

DIGITISING A ROMAN *TABULA CERATA* FROM ALBURNUS MAIOR (ROȘIA MONTANĂ, JUD. ALBA / RO)

Alburnus Maior (today Roșia Montană/Verespatak, jud. Alba/RO) is one of the best-known Roman archaeological sites of the former province of Dacia, today in Romania. Known for its subterranean gold mines and its famous wax tablets discovered between 1786 and 1855, Alburnus Maior still attracts archaeological, historical, cultural and political debates and reinterpretations. In 2021 the site was inscribed into the UNESCO World Heritage list¹. Before the detailed analysis of the recently digitised wax tablet is given, a short historiographic note is necessary for the historical contextualisation of the object.

INTRODUCTION: HISTORICAL BACKGROUND AND STATE OF RESEARCH

Gold was already being extracted in the Carpathians in the Iron Age when Herodotus remarked on the gold objects and jewels of the Agathyrsi². During the Dacian kingdom, alluvial techniques were being used for the famous Dacian gold bracelets which were made from unrefined Transylvanian panned gold (gold not deliberately alloyed or purified) mixed with the primary mineral, using a yet unknown technique of metallurgy of Hellenistic-Thracian influence³. Although pre-Roman settlements have not been attested archaeologically in the territory of Alburnus Maior⁴, the metallurgical analysis of the Dacian gold bracelets and the rescue excavations in the area suggested a pre-Roman gold-mining activity too⁵. The legend of the gold of Decebalus became a Roman ethnographic *topos* and the major financial source of his monumental architectural investments in Rome (Forum Traiani)⁶.

Alburnus Maior was settled probably from the beginnings of the new province (AD 106)⁷, although the epigraphic evidence only shows intense mining activity in the period of AD 131-167⁸. The *territorium metalli (aurariae Dacicae)* was conducted by a *procurator aurarium* from Ampelum (Zlatna/Zalatna)⁹ and unified numerous mining and military settlements in the Apuseni Mountains¹⁰. The Roman galleries (7 km long, 1.5-1.9 m high in trapezoidal form)¹¹ at Alburnus Maior represent a technological innovation in Roman mining history and the best-documented ancient subterranean gold mines in Europe¹². The settlement of Alburnus Maior was created by numerous *vici* and *castella* of the Illyrian communities which moved or were transported here in the Trajanic period¹³. Their social, religious and economic activities and hierarchies are known both from epigraphic and archaeological sources¹⁴. The Roman galleries – which have only been partially discovered and researched – were probably in use even after the withdrawal of Aurelian around AD 270, although subterranean mining from the 10th and 12th-15th centuries is attested only through ¹⁴C analysis of the wood sample discovered at the site of Cârnic I and Cetate-Zeus (both jud. Alba/RO)¹⁵. Few Roman inscriptions were identified during the Renaissance period from this area, which indicates also the looting of the Roman sites¹⁶.

The mining activities intensified at the end of the 17th century, when Transylvania became part of the Habsburg Empire and the numerous private mines were replaced by the systematic mining activities of the Austrian administration¹⁷. In 1786, on the so-called Lőrincz slope of the Igre mountain in the gallery of György Jánki, two Roman wax tablets were found, of which only one survives today¹⁸. This important discovery

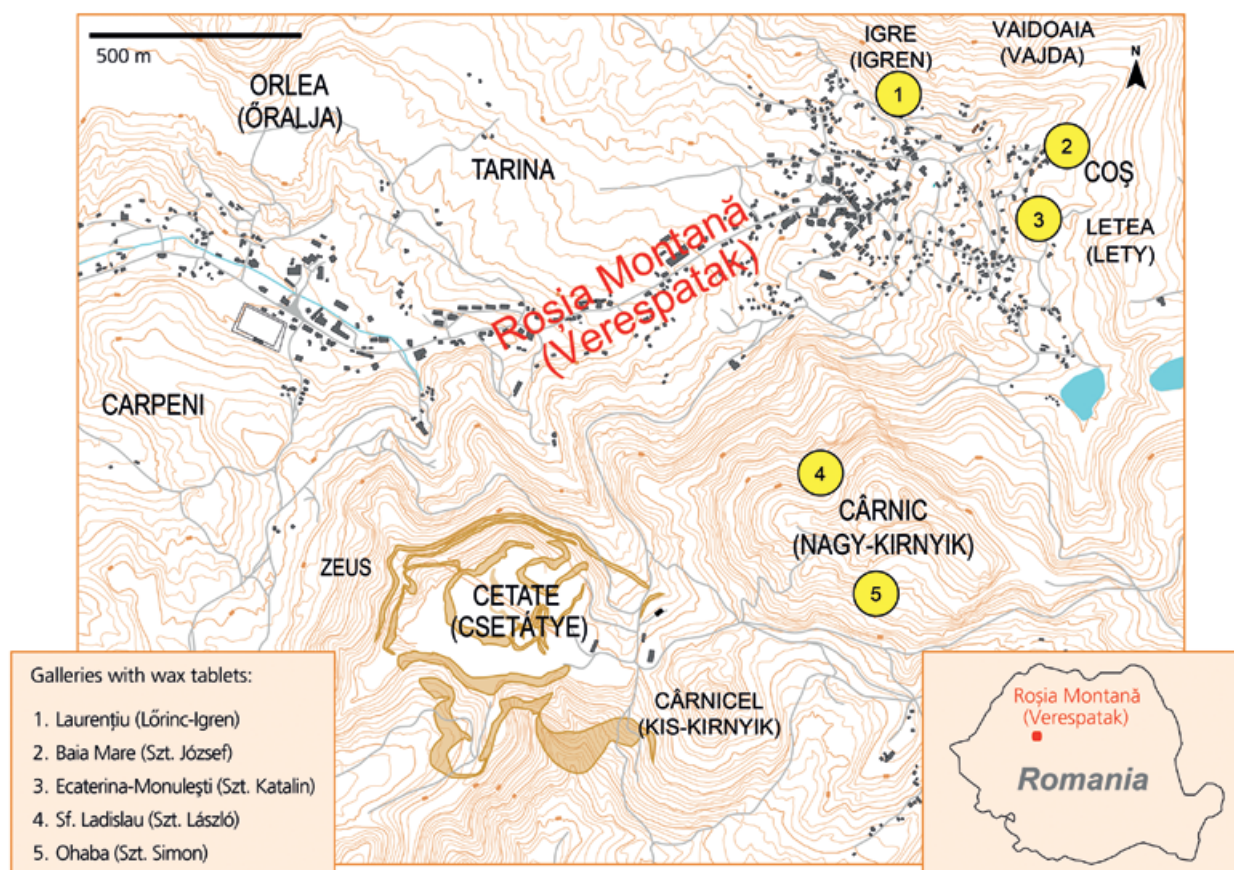


Fig. 1 Roman mining galleries where wax tablets were discovered in Roșia Montană/Verespatak. – (Based on Cauuet 2014, 84 fig. 1; Wollmann 1996, pl. LXXXVIII).

was followed by several others in 1788, 1790, 1791 and 1820. Two of the richest groups of wax tablets were identified in the Ohaba – Saint Simion gallery by Lajos Diószegi in 1854 and in an abandoned gallery of the Saint Catherine mine on the edge of the Letea/Lety hill, where approximately 40 wax tablets were identified in 1855 (fig. 1)¹⁹. The Saint Catherine mine (known today as the Cătălina Monulești mine, Coș Mountains near Letea/Lety hill) was recently excavated and systematically researched in 2011-2012, when a drainage system with large Roman wood objects was identified. However, new wax tablets have not been found since 1855²⁰. The discovery of the wax tablets from 1854 and 1855 provoked a European fascination and attracted numerous scholars to Transylvania, most notably Theodor Mommsen, who personally visited Roșia Montană/Verespatak in 1857, where he identified several Roman inscriptions too and examined the wax tablets found in Transylvania at that time²¹.

The wax tablet discussed here (TC XV = TabCerD XVI) was discovered on 24th July 1855 in the Saint Catherine gallery together with the approximately 40 tablets mentioned above²². Two years later, in the year of Mommsen's visit, it was in the antiquities collection of the Bethlen College from Aiud/Nagyenyed²³ together with another wax tablet discovered in the same mine (TC XIII = TabCerD XIV). Mommsen visited the college and made an accurate transcript of the two tablets²⁴. In September 1862, Károly P. Szathmáry was selected to teach history at the Bethlen College. His aim was to recreate the archaeological and numismatic collection of the college, partially destroyed in the 1848-1849 Revolution²⁵. From the two tablets, he sent the less damaged one (TC XV) to Mommsen in Berlin for reading²⁶. Apparently, he was not aware that the German scholar had already examined the tablet during his Transylvanian visit in 1857. Mommsen sent the

reading of the tablet back to Aiud, however, the teachers from the college were not able to read his handwriting; nonetheless, they kept Mommsen's letter with great respect in the same box with the wax tablet²⁷. The other tablet from the Bethlen College (TC XIII), considered by Károly P. Szathmáry as »unreadable and useless«²⁸ was sold to the antiquarian Egger brothers²⁹ from Pest, who gave it away to the Antiquarium in Berlin³⁰. The other tablet remained in Aiud (TC XV) and was published by Mommsen in 1873 in the 3rd volume of the *Corpus Inscriptionum Latinarum*, with additional notes by Karl Zangemeister³¹. The later historiography based their interpretation exclusively on the reading of Mommsen and Zangemeister, never examining the tablet with a later autopsy. Among those who read the tablet after the CIL in the last one and a half centuries were Karl Gooss, Manuel Rodríguez de Berlanga, Julius Jung, Alexandru Dimitrie Xenopol, Wilhelm Liebenam, Gheorghe Popa-Lisseanu, Pál Király, Béla Cserni, János Bíró, Ioan I. Russu, Hans-Christoph Noeske, Ralf Michael Thilo and Andreas Hoffmann³². Regarding the tablet's place of keeping, numerous erroneous claims were presented. In his works from 1890 and 1925, Popa-Lisseanu mentioned Hunedoara³³. Alfred Nagl noted it as a lost object in 1914³⁴. In the first volume of the *Inscriptiones Daciae Romanae*, Russu, the main publisher of the wax tablets, did not find the tablet from Aiud and used exclusively the drawing and the interpretation of Mommsen and Zangemeister³⁵. The tablet, however, was always in Aiud: between 1857 and 1948 it was part of the archaeological collection of the Bethlen College. The glazed showcase which is still preserving the tablet was made in this period, in 1909³⁶. After the Second World War, the collection was nationalised and transformed with all the mobile heritage of the College forming today the basis of the modern Historical Museum (Muzeul de Istorie Aiud)³⁷. In 2002, Volker Wollmann rediscovered the tablet in the cellar of the museum. He was also the first person to publish a photograph in his 2002 study, however, he did not compare the reading of Mommsen and Zangemeister with the object itself³⁸. After a short consultation with Wollmann in 2018, the authors of these lines documented and digitised the tablet in January 2021. As a consequence, the wax tablet from Aiud received an inventory number on 22nd January 2021 (inv. 17763).

THE WAX TABLET: PHYSICAL DETAILS

The wax tablet (*tabula cerata* or *cera*) comprises two separate rectangular wood³⁹ pieces (*pagina prior et pagina posterior*)⁴⁰ with identical dimensions: 83 mm x 115 mm x 5 mm⁴¹. The wooden boards were split or sawn from a single log⁴². On both sides of the pieces, a rectangular shallow recess was formed, creating a 6 mm wide rim of the boards (**fig. 2a-d**). The recesses were densely incised with diagonally drawn intersecting lines to form a suitable adhesive surface for the wax (**fig. 3b**)⁴³. The recesses were filled with a brown, high quality, soft, easy-to-scratch wax⁴⁴, therefore, the wood under the wax layer was not damaged by the *stilus*. The boards covered with a thin layer of wax on both sides may have originally been the inside part of a *codex*⁴⁵. Therefore, the *codex* – which now lacks the external pages – had at least four (*quadruplex* or *tetrptychon*) or more (*multiplex* or *polyptychon*) boards⁴⁶. Mommsen did not mention the wax layer of the *pagina prior recto* and *pagina posterior verso*, and the traces of letters that can be observed on them (**fig. 3a**), so the later literature – erroneously – interpreted the tablet as a diptych or triptych⁴⁷. Both pieces of the *tabula* have eight miniature holes (**fig. 4**)⁴⁸. There are two holes in pairs on the edge of one of the longitudinal sides of the wooden boards. The pairs of holes in vertical position⁴⁹ are 20 mm from the edges of the boards, their fit is precise (diameter: 3 mm). The *codex* was tied through these pairs of holes⁵⁰. On the other, longitudinal side of the wooden boards, a pair of holes in a vertical position was drilled approximately in the middle. The holes are smaller in diameter (2 mm), less precise, on the *pagina prior* they are still on the edge of the rim, on the *pagina posterior* they are already covering the waxy field.

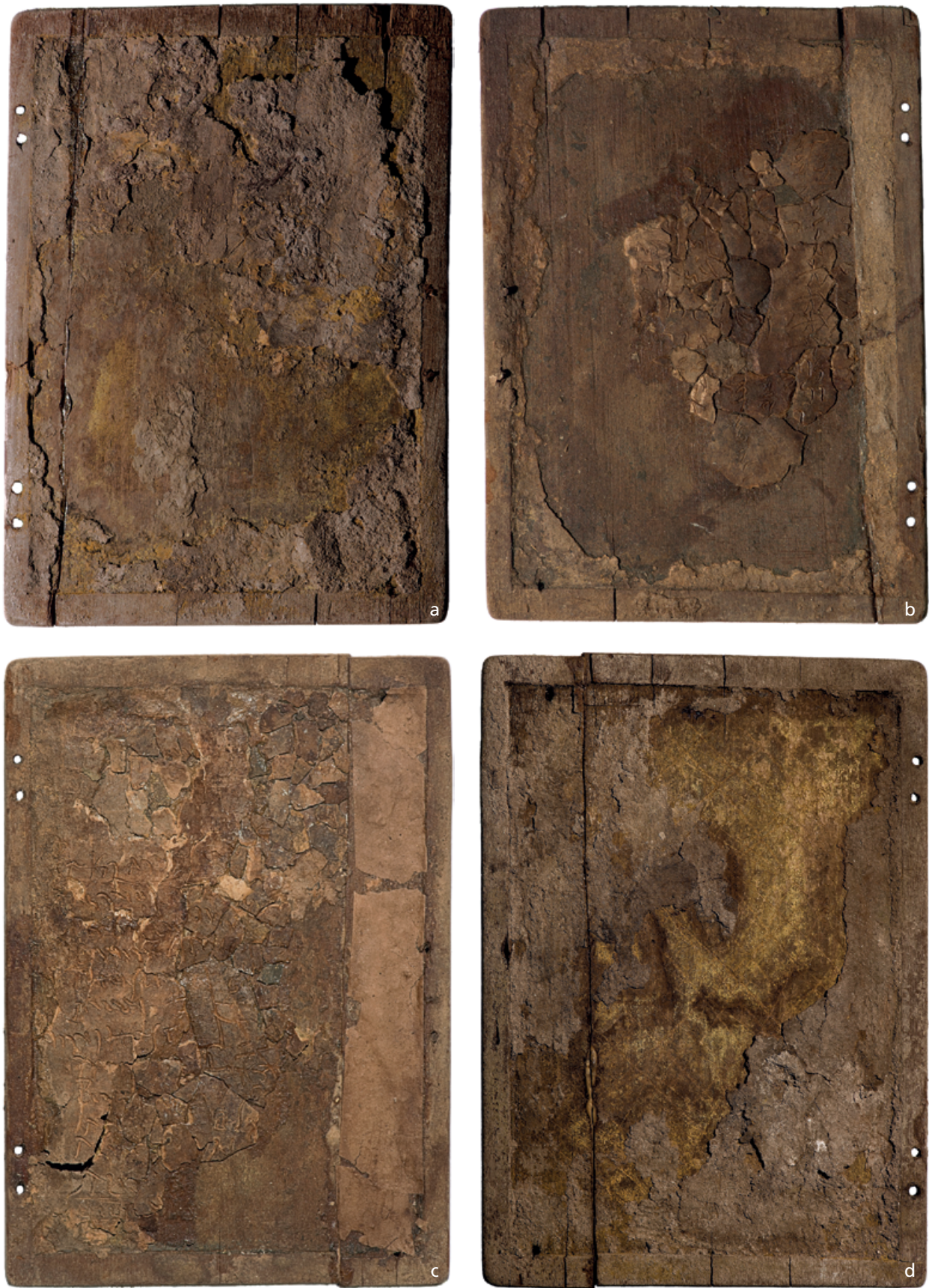
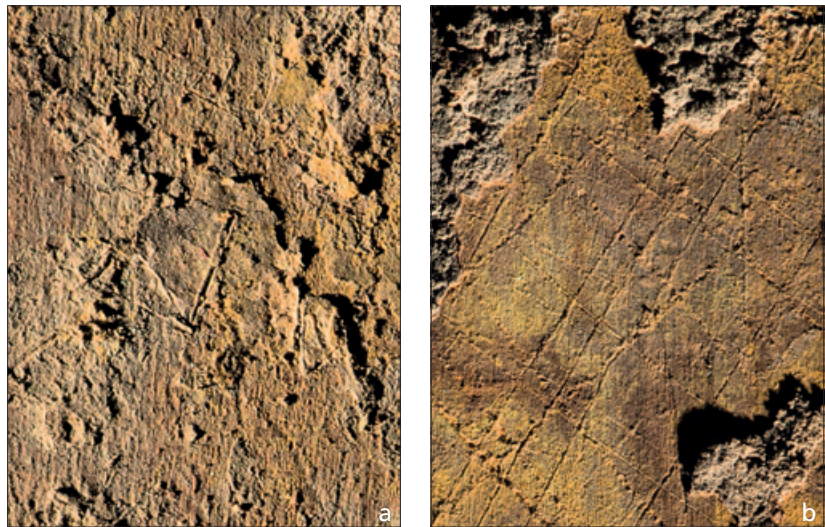


Fig. 2 *Pagina prior recto* (a) and *verso* (b). *Pagina posterior recto* (c) and *verso* (d). – (Photos H. Cociş / C. Şuteu).

Fig. 3 Traces of a *hasta* on the wax layer of the *pagina prior recto* (a) and the scratched »diamond pattern« on the *pagina posterior verso* (b). – (Photos H. Cociş / C. Şuteu).



The cord threaded through the pair of holes may have been used to secure the boards of the closed *codex*⁵¹. There are holes of smaller dimensions (2 mm) on each board, 10 mm from the corners of the waxy field, in contact with the lower and upper edges. The unusually placed holes may have played a role in closing, sealing and archiving the *codex*⁵².

The tablet is in the »portrait« format with the long axis vertical, the rows scratched into the wax running parallel to the shorter sides of the wooden boards. This solution is unique among the Alburnus Maior wax tablets. On wax tablets found in the western half of the Empire, the direction of writing was usually aligned to the longer side, parallel to the grain of the wood in the »landscape« format⁵³. This was always the case for diptychs and triptychs containing legal documents, the arrangement of which was regulated by a *senatus consultum*⁵⁴. The writing direction parallel to the shorter side may be related to the smaller *codices* (*codicilli*, *pugillares*) consisting of four or more wooden tablets⁵⁵.

Due to the unusual form of the tablet from Aiud, it cannot be integrated into the typology established for Vindonissa (Ct. Aargau/CH)⁵⁶. Based on the above-mentioned physical characteristics of the tablet, these can be integrated into the *codex*-type identified by Elizabeth A. Meyer as »account-tablets«⁵⁷, interpreted by Andrea Jördens as objects with a possible role in the formation of early Medieval books⁵⁸. Several account-tablets were discovered in Ancient Egypt⁵⁹, one copy is known from Dura Europos (gouv. Deir ez-Zor/SYR)⁶⁰. Tablets in this form are known also from Herculaneum (prov. Napoli/I), although the text is not preserved on most of them⁶¹. Such tablets can perhaps be seen on some of the wall paintings from the area around Veusvius⁶² and on certain funerary monuments⁶³, for example, on one of the funerary representations from the neighbouring Moesia Superior⁶⁴.

The wooden boards are integrally preserved in a relatively good state. Ridges can be observed on both boards following the veins of the wood. Both boards are broken in one of these ridges. The broken fragments were glued together during an unprofessional restoration attempt at an unknown date. As a result of glue leaking from cracks, furthermore, the *pagina posterior* suffered minor distortions after the use of the glue. The wax layers on the *pagina prior recto* and *pagina posterior verso* were already seriously damaged when Mommsen carried out his examination of the tablet. Although traces of one or two *hastae* are still visible (fig. 3a), these were not mentioned by Mommsen. The wax layers of the *pagina prior verso* and *pagina posterior recto* – which were relatively intact in the period of Mommsen – are broken up and scaly. Some parts of the wax layers are missing, while others were reassembled incorrectly at a certain moment.

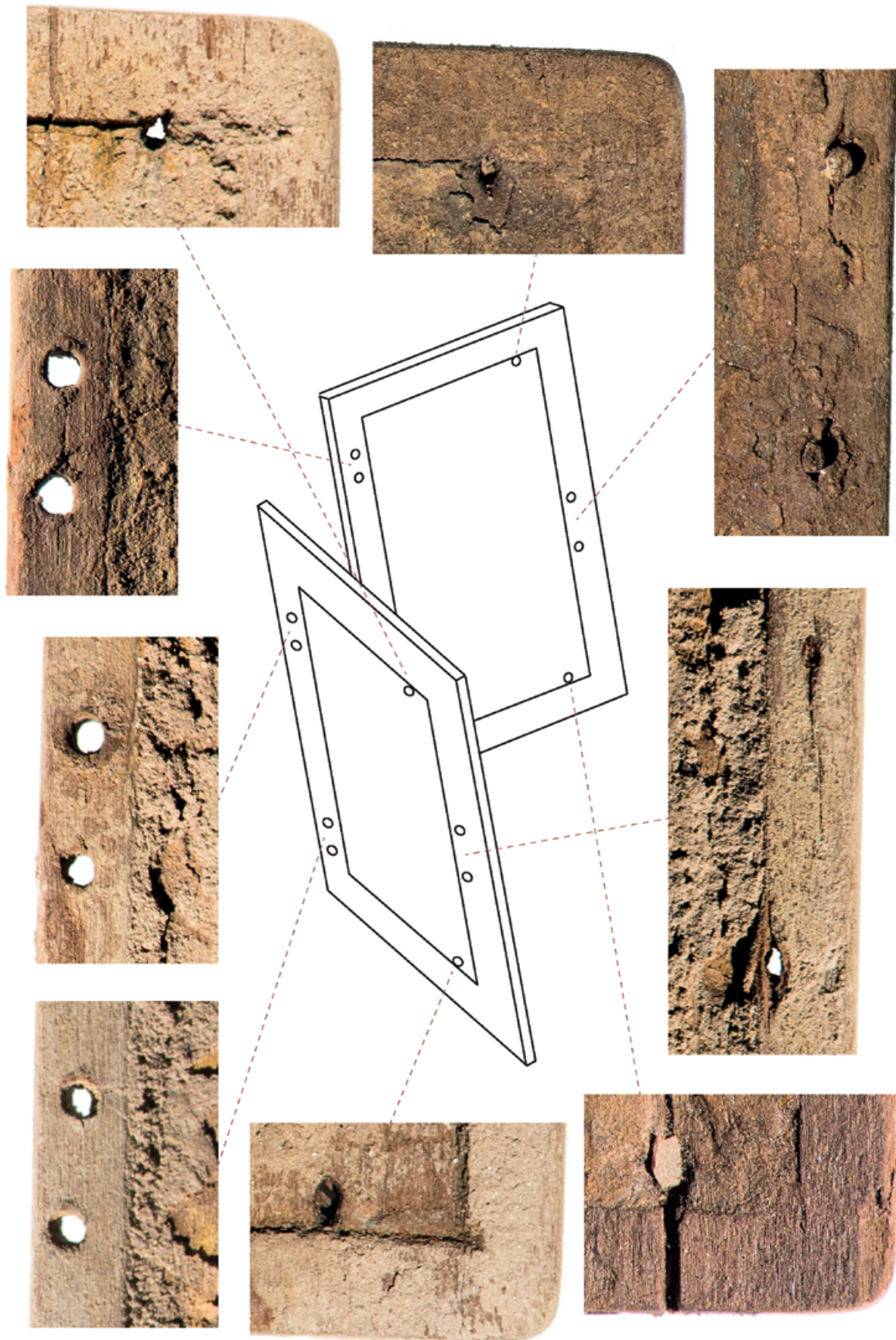


Fig. 4 Hole-marks on the boards. – (Graphics E. Szabó).

These reassembled fragments were fixed accidentally and without coherence, mixing the fragments of the *pagina prior verso* and *pagina posterior recto*. We have identified 21 inscribed pieces of wax fragments on the *pagina prior verso*. Of these, seven were part of this page but replaced in the wrong position (fig. 5b – red), three fragments belonged to the *pagina posterior recto* (fig. 5b – dark blue). The original positions of 11 fragments cannot be determined (fig. 5b – pale blue). On the *pagina posterior recto* we have identified 34 reassembled fragments with inscriptions of which six were originally part of this page but reassembled in the wrong position (fig. 6b – red), seven pieces belonged originally to the *pagina prior verso* (fig. 6b – dark blue). The original positions of 21 pieces cannot be determined (fig. 6b – pale blue). During the restoration attempt, the right edge of the waxed field of the *pagina posterior recto* was covered with a duct tape for uncertain reasons.

THE WAX TABLET: EPIGRAPHIC DETAILS

The text of the wax tablet was written in old Roman cursive⁶⁵. The older cursive was formed by the simplification of the letters of *capitalis actuariaria*. As the result of this palaeographic simplification, the Romans used a large number of ligatures. The text contains 41 ligatures of which 32 are double and nine are triple. 23 % of the letters are abbreviated in ligatures. The shape of the letters on the tablet (*tractatio*) and the flow of the text (*ductus*) show no specific, unique techniques⁶⁶. The calligraphy of the text is similar to the others found on the tablets from Alburnus Maior and indicates an experienced writer⁶⁷. Mommsen twice drew the texts of the *pagina prior verso* and the *pagina posterior recto*⁶⁸. There was a significant difference between the copies only in relation to the beginning of line 21, about which the relevant details of both drawings were given in CIL (fig. 6a)⁶⁹. He did not attempt to transcribe the beginnings of lines 19-21 and 26-27, on these only Zangemeister made some additional observations published later by Mommsen in the form of a commentary. However, Mommsen did not include these modifications in the epigraphic transcription. The recently rediscovered tablet and the partial, digital reconstruction of the epigraphic field (figs 5c-d; 6c-d) allow us to reconsider some of the readings of Mommsen and Zangemeister⁷⁰:

Pagina prior verso

	<i>IIII Nōn(as) April(es)</i>	<i>[- - -]</i>	
	<i>pr(idie) Nōn(as) April(es)</i>	<i>ac[- - -]</i>	
	<i>VII Idus Aprīl(es)</i>	<i>a[- - -]</i>	
	<i>Idibus Aprīl(ibus)</i>	<i>acc[- - -]</i>	
5	<i>XVII Kāl(endas) Māias</i>	<i>acce[- - -]</i>	<i>(denarios?)] XX</i>
	<i>XV Kāl(endas) Māias</i>	<i>acce[p]it</i>	<i>(denarios) XXII</i>
	<i>XIII Kāl(endas) Māias</i>	<i>pensio</i>	<i>(denarii) XXV</i>
	<i>VIII Kāl(endas) Māias</i>	<i>accepi</i>	<i>(denarios) XXV</i>
	<i>VII Kāl(endas) Māias</i>	<i>accepi</i>	<i>(denarios) XX</i>
10	<i>IIII Kāl(endas) Māias</i>	<i>accepi</i>	<i>(denarios) XXV</i>
	<i>Kāl(endis) Māiis</i>	<i>accepi</i>	<i>(denarios) XX[- - -]</i>
	<i>[- - -]I Nōn(as) Māias</i>	<i>accepi</i>	<i>[- - -]</i>
	<i>pri(die) Nōn(as) Aug(ustas) XXIII</i>		

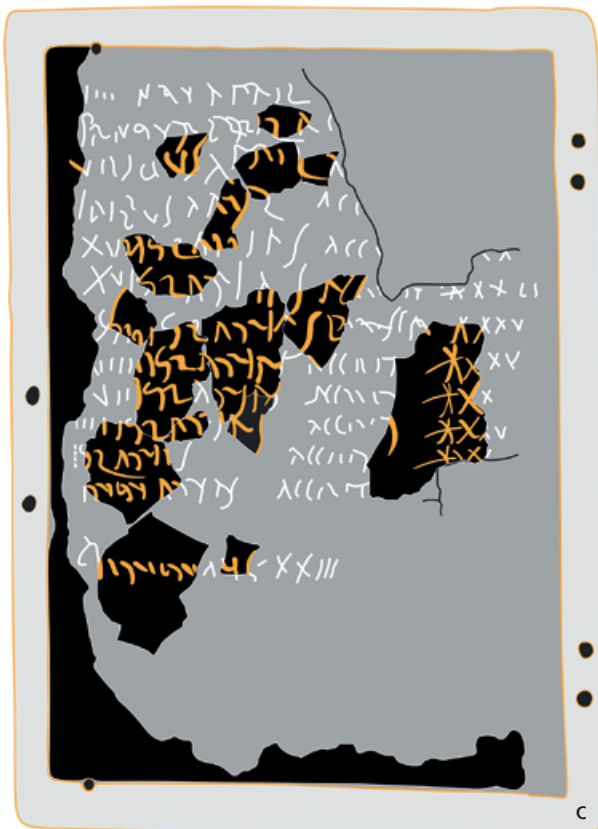
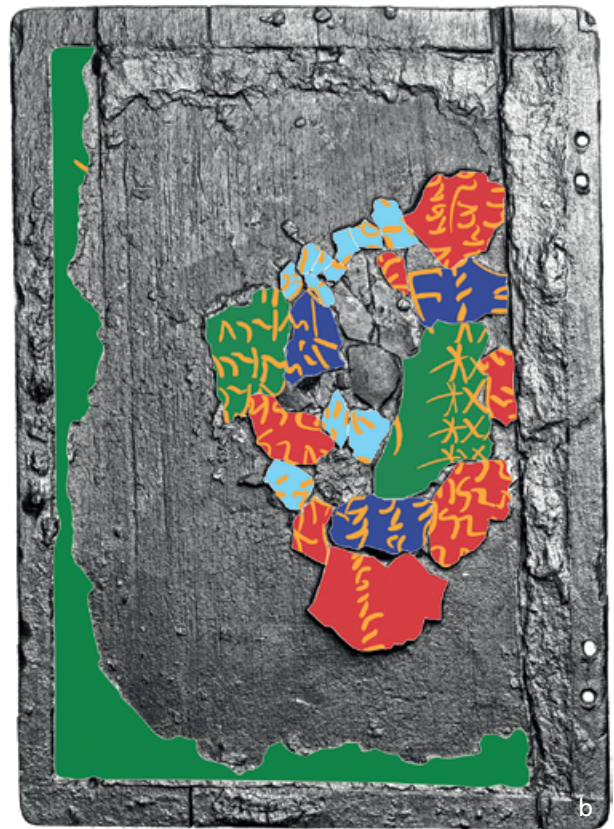
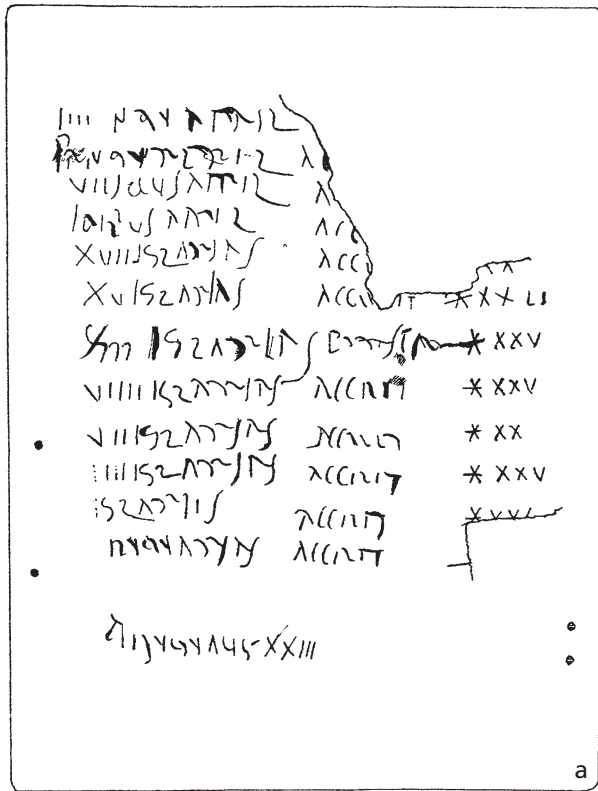
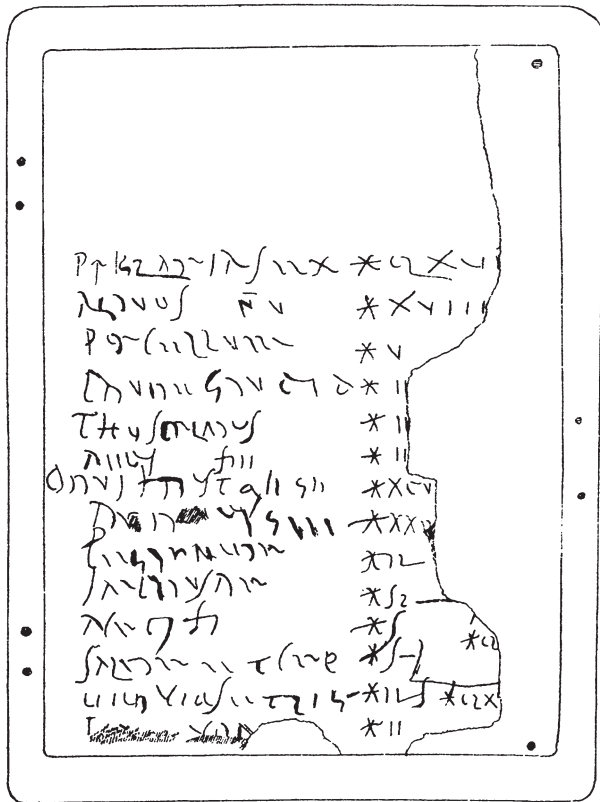


Fig. 5 *Pagina prior verso*: **a** drawing of Mommsen. – **b** the current state of the wax layer (green: in original position, red: on the correct board, but in the wrong position, dark blue: belongs to the other board, pale blue: uncertain position). – **c** drawing of the rearranged fragments projected on the drawing of Mommsen. – **d** photograph of the rearranged fragments projected on the drawing of Mommsen. – (Graphics E. Szabó).



V21 princ: ex altero apographo: *Prkz mly*

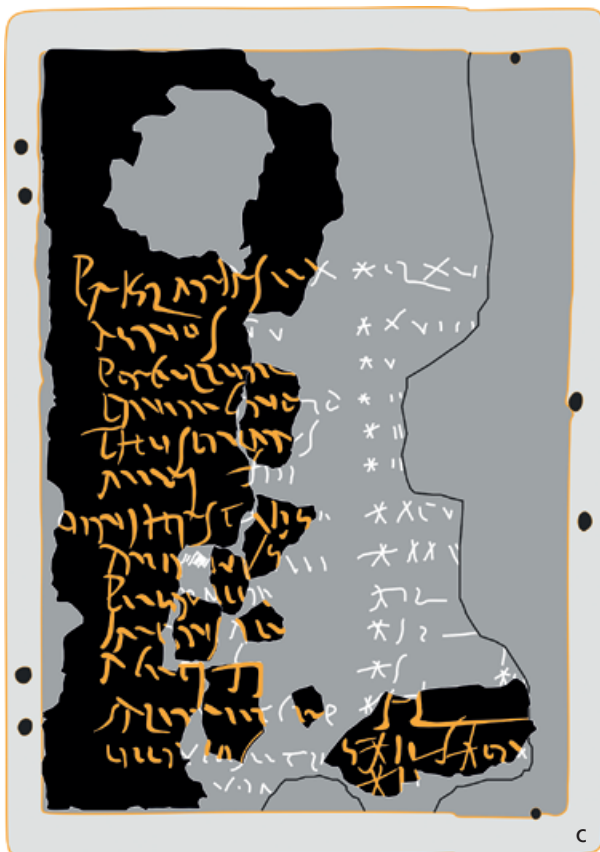
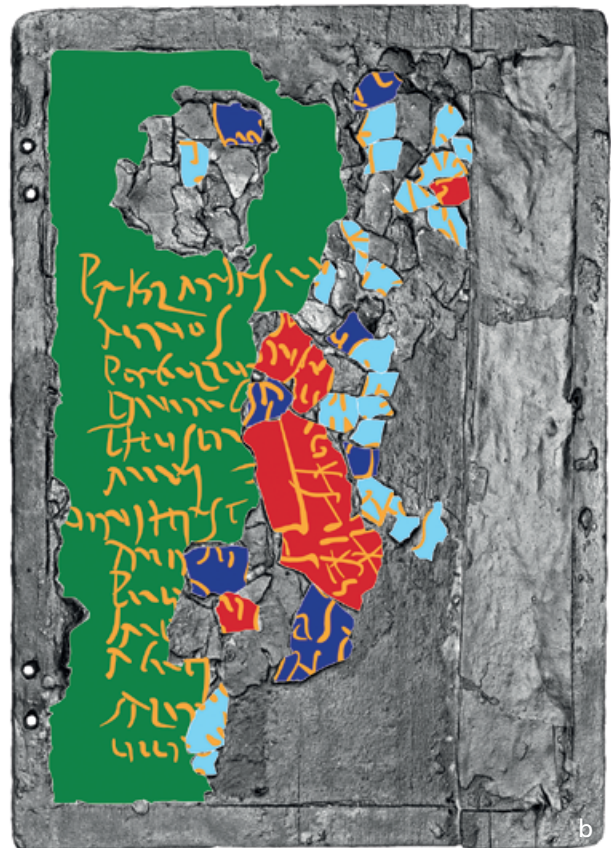


Fig. 6 *Pagina posterior recto*: **a** drawing of Mommsen. – **b** the current state of the wax layer (green: in original position, red: on the correct board, but in the wrong position, dark blue: belongs to the other board, pale blue: uncertain position). – **c** drawing of the rearranged fragments projected on the drawing of Mommsen. – **d** photograph of the rearranged fragments projected on the drawing of Mommsen. – (Graphics E. Szabó).

Pagina posterior recto

	<i>Pr(idie) K̄al̄(endas) M̄aias ex</i>	(denariis) CLXVI[- - -]	
15	<i>agnos n(umero) V</i>	(denarios) XVIII[- - -]	
	<i>p̄orcellum</i>	(denarios) V	
	<i>p̄anēm c̄andid(um)</i>	(denarios) II[- - -]	
	<i>thus p̄rim(um) (selibram)</i>	(denarios) II[- - -]	
	<i>m̄eri (sextarios) III</i>	(denarios) II[- - -]	
20	<i>vini h̄ast(aphidis) (quadrantalia) II</i>	(denarios) XCV[- - -]	
	<i>(heminas) II</i>		
	<i>[- - -] (heminas) III</i>	(denarios) XX[- - -]	
	<i>peganum</i>	(denarios) I (semunciam)	
	<i>imp̄ensām</i>	(denarium) (semissem) (semunciam)	
	<i>aceti (sextarium) I</i>	(denarium) (semissem)	(denarios?) [- - -]
25	<i>salēm et cep(am)</i>	(denarium) (semissem) (unciam) (semunciam)	(denarios) CL[- - -]
	<i>[- - -] et lig(usticum)</i>	(denarios) II (semissem)	(denarios) CLX[- - -]
	<i>[- - -]</i>	(denarios) II	

Translation

Pagina prior verso

	4 days before the Nones of April (2 April)	[- - -]	[- - -]
	the day before the Nones of April (4 April)	income/expenditure	[- - -]
	7 days before the Ides of April (7 April)	income/expenditure	[- - -]
	Ides of April (13 April)	income/expenditure	[- - -]
5	17 days before the Kalends of May (15 April)	income/expenditure	20 [denarii?]
	15 days before the Kalends of May (17 April)	expenditure	22 denarii
	13 days before the Kalends of May (19 April)	payment	25 denarii
	9 days before the Kalends of May ⁷¹ (23 April)	income	25 denarii
	7 days before the Kalends of May (25 April)	income	20 denarii
10	4 days before the Kalends of May (28 April)	income	25 denarii
	Kalends of May (1 May)	income	2[- - -] denarii
	6/4/3/1 days before the Nones of May (2/4/5/6 May) ⁷²	income	[- - -]
	the day before the Nones of August (4 August) ⁷³ 23		

Pagina posterior recto

	the day before the Kalends of May (30 April) out of	166/167/168/169 denarii
15	5 lambs	for 18/19 denarii
	suckling pig	for 5 denarii
	white bread	for 2/3/4 denarii
	half libra of first-class frankincense	for 2/3/4 denarii

	3 <i>sextarii</i> (1.638l) of neat wine	for 2/3/4 <i>denarii</i>	
20	2 <i>quadrantalia</i> 2 <i>heminae</i> (52,946l) of raisin-wine	for 95/96/97/98/99 <i>denarii</i>	
	3 <i>heminae</i> (0,819l) [- - -]	for 22/23/24/25/26/27/28/29 <i>denarii</i>	
	rue	for 1 1/24 <i>denarii</i>	
	dressing ⁷⁴	for 13/24 <i>denarius</i>	
	1 <i>sextarius</i> (0,546l) of vinegar ⁷⁵	for 1/2 <i>denarius</i>	[- - -]
25	salt and onion	for 15/24 <i>denarius</i>	for 150-189 <i>denarii</i>
	[- - -] and lovage	for 1 1/2 <i>denarii</i>	for 160-189 <i>denarii</i>
	[- - -]	for 2 <i>denarii</i>	

Problematic Fragments in the Text

V13: The transcription of Mommsen *P[RID]* is unprecise. On his drawing the fourth letter (*D*) is not represented and cannot be identified on the recently reconstructed epigraphic field either. The exact transcription is: *PRĪ*.

V14-15, V17-21: The price of certain items is preserved fragmentarily, as was already marked in the drawing of Mommsen. The later historiography ignored this aspect and did not take into consideration that the prices can be identified with different values⁷⁶. This is problematic, especially when it comes to the publications related to the pricelists of the Principate⁷⁷.

V19: As Zangemeister suggested, the sentence begins with *meri*, the letters *E* and *R* form a ligature.

V20: The reading of Zangemeister (*vini*) at the beginning of the sentence is correct. The following letters refer to the name of a wine, which has not yet been interpreted⁷⁸. We propose: *h̄ast(aphidis)*, which can be translated as raisin-wine (dried-grape wine). The Greek derivation οἶνος ἀσταφίδος⁷⁹ (or οἶνος γλυκύς/οἶνος πάσσος/*vinum passum*) refers to a special type of wine⁸⁰. Polybios mentioned that, although women were not allowed to consume wine, they could drink the raisin-wine (πάσσον) made from a certain type of raisin (ἐκ τῆς ἀσταφίδος)⁸¹. Raisin-wine was used as a dessert wine, but was also popular in cooking⁸² and herbal preparations⁸³. The *{h}astaphidis* form suggests the linguistic incompetence of the writer in Greek. Even if the scribe might not be familiar with the Greek notions, the local community certainly was using these terms⁸⁴. This is reflected by the use of the Greek word instead of the Latin technical term, *vinum passum*. The same phenomenon can be observed in V22, where, instead of the Latin notion of *ruta*, the scribe used *peganum*, namely the Latinised form of the Greek term πῆγανον⁸⁵. If our reading is correct, we could resolve the paradox mentioned already by Mommsen deriving from the high price of the item⁸⁶ and being interpreted here as a luxury good.

V22: The *peganinum* reading of Mommsen is possible only with a *GĀNĪ* ligature. This would be the only four-lettered ligature in the text. The notion itself (*peganinum*) would be a *hapax legomenon*⁸⁷. Much more plausible is the *peganum*⁸⁸ reading, where the right-wing *hasta* of the letter *A* is represented in a slightly rectangular form. The uncertainty of the calligraphy might indicate the Greek linguistic incompetence of the *scriptor*. The *peganum* (or πῆγανον/*ruta*)⁸⁹ was a widespread and popular condiment in Roman cuisine⁹⁰. It was used not only as seasoning for food but also as a condiment for wines⁹¹, herbal preparations⁹² and mixed with *merum* – which also appears in the texts – was used also against poison⁹³.

In summary, the *pagina prior verso* contains various amounts of expenditures and incomes (20/22/25 *denarii*), spent or received on every 2nd-6th day between 2nd April and the first days of May (V1-12). The cash flow was enrolled in tabular form, chronologically. Although there are no explicative legends attached to the column, the directing principle is clear. The first column mentions the day and month of the flow. In the

second column we find the nature of the cash flow using three categories. The *accepī* 1st singular verbal form refers to the incomes. The *accepit* 3rd singular verb probably refers to the payment (V6). The noun *pensio* could refer also to payment (V7), especially instalment payment⁹⁴. The incomes and expenditures are not separated, they are written in the same column. In the third column, the currency and the sum are mentioned. Such table organisation is typical for other account documents too⁹⁵. This table structure served the transparency and perspicuity of the document, but it cannot be interpreted as a general accounting method during the Principate⁹⁶. The last line of the *pagina prior verso* (V13) is not related to the table, a free space separates one another and it contains only one date (4th August) and one number (23).

The upper part of the waxed field of the *pagina posterior recto* was left empty, perhaps for later additional information. The empty area is followed by a list, where the first item (V14) is a date (30th April) and an initial sum of money (166-169 *denarii*). In the following lines (V15-27) are listed the goods bought from the above-mentioned sum (*ex denariis*). In the first column we find the name of the goods, in most of the cases with the quantity too. The second column lists the currency and the price of the items. The right part of the waxed field is damaged, but also a third column with currency and sums can be identified in the lines V24-26. Zangemesister suggested that the initial sum of money and the sum of the prices of certain items can be correlated⁹⁷. The interpretation of the sums in the third column is unsolved and problematic.

THE REINTERPRETATION OF THE TEXT: OLD AND NEW PROPOSALS

From the rich epigraphic heritage of the Roman Empire, a particular type of inscriptions was preserved on organic materials. Among these exceptional types of objects, the *tabulae ceratae* and *tiliae* are the most numerous: almost 1,200 of these were preserved in 63 locations, most numerous in Vindonissa, Londinium, Colonia Agrippinensium, Pompeii, Herculaneum and Alburnus Maior⁹⁸. These objects were usually interpreted as essential sources and documents for Roman economy, law and private life. Most of the literature focusing on the wax tablets of Alburnus Maior analysed these texts as economic or legal documents, however, our tablet was considered as one of the few exceptional cases associated with a possible private association (*collegium*). Mommsen (and Zangemeister) were reserved in the interpretation of the text, mentioning only that the tablet is an *index* of amounts received and goods bought⁹⁹. A year after the publication of the *Corpus Inscriptionum Latinarum* Gooss launched the idea that the TC XV interpreted by Mommsen as an »*index pecuniarum acceptarum rerumque emptarum*« might be the list of a *magister epularum*, responsible for a collegial *epulum* (ritual banquet)¹⁰⁰. Due to the popularity of the young and talented history teacher from Transylvania, this idea was later canonized by the historiography of the 19th century without further analysis or critical approach¹⁰¹. His idea was repeated continuously in the 20th century¹⁰² and the last two decades¹⁰³. The association of this text with a collegial context might come from the first published¹⁰⁴ and one of the best-known wax tablets from Dacia (TC I = TabCerD I) mentioning the *collegium Iovis Cerneni* and their internal problems as well as the dissolution of the association¹⁰⁵. This unique source contributed to the idea that the »*index*« of TC XV might be associated with a private *collegium* of the mining communities from Alburnus Maior, more precisely with the *collegium Iovis Cerneni*¹⁰⁶ or the *collegium aurariarum*¹⁰⁷. However, the wax tablet TC I mentions that the *collegium Iovis Cerneni* was discovered in the Saint Joseph mine, therefore the place of the discovery is not identical with TC XV. In this one there is no reference to any kind of collegial data, Mommsen did not associate the tablet with a *collegium*¹⁰⁸, although previously he dedicated his doctoral thesis to this issue¹⁰⁹. Although the tablet cannot be directly associated with a *collegium*, the goods listed on the *pagina posterior recto* – especially the frankincense – could suggest indeed a ritual, religious activity and, possibly, a banquet, but without any further, contextual data it cannot

be proven that the list was made for a religious event. Three years after the publication of the CIL, another interpretation was suggested by the Spanish scholar of Roman law and classicist Rodríguez de Berlanga. The Romans also considered keeping account books important in the private economy, i. e. the members of the *honestiores* were expected to keep various records of their financial operations¹¹⁰. Their receipts and expenditures, assets and liabilities were noted in the so-called rough books (*adversaria*), from which – probably on a monthly basis – they transcribed the data in their *codex accepti et expensi* (later named as *ratio domestica*)¹¹¹. After the interpretation of Rodríguez de Berlanga, the tablet from Aiud can be interpreted as an *adversaria*¹¹². Despite his unique interpretation in the 19th century, later works on Roman accounting ignored the wax tablet TC XV. In the mid-20th century Geoffrey Ernest Maurice de Ste. Croix pointed out this source, arguing that this is the only writing tablet from antiquity, which contains actual accounts¹¹³. The author, however, did not follow further studies on the nature and functionality of the document. Thilo, analysing more carefully the texts of the tablet from Aiud¹¹⁴, concluded that these can be interpreted as an *adversaria*¹¹⁵. It could therefore be a matter of temporary, sloppy-looking, draft-like accounting notes for reminder purposes¹¹⁶. Until now, however, none of the known material evidence was identified with certainty as an *adversaria* or a *codex accepti et expensi*¹¹⁷. The notion of *adversaria* itself is known alone from Cicero as a *terminus technicus*¹¹⁸.

We can conclude with certainty that the tablet from Aiud dated to the mid-2nd century AD¹¹⁹ contains accounting records, which partly record various cash flows in chronological order and partly detail expenditure made on a given day. This seems to be the definition of Roman accounting according to Thilo¹²⁰. However, it is still uncertain who could have made these accounting notes, whether they belong to the private economy or possibly to the military present in the mining area¹²¹.

DEFINING AND APPLYING THE H-RTI RESEARCH METHOD ON TC XV = TABCERD XVI

The study of Roman material in Romania – especially the extremely fragile, small and organic artefacts – is still an unresolved problem and needs examples of good practice. The exceptional wax tablets of Alburnus Maior are often preserved in inadequate conditions, which do not allow researchers to repeat an autopsy and examine the extremely fragile, fragmentarily preserved and organic materials. We will present here a well-known technique often used in digital humanities which can offer new perspectives not only for the detailed, digital examination of fragile, rarely accessible small finds and organic materials, but can contribute also to the public dissemination of national and world heritage, such as the wax tablets of Alburnus Maior, a UNESCO World Heritage Site since 2021.

The concept of *Reflectance Transformation Imaging* (RTI) was initially used by Tom Malzbender (Hewlett-Packard Laboratories)¹²² to define an image processing method applied by him called *Polynomial Texture Mapping* (PTM)¹²³. RTI is understood as a quantum of technologies and processes that uses photometric stereo comparisons between a dataset composed of fixed objects and camera photos but with a varying light source, generating multiple surface reflectance information¹²⁴. The polynomial texture mapping¹²⁵ could be considered the most common application of *Highlight Reflectance Transformation Imaging* (H-RTI)¹²⁶, even if in the more recent period several other applications were developed as alternative methods for different surface properties, such as hemispherical or even spherical harmonics¹²⁷.

The mathematical-based model of Malzbender describes luminance data for each particular pixel in an image-generated background, thus indicating the direction of the calculated incident illumination. All of the six coefficients of the biquadratic polynomial data are stored together with each distinct pixel's colour data, allowing to record surface properties such as self-shadowing or inter-reflection¹²⁸.

The most important aspect is that the polynomial coefficients contain essential data about the PTM image in 2D¹²⁹, an already essential asset for cultural heritage documentation techniques. The process allows a significantly improved visualisation of the micro-topography of particular objects and surfaces utilizing an interactive raking light¹³⁰. One of the PTM documentation technique's essential assets is that it can provide micro-relief and shape data of the subject using simple image-based transformations without a previous 3D Cartesian reconstruction of the surface normal, excluding the so-called warps of the 3D geometry. The reflectance transformation imaging can record even the tiniest details in large amounts of data regarding the surface's shape¹³¹.

As Massimiliano Corsini highlighted, the method can create a unique image of the studied surface encoding reflectance function in a per-pixel algorithm under controlled artificial illumination¹³². The usefulness of this applied method on epigraphic artefacts is to be seen even from the first dedicated studies on cuneiform epigraphy¹³³, rock art¹³⁴, coins¹³⁵, or, more recently, on inscribed Roman artefacts¹³⁶, the applicability of RTI analyses in archaeology and art being of great importance for Cultural Heritage Imaging (CHI) documentation¹³⁷. The H-RTI method was applied to record the surface and the micro-relief settings of the TC XV wax tablet for two reasons. Due to its precarious preservation condition, the RTI was the only method to record the necessary structural and epigraphic data without an intrusive manipulation of the objects. It was also the most suitable recording technique needed for the process of epigraphic interpretation and reconstruction. The method involved the record of raw photographic data for each part and side of the tablet from a static position (*pagina prior recto* – 47; *pagina prior verso* – 49; *pagina posterior recto* – 46; *pagina posterior verso* – 52), the only changing parameters being the orientation and the light incidence (the number of the incidences is equal to the number of photos). The raw data was processed and visualised in two dedicated software solutions provided by Cultural Heritage Imaging Technologies¹³⁸.

The visual analysis was based on the qualitative and quantitative parameters gathered from the combination of shadows and highlights orientated toward the tablet's surface digitising the 3D texture of the objects. The boards were photographed vertically using a DSLR Nikon D810 high-resolution camera equipped with 105 mm macro lenses and a mobile flash unit. The raw dataset was processed in the RTI Builder (dedicated software), extracting the light incidence based on the highlights recorded on two black spheres (shiny balls). The .rti exported file format was then subjected to a multiple visualise process in RTI Viewer (dedicated software), exporting the final result in three different (mathematical) options: the default view, the specular enhancement and the extracted normal visualisation.

As a result of the digitisation process, we were able to reconstruct virtually a new, much more detailed and corrected version of the epigraphic field known for 150 years only from the drawing of Mommsen. The digitisation allowed us also to examine individually each letter, the never examined *pagina prior recto* and *pagina posterior verso*, small, unidentified scratches and organic details of the wood, which were impossible to discover on the fragile, very small artefact during our autopsy. Examining wax tablets would need special spaces and preparations, which are often unavailable in small museums, therefore the 3D examination offers the possibility of an in-depth examination and virtual autopsy without putting the object in imminent and direct danger.

Since the site of the discovery (Alburnus Maior, Roşia Montană/Verespatak) became a UNESCO World Heritage Site in 2021, the artefacts discovered in the gold mines have attained a special significance too: the digital version of the tablets will be published on open access and online also for the greater public and the academic community for further examination and dissemination. As the first digitised wax tablet from the Alburnus Maior collection, the case study of TC XV = TabCerD XVI can serve as a starting point for further examinations of other, similarly fragmented, fragile and less researched wax tablets in Central-Eastern European museums.

Acknowledgements

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Notes

- 1) UNESCO world heritage 1552rev dossier.
- 2) »The Agathyrsi are the most refined of men and especially given to wearing gold«. Hdt. 4, 104, 1. Translated by A. D. Godley.
- 3) Constantinescu et al. 2009.
- 4) The rescue excavations from 1999-2001 identified several cases with possible pre-Roman activity. However, their interpretation was not conclusive and the ¹⁴C analysis of the wood cited without reference in the archaeological reports of B. Cauuet was not published: Cauuet et al. 2003, 502-503 for the case study of the »Zeus« and »Cârnic« area.
- 5) Cauuet et al. 2003, 470; Hirt 2010, 43. See also: Wollmann/Ciugudean 2005; Ciugudean 2012, 219-220.
- 6) Gell. 13, 25; Cass. Dio 68, 14, 1-2.
- 7) CIL III 1312 = IDR III/3, 366. See also Noeske 1977, 347; Hirt 2010, 127.
- 8) Cauuet et al. 2003, 515 fig. 15.
- 9) Noeske 1977; Ott 1995, 152; Hirt 2010, 126-127 with the previous bibliography. For the topography of Ampelum and its research history see: Szabó 2018, 155-166.
- 10) A complete map still needs to be compiled. The most complete one was published by Wollmann 1996. See also: Hirt 2010, 75 fig. 18. For the military presence in the area see: Ţentea 2003; 2009.
- 11) Cauuet 2014, 88.
- 12) Cauuet 2011.
- 13) IDR I, 187-188; Piso 2004, 291; Nemeti I. / Nemeti S. 2010; Pundt 2012. For an approximate topography of the recently identified settlements: Cauuet et al. 2003, 512 fig. 12. Compare it with IDR I, 173 fig. 76.
- 14) IDR I, *passim*; Damian 2003; Simion/Apostol/Vleja 2004; Ciongradi 2009.
- 15) Cauuet et al. 2003, 515 fig. 15. See also: Wollmann/Ciugudean 2005.
- 16) IDR III/3, 418. See also: Wollmann 1996, 11-12.
- 17) Köleséri 1717; Lukács 1901.
- 18) TC IV = TabCerD IV.
- 19) The history of the discoveries was presented in detail in: Érdy 1856. See also: CIL III 921; Gooss 1876, 124-126; Téglás 1891, 38-42; Popa-Lisseanu 1925, 169-176; IDR I, 172-174; Wollmann 2002, 91-93.
- 20) Cauuet 2014, 87.
- 21) On the Transylvanian trip of Th. Mommsen see: Cipariu 1867, 142; Kristóf 1930; Wickert 1969, 606-610; Szilágyi M. 2005, 126-133.
- 22) The approx. 40 wax tablets were hidden carefully and organised: Pošepný 1868, 154. 165 (for the exact position of the discovery see: Pošepný 1868, fig. 1. »Ein Theil der Katalin Monulesti Grube im Letier Revier zu Verespatak«). Most of them were lost after their discovery, the known examples are: TC III = TabCerD III, TC V = TabCerD V, TC VI = TabCerD VI, TC VIII = TabCerD IX, TC XIII = TabCerD XIV, TC XV = TabCerD XVI, TC XX = TabCerD XXI, TC XXI = TabCerD XXII, TC XXIV = TabCerD XV, TC XXV = TabCerD VIII. Perhaps the tablets mentioned by V. Wollmann as unpublished examples might come from this cache too: Wollmann 2002, 96-97 nos 27-32. Objects discovered in the mining gallery with the wax tablets: clay candles, hair braid, spoon, chest, hutch table, wooden bowls, barrel, tub, ladder, pot, woollens, horn glass, pieces of minerals: Pošepný 1868, 165-166. See also: Érdy 1856, 8; CIL III 934-935; Gooss 1876, 125.
- 23) Mommsen 1857, 519. According to the uncertain information of G. Téglás, the wax tablets were donated to the Bethlen College by L. Diószegi, the mining director of Abrudbánya: Téglás 1894, 6.
- 24) Th. Mommsen was informed about the wax tablets of Aiud by G. D. Teutsch in one of his letters from 3rd October 1857, where the scholar, educationalist and later bishop also proposed a detailed Transylvanian trip for Th. Mommsen: Wollmann 1983, 53-54 (Brief 13). The letter which Th. Mommsen sent to his wife on 3rd October 1857 reveals that he took the wax tablets from Aiud to Karlsburg/Gyulafehérvár/Alba Iulia, where he examined them for several days: »Mein Tagebuch ist während der letzten Tage ins Stocken gekommen, da die geistliche Gastfreundschaft die Abende allzu sehr in Anspruch nahm und auch die anstrengende Arbeit der Wachstafelentzifferung mich allzu sehr ermüdet hatte. Doch will ich versuchen das Wenige, was die letzten Tage zu erzählen gaben, nachzuholen. Ich schrieb Dir zuletzt aus Karlsburg, wo ich noch drei Tage (28. 29. 30 Sept.) blieb, beschäftigt teils mit der Aufnahme der dort und in der Umgegend zerstreuten Steine, teils mit der Entzifferung der von Enyed erhaltenen Wachstafeln«. Wickert 1969, 607. A. Vajna, the director of the Bethlen College, confirmed in his letter from 17th October 1857, that the tablets and their textual interpretation had arrived safely back to Aiud: Wollmann 1983, 57 (Brief 19).
- 25) P. Szathmáry 1868, 336. 349.
- 26) P. Szathmáry 1879. The second drawing of the tablet was made probably in Berlin by Th. Mommsen, as he mentions under his drawing in CIL III, 953: »*ex altero apographo*«.
- 27) P. Szathmáry 1879. Unfortunately, Th. Mommsen's letter has not yet been identified.
- 28) P. Szathmáry 1879. The wax tablet considered by K. P. Szathmáry as »undecipherable« (dated 28th March AD 168) was published several years before by Mommsen 1857, 521-522.
- 29) For the activity of the Egger antiquaries see: Kemenczei 2011. K. P. Szathmáry received 150 forint for the tablet and bought Neolithic and Bronze age collections and a numismatic collection from the Arpád period: P. Szathmáry 1879; 1888. The problem caused by K. P. Szathmáry had a strong echo in the contemporary press: Századok 13, 1879, 448-449; A Hon

- 17/127, 1879 május 26; *Archaeologiai Értesítő* 13, 1879, 202-204; *Korrespondenzblatt des Vereins für siebenbürgische Landeskunde* 2, 1879, 57-58. K. P. Szathmáry tried to explain his cause many years after the event: P. Szathmáry 1888. In the 1980's V. Wollmann presumed erroneously that the tablet had been stolen: Wollmann 1983, 22. 38 note 71.
- 30) The tablet was bought in 1867 by the Antiquarium (Altes Museum) from Berlin for 285 forint: *Inventarium der Terra-Cottensammlung des Königlichen Antiquariums I*, inv. 18. See also: Wattenbach 1896, 58. The tablet known as TC 5898 in the depot of the Altes Museum was presumably lost in the period between 1899 and 1935. There is no photographic documentation of the object. We are thankful for Dr. M. Maischberger (Deputy Director, Antikensammlung Berlin) for his kind help.
- 31) CIL III 953. TC XV.
- 32) *Pagina prior et posterior*: Rodríguez de Berlanga 1876, 124-125; Xenopol 1888, 232-234 notes 5-7; Popa-Lisseanu 1890 = Popa-Lisseanu 1925, 165-166 no. 14; Cserni 1901, 516-517; *TabCerD XVI* [I. I. Russu]; Noeske 1977, 407-408; Thilo 1980, 69; Hoffmann 2002, 78-79. *Pagina posterior*: Gooss 1874, 121-122; Jung 1877, 98-100; Liebenam 1890, 261-262; Király 1891, 131; 1892, 301-302; 1894, 286; Biró 1963, 16.
- 33) Popa-Lisseanu 1925, 165. 176.
- 34) Nagl 1914, 37 note 1.
- 35) *TabCerD XVI*.
- 36) The glazed showcase has the following, Hungarian inscription: »Készült 1909/IX. Spangenberg Gyula asztalos mester Nagyenyed« (made by Gyula Spangenberg carpenter, Aiud, October 1909).
- 37) From an article in the local newspaper the wax tablet was in the collection of the Historical Museum in 1955: Vita 1955.
- 38) Wollmann 2002, 92. 95 no. 15; 113 fig. 28. (The photo shows incorrectly the object upside down).
- 39) We did not have the opportunity to determine the type of tree. The material from Roşia Montană (*Alburnus Maior*) was usually defined as pine (*Abies* or *Picea*): Desjardins/Rómer 1873, 177; Hartmann 2015, 46. However, the *codices* were usually made from hardwood: Degni 1998, 66-68; Jördens 2020, 131.
- 40) Naming the two wooden boards of the tablet, we kept the terms used in the previous historiography as *pagina prior* and *pagina posterior* following CIL. Since both sides of both boards had a wax layer, we will use the *recto/verso* additions to denote the front/back of the boards.
- 41) This is the smallest longitudinal specimen among the Dacian wax tablets. See also: CIL III 924-959; IDR I, 192-256; Wollmann 2002, 94-97. Size comparison of the Dacian wax tablets with analogies from other provinces: Tegtmeier 2016, 44 fig. 19.
- 42) The designation of *codex/caudex* (»log«) also suggests this: Birt 1913, 260; Degni 1998, 37. On the production of the wax tablets see: Büll/Moser 1973, 1369-1370; Gaitzsch 1984, 189-202. Especially: Tegtmeier 2016, 63-77; Tomlin 2016, 10-13.
- 43) This »diamond pattern« technique has been used throughout the history of wax tablets: Büll 1977, 787. For analogies of similar techniques on wax tablets from Cologne and London see: Tegtmeier 2016, 449 pl. 85, 7; Tomlin 2016, 75 fig. 46 WT8. U. Tegtmeier argued that the »diamond pattern« served as decoration, while R. S. O. Tomlin argued that »there are traces of text on the inner (recessed) face, but they have been »crossed out« by scoring a series of long diagonals across them«: Tegtmeier 2016, 29; Tomlin 2016, 74.
- 44) For the composition of the dark, brown wax used in antiquity: Büll 1977, 809-810 tab. 1; 815 tab. 2 no. 2, 8. On the typology of wax see: Büll/Moser 1973, 1366-1369; Büll 1977, 808-816; Gaitzsch 1984, 191-193; Tomlin 2016, 15. 284-286.
- 45) For the term *codex* see: Roberts/Skeat 1983, 11-14; Jördens 2020, 116-117. In the literature we often find references to *codicillus*, *pugillares*, because among the *codices* there are numerous examples of small dimensions, such as the wax tablet discussed here. On the literary sources see: Degni 1998, 73-151.
- 46) Among the 612 tablets found in Vindonissa, there were only two »ordinary internal tablets« (»Einfache Innentafel«), from which M. A. Speidel concluded that *codices* were rarely used here: Speidel 1996, 25. The same results were attained by U. Tegtmeier after the analysis of the 718 tablets from Cologne: »Im Kölner Schreiftafel-Fundgut gibt es keinerlei erkennbare Zusammengehörigkeit mehrerer Tafeln zu einem Kodex«. Tegtmeier 2016, 24. There were no such types among the 405 wax tablets found in the Bloomberg site, London either: »No Bloomberg examples were identified of a further type where both faces are recessed, but are not divided«. Tomlin 2016, 25.
- 47) *Diptichon*: Thilo 1980, 68-69; *triptichon*: Popa-Lisseanu 1925, 234; Mrozek 1971, 443; Noeske 1977, 408; Ciulei 1983, 3. 5. 72; Wollmann 2002, 93.
- 48) On the drawing of Th. Mommsen, there were only four holes on the *pagina prior* (fig. 4a), the eight holes from the *pagina posterior* were drawn in their exact positions (fig. 5a).
- 49) On tablets with two pair of holes from Egypt see: Jördens 2020, 141-142 Appendix A.
- 50) The cord (*linum*) made of vegetable fibre (hemp, flax) was most often used to bind the wax tablets. See also: Tegtmeier 2016, 50; Jördens 2020, 133-135. For the bonds used in the vertically positioned pairs of holes see: Jördens 2020, 137.
- 51) In both holes of the *pagina prior* and in the lower hole of the *pagina posterior* a remnant of the cord was identified. The bonds might have been disturbed and torn only in the 19th century after the discovery of the tablets. We did not have the opportunity to examine the organic material.
- 52) For the closure system of a similar tablet from Herculaneum see: Pugliese Carratelli 1950, 271-272; Meyer 2009, 572-574.
- 53) Speidel 1996, 15. 31; Hartmann 2011, 126; Tegtmeier 2016, 21-22; Tomlin 2016, 6. 27. See also: Birt 1913, 260. 358; Gaitzsch 1984, 190; Bülow-Jacobsen 2009, 12.
- 54) For the *SC Neronianum* responsible for publishing legal documents see: Pólay 1982, 512.
- 55) Brinkmann 1911, 155; Pugliese Carratelli 1950, 277-278; Jördens 2020, 130-131.
- 56) Speidel 1996, 23-30. Cf. Hartmann 2011, 126., 128; Hartmann 2015, 44; Tegtmeier 2016, 23; Tomlin 2016, 22.
- 57) Meyer 2007, 304, esp. 307-308. In French the terminology used is »tablettes comptables«: Cauderlier 1989, 101. 116.
- 58) For the so-called Codex typ C of A. Jördens, see: Jördens 2020. E. A. Meyer sees in Roman legal documents of Egypt the di-

- rect predecessors of the early Christian *papyri codices* and later books: Meyer 2007, 308-311. 329-331. For the contrary, see: Ammirati 2013, 14 note 6.
- 59) Meyer 2007, 333-334 Appendix 2.
- 60) Inv. P.CtYBR, inv. DPM 1 = P.Dura 53 = Welles/Fink/Gilliam 1959, 190 pl. XVI, 3.
- 61) Pugliese Carratelli 1950, 271-273; Capasso 1990 = 1992 = 1995; Camodeca 2007, 83 note 11; 107 fig. 13; 2009, 17-18. 31-34; esp. 2020, 144-146 no. 3.
- 62) Meyer 2009, 574, esp. 589-591 Appendix 1, nos 2, 3, 9, 12, 13. On three wall paintings we can find the representation of *codices* in the »portrait« format, the direction of the texts are parallel with the shorter page: inv. MN 9818 = Blum 2002, 42 no. 34; inv. MN 4668C = Blum 2002, 54 no. 54; inv. MN 9823 = Blum 2002, 48 no. 49. On the last one and two other mural paintings we can also observe the paired holes on the longitudinal side: inv. MN 8598D = Blum 2002, 25 no. 14; inv. MN 4676 = Blum 2002, 28 no. 17. *Codices* are often represented in financial contexts (coins, money bags), which confirms their interpretation as account tablets.
- 63) See the webpage of the research team and project entitled »Scroll in Hand« (SIH), which collects the representations of writing tools on funerary monuments of the Roman Empire: <https://scrollinhand.hu> (21.11.2022).
- 64) SIH 189 = Spasić-Đurić 2002, 58 fig. 36. The so-called Banker-stele from Kostolac (okr. Braničevo/SRB) is only partially preserved, only the central area is intact and the epigraphic field is also missing. The central scene represents a sitting male figure holding in his left hand an opened, at least three paged wax tablet in the »portrait« format. With his right hand he is counting the coins from the money bags on the table. In front of him, another male figure is standing, holding, and reading an open scroll (*volumen*).
- 65) Roman cursive writing during the Principate was widespread and is known as »majuscule cursive« or »capitalis cursive«, more recently as »old Roman (common) script« (»écriture commune classique« / »klassische Kommunschrift«): Tjäder 1953, 387-389; Brekle 1994, 188.
- 66) In the CIL III *pars posterior* volume K. Zangemeister made an *index* (»*Formae litterarum in tabellis ceratis*«) and a figurative (drawings) summary of the letters and their typology from the wax tablets of Alburnus Maior (»*Litterarum formae ex tabellis ceratis descriptae*«). The letters of TC XV are listed only in the »*Numeri et notae*« and the special *ligaturae* of the text are not analysed: CIL III 964-966 tab. A. The table and drawings of K. Zangemeister were republished in Popa-Lisseanu 1925, stampa III.
- 67) On cursive writing in Dacia see also: Voloşciuc 2007.
- 68) First in Gyulafehérvár (Alba Iulia), later in Berlin (see the first section on the historical background). It is surprising that, in the publication from the CIL, Th. Mommsen did not draw the edge of the *pagina prior verso* and the number of holes on this tablet is also imprecisely mentioned and represented, while the drawing of the *pagina posterior recto* is precise. It is possible that the drawing of the *pagina posterior recto* was made on a different occasion and, possibly, in a different location than the *pagina prior verso*.
- 69) Under the drawing of *pagina posterior recto*: »V.21 princ: ex altero apographo«. CIL III 953.
- 70) In bold script is the text which still exists on the currently preserved epigraphic field.
- 71) The date proposed by G. Popa-Lisseanu (24th April) is wrong: Popa-Lisseanu 1925, 234. Repeated by: Beu-Dachin 2016, 240-241 (s. v. Kalendae and Māius). 244 (s. v. octāvus).
- 72) The date of 7th May proposed by G. Popa-Lisseanu cannot be taken in consideration: Popa-Lisseanu 1925, 234. Repeated by: Beu-Dachin 2016, 241 (s. v. Māius).
- 73) The date of 5th August suggested by R. M. Thilo is wrong: Thilo 1980, 70.
- 74) Dressing (*impensa*) appears often in the cookbook of Apicius (Vehling 1977, *passim*), among others, in the recipe of stuffed suckling pig (Apic. 8, 7, 1). Until recently, the word *impensa* was interpreted as a certain kind of expenditure: »Mühe« Gooss 1874, 122; Jung 1877, 100; »Trinkgeld« Grupp 1903, 291; Szilágyi J. 1956, 132 note 149; »bacşiş« Xenopol 1888, 233; Popa-Lisseanu 1925, 234-235; Abrudeanu 1928, 64-65 no. XV; »Unkosten« Liebenam 1890, 261; »munkadíj« Király 1891, 131; 1892, 301-302; 1894, 286; »borravaló« Vadnai 1942, 14; »egyéb költség« Bíró 1963, 16; »Aufwand« Thilo 1980, 70; »simbrie« TabCerD XVI [I. I. Russu]; »cost, expense; building materials« Beu-Dachin 2016, 237 (s. v. *impensa*); »unbekannte Zutaten« Tonisch 2018, 320 no. 1789.
- 75) *Acetum* can mean also low quality »sour wine«, at times mixed with water to form a drink called *posca*: Davies 1971, 124. Based on quantity, however, it is more likely to be vinegar, see numerous cases mentioned in the cookbook of Apicius: Vehling 1977, *passim*.
- 76) Cf. Gooss 1874, 121-122; Jung 1877, 99; Xenopol 1888, 233-234; Liebenam 1890, 261; Király 1891, 131; 1892, 301-302; 1894, 286; Popa-Lisseanu 1925, 165-166 no. 14; Abrudeanu 1928, 64-65 no. XV; Tudor 1957, 171; Mrozek 1968, 319; Bíró 1963, 16; Pólay 1972, 203; Thilo 1980, 69; Ciulei 1983, 50; Beu-Dachin 2016, 225 (s. v. *agnus*). 231 (s. v. *dēnārius*). 233 (s. v. *dūodeviginti*). 234 (s. v. *e, ex*). 243 (s. v. *numērus*).
- 77) Szilágyi J. 1963, 340 (»price of wine«); Mrozek 1971, 445 (»prix de l'agneau«). 446-447 (»prix du vin«); Mrozek 1975, 18. 20. 49-50. J. Szilágyi and S. Mrozek interpreted the unknown liquid of V21 as wine and compared the price of this with other data, although neither the nature of the liquid, nor the price is not certain. See also: Matei-Popescu 2012, 91; Tonisch 2018, 8 note 6; 132. 145. 148, 320-321 nos 1788-1797; 381 nos 3664-3668. M. Tonisch lists wrong and non-existing prices also in the case of the *pagina prior verso*: Tonisch 2018, 216. 375 nos 3449-3456.
- 78) In the previous interpretations – probably based on the quantity of the wine – the literature mentioned only an ordinary type of table wine: »gewöhnlicher Tischwein« Gooss 1874, 122; Jung 1877, 99; »vin ordinar« Xenopol 1888, 233; »gewöhnlicher Landwein« Liebenam 1890, 261; »asztali bor« Király 1891, 131; 1892, 302; 1894, 286; Bíró 1963, 16; »vin ordinaire« Waltzing 1895, 484; »gewöhnlicher Wein« Grupp 1903, 291; »vin de rând« Popa-Lisseanu 1925, 234-235; Abrudeanu 1928, 64-65; »közönséges bor« Vadnai 1942, 14; »vin obişnuit« Tudor 1957, 171; »közönségesebb helyi termékű bor« Csávossy 2012, 61.
- 79) Plat. leg. 845b (ἀσταφίδος οἶνος); P.Ryl. IV 583 ii; I 74 (οἶνος ἀπὸ ἀσταφίδος).
- 80) Billiard 1913, 491-492; Dzierzbicka 2018, 221-222.

- 81) Pol. 6, 11a, 4 = Athen. 1, 440e-f.
- 82) Raisin-wine appears 67 times in the cookbook of Apicius: Vehling 1977, *passim*. Apicius often offers the *passum* as an alternative for honey, which indicates that it was a very sweet wine.
- 83) »The raisin, or astaphis as it is called [...], the wine made from stoned raisins is specific for the poison of the serpent called haemorrhoidis«. Plin. nat. 23,12. Translated by H. Rackham. See also: Diosk. mat. med. 5, 3-4; Dzierzbicka 2018, 222.
- 84) There were a significant number of individuals from the Greek speaking world in Alburnus Maior. This is reflected not only in the linguistic characteristics, but also the onomastic material of the inscriptions: Beu-Dachin 2015. Another argument can be found in the legal texts of the wax tablets which reflect distinctive Hellenistic terms: Pólay 1973; 1982, 523. TC IV was written completely in Greek.
- 85) Latinised Greek words appear also on other tablets from Alburnus Maior: Beu-Dachin 2015, 147.
- 86) »Sed vide ne eiusmodi pretium in hoc vino nimium sit, cum vini boni amphoram Plinius 14, 4, 56 computet ad sestertios centum«. CIL III 953. For this contradiction see also: Gooss 1874, 122; Jung 1877, 99-100; Popa-Lisseanu 1925, 235; Abrudeanu 1928, 65; Tudor 1957, 171; Mrozek 1971, 446 note 11; 1975, 18-19 note 22.
- 87) For *peganinum* see: Beu-Dachin 2015, 148; 2016, 223. 245.
- 88) For *peganum* see: ThLL 10.1.1. 983.
- 89) The historiography interpreted this item until now as a salad: »Salat« Gooss 1874, 122; Jung 1877, 100; Liebenam 1890, 261; Grupp 1903, 291; Noeske 1977, 408; Bollmann 1998, 38; »salatã« Xenopol 1888, 233; TabCerD XVI [I. I. Russu]; »salãta« Király 1891, 131; 1892, 302; 1894, 286; Biró 1963, 16; »salade« Waltzing 1895, 484; »verdeturi« Popa-Lisseanu 1925, 234; Tudor 1957, 171; Abrudeanu 1928, 64; »zöldsegek és főzelékek« Vadnai 1942, 14; »salad« Matei-Popescu 2012, 91.
- 90) Andrews 1948. *Ruta* appears 95 times in the cookbook of Apicius: Vehling 1977, *passim*.
- 91) Plin. nat. 19, 45 (*mulsum rutatum*). See also: Billiard 1913, 230; Andrews 1948, 371.
- 92) D'Andrea 1982, 76-78.
- 93) Cels. 5, 27, 12. (*vinum merum calidum cum ruta*).
- 94) »From the same *pendere* ›to weigh or pay‹ comes *dispensator* ›distributing cashier‹, and in our accounts we write *expensum* ›expense‹ and therefrom the first *pensio* ›payment‹ and likewise the second and any others, and *dispendium* ›loss by distribution‹, for this reason, that money is wont to become less in the *dispendendo* ›distributing of the payments‹«. Varro ling. 5, 183. Translated by R. G. Kent.
- 95) Thilo 1980, 60-70.
- 96) Thilo 1980, 61; de Ste. Croix 1956, 20-21.
- 97) »Huius laterculi pagina priore indicantur res coemptae ex summa denariorum 166 vel ad summum 169, fortasse in usum Laralium k. Maiis celebrandorum. Singula pretia quae supersunt (18+5+2+2+2+95+35[aut 32]+1++2+2) collecta efficiunt 166 aut 153; praeterea lacunae versuum 15. 17-21 absumere potuerunt denarios 1, 2, 2, 2, 4, 4 [aut 2], id est ad summum 15«. CIL III 953.
- 98) For a systematic overview of the wax tablets of the Roman Empire see: Pescini 1994; Hartmann 2015 with the previous bibliography.
- 99) »*Index pecuniarum acceptarum rerumque emptarum*«. CIL III 953.
- 100) »Speisezettel eines solchen collegialen Mahles« Gooss 1874, 121-122. See also: Gooss 1876, 126.
- 101) Jung 1877, 98-100; Xenopol 1888, 232-234; Liebenam 1890, 261-262; Téglás 1891, 41. 45. 95; Király 1891, 131; 1892, 301-302; 1894, 286; Waltzing 1895, 421 note 5; 484.
- 102) Kornemann 1900, 440; Cserni 1901, 230; Brand 1903, 481; Grupp 1903, 291; Popa-Lisseanu 1925, 223. 233-235; Abrudeanu 1928, 34; Vadnai 1942, 14; Szilágyi J. 1956, 132 note 149; Tudor 1957, 170-171; Biró 1963, 16. 18. 22; Tudor 1965, 111; Mrozek 1968, 316. 319; 1971, 443; Pólay 1972, 191 note 47; 203. 224-215 note 28; Mrozek 1975, 18. 49. 61-62; Wollmann 1976, 190; Noeske 1977, 408; Ciulei 1983, 72; Bollmann 1998, 38.
- 103) Hoffmann 2002, 87; Tonisch 2016, 209 note 2; 2018, 8 note 6, 132.
- 104) Massmann 1840. The first short report on the first wax tablet was published in: Aranka 1796, 141-142.
- 105) See latest: Eckhardt 2021, 81-83.
- 106) Brand 1903, 481.
- 107) Téglás 1891, 41. 45. 95; Mrozek 1971, 447 (»college de mineurs«).
- 108) The tablet does not appear in the *collegia* list of the CIL: Cf. CIL III 1179-1183 (»*XI. Collegia*«; »*XII. Res municipalis et collegiorum*«). 2553-2556 (»*XII. Collegia*«).
- 109) Mommsen 1843.
- 110) The basic purpose of accounting was to reveal the losses that arose from the dishonesty, negligence, or inefficiency of the *dominus*'s servants or others: de Ste. Croix 1956, 34. The *census*, i. e. the correct property classification, was also necessary for the accurate registration of property at all times: Thilo 1980, 188-196; Gröschler 1997, 73.
- 111) More detailed with the previous bibliography: Thilo 1980. See also: Gröschler 1997, 71-75.
- 112) Rodríguez de Berlanga 1876, 124-125. The author mentions the tablet from Aiud related to the commentary of Cap. 81. of the *Lex Coloniae Genetivae*.
- 113) de Ste. Croix 1956, 20. 70.
- 114) Thilo 1980, 68-70.
- 115) Thilo 1980, 165 note 254. R. M. Thilo presumably was not aware of M. Rodríguez de Berlanga's century long older presumption or at least did not cite him.
- 116) »Why is it that we write down memoranda (*adversaria*) carelessly, that we make up account-books (*tabulas*) carefully? For what reason? Because the one is to last a month, the other for ever; these are immediately expunged those are religiously preserved; these embrace the recollection of a short time, those pledge the good faith and honesty of a man for ever; these are thrown away, those are arranged in order. Therefore, no one ever produced memoranda (*adversaria*) at a trial; men do produce accounts (*codicem*), and read entries in books (*tabulas*)«. Cic. Q. Rosc. 2. 7. Translated by C. D. Yonge.

- 117) Gröschler 1997, 72.
- 118) Thilo 1980, 164 note 251. In connection with Roman accounting, the literary sources only serve as an indirect reference point, the conclusions drawn on the basis of them often contradict each other. Previous publications usually use *ephemerides* as a synonym for *adversaria*, but R. M. Thilo pointed out that this is a misinterpretation: Thilo 1980, 181-187.
- 119) The datable tablets from Alburnus Maior were made between AD 131-167. On the chronology of the preserved tablets see: CIL III 921; Pólay 1972, 22-23; IDR I, 175; Noeske 1977, 339.
- 120) »Die römische Buchführung stellt sich nicht als durchgebildetes System dar, sondern nur als Sammlung einzelner Aufzeichnungen über Bestand und Veränderung des Vermögens mit dem Zweck gleichzeitiger Kontrollmöglichkeit derjenigen, in deren Händen die Vermögensverwaltung oder Geschäftsführung lag. Einzig erkennbares Prinzip der römischen Buchführung, das dem angestrebten Zweck aber völlig genügte, ist der chronologische, detaillierte Bericht und die Auflistung von Rechenposten als Gedächtnisstütze«. Thilo 1980, 319-320.
- 121) We know similar accounts in content and form among the *tiliae* from Vindolanda, which can be perhaps interpreted in context of the domestic administration of the *praetorium*: Bowman/Thomas 1983, 83-93 no. 4 (pl. II, 1-2); 93-96 no. 5 (pl. II, 3) = Bowman/Thomas 1994, 153-157 no. 190; 157-159 no. 191.
- 122) Malzbender et al. 2004.
- 123) Mudge et al. 2005.
- 124) Woodham 1980.
- 125) Malzbender/Gelb/Wolters 2001.
- 126) Earl et al. 2011, 147.
- 127) See in this direction Mudge et al. 2008 and 2010.
- 128) Mudge et al. 2005, 29.
- 129) Mudge et al. 2005, 31.
- 130) Gui et al. 2020, 235.
- 131) Mudge et al. 2005, 30-31.
- 132) Corsini et al. 2006, 1; see in this direction the recent study on dynamic shading enhancement developed for RTI in Palma et al. 2010.
- 133) Malzbender et al. 2004.
- 134) Mudge et al. 2006; see also 2008.
- 135) Mudge et al. 2005.
- 136) See, for example, several Roman artefacts from Dacia: Ciobanu 2018, 50-53; Hamat 2019; Deac/Dana 2019, 113; Gui et al. 2020, 235-236. 247.
- 137) Earl et al. 2011.
- 138) <http://culturalheritageimaging.org> (21.11.2022).

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Abbreviations

CIL: Corpus Inscriptionum Latinarum (Berolinum 1863-).
 IDR: Inscriptiile Daciei Romane (București, Paris 1975-).
 TabCerD: Täblițele Cerate Dacice. In: IDR I, 165-256.

TC: Tabellae ceratae Dacicae. In: CIL III, 921-960.
 ThLL: Thesaurus Linguae Latinae (Leipzig et al. 1900-).

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Zusammenfassung / Summary / Résumé

Digitalisierung einer römischen *tabula cerata* aus Alburnus Maior (Roșia Montană, jud. Alba/RO)

Die Studie konzentriert sich auf eine der Wachstafeln aus den römischen Minen von Alburnus Maior (TC XV = TabCerD XVI), die kürzlich in der Sammlung des Museums von Aiud (Rumänien) wiederentdeckt und von den Autoren digitalisiert wurde. Der Artikel präsentiert den Fundkontext und seine komplexe Geschichte von 1855 bis zur Wiederentdeckung des Objekts im Jahr 2018, eine detaillierte Analyse der physischen Merkmale und des aktuellen Zustands der Wachstafel sowie eine vollständige Neuinterpretation und digitale Rekonstruktion des Inschriftenfeldes, die erste seit der Lesung von Theodor Mommsen. Wir stellen die alte Interpretation des fragmentarisch erhaltenen Textes der Wachstafel in Frage und schlagen vor, dass er als eine Form einer *adversaria* kontextualisiert werden muss.

Die Autoren stellen auch die Bedeutung der H-RTI-Technik bei der Digitalisierung von fragilem, schwer zugänglichem archäologischem Erbe vor, insbesondere im Fall von Alburnus Maior, das 2021 als UNESCO-Weltkulturerbe ausgewählt wurde.

Digitising a Roman *Tabula Cerata* from Alburnus Maior (Roşia Montană, Jud. Alba/RO)

The study focuses on one of the wax tablets from the Roman mines of Alburnus Maior (TC XV = TabCerD XVI) recently rediscovered in the collection of the Museum of Aiud (Romania) and digitised by the authors. The article presents the context of the discovery and its complex history from 1855 until the rediscovery of the object in 2018, a detailed analysis of the physical features and the current state of the wax tablet, as well as a complete reinterpretation and digital reconstruction of the epigraphic field, the first since the reading of Theodor Mommsen. We question the old interpretation of the fragmentarily preserved text of the wax tablet, suggesting that it needs to be contextualised as a type of *adversaria*. The authors also present the importance of the H-RTI technique in the digitisation of fragile, rarely accessible archaeological heritage, especially in the case of Alburnus Maior, which was inscribed in 2021 as a UNESCO World Heritage site.

Numérisation d'une *tabula cerata* d'Alburnus Maior (Roşia Montană, jud. Alba/RO)

L'étude porte sur l'une des tablettes de cire des mines romaines d'Alburnus Maior (TC XV = TabCerD XVI) récemment redécouverte dans la collection du Musée d'Aiud (Roumanie) et numérisée par les auteurs. L'article présente le contexte de la découverte et son histoire complexe de 1855 jusqu'à la redécouverte de l'objet en 2018, une analyse détaillée de l'état actuel de la tablette et de ses caractéristiques physiques et une réinterprétation complète et reconstruction numérique du champ épigraphique, la première d'après la lecture de Theodor Mommsen. Nous remettons en question l'ancienne interprétation du texte de la tablette, conservé de manière fragmentaire, en suggérant qu'il doit être contextualisé comme une forme d'*adversaria*. Les auteurs présentent également l'importance de la technique H-RTI dans la numérisation d'un patrimoine archéologique fragile et rarement accessible, notamment dans le cas d'Alburnus Maior, sélectionné en 2021 comme site du patrimoine mondial de l'UNESCO.

Schlüsselwörter / Keywords / Mots-clés

Römisches Dakien / Alburnus Maior / Wachstafeln / römische Minen / *adversaria*
Roman Dacia / Alburnus Maior / wax tablets / Roman mines / *adversaria*
Dacie romaine / Alburnus Maior / tablettes de cire / mines romaines / *adversaria*

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