Between Literary and Documentary Practices: The Montserrat *Codex Miscellaneus* (*Inv. Nos.* 126-178, 292, 338) and the Material Investigation of Its Inks*

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Abstract
The Montserrat *Codex Miscellaneus* (TM 59453/LDAB 552) has been the subject of numerous studies since the publication of its first text by its owner, father Ramon Roca-Puig. Scholars have dealt with the content of its texts, as well as interrogated its origin and materiality. It is a fourth-century papyrus single quire codex, which contains texts in both Latin and Greek. It has been argued that it belonged to the Bodmer library, connected to a Pachomian library in the Thebaid. In this paper we want to contribute to the material study of the codex by presenting the first results of an archaeometric analysis performed upon the inks. The analysis was carried out within the framework of the 'PAThs' project based at Sapienza University of Rome, and executed with the close cooperation of DVCTVS, a team of scholars who curate the Roca-Puig collection. The results obtained have not only cast light on the history of production of the codex, but also, and perhaps most importantly, point out that a meaningful interpretation of the analytical data is only possible through an interdisciplinary collaboration between the humanities and the natural sciences.

Keywords
Codex Miscellaneus, book production, palaeography, archaeometry, ink analysis, interdisciplinary approach.

1. *The Montserrat* Codex Miscellaneus

The Montserrat *Codex Miscellaneus* (TM 59453/LDAB 552) was acquired by father Ramon Roca-Puig in 1955. He produced several editions of the texts contained in the codex.[1] It has been ever since the subject of much attention, and multiple studies have dealt with the content of its texts in addition to its origins and materiality.[2] It is a fourth-century papyrus single quire codex, containing texts in both Latin and Greek. It has been argued that it belonged to the Bodmer library, allegedly connected to a Pachomian library.[3]

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1 On Ramon Roca-Puig and his papyrus acquisitions, see Tragán 2015, 20-29; Ortega Monasterio 2011, 59-76; Ortega Monasterio 2015, 43-52. On the first editions of the codex, see Roca-Puig 1965 and Roca-Puig 1977.

2 E.g. Torallas Tovar - Worp 2006, 11-24; Gil - Torallas Tovar 2010, 17-31; Nocchi Macedo 2013, Nocchi Macedo 2014, 26-48; Ammirati 2015a, 57-58.

3 The *Codex Miscellaneus* was claimed to belong to the Bodmer Library by James M. Robinson already in (1990-1991) 26-40, esp. 34. See also Brashear *et al.* 1990, 3-32. Lowe had observed the palaeographical resemblance between the Montserrat codex and Chester Beatty AC1499: see Lowe 1971, no. 1782. Other formal similarities include page set up and codex typology. Camplani 2015, 124-125, also observed the coherence in the Christian contents of the *Codex Miscellaneus* and some of the Bodmer books; see also some critical remarks on the last hypothesis in Mihálykó 2019.

It may seem out of context that a project like 'PAThs', dedicated to the study of Coptic Egypt, invested its resources into the archaeometric analysis of a codex written in Greek and Latin. However, it cannot be forgotten that Egypt was characterised as having a multilingual society at that time.[4] The results obtained from the analysis of Egyptian manuscripts written in languages other than Coptic represent valid terms of comparison, thus establishing a diversity of sources crucial to maintaining a broad perspective on codices produced during the time period.

In addition, as already said, the *Codex Miscellaneus* is generally recognised as being part of one of the most important collections of manuscripts from the Late Antiquity: the so-called Bodmer Library.[5] Given the intricate and delicate situation of this reconstructed 'library', whose dating and provenance are still debated, an archaeometric approach to the study of the inks and writing supports could help future understanding of the manuscripts' history, from their production to their arrival in the institutions where they are nowadays preserved.

1.1 Description

This papyrus codex consists of a single quire,[6] of which twenty-six out of at least twenty-eight original bifolia are preserved. Eighteen bifolia are virtually complete. It is a multiple-text codex, composed of several production units, since it has been written in different moments.

The codex bears the inventory numbers 128-178, 292 and 338 in the Roca-Puig papyrus collection at Montserrat (called *P.Monts.Roca*).

The size of each folium is ca H. 12.3 x W. 11.4 cm.[7] The pages have a rather trapezoidal shape, since their height diminishes slightly from the centre of the bifolia towards the outer edge of each folium. The bifolia, originally folded vertically in the centre, were sewn together with two double stitches. Some remnants of the string are preserved, as well as pieces of parchment, which had been inserted between the papyrus leaves and the string for purposes of reinforcement. The vertical fibres appear on the outer side of the first preserved folium, the horizontal fibres appearing in the inner side of the folium. This order continues until the centre of the codex, inv. no. 153-154, where one finds two pages, 56-57, showing both horizontal fibres. After that the order of fibres changes to horizontal alternating with vertical fibres.[8]

The general content of the codex is as follows:

A: Inv. no. 128↓–149↓, pp. 5-47 of the codex (Latin): Cicero, *Catilinarian Orations*, 1-2.[9]

B: Inv. no. 149→ –153→, pp. 48-56 of the codex (Latin): *Hymn to the Virgin Mary*.[10]

C: Inv. no. 154→, p. 57, of the codex: Drawing of a mythological episode.[11]

D: Inv. no. 154↓– 157↓, pp. 58-64 of the codex (Greek): Anaphora.[12]

E: Inv. no. 158→ –161→ (the other ↓ side of Inv. no. 161 is blank), pp. 65-71 [72] of the codex (Latin): *Alcestis* in Latin hexameters.[13]

F: Inv. no. 162→ –165↓, pp. 73-80 of the codex (Latin): Tale about the Emperor Hadrian.[14]

G: Inv. no. 166→ –178↓, pp. 81-106 of the codex (Greek): Alphabetised stenographical *Commentarium*.[15]

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4 Rochette 1996, 153-168; Rochette 1998, 177-196; Oréal 1999, 289-306; Fewster 2002, 220-245; Thompson 2009, 395-417; Fournet 2009, 418-451; Torallas Tovar 2010a, 17-43; Torallas Tovar 2010b, 253-266; Buzi 2018, 15-67.

5 Fournet 2015, 8-37; Schubert 2015, 41-46.

6 This practice is the common procedure in early codices. See Kenyon 1933, I, 10-11. Ibscher 1937 claims that all papyrus codices up to the third century are single-quire codices, and it was from the fourth century on that they started to be composed in more than one quire. However, the Bodmer codices are dated to the fourth century. It is taken also as a sign of the fact that the codex comes from a school environment, cf. Kasser - Cavallo - van Haelst in Carlini 1991, 108, n. 10. For a full survey on the subject, see Robinson 1978; and also Turner 1977, 51-55, 61.

7 This is Turner's group 10; see Turner 1977, 22.

8 This is perfectly typical in single-quire codices; cf. Turner 1977, 58-60 and 65.

9 Roca-Puig 1977; Willis 1963.

10 Roca-Puig 1965.

11 Roca-Puig 1989, 139-169, text no. 4; Musso 1990, 30-32; Horak 1992, 230 (ViP 48); Nocchi Macedo 2010, 91-117.

12 Roca-Puig 1994.

13 Roca-Puig 1982; Marcovich 1988; Lebek 1983, 1-29; Parsons - Nisbet - Hutchinson 1983, 31-36; Tandoi 1984, 3-11; Nosarti 1992; Liberman 1998; Nocchi Macedo 2014.

14 Gil - Torallas Tovar 2010; Berg 2018; Ammannati 2018, 221-240.

15 Torallas Tovar - Worp 2006, 11-24; Luiselli 2017, 36-40.

At least two folia are missing from the beginning of the codex, and one more after the first preserved page. At the end of the codex, given the average length of the six individual word lists in the last section, G, we calculate that one more folium is missing with the page containing the last entries of the sixth sub-list.[16]

The binding features dimensions of H. 12.3 x W. 11.7 cm. The outside material is low quality parchment, which is at present in very brittle condition. Its hair side is on the outer side of the binding, while the inside material of the binding consists of various layers of papyrus used for padding the parchment of the binding. This papyrus-padding material still shows traces of writing and has been affected by worms.

Furthermore, four stripes of leather knotted on the inner side of one cover of the binding have been preserved, while the other cover has only two such knots preserved; there are two more holes in the parchment of this cover which might have been made for holding two more knots, establishing a symmetry between the two covers of the binding. These knots are drawn through the parchment and the padding inside, and were probably meant to keep the padding material in place.

1.2 Palaeography of the codex

While studying the history of the production of a certain manuscript, its palaeography is a crucial element that needs to be established as accurately as possible, and should be prioritised as much as any merely textual element. The fact that one or more scribes might be at work, for example, can be palaeographically established, and then successively confirmed by observing the composition of the inks as revealed by archaeometric analysis.

The successive sections of the codex (A-G) feature a different page layout.[17] The main difference is between the first six sections, which present running text, and the last, Section G (Inv. no. 166→ –178↓, pp. 81-106 of the codex), which presents three columns of, on average, thirty-two lines/entries. These sections, moreover, feature texts both in Latin and Greek. The handwriting across all texts is inscribed in a regular cursive, featuring an "informal round" for the Greek, and a minuscule with some ligatures for the Latin, both of which datable to the second half of the fourth century. Despite variations in the size of the writing and in the page layout from one text to another, the corroboration of many colleagues has helped us conclude that one single hand is responsible for both the Greek and Latin texts.[18]

The Greek hand of the codex can be described as a small, quickly written cursive, roughly bilinear (the vertical strokes of β, κ, ι, ρ, υ often reach below the lower line), and sloping slightly to the right. There are often ligatures of ει, αυ, αι, γε, επ, ελ, θω, λλ, etc. Last letters of the words sometimes project into the intercolumnar space, but not systematically. Accents and breathings have not been written. Occasionally, there is diaeresis on ι and υ.

The Latin hand is not calligraphic either. The Latin hand in the portion containing Cicero's *Catilinarian Orations* is probably the same hand, though it is written slightly smaller, as the one in the Hadrian section of the codex. It can be described as an upright mixed writing, featuring uncial and cursive elements. Lowe[19] calls it 'early half uncial'. He already pointed to the resemblance of the Montserrat codex (in Lowe, Suppl. 1782) with Chester Beatty AC 1499, though he dated this one to the end of the fifth century and preferred to date the Montserrat text to the end of the fourth century.[20] Orsini also indicates that the hand of our codex might be the same as one of the hands of the Menander codex, also from the Bodmer library.[21]

1.3 Acquisition

In 1955, Dr Ramón Roca-Puig (1906-2001) purchased a number of papyrus fragments in Cairo which turned out to belong to our codex. Two documents from Roca-Puig's personal papers may give a clue to the co-

16 For further calculations on this, see Torallas Tovar - Worp 2006, 19-20.

17 Described with line numbers and measurements in Gil - Torallas Tovar 2010, 19-21.

18 Wouters 1988, 18, n. 49, notes that almost all editors of Graeco-Latin papyri have pointed out the resemblance between both hands. There are however cases when differences are so striking that two scribes are considered to have been at work. Most recently on the hands of the codex, Ammirati 2015a, 59 and Ammirati 2015b, 16-18.

19 Lowe 1971, no. 1683.

20 With different dates in CLA 1650 and 1785, cf. Orsini 2015, 65.

21 Orsini 2015, 65.

dex's original source. Both are handwritten by father Sylvestre Chauleur, Director of the *Institut Copte* in Cairo at that time.[22] Both were completed by the summer of 1955, when, apparently, father Chauleur visited the city of Barcelona and delivered the papyri to Roca-Puig personally. In 1973, through an exchange with the *Bodmer Foundation*, Roca-Puig acquired additional fragments also belonging to this codex; these are now inv. nos. 134-135.[23] Later on, an additional fragment from the same codex showed up in the collection of Duke University (inv. no. 798), and was edited by W.H. Willis (1963); this papyrus was subsequently given an imaginary inventory number 129 in Roca-Puig's files.

1.4 Origin

The origin of the codex is not completely clear. Unfortunately, the cover of the codex does not contain any indication of its owner nor scribe. Neither is there much information to be found within the codex itself, as the only reference to an owner appears in the colophons of two of the sections.

As mentioned above, it has been claimed that the codex belongs to the Bodmer library,[24] whose manuscripts were probably produced in the Thebaid. The fact that Chauleur's letter to Roca-Puig mentions the Pachomian monasteries could be used to reinforce the thesis presented by Robinson,[25] but we have to consider the possibility that the introduction of this idea was just a marketing strategy deployed back in the 1950s, so we will not force a conclusion on this matter.[26] There are, however, some material aspects that can help us reconstruct and understand the Bodmer library, and thus find a connection between the pieces in the hypothetical corpus. The reconstruction of this 'library' is mostly the work of James M. Robinson, who lists almost 60 items that, according to him, belonged to the same collection. This is what Fournet calls the 'maximalist inventory'.[27] In assembling this list, Robinson overlooked some acquisition information[28] and often based his hypothesis on unreliable informants,[29] but there still remains some consensus on the coherence of some of the material characteristics and even the textual contents of some of the codices.

A different matter altogether is that of the origin of the codex.[30] Some, including Robinson, claim that this was the library of the Pachomian monastery of Pbow. Others prefer to think that these books belonged to a centre of high education, perhaps in Panopolis.[31] There is also the issue of the geographical proximity of the supposed origin of the Bodmer library and the Nag Hammadi find, which, together with codicological and palaeographical criteria, has been an argument for associating both libraries and proposing a Pachomian origin to both of them.[32] All arguments are based on hypotheses and analogies that cannot be proven in a definite way. Turner[33] already advanced the possibility of a Panopolitan origin, seeing as some of the Bodmer rolls were copied on Panopolitan administrative documents.[34] Gilliam suggests a

22 Both edited in Gil - Torallas Tovar 2010, 25-27.

23 For the exchange affair with Kasser and Braun, see Roca-Puig 1977: xii-xiii.

24 The most recent approach is the monographic section of *Adamantius* 21 (2015) and Nongbri 2018, with an extensive study on the acquisition of this hoard(s) and material features of these books.

25 See n. 5, and Robinson 1990-1991 and Robinson 2011. Kasser 2000, xxi-xxxvii.

26 In spite of the connection of some texts with Pachomian content, the association of the Bodmer Library with the Pachomian communities is at least an open question, if not, as many think, very dubious. Fournet 2015, 12, 16-17. Camplani 2015, 127.

27 Fournet 2015, 8.

28 Kasser 2000, xxiv, n. 5.

29 Kasser 1988, collects two contradictory testimonies: the antique dealer who negotiated its sale to Mr. Bodmer said on his deathbed that they came from Ed-Debba, 5 km. from Nag Hammadi; Mr Bodmer's secretary, on the contrary, claimed that they came from Mina or Minia, in the outskirts of Assiut and that the provenance cited by the antique dealer applied only to *P.Bodm.* 17, from a different lot. Too much speculation, indeed.

30 On the proposals, Fournet 2015, 17-19.

31 Contra Robinson, see Blanchard 1991; Cribiore 2001, 200, and n. 74, both say that this hoard must have belonged to a Christian school of advanced learning. See also Fournet 1992, 253-266. Kasser 1988, 191-194. Kasser 1995, 28, n. 37. But see recently: Pietersma - Turner Comstock 2011.

32 Also led mainly by Robinson 2014, 1118-1135. Recently reopened by Lundhaug - Jenott 2015. For a debate on this see Wipszycka - Piwowarczyk 2017.

33 Turner 1968, 51-53.

34 The rolls of the *Iliad* in *P.Bodm.* 1 (third-fourth century) are copied on the verso of a Panopolitan land register (dated to 208/9). See Geens 2014, 80; Miguélez Cavero 2008, 221-222. See the codicological argument advanced by Fournet 2015, 14.

Panopolitan origin as well, but in his opinion the use of Latin in some pieces of the library contradicts the possibility of the library ever having belonged to a monastery.[35] Fournet and Gascou propose new evidence to link the Bodmer library to Dendera, in the Panopolitan nome but very close to Dishna, based on the evidence provided by documents (and the onomastics in these documents) found in the bindings of some of the codices.[36]

Since all evidence for a safe identification both of the geographical spot and the nature of the 'library' is circumstantial, we will never really know to which hoard the *Codex Miscellaneus* belonged. More than one hoard, however, may have been in circulation and up for sale in those years,[37] and the fact that books with different content and different dates could have belonged to the same library in Antiquity has to be considered as a possibility as well. What is pertinent for our inquiry, however, is the connections between different books presenting similar material features or even textual contents regardless of the library to which they eventually belonged, connections which can instead point to the *scriptorium* from which they might have emanated. A future intervention regarding the ink of codices allegedly belonging to the same 'library' could confirm or dismantle some of these hypothetical reconstructions. May this paper be a first step in embarking upon this worthy project.

2. *Experimental protocol and handling of the fragments*

The archaeometric analysis was performed using portable and non-invasive instrumentation. This way, it was possible to work directly *in-situ* and collecting samples from the leaves analysed was unnecessary. The experimental protocol we applied for the analysis of inks on this codex consisted of a primary screening using NIR reflectography to determine the typology of ink, followed by an elemental analysis using XRF spectroscopy.[38]

Given the peculiar structure of this codex, divided in 7 different textual sections, we decided to analyse one papyrus leaf per section, in order to compare the ink(s) used across the manuscript. Table 1 gives the shelfmarks of the leaves analysed.

Shelfmark	Section
Inv. 145	A – Cicero, *Catilinarian Orations*
Inv. 150	B – *Hymn to the Virgin Mary*
Inv. 154	C – Drawing of a mythological episode
Inv. 157	D – *Anaphora*
Inv. 161	E – *Alcestis* in Latin hexameters
Inv. 163	F – Tale about the Emperor Hadrian
Inv. 172	G – Alphabetised stenographical *Commentarium*

Table. 1. Shelfmarks of the leaves analysed and correspondent textual sections.

The leaves of this codex were preserved in glass frames sealed with paper tape. The near-infrared reflectography was performed without removing the glass frame, holding the USB microscope in direct contact with the top glass. This procedure prevented the papyrus leaves from exposure to even the most miniscule amounts of physical stress due to the contact between the writing support and the external surface of the microscope. Unfortunately, it is not possible to perform XRF analysis without removing the glass frames, given that the X-ray beam must be focused directly on the surface of the manuscript. However, during this second step we decided to remove only the top glass, leaving the papyrus leaves positioned

35 Gilliam, 1978, 128-131: while both Menander and Homer are not out of place in a monastery, Latin is however unexpected. Cf. Evelyn White 1926, 320-321, for inscriptions on walls of cells with lines of the Iliad and Menander's *sententiae*. See also Stramaglia 1996, 131-135. Other hypotheses propose a Christian secondary school rather than monastic library.

36 Fournet 2015, 18.

37 As Fournet 2015, 12 also claims.

38 Rabin *et al.* 2012. For further information, see the section "Analytical protocol" contained in the paper "Gaining perspective the materiality of manuscripts: the contribution of archaeometry to the study of the inks of the White Monastery codices" in this same volume.

Fig. 1. Montserrat Abbey, Roca Puig collection, Inv. 150. On the right the micrographs under visible (top) and near-infrared (bottom) light.

on the bottom half of the glass frame. This way it was not necessary to handle the papyri directly, since the bottom glass was used as a support to move the leaves while positioning them under the X-ray beam. We followed this procedure for every leaf examined after verifying that the chemical elements present in the glass were not interfering with the analysis of the ink and papyrus. When possible, we collected at least 4 measurement spots on the inks per leaf in an attempt to portray an accurate representation of the whole surface of the text. Because X-ray penetrates the whole cross-section of the papyrus, to perform XRF it is necessary to have a blank surface on the other side of the leaf that corresponds with the spot of ink chosen for analysis. This often represented a challenge, given both that the text was very densely distributed on the two sides of each folio, and that the spots closer to the border of the paragraph, where generally it is easier to find the condition described, were often too deteriorated to obtain a satisfactory outcome.

3. *Results and discussion: the* Codex Miscellaneus

Fig. 1 shows the results of NIR reflectography on *P.Monts.Roca* inv. 150. Comparing the visible and near-infrared images we observe a slight change in the opacity of the ink. This feature is generally typical of iron-gall inks, although in this case the change in opacity is not everywhere as evident as it is normally observed in medieval iron-gall inks. A closer look at the visible and near-infrared images shows the first letter on the left changes its opacity less than the other letters. Similar observations were made on *P.Monts.Roca* inv. 145, inv. 154, inv. 157, inv. 161, and inv. 163, although the change in opacity between visible and near-infrared micrographs was in some cases more prominent than in others. In a previous work we extensively discussed the limitation of our current analytical protocol to characterise mixed inks obtained through blending carbon with either iron-gall or plant ink.[39] Since it is impossible to predict the behaviour of such inks in the near-infrared region, we tend to be cautious in the interpretation of the results from NIR reflectography when identifying the typology of ink (namely: carbon, iron-gall or plant). In the case of the inks observed on leaves belonging to sections A to F of this codex, we cannot exclude that in some cases small amounts of carbon were added to the mixture.

39 Colini *et al.* 2018.

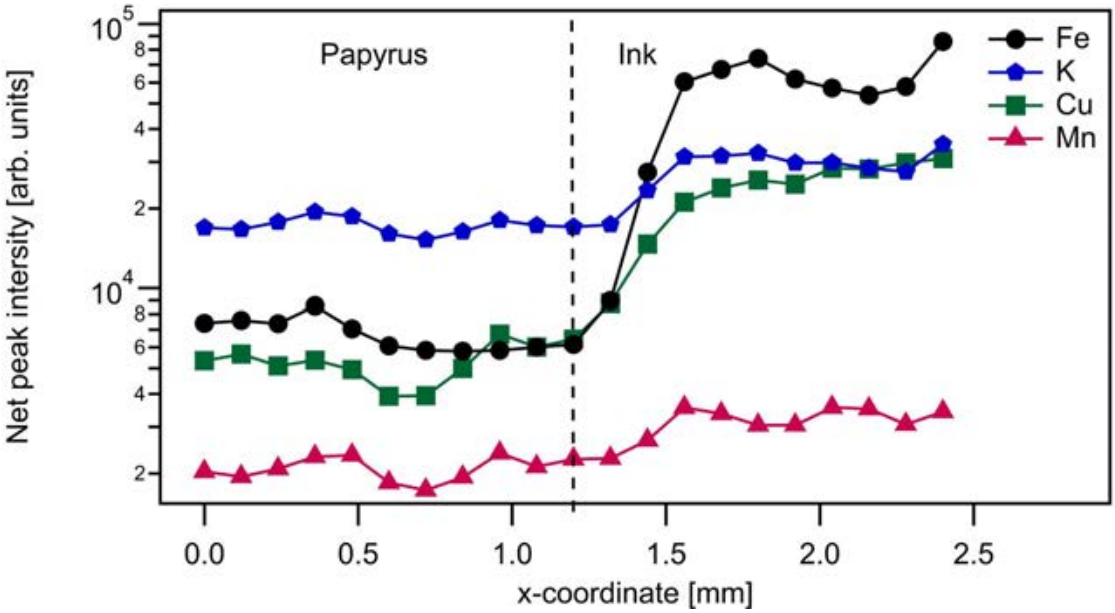

Fig. 2. XRF intensity profiles of different elements collected at the interface between papyrus and ink on Inv. 150.

XRF analysis on these same leaves detected consistent amounts of iron, copper, and potassium, along with small amounts of manganese in all the inks examined. As an example, Fig. 2 shows the intensity profiles of the elements iron, copper, potassium and manganese extracted from the XRF measurements taken along the line connecting the support and an inked area on *P.Monts.Roca* inv. 150 (i.e. the so-called line scan). The similarity of the profiles indicates that all these elements are contained in the ink. Calcium was sometimes found in large amounts, but its presence was at least partly the result of contamination, perhaps originating from papyri contained in the mummy cartonnage that was preserved in the same collection, forming a group of documents probably kept and sold together in the same lot by the papyrus trader in Cairo. This result, together with the slight change in opacity observed in the near-infrared micrographs, indicates that the main component of the writing media used on these leaves is iron-gall ink.[40] The content of potassium may generally be attributed to the binder or to the tannins, while iron, copper and manganese were probably contained in the metallic salt(s) used to prepare the inks.

It is interesting to notice that the ratio of these other elements to iron (i.e. the so-called fingerprint) is heterogeneous along the various sections of the codex, as shown in Fig. 3. Here we observe that the difference between the fingerprints from different spots of ink on *P.Monts.Roca* inv. 145, inv. 154, inv. 157, inv. 161, and inv. 163 is often of such a magnitude as to suggest that this codex was written in more than one phase, a fact that could explain many of its variations in size and page set-up.

In fact, we assume that a coherent writing phase is characterised by the same ratio of other elements to iron, the main component of iron-gall ink. Such ratio can be affected by different factors of impact. The most obvious is the preparation of a new batch of ink once the previous has been used up. In this case, depending on the ingredients (especially the metallic salts) used in the manufacturing of the new ink, the fingerprint can be either completely different in its elemental composition, or simply display a different ratio of elements to iron. In any case, it is very unlikely that the new ink prepared would display the exact same fingerprint as the old one. Differences in the preparation process might also lead to changes in the ink. Another factor influencing the fingerprint is the potential for a new binder to have been added to the ink at some point in order to prevent the particles of pigment from depositing on the bottom of the inkwell. In this case, given the characteristically high concentration of potassium in Egypt's most common binder, gum Arabic, the effect on the fingerprint would most likely be an increase in the ratio of potas-

40 To obtain iron-gall ink a source of iron (generally metallic salts) is mixed with hydrolysable tannins. These are rich in gallic acid which complexes iron to form a black pigment called iron-gallate.

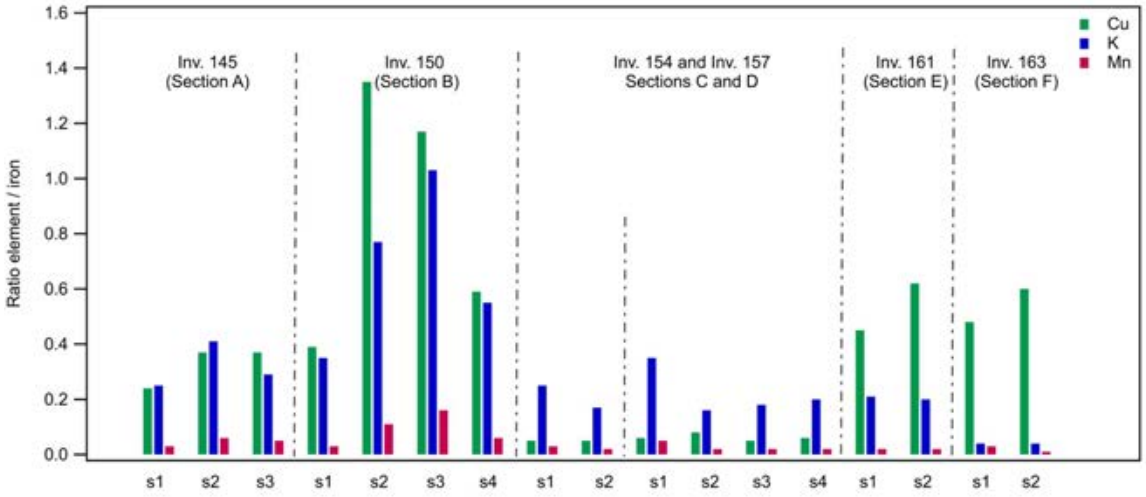

Fig. 3. Fingerprint of different spots of ink (s1, s2, s3…) on the leaves from sections A to F of the *Codex Miscellaneus*.

sium to iron. Finally, the fingerprint can change as a mere effect of time because of deposition and drying processes affecting the ink. Furthermore, experimental studies performed on iron-gall inks preserved in sealed bronze containers showed that the metallic vessel can leak into the ink with the passing of time, thus increasing the concentration of one or another element.[41] It must be stressed, though, that the use of metallic ink well during Late Antiquity has not been largely attested so far. One of the few examples we have comes from Hamuli and is probably dated between the ninth and tenth century CE.[42] Because it registers the factors of change discussed so far, the fingerprint model was applied in the past to complement codicological studies, and it successfully led to the characterisation of each writing phase when applied to texts written on rather homogeneous supports, such as parchment or European paper.[43]

Unfortunately, the situation is by far more complicated in the case of papyrus manuscripts because the heterogeneous structure of the writing support largely hampers an accurate determination of the inks' fingerprints.[44] Consequently, comparisons between the fingerprints of inks from different leaves of the *Codex Miscellaneus* must be treated with extreme caution. In any case, the analytical data presented in this work do not aim at providing an exact determination and characterisation of the various writing phases. Even if we were dealing with a more homogeneous support, this task could certainly not be accomplished analysing only a few spots of ink on 6 of the over 50 leaves that compose sections A to F of the codex. It is possible, though, to obtain a general indication regarding the different stages of writing by observing the data from Fig. 3. Here we can distinguish 5 groups of fingerprints that show significant variations in the ratios of other elements to iron:

- section A (folio 145) displaying similar ratios of copper and potassium and a lower ratio of manganese;
- section B (folio 150) where the ratio of all these three elements tends to be higher;
- section C and D (folios 154 and 157) showing ratios of potassium higher than ratios of copper and manganese;
- sections E (folio 161) displaying a ratio of copper that is almost doubling the ratio of potassium;
- section F (folio 163) showing a fair ratio of copper and very small ratios of potassium and manganese.

Obviously, the one presented here is just a rough discrimination, as can be inferred by observing the ink spot 1 analysed on section B. Its fingerprint much more closely resembles those in section A than those which immediately follow in section B. This suggests the possibility that the writing phases of the codex

41 Nehring 2019.

42 Depuydt 1993, 601, pls 465-467.

43 Hahn *et al.* 2007; Rabin - Hahn - Geissbühler 2014; Geissbühler *et al.* 2018; Hahn - Heiles - Rabin 2018.

44 Ghigo - Rabin - Buzi 2020.

Fig. 4. Montserrat Abbey, Roca Puig collection, Inv. 172. On the right the micrographs under visible (top) and near-infrared (bottom) light.

did not always coincide with the limits of a textual section. It is plausible that the scribe took breaks from writing or prepared new ink while working at the same section.

The last section of the codex (section G) is peculiar compared to the others. Unlike the previous sections it does not contain strictly a literary text, but a list of words related to the practice of stenography.[45] It is interesting to notice how the results obtained on *P.Monts.Roca* inv. 172 suggest that such peculiarity extends as well to the typology of ink used. Fig. 4 shows the corresponding visible and near-infrared micrographs. Here, no change in the opacity of the ink is observed, leaving no doubts that the text was written using a carbon-based ink. Furthermore, XRF analysis did not detect any inorganic element consistently present in the ink, confirming that this leaf was written using a pure carbon ink.

During our archaeometric studies of inks from late antique Egypt, we sometimes found carbon inks (or mixed inks containing consistent amounts of carbon) used in *marginalia* on the medieval parchment codices from the library of the White Monastery and of Saint Macarius monastery. However, the *Codex Miscellaneus* is the only case we have recorded so far of a manuscript displaying a significant discrepancy in the typology of ink used to write the main text of different parts of the codex. Carbon and iron-gall ink are very different both in the ingredients used for preparation and in the manufacturing procedure. This made us wonder about the reason of such discrepancy within the same codex. Since the practice of stenography was confined in antiquity to the sphere of the administration and justice, we decided to compare the results obtained on section G with those obtained on *P.Monts.Roca* IV 70, a documentary papyrus written in the same period.

4. *Results and discussion:* P.Monts.Roca *IV 70*

P.Monts. Roca IV 70 (inv. nos. 194 + 193 + 192 + 113 + 1204; TM 219245) contains the remains of a legal dossier, with accounts and a report of legal proceedings. In all likelihood, its provenance is Alexandria, since it contains the text of the proceedings of a trial before the Prefect of the Annona of Alexandria, Fl(avius) Cratinus. It has an internal date, 378/9 CE. It has been written in a skilled fourth-century cursive hand, performed with a very thin calamus, leaving very sharp strokes and elegantly executed letters. This fact

45 On the text, see Torallas Tovar - Worp 2006, 25-35. Stenography (or tachygraphy) is connected to notarial practice in Antiquity. On shorthand manuals and papyri, see Boge 1974; Boge 1976; Irigoin 1989; Menci 1992; Lewis 2003; Torallas Tovar - Worp 2006; Kaltsas 2007.

Fig. 5. Montserrat Abbey, Roca Puig collection, Inv. 113+192+193+194+1204. On the right the micrographs under visible (top) and near-infrared (bottom) light.

places our text in the context of a professional scribe linked to administration. Interestingly, the situation is similar for the last section of the *Codex Miscellaneous*, where one can clearly notice that a thinner calamus has been used.

The similarity between these two manuscripts extends to the type of ink used as well. Fig. 5 shows the results of the NIR reflectography on this document. The comparison between visible and near-infrared micrographs reveals that it was written using a carbon-based ink, exactly like the last section of the *Codex Miscellaneus*. In addition, XRF elemental analysis did not detect the presence of any inorganic element.

It could be argued that the comparison between the *Codex Miscellaneus* and *P.Monts. Roca* IV 70 is not appropriate, given that the area of provenance of the two manuscripts is indeed very different. In this regard, it must be mentioned that a recent study over a more significant number of documentary and literary texts, pointed out that carbon-based inks were found in most cases when analysing documentary papyri from various areas of Egypt, while iron-gall ink (or inks showing similarities to iron-gall) were used mostly in literary texts.[46] Against this background, if we accept that documentary and literary texts were produced in separate environments, we must acknowledge that both the textual contents and the archaeometric results coincide in suggesting that section G and sections A to F were composed in different environments, or in any case, using a different set of tools and materials.

5. *Conclusions*

The comprehensive analysis presented in this work cross-links textual, palaeographical, codicological, and archaeometric information, and casts light on the process of production of the *Codex Miscellaneus*. Previous palaeographic analysis identified only one hand as responsible for the composition of the codex, both in its Greek and Latin texts. The variation in language, page set-up and contents suggested that the book was not conceived as a single product, but was probably produced in successive phases according to the needs of the scribe. Now, elemental analysis on some of the leaves has revealed and confirmed that it was written in consecutive phases. We observed that there was a difference in the composition of the inks from the several sections, and in some cases, even within the same section, thus further indicating that the production did not happen in one instance, but rather the scribe stopped, maybe produced or procured new ink, and then continued writing at a later moment. In addition, both archaeometric and textual analysis suggest that the last section, the list of Greek words connected to stenography, was written in a different environment than the other sections. Further research on samples of papyrus and parchment manuscripts has pointed out the split that remained for a few centuries in the literary and documentary

46 Ghigo - Rabin - Buzi 2020.

use in some areas of Egypt: iron-gall inks used mostly for the former vs. carbon inks extensively used for the latter. We imagine that such traditions and customs weighed heavily in the production of ink in the *scriptoria* or offices where documents were produced.

In conclusion, we can assume that this small codex belonged to one single person who composed it in different moments. This only confirms the hypothesis already formulated in the past about this and similar miscellaneous codices.[47] It was most likely that the small dimensions of these types of codices made it easy to use them as 'notebooks' and thus to carry them around, a practice which likely left traces of different typologies of ink used across in different environments. The owner of the codex used iron-gall ink in the composition of the literary texts, but when he copied the words list (section G) – the only text in the codex which is not literary –, he used a different kind of ink, perhaps because he was at that point working in a *scriptorium* or office devoted to the production of documents.

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