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THE RELATIONSHIP BETWEEN CRETAN HIEROGLYPHIC AND LINEAR A: A PALAEOGRAPHIC AND STRUCTURAL APPROACH

Silvia Ferrara · Barbara Montecchi · Miguel Valério

Abstract · This work has two specific objectives: 1. The reconstruction of a palaeographic model that describes the relationship between the Cretan Hieroglyphic script and Linear A; 2. The structural analysis of the sign distribution of the two scripts and the distribution of their sign sequences (or sign groups). The two sets of analysis aim to establish via rigorous, solid parameters the degree of relation between the two scripts, by reconstructing through an evolutionary dimension the development of each sign and by establishing its positional distribution in each script corpus. The conclusions indicate that, despite sharing a nucleus of signs, the two scripts show notable divergences: a percentage of Linear A signs is not shared by the Cretan Hierolgyphic, which implies innovation strategies from a common template. In addition, the analysis of the two writing systems shows that no sign sequences are shared, in addition to different positional distributions. This evidence indicates that Linear A was the result of substantial adaptation strategies of the Cretan Hieroglyphic model.

Keywords · Linear A, Cretan Hieroglyphic, Palaeography, Adaptation.

In the first centuries of the second millennium BC, the island of Crete was a hub of writing creativity. At least two scripts were in use, the Cretan Hieroglyphic (CH) and Linear A (LA) script, and a third, isolated specimen, the Phaistos disk, which is often treated as a separate entity. The relationships between these scripts are still unclear, and as such have served as a platform for debate among Aegean epigraphists, linguists, and archaeologists. If the Phaistos disk is taken as a very iconic or 'figurative' outlier, CH and LA form an uneasy relationship. The problem is contextual, linguistic and epigraphic, because the two scripts coexist for almost two centuries, often in the same contexts, and are part of the same, broadly speaking 'Minoan' culture, if not administrative habitus.

While the contextual and historical implications are worth probing further, this article aims to analyse the palaeography of the two scripts, casting light on several, still poorly understood, features. The first set of questions relates to the sign repertoires: the goal is to address the level of similarity between the sign-repertoires, and to reconstruct a diachronic development for each sign shape wherever possible. The second set relates to the internal behaviour of their structures and the aim is to shed light, again, on the level to which the two scripts show coherence, similarity, or not: whether the scripts share entire sequences (or 'words'), and whether the inscriptions are comparable in terms of relative sign-distribution patterns.

We will devote the analysis to matters of palaeographic nature first, and then set out a discussion of how the inscriptions 'behave' from a structural perspective. We shall not enter the debate of which script comes first,[1] or try to explain their cohabitation from a contextual perspective.[2]

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[1] *Inter al.* I. Schoep, The origins of writing and administration, *OJA* 18.3 (1999), pp. 266, 270-273; J.-P. Olivier, Las escrituras egeas: 'jeroglífica' cretense, lineal A, lineal B, chiprominoicas y escrituras silábicas chipriotas del i milenio antes de nuestra era, in C. Varias (ed.), *Actas del Simposio Internacional: 55 Años de Micenología (1952-2007), Bellaterra 12-13 de abril de 2007*, Bellaterra, 2012 pp. 15 and 20.

[2] M. Perna, The birth of administration and writing in Minoan Crete: some thoughts on Hieroglyphic and Linear A, in D. Nakassis, J. Gulizio, S. A. James (eds), *KE-RA-ME-JA: Studies Presented to Cynthia W. Shelmerdine*, Philadelphia, 2014, p. 255; A. Karnava, Protopalatial Crete: One or More Economies?, *Pasiphae* 11 (2017), p. 28; M. Perna, A seal in the British Museum with a Cretan Hieroglyphic inscription (CR (?) S(1/1) 07), *Kadmos* 58 (2019), p. 57.

And although mention is made of the earliest attestations of Cretan writing, represented by the 'Archanes formula',[3] long thought to be direct evidence of continuity from CH into the LA 'libation formula', there is suspicion that the two formulas may not coincide.[4] If the traditional view that LA stems from CH is to be supported, we then need to explain how this derivation took place. This in turn entails a sign-by-sign reconstruction of its diachronic development even when such development is not observable within an accurate temporal framework or a precise archaeological setting. We will also need to make sense of the signs that are not shared by the two systems, whether in terms of innovation, adaptation or obsolescence.

1. Palaeographic comparisons between Cretan Hieroglyphic and Linear A signs

Previous tentative relations between the signs of the two scripts are laid out in Appendix 1. These are based on different interpretations, often carrying no explanation as to the strategies adopted in charting the sign correspondences. We intend to take a different approach, laying out a method for drawing 'evolutionary' lines across the two scripts, while setting rigorous parameters of analysis. Our approach aims to be comprehensive, charting the trajectories of development drawing only on the clearest and most identifiable shapes for each sign,[5] detailing observable graphic tendencies in sign development, and drawing parallels with motifs of Prepalatial and Protopalatial seals. As a proviso, in explaining derivation and development of specific signs, we have excluded inscriptions whose classification as CH or LA is considered uncertain.[6] While our palaeographic 'model' (Appendix 2) will not always present conclusive matches across the two systems, it still endeavours to avoid possible interpretive biases using a checking system that assesses the coherence of relationships between signs. To this end, we assigned one question mark for each of these circumstances: 1) the suggested graphic development from CH to LA does not follow any tendency, 2) the suggested graphic development implies a CH origin via an unattested LA sign that turns up in Linear B (CH 044 and LB 19), and 3) two or three competing developments can be postulated. Thus, a double (or triple, if applicable) question mark indicates the occurrence of any two (or three) such circumstances.

Our reconstruction of the sign correspondences across the two systems relied on specific parameters, organised as follows:

a) Sign orientation. The signs of the CH script, especially on seals, and to an extent on archival clay inscriptions too, are not consistently laid out in a coherent or standard orientation, as they can appear upside-down or rotated to 90 degrees. Also, signs as presented in the main reference corpus (*CHIC*) do not always reflect the orientation of the original. For 'normalising' orientation, we either relied on their recognisable iconicity or physical referent (shape of animal part, plant or insect), or in the case of aniconic signs, we relied on context, if proximal signs are oriented coherently. For their LA counterparts, we selected signs whose chronology, when applicable, is earlier (Middle Minoan) and thus closer to the CH temporal horizon.

[3] L. Godart, L'Écriture d'Archanès: hiéroglyphique ou linéaire A?, in Ph. P. Betancourt, V. Karageorghis, R. Laffineur, W. D. Niemeier (eds), *Meletemata: Studies in Aegean Archaeology Presented to Malcolm H. Wiener*, Liège, 1999, vol. 1, p. 299-302; J.-P. Olivier, Les écritures crétoises, in R. Treuil, P. Darque, J.-C. Poursat, G. Touchais (eds), *Les civilisations égéennes du Néolithique et de l'Âge du Bronze*, Paris, 2008, pp. 170-172; M. Anastasiadou, Drawing the Line: Seals, Script, and Regionalism in Protopalatial Crete, *AJA* 120.2 (2016), p. 171; R. Decorte, The first "European" writing: redefining the Archanes script, *OJA* 37 (2018), pp. 341-372.

[4] S. Ferrara, B. Montecchi, M. Valério, What is the 'Archanes Formula'? Deconstructing and reconstructing the earliest attestation of writing in the Aegean, *ABSA* 116 (forthcoming 2021).

[5] The range of palaeographic variations in CH can be found in the standard corpus *CHIC*, pp. 387-429; for LA, the microfiches attached to *GORILA* 5 and in the 'SigLA' online database (https://sigla.phis.me/).

[6] Documents #010, #014, #019, #048, #068, #122 are generally considered doubtful CH or LA (*CHIC*, p. 18 and V. Petrakis, Reconstructing the matrix of the 'Mycenaean' literate administrations, in P. M. Steele (ed.), *Understanding Relations Between Scripts. The Aegean Writing Systems*, Oxford, 2017, pp. 81-82). We also excluded #006 because it contains a single sign that could be interpreted as sign LA 122.

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b) *Sign shape configurations.* We considered sign shape configurations in terms of individual traits and their overall diagnostic character. If the sign shapes are complex and/or highly iconic or figurative, their correspondences and development can be reconstructed *icto oculi* or impressionistically. For example, CH sign 005 𐄁, which clearly depicts a human eye, and LA 79 𐘀 have three traits in common that occur in more than one of their instances: (1) an ovoid shape, (2) a central dot or stroke, surrounded by (3) multiple strokes. This rule also applies to signs which are iconic in CH, but undergo compression[7] resulting in different LA variants, which may preserve different traits of the original sign. This is seen, for example, in the graphic development from sign CH 020 𐄇, which depicts a bee, to LA sign 13 𐘍 (Fig. 1).

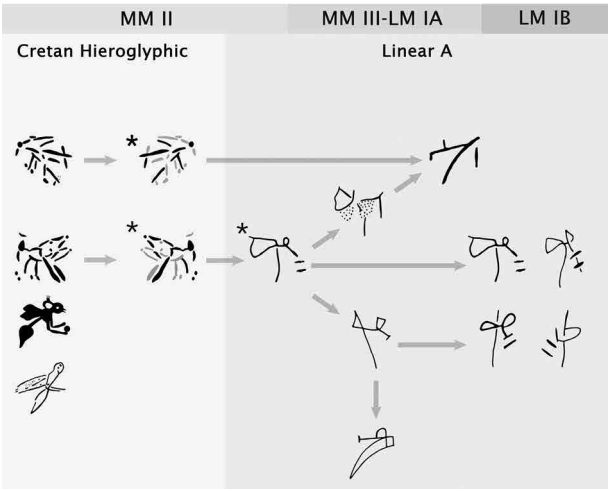

Fig. 1. Proposed diachronic palaeographic development from CH 020 to LA 13. Sign shapes marked with an asterisk are reconstructed and hypothetical.

c) *Signs with non-diagnostic basic traits.* In the case of basic geometric sign configurations, with simple traits (such as lines or dots), the chance of accidental resemblance is not unlikely, and thus a solid reconstruction proves more difficult. We can still map overall tendencies observable in the general style of LA palaeography. For example, sign CH 061, a zigzag line, can be seen as the precursor of LA 11, which in some attestations shows the same angular features of the CH examples. In other instances, LA uses more curved lines for the same segments. This tendency also applies to other signs, as sign CH 153 𐄯 developing into LA sign 120 𐘠, where its 'curvilinearity' is quite evident, given its iconic character.

1. 1. *Tendencies in the graphic development of signs*

In a similar fashion, we can chart developments following specific trends that we have categorised whenever possible. When the development of iconic signs across the two scripts is charted, our results often match correspondences that have already been suggested by other authors, since their figurative nature points in a clear direction; when more geometric shapes are concerned, we have adopted stricter criteria to outline possible trajectories that can help to explain their development. These are not intended to systematise or normalise the repertoires, but can offer a directional approach that facilitates the reconstruction of sign correspondences. The chart works with varying degrees of certitude, ranging from no discernible modification of the original sign shapes to a limited compression of strokes, and to the reduction of non-indispensable details. It is interesting to note that this diachronic inclination to simplify configurations is mirrored in all writing systems of the world whose trajectories can be mapped in successive stages of their use[8] and that the discard of non-essential traits rarely occurs at the expense of sign legibility or recognisability. The trends can be summarised as follows and are illustrated comprehensively in Fig. 2:

[7] For the use of the term 'compression' in lieu of the term 'simplification', P. Kelly, J. Winters, H. Miton, O. Morin, The Predictable Evolution of Letter Shapes: An Emergent Script of West Africa Recapitulates Historical Change in Writing Systems, *Current Anthropology* (forthcoming 2021), https://doi.org/10.31235/osf.io/eg489.

[8] P. Kelly *et al.*, The Predictable Evolution, cit. (n. 7).

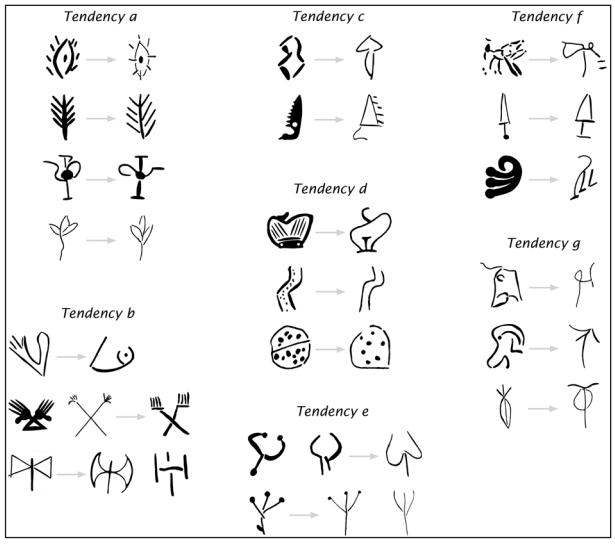

FIG. 2. Examples of the seven tendencies recognised in the graphic development from CH to LA.

a. Signs as a whole remain identical or very similar, except for changes throughout their later evolution in LA: CH 005 > LA 079; CH 006 > LA 048; CH 010 > LA 53; CH 017 > LA 85; CH 019 > LA 31; CH 023 > LA 122; CH 024 > LA 30; CH 025 > LA 04; CH 027 > LA 316; CH 031 > LA 27; CH 035 > LA 58; CH 038 > LA 57; CH 042 > LA 08; CH 052 > LA 24; CH 092 > LA 26; CH 156 > LA 131a; CH 157 > LA 123; SM 74 > LA 80. We refer here to the CH sign variants that, we argue, provided the template for their counterparts in LA.

b. Traits outlined as contours are reduced to strokes. Already in CH: CH 006 > LA 048; CH 008 > LA 28; CH 046 > LA 301; mainly in LA: CH 007 > LA 73; CH 009 > LA 01; CH 010 > LA 53; CH 011 > LA 05; CH 012 > LA 23; CH 016 > LA 22; CH 032 > LA 29; CH 042 > LA 08; CH 044 > LA 17 (the stamping part of the loop signet seal); CH 054 > LA 16 (the foot of the vessel); CH 095 > LA 10; SM 85 > LA 44. In the case of two animal signs the internal dots are also discarded: CH 012 > LA 23, CH 016 > LA 22 (the eye of the animal).

c. Traits outlined as contours are generally preserved, even if other traits are lost and the shape of the sign as a whole is simplified: CH 002 > LA 70; CH 013 > LA 61; CH 021 or 022 > LA 39; CH 043 > LA 324 (=370 ?) / LA 363 (= 364 ?); CH 045 > LA 74; CH 041 > LA 54; CH 054 > LA 16 (the body of the vessel); CH 058 > LA 69.

d. Multiple small internal strokes or dots are discarded or greatly reduced in their number: CH 011 > LA 05; CH 020 > LA 13; CH 021 > LA 39; CH 054 > LA 16; CH 058 > LA 69; CH 069 > LA 76; CH 077 > LA 78; CH 157 > LA 123.

e. Dots placed at the edges of strokes are discarded. Already in CH clay documents: CH 092 > LA 26. In LA: CH 031 > LA 27; CH 049 > LA 37.

f. Dots become straight lines or curved segments: CH 005 > LA 79 (the iris of the eye); CH 020 > LA 13 (the forelegs of the bee); CH 036 > LA 38 (the central battlement of the gate); CH 051 > LA 312 (the handle of the dagger); CH 054 > LA 16 (the base of the amphora); SM 137 > LA 50 (the tassels of the fringe or coil).

g. Vertical strokes become longer, emerge from the verticalisation of curved strokes, or are added anew: CH 012 > LA 23 (the neck of the animal); CH 016 > LA 22 (the neck of the animal); CH 026 > LA 09; CH 061 > LA 11; CH 153 > LA 120.

Tendency a (FIG. 2a) is clearly recognisable in signs that are figurative with identifiable referents, and appear also as simplified variants already attested in CH (especially, though not uniquely, on clay documents). Most of these comparisons have been met with consensus.

Tendency b (FIG. 2b) is especially productive among signs that depict human (CH signs 006-010) and animal body parts (CH signs 011, 012, 046).[9] Among the latter, it is worth mentioning the comparison between CH 011 and LA 05. Our palaeographic reassessment has prompted

[9] The shape of CH 046 was interpreted as an adze in A. J. EVANS, *Scripta Minoa: The Written Documents of Minoan Crete with Special Reference to the Archives of Knossos. Vol. I. The Hieroglyphic and Primitive Linear Classes*, Oxford, 1909, p. 189, no. 21, and, later, as a tool in *CHIC*, p. 16. Nevertheless, it rather looks like the hind leg of an animal on a stick.

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us to reinterpret the sign read as LA 06 on PH 6.1, KN Zf 31, and PL Zf 1 in *GORILA*, as a variant of LA 05 instead and to reconstruct its graphic development. PH 6.1 is the earliest attestation (MM II) and clearly shows a circle (), which might be a simplification of the ox's face (CH 011). The circle is in turn simplified in a dot on KN Zf 31 ()[10] and PL Zf 1. Finally, the dot becomes a short horizontal stroke in the widespread LM I variant of LA 05 . What links these three variants, and conversely distinguishes them from clear instances of LA 06 with a separated dot , is the vertical stroke attached to the top horizontal one. We can therefore recognise that both CH 011 and the early variants of LA 05 combine two shared traits, horizontal on top (the horns) and rounded at mid height (the face).

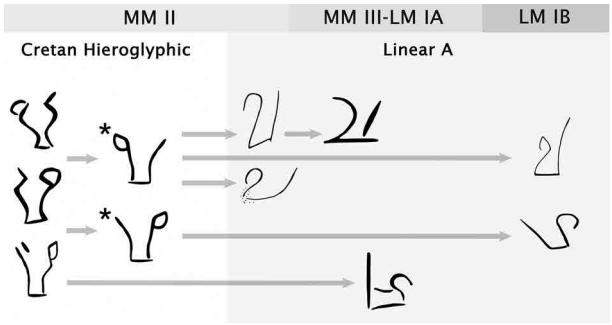

FIG. 3. Proposed diachronic palaeographic development from CH 053 to LA 60 (*tendency c*). Sign shapes marked with an asterisk are reconstructed and hypothetical.

Tendency c (FIG 2c) is evident in the transformation process of CH 053 into sign LA 60 . Original contours are preserved, but the strokes whittled down (Fig. 3). This may also apply to sign CH 037 , if two contiguous strokes were merged in a curve. Sign CH 094 might then be considered as an allograph of CH 037 and can be compared to sign LA 40 . This comparison, however, also implies the addition of a horizontal line at the base in LA.

Tendency d (FIG. 2d) is recognisable in signs which maintain their general outline, but contain multiple small internal strokes or dots in CH, and few or none in LA. A clear example is CH 058 and LA 69 , where the original internal strokes are reduced to one triangular trait or deleted in LA. In the graphic development from CH 011 to LA 05 we can also recognise *tendency d*, in addition to *tendency b* (explained above), since the dot eyes and naris of the most pictorial variants of CH are discarded in the most schematic variants of CH and LA.

Tendency e (FIG. 2e) focuses on dots placed at the edges of strokes in CH signs which have been discarded in LA, or even in the most schematic CH variants, as for example in sign CH 092. Another example is CH 031 , a vertical stroke, at times dotted, with three dotted strokes on it. Sign LA 27 , is clearly shaped similarly, but rarely maintains dots at the edges of the three upper strokes, showing the general tendency to lose this feature.

Under *tendency f* (FIG. 2f) are signs which show dots in CH, corresponding to straight lines or curved segments in LA. For example, both CH 051 and LA 312 are shaped like a dagger, but in CH 051 the handle of the dagger ends with a dot, while in LA 312 with a straight line. The same way, dots at the edge of the forelegs of the bee sign CH 020 become short straight lines in sign LA 13 (FIG. 1).

Finally, *tendency g* in LA is very productive (FIG. 2g): CH vertical strokes become longer, emerge from the verticalisation of curved strokes, or are added anew. This is particularly evident in the signs which depict domestic animals, i.e. sign CH 012 , 016 , and 017 , from which we suggest LA 23 , and 22 , and 85 respectively derive. LA 22 and 23 feature a vertical line as a fossilized depiction of the neck of the animal, whereas a vertical line is added anew to LA 85 on KH 6.7.[11] Moreover, the preference for vertical strokes may have been part of a wider tendency in LA. Worth noting that 39 out of the first 90 LA signs (43%) are articulated on a vertical axis, especially in their more 'canonical' variants from LM IB: LA 01 , 02 , 03 , 04 , 05 , 06 , 07 , 08 , 09 , 11 , 13 , 16 , 17 , 20 , 21 , 21^{f} , 21^{m} , 22 , 22^{f} , 22^{m} , 23 , 23^{m} , 24 , 26 , 27 , 28 , 28b , 30 , 31 , 41 , 44 , 66 , 69 , 79 , 120 , 120b , 122 , 303 , 304 . This

[10] KN Zf 31 features very conservative and pictorial sign shapes, like the spider-like LA 44 and the spouted-jug LA 24 (St. ALEXIOU, W. C. BRICE, A Silver Pin from Mavro Spelio with an Inscription in Linear A, *Kadmos* 11 (1972), p. 113-24).

[11] Marked as doubtful reading in *GORILA* 5, p. 271.

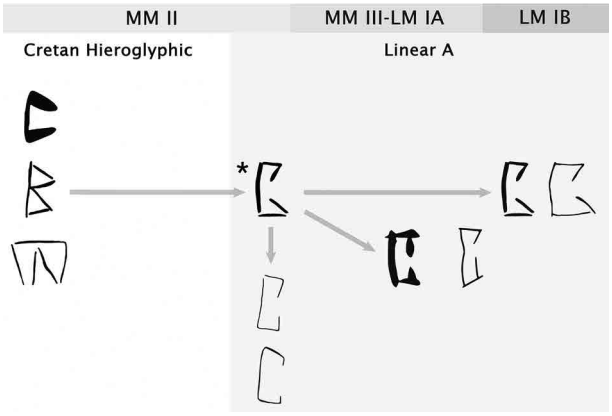

Fig. 4. Proposed diachronic palaeographic development from CH 034 to LA 59 (none of the *a-g tendencies*). Sign shapes marked with an asterisk are reconstructed and hypothetical.

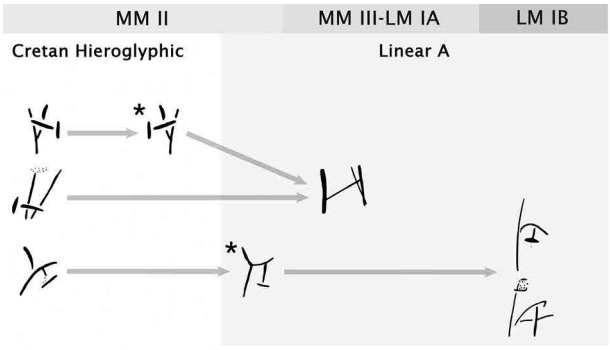

Fig. 5. Proposed diachronic palaeographic development from CH 057 to LA 65 (none of the *a-g tendencies*). Sign shapes marked with an asterisk are reconstructed and hypothetical. The reconstructed early Linear A shape is consistent with sign LA 355 (hapax attested in PH 10).

predominance is even more significant as the same feature is far rarer in the CH repertoire. In conclusion, *tendency g* is a common trend in LA, and it allows us to compare CH signs without such feature, especially in cases where MM II attestations are not present.

1. 2. *Suggestions which do not follow any of the above tendencies*

The tendencies we have outlined cannot explain all sign developments. Some signs (CH 039 and LA 56, CH 034 and LA 59, CH 048 and LA 305, CH 057 and LA 65) depart from any categorisation. However, when the traits remain stable in number, comparisons are still viable. The oblique crossing strokes of sign CH 039 became horizontal in sign LA 56. This kind of adaptation is not attested anywhere else, but this might be tied to the almost complete absence of crossing strokes in any other CH sign. Likewise, the number of traits does not vary between sign CH 034 and sign LA 59. This suggests that the closed contours in sign CH 034 became open in sign LA 59 (Fig. 4).

The number of traits does not vary between sign CH 057 and LA 65 either, if we focus on certain variants, namely CH 057 as attested on #027.δ and LA 65 as attested on HT 97a.3 and ZA 6b.1 (Fig. 5). More schematic LA variants can be explained with compression.

Conversely, the comparison between LA 305 and CH 048 entails the loss of the short horizontal "arrow" and then, as an innovation largely attested in later documents from Hagia Triada, the same kind of opening suggested above for sign CH 034 into LA 59.

1. 3. *LA signs for which two CH comparisons are possible*

Two competing hypotheses, each one implying a different tendency, are possible about the graphic origin of signs LA 02, 38, and 39. Moreover, the same tendency can lead to two mutually exclusive hypotheses about the origin of sign LA 06. We will discuss these four signs individually.

LA 02 is a very simple cross, therefore it can be compared with either CH 070, which would have lost its dots according to *tendency e*, or with CH 062 (vertical stoke with a dot in the middle), assuming that the central dot became a horizontal stroke in LA, according to *tendency f*. The original shape of LA 38 is difficult to retrace because it ranges widely and is poorly attested at the early stages of the script. Only two hypotheses show a coherent development. The first focuses on the similarity between the variant of LA 38 with short horizontal strokes crossing the two main oblique strokes and CH 028. In this case, we could recognise *tendency d*, the reduction

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of multiple internal strokes, before their rearrangement on the oblique strokes (Fig. 6).

The second hypothesis is grounded on the similarity between the earliest variants of sign LA 38 with one or two horizontal strokes and CH 036 . The comparison between CH 036 and LA 38 would lead to reassessing the variants of the latter on KN Zc 7.1, LA Zb 1, and PS Za 2.2, which had been classified as uncertain allographs of LA 37 in *GORILA*. Indeed, they look similar to instances of LA 37 (e.g. HT 27a.1 and Za 15a.3), but are in fact characterised by a curved horizontal line making them comparable to sign LA 38 on PH 2.3, 24, and PK Za 8a. *Tendencies b* (traits outlined as contours are reduced to strokes), *d* (internal dot is discarded), and *f* (dot becomes a straight line) can be recognised in different variants (Fig. 7).

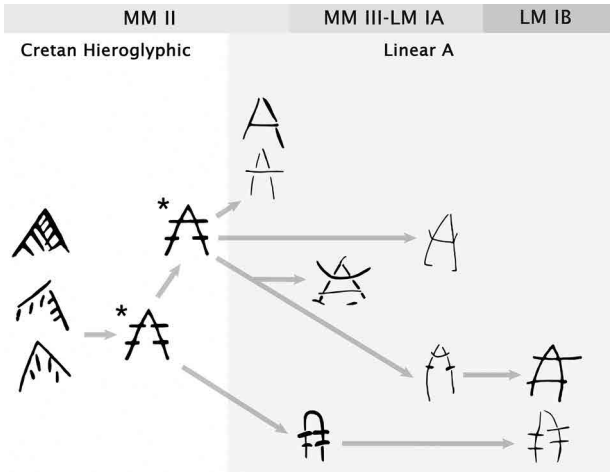

Fig. 6. Proposed diachronic palaeographic development from CH 028 to LA 38. Sign shapes marked with an asterisk are reconstructed and hypothetical.

The precursor of the insect-like LA 39 is often found in the fly-shaped CH sign 021 , but LA 39 features two converging short strokes which resemble antennae, which flies do not possess. Two hypotheses remain open: either they derive from the two dots representing the eyes of the fly-shaped CH 021, according to *tendency f*, or they match with the oblique upper strokes of CH 022 , whose body could have been simplified following *tendency c*.

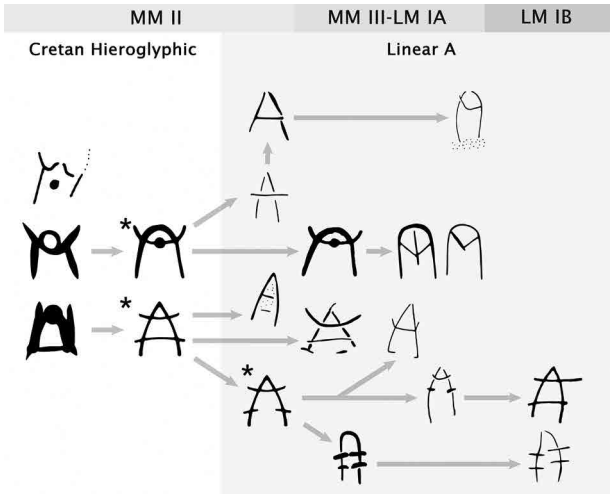

Fig. 7. Proposed diachronic palaeographic development from CH 036 to LA 38. Sign shapes marked with an asterisk are reconstructed and hypothetical.

The earliest attested variant of LA 06 consists of one top horizontal stroke and a series of broken vertical segments , as we see in PH 16a.1 (MM IIB). Later attestations may show dots, as for example on MA 2c.1 (MM III), or a single uninterrupted line in lieu of the segments, and two, instead of one, horizontal top strokes, as for example on PH 1a.1 (MM IIIB). The top dot of CH 062 might have been transformed into a line, according to *tendency f*, while its vertical line might have been at times broken to avoid any possible confusion with other similar signs, such as LA 05 and fraction LA 708 (which is T-shaped). An alternative is that the dotted variant is more conservative, as it is also incised on stone vessels (IO Za 2, KN Za 19, KO Za 1), whose *ductus* is more detailed than on clay. In this case, the graphic development might originate with dots, turned into segments, and into a single vertical line, so that LA 06 would become comparable with the triton shell motif (Appendix 3).

1. 4. *CH signs for which two LA developments are possible*

The shapes of three CH signs can be compared with more than one LA sign. The first is sign CH 043, whose most schematic variants can be compared to LA 324, whereas the most iconic ones are

better matched with LA 363 and 364. Since sign LA 324 is only attested twice at Hagia Triada, and LA 363 and 364 are only attested once at Zakros, LA 324 may be a regional variant of either LA 363 or 364. The second is sign CH 044, which is very similar to the rare LB sign 19. Therefore, one possibility is that the sign also existed in LA, though not attested. Nevertheless, the shape of sign CH 044 might also be compared with LA 17: their upper part is almost identical, while the lower part would have been reduced to a vertical stroke in the passage to LA, according to *tendency b*. Finally, the spear-shaped CH 050 can be compared with two arrow-like signs: LA 304 and LA 20.

1. 5. *LA sign comparisons with MM seal motifs*

We have also considered possible comparisons between LA signs and four graphs which are not considered CH signs in *CHIC*, but rather as possible meaningful decorative motifs attested in sequences with accepted CH signs (Appendix 3).[12] Three of these motifs were recognised as signs by Evans[13] and have been already compared with LA 80, 44, and 50, respectively, by other authors (Appendix 1), while the fourth is the triton shell whose possible comparison with LA 06 has been mentioned above. Currently, the interpretation of these graphs as writing *stricto sensu* is disputed.[14]

Finally, we detected three possible comparisons between MM seal motifs that seem never attested along with any other CH signs, and LA signs: the whirls and LA 77, the flying birds and LA 81, the scorpions and LA 41 (Appendix 4). Two possibilities remain: 1) the motifs are the predecessors of unattested CH signs from which LA signs derived,[15] 2) some seal motifs worked as sources of graphic inspiration for new LA signs.

The examination of observable tendencies, outlying developments which can still be reconciled through comparative assessments, a broader contextualised approach including iconographic seal motifs, and a close cross-palaeographic scrutiny, constitute a novel and in-depth approach to the signaries, and it is only through such strategies that we can hope to reconstruct individual sign developments from CH to LA to an exhaustive degree which encompasses the bulk of the two systems.

2. Structural comparison of Cretan Hieroglyphic and Linear A

The results of the comparative palaeographical analysis just presented show that a large proportion of the signary of CH shares a close relationship with that of LA. In this section, we address the material from a structural (or internal) perspective to show to what extent these results can be supported. This entails the examination of data on the distribution of signs in their behavioural patterns, independently from their shape and any assumptions regarding their phonetic or semantic value. Such data comprises the frequencies of the signs (in absolute terms or in terms of their occurrence in specific positions and arrangements) as well as their combinatorial behaviour as sign groups.[16] However, we also searched for matching pairs of sign groups, as a test to the hypothesis that certain CH signs were related to specific LA ones.

2. 1. *Compared distributions*

We compared the frequencies of the CH and LA signs, as matched in Appendices 2 and 3. The results are uneven, as they show some sign correspondences or pairs with similar frequencies,

[12] *CHIC*, pp. 13-4.

[13] A. Evans, *Scripta Minoa*, cit. (n. 9), pp. 209 (no. 74), 212 (no. 85), and 230 (no. 137).

[14] A. M. Jasink (*Cretan Hieroglyphic Seals. A New Classification of Symbols and Ornamental/Filling Motifs*, Pisa-Roma, 2009, pp. 46-49, 137-140, 189-190), vis à vis M. Civitillo's "icons" (*La scrittura geroglifica minoica sui sigilli: il messaggio della glittica protopalaziale*, Pisa-Roma, 2016, pp. 140-159).

[15] Sign CH 033 may have even originated from the whirl motif and may have had a variant with the external circle, although unattested so far, from which LA 77 could have derived.

[16] The phrase 'sign group' is here preferred for CH because in this script groups of signs do not always form aligned consecutive sequences (as is generally the case with Linear A).

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and others that differ significantly. For example, CH 042 𐄇 is the fourth most frequent sign of CH and represents 4.3% of the total signs. Its proposed development, sign LA 08 𐄃, is the third most frequent sign in LA and represents 3.2%. Moreover, even if we discounted attestations in repeated sign groups, the frequencies of these two signs would increase in similar proportions: 5.4% for CH 042 and 4.8% for LA 08. The opposite behaviour can be seen in CH 024 = *155 𐄎. This is a rare sign in CH (eight attestations representing 0.1% of the corpus), unlike its counterpart, LA 30 𐄁, which is frequent in LA (113 times attestations, 2.1% of the corpus).

The disparities observed are not just in terms of frequency, as we also find pairs of signs which diverge as to how often they are found in isolated position, *vs* their use in sign groups. For instance, sign CH 024 occurs six times in isolation, and only twice as part of a group. Very differently, its counterpart LA 30 is attested in sign sequences almost as often (47 times) as it is attested single (52 times).

Signs that are part of groups or sequences can also behave differently in terms of positional frequency. This refers to whether they occur in initial, medial, or final position, and how often. This is difficult to determine in CH, because, first, the reading direction of CH sign groups is not always clear (><), second, this overlooks the possibility that CH sign groups may not be fully syllabic sequences. It remains possible, if difficult to ascertain, that some sign groups in CH spell not one, but multiple morphemes, and comprise signs such as logograms or semantic determinatives in addition to phonograms (syllabograms).[17] If such spellings occurred, they might invalidate any positional frequency comparison with Linear A, where, differently, evidence suggests that sign sequences are mainly phonetic. We would not be comparing the same things. There is an even greater risk when comparing CH signs that are scarcely attested. Indeed, 83 signs in CH are attested fewer than 10 times, and 36 of them occur only once. Thus, we will examine only the positional frequency of a few better-attested CH signs in section 2.4.

In conclusion, there are notable discrepancies in terms of absolute frequency and behaviour of some matching signs. Yet this result is not surprising. Since it is an accepted notion that CH and LA are different scripts, we should not expect signs of one writing system to mirror exactly the distribution of their counterparts in the other system, even if they are related. Modifications to the precise sign values, differences in terms of the languages represented, different textual subject matters, or a combination of all these factors, can skew the figures. As an example of the change that might have caused different distributions, we can take signs CH 024/*155 𐄎 and LA 30 𐄁. CH 024/*155 is mainly attested as a single sign (what is numbered as *155 in *CHIC*), with only one possible case of use in a group (numbered CH 024 in *CHIC*). This might be due to a gap in the evidence at our disposal or to a shift in the function of the sign. Under this second hypothesis, the sign might have been only a logogram (for 'figs') in CH, which was afterwards adapted both as a logogram for figs and a phonogram (*ni*) in LA.[18] The addition of the phonetic value would explain why the sign is much more frequent in LA both in absolute terms and in sign groups.

Another striking divergence stems from the fact that the one of the most frequent CH signs, 056 𐄐 (61 attestations, 3.7% of the corpus), found both on stone and clay inscriptions, has no development in LA. The opposite also occurs: LA 81 𐄽 (5.6%), 77 𐄢 (5.2%) and 41 𐄤 (4%) are three of the four most frequent signs in LA, yet they have no correspondent in CH.[19] It is perhaps telling, though, that for these three signs we found matches among the 'motifs' or icons of MM seals

[17] Comparative evidence shows that in all potentially newly created iconic scripts (i.e. scripts with novel shapes in the repertoires of their signs) words were spelt logographically, and sometimes logo-phonetically, especially at their earliest stages of development (W. G. Boltz, *The Origin and Early Development of Chinese Writing System*, New Haven, 1994; S. D. Houston, Writing in early Mesoamerica, in S. D. Houston (ed.), *The First Writing: Script Invention as History and Process*, Cambridge, 2004, pp. 274-309; M. Valério, S. Ferrara, Rebus and acrophony in invented writing, *Writing Systems Research* 11.1 (2019), pp. 66-93).

[18] We resort to this example because LA 30 *ni* is commonly cited as deriving its value by acrophony from a non-Greek word for 'fig' (after G. Neumann, Zur Sprache der kretischen Linearschrift, *Glotta* 36 (1957), pp. 157-158).

[19] Notice that the third most frequent sign of LA is 301 𐄻 (279 attestations and 5.1% of the corpus), but its frequency is skewed by isolated attestations on nodules, and its representativeness falls sharply to 0.7% of the corpus if we count non-repeated attestations.

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(Appendix 4), which is a crucial factor when examining the shared and non-shared palaeographic material.

2. 2. *Shared and not shared signs*

As to the shared repertoire across the two scripts, our reconstructed correspondences (Appendix 2) indicate that 61 signs of CH have corresponding signs in LA. This number needs to be examined in light of its relative weight in the two scripts, because the heavier it is, the closer the relationship between CH and LA will be.

To the standard repertoire of CH comprising 96 'syllabograms' and 31 'logograms' we added five 'extra' signs (treated as 'decorative motifs' in *CHIC*): SM 74 (cat), SM 95 (spider), SM 137 (tassels), 'waterfowl', and 'triton', for a total of 132 sign shapes. However, the absolute number of shared signs vs. non-shared signs between CH and LA cannot be the starting premise. First this is because five signs are attested only on inscriptions of dubious classification, so their status as CH is disputed: CH *151, *154, *164, *165, and *175. For this reason, we excluded them for our palaeographic analysis. Second, signs CH 091 and 093 are hapax of problematic interpretation.[20] Third, among the so-called 'logograms' of *CHIC*, eight signs are actually 'syllabograms' used in isolation on accounting clay documents and so they are duplicate entries in the corpus: CH *152 (= 013) , *155 (= 024) , *159bis (= 023) , *160 (= 054) , *174 (= 031) , *176 (= 050) , *177 (= 062) , *178 (=077) . Finally, and most importantly, several CH sign shapes are very rare or hapax. Hapax in particular are in the very high number of 36, and it is likely that in some cases we are dealing with mere variants of other signs: for example, CH 074 and 075 (attested in #053.c) may both be variants of the better attested CH 078 ~ .

Rather, we should examine the frequencies of the 61 signs of CH that have counterparts in LA. From this perspective, it turns out that they represent as much as ~86% of the legible signs in the corpus of CH.[21] This is a high figure, and it supports the notion that CH was the model from which LA was created, even if in this process some modifications affected the number of signs. Only five CH signs (roughly 0.5% of the corpus) lack counterparts in LA.[22] The rest of signs that are not shared show very low frequencies. Sign CH 006 , attested 12 times adding to 0.7% of the corpus, had no counterpart in LA till recently, when one attestation of AB 48 was reported.[23] We thus may still discover very rare signs in LA that matched some of the five CH exceptions.

And how representative are the 61 signs shared in LA? A total of 182 different signs are listed in *GORILA* 5 (excluding combinations and ligatures), to which we should also add two new signs from inscriptions published afterwards.[24] Some of these 184 LA signs are very rare or hapax, especially in the series numbered A 307-373, and might be variants of other signs. The number of hapax is high (59), but represent only 1% of the corpus, and so 99% of the LA material consists of a mere 125 different sign shapes.

In the same way, the 61 signs represent 2/3 of the LA repertoire when we consider their frequencies. Crucially, this is considerably lower than the percentage of shared signs within CH (~86%). What are we to make of this result? The 1/3 of LA signs that are not shared with CH

[20] CH 091 is a hapax from an inscription on a vase (#331) that might not be a sign. CH 093 has a single damaged attestation (#317) dubious in the corpus.

[21] This percentage can vary slightly depending on whether we count CH 028 (1.5%) or CH 036 (1.7%) as the counterpart of LA 38 , and whether we count CH 022 (0.03%) or CH 021 (0.6%) as the counterpart of AB 39 . Note, however, that preferring CH 063 (0.5%) over 070 (4.42%) as the pair for AB 02 would reduce the percentage to approximately 82%.

[22] CH 060 (9 attestations, 0.6%), CH 018 (13 attestations, 0.8%), CH 047 (17 attestations, 1%), CH 029 (20 attestations, 1.2%) and, as already mentioned, CH 056 (61 attestations, 3.7%).

[23] P. Muhly, J.-P. Olivier, Linear A inscriptions from the Syme sanctuary, Crete, *AE* 2008, pp. 207-208.

[24] The new signs attested respectively on PYR Wc 4b (P. Rehak, J. G. Younger, A Minoan Roundel from Pyrgos, Southern Crete, *Kadmos* 34 (1995), pp. 83, 92), and KH Wc 2123 (M. Andreadaki-Vlasaki, E. Hallager, New and Unpublished Linear A and Linear B from Khania, *Proceeding of the Danish Institute at Athens* 5 (2007), pp. 13-15).

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include a significant number of shapes catalogued in the A 300 series, some of which are very rare or hapax, and might therefore be variants that do have recognisable precedents in CH. Likewise, the set of vessel logograms A 400-418 lacks antecedents in CH,[25] but they have very low frequency.[26] In other words, the series of vase logograms and a good part of the signs in the A 300 series cannot account for the lower percentage of matches in the LA repertoire.

Which are, then, the signs of the LA corpus that represent greater portions of material with no parallels in CH? And how might they account for this difference? To address this question, we focused on 22 signs which occur 10 or more times (representing each ca. 0.2% or more of the corpus), adding up to 28.6% of the corpus. These 22 signs constitute the 1/3 that LA does not share with CH. They are listed in Table 1.

Table 1. LA signs without counterparts in CH that are attested more than 10 times (≥ 0.2% of corpus), by decreasing order of frequency.

Sign	Attestations	% of legible corpus
AB 81	304	5.57
AB 77	282	5.17
AB 41	217	3.98
AB 67	136	2.49
AB 07	106	1.94
A 302	103	1.89
A 303	83	1.52
AB 51	61	1.12
AB 100/102	48	0.88
AB 21f	34	0.62
AB 45	28	0.51
AB 118	22	0.40
AB 188	22	0.40
A 306	19	0.35
AB 66	15	0.28
411 VAS	14	0.26
A 308	12	0.22
AB 46	11	0.20
AB 47	10	0.18
AB 180	10	0.18
A 307	10	0.18
A 310	10	0.18

These signs reflect three circumstances that may explain why they have no predecessors in CH. The first and most numerous group comprises signs that behave like, or accompany commodity logograms, at least in some instances: LA 100/102 𐄁,[27] 118 𐄃, 302 𐄂, 303 𐄀, 307 𐄄, 308 𐄅, and 411 𐄇.

[25] Excluding CH 054 𐋡 (> LA 16 𐋠 *qa*), which is used as a logogram at least once (cf. CH *160 in #053.b), CH has only three vessel signs: CH 055, *161 and *162 (the latter is a hapax and probably a variant of *161). They are all graphic combinations of a vessel with a plant inside or on top of it, perhaps to suggest vessel contents. Vessel logograms in LA are more varied and often ligatured to other signs to indicate commodities.

[26] I. Schoep, *The Administration of Neopalatial Crete. A Critical Assessment of the Linear A Tablets and Their Role in the Administrative Process*, Salamanca, 2002, p. 127.

[27] LA 100/102 is compared to CH 004 in *CHIC* (p. 19), but, according to the methodology adopted here, the palaeograph-

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It is possible that some of these signs, if not all, were introduced or became more frequent in LA as a response to changing economic or administrative practices. This would account for the absence of equivalents for them so far in the CH material.

The second circumstance concerns signs used in syllabic sequences, but which have, currently, no hypothetical phonetic transcription (because they lack a counterpart in Linear B or, if one exists, it remains undeciphered): 47 , 306 , and 310 ; 100/102 and 118 are also occasionally used in sequences and thus belong here as well. It is possible that they have sound values that were not represented in the CH script, and that their addition to the repertoire of LA was an adaptive modification.

The remaining 10 signs that are not shared, all in syllabic sequences, represent a third circumstance: LA 07 , 21[f] , 41 , 45 , 46 , 51 , 66 , 67 , 77 , 81 . Six of them, 07, 45, 51, 67, 77, and 81, have something in common that might help account for their lack of correspondents in CH. However, the possible pattern surfaces if we turn to the experimental method of applying values to Linear A signs from Linear B when supported by contextual evidence. If we transcribe these seven signs, we see that they comprise a good portion of two syllabic series. Thus, CH 009 >? LA 01 *da* being the exception, we could not reconstruct CH models for most signs in the LA *d* series (LA 07 *di*, 45 *de*, 51 *du*). Likewise, we could propose CH 002 and SM 85 (spider) as the counterpart for LA 70 *ko* and 44 *ke*, but no correspondents were found for LA 77 *ka*, 67 *ki*, and 81 *ku*. At the same time, for LA 77 *ka* and 81 *ku* we found comparisons with the motifs engraved on MM seals, and this is also the case with LA 41 *si*. This might be simply due to missing evidence in CH, or reflect the absence of sounds represented by the *d* and *k* series in CH (notice that it is not certain that CH 002 and 009 and SM 85 were phonetic signs in CH), so these two series might have been developed to notate them. All three circumstances work towards explaining that the LA signs which are not shared with CH can be interpreted as adaptive modifications.

2. 3. *Shared sign groups?*

In the third step of analysis, we turned to sign groups (or sequences) that are shared by the two scripts. To reduce the risk of similarity by chance, we examined relatively long sign groups, made of three or more signs. Our results show no matching sequences, even when longer sequences are considered.

The 'Archanes formula', 042-019, 019-095-052 (#179, #202, #203, #205, #251, #252, #292, #313, #315) frequently cited as the only sign sequence with a counterpart in LA,[28] namely 57/08-31-31-60-13 > (*j*)*a-sa-sa-ra-me* from stone libation vessels and other objects, shows evidence of no continuity into LA, as the first part of the 'formula' (042-019) is found on its own on CH inscriptions (#134, #135, #136, #137, #137bis, and *CMS* VII 31).[29] Also, our reconstructed graphic developments suggest that signs CH 095 and 052 are the counterparts of LA 10 *u* and 24 *ne*, which hinders any close connection to LA *a-sa-sa-ra-me* (019-095-052 > hypothetical *SA-U-NE*).[30]

The absence of matching sequences in the two scripts must be seen in the same way as the uneven distributions of signs: it does not contradict the notion that CH and LA were closely related, but it does not support it either.

2. 4. *Testing the matches*

We can shed light on the degree of similarity between the two scripts by testing whether the equivalences between signs correspond to similar or identical phonetic values. If evidence can be found it can reinforce the notion that CH and LA were closely related.

ic differences between the two were too significant. This led us to exclude LA 100/102 as derived from CH 004. Rather, we argue that they look similar because the physical referent, a human figure, is the same.

[28] *Inter al.* A. Karnava, On sacred vocabulary and religious dedications: the Minoan 'libation formula', in E. Alram-Stern, F. Blakolmer, S. Deger-Jalkotzy, R. Laffineur, J. Weilhartner (eds), *Metaphysis: Ritual, Myth and Symbolism in the Aegean Bronze Age. 15th International Aegean Conference, University of Vienna, 22-25 April 2014*, Leuven, 2016, pp. 352-355; M. Perna, A seal in the British Museum with a Cretan Hieroglyphic inscription (CR(?) S (1/1) 07), *Kadmos* 58 (2019), pp. 51, 54-56.

[29] A. Karnava, On sacred vocabulary and religious dedications, cit. (n. 29), p. 352.

[30] Ferrara, Montecchi, Valério, cit. (n. 4).

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This method is identical to the one applied to the signs of LA using LB values as a starting point. Building upon earlier works,[31] Duhoux performed three tests:[32] he listed multiple pairs of matching LA-LB sign sequences, typically personal and place names (e.g. *su-ki-ri-ta* 'Sybrita'), showing slight differences reflecting the use of Greek endings in LB (e.g. LA *a-ra-na-re vs.* LB *a-ra-na-ro*, a non-Greek male personal name). He then compiled LA sign sequences that occurred in similar contexts, but showed slight spelling variations, hinting at the validity of the values (e.g. *a-ta-i-*301-wa-ja* and *ja-ta-i-*301-u-ja*). Finally, he showed that the suspected 'pure vowel' syllabograms of LA (08 *a*, 38 *e*, 28 *i*, 61 *o*, and 10 *u*) are most frequent in initial position, as expected.

The first of these tests yields no results in our case: there are no comparable pairs of sign sequences in CH and LA. The result should not be taken as indication that the matching signs of the two scripts are not related. Factors that can account for this result include the relatively small corpus of CH texts at our disposal, their brevity and their typological differences from the linear scripts, and, not marginally, the possibility that sign groups in CH may have not been confined just to phonetic spelling.

The second test, which aims at finding slight spelling variations in CH, is also fraught. First, it relies on assigning experimental values that are projected backwards from LB via LA. Yet in many cases, a CH sign cannot be transliterated even experimentally because it either lacks a counterpart in LA or matches with a LA sign that cannot itself be transcribed. Second, we stumble again over the uncertainties as to how CH functioned. Finally, this test requires a significant number of long sign groups for comparison, because shorter ones would increase chance similarities. Yet the corpus of CH comprises only 50 sign groups that contain four or more legible signs, which is arguably insufficient to perform the test. We must conclude in this respect that material at our disposal is hardly informative.

The third test – looking into the positional frequency of suspected vowel signs – is the most promising, as it relies on a tendency that shows independently from the language notated. The identification of vowel signs was a major breakthrough in the decipherment of LB. Ventris deduced the values of LB 08 *a* and 61 *o* as simple vowels (V) from their expected high initial frequency. Vocalic signs have a preference for this position due to constraints on syllabic scripts with V and consonant+vowel (CV) phonograms: they will be used in initial position every time a word begins with a vowel, but in the middle of a word they will occur only when a vowel follows another vowel.[33] Of course, we cannot exclude that CH possessed signs of the VC or CVC type, but even if so a vowel sign would likely be very frequent in initial position, especially if it stood for /a/.

Thus, we turn to CH 042 > LA/LB 08 *a*. The correspondence is undisputed (Appendix 1), and CH 042 is one of the most frequently attested CH signs. Out of the 49 attestations of CH 042, excluding repeated sign groups, 32 instances (65.3%) show in initial position, 11 (22.4%) are either initial or final depending on reading direction (><), 5 (10.2%) are medial, and one (2%) is initial in *CHIC*, but could be isolated. Thus, the percentage in initial position ranges between 65.3% and a maximally 89.8%. This compares well with the percentage of LA and LB 08 *a* in initial position: 89.7% and 93.5%, respectively. Even if CH 042 was used sometimes with a possible semantic value (as a logogram or a semantic determinative),[34] its positional frequency is still strongly initial, which is consistent with a vowel value.

[31] D. W. Packard, *Minoan Linear A*, Berkeley, 1974; J. T. Hooker, Problems and methods in the decipherment of Linear A, *JRAS* 2 (1975), pp. 164-172; L. Godart, Du linéaire A au linéaire B, in C. Nicolet (ed.), *Aux origines de l'hellénisme: La Crète et la Grèce. Hommage à Henri van Effenterre*, Paris, 1984, pp. 121-128.

[32] Y. Duhoux, Le linéaire A: problèmes de déchiffrement, in Y. Duhoux, T. G. Palaima, J. Bennet (eds), *Problems in Decipherment*, Louvain-la-Neuve, 1989, p. 59-119. See also B. Davis, *Minoan Stone Vessels with Linear A Inscriptions*, Leuven, 2014; P. M. Steele, T. Meissner, From Linear B to Linear A: The problem of the backward projection of sound values, in P. M. Steele (ed.), *Understanding Relations Between Scripts. The Aegean Writing Systems*, Oxford, 2017, pp. 93-110.

[33] J. Chadwick, *The Decipherment of Linear B*, Cambridge, 1970 (2nd ed.), pp. 51-52; M. Pope, *The Story of Decipherment: From Egyptian Hieroglyphs to Maya Script*, London, 1999 (Rev. ed.), pp. 168, 171, 174. It should be noted, however, that a small number of languages in the world avoid vowels in word-initial position.

[34] S. Ferrara, De la figure à l'écriture. Tradition, iconographique et naissance du Hiéroglyphique en Crète minoenne, *Terrain* 70 (2018), pp. 97-99.

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Table 2 contains the same analysis of frequency in initial or ambiguous initial/final (><) position for CH 008, 013, 028 vs. 036 and 095, the other signs suspected of being the source of LA vowels:

Table 2. Absolute frequency and frequency in initial position of CH 008, 013, 028, 036 and 095.

Sign	Proposed LA counterpart	Freq. corpus	Total attest. in groups (excl. repetitions)	Initial attestations	Initial %	Initial / Final attestations	Initial / Final %
CH 008	LA 28 *i*	0.6%	7	4	57.1	3	42.9
CH 013	LA 61 *o*	1.8%	24	3	12.5	2	8.3
CH 028	LA 38 *e*	1.5%	24	11	45.8	5	20.8
CH 036		1.7%	16	9	56.3	5	31.3
CH 095	LA 10 *u*	0.1%	1	0	0	0	0

Signs CH 008 (> LA 28 *i*?), CH 028 and CH 036 (> LA 38 *e*?) show distributions that are compatible with 'pure vowel' values. CH 008, 028 and 036 are initial approximately half of the time, and the percentages would increase to 100%, 66.4% and 87.6% of initial frequency, respectively, if they also began a sign group in all cases of ambiguous reading direction. Also, CH 028 and 036 are both frequent signs (1.5 and 1.7% of the corpus); and while CH 008 is less so (only 0.6% of the corpus), the fact that it might potentially be initial 100% of the time is significant.

From the perspective of our palaeographical approach, both CH 028 or 036 were feasible models from which LA 38 *e* could have developed, but it is striking that CH 036 is mostly used on seals, very rarely on clay documents, and it is largely associated with the sign groups 036-092, 036-092-031, and variations thereof. Such formulaic use is inconsistent with a vowel. Conversely, CH 028 is attested both on seals and clay documents and in a greater variety of sign groups.

CH 013 (> LA 61 *o*?) and CH 095 (> LA 10 *u*?) present more problematic behaviour. CH 013 is a frequent sign, but when it is attested in groups it is rarely initial. Even counting ambiguous cases, it would not begin a sign group more than 20.8% of the time. CH 095 is a very rare sign, limited to the so-called 'Archanes formula', and never initial. Its distribution is not consistent with that of a vowel sign at all. This may be explained by the behaviour of vowel signs in syllabic scripts, which to an extent can be affected by the language notated. Thus, Chadwick noted that in the Cypriot Greek syllabary *a* and *e* are indeed highly frequent in initial position, but *i, o* and *u* appear often in the middle and final positions of a sign sequence. This is because the ancient Greek dialect of Cyprus employed *i, o* and *u* next to other vowels and in diphthongs.[35] Likewise, *u* is mostly employed in medial and final position in LB, as the second element of diphthongs in Mycenaean Greek.[36] This goes to show that we should not necessarily expect all potential vowels of CH to be highly frequent in initial position, nor to mirror exactly the distribution of their counterparts in either LA or LB. In other words, CH 013 might still be a sign with a 'pure vowel' value (and not necessarily /o/), and its greater frequency in medial and final positions may be due to linguistic factors. CH 095 is more problematic, as the sign is limited to one sign group, and it may have not received a phonetic value until it was adapted to LA.

[35] J. Chadwick, *Decipherment*, cit. (n. 34), p. 53.

[36] Y. Duhoux, Le linéaire A, cit. (n. 33), p. 66. B. Davis (*Minoan Stone Vessels*, cit., n. 33, pp. 240-241) has also stressed that, probably for linguistic reasons, LA signs 38 *e* and 61 *o* in particular, and all signs with *-o* and *-e* vocalism, in general, are much less frequent than their counterparts with *-a*, *-i*, and *-u* values. We can further illustrate how linguistic differences motivate changes in the use of vowel signs with the example of the Lycian alphabet, which was adapted from the Greek: among other changes, Greek E and O were redeployed for /i/ and /u/, and I was used for writing a glide, in part because the Lycian language lacked the sound /o/ (I. Adiego, Local adaptations of the alphabet among the non-Greek peoples of Anatolia, in S. Ferrara, M. Valério (eds), *Paths Into Script Formation in the Ancient Mediterranean*, Roma, 2018, p. 153).

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3. Adaptations: The relationship between CH and LA reassessed

The palaeography of CH is not an easy topic to address, as its material is scarce, and it shows a remarkable variation in terms of typologies of inscriptions: the seals bear a general iconic appearance and the inscriptions on clay are not normalised to the same degree we see in the pinacology of LA. Even so, a reconstruction of the development of individual signs from CH to LA and a close comparison of their sign shapes is possible, only if embedded within a method that avoids biased, impressionistic or subjective approaches. To address the palaeography of these two scripts and their relations with rigour implies that several parameters need to be set in place in assessing each sign, and in charting the overall behaviour of the signaries as systems.

In this article we presented a palaeographic 'model' (Appendix 2) that draws an evolutionary relationship between the signs of CH and LA based on strict parameters, such as the micro-analysis of each individual sign shape, in its orientation, possible diagnosticity or iconicity, or, conversely, in the absence of any such diagnostic traits. We also observed specific tendencies (9 overall) in the graphic evolution or development from CH to LA, and we attempted to explain, again through a micro-assessment of each sign, any visible trend pointing towards more curvilinear shapes (from the highly figurative character of the CH signs on seals, for instance), cursivisation or compression, and reduction of specific sign segments or traits. In addition, we postulated graphic developments for 'outlier' signs that do not seem to fit within the confines of any tendency, we charted LA signs that may have stemmed from more than one CH sign, and we compiled CH signs that show two possible developments in LA. Finally, we stepped out of the confines of the signaries, to retrace LA signs which may have stemmed from MM seal motifs.

Our model is instrumental not only to a close reconstruction of the palaeography, but to a broader framework that aims to validate its premises, by presenting an internal assessment of how the signs in each script behave, both individually and as part of sign groups. In our structural analysis we compared the distribution of signs in CH to that in LA, we assessed which signs are shared in the two systems (and which are not), and extended this examination to the average length of sign groups to assess if any are shared. In respect to the sign groups across the two corpora, we also tested whether the equivalences between signs correspond to similar or identical phonetic values, to test and shed further light on their closeness.

The results of our examination show that a core number of signs is shared (61) between CH and LA, but the percentage of the signs of CH shared by LA is larger than the percentage of sign of LA shared by CH when we consider their frequencies: up to ⅓ of the signs in the corpus of LA is not shared, which points to a clear path to innovation in LA. The distribution of the signs in the systems is also divergent, with some signs occurring with similar frequencies in both scripts (e.g. pairs CH 042 - LA 08, CH 034 - LA 59, CH 039 - LA 56, among others), whereas others diverge to a much larger extent. The disparities observed are not just in terms of frequency, but also in certain distributions: some signs occurring mainly in isolated positions in CH appear mostly within sign groups in LA (e.g. CH 024/*155 - LA 30, CH *157 - LA 123) and vice versa (e.g. CH 045 - LA 74, CH 023 - LA 122). Also, we should point to the total absence of shared sign-groups, which has implications for either a lack of common vocabulary items, or points towards more substantial differences in terms of how CH spelt words, if not, even more radically, language differentiation.

Our method for establishing matches and finding possible avenues into similar phonetic values, for CH specifically, was only partially conclusive: drawing on Ventris and Duhoux's pilots for initial position vowel-markings, one instance (CH 042) yielded promising results. Some other vowel signs can be postulated, but ultimately the small corpus of CH hinders any cogent or comprehensive definition of the vowel system. What can be safely concluded based on our palaeographic model and structural analysis is that the LA script is a largely innovative system, with a set of clear modifications that can be better explained by adaptive strategies, than wholesale indebtedness to CH.

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To a degree that is now clearer, the LA script, while closely related to its template, is the result of deliberate remodelling and reshaping, aimed to cater for specific differences that set it apart from CH. That these differences may be of linguistic or thematic or context-driven nature, cannot be ascertained at present, but the evidence points tantalisingly in that direction.

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Appendix 1.

Comparisons between Cretan Hieroglyphic and Linear A signs suggested in previous scholarship

Sign no.	Comparisons	References
CH 001	A 100/102	CHIC, Younger 2000-2020
CH 002	AB 70	Soldani 2013
CH 003		
CH 004	A 100/102	CHIC, Younger 2000-2020
CH 005	AB 79	Evans 1921, DOCS², Davis 1964, CHIC, Perna 2016, Soldani 2013, Younger 2000-2020
CH 006	AB 48	Evans 1921, CHIC, Perna 2016, Younger 2000-2020
	AB 48 and A 342	Soldani 2013
CH 007	AB 09	Evans 1921
	AB 60	DOCS² (referring to variant SM 16)
	AB 73	DOCS² (referring to variant SM 8), Soldani 2013, Younger 2000-2020
CH 008	AB 28	Soldani 2013
	A 28b and B 52	Evans 1921, CHIC, Perna 2016
CH 009	A 28b	DOCS²
	AB 61, A 123, and A 188	Soldani 2013
CH 010	AB 53	Younger 2000-2020
	AB 60	Davis 1964
	A 310	Soldani 2013
CH 011	AB 41	Younger 2000-2020
	B 32	Soldani 2013
CH 012	AB 23	DOCS², Soldani 2013, Younger 2000-2020
	A 418VAS	CHIC, Salgarella 2020
CH 013 = 152	AB 21	Soldani 2013
CH 014	AB 28b	Younger 2000-2020

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Sign no.	Comparisons	References
CH 015		
CH 016	AB 21	Younger 2000-2020
	AB 22 and A 306	Soldani 2013
CH 017	AB 85	CHIC, Soldani 2013, Perna 2016, Younger 2000-2020
CH 018	A 336	CHIC, Salgarella 2020
CH 019	AB 31	Evans 1921, DOCS², Davis 1964, CHIC, Perna 2016, Younger 2000-2020
CH 020	B 43	Younger 2000-2020
CH 021	AB 39	Soldani 2013, Younger 2000-2020
CH 022		
CH 023	A 122 and B 33	Evans 1921
	A 122 and AB 69	Younger 2000-2020
	A 314 and B 33	Soldani 2013
	B 33	CHIC, Melena 2014
CH 024	AB 30	DOCS², CHIC, Soldani 2013, Perna 2016, Younger 2000-2020
CH 025	AB 04	Evans 1921, DOCS², Davis 1964, CHIC, Soldani 2013, Perna 2016, Younger 2000-2020
CH 026		
CH 027		
CH 028	AB 09	Soldani 2013
	AB 38	Davis 1964
CH 029	AB 30	Davis 1964
CH 030	AB 29	Younger 2000-2020
CH 031	AB 27	CHIC, Soldani 2013, Perna 2016, Younger 2000-2020
= 174	AB 27 and A 328	Salgarella 2020
	AB 28	Davis 1964
CH 032		
CH 033	AB 47	Younger 2000-2020
	Possible variant of AB 79 attested on IO Za 6	CHIC
CH 034	AB 59	Soldani 2013, Younger 2000-2020
	A 305 and AB 87	Davis 1964
	A 356	Salgarella 2020
CH 035	AB 58	DOCS², CHIC, Soldani 2013, Perna 2016, Younger 2000-2020
CH 036	A 305 and B 72	Soldani 2013
	B 62	Melena 2014

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Sign no.	Comparisons	References
CH 037	AB 54	DOCS²
	AB 123	Evans 1921
CH 038	AB 56	Evans 1921 and DOCS² referring to variant SM 45, Davis 1964
	AB 57	Evans 1921 and DOCS² referring to variant SM 44, CHIC, Soldani 2013, Perna 2016, Younger 2000-2020
	AB 56 and/or 57 and/or A 327	Salgarella 2020
CH 039	AB 55	Soldani 2013
	AB 56	Younger 2000-2020
CH 040	AB 86	Evans 1921, Davis 1964, CHIC, Soldani 2013, Perna 2016
	B 68	Younger 2000-2020
CH 041	AB 09	Davis 1964
	AB 54	CHIC, Soldani 2013, Perna 2016, Younger 2000-2020
CH 042	AB 08	Evans 1921, DOCS², Davis 1964, CHIC, Soldani 2013, Perna 2016, Younger 2000-2020
CH 043	AB 01	Davis 1964
	A 364 and/or B 12	Evans 1921, CHIC, Perna 2016, Younger 2000-2020
	A 363, 364, AB 11, and B 12	Soldani 2013
	A 363 and/or 364	Salgarella 2020
CH 044	AB 17	Davis 1964
	AB 53	Soldani 2013
	AB 70	Younger 2000-2020
	B 19	Judson 2020
CH 045	AB 74	Evans 1921, DOCS², Davis 1964, CHIC, Soldani 2013, Perna 2016, Younger 2000-2020
CH 046	A 301	Evans 1921, DOCS², Brice 1991, Soldani 2013, Younger 2000-2020, Salgarella 2020
CH 047	AB 78	CHIC, Younger 2000-2020
CH 048		
CH 049	AB 20	DOCS²
	AB 37	Davis 1964, CHIC,[37] Soldani 2013, Perna 2016
	A 304 and its ligature A 629, compared to B 20[38]	Evans 1921
	A 311	Salgarella 2020 (more tentative than CH 77 – A 311)

[37] In *CHIC*, CH 049 is only compared with the Linear B variant of AB 37, while CH 093 is compared with both Linear A and B variants of AB 37.

[38] When Evans 1921 was published, the sign catalogued as AB 20 in *GORILA* 5 was only attested in Linear B.

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Sign no.	Comparisons	References
CH 050	AB 37	DOCS², Younger 2000-2020
	A 304	CHIC
	A 304, A 629, and AB 20	Soldani 2013
CH 051	A 312	Evans 1921, DOCS², CHIC, Perna 2016, Younger 2000-2020
	A 312 and AB 41	Soldani 2013
CH 052	AB 24	CHIC, Brice 1991, Soldani 2013, Perna 2016, Younger 2000-2020
CH 053	A 412[VAS]	CHIC
CH 054	AB 16 and A 325	Soldani 2013
	AB 45	Younger 2000-2020
	B 209[VAS]	CHIC
CH 055	AB 44	Younger 2000-2020
	B 68	Soldani 2013
CH 056	AB 06	Soldani 2013
	AB 61	Evans 1921
	AB 70	Younger 2000-2020
CH 057	AB 67	Davis 1964, Soldani 2013, Younger 2000-2020
	A 354 and/or 355	Salgarella 2020
CH 058	AB 29	Evans 1921, DOCS², Younger 2000-2020
	AB 69	Soldani 2013
CH 059	AB 10	Soldani 2013
	A 704	CHIC
CH 060		
CH 061	AB 53 and B 75	Evans 1921, DOCS²
CH 062	AB 06	Younger 2000-2020
CH 063	AB 03	Younger 2000-2020
CH 064	AB 01	Younger 2000-2020
CH 065	AB 55?	Younger 2000-2020
CH 066		
CH 067		
CH 068	AB 03	Soldani 2013
CH 069	AB 76	Evans 1921, DOCS², CHIC, Soldani 2013, Perna 2016, Younger 2000-2020
CH 070	AB 02	Evans 1921, DOCS², Davis 1964, CHIC, Soldani 2013, Perna 2016, Younger 2000-2020
CH 071	A 314	CHIC
CH 072	AB 66	Soldani 2013
	A 353	Salgarella 2020

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Sign no.	Comparisons	References
CH 073	AB 77	Younger 2000-2020
	AB 78	Soldani 2013
	A 309a	CHIC, Salgarella 2020
CH 074	AB 78	CHIC
CH 075	AB 78	Evans 1921, DOCS², CHIC, Perna 2016
CH 076	AB 61	Younger 2000-2020
CH 077 = 178	AB 40	Soldani 2013
	A 311	Salgarella 2020
CH 078	B 14	Younger 2000-2020
CH 079		
CH 080		
CH 081		
CH 082		
CH 083		
CH 084		
CH 085	AB 40	DOCS², Younger 2000-2020
	AB 41	Soldani 2013
CH 086		
CH 087	A 301 and B 36	Soldani 2013, Younger 2000-2020
CH 088		
CH 089		
CH 090		
CH 091		
CH 092	AB 26	Evans 1921, DOCS², Davis 1964, CHIC, Perna 2016, Younger 2000-2020
	AB 26 and A 361	Soldani 2013
CH 093	AB 37	CHIC, Younger 2000-2020, Salgarella 2020
CH 094	AB 38	CHIC
	AB 38	Soldani 2013, Perna 2016, Younger 2000-2020
CH 095	AB 13	Soldani 2013
	AB 60	Brice 1965, Godart 1999, Perna 2019, Younger 2000-2020
CH 096	AB 16	Younger 2000-2020
	AB 79 as attested on HT 11b.3	CHIC
CH 153	AB 120	CHIC, Younger 2000-2010
	A 339	Salgarella 2020
CH 154	AB 122	Evans 1921, CHIC, Younger 2000-2010
CH 155	AB 30	DOCS², CHIC, Younger 2000-2010
CH 156	AB 131a	DOCS², CHIC, Younger 2000-2010

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Sign no.	Comparisons	References
CH 157	AB 123	CHIC, Younger 2000-2010
CH 158	A 303	CHIC, Younger 2000-2003
CH 159		
CH 159bis	B 33 / 144	CHIC, Younger 2000-2020
CH 160	B 209^{VAS}	CHIC
CH 161		
CH 162		
CH 163	AB 54	CHIC, Younger 2000-2020
CH 166		
CH 167		
CH 168		
CH 169		
CH 170		
CH 171		
CH 172		
CH 173		
CH 176	A 304	CHIC, Younger 2000-2020
CH 177		
CH 179		
CH 180		
CH 181	AB 38	CHIC
	B 134 (= 190)	Younger 2000-2020
CH 182		
SM 74	AB 80	Evans 1921, DOCS^2, Soldani 2013, Younger 2000-2020
SM 85	AB 39	Brice 1991
	AB 44	Davis 1964, Soldani 2013
SM 137	AB 50	Younger 1996-1997, Soldani 2013

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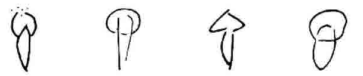
Appendix 2

Palaeographical comparisons between *CHIC* and Linear A signs. Linear A *comparanda* proposed for the first time are shown in **bold**. NB: A question mark (?) is assigned if: 1) the development from CH to LA does not follow *tendencies a-g* as outlined in section 1.1, 2) the development from CH is not observed via an identifiable LA sign, but directly to Linear B and 3) two or three competing developments can be postulated. Double question marks (??) indicate the occurrence of any two such cases.

Cretan Hieroglyphic		Linear A	
CH 002	 #058.d #059.bA #113.a #328	AB 70	 PK Za 11.b KO(?) Zf 2 HT 62+73.5 TY 3a.6
CH 005	 #018.γ #058.c #059.aA #247.γ	AB 79	 PH 6.2 HT 99b.2 ARKH 2.3 ZA 4a.5
CH 006	 #063.a2 #316 #327	AB 48	 SY Za 4
CH 007	 #043.a #098.a #114.a #308.β	AB 73	 AP Za 2.2 KN Za 19.2 PK Za 10 SY Za 1
CH 008	 #113.d #120.v.A #282.α #297.β1	AB 28	 IO Za 3 KN Zf 31 PH Zb 4 KH 10.3
CH 009	 #104.a #139 ¿#225.α?	**AB 01**	 PH 6.4 PH 7b.2 KN Zc 6.2 ARKH Zf 2
CH 010	 #043.a1 #043.a2 #248.α #262.β	AB 53	 PH 6.2 PH 7a.2 HT 87.2 KH 90.2

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Cretan Hieroglyphic	Linear A
CH 011  #013.γ #024.γ #027.b PE He 001 #272.γ	**AB 05**  PH 6.1 KN Zf 31* PK Za 16 PR Za 1 KO(?) Zf 2
CH 012  #080.a #113.cA #236.α #302.γ !#065.c!**	AB 23  HT 46a.1 ZA 21a.2
CH 013  #002.γ #038.b #119.r #120.r.A	**AB 61**  PH 2.2*** HT Wc 3006a KH Wc 2002
CH 016  #002.δ #112.b #112.b #113.cA	AB 22  HT Wc 3014b
CH 017  #021.γ #037.b #128	AB 85  HT 38.2 HT 118.1 KO(?) Zf 2
CH 019  #030.a #137 #203.α	AB 31  PH 2.4 IO Za 6 KN Zf 31 PS Za 2
CH 020  #018.γ #039.a #082.a #139	**AB 13**  IO Za 6 PK Za 11.c KH 53.1 TL Za 1 ZA 21a.1
CH 021  #059.cB #149 PE S(3/4) 02.δ	AB 39(?)  PH 2.3 IO Za 15b KN Wc 26b, Zf 13 VRY Za 1a
CH 022  #071	**AB 39(?)**  PH 2.3 IO Za 15b KN Wc 26b, Zf 13 VRY Za 1a
CH 023  #089.a #113.d #243.γ #324	AB 122  SY Za 2a HT 44a.3 ZA 11b.2a KO Za 1b****

* *GORILA* read these two signs as LA 06 *na*, but early variants of the latter are very different.

** Although this sign has been classified as 013/*152 in *CHIC*, it shows a horn that is diagnostic of CH 012.

*** This sign is read as LA 61 *o* in *GORILA* 1, but it has two features on its top part, unlike all other instances of the sign, which have only one. These features are comparable to the ear and horn that are distinctive traits of CH 012 (rather than 013).

**** This sign is read as AB 27 in *GORILA* 4, but it is more similar to the attestation of AB 122 on SY Za 2a rather than to any other instance of AB 27.

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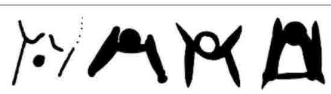
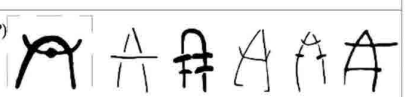
Cretan Hieroglyphic		Linear A	
CH 024 =155	 #043.a2 ¡#065.d! ¡#118.c! ¡#206.β!	AB 30	 PH 6.2, 16a.2 KN(?) Wc 26b ZA 5a.2
CH 025	 #027.δ #120.*r*.B #294.α	AB 04	 PE Zg 6.2 AP Za 2.2 KN Zf 31 KO Za 1d
CH 026	 #056.c	**AB 09**	 PH 2.1 PH 2.4 KN Zf 31 HT 115a.3
CH 027	 #049.d #319	**A 316**	 PH 1a.1 PH 8b.1 KH 91.2 PYR 1.2
CH 028	 #008.γ #049.d #059.bA #307	**AB 38(?)**	 PH 24, 2.3 KN 1b.2 PK Za 8a, 11a KH 7a.2
CH 031 =174	 #054.e #058.b #088.a #300.β	AB 27 (= **A 328**)	 PH 13a PH 15a PH Wc 46 AP Za 2.2
CH 032	 #027.γ #058.d #104.a	**AB 29**	 PK Za 15 HT Zb 160 HT 14.3
CH 034	 #070 #083.a #115.a #289.γ	AB 59(?)	 PH 6.2 PK Za 11a TY Zb 4 HT Wa 1278
CH 035	 #105.aB #115.a #119.*l.i.*	AB 58	 PH Wa 32 KN Zf 31 HT Zb 158b KH 11.2
CH 036	 #059.dA #254.γ #267.β #312.β	**AB 38(??)**	 KN Zc 7.1***** PH 24 KN 1b.2 PK Za 8a, 11a KH 7a.2

***** This instance has been catalogued as a doubtful AB 37 in GORILA, but it is better compared with instances of AB 38 featuring one curved horizontal stroke (PH 2.3, 24, PK Za 8a).

Cretan Hieroglyphic		Linear A	
CH 037	 #042.a #057.d #061.b	**AB 40**(?)	 MA 1a HT Zd 157 PH Zb 5
CH 038	 #025.γ #058.d #072.a #112.c	AB 57	 PH 18a.1 PH 28a.2 AP Za 1.bis SY Za 2.c
CH 039	 PE Hh 016.b #037.b #040.a #303.γ	AB 56(?)	 PH 28a.2 AP Za 2.1 PK Za 8.a
CH 040	 #041.b #192 #049.d #097.γ	AB 86 (=**A 359**?)	 A 359: PH 17a AB 86: HT 45a.2 KH Wa 1015α
CH 041	 #027.β #089.b #316	AB 54	 PH 6.1 IO Za 7 IO Za 8 KN Za 10b
CH 042	 #091.a #151 #168 #293.γ	AB 08	 PH 14b IO Za 2.1 IO Za 7 KO Za 1.a
CH 043	 #039.a #042.a #256.β #314.η	**A 324**(?)	 HT 9a.4 HT 122a.5
		A 363(?)	 ZA 14.2
		A 364(?)	 ZA 15a.7
CH 044	 #018.γ #040.b1 #056.aB #059.aA	**AB 17**(?)	 KN Zf 31 SY Za 4 PK 1.7 ZA 14.3
		Unattested AB 19(??)	 B19: KN Ag 90

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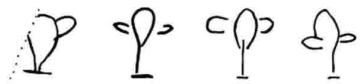
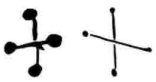
Cretan Hieroglyphic		Linear A	
CH 045	 #298.β	AB 74	 HT 16.4 HT Wa 1298 HT Wa 1317
CH 046	 #049.a #257.γ #302.β #310.γ	A 301	 AP Za 1 IO Za 6 HT Wa 1029, 1783
CH 048	 #236.α	**A 305**(?)	 PH 10 HT 10a.3 KH 7.4 ZA 6a.1
CH 049	 #049.a #106.a #120.*r*.A #316	AB 37	 MA 2b.1 KN Zf 31 KN Zc 6.1 KN 1b.1
CH 050	 #032.a #065a #120.*r*.A #306a	A 304(?)	 PH 8a.2 HT 131a.4 KH 9.6
		AB 20(?)	 KH 57.2
CH 051	 #051.a #089.b	A 312	 ARKH 3a.5 ZA 6b.2
CH 052	 #031.a #202.γ	AB 24	 PH 7a.3 KN Zf 13 KN Zf 31 ARKH 1a.5
CH 053	 #001.χ #047.a #063.b1 #115.a	**AB 60**	 PH 1a.1 PH 7b.2 IO Zb 10 KE Zb 5 ZA 7a.2
CH 054	 #003.b #034.a #130 #155 #303.*β*	AB 16	 AP Za 2.2 KN Zf 31 TL Za 1a PE 2.3

Cretan Hieroglyphic		Linear A	
CH 057	 #027.δ #049.b #103.a #306.δ	**AB 65** (= A 355?)	 PH 2.3 KN Zc 6.3 HT 97a.3 ZA 6b.1
CH 058	 #053.aB #123 #283.β	AB 69	 PH 2.1 AP Za 2.1 IO Za 2b.1 KO Za 1b
CH 061	 #035.a #036.a #056.c #058.a #085.a	**AB 11**	 KO(?) Zf 2 HT 115a.5 KH 9.1 HT 16.4
CH 062	 #095.b #127 #302.γ	AB 06(?)	 PH 1a.1 PH 16a.1 MA 2c.1
CH 063	 #049.a	**AB 02**(?)	 ARKH 5.2 ZA 8.6 KO(?) Zf 2
CH 064	 #087.a #330	**AB 03**	 PH 1b.1 PH 7a.1 IO Za 5 KN Zf 13
CH 065	 #009.γ #174	**A 319**	 HT 132.1 HT Zd 156
CH 069	 #038.b #050.b	AB 76	 PH Zb 5 HT Wa 1009 ZA 6a.6
CH 070	 #039.a #091.b	AB 02(?)	 PH 24 PH Wc 39b KO(?) Zf 2
CH 071	 #059.aB	A 314	 PH Wc 38 ARKH 3b.2 KO Za 1b

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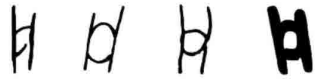
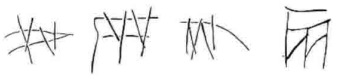
Cretan Hieroglyphic	Linear A
CH 077 =074/075?  #003.γ #038.a #039.a #079.a #095.a	AB 78  PH 9.a MA 1.a MA 1.b MA Ze 11
CH 083 = 082?  #078.α	AB 55(?)  MA 1.a IO Za 6 KN Wb 33 PK Zc 13
CH 092  #026.g #063.a1 #067.c #318	AB 26  PH 7.3 IO Za 2a.2 KN(?) Wc 26a ZA Zb 34
CH 095  #292.γ #313.β #202.β #251.α	AB 10  PH 7a.2 MA 2c AP Za 1 TL Za 1b
CH 153  #017.β #024.δ {#145}	AB 120  ARKH 5.2 HT 28b.2 KH 10.4
CH 156  #047.b #206.β {#274.α}	AB 131a  PH 9b PH 25.1 PH Wc 42 HT 19.2
CH 157  #291.β	AB 123  IO Za 16 HT 39.1 KH 53.1

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Appendix 3

Comparisons between shapes attested in Cretan Hieroglyphic sign sequences on Middle Minoan seals, but not accepted in *CHIC* as writing signs, and Linear A signs. Linear A *comparanda* that are to the best of our knowledge proposed here for the first time are shown in bold.

Cretan Hieroglyphic		Linear A	
SM 74	{#247.γ} {#287.γ} {#304.α}	AB 80	PH 7a.3 PH Wc 40 IO Za 13 MA 2c.2 ZA 15a.4
SM 85	{#310.γ}	AB 44	PH 54 KN Za 19.1 KN Zf 13 KN Zf 31 PS Za 2.1
SM 137	{#154} {#166} {#242.α} {#302.γ}	AB 50	MI 2.1 ARKH 2.5 KH 88.2 TY 2.1
TRITON SHELL	{#138}	**AB 06(?)**	PH 16a.1 MA 2c.1 IO Za 11.1 SY Za 2b KO Za 1c

Appendix 4

Comparisons between Middle Minoan iconographic motifs and Linear A signs. Linear A *comparanda* that are to the best of our knowledge proposed here for the first time are shown in bold.

MM iconographic motifs		Linear A	
WHIRL WITHIN A CIRCLE	CMS II.2 156a CMS XII 60b	**AB 77(?)**	PH Wc 37 IO Za 6 KE 1.1 SY Za 2
FOUR-ARMED WHIRL	CMS II.1 019 CMS III 218a		
FLYING BIRD	CMS II.2 234b II.2 264 II.2 334	AB 81*	MA 2b.2 KN 1a.1 KN Zc 6.2 AP Za 2.1 ZA 10a.1
SCORPION	CMS II.1 307b II.2 292b II.2 307b	AB 41	PH 3b.2 PH Wc 37 THE Zb 1 ARKH 2.2

* The earliest interpretation of AB 81 as a schematised flying bird we found is in J. Sundwall, *Der Ursprung der kretischen Schrift*, Åbo, 1920, p. 17.

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