

# ***Sacramentarium Traiectense: Revealing the Undertext of the Utrecht Sacramentary Palimpsest MS 1661***

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## **Abstract**

*MS 1661 (1 K 10) of the Utrecht University Library is a palimpsest containing a pre-Hadrianic Gregorian Sacramentary, the Sacramentarium Traiectense. Through the use of Multispectral Imaging and Principal Component Analysis, this text, possibly dating from the late seventh or early eighth century and likely created in Northern Italy, has come to light again. It is only the third known sacramentary stemming from the Tridentinum archetype, and possibly the altogether oldest surviving Gregorian sacramentary. This article contains a description of its surviving text and a discussion of the techniques employed which made the Sacramentarium Traiectense known to the world once more.*

## **Introduction**

Among the approximately 700 medieval manuscripts in Utrecht University Library, MS 1661 has features not found in any other. At first glance, it is a twelfth-century copy of the poem *Carmen Paschale*, a biblical epic written in the first half of the fifth century by the poet Sedulius.<sup>1</sup> The parchment has pricking holes on both the vertical and horizontal sides of the leaves. Closer inspection reveals traces of a horizontal undertext written largely in uncial script. MS 1661 is a palimpsest, the only one known in the collection of Utrecht University Library. Those who have used and described MS 1661 previously made no mention of the undertext, which is severely damaged and nearly illegible to the naked eye.<sup>2</sup>

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<sup>1</sup> Utrecht, University Library, MS 1661 (1 K 10). The whole manuscript can be digitally viewed via <https://utrechtuniversity.on.worldcat.org/oclc/965408903>.

<sup>2</sup> MS 1661 is used in H. J. Arntzenius and T. Wopkens, ed., *Coelii Sedulii Carminis paschalis libri V. et hymni duo [...]* (Leeuwarden: H. A. de Chalmot, 1761) and also in J. Arntzenius, ed., *Caji Plinii Caecilii Secundi Panegyricus* (Amsterdam: Janssonius Waesbergius, 1738). See further: C. P. E. Springer, *The manuscripts of Sedulius. A provisional handlist* (Philadelphia: American Philosophical Society, 1995), 103.

In this article, the undertext is made visible once more. This is achieved by means of Multispectral Imaging (MSI) and processing the resulting images using Principal Component Analysis (PCA).<sup>3</sup> These techniques allow for the separation of images of a palimpsest into different elements and greatly improves the visibility and legibility of the undertext.<sup>4</sup> The undertext is identified as a Gregorian sacramentary, a liturgical text used by a bishop or priest for Mass, possibly dating from between the late seventh and early eighth century. More specifically, the sacramentary is of the *Tridentinum* type, which makes this only the third known of its type to survive.<sup>5</sup> It is furthermore, to the best of the authors' knowledge, possibly the oldest Gregorian sacramentary to survive.<sup>6</sup>

Throughout this article, MS 1661 as a whole is referred to as the *Utrecht Sacramentary Palimpsest* (USP). The overtext is referred to as the *Carmen Paschale*, and the sacramentary undertext as the *Sacramentarium Traiectense*.<sup>7</sup> We first provide a description of the USP, with a focus on its current manuscript form, the twelfth century *Carmen Paschale*, the later additions to the manuscript, and its unclear provenance. After a short overview of the Gregorian sacramentary tradition, we discuss the method that was employed to make the undertext legible again. We give an overview of the identified contents and discuss a few of the reconstructed transcriptions of the undertext. After this we provide an overview of the different scripts of the undertext and attempt to place it. Lastly, we explain relations between the *Traiectense* and its close relatives and contextualize our findings in the Gregorian sacramentary tradition.

## Codicology of MS 1661, description of the *Carmen Paschale*, and provenance

The overtext of the USP stems from the twelfth century and is written in a Pregothisc script.<sup>8</sup> The codex measures 173×117 mm and consists of 45 folia: one paper flyleaf with catalog

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<sup>3</sup> The statistical and mathematical techniques we employ have been previously used to analyze other palimpsests that have been scanned with MSI equipment, notably the Archimedes Palimpsest and the Syriac Galen Palimpsest. E. Salerno, A. Tonazzini, and L. Bedini, "Digital image analysis to enhance underwritten text in the Archimedes palimpsest," *IJDAR* 9 (2007): 79–87; R. L. Easton Jr., K. T. Knox, W. A. Christens-Barry, and K. Boydston, "Spectral Imaging Methods Applied to the Syriac Galen Palimpsest," *Manuscript Studies: A Journal of the Schoenberg Institute for Manuscript Studies* 3, no. 1 (2018): 69–82.

<sup>4</sup> Salerno, Tonazzini, and Bedini, "Digital image analysis," 79–81.

<sup>5</sup> A. Westwell, "The Carolingian Sacramentary in Kromeríž, Arcidiecézni Muzeum inv. RKP 21134, Sign O/CV1," *Scriptorium* 76, no. 1–2 (2022): 61.

<sup>6</sup> This is in contention with Monte Cassino, Archivio Della Badia, 271 (CLA 376). This insight is based on the forthcoming work A. Westwell, P. Figurski and H. Buchinger, *Transformations of the Early Medieval Sacramentaries: Latin Mass Books and the Organisation of Liturgical Knowledge, c.800–1200*. Henry Bradshaw Society Subsidia Series (Woodbridge: Noydell & Brewer).

<sup>7</sup> As is customary with sacramentaries, the name of the sacramentary derives from the Latin name of Utrecht, *Traiectum ad Rhenum*.

<sup>8</sup> For the characteristics of Pregothisc, see E. Kwakkel, "Kissing, Biting and Treatment of the Feet: The Transitional Script of the Long Twelfth-Century," in *Turning over a New Leaf: Change and Development in the Medieval Book*, ed. E. Kwakkel, R. McKitterick, and R. M. Thomson (Studies in Medieval and Renaissance

information, one paper quire of two bifolia with premodern notes made by an unknown author, one parchment leaf with a fifteenth-century table of contents, and five parchment twelfth-century quires and a singleton.<sup>9</sup> The twelfth-century quires and the singleton contain Sedulius' *Carmen Paschale* (fol. 1r-37v), Asterius' epigram on Sedulius (fol. 38r), and Sedulius' *Hymnus I* (fol. 38r-39v). To distinguish between the twelfth-century part of the codex and the pages that were added later, the latter are numbered with Roman numerals and the former with Arabic numerals. This makes the collation formula of these quires I (I) + IV (V) + I (VI) + 4 IV (32) + III (38) + 1 (39). The binding is made of a manuscript fragment, which is only legible on the inside.<sup>10</sup> This early thirteenth-century text is written in black ink with red initials, consisting of psalms 62, 63 and 68.<sup>11</sup> Furthermore, the name "Sedulius" is written in a Gothic (semi-)textualis on the front of the binding.

Throughout the manuscript, we find many glosses, both interlinear and marginal. What stands out is the number of Gothic interlinear glosses in the hymn (see fig. 1), showing extensive use of the manuscript. Some of the marginal glosses are written in a Pregothic script, but most are written in some form of humanist cursive.<sup>12</sup> The table of contents on folio VI was written in a Gothic semi-hybrida. There are no signs of incompleteness in the codex.

MS 1661 was one of the manuscripts donated to the Utrecht University Library on 1 November 1888 by the historian and book collector Jacob Anne Grothe (1815-1899).<sup>13</sup> A previous owner was Henricus Johannes Arntzenius (1734-1797), who used it for his 1761 edition of the works of Sedulius, *Coelii Sedulii Carminis paschalis libri V. et hymni duo*. He refers to it as *Codex Arntzenianum* throughout the edition and mentions that the book belonged to his father, Joannis Arntzenius (1702-1759).<sup>14</sup> Joannis Arntzenius mentions the codex in his own work, but we are unable to trace the provenance any further.<sup>15</sup>

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Book Culture; Amsterdam: Amsterdam University Press, 2012), 86-88; and A. Derolez, *Palaeography of Gothic Manuscript Books: From the Twelfth to the Early Sixteenth Century* (Cambridge Studies in Palaeography and Codicology 9, Cambridge: Cambridge University Press, 2012 [2003]), 56-71.

<sup>9</sup> We determined that the table of contents originated from the fifteenth century, as a Gothic semi-hybrida is used. For the characteristics of the Gothic semi-hybrida, see Derolez, 163-165.

<sup>10</sup> In German, these kind of bindings are called *Koperte* (singular *Kopert*). They are discussed in A. Scholla, "Libri sine asscribus: zur Einbandtechnik, Form und Inhalt mitteleuropäischer Koperte des 8. bis 14. Jahrhunderts," PhD dissertation (Leiden: Leiden University, 2002): 60.

<sup>11</sup> Derolez, 56-72; This hand is more of a late Pregothic than an early Gothic, because of the appearance of the *d* and the *r*, the use of &, and the letters on the baseline.

<sup>12</sup> A. Derolez, "The Nomenclature of Humanistic Scripts," *Quaerendo* 41 (2011): 162-171. The use of the uncial d, however, is an eye-catching difference, ensuring that the writer of these 'humanist' glosses cannot be placed within the Italian humanist milieu.

<sup>13</sup> Utrecht University Library, MS Accessions Register, vol. 27 (c 6790-7463), 1888:

<https://utrechtuniversity.on.worldcat.org/oclc/1395252083>.

<sup>14</sup> Sedulius, *Coelii Sedulii Carminis paschalis libri V. et hymni duo*, ed. H. J. Arntzenius and T. Wopkens (Leeuwarden: H. A. de Chalmot, 1761), 29.

<sup>15</sup> The correspondence of the Arntzenius family and the ledger of Grothe (Utrechts Archief, Utrecht, 2.1.2.10.6, J. A. W. Grothe, 1850-1886, catalog number 623 (Kasboek van Jacob Anne Willem Grothe, 1886)) did not yield any useful information.

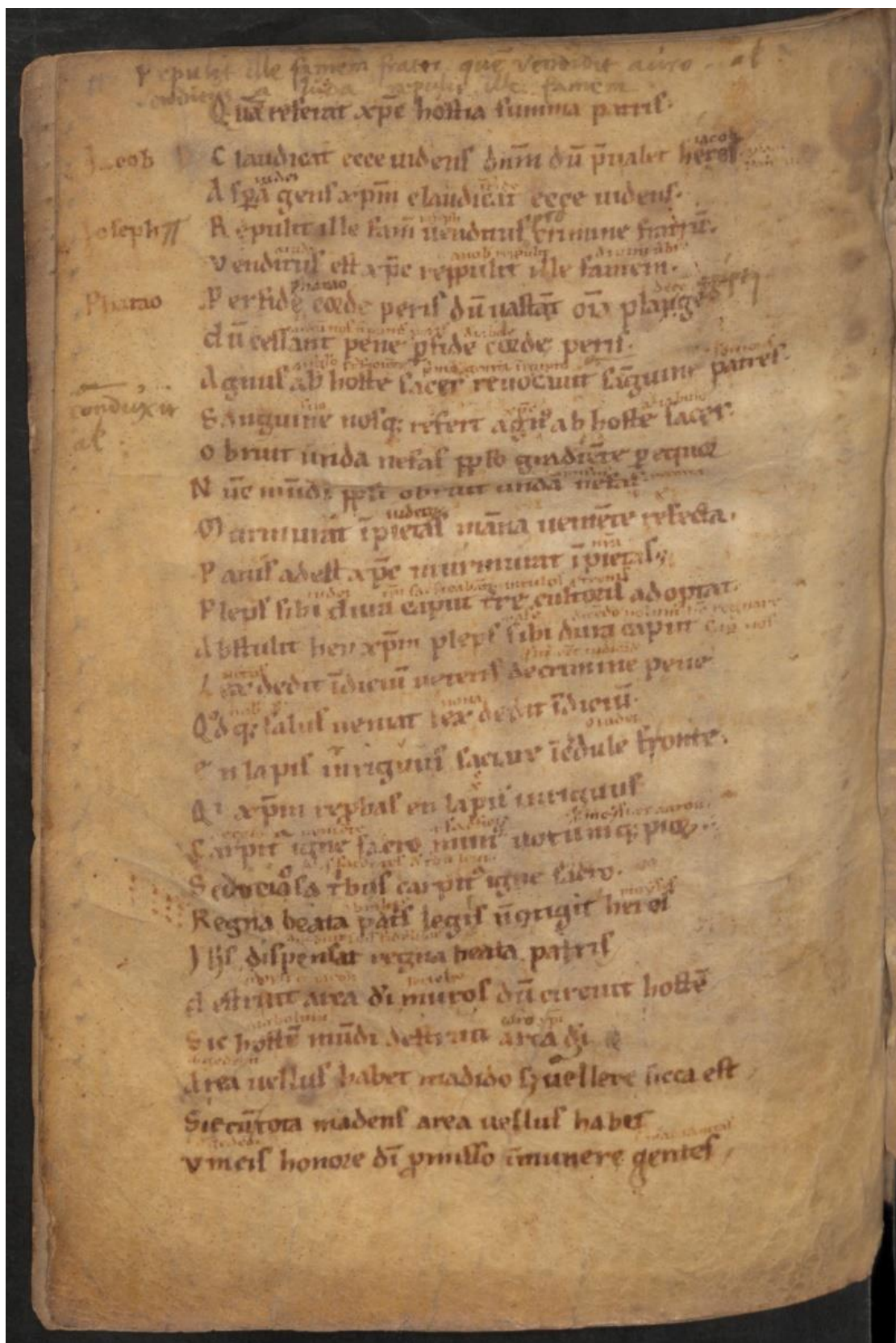


Figure 1. Utrecht, University Library, MS 1661, fol.38v. This leaf shows a variety of interlinear and marginal glosses written throughout the hymn.

## The Gregorian sacramentary tradition

A sacramentary is an early medieval liturgical book used by a priest to lead Mass.<sup>16</sup> The Gregorian sacramentary, falsely attributed to pope Gregory I (pope 590-604), is a particular recension in use from the beginning of the seventh century through the ninth century. It originally mirrored the mass books as used by the pope in Rome in both content and structure of the text, for example referring to specific Roman churches the pope would attend throughout the liturgical year.<sup>17</sup> The Gregorian sacramentary saw use outside of Rome due to its authoritative and referential character. The text was adapted and expanded according to local needs and therefore survives in many variants that can be categorized into different branches.<sup>18</sup>

A monumental effort was performed by Jean Deshusses in order to create an edition of the Gregorian sacramentary tradition.<sup>19</sup> He identified three separate branches in the last quarter of the seventh century, one of them being the hypothetical *Tridentinum* archetype, a Pre-Hadrianic Gregorian sacramentary.<sup>20</sup> The *Hadrianum* is a Gregorian sacramentary manuscript that was sent by pope Hadrian I (pope 772-795) to Charlemagne in response to his request for a Roman Mass book.<sup>21</sup> Pre-Hadrianic sacramentaries therefore lack specific contents that were present in the *Hadrianum*, such as the Thursday Masses of Lent, which were introduced to the liturgical calendar by pope Gregory II (pope 715-731), possibly around 718.<sup>22</sup> The *Tridentinum* branch has, until now, only two known surviving manuscripts, the best known being the Sacramentary of Trento, dated to ca. 825 and placed most likely in Tyrol. A second is the Sacramentary of Kroměříž, probably written in the second half of the ninth century in Reims.<sup>23</sup> Our results will show that the undertext of the USP is a third witness of this archetype, which we name the *Sacramentarium Traiectense*.

## The imaging of the USP

In order to make the undertext of MS 1661 visible again, the manuscript was captured using multispectral imaging (MSI). Under this technique, multiple images are created of the

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<sup>16</sup> A. Westwell, "Standards and Variance in the Early Medieval Mass Liturgy: Re-Making the Gregorian Sacramentary," In *Standardization in the Middle Ages : Volume 2: Europe*, ed. L. C. Engh and K. B. Aavitsland (Berlin: De Gruyter, 2024): 204.

<sup>17</sup> Westwell, "Standards and Variance in the Early Medieval Mass Liturgy," 205.

<sup>18</sup> Westwell, "Standards and Variance in the Early Medieval Mass Liturgy," 206.

<sup>19</sup> J. Deshusses, *Le sacramentaire Grégorien: Ses principales formes d'après les plus anciens manuscrits* (Fribourg: Éditions Universitaires, 1971).

<sup>20</sup> For a stemma of the Gregorian sacramentary tradition, see: J. Deshusses, *Le sacramentaire Grégorien*, 51.

<sup>21</sup> Westwell, "Standards and Variance in the Early Medieval Mass Liturgy," 204.

<sup>22</sup> This estimate is based on the order of dated events in the *Liber Pontificalis*. See: R. Davis, *The Lives of the Eight-Century Popes (Liber Pontificalis): From AD 715 to AD 817* (Rev. ed. Liverpool: Liverpool University Press, 2007 [1992]), 8.

<sup>23</sup> Westwell, "The Carolingian Sacramentary in Kromeríž," 61.

object under varying wavelengths of light. As different components of the object (which here is our palimpsest) are made from different materials, their different reflective characteristics will make them visible at different wavelengths of light. For instance, the carbon used to sketch out the *mise-en-place* of the twelfth century is visible in the infrared, while iron-gall ink becomes invisible.<sup>24</sup>

The imaging of the manuscript was executed by three different teams. In July 2022 a team consisting of Gregory Heyworth and Helen Davies in cooperation with Catherine Albers-Morris and Kathryn Kingsley of The Lazarus Project (University of Rochester, NY) visited Utrecht University Library and made multispectral images of several pages of the USP. In April 2024, the manuscript was subjected to another session of Multispectral Imaging by Andrew Beeby and Richard Gameson of Team Pigment (Durham University). These teams originally came to scan other manuscripts in the collection, and the scans of MS 1661 were only made during the time that was left after their original goals had been achieved. In January 2025, the remaining pages were scanned by Sjors Nab (Utrecht University ArtLab/Radboud University). Below, we state the cameras and different wavelengths. We emphasize that the many other components in the setup also differed, such as used filters, shutter times and lighting rigs.<sup>25</sup>

The system as used by the Lazarus Project consisted of a MegaVision e7-50mp camera with a 120mm f/4.5 Macro UV-IR Apochromat lens, and imaged the wavelengths of 365, 385, 400, 420, 450, 470, 505, 535, 580, 605, 630, 650, 670, 700, 720, 780, 850, and 940 nm.<sup>26</sup> Team Pigment employed a monochrome Canon R7 camera equipped with a Jenaoptik 60mm apochromatic lens, and imaged the wavelengths of 365, 400, 450, 500, 550, 600, 650, 700, 750, 825 and 925 nm. Finally, every leaf that had been missed so far was photographed by Sjors Nab, who used a Nikon D3100 with its IR and UV filters removed in combination with an AF-S NIKKOR 50mm f/1.8G lens. The images were taken without the use of filters at wavelengths of 365, 395, 410, 440, 453, 520, 573, 590, 606, 623, 850 and 940 nm.

The resulting images were processed using Principle Component Analysis (PCA). This technique ideally allows for the separation of the different features of the imaged object (here, the overtext, undertext, parchment etc.).<sup>27</sup> PCA was found to be the most effective in separating the undertext.<sup>28</sup> Other techniques were also run in parallel to PCA, i.e. Independent Component Analysis and Minimum Noise Fraction, but these were found to

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<sup>24</sup> C. Jones et al., “Understanding multispectral imaging of cultural heritage: Determining best practice in MSI analysis of historical artefacts,” *Journal of Cultural Heritage* 45 (2020): 340.

<sup>25</sup> We cannot do justice to the intricacies of the entire systems in this article. Information on the full systems can be supplied by the authors upon reasonable request.

<sup>26</sup> For the techniques employed by the Lazarus Project, in the same period they made their images at the Utrecht University Library, see N. Stam, C. Albers-Morris, H. Davies, and G. Heyworth. “Reading the End of Fled Bricrenn,” *Studia Celtica Fennica* 21, no. 1 (May 20, 2025): 1–25.

<sup>27</sup> R.L. Easton and D. Kelbe, “Statistical Processing of Spectral Imagery to Recover Writings from Erased or Damaged Manuscripts,” *Manuscript Cultures* 7 (2014): 40.

<sup>28</sup> The code used can be found at [https://github.com/JLKamermans/PCA\\_Utrecht\\_Palimpsest](https://github.com/JLKamermans/PCA_Utrecht_Palimpsest)

yield results that were either equal or inferior to PCA. The resulting images were edited in GIMP for increased contrast and mapped to the Viridis color scheme for greater legibility.<sup>29</sup>

## The Undertext

Through the use of MSI and PCA, we are able to see and read parts of the undertext, but it has not become visible on every page. Results where the undertext has remained invisible were cross-referenced with all original scans and confirmed to be too damaged to obtain significant results. These pages have undergone extensive physical damage as a result of the scraping process, which took place in the twelfth century (see fig. 2). The old text was scraped away line by line and once more diagonally, presumably with a penknife. This is one of the three methods that was used during the Middle Ages to remove ink from a parchment surface.<sup>30</sup> The subtext has not been scraped off equally thoroughly on each bifolium of MS 1661. On certain leaves, a portion of the original text remains visible without the assistance of digital techniques (e.g., fol. 22v). In other cases, multispectral images show much of the subtext especially in the margins of the overtext. It is possible that the *mise-en-page* of the twelfth century text was established first and the subtext was only removed in those areas that would overlap with the planned text of Sedulius. It is also possible that the subtext was initially largely removed and then, after the new *mise-en-page* was established, it was scraped off in additional locations.

The processed images show more than just the subtext. There are two crosses present, on fol. 22v and fol. 26r (fig. 4), which mostly resemble a *fleury cross* or *cross cercelée* due to the particular shape of the crosses' arms. These crosses indicate that the original sacramentary included at least some form of decoration, albeit quite simple. What exactly these crosses signified or what their relationship with the text was is unclear; the symbol of the cross did not have one single meaning when used in (early) medieval manuscripts, nor was it used consistently.<sup>31</sup> In this case, the crosses are placed in the margin of new distinct sections in the sacramentary. On fol. 22v a section on the Rite of Baptism starts with the prayer "*Benedictio salis*".<sup>32</sup> On fol. 26r a section on the Collects of Advent starts with the prayer "*Excita domine quaesumus ... liberante salvari*".<sup>33</sup> The

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<sup>29</sup> J. Nuñez, C. Anderton and R. Renslow, "Optimizing colormaps with consideration for color vision deficiency to enable accurate interpretation of scientific data," PLoS ONE 13, no. 7 (2018): e0199239

<sup>30</sup> H. Ryley, *Re-using Manuscripts in Late Medieval England: Repairing, Recycling, Sharing* (Woodbridge, Suffolk 2022), 97-98. According to Ryley, one could also remove the ink by polishing the surface of the parchment with pumice – similar to the final stage of preparing parchment – or by chemically washing away the ink on the parchment.

<sup>31</sup> E. Steinova, "Nota and Require: The Oldest Western Annotation Symbols and Their Dissemination in the Early Middle Ages," in *Scribes and the Presentation of Texts (from Antiquity to c. 1550): Proceedings of the 20th Colloquium of the Comité international de paléographie latine*, ed. B. A. Shailor, & C. W. Dutschke (Bibliologia No. 65; Turnhout: Brepols Publishers, 2021), 478.

<sup>32</sup> See figure 3. This prayer is Gr356 in the standard edition of the Gregorian sacramentary by Deshusses, *Le sacramentaire Grégorien*. For more information about the rite of baptism in liturgical books like sacramentaries, see: J. Lupi, "The development of the rite of baptism." *Melita Theologica* 39, no.1 (1988): 1-31.

<sup>33</sup> This prayer is Gr778 in the standard edition of the Gregorian sacramentary by Deshusses.



crosses thus could be interpreted as symbols that were used to structure the text, denoting when a significant event in the liturgical year starts.

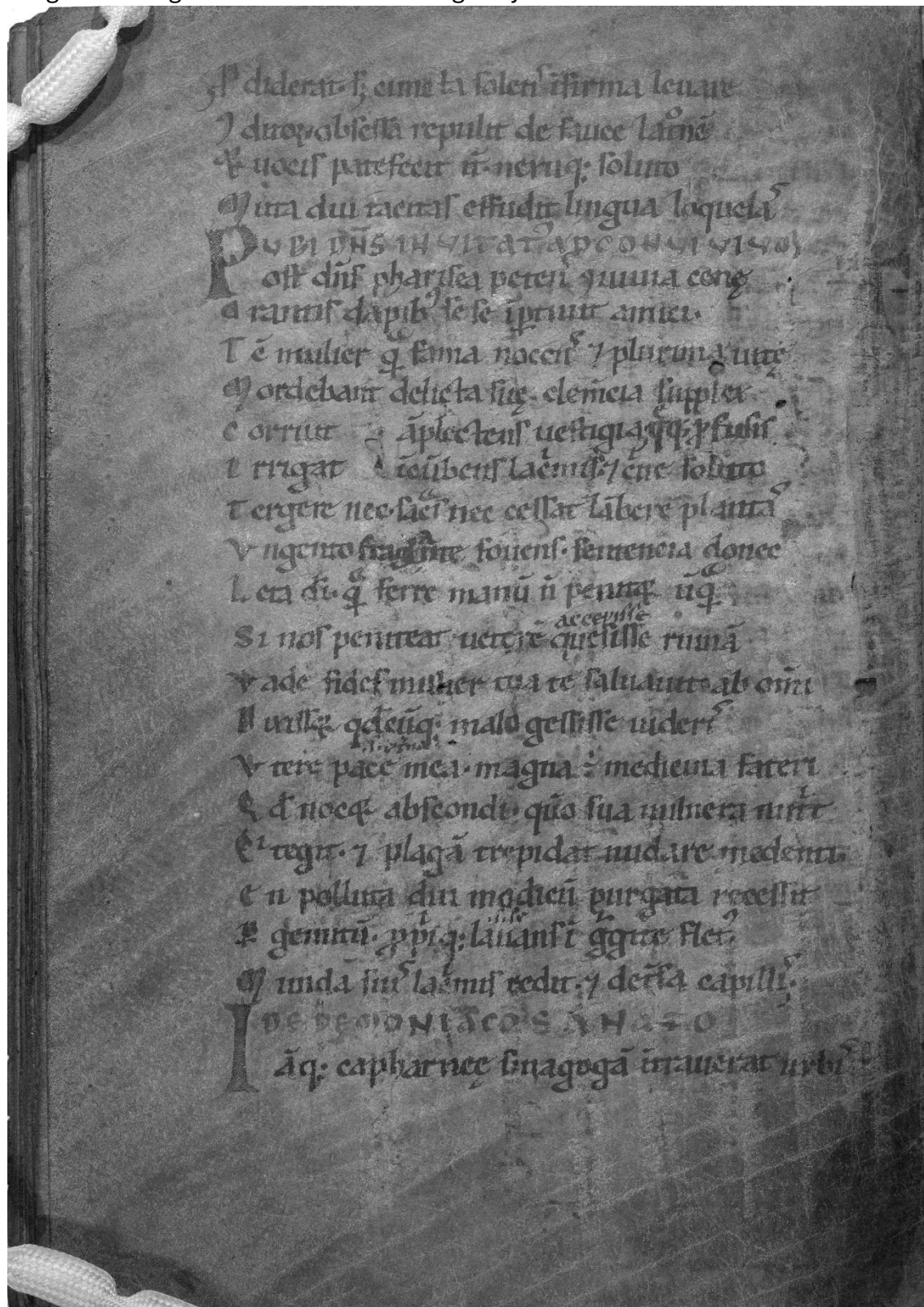


Figure 2: An image of fol. 23v in the UV, made by Team Pigment, which shows the diagonal scraping of the parchment.



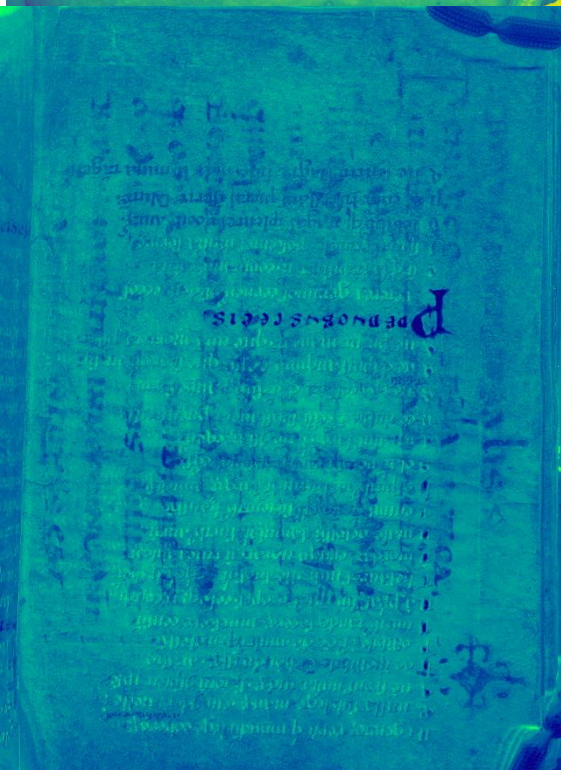
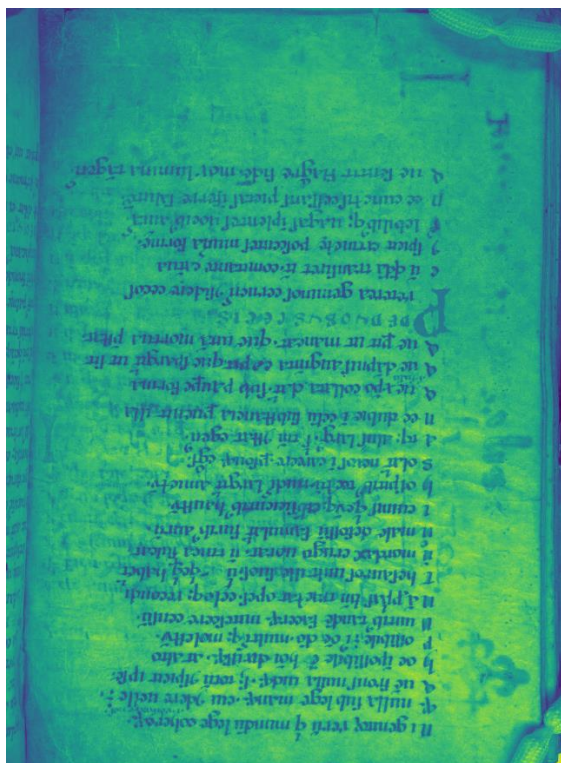
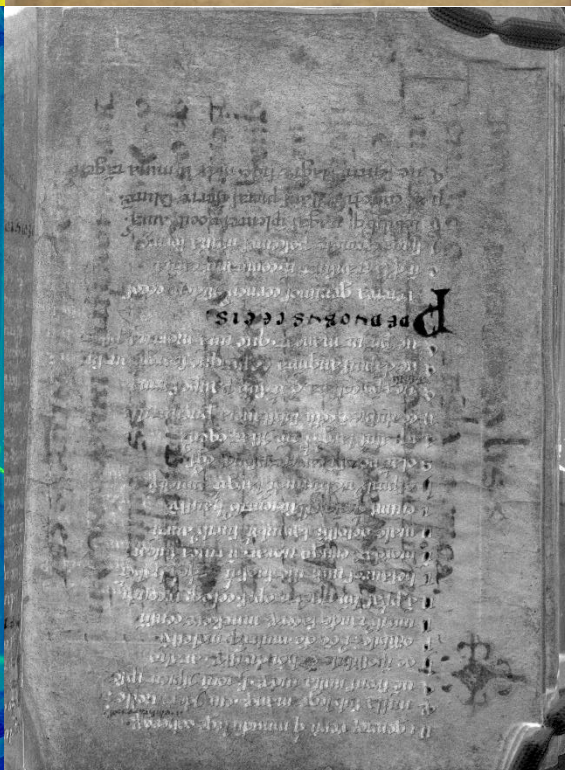
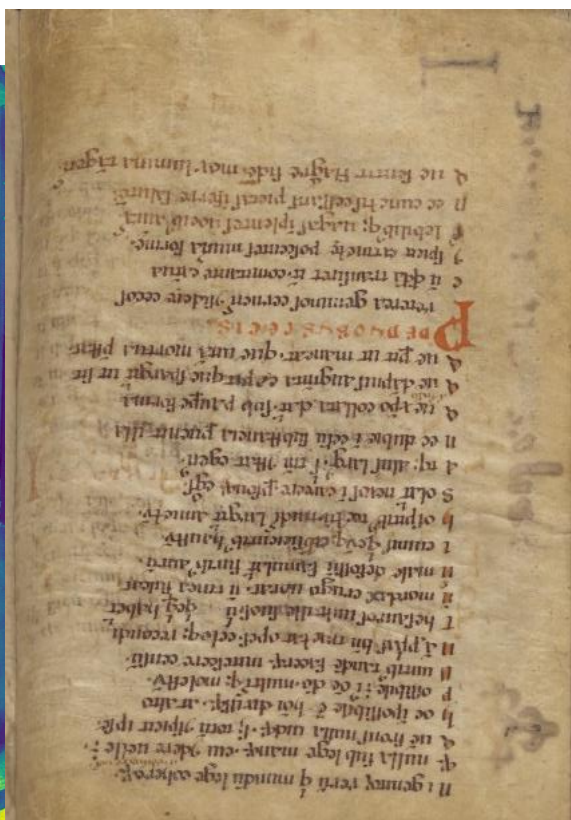


Figure 3. Top left: Utrecht, University Library, MS 1661, fol. 22v. Here you can see some traces of the subplot in the margins. Bottom left: the first order Principal Component (PC) of 22v. Top right: the third order PC of 22v in greyscale. Note that in comparison to the first order PC, the original text is more legible and the other aspects such as the overtext have disappeared to the background. Bottom right: the third order PC of 22v in Viridis. Imaging by Team Pigment with the permission of Utrecht University Library, processing performed by the authors.

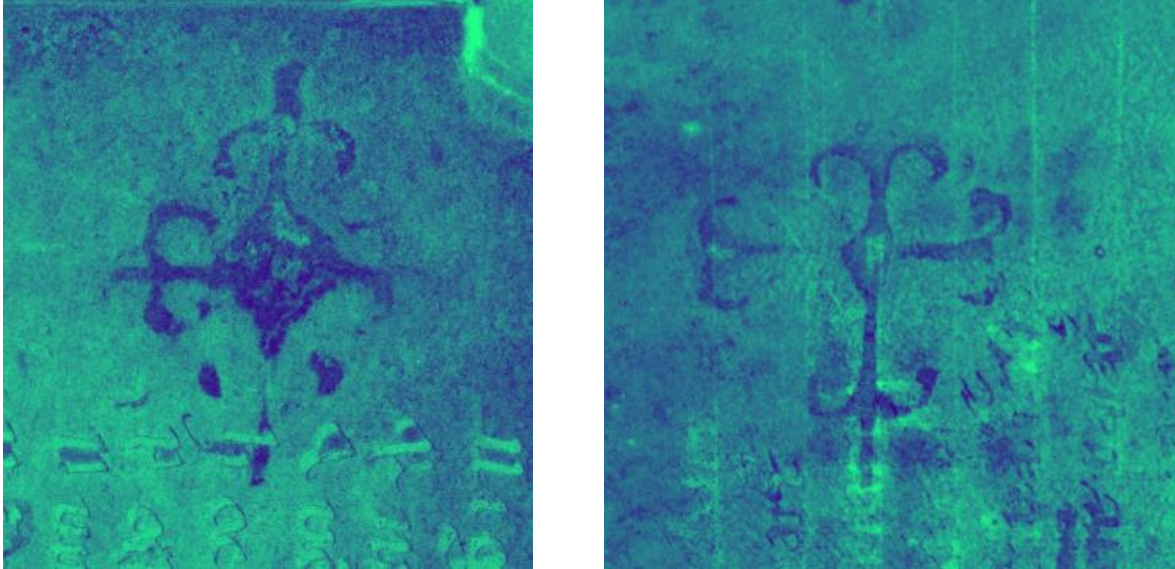


Figure 4: Symbols of a cross resembling a fleury cross or cross cercelée on fol. 22v (left) and on fol. 26r (right). Imaging by Team Pigment with the permission of Utrecht University Library, processing performed by the authors.

## Transcription of the *Sacramentarium Traiectense*

In this section, we present and discuss our reconstruction of the subtext of the USP: the *Sacramentarium Traiectense*. In Table 1, an overview of our results is provided. We refer to the original leaves using Greek capital letters. Two of the original leaves, corresponding to Δ and E are scraped in such a way that no script could be identified. The reconstructed text is given in *italics*, the letters we can directly read in **bold**, and letters not directly present due to abbreviations are underlined. Where possible, the reconstructed text is given with the spacing and line breaks as they are in the manuscript. The text is written as a fully justified and single column text, with simple initials starting each prayer protruding into the left margin. As the pages of the overtext correspond to half pages of the subtext, the images are referenced as upper and lower half. We limit ourselves to discussing seven of the original leaves here: A, Γ, K, Λ, M, N, and Y. These leaves show a clear deviation from the standard Gregorian. Only in the case of M, we use ‘recto’ and ‘verso’ to refer to the two sides of the leaf. All images, together with all transcriptions, have been uploaded to the DANS repository, and can be found at: <https://doi.org/10.17026/SS/BLKKFY>.

While transcribing the *Sacramentarium Traiectense*, we will also refer to several existing manuscripts or editions from the eighth and ninth century, which for reading convenience will be abbreviated as:<sup>34</sup>

- **Gr:** The standard version of the *Sacramentarium Gregorianum* as reconstructed by Jean Deshusses (1908-1997).<sup>35</sup>

<sup>34</sup> Where applicable, we have chosen to use the same abbreviations as Deshusses, *Le sacramentaire Grégorien*, as this is the standard work.

<sup>35</sup> Deshusses, *Le sacramentaire Grégorien*.



- **Ω:** The Trento sacramentary: Trento, Castello del Buonconsiglio (MN 1590 OA). Written in the first half of the ninth century, most likely in Tyrol.<sup>36</sup>
- **D:** The Saint-Gall Sacramentary: Oxford, The Bodleian (Ms. Add. A 173). Written in the second half of the ninth century, for the abbey of Saint-Gall in Switzerland.<sup>37</sup>
- **J:** The Sacramentary of Le Mans: Le Mans, Médiathèque Louis-Aragon (Ms. 77). Written in the third quarter of the ninth century in Saint-Amand.<sup>38</sup>
- **Pa:** The *Paduensis*: Padova, Biblioteca Capitolare 845. Written at Aachen ca. 845.<sup>39</sup>
- **Rh:** *Sacramentarium Rhenaugiense*: Zürich, Zentralbibliothek (cod. Rh 30). Written in the second half of the eighth century.<sup>40</sup> Its precise origin is unknown; however, the Rhaetian or Alemannic regions are likely candidates.<sup>41</sup>
- **W:** The Essen Sacramentary: Düsseldorf, Universitäts- und Landesbibliothek (Ms. D1). Written in the first quarter of the ninth century in north-west Germany.<sup>42</sup>

Table 1: The original folia of the USP and their identified contents

| Original leaf | Bifolia | Script    | Identified passages  | Discussed below |
|---------------|---------|-----------|----------------------|-----------------|
| A             | 1 & 8   | Uncial    | Gr322*, Gr77-78      | ✓               |
| B             | 2 & 7   | Uncial    | Gr101-102, 105       |                 |
| Γ             | 3 & 6   | Uncial    | Gr109-112            | ✓               |
| Δ             | 4 & 5   | Unknown   | Illegible            |                 |
| E             | 9 & 16  | Unknown   | Illegible            |                 |
| Z             | 10 & 15 | Uncial    | Gr97-100             |                 |
| H             | 11 & 14 | Uncial    | Pa45, Gr79-81        |                 |
| Θ             | 12 & 13 | Uncial    | Gr169-171            |                 |
| I             | 17 & 24 | Uncial    | Gr935-941            |                 |
| K             | 18 & 23 | Minuscule | Not identified       | ✓               |
| Λ             | 19 & 22 | Uncial    | Gr356-357            | ✓               |
| M             | 20 & 21 | Minuscule | Gr290-296, Gr300-302 | ✓               |
| N             | 32 & 25 | Uncial    | Gr381*-386*          | ✓               |
| Ξ             | 26 & 31 | Uncial    | Gr777-779            |                 |
| Ω             | 27 & 30 | Uncial    | Gr732-733, Gr736-737 |                 |
| Π             | 28 & 29 | Uncial    | Gr740-744            |                 |

<sup>36</sup> Deshusses, *Le Sacramentaire Grégorien*, 42.

<sup>37</sup> Deshusses, *Le Sacramentaire Grégorien*, 39.

<sup>38</sup> Deshusses, *Le Sacramentaire Grégorien*, 37.

<sup>39</sup> Deshusses, *Le Sacramentaire Grégorien*, 39; A. Catella, F. Dell'Oro, A. Martini, and F. Crivello, *Liber Sacramentorum Paduensis* (Rome: CLV-Edizioni Liturgiche, 2005).

<sup>40</sup> A. Hänggi, *Sacramentarium Rhenaugiense: Handschrift Rh 30 der Zentralbibliothek Zürich* (Freiburg: Schweiz Univ.-Verl., 1970), 64-68.

<sup>41</sup> Hänggi, *Sacramentarium Rhenaugiense*, 57-64.

<sup>42</sup> Deshusses, *Le Sacramentaire Grégorien*, 36.

|          |         |           |                       |   |
|----------|---------|-----------|-----------------------|---|
| <b>P</b> | 33 & 38 | Minuscule | <i>Not identified</i> |   |
| <b>Σ</b> | 34 & 37 | Uncial    | Gr955-960             |   |
| <b>T</b> | 35 & 36 | Uncial    | Gr841-847             |   |
| <b>Y</b> | 39      | Minuscule | <i>Possibly Gr235</i> | ✓ |

### **A upper half (fol. 8r):**

The first legible line of the *Traiectense* corresponds to the end of Rh57, reading:

***possimus imitari quorum tibi  
dicatam ueneramur infan  
tiam. Per (...)***

This variation is present in Ω, where this prayer form is inserted after Gr75 and listed as Gr322\*. After this, a line of unreadable *capitalis* in colored ink seems to be present. The next line corresponds to Gr77:

***Votua domine dona percepimus quae  
sanctorum nobis praecibus et prae  
sentis nobis quaesumus uitae partier  
et aeternae tribue conferre  
subsidium. Per.***

The word *nobis* is a distinct variation. The next prayer is illegible except for the initial D, and a few letters. Gr78 begins with *Deus*, making this a plausible fit.

### **Γ upper half (fol. 3r):**

The leaf starts with the end of Gr109:

***et ad perpetuum nobis tribue  
provenire subsidium. Per d***

We note that the prayer ends with a clearly visible *d*, while no other letters appear afterwards. Below this, Gr110 is displayed:

***Refecti participatione mune  
ris sacri quaesumus, domine deus noster ut cu  
ius exsequimur cultum, sen  
tiamus effectum. Per dominum.***

At the bottom of this half, an illegible title is present. The final lines are the beginning of Gr111:

***Deus qui beatum sebastianum  
martyrem tuum uirtutem cons (...)***

Both *tuum* and *uirtutem* could be abbreviated, but the mark above the final letters is not visible, possibly due to damage.

**Γ lower half (fol. 6v):**

The lower half continues with Gr111:

***(...) ti ex eius nobis imitatione tri  
buae pro amore tuo prospe  
ra mundi despicere, et in  
tua semper uoluntate proficere. Per.***

We note that *et in (...) proficere* is a variation that only occurs in Ω. Other manuscripts usually read *et nulla eius aduersa formidare*. After this, Gr112 begins:

***Accepta sit in conspectu tuo domine  
nostrae deuotionis oblatio  
eius nobis fiat supplicatione  
salutaris pro sollemni  
tate defertur. Per.***

Here we note that *nostrae deuotionis oblatio* is a variation that only occurs in Ω. The next line of text is very faint and illegible.

**K upper half (fol. 18r):**

Fol. 18r displays an extremely fragmented minuscule script, reading:

***(...) qui- dig- (...)  
(...) -uis (...)  
(...) p- fili- (...)  
(...) quoque  
(...) -ocis  
(...) -p-io  
(...)***

Several ascenders and descenders are legible on all lines. We are unable to fit this folio with specific prayers of the Gregorian and its variations. This makes us believe that this folio displays something of another origin, possibly a local prayer. Fol. 23v also carries a minuscule script, but curiously, fol. 23r seemingly does not. Since the parchment is badly damaged, it is possible that fol. 23r displays a combination of a minuscule and a *capitalis*, with only the *capitalis* still being visible.

**Λ upper half (fol. 22v):**

This folio features a cross on the top right side (see fig. 3). The first line is the title of the section starting directly before Gr356:

***BENEDICTIO SALIS.***

The rest of the upper half of the folio reads:

***Benedic omnipotens deus hanc crea  
turam salis tua benedictio  
ne caelesti in nomine domini nostri  
iesu christi et in uirtute sancti spiritus  
tui ad effugandum inimicum  
quam sanctificando sanctifices et  
benedicendo benedicas fiat  
que omnibus accipientibus perfecta  
medicina permanens in uisce  
ribus sumentium in nomine domini  
nostri iesu christi qui uenturus est***

This is Gr356, specifically a variation found in the D, J and W manuscripts. Gr356 as reconstructed by Deshusses stops after *christi*, while *qui uenturus est* is added in the *Traiectense*.

**Λ lower half (fol. 19r):**

On the lower half, the sacramentary continues with Gr357:

***(...) ad rudimenta fidei vocare  
dignatus es caecitatem cor  
dis ab eo expelle disrumpe om  
nes laqueos satanae quibus fue  
rat conligatus aperi ei iam uam  
misericordiae tuae et signo***

**M recto, upper half (fol. 20v):**

This half features initials and some minuscule letters on the last two lines of the upper half. The minuscule letters also seem to be part of the *Gregorianum*, corresponding to Gr290, Gr291 and Gr292:

***Sacramenti tui, quaesumus, domine, participatio salutaris, et purificationem nobis  
praebeat et medellam. Per.***

***Da quaesumus, domine, populo tuo salutem mentis et corporis, ut bonis operibus  
inherendo, tua semper mereatur protectione defendi. Per dominum.***



*Nostra tibi, quaesumus, domine, sint accepta ieiunia, quae nos et  
expiendo gratia tua dignos efficiant et ad remedia perducant aeterna. Per dominum  
nostrum iesum.*

**M recto, lower half (fol. 21r):**

On the lower half, prayers Gr293, Gr294 and Gr295 follow, again in minuscule:

*Hostias tibi, domine, deferimus immolandas, quae temporalem consolationem significant  
ut promissa non desperemus aeterna. Per dominum.*

*Da quaesumus, omnipotens deus, ut quae divina sunt iugiter exequentes, donis mereamur  
caelestibus propinquare. Per dominum nostrum.*

*Da nobis, domine, quaesumus, perseverantem in tua voluntate famulatum, ut in diebus  
nostris et merito et numero populus tibi serviens augeatur. Per dominum.*

The last line begins with an *et*-ligature followed by a long *s* or an *f*, which could correspond to Gr296, with the *et*-ligature being added in front:

*et sanctificato hoc ieiunio deus, tuorum corda fidelium miserator (...)*

**M verso, lower half (fol. 21v):**

The verso side only has three visible initials: a *D* and *Q*, which, judging by the spacing, correspond to successive prayers, and above it there possibly is a *P*. The rest of the text is illegible, apart from single minuscule letters and some *per*-ligatures. Taking the text on the recto side into account, this probably is Gr302-Gr303, starting with *Deus* and *Quod*. If the third initial is indeed a *P*, this would correspond to Gr301, starting with *Praesta*. An important note is that Gr302 and Gr303 are absent in  $\Omega$ , where they have been replaced by prayers that do not fit this page. In conclusion, the recto side of M displays Gr290-Gr296, which is likely followed by Gr300-Gr303 on the lower half of the verso side.

**N upper half (fol. 25v):**

The first prayer is part of the Common of Saints present in  $\Omega$ , in Deshusses labeled as Gr381\*, which reads:

*Purificet nos domine quaesumus, et diuini preceptio  
sacramenti, et gloriosa(e) sanctorum tuorum  
oratio. Per.*

The next line is illegible. The next prayer is extremely difficult to read, but it starts with *Adsit*, and a few other individual letters that can be read, which seem to agree with Gr382\*, the continuation of the Common of Saints. In the next line only the final three letters -*RIS* are legible. This fits the title of the next section that reads:

*ORATIONES ET PRECES IN NATALE UNIS MARTYRIS.*

The next line agrees well with Gr383\*, which reads:

***Sancti*** *martyris tui domine* ***quaesumus*** *ueneranda*  
*festiuitas salutaris auxilii nobis praestet*

#### **N lower half (fol. 32r):**

The first line starts with a vague *P* initial, with the rest of the prayer being illegible. This could indicate Gr384\*, as this starts with *Praesta*. The next prayer is consistent with Gr385\*, which reads:

***Sumptis*** *domine sacramentis quaesumus intercedente beato*  
*martyre tuo N. ad redemptionis aeter*  
***nae*** *proficiamus augmentum. Per.*

The final prayer partly agrees with Gr386\*:

***Adesto*** *domine fidelibus tuis*  
*nec ullis* *eos mentis* ***et corporis*** *patiaris (...)*

We are not convinced that the word before *ullis* spells *nec*, as a very clear descender is present, and the word *eos* seems to be missing as well, which indicates that this prayer diverges from Gr386\*. However, all things considered, we are convinced that N agrees best with the Common of Saints as found in Ω.

#### **Y lower half (fol. 39v):**

Only a singular line is partially readable on the top side of the parchment in minuscule, likely showing:

***Subueniet*** *domine misericordie tua (...)*

There are two possible origins for this prayer: it either is non-Gregorian, or it represents Gr235 with a number of copying errors, as this reads *Subueniat nobis domine misericordia tua (...)*. It is important to note that this leaf is the only singleton: it is not part of a quire, and the final one in the manuscript.

## **The scripts and the place of writing**

The main script of the subtext is a Latin uncial: a majuscule script with a distinct sloped *a* and *d*, a closed *e*, a very round *m*, an *l* with a small horizontal stroke, with overall very small ascenders and descenders. The uncial script was mainly in use between the fourth and ninth centuries as a text script and used as a display script until later. It appears to be a

slightly later uncial, determined by the slight angularity of the letters and the *f*'s and *g*'s having descenders.<sup>43</sup> For a reconstruction of the handwriting, see appendix I.I.

The uncial of the subtext is crude and slightly inconsistent, with no richly decorated initials and pages surviving. As these were less likely to be reused, the surviving pages are not indicative of the original work. Due to the presence of the crosses, it is possible the original work contained other kinds of decorations. The use of abbreviations is rare, with only abbreviations for *deus*, *domini*, *dominus*, *quaesumus* and *nobis* being consistently used, together with the *per*-abbreviation. The rubrics of the sacramentary are seemingly written in a different ink, possibly red. These use a Roman *capitalis* script, which regrettably cannot be reconstructed in full as the ink has either been scraped off more thoroughly when the parchment was reused or has faded more quickly over time (see appendix I.II).

A minuscule script is present on at least four leaves: K, M, P and Y. While these leaves are too damaged for the script to be accurately determined, a characteristic Carolingian *s* (*f*) is recognizable (see appendix I.III). This letterform was already present in pre-Carolingian minuscules, e.g. in some surviving examples from Italy.<sup>44</sup> We also note that the minuscule seems to have been used for the main text on fol. K, as it is found in a continuous section of regular Gregorian prayers, Gr290 to Gr296 and Gr301 to Gr302. A possible explanation for the change in script is the insertion of these pages as a means of repair, to make additions or to update the contents. It is therefore unlikely that the uncial parts were written at the same time as the minuscule.

The biggest clue to localizing the USP is the uncial script. We find comparanda in the *Codices Latini Antiquiores* (CLA) corpus, a monumental study of Latin manuscripts written before or around 800, and note four manuscripts that bear a resemblance to the subtext's script. They are given in Table 2 below.<sup>45</sup> The dating has been updated using work published since the CLA. We find that CLA 233b, 141 and 449 are most like the uncial found in the USP, with 279 also showing some distinct agreement. Overall, the uncial bears the closest resemblance to a (Northern) Italian uncial. We therefore deem it plausible that the USP is created in what is now Italy, likely in the North. This comparison cannot be used to date the manuscript however, as the dates of the comparanda vary between the late sixth and eight centuries.

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<sup>43</sup> R. G. Babcock, "Uncial Script," in *The Oxford Handbook of Latin Palaeography*, ed. F. T. Coulson and R. G. Babcock (Oxford, Oxford Academic, 10 Nov. 2020), 98, Online edition, <https://doi.org/10.1093/oxfordhb/9780195336948.013.39>.

<sup>44</sup> Petrucci, A. "L'Onciale Romana : Origini, sviluppo e diffusione di una stilizzazione grafica altomedievale (sec. vi-ix)." In *Studi Medievali* 12 (1971): 75-156. The minuscule for instance appears alike to the Maurdrampus script of the abbey of Corbie, often regarded as the earliest form of Carolingian minuscule. See also: D. Ganz, "Scripts of Merovingian Gaul," in *The Oxford Handbook of Latin Palaeography*, ed. F. T. Coulson and R. G. Babcock (Oxford, Oxford Academic, 10 Nov. 2020), 193-202, Online edition, <https://doi.org/10.1093/oxfordhb/9780195336948.013.97>.

<sup>45</sup> We wish to refer to the excellent *Earlier Latin Manuscripts* database based on the CLA, Earlier Latin Manuscripts: Tools for studying the scripts of the oldest Latin manuscripts, acc. July 12, 2025, <https://elmss.nuigalway.ie/>.

Table 2: The entries in the *Codices Latini Antiquiores* (CLA) most comparable to the script found in the USP.

| CLA number         | Origin                    | Agreement Letterforms                       | Disagreement Letterforms        | Date                    |
|--------------------|---------------------------|---------------------------------------------|---------------------------------|-------------------------|
| 233b <sup>46</sup> | Italy                     | a, b, c, d, f, g, i, m, o, h, p, q, s       | e, l, n, r, t, u, x             | 580 - 620               |
| 449 <sup>47</sup>  | (Northern) Italy          | c, d, e, f, i, l, m, n, o, s, t, u          | a, b, h, p, q, r                | 600 - 650 <sup>48</sup> |
| 141 <sup>49</sup>  | Italy or France           | a, c, d, e, f, h, i, l, m, n, o, p, s, t, u | b, g, q, r                      | 676 - 700               |
| 279 <sup>50</sup>  | Northern or Central Italy | b, c, f, i, n, o, p, u                      | a, d, e, g, h, l, m, r, t, s, q | 788 - 800               |

## The contents of the *Sacramentarium Traiectense* and its dating

As we have seen, the identified subtext of the USP is largely in line with the Gregorian sacramentary. As Table 1 shows, the *Sacramentarium Traiectense* broadly contains Gr77-Gr112, Gr290-Gr302, Gr732-Gr744, Gr841-Gr847 and Gr935-Gr960, with a few isolated prayers in between. It disagrees with the standard Gregorian on a number of occasions. These (dis)agreements closely follow the Trento sacramentary, especially the parts in uncial:

- Agreements between the *Traiectense* and Trento (uncial):
  - Gr76 is replaced by Gr322\*.
  - Pa45 is inserted before Gr79.

<sup>46</sup> Lowe, E. A., *Codices Latini antiquiores: a palaeographical guide to Latin manuscripts prior to the ninth century*. Part 2: Great Britain and Ireland. Oxford: Clarendon Press, 1935. Second edition, 1972. The manuscript is Oxford, Bodleian Library MS. Auct. T. 2. 26, (foll. 146–178), <https://digital.bodleian.ox.ac.uk/objects/71e1863f-9c42-4461-b948-393cd976765a/>.

<sup>47</sup> Lowe, E. A., *Codices Latini antiquiores: a palaeographical guide to Latin manuscripts prior to the ninth century*. Part 4: Italy. Perugia – Verona. Oxford: Clarendon Press, 1947. The manuscript is Turin, Biblioteca Nazionale Universitaria di Torino, F.IV.1 fasc. 2 and F.IV.14.

<sup>48</sup> An erratum to the original dating is given in Lowe, E. A., *Codices Latini antiquiores: a palaeographical guide to Latin manuscripts prior to the ninth century*. Part 6: France. Abbeville – Valenciennes. Oxford: Clarendon Press, 1953.

<sup>49</sup> Lowe, E. A., *CLA Part 2: Great Britain and Ireland*. The manuscript is New Haven, Beinecke Rare Book and Manuscript Library, MS 481.1, <https://collections.library.yale.edu/catalog/2003579>, and New York, The Morgan Museum and Library, MS G.58, <https://www.themorgan.org/manuscript/76983>.

<sup>50</sup> Lowe, E. A., *Codices Latini antiquiores: a palaeographical guide to Latin manuscripts prior to the ninth century*. Part 3: Italy. Ancona – Novara. Oxford: Clarendon Press, 1938. The manuscript is Assisi, Biblioteca Comunale S. Francesco, MS 585, [https://www.internetculturale.it/jmms/iccuviewer/iccu.jsp?id=oai%3Awww.internetculturale.sbn.it%2FTeca%3A20%3ANT0000%3APG0213\\_ms.585&mode=all&teca=MagTeca+-+ICCU](https://www.internetculturale.it/jmms/iccuviewer/iccu.jsp?id=oai%3Awww.internetculturale.sbn.it%2FTeca%3A20%3ANT0000%3APG0213_ms.585&mode=all&teca=MagTeca+-+ICCU).

- Gr111 has a distinct and long variation in its ending.
  - Gr112 has smaller variation.
  - Gr935 has a variation with an added word (*tu*).
  - At least six distinct prayers from the Common of the Saints distinct to Trento (Gr 381\*-386\*).
- Disagreements between the *Traiectense* and Trento:
    - Gr101 reads *repleti*, while this word is absent in Trento.
    - Gr743 reads *et intercedente* instead of *ut intercedente*.
    - Gr843 reads *ut partier* instead of *et pariter*.

These disagreements are based on a single word and can be explained as scribal errors. The agreements, however, are more substantial, in particular the inclusion of a part of the Common of the Saints, of which the inclusion in the sacramentary proper in this form is unique to the Trento sacramentary.

The minuscule parts of the *Traiectense*, which we argue above were later additions, disagree most with the Trento sacramentary. Leaf K shows text that does not fit into the Gregorian or any common variations. We deem it most likely that these are local prayers or other religious texts that were added later by the users of the *Traiectense*. Two other minuscule leaves (M and Y) show prayers that are potentially critical for the dating of the USP. These are Gr290-302 and Gr235 – if the latter is indeed displayed on leaf Y – which are replaced by non-Gregorian prayers in the Trento sacramentary. These prayers are used during Lent, forming a unified corpus.

Crucially, Gr300-302 are part of *FERIA V AD SANCTUM APOLLONAREM*, which refers to the Masses celebrated on a Thursday in Lent. As already mentioned, these were introduced into the liturgical calendar around 718.<sup>51</sup> If we assume that the minuscule folia were added later, it is possible that the section regarding Lent was updated to this new standard after this date by means of replacing some of the leaves.<sup>52</sup> We note that the beginning of Lent in the USP, Gr169-171 on leaf Θ, is written in uncial. Since these prayers did not concern Lent Thursdays, they did not need to be updated. If this assumption holds, the oldest parts of the *Traiectense* can be dated before this change by Gregory II. As there are no other leads for dating the USP, we can very cautiously date the uncial parts of the *Sacramentarium Traiectense* to be from the late seventh or very early eighth century, with the cutoff period being the introduction of Lent Thursdays. This is broadly speaking in agreement with the proposed paleographical dating and location of the subtext.

The agreements between the Trento and *Traiectense* show that both are descendant from the same archetype, the *Tridentinum*. The differences between these two give insight into its contents and evolution; however, the *Traiectense* is regrettably not complete enough for a full reconstruction.

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<sup>51</sup> Davis, *The lives of the Eight-Century Popes (Liber Pontificalis)*, 8.

<sup>52</sup> The prayers in the Gregorian corresponding to Lent run from Gr166 to Gr327, from which Gr169-Gr171 survive in uncial in the USP. These prayers refer to dates that did not need to be replaced.



## Conclusion

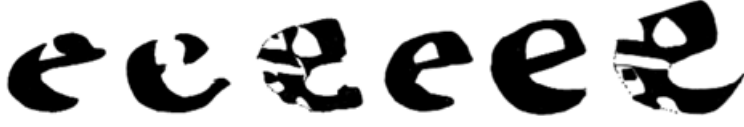
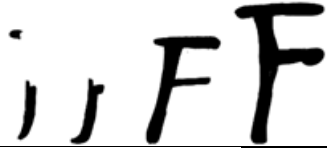
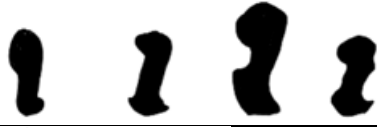
The main goal of this research was to identify and reconstruct the subtext of the USP. This was done by making use of the multispectral images that were made by the Lazarus Project, Team Pigment, and Sjors Nab. By applying PCA to the multispectral images of the pages, the subtext was rendered visible, often well enough for identification as a Gregorian type sacramentary. This *Sacramentarium Traiectense* is only the third surviving Gregorian sacramentary of the *Tridentinum* archetype, and possibly the oldest Gregorian surviving altogether. The subtext is written mostly in an uncial script, most likely originating from Northern Italy. Several pages are written in an unidentified minuscule. Due to the overall illegibility of this minuscule script, we are unable to draw specific conclusions from its use in the USP. We deem it most probable that it was inserted as a means of updating and expanding the sacramentary. If this is accepted, we can cautiously date the *Traiectense* to the late seventh or very early eighth century. For now, we can conclude that thanks to MSI a new early medieval sacramentary has been brought to light – quite literally.

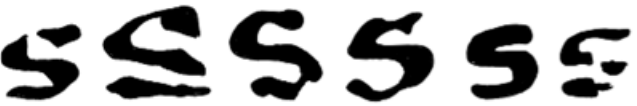
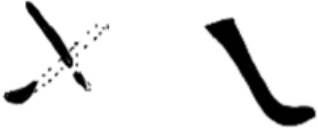
## Acknowledgements

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## Appendix I: Overview of the reconstructed letterforms

### I.I: Uncial Lowercase

|   |                                                                                      |
|---|--------------------------------------------------------------------------------------|
| a |     |
| b |     |
| c |     |
| d |     |
| e |   |
| f |   |
| g |   |
| h |   |
| i |   |
| l |   |
| m |  |

|   |                                                                                     |
|---|-------------------------------------------------------------------------------------|
| n |   |
| o |    |
| p |    |
| q |    |
| r |   |
| s |  |
| t |  |
| u |  |
| v |  |
| x |  |
| y |  |

|  |  |
|--|--|
|  |  |
|--|--|

## I.II: Uncial Capitals

|   |                                                                                     |
|---|-------------------------------------------------------------------------------------|
| A |    |
| B |    |
| C |   |
| D |  |
| M |  |
| S |  |

|   |                                                                                   |
|---|-----------------------------------------------------------------------------------|
| v |  |
|---|-----------------------------------------------------------------------------------|

### I.III: Unidentified minuscule

|   |                                                                                     |
|---|-------------------------------------------------------------------------------------|
| c |    |
| e |    |
| l |   |
| o |  |
| q |  |
| s |  |
| u |  |
| & |  |

