

Gia Kvashilava

ივანე ჯავახიშვილის სახელობის თბილისის სახელმწიფო უნივერსიტეტი (საქართველო)

გია კვაშილავა

Ivane Javakhishvili Tbilisi State University (Georgia)

gia.kvashilava@tsu.ge

On Decipherment of the Inscriptions of Linear A in the Common Kartvelian Language: Exploring Mathematical Materials¹

**A კლასის ხაზოვანი წარწერების გაშიფვრა
საერთოქართველურ ენაზე:
მათემატიკური მასალების შესწავლა**

Submitted 25.05.2025 Accepted 01.08.2025

DOI: 10.55804/jtsu.15120473.2025.18.07

Abstract

The paper presents the ancient Kartvelian script of Crete, dated to the 19th–15th centuries BC. These inscriptions contain mathematical material. The majority of the linear signs of Class A (LA), the Mycenaean period Class B (LB) linear script, and the syllabic signs of Cypriot script (CS) are graphically and phonetically identical. The problem of the LA language remained unsolved for a long time, and it was declared that its reading was impossible because this language and its culture no longer existed. The phonetic values of the LA inscriptions were not identified, and the LA tablets were declared to have been written in an unknown, dead language. The LA inscriptions have been deciphered in the Common Kartvelian (CK) language. Some of the LA tablets, which contain agricultural accounting records, have been studied using mathematical methods. Notations for combinations of natural numbers and fractions are presented in these accounts. In the course of the research, “algebraic equations” have been identified, which reveal a highly sophisticated mathematical system. Particularly interesting are the LA summation terms: ku-ro “total” and po-to-ku-ro “grand total”, “final sum”. Their meanings have been established through the application of algebraic and graphical analysis methods.

Keywords: *Common Kartvelian language, algebraic equations, natural numbers, fractions*

¹ “The meaning of one Linear A word is certain: ku-ro is the word which introduces totals, and must mean something like ‘total’ or ‘so much’. If we could find such a word in a known language, the problem of Linear A might be solved.” J. Chadwick (1970:154 ff.)

1. Natural numbers of LA script

Natural (or counting) numbers of LA script are the following signs and their combinations: **I** *one*, **—** or **•** *ten*, **○** *one hundred*, **⊕** *one thousand*. The numeral system of these arithmograms are shown in Table 1 as compared to those of other systems (comp. Sarton 1936:378; Ventris, Chadwick 1973:30, 36, 53; Olivier 1986:381; Olivier, Godart 1996:17, 19, 432–444; Chrisomalis 2010:35, 57, 59, 64, 67):

Numeral systems	1	10	100	1 000	10 000	100 000	1 000 000
LA	I	— •	○	⊕			
Mycenaean LB	I	—	○	⊕	⊕		
Cypriote syllabic	I	—					
Cretan hieroglyphic	/ >	•	○	◇			
Hieroglyphic Luwian	I	—	×	℥			
Egyptian hieroglyphic	I	∩	⓪				
Sumerian pictographic	∇	•					

Table 1

Each of these systems is a non-positional numeral system with the meaning of the number not influenced by the position of numerals (comp. Hollings 2009:16-17).

2. Fractions of LA script

The simple fractional signs of LA script are given in Table 2 (comp. Godart, Olivier 1985, V:xxvii, 316–324; Kvashilava 2011:258):

701	⋈	A	709 ²	⊔=	L ²
702	⋈	B	709 ³	⊔≡	L ³
703	⋈	D	709 ⁴	⊔≡	L ⁴
704	⋈ 7	E	709 ⁶	⊔≡	L ⁶
705	⋈	F	710	⋈	W
706	⋈	H	711	⋈	X
707	∠ ∨	J	712	⋈	Y
708	⋈	K	713	⋈ ⋈	Ω
709	⋈	L			

Table 2

The combinations of the fractional signs 7, L, and 7 with other signs are presented in Table 3:

714	$\dagger^+_{\dagger}$	$A \begin{smallmatrix} B \\ B \end{smallmatrix}$	724	$7D \equiv 7D \equiv EL^4$	734	$\xi D =$	$J \begin{smallmatrix} L^2 \\ E \end{smallmatrix}$
715	$++$	BB	725	$7D \equiv 7D \equiv EL^6$	735	$77 \quad \begin{smallmatrix} L \\ 7 \end{smallmatrix}$	JF
716	$\dagger D \equiv \dagger D \equiv B \begin{smallmatrix} L^6 \\ L \end{smallmatrix}$		726	$7P_{DD} \quad \nabla P_{DD} EYYY$	736	7λ	JH
717	$\begin{smallmatrix} 2 \\ 2 \end{smallmatrix}$	$\begin{smallmatrix} D \\ D \end{smallmatrix}$	727	$7T \quad FK$	737	$77 \quad \begin{smallmatrix} L \\ 7 \end{smallmatrix}$	JJ
718	$\begin{smallmatrix} 22 \\ 22 \end{smallmatrix}$	$\begin{smallmatrix} DD \\ DD \end{smallmatrix}$	728	$7\dot{D} \quad \begin{smallmatrix} F \\ L \end{smallmatrix}$	738	$7T \quad \begin{smallmatrix} L \\ T \end{smallmatrix}$	JK
719	$7+ \quad 7+ \quad EB$		729	$7\dot{T} \quad \begin{smallmatrix} H \\ K \end{smallmatrix}$	739	$7D =$	JL^2
720	$77 \quad 77 \quad EE$		730	$7\ddagger \quad JA$	740	$TD =$	KL^2
721	$77 \quad 77 \quad EF$		731	$7+ \quad JB$	741	$7\dot{D} \quad \begin{smallmatrix} B \\ \dot{B} \end{smallmatrix} \quad \begin{smallmatrix} L \\ L \end{smallmatrix}$	
722	$7L \quad 7L \quad \begin{smallmatrix} L \\ 7 \end{smallmatrix} \quad EJ$		732	$\xi \quad JE$	742	$7D =$	LL^2
723	$7D = \quad 7D = \quad EL^2$		733	$\xi + \quad \begin{smallmatrix} J \\ E \end{smallmatrix} B$	743	$7D = \quad \begin{smallmatrix} B \\ B \end{smallmatrix} \quad \begin{smallmatrix} L^2 \\ L^4 \end{smallmatrix}$	

Table 3

The details about the numerical values of fractional signs 7, L, ξ, 7, 77, and 7 will be presented by me in the paper below.

3. Reading of the LA sign-sequence 777 [po-to-ku-ro]

The reading of the LA sign-sequence 777 is given below. The LA signs 7, 7, 7 and 7 are read as the syllables *po*, *to*, *ku* and *ro*, which, as expected, coincides with phonological values of the corresponding signs of LB and the CS scripts. The signs are shown in Table 5:

LA	ᄒ ᄒ ᄒ ᄒ po	ᄒ ᄒ to
LB	ᄒ ᄒ ᄒ po	ᄒ to
CS	ᄒ ᄒ ᄒ po	ᄒ to

LA	ᄒ ᄒ ᄒ ᄒ ᄒ ku	ᄒ ro
LB	ᄒ ᄒ ᄒ ᄒ ku	ᄒ ro
CS		ᄒ lo

Table 5

So, the LA sign-sequence 𐀓𐀕𐀗𐀕 is thus read as po-to-ku-ro/*p^ho-t^ho-ku-roj.

Semantic interpretation of sequence po-to-ku-ro/*p^ho-t^ho-ku-roj are presented as CC archetypes:

*p^hot^h-oj – “*wide, general*”; ¹

*kur-oj – “*to bind, gather, collect, add*” (Kvashilava 2017:67);

*p^ho-t^ho-ku-roj – “*the general, whole sum, grand total*” (comp. Kvashilava 2011:266).

The reconstructed root morphemes *p^hot-, and *kur- are of CVS- structure; suffixal morpheme *-oj is of -VS structure. These phonemic structures are canonical forms of morphemes in CC language (comp. Gamkrelidze, Machavariani 1965:304, 318, 368).

These sequences display regular phonological and semantic connections to Kartvelian materials.

4. Examples of LA Inscriptions

The sign-sequence 𐀕𐀗 [ku-ro/*ku-roj] (addition) has been attested on clay LA tablets HT 9, HT 11, HT 13, HT 25, HT 27, HT 85, HT 88, HT 89, HT 94, HT 100, HT 102, HT 104, HT 109, HT 110, HT 116, HT 117, HT 118, HT 119, HT 122, HT 123, HT 127, PH(?) 31, and ZA 15. These tablets were found at Hagia Triada, Phaistos and Zakros in Crete. These are dated back to 1850–1450 BC and contain the inscriptions that could easily be interpreted as records of business accounts (Kvashilava 2015:139).

Example 4.1. The inscription on tablet HT 9b as presented by L. Godart and J.-P. Olivier (Godart, Olivier 1976, I:18; comp. Consani, Negri 1999:53-54) is shown in Figure 1:

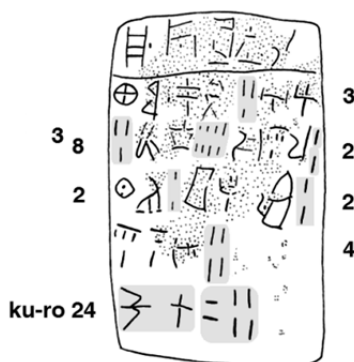


Fig. 1. LA tablet HT 9b

¹ *p^hot^h- < Georgian ფართ-ი [p^hat^h-en-i] – “*widely* (adj.)” (Orbeliani 1993, II:180, 184).

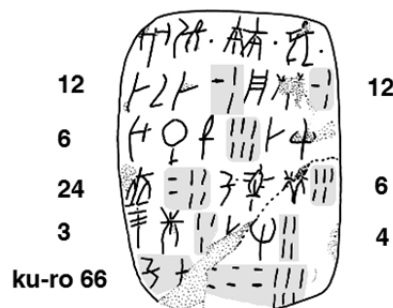
Let's find the sum of the natural numbers 3, 3, 8, 2, 2, 2, and 4. $\text{ჰ}+$ [ku-ro/*ku-roj] or the total number is =II 24.

Examples 4.2-4.5. $\text{ჰ}+$ [ku-ro/*ku-roj] is also attested on other LA script tablets as shown in Figures 2-5 (Godart, Olivier 1976, I:22, 130, 140, 196; comp. Consani, Negri 1999:55, 83, 85 ff., 100 ff.). The sum of a list of natural numbers can be calculated as follows:



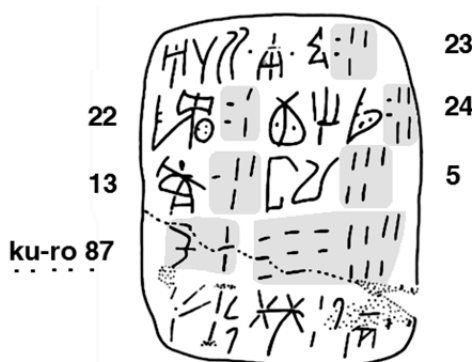
$$40 + 30 + 50 + 30 + 30 = 180$$

Fig. 2. LA tablet HT 11b



$$12 + 12 + 6 + 24 + 6 + 3 + 4 = 66$$

Fig. 3. LA tablet HT 85a



$$23 + 22 + 24 + 13 + 5 = 87$$

Fig. 4. LA tablet HT 89



$$1 + 1 + 1 + 1 + 1 + 1 + 1 + 1 + 1 + 1 + 1 = 10$$

Fig. 5. LA tablet HT 117a

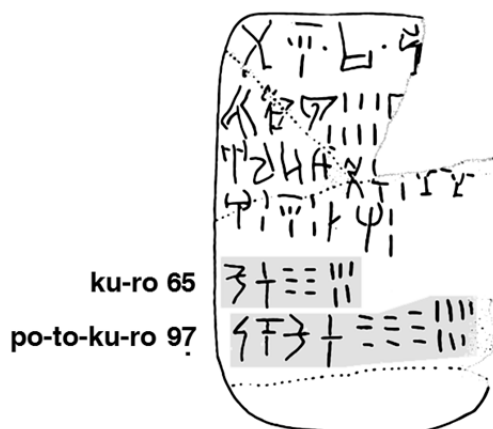
Example 4.6. L. Godart and J.-P. Olivier (Godart, Olivier 1976, I:206, 208; comp. Consani, Negri 1999:103-104) also presented the inscriptions on both sides of tablet HT 122 as shown in Figures 6 and 7:



ku-ro 31

$$31 + 1 = 32$$

Fig. 6. LA tablet HT 122a



ku-ro 65

po-to-ku-ro 97

$$32 + 65 = 97$$

Fig. 7. LA tablet HT 122b

The arithmetical meaning of *ku-ro* on side A is 31 with 1 added to it equals 32. On side B *ku-ro* is 65; and below the sum of numbers on both sides – *po-to-ku-ro* (grand total) is given: $97 = 32 + 65$.

Example 4.7. The LA inscription of tablet HT 9a is presented in Figure 8 according to L. Godart and J.-P. Olivier (Godart, Olivier 1985, V:18; comp. Consani, Negri 1999:53):



Fig. 8. LA tablet HT 9a

The sum of the natural numbers 10, 4, and 2 and mixed numbers $5\frac{1}{2}$, $2\frac{1}{2}$, $2\frac{1}{2}$, and $4\frac{1}{2}$ where $\frac{1}{2}$, $\frac{1}{2}$ and $\frac{1}{2}$ are unknown proper fractions, and also the combination of variables $\frac{1}{2}$ is $\frac{1}{2} + \frac{1}{2}$ (comp. Was 1971:41) are given in Figure 8. The 'algebraic

expression' $5\frac{1}{2} + 10 + 4 + 2 + 2\angle + 2\angle + 4\gamma$ given here equals $31\frac{1}{2}$. From the linear equation $5\frac{1}{2} + 10 + 4 + 2 + 2\angle + 2\angle + 4\gamma = 31\frac{1}{2}$ with mathematical operations of addition and subtraction of the proper fractions $\frac{1}{2}$, $\angle$ and γ on both sides of the 'algebraic equation' $2\angle + \gamma = 2$ in two variables is received.

Solutions of the 'algebraic equation' $2\angle + \gamma = 2$ are the points $(\angle, \gamma)$ in the set of all ordered pairs of rational numbers $\mathbb{Q}^2$ such that when the abscissa $\angle$ of the points is multiplied by 2, and the ordinate γ of the points is multiplied by 1, and those two numbers are added together, the answer equals 2.

Let's find the variables $\angle$ and γ for the equation $2\angle + \gamma = 2$.

$\frac{1}{2} = \angle + \gamma$, $\angle$ and γ are different proper fractions (see Fig. 8). Under this condition, strict linear inequalities in two variables $\angle$ and γ can be written in the following forms: $0 < \angle + \gamma < 1$, $0 < \angle < 1$ and $0 < \gamma < 1$ where $\angle \neq \gamma$. So the ordered pairs $(\angle, \gamma)$ are the solutions to the following system:

$$\begin{cases} 2\angle + \gamma = 2 \\ 0 < \angle + \gamma < 1 \\ 0 < \angle < 1 \\ 0 < \gamma < 1 \\ \angle \neq \gamma \end{cases} \quad (1)$$

The system (1) is solved by the graphical method on the Cartesian coordinate system. Then for every point on the line, the abscissa $\angle$ must be equal to the ordinate γ . The graph of the system (1) is illustrated in Figure 9:

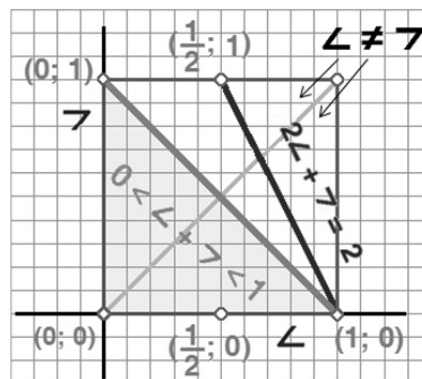


Fig. 9

Solutions to the system (1) are the ordered pairs that solve all the inequalities and the equation in the system. Therefore, to solve the system (1) I have graphed the solution sets of the inequalities on the same set of axes $\angle$ and γ , and the points of their intersection are thus determined. This intersection will define the region of

common ordered pair solutions. In Figure 9, there is no intersection of these shaded regions. Therefore, there are no simultaneous solutions. So, the system (1) does not have a solution.

According to the note by L. Godart and J.-P. Olivier (Godart, Olivier 1985, V:19; comp. Was 1971:36; Facchetti 1994:143), the ‘algebraic expression’ $5 \frac{\text{𐤀}}{\text{𐤁}} + 10 + 4 + 2 + 2\text{𐤀} + 2\text{𐤁} + 4\text{𐤂}$ was calculated to be the total as $30 \frac{\text{𐤀}}{\text{𐤁}}$. I can collect the proper fractions on the left and the numbers on the right, and give the equation $2\text{𐤀} + \text{𐤂} = 1$.

Let’s solve the following system by the graphical method:

$$\begin{cases} 2\text{𐤀} + \text{𐤂} = 1 \\ 0 < \text{𐤀} + \text{𐤂} < 1 \\ 0 < \text{𐤀} < 1 \\ 0 < \text{𐤂} < 1 \\ \text{𐤀} \neq \text{𐤂} \end{cases} \quad (2)$$

First, the graph of the linear equation $2\text{𐤀} + \text{𐤂} = 1$ is the straight line whose 𐤀-intercept is $(\frac{1}{2}, 0)$ and whose 𐤂-intercept is $(0, 1)$. The graph of the system (2) is shown in Figure 10:

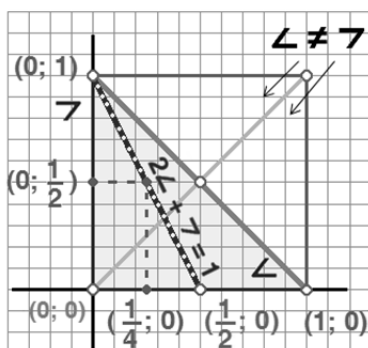


Fig. 10

As is shown in Figure 10, it follows from system (2) that

$$\begin{cases} 2\text{𐤀} + \text{𐤂} = 1 \\ \text{𐤂} = \frac{1}{2} \end{cases} \quad (3)$$

As is well seen, system (3) has exactly one solution ($\text{𐤀} = \frac{1}{4}$, $\text{𐤂} = \frac{1}{2}$). Finally, the proper fraction $\frac{\text{𐤀}}{\text{𐤁}}$ is represented as the sum of unit fractions $\text{𐤀} = \frac{1}{4}$ and $\text{𐤂} = \frac{1}{2}$, i.e., $\text{𐤀} + \text{𐤂} = \frac{1}{4} + \frac{1}{2} = \frac{3}{4}$.¹

¹ The LA fraction sign $\text{𐤂} = \frac{1}{2}$ could be compared to the Egyptian demotic script sign $\text{𐤂} = \frac{1}{2}$ (Johnson 2014:266).

Example 4.8. According to L. Godart and J.-P. Olivier (Godart, Olivier 1976, I:16; comp. Consani, Negri 1999:52 ff.), the inscriptions of tablet HT 8a and 8b are presented in Figures 11 and 12:



Fig. 11. LA tablet HT 8a

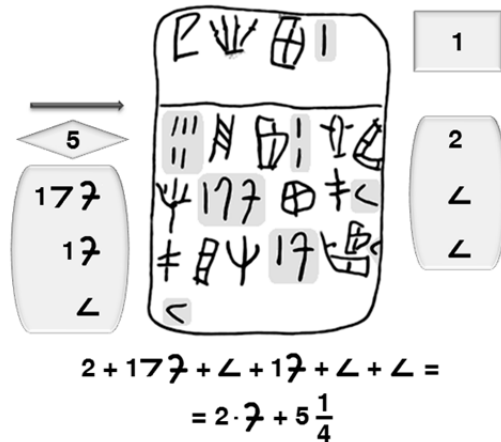


Fig. 12. LA tablet HT 8b

From Figures 11 and 12 the ‘algebraic expressions’ may be rewritten in the following matrix:

$$\begin{pmatrix} 10 & 9 \\ 5 & 2 \cdot 7 + 5 \frac{1}{4} \end{pmatrix}$$

where 7 is an unknown proper fraction. Our objective is to determine the fraction 7 for which the expression $2 \cdot 7 + 5 \frac{1}{4}$ belongs to the *set of natural numbers* N .

The proper fraction 77 is represented as the sum of fractions 7 and 7 , i.e., $77 = 7 + 7$ where $0 < 7 + 7 < 1$, $7 = \frac{1}{2}$, and $7 \neq \frac{1}{4}$.

From the obvious inequality $0 < 7 < \frac{1}{4}$ or $\frac{1}{4} < 7 < \frac{1}{2}$ we have

$$5 \frac{1}{4} < 2 \cdot 7 + 5 \frac{1}{4} < 5 \frac{3}{4}$$

or

$$5 \frac{3}{4} < 2 \cdot 7 + 5 \frac{1}{4} < 6 \frac{1}{4}.$$

In this case, the *natural*/number is exactly 6:

$$(4) \quad 2 \cdot 7 + 5 \frac{1}{4} = 6.$$

It follows from the equation (4) that $7 = \frac{3}{8}$.

Conclusion

Mathematical data from several LA tablets is examined in this paper.

1. On tablets HT 9, HT 11, HT 85, HT 88, HT 89, HT 117, and HT 122 the word *ku-ro* is given to denote the sums of natural numbers.

2. Of special interest are the inscriptions on tablet HT 122 on both sides (A and B) of which the sums of natural numbers – *ku-ro* – is given. The arithmetical meaning of *ku-ro* on side A is 31 with 1 added to it – so the sum is 32. On side B *ku-ro* is 65; and below on the tablet the sum of both sides *po-to-ku-ro* – grand total – is given: $97 = 32 + 65$.

3. The values of proper fractions $\frac{1}{2}$, $\frac{1}{4}$, $\frac{3}{4}$, $\frac{3}{8}$, $\frac{5}{8}$, and $\frac{7}{8}$ are presented in Table 6:

Signs	Value			
$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{4}$
$\frac{1}{4}$	$\frac{1}{4}$	$\frac{1}{4}$	$\frac{1}{4}$	$\frac{1}{2}$
$\frac{3}{4}$	$\frac{3}{4}$	$\frac{3}{4}$	$\frac{3}{4}$	
$\frac{3}{8}$	$\frac{3}{8}$	$\frac{3}{8}$	$\frac{3}{8}$	$\frac{1}{8}$
$\frac{5}{8}$	$\frac{5}{8}$	$\frac{5}{8}$	$\frac{5}{8}$	
$\frac{7}{8}$	$\frac{7}{8}$	$\frac{7}{8}$	$\frac{7}{8}$	
	Kvashilava	Facchetti	Was	Bennett

Table 6

As shown, the results obtained by different authors mostly coincide, but the values received in this paper have been obtained as the result of strict algebraic calculations.

References

Bennett 1980: E. L. Bennett, Linear A Fractional Retraction, *Kadmos* 19 (1), pp. 12–23.
Chrisomalis 2010: S. Chrisomalis, *Numerical Notation: A Comparative History*. Cambridge University Press, Cambridge.
Chadwick 1970: J. Chadwick, *The Decipherment of Linear B*. 2nd ed., Cambridge University Press, Cambridge.

- Consani, Negri 1999:** C. Consani, M. Negri, *Testi minoici trascritti: con interpretazione e glossario*, CNR Publishers, Roma.
- Facchetti 1994:** G. M. Facchetti, Linear A Metrograms, *Kadmos*, 33, pp. 142–148.
- Gamkrelidze, Machavariani 1965:** T. V. Gamkrelidze, G. I. Machavariani, The System of Sonants and Ablaut in Kartvelian Languages: A Typology of Common Kartvelian Structure, Metsniereba Publishers, Tbilisi (in Georgian and Russian).
- Godart, Olivier 1976, 1985:** L. Godart, J.-P. Olivier, *Recueil des Inscriptions en Linéaire A, Vols 1, 5*, Librairie Orientaliste Paul Geuthner, Paris.
- Hollings 2009:** C. Hollings, An Analysis of Nonpositional Numeral Systems, *The Mathematical Intelligencer*, 31 (2), pp. 15–23.
- Johnson (ed.) 2014:** J. H. Johnson (ed.), *The Demotic Dictionary of the Oriental Institute of the University of Chicago*, University of Chicago Press, Chicago.
- Kvashilava 2011:** G. Kvashilava, Decipherment of the Inscriptions of Linear A and Its Related Scripts in the Proto-Kartvelian-Colchian Language, *Studies in History and Ethnology*, XIII, pp. 227–310.
- Kvashilava 2015:** G. Kvashilava, Interpretation of the Common Kartvelian Linear A Script Sequences ku-ro and ki-ro, *Issues of Linguistics*, pp. 139–161.
- Kvashilava 2017:** G. Kvashilava, On Decipherment of the Inscriptions of Linear A in the Common Kartvelian Language. In: *2nd Academic International Conference on Social Sciences and Humanities: AICSSH 2017 (Cambridge) Conference Proceedings*, University of Cambridge, May 22–24, 2017, FLE Learning, Cambridge, UK, pp. 65–73.
- Olivier 1986:** J.-P. Olivier, Cretan Writing in the Second Millennium B.C., *World Archaeology*, 17 (3), pp. 377–389.
- Olivier, Godart 1996:** J.-P. Olivier, L. Godart, *Corpus Hiéroglyphicarum Inscriptionum Cretae*, L'Accademia Nazionale dei Lincei et L'Universite de Naples Federico II.
- Orbeliani 1993:** S.-S. Orbeliani, *Leksikoni kartuli (Georgian Dictionary)*, Vol. II, Merani Publishers, Tbilisi (in Georgian).
- Sarton 1936:** G. Sarton, Minoan Mathematics, *Isis*, 24 (2), pp. 375–381.
- Ventris, Chadwick 1973:** M. Ventris, J. Chadwick, *Documents in Mycenaean Greek*, 2nd ed., Cambridge University Press, Cambridge.
- Was 1971:** D. A. Was, Numeral Fractions in the Minoan Linear Script A, *Kadmos*, 10 (1), pp. 35–51.
- Was 1972:** D. A. Was, Numeral Fractions in the Minoan Linear Script A, *Kadmos*, 11 (1), pp. 1–21.

გია კვაშილავა

A კლასის ხაზოვანი წარწერების გაშიფვრა საერთოქართველურ ენაზე: მათემატიკური მასალების შესწავლა

რეზიუმე

ნაშრომში წარმოდგენილია კრეტის ძველი ქართველური დამწერლობა, რომელიც თარიღდება ძვ.წ. მეცხრამეტე-მეთხუთმეტე საუკუნეებით. ამ წარწერებში მოცემულია მათემატიკური მასალა. A კლასის ხაზოვანი (LA), მიკენური ხანის B (LB) კლასის ხაზოვანი და (CS) კვიპროსის დამწერლობების მარცვლოვანი ნიშნების უმეტესობა გრაფიკულად და ფონეტიკურად იდენტურია. LA-ის ენის პრობლემა დიდხანს გადაუჭრელი რჩებოდა და გამოცხადდა, რომ მისი წაკითხვა შეუძლებელი იყო, რადგან ეს ენა და მისი კულტურა აღარ არსებობდა. LA წარწერების ფონეტიკური მნიშვნელობები იდენტიფიცირებული არ იყო, და LA ფირფიტები გამოცხადდა, როგორც უცნობ, მკვდარ ენაზე შესრულებული. LA წარწერები გაშიფრულია საერთოქართველურ (CK) ენაზე. LA-ს ზოგიერთი ფირფიტა, რომლებიც შეიცავს სასოფლო-სამეურნეო ანგარიშებს, შესწავლილია მათემატიკური მეთოდების გამოყენებით. ნატურალური რიცხვებისა და წილადების კომბინაციების აღნიშვნები მოცემულია ამ ანგარიშებში. კვლევის პროცესში გამოვლენილია „ალგებრული განტოლებები“, რაც ავლენს უაღრესად დახვეწილ მათემატიკურ სისტემას. განსაკუთრებით საინტერესოა LA-ს შეკრების ტერმინები: *ku-ro* „შეკრება“ და *po-to-ku-ro* „ფართო შეკრება“, „საბოლოო ჯამი“. მათი მნიშვნელობები გარკვეულია ალგებრული და გრაფიკული ანალიზის მეთოდების გამოყენებით.

საკვანძო სიტყვები: *საერთოქართველური ენა, ალგებრული განტოლებები, ნატურალური რიცხვები, წილადები*