

Cracks in the Ice

Toward a Translation Method for the Voynich Manuscript

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Note: during research, the Voynich-101 transcription was used. But for presentation purposes, the EVA Hand 1 font is used in this paper.

Part I: Aldebaran Variations—A Crib into the Labels

The star Aldebaran was first identified on f68r3, and is conspicuous in the upper left “pie slice”, along with the Pleiades star cluster. To date the star’s name has been found in seven places in the VMs, in five variations.

Folio f67r2 was originally thought to be astrological in nature, showing a correlation between an 8-house and a 12-house system. The translated labels make the purpose uncertain. This variation also has the most letters.

Folios f68r1 and r2 also have the Aldebaran label, an identification based on the letters used and matches between the folio and sky maps created by the planetarium program *Starry Night Pro 4* .

In f68r3 the upper left pie slice contains the Aldebaran label.

Folio f72r2 is the Zodiac Gemini folio, and has the Aldebaran label, appropriate since that's the current astrological location of the star.

Folio f82v is in the Biological Section, and may give a clue about the meaning. This variation matches that of f68r1. It is not a label, but resides in the text.

Folio f106v is in the Recipes Section, and is also in the text.. This variation also matches that of f68r1.

Table 1: The Collected Variations

f67r2	δ	ο	ϣ	ϛ	α	Ϸ	δ	ϣ	
f68r1	δ	ο	ϣ	ϛ	Ϸ	δ	ϣ		
f68r2	δ	ϛ	Ϸ	ο	ϣ	δ	ϣ		
f68r3	δ	ϛ	ο	ϣ	δ	α	ϣ		
f72r2	δ	α	ϣ	ϛ	δ	ϣ			
f82v	δ	ο	ϣ	ϛ	Ϸ	δ	ϣ		
f106v	δ	ο	ϣ	ϛ	Ϸ	δ	ϣ		

Study of these variations has led to the conclusion that two methods were used to conceal the meaning of the label; leaving out letters, and anagramming them. Note that the number of letters in the variations decrease as they progress from folio to folio.

To prevent confusion, the two duplicates have been left out of the next two tables.

Table 2: Two Labels With Letters Left Out

f67r2	δ	ο	ϣ	ϛ	α		Ϸ	δ	ϣ
f68r1	δ	ο	ϣ	ϛ			Ϸ	δ	ϣ
f68r2	δ	ϛ	Ϸ	ο	ϣ	δ	ϣ		
f68r3	δ	ϛ	ο	ϣ	δ	α	ϣ		
f72r2	δ	α	ϣ	ϛ	δ	ϣ			

Table 3: Three Labels Anagrammed and Letters Left Out

	A	L	D	E	B	A	R	A	N
f67r2	δ	ο	ϣ	ϛ	α		Ϸ	δ	ϣ
f68r1	δ	ο	ϣ	ϛ			Ϸ	δ	ϣ
f68r2	δ	ο	ϣ	ϛ			Ϸ	δ	ϣ
f68r3	δ	ο	ϣ	ϛ	α			δ	ϣ
f72r2	δ		ϣ	ϛ	α			δ	ϣ

These variations provide all the letters of the star's name:

Table 4: The Complete Aldebaran Label

word	A	L	D	E	B	A	R	A	N
letters	δ	ο	ϣ	Ϸ	α	δ	Ϸ	δ	ϣ

Alphabetizing the letters reveals that only certain letters were omitted while writing. It is noted that only the first and last letters were not moved.

These facts may provide a clue into the encoding rules.

Table 6: Missing Letters in the Variations

	1 st A	2 nd A	3 rd A	B	D	E	L	N	R
f67r2	δ		δ	α	ϣ	Ϸ	ο	ϣ	Ϸ
f68r1	δ		δ		ϣ	Ϸ	ο	ϣ	Ϸ
f68r2	δ		δ		ϣ	Ϸ	ο	ϣ	Ϸ
f68r3	δ		δ	α	ϣ	Ϸ	ο	ϣ	
f72r2	δ		δ	α	ϣ	Ϸ		ϣ	
f82v	δ		δ		ϣ	Ϸ	ο	ϣ	Ϸ
f106v	δ		δ		ϣ	Ϸ	ο	ϣ	Ϸ

Here is provided an alphabetical listing with the seven letter values, and has a good chance of being the long-awaited crib into the text of the Voynich Manuscript.

Table 7: Alphabetical Letter Values

A	B	C	D	E	F	G	H	I	J	K	L	M
δ	α		ϣ	Ϸ							ο	
N	O	P	Q	R	S	T	U	V	W	X	Y	Z
ϣ				Ϸ								

It should also be noted that these letters comprise the first seven in terms of frequency as shown by Glen Claston's invaluable "17 Prime Letters" table which he discovered while creating the Voy-101 transcription..

Table 8: Prime Letters

No.	Prime Letter	Value
1	o	L
2	9	N
3	a	B
4	c	R
5	z	E
6	x	D
7	8	A

Part 2: Filling in the Alphabet Values

Section 1: Folio f68r3

The precise configuration of the moon and stars depicted on this folio occurs about nine times a century. It is the night before the moon occults the Pleiades star cluster.

In the upper left “pie slice”, the large star near the edge is Aldebaran.

Table 2.1 Aldebaran

word	A	L	D	E	B	A	R	A	N
letters	δ	ο	ϣ	ϛ	α			δ	ϣ
complete word	δ	ο	ϣ	ϛ	α	δ	ϛ	δ	ϣ

Also in the upper left pie slice of f68r3, another star label exists, for the Pleiades star cluster. As that word clearly does not work given the letters making up the label, some checking reveals many old star charts use the name of the brightest component; Alcyone.

Table 2.2 Alcyone

word	A	L	C	Y	O	N	E
label	δ	ο	α		ϣ	ϣ	

In contrast to the Aldebaran label, this one only has letters left out. Another letter value is revealed, for the letter "o". The use of "α" for Latin "c" would seem to be an error, but this will be addressed later.

The upper right pie slice contains two labeled stars, which star charts indicate should be Algol (closest to middle) and Mirfak.

Table 2.3 Algol

word	A	L	G	O	L	
label		ο	ϣ		ο	ϣ
anagram		ο	ϣ	ϣ	ο	

The Algol label has one letter left out and anagrammed. The letter "g" can be added to the alphabet chart. “LGOL” works phonetically.

Given the letters used and their tentative values, "Mirfak" does not work as a possibility. Consultation with Allen's *Star Names* revealed the name "Algenib" as an alternate.

Table 2.4 Mirfak (Algenib)

word	A	L	G	E	N	O	B			
label		◦	𐌆					ⱱ	ʀ	ɣ
anagram		◦	𐌆		ɣ	ʀ	ⱱ			

“Algenob” is possibly a variation used by the VMs Author.

Note that the letter for "g" is "𐌆" instead of "𐌇". This is explained by the allowed letter substitutions discovered by Philip Neal, and is discussed later in this paper.

Even with these few words, the encoding rules have started to become clear:

1. Leaving out certain letters is permissible.
2. Partial anagramming to ensure only certain letters end words.
3. Letter substitutions according to rules discussed later.

With the discovery of two more letter values, an updated letter chart can be made.

Table 2.5 Revised Letter Values Table

A	B	C	D	E	F	G	H	I	J	K	L	M
ɖ	ⱱ		ɣ	𐌆		𐌇					◦	
N	O	P	Q	R	S	T	U	V	W	X	Y	Z
ɣ	ʀ			ⱱ								

Section 2: Letter Substitutions

While working with folios f78r and f82r, Philip Neal discovered that certain letters may be substituted for certain others. There are examples from the decrypted words, but are not visible in the current alphabet format.

Table 2.6 Philip Neal’s Letter Substitutions

Letter	Allowed Substitutions						
𐌆	ɖ	ɣ	𐌇	ʀ	𐌆	ʀ	𐌆
◦	ⱱ						
ɣ	ʀ						
𐌇	𐌆	𐌆	𐌆				
𐌆	𐌆						
ⱱ	ⱱ						

A modified table is presented here, with a second cell for those letters with substitutions.

Table 2.7 Letter Values with Substitutions

A	B	C	D	E	F	G	H	I	J	K	L	M
8	a		Ɔ	Ɔ		ff					o	
	o		2	2		ff					a	

N	O	P	Q	R	S	T	U	V	W	X	Y	Z
9	2			c								
	Ɔ			cc								

Based on the Neal chart, eight letters may have either of two values, four letters may have any of four values, while “Ɔ” is extra-alphabetical, appearing word-initial and taking on any of seven values.

Three letters, “9”, “8” and “2” are not in the substitution list, so likely have only one value. This accounts for fifteen of the letters, and the rest are also likely to have only one value.

Table 2.8 Neal Sequence with Letter Values

Letter	Allowed Substitutions						
Ɔ	A	D	G	2	Ɔ	O	ff
L	B						
D	O						
G	Ɔ	ff	Ɔ				
2	E						
R	cc						

With this additional information in hand, we can now make more revisions in the alphabet chart. The second cell for those letters with one value will be darkened.

Table 2.9 Revised Alphabet

A	B	C	D	E	F	G	H	I	J	K	L	M
8	α		ϣ	Ϛ		ff					ο	
	ο		Ϛ	ϚϚ		ff					α	

N	O	P	Q	R	S	T	U	V	W	X	Y	Z
9	Ϛ			Ϛ								
	ϣ			ϚϚ								

↑	A	D	G			O	
---	---	---	---	--	--	---	--

Section 3: Toward a More Complete Letter Set

Along with creating the Voy-101 Transcription, Glen Claston discovered that seventeen letters were used far more frequently than the rest. When these letters are combined with those from Philip Neal’s work, the most important letters are revealed.

Since it has been shown that some letters have multiple values, the letter frequency has nothing to do with letter value. In the following table, the letters have been rearranged for clarity.

Table 2.10 Alphabet Comparison

	Prime Letters	Vertical Letter Sequence
1	ο	ο
2	α	α
3	Ϛ	Ϛ
4	ϚϚ	ϚϚ
5	ϣ	ϣ
6	8	8
7	ff	ff
8	Ϛ	Ϛ

9	2	2
10	2	2
11	2	2
12	4	4
13	4	4
14	9	
15	9	
16	2	
17	2	
18		4
19		4

Section 4: Search for Additional Values

Before continuing the attempts to decode labels, more values are needed, as there are only nine of nineteen known. The most logical place to look is the letter columns in the margins of folios f49v, f66r, and f66r.

The column on f49v was most valuable. When known values were inserted, it became clear the column is partially alphabetical, and revealed the values of several more letters.

The remaining letter columns reveal nothing new, nor does the purpose of the columns become apparent. It is proposed here they were created as a reminder. A few rare letters appear, but the significance or values remain undetermined. One of the two remaining unknown gallows letters appears, but there is no context for determining a value.

Table 2.11 f49v Letter Column

Number	Letter	Value
	ƿ	K
1	o	L
2	ɔ	M
3	9	N
4	c	R
5	ʹ	S
	ff	G
	2	H
	ƿ	K
	o	L
	ɔ	O
	9	N
	c	R
	ʹ	S
	2	H
	ƿ	K
	o	L
	ɔ	O
	9	N
	c	R
	ʹ	S
	8	A
	9	N
	c	R
	ff	G
	9	N

A surprise is the letter “Ö” for the value “S”. It appears in the prime letter list as part of the letter “𐌲”, associated with the letter “𐌷” (“E”) so might actually be a combined letter, “ES”, pronounced “S”. Perhaps a joke by the Author?

Table 2.12 Updated Neal Chart

Letter	Allowed Substitutions						
𐌲	A	D	G	H	K	O	𐌲
L	B						
D	O						
G	𐌲	𐌲	K				
S	E						
R	𐌷						

Table 2.13 Revised Alphabet

A	B	C	D	E	F	G	H	I	J	K	L	M
𐌲	𐌷		𐌲	𐌷		𐌲	𐌲			𐌲	𐌷	𐌲
	𐌷		𐌲	𐌲		𐌲				𐌲	𐌷	

N	O	P	Q	R	S	T	U	V	W	X	Y	Z
𐌲	𐌲			𐌷	𐌲							
	𐌲			𐌷	𐌷							

𐌲	A	D	G	H	K	O	
---	---	---	---	---	---	---	--

Section 5: The Missing Vowels

During the collection of letter values, the vowels “I” and “U” continued to be conspicuously absent, as are letters with the “v”, “w”, or “ww” strokes, even though two are in the Prime Letter List. Those two facts put together lead to the conclusion that the strokes ARE the vowels. Evidence is found with the anomalous spelling of “Alcyone” noted in Section 2:

Table 2.14 Alcyone from f68r3

word	A	L	C	Y	O	N	E
label	𐌲	𐌷	𐌷		𐌲	𐌲	

Close examination of the label in the high-resolution picture file reveals the letter “a” is an incorrect transcription, noticeable when compared with the “a” below it, in the “Pleiades-Moon Curve” word. The letter as written is akin to a strikeover, actually composed of “c” and “v”, with the “v” belonging to the next letter, “v”.

Table 2.15 Alcyone Corrected

word	A	L	C	IO	N	E
label	δ	o	c	v	9	

This correction has revealed is the other value of “c”.

Table 2.16 Updated Alphabet

A	B	C	D	E	F	G	H	I	J	K	L	M
δ	a	u	f	z		ll	2	v		ϕ	o	v
	o	c	v	z		ll				ϕ	a	

N	O	P	Q	R	S	T	U	V	W	X	Y	Z
9	v	ll		c	z	ϕ	u					
	f	ll		u	z	ϕ						

↑	A	D	G	H	K	O	P
---	---	---	---	---	---	---	---

The Vertical Letter Sequence indicates there are eight letters with two values each, and four (the gallows letters) as interchangeable. However, it should be noted that three of them appear as values for “↑”. The assumption is made that the single-legged gallows share values, as do the double-legged. So twelve letters share values, with the remaining five one each.

Tentative assignments for “P” and “T” are made, as the other values of the gallows.

The Alphabet Comparison (table 2.10, above) can now be modified to reflect the improved knowledge of alphabetical values. The combined letters, “v” and “v” are removed, but the base letter is left, leaving the letter count at 18.

Table 2.17 Modified Alphabet Comparison

	Prime Letters	Vertical Letter Sequence
1	o	o
2	a	a
3	c	c
4	œ	œ
5	ƒ	ƒ
6	đ	đ
7	ff	ff
8	ʀ	ʀ
9	ʁ	ʁ
10	ʂ	ʂ
11	cc	cc
12	ƚ	ƚ
13	ff	ff
14	ɣ	
15	ɥ	
16	ɔ	
17		Ɔ
18		Ɔ

Part 3: The Nature of the Alphabet

Section 1: The Basis for the Alphabet

Here is the alphabet and values as they currently stand, taken from Part 2 of this paper. The values for the “𐌆” character have been omitted to prevent confusion. They will be discussed later.

Table 3.1: The Alphabet

A	B	C	D	E	F	G	H	I	J	K	L	M
𐌆	𐌁	𐌂	𐌃	𐌄		𐌇	𐌈	𐌉		𐌋	𐌌	𐌍
	𐌎	𐌏	𐌐	𐌑		𐌒				𐌔	𐌕	
N	O	P	Q	R	S	T	U	V	W	X	Y	Z
𐌖	𐌗	𐌘		𐌙	𐌚	𐌛	𐌜					
	𐌝	𐌞		𐌟	𐌠	𐌡						

An addition to this table is the filled in cells. As all of the two-value letters are known, the rest will have only one value. Putting the values in English frequency order reveals nothing new.

Table 3.2: English Letter Frequency and Substitutions

E	T	A	O	I	N	S	H	R	D	L	U	C
𐌄	𐌋	𐌆	𐌗	𐌉	𐌖	𐌚	𐌈	𐌙	𐌃	𐌌	𐌜	𐌟
𐌚	𐌛		𐌃			𐌄		𐌟	𐌗	𐌁		𐌙
M	F	Y	W	G	P	B	V	K	X	Q	J	Z
𐌍				𐌇	𐌘	𐌕		𐌋				
				𐌇	𐌇	𐌌		𐌋				

However, the story is quite different when the Latin frequency order is employed.

Table 3.3: Latin Letter Frequency

I	10.1%	S	6.8%	C	3.3%	Q	1.3%	H	0.5%
E	9.2%	R	6.8%	P	3.0%	B	1.2%	J	0.0%
U	7.4%	N	6.0%	L	2.1%	F	0.9%	K	0.0%
T	7.2%	O	4.4%	D	1.7%	V	0.7%	Y	0.0%
A	7.2%	M	3.4%	G	1.4%	X	0.6%	Z	0.0%

The variants “J” and “V” were combined with “I” and “U” respectively, which made no difference to the order. The Greek letters “W”, “Y”, and “Z” were discarded.

Table 3.4: The Alphabet in Latin Letter Frequency

I/J	E	U/V	T	A	S	R	N	O	M	C
∖	ε	υ	Ɔ	δ	ζ	Ϸ	Ϸ	Ϸ	Ϸ	Ϸ
	ζ		Ɔ		ε	Ϸ		Ϸ		Ϸ

P	L	D	G	Q	B	F	X	H	K
Ɔ	ο	Ϸ	Ɔ		α			Ϸ	Ɔ
Ɔ	α	Ϸ	Ɔ		ο				Ɔ

The values “Q”, “F”, and “X” have not yet been assigned a letters, so are left blank. They may be filled with one from the following table, but no examples have yet been translated.:

Table 3.5: Unassigned Letters

Ϸ	Ϸ
---	---

Section 2: The Extra-Alphabetical Letters

The values and uses of the word initial half-gallows letter “Ɔ” and its variant “Ɔο”, along with the “platform gallows” is one of the greatest mysteries of the Voynich Manuscript. However, Table 1.4 above provides the clues needed to make them clear.

Table 3.6: “Ɔ” Values

Ɔ	A	D	G	H	O	P	T
---	---	---	---	---	---	---	---

As the “ο” letter has two values, the variant “Ɔο” has fourteen possible values. However, all of them might not be used.

Table 3.7: “Ɔο” Values

Ɔο	AL	DL	GL	HL	OL	PL	TL
	AB	DB	GB	HB	OB	PB	TB

The platform gallows are combined letters, like those that use the “∖” and “υ” strokes. The “E” may appear on either side of the consonant.

Table 3.8: Platform Gallows Values

	𐌲 G	𐌴 K	𐌶 P	𐌸 T
𐌺 E	𐌺𐌲 EG	𐌺𐌴 EK	𐌺𐌶 EP	𐌺𐌸 ET

The vowel may come before or after the consonant, depending on need.

Section 3: Patterns and Breakdown of the Alphabet

Examination of Table 3.4 above gives an indication that a pattern is present; something not visible in the English order tables. The table may be broken down into sub tables, each with one letter less than the last.

No modifications were made to the letter order or values, yet the pattern is perfect. This cannot be coincidence.

For clarity, the breakdown is displayed as a whole, on the page below.

Table 3.9: Alphabet Table Breakdown

I/J	E	U/V	T	A	S
∖	↷	↻	⌘	⊗	↺
	↺		⌘		↷

R	N	O	M	C
↶	9	2	3	↻
↻		⌘		↶

P	L	D	G
⌘	o	⌘	⌘
⌘	a	2	⌘

Q	B	F
	a	
	o	

X	H
	2

K
⌘
⌘

This looked like the left corner of a larger table, so it was created; six copies of the Latin letter frequency list make a 21 x 6 table. It's color-coded to differentiate between the copies. The red section on the left is the table breakdown above.

Table 3.10: "Magic Rectangle"

I	E	U	T	A	S	R	N	O	M	C	P	L	D	G	Q	B	F	X	H	K
R	N	O	M	C	P	L	D	G	Q	B	F	X	H	K	I	E	U	T	A	S
P	L	D	G	Q	B	F	X	H	K	I	E	U	T	A	S	R	N	O	M	C
Q	B	F	X	H	K	I	E	U	T	A	S	R	N	O	M	C	P	L	D	G
X	H	K	I	E	U	T	A	S	R	N	O	M	C	P	L	D	G	Q	B	F
K	I	E	U	T	A	S	R	N	O	M	C	P	L	D	G	Q	B	F	X	H

Section 4: Encoding/Decoding Scheme

For brevity and clarity, a single word will demonstrate the use of the Magic Rectangle in the VMs cipher.

The “PM Curve” label on f68r3 has been decrypted as the word “cobbled” introduced circa 1490 CE. The word means “to put together loosely”, which is appropriate for the astronomical event it depicts, the occultation of the Pleiades cluster.

Table 4.1 shows the Voynich word and the English letter values.

Table 4.1: PM Curve Word

o	a	g	z	c	o	g	BLDECBO
L	B	D	E	R	L	D	COBBLED
B	L	O	S	C	B	O	cobbled

In Jeff Haley’s paper on the ‘cobbled’ anagram, the method he used was to look at each column in the Rectangle and find the letters in order, noting which color they appeared in. Once the entire word was found he created the table below with the plaintext word horizontal, and the enciphered word vertical (as per Neal).

He shuffled the colors of the Magic Rectangle, and when “d” appeared in the violet section, went back to the blue section for the preceding “e”.

Table 4.2: Jeff Haley’s Encryption

	C	O	B	B	L	E	D		cipher
1			B						B
2					L		D		L D
3						E			E
4	C								C
5				B					B
6		O							O

His earlier paper on letter patterns in the Magic Rectangle indicate they persist when wrapped back to the beginning. Working with other deciphered labels also indicate that the letters wrap back around to the first (red) section.

The blue table is the only one that provides the encryption, and adds evidence to Philip Neal’s speculation that the text was encoded vertically. It was not necessary to re-arrange the color order.

This method also explains why the average VMs word is 5.5 characters long. No attempt to decode a word longer than six letters has not yet been attempted.

Table 4.3: Blue Section Start

	C	O	B	B	L	E	D		cipher
1				B					B
2					L				L
3							D		D
4						E			E
5	C								C
6		O	B						O B

According to Neal’s work, “**xo**” is forbidden as word final, but “**ox**” is used. The Author anagrammed those two letters to conform to that rule. It is significant that the two letters appear in the same color, as this happens in other labels with letters anagrammed.

The entire set of “cobbled” tables is appended for the reader to compare.

Another as-yet-undefined rule concerns the pattern of which letter value is used for letters with two values.

Applying this method to the entire manuscript has been delayed by the need to test already decrypted labels and words and see if more than just the Blue Section as a starting point is used, and if so how. Also by looking for a quick and easy method of using it on sentences.

This is the current state of investigation into the alphabet and labels of the Voynich Manuscript. It is hoped that other researchers will take this as a basis for further discoveries.

Appendix A: f68r3 “cobbled” Tables

Note: the enciphered word is “BLDECBO”.

Red

	C	O	B	B	L	E	D		cipher
1	C					E	D		C E D
2		O							O
3			B						B
4				B					B
5									
6					L				L

Orange

	C	O	B	B	L	E	D		cipher
1						E	D		E D
2	C								C
3									
4		O	B						O B
5				B					B
6					L				L

Yellow

	C	O	B	B	L	E	D		cipher
1						E	D		E D
2									
3	C								C
4			B						B
5		O		B					O B
6					L				L

Green

	C	O	B	B	L	E	D		cipher
1						E	D		E D
2									
3									
4	C		B						C B
5		O		B					O B
6					L				L

Blue

	C	O	B	B	L	E	D		cipher
1				B					B
2					L				L
3							D		D
4						E			E
5	C								C
6		O	B						O B

Violet

	C	O	B	B	L	E	D		cipher
1		O							O
2			B						B
3				B	L				B L
4									
5							D		D
6	C					E			C E

Appendix B

The Label Letter Value Reference has been separated from the body of the paper for the convenience of other researchers who wish to attempt translation.

Label Letter Values Reference

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Table 1: Letter Values

I/J	E	U/V	T	A	S	R	N	O	M	C
ᵛ	ᵉ	ᵘ	ᵗ	ᵃ	ᵃ	ᵃ	ᵃ	ᵃ	ᵃ	ᵃ
	ᵉ		ᵗ		ᵉ	ᵃ		ᵃ		ᵃ

P	L	D	G	Q	B	F	X	H	K
ᵗ	ᵃ	ᵃ	ᵗ		ᵃ			ᵃ	ᵗ
ᵗ	ᵃ	ᵃ	ᵗ		ᵃ				ᵗ

Table 2: “ᵗ” Values

ᵗ	A	D	G	H	O	P	T
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Table 3: “ᵗ” Values

ᵗ	AL	DL	GL	HL	OL	PL	TL
	AB	DB	GB	HB	OB	PB	TB

Table 4: Platform Gallows Values

	ᵗ G	ᵗ K	ᵗ P	ᵗ T
ᵉ E	ᵉᵗ EG/GE	ᵉᵗ EK/KE	ᵉᵗ EP/PE	ᵉᵗ ET/TE

Table 5: Unassigned Letters

ᵃ	ᵃ
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