Proposal to encode the Khwarezmian script in Unicode

Anshuman Pandey
pandey@umich.edu

January 10, 2018

1 Introduction

This proposal is a substantial revision and expansion of the following:

- L2/17-054R: "Proposal to encode the Khwarezmian script in Unicode"

It incorporates comments provided by the UTC Script Ad Hoc Committee in:

- L2/17-255: Recommendations to UTC #152 July-August 2017 on Script Proposals

Major revisions include: analysis of the script as a cursive joining *abjad*; details on the joining properties of letters; the inclusion of a vocalization sign; and additional specimens of usage.

2 Background

A distinctive script derived from Imperial Aramaic was used between the 2nd and 9th centuries CE for writing the Khwarezmian language in Khwarezm, a region in Central Asia at the delta of the river Amu Darya, which spans across portions of present-day Uzbekistan, Kazakhstan, and Turkmenistan. The land is known in the *Avesta* as ᛞᛚᚨᛁᛖᛗ *hvâirizem* (*Yašt* 10.5.14). The Achaemenians referred to it as 𐎹𐎠𐎼𐎵𐎡𐎹 *uvârazmiš* (XPh inscription, lines 21–22). It is known in classical Persian as خوارزم *xvārazm*. The Greeks knew it as *Χορασμία*, and this hellenic form entered the English lexicon as 'Chorasmia'.

In contemporary English usage, the region is referred to using two spelling variants: 'Chorasmia' and 'Khwarezm', the latter representing a normalized transcription of the Persian name. Adjectival forms of these are 'Chorasmian' and 'Khwarezmian', with the variant spellings 'Choresmian', 'Khwarazmian'. Both 'Khwarezmian' and 'Chorasmian' are used for the language and script in English scholarship: 'Khwarezmian' by Durkin-Meisterernst (2009), Federov (2005, 2006), Livshits (1964, 2003), Skjærvø (1996); and 'Chorasmian' by Humbach (1998), MacKenzie (1991), with the variant 'Choresmian' used by Azarpay (1969), Henning (1965). The spellings 'Khwarezm' and 'Khwarezmian' align with 'Хорезм' and 'Хорезмийский', names used by Russian scholars who have conducted extensive archaeological and palaeographical studies of the region, language, and script. Therefore, 'Khwarezmian' has been selected as the identifier for the script in Unicode as it represents a familiar nomenclature that is suitable for global usage.

The script is one of three used for recording the Khwarezmian language: 1) the Imperial Aramaic script; 2) the proper Khwarezmian script derived from Imperial Aramaic; and 3) the Arabic script.

Scholars classify the proper or indigenous Khwarezmian script into 'archaic', 'lapidary', and 'cursive' types (Lurje, personal communication, December 2017). The archaic type occurs, for instance, on silver bowls no. 1 and no. 2 from Isakovka (Исаковка) (see fig. 31). These inscriptions are dated to the Achaemenid period and appear in a script closely related to Imperial Aramaic. They are the earliest attentations of the Khwarezmian written language (Livshits 2003: 147–148). The lapidary type is found on a flask uncovered in 2005 at Chirik-rabat (Чирик-рабата), described in Ivantchik and Lurje (2013: 286; see fig. 32 here). Inscriptions bearing similar types occur on ostraca from Koi-krylgan Kala (Кой-крылган-калы). A table of archaic and lapidary types is shown in fig. 33. Both of these types are non-joining *abjad* scripts.

The cursive Khwarezmian script differs substantially from the above two types. It is a cursive joining *abjad* that may be considered the latest distinctive development of the Khwarezmian script. It is attested on at least five major inscriptional sources:

- Coinage with Khwarezmian legends, which are the earliest attested records in the script, from the 2nd century CE onwards (see Vainberg 1977, Federov 2005). The coins have been classified by Vainberg and are referred to using the Cyrillic and Roman numeral designations БII–ГVI. Facsimilies of these coins are shown in fig. 2–6 and tracings of inscriptions are shown in fig. 7–13.

- Inscriptions on wooden items and leather from the palace at Toprak Kala (Топрак-кала), dated to the 3rd century CE.

- Leather inscriptions found at a fort at Yakke Parsan (Якке парсан) dated to the 8th century CE.

- Ossuary inscriptions at Tok Kala (Ток-кала), from the 7th and 8th centuries CE. These records represent a development of the script of the documents from Toprak Kala. Some have been reproduced in Tolstov and Livshitz (1964), as well as in Lurje (2013). Nine ossuary inscriptions are shown in fig. 22–30.

- Inscriptions on silver vessels dated between the 6th and 8th centuries CE. Nearly all of the inscriptions were reproduced in Smirnov (1909), and republished in Azarpay (1969). Seven bowls and one pitcher and their inscriptions are shown in fig. 14–21.

The Khwarezmian script of these sources is related to other Iranian scripts derived from Imperial Aramaic, such as Inscriptional Pahlavi, Inscriptional Parthian, and the Old Sogdian of the 'Ancient Letters' (see table 1). However, as asserted by Tolstov and Livshits, among the Iranian scripts derived from Aramaic, Khwarezmian underwent considerably less change than its sister scripts, and retained older features in terms of letterforms (1964: 234).

The Khwarezmian script was replaced by the Arabic script in the 11th century, and the language was eventually superseded by Turkic languages around the 14th century.

3 Approach to the encoding

The repertoire and encoding model is based upon an analysis of script styles used on coinage, silver vessels, and the Tok Kala ossuaries. An examination of these sources provides the following details:

- *Typology*   The encoding is intended to support the cursive Khwarezmian script. The archaic type on vessels from Iskovka and the lapidary type on the jar from Chirik-rabat are non-joining scripts that may be unified with Imperial Aramaic.

- *Repertoire*   Of the 22 letters of the Aramaic alphabet, 19 are attested collectively across the relevant sources. The Tok Kala ossuaries contain all 19 letters. Analogues for *teth*, *qoph*, and *sadhe* do not exist. Numerical signs are attested in ossuaries and on silver bowls. A special vocalization sign is attested in some ossuaries for denoting a final vowel marking possessive forms. A comparison of the repertoire and letterforms made by Vainberg (1977, plate VIII) is reproduced here in fig. 1.

- *Structure*   The script is a cursive joining *abjad*. The joining properties of letters are fairly regular across the sources. All letters may be considered right-joining, but only some are also left-joining. There are exceptions to the joining behavior of letters, such as *aleph* and *pe*.

- *Letterforms*   The nominal shapes of letters are relatively uniform. There are variant forms of *shin* and *taw*. Letters may change shape depending upon their position within a word. The nominal forms of several letters are similar, for example, *waw*, *yodh*, *zayin*. The same applies to *daleth*, *ayin*, *resh*, as well as *beth*, *nun*, *pe*. These characters may be distinguished by their joining features.

- *Directionality*   The script is written from right to left, with lines that advance from top to bottom.

It is practical to consider the varieties as developmental phases of a distinctive 'Khwarezmian' writing system. For purposes of character encoding the varieties should be unified as a single 'Khwarezmian' script in Unicode. This approach enables texts to be represented using the same underlying character set, using normative glyphs. The display of the script style of particular records would be managed by custom fonts.

4   Encoding model

Character repertoire   The proposed repertoire contains 30 characters: 20 letters, 1 vocalization sign, and 7 numbers. The encoded set may differ from traditional and scholarly inventories of script varieties that occur in written and inscriptional sources. Such differences naturally arise from the requirements for digitally representing a script in plain text and for preserving the semantics of characters.

Representative glyphs   The representative glyphs are based upon the letterforms in the Tok Kala ossuaries. These forms reflect the distinctiveness of the script and the latest phase of its development.

Character names   Traditional names for Khwarezmian letters are not attested. Therefore, Unicode character names are based upon those of 'Imperial Aramaic' characters. This convention has been followed for Unicode encodings of other Iranian scripts such as 'Inscriptional Parthian', etc. In this document names in italics refer to scholarly names for graphemes while names in small capitals refer to Unicode characters, eg. ↵ is *aleph* and KHWAREZMIAN LETTER ALEPH. For sake of brevity, the descriptor 'KHWAREZMIAN LETTER' is dropped when refering to Khwarezmian characters, eg. KHWAREZMIAN LETTER ALEPH is referred to as ALEPH. Characters of other scripts are designated by their full Unicode names. Latin transliteration of Khwarezmian follows the current scholarly convention, with Aramaic heterograms given in uppercase letters.

4.1 Letters

The nominal form of each letter is given in the 'X$_n$' column. The labels 'X$_i$', 'X$_m$', 'X$_f$' refer respectively to the initial, medial, and final forms of letters. The red dash indicates the location on a glyph were connections should occur, while a vertical bar indicates that a connection occurs without an extension.

Character name	X$_n$	X$_f$	X$_m$	X$_i$	Join	Latin
KHWAREZMIAN LETTER ALEPH	⅃	➖	' , ⊥	⊐	dual	ʾ
KHWAREZMIAN LETTER ISOLATED ALEPH	'	'	'	—	non	ʾ
KHWAREZMIAN LETTER BETH	⊃	⊥	⊥	⊃	dual	b
KHWAREZMIAN LETTER GIMEL	⅂	⅂	⅂	⅂	dual	g
KHWAREZMIAN LETTER DALETH	𐏓	𐏓	𐏓	𐏓	right	d
KHWAREZMIAN LETTER HE	⟩	⟩-	⟩-	⟩	right	h
KHWAREZMIAN LETTER WAW	�	L	L	⎸	right	w
KHWAREZMIAN LETTER ZAYIN	⌐	⌐	⌐ , ⌐	⌐ , ⌐	dual	z
KHWAREZMIAN LETTER HETH	⊓	⊓	⊓	⊓	right	ḥ
KHWAREZMIAN LETTER YODH	⎸	L	L	⎸	right	y
KHWAREZMIAN LETTER KAPH	⅂	𐏓	⊥	⅃	dual	k
KHWAREZMIAN LETTER LAMEDH	⅃	⅃	⅃	⅃	dual	l
KHWAREZMIAN LETTER MEM	℔	℔	℔	℔	right	m
KHWAREZMIAN LETTER NUN	⅃	⊢	⊥	⅃	dual	n
KHWAREZMIAN LETTER SAMEKH	⅁	⅁	⅁	⅁	dual	s
KHWAREZMIAN LETTER AYIN	𐏓	𐏓	𐏓	𐏓	right	ʿ
KHWAREZMIAN LETTER PE	⌐	⊥	⅃ , ⊥	⌐	dual	p
KHWAREZMIAN LETTER RESH	𐏓	𐏓	𐏓	𐏓	right	r
KHWAREZMIAN LETTER SHIN	ⱳ	ⱳ	ⱳ	ⱳ	right	š
KHWAREZMIAN LETTER TAW	ⱳ	ⱳ	ⱳ	ⱳ	dual	t

4.1.1   Joining behavior

The joining model and shaping requirements for Khwarezmian are similar to that of Arabic. A summary of the joining properties of the letters is given below:

       right- & left-joining   *aleph, beth, gimel, zayin, kaph, lamedh, nun, samekh, pe, taw*

       right-joining   *daleth, he, waw, heth, yodh, mem, ayin, resh, shin*

Throughout this document when a letter is described as joining another letter to the left, it is implied that the joining occurs only if the following letter is right-joining. Equally, a letter described as joining to the right implies that the preceding letter is left-joining. Otherwise, no connections are made between the letters.

The shaping engine substitutes the nominal glyph for each letter in the input with the appropriate positional glyph to produce the expected joined output. As indicated by the red bars in the above table of proposed letters, the majority of letters connect to following letters at the baseline. The contextual forms of many letters do not differ drastically from the nominal form. Font designers will be required to draw extensions at the bearings of positional glyphs in order to effect connections between letters. Also, while the nominal form of a letter is distinctive, its medial form may be similar or identical to the medial form of other letters.

The default joining behavior of letters may be modified using the following control characters:

- ⸬ U+200C ᴢᴇʀᴏ ᴡɪᴅᴛʜ ɴᴏɴ-ᴊᴏɪɴᴇʀ (abbreviated as ᴢᴡɴᴊ)
- ⸬ U+200D ᴢᴇʀᴏ ᴡɪᴅᴛʜ ᴊᴏɪɴᴇʀ (abbreviated as ᴢᴡᴊ)

The following letters exhibit special joining behaviors:

- **aleph**   Suspension of connections for *aleph* occurs with preceding and following letters.

  - Final *aleph* is written as an elongated stroke ⟿ that does not connect to the preceding letter, eg. ⟿ ורח *YRḤ* ’ (TK 25, fig. 23). This is the default behavior for final *aleph* and does not require breaking of the normal cursive behavior. However, final *aleph* triggers the display of a preceding letter using its final glyph, eg. *ZWZN-* ’ is written as ⟿זון, not as ⟿זונـ*. For this reason, ᴢᴡɴᴊ is to be used for producing the final form of *nun* when it occurs before final *aleph*.

  - In coinage and the TK ossuaries, word-initial *aleph* does not rest on the baseline, but is written at the midpoint and attaches to adjacent letters at this position, eg. ᴘ *ʾy*. This behavior occurs mostly before letters with a stroke at the right edge. It is a scribal style and there is no semantic distinction between the positions of attachment.

  - An isolated form ⸰ of *aleph* is used for representing possessive forms. It is attested in the ossuary inscriptions. This form occurs in medial and final positions. eg. סכבדיך *tknpʾn-ʾ-k* (TK 52, fig. 22); דויכ *hyʾn-ʾ* (TK 26); compare to its default medial joining behavior, eg. סכבצ *tnbʾr* (TK 52, fig. 22). Usage of ᴢᴡɴᴊ to produce this form is not feasible. Therefore, it is encoded as the separate letter ɪꜱᴏʟᴀᴛᴇᴅ ᴀʟᴇᴘʜ.

- **gimel**   The *gimel* connects to the left at the top, eg. *gimel* + *waw* as **ה** in the name of a day, **חשׁמ** *gwšt*; *gimel* + *resh* as **רג** in **רגרדכׁ** *grdmʾn* 'paradise'. Sequences of *gimel* + *waw* or *yodh* may resemble the letter **ח** *heth*, but are distinguishable based upon context.

- **zayin**   The joining properties of *zayin* differs across the sources. In some Aramaic heterograms it joins to the left, eg. **נע** *ZNH*, while in others it does not, **וון** *ZWZN*. As there is no feasible means for selecting optional connections for a letter using ZWJ, it is necessary to define *zayin* as a dual-joining letter. The ZWNJ may then be used to break the connection. When it connects on the left, the terminal stroke is curved at the baseline to join the following letter.

- **ayin**   In the available sources the *ayin* occurs in the words **כדכ** *ʿBDt* 'done, made' and **לע** *ʿL*, an Aramaic heterogram indicating 'to'. In both of these cases, it occurs in word-initial position and does not connect to the left. Given its similar structure to the non-left-joining *daleth* and *resh*, it is likely that *ayin* is not left-joining. On the same basis it is likely that *ayin* is right-joining. If additional evidence indicates that it is non-joining, then the property may be modified at that time.

- **pe**   Although it is a default dual-joining letter, in some sources medial **כ** PE does not connect to the left, compare **שׁבמכ** *ʾpbntn* with **שׁבמכ** *ʾp-bntn*. Usage such is unpredictable and appears to be a scribal convention. Default joining may be broken using ZWNJ.

- **taw**   Letters that follow **ㅎ** *taw* join to its left edge without any spacing or extension of the baseline, or are incorporated into the left edge of the glyph, eg. *taw* + *waw* is written **ㅎ** *tw*, as in the name **מסמחﬡ** *twtwxs* on type BI coins (fig. 8); *taw* + *yodh* as **ㅎ** as in **יﬡסﬧ** *ʾztyk* on TK no. 52 (fig. 22); and *taw* + final *nun* as **מ** in **שׁבﬡﬡ** *ʾpbntn*.

- In some sources, *waw* and *resh* appear as if they connect to a following letter, although they are not left-joining. It is not certain whether the joining of these letters is intentional or an effect of careless writing or an elongation of terminal strokes. For such cases, it may be useful to consider Henning's advice:

  > It becomes then all the more important to observe, in the strictest manner, certain scribal conventions that arise from the material, in particular the rules of linking and separating letters. It seems to me that by refusing any license in such matters we can improve the security of reading [...] Attempts have been made from time to time to arrogate to oneself some license, so as to assert: "in this work *W* has been connected to the left"; in the long run they have invariably been rejected.   (1965: 171)

  These letters are defined as right-joining letters. In the event that a different joining behavior is attested, then their joining properties may be adjusted later.

In order to illustrate the joining properties of letters, representations of words from Khwarezmian records are given below along with their input strings:

ʾgʾdk	**כרﬡגﬡ**	<ﬡ ALEPH, ﬧ GIMEL, ﬡ ALEPH, ﬧ DALETH, כ KAPH>
ʾpbntn	**שׁבﬡﬡﬡ**	<ﬡ ALEPH, כ PE, כ BETH, ﬡ NUN, ㅎ TAW, ﬡ NUN>
ʾp-bntn	**שׁבﬡﬡﬡ**	<ﬡ ALEPH, כ PE, 🄰 ZWNJ, כ BETH, ﬡ NUN, ㅎ TAW, ﬡ NUN>
BŠNT	**ㅎﬡﬡﬡ**	<כ BETH, ﬡ SHIN, ﬡ NUN, ㅎ TAW>

grdmn	רגדמﬁﬡ	‹ר GIMEL, ﬔ RESH, ﬔ DALETH, מ MEM, ﬡ ALEPH, ﬔ NUN›

grdm'n — רגדמﬁﬡ — ‹ר GIMEL, ﬔ RESH, ﬔ DALETH, מ MEM, ﬡ ALEPH, ﬔ NUN›

gwšt — חשﬔﬔ — ‹ר GIMEL, ﬡ WAW, ﬔ SHIN, ﬔ TAW›

hwnšk — רושﬔﬔ — ‹ר HE, ﬡ WAW, ﬔ NUN, ﬔ SHIN, ﬔ KAPH›

hy'n-' — רוﬔﬡ — ‹ר HE, ﬡ YODH, ﬔ ALEPH, ﬔ NUN, ⟦ZWNJ⟧ ZWNJ, ' ISOLATED ALEPH›

ZNH — ננﬔ — ‹ﬔ ZAYIN, ﬔ NUN ﬔ HE›

ZNH — ננﬔ — ‹ﬔ ZAYIN, ⟦ZWNJ⟧ ZWNJ, ﬔ NUN ﬔ HE›

ZWZN — זווﬔ — ‹ﬔ ZAYIN, ⟦ZWNJ⟧ ZWNJ, ﬡ WAW, ﬔ ZAYIN, ⟦ZWNJ⟧ ZWNJ, ﬔ NUN›

ZWZN-' — זווﬔﬡ — ‹ﬔ ZAYIN, ⟦ZWNJ⟧ ZWNJ, ﬡ WAW, ﬔ ZAYIN, ⟦ZWNJ⟧ ZWNJ, ﬔ NUN, ⟦ZWNJ⟧ ZWNJ, ﬡ ALEPH›

ḥwsrw — חוﬔרﬡ — ‹ﬔ HETH, ﬡ WAW, ﬔ SAMEKH, ﬔ RESH, ﬡ WAW›

ḥwpsk — חוﬔﬔﬔ — ‹ﬔ HETH, ﬡ WAW, ﬔ PE, ﬔ SAMEKH, ﬔ KAPH›

YRḤ' — וﬔחﬡ — ‹ﬡ YODH, ﬔ RESH, ﬔ HETH, ﬡ ALEPH›

KSP — ﬔﬔﬔ — ‹ﬔ KAPH, ﬔ SAMEKH, ﬔ PE›

MLK' — מﬔﬔﬡ — ‹מ MEM, ﬔ LAMEDH, ﬔ KAPH, ﬡ ALEPH›

MR'Y — מﬔﬡﬡ — ‹מ MEM, ﬔ RESH, ﬡ ALEPH, ﬡ YODH›

sy'wršprn — ﬔﬡﬡﬡﬔﬔﬔﬔﬔ — ‹ﬔ SAMEKH, ﬡ YODH, ﬡ ALEPH, ﬡ WAW, ﬔ RESH, ﬔ SHIN, ﬔ PE, ﬔ RESH, ﬔ NUN›

'BDt — ﬔﬔﬔﬔ — ‹ﬔ AYIN, ﬔ BETH, ﬔ DALETH, ﬔ TAW›

'L — ﬔﬔ — ‹ﬔ AYIN, ﬔ LAMEDH›

pr'ny'ty — ﬔﬔﬡﬔﬡﬔﬔ — ‹ﬔ PE, ﬔ RESH, ﬡ ALEPH, ﬔ NUN, ﬡ YODH, ﬡ ALEPH, ﬔ TAW, ﬡ YODH›

twtwḥs — מﬔﬔﬔﬔﬔ — ‹ﬔ TAW, ﬡ WAW, ﬔ TAW, ﬡ WAW, ﬔ HETH, ﬔ SAMEKH›

tnbryk — מﬔﬔﬔﬡﬔ — ‹ﬔ TAW, ﬔ NUN, ﬔ BETH, ﬔ RESH, ﬡ YODH, ﬔ KAPH›

4.1.2 Glyphic similarities of letters

- ﬔ *beth*, ﬔ *nun*, ﬔ *pe* These letters are often written using a shape similar to ﬔ in medial position, which also resembles the medial form of ﬡ *aleph*. The initial forms of these three letters are distinguished by the degree of curvature of the primary stroke.

- ר *gimel*, ﬔ *he*, ﬔ *kaph* These letters have the same structure: a horzontal stroke attached to a descending stroke. The *kaph* is identified by its broad, horizontal top stroke, and the elongated descender of its final form. The *gimel* is written with a 90° angle, while the *he* consistently appears with a descending top stroke and angled bottom stroke. They are further distinguished by their joining behavior: *gimel* is dual joining and *he* is right-joining, as indicated by their interactions with ﬡ *waw* in חשﬔﬔ *gwšt* and רושﬔﬔ *hwnšk* (TK 52, fig. 22), and ﬔוﬡ *kw'n-y* (TK 25, fig. 23).

- ך *daleth*, ע *ayin*, ך *resh*   These letters have the same basic structure, but are differentiated in terms of joining properties and graphical features. The *daleth* has a shorter primary stroke than *resh* and a wider top angle than *ayin*. The *ayin* is written with a narrower angle at the left as compared to *daleth* and *resh*, and the left stroke connects at a lower point on the right stroke, eg. עכטם *'BDt*. It a non-joining letter. The *resh* is a right-joining letter. While it may appear as to join to the following letter in some sources, the connection is a result of letter spacing, not an inherent cursive property of the letter. The *resh* and *daleth* are differentiated by the length of the primary stroke, with that of ך *resh* being longer than that of ך *daleth* as shown in רדרכם *grdm'n* (TK no. 25, fig. 23). Such a distinction appears to be carried over from Imperial Aramaic, where ך *resh* and ך *daleth* differ by the length of the primary stroke.

- ו *waw*, ו *yodh*   The letters *waw* and *yodh* are difficult to distinguish in various sources and they have the same joining properties. However, *yodh* has a notched head, while *waw* is typically a vertical stroke, either straight or slightly curved. The two may be written similar to ו *zayin*, but the latter is often distinguished by a curved terminal.

4.1.3   Glyphic variants

- *aleph*   The *aleph* has the variant shape ◢, which is a version of ◣ that has an extension at the baseline before the body of the letter.

- *nun*   Word-final ◣ *nun* is written as ן in the ossuary inscriptions. In coinage and silver vessels, the final form appears as ﹍ﺟ. The orientation of the tail may be guided by the vertical constraints of location of the inscription, ie. at the edge of a coin. When *nun* is followed by *aleph*, it is shaped using its final form because the *aleph* in this position is default non-joining. For example, ﬦﬡﬠ *ZWZN-'* occurs on silver vessels, and would be normalized as ﬦﬡﬠ.

- *shin*   The letter ש has the glyphic variant form ﭏ on some coins.

- *taw*   The *taw* has a glyphic variant form ﬡ that has an open right stroke.

4.2   Vocalization sign

Character name	X_n	X_f	X_m	X_i	Join	Latin
KHWAREZMIAN VOCALIZATION SIGN	ﬠ	—	—	—	non	*-w, -y*

In TK 25 and 52 a final *waw* and *yodh* is written using a letter-like sign ﬠ, which is transliterated as either *-w* or *-y* depending upon context. This sign is non-joining, therefore, the preceding letter is rendered using its final form. It is described by Henning as a "vocalization mark", which is "a rounded form reminiscent of an Arabic *ḍamm*" and occurs in words, such as *wḥwnt'n-w*, which is a possessive functioning as a patronym (1965: 178). The "*ḍamm*" to which Henning refers is the ُ U+064F ARABIC DAMMA.

wḥwnt'n-w   ﬠﬡﬠﬠﬡﬠﬠ   <ו WAW, ח HETH, ו WAW, ◣ NUN, ﬡ TAW, ◣ ALEPH ◣ NUN, ﬠ VOCALIZATION SIGN>

k'k'n-y   ﬠﬡﬠ   <ך KAPH, ◣ ALEPH, ך KAPH, ◣ NUN ﬠ VOCALIZATION SIGN>

4.3 Numbers

The representative nominal form of each number is given in the 'X_n' column. The red dash shown in the positional forms indicate connection points.

X_n	Character name	Value	X_f	X_m	X_i	Join
ı	KHWAREZMIAN NUMBER ONE	1	ı	ı	ı	non
ıı	KHWAREZMIAN NUMBER TWO	2	ıı	ıı	ıı	non
ııı	KHWAREZMIAN NUMBER THREE	3	ııı	ııı	ııı	non
ıııı	KHWAREZMIAN NUMBER FOUR	4	ıııı	ıııı	ıııı	non
ﬤ	KHWAREZMIAN NUMBER TEN	10	ﬤ-	ﬤ-	ﬤ	right
ϡ	KHWAREZMIAN NUMBER TWENTY	20	ϡ	ϡ-	ϡ-	dual
ﭒ	KHWAREZMIAN NUMBER ONE HUNDRED	100	ﭒ	ﭒ	ﭒ-	left

Primary units   The primary units are expressed using repetitions of the sign ı, which is a non-joining character. The numbers 5–9 are written using sequences of ONE arranged in groups containing three or four instances of ı. See, for example, '$ııı$ $ıııı$' for 7 and '$ıııı$ $ıııı$' for 8 in TK no. 19 (fig. 24), as well as '$ı$ $ııı$ $ııı$' for 7 in TK no. 25 (fig. 23). Also, '$ıı$ $ııı$' for the number 5 in silver bowl #2 (fig. 15). The number 5 in silver bowl #5 appears as '$ııııı$' without a spaced grouping, but the extended terminal of the third ı suggests the intended grouping '$ıı$ $ııı$' despite lack of spacing (see fig. 18).

Given the grouping behavior of ı, the numbers ı ONE .. $ıııı$ FOUR are encoded atomically. This model for ONE .. FOUR follows the encoding for 'Inscriptional Parthian', eg. ﹁U+10B58 INSCRIPTIONAL PARTHIAN NUMBER ONE .. ﹘U+10B5B INSCRIPTIONAL PARTHIAN NUMBER FOUR. This model is also used in the encodings for 'Imperial Aramaic', 'Inscriptional Pahlavi', and the forthcoming encoding for 'Old Sogdian'.

Ten   The ﬤ TEN resembles a vertically compressed ﭏ LAMEDH. It is a right-joining character.

Twenty   The sign for ϡ TWENTY is derived palaeographically from a vertical stack of two instances of ﬤ TEN. The sign is treated as an atomic character. It is a dual joining character.

Hundreds   The number 100 is written using ﭒ ONE HUNDRED. The ONE HUNDRED also functions as a unit mark for the hundreds. Multiples of hundred are indicated using primary numbers placed before ONE HUNDRED. It is a left-joining character.

Higher orders   There are no distinctive sign for orders above the hundreds.

4.3.1 Numerical notation

The ordering of numbers follows the right-to-left directionality of the script. The expression of numbers is additive. Compounds of different units are produced by placing larger units first. The exception is the usage of primary units for expressing multiples of hundred, which are placed before the character ONE HUNDRED. Spaces are used for separating groups of primary numbers.

The numbers 5–9 may be represented as shown below. Some numbers have more than one representations, as attested in the available sources:

5	⁏⁏ ⁏⁏⁏	⁏⁏⁏ THREE, ⁏⁏ TWO
6	⁏⁏⁏ ⁏⁏⁏	⁏⁏⁏ THREE, ⁏⁏⁏ THREE
7	⁏⁏⁏ ⁏⁏⁏⁏	⁏⁏⁏⁏ FOUR, ⁏⁏⁏ THREE
	⁏ ⁏⁏⁏ ⁏⁏⁏	⁏⁏⁏ THREE, ⁏⁏⁏ THREE, ⁏ ONE
8	⁏⁏⁏⁏ ⁏⁏⁏⁏	⁏⁏⁏⁏ FOUR, ⁏⁏⁏⁏ FOUR
9	⁏⁏⁏ ⁏⁏⁏ ⁏⁏⁏	⁏⁏⁏ THREE, ⁏⁏⁏ THREE, ⁏⁏⁏ THREE

Multiples of ten are written using sequences of ꡃ TEN and ꡅ TWENTY. Even multiples are expressed with repetitions of TWENTY. Odd multiples are produced by attaching TEN at the end.

10	ꡃ	ꡃ TEN
20	ꡅ	ꡅ TWENTY
30	ꡃꡅ	ꡅ TWENTY, ꡃ TEN
40	ꡅꡅ	ꡅ TWENTY, ꡅ TWENTY
50	ꡃꡅꡅ	ꡅ TWENTY, ꡅ TWENTY, ꡃ TEN
60	ꡅꡅꡅ	ꡅ TWENTY, ꡅ TWENTY, ꡅ TWENTY
70	ꡃꡅꡅꡅ	ꡅ TWENTY, ꡅ TWENTY, ꡅ TWENTY, ꡃ TEN
80	ꡅꡅꡅꡅ	ꡅ TWENTY, ꡅ TWENTY, ꡅ TWENTY, ꡅ TWENTY
90	ꡃꡅꡅꡅꡅ	ꡅ TWENTY, ꡅ TWENTY, ꡅ TWENTY, ꡅ TWENTY, ꡃ TEN

Multiples of the hundreds are represented using ꡅ ONE HUNDRED in conjunction with the primary units. The primary units are placed before ONE HUNDRED in the input sequence.

100	ꡅ	ꡅ ONE HUNDRED

200   �3ıı   ıı TWO, ꝫ ONE HUNDRED

300   ꝫııı   ııı THREE, ꝫ ONE HUNDRED

Composite numbers found in the sources are given below along with their encoded representations:

570   Ꙣꝫꝫꝫꝫꝫ ıı ııı   ııı TWO, ııı THREE, ꝫ ONE HUNDRED, ꝫ TWENTY, ꝫ TWENTY, ꝫ TWENTY, Ꙣ TEN

678   ıı ııı ııı Ꙣꝫꝫꝫꝫꝫ ııı ııı   ııı THREE, ııı THREE, ꝫ ONE HUNDRED, ꝫ TWENTY, ꝫ TWENTY, ꝫ TWENTY, Ꙣ TEN, ıı TWO, ııı THREE, ııı THREE

4.4 Punctuation

Spaces are commonly used for separating words in the ossuary inscriptions and on some silver bowls. There are no special signs for punctuation.

4.5 Line-breaking

There are no formal rules for the breaking of words at end of line. Moreover, the available sources do not contain text with line-breaks for words. It may be assumed that words were not split at line boundaries. There are no indications of hyphens or other continuation marks. In digital layouts, line-breaks should occur occur after words.

4.6 Collation

The sort order of the letters follows the encoded order:

ⅎ ALEPH   <   ' ISOLATED ALEPH   <   ꓳ BETH   <   ꓶ GIMEL   <   ꓷ DALETH   <   � HE   <   ı WAW   <

ı ZAYIN   <   ꓵ HETH   <   ı YODH   <   � KAPH   <   ⅃ LAMEDH   <   ꓝ MEM   <   ⌐ NUN   <

ꓐ SAMEKH   <   ꓬ AYIN   <   ꓒ PE   <   ꓭ RESH   <   ᴓ SHIN   <   ꚙ TAW

The ꙛ VOCALIZATION SIGN should be sorted after TAW.

5 Character Properties

5.1 Core data: `UnicodeData.txt`

```
10F00;KHWAREZMIAN LETTER ALEPH;Lo;0;R;;;;;N;;;;;
10F01;KHWAREZMIAN LETTER ISOLATED ALEPH;Lo;0;R;;;;;N;;;;;
10F02;KHWAREZMIAN LETTER BETH;Lo;0;R;;;;;N;;;;;
```

```
10F03;KHWAREZMIAN LETTER GIMEL;Lo;0;R;;;;;N;;;;;
10F04;KHWAREZMIAN LETTER DALETH;Lo;0;R;;;;;N;;;;;
10F05;KHWAREZMIAN LETTER HE;Lo;0;R;;;;;N;;;;;
10F06;KHWAREZMIAN LETTER WAW;Lo;0;R;;;;;N;;;;;
10F07;KHWAREZMIAN LETTER ZAYIN;Lo;0;R;;;;;N;;;;;
10F08;KHWAREZMIAN LETTER HETH;Lo;0;R;;;;;N;;;;;
10F09;KHWAREZMIAN LETTER YODH;Lo;0;R;;;;;N;;;;;
10F0A;KHWAREZMIAN LETTER KAPH;Lo;0;R;;;;;N;;;;;
10F0B;KHWAREZMIAN LETTER LAMEDH;Lo;0;R;;;;;N;;;;;
10F0C;KHWAREZMIAN LETTER MEM;Lo;0;R;;;;;N;;;;;
10F0D;KHWAREZMIAN LETTER NUN;Lo;0;R;;;;;N;;;;;
10F0E;KHWAREZMIAN LETTER SAMEKH;Lo;0;R;;;;;N;;;;;
10F0F;KHWAREZMIAN LETTER AYIN;Lo;0;R;;;;;N;;;;;
10F10;KHWAREZMIAN LETTER PE;Lo;0;R;;;;;N;;;;;
10F11;KHWAREZMIAN LETTER RESH;Lo;0;R;;;;;N;;;;;
10F12;KHWAREZMIAN LETTER SHIN;Lo;0;R;;;;;N;;;;;
10F13;KHWAREZMIAN LETTER TAW;Lo;0;R;;;;;N;;;;;
10F14;KHWAREZMIAN VOCALIZATION SIGN;Lo;0;R;;;;;N;;;;;
10F15;KHWAREZMIAN NUMBER ONE;No;0;R;;;;1;N;;;;;
10F16;KHWAREZMIAN NUMBER TWO;No;0;R;;;;2;N;;;;;
10F17;KHWAREZMIAN NUMBER THREE;No;0;R;;;;3;N;;;;;
10F18;KHWAREZMIAN NUMBER FOUR;No;0;R;;;;4;N;;;;;
10F19;KHWAREZMIAN NUMBER TEN;No;0;R;;;;10;N;;;;;
10F1A;KHWAREZMIAN NUMBER TWENTY;No;0;R;;;;20;N;;;;;
10F1B;KHWAREZMIAN NUMBER ONE HUNDRED;No;0;R;;;;100;N;;;;;
```

5.2 Linebreak data: `LineBreak.txt`

```
10F00..10F13;AL   # Lo  [20] KHWAREZMIAN LETTER ALEPH..KHWAREZMIAN LETTER TAW
10F14;            # Lo       KHWAREZMIAN VOCALIZATION SIGN
10F15..10F1B;AL   # No  [7] KHWAREZMIAN NUMBER ONE..KHWAREZMIAN NUMBER ONE HUNDRED
```

5.3 Shaping properties: `ArabicShaping.txt`

```
10F00; KHWAREZMIAN ALEPH; D; No_Joining_Group
10F01; KHWAREZMIAN ISOLATED ALEPH; N; No_Joining_Group
10F02; KHWAREZMIAN BETH; D; No_Joining_Group
10F03; KHWAREZMIAN GIMEL; D; No_Joining_Group
10F04; KHWAREZMIAN DALETH; R; No_Joining_Group
10F05; KHWAREZMIAN HE; R; No_Joining_Group
10F06; KHWAREZMIAN WAW; R; No_Joining_Group
10F07; KHWAREZMIAN ZAYIN; R; No_Joining_Group
10F08; KHWAREZMIAN HETH; R; No_Joining_Group
10F09; KHWAREZMIAN YODH; R; No_Joining_Group
10F0A; KHWAREZMIAN KAPH; D; No_Joining_Group
10F0B; KHWAREZMIAN LAMEDH; D; No_Joining_Group
10F0C; KHWAREZMIAN MEM; R; No_Joining_Group
10F0D; KHWAREZMIAN NUN; D; No_Joining_Group
10F0E; KHWAREZMIAN SAMEKH; D; No_Joining_Group
10F0F; KHWAREZMIAN AYIN; R; No_Joining_Group
10F10; KHWAREZMIAN PE; D; No_Joining_Group
10F11; KHWAREZMIAN RESH; R; No_Joining_Group
10F12; KHWAREZMIAN SHIN; R; No_Joining_Group
10F13; KHWAREZMIAN TAW; D; No_Joining_Group
10F14; KHWAREZMIAN VOCALIZATION SIGN; N; No_Joining_Group
10F15; KHWAREZMIAN ONE; N; No_Joining_Group
10F16; KHWAREZMIAN TWO; N; No_Joining_Group
```

```
10F17; KHWAREZMIAN THREE; N; No_Joining_Group
10F18; KHWAREZMIAN FOUR; N; No_Joining_Group
10F19; KHWAREZMIAN TEN; R; No_Joining_Group
10F1A; KHWAREZMIAN TWENTY; D; No_Joining_Group
10F1B; KHWAREZMIAN ONE HUNDRED; L; No_Joining_Group
```

6   References

Azarpay, Guitty 1969. "Nine Inscribed Choresmian Bowls". *Artibus Asiae*, vol. 31, no. 2/3, pp. 185–203.

"Coins of Central Asia". `http://www.sogdcoins.narod.ru/english/khwarezm/coins.html`

Durkin-Meisterernst, Desmond. 2009. "Khwarezmian'. In *The Iranian Languages*, Gernot Windfuhr [ed], pp. 336–376. New York: Routledge.

Federov, Michael 2005. "On Some Articles in the Recent Issues (Nos. V, VI, VII) of the Нумизматика Центральной Азии (Numismatics of Central Asia)". *Central Asiatic Journal*, vol. 49, no. 2 (2005), pp. 175–203.

———. 2006. "First Reported Find of an Early Medieval Khwarezmian Drachm in the Kyrgyz Republic". *American Journal of Numismatics*, vol. 18 (2006), pp. 123–130.

Federov, Michael and Kuznetsov, Andrew. 2008. "A hoard of early mediaeval Khwarezmian drachms from the Kuiuk-kala hill fort". *The Numismatic Chronicle*, vol. 168 (2008), pp. 446–451.

———. 2011. "On some previously unknown Khwarazmian drachms and the names of rulers on them". *Iran*, vol. 49 (2011), pp. 79–88.

———. 2012. "Returning to the Kuiuk-Kala hoard of early Mediaeval Khwarezmian drachms: Khorezm, eastern delta of the Amu Darya, Kuiuk-kala hill fort, 2008". *The Numismatic Chronicle*, vol. 172 (2012), pp. 335–341.

Henning, Walter B. 1965. "The Choresmian Documents". *Asia Major*, vol. 11, no. 2, pp. 166–79.

Humbach, Helmut. 2011 [1998]. "Epigraphy i. Old Persian and Middle Iranian epigraphy". *Encyclopædia Iranica*, vol. VIII, fasc. 5, pp. 478–488. `http://www.iranicaonline.org/articles/epigraphy-i`

Иванчик, А. И.; Лурье, П. Б. [Ivantchik, A. I.; Lurje, P. B.]. 2013. "Две надписи из Чирик-рабата". *Commentationes Iranicae*. Сборник статей к 90-летию Владимира Ароновича Лившица, Под редакцией С. Р. Тохтасьева и П. Б. Лурье, pp. 286–294. Санкт-Петербург: Нестор-История.

Livshits, Vladimir A. 2003. "Three silver bowls from the Isakovka burial-ground no. 1 with Khwarezmian and Parthian inscriptions". *Ancient Civilizations*, vol. 9, no. 1–2, pp. 147–172.

Лурье, П. Б. [Lurje, Pavel B.] 2013. "Несколько неизданных хорезмийских надписей из Ток-Калы". *Scripta Antiqua*: *Вопросы древней истории, филологии, искусства и материальной культуры* [= *Ancient history, Philology, Arts and Material Culture*], Том третий [= Volume three], К юбилею Эдварда Васильевича Ртвеладзе [= E.v.Rtveladze Felicitation volume], с. 729–740. Москва: Собрание.

MacKenzie, D. N. 2011 [1991]. "Chorasmia iii. The Chorasmian Language." *Encyclopædia Iranica*, vol. V, pp. 517–520. `http://www.iranicaonline.org/articles/chorasmia-iii`

Pandey, Anshuman. 2016. "Proposal to encode the Old Sogdian script in Unicode" (L2/16-312R). `http://www.unicode.org/L2/L2016/16312r-old-sogdian.pdf`

Skjærvø, Prods Oktor. 1996. "Aramaic Scripts for Iranian Languages." *The World's Writing Systems*, edited by Peter T. Daniels and W. Bright, pp. 515–535. New York and Oxford: Oxford University Press.

Смирнов, Я. И. [Smirnov, I. A.] 1909. *Восточное серебро* [= *Vostochnoe Serebro*]. Атлас древней серебряной и золотой посуды восточного происхождения, найденной преимущественно в пределах Российской империи.

Tolstov, S. P. and Livshitz, V. A. 1964. "Decipherment and Interpretation of the Khwarezmian Inscriptions from Tok Kala", *Acta Antiqua Academiae Scientiarum Hungaricae*, vol. 12, pp. 231–251.

Вайнберг, Бэлла Ильинична [Vainberg, B. I.]. 1977. *Монеты Древнего Хорезма* [= *Monety Drevnego Khorezma*]. Москва: Наука, Глав. ред. восточной литераы

7   Acknowledgments

Also known as 'Chorasmian'.

Letters

10F00	⌐	KHWAREZMIAN LETTER ALEPH
10F01	·	KHWAREZMIAN LETTER ISOLATED ALEPH
10F02	כ	KHWAREZMIAN LETTER BETH
10F03	ך	KHWAREZMIAN LETTER GIMEL
10F04	ך	KHWAREZMIAN LETTER DALETH
10F05	ל	KHWAREZMIAN LETTER HE
10F06	ו	KHWAREZMIAN LETTER WAW
10F07	ו	KHWAREZMIAN LETTER ZAYIN
10F08	π	KHWAREZMIAN LETTER HETH
10F09	ו	KHWAREZMIAN LETTER YODH
10F0A	ך	KHWAREZMIAN LETTER KAPH
10F0B	ل	KHWAREZMIAN LETTER LAMEDH
10F0C	ђ	KHWAREZMIAN LETTER MEM
10F0D	ل	KHWAREZMIAN LETTER NUN
10F0E	ђ	KHWAREZMIAN LETTER SAMEKH
10F0F	ץ	KHWAREZMIAN LETTER AYIN
10F10	כ	KHWAREZMIAN LETTER PE
10F11	ץ	KHWAREZMIAN LETTER RESH
10F12	ש	KHWAREZMIAN LETTER SHIN
10F13	ω	KHWAREZMIAN LETTER TAW

Vocalization sign

10F14	כ	KHWAREZMIAN VOCALIZATION SIGN

Numbers

10F15	ı	KHWAREZMIAN NUMBER ONE
10F16	ıı	KHWAREZMIAN NUMBER TWO
10F17	ııı	KHWAREZMIAN NUMBER THREE
10F18	ıııı	KHWAREZMIAN NUMBER FOUR
10F19	כ	KHWAREZMIAN NUMBER TEN
10F1A	ʒ	KHWAREZMIAN NUMBER TWENTY
10F1B	ʒ	KHWAREZMIAN NUMBER ONE HUNDRED

	10F0	10F1
0	⌐ 10F00	ɔ 10F10
1	· 10F01	ɣ 10F11
2	כ 10F02	ש 10F12
3	ך 10F03	ω 10F13
4	ך 10F04	ɔ 10F14
5	ל 10F05	ı 10F15
6	ו 10F06	ıı 10F16
7	ו 10F07	ııı 10F17
8	π 10F08	ıııı 10F18
9	ו 10F09	כ 10F19
A	ך 10F0A	ʒ 10F1A
B	ل 10F0B	ʒ 10F1B
C	ђ 10F0C	
D	ل 10F0D	
E	ђ 10F0E	
F	ץ 10F0F	

	Khwarezmian	Old Sogdian	Inscriptional Pahlavi	Inscriptional Parthian	Imperial Aramaic
aleph	ﮏ	✗	⅄	⅄	✗
beth	ﮄ	ﮯ	⅃	﮵	ﮕ
gimel	ㄱ	ﮋ	⅃	ﮅ	ﮰ
daleth	ﮛ	(ﮋ)	ȝ	ﮝ	ﮕ
he	ﮔ	ﮋ, ⊏	ﮱ	ﬣ	﮶
waw	ﺍ	ﮊ	￳	ﮊ	ﮕ
zayin	ﮋ	ﮔ	s	ﮜ	ﺍ
heth	�	ﮋ	ﮞ	⅄	ﮗ
teth	—	—	￷	ﮅﮜ	ﮬ
yodh	ﺍ	ﮋ	ﮞ	ﺍ	ﮞ
kaph	ﮓ	ﮜ	ﮞ	ﮝ	ﮞ
lamedh	ﮄ	ﮋ	ﮞ	ﮄ	ﮄ
mem	ﮅ	ﮌ	﮴	﮶	﮶
nun	ﮄ	ﮋ	ﮞ	ﮄ	ﮞ
samekh	ﮄ	ﮌ	﮴	﮴	﮶
ayin	￳	ﮋ, (ﮋ)	(﮴)	﮴	﮴
pe	ﮌ	﮷	﮷	﮴	﮶
sadhe	—	﮶	﮳	﮴	﮾
qoph	—	—	(﮴)	ﮋ	﮿
resh	ﮛ	ﮋ	(ﮋ)	ﮛ	ﮕ
shin	ﮄ	ﮌ	﮴	﮳	﮴
taw	ﮄ	ﮋ	﮷	﮴	ﮬ

Table 1: Comparison of Khwarezmian letters with those in Unicode blocks for related Iranian scripts and Aramaic. Parenthesis indicate that a letter has been unified with another in the respective encoding. In Inscriptional Pahlavi, *ayin* and *resh* are unified with *waw*, and *qoph* with *mem*. For Old Sogdian, *daleth* and regular *ayin* are unified with *resh*.

16

	Khwarezmian	Old Sogdian	Inscriptional Pahlavi	Inscriptional Parthian	Imperial Aramaic
ONE	▪	ل	⟩	ل	▪
TWO	▪▪	لل	⟩⟩	�	⎇
THREE	▪▪▪	للل	⟩⟩⟩	⎇⎇	⎇⎇
FOUR	▪▪▪▪	للل	⟩⟩⟩	⎇⎇⎇	—
FIVE	—	للل	—	—	—
TEN	⎆	⎆	⎋	⎌	⎍
TWENTY	⎎	⎎	⎏	⎐	⎑
THIRTY	—	⎒	—	—	—
ONE HUNDRED	⎓	⎔	⎕	⎖	⎗
ONE THOUSAND	—	—	⎘	⎙	⎚
TEN THOUSAND	—	—	—	—	⎛
ONE HALF	—	⎜	—	—	—

Table 2: Comparison of Khwarezmian numerical signs with those in Unicode blocks for related Iranian scripts and Aramaic.

Figure 1: Inventory of characters on Khwarezmian coins (БII–ГVI), Toprak Kala (Топрак-кала), Yakke Parsan (Якке парсан), Tok Kala (Ток-кала) (from Vainberg 1977: Table 8).
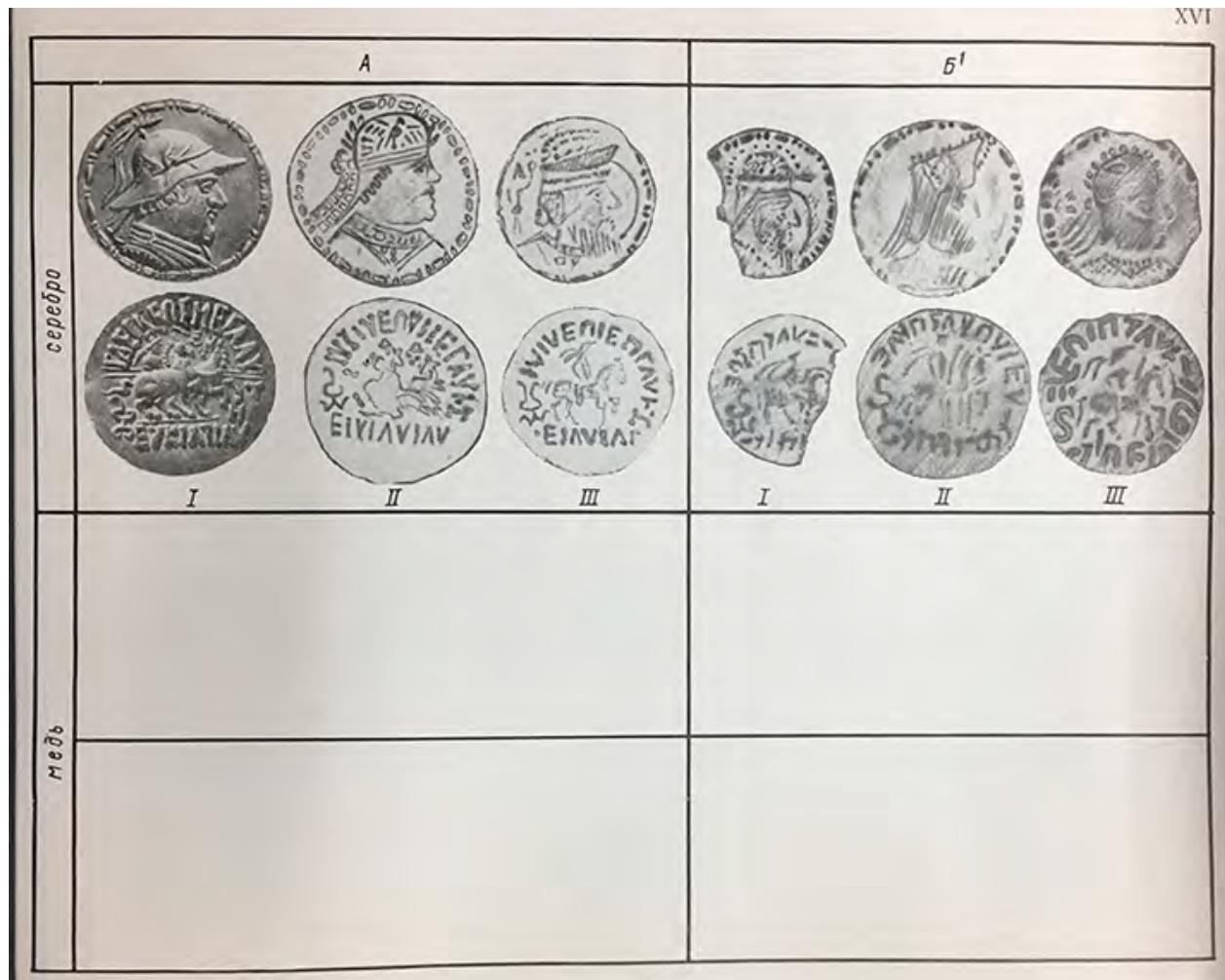
Figure 2: Khwarezmian coins (from Vainberg 1977: Table 16).
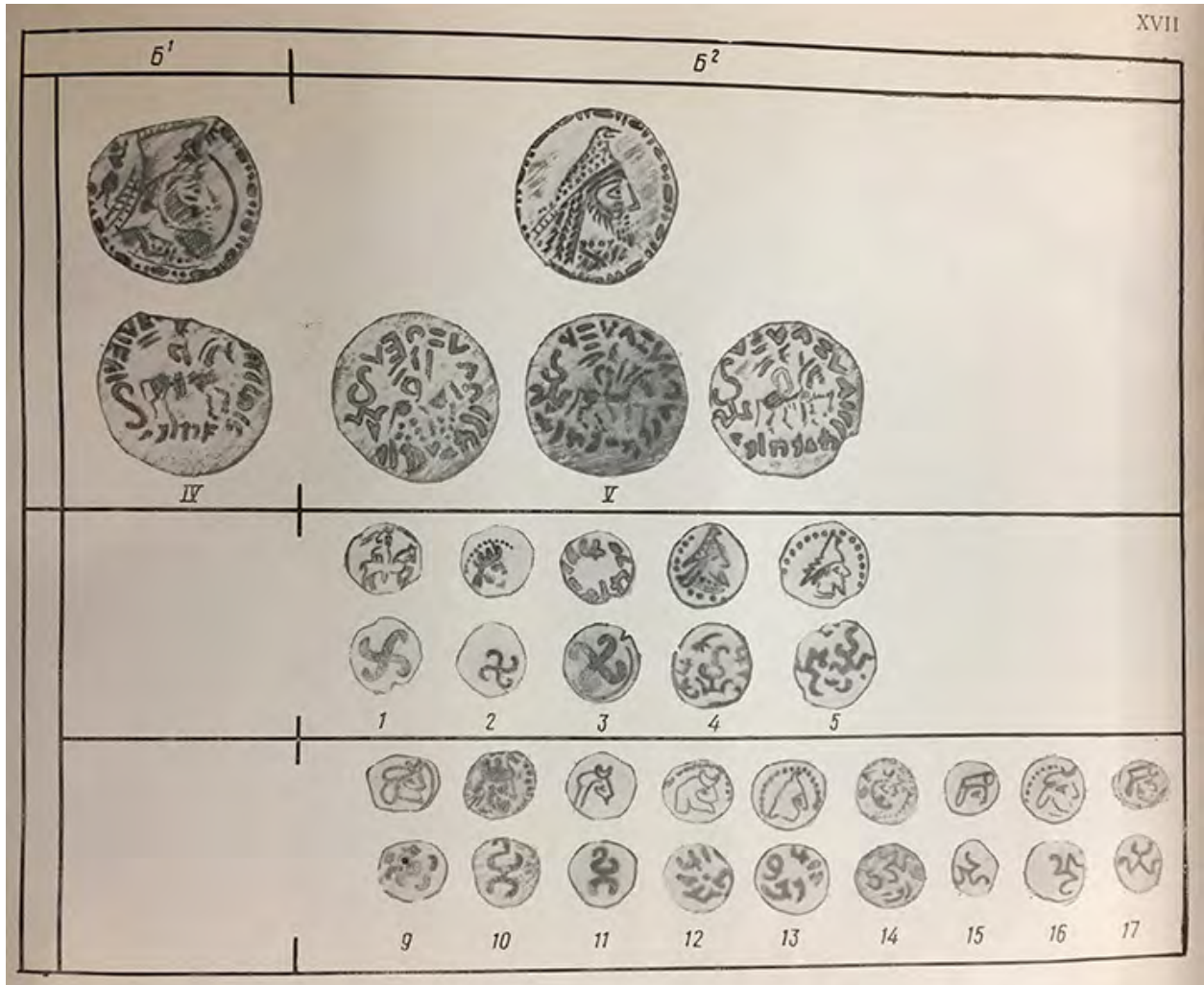
Figure 3: Khwarezmian coins (from Vainberg 1977: Table 17).
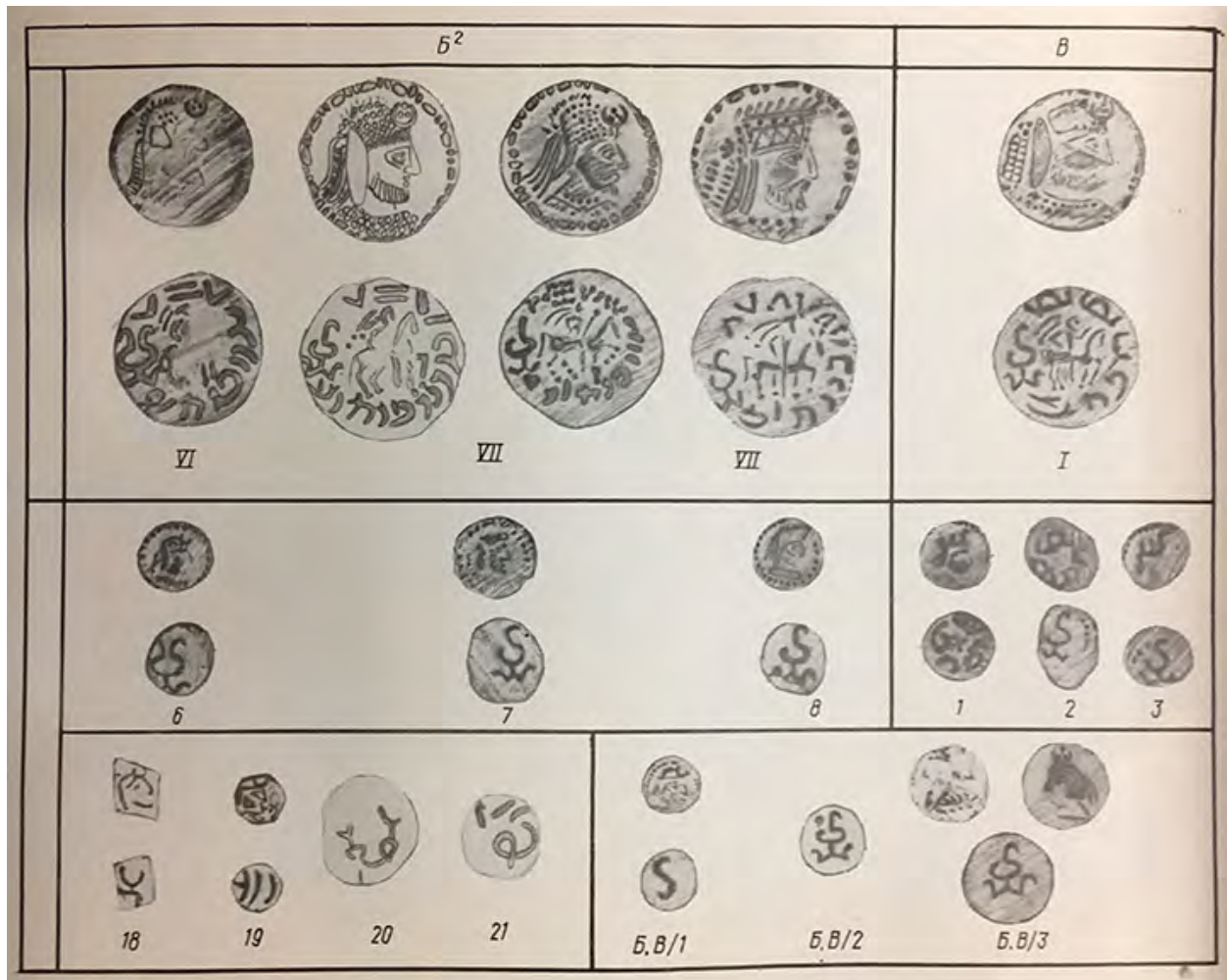
Figure 4: Khwarezmian coins (from Vainberg 1977: Table 18).
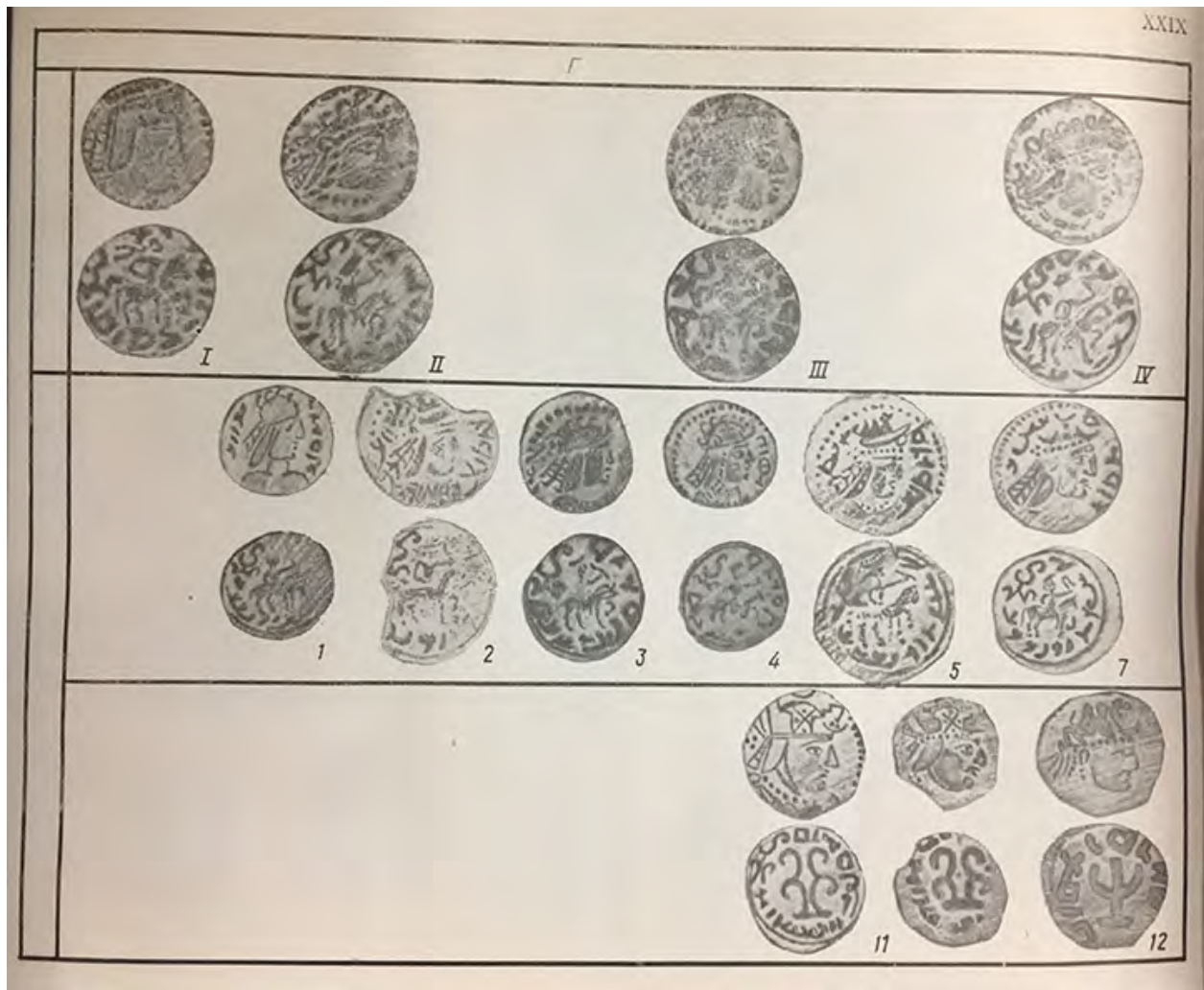
Figure 5: Khwarezmian coins (from Vainberg 1977: Table 19).
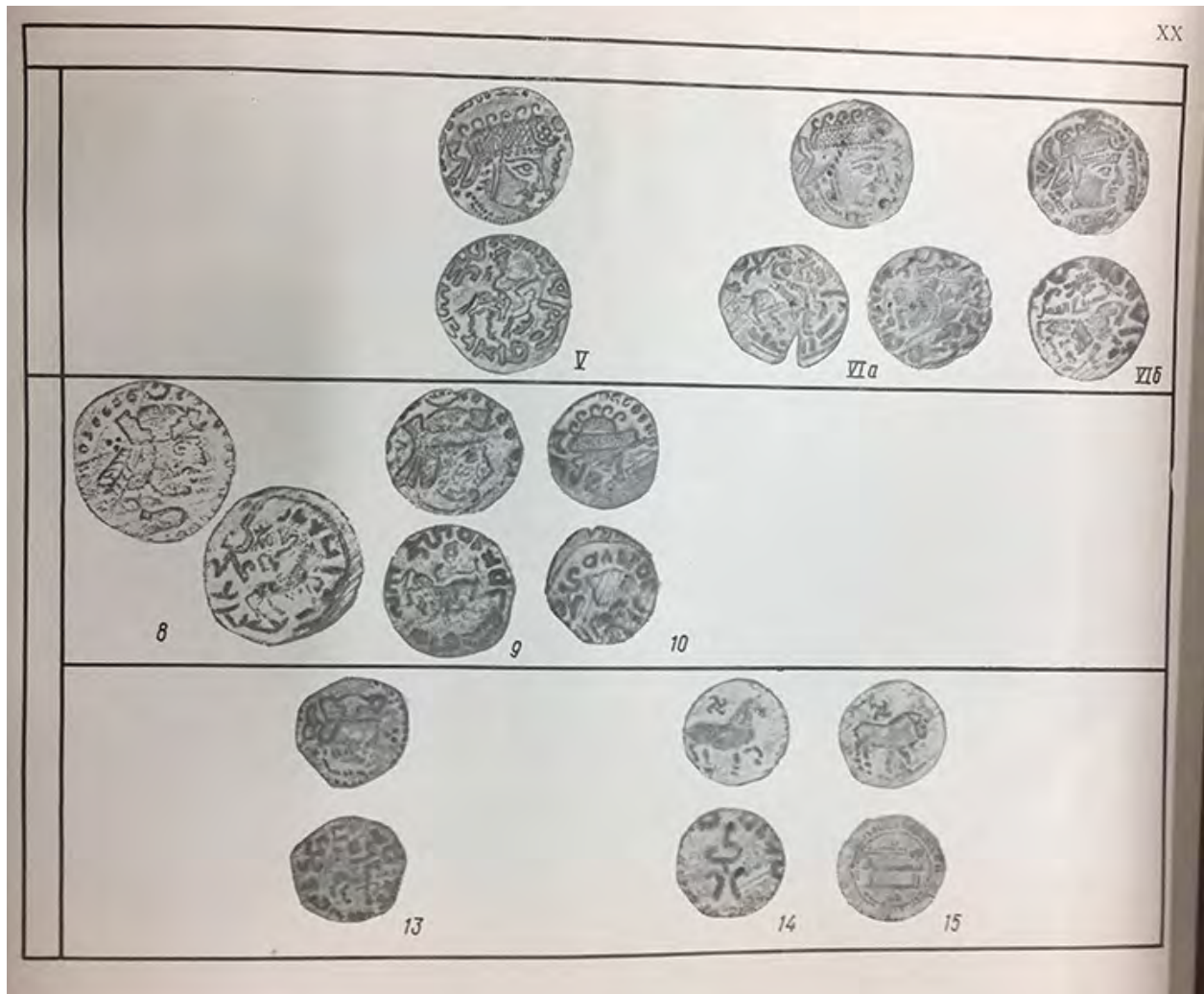
Figure 6: Khwarezmian coins (from Vainberg 1977: Table 20).

Figure 7: Inscriptions on Khwarezmian coins (from Vainberg 1977: Table 1).
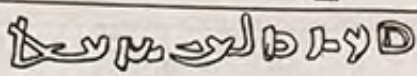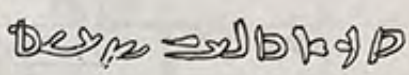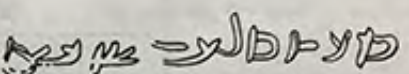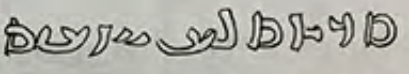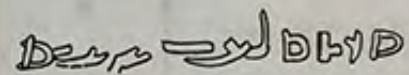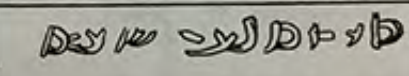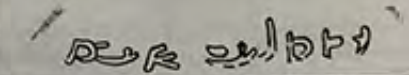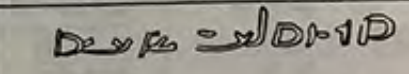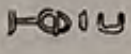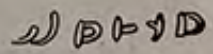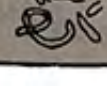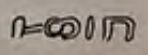
Figure 8: Inscriptions on Khwarezmian coins (from Vainberg 1977: Table 2).

Figure 9: Inscriptions on Khwarezmian coins (from Vainberg 1977: Table 3).

Figure 10: Inscriptions on Khwarezmian coins (from Vainberg 1977: Table 4).

Figure 11: Inscriptions on Khwarezmian coins (from Vainberg 1977: Table 5).

Figure 12: Inscriptions on Khwarezmian coins (from Vainberg 1977: Table 6).

Figure 13: Inscriptions on Khwarezmian coins (from Vainberg 1977: Table 7).
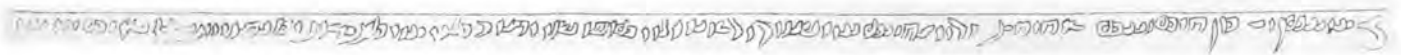
Pl. 1:a   *Choresmian No. 1:* A.D. 658. Inscription from silver phiale in the British Museum, Smirnov, *VS*, pl. XIX:43.

Pl. 1:b   *Choresmian No. 1:* A.D. 658. Silver phiale in the British Museum, see pl. 1:a. Diam. 12.7 cm. Photo courtesy the
Trustees of the British Museum.

Figure 14: Silver vessel #1: 658 CE (from Azarpay 1969: Plate 1:a, b). Silver philae in the British museum. Original from Smirnov 1909, plate XIX: 43.
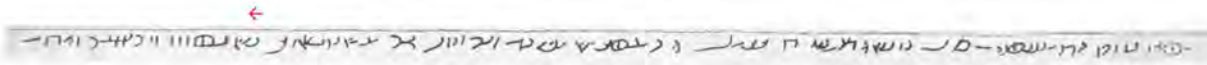
Pl. 3:a   *Choresmian No. 2:* A.D. 538 (probably 638). Inscription from silver phiale in the Hermitage Museum, Leningrad, Smirnov, I.S, pl. XIX: 42.

BŠNT 3 2 100 20 20 20 10 YRX ꜣ ꜣtry BYWM bgy ꜣpbntn yꜣ MN bwnšrgk-š x(r)kꜣn ʿL ꜣtršnky bg ZNH ZWZN 20 10 ꜣšpynšwk

Pl. 3:b   *Choresmian No. 2:* A.D. 538 (probably 638). Silver phiale in the
Hermitage Museum, Leningrad, see pl. 3:a. Diam. 10,6 cm.

Pl. 3:c   *Choresmian No. 2:* A.D. 538 (probably 638). Silver phiale in the Hermitage Museum, Leningrad, see pl. 3:b. Smirnov,
I.S, pl. XVIII:42.

Figure 15: Silver bowl #2: either 538 or 638 CE (from Azarpay 1969: Plate 3:a, b, c). Silver philae in the Hermitage Museum (St. Petersburg). Original from Smirnov 1909, plate XIX:42 and XVIII: 42.

Pl. 5:a　*Choresmian No. 3:* inscription from silver phiale in the Hermitage Museum, Leningrad, Smirnov, *VS*, pl. XIX:44.

נכנתם ו— לן שאלתו זל כתב חו … נוזן

ɔpbntn y' MN nš(m)y 'L (x)-'sx… KSP hy … ZWZN

Pl. 5:b　*Choresmian No. 3:* silver phiale in the Hermitage Museum, Leningrad, see pl. 5:a, diam. 12.5 cm. Smirnov, *VS*, pl. XVIII: 44.

Pl. 5:c　*Choresmian No. 3:*silver phiale in the Hermitage Museum, Leningrad, see pl. 5: b.

Figure 16: Silver vessel #3 (from Azarpay 1969: Plate 5:a, b, c). Silver philae in the Hermitage Museum (St. Petersburg). Original from Smirnov 1909, plate XIX: 44 and XVIII: 44.

Pl. 8 :a
Choresmian No. 4: inscription from silver phiale in the Hermitage
Museum, Leningrad, Smirnov, *VS*, pl. XIX:45.

Pl. 8 :b   *Choresmian No. 4:* silver phiale in the Hermitage Museum,
Leningrad, see pl. 8 :a. Diam. 12.7 cm.

Pl. 8:c   *Choresmian No. 4:* silver phiale in the Hermitage Museum,
Leningrad, see pl. 8:b. Smirnov, *VS*, pl. XVIII:45.

Figure 17: Silver vessel #4 (from Azarpay 1969: Plate 8:a, b, c). Silver philae in the Hermitage
Museum (St. Petersburg). Original from Smirnov 1909, plate XIX: 45 and XVIII: 45.

ʾpbntn yʾ MN wrmwzbntk ʾrʾškrk ʿL (g)nyt ʿL byrty zmhy ZWZN-ʾ 20 20 3 2

Pl. 11:a,b,c   *Choresmian No. 5:* silver phiale in the Hermitage Museum, Leningrad, Smirnov, *VS*, pl. XIX:47. Diam. 13 cm.

Figure 18: Silver vessel #5 (from Azarpay 1969: Plate 11:a, b, c). Silver philae in the Hermitage Museum (St. Petersburg). Original from Smirnov 1909, plate XIX: 47.

Figure 19: Silver vessel #6. Original from Smirnov 1909, plate L: 84.

Pl. 9:a   *Choresmian 7:* silver phiale in the Hermitage Museum, Leningrad, Smirnov, *VS*, pl. XX:46.

Pl. 9:b   *Choresmian No. 7:* silver phiale in the Hermitage Museum, Leningrad, see pl. 9:a.

Figure 20: Silver bowl #7 (from Azarpay 1969: Plate 9:a, b, c). Silver philae in the Hermitage Museum (St. Petersburg). Original from Smirnov 1909, plate XX: 46.

Pl. 10:a, b, c   *Choresmian No. 8:* silver phiale in the Hermitage Museum, Leningrad, Smirnov, *VS,* pl. CXIV: 286.

Figure 21: Silver bowl #8 (from Azarpay 1969: Plate 10:a, b, c). Silver philae in the Hermitage Museum (St. Petersburg). Original from Smirnov 1909, plate CXIV: 286.

BŠNT III III C XX XX XX X III III II YRḤ ʾ
ʾhwrym BYWM gwšt ZNH tnbryk
ʾy tnbʾr ʾy hwnšk (?) tʾbʾnʾnʾk (?)
ʾy ʾyrw|zmʾwʾn ʾztyk

Year 678. Month Ahurem, day Gost. This
ossuary contains the body of hwnsk
tʾbʾnʾnʾk, son of ʾyrw|zmʾwʾn

Figure 22: Tok Kala no. 52, ossuary inscription (from Tolstov and Livshitz 1964: Figure 1). Transliterations from same; but may be erroneous or outdated.
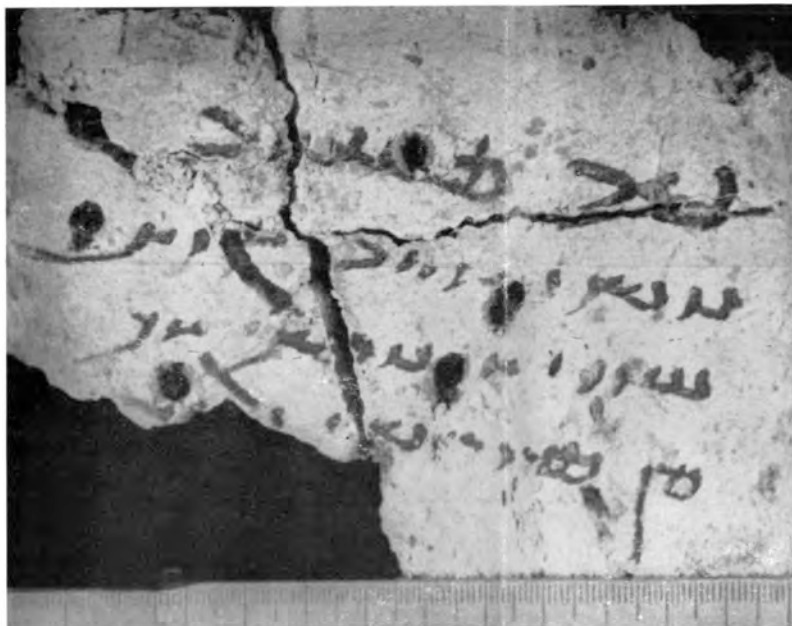
BŠNT III III I C III III YRḤ'
brwrtn BYWM brwrtn ZN[H] tnbryk
nwšy (?) 'y srywyk tyšy'n'ny 'rw'n
GD kw'n[y] 'y 'rw'n 'L nwš grdm'n
pr'ny'ty

Year 705. Month Rawacina, day Rawacina. This is the
ossuary of srywyk [son] of tysy'n,
soul [whose] [possesses] kayan farrah. Soul [his]
may be sent to the beautiful Paradise.

Figure 23: Tok Kala no. 25, ossuary inscription (from Tolstov and Livshitz 1964: Figure 2).
Transliterations from same; but may be erroneous or outdated.
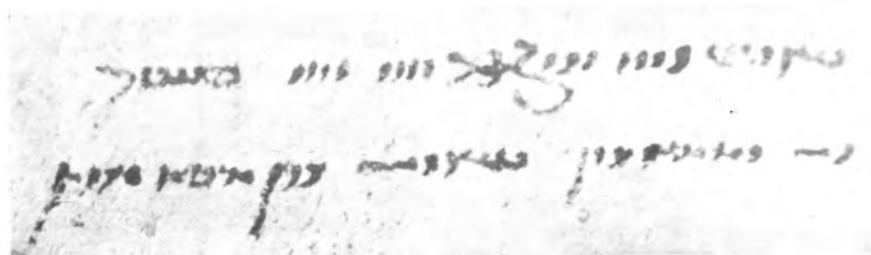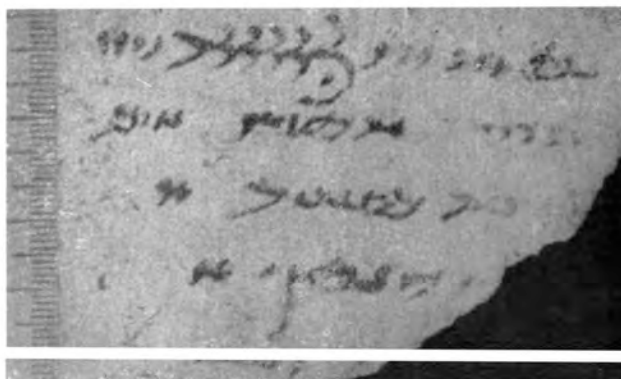
Fig. 3. Inscription №. 19.

כאנש ווווו ווו 𐀺𐀺כ ווווו ווווו חבצויכ
ו— ויעפצוין נושוי— רען יצהנו יצוין

BŠNT IIII III C XX X IIII IIII tnbryk
y' w'z'sw|ydyn nwšy' ?grn 'rt'w 'rw'n

Year 738. This is the ossuary of w'z'swdyn (?)
[May] in the beautiful Paradise [be sent his] true soul.

Figure 24: Tok Kala no. 19, ossuary inscription (from Tolstov and Livshits 1964: Figure 3). Transliterations from same; but may be erroneous or outdated.

41

Fig. 4. Inscription №. 8.

עג מתצוץ
יעשׁאו שׁרק נונו
ע עלשׁאו ? יׄק
מׄן סׄוׄנׄכׄוׄנׄדׄו נל ...

ZNH tn[b]⌈r⌉yk
'(?)ynšy ⌈šh⌉k '.wn⌈y⌉.
…'y nykšy ? 'YK
MN ty'zhwndy 'L … [

This is the ossuary of woman (? shk, daughter of '.w …
May [soul her be sent] from the [world] of full danger to
(the world of safety?).
ḥ

Figure 25: Tok Kala no. 8, ossuary inscription (from Tolstov and Livshitz 1964: Figure 4). Transliterations from same; but may be erroneous or outdated.
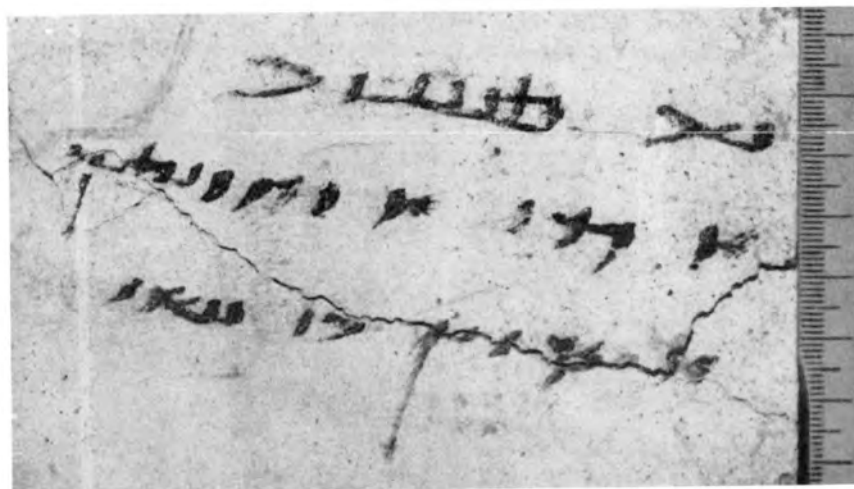
Fig. 5. Inscription №. 69.

עג מבצוק
מ דזו מ וחונםך
מ ידוץ לו עשו

ZNH tnbryk
'y gry 'y wḥwntk
'y 'rw'n kw nwšy

This ossuary contains the body of wnwnxk
Soul [his may be sent] to the beautiful [Paraside].

Figure 26: Tok Kala no. 69, ossuary inscription (from Tolstov and Livshitz 1964: Figure 5). Transliterations from same; but may be erroneous or outdated.

Fig. 6. Inscription №. 39.

ꭒꮯꭒꮣ ⵏⵏⵏⵏ ⵏⵏⵏ ꝫ ꝫꝫꝫꝫ ⵡⵣⵏ—
ⵡⵔⵓⵎⵏ ⵏⵏⵣ
ꭑ…ⵓⵣ ⵏⵏ ꭑꮣꮯⵧ ⵏⵕⵓⵏⵧ

ᒣBŠNTᒥ III III C XX XX XX X YRḤʾ
mᒣtry?ᒥ ᒣBYWᒥM whwmn ZNH
tnᒣbrᒥyk ʾy tnbʾr ʾrwʾzd
w … nᒣyᒥ zyt brwrtyk

Year 690, month of Miri, day of Ahumen. This ossuary
holds the body of ʾrwʾzd w…n, son of Hravardik.

Figure 27: Tok Kala no. 39, ossuary inscription (from Tolstov and Livshitz 1964: Figure 6).
Transliterations from same; but may be erroneous or outdated.

Fig. 7. Inscription №. 12

ⲕⲥⲣⲩⲱ ⲓⲓⲓⲓ ⲓⲓⲓⲓ ⲓⲓⲓⲓ ⳝ ⲇⲇⲇⲇⲇ ⲓⲓⲓⲓ
ⲩⲇⲩ— ⲓⲩⲙⲟⲩⲱ ⲕⲩⲩⲗ
ⲩⲩⲣ ⲙⲃⲇⲩⲣ ⲩ
ⲟⲩⲱⲩ ⲩ
[…]

ꜣBŠꜣNT III III C XX XX XX XX X IIII
YRḤ' 'rtwyš BYWM
]. ZNH tnbryk 'y
]. s|ḥnt'ny 'y
]. y'

Year 694, month of Ardwis, day [] This ossuary ...
[of son] of …s|ḥnt…

Figure 28: Tok Kala no. 12, ossuary inscription (from Tolstov and Livshitz 1964: Figure 7).
Transliterations from same; but may be erroneous or outdated.

45

BŠNT III IIII YRḤ’
tnbryk y’ ’y wrt
k’k’ny

Year 7[00]. Month. This is the ossuary of wrt, [of son] of k’k.

Figure 29: Tok Kala no. 26, ossuary inscription (from Tolstov and Livshitz 1964: Figure 8). Transliterations from same; but may be erroneous or outdated.

Fig. 9. Inscription №. 21.

ꢔ
ꢕ
ꢖ
ꢗ
ꢘ

BŠNᒥTᒧ [
YRᒥHᵓᒧ [
whwmn' [ZHN tnbryk 'y ḥw'r'n [
wḥnwy(?) [

Figure 30: Tok Kala no. 21, ossuary inscription (from Tolstov and Livshitz 1964: Figure 9). Transliterations from same; but may be erroneous or outdated.
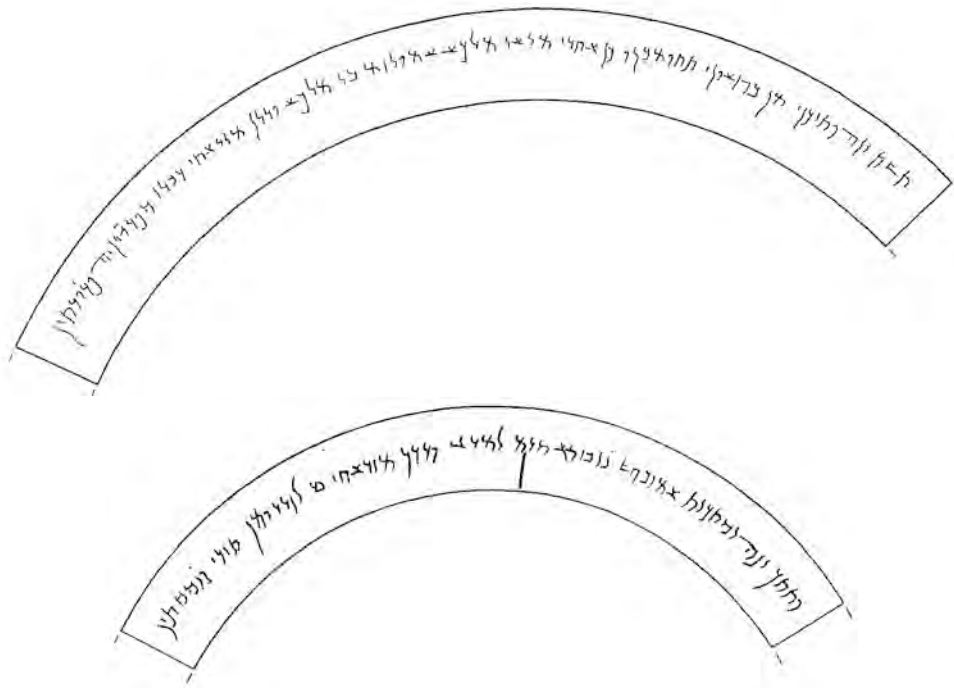
Figure 31: Archaic Khwarezmian inscriptions on silver bowls no. 1 (top) and no. 2 (bottom) from Isakovka from the Achaemenid period (from Livshits 2003: 152, 163). This type of script is out of scope for the present encoding, and may be unified with Imperial Aramaic.

Figure 32: A lapidary Khwarezmian inscription from Chirik-rabat, likely dated between the 2nd and 5th century BCE (from Ivantchik and Lurje 2013: 286). The likely reading is *tyrybwdy*. This type of script is out of scope for the present encoding, and may be unified with Imperial Aramaic.

Имперский арамейский		Парфянский		Бактр. (?)	Согдийский				Хорезмийский						
Бактрия 1)	Арахосия 2)	Ниса 3)	Авроман 4)	Ай-Ханум 5)	Афрасиаб 6)	Куль-тобе 7)	Ст. письма 8)	Шатиал 9)	Айбуйир 10)	Исаковка 11)	Бурлы-кала 12)	Калалы-гыр 13)	Кой-Крылган 14)	Чирик-рабат	

(The table body consists of comparative script glyph forms for each letter — ', b, g, d, h, w, z, ḥ, ṭ, y, k, l, m, n, s, ʿ, p, ṣ, q, r, š, t — which are handwritten characters not reproducible as text.)

1 — *Shaked, Naveh* 2012, Doc. A1;
2–5 В.А. Лившиц по *Расторгуева, Молчанова* 1981;
6 — *Grenet* 2006;
7 — *Sims-Williams, Grenet,* 2006;
8, 9 — *Исхаков* 2008. Табл. XI, XV;
10 — В.А. Лившиц по *Мамбетуллаев* 1979;
11 — *Лившиц* 2002;
12 — *Лившиц, Мамбетуллаев* 1985;
13 — *Лившиц* 2004;
14 — *Толстов, Вайнберг* 1967. С. 220.

Илл. 2. Знаки чирик-рабатской надписи в сравнении с другими письменностями древней Средней Азии

Figure 33: Comparison of early Iranian lapidary script types derived from Imperial Aramaic (from Ivantchik and Lurje 2013: 290).