The Evaluation by 3D Imaging of the Purported Coded Runes on the Kensington Rune Stone
By Dr. Richard Nielsen
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Note: This article will be used as part of a comprehensive presentation planned for an academically accredited journal and may be subject to future revision. Because of the current high interest in 3D imaging it is appropriate that these technical results are published and posted at this time. Abbreviations used are (RSM) Runestone Museum, (RN) Dr. Richard Nielsen, (MHS) Minnesota Historical Society, (KRS) Kensington Rune Stone, and (ESOP) Epigraphic Society Occasional Papers.

The 3D imaging studies use the data base developed with Accurex in October 2008 and I operate the data base under two agreements with the RSM and myself arrived at in September 2008 and September 2009. My sole obligation to the RSM is to furnish them the 3D images I choose to publish. We both enjoy joint copyright on these images. The RSM does not have any rights to the Accurex data base and I have always been in full compliance with our mutual agreements regarding the images produced from the database.

A. Introduction

3D Imaging was undertaken by Accurex Measurement in October 2008 to create a database of the entire KRS surface that would not be influenced by the black silicon staining that the KRS was subjected to by a molding process in the spring of 2003 (see Nielsen 2010b). Additional advantages were seen to be:

- A back side image to assist measurements of the deep punches and chisel carvings since here grooves become ridges and holes become volcano like peaks.
- Documentation of the frequent past damage to the KRS by actual tools and tool like objects
- A process uninfluenced by the color of the staining on the KRS.
- A process that allows an infinite number of replicable images from any direction, angle and multiple lighting condition
- A process which lends itself to web events with other researchers
- A process that lends itself to access by server
- Output of screen shots which can be treated like any other image.
- A production of a fully controllable 3D image of the entire KRS
- A process that can be read by the many available readers on the market.
- A process to determine the runic geometrical forms by recorded measurements including depth of cuts and punches.
- A process that can show the runes from either a perspective or orthogonal view.
- An accurate measurement system to one micron in depth and nine microns in the plane perpendicular to depth.

In 1985, the famous Danish runologist Erik Moltke advanced to fellow runologists this advice on observing runes forms by use of photographs: “But if there is any doubt, no photograph can ever take the place for the runestone itself. Go and look at it” (Nielsen and Wolter 2006: 53). This is exactly the reason Prof. Henrik Williams of Uppsala University from Sweden inspected the Kensington Runestone at the Runestone Museum in Alexandria, Minnesota on September 30, 2010.

It is definitely hard to believe today that we two authors of Nielsen and Wolter (2006), one with a Bachelor of Science degree in Geology and the other with a Doctor of Engineering Technology, dared venture to make final decisions to confirm the character of the rune forms on the KRS. This was definitely a task for a trained runologist from Scandinavia. Unfortunately in our misplaced enthusiasm over our own photographs, we both ignored some of the key results of the Scandinavian runological inspection of the KRS made in October 2003 in Stockholm. This runological team included Dr. Helmer Gustafson of the Swedish Heritage Board, Prof. Henrik Williams of Uppsala University, both from Sweden, and Prof. James Knirk from Oslo University, Norway.
Therefore we two authors certainly should be severely criticized for being too aggressive in our use of 2D photograph images to determine new rune forms on the KRS without the help of the trained runologists from Scandinavia. This omission was by and large a major misstep and has caused confusion.

This article now rejects the following suggested in Nielsen and Wolter (2006: 117-121; 126-132):

- The purported dotted r-rune (恹) in norr (were) on the 5th line
- The purported dotted r-rune (恹) in war (were) on the 6th line
- The purported Grail (GRAL) Code speculation on the KRS in Nielsen and Wolter (2006: XV), \( \text{ XR } \text{ XF } \text{ XR} \) “grail is”.

The following suggested dotted runes are also rejected:

- A punch for (恹) cannot begin to be determined in normen (Northmen).
- The purported forked þ-rune (⁄) in hade (have) on line 4.
- A possible r-rune (恹) in äptir (after) on line 6
- A final dotted þ-rune ( opendir) in þeþ (death) on line 8.
- A dotted a-rune (ą») in af (from) on line 9

Photograph Study Results: In Nielsen and Wolter (2006: 117-121; 126-132) a series of new runes with dots or punches were proposed on the KRS based on photos recorded in a photographic study of runes under a microscope in Wolter (2002). This study, now nine years old, is obviously obsolete today with the advent of 3D imaging. The resulting purported code in the book used runes with punch marks on Line 1 to Line 10 to establish this sequence:

\[
\text{ XR } \text{ XF } -10M10W.
\]

(Grail is 10M10W)

These purported coded runes in the series above found are now rejected due to the clearer 3D imaging results than used in the book. The 3D imaging results for the first four runes, the gral (Grail) runes have already been reported in Nielsen (2009: 133-138). The runes in question are in sequence:

- The dotted g-rune ( nhiễ) in Göter (Götalanders) on line 1
- The dotted r-rune (恹) in Göter (Götalanders) on line 1
- The a-rune (X) on line 2 may have tool-like object damage (to be further determined) making evidence for an intended mark quite ambiguous.
- The l-rune ( Fist) on line 3 is shown without the horizontal mark in the 1899 Steward photograph making evidence for an intended mark quite ambiguous.
- The purported coded ä-rune (X) in läger (camp) on line 4
- The purported r-rune (恹) in läger (camp) on line 4
- The purported dotted 10 (ą») in 10 man (10 men) on line 7
- The purported coded M (M) in AVM on line 8
- The purported dotted 10 (į) in 10 mans (10 of man) on line 10
• The purported coded w-rune (ᛩ) in hawet (the inland sea) on line 10

**The Grail:** In Nielsen (2009a) the Grail (GRAL) Code theory advanced in Nielsen and Wolter (2006: xv) fell by the wayside because there were unnoticed punch marks in the te-runes in Göter (Götalanders) that then yielded GRTERAL and destroyed the sequence. These punch marks in “te” were missed in the review of the photographs presented in the photo study by Wolter (2002). The Grail Code was always a speculation as clearly stated in Nielsen and Wolter (2006: XV).

| Dotted r in war (were) on the 6th line | Figs. 2 & 3 and Figs. 5 to 11, 13, 28 and 29 |
| Dotted r-rune in normen on the 13th line | Figs. 15 & 16 |
| Dotted r-rune in norr (north) on line 5 | Fig. 17 |
| Dotted r in äptir (after) on the 6th line | Figs. 12, 18 and 19 |
| The two purported dotted tens (ᚴ, ᚵ) on lines 6 & 10 | Figs. 20 & 21 |
| Dotted þ-rune in þeþ (death) on line 8 | Fig. 22 |
| Forked þ-rune in hade (had) on line 4 | Fig. 23 |
| Dotted a-rune on af (from) on line 8 | Fig. 24 |
| Coded Dots in M in AVM on line 8 and the w-rune on line 10 | Fig. 25 |
| Coded Dot in läger (camp) on Line 4 | Fig. 26 |
| Coded Runes in GRAL (grail) | Fig. 27 |
| Pentadic numbers 14 and 1362 | Figs. 30 & 21 |
| Coded Runes for the Perpetual Calendar on lines 1, 4 and 9. | Fig. 32 |

Table 1. Tracking of Purported Runes to the Figures Relating to Them.

**The Inspection of the KRS in September 2010:** This article is also a follow-up to the inspection of the KRS by the runologist Prof. Henrik Williams of Uppsala University at the RSM on September 30, 2010 and presents more information on 3D imaging results on the KRS with the Accurex Measurement system and supplementing the information presented in Nielsen (2009a). It will be shown in this article that this dotted r-rune (R) in war (were) on the 6th line of the KRS is likely a product of a tool-like form dragged across the rune. There are at least two tool-like marks to consider; one, a crescent groove first seen in the MHS (1910) photograph published in their 1915 proceedings, but not seen in the Steward (1899) photograph of the KRS seems to indicate damage to the KRS since its discovery. The second tool mark is a deep linear-like drag mark over the location of the purported punch of the purported dotted r-rune.

The shallowness (under 500 microns) of the purported r-rune is not in dispute. It is approximately 250 microns measured from the lip of the punch. Dragged tool-like processes were obviously capable of extracting either a mineral or rock fragment to create the pock mark. The purported punch or pock does not conform in depth, diameter and cone shape to the genuine punch marks on the KRS. There are many pock marks of equal depth or more on the surface of the KRS face and the purported punch is not distinguished from any of these except by its location in the loop of the r-rune (R) in question, but even here it is not exactly centered in the loop as would be expected. The conclusion must be that the evidence for a punch in the r-rune (R) of war (were) is far from unambiguous and cannot be used to prove a medieval origin of the KRS. The same conclusion is true for the purported dotted thorn rune (𐌈) on the 8th line.
Table 2. Current Status of the KRS Rune-Row with Its Proposed Variants. Copyright © April 20, 2011

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Row 1: The equivalent Latin or Roman letters are marked in **blue**.

Rows 2 and 3: The currently accepted runes found on the KRS are marked in **black** runes.

Row 4: New runes identified by 3D Imaging are shown in red (X_sender). Their impact on the provenance of the KRS is yet to be fully determined.

Row 5. The runes shown in black on yellow, (Arial R Helvetica X F X R) are the GRAL Code speculation “grail is” suggested in Nielsen and Wolter (2006: XV,). These runes have now been eliminated from consideration by image data obtained from 3D Imaging as per Nielsen (2009a, 2010c and 2010d) and this article.

Row 6. The purported dotted runes marked in white on purple (Arial R Helvetica P P) have been rejected for consideration as dotted runes in this article. The two runes, R and P, have disqualifying shallow punches and the rune R now has two punches yielding R. The two number tens, both P and P, have no punches to be seen in 3D imaging.

Row 7: The runes in white on blue runes, (Arial R Helvetica X F X R) for mwd, which were proposed coded runes in Nielsen and Wolter (2006: 118-120) now fail to have special meaning since these purported code marks were part of the template punches defining the rune as has been documented in Nielsen (2009a). In Nielsen and Wolter (2006: 67) the d–rune (R) is reported but not designated as a coded rune; however the forked mark in the foot is apparently not an intended mark.

Orthography Note: The letters w and v are treated the same. The thorn þ can be unvoiced as a “th” in “thin,” voiced as a English “dh” in “dhe” (the) and an Old Swedish “dhag” (day) or as the stop “d” in “day.” The spirant “th” has also been reduced to “t” by 1362 and all three letter forms, as in thenno, tenno, and þeno, can be found in diplomas from the 1340s to the early 1400s.

Table: On the KRS the o-rune is used for both “o” and “å = aa.” Therefore in transliteration po = paa (on), fro = fraa (from) twice, from = fraam (from), wore = waare (are); and the o-forms are: ok (and), norrmen (Northmen), optagelse (acquisition), of (extremely), norr (north), theno (this) twice, ok fiske aa fiske (fishing), kom (came) and blod (blood) and og (and). Double consonants are not required, hence theno for thenno, mans for mans (of men), fan for fann (found), kom for komm (came), but on the other hand the forms norr (north) and norrmen (Northmen) both have “rr”.
The Runes by Dr. Richard Nielsen

1. 8 Götalanders and 22 Northmen upon
2. (this) acquisition journey from
3. Vinland far to the west, we
4. had camp by two (shelters ?) one
5. day’s journey north from this stone.
6. We were fishing one day. After
7. we came home found 10 man red
8. from blood and death. Ave Maria,
9. Save from evil.
10. 10 men are by the inland sea to look
11. after our ships 14 day journey
12. from this peninsula. Year 1362.

The English Translation by Prof. Henrik Williams and Dr. Richard Nielsen © (2010)

1. 8 Götalanders and 22 Northmen upon
2. (this) acquisition journey from
3. Vinland far to the west, we
4. had camp by two (shelters ?) one
5. day’s journey north from this stone.
6. We were fishing one day. After
7. we came home found 10 man red
8. from blood and death. Ave Maria,
9. Save from evil.
10. 10 men are by the inland sea to look
11. after our ships 14 day journey
12. from this peninsula. Year 1362.

The Transformation to Roman Alphabet by Prof. Henrik Williams and Dr. Richard Nielsen
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1. 8 göter ok 22 norrmän på
2. (ten)ø optagelsefard fraa
3. winland of west, wi
4. hade läger ved 2 skelar en
5. dags rise norr fraa teno sten.
6. Wi war ok fiske en dagh. Äptir
7. wi kom hem fan 10 man röde
8. af blod og þeþ. AVM
9. fræelse af illu.
10. Här 10 mans we havet at se
11. äptir waare skip 14 dagh rise
12. fraam teno öh. Ahr 1362.

The Modern Swedish Translation by Prof. Henrik Williams
Copyright © 2010

1. 8 Göter och 22 norrmän på
2. (denna?) förvärvsresa från
3. Vinland (?) vest. Vi
4. hade läger vid 2 ?? en
5. dagsresa norrut från denna sten
6. Wi var och (för att) fiska en dag. Efter (at)
7. wi komm hem fann wi 10 men röda
8. av blod och död. Ave Maria
9. må frälsa från ondo.
10. (Det) är 10 man vid havet för att se
11. efter våra skepp 14 dag(ars) resa
12. från denna ö. År 1362.

Table 3. The KRS Inscription in Runes, Transformation to the Roman Alphabet, Modern Swedish and English.
The 3Axis rotatable 3D model was not used in this runic study. The above images used to locate the rub line on the KRS shows some of the advantages of this system to locate shallow impressions on the KRS face.
B. 3D Imaging Measurements

The Accurex Measurement system uses both (mm) one millimeter with 25.4 mm to the inch, and (μm), which is one micron millimeter (one thousand microns to the mm). The system selected for the KRS is accurate to 1 micron in depth and 9 microns spatially in plan relative to the depth elevation. Most KRS runes are about 25 mm high or 25,000 microns. A KRS punch is ca. 2 mm in diameter (1/12th of an inch), which is about 2000 microns in diameter.

The certified KRS 3D data base is held by Accurex. All 3D images shown here can be replicated at any time against the standard data base to insure against alterations. This is not possible with photographic images. However, the 3D image output is a screen shot and all normal enhancements to photographic images are available. The 3D image should be treated as any normal photograph in the peer review process. Independent verification of 3D imaging results is possible now and in the future. This capability does not exist with photographs and photographs published outside of normal academic protocol should be subject to careful scrutiny.

Figure 1. A Moonscape on the KRS: Here we see the reverse side of the r-rune (R) in war (were), an image developed from the 3D data base on the KRS by the Accurex Measurement system. An infinite number of images can be created as a jpeg or tiff file and other image processes as well. The volcano shaped forms are caused by the cone shape of the punch tips. Note that the orientation of the image is shown by the XYZ pointers in the upper left corner. Measurements in any of the three directions can be made by use of a simple measurement pointer. There is also a grid that can be imposed. This image is a perspective projection rather than an orthogonal projection.
Fig. 2a. **Punch Character.** Runes seen are marked in red: þağh : áptir (day after) = þX¶# : XêTIR. Note the deep character and form of the punches in both the g-rune and the á-rune and the word divider punched between.

Fig. 2b. The purported punch (dot) in the r-rune (ɾ) in war (were) is quite shallow.

**Figures 2a and 2b. KRS Punch Characteristics.** The punch (dot) in the r-rune (ɾ) in war (were) on the 6th line in no way compares to the characteristic punches in the agh-ápt sequence above or to the ca. 2000 micron punch depth marked with a yellow arrow in the a-rune (X).
**Figure 3: Purported Punch Location:** The yellow arrow points to the purported punch location in the r-rune (R) in *war* (were) on the 6th line. The depth of the object is shallow and of the order of magnitude of the frequent pock marks to be found on the KRS (see the light blue arrow that points to the extraction of a quartz size mineral from the surface of the KRS).

**Figure 4. Punch Cone Tip Dimensions.** The XYZ measurement can be taken anywhere in 3D imaging. Here the right downward projection shows the lower word divider punch depth just before *war* (were). This diameter punch of circa 2 mm (ca. 2000 microns) has a cone height of circa 2 mm (up to 2000 microns). Depth of punches is measured from the horizontal plan of entry of the punch.
Figure 5: Indicative Depths in Microns by Rainbow Imaging in the r-rune (℞) in war (were). The purported r-rune (℞) in war (were) on the 6th line shown here was produced by Accurex in November 2008. The distance between the red error markers placed by me is about 250 microns plus or minus say 50 microns. If we want to investigate the purported punch to a more accurate degree, setting the min/ max to say 400-500 microns (mm times 10 to the power of -3) would help to accomplish this, however the measurement pointer accomplishes the same objective. The issue is to establish the initial measurement plan as near to the point of entry of the purported punch (shown by the purple arrow). In my case I have used the green area to the left of the purported punch (shown by the gold arrow). Since a punch depth on the KRS is expected between 1000-2000 microns deep, the purported punch in the r-rune (℞) is likely caused by extraction of a quartz grain when the area was dragged over by a tool-like form of some sort as seen in images to follow.
C. 3D Imaging

The Image on the r-rune (ř) in war (were) at left is reproduced from Nielsen & Wolter (2006: 52). The center image is the 3D Image of the face and the 3D image on the right is the back side image and both are depicted in Nielsen (2010b: Question 4). The back side image is from the reverse side of the surface defining the KRS front surface. Here grooves become ridges and punch holes become peaks.

**Figure 6: Crescent Groove Over-Striking the Purported Dot in the r-Rune (ř) in war (were).** The crescent mark (noted by a red arrow) first appears the 1910 photograph in the Minnesota History Society report of 1915 (see Figure 9) and it is the deepest mark as seen in the 3D images. This crescent like damage could well have dislodged the mineral grain. The absence of this crescent mark on the Steward photograph of 1899 is yet to be explained, see Fig. 9.
The purported pock or dot (identified by gold arrows) shows no evidence of a punch in size or shape. It to the contrary indicates that the impression is either that of an extracted rock fragment or some type of tool-like mark.
Figure 9. The Purported Dotted r-Rune (rå) in War (were) on Line 6 on the KRS Cast. When writing Nielsen and Wolter (2006: 53) we authors had no direct contact with the KRS itself. This photo of the RSM cast, the Landon cast and Fig. 6a were the only evidence we had available in 2005 to evaluate the potential dotted r-rune (rå) in war (were) on the 6th line. Upon viewing the KRS itself again at the Runestone Museum in March 2008, I determined that 3D imaging was necessary to reevaluate the existence of the dotted r-rune (rå) in war (were). The cast photo above was taken with a low light angle creating the illusion of a large hole. Note the vertical crescent like cut through the rune. The 3D imaging depicted in Figs. 7 and 8 inserted here to the right of the above cast photo r-insert shows this photographic presentation of the dotted r-rune (rå) in war (were) to be quite far from the reality shown in 3D imaging.

Left to right: a. Winchell (1910) MHS; b. Landon Cast (ca. 1941) MHS; c. RSM Cast (2003); d. Nielsen and Wolter (2006:52); e. Fig. 7 above, 3D Backside Image; and f. Fig. 8 above. 3D Front Image

These casts and photographs give no indication of depth. The Winchell (1910) is the first photo record of the crescent mark since the Steward Photograph of 1899 does not exhibit this crescent mark. 3D imaging is capable of great detail and gives accurate depth information. This crescent mark is about 250 microns below the lip of the mark.
D. Some of the Tool Marks from Various Objects (Tool and Tool-Like) on the KRS Detected by 3D Imaging

A tool mark could be caused by a piece of rock, iron or wood used deliberately or by accident that results in damage to the runes and surface of the KRS. Sticks and nails used for initial cleaning of the runes fit this description. The seven year storage in the Ohman shed could have resulted in all types of wear and tear. Careless use of actual tools may have resulted in damage as well since there are triangular and rectangular marks on the KRS most likely resulting from blacksmith made tools of one sort or another. The term “tool mark” refers to all types of marks on the KRS surface.

Two Sets of Duplicate Photos for Comparison

Fig. 10. Tool Mark Evidence. The arrow indicates two linear marks, one of which runs over the pock mark in question in the r-rune (R) in war (were). These are clearly man-made marks in either modern or medieval times. Most likely a quartz grain—these are up to 1 mm as per Prof. Weiblen (2001) — was extracted as an object was dragged over this mineral fragment making the hole. Imaging done by Accurex Measurement.

Fig. 11. Right Angle Tool Drag Mark the r-Rune (R) in war (were). The right angle lines indicate what looks like a tool mark.

Figure 12. The Small Circular Damage Marks to Ẅäptir (after) on the 6th Line. It is almost as if a pack of ball bearings had been dropped on the KRS face causing these pock marks. This 3D Imaging was carried out by Accurex Measurement.
Figure 13. Back Side Image of the Damage Adjacent to the r-Rune (§) in war (were). The KRS is pock marked in many places. One such pock mark, here indicated by the upper yellow arrow circa 500 microns deep. The purported dotted r-rune (§) in war (were), shown here in light blue, is at a much smaller depth of ca. 250 microns. The runes read ar: ok on the 6th line in wi : war : ok : fiske (we were fishing). The XYZ measurement is in multi millimeters to two decimal places (xx.00).

Figure 14. Triangular Tool Damage to ἵῤῥ illu (evil). The damage marks number in the many hundreds on the KRS. 3D imaging gives the chance to monitor such damage in the future.
E. Rejection by 3-D Imaging of Other Purported Dotted Rs

Figure 15. Rejection of norrmen (Northmen) on the 1st Line as Evidence for a Dotted r-Rune (R). There is no evidence in these back side images that this r-rune (R) was intended to be a dotted r-rune (R). The idea of some that this rune was spalled when attempting a punch is unsupported without the evidence for a punch as shown by the damage indicated by the light blue arrow. There is no evidence of spalling in the w-runes (ᚲᚲ) and g-runes (ᚴᚴ) on the KRS. The yellow arrows show other damage marks. This rune in Nielsen and Wolter (2006: 218-19) is shown as a normal r-rune (R). Wolter (2011) now brings it in to discussion regarding support for a dotted r-rune (R) in war (were) on line 6.
Fig 16. 3D Imaging Results for norrmen: po (Northmen on). Note the menu in the right hand box to input a range for the rainbow display. There is also a grid work that can be overlaid. There is no evidence of a punch in the second r-rune (R) in norrmen (red arrow). The 3D Imaging was produced by Accurex Measurement.
The r-rune (ṛ) in ᵉʳʳ norr (north) has misplaced word dividers as does the final r-rune (ṛ) depicted in läger (camp) on the 4ᵗʰ line above. The red arrow indicates the punch that had been missed in norr. It was partially covered by debris from damage of some sort and it took many images to reveal what had obscured the identification. Note: Barry Hanson inspected this rune with a microscope in 2000, but concluded it was a natural defect. This then started a discussion with Barry Hanson and Prof. Henrik Williams and myself at the Scandinavian Heritage Conference at 1000 Oaks, California in February 2002. Prof. Williams stated that norr (north) would not have a palatal R-rune (responseObject) in this word. On Gotland the Gotlandic palatal R (responseObject) was used until the late 1300s, but then often incorrectly. There are no confirmed dotted r-runes (ṛ) for the palatal R on Gotland. Those suggested dotted r (responseObject) runes to be found in Gotland by Nielsen and Wolter (2006: 54-58) have proven to have ambiguous evidence against their acceptance. Rejection of some of these suggested dotted Rs in Gotland are discussed in Nielsen (2009a: 135).
The word dividers are shown at the expected height of a true punch on the KRS.

The two shallow dots in the r-rune below the lower legs are not made by the KRS punch since its cone shape is not indicated. Perhaps the two punches are tool-like impressions.

Figure 18. 3D Imaging Results for äpir (after) on the 6th Line. This rune has not been reported before. However, the pock mark is too shallow to be an intended punch. In Runic Swedish äftir (after) could linguistically have had a palatal R (R) until ca. 1300.

Figure 19. 3D Imaging Rainbow Results for the Purported Dotted r-rune (R) äpir (after) on the 6th Line. The two pock marks can be seen in the r-rune (red arrow). This image was produced by Accurex Measurement in 2008.
F. Other Potentially Modified Runes

Figure 20. Rejection of the Punch in the Rune for 10 ( בקו) in Line 7 by 3D Imaging. In Nielsen and Wolter (2006: 130) the 10 (👥) is postulated to have a dot in the right hand loop like (👥). The back side 3D Imaging (brown color) shows that this dot is too shallow to be an intended punch.

Figure 21. Rejection of the Punch in the Rune for 10 (👥) in Line 10 by Rainbow Presentation. In Nielsen and Wolter (2006: 130) the 10 (👥) is postulated to have a dot in the left (shown right on the backside image above) hand loop like (👥). Back side 3-D Imaging shows that this dot does not exist on the KRS. These Rainbow Images are from Accurex Measurement in Nov. 2008.
Figure 22. No Dotted Thorn Rune in þþ pedh (death) for þþ ded (death) on the 8th Line. The final þ-rune (þ) in þþ is shown above and is identified by a red arrow. The depth of about 320 microns (by XYZ counter) is deemed too shallow for an intended punch. Inspection of the candidate dotted thorn runes was first proposed to the RSM in Nielsen (2010b: Appendix A) on June 1, 2010. This Rainbow Image is from Accurex Measurement in Nov. 2008.
Figure 23. No Forked Thorn Rune (ᛡ) in hade (had) on the 4th Line. In Nielsen and Wolter (2006: 67) this rune is shown as a modified thorn rune (ᛡ). 3D Imaging shows that the forked feature apparently is due to the drag of a tool-like object and that the rune is to be considered to be a normal thorn. In any case the evidence is ambiguous for the forked rune case.
Figure 24. No Dotted a-Rune (X) in af (from) for äf (from) on the 9th Line. The potential dotted a-rune (X) in af (from) on the 9th line is similar to the potential dotted r-rune (R) in war (were) in that the punch depth is shallower than the many pock marks appearing on the face of the KRS. This potential dotted a-rune (X) is rejected on this basis.
G. Three More Purported Code Marked Runes

**Figure 25a.** The dotted M (M) in perspective projection. Punch marks are shown with yellow arrows are not unique and hence not a code as suggested in Nielsen and Wolter (2006: 119-120).

**Figure 25b.** The shaft dotted w-rune (Ψ) in hawet (the inland sea). Punch marks are shown with red arrows are not unique and hence not a code as suggested in Nielsen & Wolter (2006: 119).

**Figure 25c.** Punches in we (by) on line 10 similar to those on Fig. 29b

**Figure 25.** The Purported Code Punch on M (M) in AVM and on the w-Rune (Ψ) in hawet (the inland sea) on Lines 8 and 10 Respectively. These are actually punch marks that seem to be part of a carving template prepared before the chisel cuts for the rune was made.
Figure 26: The Purported Coded Punched þ-Rune (Þ) in lager (camp) on Line 4. The dotted runes shown by the blue arrows define the lower line for the carving of the runes. They do not serve the purpose of a code since they are not unique counter to what was suggested in Nielsen and Wolter (2006: 118). These seem to be obvious template marks. Images were produced by Accurex Measurements in 2008.
Figure 27. End of Speculation on the Grail Code for GR (û Œ). Quoting Nielsen and Wolter (2006: XV), “It is a fact that the word (û Œ X Œ Œ gral är) ‘grail is’ appears when the first six unique runes in the inscription are read in sequence; it is sheer speculation that it was what the carver intended. We implore the reader to avoid confusion between fact and speculation.”

In Nielsen (2010 b and 2010c) two additional punch marks in the te-runes, identified here with black arrows, demonstrated that GRAL was not a unique code since the sequence was now GTERAL. The blue arrows show the extensive set of punch marks apparently used to lay out a template for the runes (Nielsen 2009a: Fig. 5. 129-130).

The three signs û Œ for “8gr,” which were thought to have only the punches identified with red arrows, are therefore not unique code signs as shown for the latter two in Nielsen (2009a). Obviously ‘grail is’ is not coded with punches on the KRS. The runes X Œ for “al” in the new sequel GTERAL will be treated in a later article.

The two purple arrows identify two apparent word dividers as would result in the form g:öter:, but it remains clear from this image that the KRS surface is covered in pock marks and other damage (up to 400 microns and more in depth on average).
H. Conclusions

The foregoing illustrations and captions have established that there were:

- No dotted r-runes (R R R R) for suggested palatal R-runes on the KRS in lines 1, 4, 5, and 6:
  a. Line 1: göteR (Götaland) and norRmen (Northmen).
  b. Line 4: lägeR = läger (camp) with an overwritten word divider.
  c. Line 5: norR = nor (north) with an overwritten word divider for the former T-RR.
  d. Line 6: warR (were) and äptiR (after).
- No dotted thorn rune (Ƿ) on line 8 in þeþ (death).
- No tick marked thorn rune (þ) in hade (had) on line 4.
- No dotted a-rune (X) on Line 9 in af (from).
- No dots in the loop of the ten (Ƿ) on lines 7 and 10.
- No code dots in the M (M) in AVM on the 8th line or the w-rune (Ψ) in hawet (inland sea) on line 10.

<table>
<thead>
<tr>
<th>r-rune on line 1</th>
<th>r-rune on line 5</th>
<th>r-rune on line 6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wolter (2002)</td>
<td>Nielsen and Wolter (2006: 52) and in Figs. 17 above</td>
<td>Nielsen and Wolter (2006: 52) and in Figs. 2, 3 and Figs. 5-11 and 13 above</td>
</tr>
</tbody>
</table>

Figure 28. The Three Purported Dotted r-Runes (R R R). 3D Imaging has shown that these three photographs cannot be used to establish that the KRS has any dotted r-runes.
The pock depth of ca. 250 microns on the r-rune in war (were) does not correspond to the measurement of intended punches found on the KRS, which are much deeper. Other points on war (were) are:

- This paper presents 3D graphic evidence showing that the r-rune has two different tool-like marks that could have extracted the mineral grain to create the pock mark. One is the obvious crescent-like groove and the other is the tool-like linear drag marks.
- The depth of the purported punch mark at 250 microns is insufficient to remove it from the character of many other pock marks on the KRS. For example one pock mark just after the r-rune in war (were) is circa 460 microns deep. There are many more like this on the KRS face surface.
- There is no way this pock mark could be used as proof that the KRS has a dotted r-rune. The evidence for such a proof is far from the rigorous unambiguous solution that is required for such a claim.
- In Fig. 29 the comparative depth reported in Wolter (2011) is actually 250 microns from the lip of the pock, not 386 microns as claimed.

Other conclusions are:

- A previous claim that the second r-rune in normen (Northmen) was spalled while carving a dotted r-rune is unsupported. The purported spalling extends to the adjacent rune and the imprint suggests that a round-like object caused this damage.
- Norr nor (north) is seen to have two preplaced word dividers. This is not evidence for a dotted r-rune.
- Äptir (after) on the 6th line has a dotted r-rune that is too shallow for an intended punch.
- Af (from) on the 9th line has a punch like mark in the a-rune that is too shallow for a dotted ä-rune.
- Hade (had) on the 4th line has a forked foot in the þ-rune that is obviously the result of a random tool-like mark.
- The last rune in þep (death) on the 8th line has a shallow punch and it cannot be an intended punch in the rune. Evidence has to be absolutely unambiguous and it is not for this rune.
- The purported punches in the loop of the ten (Ƥ) on lines 7 (Ƥ) and 10 (Ƥ) were not observed.
- The purported coded ä-rune (Ẋ) in läger (camp) on line 4 was not unique. The dots in the r-rune (Ȓ) are owing to misplaced word dividers.
- The purported coded M (M) in AVM on line 8 was not unique.
- The purported coded w-rune (Ŵ) in hawet (the inland sea) on line 10 was not unique.
- Frankki (2009) has reported a single dotted ä-rune (Ẋ) on the KRS. The ö-rune (Œ) with a macron is reported in Nielsen (2009a). The impact of these on the provenance of the KRS will be a subject of a future article on the Larsson rune rows.
Recently Wolter (2011) published his report on a digital microscope inspection on the r-rune in *war* (were) and the thorn rune in *þebra* (death) in lines 6 and 8 on the KRS respectively. The reduced resolution (to 20%) images do not support the claim that these runes have intentional punches (dots), so I will await the publication of high resolution results before commenting further. However 3D-Imaging results for various runes in this article do not support the presence of intentional punches, particularly due to their shallow holes.

![Figure 29. The Depth of the Purported Punch in the r-Rune in *war* (were).](image)

Figure 29. The Depth of the Purported Punch in the r-Rune in *war* (were). Quoting Wolter (2011, Figure 11), “When a digital cross-sectional profile is created and reviewed the maximum depth of the ... “dot”, in the upper plateau of rock of the “R”-rune in line six is 383 microns. The maximum depth of the carved groove in upper right is 638 microns.”

The vertical scale of the above figure is circa 128 microns per line. The 383 micron purported punch is measured from the ridge top (red arrow). When measured from the starting point at the edge of the purported punch is closer to 250 microns below its right lip (blue arrow) and 190 microns below the left lip (purple arrow) in the drawing above. However what is the key issue here is that actual punch marks associated elsewhere with *war* (were) have a depth on the order of 1500 – 2000 microns as due the other punches for dots on line 6. Hence the evidence for an intended punch is ambiguous. Unambiguous evidence is required to establish an intended dotted r-rune and this unambiguous evidence does not exist.

The 256 micron depth is confirmed from 3D imaging with a Accurex Measurement system accurate to one micron in the vertical direction and 9 microns in the horizontal directions. Whether it is 383 or 250 microns does not change the fact that the existing punch depth is much too shallow.
J. Postscript. Pentadic Numbers on the KRS

Interest has been shown in the carving characteristics of the pentadic numbers 13 (இரு) and 14 (இரு) on the KRS.

![Pentadic 13 (இரு) in the 1362 date](image1)

![Pentadic 14 (இரு)](image2)

**Figure 30. Pentadic 13 and 14 on Lines 12 and 11 Respectively.** Images were produced by Accurex Measurements in 2008.

![Pentadic Date of 1362 (இரு) on the KRS.](image3)

**Fig. 31. Pentadic Date of 1362 (இரு) on the KRS.** The back side image of 1362 shows the carving of the runes cannot be easily mistaken for 1472 as possibly indicated in the low resolution 3D results imaged taken in Sweden in 2003.
Figure 32. Accepted Codes on the KRS Yielding 1362 on the Perpetual Calendar. There is no unique punch on the pentadic 8 (♯) for a code. The blue arrows denote the five template punches and the yellow and red arrows the accepted cross bars on the l-rune (†) and the u-rune (¶) to identify the year. In 1362 the l-rune (†) was the Golden Year Number (14), the 14th year of the 19 year moon cycle and the u-rune (¶) was the Sunday Number (the first Sunday 1362 was January 2, 1362). The Year 1362 also falls in the 8th column of the Perpetual Calendar (incorrectly named the “Easter Calendar” in Nielsen and Wolter (2006: 57)).

I. References


Steward, John (1899). The First Photograph of the KRS. The Danish Royal Library, Copenhagen.


