Georgian Manuscripts from the Graz and Leipzig Collections: Results of Ink Analysis

Sebastian Bosch, Eka Kvirkvelia (Hamburg)

DOI: https://doi.org/10.62235/dk.4.2025.10507
sebastian.bosch@uni-hamburg.de || ORCID: 0000-0003-0469-7442
eka.kvirkvelia@uni-hamburg.de || ORCID: 0000-0001-8853-9964

Abstract: This article presents the results of an ink analysis conducted on the collections of Georgian manuscripts preserved at the Universities of Graz (Austria) and Leipzig (Germany). Notably, this study represents the first systematic ink analysis ever carried out on Georgian manuscripts. It focuses on identifying the composition of red and black inks using a range of analytical methods, including X-ray fluorescence (XRF), Raman spectroscopy, ultraviolet (UV), visible (VIS), and near-infrared (NIR) microscopy. The research was carried out within the framework of the project "The Development of Literacy in the Caucasian Territories" ("DeLiCaTe") by the laboratory of the Centre for the Study of Manuscript Cultures (CSMC) at the University of Hamburg. The primary aim of the study is to analyze inks from as many manuscripts as possible in order to establish a unified database identifying metals characteristic of specific regions and periods over time. Manuscripts whose date and place of origin are securely identified through colophons play a crucial role in building this database. Identifying inks of the same composition in manuscripts lacking such historical information can provide valuable evidence for determining their origin and, potentially, their date of production.

Keywords: Georgian manuscripts, Graz collection, Leipzig collection; ink analysis, XRF imaging, Raman spectroscopy, UV/VIS/NIR microscopy.

1. Introduction

The Georgian manuscript collections of the University Libraries of Graz (Austria) and Leipzig (Germany) are among the most significant collections outside of Georgia, due to the importance of the manuscripts they preserve. These collections, which contain both complete and fragmentary manuscripts, have repeatedly been the subject of research by Georgian and foreign scholars. They have been studied and described,[1] and in the case of the Graz collection, even published.[2] For the fragments, it has largely been established to which manuscript collections they originally belonged.[3] This information is particularly valuable for our research, as the original manuscripts sometimes provide clues regarding the provenance of the fragments, including their place and time of copying. However, for certain manuscripts or fragments, these questions remain unresolved.

In order to determine the origin and, if possible, the age of the manuscripts, the project "The Development of Literacy in the Caucasian Territories" ("DeLiCaTe"), carried out at the Centre for the Study of Manuscript Cultures (hereafter CSMC) at the University of Hamburg under the leadership of Jost Gippert, initiated the study of the chemical composition of various inks used in Georgian manuscripts to identify metals characteristic of specific regions as well as plant-based components. A key goal of this approach is the creation of a database encompassing as many manuscripts as possible, for the accurate compilation of which

[1] For the Graz collection, see Tsagareli 1888; Schuchardt 1928; Garitte 1960; Outtier 1972; Kern *et al*. 2023; Zammit Lupi 2023. For the Leipzig collection, see Tischendorf 1855; Vollers 1906; Assfalg 1963.
[2] Shanidze 1929; Shanidze 1944; Tarchnišvili 1950; Garitte 1955; Shanidze 1960; Imnaishvili 2004.
[3] For the most recent comprehensive material on this, see Gippert forthcoming (a); Gippert forthcoming (b).

manuscripts with securely dated colophons indicating their place of origin play an essential role.

The first stage of the study was conducted on the Georgian collection of Graz between 22 April and 3 May 2024, followed by an examination of the Leipzig collection between 21 October and 1 November 2024. The manuscripts were investigated by the CSMC laboratory staff using several multi-analytical material characterization methods.[4] In the current article, we focus on the results of the ink analysis, carried out using XRF imaging, Raman spectroscopy, ultraviolet (UV), visible (VIS), and near-infrared (NIR) microscopy. For a detailed description of the methodology, see Section 3. The preliminary results were presented in March 2025 at the CSMC.[5]

2. Place of Origin and Date of the Manuscripts

It has already been established that the Georgian manuscripts of Graz University Library all stem from the Georgian collection of St Catherine's Monastery on Mount Sinai. All of them were still described by Aleksandre Tsagareli as being part of that collection in his catalogue published in 1888.[6] However, this does not necessarily imply that they were copied at Sinai. It is possible that they were produced at another scriptorium and subsequently brought to Sinai.

Regarding the Leipzig collection, with two exceptions – which also stem from the Sinai collection – the manuscripts derive from the Jerusalem collection of Georgian manuscripts, today kept in the Library of the Greek Orthodox Patriarchate.[7] Some of these manuscripts were also described by Aleksandre Tsagareli.[8]

Our task is to examine these manuscripts and fragments individually, either directly or through the colophons of their original manuscripts, and to classify them into two groups: those with a known place and date of copying, and those without. This classification will then allow us to compare the historical information with the laboratory data on the composition of the red and black inks used.

2.1 The Graz Collection

The Georgian manuscripts in the Graz collection comprise four nearly complete codices (MSS 2058/1, 2058/2, 2058/3, 2058/4), one scroll (2058/5), and three fragments (2058/6a, 2058/6b, 2058/6c). Of these, the place of origin (St Catherine's Monastery on Mount Sinai and the Holy Lavra of St. Sabas) and the date are known for one manuscript, 2058/4, and two fragments: 2058/6b and 2058/6c.

2.1.1 MS 2058/4 contains the *Liturgy of James* (fols 1r–94v) and the *Missa praesanctificatorum* by Gregory the Great (fols 96r–110v).[9] The manuscript was copied by two scribes. Following the first part is the colophon as shown in Fig. 1: "When this Liturgy was written on Holy Sinai

[4] We would like to express our special gratitude to the laboratory members for their contribution: Olivier Bonnerot, Claudia Colini, Katerina Grigoriadou, Małgorzata Grzelec, Kyle Ann Huskin, Giuseppe Marotta, Greg Nehring, Sowmeya Sathiyamani, Ivan Shevchuk, Chen Yu.
[5] Bosch & Kvirkvelia 2025.
[6] Tsagareli 1888, приложеніе II: 193–240.
[7] For a summary see Gippert forthcoming (b), 2.1.6.
[8] Tsagareli 1888, приложеніе I: 143–192.
[9] In Tsagareli's catalogue, this manuscript is described under number 31 (1888: 210). The first quire of the manuscript has been preserved in the National Museum Library in Prague (DJ VI 1); see Jedlička 1961a and 1961b.

by the hand of John, the very sinful Zosimus, in the days of my wretched old age, for prayers on my behalf and for all my relatives, the year after Creation in Georgian was ხფ˜ჳთ (6589), and the chronicon was ს˜ე (205)" (MS 2058/4, 95r, see Fig. 1).[10] This indicates that the first part was written by John Zosimus on Mt Sinai in the year 985 CE.

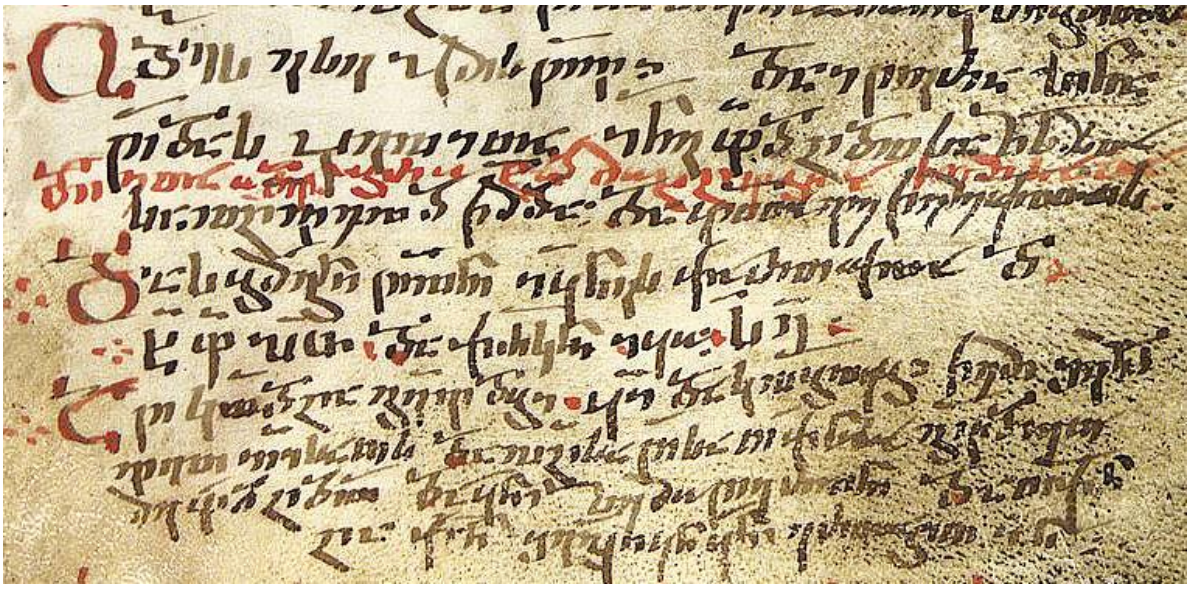

Fig. 1: Graz, UBG, MS 2058/4, fol. 95r (excerpt: scribe's colophon)

Since the place and date of copying of the first part of MS 2058/4 are beyond doubt, identifying the composition of the inks used in both parts may help clarify its relation to the second part.[11] Non-destructive ink measurements were conducted from fols 1v, 5r, 31r, 43v, 49v, 60v, 70r, 93v, 95r (part I), and folios 96r, 100r, 110v (part II). In addition, ink samples were taken from fols 5r and 60v: the former contains the marginal note კქსი (for კუერექსი "prayer litany") and the monogram for Jesus Christ (ქ) written in a different ink, while the latter bears another inscription, presumably in Syriac (see Figs 2 and 3).

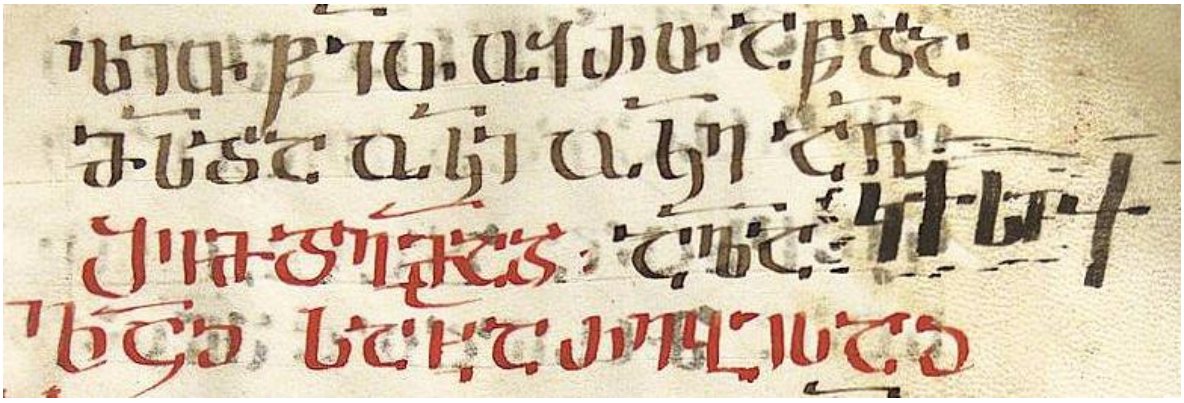

Fig. 2: Graz, UBG, MS 2058/4, fol. 5r (excerpt showing marginal note)

[10] Vakhtang Imnaishvili published the full text of the colophon with abbreviations resolved (2004: 311): ოდეს ესე ჟამისწირვაჲ დაიწერა სინა წმიდას ჴელითა იოანე ფრიად ცოდვილისა ზოსიმწსითა, დღეთა ოდენ ბოროტად მოხუცებისა ჩემისათა, სალოცველად ჩემდა და ყოველთავე ჩემეულთათჳს, დასაბამითგანი წელნი იყვნეს ქართულად ხფ˜ჳთ (6589) და ქრონიკონი იყო ს˜ე (205).

[11] A radiocarbon analysis taken of both parts has revealed that the second part is probably 30 years older than the first; see Gippert, this volume, 1.4.

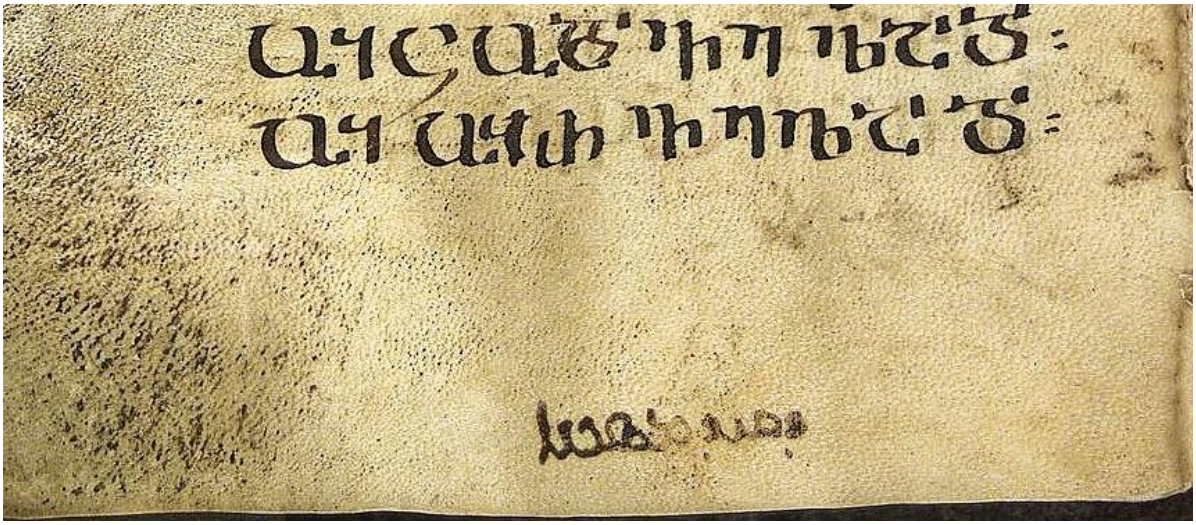

Fig. 3: Graz, UBG, MS 2058/4, fol. 60v (excerpt showing marginal note)

2.1.2 It has for long been established that the Graz fragments MS 2058/6b and MS 2058/6c belong to another manuscript from Mount Sinai, namely, Sin. georg. 35,[12] which contains a large collection of *Ascetica*. Fragment 2058/6b is the last folio of its quire 3 and fits perfectly after fol. 22v of Sin. georg. 35. Fragment 2058/6c is considered a continuation of the last folio (320v) of the same codex.[13] In an article published in 1978, Manana Dvali and Lali Jghamaia argued that the flyleaf of another Sinai manuscript, Sin. georg. 67, represents the last folio of Sin. georg. 35 and, most importantly, its colophon indicating the date and place of origin.[14] The text of the colophon reads as follows (Fig. 4): "And you who read this book, remember me, sinful and the least (of all), in your prayers, as well as all those who were the reason for this book to be begun: the monk Arsen and his spiritual children. I have written it with my own hand, I, the unworthy one, in (the Lavra of) St Sabas, under the patriarchate of Elia (III) from Damascus, son of Manṣūr, and during the abbotship of Symeon of the Holy Laura, in the year ხჳ̃ა (6511) after Creation. And Elia the Patriarch died in the same year, on 4 October, a Saturday, before sunrise. After him, on the 7th of the same month, Sergius from Ramallah was instated as the patriarch" (Sin. georg. 67, back flyleaf, "recto").[15] This means that the corresponding part of the manuscript was copied in 907 CE at the Lavra of St Sabas. As the Graz fragments (as well as Sin. georg. 35) were written by different hands, non-destructive ink measurements were conducted from the recto and verso sides of both sheets.[16]

[12] For the first description of the Sinai codex see Tsagareli (1888: 232–233, no. 80); for the identification of the Graz fragments, see Shanidze 1929: 349–350.

[13] See Gippert forthcoming (a): 7.

[14] Dvali & Jghamaia (1978).

[15] ხოლო რომელნი იკითხვიდეთ წიგნსა ამას, მე, ცოდვილი და ნარჩევი, ლოცვასა მომიჴსენეთ და ყოველნი მიზეზნი ამის წიგნისა დაწყებასა, არსენი ბერი და სულიერნი შვილნი მისნი. დავწერე ჴელითა ჩემითა მე საწყალობელმან საბაწმიდას შინა, პატრიაქობასა ელია დამაშკელისა მანსურის ძისასა და საბაწმიდას სჳმიონის წინამძღრობასა დასაბამითგან წელთა ხჳ̃ა (6511). და აღესრულა ელია პატრიაქი მასვე წელსა, თუესა ოქდონბერსა დ̃ (4), დღესა შაბათსა განთიად. და დაჯდა სერჯი რამლელი ზ̃-სა (7), მასვე თუესა.

[16] A radiocarbon analysis of the two fragments has revealed nearly the same dates; see Gippert, this volume, 1.8.

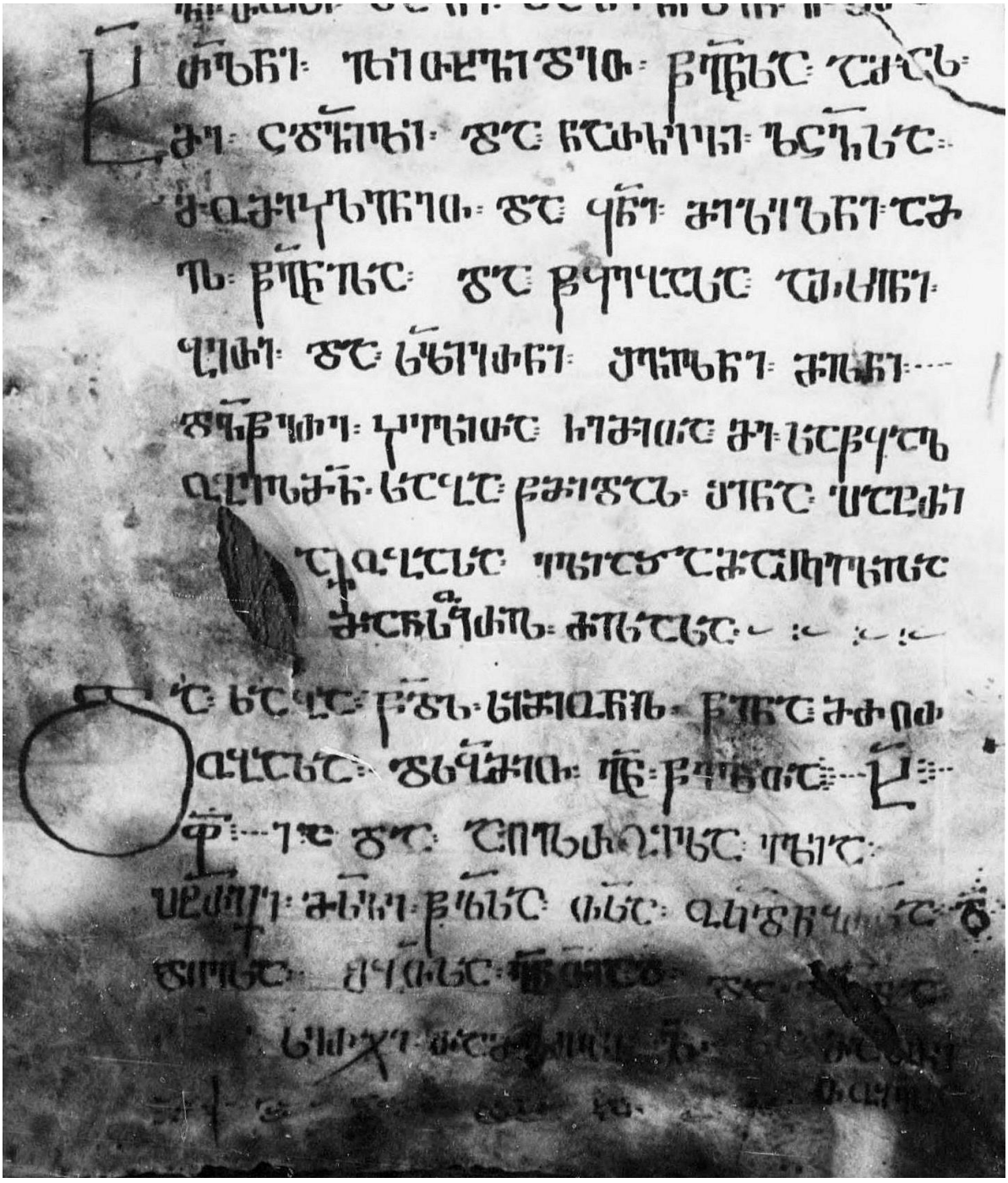

Fig. 4: Sin. georg. 67, scribe's colophon on back flyleaf (excerpt)

2.1.3 As for the remaining manuscripts in the Graz collection, neither their dates nor their places of copying are indicated in colophons or the like. The most important one among them is the Sinai Lectionary (MS 2058/1), also known as the *Khanmeti* Lectionary, which represents, within the Georgian tradition, the earliest form of the Jerusalem Lectionary;[17] it was first described by Aleksandre Tsagareli as no. 9 of the collection of St Catherine's Monastery[18] and edited by Akaki Shanidze in 1944. Notably, it is the only source from the *khanmeti-haemeti*

[17] Kvirkvelia forthcoming, 3.1.
[18] Tsagareli 1888: 199–200, no. 9.

period that has survived in a non-palimpsested form. A single leaf belonging to this manuscript is preserved today in Paris (Bibliothèque nationale de France, géorg. 30),[19] and another one in Birmingham (Cadbury Research Library, Mingana Collection, Georg. 7).[20] The Birmingham leaf contains the colophon of Ioane Zosime, which Aleksandre Tsagareli transcribed in his description of his no. 9 of the Sinai collection.[21] This colophon provides the date (983 CE) and the place (Mount Sinai) of the third binding undertaken by John Zosimus;[22] however, the manuscript itself is much older, as confirmed by a radiocarbon (^{14}C) analysis, which dates it to between 433 and 574.[23] Before the ^{14}C analysis, it had been dated to the 7th century from both paleographical and linguistic perspectives. As the provenance of this manuscript is still unknown, non-destructive ink measurements were conducted from fols. 1r, 1v, 5r, 5v, 7v, 23v, 26r, and 27r.

2.1.4 The next codex of the Graz collection (MS 2058/2), desribed by Tsagareli under no. 2,[24] is a palimpsest with an Armenian undertext; its Georgian layer contains the Psalter (fols 1r–258v) and the nine biblical Odes (fols 259r–282v), with the latter being incomplete.[25] Between these two sections there is a colophon (folios 258v–259r) that mentions only the scribe, Serapion (სერაპიონ), and his brother Peter (პეტრე), without specifying the place or date of the manuscript's copying.[26] Non-destructive ink measurements were conducted from fols 42v, 57v, 83v, 136r, 136v, 137r, 166r, 137r, 166r, 234v, 236r, 243r, and 259r (colophon).

2.1.5 Graz 2058/3, described by Tsagareli as no. 69 of the Sinai collection,[27] preserves the Georgian version of the *Life of Symeon Salos* by Leontius of Naples (*BHG* 1677, *CPG* 7883). The colophon, which starts on fol. 171v, mentions the name of the scribe, Teodore Ṣḍudeleli (თეოდორე წყუდელელი), who wrote this manuscript for Mt Sinai. Unfortunately, the major part of the last folio of the colophon (fol. 172), which might have contained the date and place of origin, is lost. Tsagareli did not provide a transcription of this part, but he recorded the note of John Zosimus on folio 172v, which states that he bound the manuscript in the year after Creation ხფ˜პე (6585, i.e. 981), the chronicon was ს˜ა (201, i.e. 981)."[28] The number ს˜ა (201) is still visible on the remnants of the verso of fol. 172 (see Fig. 5). Jost Gippert has distingushed three different hands in the manuscript (fols 2r–88v, 89r–168v, and 169r–172r).[29] Non-destructive ink measurements were conducted from fols 2r, 82r (hand 1), and 89r, 96v (hand 2); due to time constraints, the ink of hand 3 could not be analyzed.

2.1.6 The only scroll of the Graz collection (MS 2058/5), first described by Aleksandre Tsagareli as no. 29,[30] comprises the Liturgy of John Chrysostom (*CPG* 4686). It does not

[19] Identified and edited by Outtier (1972).
[20] Identified and edited by Garitte (1960).
[21] Tsagareli 1888: 200.
[22] See Tsagareli 1888: 200 and Garitte 1960: 254–257.
[23] See Gippert, this volume, 1.1.
[24] Tsagareli 1888: 196, no. 2.
[25] For the missing parts, see Gippert forthcoming (a): 26–27.
[26] For the proposed dating of the undertext by different scholars as well as the results of a ^{14}C analysis, see Gippert, this volume, 1.2.
[27] Tsagareli 1888: 226, no. 69.
[28] Tsagareli (1888:226): "შეიმოსა წმიდა ესე წიგნი... სინა წმიდასა ჴელითა იოვანე ფ˜დ-ცოდვილისათა, ბრძანებითა დეკანოზისა სინა წმიდისა... წელსა ხფ˜პე (981 ს.), ქ˜კს სა (981 ს.)."
[29] Gippert forthcoming (a): 3.
[30] Tsagareli 1888: 209, no. 29.

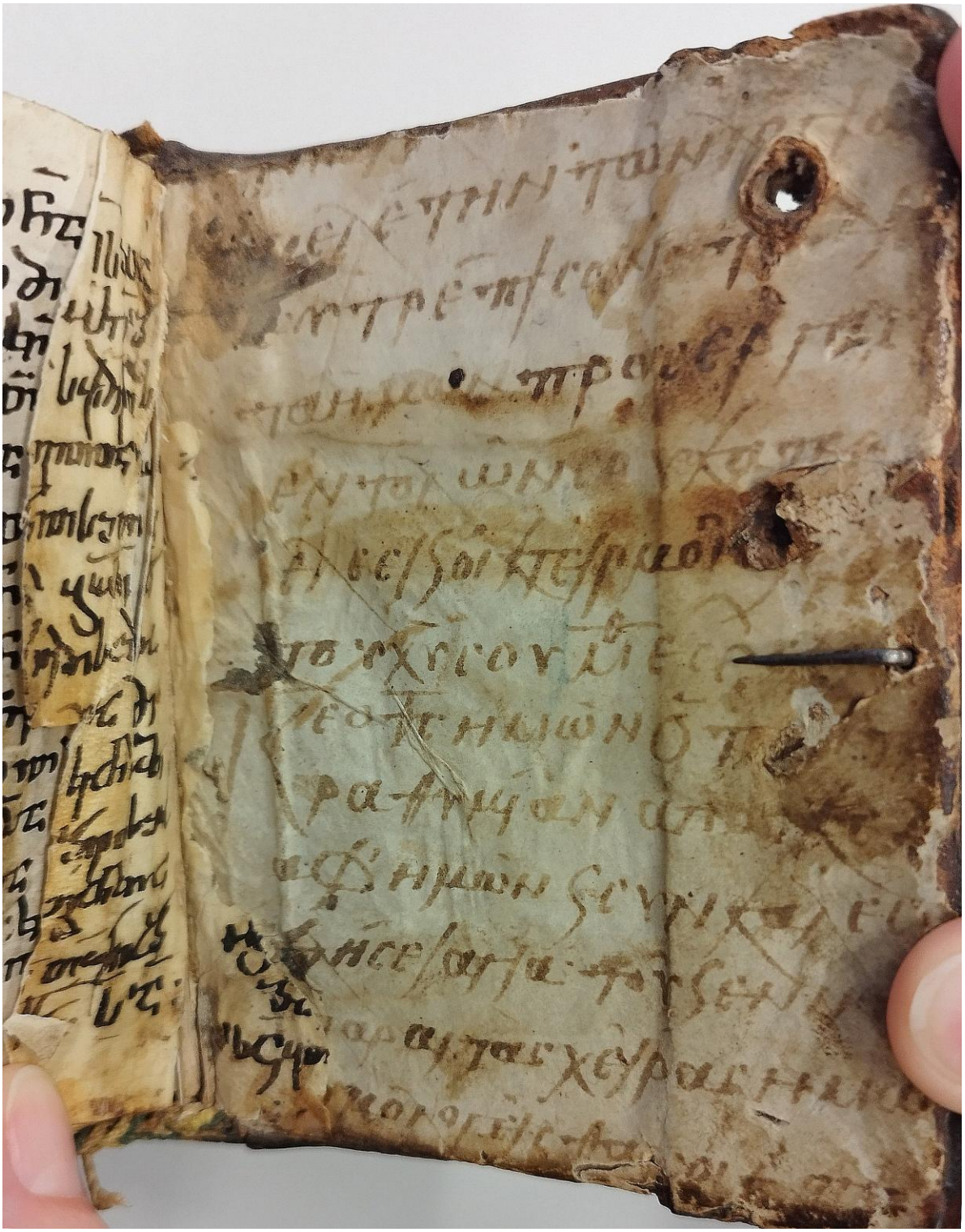

Fig. 5: Graz, UBG, MS 2058/3, fol. 172v, remnants of back flyleaf and Greek pastedown

include a colophon indicating the date or place of origin.[31] Non-destructive ink measurements were conducted from the drawing and text in the first two lines (l. 1, l. 2).

[31] Scholars have proposed different datings: Aleksandre Tsagareli suggested the 11th–12th centuries (1888: 209), Michael Tarchnišvili the 10th–11th centuries (1950: 111), while André Jacob dated it to after the 12th century (1964: 65–66). A radiocarbon analysis has now confirmed Tsagareli's dating; see Gippert, this volume, 1.5.

2.1.7 The final fragment from the Graz collection, MS 2058/6a, contains a passage from the Gospel of John (15:8–19). Akaki Shanidze identified it as a continuation of the text broken off on fol. 57v of Sin. georg. 63, which had first been described by Aleksandre Tsagareli under no. 13.[32] No colophon is preserved for the Sinai codex. Non-destructive ink measurements were conducted from both the recto and verso of the fragment.

2.2 The Leipzig Collection

The Leipzig collection of Georgian manuscripts contains five objects (V 1094 – V 1098). Only one of them, V 1094, derives from a single original codex, preserving nine folios of it; the others consist of fragments from different codices bound together. As noted above, the provenance of the collection is Jerusalem, with two exceptions, V 1096-2 and V 1096-5, which have been identified as originating from the Sinai collection.[33]

The place of origin is known for only four fragments from the Georgian manuscripts in the Leipzig collection: V 1094 (the Monastery of the Holy Cross, Jerusalem), V 1096-2 (the Lavra of St Sabas), V 1096-5 (Mount Sinai), and V 1097-3 (probably the monastery of Ss Cosmas and Damian on Mount Olympus in Bithynia). For all other fragments, the place of origin remains unknown.

2.2.1 The nine folios of V 1094, which contain a hagiographical collection for the month of October, together with an additional fragment preserved in the University Library of Cambridge (MS Add. 1890.3 / Georgian Ms. 5),[34] derive from a sister manuscript of Oxford, Bodleian Libraries, Georg. 1.[35] The latter preserves a colophon indicating its place of origin: "... God made me, poor Prokhore, worthy to write this soul-enlightening (book) of holy martyrs. And I have completed it and placed it, by the will of God and with the help of all the saints, in the Church of the Holy Cross, built up by me" (Oxford, Georg. b1, fol. 501v).[36] According to Enriko Gabidzashvili, who published the synaxarian version of the Life of Prokhore,[37] the saint completed the construction of the Church of the Holy Cross in 1057–1058 CE. In 1061, he withdrew to the desert of Arnon. This allows the manuscripts to be dated between 1058 and 1061.[38] Non-destructive ink measurements were conducted from fol. 1v.

2.2.2 Fragment V 1096-2 (fols. 4–7) preserves material from a hymnary (*Iadgari*). As determined by Lili Khevsuriani, it belongs to the well-known liturgical codex compiled and written by John Zosimus, Sin. georg. 34.[39] Additional fragments of this manuscript are preserved in the National Library of Russia in St Petersburg under the shelfmarks Ф. № 906 (Греч.) VI (fols. 1–3), VII (fols. 1–8), XLI (fols. 1 and 3), and Сир. Н. С. 16/1 (fols. 11–21, 24–29, 56, 57) and 16/3 (fols. 1–6).[40] These fragments preserve a colophon that provides both

[32] Tsagareli 1888: 204; Shanidze 1929: 349.
[33] Gippert forthcoming (b), 2.1.6.
[34] Assfalg 1963: 35–39.
[35] Blake 1932: 216.
[36] ... ღირს-მყო ღმერთმან მე გლახაკი პროხორე დაწერად ამის სულთა განმანათლებელისა წმიდათა მოწამეთა წიგნისა. და გავასრულე და დავდევ ნებითა ღმრთისაჲთა და შეწევნითა ყოველთა წმიდათაჲთა ჩემ მიერ აღშენებულსა ეკლესიასა წმიდისა ჯუარისასა.
[37] The publication of the text was prepared on the basis of the manuscripts Jer. georg. 24 and four codices of the Korneli Kekelidze Georgian National Centre of Manuscripts: NCM H-1661, H-886, Q-105a, and Q-75; see Gabidzashvili 1968: 345–346.
[38] Gabidzashvili 1968: 110–111.
[39] Khevsuriani 1978: 88–122. The codex was first described by Tsagareli (1888: 206) under no. 19.
[40] Metreveli *et al*. 1978: 131–143.

the date and the place of origin; according to it, the manuscript was written by John Zosimus in the Lavra of St Sabas in the year after Creation (Georgian style) ხფ˜ნგ (6569) and the chronicon რ˜პე (185), both corresponding to the year 965 CE (Сир. Н. С. 16/1, 17rv).[41] Non-destructive ink measurements were conducted from fols 4r, 4v, 5v, and 7r.

2.2.3 Fragment V 1096-5, represented by a single folio (12), contains 1 Peter 1:11–22; it stems from a Sinai Apostolos codex that has been preserved in three parts: Sin. georg. 58, 31, and 60.[42] At its end, Sin. georg. 60 provides a colophon mentioning the scribe Ḳviriḳe Soxastṛeli (კვრიკე სოხასტრელი), who came to Mt Sinai and wrote this manuscript for the commissioner Ḳviriḳe Miʒnaʒoroeli (კვრიკე მიძნაძოროელი) and his priest, who served as sacristan at Mt Sinai at that time. The colophon further reads: "The year after Creation was ხფ˜პა (6581) and the chronicon was რჟ˜ზ (197)",[43] both indicating that the manuscript was copied on Mt Sinai in 977 CE. Non-destructive ink measurements were conducted from fol. 12r.

2.2.4 Jost Gippert determined that the four folios of V 1097-3 (fols 5–8), containing Romans 2:5 – 5:13, derive from the Praxapostolos codex today stored in the Greek Patriarchate of Jerusalem as Jer. georg. 94 and 82. He also identified the same scribe's hand in three manuscripts of the Athonite collection preserved at Iviron Monastery on Mount Athos. These are Ivir. georg. 11, a homiliary (*mravaltavi*) codex; Ivir. georg. 25, a hagiographical-homiletic collection; and Ivir. georg. 42, another Praxapostolos codex (Fig. 7).[44] Among these manuscripts, only Ivir. georg. 42 contains a colophon: "It was written on Mt. Olympus, in the abode of Ss. Cosmas and Damian, during the patriarchate of Polyeuctus in Constantinople (and) the reign of Nikephoros" (Ivir. georg. 42, fol. 236r).[45] This indicates that the manuscript was copied between 963 and 969 CE. The colophon also records the commissioner, Mikael Zeḳeṗe (მიქაელ ზეკეპე), and his supporter Iovane Ḳaxi (იოვანე კახი), who might have been the scribe.[46] Non-destructive ink measurements were conducted from fol. 6v.

2.2.5 Fragments V 1095-1 (fols 1–4, 6, and 9–11) and V 1097-1 (fols 1–2) originate from the triodion–pentecostarion preserved in the Greek Orthodox Patriarchate of Jerusalem as Jer. georg. 101.[47] Neither the original codex nor any one of the fragments contains a colophon indicating the place or date of their production. Non-destructive ink measurements were conducted from fol. 2v of V 1095.

2.2.6 Fragment V 1095-2 (fols 5, 7, and 8), which contains a menaion of September, derives from Jer. georg. 110, a codex that likewise preserves no indication of its date or place of origin. Non-destructive ink measurements were conducted from fol. 5v.

2.2.7 Fragment V 1095-3 (fols 12r–15v) contains *aġaṗebi* (აღაპები), i.e. commemorative notes, for the Georgian community in Jerusalem, written by different hands over an extended period (13th –17th centuries). Their content is primarily devoted to the remembrance of deceased persons. These notes belong to the synaxary of the same community, which is preserved in the

[41] Metreveli *et al*. 1978: 142.
[42] First described by Tsagareli (1888: 205–206) under no. 16.
[43] დასაბამითგანი წელნი იყვნეს ხფ˜პა და ქრონიკონი იყო რჟ˜ზ.
[44] Cf. Gippert forthcoming (b), 2.1.4, figs 28–31.
[45] დაიწერა წმიდასა მთასა ოლინბოდსასა, საყოფელსა წმიდათა კოზმან დამიანეთასა, პატრიაქობასა კოსტანტიპოვლეს პოლიოკტოდსა, მეფობასა ნიკიფორესა.
[46] For the full text of the colophon, see Gippert et al. (2022: 399).
[47] Assfalg 1963: 55–59; Gippert forthcoming (b): 2.1.2.

two codices Jer. georg. 24 and Jer. georg. 25.[48] Non-destructive ink measurements were conducted from fols 12r–15r.

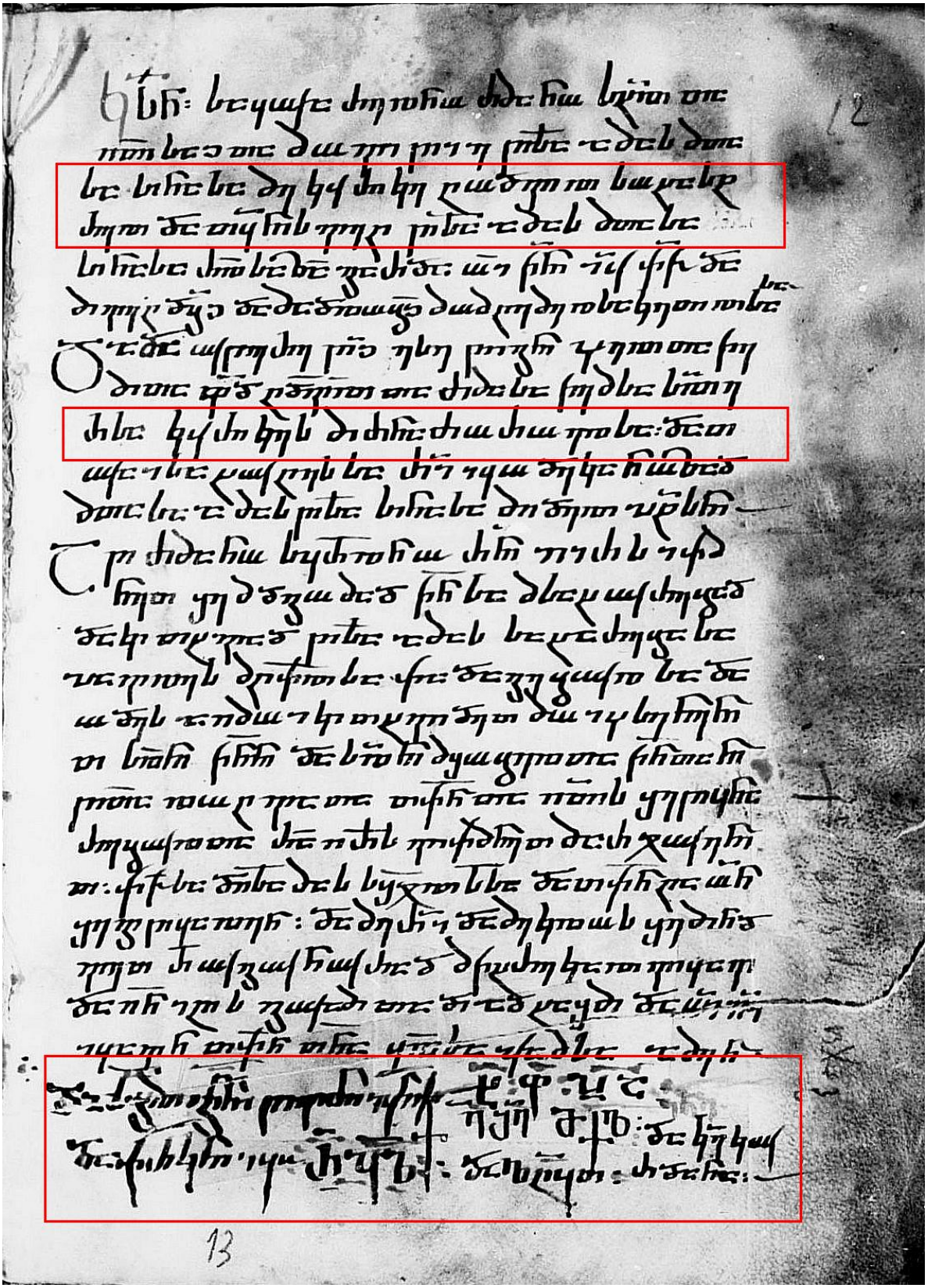

Fig. 6: Sin. georg. 60, fol. 12r: colophon by Ḳviriḳe Soxaṣṭreli

[48] See Gippert forthcoming (b): 2.1.2.

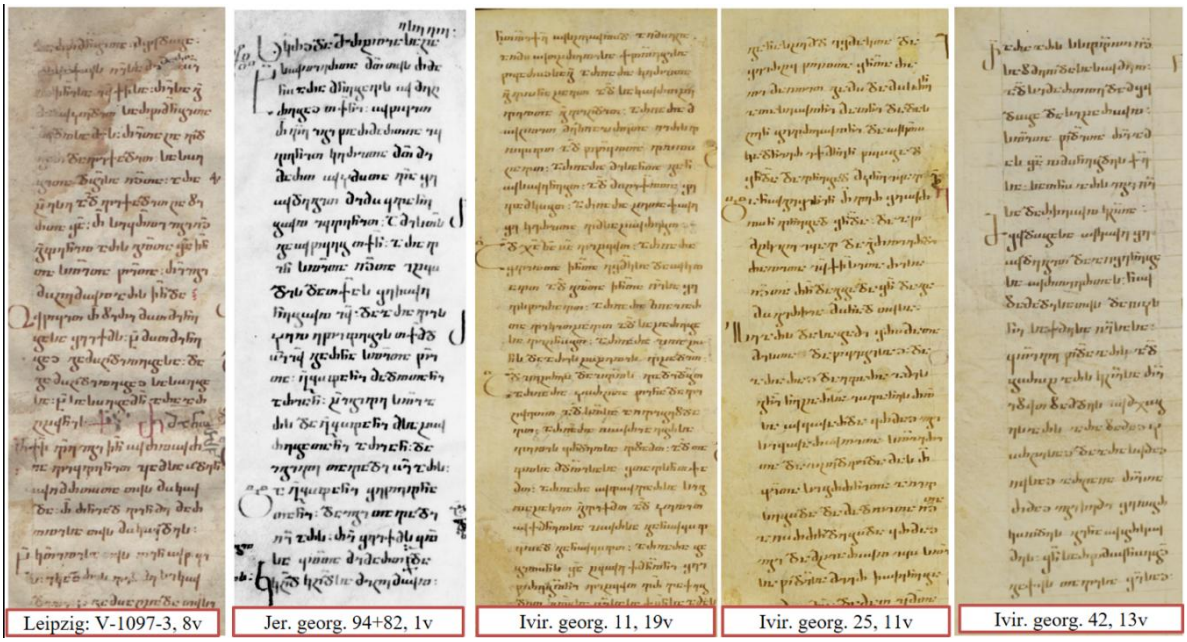

Fig. 7: Scribe's hand of Ioane Ḳaxi (?), Mount Olympus

2.2.8 Fragment V 1096-3 (fols 8r–10v) preserves theological Questions and Answers. A similar fragment, housed in the Schøyen Collection in Oslo as MS 1600, derives from the same original manuscript, which has not yet been identified. The authorship of the text has been attributed by Jost Gippert to (Pseudo-)Athanasius of Alexandria. The questions numbered 109, 110, and 113 attested in the Leipzig fragment are part of the *Quaestiones ad Antiochum ducem* (CPG 2257), corresponding to numbers 113, 114, and 117 in the Greek tradition, while questions 96–98 (corresponding to numbers 100–102 in the Greek) are preserved in the Oslo fragment.[49] No further information regarding the provenance or date of these fragments is provided. Non-destructive ink measurements were conducted from fols 8r and 11r.

2.2.9 Fragment V 1097-2 (fols 3–4) preserves Apostolos lections for 7–9 September and 3–14 October. The original manuscript from which this fragment derives has not yet been identified. Non-destructive ink measurements were conducted from fol. 3v.

2.2.10 Fragment V 1097-4 consists of four folios (fols 9–12) and derives from a menaion for February today preserved in the Austrian National Library in Vienna (Vienna, ÖNB, georg. 3). The provenance of the Vienna codex is again Jerusalem, as it was described by Aleksandre Tsagareli among the manuscripts of the Monastery of the Holy Cross.[50] This is confirmed by the scribe's colophon on fol. 258v, also cited by Tsagareli: "I, poor and unworthy John of Khakhuli (იოანე ხახულელი), have written this menaion" (Vienna, ÖNB, georg. 3, fol. 258v).[51] No further information concerning the date or place of copying is provided. Non-destructive ink measurements were conducted from fol. 12v.

2.2.11 Fifty-six folios of V 1098-1 contain a menaion for July. Jost Gippert assumes that this fragment might derive from one of several parchment menaia of the Jerusalem collection

[49] Gippert forthcoming (b): 2.1.3.
[50] Tsagareli 1888: 164, no. 35.
[51] მე გლახაკმან და უღირსმან იოანე ხახულელმან დავსწერე ესე თთუენი. See Gippert forthcoming (b): 2.1.4 for further details.

described by Aleksandre Tsagareli (nos. 31 and 40),[52] which were no longer present or identifiable when Robert P. Blake compiled his catalogue in the 1920s.[53] Non-destructive ink measurements were conducted from fol. 4r.

2.2.12 The last folio of V 1098-2 has been identified as containing a hymn for the Resurrection in the 3rd mode plagal composed by Mikael Modrekili. A possible candidate for the source might be Jer. georg. 123.[54] Non-destructive ink measurements were conducted from fol. 57r.

To summarize the information collected above regarding the dates and places of origin of the Georgian manuscripts from the Graz and Leipzig collections, we present it in Table I below. The Table first lists the manuscripts whose place of origin and date are known, then those whose origin and date remain unknown.

3. Analytical Methods

The inks of the manuscripts were analyzed according to a standard protocol, developed and improved in our laboratory.[55] It is best suited for the analysis and comparison of historic inks using exclusively non-destructive and non-invasive techniques, which are essential to prevent damage to the objects. In a first step, a preliminary screening to determine the ink typology is conducted with a digital USB microscope (Dino-Lite AD413T-12 V) equipped with built-in near infrared (NIR) and ultraviolet (UV) lights at 940 nm and 395 nm, respectively, to which we added an external LED white light source (VIS). The principle of differentiation between the three main kinds of ink (carbon-based, plant, and iron-gall) is based on the comparison of the ink's opacity in visible and NIR light.[56] In contrast to the constant black colour of carbon ink, plant inks become transparent at the red end of the visible light region, *c*. 750 nm, while iron-gall inks only start losing opacity at this wavelength, turning totally transparent at much longer wavelengths (*c*. > 1400 nm).

The elemental composition of the inks was analysed by X-ray fluorescence (XRF) imaging using a Bruker M6 Jetstream high-speed scanning micro-XRF spectrometer featuring focusing polycapillary optics and a variable-sized X-ray spot. The instrument was equipped with a mobile XRF probe that moved over the manuscript at a distance of 5 to 10 mm. The areas of investigation and the scanning parameters (X-ray spot, xy resolution, and acquisition time) were determined before each scan. For the measurements presented here, the probe was operated under the following conditions: Rh X-ray tube at 50 kV, 600 µA, and X-ray spot size of 50 µm. The acquisition time for each scan ranged from 50 to 600 ms/pixel, with a pixel (step) size of 30 to 100 µm. The X-ray emission peaks were fitted based on Gaussian deconvolution using the Bruker M6 Jetstream software. The abundances of the elements are depicted in the resulting XRF maps. Net intensity values for the detected elements were further subtracted by measured areas from the writing support.

[52] Tsagareli (1988:163, 165).
[53] Blake 1922–26: [IV], 155; Gippert forthcoming (b): 2.1.5.
[54] Gippert forthcoming (b): 2.1.5.
[55] Colini *et al*. 2021.
[56] Mrusek *et al.* 1995.

Table I: Content, Provenance, and Dating of the Manuscripts in the Graz and Leipzig Collections

Collaction, no.	Content	Date, Place	Relations	Analyzed
Manuscripts with Known Origin and Date				
Graz 2058/4, 1st part (1r–94v)	Liturgy (James)	985 CE, Mt Sinai	< Tsagareli 31; + Prague, National Museum Library, DJ VI 1	1v, 5r, 31r, 43v, 49v, 60v, 70r, 93v
Leipzig V 1096-5	Catholic Epistles	977 CE, Mt Sinai	< Tsagareli 16 > Sin. georg. (58-)31(-60)	12r
Graz 2058/6b, 2058/6c	7th Letter of St Antony Evagrius Ponticus, Martyrius Monachus	907 CE, St. Sabas	< Tsagareli 80 > Sin. georg. 35 + Sin. georg. 67 (flyleaf)	r, v r, v
Leipzig V 1096-2	Hymnary (Iadgari)	965 CE, St. Sabas	< Tsagareli 19 > Sin. georg. 34 + St Petersb. Ф. № 906	4r, 4v, 5v, 7r
Leipzig V 1094	Hagiography	1058–1061 CE, Holy Cross, Jerusalem	+ Cambridge, UL, georg. 5, Oxford, BL, georg.1	1v
Leipzig V 1097-3	Pauline Epistles	between 963 and 969 CE, Ss Cosmas and Damian on Mt Olympus (Bithynia)	< Jer. georg. 94(+82)	6v
Manuscripts with Unknown Origin and Date				
Graz 2058/4, 2nd part (96r–110v)	Missa praesanctificatorum		< Tsagareli 31; + National Museum Library in Prague (DJ VI 1)	96r, 100r, 110v
Graz 2058/1	Jerusalem Lectionary	(VII?)	= Tsagareli 9; + Paris, BnF, géorg. 30; + Birmingham, CRL, Mingana Coll., Georg. 7	1r, 1v, 5r, 5v, 7v, 23v, 26r, 27r
Graz 2058/2	Psalter / *Gospel of John*	(VII–VIII?)	= Tsagareli 2	42v, 57v, 83v, 136r, 136v, 137r, 166r, 137r, 166r, 234v, 236r, 243r, 259r
Graz 2058/3	Life of Symeon Salos	(before 981 CE)	= Tsagareli 69	2r, 82r, 89r, 96v
Graz 2058/5	Liturgy (John Chrysostom)	XI–XII?	= Tsagareli 29	drawing, l. 1, l. 2
Graz 2058/6a	Gospel of John	IX-X	< Tsagareli 13 > Sin. georg. 63	r, v
Leipzig V 1095-1, V 1097-1	Triodion-Pentecostarion	XII-XIII	< Jer. georg. 101	2v
Leipzig V 1095-2	Menaion, September	XII-XIII	< Jer. georg. 110	5v
Leipzig V 1095-3	Commemorative Notes	XIII-XVII	< Jer. georg. 24-25	12r–15v
Leipzig V 1096-3	Erotapokriseis	IX-X	+ Oslo, Schøyen MS 1600	8r
Leipzig V 1097-2	Apostolos	XII-XIII	?	3v
Leipzig V 1097-4	Menaion (February)	XI	< Tsagareli 35 (Jer.) > Vienna, ÖNB, georg. 3	12v
Leipzig V 1098-1	Menaion (July)	XII-XIII	< Tsagareli 31? 40? (Jer.)	4r
Leipzig V 1098-2	Hymn (Mikael Modrekili)	XII-XIII	< Tsagareli 123? (Jer.)	57r

Raman spectroscopy was performed on selected inks to verify the presence of specific materials that cannot be conclusively identified by XRF alone. For this study a Renishaw inVia Raman spectrometer with an infrared laser (300 mW, 785 nm) was used for the acquisition of the spectra, recorded under a microscope with a 100× long distance objective, at laser power 2% (~2.2 mW), with an accumulation of 20 scans of 2 s each.

The complete data set with raw files and images and their further step-by-step evaluation can be retrieved from the repository of the University of Hamburg.[57]

[57] For the step-by-step strategy of data evaluation, see Bosch (2025)

4. Results

An initial microscopic examination was carried out using a Dino-Lite digital microscope under ultraviolet (UV), near infrared (NIR) and visible (VIS) light source to discriminate between the general black ink types, namely, plant, iron-gall, and carbon ink. Most inks in the Graz and Leipzig collections showed changes in opacity under NIR illumination, suggesting the use of iron-gall inks. Only some texts (e.g., marginal notes) exhibited no loss of opacity under NIR light and appeared very dark black to the naked eye. This is shown in Fig. 8 for three different inks of MS Graz, UBG, 2058/4. The main text and the marginal note on fol. 60v were written in iron-gall ink, whereas the marginal note on fol. 5r is clearly carbon ink.

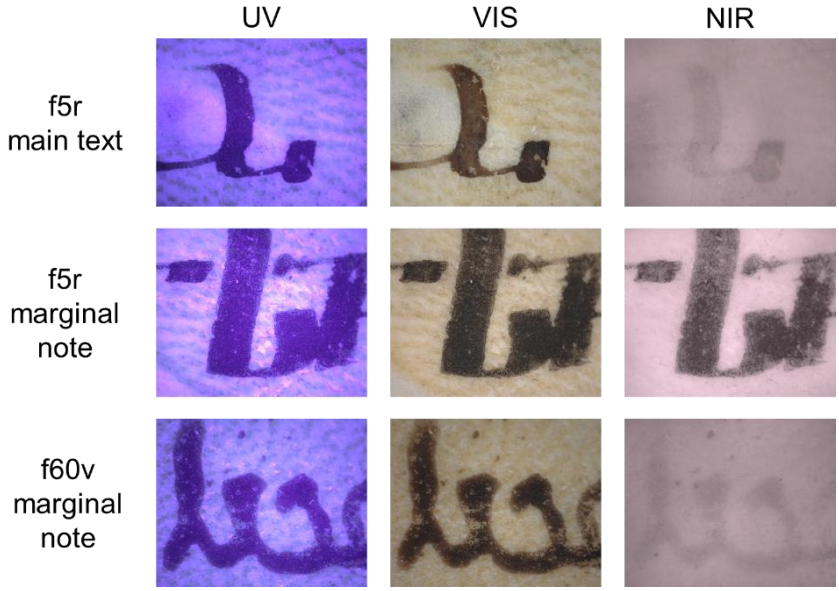

Fig. 8: Digital microscope images under UV (left), visible (centre), and NIR (right) light of the main ink and two marginal notes of MS Graz, UBG, 2058/4.

Microscopic screening revealed that manuscripts from both collections contain a variety of inks, ranging in color from pale brown to deep black, with some inks already faded or undergoing degradation. Fig. 9 shows the results of XRF imaging of a scanned area on fol. 13v of fragment Leipzig, UL, V 1095-3. The element maps clearly reveal different iron-gall inks with varying ratios of iron (Fe), copper (Cu), zinc (Zn), manganese (Mn), calcium (Ca), and potassium (K). Note that, due to the XRF penetration depth, signals from the verso (rear) side can also be detected. This phenomenon posed challenges in sampling exact areas for the quantitative comparison of intensities and elemental ratios across inks throughout both collections. To mitigate these effects, the scanned areas were chosen with particular care.

XRF imaging also revealed pronounced differences among the red inks used. In most manuscripts, the red inks exhibited mercury (Hg) and sulfur (S) signals, indicating the use of the pigment vermilion derived from the mineral cinnabar (HgS). This is illustrated in Fig. 10a for the red ink used in Leipzig, UL, V 1095-3. On the same folio, one red letter (at the bottom of the scan) shows no Hg or S signals but instead strong lead (Pb) signals, indicating the use of the lead oxide pigment minium (Pb_3O_4). Mixtures of both pigments were also detected, predominantly in manuscripts from the Graz collection; an example from MS 2058/1, fol. 5v, is shown in Fig. 10b. However, Pb signals alone do not conclusively prove the presence of minium, as lead may also originate from the basic lead carbonate pigment lead white

($2PbCO_3 \cdot Pb(OH)_2$), which could have been used in mixtures to brighten the red colour. Raman spectroscopy was used to verify these findings and showed that, in red inks containing Hg and Pb, characteristic Raman bands of both pigments could be detected at 231, 252, and 320 cm^{-1} for cinnabar, and at 122, 152, 392, and 551 cm^{-1} for minium (Fig 10c).

Fig. 9: XRF element maps of iron (Fe), copper (Zn), manganese (Mn), calcium (Ca), and potassium (K) for a scanned area on Leipzig, UL, V 1095-3, fol. 3v.

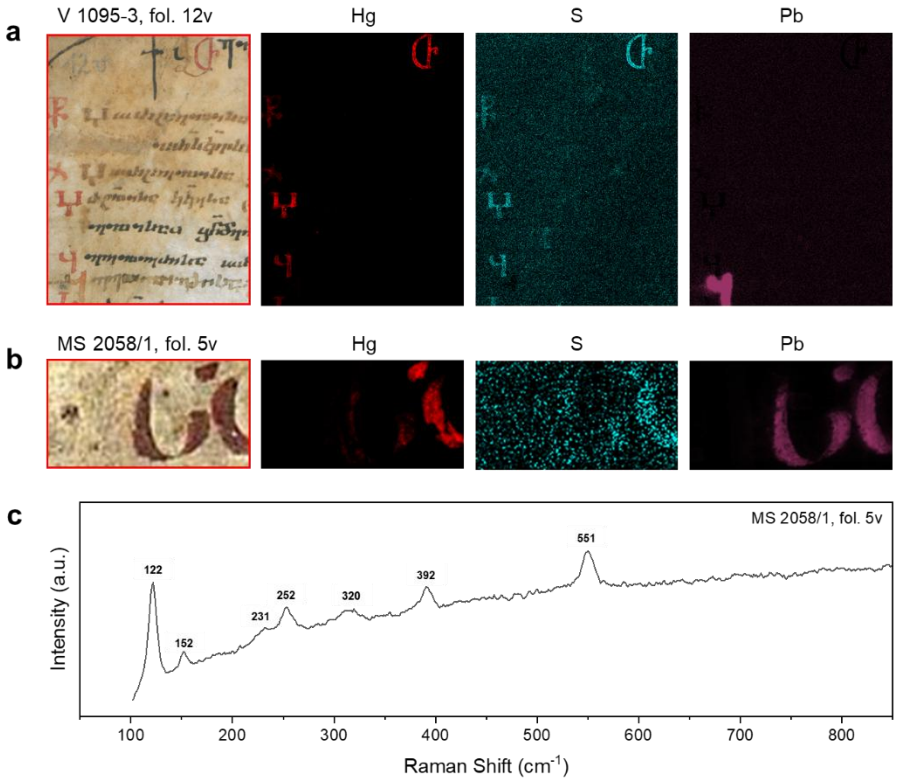

Fig. 10: XRF element maps of mercury (Hg), sulfur (S), and lead (Pb) for a scanned area on Leipzig, UL, V 1095-3, fol. 12v (a), and on Graz, UBG, MS 2058/1, fol. 5v (b), together with the corresponding Raman spectrum (785 nm) of the red ink (c).

In very rare cases of red ink, neither Hg nor Pb was detected; instead, low iron (Fe) signals were observed, indicating the use of red ochre (iron oxide mineral). This is illustrated in Fig. 11 for a red letter in Leipzig, UL, V 1097-3, fol. 6v. Because much stronger Fe signals were detected from the black/brown ink, the Fe elemental map required filtering by pixel averaging (3 × 3), conversion to a black-and-white scale, and reduction of the number of bins from 256 to 20.

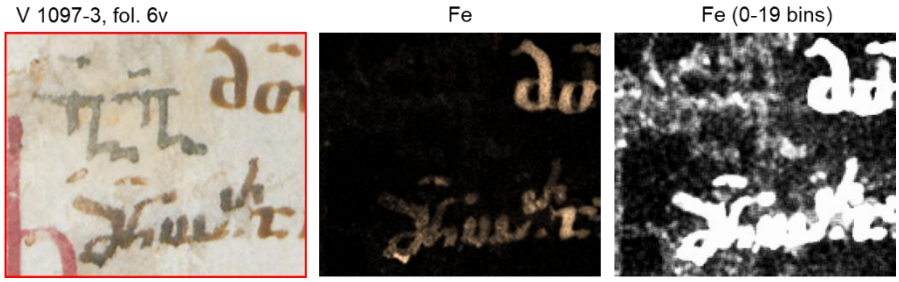

Fig. 11. XRF element map of iron (Fe) in standard visualisation (centre), and filtered by pixel averaging, black-and-white scale, and reduction to 20 bins (right) in order to highlight the weak iron signal of the red letter.

The XRF results of the black and red inks measured on all the investigated manuscripts of both the Graz and Leipzig collections are summarized in specific scatter plots to facilitate visualization of the large number of measurements.[58] Fig. 12 shows the combined results for the brown/black inks measured on selected folios of the investigated manuscripts, following detailed evaluation of the raw XRF imaging scans and principal component analysis (PCA) of the signal intensities of the relevant detected elements. For clarity, the results are further separated into individual plots for each manuscript (Fig. 13). It can be seen that most inks cluster in area **A** with an elemental profile of mainly Fe, and only traces of other elements, indicating the presence of non-vitriolic iron-gall inks,[59] whereas area **B** highlights inks with varying amounts of Cu and Zn, a very common profile of iron-gall inks. Area **C** shows a small cluster of iron-gall inks with a relative high amount of Pb, and only the inks of V 1097-3 are highly heterogeneous spread in areas **D** and **E** with high amounts of sulfur and potassium. The evaluated results are further summarized in Table II.

In contrast to the complex elemental profiles of the brown/black inks, the red inks can be distinguished by the presence of Hg and S (vermillion), Pb (minium), Fe (red ochre), or mixtures of these pigments. For this reason, their signal intensities are plotted as the ratios Pb/(Hg+S) and Fe/(Hg+S) in scatter plots for each manuscript (Fig. 14). Most red inks are composed of vermilion, as indicated by the clustering in area **a**, characterized by high signal intensities for Hg and S and low or no detection of Fe and Pb. For one red ink in Leipzig, UL, V 1095-3, fol. 12v (Fig. 10a), only Pb was detected as a prominent signal, with only trace amounts of other elements, resulting in very high intensity ratios (Fig. 14, data point **d**), consistent with the presence of vermilion. Areas **b** and **c** indicate red ink mixtures with varying amounts of vermillion and minium, e.g. Graz, UBG, MS 2058/1, fol. 5v (Fig. 10b). Data point **f** marks the red ink on V 1097-3, fol. 6v (Fig. 11) with the complete absence of Hg and Pb signals but low Fe signals observed, indicating the use of red ochre. For the drawing at the beginning of the scroll (MS 2058/5, data points **e**), high signals of Hg and Fe could be detected assuming the use of vermillion either mixed with red ochre or contaminated by other iron containing materials. The evaluated results are further summarized in Table II.

[58] For the step-by-step strategy of data evaluation, see Bosch (2025).
[59] Ghigo *et al*. 2020.

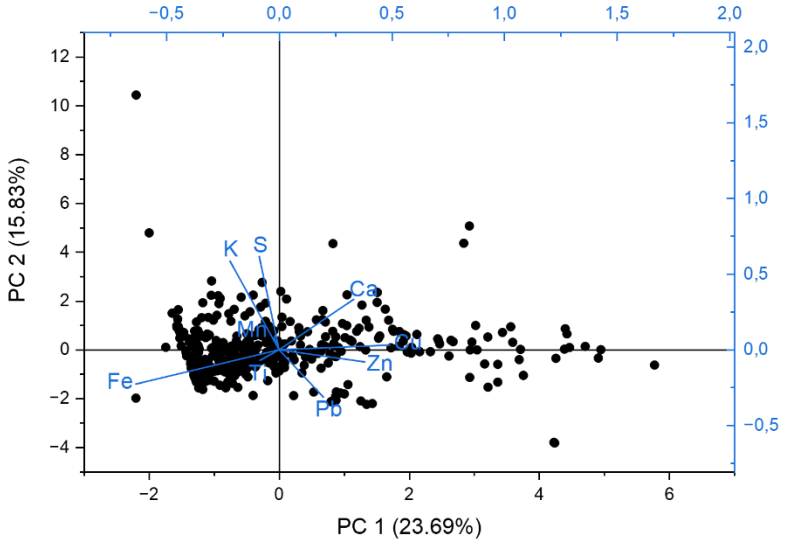

Fig. 12. Biplot showing the PCA results of elements detected from brown/black inks with XRF imaging with the loading plot (blue) and the scores plot of all measurements (black).

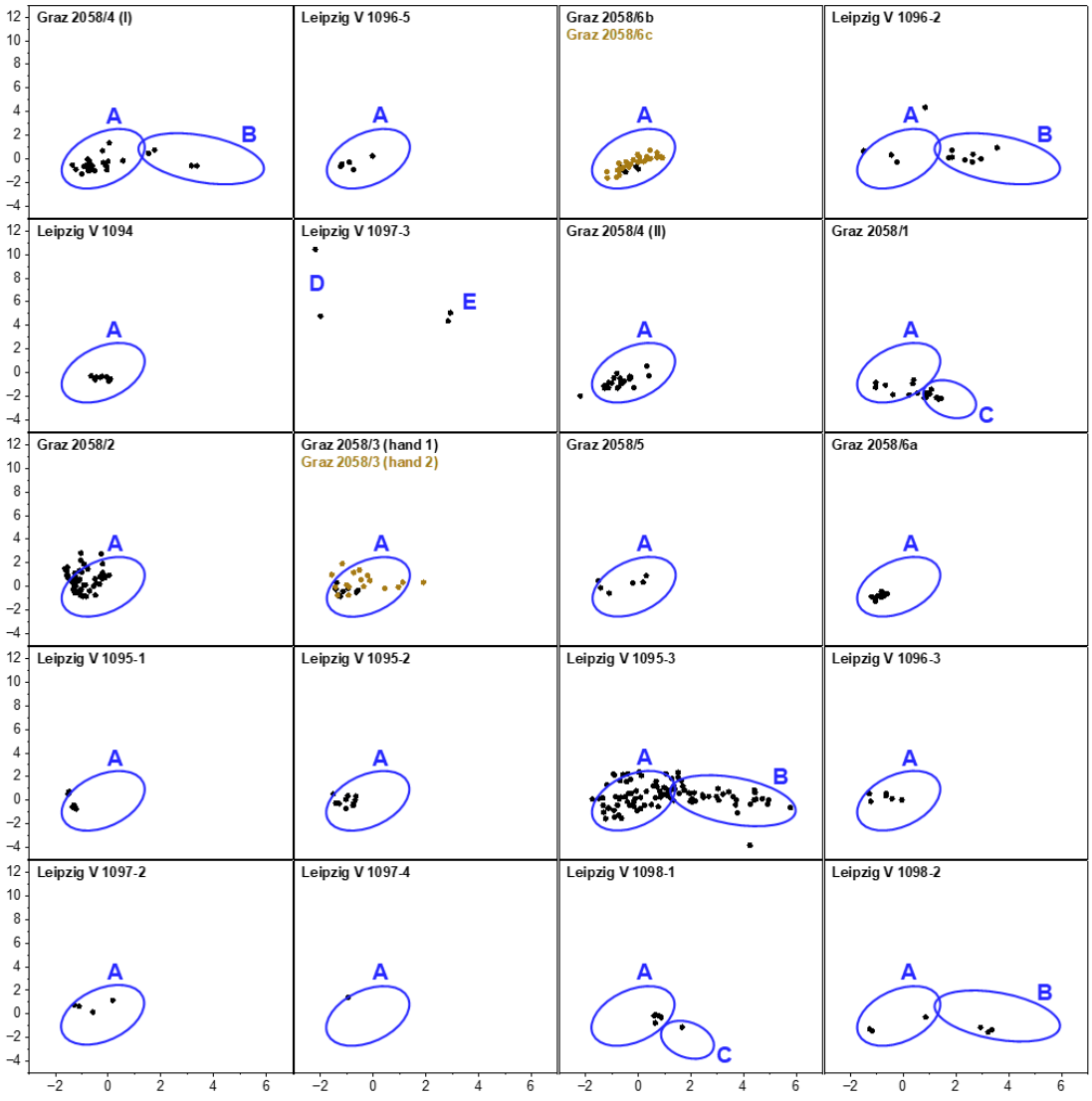

Fig. 13. Individual PCA score plots of the measured brown/black inks of each manuscript with areas A-D of clusters indicating the same or a similar ink.

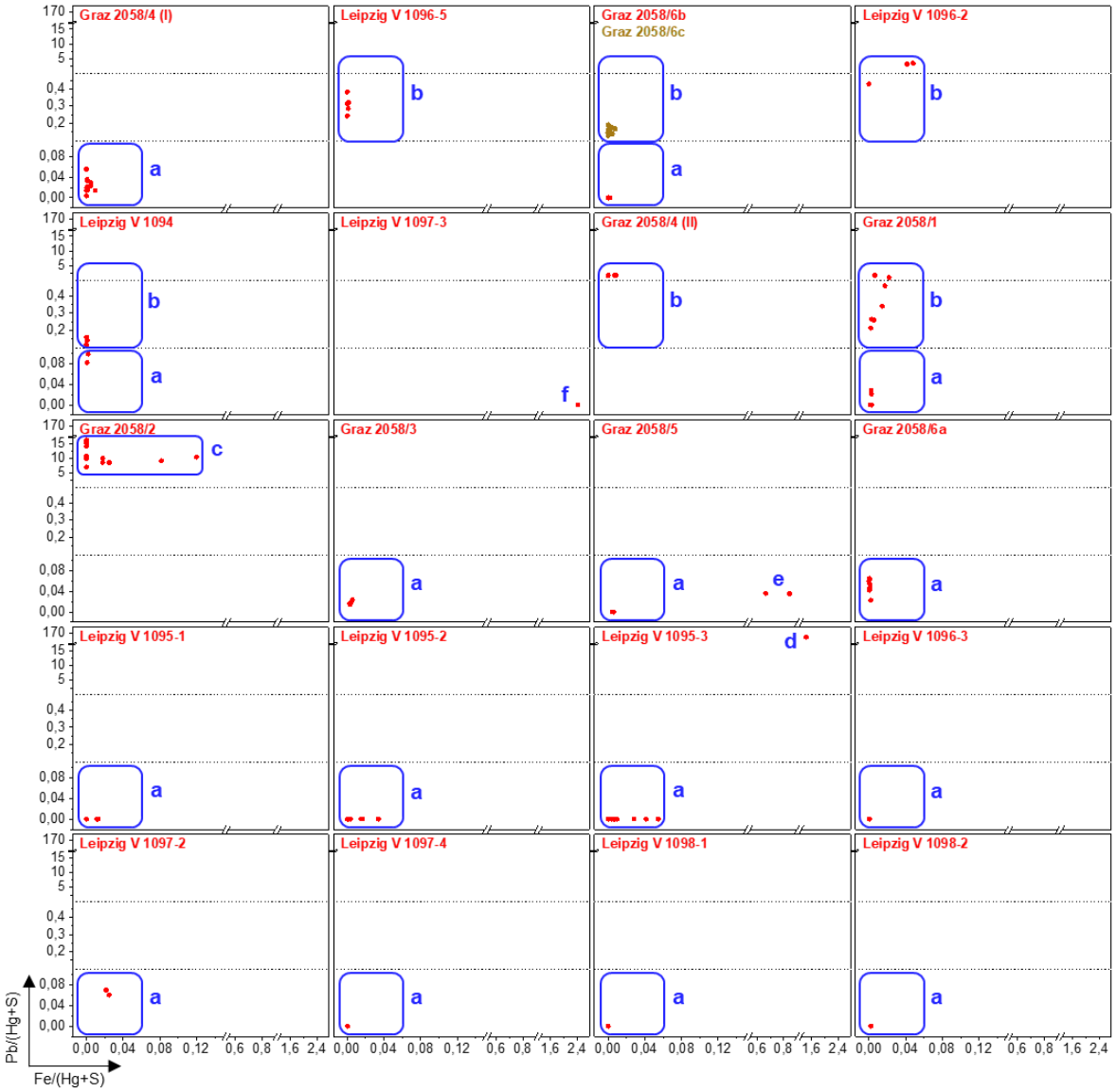

Fig. 14. Individual scatter plots with XRF intensity ratios of the detected elements from the measured red inks of each manuscript

The analytical results of this study are summarized in Table II, sorted by the cluster types of brown/black inks (BI) and red inks (RI).

5. Summary

The existing database of analysed manuscripts provides a basis for adding new material and thereby strengthening its reliability. The apparent exception, i.e. the case of the two parts of a manuscript presumed to have been copied at Sinai (2058/4, part I and 2058/4, part II), which show differences in ink composition from each other, can be explained; however, this is not our focus here. For ink analysis to be reliable as a research method, it is necessary to examine as many manuscripts as possible, so that a large body of data can accommodate occasional exceptions, which may have their own logical explanations.

Table II also shows that the manuscript copied at the monastery of Saints Cosmas and Damian on Mount Olympus (V 1097-3) stands out as distinct, which is likewise a significant result. In the future, as the range of scriptoria and the number of analysed manuscripts increase, we will gain a clearer picture of the inks used in different places, enabling us to determine the origin of Georgian manuscripts more accurately.

Table II: Summary of the analytical results of the Manuscripts in the Graz and Leipzig Collections

Collection	Shelf no.	Date	Place of Origin	BI	RI
Graz	2058/3	(before 981)		A	a
Graz	2058/6a	IX-X		A	a
Leipzig	V 1095-1 V 1097-1	XII-XIII		A —	a —
Leipzig	V 1095-2	XII-XIII		A	a
Leipzig	V 1096-3	IX-X		A	a
Leipzig	V 1097-2	XII-XIII		A	a
Leipzig	V 1097-4	XI		A	a
Graz	2058/6b 2058/6c	907 CE	Lavra of St. Sabas	A A	a b
Leipzig	V 1094	1058–1061	Holy Cross, Jerusalem	A	a, b
Graz	2058/4, part II			A	b
Leipzig	V 1096-5	977 CE	Mt Sinai	A	b
Graz	2058/5	XI-XII?		A	a, e
Graz	2058/2	(VII-VIII?)		A	c
Graz	2058/4, part I	985 CE	Mt Sinai	A, B	a
Leipzig	V 1098-2	XII-XIII		A, B	a
Leipzig	V 1095-3	XIII-XVII		A, B	a, d
Leipzig	V 1096-2	965 CE	Lavra of St. Sabas	A, B	b
Leipzig	V 1098-1	XII-XIII		A, C	a
Graz	2058/1	(VII?)		A, C	a, b
Leipzig	V 1097-3	963–969 CE	Ss Cosmas and Damian on Mt Olympus	D, E	f

Acknowledgements

This publication is part of a project that has received funding from the European Research Council (ERC) under the European Union's Horizon 2020 research and innovation programme (Grant agreement no. 101019006) and from the Deutsche Forschungsgemeinschaft (DFG, German Research Foundation) under Germany's Excellence Strategy – EXC 2176 'Understanding Written Artefacts: Material, Interaction and Transmission in Manuscript Cultures', project no. 390893796. The research was conducted within the scope of the Centre for the Study of Manuscript Cultures (CSMC) at the University of Hamburg.

Picture credits

Figs 1–3, 5: Graz University Library
Figs 4 and 6: Library of Congress, Washington DC
Fig. 7: Leipzig University Library; Library of Congress, Washington DC; Iviron Monastery
Figs 8–14: Sebastian Bosch

References

Assfalg (1963): *Georgische Handschriften*, beschrieben von Julius A. (Verzeichnis der orientalischen Handschriften in Deutschland, 3), Wiesbaden: Steiner. https://digital.staatsbibliothek-berlin.de/werkansicht/?PPN=PPN1878674927.

BHG: Bibliographia hagiographica graeca. 3e édition, mise à jour et considérablement augmentée par François Halkin. 3 vols. Bruxelles: Société des Bollandistes 1957.

Blake (1922–26): Robert Pierpont B., "Catalogue des manuscrits géorgiens de la bibliothèque patriarcale grecque à Jérusalem", *Revue de l'orient chrétien,* 3e sér., [I]: 3=23, 1922–1923, 345–413; [II]: 4=24, 1924, 190–210; [III]: 4=24, 1924, 387–429; [IV]: 5=25, 1925–1926, 132–155. https://archive.org/details/cataloguedesm00bibl.

— (1932): id., "Catalogue of the Georgian Manuscripts in the Cambridge University Library", *The Harvard Theological Review* 25/3, 207–224. https://www.jstor.org/stable/1508314.

Bosch (2025): Sebastian B., "Multi-analytical Material Characterization of Georgian Manuscripts from the Graz and Leipzig Collections" [Data set]. https://doi.org/10.25592/uhhfdm.18218.

Bosch & Kvirkvelia (2025): Sebastian B. and Eka K., "Multi-analytical Material Characterization – Background and Results", presentation at the workshop *Manuscript Cultures in the Caucasus*, University of Hamburg, Centre for the Study of Manuscript Cultures, 25.3.2025. https://doi.org/10.25592/uhhfdm.17525.

Colini *et al*. 2021: Claudia C., Ivan Shevchuk, Kyle Ann Huskin, Ira Rabin, and Oliver Hahn, "A New Standard Protocol for Identification of Writing Media", in Jörg B. Quenzer (ed.), *Exploring Written Artefacts: Objects, Methods, and Concepts*, Berlin, Boston: De Gruyter, 161–182. https://doi.org/10.1515/9783110753301-009.

CPG: Clavis patrum graecorum qua optimae quaeque scriptorum patrum graecorum recensiones a primaevis saeculis usque ad octavum commode recluduntur, cura et studio Mauritii Geerard. 5 vols. Turnhout: Brepols 1983–1987.

Dvali & Jghamaia (1978): მანანა დვალი, ლალი ჯღამაია, "მეათე საუკუნის პატერიკის (Sin-35) ერთი ფრაგმენტის შესახებ", *მრავალთავი / Mravaltavi* 6, 72–80. https://dspace.nplg.gov.ge/handle/1234/259003.

Gabidzashvili (1968): *ძველი ქართული აგიოგრაფიული ლიტერატურის ძეგლები.* IV. *სვინაქსარული რედაქციები (XI–XVIII სს.),* გამოსაცემად მოამზადა და გამოკვლევა დაურთო ენრიკო გაბიძაშვილმა, ილია აბულაძის ხელმძღვანელობითა და რედაქციით, Tbilisi: Mecniereba. https://dspace.nplg.gov.ge/handle/1234/330723.

Garitte (1960): Gérard G., "Les feuillets géorgiens de la collection Mingana à Selly Oak (Birmingham)", *Le Muséon* 73, 239–259.

— (1955): *Lettres de S. Antoine. Version géorgienne et fragments coptes*, édité par Gérard G. (Corpus scriptorum christianorum orientalium, 148 / Scriptores iberici, 5), Louvain: Secrétariat du CorpusSCO.

Ghigo *et al*. (2022): Tea Gh., Ira Rabin, and Paola Buzi, "Black Egyptian inks in Late Antiquity: new insights on their manufacture and use", *Archaeological and Anthropological Sciences* 12: 70. https://doi.org/10.1007/s12520-019-00977-3.

Gippert (forthcoming a): Jost G., “Towards Holistic Cataloguing: The Graz Collection of Georgian Manuscripts”, to appear in *მრავალთავი* / *Mravaltavi* 30, 2024 [2026], 23–44.

— (forthcoming b): id., “News from the Diaspora: Georgian Manuscripts in Germany”, to appear in Mariam Kamarauli (ed.), *Caucasiology in the Digital Era,* Wiesbaden: Reichert.

Gippert *et al.* (2022): Jost G., Bernard Outtier, Sergey Kim in cooperation with Ketevan Asatiani, Manana Dolakidze†, Lali Jghamaia, Maia Karanadze, Mikheil Kavtaria†, Lili Khevsuriani†, Lia Kiknadze, Tinatin Tseradze, Tsitsino Guledani, Tinatin Jikurashvili, Eka Kvirkvelia, Giorgi Lomsadze, Sopio Sarjveladze, Mzekala Shanidze, Darejan Tvaltvadze, and Georgios Boudalis, *Catalogue of the Georgian Manuscripts.* Mount Athos: Holy Monastery of Iviron.

Imnaishvili (2004): ვახტანგ იმნაიშვილი, *უძველესი ქართული ხელნაწერები ავსტრიაში. ხანმეტი ლექციონარი, ფსალმუნი, სვიმეონ სალოსის ცხოვრება, იოვანე ოქროპირისა და იაკობ მოციქულის ჯამისწირვები...* თბილისი: საქართველოს საპატრიარქო.

Jacob (1964): André J., “Une version géorgienne inédite de la liturgie de Saint Jean Chrysostome”, *Le Muséon* 77, 65–119.

Jedlička (1961a): Jaromír J., “Das Prager Fragment der altgeorgischen Jakobusliturgie”, *Archiv Orientální* 29, 183–196. https://kramerius.lib.cas.cz/periodical/uuid:dc4f061b-3e44-11e1-bdd3-005056a60003.

— (1961b): იარომირ იედლიჩკა, “იაკობის ჯამისწირვის ხელნაწერი პრაჰაში”, *მნათობი* 1961/6, 175–180. https://dspace.nplg.gov.ge/handle/1234/17255.

Kern *et al*. (2023): *Die Handschriften der Universitätsbibliothek Graz,* Bd. 1–2: Anton K.; Bd. 3: Maria M.; zusammengeführt und überarbeitet von Hans Z.. Graz: Universitätsbibliothek. https://unipub.uni-graz.at/download/pdf/9339265.pdf.

Khevsuriani (1978): ლილი ხევსურიანი, “Sin. 34-ის შედგენილობის საკითხისათვის”, *მრავალთავი* / *Mravaltavi* 6, 88–122. https://dspace.nplg.gov.ge/handle/1234/259003.

Kvirkvelia (forthcoming): Eka K., “Georgian Witnesses of the Jerusalem-rite Lectionary: Structures and Developments”, to appear in Jost Gippert, Mariam Kamarauli and Eka Kvirkvelia (eds), *The Ecumene of the Jerusalem Rite. Lectionary Traditions of the First Millennium* (Eastern Christian Cultures in Contact), Turnhout: Brepols (2026).

Metreveli *et al*. (1978): *ქართულ ხელნაწერთა აღწერილობა. სინური კოლექცია.* ნაკვ. I, შეადგინეს და დასაბეჭდად მოამზადეს ელენე მეტრეველმა, ციალა ჭანკიევმა, ლილი ხევსურიანმა, ლალი ჯღამაიამ. თბილისი: მეცნიერება. https://dspace.nplg.gov.ge/handle/1234/268226.

Mrusek *et al*. 1995: Ralf M., Robert Fuchs, and Doris Oltrogge, “Spektrale Fenster zur Vergangenheit – ein neues Reflektographieverfahren zur Untersuchung von Buchmalerei und historischem Schriftgut”, *Naturwissenschaften* 82, 68–79. https://doi.org/10.1007/BF01140144.

Outtier (1972): Bernard Ou., “Un feuillet du lectionnaire géorgien ḫanmeti à Paris”, *Le Muséon* 85, 399–402.

Schuchardt (1928): Hugo Sch., “Mittheilungen aus georgischen Handschriften”, *ტფილისის უნივერსიტეტის მოამბე* / *Bulletin de l’Université de Tiflis* 8, 347–376. https://dspace.nplg.gov.ge/handle/1234/429542.

Shanidze (1929): აკაკი შანიძე, “ქართული ხელნაწერები გრაცში”, *ტფილისის უნივერსიტეტის მოამბე / Bulletin de l’Université de Tiflis* 9, 310–353. https://dspace.nplg.gov.ge/handle/1234/457461.

— (1944): *ხანმეტი ლექციონარი. ფოტოტიპიური რეპროდუქცია*, გამოსცა და სიმფონია დაურთო აკაკი შანიძემ (ძველი ქართული ენის ძეგლები, 1), თბილისი: საქართველოს სსრ მეცნიერებათა აკადემიის გამომცემლობა. https://digitallibrary.tsu.ge/book/2018/SXVA/shanidze/shanidze_xanmeti.pdf; https://dspace.nplg.gov.ge/handle/ 1234/363402.

Shanidze (1960): *ფსალმუნის ძველი ქართული რედაქციები X–XIII საუკუნეთა ხელნაწერების მიხედვით*, გამოსცა მზექალა შანიძემ. I. ტექსტი (ძველი ქართული ენის ძეგლები, 11), თბილისი: საქართველოს სსრ მეცნიერებათა აკადემიის გამომცემლობა. https://dspace.nplg.gov.ge/handle/1234/456531.

Tarchnišvili (1950): *Liturgiae Ibericae Antiquiores*, edidit Michael T. (Corpus Scriptorum Christianorum Orientalium, 122 / Scriptores Iberici, 1). Louvain: Secrétariat du CorpusSCO.

Tischendorf (1855): *Anecdota sacra et profana ex Oriente et Occidente allata, sive Notitia codicorum graecorum, arabicorum, syriacorum, copticorum, hebraicorum, aethiopicorum, latinorum cum excerptis multis maximam partem graecis et triginta quinque scripturarum antiquissimarum speciminibus*, edidit Aenoth[eus] Frid[ericus] Const[antinus] Tischendorf. Lipsiae: Emilius Graul. https://archive.org/details/anecdotasacraet00tiscgoog.

Tsagareli (1888): А[лександръ] [Антонович] Цагарели, *Памятники грузинской старины въ Свѧтой Землѣ и на Синаѣ* (Православный палестинский сборникъ, IV/1). С.-Петербургъ: Православное палестинское общество. https://books.google.de/books?id=5xotAAAAYAAJ.

Vollers (1906): *Katalog der islamischen, christlich-orientalischen, jüdischen und samaritanischen Handschriften der Universitäts-Bibliothek zu Leipzig.* Von Karl V. mit einem Beitrag von J. Leipoldt (Katalog der Handschriften der Universitäts-Bibliothek zu Leipzig, 2). Leipzig: Otto Harrassowitz. https://opendata.uni-halle.de/handle/1981185920/100465.

Zammit Lupi (2023): Theresa Z. L., “A Codicological Description of the Georgian Lectionary at Graz University Library”, *Digital Kartvelology*, 2, 124–134. https://doi.org/10.62235/dk.2.2023.7472.

All URLs quoted were last accessed on 29 December, 2025.

გრაცისა და ლაიფციგის კოლექციების ქართული ხელნაწერები: მელნის ანალიზის შედეგები

სებასტიან ბოში, ეკა კვირკველია (ჰამბურგი)

DOI: https://doi.org/10.62235/dk.4.2025.10507
sebastian.bosch@uni-hamburg.de || ORCID: 0000-0003-0469-7442
eka.kvirkvelia@uni-hamburg.de || ORCID: 0000-0001-8853-9964

წარმოდგენილ სტატიაში განხილულია გრაცისა (ავსტრია) და ლაიფციგის (გერმანია) უნივერსიტეტებში დაცულ ქართულ ხელნაწერთა კოლექციაზე ჩატარებული მელნის ანალიზის შედეგები. მნიშვნელოვანია, რომ ამგვარი კვლევა ქართულ ხელნაწერებზე ისტორიაში პირველად განხორციელდა. იგი გულისხმობს წითელი და შავი ფერის მელნის შედგენილობის კვლევას რამდენიმე მეთოდის გამოყენებით, როგორებიცაა: რენტგენოფლუორესცენცია, რამან-სპექტროსკოპია, ულტრაიისფერი/ხილული/ახლო-ინფრაწითელი მიკროსკოპია. კვლევა ჩატარდა პროექტის „მწიგნობრობის განვითარება კავკასიის ტერიტორიებზე“ („DeLiCaTe“) ფარგლებში, ჰამბურგის უნივერსიტეტის ხელნაწერთა კულტურების შესწავლის ცენტრის (CSMC) ლაბორატორიის მიერ. კვლევის მიზანია, მელნის ანალიზი ჩაუტარდეს რაც შეიძლება მეტი რაოდენობის ხელნაწერს ერთიანი მონაცემთა ბაზის შესაქმნელად. ბაზაში თავს მოიყრის ინფორმაცია მელნის შედგენილობის შესახებ, რომელიც კონკრეტული რეგიონებისა და პერიოდებისთვის არის დამახასიათებელი. ამ მონაცემთა ბაზის შექმნაში საკვანძო როლი აქვს ისეთ ხელნაწერებს, რომელთაც გადაწერის ადგილი და თარიღი ახლავს. იმავე შედგენილობის მელნის გამოვლენა სხვა უანდერძო ხელნაწერის შემთხვევაში, იქნება უტყუარი საბუთი მისი წარმომავლობისა და, შესაძლოა, გადაწერის თარიღის დასადგენად.