

## Digital acquisition and modeling of the Minoan seals and sealings kept in two Italian Museums

Niccolò ALBERTINI<sup>1</sup> | Anna Margherita JASINK<sup>2</sup> | Barbara MONTECCHI<sup>2</sup>

<sup>1</sup>DREAMS Lab, Scuola Normale Superiore di Pisa | <sup>2</sup>Dipartimento SAGAS, Università di Firenze

**Abstract:** Seals are small semi-precious or common stones cut into standard shapes, polished and engraved with ornamental patterns or figures. Sealings are small clay lumps impressed one or more times by seals and occasionally inscribed. In the Minoan Palatial administrative system (First half of the II Millennium BC) some types of sealings were used as receipts or tokens to check incoming and outgoing of commodities, other types were fastened to commodities and/or to documents written in perishable material as labels. A selection of Minoan seals and sealings are currently housed in the Archaeological Museum of Florence and the Prehistoric and Ethnographic Museum Pigorini of Rome.

Almost all the sealings kept in these two museums come from the site of Haghia Triada (South-Central Crete); the only exception is one from Zakros (Eastern Crete), for a total of 40 pieces. All are dated to the so called Neopalatial Period (around the XVI cent. BC). Neopalatial sealings are grouped in four main types, which are all represented in the Italian collections, apart from the roundels.

We intend to elaborate 3D models of the most representative and best preserved seals and sealings housed in the two Italian Museums with the aim of applying a multidisciplinary methodology designed to develop solidly based hypotheses on the use and function of such items. Sealings show different shapes and bear various signs and traces on the clay, which can be valorised in the 3D models. Finally, we intend to show a brief virtual simulation of the suggested scenarios to verify the verisimilitude of the elaborated hypothesis. In other words, we intend to operate an update of the traditional practices of experimental archaeology, with the technical assistance of a specialist in 3D laser scanner survey applied to cultural heritage. Therefore, the present contribution is aimed at integrating theoretical and “experimental” studies, conducted with updated technical.

**Keywords:** Seals in Italian Museums, Bronze Age Aegean, 3D reconstructions, Aegean Lab Florence, DREAMS Lab Pisa

### General remarks

In the Minoan Palatial polities (Crete, first half of the Second Millennium BC) sealings were means of an administrative system aimed at controlling the mobilization of resources and goods. They are small clay lumps impressed one or more times with a seal, and at times inscribed with one or two Linear A signs. Seals are chiefly small semi-precious or common stones cut into standard shapes, polished and engraved with ornamental patterns or figures, more rarely metal rings engraved with figurative scenes.

A selection of Minoan seals and sealings are currently housed in two Italian Museums: the Archaeological Museum in Florence (here after MAF) and the Prehistoric and Ethnographic Museum “L. Pigorini” in Rome (here after MPR).

Almost all the sealings kept in these two museums come from the site of Haghia Triada (South-Central Crete), the only exception is one from Zakros (Eastern Crete), for a total of 40 pieces.

The site of Haghia Triada (here after HT) was excavated by the Italian Archaeological Mission in Crete under the direction of Federico Halbherr since 1902. The Italian mission was sponsored by Luigi Pigorini, director of the Museo Preistorico Etnografico of Rome and by Adriano Milani, Director of the Regio Museo Archeologico of Florence; as a consequence, both Museums received part of the discovered objects. As to the sealings, they come from the 1902-1903 excavations and the most part, with the exception of these two sets, is kept in the Archaeological Museum of Heraklion. The 30 sealings in MPR were sent by the Cretan government to the Roman Museum as a gift in 1904<sup>1</sup>, while the 9 sealings in MAF were sent directly to the Florentine Museum by Pernier in the same year<sup>2</sup>. Pernier, together with the sealings from HT, sent also a sealing from Zakros (here after ZA), where excavations had been carrying out by the British School at Athens (HOGART 1902).

All sealings are dated to the so called Neopalatial Period, specifically to LM IB phase, i.e. around the middle of the XV century B.C., according to the traditional “Low Chronology”, or the middle of the XVI century B.C., according to the “High Chronology”<sup>3</sup>.

We intend to present here a work carried out with the aim of applying a multidisciplinary methodology designed to investigate the use and function of such material. Since the debate about the purpose and the exact method of use of various types of Minoan documents, especially with regard to the sealings, a significant contribution may arise from the application of new Information Technologies to the study of these documents. In fact, they allow us to manage large amounts of digital information, even heterogeneous in nature – diagnostic imaging, 3D reliefs, texts, images, sounds, and movies – to deepen the knowledge of cultural heritage, and also to build the theoretical basis for the creation and application of multimedia content useful to promote, share and exploit the results of the research. In this framework, new technologies can be applied profitably to our field, as we have already shown with the MUSINT project (MONTECCHI, JASINK 2011). Since the sealings show different shapes and various seal impressions, signs and other traces on the clay, we elaborated 3D models of the most representative and best preserved seals and sealings housed in the two Italian Museums, to valorise such evidence. Moreover we created a brief virtual simulation of the suggested administrative procedures involving the investigated documents. The manipulation of digital copies of the documents in the virtual environment can make easier the understanding of their original

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<sup>1</sup> In origin they were 32, but two of them were lost before the editio princeps of the Catalogue (BORDA 1946). See DEL FREO 2002-2003: 55-58 (with a detailed description of their acquisition).

<sup>2</sup> See ASBAT 1904 A/11, where they are improperly defined as “duplicati di cretule impresse”.

<sup>3</sup> The absolute chronology of the Bronze Age Aegean is a matter of dispute. For the relative chronology of the documents from Haghia Triada see MILITELLO 1988.

function and use, because we can simulate their use in the original context, once it is virtually recreated.  
(fig.1)

Summing up, the creation and use of 3D digital models of our documents will be useful for:

- 1) Understanding the formal and geometric characteristics of the objects under investigation.
- 2) The creation of an archive of digital copies, which is very useful because, due to their small size and the fact that they were unbaked, these sealings are very fragile.
- 3) The diffusion and sharing of results of the research among the international scientific community and knowledge among a wider public.



Fig. 1 – 3d scan of the sealings

The present contribution offers, therefore, the opportunity to integrate theoretical and “experimental” studies, but it is important also to emphasize that information technology is very useful to implement the archaeological and historical research when it acts as a result of information, knowledge, and presentation of the specific difficulties and uncertainties of the subject. On this ground, firstly, we will discuss our material, giving short information about shapes, typologies, seal types (potentially informative regarding the seal-users), inscriptions, and archaeological features, such as clay characteristics and traces left on the clay by the objects to which the flat based nodules were attached. Then, previous suggestions about their function and use will be reviewed. Finally, we will give elements about the contribution of the application of new digital technologies, which represents the real highlight of this paper. Moreover, on our on-line laboratory called @aegean lab (<http://aegean.sns.it/>) the possibility is given to see both the digital image of the objects in a dynamic 3/dimensional display and the interactive path from the outside to the inside of the Haghia Triada Villa.

(N.A, A.M.J, B.M.)

## Shapes

Neopalatial sealings have been grouped into four main types, conventionally called roundels, *noduli*, flat-based nodules (here after F-B) and hanging nodules. The latter are in turn divided in two- and single-hole hanging nodules (here after T-H and S-H nodules). (fig. 2)

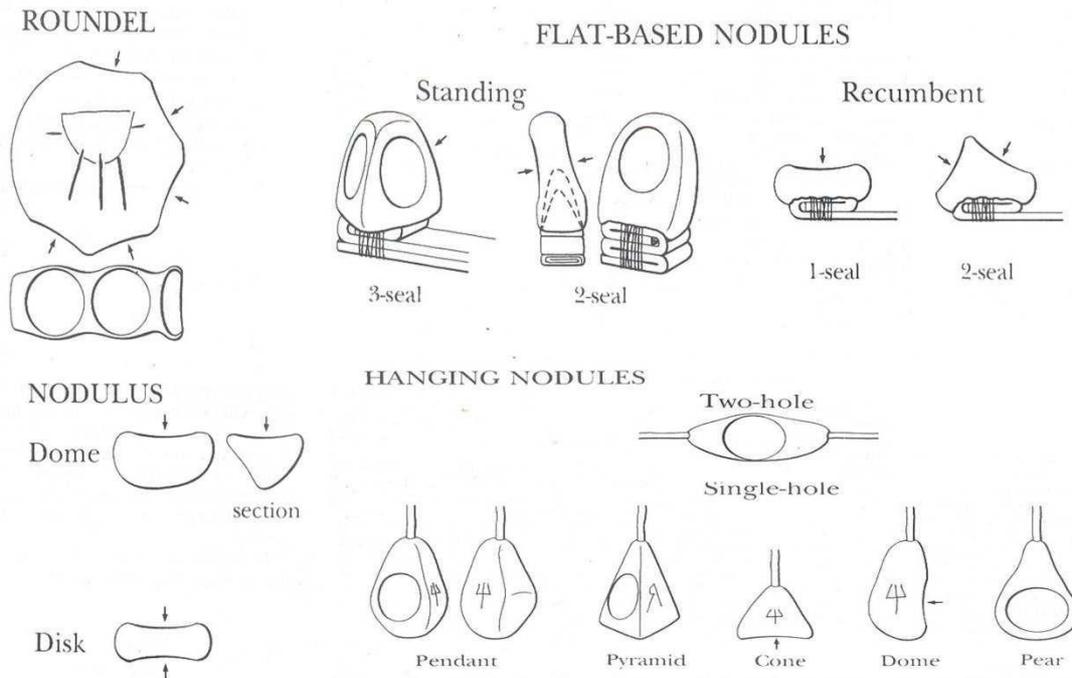


Fig. 2 – Sealing shapes

A **roundel** is a clay disk with one or more seal impressions along the edge and, usually, but not always, inscribed on one or both faces.

A **nodulus** is a small clay lump bearing from one to three seal impressions, at times inscribed, and, like the roundel, was never fastened to anything.

The so called **flat-based nodules** are little clay lumps of about 2 x 1.5 cm, whose main characteristic is the negative impression on their reverse (or base), which shows traces of fairly thin threads. They have been interpreted as sealings placed upon folded pieces of small, thin and lightly worked leather, presumably documents written on parchment, around which was wound the thread (WEINGARTEN 1983; HALLAGER 1996, I: 135-145; CMS II/6: 349-360, 367-68, figs. 7-16; KRZYSZKOWSKA 2005: 155-158). **Hanging nodules** are also small clay lumps, about 2 cm in length, characterized by string holes which show that this type of nodule was hanging from a string in turn tied to something else (an object or a document). The T-H type shows a string-hole that goes all way through the long axis of the nodule, while the S-H has a single aperture at one end of the nodule. The impressions left by the string through the holes of the broken nodules show that the T-H nodule had been formed over the two ends of a string, instead, the S-H nodule was formed over a single knotted end of a string, just to label it. It is even possible that two different S-H nodules were fastened to the same string, one to each end.

All the types described above are represented in the Italian collections, apart from the roundel and T-H nodules: in MAF we have nine S-H nodules from HT and one F-B from ZA (JASINK 2009); in MPR we have five *noduli*, two F-B and twenty three S-H nodules, which were all found in the “Villa” of HT, without counting the two lost nodules <71968> and <71970> (DEL FREO 2002-2003).

Fig. 3 shows 3D models of two of the three flat based nodules kept in the two Italian Museum: the first is the unique sealing in MAF coming from Zakros, the second is one of the two exemplars kept in MRP. *Noduli*, F-B and S-H nodules may have different shapes: *noduli* may be dome-/gable-shaped or disk-shaped (KRZYSZKOWSKA 2005: 161-163), F-B nodules may be “standing” or “recumbent”, S-H has been divided into “pendant”, “pyramid”, “cone” “dome” and “pear” (HALLAGER 1996: 121, 137 and 162-163). Nevertheless it is unclear if such a difference in shapes is significant from the point of view of their function, because the actual shaping must have been a routine job and was therefore not always executed with the same precision. Among our materials, in fact, we have five nodules whose shapes are not so clear: Nr. 94759 in MAF and 71964 in MPR have been classified as pendant, but they have a base like the pyramidal variety and therefore, unlike the pendants, can stand; Nr. 94760 in MAF and 71965 in MPR are very flattened pendants, with a convex non-functional base; Nr. 71967 in MPR has been previously classified as pendant, but it is actually an hybrid: a pyramid with the seal impression on its base, like the cone. In conclusion, different shapes are certainly caused by different ways in manufacturing, but we lack evidence to argue that they were aimed at different functions. The cone shaped S-H, for example, was caused by the pressure of fingers in connection with the impression of the seal. This type was deliberately shaped as a cone either by the fingers or by rolling clay lump before it was impressed by the seal and inscribed, but, like all the other S-H, hung from a string and did not need to stand on a surface (even if its peculiar shape allows it).

(B. M.)



Fig. 3 – Flat Based Nodules

### **The seal impressions**

One of the most intriguing questions about the sealings from HT is represented not so much by the diversity of the seals by themselves – a diversity likely connected to the seal owners -, but by the fact that identical seals are stamped on sealings which differ from each other both in the shape and in the additional signs carved on them.

The 9 sealings in MAF from HT are impressed by 6 different seals (3 twice, and 3 once). To them the Zakros' sealing may be added. The 30 ones in RMP are impressed by 16 different seals (1 six times, 1 five times, 2 three times, 1 twice, and 11 once), but four are identical to those in MAF. Thus we have in total 18 different seal motifs, which we describe following the numbering in CMS II6 (in parenthesis Levi's number) and list in fig. 4 (the inventory numbers into parentheses).

Motif	Recurrence				Sealing's shape	Seal's shape
	MAF	RMP	HM	Total		
70/79	2 (Nos. 94757-58)	3 (Nos. 71961-63)	HMs: 37 AAPM: 1	43	Single-hole hanging nodule (dome)	Likely bezel from a metal (gold) oval ring
11/125	2 (Nos. 94762-61)	6 (Nos. 71950-55)	HMs: 247 HMpin: 1	256	Single-hole hanging nodule (pendant)	Likely bezel from a metal ring
117/19	2 (Nos. 94759-60)	3 (Nos. 71964-66)	HMs: 33	38	Single-hole hanging nodule (pendant)	Lentoid, soft stone
28/105	1 (No. 94763)	1 (No. 71973)	HMs: 59	61	Single-hole hanging nodule (pendant)	Lentoid, soft stone
87/43	1 (No. 94764)		HMs: 3	4	Single-hole hanging nodule (pyramid)	Lentoid, hard? Stone
66/147	1 (No. 94565)			1	Single-hole hanging nodule (pendant)	Lentoid, soft stone
20/118		5 (Nos. 71956-60)	HMs: 40	45	<i>Nodulus</i> (dome)	Bezel from a metal (gold) oval ring
101/95		1 (No. 71977) + 1 lost	HMs: 101	102	Single-hole hanging nodule (pendant ?)	Lentoid, hard? Stone
140/34		1 (No. 71969)	HMs: 4	5	Single-hole hanging nodule (cone)	Bezel from a metal round ring ?
99/99		2 (Nos. 71971-72)	HMs: 22	24	Single-hole hanging nodule (pyramid)	Lentoid, hard stone
44/145		1 (No. 71974)		1	Flat-based nodule (recumbent)	Bezel from a metal oval ring
85/45		1 (No. 71975)	HMs: 24	25	Single-hole hanging nodule (pyramid)	Lentoid, soft stone
18/116		1 (No. 71976)	HMs: 16	17	Single-hole hanging nodule (cone)	Cushion, hard stone
110/13		1 (No. 71977)	HMs: 138	139	Single-hole hanging nodule (pyramid)	Flat rectangular seal, hard? Stone
84/38		1 (No. 71978)	HMs: 4	5	Single-hole hanging nodule (pyramid)	Lentoid, soft stone
1/140		1 (No. 71979)	HMs: 5	6	Single-hole hanging nodule (pyramid)	Bezel from a metal oval ring
X/146		1 No. 71980)		1	Flat-based nodule (recumbent)	Bezel from a metal oval ring
136/6		1 (No. 72460)	HMs: 2	3	Single-hole hanging nodule (pendant)	Lentoid, soft stone
Y and Z	1 (No. 94766)		From Zakros		Flat-based nodule (from two seals)	Lentoid

Fig. 4 – Motifs in MAF and RMP (and HM) sealings and their recurrence

#### A. Four identical impressions of seals common to the two Italian Museums (fig. 5)

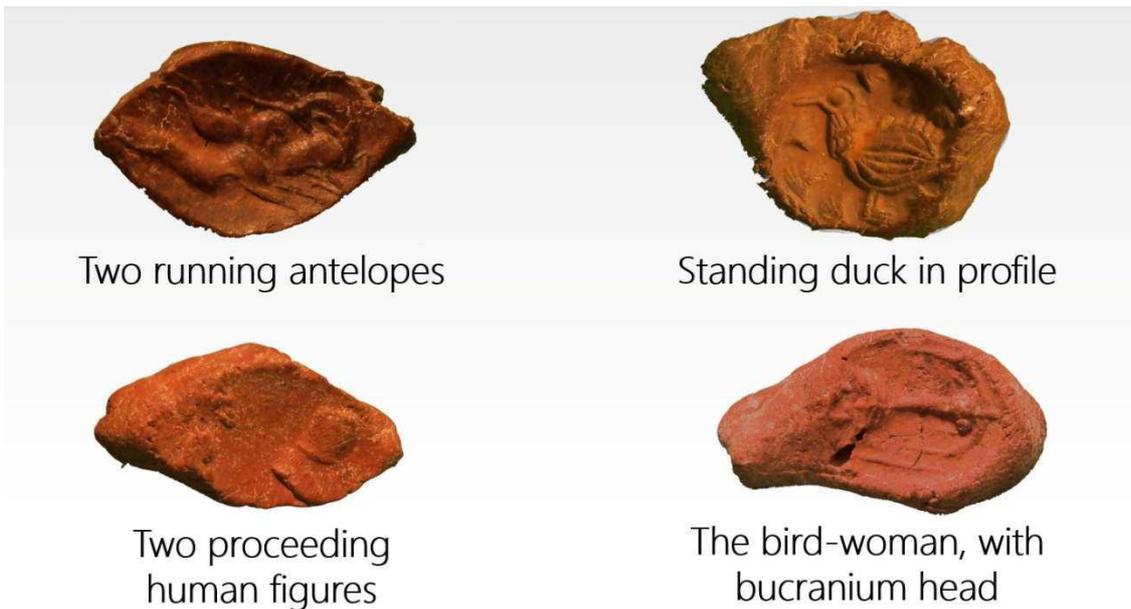


Fig. 5 – Four identical impressions of seals common in both Museums

##### **Motif 70** (HT 79): *two running antelopes*

With its 43 recurrences, and the presence of the roundel (see above), this seal may be defined as belonging to an important functionary of HT. The seal itself and the high quality of the image seem to confirm such hypothesis. The definition of “Minoan naturalism” may be applied also to this seal (WEINGARTEN 1988: 109 and n. 46). Only two of these sealings (in RMP) have the same added writing symbol.

##### **Motif 11** (HT 125): *two proceeding human figures*

The seal outlined by this design is the most stamped seal on sealings, representing the mainly used seal in the administration of HT, with almost the double of recurrences with respect to the second used seal (139 times). The quality of the seal is well confirmed both from its shape and from the complex motif, representing a cult procession: two persons in a likely religious garb are walking in left. The first has a stick leaned on his shoulder, the second has a particular dress that covers his body; they proceed from a columnar structure (likely an altar or shrine). This motif is rendered with the so-called “Minoan naturalism” (WEINGARTEN 1988: 109). The shape of “pendant” is applied also to 245 sealings from HM, and of the three remaining 2 are “two-hole nodules” and 1 is a roundel (in this last case only part of the motif is preserved; HALLAGER 1996, II: 27). The presence of a roundel (see PERNA 1991 and 1994 about the roundels of HT) with this motif has reinforced the hypothesis that the seal-owner was himself an administrator, perhaps the most important functionary in HT. The added incised signs on other faces of our nodules with Motif 11, only two of them having the same sign, seem to confirm how the same seal owner – either a single functionary or, perhaps, not a single person but an “office” at the top position of the administrative hierarchy (MILITELLO 2000: 228) - works together with different scribes and with different goods, limiting to give his authentication to the whole transaction.

**Motif 117** (HT 19): *standing duck in profile, surrounded by small branches or palmettes*

The use of this nodule, with its 38 recurrences, is similar to the previous one. But, in this case, we are dealing with a convex lentoid in soft stein pierced along its vertical axis. The motif itself has been object of numerous studies and belongs to a precise group, according to Weingarten definition as “the School of the Ayia Triada Palmettes, (SchHATP)” (WEINGARTEN 1988: 99-101), characterized by a different central main element, but always surrounded by identical series of branches/palmettes, and carved on a convex lentoid in soft stone. The duck or water bird is represented in a semi-schematic way, with a dot-eye and the body, the neck and the legs rendered with almost parallel lines. Differently from the first two groups of sealings quoted above, not only the shape of the five sealings with Motif 117 in the two Italian Museums is always the same, the “pendant”, but also the written symbol is always the so-called “three-pronged fork” (KU).

**Motif 28** (HT 105): *bird-woman, with bucranium head*

This motif is very common on sealings in HT and seems the four most used. It may be interpreted in two superposed ways: from one side we see the “bird-lady”, where both arms may be intended as wings; but the upper part of the woman represents a bucranium as well, where the eyes correspond to the breasts, the horns to the arms and the muzzle to the bodice. This is the unique representation where the two motifs seem mixed. Normally the seals with the “bird-lady” motif have the shape of a convex lentoid in soft stone, but we have also an example from a cushion seal (DIONISIO, JASINK, WEINGARTEN 2014: Cat. 185). The two sealings from the Italian Museums have a “pendant” shape, while the exemplars in HT, equally single-hole hanging nodules, are properly defined as the variant “pyramid”.

**B. Motifs attested once on nodules in MAF (fig. 6)**



Lion regardant, in right profile

Quadruped regardant, in left profile

Fig. 6 – Two motifs attested once on nodules in MAF

**Motif 87** (HT 43): *lion regardant, in right profile, with its head turning back and bended on its anterior legs*

The lion's motif is commonly represented on HT sealings – as in many seals of the Neopalatial Period -, but the stylistic rendering are extremely various. In this case, we are in front of a naturalistic design

**Motif 66** (HT 147): *quadruped regardant, in left profile*

This motif has some resemblance with the previous one, in the naturalistic posture of the animal. However, in this case the identity of the quadruped is uncertain, being its turning back head without particular characters (perhaps a deer?) and it is in left profile. It is the sole exemplar from HT.

### C. Motifs housed in Italy only in RMP (fig. 7)



Fig. 7 – 12 motifs attested in Italy only in RMP

**Motif 20** (HT 118): *rowing boat with rower*

The motif is the sole represented in HT concerning a boat with a rower, which is almost common in Minoan glyptic (e.g. the gold ring from Mochlos and the cushion seal from Anemospilia (JUNG 1989: 104-108; SAKELLARAKIS, SAPOUNA-SAKELLARAKIS 1991; DIONISIO, JASINK, WEINGARTEN 2014: Cat. 200)). These noduli have no carved sign.

**Motif 101** (HT 95): *two griffins in specular arrangement, each one with a smaller griffin in front*

This motif has the third place as to the recurrences of its use. In RMP only one sealing is hosted at present, even if it is possible that a second sealing has vanished after the initial inventory and before the Catalogue by Borda in 1946 (DEL FREO 2002-3: 55-58). The style has been related to the “talismanic” one, even if no representation of griffin has been included in the typical talismanic style. The single small griffins in front to each griffin perhaps complete the representation of the whole imaginary family.

**Motif 140** (HT 34): *three fan-shaped leafs*

This motif, of good quality, is attested only on five supports. However we may note that a very similar motif appears on 8 sealings in HMs (CMS II6 Motif 141).

**Motif 99** (HT 99): *griffin in left profile, regardant, with vertical parallel lines forming its wings*

This motif may be ascribed to the so-called “middle position” functionaries of the administrative hierarchy. Weingarten suggests its belonging to the “The School of the Ayia Triada Winged Figures (SchATWF)”, (see below, concerning motif 110), even if we are not dealing with “displayed birds”, but with a female griffin, clearly very different in style and shape from the above described griffins on sealings with Motif 101. In our opinion the style is not so different from the talismanic one.

**Motif 44** (HT 145): *scene of bull-leaping*

The “bull leaping” is one of the best known and used motifs in Minoan art, from frescos, to vessels and glyptics. At HT only one sealing has been found, which is kept in RMP, from the same seal which has been used for sealings arrived in other administrative centers of the island: the one at Gournia (CMS II6 Motif 162) and the other at Sklavokambos (CMS II6 Motif 255). This is a sure evidence of the dislocation in Crete of documents belonging to the same administration (likely under the control of Knossos). The shape of the sealing is a flat-based nodule (specifically 1-seal recumbent nodule), bearing on the versus the impression of the sealed parchment (?) document (see fig. 3).

**Motif 85** (HT 45): *lion in left profile, regardant*

The lion depicted on this seal is completely different from the above analyzed Motif 87. Also in this case the lion is in profile - left instead of right – and regardant: but the resemblance ends at this point.

*“Except for its mane, the engraving is so poor that it could equally well depict a scratching dog about to fall over”*

(WEINGARTEN 1988: 105)

The use of dots and the depiction of the mane by rows of short strokes, the tail raising from the lower back makes this seal close to the works of the “Jasper Lion Master” (YOUNGER 1983: 119-120).

**Motif 18** (HT 116): *two stylized men protected by the 8-shaped shield*

Only one sealing with this motif is housed in RMP (DEL FREO 2002-3: 68). The motif, carved only on cones, is composed by stick/stylized figures of two men with figure-of-eight shields, stamped, according to Weingarten, by the thirteenth most active seal-user at HT, a member of the administrative Group I. Of the over 1,000 sealings stamped by 148 different seals found at HT, only three of the seals can be identified as cushions (DIONISIO, JASINK, WEINGARTEN 2014: Cat. S-34, S-35, S-36, S-37) and only one, just with Motif 18, is present in an Italian Museum.

**Motif 110** (HT 13): *bird with unfolded wings*

This motif, with its presence on 139 HT sealings, is consequently belonging to the second most used seal, following that with motif 11 (see above). Only one exemplar is kept in RMP. The execution of this motif – a displayed bird in a “quasi-talismanic” style – is the only one carved on a rectangular seal, while the remaining five analogous motifs (111-115, all in talismanic style) are carved on lentoids. According to Weingarten (1988: 91-98), the motif of the “displayed birds” is inserted in a larger group defined as “The School of the Ayia Triada Winged Figures (SchATWF)”, but for our purpose the most interesting datum is the presence on these nodules of the talismanic style, which has been found at most only in other 15/16 HT

seals (59?, 60, 99?, 101?, 111-116, 129, 130, 131, 133-135), which are well distinguishable from geometric, schematic/stylized and naturalistic styles that complete the HT sealings.

**Motif 84** (HT 38): *lioness in left profile, regardant*

The lioness depicted on this seal, well recognizable for the three dots symbolizing the breasts, has some resemblance in its forequarter with motif 85, even if Younger includes this seal in the “Cretan Popular Group, Miscellaneous Lions (YOUNGER 1983: 124). As it has been stressed (KENNA 1960: 53) in HT sealings the lion is usually alone – but just in RMP a motif with a couple of lions is represented, see below -, sometimes in agonizing posture, but never attacking other animals. This is one of the various differences between HT and Zakros, especially in the interpretation of similar motifs.

**Motif 1** (HT 140): *complex cult scene*

Three women, arms akimbo with hands on hips, the central one being higher in respect with the two flanking figures, in the typical Minoan long flounced skirts, move towards a shrine(?) from the top of which a tree emerges dividing in three roundish flowers, preceded by a palmette (on the architecture in glyptic cult scenes see KRATTENMAKER 1995). The seal is executed in “the best style of the flowering of Minoan naturalism” (WEINGARTEN 1988: 106).

**Motif X** (HT 146): *two galloping lions, in front of a palm-tree*

This is the unique sealing from HT not collected in CMS II6, but in CMS II7.71. We give here the Nr. X, in relation with the Motifs we will call Y and Z, housed in MAF, from Zakros (see below). This motif is found only on this nodule, but it seems analogous (or identical) to the motif stamped on two T-H hanging nodules now housed in the Heraklion Museum (HMs 40/1-2), coming from Zakros, Hause A, Room VII.

**Motif 136** (HT 6): *wild boar tusk helmet*

This motif represents a wild boar tusks helmet with cheeks and nape shelters and a toothed crest (ram horn) as a finishing touch. A semi-circle of blob palmettes completes the scene. (For a comparison with the workers of SchAPT see WEINGARTEN).

#### D. The unique sealing in MAF from Zakros (fig. 8)



A sort of heart or of imaginary face above two antithetic water birds

A sort of animal head with two butterfly wings

Fig. 8 – The unique nodule in an Italian Museum (MAF) found in Haghia Triada but coming from Zakros

**Motifs Y** (CMS II.7.104A): *two antithetic water birds*

**Motif Z** (CMS II.7 157): *imaginary animal head*

This sealing has the shape of a flat-based nodule, but, differently from HT 146 (see above) has been stamped with two seals, each one on a different face. In Motif Y, above the two antithetic water birds, two complex scrolls form a sort of heart, or a sort of imaginary face with two eyes and a nose. Motif Z is an equally imaginary motif, composed by a sort of animal head with two butterfly wings, each one with a rosette in the middle; a lotus flower completes the upper part of the face.

This sealing arrives in MAF together the HT sealings, but the provenance from Zakros is well specified. Consequently, this fact strengthens the hypothesis that at Haghia Triada this typology of nodules was not local, but only imported from outside. Moreover, just from Zakros we have other flat-based nodules stamped with these same seals together and many other objects of the same type.

(A.M. J.)

#### Inscriptions

Most *noduli* are not inscribed. We have, in fact, only nine inscribed examples: seven from HT (We 1019, 1023, 1024 = CMS II/6 122; We 1020 = CMS II/6 80; We 1021 = CMS II/6 98; We 1852 = CMS II/6 75; We 3020 = CMS II/6 115) and two from Samothrace (SA We 3 and 4 = CMS V/Suppl 1B 327 and V/Suppl. 3,2 343). On such *noduli* we may find ideograms (A \*304+03 and \*303), syllabic signs and groups (the latter perhaps personal names), and fraction signs incised *supra sigillum*. Besides these, only other two *noduli* from Knossos, dated to Mycenaean Period, are inscribed with the Linear B ideograms for man and woman (respectively KN Wn 8713 and Wn 8752).

The five *noduli* kept in the MPR (71956-60) were originally part of a group of 45 un-inscribed *noduli*, characterized by the same seal impression (CMS II/6.20), which were found altogether in a storeroom of the Villa of HT (room 27).

F-B nodules are very rarely inscribed: HT Wb 2001 and 2002, with the single sign AB 02/RO, perhaps ZA Wb 37, with a sign doubtfully readable as AB 41/SI, and PH Wb 33-35, 55, with illegible signs<sup>4</sup>. As we will see below, RO and SI are largely attested on S-H nodules.

T-H nodules are virtually never inscribed<sup>5</sup>. By contrast, S-H nodules bear very frequently an inscription on one side (never the same of the seal impression), normally only one sign, a few are inscribed with two signs on one or two faces, generally kept from a restricted repertoire of signs (the most common are: A 301, AB 81/KU, 44/KA, 41/SI, 02/RO, 74/ZE, 28/I, 04/TE, 54/TA). The use of such signs on the tablets is not constant: some of them occur often as first elements of likely personal or place names, others as “transaction signs”, others as abbreviations for names of commodities (HALLAGER 2000). In other words, it is very hard to reach a conclusion on the meaning of such signs from the evidence at our disposal. It is even possible that they served as symbols rather than as true legible syllables.

Fig. 9 shows the inscriptions incised on the S-H kept in MAF and MPR. Here we would like to point out that the reading of the signs is not always so clear and certain as one may believe on the ground of GORILA II. The signs inscribed on S-H nodules 94759 and 94760 in MAF are read as \*81/KU (Wa 1557 and 1558), but it might resemble \*41/SI as well. The same doubt afflicts also nodules 71973, 71976 and 71961 in MPR. The latter in particular where the sign, might resemble even \*28/I or \*09/SE. Numbers 71964, 71966 and 71967 are incised with an oval sign cut in the middle by a segment, whose reading as KU (Wa 1559, 15560 and 1512) is doubtful; on 71966, the oval sign is open and thus may look like \*44/RE, but it is odd in any case. Also the sign on nodule 71965 is read as KU (Wa 1561), but it might resemble \*08/A as well. Finally, on number 71972 the sign read as ZE (Wa 1283) is so light and inaccurate that one might wonder if they are unintentional marks, such as impressions left by threads. Obviously these observations are just starting points for further reflection and discussion.

(B. M.)

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<sup>4</sup> The *nodule* from Phaistos identified as Wb 36 in GORILA II is inscribed with the sign AB 04/TE, but it has been subsequently classified as a direct object sealing (Wg 36) by HALLAGER 1996, II, p. 295 and 299.

<sup>5</sup> Two hanging nodules inscribed with a single sign from Haghia Triada (Wa 1143 and 1617) and two from Khandia (Wa 1003 and 1004) are considered T-H by E. Hallager (HALLAGER 1996, II, p. 243), but they are more likely S-H (CMS II/6.064 and 039, and CMS V/Suppl.1A.153).

Schemat. Drawing	Transcription	Museum	Inventory number	Motif CMS / HT	Inscription number	Scribe
	AB 04 TE	MAF	94757	70 / 79	Wa 1125	Wa 57
	AB 02 RO	MAF MAF RMP RMP	94758 94763 71969 72460	70 / 79 28 / 105 140 / 34 136 / 6	Wa 1086 Wa 1094 Wa 1108 Wa 1110	Unknown Unknown Wa 63 Unknown
	AB 81 KU	MAF MAF RMP RMP RMP RMP RMP RMP RMP	94759-60 94762 71951 71961 71964, 66 71965 71973 71976 71977	117 / 19 11 / 125 11 / 125 70 / 79 117 / 19 117 / 19 28 / 105 18 / 116 101 / 95	Wa 1557-58 Wa 1471 Wa 1472 Wa 1542 Wa 1559-60 Wa 1561 Wa 1593 Wa 1547 Wa 1512	Wa 90 Wa 84 Wa 84 Wa 87 Wa 86 Wa 90 Wa 93 Wa 89 Wa 86?
	AB 77 KA	MAF MAF RMP	94761 94565 71962-63	11 / 125 66 / 147 70 / 79	Wa 1323 Wa 1322 Wa 1408-07	Unknown Unknown Unknown
	AB 61 O	MAF	94764	87 / 43	Wa 1279	Wa 74
	AB 41-77 SI-KA	RMP	71950	11 / 125	Wa 1014	Wa 54
	AB 41 SI	RMP	71952	11 / 125	Wa 1176	Wa 68
	AB 28 I	RMP	71953	11 / 125	Wa 1150	Wa 63
	AB 73 ZE	RMP RMP RMP	71954 71972 71977	11 / 125 99 / 99 110 / 13	Wa 1294 Wa 1301 Wa 1283	Wa 80 Unknown Unknown
	A *301 ?	RMP RMP RMP RMP RMP	71955 71971 71975 71978 71979	11 / 125 99 / 99 85 / 45 84 / 38 1 / 140	Wa 1744 Wa 1759 Wa 1779 Wa 1623 Wa 1830	Wa 98 Unknown Wa 100 Wa 100 Wa 106

Fig. 9 – Inscriptions with reference to museums and motifs

### Functions

As we have already said, the five *noduli* kept in the MPR were originally part of a group of 45 un-inscribed *noduli* impressed by the same seal (CMS II/6.20) and found altogether in a storeroom of the main building of HT, the so called “Villa” (room 27) (HALBHERR, STEFANI, BANTI 1977: 39-43). In this case at least, it is likely that the seal impression served both to identify a seal-owner and group the *noduli*. The hypothesis that

the *noduli* served as “tokens” is more flexible than the idea they served as docketts, i.e. receipts for work done (WEINGARTEN 1986 and 1987; HALLAGER 1996, I: 130-133), and fits better the evidence from HT. The position of storeroom 27 close to an outside door fits the hypothesis that *noduli* were tools used in monitoring incoming and outgoing commodities. Moreover, some finds from room 27 and its surroundings may suggest a connection between this storeroom and textile industry: a clay tablet recording wool (HT 24), loom weights, needles, daggers/knives and middle sized pithoi<sup>6</sup>.

F-B nodules have been interpreted as sealings placed upon folded pieces of small, thin and lightly worked leather, presumably documents written on parchment, around which was wounded the thread (CMS II6: 349-360, 367-68, figs. 7-16). Some F-B nodules certainly travelled as it is attested by the clay characteristics and sealings impressed by the same seals found in different sites (in particular HT, Akrotiri (Thera), Gournia, Skalvokambos and Zakros) (HALLAGER 1996, 145-146; KARNAVA 2010). As we have already pointed out, in fact, the 1-seal recumbent F-B nodule Nr. 71980 of the MPR, was found at HT but bears the same seal impression as two T-H nodules found at Zakros (CMS II/7.71).

T-H and S-H were hung from a string tied to something, i.e. to commodities or documents written in perishable material, but the specific function and way of using T-H and S-H are already matters of dispute. I have already reviewed various hypotheses on this matter (MONTECCHI in press), thus I limit myself to remind here the main current hypothesis: T-H nodules would have labelled commodities, as the Mycenaean gable-shaped hanging nodules did, and S-H, which were used no longer by Mycenaeans, papyrus documents. It is possible that different kind of matters were recorded on different types of supports: in this scenario, the tablets would have recorded transactions of low economic profile, and papyrus or parchment documents would have dealt with either legal issues, such as bilateral contracts, as suggested by E. Hallager (HALLAGER 1996, I: 224, and 2000: 254 and 259), or transactions of high economic profile or relating to foreign trade. In the Neopalatial period, in fact, we get a greater typological variety and patterns of application of sealings, in addition to evidence for sophisticated intra- and perhaps inter-regional communication via ephemeral documents to which sealings might have been attached.

In the HT Villa, about 975 hanging nodules, almost all S-H, were found spread over a large area in the North-western quarter, with a few more specimens possibly coming from the North magazines. The sealings found in the NW quarter were at a height of 0.50-1.50 m above the pavement, for this reason the archaeologists suggested they had fallen down from an archive located at the first floor (MILITELLO 1988: 239). In other words it has been suggested that a long-term archive, where hundreds or thousands of papyrus documents could have been housed, was located above the hall 13 in a room facing a painted porch above the court 11 (PARIBENI 1903: 327. 330).

(B. M.)

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<sup>6</sup> For the connection between the 45 *noduli* and tablet 24 and the textile industry see HALLAGER 2002.

### The 3D reconstruction

The creation of 3D interactive applications on Hagia Triada, including the external environment, the sealings and the rooms where they were found, has required several steps.

First we made a series of scans with our NextEngine 3d scanner of the sealings that are kept in the two Italian museums. After the 3D acquisition we moved on to the phase of color acquisition, snapping a lot of photos of the artifacts at every angle. In our DREAMS laboratory, we proceeded to the 3D modeling; the alignment of the scans was performed with ScanStudio, while the modeling and the color projection were done with MeshLab, obtaining 3D models with high-resolution geometry and high quality texture. (fig. 10)

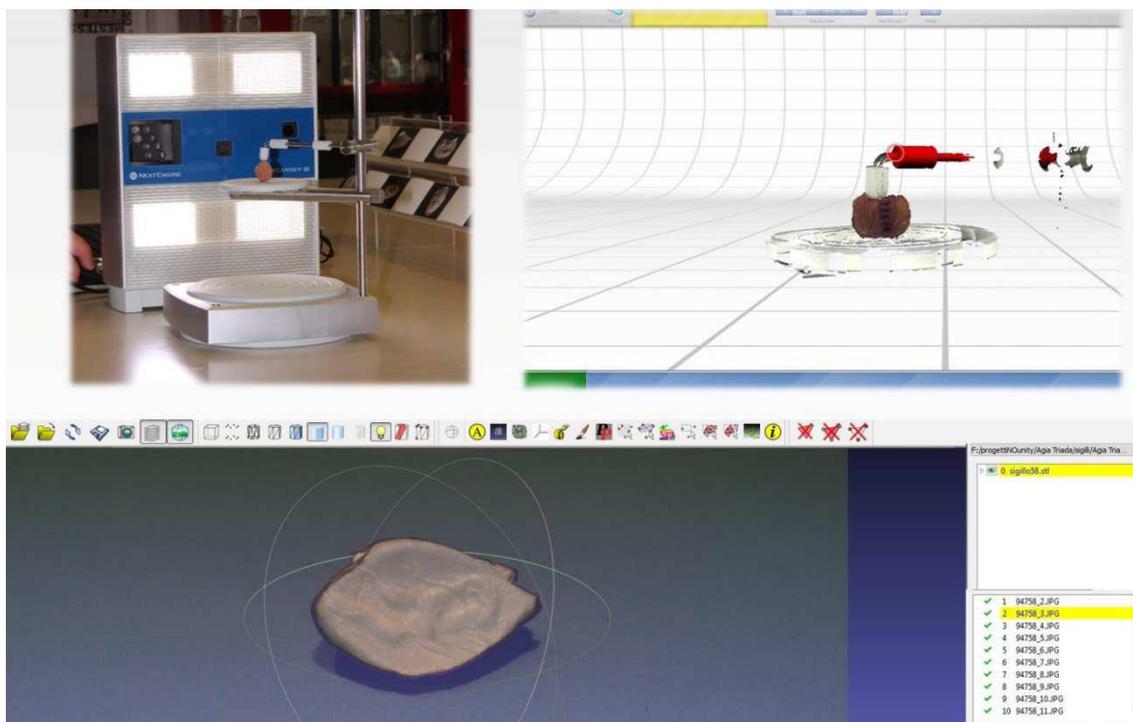


Fig. 10 – 3d acquisition and modeling

The models obtained were exported in two versions: the first in high-resolution, for 3D offline video, which provides an overview of the sealings at every angle; the second optimized for use in real time applications such as the reconstruction of Hagia Triada. In order to create the optimized version, we made a decimation of the high-resolution models.

Once the the sealings in 3D were obtained, it was possible to begin to work on the reconstruction of the rooms where they were found. Using SketchUp we elaborated the structure of the rooms in details, connecting the 3D models directly to the architectural plans and other archaeological evidence. For ceilings, window frames, doors, and all the parts that were not present in the excavation of the two rooms of interest, we have relied on similar finds in the rest of the building.

Through photographic comparisons with actual photos of the excavation it has been possible to define the appearance of the walls and floors (fig. 11).



Fig. 11 – Actual photo of Haghia Triada

In addition to the structure, we reconstructed the objects found inside the rooms, including common objects; each object location is based on archaeological materials. Some items, such as clay tablets, were created using photos of real objects, to increase the accuracy of reconstruction.

In addition, to enrich the understanding of the context, we have recreated the landscape surrounding the outside of the building (fig. 12).



Fig. 12 – Previous reconstruction of the so called “Villa” at Haghia Triada made by Panaiotis Kruklidis

Once the 3D models were worked out, we proceeded to build the interactive application. The exploration of the building is dynamic: the user can navigate through the reconstructed rooms and can interact with

acquired objects by simply approaching a POI (Point of Interest). In these specific points, you can see the seals in detail, read additional information or see photos relating to the real finds. (fig.13, fig.14)



Fig. 13 – Zoom on the 3D model of a nodulus from storeroom 27 of the "Villa"



Fig. 14 – Zoom on the 3D model of a one-hole hanging nodule from the archive (shelves and documents on them are only exemplificative, not reliable reconstructions)

To allow for observation of the exterior of the building, in some POI you can switch to "free camera mode". In this way, it is possible to navigate outside, having a complete view of the surrounding context (fig. 15).

(N. A.)



Fig. 15 – Overview of the “Villa” digital model from outside

## Aknowlegments

The authors are most grateful to the directors of the National Archaeological Museum of Florence and the Prehistoric and Ethnographic Museum “L. Pigorini” of Rome, Dr. Giuseppina Carlotta Cianferoni and Dr. Francesco Di Gennaro, respectively, for the permission to make the digital acquisition and modeling of the Minoan seals and sealings from Haghia Triada kept in both Museums, and to publish here the images of some of them (photos by Giulia Dioniso and Barbara Montecchi and 3D models by Niccolo Albertini). This paper shows the first digital acquisition for the sealings of Pigorini Museum, and hopes to represent the first step for a future collaboration of the @egeanlab of the University of Florence with the Roman Museum: we are, in fact, arranging an Interactive Museum which has the aim to continue the already online MUSINT (<http://musint.dreams.sns.it>) with a specific section on pieces – for the moment the sealings - coming from the Italian Archaeological Mission in Crete and located in the two Italian Museums.

## References

- BORDA, M. (1946) *Arte cretese-micenea nel museo Pigorini di Roma*, Roma.
- DEL FREO, M. (2002-2003) “Le cretule di Haghia Triada nel Museo Nazionale Preistorico Etnografico “Luigi Pigorini”. *Catalogo*”, *Bullettino di Paletnologia Italiana*, n.s. 11-12: 53-75
- DIONISIO, G., JASINK, A.M., WEINGARTEN, J. (2013) *Minoan Cushion Seals. Innovation in Form, Style, and Use in Bronze Age Glyptic*. Rome.
- GORILA = GODART, L., OLIVIER, J.-P. (1976-1985) *Recueil des inscriptions en Linéaire A*, Paris, , voll. I-V.
- HALBHERR, F., STEFANI, E., BANTI, L. (1977) “Haghia Triada nel periodo tardo-palaziale”, *AsAtene* 55 (N.S. 39, 1980): 7-296.
- HALLAGER, E. (1995) ‘The Knossian bull: political propaganda in Neo-Palatial Crete?’ in (R. Laffineur d W.-D. Niemeier, eds.) *POLITEIA: Society and State in the Aegean Bronze Age*, II. Liège and Austin: 547-556.

- HALLAGER, E. (1996) *The Minoan Roundel and Other Sealed Documents in the Neopalatial Linear A Administration* (Aegaeum 14), Liège, 2 voll.
- HALLAGER, E. (2000) "The Hanging Nodules and their inscriptions", in M. Perna (ed.), *Administrative documents in the Aegean and their Near Eastern counterparts* (Proceedings of the International Colloquium, Naples, February 29-March 2, 1996), Torino: 251-260.
- HALLAGER, E. (2002) "One Linear A Tablet and 45 Noduli", *Creta Antica* 3: 105-109.
- JASINK, A. M. (2009) "La collezione di sigilli e cretule egee", in A. M. Jasink, L. Bombardieri (eds.), *Le collezioni egee del Museo Archeologico Nazionale di Firenze*, Firenze: 77-88, tavv. 35-44.
- JUNG, H. (1989) "Methodisches zur Hermeneutik der minoischen und mykenischen Bilddenkmäler", in I. Pini (ed.), *Fragen und Probleme der bronzzeitlichen ägäischen Glyptik. Beiträge zum 3. Internationalen Marburger Siegel-Symposium, 5.-7. September 1985*. (CMS Beih. 3).
- KARNAVA, A. (2010) "The LM IA Cretan Sealings from Akrotiri: Chronological and Historical Implications", *Pasiphae* 4: 87-91.
- KENNA, V.E.G. (1960) *Cretan seals. With a catalogue of the Minoan Gems in the Ashmolean Museum*, Oxford.,
- KRZYSZKOWSKA, O. (2005) *Aegean Seals an Introduction*, London.
- LEVI, D. (1925-1926), "Le Cretule di Haghia Triada", *ASAtene* 8-9 (1929): 7-156.
- MILITELLO, P. (1988) "Riconsiderazioni preliminari sulla documentazione in lineare A da Haghia Triada", *Sileno* 14: 233-261.
- MILITELLO, P. (2000) "L'archivio di cretule' del vano 25 e un nuovo sigillo di Festòs", in M. Perna (ed.), *Administrative Documents in the Aegean and their Near Eastern Counterparts* (Proceedings of the International Colloquium, Naples, February 29-March 2, 1996), Torino: 221-243.
- MONTECCHI, B. (IN PRESS) "Counting, labelling and sealing: a fresh look at Neopalatial administrative practices", in *Proceedings of the 1ère Journée d'études égéennes, Université de Genève, Département des science de l'Antiquité, 03/11/2012*.
- MONTECCHI, B., JASINK, A. M. (2011) "Un percorso virtuale attraverso i secoli, i volti, i paesaggi, i documenti: da Creta all'Italia, dalla protostoria alla storia" in A.M. Jasink, G. Tucci, L. Bombardieri (eds.), *MUSINT. Le Collezioni archeologiche egee e cipriote in Toscana. Ricerche ed esperienze di museologia interattiva*, Firenze, Firenze University Press: 243-262.
- PARIBENI, R. (1903) "Lavori eseguiti dalla missione archeologica italiana nel palazzo e nella necropoli di Haghia Triada dal 23 Febbraio al 15 Luglio 1903", *RendLinc* 12: 317-351.
- PERNA, M. (1991) "A propos de la fonction des rondelles minorenne", *Kadmos* 30: 105-112.
- PERNA, M. (1994) "The Roundel in Linear A from Zakro Wc 2 (HM 84)", *Kadmos* 33: 29-37.
- SAKELLARAKIS, J. A., SAPOUNA-SAKELLARAKIS, E. (1991), "The seal from Anemospilia", in *Archanes. Minoan Crete in a New Light*, Athens: 692-694.
- WEINGARTEN, J. (1983) "The Use of the Zakro Sealings", *Kadmos* 22: 8-13.
- WEINGARTEN, J. (1986) "Some Unusual Minoan Clay Nodules", *Kadmos* 25:1-21.
- WEINGARTEN, J. (1987) "Seal Use at LM I B Ayia Triada: a Minoan Elite in Action I. Administrative Considerations", *Kadmos* 26: 1-43.
- WEINGARTEN, J. (1988) "Seal Use at LM I B Ayia Triada: a Minoan Elite in Action II. Aesthetic Considerations", *Kadmos* 27: 89-114
- YOUNGER, J.G. (1983) "Aegean seals of the Late Bronze Age: masters and workshops II. The first generation Minoan masters", *Kadmos* 22: 109-136.
- YOUNGER, J.G. (1993) *Bronze Age Aegean Seals in their Middle Phase (ca. 1700-1550 B.C.)*, *Studies in Mediterranean Archaeology* CII, Jonsered.

**Imprint:**

Proceedings of the 18th International Conference on Cultural Heritage and New Technologies 2013 (CHNT 18, 2013)  
Vienna 2014

<http://www.chnt.at/proceedings-chnt-18/>

ISBN 978-3-200-03676-5

Editor/Publisher: Museen der Stadt Wien – Stadtarchäologie

Editorial Team: Wolfgang Börner, Susanne Uhlirz

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