure A illustrates a molding on ID.4. Figure B illustrates a molding on ID.55. Figure C & D illustrate a molding on ID.76. Figure E illustrates veneer on ID.92. Figure F illustrates veneer on ID.625. Figure G illustrates a molding on ID.637. Figure H illustrate construction frame on ID.4. © F. Hermesen

Identifying evidence of ebony imitation by visual inspection alone has proven challenging. The distinction between solid ebony, stained ebony, and ebony imitation is often subtle and ambiguous. In several cases, photographing clear indicators of imitation was difficult due to time constraints, limited space, and restricted maneuverability, which hindered proper documentation. However, through closer examination, following results could be made.

- ID.4 exhibited several restored sections, clearly distinguishable from the original material. In the restored areas, ebonized wood was used, although the presence of actual ebony could not be confirmed. The use of imitation veneer remained unclear. In several places, faded wood tones were visible beneath damaged moldings and other construction elements, and black inner wood was observed where the moldings were damaged.
- ID.20 showed the least evidence of possible imitation. Both the moldings and veneer appeared uniformly black, with no visible indications of substitution or staining.¹⁵⁴
- ID.55 presented obvious signs of possible ebony imitation in the moldings and structural frame. The veneer was more ambiguous and could not be definitively classified as ebonized wood.
- ID.76 provided convincing evidence of ebonized wood. Three moldings were loose and could be closely examined, all showing similar indicators of imitation. The veneer showed some areas of black fading, but these results remained inconclusive.
- ID.92 revealed various restoration interventions, some using imitation ebony and others possibly using real ebony. Both the veneer and moldings displayed uneven degrees of black coloration, exposing different underlying wood tones.
- ID.625 showed multiple instances of possible ebony imitation in both the veneer and at the side of different moldings.
- ID.637 displayed a range of color variations, especially in the moldings and in some sections of the veneer, suggesting inconsistent material use that could indicate imitation.

¹⁵⁴ In consultation, a sample was still taken from the cabinet.

4.2 Wood identification - Scanning Electron Microscopy (SEM)

Table 12 presents the results of the wood identification. The characteristic combination of alternate and polygonal intervessel pits was observed in samples ID.4, ID.20, ID.76 (veneer) and ID.637. In the remaining samples, these features were not detected, likely due to the low surface quality, though their presence cannot be ruled out. The intervessel pit diameter varied among samples, but only ID.20 and ID.76 (veneer) exceeded the typical range found in *Pyrus sp.*. Helical thickenings in the vessel elements were observed in ID.76 (molding), which is found in *Pyrus sp.* and not in *Diospyros sp.*. However, the diameter of vessel lumina in all samples fell within a range that does not strongly differentiate between genera. Gums and other deposits were present in ID.4, ID.20, and ID.76 (veneer), supporting a possible attribution to *Diospyros sp.*, in contrast to ID.76 (molding), where such deposits were absent. Ray width could be divided into two groups: ID.55, ID.76 (molding), and ID.625 generally displayed rays wider than one cell, aligning more closely with *Pyrus sp.*. The remaining samples showed rays predominantly one cell wide, which corresponds with *Diospyros sp.*. None of the samples exhibited storied rays, as might have been expected. Where prismatic crystals were found (in several IDs), they appeared in different regions of the samples and ranged in size from 15 μm to 25 μm .

The samples that showed the strongest correlation with the *Pyrus* genus were ID.55, ID.76 (molding), and ID.625. Among these, ID.76 (molding) exhibited the clearest match, particularly due to the presence of helical thickenings in the vessel elements, a characteristic absent in *Diospyros sp.*. In addition, the ray width in this sample more closely aligns with the typical features of *Pyrus sp.*. While ID.55 and ID.625 also display traits consistent with *Pyrus sp.*, their identification should be interpreted with caution due to the limited data available. In particular, ID.625 relies on archival photographs, as the original cross-section could not be located, and the precise sampling location remains unknown. In contrast, ID.20 and ID.76 (veneer) are more consistent with *Diospyros sp.* than *Pyrus sp.*, as their intervessel pit sizes exceed the typical range for *Pyrus sp.*, and their ray width is consistently one cell, which is characteristic of *Diospyros sp.*. Based on ray width and other anatomical features, ID.4, ID.20, ID.76 (veneer), and ID.637 are also considered unlikely to originate from the *Pyrus* genus and are more plausibly attributed to *Diospyros sp.*¹⁵⁵

¹⁵⁵ Given the small sample sizes and incomplete data, these identifications remain tentative.

Table 12: Overview of most important observed anatomical features of the seven samples. Values between brackets are considered outliers. ? refers to possible presence. Conclusion is tentative due to limited size. ID.76 and ID.625 were analyzed with a microscope (OM), and the other samples were analyzed with the SEM. The row in red shows a key difference between *Diospyros sp.* and *Pyrus sp.*. The characteristic features of were obtained from inside wood.

Characteristic	Sample							Reference genus	
	ID.4 veneer	ID.20 molding	ID.55 veneer	ID.76 Coupe molding (OM)	ID.76 veneer	ID-625 (OM) veneer	ID.637 veneer	<i>Rather Pyrus sp.</i>	<i>Rather Diospyros sp.</i>
20-23. Intervessel pits arrangement	Alternate + Shape of alternate pits polygonal	Alternate + Shape of alternate pits polygonal	?	?	Alternate + (possibly polygonal)	?	Alternate + Shape of alternate pits polygonal	Alternate	<i>Mostly Alternate + Shape of alternate pits polygonal</i>
24-28. Intervessel pit size	4 µm	9-10 µm	?	?	7-10 µm	?	4 µm	<4-7 µm	<i>3-10 µm</i>
36-37. Helical thickenings in vessel elements	Absent	Absent	?	Present	?	?	?	Present	<i>Absent</i>
40-42. Diameter of vessel lumina	44 µm	90 µm	44 µm	<= 50 µm	?	?	90 µm	<= 50 µm (50 - 100 µm)	<i>(<= 50 µm) 50 - 100 µm 100-200 µm</i>
58. Gums and other deposits in heartwood vessels	Present	Present	?	Absent	Present	?	?	Mostly Absent	<i>Mostly Present</i>
75. Axial parenchyma	?	?	?	Present	?	?	?	Present	<i>Present</i>
97. Ray width	1-(2)	1	(1)-2	(1)-2	(1)	3	1-(2)	(1)-2-3	<i>1-(2-3)</i>
118. All rays storied	?	Not storied	Not storied	Not storied	?	?	Not storied	Not storied	<i>Not storied (storied)</i>
136. Prismatic crystals	Present	Present	Not present	?	Present	?	Present	Present and not	<i>Present and not</i>
Cristal size	25 µm	20 µm	/	?	15 µm – 19 µm	?	25 µm	/	<i>/</i>

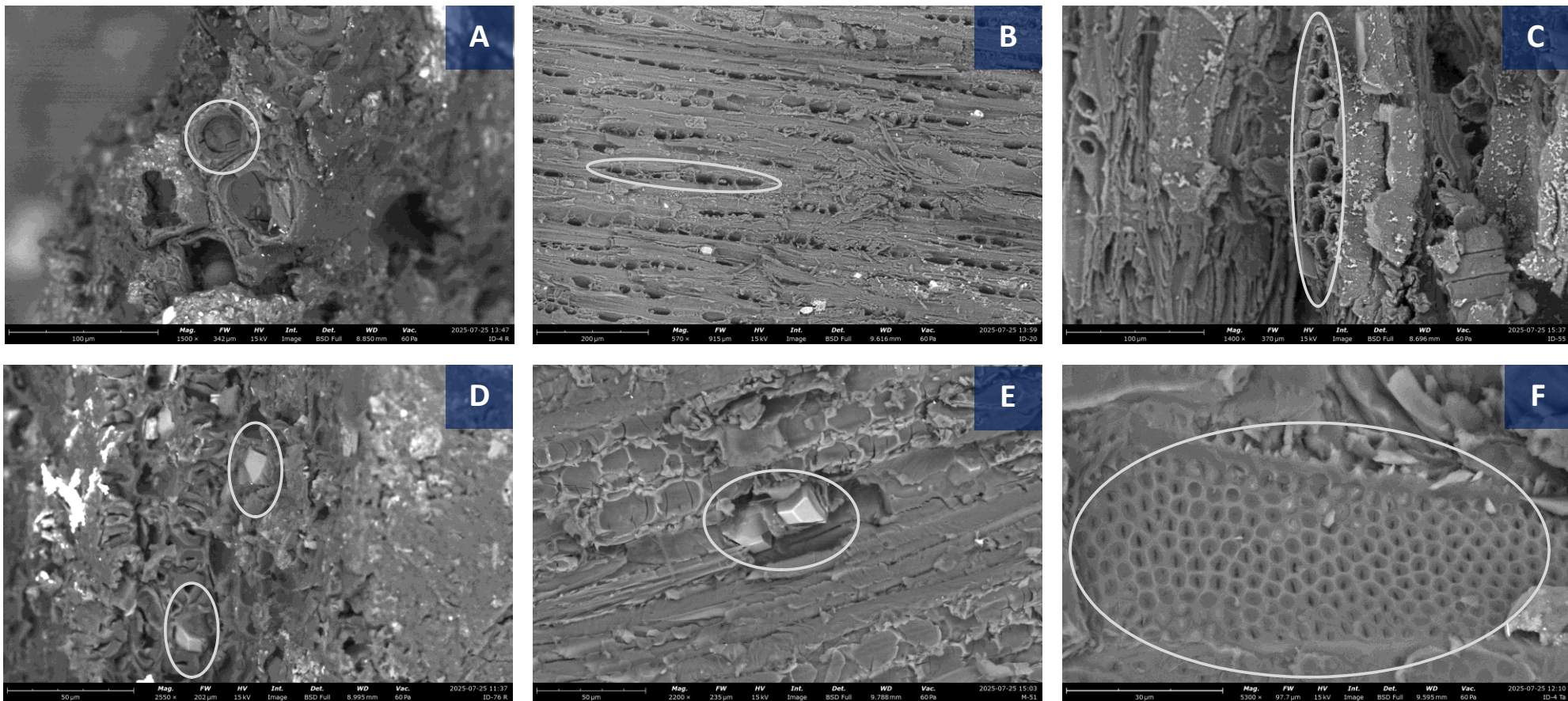


Figure 18: Examples of images taken from the samples. Figure A shows deposits in heartwood vessel in ID.4 (transversal cut). Image B shows rays with a width of one in ID.20 (tangential cut). Image C shows rays with a width of two/three in ID.55 (tangential cut). Image D shows two crystals with a width 15 μm – 19 μm in ID.76_veneer (tangential cut). Image E shows two crystals in ID.637_veneer (tangential cut). Image F shows the intervessel pits of alternate + polygonal shape in ID.4 (tangential cut).

4.3 Color technology - Penetration depth mockups

In Figure 18, the staining penetration depth is shown for six of seven mock-ups. These depths ranged from 0.01 to 0.1 mm, as determined by optical microscopy. Mock-up 1664 appeared entirely black. SEM analysis was not employed because optical microscopy provided sufficient clarity to assess the staining layers. Moreover, SEM imaging required more time, and initial results failed to clearly distinguish the transition between stained and unstained wood, making optical methods more efficient and informative in this context. However, a chemical image would help the interpretation of elements obtained from the EDX as specific elements can be attributed to staining on the basis of location, and the results could be better compared with Canevari et al (2016), who also used EDX for analyses.

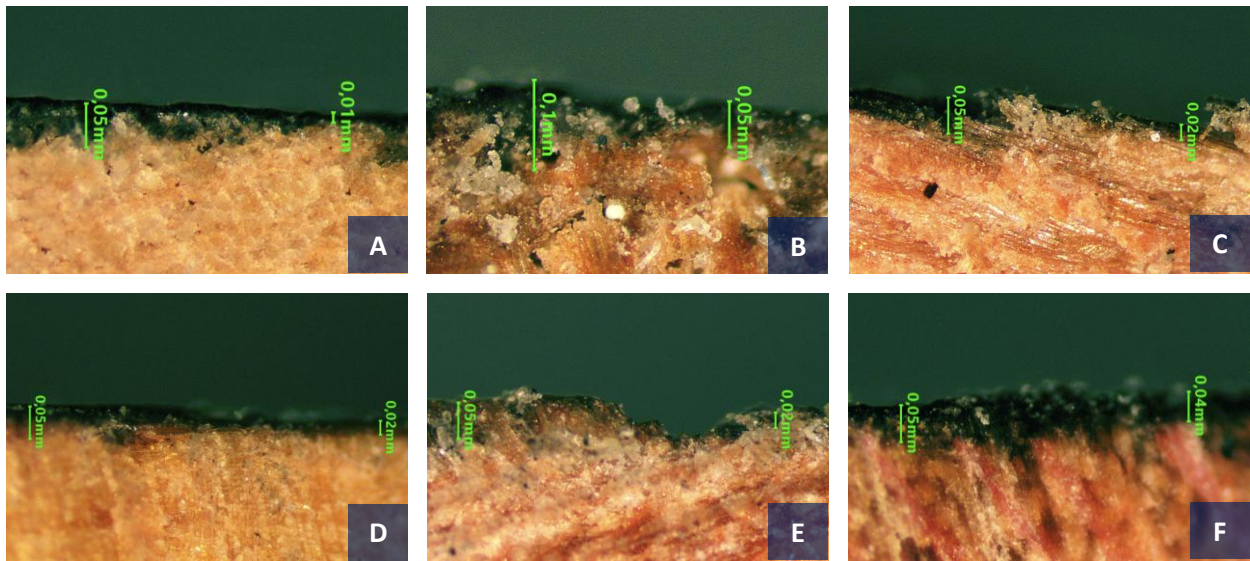


Figure 19: Penetration depth of the mockups: **A**-1635 by Lebrun (0,01-0,05 millimeter), **B**-1764 (0,05-0,10 millimeter), **C**-1771 (0,02-0,05 millimeter), **D**-1778 (0,02-0,05 millimeter), **E**-1778A (0,02-0,05 millimeter) and **F**-1778B (0,04-0,05 millimeter). The place of measurement was randomly selected. For further details on the mockups, see context and attachments.

4.4 Color technology - X-Ray Fluorescence (XRF)

In Table 13, an overview is given of the most important data analyzed from the spectra. Both the low- and high-energy spectra are included. For XRF, higher-energy spectra are typically used, as heavier elements appear in these spectra. But low-mass elements like sulfur do not appear readily in high-energy spectra. As sulfur is an essential element that indicates staining, the results were combined to give a better understanding. The trace elements were not used as these were highly variable and would not help the analysis further. It has been taken into account whether the measurement was performed on a molding or veneer. All the individual measurements and information can be consulted in the attachments.¹⁵⁶

¹⁵⁶ The raw data can be found at university of Antwerp, accompanied with spectra in better resolution.

Table 13: presents the interpreted XRF results of all performed measurements. The rows are organized according to the reference mock-ups and the cabinets, which are identified by their respective IDs. Each column corresponds to a specific mock-up or cabinet. The measurement number refers to the associated data files, in which the corresponding spectra can be consulted. Due to the nature of the technique, the XRF results are automatically divided into low- and high-energy spectra. The elements detected in the spectra are categorized as main or minor elements, in accordance with the criteria outlined in the methodology section.

	Name	Low Energy spectrum		High Energy spectrum	
		Main elements	Minor elements	Main elements	Minor elements
Mockup	Reference ebony	Ca	/	/	Ca
	1635_10 Pear	S, Fe	K, Ca	Fe	/
	1694_20 Apple	/	S, Ca, Fe	/	/
	1771_14 Apple	S, Fe	/	Fe	/
	1778A_18 Apple	/	S, K, Ca, Fe, Cu	Cu	Fe
	1778B_06 Plum	Fe	S, K, Cu	Cu	Fe
	1778_19 Cherry	S	K, Ca, Cu	Cu	/
	1764_01 Plum	Fe	(Ti)	Fe	/
ID.4	Veneer – Measurement 1, 2 and 5	Ca	K	/	Ca
	Veneer - Measurement 3	Ca	S, K	/	Ca
	Veneer – Measurement 4	K, Ca	S	/	Ca
	Molding – Measurement 6	Ca	S, K	/	Ca
	Molding – Measurement 7	Ca	S, Fe	/	/
ID.20	Veneer – Measurement 1	Ca	K	/	Ca
	Veneer – Measurement 2	Ca, K	/	/	Ca
	Veneer - Measurement 3	Ca	S, K	/	Zn
	Molding – Measurement 4	S, K, Ca	/	/	Ca
	Molding – Measurement 5	Ca	S, K	/	Ca
	Molding – Measurement 6	Ca	/	/	/
	Molding – Measurement 7	Ca	/	/	Ca
ID.55	Veneer – Measurement 1	Fe	S, K, Ca	Fe	/
	Veneer - measurements 3	Ca	S,K	/	Ca
	Veneer - measurements 5 and 7	Ca	S, K	Ca	/
	Molding - measurements 2	Ca, Fe	S, K, Mn	/	Fe, Pb
	Molding - measurements 4	Ca	S, K	Pb	Ca
	Molding - measurements 6	Fe	S, K, Ca	Fe	Pb
ID.76	Veneer - Measurement 4, 5, 6 and 12	Ca	Fe	/	Ca
	Molding - Measurement 9	Ca	Fe	/	Ca, Zn
	Molding - Measurement 8	Ca	Fe	/	Ca
	Molding - Measurement 11	Ca, Fe	Zn	/	Ca, Zn
ID.92	Molding – Measurement 1, 6 and 4	Ca	/	/	Ca
	Veneer – Measurement 2, 3 and 7	/	Ca	/	/
	Veneer – Measurement 5	/	K, Ca	/	/
ID.625	Molding – Measurement 2	Fe	Ca	/	Fe
	Veneer - Measurement 3	Ca	Fe	/	Ca
	Veneer – Measurement 4	Ca	/	/	Ca
	Veneer – Measurement 5	Ca	Fe	/	/
	Veneer – Measurement 6, 7 and 8	Ca	K	/	Ca

The results in Table 13 are divided into six groups, based on both reference mockups and analytical findings, see Table 14. The first group (black) consists of ebony, which serves as the main reference point for interpreting the results. Group 2 are measurements containing iron in combination with sulfur. Group 3 consisted of copper and sulfur besides iron, calcium and potassium. Group 4 consisted of copper and sulfur, as well as calcium and potassium. Group 5 consisted of sulfur, besides calcium and potassium. Group 6 contains iron, besides calcium and potassium. In addition, a brief discussion is provided on other detected elements that do not fit within these main categories. After discussing each group individually, an overall interpretation is offered for the cabinets.

Table 14: The groups are defined based on the reference mock-ups and measurements performed on the cabinets. The grouping criteria are based on the presence of specific elements. This classification aims to facilitate interpretation and to provide a clearer overview of the results.

Nr	Contents of the group
Group 1	Measurements containing elevated calcium and/or potassium
Group 2	Measurements containing both iron and sulfur (besides elevated calcium and potassium levels).
Group 3	Measurements containing copper, iron and sulfur (besides elevated calcium and potassium levels).
Group 4	Measurements containing copper and sulfur (besides elevated calcium and potassium levels).
Group 5	Measurements containing sulfur and no metal.
Group 6	Measurements containing only iron (besides elevated calcium and potassium levels).
Subgroup	Measurements containing other elements (Pb, K, Ca, Zn, Ti, Sr)

Group 1: Ebony - Measurements containing elevated calcium and/or potassium

Group 1 consists of spectra containing only elevated calcium and/or potassium spectra. Besides the mockup shown in Figure 19, 18 measurements correspond to this spectrum out of a total of 42 measurements (42,86%). Similar spectra were observed across all cabinets except ID.55 and ID.76. Cabinet ID.92 displayed only this type of spectrum. No correlation was found between veneer and molding compositions.

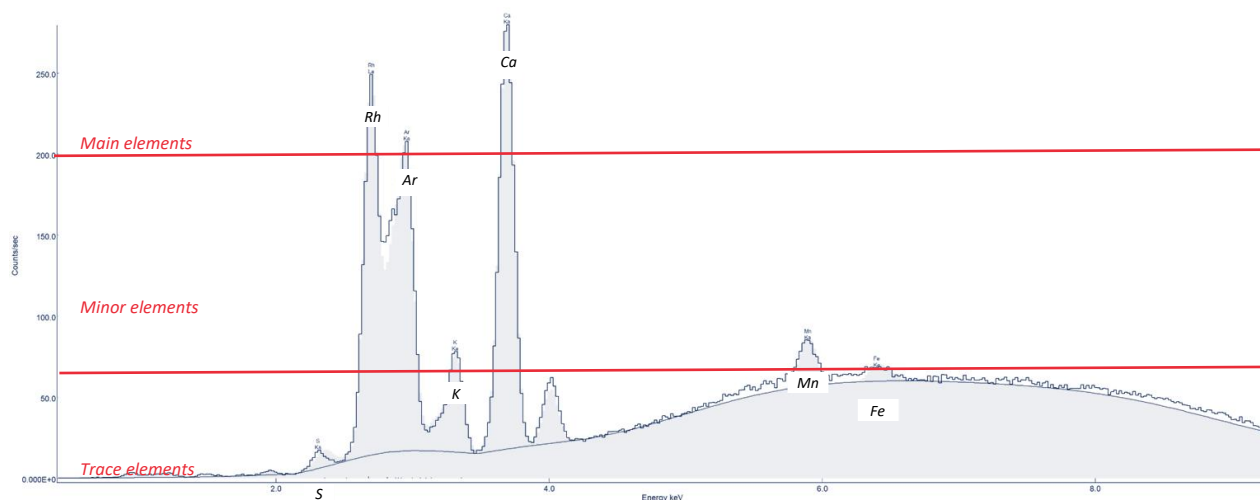


Figure 20: Spectra of the ebony mockup, showing only a high content of calcium.

Group 2: Measurements containing both iron and sulfur

This group consists of three mockups that show elevated iron and sulfur levels. One mockup (1694) showed the lowest iron and sulfur values among the three mockups in this group. ID.4 and ID. 55 showed a total of four measurements in line with this group, out of the 42 measurements (9,52%). None of the cabinet measurements in this group showed sulfur as main element.

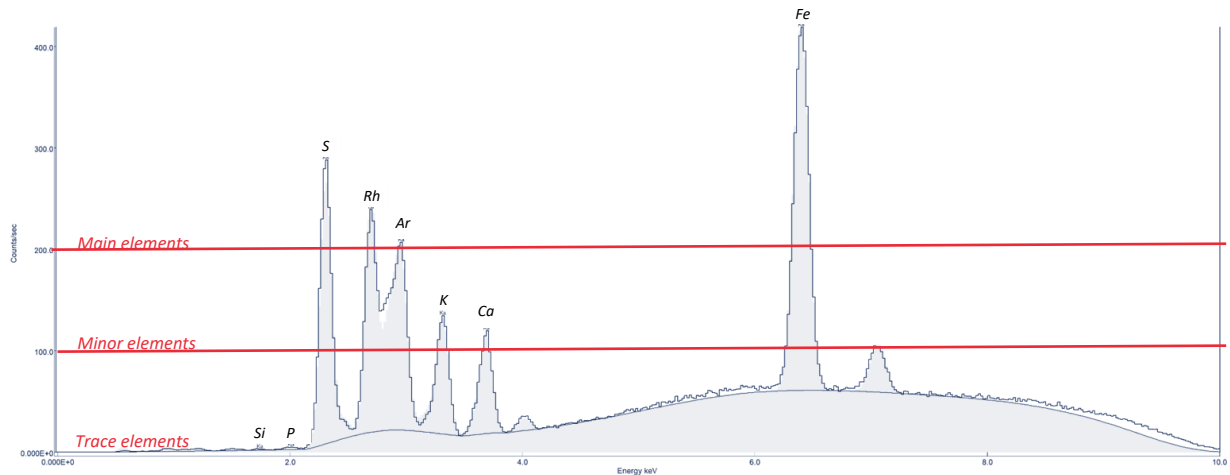


Figure 21: Spectra of the mockup 1635_10 Pear, showing an elevated content of sulfur and iron.

Group 3: Copper-iron-sulfur-based stain

This group contains the mockups treated with copper + iron-based stains. Of the measurements taken on the cabinets, none showed substantial copper values (0%).

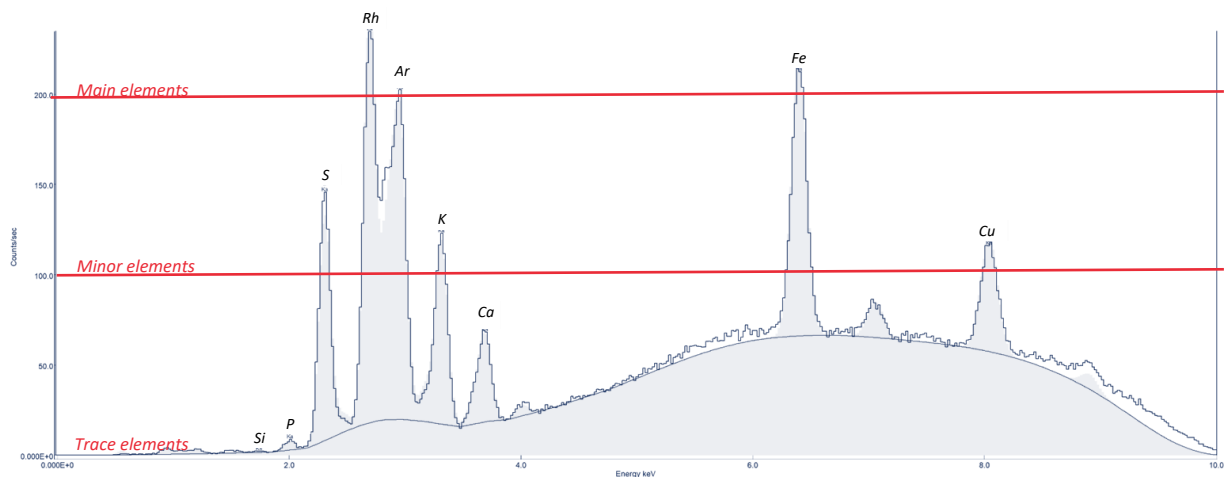


Figure 22: Spectra of the mockup 1778B_06 Plum, showing an elevated content sulfur, iron and copper.

Group 4: Copper-sulfur based stain

This group contains the mockup (1778) treated with copper. Of the measurements taken on the cabinets, none had this type of spectrum (0%).

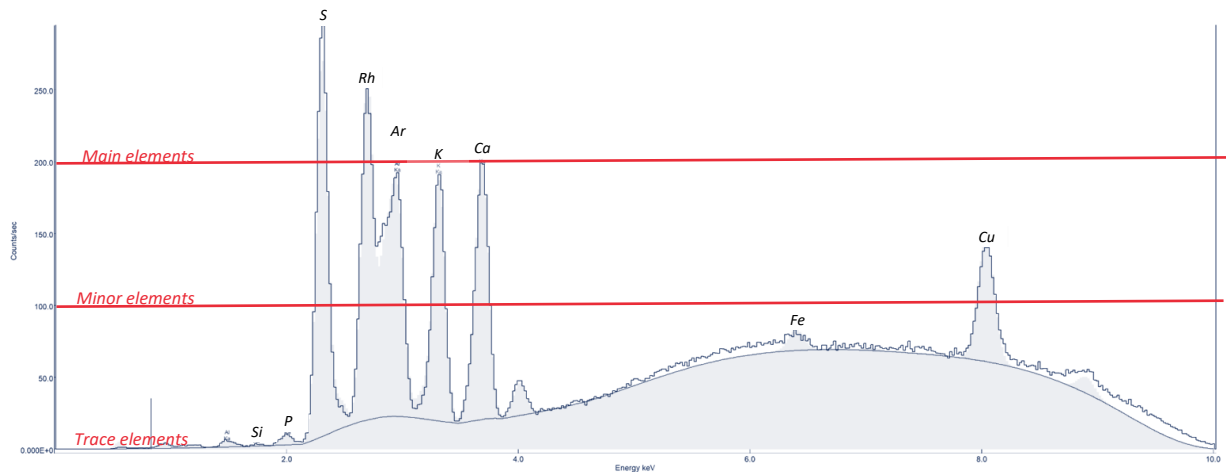


Figure 23: Spectra of the mockup 1778_19 Cherry, showing an elevated content sulfur and copper.

Group 5: Sulfur-containing results (without a metal)

This group contains measurements showing sulfur without accompanying metals. No differences were observed between molding and veneer measurements. These spectra were detected in samples ID.4, ID.20, and ID.55, for a total of 10 measurements out of 42 (23,81%).

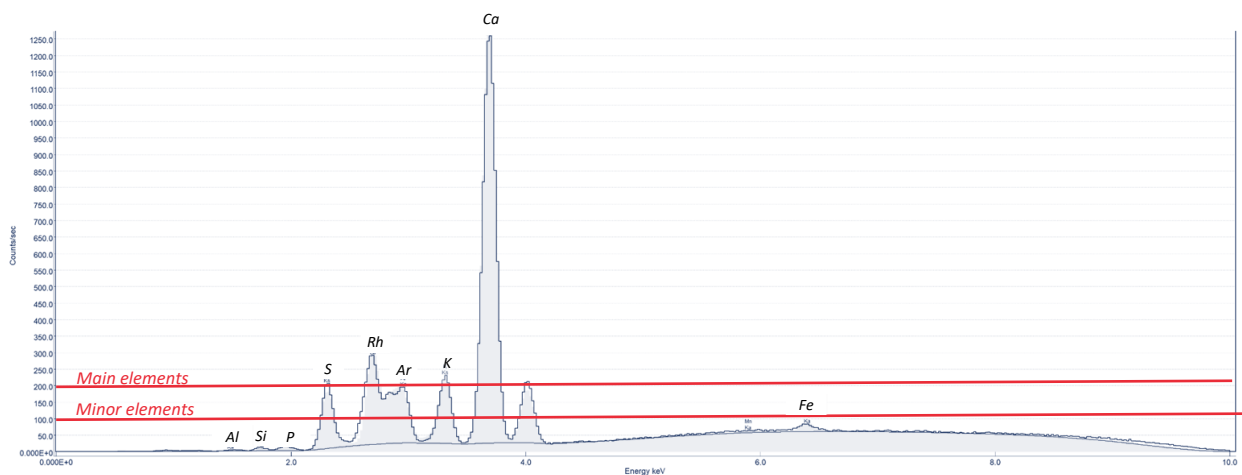


Figure 24: Spectra of ID.20_4 within the high , showing an elevated content of sulfur with no metal peaks.

Group 6: Iron-containing results (without sulfur)

These results show measurements with elevated iron levels but no elevated sulfur. Mockup 1764 showed this type of spectrum. ID.76 contained only this type of spectrum, and ID.625 showed three out of eight of this kind. Out of the 42 measurements taken on cabinets, 10 showed this spectrum (23,81%).

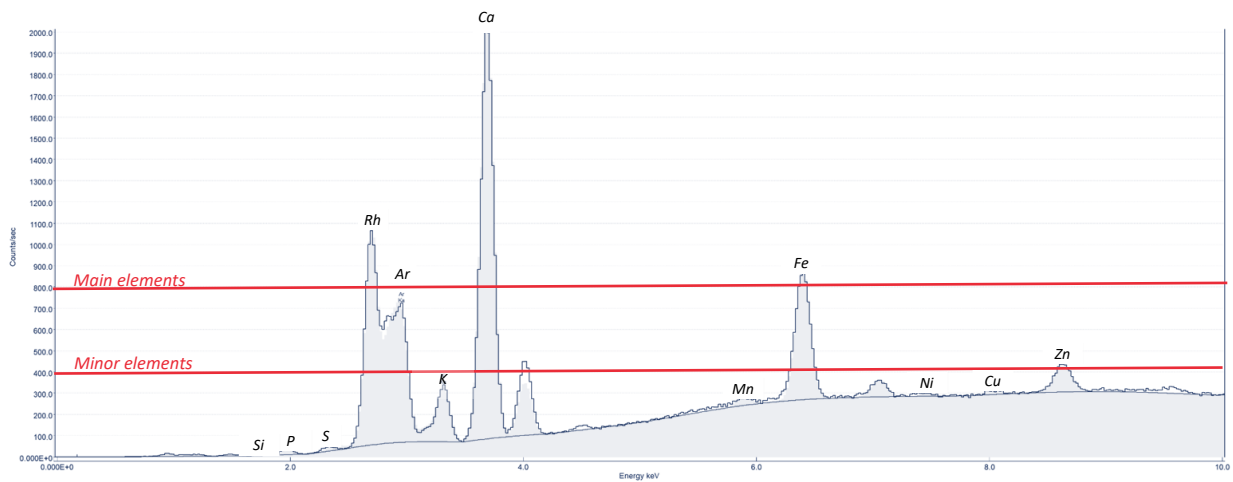


Figure 25: Spectra of ID.76_11, showing an elevated content of iron and zinc.

Other elements (Pb, K, Ca, Zn, Ti, Sr)

In the 42 analyzed measurements of the cabinets, different exceptions were registered of those that could not be grouped together. All spectra contained calcium in different quantities. Potassium was registered 20 times (47,62%). Potassium was not found in combination with group 6. Potassium was always present in combination with group 2 and group 5. And nine out of eighteen spectra in group 1. Aluminum is not detected in high enough quantities. Three cases were identified where Zinc was registered. Two times on ID.76 and one on ID.20. Pb was also registered three times, all on ID.55. Once, titanium was found on mockup 1764. Strontium was also found in several different spectra.

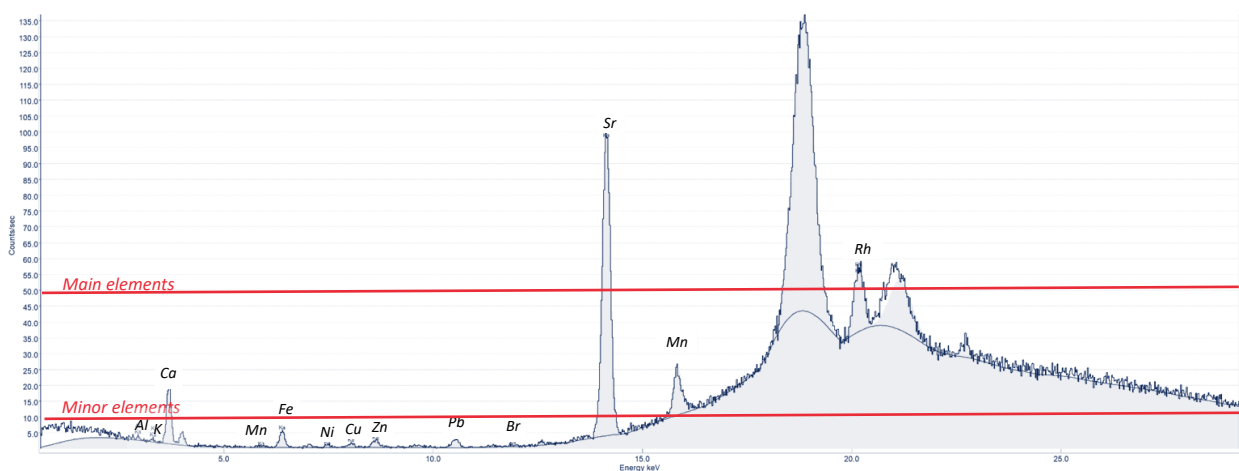


Figure 26: High energy spectra of ID.76_11, showing an elevated content of strontium.

4.5 Color technology - Scanning Electron Microscopy - Energy Dispersive X-ray (SEM-EDX)

Table 15 presents the results of the analyzed samples. Ideally, SEM-EDX analyses would also have been performed on the mockups to complement the EDX data. However, this was not possible due to time constraints. In the discussion, the available results will be compared with the XRF findings. The primary objective of this comparison is to assess whether the sampled areas are representative of the veneer or molding in other parts of the cabinet, when compared to the XRF. Because the interpretation of the SEM-EDX maps is based on visual assessment of relative signal intensity and spatial distribution, the results are subject to interpretive uncertainty and should be considered qualitative. See attachments for spectra and images.

Table 15: The following table presents the spatial distribution and relative intensity of elements detected in the sampled materials. The results are arranged from low to high intensity, with the final column indicating elements that display a recurring pattern consistent with features observed in the corresponding microscopic photographs. Where applicable, EDX analyses were conducted on both the front (F) and back (B) of the samples. Not all elements are present in every sample. For example, copper is absent in some cases because during. The corresponding EDX images and spectra are provided in the attached files. This table is based on visual interpretation of the EDX maps and should therefore be understood as subject to visual and interpretive bias. The primary aim is to contextualize the EDX results within each individual cabinet and its associated analytical findings.

Interpretative results of SEM-EDX images				
Relative intensity	Low	Medium	High	
Ebony	Mg, Al, Si, Fe, Ca	P, S	Cl, K	/
ID.4 – F (cross-section)	Mg, Al, Si, Cu	Cl, Ca, Fe	S, K	/
ID.4 – B (cross-section)	Mg, Al, Si, K, Ca	P, S, Cl, Fe	/	/
ID.20 - F	Mg, Si, P, Fe, Cu	Al, S, Ca	K	Cl
ID.20 - B	Mg, Al, Si, P, Fe, S	K, Ca	/	/ (Cl part of front side)
ID.55 - F	Mg, Al, Si, P	/	K, Fe	S, Ca, Cl
ID.55 - B	Mg, Al,	P, K	S, Fe	Si, Ca
ID.76 - B1	Mg, Si, Cl, K, Fe, Cu	Al, P, Zn	/	S, Ca
ID.76 - B2	Mg, Al, Si, Cl, K, Fe, Cu	P, Zn	/	S, Ca
ID.92 - F	Mg, Si, P, S	Al, K, Fe, Ca	Cl	/
ID.637 - F	Mg	Al, Si, P, Cl, Fe	/	K, S, Ca
ID.637 - B	Mg, Al, Si, P, Fe	S	Ca, K	Cl
Surface distribution	Distributed sporadically	Elements semi to clear homogenous distributed in the wood/upper layer	Elements follow an upper layer	

Based on Table 15, no sample exhibits an elemental distribution or relative intensity comparable to that observed in the reference ebony sample. Furthermore, comparison between the samples indicates that none share identical elemental distribution patterns or intensity profiles. Differences in elemental distribution are also consistently observed between front and back surfaces of individual samples. Sample ID.76, for which the same backside was unintentionally analyzed twice, shows comparable elemental maps and interpretations, except for aluminum.

Magnesium is detected in all samples at low relative intensity and displays a sporadic, heterogeneous distribution. Aluminum is detected in seven out of eleven samples and similarly exhibits low relative intensity without a homogeneous distribution or clear association with a surface finishing layer. Silicon follows a comparable trend, being detected at low intensity in nine out of eleven samples, predominantly in a sporadic distribution. In one sample, silicon shows a semi-distributed pattern, while in another it appears associated with a superficial structure on the backside.

Potassium and sulfur do not display consistent trends across the dataset. However, in samples for which both front and back surfaces were analyzed, these elements tend to show higher relative intensity on one surface and a more homogeneous distribution, in some cases associated with an upper surface layer. Phosphorus exhibits variable behavior, with higher relative intensities detected on either the front or back surface depending on the sample. Chlorine is observed following a superficial structure in samples ID.20 and ID.55. Calcium and iron do not show consistent distribution patterns across the samples. Copper is not detected in all samples. When present, it exhibits low relative intensity and a sporadic distribution. Zinc was only analyzed in sample ID.76.

5 Discussion

In the following chapter, the results are discussed. Given the use of multiple analytical techniques to investigate the presence of ebony imitation, the mock-ups and cabinets are first examined individually in depth, allowing for a more nuanced and context-sensitive interpretation of the findings. This is followed by an integrative discussion that synthesizes the individual observations across the dataset. Finally, each analytical technique is critically discussed and evaluated with respect to its contribution and limitations. This structure facilitates a more coherent and meaningful discussion than an approach organized strictly by technique. Within this framework, SEM-EDX analysis is primarily employed to support and contextualize the XRF measurements and the sample.

5.1 Case per case

5.1.1 Ebony

XRF analysis identified potassium (K) and calcium (Ca) as the dominant elemental constituents, with manganese (Mn) and sulfur (S) present at lower intensities, consistent with their documented natural occurrence in wood substrates.¹⁵⁷ SEM-EDX analysis produced comparable elemental spectra. In particular, potassium exhibited intensities similar to calcium, reinforcing its interpretation as an intrinsic component of the wood rather than as an indicator of applied treatment. Other detected elements occurred only at trace levels. Notably, manganese was not detected in the SEM-EDX spectra, possibly due to its limited detection area. Iron (Fe) was not detected at significant levels by either method. Likewise, the reference ebony sample did not exhibit elevated iron concentrations in either XRF or SEM-EDX analyses. This observation differs from the results reported by Dijkstra and underscores the variability in the elemental composition of ebony.¹⁵⁸

5.1.2 Groups based on the mockups

All mock-ups display varying degrees of purple-to-black coloration capable of imitating ebony. No clear correlation was observed between the applied staining method and the depth of penetration, except for mock-up 1664, which exhibited uniformly black coloration throughout the sample. This case is discussed separately below. Overall, these observations are consistent with the findings of Canevari et al. (2016, p.30).

Measurements containing both iron and sulfur

The first group comprises mock-ups 1635, 1694, and 1771, all of which exhibit elevated levels of both iron (Fe) and sulfur (S). Among these, mock-up 1694 shows comparatively lower intensities of iron and sulfur. In this case, the wood was subjected to boiling, which may have caused surface darkening or partial carbonization. Such thermal alteration could produce a blackened appearance independent of chemical

¹⁵⁷ Dijkstra also found elevated manganese in ebony, this can be possibly a first indicator that manganese can be rather found then in an endemic wood species. Except, in the spectra, this was not consistently found in group 1 measurements.

¹⁵⁸ This discrepancy may be attributed to differences in the sensitivity of the XRF devices used in each study. The absence of elevated iron in this study's ebony reference simplifies the identification of stained wood, in contrast to Dijkstra's more ambiguous results. Another reason that lower iron results were obtained could be the result of using the setup differently. The difference of this, impedes the comparison between the studies.

staining, resulting in low intensity in XRF analysis. For mock-ups 1635 and 1771, the XRF spectra are consistent and indicative of an iron–sulfur–based staining process. The recipe for mock-up 1635 includes lamp black, iron gall ink, vinegar, horsetail, and beeswax. The detected iron and sulfur are attributable to the iron gall ink, while potassium and calcium likely originate from the wood substrate. Mock-up 1694 contains alum, vitriol, linseed oil, and sulfur. The iron and sulfur can be explained by the presence of vitriol and sulfur compounds, whereas calcium may again reflect the natural composition of the wood. The recipe for mock-up 1771 includes gallnut ink, gallnuts, vinegar, and beeswax. Here, iron and sulfur are likewise attributable to the ink. As expected, no elemental markers associated with gallnuts, vinegar, or beeswax were detected, as these materials do not contain elements identifiable by XRF.

Measurements containing copper, iron, and sulfur

Mock-ups 1778A and 1778B form a coherent group. The recipe for 1778A includes gallnuts, logwood, vitriol, verdigris, and demineralized water. The presence of iron and sulfur is consistent with the use of vitriol, while copper (Cu) can be attributed to verdigris. Potassium and calcium are most plausibly explained by their natural occurrence in the wood. Mock-up 1778B follows the same recipe but substitutes water for vinegar, which explains the relatively higher iron levels observed. Vinegar can act as a proton donor, promoting chelation and potentially increasing iron uptake. This group represents mock-ups treated with combined copper–iron–based stains. The presence of copper is a strong indicator of artificial staining, as it is not typically present in wood. This interpretation aligns with Dijkstra's findings, who identified copper as a reliable marker based on XRF measurements. The key elements characterizing this group are iron, sulfur, and copper, although iron is not necessarily required for copper-based staining, as demonstrated by mock-up 1778, see below. Importantly, none of the cabinet measurements contained detectable copper, indicating that copper-based staining techniques were not employed in the analyzed objects. Variations in copper intensity among the mock-ups correspond to differences in the quantities of copper-containing materials specified in the recipes.

Measurements containing copper and sulfur

Another subset of recipe 1778 does not include iron but relies on copper-containing compounds. The recipe comprises alum, verdigris, copper acetate, vinegar, logwood, and water. Copper is attributable to verdigris and copper acetate, while the sulfate component of alum explains sulfur. Potassium and calcium are again most likely derived from the wood substrate.

Measurements containing only iron

Finally, mock-up 1764 exhibits elevated iron alongside titanium (Ti). The recipe includes gallnuts, demineralized water, vinegar, vitriol, and olive oil. Iron can be attributed to vitriol, while the presence of titanium is difficult to explain and may result from contamination during preparation, as this element is not observed elsewhere in the dataset. The use of vinegar as a proton donor, analogous to sulfate-based systems, suggests a distinct staining mechanism and defines a separate analytical group. This group comprises measurements with elevated iron levels in the absence of sulfur. Several explanations may account for this pattern. Certain wood species naturally contain higher iron concentrations, as noted by Dijkstra, who reported elevated iron levels in untreated ebony. Alternatively, iron-based staining using vinegar rather than sulfate compounds would result in elevated iron without detectable sulfur, since acetate ions (CH_3COO^-) are not detectable by XRF. Among the cabinet measurements, only ID.76 and ID.625 display this spectral profile.

Measurements containing sulfur

This group contains measurements showing sulfur without accompanying metals. This group was not reported in Dijkstra's study. Since metals are essential for chemical staining, these readings do not indicate staining activity. However, they also do not necessarily represent plain ebony, as such high sulfur concentrations were not found in the ebony mockup. Possible explanations for these elevated sulfur levels are tentative and include surface finishes, natural variation related to the tree's growing conditions, and historical contamination. No significant differences were observed between molding and veneer measurements.

5.1.3 ID.4

This cabinet showed contradictory findings upon visual analysis. Some areas showed faded black wood, revealing lighter wood underneath, and in other places, black inner wood was found. The wood identification of a piece of veneer found in one of the drawers showed more common characteristics with *Diospyros sp.* than with *Pyrus sp.* When considering possible coloring techniques, the XRF results show only one measurement that fits a mockup, indicating the presence of Iron and Sulfur. The other three measurements correspond more closely to ebony. And three other measurements were grouped within results containing sulfur but no metal, so there was no direct indication of staining. This is the only cabinet in which the measurements are divided into three groups, which may explain the contradictory findings and suggest a nonhomogeneous cabinet. The analyzed sample under the EDX showed homogenous distributed of sulfur and potassium on one side. No layering was observed in the EDX or microscopic images. This does suggest that no technique was used to stain the veneer. In conclusion, there are minimal indications that the sample and the cabinet used an imitation substrate and a staining technique.

5.1.4 ID.20

ID.20 exhibits the fewest visual indications of imitation among the examined cabinets. Wood identification reveals characteristics more consistent with *Diospyros sp.* than with *Pyrus sp.* With respect to coloring techniques, none of the XRF measurements correspond directly to the reference mock-ups. Four of the seven measurements align with the spectra associated with untreated ebony, while three measurements fall within the group characterized by elevated sulfur levels in the absence of metallic elements. These latter results do not support the use of chemical staining. Comparison with the SEM-EDX results provides additional context. Chlorine was detected predominantly in the uppermost layer of the sample and was partially visible beneath the surface, suggesting its association with a finishing or surface treatment rather than with the wood substrate. The remaining elemental distributions are ambiguous and may reflect either the natural elemental composition of the wood or a combination of inherent and applied materials. SEM imaging revealed numerous small inclusions corresponding to calcium and sulfate, which may be attributable to prismatic crystals. However, this does not account for the co-localized presence of sulfur. Taken together, the analytical results do not support the presence of an ebony-imitation substrate or the application of a staining technique in this cabinet.

5.1.5 ID.55

ID.55 exhibited clear visual indications of a lighter-colored wood substrate beneath a darkened surface layer. Wood identification indicated that the material is more consistent with *Pyrus sp.* than with *Diospyros sp.* XRF analysis showed that none of the measurements corresponded to the elemental profile of untreated ebony. Three out of seven measurements fall within the group characterized by the combined presence of iron and sulfur, suggesting the application of a chemical staining treatment. In several measurements, lead (Pb) was also detected. As a metallic element, lead could act as a proton donor during the staining procedure. SEM-EDX analysis corroborated the XRF results by confirming the presence of both iron and sulfur. Lead, however, was not detected by SEM-EDX. Aluminum, phosphorus, and silicon were observed with similar spatial distributions on both the front and backside of the sample, suggesting a predominantly natural origin within the wood substrate. Potassium exhibited a more homogeneous distribution, further supporting its attribution to the intrinsic wood composition. In contrast, chlorine was detected exclusively on the front side of the sample, where its spatial distribution follows an upper surface layer, indicating its likely association with a finishing or surface treatment. Calcium also showed increased intensity near the surface, which may likewise relate to finishing materials. Taken together, these observations suggest the use of a chemical staining technique applied to a non-*Diospyros* wood substrate. Combined with the wood identification results, this supports the interpretation of ID.55 as a possible example of ebony imitation.

5.1.6 ID.76

ID.76 exhibited clear visual indications of ebony imitation on the moldings. In contrast, the veneer yielded ambiguous results during visual inspection, preventing a definitive assessment based solely on macroscopic observation. Wood identification demonstrated that the moldings are more consistent with *Pyrus sp.* than with *Diospyros sp.*, whereas the veneer sample shows characteristics more closely aligned with *Diospyros sp.* than with *Pyrus sp.* All XRF measurements fall within the group characterized by elevated iron levels in the absence of sulfur. This elemental profile corresponds to a reference mock-up in which vinegar was used as a proton donor, functioning similarly to sulfate-based systems but remaining undetectable by XRF due to the low atomic mass of acetate ions. Zinc was also detected, while zinc can occur in certain vitriol-based materials, these contain sulfate, which does not account for its presence in this case.

SEM-EDX analysis revealed a clear spatial correlation between sulfur and calcium within the sample. Upon closer examination of the sampled area, this elemental distribution may plausibly be attributed to the presence of an adhesive layer. Phosphorus supports this interpretation in one of the two analyses, as its spatial distribution follows the same pattern. Notably, both SEM-EDX analyses were conducted on the backside of the sample due to an accidental positioning, which nevertheless demonstrates that repeated analyses can yield reproducible results. Aluminum was the only element to shift between interpretative categories, which may be attributable either to interpretative variability or to differences in sample positioning within the instrument, resulting in improved signal quality in one of the measurements. Zinc was also confirmed in the SEM-EDX analysis, indicating that its presence warrants further investigation. Overall, the combined results suggest that the moldings of ID.76 were produced using an imitation substrate in combination with a staining treatment. The veneer, by contrast, appears to consist predominantly of ebony, although the absence of a clear distinction between the XRF measurements of the moldings and the veneer suggests that staining may also have been applied to the veneer.

5.1.7 ID.92

ID.92 yielded ambiguous results, as evidence of a restoration involving an ebony-imitation material was observed in some areas. In contrast to the other cabinets examined, the inlaid veneer was not uniformly black. Wood identification based on the sampled material was inconclusive, due to the presence of a thick finishing layer and the limited amount of exposed wood tissue. XRF analysis provided no signs of staining agents. All measurements corresponded to the group associated with untreated ebony. SEM-EDX analysis revealed a relatively uniform presence of chlorine across the spectra, suggesting its possible association with a finishing or surface treatment. Calcium may also be related to this finding, although its presence was less pronounced. Other detected elements occurred sporadically or at low intensities, limiting their interpretative value. Overall, the results suggest that this cabinet likely incorporates genuine ebony without the application of a chemical stain, which may account for the observed variations in black tonality within the inlaid elements.

5.1.8 ID.625

This cabinet was selected based on a restoration report documenting the use of ebony imitation. Upon closer examination, several areas were identified in which the application of an imitation material appeared plausible, although it was not visually unambiguous. As a wood identification had already been carried out during restoration, no additional sampling was undertaken for this study. The photographic documentation, included in the restoration report, suggests that the veneer is more consistent with *Pyrus sp.* than with *Diospyros sp.* XRF analysis revealed that three of six measurements are consistent with an iron-based staining technique in the absence of sulfate. The remaining measurements correspond to the spectra associated with untreated ebony. As no physical samples were taken, SEM-EDX analysis could not be performed. These results suggest the possible use of an ebony-imitation substrate combined with a staining treatment.

5.1.9 ID.637

This cabinet exhibits color variations comparable to those observed in ID.92, particularly in areas with inlaid veneer. Wood identification indicates that the sampled material corresponds more closely to *Diospyros sp.* than to *Pyrus sp.* No XRF measurements were conducted for this cabinet due to time constraints. SEM-EDX analysis of the front side, specifically in areas where the finishing layer is damaged, revealed pronounced and spatially correlated signals of sulfur and calcium. Aluminum, silicon, and phosphorus were also detected following the same surface-related distribution, albeit at lower intensities. In contrast, analyses of the backside showed these elements only sporadically and at low levels, suggesting that their presence on the front is at least partially related to surface treatment rather than to the wood's natural elemental composition. Potassium exhibited increased intensity in areas where the finishing layer is damaged, whereas on the backside, it appeared more homogeneously distributed, indicating a likely natural contribution from the wood substrate. Iron displayed a similar distributional pattern. Taken together, the results suggest the use of a *Diospyros sp.* rather than *Pyrus sp.*. However, interpretation of coloring techniques remains limited, as no XRF measurements were available for this cabinet and direct comparison with reference mock-ups was therefore not possible. While elemental associations and spatial relationships could be identified, no chlorine was detected in relation to the finishing layer.

5.1.10 Additional findings (Pb, K, Zn, Ti, Sr)

As previously discussed, potassium (K) may serve as an indicator of staining processes involving alum. Dijkstra asserts that alum use should result in detectable aluminum levels. However, it is possible that aluminum does not chemically bind and could be washed away after staining, a limitation that also applies to potassium detection.

The interpretation of lead (Pb) readings requires careful consideration, as XRF software may misidentify lead as arsenic (As), and vice versa, due to overlapping spectral lines. While lead could indicate metal-based staining, arsenic might be present instead due to its historical use as a pesticide. Arsenic was detected in cabinet ID.4 and ID.55. Additionally, zinc (Zn) appeared consistently in ID.76 and in one measurement of ID.20. Since Dijkstra's study did not report zinc, its presence raises questions about potential contamination or undocumented staining applications. Titanium (Ti) was detected in one sample and may be a modern contaminant of the mockup, as it does not appear in the spectra of the IDs and other mockups. Finally, strontium (Sr) deserves special consideration, as this element appeared in varying intensities across several spectra in different cabinets. Franceschi and Focardi (2013) found a correlation between the presence of strontium and calcium, possibly indicating the use of gypsum in XRF spectra.¹⁵⁹ However, the reason for its abundant presence in different spectra remains unclear and warrants further investigation.

5.2 Final discussion cases

In Table 16 a comprehensive overview of the researched cabinets is presented. Out of the seven examined cabinets, three show indications of ebony imitation: ID.55, ID.76, and ID.625. This conclusion is for cabinet ID.55 and ID.76 supported by the combined evidence of wood identification, XRF analysis and SEM-EDX. For ID.625, the indication is based on wood identification and XRF. The used mockups showed the potential to indicate if staining was applied, although certain lacunae remain, since multiple techniques for imitating ebony were historically available. The results for ID.76 further suggest that genuine ebony and ebony imitation could have been applied in combination, an outcome consistent with accounts in historical literature, see 1.6.1. The results obtained for ID.4 and ID.76 indicate that staining may have been applied to veneers identified as ebony. The variability observed across the cabinets could suggest that such treatments were applied locally rather than uniformly, resulting in heterogeneous analytical outcomes. It should be emphasized that the present results do not account for the full range of historical coloring practices. Alternative techniques, including pigment-based applications or carbonization processes, may also have been employed but fall outside the analytical scope of this study. Methodologically, the applied techniques were limited to assessing the affinity of the analyzed wood samples with *Pyrus sp.* or *Diospyros sp.*, and, with respect to coloring strategies, to the identification of chemical staining processes. Consequently, the absence of staining evidence should not be interpreted as evidence of the absence of other coloring techniques.

¹⁵⁹ Enrico Franceschi and Federico Locardi, "Strontium, a New Marker of the Origin of Gypsum in Cultural Heritage?," *Journal of Cultural Heritage* 15, no. 5 (2014): 522–27, <https://doi.org/10.1016/j.culher.2013.10.010>. 526.

Table 16: Summary of the results obtained using the different analytical techniques. The results are organized into four columns. The visual inspection column briefly discusses the presence or absence of indicators of ebony imitation. The wood identification column presents the criteria used for the inclusion or exclusion of *Pyrus sp* or *Diospyros sp.*. The XRF column summarizes the analytical findings, with “**M**” indicating the number of measurements found. The SEM-EDX column lists indicative and important observations derived from the analyses. Each row concludes with an overall assessment indicating the likelihood of ebony imitation. This table is limited in results; the aim is to give an overview of found observations.

ID	Cabinet	Visual inspection	Wood identification	XRF	SEM-EDX	Conclusion
ID.4		Minimal indications - At the back on moldings - On moving parts	Rather <i>Diospyros sp.</i> - Ray width 1 – (2) - Absent helical thickenings	Mixed indications of a stain - 3M same as ebony - 3M high S content - 1M FeS based stain	No indications of staining.	Minimal indications of an imitation substrate and a staining technique
ID.20		Minimal indications - No specific locations were found	Rather <i>Diospyros sp.</i> - Ray width 1 - Absent helical thickenings	Probably no stain - 4M same as ebony - 3M high S content	- Possibly finished with chlorine-based material	Minimal indications of an imitation substrate and a staining technique
ID.55		Major indications - Damaged moldings - On moving parts - At the back on moldings	Rather <i>Pyrus sp.</i> - Ray width (1) – 2	Probably stain - 3M FeS based stain - 4M high S content	- Possibly finished with chlorine-based material	Added indications of imitation substrate and a staining technique
ID.76		Major indications - Damaged moldings - On moving parts - Side of molding	Molding rather <i>Pyrus sp.</i> - Ray width (1) – 2 - Present helical thickenings	Probably stain - 7M Fe based stain	- Zinc showed up, corresponding to the XRF spectra	Added indications of imitation substrate and a staining technique
ID.92		Mixed indications - On moving parts	Unclear - Could not be checked	Probably no stain - 7M same as ebony	- Possibly finished with chlorine-based material	Minimal indications of an imitation substrate and a staining technique
ID.625		Major indications - At the side of moldings	Rather <i>Pyrus sp.</i> - Ray width 3	Mixed indications of a stain - 4M same as ebony - 3M Fe based stain		Added indications of imitation substrate and a staining technique
ID.637		Mixed indications - Color variations on the veneer - On moving parts	Rather <i>Diospyros sp.</i> - Ray width 1-(2)	Not executed	- Possibly finished with sulfur, potassium and calcium material	Minimal indications of a staining technique

5.3 General discussion

As discussed earlier, visual identification of ebony imitation proved challenging because individual cabinets presented contradictory indications. A cabinet can exhibit clear evidence of ebony imitation in one location, while other areas suggest plain ebony. As outlined in the methodology, the presence of restorations was anticipated and indeed observed. These interventions were identifiable through differences in execution, such as variations in profile pattern or material thickness. Considering the analytical results, it is possible that certain restorations remained undetected across all applied techniques. For future researchers assessing the presence of ebony imitation via visual examination, several observations are highlighted. For example, areas where moving components come into contact often reveal underlying wood tones. In some cases, ebony imitation was found on the veneer, particularly on edges, whereas structural framework elements were often merely stained or colored, a practice in this thesis not regarded as ebony imitation. The most reliable visual indicators were observed on moldings in areas affected by damage that was not immediately apparent during initial inspection. For instance, damage caused by handles impacting moldings on the sides of cabinets revealed clearer evidence of imitation in two out of three cases (ID.55 and ID.76, compared to ID.4). Visual identification on veneer was difficult because the thickness typically measures approximately 1 mm. Table 16 further demonstrates that visual examination constitutes a valuable preliminary step prior to sampling and instrumental analysis, as cabinets displaying multiple visual indicators were more likely to exhibit probable ebony imitation.

In contrast to Herzinger's thesis, the identification of wood species from small samples proved to be extremely challenging. Although a different methodology was employed, using SEM rather than sample slicing and coloring, the results indicate that while SEM allows for non-destructive examination, it yields limited information on wood anatomical structure. Larger wood samples would be more suitable, especially when SEM is combined with DART-TOFMS, which enables wood identification without destroying the sample, provided that appropriate reference material is available in the database, as shown by Van Meenen (2024). In the present study, the samples were too small to be effectively analyzed using DART-TOFMS, as the limited amount of material would not yield reliable results.¹⁶⁰ Alternatively, anatomical sections could be prepared following the approach described by Herzinger. However, this would require destructive sampling and may still result in inconclusive identifications when working with small fragments. For these reasons, it may be more appropriate in future research to apply other analytical techniques tailored to different research aims to these samples, such as mass spectrometry-based methods for identifying finishing or surface materials rather than wood species.

XRF once again demonstrated its usefulness in analyzing stained wood. In particular, the analysis of reference mock-ups proved essential for interpreting the results. One observation that should be highlighted is that, in this case, the reference spectra of ebony did not exhibit iron contents as high as those reported by Dijkstra. For this reason, further XRF analyses of unaltered ebony samples would be valuable for a better understanding of the natural occurrence and variability of certain elements within the wood. In addition, measurements on the reverse sides of the mock-ups would help more clearly distinguish between elements naturally present in the wood and those introduced through the staining process. Furthermore, scanning the wood samples vertically without any backing material facilitated interpretation of the results, in contrast to the approach described by Dijkstra. Finally, the use of clearly

¹⁶⁰ This was discussed with researchers from the wood department of the Royal Museum for Central Africa.

defined threshold values improved the comparability of the data and enhanced objectivity in the interpretation of the results.

SEM-EDX proved to be a challenging technique regarding interpretation. The method is limited in its capacity for quantitative analysis and is better suited to the interpretation of individual, in-depth case studies, as it was applied in the discussion. By comparing the front and back sides of the samples, a clearer understanding of the distribution of certain elements could be achieved. More informative results might have been obtained if the samples had been embedded and analyzed in cross-section, as suggested by Dijkstra. Interpretation of the EDX spectra was further complicated by the absence of reference spectra from the mock-ups and by low peak intensities, which prevented the application of reliable threshold values, as with the XRF results. Despite these limitations, EDX proved valuable for detecting lighter elements, such as chlorine, and for confirming elements identified by XRF, for example, zinc in sample ID.76. However, for quantitative analyses, SEM-EDX is time-intensive and less suitable for this research.

Revised SOTA table

Based on the discussed results, Table 17 provides an interpretive overview of elements that are analytically compatible with the known staining and finishing techniques used to imitate ebony. Chemical staining approaches involving iron, copper, and sulfate yield the most analytically supported correlations, as these elements produce detectable and interpretable signals within the applied XRF and SEM-EDX analyses. In addition, the absence of specific elements may also be informative. For instance, acetate-based compounds could have been employed as alternatives to sulfate-based formulations, yet remain analytically inaccessible to XRF or SEM-EDX. No analytical indication of tin was observed in any of the measurements, suggesting a limited role for tin-based compounds within the scope of the applied techniques. The identification of alum remains methodologically challenging, as both potassium and aluminum may occur naturally in wood. However, mock-up 1778 demonstrates that the sulfate component of alum can produce a sufficiently strong signal to be analytically supported. SEM-EDX proved more sensitive to aluminum than XRF, as aluminum lies close to the lower detection limit of XRF. The distinction between naturally occurring aluminum and aluminum introduced through treatment remains analytically ambiguous. A similar interpretive limitation applies to potassium, which displays considerable variability across the samples.

Among pigment-based techniques, a plausible analytical association with bone black may be suggested, as this material contains phosphate, which was detected in several SEM-EDX analyses. However, these observations remain inconclusive and cannot be considered analytically supported. A potential association with iron gall ink may also be considered, given the overlap in elemental composition with certain chemical staining techniques, though this likewise remains analytically plausible rather than demonstrable. The presence of potash lye cannot be excluded, but no definitive analytical indication could be established. Carbonization techniques were not analytically identified. Regarding finishing materials, no analytical indication of tin oxide polishing agents was observed. Possible associations with Tripoli or pumice stone were considered, as these materials contain silicon (and aluminum in the case of pumice), both of which were detected. However, these signals remain analytically ambiguous and insufficient to support any conclusions. If such polishing materials were applied, their residues would be expected primarily on the surface of the samples, as may be observed in sample ID.637. Even in this case, it remains

unclear whether silicon would persist, as such materials are expected to be washed away during the polishing process.

Despite these limitations, the table demonstrates interpretive value by highlighting elements that are not directly represented in the mock-ups or documented in historical recipes. Importantly, the absence of correspondence between mock-ups and analytical results does not imply that a given technique was not employed. For example, zinc was detected in a cabinet despite not being represented in the mock-ups. Further literature review suggests that zinc may originate from vitriol-based compounds, rendering this association analytically plausible. Nevertheless, the table could be further refined to enhance interpretability. At present, it does not sufficiently contextualize the analytical expectations for elements such as lead, strontium, or chlorine. Chlorine would more likely be related to finishing materials based on its surface presence in the samples. Future iterations of this table would benefit from including adhesive types and their associated elemental markers. Currently, some materials are broadly categorized as carbon-based, even though they may contain minor amounts of elements such as potassium or chlorine. Furthermore, the natural elemental composition of wood itself requires further clarification, as it remains a significant source of uncertainty when distinguishing between inherent material signals and those resulting from applied staining or finishing techniques.

Table 17: Revised table of coloring techniques potentially used to imitate ebony. The fourth column summarizes the extent to which materials associated with each technique are analytically compatible with the results. Analytically supported indicates that elemental signals consistent with the proposed material were observed in both reference mock-ups and cabinet samples, although the association remains tentative. Analytically plausible refers to cases where indirect or partial indications are present in the analytical data, but without direct correspondence. No analytical indication denotes materials that, based on the applied analytical techniques and their detection limits, would be expected to produce detectable signals but were not observed. Not assessable includes materials or techniques that cannot be detected or distinguished using the applied analytical methods.

Color technique to imitate ebony			
Material	Elemental	Explanation	Analytical link (XRF + EDX)
Chemical staining			
Gallnuts	Tannins	<i>To produce a deeper stain</i>	Not assessable
Logwood	Tannins	<i>To produce a deeper stain</i>	Not assessable
Iron sulfate	FeSO ₄	<i>Cation + anion</i>	Analytically supported
Vitriol	Fe(II)SO ₄ , ZnSO ₄ or Cu(II)SO ₄	<i>Cation + anion</i>	Analytically supported
Iron gall ink	Fe(II)SO ₄	<i>Cation + anion</i>	Analytically supported
Copper acetate	Cu ₂ Al(AsO ₄)(OH) ₄ ·4(H ₂ O)	<i>Cation + anion</i>	Analytically supported
Verdigris	Copper holding	<i>Cation + anion</i>	Analytically supported
Tin salt	Sn(II)Cl ₂	<i>Cation + anion</i>	No analytical indication
White wine/vinegar	CH ₃ COOH	<i>Anion</i>	Analytically supported
Lye	NaOH	<i>Anion</i>	Not assessable
Solfer	S	<i>Anion</i>	Analytically supported
Nitric acid	HNO ₃	<i>Anion</i>	Not assessable
Alum	KAl(SO ₄) ₂ ·12H ₂ O	<i>Anion</i>	Analytically plausible
Pigment based			
Indigo	C ₁₆ H ₁₀ N ₂ O ₂	<i>Dye</i>	Not assessable
Water	H ₂ O	<i>Solvent</i>	Not assessable
Lamp black	Carbon based molecule	<i>Pigment</i>	Not assessable
Soot	Carbon based molecule	<i>Pigment</i>	Not assessable
Bone black	C, PO ₄ ,	<i>Pigment</i>	Analytically plausible
Asphalt	Carbon based molecule	<i>Pigment</i>	Not assessable
Iron gall ink	Fe(II)SO ₄	<i>Solvent (and dye)</i>	Analytically supported
Animal glue	Carbon based molecule	<i>Binder</i>	Not assessable
Gum Arabic	Carbon based molecule	<i>Binder</i>	Not assessable
Egg	Carbon based molecule	<i>Binder</i>	Not assessable
Casein	Carbon based molecule	<i>Binder</i>	Not assessable
Potash lye	KOH	<i>As a degreasing agent</i>	Analytically plausible
Carbonized			
Linseed oil	Carbon based molecule	<i>Boiling medium</i>	Only found on mockup
Finishing			
Bee wax	Carbon based molecule	<i>Coating</i>	Not assessable
Animal glue	Carbon based molecule	<i>Coating</i>	Not assessable
Bleached wax	C, [NH ₄] ₂ CO ₃ , KOH	<i>Coating</i>	Not assessable
Tin oxide	SnO	<i>Polishing</i>	No analytical indication
Tripoli	SiO ₂	<i>Polishing</i>	Analytically plausible
Flour	Carbon based molecule	<i>Polishing</i>	Not assessable
Chalk	Ca	<i>Polishing</i>	Not assessable
Charcoal	Carbon based molecule	<i>Polishing</i>	Not assessable
Pumice stone	SiO ₂ , Al ₂ O ₃ ,	<i>Polishing</i>	Analytically plausible
Horsetail	Carbon based molecule	<i>Polishing</i>	Not assessable

6 Conclusion

This thesis examined how non-black-stained wood species were used to imitate ebony in selected seventeenth-century Flemish cabinets and whether these materials could be reliably identified through minimally intrusive examination. The analysis of the seven cabinets confirmed the variable presence of ebony imitation. Visual inspection demonstrated its usefulness for identifying imitation in moldings and veneer when damage is present or when the side of a molding is visible (thus not the visible front side). In three cabinets, *Pyrus sp.* was identified instead of *Diospyros sp.* in both veneers and moldings, while one cabinet showed a combined use of the two. In these same cases, staining was examined and revealed a founded relationship between wood species and the staining technique. These chemical staining methods could be identified through mockups based on contemporary written sources.

At the same time, the overview of wood species and coloring methods used for ebony imitation demonstrates the considerable variety of materials historically employed. The detection limits of the applied analytical techniques indicate that the results obtained here represent only a partial view of the broader practice of ebony imitation in 17th-century Flanders. As such, the study must be understood as exploratory. The primary limitation of this research is the small sample size. Wood samples measuring approximately 1–2 mm³ proved insufficient for consistent identification; samples of at least 5 mm³ would likely yield more reliable results. Additionally, the unavoidable risk of sampling restored areas posed a significant challenge, as promising sample locations were occasionally dismissed upon identification as later restorations. While XRF analysis proved successful as a non-destructive technique, the mockups were unable to fully explain all detected elemental results, leaving certain findings unresolved. SEM-EDX proved useful for contextualizing the samples, but remained ambiguous for identifying stain technology.

Future research could expand this study by preparing resin-embedded cross-sections of collected samples to improve anatomical identification, although limited identification would remain present. Additional XRF measurements on plain ebony and endemic wood species would help establish baseline elemental compositions and improve the interpretation of results. The XRF data from this thesis and previous studies, such as Dijkstra, could be integrated into a shared database to provide greater contextualization for future research. Further analysis using mass spectrometry could help identify materials undetectable by SEM-EDX and XRF. SEM-EDX could prove more satisfactory when the samples are examined in cross-section.

The correspondence between color-technological results and wood identification highlights the importance of combining multiple analytical approaches. Overall, this thesis demonstrates that historical records concerning ebony imitation contain a certain degree of accuracy and represent a valuable foundation for further research. By systematically examining material evidence alongside documentary sources, this study establishes an initial step toward a more comprehensive understanding of this complex practice. By uncovering each lead, this thesis set out the first steps in uncovering the case of ebony imitation.

7 Postscript

7.1 Restoration practices

With global biodiversity in decline and *Diospyros* species with it, the use of ebony has become ever more contested, as it was in the 17th century. Discussions with restorers revealed that some still use ebony as a restoration material. Yet this study demonstrates that imitation techniques and alternative wood species were historically employed and remain viable options today, particularly for veneers and moldings. In the field of restoration, the question must be raised whether authentic ebony is necessary when visually compatible substitutes exist. The historical evidence of imitation shows that the argument of “staying true to the original” is not absolute, since ebony substitution was probably practiced in the 17th-century. Restorers have also developed methods to ensure transparency. For example, some apply UV markers to restored areas (provided the markers are chemically stable and not applied on original material).

Such techniques allow future researchers to clearly distinguish restored parts from original ones, while avoiding the ethical and ecological burden of using endangered materials. In this light, the investigation of ebony imitation is not only relevant to understanding 17th-century cabinetmaking but also to informing contemporary practice. By re-evaluating the necessity of authentic ebony, the restoration community has an opportunity to contribute to sustainability without compromising historical fidelity.

7.2 Next life of the samples and the data

For this research, six samples were taken from six different cabinets. One of the conditions set by the author and the associated institutions was that the analytical techniques applied to these samples be non-destructive and suitable for potential future research. Should further study of one or more of these samples be desired, they are preserved at the university, subject to permission from the relevant institution. As noted in the methodology, a carbon coating was applied for SEM-EDX analysis, and minor clay residues may be present on the samples, as clay was used to position the samples during SEM examination. A reference clay sample is included within the sample collection. Both the raw and processed analytical data are archived in the university library.

7.3 A Critical-Heritage Approach

In the following two pages, a brief critical reflection on this thesis will be presented. The aim is to clarify why this research was conducted within a broader context, extending beyond the historical lacunae and the practical benefits for conservation and restoration practices. By doing so, the thesis is placed within a wider framework, allowing it to resonate with a broader audience and to underline its relevance and meaning beyond its immediate academic scope.

A critical reflection

This thesis aimed to investigate whether the ebony present on the cabinets was genuine or rather an imitation. The research situates itself at what scientific inquiry strives to achieve: making facts of facts.¹⁶¹

¹⁶¹ Albena Yaneva, *Latour for Architects*, 1 online resource : illustrations. (Routledge, 2022). 22.

In this case, it challenges the accepted ‘fact’ that the cabinets were decorated with authentic ebony. Museums are often perceived as institutions from which authoritative knowledge emanates, repositories of facts. Their objects, labels, and documentation are frequently treated as unquestionable truths, often used by entities such as auction houses as primary references. However, this thesis revealed that several cabinets catalogued and exhibited as being decorated with ebony were, in fact, not. This discovery disrupts the assumption of infallibility, highlighting that museums, too, are susceptible to error.¹⁶²

What emerges here is the strength of critical, material-based inquiry. Rather than accepting ready-made science, ‘ebony’ as an unquestioned label, this research reveals a process of ‘science in the making’ where findings remain open to scrutiny and reinterpretation. In doing so, the objects themselves gain translational power: they speak anew, resist previously imposed identities, and invite alternative readings.¹⁶³ This process not only challenges established narratives but also breathes new life into historical objects, creating a new life cycle.

The life cycle

Museum collections operate within a dynamic framework. Collections expand through the acquisition of new objects and contract as materials degrade or are deaccessioned. Each object within the collection follows a life cycle, shaped by its material condition, context, and the values assigned to it. Within this cycle, various stakeholders (curators, conservators, researchers, and the public) engage with the object for specific purposes. For instance, a museum may wish to exhibit an object to attract visitors. If the object is damaged or incomplete, it might be deemed unsuitable for display. However, if it is endowed with significant historical or cultural value, its perceived worth may transcend its physical imperfections, expanding the life cycle.¹⁶⁴

Perception, therefore, plays a crucial role in the object's life cycle. As our understanding of an object deepens, its potential for continued relevance and preservation increases. In this light, material intervention, such as sampling for analysis, can contribute to a broader preservation strategy. By temporarily compromising a small part of an object to gain insight, we may enable the long-term safeguarding of not only that object but also others within the collection.¹⁶⁵

The importance of research

As demonstrated, research extends beyond restoration, (preventive) conservation, and questions of authenticity. By integrating art historical inquiry with material-technical analysis, this approach provides new and often critical insights. Such interdisciplinary engagement allows for the re-evaluation of existing methodologies and the advancement of scientific techniques.¹⁶⁶ Without this kind of critical and investigative work, objects risk being overlooked or forgotten in storage, thereby shortening their life cycle. The goal is not solely to define these objects through scientific characterization of materials, but

¹⁶² Of course, museums cannot always keep pace with ongoing research and therefore tend to lag the most recent scholarly insights, as object descriptions and exhibitions cannot be continuously updated. This delay can, in fact, be beneficial, as it allows time for scholarly debates to develop and for interpretations to be more thoroughly assessed.

¹⁶³ Yaneva, *Latour for Architects*. 32.

¹⁶⁴ Kalliopi Fouseki, *Heritage Dynamics Understanding and Adapting to Change in Diverse Heritage Contexts*, 1 online resource (UCL PRESS, 2022). 99-105.

¹⁶⁵ This, however, may appear to contradict the museum's function as an institution responsible for safeguarding its collection. A certain degree of caution toward researchers seeking access to collections is both appropriate and necessary, as museums must assess whether proposed research is well considered and genuinely beneficial. The intention is not for the author to position themselves as an authority defining good or bad practices. Rather, this chapter aims to highlight the potential benefits of the research beyond its strictly academic audience.

¹⁶⁶ Yaneva, *Latour for Architects*. 26.

also to embed them in ongoing dialogues. Through research, these objects are reactivated and reframed, not only as remnants of the past but as active participants in shaping futures.

An unravelling future

The discovery of imitation reveals a range of possible wood types, each containing a certain interpretive potency. This latent potential translates into a form of power, an enforcement of possibility that becomes activated through specific configurations of objects, people, and methods.¹⁶⁷ By incorporating objects into particular scientific analyses and research networks, a new epistemic trajectory is set in motion, one that could have been different had other objects or approaches been chosen. In this sense, heritage is not merely about preserving the past, but about mobilizing actors in a way that shapes futures. The knowledge does not flow linearly from object to expert, but rather emerges from the interplay between all entities in the network. Thus, research choices are not neutral. They actively define which futures are enabled and which are excluded. What is studied, what is left aside, and who participates in the network all contribute to a shared understanding that becomes embedded in both cultural and scientific practice.¹⁶⁸

¹⁶⁷ Rodney Harrison et al., *Heritage Futures : Comparative Approaches to Natural and Cultural Heritage Practices*, 1 online resource : illustrations (some colour) (UCL Press, 2020). 35.

¹⁶⁸ Harrison et al., *Heritage Futures : Comparative Approaches to Natural and Cultural Heritage Practices*. 484-485.

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10 Attachments

10.1 Procedure for sampling and XRF analysis

Depending on the possibilities for sampling, a specific step-by-step procedure is followed. This protocol ensures that no critical information is overlooked during sample collection and that the methodology remains transparent and reproducible.

Decision Tree for the Identification and Sampling of Blackened Wood

Step 1: Identification and Documentation of Blackened Wood

- Identify three separate locations on the cabinet with blackened veneer and three with blackened moldings.
- Document these locations with photographs and written notes.

Step 2: General Documentation

- Measure the dimensions of the moldings.
- Measure the thickness of the veneer.
- Are any maker's marks present?
 - Yes → Document them.
 - No → Proceed to Step 3.

Step 3: Permission for Sampling and Expectations

- Is sampling permitted? Discuss expectations and the possibility of returning the sample.
 - Yes → Proceed to Step 4.
 - No → Document the dimensions and features without sampling.

Step 4: Examination for Large Detached Material

- Are there detached veneer or molding fragments larger than 3 mm³?
 - Yes → Are these representative and traceable to their original location?
 - Yes → Is permission granted to use the material for analysis?
 - Yes → Proceed to Step 8.
 - No → Proceed to Step 6.
 - No → Proceed to Step 5.
 - No → Proceed to Step 5.

Step 5: Examination for Small Detached Material

- Are there detached veneer or molding fragments ≤ 3 mm³?
 - Yes → Are these representative and traceable to their original location?
 - Yes → Is permission granted to use the material for analysis?
 - Yes → Proceed to Step 8.
 - No → Proceed to Step 6.
 - No → Proceed to Step 6.
 - No → Proceed to Step 7.

Step 6: Permission for Sampling Small Loose Material

- Is permission granted to sample this material?
 - Yes → Proceed to Step 9.
 - No → Proceed to Step 7.

Step 7: Finding a Suitable Sampling Location

- Is there a location where veneer or molding is partially detached and sampling is permitted?
 - Yes → Proceed to Step 10.
 - No → Is there a damaged area where sampling is permitted?
 - Yes → Proceed to Step 10.
 - No → Is there another inconspicuous area suitable for sampling?
 - Yes → Proceed to Step 10.
 - No → Sampling is not possible. End the process.

Step 8: Documentation and Sampling of Material > 3 mm³ (Veneer/Molding) – Analysis: Macro, Micro, (μCT), SEM, and DART

- Take an overview photo of the full cabinet side.
- Take a detailed photo of the sample environment.
- Take a detailed photo of the original sample location.
- Collect the sample and store it in an acid-free paper envelope labeled with a sample number and cabinet ID.
- Carefully inspect the sample.
- Discuss the return date of the sample (if applicable).

Step 9: Documentation and Sampling of Material ≤ 3 mm³ (Veneer/Molding) – Analysis: SEM

- Take an overview photo of the full cabinet side.
- Take a detailed photo of the sample environment.
- Take a detailed photo of the sample location.
- Collect the sample and store it in an acid-free paper envelope labeled with a sample number and cabinet ID.
- Carefully inspect the sample.
- Discuss the potential return date of the sample (if applicable).

Step 10: Documentation and Sampling of Material ≤ 3 mm³ (Veneer/Molding) – Analysis: SEM

- Take an overview photo of the full cabinet side.
- Take a detailed photo of the sample environment.
- Take a detailed photo of the sampling site before sampling.
- Choose the appropriate tool for sampling: plane, tweezers, scalpel, biopsy punch, chisel, or core drill.
- Collect the sample and store it in an acid-free paper envelope labeled with a sample number and cabinet ID.
- Carefully inspect the sample.
- Discuss the potential return date (if applicable).
- Take a photo of the sampling location after sampling.

Decision Tree for Identification and XRF of Blackened Wood

Step 1: Identification and Documentation of Blackened Wood

- Identify three separate locations on the cabinet with blackened veneer and three blackened moldings.
- Document these locations with photographs and notes.

Step 2: General Documentation

- Measure the dimensions of the moldings.
- Measure the thickness of the veneer.
- Are any maker's marks present?
 - Yes → Document them.
 - No → Proceed to Step 3.

Step 3: Permission for XRF and Expectations

- Is XRF analysis permitted? Discuss expectations.
 - Yes → Proceed to Step 4.
 - No → Document the dimensions and features without analysis.

Step 4: Execution of XRF Analysis

- Perform six XRF measurements (each 60 seconds).
- Document the measurement locations.
- Discuss with the conservator whether they wish to receive the results (raw data and/or thesis).

10.2 Typological model classification of cabinets

Typological model classification of (art) cabinets in the Cabinet database developed during the FED-tWIN HOME-AGE project	
Typological group	Description in the Cabinet Database
1	Front is symmetrical and consists of three bays. The central bay is flanked on the left and right by identical bays consisting of 5 drawers that range from top to bottom. Two stylized central doors covering the 'perspectiefje'. Central doors are separated by one column and each flanked by a set of two columns. Below each door, two drawers are found. Above the door, a decorative centerpiece is found (occasionally flanked by drawers).
2	Front is symmetrical and consists of three bays. Similarities to Relation group 1: central doors separated and flanked by one column. The bays on the left and right consist of 5 drawers (with or without central cartouches in turtle shell). This group distinguished itself from Relation group 1 by the complex three-dimensional turtle shell veneer shaped cartouches on the door fronts (calabas and heart shapes).
3	Small table cabinets that resemble closely to the table treasury boxes from the 17th century. A profiled lid on top, ball-shaped feet at the bottom. All executed in (veneered) ebony. Similar in style and execution are the large table cabinets from Relation group 4.
4	Cabinets on stand/Table cabinets that have a profiled top and left, right and front parts are executed in a strict geometrical design, primarily consisting of rectangular designs bordered by profiled of wave form moldings. The exterior is executed in (veneered) ebony. The decoration of the interior varies from paintings, silver work, engraving in ivory/bone, or embroidery. The interior consists of a central door surrounded by a varying number of drawers.
5	This relation group is unique to its strict rectangular cuboid shape, where each exterior surface is flat and decorated by geometrical patterns consisting of rectangular or L-shaped designs which are bordered by inlay of thin pieces of bone or exotic wood species. Unique to this group is the use of both heartwood (dark) and sapwood (white) of the resulting in a unique decorative effect. Only few types of wood species with this highly contrasting heart and sapwood could be used: <i>Swartzia benthamiana</i> , <i>Dalbergia melanoxylon</i> , <i>Diospyros crassiflora</i> , and <i>Diospyros mespiliformis</i> . The <i>Dalbergia melanoxylon</i> is most likely used although a wood anatomical study is needed to confirm this attribution. Additionally, there are some conflicting opinions about the regional attribution of these cabinets. Some sources mention a production in the low Countries whereas others mention these are of Italian origin.
6	Similarities with Relation groups 1 and 2 but differ due to a very minimalistic finishing and stylized central doors. The front consists of 3 to 4 bays, two central doors, flanked by, or surrounded by, drawers
7	This Relation group differs from others by similarities by the finishing of the top of the carcass with a baluster. that is decorated with figures or other decorative elements on each corner. The casket rests on ball or claw shaped feet. The central door is flanked by two or three columns
8	This Relation group distinguished itself from other Relation groups by being cabinets on stands. The layout is similar to Relation group 7 although no feet are present
9	This Relation group differentiates itself due to the decoration with lacquer burgauté, or mother of pearl pieces incorporated in a colored lacquer matrix. Most of the known objects with this decorative technique are small table cabinets with a configuration of 6 to 9, or more drawers. No scientifically supported research has been published on these cabinets.
10	This Relation group is unique and shows no resemblance to other relations groups. These monumental cabinets with their deep-black monolithic design and highly detailed sculptured scenery and details in haut-relief are unique. Literature discussing their production region often contradicts each other: referring to Antwerp and/or Paris.

Table 18: Typological model classification of (art) cabinets © FED-tWIN HOME-AGE project, De Boeck 2024

10.3 Object files

Each object is presented according to a consistent analytical structure. This includes catalogue information, photographic documentation indicating proposed locations of ebony imitation. Then, details on the sample information and sampling locations are provided. This is followed by XRF information, corresponding locations, and the resulting spectra. Subsequently, SEM-EDX results are presented, including elemental maps and spectra from both the front and backside of the samples (where available). The section concludes with SEM micrographs, from which the most informative images were selected for wood identification. The mockup reports include a list of materials used from the recipe, along with the XRF location and measurements. All obtained raw and refined data can be found back at the university's library.

Object file ID.4



General information

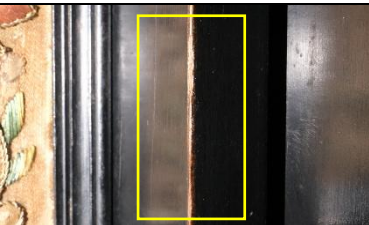
Object type	Table cabinet (group 4)	Collection type	Public
Owner	Snijders&Rockoxhuis		
Curator	Dr. Maarten Bassens		
Contact	/	maarten.bassens@kbc.be	
Url: website	https://www.snijdersrockoxhuis.be/wat-is-er-te-zien/collectie/meubels/details?id=255&title=antwerps-kunstkabinet-eerste-helft-17de-eeuw		
Item number	Inv. 77.58	Manufacture	1601-1650
HOME-AGE cabinet database number	ID.4	Production site	Antwerp
Cabinet dimensions	Height	depth	Width
	59,0 cm	37,3 cm	66,0 cm
Profile frame dimensions	8.98 ± 0,02 mm	3.11 ± 0,02 mm	
Thickness of veneer	0.98 ± 0,02 mm		
Suspicion of restorations of veneer or profile moulding	Extensively restored.		
Additional archive material?	No		

Existing finishing materials

Blackened wood	Ebony	Other types of wood	Bone	Embroidery	Painting
X	X?			X	
Turtle shell	Ivory	Metal	Paper	Other	Other
		X			

Finishing techniques available

Molding	Rippled molding	Maker's mark	Stamps		
X					

Evidence of blackened timber at other locations			
Veneer /Frame			
			
Lists			
			
Sample information			
Location during sampling	Kabinet was sampled in the exhibition room of the Snijders&Rockox house.		
Date of sampling	24/02/2025		
Supervisor	Dr. Maarten Bassens		
Method of sampling	Not applicable		
Comments	A fragment of veneer was found loose inside a drawer. Its original location could not be determined with certainty, but it appears to fit along the side of the right door. .		
Sample location			
			

pXRF information	
Location during measurments	Exposition room of Snijders & Rockox museum
Datum van measurement	12/05/2025
Supervisor	Dr. Maarten Bassens
pXRF executor	Kirsten Derks
Comments	/
pXRF locations	
	

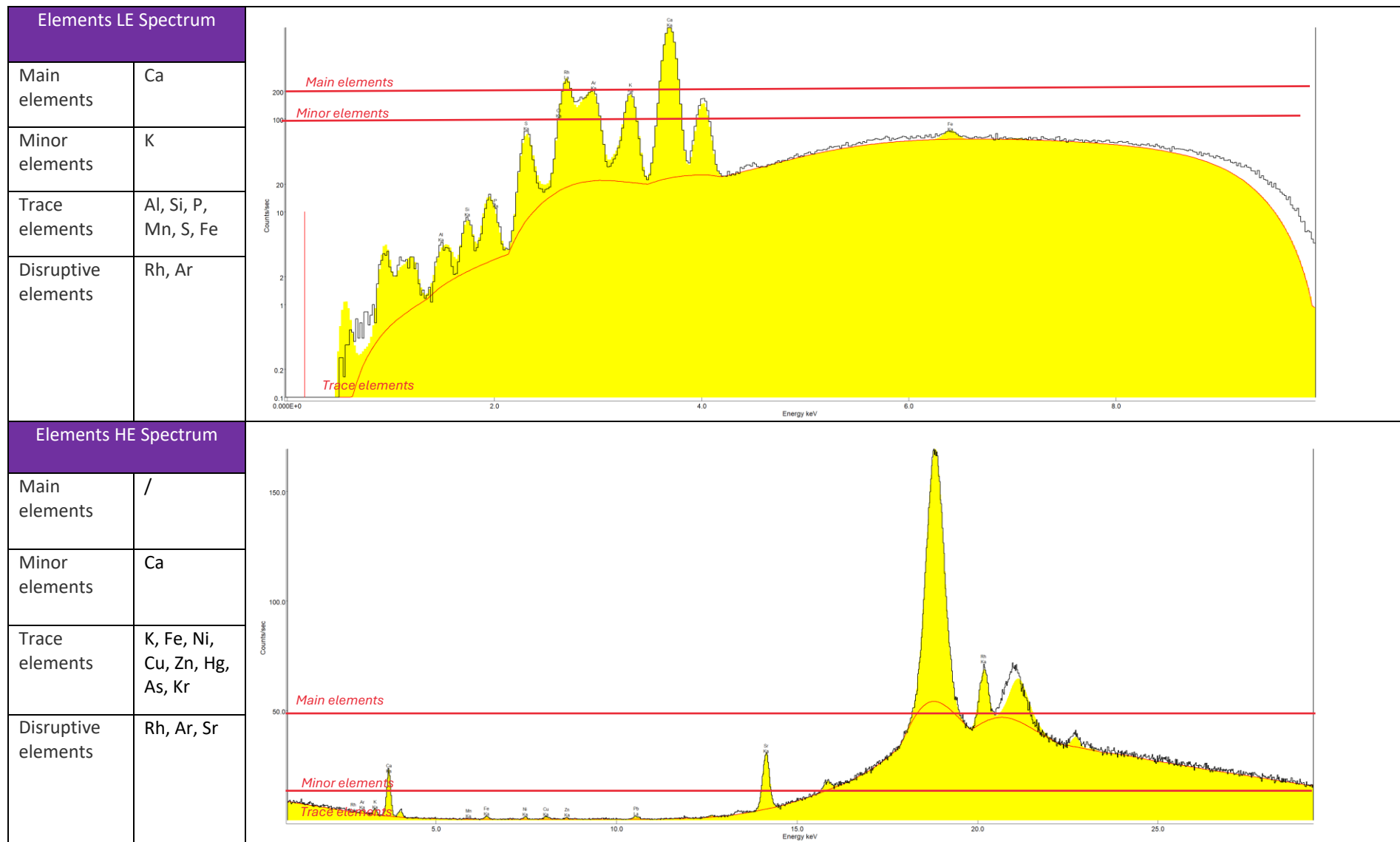


Table 1: pXRF measurements ID.4_1

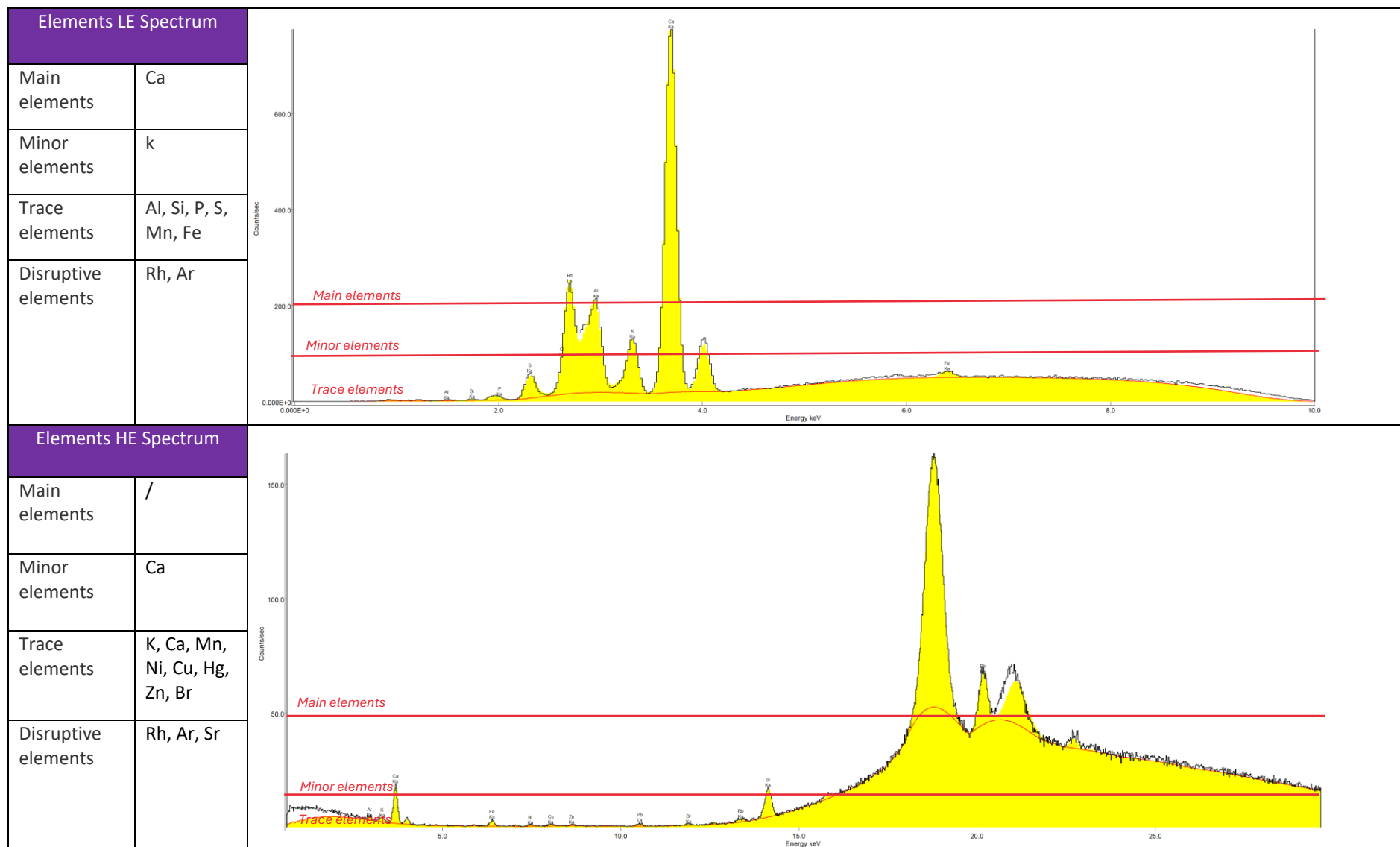


Table 2: pXRF measurements ID.4_2

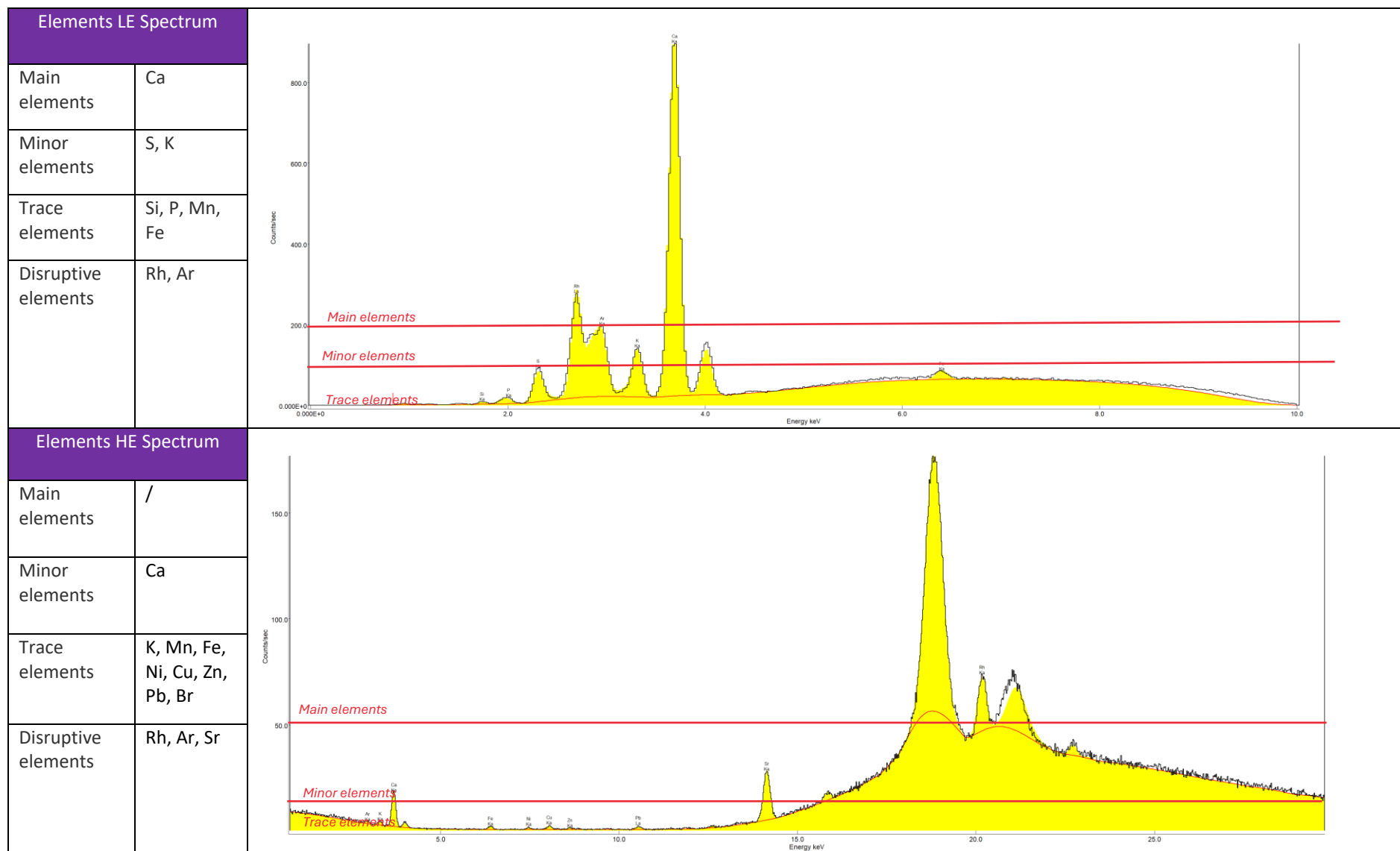


Table 3: pXRF measurements ID.4_3

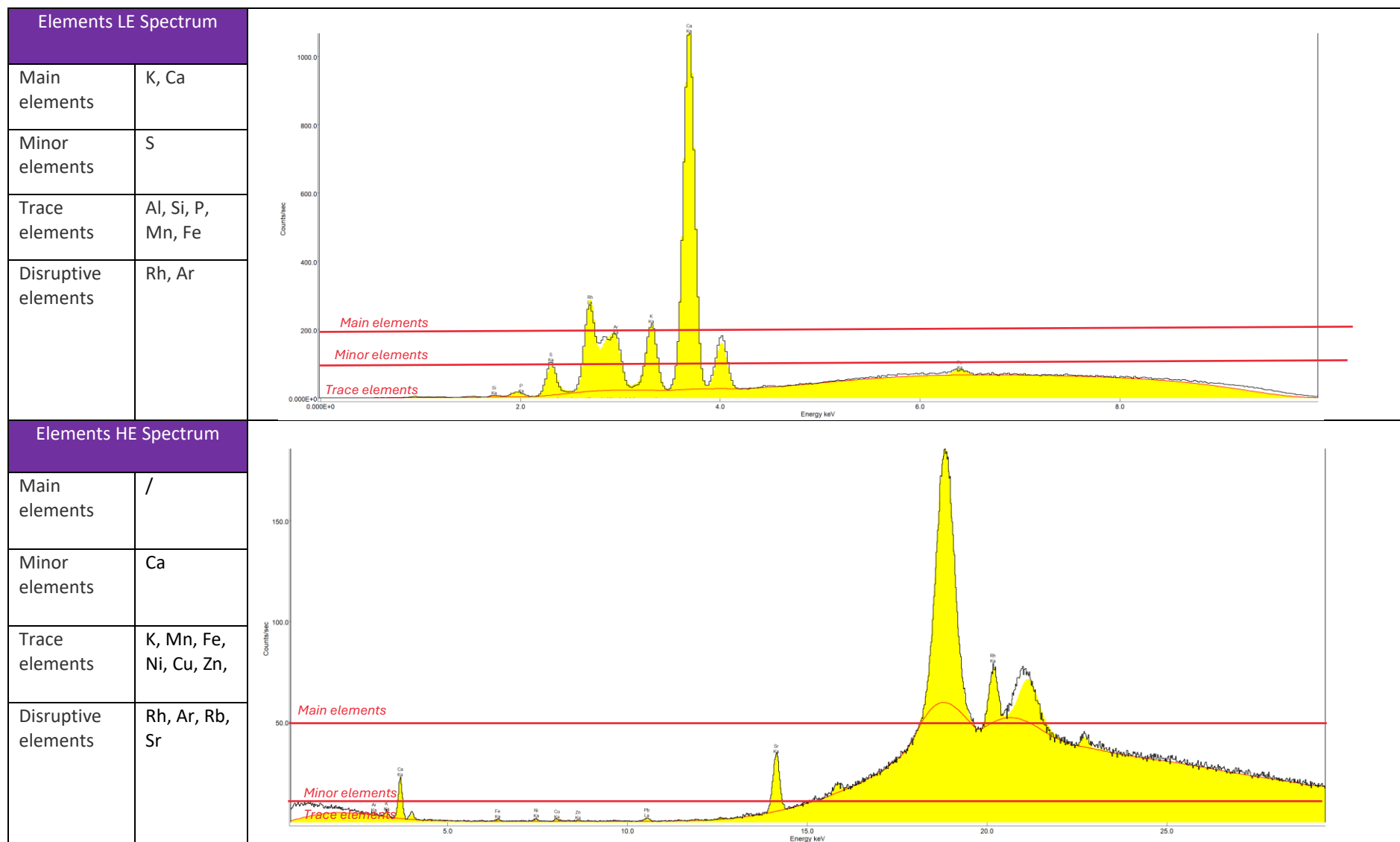


Table 4: pXRF measurements ID.4_4

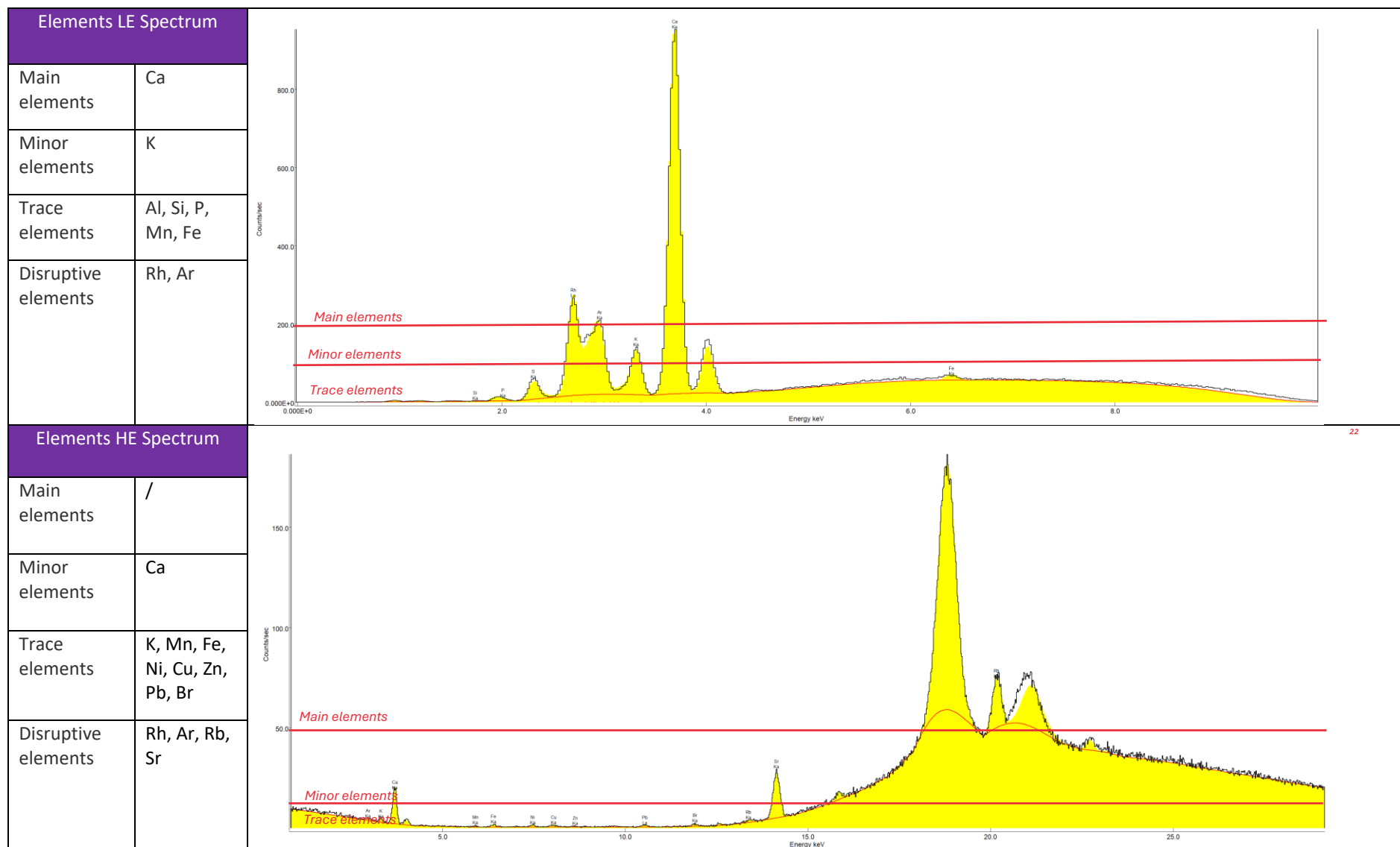


Table 5: pXRF measurements ID.4_5

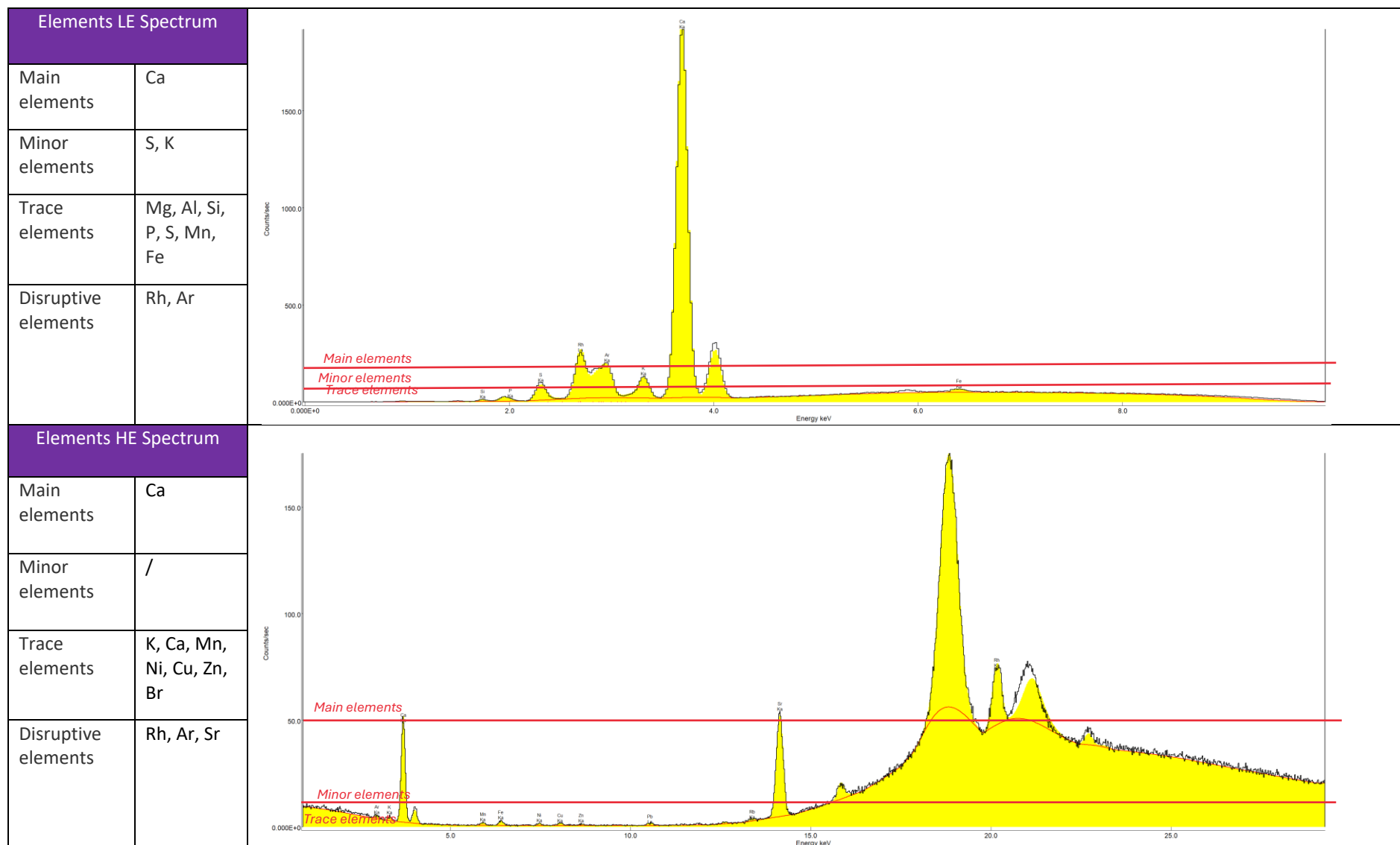


Table 6: pXRF measurements ID.4_6

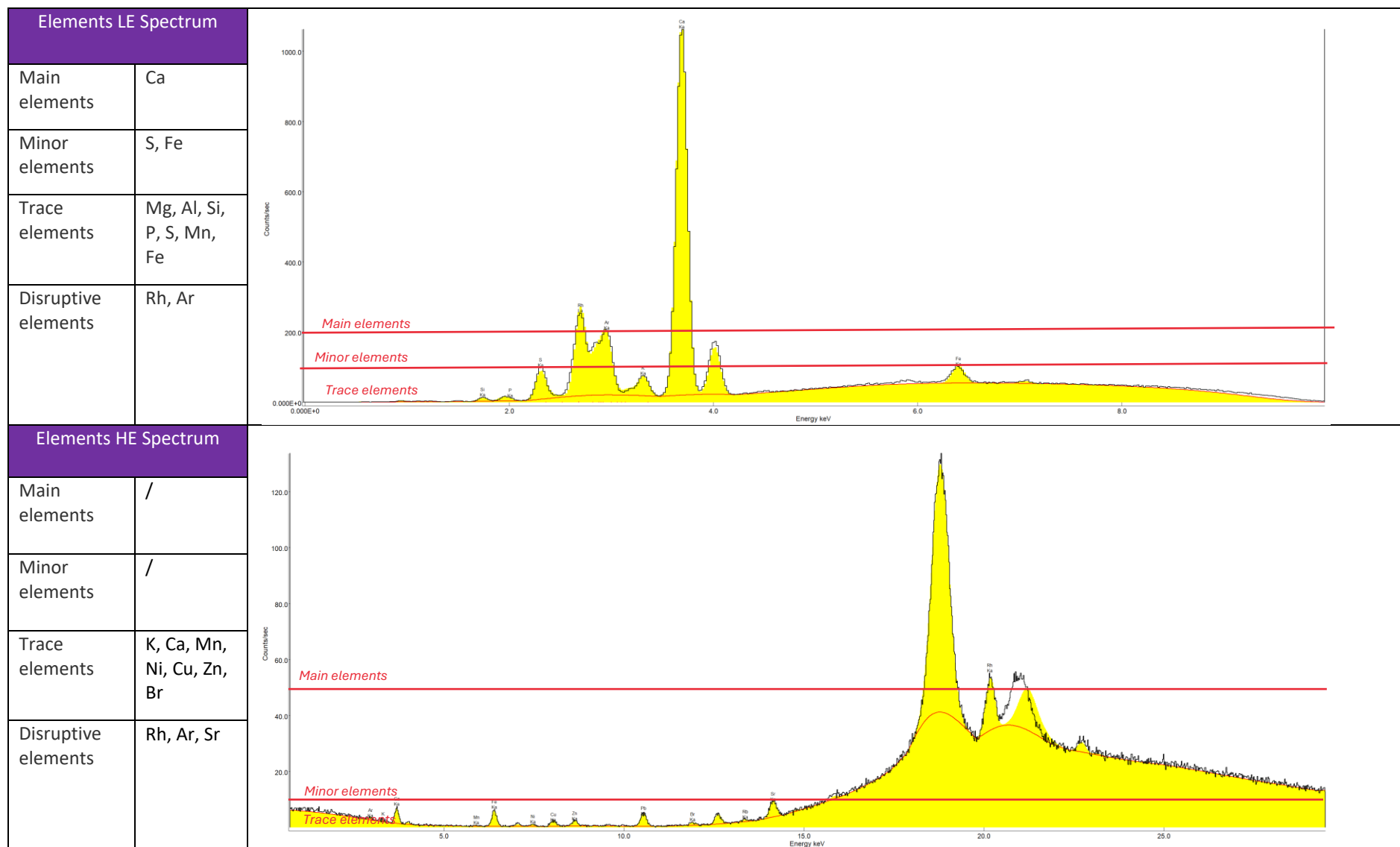
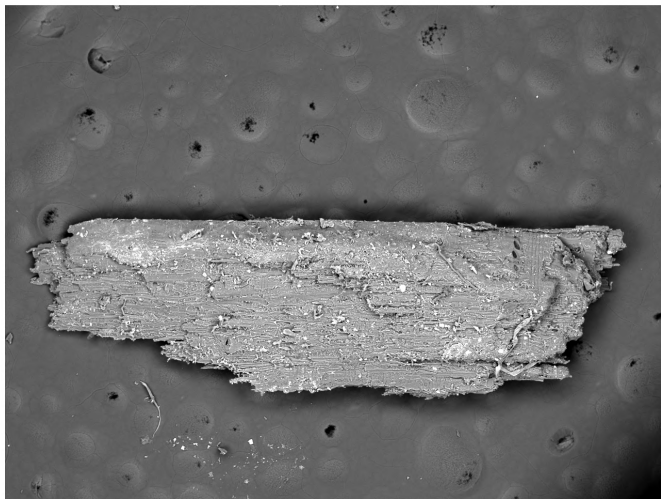


Table 7: pXRF measurements ID.4_7

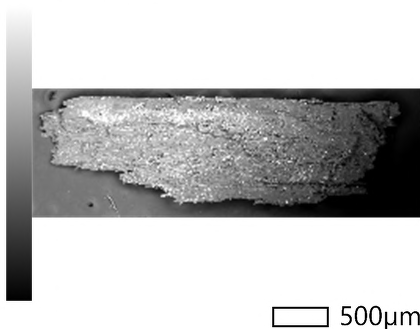
Sem_BED-C_001



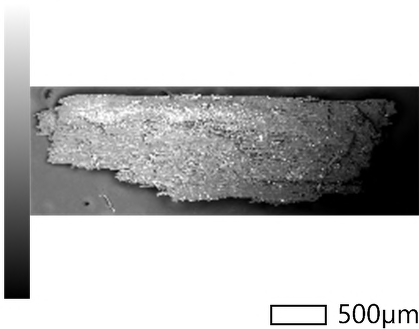
500 μ m

Signal BED-C
Landing Voltage 20.0 kV
WD 11.4 mm
Magnification x37
FOV 3.459 x 2.595 mm
Probe Current number Std. 63.0
Scan Rotation 0.0°
Vacuum Mode LowVacuum
Pressure 30 Pa

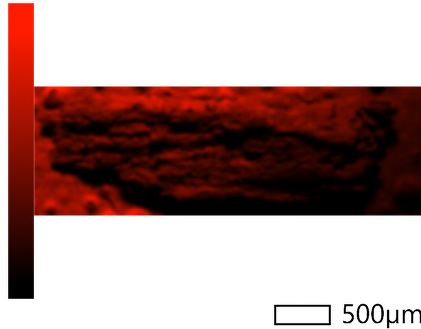
IMG1(1st)



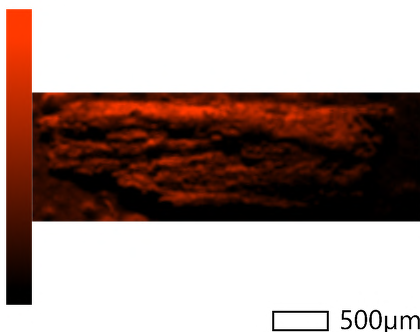
IMG1



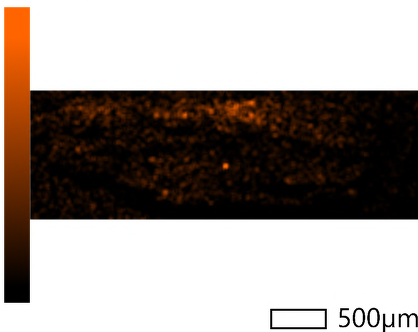
C-K



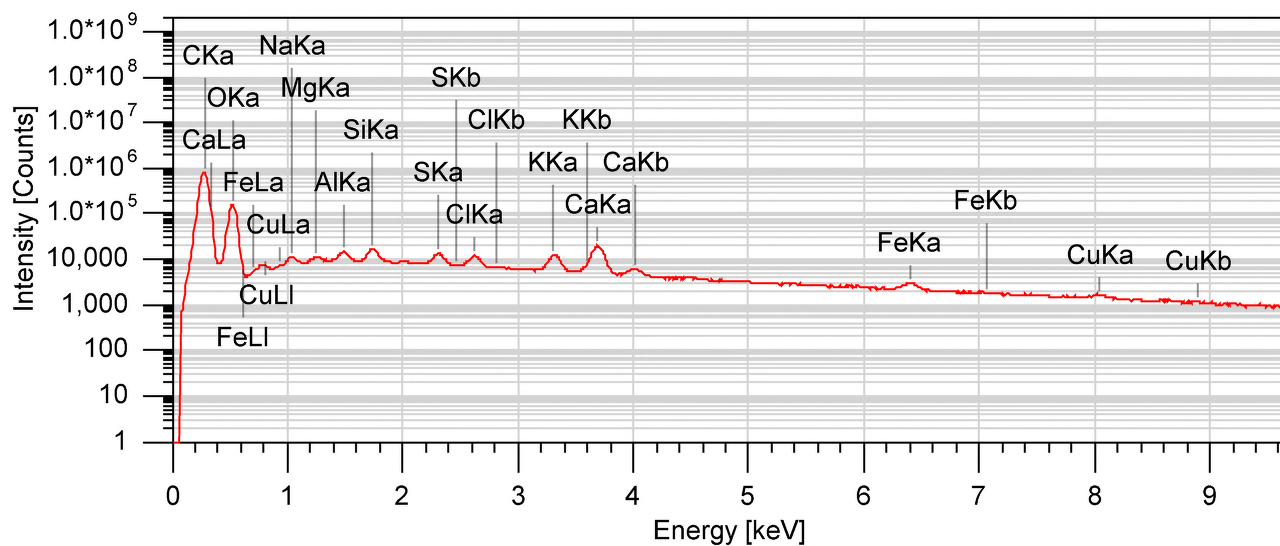
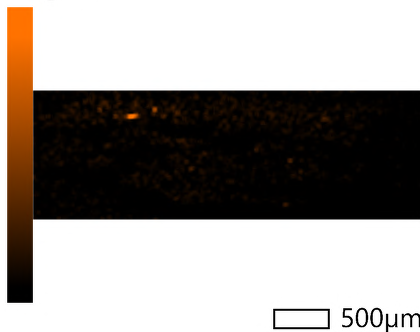
O-K

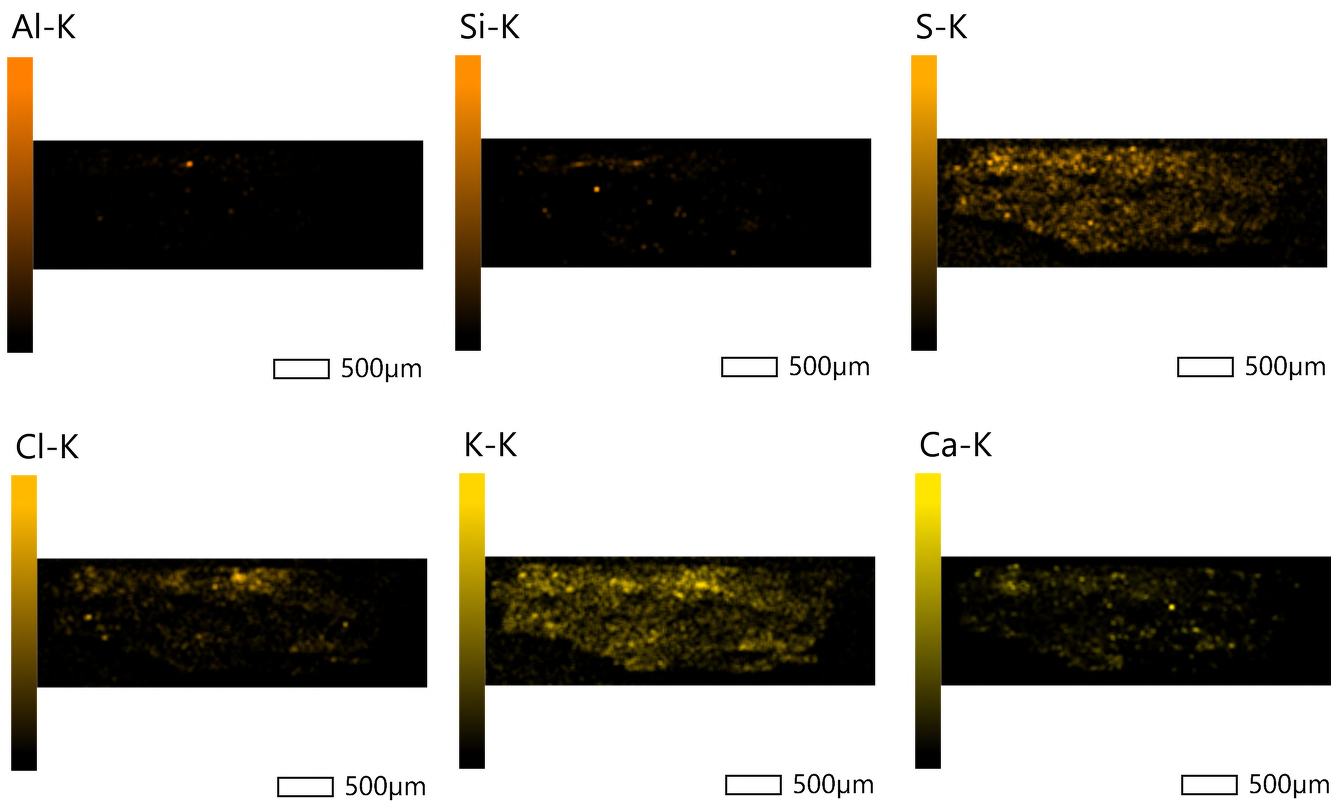


Na-K

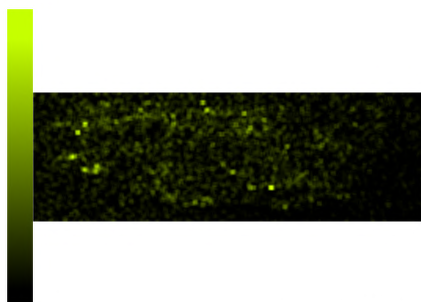


Mg-K



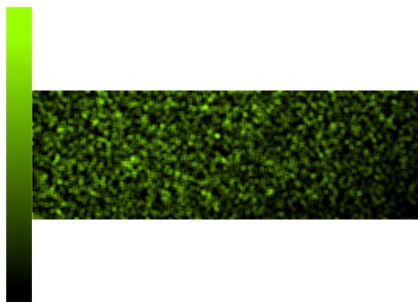


Fe-K



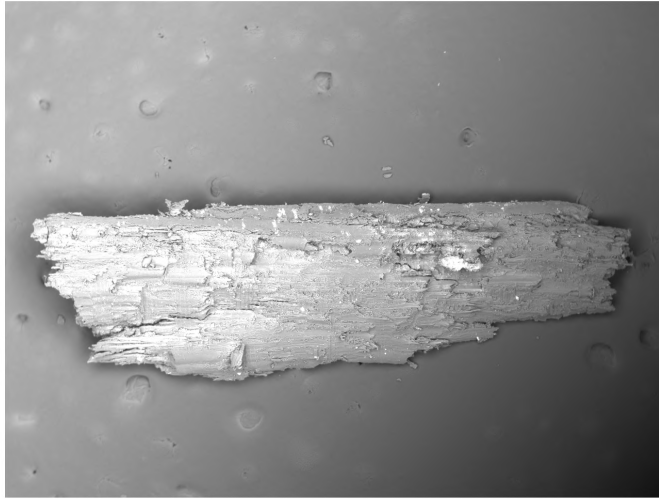
500μm

Cu-K



500μm

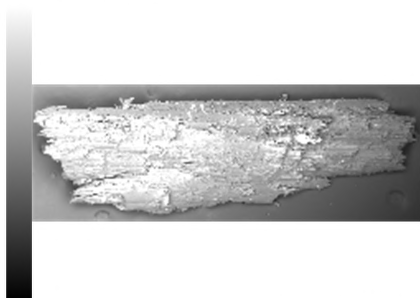
Sem_BED-C_002



500 μm

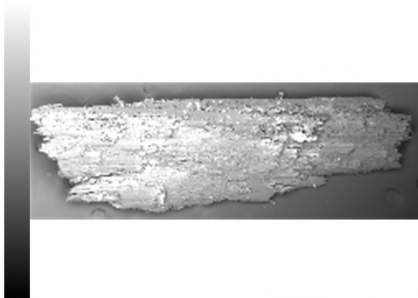
Signal BED-C
Landing Voltage 15.0 kV
WD 11.6 mm
Magnification x37
FOV 3.459 x 2.595 mm
Probe Current number Std. 60.0
Scan Rotation 0.0°
Vacuum Mode LowVacuum
Pressure 30 Pa

IMG1(1st)



500µm

IMG1



500µm

C-K



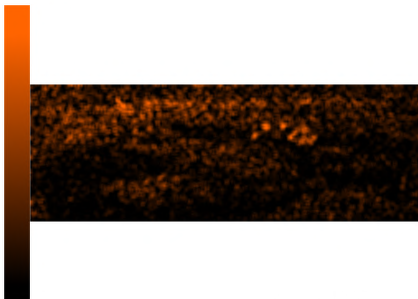
500µm

O-K



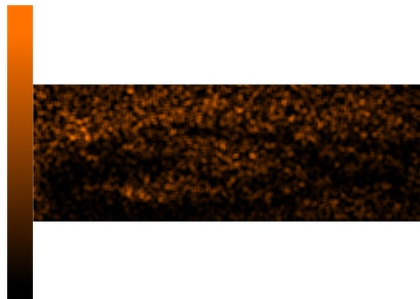
500µm

Na-K

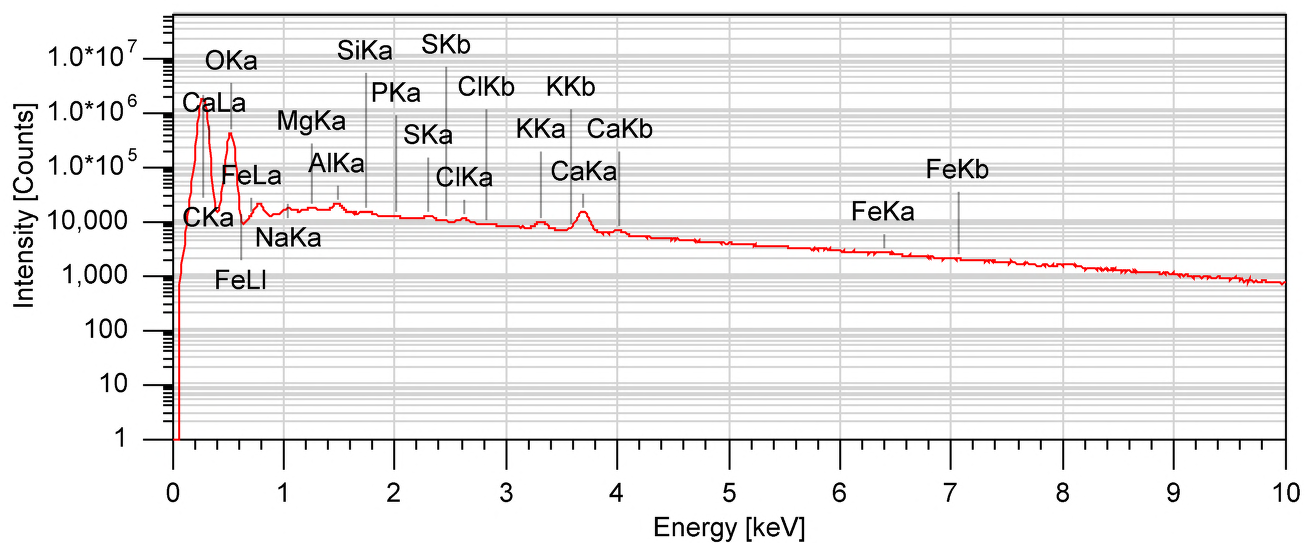


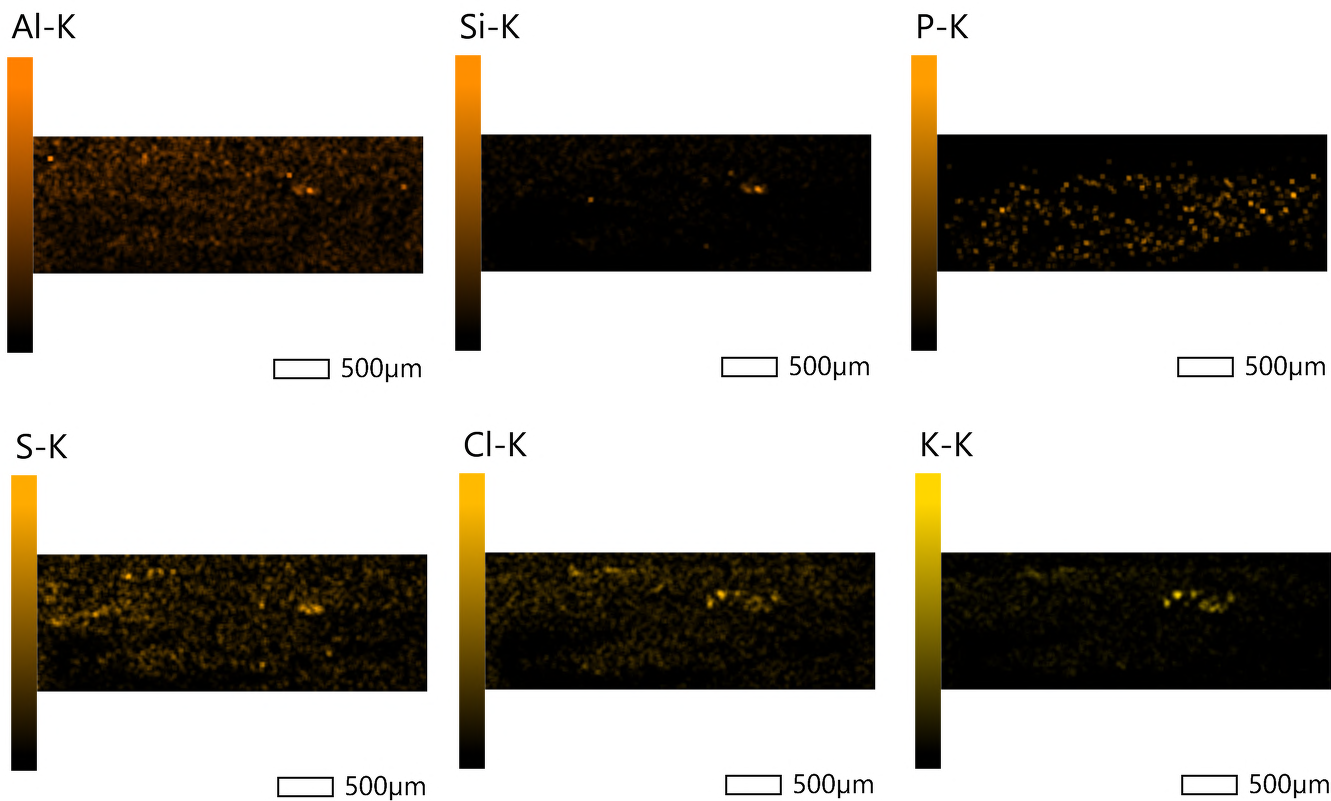
500µm

Mg-K

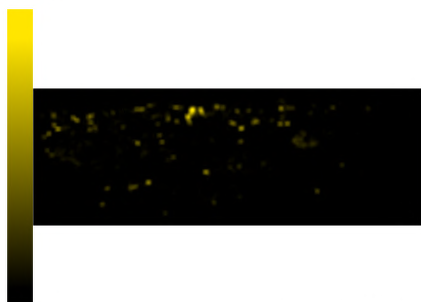


500µm



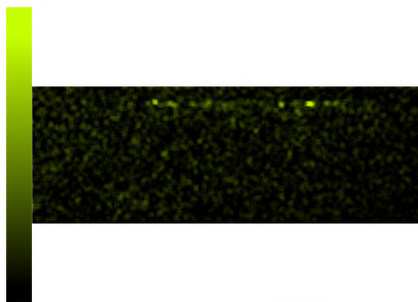


Ca-K



500μm

Fe-K



500μm

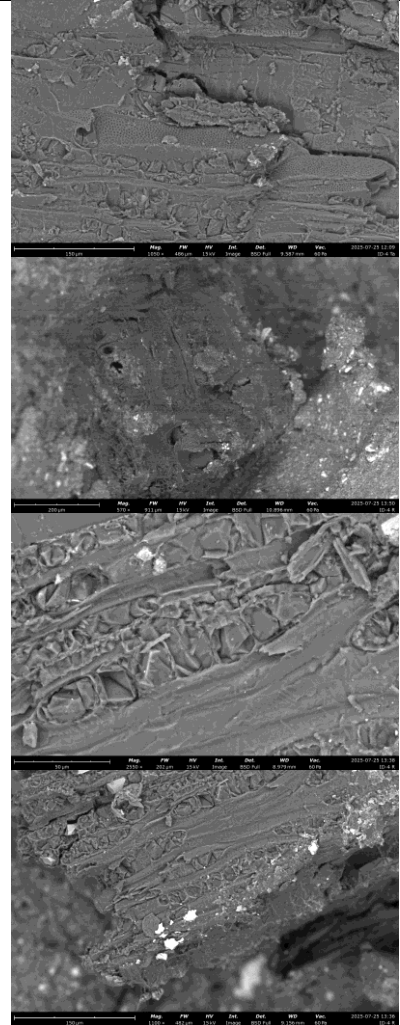
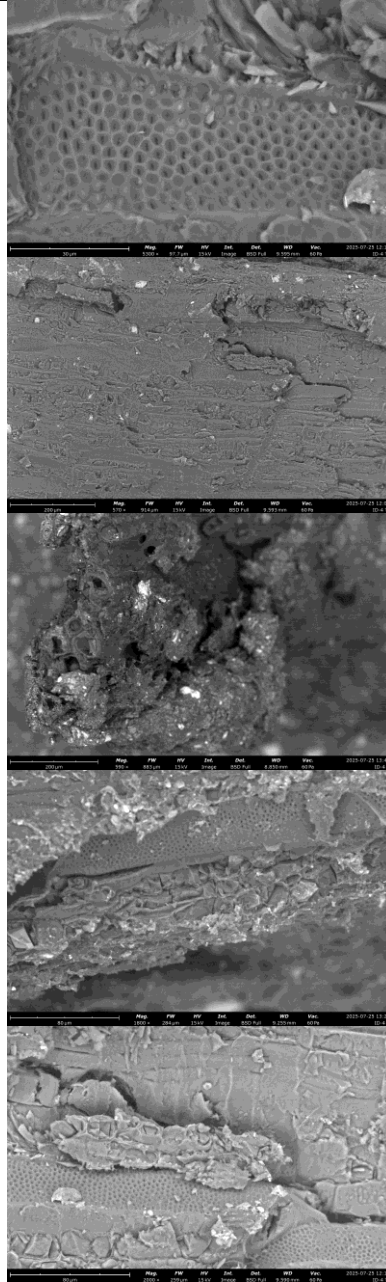
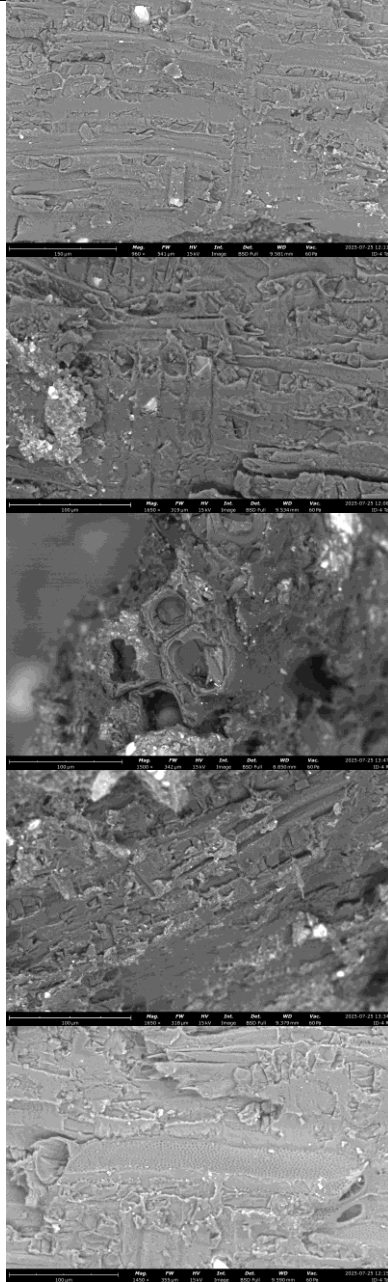
SEM images

Location	Woodlab Africamuseum
Datum van measurement	25/07/2025
Supervisor	Blanca Van Houtte Alonso and Michael Monnoye
SEM executor	Flynn Hermesen
Comments	/

Overview



Images





General information

General information					
Object type	Table Cabinet (groep 3)		Collectie type	Openbaar	
Owner	DIVA (in depot MAS)				
Curator	Vera De Boeck				
Contact			vera.deboeck@antwerpen.be		
Url website	https://balat.kikirpa.be/photo.php?path=B191013&objnr=142348&lang=nl-NL&nr=16 https://dams.antwerpen.be/asset/nnek9XWRVqkDVPXEDCqkZHGj#id				
Item number	AV.7024		Date	Ca 1650	
HOME-AGE cabinet database number	ID.20		Production place	Antwerp	
Cabinet dimensions	Height	depth		Width	
	26,0 cm	21,0 cm		32,0 cm	
Molding dimensions	2,34 - 2,91 mm ± 0,02 mm	10,01 - 10,23 mm ± 0,02 mm		/	
Thickness of veneer	0,83 - 1,21 mm ± 0,02 mm				
Vermoeden van restauraties van fineer of profiellijst		No			
Aanvullend archief materiaal?		No			
Existing finishing materials					
Blackened wood	Ebony	Other types of wood	Bone	Embroidery	Painting
?	?			X	
Turtle shell	Ivory	Metal	Paper	Varnish	Other
		X		X	
Finishing techniques available					
Molding	Rippled molding	Maker's mark	Other marks		
	X				

Evidence of blackened timber at other locations		
Veneer		
		
Molding	No indications of blackened wood	
Monsterinformatie		
Location during sampling	Cabinet was sampled in the depot of MAS (Antwerp)	
Date of sampling	10/03/2025	
Supervisor	Woodrestorer Maarten Breunesse	
Method of sampling	Micro chisel	
Comments	Successful	
Sample location		
		
Before sampling		After sampling
		

pXRF information	
Location during measurments	Depot MAS
Datum van measurement	28/05/2025
Supervisor	Liselotte Bertells
pXRF executor	Lowie Vercruysse
Comments	/
pXRF locations	
	

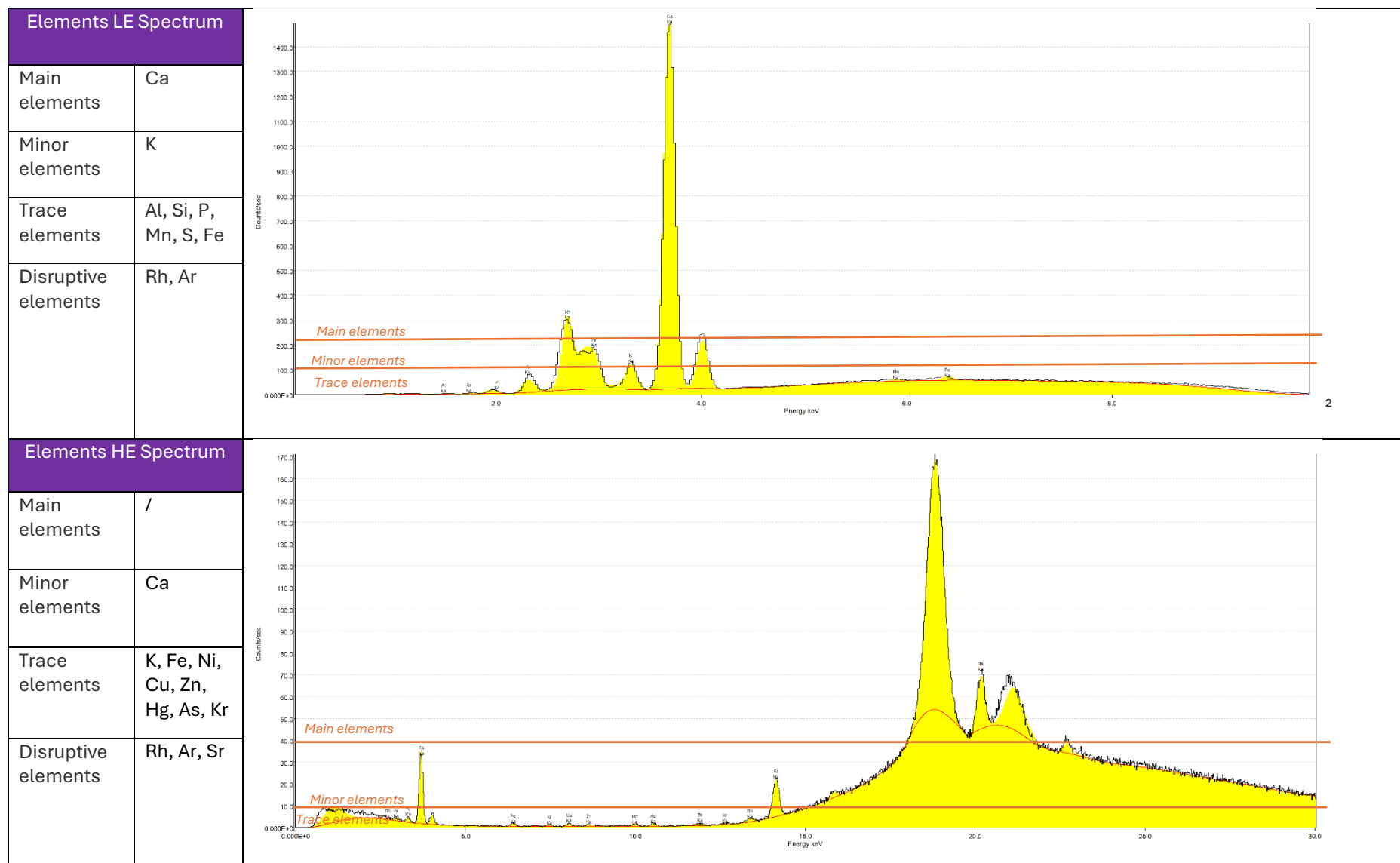


Table 1: pXRF measurements ID.20_1

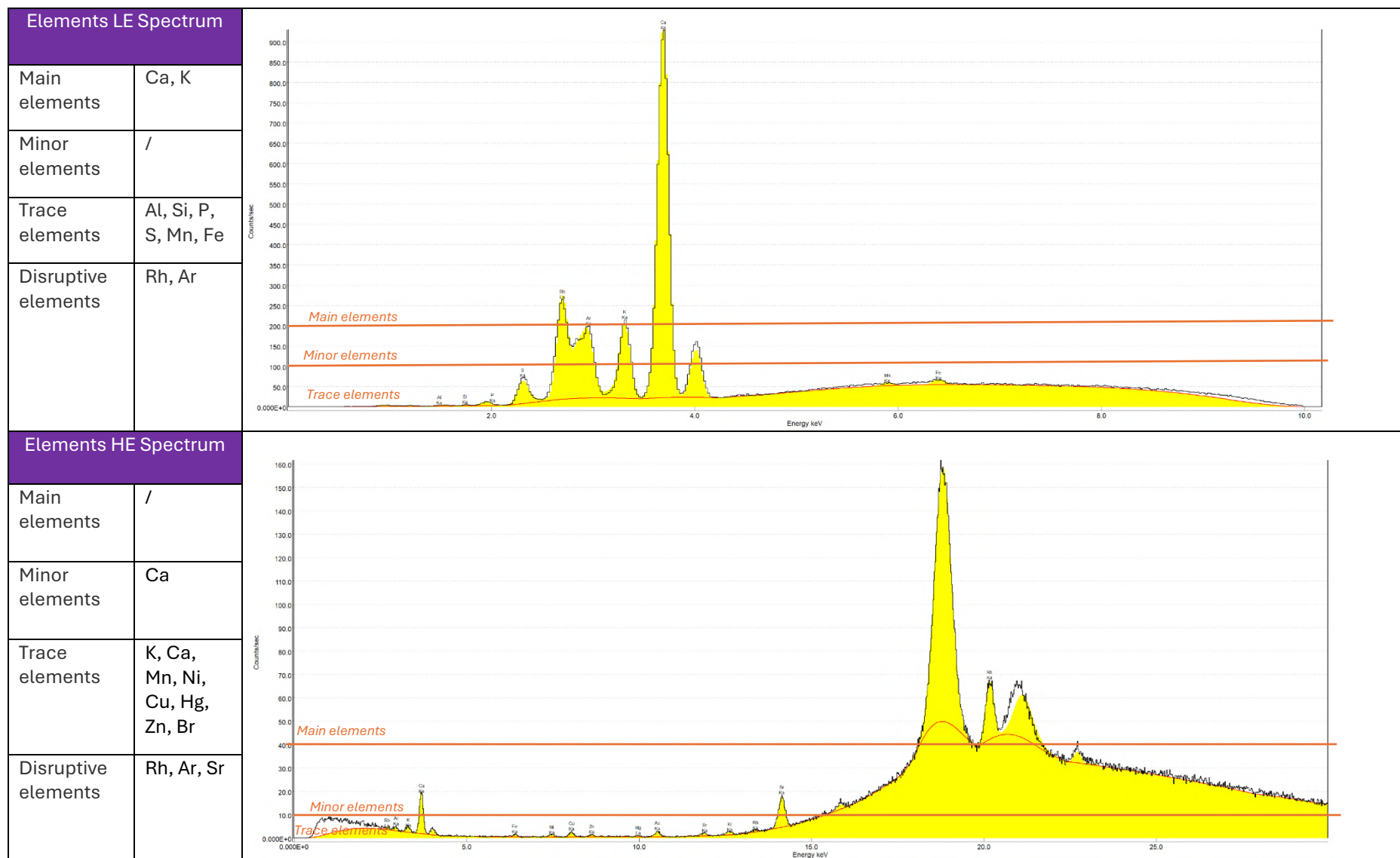


Table 2: pXRF measurements ID.20_2

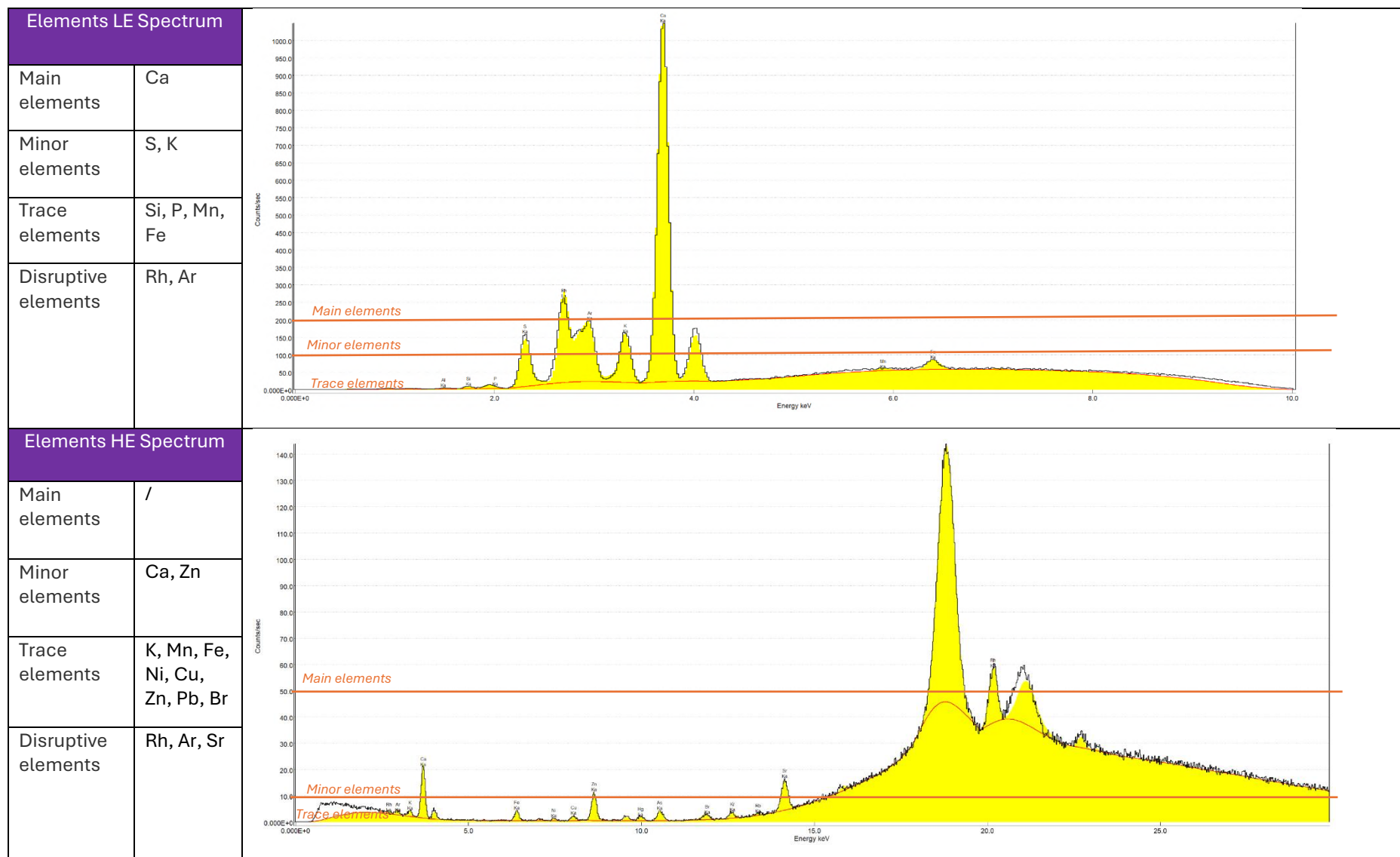


Table 3: pXRF measurements ID.20_3

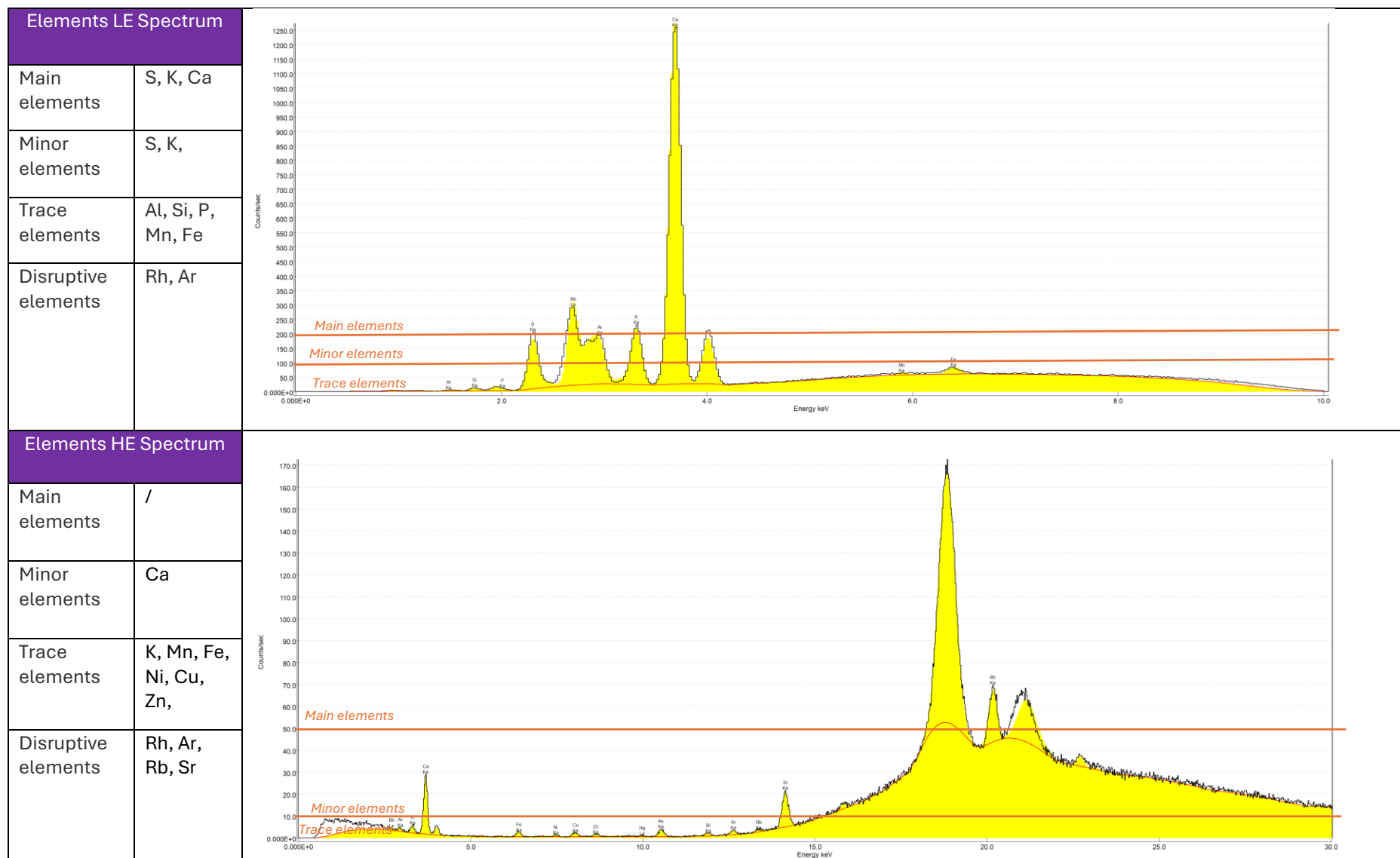


Table 4: pXRF measurements ID.20_4

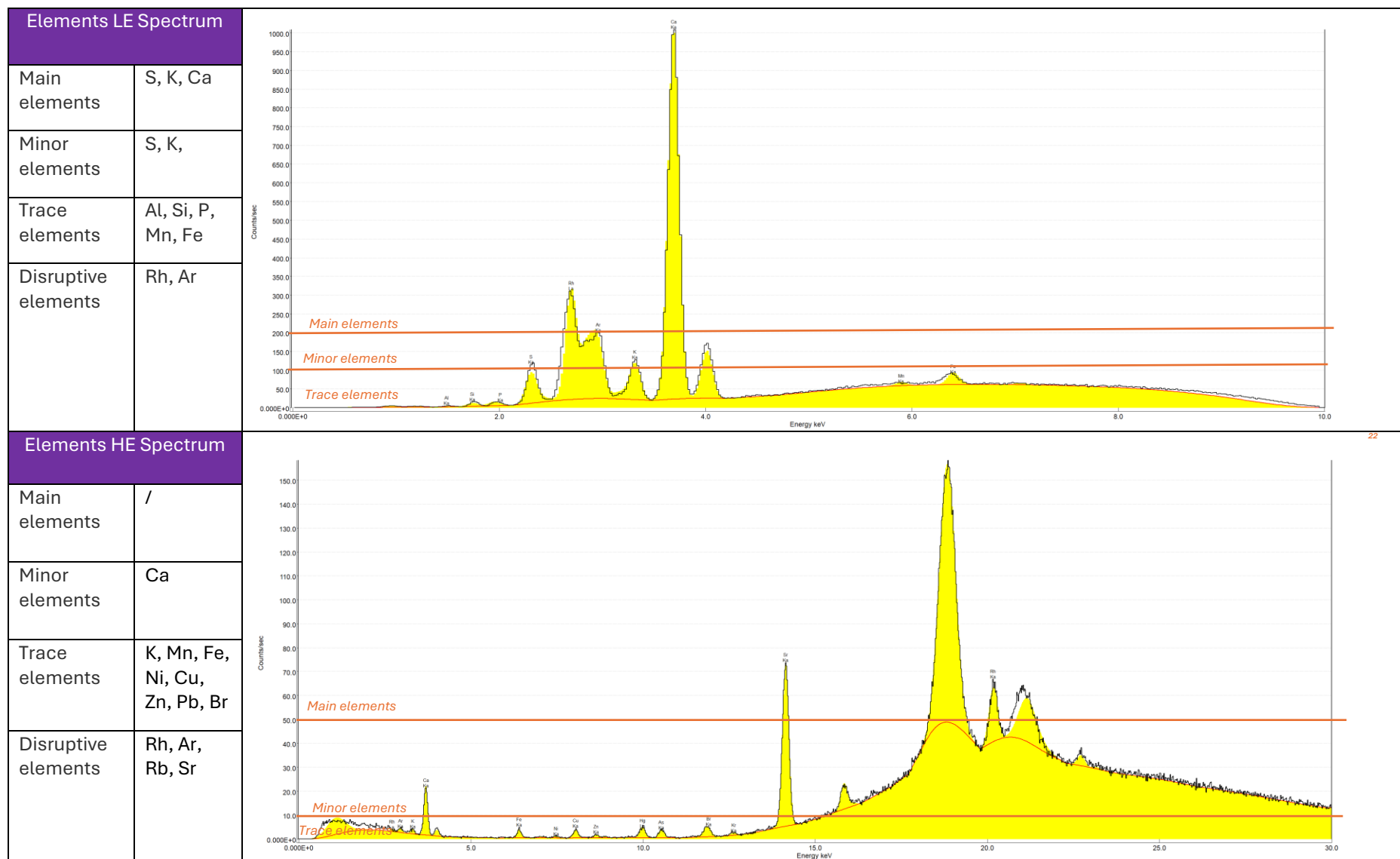


Table 5: pXRF measurements ID.20_5

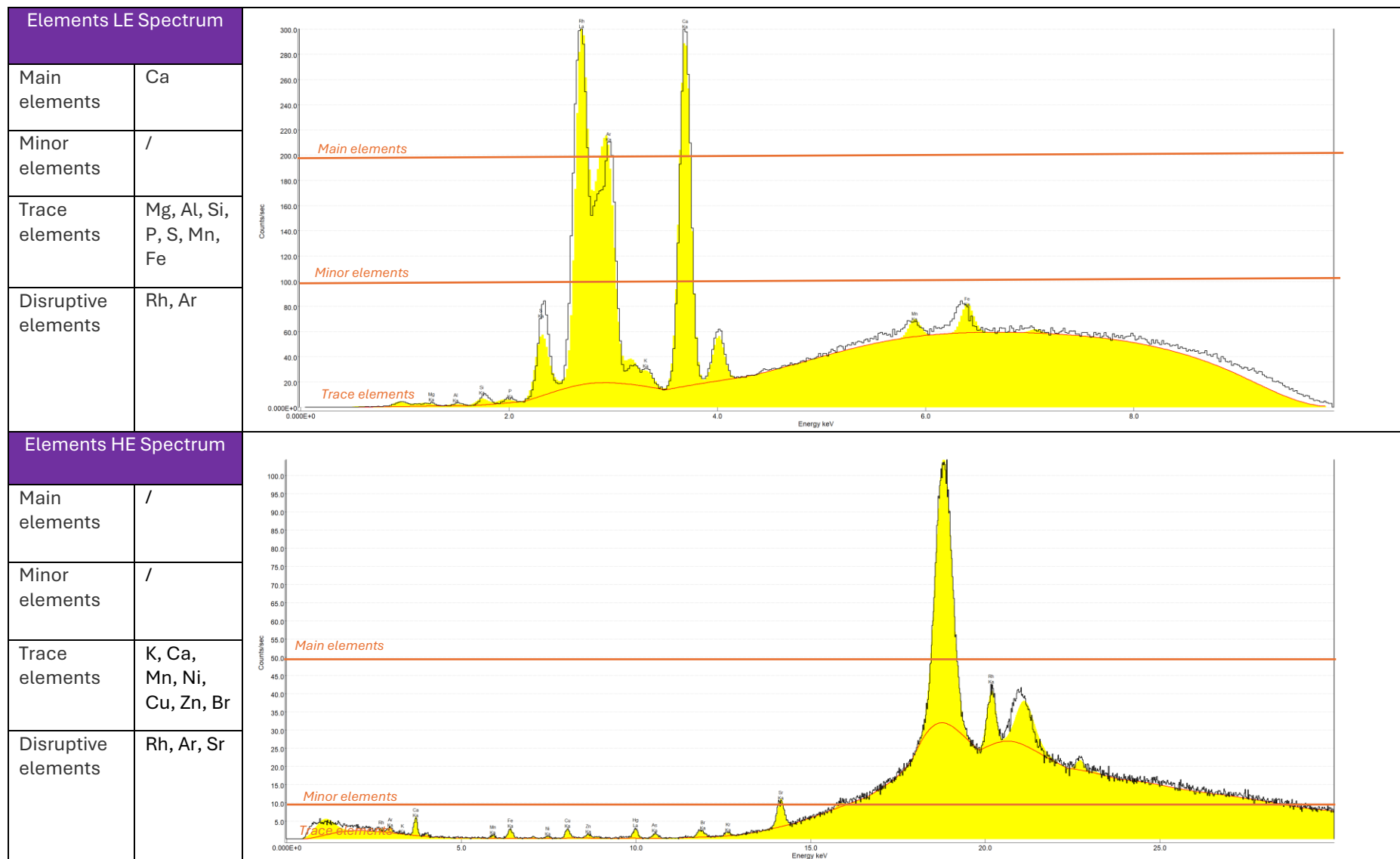
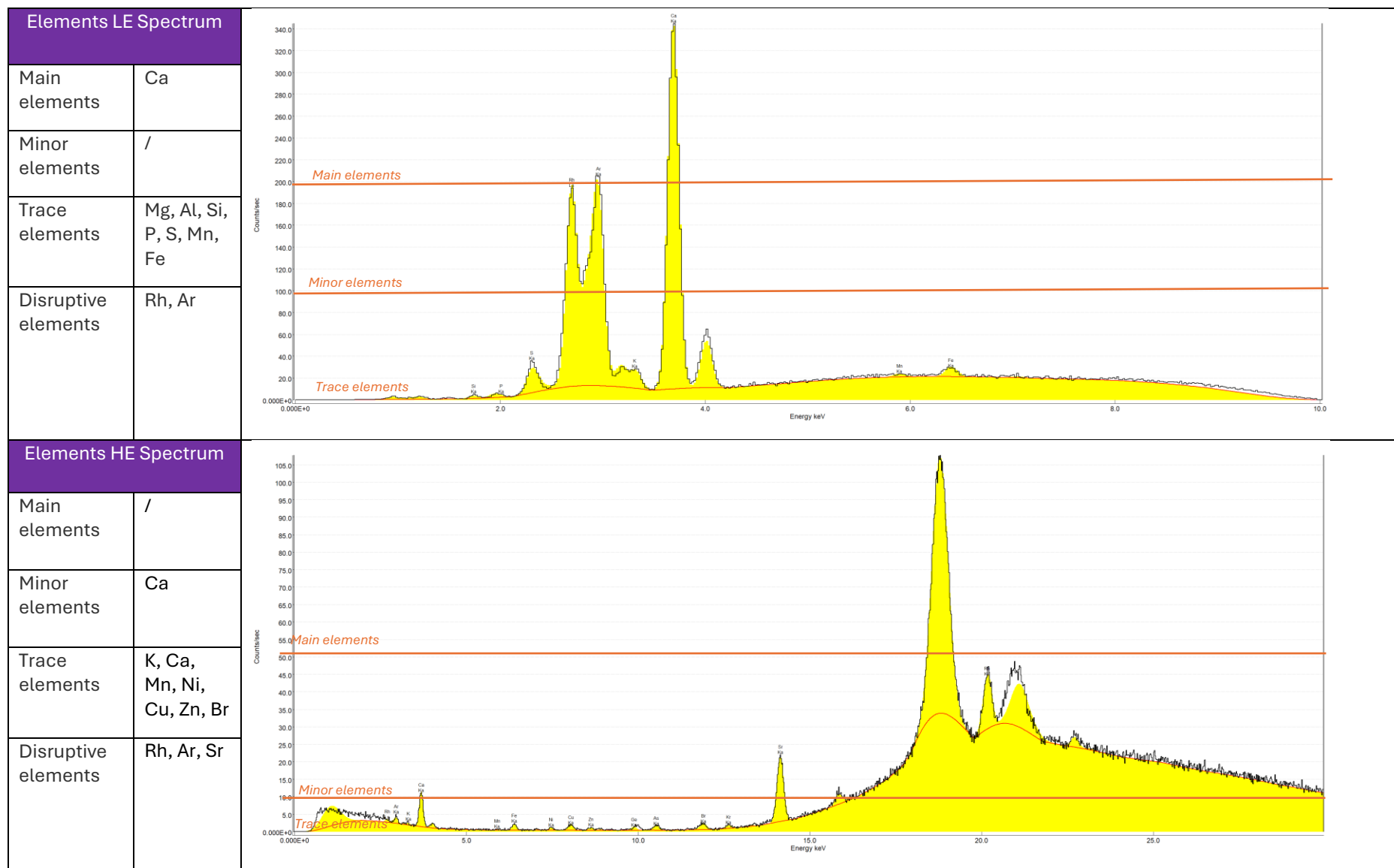
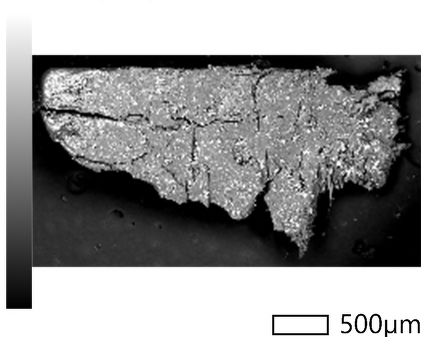


Table 6: pXRF measurements ID.20_6

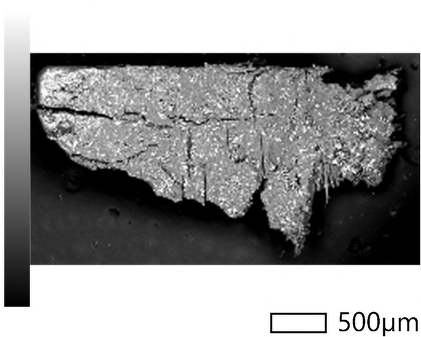


Tabel 7: pXRF measurements ID.20_7

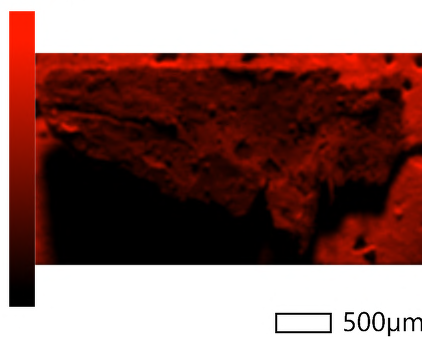
IMG1(1st)



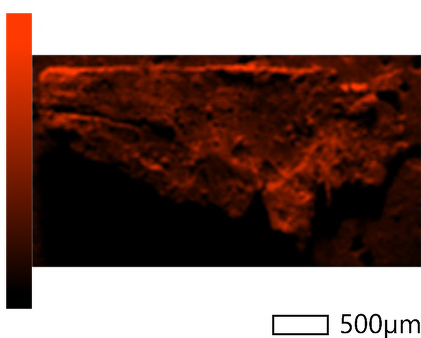
IMG1



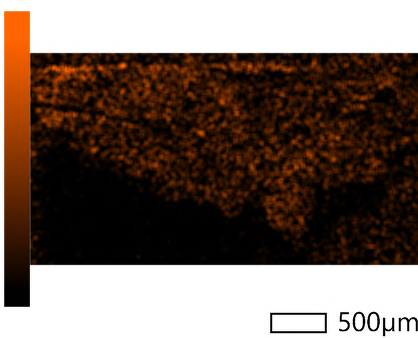
C-K



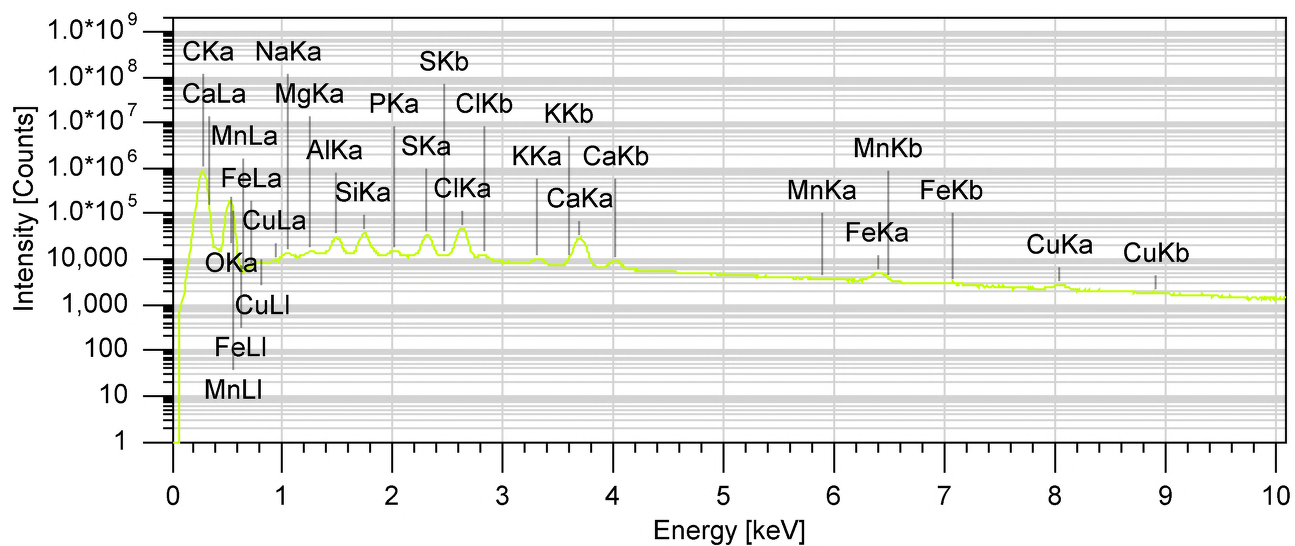
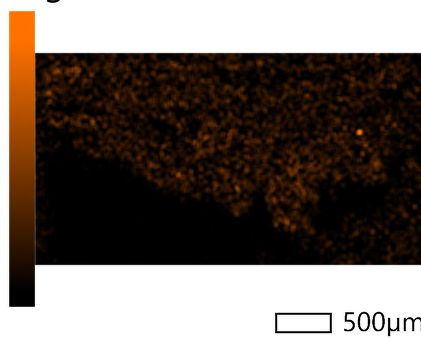
O-K

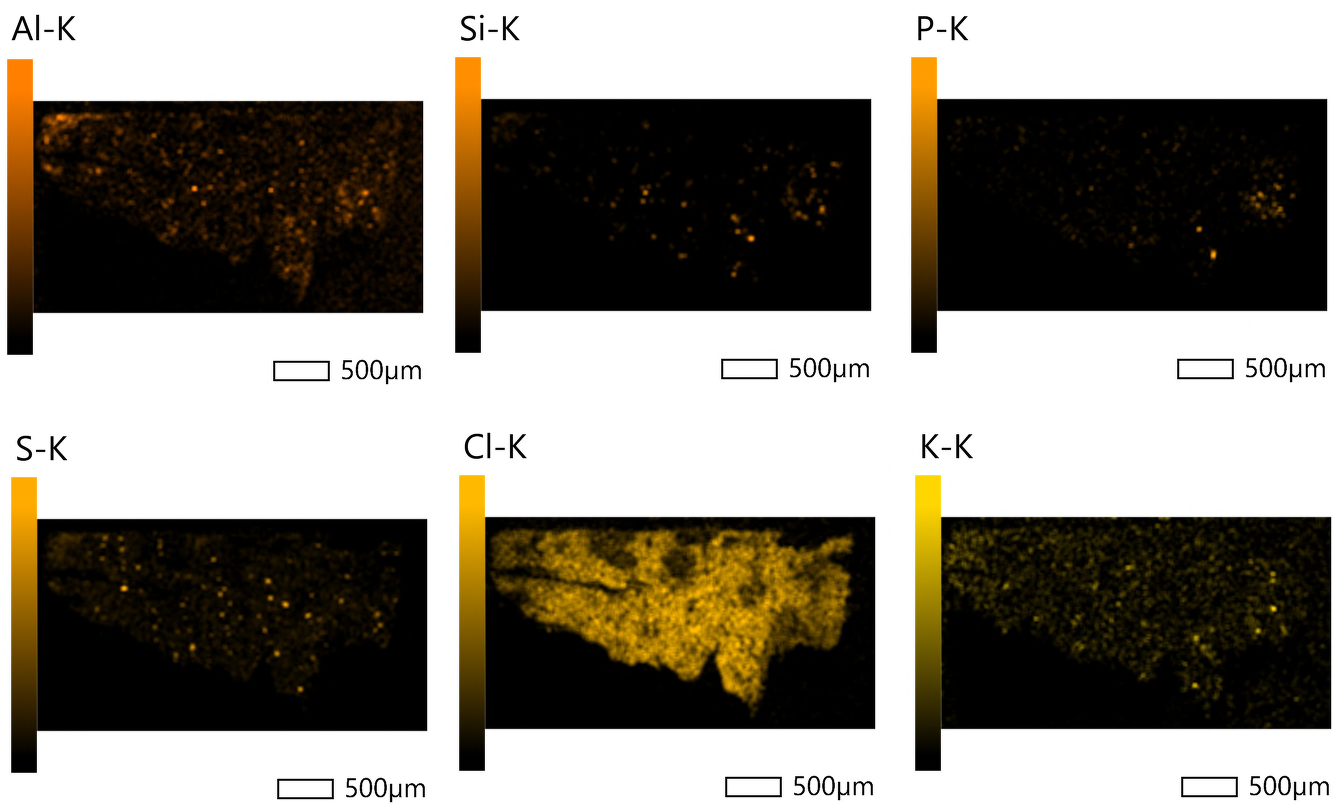


Na-K



Mg-K



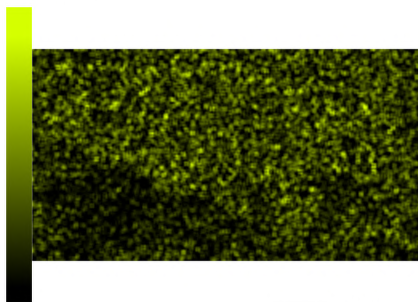


Ca-K



500μm

Mn-K



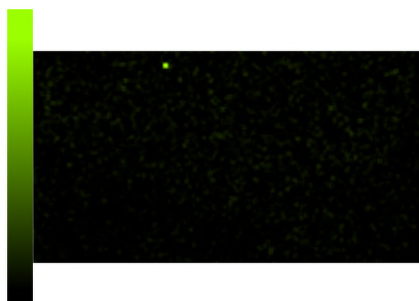
500μm

Fe-K



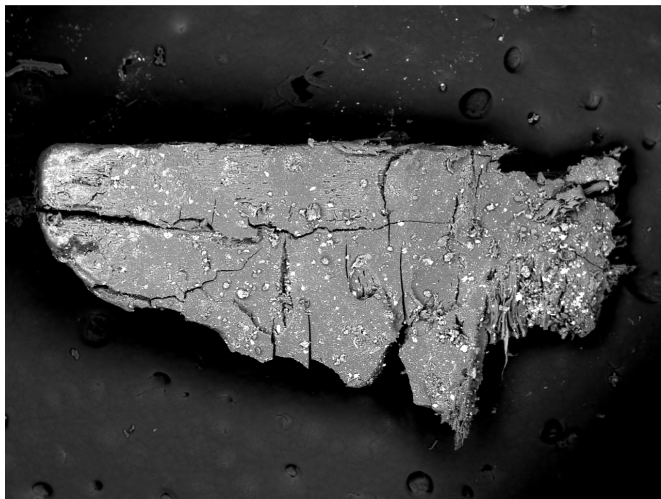
500μm

Cu-K



500μm

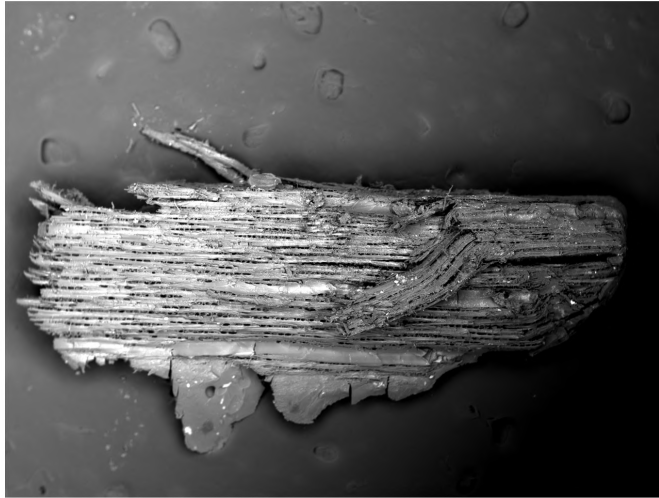
Sem_BED-C_002



500 μ m

Signal BED-C
Landing Voltage 20.0 kV
WD 12.3 mm
Magnification x37
FOV 3.459 x 2.595 mm
Probe Current number Std. 63.0
Scan Rotation 0.0°
Vacuum Mode LowVacuum
Pressure 30 Pa

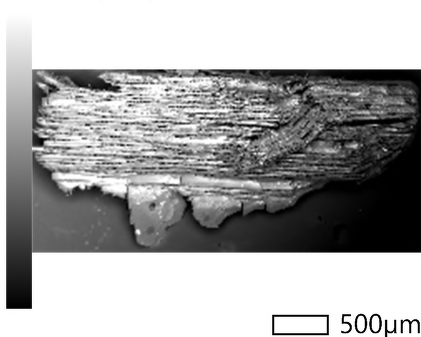
Sem_BED-C_005



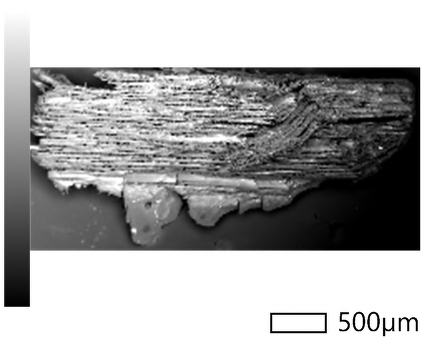
500 μm

Signal BED-C
Landing Voltage 15.0 kV
WD 11.3 mm
Magnification x37
FOV 3.459 x 2.595 mm
Probe Current number Std. 60.0
Scan Rotation 0.0°
Vacuum Mode LowVacuum
Pressure 30 Pa

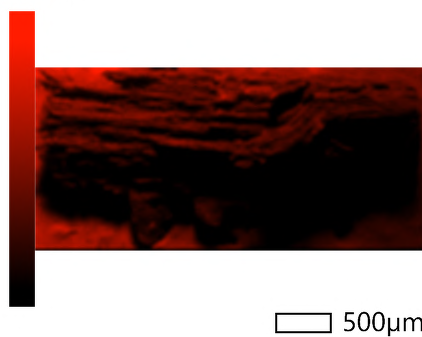
IMG1(1st)



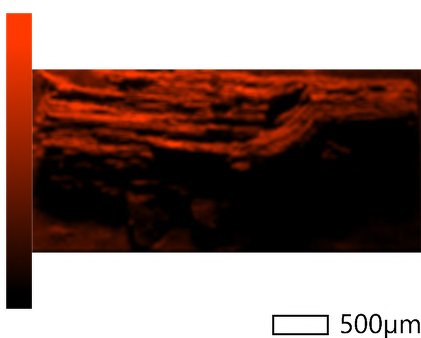
IMG1



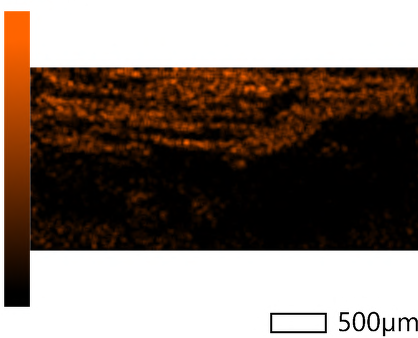
C-K



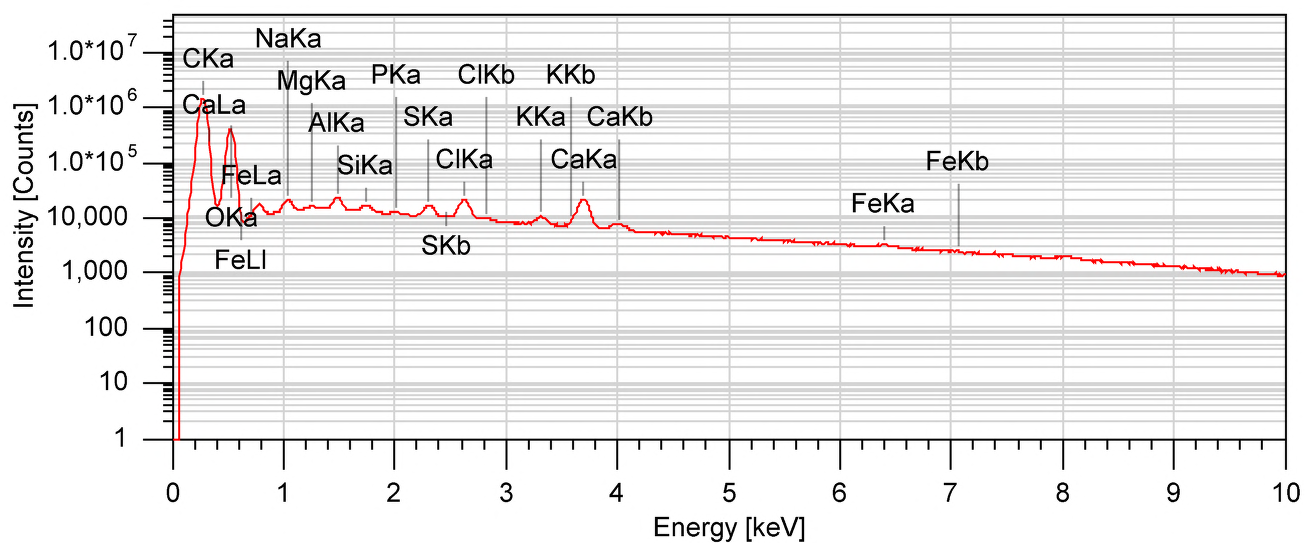
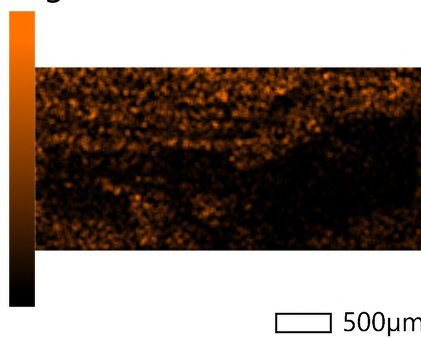
O-K

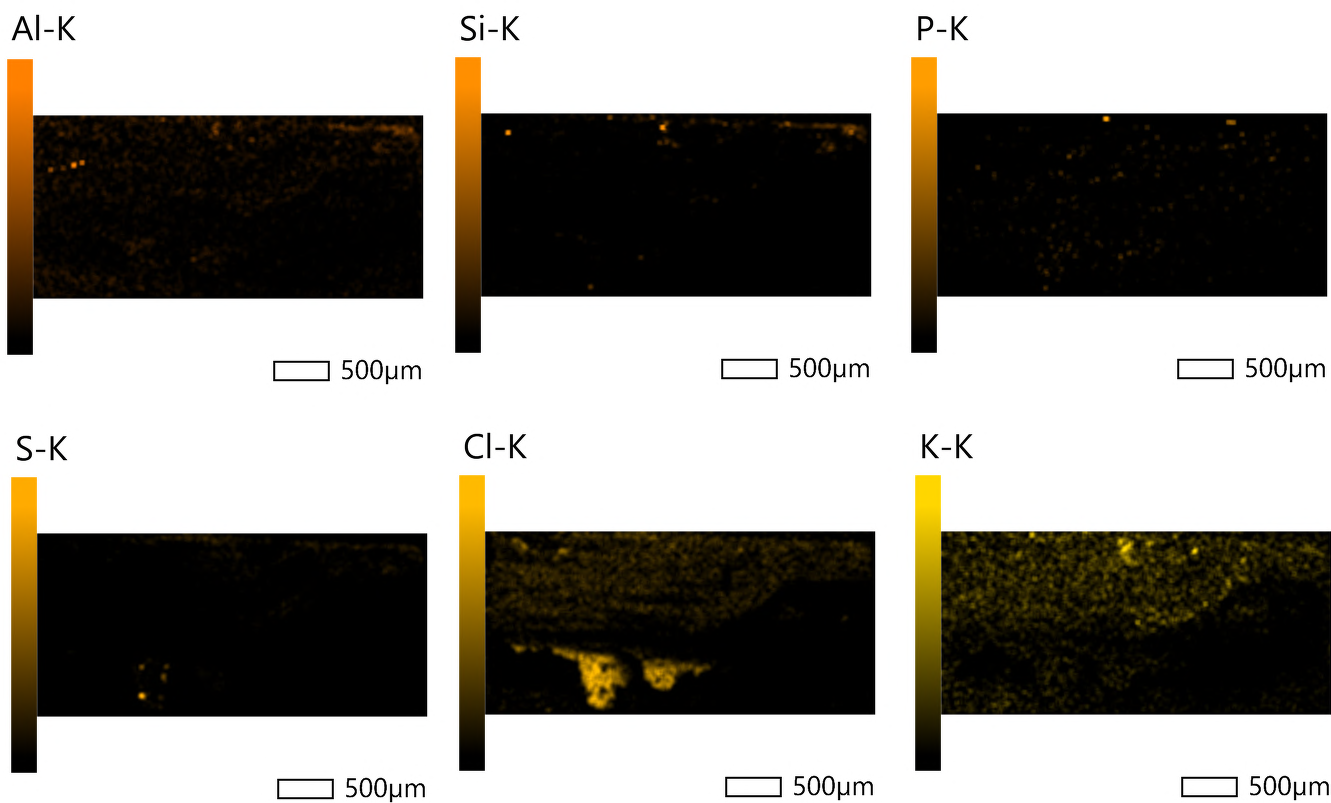


Na-K

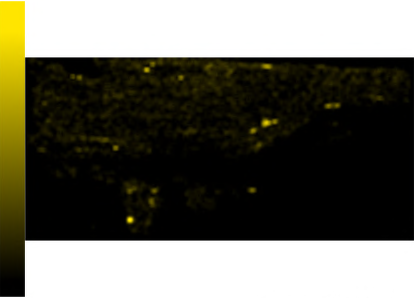


Mg-K



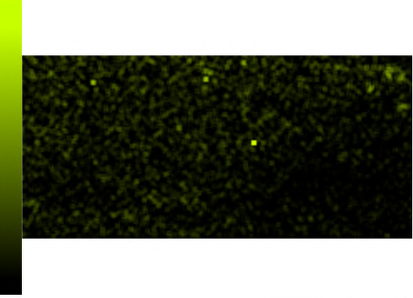


Ca-K



500μm

Fe-K



500μm

SEM images	
Location	Woodlab Africamuseum
Datum van measurement	25/07/2025
Supervisor	Blanca Van Houtte Alonso and Michael Monnoye
SEM executor	Flynn Hermesen
Comments	/

Woodlab Africamuseum

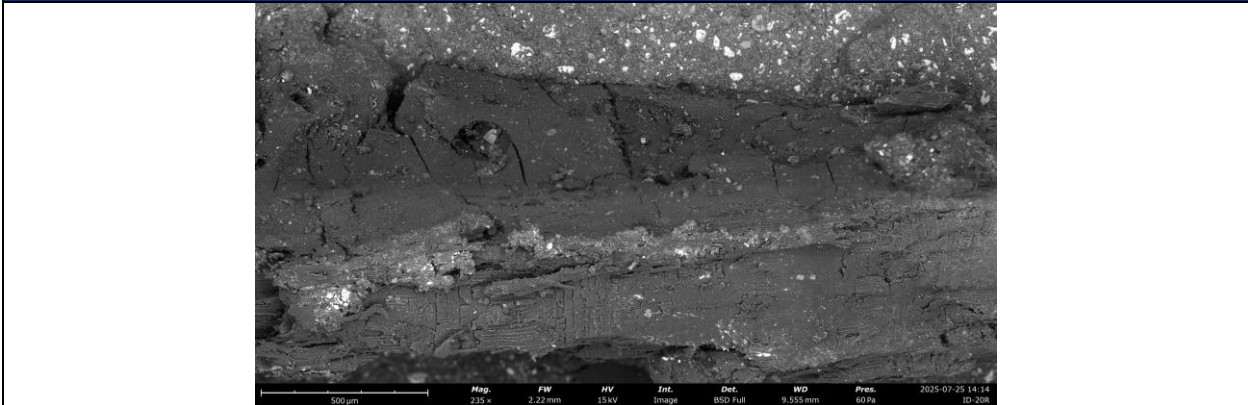
25/07/2025

Blanca Van Houtte Alonso and Michael Monnoye

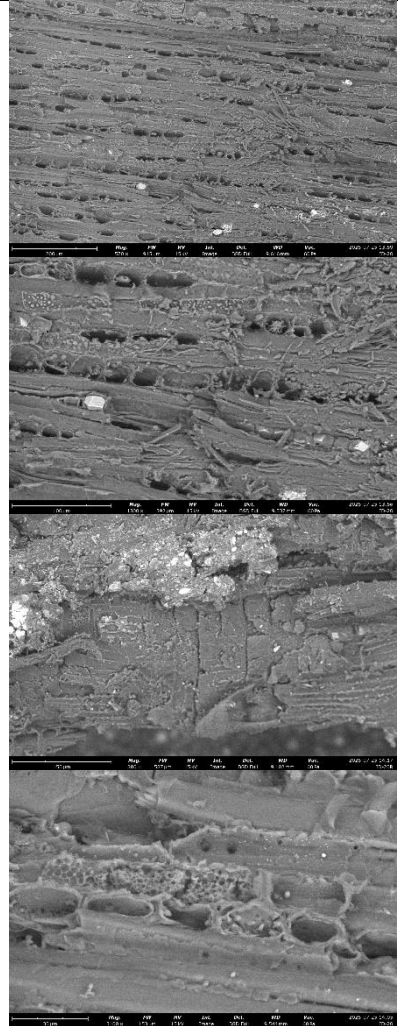
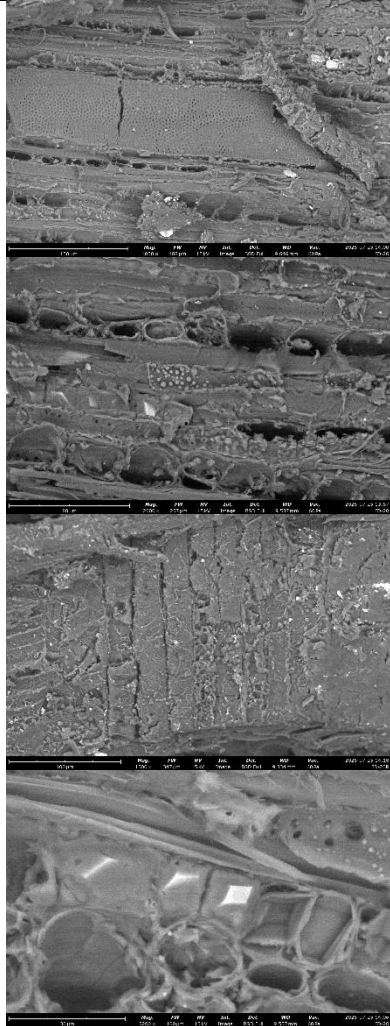
Flynn Hermesen

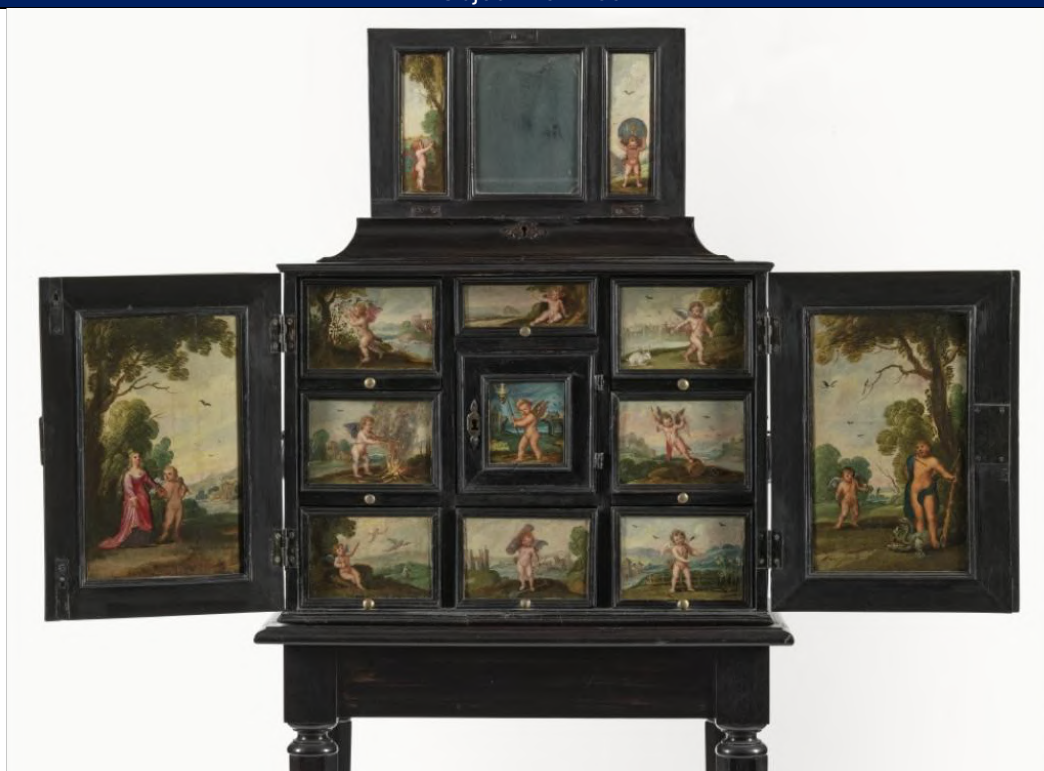
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Overview



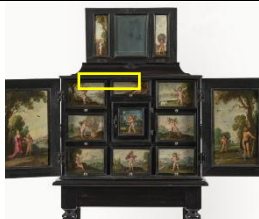
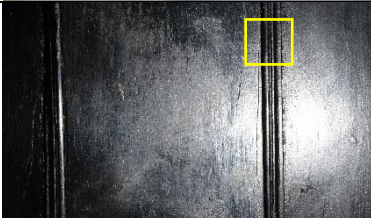
Images

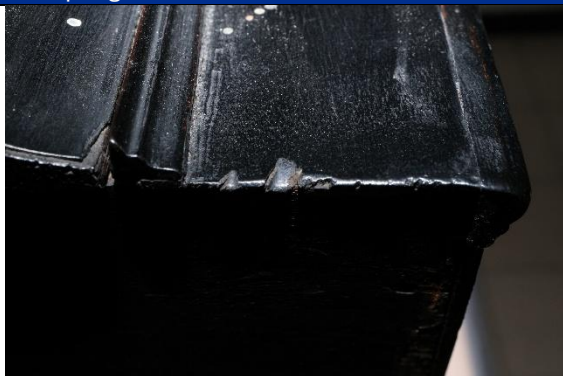
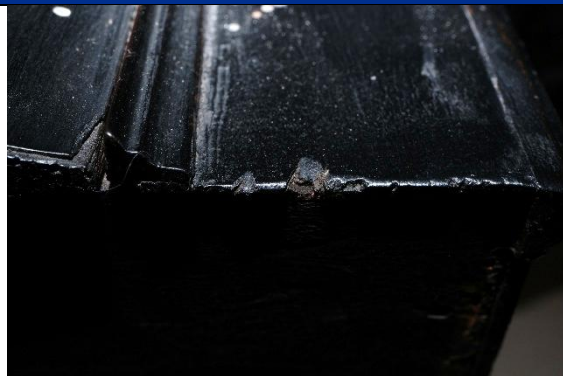
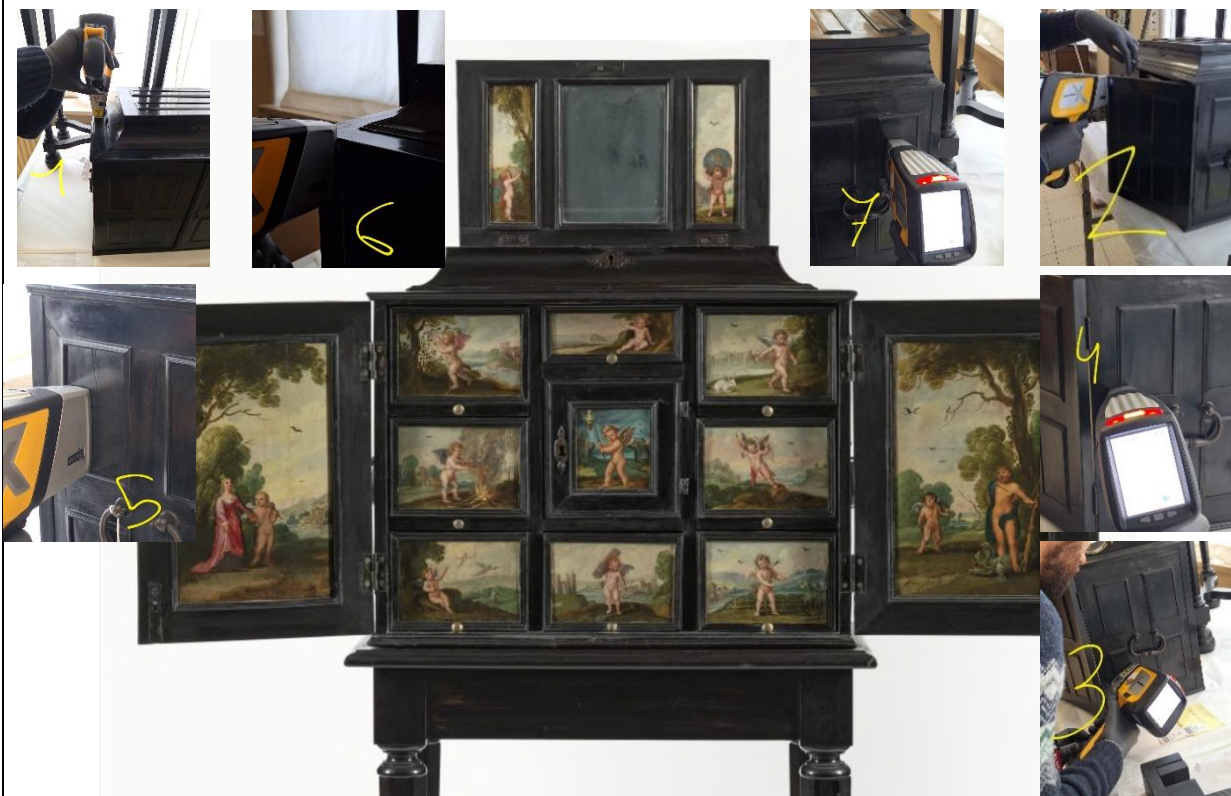




General information

Object type	Table cabinet (group 4)	Collection type	Public		
Owner	Collection City of Antwerp, MAS, Hanzestedenplaats 1, 2000 Antwerp				
Curator	Marina Christiaens				
Contact	Cell phone: +32 (0) 476 73 95 71 Fixed number: + 32 (0) 3 206 09 31	Marina.Christiaens@antwerpen.be Office: Hessenhuis – Falconrui 73, 2000 Antwerp (BELGIUM) Postal address: Francis Wellesplein 1, 2018 Antwerpen			
Url: website	https://dams.antwerpen.be/asset/QLqWZVQM4SsFZSUGTKUTL7jS#id https://balat.kikirpa.be/photo.php?path=M007903&objnr=11041893&lang=nl-NL&nr=1				
Item number	Sm.0774.1-3	Date	1610-1620		
HOME-AGE cabinet database number	ID.55	Production site	Antwerp		
Dimensions	Height	depth	Width		
	43,5 cm	28,0 cm	51,0 cm		
Profile frame dimensions	3.08 - 3.25 mm ± 0,02 mm	5.56 mm ± 0,02 mm	/		
Thickness of veneer	0,50 – 0,59 mm ± 0,02 mm				
Suspicion of restorations of veneer or profile moulding		Restorations in veneer			
Additional archive material?		No			
Existing finishing materials					
Blackened wood	Ebony	Other types of wood	Bone	Embroidery	Painting
X	X?				X
Turtle shell	Ivory	Metal	Paper	Varnish	Other
		X		X	
Finishing techniques available					
Molding	Rippled molding	Maker's mark	Stamps		
X					

Evidence of blackened timber at other locations			
Carcas s			
Lists			
			
			
Sample information			
Location during sampling	Cabinet was sampled in Luchtbal's depot		
Date of sampling	10/03/2025		
Supervisor	Woodrestorer Martijn Breunesse		
Method of sampling	Tweezer and scalpel		
Comments	Piece of veneer was already partly loose.		
Sample location			
			

For sampling		No monstername	
			
pXRF information			
Location during measurments		Depot Luchtbal	
Datum van measurement		25/05/2025	
Supervisor		Liselotte Bertells	
pXRF executor		Andrea Marchetti	
Comments		/	
pXRF locations			
			

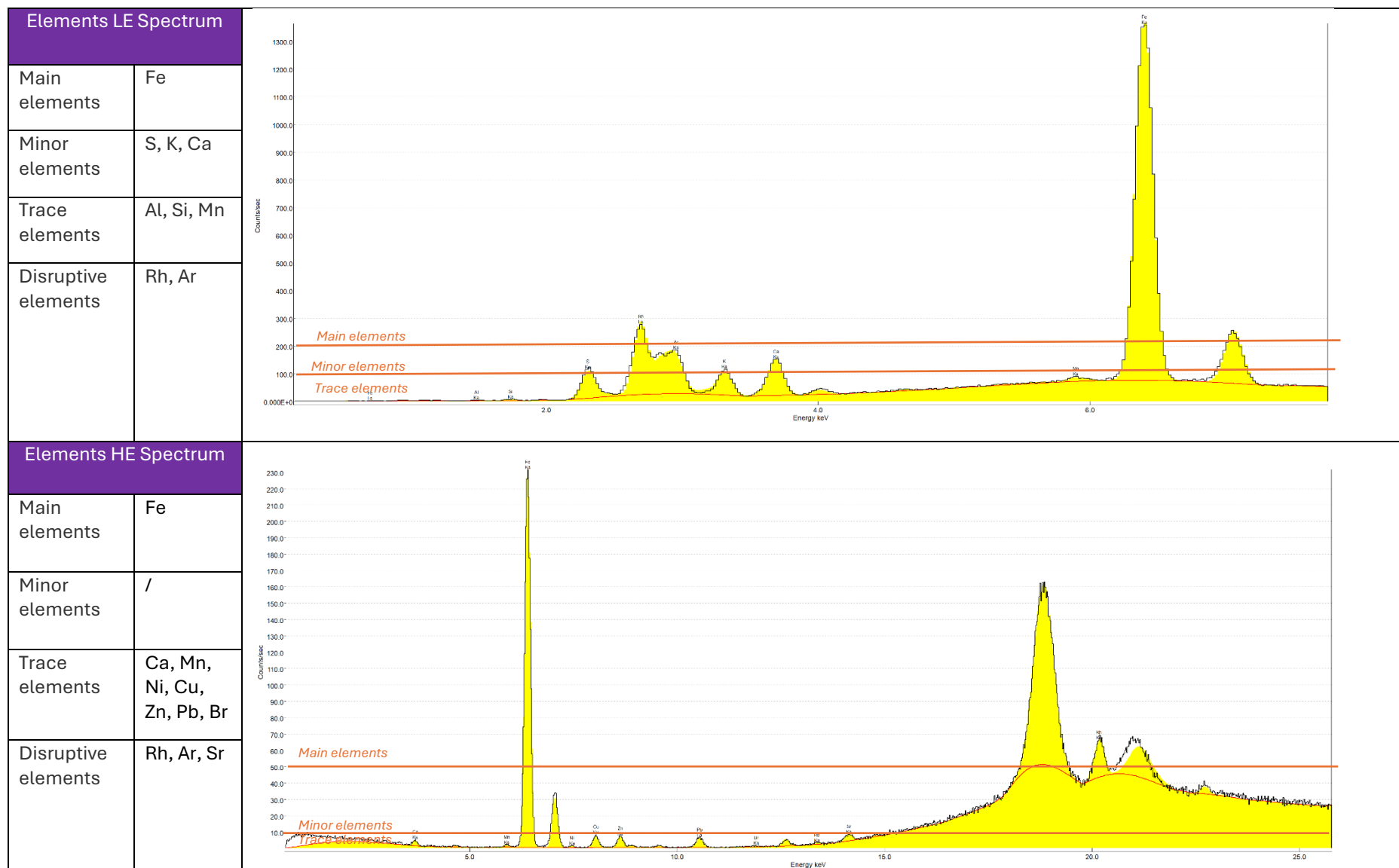


Table 1: pXRF measurements ID.55_1

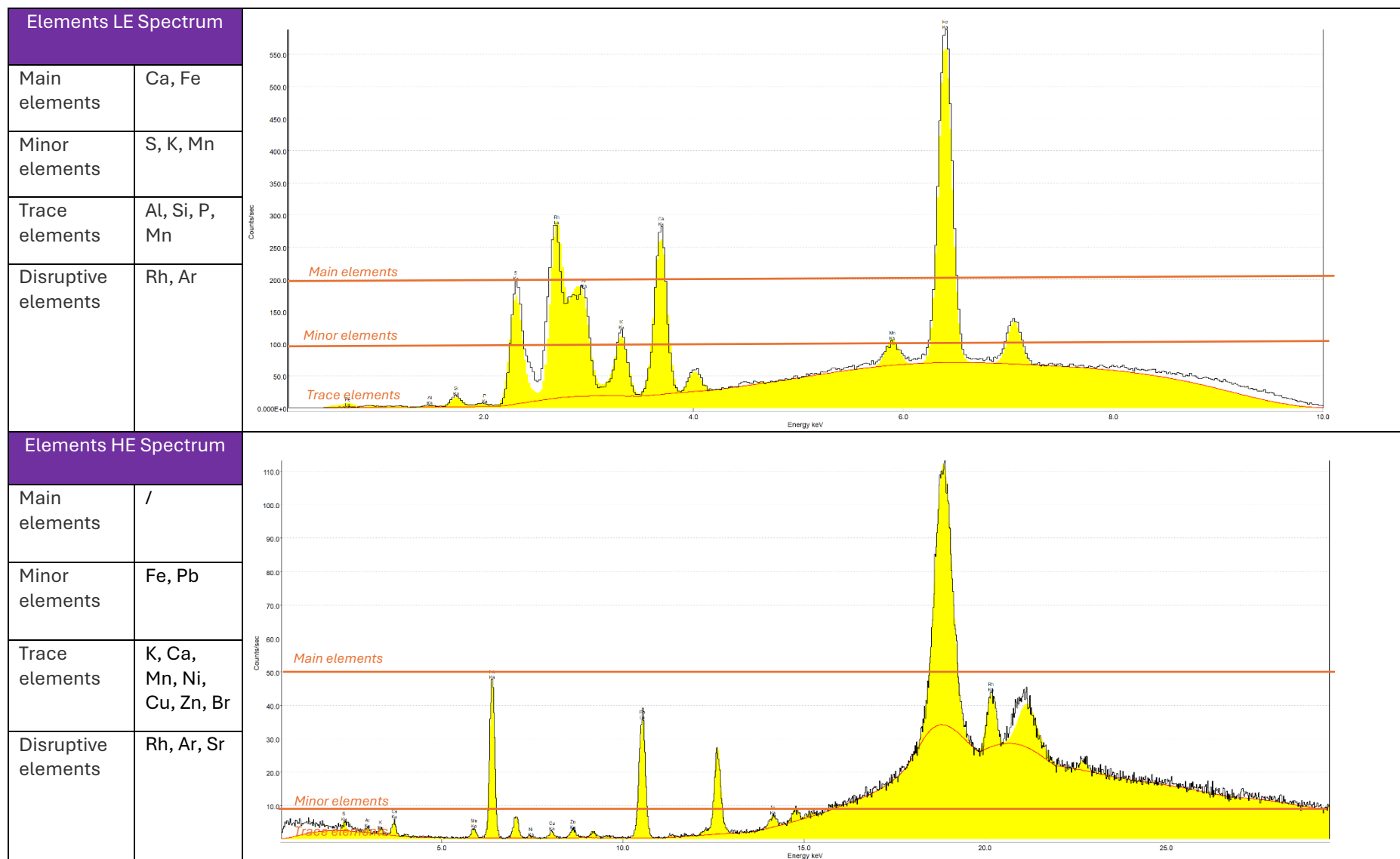


Table 2: pXRF measurements ID.55_2

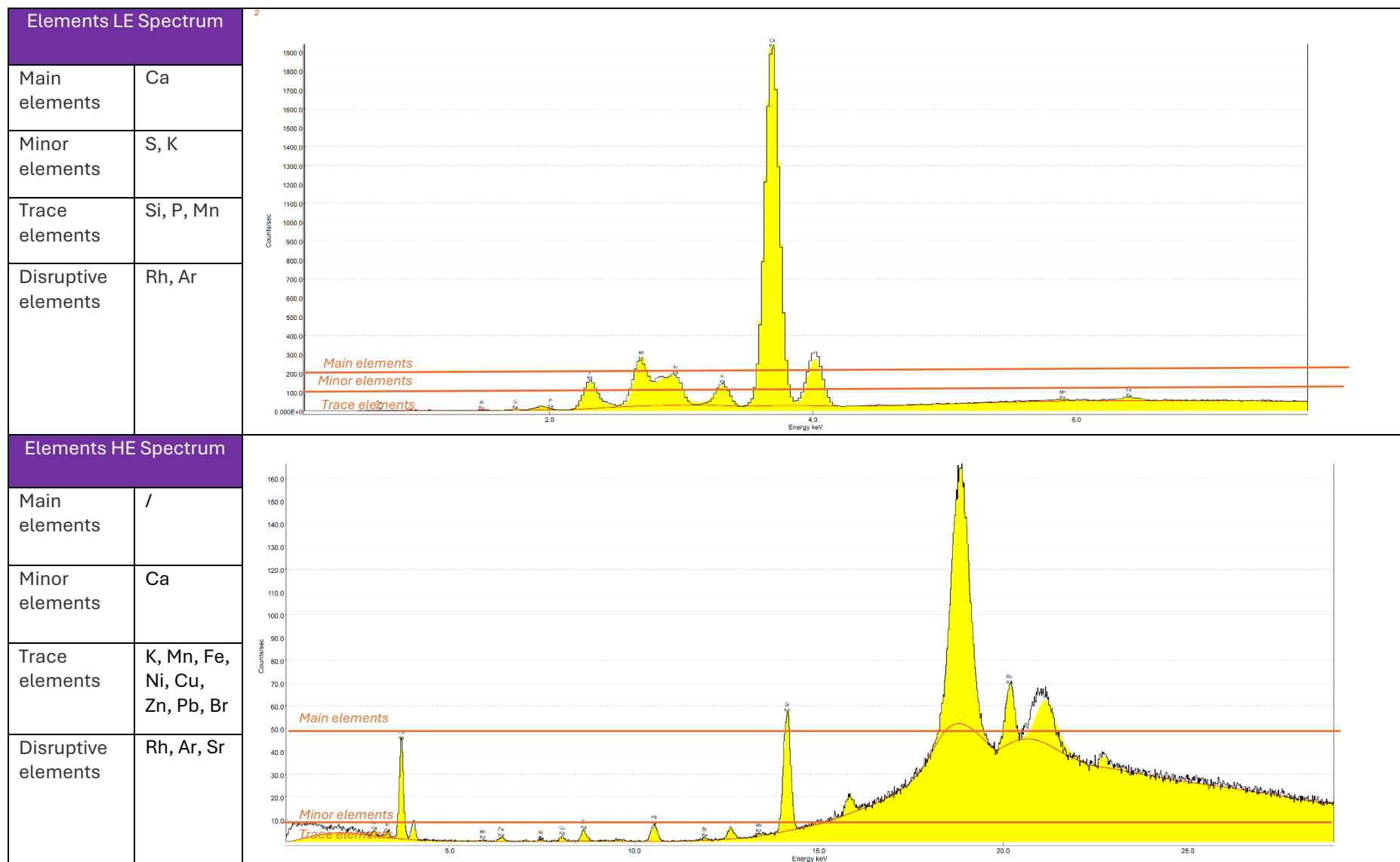


Table 3: pXRF measurements ID.55_3

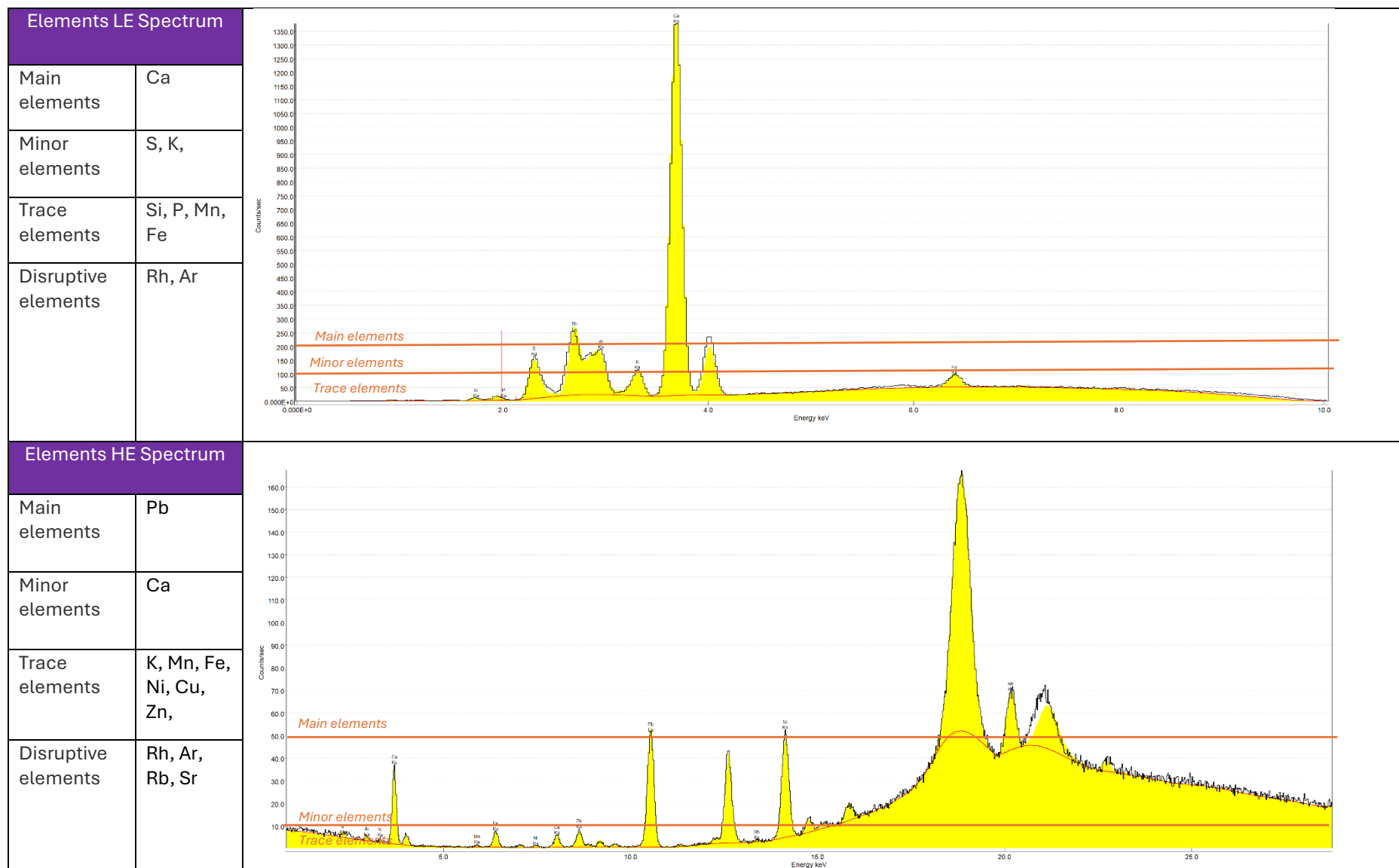


Table 4: pXRF measurements ID.55_4

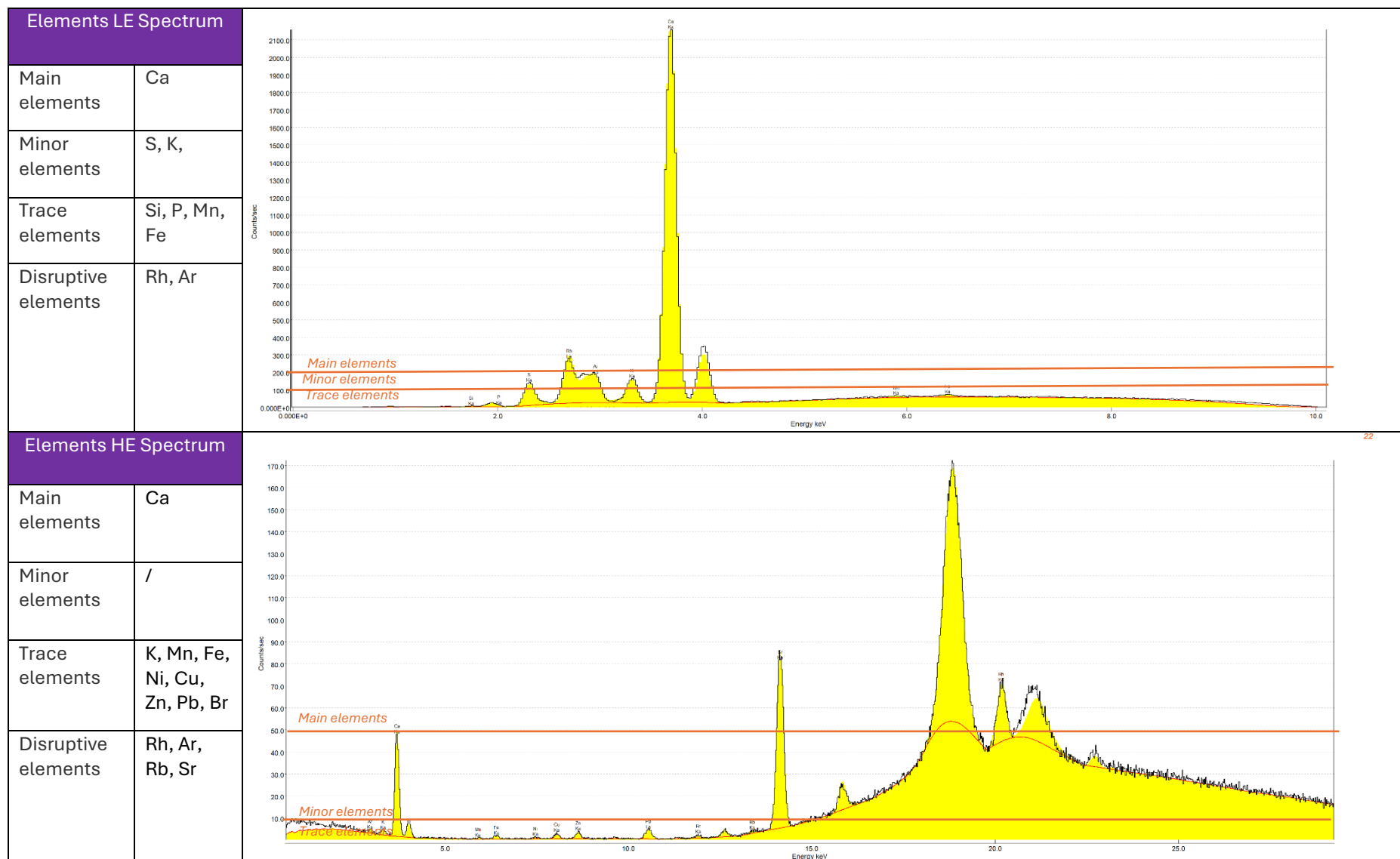


Table 5: pXRF measurements ID.55_5

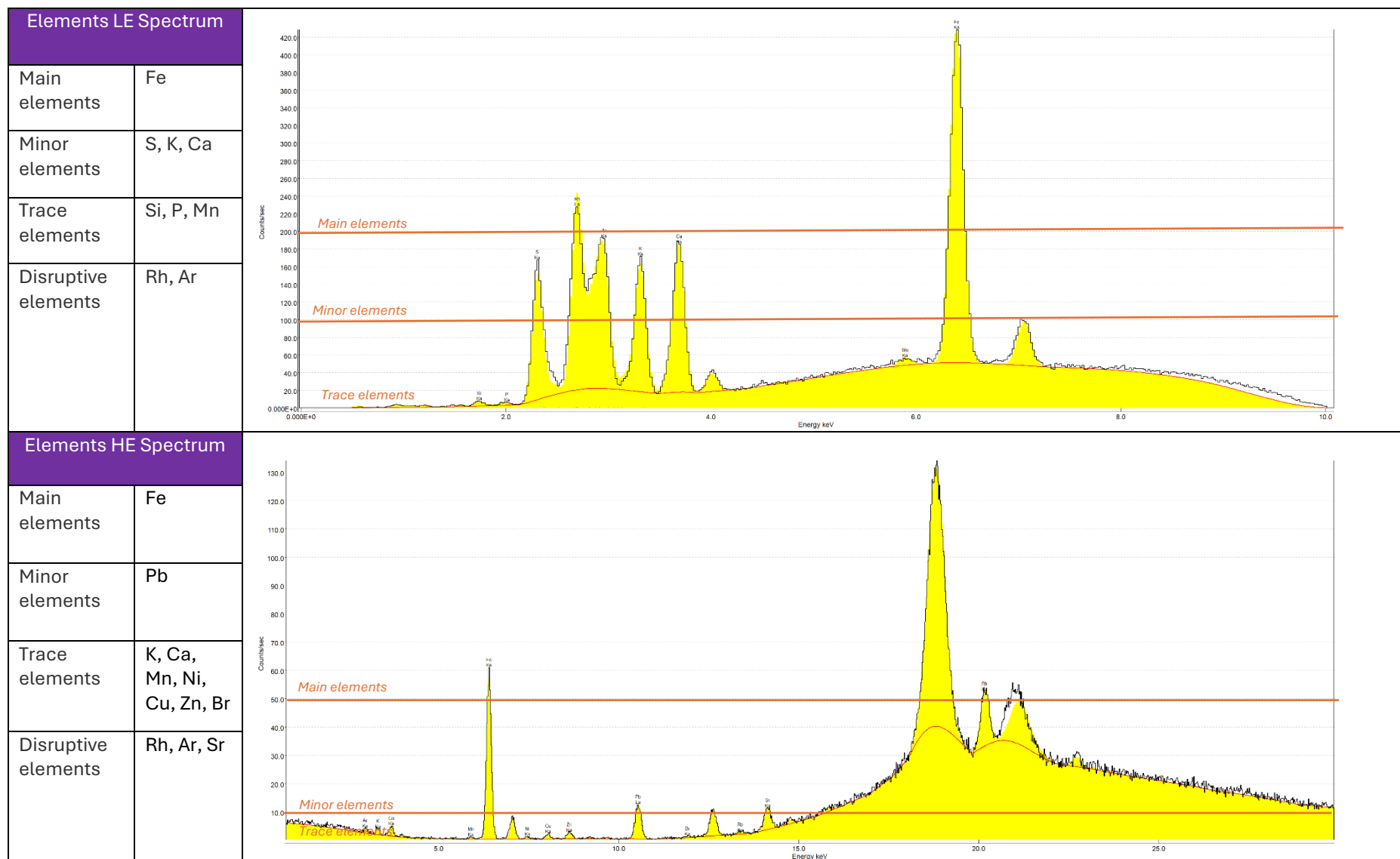


Table 6: pXRF measurements ID.55_6

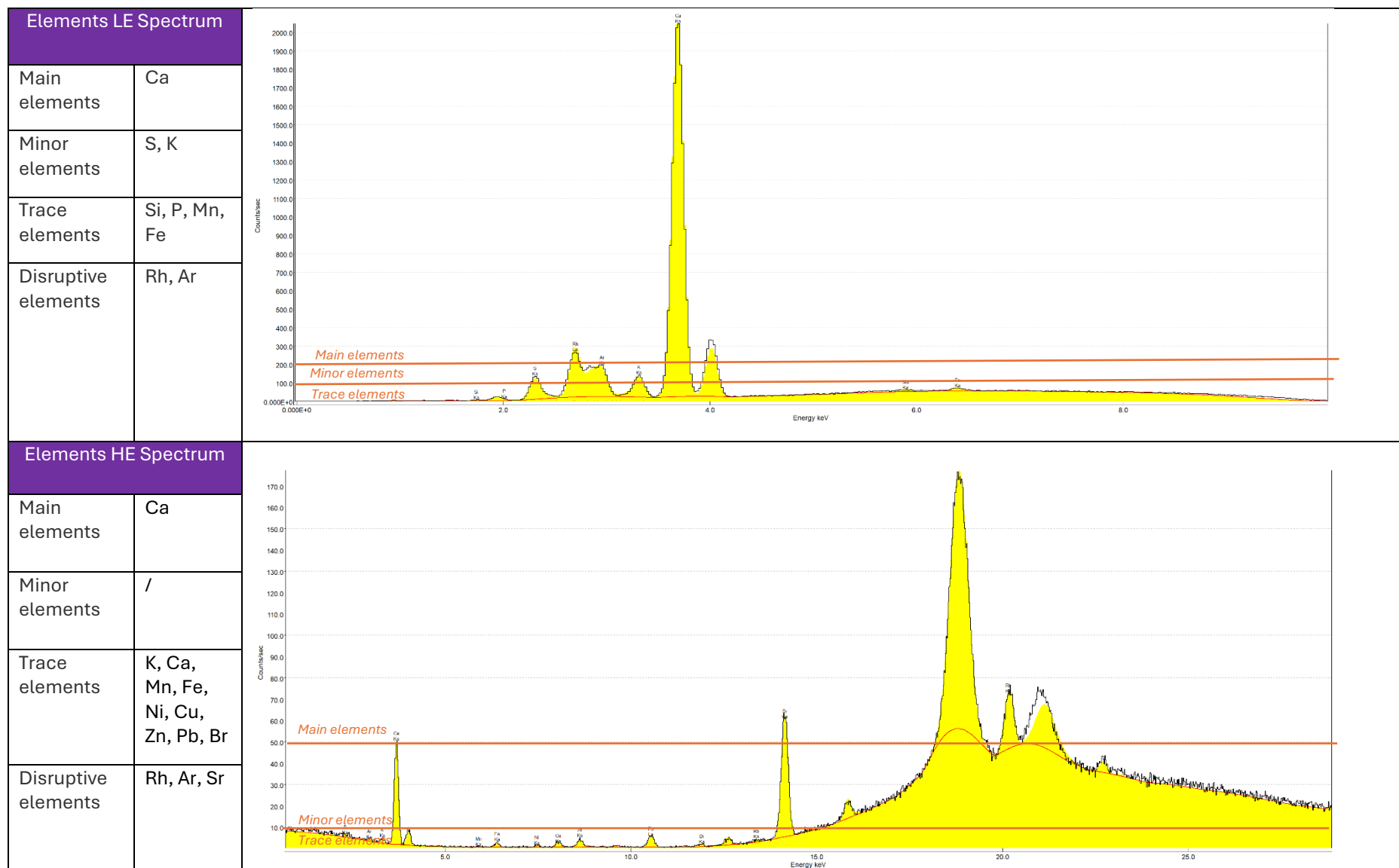
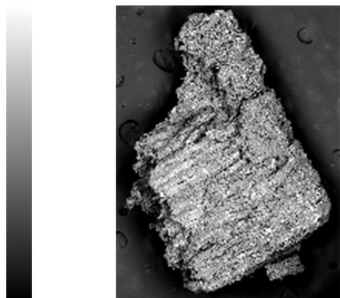


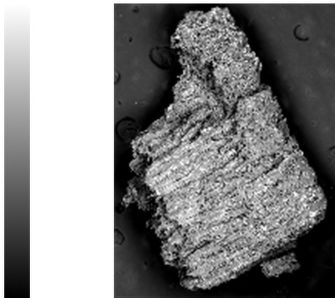
Table 7: pXRF measurements ID.55_7

IMG1(1st)



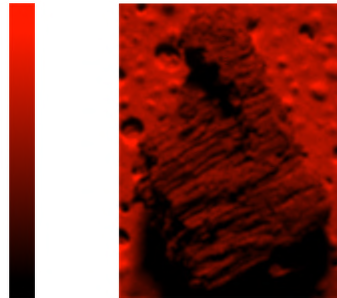
500μm

IMG1



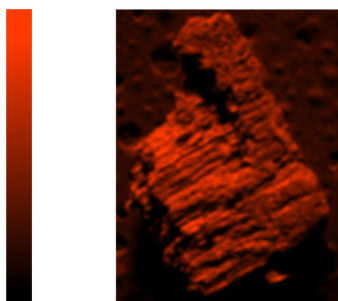
500μm

C-K



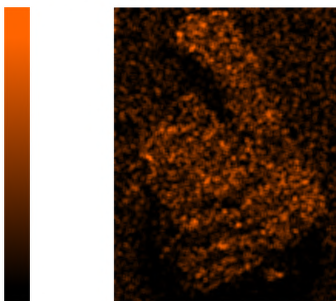
500μm

O-K



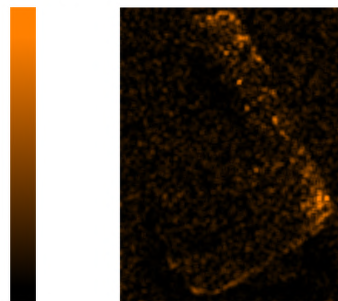
500μm

Na-K

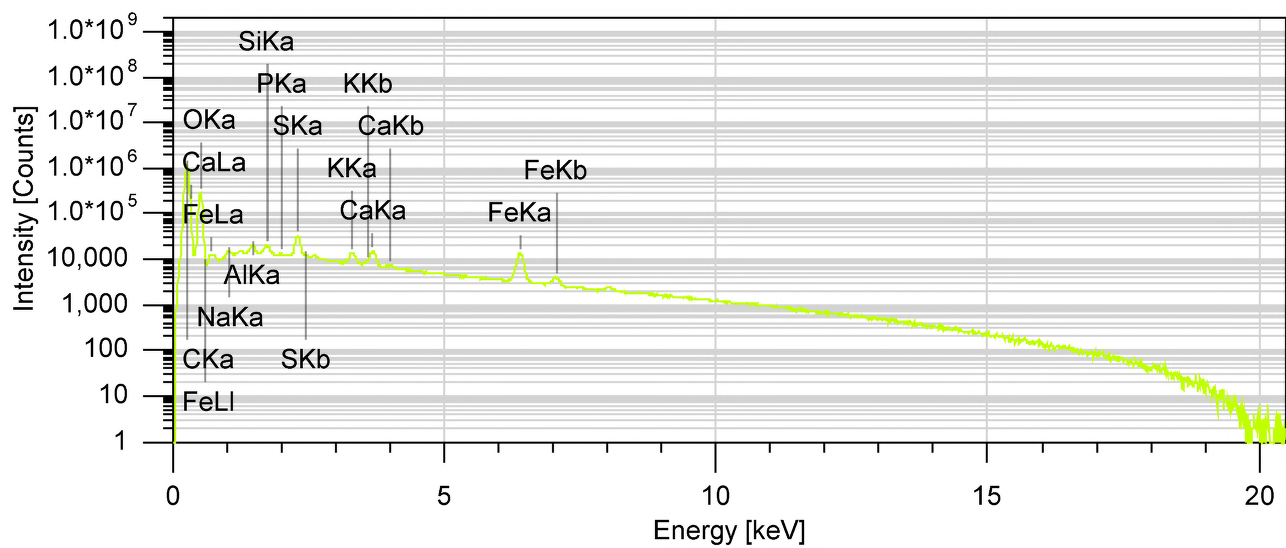


500μm

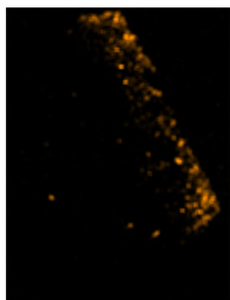
Al-K



500μm

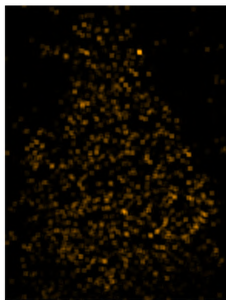


Si-K



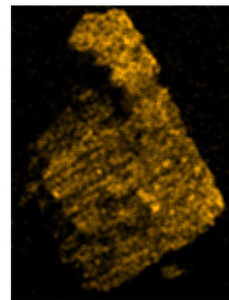
500μm

P-K



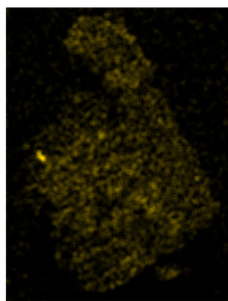
500μm

S-K



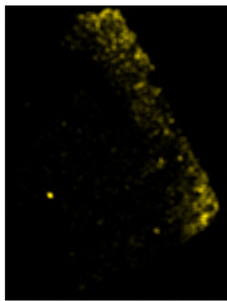
500μm

K-K



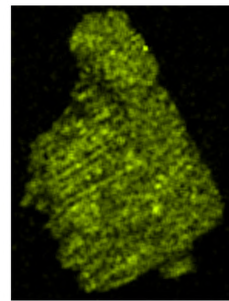
500μm

Ca-K



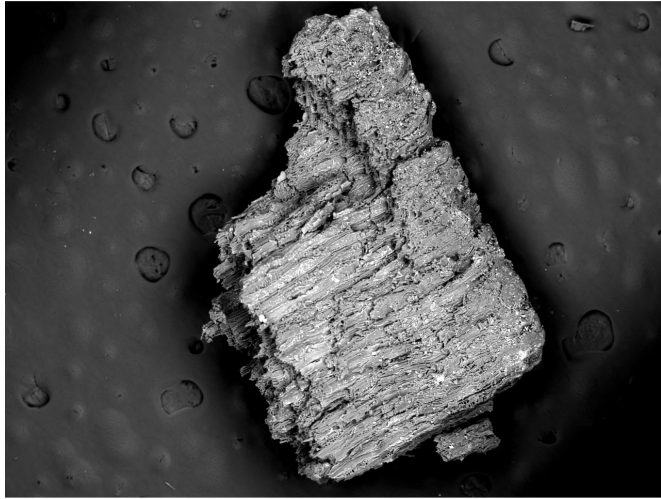
500μm

Fe-K



500μm

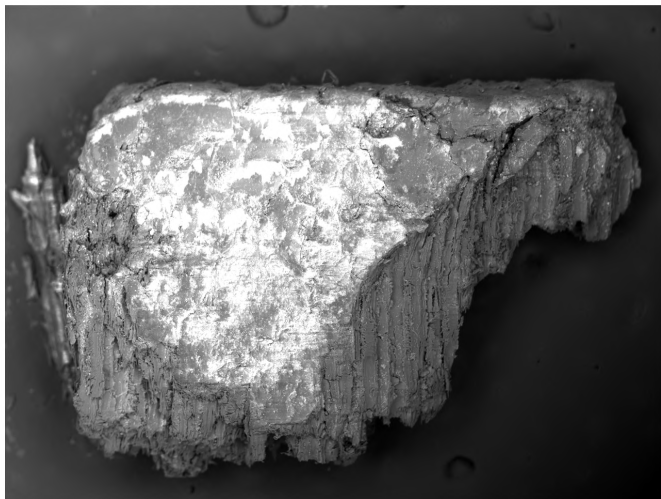
Sem_BED-C_001



500 μm

Signal BED-C
Landing Voltage 20.0 kV
WD 12.4 mm
Magnification x33
FOV 3.879 x 2.909 mm
Probe Current number Std. 63.0
Scan Rotation 0.0°
Vacuum Mode LowVacuum
Pressure 30 Pa

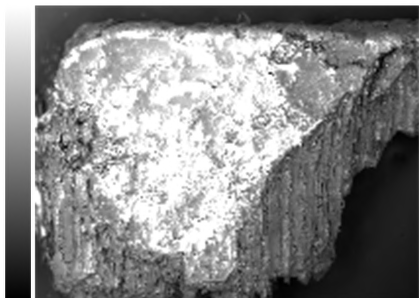
Sem_BED-C_004



500 μm

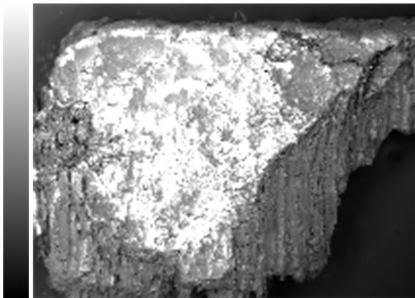
Signal BED-C
Landing Voltage 15.0 kV
WD 11.1 mm
Magnification x45
FOV 2.844 x 2.133 mm
Probe Current number Std. 60.0
Scan Rotation 0.0°
Vacuum Mode LowVacuum
Pressure 30 Pa

IMG1(1st)



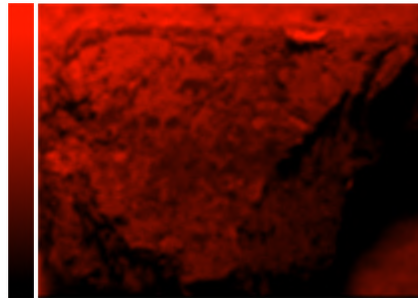
500μm

IMG1



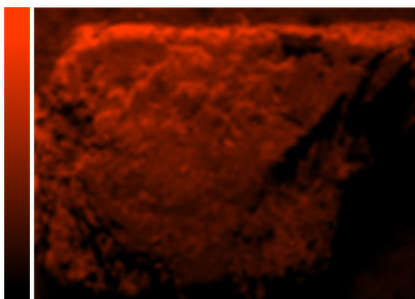
500μm

C-K



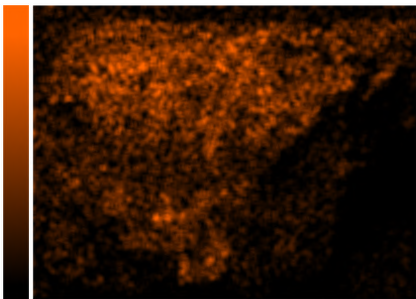
500μm

O-K



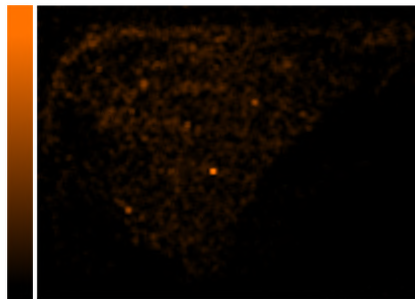
500μm

Na-K

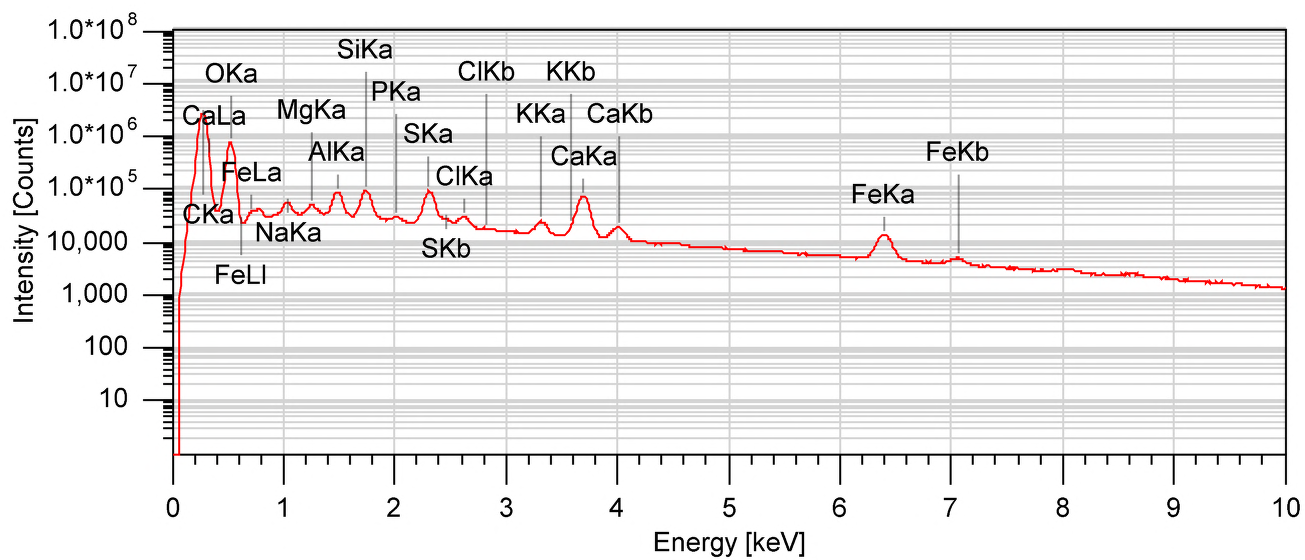


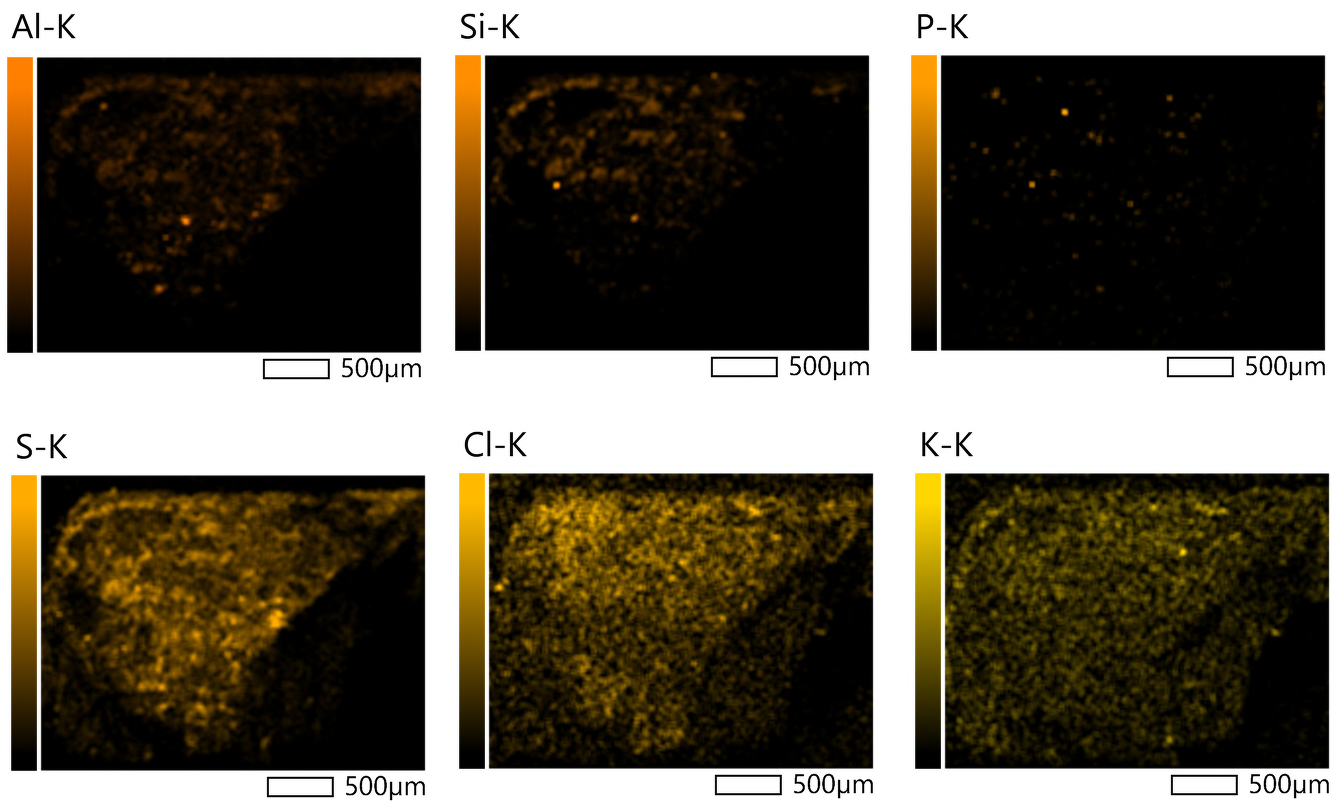
500μm

Mg-K

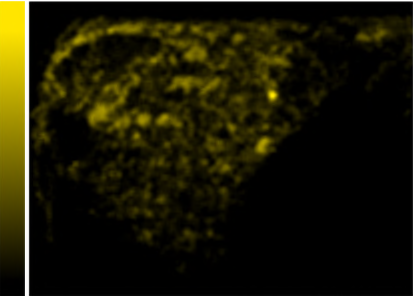


500μm



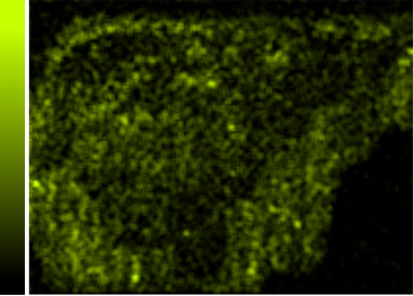


Ca-K



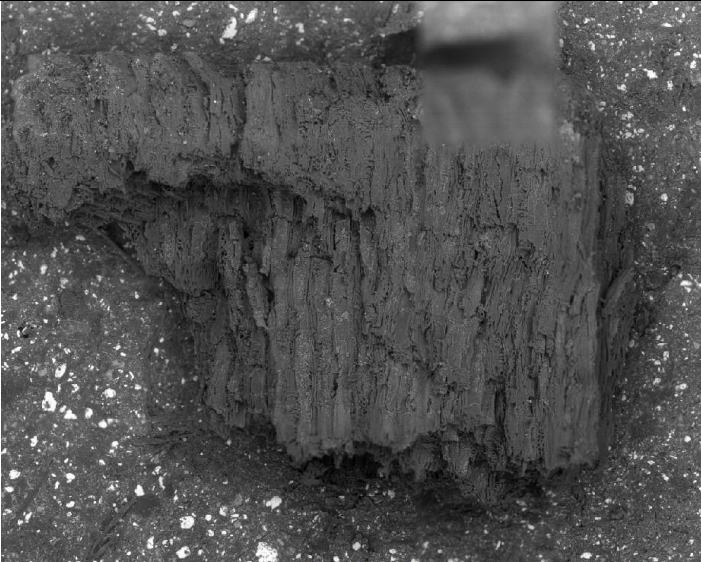
500µm

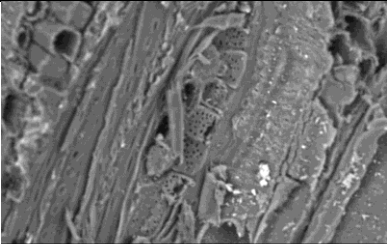
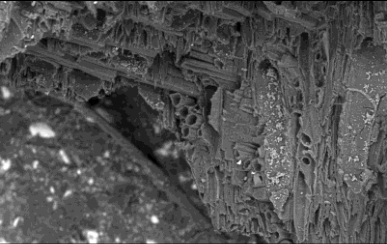
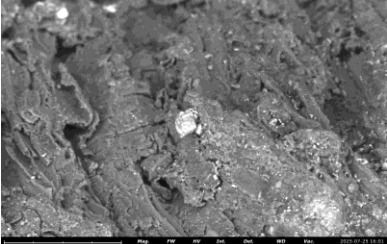
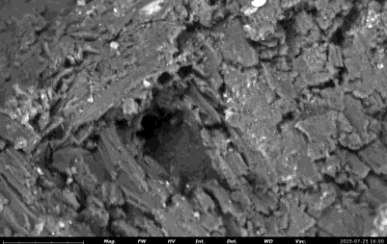
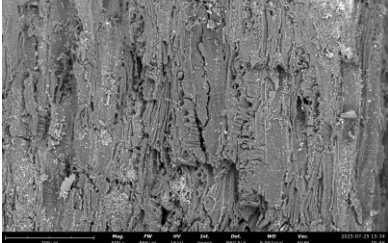
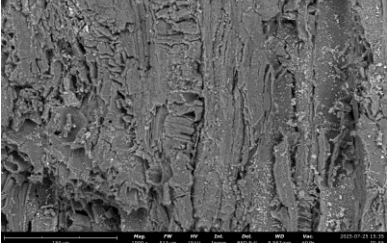
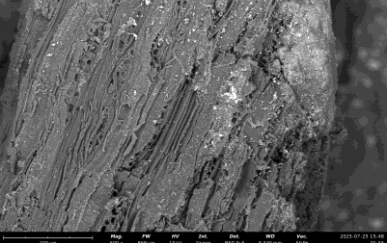
Fe-K

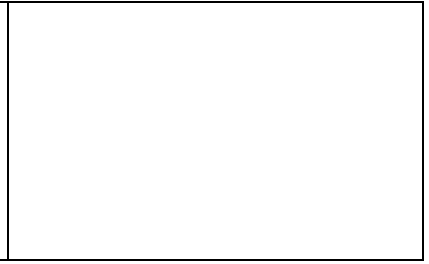
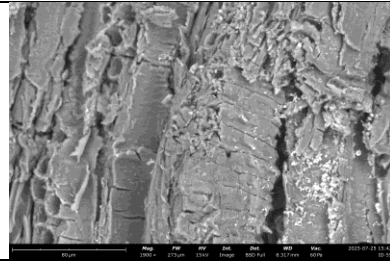
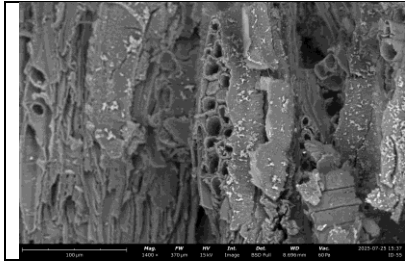


500µm

SEM images	
Location	Woodlab Africamuseum
Datum van measurement	25/07/2025
Supervisor	Blanca Van Houtte Alonso and Michael Monnoye
SEM executor	Flynn Hermesen
Comments	/

Overview	
	 800 µm Mag. 145 x FW 2.77 mm HV 15 kV Int. Image Det. BSD Full WD 9.072 mm 2025-07-25 15:33 ID-55

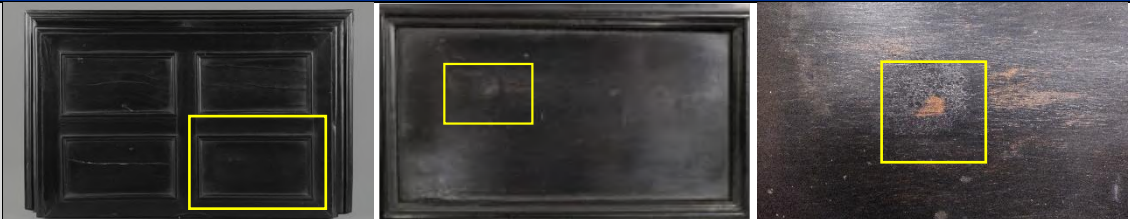
Images	
 200 µm Mag. 145 x FW 2.77 mm HV 15 kV Int. Image Det. BSD Full WD 9.072 mm 2025-07-25 15:33 ID-55	 200 µm Mag. 145 x FW 2.77 mm HV 15 kV Int. Image Det. BSD Full WD 9.072 mm 2025-07-25 15:33 ID-55
 200 µm Mag. 145 x FW 2.77 mm HV 15 kV Int. Image Det. BSD Full WD 9.072 mm 2025-07-25 15:33 ID-55	 200 µm Mag. 145 x FW 2.77 mm HV 15 kV Int. Image Det. BSD Full WD 9.072 mm 2025-07-25 15:33 ID-55
 200 µm Mag. 145 x FW 2.77 mm HV 15 kV Int. Image Det. BSD Full WD 9.072 mm 2025-07-25 15:33 ID-55	 200 µm Mag. 145 x FW 2.77 mm HV 15 kV Int. Image Det. BSD Full WD 9.072 mm 2025-07-25 15:33 ID-55
 200 µm Mag. 145 x FW 2.77 mm HV 15 kV Int. Image Det. BSD Full WD 9.072 mm 2025-07-25 15:33 ID-55	 200 µm Mag. 145 x FW 2.77 mm HV 15 kV Int. Image Det. BSD Full WD 9.072 mm 2025-07-25 15:33 ID-55



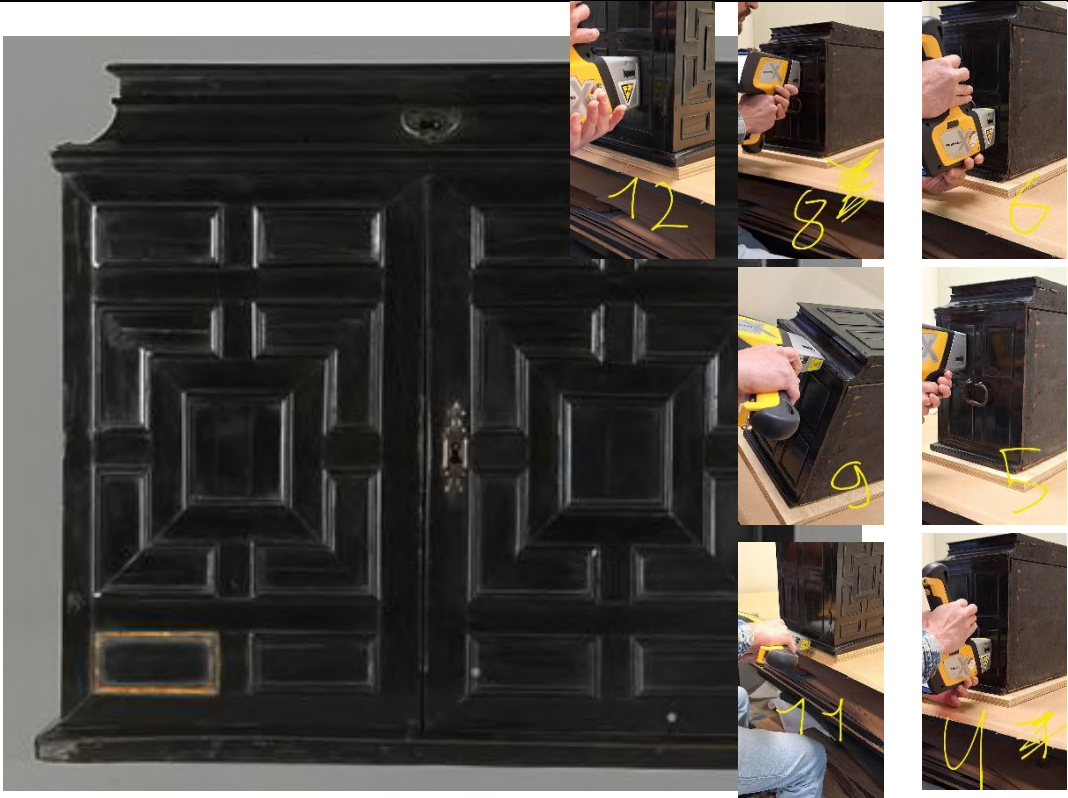


General information

Object type	Table cabinet (group 4)		Collection type	Public	
Owner	Royal Museum of Art and History, Parc du Cinquantenaire 10, 1000 Brussels				
Curator	Emile van Binnebeke				
Contact	+32474-046374		e.vanbinnebeke@kmg-mrah.be		
Url website	https://balat.kikirpa.be/photo.php?path=B202527&objnr=20048922&lang=nl-NL&nr=2				
Item number	IV.0071		Date	Ca 1650	
HOME-AGE cabinet database number	ID.76		Production place	Antwerp	
Cabinet dimensions	Height	depth		Width	
	38.4 cm	25.9 cm		42.8 cm	
Molding dimensions (of sample location nr 1.)	3,13 mm ± 0,02 mm	4,82 mm ± 0,02 mm		/	
Thickness of veneer	0,93 ± 0,02 mm				
Suspicion of restorations of veneer or profile mouldings		No, minimal restoration interventions			
Additional archive material?		No			
Existing finishing materials					
Blackened wood	Ebony	Other types of wood	Bone	Embroidery	Painting
X	X?			X	
Turtle shell	Ivory	Metal	Paper	Varnish	Other
		X		X	
Finishing techniques available					
Molding	Rippled molding	Maker's mark	Other marks		
X		x			

Evidence of blackened timber at other locations			
Veneer			
Lists			
			
			
Sample information			
Location during sampling	Cabinet was taken by the RMAH-MRAH to C/R lab wood, University of Antwerp. Blindestraat 9, 2000 Antwerp		
Date of sampling	Piece of profile frame had already come loose		
Supervisor	Prof. Vincent Cattersel		
Method of sampling	Not applicable		
Comments	Profile list had already been released. Cabinet was restored between November and December 2024. The top profile list will be fixed at the end of the academic year. See treatment report at RMAH.		
Sample location 1			
			

Coupe	
	
Sample location 2	
Location during sampling	Cabinet was taken by the RMAH-MRAH to C/R lab wood, University of Antwerp. Blindestraat 9, 2000 Antwerp
Date of sampling	03/07/2025
Supervisor	Prof. Vincent Cattersel
Method of sampling	Chisel
Comments	/
	
Before sampling	
	

pXRF information	
Location during measurments	Cabinet was analyzed in Conservation & Restoration lab wood, University of Antwerp. Blindestraat 9, 2000 Antwerpen
Datum van measurement	07/04/2025
Supervisor	/
pXRF executor	Pedro Viviani De Campos
Comments	The measurements were accidentally performed in AlloyPlus mode instead of Geochem mode. This primarily affects the counts per second (cps) axis. To compensate, the thresholds of 100 cps and 200 cps were adjusted to 400 cps and 800 cps, respectively.
pXRF locations	
	

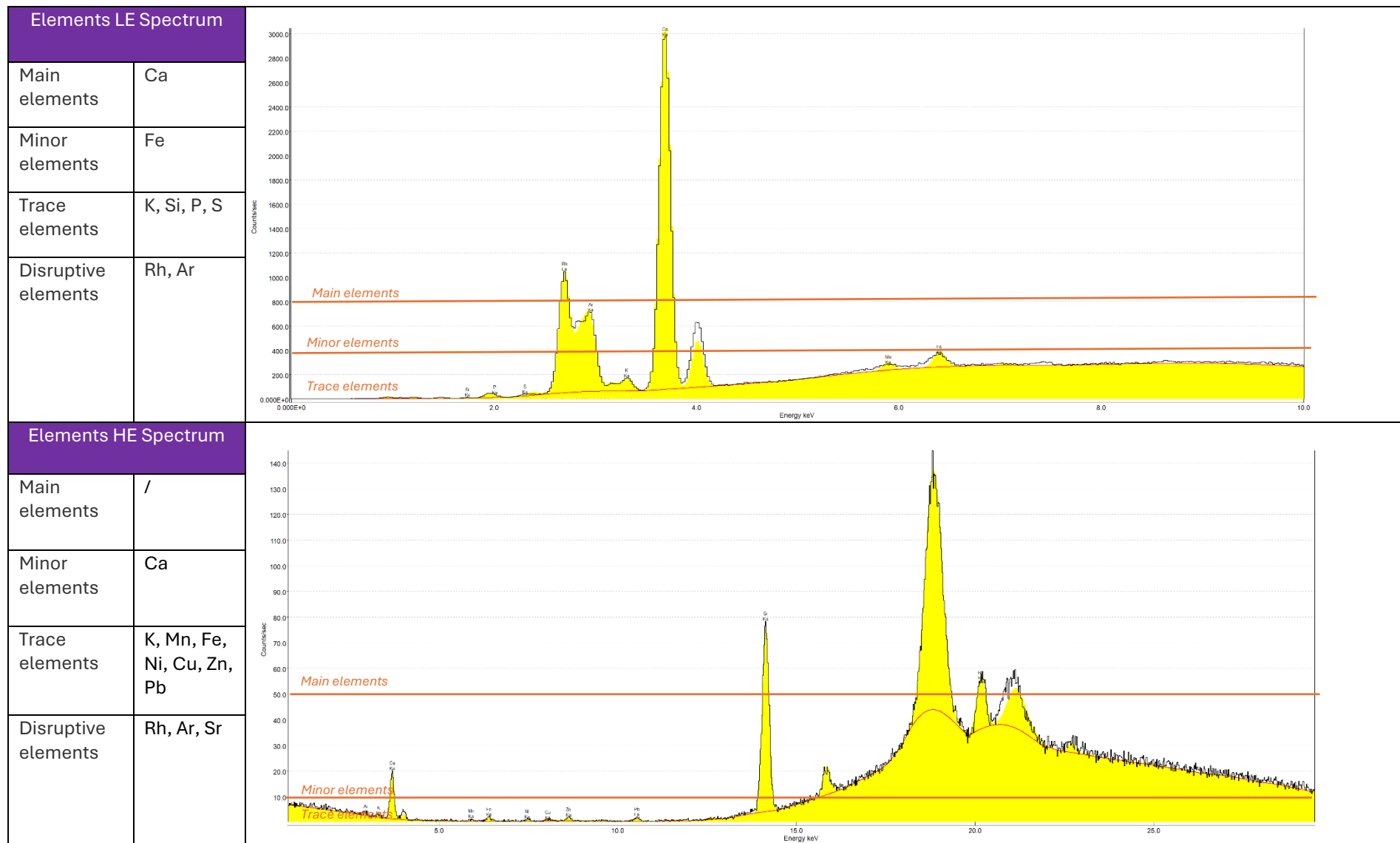


Table 1: pXRF measurements ID.76_4

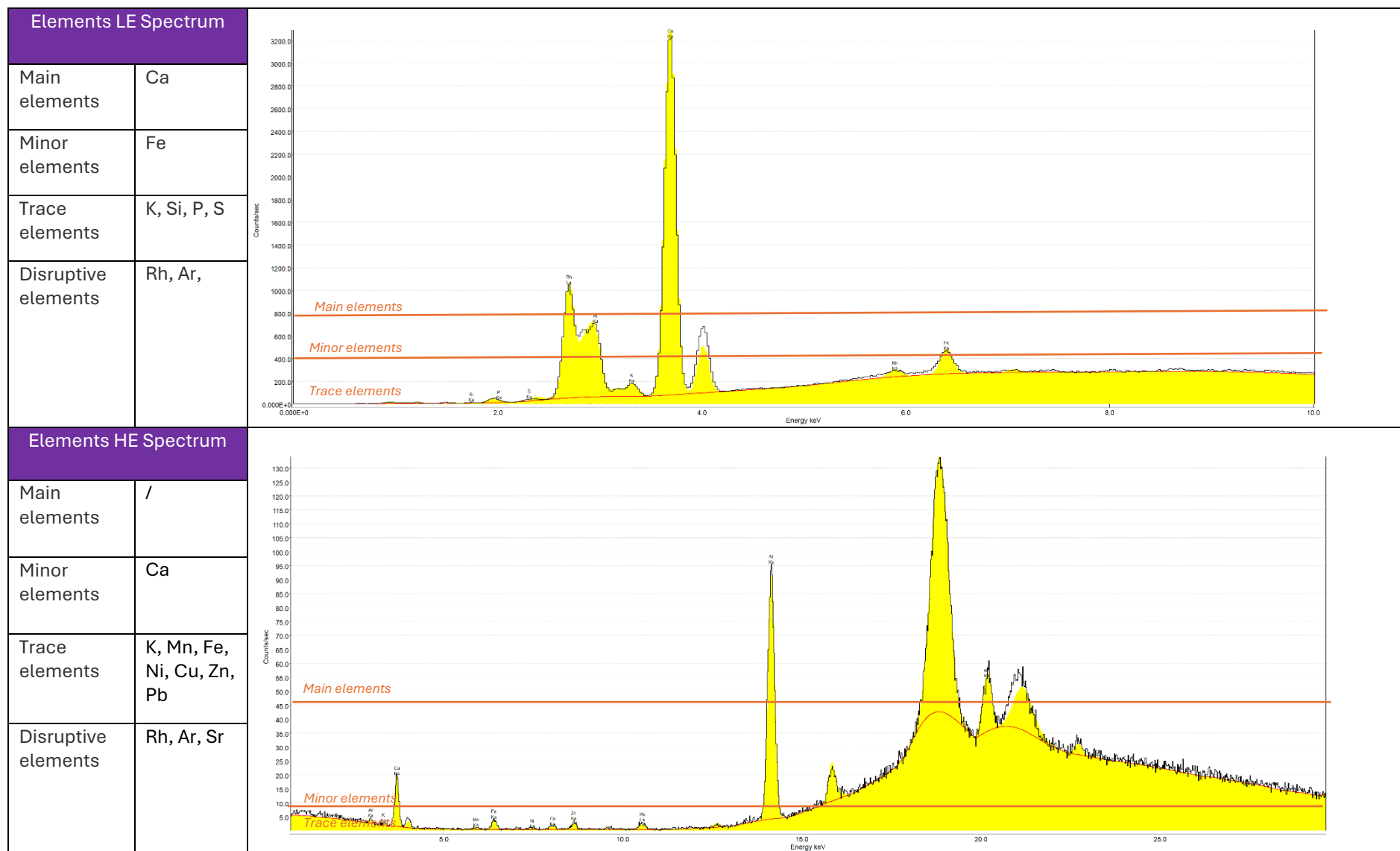


Table 2: pXRF measurements ID.76_5

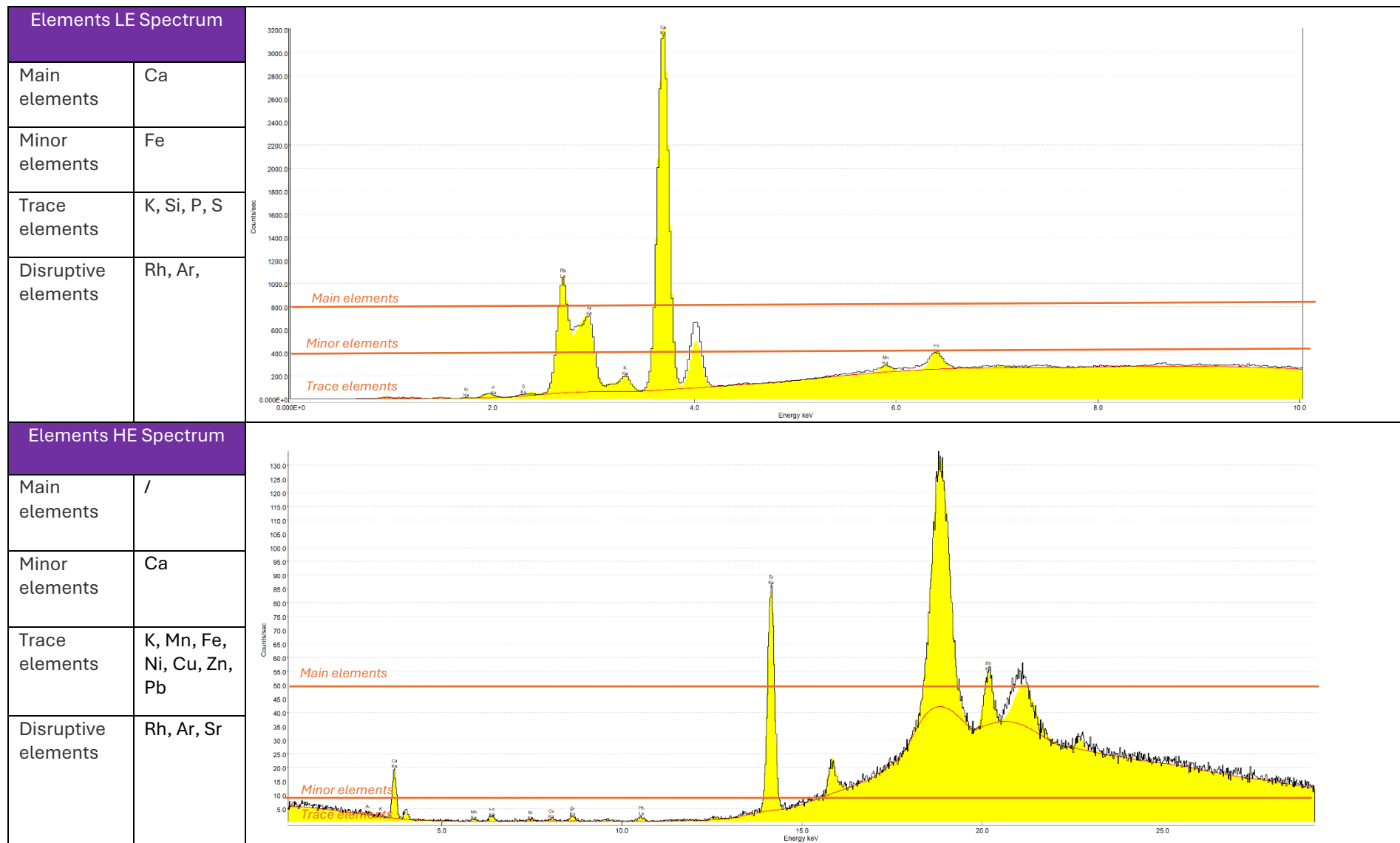


Table 3: pXRF measurements ID.76_6

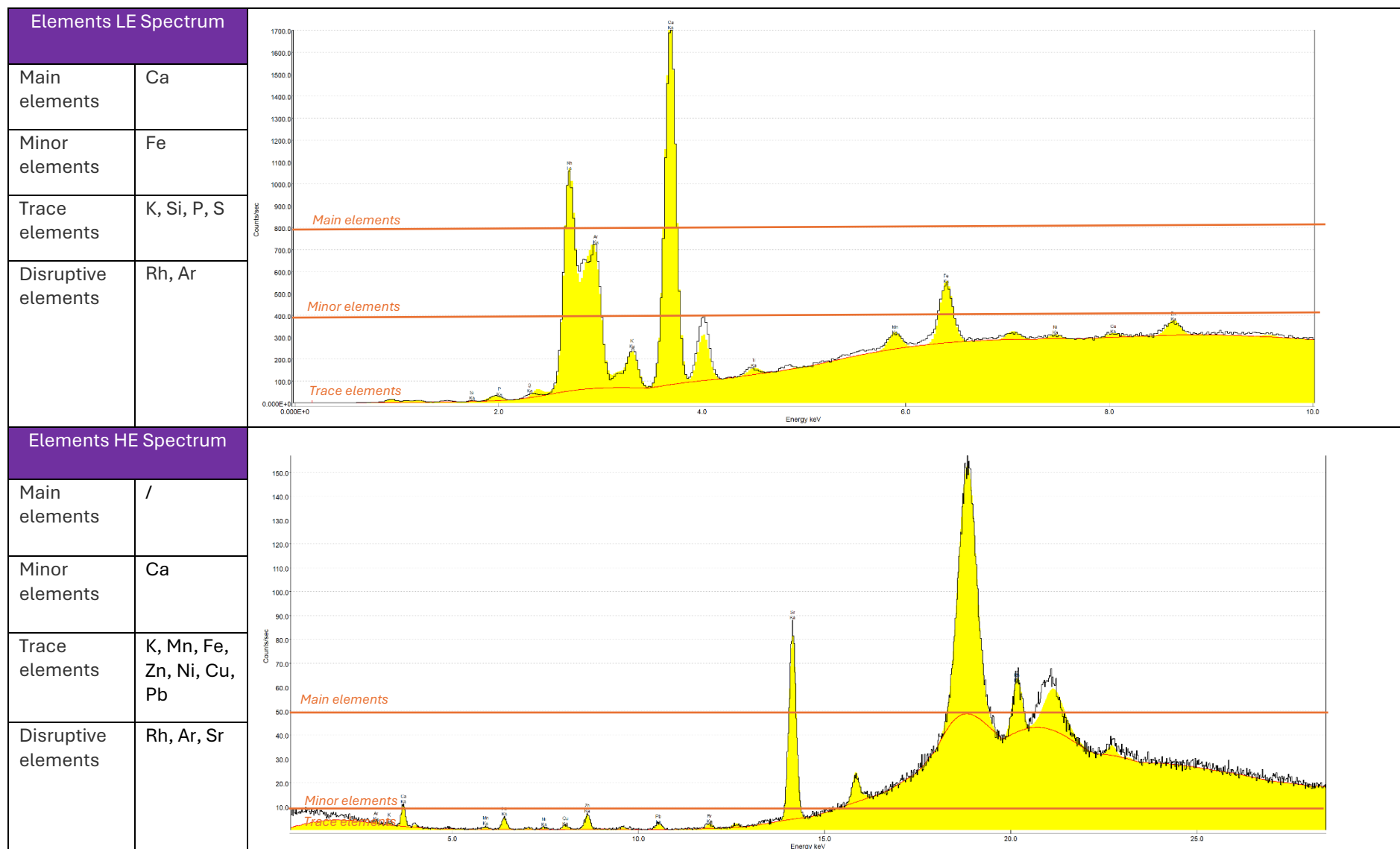


Table 4: pXRF measurements ID.76_8

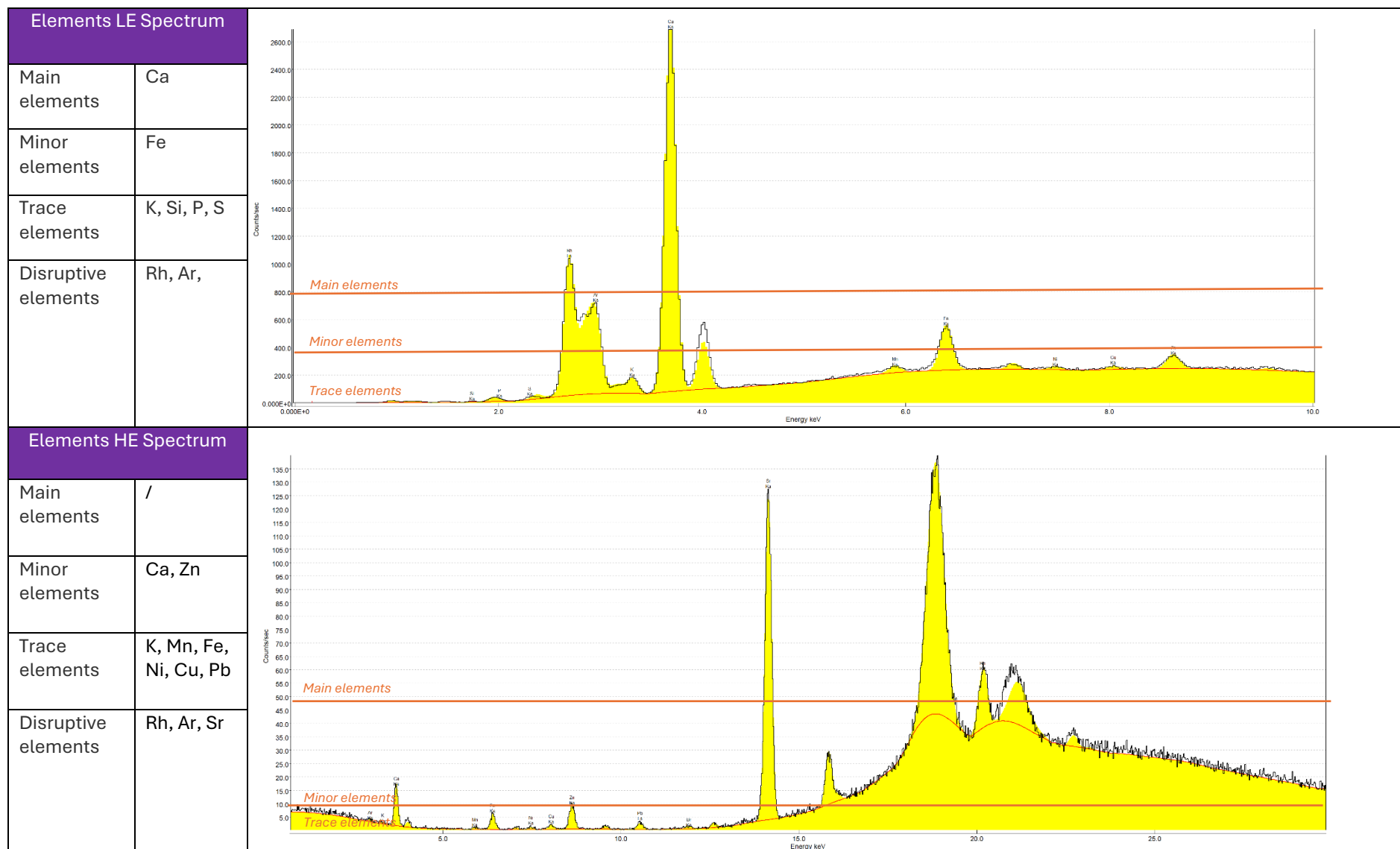


Table 5: pXRF measurements ID.76_9

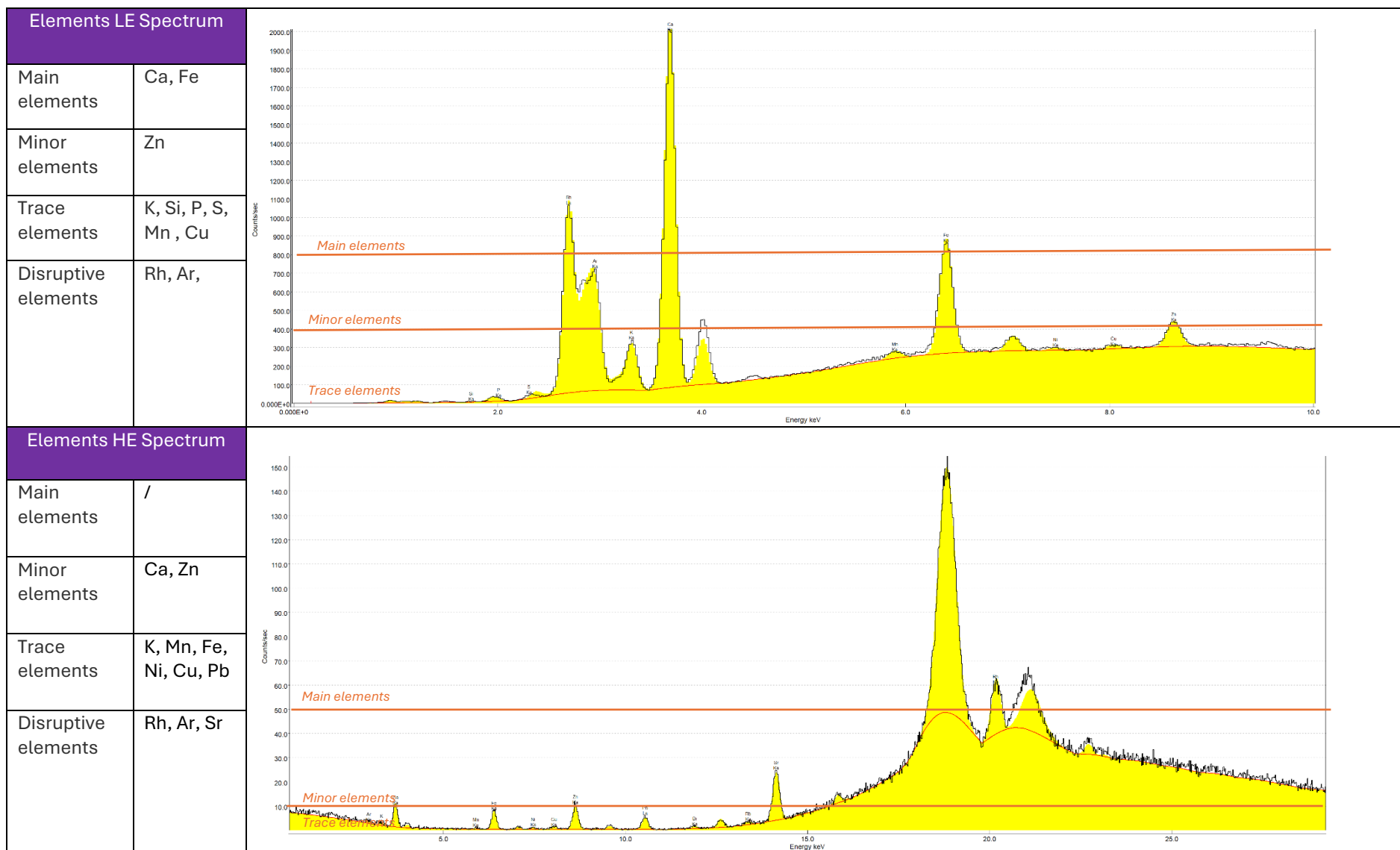


Table 6: pXRF measurements ID.76_11

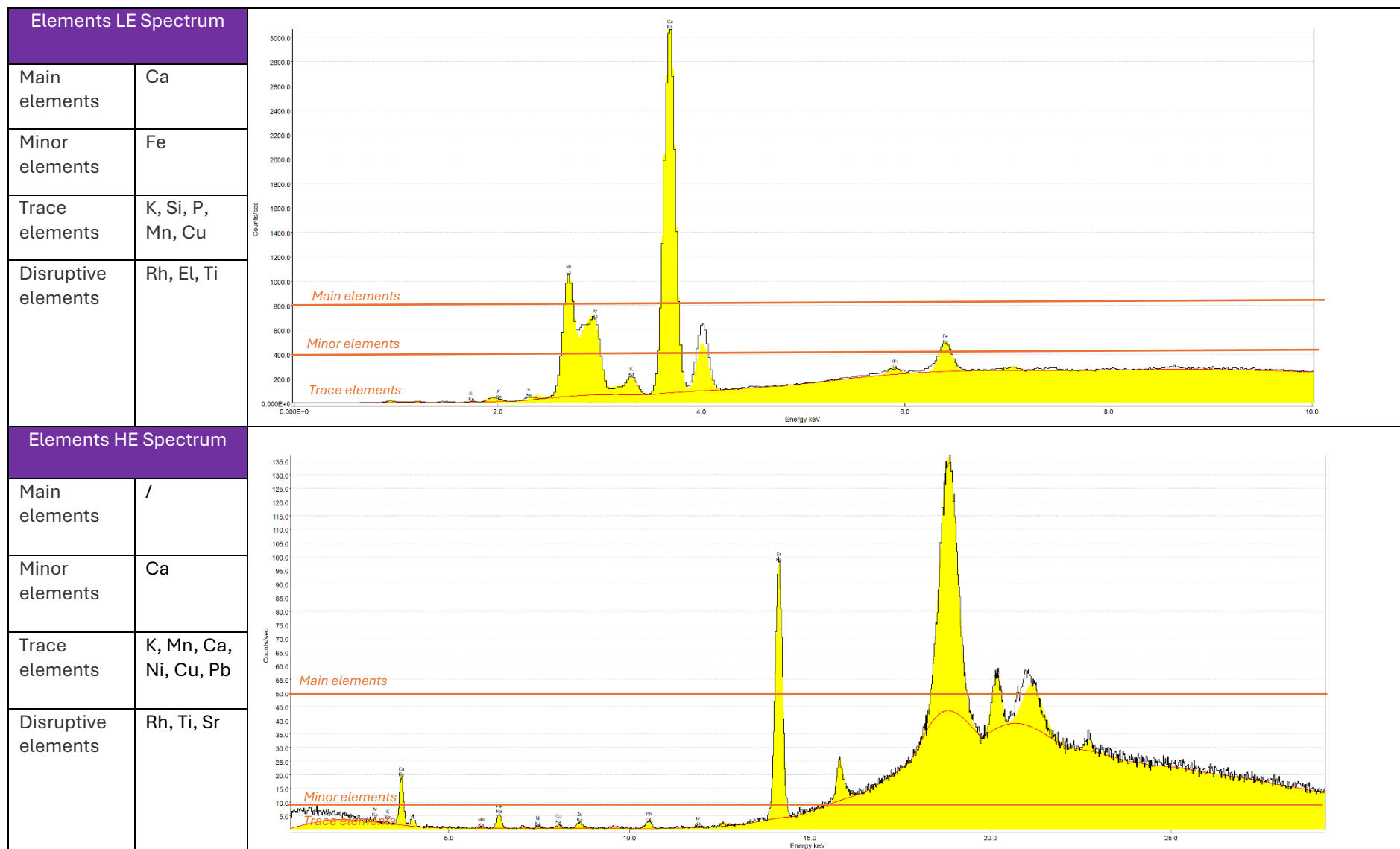
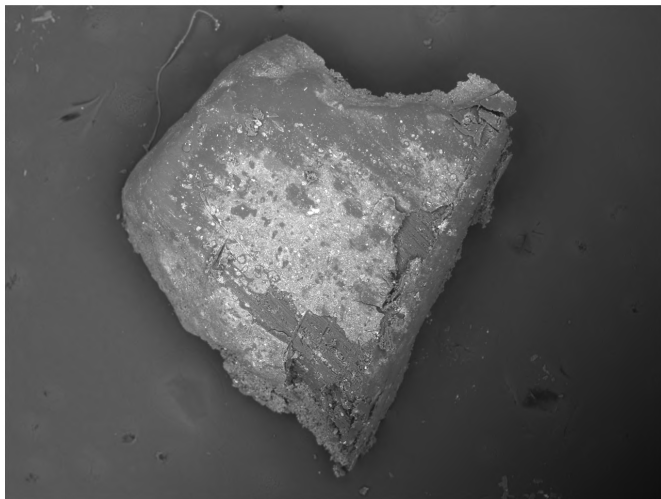


Table 7: pXRF measurements ID.76_12

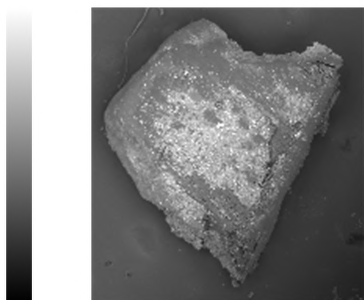
Sem_BED-C_002



500 μm

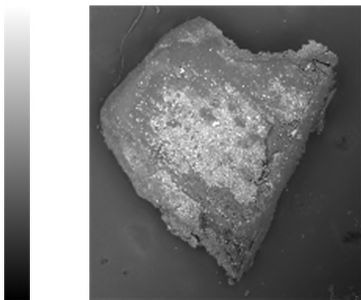
Signal BED-C
Landing Voltage 20.0 kV
WD 11.1 mm
Magnification x45
FOV 2.844 x 2.133 mm
Probe Current number Std. 63.0
Scan Rotation 0.0°
Vacuum Mode LowVacuum
Pressure 30 Pa

IMG1(1st)



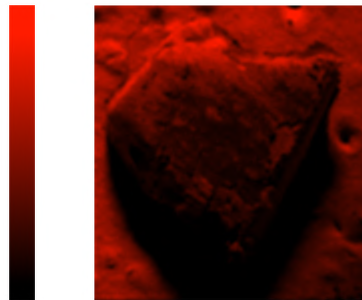
500μm

IMG1



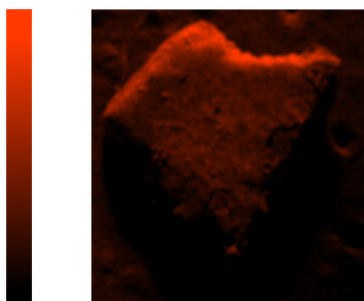
500μm

C-K



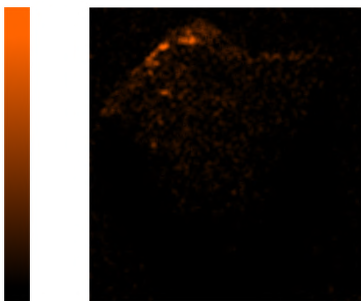
500μm

O-K



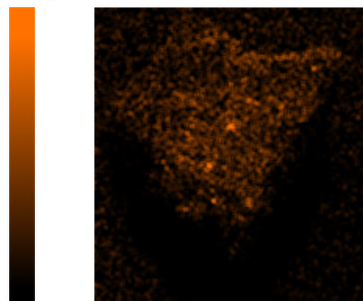
500μm

Na-K

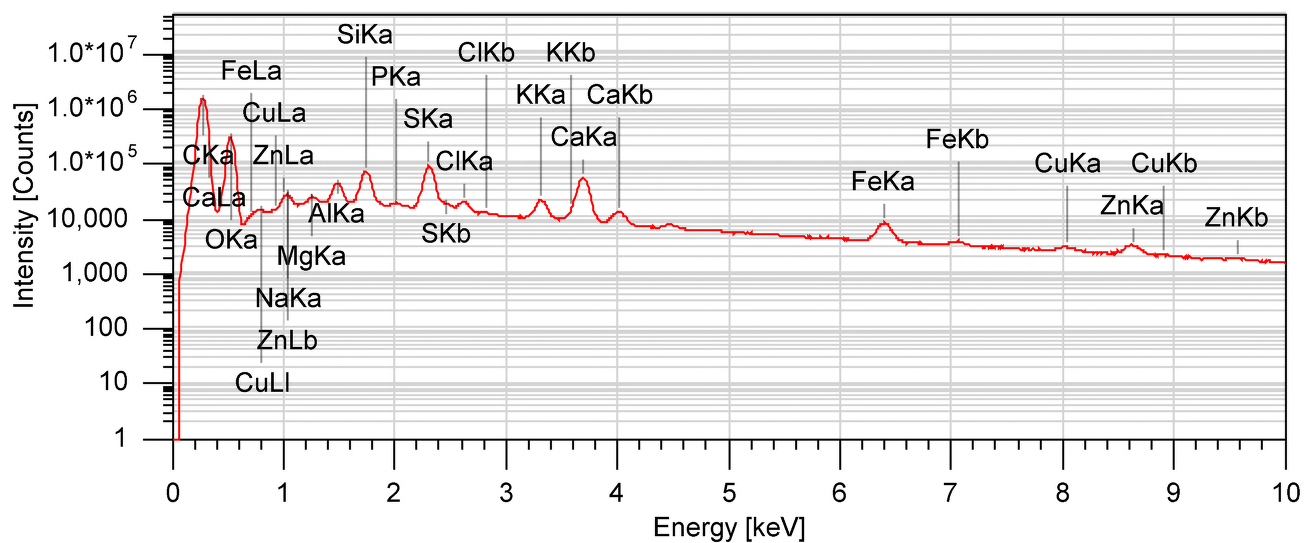


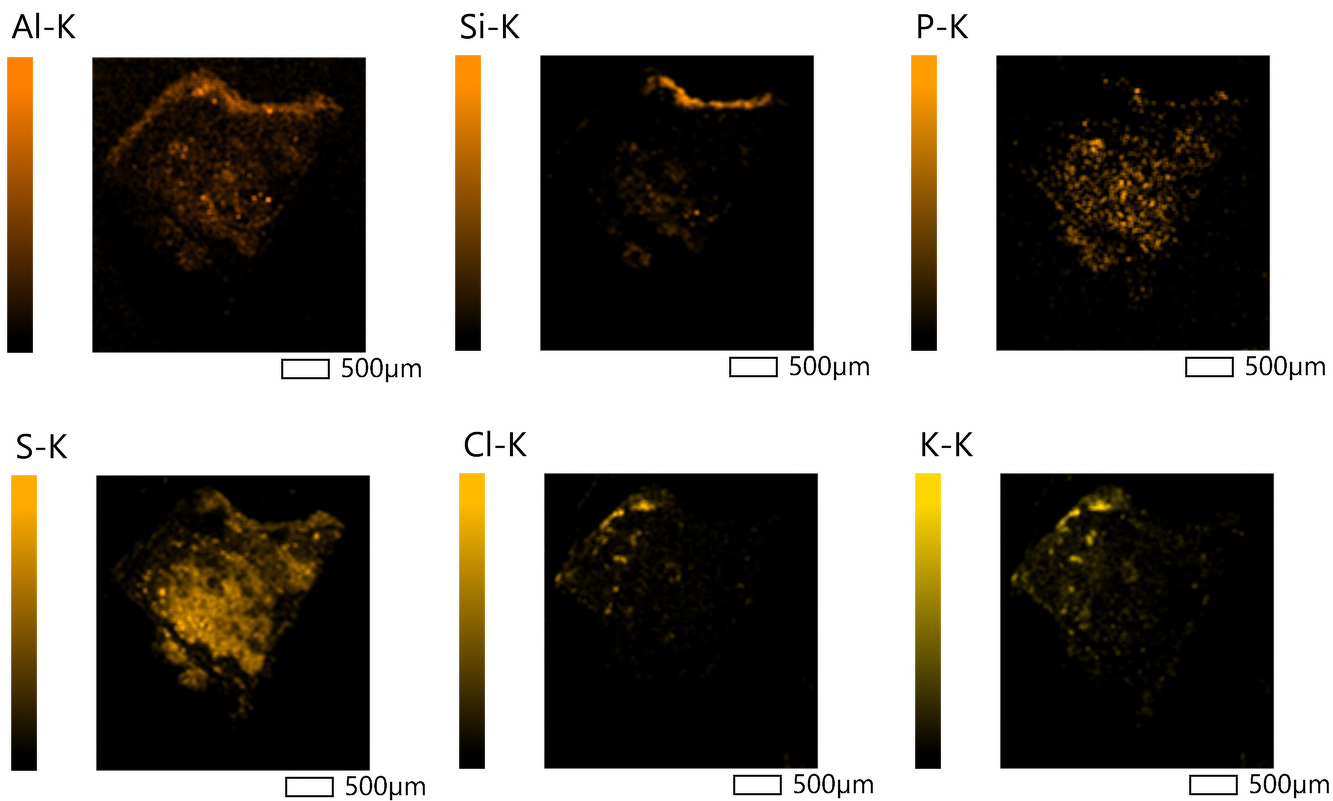
500μm

Mg-K

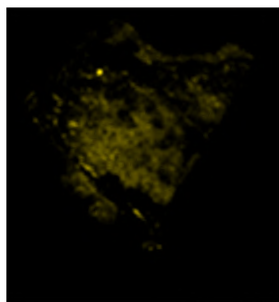


500μm



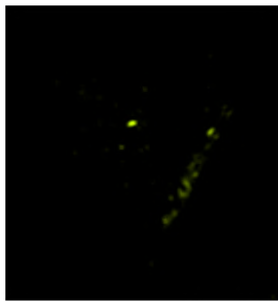


Ca-K



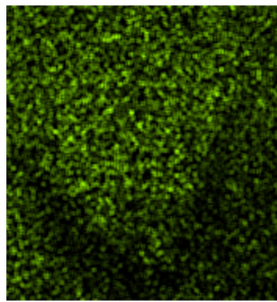
500μm

Fe-K



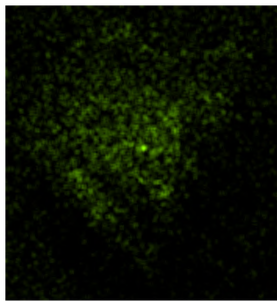
500μm

Cu-K



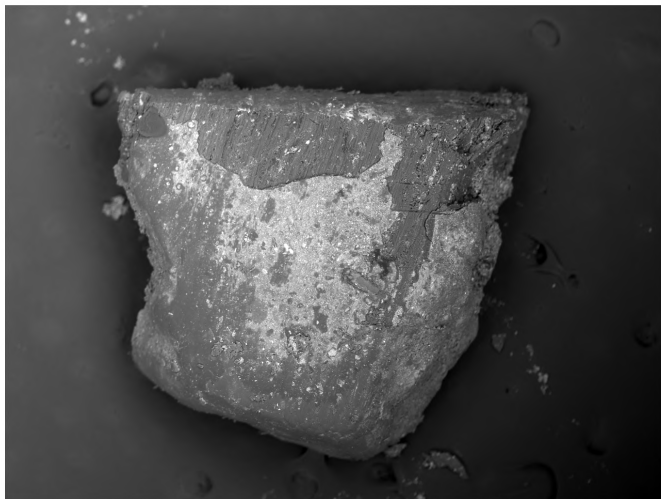
500μm

Zn-K



500μm

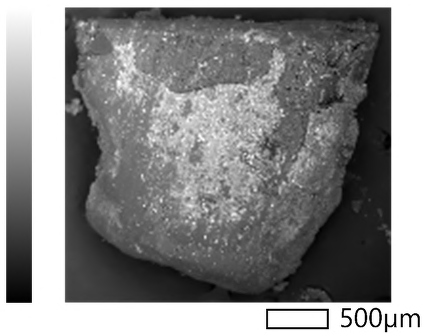
Sem_BED-C_006



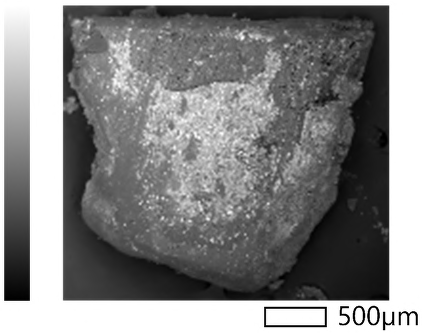
500 μm

Signal BED-C
Landing Voltage 15.0 kV
WD 11.2 mm
Magnification x50
FOV 2.560 x 1.920 mm
Probe Current number Std. 60.0
Scan Rotation 0.0°
Vacuum Mode LowVacuum
Pressure 30 Pa

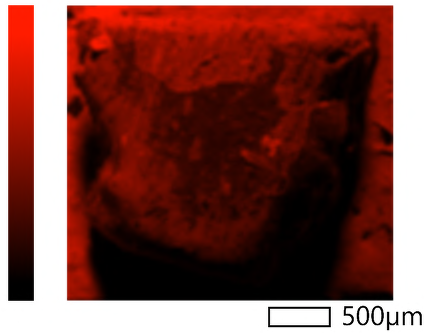
IMG1(1st)



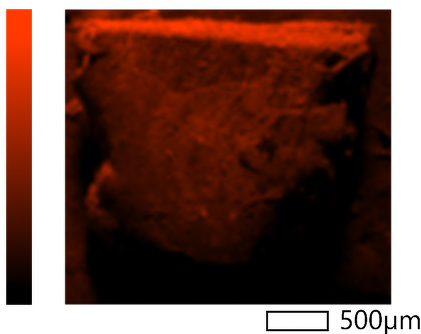
IMG1



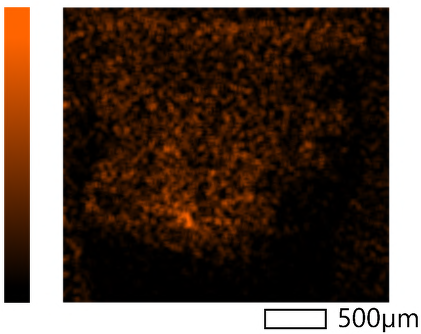
C-K



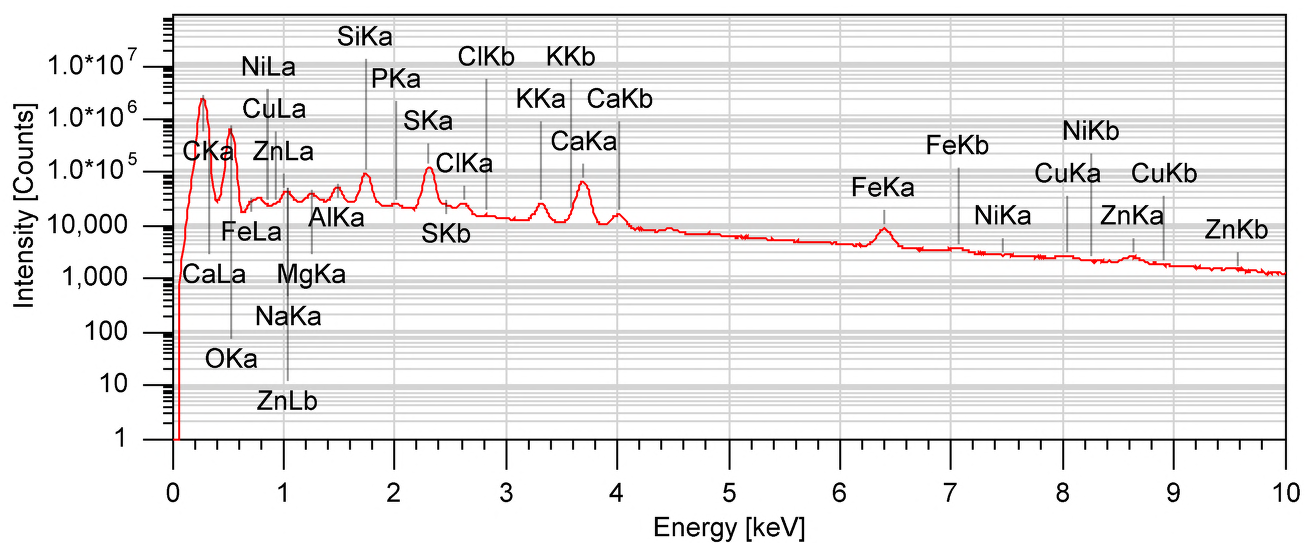
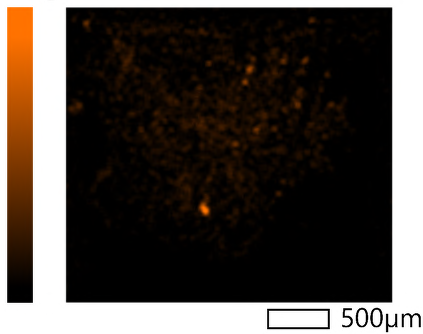
O-K

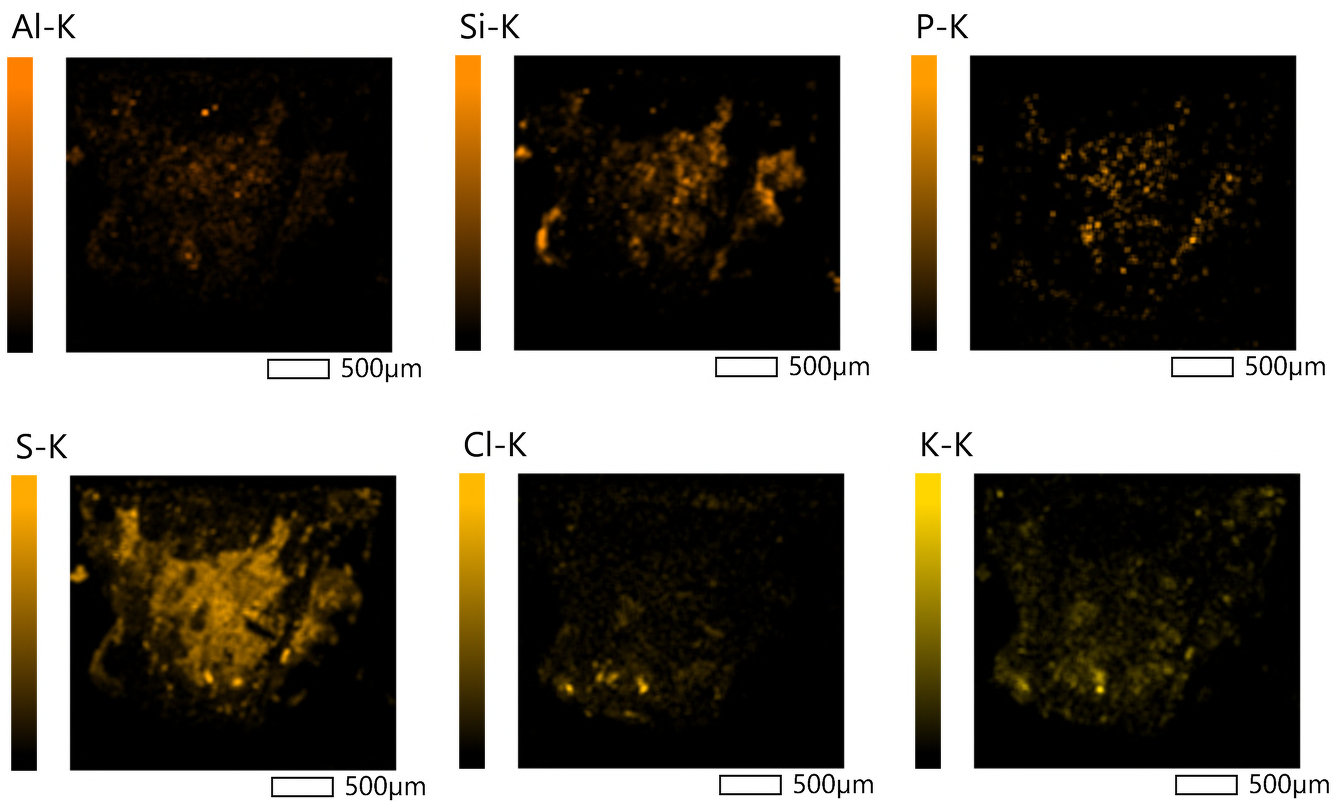


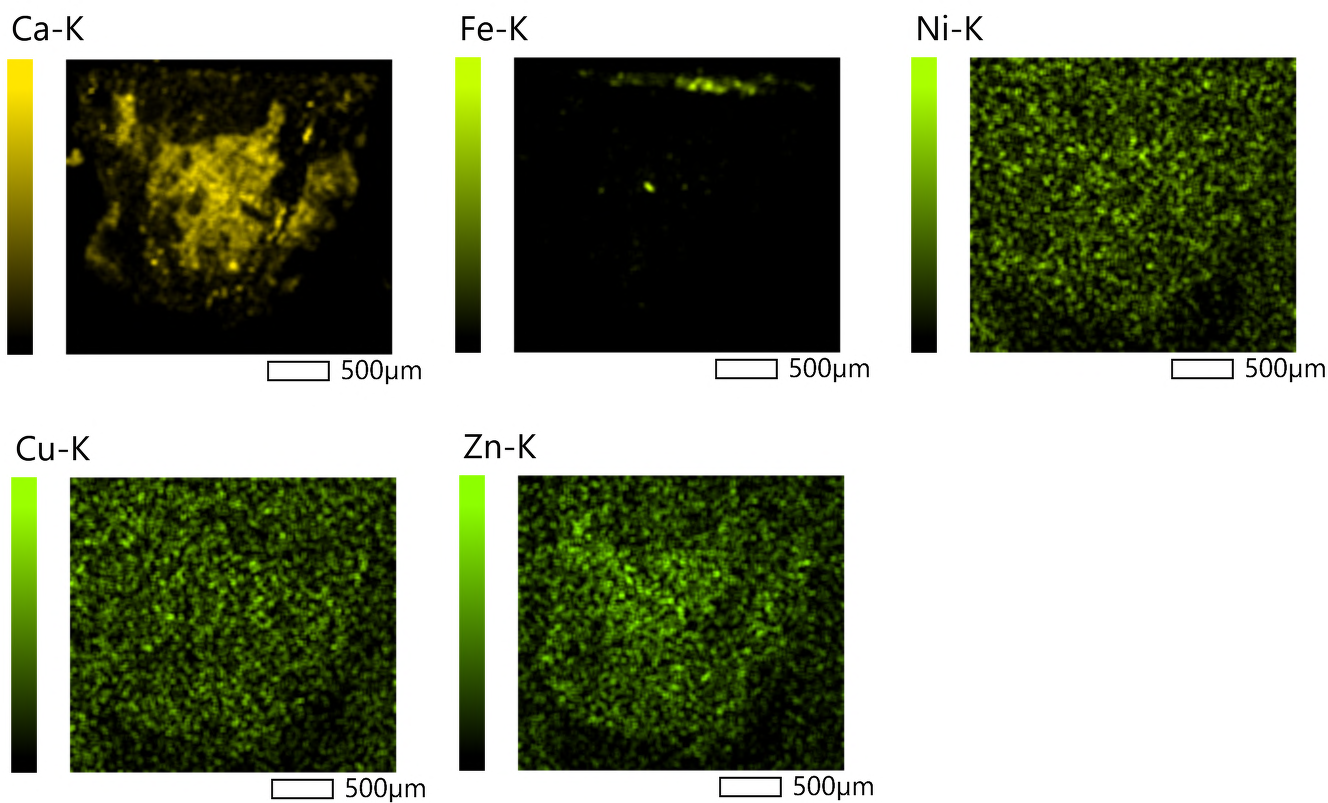
Na-K



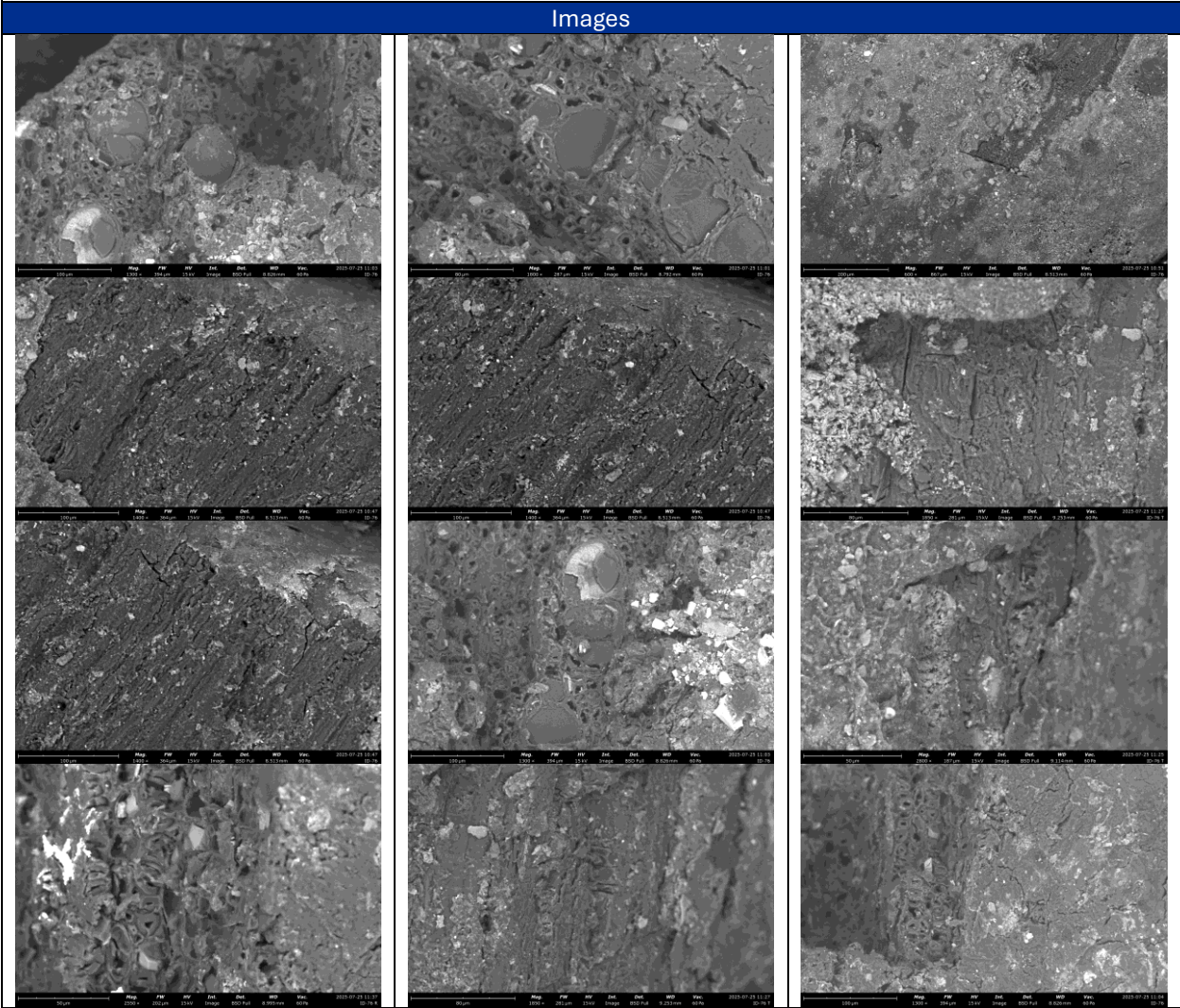
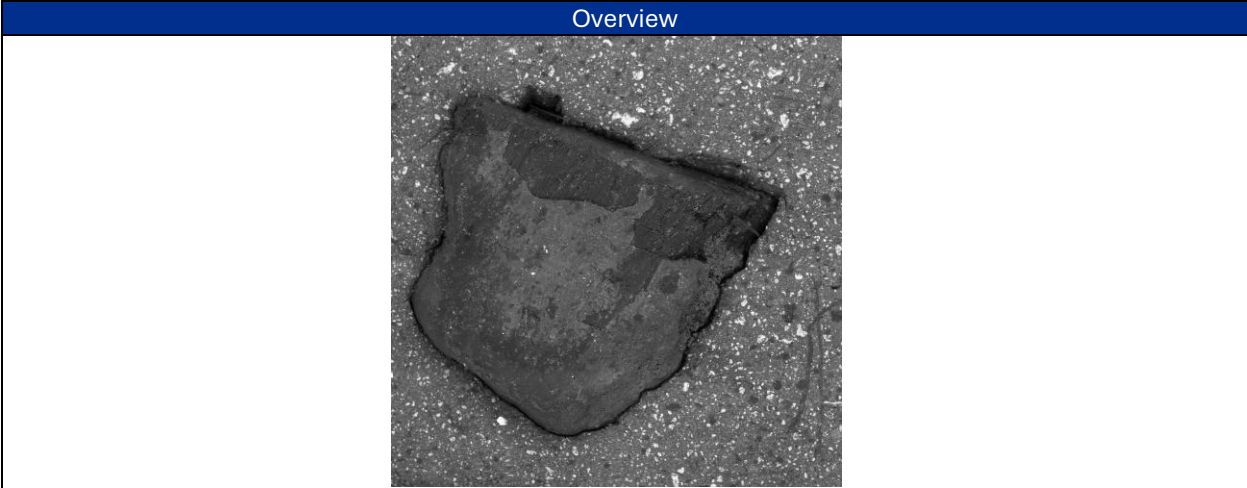
Mg-K

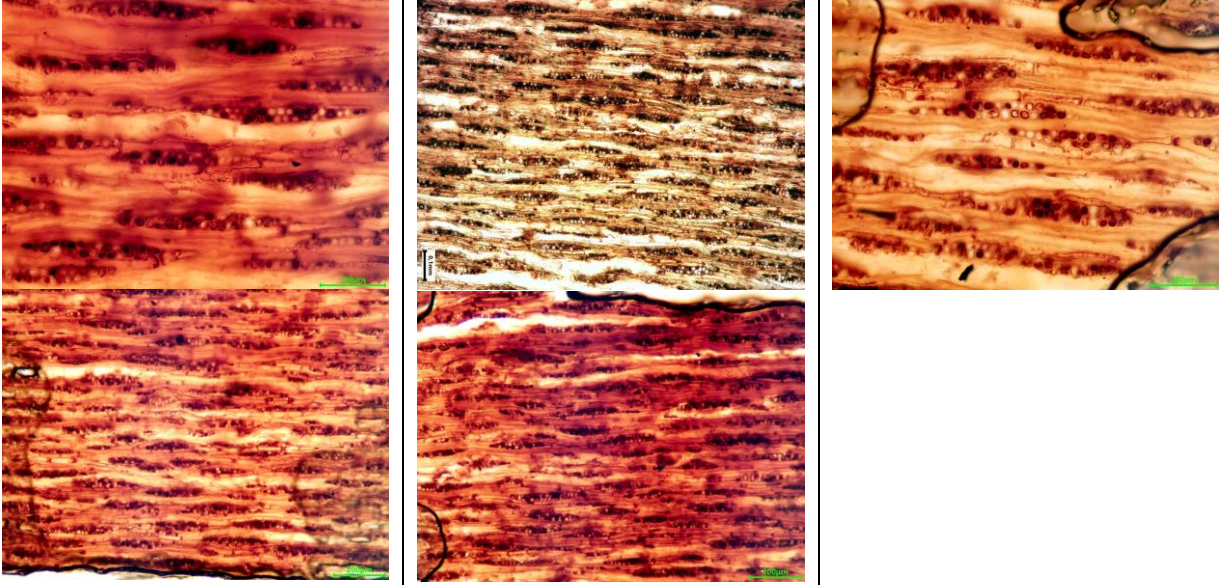






SEM images sample 2	
Location	Woodlab Africamuseum
Datum van measurement	25/07/2025
Supervisor	Blanca Van Houtte Alonso and Michael Monnoye
SEM executor	Flynn Hermesen
Comments	/

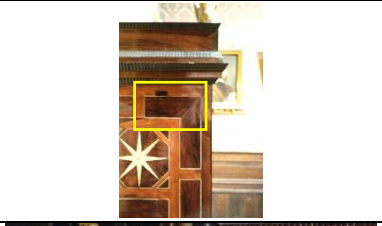
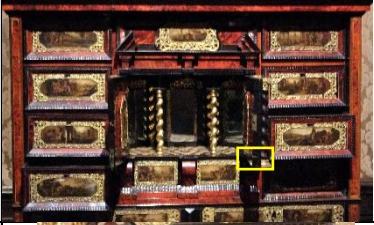
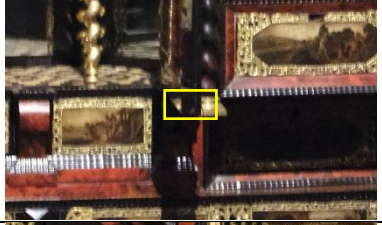
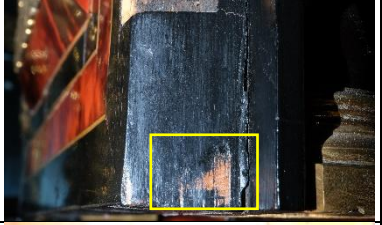
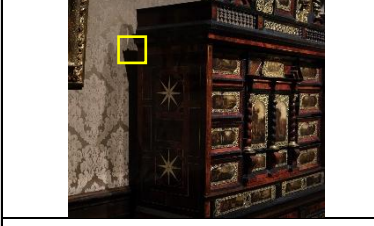


Coupe image sample 1	
Location	Woodlab Africamuseum and university of Antwerp
Datum van measurement	01/04/2025 and 25/07/2025
Supervisor	/
Executor	Flynn Hermesen
Comments	/
Overview	
	
Images	
	



Algemene informatie

Object type	Group 8	Collection type	Public		
Owner	Plantin-moretus				
Curator	Vera Nys				
Contact	/	vera.nys@antwerpen.be			
Url website	https://search.museumplantinmoretus.be/Details/collect/149314 https://balat.kikirpa.be/photo.php?path=B016531&objnr=11013425&nr=29				
Item number	MPM.V.II.01.002	Date	1659-1699		
HOME-AGE cabinet database number	ID.92	Production place	Antwerp		
Cabinet dimensions	Height	depth	Width		
		54 cm	150 cm		
Molding dimensions	7,64 mm	10,59 mm	/		
Thickness of veneer	1,12				
Suspicion of restorations of veneer or profile mouldings	Yes, unclear if restorations are done in ebony..				
Additional archive material?	Yes, see file at KIK-IRPA				
Existing finishing materials					
Blackened wood	Ebony	Other types of wood	Bone	Embroidery	Painting
X?	X?	X	X		X
Turtle shell	Ivory	Metal	Paper	Varnish	Other
X		X		X	Marble
Finishing techniques available					
Molding	Rippled molding	Maker's mark	Other marks		
	X				

Evidence of blackened timber at other locations			
Fineer			
			
Lijsten			
			

Sample information	
Location during sampling	Depot Luchtbal
Date of sampling	18/06/2025
Supervisor	Martijn Breunesse
Method of sampling	Chisel
Comments	Succesfull

Sample location	
	
Before sampling	After sampling



pXRF information	
Location during measurments	Cabinet was analyzed Plantin-Moretus museum
Datum van measurement	03/03/2025
Supervisor	Vera De Boeck
pXRF executor	Lowie Vercruysse
Comments	/
pXRF locations	



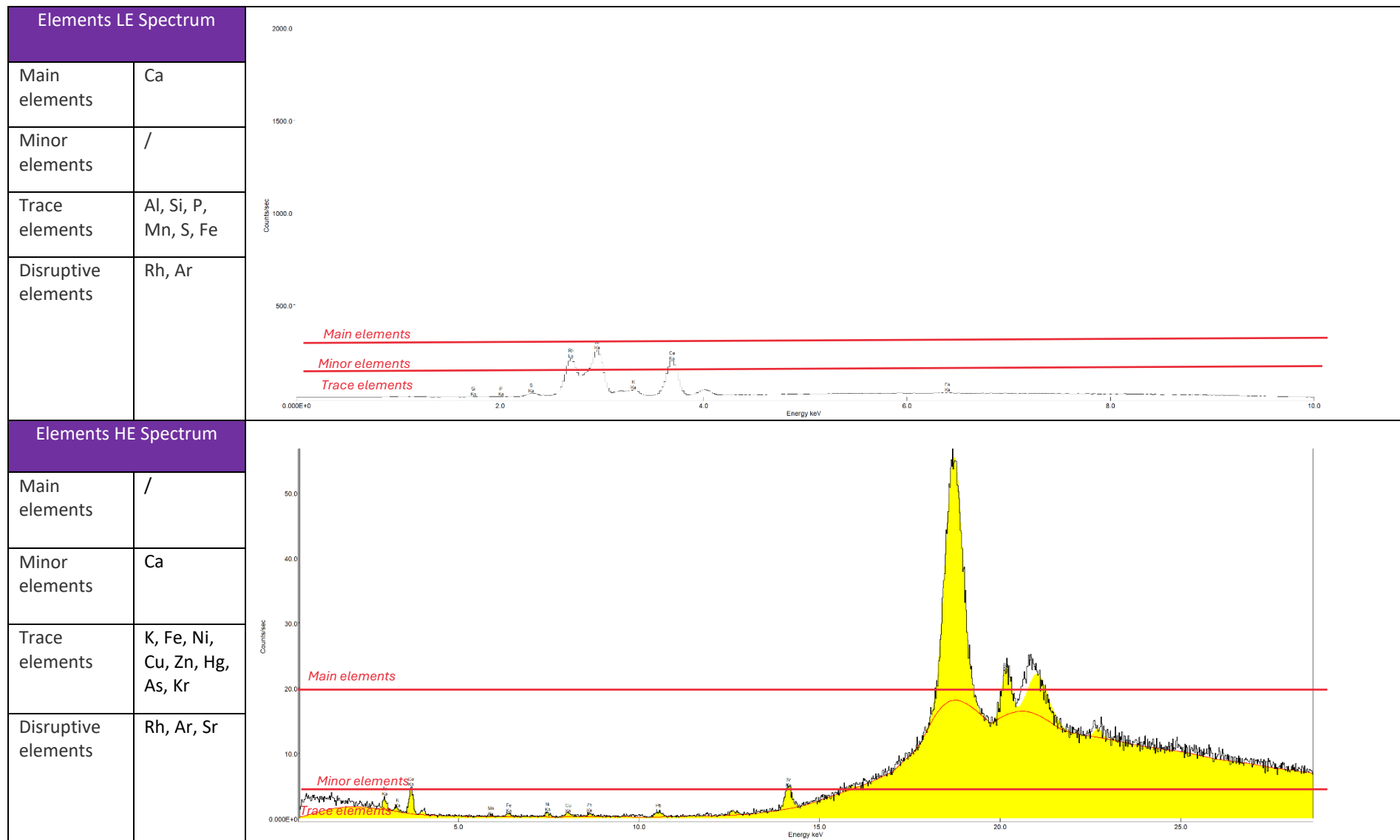


Table 1: pXRF measurements ID.92_1

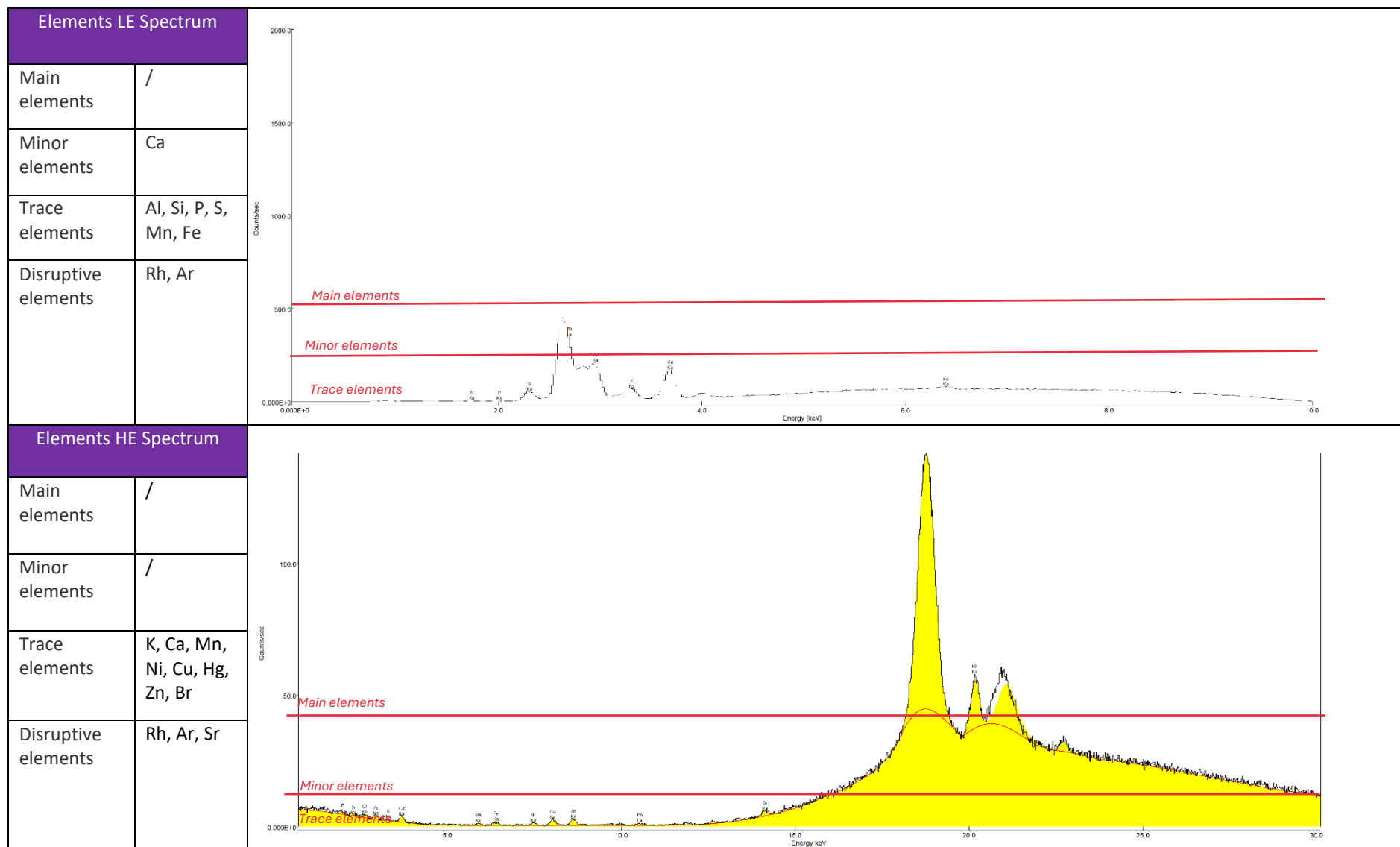


Table 2: pXRF measurements ID.92_2

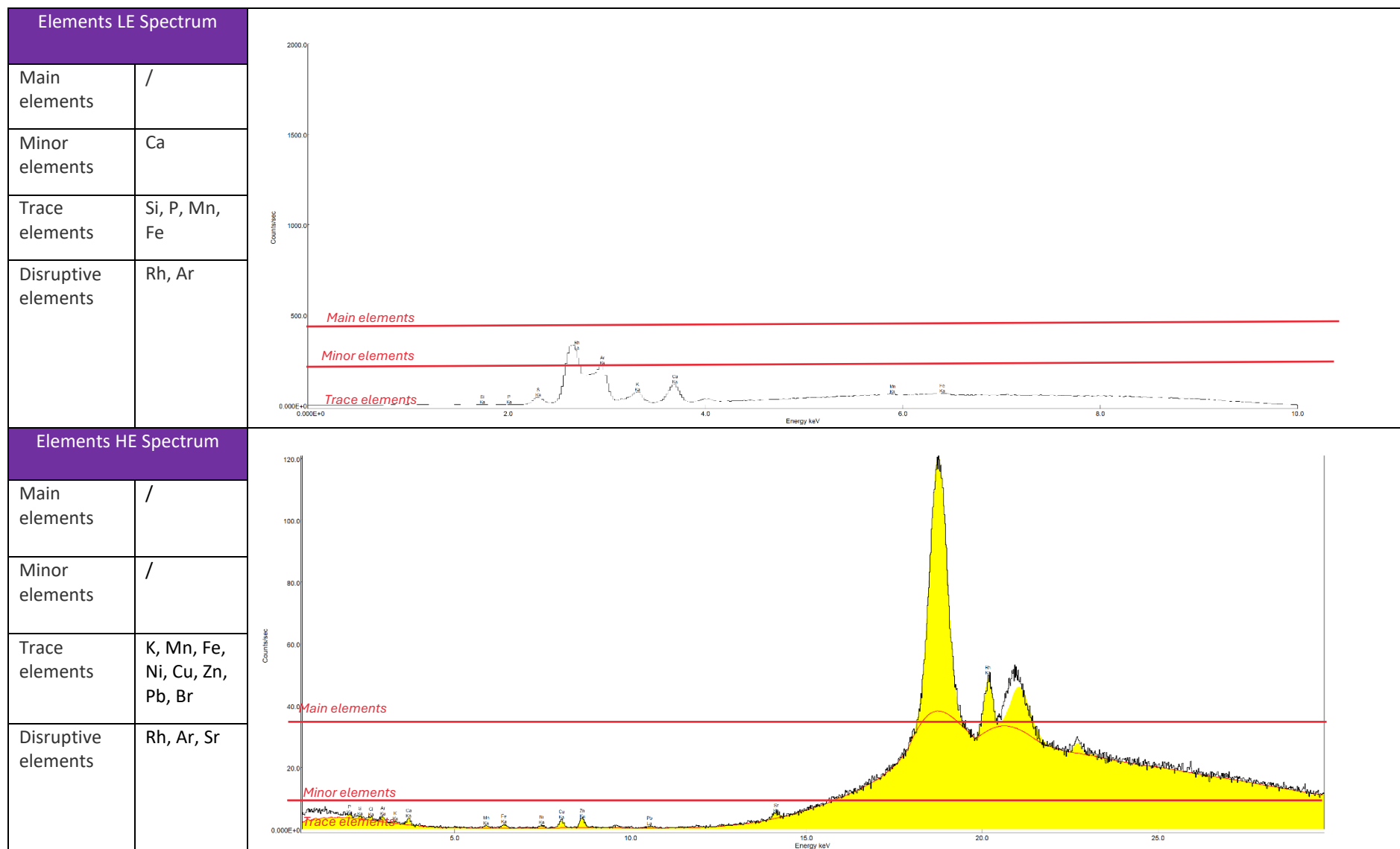


Table 3: pXRF measurements ID.92_3

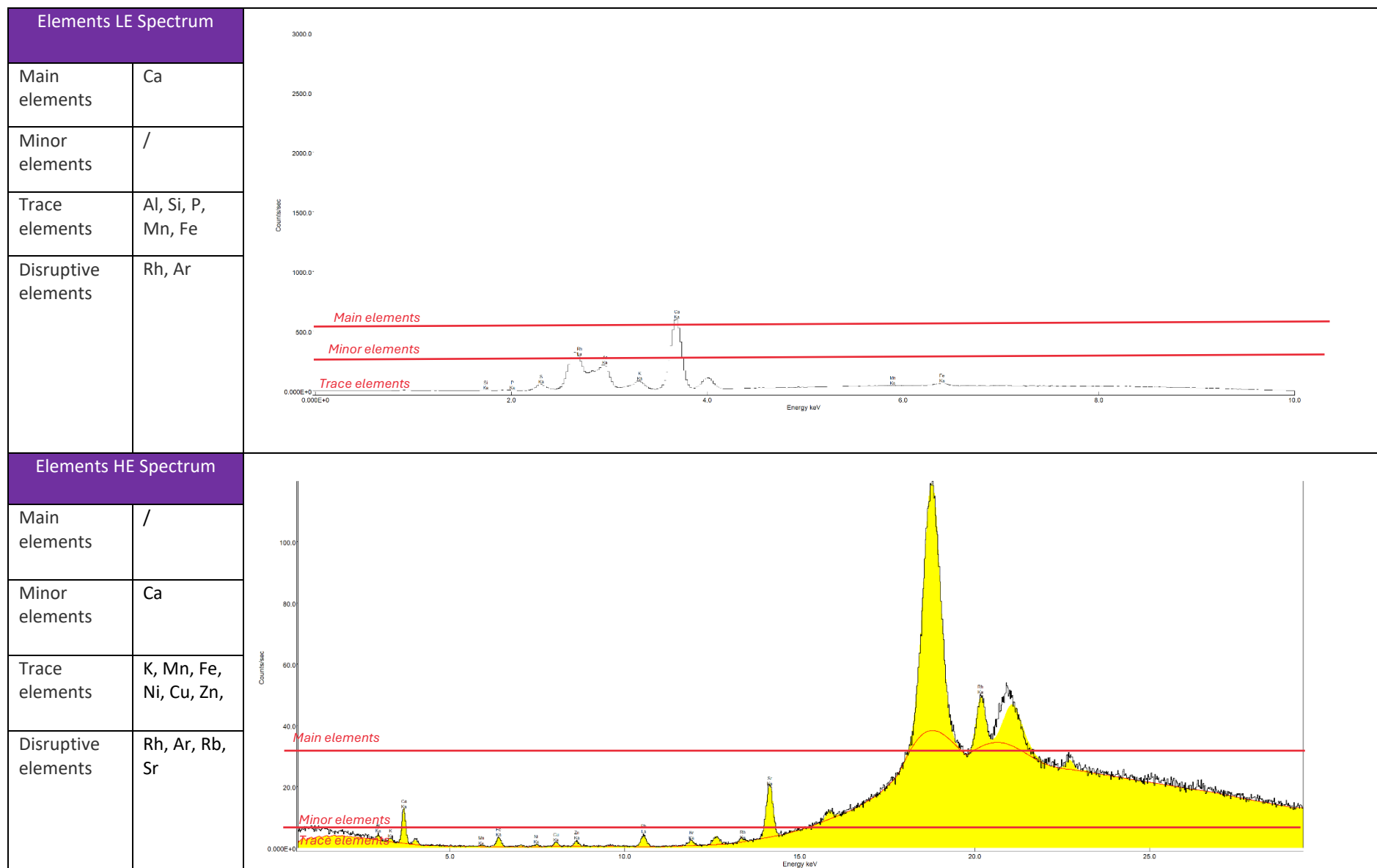


Table 4: pXRF measurements ID.92_4

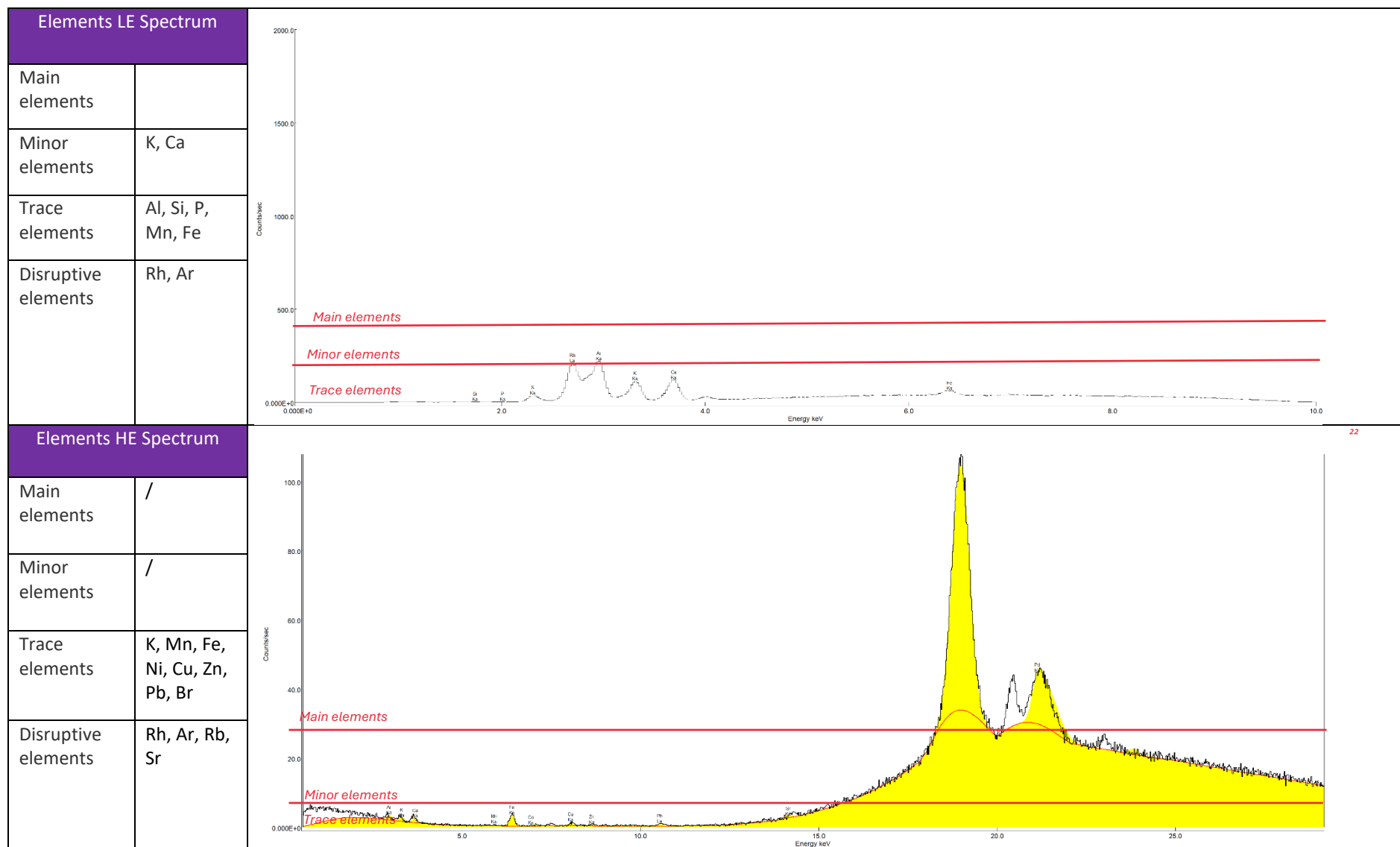


Table 5: pXRF measurements ID.92_5

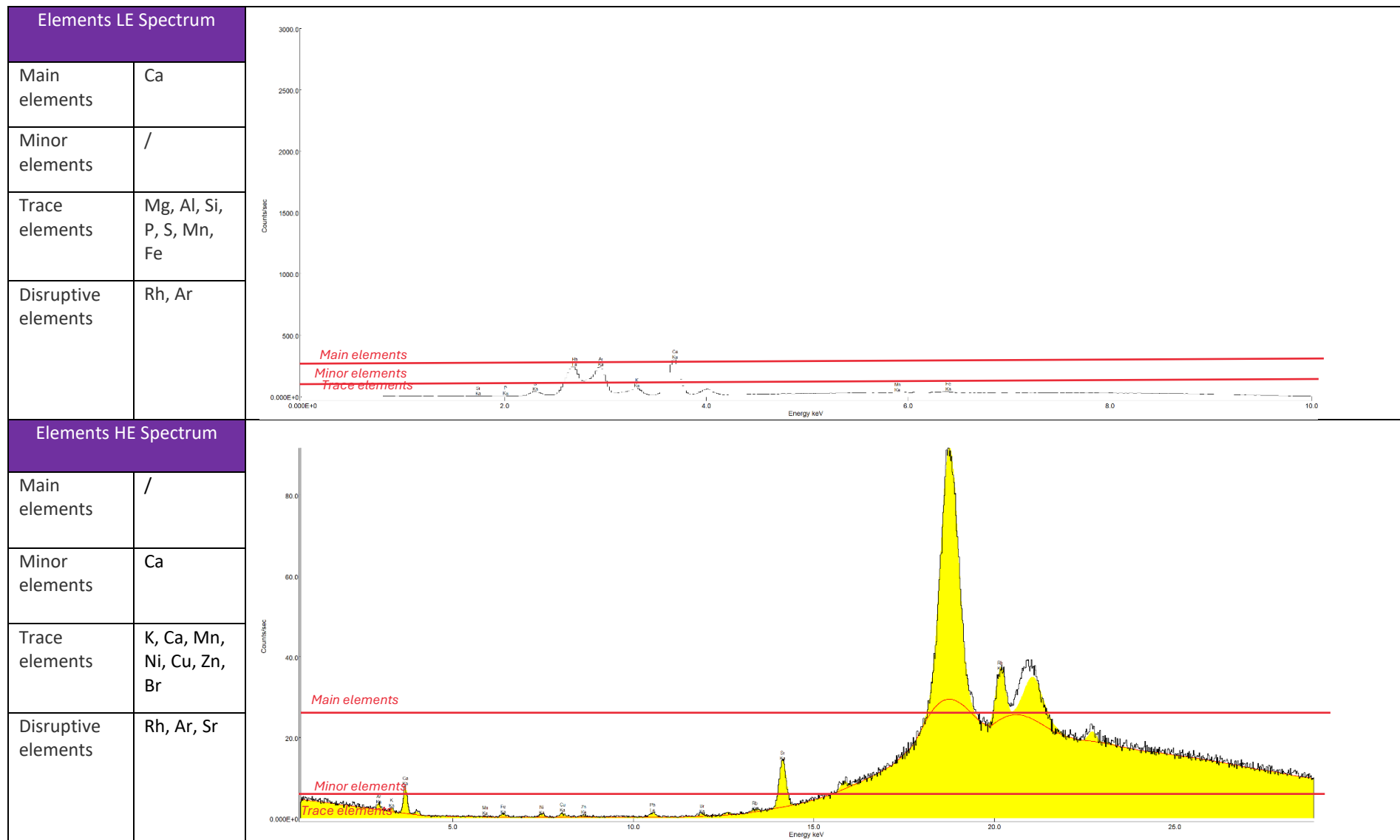
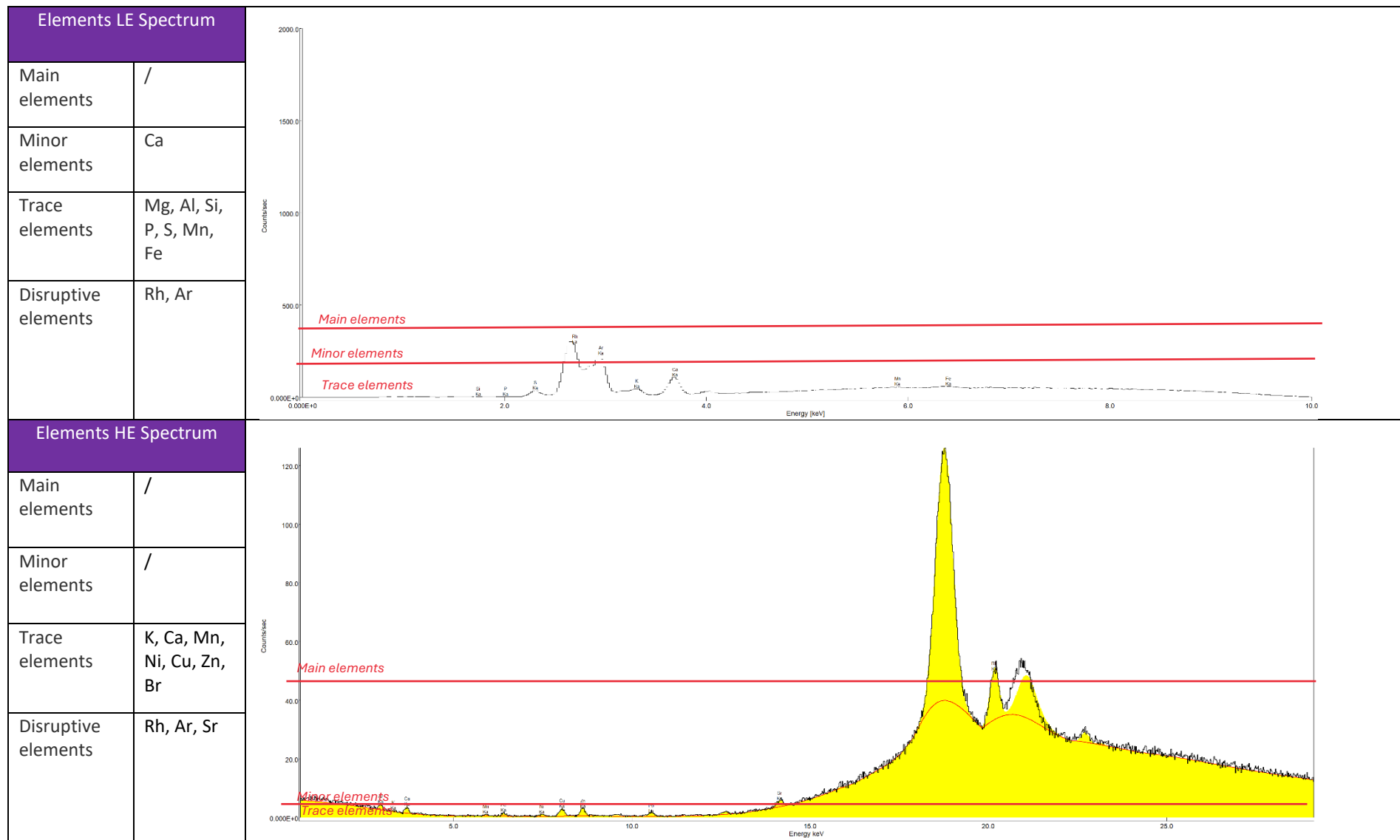
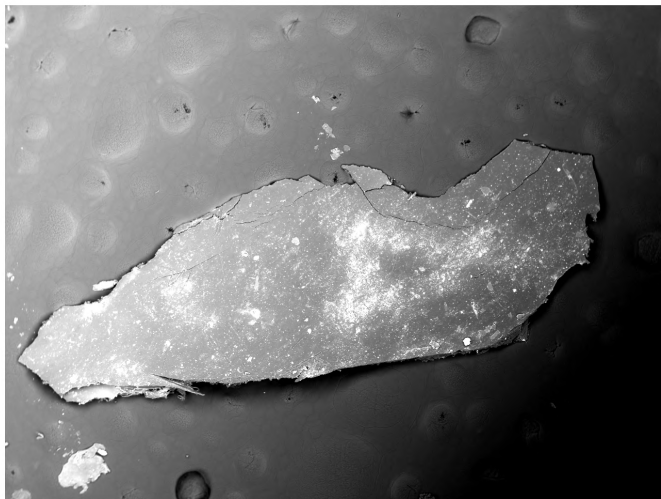


Table 6: pXRF measurements ID.92_6



Tabel 7: pXRF measurements ID.92_7

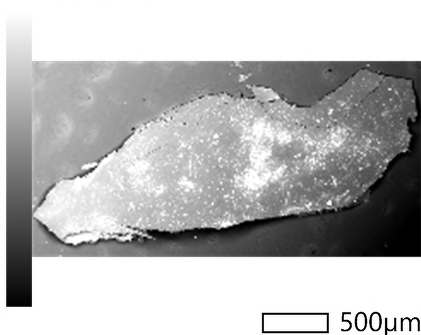
Sem_BED-C_001



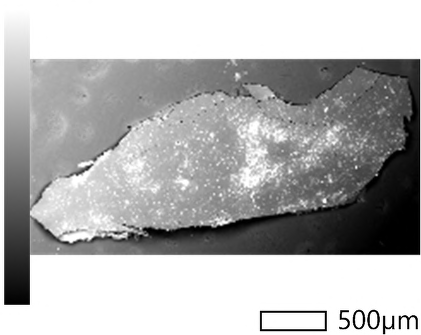
500 μm

Signal BED-C
Landing Voltage 15.0 kV
WD 11.7 mm
Magnification x43
FOV 2.977 x 2.233 mm
Probe Current number Std. 60.0
Scan Rotation 0.0°
Vacuum Mode LowVacuum
Pressure 30 Pa

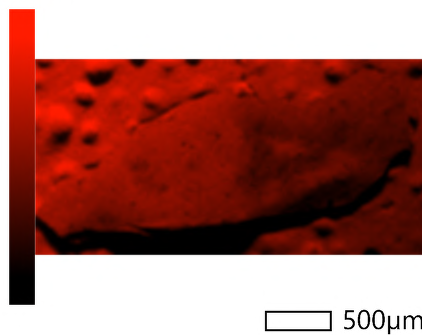
IMG1(1st)



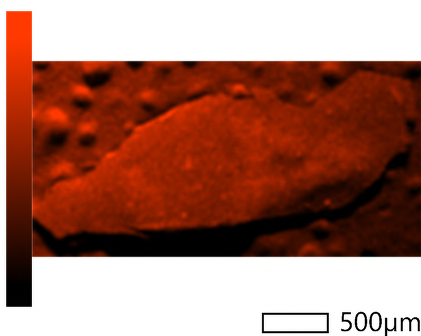
IMG1



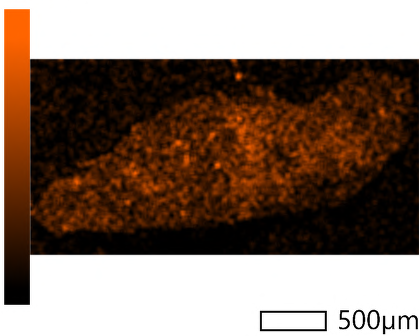
C-K



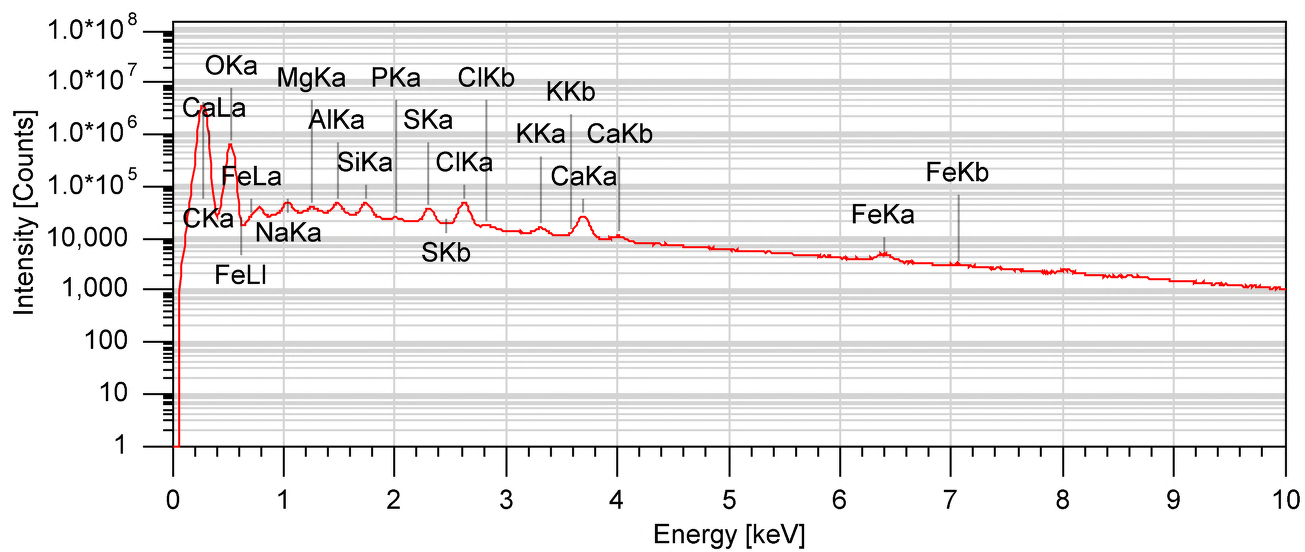
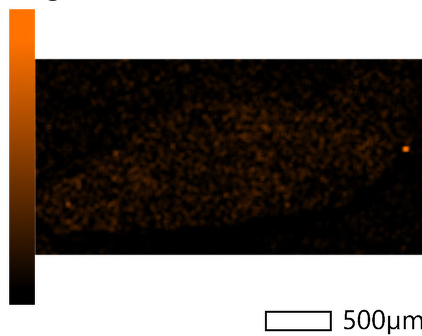
O-K

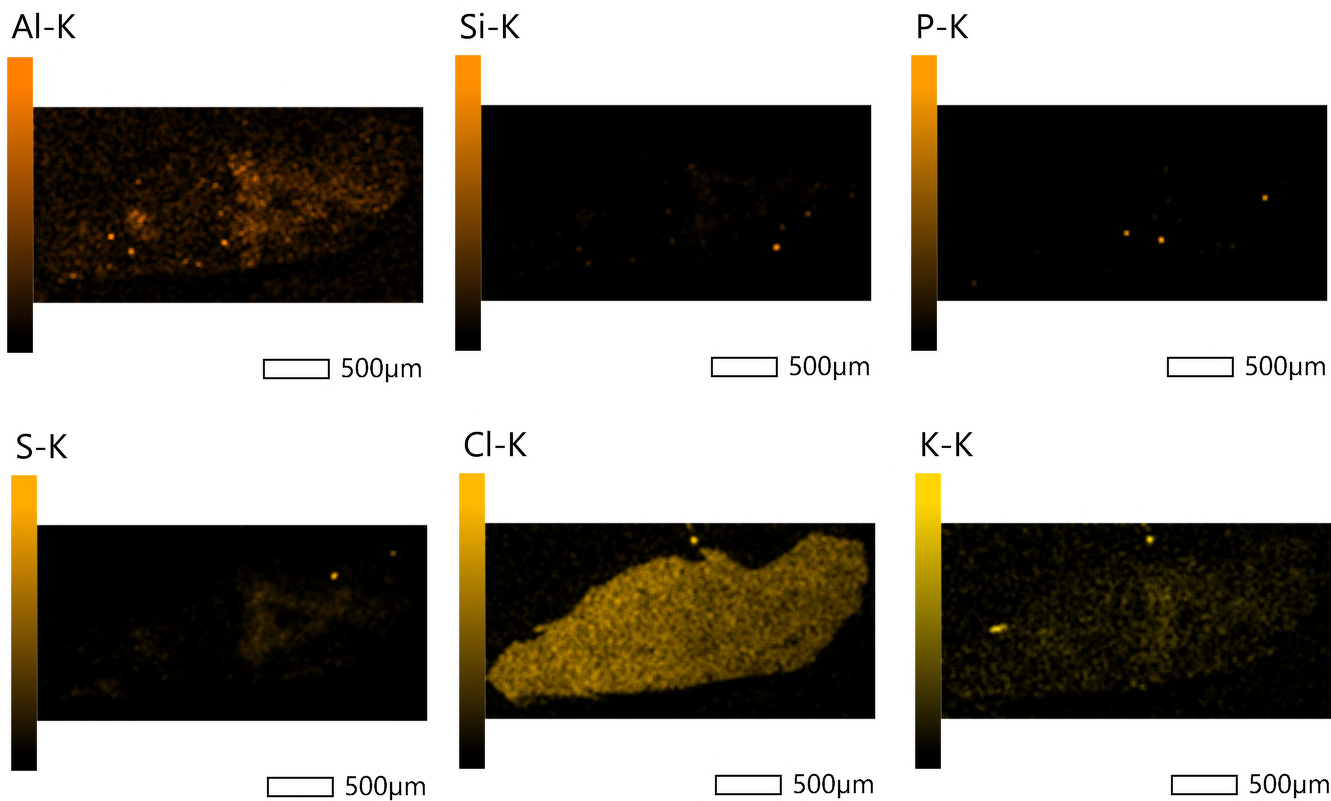


Na-K

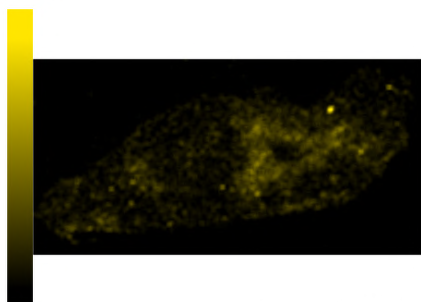


Mg-K



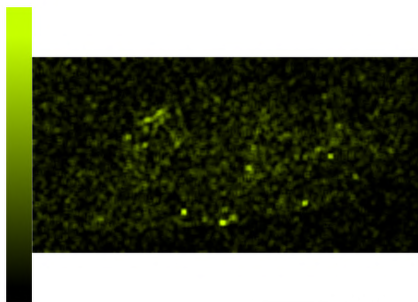


Ca-K

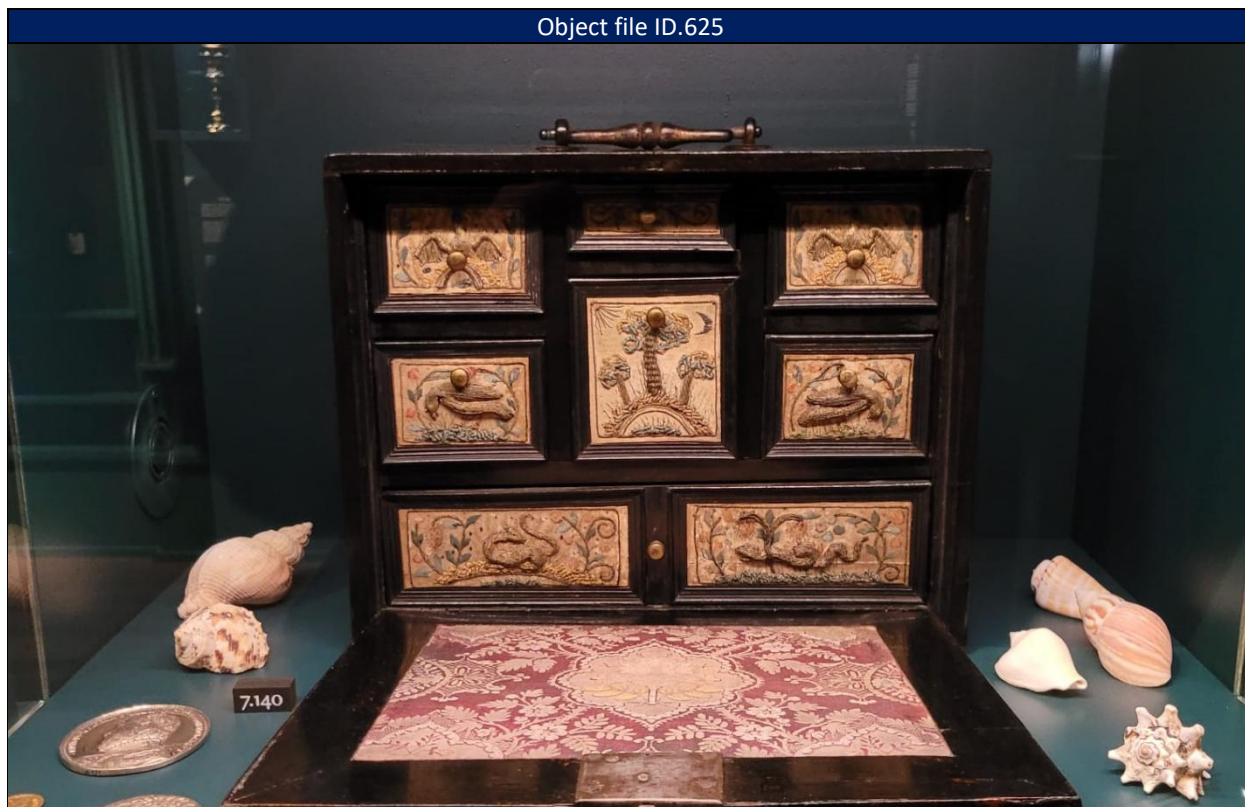


500µm

Fe-K



500µm



General information

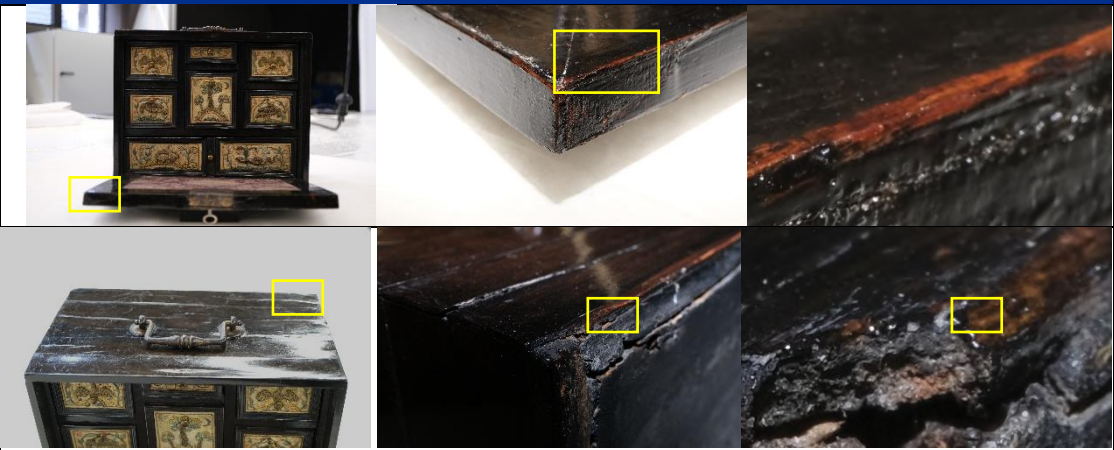
General information			
Object type	Table cabinet (group 3)	Collection type	Public
Owner	DIVA Antwerp		
Curator	Kristina Valiulis		
Contact	Kristina.VALIULIS@divaantwerp.be	collectie@divaantwerp.be	
Url: website	https://www.divaantwerp.be/en/collection/explore/s5866-26578		
Item number	S58/66 or 7.137	Manufacture	17 th century
HOME-AGE cabinet database number	ID.625	Production site	Antwerp
Cabinet dimensions	Height	depth	Width
	30,50 cm	17,50 cm	24,00 cm
Profile frame dimensions	2,67 mm ± 0,02 mm	5,18 mm ± 0,02 mm	/
Thickness of veneer	1,23 mm ± 0,02 mm		
Suspicion of restorations of veneer or mouldings		No	
Archival information		Yes	

Existing finishing materials

Blackened wood	Ebony	Other types of wood	Leg	Embroidery	Painting
X	?			X	
Turtle shell	Ivory	Metal	Paper	Varnish	Other
		X		X	

Finishing techniques available

Molding	Rippled molding	Maker's mark	Stamps		
X					

Evidence of blackened timber at other locations	
Veneer	
Molding	Indications of blackened timber were not directly observed on the moldings, except for a few small areas that could not be properly photographed due to time constraints. No sample was taken because there was done a preliminary study by a student, which showed that the veneer and moldings were made from pear. Report can be consulted at DIVA.
pXRF information	
Location during measurments	Research department
Datum van measurement	28/05/2025
Supervisor	Kristina Valiulis
pXRF executor	Lowie Vercruysse
Comments	/
pXRF locations	
	

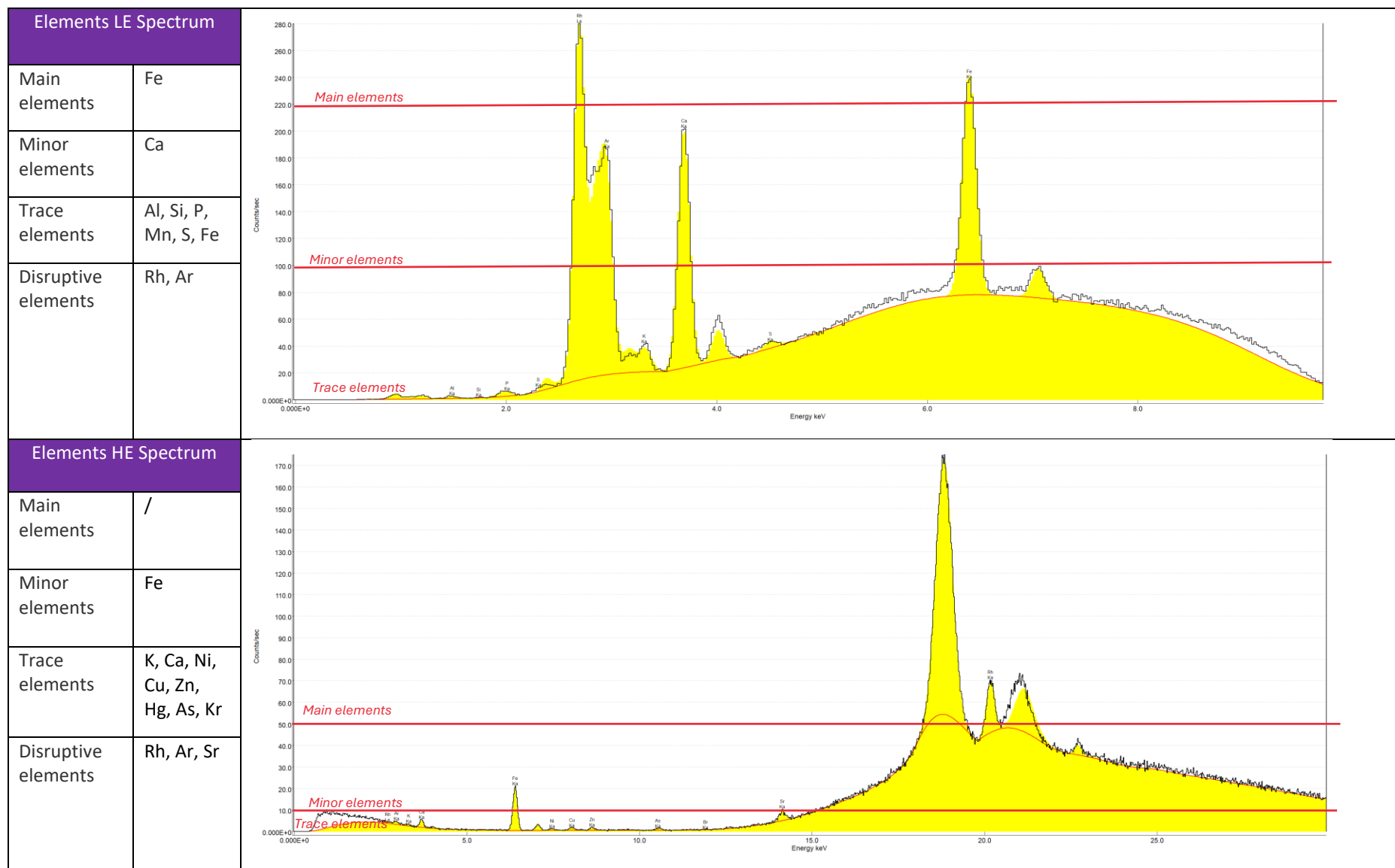


Table 1: pXRF measurements ID.625_2

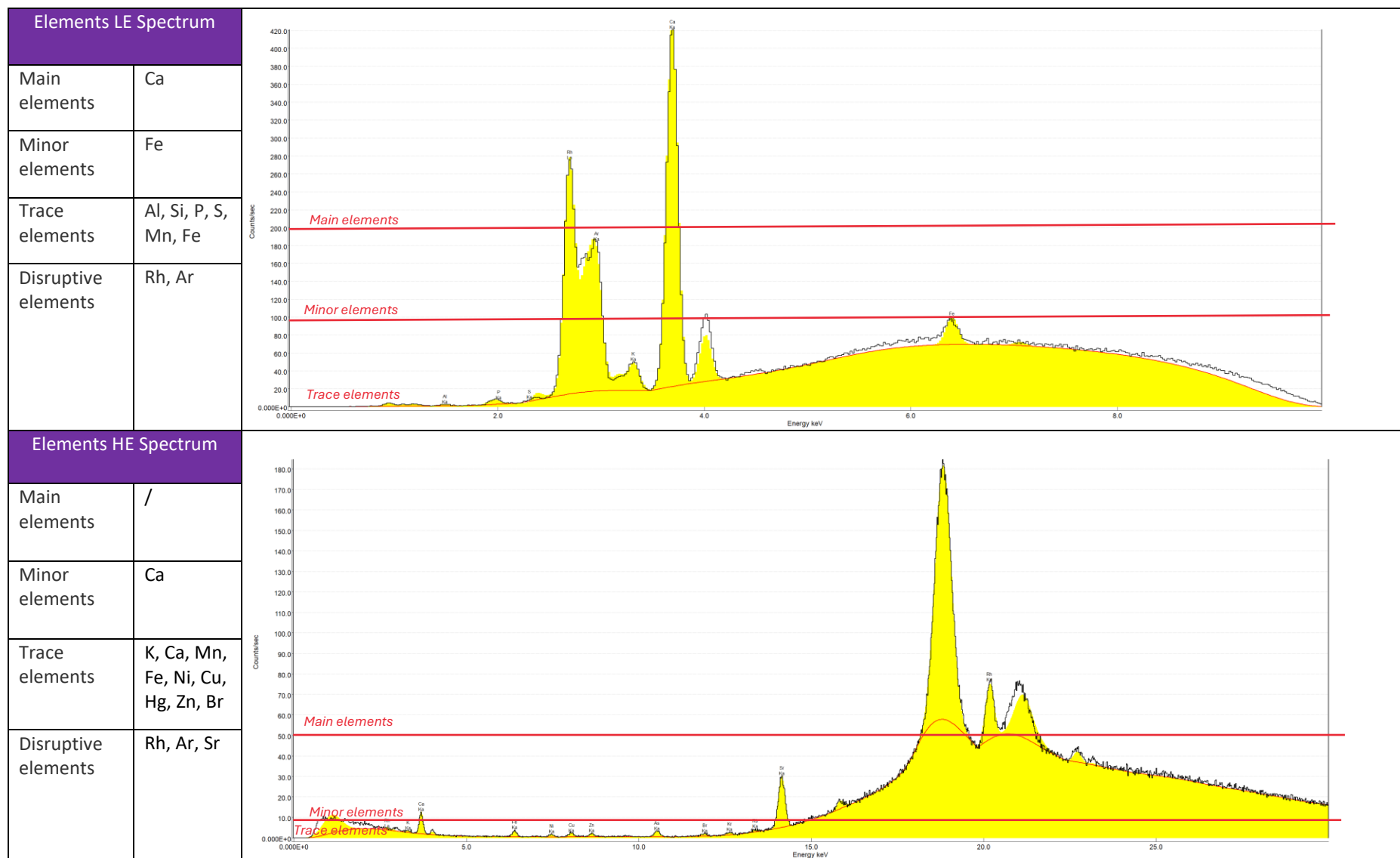


Table 2: pXRF measurements ID.625_3

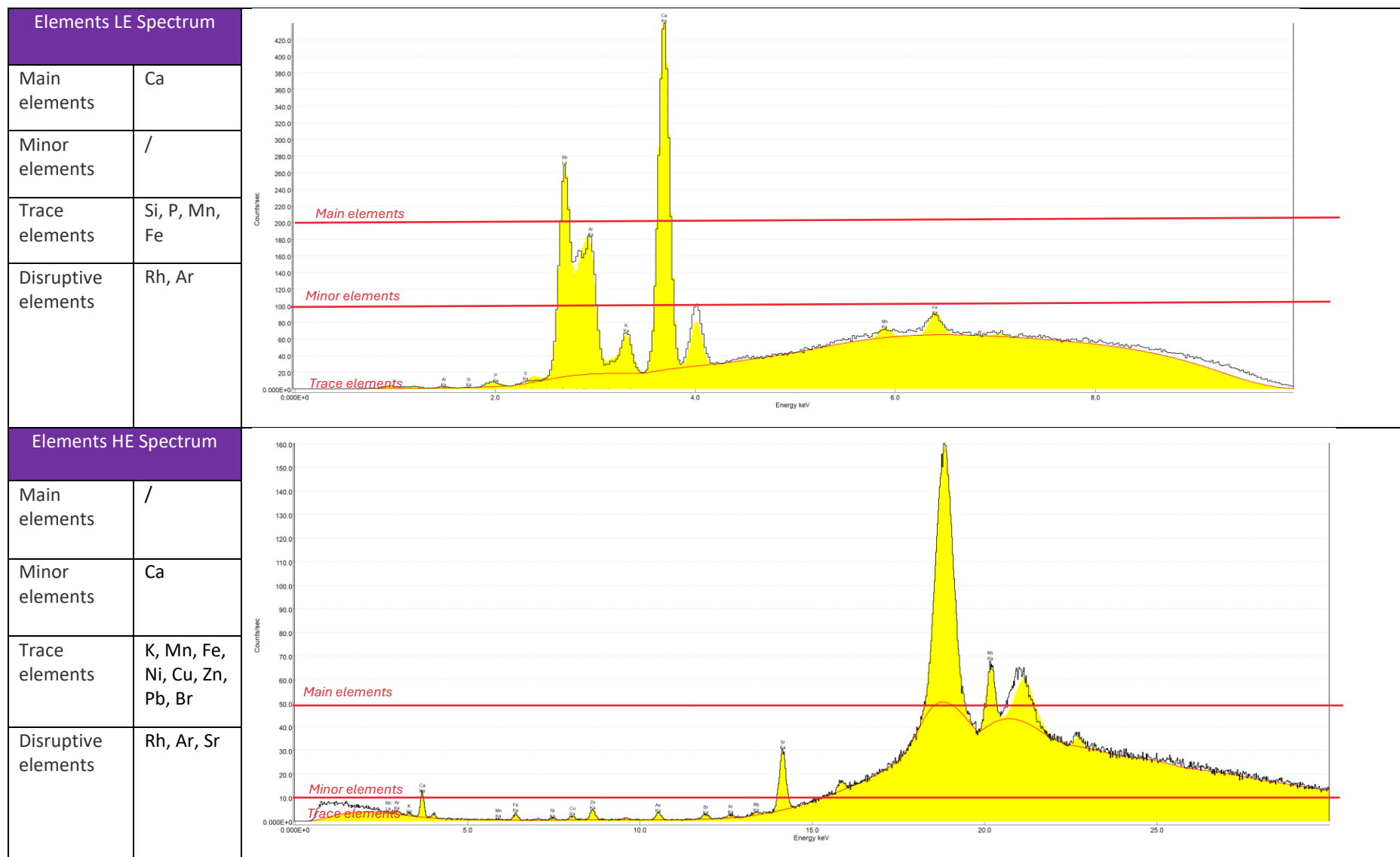


Table 3: pXRF measurements ID.625_4

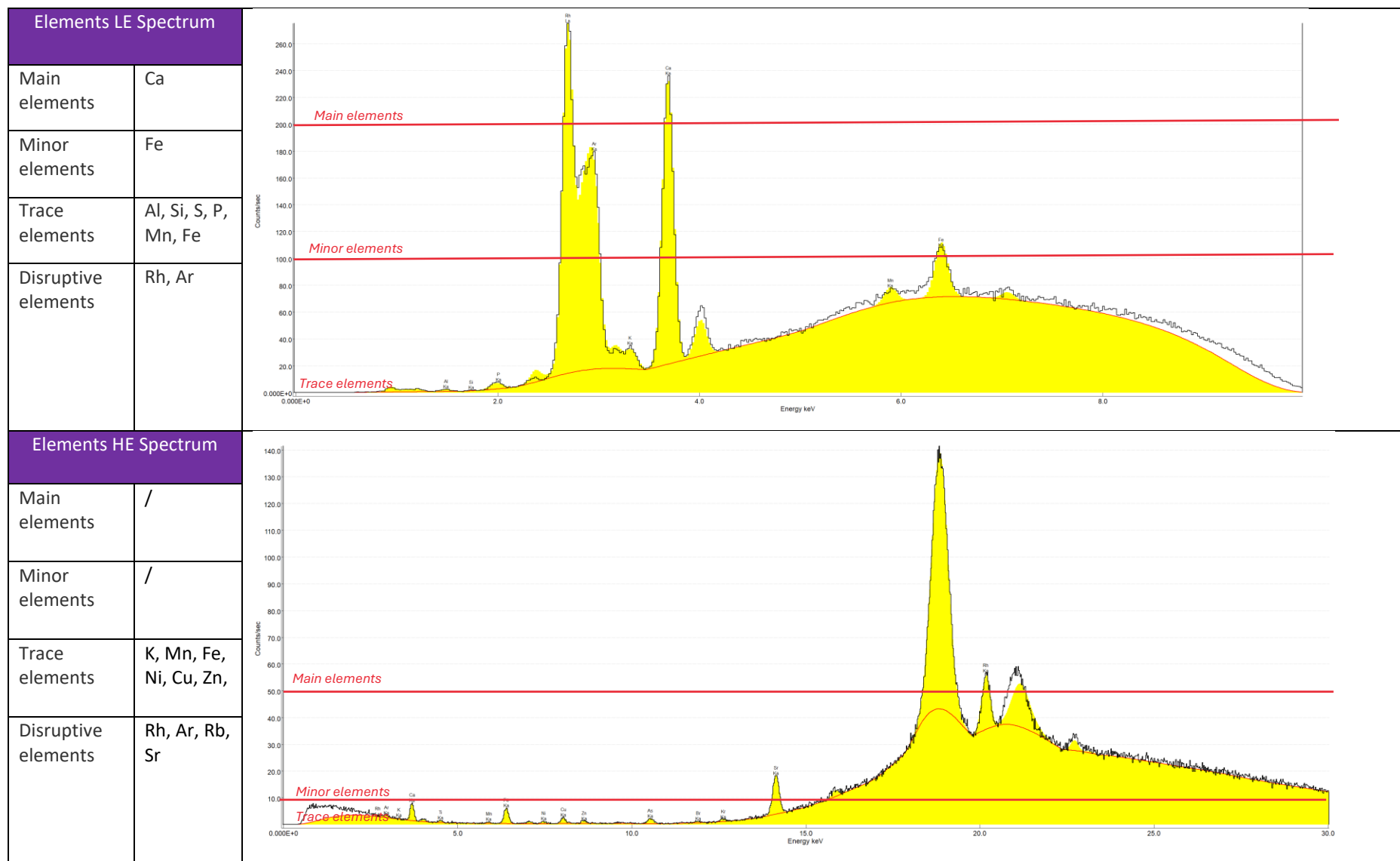


Table 4: pXRF measurements ID.625_5

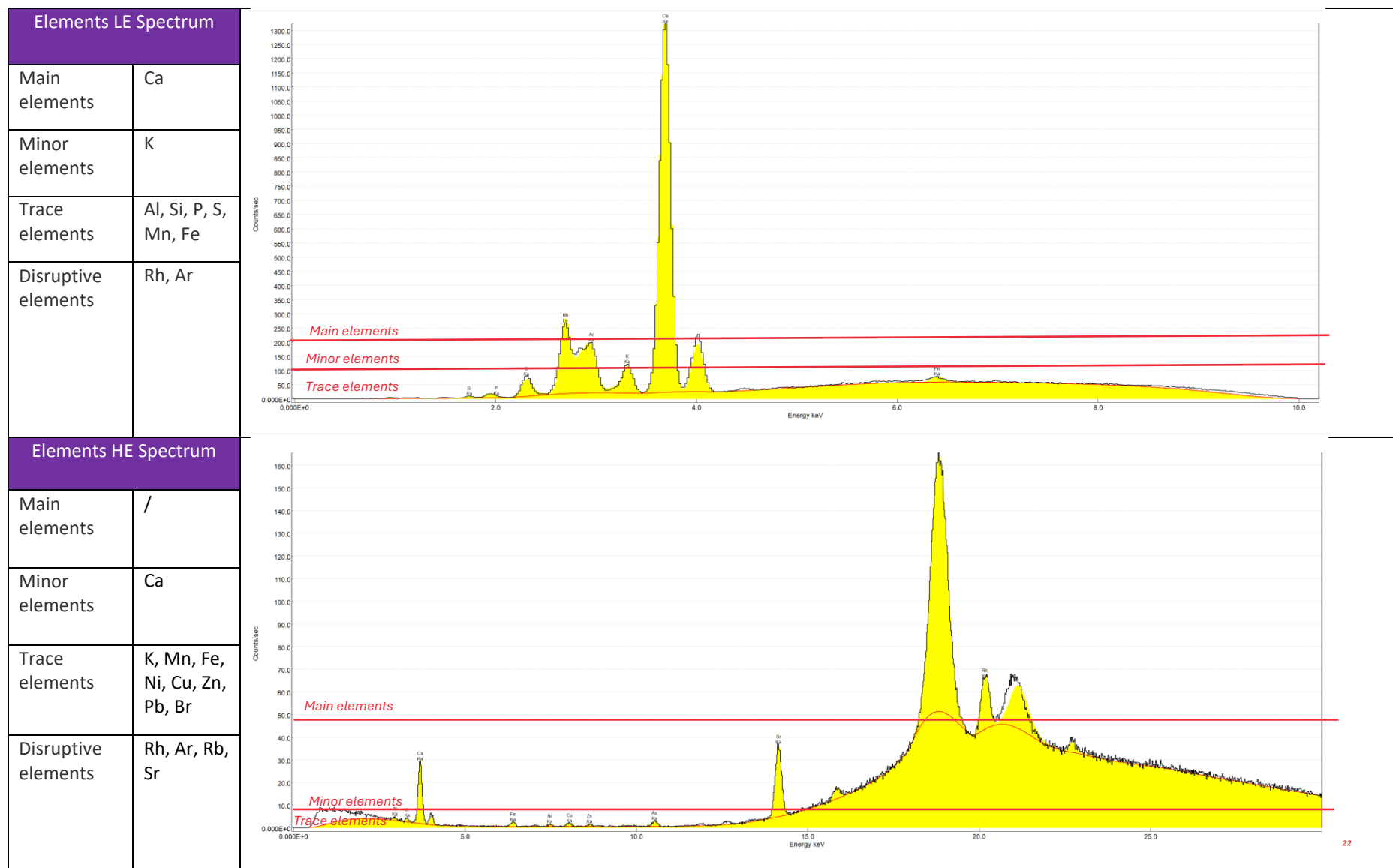


Table 5: pXRF measurements ID.625_6

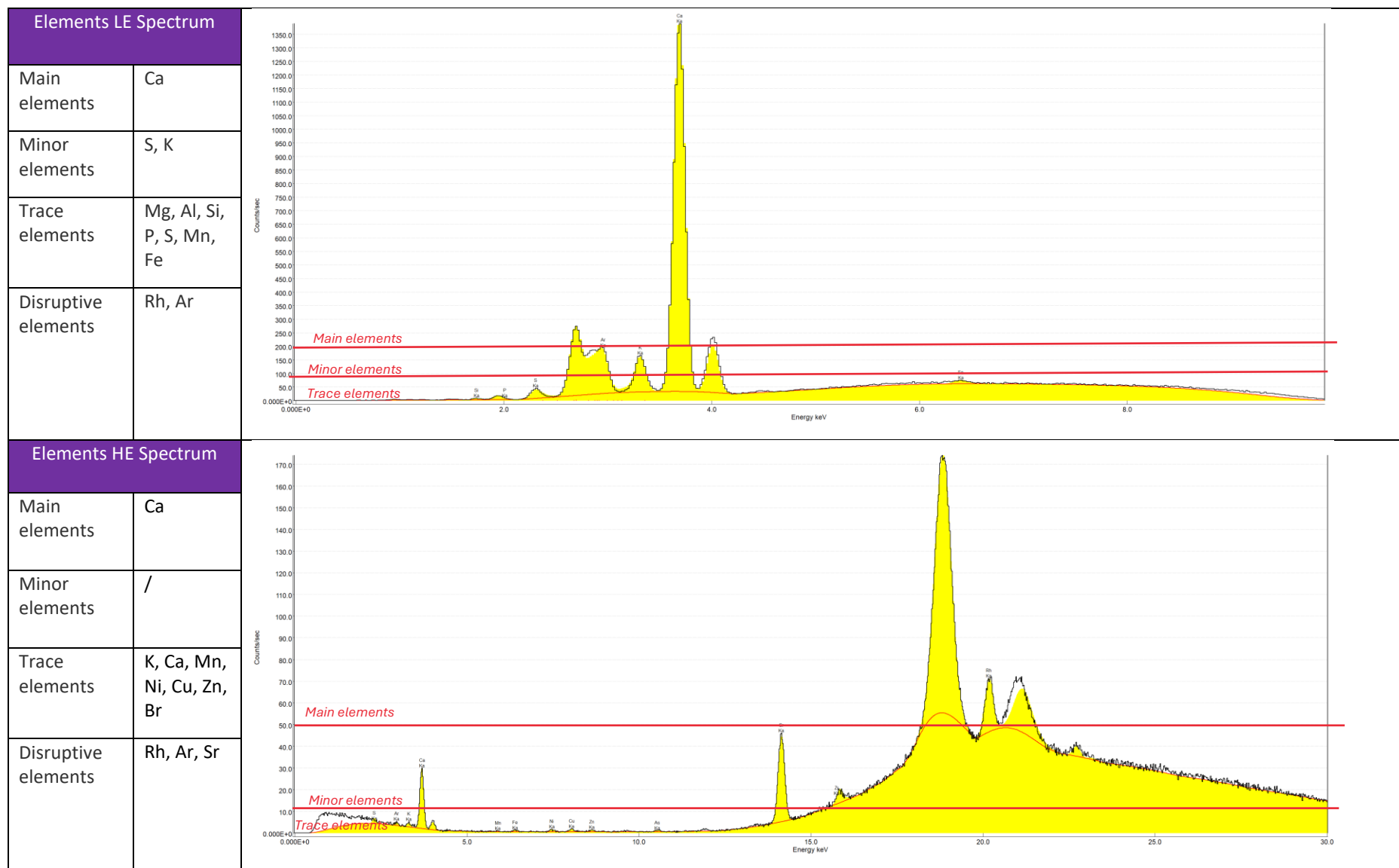


Table 6: pXRF measurements ID.625_7

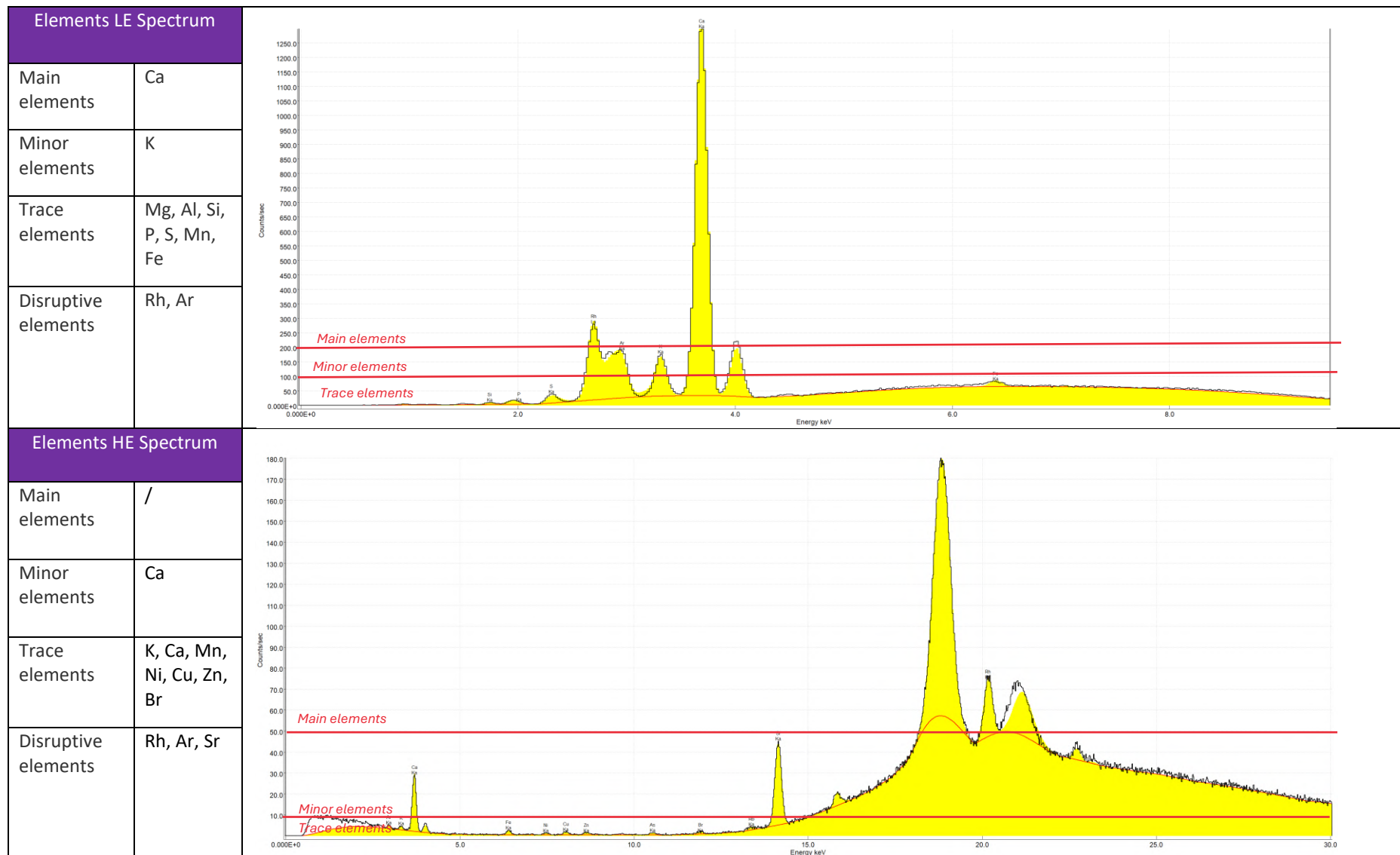


Table 7: pXRF measurements ID.625_8



General information

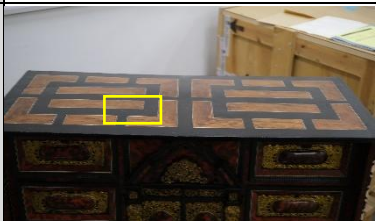
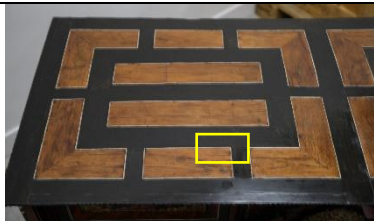
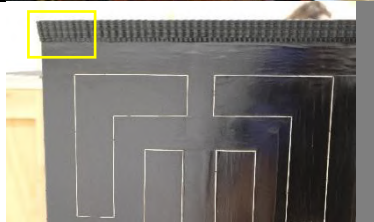
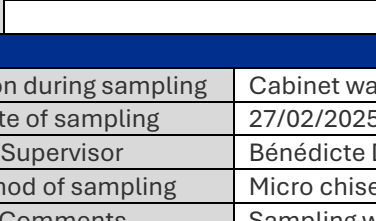
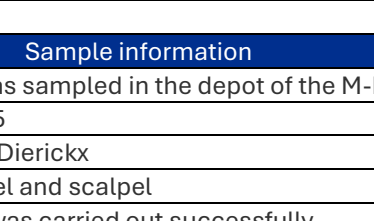
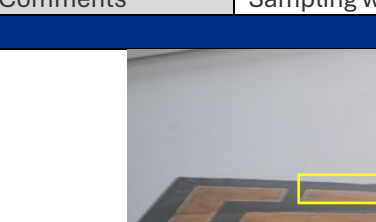
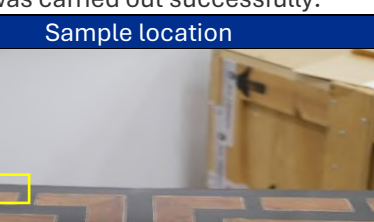
General information			
Object type	Group 5	Collection type	Public
Owner	Collection of M Leuven		
Conservator	Bénédicte Dierickx		
Contact	/	Benedicte.Dierickx@mleuven.be	
Url: website	https://www.erfgoedplus.be/details/24062A51.priref.18904 https://www.mleuven.be/collectie/kabinet-op-voet https://balat.kikirpa.be/photo.php?path=A116836&objnr=112481&nr=1		
Item number	M/51	Manufacture	1600-1690
HOME-AGE cabinet database number	Not yet present	Production site	Antwerp
Dimensions of the upper frame	Height	depth	Width
	72 cm	43 cm	104 cm
Rippled molding drawer	19,02 mm ± 0,02 mm	8,95 mm ± 0,02 mm	/
Rippled molding side	22,75 mm ± 0,02 mm	16,71 mm ± 0,02 mm	/
Thickness veneer	1,23 mm ± 0,02 mm		
Suspicion of restorations of veneer or profile moulding	Restorations with ebony have been carried out.		
Additional archive material?	Yes, restoration report		

Existing finishing materials

Blackened wood	Ebony	Other types of wood	Bone	Embroidery	Painting
X	X?	(palisander?)	X		
Turtle shell	Ivory	Metal	Paper	Varnish	Other
X		X		X	

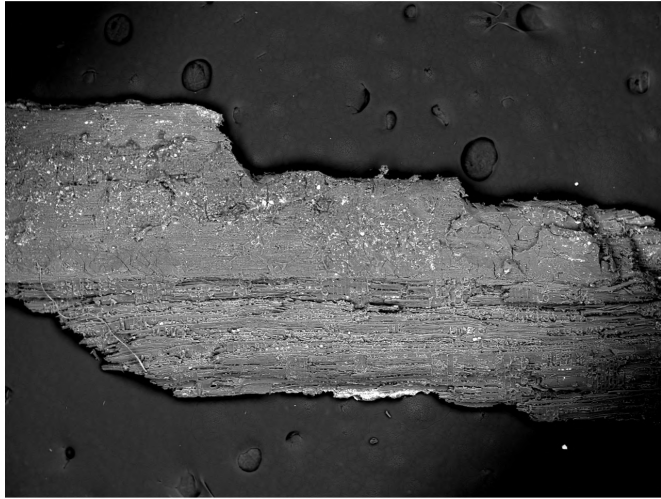
Finishing techniques available

Molding	Rippled molding	Maker's mark	Stamps		
	X				

Evidence of blackened timber at other locations		
Veneer		
		
Lists		
		
		
		
Sample information		
Location during sampling	Cabinet was sampled in the depot of the M-Leuven.	
Date of sampling	27/02/2025	
Supervisor	Bénédicte Dierickx	
Method of sampling	Micro chisel and scalpel	
Comments	Sampling was carried out successfully.	
Sample location		
		

For sampling	No monstername
	
	

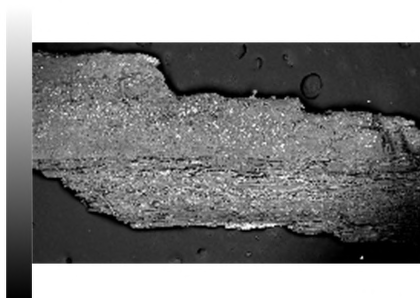
Sem_BED-C_003



500 μ m

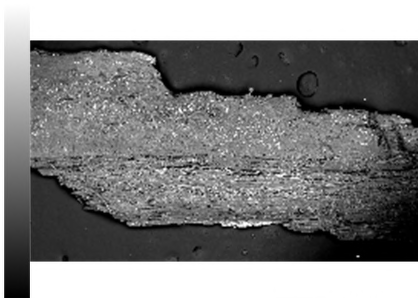
Signal BED-C
Landing Voltage 20.0 kV
WD 12.6 mm
Magnification x33
FOV 3.879 x 2.909 mm
Probe Current number Std. 63.0
Scan Rotation 0.0°
Vacuum Mode LowVacuum
Pressure 30 Pa

IMG1(1st)



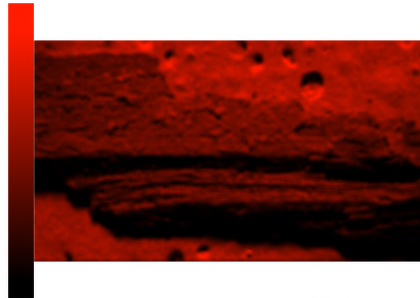
500μm

IMG1



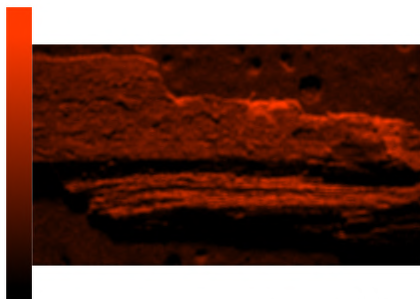
500μm

C-K



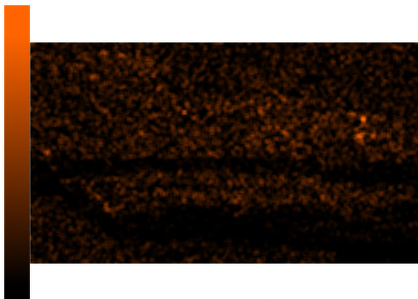
500μm

O-K



500μm

Na-K

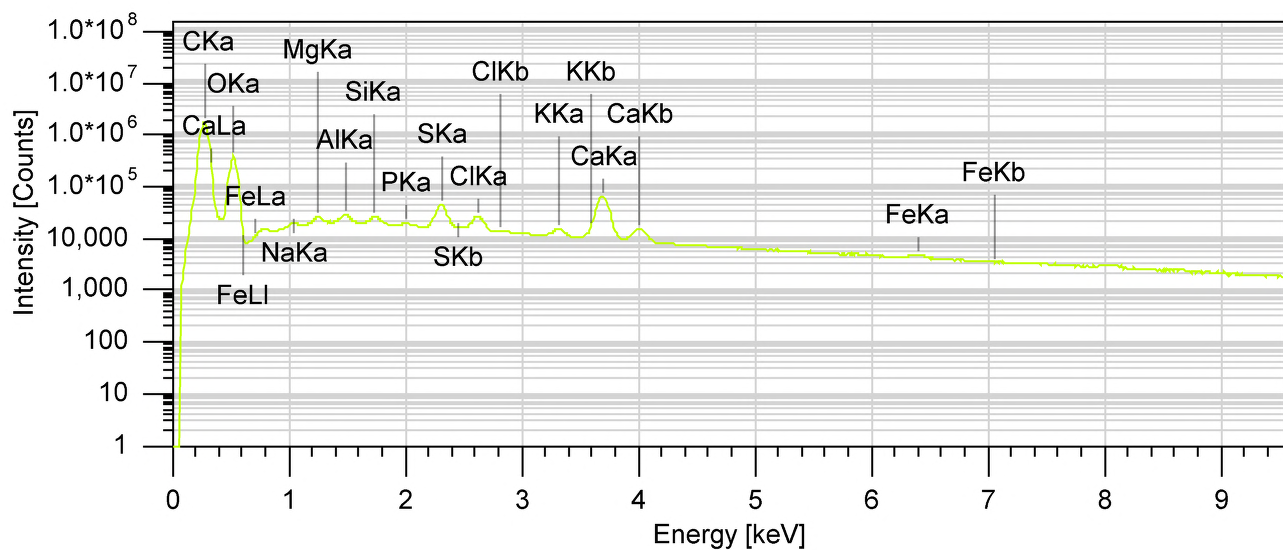


500μm

Mg-K



500μm



Al-K



500µm

Si-K



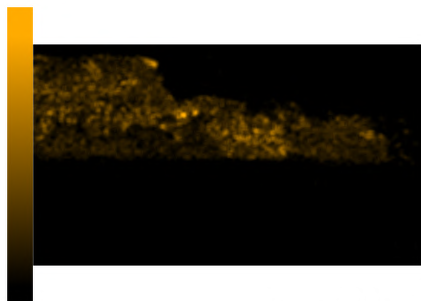
500µm

P-K



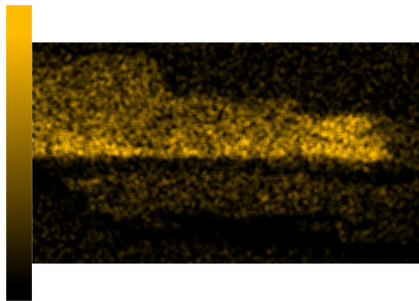
500µm

S-K



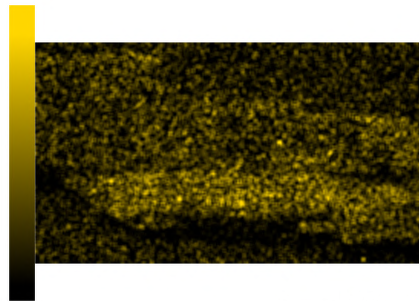
500µm

Cl-K



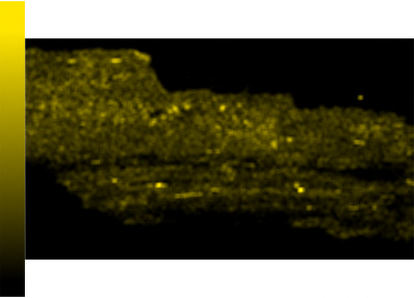
500µm

K-K



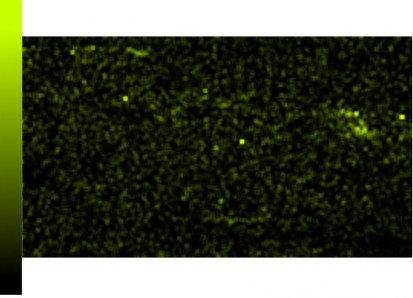
500µm

Ca-K



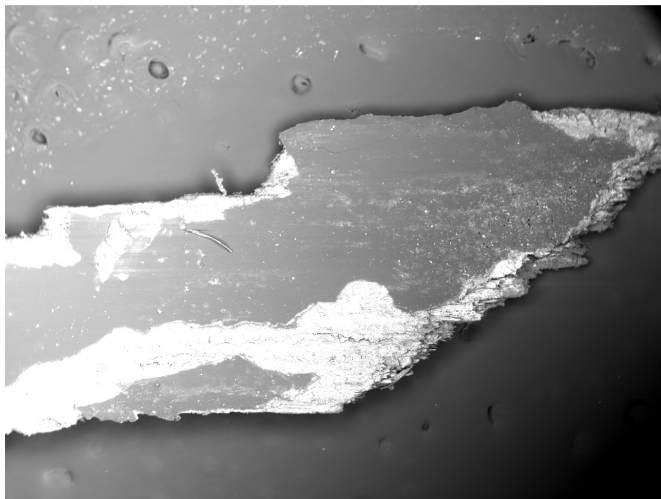
500µm

Fe-K



500µm

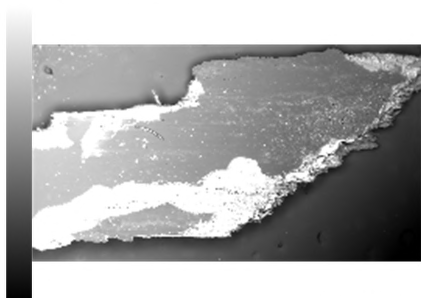
Sem_BED-C_003



500 μ m

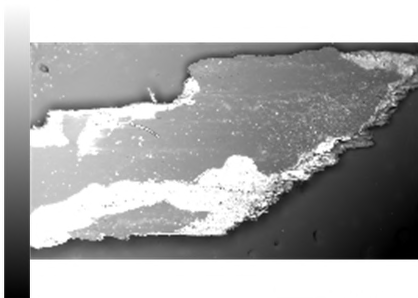
Signal BED-C
Landing Voltage 15.0 kV
WD 11.6 mm
Magnification x33
FOV 3.879 x 2.909 mm
Probe Current number Std. 60.0
Scan Rotation 0.0°
Vacuum Mode LowVacuum
Pressure 30 Pa

IMG1(1st)



500μm

IMG1



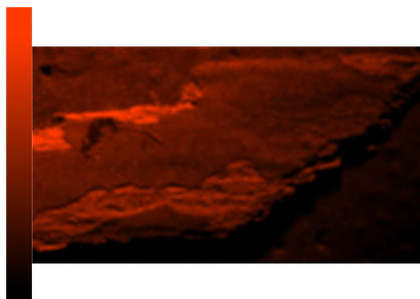
500μm

C-K



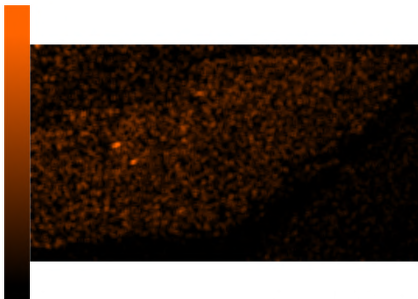
500μm

O-K



500μm

Na-K

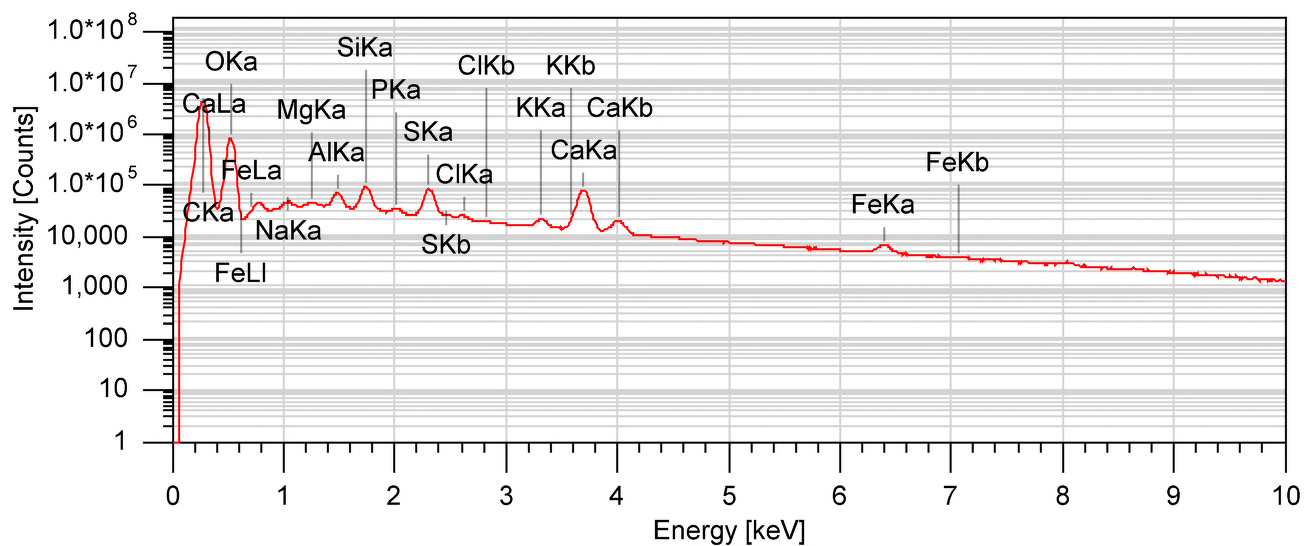


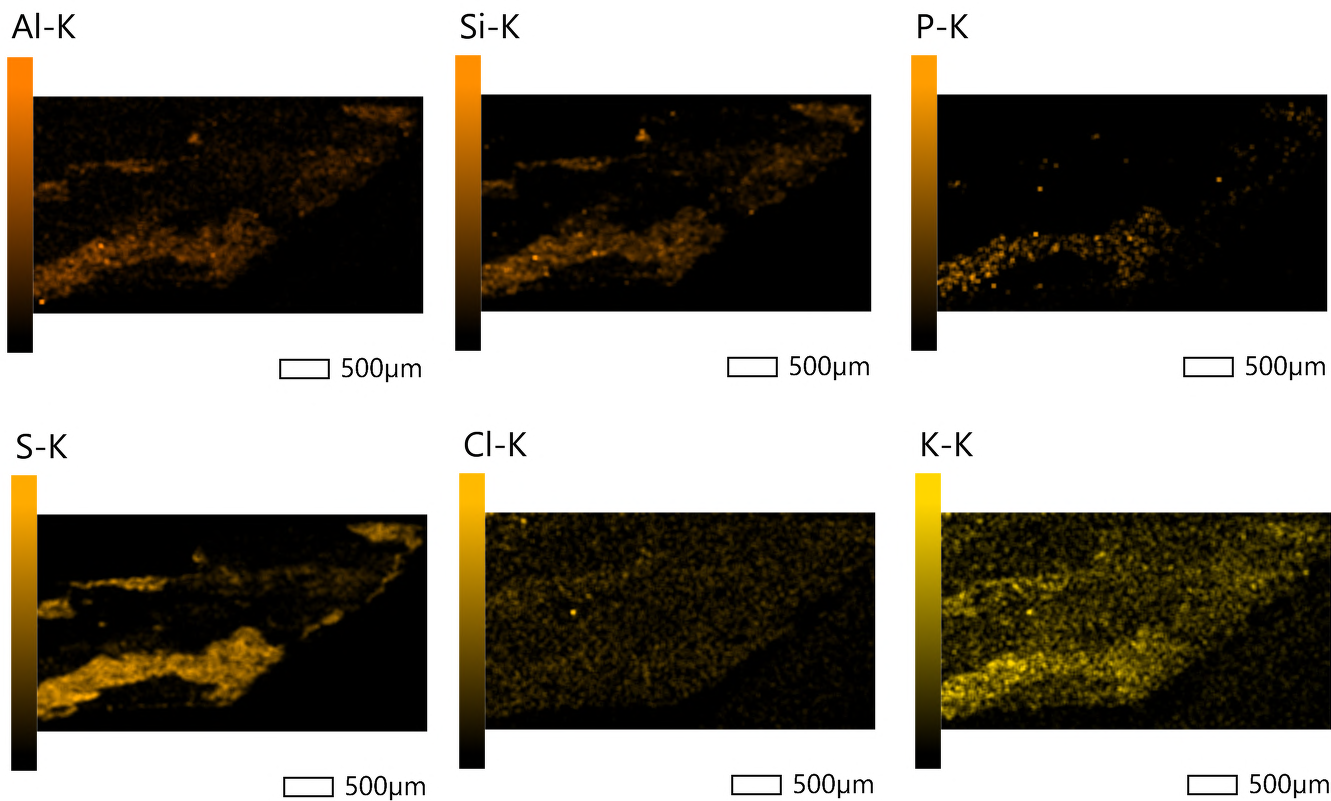
500μm

Mg-K

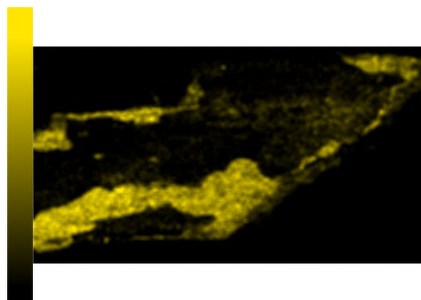


500μm



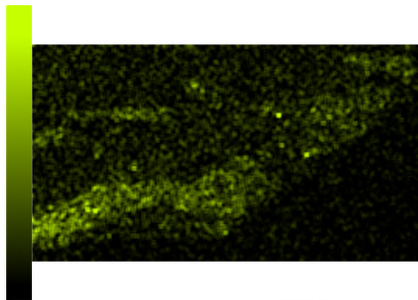


Ca-K



500μm

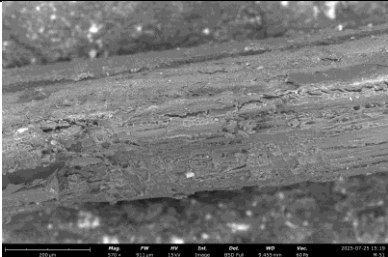
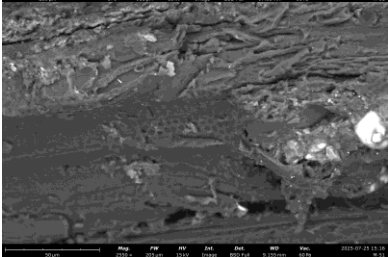
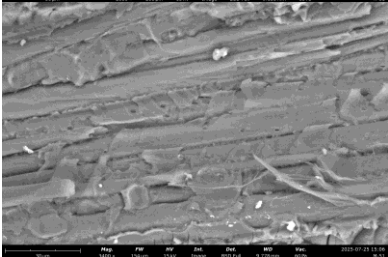
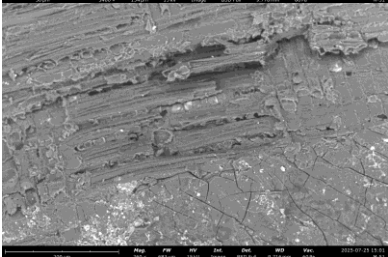
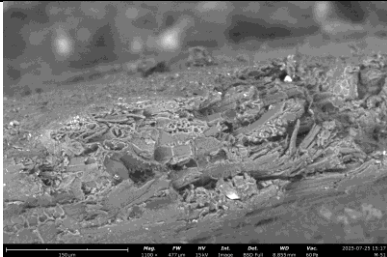
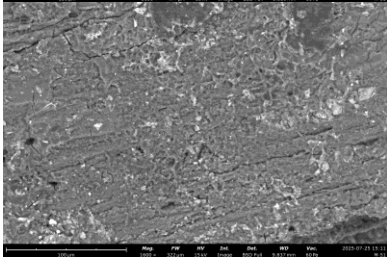
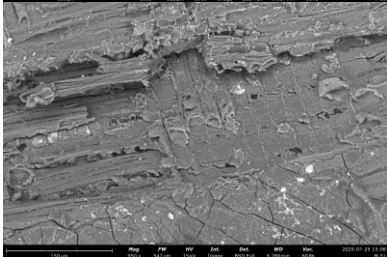
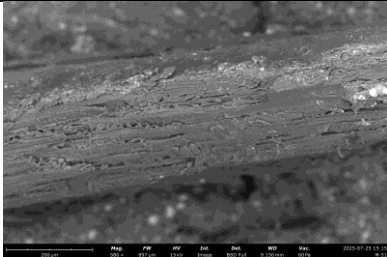
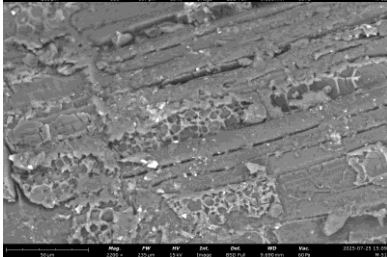
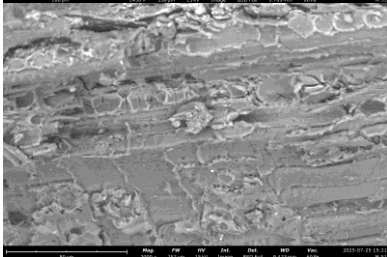
Fe-K



500μm

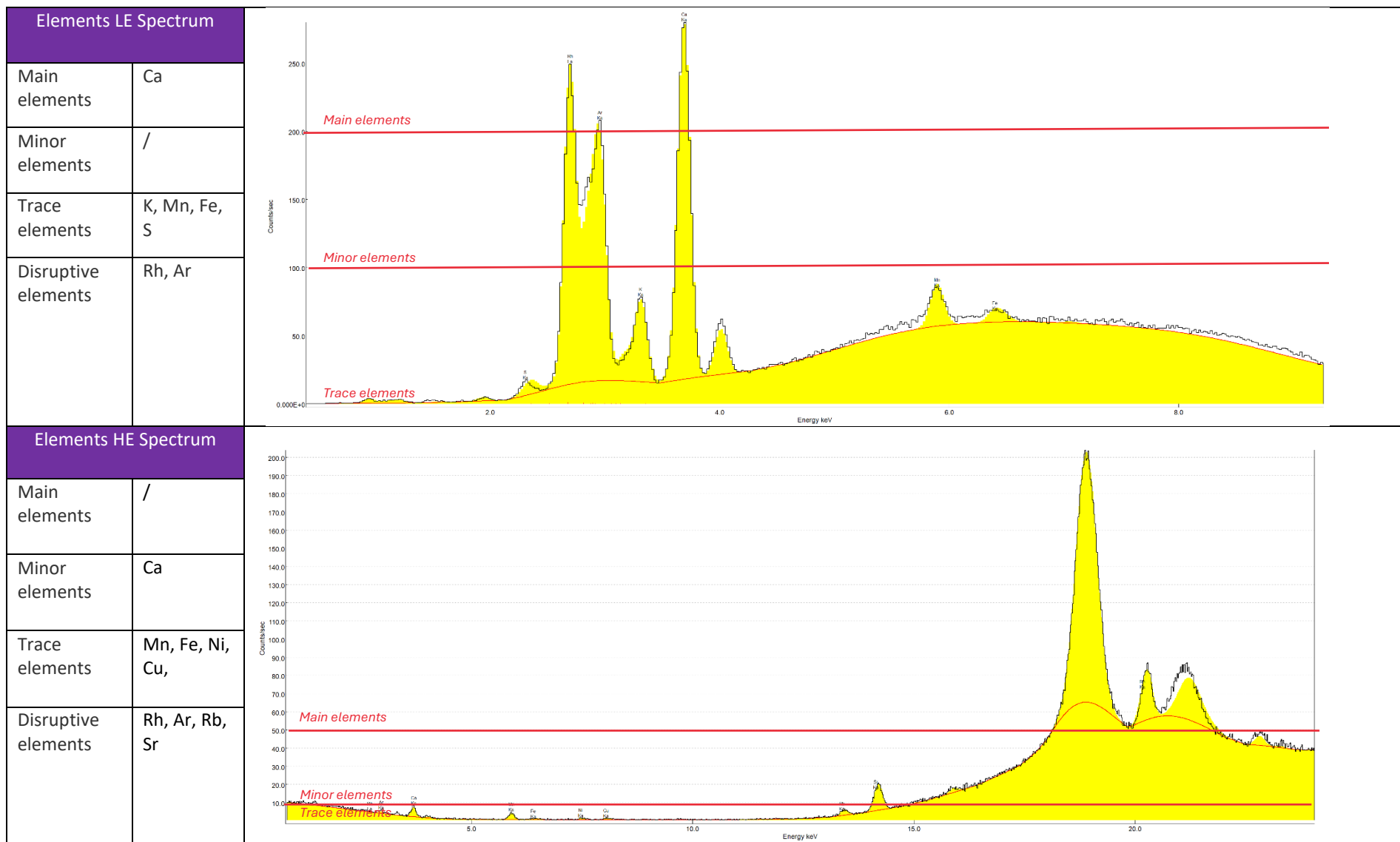
SEM images	
Location	Woodlab Africamuseum
Datum van measurement	25/07/2025
Supervisor	Blanca Van Houtte Alonso and Michael Monnoye
SEM executor	Flynn Hermesen
Comments	/

Overview		
		

Images		
   	   	   

Mockup Ebony wood	
	
Chemical compounds used in recipe	
/	/
Comments	
Species unknown	

Tabel 1: Overview Mockup ebony



Tabel 2: Overview Mockup ebony

Mockup 1635_10 Pear



Chemical compounds used in recipe

Carbon black	C
Iron gall ink	Fe(II)SO ₄
Vinager	CH ₃ COOH
schaafstro (Equisetum hyemale)	/
Bees wax	Organic mix of acids, esters, hydrocarbons
Comments	
Pour contrefaire le bois d'ebene, 1635 by LeBrun - Recueil des essais des merveilles de la peinture	

Tabel 3: Overview Mockup 1635_10 Pear

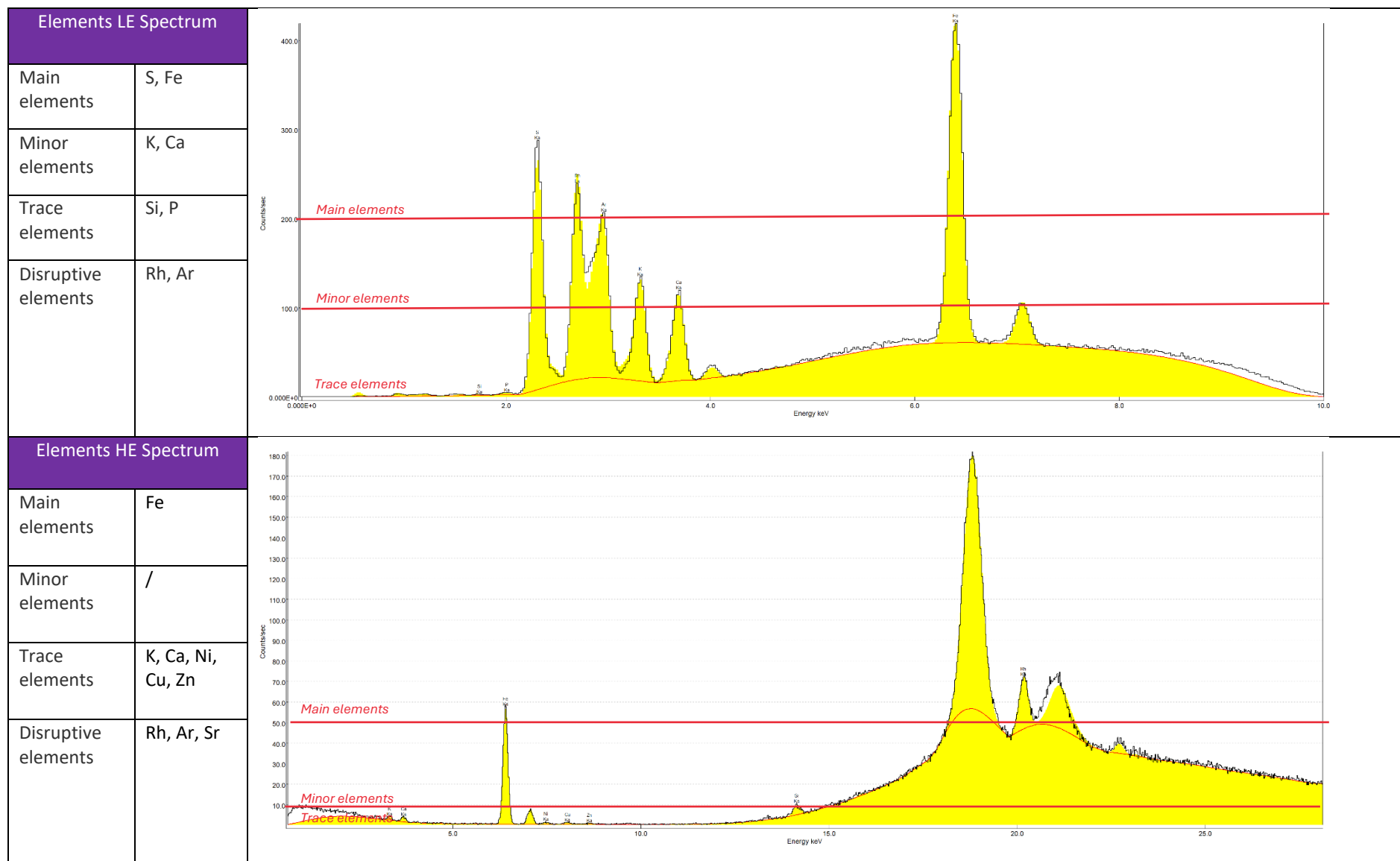


Table 4: pXRF measurements Mockup 1635_10 Pear

Mockup 1764_01 Plum	
	
Chemical compounds used in recipe	
Gall nuts	Tannins
Deminralised Water	H ₂ O
White Wine vinager	CH ₃ COOH
Vitriol	Fe(II)SO ₄ in demi water
Olive oil	Organic mix
Comments	
Om zwart te verven, 1764 by Ludeman - Konst-kabinet van wonder-zeldzaame beproefde en nooit voor bekende verborgentheden,	

Tabel 5: Overview Mockup 1764_01 Plum

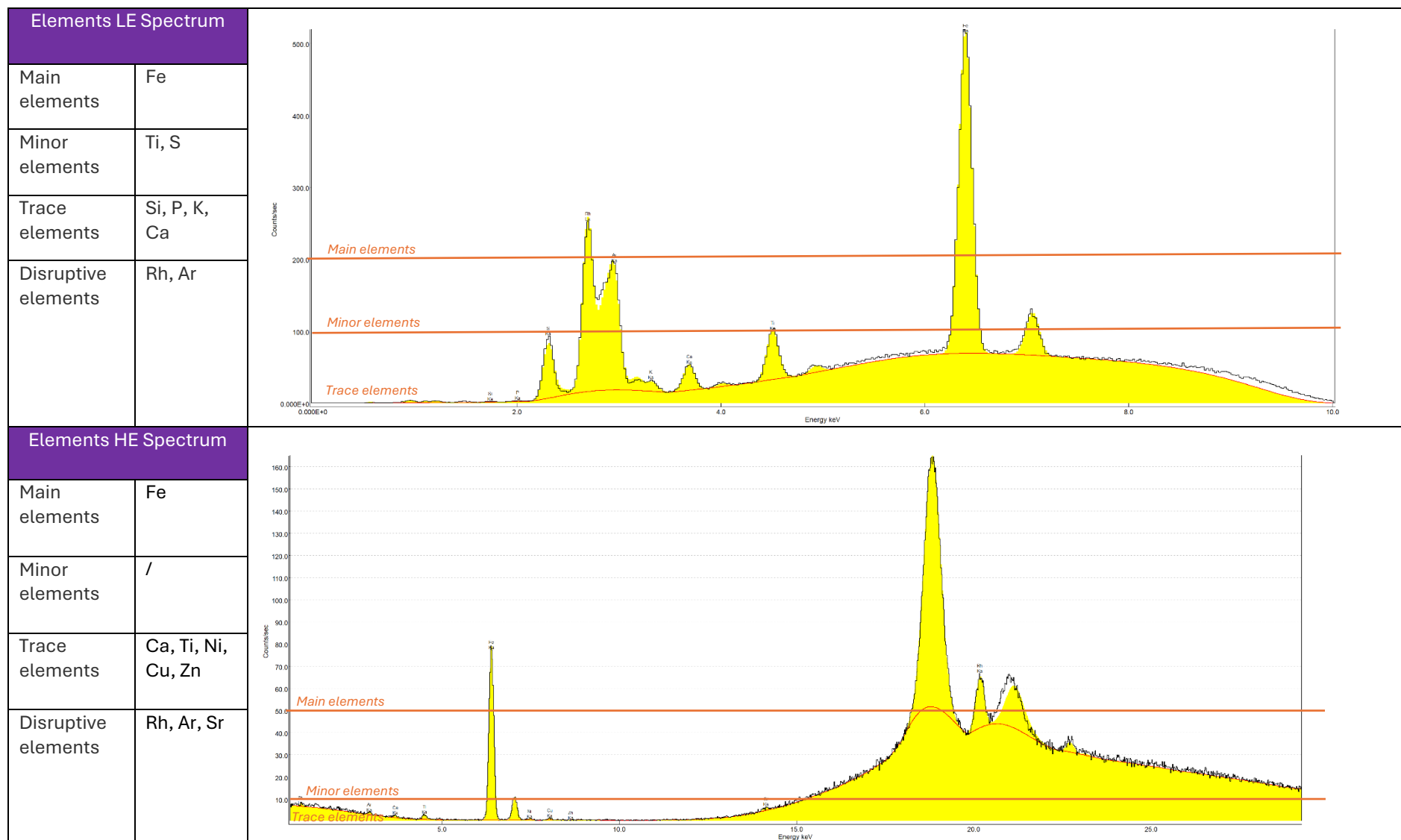
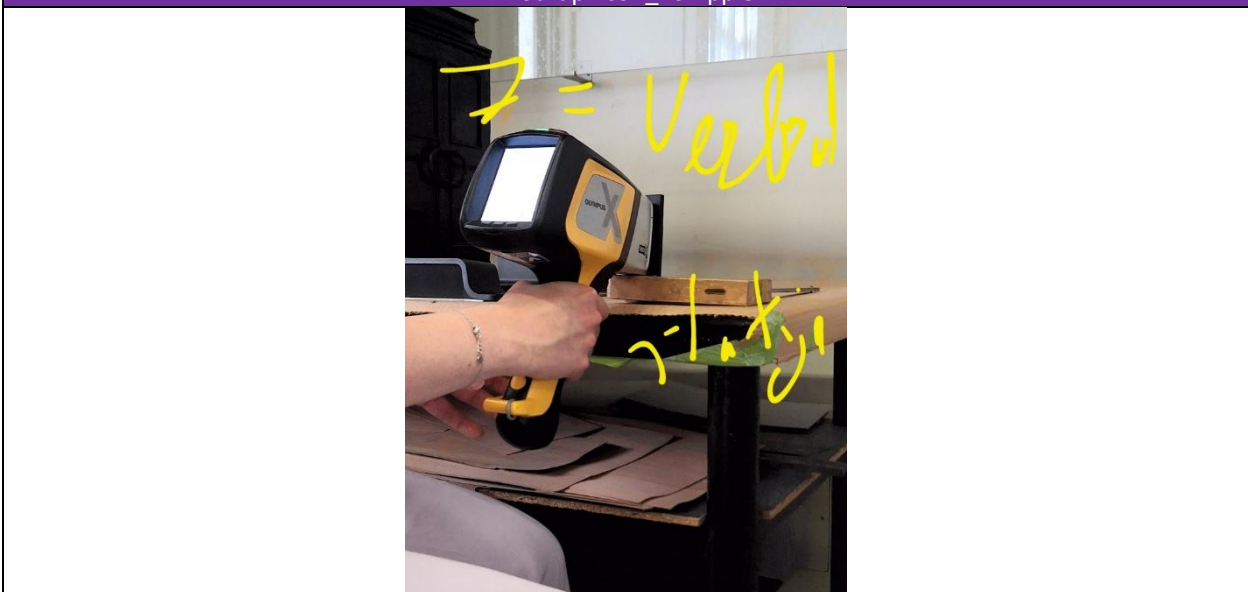


Table 6: pXRF measurements Mockup 1764_01 Plum



Chemical compounds used in recipe

Alum	$\text{KAl}(\text{SO}_4)_2 \cdot 12\text{H}_2\text{O}$
Vitriol	Fe(II)SO_4
Linseedoil	Organic mix of acids, esters, hydrocarbons
Solfers	S

Comments	
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Piece is probably burned through the centre - Om Ebbenhout te maken, gelijk oft alsoo gewassen ware 1684 - Het secreteet-boek vol heerlijke konsten

Tabel 7: Overview Mockup 1694_20 Appe

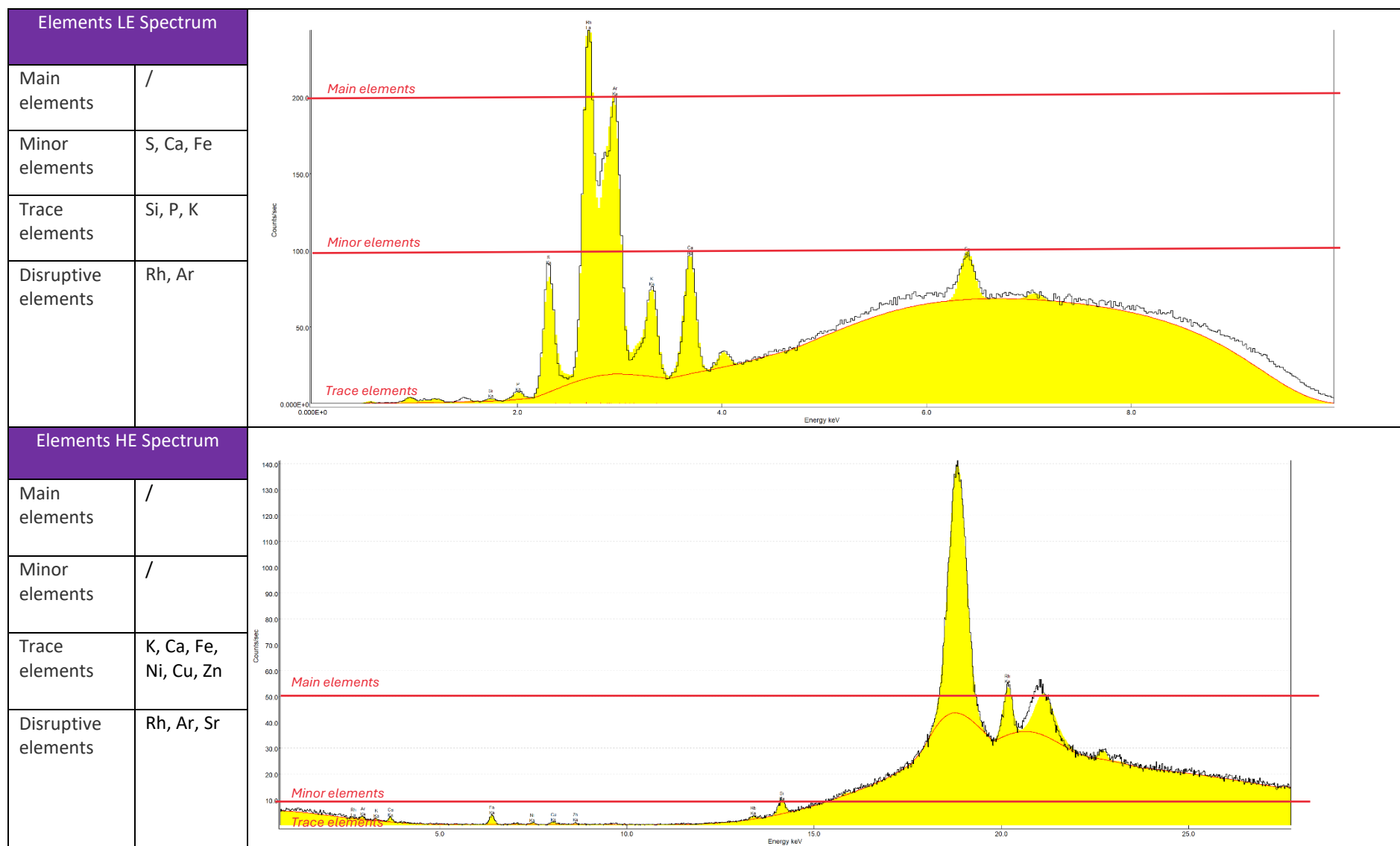


Table 8: pXRF measurements Mockup 1694_20 App

Mockup 1771_14 Apple



Chemical compounds used in recipe

Gall nuts ink	Tannins + Fe(II)SO_4
Gall nuts	Tannins
Vinager	CH_3COOH
Bees wax	Organic cmix

Comments

Ebbe - S. J. Baalde 1771 - Nieuw en volkomen woordenboek van konsten en weetenschappen

Tabel 9: Overview Mockup 1771_14 Appl

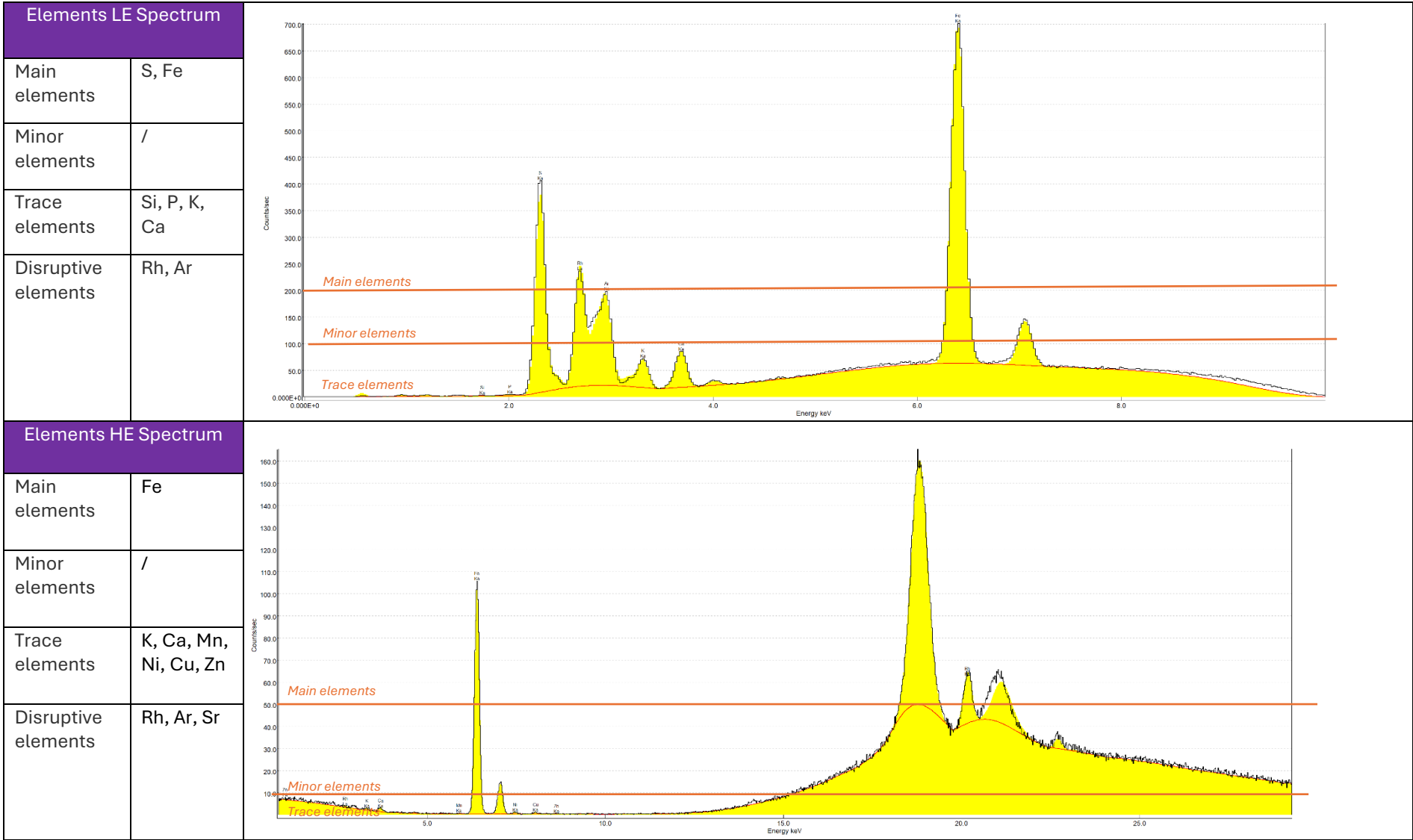


Table 10: pXRF measurements Mockup 1771_14 Apple

Mockup 1778A_18 Apple



Chemical compounds used in recipe

Gall nuts ink	Tannins = Fe(II)SO_4
Gall nuts	Tannins
Vinager	CH_3COOH
Bees wax	Organic cmix

Comments

Om ebbenhout te imiteren - Chomel 1778A - Algemeen huishoudelijk-, natuur-, Zede kundig- en konst- woordenboek volume2, p1155 (with water)

Tabel 11: Overview Mockup 1778A_18 Apple

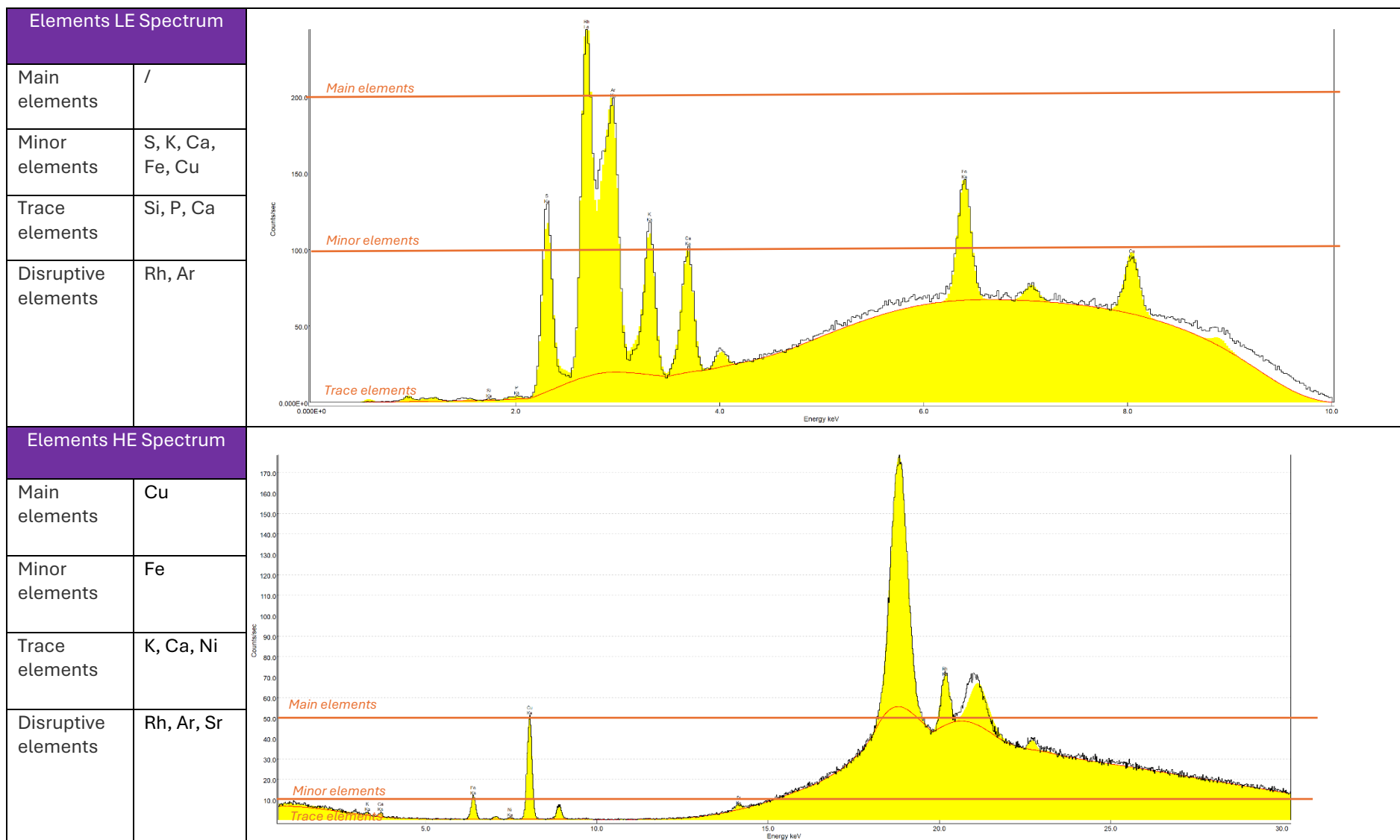


Table 12: pXRF measurements Mockup 1778A_18 Apple

Mockup 1778B_06 Plum



Chemical compounds used in recipe

Alum	$\text{KAl}(\text{SO}_4)_2 \cdot 12\text{H}_2\text{O}$
Indigo	$\text{C}_{16}\text{H}_{10}\text{N}_2\text{O}_2$
Koperacetaat	$\text{Cu}_2\text{Al}(\text{AsO}_4)(\text{OH})_4 \cdot 4(\text{H}_2\text{O})$
Azijnzuur	CH_3COOH
Campechie-hout	Haematoxylon campechianum

Comments

Om ebbenhout te imiteren - Chomel 1778A - Algemeen huishoudelijk-, natuur-, Zede kundig- en konst- woordenboek volume2, p1155 (with vinegar)

Tabel 13: Overview Mockup 1778B_06 Plum

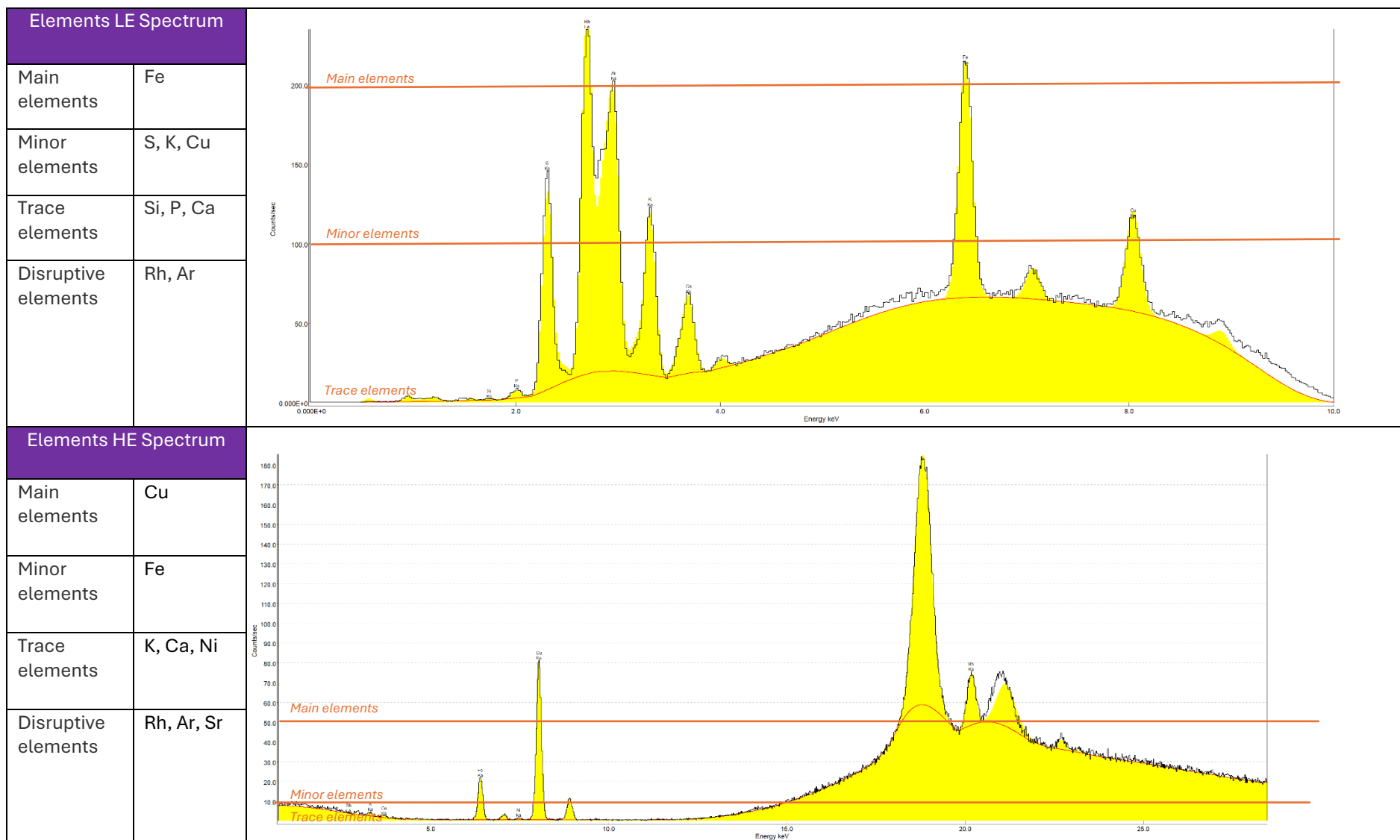


Table 14: pXRF measurements Mockup 1778B_06 Plum



Chemical compounds used in recipe

Alum	$\text{KAl}(\text{SO}_4)_2 \cdot 12\text{H}_2\text{O}$
Verdigris	$\text{C}_{16}\text{H}_{10}\text{N}_2\text{O}_2$
Koperacetaat	$\text{Cu}_2\text{Al}(\text{AsO}_4)(\text{OH})_4 \cdot 4(\text{H}_2\text{O})$
Vinager	CH_3COOH
Campechie-hout	Haematoxylon campechianum
Demineralised water	H_2O

Comments

Om ebbenhout na te bootzen – N. Chomel 1778 - 'Het algemeen huishoudelijk-, natuur-, zedekundig- en konst- woordenboek

Tabel 15: Overview Mockup 1778_19 cherry

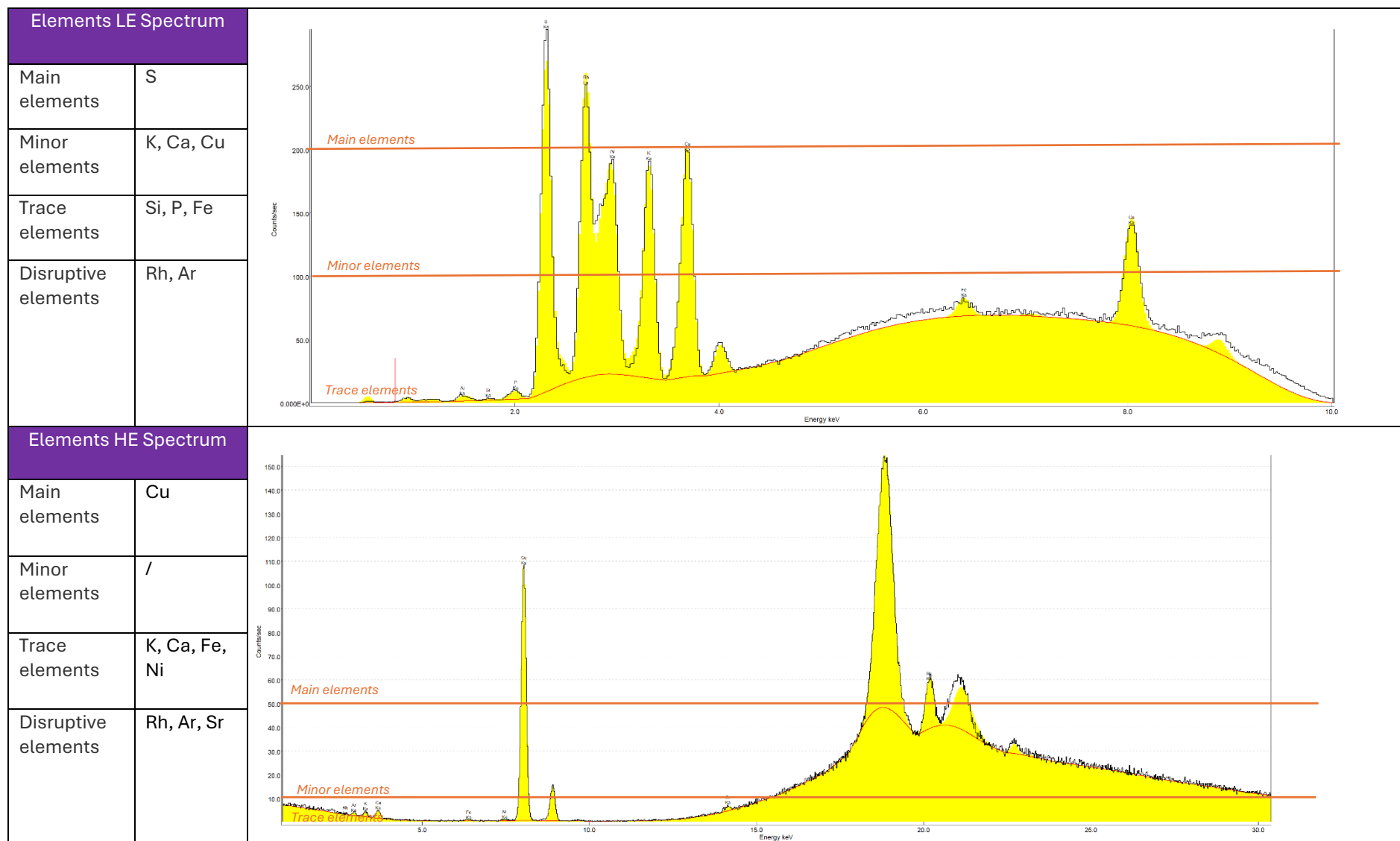
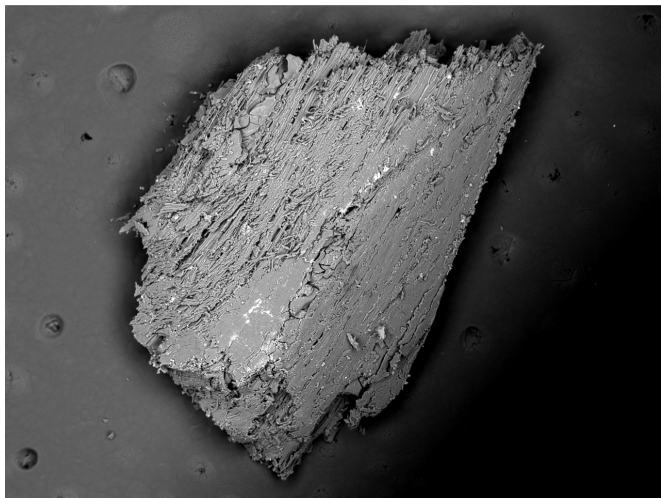


Table 16: pXRF measurements Mockup 1778_19 cher

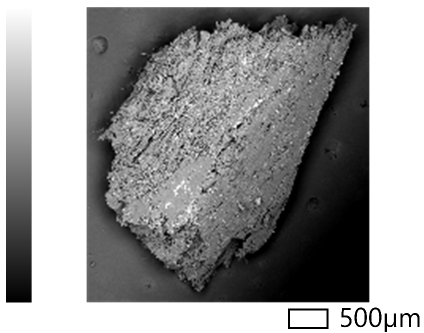
Sem_BED-C_003



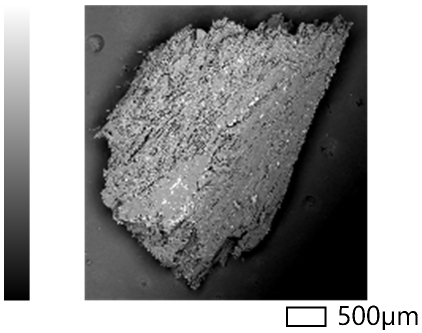
500 μm

Signal BED-C
Landing Voltage 20.0 kV
WD 11.4 mm
Magnification x37
FOV 3.459 x 2.595 mm
Probe Current number Std. 63.0
Scan Rotation 0.0°
Vacuum Mode LowVacuum
Pressure 30 Pa

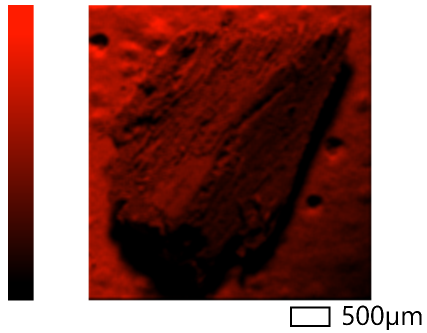
IMG1(1st)



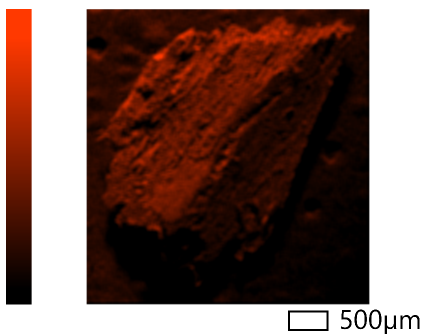
IMG1



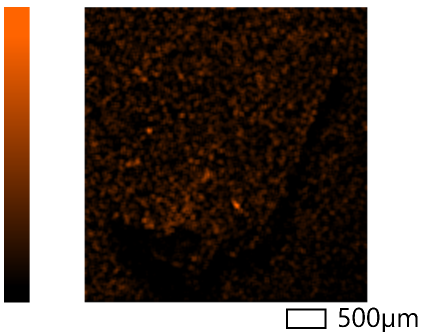
C-K



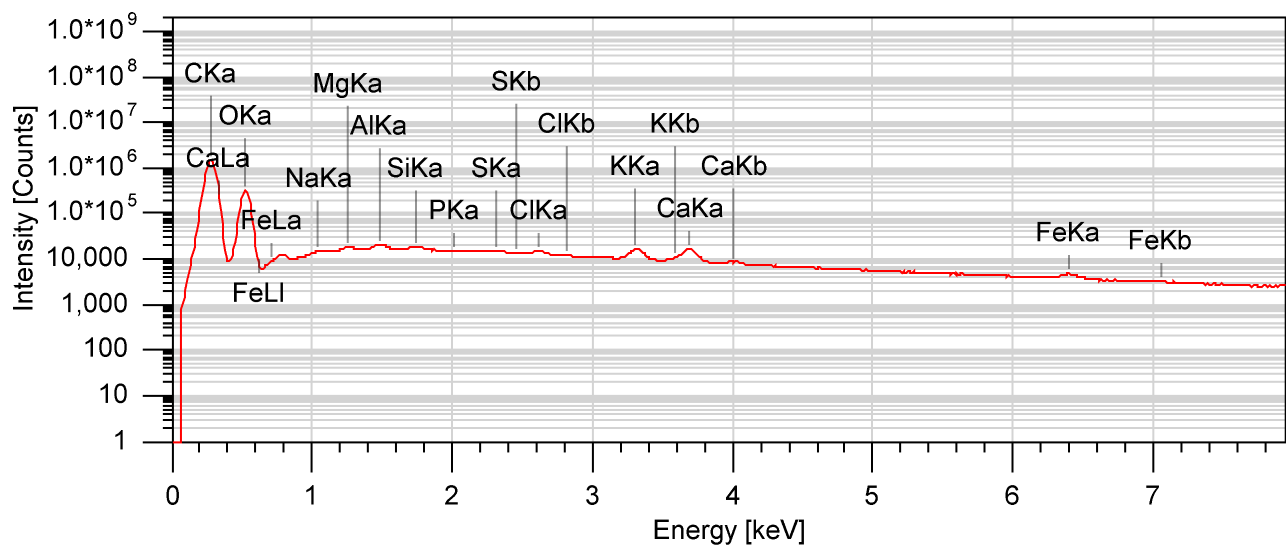
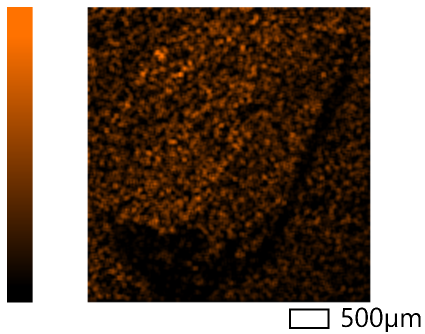
O-K

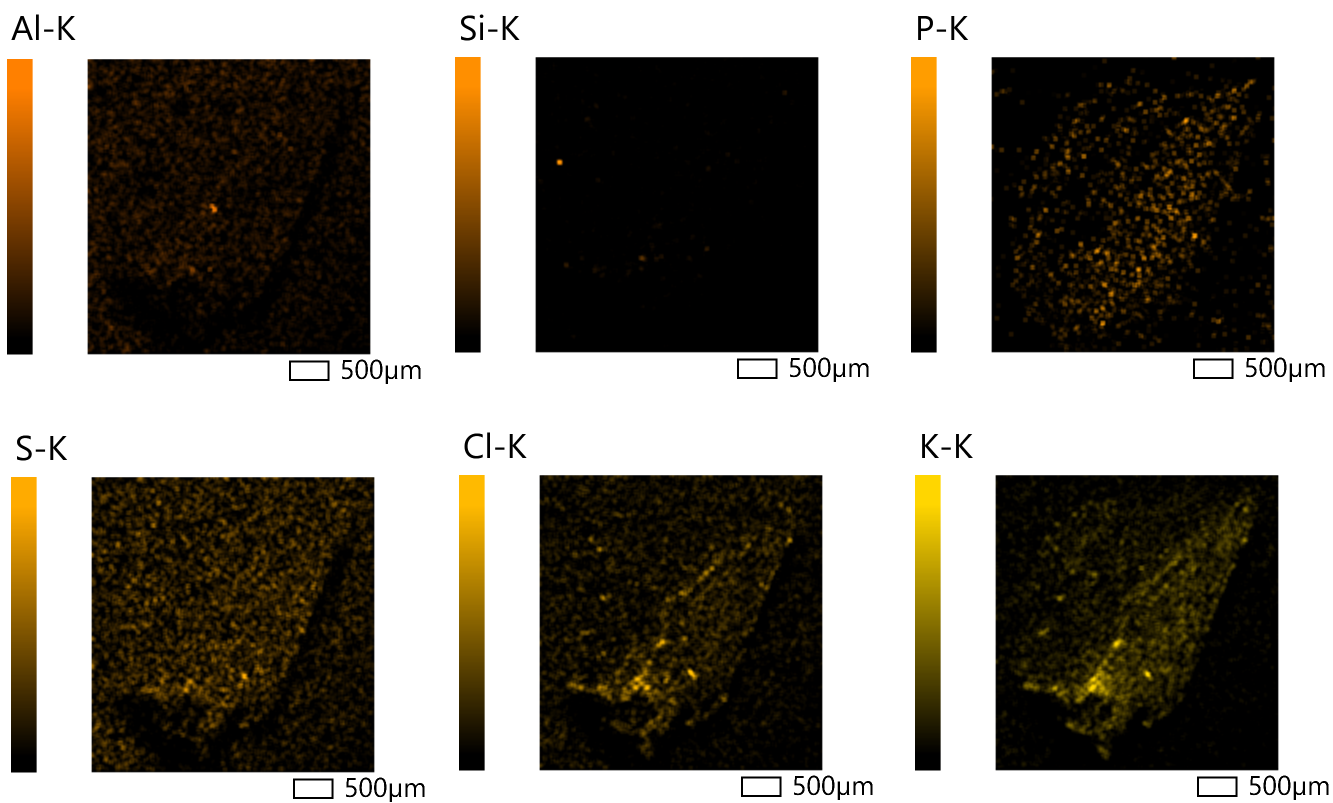


Na-K

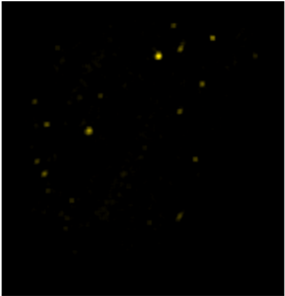


Mg-K



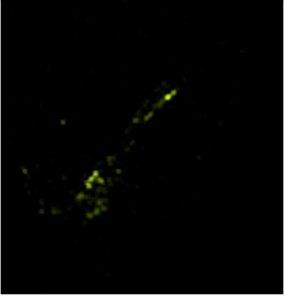


Ca-K



500μm

Fe-K



500μm