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FROM IMAGES TO SIGNS: CRETAN HIEROGLYPHIC AND LINEAR A IN
CONTEXT

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Abstract

This dissertation adopts a multidisciplinary approach to investigate graphical and formal features of Cretan Hieroglyphic and Linear A. Drawing on theories which understand inscribed artefacts as an interplay of materials, iconography, and texts, I combine archaeological and philological considerations with statistical and experimental observations. The work is formulated on three key-questions.

The first deals with the origins of Cretan Hieroglyphic. After providing a fresh view on Prepalatial seals chronology, I identify a number of forerunners of Hieroglyphic signs in iconographic motifs attested among the Prepalatial glyptic and material culture. I further identified a specific style-group, i.e., the 'Border and Leaf Complex', as the decisive step towards the emergence of the Hieroglyphic graphic repertoire.

The second deals with the interweaving of formal, iconographical, and epigraphic features of Hieroglyphic seals with the sequences they bear and the contexts of their usage. Through two Correspondence Analyses, I showed that the iconography on seals in some materials and shapes is closer to Cretan Hieroglyphics, than that on the other ones. Through two Social Network Analyses, I showed that Hieroglyphic impressions, especially at Knossos, follow a precise sealing pattern due to their shapes and sequences. Furthermore, prisms with a high number of inscribed faces adhere to formal features of jasper ones. Finally, through experimental engravings, I showed differences in cutting rates among materials, as well as the efficiency of abrasives and tools unearthed within the Quartier Mu.

The third question concerns overlaps in chronology, findspots and signaries between Cretan Hieroglyphic and Linear A. I discussed all possible earliest instances of both scripts and argued for some items datable to the MM I-IIA period. I further provide an insight into the Hieroglyphic-Linear A *dubitanda* and criteria for their interpretation. Finally, I suggest four different patterns in the creation and diversification of the two signaries.

Keywords

Cretan Hieroglyphic

Linear A

Correspondence Analysis

Social Network Analysis

Experimental Archaeology

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Acknowledgments

Introduction

This dissertation focuses on two writing systems: Cretan Hieroglyphic and Linear A. Although the bulk of their documentation comes from Crete, a few inscriptions attesting to their usage, especially in Linear A, are scattered through different locations in the Western Aegean. These two writing systems represent essential elements for understanding Minoan society, and for that of the Western Aegean in the Middle and Late Bronze Age. They still remain mysterious in more than one respect. First and foremost, they are undeciphered. Some information has been deduced from their texts through the analysis of logograms, arithmograms and several epigraphic characteristics. Despite this, most of the sign sequences remain opaque. How to deal with inscriptions whose content is still obscure?

In recent years, scholarly works on ancient writing systems have highlighted the need for a holistic approach to inscribed documents. In other words, the meaning conveyed by inscriptions cannot be grasped *in toto* by virtue of the texts they bear. Conversely, inscriptions must be understood by cross-matching data coming from their context, formal properties, iconographic features, especially when dealing with highly iconic scripts, and links to other items of the material culture. Such an approach proved crucial for understanding Cretan Hieroglyphic and Linear A inscriptions, as their texts will remain 'silent' until their decipherment.

Accordingly, I focus on the intersections between images and signs, material culture and epigraphic features, as well as between practical and social constraints in the production and usage of an inscribed document. In **Chapter 1**, I reassess the key-questions entailed by these categories and the role they played in past scholarship on Cretan Hieroglyphic and Linear A. Therefore, the following Chapters of my work focus on one or more of the 'boundaries' between these categories and try to shed light on the meaning conveyed by Hieroglyphic and Linear A documents.

First, images and signs. Cretan Hieroglyphic, especially on seals, shows a high degree of iconicity, pointing to the selection of a number of figurative motifs as signs of writing. Seals are also the support attesting the earliest examples of writing on Crete, i.e., the s.c. 'Archanes formula', possibly connected with the

Hieroglyphic tradition. In **Chapter 2**, I explore the origin of the Hieroglyphic graphic repertoire, by searching for potential forerunners of its signs on Prepalatial glyptic and material culture. After a reassessment of the chronology of the Prepalatial glyptic, I suggest that a good number of signs can be safely traced back to Prepalatial ancestors. The formation of the iconographic repertoire, I suggest, is mainly tied to a late Prepalatial style-group, i.e., the 'Border and Leaf Complex', which includes the 'Archanes Script'.

Second, I move on to the formal and epigraphic features of writing. Hieroglyphic seals were not only supports for texts, but also luxury items to show off. As such, they indicate the hierarchical position of their owners. All these data are combined through both a statistical and an experimental approach. In **Chapter 3**, I investigate the connection between seal materials, shapes, iconography and writing by means of a statistical model, i.e., the Correspondence Analysis. These analyses show that some materials (mainly green jasper) and some shapes (mainly *Petschafte* and prisms) are tied to iconographic motifs akin to Hieroglyphic, while others clearly are not. Following this line, in **Chapter 4**, I employ another statistical model, i.e., the Social Network Analysis, in order to combine formal, epigraphic and contextual characteristics of Hieroglyphic seal impressions and prisms. I consequently argue that, on the one hand, the way in which administrations made use of Hieroglyphic seals and sequences clearly differed from site to site. Only at Knossos, is a precise pattern of stamping observed, mostly involving a well-defined usage of formulas and seal shapes. On the other hand, I show that formal features and writing are highly interwoven on prisms. Indeed, a high number of inscribed faces is associated to features shared by jasper seals (including readability, sizes and perhaps color), while less valuable items show formal features akin to those of Hieroglyphic seals in steatite. Finally, in **Chapter 5**, I explore practical constraints linked to the production of seals with materials and techniques in use for Hieroglyphic ones. I investigate these issues by means of experiments conducted with an experienced artisan. Accordingly, I show discrepancies in cutting and wear rates between different stones, as well as the pros and cons of the usage of different abrasives, different materials for tools and different processes in achieving the whole production cycle of a Hieroglyphic seal.

Third, I consider overlaps in chronology, findspots and signaries between Cretan Hieroglyphic and Linear A. Both Cretan Hieroglyphic and Linear A were invented on Crete, possibly at the dawn of the Protopalatial period (MM IB). They overlapped for a long time span, between the MM II and the MM III periods. Moreover, they co-existed at the same locations at least during the MM III period and share a part of their graphic repertoires. In **Chapter 6**, I try to unravel the puzzle of this complex co-habitation. Indeed, I explore documents pointing to the inception of the two scripts, by suggesting some evidence in favor of their co-existence as early as the beginning of the Protopalatial period. I also reassess the attribution of each *dubitandum*, by redefining criteria behind such interpretations. Finally, I suggest four different patterns in the creation and diversification of the two signaries.

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Chapter 1 – Setting the scene: three key-questions

1.1 Introduction

This dissertation aims at improving the knowledge of Cretan Hieroglyphic and Linear A by adopting a multidisciplinary approach and comparing data from palaeography and epigraphy with material and technical constraints tied to the production of an inscription. As is well known, both Cretan Hieroglyphic and Linear A resisted decipherment till nowadays, and linguistic data only provide weak evidence to understand the processes of script formation and development (e.g., Salgarella 2020).

Fortunately, Boltz (1994: 9-10) distinguishes between a *material* and a *linguistic* history of writing. The former would be defined by the developments of the shape of signs, including the influence exerted by materials and writing techniques, and the different way in which the script was used across time and space. The latter is primarily the history of glottography and its interaction with the spoken words it records. This dissertation mainly deals with the former 'history', by addressing the shapes writing took on over time and their relation to the material features of the written objects.

1.2 First key-question: what are the origins of Cretan Hieroglyphic?

The fact that a primary invention of writing taps into a previous iconographic tradition is commonly reputed as being typologically likely (Harris 1986: 26, Bottéro 1992: 76; Robertson 2004: 21-22, Hyman 2006: 233-234, McDorman 2009: 2 and Smith 2012). Such an idea comes from evolutionary theories and was firstly put forward during the 18th century.[1] A comprehensive account of its implications was set up in Taylor (1899). The author (p. 5) stated that "every system of writing has begun with rude pictures of objects; these pictures, more or less

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[1] For a history of this idea and its forerunners, see Schmandt-Besserat (1992: 4-6) and references.

conventionalized, were gradually assumed as the representatives of objects, and afterwards became the symbols of more or less elementary sounds". The path from icons to signs of writing (called "symbols") is therefore depicted as basically involving two different steps, from 'ideograms' – representing real objects or abstract concepts – to 'phonograms', tied to language's sounds. The latter were subsequently divided into "verbal signs, which stand for entire words" (i.e., the logograms), syllabograms and alphabetic signs, this triad too being supposed to represent a chronological progression. Such a scheme was deeply influenced by two assumptions commonly dismissed today, namely the positivistic evolution from "arduous" scripts through (allegedly more efficient) alphabets and the idea that writing systems merely served to record speech (Trigger 1998: 40).

An insight against the pure pictoriality of 'proto-forms' of writing was provided by scholars working on cuneiform. Schmandt-Besserat (1992) suggested that proto-cuneiform characters mainly go back to tokens used for administrative purposes, rather than being schematic renderings of iconographical motifs. Notably, such tokens, whose shape was originally incised on clay, would have represented by themselves a standardized set of symbols. Consequently, regardless of their actual 'referent', signs of primary invented writing systems would come from the selection of a sub-set of symbols from a given repository of images/abstract motifs. Moreover, proto-cuneiform, probably non-glottographic at all (Hyman 2006: 235-236), arranged these signs in a linear way in order to account for some economic transactions (Michalowski 1996: 36). From these assumptions, Damerow (2006: 6) concludes that "proto-cuneiform writing was based on a core of standardized signs. These could, however, be flexibly complemented by modifications of existing signs or by the creation of new signs that were used only in specific contexts, and that never developed into standardized signs of cuneiform writing".

Indeed, such a situation is not confined to cuneiform, but basically characterizes the vast majority of ancient writing systems, such as Egyptian Hieroglyphic (Baines 2004), Mayan (Boone 2000) and Chinese (Boltz 1994). Consequently, Ong (2013 [1982[1]]: 84) stated that "most if not all scripts trace back directly or indirectly to some sort of picture writing, or, sometimes perhaps, at an even more elemental level, to the use of tokens". Likely, these antecedents would therefore be part of the previous illiterate culture (Smith 2012). Furthermore,

differently from the Taylorian view, it is commonly agreed that writing systems can combine more categories of signs. The inclusion of logograms in scripts mostly composed by syllabograms, or even in alphabets, is frequent. Still, as confirmed by all the earliest inventions of writing, the path connecting an iconographic tradition to a related writing system clearly involved the passage from semasiographic to (partially) glottographic symbols.

Data provided by both cuneiform and Chinese point to the usage of a well-recognizable system of symbols, in the time immediately before the inception of writing, remarkably on the same supports destined for hosting writing. Coulmas (2003: 46) suggests that a clear difference between semasiograms and logograms could have been absent from the mind of the scribes who employed signs according to both these values at the same time. The passage to a glottographic writing, most probably already featuring the Cretan Hieroglyphic too, basically entails that a correspondence between the semasiograph and its 'reading(s)' was established (Trigger 1998: 48).

To make this possible, a symbol must have been selected from its related repository. The selection of a part of the iconographic repertoire is chiefly driven by the social actors responsible for the inception of writing and their cultural environment (e.g., Battestini 1997: 37). Together with motifs with a clear physical referent, signaries would have selected a "small yet distinct number of geometric patterns that are combined to form more complex characters" (McDorman 2009: 10). This process of selection would therefore have been applied to an iconographic tradition, either local or not, which at some time started to be intended as a (non-)glottographic script composed of a finite number of sematograms. With reference to original inventions of writing, Smith (2012) suggested that this mechanism would have worked due to the specialization of a set of symbols through a series of well-defined usages. Since the association of an image to a word describing it would be a natural human behavior (Dehaene *et al*. 2005: 339), the repetition of these 'performances' of writing (i.e., the constant usage of the same set of symbols) would have led to a progressive stabilization of signaries, their transmission and manipulation according to historical and cultural factors (Benelli 2020).

McDorman (2009) argues for the existence of a 'universal iconography', composed of semantic categories like 'human', 'animal' etc., at the basis of all primary invented writing systems. Regardless of its universality, it is noticeable that the typology of this iconography is entirely congruent with the taxonomy of Hieroglyphic signs (*CHIC* 15). Notably, the first attestations of writing during the Bronze Age are generally characterized by the usage of the same sign as both a logogram and a syllabogram (Robertson 2004: 30-31). As is evident for Egyptian Hieroglyphs, signs of writing are not clearly separate from images employed on uninscribed artefacts, when those images are graphically akin to signs (e.g., Davier & Laboury 2020: 3). Moreover, signs are arranged by means of a scarce syntax, as in proto-cuneiform (Damerow 2006: 7-8).

1.2.1 Does Cretan Hieroglyphic adhere to this pattern?

At first glance, Hieroglyphic signs represent by themselves a wholly structured example of a set of iconographic motifs (see Fig. 1.1), which corresponds to 4% of the Protopalatial repertoire on seals (Anastasiadou 2016: 162). Each sign is featured by a series of distinctive characteristics which make it recognizable among more or less different variants (Bottéro 1992: 76 and Hyman 2006: 240). According to Smith (2012), once a script has been stabilized, reproductions of distinctive features must be faithful only to a sign's graphic form and no longer to its iconic referent.

TABLEAU DES SIGNES STANDARDISÉS (MAIGRES ET GRAS) DE L'HIÉROGLYPHIQUE CRÉTOIS

Syllabogrammes	025	050	075	*153	*177
001	026	051	076	*154	*178
002	027	052	077	*155	*179
003	028	053	078	*156	*180
004	029	054	079	*157	*181
005	030	055	080	*158	*182
006	031	056	081	*159	Klasmatogrammes
007	032	057	082	*159bis	301 Γ
008	033	058	083	*160	302 Δ
009	034	059	084	*161	303 Θ
010	035	060	085	*162	304 Λ
011	036	061	086	*163	305 Ξ
012	037	062	087	*164	306 Π
013	038	063	088	*165	307 Σ
014	039	064	089	*166	308 φ
015	040	065	090	*167	309
016	041	066	091	*168	Arithmogrammes
017	042	067	092	*169	1
018	043	068	093	*170	10
019	044	069	094	*171	100
020	045	070	095	*172	1000
021	046	071	096	*173	Stiktogrammes
022	047	072	Logogrammes	*174	
023	048	073	*151	*175	
024	049	074	*152	*176	

Ligatures:
302+303
302+307
304+302
304+303

Fig. 1.1 - List of standardized Hieroglyphic signs, as elaborated by *CHIC* (17)

Notably, from a synchronic point of view, a certain number of motifs identical to Hieroglyphic signs also occurred putatively devoid of a syllabographic or logographic value on the same seal's surfaces, often in a reduced scale (e.g., Decorte 2017a: 21). Other seals, generally excluded from the Hieroglyphic corpus, show an entire face covered by one motif identical to a Hieroglyphic sign (Anastasiadou 2016: 162). The latter phenomenon constitutes one of the key pieces of evidence put forward by Decorte (2017a) to suggest the semasiographic interpretation of some motifs attested alongside Hieroglyphic sequences but normally excluded from transcriptions. However, their pertinence with the logo-syllabic sequences on seals is still disputed. The same uncertainty remains on a series of motifs – such as S-spirals or scrolls – sometimes reputed signs of writing (Jasink 2005; 2009 and Decorte 2017a). Nonetheless, all these theories are weakened by the fact that a thorough comprehension of both the formation and the selection of the Hieroglyphic signary is still a *desideratum*.

In this regard, as widely assumed, a certain degree of connection between Cretan Hieroglyphic and the previous glyptic is evident from a partial sharing of both iconography and syntactic criteria, as is shown well by the 'Archanes Script' (Decorte 2018b: 342). Nevertheless, according to Ferrara (2015: 41), research on the origins of writing would primarily be faced with two possible drawbacks. First of all, our view on writing is chiefly indebted to archaeological surveys. Therefore, material coming to light predictably lacks homogeneity. Consequently, we cannot be sure that finds dated to the most ancient periods correspond to the first usages of writing. On the other hand, problems arise in discerning the "degree of borrowing from a template to a new system", i.e., what was the dynamic behind the transmission and adaptation of signs from one system to another?

As regards the first issue, Cretan glyptic is a decidedly fortunate case. A high degree of continuity in Prepalatial was already recognized for most of its iconographic and syntactic properties. Archaeological findings safely allow us to appreciate glyptic developments at least from late EM II through MM I period, the crucial phase for the inception of writing (Younger 1998: 195-204). On seals, Cretan Hieroglyphic flourished roughly one century later, during the MM II period. It attests to a number of variants such as to presuppose a rather long, cumulative phase of formation (Ferrara *et al.* 2020: 15). What is more, the earliest occurrences of the 'Archanes formula' might provide an insight into the intermediate stage immediately before such a *floruit* (Decorte 2018b: 342).

By contrast, the second problem, which is specifically addressed in §2, would require more complex elucidations. When discarding Neolithic marks as an impossible source for Chinese writing, Boltz (2000/2001: 3) states that "it is quite impossible that any writing system would take centuries or millennia to develop. Until a writing system is fully formed, it is *as writing* next to useless. And there is no reason why a people would maintain a nearly useless rudimentary partial script for any length of time". It can be anticipated that Prepalatial iconography would not constitute a sort of 'proto-writing', but rather a number of standardized symbols not behaving as a writing inventory (see §1.3.3). Such a state of affairs often preceded the inception of writing, such as in Egypt (Stauder 2022a; 2022b).

By considering the point discussed so far, characteristics synchronically detectable on signs/motifs featured on both inscribed and uninscribed artefacts can be split in two groups:

a) Iconographic properties, namely the distinctive features distinguishing each of the Hieroglyphic signs and the other iconographic motifs.

b) Syntactic properties, namely the principles governing field division and distribution of signs/motifs on the surface.

The emergence of Cretan Hieroglyphic can therefore be properly understood by reconstructing the development of these two features from the Prepalatial illiterate material culture and iconography up to the emergence of a stable inventory of signs. In detail, within point a) it is possible to single out two different groups of motifs. The first and less problematic is constituted by the 'iconic' ones, which are commonly grouped into interacting coherent semantic categories. If the iconic features of these categories are traced on Prepalatial glyptic, it would be difficult to consider their Hieroglyphic correlates as due to chance. As regards geometric/abstract motifs, Boltz (2000/2001: 2) conversely notices that geometric/abstract motifs (such as strokes, triangles, circles etc.) can be found all over the world. Given their simplicity and universality, such homographs can therefore merely be due to chance (see also McDorman 2009: 11).

1.2.2 Understanding the 'iconicity' of Cretan Hieroglyphic

Evans (1909) used the names "conventionalized pictographs" and "conventionalized Hieroglyphs" in order to stress the iconic nature of this script. Such a "pictorial aspect", he claimed, would mainly consist in the recognizability (for a modern scholar) of the alleged physical referent of signs. Admittedly, however, not all Hieroglyphic signs show such a property, and not all the allographs of a sign show the same degree of iconicity.

Typologically, iconicity can be lost over time and the iconic referent of a sign can become opaque (e.g., Xiao & Treiman 2012: 954 and Fay *et al.* 2014: 245).

It should be noted that, since Cretan Hieroglyphic remains undeciphered, it is impossible to precisely detect this kind of data and ultimately to understand what specific object each sign was meant to allude to. We are therefore constrained to set the iconic referent by default as the (entire) real object closest to the sign. This investigation will be undertaken by focusing on two elements, namely the shape of the sign and the contexts of its attestation, whether potentially narrative or not. What is more, 'iconicity' of a sign must be framed within the whole iconographic system it belongs to. According to the theoretical framework devised by Stauder (2018), in a writing system it is possible to distinguish two kinds of iconicity:

a) External iconicity, which traces the sign back to a real object assumed as its referent.

b) System-internal iconicity, which analyses the script as a system understandable by singling out groups of signs whose iconicity is interrelated and makes sense only by considering them as a whole.

Notably, all writing systems tend to uniformize the shape of their signs. As noted above, the same process has already been described by McDorman (2009: 10), who states that each script selects a small number of shapes to create symbols through their combinations. For example, the Egyptian glyph of a crouched man carrying a vessel would be unnatural at a first glance, since a standing position is clearly more adequate for hauling objects. Nevertheless, the sign is understandable since a crouched position has been selected and generalized at an early stage to represent men (Stauder 2018: 382). Often, system-internal iconicity works based on the phonetic value of signs. Some cases of this type were posited by Salgarella (2021) for some Linear A possibly sharing the same vocalic value. Given that Cretan Hieroglyphic lacks any phonetic interpretation, the existence of such a process in this script cannot be identified with certainty.

All independent inventions of writing presuppose either a rebus or an acrophonical formation of syllabic signs (Trigger 1998: 46 and McDorman 2009: 6). As *per* Coulmas (2002: 47), rebus and acrophony would have been sped up by the loss of "pictoriality", although even highly iconic writings regularly underwent these kinds of processes (Smith 2012). Even though it does not represent a primary invention, this process is clearly recognizable within the Anatolian Hieroglyphic,

where stylized syllabograms are traceable back to logograms still in use, whereas only the latter retain the iconicity (Yakubovich 2008: 29-30). Since Cretan Hieroglyphic remains undeciphered, however, we cannot reconstruct this phenomenon with certainty, namely by comparing phonetic features. Moreover, it must be noted that some Hieroglyphic signs would have been used as both syllabograms and logograms (and even as iconographic motifs), regardless of their 'iconicity'. A number of potential acrophonies were posited for Linear A signs by Salgarella (2021), although no clear evidence can be found to demonstrate them.

Conversely, the retention of iconicity seems to have followed different trajectories. Egyptian phonograms, for example, remain wholly undistinguishable in shape from their related logograms, whose iconic referent is almost always well-recognizable, while Anatolian syllabograms underwent a premature process of stylization. Robertson (2004: 34) sought to sketch a typology of these changes:

If there are changes, they seem to be either from icon to symbol, or from icon to phoneticism or both. Mayan writing maintained a strong iconic component, but with time become more phonographic. Egyptian remained strongly iconic, but also, over time, developed more phoneticism. Chinese, on the other hand, never did develop a robust phoneticism, but the logographs became more symbolic.

As noted in §1.2.2, iconicity is without doubt a well-defined feature of Cretan Hieroglyphic (see Ferrara 2018: §15), although it has never been analyzed, either in detail or from a (synchronic and diachronic) comparative perspective. Predictably, a certain degree of variation is inferable – apart from as an intrinsic feature of an independently invented script – due to the material support hosting the writing and thus the adopted technique. Unsurprisingly, the most impressive difference is easily recognizable between clay and seal attestations, the former bearing less iconic variants. This difference is likely due to the technique used for inscribing documents and to the fact that clay objects were surely destined for a temporary use, after which they were destroyed, while the lifetime of seals probably extended to more generations.

Apart from these differences, however, iconicity seems to have been deeply manipulated even on the same support. Interestingly, already Evans (1909) argued for two different classes of seals, distinguished by different iconicity, pointing to a

chronological development. Although this hypothesis is now untenable, it still underlines how differences in iconicity may arise even within seals. Thus, by comparing for instance the occurrences of CH 010 on both clay and seals (see Fig. 1.2), it is clear that the iconic rendering of the sign can be decidedly different, while distinctive features were preserved in any case. As a rule, it seems that iconic motifs were more frequently engraved on seals made of hard stone, a feature shared by both inscribed and uninscribed Protopalatial seals (Krzyszkowska 2005: 94).

#043a.2   #249a   #289d

Fig. 1.2 – Palaeographic variants of CH 010

1.3 Previous attempts at tracing the origins of the Hieroglyphic inventory

In the following sections, I reconstruct the history of theories addressing the origins of Cretan Hieroglyphic. I chose to follow the diachronic development of these theories in order to highlight their connections with studies on Minoan glyptic. Indeed, since the link between writing and seals was a key-tenet starting from their first excavator, studies on the origins of Cretan Hieroglyphic were deeply influenced by the interpretation of the whole Pre- and Protopalatial glyptic. Accordingly, major changes in the dating of seals were always accompanied by new paradigms for understanding the emergence of writing. In this overview, I therefore aim at showing the different pathways taken side-by-side by scholars of both Cretan Hieroglyphic and Minoan glyptic.

1.3.1 From "pictograms" to writing: Evans (1909) and his legacy

At the very beginning of the work on writing systems discovered during the Knossos excavations, Evans (1909: 10) clarified that "the evidence conclusively pointed to Crete as the principal source of these hieroglyphic forms". The first

discoverer, however, did not exclude a foreign influence on such graphic repertoire (Evans 1910: 130) and, when possible, indicated either Egyptian or Anatolian signs showing a comparable shape. For instance, both signs depicting a "horse's head") (= CH 014) and a 'dog's head' (= CH 018) are paired to Anatolian Hieroglyphs ("Hittite" per Evans), i.e., respectively L. 100 ('ASINUS') and *112 ('LINGERE'). Conversely, signs analyzed as "kid or doe" (= No. 66, no longer accepted as CH sign) are claimed to come from the Egyptian Hieroglyph E8/*ib*, representing a standing kid. In a few cases, Evans even seems to admit multiple sources. For instance, the sign interpreted as 'mountains' (= CH 034) is paralleled to the Egyptian Hieroglyph N26/*ḏw*, but still the connection with the more iconic instances of the cuneiform URU is not ruled out.

Apart from an alleged group of 'linear' pictograms on seals, not resulting in known writing systems (see Decorte 2017a: 101-106), Evans mainly divided the history of Cretan Hieroglyphic into three phases, assuming a chronological progression. The first and oldest phase included a number of "early pictographic" seals. Evans (1909: 119) posits an extremely long timespan for such seals, ranging from the EM II up to the MM I. This class is represented by a number of seals bearing motifs either in possible narrative scenarios (through a frieze-like arrangement) or in complete isolation. The second phase was the so-called "Hieroglyphic Class A". This class groups together almost all Hieroglyphic seals fashioned from soft stones and commonly showing small and repetitive formulas, such as CH 044-049 and 038-010. Lastly, the most recent group is named "Hieroglyphic Class B". It is made up of hard-stone Hieroglyphic seals with a more elaborate iconography, a more dexterous engraving and a wider range of possible signs. Thus, Evans (1909: 143) suggests a chronological hiatus by identifying the MM III as the *floruit* of the Class B. Such a hypothesis is notably grounded on an evolutionary perspective, which led to postulate a chronological hiatus between documents distinguished by technical and functional features.

The hypothesis of Evans therefore pointed to a marked and multi-faceted Egyptian influence, traceable in both palaeographic and epigraphic features of Cretan Hieroglyphic, which however would have re-fashioned the foreign stimuli through its own iconographic tradition. Such an idea was taken up by Sundwall (1924: 97), who only argued for a quantitatively more pronounced Egyptian

influence on Hieroglyphic iconography. Notably, the two scholars agreed on recognizing some Minoan motifs as the source of a number of Hieroglyphic signs. A direct Egyptian influence was conversely supposed by Diringer (1962, who refers to Sundwall 1924), at least for what was called the 'Hieroglyphic Class A' but failed to gain wide consensus.

The main limitation of the assumptions of both Evans and Sundwall was the lack of a precise chronological basis for framing the emergence of Hieroglyphic signs on seals. Such a stylistic dating was largely driven by an evolutionary approach opposing allegedly earlier 'schematic' signs to the later 'mature' and more iconic writing.

External influences on Minoan iconography were taken up by Matz (1928). He re-organized Evans material according to a more robust distinction of shapes, materials and iconographic classes, in order to compare them with features of the Near Eastern glyptic. The main conclusion was that Minoan engravers would have re-elaborated a foreign iconographic repertoire (coming from Anatolia, Mesopotamia and Egypt) according to original syntactic criteria. Yet, the presence of idiosyncratic 'creations' ("Schöpfungen") is sporadically assumed (Matz 1928: 124).

More in general and apart from a few exceptions, the whole Minoan glyptic is considered as being deeply indebted to the Oriental one. For instance, as regards the 'dog's head' (= CH 018), he agrees with Evans in tracing the origin of the shape back to the Anatolian Hieroglyph A112 (Matz 1928: 118). However, he stresses that its usage in complete isolation would have been the outcome of a local innovation. Conversely, he claimed, both the outline and the syntactic arrangements of the 'head of a wild goat' (= CH 016) would be paralleled by Mesopotamian and Anatolian roll cylinders. Notably, the Anatolian Hieroglyphic became phonetic around 1400-1300 BCE (Valério 2018: 143), more than half a millennium later than the emergence of Cretan Hieroglyphic. As a consequence, its relationship with Aegean syllabaries was later overturned by assuming an Aegean influence on the formation of the Anatolian Hieroglyphic inventory (Hawkins 1986: 274; 2003: 168).

Notably, however, Matz (1928: 106) noticed that the same motif could have occurred on coeval (Protopalatial) documents as both a Hieroglyphic sign and "in rein ornamentaler Verwendung". Indeed, such a statement already questioned Evans' division between the two phases of Cretan Hieroglyphic based merely on functional properties.

Almost four decades later, Kenna (1962) put forward an antithetical hypothesis, still retaining the idea of a complex intertwining of external stimuli. Indeed, although he argued that both sealing and writing practices would have been substantially distinct from the Near-Eastern and Egyptian *comparanda*, he suggested that the Egyptian imports would have heavily influenced the process of script formation on seals. Crucially, the external influence is explicitly confined to the syntactic principles of the inscribed surfaces, i.e., the criteria by which Egyptian Hieroglyphic were displayed on the seal faces. By contrast, the 'borrowing' of the iconographic template is not mentioned. A process internal to Minoan glyptic seems therefore supposed.

Kenna himself based all his observations on a partial restructuring of Minoan glyptic chronology put forward in the epoch-making volume *Cretan Seals* (1960). For the earliest stage, he recognized two stylistic and competing trends, and both anchored in EM contexts. Both Evans' "proto-linear signs" and most of his "early pictograms" are gathered together within one of these two groups, roughly assigned to the EM III period. Crucially, however, no direct connection between these seals and the inscribed ones is mentioned. Kenna (1960: 25-27) then posited a "First Transitional Phase" including ivory pieces and a few gables ("three-sided prism beads" in his own terminology). Such group of seals is weakly anchored in a single EM III-MM I context (i.e., the Platanos Tholos B), and its posteriority with respect to the EM III seals was mainly postulated based on a typological consideration, namely the alleged 'hybridizing' of features previously kept separate by the two glyptic traditions. The inception of "pictography" is dated to the MM I. Within the editions of *CMS* VII (1967) and VIII (1966), Kenna included in this phase seals bearing the 'Archanes formula', as well as 'Egyptianizing' pieces with round faces from Platanos Tholos B (Kenna 1960: 33-34) and pieces belonging to Evans' "early pictograms". The MM II period is conversely regarded as dominated by hard-stone uninscribed *Petschafte*. Writing would have originally appeared

within the Hieroglyphic Deposit at Knossos. He considered its dating as oscillating between the MM II and the MM III (Kenna 1960: 38 fn. 4). Such a view was modified with the edition of the *CMS* VII, when a soft-stone inscribed prism is placed among hard-stone *Petschafte* and dated to the MM IIA, while the vast majority of soft-stone Hieroglyphic seals were dated to the MM IIB. In *CMS* XII (1972), Kenna adopted a more prudent dating to the MM II period. Among the Protopalatial seals, he included Hieroglyphic seals (in both soft- and hard stones) which do not show a wide usage of devices alongside writing signs. By contrast, all the other inscribed seals, mostly fashioned from hard stones, are assigned to the "Second Transitional Phase", i.e., the MM III period.

Crucially, Kenna overturned Evans teleology of writing, but still retained a three-stepped conception of the origins of writing. Indeed, alleged MM III seals are considered as having used Hieroglyphic characters in a mere decorative manner, while full glottography would have been achieved in the previous period. His distinction between the two groups of Hieroglyphic seals was therefore functional and formal at the same time. More so than on sequences, he seems to distinguish seals based on formal features, as proved by the fact that #216 is dated to the MM II period, while #257 to the "Second Transitional Phase". Yet, in both *Cretan Seals* and *CMS* VII and XII, Kenna applied an evolutionary approach to the whole glyptic, allegedly developing from less to more skilled engravings, which inevitably conditioned the understanding of the inscribed seals. As a consequence, such a perspective produced some more or less arbitrary considerations. The most evident is that seals all belonging to the same context, i.e., the Platanos Tholos B, were chronologically distinguished mainly based on the skillfulness of the artisans responsible for their manufacture. Notably, in *CMS* XII (1972), Kenna returned to a more outdated view, by assigning all the soft-stone seals to the MM II, while most of Evans' "early pictograms" are analyzed as MM I in date and the hard-stone ones (including the inscribed *Petschafte*) as MM III.

The latter hypothesis featured mainly in the first volume of the *Corpus der Minoischen und Mykenischen Siegel* too, devoted to seals in National Archaeological Museum of Athens, by Sakellariou (1964). The only inscribed seal in this catalogue is I 425 (= #310), a four-sided prism in carnelian. This seal is included among objects dated to the 'Protopalatial', which gathered together seals

fashioned from hard stones (nowadays analyzed as either MM II or 'architectural' ones) and a few soft stone ones with traces of drilling (e.g., I 427). Conversely, all the other soft-stone seals, including those bearing Evan's 'pictograms', are placed within the 'Prepalatial' section of the volume.

1.3.2 A change of paradigm: the excavations of the Quartier Mu

A turning point in the understanding of Cretan Hieroglyphic was made possible by the seven excavation campaigns (1966-1972) bringing to light the Quartier Mu at Mallia. The site was abandoned at the end of the Protopalatial period and therefore provides an extremely reliable stratigraphical anchoring. The excavations uncovered a huge number of seals and inscribed clay documents coming from the destruction layers dated to the MM IIB.

As a result, the first publication of seals housed at the Iraklion Museum (i.e., *CMS* II.1 = Platon 1969), which aimed at presenting the Prepalatial material only (i.e., EM I-MM IA, see Platon 1969: xi), excludes those matching with Evan's 'early pictograms' and Kenna's (1966-1967) EM III seals. Notably, the contemporaneous publication of another holding of the Iraklion Museum (the Metaxas Collection), i.e., the *CMS* IV by Sakellarakis & Kenna (1969), analyzed as EM III in date only two seals that are possibly comparable to the finds from Mallia and today included within the 'Mallia Steatite Group' (i.e., IV 010-11). All the others are conversely still assigned to either the "Frist Transitional Period" or the "Protopalatial" one. An even clearer change of mind is implied by the following *CMS* XIII, edited by Kenna & Thomas in 1974. This work only distinguished between "Frühminoisch", "Mittelminoisch" and "Spätminoisch / Späthelladisch" and groups together all typologies included within *CMS* XII's "First Transitional Phase", "MM II" and "MM III" under the label "Mittelminoisch".

As a result, in the Introduction to *CMS* II.2, devoted to the Protopalatial findings housed in the Archaeological Museum of Heraklion, the authors explicitly cast doubts on the chronological boundary of the three-stepped history posited by Evans. They noted that the alleged "early pictograms" often appear alongside Hieroglyphic characters of the "Class A". Moreover, both Evans and Kenna's

dating of these objects to the EM is considered unprovable from a stratigraphical perspective. Indeed, while none was found within an EM context, some of them are safely anchored to the 'Mallia Workshop Complex'. What is more, such occurrences are conceived as being contemporaneous to Evans' "Hieroglyphic Class A" on hard stones. Crucially, even though a functional difference in the usage of writing is assumed for hard-stone seals (i.e., "Hieroglyphensiegel, die in höchster Vollendung erscheinen"), it is highlighted that writing signs were still employed as "reine Bildmotive" on them. Accordingly, the catalogue of *CMS* II.2 does not postulate any chronological differentiation among the objects (i.e., they are all considered as generically Protopalatial) and groups Hieroglyphic seals in both hard- and soft stones, together with Evans' "early pictograms".

In the same years, the Evansian distinction and chronological span soon began to fade out of scholarly works. When discussing the methodology behind the composition of *CHIC* (provisionally titled '*CIHC*' at that time), Olivier (1981: 105) compared seals allegedly belonging to different "classes" by supposing their contemporaneity. Notably, the first publication of the inscribed material from the Quartier Mu (see Godart & Olivier 1978: 37-38) agrees with the editors of *CMS* II.2 and suggests an MM II dating for the whole published material.

Yule (1980) expresses an intermediate position. He largely followed the line taken by the two *CMS* volumes on the Iraklion Museum (II.1 and II.2) – and indeed excluded Neopalatial objects from his study. He rationalized data available at that time in order to reconstruct the chronological development of Minoan glyptic. The major step forward lies in the recognition that inscribed seals were part of wider stylistic trends datable between the Pre- and the Protopalatial periods. Indeed, not only inscribed seals share the adoption of shapes, materials and technical features with the coeval uninscribed ones, but also their iconography does not noticeably differ from those.

The first known attempts of writing on Crete (i.e., bone and steatite seals bearing the 'Archanes formula', see §2.2) are placed within a wider late Prepalatial stylistic group (dated to the EM III-MM IA), named 'Border and Leaf Complex'. Without any specific reference to inscribed seals, Yule notes that the 'Border and Leaf Complex' would show a strong Egyptian influence as regards shape, materials

and iconography. Such an assumption basically confirms the idea of Evans (1909) of an 'Egyptianizing' trend featuring the first inscribed seals. Admittedly, however, the latter was based on the observation of seals coeval to the Hieroglyphic ones, whereas Yule's assumptions are now made on Prepalatial pieces. Nevertheless, Yule (1980: 169-172) formally retains the 'splitting' of Hieroglyphic attestations into classes A and B. In order to explain their distribution, he divided them into two style-groups. The former would belong to the 'Mallia Workshop Complex', dated to the MM IB-II, together with the vast majority of uninscribed soft-stone prisms coming from Mallia. Such a group is generally congruent with the 'Mallia Steatite Group', whose stylistic homogeneity was accepted so far (see Anastasiadou 2011). Hard-stone Hieroglyphic seals are conversely grouped within the 'Hieroglyphic Deposit Group', dated to the "MM II (-?)", which is almost solely constituted by inscribed pieces. Accordingly, Yule still retains the idea that soft-stone Hieroglyphic seals (i.e., Evan's 'Hieroglyphic class A') would have predated the hard-stone ones (i.e., Evan's 'Hieroglyphic class B'), even though the two groups, he claims, would overlap at the end of the Protopalatial period.

	EM (I)-II	EM III	MM I	MM II	MM III
Evans (1909)					
Kenna (1960)					
Platon, Pini & Salies (1977)					
Poursat & Olivier (1978)					
Yule (1980)					
Sbonias (1995)					

Table 1.1 – Dating of the same five seals from Evans (1909) to Sbonias (1995). Different dates are the manifest outcome of changes in the chronological sequences in which the entire Minoan glyptic (including inscribed seals) was framed from time to time

1.3.3 Filling in the gap: Prepalatial imagery and its sources in the last three decades

Discoveries from Mallia pointed out that the early period of Minoan glyptic was not dominated by a sort of pictographic proto-writing (or pre-writing). Indeed, a number of style-groups were individuated. The connection between these style-groups and writing remained rather opaque, although a vague correspondence between the late Prepalatial iconography and seal shapes and the attestations coming from the Protopalatial 'Mallia Workshop Complex', was recognized (Sbonias 1995: 110-111). In the following decades, scholars therefore addressed

the issue of the relationship between the Prepalatial glyptic and the emergence of Cretan Hieroglyphic.

Since it was clear that a good part of the Protopalatial glyptic employed a centuries-old iconographic repertoire, scholars principally tried to interpret Cretan Hieroglyphic signs according to such a paradigm. On the other hand, given that intense contacts between Crete and Egypt date back at least to the EM II and inscribed scarabs were found in contexts coeval to the 'Archanes formula', an Egyptian influence was only rarely rejected.

The outcome of these two different influences is well summarized in the assumptions put forward by Olivier (1986: 378; 1989: 41), who firmly denies the borrowings of sign templates from abroad. Nevertheless, the idea of writing is traced back to an Egyptian stimulus. One clue for such a theoretical statement is suggested by Flouda (2013: 144-155), whose approach ultimately recalls the hypothesis of Kenna (1962). Indeed, she traces the alleged Egyptian influence back to the syntactic arrangement of motifs on Pre- and Protopalatial seals. Such an influence, she claims, would have triggered a new way of combining motifs and the manipulation of their iconic features.

Alongside this, in the past decade, two theoretical assumptions were applied to the study of the origins of writing on Crete and represent fundamental key-tenets today. First, writing systems, especially at the initial stages of their formation, would largely be devoid of any glottographic nature. Specifically, scholars argued that writing systems were not always designed in order to register the language (Hill Boone 2004: 313-348 and Damerow 2006), and it might have been the case of Cretan Hieroglyphic too (see Schoep 2020: 48 and references). Second, the development of a graphic repertoire does not follow a one-way and linear continuum from pictography to full glottography. Conversely, on one hand, systems of signs do not necessarily develop into a full glottographic system (Decorte 2018: 39-40 and Schoep 2020: 44). On the other, the reliability of a slow and continuous process leading to the emergence of writing *sensu stricto* was seriously questioned. As a consequence, it was replaced by a model of "punctuated equilibrium", featured by an alternation of (more and less long) periods of stable cultural features followed by sudden changes (Ferrara 2015: 43, Decorte 2018: 42 and Schoep 2020: 43).

Accordingly, it is now almost unanimously accepted that the Cretan Hieroglyphic signs' inventory generally re-elaborated an iconographic repertoire which had already formed on Crete many centuries before and had extensively been widened at the dawn of the Protopalatial period (e.g., Karnava 2018: 64). However, the precise dynamic of such a process, as well as the exact source of each sign, remained obscure until today. Indeed, several studies were devoted to identifying elements of the Minoan material culture and, more in general, of the "physical world" (Karnava 2015: 140), as the source of Hieroglyphic signs. The first attempts in this direction go back to the 1960s. For instance, Branigan (1965) suggested a number of scrapers coming from the Mesara tombs as the visual referent of CH 044. Notably, such an idea was later modified by Cristiani & Ferrara (2016), who pointed to another object of the Minoan world, i.e., the *Petschaft*. More recently, both Karnava (2015) and Civitillo (2016) argued for a number of items of the Pre- and Protopalatial material culture, such as votive figurines and seal shapes, as the source respectively of signs depicting human body parts (i.e., CH 006-010) and those depicting some animals (e.g., CH 011 and 021). Nonetheless, although the emergence of writing on Crete must be undoubtedly tied to the development of glyptic trends (Salgarella 2021), a close scrutiny of the Prepalatial iconography on seals, as well as on other luxury items, is still pending.

Works immediately following the volume of Sbonias (1995) mainly focused on the role played by the 'Archanes formula' in defining the emergence of writing. At least three different positions were put forward: the 'Archanes formula' is a forerunner of the Cretan Hieroglyphic only (e.g., Ferrara *et al.* 2021); or it is a forerunner of the Linear A only (Godart 1999); or again, both Cretan Hieroglyphic and Linear A originates from a template reflected in the 'Archanes formula' (Flouda 2013: 142-143 and Whittaker 2013: 105-106). The relationship among these three forms of writing is beyond the scope of this chapter. Still, it is important to stress that the whole discussion on this point only searched for correspondences between the 'Archanes formula' and the MM II occurrences of writing. Conversely, the possible Prepalatial source of the iconographic template(s), including that of the 'Archanes formula', are neglected in these works.

As regards the Prepalatial iconography, Decorte (2018: 43) argued for the existence of an "early glyptic vocabulary", i.e., a standardized and highly

recognizable set of 10 motifs in use up to the MM IB. In his view, it would have been provided with a semiotic meaning, possibly tied to the administrative practices. Such a vocabulary would have represented the "conceptual background" for Cretan Hieroglyphic, which would have inherited its functions and applied them to an innovative Protopalatial iconography.

Such an idea recalls a well-established principle in understanding Minoan glyptic, namely that, especially in absence of narrative scenarios, motifs on seals must be symbols somehow tied to the owners and their community (e.g., Younger 2020). Indeed, several motifs were selected by each Prepalatial style-group and used with relative consistency and/or degree of standardization. Moreover, it could not be due to chance that extremely simple motifs such as grids, crosses and triangles are ubiquitous in EM I(I)-III glyptic. Their reproduction does not require a particularly skilled craftmanship. Notably, such an assumption does not exclude that these motifs were later re-functionalized. Nevertheless, some of these motifs tend to play a rather marginal role within the late Prepalatial glyptic. In other cases, such as the "spiral pattern" (quoted through the example II.1 039 and possibly to be connected with both II.1 224b and 227b), they are confined to a few attestations within the PL/S.

Another issue raised by such an interpretation is that the "early glyptic vocabulary" does not have any special relation to inscribed seals during the Protopalatial period. Indeed, half of the motifs (i.e., the "meander", "spiral pattern", "elaborated swastika", "rosette" and "radiating centre") are either never to be found on inscribed seals or unattested by Protopalatial glyptic at all. All the other motifs, despite appearing either on inscribed seals or alongside Hieroglyphic sequences, are basically part of the MM II iconographic tradition and are widespread on uninscribed seals too. As a consequence, the occurrence of these motifs alongside Hieroglyphic characters does not provide any evidence in favor of their closeness to writing.

Building on the same theoretical framework, Schoep (2020) points to the iconography attested by the so-called 'white pieces' as another set of standardized motifs in close connection to the emergence of writing. 'White pieces' are unanimously recognized as Egyptianizing artefacts (see also §2.2.2). If they

constituted the main conceptual background for writing, the author claims (Schoep 2020: 49), they would therefore testify to an Egyptian influence on the emergence of Cretan Hieroglyphic. Such an influence would have featured both an "ideological link with Egyptian scarabs" (i.e., a stimulus triggered by imported inscribed objects) and a "technological" one (i.e., the knowledge of the functioning of a writing system).

Still, it should be stressed that 'white pieces' do not have any special feature of iconographic standardization or linear arrangement with respect to the whole 'Border and Leaf Complex'. The presence of a restricted number of motifs and rather homogeneous syntactic criteria mainly reflects a behavior shared by all the Pre- and Protopalatial style groups. Notably, 'white pieces' clearly share their syntax with the 'Border and Leaf Complex'. What is more, motifs analyzed as (proto-)writing signs are often shared with other stylistic groups, including the 'Cip-Cut/ Small Plate Signet Group' and the 'Parading Lions/Spiral Complex'. As a consequence, there is no clear evidence pointing to the usage of such motifs as signs of writing.

To conclude, the connection between the Hieroglyphic (and Linear A) graphic inventory and the iconographic repertoire mostly occurring on Pre- and Protopalatial seals was once again underlined by both Salgarella (2021) and Ferrara *et al.* (2021). The former does not involve Prepalatial comparisons and focuses on Proto- and Neopalatial iconographic motifs coeval to script signs and allegedly attesting a more iconic outline. By contrast, Ferrara *et al.* (2021) suggest a more nuanced pathway into script formation. They argue for four processes at work during the formation of the Hieroglyphic inventory, namely the direct borrowing of an Egyptian sign (restricted to one occurrence only, i.e., the 'wine' logogram CH *156), the continuing of icons attested during the Prepalatial (i.e., CH 020 'bee/wasp' in comparison to II.1 159), the creation of a new sign based on referents of the material culture (e.g., CH 020 'fly' in comparison to the fly-shaped seal II.1 379) and the creation of a new sign based on referents of the "immaterial" world (i.e., CH 007 'crossed arms' in comparison to the related widespread gesture).

1.4 Second key-question: to what extent is writing on seals interwoven with material, technical and cultural factors?

The second key-question addresses a holistic view on the inscribed seals, by correlating data not only from the philological analysis of the engraved sequences, but also through patterns involving both their formal and epigraphic properties, as well as their contexts of usage. Given the large amount of data under investigation, such an analysis makes use of statistical models (§3-4) and combines their results with data provided by experimental archaeology (§5).

Since the 1970s, inscribed artefacts have been understood as objects including not only the graphic notation of (linguistic) information, but also as being embedded in the material culture by means of their formal characteristics (Piquette & Whitehouse 2013: 2). They convey meaning not only through the inscriptions they bear, but also by virtue of features visible to both the literate and illiterate (Waal 2022). In this respect, Cretan Hieroglyphic seals are clearly a privileged case study. Since they constituted strictly personal objects to be worn and shown off, they were plausibly prestige markers used to indicate the social position of their owners (Hruby 2012). Alongside this, seals were in use for administrative purposes, and the impressions they left on sealings was meaningful to distinguish groups of seal owners and their role within the administration (Relaki 2009).

Accordingly, the meaning assigned to inscriptions and their use within a literate society can be properly understood only by paying attention to the relationship between the material features of the object and its graphic properties. This statement is crucial for what concerns the study of undeciphered inscriptions. As no transparent information is available from texts, the interplay between visual properties of the written object and signs of writing therefore represents the best source to reconstruct the function of the inscription. All these factors suggest investigating Cretan Hieroglyphic on seals by taking into account the entire features of the seals *vis-à-vis* the agents involved in their use. These features are:

a) *Material*. At the very beginning of the Protopalatial period, hard semi-precious stones, mostly imported from overseas (see §3.1.2), began to be engraved thanks to new technologies coming from the Near East (Krzyszkowska 2005: 81-82), though soft stones continued to be the privileged support for Minoan glyptic.

Differently from soft stones, seals in hard stones would have therefore presupposed a restricted access to long distance trade networks and the availability of both highly skilled artisans and complex instruments. Accordingly, the fact that hard stones can be easily distinguished from soft stones (even *en plein air*) would have contributed framing their owner within a small social élite. The interplay between technical and social factors would have therefore determined the choice of the stone.

b) *Shape*. Alongside materials, Protopalatial glyptic is characterized by a marked renewal in seal shapes. Shapes clearly differ in motifs engraved on them (Hruby 2012: 393). Accordingly, they would have plausibly provided hints to distinguish groups of owners. Crucially, on inscribed seals the number of faces is commonly tied to the number of sequences they bear. According to Poursat (2000), Hieroglyphic formulas engraved on seals would correspond to different administrative functions. He noted that while some formulas can appear on seals inscribed on one face only, others cannot and are generally associated to other formulas (see also Civitillo 2016). Such a distribution led Poursat to conclude that formulas and number of inscribed faces would have pointed to an administrative hierarchy, i.e., more formulas and more inscribed faces would have meant a higher hierarchical degree. As a consequence, at least for inscribed artefacts, seals with a high number of faces (such as three- four- or eight-sided prisms) would have provided a clue to infer a higher social status of their owners.

c) *Color*. Only a few studies have been devoted to seal colors and their distribution in Minoan glyptic. Yet, colors represent one of the most visible features of seals and the best clue to identify their material. During the Protopalatial period, both hard and soft stone seals show a noticeable variety of colors and light effects. They range between translucent or opaque dark to light steatites up to highly brilliant red and green semi-precious stones. Such features played a role in the readability of motifs too. Transparent to translucent stones enable only a poor reading of seal iconography, while the opposite is the case of the opaque ones.

d) *Dimensions*. Late Prepalatial and Protopalatial seals are normally characterized by being smaller than the ones of the previous periods. During the MM II period, hard stone seals are almost always smaller than soft stone ones. Such a feature provides even the modern scholar with an instrument for identifying the

material. Moreover, most shape-classes show little variation in sizes, which can therefore be distinctive of a given typology of seals (e.g., Yule 1980: 76-77). A relative homogeneity is observed as regards style-groups too, such as the "Mallia/Eastern Crete Steatite Seal" (see Anastasiadou 2011: 109, in part. fn. 562). Differently from color and (partially) shapes, dimensions are visible on the impressions. 'Readers' of the sealings would therefore have been able to infer the matrix material of a given impression by means of both its technical properties and sizes.

e) *Iconography*. As is well known, motifs on seals (including Hieroglyphic signs) were selected and combined in order to convey information tied to the seal owners. Frequently, motifs out of the Hieroglyphic inventory interact with writing signs on the same face (Decorte 2017a). Protopalatial glyptic shows a partially renewed iconography, characterized by the introduction of a high number of iconic motifs mostly representing humans, animals, and objects of the material culture. A distinction was found as regards soft- and hard stone seals, which tend to bear a partially distinguished iconography reflecting the activity of separate workshops (Pini 2010). Indeed, a number of motifs are confined to either soft- (e.g., the "scorpion", see Anastasiadou 2011: 190) or hard-stone seals (e.g., the 'full-bodied cat' and the 'cat-mask' but I 423). Similarly, a number of techniques were only suitable for cutting soft materials (i.e., all the freehand techniques employing burins, points, chisels etc.), while the usage of the horizontal spindle was almost solely confined to (medium)-hard stones.

The value assigned to these features largely results from the activity carried out by different agents. In a preliminary stage, the agents are distinguished by the role they played in different moments of the seal's life cycle (e.g., production, impression etc.) and by the context in which they operated (e.g., workshops, palaces etc.). It follows that agents would have manipulated the seal and influenced its features at a different level and in different situations (Civitillo 2021b: 83-85). Moreover, as not all a seal's functions require the same degree of literacy, the meaning conveyed by seals was plausibly interpreted according to the reader's degree of literacy. According to these parameters, I distinguish among three categories of agents:

a) *E n g r a v e r s .* On Protopalatial Crete, complex workshops existed and produced highly standardized and low-quality objects, as well as unique pieces of extremely high-quality manufacturing (e.g., Poursat 1996: 103). Even within the same stylistic group, relevant differences can be appreciated (Anastasiadou 2011: 75). Specifically, seal engravers would adhere to constraints determined by the material of the seal and the available techniques. What is more, each material requires partially different tools affecting the way in which motifs were carved and requiring a different level of expertise to be efficiently performed (see §3.1.1). Lastly, the artisan's personal skills influence the paleographic features of Hieroglyphic signs and would be plausibly connected to the rank of the person who requested the seal. All these features point to a strong correlation between technical constraints and iconography/writing engraved on seals. In other words, tools at disposal of each engraver, their ability and the organization of the related workshop might have deeply influenced both *which* Hieroglyphic characters were put on the seal and *how* they were designed.

b) *R e a d e r s   a n d   v i e w e r s .* With these labels, I intend all those (apart from engravers and owners) which are meant to caught one or more meanings associated with the seal. Civitillo (2021b: 85-92) singles out a category made up of "those who would have read the impression", with reference to people involved in the administrative sphere (i.e., administrators and scribes), with a high degree of literacy. These administrators were plausibly able to correctly read the Hieroglyphic sequence, as some 'formulas' are to be found incised on clay documents too (see §4.4.2). That said, seals are still meant to be viewed *en plain air* and by people either with a low degree of literacy or illiterate at all. Accordingly, they would have plausibly conveyed meaning at multiple levels, including material, epigraphic and iconographical properties. Indeed, a number of features such as the shape (e.g., the four-sided prisms, see Karnava 2000: 164), the color (e.g., the intense-green jasper, see also §3.9.2 and §4.14) and the "paratactic" arrangement of motifs (Civitillo 2021b: 92) are so closely tied to writing that this association could have predicted its presence on the seal. All these features contribute to determining the sense of the written sequence and could have been decrypted according to the degree of literacy and the working context of the readers/viewers.

c) *Owners*. Both material and iconographical features pointed to ownership and social differentiation. Although it is a commonplace that the existence of stylistic groups would point to owners who were closely akin (e.g., Anderson 2016: 102-103), the analysis of stylistic differences of Hieroglyphic seals is still pending. Differently from the other two categories, owners were involved in all the processes of the seal's life cycle. Such situation is reflected in both the production and the (administrative) usage of seals, as well as in the material features determining the way in which they were worn and shown off.

In conclusion, as seals presupposed multi-levelled possible analyses, it follows that the interlacing between, on the one hand, all their features and, on the other, all participants involved in their life cycle, could shed new light on both the meaning played by inscribed seals and the role Hieroglyphic characters played on them.

1.5 Third key-question: how did Cretan Hieroglyphic and Linear A differ and co-exist?

Cretan Hieroglyphic and Linear A, despite the typological similarity (i.e., both would be logo-syllabaries) and a good number of shared signs (Ferrara *et al.* 2022), conceal relevant differences in their repertoires of signs, on both a structural and palaeographic grounding (see Figs. 1.1 and 1.3). Furthermore, the context of the emergence of writing on Crete is clearly tied to the *vexata quaestio* of co-habitation of two scripts (Schoep 1999). How these processes were triggered and how they could have interacted with the symbolic system built up by the presence of writing, remain open questions. Moreover, Cretan Hieroglyphic and Linear A starkly differ in epigraphic features and, partially, in the typology and geographical distribution of contexts in which they were unearthed. Similarly, both scripts frequently employed different strategies to organize the text on inscribed objects, and possibly conveyed different information in different manners.

Fig. 1.3 – List of standardized Linear A signs, as elaborated by *GORILA* V (xxii-xxiii)

The fact that two different writing systems are attested in Proto- and Neopalatial Crete is a *communis opinio* starting from the first studies of their discoverer (Evans 1909). As noted above, the labels 'Cretan Hieroglyphic' and 'Linear A' were mainly intended to stress the alleged different iconicity of these two scripts. Furthermore, Evans (1909) posited the existence of an earlier linear group of symbols, although this would have been unable to generate a writing system. This idea has recently been taken up by Decorte (2017b), who similarly suggested that only a small number of signs of this alleged proto-writing would have been inherited by either Cretan Hieroglyphic or Linear A. Schoep (1999) does not exclude the existence of a common ancestor, but suggested that Cretan Hieroglyphic and Linear A basically existed separately and were adopted by two different types of administration.

The divergence of these administrative centers emerged during the MM IA-B in the context of illiterate administrations, as would be proved by the differentiation between documents in use with Cretan Hieroglyphic and those employed by Linear A. More recently, Anastasiadou (2016: 172) states that Cretan

Hieroglyphic and Linear A would have constituted two different and well-defined traditions of writing. The former would have been associated with multi-faced documents (e.g., three-sided prisms and four-sided bars), on which writing was arranged in a wide range of possibilities, from rotation through linearity. By contrast, one or two-sided documents (typically tablets and roundels) and a linear arrangement even on circular surfaces, would have been preferred for Linear A. Finally, while Cretan Hieroglyphic would have been combined with other types of motifs, objects bearing Linear A inscriptions would have been strictly reserved to host signs of writing. These ideas are now almost a *communis opinio*, as Crete is understood as divided in several political and administrative areas at least until the end of the MM III period. One of them, located in the North-Eastern part of the island, would have adopted Cretan Hieroglyphic for administrative purposes, while Linear A would have been particularly at home in the Mesara (e.g., Schoep 2001: 143). In such context, the original position of Knossos is still disputed (e.g., Karnava 2000 argues for a Linear A administration, while Schoep 2001 for a Hieroglyphic one).

Despite these hypotheses, all attestations would point to a more nuanced situation. First of all, co-occurrence between Cretan Hieroglyphic and Linear A is not sporadic but involves locations far from each other in time and space. The two scripts possibly co-existed even on the same object, as on #135 = SA Wc 1, a nodulus from Samothrace bearing a Hieroglyphic impression (although it refers to the 'Archanes formula') and a Linear A inscription. They are also attested side-by-side in the same findspot. For instance, it is commonly agreed that they co-occurred in the Mallia '*Dépôt Hiéroglyphique*', generally dated to MM III. Karnava (2000), although advocating that, during the Protopalatial period, Linear A would have been chiefly at home at Phaistos and Knossos, while Cretan Hieroglyphic at Mallia, Petras and Syme, suggests that both scripts could have been simultaneously employed at Knossos during either the MM II or MM III periods, depending on the dating of the 'Hieroglyphic Deposit' (see §6.7.2 on this point). According to this evidence, Anastasiadou (2016: 185) states that "active users (i.e., not only users of Hieroglyphic seals but also scribes) of Cretan Hieroglyphic were present at Knossos at some point in the Protopalatial/early Neopalatial period". The situation observed at Knossos is not isolated, since other locations – even in the Mesara – co-attest the usage of both Cretan Hieroglyphic and Linear A. Phaistos, among the earliest sites

showing an extensive usage of Linear A, contains traces of Cretan Hieroglyphic too. An intriguing case, analyzed in Chapter 6, is the Phaistos tablet tentatively included within *CHIC* (#122) but sometimes reputed inscribed in Linear A. The presence of *dubitanda* themselves testify to a certain degree of interaction between the two scripts (Petrakis 2017). Finally, even though attestations are far from being balanced, Cretan Hieroglyphic and Linear A sometimes share the adoption of the same typology of documents. Linear A is possibly attested 4 times on seals, while Cretan Hieroglyphic also occurs on tablets and stone vases. Since the typological distinction can hardly be due to chance, it is possible that this 'conflating usage', together with a precise observation of their chronology and their contexts, could provide a clue towards understanding both their origins and different employment. By contrast, the diffusion outside Crete is undeniably different. All Hieroglyphic documents but #267 (from Kythera) and #135-137 (from Samothrace) were found on Crete, most of them in the NE part of the island. Linear A is conversely widespread among Cyclades and perhaps even reached the Near East (see §6.2-5 more in detail).

Regardless of the nature of the 'Archanes Script', the overlap of Cretan Hieroglyphic and Linear A is also chronologically broad. In general, Cretan Hieroglyphic would be attested since MM IB-IIA (Decorte 2018b: 31), while the vast majority of documents date to the MM II-III period. On LM I materials, some Hieroglyphic sealings appear to be in use. Although they are highly disputed, the possible earliest attestations of Linear A come from the Knossos South-West House (MM IIA) and the Archanes Tholos E (before the end of MM IIB). The emergence of Linear A should therefore predate the MM IIB (see §6.5 more in detail). Differently from Cretan Hieroglyphic, Linear A was widespread during the late Neopalatial period, as proved by the reach archives found at Hagia Triada, Khania and Zakros, all safely anchored to LM IB levels.

In sum, a thorough comprehension of the dynamic behind the parallel emergence and development of two scripts on Crete is still far from being reached due to both chronological and palaeographical issues which still require unravelling. In Chapter 6, I confront these issues by reassessing most of the disputed points behind the overlaps between Cretan Hieroglyphic and Linear A.

1.6 Conclusions

In this chapter, I set out the three key-questions I seek to unravel in this dissertation. The first one addresses the origin of the Hieroglyphic graphic repertoire, in order to define whether the process of script formation on Crete must have implied either a strong local creation or the adaptation of a template from abroad. In both cases, following a century-old discussion, it is crucial to reassess the chronological span of such a phenomenon *vis-à-vis* the development of the main host of Minoan writing, especially during the Pre- and Protopalatial period, i.e., seals and seal impressions. On the other hand, it is clear that seals represented the main pathway l towards the emergence of writing. It follows that a special link between glyptic and writing is decidedly predictable. It would therefore involve not only the sharing of supports, but also a common iconographic repository and a (partially) shared functions within the administrations and the Minoan society.

The second question concerns the interweaving among the Hieroglyphic graphic repertoire, as well as its combinations, together with formal features of seals and contexts in which seals were used. Indeed, on seals, both inscribed and uninscribed ones, engraved iconography was only one of many ways to convey meaning. Alongside it, formal features, duly combined with the contexts of their usage, would have been crucial in defining the hierarchical role of the seal owners. Such an issue implies adopting a full circle perspective on the materiality of the inscribed artefact and on its entire life cycle. In other words, my aim is to consider the whole spectrum of formal features, including materials, shapes, sizes, colors etc., *vis-à-vis* the full spectrum of agents involved in seal production and consumption.

To conclude, I presented an overview of the complex relationship between Cretan Hieroglyphic and Linear A. The study of their co-habitation principally requires an in-depth analysis of three factors. First and foremost, the chronological hiatus featuring their origins, i.e., did they originate at the same time or not? Such an issue implies taking into account the weak evidence in favor of the existence of the two scripts before the MM IIB period. Second, the typology of documents, and the differences in the administrative practices. In particular, it is crucial to

understand the role of both Cretan Hieroglyphic and Linear A within archives in which they co-habited side by side , i.e., were they distinctly separated in a functional perspective or not? Third, the development of the two signaries. Specifically, while it is clear that Cretan Hieroglyphic and Linear A share a number of signs, the exact trajectory of their formation and differentiation remains obscure. What is more, it is still debated whether some signs were directly borrowed from one system to the other or were independently acquired. Accordingly, more light can be shed on these issues by means of a synoptic comparison of the two documentations, with special focus on their chronology, contexts of usage and paleographic differences.

Chapter 2 – The origins of the Hieroglyphic graphic repertoire

2.1 Introduction

This chapter addresses the origins of Cretan Hieroglyphic graphic repertoire. As shown in §1.3.3, it is now commonly agreed that Cretan Hieroglyphic mainly continued an iconographic repertoire formed on seals between the Pre- and the Protopalatial period. Still, as pointed out by Ferrara *et al.* (2021: 15), "a systematic scrutiny of the signs and their shapes, and their possible sources" can lead to a thorough comprehension of the process of script formation. What is more, such an analysis could provide a valid typological framework to understand the creation of scripts of 'secondary formation', particularly those whose template was not directly borrowed from another writing system.

As the presence of local elements within the Hieroglyphic graphic repertoire is assessed, this work aims at scrutinizing the whole Hieroglyphic signs inventory *vis-à-vis* iconographic items coming from the periods preceding its *floruit* in the MM II period. Such an investigation therefore seeks to shed light on the dynamics behind the formation of the Hieroglyphic iconographic repertoire, its adaptation in an inventory of signs and the chronological boundaries of its formation and development.

2.2 Theoretical framework: identifying devices, fillers and signs

This chapter compares iconographic and syntactic criteria of each Hieroglyphic sign with those of Prepalatial motifs to search for a possible set of Prepalatial forerunners of Hieroglyphic signs. I focused particularly on the stylistic peculiarities and iconic properties of both Hieroglyphic and Prepalatial graphic repertoires. This section therefore aims at clarifying the theoretical assumptions driving the iconographic comparisons and related methodological and terminological choices.

According to Anastasiadou (2011: 327-239), all motifs – called "independent devices" – recognizable as self-standing elements were used and combined in different ways. In this respect, it is clear that signs of writing are "independent devices" too. Thus, 'independent devices' constitute the best *termini comparationis* for the Hieroglyphic iconographic repertoire. On Minoan seals, 'independent devices' are employed as either "main devices" or "fillers". Main devices are defined by Anastasiadou as "integral components of the image in that they define its subject", while 'fillers' would be "placed in the field around or between the main devices with the objective of enhancing or ornamenting the image". The distinction between these two categories would generally be manifested through the "nature, size, and positioning of the individual devices with respect to the overall composition". Still, Anastasiadou restricted the definition of 'fillers' to those devices appearing alongside highly iconic motifs, whose function as meaningful symbols is well-established. However, potential fillers occurring side-by-side with bigger and syntactically focused geometric or floral motifs are considered as being 'main devices', since, she claims, they "could also have had a similar function as the larger ones". Such a statement is prompted by the idea that iconic motifs would have neatly defined the "topic" of the seal face, while geometric and floral ones would not have.

As shown in Fig. 1, when examining Hieroglyphic seals, such a theoretical framework raises a series of issues. First, motifs belonging to the Hieroglyphic inventory can be used as both 'main devices' and 'fillers' or minor devices even on the same seal. For instance, both CH 031 and a motif matching its shape are used, possibly to gain intra-facial homogeneity, on #242 and PTSK 05.259 (Civitillo 2021b: 99-100). Second, Anastasiadou considers a number of geometric and floral motifs occurring alongside Hieroglyphic seals and having the same size as 'fillers' by virtue of their "nature". As repeatedly discussed over the last two decades, while they are considered untied to writing by *CHIC* too, such an approach could bias the understanding of Hieroglyphic sequences (Jasink 2009, Decorte 2017a and Ferrara *et al.* 2022). Indeed, such motifs are excluded from transcriptions and transnumeration as they never appear on clay documents. However, their position on the seal face does not allow distinguishing them from Hieroglyphic sequences. What is more, such a behavior features iconic motifs possibly tied to writing (e.g., the 'cat-mask', see Jasink 2009: 46-48 and §3.9.2), as well as motifs belonging to

the Hieroglyphic inventory too (e.g., a 'crouched man' matching CH 001 on #240). Third, smaller elements could have played a role in defining the meaning conveyed by the Hieroglyphic sequences. For instance, signs such as CH 042 and 044 are often separated by means of dividers and minor devices, suggesting these signs could have played a different role within the Hieroglyphic sequence (Ferrara 2018: §46). Similarly, some motifs in well-known formulas, such as CH 038 in CH 038-010-031 are often backgrounded through a 'lattice' motif, possibly pointing to a different meaning of these signs with respect to the other ones (Decorte 2017b: 55). Such minor devices can even match Hieroglyphic signs in shape (e.g., the 'sun' matching CH 033 on #257c, see Fig. 2.1). Fourth, as a good number of Hieroglyphic signs are geometric, abstract, or floral in shape, they must have determined the 'topic' of the seal face as well as the more iconic ones. Notably, iconic signs are combined in Hieroglyphic sequences without any detectable pattern.

Fig. 2.1 – Different usage of a motif matching CH 033. (From left to right) IV 156a (= #247), #257c and #290c

Within the domain of 'independent devices', Anastasiadou (2011: 341-356) distinguishes the usage of motifs among "descriptive", "pictographic" and "ornamental". Descriptive motifs are images possibly depicting, in kinds of narratives, scenes from everyday life. Otherwise, the behavior of images is split between 'pictographic' and 'ornamental' by adopting the categories used to distinguish 'main devices' from 'fillers'. Indeed, iconic devices but floral ones would have behaved as 'pictograms', i.e., "kinds of symbols". On the other hand, geometric, abstract, and floral motifs would have had a merely ornamental function. The distinction between descriptive and non-descriptive images is crucial for the emergence of writing. As often noted (see §1.3), writing systems emerge from a set of motifs already able to convey a meaning not directly tied to the representation of the physical world. It follows that motifs employed in a non-descriptive (i.e., 'non-narrative') manner would be functionally closer to writing signs than 'descriptive' ones. Unsurprisingly, some motifs behaving in a non-descriptive way indeed

constitute the *corpora* of alleged proto-signs identified by both Decorte (2018: 43) and Schoep (2020: 45). Accordingly, as criteria used to single out 'main devices' and 'fillers' cannot be wholly maintained with Hieroglyphic seals, it follows that 'pictograms' and 'ornamental motifs' too must be considered together when discussing possible forerunners of Hieroglyphic signs and its Protopalatial palaeographic variants.[2]

Moreover, as pointed out by Anastasiadou (2011: 345) , the distinction between 'descriptive' and non-'descriptive' is not clear-cut. Indeed, combinations of motifs admitting a descriptive interpretation mostly juxtapose devices elsewhere provided with a clear symbolic reading (see Fig. 2.2). Often, such combinations involve two or more motifs also employed as Hieroglyphic signs. Consequently, it cannot be excluded that motifs in more complex narratives too would have conveyed meaning unrelated to the descriptive image (see Fig. 2.2).

Similarly, motifs in absolute isolation are ambiguous in their putative descriptive nature. According to Ferrara (2018: §11-12), such a characteristic, especially when characterizing motifs employed within Hieroglyphic sequences too, could be typologically associated to the presence of logograms. Another hint of their function might lie in the fact that they tend to be flanked by minor devices. One of these is the X-stiktogram, which elsewhere only features Hieroglyphic sequences (Ferrara & Weingarten 2022: 114). Notably, such characteristic clearly featured several Hieroglyphic signs and geometric/abstract motifs without any clear reference to the physical world. Lastly, a good number of iconic motifs occurring in absolute isolation is represented by heads of quadrupeds matching Hieroglyphic signs. They cannot directly represent scenes from the everyday life, as at least a process of *pars pro toto* must be posited. Furthermore, they frequently appear alongside each other in non-descriptive compositions, pointing to a non-narrative interpretation of such heads of a quadruped (see §3.9.2).

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[2] These categories find correspondence in the division between "symbolic (or emblematic)" and "narrative" images posited by Wedde (2000: 16).

Fig. 2.2 - (From left to right) Animal scene flanked by a minor device (i.e., II.2 306a), head of a quadruped in isolation flanked by two X-stiktograms (i.e., VII 034) and the interaction of a number of heads of a quadruped (i.e., XI 143b) found in absolute isolation elsewhere

Consequently, I analyze both Pre- and Protopalatial 'main devices' (including Hieroglyphic signs) by concentrating on their formal features and their syntactic behavior, regardless of their (alleged) iconicity and the very nature of their physical referents. Relative sizes and syntactic behaviors of signs are analyzed in the broad context of each stylistic group to compare criteria detected on Prepalatial glyptic with those observed on Hieroglyphic seals. Following Decorte (2017a), I do not consider minor devices and geometric/floral ones a priori as less meaningful in the message conveyed by seal's iconography, even though the opposite is clearly not always the case. While Decorte (2018b) takes into account several Prepalatial motifs graphically untied to Cretan Hieroglyphic as they would constitute its "conceptual background" (see §1.3.3 and see also Schoep 2020), I only investigate motifs with a palaeographically plausible development into Hieroglyphic characters. Finally, because of the aforementioned reasons, although the distinction between narrative and non-narrative contexts is taken into account, my dataset assumes as *termini comparationis* the motifs included in a narrative scenario as well.

2.3 Defining the dataset

The dataset under investigation is primarily represented by Prepalatial and early Protopalatial seals. As shown in §2.2, seals attest the first sequence interpretable as writing (i.e., the 'Archanes formula'). Likewise, during the MM II period, Cretan Hieroglyphic is extremely widespread on seal stones, although it also appears on clay documents and vases. This suggests that the emergence of writing on Crete must have been in close connection with the development of the glyptic tradition. What is more, it is commonly assumed that seals would have represented the largest iconographic repository in Minoan material culture (Crowley 2013: 4). Indeed,

relevant iconographic innovations - mostly tied to the introduction of figurative motifs - were widely incorporated into the glyptic tradition during the Early Minoan period, especially from the EM III (Krzyszkowska 2019: 34-35). Meanwhile, geometric and simple floral decorations still predominated on pottery and other media (Walberg 1987: 36-37). Sporadic exceptions to this rule constitute special cases and will be discussed *ad locum* as potential variants of a given motif.

From a chronological perspective, this chapter focuses on the formation of the iconographic repertoire before the *floruit* of Cretan Hieroglyphic (during MM II). Therefore, I included the objects dated from the very beginning of Minoan glyptic production to the dawn of the Protopalatial period, possibly contemporaneous of the 'Archanes formula'.

It is clear that a huge number of motifs, once having been standardized and isolated, was inherited over the centuries by several glyptic traditions and adapted to the syntactic requirements of each style-group. According to Sbonias (1995: 101), such a process can be safely reconstructed for a good number of images featuring Prepalatial seals and later adapted to the syntactic criteria of the 'Mallia Steatite Group'. As noted in §2.2.2, Hieroglyphic signs too might have taken part in this process. Indeed, Hieroglyphic seals mostly belong to wider style-groups, as signs of writing are commonly coherent with coeval iconography and are arranged according to the same principles (e.g., Yule 1980: 215-217).

2.4 Interpreting the dataset

I combined a reassessment of the archaeological issues tied to the dating of relevant objects with a scrutiny of the formal (i.e., iconographical, syntactical and technical) features of both Pre- and Protopalatial 'independent devices' which are connected to Hieroglyphic signs. Such an approach aims at detecting possible Prepalatial forerunners of Hieroglyphic signs and understanding the plausible trajectory of (icono)graphic development.

According to Wedde (2000: 18-23), variants of the same motif can be grouped in clusters (i.e., a 'grapheme' for writing signs) in which items are matched

through isomorphism and distinguished by the occurrence of a hierarchical set of characteristics:

Primary features are those which constitute the general form of the object depicted, without which it could not be rendered, and thus the message not transmitted. Secondary traits include all frequently occurring additions to the basic shape, elements common to several members of a cluster but neither universal nor irreplaceable. Incidental elements are occasional additions to the image, having no classificatory significance.

Such a hierarchy is particularly visible for figurative motifs with a high degree of iconicity. The different realizations of these motifs were tentatively explained as representations of slightly different referents put together in a single motif/grapheme (see Karnava 2015: 148). For example, the sign CH 077 has two mandatory rounded/oval elements (see Table 2.3), allowing distinguishing the sign from the others. However, the two rounded elements can be connected in different ways (e.g., #139 and #164) and their shapes show major fluctuations (e.g., #293a and #295b). Both whenever employed as a writing sign and as 'main device' on uninscribed surfaces, the crouched man (CH 001) can be featured by either one or two arms, as well as by a sporadic facultative mouth. All these caveats suggested tracing the possible forerunners of the Hieroglyphic signs by re-evaluating their iconic features ("decodification" per Wedde 2000: 16) and their common referent(s). It goes without saying that such an analysis can only result in a *plausible* connection between two motifs, especially because Cretan Hieroglyphic signs often depict common elements of the natural world (humans, plants, animals etc.), whose iconic features are consistent worldwide with slight differences only. Therefore, my analysis will follow these steps:

a) Comparing either the possible referent (for iconic signs) or the underlying geometric pattern (for geometric and abstract ones). Prepalatial glyptic extensively tends to schematize figurative motifs, whose iconic features are not always obviously recognizable by a modern scholar. Therefore, the identification of motifs and their comparison requires a special methodological rigor. Scholarship produced countless attempts to identify the tangible referents of seal motifs, naturally also for Cretan Hieroglyphic signs (e.g., Crowley 2013: 9-13, 25-32). However, only a part of them has been indisputably accepted, and clear-cut assumptions are often extremely difficult to posit (Wedde 2000: 16). Such an issue is conflated to the fact

that even the 'same motif' (either part or excluded from the Hieroglyphic inventory) can show a certain degree of variability, pointing to the lack of a strong standardization of their shapes (Blakolmer 2020: 54). Clearly, on the other hand, more complex motifs, while showing a certain degree of variability, would show a less ambiguous pattern of distinctive features (Ferrara *et al.* 2021).

b) Comparing secondary characteristics. Secondary characteristics of each Hieroglyphic sign are compared with their plausible Prepalatial forerunners. A high degree of isomorphism between a Hieroglyphic sign and a Prepalatial motif can indeed support the plausibility of a palaeographic development. Secondary characteristics can further indicate the way in which motifs belonging to the Hieroglyphic repertoire were selected from coeval iconography and among several potential graphic variants. Given the broad timespan under investigation, such an analysis should take into account changes in both techniques and stylistic trends, which might have affected the engraving of a motif.

c) Comparing the distribution of incidental characteristics. Such features, when present, could reveal the persistence of a given criterion in the representation of motifs. They have no role in identifying the motif's referent. Their presence is mainly due to the existence of some iconographic conventions, as well as to idiosyncratic choices. Therefore, they can point to a strong connection between a Prepalatial motif and a related Hieroglyphic sign.

d) Comparing syntactic and functional properties. As stated, the position of motifs on the seal face was clearly meaningful for the message they convey (e.g., Anderson 2016: 177-178). Within the syntactic criteria of each style-group, not all motifs can occur in all the positions. According to Ferrara (2018: §23), on Protopalatial seals, motifs partnering with Hieroglyphic signs tend to occur on some focused positions, such as *tête-bêche* and in absolute isolation. Notably, this arrangement can even be observed on inscribed faces. Most of these patterns are already attested on Prepalatial glyptic. The arrangement of a given motif within each style-group can therefore reveal its role in different stylistic trends as well as its degree of interconnection with the other elements of the same stylistic group.

e) Comparing the diffusion among stylistic groups and glyptic typologies. Each style-group has slightly different iconographic rules. The usage of signs on a

given object must therefore be framed within the peculiarities of its stylistic trend. Moreover, such an investigation has an impact on our understanding of the emergence of inscribed seals and their prehistory. Indeed, each style-group is tied to a specific chronological span and (rarely) to a geographical frame. Understanding the diffusion of forerunners of Hieroglyphic signs can shed light on both the chronological span in which such an inventory was selected and the categories of seals more frequently involved in the process of script formation.

In my investigation, I consider Hieroglyphic signs included in *CHIC* (19) sign list and unanimously accepted as part of the Hieroglyphic inventory. However, I do not discuss in detail the ancestors of motifs regarded as Hieroglyphic signs by Evans (1909: 232-233, Fig. 103), partially followed by Jasink (2009) and Decorte (2017a). Indeed, the role they played in the process of script formation cannot be safely estimated as consensus on their inclusion within the Hieroglyphic inventory is far from being reached.

2.5 The chronology and taxonomy of Prepalatial seals

Following a centuries-old discussion (see §1.3), I give here an updated overview on the chronological framework in which Prepalatial style-groups may be understood, including the relative chronology of the earlies attestations of writing, i.e., the 'Archanes formula'. Such an overview is functional to the understanding of the chronology behind the emergence of Cretan Hieroglyphic, as well as to the individuation of the style-groups involved in such a process to a greater extent.

2.5.1 The first stages: EM II and (early) EM III

Almost all the alleged Prepalatial glyptic comes from funerary contexts, where seals were brought to light together with other artifacts linked to burial practices (Sbonias 1995: 3). Also, we have some impressions that were discovered in later Palatial deposits and generally assigned to Prepalatial matrixes on the bases of stylistic considerations (see e.g., Weingarten 2003). Unfortunately, burials were subject to

frequent reuses and often disturbed by external causes. Therefore, materials ranging across a long period - rarely limited to the Prepalatial one - are often co-attested even in single stratigraphical layers.

In the 1960s, Kenna (1960: 13) lamented the lack of contexts for EM II seals. Luckily, some seals unearthed within stratigraphically safe spots can today document the earliest stage of Minoan glyptic. Two impressions and a foot-shaped seal come from certain EM II contexts at Myrtos Phournou Koriphi (*CMS* V 020), Trypiti (Vasilakis 1989: 56) and Krassi (*CMS* II.1 407, also possibly EM I-II, see Sbonias 1995: 76 fn. 20). Well-stratified spots are provided by the Archanes Tholoi E (Panagiotopoulos 2002: 61-64) and Gamma (Papadatos 2005: 42-44), both attesting seals in their lower strata (EM IIA), as well as in the upper ones. Finally, stratified contexts of Lendas Tholoi I, II and IIa provide a further insight into the usage of seals during the EM IIA, located in layers immediately below the EM III-MM IA ones (Alexiou & Warren 2004: 129).

Furthermore, clear Early Minoan contexts are also provided by the Mochlos Tomb XVIII (Seager 1912: 69) and Sphoungaras Deposit B (Karantzali 1996: 51), dated to the EM II-III period. Besides Lendas, a late Prepalatial dating (EM III-MM IA) also seems definite for Galana Charakia Rock Shelter A (Platon 1954: 512-513 and Christakis 2005: 75). Finally, the cemetery at Moni Odigitria, which shows extremely weak evidence in favor of a frequentation after the Prepalatial period, provides a number of seals from Prepalatial strata (Sbonias 2010: 204). The same findspot is also traditionally posited for several pieces belonging to the Mitsotakis Collection (Pini 2004: 227-256).

However, most of the seals assumed to be Prepalatial were dated on the bases of their stylistic characteristics. The methodology adopted by scholars anchored a series of style-groups, defined by recurrent motifs and syntactic principles – presumably tied to technological possibilities – to a small number of seals from datable contexts presenting the same features. Furthermore, the use of materials and/or shapes chronologically relevant provides further clues for dating these objects.

The earliest Cretan style-group is unanimously identified in the Yule's 'Chip-Cut / Small Plate Signet Group' (hereafter C/P), essentially dominated by

grid and simple motifs, such as triangles and meanders (e.g., Sbonias 1995: 75-93). During this phase, alongside the usage of exclusive shapes (e.g., the *epomia*), seals would have been fashioned from common local materials, i.e., bone and soft stones. Their *floruit* at the end of the EM I has been supposed due to their omnipresence within all of the sure EM IIA contexts. A late EM I attestation at Krassi is also possible (see above).

2.5.2 The late Prepalatial period and the 'Archanes formula': an age of overlaps?

The late Prepalatial period would attest to the rising use of more complex iconographic motifs, renewed syntactic criteria and the usage of innovative and imported materials. Its earlier stage seems dominated by the Yule's 'Parading Lions / Spiral groups' (hereafter PL/S). For this group, a series of sub-divisions were proposed (e.g., Sbonias 1995: 84-102 and Anderson 2016: 171-283), although the chronological frame of its members remains rather unquestioned within the scholarship. The PL/S could have been entirely comprised within the Prepalatial period. *CMS* II.1 471, generally accepted as a member of PL/S and coming from an (early) EM II context, namely the lower stratum of Mochlos Tomb VI (Seager 1912: 54, 180, Younger 1988: 197-198 and Girella 2004: 180), would attest to the earliest usage of the group's stylistic criteria in a period when the use of ivory still seems sporadic (Krzyszkowska 2005: 63).[3]

An early date for the production of ivory seals could also be proved by their appearance within the lower Stratum II at Archanes Tholos Gamma (Papadatos 2005: 43), as well as by the impression II.8 006 on an EM III jar stopper found *in situ* (Hood & Cadogan 2011: 234-235). The best example of a chronological hiatus between soft stone/bone seals with geometric decorations and ivory cylinders and conoids associated to the PL/S is provided by the Archanes Tholos E. The lower stratum (EM IIA) only attests the former ones, decorated with motifs common for

[3] Younger (1988: 196) suggested placing the *floruit* of this style-group during the EM III period, based on an unspecified "sealing from a house of Knossos". Given that the alleged evidence is unspecified, this hypothesis is however unverifiable.

the C/P. Conversely, excavations in the upper strata (MM IA-MM II), unfortunately mixed to each other, brought to light a series of ivory seals clearly linkable to the PL/S in both shape and decoration (Panagiotopoulos 2002: 61-64). Similarly, in Lebena Tholos II, ivory seals only appeared from the second stratum upwards, while those belonging to the C/P were found in the lowest one. The presence of ivory cylinders during the MM I is proved by the stratified context at Galana Charakia, in which II.1 446 came to light. Notably, at the same spot, a context dated to the EM III is only provided with seals belonging to the C/P (Warren 1969: 195 fn. 2 and Christakis 2005: 75).

A precise dating for the 'Border and Leaf Complex' (hereafter B/L) is far from being accepted. Yule's original proposal (1980) is the EM III-MM IA period. He suggested the style-group was entirely Prepalatial. According to Younger (1988: 198-199), despite the sporadic overlap of shapes and iconographic motifs, it seems that this group was generally later than the PL/S and mostly at home during the MM I. This suggestion might also be confirmed by the large usage of bone, steatite, and white paste, while ivory is rare and perhaps already obsolete (Krzyszkowska 2005: 63-64). The alleged productivity of the B/L up to the MM II period was suggested only based on the use of a tubular drill on IV 042, whose features are however marginal within the B/L, as shown by the cylindrical shape and the outlined composition. Nonetheless, the cylinder II.1 205 from the upper stratum of Lebena Tholos IIa (EM III-MM IA) confirms that this group was already part of the late Prepalatial glyptic. It is possible that it fully developed only in the final part of this period. A dating to the EM III-MM IA period seems unlikely for the Archanes Cemetery, which would have been used at least until the MM IB period (Sakellarakis & Sapouna-Sakellarakis 1997). It appears that Gournes Pediada, providing the only other datable context, points to the MM IA-B (Yule 1980: 210). As already stated by Younger (1988: 200), it is clear that the 'Ladder and Spiral Group' (hereafter L/S), dated to the MM IA-B period, can be considered a B/L's sub-group. Therefore, a period of partial overlap between the B/L and the PL/S remains possible for the EM III period and especially for the MM IA period.

Starting from Sbonias (1995: 73-121), followed by Karytinos (1998; 2000) and Krzyszkowska (2005), the aforementioned alleged overlap led scholars to question the uniform nature of the MM IA period. Ceramic data do not allow to

split this period in different phases. Some pieces can even often be confused with EM III sherds (Krzyszkowska 2005: 74). As a consequence, arguments are fundamentally based on glyptic evidence. Specifically, it has been suggested that the fact that some materials and shapes are almost confined to one style-group only (either the PL/S or the B/L) would be indicative of a chronological hiatus between these Prepalatial style-groups. Without upsetting Yule's system, Sbonias (1995) basically suggests redating the late Prepalatial groups, previously considered as entirely overlapping during the EM III-MM IA(-B). The new chronology would be the EM III- *early* MM IA for seals belonging to the PL/S and the *late* MM IA-B for the B/L. Sbonias posited the 'second' MM IA period based on the marked differences in both material (such as the introduction of 'white paste') and decoration of the seals between the two style-groups.

As pointed out by Alexiou & Warren (2004: 130), 'white paste' is however already attested during the EM II – although possibly not used for seals – and both an Egyptian and a north Syrian source has been proposed. Moreover, the presence of a different iconography clearly does not automatically point to a different chronological span, especially if stratigraphical evidence seems to coincide. As is clearly the case for the MM II period, in which even separated workshops might have existed at the same spot (Pini 2010), there is no typological proof in support of this theory. Revealingly, such an overlap might be confirmed by both archaeological and iconographical data. Seals belonging to the PL/S and to the B/L were buried together in several late Prepalatial contexts. What is more, a certain degree of reciprocal influence can be observed on formal grounds (see Fig. 2.3). For instance, the cube II.1 064, from a datable EM III-MM IA context at Hagia Triada Tholos A (Cultraro p.c.), is clearly comparable in both shape and iconography to the seals bearing the 'Archanes formula' (Sbonias 1995: 107-108), while it may be fashioned from hippopotamus ivory, which almost only occurs for seals of the PL/S.[4] On the other hand, the reel V 301a is a clear case of PL/S iconography on a seal type otherwise featuring either B/L or the L/S, and was even attested during the MM II(-III) period. Obviously, the fact that such an example is

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[4] Hippopotamus ivory was claimed by Krzyszkowska (1989: 118) and confirmed on the Arachne's website. By contrast, Jasink (2011: 132) suggests it could be made in bone.

featured on reels, which are typologically akin to cylinders, could not be due to chance. Notably, the S-spiral, which is considered the most typical geometric motif of the PL/S (Yule 1980: 209), is commonly found on seals decidedly matching the features of either the B/L or the L/S (e.g., Sbonias 1995: 305-306). The same holds true for most of the other geometric motifs (see §2.5.4).

Fig. 2.3 – (From left to right) The cube II.1 064 from Hagia Triada and 'hybrid' seals of Sbonias (1995: 99-100)'s 'Blätter/Elfenbein-Gruppe' (i.e., II.1 242)

From a glyptic point of view, the transitional phase between Pre- and Protopalatial would represent the step immediately before the emergence of the vast majority of Hieroglyphic attestations, dated to the MM II or even later (see §6.4). By postponing the end of the B/L and the *floruit* of the AS to the MM IB or even later, they would represent the best bridge between Pre- and Protopalatial glyptic and would definitely provide a clue to fill the alleged MM IB-IIA epigraphic gap posited by Perna (2014: 253) before the actual moment of the inception of writing. Nevertheless, it seems decidedly plausible that the two traditions represented by the PL/S and the B/L (and related subgroups) mostly overlapped between the end of the Prepalatial and the beginning of the Protopalatial period. An even clearer 'bridge' might be represented by a small number of seals, mostly gables and reels, normally dated to the MM I period and stylistically on the boundary between the B/L and the 'Mallia Steatite Group' (see §2.7).

One can therefore recognize three different macro-groups within the Prepalatial tradition, i.e. the C/P, the PL/S and the B/L (with a number of sub-groups). The first (i.e., C/P) and the third (i.e., B/L), clearly distinguished by shapes and decorative patterns, would share the employment of local materials, except for 'white paste'. The second group is characterized by the use of ivory, especially on cylinders and conoids, and by the syntactic characteristics of the PL/S (see also §2.9). According to the archaeological findings, the second and third groups would

have co-existed at least during the 'ceramic' MM IA, while only the latter has examples from MM IB period.

The 'Archanes Script' only attests both bone and steatite seals, alongside motifs diagnostic for the B/L. It never occurs in a context surely abandoned at the end of the Prepalatial period. It would therefore be at home in MM IA-B. Furthermore, it features a series of seals which cannot be earlier than the MM IB or even belonging to the MM II (Decorte 2018a: 363). The MM IB thus may represent the key-moment for the emergence of this group.

In conclusion, I argue that, following the earliest phase (i.e., the C/P dated to the EM II-III period), two main competing stylistic trends were at home at the end of the Protopalatial period. They each employed a partially different iconography. On the one hand, the PL/S, featured by the usage of ivory and a relative homogeneity of seal shapes (mostly cylinders and conoids). On the other, the B/L, which possibly begun slightly later than the previous one and was still productive during the MM I period. It is featured by the usage of bone and soft stones. Its seal shapes are scarcely homogenous. Notably, the B/L is clearly tied to the AS and its features are generally to be found on MM I gables and reels too. Conversely, the relation between formal and iconographical features of the PL/S and those of the AS are decidedly weaker. These features seem to have become rather obsolete at the dawn of the Protopalatial period.

2.6 Signs showing integral and likely forerunners in the Prepalatial period

This section discusses instances in which a Hieroglyphic sign finds reference on Prepalatial seals. Indeed, in all the following cases, the Prepalatial motifs share both the referent and the graphic variability with related Hieroglyphic signs. Consequently, I argue that these motifs can be safely considered as direct forerunners of the Hieroglyphic ones, i.e., they were selected from an iconographic repository in which they are actually attested.

2.6.1 The full-bodied human figure (CH 001)

CH 001 represents a seated human figure (see Fig. 2.4). In the Hieroglyphic sign, at least one arm is visible and raised forward. Following *CHIC*'s doubts regarding the attestations on seals, this sign was variously reputed a *hapax* on clay (Karnava 2015: 142f.) or with both a syllabographic and an 'ideographic' value (Jasink 2009: 60). Among the MM II glyptic, the same distinctive features appear on seals where the 'crouched man' covers the entire surface (e.g., *CMS* IX 014a) or even on seals, excluded from the corpus, in which the 'crouched man' is combined with other motifs identical to Hieroglyphic signs (e.g., *CMS* VI 033b with CH 053 and *CMS* VI 036b with CH 016).[5]

Crucially, on Prepalatial seals, such a motif was employed in both narratives and highly symbolic contexts (see Fig. 2.5). It follows that it must have been highly standardized, and it would mirror fluctuations in motifs' usage which are commonly at home on MM II seals. Indeed, the same shape is provided with a datable EM II-III context on II.1 477a. Jasink (2009: 58) suggests that II.1 477a would share its representational criteria (i.e., a man sitting with head and legs in profile, chest and arms *en face*) only with the instance on clay (#041b), while Hieroglyphic seals would always represent a man in profile and in a more generic 'bent' posture. However, the sign on #041b is actually too stylized to discern the precise position of the components.

In any case, occurrences on seals from both Prepalatial and Hieroglyphic seals generally show a similar dimension of both the chest and the arms compared to the rest of the figure and no other detail allows us to exclude that their depictions follow exactly the same criteria. Of note, the outline of the motif on II.1 477a clearly partners with CH 001 on #310b, where both the chest and the arms could be seen in prospectus. A crouched man in a generic bent, namely non-explicitly sitting posture, is widespread on seals belonging to the PL/S (e.g., II.1 222 and II.6 149), also attesting the same disposition of the arms as on #310b, while it is absent from the B/L. Most of their iconographic features, i.e., the circular head, the trapezoidal

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[5] See also Decorte (2018b: 21) on *CMS* VI 029.

or triangular body and the raised arms, are ubiquitous on Prepalatial glyptic (see Matz 1928: 104-105 and Anderson 2016: 216) and are revealingly shared by CH 001.

Fig. 2.4 – Occurrences of CH 001 according to *CHIC* (386)

Notably, II.2 118a, bearing a human figure identical to CH 001, was included by Anastasiadou (2011: 115) among Middle Minoan seals combining Prepalatial tradition within innovative patterns. Indeed, this figure was compared to the ones on II.1 310a and 385a (Poursat & Papatsarouha 2000: 395). Anastasiadou (2011: 72) suggests a more precise connection with II.1 222a based on the 'fishbone' rendering of the chest.

Fig. 2.5 – Examples of possible forerunners of CH 001. (From left to right) *CMS* II.1 477a (ivory pyramoid from an EM II-III context within the Mochlos Grave XVIII), II.6 149 (ivory frustum of unknown provenance), II.1 310a (chlorite cylinder from Platanos Tholos B), II.1 285a (ivory cylinder from Archanes Grave 6, Room 1), II.1 055 (ivory pyramidoid from Hagia Triada Tholos A) and II.1 138b (ivory cylinder from Koumassa Tholos B).

2.6.2 Full-bodied animals (CH 019, 020 and 092)

On Prepalatial seals, the presence of animals is exceptionally rare during the earliest phase (i.e., the C/P), while their rapid increase occurs from the EM III onwards. Cretan Hieroglyphic inventory selected a good number of animals as referents of signs. Three of them represent animals from a frontal view, i.e., CH 011, a 'bucranium', CH 021, possibly a fly and CH 022, whose physical referent is uncertain. Apart from few full-bodied animals (i.e., CH 019 'fish', 020 'bee/wasp' and 092 'scorpion'), a number of signs depict heads of quadrupeds either in profile

or prospectus (i.e., CH 012-018). None of these finds a direct correspondence on the iconography engraved on seals (with a single exception) and will be analyzed later (§1.6). Conversely, full-bodied animals are well attested on Prepalatial seals.

The identification of CH 019 as a cuttlefish is the persistence of an erroneous Evansian idea. Cuttlefishes are not attested before the late Protopalatial occurrences in Vano XXV of the Phaistos' Palace and are particularly widespread among the talismanic glyptic. They show entirely different features from CH 019, e.g., large head, more than two 'fins' etc. The absence of fins is extremely uncommon and seems to be an idiosyncratic feature of the Hieroglyphic sign. Indeed, it could not be due to chance that one of the rare finless fishes is found on an inscribed seal, i.e., IS 073a. A basic distinction between dolphins and other kind of fishes is rather omnipresent within the scholarship (see Yule 1980: 135, Onassoglou 1985 and Younger 1988). Dolphins can be singled out by their curved position (Matz 1928: 120), the smoot, the curved body, the position of the fins (Yule 1980: 135) and the waving line(s) on the bellies (Yule 1980: 135 and Gill 1985: 69). Accordingly, it is plausible that CH 019 does not depict a dolphin.

By contrast, consensus regarding the identification of the other species is far from being reached (see Powell 1996: 67). Nevertheless, the identification of CH 019 as a fish is likely (Anastasiadou 2011: 186-187). All the Prepalatial depictions of fishes share with CH 019 the straight Y-shaped outline (see Fig. 2.6). The loss of iconicity, which hides the exact species behind the motif, is indeed a development common to both CH 019 and its possible Prepalatial forerunner(s). Notably, when CH 019 is part of the 'Archanes formula', it often shows an elongated 'body' (e.g., #202a). This shape is close to the "large fish" described by Yule (1980: 135) on the cylinder II.1 446b, from an MM I context at Galana Charakia. What is more, such a shape is among the few figurative motifs already occurring on Prepalatial vases.

Fig. 2.6 – (From left to right) CH 019 on a seal bearing the 'Archanes formula' (i.e., #202a) and possible instances of the fish on Prepalatial glyptic (i.e., II.1 446b, 287b, III 037 and VS1A 302) and a Prepalatial jar

The sign CH 020 adheres to same pattern (see Fig. 2.7). Despite its rarity in Prepalatial iconography, two wasps on II.1 159 partner with CH 020 (Matz 1928: 120-121), as all its features (i.e., a pointed mouth, two legs at the front of the thorax, two narrow wings from the back, a swallowing shaped abdomen and the antennae, see Crowley 2013: 133) are attested (see Fig. 2.7). The narrowing of the thorax points to the Prepalatial forerunners of Hieroglyphic signs not necessarily implying a higher degree of iconicity. Against the indication of Platon (1969: 181), Matz (1928: 120) and Yule (1980: 134) consider this ring as made of ivory, which would support an EM III-MM IA date. Notably, the same *tête-bêche* composition is mirrored by a Protopalatial steatite three-sided prism belonging to the 'Mallia Steatite Group' (i.e., *CMS* VS3 148b). One of the wasps/bees seems to attest an eye sporadically shown by CH 020 too (see #139 and #262c).

Fig. 2.7 – (From left to right) CH 020 on #303a and instances of two bees/wasps arranged in *tête-bêche* on *CMS* II.1 159 and *CMS* VS3 148b

The sign CH 092 can be interpreted as a scorpion (Salgarella 2021: 16), as seems confirmed by its most iconic instances on seals (see #262a and #267b, see Fig. 2.8). As well as the Hieroglyphic sign, in all its instances on seals, the scorpion is seen from above (Crowley 2013: 250). During the Prepalatial period (see Fig. 2.8), scorpions were confined to ivory cylinders and were possibly part of the 'exotic' animal repertoire introduced by the 'Parading Lions / Spiral Group'. In these instances, the head and thorax are merged. This feature is frequently attested for CH 092 too (e.g., #229a and #272b). Interestingly, however, the Protopalatial variant with a protruding head is sometimes introduced (e.g., II.2 292b and #265c). 'Needles' in the head's upper part are sporadically attested, but they are confined to the Protopalatial too (e.g., IV 011b and #262a). It would appear that the bifurcation of pedipalps is sporadically attested on Protopalatial seals only, even though it is never replaced by dotted ends out of inscribed seals. As with CH 019, the Hieroglyphic sign points to a less iconic variant *vis-à-vis* scorpions attested on both Pre- and Protopalatial seals. Such a stylization reduces the thorax to a small

vertical stroke or even completely leaves it out (see #312b), while tail and legs are never depicted.

Fig. 2.8 – The two variants of CH 092 and motifs of the scorpion. (From left to right) the 'headless' variant on #309d and on II.1 225b, 248b and 250b; the variant with protrusion on #262a and IX 014b.

2.6.3 Floral motifs (CH 023, 025, 026, 031, 068 and 077)

The best example of inheritance of an organic iconographic group is provided by signs linked to a plant referent. During the Prepalatial period, this kind of motifs was extremely widespread starting from the PL/S (Sbonias 1995: 87) and even constituted a diagnostic element for the B/L (Yule 1980: 210 and Younger 1988: 199). The study of floral motifs in Minoan iconography has been deeply influenced by the seminal work of Evans (1901) and therefore more oriented towards their Late Minoan religious meaning (e.g., Marinatos 1989 and Sourvinou-Inwood 1989). In this section, I discuss possible forerunners of Hieroglyphic signs depicting floral motifs.

CH 023 is defined by a trifoliate motif with a stalk (see Table 2.1). CH 096 attests a typologically common variant, also independently developed by Linear B (e.g., KN Np 85 and 856), and could therefore be considered as an allograph of CH 023. Moreover, this sign is comparable to the logogram *154, showing exactly the same leaf shape. This logogram co-attests two variants with and without the stalk (see #122[r].1 and 2). It is surely attested on two documents only and always in isolation (#006c) or together with a fraction sign (#122[r]). Notably, a difference in the rendering of the central leaf can be observed for CH 023 too (see #023d and #043a.1).

Evans (1909: 213) argued for the formal closeness of CH 023 with the crocus/saffron.[6] Such an idea was mainly triggered by the shape on #243c, in which the sign shows two strands in between the leaves. *CHIC* (19) reproduces Evans' view by comparing CH 023 with the logogram B *144/*CROCUS*. Yet, it must be noted that, apart from #243c, CH 023 is defined by a trifolium only. Rather than with B *144/*CROCUS*, such a motif finds correspondence with the logogram AB *122/*OLIV* (Day 2011: 370).

By contrast, both B *144/*CROCUS* and B 33/*ra₃* continue the canonical features of the crocus/saffron. Notably, starting from the Prepalatial period, the iconography of both olive and crocus/saffron converged. Such motifs are only distinguished through the presence of strands, while the trifoliate part is rendered in the same way (Day 2011: 370). As noted by Evans, the trifoliate motif on #243c is graphically interpretable as a crocus/saffron based on its strands (see Fig. 2.9). Such a hypothesis was confirmed by Palaima (2020: 10), who noticed that the side leaves on the stem of CH 023 on #243c are likely to be the "prototypes" for the same element occurring on B 33/*ra₃*. If this was the case, then such a motif could be independent from the occurrences of CH 023. What is more, the medallion #039 could suggest splitting CH 023 in two motifs too. On face a, *CHIC* (93) reads with uncertainty an instance of CH 023. This sign clearly occurs on the face b in its prototypical shape (see Table 2.1). By looking at the alleged CH 023 on face a (see Fig. 2.9), it is counterintuitive to analyze it as an allograph of CH 023 on face b. Indeed, it is unlikely that such a major graphic variability would be featured on the same document. What is more, criteria by which signs were realized are divergent. CH 023 on face b shows a long Z-shaped stem, which is conversely absent on face a, even though the blank space would have allowed it. Furthermore, on face b, leaves are rendered through five strokes, four of them being convergent in pairs. Instead, on face b, one can find seven strokes, mostly pointing to different

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[6] The connection with AB 69/*tu*, proposed by Younger, seems unlikely as the latter is mainly a heart-shaped motif without any stem. Furthermore, according to Jasink (2009: 34), the interpretation of CH 023 as a lily is untenable, since the latter is clearly featured by two looped and divergent leaves. A 'lily' is actually attested on some inscribed seals and listed as *SM* No. 90 by Evans but excluded by *CHIC*.

directions. As a consequence, given that the saffron motif is realized by adding two strands to the olive motif, it cannot be excluded that such an instance would be a counterpart of #243c on clay.

A motif matching the 'olive' shape of CH 023 is widespread on Prepalatial seals (see Table 2.1) in correlation with both the P/L (e.g., VS1A 252) and the B/L (e.g., II.2 258b). In the latter style-group, it often occupies a central and/or focused position (see §2.8). Notably, the main variants attested by CH 023 and *153, with reference to both the size of leaves (see #036a and #089a respectively with VS1A 225 and IV 110) and the presence of the stalk (see #122r.1 and 2 respectively with VS1A 252 and 225), are attested on Prepalatial seals.[7] As regards the stalk, it could be not due to chance that a stalkless variant is the only one attested within the B/L, while the PL/S show exactly the opposite situation. According to Sbonias (1995: 110), this pattern would not be unsurprising, since a series of motifs belonging to the AS and successively part of the MM II iconographic repertoire seems to have 'overridden' the B/L and can only be retraced within the PL/S.

Table 2.1 – Palaeographic variants of CH 023 *vis-à-vis* trifoliate motif attestations on Prepalatial seals

On the other hand, crocus/saffron is extremely rare on seals before the Late Minoan and unattested on Prepalatial pieces. The earliest attestation of the motif is

[7] The high quality of the depiction of this sign is rather isolated within both coeval and previous glyptic (see Anastasiadou 2011: 255).

on an MM IA-B Kamares cup from the Town Drain at Knossos (Dewan 2015: 44). In this case, the trifoliate motif is stalkless in accordance with the vast majority of attestations of olives on seals (see Fig. 2.9). In such a frame, it is noticeable that crocus/saffron and olive leaves share the same properties also on Prepalatial jewelries from Mochlos and were even perhaps co-attested on the same gold diadem (Hickman 2008: 61).

Fig. 2.9 – (From left to right) Saffron on the Kamares cup from the Town Drain at Knossos (from Dewan 2015: 44), the alleged instance of CH 023 on #039a, that on #243c and an example on a three-foliated motif with stalk on a Prepalatial seal (i.e., VS1A 252)

CH 025 is a worldwide diffused motif characterized by a vertical stroke, from which a number of upward 'needles' branch off (see Table 2.2). It was interpreted by Evans (1909: 217), followed by Jasink (2009: 72), as a "tree with ascending branches", while Karnava (2015: 143) argues that "with plants, only flowers and tree branches in various combinations appear, indicating […] a part of the whole plant". The same interpretation (i.e., "branch") is given by Yule (1980: 143). Matz conversely proposed either a twig or a tree. Similarly, a comparable sign in Anatolian Hieroglyphic (*149/150) has been analyzed as a twig (Waal 2017: 120) and notably attests the same oscillation between up- and downwards oriented 'leaves'. However, while on clay documents the physical referent of this sign remains rather ambiguous, the most iconic occurrences on seals would speak in favor of Evan's hypothesis, as is clear from #182 and especially #266b.

Depictions of trees are generally regarded as rare in Minoan glyptic and almost completely absent before the Neopalatial period. However, possible 'trees' occur on inscribed seals too, e.g., VII 028b and II.1 284a, in which a 'tree' covers the entire surface but is reputed to be a "bilateral branch" by Yule (1980: 211). Regardless of their physical referent, CH 025 clearly matches motifs widespread from the EM II onwards, such as ones on II.1 064b and II.1 367 (see Table 2.2). On these seals, the 'tree' is in a narrative scenario alongside other plants and grass-motifs representing the natural landscape in which an agrimi is located. The fact

that the alleged branch appears isolated at the ground level – as suggested by the agrimi's legs – point to the presence of a tree or a seedling. A very similar situation is found on II.8 032, where the absence of the central twig clearly excludes a branch.

What is more, graphic variants of the 'tree' on Prepalatial glyptic would be mirrored by some palaeographic variants of CH 025 (see Table 2.2). Indeed, the variant with leaves starting from the base of the three (#328) finds correspondence on Prepalatial seals (e.g., II.1 367), as well as the more common one with leaves starting from roughly one third of the 'trunk' (see #294a and II.1 064b).

Table 2.2 – Palaeographic variants of CH 025 *vis-à-vis* tree attestations on Prepalatial seals

Other signs depicting plants find numerous correspondence on Prepalatial seals. CH 026, a *hapax* on #056c and plausibly a leaved branch, find parallels on II.1 042, 367 and II.8 028 (see Fig. 2.10). On II.5 230 and 325, clear forerunners are attested for CH 031 as well (see Fig. 2.10), namely three branched motifs without leaves/needles (e.g., #218c and #284b).

Fig. 2.10 – Shapes of CH 026 and 031 and possible Prepalatial forerunners. (From left to right) CH 026 on #056c and ; CH 031 on #248a and II.5 230

CH 068 generally does not retain a high degree of iconicity (see Fig. 2.11). It was defined as "two almost parallel strokes opening upwards with short oblique double strokes attached at either end" (Tsipopoulou & Hallager 2010: 173). Some allographs later grouped under the label of CH 068 were originally singled out by Evans (1909). He interpreted the more iconic occurrences on seals (i.e., #225a and #272c), which show an ovoidal figure with closed extremities, as "ear of barley". Conversely, he classified the 'opened' variant attested on clay as a different sign (*SM* No. 90), but revealingly argued for "parallel branches". This distinction is accepted by Jasink (2009: 100), who recognizes on VI 087b (= #239) too an instance of *SM* No. 90, allegedly featured by two parallel branches with needles on one side only. However, as regards CH 068, the latter shape is likely due to the loss of iconicity on clay. Conversely, the combination of two "*Tannenzweige einseitige*" is extremely widespread on seals both in absolute isolation (e.g., III 189c) and in combination with other motifs (e.g., II.2 087c). It would therefore point to a motif unrelated to CH 068. What is more, all the attestations of CH 068 show two (rather stylized) needles for each side, which is rarely the case for the *Tannenzweige einseitige*.
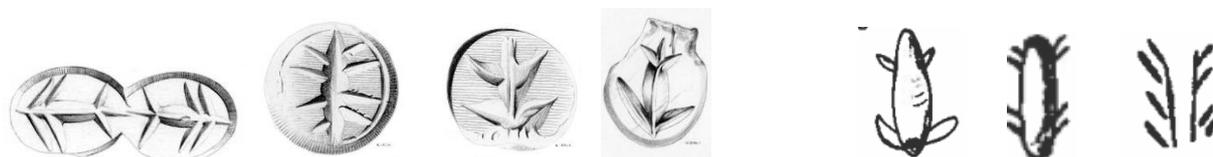
Fig. 2.11 – Examples of the bilateral branch on Prepalatial seals, (From left to right) II.1 254b, 305b, 326a and IV 034b and the sign CH 068 on #225a, #272c and 002c

CH 068 belongs to a well-known group of motifs of the EBA Mediterranean glyptic. The oblique strokes can be indifferently down- or up-oriented (see Fig. 2.11). The same fluctuation of down- (II.1 389c) and upwards oriented strokes (II.1 326a and IV 034b) is reflected on Prepalatial glyptic, even on the same surface (II.1 254b). Such instances were interpreted as a 'twig' (Platon 1969 and Sakellarakis & Kenna 1969 *s.u.*) or 'bilateral branch' (Yule 1980: 171 and Jasink 2009: 132). The same Yule highlights that this motif "appears to be essentially geometric in inspiration" (*ibidem*), which is exactly the same situation attested by CH 068. On Cretan seals, however, it would have been standardized by the depiction of two 'leaves' for each side (see Fig. 2.11).

CH 077 displays a rather high palaeographic variability, which led Evans (1909) to split the allographs later grouped together by *CHIC* into three signs, namely *SM* No. 93, reputedly the "heart-shaped fruit of the silphium plant", *SM* No. 122, tentatively associated to the Egyptian Hieroglyph for 'kidney' and *SM* No. 139, a bifoliate sign to "be regarded simply as decorative". Always excluded from transcriptions, the latter bifoliate motif appears on #203a (Decorte 2018a: 360), perhaps on #313a (see Jasink 2011: 142) alongside the first part of the 'Archanes formula' and on II.1 393c together with its second part.[8] Finally, the same motif is attested in association to well-known formulas, and was therefore ignored by the transcriptions (e.g., #259, see Civitillo 2016: 106).

In essence, CH 077 is composed of two rounded or ovoidal elements put together by a stroke, pointing to a double-leaf and, more in general, to the external protuberance of a branch (see Table 2.3). On clay, the rounded elements are always filled by dots, while this feature is absent on seals. On seals, the degree of palaeographic variability decreases by considering CH 077 on #164 as an instance of CH 034. This is clear by rotating by 180° *CHIC*'s drawing of #293a, and deleting the lower horizontal strokes, which is indeed not noted in the *CMS*' drawing.[9]

A double-leaf is the earliest attestation of floral motifs in Minoan glyptic (see Table 2.3) and remains extremely widespread during the Prepalatial period (Yule 1980: and Anderson 2016: 239) up to the AS (e.g., II.1 391n). Its spreading relates to the rise of floral motifs on late Prepalatial ivory seals and a sequence of double-leaves, especially when outlining a round face, is particularly diagnostic for the PL/S. Most of these instances match the distinctive features of CH 077, as is apparent from II.1 183, 251a, 379, II.8 003 and XII 074 (see Table 2.3).

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[8] Recognized by *CMS*, while *CHIC* reads the double-leaf as part of CH 095. On the value of this motif, see also Jasink (2009: 22-23), who, however, does not believe that the bifoliate motif on the 'Archanes formula' could be tied to CH 077.

[9] Strokes as 'fillers' are in any case commonly used on Hieroglyphic seals, especially when on those in hard stones. For example, see CH 010 on #254a, CH 036 on #263a and #272c, CH 044 on #309b, CH 049 on #301a, CH 092 on #265 and #312b etc.

Revealingly, the palaeographic variability noted for CH 077 finds correspondence on Prepalatial bifoliate motifs. The dotted variant is attested e.g., on II.1 044 and IV 103b. All the occurrences also show the same fluctuation between a rounded (e.g., #139) and an ovoidal variant of the leaves (e.g., #290d), and even merge them in one case (see #079a and II.1 266a). Apart from seals, the double leaf is ubiquitous on other media. For instance, it is among the most common shapes for pendants and luxury ornaments, such as the foliate attachment to a gold diadem from EM II-III Mochlos (i.e., HM 4352, see Table 2.3).

#047a		VS1A 264a	
#079a		II.1 266a	
#095a		II.1 044	
#139		II.1 251a	
#295b		IV 107	
		HM 4352	
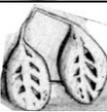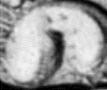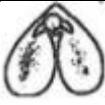
Table 2.3 – Palaeographic variants of CH 077 *vis-à-vis* bifoliate motif attestations on Prepalatial seals and jewelry

2.6.4 Geometric motifs (CH 059, 061, 066, 072 and 073)

Geometric motifs are the earliest devices employed on Minoan seals and functioned as independent devices continuously until the end of the Protopalatial period (see Table 2.4). The 'ennobling' of older decorative elements as meaningful symbols able to occupy semantic relevant positions is a mechanism shared by the whole Cretan artistic tradition. Although it cannot be theoretically excluded that such 'geometric' motifs would represent a stylized version of other icons (see *infra*), their massive appearance from the very beginning of Prepalatial glyptic would point

to genuine geometric symbols. Notably, geometric motifs represented the core of vase paintings too up to the end of the Protopalatial period (Walberg 1987: 36).

The fact that geometric motifs are sometimes employed as fillers (i.e., possibly only bearing an aesthetic value) cannot exclude that they could also have been used with another meaning. Indeed, such a hybrid nature is proved by CH 'geometric' signs themselves. Hieroglyphic 'geometric/abstract' signs clearly attest a syllabographic(/logographic) value when occurring in sequences with other signs, while elsewhere they could have functioned as decorative elements. For example, the J-hook (CH 059) can be analyzed as a syllabogram on #242 whereas on #216 it would likely constitute a minor device alongside the sign CH 044 (see Fig. 2.12). Moreover, 'geometric' motifs were widely employed on uninscribed Protopalatial seals as main devices with a plausible symbolic meaning.

Fig. 2.12 – (From left to right) Instances of CH 059 on #242 and #216

CH 059, identical to CH *309/Δ, was initially tentatively connected with the Egyptian Hieroglyphic for the 'cloth' (Evans *SM* No. 193). Nevertheless, the sign represents a mere geometric shape which can hardly be connected to a physical referent.[10] The same motif also appears on a number of inscribed seals (e.g., #127 and #158) alongside some Hieroglyphic signs. In these cases, it is therefore reputed a decorative element by *CHIC* and excluded from transcriptions. Conversely, Jasink (2005: 34), followed by Decorte (2017a: 45), suggests that all the three types of occurrences have a meaningful value and can be traced back to "an ideogram referring to some specific (administrative) entity, which later evolved into two separate symbols". Other signs allegedly traced back to J-hooks (i.e., CH *179-182,

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[10] A comparable shape only comes from the 'baton' on III 214a (dated to the MM II period). However, the number of the Prepalatial attestations cannot exclude that this similarity could be simply due to chance.

see Jasink 2009: 85) are more likely sub-variants of a well-known motif (see §2.7.1).

A derivation of CH 059 from Prepalatial 'abstract' J-hooks depicted on seals has already been suggested by Jasink (2009: 86), who highlights that, at the end of the Prepalatial period, the J-hook would have represented an autonomous "decorative" motif. Indeed, the usage of J-hooks as an independent device was extremely widespread during the late Prepalatial period (see Table 2.4), where it is used in almost all of the possible syntactic constructions (Yule 1980: 159 and Decorte 2018b: 192-195).[11] The occurrences of J-hooks, together with their relative sizes and centrality into the composition, seem to progressively increase over time. They are therefore considered as diagnostic elements for the L/S (Yule 1980: 211). *Pace* Jasink (2009: 86), such a motif was clearly distinguished from 'scrolls' already during the Prepalatial period (e.g., II.1 081 and II.1 003a). Notably, a slightly more looped variant of the motifs characterized both Prepalatial J-hooks and CH 059 (see II.1 205b and #291d).[12]

Similarly, the usage of both Z- and S-motifs, which are respectively linkable to CH 061 and CH 309 (see Jasink 2009: 4, 87), is widespread on Prepalatial seals (see Table 2.4). The sign CH 061 resembles the schematic representation of the two snakes as attested on *CMS* III 065a, even though no decisive evidence is available for such an identification. The 'waved' variant on the clay bar #062 could point in this direction if compared to the snake on #257a.

Both Z- and S-motifs follow an identical progressive increase during the Prepalatial period, the latter even being a diagnostic element for the PL/S. Notably, neither Z- nor S-motifs ever enter circular/outlined compositions - almost unknown to Cretan Hieroglyphic - but they are always positioned either in a linear

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[11] See II.1 081, 082, 205b, 295a, 303, III 098, IV 035 and XII 086.

[12] On Prepalatial seals, a 'scroll' is attested e.g., on VI 007. Notably, it is never to be found in syntactic positions typically occupied by J-hooks, i.e., the edge of concentric compositions within the PL/S or the circular arrangement within the B/L.

arrangement or, more often, in the middle of the field, dividing it in two specular parts.[13]

Motif	PL/S	B/L	AS	L/S	Hieroglyphic sign
J-hook			None		
Z-motif				None	
S-motif					

Table 2.4 – Presence of J-hooks, Z- and S- motifs on the various Prepalatial style-groups and their combination with different syntactic frameworks. From the top left: *CMS* II.1 295a (Ivory cylinder from the Platyvola Tholos B), II.1 205b (white paste cylinder from Lebena Tholos IIa), II.1 303 (Soft stone conoid from Platanos Tholos B). From central left: *CMS* II.1 230b (bone disc from Marathokephalo Tholos), VS3 135 (white paste scarabaeus from the Mitsotakis Collection and tentatively assigned to Moni Odigitria), IVD 020 (white paste zoomorphic seal, tentatively assigned to Kali Limenes). From the bottom right: *CMS* IV 034a (ivory cylinder, tentatively assigned to Krotos), II.2 310b (three-sided prism of unknown provenance), II.1 286a (white paste disc from Platanos Tholos B), II.1 190 (chlorite conoid from Lebena Tholos II).

Circles and triangles are among the simplest shapes conceivable. Of course, they are widespread worldwide and often feature at the very beginning of iconographic traditions. CH 073 merely depicts a ring. It should be noted that such motif is identical to the numeral for 100, which is also preserved in Linear A and B. The sign is well-attested on clay as a circle. On seals, the only sure attestation would be on #198, in which it appears as a 'ring' realized through the tubular drill. In all the other three possible occurrences, the sign is conversely rendered as a 'cup-sinking'. Two of them should theoretically be excluded from transcriptions, as they appear alongside well-known formulas. During the MM II period, rings and dots appear almost everywhere, mostly with a merely ornamental purpose (Anastasiadou 2011: 270-271). Still, rings are duplicated in a frieze-like arrangement on a four-sided prism possibly miming the Hieroglyphic ones (i.e., II.6 242, see Civitillo 2016: 145). Revealingly, on inscribed seals they can be either duplicated in an antithetic position mirroring a *tête-bêche* arrangement (see II.2 230c = #229) or used as fillers and/or dividers (see #310b).

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[13] For the particular position of these motifs, see §2.10.

The usage of rings as independent devices is widespread on Prepalatial glyptic, but difficult to find within the B/L (see Fig. 2.13). According to Anderson (2016: 138), a ring was engraved at the center of the surface within the PL/S in order to serve as a guideline for 'rotating' elements. These elements were directly attached to the ring (see II.1 382a), adjacent to its circumference (see II.1 251a) or isolated (see II.1 052a). Sometimes, it can be placed to divide two different layers of the outline (see II.1 228). Rings engraved at the center of a round surface predate the PL/S and belong to the set of simple motifs featured on EM I-III seals (see II.1 210). Out of the center of the face, a ring in isolation can be found together with a quadruped on VS1A 034a, an ivory cylinder from Hagios Charalambos. Crucially, such a figure partners with II.5 253, which associates the ring to a quadruped in a pose known during the Prepalatial period (see II.1 064b).

On seals belonging to the B/L, only bigger 'cup-sinkings' are to be found. However, they are almost always placed in extremely simple compositions, usually in chains with other 'cup-sinkings' (e.g., VS1A 238). Therefore, they might simply have been decorative compositions.

Fig. 2.13 – Relevant instances of a ring in isolation on Prepalatial seals. (From left to right) II.1 052a, 248a, 382a and VS1A 034

As well as rings, triangles are among the simplest motifs and their presence within an iconographic vocabulary is somehow predictable. On EM (I-)II seals, triangles and zig-zag lines are diagnostic for the subgroup of the 'Kersbschnitt seals' (e.g., II.1 202, see Sbonias 1995: 79). They constituted almost the only alternative to grids, which were easily engraved by filing (Anderson 2016: 59). Their usage was later continued by both the PL/S (e.g., II.1 124) and the B/L (e.g., II.8 023).

Although the simplicity of the sign necessitates a tentative approach, it is worth noting that the usage of triangles as main devices spread on late Prepalatial seals (see Fig. 2.14). For instance, it is attested at the center of the face on II.1 292b,

a gable in white paste from the Platanos Tholos B. Moreover, on VS1A 039, a rare plate-shaped seal with a round face and a vertical perforation, a triangle shows a rotating pattern reminiscent of the PL/S. Notably, the only object comparable to VS1A 039 is II.1 426, differently engraved on both faces and bearing the only potential Prepalatial occurrence of the bow with an arrow. Another white paste gable, namely II.2 260c, shows two triangles in a back-to-back composition, divided by a branch-motif and flanked by both parallel lines and hatched triangles. Two triangles in back-to-back composition already featured an EM II pierced-grip seal from the Tholos II at Lendas. Notably, such a duplication and association with the typical B/L syntactical structures is shared by other forerunners of Hieroglyphic signs (see §2.10). On II.2 260b itself, two 'scrolls' (motifs well-known on Hieroglyphic seals, see Jasink 2009: 13-20) are attested in the same arrangement.[14] Within the PL/S groups, triangles are commonly small devices used as fillers (e.g., II.1 037) or in an outline (e.g., II.8 023). A possible exception is the disc VS1A 039, which is however fashioned from chlorite, bearing a chain of triangles immediately following the stringhole at the core of the outline.

Fig. 2.14 – Relevant instances of a triangle in isolation on Prepalatial seals. (From left to right) II.1 202, 203, 292b, II.2 260c, II.8 023 and VS1A 039

2.6.5 Other motifs (CH 033, 040 and 069)

The sign CH 033 can be interpreted as a sun (see Goodison 2020: 172-173, suggesting a solution for a puzzle going back to Evans 1909: 221 "day-star or sun with revolving rays"). It constitutes a well-known motif within the Protopalatial glyptic (Anastasiadou 2011: 281, 283-284). Outside of the sequences in which it is transcribed by *CHIC*, it occurs alongside Hieroglyphic seals, often as a minor

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[14] This gable can in fact be regarded as akin to the MM II three-sided prisms, as its 'main' face is 0.3 cm only longer than the other ones.

device (e.g., #257c), as well as on uninscribed faces possibly as the main device (e.g., IV 156c = #247). Moreover, it often occurs together with motifs matching Hieroglyphic signs in seals excluded by *CHIC* (e.g., VI 089a, VI 142 and XII 062a).

This motif is very widespread in Prepalatial glyptic (see Fig. 2.15). It appears in a descriptive context within the PL/S (see II.1 055, see Fig. 2.5), where it preserves its 'narrative' function, and as an isolated sign within the B/L (see II.1 308) or slightly later (see X 041). The Prepalatial 'sun' is generally brought back to Yule's 'whirls' (see Jasink 2009: 40). In Yule's taxonomy, however, this label groups together the 'sun' and a series of motifs clearly featured by a spiraliform shape of rays and therefore rather unrelated to CH 033. And yet, formal features of the 'sun' are widespread among a slightly later MM IA-B material, as attested by a huge number of seals provided with a 'sun' in absolute isolation and sporadically encircled by a border band (e.g., VS3 326). These positions are particularly relevant, as they commonly feature motifs matching Hieroglyphic signs, and sometimes regarded as possible logograms, although such a value was not entirely demonstrated (see also §3.7.1). Notably, this composition survived even up to the MM II-III period, as proved by the discoid in amethyst CMS XII 116.

Fig. 2.15 – Possible instances of the 'sun' on late Prepalatial seals. (From left to right) II.1 308, VS3 326 and X 041

CH 040 is always characterized by the mast and at least two tie-rods (see Table 2.5). The stern is invariably high and pointing upwards, while the bow can be curved (see #124), slightly upwards (see #191) or flat (see #129). Oars are facultative and feature in 55.5% of the total occurrences. Similarly, the prong on the stern can be found in 40% of the occurrences. The hull is almost generally curved (almost 75% of the total instances), even though it is not always the case (e.g., #118b and #129). The latter features suggest that the Hieroglyphic sign would have 'merged' more pre-existing representations of ships. Revealingly, more than one type of ship is to be found on Prepalatial iconography.

First, a longboat with a straight hull (= Wedde 2000's Type I > Van de Moortel 2017's Type A1) appears as a model from EM II Palaikastro, as well as on 'frying pan' of unknown provenance, and a stone slab from Korphi t'Anoriou, the latter two dating to the EC IIA period (see Table 2.5). Such a depiction is inherited by a few images on seals of the 'Mallia Steatite Group' (see II.2 276b) and attests the inception of sailing propulsion by means of mast and tie-rods (= Wedde 2000's Types II > Van de Moortel 2017's Type B1). These features are continued by those instances of CH 040 which show a straight asymmetrical hull (see #113.cB and #129).

Second, two askoi coming from EH IIB Orchomenos attest a longboat equipped with a curved hull (= Wedde 2000's Type I > Van de Moortel 2017's Type A2). In the late Prepalatial period, such a hull-type is mirrored by the ship on the bone gable II.1 287b, and it is the rule on seals of the 'Mallia Steatite Group' (see Table 2.5). Obviously, the Protopalatial depictions show the characteristics of the EM III-MM II ships (= Wedde 2000's Type II > Van de Moortel 2017's Type B2). These features are continued by instances of CH 040 showing an asymmetrical and curved hull (see #191). Notably, the ship on II.1 287b has an asymmetrical hull, with a high stern equipped with prongs and a horizontal projection of the bow. Such a configuration is attested by the clay model from Palaikastro too. These features are both widely continued during the MM II period regardless of the shape of the hull and are sporadically to be found on CH 040 too (see #097c and #118b).

Third, starting from several EC/H IIB potmarks, another type of ship is attested. This ship has a symmetrical curved hull, i.e., the bow and the stern rise almost at the same level (= Wedde 2000's Types III, IV > Van de Moortel 2017's Type C2). As proved by potmarks, the mast characterized these ships already at an early stage. Such a type finds robust evidence on CH 040 (see #097c and #294a), and the bow/stern decorations match the ones identified by Wedde (2000: 52-54). While it is well attested within the 'Mallia Steatite Group' (e.g., XI 144a), it was never recognized on Prepalatial seals (see Table 2.5).

Fourth, very little Protopalatial evidence might point to a type with a symmetrical straight hull (= Wedde 2000's Types III, IV > Van de Moortel 2017's Type C1). Yet, evidence for this type is weak and its very existence has been

questioned (Van de Moortel 2017: 267). Still, the rectangular block VS1B 333a from Mochlos, included in the 'Mallia Stetatite Group', could attest this type (see Table 2.5). Revealingly, the same type could be attested by a Prepalatial boat model in clay found at Mochlos. As regards CH 040, such a type is only represented on clay (see #097c) and could therefore refer to an idiosyncratic schematization of the scribe.

Van de Moortel (2017)'s Type	Early Cycladic / Early Helladic	Prepalatial Crete	Protopalatial Crete	CH 040
(A1 >) B1				
(A2 >) B2				
C1	-			
C2		-		

Table 2.5 – Variants of the ship between Pre- and Protopalatial iconography

Sign CH 069 is composed of two Z-shaped parallel strokes with dots in between (see Fig. 2.16). In one case (i.e., #041a), the two strokes are joined together, resulting in a closed shape. As concerns its physical referent, Evans (1909: 224-225) did not put forward any hypothesis due to the extreme simplicity of the shape. Karnava (2000: 111) suggests that a dotted interior was adopted in order to distinguish CH 069 from CH 071. However, these two signs are clearly differentiated by the number of Z-shaped motifs (as well as e.g., CH 066 from the |-stiktogram). Moreover, on #041a, CH 069 is even 'closed' at the edges and by no means can it be confused with CH 061.

Landscape elements are rare on Minoan Pre- and Protopalatial seals and the representation of freshwater is entirely unknown until the MM III (see also Berg 2011 for marine landscapes). The only motif attesting a comparable pattern is found on a bone pyramidoid from Lendas Tholos IIa (i.e., II.1 207, see Fig. 2.16). The lack of both an iconographic context and clear *comparanda* for such a seal, however, does not allow excluding a mere geometric pattern, and such comparison

cannot be proved or disproved.[15] Notably, on Protopalatial seals, CH 068 is unparalleled. It therefore remains confined to Cretan Hieroglyphic.

Fig. 2.16 – The sign CH 069 on #287b and the bone pyramidoid II.1 207 from Lerna Tholos IIa

2.6.6 Two animal heads on Prepalatial seals?

Animal heads, well attested within the Hieroglyphic inventory (CH 011-018), are almost absent in Prepalatial glyptic as independent devices, apart from II.1 105b and probably II.1 311b (see Fig. 2.17).

The former is a clay cylinder bearing a hunting scene, in which an (head of an) ox is possibly trapped in a net. The head of this quadruped attests all the distinctive features of CH 012, i.e., a prospectus view, a protruding horn, an ear and a slightly elongated outline (see Fig. 2.17). The narrative scenario in which the motif is included is well-known from the later imagery (Isaakidou & Halstead 2021: 58). The presence of a narrative is rather clear, as the heads of the standing human figures are oriented in the same direction as their legs. The typology of the cross on the face a. is well attested during the Prepalatial period (e.g., II.1 288, II.1 344, 366a, 431, 457 and 478).

The seal II.1 311b shows a head matching CH 018 due to its open mouth (Anastasiadou 2011: 178-179 and Jasink 2009: 69). This head does not show the protruding tongue, which is frequent for CH 018, although it is facultative (see #314d). Still, it is clearly placed at the top of a human body, although these two parts are not directly attached to each other (see Fig. 2.17). As a consequence, it

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[15] Notably, given its simplicity, this zig-zag motif is attested starting from the Early Neolithic fine ware. On these vases, it is diagnostic for a well-known technique called *pointillé* (see Betancourt 1985: 7-8).

could be a part of a *Mischwesen* (see Anastasiadou 2021 for these kinds of motifs).
Although a full-bodied canine is well-attested on Prepalatial glyptic (Ferrara *et al.*
2020: 10-11), such a *Mischwesen* might represent the only instance of the head of
a dog used independently (i.e., not part of the full-bodied animal). If the motif on
II.1 389a is an extremely schematic quadruped (as suggested to me by Maria
Anastasiadou p.c.), it would be the only clear example of a protruding tongue on
such an animal.

Fig. 2.17 – (From left to right) CH 012 on 271a, II.1 105b, CH 018 on #314d and II.1 311b

2.7 Motifs only attested in groups linked to the 'Archanes Script Group'

This section discusses instances in which a Hieroglyphic sign is mirrored by a
Prepalatial motif confined to style-groups tied to the AS. Like those described in
§2.6, these motifs share the referent with Hieroglyphic signs, while their graphical
variability cannot always be detected due to the low number of attestations.

Consequently, I argue that these motifs can be safely regarded as
forerunners of the Hieroglyphic ones attested during the MM II period, and that
their emergence may be linked to the last phases preceding the standardization of
the Hieroglyphic graphic repertoire.

2.7.1 Motifs on seals linked to the 'Archanes formula'

Although it is generally agreed that the AS constituted the decisive step toward the
emergence of writing (e.g., Sbonias 1995: 108), in the previous section I showed
that a good number of Hieroglyphic signs could actually go back to earlier
iconographic motifs. That said, some signs appear as clear forerunners only on seals
belonging to the AS and their emergence could therefore be directly tied to the
graphic tradition yielding the first examples of writing. It is understood that, as these
motifs are attested in the style-group including the 'Archanes formula', one cannot

exclude that they could have had a function comparable to the signs of the formula as well. Accordingly, it could not be due to chance that, although several seals belonging to this group were found in Southern Crete (Sbonias 2012: 281-285), almost all motifs matching Hieroglyphic signs come from Northern Crete. The only clear exception would be the ship (CH 040) on II.1 287b, which still cannot be regarded as the only forerunner of the Hieroglyphic sign (see §2.6.5). Still, it is worth highlighting that all of these, with the exception of the 'hand' (CH 008), are attested only once.

Possible forerunners of CH 008 and CH 010 have already been widely recognized due to the special position in which they occur (see Fig. 2.18). The former represents either a palm or a torso of a hand. It occurs on the inscribed seal II.1 391j in the same position of the only (clear) attestation of the leg (which appears on the face l). As regards CH 010, it should be noted that a leg probably stands for a human figure on II.1 105b too (see Fig. 2.17), although the narrative scenario seems to exclude a symbolic meaning. As underlined by Weingarten (2003: 295), there is no definitive evidence to exclude that, on II.1 391, such motifs already conveyed a (logographic?) meaning as script signs, as well as those included within the 'Archanes formula'.

A hand is also present on II.8 015 (see Fig. 2.18), found on a nodulus associated to both MM IIA debris and a possible Linear A (i.e., KN 49, see §6.5) fragmentary tablet in the S-W House at Knossos. Forms and type of the impression would suggest an ivory or bone object. The interlacing background has an irregular pattern unknown elsewhere. The *CMS* editors compared the background to that on II.1 064a. It is another complex interlace, but still based on a radial pattern and a curved band which cannot be compared to II.8 015. It would seem that the two parallels suggested by Weingarten (2003: 294 fn. 22), i.e., II.1 244 and 471, do not match the shape of the interlace on II.8 015. The former is not an interlace at all, as it merely crosses two semi-circular bands. The latter is a compounded shape, which merges a square and a 'dotted' cross. This shape finds a wide range of parallels (e.g., II.1 313). These backgrounding interlaces cannot in fact be directly compared to the endless bands appearing on Phaistos impressions and their relatives. Indeed, such impressions show few combinations of extremely symmetric bands. Moreover, such bands never functioned as a background, but always appear either

in focused positions (i.e., at the very center of the composition) or in absolute isolation. The best comparison, in my opinion, is the ivory pyramidoid VI 005, unfortunately without a context. As a consequence, such impressions cannot be stylistically tied to a precise group. Thus, based on both the technical cues and the general iconography, it could only be recognized as coming from a late Prepalatial matrix.

A radial interlace also constitutes the background of the only possible forerunner of CH 041. It appears on the ivory cube II.1 064a from an EM III-MM IA context (see Fig. 2.18). As already shown, this seal can be considered at the boundary between the PL/S and the B/L, and it is graphically akin to the AS. The background does not find any direct parallel. Yet, it should be noted that a different kind of interlace is attested on the chlorite conoid II.1 084 from the same context. The interlace on II.1 084 is framed within a 'ladder' border, which is popular on MM I seals. Such an occurrence supports the association of II.1 064 to the B/L sub-groups.

What is more, it could not be due to chance that, when an interlace constitutes the background, it is always combined with a possible Hieroglyphic sign in isolation. On another face of the cube (i.e., II.1 064d), a full-bodied quadruped is encircled by a floral border encountered on Hieroglyphic seals (e.g., #131, see Weingarten 2003: 292), as well as on Protopalatial impressions from Phaistos (e.g., II.5 301).
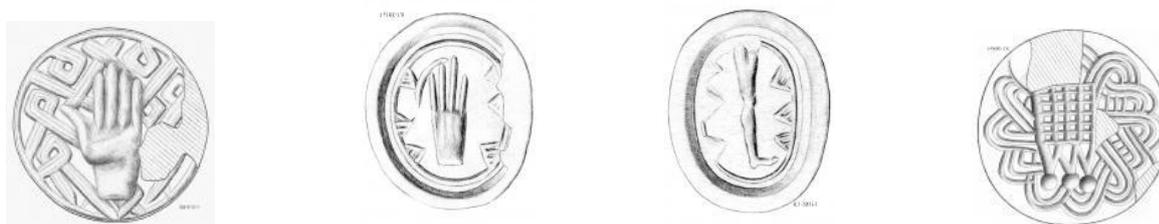
Fig. 2.18 – Prepalatial instances on seals of the CH 008, 010 and 041. (From left to right) II.8 015, II.1 391j, II.1 391k and II.1 064a

CH 039 (see Fig. 2.19), probably a fence, finds correspondence on a scarab (II.1 402). On this seal, it appears in a focus position within a typical syntactic structure of the B/L and the AS (see the 'leg' on II.1 391k and the hand on II.1 391l). Such motif is rather rare in Protopalatial (but see II.2 286a and II.5 025) and

gained attestations starting from the later 'Architectural Group'. A sign only attested once on clay, i.e., CH 089, regardless of its 'interpretation', could seemingly find a good *comparandum* in the same syntactic position on II.1 390 from the Archanes Room I (see Fig. 2.19). Given the scarcity of the attestations of both the Hieroglyphic and the Prepalatial motif, this comparison should however be regarded as unsure. Finally, a parallel of CH *181 can be recognized three times on seals belonging to the AS (i.e., II.1 126b, 391d and 392a). In two cases it appears in absolute isolation, while on II.1 392a it is flanked by a trifoliate motif close to CH 023 (see §2.6.3) and two hatched borders.

Fig. 2.19 – Possible forerunners for CH 039 (II.1 402, white paste scarabaeus from Gournes Tomb B and belonging to the AS), CH 089 (II.1 390a, steatite discus from Archanes Tomb 6 and belonging to the AS) and CH *181 (.

Finally, I consider motifs belonging to the 'Archanes formula'. As already shown, only one (i.e., CH 019) would attest a long-lived tradition, while the other three never appear previously. The double-axe (CH 042) is attested outside the formula on an MM I seal of the AS (II.2 215a, see Fig. 2.20). As observed by Decorte (2018a: 365-366), Protopalatial instances of the double-axe tend to reduce the size of the vertical stroke (i.e., the 'shaft', see #303b and #305a), which can even be sometimes omitted (see #331). However, even a shaftless double-axe might have been at home during the MM I too.

A stylized double-axe might be recognized on VI 017 (see Fig. 2.20), a steatite conoid attesting at least another figurative motif, plausibly a three-leaved blossom matching CH *159bis. Its formal features clearly match the ones on #222b and on more schematic variants such as on #068ʳ.a. Nevertheless, without a sure iconographic context, no definitive interpretation can be put forward.

At least two other possible attestations could be suggested. The former is on the gable II.2 311a (see Fig. 2.20). As already observed, such a gable is clearly part of the same stylistic cluster as II.2 215. Indeed, apart from the alleged signs of writing on their 'main' faces, the other two show an extremely similar iconography. Of note, the schematic rendering of the quadrupeds on both II.2 215c and II.2 311b

has a match with other pieces of the AS (e.g., II.1 389). Moreover, on both these gables, at least a sequence CH 042-019 could be recognized. By contrast, the other motifs are more difficult to interpret.

The second evidence is on an eight-shield shaped seal in 'white paste', i.e., XI 075 (see Fig. 2.20). A butterfly-shaped blade of a double-axe could be flanked by two trifoliate motifs, matching CH 023. Such a composition is known on seals belonging to the B/L, and on one occasion features an S-spiral matching CH 309. Cases in which only the blade of the double-axe is represented are well-known, as II.2 311a itself shows. A shaftless double-axe is perhaps also attested on an EM II bowl from Mochlos (see Betancourt 1985: 43, Fig. 24). Crucially, one of the central leaves of the trifoliate motifs is adjacent to the central part of the blade, and could therefore be a rendering of the shaft. What is more, both the striated blade and a shaft represented by another motif would find a counterpart on the impression II.5 233 from Phaistos Vano XXV (see Fig. 2.20). If this was the case, such a seal would attest the only case of a Prepalatial double-axe entirely independent of the 'Archanes formula'.

Fig. 2.20 – (From left to right) II.2 311a, VI 017, XI 075 and II.5 233

CH 053 represents a well-known spouted jar, clearly in use starting from the Prepalatial period (e.g., Momigliano 2007: 87). On seals from the mainland, such a motif is attested on the impression V 109 from EH II Lerna. However, it is absent on Minoan seals up to the MM I-II period. Its presence within the iconography is testified by a miniature ivory pendant found at Moni Odigitria. This pendant shows features (i.e., ovoidal body and triangular 'beak') well-attested for CH 053 (see #309b). CH 095, a 'bust of a sphinx' (Kanta *et al.* 2022: 74-75), is not attested as a script sign outside of the 'Archanes formula'. Apart from few full-bodied sphinxes (e.g., VI 128), this motif is uncommon in Minoan seal iconography. Notably, both CH 053 and 095 show a high degree of stylization, which speaks in favor of their high recognizability at least in the context of the 'Archanes formula'.

2.7.2 The sub-groups of gables and their relatives during the MM I

An interesting sub-group is represented by gables. The dating of these seals is difficult to state with precision. Gables are commonly found on EM III-MM I glyptic and documented within an EM II-III context in Maronia (see II.1 421). The datable contexts of gables stylistically close to the AS go up to the MM IB or the MM II period (see XI 073). Some of these gables were analyzed by Decorte (2017b: 363) as bearing a set of motifs interpretable as "proto-writing", as well as the other seals of the AS. Regardless of this suggestion, iconography on gables is generally in line with one of the seals belonging to the B/L, especially the AS. Gables are a privileged host for the 'Archanes formula' (see #251-252). Moreover, motifs widespread within the B/L, such as 'ladders' and 'trifoliate' motifs, are well-attested on gables (e.g., II.2 310). Revealingly, the other seal shape hosting the 'Archanes formula', i.e., the disc (see II.1 394), always shows an iconography with a close connection to gables (e.g., IV D025). Even so, a number of gables display some stylistic peculiarities, generally confined to this seal shape and sporadically attested on discs only. For instance, motifs are often realized in an extremely stylized manner through single V-cuts (e.g., II.2 311c, VI 041a, XI 140c and XII 063c), such a feature being extremely rare when not on gables and never found outside of the B/L.

Decorte (2017b: 201-202) singles out a group of Prepalatial (or early Protopalatial) prisms with three faces. Among them, he distinguishes three seals as part of the AS (i.e., II.1 126, 287 and 393), three bearing 'linear motifs' (II.1 309, 389 and 453), while the others would show an "EM II-MM IB glyptic vocabulary". However, such a subdivision is highly unlikely. He associates the two seals without the 'Archanes formula' (i.e., II.1 126 and 287) to the AS by virtue of quadrupeds flanked by hatched triangles or semicircles. Notably, such an iconography was not confined to seals with three faces nor to the AS *sensu stricto*, but is featured on a larger group of seals belonging to the B/L, as proved e.g., by II.1 268a and XII 063b.

Seals with "linear motifs" include two three-sided prisms (i.e., II.1 309 and 453) and one gable (i.e., II.1 389). The prism II.1 309 comes from Platanos Tholos

B, where another four three-sided prims were unearthed, all being dated to the MM II. An MM I date for this seal was refuted by Anastasiadou (2011: 143) in favor of the MM II on the basis of the comparison with VII 1 and II.2 201. Although it is a three-sided prism too, II.1 453 belongs to a separate group from the AS and possibly dated to early MM I or EM III-MM I (Anastasiadou 2011: 143-147). The gable is conversely tied to the end of the Prepalatial period. Notably, it shows two quadrupeds depicted according to different criteria than the one on *CMS* II.1 309b, i.e., the absence of a linear rendering of the body and depiction of only two paws. The linear motifs on the face b can be analyzed as a hatched triangle, a bifurcated scroll and two damaged hatched motifs, all constituting well-known motifs within the AS and the B/L. Accordingly, gables are always safely interpretable as prototypical members of the B/L (especially the AS). Conversely, the few three-sided prisms, possibly Prepalatial in date, are generally not. Indeed, most of them are unique pieces with few comparisons, such as II.2 293, with five engraved faces.

Some possible forerunners of Hieroglyphic signs are only to be found on gables. The only engraved face of XI 099 bears a ladder motif tentatively associated to CH 038 by the editor. The association is particularly clear by considering the depiction of the sign on soft stones, in which it assumes a 'ladder'-shape and the horizontal strokes are commonly drawn through a single V-cut (see #204, #212 and #251c). The number of horizontal strokes, i.e., four, matches the one on the vast majority of the attestations of CH 038.

Synchronically, CH 062-065 represent a coherent class from a palaeographic perspective. Yet, their physical referents remain rather opaque and seem almost totally absent from Prepalatial glyptic (Jasink 2009: 89-91). CH 062 is represented by a wedged or rectangular elongated body (on clay, the body is reduced to a single vertical stroke) ending with a dot. Such a shape does not find any clear correspondence on Protopalatial seals (Anastasiadou 2011: 246). The best *comparandum* comes from an MM I steatite horizontal plate from Porti (*CMS* II.1 365), whose context provides a *terminus ante quem* at the MM IA (Koehl 2006: 72) or MM IB (Caloi 2009: 431). The triangular head, even though rare, is not unknown for CH 062 (see #271a and #289c). Another detail may be recognized in the small horizontal band near the end of the wedged body, which found a parallel on #303a, a seal displaying a high degree of detail for the other signs. Moreover, if the iconic

facet of the sign should point to an object of jewelry (i.e., a 'pin', see Jasink 2009: 89) or to a tool (perhaps a 'spindle with whorl', see Nosch & Ulanowska 2021: 89), its connection with a human figure could appear meaningful. Notably, a spindle flanking a possible spinner would feature a number of seals belonging to the 'Mallia Steatite Group' too (Nosch & Ulanowska 2021: 88, Fig. 5.5 and 90, Fig. 5.6).

Finally, two signs representing weapons could be matched to motifs attested on MM I gables (see Figs. 2.21-22). Weapons are well attested on Protopalatial seals. The shapes of these motifs clearly mirror depictions of some Hieroglyphic signs. While they are generally excluded from early Prepalatial iconography, a few seals datable to MM I could show the first attempts to include weapons in the glyptic iconography. Two of them, an arrow (= CH 049) and a spear (= CH 050) are confined to a style group tied to two steatite prisms from Kalo Chorio and Psychro, possibly dated to early MM I or EM III-MM I (Anastasiadou 2011: 147). A possible arrow is attested on III 035a, where it shows all the features of CH 049. The other motif shows the same pair of inner dots of the bow on II.1 426b. Notably, two arrows in antithetical arrangement decorate a gold diadem from Prepalatial Mochlos (Hickmann 2008: 357). Less iconic instances of the sign, which sometimes tends to assume an M-shaped form, does not allow excluding further comparisons (e.g., III 226c *vis-à-vis* II.6 189), which however remain more tentative.

Fig. 2.21 – (From left to right) CH 049 on #226b, III 035a and the so-called 'arrow diadem' (after Seager 1912: Fig. 9.II.8)

Differently from CH 049, CH 050 is featured by a longer vertical shaft and a small triangular blade, which on seals is always closed. The same features can be found on *CMS* III 226b, possibly one of the earliest three-sided prisms (Anastasiadou 2011: 144-145), although one of the two sides of the point is interrupted by the surface's border. In any case, it should be noted that on Protopalatial seals one of the two sides of the spear can be heavily reduced as well (see HM 2664a).
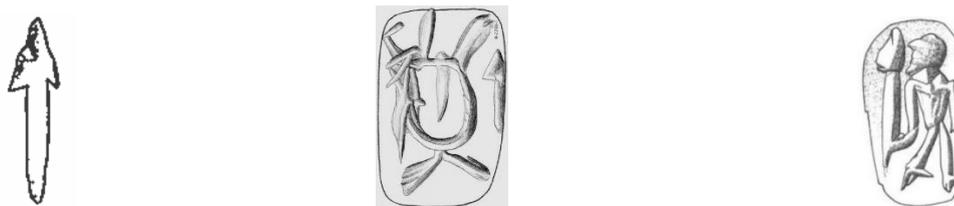
Fig. 2.22 – (From left to right) CH 049 on #234a, III 226b and HM 2664a (after Poursat 1996: Pl. 64)

2.8 Signs depicting heads of quadrupeds and the process of *pars pro toto*

This section discusses the possible origin of the group of Hieroglyphic signs representing heads of quadrupeds in profile view (i.e., CH 012-018). Apart from two instances (see §2.6.6), these signs do not find parallels on Prepalatial glyptic. However, the typology of full-bodied quadrupeds on Prepalatial glyptic suggests they were the starting point for a graphical development employed by writing systems worldwide, i.e., the *pars pro toto* (Neumann 1992: 31 and Thuault 2020). Such an assumption is relevant as it sheds light on the manipulation of iconicity in the process of forming the Hieroglyphic repertoire.

According to Karnava (2015: 146), the process of dividing a motif and/or a physical referent in a number of meaningful sub-parts would be extremely common in the development of the iconography. Apart from signs depicting a body part, whose iconographic and 'linguistic' value could indeed be easily conceived as distinct from the whole figure, the Hieroglyphic inventory involves a number of animal parts (CH 011-017).

Revealingly, heads of a quadruped depicted by Hieroglyphic signs find correspondences in the heads of full-bodied animals on Prepalatial glyptic. Although they are infrequent within the 'Parading Lions / Spiral Group', agrimi and horses are attested in the well-known 'parade' composition, respectively on II.1 311a and II.1 481a. Conversely, the number of these motifs increased with the B/L. Interestingly, the quadruped's taxonomy shown by B/L seals, particularly visible on the objects included within the AS, seems almost perfectly reflected in the Hieroglyphic inventory. Apart from a possible ram without counterparts among signs accepted by *CHIC* (see II.1 391a), but still appearing in absolute isolation together with an X-stiktogram (see §3.9.2), all the other quadrupeds attested within

the B/L would be mirrored by Hieroglyphic signs.[16] What is more, these quadrupeds are sometimes represented on multi-faced seals in a 'serial way', i.e., by homologizing their iconographic features.

During the Prepalatial period, the effect of this trend is to make the bodies of these quadrupeds indistinguishable from each other. Indeed, these quadrupeds can only be distinguished by looking at the shape of their heads. Two examples are perfectly revealing. On the cube II.1 064, all the readable faces show items included in the Hieroglyphic inventory (see Table 2.6). It displays an agrimi, a pig and a calf, whose heads are compatible respectively with CH 016, 017 and 013. The calf on this seal fully matches the one on II.1 70, and the features of these motifs are closely comparable to those of CH 013 as attested e.g., on #277b and #304d. A similar pattern is repeated on the 14-sided prism II.1 391 (see Table 2.6). This seal shows a series of four quadrupeds clearly linked in their iconographic representation, as they appear in profile/prospectus and the drawing of their bodies tends to be homologous. At least three of these four quadrupeds match one Hieroglyphic sign (see Table 2.6). The animal on the face a. is featured by a curved protruding horn without parallels in Pre- and Protopalatial glyptic.

	CMS **II.1 064**	*CMS* **II.1 391**
'Calf' (= CH 013)		
'Horse' (= CH 014)	None	
'Agrimi' (= CH 016)		

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[16] The 'lion' highlighted by Younger (1988: 199, fn. 15) on XII 074 may be better analyzed as a dog, on the basis of its open mouth and small head.

'Pig' (= CH 017)		None

<div align="center">Table 2.6 – Quadruped's taxonomy on CMS II.1 064 and II.1 391.</div>

The same trend involves motifs from different seals, whose comparison shows that the type of quadruped is recognizable only due to the characteristics of the head. For example, the agrimi on II.1 126a and the calf on II.1 287a are depicted in the same way apart from the distinctive element on their heads. The same pattern is also true for an ox comparable to CH 012. On the ivory conoid II.1 369, from the datable EM I-III context of Siva Tholos N[17], both an agrimi and an ox co-occurred. Their heads in profile share the outline respectively with CH 016 and 012 (see respectively #098a and #302c)[18] and are notably distinguished by the same distinctive features of the two signs, namely the two horns oriented backwards for the agrimi and a single protruding one for the ox. By contrast, the central-lower part of the animals is identically drawn through a triangular body and narrows legs. Such a phenomenon can be further recognized on the plastic rendering of the heads of quadrupeds too, i.e., the seal shapes (see §2.9). An agrimi with an extremely schematic body and only characterized by a curved horn backwards can also be found on the so-called 'Agrimi Diadem' from Mochlos (Davaras 1975: 104 and Hickmann 2008: 139).

This framework is particularly underlined in Yule's 'Platanos Goat Complex', which cannot be anchored to a datable context but is commonly considered contemporaneous to the B/L on stylistic grounds. On two of its three members, namely II.1 284 and 307c, an extremely stylized agrimi is only featured by two horns on the head, while the body is represented by a simple stroke (see Table 2.7). Notably, the same can be said for motifs linked to CH 012 (XII 063b), 013 (II.1 374a), 014 (VI 039a) and 018 (II.1 077). Another quadruped showing this trend is the dog (= CH 018), attested since the datable EM II-III context of the

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[17] Less sure is the usage of the Tholos during the MM I (see Goodison & Guarita 2005: 195 and ref.).

[18] Of note, the slightly spiraliform design of the horns of the agrimi finds correspondence on #305a.

Sphoungaras Deposit A.[19] Its distinctive feature is solely the open mouth (e.g., II.5 282), as is clear from stylized versions (II.1 077, 469 and XII 074).

	Standard	**Stylized**
Ox (i.e., CH 012)		
Calf (i.e., CH 013)		
Horse (i.e., CH 014)		
Agrimi (i.e., CH 016)		
Dog (i.e., CH 018)		

Table 2.7 – Examples of both standard and stylized depiction of quadrupeds.

2.9 Figures on seals and figural seals: the interplay between iconography and material culture

So far, I analyzed a number of signs as continuing iconographic devices already commonly found on Prepalatial glyptic. Such a process entails that several motifs

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[19] Although the general context of this deposit is mixed with MM I ceramic, the excavator reports that this seal was found within an undisturbed area dominated by EM II-III sherds. He therefore tentatively dates the object to the EM II period (see Hall 1912: 52-53).

employed on seals were re-functionalized during the development of glyptic trends. Nonetheless, Aegean writing systems seem to have selected as script signs motifs not previously employed as (standardized) icons on the artefacts hosting writing, i.e., seals and vases. Knappett (2008: 148-149) suggests that at least some logograms do refer to objects of the physical world through an iconic relationship. Indeed, as repeatedly clarified in the last decade, (Karnava 2015: 153-154, Civitillo 2016: 171-176 and Ferrara *et al.* 2020: 9), a number of Hieroglyphic signs do not find any correspondence on both Pre- and Protopalatial glyptic and their source is therefore to be found elsewhere.

Crucially, seals constituted only a small part of the Minoan iconographic landscape. Panagiotopoulos (2012: 65-66) notes that the public space of Minoan settlements was mostly aniconic, and images were primarily meant to interact within a restricted group of wealthy people. In such a space, images still circulate on a wide range of media, such as vases, statuettes, figurines, jewelry, and other items of the material culture. Notably, motifs provided with a symbolic meaning were used in both Pre- and Protopalatial periods as marks on pottery and masonry. What is more, iconography on seals was difficult to read *en plain air* and mainly visible within the archives to a restricted number of administrators. Conversely, images on vases and plastic models could obviously be appreciated in more environments. Alongside this, it is worth noting that iconography on seals, although representing a special case during both the Pre- and Protopalatial period, was far from being isolated *vis-à-vis* the iconography on the other media (e.g., Blakolmer 2012).

For instance, the connection between seals and jewelry manufacture is particularly evident in the case of beads. They are perforated objects whose shapes occasionally show identical features with respect to coeval seals and employ the same materials. In the past, some confusion even arose in distinguishing between beads and unengraved seals. Indeed, some bone and ivory pendants and amulets of the late Prepalatial period would have imitated the contemporary seals (see Sakellarakis & Sapouna-Sakellaraki 1997: 632 for Archanes and Michelaki & Vasilakis 2010: 192 for Moni Odigitria). In any case, apart from the lack of engraving, the main difference lies in the fact that beads were commonly arranged in series to form a necklace (Hruby 2012: 391). Such a similarity holds true for

figurative shapes, as proved by the frog-shaped pendant from an EM II-MM IA context in Kommos Tholos B (Hickman 2008: 346) compared to the seal VS1A 040 (see Fig. 2.23), from a context abandoned at the end of the MM IIB period at Hagios Charalambos.

Fig. 2.23 – A frog pendant from Kommos and the frog-shaped seal VS1A 040

Such an interplay between seals and items of the material culture is not limited to formal features. Indeed, iconographic motifs found on seals were also displayed on other objects, such as bosses, vases (see Fig. 2.24), or constituted the shape of some luxury items. This is exactly the case of a number of motifs matching Hieroglyphic signs. As shown, two arrows and an agrimi found on gold diadems from Mochlos (i.e., HM 4313) match the features of these motifs on seals of the B/L. What is more, the duplication and the arrangement of double-leaves on a gold boss from Mochlos (i.e., HM 350, see Vasilakis 1996, Fig. 55c) clearly matches the one found on both IV 111 and II.1 333b.

Fig. 2.24 – Replica of the same pattern of double-leaves. (From left to right) On seal (i.e., IV 111), on a boss (i.e., HM 350) and on EM III pottery (see Walberg 1983: 205 and ref.)

Such an iconographic network is even clearer when examining vase paintings. Although vases show a decidedly more conservative iconography than seals, patterns of decorations in vogue on Prepalatial seals are clearly recognizable on both coeval and Protopalatial pottery. Such a relationship holds true not only for the use of motifs, but also for complex iconographic combinations and syntactic criteria. For instance, the foliate band noted in Fig. 2.24 features a number of vases dated to the EM III-MM IA. The decorations carved on EM I-III seals of the C/P match the incision on EM IIA Fine Gray Ware (Betancourt 1985: 41).

Recently, Karnava (2015) associated signs depicting human body parts (CH 006-010) to votive figurines widespread in both sanctuaries and 'laic' settlements. Some motifs, such as a 'leg with foot', can be employed as both seal shapes (see II.1 212 and 407) and amulets (Alexiou & Warren 2004: 128). Revealingly, these signs are almost entirely absent from glyptic imagery. Outside of Hieroglyphic sequences, a human leg is attested once within the 'Archanes Script' (see §2.7.1) and once within the 'Mallia Steatite Group' (i.e., II.2 221b). In the latter case, it appears together with another motif matching a Hieroglyphic sign (possibly CH 053, see Platon, Pini & Salies 1977: 305). Even the curved leg is attested by a figurine (Sakellarakis & Sapouna-Sakellarakis 1997: 517-518). This material is also reminiscent of foot-amulets attested in early Anatolia, Syria and Egypt and possibly mirrored by Minoan Prepalatial leg/foot-shaped seals (Aruz 2008: 43-44). However, CH 010 does not show the long foot widely attested on Prepalatial seals and its model should therefore be closer to leg figurines from Petsofas. The Z-shaped outline of CH 010 on the other hand is possibly based on the crouched human figure and should be an inner-Minoan (late) development.

A case worth noting is represented by CH 002, only attested on clay. This sign depicts an armless human bust. Even though the features of this bust recall the representation of full-bodied human figures, a *pars pro toto* process cannot be proved. Indeed, the features of a bust, i.e., either triangular or 'wavy', are known worldwide and could have been easily independently drawn. On the other hand, the similarity between the depictions on #058-059 and a series of votive figurines is noticeable (Karnava 2015: 146-150). The most distinctive feature shared by these two items is, in my opinion, the absence of the arms, which are never excluded from both Pre- and Protopalatial human representation and could therefore point to a different referent. Karnava herself admits that "there are variations on this presumed votive prototype, suggesting that not all scribes were taught exactly the same sign forms, or they did not replicate them exactly". The variants grouped by *CHIC* under CH 002 are mainly three, i.e., (i) the triangular body (3×), (ii) a rectangular 'wavy' body (2×) and (iii) the head without body (1/2×). The latter is rather uncertain and only attested on a damaged document (#058c) and on a vase (#328). Revealingly, while the triangular body finds correspondence on votive figurines, the 'wavy' one matches a seal shape known during the Protopalatial period (see Table 2.8). As observed for CH 040, it is therefore possible that CH 002

'merged' into its allographs the link to different physical referents labelled under a single domain, i.e., the plastic rendering of the human figure.

The female figure might be another case of merging between seal shapes and votive figurines iconography. Only one female figure is attested on Prepalatial glyptic (i.e., on II.1 162), but it does not match the sign CH 004, apart from the general way of distinguishing women from men. Still, a female figure is sometimes employed as a seal shape (e.g., II.1 277 and III 018, see Table 2.8). Such a shape continued up to the Protopalatial period (see III 004). Two features are particular distinctive here: the arms on the breast and the horizontal fold on the skirt. Conversely, a skirt with vertical folds occurs on a terracotta figurine from Chamaizi dated to the MM I. Such figurine might also be mirrored by a group of headless women statuettes from MM II Hagia Triada (La Rosa 2010: 193). Such group could also be paired with the Protopalatial figurine from Archanes (Sakellarakis & Sapouna-Sakellarakis 1997: 513).

The resemblance between a Hieroglyphic sign and a seal shape is not an isolated case, which also speaks in favor of a relationship between seal shapes and seal iconography (Ferrara & Jasink 2017: 43-46). A clear example is CH 044 representing a *Petschaft*, a motif also used on seals normally excluded by the corpus and a seal shape unknown during the Prepalatial period (see Cristiani & Ferrara 2016). Although they do not constitute the predominant shapes, it is worth noting that figural seal shapes were particularly in vogue at the end of Prepalatial. Civitillo (2016: 171-176) proposed a series of associations between Prepalatial seal shapes and motifs occurring on Protopalatial seals, most of them readily accepted as script signs.

Notably, a Prepalatial seal from the Mitzotakis collection, i.e., VS1A 225, shows the typical head of a dog with the open mouth, well-distinguished by the head of a lion with closed mouth and mane (e.g., IV 030). Seal shapes matching 'Hieroglyphic' quadrupeds can also be found in the case of CH 012 and 017 (see Table 2.8). All these heads of quadrupeds show the same distinctive features observed for full-bodied quadrupeds on Prepalatial seals.

In particular, the *bucranium* (= CH 011), given its frontal view and its later appearance, could have had a different history with respect to the other heads of

quadruped. Indeed, Karnava (2015) points out that living-beings are only rarely represented in frontal view. This is never the case for quadrupeds, apart from CH 011. Interestingly, a steatite seal takes the shape of a *bucranium* (unfortunately, hard to date with precision) with the T-shaped horns typical of CH 011, echoing the bull's head-rytha regarded by Karnava (2015) as the source of such sign.

Sign	Sign shape	Seal and figurine shapes	EM III-MM I iconography	MM II iconography
CH 002	#058b #113a	Detournay *et al.* 1980 :101, after Karnava 2015 : 151) IV D004	None	[?]Betancourt (2003: 9, after Anastasiadou 2011: 707)[20]
CH 004	#049d #264a	II.1 227 III 018	II.1 162	PTSK 05/291a
CH 010	#058c	II.1 407 II.1 212	II.1 3911	II.2 221b
CH 011	#041b #183	III 028 HM 2853 (Sbonias 2010: 205, no. S38)	None	III 193
CH 013	#038b #139	II.1 017	None	[?]III 151
CH 017	#021c	II.1 294	None	II.2 213
CH 018	#055a	II.1 018	[??]II.1 311b	VI 127

[20] The outstretched arms (see also II.2 262c) are never attested for CH 002, nor CH 003, and might therefore point to a different referent.

CH 042	#296a			
	#309b	VS1A 310	XI 075	II.5 233

Table 2.8 – Possible forerunners of Hieroglyphic signs on seal shapes and/or statuettes in comparison to seal iconography pointing to the same referents

2.10 Syntactic principles and arrangement of motifs between Prepalatial and Hieroglyphic seals

According to Ferrara (2018: §23), on Protopalatial seals, a number of motifs seems to behave in a slightly different way. Specifically, such a behavior involves

La duplication successive des figures particulières – hommes, bateaux, poissons, bucranes, araignées, spirales, ânes, têtes de chèvres, faces de chat, etc. – pour former des séquences emphatiques où elles apparaissent parfois tête-bêche ou dans des directions opposées. De façon frappante, les figures qui tendent à être les plus dupliquées sont précisément celles qui deviendront, à terme, des éléments constitutifs de l'écriture hiéroglyphique crétoise.

The vast majority of these 'emphatic' compositions are clearly inherited from Prepalatial style-groups. For instance, both the antithetical and the *tête-bêche* arrangements are well-known from the very beginning of Minoan glyptic (see Figs. 2.6-7 and Table 2.9). Moreover, they feature a good number of 'figurative' motifs on late Prepalatial groups and can even be employed for a Hieroglyphic sign within a writing sequence (e.g., CH 010 on #262b and CH 049 on #264b). Indeed, such a phenomenon is widely continued on Protopalatial seals (see Fig. 2.25).

Fig. 2.25 – Protopalatial motifs matching Hieroglyphic signs in *tête-bêche arrangement* (From left to right) IX 022a, II.2 261 (see CH 019)

Starting from the PL/S, it seems that some signs, most of them possible ancestors of a Hieroglyphic sign, would have been placed in specific positions, which emphasized their usage as 'main devices' and were possibly crucial to the

transmission of the message. Interestingly, possible forerunners of Hieroglyphic signs never appear in the level featuring the 'parading lions', whereas they can only occupy the center of the face or the outermost layer. On II.6 149, two crouched men (matching CH 001), disposed in a *tête-bêche* arrangement, are placed in the focal point at close to the 'parading lions'. As proved by II.5 383, within the PL/S, a reduplication in *tête-bêche* is used in absolute isolation too. Notably, crouched men in *tête-bêche* are well-attested on seals belonging to the 'Mallia Steatite Group' (see VI 074c and IX 022a).

The outermost level of the outline is commonly occupied by geometric and floral motifs. In almost the totality of the instances, such motifs are either J-hooks or double leaves. According to Anastasiadou (2011: 338), on MM II seals, this section would have provided the "thematic framework" of the iconography. Given the consistency in the composition of the PL/S outline, as well as the fact that only two typologies of motifs were found in its outermost part, it is conceivable that their usage too would have been highly standardized.

Moreover, the specular arrangement of two motifs flanking a main device in the center of the face, called "centre-highlighting" by Anastasiadou (2011: 338), features both Prepalatial and Hieroglyphic motifs (e.g., XI 233b, see Fig. 2.26). Although the presence of minor devices features the PL/S too, such a mechanism is particularly at home within the B/L. In particular, it commonly employs geometric motifs (Z- and S-motifs, with parallels within the Hieroglyphic inventory, see §2.6.4) as main devices, and floral ones as flanking motifs. Notably, on MM II seals, such a composition is almost only confined to motifs matching Hieroglyphic signs.

Fig. 2.26 – 'Centre-highlighting' composition on a Prepalatial (i.e., II.2 293b) and a Protopalatial seal (i.e., XI 233b)

Furthermore, even though motifs in absolute isolation are attested within the PL/S (Anderson 2016: 91), their usage clearly increases on seals belonging to the

B/L, especially in the AS (Sbonias 1995: 112). Such a principle is widespread on seals dated to the MM II period (Anastasiadou 2011: 341 fn. 2072). Since motifs in absolute isolations are frequently identical to Hieroglyphic signs and are sometimes flanked by the X-stiktogram, they were recently interpreted as possible logograms (Jasink 2009: 113-134). Crucially, on Prepalatial seals too, motifs which occur either in absolute isolation or flanked by small border devices (such as the hatched triangles) frequently match Hieroglyphic signs. A well-known case is represented by the 'hand' (= CH 008) and the 'leg' (= CH 010) on II.1 391. In the same position, one can also find, for instance, the 'fence' (= CH 039), 'Z-motif' (= CH 061) and 'double leaf' (= CH 077). On II.1 328, a floral motif comparable to CH 025 covers the entire surface within a rectangular border never attested elsewhere.

Similarly, possible forerunners of Hieroglyphic signs tend to be placed in the focal point of the composition, i.e., in its very center and flanked by minor devices directing the viewer to them. For example, such an effect is achieved in frieze-like compositions, in which one device is placed between two identical ones arranged either *tête-bêche* or antithetically (see Table 2.9). Some of these motifs appear in the very center of the outline on seals belonging to the PL/S, encircled by parades featuring either lions or other animals.

focal point				
tête-beche				
sided by triangles				
circular/outlined				
central/isolation				

Table 2.9 – Usage of Prepalatial field divisions among the possible forerunners of Hieroglyphic signs

2.11 The emergence of the iconographic repertoire and its relation to Prepalatial style-groups

As noted in §1.3.3, the emergence of writing as a slow and progressive process has recently been questioned. Conversely, it must have been the outcome of a 'punctuated equilibrium', i.e., the alternation between periods featured by a low degree of innovation and sudden changes. Minoan glyptic likewise underwent a rather rapid development between the EM II and the EM III periods. Such a development is mainly tied to the introduction of new materials such as ivory and, later, white paste, alongside the development of two different stylistic trends, i.e., the PL/S and the B/L (including the AS and the L/S), one of them (i.e., the AS) bearing the first attestations of writing.

Crucially, such a frame finds correspondence in the attestations of possible forerunners of Hieroglyphic seals. Table 2.27 shows the absolute frequency (ordinate) of forerunners of Hieroglyphic potential syllabograms according to the three main stylistic groups (abscissa). Each bar is sub-partitioned in order to represent the frequency of possible forerunners for each Hieroglyphic sign. Accordingly, more than two thirds (68%) of the total attestations belong to seals included within the B/L and its sub-groups. Moreover, the B/L frequently attests forerunners which are conversely rarer on seals belonging to the PL/S. In such a frame, it is worth noting that seals at the boundary between B/L and PL/S, i.e., those identified by Sbonias (1995: 100-102) as having hybrid features (see §2.5.2), were assigned to both stylistic groups. Furthermore, motifs which would have undergone major modifications, such as the *pars pro toto* for heads of quadrupeds (= CH 013, 014, 016 and 017), almost all attested within the B/L, were excluded.
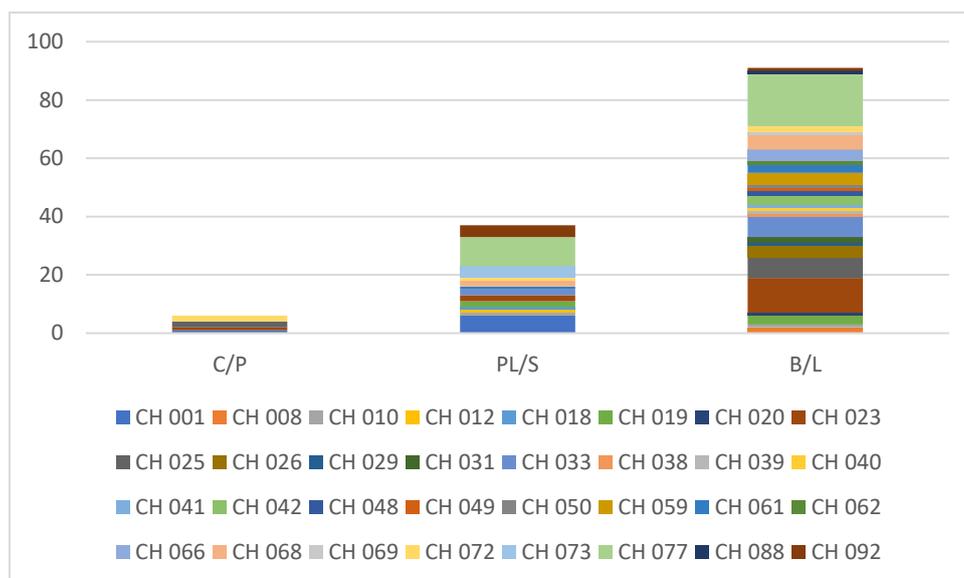
Fig. 2.27 - Attestations of forerunners of Hieroglyphic potential syllabograms according to the main Prepalatial stylistic trends

The earliest stage, which largely predates the introduction of both ivory and new seal shapes (i.e., the C/P), accounts for 4.5% of total attestations. Such a value is mainly the result of the kind of motifs engraved of EM I-III seals, which were still basically in line with coeval pottery decorations. Indeed, apart from a few exceptions, the entire glyptic of this period was dominated by a few geometric motifs (often triangles matching CH 070 on a formal ground), also found on seals from Cyclades and from the mainland (Sbonias 1995: 79-86). Still, such motifs were already arranged in 'emphasizing' compositions, such as the antithetical one (see II.1 201). Two chlorite cylinders, provided with Δ-shaped stringholes, and therefore akin to the PL/S in both formal and iconographical features (i.e., II.1 196 and VS1A 271), indeed show the only 'figurative' forerunners in this stylistic group. Moreover, a few forerunners might come from *epomia* (e.g., the 'bush' on II.1 061, the 'parallels' on II.1 281, the 'circle' in the very center of the face on IV D002 and the 'trifoliate' motif on VS1A 295), provided with Δ-shaped stringholes too. Such a shape is not continued by later glyptic and shows a more pronounced diversification of motifs. Most of them are continued by late Prepalatial style-groups and Hieroglyphic signs.

The PL/S, albeit showing a good number of possible forerunners (27.5% of the total attestations), was clearly not the decisive step toward the emergence of writing. Indeed, most of its distinctive features do not show a relevant continuity

with the tradition represented by Hieroglyphic seals. Such a frame is particularly evidenced by the distribution of motifs among style-groups (see Figs. 2.27-28) Notably, more than a half of them (58%) are confined to the B/L and might therefore have been introduced together with this stylistic group. Conversely, only 9.5% are confined to the PL/S. As noted in Figs. 2.27, most of the shared motifs find more attestations on seals belonging to the B/L than on PL/S ones. As stated (see §2.5.2), the two groups were coeval. So, a direct filiation from one to another cannot be assumed. Therefore, the Hieroglyphic tradition would principally continue the one represented by the B/L and its sub-groups.
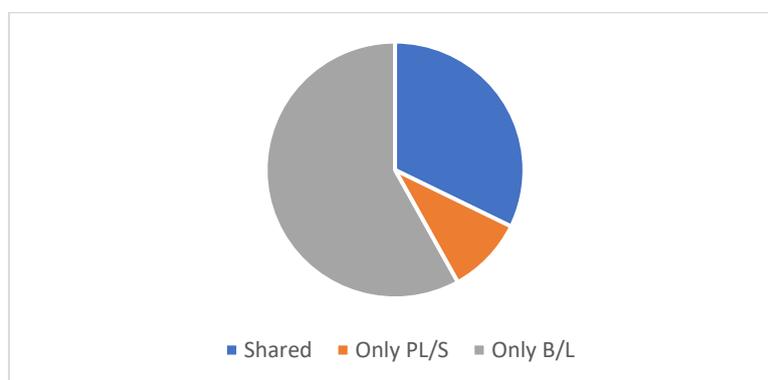
Fig. 2.28 – Distribution of potential syllabograms according to the stylistic group

Most of the materials, iconography and shapes characteristic of the PL/S underwent a premature obsolescence. By contrast, most characteristics of the B/L find correspondence on MM II seals.

First, ivory was almost abandoned either at the end of the Prepalatial period or at the beginning of the Protopalatial one. Very few ivory seals were used outside the PL/S. Apart from the cube from Hagia Triada (see §2.5.2), one could include the conoid II.1 041, even though its materials have not been definitively identified yet. This conoid is dated to the MM I (and therefore coeval to gable-prisms) due to the grooves on its surface. Notably, the only other example is a Hieroglyphic seal, i.e., #207, whose wedged-shape is elsewhere attested only twice. Its dating is therefore rather debatable (see §6.4.2).

Fig. 2.29 shows the relative frequency of possible forerunners according to the material of the seals on which they are attested. Crucially, 'white paste' is the most frequent support. Seals in ivory still show the second highest value. This is

because of the high frequency of few 'figural ancestors', such as the 'crouched man' (= CH 001) and the 'scorpion' (= CH 092). A lower value is registered by both soft stones and bone, especially *vis-à-vis* the ivory. However, this is clearly explained by the fact that ivory is almost the only material employed within its style-group (i.e., PL/S), while seals belonging to the B/L used three different main materials (i.e., bone, soft stones and 'white paste'). Moreover, both soft stones and bone include data from EM I-III seals of the C/P (for which ivory was not utilized). In this style-group, the emergence of the 'Hieroglyphic' graphic repertoire was still difficult to observe.
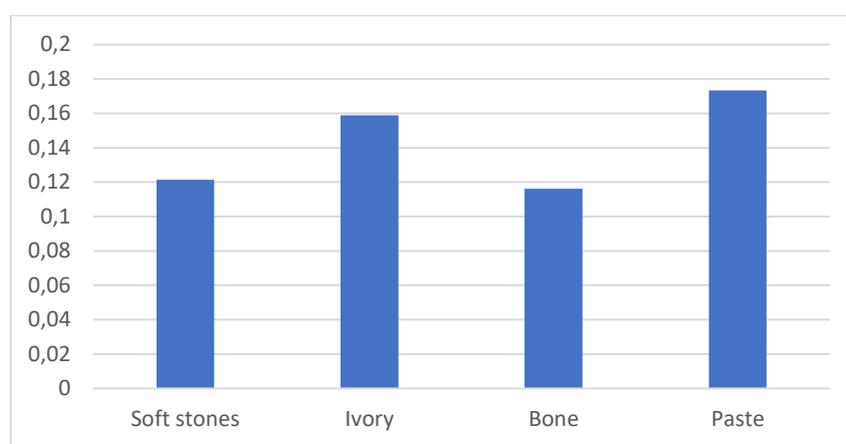
Fig. 2.29 – Relative distribution of potential syllabograms according to the material (i.e., number of forerunners / total number of faces of Prepalatial seals in that material)

Second, the distinctive iconography of the PL/S was not at home on Hieroglyphic seals. Curiously, all the "fabulous five", i.e., exotic animals confined to the PL/S and constituting typical devices and seal shapes within this style-group (Crowley 2021: 208-209), were not continued by Hieroglyphic signs and are never to be found on inscribed seals. The only forerunners firmly grounded within the PL/S are the 'crouched man' and the 'scorpion', which are still shared by other Prepalatial style-groups.

Third, seal shapes and related syntactic criteria of the PL/S played a marginal role on inscribed seals. Although a rotational arrangement is sometimes employed to fit the round faces of *Petschafte*, multi-layered outlined compositions are extremely rare on MM II seals and basically attested only once on inscribed seals, see #182. Notably, on round faces, inscriptions are sometimes adapted in a frieze-like composition too (e.g., #190 and #191). On the other hand, stamp

cylinders are mostly confined to this style-group and entirely abandoned at the dawn of the MM II period. Similarly, although the production of conoids went well beyond the Prepalatial period, the particularly elongated shape resulting from the hippopotamus' tusks is still confined to ivory pieces belonging to the PL/S.

2.12 Conclusions

This Chapter assessed the emergence of the Hieroglyphic repertoire within a chronological frame principally in line with the observation of the first two volumes of *CMS* II (now confirmed within the Arachne's website). Such a chronology implies a marked overlap within the two late Prepalatial traditions, i.e., the PL/S and the B/L (and its subgroups, including the AS), although the former was likely at home already during the EM II period, while the latter continued up to the beginning of the Protopalatial period (i.e., the MM IB). In such a slightly revisited frame, I argue that:

a) The Hieroglyphic graphic repertoire clearly continues iconographic motifs already attested as independent devices during the Prepalatial period and used in relevant positions on late Prepalatial style-groups. Such a group includes not only figurative motifs, but also the vast majority of geometric ones. For instance, the usage of motifs without reduplication and/or in emphasizing structures (e.g., the *tête-bêche*, the central position in isolation or flanked by hatched triangles). Although they are attested on seals belonging to the PL/S too, all these principles seem to have received an impulse during the MM IA-B period of the B/L, L/S and AS. Most of this iconography was already elaborated at an early stage, as suggested by the fact that some motifs show graphic variants matching the palaeographic features of the related Hieroglyphic signs. Despite this, it is conversely clear that some Hieroglyphic signs either merge or replaced Prepalatial motifs with innovations introduced during the MM II period.

b) Some of these signs would have undergone complex developments, mostly following a *pars pro toto* paradigm. Notably, such a phenomenon involves a group of signs semantically homogeneous, i.e., the heads of quadrupeds (CH 012-018).

c) Even though a number of motifs are present on seals belonging to the PL/S (and some geometric ones to the C/P), the vast majority of the forerunners of Hieroglyphic seals is clearly associated to the stylistic trend of the B/L and its subgroups. As the latter includes the AS, such a result was somewhat predictable. Indeed, while typical motifs of the PL/S are excluded from the Hieroglyphic inventory, some *hapax* on seals of the B/L are directly continued by Hieroglyphic signs. Moreover, with the respect to the PL/S, the B/L has a closer continuity with the MM II stylistic groups. Notably, Hieroglyphic forerunners are particularly dense on 'white pieces'.

Chapter 3 – The interplay between formal features, iconography and writing on Protopalatial seals

3.1 Introduction

This chapter addresses the interaction between iconography and material features of Cretan Hieroglyphic seals and the role they played in defining the functions of writing. The investigation was conducted by means of a multidisciplinary approach combining both philological and archaeological data and making use of statistical models. As widely discussed in §1.4, writing on inscribed seals is only partially comparable to that on clay documents. Indeed, seals conveyed meaning at multiple levels through the interplay of both formal and iconographical features, including Hieroglyphic characters.

Consequently, I will initially reassess the features which contribute to defining the meaning conveyed by inscribed seals in relation to the agents involved in its creation and usage. As shown in §1.4, on one hand, these features include the formal characteristics of the seals, i.e., shape, size, material and color. On the other, the iconography of Protopalatial seals contributes, alongside the formal features, to conveying meaning and singling out groups of owners. What is more, iconography is not decisively separate from writing from a functional perspective. It follows that the usage of some motifs on Protopalatial seal would seemingly shed light on the value of Hieroglyphic sequences. Building on these assumptions, I subsequently test the interplay between formal and iconographical features in relation to what is observed on inscribed seals, in order to understand which features were more akin to Cretan Hieroglyphic and how they were distributed. Accordingly, this chapter is organized as follows:

The first part of the chapter (§3.2-3.6) combines philological and archaeological data in order to reassess the significant features of the inscribed seals and shed light on the meaning each of them conveyed. I firstly investigate the formal characteristics by virtue of which a seal can be interpreted, i.e., the visual differences between the physical objects and the impressions they left on clay (§3.2), the implication of the usage of different materials for shaping seals (§3.3), the color differences and their relationship to the material (§3.4) and the degree of

both legibility and readability of a seal (§3.5). *In secundis*, I explore the fuzzy boundaries between iconography and writing, as well as the cooperation between the former and formal features in defining the value of Cretan Hieroglyphic on Protopalatial seals (§3.6).

The latter part of the Chapter (§3.7-3.8) applies data shown in §3.2-3.6 to a statistical model, i.e., the Correspondence Analysis. The purpose of such an investigation is to verify how both formal and iconographical features of Protopalatial inscribed seals can shed light on the value conveyed by Hieroglyphic characters on them. In particular, by limiting the investigation to uninscribed seals in (medium-)hard stones, I compare the distribution of two different formal features, i.e., materials (§3.7) and shapes (§3.8), to that of some iconographical devices. This analysis aims at making clusters explicit and provide a *terminus comparationis* for the situation observable on inscribed seals, in order to understand if a given feature would have been more or less associated to writing and to what extent it played a role in defining the meaning conveyed by Hieroglyphic seals.

3.2 Seals vs. seal impressions: visual properties and functions

During the Protopalatial period, Minoan glyptic largely had a two-fold function. First, providing a tool for different administrative purposes, which implied the stamping of one or more seal impressions on clay or parchment/leather documents. Second, identifying seal owners in social contexts by means of their aesthetic characteristics and a possible magic/amuletic value associated to them. It follows that the life cycle of a seal generally entails the involvement of two different material artefacts and their interaction:

a) *S e a l s*. They were plausibly personal objects worn either as pendants or necklaces. As such, seals can function as both identity markers and administrative tools. The former function could have been theoretically performed anywhere, as physical characteristics of seals would have defined the owner's position in the social hierarchy. For instance, the shape, color, and quality of the stone can be easily appreciated at a distance, with non-direct illumination and even by illiterate persons. By contrast, engraved motifs can hardly be recognized *en plain air* and at

a distance, apart from a small group of objects (see §1.4) and require a higher degree of literacy to be properly interpreted.

All features of Hieroglyphic seals would have made their owners rather recognizable even outside the administrative sphere. Indeed, Cretan Hieroglyphic selected only a small part of the Protopalatial glyptic potential. Steatite is the only soft stone discovered so far as bearing Hieroglyphic characters. Notably, while inscribed seals in soft stone represent 8% of the total production using this material, 42.5% of hard-stone seals bear at least one inscribed face. The inventory of shapes is mainly restricted to three typologies: *Petschaft*, three- and four-sided prisms, together featuring more than 80% of Hieroglyphic seals and seal impressions. Finally, Cretan Hieroglyphic commonly features particularly elaborate artifacts, as is the case for seal shapes attested only once, such as the 14-sided baton #315 and the 8-sided prism #314. Furthermore, although metal seals are extremely rare during the MM II period, one can still find two occurrences out of four gold and silver ones inscribed with Hieroglyphic.

Within the archives and in contexts with a suitable illumination, Hieroglyphic characters and related motifs would have been visible and differently interpretable according to the degree of literacy of the readers and viewers. In such a circumstance, seals with a high degree of readability would have conveyed meaning which cannot conversely be inferred for seals which are (almost) always illegible.

Moreover, soft-stone seals would often have been recognizable as sometimes they did not undergo a polishing process. Indeed, no MM II seal in hard stone shows the characteristic toolmarks deriving from sawing and filing processes (see Fig. 3.1). Conversely, this is often the case for soft stone seals. Such a feature points to the fact that polishing, plausibly performed after the engraving, was not always carried out for seals in soft stones, while it is the rule for hard stone ones.

Fig. 3.1 – Seals with toolmarks. (From left to right) III 209, II.2 086b, XI 012, VI 132

b) *Impressions*. Seal impressions were found on a wide range of administrative clay tools called 'sealings', as well as on few vases. Commonly, sealings are interpreted as objects in use either to secure documents and places they were attached to or to provide information about a given administrative process they refer to.

Predominantly, impressions convey meaning by virtue of the motifs engraved on them. As regards Hieroglyphic seals, the value of different sign groups was brilliantly established by Poursat (2000), who argued for a hierarchy of sequences, possibly reflecting different levels on the administrative scale. Moreover, Hieroglyphic seals are also featured by the usage of iconographic motifs, possibly without any phonetic interpretation. It has been suggested that the usage of some motifs would have contributed to defining the identity of the seal owner and framed it within a recognizable group (e.g., Relaki 2009: 357). Indeed, starting from the Prepalatial period, Minoan seals tend to confine motifs to certain stylistic groups (see e.g., Anderson 2016: 83-85). Such a hypothesis finds further correspondence in the so-called 'looks-alike' (see §3.7.2), namely impressions – firstly discovered within the Phaistos Vano XXV – bearing a series of almost identical motifs and therefore possibly reflecting different matrixes all referring to similar administrative identity.

On the other hand, seal impressions can shed light on the physical property of their matrix and the work-chain behind it too. On one hand, shape and dimensions of the matrix can often be reconstructed based on the impression. For instance, more than 98% of elongated rectangular faces (i.e., in which the long side is more than 0.5 cm longer than the short one) belong to four-sided prisms. The only exceptions are represented by a few 'rectangular blocks'. Interestingly, such a shape would have resembled four-sided prisms at least at some distance and for non-expert viewers (see Fig. 3.2). The main differences with four-sided prisms lie in the fact that the latter all have the faces of the same dimensions and 'rectangular blocks' of the MM II period are only engraved on the bigger ones.

Fig. 3.2 – (From left to right) The rectangular block XII 114 and the four-sided prism XII 095

Nonetheless, their impressions can commonly be recognized through (a) their iconography, which commonly show a single motif arranged according to the long side, and (b) a (slightly) less pronounced elongation, especially of the bigger faces (see Fig. 3.3). Notably, almost only the three hard stone 'rectangular blocks' cannot be easily distinguished according to these two features (i.e., II.2 286, III 065 and VI 107). They would likely therefore mimic the four-sided prisms in both shape and iconography.

Fig. 3.3 – (From left to right) Impressions of the rectangular blocks III 243a and VI 107b and of the four-sided prism #278c

Similarly, oval elongated faces almost always belong to three-sided prisms (see Fig. 3.4). Impressions from a rounded matrix are instead more ambiguous, as they can be traced back to a large series of matrixes, including *Petschafte*, three-sided prisms, buttons etc. Notably, even though three-sided prisms with round faces are widespread during the MM II period, only one is inscribed (i.e., #249) and less than 5% are in hard stones.

Fig. 3.4 – (From left to right) Hieroglyphic impressions left by the *Petschaft* #183, the three-sided prism with round face #243 and the three-sided prism with oval face #258a

On the other hand, given the clear readability of the engraving, impressions are able to show the employment of different techniques better than seals. Such a property has already been detected for Mesopotamian glyptic, in which the introduction and usage of new techniques was better understood on the basis of the impression they leave (Sax & Meeks 1995: 32-33).

Another important characteristic of the impressions lies in the fact that they often provide hints on the material of the related matrixes, i.e., whether they were fashioned from soft- or (medium)-hard stones. Such a distinction can be made

according to at least two features, all of them being easily detectable by a Minoan administrator too:

(i) The regularity of the intaglio. Soft stone seals, being almost always engraved by free-hand techniques possibly with no abrasive, commonly present a decidedly less smooth and regular intaglio. Especially on seals in steatite, the outline of motifs tends to show a less clear design and signs are almost always more schematic (see Fig. 3.5). Moreover, either the absence or the roughness of the polishing process is still visible on the impressions. By contrast, hard stone seals were commonly featured by a more regular intaglio and the surface is uniformly flattened after polishing (see Fig. 3.5). Toolmarks and irregularities can show up within the intaglio too, as a result of the usage of free-hand techniques (Anastasiadou 2011: 36). Regardless of the skills of single engravers, which were often higher with hard stone seals, regular and smooth intaglios are mainly the result of the usage of the horizontal spindle with abrasive (Anastasiadou 2011: 46).

Fig. 3.5 - (From left to right) Impressions of the steatite prism II.2 105 and of the carnelian zoomorphic seal III 022

(ii) The use of specific techniques, leaving a particular trace within the intaglio. For example, the tubular drill led the engraving of circles on hard stones to become more widespread. Unsurprisingly, the frequency of such an ornament dramatically decreases when considering steatite seals. What is more, free-hand techniques used to engrave circles on soft stones always result in shallower and more irregular outcomes (see Fig. 3.6).

Fig. 3.6 - (From left to right) Circles on two soft-stone seals, i.e., VII 018c and XIII 088c, and on a hard-stone one, i.e., I 428

Another highly visible feature derived from the usage of the tubular drill is the 'lunette'. Such a motif sporadically features on late Prepalatial seals too. However, on hard stone MM II seals it was realized by holding the surface obliquely towards the tubular drill. Such a technique results in an extremely recognizable and clear outline, which was never achieved through free-hand techniques on soft stones (see Fig. 3.7). On steatite, the usage of such a technique could be postulated for two objects only, resulting is a manifestly different outcome of lunettes.

Fig. 3.7 – (From left to right) 'Lunettes' made free-hand on the steatite seals #209 and IS 106c, drilled on the steatite seal II.2 291b and on the chalcedony seal #253c

In conclusion, seals and seal impressions contribute to conveying meaning by means of different strategies. These differences clearly reflect the different environments in which their properties were exploited. Seals (particularly hard-stone ones) were luxury items, and their formal characteristics were visible both *en plain air* and within the archives by a large part of the population, whereas impressions are an administrative tool, sometimes intended to be read abroad too. Accordingly, the former was mainly meant to define the hierarchical position of their owners by means of their physical features (and only rarely 'read'). By contrast, the latter made use of the outline of their shapes and both the technical and iconographical implications of the engraving to achieve the same results.

Accordingly, the next three sections (§3.3-3.5) explore the main features associated with the physical seals in greater depth. Subsequently, I will focus on iconographical properties that are always visible on seal impressions, and sometimes on physical seals, and their relation, on the one hand, to the formal features of the seals and, on the other, to the graphical and syntactic principles observed for Hieroglyphic signs.

3.3 Source and features of the Hieroglyphic seals' materials

This section provides an overall picture on the possible provenance of materials used to fashion Hieroglyphic seals. It is commonly agreed that the material of a seal was a crucial clue to infer the hierarchical position of its owner. Such a statement holds true worldwide (see Papadopoulos & Urton 2012: 34-35). As a rule, social *élites* indeed control the access to luxury items and raw materials (see Bevan 2007 for Minoan Crete). Accordingly, they define their privileged position by means of their usage and flaunting. The value of a given material can enormously vary from culture to culture, and it is mostly associated with both the difficulty involved in its supply and the cultural value each society assigns it. Unfortunately, only weak evidence can be put forward to understand this latter point in Minoan Crete and, in any case, they all come from Late Minoan environments (Peters 2008 and Gillis 2015). Conversely, the reconstruction of Bronze Age trade networks can shed light on the access Minoan *élites* had to luxury items and raw materials.

Only few hard stones were plausibly collected from quarries on Crete, all the others most likely being imported from overseas. As stressed by Krzyszkowska (2005: 82), no positive evidence is available to pinpoint the origins of materials used for seals. In absence of chemical analyses and robust information on the exploitation of quarries during the Bronze Age, only archaeological and historical considerations can be tendered, and no definitive answer can be provided on the source of the vast majority of semi-precious stones used during the Middle Minoan period.

a) *Green jasper*. Krzyszkowska (2010: 253-254) notices that seals classified as made in 'green jasper' by the CMS *could* go back to different stones, all being placed at the same level of the hardness scale though. The concordance of both CMS and CHIC, however, induced me to retain the same label at the very least for the Hieroglyphic ones. Since no evidence is available for the presence of green jasper on Crete, we must assume that it was imported. Krzyszkowska (2005: 83) points out that cylinders made in green jasper were popular in the MBA Syria, where the so-called 'Green Jasper Workshop' produced Egyptianizing seals. Since one of them was deposited in Poros tomb P 1967 (Collon 1986: 176-177) and two Hieroglyphic prisms (i.e., *CMS* VII 040 and IX 012) could have been re-worked

cylinders, she argues for a Near-Eastern source. By contrast, Warren (2018: 211) suggests Egypt, where green jasper is found in the eastern desert, as the main source. Notably, cylinders of the 'Green Jasper Workshop' are commonly assumed as being shaped from Egyptian jasper (Kopetzky & Bietak 2016: 361-364).

b) *Red jasper*. Differently from the green variety, sources of red jasper are known west of Nea Krya Vrysi and on Chrysi island (see Warren 2018: 208 fn. 8) and this material could go back to a local source.

c) *Carnelian*. This stone was already in use during the EM II period and some beads found within the Prepalatial cemetery of Mochlos could have been imported or have imitated the barrel-shaped ones from Mesopotamia (see Colburn 2008: 208-209, in part. fn. 50). Near-Eastern beads were not from local sources too (Collon 1990: 35), but a huge number of potential quarries ranges from Greece to India (Moorey 1994: 97-98 and Albaz & Reed 2022: 55-56). A partial indication comes from the SEM analysis of Pieniążek (2016), pointing to the Indus Valley as the most probable source for the Aegean cornelian, even though the actual trajectory of the exchange remains uncertain. At least during the Prepalatial, carnelian could have reached the Aegean through a maritime route involving either North Syria or Cilicia and then following the South-Anatolian coast (Sherratt & Sherratt 1991: 368).

d) *Blue chalcedony*. The raw material was among the earliest documented exotic on Crete, possibly being present as early as the EM I period. In both Egypt and the Near East, the exploitation of this stone for the production of valuables is earlier, respectively going back to the Predynastic (Andrews 1990: 41) and the late prehistoric period (Colburn 2008: 207), and both could have employed local sources. According to Krzyszkowska (2005: 84), the actual provenance of this stone is therefore difficult to state.

e) *Agate*. Good sources can be found in both Egypt, Eastern Desert, and in the Indian Subcontinent (Hughes-Brock 2020: 10). From the latter region, finished beads possibly both of Indian and Near-Eastern (or even Egyptian), manufacture reached the Aegean during the Bronze Age (Arnott 2022: 100). Conversely, Warren (2018: 211) included agate among the stones likely imported from Egypt, albeit without motivating such a preference.

f) *Rock crystal*. As noted by Krzyszkowska (2018: 2 fn. 3), this stone knows at least one Cretan source, namely the White Mountains. Possibly imported raw material is only found at Neopalatial Zakros (Platon 1974: 201). Accordingly,

Warren's inclusion (2018: 211) of the rock crystal among the semi-precious stones allegedly imported from the Egypt cannot be proved and a local provenance cannot be ruled out.

g) *Metals*. Silver comes from an Aegean source, either the mainland or the Cyclades, where it was extracted, possibly following an increasing demand in the Near-East, since the EBA period (Sherratt & Sherratt 1991: 367). The source of the gold used in BA Crete is virtually unknown, as a high number of more or less close sources was identified but no definitive evidence is available (Legarra Herrero & Martinón-Torres 2021: 339-340). Chemical analysis proved that Mycenaean gold artefacts from the mainland made use of Thracian quarries (Vavelidis & Andreou 2008), but it still lacks an investigation on Minoan objects.

In conclusion, three different categories of materials, as regards their provenance, can chiefly be identified. First, materials mined on Crete, including all the soft-stones, as well as two hard stones, i.e., the rock crystal and the red jasper. Second, materials coming from the western Aegean, including the Cyclades and the Greek mainland, i.e., probably all metals. Third, materials coming from either the Egypt of the Near East, or from even farther regions. They include all the microquartz varieties except red jasper, i.e., green jasper, chalcedony, agate and carnelian. Two of them, i.e., chalcedony and carnelian, reached Crete as early as the Prepalatial period, while no positive evidence for green jasper and agate is available before the MM II period. Bearing these conclusions in mind, the first Correspondence Analysis (§3.9) seeks to show if some of these materials were linked to the Hieroglyphic iconographic trend more than others.

3.4 Color differences and their implications

Color is among the most visible features of seals and is worldwide regarded as providing inscribed objects with specific meanings (Piquette 2013: 228 and Finlayson 2021: 263). However, a close scrutiny of colors of Minoan inscribed seals, especially in comparison to their epigraphic features, is still pending. Such an analysis is specifically addressed through a Social Network Analysis in the next Chapter (§4.11-19). In this section, I reassess the chromatic properties of Hieroglyphic seals, as well as their connection to the other formal and iconographical features.

While colors of Prepalatial seals only varied to a minor degree in relation to the usage of either white (organic) material (i.e., bone, ivory and paste) or darker soft stones (i.e., steatite and chlorite), the introduction of hard stones during the MM II period results in a decisive broadening of the available tonalities. According to Krzyszkowska (2010: 176), stylistic groups on talismanic seals would have been tied to a specific class of colors. What is more, colors often point to a specific material. For instance, the intense lucent green and the jasper almost display a one-to-one correspondence. Indeed, such a tonality is hard to find when not on jasper, while other tonalities of the latter are rarely used during the MM II period. Similarly, colorless and transparent seals in rock crystal do not find any parallel within the Protopalatial glyptic. What is more, colors help define the boundaries between hard and soft stones. Excepting jasper, for instance, red is almost absent from steatite seals, while it is characteristic of a high number of agate and carnelian ones. Similarly, an ochre-brownish and olive-green tonality features the absolute majority of steatite seals, while it is rare on hard stone ones.

Light effects would appear to help defining material in the same way. Indeed, steatite ranges from translucent to almost opaque varieties, all of them being employed from the very beginning of Minoan glyptic. All hard stones with the exception of jasper are generally highly to slightly translucent. Instead, jasper is the only stone employed by Minoan seals engravers which is constantly opaque. As a consequence, the combination of color and light effects would safely point to a given material. For example, even though the tonality is almost the same, translucent pieces in red carnelian can be safely distinguished from ones in red limestone (see Figs. 12f and 13d). Similarly, black(ish) steatite almost always appears clearly different from dark green/black jasper due to its translucency (see Fig. 12c and m).

Yet, some cases remain ambiguous. Finely polished yellow/orange translucent steatite can resemble agate and chalcedony (see Fig. 3.8). Crucially, a number of opaque white pieces can be compared to jasper. As shown, opacity is a feature commonly confined to the latter material. Nevertheless, some seals fashioned from white steatite are only slightly translucent to opaque and show features akin to white middle hard stones, whitened agate and carnelian and white jasper (see Fig. 3.13a).

Fig. 3.8 - (From left to right) The steatite three-sided prism XII 018 and the agate four-sided prism #296a

Notably, the steatite four-sided prism #286, showing a wide whitish patina and rather opaque was analyzed as being in jasper by *CHIC* (270). What is more, agate, carnelian and chalcedony, when exposed to high temperatures, become softer, opaque and white (see Fig. 3.9). Bands of different colors can appear depending on the temperature, as well as small pits on the surface (Betts 1980: 17-18 and Müller 2007: 14-15). Evidence for such a process is available starting from the MM II period onwards (e.g., X 050). Banded 'whitened' pieces bearing Hieroglyphic sequences too are attested, such as #265 with a red/brownish color between the inscribed faces.

Fig. 3.9 - The rectangular block in whitened opaque agate X 050a and the three-sided prism in banded red and white translucent agate #225

A consistent behavior features a number of middle-hard stones, especially those falling within the category of 'pseudo-jasper'. Such a group of stones, slightly different from each other (see Krzyszkowska 2018: 8), is characterized by a high opacity and tonalities so as it almost cannot be distinguished from jasper (Müller 2007: 15).

3.5 Legibility and readability

On Hieroglyphic seals, both legibility and readability are not always the same (Flouda 2013: 156). As shown in §1.4, the identity of Minoan 'readers', both within and outside of the archives, as well as their possible degree of literacy, was recently rediscussed (Weingarten 1995: 302, Finlayson 2020: 257-258 and Civitillo 2021b:

86-92). Legibility and readability were the object of several works, mostly focusing on the features of different type settings of the Latin alphabet (e.g., Beier 2009 and Richardson 2021). As regards the BA Aegean writing systems, a higher 'readability' was analyzed as one of the main purposes of a horizontal alignment of writing on four-sided prisms, although with exclusive reference to the impressions (Civitillo 2021a: 199). Impressions themselves provided further clues on the 'legibility and 'readability' of Minoan inscriptions. Indeed, some impressions were so shallow (e.g., Ferrara *et al.* 2016: 96) or intentionally obliterated (Relaki 2012: 313) to be unreadable. Accordingly, it was suggested that the performative act of impressing a seal was more meaningful than the content of its impressions, namely "it is the person or people wielding the seal who are recognized first, and everything else is to a certain extent 'set-dressing'" (Finlayson 2020: 191-192). Likewise, highly worn surfaces of soft-stone seals suggested that their formal properties, rather than their iconography, would have helped in defining the status of the owner (Anastasiadou 2016b: 83, in part. fn. 28 and Finlayson 2020: 185).

Despite this, the analysis of 'legibility' and 'readability' of Minoan physical seals, as well as their connection to the inscriptions the seals bear, has never been carried out. Alongside colors, I discuss these parameters in relation to writing through a Social Network Analysis in the following chapter (§4.12-19). In this section, I reassess the value of both 'legibility' and 'readability' on Hieroglyphic seals according to their formal and iconographical features. Such an analysis results in a hierarchical pyramid in which inscribed seals are ordered according to these parameters.

Scholarship mostly failed to adopt a consistent definition of both 'legibility' and 'readability', which are often either used interchangeably, or the usage of 'readability' is wholly avoided (Beier 2009: 22-23). Attempts to define their differences mostly tend to frame legibility at the level of the characters, i.e., it would express the signs' "quality to be decipherable and recognizable" (Tracy 1986: 31), while 'readability' is understood on the page level, i.e., it would express "the level of strain a reader experiences when the eye moves along the line of text" (Baier 2009: 23) and the degree of comprehension of a given text (Falk *et al.* 2021: 232). Civitillo (2021a: 103) uses "legibility" with this latter sense. Conversely, she refers to an inscription as "readable" in the sense of Olivier (1986)'s "*lisible*", i.e., if its

Hieroglyphic sequence has a linguistic interpretation. With reference to Hieroglyphic seals, Flouda (2013: 156) labels "legibility" the property of an inscription to be detected from the physical seal, while she labels "readability" the property of an inscription to be detected from the impression.

In this work, I will adopt the distinction between 'legibility' and 'readability' introduced by Wang (2019: 838-839) for inscribed woven Chinese artefacts datable from the 1st up to the 5th century CE. Notably, her distinction takes into account both the processes of production and fruition of the inscriptions. Indeed, the label 'readability' is associated with the possibility of reading, understanding and interpreting the whole inscribed sequence(s). As woven inscriptions are rather big (ranging from 25 cm to a couple of meters), such a property is only 'at home' when the object is observed from a distance. By contrast, 'legibility' is used to define the perception of the weaving techniques, which can only be achieved at a short distance. This splitting entails that the producers and readers mostly deal with opposite degrees of legibility and readability. Indeed, while the former would have normally worked in the "realm of legibility", the latter are mainly affected by the readability of the textile. Still, artisans can move to observe readability when planning or correcting their work, just as readers would observe its technical features by getting closer to the inscription. Notably, the combination of these parameters constitutes the skills needed by the so-called 'iconic literacy', in order to comprehend an inscription. These skills are mainly featured by "awareness of the conventions which regulate the production, transmission and interpretation of any message" (Perego 2013: 260).

Building on such a theoretical framework, Wang (2019: 854-855) distinguished among three levels of interpretation of the inscribed object, depending on the distance of the viewer and therefore to the degree of both legibility and readability. To a high degree of readability corresponds a "semantic" interpretation, referring to the analysis of the meaning conveyed by signs and iconographic motifs. A closer view would determine a "syntactic" interpretation, namely the understanding of the iconographic features binding together and defining the elements of both a sign and a written sequence. Finally, to a high degree of legibility corresponds a "technological" interpretation, namely the recognition of the techniques used and the traces left by the related tools.

With respect to Hieroglyphic seals, both sequences and techniques proved to be crucial in defining the seal's properties (see §1.4). Yet, seals differ from one-meter-long textiles as, by looking at seals to the naked eye, only a view of the whole face is possible. By contrast, by looking at big textiles, one can infer the working technique without understanding the whole motif(s) drawn on the object. Moreover, especially on faces shorter than 1 cm, technical features are often too small to be clearly appreciated to the naked eye. On the other hand, on Chinese textiles, the proportions between the dimensions of characters and those of the meaningful technical features is decidedly higher than the one on Minoan seals. For instance, on #210, each sign occupies roughly one third of the entire face. Nevertheless, on hard-stone prisms, signs are sometimes carved by joining together simple drillings that represent their most distinctive features. For example, the sign CH 044 is often carved by unifying three 'cup-sinkings' arranged vertically (e.g., #277a and #293d). Similarly, the core of signs such as CH 013, 016 and 033 is sometimes shaped through a single circle made by the tubular drill (e.g., #193, #290d and #312d). Accordingly, the recognition of signs commonly implies recognizing the technical operations used to make them. By looking at Hieroglyphic seals, it is clear that the main difference lies in the low degrees of readability. Technical clues for hard stones, such as the drilled circles, can be visible even though signs are never discernable (see Figs. 10d, e). Both parameters, however, are directly proportional and mainly influenced by the same formal characteristics.

Both color and light effects play a crucial role in defining the degree of readability of a seal. In particular, readability is clearly inversely proportional to translucency. Indeed, opaque materials such as jasper and gold, as well as white opaque steatite and 'whited' quartz, always display a higher degree of readability *vis-à-vis* those fashioned from translucent to transparent stones. Moreover, banded and two-toned surfaces are often an obstacle to the recognition of Hieroglyphic signs, as they tend to conceal connections and separations among the elements of the intaglio.

Nevertheless, readability is not completely predictable by considering the material, color, and light effects, as it can also be affected by a number of other parameters. First, the mineral composition of the engraved stone. Under the same - modern - label, one can find stones with slightly different mineral compositions

grouped together. For instance, seals in green jasper can display a more or less intense tonality due to different intrusions included within each piece (see Figs. 11n, 12i and 13a). All the other quartzes can range from an extremely high level of translucency and light tonalities, resulting in low degrees of readability, to dark uniform colors and semi-translucent diaphaneity, showing a high readability.

Moreover, the mineralogical composition of the stone conditions the inner part of the intaglio too. As such, it affects the readability of the engraved motifs. When carved, stones can show a (slightly) different color in the inner part of the intaglio, depending on their mineralogical composition. A starker contrast between the unengraved surface and the motifs resulting from the intaglio enhances their readability. On a few seals in steatite, a whitish patina is visible within the intaglio and produces a tonal difference with respect to the unengraved surface. The fact that such a patina is only observable within the intaglio could point to a feature produced by the process of carving (see Müller 2007: 17-18). Crucially, this patina enhances the readability even on white seals, as it neatly distinguishes the intaglio from the unengraved surface. Yet, as it is mainly to be found on workshop-fresh (and therefore unused) objects, it was suggested that such an effect might have disappeared after the seals where repeatedly stamped (see Anastasiadou 2011: 31).

Second, in all the light conditions, deep intaglios are commonly more legible than shallow ones. A deep intaglio can be achieved by both free-hand and mechanical techniques. Since it is the rule for MM II seals, differences in readability of Hieroglyphic seals do not depend on this factor. Conversely, a clear-cut difference can be perceived as regards the sizes of the intaglio. Specifically, outlines designed through a single and narrow cut are clearly less perceivable than wider ones. By comparing two stones with similar color and diaphaneity, it is evident that wide signs on #210 are decidedly more visible, especially at longer distances and with unsuitable illumination, than those on #244a (see Figs. 11c and 12a). Notably, wider signs are mainly featured on works on hard stones and those on steatite made by more skilled hands.

Finally, external factors resulting from time or accidents occurring to seals should be considered as potentially concealing their original features. For instance, some objects underwent severe fractures and abrasion. In other cases, a chance fire

event possibly changed both the color and the diaphaneity of the piece. Whenever the original conditions cannot be safely reconstructed, I will catalogue the seal's readability according to the value normally registered by its material and color. Such a choice is motivated by the fact that behaviors beyond the norm are extremely rare.

Accordingly, I will consider readability as ranging among five different degrees that define a pyramid of readability (see Figs. 3.10-14). Each of them is associated with a certain number of materials and/or single objects. That said, cases in which the same materials show objects included within different categories are rather rare.

(i) *Very low readability*. In all the light conditions, motifs are not visible, and the syntactic arrangement of the engraved motifs is barely perceptible. Depending on the technique, legibility can sometimes be slightly higher than readability. For example, drilled circles on the rock crystal prism #245b (see Fig. 3.10d), as well as the 'cup-sinking' on the agate one (see Fig. 3.10f), are visible, even though the entirety of the motifs cannot be detected.

	Ivory
a #202a	#207
b #204	Brown-green steatite
c #234	Black-orange breccia
d #245b	Rock crystal
e #205a	White-grey agate

| f | Grey and white agate |
| g #267a | Yellow agate |
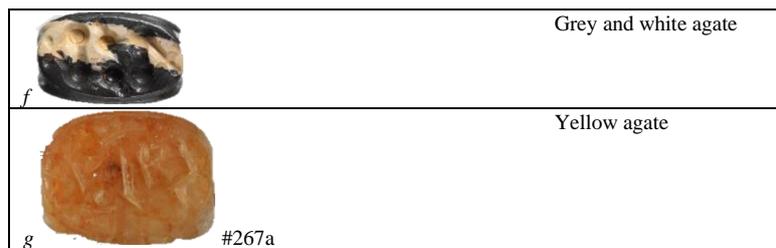
Fig. 3.10 – Seals with a very low degree of readability

(ii) *Low readability*. Main devices fade *en plain air*, while they can more or less be understood with a direct illumination. However, small features, which can sometimes be distinctive, can commonly be confused. Minor devices cannot be seen in almost all the light conditions.

a #202a	Bone
b #313	Ivory
c #244 #237 #211	Olive-green steatite
d #180	Brownish steatite
e	Brown steatite
f #227	Honey-colored steatite
g PTSK14.2604b	Reddish orange limestone
h #225	Red-white banded agate
i #229	Light orange carnelian

Fig. 3.11 – Seals with a low degree of readability

(iii) *Moderate readability*. Both main devices and the syntactic organization of the face are almost always recognizable, even though with non-direct illumination their features tend to be more ambiguous. In this case too, readability and legibility can register different values. Legibility is almost invariably high, even in cases in which the main devices tend to fade. This is due to the fact, on seals with moderate readability, that both the smoothness of the intaglio and the presence of marks characteristic of fast-rotating tools, such as circles produced by the tubular drill, can almost always be appreciated. Smaller elements are barely perceptible *en plain air*, while they can be more or less visible in suitable light conditions.

a #210	Yellowish with grey-brown inserts steatite
b #286a	Ocher-brownish steatite
c #291	Black steatite
d #236	Blackish steatite
e #238	Grey-green steatite
f PTSK13.1485	Reddish limestone
g VRY S 01	Brown serpentine
h #240	Blue-orange chalcedony
i #302b	Blue (burnt) chalcedony

l #296	Translucent agate red with dark patch
m #308	Green to black jasper
n #293	Green (unpolished[?]) jasper

Fig. 3.12 – Seals with a moderate degree of readability

(iv) *High readability*. Main devices are always recognizable, and sequences can be read in all the light conditions. However, signs on translucent and darker pieces can tend to fade at relatively longer distances and with unsuitable illumination. This is mostly the case with smaller and shallower devices, e.g., 'fillers' and the X-stiktogram.

a #288	White steatite
b #284b #285b	Cream-colored steatite
c #260c	Red and black breccia
d #303b	Opaque to weakly translucent white chalcedony
e #274b	Opaque to weakly translucent white agate
f #269a	White opaque (burnt[?]) agate
g #257c	Dark red carnelian
h PTSK05.291a	Red and yellow jasper

	Dark green jasper
i #299b #295	

Fig. 3.13 – Seals with a high degree of readability

(v) *Very high readability*. Highly opaque pieces with deep and clear intaglios, whose elements are both legible and readable in all conditions.

	Green jasper
a #195 #264b	
b #306	Gold
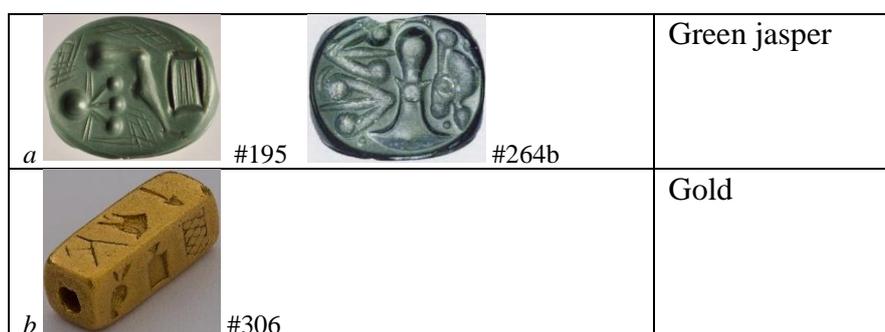
Fig. 3.14 – Seals with a very high degree of readability

In conclusion, with exclusive reference to inscribed seals, I argue for a hierarchy of readability according to materials, color and techniques. Accordingly, only some seals in opaque materials, such as green jasper and gold could have been easily 'read' in all conditions, although this was not always the case. Conversely, intaglios on highly transparent, veined and shallower engraved stones, such as rock crystal, light and multi-colored agate, cannot be 'read' even in highly suitable light conditions and at a small distance. By contrast, legibility can be relatively high even on seals measuring a low readability. This means that one could have been aware of both the material and the *chaîne opératoire*, i.e., one could have inferred the status of its owner, even when a glance at its iconography was impossible. Obviously, both observations were highly facilitated on seals measuring a high readability.

3.6 Palaeography of the Cretan Hieroglyphic and its relation to the formal features

The interplay between technical constraints and personal skills of seal engravers produced a number of patterns in palaeographic features of Hieroglyphic signs. It

is commonly agreed that motifs on soft stones differ from those on hard stones, as the former generally appear 'schematic' and 'less accurate' with respect to the others (Anastasiadou 2011: 67 and Flouda 2013: 146). Moreover, Anastasiadou (2011: 87) noticed that, on soft-stone, three-sided prisms, fewer schematic signs are featured on seals with more inscribed faces. In this section, I look into this issue with special focus on Hieroglyphic seals, by pointing out a number of technical constraints linked to the engraving of Hieroglyphic sequences and the iconography which appear alongside them.

As a premise, it should be emphasized that the number of analyzable items differs starkly between soft- and hard-stone seals. Indeed, soft stone seals bear only a small number of sequences, mostly the formulas CH 044-049 and 038-010 (-031) (see §4.15). As a consequence, only a part of the iconographic repertoire occurs on them, while signs often find attestations on hard stones and clay only. Out of 67 signs attested on seals, only 30 are to be found on (middle-)hard stones. From a paleographic perspective, soft stones therefore often do not provide a *terminus comparationis* at all. In signs occurring on both soft- and hard stones, two main tendences can be detected:

a) *Changes in the shape of the signs*. As observed, signs on soft stones tend to be more schematic than on hard stones. For instance, the sign CH 010 (depicting a leg) is often rendered by means of a narrow straight stroke with a semicircular element pointing to the calf. On #239a, the knee is conversely represented with a triangular element. By contrast, on hard-stone seals the anatomy of the leg is more precisely depicted by a more curvilinear outline. Such an effect is mainly due to the usage of specific techniques, especially the solid drill. Although a similar outcome is not unachievable by free-hand techniques, the rounded edge of this drill allows shaping a clear curvilinear outline and a wider intaglio. Moreover, such a tool was particularly suitable for shaping 'cup-sinkings'. On hard stones, the calf is in fact sometimes rendered by means of a 'cup-sinking' (e.g., #263b and #272a), which corresponds to either a single cut made by the tubular drill or a double cut combining both tubular and solid drill (Anastasiadou 2011: 41). Nevertheless, it is more often rendered by a continuous curve and following the natural proportions (e.g., #250c and #262b). The same effect is visible e.g., for the

sign CH 028 respectively on the steatite four-sided prism #307 and on the agate one #296.

On hard-stone seals, the inner part of the intaglio is often engraved to different depths, in order to detail the representation of the motif. Such a process is decidedly rarer on soft-stone ones. For instance, the muscles of the thigh of CH 010 are sometimes represented by varying the depth of the intaglio (e.g., #265a, see Fig. 3.15). Notably, differences in the depth of the intaglio are commonly employed on hard stones to distinguish between main and minor devices. For instance, the lattice-motif behind Hieroglyphic signs on both #181 and #195 is shallower than the Hieroglyphic signs (see Fig. 3.15). On highly opaque stones such as the green jasper, this difference is visible on both the seal and the impression.

Fig. 3.15 – (From left to right) The three-sided prism in whited carnelian #265a, the *Petschaft* #181 and the halfovoid #195

Admittedly, on soft stones, rare variants showing a more naturalistic outline and a greater usage of minor devices are to be found. Most of them come from seals with more inscribed faces (e.g., #288, see Fig. 3.13a), although such a factor does not seem to be decisive (see §4.16.1). Indeed, signs showing smoothed and naturalistic outlines and flanked by minor devices and fillers are also attested for prisms with one or two inscribed faces (e.g., #286), as well as on a few *Petschafte* (e.g., #180). On the other hand, 2 out of 4 steatite prisms with four inscribed faces would be palaeographically akin to less valuable ones (Anastasiadou 2011: 87).

Furthermore, soft stone seals sometimes attest variants with a lower degree of iconicity, this process being conversely absent on hard stones. For instance, the 'foot' is often omitted from CH 010 on soft stones (see #212), while it always appears on hard stones. Moreover, on soft stones, some variants attest unnatural proportions (see #289d). Similarly, on soft stones, the sign CH 034 (depicting a breast, Anastasiadou 2011: 244) loses both its 'globular' outline and (always but #204a) the dotted ends (see Table 3.1). Conversely, both these features are almost

always preserved on hard stones. Of note, paleography on middle-hard stones is akin to hard- stone ones.

	CH 010	CH 034
Steatite (one inscribed face)		
Steatite (more than one inscribed face)		
Middle-hard stones		
Hard stones		
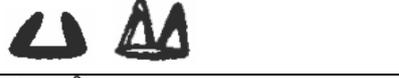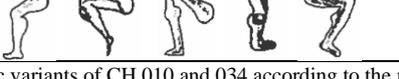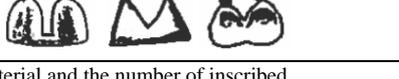
Table 3.1 – Palaeographic variants of CH 010 and 034 according to the material and the number of inscribed faces.

b) *Changes in the syntactic features of the seal's face*. Seals in soft stones commonly display main devices juxtaposed to each other and a scarce usage of smaller devices and fillers. Revealingly, a few exceptions comprise those seals displaying more iconic signs and engraved by more skilled artisans (e.g., #180, see Fig. 3.11d), even if uninscribed (e.g., VS3 017). Conversely, hard stone seals adopt a wide range of minor devices and fillers, sometimes even matching the shape of Hieroglyphic signs (e.g., #257c, see Fig. 13g). According to Olivier (1986), such minor devices often recall motifs engraved on other faces of the same seal and were possibly engraved in order to give an impression of general coherence (e.g., #242, see Fig. 3.16). As a consequence, such a coherence is almost absent from soft-stone seals, while it can clearly be recognized on hard-stone ones.

Fig. 3.16 – The three-sided prism in rock crystal #242

Similarly more elaborate arrangements of Hieroglyphic signs are only to be found on hard-stone seals (e.g., reduplication of signs, their placement in focused or *tête-bêche* positions etc.). Furthermore, the so-called '*cartouche*' or 'monograms', namely the arrangement of a well-known formula in a monogram binding the three signs together, is only to be found on hard- stone seals (see Fig.

3.17). 'Monograms' are confined to three-sided prisms, suggesting that this composition was conceived to fit their oval faces (Civitillo 2021b: 105-106). It is worth observing that monograms are often merged with complex iconographic motifs or flanked by minor devices which are almost entirely absent from soft-stone seals (see Fig. 3.17).

Fig. 3.17 – (From left to right) Examples of monograms, i.e., #257b, #272b and #229

3.7 Writing vs. iconography: iconicity and multivalency of Hieroglyphic motifs and Protopalatial iconography

After discussing the relationship between writing and formal features on Protopalatial seals, I complete the overview on the meaningful features of inscribed seals by exploring the only other component apart from the Hieroglyphic sequences, namely the iconographic motifs normally excluded from the transcription. The interplay between all these features is addressed in the following sections by means of statistical models (§3.8-10). In this section, I limit the review to two case studies, shedding light on two 'antithetical' occurrences. On the one hand, the behavior of motifs identical to Hieroglyphic signs on seals and generally analyzed as uninscribed. On the other, the usage of 'look-alike' motifs that surely do not belong to the Hieroglyphic inventory on inscribed seals.

Apart from a few inscribed vases painted with abstract/geometric motifs (Raison 1968: 184), seals are the only Minoan medium on which both writing and images coexisted. It is commonly agreed that communities would have been identified by means of motifs and stylistic groups. Indeed, iconography and formal features of seals often match since the very beginning of the Minoan glyptic and show highly repetitive patterns (Sbonias 2010: 319). The absence of narratives on Protopalatial seals would further point to a strong symbolic use of motifs, with

reference to recognizable information regarding the social status and/or the administrative functions of the owners (e.g., Younger 2020).

The presence of motifs pointing to a group of seals shared by a community would be particularly manifest through the so-called 'look-alike' iconographic motifs. The label 'look-alike' refers to a series of seals bearing an iconography almost indistinguishable from each other (see Fig. 3.18). Such iconography is mainly construed on a more or less complex "core motif" which is replicated on a good number of seals (Relaki 2009: 361). Even though 'look-alike' motifs are commonly found in absolute isolation, both the 'core motifs' and the minor devices sporadically encountered alongside them can undergo some minor variation (Relaki 2009: 362). The strongest evidence for the active usage of 'look-alikes' is provided by sealings from the Phaistos Vano XXV, although they were also to be found at other Protopalatial spots (Relaki 2012: 295). In this context, impressions of 'look-alikes' involve both figural motifs such as the 'bulls' on II.5 269 and 269 (Blakolmer 2020: 54) and geometric ones, such as the 'interlace' on II.5 152 and 155 (Weingarten 2003: 289-291).
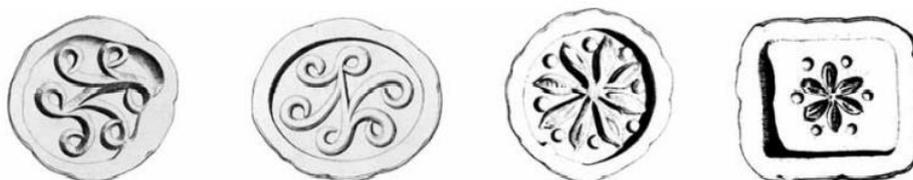
Fig. 3.18 – (From left to right) Examples of 'look-alike' motifs, i.e., II.1 224, 227, 373 and 374 (modified from Relaki 2009: 361, Fig. 3)

As repeatedly suggested, Hieroglyphic signs would have functioned in a similar way regardless of their phonetic interpretation. According to Civitillo (2021b: 102-104), most of the Hieroglyphic signs would have been semiotically multivalent. Indeed, on the one hand, their shape often partners with symbols occurring elsewhere with no reference to writing and intimately tied to the Minoan symbolic culture (see Jasink 2009: 113 and the *Case Study 1* below). On inscribed faces, *CHIC* (14) notes the presence of these signs and defines them as "*decoration éventuallement signifiante non évidente*" and includes them in the transcription within curly brackets, while they are represented by a symbol {!} in the

transnumeration. Jasink (2009: 113) suggests they would simply testify that the same sign could have assumed a putatively "ideographic" behavior alongside the phonetic one. On the other hand, the syntactic position of some signs on the seal's face would unlikely be motivated by its phonetic features and would point to an interpretation based on its iconographic nature. For example, the centered position of CH 011 on #182 finds parallels on uninscribed seals and would be motivated by the cultural value assigned to this device (see *Case Study 1* below). Similarly, the reduplication of signs (e.g., CH 010 on #262b and CH 049 on #264b) clearly matches a scheme observed on uninscribed seals (see §2.10) and would therefore adhere to iconographic criteria rather than to the needs of spelling a given phoneme (Civitillo 2021b: 90).

Furthermore, both the syntactic arrangement of some signs and their interaction with minor devices within the seal's face would suggest singling them out from the sequences they flank (Decorte 2017a: 54-55). For instance, both CH 042 and 044 are often separated from the other signs by means of minor devices such as parallel strokes, suggesting they are not part of a signs' sequence (see Ferrara 2018: 99). The usage of parallel strokes as dividers on seals is substantiated, as they are used to separate well-known formulas (see #283a). Notably, strokes perpendicular to the direction of writing are employed as dividers on clay bars too (e.g., #061a, see Fig. 3.19). Such behavior can be compared to the fact that these signs are also used entirely alone, frequently on inscribed seals or on impressions stamped on inscribed sealings (see Fig. 3.19). Possibly, various interpretations could also have been triggered by the different degree of literacy of the reader. Indeed, while the understanding of complex sequences and rare signs would presuppose a high degree of literacy, the interpretation of iconographic motifs, well-known sequences of two and three signs and monograms, could be achieved by decidedly less literate persons.

Fig. 3.19 – (From left to right) Example of parallels separating CH 044 from the other signs, i.e., the four-sided prism in carnelian #298c; example of CH 044 used out of Hieroglyphic sequence and alone, i.e., III 227c; example of clay bar using a stroke as divider, i.e., #061a

Moreover, it has recently been suggested that a number of devices would have provided information regarding the meaning of the written sequences. Most often, such devices are clearly smaller than Hieroglyphic signs and were previously interpreted as fillers with a mere decorative function. Yet, according to Decorte (2017a), the fact that they are ubiquitous on hard stones would point to a semantic interpretation somewhat tied to the information provided by the written sequence. What is more, sequences are often flanked by main devices having the same size of Hieroglyphic characters. As they are frequently found together with well-known sequences and are never attested on clay, *CHIC* (13) considers them as motifs possibly conveying a semantic meaning as symbols/badges (i.e., *decoration éventuellement signifiante évidente*), not directly linked to the putative phonetic interpretation of the Hieroglyphic sequence. As such, they are excluded from both the signs' inventory and the transnumeration. More recently, Jasink (2009: 3) suggested that they "may be simply included within the ideographic section, well-known in both cuneiform and Hieroglyphic (Egyptian and Anatolian) writings".

This section discusses two case studies. The former (*Case Study 1*) refers to the usage of a Hieroglyphic sign outside of inscribed seals, and therefore possibly pointing to a logogram. The latter (*Case Study 2*) deals with a motif replicated in possible 'look-alikes' which are closely associated with inscribed seals. As such, they could be analyzable as pointing to a 'logo' going back to the owners of inscribed seals.

3.7.1 Case Study 1: the 'bucranium' (= CH 011) as a possible logogram?

CH 011 is widespread on Cretan Hieroglyphic documents (26 occurrences). At least 75% of the sequences featuring CH 011 are longer than three or more signs. Moreover, 25.5% of them are composed by four or more signs. As is safely attested in the internal position too, it follows that CH 011 must have had a syllabographic value. Its usage as a syllabogram is also taken on by AB 05/*to* (Ferrara *et al.* 2022: 84-85).

It belongs to a class of motifs representing animal heads in frontal view. Such motifs are only attested from the MM II periods, while signs depicting heads

in profile were plausibly inherited from the Prepalatial glyptic. As shown in §2.9, living beings in frontal view are extremely rare in Minoan iconography, and it is possible that the *bucranium* rather refer to well-known items of the material culture. Variants with horns slightly pointing downwards are clearly distinguishable from both the 'deer's head' and the 'ram's head', both having decidedly longer horns. Indeed, the former has S-shaped horns pointing outwards, while the latter has C- or S-shaped ones pointing downwards (see Fig. 3.20).

Fig. 3.20 – (From left to right) Difference in horns length and orientation among the *bucranium* (III 222a), the 'ram's head' (III 165a) and the 'deer's head' (XII 084b).

The *bucranium* is an evocative and widespread symbol all over the Mediterranean at least starting from the 6th millennium BCE (Kreiter *et al.* 2021: 2-3). Since the Protopalatial period, the *bucranium* is among the most widespread motifs within the Minoan glyptic and well-attested in material culture as both vase and seal shape. The following characteristics suggest that the iconography of CH 011 was not distinct from the one of the *bucranium* depicted on uninscribed seals. As a consequence, CH 011 could have plausibly evoked those meanings entailed by the latter and *vice versa*.

a) *S u p p o r t*. 29 out of 30 Protopalatial occurrences are to be found on three-sided prisms and 26 of them are fashioned in steatite. Almost all these prisms are clearly recognizable when impressed due to their characteristic oval face. As a consequence, the *bucranium* is almost only confined to three-sided prisms belonging to the 'Mallia Steatite Group'. This stylistic group accounts for the majority of Hieroglyphic seals in soft stone, more than 65% of them indeed being three-sided prisms. The only occurrence apart from prisms is to be found on the disc V 028b. Stylistically, it belongs to the 'Mallia Steatite Group' too. Nevertheless, soft-stone discs are extremely rare during the MM II period and never

inscribed. Conversely, they were highly widespread during the late Prepalatial period, one of them bearing the 'Archanes formula'. Revealingly, MM II discs always show a hole commonly bigger and a thickness from 1/3 to twice that of V 028. By contrast, the latter partners with Prepalatial ones (see Fig. 3.21) Clearly, the *bucranium* was therefore a motif linked to a single stylistic tradition which made use of writing. As such, it must have easily connected its owner to the ones using Hieroglyphic seals.

Fig. 3.21 – (From left to right) The discs V 028 (0.5 cm), III 114 (1.03 cm) and #202 (1.51× 0.62 cm, stringhole 0.63 cm)

b) *Paleography*. On uninscribed seals, the *bucranium* attests the same paleographic features of CH 011 and shows the same facultative elements. As shown in Table 3.2, all paleographic variants of CH 011 find parallels on uninscribed seals. In both cases, variants without correspondence are never to be found. Such a correspondence indicates that engravers of the *bucranium* on both inscribed (i.e., CH 011) and uninscribed seals knew the same range of possible graphic variants. A minor exception is represented by the presence of the eyes, which is sporadically attested for CH 011 on both seals and clay, while it is absent elsewhere.

Features	CH 011	*Bucranium*
Straight horns		
Straight horns and ears		
Slightly downward horns		

Upward horns			

Table 3.2 – Palaeographic variants of the *bucranium* when used both as script sign (i.e., CH 011) and as iconographic motif

c) *Loss of iconicity*. Decidedly more than the vast majority of Protopalatial motifs, the *bucranium* tends to become a less iconic motif and either approaches a T-shaped figure (see III 208b and VI 037) or is variously modified with subsequent loss of recognition cues (see III 206a, see Fig. 3.22). In other instances, the head is merely rendered through two 'cup-sinkings' joined together by a stroke (see VI 043). On both inscribed and uninscribed seals, both ears and horns of the *bucranium* can be variously omitted or rendered in a more or less schematic way. Such a behavior would suggest that it was a highly standardized symbol and that the connection with its physical referent was weak. Typologically, motifs undergoing such a process are employed as either logos or logograms by virtue of their marked recognizability. Unsurprisingly, the same pattern is indeed observable for writing signs.

Fig. 3.22 – (From left to right) Occurrences of the *bucranium* on III 208b, VI 037 and 043

d) *Syntactic positions*. 28 out of 30 occurrences show the *bucranium* either completely on its own or as the bigger device flanked by one or two smaller ones (see Figs. 3.20 and 3.22). The former case usually features motifs matching Hieroglyphic signs too (Jasink 2009: 113). Moreover, it is often to be found duplicated in *tête-bêche* or (more frequently) antithetical arrangement (see Fig. 3.21), such a behavior being typical of Hieroglyphic signs (see §2.10). Such a behavior is typical of logos and logograms and almost always involves Hieroglyphic signs.

The minor devices flanking the *bucrania* are commonly either abstract or floral motifs. Notably, these signs are used in the same way alongside Hieroglyphic signs on inscribed seals (see Fig 3.23). Most of these cases mirror the ones distinguished by Decorte (2017a: 45) as highlighting the value of CH 044. If this was the case, a comparable meaning could have been conveyed by these instances of the *bucranium* on uninscribed seals. A syntactic parallel can also be recognized in the composition displayed by #182, in which CH 011 is placed in the center of a radial composition, between CH 025 and 029. Such a pattern plainly recalls cases in which a *bucranium* is in the center of the face and flanked by trees (see VS1A 325c) or branches (see VI 064a).

Fig. 3.23 – The *bucranium* and Hieroglyphic motifs respectively flanked by (left) 'two-armed whirls' (i.e., III 206a and #243a), (center) two S-spirals (i.e., VI 026 and #220), (right) two J-hooks (i.e., III 222a and #213)

Furthermore, the *bucranium* is often bordered by the heads of two quadrupeds (see Fig. 3.24), representing a calf (= CH 013), a horse (= CH 014) or an agrimi (= CH 016). Sometimes, the same configuration can appear with a duplicated *bucranium* (see Fig. 3.24). Although such figures might have presupposed the need for semantic coherence, it is worth noting that all these motifs match a Hieroglyphic sign exactly. Indeed, such a pattern appears on the uninscribed face of an inscribed three-sided prism (i.e., VI 096b = #241). Similarly, on VI 086a, the *bucranium* is flanked by two 'sun/star'-motifs matching CH 033 and used as minor devices on inscribed seals too (see §2.6.5).

Fig. 3.24 – (From left to right) The three-sided prisms VII 007, XII 061b, VI 096b and VI 086a

3.7.2 Case study 2: the 'needled swastika' and 'look-alike' motifs as possible logograms?

A number of Protopalatial three-sided prisms in steatite can be grouped together by virtue of the fact that a 'needled swastika' flanked by two 'hatched Ds' always takes up one of their faces (see Table 3.3). On these seals, such a motif is only to be found without any other device. This section argues that such seals would go back to a well-defined group with a special bond to writing.

The 'swastika' was a widespread motif up to the end of the Protopalatial period. It always occurs either as the only main device in the center of the face or entirely alone. Earliest occurrences go back to the Prepalatial period, in which the latter is always the case. Notably, such a behavior is shared by a few impressions from EH II Lerna.

Starting from the MM II period, the 'swastika' is to be found with 'needles' on their edges (see Anastasiadou 2011: 284). Plausibly, the 'needled swastika' was a motif pointing to a defined group of owners. Indeed, it is confined to a single period (i.e., the MM II), shape (i.e., the three-sided prism), material (i.e., the steatite) and stylistic group (i.e., the 'Mallia Steatite Group'). Such consistency was already a feature of Prepalatial occurrences, as they are only to be found on cylinders and pyramids in ivory. Seals bearing the 'needled swastikas', especially those flanked by 'hatched Ds', are clearly distinguishable through their oval faces. Conversely, other 'swastikas' are to be found on round or squared faces.

The 'hatched D' finds several occurrences, all being confined to the late Prepalatial 'Border and Leaf Complex' (Sbonias 1995: 103-114) and the Protopalatial 'Mallia Steatite Group' (Anastasiadou 2011: 240). In particular, during the Prepalatial, it is always attested on seals fashioned from white paste. During the MM II period, it appears only to be found on steatite three-sided prisms. Inscribed seals with such a 'look-alike' all show coherent features suggesting they belong to the same community.

CMS (= CHIC) number	Face length	Formula 1 / Icons	Formula 2 / Icons	'Logo'
II.2 116 = #233	1.8 cm		vacat	

II.2 220 = #208	2 cm			
II.2 259 = #248	2.1 cm			
II.2 269 = #237	2 cm			
III 231 = #	1.48 cm			
II.2 134	1.4 cm			
III 213	2.15 cm			
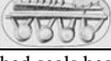
Table 3.3 – The cluster of the inscribed seals bearing the 'needled swastika' with the 'hatched Ds' and pieces akin to them

First, they are consistent in formal features. As already shown, all the members of the cluster are attested in a single shape typology (i.e., the three-sided prism) and material (i.e., the steatite). Moreover, all of them have almost exactly the same face length (see Table 3.3). Notably, their size is higher than the average of the inscribed three-sided prisms in steatite (i.e., 1.74 cm, see Table 4.11).

Second, they are consistent in both iconography and engraving techniques. All the prisms with one inscribed face only bear the formula CH 044-049. Such a feature suggests that their owners would have shared the same administrative function. As the prism #248 bears two inscribed faces and was fashioned from a rarer type of steatite, it might have referred to a higher social status within the same group. Revealingly, the latter also features a decidedly more accurate and dexterous engraving, pointing to a more skilled and valuable manufacturing.

All the seals belong to the broad stylistic trend defined as 'Deep Cut Style' (see Anastasiadou 2011: 87). Moreover, the three ones showing a single inscribed face are clearly part of the same stylistic cluster (Anastasiadou 2011: 103). Indeed, it is noteworthy that both #208 and #237 bear a pig/boar on one face, which means that all their three faces were conceived according exactly to the same iconographic criteria. Notably, both these seals match perfectly in face length, i.e., 2 cm.

The three-sided prism III 231 shows a tentative engraving and it might be possible that some of its features are the outcome of a less dexterous or hasty manufacturing. It has one inscribed face only and bears the formula CH 044-049.

Interestingly, III 231b bears an animal arranged in the sense of the face length, although it possibly refers to a squid. Yet, its swastika is not exactly a 'look-alike' if compared to the core members of the cluster. Indeed, it would be compounded with 'saw branches' attached at the four arms of the 'swastika'. Notably, such a motif is without parallels in Minoan glyptic.

Crucially, both uninscribed seals with a 'needled swastika' flanked by two 'hatched Ds' are characterized by formal differences with respect to the other ones and could not be part of the 'look-alike' motifs. Indeed, the 'swastika' on the prism II.2 134 is oddly rotated clockwise, while all the others are rotated counterclockwise. Furthermore, it is decidedly smaller (face length = 1.4 cm). On the other hand, the arms of the 'swastika' on III 213 form a 90-degree angle, which is the rule during the Prepalatial but absent from the MM II glyptic. Such a 'swastika' seems carved in a more tentative manner *vis-à-vis* the ones featuring the inscribed seals.

3.8 The interaction among materials, shapes, iconography, and writing: setting up the Correspondence Analyses

This section aims at understanding the role played by both formal and iconographical features in defining the identity of seal owners as members of the literate *élites*. As observed in the previous sections, both formal and iconographical features are closely intertwined with writing in defining the meaning conveyed by the seal. This objective is achieved by comparing the distribution of iconographical motifs according to two different formal features, i.e., the seal materials and shapes. In order to compare this data, I employ a statistical model, namely the Correspondence Analysis (hereafter CA). The main goal of CA, with particular reference to archaeological finds, was described by Clouse (1999: 96):

The primary goal of Correspondence Analysis is the transformation of a table of numbers into a more readily interpretable graphical display. Correspondence Analysis, along with other forms of graphical techniques such as histograms, box-plots, and scattergrams are exploratory in the sense that they describe rather than analyze data. The emphasis of the method is the communication of numerical data through expression in a different form. Correspondence Analysis is unique in the manner of its display of such tables.

Notably, CA allows crossing data of (at least) two different variables typically interacting in the material culture, such as iconography and formal features of the artefacts (see Alberti 2013: 479-480 and ref.). Accordingly, CA was exploited in archaeology since the last decade of the past century and proved to be particularly suitable in investigating the iconography on seals (e.g., Camiz & Rova 1991). Karytinos (1998: 65-83) used the CA to investigate the geographical distribution of Prepalatial seal materials. These studies clearly demonstrated the suitability of CA to organize and cluster archaeological data from glyptic. Contingency tables behind the analyses are commonly built by considering the frequency with which entries are observed. Frequencies are particularly relevant to extrapolate social factors hidden by archaeological finds, as well as the degree of reciprocal influence.

3.8.1 Dataset of the Correspondence Analyses

The two CAs consider MM II uninscribed seals in hard stones. The *terminus comparationis* for the first CA is constituted by the iconographic motifs attested on them. In fact, iconography is unequally distributed on Protopalatial seals. Regardless of their standardization and semantic value, it is indeed clear that a number of motifs privilege Hieroglyphic seals and often appear together with writing sequences. Conversely, other devices are either commonly to be found on uninscribed seals or frequent on both inscribed and uninscribed ones. For instance, the 'cat-mask' appears 7 out of 12 times on inscribed seals or even on inscribed faces.[21] Similarly, the X-stiktogram is normally to be found alongside Hieroglyphic sequences, although it is sometimes placed with entirely separate motifs on uninscribed seals (Ferrara & Weingarten 2022). Such a behavior also involves more abstract motifs. For instance, the so-called 'lattice' is repeatedly encountered on

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[21] This number rises to 8 out of 13 by considering NYMM 26.31.146 (supposed to be forgery by Kenna 1972, but recently re-discussed and included among the Hieroglyphic inscriptions, see Civitillo 2015). The impressions II.6 185 and II.8 085 are excluded from the total amount, as their matrixes (four-sided prisms in hard stones) cannot obviously be reconstructed.

inscribed seals (Decorte 2017a: 55), while it is extremely rare elsewhere and never occurs on soft stones.

Alongside them, I showed that some Hieroglyphic signs were employed as iconographic motifs too, i.e., mostly either entirely alone or in frieze-like compositions which are commonly not analyzed as sequences of writing (see §3.7.1). Moreover, recurring motifs on inscribed seals might have pointed to specific groups of persons making use of writing (see §3.7.2). By contrast, other motifs are normally excluded from Hieroglyphic seals, and rarely appear alongside those motifs more closely tied to writing. For instance, the 'rosette', although it is well-attested on Protopalatial glyptic, is always to be found either alone or as the only main device on uninscribed seals.

The *termini comparationis* for the second CA is constituted by materials used to fashion inscribed seals and the most common Protopalatial seal shapes. They were chosen as inscribed seals and are not equally distributed among Minoan glyptic. The percentage of hard-stone seals bearing Hieroglyphic characters is decidedly higher than that of soft-stone ones. Similarly, while writing is frequent on some seal shapes (e.g., the *Petschaft* and the prisms), it is either absent or extremely rare on many others.

Despite this, it is worth highlighting that a huge number of motifs are commonly featured in the whole Minoan glyptic. In particular, inscribed seals in steatite are commonly engraved through iconographic criteria belonging to the 'Mallia Steatite Group' (Anastasiadou 2011: 91). Such iconography in mainly made up of geometric and floral motifs inherited from the Prepalatial glyptic, such as S-spirals, scrolls, hooks and leaves, as well as quadrupeds. Conversely, hard-stone inscribed seals tend to attest motifs which are rarely found elsewhere. Apart from the aforementioned ones, another example is represented by the 'lily with a stem'. On soft stones, possible 'lilies' are always rendered either without a stem (the 'lily blossom', such a motif being present on hard stones too) or with a base, sometimes shaped on a C-spiral. According to Anastasiadou (2011: 248), the latter would have been variants of the 'lily blossom'. On hard stones, a lily with a longer and narrow stem appears 18 times on hard stones, more than half of them being on inscribed faces (see Fig. 3.25). Following Pini (2010), it would therefore be plausible that a

certain degree of independence between the iconography on soft- and hard stones existed. Hard stones would have more often featured motifs which are well attested on inscribed seals, especially when in hard stones.
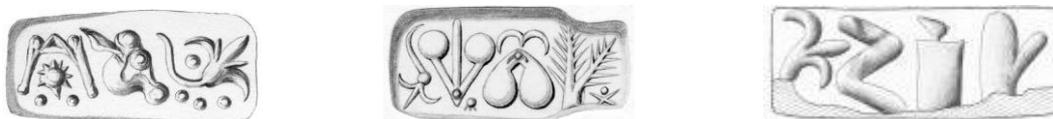
Fig. 3.25 – The four-sided prisms #304b and #295b, and the impression #156

3.8.2 First step toward the Correspondence Analyses: creating a contingency table

CA is the graphic representation on a cartesian plane of a contingency table. A contingency table is "a form of presentation of grouped data" (Gokhale & Kullbach 1978: 5), i.e., data which were grouped according to their frequency. As the purpose of the two CAs is to match two different categories, I devised a "two-way table" (Gokhale & Kullbach 1978: 5), i.e., a table in which data are classified according to two categories, namely rows and columns.

The values of this contingency table are constituted by the frequencies of given entries (i.e., the rows) in given environments (i.e., the columns). With reference to the two CAs carried out in this section, I counted the frequencies of iconographical motifs (rows) according to seal materials and shapes (columns). Both row and column entries are represented on the plane by means of labels, whose position individuates the relations among them.

In the first CA, columns represent those materials used for Hieroglyphic seals, i.e., agate, carnelian, chalcedony, jasper, pseudo-jasper, rock crystal, breccia, gold and silver. For the identification of materials, metadata was drawn from the Arachne's website. In the second CA, columns represent different seal shapes in use during the MM II period. In particular, all shapes but cushions attested more than once for Hieroglyphic seals were selected as entries by themselves, i.e., *Petschafte*, three- and four-sided prisms, halfovoids, cylinders and rectangular blocks. Shapes too were imported from the Arachne's website.

A 46×10 contingency table was compiled. *Hapaxes* were deleted from rows' entries, in order to avoid their excessive interference with graphical displays and statistical results.

3.8.3 How to interpret the Correspondence Analyses

The output of the CA is a two-dimensional scatterplot, based on a cartesian plane, in which rows and columns are represented through labels and distinguished by means of two different shapes of the labels and two different colors. Such a graphical output allows producing the best synthesis of data variability (Alberti 2013: 27). Given the nature of the scatterplot, strong emphasis is given to the cartesian distance between the labels, which is easy to detect by looking at the plane.

The distance between labels on the scatterplot can be interpreted according to two different typologies. First, the distance between labels belonging to the same category, i.e., row-to-row and column-to-column. This distance graphically marks to what extent these labels refer to entries having the same profile. Second, the distance between labels belonging to different categories, i.e., row-to-columns and *vice versa*. This distance graphically marks to what extent a column entry is frequent in the attestations of a given row entry. In other words, with reference to the CAs carried out in this section, it defines to what extent a given iconographic motif is associated with a given material/shape. The origin of the axes corresponds to the average of the profiles, i.e., the null hypothesis of homogeneity in data (Greenacre 2007: 32 and Alberti 2013: 27).

Once established what a distance on the scatterplot is, I went on to consider which distances should be considered and which kind of patterns should be highlighted on the scatterplot. These questions are answered by means of the evaluation of the (number of) dimensions to take into consideration. Dimensions refer to the trends of variation in the dataset. Therefore, dimensions reflect the inertia (i.e., the variation) of the entries on the table. Each dimension explains only a part of the total variation of the table. The profiles of the different entries of the table are such as to polarize according to one or the other dimension. When a profile is polarized beyond the average, i.e., it shows high variation according to that trend,

it is said to be a 'major contributor'. Thus, dimensions are built around their major contributors.

On the scatterplot, dimensions are represented through the cartesian axes. It follows that the coordinates of each label were directly tied to its contribution to the dimensions according to which the plane was set up. Therefore, the higher the contribution of an entry to the dimension, the greater the distance between its label and the center of the axis representing that dimension on the scatterplot. The orientation of a label toward one or the other pole of the dimension is determined by the comparison between its profile and those of the major contributors of the dimension.

Now, as dimensions represent trends of variation, one should interpret *which* trend was represented by significant dimensions.[22] To do so, I examine the column labels with a higher contribution than the average.[23] Therefore, both their distance from the origin of the axis and their 'domain', i.e., the row labels close to them, contribute to defining the kind of variation explained by that dimension. Once the type of variation represented by each significant dimension was established, it is possible to analyze the relation between rows and dimensions, as well as the specific domain of each column.

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[22] The number of dimensions to be considered as significant is a longstanding problem in scholarly works (see Alberti 2013 and ref.) and its precise definition goes far beyond the scope of this section. The choices I made for each CA are therefore discussed in the related sections (see §3.9-10).

[23] Packages provided by *R* show entries' contribution to each dimension in percentages, i.e., the total variation explained by each dimension (100%) was divided among each entry (see Tabs. 3.5-6, 8-9). It goes without saying that the average contribution for a given category *X* is represented by the value of $100/X_n$, with n = number of entries for that single category. For example, if the contingency table has 10 columns and 20 rows, average contribution for columns is $100/10 = 10\%$, while for rows it is $100/20 = 5\%$. All entries contributing more than these values should be considered as significant for that dimension.

3.9 Correspondence Analysis 1: the relation between materials and iconography

The scatterplot of the first contingency table, crossing materials (columns) and iconography (rows), is presented in Fig. 3.26. The first two dimensions explain 43.1% of the total inertia and are considered as adequate for the purposes of this analysis. Such a value fits into the criterion established by Lorenzo-Seva (2011: 97), who suggests considering only dimensions explaining more than the average inertia (i.e., 100/*N*, with *N* = number of dimensions). Given that 6 dimensions resulted from the CA, the average contribution measures 16.7% (see Table 3.4). This value is higher than the contribution of all the dimensions but the first two.

The table does not pass the chi-squared test and indeed shows an extremely high *p*-value (0.571). This is due to low-frequency items in both variables and to the presence of motifs shared by almost all materials. Nevertheless, as proved by the strong association between some motifs and related materials in the plane, the vast majority of frequencies do show statistically significative distributions.
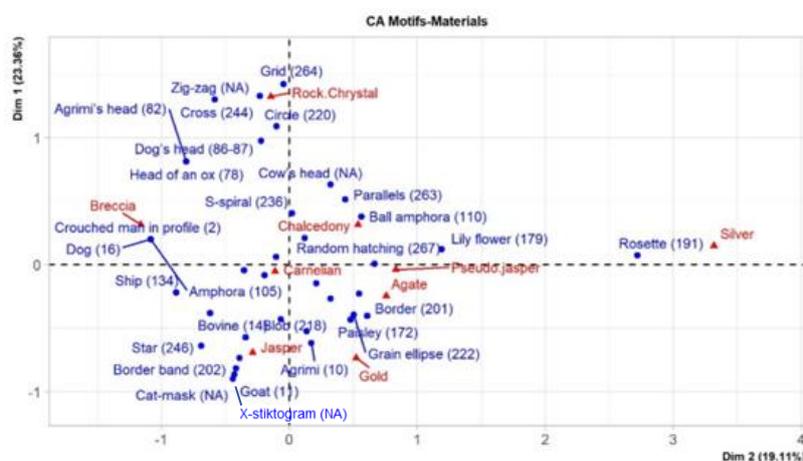
Fig. 3.26 – Correspondence analysis of motifs (blue circles) and materials (red triangles)

	D1	D2	D3	D4	D5	D6	D7	D6
Variance	0.415	0.349	0.285	0.247	0.167	0.133	0.106	0.069
% of variance	23.407	19.687	16.078	13.958	9.444	7.525	6.004	3.895
Cumulative % of variance	23.407	43.094	59.173	73.131	82.575	90.101	96.105	100.000

Table 3.4 – Variance of each CA's dimension.

In order to further verify the dataset, a second contingency table was compiled by deleting motifs with less than four attestations and the ones manifestly

shared without any pattern (see Fig. 3.27). The resulting table indeed shows a significative *p*-value (0.0366), whereas the correspondent plane confirms clusters emerging in Fig. 3.26. Notably, in this plane, the first two dimensions explain more than one-half of the total inertia (i.e., 64.2%).
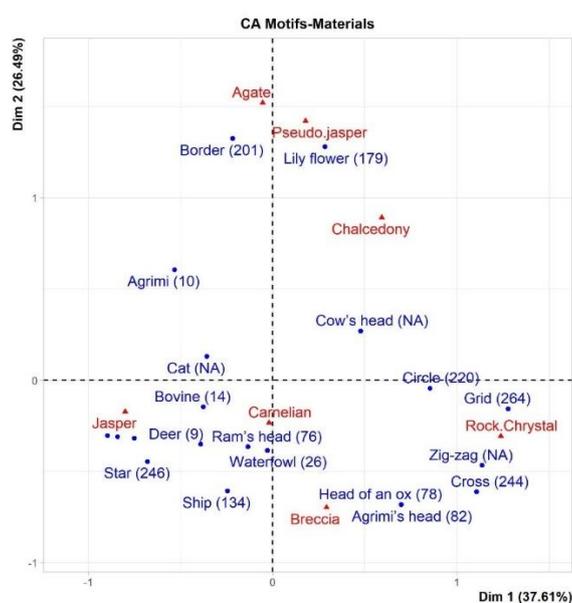
Fig. 3.27 - Correspondence analysis of motifs (blue circles) and materials (red triangles) employing a reduced dataset

3.9.1 The two trends of variation

In this section, I explore the trends of variation underlined by the two significant dimensions. Therefore, I suggest interpreting these trends as follows:

Trend (a) – 'Figurative' vs. 'abstract' motifs. This trend corresponds to the first dimension and is therefore graphically displayed through the ordinate axis (see Fig. 3.26). Major column contributors are rock crystal and jasper (see Tab. 3.5), respectively polarized on the upper and lower part of the plane. Major row contributors (see Tab. 3.6) are geometric/abstract motifs, such as 'cross' and 'circle' falling into the domain of the rock crystal. On the other hand, the contribution of 'figurative' motifs, such as 'cat-mask' and 'agrimi', is either slightly higher or lower than average, and almost all fall in the domain of microquartz in the center-lower part of the plane.

Trend (b). – Widespread vs. rare motifs. This trend corresponds to the second dimension and is therefore graphically displayed through the abscissa axis (see Fig. 3.26). Major column contributors are silver, breccia and agate (see Tab. 3.5), respectively polarized on the right (silver and, to a less extent, agate) and left part (breccia) of the plane. Major row contributors (see Table 3.6) are 'lily flower' and 'rosette', both being attested on silver, an extremely rare material for Protopalatial seals. Notably, 'rosette' is confined to silver and is rare on soft stones too (Anastasiadou 2011: 260). On the other hand, breccia is rare too, but its iconography is always shared by seals in microquartz. In any case, the fact that almost all the motifs are grouped in the center-left part of the plane is indicative of the number of shared motifs and the graphic koine of Protopalatial seals.

Columns	Contribution (D1)	Contribution (D2)
Agate	1.211	**19.497**
Carnelian	0.006	1.174
Chalcedony	1.830	7.003
Jasper	**34.749**	6.124
Pseudo-jasper	0.001	9.640
Rock Crystal	**59.054**	1.342
Breccia	1.672	**23.082**
Gold	1.232	1.043
Silver	0.244	**31.095**

Table 3.5 – Columns' contributions to the first two dimensions. Values higher than the average are in **bold**

Rows	Contribution (D1)	Contribution (D2)	Rows	Contribution (D1)	Contribution (D2)
Agrimi (10)	**2.637**	0.363	Goat (11)	**4.653**	1.207
Agrimi's head (82)	**2.571**	**2.937**	Grain ellipse (222)	0.620	1.659
Amphora (105)	0.158	**3.391**	Grid (264)	**14.627**	0.059
Ape 'a' in profile (7)	0.076	0.944	Head of an ox (78)	**2.571**	**2.937**
Ball amphora (110)	0.848	1.907	Ladder (140)	0.742	0.325
Blob (218)	**2.766**	0.436	Lattice (NA)	1.952	0.614
Border (201)	1.433	**4.940**	Leaf (186)	0.076	0.944
Border band (202)	**3.279**	0.909	Lily blossom (179)	0.020	0.072
Bovine (14)	1.148	**3.530**	Lily flower (179)	0.352	**21.047**
Bull (13)	0.742	0.325	One-armed whirl (248)	0.506	1.053
Cat (NA)	0.898	0.014	Owl (NA)	0.742	0.325
Cat-mask (NA)	**6.558**	1.818	Paisley (172)	1.044	2.005
Centred-circle (226)	0.192	0.622	Parallels (263)	1.381	1.134
Circle (220)	**16.036**	0.367	Ram's head (76)	0.011	0.740
Cow's head (NA)	1.634	0.426	Random hatching (267)	0.006	2.073
Croix-pommée (245)	0.742	0.325	Rosette (191)	0.138	**20.589**
Cross (244)	**10.390**	**2.733**	Ship (134)	0.136	**3.316**
Crouched man in profile (2)	0.158	**3.391**	Spider (39)	0.076	0.944
C-spiral (224)	0.256	0.084	S-spiral (236)	1.338	0.003
Deer (9)	0.509	0.377	Star (246)	**3.001**	**3.847**
Dog (16)	0.158	**3.391**	Waterfowl (26)	0.001	0.132
Dog's head (86-87)	**2.416**	0.193	X-stiktogram (NA)	1.952	0.614
Fish (29)	1.952	0.614	Zig-zag (NA)	**6.492**	0.323

Table 3.6 – Row contributions to the first two dimensions. Values higher than the average are in **bold**

3.9.2 The bottom-left quadrant: jasper and carnelian

In this and the following sections (§3.9.3-3.9.5), I examine the properties of the single domains with reference to the way in which labels are clustered on the plane. The purpose of this investigation is to detect the special linkage of groups of iconographic motifs to some materials, in order to correlate the situation observed on uninscribed seals with that of inscribed ones.

The bottom-left quadrant includes materials showing the closest iconography to the one attested on Hieroglyphic seals. Specifically, they tend to attest those motifs clearly tied to MM II *élites* and mostly excluded from the coeval soft-stone seals. In light of this, it is significant that these two materials represent the privileged glyptic supports of Cretan Hieroglyphic.

Jasper lies at the negative pole of the vertical axe. Almost all the motifs in its domain are (a) close to the Hieroglyphic inventory or widely attested on Hieroglyphic seals and (b) uncommon on soft stone seals. For instance, this is particularly the case of 'X-stiktogram', 'cat-mask', 'ram's head' and 'lattice'. Notably, the only non-figurative motif akin to jasper (i.e., the 'blob') is ubiquitous on Minoan seals (Anastasiadou 2011: 269) and well-attested on Hieroglyphic seals (Karnava 2000: 180).

As already discussed (§3.2.1), X-stiktogram had an indexical value strictly linked to writing. It is therefore extremely likely that motifs in isolation flanked by one or more X-stiktogram(s) would have been somewhat linked to writing, plausibly through a logographic value (Ferrara 2018: §33-36, 42). It only occurs four times on seals excluded by *CHIC*, two of them being in jasper, the other ones respectively in quartz and an impression. In such two cases, it flanks motifs either already attested on inscribed surfaces or used entirely alone on other occasions (see Fig. 3.28). Notably, these motifs too are confined to jasper and carnelian.

Fig. 3.28 – (Top, from left to right) X-stiktogram on jasper seals (VII 034 and VI 131) and (Bottom, from left to right) related motifs on uninscribed (VI 038a) and inscribed (#309a) seals

Cat-mask was traditionally linked to Cretan Hieroglyphic and writing in general, as it represents the sign AB 80/*ma* too. As often discussed (e.g., Civitillo 2007 and Krzyszkowska 2015), the cat-mask was undoubtedly a prestige marker, plausibly imported from Egypt at the beginning of the Protopalatial period. Like the full-bodied cat, it frequently appears together with Hieroglyphic signs and in association with well-known formulas (Krzyszkowska 2015: 105). Its special connection with jasper cannot be doubted. On uninscribed surfaces, 75% of cat-masks are attested on jasper, the remaining ones on carnelian and once on pink quartz.

The head of a ram is found on soft stones too (see on Anastasiadou 2011: 209-210) and once on rock crystal (II.2 283). Nevertheless, both the presence of the X-stiktogram and its occurrence entirely alone make the connection to writing extremely likely. Notably, such configuration mirrors the occurrence of other Hieroglyphic signs, e.g., CH 017 on II.8 038 etc. The association with the X-stiktogram is confined to a *Petschaft* in jasper (i.e., VII 034, see Fig. 3.29). On the latter, two X-stiktograms flanking the motif are to be found. Such configuration is well-attested for Hieroglyphic signs even when included in well-known sequences (e.g., #299b) and likely conveys a meaningful value tied to writing (Ferrara 2018: 101).

Fig. 3.29 – (From left to right) Usage of the X-stiktogram flanking (i) an isolated Hieroglyphic motif (II.8 038) and (ii) a Hieroglyphic sign in a well-known formula (#299b)

'Lattice' was singled out from the 'grid' motif as it never occurs in isolation, but commonly flanks main devices and/or is set behind them. Apart from a Hieroglyphic prism in carnelian (#298d), such motif is confined to seals in jasper. 'Lattice' is well-attested on inscribed seals but almost only confined to them. When interacting with Hieroglyphic sequences, 'lattice' can either cover the entire surface (e.g., #193) or delimit one of its parts (e.g., #309c). As noted by Decorte (2017a: 55), it isolates one or more signs from the others on the same face. A comparable manner is attested on the jasper *Petschaft* VII 033, in which it flanks a *croix pommée* (see Fig. 3.30). It could therefore constitute a (decorative) device that largely characterizes inscribed seals or even identifies a special function of some signs. As a consequence, impressions bearing 'lattice' would have made literate owners immediately recognizable.

Fig. 3.30 – (From left to right) Examples of 'lattice' motif on both inscribed (#193 and #309c) and jasper uninscribed seals (VII 033)

3.9.3 The top-left quadrant: rock crystal and breccia

Rock crystal and breccia are the least associated to both writing and MM II innovations in iconography. Even though they occupy the same quadrant, they share only few motifs and are both rather isolated on the plane. They both generally show an iconography widely attested, even since the Prepalatial period, on soft stone seals. As a consequence, both scarcely reflect an innovative situation, and would constitute less valuable artifacts. This is unsurprising given that (a) breccia could also represent softer varieties and rock crystal is the softest one among hard stones and (b) both come from local sources, differently from the other hard stones which were imported from overseas.

Rock crystal attests the vast majority of abstract/geometric motifs, which reflect a lower elaboration of the iconography and plausibly required less skilled artisans. Although some of them are included within the Hieroglyphic inventory, they clearly go back to an ancient tradition, generally continued on soft stone and could merely be interpreted as decorative patterns. Revealingly, rock crystal and breccia attest shapes mostly at home in the previous periods. For instance, they show the only examples of spools in hard stones, i.e., IV D028 (MM II), XI 118 (unengraved) and 147 (architectural). Unsurprisingly, they were engraved with an 'old-fashioned' and geometric iconography (see Fig. 3.31). The same is true for the pierce-grip seal. The only artefacts apart from soft-stone ones, i.e., and II.1 103 and XI 275, were respectively fashioned in rock crystal and breccia. Their iconography is clearly to be found on a huge number of Prepalatial seals of pear-shaped seals (e.g., II.1 026 and IV 064).

Fig. 3.31 – (Top, from left to right) Iconography of 'conservative' shapes in rock crystal and breccia: spools (IV D028 and XI 147); pear-shaped seal (II.1 103); pierce-grip seals (III 072). (Bottom, from left to right) Two pear-shaped Prepalatial seals (II.1 026 and IV 064)

'Figurative' motifs belonging to this quadrant, mostly quadruped heads, are commonly at home on soft-stone seals, especially within the 'Mallia Steatite Group'. Differently from jasper and carnelian seals, some three-sided prisms in rock-crystal mirror both the iconographic patterns and the syntactic criteria of the ones belonging to the 'Mallia Steatite Group'. For instance, all faces of III 181 are matched by motifs on soft stone three-sided seals (see Fig. 3.32). Furthermore, cases such as II.2 232 and III 153 testify that both *tête-bêche* cow's heads and two ball amphoras were associated with a full-bodied quadruped on another face.
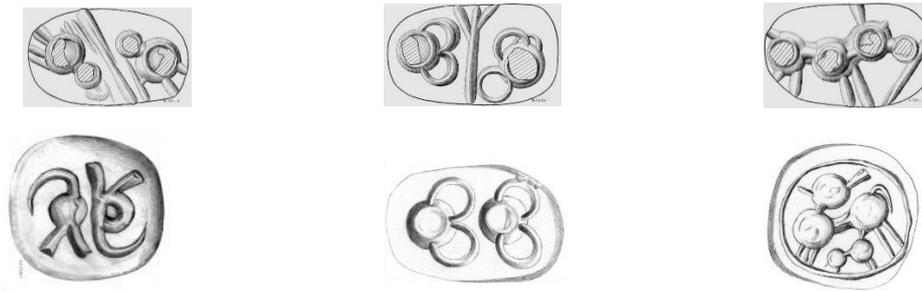
Fig. 3.32 – (Top, from left to right) The three-sided prism III 181; (Bottom, from left to right) II.2 232, XII 093c and XII 059b

All motifs akin to breccia, i.e., 'crouched man in profile', 'amphora' and 'dog', show the same characteristic. Although they are commonly recognized as being part of the Hieroglyphic inventory, they are still noticeably employed on soft stone seals. Notably, the only motif of the bottom-left quadrant showing such a behavior is the 'ship', which is the closest one to the breccia.

3.9.4 The bottom-right quadrant: agate, pseudo-jasper and gold

Among the hard stones commonly employed for Hieroglyphic seals, agate is clearly the most eccentric one as regards its iconography. As it is definitely the harder one (see §5 *passim*, in part. §5.2.1), such a difference could not be due to chance. As reflected in its relative position, agate does not show a clear preference for certain motifs, apart from the 'border'. Agate only attests motifs noticeably widespread on hard stone seals. Almost always, they are attested only once on it, as is the case of e.g., the 'agrimi', 'bovine', 'one-armed whirl', 'paisley' etc. (see Fig. 3.33). Moreover, it normally does not bear motifs tied to the Hieroglyphic repertoire. Still, it attests that some motifs are to be found on Hieroglyphic seals (especially when in soft- or middle hard stones), such as the 'spider' and the 'ball amphora'. This situation is much clearer in the plane reflecting the reduced table. On it, agate is even the most isolated column label and is only tied to the 'border' motif.
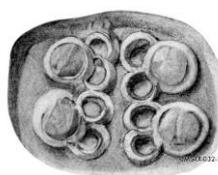
Fig. 3.33 – (From left to right) Motifs on agate seals attested on both Hieroglyphic seals and other uninscribed seals in hard- and soft stone, i.e., VI 149; IX 032; XII 099

Pseudo-jasper identifies a middle-hard stone that is aesthetically close to jasper. Like the other middle-hard stones, it was frequently used for writing purposes during the MM II period. It is the closest label to agate. All its motifs except the 'C-spiral' and the 'Cow's head' are attested on agate too. Like agate, it shows an iconographic repertoire clearly linked to the 'Mallia Steatite Group' and rather far from the jasper one. Of note, pseudo-jasper is similar to rock crystal and breccia in the sense that it came from local sources. For different reasons, both agate and pseudo-jasper might therefore have selected a slightly less prestigious iconographic inventory with respect to jasper and carnelian and shared a wider part of their repertoire with seals in soft stones.

Apart from the inscribed four-sided prism #306, only three gold seals can be dated to the MM II period. All have one face only and bear extremely simple geometric (and perhaps one floral) motifs. Indeed, only three motifs were included for gold (i.e., the 'blob', the 'paisley' and the 'leaf'), all being widespread throughout the Minoan glyptic. Gold has therefore a rather isolated position in the graph and only minimally contributes to the definition of the first two dimensions.

3.9.5 The top-right quadrant: chalcedony and silver

Although they share the same quadrant, chalcedony is topologically close to agate and carnelian, while silver is extremely isolated.

In particular, chalcedony recalls the situation observed for agate, as it mainly attests motifs well-known on other hard stone seals. Although it sometimes attests simple abstract/geometric motifs commonly excluded from jasper, carnelian and agate, differences from the latter material consist in the presence of motifs tied to writing and showing a preference for valuable materials, such as the 'cat' and the 'lily blossom'.

Silver shows the opposite situation with respect to agate. Its contribution to the first dimension is minimal, which means that it does not show any pattern as

regards the presence of figurative motifs and their connection to writing. Admittedly, only one uninscribed seal datable to the MM II period is attested. New finds could therefore change such a picture dramatically.

3.10 Correspondence Analysis 2: the relation between shapes and motifs

The scatterplots of the second contingency table, crossing shapes (columns) and iconography (rows), are presented in Figs. 3.34-36. The scatterplot in Fig. 3.34 shows the CA according to dimensions 1-2, the one in Fig. 3.35 according to dimensions 2-3 and the one in Fig. 3.36 according to dimensions 1-3. I show three scatterplots since, in this case, three dimensions are significant. The first three dimensions count for more than a half of the total inertia (53.4%). The average contribution for 8 dimensions is 12.5% (see Table 3.7). Although the fourth one is slightly higher than the average (i.e., 12.8%), I did not consider it necessary towards explaining the data at hand.

The planes obtained show even clearer clusters than the previous ones. Indeed, although they contain low-frequency items, the related contingency table measures an extremely low p-value (0.0004). Thus, they point to a strong dependence between seal shapes and the iconography on them.
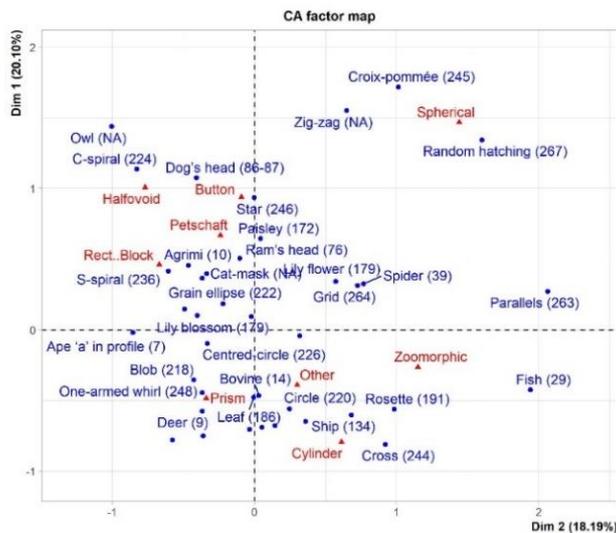
Fig. 3.34 – Scatterplot of the CA crossing motifs and shapes according to dimensions 1-
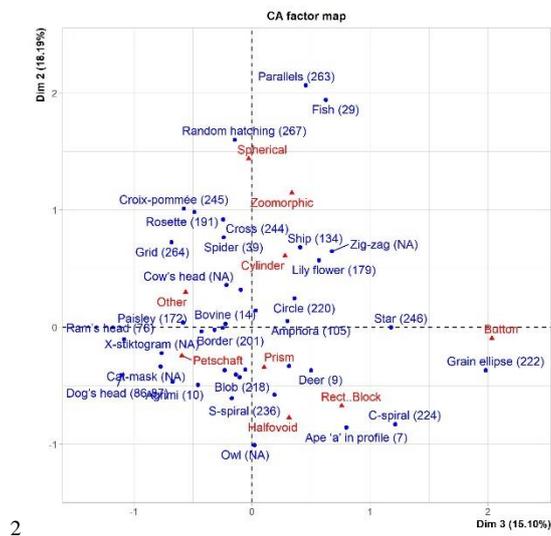
Fig. 3.35 – Scatterplot of the CA crossing motifs and shapes according to dimensions 2-3
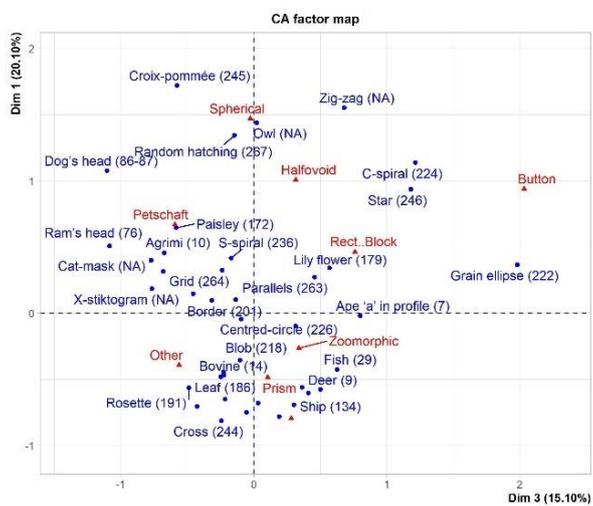
Fig. 3.36 – Scatterplot of the CA crossing motifs and shapes according to dimensions 1-3

	D1	D2	D3	D4	D5	D6	D7	D8
Variance	0.387	0.350	0.290	0.246	0.224	0.199	0.122	0.107
% of var.	20.101	18.189	15.096	12.773	11.631	10.341	6.328	5.539
Cumulative % of var.	20.101	38.290	53.386	66.159	77.791	88.132	94.461	100.000

Table 3.7 – Variance of each CA's dimension.

3.10.1 The three trends of variation

In this section, I explore the trends of variation highlighted by the three significant dimensions. Therefore, I suggest interpreting these trends as follows:

Trend (a) – Shapes attesting writing vs. Shapes not attesting writing. This trend corresponds to the first dimension and is therefore graphically displayed through the ordinate axis (see Figs. 3.31 and 3.36). Major column contributors are spherical seals (upper part), *Petschafte* and prisms (center-lower part) (see Tab. 3.8). Note that spherical seals are less attested during the Protopalatial than most of the other ones. Major row contributors (see Table 3.9) are, on the one hand, motifs unconnected to Hieroglyphic seals (e.g., 'zig-zag', 'owl', 'random hatching' etc.) and therefore close to the domain of 'spherical seals'. On the other hand, motifs close to Cretan Hieroglyphic, are either shared by soft-stone seals (e.g., '*croix pommée*' and 'ship') or mostly confined to hard stones (e.g., 'cat-mask').

Trend (b) – Widespread vs. Hard-stones specific motifs. This trend corresponds to the second dimension and is therefore graphically displayed through the abscissa axis in Fig. 3.34 and the ordinate in Fig. 3.35. Major column contributors are spherical seals and halfovoids (see Table 3.8), which represent the poles of the related axis. Major row contributors (see Table 3.9) show the opposition between, on the 'spherical seals-side', motifs widely in use for Protopalatial soft-stone seals and, on the 'halfovoids-side', motifs closer to both hard-stone seals and inscribed ones. Revealingly, the same distinction applies to column labels too. This points to a strong correlation between shapes normally, although not exclusively, employed with hard stones and an iconography linked to Cretan Hieroglyphic.

Trend (c) – MM II innovations vs. Inherited motifs. This trend corresponds to the second dimension and is therefore graphically displayed through the abscissa axis (see Figs. 3.35-36). Major column contributors are buttons (right side), *Petschafte* and 'others' (left side) (see Tab. 3.8). Buttons in hard stones are rare and this explains why most of the labels are concentrated in the left part of the planes. The pole represented by both *Petschafte* and 'others', especially the domain of the former shape, bind together extremely rare motifs on Protopalatial seals, i.e., Protopalatial innovations connected to Cretan Hieroglyphic (e.g., 'cat-mask', '*croix pommée*', 'head of a ram' and X-stiktogram). On the other hand, the right side is mostly occupied by well-known motifs on Prepalatial seals (e.g., 'star', 'C-spiral', 'ape in profile').

Columns	Contribution (D1)	Contribution (D2)	Contribution (D3)
Petschaft	**23.317**	3.380	**24.593**
Zoomorphic	1.981	**41.287**	4.309
Halfovoid	10.364	6.734	1.345
Cylinder	5.014	3.262	0.829
Prism	**22.431**	**12.313**	1.356
Spherical	**22.016**	**23.366**	0.011
Button	7.009	0.078	**43.630**
Rectangular block	2.646	6.229	9.587
Other	5.221	3.350	**14.340**

Table 3.8 – Columns' contributions to the first three dimensions. Values higher than the average are in **bold**

Rows	Contribution (D1)	Contribution (D2)	Contribution (D3)	Rows	Contribution (D1)	Contribution (D2)	Contribution (D3)
Agrimi (10)	1.419	1.631	**4.094**	Grain ellipse (222)	0.303	0.341	**11.853**
Agrimi's head (82)	0.691	0.419	0.056	Grid (264)	0.782	**4.601**	**4.900**
Amphora (105)	**2.170**	0.013	0.546	Head of an ox (78)	1.381	0.838	0.111
Ape 'a' in profile (7)	0.001	1.842	1.937	Ladder (140)	0.691	0.419	0.056
Ball amphora (110)	**2.616**	0.127	0.008	Lattice (NA)	0.049	0.611	0.628
Blob (218)	1.856	**2.993**	0.212	Leaf (186)	1.300	0.000	0.468
Border (201)	0.082	0.006	1.215	Lily blossom (179)	0.047	0.822	0.113
Border band (202)	**2.763**	1.676	0.222	Lily flower (179)	1.055	**3.270**	**3.902**
Bovine (14)	1.974	0.008	0.610	One-armed whirl (248)	1.354	1.027	0.480
Cat (NA)	0.006	0.380	0.041	Owl (NA)	**7.043**	3.815	0.002
Cat-mask (NA)	1.438	1.141	**7.212**	Paisley (172)	**3.786**	0.017	**4.130**
Centered-circle (226)	0.138	1.803	1.925	Parallels (263)	0.335	**21.354**	1.262
Circle (220)	**8.211**	1.723	**4.559**	Ram's head (76)	0.874	0.041	**5.325**
Cow's head (NA)	**2.390**	0.806	0.351	Random hatching (267)	**8.188**	**12.826**	0.128
Croix-pommée (245)	**6.699**	**2.527**	1.010	Rosette (191)	1.073	**3.635**	1.075
Cross (244)	**4.485**	**6.356**	0.541	Ship (134)	0.824	1.163	0.506
Crouched man in profile (2)	0.691	0.419	0.056	Spider (39)	0.240	1.469	0.172
C-spiral (224)	**7.339**	**4.313**	**11.126**	S-spiral (236)	**3.127**	**7.413**	0.699
Deer (9)	1.879	0.849	1.896	Star (246)	**7.942**	0.000	**16.799**
Dog (16)	**3.192**	0.820	0.023	Waterfowl (26)	1.128	0.003	0.548
Dog's head (86-87)	**2.622**	0.420	**3.682**	X-stiktogram (NA)	0.155	0.249	**3.536**
Fish (29)	0.205	**4.720**	0.594	Zig-zag (NA)	**5.459**	1.054	1.391

Table 3.9 – Rows' contributions to the first three dimensions. Values higher than the average are in **bold**

3.10.2 Petschaft

In this section and in the following (§3.10.3-3.10.6), I analyze the properties of the single domains with reference to the way in which labels are clustered on the planes. The purpose of such investigation is to detect the special linkage of groups of iconographic motifs to some shape classes, in order to correlate the situation observed on uninscribed seals with that of inscribed ones.

The production of *Petschafte* almost perfectly matches the lifespan of Cretan Hieroglyphic on Crete. All but two can indeed be dated between the MM II and the MM II-III period. Moreover, hard stone *Petschafte* are confined to MM II. 13,5% of them are considered inscribed, while only 6,5% of soft-stone ones bear Hieroglyphic characters.

The domain of *Petschaft* includes the vast majority of motifs in close connection to Cretan Hieroglyphic. Such characteristic is confirmed by its position in all the three dimensions, where it is always placed close to the row labels linked to writing and hard stone innovations. In both the first and second dimension, it indeed occupies the positive pole near the halfovoids, the other one-faced seal shape bearing writing during the MM II period. In the second dimension, it is also the closest label to prisms. As already observed, the negative pole of this dimension includes almost all the motifs encountered on Hieroglyphic seals.

Petschaft is the privileged support for X-stiktogram (2 instances out of 4) and motifs with a possible logographic interpretation, e.g., 'cat-mask' (5 instances out of 8), 'ram's head' (2 out of 3), 'dog's head' (2 out of 2). Regardless of their formal characteristics, a logo(graphic) interpretation of such motifs is reinforced by their entirely self-standing position , i.e., without any other main device, and in the center of the seal face (see Fig. 3.37). Moreover, *Petschafte* attest almost all the other motifs closely tied to Hieroglyphic seals, such as 'lattice', 'cat', 'S-spiral', 'lily flower/blossom', 'one-armed whirl' etc. On *Petschaft*, the sole occurrence is to be found of a *croix-pommée,* stylistically close to CH 070 and over a 'lattice' motif (see §3.9.2 and Fig. 3.30).

Fig. 3.37 - (From left to right) *Petschafte* in hard stone, i.e., VIII 103, II.2 282 and VI 132

Nevertheless, hard stone *Petschafte* tend to exclude 'figural' motifs, widespread on soft stone prisms, such as the 'amphora', 'cow's head' etc., although they are frequently related to Hieroglyphic signs. Revealingly, uninscribed *Petschafte* in soft stone were rarer during the MM II period and always engraved through simple geometric/abstract or floral motifs, entirely unrelated to Hieroglyphic signs and inscribed seals' iconography (see Fig. 3.38).

Fig. 3.38 – (From left to right) Soft stone *Petschafte*, i.e., II.1 331, 334 and III 107

By contrast, abstract/geometric (e.g., 'zig-zag', 'cross' etc.) or floral (e.g., 'rosette') motifs, hard to find on Hieroglyphic seals, are absent or decidedly less represented. Hard stone *Petschafte* with simple geometric (either patterns or spirals) or floral (either paisleys or leaves) decoration represent less than 15% of the total occurrences. As is the case of I 430, some of them might nevertheless represent symbols tied to the Hieroglyphic tradition (see #301b, see Fig. 3.39).

Fig. 3.39 – (From left to right) The hard stone *Petschaft* I 430 and the inscribed four-sided prism #301b

This fact could also be reflected in the special link between *Petschaft* and green jasper. Indeed, 40% of the hard stone occurrences were fashioned in this material, while carnelian, agate, chalcedony, and rock crystal only account for slightly more than 10% each. As a consequence, *Petschaft* and green jasper match in the distribution of motifs. Although only two out of 17 jasper *Petschafte* are

considered inscribed, all but IX 031 are in fact either clearly connected to the Hieroglyphic iconographic repertoire or to innovative iconography confined to MM II hard stone seals.

3.10.3 Three- and four-sided prisms

Even more so than *Petschafte*, hard stone prisms were chiefly conceived to host Hieroglyphic inscriptions. More than 73% (30 out of 41) three-sided prisms datable to the MM II period are inscribed and more than 83% (20 out of 24) four-sided prisms of the same period are inscribed, as are more than 92% of the impressions going back to such a shape. While three-sided prisms in soft stones are common, four-sided prisms might have primarily been items fashioned in hard stones. As already observed for *Petschafte*, the number of inscribed items dramatically decreased when considering both three- and four-sided prisms in soft stone.

Prisms share with *Petschafte* a number of motifs related to the Hieroglyphic and almost wholly confined to these two shapes, i.e., 'X-stiktogram', 'agrimi', 'one-armed whirl' and 'lattice'. Prisms and *Petschafte* are also very privileged in hosting 'S-spirals' and 'blob' decorations, respectively accounting for 69% and 80% of the total occurrences. In Fig. 3.35 arranged according to the second and third dimensions, prism and *Petschaft* domains are indeed extremely close to each other and form a rather separated cluster from the other labels.

Prisms mainly differ from *Petschafte* as regards the first dimension. This is largely due to the intertwining between prisms (especially three-sided prisms) and the iconography on soft stones. A number of motifs matching Hieroglyphic signs and generally well known within the 'Mallia Steatite Group' are confined to prisms, even though they are often attested only once. For instance, 'crouched man in profile' (= CH 001), 'head of an ox' (= CH 011), 'agrimi's head' (= CH 016), 'ladder(/door)' (= CH 038) and a sign identifiable as a spindle whorl (= CH 063, see Ulanowska 2021: 89-90), all find a match on soft stone seals (particularly on three-sided prisms, see Anastasiadou 2011 *s.v.*). Other signs of this type are mostly attested on (although not confined to) prisms, such as the 'amphora' (= CH 054), 'ship' (= CH 040) and 'star' (= CH 033). Notably, this group of signs is generally

employed on both jasper and carnelian seals (see §3.9.2). It might therefore constitute a selected part of the iconographic repertoire in use on both soft- and hard stone prisms and directly referring to writing.

Moreover, such a phenomenon involves some 'figural' motifs not particularly tied to writing, but still to be found on inscribed seals and common on soft stone three-sided prisms, such as 'dog' (see Fig. 3.40), 'ball amphora' (see Figs. 3.32-33) etc. As visible in Fig. 3.40, their syntactic arrangement was also known to Hieroglyphic seal engravers.

Fig. 3.40 – (From left to right) Dog on the uninscribed three-sided prism VI 097b; Quadruped arrangement comparable to the dog on VI 097b (on VI 100d = #283); Dog on the inscribed three-sided prism XI 331= #222

Differently from *Petschafte*, prisms make wide use of geometric motifs such as 'centered-circles' and 'borders' framing the main devices (see Fig. 3.41). Although such motifs are not absent from inscribed seals (e.g., #245b and #298), they are normally to be found on soft stone and uninscribed ones since the end of the Prepalatial period. Four-sided prisms are the preferred support for 'centered circles' (7 out of 13 instances). This motif, even included as *SM* no. 109 by Evans (1909) within the Hieroglyphic inventory, sometimes interact with Hieroglyphic signs but its meaning remains uncertain (Jasink 2009: 42-43). In any case, its function on soft stone clearly seems decorative (Anastasiadou 2011: 273).

Fig. 3.41 – Centered-circle on uninscribed (II.2 273a) and inscribed four-sited prisms (#298c and #308d)

3.10.4 Halfovoid and rectangular block

Halfovoid seems to be a rather favored 'host' of writing. Only 21 examples survive, ranging between the end of the Prepalatial to the MM II-III. 15 items come from the MM II period and ten out of them are fashioned in hard stones. Three hard stone

halfovoids are inscribed (#194-196), while VI 147 might be either pseudo- or actual writing (see Fig. 3.42).

Fig. 3.42 - The halfovoid in amethyst VI 147

Such a close relationship between halfovoids and the Hieroglyphic repertoire is suggested by their iconography too. Halfovoids are akin to *Petschafte* in the first and second dimensions and to prisms in the second and third ones. They represent the negative pole of the second dimensions, as almost all their instances bear motifs well known on both hard stones and inscribed seals. Commonly, such motifs clearly match Hieroglyphic signs, i.e., the 'S-spiral' and CH 309, the three-leaved plant and CH 023 (see Fig. 3.43). Moreover, other motifs in isolation on halfovoids such as the 'sun with four moons' and the 'lily flower' proved to be closely related to the Hieroglyphic seals (see Jasink 2009: 43 and ref.).

Fig. 3.43 – Halfovoids in hard stones. (From left to right) III 093-095

This iconography perfectly matches the one on rectangular blocks, even though they are not particularly related to writing (only one item in steatite is inscribed, i.e., #289) nor to hard stones (44% of the total items). However, occurrences in hard stones clearly differ in both regularizing their formal features (only two engraved faces and less fluctuant dimensions) and adopting an abstract/geometric and floral iconography widely diffused within the Minoan glyptic (see Fig. 3.44).

Fig. 3.44 – Two hard- (II.2 284b and VI 107b) and a soft stone rectangular blocks (III 064)

Thus, in the third dimension, both halfovoids and rectangular blocks are close to prisms, as they tend to bear motifs attested within both the Hieroglyphic and the 'Mallia Steatite Group' iconographic repertoire. For instance, both the S-spiral and the *tête-bêche* lilies are often to be found either in isolation or arranged together in a kind of *cartouche*. Such a composition is employed on inscribed four-sided prisms, uninscribed steatite three-sided prisms and even on one hard stone *Petschaft* (see Fig. 3.45).

Fig. 3.45 - *Tête-bêche lilies* on (from left to right) the halfovoid VS3 041, the rectangular block II.2 286b, the inscribed four-sided prism #295a, the *Petschaft* IX 029 and the steatite three flanked prism IX 018c

Notably, all the three engraved soft stone halfovoids datable to the MM II period bear entirely self-standing motifs and matching Hieroglyphic signs as they are attested on seals of the 'Mallia Steatite Group'. These occurrences are mirrored by a small group of rectangular blocks in steatite bearing figurative motifs. As well the halfovoids, they show wholly isolated motifs and often related to a Hieroglyphic sign (see Fig. 3.46).
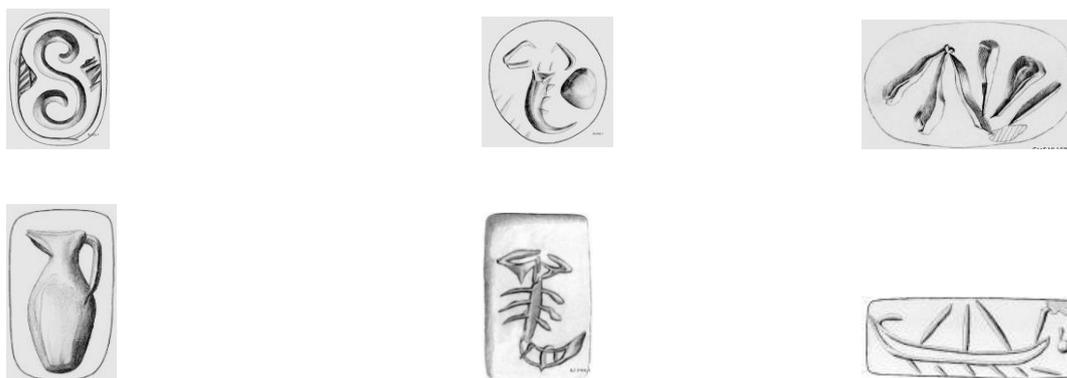
Fig. 3.46 – (Top, from left to right) Halfovoids in soft stone, i.e., III 066, 096 and VI 150; (Bottom, from left to right) Rectangular blocks in soft stone, i.e., III 243d, II.2 240b and VS1B 333a

3.10.5 Zoomorphic seals, cylinders and other shapes

The group of zoomorphic seals, (semi)cylinders and other shapes share the similar feature of being continuants of Prepalatial shapes and only being rarely inscribed. Moreover, they all show preference for soft stones.

Overall, their iconography matches the one observed within the 'Mallia Steatite Group'. Differently from *Petschafte*, prisms and halfovoids, they therefore do not show any relevant difference between iconography on hard- and soft stone. Thus, the iconography of such shapes is largely unrelated to the one observed on Hieroglyphic seals, apart from those motifs well attested within the 'Mallia Steatite Group'. Such a behavior is manifest in Fig. 3.34, in which all these shapes are grouped together in the bottom-right quadrant. Topologically, they are akin to prisms, which show a wide use of the iconography attested on soft stone seals of the MM II period. Indeed, their closest row labels are those figurative and floral motifs well-attested on steatite seals (e.g., the 'fish', the 'ship' and the 'leaf'), as well as those abstract/geometric ones widely employed on both soft- and hard stone ones (e.g., the 'circle').

An exception to this picture is represented by the position of the label 'Others' in the third dimension, in which it is the closest one to the *Petschafte*. Such a position is determined by the (rare) presence on both discoids and signets of motifs whose preferred support is the *Petschaft,* and which are plausibly related to Cretan Hieroglyphic (see X 280 and II.2 283 in Fig. 3.47). Some of them such as the 'cat-mask' and the 'ram's head' are sporadically attested on soft stone too. The presence on the pink quartz signet X 280 of a cat-mask flanked by an X-stiktogram would speak in favor of the connection between its owners and the literate administration. Admittedly, this signet could merely represent a 'relative' of the *Petschaft* (as *per* Betts 1980: 252) and as such the presence of such an iconography would be unsurprising. Of note, both X 280 and II.2 283 are made in less valuable, legible, and tied to writing materials, i.e., respectively quartz and rock crystal. Moreover, the signet X 280 is particularly small, its diameter measuring 0.75 cm. Accordingly, they may therefore point to the usage of the same signs at a slightly lower level.

Fig. 3.47 – The signet in pink quartz X 280 and the discoid in rock crystal II.2 283

3.10.6 Spherical and button seals

Both spherical and button seals do not show a clear preference for hard stones and writing is almost absent on them. Only 38% spherical seals are in hard stones and none of them is inscribed. One poor legible steatite hemisphere bears a possible sequence, whose identification as Hieroglyphic nonetheless being extremely tentative. Buttons show a clear preference for soft stones (more than 85%) and none of them is inscribed.

Such a discrepancy is clearly reflected in the iconography on these seal shapes (see Fig. 3.48). On the surfaces, they always take up the most peripheral positions, as they almost only attest either simple geometric motifs already known since the very beginning of Minoan glyptic or merely random hatchings. It follows that their iconography is certainly far from the one attested on Hieroglyphic seals.
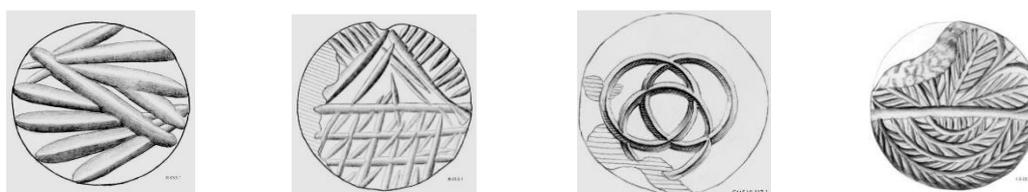
Fig. 3.48 – Middle-hard (III 055) and hard stone (III 092) hemispheres; two hard stone buttons (VI 117 and II.2 203)

The most typical motif is a 'cross/star', which does not match any Hieroglyphic sign. It is attested on both soft stone buttons and green jasper buttons and hemispheres (see Fig. 3.49). On soft stone spheres, it is mirrored by a star-like pattern motif. Especially when in green jasper, such a motif could have constituted, together with the material features of the related seals, a recognizable marker for some seal owners. Notably, the only motif on buttons possibly related to a

Hieroglyphic sign is a grain ellipse (= CH *153), found on both a green jasper and a steatite piece (see Fig. 3.49).

Fig. 3.49 - (Top, from left to right) Selection of 'cross/star' occurrences on a hard stone hemisphere (III 073), on buttons (VIII 038 and II.2 031), and on a soft stone button (II.2 327); (Bottom, from left to right) Possible instances of grain ellipse on hard (II.2 006) and soft stone buttons (VI 113)

3.11 Conclusions

This chapter analyzed the relationship between formal and iconographical features of the inscribed seals by combining a philological, archaeological, and statistical approach.

As a primary step, I reassessed the significant features for the study of inscribed seals, namely those conveying meaning in relation to the agents involved in its production and usage. The analysis, I suggested, can be carried out on two different types of objects. On the one hand, the seal impressions, mainly administrative tools shedding light on the possessors of the related matrixes by means of (a) their iconography, including writing, (b) the carving techniques, providing hints on the softness of the material and the type of manufacture, (c) the shape's outline, singling out groups of seals which were commonly inscribed from those that were not.

On the other hand, the 'physical seals', personal items closely tied to their owner and often shown off as luxury goods. All these features proved directly intertwined with writing in defining the hierarchical role of the seal owners.

Accordingly, the way in which a seal conveys meaning can be defined in relation to:

(a) Shapes and sizes, which mainly provide clues to distinguishing among style-groups, i.e., plausibly groups of owners. Indeed, only few of them are employed with hard stones and directly tied to writing.

(b) Materials, which were distinguished according to their provenance, i.e., Crete (soft-stones, rock crystal and red jasper), Western Aegean (metals) and Egypt/Near East or far away (all other microquartz). Consequently, materials would point to the restricted access to rare goods by a small group of owners.

(c) Colors, commonly understood as features singling out groups of seals, and directly pointing to the achievement of specific techniques, such as the polishing, and the capacity to afford particularly prestigious materials.

(d) Readability and legibility. The two terms are not interchangeable. Readability allows readers and viewers to be aware of the motifs engraved on seals and, in the case they possessed an adequate degree of literacy, to interpret the Hieroglyphic sequences held by their owners. Legibility allows readers and viewers to be aware of the techniques used to carve the intaglio, i.e., to reconstruct the *chaîne opératoire* behind the seal production. Both readability and legibility are the outcome of different features, namely the materials (in relation to their diaphaneity), colors (in relation to their brilliance and homogeneity) and techniques (in relation to the depth of the intaglio and the usage of some distinctive fast-rotating tools).

(e) Iconography (when detectable). Specifically, different paleographic variants of Hieroglyphic seals point clearly not only to the material of seal, but also to the quality of the engraving, as well as the personal skills of the artisan. What is more, some iconographical motifs would have clearly bound the owners of inscribed seals together. Indeed, on the one hand, some motifs on 'uninscribed' seals, which are identical to Hieroglyphic signs, can be analyzed as logograms (see also Ferrara 2018: §41-43). On the other, some motifs systematically employed on inscribed seals showing similar formal features could have been used for signaling the presence of groups adopting writing on their seals.

The observations provided by shapes (a), materials (b) and iconography (e) were crossed through a statistical model, i.e., the Correspondence Analysis. Specifically, I compared the distribution of both formal (i.e., shapes and materials) and iconographical features on uninscribed hard-stone seals with that observable on inscribed ones. Such an investigation proved that iconography, writing and material features were closely intertwined.

Indeed, motifs which are more frequently encountered on Hieroglyphic seals or even confined to them, as well as motifs possibly behaving as logograms, are mainly at home on seals in jasper and, to a minor degree, carnelian. On the opposite side, uninscribed seals in rock crystal tend to feature a geometric iconography commonly at home on soft-stone seals. A comparable pattern emerges when comparing seal shapes. *Petschafte* and, to a lesser degree, prisms, are intimately connected with the iconography associated to Hieroglyphic seals. On the other hand, those shapes never attesting inscribed pieces and directly continuing Prepalatial forerunners (e.g., spherical and zoomorphic seals) are normally characterized by an iconography at home within the 'Mallia Steatite Group' or by simple geometric motifs.

Conversely, the following chapter provides an insight into the remaining features, i.e., color (c) and readability/legibility (d), by means of a statistical model reputed adequate for such a purpose, namely the Social Network Analysis. This analysis will be further used to shed light on the other typology of objects linked to writing on glyptic, i.e., the seal impressions.

Chapter 4 – The network of the Hieroglyphic documents: understanding the interaction among formal, epigraphic, and paleographical features

4.1 Introduction

This chapter aims at showing the results of Social Network Analyses (henceforth SNA), tracing patterns of interaction and reciprocal influence among formal, epigraphic, and palaeographical features as defined in §1.4 and §3.2-3.6. I carried out two SNAs in order to investigate two different types of Hieroglyphic documents, respectively the seal impressions and the prisms.

I chose seal impressions in order to determine the pattern of cross-reference between their formal and iconographical features discussed in §3.2, as well as to reassess differences in the usage of Hieroglyphic seals in different administrative contexts.

I chose prisms to determine the intertwining between the formal features discussed in §1.4 and §3.3-3.6 and the Hieroglyphic sequences on 'physical seals'. I limited the investigation to prisms (both three- and four-sided ones) as, on the one hand, they constitute a well-attested typology of inscribed objects and are all commonly dated to the MM II period. On the other, given that a large part of the networks was conceived by matching Hieroglyphic sequences, the inclusion of seals with one or two faces would have inevitably implied the presence of objects with very few matching sequences. Consequently, this would yield their excessive dispersion on the SNA model and would have forced the clustering of prisms. As a result, patterns involving prisms would have been hidden, to the advantage of a predictable distinction based on the number of faces.

Over the past decade, SNA found a wide application in archaeological studies, including those focusing on material culture and the dynamics behind its production and consumption. As regards material culture, SNA is mainly carried out in order to a) *explore* datasets by means of a graphic model and statistical measurements; b) *validate* the indication a dataset provides to the analysis carried out through traditional observations (Knappett 2012: 8-9). Indeed, SNA integrates

data from multiple sources and is able to compare a great number of features from a single object (i.e., a 'node'), such as its context, iconography and so on.

This property allows us to reconstruct the possible interaction among different seal owners and the role they played within each administration. An SNA involving Minoan seal impressions has already been carried out by Weingarten (2010). The researcher points out that the information provided by both iconographic motifs and sealing criteria are crucial in order to discern the administrative practices behind them. From a theoretical perspective, Weingarten (2010) highlights that SNA prototypically "include all of the actors that occur within some set boundary". It follows that such an approach is particularly suitable for archaeological finds, which do not inevitably provide a useful set of data to extract a homogeneous sample.

4.2 The network of Hieroglyphic impressions

This SNA aims at understanding the relations among the Hieroglyphic impressions and evaluating the distribution of both their formal and contextual features in comparison to the Hieroglyphic sequences. Such features are commonly thought to provide relevant information about the administrative and social structure behind them, as well as on the degree of literacy required for the management of seals, sealings and impressions.

The work I carried out focuses on the intertwining among different features of Hieroglyphic impressions. Each impression recognized by *CHIC* as bearing a Hieroglyphic sequence constitutes a node of the SNA. If impressions coming from Protopalatial contexts were found on more than one object, then each occurrence constitutes a node (e.g., 172a, b etc.) The edges among the nodes represent the number of features shared by the impressions and are therefore weighted.

Parameters contributing to the edges' weight combine the formal and the iconographical features of both the sealings and the impressions. Such parameters are:

a) The type of material. Through a close scrutiny of a seal impression, techniques and their different traces on the surfaces can be detected. Even though the actual material is impossible to affirm, a distinction among hard and soft stones and metal can still be appreciated. As is well known, such a distinction was crucial in social terms. Soft- and hard-stone seals would have distinguished the role of the owners at a different level and would have involved a different chain of production.

b) The number of the faces of the matrix. The typology of the seal was deduced for typological reasons by *CHIC*. Multi-faced seals, since they were able to host a higher number of sequences, are commonly reputed to be more valuable with respect to the ones with a smaller number of faces made out of the same stone.

c) The length of the face. Dimensions must have been one of the most visible properties of a seal and an effective way in which their owners negotiated their identity (Hruby 2012). As already observed, the 'length' of a seal's face, i.e., the measure of its long edge, tends to vary according to the quality of the object and its linkage to writing.[24] When the face is round, its length corresponds to the diameter. In order to avoid hardly perceptible distinctions by Minoan engravers, differences of 0.5 cm or less were not considered. For example, two faces with a length respectively of 1.60 cm and 1.65 cm are considered as matching.

d) The Hieroglyphic sequence. As frequently highlighted (e.g., Poursat 2000 and Civitillo 2016), sequences must have referred to different levels within the administration and must therefore point to the different roles played by the seals' owners.

e) The type of document on which the impression was stamped. Documents are ordered according to the taxonomy created by the related publications of the *CMS* and reflected in the website's metadata. Hieroglyphic impressions are found on crescent-shaped nodules (*Hörnchenplomben*), noduli (*Noduli*), string-nodules (*Schnurplomben*), packet-nodules (*Päckchenplomben*), vase handles (*Gefäß, Henkel*) and weights (*Gewichte*). As sealings typologies are often confined to a few locations and/or periods, they witness the changes in interaction between writing and different administrative systems.

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[24] Conversely, the measure of the short edge of a seal's face underwent only minor and apparently irregular variations. Hence, this measure was excluded from the analysis.

f) The presence of a Hieroglyphic inscription on the document. This is the sole parameter with a binary behavior, i.e., the only possible values are H = inscribed and A = anepigraphic. Of course, inscribed sealings would have concealed a different administrative procedure *vis-à-vis* the uninscribed ones.

g) The number and type of sequences inscribed on the document. In this parameter, three potential matches co-occur. Given their rarity, they occupy only one column in the table. First, the number of possible 'sequences'. According to *CHIC*, a 'sequence' can be defined as a row of more than one sign. Second, the number of possible 'logograms'. Third, the match between sequence incised on the sealing and the ones legible on the impression.

h) The type of impressions on the same document. Just as the formal features of the hosting sealing, the sealing pattern testify to both a different interaction among written and unwritten seals and a different role inscribed seals played within different administrative systems.

i) The eventual co-attestation of two Hieroglyphic impressions. This parameter adds an extra-weight to the relation between two impressions co-attested on the same sealing.

j) The provenance of the impression.

Thus, the weight of the edges was determined as follows. Each impression was placed as row-input in a table whose column-input contains all the aforementioned features. If a feature between two nodes (i.e., impression) matches, then the related edge's weight was increased by 1. For example, if two impressions both come from seals in hard stone and were found at Knossos and no other features are shared, then the resulting edge will have a weight of 2.

Since no direct influence of one seal on another can be stated *a priori*, all the edges are undirected, i.e., the connections between the nodes do not presuppose a directed exchange of features.

The SNA model is spatialized through the layout ForceAtlas2. Such layout was implemented in order to emphasize the differences among the different communities of nodes.

4.3 General features of the SNA model for seal impressions: compactness and geographic pattern

The model resulting from the SNA is illustrated in Fig. 4.1. From a statistical viewpoint , it is extremely compact, as is evident from the values of density (0.948), clustering coefficient (0.967) and average path length (1.052). Such values mean that all nodes tend to share at least one feature with each other. Indeed, the average weight of the edges is 1.015 (average degree = 56.852).
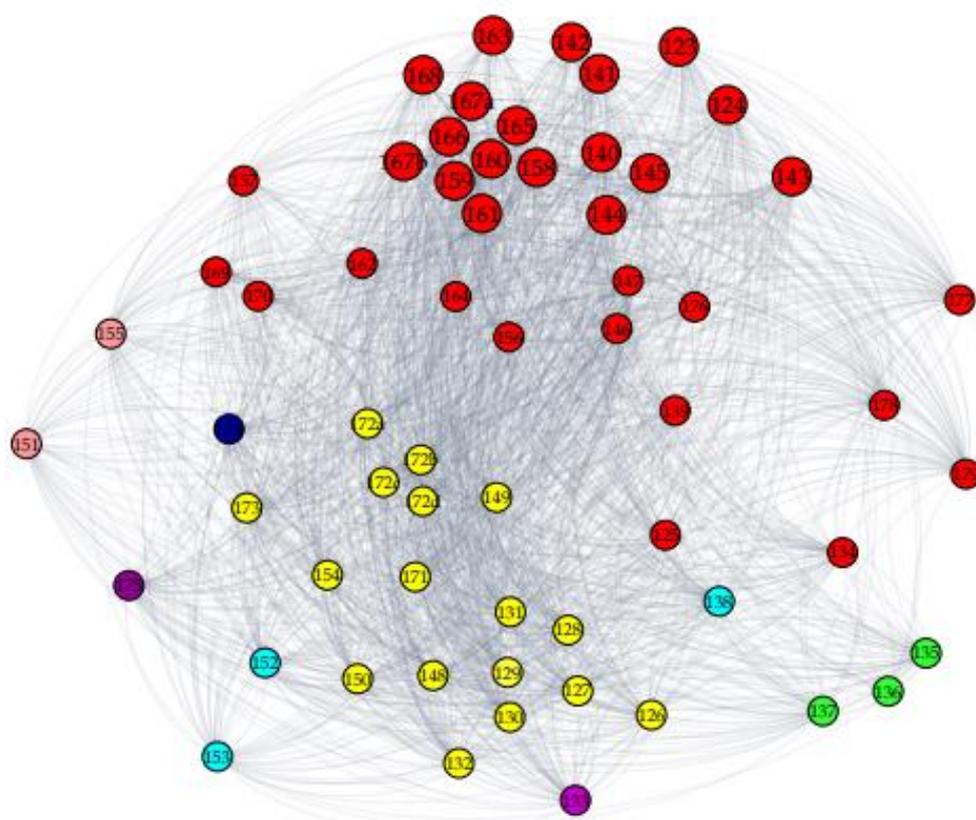
Fig. 4.1 – SNA model of the Hieroglyphic impressions. Labels refer to numbers in *CHIC*

The first reason for the compactness of the SNA model lies in the fact that almost all the impressions (82%) share the feature of coming from a seal in hard stone. It is worth noting that fewer than 50% of the attested sealstones are made in hard stone, although each of them tends to have a higher number of inscribed faces compared to the ones in soft stone. It follows that 65% of the attested inscribed surfaces come from seals in hard stone. This value is still substantially lower when compared to the number of impressions from seals in hard stone. As a result, inscribed seals in hard stones were clearly preferred for making impressions and

their owners could therefore have been more active within the administrative system. Unsurprisingly, the 'monotony' of materials results in a low variation in sizes of the artefacts. 64% of the impressions span in a range between 1.3 and 1.6 cm of face length.

The second reason is that only four seal typologies were considered according to the possible number of faces. However, it should be stressed that such a situation is not so different from what is possible to observe for the preserved inscribed seals.

Finally, the provenance of the impressions is not particularly varied. 34 out of 56 come from Knossos, while 17 were found in Mallia. It follows that respectively 61% and 30.5% of the nodes were tied together by virtue of coming from one these locations.

Macroscopically, the position of nodes tends to reflect the geographic distribution of the impressions. The top and right part of the SNA model is taken up by the impressions coming from Knossos (in red). Among them, impressions coming from the 'Hieroglyphic Deposit' form a very compact group in the top-center of the graph. All the other locations are grouped in the center-right and bottom section. Impressions from Mallia (in yellow) have a central and bottom position. On the center-left, two impressions from the Mesara (Phaistos and Hagia Triada, in pink) and the only one from Palaikastro (in blue). Conversely, impressions from Myrtos Pyrgos (in purple) and Zakros (in sky blue) are rather scattered in the bottom part of the model.

To a degree, this distribution is due to the fact that the provenance of the impressions was considered among the parameters of the network analysis. However, such a clear-cut outcome points to the presence of other features confined to the items from Knossos. Similarly, the central group of impressions from Mallia suggests that the administrative system performed in the Quartier Mu bears some peculiar features that are rare or absent in the other sites.

As pointed out by Weingarten (1995: 302-303, 309), this SNA argues that the administrative system attested within the Knossos 'Hieroglyphic Deposit' reflects a more structured intertwining among inscribed documents, i.e., a more

complex system of cross-references between inscribed seals and inscribed clay documents, with respect to the other locations. Such an administrative system would have required a higher number of fully literate actors in order to use the Hieroglyphic sequences the right way. Such pattern is reflected in the distribution of the nodes in the graph. Impressions akin to the sealings bearing writing incised on them tend to be positioned in the upper part, namely close to the impressions from the Hieroglyphic Deposit. Features singling impressions from Knossos out of the others therefore constitute evidence for such a different system.

The next sections discuss the reasons behind the distribution observed in the model, by examining the particular features of each location. The special role played by Knossos (§4.4) is mainly due to three factors, namely the interaction between writing on clay and writing on seals (§4.4.1), the sealing system (§4.4.2) and the usage of formulas (§4.4.3). After discussing these features, I turn to analyzing the situation at Mallia (§4.5), Myrtos Pyrgos (§4.6), in relation to a specific group attesting the 'Archanes formula' (§4.7), Kato Zakros (§4.8), Messara (§4.9) and Palaikastro (§4.10). Finally, I discuss seal impressions which are not clearly clustered with one or the other group (§4.11).

4.4 Seal impressions at Knossos

The sealing typologies attested within the 'Hieroglyphic Deposit' and their usage are patently divergent with respect to the other locations. Knossos is the only location in which inscribed sealings were impressed by inscribed seals. Indeed, only one type of sealing attests such a phenomenon: the crescent-shaped nodules. The usage of inscribed crescents itself (out of three cases from Petras) is confined to the Hieroglyphic Deposit. This archive also provides the vast majority of crescents impressed by a Hieroglyphic seal. As a result, the active interaction between writing on seals and writing on clay only existed on a single support (the crescent) within a single archive (the Hieroglyphic Deposit).

The special link between crescents, writing and the 'Hieroglyphic Deposit' is noteworthy (see Table 4.1). Out of 36 crescents unearthed so far, 72% were found at Knossos within the Hieroglyphic Deposit, the remaining ones being divided

between the Mallia Quartier Mu (19%) and the Petras Hieroglyphic archive (9%). Even clearer is the link between crescents and writing, pointing to a support almost exclusively used for writing. Indeed, crescents were only found in the three locations attesting a Hieroglyphic administration. 78% of them bear incised Hieroglyphic signs and 64% show at least one sure Hieroglyphic impression.

Typology of sealings	Hieroglyphic Deposit and related strays (MM II-III)	Quartier Mu (MM IIB)	Other Protopalatial spots	Late Minoan Knossos	Other Neopalatial spots
Inscribed crescents	#123 on #027 #124 + #167a on #013 #140 + #158 on #018 #141 on #023 #142 on #024 #143 on #025 #144 on #028 #145 on #020 #159 + #160 on #005 #161 on #007 #163 on #022 #165 + #166 on #011 #167b on #015 #168 on #026				
Uninscribed crescents	#146 + #147 #162 #164a + 176	#149 #172 (4x)			
Noduli	#139 + 156 (Mag. 4)	#126 #127 #128 #129 #130 #131 #148 #171		#177 (ETR)	#137 (SA)
Direct-objects		#173	#151 (PH) #178 (KN – SE Pillar Room)	#169 + #170 (?)	#138 (ZA)
Packet-nodules	#157 #164b				#152 (ZA) #153 (ZA) #154 (MA – Depôt Hiéroglyphique)
String nodules				#125 (Little Palace)	#155 (HT)
Vase's handles		#132 #150	#133 (PY) #175 (PY)		
Weights			#174 (PK)		

Table 4.1 – Distribution of Hieroglyphic impressions in relation to their provenance and their sealing typology

While seals employed on inscribed crescents were not impressed elsewhere, one can find the same impression on an uninscribed crescent (#164a) and a packet-nodule (#164b, see Fig. 4.2). Packet-nodules bearing Hieroglyphic impressions are rather rare and mostly come from Neopalatial spots. However, their presence within the 'Hieroglyphic Deposit' is unsurprising, as they represent the second most attested typology of sealing in the archive (19 occurrences in total). Such a phenomenon might testify to the fact that uninscribed crescents would have

interacted with other sealing typologies more than the inscribed ones. Notably, uninscribed crescents were adapted to local sealing practices in the Quartier Mu too.

Fig. 4.2 – (From left to right) Drawing of #164 photograph of #165b on a packet-nodule

On the other hand, the absence of some documents from the 'Hieroglyphic Deposit' tends to set its impressions apart from the ones coming from other locations. For instance, noduli and direct-object sealings, both well-known elsewhere, are almost entirely absent from Knossos. The only nodulus found from Knossos bearing Hieroglyphic impressions (#139 and #156) is a stray from the Magazine 4 and in any case attests both a shape and a sealing pattern confined to Knossos (see Weingarten 1995: 310).

4.4.1 The sealing system at Knossos

Hieroglyphic impressions from the 'Hieroglyphic Deposit' show a highly coherent sealing pattern depending on the spots they were found at. The 'Hieroglyphic Deposit' is the only place in which two inscribed seals (or surfaces) were stamped on the same document. The fact that crescents would have constituted a rather closed administrative system could be confirmed by the fact that impressions on them are never to be found on other documents and/or combined in different ways (Weingarten 1995: 307). As summarized in Table 4.2, crescents are normally stamped by two surfaces, possibly corresponding to one or two seal owners.

	None	H	1I	2I	1S
Crescents	35%	**50%**	14%	0%	11%
Noduli	**67%**	17%	8%	0%	8%
Direct-objects	**43%**	28.5%	0%	28.5%	0%
Packet-nodules	**80%**	0%	0%	0%	0%
Vase handles	**100%**	0%	0%	0%	0%

Table 4.2 - Co-stamped partner(s) for each Hieroglyphic impression within the most represented typologies of sealings

Pace Weingarten (1995: 310), multiple impressions of the same surface on crescents (14%) cannot be due to the need for supplying an absent 'partner'. Counterevidence is clearly provided by the fact that (i) Hieroglyphic impressions can occur alone and (ii) sometimes, a Hieroglyphic seal was stamped twice even in presence of a (non-)Hieroglyphic partner.

Conversely, all the other typologies are commonly at home with only one impression. The relatively high percentage of Hieroglyphic partners on direct-object sealings (28.5%) actually refer to a single object bearing #169 and #170 (see Fig. 4.3). However, such object has a *terminus post quem* at the LM I period, where Cretan Hieroglyphic was not in use anymore, and Hieroglyphic impressions would not have had the same function as the ones coming from MM II contexts.

Fig. 4.3 – The impressions #169 and #170 and direct-object sealing on which they were stamped

Given that the distribution of documents clearly differs in relation to the context in which they were found, it follows that such a discrepancy would have reinforced the split of the nodes according to the geographical distribution of the related impressions. What is more, by looking at the two principal spots attesting impressions from Protopalatial contexts (see Table 4.3), it is clear that sealing patterns themselves are largely a matter of conventions at different places, i.e., documents tend to be sealed according to local practices and the usage of a single typology can differ much more than sealing criteria within the same spot.

	None	Hieroglyphic	1 identical	1 non-Hieroglyphic	2 non-Hieroglyphic	4 non-Hieroglyphic
Knossos (HD)	13.5%	**62%**	13.5%	8%	0%	4%
Mallia (QM)	**82%**	0%	6%	6%	6%	0%

Table 4.3 - Co-stamped partner(s) for each Hieroglyphic impression within the two most represented

Protopalatial spots

Notably, co-stamping which involves Hieroglyphic seals seems to follow a structured trend too. In the vast majority of the occurrences, a four-sided prism was stamped together with one having a rounded or oval face (coming from either a *Petschaft* or a three-sided prism) or another four-sided prism. Combinations of two oval/rounded surfaces pointing to three-sided prisms and/or *Petschafte* are however extremely rare (see Table 4.4).

Pattern 1	Four-sided prism	Four-sided prism	43%	(#159-160); (#161-II.8 085); (#162-II.8 040); (#165-166); (#168-II.8 058); (#169-170)
Pattern 2	Four-sided prism	Three-sided prims/Petschaft	43%	(#124-167); (#139-156); (#140-158); (#162-II.8 040); (#164-176); (#172-II.6 195)
Pattern 3	Three-sided prism/Petschaft	Three-sided prism/Petschaft	14%	(#123-II.8 037); (#146-147)

Table 4.4 – Sealing pattern involving Protopalatial Hieroglyphic impressions

The sealing pattern of #123 (see Fig. 4.4) is unique among the inscribed documents and therefore occupies a peripheral position. It is stamped twice. Such a practice is rather rare, although it registers the maximum frequency for Hieroglyphic impressions both on crescents (14%) and within the 'Hieroglyphic Deposit' (13.5%). On the same document, notably, another seal with a rounded surface (II.8 037) was stamped twice. This pattern would correspond to *Pattern 3* of Table 4.4, which is the rarest one (14%). Such impression was reputed uninscribed by *CHIC* but could likely bear a logogram comparable to CH 017. The resulting pattern of two Hieroglyphic impressions (#123 and II.8 037) both from rounded surfaces and stamped twice is never attested elsewhere. The impressions #146-#147 (see Fig. 4.4) are the only ones apart from #123-II.8 037 to attest the *Pattern 3*. Revealingly, #146 bears only a single sign analyzed as CH 011 and as such would be comparable to II.8 037. All these rare features could therefore have been linked to the exigence of combining a sequence (on a three-sided prism) with an impression bearing a logogram.
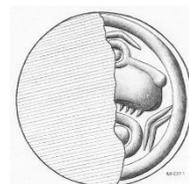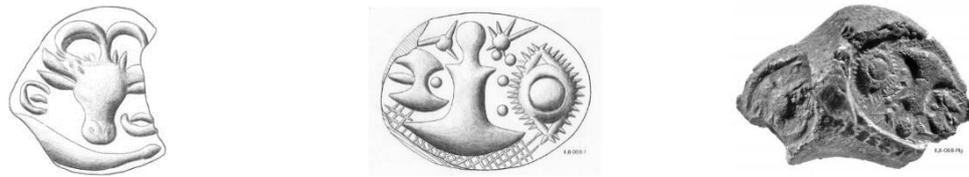
Fig. 4.4 – (From left to right) (Top) The impressions #123 and II.8 037. (Bottom) The impressions #146, #146 and the sealing AM 1938.940

On the other hand, co-stamping of a Hieroglyphic impression together with a non-Hieroglyphic one would have been extremely rare. All these cases can be explained as coming from later documents. Most of them constitute the top-left margin of the graph. Both the instances from crescents (#162 and #168) come from a group of sealings within the 'Hieroglyphic Deposit' whose stylistic and typological features would point to a slightly later period (MM II-III) *vis-à-vis* the Hieroglyphic seals (see Weingarten 1992).

4.4.2 Hieroglyphic sequences and the use of formulas at Knossos

A more complex usage of Cretan Hieroglyphic at Knossos can also be inferred from the attestations of formulas on both impressions and clay documents. Specifically, Knossos is the only location in which sequences attested on seals are regularly found on clay documents. Moreover, impressions from Knossos show a robust usage of formulas, while in the other locations *hapaxes* predominate.

75% of the formulas appear on documents from Knossos. Three times (#138, #169, #170), formulas appear in Late Minoan contexts. As the usage of Cretan Hieroglyphic did not survive after the MM III, their actual value must not have been meaningful anymore, and they would have merely functioned as iconographic devices. By confining the analysis to formulas coming from Middle Minoan contexts, still 77% of them were found at Knossos.

On Middle Minoan documents, the formula CH 044-005 is confined to Knossos apart from a weight discovered at Palaikastro (#174, see Fig. 4.14). Moreover, at Knossos it is only impressed on inscribed crescents. In one case, it is

even attested both impressed twice and inscribed on a sealing (#140-#158 on #018, see Fig. 4.5). CH 038-010-031 is confined to Knossos too. Its only attestation from a Protopalatial context (i.e., #168) is on the uninscribed crescent co-stamped together with an MM II-III seal (II.8 040). The usage of the formula CH 044-049 is slightly less attested. It was impressed twice on two inscribed crescents and once on a packet-nodule from the Hieroglyphic Deposit. The only attestation out of Knossos occurs on a vase handle discovered within the Quartier Mu (#150, see Fig. 4.10). As frequently recognized (e.g., Poursat 2000: 188), the formulas CH 044-049 and 038-010-031 would have had a different behavior with respect to CH 044-005, since the former are able to occur on seals without any further Hieroglyphic sequences. By contrast, CH 044-049 only occurs if at least two faces of the seal are inscribed. Such a distribution was interpreted as a clue to the fact that CH 044-005 would have referred to a higher hierarchical level than the ones represented by the other two (Poursat 2000: 189). If this was the case, then the observed distribution of the three formulas would confirm the special linkage both between high-rank officials and inscribed documents and between high-rank officials using writing and the administrative system of the Hieroglyphic Deposit.

Fig. 4.5 – (From left to right) The crescent #018 (photograph and drawing) and the impressions #140 and #158

Almost all the cases in which a clay document bears a sequence attested on seals come from Knossos. Both CH 044-049 and 044-005 are to be found only on clay documents from Knossos (see Fig. 4.6).[25] As already noted, the only nodule co-attesting two Hieroglyphic impressions (i.e., #139 and #156) comes from the Magazine 4. Both these sequences find a correspondence on two inscribed

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[25] At Mallia, a sequence CH 044-049-023 is attested on the lame #089a. This sequence could also be understood as being formed by the formula CH 044-049 and the logogram *159bis, already attested on #029b. However, as we lack any further evidence for such an interpretation, this can neither be proved nor disproved.

crescents, respectively #003 and #018. This fact would convincingly point to the involvement of such an object in the administration carried out within the Hieroglyphic Deposit. Notably, clay documents from Knossos also attest sequences found impressed within the Quartier Mu. This is the case of the sequence CH 031-021-061, found on both the impression #149 and the half-ovoid #197 from the Quartier Mu and incised on the bar #059c.

Fig. 4.6 – Sequences (apart from ‚formulas') attested on both clay and seals. (From left to right) (Top) The sequence CH 009-077-013-020 on the crescent #003b and the impression #139; (Center) The sequence CH 009-056-061 at the and the impression #156; (Bottom) The sequence CH 031-021-061, on the bar #059c, the impression #149 and the half-ovoid #197

4.5 Seal impressions at Mallia

Impressions from Mallia are grouped in the central-bottom part of the SNA model and go back to a clearly distinct administrative system with respect to the one attested at Knossos. All documents except #154 (found within the Depôt Hiéroglyphique) come from the Quartier Mu and are therefore safely datable respectively to the MM IIB and the MM III period. Their closeness on the SNA model is mainly due to the fact that they all are uninscribed, and their typologies are fairly homogeneous. As their sequences are almost always *hapaxes*, no connection is possible on this basis.

All impressions from the Quartier Mu except #132 (see Fig. 4.7) and #173 were found on two sealing typologies, either noduli or crescents. Noduli from the Quartier Mu must have been particularly tied to writing, as 56% of them bear a

Hieroglyphic impression. Nodes going back to impressions on noduli (#126-131, 148, 171) are grouped together in the center-bottom part of the graph. Five out of seven (#126-131) constitute a very close group of impressions in the bottom section of the cluster. All come from round surfaces, i.e., likely from *Petschafte*. Apart from #132, they would go back to extremely similar objects, as their face length is rather close to each other and smaller than the average of the impressions from hard stone seals. Revealingly, #132 was found within the Room IV.13, occupying an area in *Bâtiment* B in which no other sealing was found and could therefore refer to a different administrative procedure. Conversely, all the others come from rooms in which other noduli were found.

Fig. 4.7 – The impression #132 (drawing and photograph)

Noduli from Mallia are also grouped together due to their repetitive sealing pattern, namely the Hieroglyphic impression is commonly found alone on the document. Such a feature is shared by both inscribed and uninscribed noduli from the Quartier Mu. #126 is the most unconventional impression among the ones found on noduli (see Fig. 4.8). This is because it is on the only nodulus from the Quartier Mu stamped twice and is the only Hieroglyphic impression coming from a metal object. Given the different material, the odd multiple stamping could be the correction of a mistake (as *per* Poursat 1980: 193) or merely absolve the requirement for a different sealing pattern. It is worth noting that also at Knossos the sealing patterns involving noduli are rather variable. Of the two nodules bearing a Hieroglyphic impression from Knossos, the one from the Magazine 4 follows a sealing pattern typical of the inscribed crescents (i.e., it bears two different Hieroglyphic impressions), while the one coming from the ETR co-attests a Hieroglyphic and a non-Hieroglyphic impression.

Fig. 4.8 – The impression #123 (drawing and photograph)

Out of six crescents found within the Quartier Mu, five bear a Hieroglyphic impression, although four of them were stamped by the same matrix (#172). Differently from the impressions on noduli, only a three-sided and a four-sided prism were found impressed. The typology of both the seals and the sealings would place these impressions closer to the ones from Knossos. Nevertheless, *pace* Poursat (1980: 196-197), there is no evidence to state that crescents would have been conceived for multiple sealing. All but #172a (see Fig. 4.9) bear only one impression and seem therefore to follow the same sealing pattern as the noduli. The impression #172a, co-stamped together with a non-Hieroglyphic one (II.6 195, see Fig. 9), attests a sealing pattern never attested on the crescents nor at MM II-III Mallia at all.

Fig. 4.9 – The impressions #172 and II.6 195

A differentiation of the administrative practices is suggested by the specialization of the rooms too. All the four crescents bearing the #174, representing 80% of the crescents stamped by a Hieroglyphic seal from the Quartier Mu, come from Room III.16. In this room, noduli are absent. Apart from the crescents, the only document surely found within Room III.16 is a direct-object sealing bearing a Hieroglyphic impression (#173). On the other hand, noduli with Hieroglyphic impressions are more scattered among both Bâtiment A (Rooms IIIb and III.17) and Bâtiment B (Room V.5).

4.6 Mallia and Myrtos Pyrgos: Hieroglyphic impressions on vase handles

At the bottom margin of the Mallia cluster, two impressions, i.e., #132 and #150 (see Fig. 4.10), attest the usage of Hieroglyphic seals on vase handles. Since they are always stamped alone, they are the closest nodes to the ones going back to the noduli from Quartier Mu. The two impressions coming from Myrtos Pyrgos are

from handles of the same type too. Differently from the great majority of the other locations, impressions from Myrtos Pyrgos are not close in the graph. Another finding from Myrtos Pyrgos (II.6 230) was recently analyzed as being inscribed and comes from a vase handle too (Ferrara *et al.* 2016: 83). Impressions on vase handles are rare within the Quartier Mu and commonly involve seals either bearing geometric motifs or possible heirlooms. Given the absence of other indication, it is therefore difficult to prove that full literacy was needed in order to use such objects.

Only one out of five Hieroglyphic impressions on vase handles might come from a four-sided prism. Out of nine impressions found on vase handles at Myrtos Pyrgos, this is the only one from a rectangular surface. Seven of them, including the Hieroglyphic #133, come from rounded surfaces, likely belonging to seals having one face. On the other hand, two Hieroglyphic impressions from Myrtos Pyrgos, i.e., II.6 230 and #175, are respectively from a half-ovoidal and a rectangular surface. The former could point to a series of shapes either with one, two or three-faces, while the latter likely goes back to a four-sided prism. Revealingly, the latter two are the only ones stamped on the base of the handle. By contrast, impressions from rounded surfaces are always stamped over the junction between the handle and the rim. This pattern is followed by the impression #132 from the Quartier Mu too.

Fig. 4.10 - Two impressions on the handle's base from a three-sided prism (#150) and a four-sided prism (#175). Two impressions on the juncture between handle and rim from a rounded surfaced (II.6 227 and II.6 225).

Such distribution could not be coincidental. A different behavior of three- and four-sided inscribed seals *vis-à-vis* those with one face has already been observed for noduli and crescents from the Quartier Mu. Notably, three- and four-sided prisms were clearly closer to the inscribed sealings (see Table 4.5) and tend to host writing more often (see §3.10.3). As summarized in Table 1, this fact is also reflected in the attestations of each seal typology at each spot.

No. of faces	Crescents	Noduli	Direct-objects	Handles	Inscribed sealing	Co-stamped impression
1	20%	**60%**	0%	20%	20%	20%
3	**71%**	14%	7%	7%	43%	36%
4	**67%**	21%	4%	4%	42%	38%

Table 4.5 – Reconstructed number of faces Hieroglyphic impressions' matrixes according to the sealing they are stamped on

4.7 Seal impressions of the 'Archanes formula cluster'

The right and bottom-right part of the SNA model is taken up by impressions bearing sequences linkable to the 'Archanes formula'. Indeed, regardless of the sequence, such documents provide other shared features and would have constituted a highly recognizable group of objects (see Fig. 4.11). Three of them were excavated in a Neopalatial context in Samothrace. All these cushions were made out of soft stone and bone. As they constitute 63% of the impressions from seals not in hard stone, this fact would point to the presence of a separate tradition tied to both the Archanes formula and the cushion seals and involved in different administrative lines. Indeed, such cushions are extremely close in size (length spans between 1.45 and 1.23 cm), often producing matches in the SNA and therefore suggesting a coherent production.
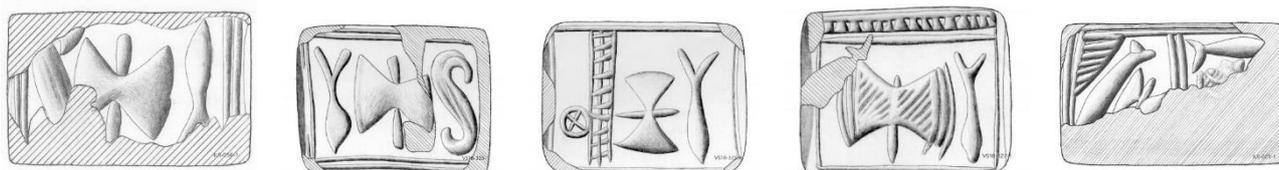
Fig. 4.11 – The impression #134-137 and #179

Notably, one of the two earliest Hieroglyphic impressions, i.e., #134, coming from an MM IB context in the Knossos SE Pillar Room, is included in this cluster. It follows that, although cushions are commonly dated to MM II-III, i.e., slightly later than the bulk of Hieroglyphic seals, this cluster could refer to objects produced around the very beginning of the Protopalatial period. Such hypothesis could find further evidence in the impression #179, possibly coming from a cushion in bone, as the usage of such material was particularly in vogue between the Pre- and the Protopalatial period but extremely rare during the MM II period (Krzyszkowska 2005: 81).

4.8 Seal impressions at Kato Zakros

All of the three impressions from Zakros come from Maison A, dating to the LM IB period. Two of them, i.e., #152 and #153 (see Fig. 4.12), found on two packet-nodules, are in the bottom-left part of the graph. Even though the latter is only fragmentarily preserved, it is clear that they come from two seals akin in both formal features. They are both impressions from three-sided hard stone prisms, whose surface length is extremely close (1.2 and 1.3 cm). The preserved part of #153 attest CH 054, which also features the sequence CH 054-044 on #152. However, the remaining *vestigia* cannot be safely interpreted and there is no decisive evidence even for identifying this impression as a Hieroglyphic one (see *CHIC* 201). Their position close to the left margin of the 'Mallia cluster' is justified by their ties with #154. The latter is indeed the only Hieroglyphic impression found on a packet-nodule at Mallia and remarkably comes from the latest context. As shown, it is therefore possible that their usage spread from Knossos to the other sites.

Conversely, #138 (see Fig. 4.12) was impressed from a cushion-seal and occupies a center-right position in the model, not far from the 'Archanes formula cluster'. Nevertheless, it is a clearly different object from the cushions part of the latter cluster, as (a) it is the only attested Hieroglyphic impression from a cushion in hard stone; (b) its face length is noticeably bigger (1.7 cm) and (c) it does not bear (a part of) the 'Archanes formula', but the formula CH 044-005.

Unsurprisingly, it is decidedly unconventional with respect to this group and its closer node is indeed the other most isolated impression, i.e., #125 (see §4.11).

Fig. 4.12 – (From left to right) The impressions from Zakros, i.e., #138, #152 and #153

4.9 Seal impressions from the Messara

The two nodes in pink group together impressions coming from both different locations and periods from the Messara plain. The impression #151 (see Fig. 4.13) was found on a direct-object sealing within the MM IIB context of the Phaistos Vano XXV. It could represent the only trace of Hieroglyphic seals at Phaistos, even though its signs could even be read as AB 08-24/*a-ne*. The impression #155 (see Fig. 4.13) comes from an LM IB context within the Hagia Triada Casa del Lebete. Despite such differences, the proximity of #151 and #155 would indicate that they share similar relations with the other members of the graph. First, they both bear a sequence not attested elsewhere. Second, they are among the very few cases of Hieroglyphic impressions stamped more than twice on the same document. In particular, the fact that #155 was stamped four times presupposes a sealing system close to the one of Neopalatial roundels and is therefore never attested for Hieroglyphic impressions.

Fig. 4.13 - (From left to right) The impressions from the Mesara, i.e., #151 (drawing and photograph), and drawing of #155

4.10 Seal impressions from Palaikastro

The impression #174 from Palaikastro (see Fig. 4.14) is the only Hieroglyphic impression on a weight. Despite this odd characteristic, its position in the central part of the SNA model is due to the presence of features close to impressions from Knossos, namely (a) it comes from a hard stone four-sided prism; (b) its face length (1.5 cm) is normally to be found on impressions from Knossos and (c) it is the only Middle Minoan attestation of the formula CH 044-005 apart from the crescents from Knossos.

Fig. 4.14 - (From left to right) The impression from the Palaikastro, i.e., #174 (drawing and photograph of the weight hosting the impression)

4.11 Fuzzy boundaries among clusters: impressions showing a 'hybrid' behavior

Despite the existence of a clear-cut divergence between different administrative systems, there are still few objects attesting features close to more than one cluster. Specifically, these impressions show 'hybrid' features, namely they share a number of characteristics with a given cluster and others with a different one. In this respect, they therefore behave inconsistently with the rest of tradition. Accordingly, the presence of this kind of impressions is crucial in order to understand to what extent administrative systems were in contact to each other and how they were modified through time.

Among the statistical tools provided by the SNA, measures of 'centrality' are commonly employed to investigate the position of each node with respect to the different communities. In graph theory, 'centrality' basically measures the degree of interconnection among nodes. For our purpose, the metrics defined as 'shortest-paths betweenness centrality' (termed 'betweenness centrality' from now on) fits well into the definition of the boundaries among clusters and the presence of less

prototypical objects suggesting the interaction among different administrative systems.

Betweenness centrality is defined as the number of shortest paths between all the possible pairs of nodes passing through a given node. Thus, the higher it is, the more a node shares features with more than one group, i.e., when it has a hybrid behavior with respect to the parameters used for the SNA. Conversely, if a node shares all its features with few others and such features are unknown in other groups, then its betweenness centrality will result low.

In archaeology, betweenness centrality has been widely used to estimate the presence of finds attesting the interaction among different communities of a given network (e.g., Rivers, Knappett & Evans 2012). When dealing with material culture, it can point to the presence of influential objects either spreading one or more trends towards the others or acquiring features generally at home elsewhere.

Another metric normally employed by archaeologists for estimating the degree of connection of each node is the 'eigenvector centrality'. It is defined as a 'weighted centrality', namely while standard centrality "gives a simple count of the number of connections a vertex [i.e., a node] has, eigenvector centrality acknowledges that not all connections are equal". As a result, high values of eigenvector centrality features nodes connected with more influential ones (i.e., those having many connections). Notably, eigenvector centrality is almost invariably high for this SNA, as a predictable result of the compactness of the model. Table 4.6 provides values of these metrics for a sample of relevant impressions.

Impression	Betweenness centrality	Eigenvector centrality
#123	3.0	0.924
#124	2.873	0.874
#125	3.978	1
#126	3.978	1
#130	1.093	0.995
#131	1.093	0.995
#134	3.705	0.97
#138	3.978	1
#139	3.978	1
#141	3.525	0.971
#144	0.904	0.981
#145	1.093	0.995
#146	1.093	0.995
#151	0.218	0.818
#153	0.389	0.867

#155	1.093	0.995
#160	0.418	0.953
#163	3.150	0.957
#168	0.230	0.938
#171	1.093	0.995
#178	3.809	0.985

Table 4.6 – Betweenness and Eigenvector centrality of a relevant sample of impressions

Consequently, the key-metric to understanding the intersection between clusters is the 'betweenness centrality', which significantly vary among nodes. As shown, 'betweenness centrality' varies according to the hybridization of the features of a node. In other words, if a sealing shows all and only the features normally at home within a well-defined cluster (e.g., the sealings from Knossos 'Hieroglyphic Deposit') and attests few or no feature found elsewhere, then it should measure a low value of 'betweenness centrality'. On the SNA model, nodes with low betweenness centrality tend to be placed in the very center of the clusters they belong to.

On the other hand, if a sealing shows some features normally at home within a well-defined cluster, and others which are confined to another cluster, then it should register a high value of betweenness centrality. On the SNA model, nodes with high betweenness centrality tend to be placed either at the periphery of the clusters with which they share the majority of features or between two or more clusters. Accordingly, they represent the 'bridge' among different administrative systems and testify to the (imperfect) sharing of information and practices. The most relevant ones are:

a)   The two oldest impressions attest features shared by several traditions and are therefore 'hybrids' if compared to the other ones. Both go back to soft stone seals. It follows that they represent two connecting points between sealings from Knossos and all the other impressions from soft stone seals. The cushion #134 (see Fig. 4.11), bearing the Archanes formula, represents the main 'bridge' between the 'Archanes formula group' and the other clusters, especially the ones related to Knossos. It is attested on a string nodule. Such a sealing strongly points to a different system with respect to the other spots at Knossos and Mallia. Nevertheless, #134 is well linked to the other impressions through its widespread sealing criterium, namely it is in absolute isolation. Moreover, it attests the longest surface

(1.45 cm) among the cushions, which tend to match more frequently with three- and four-sided prisms' ones. The impression #178 (see Fig. 4.15) too connects multiple clusters through its features. It is attested on a direct-object sealing, which is rare but ubiquitous apart from the Hieroglyphic Deposit. Again, both sealing criterium (i.e., absolute isolation) and face length (1.7 cm) link this impression respectively to the uninscribed sealings found all over Crete and to the bigger sealstones attested on hard stone sealings, especially the ones from the Quartier Mu.
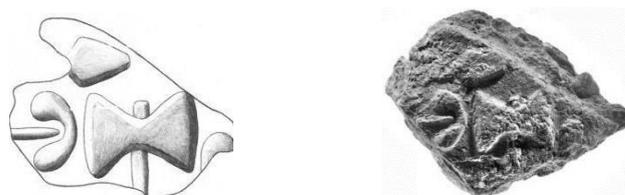
Fig. 4.15 - (From left to right) The impression #178 (drawing and photograph)

b)   Another noticeable hybrid behavior is to be detected for the impression #139. It was co-stamped together with #156, on a nodulus found within Magazine 4 at Knossos (see Fig. 4.6). Magazine 4 provided a medallion too and could contain strays from the 'Hieroglyphic Deposit' (Schoep 2001: 145). This impression represents a true bridge between finds from Knossos and Mallia. On the graph, it is indeed the closest one to the Mallia cluster. Co-stamping of two different Hieroglyphic impressions (#156) is a feature exclusive of the Knossos documents. On the other hand, 73% of the noduli bearing a Hieroglyphic impression were found within the Quartier Mu, while this is the only one from Protopalatial Knossos. Noduli from MM II Mallia commonly have a gable-shaped or pyramidal back. The one bearing #138 and #156, conversely, is a disc-shaped nodulus. This form, totally unknown at Mallia, knows very few possible occurrences from Protopalatial contexts at Knossos (Müller 2002: 75), while it constitutes the very majority of findings within the Eastern Temple Repository (ca. 56%, see Weingarten 1989: 43). Incidentally, one of such nodules attests a Hieroglyphic impression (#177). Revealingly, the only nodulus attested within the 'Hieroglyphic Deposit' (HMs 131) has a pyramid shaped back but does not bear a Hieroglyphic impression. The latter document could therefore witness the contact between practices typical of the Hieroglyphic administration at Knossos and the ones in vogue at Mallia at the same

time. By contrast, the sealing bearing #138 is directly linked to the innovations of Neopalatial administration at Knossos and makes use of a local sealing criterium.

c)   Impressions #141 and #142 (see Fig. 4.16) come from three-sided prisms stamped on inscribed crescents from Knossos. Such objects are slightly on the right of the four-sided prisms on inscribed crescents. Their stamping criterium, i.e., the Hieroglyphic seals are stamped twice in isolation, attests a rare practice shared by inscribed crescents, a nodulus from Mallia and a roundel from Samothrace. The latter feature occurs only once among the four-sided prisms, i.e., on #163, which indeed possess a very high value of betweenness centrality (3.15). Moreover, the logogram on their sealings connects them with two impressions coming from four-sided prisms.

Fig. 4.16 - (From left to right) The impressions #141 (drawing and photograph of the sealing) and #142

d)   The impression #143 (see Fig. 4.17) represents a 'bridge' between the cluster of inscribed crescents and the other administrative traditions. It goes back to a three-sided prism in soft stone. Notably, while both the two impressions from the MM IB South-East Pillar Room (#134 and #178) come from soft stone seals, no evidence for their usage within both the 'Hieroglyphic Deposit' and the Quartier Mu is available. This is therefore the only Hieroglyphic impression from a soft stone seal directly linked to a spot in which writing was actively used. Moreover, it is in isolation, a feature generally attested on uninscribed documents and mostly avoided within the Hieroglyphic Deposit.

Fig. 4.17 - (From left to right) The impressions #143 (drawing and photograph)

e)   The common avoidance of seals with one face on inscribed sealings is reflected in the high betweenness of #123 (see Fig. 4.4) and #124 (see Fig. 4.18). They are the most eccentric nodes with respect to the other impressions found on inscribed documents and are in axes with the other impressions coming from seals with one face. They indeed attest the rare involvement of their owner in procedures needing inscribed sealings.
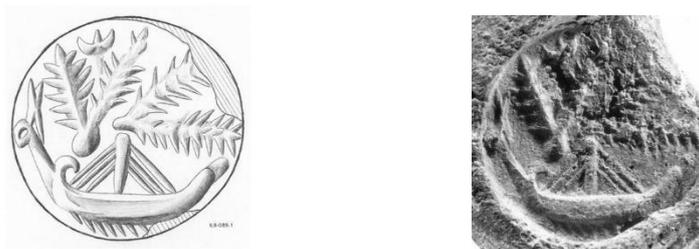
Fig. 4.18 - (From left to right) The impressions #124 (drawing and photograph)

By contrast, impressions measuring a moderate value of 'betweenness centrality' are to be found on uninscribed crescents and nodules from Mallia. Their value testifies to the fact that all these impressions constitute a rather uniform group, which still share a number of traits with all the others. Such a property is particularly manifest if they are compared to most of the inscribed crescents from Knossos, which conversely possess a very low value of 'betweenness centrality'. At Mallia, inscribed sealings are never attested and this feature connects their practices to both the uninscribed sealings from Knossos and to the ones from all the other spots. Similarly, both their stamping criteria and the typology of sealings (among which, vase handle's and direct-object sealings are never attested in Protopalatial Knossos) are commonly shared all over Crete and in use for a long span of time. By contrast, the features described in 3.3.3 for Knossos make this group hardly linkable to the other and its members measure the lowest values of betweenness.

To summarize, although this SNA highlighted the presence of well-defined clusters of Hieroglyphic impressions, mostly linked to the administrative systems carried out at different locations, some impressions escape a clear-cut inclusions in one or the other cluster. Thus, they could point to either the contact between

different administrations (see also §6.3 on this point) or sealing practices scarcely survived in the extant documentation. For instance, both #123 and #143 would attest the rare involvement of the certain owners sealing practices of the 'Hieroglyphic Deposit' from which they were normally excluded. Similarly, #141 and #142 attest a rare practice attested three times only, revealingly at Knossos, Mallia and Samothrace. The other three cases have either a peculiar dating (i.e., #134 and #178) or a peculiar findspot (i.e., #139) and once more point to the usage of Hieroglyphic seals in a different way with respect to what can be expected by looking at the two main deposits.

4.12 The network of Hieroglyphic prisms

This SNA aims at mapping the interrelation of both formal and epigraphic features of Hieroglyphic three- and four-sided prisms. Each prism is therefore understood in the network of the multi-layered meaning conveyed by seals, i.e., it is compared to the other prisms not only by means of the inscription it bears, but also as a luxury item meaningful in other respects too. Specifically, my purpose is to cross the distribution of formal and epigraphic features in order to search for correlations between *what* is inscribed on the Hieroglyphic prisms (i.e., sequences), *how* signs were engraved (i.e., palaeographic features) and formal characteristics commonly left out of the scholarly discussion.

With reference to the latter category, as already discussed (see §1.4 and 3.1), formal features (i.e., shape, material, sizes, colors, readability and legibility) co-operated with writing in conveying the meaning of inscribed objects and in defining the hierarchical position of seal owners. It follows that each seal would have been distinguished to both the other seals and the other prestige markers by means of several features either showed off or impressed on the clay. As a consequence, the study of the seals as a whole may help understand both their relation to each other and the role Hieroglyphic played with respect to the social context in which they were included.

This SNA is based on the same methodology as applied above (see §4.2). I considered as parameters (a) the material (steatite, jasper, agate etc.); (b) the color (see above); (c) the readability (according to pyramid of readability described in §3.5); (d) the face's length; (e) the number of inscribed faces; (f) the sequences.

Given the difficulty of their identification and the close correspondence in the carving techniques, I considered all the medium-hard stones as a single category.

Differently from the previous SNA, I did not include the shape of the seal (i.e., three- vs. four-sided prisms), the type of material (hard vs. medium-hard vs. soft stones) and the provenance of the seals. The former two were excluded as they mostly represent binary categories deeply influenced by the choice of the dataset. Thus, they would have hidden patterns generated by other features without adding relevant information. By contrast, I ruled out the provenance, since such an information is unknown for more than one-half of the dataset.

4.12.1 Identifying the color

Since each block of stone is composed by a (slightly) different mineral composition, each seal shows a peculiar color variant. Such variants can vary from minor nuances of the same tonality (see e.g., #211 and #237, almost the same dark olive-green steatites, see Fig. 4.19) up to more visible patches of a totally different color (e.g., #246, an olive-green steatite with dark intrusions, see Anastasiadou 2011: 627).

Fig. 4.19 – (from left to right) The three-sided prisms #211 and #237

Nevertheless, small nuance differences are often not neatly distinguishable to each other, especially at long distances and for untrained eyes. Indeed, most objects' color can be framed into small Pantone's squares. It follows that one or

more materials can yield pieces resembling each other as regards their color and light effects. One clear case is the s.c. 'pseudo-jasper', whose highly opaque white(/ish) tonality gives the impression of being in front of a semi-precious stone (Krzyszkowska 2019: 10). A jasper-like effect was also obtained by warming carnelian and agate up through high temperatures (Betts 1980: 17 and Müller 2007: 17). Accordingly, I divided colors into eight macro-categories, as illustrated in the Table 4.7.

Category	Color	Featured stones	Examples
a	Translucent dark-red, brown, and greenish	Steatite, agate, carnelian, jasper	Fig. 3.10b, 3.11c-f, 3.12a-b,g,l
b	Opaque to weakly translucent white, whitish and cream-colored	Steatite, carnelian, agate, chalcedony, pseudo-jasper	Fig. 3.10e, Fig. 3.13a-b,d-f
c	Translucent light red, yellow, and orange	Carnelian, agate, steatite	Fig. 3.10g, 3.11g-i, 3.12f, 3.13c,g-h
d	Blue	Chalcedony	Fig. 3.12h-i
e	Intense green	Jasper	Fig. 3.14a
f	Opaque to weakly translucent dark green	Jasper, steatite	Fig. 3.12n, 3.13i
g	Opaque to weakly translucent black, blackish and dark grey	Steatite, jasper	Fig. 3.12c-e,m
h	Colorless	Rock crystal	Fig. 3.10d

Table 4.7 – Color categories employed for the SNA

Unique pieces, such as banded or multi-colored ones, as well as gold, do not match any other and were not listed here. By contrast, two-toned seals in which one color is neatly predominant were listed within the latter's related category. For instance, although it is red and white banded, I included the seal #225 (see Fig. 4.20) within the group (c).

Indeed, bands are not equally distributed among faces. It follows that, from some perspectives, the seal can appear as almost completely red.

Fig. 4.20 – The three-sided prism in red and white banded agate #225

The identification of color is obviously rather subjective and determined by different conditions of lighting. Still, each piece possesses its own tonality, which can be more or less starkly different from the ones of the other objects. Fortunately, such an ambiguity would have conditioned Minoan readers of Hieroglyphic seals too, as well as people looking at a seal *en plain air*.

I checked with autopsy many documents at the Archaeological Museum of Heraklion. In the other cases, I checked the photographs, when available. Generally, I tended to assume the past interpretations when both *CHIC* and the *CMS* editor(s) agree in color description. However, the following ambiguities remain:

a)   *CHIC* and the *CMS* consistently use different terms plausibly referring to the same color. Unsurprisingly, *CHIC* is often more consistent, while the interpretation in the *CMS* volumes varies according to editors and years. Still, such cases do not raise particular issues, as color categories are enough wide to include all the possible minor varieties.

b)   Color definitions of *CHIC* and the *CMS* diverge enough to presuppose two different chromatic categories. Most of these cases were solved through my own check of the photographs. In the few cases in which no photograph was available, I selected the most recent publication, especially if further details are added to color description. In particular, for soft-stone prisms, a third description is always available in the catalogue provided by Maria Anastasiadou (2011: 487-670).

c)   *CHIC* does not indicate the color of the seal. Some of these cases merely mean that the object shows the commonest tonality of the stone, i.e., light blue for chalcedony, reddish for carnelian and intense red for agate. However, such a case sometimes fails to occur, as proved by the seal #269. Although this seal is reputed in calcedony by *CHIC*, it was later analyzed as coming from an opaque beige agate (Müller & Pini 2007: 380). The latter hypothesis is confirmed by the colorful photograph (see Fig. 4.21). The same is true for #240, which is again merely described as chalcedony even though having a white orange-greyish blue tonality (see Fig. 4.21).

Fig. 4.21 – (From left to right) Three-sided prisms in chalcedony (#240) and agate (#269)

Finally, all seals described by both *CHIC* and the *CMS* as two-toned, but showing a rather uniform coloration in the photograph, were included in the related category. As for the three-sided prism #238 (see Fig. 4.22), *CHIC*'s green-grey steatite mostly refers to an extremely dark tone and is akin to blackish pieces of the category (g).

Fig. 4.22 – The three-sided prism in steatite #238

4.13 General features of the SNA model

The model resulting from the SNA is illustrated in Fig. 4.23, in which nodes are colored according to different materials. From a statistical point of view, the model is less compact than the previous one, but still shows a rather high value of density (0.742), clustering coefficient (0.800) and average path length (1.258). Such metrics highlight that clusters tend to emerge in presence of more than one matching parameter. The less compactness is the outcome of the deletion of binary variables and parameters attesting low variability. Nevertheless, the vast majority of nodes commonly share at least one feature to each other. Such a property is due to the fact that Hieroglyphic seals engravers selected only a small part of the available material, from both a formal and an iconographical perspective (see §3.11).

Fig. 4.23 – The SNA model of the three- and four-sided prisms inscribed in Cretan Hieroglyphic. Colors of nodes single the material ofeach seal out from the other ones, i.e., gold (golden yellow), jasper (green), 'whitened' opaque agate and carnelian (pink), translucent agate (grey), translucent carnelian (red), chalcedony (blue), rock crystal (white), breccia (black), pseudo-jasper (light blue), limestone (light yellow), serpentine(dark brown), marble (purple), steatite (brown-ochre) and ivory (dark grey). Nodes' colors are conventional and are not meant to describe the tonality of seals

The model is mainly polarized around two principal clusters, namely jasper prisms (on the left side) and steatite ones (on the right side). Such a distribution shows that each of these two groups tends to consistently attest more than one feature which is conversely not to be found in the other one. Notably, while seals in both jasper and steatite tend to be topologically close to each other, objects in other materials are rather widespread among the SNA model. Such a distribution is due to the fact that seals in (medium-)hard stones but jasper commonly show high variability according to physical properties and written sequences.

In particular, seals in jasper form a highly homogeneous and topologically compact cluster in the left and bottom-left part of the model (see Fig. 4.23). Notably, this group is the only one relatively close to the gold prism #306. Furthermore, it is

only flanked by nodes referring to hard stone seals but a pseudo-jasper prism (i.e., #292).

On the other hand, seals in steatite show a higher degree of variability as regards both physical and epigraphic properties. Yet, an extremely homogeneous cluster of steatite seals can be neatly singled out in the right part of the model (see Fig. 4.23). Such a cluster mainly groups together three-sided prisms with one inscribed face only, representing the absolute majority of inscribed three-sided prisms in steatite. It follows that, differently from jasper ones, the behavior of three-sided prisms in steatite diverges from the one of four-sided prisms. Moreover, although steatite prisms show both some carnelian and agate prisms in their neighbors, they mainly interact with ones fashioned from materials available on Crete, such as medium-hard stones (breccia and limestone) and rock crystal.

4.14 The 'left' pole: features of jasper seals

Almost all seals in jasper fall within two color typologies, i.e., they are either intense or dark green. The only exception are two green-blackish pieces (i.e., #254 and #308) and one red-yellow four-sided prism from Petras, i.e., P.TSK 05/291. As green and highly opaque stones are almost absent in MM II glyptic apart from seals in jasper, such a color would have made jasper objects highly recognizable regardless of minor internal differences.

What is more, the recognition of this cluster might have been enhanced by the fact that jasper was used for a small range of seal shapes. In particular, green jasper is almost only attested for the main supports of Cretan Hieroglyphic, i.e., *Petschaft*, three- and four-sided prism. Elsewhere, it only occurs on shapes sporadically in use for writing too, such as buttons and discoids.

As a consequence, jasper seals tend to be consistent as regards readability too. As described in §3.4-5, jasper is among the few opaque stones employed for Minoan seals. Such a property gives to both intense and dark green seals in jasper a high to very high degree of readability. It follows that, together with its physical features, iconography on seals in jasper would have been immediately recognizable

even by untrained eyes and with either partial or unsuitable illumination. Notably, a very high degree of readability is only shared by the gold prism #306. By contrast, both steatite and other hard stones can be easily set apart from jasper pieces by virtue of their moderate to high translucency.

On the other hand, only the two green-blackish ones would have been less readable, although a moderate degree of readability can be still posited (§3.5). Anyway, both the high opacity of such two stones and their shape (four-sided prisms) would have raised few doubts as regards the type of stone.

Jasper seals can be further significantly singled out due to their epigraphic features. Indeed, they are never attested with one inscribed face, and only rarely they show two inscribed faces (15.5% of the total), especially in case of four-sided prisms (4%). By contrast, they show a clear-cut preference for three and four inscribed faces and especially for prisms entirely covered by written sequences (73% of the total).

Notably, although differences between hard- and soft-stones (Poursat 2000: 188) find a clear confirmation, it must be stressed that jasper show a significatively different behavior *vis-à-vis* the other hard stones. The Table 4.8 considers both agate and carnelian, as they are the most employed ones for writing apart from jasper. In both cases, the preference for seals with 3 and 4 inscribed faces is lower (50% of the total for agate and 70% for carnelian) than the jasper's one (84.5%). Moreover, one fifth of Hieroglyphic seals in both agate and carnelian bear one inscribed face only, such a case being conversely totally absent from jasper ones. Still, carnelian prisms show a behavior closer to jasper than ones in agate, especially as regards seals with two or more inscribed faces. Such a difference is clearly reflected in the model, where carnelian seals tend are commonly closer to jasper ones.

Material / Inscribed faces	1/3	1/4	2/3	2/4	3/3	3/4	4/4
Jasper	0%	0%	11.5%	4%	42%	11.5%	31%
Agate	10%	10%	30%	0%	30%	0%	20%
Carnelian	20%	0%	10%	0%	30%	10%	30%
Steatite	58.5%	6.5%	9%	6.5%	6.5%	6.5%	6.5%

Table 4.8 – The relationship between material and number of inscribed faces

If compared to the proportion of inscribed seals for each material (see Table 4.9), the previous distribution confirms that hard stones would have been the privileged host for Hieroglyphic inscriptions and would have been mostly conceived to host writing. What is more, jasper proved clearly to be preferred host of Hieroglyphic inscriptions. A minor difference is provided by usage of carnelian, showing a percentage of uninscribed pieces decidedly higher than the all the other but rock crystal. Still, the absolute number of inscribed pieces is in line with the one of both agate and chalcedony. Notably, it is often hard to establish if 'whitened' pieces were fashioned from agate, carnelian or chalcedony and sporadic confusion cannot be ruled out.

Material	Inscribed	Uninscribed
Jasper	26	22
Agate	12	13
Carnelian	11	25
Chalcedony	10	8
Rock Crystal	3	16

Table 4.9 - Inscribed seals for each material

4.15 The right pole: steatite three-sided prisms

Steatite three-sided prisms constitute an extremely compact cluster in the right part of the SNA model. The vast majority of these prisms are homogeneous as regards both physical and epigraphic characteristics.

First, the absolute majority (67%) is fashioned from a brownish/greenish stone. This color is the most widespread among Protopalatial glyptic (Müller 2007: 17) and neatly dominant for uninscribed seals of the 'Mallia Steatite Group'. As a brownish/greenish tonality is rare for hard stone seals and totally absent from jasper ones, such feature provides a relevant clue for determining the discrepancies behind the two poles of the SNA model. Only two three-sided prisms in brownish/greenish steatite (9% of the total) are inscribed on two faces, while the only one allegedly with all the three faces inscribed and MM II in date could be a case of pseudo-

writing (see §4.18). Notably, the two four-sided prisms in brownish/greenish steatite, i.e., and #281 and #286, bear respectively one and two inscribed face too.

Such seals, especially those from a brownish/greenish stone, are commonly rather translucent. Readability is therefore mostly low for objects of with a translucent dark-red, brown, and greenish color (i.e., color group (a), see Table 4.7) and moderate for the ones with an opaque to weakly translucent black, blackish and dark grey color (i.e., color group (g), see Table 4.7). As well as color, readability tends therefore to form a hiatus between steatite and jasper seals.

Second, steatite three-sided prisms are decidedly homogeneous as regards the Hieroglyphic sequences they bear. Almost 79% of them (26 out of 33) are inscribed on one face only. With few exceptions (23 out of 26), the inscribed face of these prisms bears one of the two most attested formulas, i.e., either CH 044-049 or 038-010(-031). Such a usage of these sequences, however, is rather unusual. Indeed, while they are common on hard stone seals with more than one inscribed face, they are never to be found in absolute isolation and only rarely without any other 'formula'.

Notably, a correlation can be found between the usage of formulas on three-sided prisms with one inscribed face and their color (Table 4.10). Indeed, while prisms in brownish/greenish steatite only attest the two formulas, all the three exceptions belong to less attested color categories, which conversely never bear the formula CH 038-010(031). The formula CH 044-049 is still the most attested sequence in prisms not in brownish/greenish steatite (6 out of 9 occurrences), but a rare sequence (i.e., CH 042-038 on #224) and two *hapaxes* occur alongside it. Notably, outside #224, the sequence CH 042-038 is confined to seals in (medium-)hard stones with all the faces inscribed. The carnelian prism #229 is only apparently an exception. Indeed, it bears the formula 036092, which is commonly specialized on high-ranked seals (Poursat 2000: 188) and would therefore single such object out of the other prisms with one inscribed face.

	CH 044-049	CH 038-010(-031)	Other
Steatite, color group (a)	13 (76.5%)	4 (23.5%)	0 (0%)
Steatite, other colors	6 (66.5%)	0%	3 (33.5%)
Hard stones	1 (20%)	0 (0%)	4 (80%)

Table 4.10 – The relationship between colors and Hieroglyphic sequences on three-sided prisms with one inscribed face

Revealingly, such a pattern finds correspondence in three-sided prisms from (medium-)hard stone with one inscribed face. The formula CH 044-049 is attested only once (i.e., #240). By contrast, all the other seals (4 out of 5) bear either *hapaxes* or the sequence CH 017-050 on #234. The latter might be recognized in the sequence CH 017050-001 on the four-sided prism in red carnelian #310. Indeed, CH 001 is also to be found together with the formula CH 044-049 on #240, a seal belonging to the same cluster of #234. Moreover, a crouched/seated human figure is further attested alongside writing on II.1 420 and perhaps IX D003c. Thus, a similar role on #310 is conceivable.

Third, seals in steatite and, more in general, seals in soft stones tend to be bigger. Notably, although it is tempting to link such a behavior with the availability of the raw material, no correspondence can be found for those hard stones which were mined on Crete, such as rock crystal and red jasper. Nevertheless, it is clear that jasper and steatite represent the two poles between whom all the other materials fall (see Table 4.11). The average sizes differ of slightly less than 0.5 cm, a hiatus which could have strengthened the recognition of material and quality, especially at small distances. Notably, steatite prisms with either 1 or 2 inscribed faces are decidedly bigger than ones entirely covered by Hieroglyphic sequences. The latter attest an average length close to those fashioned from jasper. As they would point to a higher level within the administrative hierarchy, the convergence with the seals commonly inscribed on all their faces may testify the intention to mimic more valuable artifacts.

Notably, although only small differences were detected, the relative position of both agate and carnelian is congruent with the distribution observed as regards the number of inscribed faces. Such a behavior is even clearer in the case of prisms with all the 3 faces inscribed.

Material	Avg. length of three-sided prisms	Avg. length of three-sided prisms with 3 inscribed faces
Jasper	1.35 cm	1.36 cm
Agate	1.6 cm	1.7 cm
Carnelian	1.55 cm	1.5 cm

Steatite	1.72 cm	1.33 cm

Table 4.11 – The relationship between materials and face's length on three-sided inscribed prisms

The situation of four-sided prisms perfectly mirrors the one described for three-sided ones (see Table 4.12). In the case of prisms with either 3 or 4 inscribed faces, data for both carnelian and agate were rather small. Still, it is noticeable that they confirm the relative position attested by three-sided prisms. The high value of steatite is mostly conditioned by two exceptionally big pieces, i.e., #294 (3.95 cm) and #307 (2.9 cm). Crucially, as these sizes do not find parallels for hard-stone seals, and these seals clearly display a less accurate manufacture (see §4.16.1 and Fig. 4.27), it is plausible that big seals would have strongly pointed to less valuable objects.

Material	Avg. length of four-sided prisms	Avg. length of four-sided prisms with either 3 or 4 inscribed faces
Jasper	1.65 cm	1.65 cm
Agate	1.83 cm	1.9 cm
Carnelian	1.76 cm	1.75 cm
Steatite	2 cm	2.42 cm

Table 4.12 – The relationship between materials and length on four-sided inscribed prisms

4.16 The center of the SNA model

The center of the model is occupied by nodes referring to both (medium-)hard and soft stone prims, featured by a high variety of properties. The position of such nodes is mostly determined by their closeness to one of the two principal clusters.

Topologically, such a position features almost all color typologies, still being it clearly dominated by nodes referring to white objects though. Indeed, seals belonging to the color category (b) represents the vast majority of those measuring a value of betweenness over the average (see §4.19).

4.16.1 Steatite four-sided prisms

Differently from three-sided prisms, four-sided prisms in steatite show a higher variability as regards both formal and epigraphic properties. Still, patterns tied to general tendencies can be recognized.

First, the position of nodes referring to steatite four-sided prisms change according to their color. Indeed, while white seals are commonly to be found in the very center of the SNA model, the ones displaying other colors tend to be placed either close to the steatite three-sided prisms cluster or in peripheral areas. Such a behavior is mainly due to the relationship between color and number of inscribed faces. Indeed, while brownish/greenish pieces are mostly confined to prisms bearing either one or two inscribed faces, white and black ones commonly show two or more inscribed faces. As seals with more inscribed faces are commonly fashioned from hard stones, such a pattern clearly mirrors the one observed for sequences on three-sided prisms. In particular, no four-sided prism in white steatite with one inscribed face only is attested. Notably, such a coloration is the rarest one for steatite prisms during the MM II period. As well as pseudo-jasper, when opaque it resembles hard stones, especially jasper or 'whitened' agate and carnelian (Müller 2007: 17). Notably, the only four-sided prism in brownish steatite with two inscribed faces (i.e., #286) shows a huge whitish patina within the intaglio (see Fig. 4.24) If such a patina is the result of the engraving, this piece might have been chosen since, at a first sight, it can resemble white steatite.[26]

Fig. 4.24 – The four-sided prism in ochre-brownish steatite #286

Second, over-sized prisms tend to share less features with the 'jasper cluster' than the ones with a length between 1.5 cm and 1.8 cm. The closest one to the 'jasper cluster' is indeed #288, in white steatite and length measuring 1.7 cm.

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[26] This seal was analyzed as being in jasper by *CHIC*. The identification was chosen in accordance with the publication on the Arachne's website.

Notably, it bears three formulas, i.e., CH 038-010, 044-005 and 036-092, which are attested together only on seals fashioned from jasper (see Fig. 4.25).

Fig. 4.25 – The four-sided prism in white steatite #288

Crucially, formal and palaeographic characteristics of these seals adhere to the same pattern. The craftsperson of #288 was extremely skilled, and the design of Hieroglyphic character more curated than the one on most of the other seals in steatite. Moreover, signs are flanked by fillers and minor devices which are commonly to be found on hard stone seals, while they are normally absent from steatite ones. A similar behavior is to be found in the light-yellow seal #300 (see Fig. 4.26 and Anastasiadou 2011: 69-70), which is entirely inscribed and 1.7 cm long. Indeed, minor devices on it agree to each other following criteria of compositional homogeneity normally recognized on hard stone seals. Again, the engraving is slightly less dexterous than the one of #288, but still visibly better than the other soft-stone four-sided prisms. Signs are enriched of more particulars.

Fig. 4.26 – The four-sided prism in light yellow steatite #300

By contrast, over-sized prisms are commonly engraved through a less dexterous technique (see Fig. 4.27). For instance, the bad engraving of #307 even raised doubt about the authenticity of the piece, together with its rare sizes and the rarity of the sequences (see *CHIC* 285). The same is true for both #289 and #307, whose signs are definitely more schematic and less accurately engraved. Moreover, frequent tool marks on these seals suggest a less accurate polishing *vis-à-vis* both #288 and #300.
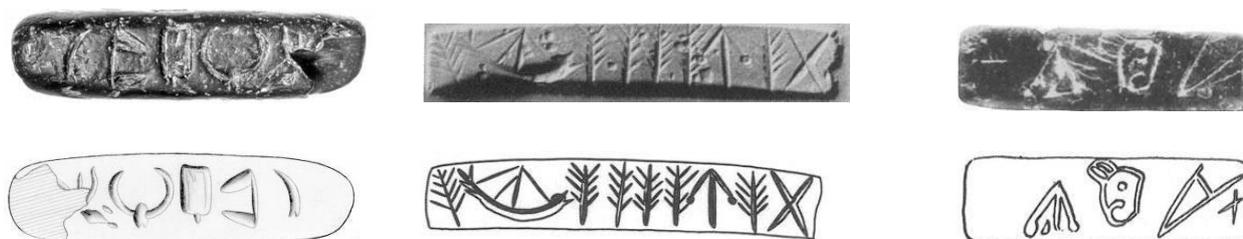
Fig. 4.27 – (From left to right) The 'over-sized' four-sided prisms in steatite #289, #294 and #307

Notably, a comparable behavior can be observed for steatite three-sided prisms with two inscribed faces (see Fig. 4.28). The only one in white steatite (i.e., #248) shows a particularly dexterous and accurate engraving (Anastasiadou 2011: 514). By contrast, the two ones in brownish steatite, especially the over-sized #244 (2.25 cm), show more schematic signs, a lower uniformity in signs' arrangement and a general worst skillfulness.

Fig. 4.28 – (From left to right) The three-sided steatite prisms with two inscribed faces, i.e., #248, #244 and #250

4.16.2 Hard-stone prisms

Apart from steatite ones, white three- and four-sided prisms constitute a rather coherent cluster in the center of the SNA model. As it includes pieces from different medium-hard and hard stones, they show a relative variability in translucency. Topologically, white seals are closer to jasper than to steatite. Such a general tendence is mainly the result of a higher number of inscribed faces and the sharing of sequences with jasper seals. It follows that this behavior, together with their rarity, may strengthen the hypothesis that white pieces would have been commonly analyzed as most valuable artefacts *vis-à-vis* brownish/greenish and black ones.

The closest ones to the 'jasper cluster' are 'whitened' pieces in carnelian, agate or chalcedony (i.e., #253, #265, #274 and #297). These group mainly partners with two four-sided prisms in blue chalcedony (i.e., #302 and #303) and a pseudo-jasper four-sided prism (i.e., #292). Apart from readability (see §3.5), these seals share with jasper the feature of being entirely covered by writing.

Notably, such hard stone seals tend to be placed far from prisms fashioned from soft stones, even though material typology was not included among the SNA's parameters. This is the effect of shared sequences, most of them being confined hard stone seals close to the 'jasper cluster'. For instance, the formula 046-044 is only to be found on hard stone prisms, one half of them being 'whitened' pieces. Similarly, the formula 036-092(-031), found on #265, is confined to hard stone seals but #288. The absolute majority of them (9 out of 15) are in green jasper. Finally, the same is true for rare formulas, such as CH 042-054-061 (once on green jasper, i.e., #293, and once on opaque white chalcedony, i.e., #303).

Crucially, although translucid prisms in agate and carnelian tend to show a comparable behavior, still the latter are commonly slightly closer to jasper ones. Such a pattern is in line with data observed for features defining the 'jasper cluster' (see §4.14). Indeed, differently from the 'whitened' pieces, translucent prisms in agate and carnelian are commonly farer from jasper ones.

Prisms in translucent red, yellow or light blue carnelian mostly occupy the center-bottom part of the model, with the exception of three 'peripheral' seals close to the 'steatite cluster' (see §4.15). For instance, the three-sided prism #257 shows an extremely elaborate syntax, a dexterous engraving and a full-bodied cat, a motif strongly associated to high-ranked seals (see Fig. 4.29). Unsurprisingly, sequences on it matches those found on green jasper and 'whitened' pieces.

Fig. 4.29 – The three-sided prism in red carnelian #257

The same is true for #287 and #298, although their lower readability set them farer from jasper seals (see Fig. 4.30). Notably, both these seals show the same iconographical features pointing to particularly valuable objects, such as an extremely elaborate syntax and the cat-mask. Such a behavior is shared by agate prisms with all the inscribed faces too, such as #261 and #301 (see Fig. 4.30).

Fig. 4.30 – (From left two right) Two carnelian four-sided prisms, i.e., #287 and #298, an agate three-sided prism, i.e., #261, and an agate four-sided prism, i.e., #301

The four-sided prism in agate #296 (the so-called 'Chester's seal') is a unique piece and is therefore in the very center of the model, rather far from each cluster (see Fig. 4.31). It is the only four-sided prism with an oval face, which means that it left an impression resembling those of three-sided prisms. Moreover, it is the biggest hard stone four-sided prism unearthed on Crete, more likely partnering with sizes of the biggest seals fashioned from soft stones. Notably, both its sequences and epigraphic features suggest a connection with soft stone prisms. Apart from two *hapaxes*, it bears the formulas CH 044-049 and 057-034-056. As already noticed, the latter is strongly linked to soft sones, while the former is basically widespread all over the Hieroglyphic seals. The exclusive combination of these two formulas itself only occurs on a brownish/greenish steatite three-sided prism with two inscribed faces (i.e., #244) and almost equal length (i.e., 2.25 cm). Finally, only few secondary devices are used on #296, and signs are juxtaposed in a more irregular way than on the vast majority of jasper and carnelian seals.

Fig. 4.31 – The four-sided prism in agate #296

The three other agate seals are conversely in 'peripheral' positions, mostly tied to the steatite cluster for both physical and epigraphic properties (see §4.17).

4.16.3 Medium-hard stone prisms

Among the prisms fashioned from medium-hard stones, pseudo-jasper ones are the closest ones to the 'jasper cluster'. As suggested by the conventional name of this material, such a behavior could not be due to chance. Indeed, the formal features of pseudo-jasper could have facilitated the identification with a more valuable class of seals.

Unsurprisingly, while one of the two occurrences (i.e., #292) bears the 'Archanes formula', the other one (i.e., #276) attest a combination of formulas (i.e., CH 044-049 and 044-005) and a rare sequence (i.e., CH 042-038) which are almost exclusively confined to hard stone prisms (see Fig. 4.32).

Fig. 4.32 – The pseudo-jasper three-sided prism #276

A combination of formulas only attested on hard stones (i.e., CH 044-049, 038010 and 044-055) and commonly understood as the complete access to the three principal administrative procedures (Civitillo 2016: 236), features the four-sided prism #311. This seal is heavily abraded and the definition of material (marble per *CHIC*) still uncertain.

By contrast, breccia is closer to the 'steatite cluster'. The three-sided prism #260 (see Fig. 4.32) attests a formula (i.e., CH 057-034-056) which is widespread on prisms in brownish/greenish steatite and highly translucent agate and carnelian, while it is attested only once on green jasper.

4.17 Around the clusters: 'peripheral' seals

Some nodes occupy the very edge of the model, commonly in almost exclusive association to one or more of the clusters. Indeed, the fact that such nodes have a low betweenness centrality (see §4.19) entails that they are unique pieces with peculiar functions rather than objects conveying a meaning crossing the main clusters. Such a characteristics can be further captured through the lower density of the edges in proximity of such peripheral nodes. In particular, each edge shows rather homogeneous features:

a)   The top periphery is constituted by the over-sized four-sided prism in steatite, which are the only steatite prisms with four inscribed faces, even though the sequences they bear are never attested elsewhere.

b)   The bottom periphery is mainly constituted by hard-stone seals with a readability lower than the average and sequences akin to less valuable prisms. Topologically, such a cluster is closer to the 'steatite cluster' than to jasper prisms. The lower value of these objects may be confirmed by the fact that possibly none of them bears sequences on all the faces.[27]

c)   The bottom-left periphery is occupied by the two less prototypical jasper seals, i.e., the three-sided prism #243 and the four-sided prism P.TSK 05/291. Both these seals are still relatively close to their related cluster, as prisms in jasper show only a relatively little variation in both formal and epigraphic features. Notably, the prism #243 is the smallest inscribed prism (0.94 cm), as well as the smallest three-sided prism in hard stone dating to the MM II period. Given its round face (elsewhere attested by #262 only) and the circular arrangement of characters

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[27] Both #256 and #267 are reputed inscribed on all their three faces by *CHIC*. However, the former merely bears a sign per face and therefore attests a single sequence only (see Fig. 16). On the other hand, the face

a. of #267 is read as a *hapax* CH 054-010-054, but it more likely displays a well-known syntax, i.e., two *tête-bêche* amphoras divided by a Z-motif.

(see Fig. 4.33), it rather resemble a group of extremely small *Petschafte* in green jasper, such as #181 (0.8 cm), #183 (1.14 cm), #184 (1.12 cm), #185 (1 cm).

Fig. 4.33 – (From left to right) The impressions left by the three-sided prisms #243 and #262 and by the *Petschafte* #181, #183 and #184

The prism P.TSK 05/291 (see Fig. 4.34) was perhaps slightly less valuable object than green jasper seals. Indeed, it is fashioned from red-yellow jasper, a stone available on Crete (see §3.3). Furthermore, it bears the formula CH 044-049 with two *hapaxes*, a pattern featuring a rock crystal prism (i.e., #270). Revealingly, on hard stones, it can only be found on a green jasper four-sided prism with 3 inscribed faces too (i.e., #290).

Fig. 4.34 – The three inscribed faces of the four-sided prism in red and yellow jasper P.TSK 05/291

d) The right periphery is occupied by less valuable (medium-)hard stone prisms. Within the SNA model, this group is mainly linked with the 'steatite cluster'. Indeed, all these prisms are characterized by the fact that they bear Hieroglyphic signs on one face only.

As observed for steatite prisms (see §4.16.3), less valuable seals are sometimes further featured by a less dexterous engraving and a more schematic rendering of Hieroglyphic signs. Notably, uninscribed faces of both #234 (i.e., II.2 168b) and #225 (i.e., XII 93b) are featured by a double 'ball amphora', a motif only attested on soft stones and (medium-)hard stones uninscribed seals (see Fig. 4.35).
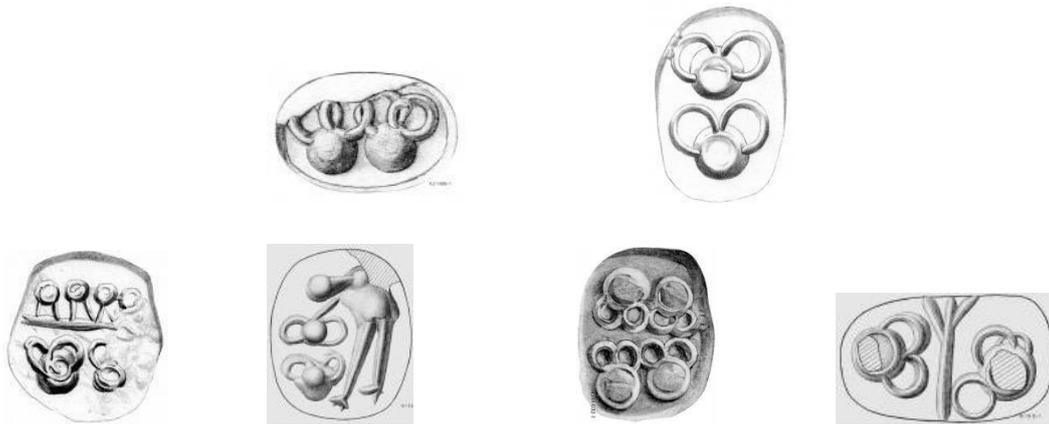
Fig. 4.35 – (From left to right) (Top) The two uninscribed faces of #234 (i.e., II.2 168b) and #225 (i.e., XII 93b); (Bottom) Examples of two 'ball amphorae' belonging to the 'Mallia Steatite Group', i.e., IV 010c and III 153; the two occurrences of the 'ball amphora' on hard stones, i.e., IX 032 and III 181b

4.18 Readability and number of inscribed faces: a possible correlation?

As already observed, some colors and typologies of material would have been specialized for seals with a given number of inscribed faces and bearing only a selected number of sequences' combinations. This section aims at determining if these constraints show a distribution which is in correlation with the readability of the seals.

Accordingly, I preliminarily check the distribution of these features on the SNA model by highlighting their presence/absence on the nodes. The result is displayed in Figs. 4.36-38. Specifically, Fig. 4.36 shows nodes all having the same color (purple) but different tonalities according to the readability of related seals, i.e., darker the node is, higher is the readability of the seal. Fig. 4.37 shows nodes all having the same color (red) but different tonalities according to the number of inscribed faces of related seals, i.e., darker the node is, higher is the number of inscribed faces. Finally, Fig. 4.38 highlights nodes referring to seals having all the faces inscribed, either three (for three-sided prisms) or four (for four-sided prisms), by marking them in red.

Revealingly, the SNA model highlights a certain degree of correlation. By focusing on the distribution of readability (Fig. 4.36) and number of inscribed faces (Fig. 4.37), it is evident the two SNA models are split in the same way. Indeed, the whole left part of Fig. 4.36 is featured by seals having a high to very high

readability. This pattern is almost perfectly mirrored in Fig. 4.37, in which the left part is mostly occupied by seals with three or four inscribed faces.

I now consider the central part of the SNA model. The situation is rather close to that observed for the left part. In Fig. 4.36, it is occupied by many seals having a high readability, while few of them are featured by a moderate readability. Most of those with high readability are grouped in the central-lower part of the graph. Similarly, in the central part of Fig. 4.37, most of the seals have four or three inscribed faces, while few have two inscribed faces. The central-lower part starkly corresponds to that in Fig. 4.36, as it shows prisms with three or four inscribed faces. Notably, seals with three inscribed faces in this part are generally three-sided prisms (see Fig. 4.38). In the upper periphery of Fig. 4.37, one can find a group of four-sided prisms inscribed on all their faces. Here, there is only a partial correspondence with Fig. 4.36, in which this group have a moderate to high readability, although all its members have a rather high legibility.

Finally, I consider the right part of the model. The situation is antithetical to that observed for the left part. Indeed, in Fig. 4.36, nodes refer to seals with a moderate to very low legibility. Once more, this pattern is perfectly congruent with that observed in Fig. 4.37, in which the whole left part is occupied by prisms with two or one inscribed faces. Notably, the few prisms with moderate legibility in this part are grouped in the top right of the SNA model and are close to the four-sided prisms with all the inscribed faces.

To summarize, the analysis of SNA model shows that there is a stark topological correlation between readability and number of inscribed faces of Hieroglyphic prisms. In the model, these features are indeed distributed according to the same rules, i.e., nodes with high readability are normally featured by three or more inscribed faces, while nodes with low readability are normally featured by two or less inscribed faces.
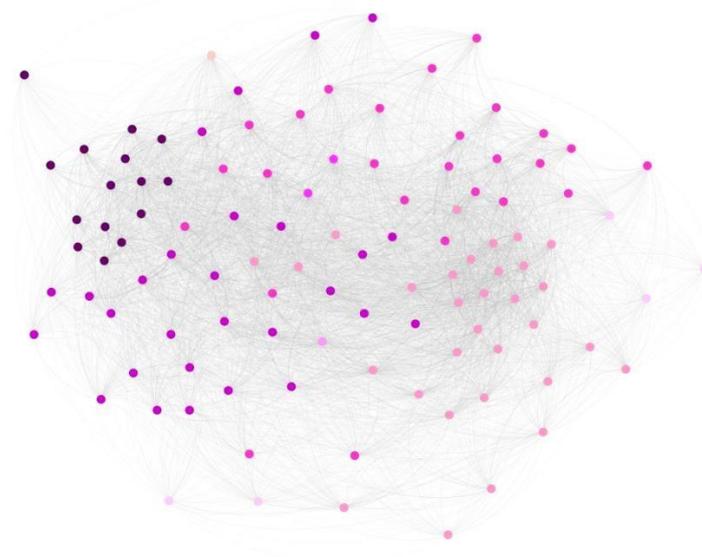
Fig. 4.36 - SNA model with nodes colored according to their readability, i.e., the darker they are, the higher is the readability of the related seal
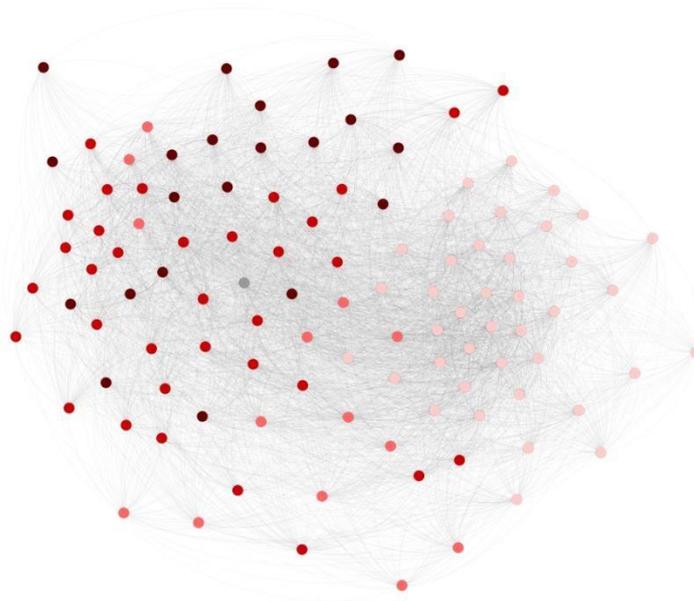
Fig. 4.37 - SNA model with nodes colored according to the number of inscribed faces, i.e., the darker they are, the higher is the number of inscribed faces of the related seal
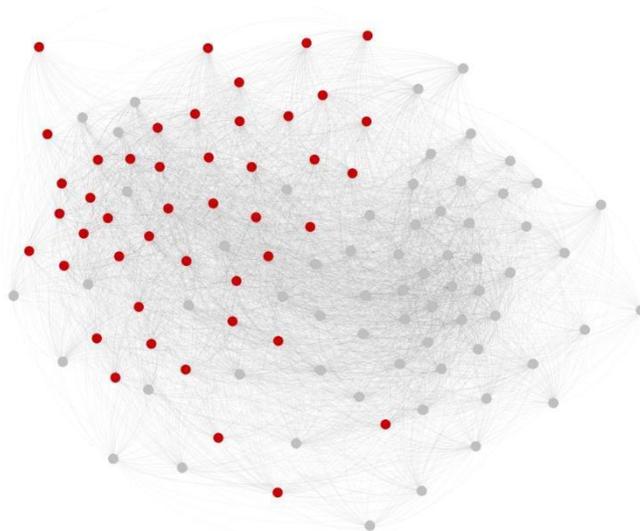
Fig. 4.38 - SNA model in which nodes referring to prisms with all the faces inscribed are highlighted in red

After having shown the topological congruency, on the SNA model, of readability and number of inscribed faces, I turn back to the dataset. The Table 4.13 displays the frequency of different degrees of readability according to the number of inscribed faces. It can be observed that the absolute majority (75.5%) of prisms with high to very high readability has at least three inscribed faces. On the other hand, such a percentage dramatically lowers for seals with a moderate readability (48%). Finally, among seals with two or less inscribed faces, those with a high are decidedly outnumbered (21.5%) with respect to that with a moderate to very low readability.

Such a proportion partners with data taking into account seals with all the faces inscribed, more than 67% of them being highly to very highly legible, while only 16% of them is lowly to very lowly legible. By contrast, less than 8% of prisms with a high readability is inscribed on one face only, while this is never the case for highly legible prisms.

Readability/ Inscribed faces	1 face	2 faces	3 faces	4 faces
Very high	0	3	**10**	3
High	3	5	**11**	9
Moderate	**13**	2	8	6
Low	**19**	5	6	1
Very low	**3**	2	0	1

Table 4.13 – The relationship between readability and number of inscribed faces

The fact that both highly and very highly legible seals with three inscribed faces are more numerous than the ones with four inscribed faces (see Table 4.13) trivially reflect the higher number of inscribe three-sided prisms *vis-à-vis* the four-sided ones. Indeed, almost all of those are three-sided prisms with all the faces inscribed. The values found within this contingency table are further supported by the chi squared test. The resulting χ^2 measures 31.219, corresponding to an extremely significative *p*-value of 0.0018.

Such a behavior is clearly tied to the material employed for seals entirely covered by Hieroglyphic signs. Indeed, green jasper seals almost always have a high to very high degree of readability. As they are commonly inscribed either on three or four faces, high readability would consequently characterize most of seals with more inscribed faces. Unsurprisingly, an intermediate situation is provided by *Petschafte*. Such support is extremely tied to writing (see §3.10.2), but it is meant to bear only one engraved face. Only one fourth (4 out of 16) are fashioned from soft stones. Still, the 50% of the remaining ones (corresponding to the 37.5% of the total) are made in jasper.

Nevertheless, the pattern crossing readability and number of inscribed faces features prisms in other stones too. As shown in the Table 4.14, when not considering seals in jasper, still 68.5% of highly to very highly legible prisms bear at least three faces inscribed (see Table 8). Since only two seals in jasper are not highly legible, the values for the other degrees of readability almost remain unchanged.

Readability/ Inscribed faces	1 face	2 faces	3 faces	4 faces
Very high	0	0	0	**1**
High	3	3	**7**	5
Moderate	**12**	2	6	4
Low	**19**	5	6	1
Very low	**3**	2	0	1

Table 4.14 – The relationship between readability and number of inscribed faces by excluding prisms in jasper

Revealingly, most of seals with a low degree of readability and three or four inscribed faces belong to special groups:

a)   #251 and #252 are gables bearing the 'Archanes formula' and unearthed within the Archanes cemetery (see Fig. 4.39). Such seals are therefore Prepalatial in date and would have followed different criteria *vis-à-vis* the ones engraved during the MM II period.

Fig. 4.39 – (From left to right) The two gables bearing the 'Archanes formula', i.e., #251 and #252

b)   #270 is a rock crystal seal (see Fig. 4.40). This material can be safely recognized as being less valuable than other hard stones, as it comes from local sources and only a small percentage were used to fashion Hieroglyphic seals. What is more, this seal is a *gemma dubitanda* (= IV D027) and *CHIC*'s editors too declared to be inclined to reject its authenticity (pp. 25 and 261). Indeed, palaeographic features of almost all signs show unique oddities. Both CH 070 (face a) and CH 049 (face b) are rendered through circles at their edges, rather than 'cup-sinkings', and no other evidence exist for such a variant. The motif alongside CH 070 would be a *hapax*, as it cannot be read as CH 038, given its diversity from the 'ladder' motif on face c. On face b, the alleged CH 044 does not show any 'head' (i.e., the round part of the *Petschaft* bearing the stringhole), such a variant being unattested elsewhere. On face c, both the alleged CH 010 and 031 are extremely bad engraving and raise doubt on the identification of these signs. The former is reduced to a vertical line crossed by two small and roughly perpendicular and shallower ones at one edge (putatively, the foot). The latter is basically a vertical stroke too, with either two or three shallower ones diverging from one edge (putatively, the 'branches'). Moreover, on the same face, the sequence CH 038-031-010 is akin to the widespread formula CH 038-010-031 and could point to either a

mistake or a proof. Anyway, the fact that almost all the signs resemble Hieroglyphic ones, the duplications of drillings at the edge of CH 070 and the regularity of formal features could likely point to a trial piece, rather than a modern one.

Fig. 4.40 – The rock crystal three-sided prism #270

c) #271 could be a case of pseudo-writing (see Fig. 4.41). Among Hieroglyphic seals, especially those with more than one face inscribed, it displays one of the less accurate manufacturing. As well as #270, some signs pose palaeographic issues. On face b, the alleged CH 044 show an hourglass shape without parallels elsewhere. It could refer to a variant made without 'head', even though its shape might also point to a vessel (e.g., II.2 308c). If the latter was the case, both the face a and b would show signs confined to the same semantic class. Thus, the face a could be recognized as a sequence of quadrupeds' heads not to be interpreted as writing signs. Co-habitation of at least two quadrupeds' heads, frequently in a linear chain, on the same face is widespread on MM II glyptic (e.g., XII 048a), although #271a would be the only instance in which three different animals would have been represented. On face c, the sign CH 041 is well recognizable, although it is the only one with two crossing strokes within the squared element.

Fig. 4.41 – (Top) The three-sided steatite prism #271; (Bottom) Comparisons for the quadrupeds' heads in linear arrangement on face a (i.e., XII 048a) and for the alleged CH 044 on face b (i.e., II.2 308c)

d)   #311 is the only Hieroglyphic seal in marble (see Fig. 4.42). Admittedly, a low readability was assigned by virtue of the comparison with few other seals in marble, since the seal faces are too heavily abraded to be correctly understood. What is more, the number of inscribed faces is unsure. *CHIC* includes this seal among the ones with 4 inscribed faces. However, the face d is entirely illegible, and it is reputed inscribed only because the linear arrangement of *vestigia* is compatible with that of Hieroglyphic motifs. On the other hand, on the face a, the only clearly recognizable sign is the 'ladder' motif matching CH 038, all the others being hardly comparable with the other Hieroglyphic signs.
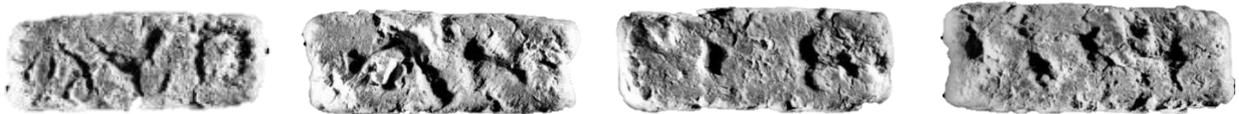
Fig. 4.42 – The four-sided prism in marble #311

By excluding these seals, it follows that only three pieces with a low readability are surely inscribed on either three or four faces, namely the carnelian three-sided prism #258, the carnelian four-sided prism #298 and the agate four-sided prism #301. By contrast, all the other lowly legible prisms in hard stone show epigraphic features akin to the 'steatite cluster'. Indeed, all prisms in (medium-)hard stone with less than two inscribed faces show a low to very low readability. As a consequence, they occupy the peripheral areas of the model (see §4.17). Moreover, apart from #271, none of steatite seals with a low readability bears more than two inscribed faces.

A relevant clue to establish a linkage between color/readability and writing can be provided by four prisms, i.e., #255, #265, #274 and #297, all bearing writing on all the faces. Such seals were fashioned from either carnelian or agate. They are the only Hieroglyphic seals (and among the very few ones to be found for the MM II period, see Betts 1980: 17-18) which underwent the process of 'whitening'. Crucially, the process of 'whitening', while softening the stone, almost cancel its

translucency (see Fig. 4.43) Differently from the other pieces in both agate and carnelian, 'whitened' ones are therefore opaque and highly legible. Another 'whitened' piece is #269, which however accidentally suffered a firing event. Therefore, it is hard to establish whether its opacity was intentionally achieved.

Fig. 4.43 – Difference in readability between a highly translucent (#267) and an opaque (#269) Hieroglyphic prisms in agate

Moreover, even within rather homogeneous clusters, the behavior of seals often varies according to their readability. Indeed, as already noticed, all steatite three-sided prisms with one inscribed face and palaeographic features akin to those of (medium-)hard stone ones show a moderate to high readability, as they are mostly fashioned from either black or white steatite (see §4.15). Furthermore, as already proved, on seals in steatite, a clear difference is also provided by palaeographic features. Indeed, seals in white steatite are commonly engraved with more accuracy and signs on them are more iconic and closer to ones on hard stone seals (see §3.7 and §4.16.1). Such a tendency could not be due to chance, when considering that, differently from brownish/greenish (mostly lowly legible) and, partially, black ones (mostly moderately legible), their engraving was able to be appreciated by a larger group of viewers.

The same patterns find correspondence on medium-hard stones. Both instances of highly legible pseudo-jasper bear all the faces inscribed. Conversely, the two three-sided prism in limestone (i.e., PTSK 13/1485 and PTSK 14/2604) with a moderate to low readability bear one inscribed face only. Notably, the two instances of breccia (i.e., #260 are congruently distributed according to their readability (see Fig. 4.44). In such a case, number of faces could not have been influenced by color, as #260 is in a brownish stone close to less valuable (steatite) prisms.

Fig. 4.44 – (From left to right) The two three-sided prisms in breccia, i.e., #234 and #260

Finally, distribution of *hapaxes* varies according to material and readability (see Table 4.15). I restricted the research to *hapaxes* consisting of more than two syllabograms. Indeed, combinations of two possible Hieroglyphic signs are widespread among the MM II glyptic and their inclusion within the catalogue is uncertain.

	Soft stones	(Medium-)Hard stones and gold	*Total*
High to very high	10%	47%	57%
Moderate	10%	16.5%	26.5%
Low to very low	0%	16.5%	16.5%
Total	20%	80%	

Table 4.15 – Distribution of *hapaxes* composed by more than 2 syllabograms according to material and readability

Notably, either a lower number or the absence of formulas do not automatically point to a low-ranked object, as proved by the gold four-sided prism #306, entirely covered by *hapaxes*. As observed in §4.17, most valuable three-sided prisms with one inscribed face would point in the same direction. What is more, such *hapaxes* attest the sporadic employment of a number of signs, which are therefore confined to hard stone seals and point to the selection of a larger iconographic repertoire (Pini 2010). A further clue would come from the fact that a couple of these sequences are attested on clay documents, namely CH 011-056 on both #297c and #015c and CH 057-023 on both #243c and #049b (see Fig. 4.45). Notably, only sequences on hard stone seals are found on clay documents too. The same behavior features the sequence CH 042-054-061, attested twice respectively on green jasper and chalcedony (i.e., #293c and #303b), and finding correspondences on four clay documents (i.e., #037a, #050a, #058a and #062bB,cB,dB) (see Fig. 4.45). Crucially, most of the occurrences of these sequences on clay are to be found alongside entries featured by the formulas CH

044-049 and CH 044-005. As a consequence, all these features suggest a more complex usage of writing and would require a higher level of literacy.

Fig. 4.45 – (From left to right) (Top) Seals whose sequences find correspondence on clay, i.e., #297c, #243c and #293c; (Bottom) Clay documents whose sequences find correspondence on seals, i.e., #024c, #049b and #062cB

4.19 Seals at the boundary between categories: betweenness centrality and clusters

Given the higher number of seals, degrees of betweenness are shown through the scaling of nodes. In Fig. 4.46, bigger and darker nodes correspond to higher values of betweenness and *vice versa*.
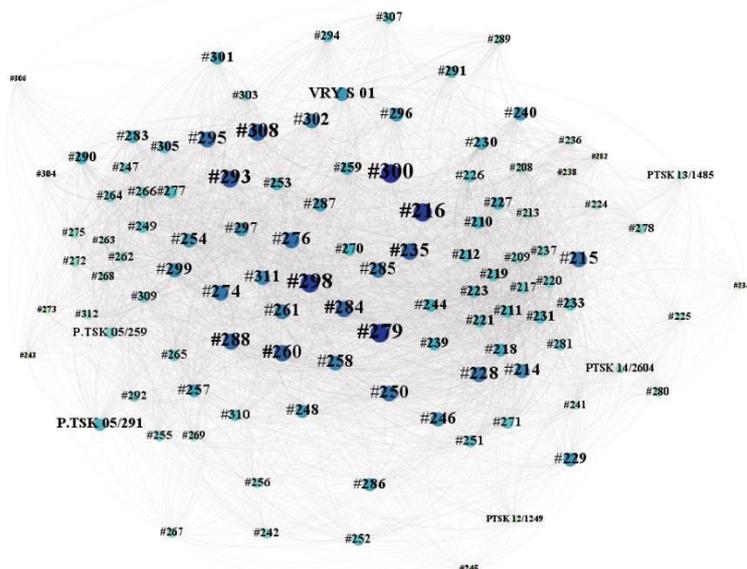
Fig. 4.46 – SNA model with nodes colored and scaled according to their betweenness centrality

Since this model is less compact with respect to the one representing Hieroglyphic impressions, betweenness centrality is commonly higher and undergoes major oscillations. Lowest values range from 2.5 to 6 and denote rather isolated objects in peripheral positions and with a low number of matches with all the other ones.

As well as in the SNA involving Hieroglyphic impressions, the high levels of prototypicality (i.e., betweenness ranging from 6.5 to 13) are attested in the poles of the model. Accordingly, such values mainly correspond to the two clusters polarizing the model (see §4.14-15). Notably, seals in green jasper measure a betweenness decidedly low than the ones in brownish/greenish steatite. This fact confirms that the formers tend to show a more consistent and uncommon behavior *vis-à-vis* the other materials adopted for inscribed seals.

Low prototypical objects are featured by a betweenness ranging from 17 to 26.5. The highest value is provided by the four-sided prism in carnelian #298, which indeed occupy the very center of the model. Indeed, it is the only prism with four inscribed faces and a low readability. Notably, due to such rare characteristics, both the three-sided prisms #258 and #261, respectively in translucent carnelian and agate, measure a rather high betweenness too.

All the other less prototypical objects can be grouped in three categories describing seals with rare combinations of features and attesting the intertwining among different categories:

a)   Prisms in either steatite or medium-hard stones with a moderate to high readability and a high number of inscribed faces (i.e., #260, #276, #288, #300 and #311). This category is mainly featured by prisms in either white or green steatite, with clear and deep intaglios and often a milky white patina within them. As shown in §4.16.1, 3, such objects also show Hieroglyphic sequences closer to patterns described for hard-stone ones. By contrast, they are commonly still featured by the lack of some engraving techniques and a rarer usage of secondary devices.

b)   Prisms in steatite with a color normally featuring seals with three- or more inscribed faces and epigraphic features congruent with the 'steatite cluster' (i.e., #216, #235, #279 and #284). They refer to pieces assigned to either color (e) or (b), both being rather rare among the MM II glyptic. Crucially, although they were assigned to such color categories, they show relevant discrepancies from seals of the same category. The three-sided prism #216 was fashioned from a two-tone green-white stone (see Anastasiadou 2011: 598), which lowers the readability with respect to both green and white pieces. The only other green-white prism (i.e., #226) shows exactly the same features (see Anastasiadou 2011: 629). The four-sided prism #284 (see Fig. 3.13b) displays a particularly light tonality closer to olive-green and greenish ones. Similarly, #235 shows a slightly darker tonality described as "beige" (see Anastasiadou 2011: 560) and #279 is described as being "light green" (see *CHIC* 266). Still, it must be stressed that #235 shows an outstanding confident and accurate engraving (Anastasiadou 2011: 560), which is rather unusual among soft stone Hieroglyphic seals. Conversely, four-sided prisms in cream-colored and light green steatite were clearly fashioned with less accuracy with the respect to the ones in white steatite.

c)   Prisms at the boundary of the main clusters. Few prisms in both jasper (i.e., #293 and #308) and steatite (i.e., #215, #228) display less prototypical features with respect to the seals of the same cluster. Pieces in jasper all are four-sided prisms entirely covered by Hieroglyphic sequences. Only two seals in jasper (i.e., #254 and #308) show an extremely dark tonality close to black (see Fig. 4.47). On both, readability is also lower than the other jasper seals. By contrast, #293 is dark green-colored, but featured by a lower readability possibly due to a more impure and unpolished stone (see Fig. 4.47). Still, none of these seals show relevant variations in epigraphic features.

Fig. 4.47 – (From left to right) The four-sided prism in green jasper #293 and the one in green to black jasper #308

On the other hand, the three-sided prism #215 shows a light-yellow tonality (see Fig. 4.48) which is only to be found on a steatite four-sided prism with 4 inscribed faces (i.e., #300, see Fig. 4.26). Differently, #225, as well as #212, #214 and #218, measures a higher value only by virtue of the formula CH 038-010(-031), which is less common than CH 044-049 on three-sided prisms with one inscribed face (see Table 3).

Fig. 4.48 – The three-sided prism #215 (Image from the Online Collection of the Ashmolean Museum, Oxford. Reference Url: https://collections.ashmolean.org/object/728815)

4.20 Conclusions

This Chapter made use of computer-based SNA in order to understand the way in which Cretan Hieroglyphic impressions, with special reference to the epigraphic and formal features of their matrixes, relate to the sealing system of Proto- and Neopalatial Crete. Moreover, a second SNA was carried out in order to detect patterns between sequences and paleography of Hieroglyphic prisms and related formal features, such as material, size, color and legibility. Accordingly, I argue that:

a)   The usage of Hieroglyphic seals strongly differs according to the different administrative systems. Indeed, it is observed that patterns of seal impressions tend to be defined according to the location in which they were unearthed. In particular, the 'Hieroglyphic Deposit' of Knossos is the only location in which Hieroglyphic seals were systematically combined (i.e., co-stamped) to each other and frequently partners with impressions bearing a possible logogram. What is more, such an archive is the only one attesting an administrative system making use of inscribed impressions on inscribed sealings. By contrast, all the other locations generally set inscribed impressions apart from inscribed clay documents

and make a wider use of sequences pointing to a less standardized usage of writing within the administration. Within the Quartier Mu at Mallia, Hieroglyphic impressions are mostly found on noduli, a sealing which is never inscribed in Hieroglyphic. Similarly, out of Knossos, Hieroglyphic impressions are almost always to be found without stamping partners. It follows that the administrative system at Knossos would have reached the highest integration of Hieroglyphic writing, in both sealing and accounting procedures, while elsewhere it was employed more sporadically.

b) There is a strong correlation between the formal features of seals and their iconography, including writing. In particular, jasper is not only the privileged host of writing, but also the material from which the absolute majority of prisms with a high number of inscribed faces were fashioned. Alongside this, jasper proved to have formal characteristics (especially size, color and readability) which tend to be normally associated to highly valuable inscribed objects. Indeed, those seals fashioned from other materials but still showing akin features commonly bear a high number of inscribed faces. Revealingly, as jasper is a highly opaque stone, readability seems to be directly proportional to the number of inscribed faces. Such a rule holds for other stones too, as also proved by opaque and one-toned medium-hard stones resembling jasper. Moreover, all these pieces are rather consistent as regards the usage of formulas and other sequences. Such a behavior confirms that some sequences would have been almost exclusive prerogative of few groups. As both hard stones and these sequences are more represented within the impressions, especially those found at Knossos, it is plausible that such groups would have been more active within the literate administrative systems.

c) At the lowest degree of the social hierarchy inferable from Hieroglyphic seals, one can predictably find the only soft stone employed for inscriptions, i.e., steatite. Seals in steatite proved to be particularly consistent as regards both formal and iconographic feature. They are commonly the farthest one to the inscriptions on jasper seals. Still, pieces showing features closer to jasper are those fashioned from uncommon colors, especially the white steatite, and more readable. When considering the hard stones, rock crystal is clearly the less tied to writing. It is indeed normally featured on seals with a low number of inscribed

faces. Notably, rock crystal, as well as steatite, was probably mined on Crete and could have therefore been understood as a less valuable material. Indeed, materials from local sources, including red jasper, are scarcely represented by Hieroglyphic inscriptions. Moreover, rock crystal is invariably transparent, and therefore shows low readability. Notably, a comparable pattern also affects the palaeography of the Hieroglyphic seals. Indeed, the accuracy of the manufacturing seems to be directly proportional to the closeness to the jasper's formal features. As a consequence, more dexterous engraving on steatite seals seems commonly related to the number of inscribed faces, the readability, the sizes, the color and the sequences they bear.

Chapter 5 – Following the engravers on Protopalatial Crete: experimental investigations on Hieroglyphic seals' production

This Chapter shows the results of experiments I carried out in order to test the interaction between tools, materials and iconography during the process of seal engraving. I carried out all the experiments thanks to the help and the tools provided by a highly experienced artisan working in Udine, Italy.

As observed in Chapters §3-4, the relation between formal and material features was crucial in order to understand the meaning conveyed by inscribed seals. Accordingly, all these features were meaningful by themselves, i.e., each Hieroglyphic seal was distinguished from the others and the uninscribed ones not only by means of the sequence(s) it brought, but also through each single formal feature. By investigating the outcome of different techniques on different materials, I will try to shed light on technical constraints behind the emergence of the aforementioned features.

Such an analysis might allow to assess the role played by such constraints in the choices made by artisans and consumers. Consequently, it might clarify to what extent technical constraints determined the formal and epigraphic features adopted for inscribed Protopalatial seals. In parallel, the experiments addressed the issue of the reliability of a number of tools and techniques, as well as their outcome in relation to a given iconography.

Accordingly, this Chapter describes the possible production cycle of an inscribed seal, starting from the work on the raw material (§5.3), the coarse polishing (§5.4), the opening of the stringhole and the usage of the abrasives (§5.5-6), the engraving (§5.7-8) and the finishing processes (§5.9).

5.1 Background: Minoan seals' manufacture and experimental archaeology addressing Bronze Age stone working

Experiments involving stone working and seal manufacture were conducted starting from the end of the 70s (e.g., Gorelick & Gwinnett 1978 and Yule & Schürmann 1981). Although students of glyptic techniques commonly work far from those of the other stone artefacts (e.g., vases and beads), it is obvious that, on the one hand, workshops producing seals mostly overlap (or, anyway, are in close connection with) those responsible for stone objects manufacturing.[28] On the other hand, almost the whole toolkit of seal engravers is a reproduction, at a smaller scale, of that used by vase makers and mason cutters (e.g., Poursat 1996: 125-126). Of course, a number of idiosyncrasies are possible. Most of them are connected to the working of hard semi-precious stones, whose variety in both seal and bead production is not to be found elsewhere.

Studies on seals' manufacture go back at least to the 19th century (e.g., King 1866: 7-9 and Petrie 1884). Obviously, as most of the documentation on Crete was unearthed between the end of 19th and the beginning of the 20th century, works involving Minoan material start slightly later. All these works are firmly grounded on previous studies on Mesopotamian and Egyptian seals (e.g., Evans 1925 and Kenna 1961; 1968).

Almost at the same time, two seminal summaries on stone working techniques were produced as regards vases (Warren 1969) and seals (Boardman 1970). The latter devotes an entire section to seals' manufacture, in which he catalogued all the principal literary and iconographic sources of the ancient world pointing to tools and processes. Accordingly, Boardman recognized with a good degree of certainty all the main tools (both free-hand and entailing fast rotation) at use for seal engraving, as well as the whole *chaîne opératoire*.

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[28] Notably, so far, Mallia 'Atelier de Sceaux' is the only workshop interpreted as specialized in glyptic production.

A decade later, Yule (1980: 200-201) gave a precise chronological interpretation of the evolution of techniques, as he tied their occurrences to style-groups recognized after the Quartier Mu excavation campaigns. Specifically, he recognized that seals datable to the Prepalatial period were almost only engraved freehand, while drilling techniques developed starting from the MM IB period and are mainly tied to the emergence of hard stones. Observations on seals were further refined by Betts (1989: 9-14) and Anastasiadou (2011: 37-48). Accordingly, the Prepalatial glyptic would be dominated by freehand techniques employing knives, blades and files (in perishable material or obsidian) to work on hard stones. At the same time, solid drills would have been used for opening the stringhole and, sporadically, cup-sinkings. Both freehand and rotary techniques would have sometimes employed the abrasive. The tubular drill would be mainly at home during the MM II ("but its use was not completely mastered until MM III", see Betts 1989: 12), although it firstly appears on a MM IB cylinder. Finally, the horizontal spindle would have been introduced during the MM II period. It would have been (sometimes) involved in the whole production cycle, including the cutting of the raw material and the final polishing. Its main advantages consist in a more fluid engraving, determined by the nonfixed position of the seal, the possibility of fast rotating more types of bits (such as the cutting wheel) and, if actioned by an assistant, by leaving one hand of the engraver free. Such a frame was further confirmed by the proofs carried out by Müller (2000) through the reproduction of two spindles and is nowadays assumed as a *communis opinio* (Krzyszkowska 2019: 37-39). Notably, the emergence of fast-rotating tools coincides with the same time span in which Cretan Hieroglyphic was created and flourished on seals.

Drawing on previous studies, Yule & Schürmann (1981) conducted a pioneering experiment by an artisan at Idar-Oberstein (Germany). In this experiment, the artisan reproduced an architectural seal. The operation was conducted through modern tools (e.g., diamond abrasive) and revealed the differences between those and tools in use during the MM period. Still, this experiment confirms that assumptions of scholars between the 19th and the 20th

century were mostly correct, such as the usage of the cutting wheel, tubular and solid drills and the work with abrasive.[29]

Crucial analyses of stone working techniques were carried out by Stocks (2003), who provides a high number of experimental interpretations of the usefulness of supposed techniques and relating tools. By referring to Egyptian stone working (including vases, beads and masons), he demonstrated that a number of techniques were employed as they provide the best balance between speed, availability of tools and good outcome, for instance the usage of flint for cutting and leather laps for polishing. Importantly, most of these suggestions found correspondence through the 'use-wear' analysis and were therefore tested in the experiments I carried out. Similarly, based on experimental observations, Stocks reconsidered a number of applications often rejected (e.g., the usage of wet abrasive).

The functioning of these tools, as well as their actual applications, were further clarified by seminal experimental and philological observations crossing Mesopotamian, Egyptian and Minoan glyptic material (e.g., Younger 1981, Calley & Grace 1988 and Stocks 1989). Gorelick & Gwinnett (1978; 1989; 1990; 1992) and Gwinnett & Gorelick (1979) used Scanning Electron Microscope (SEM) to analyze the marks left by ancient tools on impressions and try to replicate it in order to identify the employed technique. Similarly, Sax and colleagues recognized specificities of each engraving tools on the intaglios (e.g., micro-chipping, cutting wheel, tubular drill etc.), by means of a close scrutiny of the traces they left (Sax &

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[29] Furthermore, Yule & Schürmann (1981) addressed the question of the 'whitened' seals and, more in general, the manipulation of the stone's color. Still, they do not provide any definitive answer to the questions they raised. They examined two possible techniques, i.e., the diving of stones within solutions of different liquids (such as olive oil, water and vinegar) and the exposition of stones to different flames. Both these experiments were conducted on pieces of banded agate and one piece of jasper, the latter employed not with all the techniques. The former technique mainly failed to achieve relevant result and was therefore unlikely to be used on seals. The latter shows that fractured seals were probable whitened after firing events, while no decisive answer was provided for those with a regular surface.

Meeks 1994; 1995; Sax *et al.* 1998). Consequently, they suggested the way and contexts in which some tools were typically employed. Such methods, called 'use-wear analysis', proved extremely useful to understand the process of seal (and beads) manufacture, and were repeatedly employed for Mesopotamian, Egyptian and Indian material (Chevalier *et al.* 1982, Vianello 1986, Unger-Hamilton *et al.* 1989, Berna 1995, Roux 2000, Altinbilek *et al.* 2001, van Gijn 2006, Wright *et al.* 2008, Yang *et al.* 2009, Gurova *et al.* 2013, Groman-Yaroslavski & Bar-Yosef Mayer 2015, Kenoyer 2017 and Kenoyer & Frenez 2018), as well as for Minoan vase making (Vargiolou *et al.* 2007 and Morero 2016).

Unfortunately, an in-depth analysis of Minoan glyptic material is still pending. This is reflected in the numerous uncertainties admitted by *CMS* editors as regards the recognition both materials and techniques. Moreover, as stressed by Müller (2000: 202), no experiment comparing more stones and tools employed by Minoan seal engravers was never carried out. So far, the latter tests carried out on three stones only (i.e., steatite, serpentine and jasper) through an horizontal spindle and a diamond bit remains the only attempt to define the time needed by Minoan engravers, as well as troubles related to it.

5.2 Setting the scene

As the experiments are meant to show the effectiveness and suitability of tools and materials, as well as the amount of work needed by each of them, I tried to establish comparisons among features of Minoan seal working. As a consequence, I established different protocols according to the employed tools and the task of the experiment, which are clarified in the related sections. In general, following Müller (2000: 198), I engraved only few grooves and small linear motifs. Indeed, the carving of complex images would require a long-term training. What is more, the understanding of the details of the engraving of complex motifs is beyond the scope of this work. Accordingly, all the experiments must be considered as carried out by an untrained hand (my own).

The next sections describe the instruments I used for the experiments, as well as their properties and the reasons behind their adoption. I start describing the physical properties of tested materials and how they relate to Protopalatial glyptic production (§5.3.1). Successively, I will describe tools I employed to perform experimental carving on those materials (§5.3.2).

5.2.1 Materials and their properties

I chose tested materials, i.e., the engraved stones, in order to represent the whole spectrum of stones employed for Hieroglyphic seals. In particular, I paid attention to representing all the Mohs values, as well as the whole range of hard stones bearing inscriptions. Consequently, typologies of stones can be divided as follows:

a)   The only inscribed seals in soft stones were fashioned from steatite, whose Mohs hardness was estimated as ranging between 1 and 2.5. As it was not available when the experiment was conducted, I replaced it by a kind of alabaster softer than Mohs 2.5 (see Table 5.1), as proved by the fact that it can be carved by fingernails.

b)   Inscribed seals in medium-hard stones, i.e., those ranging between 3.5 and 4.5 of the Mohs scale, were fashioned from a good number of stones (i.e., serpentine, limestone, marble, 'pseudo-jasper' and breccia). As shown in §3.3, some of them are hard to identify and mistakes in cataloging cannot be excluded. For this experiment, I employed a green marble and a serpentine (see Table 5.1). The hardness of the piece of marble (= Mohs 6) decidedly differs from the expected one, as marble commonly ranges between Mohs 3 and 5. This is due to the presence of some impurities, mostly pyrite (= Mohs 6-6.5), which are common intrusions in marble.

c)   Inscribed seals in hard stones, which were fashioned from jasper, chalcedony, agate, carnelian and rock crystal. I included all these materials into the experiments (see Table 5.1). Moreover, I considered two different varieties of jasper.

Material	Misurated Mohs hardness	Expected Indentation hardness (GPa)	Specific gravity
Alabaster	1.5	0.14 ± 0.03 to 0.61 ± 0.15	2.2-2.8
Serpentine	5.5	5.47 ± 0.82 to 6.87 ± 0.66	2.2-2.9
Marble	6	6.87 ± 0.66	2.7-2.85
Jasper	6.5	6.87 ± 0.66 to 12.11 ± 1.14	2.58-2.91
Agate	7.5	12.11 ± 1.14 to 12.85 ± 1.32	2.57-2.64
Chalcedony	7	12.11 ± 1.14	2.57-2.64
Rock Crystal	6.5	6.87 ± 0.66 to 12.11 ± 1.14	2.65
Carnelian	7.5	12.11 ± 1.14 to 12.85 ± 1.32	2.59-2.61

Table 5.1 – Material engraved during the experiment and their physical properties

It is worth noting that the Mohs scale marks the relative differences among stones, while it does not quantify the actual distance between one another. Such a distance is reflected into the 'indentation hardness' (also called 'absolute hardness). Still, Mohs and indentation hardness do not refer to exactly the same thing. Indeed, Mohs scale is based on the resistance of stones to scratching, while indentation hardness is based on the resistance to a vertical load. Moreover, the latter raises a series of issues in measurement, which allow only an approximative estimation. Although they are not directly proportional, it is clear that higher Mohs values correspond to higher indentation hardness (see Fig. 5.1). As the Minoan tools presuppose both vertical pressure techniques and scratching, it follows that both these values are involved in the outcomes.
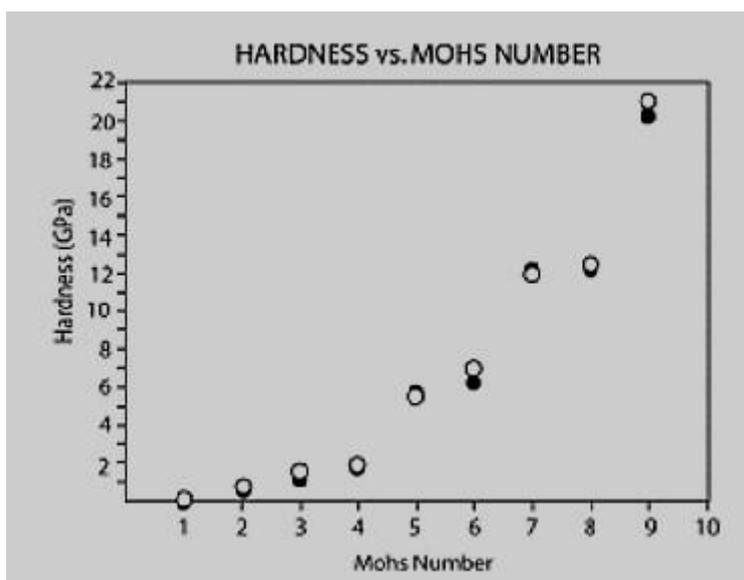
Fig. 5.1 – The variation of indentation hardness in relation to the Mohs scale (after Whitney *et al.* 2007: 60, Fig. 3)

5.2.2 Tools

For these tests, I employed two typologies of tools, both prepared by the artisan, each of them pursuing a specific task. The Table 5.4 displays the measured hardness of the bits, according to their material.

a)   Replica of tools employed by Minoan craftspeople (full list in Table 5.2). When attestations are available, the artisan reproduced the unearthed tools as faithfully as possible. Otherwise, he shaped tools through the comparison of iconographic and literary sources with the toolmarks and the intaglios visible on Minoan inscribed seals. I employed these tools in order to account for the effectiveness of techniques in (relatively) low speed working tools, their usage when combined with abrasives, as well as other tools, and troubles connected with them. Moreover, I used reconstructed tools to test the freehand techniques, which cannot be obviously replied through modern ones.

Type of tool	Material of the shaft	Material of the edge	Size of the whole tool (cm)	Size of the edge (cm)
Drill	Walnut	Copper	35 – Ø 1.15	2 × 0.1
Drill's bow	Walnut, twine	-	15.7 (radius)	-
Cutting wheel	-	Copper	-	4 mm (radius)
Tubular bit	-	Copper	-	4 mm (radius)
Saw	Walnut, twine	Bronze	17 – Ø 1	6 × 0.9
File	Walnut, twine	Bronze	15.7	17 × 0.04
Burin 1	Walnut, twine	Bronze	12.5 – Ø 1	4.6 × 0.8
Burin 2	Walnut, twine	Bone	11.2 – Ø 1	2.3 × 0.4
Burin 3	Walnut, twine	Copper	15 – Ø 1	2.3 × 0.3
Burin 4	Walnut, twine	Flint	11.1 - Ø 1	2 × 0.3
Burin 5	Walnut, twine	Copper	12.7 - Ø 1	3 × 0.1
Burin 6	Walnut, twine	Obsidian	17.5 - Ø 1	3.6 × 0.3
Chisel	-	Copper	12.1 – Ø 0.7	
Ruler for cleavage	-	Bronze	-	6.4 × 1.4 × 0.13
Lap 1	-	Sandstone	-	33 × 18
Lap 2	-	Buckskin		
Lap 3	-	Bronze		
Hammer	Conglomerate	-	6.5 × 4.2 × 3.2	-
Mace	Boxwood	-	14.2 × 3.2	-

Table 5.2 – Replica tools employed during the experiments and their properties

b)   Tools used by modern engravers and as such powered by electricity (full list in Table 5.3). I used these tools in order to test the behavior of bits in comparison to both abrasives and materials. Regardless of the actual efficiency of the tools, I employed drills powered by electricity in order to take appreciable measurements

in a relatively small amount of time. Given the effect of fast rotation, observations should therefore be taken as relative and only useful in a comparative manner. Similarly, as regards the efficiency of tools and their wear, the comparison with hand-powered tools should be taken as tentative.

c)

Type of tool	Brand	No-load speed
Horizontal spindle	Kirjes (Grinder and polisher, class E-PI55)	3000rpm
Drill	Bosch (3 603 A26 000)	180rpm

Table 5.3 – Electricity-powered tools employed during the experiments and their properties

Material	Misurated Mohs hardness	Indentation hardness (GPa)	Specific gravity
Sandstone	3	0.61 ± 0.15 or 1.49 ± 0.11 or 1.85 ± 0.06	2.70
Copper	3	1.49 ± 0.11	8.8-8.95
Bronze	3	1.49 ± 0.11	7.7
Bone	5	5.47 ± 0.82	2.00
Obsidian	5.5	5.47 ± 0.82	2.40
Flint	7	12.11 ± 1.14	2.60-2.64

Table 5.4 - Materials of the tool's cutting edges and their physical properties

5.3 Step one: shaping the seal

During the Protopalatial period, the seal shape was achieved starting from more or less re-worked pieces. The usage of saws is safely established (Anastasiadou 2011: 47). More than 20 small, toothed saws fashioned from copper were unearthed within the Quartier Mu (see Fig. 5.2) and other Protopalatial spots (Evely 1993: 26-28). Saws from the Quartier Mu does not attest rivets for fixations and were "simplement insérées dans un manche en bois" (Poursat 1996: 107). Moreover, a good number of scraps and drafts of seals, unearthed within or near the 'Atelier des Sceaux', show the characteristics parallels striation. They therefore testify to the sawing of extremely small and parsimonious blocks of stones (Poursat 1996: 105 and Fig. 48a-b). Notably, all these pieces are rather far from the supposed final shape. It is therefore conceivable that these objects were directly cut from a piece of raw material. Marks of sawing are visible on engraved faces too (e.g., II.2 087). Furthermore, it was tentatively suggested that this tool (even in combination with

abrasives) would have been also employed for the intaglio (Anastasiadou 2011: 38).

Anastasiadou (2011: 47) suggests that saws were primarily used for cutting the raw material, while the final shape of the seal would have been commonly achieved through filing. As already observed, toolmarks does not however allow to totally exclude the usage of saw for such a process too. Still, she does not exclude that blades would have been used for faceting the seal too (Anastasiadou 2011: 40), especially for soft stones (see also Dierckx 1992: 246). Similarly, both untoothed saws and the untoothed edges of saws were suggested as utils for Egyptian stone working (e.g., Stocks 2003: 32).

Fig. 5.2 – A saw found within the Quartier Mu (after Poursat 1996: Pl. 42j) and the saw employed for the experiment

5.3.1 Setting the experiment up

For the test, the artisan prepared two tools. First, a copper saw (see Fig. 1) 5.90 cm long (avg. from the Quartier Mu = 5 cm) and 1 cm large (avg. from the Quartier Mu = 1.2 cm). Tooths are 0.1 cm long, in accordance with the proportions of those found within the Quartier Mu (see Fig. 5.2). The artisan fixed the saw onto a wooden shaft by means of a twine. Since only one blade of the saw is toothed, I was able to test both a toothed and an untoothed blade. Second, a file with a copper cutting edge and a wooden handle fixed to the edge by means of a twine.

Furthermore, the artisan prepared a wooden bar provided with grooves 1 mm ca. larger than the thickness of the stone pieces (see Fig. 5.3). I inserted each stone piece within the related groove and fixed it by means of a wooden wedge. Subsequently, I hammered the wedge through the boxwood mace between the stone and the groove's wall until both the stone and the wedge were not free to move under vertical nor horizontal pressure.

Fig. 5.3 – The positioning of the raw material into the grooved vice and its working with saw and file

5.3.2 Results of the experiment

I carried out experimental sawing and filing on alabaster, marble and jasper (see Fig. 5.3). During the tests, the toothed saw proved to be neatly the faster tool (see Table 5.5). The ratio with the cutting rates produced by other tools is inverse proportional to the material's hardness. As such, the toothed saw penetrates 8 times faster than untoothed one and file on alabaster, while only more or less 2 times faster on both marble and jasper. The relatively good efficiency of these tools makes the usage of tubular drill rather unnecessary for small pieces of raw material.

	Saw with dentation	Saw without dentation	File
Alabaster	8 mm/min	1 mm/min	1 mm/min
Marble	0.7 mm/min	0.5 mm/min	0.3 mm/min
Jasper	0.8 mm/min	0.3 mm/min	0.4 mm/min
Agate	0.1 mm/min	0.03 mm/min	0.2 mm/min

Table 5.5 – Cutting rates with sawing and filing according to different materials

Saw without tooths and file theoretically differ in efficiency. Indeed, the former removes more material by reaching the same depth (see Fig. 5.4). However, the intended purpose of such operation is splitting two blocks off. It follows that removing more material is useless for such a process. Accordingly, saws produce a double waste of raw material, although at a small scale. Notably, such a difference also features the cut produced by the saw with tooths. As a consequence, toothed

saws, while resulting in a boost of the cutting process determine a more pronounced waste of (raw) material.

Crucially, I failed to observe a better work efficacy with dentated saw for agate. Such a stone proved to be the most resistant to the tools and its cutting is in general slower. Such observations are not coincidental. Indeed, given the exponential differences in hardness among stones at high positions of the Mohs scale (see §5.2.1), the fact that saws imply a more pronounced remotion of material result in a decidedly higher time of cutting. Such a test is confirmed by the fact that working with untoothed saw is enormously slower than filing with agate only.
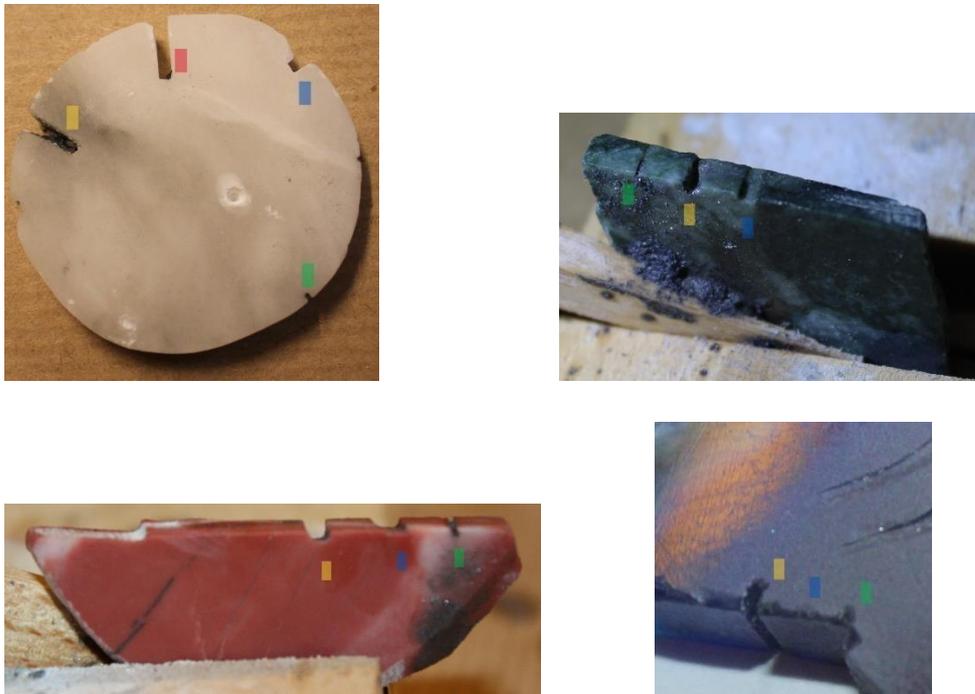
Fig. 5.4 – Cuts resulting from the different operations. (From left to right) (Top) Alabaster and marble; (Bottom) Jasper and agate. Colors legend: Yellow: toothed saw with abrasive; Red: Toothed saw without abrasive; Blue: untoothed saw; Green: file (either with or without abrasive)

Another important difference lies in the wear rate of the tools. I used both the toothed edge of the saw and the file for 10 minutes each. Notably, after such a usage, the tooths of the saw were almost totally abraded and cutting rates dramatically decreased. Therefore, I needed to either rework or replace the tool (see Fig. 5.5). By contrast, file showed no trace of wearing and the cutting rate did not

undergo major differences. As shown by Fig. 4, this problem does not affect the untoothed edge of the saw.

Fig. 5.5 – Highly worn copper saw after 10 minutes cutting

5.3.3 Another way for shaping seals in quartz

As quartz is provided with a conchoidal fracture, all its varieties (including jasper, chalcedony, carnelian and agate) can be quicker cut through a hammer and a ruler. I tested such a process through a piece of agate. The artisan provided a bronze ruler with a straight sharp edge and a boxwood mace.

I filed the stone in order to shape a small channel 1 mm ca. deep. Within the channel, I subsequently laid the copper ruler. The channel is needed to orientate the pressure exercised by the ruler and avoid fractures in undesired directions. I therefore hammered the ruler only once. A moderate pressure was enough to cause the stone breaks in the sense of the channel. Thus, such a process is able to roughly split a (small) stone in two parts, while a more precise shape can only be achieved by filing the entire piece (see Fig. 5.6). Although the channel yielded by filing is straight, the resulting fracture is indeed rather irregular. In some cases, however, the resulting surface can be regular enough to be simply flattened by pre-engraving processes.

Fig. 5.6 – Process of cleavage on a piece of agate

5.3.4 Interpreting traces of the *mise en forme*

On seals, especially soft-stone three- and four-sided prisms, a number of scratch marks are visible. Anastasiadou (2011: 19 fn. 66) tentatively suggests that they "could have been created for example when the seal was being given its shape". Notably, such marks follow the outline, mostly on the profile face, of the seal, i.e., they are triangular on three flanked prisms and rectangular on four-sided ones (see Fig. 5.7).

It is therefore likely that such strokes represented guidelines for the cutting of the stone block (on the profile and, sometimes, on the engraved faces) and the carving of motifs (on the engraved faces only). Indeed, on three-sided prisms, a more or less closed triangle follows the outline of the profile and delimits roughly two third of its total surface. Such configurations are compatible with the drawing of shapes and grid on larger stone blocks, in order to identify the surface to be cut. The fact that the stone was not precisely cut in coincidence of these scratches is plausibly due to the necessity of preventing mistakes (e.g., shape a seal too small) and delimiting a suitable space for each face in comparison to the dimension of the stringhole. Revealingly, such a simple process was employed for cutting huge stone blocks from quarries (e.g., Arnold 1991: 29-33).

Fig. 5.7 – (From left to right) The profile of II.1 111, XII 070, #288 and #197

5.4 Step two: flattening and coarse polishing

The selected (and eventually sawed/filed) piece of raw material must undergo a process of roughing out before the engraving. Indeed, raw surfaces, as well as those resulting from both sawing and filing, show major irregularities. According to Groman-Yaroslavski & Bar-Yosef Mayer (2015: 84), before roughing out, Levantine beads in translucent quartz (i.e., agate and carnelian) would have

undergone a heat treatment enhancing color and producing micro-fractures before the coarse polishing. Notably, such evidence is in line with those of Yule & Schürmann (1981) on Minoan seals. Similarly, after polishing, their color decidedly differs from the one attested by finished sealstones.

Subsequently, the preparing of the surface was plausibly achieved by means of pre-engraving processes on the stone's surface, namely the flattening and the pre-polishing. The former mainly consists of a coarse polishing which deletes major irregularities, i.e., the most visible differences in the height of the surface. Coarse and successive polishings probably employed similar tools. Within the Quartier Mu, they were unearthed (a) rubbers and chisels in schist or sandstone ("polissoirs actifs"), (b) slabs in schist or sandstone ("polissoirs passifs"), (c) grinders/polishers fashioned from different metamorphic rocks. Most of the occurrences of the first two typologies come from the 'Atelier de Sceaux' and its neighborhood (Procopiu 2013: 60, 63).

In the next sections, I therefore turn to consider pros and cons of tools involved in polishing processes (§5.4.1) and show experiments I made to test their efficiency *vis-à-vis* different materials (§5.4.2).

5.4.1 Tools suitable for polishing processes

According to the previous observations, I discuss the differences between active and passive polishers. First, rubbers and chisels were suitable for preparing the surface (see also Stocks 2003: 86), although the same result can be achieved through the other tools too. Notably, as rubbers of different granulometry were found, it can be safely assumed their involvement in more than one polishing operation (Procopiu 2013: 60). Rubbers were basically pebbles, mostly unretouched, rubbed against the surface of the stone. They were plausibly enacted through a lubricant (i.e., water or olive oil) and sometimes an abrasive powder. Coarse polishing does not require a high amount of time. For instance, Stocks (2003: 85-86) took 45 minutes to flatten a 120 cm^3 surface with a flint nodule. The same operation can be also achieved through flat chisels with a wider blade powered by a hammer. Such

a technique, still used nowadays, is attested for masonry by a number of Egyptian paintings (Davies 1943, Fig. LXII) and supposed for Minoan metalworking too (Lowe Fri 2012: 116). Still, no positive evidence is available for Crete, especially in case of small blocks such as those employed for seals (Shaw 2009: 52-53).

Second, passive polishers are mainly slabs of schist and sandstone (stones that, already in quarries, can be found in slabs). Notably, after a preliminary analysis, on rubbers from the Quartier Mu only traces of metal were found, while it is clear that polishing slabs were employed with stones and involved within the seal manufacture (Procopiu 2013: 62). Depending on the polished material, abrasives and/or lubricants can be more or less effective. Passive polishers in perishable material, i.e., wood, were reconstructed for Levantine beads making (Groman-Yaroslavski & Bar-Yosef Mayer 2015: 85-86). Only use-wear analysis could shed light on their presence on Crete too. By contrast, polishers fashioned from metamorphic rocks are scarcely documented and no traces of stone working are to be found on them. As a consequence, their usage for seal production seems rather uncertain.

All these tools were probably employed alongside other (active only?) polishers fashioned from perishable materials. In particular, it is unanimously recognized that leather laps would have served for this purpose. The leather lap must be combined with abrasives and sometimes with water or olive oil. According to Morero (2013: 82), the latter would yield an extremely brilliant surface, which is sometimes to be found on inscribed seals (e.g., #195 and 274). The outcome of leather laps is summarized by Morero (2016) as showing marks "des trajectoires différentes (oblique, verticale ou horizontale par rapport à l'axe du vase [...]). Plusieurs opérations sont nécessaires pour atteindre le niveau de finesse souhaité, qui se traduit par une superposition des stries". Comparable marks are detectable on the steatite *Petschaft* #197 by means of its 3D model (see Fig. 5.8).

A crucial advantage of perishable materials, especially when working on small and irregular cavities, is that they can perfectly adapt to the shape of the polished object. Such a property implies that the polishing does not produce irregular facets on the surface (Morero 2009: 401). Another technique, displayed by a painting in the Egyptian tomb of Sebekhotep at Thebes, works by means of

grooved bench in wood or stone. The object was rubbed within the grooves filled by abrasive (Stocks 2003: 203).

Fig. 5.8 – (From left to right) Possible marks of leather polishing on the *Petschaft* #197 and on a vase from the Quartier Mu (modified after Morero 2009: 401, Fig. 3.47)

Overall, the whole polishing process mainly consists in multiple operations making use of progressively finer granulometry of the abrasive and possibly of different tools. It is summarized in Table 5.6, which is not meant to provide a detailed description of the physical output of the processes, but only to observe their macroscopic properties. Importantly, each of these stages could have indeed been further divided in more substages, according to the available tools and/or the different granulometry of the abrasives.

Phase	(Stage 0)	Stage 1	Stage 2	Stage 3
Description	Heat treatment	Coarse abrasion/polishing	Polishing	Final polishing
(Unearthed) tool	Furnaces?	Rubbers, slabs, chisels?, (coarse grained abrasive)	Rubbers, slabs, grinders?, (fine grained abrasive)	Rubbers, slabs, grinders?, (leather laps), (fine grained abrasive)
Indirect evidence	Whitened or intense red pieces	Lack of sawing and filing marks	Smooth, brilliant and very flat surface	Extremely smooth and brilliant surface
Evidence of lack	Light red/orange pieces	Presence of sawing and filing marks	Unsmooth and less brilliant surface	Irregularities within the intaglio

Table 5.6 - Summary of macro-processes involved in the treatment of the seal's surface. In red, the stages possibly preceding the engraving/perforation of the seal

5.4.2 Experiments for polishing

I tested the efficiency of a sandstone slab (i.e., a passive polishers) for coarse polishing by rubbing onto it both a serpentine (3.5 × 5 cm ca.) and a jasper (2 × 2 cm) surface. The former shows a relatively flat surface found in nature, while the second results from sawing. The sandstone was lubricated through water. I took 7 minutes ca. to achieve a regular surface and abrade major irregularities. I also tested active polishers, but they proved by far less effective. The efficiency of passive tools for coarse polishing is due to the fact that this process requires a decidedly high pressure.

Most part of the resulting surfaces are smooth and lowly brilliant (see Fig. 5.9). They clearly show macroscopical toolmarks resulting from the action of the abrasive particles produced by the rubbing on sandstone. Notably, I was not able to remove smaller irregularities in the surface. Similarly, the serpentine piece shows deeper depressions which I did not remove during the small test and would have required at least some hours of work. Obviously, the latter would have been easily removed through either filing or a chisel under indirect pressure.

In order to tests differences among contact materials, I carried out further experiments on coarse polishing. I polished roughly rectangular stone surfaces (9-16 cm^2 ca.) resulting from the wheel cutting and therefore showing its typical tool marks and major irregularities. I budded these pieces on a tool employed by modern engravers, i.e., a bronze circular lap. I fixed the lap onto a wooden block to enhance the stability of the lap. A powdered emery abrasive (granulometry of roughly F220) and a water lubricant are mandatory to polish stones harder than alabaster. I rubbed the stone pieces in a circular way and frequently lifted them in order to prevent the abrasive from coming out of the lap.

Fig. 5.9 – (From left to right) Results of coarse polishing on two pieces of jasper and the setting of the experiment

Such a polishing produced more regular and flattened surfaces by removing both major irregularities and most of the marks left by the cutting wheel. Still, the resulting surfaces retains all the minor irregularities, mostly being small pits and scratches (see Fig. 5.10). Similarly, although the abrasive has a relative fine granulometry, macroscopic marks yielded by its action when rubbing are observable. They are chiefly parallel grooves reflecting the circular rubbing of the stone on the lap. Notably, after 7 minutes working, deeper depressions on jasper faded thanks to the action of the emery abrasive. No progress toward a brilliant surface is manifest.

Fig. 5.10 – (From left to right) Detail of toolmarks after coarse polishing on the jasper piece and (un)polished agate one

Differences among materials are comparable to those observed for the cutting of raw materials (see Table 5.7). I coarse polished a sawed surface in alabaster showing noticeable irregularities (more than 2 mm of differences with the respect to the flattened surface) 3 times faster than a marble one. The latter registered a value akin to that of both rock crystal (1.13 times slower) and jasper (1.36 times slower). By contrast, I polished agate 12.5 times slower than jasper. Still, as the latter is harder than the previous ones, less marks resulting from the action of the abrasive are visible on the resulting surface.

Material	Coarse polishing rates (cm^2/min)
Alabaster	10.28 (after roughing out) ~ 5.04 (no roughing out)
Marble	3.4
Rock crystal	3
Jasper	2.5 (after roughing out) ~ 2 (no roughing out)
Agate	0.2

Table 5.7 – Speed rates of coarse polishing

5.5 Step three: perforating the seal

Poursat (1996: 106) placed the process by which the stringhole was opened before the engraving of the seal, while Younger (1981: 38) expressed the opposite opinion. Although the former view rather remains a *communis opinio*, it must be stressed that a number of engraved seals show either unfinished or no stringhole, while the opposite never occurs. Moreover, some seal shapes are never perforated and would imply that either they were not worn, or the string was bound around the surface.

There is clear evidence that the stringhole was perforated starting from two different extremities. Indeed, few seals with incomplete stringhole show two perforations starting from two opposite sides (see HM 2750 = Poursat 1996: 105). On an unfinished lentoid (Younger 1981: 32, Fig. 3), a relatively shallow hole was drilled before the engraving. Although it could obviously refer to an in-progress stringhole, Younger (1981: 31) supposes that it was made in order to secure the seal to a "raked stand, perhaps of wood".

5.5.1 Experiments for opening the stringhole

At least on steatite, the stringhole was plausibly opened through vertical pressure. Actually, this is the most probable way for hard stones too and matches a number of evidence coming from beads perforation techniques (e.g., Müller 2000: 198 and Stocks 2003: 213-230). Thanks to such a technique, following a straight path during the perforation is not particularly difficult for an artisan provided with at least moderate skills.

By contrast, I noticed a more relevant disadvantage of opening the stringhole with a single channel, i.e., not starting the perforation twice from the opposite sides. Indeed, the surface opposite to that from which the drilling started tends to fracture and produces a jagged edge. I proved such a phenomenon on alabaster and marble (see Fig. 5.11). Notably, the same observation was made for agate and carnelian too (Kenoyer & Frenez 2018: 403). The cutting rates of such

operation, according to the different materials, are discernable from the rates of both solid and tubular drill impressing a vertical load (see Tables 5.11 and 5.13).

Fig. 5.11 – Outcome of perforations starting from one side only. (From left to right) On alabaster and on marble

5.5.2 A peculiar class of stringholes

An interesting category is represented by seals having an eight-shaped stringhole (see Fig. 5.12). Such a feature was detected by Anastasiadou (2011: 19) on five three-sided prisms. It is regarded as an example of either a double or an imperfect perforation. The double perforation of two almost adjacent holes was only employed for V-shaped stringholes. However, a V-shaped stringhole is attested only once on MM II seals (i.e., III 062, an unfinished cube), while it is normally at home on Prepalatial ones. What is more, such a stringhole is incompatible with the fact that the opposite side is holed too.

Some experiments demonstrated that, on Crete, a wooden type of the Egyptian stone eight-shaped borer might have been adopted (Morero 2011: 215-216 Fig. 13; 2013: 73; 2014: 341). On steatite, such a result can be easily achieved by enacting the tool freehand. Larger and asymmetrical stringholes are also attested on III 190 and 212 and might be tentatively associated with the usage of a borer.
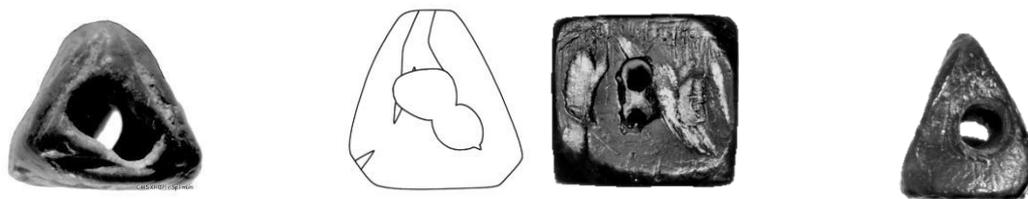
Fig. 5.12 – (From left to right) Three-sided prisms with eight-shaped stringhole, i.e., XII 071 and II.2 055; a four-sided prism with double perforation, i.e., III 062 and a three-sided prism with "atypic" perforation, i.e., III 212

5.6 Abrasives and their implications

Although the chronological hiatus with the MBA period is huge, it is worth noting that abrasives are among the few seal engraving tools certified by ancient literary sources.

Specifically, Thphr. *Lap.* 44 refers to it as ἀκόνη 'whetstone, hone', a term employed at least from the 6th-5th century BCE for an abrasive in use to sharpen metal edges. As it was quoted as coming from Naxos (see Pind. *Isthm.* VI 73 ἀνδράσιν ἀεθληταῖσιν Ναξίαν ἀκόναν), it is commonly identified as emery, also mentioned by Plin. *Nat. Hist.* XXXVI 52, 164 as exclusively employed for engraving seals.[30] Emery is commonly recognized as being the best abrasive in the antiquity (Mottana & Napolitano 1997: 180). It roughly measures 9 on the Mohs scale and is therefore able to easily carve all the hard semiprecious stones in use for Minoan seals.

However, direct traces of its usage only come from Neopalatial environments (Warren 1969: 160 and Lazzarini 2001: 576). The usage of this abrasive during the Protopalatial period is therefore nowadays still hotly debated. The exploitation of the emery at Naxos goes back to the Late Neolithic period (Boleti 2014: 174). A lump of Naxian emery was noticeably found in an EM I context within the Knossos Palace Well (Hood & Cadogan 2011: 62, 70). Accordingly, the presence of emery at least from the Protopalatial period still finds consensus in the absolute majority of scholars (Gorelick & Gwinnett 1992: 60-61, Krzyszkowska 2005: 86, Evely 2010: 396, Konstantinidi-Svyridi *et al.* 2014: 12 and Watrous 2021: 38).

On the other hand, Stocks (2003: 91) highlights that another potential abrasive powder would have suitable and easily accessible, namely the waste production of previous hard stone engravings. This by-product would include the abrasive employed for the previous work, the material of the worn tool and the

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[30] Yet, as Theophrastus noted that Armenia would have been the best source for ἀκόνη, it is plausible that the latter was referring to the radiolarite (see Mottana & Napolitano 1997: 180).

engraved hard stone itself. Alongside this, another candidate is the quartz sand, roughly 7 of the Mohs scale. Its employment was suggested for Minoan stone engraving (Morero 2013: 70), as such a stone too is available on Naxos. Once more, direct evidence is still lacking. Notably, an abrasive produced from a stone of the same hardness of the one which should be carved is still able to engrave it, although the process is predictably slower.

5.6.1 Experiments with abrasives of different hardness

I tested the difference between abrasives of different hardness by means of an electric horizontal spindle provided by the artisan. The bit I employed was a copper cutting wheel (Ø 4 mm). I tested the efficacy of abrasives on two different stones, i.e., marble and jasper. I carried out two measurements for each stone by carving 2 mm deep stroke. I made the first measurement by working with an emery wet abrasive, while the second was made through a garnet wet one (Mohs 6.5-7.5). In both cases, I mixed the abrasive powder with olive oil.

Garnet was plausibly employed as an abrasive during the Bronze Age and approximates the supposed hardness of both the by-product of (medium-)hard stone seals manufacture and the sandstone found at Naxos. The results (see Table 5.8) show that, with a medium-hard stone, no decisive difference is to be detected. By contrast, the work on jasper is almost 1.5 times faster with the emery abrasive. After slightly less than 20 minutes of cutting, I did not register relevant differences in the wear of the instrument.

Material	Garnet abrasive	Emery abrasive
Marble	0.8 mm/min	0.83 mm/min
Jasper	0.57 mm/min	0.85 mm/min

Table 5.8 – Cutting rates according to material and abrasive

5.6.2 Experiments with wet and dry abrasives

It is commonly agreed that abrasives are not mandatory to engraving soft stones, as materials of freehand tools (e.g., bone, copper and bronze) are harder than them (Evely 1993: 150-152). The work without abrasive proved totally ineffective with the marble employed in these experiments. On the other hand, with soft stones, all kinds of abrasives do not improve the efficiency of the work. In general, this is due to the fact that stones less than 2.5 on the Mohs scale are soft enough to make the action of hard abrasives useless. What is more, abrasives (especially when wet) tend to merge with powder produced by soft stones such as talc (including steatite). As a consequence, the abrasive yields a relatively dense paste which obstructs the cavity of the intaglio and hampers the carving process. Such a phenomenon is particularly visible with the tubular drill. Indeed, this drill tends to be filled by the abrasive. This phenomenon, much faster with soft stones, slows the further operation down and the drill must be frequently withdrawn (Stocks 2003: 126).

Therefore, Stocks (2003: 128) suggests that a dry abrasive could solve this problem. Dry abrasive normally does not drastically reduce the efficiency of the tool. Still, on soft stones, I noted that dry abrasive does not speed the work up (see Table 5.9), even though troubles with both free-hand and rotatory tools are reduced. Such observations are in line with those of Stocks (2003: 112), who does not appreciate differences in cutting rates.

Tools powered by hand	No abrasive	Wet emery abrasive	Dry emery abrasive
Saw with tooths	8 mm/min	8 mm/min	8 mm/min
Saw without tooths	2 mm/min	1 mm/min	1 mm/min
Bow solid drill	3 mm/min	2 mm/min	2 mm/min

Table 5.9 – Cutting rates according to hand-powered tools and abrasive solution

Despite this, the usage of abrasives on soft stones might be needed in order to enhance the aesthetic quality of the engraving. Indeed, with a hand-powered solid bow drill, a cup-sinking carved by means of the abrasive clearly show a smoother intaglio (see Fig. 5.17). As pointed out by Anastasiadou (2011: 39), abrasive may also serve in order to achieve a more homogeneous cavity when cutting freehand. Another effect of the abrasive is observable after sawing. Anastasiadou (2011: 39)

noticed that 'blanks' created through freehand techniques can be blunt up to a U-profile by means of abrasive. Notably, I achieved a U-profile by sawing with abrasive on both soft- and hard stones (see Fig. 5.4). Conversely, the outcomes of working without abrasive are almost perpendicular to the surface.

5.7 Step four, part 1: engraving a soft-stone seal

The next sections explore techniques employed for carving motifs on seals, the appropriate tools and their related efficiency by means of a series of tests. I begin with freehand techniques employed for soft stones. I tested the efficiency of three different tools, i.e., burin (§5.7.1-2), point and chisel (§5.7.3), by comparing their efficiency and wear rates according to the different materials from which these tools were possibly fashioned. Furthermore, I investigate the aesthetic outcomes of the different ways in which these tools can be used, as well as differences according to the contact materials.

Engraving soft stones, mostly steatite, was commonly performed through freehand techniques, while the usage of drills was extremely rare, especially during the MM II period. The toolkit of artisans working with steatite included burins, points, chisels, knives, and other kind of blades. The cutting edge of these instruments may vary among metal, bone, and stone. Such tools were not exclusive of seal manufacturing, but obviously employed for a wide range of tasks, e.g., stone vase manufacturing (Warren 1969: 157-165). Moreover, all these tools could have been in use for pre-engraving processes too (Anastasiadou 2011: 38).

Within the 'Atelier de Sceaux', a number of possible metal edges employed for burins were unearthed, as well as scrapers and points (Poursat 1996: 107). Similarly, the existence of bone points attached to burins is reputed as extremely likely (e.g., Dessenne 1957: 127 and Dierckx 1992: 4). Although evidence from the Quartier Mu is scarce (Poursat 1996: 108), their usage is confirmed by findings from other spots, which range from the Prepalatial onwards (Evely 1993: 88-89).

Alongside metal and bone, obsidian is unanimously accepted as one of the materials in use for making seal intaglios, by means of points, flakes and chisels

(e.g., Galanakis 2005: 25 and Anastasiadou 2011: 42) and possibly to open the stringhole, especially on soft stones (Poursat 1996: 106). The 'Atelier de Sceaux' is provided with the second largest obsidian assemblage at MM II Mallia and the whole reduction cycle is here represented (Carter 2013: 15). Most of the unearthed blades (82 out of 116) show clear edge damage from use. Such an observation leads scholars to suppose their usage for cutting soft and medium-hard stones (Evely 1993: 150). Moreover, Carter (2015: 16) suggests that intaglios from seals found within the Quartier Mu would match "the width and the length that one would associate with the workshop's obsidian blades". For instance, one of this evidence would be provided by the inscribed seal in steatite #191. A single trait is recognizable for the X-stiktogram, whose intaglio is 0.25 mm ca. large. Few obsidian flakes and burins come to light in the same context or in its neighborhood (Poursat 1996: 107 and Bellot-Gurlet *et al.* 2010: 10-11), as well as all over Crete (e.g., Younger 1981: 31; Dierckx 1992: 225; D'Annibale 2008: 191). Notably, tools such as burins and points are extremely marginal within the obsidian assemblages, both at Mallia and elsewhere, and never associated with the Quartier Mu. The vast majority of findings is indeed composed by small flakes with a narrow edge and cores waiting for a final design.

Fig. 5.13 – (From left to right) Burin in metal from Mallia Quartier Mu (after Poursat 1996: Pl. 43n); burin in obsidian from Mallia sc. 'Atelier de Fondeur' (*Bâtiment* IX-G'-couche 1) (after Bellot-Gurlet *et al.* 2010. Pl. 7b)

5.7.1 Experiments with burins

I firstly tested freehand techniques by means of three identical burins, respectively provided with bone, obsidian, and copper cutting edges. These tests aim at determining differences in techniques' outcomes and the efficiency of materials, as well as the suitability of the tool. Differently from blades, small edges of burins and points allow for a decidedly wider freedom of movement and graphic complexity with respect to the elongated edge of blades. Anastasiadou (2011: 38-39) suggests the existence of two different techniques with these tools. On the one end, the work with a vertical or sightly oblique pressure, forcing a deep penetration into the stone

("gouging" *per* Sax & Meeks 1998: 4). On the other hand, a horizontal chafing possibly manifest in shallower intaglios ("scratching/scraping" *per* Sax & Meeks 1998: 4). I tested both these techniques by means of the three burins.

Technique	Bone	Obsidian	Copper
Scratching	100	120	120
Gouging	80	160	80

Table 5.10 – Time (in seconds) to engrave a stroke 4 cm long and 2 mm deep on alabaster

These experiments point out that obsidian tools behave in a different way *vis-àvis* both bone and copper ones (see Table 5.10). With each of them, it was drawn a stroke 4 cm ca. long and 2 mm ca. deep by applying a moderate pressure. With horizontal chasing, a slightly lower cutting rate was observed. Still, with the bone tool, the vertical pressure is only 1.25 times faster. As both can achieve the same result (Anastasiadou 2011: 39), the choice between the two techniques could have been therefore often driven by idiosyncratic preferences.

Yet, with the obsidian burin, the vertical load is the slower operation at all, twice the time needed by bone and copper, and even slower than chasing. Bone is more brittle than copper, and I had to re-work its point more frequently. In particular, although bone can cut medium-hard stones (such as sandstone and serpentine) without abrasive, its usage on this kind of material provoked major worn after more or less a minute of engraving.

5.7.2 Which role for obsidian?

Regardless of the cutting rates, the obsidian burin shows an even more crucial difference. With obsidian burins and points, I was only able to engrave relatively wide strokes (i.e., no less than 0.3-0.4 mm, see Fig. 5.14). That means that small elements of motifs and details were hardly achievable with obsidian free-hand tools. Such a feature is due to the physical properties of the obsidian. Indeed, I tested on

alabaster an obsidian edge sharp as much as the bone and copper ones. However, it broke in a few seconds before the work was achieved (see Fig. 5.14).

Notably, by considering findings from Pre- and Protopalatial Mallia, burins in metal are commonly 0.3-0.4 cm width (Poursat 1996: 107), while those obsidian blades are twice wider, with an average of 0.89 cm and a thickness of 0.25 cm (Carter 2013: 20). As the intaglio of the X-stiktogram on #197 is 0.25 mm ca. wide and 0.5 mm ca. deep, it is therefore unlikely that it was made through an obsidian point/burin. Of course, such a width can be achieved through a blade. Still, the shorter blade found withing Quartier Mu is 1.61 cm long, which seems uncomfortable to shape the 2.87 mm long stroke of the X-stiktogram. What is more, as most of motifs display curved elements which are hardly engravable through a straight lame, it seems rather counterintuitive to postulate the usage of two different tools, whereas a metal or bone burin would have been enough for the entire work. Strokes on a number of unfished and trial pieces (e.g., Poursat 1996, Fig. 49) are admittedly compatible with an obsidian blade, although, without microscope analysis, no definitive prove can be adduced for determining the tool employed.

Fig. 5.14 – (From left to right) Difference in strokes width after working on alabaster with a bone, obsidian and copper burin; broken point of the obsidian edge, thought to engrave a stroke of the same width as the ones produced by the bone and the copper burin

Crucially, obsidian proved to be ineffective for hard stone engraving too. By means of an electric horizontal spindle, I was not able to penetrate into agate by means of an obsidian pointed bit with emery abrasive. I repeated the test after having applied after an access made through a diamond bit. In this case, the obsidian bit carved less than 0.1 mm deep after slightly more than 3 minutes working.

Notably, although obsidian is often thought to be the Minoan counterpart of the Egyptian flint, the latter show relevantly different features. Indeed, flint measures 7 on the Mohs scale and can even engrave the softest varieties of quartz.

As a consequence, especially with medium-hard and soft stones, it does not tend to break and produces intaglios with extreme facility. Notably, the toolkit of an Akkadian artisan, datable around 2300 BCE and working carnelian, as well as softer stones, included numerous flint tools, while no obsidian ones were found (Sax & Meeks 1995).

5.7.3 Experiments with points and chisels

Finally, another way to carve soft stones with hand-held tools consists in exercising an indirect pressure by means of a hammer or a mace (Evely 1993: 202 and Sax & Meeks 1998: 4). I tested this technique by means of a shaftless point and a flat-edged chisel reproducing attested tools (Evely 1993: 198, Fig. 78). The artisan fashioned points and chisels from both copper and bone. The latter showed a decidedly higher wear rate and must be frequently reworked to obtain relatively narrow strokes (2 mm of width ca.). Indirect percussion proved decidedly more efficient for producing deep intaglios.

On alabaster, I achieved a 1 mm ca. deep stroke through a single cut, without necessity of chafing the intaglio more times. The difference in cutting rate is even higher on harder stone. The same behavior was noted by Sax *et al.* (1998: 5) on rock crystal, in which a gouging copper point combined with abrasive was ineffective when powered by hands, while it works (with emery abrasive only) if used through indirect percussion. Still, it must be emphasized that, with small scale works, cutting rates' differences are too small to suppose a neat preference for one or the other tool. Moreover, skills needed for producing complex intaglios with indirect percussion are higher than those required for drawing with direct contact.

I tested these differences by drawing two 7 cm long and 2 mm deep strokes on a sandstone block (Mohs 3) by means of both indirect percussion and gouging. The outcomes slightly differ as regards both the cutting rate and the aesthetic result. Indeed, indirect percussion took roughly half the time needed by gouging (1 vs. 2 minutes ca.). The latter also implies a greater effort by the engraver. Moreover, the trace left by each technique are rather distinct. Indirect percussion shapes a smooth

intaglio provided by vertical walls. Conversely, gouging, when not further modified by chafing, is reflected in a clear V-shaped intaglio.

5.8 Step four, part 2: engraving a (medium-)hard stone

After discussing the techniques employed on soft stones, I turn to experiments carried out in order to explore the usage of fast-rotating tools. On the one hand, freehand techniques are indeed almost ineffective for carving (medium)-hard stones. On the other, although fast-rotating tools were sometimes employed for cutting on soft stones too, they were clearly the tools *par excellence* for (medium)-hard stone workings.

In the next sections, I therefore deepen the usage of three tools employed by Protopalatial artisans, namely the solid drill (§5.8.1), the cutting wheel (§5.8.2) and the tubular drill (§5.8.3). I carried out these experiments by addressing two main issues. First, the efficiency of each tool *vis-à-vis* a number of contact material and the technique employed for powering the tool. Second, pros and cons of specific techniques tied to the usage of these tools, such as their wear rates and the aesthetic quality of related outputs.

5.8.1 Experiments with the solid drill

For carving the intaglios, the usage of the solid drill is attested since the MM II period. For Protopalatial soft stone three-sided prisms, it is documented for almost one half of the extant objects by Anastasiadou (2011: 487-670). Similarly, its usage on hard stones is almost ubiquitous. Moreover, the solid drill would have been employed for opening the stringhole too. Such a usage would predate the creation of drilled 'cup-sinkings' and was possibly at home already during the Prepalatial period.

As it is well known, no direct evidence of the manner of propulsion is available for BA Crete. This process is mainly reconstructed on the grounds of

Egyptian paintings displaying bead/seals artisans. In such representations, a solid drill exercises a vertical pressure being powered by a bow held by an artisan (see Fig. 5.15). The drill is kept still through a rounded cup, which was bored in order to be fixed at the top extremity of the drill. Such a cup is held with the hand not working in impressing motion to the bow.
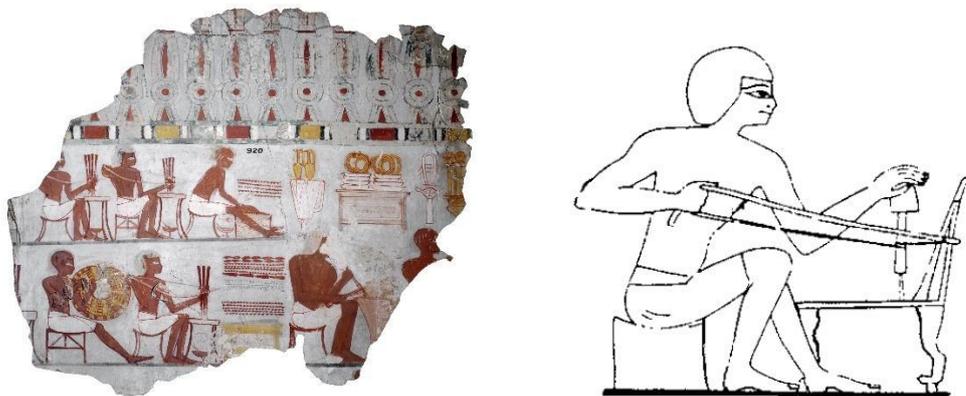
Fig. 5.15 – (From left to light) Fresco from the tomb of Sebekhotep at Thebes (18th Dynasty) showing a bead-making workshop (© The British Museum); drawing of a bow-driving artisan from a fresco in tomb of Rekhmire at Thebes (18th Dynasty) (after Stocks 2003: 50, Fig. 2.41)

The artisan prepared a solid drill (see Fig. 5.16). This tool exercises a vertical pressure set by a bow powered by the hand (see also the tool prepared by Groman-Yaroslavski & Bar-Yosef Mayer 2015: 81 for Levant bead production). The artisan built the drill according to the proportions reflected by Egyptian paintings and commonly analyzed as suitable for Minoan carving processes too (Evely 1993: 152-154). Specifically, it is composed by a 33 cm long baton with a diameter of 11.5 cm fashioned from walnut and a copper solid bit 2 cm long and measuring 1 cm of maximum diameter. The bow has a radius of 14 cm, resulting from an arc fashioned from walnut 45.6 cm long and a bowstring 47 cm long. In the lower part of the drill, the artisan inserted a stone weight in order to stabilize the rotation. To work with it, I employed an emery abrasive with a granulometry of roughly F360.

Fig. 5.16 – (From left to right) The prepared solid drill, the related bow and the positioning of the tool on working table

The engraving resulting from the actioning the solid drill on a stone piece roughly of the dimension of a MM II seal obviously takes the shape of a cup-sinking. As the depth of the cup-sinking is directly proportional to the removed material, I measured the former to estimate the cutting rates of each test, then checking it by weighting the worked object. For instance, with toothed saw, the alabaster piece lost 0.2 g after an 8 mm depth cut, while roughly 0.025 after a 1 mm depth one. Thus, values referring to the depth of the resulting cup-sinkings are employed to describe the efficiency of the tools according to different materials. In total, I worked with the tool for 40 minutes ca. and I observed no relevant wear of the copper point.

The results show that working on soft stones takes 28 up to 42 times less time than on medium-hard (i.e., marble) and hard stones (i.e., jasper). Moreover, working on soft stones does not require abrasives like in the two other cases. Indeed, abrasive is ineffective in improving the cutting rate on soft stones and even results in a work one third slower. Wet abrasive tends to merge with the powder produced by the abrasion. As a result, in the first take of the experiment it obstructed the cup-sinking and reduced the contact between the drill's bit and the stone, making a frequent cleaning of the surface necessary. Therefore, I repeated the test with dry abrasive in order to reduce the obstruction of the cup-sinking. However, I appreciated no noticeable difference in cutting rate, with the abrasive powder still hindering the movement of the bit and its contact with the stone. Still, the general process was faster, as no frequent cleaning was needed. Lastly, I tried to achieve the same result with bare hands. I produced another 'cup-sinking' of the same

diameter trough a copper point rotating backwards and forwards and applying vertical pressure. The work was decidedly slower, and the resulting outline clearly more irregular (see Fig. 15 and Sax & Meeks 1994: 153).

Fig. 5.17 – (From left to right) Cup-sinkings resulted from (a) working with drill and without abrasive; (b) working with both drill and abrasive; (c) working free-hand without abrasive

In all the other cases, working without abrasive proved to be totally ineffective. Marble and jasper are rather close in cutting rate, thought I carved the former slightly more than 25% faster (see Table 5.11). I repeated the test with a piece of black, red-veined jasper, on which I registered the same cutting rate as the red one. Noticeably, the result I obtained on jasper is in line with the experiment carried out by Evely (1993: 79) with a tubular copper drill on "quartz", which reports that half an inch was cut in 3 hours. Similarly, Stocks detected a ratio of 1 : 10 with solid drill between calcite (Mohs 3) and quartz. Indeed, the cutting rate produced by solid bow drill would yield a 1.26 cm cut after a 3-hours working. I detected no difference between working on jasper with or without dry abrasive. Cleaning is not frequently needed, as the powder produced by the abrasion is less in comparison to alabaster.

The only other experiment addressing Minoan seals by means of ancient tools' reproductions, i.e., Müller (2000), employed a diamond point mounted on the horizontal spindle to cut jasper (said to be Mohs 6-7), serpentine (4) and steatite (2). Interestingly, jasper was cut only three times slower than steatite, which confirms its relative softness (see Table 5.11). The difference with serpentine (*vis-à-vis* the marble employed in this experiment) are predictable given its hardness. As Müller (2000: 202) does not provide information on the granulometry of the cutting point nor on its actual sizes, and the hardness of jasper is rather vague, more precise comparisons cannot be made.

Material	Cutting rates (mm/min)	Müller (2000: 202)
Alabaster	3 (no abrasive) ~ 2 (wet abrasive) ~ 2 (dry abrasive)	6 (Steatite)
Marble	0.09	4 (Serpentine)
Red jasper	0.07 (wet abrasive) ~ 0.07 (dry abrasive)	2
Red and blackveined jasper	0.07	-
Agate	0.007	-

Table 5.11 – Cutting rates with solid bow-powered drill according to the materials and their comparison with Müller's results (2000: 202)

By contrast, carving on agate takes up to 10 times more time than that on jasper (see Table 5.11). A cup-sinking within CH 044 on #293 is roughly 0.8 mm deep. As the seal is fashioned from jasper, one may therefore estimate slightly more than 11 minutes to accomplish the work, while on agate it would require almost two hours. Notably, the bit penetrates with extreme difficulty within the agate. To do so, it needs a guiding channel, which took me at least around a minute to make. Only after fixing the guiding channel, I could start the proper carving. Such a problem was likely solved by carving a small dot roughly of the measure of the bit by means of a knife helped through the abrasive (Anastasiadou 2011: 38). Such an operation is conversely rather unnecessary for jasper and medium-hard stones.

Cup-sinkings engraved through the solid drill only are widespread on jasper seals. As it is well known, they often appear as fillers on inscribed ones and are employed to shape the outline of the motifs. Revealingly, they are decidedly rarer on both agate and carnelian seals, where they are almost invariably made through the combination of tubular and solid drill. On inscribed ones, they never appear as fillers and are mostly replaced by lunettes and circles made through the tubular drill. Notably, exceptions are represented by two 'whitened' pieces (i.e., X 050 and #269), which might be softer. The smoothness of the wall of the cup-sinking is mostly directly proportional to the hardness of the stone and the difficulty in engraving it (see Fig. 5.18). The medium-hard stone (i.e., the marble) shows a rather irregular outline and a number of small mistakes (mostly hard to observe without a close scrutiny of the object) widening the cup-sinking in the wrong direction.

Conversely, the 'cup-sinking' resulting from drilling on agate perfectly mirrors the shape of the bit and minor irregularities of the outline are almost absent at all.

Fig. 5.18 – (From left to right) Cup-sinkings engraved on marble, red jasper, black, red-veined jasper, and agate

Anastasiadou (2011: 40) suggests that, as the vertical pressure technique was merely employed for centered-circled, lines and cup-sinkings during the Prepalatial period, it "was unsuitable for the production of other shapes". According to the previous observations, a 4 cm long stroke would have needed more than 13 minutes to be engraved with a solid drill, while only 2 minutes ca. are required by a burin. Similarly, it must be stressed that the engraving of complex motifs through a fixed tool is particularly hard by itself, as it implies that the drill must be lifted and re-positioned a high number of times. It is therefore possible that such differences would have forced the engravers to prefer free-hand techniques.

5.8.2 Experiments with the cutting wheel

Cutting wheel cannot be employed through vertical pressure and its appearance was tied to the introduction of the horizontal spindle. Indeed, in Mesopotamia too it appears from the 2nd millennium BCE (Sax *et al.* 1998: 1). As repeatedly stressed (e.g., Sax *et al.* 1998: 3 and Anastasiadou 2011: 46 fn. 257), the cutting wheel leaves a trace decidedly akin to that of the file. Indeed, without a duly magnification, it is sometimes hard to distinguish them based on physical characteristics. However, files and cutting wheels differs for a number of features.

According to Sax *et al.* (1998: 4), on Mesopotamian roll cylinders, the usage of files and cutting wheels is almost equivalent if they are used perpendicularly to the stringhole, i.e., by exploiting the convexity of the surface. In the opposite direction, in which the engraved surface is more or less flat, files are unsuitable to cut small strokes and the generalization of cutting wheel can be safely established. Now, almost all the MM II seals have a flat surface, while convex ones mainly

spread starting from the MM II-III cushion seals. Starting from the Prepalatial period, filing on such surfaces is clearly employed for strokes reaching the edge of the surface. Conversely, the cutting wheel is decidedly more suitable for small strokes at the center of the surface. Furthermore, although sometimes they can be confused, impressions reveal that filed strokes can only leave a linear longitudinal profile, while wheel cut ones are commonly more curvilinear (see Fig. 5.19).
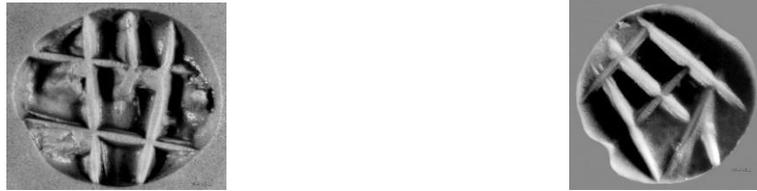
Fig. 5.19 – (From left to right) Strokes carved with file, i.e., III 050, and with cutting wheel, i.e., VIII 048

I carried out tests with the cutting wheel by applying emery abrasive. For each test, I held the hard-stone piece so that it was parallel to the bit (see Fig. 5.20). I then applied a moderate pressure on the object towards the spinning wheel. To take time measurements as precise as possible, I employed the following method. Given that the stones were parallel to the bit, it was possible to measure the time at which the bit touched the stone. After few seconds the bit is contact with the carved stone, it indeed yields a straight groove starting from the stroke carved by the wheel (see Fig. 5.20). In order to make such grooves more manifest, I applied abrasive to the bit too. Obviously, when the bit is in touch with the stone, the wheel cannot penetrate deeper. Since the bit is placed at the very center of the wheel, it follows that, when the bit touches the stone and grooves begin to appear, the wheel must have cut a stroke with a depth equal to its radius. I carried out this test on all stones but alabaster. the usage of the cutting wheel on soft stones is indeed unattested.
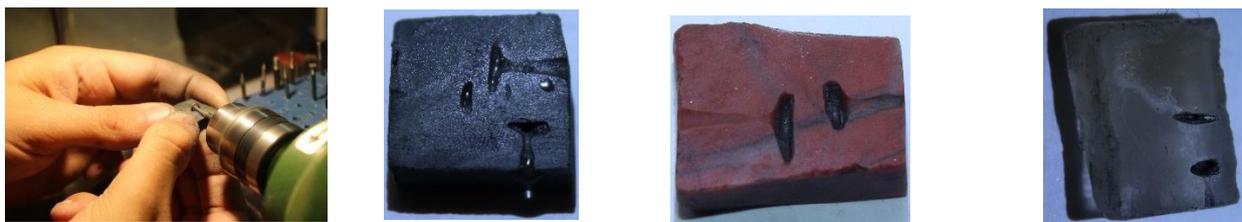
Fig. 5.20 - (From left to right) The positioning of the stone pieces with respect to the cutting wheel; outcome of the wheel cut and related grooves on marble, jasper and rock crystal

The results (see Table 5.12) mainly individuate two groups of stones. Indeed, with marble, rock crystal and jasper, the wheel worked 2.13-2.70 times faster than on agate, carnelian, and moos agate. Moreover, the former group caused only minor wear to the tool. Conversely, 15 minutes of cutting on stones of the second group consumed roughly 30% of the wheel's diameter. In both cases, chalcedony is at the boundary between the two groups. Working on it is slightly less efficient than that on stones of the first group (1.25 times slower), but still twice faster with respect to agate, carnelian and moos agate. Similarly, its rate of tool wearing is placed in-between the two groups. In respect to the solid drill, differences between materials are less pronounced, because of minor surface of abrasion and the usage of the electrified tool.

Material	Cutting rates (mm/min)	Wear rates (mm of radius)
Marble	0.53	Less than 0.05
Rock crystal	0.51	Less than 0.05
Jasper	0.53	Less than 0.05
Chalcedony	0.43	0.05-0.1
Carnelian	0.2	0.1 ca.
Agate	0.23	0.1 ca.
Moos agate	0.24	0.1 ca.

Table 5.12 – Cutting and wear rates with cutting wheel according to different materials

5.8.3 Experiments with the tubular drill

The tubular drill represents one of the most crucial innovations in Minoan stone working and its usage is extremely widespread on Protopalatial glyptic. Such a tool was plausibly introduced from Egypt or the Near East between the end of the Prepalatial and the beginning of the Protopalatial period. Only two seals, i.e., II.1 272 and II.1 366 (see Fig. 5.21), could hint towards a usage of the tubular drill before the MM II period. The former is a typical late Prepalatial (EM III-MM IA) piece in shape and material, i.e., a steatite cylinder with Δ-shaped stringhole. The latter is another cylinder. It would putatively attest, together with II.1 103, also in rock crystal, the earliest examples of seals fashioned from hard stones.

So, two of the earliest seals worked with the tubular drill are both in rock crystal. Rock crystal was quite easily locally sourced from mines. It was even a popular material for vases. The first attestation of tubular drilling on vases comes from a rock crystal core from MM I-II Vat Room Deposit at Knossos (Panagiotaki 1999: 33). When hollowing a solid vase with a large tubular drill, waste material is shaped like a cylinder. It could be that the idea and the techniques of working with the tubular drill on hard stones came to seals via rock crystal vases, whose waste material was very similar in shape to cylinder seals. Moreover, as shown in §3.9.3, iconography on seals in rock crystals clearly differ from the one on the hard stone seals.

Fig. 5.21 – Impressions of II.1 272 and II.1 366

There is good evidence in this direction. First, the analysis carried out by Gorelick & Gwinnett (1992: 61) shows a "conchoidal pattern" on Proto- and Neopalatial stringholes compatible with the work of a copper tubular drill. Notably, such a pattern is only to be found on hard stone seals, while soft stone ones show rather different concentric grooves. Second, at least a carnelian seal from the Quartier Mu was clearly holed through a tubular drill (Poursat 1996: 106-107). Notably, the close association with perforation on hard stones might be linked to a crucial enhancement of the cutting rate, obtained with drills with a smaller cutting edge with respect to the solid bit. Such a difference is indeed less relevant for soft stones, in which all the fast-rotating tools easily penetrate. Notably, only six Protopalatial seals in soft stones display motifs engraved with the tubular drill and its usage continued to be extremely rare on soft-stone seals belonging to MM II-III style groups.

A few tubular drills survived from the Quartier Mu (Poursat 1996: 106). They are all made in copper and measure a diameter of approximately 2 mm. The

existence of larger tubular drills is however entailed by good evidence. For instance, the sign CH 005 on the green jasper four-sided prism #295 was engraved through a tubular drill with a diameter of 3.5 mm, whose wall was slightly more than 0.3 mm thick. According to Vargiolou *et al.* (2007: 48), wood is another good candidate for tubular bits. As wood is a perishable material, the only (indirect) evidence would lie in the fact that no copper drills for vase manufacturing was unearthed on Crete.

In these experiments, I employed a copper tubular drill for both the opening of the stringhole and the intaglio (see Fig. 5.22). Therefore, I measured the cutting rates as the tool worked under both a vertical and a horizontal pressure. In both cases, I employed an electric drill. To improve the efficiency of tool (Vargiolou *et al.* 2007: 50), I lifted the drill every 30 seconds ca. Such a procedure and was plausibly known by Minoan engravers.

Fig. 5.22 – (From left to right) The tubular bit employed for the experiments; the application of the tubular drill with vertical pressure for opening the stringhole; the application of the tubular bit on the horizontal spindle for carving a ring

The cutting rates of materials confirm the observations made for solid drill and cutting wheel (see Table 5.13). As a tubular bit, with respect to the solid one, reduces the engraved surface, differences among materials are less evident. Working on soft stone was decidedly more efficient without abrasive. In this latter case, it is almost 6.5 times faster than that on marble, while with wet abrasive it is 5 times faster. The worst disadvantage of the abrasive, especially the wet one, is that it almost instantly obstructs the tubular drill. Although it is slightly slower, such a process occurs with (medium-)hard stones too (see also Stocks 2003: 112 for a similar result through a 1 cm diameter reed tube).[31]

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[31] Another problem tied to wet abrasive is that, at least big-scale artefacts, it is harder to remove than the dry one (Stocks 2003: 123). However, removing the abrasive, even the wet one, from a cup sinking or a circle on seals is easily achievable through water and a small brush and no decisive

Again, marble and jasper proved to be much closer than the latter and the other hard stones employed for Hieroglyphic seals. With vertical pressure technique, jasper was engraved about 3.7 times faster than agate, while the ratio is exactly 5 : 1 with agate and 3 : 1 with chalcedony in the case of the horizontal spindle (see Table 5.13). By contrast, rock crystal, which was only tested with the horizontal spindle, shows the highest cutting rate. Notably, differently from cup sinkings, it is not possible to cut a guiding channel for the tubular drill.[32] The marble does not show a particular difference with respect to both rock crystal and jasper. Importantly, the measurement was taken after a cut in the sense of the vein, which is pretty rare for Minoan stringholes (Younger 1981: 38). Depending on the material, or even on the single piece, cross cutting can drastically reduce the speed rate.

Material	Cutting rates with vertical pressure (180rpm) (mm/min)	Cutting rates with horizontal spindle (3000 rpm) (mm/min)
Alabaster	4.5 (no abrasive) ~ 3.5 (wet abrasive)	-
Marble	0.70	0.39
Rock crystal	-	0.55
Jasper	0.71	0.45
Chalcedony	-	0.15
Agate	0.19	0.09

Table 5.13 – Cutting rates with the tubular bit according to both type of pressure and material

5.9 Step five: post-engraving processes

As shown in §5.4.2, after the seal was engraved and perforated, it often underwent a process of (final) polishing. Such a process involves progressively finer abrasives and/or tools such as rubbers and slabs, in order to remove toolmarks and

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difference *vis-à-vis* the dry one would be entailed. The same applies to the abrasive trapped within the tubular drill. Indeed, while it is reported that in 1-8 cm of diameter tubes "wet sand powder, owing to its weight and fluidity, cannot be withdrawn; it sinks to the bottom" (Stocks 2003: 126), wet abrasive powder can be removed from a 2 mm diameter in a relatively short time by means of water and a point. Of course, dry abrasive does not require such a process.

[32] Such a process was conversely in use for vase-making (see Stocks 2003: 158), but it seems unlikely for seal engraving.

irregularities produced by the engraving. The positioning of these processes within *chaîne opératoire* is suggested by the fact that a number of workshop fresh seals display signs of sawing and/or filing, as well as shallow scratch marks. It is therefore possible that such seals are actually unfinished. On steatite, such marks are however removable even through a coarse polishing, pointing to the absence of polishing processes at all. Still, it must be noticed that few (not workshop fresh) seals show toolmarks on the unengraved parts only, i.e., on the profile (see Fig. 5.23). By contrast, no (medium-)hard stone seal datable to the MM II period present toolmarks. Similarly, no inscribed seal is unpolished but #232. As shown in §4.3.1, it is however uncertain if it is truly inscribed or not.

Fig. 5.23 – Profile and engraved faces of III 209, workshop fresh and showing toolmarks on the profile only

However, there are at least two possible evidence pointing that polishing was sometimes carried out before the perforation and the engraving of the seal. First, both solid and tubular drill, regardless of the speed of motion, leave small irregularities along the circular hole. Such irregularities mainly consist in a narrow and shallow ring all around the wall of the hole. Through the scrutiny of 3D models of Hieroglyphic steatite three- and four-sided prisms (see Fig. 5.24), it is evident that such a ring features their stringholes too. Second, scratches on the profile - and often on the engraved faces too - are visible (see Fig. 5.24). These shallow lines are removable in a few seconds through polishing on a sandstone slab with a water lubricant (see Fig. 5.26).

Fig. 5.24 – (From left to right) Stringholes on the 3D models of #236 (three-sided prism in black steatite) and #291 (stepped four-sided prism in black steatite); the grooves on the profile of XII 016 and the full-polished profile of XII 049

Notably, II.2 117 has a well-polished surface but an unfinished stringhole (see Fig. 5.25). A highly translucent polished surfaced is also visible on HM 2750 (= Poursat 1996: 105), with only half of the stringhole finished but the engraving already executed. Similarly, the three-sided prism II.2 082 (see Fig. 5.25) has both the stringhole and a polished surface, while the engraving is unfinished. Such discrepancies highlight that not all seals, even those belonging to the same stylistic group, where fashioned exactly in the same way.

Fig. 5.25 – Polished surfaces of II.2 117a (with unfinished stringhole) and II.2 082a (with unfinished intaglio)

In this study, I did not consider the alleged application of polishers on fast-rotating tools, as evidence for such implements is scarce. Accordingly, I tested these processes with progressively finer abrasives applied on passive polishers, either wooden or buckskin laps. To ensure it was fixed, I nailed the buckskin piece to the working table. Active (leather) laps proved rather antieconomic for polishing processes involving the entire surface, although their usage cannot be excluded (e.g., Younger 1981: 34 and Stocks 2003: 91). Notably, a wet leather lap (e.g., lubricated with water) retains the abrasive particles when rubbing and reduces its waste. As observed in §2.4, active and passive polishers can yield the same results, although the latter allow a greater force to be applied. I tested passive polishers on stone surfaces were tested by reproducing the (final) polishing stages on a piece of marble.

On alabaster, polishing through slabs deletes shallow marks of roughly less than 0.5 mm. This means that, on soft stones, polishing of the surface was possible after the engraving took place too, although it can sometimes produce damages on the motifs' wall (see Fig. 5.26). By contrast, slabs and rubbers are ineffective for polishing inside the intaglio, even in case they are combined with abrasive. Such a work is better achieved by means of a leather lap used actively or a soft and flat burin/point combined with abrasive.

I experimented both these processes on a replica of the sign CH 044 that I engraved on alabaster. The burin proved more efficient than the leather lap. Indeed, leather was rubbed inside the intaglio with more difficulty, as its width does not allow a precise positioning, especially inside smaller motifs. On the other hand, wet abrasive can be thrown within the intaglio and rubbed through a flat-edged tool. By means of the latter, I was able to polish the sign up to a highly brilliance in roughly 40 minutes. With leather, the same work would have taken more than twice this time. This process also reduced damages on the intaglio's wall. As noticed by Anastasiadou (2011: 38), such a process implies that the engraver precisely controls the applied pressure, and more check would be needed to achieve a regular intaglio.

Fig. 5.26 – (From left to right) The sandstone polisher; Shallow scratches replicating guidelines on the three-sided prisms profile and toolmarks after polishing of this surface

I decided to further test such a process on an unengraved marble surface, using all the tools passively (see Fig. 5.27). Through an increasingly finer emery powder (i.e., F220, F360, F400, F800, F1000 and F1200), I carried out six different stages of polishing, from coarse polishing up to the final smoothing. Each phase took roughly 10 minutes. I moved the marble piece circularly onto the lap, after lubricating it with water and throwing the abrasive powder on it. Notably, although all the processes involved the same dynamic, i.e., a stone piece rubbed onto a fixed lap, stone and bronze laps proved much more effective for the first stages. By contrast, it is almost impossible to flatten small cavities and minor irregularities caused by the action of the polishing abrasive by working on stone or bronze laps. Accordingly, I was able to successfully carry out this last stage by means of the leather lap only. The latter can indeed fit the actual outline of the surface and rub the abrasive particle inside small irregularities. Thus, the process yielded a highly brilliant and flattened surface, whose veins are well distinguishable and toolmarks invisible with necked eye (see Fig. 5.27).

Fig. 5.27 – (From left to right) The process of polishing with the passive leather lap; the piece of marble before and after the final polishing

5.10 Conclusions

This Chapter compared data available from archaeology and previous experimentations with the results of experiments I carried out in order to test the efficiency of these tools according to materials and abrasives.

I carried out experiments by employing a wide range of tools and contact materials. Specifically, I tested hand-held tools for cutting raw materials (saws, files and rulers), engraving (burins, points and chisels) and polishing (stone slabs, rubbers and leather laps). Alongside this, I tested fast-rotating tools, i.e., solid and tubular drill and cutting wheel. I checked different applications for these tools, e.g., the application of hand-held ones with both freehand and through indirect percussion, as well as the difference between the vertical drill and the horizontal spindle for fast-rotating ones.

On the other hand, I chose contact materials in order to represent the whole spectrum of hardness attested for Hieroglyphic seals. I therefore employed a soft-stone (i.e., alabaster), two medium-hard ones (i.e., marble and serpentine) and all the hard stones employed for Hieroglyphic seals (i.e., jasper, carnelian, agate, chalcedony and rock crystal).

I showed that materials used for Hieroglyphic seals and related techniques refer to partially different *chaînes opératoires*. As they require different degrees of skills, as well as a more or less long process of engraving, it is plausible that such *chaînes opératoires* would have contributed to defining the hierarchical role of the

seal owners. Obviously, as Hieroglyphic seals in hard materials tend to have more inscribed faces, it follows that their value and affordability was not only tied to the supplying of the raw materials, but also to the hiring of a skilled artisan able and available to work with fast rotating tools for a huge amount of time.

For instance, marks left by the cutting wheel imply that the artisan/workshop responsible for the production of that seal possessed and was able to use a horizontal spindle. Similarly, a highly brilliant surface indicates the presence of a good number of laps and/or abrasives with increasingly finer granulometry and the possibility of working with them for many hours. Palaeography too, even on soft stones, is affected by these constraints. Indeed, complex and extremely small motifs and fillers imply the usage of particularly fine burins/points in metal and their frequent re-working. By contrast, larger motifs, as well as simple strokes, can be easily carved with tools in bone and obsidian too, or even with files and blades. Consequently, recognizing the usage of cutting wheels and other fast-rotating tools on a seal would have pointed to a precise status of its owner.

By means of the experiments, I was able to quantify and qualify such a difference. All processes on alabaster took at least 10 up to 28 times less time than the others. Moreover, it is the only stone that can be easily engraved free hand and without abrasive.

First, I experimented the time employed for engraving different materials with different techniques. I showed that medium-hard (i.e., impure marble) and hard stones (i.e., rock crystal and jasper) measuring around 6-6.5 of the Mohs scale starkly differ from carnelian and agate, measuring around 7-7.5 of the Mohs scale. Such a difference resulted in a dramatic decrease of cutting rates. All processes on agate took 5 up to 10 times more time than those on jasper. For instance, if a 1.26 cm stringhole (such as that of the *Petschaft* #197) would have been engraved in more or less 3 hours on jasper, it would have taken 30 hours on agate. Moreover, while hard stones and by-products of abrasions can be more or less efficiently used for marble, jasper and rock crystal, their usage on agate and carnelian is possible but decidedly less effective. Notably, although rock crystal is commonly reputed harder than the other quartz, it is scratched easier than the other ones.

As a consequence, jasper, which is the hard stone most tied to writing, is the easier one to be carved and require much less effort than both agate and carnelian. It follows that jasper is the only *exoticum* whose cutting rates is comparable to that of local materials, such as rock crystal and some medium-hard stones. By contrast, agate, carnelian and, partially, chalcedony, would have required a much more time. Notably, such a difference is reduced by the firing process, which also tend to increase the opacity of the objects, up to the 'whitened' pieces from the MM II period onwards.

Second, I shed light on the aesthetic implications of cutting with different tools and on different materials. For instance, I demonstrated that abrasives on soft stones are useless to speed the work up, but they produce decidedly smoother intaglios. Such a difference proved true also when comparing different applications of tools. For instance, strokes I drew by chisels enacted through indirect percussion are by far smoother and more precise than those I made with burins applied freehand.

Third, I experimented the whole cycle of seal's production, starting from the cutting of the row material up to the final polishing, and shed light on pros and cons of different techniques. Specifically, I reassessed possible operations carried out during the following phases of the *chaîne opératoire*:

a)   The cutting of the raw material. Such a process was likely achieved through saws and files. For those provided with a conchoidal fracture, cleavage is another option. Toothed saws are (slightly) faster than files up minerals measuring 6.5-7 on the Mohs scale. This is because files should remove a smaller quantity of material. As a consequence, the latter tool also limits the waste of raw materials.

b)   The abrasion and coarse polishing. The first stages of flattening are likely obtained by means of polishers, some of them were found within the 'Atelier de Sceaux' (Quartier Mu, Mallia). Passive polishers, especially those in harder materials, are more suitable for the first stages. Stones such as sandstone and schist can be employed either with or without abrasive, the latter unsurprisingly producing a (slightly) faster work. By contrast, metals and perishable materials are ineffective without the abrasive.

c) The perforation of the seal. The stringhole was opened in two times, starting from each side of the seal's profile. Such a process was probably carried out in order to avoid fractures in the surface. Both tubular and solid drill were employed, the latter speeding the work up and therefore mostly employed on hard stones. Perhaps, a number of borers were used on soft stones, producing "atypical" eight-shaped or asymmetrical stringholes.

d) The engraving of the surface. The tools behave according to their characteristics. The engraving of soft stones would have been made through chafing/scratching, gouging, and indirect pressure. The latter is rather more economic, especially with stones measuring 3-3.5 on the Mohs scale. Obsidian proved almost ineffective for small-scale intaglios on soft stones, as well as bit's material combined with fast-rotating tools on hard stones. With all the fast-rotating tools, abrasive is mandatory for (medium-)hard stones. With soft stones, it only enhances the aesthetic quality of the cup-sinking. The tubular drill was tested with both vertical and horizontal pressure, the latter resulting in a faster work. With dry abrasive, the paste resulting from the abrasion must be less frequently removed from the core of drill. The smoothness of the outcome is direct proportional to the hardness of the contact material. The cutting wheel was widely employed for the outlines, as it can serve for both straight and curved strokes. Given the reduced contact edge, it penetrates faster than the other tools, but can be obviously only attached to a horizontal spindle.

e) The final polishing. Advanced phases of polishing (possibly performed after the intaglios was carved) were achieved by means of either active or passive polishers, depending on the addressed outcome. Apart from polishers putatively applied on drills, stone and wood passive polishers are still more efficient for achieving a good degree of brilliance, especially if combined with a fine-grained abrasive. Conversely, polishing inside the intaglio and deleting abrasion marks, as well as microscopic irregularities, can only be achieved by a leather lap, plausibly used actively. For polishing inside the intaglio, the fastest technique to be detected involve the combination of a flat tool combined with an abrasive thrown within the intaglio. Still, the latter require caution in order to avoid an irregular chafing of the surface.

Chapter 6 - Redefining the boundaries between Cretan Hieroglyphic and Linear A

6.1 Introduction

This Chapter addresses the ongoing discussion on the relationship between Cretan Hieroglyphic and Linear A. Specifically, I address the interaction between the two scripts by redefining the available sources to discern their origins and differences as early as the Protopalatial period. The analysis combines an archaeological and palaeographical approach. On the one hand, I rediscuss archaeological data in order to precisely define potential stratigraphical anchoring of the first instances of each script. On the other hand, I adopt a palaeographic perspective to clarify the dating of these objects and, with reference to early Protopalatial material only, examine whether they can be safely attributed to one or the other script and, sometimes, whether they can be regarded as inscriptions or not.

Furthermore, with reference to Proto- and Neopalatial material, I investigate documents showing 'hybrid' features and as such being hard to frame within one or the other scribal tradition. As most of these documents come from contexts showing a strong co-habitation of Cretan Hieroglyphic and Linear A, this work further aims at pinpointing the degree of interaction and reciprocal influence between the administrations behind those documents.

Finally, I rediscuss the formation of each graphic repertoire, with special emphasis on the selection and development of palaeographic variants, their reciprocal influences and the choice of distinctive signs. Such an analysis intends to bring together iconographic sources from Proto- and Neopalatial Crete (e.g., seals, decorations on pottery, pot- and mason's marks etc.), mostly employing motifs akin to those selected by both Cretan Hieroglyphic and Linear A, in order to shed light on the process of selection and standardization of two close writing systems *vis-à-vis* their related iconographic repertoire.

6.2 Where is it from? The origins of Linear A and its relation to Cretan Hieroglyphic

As it is well-known, Evans (1909), by analyzing documents unearthed at that time, deduced the existence of three main writing systems on Bronze Age Crete (not including the 'Phaistos disc') and argues for their chronological consequentiality, i.e., Cretan Hieroglyphic (MM I-II(I) > Linear A (MM III-LM I) > Linear B (LM II). The first excavator tied such a chain to a functional 'evolution', believing that a mostly "ideographic" Hieroglyphic would have progressively incorporated glottographic values up to the "syllabographic" linear scripts.

However, some decades later, as more materials became available and Evansian findings were partially redated, the 'left edge' of his chain (i.e., the sequence Cretan Hieroglyphic (MM I-II(I) > Linear A (MM III-LM I)) has been seriously questioned, while the relative disposition of 'right' one (Linear A > Linea B) holds true till nowadays. Indeed, on one hand, a number of Linear A documents proved be at latest MM IIB in date, and therefore contemporaneous to the bulk of Hieroglyphic ones. On the other hand, it is assured that Cretan Hieroglyphic was in use at the beginning of the Neopalatial period, namely during the MM III. The functional distinction too, mainly understandable from a positivistic perspective, is now untenable, as sequences displayed by both Cretan Hieroglyphic and Linear A would speak in favor of two logo-syllabic scripts.

In any case, Evans (1921: 612) also inaugurated the comparisons between the two signaries. The British archaeologist did not detect a high similarity between the two inventories and therefore supposed a heavy graphic reform, involving both the shape and the function of signs:

It is not only the increased use of the Art of Writing for the purposes of ordinary life that now strikes us, but the evidence of the introduction of an advanced linearized script, so divergent from the preceding hieroglyphic system, that it is only in about a third of the signs that we are able to trace a direct relation to it.

Later scholarship mainly focused on confirming or rejecting the quantification (i.e., "about a third") proposed by Evans, and accordingly argues for more and less innovative interpretative models. Such models are mainly based on two factors which orientated the conclusions of different scholars, namely (a) the

dating of the earliest instances of the two writing systems and (b) the number of shared signs, mostly reconstructed based on palaeographic and functional criteria. Accordingly, on one side, scholars emphasizing that both Cretan Hieroglyphic and Linear A flourished during the MM II period exclude they were directly linked to each other (Olivier 1989: 51, Militello 1990: 332-333, Schoep 1999: 267 and Perna 2014: 254; 2016: 87-88). On the other side, scholars who reconstruct a wider connection between the two signaries are more inclined to retain the Evansian hypothesis (Chapoutier 1930: 62-74, Grumach 1969: 239-240 and Davis 2014: 144). According to Ferrara *et al.* (2022), the latter view on the number of shared signs must be preferred, although issues still remain as regards both the dating of the earliest documents and the interpretation of their reciprocal interaction.

Notably, the common trait of these theories is that they all search for comparison between two 'monolithic' writings systems. Implicitly, they are understood as hard-to-modify and both highly standardized and scarcely communicant. Indeed, all the comparisons between signaries basically match occurrences from different periods, and, most times, even fail to acknowledge that the two scripts co-existed side-by-side in different archives. Moreover, it is rarely recognized that a number of comparisons are built on signs with three or less occurrences, as well as on those confined to a single findspot. Such a view was mainly triggered, regardless of the graphical diversity, by a more or less clear-cut geographical and typological distribution. Following this line, a more original position was put forward by Godart (1979: 32-33), who suggested that Cretan Hieroglyphic was mainly meant for writing on seals, and later adapted to clay documents too, while the Linear A would have originally been an administrative tool.

Still, such a distribution shows a number of counterexamples and can by no means be viewed as complementary (see §6.3.1). As shown by Ferrara *et al.* (2022), paying attention to the chronology of each instance can however reveal palaeographic matches which are hardly discernible without considering both Cretan Hieroglyphic and Linear A internal chronological articulation.

What is more, as observed in §2, the process of script formation was extremely complex and mostly tied to the interaction with coeval iconography. This

is particularly visible for Hieroglyphic attestations on seals, whose script signs mostly mirror iconographic motifs used on uninscribed seals during the MM II period.

A relevant operation was carried out by Evely (2000), who proposed a new table of comparisons enriched by the matches with symbols coming from non-writing contexts, such as pot- and mason's marks. As observed in §2.7, it is likely that the graphic inventories of Minoan scripts were not impermeable systems, nor the signs were conceived as exclusive of writing. By contrast, the graphical shape of both Hieroglyphic and Linear A signs is closely intertwined to the whole coeval iconography, including luxury objects, such as seals, jewelry and, in part, pottery, as well as more utilitarian usages of marks, namely on pottery and masonry. A similar pathway was already proposed through the comparisons between Hieroglyphic signs and Maliote potmarks by Godart & Olivier (1978: 50-55), who however excluded Linear A from their analysis.

6.3 Breaking the wall: scripts development and co-habitation of Cretan Hieroglyphic and Linear A

Curiously enough, the perspective described in §6.1.2 was deeply questioned starting from 'external' viewpoints. Notably, works between the 1950s and the 1960s, addressing (more or less fanciful) language reconstruction, already avoid positing a direct filiation, but rather referred to a complex relationship between the two scripts (*Docs* 31-33 and Davis 1964: 107-109). More recently, the need of reconstructing the origins of Minoan and Mycenean administrative practices drove a holistic reassessment of the available documentation in both Cretan Hieroglyphic and Linear A. Schoep (1999: 267), who framed herself within the theory of two contemporaneous creations, recognized that both scripts share some typologies of documents, perhaps independently inherited from the Prepalatial period. During the past two decades, the number of shared documents increased together with the discovery of new archives (Hallager & Tsipopoulou 2010: 157, Hallager 2011 and Tomas 2010; 2011). Moreover, emphasis was placed on the fact that, especially where Cretan Hieroglyphic and Linear A co-existed within the same archive,

documents show clues of 'hybridization' and reciprocal influence. According to Petrakis (2017: 88), these observations even cast doubts on the boundary commonly drawn between the two writing systems:

> The way these assemblages [i.e., Knossos 'Hieroglyphic Deposit' and Mallia '*Dépôt Hiéroglyphique*'] are shaped, and the intertwined associations between CH and LA elements within them, suggest that we may no longer label this as 'digraphia' or mere co-existence or symbiosis of scripts or systems that are otherwise well-defined. Proper description and interpretation of this phenomenon may call for a thorough revision of our conceptual and classificatory arsenal. I think just enough momentum has been gathered to make a rather provocative suggestion: that what the Knossos and Malia assemblages actually represent is neither CH nor LA, but a hitherto unrecognised entity: a 'North Central Cretan Second Palace period administrative system' defined by the fusion of the CH and LA categories that modern scholarship, in other cases, had so far defined as distinct and mutually exclusive.

Similarly, starting from a *dubitandum* from Myrtos Pyrgos (i.e., PYR Zb 5), with possible features of reciprocal influence, Ferrara *et al.* (2016: 96) concludes that:

> It may not then be so coincidental that Pyrgos may be a site where Hieroglyphic and Linear A interplayed, producing inscriptions that override the neat script boundaries that Evans was drawn to use for his classification. Even more significant is the fact that this appears to be the case at Petras also. It may be even less coincidental that one of the signs on the Tel Haror sherd can be equated, even though it is encased inside a rectangle, to Hieroglyphic sign 025. Olivier himself postulates a possible Hieroglyphic/ Linear A shadow line for the whole 'graffito'.

Still, the possible interaction and reciprocal influence between *two* scripts is only one side of the coin. Indeed, partially following the discussion regarding the boundaries between them, the 'monolithic' character of both Cretan Hieroglyphic and Linear A was questioned. Specifically, on the one hand, it is clear that Linear A shows relevant internal differentiations according to both the chronology and the provenance of the inscriptions. For instance, a good number of signs are confined to a single findspot (Salgarella 2020: 180-181). As some of them, mostly being *hapaxes*, are only to be found at MM IIB Phaistos, it cannot be excluded that these signs/allographs were simply not continued later on. These differences pertain both the inventory of signs, characterized by local differences, and the employment of site-specific palaeographic variants. Such a situation was extensively summarized by Salgarella (2020: 283):

On a graphic level LA does not appear to represent a monolithic and standardised entity, as we might be led to suppose by looking at GORILA's charts of 'standardised' signs. Rather, slightly different local varieties seem to have existed, each one characterised by a specific sign repertory and (although to a lesser extent) specific palaeographical features. LA can thus be envisaged as comprising a number of different site-specific local varieties: we could call these varieties 'LAs'. Each variety is composed of two sets of signs: an 'A core' of signs (shared between all 'LAs'), and a subset of site-specific signs (one subset for each LA variety).

Turning to the Hieroglyphic side, the framework is much complex as well. Indeed, some signs are confined to seals (e.g., CH 014, 075, 095, perhaps 001 etc.) and *vice versa* (e.g., CH 002, 003, 035 etc.). Some of them do not occur on MM II archival documents from Mallia and Petras (e.g., CH 002, 003, 017 etc.) and. in theory, a later introduction cannot be excluded. Finally, MM II documents from the Quartier Mu and the Petras 'Hieroglyphic Archive' show a number of idiosyncratic palaeographic variants which are rather distant from those occurring within both the Knossos 'Hieroglyphic Deposit' and the Mallia '*Dépôt Hiéroglyphique*' (see §6.4.3).

Overall, it seems that the boundary drawn between Cretan Hieroglyphic and Linear A would need to be substantially re-defined, as well as the nature itself of these two writing systems. The organization of this Chapter is therefore structured in order to shed light on three of the main issues tied to these problems, namely the chronology of the earliest phases of the two scripts and their overlap (§6.4-6), the *dubitanda* and the interaction between their palaeographic, structural and epigraphic features (§6.7) and, finally, the origins and development of the Linear A signary *vis-à-vis* the Hieroglyphic counterpart (§6.8).

6.4 Cretan Hieroglyphic before the MM IIB period

This section and the following (§6.5) are meant to answer a long-lasting question: can we safely consider either Cretan Hieroglyphic or Linear A earlier than the other one?

Accordingly, this section's purpose is to gather together all the Cretan Hieroglyphic inscriptions (apart from those bearing the 'Archanes formula')

regarded as being earlier than the MM IIB period and redefine their exact chronology. Indeed, the MM IIB period constitutes a safe *terminus ante quem* for the origins of both Cretan Hieroglyphic and Linear A, as the vast majority of their earliest documents come destruction levels dating to the end of the Protopalatial period. In the case of Cretan Hieroglyphic, such a chronological anchoring mostly corresponds to findings from the Quartier Mu at Mallia and the 'Hieroglyphic Archive' at Petras. By contrast, the chronological hiatus between the late Prepalatial and the early Protopalatial period (i.e., the MM I-IIA period) was defined as a 'dark-hole' in the history of Minoan writing system, only partially filled by the possible later dating of some bone seals bearing the 'Archanes formula' (Decorte 2018b: 345). As summarized in the Table 1, a number of documents, most of them being *dubitanda* (i.e., attributable to both Cretan Hieroglyphic and Linear A), were tentatively dated before this period. Obviously, their correct dating is crucial to understand the dynamic leading, at the end of the Protopalatial period, to the emergence of two writing systems on Crete.

	MM I	MM IIA	MM IIB	MM III
Cretan Hieroglyphic	#199$^{??}$ #207 #248$^?$	**#248$^?$ MA/V Yb 04 PH Yb 01$^?$**	Mallia Quartier Mu (#070-096, #149, #316-322, #324-327, 329) MA/V Yb 3 #150, #174, #175, #325-327, #329$^?$ SY Hf 1 Petras Hieroglyphic Archive (see Tsipopoulou & Hallager 2010) Knossos Hieroglyphic Deposit (#001069)$^?$ SY Hf 01	Palace of Mallia (#97-120, #154) Knossos Hieroglyphic Deposit (#001069)$^?$ **PH Yb 01$^?$** GO Yb 1 #204$^?$ #329$^?$ CMS **XI 311**
Linear A	ARKH Zc 8$^?$ ARM Zg 1$^{??}$	ARKH Zc 8$^?$ ARKH Zf 9$^?$ **KN 49** PH 6$^?$, 25$^?$, **Yc 01**$_?$	ARKH Zc 8$^?$ ARKH Zf 9$^?$ CR Zg 4 PH 6$^?$, 7-24, 25$^?$, 26-28 SA Wc 1-2$^?$, We 3-4$^?$ **CMS II.2 213$^?$, VI 031,** XII 096$^?$	KE 1, 6, Wc 2, Zb 4 KH Zb 1 KN Wb 33, Zb 4, <27>, Zf 13, 57 MA 1, 2, 4, 6, 9, 10, Wc 7 PE Zg 6 PH 1, 3 54, Wa 32, 52, **Yc 01$^?$** MIL Zb 4 SA Wc 1-2$^?$, We 3-4$^?$ SY Za 6 TL Za 1 CMS **II.2 213$^?$,** XII 096$^?$

Table 6.1 – Earliest documents in Cretan Hieroglyphic and Linear A and the 'overlap phase'. All the Hieroglyphic seals not mentioned inthe Table (apart from those bearing the 'Archanes formula') are considered to be MM II in date.
Legend. (i) *Dubitanda* are in **bold**. (ii) A question mark $^?$ is used on inscriptions whose dating is uncertain. They were repeated in all the columns corresponding to their possible dating. (iii) A double question mark $^{??}$ is used on documents which could be uninscribed

6.4.1 The vase fragment MA/V Yb 04 (previously #330quater)

The most cited evidence in favor of the appearance of Cretan Hieroglyphic before the MM IIB is MA/V Yb 04 (see Fig. 6.1), i.e., a vase fragment with three incised signs found within the *Bâtiment Pi* at Mallia (e.g., Decorte 2018a: 32 and ref.). The object was previously referred as coming from a MM IB-MM IIA assemblage (Pomadère 2009: 636), but later confined to the MM IIA only (Pomadère *et al.* 2012/2013: 649). The reading suggested by A. Karnava (in charge of the publication) is CH 023-025-003[(Del Freo 2012: 6), a sequence which is not attested elsewhere. However, none of the three signs allows to clearly distinguish between Hieroglyphic and Linear A. The leftmost one depicts a motif which is present in both scripts (i.e., CH 023 and AB 122/*OLIV*) with no relevant palaeographic variability (see Fig. 6.1). The torsion of the lower part of the stem, although it is generalized by Hieroglyphic scribes, is present in Linear A documents too (e.g., HT 44a.3, 91.3 and 131b.3). What is more, the second sign, although present in both scripts (i.e., CH 025 and AB 04/*te*), shows a variant with straights horizontal strokes which is only to be found in Linear A (see Fig. 6.1). As pointed out by the editor herself, the reading of the third sign is rather uncertain. The motif is highly damaged. Moreover, the floral upper motif combining 'needles' and leaves (suggested by the curved convergent strokes) is not attested. Similarly, no clear *vestigia* pointing to the head/body of CH 003 are to be safely detected. Still, unless proposing a later split into two or more signs, no Linear A comparison for such a motif seems obvious and it remains the best evidence for attributing such an inscription to the Cretan Hieroglyphic.
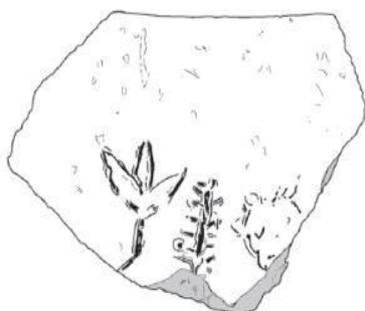
	Cretan Hieroglyphic	Linear A
CH 023 = AB 122/*OLIV*		
CH 025 = AB 04/*te*		

Fig. 6.1 -The document MA/V Yb 04 (after Decorte 2018: 25) and related palaeographic comparisons with Hieroglyphic and Linear A signs

6.4.2 The seal #207

The best evidence for the production of Hieroglyphic seals before the MM II is represented by #207 (see Fig. 6.2). Yule (1980: 223 fn. 21) included it within his MM IB-II 'Mallia Workshop Complex' because of the script. *CHIC* (31) quotes it as the only example of seal with a dating before the MM II "pour des raisons d'ordre stylistique, de forme ou de matériau". First, the seal was fashioned from hippopotamus ivory, a material which would have been abandoned by seal engravers at the end of the Prepalatial or at the beginning of the Protopalatial period (Krzyszkowska 1988: 215-216; 2005: 81).[33] Notably, a Prepalatial date was the choice of the first *CMS* editors, which indeed included the seal (= II.1 240) within the first volume devoted to the Heraklion Museum (i.e., *CMS* II.1). The Arachne's website conversely analyzes it as part of the 'Mallia Steatite Group', although no formal neither stylistic clue is available. Second, it is a wedge-shaped seal, a shape represented by two other instances, i.e., II.1 139 (in hippopotamus ivory) and VS1A 309 (undefined material), being stylistically datable at the EM III-MM IA and MM I respectively. On #207a, the formula CH X 044-049 is flanked by crouched man dealing with vessels ("Weinpresse mit Ausguß, in der ein Mann den Wein tritt" *per* Platon 1969: 496).[34] Such a motif is common within the 'Mallia Steatite Group', but represented on Prepalatial seals too (see §2.4.1). On #207b, the only well-recognizable sign is CH 092, depicting a scorpion. As observed in §2.9, both scorpion and crouched man are among the few forerunners of Hieroglyphic signs which are mainly at home on Prepalatial ivory seals.
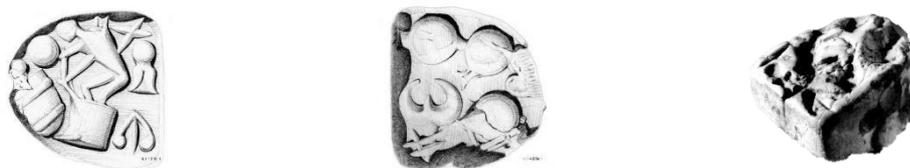
Fig. 6.2 – (From left to right) Drawing and photograph of the seal #207

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[33] In a MM IIB context within the *Espace* 17 of the Mallia *Bâtiment Pi*, an unpublished prism (labeled MA/V S (1/3) 02) in either bone or ivory with three faces (i.e., either a three-sided prism or a gable) bearing the same sequence CH 044-049 was found together with MM II prisms (Pomadère 2011: 611-612 and Del Freo 2012: 6). No three-sided prisms in bone or ivory are documented, and such a seal could constitute a crucial boundary between Pre- and Protopalatial glyptic traditions.

[34] On the same line, see Weingarten 1995 and references.

6.4.3 The seal #199

The seal #199 (see Fig. 6.3) is the only one in bone or ivory (labelled by the Arachne's website as "*bein*", in ivory *per* Del Freo 2012: 6) coming from the Atelier de Sceaux. Apart from #207, only two others were found in Mallia, i.e., II.1 413 (a bottle-shaped from the Quartier E, dated to the MM I) and III 003 (an EM III-MM IA zoomorphic one). Moreover, all the other half-cylinders in bone or ivory are clearly anchored to Prepalatial style-groups. However, it is not clear whether the seal is truly inscribed.

The only visible motif is a *croix pommée* (= CH 070). Two crossed strokes starting from its edges suggest the sign might be reduplicated, a situation admittedly attested on #167 (CH 049-070-070, see Fig. 6.3). Nevertheless, on the latter seal, the signs are neatly separated from each other, and 90 degrees rotated. Indeed, as highlighted on the Arachne's website, the presence of two attached crosses could point to a grid pattern too. Anyway, two ligatured signs are almost absent on Hieroglyphic seals, with the exceptions of the s.c. "*cartouches*". Furthermore, it must be stressed that the *croix pommée* itself appears as non-writing sign (on soft stones, always compounded with a lily flower) in a good number of documents (Anastasiadou 2011: 356).

Fig. 6.3 – (From left to right) The seals #199 and #167

6.4.4 The seal #248

As observed in §3.6, the three-sided prism #248 (see Fig. 4.11) belongs to a well recognizable series defined by a 'needled swastika' flanked by two 'hatched Ds'. All the other prisms of this group are firmly anchored to the 'Mallia Steatite Group'

on a stylistic base. The exceptionality of #248 lies in the fact that it comes from a context tentatively dated to the MM I-IIA (Anastasiadou 2011: 514) or even the MM I only (Platon *et al.* 1977: 369). The excavator more vaguely refers to "Middle Minoan" (Dawkins 1903/1904: 202). Notably, a comparable situation is shared by another three-sided prism from Palaikastro Tou Galeti i Kefala, i.e., II.2 257, dated either to MM I-MM II (Anastasiadou 2011: 511) or the MM I (Platon *et al.* 1977: 369). Only one three-sided prism is surely anterior to the MM II period (Anastasiadou 2011: 560), i.e., HM 2844 (unpublished), which is however in white paste. Anastasiadou (2011: 57) refers that "the excavator of another piece [i.e., VS1A 056] suggests that it could have come from a MM IB layer". The object comes from the Pièce XI 2 of the Atelier Sud at Mallia Quartier Mu, where the "MM IB layer" possibly refers to the MM IB walls onto which the new building was built (Poursat 2012: 179). Still, the Arachne's website confirms the MM IIB dating for this context. Based on these data, a MM IIA date for #248 seems more prudent. Although the production date of the other three-sided prisms in Hieroglyphic cannot be further verified, such a piece could represent evidence in favor of an established presence of writing on seals at the very beginning of the MM II period.

6.4.5 The seal VII 031

The last chronological issue regards the seal VII 031 (see Fig. 6.4). It is a fragmentary seal possibly analyzable as a pierce-griped one. The seal face is flat. Pierce-gripped seals with a flat face are extremely rare after the MM II period, and only one example is available with a conoidal profile (i.e., V 285). Alternatively, it could go back to a bell-shaped conoid, which is at home during the Prepalatial (e.g., VS1B 023 and VS3 090) and perhaps the Protopalatial (e.g., III 045) period. If this was the case, such a seal would partner with the first occurrences of the 'Archanes formula' at the end of the Prepalatial period. A more unlikely possibility, i.e., a button-shaped seal, was put forward by Kenna (1968: 60). Yet, buttons normally show a more pronounced concavity. The seal is tentatively dated to the MM II. The Arachne's website goes, although uncertainly, for a Linear A seal. Perna (2019) argues that it is inscribed in Cretan Hieroglyphic based on the 'dotted-end' in the

lower part of the double-axe's shaft. The sequence clearly points to the first part of the 'Archanes formula', and it would just belong to the group of EM III-MM II seals bearing it. Its interpretation is therefore tied to the attribution of the formula to one of the two scripts.

Fig. 6.4 - (From left to right) Drawing and photograph of the seal VII 031 and the bell-shaped conoid VS1B 023

6.5 Linear A before the MM IIB period

This section represents the counterpart of §6.4, as it aims at discussing the Linear A documents possibly antedating the MM IIB period. In the case of the Linear A, this period is clearly represented by documents found within the Vano XXV at Phaistos, together with few other documents whose dating and attribution is however still uncertain (see Table 6.1).

6.5.1 The fragment KN 49

Commonly, the inscription KN 49 (see Fig. 6.5), found in a MM IIA context within the Knossos SW House, is regarded as the oldest Linear A archival document (e.g., Hallager 1996: 42; Olivier, pers. comm. in Del Freo 2008; Del Freo & Zubarch 2011: 89, not listed as "document douteux"; Perna 2014: 254; 2016: 94). However, as widely pointed out (Decorte 2018b: 22-23), there is no evidence for this document being inscribed in Linear A.

The inscription is badly damaged, and the only safely readable signs are arithmograms for 30 readable in both Cretan Hieroglyphic and Linear A. The leftmost traces are constituted by a 'cross', whose perpendicular strokes crossed

each other close to respectively their lower and right edges. Such a configuration cannot be diagnostic for any attested sign, as it can easily traced back to a high number of possibilities (e.g., CH 038 on #097c, CH 056 on #118a and 057 on #038b for Cretan Hieroglyphic and AB 57/*ja* on KN Wc 26a, AB 164[d] on KH Wc 2039 for Linear A). The identification as a part of A 602 is unlikely, as the strokes of its cross always cross each other in their very center. Similarly, the presence of A 743, based on the oblique sign with a straight protruding stroke (Perna 2016: 92) is excluded by the direction of the sign and the absence of the vertical line (see also Decorte 2018b: 23). Again, such a shape could go back to a good number of signs (for instance, a ligature with AB 73/*mi* proposed by Olivier, pers. comm. in Del Freo 2008 is not impossible, as well as, e.g., CH 040) and is by no means diagnostic.
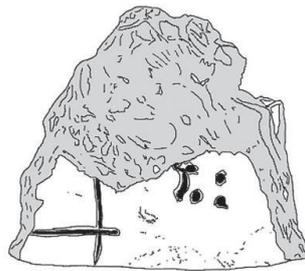
Fig. 6.5 – The inscription KN 49 (after Decorte 2018: 23)

6.5.2 The inscription ARKH Zc 8

A puzzling case is the chronology of ARKH Zc 8 (see Fig. 6.6). The document consists of three Linear A signs painted on a sarcophagus. *Pace* Owens (1996: 107), the template perfectly adheres to the attestations of Linear A, while no relation with Hieroglyphic inscriptions can be found. Indeed, the two last signs are clearly instances of AB 59-46/ *ta-je*, both shapes being unparalleled in Hieroglyphic. The first sign represents a deer, which is remarkably the only quadruped attested on Prepalatial seals without Hieroglyphic continuants. Among the different interpretations (Del Freo 2008 and ref.), the connection with A 306 seems particularly congruent with the iconic properties of the sign (Decorte 2018: 23 and

see §6.4) and would point to a known sequence (see KH 6.4).[35] The object was found in the Stratum 2 of the Archanes Tholos E. The stratigraphy of the burials is somehow disturbed and mainly divided in two periods, i.e., the lower burials (Stratum 4) and the upper burials (Strata 1-3). Strata of the upper burials do not seem to follow a chronological consequentiality and are commonly dated all together at the same chronological span. Unfortunately, the context of ARKH Zc 8 is not provided with pottery, nor they are its associated sarcophagi. Within the West section of the Stratum 2, a single seal was unearthed, i.e., a gable in bone safely datable at the MM I.

Mainly based on historical considerations on the emergence of the Linear A, Panagiotopoulos (2002: 60) dates the object to the final phase of the Tholos E, i.e., the MM II(B). The frequentation of the Tholos E during the MM II period was suggested by the author himself, as at least 19 out of 56 datable pottery sherds from the upper level would belong to a MM II phase (see also Del Freo & Zubarch 2011: 84-85, Legarra Herrero 2014: 218 and Decorte 2018: 22 "*terminus ante quem* at the end of the MM II").

Such a hypothesis seems further strengthened by the sporadic presence of 'architectural' seals, all being associated to the Stratum 3 (sarcophagi nos. 17 and 25). Above it, within the Stratum 2, the MM I bone gable only was unearthed. On the other hand, the Tholos E was analyzed as being entirely Prepalatial (EM II-MM IA) by Sakellarakis (1975), which later changed his mind by defining including the MM II too (Sakellarakis & Sapouna-Sakellaraki 1997: 187). Karytilos (1998: 35) interpreted Panagiotopoulos' data in a slightly different way and suggested that "the upper level of Tholos E is mainly dated to MMIA but has also MM IB and MM II material". The more radical idea was more recently re-expressed by Sakellaraki *et al.* (2018: 21-22, esp. fn. 6-7), for whom the Tholos E would have been "utilisée du MA II jusqu'au MM IA". Unfortunately, no further details are provided in favor of

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[35] Olivier proposed either AB 21f or AB 53/*ri*. However, the former clearly show a head with one ear only, therefore pointing to a cow. Similarly, the latter is clearly reminiscent of CH 010 and would therefore point to a stylized rendering of a human leg (cf. Ferrara *et al.* 2022: 84).

the anticipation of the abandonment of the Tholos and the problem will remain unsolved up to a fresh investigation of the extant material and its precise findspot.

Fig. 6.6 – (From left to right) Drawing of ARKH Zc 8 (after Decorte 2018: 23) and palaeographic variants of A 306

6.5.3 The hairpin ARKH Zf 1

A silver hairpin from Archanes, i.e., ARKH Zf 1 (see Fig. 6.7), was thought to be among the oldest documents in Linear A. The object comes from the pillar room of the Tholos B, a burial complex in use from the MM IA up to the LM IIIA. Based on the comparison with KN Zf 31, Verduci & Davis (2015: 55) dates it to LM I. However, Sakellaraki *et al.* (2018: 22-23) highlighted that it was associated with an assemblage likely pointing to the "Protopalatial" period and to its contemporaneity with documents (e.g., ARKH Zc 8, KN 49 and PH 6-7) considered to be either MM I or II in date.
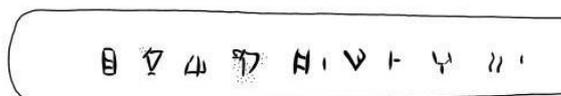
Fig. 6.7 Drawing of silver hairpin ARKH Zf 9 (after Sakellaraki *et al.* 2018: 22)

6.5.4 The seal ARM Zg 1

The opposite situation features ARM Zg 1 (= VS1B 310, see Fig. 6.8). It was interpreted as inscribed in Linear A and featuring the ligature A 301 + AB 73/*mi* = A 605 (Godart & Tzedakis 1992: 108, 146). It is a pendant pyramidoid found within a LM II-IIIA context within the grave 200 at Armeni. Such a shape was employed starting from the EM II period (e.g., II.1 218) and in use at the same time on the

mainland too (e.g., VS1B 369). It was already obsolete during the MM II period, for which an example only (out of 42 instances) was posited due to the usage of the tubular drill (XII 054). As a consequence, the tentative dating to the MM I period, put forward on the Arachne's website, must be understood as a *terminus ante quem* and the seal could therefore constitute one of the earliest examples of Linear A.

Yet, motifs on it resist a safe interpretation. In particular, while A 301 would be safe, although partially abraded, the identification of the second motif still leaves some doubts (see Fig. 6.9). The sign A 301 frequently occurs in ligatures, and such a possibility is particularly exploited at Chania. Given the dating of the seal and the different nature of documents, however, the comparison with LM IB Chania administrative documents should be taken as extremely tentative (see Fig. 6.9). The sign AB 73/*mi* goes back to a human arm and normally assume a V-shaped outline. Still, especially in A 605 (confined to Chania), it tends to be written as a reversed Π-shaped sign with an internal line and a dot (see Fig. 6.9). Issues in reading AB 73/*mi* in ARM Zg 1 are raised by the fact that the latter two elements are absent and the sign in A 605 is always 90 degrees counterclockwise rotated with respect to the alleged position on the seal. From a palaeographic perspective, the motif could match the sign AB 59/*ta* (see Fig. 6.9), especially some variants incised at Chania (e.g., KH 7a.3, b.1 and 60.1). It occurs on ARKH Zc 8 and could have been therefore part of the Linear A repertoire already in the early Protopalatial period. Such a sign is ligatured at Chania only, although always with A 302 (= A 615). Consequently, the resulting sequence would be a *hapax*.

Fig. 6.8 – (From left to right) Drawing and photograph of the seal ARM Zg 1

What is more, the R-shaped (allegedly A 301) motif is clearly comparable with an identical shape found on MM I seals (see Fig. 6.9). More in general, it would belong to a well-defined group of MM I seals (Anastasiadou 2011: 143-147), mostly showing difficult-to-interpret linear motifs, i.e., the Evansian "proto-linear"

characters (Evans 1909: 115116). Some of them show a vague resemblance to Linear A signs (e.g., II.1 113b), although a mere coincidence cannot be ruled out due to their extreme simplicity. In theory, they can indeed also be graphic variants both 'figurative', as well as 'geometric' motifs well-known on EM III-MM IA glyptic (see §2.5.2). On one of these seals, i.e., II.1 109, a possible R-shaped motif is paired with a J-hook. Based on this formal resemblance, Decorte (2017b: 194) argues that it could be an instance of A 301, and therefore constitute the earliest attestation of Linear A. The fact that such a sign would be represented by two different strokes, he claims, would find parallels on other Linear A inscriptions, as it is revealingly the rule on roundels from Chania (see e.g., Fig. 6.9). On the other hand, Younger (1993), followed by Karnava (2000: 25), posited for the R-shaped motif a Hieroglyphic signs-group composed by SM 55 and CH 053. The J-hook is interpreted as CH 059. The latter claim was questioned by Jasink (2009: 192-193), as such an alleged palaeographic variant would be unattested elsewhere in the Hieroglyphic *corpus*. Notably, however, it finds correspondences among instances of A 704 (e.g., HT 131a.4 and KH 100.3). A merging (i.e., a ligature?) of both SM 55 and CH 053 is unlikely, given that the motif is 'open' at one edge. Still, CH 053 cannot be completely ruled out, although the concave (i.e., non-globular) variant of its body is rare. If this was the case, the J-hook might be also analyzed as CH 302/Δ, although it would raise the same 'graphic' issues as CH 053. Notably, Younger (2013: 55) himself changed his mind suggesting a connection of II.1 109 to the Linear A, and the seal is now excluded from its list of Hieroglyphic sealstones. In the case of ARM Zg 1, however, the shape of the motif alongside the R-shaped one on ARM Zg 1 does not find any parallel in Cretan Hieroglyphic nor on Pre- and Protopalatial glyptic. As a consequence, the exact position of these seals with respect to writing is decidedly uncertain, and the question on the interpretation of ARM Zg 1 (as well as of II.1 109) must remain open.

KH Wc 2055   KH Wc 2049

Fig. 6.9 – (From left to right) (Top) Particular of the abraded motif comparable to A 301 on the 3D model of ARM Zg 1, palaeographic comparisons for the ligatures A 605 and 606, and the seal II.1 109. (Bottom) Palaeographic comparisons for the 'second' motif, i.e., AB 73/*mi* and AB 50/*ta*

6.5.5 The seal CR Zg 4

The seal CR Zg 4 (= XII 096, see Fig. 6.10) is considered to be the only seal surely inscribed in Linear A (Perna 2014: 256). The face a is commonly transcribed as AB 0802-04/ *a-ro-te*, while the face b is generally read as AB 28-01-01/ *i-da-da*. All these signs found correspondence in Cretan Hieroglyphic (Ferrara *et al.* 2022: 149-150). Still, all of them display a palaeographic variant decidedly akin to the Linear A ones.

The seal comes from the Richard Seager bequest and is therefore without context. It was probably made in chlorite (serpentine *per* Kenna 1963: 4), a soft stone widely employed all over the Minoan glyptic. As it was simply cut freehand, no dating based on technical features is possible. Conversely, a good clue for its dating is the shape. Indeed, the seal is reel-shaped (see Fig. 6.10), a typology which is hard to place after the end of the Protopalatial and would be mainly at home during the MM I-MM II period. Out of eight reels in chlorite (excluded CR Zg 4), four are stylistically datable to the Prepalatial period (i.e., II.1 083, 116, V 301 and VIII 035), three would be early Protopalatial (i.e., II.1 452, 152 and VS1A 278), while only one (i.e., XII 104) is dated to the MM II-III period by the Arachne's website, although it clearly matches both quadrupeds and floral motifs from Phaistos Vano XXV and MM II hard-stone seals. All the other soft-stone reels can be dated at the down of the Protopalatial period too. Two rock crystal reels bear grids and crosses possibly analyzable as architectural (i.e., IV D028 and XI 147), a typology already attested within the Archanes Tholos E.

Stylistically, Kenna (1963: 4), followed by Perna (2014: 256) defines the seal as "architectural" and dated it at the end of the MM III(-LM IA) period. By contrast, the Arachne's website suggests the MM II period. The most diagnostic

motifs are the rhomboidal figures on face a and perhaps the 'papyrus' on the face b. The latter motif is attested staring from the Neopalatial period, although with a totally different shape. The one on CR Zg 4 conversely show a stalk close to lilies as they are attested on MM II seals (e.g., VS3 041). Such a configuration is perfectly matches by an impression found on a roundel (KN Wc 26, see Fig. 6.10) from the Knossos 'Eastern Temple Repository' (hereafter ETR). Notably, the roundel is inscribed in Linear A on both sides. What is more, the upper part of the 'papyrus' on KN Wc 26 is composed by a ladder motif which is highly reminiscent of the cushion impressions from Mikro Vouni, a group of impressions closely tied to Linear A inscriptions (see Table 6.4).

On the other hand, the rhomboidal figure is well-known within the Protopalatial glyptic. It appears impressed at Phaistos Vano XXV (i.e., II.5 290, see Fig. 6.10) and at Mikro Vouni, Samothrace (i.e., VS3 343 = SA We 3, MM IIB(-III) context, see Table 6.4) on a nodulus inscribed in Linear A.[36] The latter instance belongs to a group of cushions stamped at both Knossos and Mikro Vouni, which are stylistically tied by the presence of the ladder (or double-ladder) motif and the frequent appearance of (a part of) the 'Archanes formula' (Dionisio *et al.* 2014: 104).[37] Two of its possible members, i.e., V 479 from the Room 21 of the House EJ at Hagia Irini, Kea and II.8 056 = #134 from the SE Pillar Room at Knossos (see Table 6.4), would come from an early Middle Minoan context.

Notably, the inscription on SA We 3 document shows a ligature AB 08 + AB 04/ *a* + *te* which might feature on the face a of CR Zg 4 too. Indeed, a rhomboidal shape for AB 02/*ro* is never attested. Since this sign would be graphically tied to AB 707/J, CH 070 and 307/Σ (Jasink 2005: 29-31 and Ferrara *et al.* 2022: 107), such a palaeographic variant is highly unlikely. As the 'concave

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[36] Such a motif also appears as a 'main device' on VII 014, which is however tentatively analyzed as non-Minoan on the Arachne's website.

[37] The impression VS3 343 itself clearly displays an instance of the 'fish' motif, linkable to both CH 019 and AB 31/*sa*. As a consequence, it was sometimes analyzed as being inscribed, although none of the remaining motifs can be safely connected to known signs or would produce known sequences (cf. Dionisio *et al.* 2014: 74).

rhomboid' is employed in the upper register too, its usage between the two signs would be justified in order to obtain an iconographical coherence of the two registers. Strategies to achieve iconographical coherence on seals are indeed hugely widespread on Protopalatial glyptic and feature also on inscribed seals. For example, the two registers of #291c are linked by means of the same trifoliate stalk, which is duplicated in one of them.
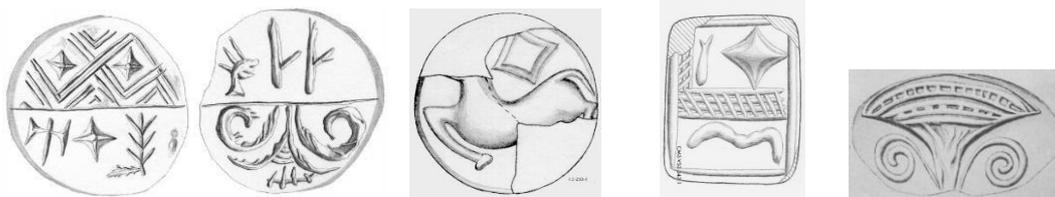
Fig. 6.10 – (From left to right) The seal CR Zg 4 and the impressions II.5 290, VS3 343 and that on KN Wc 26

6.5.6 An incision from early Protopalatial Gournia

Finally, another enigmatic object is a shoulder's fragment of a large bowl (see Fig. 6.11), found in a MM IB-MM II context within the Southeast Building at Gournia (inv. no. 11.872). The document was excluded by Del Freo & Zubarch (2011) and not listed on the website of John Younger, who is in charge for the publication of Gournia's inscribed findings. The excavator compares the attested sequence with A 318, by pointing to its correspondence on PH 8b.1 (Watrous *et al.* 2015: 452). The latter, however, shows a stroke both adjacent and perpendicular to A 318. Better comparisons would be HT 45a.3, b.3, 94a.4 and 126a. Yet, the second horizontal stroke is unparalleled. A reading as an arithmogram is weakened by its position above the alleged sign. Notably, a sign graphically matching A 318 but with the horizontal stroke slightly separated from the cross is widely employed as mark on pottery, masons etc. (e.g., Pernier 1935: 402 and Caskey 1970: 111).

HT 45a.3

Fig. 6.11 – (From left to right) Photograph and drawing of the possible inscription found at Gournia (inv. no. 11.872), comparison with an instance of A 318 and a mason's mark from Phaistos.

6.6 Isolated Proto- and Neopalatial inscribed seals

The brown-green steatite amygdaloid #204 (= II.3 151, see Fig. 6.12) is a surface finding coming from Quartier Mu's vicinities, together with other Neopalatial seals. The emergence of amygdaloids is clearly tied to the Neopalatial period, and anyway later than both the MM II style-groups and the bulk of Hieroglyphic seals. Few of them show 'architectural' design and could be at home during the MM II-III period, as perhaps further confirmed by stratigraphical evidence at Agia Irini and Kamilari (Yule 1980: 31-32). Still, it must be stressed that an earlier date for (the inception of) 'architectural' seals seems suggested by their presence within the Archanes Tholos E (Panagiotopoulos 2002: 45). Yet, no amygdaloids were found.[38] All the other are either talismanic or later. Moreover, the seal displays the usage of both cutting wheel and solid drill. On steatite, it is attested only twice during the Protopalatial period (i.e., on #180 and II.2 291b), while it is sporadically employed for the following one (Betts 1989: 14).[39] Notably, the rendering of CH 034 is unparalleled, as the combination of dotted-ends and an unengraved inner part is never to be found on seals. Specifically, the latter only occur on the 'anomalous' four-sided steatite prism #294. Similarly, the 'ladder' outline of CH 038 finds correspondence on #194 only, while its six horizontal strokes are unparalleled at all.

Another amygdaloid, i.e., CR Zg 3 (= XI 311, see Fig. 6.12) in white limestone, was (tentatively) analyzed as being inscribed in Linear A (Del Freo & Zubarch 2011: 86). Nevertheless, there is no Linear A sign clearly identifiable, as well as no obvious evidence of writing at all. A possible amygdaloid inscribed in Linear A is known, i.e., II.3 023 (see Brice 1961, pl. xxx no. V 12; Platon & Pini

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[38] 'Architectural' seals found within the Tholos E include a cushion (HM 2588), a roll cylinder (HM 2589), a discoid (HM 2580) and a finger ring (HM 4190).

[39] Remarkably, the seal is analyzed as being in serpentine by the Arachne's website. If this is the case, the choice of the tools could have been driven by the hardness of the material (up to Mohs 6).

1984: 26; Del Freo & Zubarch 2011: 89, fn. 62-63 and the Arachne's website), and perhaps belonging to the Late Minoan 'Cretan Popular Group'. The latter was excluded by both *GORILA* (see vol. IV: xxi "V 12 [hiéroglyphique crétois?]") and *CHIC* (not mentioned). Although interpretations as Hieroglyphic was claimed (see also Younger 2005-2022), the presence of AB 01/*da* and a stylized AB 61/*o* seems diagnostic for Linear A.[40] Moreover, all the other recognizable motifs are easily traceable back to Linear A signs, such as AB 02/*ro* (or A 702/B), AB *34 (or A 707/J), AB 37/*ti*[?], and A 703.
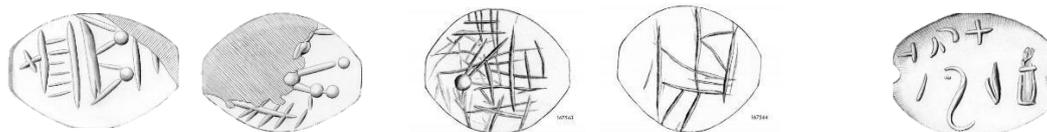
Fig. 6.12 – (From left to right) The amygdaloids #204, CR Zg 3 and II.3 023

6.7 *Dubitanda* : how to distinguish between Cretan Hieroglyphic and Linear A?

Following the label given to each script, criteria established by Evans (1909) to assign documents to either Cretan Hieroglyphic or Linear A were mainly based on the perception that the Cretan Hieroglyphic would have displayed more figurative signs, while the Linear A schematic and less iconic ones. At the same time, such a typology was tied together with chronological considerations, by which Protopalatial inscriptions would have been likely to bear Cretan Hieroglyphic,

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[40] Younger (2005-2022) interprets the seal as mirroring the Hieroglyphic ones combining commodities and fractions, such as #206, #291-292 and suggests a reading: 1. *157, *308, *309 ; 1-2. *155, *302/Δ, *307/Σ. However, such a reading does not find clear correspondences in the palaeography of signs, as (i) *157 would lack both the triangular 'cup' and the handle; (ii) *308 would lack one horizontal stroke and, what is more, the two lines should be perpendicular; (iii) in theory, the line 2. can be read in both Hieroglyphic and Linear A. However, the second sign is hard to reconcile with the shape of *302/Δ, which always displays a (looped) J-hook and would be better conceivable, if it is a fraction, as A 707/J; (iv) Younger's reading would imply a boustrophedon orientation which is hard to be found elsewhere; (v) All the Hieroglyphic seals with commodities and logograms belongs to a specific and well-recognizable group of seals in which such signs are singled out either through a divider or through the seal's shape, i.e., the 'stepped' four-sided prisms (cf. Jasink 2011: *passim*). None of these features seems present on II.3 023.

while Neopalatial ones would have employed Linear A. After more than one century of studies, such a picture is by far more nuanced, as both palaeographical and chronological clues fail to individuate biunivocal correspondences with one or the other script. Despite of this, the attribution of documents stated by Evans was mostly held true till nowadays. Catalogues of both Cretan Hieroglyphic (i.e., *CHIC*) and Linear A (i.e., Pugliese Carratelli 1945; Brice 1961; Raison & Pope 1980; 1994 *GORILA* I-V) mainly divide documents according to such original repartition. Although they are rarely made explicit, criteria orienting the attribution to one or the other scripts can be therefore summarized as follows:

a) *Inventory of signs*. It has been recognized that Cretan Hieroglyphic 'prototypical' documents shared a number of signs which are conversely never attested on Linear A ones and *vice versa*. For example, the recently discovered inscription GO Yb 01 was assigned to Cretan Hieroglyphic, among the other clues, by virtue of the X-stiktogram, as well as MA/V Yb 04 is generally reputed in Hieroglyphic too by virtue of the alleged CH 003. Still, such a criterium cannot solve all the problems. For instance, although the X-stiktogram clearly predominates on Hieroglyphic documents, it occurs on a Linear A one too (i.e., MA 1). Moreover, a large part of the signary is shared (see Ferrara *et al.* 2022) and a relevant number of signs is composed by either *hapaxes* or signs attested less than three times. Finally, it is possible that the small documentation available did not produce the whole signary, as it were the case of AB 48/*nwa*, considered as confined to Cretan Hieroglyphic (and Linear B) up to its recent discovery on SY Za 4.

b) *Palaeography*. Although a good part of the graphic inventory is shared, still Hieroglyphic documents seem to be consistent as regards the employment of distinctive palaeographical traits and *vice versa*. For example, the interpretation of GO Yb 01 as Hieroglyphic is strengthened by the occurrence of the 'butterfly'-type of CH 042. For the same reason, the attribution to Linear A of #068, in which the 'linear'-type occurs, was frequently suggested. In some cases, it seems that a high degree of iconicity was actually at home on Hieroglyphic documents (e.g., CH 020 vs. AB 13/*me*), but such a parameter normally reflects the employment of different supports, especially when dealing with glyptic conventions. The recently discovered 'scepter' from Neopalatial Knossos (Kanta *et al.* fthc.) shows extremely iconic variants of Linear A signs, most of them being previously unexpected.

Indeed, although signs on seals often resemble Hieroglyphic (on clay) more than Linear A ones, this criterium is not enough to assign them to one or the other script and should be corroborated by the following parameters c), d) and e).

c) *Sequences*. Most documents grouped within the same script share a number of sequences which help to understand the template behind ambiguous documents and defining the distribution of the typology of documents. For instance, two of the three most widespread formulas on Hieroglyphic seals are attested on clay administrative documents too (see §4.2.3). Similarly, Linear A texts, especially those coming from the same contexts, share a good number of sequences. Still, it must be emphasized that the vast majority of the attested sequences are either *hapaxes* or confined to a sign typology of documents, and such a parameter can only rarely be relied upon.

d) *Epigraphical features*. With very few exceptions, and anyway never on administrative documents, Linear A is written from left to right. By contrast, the orientation of writing seems to have been much freer on Hieroglyphic documents. Similarly, Linear A signs have a standard orientation which is always respected. By contrast, signs on Hieroglyphic documents are commonly to be found 90 or 180 degrees rotated, although such a practice could have hidden a semantic value (Ferrara 2018). On the other hand, sequences or even single signs on Hieroglyphic documents are often singled out by means of divider, such a practice being rarer on Linear A ones. Conversely, on Linear A document, sequences are frequently separated to each other or from logograms by means of a divider (i.e., a dot). On both sides, however, exceptions are known.

e) *Typology of the inscriptions*. Recently, especially after the discovery of roundels within the 'Hieroglyphic Archive' at Petras, many doubts were cast on a clearcut distinction between Cretan Hieroglyphic and Linear A based on functional and typological criteria (Hallager & Tsipopoulou 2010: 157). However, Petrakis (2017: 75, 86) noted that a number of documents can still be more and less regarded as confined to one of the two scripts only, although it is likely that, within spots in which the two systems co-existed, some forms of 'hybridization' would have been developed. Notably, for instance, three crescents, generally regarded as 'prototypical' Hieroglyphic documents, are actually *dubitanda* (see §6.7.1), as well

as five tables were assigned to Cretan Hieroglyphic, two of them being *dubitanda* too.

f) *Chronology*. As observed in §6.2, the earliest attestations (apart from the 'Archanes formula') of both scripts can be approximately placed in the first phases of the Protopalatial period (MM IB-IIA), but a clear-cut boundary cannot be drawn. As a consequence, chronological considerations can be only diagnostic for the phase in which the Cretan Hieroglyphic is considered as extinct, while the Linear A still survived, i.e., the LM I period. The only Hieroglyphic document perhaps produced at that period, i.e., NYMM 26.31.146, was likely to be an imitation of MM II prisms (Civitillo 2015: 77-78).

g) *Findspot*. It is generally agreed that Cretan Hieroglyphic and Linear A follow a rather clear geographical distribution, at least for the 'overlapping' phase. Indeed, Cretan Hieroglyphic is mainly attested in the central-north and eastern part of the island, while the Linear A is considered as being originally at home in the Mesara. Still, such a frame shows some relevant exceptions. It is clear indeed that at least two documents from Archanes (i.e., ARKH Zc 8 and Zf 9) were Protopalatial in date and inscribed in Linear A. Similarly, during the MM III period, Linear A is clearly attested at spots commonly associated with Hieroglyphic administrations, such as Knossos, Mallia and Petras. On the other hand, although Cretan Hieroglyphic is admittedly rare in archives of the MM II-III Mesara, some inscriptions from Phaistos Vano XXV are *dubitanda*. What is more, at least within the Mallia *Dépôt Hiéroglyphique*, it is safe to assume that both Cretan Hieroglyphic and Linear A co-existed side-to-side. According to Petrakis (2017), such an interplay was extremely complex and plausibly involved other archives too. It follows that, at least for center-north part of the island, including the major archives of Knossos and Mallia, the findspot cannot be of great help in identifying the script.

From this discussion follows that, apart from few exceptions, a single parameter is hardly enough to safely attribute a document to one or the other script. According to them, the following sections try to reassess the attribution of those documents assigned to both Hieroglyphic and Linear A by different scholars, and whose attribution is therefore still disputed. Such a 'limbo' is mainly occupied by

inscriptions which either have no diagnostic parameters or have two or more parameters in apparent contradiction, namely pointing to different scripts.

6.7.1 Clay documents from the Hieroglyphic Deposits: #010, 014, #019 and #110

Regardless of the dating of the Knossos 'Hieroglyphic Deposit', crescents in Cretan Hieroglyphic appeared when documents in Linear A were surely produced at both Phaistos and in North-Central Crete. Moreover, as observed in §6.2.3, a document from MM IIA Knossos (i.e., KN 49) might be inscribed in Linear A. Doubts on the dating of the Hieroglyphic deposit are mainly triggered by two factors, namely (a) the absence of associated ceramic and (b) the presence of sealings typically at home in MM II Hieroglyphic archives (i.e., crescents), which are often inscribe in Hieroglyphic and stamped by seals belonging to MM II style-groups, alongside few other sealings stamped by later matrixes. To make matters worse, it is clear that a number of documents attributed to the Hieroglyphic Deposit were actually unearthed elsewhere, plausibly in its vicinities. By contrast, supporters of the 'homogeneity' of the 'Hieroglyphic Deposit' stress that two different types of sealings were impressed by the same matrix.

According to the highlighted features, the date of the deposit was therefore assigned to the MM II(B) (Yule 1980: 215 and *CHIC* 28), MM IIB-IIIA (see Weingarten 1994: 179, fn. 28-29), MM III (Reich 1970 and Younger 1999: 381-381), MM IIIA (Schoep 2001: 147) and MM III-LM I (Pini 1990: 41-43 and Petrakis 2017: 87), while Karnava (2000: 217) and Anastasiadou (2016: 170), among others, decided to remain agnostic. As stressed by Reich (1970: 407), the Protopalatial date was traditionally driven by the presence of Cretan Hieroglyphic. This even led Evans (1921: 275) to change his archaeologically based MM III dating (Evans 1909: 19-20). Still, given the presence of late seal impressions, it seems clear that 'homogeneity' and Protopalatial dating of the Hieroglyphic deposit must exclude each other. Indeed, by assuming the latter, one should admit that documents impressed by MM III-LM I seals were wrongly associated to the deposit. Conversely, by assuming that the whole assemblage was found *in situ*, one should note that "die jüngsten Merkmale einen Fundkomplex datieren" (Pini 2002: 41).

According to such a frame, the presence of the Linear A within the Hieroglyphic Deposit's assemblage cannot be aprioristically excluded. What is more, especially by assuming either a MM III(-LM I) date or the presence of Neopalatial stray-finds, this case would be even somehow predictable.

Two out of three crescents included by *CHIC* (18) among the *dubitanda*, i.e., #010 and #014 (see Fig. 6.13), are heavily broken, and signs are decidedly hard to interpret. These two documents are both reputed in Linear A by Decorte (2018b: 22, fn. 28) "on the grounds of incongruous palaeography and close resemblance to Linear A signs". Both crescents are sealed by MM II matrixes (respectively II.8 060 and 061) showing extremely similar motifs, i.e., respectively one and two *amphorae*. As regards the crescent #010, *CHIC* (73) signals that the first and the third signs cannot be safely attributed neither to Hieroglyphic nor to Linear A. Both impressions, i.e., II.8 036 and 060, are safely datable to the MM II. The former shows a ram's head, which is common on both soft- and hard-stone prisms and even flanked by the X-stiktograms (see §3.8.3). The only legible sign can be analyzed as either CH 038 or AB 57/*ja*. The shape of the sign is decidedly more common on Linear A inscriptions, but still, it appears on another crescent from the 'Hieroglyphic Deposit' (i.e., #025) which is likely to be in Hieroglyphic.[41] The other two signs conversely point to a high number of both Hieroglyphic and Linear A signs and cannot be diagnostic. Notably, the orientation reported in *CHIC* is arbitrary, and the signs could be understood by turning them upside down too. Similarly, the crescent #014 (stamped by a MM II prism with two *amphorae*, i.e., II.8 061) shows traces of CH 038 = AB 57/*ja*, while the other sign is too fragmentary to be interpreted.

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[41] Such a crescent bears the sequence CH]-011-038, which might be further attested on #072a and #148.

Fig. 6.13 – (From left to right) (Top) Drawing of the crescent #010 and of the two impressions found on it, i.e., II.8 060 and 036; (Bottom) Drawing of the crescent #014 and of the impression found on it, i.e., II.8 061

The situation of #019 (see Fig. 6.14) is different. The identification of the document as linear A, against the interpretation of Evans (1909: 161), was put forward *en passant* by Meriggi (1973: 172 fn. 1) without explanation of the reasons behind this choice. Although the document has been later included into the Hieroglyphic catalogue (CHIC #019), its authors highlighted as a reading of the face c. as Linear A [07] 10-53-04/ []*na*, *u-ri-te* is conceivable. A tentative interpretation as Linear A was also included by Pini (2002) into the description of the sealing no. 124 of *CMS* II.8, while a stronger position is assumed by Decorte (2017b: 56-57 fn. 48), who also includes #010 within list of the linear A crescents catalogued by CHIC. Both Pini and Decorte, however, do not motivate their hypothesis, rather vaguely stating a resemblance with Linear A. A divergent interpretation was put forward by Weingarten (1995: 294). In her catalogue of sealing and sealed document from the 'Hieroglyphic Deposit', the author reads a sequence CH 038-065-025 (see Table 6.2), preceded by a sign corresponding to AB 07/*na* but without parallels in Cretan Hieroglyphic. Such an odd occurrence is left unexplained. Moreover, she tentatively argues for the presence of CH 044 on the impression, which however extremely hard to confirm through the photograph and was not detected by the *CMS*' editors.

Fig. 6.14 – (From left to right) Drawing of the crescent #019 and of the impression found on it, i.e., II.8 124

From a palaeographic perspective, the inscription fits better into the Linear A standards for at least three reasons. First, both the sign in isolation on face a and

leftmost one on face b does are unparalleled on Hieroglyphic documents. The latter is clearly an instance of AB 07/*di* (see Table 6.2), one of the few signs unanimously regarded as diagnostic for Linear A. The sign in isolation is harder to interpret, although it cannot be an instance of the X-stiktogram, as the latter is always represented as a small straight cross and never occur in isolation (see Table 6.2). Second, on the side b, the two sequences are separated though a dot. This habit is never to be found on Hieroglyphic documents, while it is widespread on Linear A ones. Third, the signs of the rightmost sequence are hardly reconcilable with Hieroglyphic ones. Specifically, the alleged CH 056 would show two separated traits, a feature unparalleled elsewhere. Similarly, the lower stroke on the vertical line is unattested both on clay and on seals. These traces are conversely well compatible with two Linear A signs, i.e., AB 10/*u* and 53/*ri* (see Table 6.2). Notably, the latter would display a palaeographic variant attested on earliest documents (see PH 6.2,3,4 and 7.2), while it is mostly excluded from later ones.

Moreover, another hint in favor of Linear A might come from the seal impression (see Fig. 6.14). Graphically, the double-axe is drawn with an extremely narrow long edge, outlined through a single cut. This feature is confined to Linear A documents, and still preserved on both 'libation vessels' (see IO Za 3) and on the seal CR Zg 4. Moreover, the Arachne's website points to the LM I period. If this was the case, it would by itself provide diagnostic evidence for Linear A. However, such a dating is mostly due to the shape of the double-axe. Indeed, in the upper part over the blades, it shows the s.c. 'sacral knot'. This motif is generally regarded as a Neopalatial one (Matoušková 2018: 20-21). On pottery, it is attested starting from the MM III Palaikastro (Niemeier 1985: 117).

However, the 'knot' appears on an impression from Phaistos Vano XXV too (i.e., II.5 234), although on a shaftless double-axe. The shaft itself is another distinctive feature of this image. On both seals and pottery from the Late Minoan period, trifurcated shafts are typical of double-axes compounded with 'sacral knots'. Still, the shaft of the double-axe on II.8 124 seems rather bifurcated, although some unclear signs in its lower part could tentatively allude to a trifurcation. Otherwise, as a bifurcated shaft is only attested on II.1 391i, it could allude to the first part of the 'Archanes formula' (Decorte 2017a: 53). All in all,

although a Late Minoan dating for this impression cannot be taken for granted, the attribution of #019 to the Linear A seems likely.

	Weingarten (1995) (AB 057? CH 038-065-025)	*CHIC* and Younger (2005-2022) (b: <u>X</u> ; c: <u>025</u>-<u>056</u>[[•]][><)	Linear A alternatives (b. <u>311</u> + • c:]57, 10-53-04 /]*na, u-ri-te* or]57, 51-53-04 /]*na, du-ri-te*
〽	⊓ ⌶	None	⊓⊓
𐀟	⊟ ⌶	⌇𝖯 𝙝 𐊤	𝅭 and ▮
⍦	⍦	⍦	⍦
⍻	None	✝	⟳ Ligature with A 311? ⍻ ⌐ AB 46/*je*?

Table 6.2 – Palaeographic comparisons for the signs incised on the crescent #019

The lame #110 (see Fig. 6.15), an 'old' *dubitandum*, was recently rediscussed by Petrakis (2017: 80). The document was indeed considered as a case of Cretan Hieroglyphic/Linear A digraphia by its excavator (see Chapouthier 1930: 23, followed by Brice 1960: 19). Indeed, while the side a. is clearly comparable to other Hieroglyphic documents based on the shapes of both CH 040 and 044, the face b. displays a poorly legible motif vaguely resembling some Linear A signs (e.g., tentatively AB 39/*pi* and AB 40/*wi*). By contrast, *CHIC* reads the sign as CH 085, allegedly attested on #041b (from Knossos 'Hieroglyphic Deposit') only. As no clear connection with Linear A can be proved, Petrakis (2017: 80) analyzed CH 085 as evidence supporting the graphic koine between the two 'Hieroglyphic Deposits'. However, the issue has been better solved by Ferrara *et al.* (2021: 14-15), who convincingly argued for an instance of CH 057, while CH 085 on #041 would be an allograph of both CH 037, attested three times within the Knossos 'Hieroglyphic Deposit' (i.e., #042c, 057d and 061b), and 094, whose only safe attestation is on #328. This document can be therefore safely framed within the Hieroglyphic tradition.
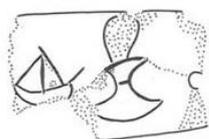
Fig. 6.15 – Drawing of the lame #110

6.7.2 A rare typology of documents: the three-sided bar #048

The three-sided bar #048 (see Fig. 6.16), unearthed within the Knossos 'Hieroglyphic Deposit', was reputed inscribed in Hieroglyphic by Evans (1909: 148) and therefore included into *CHIC*. Nevertheless, the authors of the catalogue highlighted that this document could be also interpreted as Linear A (see also Schoep 2001: 155). Indeed, the typology of the document is unknown to Cretan Hieroglyphic, while it is attested for Linear A within the Mallia *Dépôt Hiéroglyphique*, i.e., MA 2. Notably, the dimensions of the two documents are almost identical, as #048 measures [4.5] × 2.5 × 2.1 cm and MA 2 measures [5] × 2.2 × 2.2 cm. Within the *Dépôt Hiéroglyphique* itself, the tablet MA 4 attests the same ligatured logograms. Regardless of such logograms, the indications pointing to the attribution of MA 4 to the Linear A are (a) the typology of document, although sporadically attested for Cretan Hieroglyphic too (e.g., #119) and (b) the shape of AB 08/*a* on MA 4b, whose horizontal upper edge is unattested in Cretan Hieroglyphic, as well as such a stylized variant is perhaps attested only once (see §6.3.4).

Apart from such clues, there at least two other reasons to interpret #048 as Linear A. On the one hand, such a logogram, while it would be a *hapax* in Cretan Hieroglyphic, is well-known for Linear A and also inherited by the Linear B (i.e., AB *180). Indeed, it is attested at both Mallia (i.e., MA 4b, 6a,b,d and Wc 7, the latter likely to be Linear A for typological reasons, but see Tsipopoulou & Hallager 2010: 157 for possible exceptions) and Phaistos (i.e., PH 10, 12a, 13a and 15b).[42] What is more, the ligatures attested by MA 4b and 6a (i.e., a fractional sign on the bottom-right corner, see Salgarella 2020: 121) match the ones found on #048. Notably, AB *180 is confined to documents dating between the MM IIB (Phaistos) and the MM III period (Mallia), which is in line with the date proposed for the Knossos 'Hieroglyphic Deposit'. Revealingly, both the typology of the document

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[42] This motif also appears on a seal impression for the Knossos Palace, i.e., II.8 031. I am indebted to J. Weingarten for this notice.

and the palaeographic variant attested by KN 49 suggest it is more akin to the ones coming from MM III Mallia. Furthermore, AB *180 never appears with ligatures at Phaistos, while this is often the case at Mallia.

On the other hand, the epigraphical features of the bar are common in Linear A, while they are totally unknown to Hieroglyphic documents. Indeed, ligatured logograms, and ligatures in generals, are widespread all over the Linear A documents (Salgarella 2020). By contrast, they are rarer on Hieroglyphic documents. Similarly, the repetition of the same (ligatured) logograms, with numerals and without direct connection to syllabographic sequences, was employed elsewhere by administrations adopting the Linear A (e.g., HT 31.2-3 and TY 2). Conversely, such a pattern is never to be found with Hieroglyphic ones.
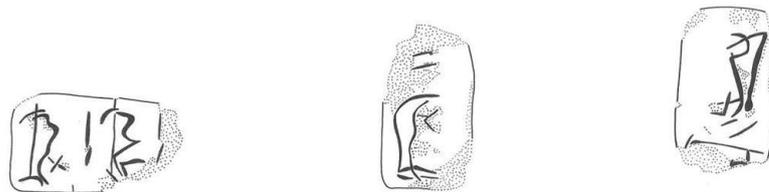
Fig. 6.16 – Drawing of the three-sided bar #048

6.7.3 Atypical Hieroglyphic documents: the tablets #068 and #122

Only five tablets are thought to be inscribed in Cretan Hieroglyphic. The tablet #068 (see Fig. 6.17), found within the Knossos 'Hieroglyphic Deposit', was reputed inscribed in Hieroglyphic by Evans (1909: 148), who published it turned upside down, and included into *CHIC* with uncertainty (*CHIC* 18). A number of scholars then questioned its attribution and suggested that it would be rather inscribed in Linear A (see Meriggi 1973: 172, fn. 1 and Decorte 2018b: 22, fn. 28 "on the grounds of incongruous palaeography, especially on the clearly 'linear' instance of CH 042 [...] in the whole corpus of Cretan Hieroglyphic").

So far, the best evidence in favor of Cretan Hieroglyphic was the alleged presence of CH 003, which is not attested in Linear A. However, as recognized by *CHIC* (123), such a palaeographic variant would be rather distant from the other attestations of this sign and no other Hieroglyphic signs can be hypothesized (see

Fig. 6.17). A more plausible suggestion is to be found on the INSCRIBE's website, i.e., a ligature AB 302/*OLE* + AB 73/*mi* (see Table 6.3), widely attested on documents from Hagia Triada (e.g., HT 14.1,4, 28a.2 etc.). The latter sign is an iconic rendering of a human arm (see also KN 22c) akin to CH 007. Admittedly, the palaeography of AB 302/*OLE* does not find any precise correspondence, as its 'leaves' are always needle-shaped and divergent with respect to AB 73/*mi* and the ligature 302/*OLE* + AB 73/*mi* is oriented in a different way in Linear A. From a palaeographic perspective, the supposed AB 302/*OLE* matches CH *171 (see in particular #067a and SY Hf 01), representing a commodity (see Table 6.3). If this was the case, the disposition of signs (i.e., CH 023 *171) is not unknown (e.g., CH 049 and 041 on #060a). In theory, as regards these signs, one could therefore admit either a sequence CH 007 *171 or a ligature 302/*OLE* + AB 73/*mi*, the latter by supposing a slightly different variant of the former sign.

Conversely, the klasmatogram CH 306/Π would be a *hapax* within the Hieroglyphic corpus, while it is well known as A 706/H. Another important clue in favor of Linear A is the presence of the divider, i.e., a dot between the first and the second sign of the line 1 (see Fig. 6.17). Such an instance suggests that the second sign is not a numeral. Good candidates to match it are AB 06/*na* and AB 07/*di* (e.g., respectively KN Zb 20 and KN Zb 35 for their shape), which is also attested on another *dubitandum* from the Knossos 'Hieroglyphic Deposit', i.e., #019. The latter sign is well attested as a logogram in Linear A (e.g., HT 32.4 and 69.1), while the former is not. By also considering the observation of Decorte (2018b: 22, fn. 28) on CH 044 and AB 08/*a*, three out of four diagnostic instances would speak in favor of the Linear A, while the other one is uncertain.[43]

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[43] Of course, based on the same way of reasoning, one may assign HT Wa 1148 to the Cretan Hieroglyphic. However, both typological and contextual features of the document would make such a statement unlikely.

On this object and on this palaeographic variant, see §6.8.2.

Fig. 6.17 – (From left to right) Drawing of the tablet #068 and particular of the possible Linear A sequence 67, 06 X

302+73 on the 3D model

Similarly, the attribution of the tablet #122 (see Fig. 6.18) to Cretan Hieroglyphic received many criticisms (see Raison & Pope 1980: 276 = PH 32, Decorte 2018b: 22, fn. 28 and Karnava 2000: 64, fn. 17). There is no obvious evidence pointing to the Cretan Hieroglyphic, while a number of proofs can be adduced in favor of its attribution to Linear A. First, some signs are unparalleled in Cretan Hieroglyphic from both a palaeographic and a functional perspective. Specifically, in Cretan Hieroglyphic, the logogram for 'grain' always has a vertical stroke, either starting from the upper or the lower part of the oval element. By contrast, the shapes on #122 find correspondence on Linear A documents (see Table 6.3). Notably, the variant without the vertical stroke is only attested on MM IIB tablets from Phaistos Vano XXV. The alleged CH *153 (same shape of CH 024) is always drawn through a longer vertical trait, which is absent on #122. This shape is conversely at home on Linear A inscriptions and noticeably found on a MM IIB tablet from Phaistos (i.e., PH 16a.2, see Table 6.3). The occurrence of the 'stemless' CH 023 on this tablet led to consider KH Zb 98 (previously published as Zb 01, see Del Freo & Zubarch 2011: 87) as a *dubitandum* (Andreadaki-Vlasaki & Hallager 2007: 17).
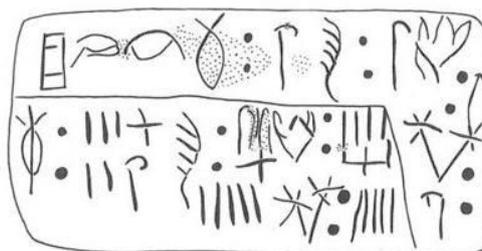
Fig. 6.18 – Drawing of the tablet #122

Second, the klasmatogram CH 302/Δ is always turned upside down on administrative documents in which the orientation of the signs seems to be consistent (see #065d, 067a and 118b), while the sign A 704/E would be in its usual position (see Table 6.3). Moreover, the usage of CH 307/Σ in combination with other klasmatograms is never to be found on Hieroglyphic documents, while it is widespread on Linear A ones for AB 702/B. For the same reason, the alleged CH *158 is hardly compatible with its only other occurrence, i.e., on #065d. The latter clearly shows the same shape as AB 09/*se* (see Table 6.3) on a coeval document from Phaistos (see PH 9.1,4) and on a MM IIIB sealing from Knossos (see KN Wb 33b). Obviously, this sign would have been employed as a logogram on #122 and would be therefore comparable to AB 302/*OLE* too, which is not attested on MM IIB inscriptions and generalized three oblique strokes on later inscriptions. The precise relation between AB 302/*OLE* and AB 09/*se* is unfortunately still unclear, although their shapes are extremely close to each other. Anyway, no clear comparison exists between the alleged CH *158 and other Hieroglyphic signs. Also given the context of its finding (no Hieroglyphic documents were found at Chania), the assignment of #122 to the Linear A would strengthen the attribution of KH Zb 98 to the same script.

	Cretan Hieroglyphic	Linear A
#068		
	or	
	or +	
	None	
#122		

	None	

Table 6.3 – Palaeographic comparisons for the signs attested on #068 and #122

6.7.4 The impression #151

The impression #151 (= II.5 239, see Fig. 6.19) was found on a direct-object sealing (i.e., HM 733) within the Phaistos Vano XXV. On the one hand, the typology of the document would make preferences steer for Cretan Hieroglyphic, although a MM II(-III) seal in Linear A was found. On the other hand, the Phaistos Vano XXV is the spot *par excellence* for MM IIB Linear A, and no other Hieroglyphic document was unearthed there. The sequence CH 008-053 is a *hapax*. As highlighted by Pope (1980: 276), two signs are not enough to make a seal indubitably inscribed. Indeed, some of the cases in which two motifs comparable to Hieroglyphic signs occur together in a 'sequence' not attested elsewhere are excluded from *CHIC* (e.g., II.2 221b and XII 062a). Similarly, the sequence AB 08-60/*a-ra* is known on Linear A documents, although it neither never appears in isolation nor before the LM IA period. Thus, until such sequence is not found elsewhere, further suggestions will remain speculative.
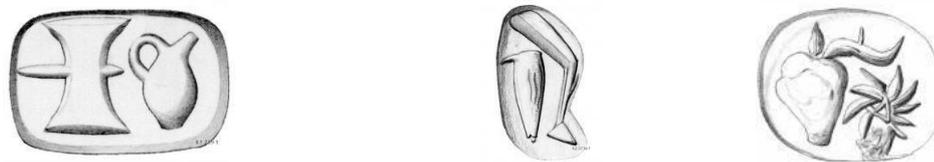
Fig. 6.19 - (From left to right) The impression #151, the seal II.2 221b, possibly readable as CH 053-010 and the seal XII 062a, possibly readable as CH 012-033

6.7.5 The inscription PYR Zb 5

Two signs on PYR Zb 5 (see Fig. 6.20) were incised before firing on a coarse ware jar, mostly associated with LM I pottery, although few MM sherds could have been identified too (see Ferrara *et al.* 2016: 87). The inscription was generally reputed as bearing a Linear A sequence AB 04-57/ *te-ja* (see Younger 2000-2022 and Del Freo & Zubarch 2011: 86). By contrast, Ferrara *et al.* (2016: 94-95) cast doubts on such an analysis, by claiming that (a) the lateral strokes of AB 04/*te* are often straight, especially on LM I occurrences, while those of CH 025 are invariably oblique and (b) there is no evidence for the second horizontal stroke of AB 57/*ja*, while such motif could be an instance of CH 056. The resulting sequence CH 023-056 would find a partial match, although not in isolation, on PE Hh 016d bearing CH 025-056-005.

The alleged CH 056 is badly damaged, and no definitive answer can be provided. The small oblique stroke in its lower part is a common mistake for rectangular shapes, and finds indeed correspondence for CH 056 too (see #076a). An argument against such an interpretation is that no traces of the triangular 'handle' is visible in the upper part preserved. On the other hand, the lower stroke of AB 57/*ja* is never oriented downward, although it sometimes reduced (e.g., KN 1b.1). A safe identification is therefore hard to state. Moreover, one should notice that the 'scroll' of the floral motif (either CH 025 or AB 04/*te*) is never to be found elsewhere. Consequently, it cannot be excluded that the other sign too would have shown a rare paleographic variant.

Fig. 6.20 – (From left to right) Photograph and drawing of the inscription PYR Zb 5

6.7.6 Two inscribed vases from Phaistos: PH Yb 01 and Yc 01

The inscriptions PH Yb 01 (see Fig. 6.21) and Yc 01 (see Fig. 6.22), respectively painted and incised on *skouteli* fragments, were both found at Phaistos in contexts dominated by MM IIA and MM III ceramic. Militello (1990: 327) argued for reading either AB 58-24/ *su-ne* or CH 035-052, with a preference for the former as AB 58/*su* would be more widespread on Linear A documents than CH 035 on Hieroglyphic ones. Still, the palaeographic variants of AB 58/*su* compared by Militello (1990: 327) to the instance on PH Yb 01 actually refer to cases in which the upper part is realized with one or two strokes (see Fig. 6.21) less than the sign on Yb 01. Within the extant documentation of both CH 035 and AB 58/*su*, such a shape is only attested once, i.e., on KN Zf 31. Obviously, as such a comparison is based on one instance only, the attribution to the Linear A must be regarded as tentative.

KN Zf 31   PH Wa 32   KN 22a

Fig. 6.21 – (From left to right) Drawing of the inscription PH Yb 01 (after Militello 1990: 341, courtesy of the author and the editor) and palaeographic comparisons for the sign AB 58/*su*

By contrast, the 'first' sign on PH Yc 01, again interpreted as a variant of either CH 035 or AB 58/*su* ("eseguito accentuando ulteriormente il carattere labirintico") by Militello (1990: 329) does not match any attested occurrences of this sign. Moreover, the presence of two concentric rectangular elements is hardly linkable to the meander of the supposed sign(s). The inscription is analyzed as Hieroglyphic, based on the 'eye' sign (= CH 005), which, Militello claims, would find no obvious *comparandum* in Linear A. However, such a shape is well attested as AB 79 starting from the oldest documents from Phaistos (i.e., PH 6.2) a well retained in later documents (see HT Wc 3011, 3012a and ZA 4a.5), and cannot be diagnostic for Hieroglyphic. Still, tentatively, the best candidate to interpret the second sign would be CH 053, which does not find any parallel in Linear A. Such a sign is sometimes drawn by two concentric rectangles (see Fig. 6.22), whose configuration is so far unknown for other Hieroglyphic and Linear A signs, both

alone and in ligature. Revealingly, the resulting sequence, i.e., CH 005-053, is matched on PE Hh 016a and, with in a longer sequence CH 025-005-056, on the side d of the same document.
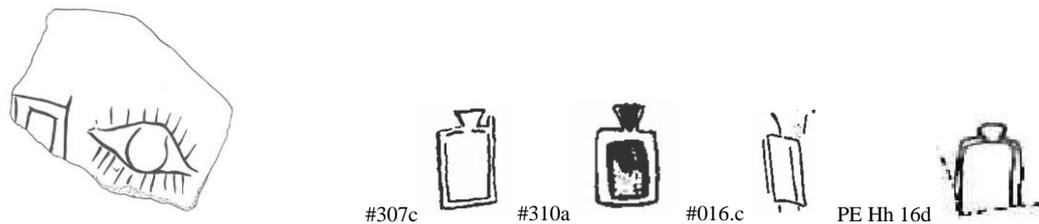
Fig. 6.22 – (From left to right) Drawing of PH Yc 01 (after Militello 1990: 341, courtesy of the author and the editor) and palaeographic comparisons with CH 056

6.7.7 Roundels between Cretan Hieroglyphic and Linear A and the inscriptions from Samothrace

Roundels are generally regarded as documents in close connection with Linear A 'administrative systems' (e.g., Finlayson 2013: 131), as they are often inscribed and tend to appear in contexts where the Linear A was employed for administrative purposes (e.g., Matsas 1991: 168-169). Still, a one-to-one connection is far from being established. Indeed, roundels appear in Mallia *Dépôt Hiéroglyphique* (Petrakis 2017: 85), a context showing a strong interaction between Cretan Hieroglyphic and Linear A, as well as in the archive of Petras (Hallager & Tsipopoulou 2010: 157). Moreover, some roundels from Knossos and Samothrace were impressed by cushions bearing (a part of) the 'Archanes formula' but incised with signs often reputed as Linear A. Finally, an inscribed roundel from the Knossos ETR, i.e., KN Wc 23, is regarded as a *dubitandum* (Petrakis 2017: 88).

The roundel SA We 4 (see Table 6.4) bears one impression displaying the first part of the 'Archanes formula', and as such included into *CHIC* (i.e., #137). This impression comes from a cushion clearly tied to other matrixes of the same type stamped at either Mikro Vouni or Knossos (Dionisio *et al.* 2014: 74). At least one of them, i.e., VS3 343, is employed on a nodulus bearing a Linear A ligature (i.e., SA Wc 3, see Table 6.4). Moreover, other two roundels carry impressions of the same group, i.e., #135 and SA We 1. The latter comes from a MM IIB context. Although it is now reputed uninscribed (Del Freo & Zubarch 2011: 86), Matsas

(1991: 170) recognized faint traces of AB 81/*ku* written through ink when he found it. What is more, as observed in §6.5.5, this group is stylistically tied to a Linear A seal (i.e., CR Zg 4), which even possibly attested the same sequence incised on SA Wc 3. Notably, Mikro Vouni is only spot, apart from Knossos, attesting a 'linear'-double axe graphically akin to AB 08/*a* employed as mark, found on a mud brick (see Matsas 1991: 164). Given that there is no impeding reason to recognize the presence of the Linear A on this roundel, it must be acknowledged that the shape of the fraction sign A 708/K clearly points in this direction and would exclude a Hieroglyphic inscription.

Impressed cushions from Mikro Vouni			
Inventory number	Type of sealing	Photograph of the sealing	Drawing and number of the impression
SA We 3	Nodulus		VS3 343
SA We 4	Nodulus		VS1B 327 (=#137)
SA Wc 2	Roundel		(2x) VS1B 322-25
SA Wc 1	Roundel		(4x) VS1B 326 (= #135)
Comparanda from Knossos and Kea			
HM 159 (MMIB)	String-end nodule with pyramidal rear		II.8 056 (= #134)
HM 372	Direct-object		II.8 029 (= #179)
HM 1459	String nodule steep		II.8 103
Private collection	Roundel		KN Wc 26
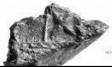
KAM 8.112	Direct-object		 V 479

Table 6.4 – The group of impressions from cushions related to both the 'Archanes formula' and Linear A inscriptions

By contrast, the roundel KN Wc 23 (see Fig. 6.23) cannot be safely interpreted. This document, coming from the 'Eastern Temple Repository' (hereafter ETR), is stamped twice by a matrix stylistically dated to the MM III-LM I, the latter being therefore congruent with the dating commonly assumed for the ETR. *GORILA* II (lvi) interpreted it as uninscribed. Younger (2000-2022) reads the document as bearing a sequence A 703-703/ D D. By contrast, Petrakis (2017: 88-89) analyzes it as a *dubitandum*. Indeed, the fraction A 703 is virtually homograph of CH 309/ꝫ. This sign is attested on seals only and possibly refers to a commodity rather than a fraction (see Jasink 2005: 2329). No direct hints for Linear A are further provided by the inscription. Anyway, both Younger and Petrakis assume a replicated sign in back-to-back position. Such a graphical habit is common on both inscribed and uninscribed seals but, to my knowledge, totally unknown on archival documents. Crucially, the two S-shaped motifs are not mere duplicates, as the one on right is more looped, while the other has its lower part projected downward. Moreover, the two motifs are adjacent in their upper part. Such a shape would suggest we are dealing with a single motif, plausibly a vessel described by two handles and a globular body. Such a shape is comparable to the amphora depicted by CH 054 and AB 16/*qa*. Moreover, logograms depicting vases are widespread in both Hieroglyphic and Linear A. Specifically, the amphora is known as Hieroglyphic logogram (i.e., CH *160), even in ligature (i.e., CH *161). In Linear A, it is not directly attested, although the sign AB 16/*qa* could be interpreted as a logogram on both and ARKH 1a.1 and HT Wc 3017a. Yet, given the productivity of vases' logograms in Linear A, a *hapax* of this type would be unsurprising, and the attribution cannot be safely stated.
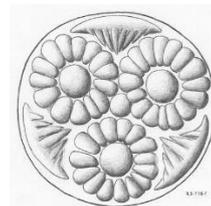
Fig. 6.23 – (From left to right) Drawing of the roundel KN Wc 23 and of the impression found on it, i.e., II.8 116

6.7.8 PK 3: a second four-sided bar in Linear A?

Only two four-sided bars were assigned to Linear A, i.e., PK 3, which was however excluded by *GORILA*, and MA 10. The latter (see Fig. 6.24) was found in a MM III context within the room IXb of the Palace of Mallia (Schoep 2001: 10). Evidence for Linear A is provided by (a) the usage of a dot as divider (faces a. and b.1), (b) the palaeography of AB 39/*pi* (vs. CH 022), (c) the palaeography of AB 54/*wa* (vs. CH 041) and perhaps (d) the possible presence of AB 51/*du*, which is unparalleled in Cretan Hieroglyphic. By contrast, no direct clues in favor of Cretan Hieroglyphic are to be found. According to Schoep (2001: 10), such a rare occurrence is conceivable in the frame of the interaction between the two scripts within the 'Hieroglyphic Deposits'.
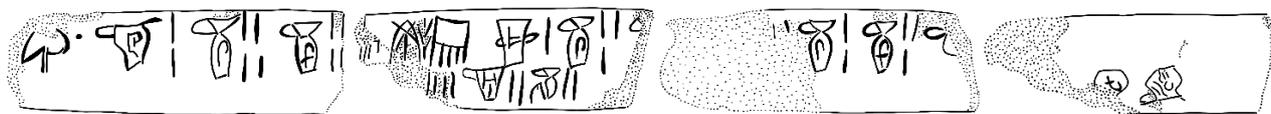
Fig. 6.24 – Drawing of the four-sided Linear A bar MA 10

The findspot of PK 3 (see Fig. 6.25) is unknown. Apart from both context and dating of the object, the Linear A seems suggested by the presence of a sign, i.e., AB 81/*ku*, which is unparalleled in Cretan Hieroglyphic. Moreover, signs attested in both templates, such as AB 01/*da* = CH 009 and AB 37/*ti* = CH 049, clearly show palaeographic variants widespread on Linear A documents, while they are totally unattested on Hieroglyphic ones. The situation of the numeric system is more nuanced, although it overall speaks in favor of Linear A too. Indeed, the presence of the horizonal strokes (i.e., arithmograms for tens) strongly points to the latter scripts. In Cretan Hieroglyphic, curved horizontal strokes stand for unities on #063a only. Still, their position on a.2 in front of another arithmogram excludes that they are unities here. In the same line, such a sequence could be also observed on

the right of AB 01/*da*, in Brice's AB 56 could be rather analyzed as <u>31</u> (Raison & Pope 1994: 273).

As MA 10 is likely to be inscribed in Linear A, the typology of PK 3 does not raise particular problems *per se*. However, the usage of a horizontal division line strongly points to the adoption of a Hieroglyphic habit (see #063 and #113), which is not to be found on MA 10. What is more, the position of numerals indicates that the inscription is written retrograde. As it is well-known, Hieroglyphic administrative documents commonly show a rather fluctuant order of writing, as well as their orientation. By contrast, Linear A is sometimes written from right to left too, but this is almost always the case of non-archival documents. A possible exception was suggested by Younger (2000-2022) on PH 14b, based on the position of the syllabogram AB 08/*a*, which is often to be found at the beginning of sequences, but can be found at their end too (e.g., HT 15.1 and KH 9.1). Again, the combination of these epigraphic 'oddities' would suggest an interaction with Hieroglyphic administrative practices. Of course, it could not be due to chance that such a pattern is observed on a four-sided bar.

| a.1A [•]-<u>37</u> | 3 | •-*ti* | 3 | | | a.1A]-78 | 3 |]-*qe* | 3 |

a.1B 57	30	*ja*	30		a.1B 57	20	*ja*	20
a.2 [•]-56-01-27	42	•-56-*da-re*	42		a.2A	31		
b. 37	2	*ti*	2		a.2B 01-27	72	*da-re*	72
c. 01-[•]-81-[•]		*da-•-ku-•*			b. [•]-37	2	•-*ti*	2
d.	3		3		c. [•]-81	3	•-*ku*	3
					d. [•]	3	•	3

Fig. 6.25 – (From left to right) (Top) The drawing of the four-sided bar PK 3 made by Brice (1961) and that of the face a of the same document published by Bosanquet & Evans (1902); (Bottom) The transcription of the possible Linear A sequences by Brice (1961) and Raison & Pope (1994), followed by Younger (2000-2022).

Moreover, the numerical system of this bar raises a number of issues. The line a.1B shows three horizontal strokes. *Pace* Raison & Pope (1994: 273), the lower one can be safely posited through both drawings, although being in a broken area. The line a.2 would display a longer sequence, including four horizontal strokes, two oblique ones, a dot and a semi-circle. The interpretation of Raison & Pope (1994: 273), followed by Younger (2000-2022), is hard to prove based on the two drawings. Notably, the latter two signs are highly reminiscent of the Hieroglyphic arithmograms for tens and units (e.g., #059a-b). Yet, their position would exclude such an analysis. A clue to interpret the numerical sequences in a.1B-2 could lie in the fact that the horizontal divider ends well before the edge of the bar. Such a usage is known from a Hieroglyphic four-sided bar from Mallia *Dépôt Hiéroglyphique*, i.e., #112a (see Fig. 6.25). It is an expedient employed for the sake of space, whenever a string of signs goes further than its related line. Writing a numeral string 'in column', rather than by starting from the following line, is further attested on Linear A tablets, such as HT 34.6 (see Fig. 6.25). If this was the case, it is possible to interpret the leftmost two signs of a.2 as the fraction A 707/J followed by a divider, used to disambiguate its reference to the upper arithmograms.
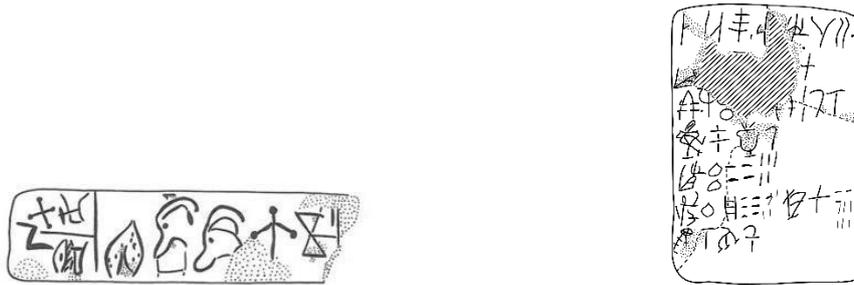
Fig. 6.26 – (From left to right) The bar #112a and the tablet HT 34

6.8 Fuzzy boundaries between two scripts: the development of the signs' inventories

This section aims at showing similarities and differences in the selection of signs and palaeographic development between Cretan Hieroglyphic and Linear A. As observed in §6.2-3 and §6.7, the two scripts display a good number of shared features. However, they diverge due to several idiosyncratic behaviors. Each script, in fact, selected an exclusive inventory of signs to complement the shared ones. Similarly, some palaeographic variants of shared signs were confined to either Cretan Hieroglyphic or Linear A.

Countless studies on palaeographic features of Linear A allow us a thorough comprehension of its development and site-specific variability (Karetsou *et al.* 1985: 112126, Militello 1989, *GORILA* V, Tomas 2011, Sakellaraki *et al.* 2018: 26-30 and Salgarella 2020: 150-177). After the publication of the main catalogue (i.e., *CHIC*), palaeography of Cretan Hieroglyphic was the object of a number of studies centered on its features on seals (Jasink 2009, Anastasiadou 2011: *passim* and Civitillo 2016), clay documents (Karnava 2000 and Hallager & Tsipopoulou 2010) or both (Ferrara *et al.* 2021). What is more, the palaeographic comparison between signs possibly shared by the two scripts was recently undertaken (Ferrara *et al.* 2022).

By collecting all the previous observations, it is therefore possible to investigate nuances within and between the two 'monoliths', namely their

diachronic and diatopic variations, as well as cases of reciprocal convergence.[44] I therefore intend to shed light on the origins and development of the two signaries by investigating them as complex and dynamic iconographic repertoire, which were likely to be in close contact at least at the beginning of the Neopalatial period and influenced each other within the administrative sphere.

Accordingly, this section suggests four different typologies of interaction between the Hieroglyphic signary and the Linear A one, by discussing some relevant case studies each. Such typologies are built by paying attention to the (possible) chronology of each attestation, as well as to the geographical distribution of the analyzed features, in order to shed light on the diachronic evolution of both scripts and their interaction in different chronological phases and in different places.

6.8.1 Type 1: Signs showing the same palaeographic variability

Some signs show the same typology of palaeographic variants in both Cretan Hieroglyphic and Linear A. It is likely that these signs have stemmed from the same iconographic motif and developed from it side-by-side, in a similar way. Predictably, alongside common variants, both scripts often developed one or more idiosyncratic shapes. The vast majority of signs showing clear *comparanda* between Hieroglyphic and Linear A fall in this typology.

It is clear that the loss of iconicity, whenever observable, cannot be reconstructed according to a chronological linearity. Indeed, some Neopalatial instances show variants which are decidedly more 'iconic' than Protopalatial ones. It follows that palaeographic development, for both Cretan Hieroglyphic and Linear A, was mainly influenced by two factors. Those are (a) the support of the inscription and (b) the graphic tradition acquired by the scribe/engraver from his/her teacher or

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[44] Following the discussion in §6.7.1, in this section, I include the Knossos 'Hieroglyphic Deposit' among the findspots dating to the MM III period, as no positive evidence in favor of a Protopalatial dating are available, apart from the Hieroglyphic sealings. Still, evidence coming from such a deposit are excluded from the discussion of the chronology of palaeographic developments.

workshop. Factor (a) is visible in the fact that the degree of iconicity is generally consistent according to the distinction between ephemeral and durable supports. Already during the MM II period, most of Hieroglyphic signs on clay documents are palaeographically akin to their Linear A counterparts, while on seals they show rather different features. Similarly, Linear A signs on Neopalatial libation vessels and other durable artefacts are more comparable to Hieroglyphic counterparts on seals, rather than to coeval administrative documents. Factor (b) is visible in the paleographic consistency generally detectable according to geographical distribution. Moreover, some of the paleographic variants attested in a specific location and timeframe cannot derive from those attested there by more ancient inscriptions. This suggests a contribution from different traditions, or decisive, even personal, internal innovations. These two factors were therefore combined and modified by the writer, who could predicably also produce idiosyncratic variants and partially diverge from the inherited tradition.

Among the many possible examples (Ferrara *et al.* 2022 for an overview on the palaeographic variants of the two scripts), I here present two from 'semantically' homogeneous groups.

First, signs depicting human body parts (see Table 6.5). All these signs are likely to be employed as syllabograms by both Cretan Hieroglyphic and Linear A. On clay administrative documents, most of them perfectly meet the shape encountered in Hieroglyphic inscriptions. Such a phenomenon is particularly visible on the earliest documents, dating back to the MM II period. For example, the signs going back to a human 'eye', i.e., CH 005 and AB 79, shows exactly the same shape on both Hieroglyphic and Linear A instances from Phaistos Vano XXV (see Table 6.5). The only difference between them lies in their orientation, as the Linear A sign has the long ax perpendicular to the sense of the script, as it occurs for most of its signs, and *vice versa*. According to this principle, Linear A attests an idiosyncratic variant on documents dated to the LM IB, in which the 'eye' lies on a vertical stroke. Such a palaeographic development is common to a good number of other signs (Ferrara *et al.* 2022: 85), although it is never generalized. Similarly, on LM IB document, the sign AB 53/*ri* sometimes occur as a S-shaped motif without further connotates, while the variant attested at MM IIB Phaistos is decidedly

similar to that occurring within the Knossos 'Hieroglyphic Deposit' (see Table 6.5). Moreover, both Cretan Hieroglyphic and Linear A developed a stroke in place of the dot of the 'pupil'. The same pattern is to be found, among the others, for the 'calf' of AB 53/*ri* and the inner dots of AB 78/*qe* on Neopalatial inscriptions (see Table 6.5).

In the case of AB 28/*i* (vs. CH 008) and AB 01/*da* (vs. CH 009), scribes of the Vano XXV adopted a more 'linearized' variant (see Table 6.5). In the latter case, such a variant is likely to have been standardized for Linear A, as it also occurs on CR Zg 4b and ARKH Zf 9. Moreover, it is always retained on Linear A documents up to the end of the LM IB period. By contrast, the shape of AB 28/*i* would be an idiosyncratic development occurred at Protopalatial Phaistos. Indeed, this sign shows a high paleographic variability. This implies that an iconic instance of the hand was variously manipulated according to the preferences of each scribe. Notably, the same variability is mirrored by the behavior of CH 008. Notably, as further confirmed by the instance of AB 28/*i* on the Knossian Neopalatial 'scepter' (Kanta *et al.* fthc.), a 'static' loss of iconicity should be ruled out for Linear A, even though it is featured on the Protopalatial documents.

Interestingly, some signs seem to develop palaeographic variants side-by-side. For instance, CH 007 depicts a bent arm through a L-shaped disposition, which is always to be found on both seals and clay documents (see Table 6.5). The latter is the only to be found at MM IIB Phaistos too. By contrast, on ARKH Zf 9, a V-shaped variant appears.

Starting from the MM III period, this variant seems to have replaced the L-shaped one on both Hieroglyphic and Linear A documents, in which the latter is never employed anymore.

	MM II	MM III	LM I
CH 005	#180	#122a #058c	-
AB 79	PH 6.2	-	HT 99b.2 HT 36.2

CH 006	#302c #316 PE He 16c 64	#043a.1 #063a.1	-
AB 48/*nwa*	-	-	SY Za 4
CH 007	#070 #296a	#043a.1 #114a	-
AB 73/*mi*	PH 14b ARKH Zf 9	MA 1a PH 30.2	HT 27a.3 KH 9b.2
CH 008	#076a #282a PH 6.2	#113d #120*v*.a PE Zg 6.1 SY Za 6	-
CH 009	#075a #225	#003c #018c	-
AB 01/*da*	PH 6.4 ARKH Zf 9	SY Za 6	HT 117a.8 ZA 10a.4
CH 010	-	#043a.2 #043a.1 #058c	-
AB 53/*ri*	PH 6.2 PH 7a.2	PH Wa 32	KH 90.2 ZA 11b.1 HT 4.2
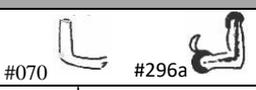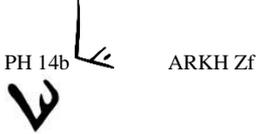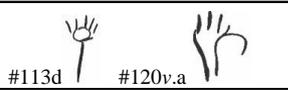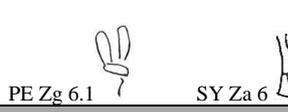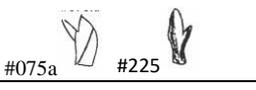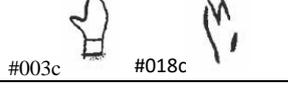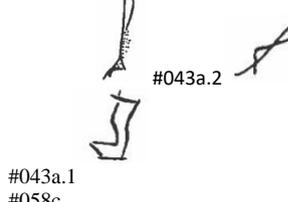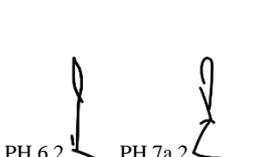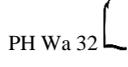
Table 6.5 - Examples of signs depicting human body parts possibly falling within the Type 1

Second, signs depicting floral motifs (see Table 6.6). Most of them basically employed the same palaeographic variant all over their history, with only minor changes (see CH 023 vs. AB 122/*OLIV*, CH 027 vs. AB 316 and CH 031 vs. AB 27/*re* = A 328). Indeed, as observed in §6.7, few occurrences of floral motifs can be diagnostic of one of the two scripts. The sign AB 04/*te*, which is as a rule identical to CH 025, developed as early as the MM II a well-recognizable variant

with straight horizontal strokes. Notably, such a variant is indeed attested on MA/V Yb 04 too (see Table 6.6). It attests the presence of a scribal tradition for this sign perhaps less tied to its Hieroglyphic counterpart. In all the other cases, both Hieroglyphic and Linear A goes hand-in-hand in attesting the same palaeographic variability.

The case of CH 077 and AB 78/*qe* is particularly relevant (see Table 6.6). Indeed, on Hieroglyphic documents from the Quartier Mu, two variants are attested, i.e., one showing a dotted circle divided by a stroke and the other one displaying two different leaves bind together by a bent line. By contrast, coeval documents in Linear A only show the former one, although without the inner stroke. Now, while the Hieroglyphic scribal tradition only continues the 'double-leaved' variant on MM III documents from both Mallia and Knossos, the Linear A merely attest the one at home at Protopalatial Phaistos. While during the MM II the two signs shared therefore a common variant, within MM III archives they could have been totally differentiate and diagnostic for each script.

	MM II	MM III	LM I
CH 023	#089a	#039b #113d	-
AB 122/*OLIV*	-	-	HT 91.3 TY 3a.4
CH 025	#316	#027d #120r.B	-
AB 04/*te*	PH 12c PH 15a	MA 10a SY Za 6	HT 8a.3 HT 12.1
CH 027	#073a	#049b	-
A 316	PH 8b.1	PH 1a.1	KH 91.2
CH 031	#088a	#017d #120r.B	-

AB 27/*re* = A 328	PH 15a	MA 2b	HT 13.2 ZA 8.2
CH 077	#079 #095a	#039a #112a	-
AB 78/*qe*	PH 9a	MA 1a	HT 6a.6 ZA 14.4

Table 6.6 – Examples of signs depicting floral motifs and possibly belonging to the Type 1

6.8.2 Type 2 : Signs showing divergent traditions as early as the MM II period

Several signs are clearly tied to the rendering of the same iconographical device, although they seem to continue slightly different graphical variants. Notably, this discussion mostly deals with palaeographic variants attested by clay administrative documents. Indeed, it must be recalled here that inscribed seals were plausibly engraved by craftsperson who was responsible for the manufacture of uninscribed ones too. As a consequence, the paleography of signs on seals mainly adheres to technical constraints imposed by this specific support, as well as on iconographic criteria common to instances in which the same motif does not represent a script sign.

The aforementioned pattern is visible in two signs with a long-lasting tradition, i.e., the 'double-axe' and the 'door'. The signs CH 042 and AB 08/*a* represent a motif omnipresent in Minoan culture from the Prepalatial period up to the very end of the Bronze Age. It is attested as iconographic device on all media of the material culture (e.g., seals, frescoes, pottery etc.), possibly often with a religious function (e.g., Marinatos 2010: 129 and MacGillivray 2012: 118) but mainly a polysemic symbol tied to diverse social *élites* (Womack 2005: 3; Haysom 2010: 50; Whittaker 2014: 75-76). Furthermore, a huge number of (miniaturized) double-axes were unearthed in Minoan and Mycenaean contexts, generally as votive offers in burials and peak sanctuaries (Flouda 2015: 44 and ref.). Two bronze double-axes, as well as a gold and a silver one, are even inscribed in Linear A (i.e., AR Zf 1-2, CR Zf 5 and SE Zf 1) and another one (i.e., HM X2416, the s.c. 'Arkalochori Axe', see Flouda 2015) bears writing characters of a type not reconcilable with Cretan Hieroglyphic nor Linear A. Finally, the double-axe was a

widespread every-day tools, possibly in use for wood and stone working, as well as for the treatment of the animal carcasses, in a wide range of operations (Evely 1993: 51, Shaw 2009: 39, Lowe Fri 2011 and Flouda 2015: 44-45).

The earliest type of double-axe attested in Minoan iconography is the s.c. 'butterfly'-type (see #070 on Table 6.7), i.e., in which the blades are rendered by means of two triangles in front-to-front disposition. The 'butterfly'-type is featured on the EM III-MM I seals bearing the 'Archanes formula', as well as on all the pot- and mason's marks from Proto- and Neopalatial spots. Within the system of mason's marks coming from the Palace of Knossos, in a small phase during the MM III period, such type coexisted with a 'linear'-type (see PH 6.3 on Table 6.7), whose main characteristic is a narrow horizontal stroke standing for the long edge. Notably, no functional difference tied to these variants can be posited. Indeed, a flared axe is self-evident for the 'butterfly' type, but it can be posited for the 'linear'-type too by virtue of the dimension of the blades with respect to the long edge. Similarly, the blades can be, in both types, indifferently straight and curved.

Now, it is clear that Cretan Hieroglyphic and Linear A strongly differ on administrative documents. The sign CH 042 generally occurs with the 'butterfly'-type (88% of instances). The five instances from Petras (Hallager & Tsipopoulou 2010: 171) show an idiosyncratic variant generalizing the Evely's type 4 and sporadically used as mason's mark at Knossos, Mallia and Phaistos (see Hood & Bendall 2020: 24-25, who defines it "a more naturalistic rendering"), as well as it is attested as variant of CH 042 on seals (e.g., #205a.1). Finally, in two cases, a 'bolded' variant occurs, in which the long edge takes a rectangular shape. By contrast, on Linear A archival documents, the 'linear' type neatly predominates, without exception when the double-axe is employed as a syllabogram. On non-perishable inscriptions, such a distinction conversely tends to fade.

Especially on documents made of stone, such as the 'libation vessels', the double-axe tend to assume a shape close to CH 042 on seals (see IO Za 2a.1 and #155b, IO Za 7 and #205a.1). Still, the gold ring from Knossos (i.e., KN Zf 31) and the inscribed silver pins all attest the 'linear'-type only.

Sign	MM II	MM III	LM I
CH 042	074a PE He 001 #070 #222b	#027b #033b	-
AB 08/*a*	PH 6.3 CR Zg 4a	MA 1b KN Zf 13	HT 9a.5
A 317 and 640	PH 9a	-	ARKH 3a HT 96a.3 KH Wa 1002

Table 6.7 – Variants of the double-axe between Cretan Hieroglyphic and Linear A

As noticed by Hood & Bendall (2020: 25), while the 'butterfly'-type is the normal shape all over the Minoan iconography, the 'linear'-type firstly appeared as a script sign (i.e., AB 08/*a*) on clay documents from Phaistos Vano XXV and was consistently in use by Linear A scribes up to the LM IB period. Indeed, Hood & Bendall (*ibidem*) are inclined to think that its usage as mason's mark at MM III Knossos was mainly derived from the adoption of the Linear A sign. Accordingly, the 'linear'-type would be basically untied to Minoan iconographic tradition. It follows that it would an idiosyncratic palaeographic variant developed by the Linear A scribes and generalized as early as the MM II period.

Still, AB 08/*a* is not the only double-axe within the Linear A signs' inventory. The logogram A 317 depicts a double-axe too, although the long edge is represented by two parallel strokes, rather than the single one of the 'linear'-type. The earlies occurrence, i.e., PH 9a, matches the rare variant of CH 042 on #033b (Knossos 'Hieroglyphic Deposit) and #074a (Mallia Quartier Mu). What is more, it is 90 degrees rotated, as well as the vast majority of instances of CH 042 on clay documents (see Fig. 6.26).

Fig. 6.27 – (From left to right) The Linear A lame PH 9a and the Hieroglyphic medallion #074a

Such a sign was later graphically 'updated' (see ARKH 3a on Table 6.7 and see §6.8.3 for such a development), as its Neopalatial occurrences matches the coeval double-axe with 'duplicated' blades (see II.8 125, see Fig. 6.27), such feature being already attested twice on impressions of the Phaistos Vano XXV (see II.5 233-234, see Fig. 6.27). It must be emphasized that the opposition between AB 08/*a* and A 317 was therefore attested starting from the Phaistos MM II(A-)B documents. Revealingly, at Hagia Triada, two out of three cases in which AB 08/*a* is in absolute isolation (i.e., Wa 1148-1149), when it likely functioned as a logogram, are those which show the odd 'butterfly'-type identic to CH 040. Such an observation can be also made for the ligatured logogram A 640, attested twice at Chania (i.e., KH Wa 1001-1002). The fact that the 'linear'-type appears with a logographic value on #068, which is a *dubitandum* interpreted as Linear A in this work, could point to the will of the scribe of differentiating between the two scripts.

Fig. 6.28 – (From left to right) Drawings of II.8 125 and II.5 233-234

Accordingly, the consistent differentiation observed on clay documents could be motivated by the assumption that (at least two) different scribal traditions would have developed a number of variants more and less independently as early as the Protopalatial period. These variants could be not merely due to the different development of the same sign but would probably hide a conscious choice already during the Protopalatial period.

Specifically, Linear A scribed would have used the paleographic 'variant' of the double-axe attested by CH 042 with a logographic value (i.e., A 317 and

640), while another idiosyncratic variant, i.e., the 'linear'-type predominant for AB 08/*a*, would have been employed with a syllabographic value.

The sign CH 038 shows a high palaeographic variability (see Table 6.8), basically merging three motifs which are, outside Cretan Hieroglyphic studies, are kept separated, i.e., the 'ladder', the 'window' and the 'door', which is attested only once on #025. Notably, the latter shape is absent from seals too. By contrast, the sign AB 57/*ja* only attests the 'closed' variant, which is normally labeled 'door'. The only possible exception is to be found on SY Za 2, in which however the 'closed' variant predominates and the longer left vertical stroke could be idiosyncratic.

Sign	MM II		MM III			LM I
CH 038	#072a #148	#195	#057c	#025c	#021c	-
AB 57/*ja*		ARKH Zf 9	MA 2b.2	KN Zb 4	HT 7a.3	ZA 15a.6
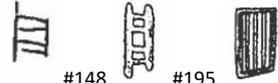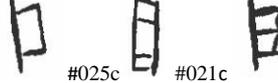
Table 6.8 – Palaeographic variants of CH 038 and AB 57/*ja*

Notably, a similar distinction is matched on pot- and mason marks, in which the two motifs are well attested. Indeed, on potmarks from Protopalatial Phaistos, a 'closed' variant resembling AB 57/*ja* was generalized (Militello 2017: 60 and see Fig. 6.28).

Similarly, such a variant is the only to be found on masons' marks, although only Neopalatial examples are available (Pernier 1935: 404, 410). Conversely, within the Quartier Mu, a sign of this group is only attested as a potmark, a 'window' close to the CH 038 (Godart & Olivier 1978: 126-128 and see Fig. 6.28). Revealingly, the only case in which a Hieroglyphic document attest the 'door', i.e., #025, comes from the Knossos 'Hieroglyphic Deposit'. Such an observation is unsurprising, given that the Knossos 'Hieroglyphic Deposit' exhibits a high degree of interaction between Hieroglyphic and Linear A administrative systems (Schoep 1999: 267 and Petrakis 2017: 80). As a consequence, it might therefore be suggested

that the two iconographic traditions partially diverged already during the MM II period, and both Linear A and Cretan Hieroglyphic inherited only one of them.

Fig. 6.29 – The 'closed' variant (= AB 57/*ja*) from Phaistos masons' marks and the 'opened' variant from Mallia potmarks

Further confirmation could come from the behavior of CH 019 *vis-à-vis* that of AB 31/*sa*. This sign has two main palaeographic variants, one taking the shape of a reversed-A, while the other is Y-shaped and close to the earliest attestations of the sign on bone seals bearing the 'Archanes formula' (see Table 6.9). Now, on archival documents from both the Quartier Mu and the Petras 'Hieroglyphic Archive', a 'reversed-A-shaped' variant is attested. By contrast, at MM II Phaistos, documents in Linear A only attest the Y-shaped variant. The latter is further retained all over the Linear A documentation, in which no traces of the reversed-A variant are to be found. Revealingly, the only instance on Hieroglyphic clay documents of the Y-shaped variant comes from the Knossos 'Hieroglyphic Archive', i.e., #030a. Of course, given that the Y-shaped variant is common on seals, an analogy with these documents cannot be ruled out. Accordingly, it seems likely that Cretan Hieroglyphic and Linear A developed two distinct graphic traditions, perhaps going back to the same motif, as it would be suggested by their reciprocal interaction within the Knossos 'Hieroglyphic Deposit'.

	MM II			MM III		
CH 019	#068a	#093b	PE He 009	#030a	#109a	
AB 31/*sa*		PH 6.4				

Table 6.9 – Palaeographic variants of CH 019 and AB 31/*sa*

6.8.3 Type 3 : Signs showing iconographic 'updates'

A series of Linear A occurrences show significantly palaeographic differences *vis-à-vis* both Linear A allographs and Hieroglyphic counterparts according to the chronology of their attestation. A clear example is the logogram A 100/102. On MM II documents from Phaistos, this sign appears as a stylized human figure in profile, with a 'chiastic' disposition of its arms (see Table 6.10). By contrast, all documents datable at the LM I period display a decidedly different outline (see Table 6.10). Indeed, the 'Neopalatial' human figure is always represented with one arm akimbo and the other one raised forward. Moreover, the body is commonly represented shorter, with respect to the longer legs. Finally, legs are never raised nor put forward, but always represented in standing position.

Revealingly, such a difference perfectly matches the situation displayed by Minoan iconography. A stylized standing human figure, mostly without explicit gender connotates (and therefore analyzable as a masculine one) is ubiquitous on both Pre- and Protopalatial glyptic (see Table 6.10). On soft-stone seals, men's bodies are indeed usually represented by means of single cuts sketching the outline of body, arms and legs, while the heads are generally represented by means of a cup-sinking. Often, both the standing and crouched figure display the 'chiastic' disposition of the arms, which is indeed inherited by CH 001 too. These criteria for human representation are still the only used on seals impressing within the Phaistos Vano XXV and can be safely regarded as a very rule for the whole Protopalatial period.

Moving to Neopalatial glyptic, the representation of the human figure suddenly changed starting from the LM I period. Regardless of technical and stylistic changes affecting the more and less 'synthetic' rendering of each body part, it is important to stress that both male and female figures display as a rule (a) one harm akimbo, with the hands on the hips, (b) a shorter body, (c) legs either standing or slightly crouched (see Table 6.10). Notably, the arm akimbo can be combined with more than one configuration of the other arm, which means that it can occur with different (ritual) gestures. On seals, such a configuration also tends to be represented in a schematic way, in which the arm akimbo assumes a 'rectangular'

outline. Such a pattern finds a perfect parallel on Linear A instances of A 100/102, in which the arm akimbo can be represented as either a 'rectangle' or a 'semicircle'. As a consequence, all the features attested on seals manifestly match the ones occurring for A 100/102 on Neopalatial documents. During this period, seals and Linear A inscriptions also share the iconographic criteria adopted to distinguish the gender of the human figure. According to Galanakis (2005: 78), it is indeed represented by clothing rather than physical connotates. Indeed, on both Neopalatial seals and instances of A 100/102, the male figure is mostly shown either naked or with few clothes, while the female one is commonly distinguished by means of a hatched long skirt.

Such a behavior suggests that Minoan writing was in close connection with the iconography up to the end of the Protopalatial period. As a consequence, iconography on other media would not only crucial to understanding the origins of both Hieroglyphic and Linear A graphic repertoires, but also to partially explain their developments.

Chronology	Seals	AB 100/102
MM II-III	 II.2 204a II.2 098b II.5 324 VI 183	 PH 8a.2 PH 12a
LM I	 II.3 145 II.3 171 VI 286 XI 255 III 349	 HT 55a.1 HT Wc 3022 HT 108.1
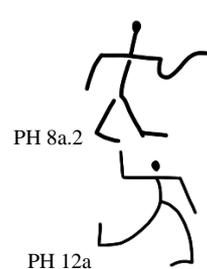
Table 6.10 – Comparisons between the palaeographic development of AB 100/102 and the iconography on seals

Another worth noting example is provided by the Hieroglyphic sign for the ship, i.e., CH 040, in comparison to AB 86, these two signs being already paired by Ferrara *et al.* (2022: 105). Ships depicted by CH 040 were widely described in §2.4.5 as matching at least three different typology of ships attested on seals and other media between the Pre- and the Protopalatial period. Safe instances of AB 86 are confined to LM IB contexts at Hagia Triada and Chania (see Table 6.11).[45] If directly coming from the representation of CH 040, the ship of AB 86 would inherit Van de Moortel (2017)'s type C2 and represent only one-half of it (i.e., the bow) after a *pars pro toto* process. Furthermore, oars would have vanished from all the attestations. Such a scenario is theoretically conceivable for the 'opened' variants attested at Chania (i.e., KH Wa 1013-1016), but finds drawbacks with the 'closed' ones from Hagia Triada (i.e., HT 26b.4, 94a.1, b.4 and 140.1). In this context, the 'hatched' hull is never to found on instances of CH 040.

A more plausible explanation is that the same process occurred for A 100/102. Indeed, the iconographic type of AB 86 can be obviously reconciled with the shape of the s.c. 'talismanic ship', attested on seals from the (MM III)-LM I period onwards (see Table 6.11). According to Wedde (2000: 130), such a depiction show constitutes "a compressed representation of a ship" in which "the image is reduced to a bow with the characteristic bird symbol upon which is placed the *ikrion*". Notably, however, the 'bird' decoration is facultative (e.g., VII 101). The hull is commonly closed by a vertical stroke opposite to the decoration. Moreover, the hull is often 'hatched' by beans of oblique strokes drawn through a single cut. All these features are perfectly compatible with the ship attested by AB 86 and would explain those characteristics unattested by CH 040. When the sail is represented, the related mast is at the very center of the hull and the sail goes down up to the bow's decoration, while another mast is represented behind the more advanced one. Such a pattern possibly occurs for the ship on HT 27a.2. Notably, Ferrara *et al.* (2022: 150) tentatively suggests that A 359, a *hapax* on PH 17a whose function is hard to discern, would represent an instance of AB 89. Revealingly, if this was the case, the shape of this instance would match that of the 'Protopalatial'

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[45] The sign is perhaps found on a MM III inscription from Miletus, i.e., MIL Zb 4. Unfortunately, the survived fragment does not allow to recognize which type of ship is represented.

ship of the type C and AB 89 would display the same graphic 'updates' as A 100/102 (see Table 6.11).

Chronology	Seals		CH 040, AB 86 and 359
MM II	III 026	VS1B 333a	#118b #124 PH 17a
LM I	VII 101 XI 125 VII 104		HT 27a.2 HT 26b.4 KH Wa 1015a

Table 6.11 - Comparisons between the palaeographic development of CH 040, AB 86, 359 and the iconography on seals

6.8.4 Type 4 : Signs (allegedly) diagnostic for each script

As observed in §6.7, a number of signs were so far found only on documents clearly belonging to one of the two scripts. Consequently, these signs would have been regarded as distinctive features for each script. As suggested by the recent discovery of AB 48/*nwa* on SY Za 4, we cannot exclude that the current knowledge of script-specific signs is heavily influence by the relatively small available documentation. Moreover, although important steps forward have been made in recent years, the discussion on possible *comparanda* between Hieroglyphic and Linear A signs is still ongoing.

All in all, it is likely that both Hieroglyphic and Linear A would result in a more or less pronounced standardization of a 'core signary', including all those signs widely employed during the whole history of the scripts and at all places (Salgarella 2020: 180). Alongside these, a number of signs are conversely either site-specific or confined to a smaller timespan. Both Hieroglyphic and Linear A 'core' signaries are mostly composed by those signs having a plausible

syllabographic function. By contrast, on Linear A documents, the 'creation' of logograms proliferated up to the LM IB period. On Protopalatial documents from Phaistos, 28% ca. of the signs are site-specific, almost all being *hapaxes.* I calculated a similar percentage (i.e., 25% ca.) for Hagia Triada too. However, as Hagia Triada attests the absolute majority of Linear A documents, such a value would have been more predictable. Still, at both MM IIB Phaistos and LM IB Hagia Triada, almost all the site-specific signs are likely to be logograms. By looking at coeval Hieroglyphic documents from the Quartier Mu and Petras 'Hieroglyphic Archive, the existence of a 'core' signary continued by later Hieroglyphic documents seem already in place. Indeed, almost all signs included in sequences longer than two signs, and therefore analyzable as syllabograms, are attested on later documents. Both the possible exceptions, i.e., CH 082 and 083 (which are allographs, see Ferrara *et al.* 2021: 23-24), could be variants of CH 011 (see *CHIC* 133). As well as at MM IIB Phaistos, a number of palaeographic variants do not find correspondence on later inscriptions (e.g., CH 011 on #072 and CH 077 on #079). What is more, the creation of logograms clearly without parallels in Linear A seems productive (e.g., CH 081 on #077 and CH 084 on #089a).

Although a good number of unshared signs are either *hapaxes* or site-specific signs, still part of the each 'core signary' does not find correspondence in the other one. Within the Hieroglyphic inventory, clear instances could be found e.g., for CH 001 and 068, which are both well tied to both Pre- and Protopalatial iconography. Therefore, their presence within the Hieroglyphic inventory could plausibly be the result of the selection of motifs excluded by the Linear A one(s). Similarly, most of the signs confined to Linear A would find parallels in coeval iconography and could therefore attest the inverse process. Accordingly, this section aims at showing example in favor of such a pattern by presenting two case studies of different interactions between these signs confined to Linear A and coeval iconography.

Case study 1: Motifs attested on MM II seals

This case study shows that a number of signs confined to Linear A matches motifs attested on Protopalatial glyptic and are therefore likely to have been selected from

the local iconographic repertoire. In such a case, the process of script formation perfectly mirrors that described in §2 for Cretan Hieroglyphic.

First, the sign AB 59/*du* represents a human standing figure with a long (generally hooked) object in its hand and at least one arm put forward (see Table 6.12). This sign is attested on documents from Mallia *Dépôt Hiéroglyphique* and would have been selected not after the MM III period. On seals of the 'Mallia Steatite Group', such a configuration represents a standardized way to represent men working with different tools, such as poles, spears etc. (see Table 6.12). Most of these objects have a protruding upper edge, which could have been resulted in the hooked shape of the vast majority of the palaeographic variants. By contrast, such a configuration is decidedly rarer on Late Minoan seals.

Table 6.12 – Palaeographic variants of AB 59/*du* and their comparison with MM II iconography

Second, the sign 81/*ku* represents without doubts a flying bird (see Table 6.13). The earliest attestation, i.e., MA 2b, displays an extremely stylized shape, which was rarely equated on later inscriptions (e.g., HT Wa 1020a). The physical referent was confirmed by the finding of the 'sceptre' from Neopalatial Knossos (Kanta *et. al.* fthc.). Regardless of the precise ornithological identification, such a depiction clearly matches a number of Protopalatial flying birds, commonly attested on seals belonging to the 'Mallia Stetatite Group' (e.g., III 170a), as well as on a possible MM I seal (i.e., II.2 334, see Table 6.13). Notably, such a figure was widespread within Minoan iconography at least from the early Protopalatial period (e.g., the MM I jug from Knossos, see Evans 1921: 369, Fig. 180).

Table 6.13 - Palaeographic variants of AB 81/*ku* and their comparison with MM I-II iconography

Third, the sign AB 50/*pu* is always represented by three vertical lines ending in either small strokes or dots and a line curved counterclockwise starting from the upper part of the three vertical lines (see Fig. 6.30). This sign shows a configuration matching AB 21/*qi*/*OVIS*, a sign employed as both syllabogram and logogram for a cow (see Fig. 6.30). Regardless of the contexts of its usage, the physical referent of AB 21/*qi*/*OVIS* is further confirmed by more iconic instances, such as KH 88.1. In the latter occurrence, the oval frame defined by the curved line refers to the head of the quadruped, as it is marked by a 'eye'. The vertical lines of AB 21/*qi*/*OVIS* can be two (e.g., ZA 26a.2), three (e.g., ZA 22.5) or four (e.g., ZA 5a.1), in the latter two cases clearly representing the paws. When the vertical lines are two, the resulting shape strongly resemble that of A 306, whose physical reference is conversely the neck, rather than the paws of the quadruped (see Fig. 6.30). As these two signs can be employed as logograms, it cannot be excluded that they influenced each other. Still, it is likely that AB 21/*qi*/*OVIS* mainly represents a full-bodied quadruped. Returning to AB 50/*pu*, this sign is mainly distinguished from AB 21/*qi*/*OVIS* by the stroked or dotted edges and the generalization of three vertical lines (see Fig. 6.30).

Fig. 6.30 – Comparison between AB 50/*pu*, AB 21[f]/*qi*/*OVIS* and A 306

On MM II glyptic, full-bodied animals are extremely widespread, and their outline strongly matches the schematic depictions of both AB 50/*pu* and AB 21/*qi*/*OVIS* (see Table 6.14). On seals, such a parallelism is especially visible for quadrupeds rendered in a more schematic fashion (e.g., VI 019a). In the case of

both AB 50/*pu* and AB 21/*qi*/*OVIS*, the oval frame is therefore conceivable as depicting either the head or the body of the animal. The rendering of three hocks on a quadruped's profile was at home already on seals of the 'Parading Lions/Spiral Group' and mostly continued during the MM II period. Similarly, on Protopalatial seals, hocks are facultatively ended by either strokes, commonly on soft stones, or dots, commonly on hard stones (e.g., respectively VI 035a and 100d). The outline of the sign could therefore point to a similar referent as AB 21/*qi*/*OVIS* and anyway to a quadruped in either a standing or a regardant pose. The latter is particularly likely given the generalization of the three hooves, which often occur on seals when the animal is in such a posture. Moreover, the fact that the oval frame never goes ahead the rightmost 'hoof' could indicate that it is not intended to represent a head nor a standing body.
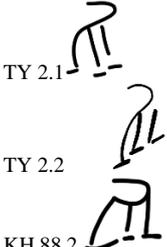
Table 6.14 - Palaeographic variants of AB 50/*pu* and their comparison with MM II iconography

Fourth, the sign AB 80/*ma*, depicting the 'cat-mask', finds clear *comparanda* on Minoan glyptic, all confined to the MM II period, with a possible exception only (Civitillo 2015). As this sign is attested on PH 7a.3 and 15a (see Table 6.16), it is likely that it was selected among the Protopalatial iconographic repository and inherited all over the Linear A tradition. Its palaeographic development is indeed clearly untied from external iconographic sources and mainly follows the geographical distribution of its attestations.

Indeed, the palaeography of sign plausibly developed side-by-side with that of AB 45/*de*, another sign without clear counterpart in Cretan Hieroglyphic (see Table 6.15). Such a behavior would be due to the similarity of their physical referents, as AB 45/*de* might going back to a quadruped, which at Hagia Triada is drawn with crossed legs. However, quadrupeds in frontal view with two or more

legs are absent from Minoan iconography and no parallels are to be found among both Hieroglyphic and Linear A signaries.

	MA 1	KH 88	KH 99, 61	HT 31	ZA 10
AB 45/*de*					
AB 80/*ma*					

Table 6.15 – Palaeographic comparison of AB 45/*de* and AB 80/*ma*

It is still hotly debated whether the 'cat-mask' (= SM 74 but excluded from *CHIC*) should be included within the Hieroglyphic inventory or not (Jasink 2009: 46-48, Decorte 2017a: 43-44 and Ferrara *et al.* 2022: 84). Exactly the same situation features AB 44/*ke*, clearly continuing a well-known motif in Protopalatial glyptic (i.e., the "spider", see Anastasiadou 2011: 191-192), but perhaps a Hieroglyphic sign too (see Table 6.16). If this was the case, both AB 44/*ke* and 80/*ma* would rather belong to our Type 1.

AB 80/*ma* = SM 74?	PH 7a.3 ZA 10b.3	VIII 034 X 280
AB 44/*ke* = SM 85?	PS Za 2a HT 98a.4	VI 158a III 172

Table 6.16 – Palaeographic variants of AB 80/*ma* and AB 44/*ke* and their comparison with MM II iconography

Case study 2: Signs whose iconographic source is uncertain

This case study shows some signs without Hieroglyphic *comparanda* but which find at least feeble parallels in coeval iconography, and it is rather uncertain whether their selection was triggered by the inclusion of a motif already employed on other media.

First, the sign AB 77/*ka* was analyzed by Evans (1909: 87) as depicting a wheel, although such a statement was mainly triggered by the comparison with later images of chariots and the logogram B 243/*ROTA* (Weilhartner 2015: 261). As a consequence, although a 'wheel'-shaped motif is well-attested on seals from the MM I period onward (e.g., VIII 112), and an encircled cross graphically akin to AB 77/*ka* is featured on Protopalatial seals (see VI 147), including an impression bearing the 'Archanes formula' (i.e., #135), as well as on 'talismanic' ones (e.g., VII 238), a clear forerunner cannot be safely individuated (see Table 6.17).[46]

| AB 77/*ka* | PH Wc 37a   KE 1.1   HT 91.1 | VI 147 #135 |
| | | VI 238 |

Table 6.17 – Palaeographic variants of AB 77/*ka* and their comparison with MM II iconography

Second, the sign AB 57 is defined in its earliest attestations from MM IIIB Mallia *Dépôt Hiéroglyphique* as a crossed circle, in which the branches of the cross are about twice the diameter of the circle in length (see Table 6.18). The lower part of the cross tends to become longer on LM I attestations (e.g., HT 115a.1 and ZA 15a.1), in order to develop the sign on its vertical axis. Such a motif is replicated at least on a three-sided prism in breccia (i.e., XII 092c, see Table 6.18) and described as a 'starlet' by the Arachne's website.

| AB 47 | MA 1a   ARKH 4a | XII 092c |

Table 6.18 – Palaeographic variants of AB 57 and their comparison with MM II iconography

Third, the sign 191 is a *hapax* on KH Wc 2028, a roundel on which it is in absolute isolation. Fortunately, it was more attested in Linear B, where it was safely

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[46] Notably, both VI 147 and #135 show the 'wheel'-shaped motif in association with other possible script signs.

identified as a helmet (Vandenabeele & Olivier 1979: 19). Notably, its shape shows the same distinctive features as the helmet motif on Neopalatial glyptic (see X 243, see Table 6.19). Such an image was widespread in Minoan iconography from the Neopalatial period onward and was employed on more media (e.g., Xenaki-Sakellariou 1953 and Molloy 2012: 120, see Table 6.19).

| AB 191 | KH Wc 2028 | X 243 Engraving on a LM I-III double-axe | |

Table 6.19 – Palaeographic variants of AB 191 and their comparison with Late Minoan iconography

6.9 Conclusions

This Chapter reassessed the origins, development and interaction between Cretan Hieroglyphic and Linear A by assuming that the boundary between the two scripts is not clear-cut as previously stated. Such an assumption proved hermeneutically useful during the investigation of three crucial aspect of the history of both Cretan Hieroglyphic and Linear A:

a)   The chronology of the earliest attestations of both scripts is extremely uncertain, and it is difficult to state whether one or the other was fully developed prior to the MM II period. As a consequence, data at our disposal do not allow to clearly discern whether one or the other template was standardized before the other came into use. By contrast, they rather suggest that the formation of the iconographic repertoires mostly took place at the same time and continues up to the end of the MM III period.

b)   The fact that a number of *dubitanda*, most of them coming from places in which Cretan Hieroglyphic and Linear A co-existed, are difficult to assign to one or the other script confirms the high degree of similarities between the two scripts, as well as the fact that a clear boundary between them is not always easy to draw. Moreover, the attribution of both #019 and #068 to the Linear A sheds new light on the co-habitation of the two scripts within the Knossos 'Hieroglyphic Deposit' and

suggests that, between the Proto- and the Neopalatial period, two major centers such as Knossos and Mallia would have employed both scripts for administrative purposes. The same situation is possibly shown by the two sherds from Phaistos (i.e., PH Yb 01 and Yc 01), as well as by sealings from Mikro Vouni, incised with Linear A characters but stamped by a group of cushions strongly tied to the 'Archanes formula'.

c)   The development of the two signaries, as well as their reciprocal interaction, follows different paths according to the signs under consideration. First, most of the signs are safely traceable back to the same iconographic sources and often share the same palaeographic variants, especially during the MM II period. Second, some signs would inherit the same 'physical referent', but the signs developed respectively by Cretan Hieroglyphic and Linear A seem to inherit two slightly different iconographic traditions. Third, on Neopalatial documents in Linear A, some signs adapt their shape to iconographic trends in vogue at that time, rather than using their counterparts employed by Protopalatial scribes. Fourth, some Linear A signs are not shared with Hieroglyphic and most of them are easily understandable as the independent selection of motifs from either the Proto- or the Neopalatial iconographic repository.

According to these three observations, I hope to have shown that the relationship between Cretan Hieroglyphic and Linear A is far from being frameable into biunivocal correspondences between two monolithic signaries. Rather, it is likely that the 'wall' between the two scripts was often permeable during both the Proto- and the Neopalatial period, at least at places in which they co-existed side-to-side and during the magmatic early Protopalatial period in which no clear hints are available for the extensive usage of one or the other.

Chapter 7 – Conclusions

This dissertation employed an innovative multi-disciplinary approach. I merged archaeological, philological, statistical, and experimental data to provide a thorough understanding of the origins and development of Cretan Hieroglyphic and Linear A.

My investigation started from two theoretical assumptions. First, both Cretan Hieroglyphic and Linear A emerged from the selection of an iconic graphic repertoire. Such a process was closely tied to the development of glyptic between Pre- and Protopalatial periods. Second, Hieroglyphic seals were not 'neutral' hosts of writing. They rather constituted luxury items, which pointed to the hierarchical role of their owners thanks to the interaction between formal and iconographical characteristics.

Accordingly, I scrutinized the whole Pre- and Protopalatial glyptic iconography *vis-à-vis* Hieroglyphic and Linear A graphic repertoires. I went on by setting up a brand-new methodology to capture the entanglement between formal and iconographic features of Hieroglyphic seals. Finally, I carried out experimental tests by reproducing for the first time the whole production cycle of Minoan seals in a workshop. I therefore suggested answers to the three key-questions I raised at the beginning of my work:

First, which are the origins of Cretan Hieroglyphic? Following a well-known *desideratum*, I closely investigated distinctive features of each Hieroglyphic sign and searched for iconographic parallels within the whole Prepalatial glyptic and material culture. I therefore provided deep insight into the origins of the Hieroglyphic graphic repertoire. As a result, I showed that several Hieroglyphic signs find correspondence on Prepalatial seals and in material culture. On Prepalatial glyptic, these devices were employed as symbols, as they tend to occur in relevant syntactic configurations mirrored by Hieroglyphic signs. I therefore argued that these iconographic motifs would have constituted the main repository from which the Hieroglyphic inventory was selected. In line with a 'punctuated equilibrium', the process of script formation I reconstructed shows that the 'Border and Leaf Complex', significantly including the 'Archanes Script' among its sub-

groups, attests the employment of a considerable number of forerunners of Hieroglyphic signs. As such a behavior does not find parallels neither during the EM III period, nor in the almost contemporaneous 'Parading Lions/Spiral Group', I suggested that the 'Border and Leaf Complex' was the decisive step before the emergence of the first European writing.

Second, to which extent is writing on seals entangled with material, technical and cultural factors? For a long time, physical and formal properties of seals (i.e., color, material, size, and readability) - especially of inscribed ones - did not receive much scholarly attention. What is more, such characteristics were never studied in association to Hieroglyphic sequences. I filled this gap by introducing in Aegean studies two statistical models only rarely employed until today, i.e., the Correspondence Analysis and the Social Network Analysis. These models allowed me to interpret for the first time datasets constituted by all the features of inscribed seals. Furthermore, these models provided a precise and highly intuitive graphic rendering of datasets.

As a result, I argued for a strong correlation between formal features, iconography, and Hieroglyphic sequences. It follows that formal features would have conveyed a meaning consistent with the one supposed for Hieroglyphic texts. Specifically, I used two Correspondence Analyses to test the degree of correlation among iconography, seal shapes, and materials. Thus, having shown that a selection of iconographic motifs must have been closely tied to a literate *élite*, I showed that only few seal shapes (mainly *Petschafte* and prisms) and materials (mainly jasper) are intimately connected with such an iconography. Seals characterized by other shapes and materials mostly share their iconography with both Pre- and Protopalatial less valuable objects instead.

Furthermore, I employed two Social Network Analyses to provide the first overall insight into Hieroglyphic seal impressions and prisms. Specifically, I succeeded in including colors, materials, sizes and readability in the understanding of inscribed artifacts. For both impressions and prisms, the Social Network Analysis allowed me to test the correspondence between these formal features and related Hieroglyphic sequences. I showed that, on the one hand, patterns of seal impressions differ from one archive to another. Within the Knossos 'Hieroglyphic

Deposit', Hieroglyphic impressions are mostly combined by virtue of their shape and sequences. They revealingly show a structured intertwining with Hieroglyphic clay documents. Such a situation is not detectable elsewhere. For instance, at Mallia, Hieroglyphic impressions are not clearly disjoined from uninscribed ones, and are therefore stamped according to local practices involving the whole glyptic.

On the other hand, I found a still undetected correlation between the number of inscribed faces of Hieroglyphic prisms – and partially the sequences they bear – and formal features of physical objects. For instance, almost all seals with a high number of inscribed faces have a high readability. Moreover, they are commonly associated with other formal features belonging to prisms in jasper, such as their sizes and sometimes even color. Crucially, few prisms which do not adhere to this pattern show relevant palaeographic idiosyncrasies too. On the opposite side, prisms with a small number of inscribed faces are commonly lowly readable. They mostly match formal features belonging to the ones fashioned from brownish/greenish steatite.

Materials proved to be crucial in defining the nature of Hieroglyphic seals. Therefore, I carried out experimental analysis never conducted before on Minoan seals to establish the effects of tools and materials through the entire process of seal manufacture. The experiments I carried out reproduced the whole production cycle of a Protopalatial seal. They highlighted the differences in the application of different techniques on different materials. Accordingly, I showed that the time required for engraving a seal starkly differ from stone to stone. According to the tool employed, I engraved soft materials 10 up to 28 times faster than (medium)-hard ones. Among microquartz, jasper proved to be the easier one to engrave, i.e., 5 to 10 times faster than agate. I also demonstrated pros and cons of different cutting tools (e.g., the difference between saw and file, as well as between different applications of the tubular drill), polishers (e.g., the progression of the polishing process from 'passive' stone polishers to 'active' leather laps) and abrasives (e.g., the difference between garnet and emery).

Finally, the third key-question: how did Cretan Hieroglyphic and Linear A differentiate and co-exist? I faced this issue by crossing chronology, typology, and palaeography of both Hieroglyphic and Linear A documents. Recently, all these

data were deeply refined and re-discussed, but they still awaited a holistic understanding of their meaning.

As a first step, I reassessed the chronology of documents possibly dating prior to the MM IIB period, i.e., a phase in which neither Cretan Hieroglyphic nor Linear A were extensively in use. I argued that only few documents, both in Hieroglyphic and Linear A, could be assigned to this period, although no one is safely dated and attributed to one or the other script. Moreover, I rediscussed the attribution of *dubitanda* to one or the other script, by providing insight into the typological and palaeographical boundaries, whenever they could be drawn, between the two writing systems. Lastly, I proposed a fourfold pathway for the emergence and differentiation of the two signaries. With reference to both inventories, I indeed recognized (a) signs showing the same palaeographic variability, (b) signs showing divergent traditions as early as the MM II period, (c) signs 'updating' their iconography through time according to stylistic trends involving glyptic and material culture too, (d) signs confined to one or the other signary.

In conclusion, I showed the effectiveness of a holistic approach to inscribed documents, which proved able to shed light on the value of documents in their cultural and administrative context. Alongside this, I highlighted the advantages of both statical and experimental analyses to cross the huge amount of information provided by inscribed artifacts.

Indeed, crossing data from different fields and through different theoretical models was crucial to rightly understand extremely diversified and scarcely homogeneous epigraphic traditions, such as those of Cretan Hieroglyphic and Linear A. What is more, such an approach opens new paths toward the understanding of the role played by texts themselves and ultimately on the way in which writing emerged and developed on Crete.

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Appendix

Concordances of Hieroglyphic seals and seal impressions in *CHIC*

Abbreviations

AM = Ashmolean Museum, Oxford

HM Met. = Collection Metaxas

ANM = Archaeological Museum of Agios Nikolaos

KNSM = Stratigraphical Museum of Knossos

BM = British Museum, London

Liv. CM = City Museum, Liverpool

BSM = Staatliche Museen, Berlin

MASM = Musée Stratigraphique de Malia

Camb. FM = Fitzwilliam Museum, Cambridge

MASM = Stratigraphical Museum of Mallia

CdM = Cabinet des Médailles, Paris

NMA = National Museum of Athens

Coll. E rl. = Collection Erlenmeyer

NYMM = Metropolitan Museum of Art, New York

Coll. P.-S. = Collection E. Peters-Schmidt, Switzerland

SAM M = Archaeological Museum of Samothrace

HM = Heraklion Archaeological Museum

Sit. M. = Archaeological Museum of Sitia

HM Giam. = Gialamakis collection

WKM = Kunsthistorisches Museum, Wien

CHIC number	Inventory number	*CMS* number
#123	HM 172	II.8 090
#124	HM 206	II.8 089
#125	HM 657	II.8 084
#126	HM 1052	II.6 180
#127	HM 1053	II.6 177
#128	HM 1057	II.6 182
#129	HM 1079	II.6 176
#130	HM 1087	II.6 181
#131	HM 1101	II.6 179
#132	HM ?	-
#133	HM 1096	II.6 229
#134	HM 159	II.8 056

#135	SAM M MB/EE 7	VS1B 326
#136	SAM M MB/EE 775k	VS1B 325
#137	SAM M MB/EE 769	VS1B 327
#138	HM 35/1-3	II.7 215
#139	HM 107	II.8 080
#140	HM 174	II.8 064
#141	HM 182	II.8 086
#142	HM 191	II.8 075
#143	HM 194	II.8 081
#144	HM 198	II.8 077
#145	HM 200	II.8 078
#146	AM 1938.940	II.8 087
#147	AM 1938.940	II.8 088
#148	HM 1054	II.6 187
#149	HM 1090	II.6 188
#150	MASM 70/E 28	II.6 189
#151	HM 733	II.5 239
#152	HM 33	II.7 213
#153	HM 34	II.7 214
#154	HMpin 1403	II.6 168
#155	HM 556/1-4, 599, 600	II.6 143
#156	HM 107	II.8 074
#157	HM 132	II.8 082
#158	HM 174	II.8 065
#159	AM 1910.207	II.8 063
#160	AM 1910.207	II.8 062
#161	HM 178	II.8 083
#162	HM 179	II.8 067
#163	HM 181	II.8 068
#164	HM 185	II.8 079
#165	HM 192	II.8 076
#166	HM 192	II.8 073
#167	HM 206, 1611	II.8 071
#168	HM 207	II.8 072
#169	AM 1938.1153b	II.8 069
#170	AM 1938.1153b	II.8 070
#171	HM 1080	II.6 178
#172	HM 1083, 1085, 1088	II.6 184
#173	HM 1086	II.6 183
#174	HM 4815	II.6 245
#175	KNSM MP/73/239	II.6 231
#176	HM 186	II.8 066
#177	HM 354	II.8 120
#178	HM 363	II.8 057
#179	HM 372	II.8 029
#180	HM Giam. 3454	III 103
#181	Liv. CM B. 209	VII 255
#182	Coll. Erl.	X 053
#183	NYMM 26.31.169	XII 101
#184	NYMM 26.31.168	XII 102
#185	?	-
#186	AM 1938.0932	VI 125
#187	HM Giam. 3344	III 027
#188	HM 2465	-

#189	HM 2526	-
#190	HM Met. 1126	IV 131
#191	HM 748	II.2 249
#192	AM AE 2327	VI 126
#193	AM 1938.0936	VI 124
#194	AM 1938.0925	VI 146
#195	BM 1901.10.16.3	VII 041
#196	AM 1910.0236[47]	VI 145
#197	HM 2390	-
#198	AM 1910.0236	VI 141
#199	HM 1782	II.2 112
#200	HM 1883	II,2 227
#201	Coll. Grum.	XI 073
#202	HM 2245	II.1 394
#203	AM 1938.0929	VI 013
#204	HM 1796	II,3 151
#205	BM 1921.7.11.2	VII 035
#206	HM Giam. 3082	III 149
#207	HM 1442	II.1 420
#208	HM 1191	II.2 220
#209	HM Giam. 3232	III 233
#210	HM Giam. 3289	III 231
#211	HM Giam. 3579	III 232
#212	AM 1910.0232	VI 030
#213	AM 1938.0774	VI 026
#214	WKM IX 1980	IX 299
#215	AM 1938.0748	VI 029
#216	BM 1947.9.26.8	VII 028
#217	CdM N 4421	IX 022
#218	CdM N 7988	IX 023
#219	BSM 31407	XI 010
#220	BSM 31420	XI 011
#221	BAKM B 153	XI 081
#222	? (Only impression)	XI 331
#223	NYMM 26.31.124	XII 083
#224	NYMM 26.31.135	XII 084
#225	NYMM 26.31.149	XII 093
#226	AM 1910.0233	VI 088
#227	HM 1688	II.2 277
#228	? (Only drawing)	-
#229	HM 383	II.2 230
#230	? (Only photograph)	-
#231	HM 1770	II.2 100
#232	HM 1773	II.2 103
#233	HM 1786	II.2 116
#234	HM 1840	II.2 168
#235	HM 2750	-
#236	HM 1304	II.2 078
#237	HM 955	II.2 269

[47] CHIC refers to AM 1938.0924.

#238	ANM 3114	V 025
#239	AM AE 1191	VI 087
#240	HM Giam. 3111	III 230
#241	AM AE 1194	VI 096
#242	HM Giam. 3427	III 227
#243	BSM FG 58	XI 012
#244	NYMM 26.31.118	XII 072
#245	NYMM 26.31.173	XII 115
#246	AM AE 1771	VI 027
#247	HM Met. 190	IV 156
#248	HM 571	II.2 259
#249	? (Only photograph and drawing)	-
#250	CAMB FM GR 71.1901	-
#251	AM 1938.0928	VI 014
#252	HM 2266	II.1 393
#253	HM 115	II.2 296
#254	HM Met. 181	IV 137
#255	AM AE 1777	VI 091
#256	AM 1910.0235	VI 095
#257	AM 1938.0791	VI 093
#258	BSM FG 57	XI 013
#259	AM 1938.0797	VI 028
#260	NYMM 26.31.162	XII 089
#261	NYMM 26.31.122	XII 110
#262	NYMM 26.31.175	XII 117
#263	NYMM 26.31.153	XII 010D
#264	AM 1938.0792	VI 092
#265	AM 1938.0796	VI 094
#266	? (Only drawing)	-
#267	BM 1900.6.13.2	VII 036
#268	HM Giam. 3580	III 229
#269	HM Giam. 3373	III 288
#270	HM Met. 178	IV 027D
#271	HM 97	II.2 244
#272	CdM N 3444	IX 021D
#273	Coll. P.-S.	X 312
#274	NYMM 26.31.150	XII 105
#275	? (Only impression)	-
#276	HM Met. 1173	IV 135
#277	HM Met. 1066	IV 029D
#278	NYMM 26.31.159	XII 111
#279	NMA X 565	-
#280	HM Giam. 3336	III 237
#281	HM Met. 175	IV 128
#282	HM 2536	-
#283	AM 1938.0793	VI 100
#284	NYMM 26.31.125	XII 070
#285	NYMM 26.31.98	XII 087
#286	HM Giam. 3581	III 235
#287	NYMM 26.31.161	XII 112
#288	HM 2184	-
#289	Sit. M 8254	VS1B 337
#290	NMA 9975	IS 073
#291	HM 1269	II.2 315

#292	HM 1868	II.2 217
#293	HM 1694	II.2 256
#294	NMA 8915	-
#295	HM 1537	II.2 316
#296	AM 1889.0998	VI 104
#297	AM 1938.0794	VI 101
#298	BSM FG 56	XI 014
#299	BM 1934.11.20.1	VII 040
#300	Coll. Erl.	X 052
#301	NYMM 26.31.155	XII 106
#302	NYMM 26.31.156	XII 107
#303	NYMM 26.31.157	XII 109
#304	NYMM 26.31.152	XII 113
#305	HM Met. 168	IV 136
#306	HM Giam. 3325	III 234
#307	? (Only photograph and drawing)	-
#308	AM AE 1774	VI 103
#309	HM 2595	-
#310	NMA 4579	I 425
#311	HM Met. 186	IV 138
#312	AM 1910.0234	VI 105
#313	HM 2850	-
#314	AM 1938.1166	VI 102
#315	HM 2260	II.1 391