

# THE EARLY CRETAN WHITE SEALS IN THE ASHMOLEAN MUSEUM, ANCIENT AND MODERN: SOME ENIGMATIC MATERIALS

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'Enigma' is a good honest word and one which archaeologists ought to use more often, there being no shame in admitting defeat and inviting others to renew the assault on a problem at some time in the future. 'White', on the other hand, as I use it in this paper, is not so honest, for some of the objects discussed below are far from white to look at. Some are brown with age, one is partly black and so led a colleague astray, a third is dark grey-brown and fooled me and several others at first because we were assuming that it was – in principle, so to speak – white. The materials which are 'white in principle' *par excellence* are of course bone and ivory. Stone, be it steatite, 'steatite' or some other stone, can be confused with these two, as again can the synthetic pastes of various composition, for which Paul Yule, following Diantha Haviland, uses the conveniently non-committal term 'frit/faience'<sup>1</sup>. That it is important to identify these materials correctly goes without saying: we need to know whether we are dealing with a foreign object, an imported raw material such as ivory or even white stone<sup>2</sup>, a foreign or local recipe for a 'frit/faience' substance, a modern fake and so on. But it does perhaps need to be said that the diagnoses can be very difficult even for those with experience and that some of them will undoubtedly be beyond our grasp for a long time to come.

The 'white' objects at the Ashmolean fall into two groups. Ten belonged to Sir Arthur Evans, have been in the museum since 1941 or before and are catalogued in CS. The other eleven were acquired in 1968 and 1970 from Mr. J.C. Cohn of London<sup>3</sup>. Together the groups accounted for

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Abbreviations used are as follows:

CS	V.E.G. Kenna, Cretan Seals (1960)
ECS	Paul Yule, Early Cretan Seals (1981)
GGFR	John Boardman, Greek Gems and Finger Rings (1970)
K	catalogue number in Kenna, Cretan Seals
MinSoc	O. Krzyszkowska and L. Nixon, eds., Minoan Society: Proceedings of the Cambridge Colloquium 1981 (1983)
SH	string-hole

<sup>1</sup> ECS p. 194.

<sup>2</sup> Cf. Olga Tufnell and W.A. Ward, Relations between Byblos, Egypt and Mesopotamia at the end of the third millennium B.C.: a study of the Montet Jar, Syria 43, 1966, p. 176.

<sup>3</sup> H.W. Catling, ARepLondon 1974–75 p. 29.

five or six materials, two of them surprising. None, however, proved to be of any kind of 'frit/faience'. This was in a sense a disappointment, since these materials are badly in need of analyses and the existence now of non-destructive processes such as X-ray fluorescence and neutron activation analysis should begin to make them possible. Most of our problems lay with ivory, bone and stone. After outlining some of them I shall discuss the objects themselves, letting each case illustrate problems and methods of approaching them. Some cases involved a whole handful of people, gathered like doctors around a bedside, and a number of methods had to be tried before a successful diagnosis could be made.

For bone and ivory I am much indebted to Dr. Olga Krzyszkowska, who is preparing a guide to them<sup>4</sup>. To tell them apart without taking destructible samples<sup>5</sup> morphology is a good starting point. Even the largest cattle bones do not yield large *solid* pieces of material as ivory does, like K 31 below. Again, the marrow cavity of long leg bones and the shape of the ends inspired and determined certain shapes of seal (cf. 1968.1844, 1970.586–7 below). Where shape cannot give a clue, surface characteristics may do so. Ivory grows in rings like a tree. These laminations or lamellae may be visible as fine parallel lines running lengthwise down the tusk or in concentric circles in the cross-section: see CMS II 1 Nos. 16. 54. 300. 351. 387. The striations on the surface of bone are less straight, and the surface may look rather grainy, as on CMS II 1 No. 170 (lower left portion of face) and 232<sup>6</sup>. The veining of stone, which does not have to follow the dictates of biology, is usually distinguishable from either (see K 91–92 below). There can be surface marks of another kind, irregular little grooves or pitting, which are nothing to do with the natural structure and are caused by reactions in the soil: see CMS II 1 Nos. 11 and 12. They are quite normal and do not deserve colourful explanations (see K 30 below!). Toolmarks are sometimes easy to recognise, as on CMS II 1 No. 177 (edge of hoop) and 305, but not always (see on K 85 and cf. n. 44). If the surface is not helpful but the object is broken or damaged, one may be in luck, as we were with 1968.1841 and 1938.790, but the luck can be reversed if conservation materials cover up the damaged spot, as on 1968.1840, or alter the look of the surface (see n. 17). The interior of ivory should have a fine compact texture, whereas bone will look coarser and somewhat porous or granular.

There are two considerations of a more theoretical nature which can sometimes be of use, though one must be cautious and of course beware of circular argument. First, if there are similar finds from the same or a nearby site, what material are they made of? Second, do the design and the quality of the workmanship point towards a particular material? Yule's work can be helpful here. Our first three seals below support his method very nicely.

A few of our cases required no more than the naked eye. Beyond that our methods had to follow what one might call an 'ascending scale of bewilderment'. First came the ordinary low-power magnifying glass ( $\times 2$ ,  $\times 3$ ). This, fortunately, is often more helpful than higher magnification ( $\times 10$ ,  $\times 15$ ), under which it can be hard to focus on something with an irregular surface. A microscope used at  $\times 25$  or more can reveal the tissue of organic materials, as with 1968.1840 and 1938.790. For the really difficult seals K 85–88 we had to ascend to the Scanning Electron Micro-

<sup>4</sup> Ivory and Related Materials: an Illustrated Guide (Institute of Classical Studies, University of London, Handbook 3, in preparation).

<sup>5</sup> Cf. J. Betts, CMS X p. 20.

<sup>6</sup> Cf. Krzyszkowska in MinSoc p. 170 n. 6.



Fig. 1 The white seals in the Ashmolean Museum.

scope. Even that was not high enough up the scale to solve the enigma of their coating. Beyond lay possibilities such as X-ray diffraction, but destructive methods are out of the question on such small objects<sup>7</sup>.

Our first case, K 31, is easy. It is cream-coloured with a light brown patch on each side. The surface is shiny, and the marks on it, visible even in Kenna's illustration, indicate either bone or ivory, not stone. We need hardly go further than morphological considerations to decide between the two, because only ivory could yield a solid chunk of this size. Further investigation under a microscope revealed the characteristic lamellae. This fits satisfyingly with Yule's observation that large hemispheroids, all of "very good" workmanship like ours, are made of ivory<sup>8</sup>. Indeed of the eight pieces Yule lists all but one are bigger than ours.

The little owl K 62 is also easily identified as ivory. Parallel cracks in the shiny surface are not conspicuous but can be seen in *GGFR* pl. 38 on the eyes. The quality of the craftsmanship goes well with a luxury material.

K 30 again is unquestionably ivory – the fracture at the top reveals the fine texture and lamellae very clearly – but there is a salutary lesson to be learnt from the surface. Kenna's fantasy led him to suppose that "this seal was apparently used later as a prophylactic in cases of epilepsy, for the body of the seal has been indented with what are clearly tooth-marks"<sup>9</sup>. True, the surface is unusually heavily pitted, as Kenna's photograph shows, but the marks themselves are quite normal. The surface is light brown and highly polished, the interlace pattern on the face very finely executed.

From these fine and easily identified pieces we proceed to the 1968–1970 group (*Fig. 1*). 1968.1841<sup>10</sup> is similar to the preceding piece in shape and material. The material could very easily have been taken for bone, but, as with K 30, the laminations and the compact texture of ivory are conveniently revealed by a fracture. The motif does not take account of the field as a whole as it does in good Minoan work, and half of it is so vague as to be indescribable.

The pyramid 1968.1839<sup>11</sup> is unbroken and was not investigated under the microscope. With the naked eye three experts with considerable experience of bone and ivory could not be certain which it is – a useful reminder of how difficult the problem can be. Surface marks which at first glance looked somewhat like striations are probably just toolmarks. The shape and size can be compared to CMS II 1 No. 56, but the motif looks like a garbled version of something that would be more at home on a 'steatite' prism.

1968.1840<sup>12</sup>, a small flattened conoid with oval face, also raised problems for our experts, but they were inclined to favour ivory and microscope examination seemed to confirm this. Neither irregular striations nor parallel lamellae could be seen with the naked eye. The area of exposed interior where the top is chipped away is too small to be helpful and is covered with glue. The motif is muddled but looks something like a quadruped if the long side is seen vertically. Yule's

<sup>7</sup> The sample required might be a cylinder about 3 mm in diameter, 5 mm long. Cf. K.P. Foster, *Aegean Faience of the Bronze Age* (1979) p. 4.

<sup>8</sup> ECS p. 61.

<sup>9</sup> CS p. 91.

<sup>10</sup> Face 1.85×0.6. Ht. 3. Δ-boring 0.2.

<sup>11</sup> Face 1.2×1.05. Ht. 1.4. Δ-boring 0.22 at sides, 0.15 at top.

<sup>12</sup> Face 1.0×0.7. Ht. 1.3. SH apparently a Δ-boring, approx. 0.15 (filled with glue). Cracked, split in two and mended.

useful lists of elongated and miscellaneous conoids offer no parallel for the combination of shape and motif<sup>13</sup>.

1968.1842<sup>14</sup>, a very flattened cylinder or truncated cone with long oval face, was another case where only the microscope could give the final verdict – ivory. Using the naked eye our experts disagreed among themselves. One remarked that although the top of the object showed concentric circles like ivory, the sides seemed more like bone: one is mostly smooth, the other has a matt surface as frequently seen in bone. The object is whiter than the others in this group. Cross-hatching (a pattern which Yule associates overwhelmingly with ivory) is rarely associated with a border, and when it is, the border follows the shape of the face<sup>15</sup>. Contrast CMS IV No. 8, a bigger piece of somewhat similar, though less flattened, shape. CMS IV No. 45 is nearer in shape and size of face (the top is missing) but has a leaf pattern and is a respectable member of Yule's Border/Leaf Complex<sup>16</sup>. CMS IV No. 1D could be compared to our piece, not least in being dubious.

1968.1844<sup>17</sup> is an epomion, light grey-brown and shiny. Examination under the Scanning Electron Microscope showed it to be made of bone<sup>18</sup>. Morphological considerations had already pointed towards bone. Like the ring and hammer-headed seals, which are even more directly dependent on bone shapes, the epomion belongs with this material<sup>19</sup>. It is easily made from cattle metacarpals, hollow long bones which have a half-moon section with one flat or flattish surface<sup>20</sup>. The cross-hatching and lengthwise central line are typical of genuine epomia (e.g., CMS II 1 Nos. 76.316–318.320), and the carelessness of execution can be paralleled too<sup>21</sup>. Nowhere, however, do we find dots intruding on the linear pattern. Only on CMS IV No. 2D does any intrusion occur at all, and the 'D' of that 'parallel' lends no support to our object.

One of the most famous pieces from Evans' collection is the 'ivory' half-cylinder 1938.790 with scenes of 'betrothal' and 'hunting'<sup>22</sup>. After examination under an ordinary microscope at  $\times 25$  or  $\times 50$  Mr. Mark Norman of the Conservation Laboratory at the Ashmolean concluded that it is "bone with traces of modern wax polish in the design". Our other experts had already agreed on bone using the naked eye and concentrating on a small exposed patch at one corner where striations could be seen. The rest of the surface is very glossy, giving to the condition, as Margaret Gill noticed (and shows well in her photograph), the "superficial appearance of excel-

<sup>13</sup> ECS pp. 42–43.

<sup>14</sup> Face  $1.5 \times 0.65$ . Ht. 1.75. Two SH, approx. 0.2, trying to imitate a  $\Delta$ -boring but not meeting at the top.

<sup>15</sup> Cf. ECS p. 147, pls. 16–17; CMS II 1 Nos. 76 and 262 (rectangular face), CMS IV No. 99 (oval); HM 2458 (round: J.-C. Poursat in B. Detournay, J.-C. Poursat, F. Vandenaebale, Mallia, *Le Quartier Mu II* p. 170 no. 239).

<sup>16</sup> ECS p. 141 no. 14, p. 209.

<sup>17</sup> Face  $2.4 \times 1.4$ . Ht. 1.85.  $\Delta$ -boring at top.  $0.3 \times 0.5$ , at sides 0.27.

<sup>18</sup> "There are high concentrations of calcium and phosphorus with a curiously high silica content also. As the analysis is only of the surface, however, this could well be a contaminant".

<sup>19</sup> Cf. J. Betts, CMS X p. 20. Yule's caution in observing that of the 26 epomia he lists, all but one "seem to be" of ivory (ECS p. 54) will probably prove justified when further work on these objects is published.

<sup>20</sup> Krzyszkowska in *MinSoc* p. 165 and see her forthcoming Guide.

<sup>21</sup> Cf. CMS II 1 Nos. 76. 361. 424; CMS IV No. 21. Yule calls the workmanship of epomia "sometimes good and usually very good" (ECS p. 55) but perhaps was thinking primarily of the objects, not the motifs.

<sup>22</sup> L. 4.9. W. of object 1.8, of face 1.5. Th. 0.75. SH. 0.3. Evans, *Palace of Minos I* pp. 196f. Fig. 145 and elsewhere (see Index); M.A.V. Gill, *Kadmos* 6, 1967, pp. 114–118; *Cs* p. 154 pl. 20 and Kenna, *Kadmos* 7, 1968, pp. 175f.

lence” which Kenna found suspicious. One can easily see how Evans and others were deceived into taking the object for a fine piece of polished ivory<sup>23</sup>.

The half-cylinder had been known for decades and widely illustrated before Kenna first questioned its authenticity in 1960<sup>24</sup>. The ensuing controversy in *Kadmos* between Kenna and Dr. Gill brought to light some interesting points but, as Pini has remarked, did not exhaust the subject<sup>25</sup>. More might now be said about the suspiciously unparalleled shape. In fact it does have parallels – but not among seals<sup>26</sup>. Hemi-cylindrical white plaques, perhaps used for attachment to wooden objects, have not only been published from Mallia and Phaistos (from MM contexts) but moreover have been found at Knossos, the provenance Evans gives for 1938.790, in the LM IB ivory workshop excavated by Hood in 1959–60. Some bone inlays found by Evans himself are housed in the Stratigraphical Museum but have no date or provenance<sup>27</sup>. Our object, then, could be an ancient ‘D-plaque’ bone inlay or copied from one, with the engraving a modern ‘improvement’ by one of Evans’ men. It has, incidentally, two points of resemblance with K 201 – the tree, noticed by Matz, and the crossing tips of the goat’s horns, which appear to be an unusual feature<sup>28</sup>. However, I cannot trace the history of K 201 before its publication in *Palace of Minos I* in 1921. If Evans acquired it early in his collecting days, it could certainly have been seen and used as a model even before Mackenzie in 1903 noted in his Knossos excavation Day-book the “ivory seal of flat cylindrical shape ... with hunting scenes” which Miss Gill suggests may be our piece. Her identification may well be right, but our object could of course have been ‘planted’ in the excavation<sup>29</sup>.

1970.586 and 587<sup>30</sup> aroused suspicion not only to the eye but to the nose and hands. Their white surface smelt and it left dust on one’s fingers, deceiving some into thinking they were gyp-

<sup>23</sup> The streaks created when a preservative is applied with a brush can look like lamellae, adding to this kind of deception.

<sup>24</sup> Evans first mentioned it in 1909 (*Scripta Minoa I* p. 129). After the publication with illustration in *Palace of Minos I* in 1921 the interest it aroused got it very quickly into the literature. By 1939 it had already been illustrated by six other authors and in four more places by Evans and mentioned without illustration in at least four other works.

<sup>25</sup> I. Pini, CMS Beiheft 1 p. 140 n. 31.

<sup>26</sup> The ‘Elfenbein’ half-cylinder from the Mallia Workshop CMS II 2 No. 112 not only is much smaller but also looks to me like stone in the photograph and was indeed described as “en marbre blanc” by A. Dessenne (BCH 81, 1957, p. 693).

<sup>27</sup> P. Demargne and H. Gallet de Santerre, Mallia, Maisons, I p. 18, pl. 46; P. Demargne, Mallia, Nécropoles, I pp. 57f. pl. 68, where 6th from left in top row looks similar in size to ours; D. Levi, *Festòs I* p. 348 pl. 244s. The ‘D-plaques’ from Knossos were kindly brought to my attention by Drs. Krzyszkowska and Evely, and I am grateful to Mr. Hood and the Managing Committee of the British School at Athens for allowing me to mention them. See M.S.F. Hood, *AREpLondon 1959–60* p.24, 1960–61 pp. 26f.; R.D.G. Evely, *The Ivory Workshop on the Royal Road, Knossos* (abstract of Mycenaean Seminar paper), BICS 32, 1985, p. 156.

<sup>28</sup> Die frühkretischen Siegel pp. 122, 113.

<sup>29</sup> 1938.790 has had offspring of its own. Buchholz spotted its curly-tailed hounds on the white cylinder now in the Museum of Cultural History, Los Angeles, no. X 65–10348 (H.-G. Buchholz in G. Bass et al., *Cape Gelidonya* p. 154 no. 23a and *ActaPrHistA 1*, 1970, p. 132). Betts, seeing the creatures as horses, rejected the cylinder as anachronistic and a fake (CMS X p. 11; CMS Beiheft 1 p. 18 no. 2). CMS XIII omits it as not Minoan (Matz and Pini, CMS XIII p. XI n. 10 “möglicherweise ... einen Inselstein”). The material seems to drive the final nail into its coffin, for Ms. P.B. Altman of the Museum of Cultural History kindly reports that examination by X-ray diffraction at the geological museum of the University of California at Los Angeles revealed this as enstatite, an uncommon magnesium silicate listed as occurring in Norway and elsewhere but apparently not in Greece.

<sup>30</sup> Respectively face 2.4×2.1, H. 2.5; face 2.2×1.95, H. 1.7.

sum. Under the microscope the 'gypsum' was seen to be superficial, apparently a pathetic attempt to beautify with a plaster coating the core material, which is bone. The forger at least achieved a plausible combination of shape and material. The ridges on 1970.586 have their ancestry in the natural shape of the distal end of metapodials, well seen on, e.g., CMS II 1 Nos. 159 and 211 (ring-shaped), 46 and 210 (hammer-headed)<sup>31</sup>. The disorderly maeandroid motif of 1970.586 brings to mind Betts' remarks (CMS X p. 25) on CMS X No. 27. The motif on 1970.587 would have looked more convincing on an epomion (see above on 1968.1844).

The creator of 1968.1836–1838<sup>32</sup> used a novel material – antler, probably of red deer. Morphological considerations ruled out bone: the central hollows of all three are too small and show no sign whatsoever of the septum and corresponding depression<sup>33</sup>. Moreover, bone has short disconnected 'canals', while the runnels in antler are long and continuous<sup>34</sup>. Antler artifacts are rare in the Bronze Age Aegean, though no doubt some have escaped notice through misidentification. In any case it was noticed long ago that the deer portrayed on frescos etc. are normally not red deer (*Cervus elaphus L.*) but fallow deer (*Dama dama L.*), which may have been introduced into Crete by the Minoans as a park animal<sup>35</sup>. These three, probably also the preceding two (and others from the 1968 group?) must belong with the monstrosities in Salonica confiscated in 1965 and published by Petsas, of which other specimens found their way to the Heraklion Museum, the Metaxas collection, the Museum of Fine Arts in Boston and the New York exhibition of 1965<sup>36</sup>.

1968.1843<sup>37</sup> perplexed us utterly. The problem was of our own making. Classing it unthinkingly as a 'white' object, we did not look at it with open eyes. It is in fact very dark grey-brown towards the base, lighter at the top. The surface is shiny and bears flat vertical streaks. All this, coupled with the exotic shape, had us mystified. Chemically it was found to contain "Al, Si, K,

<sup>31</sup> Cf. Krzyszkowska in MinSoc pp. 164f. On the bone shape see Arthur MacGregor, *Bone, Antler, Ivory and Horn: the Technology of Skeletal Materials since the Roman Period* (London, 1985) p. 47 fig. 30. R.M. Boehmer expounds parallels in Mesopotamia (BaM 16, 1985, pp. 138f. fig. 4).

<sup>32</sup> Respectively D. 2.6, L. 2.9, central hollow 1.1–1.3, three-way SH through sides and top 0.25; D. 2.5, L. 2.7, hollow 0.9–1.2, two opposing SH running diagonally through sides and top. 0.25; L. 0.5, W. of face 1.6, H. 2.3, hollow 1.1, SH 0.3 (unfinished). Supposedly 'from the Trapeza region'.

<sup>33</sup> CMS II 1 No. 179 shows these well. The depression, looking like an incision interrupting the ridge on the hoop, is clear in the CMS photograph. The septum, a ridge of bone like a small triangle projecting into the hollow, is much clearer in Alexiou's photograph, AA 1958 p. 7 fig. 4=BCH 83, 1959, p. 744 fig. 14.

<sup>34</sup> Cf. MacGregor, *op.cit.* (n.31 supra) p. 12 fig. 9; C. Leroy-Prost in N. Lambert et al., *La Grotte préhistorique de Kitsos (Attique): Missions 1968–1978* (Paris, 1981) figs. 136, 148 (bone), 139 (antler, to left).

<sup>35</sup> G. Rodenwaldt, *Tiryns II* p. 151; further references in H.-G. Buchholz, G. Jöhrens, I. Maull, *Jagd und Fischfang, Archaeologia Homerica II*, p. 46 n. 178. On fallow deer in Crete see C. Gamble in *Thera and the Aegean World I* p. 752, mentioning a theory by M. Jarman. Red deer are now rare even on the Mainland. Taken from seals alone, the evidence might be ambiguous, since the execution does not always indicate clearly the flat, spade-like antlers of *Dama dama*, still less its dappled coat. On CMS IX No. 20D the plain cylindrical antlers might be thought to look more like those of *Cervus elaphus*: cf. I. Pini, CMS Beiheft 1 p. 157 n. 104. It is not included in F. Brein's list of seals, *Der Hirsch in der griechischen Frühzeit*, Diss. Wien 34, 1969, pp. 83–107.

<sup>36</sup> Ph. M. Petsas, *ADelt* 24, 1969, B' 2, pp. 292f. pls. 296–298a and *Makedonika* 14, 1974, pp. 323–326 figs. 13f. Cf. J. Sakellarakis in *Πεπραγμένα του Γ' Κρητολογικού Συνεδρίου 1971 A'* pp. 303f. C.C. Vermeule, *CIJ* 62, 1966, pp. 98–100 and *The Art of the Greek World: Prehistoric through Perikles, Art of Antiquity II:1* (1982) pp. 21–22 figs. 41. (I am grateful to Dr. Vermeule and to Mr. Michael Padgett for information from Boston). *Early Art in Greece*, André Emmerich Gallery, New York 1965, pp. 23–25. Dr. Sakellarakis kindly identified the Ashmolean specimens in 1977.

<sup>37</sup> D. of face 1.1, length 6.7. No clear trace of SH where top is broken off.

Ca with lesser amounts of Fe and Ti”, but this information alone was not sufficient to identify the material and we were told that analysis of a sample by X-ray diffraction was what we needed. Only on a later inspection did the material suddenly ‘snap into place’ before my eyes as something perfectly familiar – burnished clay! The Ashmolean conservator Mark Norman agreed, and the microscope confirmed our diagnosis: at  $\times 6$  we saw little bits of grit in the chipped areas, at  $\times 30$  some shining particles which must be the silicon identified in the chemical analysis. Examination under the Scanning Electron Microscope was made for good measure and gave high readings for Al, Si and Ca, but the naked eye and an ordinary magnifying glass would have sufficed.

Burnished terracotta seems a curious and troublesome material for a forger, though the face of the ‘inscribed seal’ in Berlin published by Brice but called “*verdächtig*” by Sakellarakis is described as burnished<sup>38</sup>. The motif is cut rather shallow. Apart from CMS II 1 No. 478 and perhaps CMS II 1 No. 431 and HM 787<sup>39</sup>, possible parallels for it (including the closest, CMS II 1 No. 466, a clay disc from Gournia) either are not closely datable or take us beyond a time when Minoans were in the habit of burnishing clay. About the nearest one can get to the size and shape is CMS II 1 No. 143.

For K 91 and 92, two thick discs, again the naked eye is enough. Both are simply stone. Although Yule puts them with his “frit/faience and related materials” (and in one place makes K 91 “ivory[?]”), calling them “light-colored and fine-grained”, neither is entirely light-coloured<sup>40</sup>. K 91 is mostly very dark on face a, ranging from blackish to olive green; face b is cream-coloured and has fine dark green and brown veins, which are veins and not like the fine cracks of bone and ivory. Kenna’s “yellow steatite” is off the mark. The stone is in any case serpentine. K 92 is more fine-grained – this is especially visible where a break reveals its layered structure – and was called by our mineralogists ‘schist’ or ‘soapstone’. The colour range is not dissimilar to that of K 91<sup>41</sup> but is predominantly lighter – blue-grey and cream. By accident or clever craftsmanship the seal-maker positioned the face so that the very outermost surface lay along a blue-grey vein, while the hollows of the design and the sides of the stone are mostly cream-coloured. This is what led Kenna to see “grey steatite with traces of glaze” and Boardman “‘steatite’ with an altered surface”<sup>42</sup>.

A consideration of these two seals against the background of Yule’s list of Bordered Discs<sup>43</sup> rubs one’s nose in the mess of our ignorance about materials. The CMS, Matz, Yule and various excavators are too often at variance, and Yule’s judgement that “most of these seals are in ivory” will certainly need to be re-phrased one day. Are CMS II 1 Nos. 286 and 302 ivory or stone?

<sup>38</sup> W.C. Brice, *Kadmos* 7, 1968, pp. 103f. Cf. Sakellarakis, *op.cit.* (n. 36 supra) p. 103.

<sup>39</sup> A signet of some sort in soft stone, unpublished but on record in the CMS archive, associated with Tomb XIX at Mochlos, which contained a couple of burnished vessels. See ECS pp. 9, 83f. (shape 31f), 148f. (motif 26:32); R.B. Seager, *Explorations in the Island of Mochlos*, pp. 71f.

<sup>40</sup> ECS pp. 109 n. 83, 194, 202 n. 31. On autopsy in 1976 he considered K 91 “burnt fossil ivory”, misled, apparently, by the black patch on face a; hence “ivory(?)”, p. 178 n. 41.

<sup>41</sup> and of, among others, K 10, 22, 24, 49, 50, 65, 73.

<sup>42</sup> CS p. 100; J. Boardman, *ClRev* 85, N.S. 21, 1971, p. 463, cf. GGFR p. 98.

<sup>43</sup> ECS p. 49.

(Both have fluted sides – more suited to stone?) What are CMS IV Nos. 103.19D.24D<sup>44</sup>? Does ‘frit/faience’, that kind of enigmatic materials, have any part in the Bordered Discs at all?

Yule’s useful list pinpoints another problem about K 91, the disquieting motif on face b, which Kenna took for a much later addition. Yule’s assertion that “all of the examples carry motifs on both seal faces” is not quite true if one accepts his list unaltered but does stand if one omits CMS II 1 No. 451 (which looks out of place to me) and CMS IV No. 19D, which, although Yule accepts it, may stand convicted by his own argument. Perhaps then we cannot dismiss face b as a later addition – and that, to my mind, leaves it the more disquieting<sup>45</sup>. Is it an unfinished failure?

We proceed finally to the thorniest group of all, K 85–88<sup>46</sup>. All came from Evans’ collection, though he never published them – a pity, for his judgement might have been interesting. Of K 85 (intertwined animal parts) Kenna says, “Uncertain. This may be ivory much calcined or steatite which has been burnt, or perhaps fine clay”. Boardman chooses “grey steatite”, Yule bone. Our two bone experts admitted to uncertainty and disagreed, Mr. MacGregor preferring gypsum or calcite for all four seals, Dr. Krzyszkowska choosing bone for K 85 but remarking on the “sense of an extra surface”. Dr. Evelyn considered that real ‘glazing’ would not have left the carving so sharp and wondered whether the flat polished-looking places could be simply marks left by a metal carving-tool.

For K 86 (monkey?) grey steatite is the favourite, only Yule preferring bone, but Kenna sees “traces of glaze” à l’égyptienne and is corrected with some diffidence by Boardman (“The patinated surface is rubbed, not glazed, it seems”), who elsewhere speaks of “‘steatite’ with an altered surface”<sup>47</sup>. Dr. Krzyszkowska interpreted the “glaze” or “patina” as “something resembling paint”.

With K 87 (duck?) and K 88 (half-barrel, half-ovoid, Brotform) Kenna moves to white faience, Boardman remains with his “grey ‘steatite’ with an altered surface”, Yule and (with some hesitation) Dr. Krzyszkowska with bone.

Clearly only science could lighten this darkness. When it did, all four were found to be of the same material! K 85 and 87 were examined at the Oxford University Research Laboratory for Archaeology and the History of Art by Dr. Julian Henderson, whose report I quote in full, adding explanations given to me by Dr. Henderson verbally.

“The seals were subjected to non-destructive chemical analysis in order to determine their composition as an aid to identifying the substance from which they are made. A further question concerned the identity of a layer of apparently ‘vitreous’ material which coats one face of K 87. The techniques used were Scanning-Electron Microscopy and Electron-Probe Microanalysis, which when combined provide a well defined analytical spot and an opportunity to examine the artifact under magnification (up to 400×). The technique is very superficial and penetrates up to 5 μm. [5 microns, i.e., 0.0005 cm].

K 87. A qualitative analysis of both the front and the back of the artifact was carried out, and both were found to contain major quantities of silicon (Si) and magnesium (Mg). In addition aluminium (Al) was

<sup>44</sup> 25D is clearly enough shiny soft stone. Do the “vertically scored” sides which made Sakellarakis and Kenna dubious simply show normal toolmarks?

<sup>45</sup> Cf. H. Hughes-Brock, *ClRev* 97, N.S. 33, 1983, p. 88.

<sup>46</sup> CS p. 100; GGFR pp. 98f., 390, pls. 39, 41 (on p. 98, caption for pls. 39, “next two” should be “next but one”); ECS pp. 93, 98, 95, 59 respectively.

<sup>47</sup> Boardman, *op.cit.* (n. 42 *supra*) p. 463.

found to be present at relatively high levels on analysis of the back. Minor quantities of sulphur (S), potassium (K), calcium (Ca) and iron (Fe) were also found. The sulphur could result from finger grease and is not thought to be significant. Where a layer of apparently 'vitreous' material was observed, the analysis revealed the presence of an organic material in the form of a characteristic background on the spectrum. Further visual examination suggested that it was probably varnish which was flaking off in some areas [leaving the deposit thicker in the crevices, i.e., not peeling off in the way that glass does. The absence of phosphorus shows that we are not dealing with bone].

K 85. Similar quantities of all the elements found in K 87 were also found in this artifact, indicating that it is made of similar material.

Interpretation. The presence of Mg at relatively high levels suggests that both seals are made of soapstone: they are both certainly magnesium-silicates and could be talc or sepiolite (the latter is found in Greece). A full analysis would have to be destructive, using a technique such as X-ray diffraction. The material used is certainly not calcite [because there is too little Ca] and the presence of aluminium suggests other possibilities."

K 86 and 88 were examined on separate occasions by Dr. F.B. Atkins at the University Museum, at the Department of Earth Sciences and twice at the Conservation Laboratory of the Ashmolean. The very soft stone is probably steatite. (Dr. Atkins thought "perhaps talc (soapstone) but they contain significant Ca, therefore perhaps talc and calcite mixed".) "The surfaces of both these seals", Mark Norman wrote, "have been coated with a modern resin, presumably to consolidate them". The earlier report from the Ashmolean read, "[K 86] appeared to be coated with a lacquer of some sort, which dissolved in acetone. The 'paint' looks, under the microscope, to have been put on in antiquity – possibly a gesso or other decorative coating". What exactly this coating is and what it has to tell us will have to remain an enigma for the time being, it seems.

Meanwhile these results, set alongside the photographs in CMS, prompt me to some speculations. CMS II 1 No. 1 gives the same impression of an "extra surface" as Dr. Krzyszkowska noted on K 85. It appears as ivory in the CMS, but Xanthoudides called it white steatite. Perhaps he was right<sup>48</sup>? Exploring among the parallels for K 86 we find that with CMS II 1 Nos. 114 and 357 again the earlier scholars (Xanthoudides, Evans, Matz) preferred steatite to Platon's (and now Yule's) ivory. CMS IV No. 28 appears on different pages of the volume as "white glazed steatite" and "white faience"; Boardman favours the former, Yule the latter<sup>49</sup>. The ridged areas on it and on CMS IV No. 18D ("brown and green steatite with a white slip") are like those on K 85 and 86 (cf. GGFR pls. 39, 41), but the photographs do not reveal whether or not they have the same surface characteristics. The surface of CMS IV No. 23D ("yellow faience") shows up more clearly. Yule considers the latter two genuine<sup>50</sup>. The motif of K 86 is closely paralleled on CMS II 2 No. 109 from the Mallia Workshop, called white steatite. With K 88 we enter a veritable jungle of scarabs and more or less scaraboid shapes where Egyptian connections have brought in white 'frit/faience'<sup>51</sup>. Hacking our way through here, branch by

<sup>48</sup> Yule does not give an opinion but merely says that of his seven 29a scarabs "most are in frit/faience" (ECS p. 78). Only one, CMS IV No. 111, is published as such.

<sup>49</sup> CMS IV pp. VIII, 34. Cf. Boardman, *op.cit.* (n. 42 *supra*) p. 463; ECS p. 100.

<sup>50</sup> ECS pp. 96f., 141 (motif 19:15), 209 and pp. 98, 152 (motif 30:7), 209 respectively.

<sup>51</sup> Cf. n. 48 *supra* and e.g., CMS II 1 No. 199, CMS X Nos. 38–39.

branch, will not be easy, but it will have to be done if we want a more correct picture of relations between Crete and Egypt.

Clearly we have a long agenda before us in this matter of the 'white' materials. We have not solved all our enigmas at the Ashmolean, but I would hope that our efforts may have offered some instruction, some warnings and some encouragement.

#### DISKUSSION

N. MARINATOS weist auf Geweihmaterialfunde auf Thera hin, die aus Kultgebäuden stammen, denen, wie z.B. im nördlichen Komplex Delta, Werkstätten angeschlossen waren. Sie fragt H. Hughes-Brock, welche Verwendung für solches Material dort in Frage kommen könnte.

H. HUGHES-BROCK hält es durchaus für möglich, daß es noch mehr Geweihmaterial gab, welches bei Grabungen nur nicht erkannt wurde. Außerdem ist über Tierknochenfunde auf Kreta nur sehr wenig publiziert worden. Einige wurden im neolithischen Knossos gefunden, jedoch, soweit ihr bekannt ist, nicht in minoischen Schichten.