Article

An Attempt at a Systematic Study of Inks from Coptic Manuscripts

Tea Ghigo, Olivier Bonnerot, Paola Buzi, Myriam Krutzsch, Oliver Hahn, and Ira Rabin | Rome, Berlin, Hamburg

Introduction

When it comes to Egyptian writing and drawing materials, it is surprising to realize how much information we have on pigments compared with the little we know about inks.

It is well documented that throughout Antiquity, ancient Egyptians used mostly carbon inks as a writing material.[1] In Late Antiquity, some metals started to be added to carbon-based inks. We have records of five manuscripts from the Dead Sea Scrolls collection whose carbon inks were found to contain copper.[2] Also, lead was recently found as an additive in carbon inks on a charred fragment from Herculaneum.[3] Furthermore, the earliest evidence of iron-gall ink was found in the Book of Proverbs (Codex Ms. Berol. orient. oct. 987) dating to the third fourth centuries CE.[4] It has been suggested that along with carbon and iron-gall inks, there is no reason to think that purely tannin inks were not also in use in Egypt.[5] However, so far, we just have evidence of a copper-tannin ink identified in a number of documents from Egypt in the first third centuries BCE.[6]

In an attempt to fill this gap in this extremely fragmented scenario during our studies of the socio-geographic history of inks, we arrived at the conclusion that the continuous production of Coptic manuscripts from Late Antiquity to the Middle Ages offers a unique opportunity for the historical study of inks across a large geographic area. Few analyses with specific reference to Coptic Egypt have been conducted so far. Among them, we can list the study of a fragment of parchment purchased in Cairo in the mid-1970s. This revealed that the two sides of the document had been inscribed with iron-gall inks that differ in their metal salts composition, suggesting that the same manuscript may have been inscribed by more than one person or by the same person but at different times.[7] A previous study of Coptic inks and pigments laid on a variety of supports dating from the sixth to the eighth centuries, pointed out that carbon ink was used on pottery while iron-gall inks were used on parchment.[8]

Aim of the project

The studies presented so far are just sporadic pieces of investigation into the history of writing materials in Egypt. For this reason, thanks to the collaboration with the ERC project 'PAThs' (www.paths.uniroma1.it) based at the Sapienza University of Rome and within the activities of a PhD research dedicated to this topic, we created a new project focused entirely on the analysis of Coptic inks. Pigments and dyes, if present in the manuscripts, will also be investigated.

This study of Coptic codices will address primarily the history of the development of inks. As stated above, we have record of different kinds of inks used in Coptic fragments, but we still do not know if this difference is due to an evolution of materials and methods during the Coptic period or to a regional arrangement of the writing materials, which seems to be very possible considering that the Coptic language experienced a regional fragmentation into various dialects throughout its history.[9] We hope that systematic study will be able to unequivocally address the validity of MacArthur's suggestion that the choice of ink type might

[1] e.g. Lucas 1962.

[2] Nir-El and Broshi 1996.

[3] Brun et al. 2016.

[4] Rabin and Krutzsch 2016 (unpublished lecture).

[5] Buzi and Emmel 2015.

[6] Delange et al. 1990.

[7] Rabin et al. 2012.

[8] MacArthur 1995.

[9] Buzi 2015.

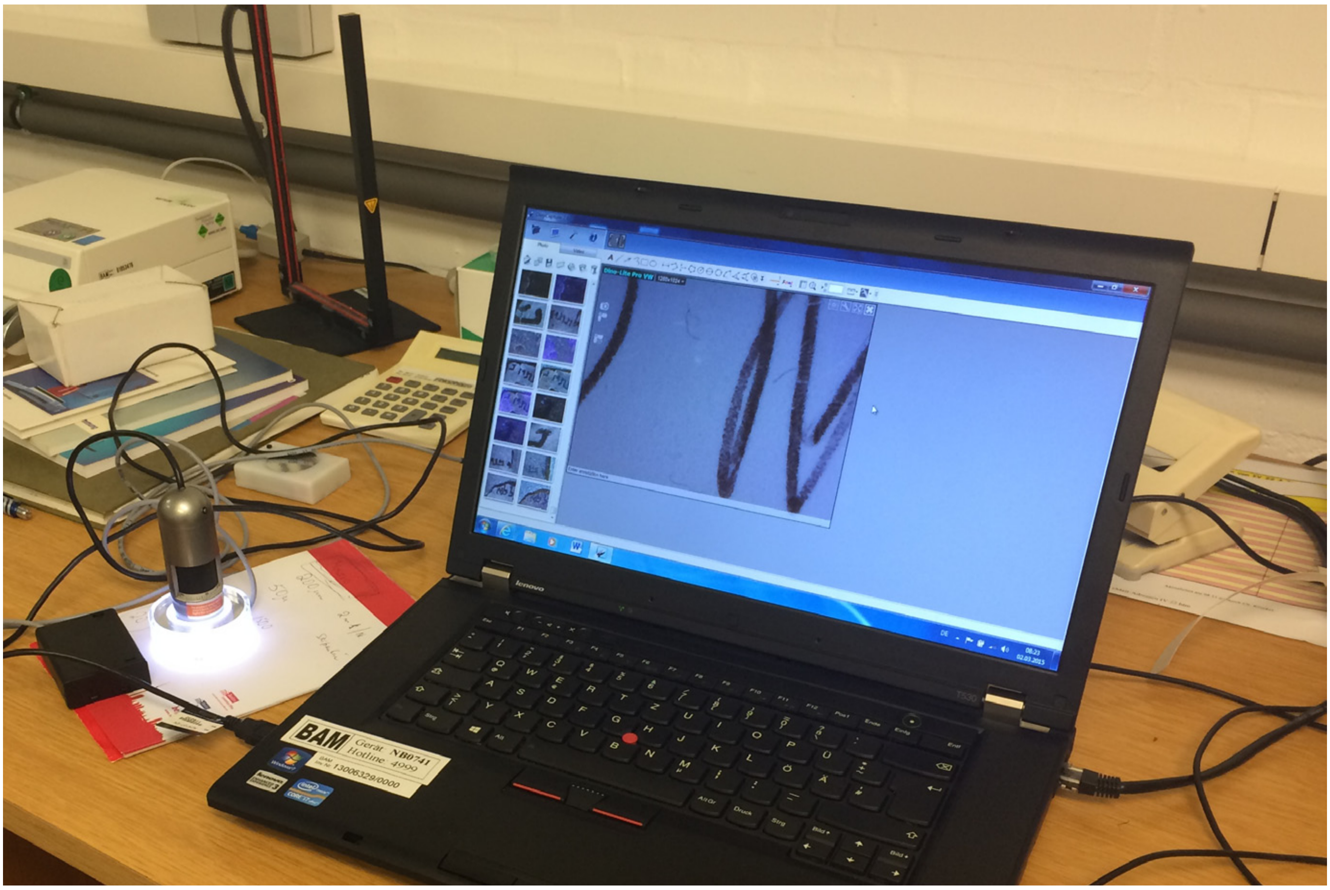

Fig. 1: DinoLite microscope, AD413T-12V.

have depended on the writing surface.[10] Therefore, the study will include the detailed description and characterization of the writing surfaces parchment and papyrus. Of course, it is also possible that more than one of the conditions presented above coexisted in the same temporal and spatial context, thus making the results of this study even more important.

Aside from the study of the history of writing materials, this investigation may make a valuable contribution to Coptic paleography and codicology. As already demonstrated in a previous study,[11] a correct scientific approach to the study of writing materials makes it possible not only to distinguish among different types of inks, but also, in the case of iron-gall inks, to distinguish among different types of materials used in the preparation of the inks. This information, if complemented by additional paleographical and codicological expertise, might lead to some interesting considerations regarding the persons and phases involved in the production of a specific codex.

[10] MacArthur 1995.

[11] Rabin et al. 2012; Buzi 2016.

Finally, the ink production recipe revealed by scientific methods can be used as a geochronological marker, making it possible to lay a first foundation stone for an inks database. This could help to date, localize, or provide new elements for understanding the typology and dating of some other Coptic scripts, thus completing dating results obtained so far from paleographic and textual methods.

Corpus

The full corpus of the documents covering a broad time span is still to be defined and adjusted in accordance with the results obtained in the course of work. In any case, we are going to work with the texts whose codicological and paleographical aspects have been properly studied in the frame of the PAThs project.

Our first analysis deals with the manuscripts that very likely originate in the cathedral of Thi(ni)s, nowadays Girga, located not far from Abydos. The library of Thi(ni)s is indeed a crucial and transitional instance in the history of Coptic manuscripts, which saw the creation of new codicological and palaeographical features, on the one hand, and the

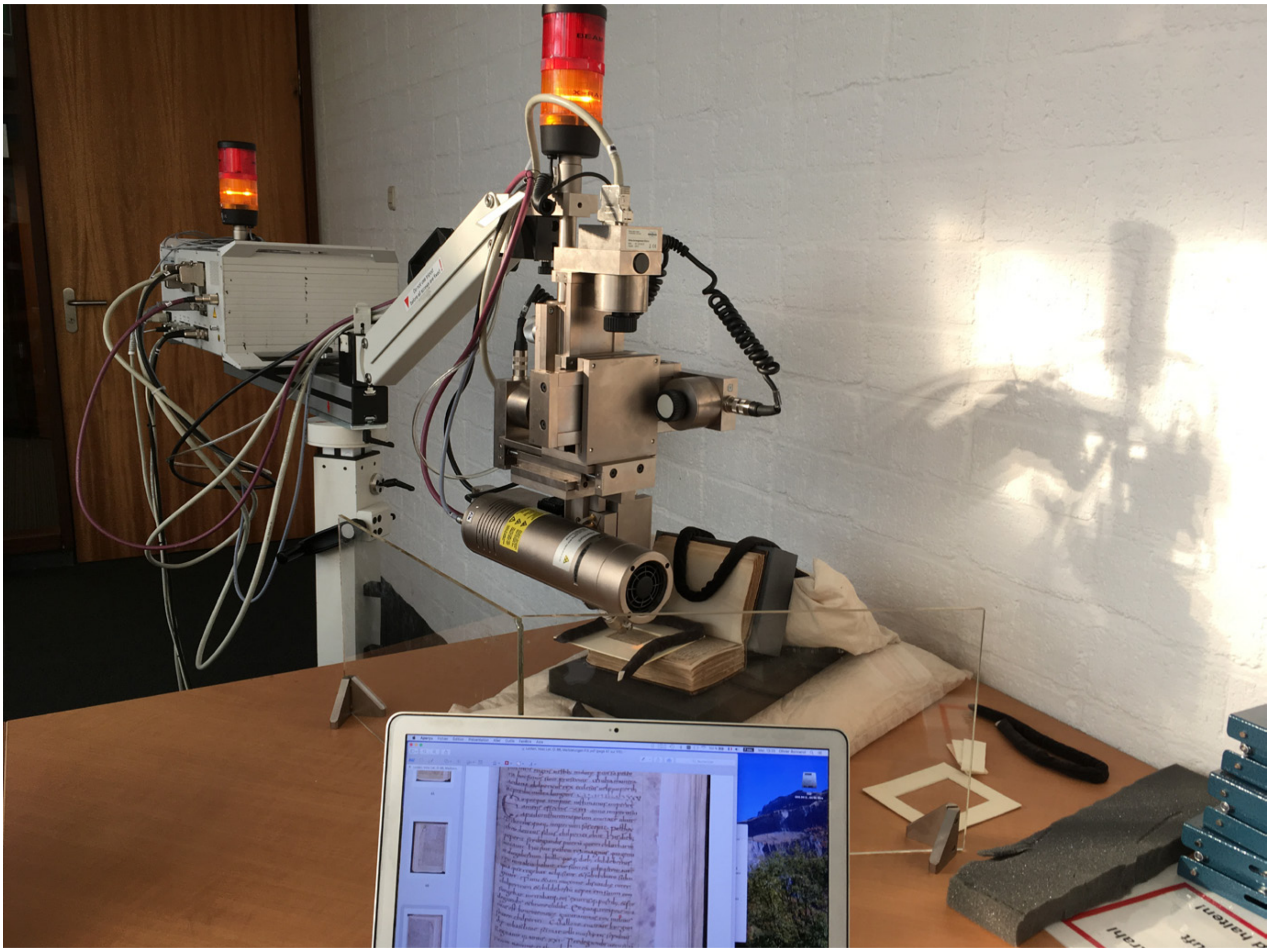

Fig. 2: ARTAX Bruker Nano GmbH.

progressive emergence of multiple-text codices, on the other. This explains the great importance of acquiring information concerning the material aspects of these codices. Besides, the fact that the manuscripts in question were very likely manufactured in a limited span of time and were written by a limited number of copyists made the study of the library of Thi(ni)s the first choice in our corpus.

The other collection to be analyzed includes fragments from the White Monastery in Sohag (Upper Egypt). Under the leadership of Shenoute (approximately 348–465/66 CE), the confederation of monasteries coordinated by the White Monastery became one of the most important centers of Coptic literary production. Its library (dating back to the ninth–eleventh centuries) is nowadays preserved in several collections all over the world, because the codices were dismembered and ended up in different places[12] such as the Staatsbibliothek zu Berlin (State Library Berlin)and the Bibliothèque nationale de France (National Library of France) in Paris.

Furthermore, we will work also on some manuscripts from the Michaelides collection. George Michaelides, a Greek collector who died in 1873, possessed a fine collection of manuscripts. The Cambridge University Library acquired part of this collection between 1976 and 1979, including some texts in Coptic. According to Michaelides, the texts date to the period between the sixth and ninth centuries and originate in the Fayyum region.[13]

Growing recognition of the importance of the material studies of the manuscripts, coupled with the development of the non-invasive protocols, encouraged many renowned institutions to give us access to their collections. We have already carried out analysis at the Egyptian Museum in Turin, at the State Library Berlin, and at the Cambridge University Library. During the first year of the project, we

[12] Buzi 2016.

[13] Clackson 1993.

plan on performing the analysis also at the Apostolic Vatican Library in Rome and at the National Library in Paris. Finally, the Bodmer Library in Cologne has also expressed its interest in cooperating with the project.

Experimental protocol and equipment

Our standard protocol for ink analysis consists of a primary screening to determine the type of the ink and a subsequent in-depth analysis using several spectroscopic techniques: XRF, FTIR, and Raman .[14]

The primary screening is carried out by means of NIR reflectography. Strictly speaking, optical differences between carbon, plant, and iron-gall inks are best recognized by comparing their response to the infrared light: carbon ink has a deep black colour, iron-gall ink becomes transparent above 1200 nm, and plant ink disappears at about 750 nm. We have simplified the analysis using a small USB microscope (with the built-in NIR (940 nm) and UV (390 nm) LED in addition to an external white light source. Working at 940 nm, we determine the ink typology by observing the changes in the opacity of the ink. Here, carbon-based inks show no change in their opacity when illuminated with NIR wavelengths, while the opacity of iron-gall inks changes considerably, and plant inks become transparent.[15] The in-depth investigation includes micro-XRF analysis to obtain the contribution of the inorganic components of the ink. In the case of iron-gall inks, we establish the fingerprints, i. e., the characteristic ratios of the vitriolic components of the ink.[16] Finally, in specific cases that may require more insight and further investigation, we perform FTIR spectroscopy to collect information on the chemical composition of the binders and Raman spectroscopy to determine the co-presence of carbon and iron-gall ink.

First results

The evidence of the earliest iron-gall ink we have ever measured comes from the Book of Proverbs kept at the Staatsbibliothek in Berlin (Ms. Berol. orient. oct. 987).

The single-layer Book of Proverbs codex consists of forty bifolia and three single folios that were cut to shape from three papyrus rolls. As Hugo Ibscher[17] has already determined, the rolls were previously halved in height. The dimensions of the folios are about 13 cm (height) × 29 cm (width), while the inner double folios are up to 4 cm narrower because this was the only way the form of the book block could be shaped in a unified way. If the double folios, detached from the codex, are laid beside each other individually in the sequence of the pages in the codex, the work method of cutting the sheets to shape from the roll becomes recognizable. The course of the fibers on the recto side shows that the double sheets were cut from the roll from right to left.

It is difficult to examine the material quality and technical details of the papyrus, because the codex was embedded in chiffon silk in 1958 and 1959. It is nonetheless possible to determine that the papyrus material is of low quality and poor structure. The quality difference between the recto and the verso is obvious. Thus, many verso sides display conspicuously dark, very coarse fiber strands. Six double folios (fols 2, 4, 12, 21, 30, and 40) have patches; here, too, these are on the verso side.

An examination of the codex showed that two-thirds of the double sheets display two sheet glue bonds each; one-third have only one-sheet glue bond; and one double sheet has no glue bond. The sheet glue bonds are manufactory glue bonds[18] of the common Type II. As could be expected, the left sheets lie over the right sheets. The sequence of the sheets thus corresponds with the direction of the script. The width of the glue bonds varies between 2 and 3 cm; it reaches 3.5 cm in three cases and even 4 cm in one case. Precisely the width of the sheet glue bonds can indicate the time of the production of the papyrus material placing it in in Roman or even Byzantine times.

Figures 3a and 3b show the reflectographic images and the XRF spectra. The observed loss of opacity when the illumination is changed from the white (Fig. 3a left) to the NIR light (Fig. 3a right) indicates that the ink belongs to the iron-gall type. In Fig. 3b, we observe that the peaks corresponding to iron (Fe), copper (Cu), and potassium (K) grow considerably in the spectrum of the inks as compared with that of the underlying writing surface papyrus. A constant ratio between copper and iron, found throughout the ink of the manuscript, delivers a decisive proof that we are dealing with iron-gall ink.

[14] Rabin et al. 2012.

[15] Mrusek et al. 1995.

[16] Hahn 2010; Rabin 2012.

[17] Ibscher 1958.

[18] Krutzsch 2017.

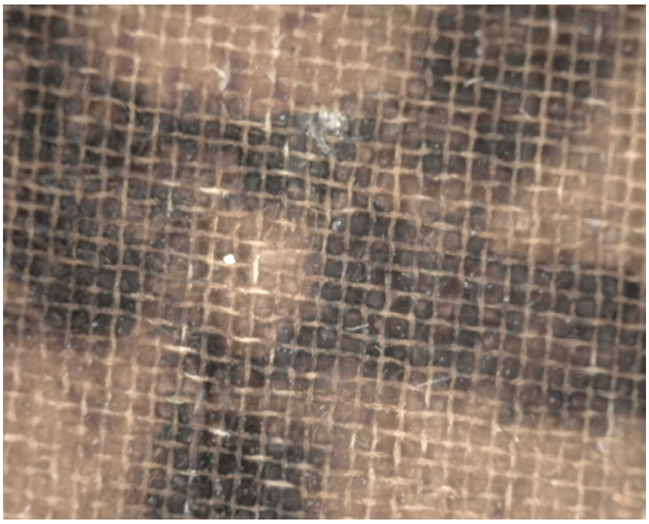

Fig. 3a: VIS images of a black ink from the Book of Proverbs.

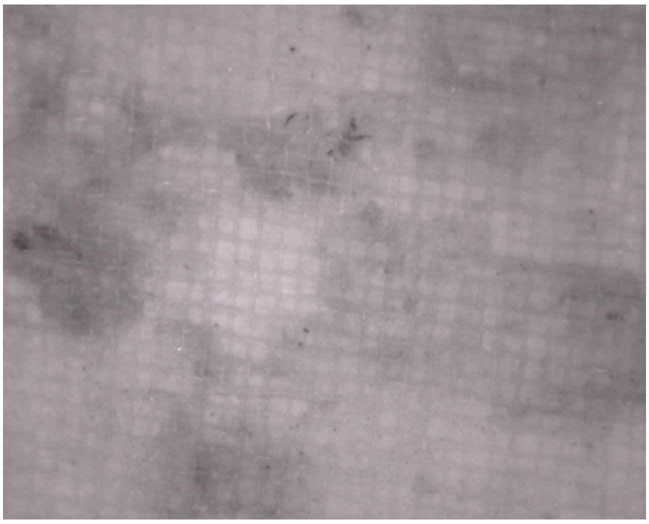

Fig. 3b: NIR images of a black ink from the Book of Proverbs.

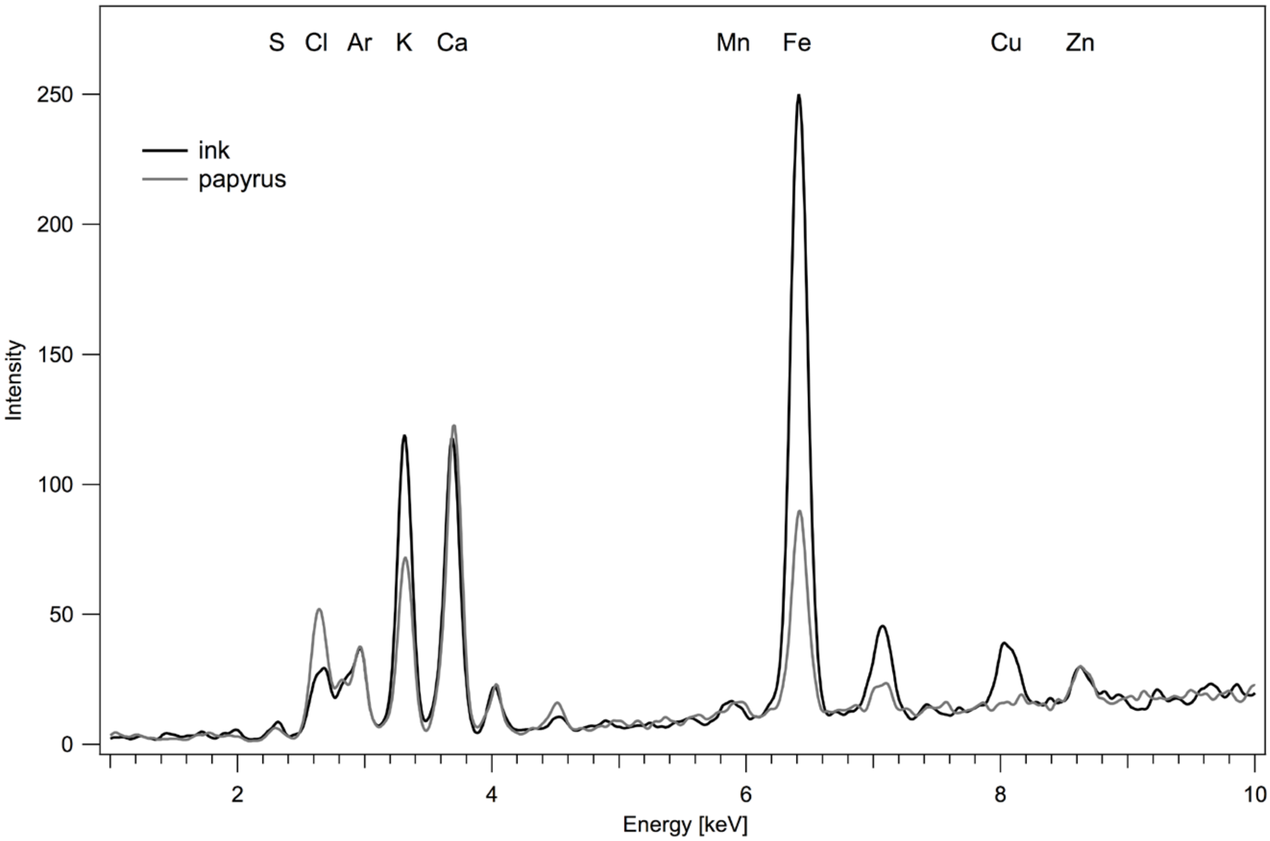

Fig. 3c: XRF spectra of the papyrus and the ink (grey and black curves, respectively).

Fig. 4a: VIS images of a black ink from Codex II preserved at the Egyptian Museum in Turin.

Fig. 4b: NIR images of a black ink from Codex II preserved at the Egyptian Museum in Turin.

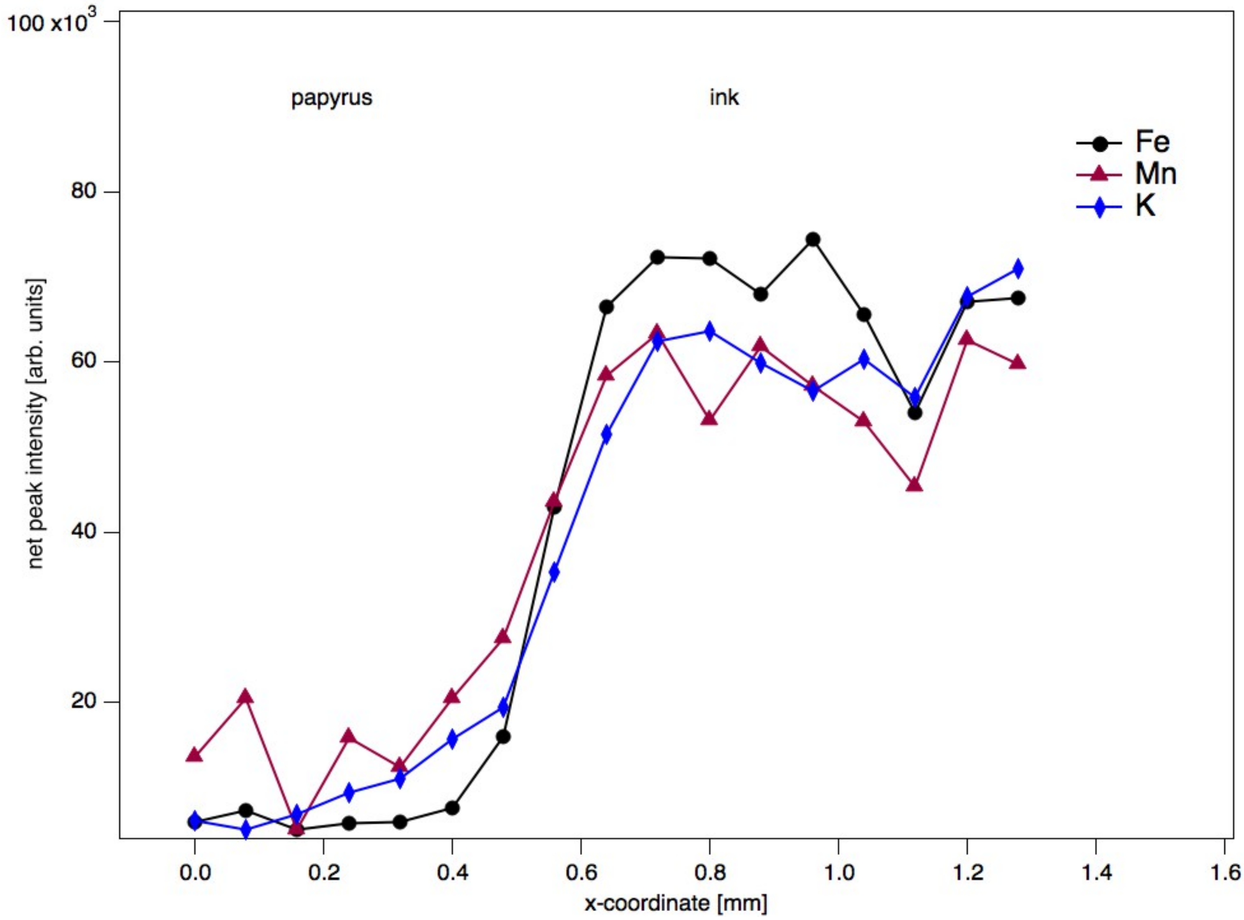

Fig. 4c: Intensity profiles of the characteristic ink from Codex II preserved at the Egyptian Museum in Turin.

Our next surprising finding was that a deep black colour of the ink from the Thi(ni)s fragments corresponded to iron-gall rather than carbon ink, as we instinctively believed. As in the previous case, the change in opacity observed in reflectographic analysis indicated the iron-gall nature of the ink. The composition study by means of XRF analysis confirmed a considerable growth of the iron signal in the ink. Figure 4b shows the intensity profiles of the elements iron, potassium, and manganese extracted from the measurements taken along the line connecting non-inked and inked areas, called the line scan. From the similarity of the profiles, we conclude that all three elements belong to the ink composition. Potassium is usually present in plant inks, but its increased abundance most probably indicates that gum arabic was used here as a binder in accordance with many recipes for iron-gall inks. The element manganese could be an indication of the use of a specific form of vitriol that lacked copper and zinc. On the other hand, it could be an indication that the ink was produced using a source of iron other than vitriolic salts. We plan to address this question in our future experiments.

Our third preliminary result that we would like to mention here is connected with the Michaelides collection preserved at the Cambridge University Library. Here we find carbon and iron-gall ink in different fragments that allegedly originated in the same region and within a relatively short time span, thus confirming the coexistence of different kinds of ink in Coptic Egypt.

Conclusion

The number and reputation of the institutions involved indicate that the study attracts the attention not only of the community of scholars working on Coptic manuscript tradition, but also of all professionals dealing directly or indirectly with the history of inks and writing materials. In fact, this pioneering study aims not only at a better understanding of the complex Coptic multicultural and plurilingual society, but also and mainly at clarifying the links among the Coptic and other societies in the ancient and medieval eras. Finally, it will cast light on the history of the technological development of inks in the Eastern world, from Antiquity to the Middle Ages.

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