



Unveiling magic from the middle ages: tomographic reading of a folded lead amulet from Dřevíč fortress (Czech Republic)

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Abstract

The discovery of a singular magical leaden artefact from the Middle Ages in Central Bohemia provoked the ambition to visualize and decipher the text hidden inside while still keeping the object in its original folded state. To fulfil this goal, several X-ray tomographic scans were done in conjunction with advanced data processing. Though parts of the text still remain inaccessible or unclear, the Dřevíč amulet is the first medieval object of its kind ever to have been successfully virtually unfolded and read. Leaden amulets are still very rare and under-researched finds in the archaeological record, with just over a hundred surviving examples mainly found in Southern Scandinavia and Central Germany. They are testimonies to the once widespread practice of Christian curative magic with roots in older pagan traditions. Comparable charms and blessings are extant in countless medieval manuscripts, while similar amulets written on parchment and most other organic materials have not survived. The information gained through digital imaging revealed not only the amulet bearer's name but also a number of yet unknown and personalized magic formulae destined to protect the bearer of the artefact unattested elsewhere.

Keywords Christian amulet · Lead amulet · Virtual unfolding · Computed tomography · Late Carolingian minuscule · Protective magic · Adiuro

Introduction

Various magical items and practices have been used for protection from potential misfortune since time immemorial. Diseases, poisonous animals, wars and natural disasters could not only jeopardize but also quickly end a human life. The use of magic for protection and deliverance from diseases has, therefore, been widespread from the earliest times. People in

the ancient Greco-Roman world, as well as those in later medieval times, felt exposed to innumerable dangers. Thus, they invoked diverse higher powers (such as Yahweh, Christ or Abraxas) to obtain protection through them. A favourite and widespread 'safety device' were amulets – small objects destined for personal protection to be worn close to one's body – which were believed to have magical or miraculous power to protect their owners or to treat various illnesses. Amulets were in demand for every imaginable situation in life. Most frequently, they were used to cure diseases and injuries and to drive away dangerous beasts and demons, which were often held responsible for various health difficulties. Charms encouraging good luck, power or prosperity are usually differentiated as talismans. Diverse objects may have fulfilled the function of a protective charm, including simple natural materials (e.g. shells, herbs and gemstones). The application of an amulet was often accompanied by uttered prayers or incantations.

In later times, we encounter a large number of amulets from ancient Mediterranean regions (Egypt, Greece, Asia Minor, Palestine, Italy) containing prayers and incantations written on small papyrus sheets or on small plates of precious kinds of metal, especially golden and silver plates or engraved on gems. In ancient times, these magical objects (except the

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gems) were usually inscribed and then folded or rolled to be worn in a capsule as a piece of jewellery around the neck. This magical protective practice did not become extinct with the ascension of Christianity. Instead, it survived and continued to be adapted to contemporary beliefs.

From late Antiquity and the Christian Middle Ages, several dozens of lead amulets have also survived and been found in the archaeological record in Central and Northern Europe. These date from the 11th to 15th centuries CE and were inscribed with prayers whose magical repertoire is enriched with passages taken from the Bible and ecclesiastical liturgy (Muhl and Gutjahr 2013). There have only been a few scattered finds of such objects in the last 150 years, but the number has been considerably increasing in recent years due to the use of metal detectors in archaeological surveys. In general, amulets are folded down to a portable size, sometimes as small as a thumbnail, and contain an inscription with prayers, blessings and/or incantations for protecting an individual from various negative influences. Finds from grave contexts, as well as instructions in medieval manuscripts, suggest that they were worn on the body, mostly in a pouch around the neck. Once folded, they could not be opened and read again without being irreparably damaged, so their continuous efficacy came from the material and invisible presence of the powerful words alone. Nevertheless, over the past decades, a number of these surviving amulets have been unfolded and their formerly hidden texts transcribed, shedding some light on the compositional schemes and typical elements of this Christian form of written magic.

Callidi diaboli: the discovery of the amulet

The Dřevíč hillfort located on a plateau in Central Bohemia (50 km to the northwest of Prague, Czech Republic) is an important archaeological multicultural site. Its significance for the wider territory is indicated by numerous finds. These finds prove the continued existence of activities and/or settlements in the location, dating from the Early Stone Age until the Late Middle Ages, including a particularly important stage in the Early Middle Ages. The Archaeological Department of T. G. Masaryk Museum in Rakovník is carrying out regular monitoring and exploration of this cultural monument. On 24 May 2014, a survey with the use of metal detectors was undertaken on the northwestern hillfort slope. Among other small finds, a small rounded block made of corroded lead was discovered, see Fig. 1, where original state of the amulet with remaining soil is depicted. Immediately after its unearthing, the artefact did not attract much attention, since, following iron, lead is probably the most common metal present on the Dřevíč location, not only in the form of firearm projectiles but also in the form of various ingots and fractions of raw material.

In accordance with standard archaeological practice, the object was carefully cleaned with water, and it appeared to be made from a folded lead sheet. This sheet was heavily



Fig. 1 Photography of the lead amulet shortly after discovery

corroded and damaged on the outside – nearly 85% of the top layer had disappeared on one side and 40% on the other side. Some other small fragments were removed during further cleaning. But surprisingly, the engraved late Carolingian minuscule script began to appear (see Fig. 2).

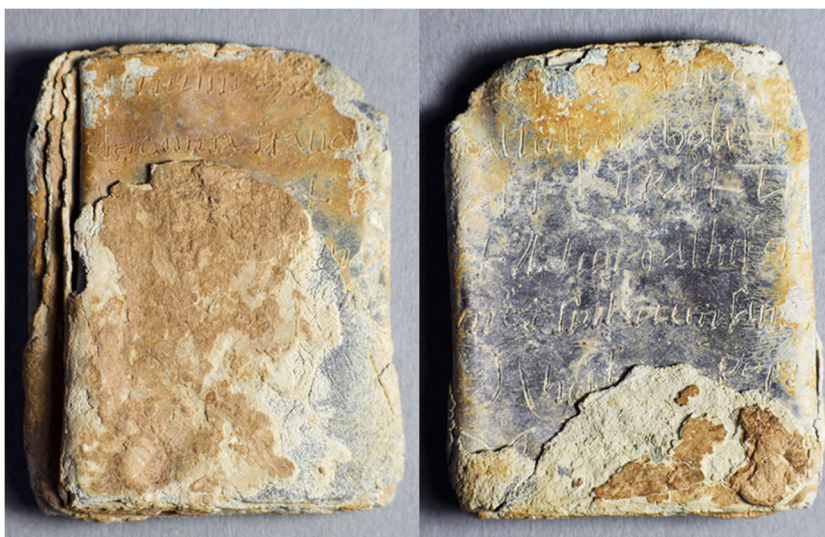
Subsequently, an essential part of the text could be deciphered which hinted the object's nature. The second line of the text contains the words *callidi diaboli...* ('crafty/tricky/deceitful/scheming devil'), which suggested that it might be a medieval Christian text. Obviously, it attracted attention about artefact classification and dating, as it had no known analogy in the territory of today's Czech Republic so far. Based on later research, it was clarified that similar artefacts have been discovered in graves in the territory of Germany (mainly Saxony-Anhalt) and identified as medieval Christian amulets. This discovery was followed by research into the origin and age of the object as well as by research into the possibilities of reading the remaining text which was most likely concealed inside.

The revisionary field survey carried out during the ongoing deforestation showed that we can assume the previous existence of a forest path passing across the slope, heading southwest towards the foot of the hillfort. In an analogy with amulets found in the territory of Germany, we assume that the object could have been shifted by erosion from its original location, probably in the context of a grave or settlement in the hillfort, or was lost, thrown away or deposited after usage closer to its finding place.

Description of the visible parts of the amulet

Any possible decoration of the outer faces of the amulet (parallels from Central Germany often show crosses or other

Fig. 2 Photography of the amulet from both sides. The words *callidi diaboli* are recognizable on the right, in the second line



apotropaic symbols) was lost due to massive corrosion. As these faces were partially lost, some fragments of the Latin text originally hidden inside of the amulet came to the surface on both sides of the amulet. These engravings made it clear that the object contained a Christian magical text as well as a cruciform sigil for protective and/or healing purposes and was probably meant to be worn on the body.

The visible parts of the text can be translated only partially, first published in (Blažková et al. 2017) *...dei contra fraud(em)/callidi diaboli...* ‘...God against the maliciousness of the scheming/deceitful devil...’ *...riskas (=arescas?)* ‘... may you wither! (?)’ *...adiuro albis qu(i)* ‘I implore (you) albis who...’ (*per patrem et filium et spiritum sanc(tum)*)... ‘(through the Father, Son) and Holy Spirit...’. The optically visible text is schematically depicted in Fig. 3. These short passages of the text in combination with the object’s shape, size and materiality allowed us to classify the Dřevíč find as belonging to a group of similar Christian lead amulets from

the eleventh to thirteenth centuries mainly found in Central Germany and Southern Scandinavia (Muhl and Gutjahr 2013). According to palaeographical analysis, our amulet may be dated to the first half of the twelfth century, see page 138 in (Blažková et al. 2017).

Information about the amulet’s fabrication can be concluded from outside observation. The folded amulet measures 34 × 43 × 3.8 mm (max.), while its weight is around 40 g. It was made from a lead sheet with a thickness of 0.5 mm. The sheet was inscribed on one side and then folded so that eight layers could be identified (see Fig. 4) – the unfolded sheet measured approximately 120 × 80 mm.

After its inscription, the lower part of the text side was folded in half horizontally onto the upper part. In the second step, the left and the right side of the sheet were again folded in half towards the middle and again unto each other, so that the now closed amulet looked like a small book in codex format. See Fig. 5 for a schematic illustration of the folding

Fig. 3 Transcription of the visible text

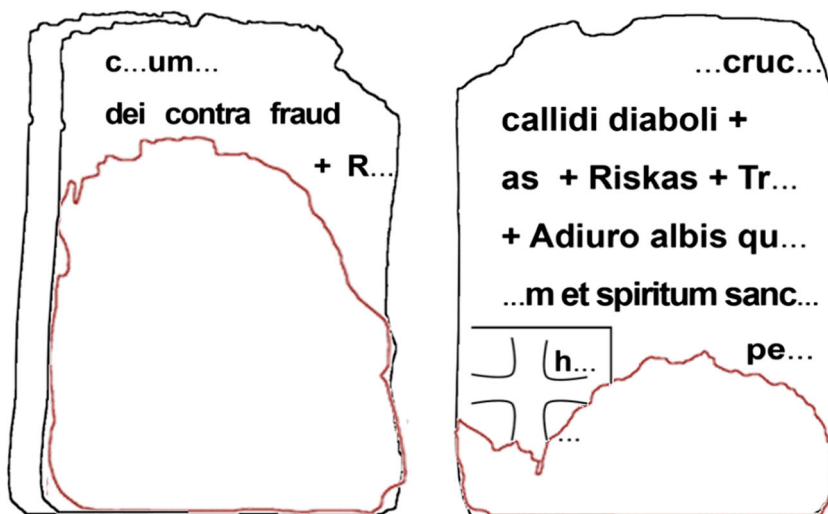




Fig. 4 Photography of the amulet showing its folding layers

In comparison with amulets already unfolded in the past, it thus became evident that, in the case of Dřevíč, much important information was still inaccessible. This includes, for example, the name of the protected person, further details about the nature of the addressed condition and its causing entities, the formulae used to banish them and the heavenly forces employed. However, these are surely present in other parts of the text. Because of the rareness of the amulet (it is the first leaden sample from medieval Bohemia) and the risk of irrevocable damage and the potential loss of the text-bearing

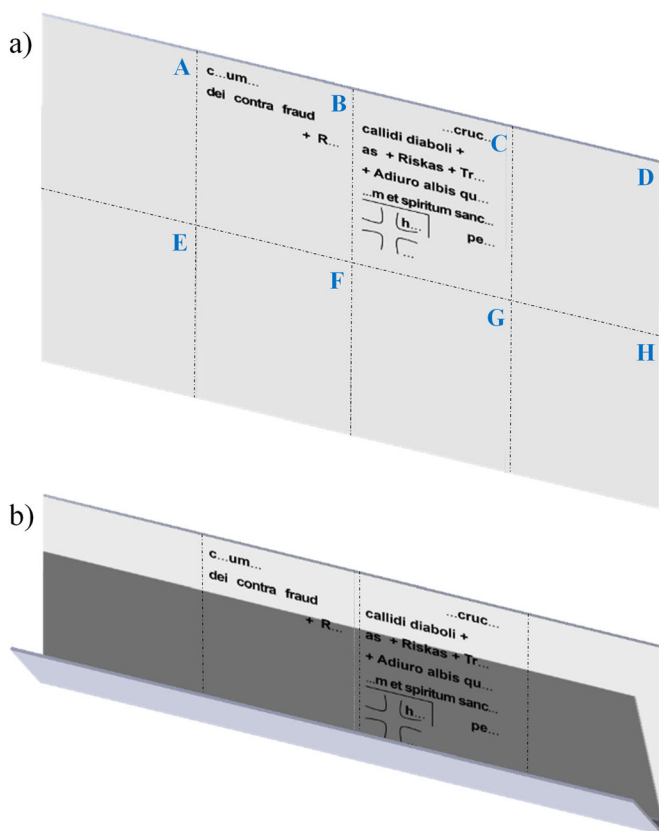


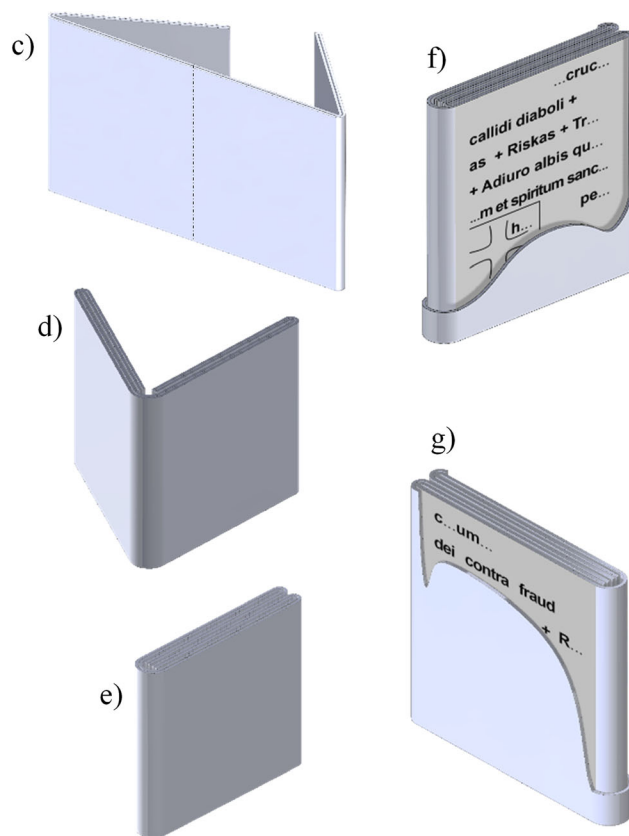
Fig. 5 Schematic illustration of the amulet folding: (a) unfolded sheet with optically visible text, sheet is divided into 8 parts (pages hereafter) marked by letters A–H according to folding scheme; (b) folded up along horizontal centerline; (c) sides bent towards vertical centerline; (d) and (e)

surface caused by mechanical opening, a non-invasive method of accessing the hidden inscription was sought.

The only solution seemed to be the exposure and reading of the entire inscription by tomographic measurement. This measurement was the only way to read, without damaging the artefact, the entire text concealed within the folded lead sheet. Doing so could clarify the specific purpose of the artefact, provide information on its owner and make it possible to determine the amulet's connection to the period context of magic objects and incantations.

Tomographic reading of the hidden text

X-ray computed tomographic (CT) reconstruction gives us insight about the three-dimensional inner structure of the investigated object from a series of two-dimensional radiographic images (projections) taken during rotation of the investigated object in relation to the imaging line consisting of an X-ray tube and X-ray imaging detector. The reconstruction itself is ordinarily performed by utilizing a well-known filtered back projection algorithm. VG Max software (Volume Graphics Ltd.) was used for this purpose. As a result of the CT reconstruction, a 3D matrix of the voxels (volumetric pixels)



final folding along vertical centerline; (f) and (g) top part of the sheet virtually removed with text partially visible in accordance with present condition depicted in Fig. 2

is obtained. Each voxel represents the calculated density of the object at a specific point. Inspection of the volume is usually done by going through and viewing its planar cross sections (slices thereafter). Each selected slice has a coordination system identical with the global one by default, but it can be changed to have a slice crossing the volume at arbitrary angles. A related visualization of the reconstructed data was also done using VG Max software in this work.

In general, the parameters of the tube have to be chosen in accordance with the X-ray attenuation of the object. Only a very small portion of the incident X-rays pass through the investigated amulet due to its high X-ray attenuation. Therefore, the maximal possible tube voltage and current have to be selected to produce a reasonable signal in the X-ray images – the signal-to-noise ratio has to be high enough to allow recognition of the features searched (the hidden inscription). High tube voltage leads to the intensive scattering of X-rays – resulting in blurred projections. Moreover, high tube current leads to a large emission spot on the tube target and, thus, a decrease in image resolution. As a result, CT measurement is quite challenging for such dense materials as lead.

For CT measurement, a multipurpose Twinned Orthogonal Adjustable Tomograph (TORATOM) located at the Centre Telč (CET) – of the Institute of Theoretical and Applied Mechanics was primarily used. See Fig. 6 where the amulet fixed inside of a Plexiglas tube is installed in the TORATOM.

Generally, the TORATOM employs the principal arrangement normally used for scientific/technical purposes – the object is mounted on a rotation stage, lying between the tube and detector, which has a stable position during the CT measurement. The position of the detector and stage can be set in the accordance with actual requirements. This solution allows selecting the projection magnification of the object by



Fig. 6 Amulet fixed inside a Plexiglas tube installed on a rotation stage between the X-ray tube and detector. The detector right behind the stage is covered by steel sheets to reduce the scattering effect. A tin filter cutting-off low-energy photons is mounted onto the X-ray tube head in front of the sample at left. The distance between the tube and detector is minimized to have the maximal possible photon flux within a given magnification

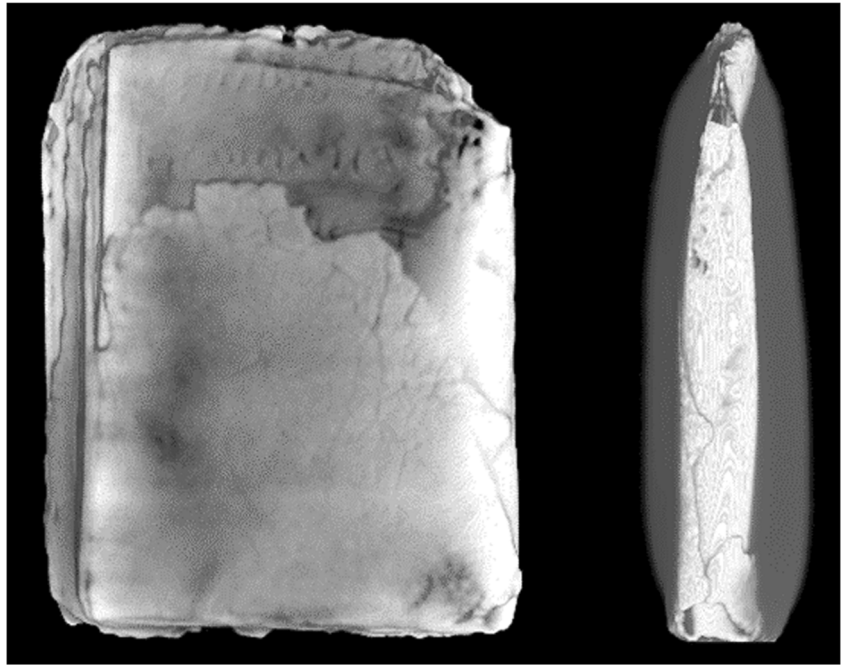
changing the ratio between ‘tube – object’ versus ‘tube – detector’ distances. It is worth mentioning that the lead shielding of the CT scanner cabinet at CET is comparable to the amulet’s thickness. (Besides the shielding, X-ray intensity decreases with the square of its distance.)

A Perkin-Elmer flat panel detector (410×410 mm, 0.2 mm pixel pitch) was used for imaging. Various tube and geometrical parameters of the CT scanner were tested, from which a tube voltage of 240 kV and 0.8 mA were chosen as a trade-off between image resolution and the signal obtained. Such high tube power represents a tube spot size of ~ 0.2 mm; it implies an X-ray image resolution around 0.1 mm. The projection magnification given by the CT scanner geometry was set at $8\times$, which resulted in a $25 \mu\text{m}$ image pixel size. Quite a long exposure time of 3×3 s for one projection was needed to have a reasonable signal behind the amulet. The scattering effect was reduced by utilizing a 3.6 mm tin filter in front of the tube and a 1 mm steel filter placed onto the detector. The full tomographic data set covered by 1200 projections represented almost 5 h for acquisition, including the time needed for the detector read-out. An example of the frontal and lateral 3D visualization of the reconstructed amulet is depicted in Fig. 7. The visible halo phenomenon on the right comes from the X-ray photons scattering.

Looking into the reconstructed volume, it appears almost as like the amulet was made from one solid block of lead. See the horizontal slice in Fig. 8a. This means that the lead sheets are visible as separated only partially due to the intensive scattering of X-rays and due to compression of the amulet after its folding. Identification of the individual pages of the amulet regarding its folding scheme was therefore not possible. This makes reading the unattached amulet harder, compared to another artefact where the silver sheet is not itself attached (Hoffmann et al. 2015). Nevertheless, single inscribed letters are manifested as voids in this slice (in the longitudinal slice as well). The visibility/contrast of such voids (and other fine features) is improved if the scattering phenomenon is reduced – signal outside of the amulet body is fitted by the appropriate polynomial surface for each horizontal slice and if this surface is subtracted from the original data.

If we look at the frontal slice (Fig. 8b) passing the dashed red line in the horizontal slice, some letters become visible. However, the identification of whole words is relatively unsure, because the bending of the writing surface is not parallel to any tomographic slice due to the deformation of the amulet. This problem can be partially resolved thanks to morphological data processing – the reconstructed amulet was virtually straightened. Compare Fig. 8c and f). The text afterward became much more easily recognizable. Compare Fig. 8b and e. Virtual amulet straightening was done thanks to the identification of the amulet’s outside faces – each slice was shifted and rotated to be symmetric with the central frontal plane. It

Fig. 7 Frontal and lateral views of the reconstructed volume



was not possible to fully straighten the amulet's shape, since it is not simple and fully convex. Both scattering reduction and virtual amulet straightening were done utilizing proprietary software based on MATLAB (MathWorks®) scripting.

The next step was the identification of the amulet pages within the reconstructed volume. It was necessary to go through and look for text fragments in individual frontal slices, respecting that text orientation changes in accordance with the folding scheme. Moreover, it was

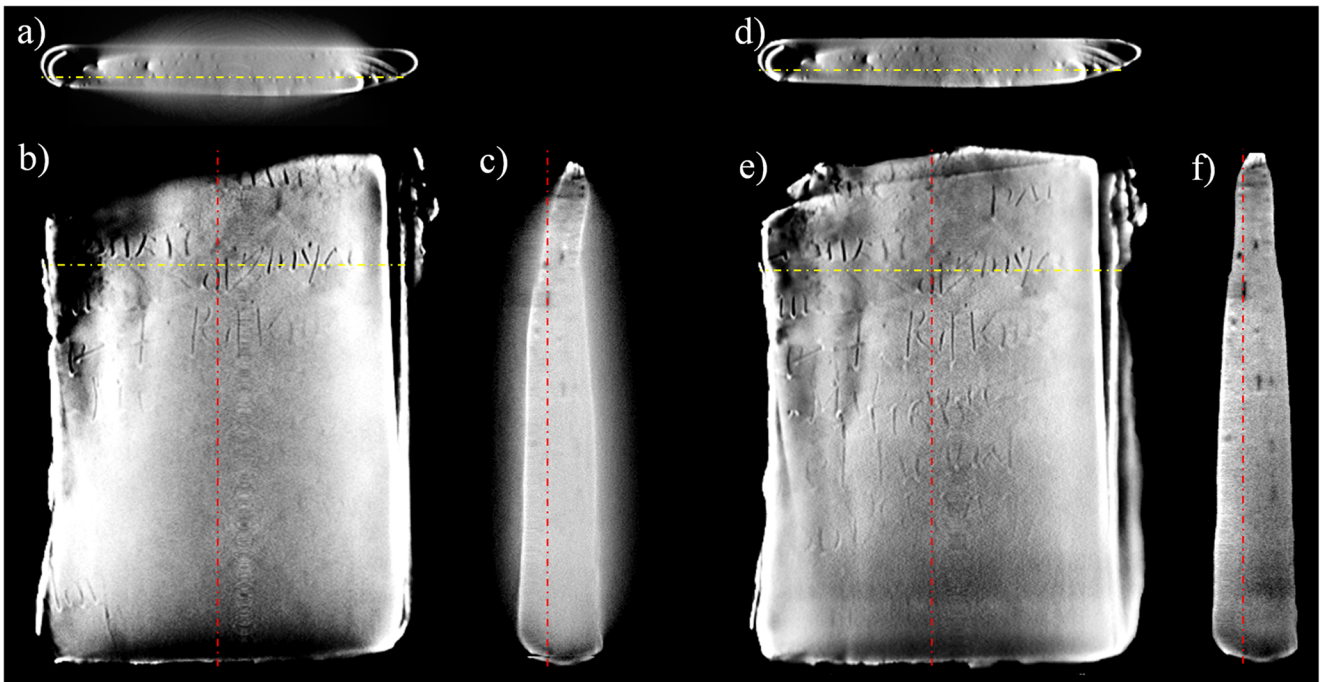


Fig. 8 (a) horizontal slice taken directly from the reconstructed volume, halo phenomena from the scattering; (b) frontal slice from the same volume, position related to the horizontal slice is emphasized by the yellow line; (c) longitudinal slice, position in the frontal slice marked by the red line; (d) horizontal slice after scattering suppression and

virtual amulet straightening, voids related to the letters become clearly visible; (e) text fragments appear clearer in the frontal slice after processing; (f) amulet straightening illustrated in the longitudinal slice, scattering suppressed

necessary to slightly change the spatial orientation of the frontal slice to follow the local orientation of the amulet page. After many hours of checking the visible text fragments, the amulet was virtually unfolded (see Fig. 9). An additional high-pass filter was applied on the amulet pages to suppress variations of the reconstructed density caused by the geometry of the folded lead sheet (compare Fig. 8e) and page A in Fig. 9). Note that the slice spatial orientation for each page was selected to maximize the visible text, i.e. other text can be shown by changing the slice positions, as described later.

It was found that the letters on the bottom part have a very low contrast, as the amulet is 20% thicker there than on the top part. Therefore, a complementary tomographic measurement was performed at the Development Center X-Ray Technology EZRT (Fürth, Germany), where a technical CT scanner with a much more powerful tube was available (designed for the investigation of car engines). The disadvantage of this tube for our purposes was its relatively large spot size of 0.5 mm, which leads to the image resolution being 2.5× worse in comparison with the measurement realized at CET.

The EZRT scanner has a fixed tube-detector distance of 2000 mm with a variable tube-object distance, allowing it to change projection magnification. A Perkin-Elmer flat

panel detector (387 × 387 mm, 0.2 mm pixel pitch) was used for imaging, and the following scanner parameters were chosen: tube voltage at 586 kV and current at 1.19 mA; exposure time of 3 × 0.8 s; filter composed of 3 mm tin and 3 mm copper sheets in front of the tube and 0.5 mm copper placed on the detector. In total, 2000 projections were acquired at a geometrical magnification of 1.4×. The reconstructed volume was processed in the same manner as the CET measurement above. The virtually unfolded amulet is depicted in Fig. 10. Contrary to Fig. 9, the slice spatial orientation for each page was selected to specifically show the text at the bottom.

Once the amulet was unfolded, the identification of the whole text was simplified. We can document the process of text searching on page A (see Fig. 11). When some text fragment is found, the missing letters are found by looking at slices above and below. A slight slice spatial tilting is also applied for this purpose.

Combining both CET and EZRT measurements, the bigger part of the remaining text could be identified. See Fig. 12 for a handmade facsimile following the distinguishable engravings. Generally, the text interpretation and the identification of single letters are often possible only if the context is taken into account. See the next chapter for more details.

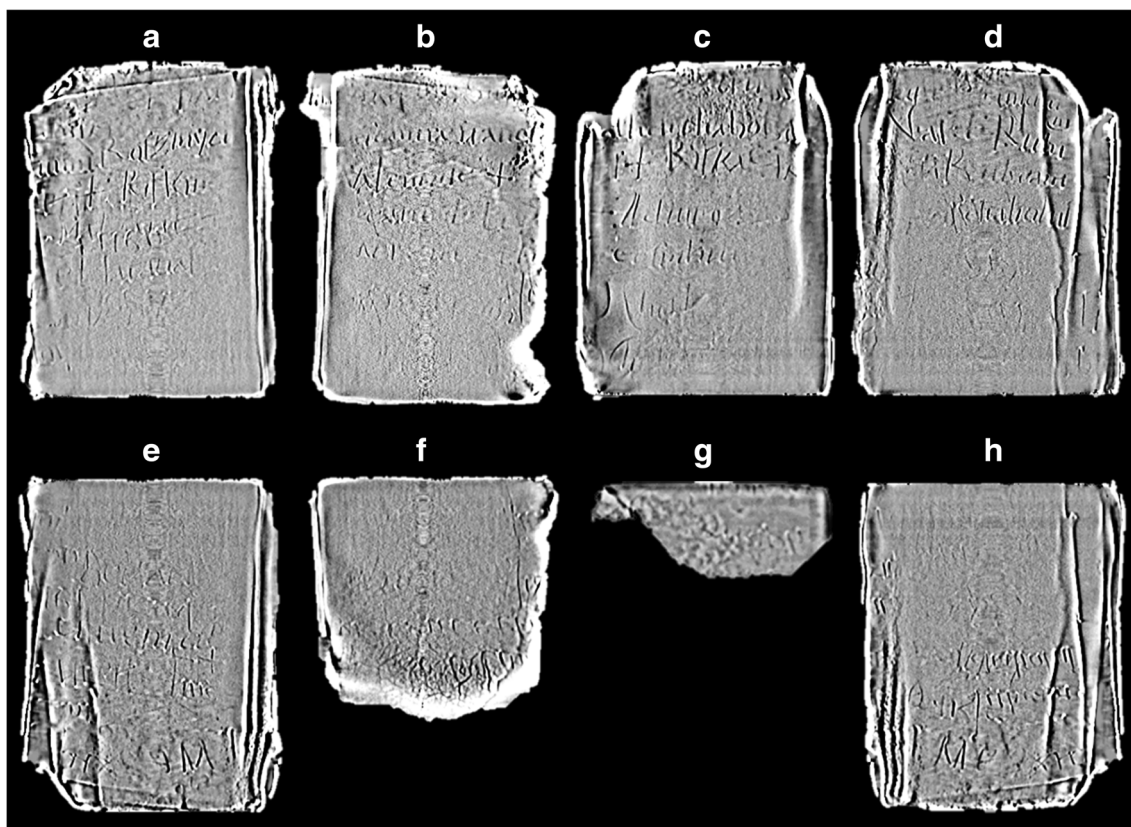


Fig. 9 Virtually unfolded amulet, CET data

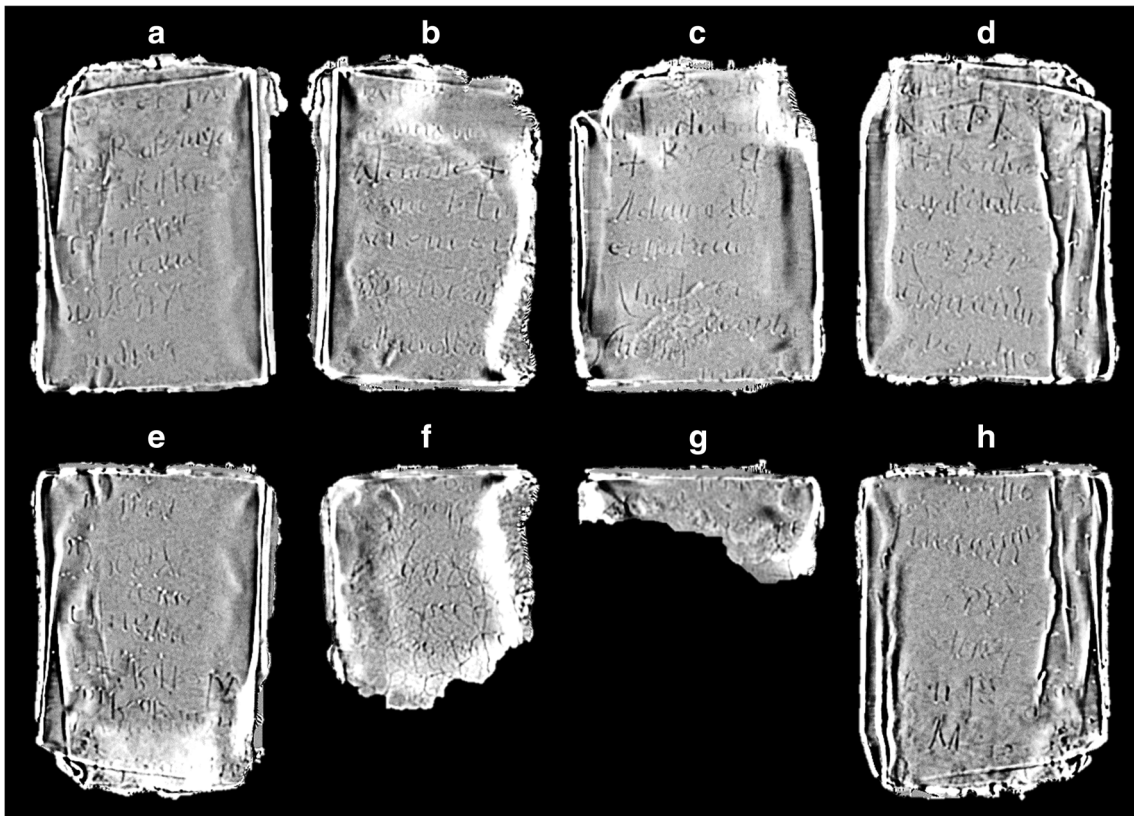


Fig. 10 Virtually unfolded amulet, EZRT data

Interpretation of the text

The text reading and interpretation are complicated due to several factors. The letters do not have enough contrast in many cases. Also, their position and form can be shifted from the original state through the folding process, and some words are evidently missed, especially in areas around folding bends or where the material is heavily cracked and corroded.

Moreover, some unusual word forms, magic formulas, and symbols were found which are difficult to interpret. For these reasons, we can assume that a full-text interpretation would still remain questionable in parts, even if the amulet was physically unfolded in the future.

The following reading depicted in Table 1 is based on a combination of the measurement results from both Telč and Fürth. Passages in bold script are optically recognizable on the



Fig. 11 An example of the text identification: (a) *pax et pat* is visible in the first line; (b) the missed letter *r* is recognizable – *pax et patr* in field A is completed; (c) text fragment *um Roszmyc* in the second line; (d) previously missed letters completing the words into *[t]uum Roszmycil*

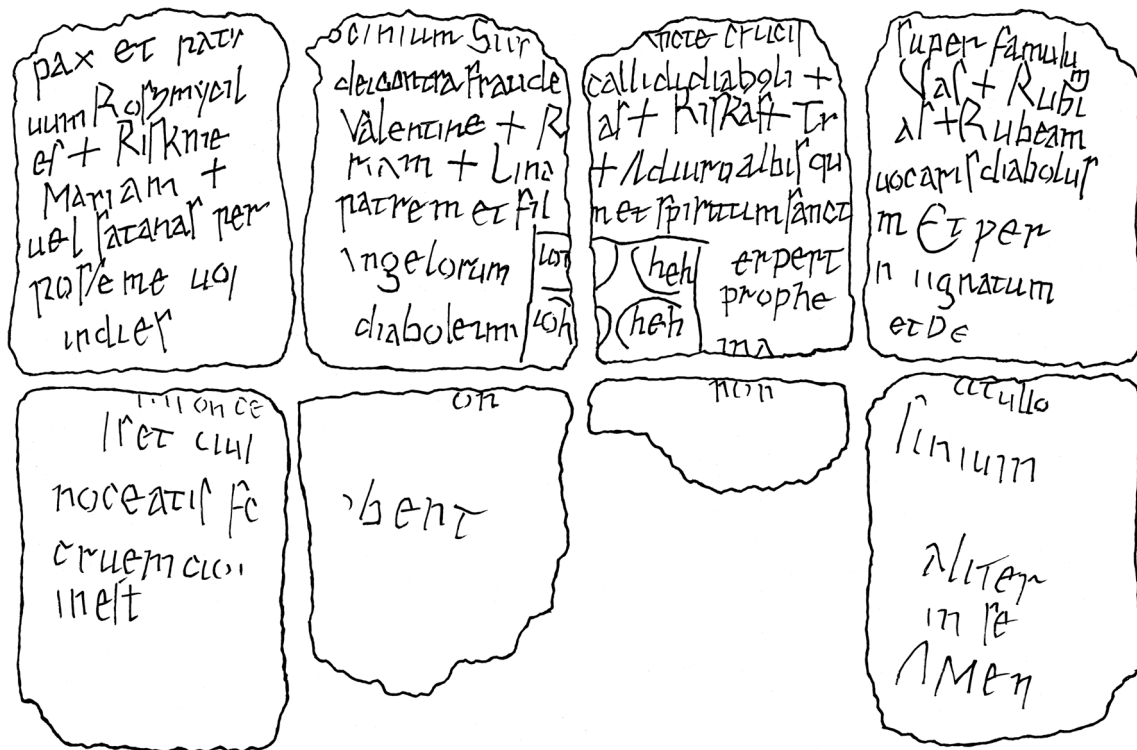


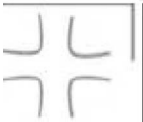
Fig. 12 Facsimile of the whole identifiable text

outsides of the amulet. All italic letters are derived from the tomographic slices only, sometimes with only parts of the letters recognizable. They are given in their most probable

determination as far as possible, even if the resulting word is not (yet) interpretable.

The following emended text illustrates how it was written on the originally unfolded lead sheet:

Table 1 Text transcription

	A	B	C	D
1	<i>pax et patr</i>	ocinium <i>Sacr[o]</i>	<i>sancte crucis</i>	<i>super famulum</i>
2	<i>[t]uum Roszmycil</i>	dei contra fraude <i>[m]</i>	callidi diaboli †	<i>[- - -] Vas † Rubi</i>
3	<i>es † Riskme</i> <i>[..]</i>	<i>Valentine † R[isk]</i>	as † Riskas † Tr	<i>[isk]as † Rubeam</i>
4	<i>Mariam †</i> <i>[- - -]</i>	<i>r[.]am † Lina[.]</i>	† Adiuro albis qu[i]	<i>uocaris diabolus</i>
5	<i>uel satanas per</i>	<i>patrem et fil[iu]</i>	m et spiritum sanct	<i>[u]m Et per</i>
6	<i>posse me uos</i>	<i>angelorum</i>	<i>[.]erper</i>	<i>[ua]m signatum</i>
7	<i>in dies</i> <i>[- - -]</i>	<i>diaboleum</i>		<i>et De</i> <i>[- - -]</i>
				
			<i>prophe</i> <i>[- - -]</i>	
8	<i>[- - -]on ce</i> <i>[- - -]</i>	<i>on</i> <i>[- - -]</i>	<i>ina</i>	<i>[- - -]cet ullo</i>
9	<i>[- - -]set eius</i>	<i>[- - -]</i>	<i>non</i> <i>[- - -]</i>	<i>sinium</i>
10	<i>noceatis fe</i> <i>[- - -]</i>	<i>bent</i> <i>[- - -]</i>		
11	<i>cruem cio</i> <i>[- - -]</i>	<i>e</i> <i>[- - -]</i>		<i>aliter</i>
12	<i>in est</i> <i>[- - -]</i>	<i>s</i> <i>[- - -]</i>		<i>in se</i>
13	<i>[- - -]</i>			<i>AMen</i>

- 1 | *pax et patrociniūm Sacr[o]sancte crucis super famulum* |
 2 | *[t]uum Roszmycil dei contra fraude[m] callidi diaboli*
 † [- - -] *Vas † Rubi* |
 3 | *es † Riskme [...] Valentine † R[isk]as † Riskas †*
Tr[isk]as † Rubeam |
 4 | *Mariam † [- - -]r[.]am † Lina[.] † Adiuero albis qu[i]*
uocaris diabolus |
 5 | *uel satanas per patrem et fil[iu]m et spiritum sanc-*
t[u]m Et per |
 6 | *posse me uos angelorum // [.]erpert[ua]m signatum* |
 7 | *in dies [- - -] diaboleum // prophe[- - -] et De[- - -]*
 8 | *[- - -]on ce[- - -]on[- - -] // ina [- - -]cet ullo* |
 9 | *[- - -]set eius [- - -] non [- - -]sinium* |
 10 | *noceatis fe[- - -]bent [- - -]*
 11 | *cruem cio[- - -]e[- - -] aliter* |
 12 | *in est [- - -]s[- - -] in se* |
 13 | *[- - -] AMen* |

The amulet features the drawing of a cross in a rectangular field in lines 6–8, with the following syllables written in its four corners: *iot* | *heh* | *ioh* | *heh*.

Commentary

The phrase *pax et patrociniūm* (l. 1) seems to belong to *sacr[o]sanct(a)e crucis*. Neither phrase had yet been known from surviving amulets nor manuscript formulae, but the invocation of the Holy Cross (usually *sanct(a)e crucis*) is common. Instead of the barely determinable *sacr[o]-*, we initially thought of an interspersed *sup[er?]*, which might have been a transcription error (in copying from a manuscript model) and a duplication of the next passage (such errors commonly appear in amulets due to poor writing skills and small font sizes). *Super famulum tuum Roszmycil dei* (l. 1–2) is a combination of the common titulations of the person to be protected as *famulus/a dei* or *famulus/a tuus/a* (referring to God). *Roszmycil* is a medieval Latin transcription of a Czech name, *Rozmysl* (analogous to *Přemysl*), meaning ‘he who contemplates’ (in (Pleskalová 2017) and page 102 in (Svoboda 1964)). Both name components are well attested for in the old Czech language of the twelfth century. The Bohemian place name, *Rozmyšl* is accounted for in 1314 (page 599 in (Profous 1951)) and is also mentioned as a personal name in the Dictionary of Ancient Polish Names (page 174 in (Ciešliková 2000)).

The following section of single words interspersed with crosses (lines 2–4) may have been derived from one or more pre-existing list(s) of divine names and powerful words. In it, Saint Valentine and probably Mother Mary are addressed to aid the bearer. *Vas*, meaning ‘vessel’, might refer to a particular organ or to the human body as a whole (cf. *ne vas corruptatis christianitatis* in Carmian Burana 54, an

exorcism in the form of a song, BSB Munich Clm 4660,18r). *Rubies*, as well as *Rubeam* in the sense of ‘reddening’, may refer to an inflammation, which is implored to vanish through the unusual expression *Riskas*, employed twice and set together with the similar sounding but completely unintelligible *Triskas* to build a magical tricolon spell (like the more common variants on, e.g. *agla* and *pax*, pages 32 and 262 in (Lecouteux 2015)). It may have been derived from *arescas* (‘you shall dry out’), which figures in a curative spell in an eleventh/twelfth century manuscript from Maria Laach. The same manuscript also features an amulet recipe against the ‘Devil’s Arrow’ (*Contra sagittam diaboli*) with the passage *riscas rubries riscas melones*, meaning ‘dry out reddening, dry out swelling’, page 551 in (Heim 1892). The most explicit conjuration follows in line 4 with the formula *adiuero*, which should forbid the evil entity from harming the amulet bearer. Its object *albis* refers to a mysterious – but originally not necessarily evil – being of Germanic mythology. Parallels are well attested from contemporary lead amulets and manuscript charms, but the beings are designated mostly by the gendered and pluralized terms *eluos aut eluas* or in similar forms (Simek 2011; Gastgeber and Harrauer 2001). The closest parallel to *Dřevič* is the amulet of Halberstadt (dated to 1142), where the shortened name of the being was originally reconstructed as ‘Alber’ (a probably fictitious name form perhaps given in reverence to the dwarf Alberich from the medieval Nibelungen saga), but it may now accordingly be transcribed as *alb(is)*. Like in most other amulets, these ‘elves’, who are thought to cause illnesses, are at the same time characterized as demonic beings (e.g. *demones sive albes* in (Gastgeber and Harrauer 2001)) and are thus subjected to a Christian interpretation, in this case as *diabolus* or *satanas* (l. 4–5).

After the invocation of the Holy Trinity against the *albis*, the text is severely damaged and unreadable, but the next words *Et per* (l. 5) suggest that further celestial entities are addressed to give power to the banishment of the demonic being. The insecure reading *posse me uos angelorum* may refer – in abbreviated form – to the *potestas*, ‘might’ of the angels and/or to a host of them as in the invocation from Halberstadt: *(et)//p(er) om(ne) s ang(e)los (et) arca(n)/g(e)los*. In the visible parts of the text, though, there is no evidence for the use of scribal abbreviations or *nomina sacra*. All securely determinable words appear to be written out to the letter. In fact, the scan shows that the ‘m’ of *famulum* at the end of line 1 is subscribed rather than abbreviated. After *angelorum*, the text is interrupted by the cross sigil featuring in its four corners the words *iot* | *heh* | *ioh* | *heh*. This is most probably a latinized and faulty spelling of the Hebrew letters יהוה for the name of God, the so-called *Tetragrammaton*, which is often used in various spells and magical signs for its apotropaic power. The next words on the right of the sigil probably read *[p]erpertuam* [sic!] *signatum*, ‘eternally marked’, and may

refer back to the mentioning of the Holy Cross from the first line as well as to the central cruciform sigil, similar to a passage from the amulet of Elbeu (*signaculo sancte crucis*, page 10 in (Muhl and Gutjahr 2013)).

The increasing denseness of the folding towards the centre results in poor resolution of the tomographical scan after the middle of the inscription. At least 13 lines in total, considerably sloping to the right towards the bottom, can be safely determined. Due to this fact, as well as the missing context and the loss of one third of the lower half of the writing surface through corrosion of the outermost folding layers, it is not possible to make any coherent sense of the lower half of the inscription. Some words, though, can be identified and may compare to textual sequences known from closely related amulets. In line 7, *prophetae* is mentioned, probably adding to the number of celestial helpers. Line 8, ending with *-cet ullo*, may refer to the prohibition (*licet ullo*, ‘none is allowed’?) of an explicitly stated malevolent action not to be undertaken by the *albis*. Together with *non [...]* *noceatis* in lines 9–10, it may belong to a longer list of prohibitions, common also in early medieval exorcism (pages 579–581 in (Franz 1909)), protecting the bearer by individually naming various body parts and/or various circumstances. The phrase *non noceatis* appears in lead amulets from Schleswig (D), Romdrup, Blæsinge (DK) (Düwel 2001; Franz 1909) as part of such formulae. In the Blæsinge find, this part reads *[...] ut non noceatis istam famulum Dei, neque in oculis, neque in membris, neque in medullis, nec in ullo compagine membrorum eius [...]*, ‘...that you should not harm this servant of God, neither in his eyes nor in his limbs nor in his bone marrow, and not in any ligaments of his limbs...’. The use of the plural form in addressing a singular demonic being might – again – hint at the ignorant copying of an extant recipe by a lesser trained scribe. The word *cruem* (= *cruorem*) (line 11), ‘blood’, was probably mentioned as part of such a list alongside other parts of the body to be purified from demonic influence, though the scanning is too blurred to be sure. The last and closing word of the inscription in line 13, though, is clear. It is *AMen* (written with a capital M), which figures not only in the three amulets mentioned above but, as the standard conclusion of a prayer, in a greater number of finds from Southern Scandinavia as well as Central Germany.

Tentative translation

Peace and protection of the most venerable cross over your servant Rozmysl, (servant) of God against the maliciousness of the scheming devil [...] vessel † reddening [...] (Saint) Valentine † dry out [...], inflammation! Mary(?) [...] I implore you, elf, who you are called devil or Satan, through the Father and the Son and the Holy Spirit and through [...] of the angels [...] eternally(?) marked in the days [...] devilish [...] prophets

[...] not any [...] but his [...] you shall not harm [...] the blood(?) [...] otherwise [...] is not [...] in it [...] Amen.

Conclusions

The combination of X-ray computed tomography in conjunction with advanced data processing, including the virtual straightening of the amulet and suppressing scattering and high-pass filtering, allowed the virtual unfolding of the amulet and a transcription of the identified letters into readable text. However, identification of the orientation and position of the individual text fragments was a long and laborious process.

The decipherable text reveals previously unknown components but may in other parts be compared to high medieval amulets and corresponding manuscript recipes. This fits well with the palaeographic assessment of the script as a characteristic late Carolingian minuscule, dating the time of the amulet’s fabrication around the first half of the twelfth century (Blažková et al. 2017).

The slightly insecure and uneven handwriting without abbreviations and the various spelling and syntax errors suggest that the author was not very skilled in Latin and probably did not have much scribal training either. However, the unevenness of the letters may partially be attributed to the use of lead as an uncommon writing material with its own characteristics. The Dřevíč lead amulet is at present a unique find in Bohemia and attests the wider spread of the still lesser known medieval practice of Christian magic and popular belief. Though a considerable part of it remains yet unreadable, the evidence for the rare name form *albis* is remarkable. The appearance of ‘elves’ instead of figures from the Slavic tradition at the very periphery of German(ic) mythology (probably due to the use of a pre-existing charm written in the west) is also remarkable. The Czech name of the amulet’s owner and the appearance of several other textual elements hitherto unknown or not before documented in the practical application is also completely unique. The magic formula with *adiuro (adiuro albis [...]) per patrem [...]* used in this medieval amulet is one of the oldest verbal components featuring in various spell techniques, attested since Greek (in the form of ἔξορκίζω) and Roman antiquity from diverse magical texts (curses, amulets, exorcisms). This specific form of employing a higher power in controlling a subordinate entity survived from paganism into Christian times and remained an integral part of the magical traditions, employed – to a different end – in such diverse contexts as the ecclesiastical rites of exorcism and consecration and late medieval and renaissance scholarly and demonic magic (page 382 in (Vogel 2001) and page 128 in (Kieckhefer 1998)). These were often performed orally together with a set of accompanying procedures. As evidenced through the surviving amulets, this formula could also be materialized to work continuously in the hope of keeping a person safe from all kinds of evil.

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References

- Blažková K, Šámal Z, Urbanová D, Knauber K, Havel D (2017) Středověký olověný amulet z hradiště Dřevíč k. ú. Kozojedy, o. Rakovník (A medieval lead amulet from the Dřevíč hillfort in Central Bohemia). *Archeologické rozhledy* 69(1):121–142
- Ciešliková A (2000) Słownik etymologiczno-motywacyjny staropolskich nazw osobowych. Vol. 1, Kraków, pp 174–175
- Düwel K (2001) Mittelalterliche Amulette aus Holz und Blei mit lateinischen und runischen Inschriften. *Ausgrabungen in Schleswig* 2:227–302
- Franz A (1909) Die kirchlichen Benediktionen im Mittelalter Bd. II, Freiburg im Breisgau
- Gastgeber C, Harrauer H (2001) Ein christliches Bleiamulett aus Schleswig. *Ausgrabungen in Schleswig* 2:207–226
- Heim R (1892) *Incantamenta magica graeca latina*. Teubner, Leipzig
- Hoffmann B G, Larsen J M, Lichtenberger A, Raja R (2015) Revealing text in a complexly rolled silver scroll from Jerash with computed tomography and advanced imaging software. *Scientific reports* 5, article number 17765. <https://doi.org/10.1038/srep17765>
- Kieckhefer R (1998) *Forbidden rites. A necromancer's manual of the fifteenth century*. The Pennsylvania State University Press, University Park
- Lecouteux C (2015) *Dictionary of ancient magic words and spells*. Rochester / Toronto
- Muhl A, Gutjahr M (2013) Magische Beschwörungen in Blei – Inschriftentäfelchen des Mittelalters aus Sachsen-Anhalt, Kleine Hefte zur Archäologie in Sachsen-Anhalt 10. Halle (Saale)
- Pleskalová J (2017) *Primitivní pravopis – (Primitive Orthography)*. In: Karlík P, Nekula, M, Pleskalová J (eds), *CzechEncy - Nový encyklopedický slovník češtiny*. New Czech encyclopedic vocabulary. <https://www.czechency.org/slovník/PRIMITIVNÍ%20PRAVOPIS>
- Profous A (1951) *Místní jména v českých, jejich vznik, původní význam a změny. (Place names in Bohemia their formation, original meaning and changes)*, Vol. II., Academia, Prague
- Simek R (2011) *Elves and exorcism. Runic and other Lead amulets in medieval popular religion*. In: Anlezark D (ed) *Myths, legends and heroes: essays on old Norse and old English literature in honour of John McKinnell*. Toronto, pp 25–52
- Svoboda J (1964) *Staročeská osobní jména a naše příjmení (Old Czech personal names and our surnames)* Czech Academy of Sciences and Arts, Prague
- Vogel V (ed) (2001) *Ausgrabungen in Schleswig. Berichte und Studien* 15, Neumünster, pp 227–302

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