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RETRIEVING CAPACITY DATA FROM CRUSHED LEAD VESSELS: AN EXAMPLE FROM THE HOUSE OF LEAD, MYCENAE

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ABSTRACT

The poor preservation of many Mycenaean lead vessels, most of which have been found crushed within layers of settlement destruction debris, limits the quality and quantity of information that potentially can be recovered from these artefacts. This problem has substantially hampered investigation into their social function and status during the Late Bronze Age on the Greek mainland, despite their appearance at many major sites. Using the example of a lead vessel found within the House of Lead at Mycenae, this article presents a mathematical method for the reconstruction of vessel capacity from five basic measurements that are often still retrievable even from crushed specimens: their weight, rim circumference, width of the rim, thickness of the rim, and thickness of the body. Vessel capacity is an important, yet often neglected, metric that directly relates to the use of these objects. Results from this model are compared against those derived from pottery assemblages to strengthen the argument that the most common form of lead vessel was a non-portable, multi-functional storage solution. Evidence from the ceramic corpus suggests that some form of standardisation existed regarding vessel capacity, and further exploration of this issue is needed to gauge the degree of its relevance to the metal assemblage. The wider application of this model will enable the integration of another dataset into this debate, and allow better engagement with these lead vessels from the perspective of their intended users.

KEYWORDS: *Bronze Age Greece, lead vessels, volume, geometric modelling, vessel capacity, household storage*

1. INTRODUCTION

The mutual relationship between people and objects (Graves-Brown 2000: 1-2) means that physical sensory engagement and bodily capabilities mould the forms that artefacts must take in order to be functional (Edwards, Gosden and Philips 2006: 5; Hinde 1998: 176). These characteristics or affordances then reflect back to their users the culturally-correct modes of practice (Ingold 2007: 14; Knappett 2012: 189-190). Capacity is an important primary attribute of vessels which governs their usage (Thalman 2007: 431), yet because it is of less descriptive value to archaeologists and is difficult to calculate, it is rarely explicitly considered.

It could be argued that stating the height and diameter of vessels is enough to provide a rough guide, yet without accompanying illustration of their profile this information is quite meaningless; shape is fundamental to their capacity. For example, giving the height of one particularly common Mycenaean vessel shape, the kylix, gives no indication as to its capacity due to the variability in the height of the stem. Furthermore, Katsa-Tomara reported that vessels of very similar external visual appearance could in fact vary in capacity by up to one to two litres (1990, 39).

Where investigation has been taken further, it seems clear that some form of standardisation within Aegean vessel capacities did exist (Alberti 2012; Lang 1964; Katsa-Tomara 1990; Doulas and Constantinides 1990; Stronk 1972; Ventris and Chadwick 1956), which may relate to both their function and the potential logistics of storage and trade. It is also thought that the study of vessel capacities may provide further information regarding foodways, trade and production (Rodriguez and Hastoff 2013: 1182), by placing emphasis on the experience of their intended users, and within the Aegean they have been brought to bear on the issue of redistribution, subsistence and the economic role of palaces (Christakis 2008; Mudd 1984; Evans 1935; Graham 1962).

Thus far, such capacity studies have been restricted to the ceramic corpus. Expanding this to include vessels manufactured from metal could provide evidence of another point of articulation between vessel assemblages of differing materials. For the majority of metal vessels, this will require a very similar measurement process to that conducted on the ceramics. However, this is rarely possible for lead vessels due to their poor state of preservation; they are often found completely crushed together and their fragility prevents restoration.

Using as a test subject a vessel recovered from the House of Lead at Mycenae, a mathematical model

will be applied using five basic metrics that are often still retrievable, even from crumpled specimens.

2. THE HOUSE OF LEAD



Figure 1. The Atreus Ridge, as seen from the citadel at Mycenae. Photograph courtesy of David Mason

The House of Lead (French *et al.* 2003: E4:11) lies southwest of the citadel at Mycenae, on the Atreus Ridge, shown in figure 1. This area has been badly affected by natural erosion processes and stone-robbing (Wace 1955: 40). Preliminary investigation of the area began in 1939, after Wace deduced the presence of houses on this ridge based upon the considerable quantity of household refuse discovered downhill from the site, particularly in a rock cleft adjacent to the Treasury of Atreus itself (Wace 1956: 119).

Fuller excavation of the ridge did not take place until 1955, when a retaining wall of Cyclopean masonry for a large terrace intended to support a significant Mycenaean dwelling was uncovered (Wace 1955: 40; Wace 1956: 119-120; French 1963: 47; French 2002: 68), as shown in figure 2. The entire original structure was not uncovered meaning that the full plan of the building is still unknown (Wace 1956: 121).

The only other excavated remains of the House of Lead are a set of what are described as “basement” rooms at the northwest corner, shown in figure 3. The use of the term “basement” by the excavator is somewhat vague. There is no reason to believe that these rooms were completely subterranean; it is possible that the excavator wanted to indicate his idea that they were primarily for storage rather than living quarters, or perhaps that they lay in part below the original ground surface.



Figure 2. 1955 image of the excavations in progress at the House of Lead looking east, showing the terrace wall. Photograph courtesy of the Mycenae Archive

One of these “basements” contained a selection of several large storage vessels (Wace 1956: 120). The large lead vessel (excavation number 55-89, designated MYC281 in Aulsebrook 2012) was recovered from another “basement” room to the south of this lying squashed upon the floor, which was of beaten clay or earth intermixed with the cut-down rock surface (Wace 1956: 121; Higgins 1955). In the field notebook kept by Reynold Higgins, the vessel was described as a “lead box or tray”. It was found on 10 August 1955 in trench E1, where two workmen had been excavating, 0.60m down from the surface. The find inspired the excavator to name this building “The House of Lead” (Wace 1956: 120) and his own field notebook shows that this epithet was applied immediately the day following the discovery of the vessel.



Figure 3. 1955 image of the excavations at the House of Lead in progress at the top of the ridge looking east, showing the “basement” rooms. Photograph courtesy of the Mycenae Archive

Pottery excavated from the same area as the vessel was dated to LH IIIB, according to papsing notes for recovered ceramics from the back of the Reynold

Higgins 1955 field notebook. From the same room, higher in the debris, a decorative metal sphinx or griffin wing was also found (Wace 1956: 121), as shown in figure 4. Analysis of this wing has shown it to be composed of a low-tin bronze with added silver and gold (84% Cu, 7% Au, 5% Sn, 2% Ag, 2% Pb) with gold-copper alloy foil decoration (Demakopoulou *et. al.* 1995: 148).

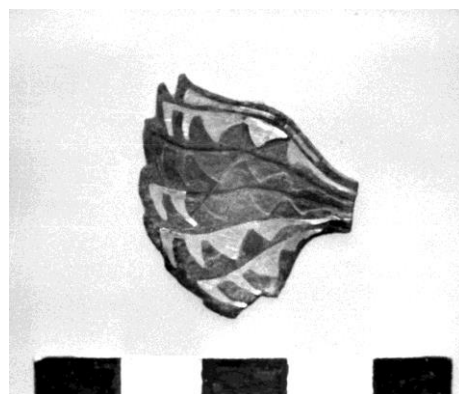


Figure 4. The metal griffin or sphinx wing found in the House of Lead in the same room as the lead vessel 55-89. Photograph courtesy of the Mycenae Archive

The presence of such an object, along with the fresco fragments recovered from the rock cleft and the rich chamber tombs located close to the ridge, suggested to Wace that the House of Lead was the residence of a wealthy Mycenaean family (1955: 40; 1956: 122). Examination of ceramics from the terrace fill suggests that it, and presumably the buildings upon it, were constructed at the beginning of LH IIIB (French 1963: 47). It seems that it did not stand in isolation, based upon the numerous traces of human occupation found on the southern end of the Atreus ridge (Wace 1956: 119). The house was destroyed by fire during mid LH IIIB, at the same time as other structures at Mycenae outside the citadel walls

(French 2002: 67), not at the end of LH IIIB as stated elsewhere (Wace 1955: 40; Wace 1956: 120).

The House of Lead has not received any detailed publication beyond the preliminary report (Wace 1956), and consequently finds from this structure are not widely known. Aside from the vessel, a further four lead objects were registered from The House of Lead excavation:

1. Ex. no. 55-584: length: 0.037m; width: 0.015m; weight: 0.017kg. Found August 31st in Trench J. Lead fragment from a molten flow, no indications as to its original shape, broken off at both ends
2. Ex. no. 55-585: length: 0.057m; width: 0.036m; weight: 0.046kg; individual sheet thickness: 0.004m. Found August 29th in Trench H (south). Two separate pieces of lead sheeting pressed together, edges all broken. Two definite parallel grooves on one sheet, with further possible parallel grooves visible on both; grooves are of differing lengths and starting points - may be damage from recovery rather than decoration
3. Ex. no. 55-594: length: 0.097m; width: 0.070m; weight: 0.118kg; thickness: c. 0.003m. Found August 9th in Trench E (House of Lead main building). Part of a lead flow or semi-molten lead sheet, no indications as to original shape, bumpy and uneven surface
4. Ex. no. 55-595: three fragments, probably originally joined. Found August 19th in Trench E (House of Lead main building)
 - a. three joined rivulets of lead flow, length: 0.062m; width: 0.102m; weight: 0.078kg
 - b. almost rectangular lump with one long rivulet of lead flow, length: 0.143m; width: 0.074m; weight: 0.149kg
 - c. shapeless fragment, edges partially folded over, length: 0.093m; width: 0.108m; weight: 0.241kg

Very little can be deduced from these fragments because their poor state of preservation now prevents any speculation regarding their original shape. However, their presence does demonstrate that lead was being used in other areas around The House of Lead complex.

3. LEAD VESSEL FROM THE HOUSE OF LEAD

The preservation of this vessel is relatively good in comparison to the condition of other similar lead vessels from destruction debris contexts. There are nine surviving fragments over 0.150m in length and

a further nine fragments above 0.070m in length. Many of the fragments are crumpled and folded, some even torn and twisted with corrosion holes and signs of delamination. Fresh breaks are visible along some edges, showing white, dark red-brown, and mid to dark grey. These breaks are probably due to the lifting of the vessel and subsequent decomposition of the object whilst in storage, particularly with the original transportation of this vessel from the site to the Nauplion Museum and then more recently to the Mycenae Museum.

Several pieces still retained large quantities of soil from excavation. This would have very slightly increased the weight reported for some fragments, but it is unlikely to have caused the weight of the entire vessel to be overestimated due to the damage caused by corrosion and the likelihood of missing fragments.

The lead has oxidised, giving a dull surface that varies from light to mid grey. In contrast to the majority of the other lead fragments recovered from the House of Lead, there are no signs of significant damage to this vessel through heat. The melting point of lead is relatively low, at 327°C (Mossman 1993: 16), making it particularly vulnerable to fire.

Two fragments (fragments 3 and 9, see appendix) have retained sections of the rim; although it is difficult to be absolutely certain that the complete rim has been preserved. The softness of lead means that fragments are usually warped and deformed. This means it is not possible to fit together a vessel from lead fragments in a comparable manner to ceramic sherds. The measurements from these two fragments give a circumference of 0.805m and therefore a rim diameter for the vessel of 0.256m. The thickness of the lead sheeting varies between 0.0015-0.0020m.

When uncovered it was reported as having a maximum diameter of 0.550m (Wace 1955: 40) and elsewhere as approximately half a metre (Wace 1956: 121). This measurement has not been used in the following calculation of the capacity for two reasons. First, the aim of the model is to utilise metrics available for the greatest number of lead vessel candidates, but few are found preserved in such a way that a maximum diameter can be measured. Secondly, unless this vessel was crushed absolutely vertically without expanding outwards, the maximum diameter recorded at the time of recovery is likely to significantly overestimate the original maximum diameter of the vessel.

During the study of a lead vessel from LH IIIB/C Dimini (Adrymi-Sismani 2004-2005: 23) a clear line was found running internally around the midpoint of the body, demonstrating that it was manufactured in two pieces that were subsequently joined together (Adrymi-Sismani, Rehren and Asderaki-Tzouerkoti

2009: 697). However, no such line was visible on any of the fragments from the vessel from the House of Lead, which indicates it was made from a single lead sheet. This suggests that there were multiple methods of production for lead vessels, perhaps varying by workshop, region or period.

4. THE FUNCTION OF THE VESSEL

The separate typology for lead vessels, their limited ornamentation, their restricted arenas of usage and their exclusion from the funerary sphere during the LH III period all imply that they were regarded very differently to other types of metal vessel (Aulsebrook 2012: 314). Several different theories as to the function of these large lead *alabastra* have been put forward over many decades without a satisfactory conclusion (a comprehensive summary is given in Mossman 1993: 91). Indeed, a review of the contexts in which lead vessels have been discovered suggests that they were static installations, utilised for a range of functions in a variety of locations (Aulsebrook 2012: 314).



Figure 5. 1955 image of the excavations in progress at the House of Lead, showing the lead vessel 55-89 in-situ. Photograph courtesy of the Mycenae Archive

The bulkiness of such vessels tends to discount the idea that they were used as lids as suggested by Broneer (1939: 416); the heaviest vessel recorded by Mossman in her study was at least 18.5kg (1993, no. 7). Although lead as a material is inextricably linked in modern minds with the effects of lead poisoning, in fact so long as water is of a sufficient hardness, as at Mycenae (Bintliff 1977: 174), its storage within lead vessels would not be problematic, although they should not be used for rainwater as this is naturally soft (contra Mossman 1993: 336).

It is worth highlighting though that the general disease and malnourishment burden carried within Mycenaean populations, as suggested by evidence across the Greek mainland (Arnott 2005: 24-25), means it is unlikely that the issue of lead poisoning

would have affected decision-making within these societies. The ability of individuals to establish this link in the past would have been hindered by its specific effects being masked. Nevertheless any suggestion that this specific vessel could have been used for the collation of water is proved unlikely by its find location, within a basement, and so a passive storage function appears more probable.

There is no indication, however, as to what the contents of the vessel may have been. Grain is a possibility, given the carbonised grains found adhering to a fragment of lead sheeting at Mycenae (Tsountas 1886: 75). A lead vessel found in room 31 of the Room of the Fresco Complex in the Cult Centre at Mycenae contained a faience plaque of Amenhotop III, which has led to the suggestion that they may have been used to store "luxury" items (Mossman 1993: 92), although no such objects appear to have been found in direct association with this particular example. Since the plaque was found in the mouth of the now crushed vessel (Phillips and Cline 2005: 323), its location may be accidental; another suggestion for the presence of the lead vessel in this room is that it was used for the manufacture of perfumed oil (Moore 1988: 424, 427). This would only have been possible if its role did not require any form of direct heating (Mossman 1993: 16).

5. MATHEMATICAL MODELLING OF CAPACITY

In order to make this calculation of vessel capacity several assumptions are required, and these must be discussed to demonstrate the limitations of the model. Despite the introduction of numerous methods, there are many potential sources of error that renders it impossible to calculate the capacity of even complete vessels at 100% accuracy (Senior and Birnie 1995). As many ceramic vessels are found incomplete or are too fragile for their capacity to be measured directly, a number of solutions have been developed. It has been shown that the most accurate method of mathematically modelling the capacity of a vessel is to base the calculation upon a geometric shape analogous to the vessel form whilst taking two measurements of the rim diameter, creating an elliptical cross-section to account for any irregularities in shape (Rodriguez and Hastorf 2013). However, as the original degree of circularity for the vessel is unknown and the rim diameter used in this model is derived from the rim circumference, a standard circular cross-section must be used.

Establishing which geometric shapes should be used for the basis of the model is complicated by the lack of conclusive proof regarding the typical shape of Mycenaean lead vessels, as the softness of the

metal has ensured that the majority of surviving specimens have suffered damage to their form. That the vessel from the House of Lead would have been, like others, roughly spherical is undoubtable; however, its exact type of base is unknown. It seems fair to presume that it had a rounded base, judging by other better-preserved vessels, as the only known examples that can be described as “footed” all come from shaft graves IV or V at Mycenae (vessels (a) to (f) in Karo 1930: 160; currently held in the Athens National Museum, inventory numbers unknown. See Karo 1930 figure 79 for a clear illustration of the vessel foot). Not only are these considerably earlier than the vessel under analysis here, but their rarity and confinement to a single set of contexts suggests that they represent a typologically-separate and short-lived branch of lead vessel development.

A flattened sphere is therefore most likely to be analogous to the original shape but for the purposes of this calculation the vessel will be modelled as a perfect sphere, which, without any further guiding evidence regarding the degree of flattening, is the most neutral and simplest solution. This will overestimate the capacity of the vessel.

The remaining assumptions relate to the veracity of the measurements taken. The mass of the vessel is the most problematic, as not only did many pieces still have soil adhering to them, it is also impossible to be certain whether the complete vessel has been retrieved. This measurement will also have been affected by processes of corrosion. Thus the mass must be accepted as an estimate, and most likely an underestimate, thus partially countering the use of a perfect sphere in the model as discussed above. A second potential source of error is the wall thickness of the vessel. This is unlikely to have been completely consistent across the entirety of the vessel, but the importance of its role within the calculation means that a small variation can greatly affect the final result. It is therefore suggested that producing a minimum and maximum figure for the capacity, based upon the extremes of the wall thickness variation, is preferable.

Finally, the calculated capacity will, by necessity, be the maximum volume for the vessel. It is highly unlikely that vessels were intentionally filled to the brim but the exact level to which they were filled would have varied by the context of use, the type of contents, the degree of portability required and the vessel shape. Some vessel features, such as carinations in the wall profile close to the rim, may have been intended in part to provide a guide to the optimum level for a specific shape and lower the likelihood of spillages.

It could be argued that the size of lead vessels could be correlated to the wealth of their owner ra-

ther than their function. However, there are several factors that would count against this hypothesis. First, despite the presence of a few specimens in quite high-profile locations, such as cult rooms, the vast majority are typically found in areas identified as storage zones. In addition, very few lead vessels show any sign of decoration at all, and where it is present it involves simple geometric forms scratched into the surface of the lead. The only exceptions to this are the footed cauldrons from the shaft graves which appear to have had rims clad in decorated bronze; this emphasises the great gulf between these examples and the remainder of the lead vessel corpus.

Thus their general lack of elaboration through ornament and placement in low-key storage areas would suggest that although display may have been a factor in their size, dismissing any link between size and practical usage would be unwarranted. This means that the use of the maximum capacity in this model allows comparability between vessels as well as again providing the simplest and most neutral solution in the absence of relevant evidence.

A visual representation of the model used to estimate the capacity of this vessel is presented in figure 6. As we know both the mass of the vessel and the density of lead (at 1 atm (or standard pressure at 0 masl) and at room temperature (20°C) the density of lead is 11.34g/cu cm), it is possible to obtain the volume of material used to create the vessel. Subtracting the volume of material used for the everted rim (calculated using its width and thickness) gives a final volume of material used to enclose space Z inside the vessel, with Z therefore representing the estimated volume capacity.

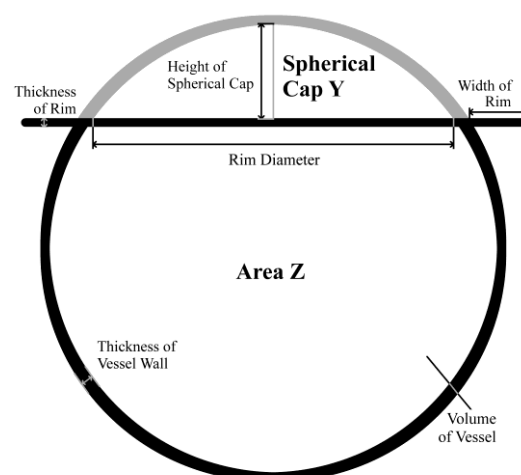


Figure 6. A two-dimensional visual representation of the mathematical model used to find the capacity of a lead vessel. The vessel profile is represented by the heavy black line with the key measurements for the calculation highlighted

To find the size of Z it is thus necessary at this point to use the standard formula to calculate the volume of two spheres (volume of a sphere = $(4/3)\pi r^3$): an inner sphere representing the interior of the vessel and an outer sphere representing the exterior of the vessel. The difference in volume between these two spheres would then equal the volume of material used to enclose space Z with one further adjustment. As the vessel was not an entire sphere, but was truncated at the level of the rim, it is necessary to subtract the empty region represented by spherical cap Y (volume of a spherical cap = $(\pi h/6)(3a^2+h^2)$). To carry out the actual calculation, a spreadsheet was drawn up on Microsoft Excel and the "goal seek" function used to provide an answer. As the radius of the sphere, which is fundamental to this calculation, is not one of the known variables, this function effectively requests the program to limit the discrepancy between the known mass and the total given by the model to zero by finding this radius through trial and error.

Applying this model to the vessel from the House of Lead gives a capacity ranging from 22.32 to 32.68 litres, based upon an overall vessel thickness ranging between 0.015 and 0.020m. Currently this model cannot be used to compare this result to other lead vessels as no other published examples include all five of the necessary measurements. Unfortunately, in her detailed study of lead vessels, Mossman did not include the rim width as one of the standard measurements taken. It is hoped that this additional data can be collected in the near future. The lead vessel studied by Adrymi-Sismani, Rehran and Asderaki-Tzoumerkioti (2009) was not weighed.

However, it is possible to contrast the capacity of this vessel against the ceramic corpus. In her 1964 study of the capacity of vessels from the excavations at the Palace of Nestor, the only vessel measured by Lang that comes close to the capacity of this lead vessel is a jar that could hold 22.000 litres. Unfortunately, few of the largest vessels could be measured due to the combination of their fragility and the greater weight of grain they would have had to support (Lang 1964: 101). In comparison the capacities of the kylikes measured as part of the same study varied between 0.010 and 7.000 litres (Lang 1964: 101-103).

Alberti's analysis of a small group of LM IA storage and cooking wares from House I.1 at Petras found that the vessel with the largest capacity was an oval-mouthed amphora, at 13.5-13.8 litres (2012: 243). The average large stirrup jar (FS 164) was estimated by Haskell to be of a similar size, at 13.5 litres (1984: 101) or elsewhere calculated at 12 to 14 litres (Ventris and Chadwick 1956: 59-60). This implies that the capacity of this lead vessel may make it more comparable to pottery intended for storage

rather than transportation. It fits more closely with the biggest version of the ovoid funnel-mouthed pithoi at Akrotiri, which averaged 28428.5 cm³ (28.4285 litres) (Katsa-Tomara 1990: 38). The largest examples of bridge-spouted jars and open-mouthed jugs measured for the same study were 15 litres and 1.9 litres respectively (Katsa-Tomara 1990: 34, 35).

However, the study by Christakis demonstrates that the majority of pithoi were much larger than this, as half of the forms identified in his typology held over 100 litres, with the biggest examples having a capacity that ranged between 2500-3000 litres (Christakis 2005). Therefore, it is likely that in terms of function, this lead vessel was destined for a storage role, but its contents did not demand so grand a scale or such a long period as those stored in pithoi. Indeed, ceramic vessels of a similar capacity to the vessel from the House of Lead, found at Tell Arqa, in North Lebanon, were interpreted as short-term static storage containers (Thalmann 2007: 433).

The capacity can also be used to estimate the total weight of the vessel when completely full. Using water as a base model (with the same parameters of 1 atm and 20°C), the weight of the water and vessel combined would have been between 31.12 and 41.46kg. This clearly makes movement of the vessel prohibitive whilst full; a recent study to ascertain safe maximum lifting limits for repetitive activities based upon the average American male suggested a ceiling of 68lb (30.8kg) (Chapla 2004: 40). The sheer bulk, lack of handles, and awkward shape of these containers would also have been salient factors in their intended portability.

A recent study of the capacity of ceramic vessels from Tell Arqa also found a grouping of 20 – 25 litre vessels with handles placed very low on their body below the centre of gravity (Thalmann 2007: 433). The author implied that any restriction in their portability was based upon the poor placement of these handles not their capacity; I would suggest that this instead demonstrates that vessels of this size were not intended to be moved frequently and thus the handles were placed accordingly.

Given the known weights and rim diameters of other lead vessels measured by Mossman suggest larger vessels than this example were not unusual (1993), this provides further support for the hypothesis that these containers were semi-permanent or permanent fixtures in a similar vein to *pithoi* but on a smaller scale, rather than portable like the majority of vessels manufactured from other metals.

6. CONCLUSION

The mathematical model presented here can be successfully used to estimate the original capacity of

a now deformed lead vessel using five basic measurements that should be obtainable from many otherwise poorly-preserved specimens: the weight, the rim circumference, the width of the rim, the thickness of the rim, and the thickness of the body. Although there are no other lead vessels for which those five measurements have been recorded, further study should be able to fill in those gaps relatively quickly and thus provide a new body of evidence that can be used to discuss the role and status of vessels in Mycenaean societies.

The results of this study have firmly reiterated the high likelihood that these containers were intended as static fixtures and perhaps were even perceived as architectural features. From comparison with the ceramic corpus and integration with other contextual evidence a short-term storage role for these vessels seems most probable, which was possibly shared with smaller-scale pithoi such as the ovoid funnel-mouthed pithoi from Akrotiri. The appearance of lead vessels mainly within higher status buildings, but installed in basements, magazines and corridors, indicates that ownership of them was economically beyond the reach of the majority of the population yet they were not primarily employed as markers of social status. This may imply that they were considered by certain Mycenaean societies as particularly suited for a specific purpose or range of purposes, whether rooted in empirical observation or cultural tradition.

As predicted, the possible value range is relatively large due to the high fluctuation in the thickness of the vessel wall. The accuracy of the model would be improved through greater precision in this measurement, perhaps by producing an average figure weighted according to the range in variation and character. This should then allow data from lead vessels to be compared against the standardised units of capacity suggested for the ceramic corpus. It must be borne in mind that the degree of error in this calculation of vessel capacity is likely to exceed that inherent in direct measurement or use of a vessel profile. However, in the absence of these possibilities, this model currently provides the only possible method of obtaining a reasonable estimate for the capacity of lead vessels.

7. APPENDIX: LIST OF REMAINING FRAGMENTS

1. Light grey in surface, dark grey to red in breaks; single sheet fragment, folded in two, slightly crumpled. Maximum length: 0.162m; maximum width: 0.098m; sheet thickness: 0.0015m; weight: 0.230kg. Part of body, no finished edges
2. Light to mid grey surface, white and dark red in breaks; large quantity of soil still retained; single sheet fragment, top folded downwards, left end crumpled and twisted, large tear on left side, overall crumpled. Maximum length: 0.177m; maximum width: 0.094m; sheet thickness: 0.0015-0.0020m; weight: 0.238kg. Part of body, no finished edges
3. Light grey surface, white, dark grey and dark red in breaks; medium quantity of soil retained; single sheet fragment with rim, bent outwards against natural curve, folded over in places along bottom edge, rim folded out on right hand side, crumpled and ends bent together distorting shape of the central part. Maximum length: 0.231m; maximum width: 0.122m; sheet thickness: 0.0015-0.0020m; rim width: 0.022m; rim thickness: 0.006m; surviving rim length: 0.238m; weight: 0.431kg. Part of body and rim with one finished edge. Original line of fold still visible where rim has been deformed. Original rim may have been slightly uneven
4. Light to mid grey surface, white, dark grey and dark red in breaks; single sheet fragment, quite crumpled, edges bent at bottom, slight fold just off centre, cracks and a hole visible in surface. Maximum length: 0.228m; maximum width: 0.090m; sheet thickness: 0.0015-0.0020m; weight: 0.291kg. Part of body, no finished edges
5. Light grey surface, white, dark grey, some dark red in breaks; single sheet fragment, bottom folded underneath, large tear and crack just left of centre, puckering of most edges. Maximum length: 0.221m; maximum width: 0.091m; sheet thickness: 0.0015-0.002m; weight: 0.434kg. Part of body, no finished edges
6. Light grey surface, white and dark grey in breaks; still retains medium quantity of soil; single sheet fragment, bottom folded over causing tears, crumples and holes, on left side this area has folded over itself twice, right hand side concertinaed in causing large ridges and network of folds on the reverse, hole in sheet just right of centre, top edge bent, fragile, large tear on top of fold ridge on left side, entire piece crumpled with many ridges. Maximum length: 0.450m; maximum width: 0.273m; sheet thickness: 0.0015-0.0020m; weight: 3.360kg. Part of body, no finished edges
7. Light grey surface, dark red and dark grey in breaks; small quantity of soil retained; single sheet fragment, bottom of sheet has folded

- over itself twice causing tears, at right hand side the end has become completely crumpled and twisted. Maximum length: 0.129m; maximum width: 0.097m; sheet thickness: 0.0015-0.0020m; weight: 0.228kg. Part of body, no finished edges
8. Light to mid grey surface, dark brown, dark grey and white in breaks; single sheet fragment, flattened out, part of top edge folded over on right hand side, left edge slightly crumpled creating two cracks. Maximum length: 0.153m; maximum width: 0.039m; sheet thickness: 0.0015-0.0020m; weight: 0.074kg. Part of body, no finished edges
 9. Light grey surface, red, mid to dark grey and white in breaks; some soil still adhering; single sheet fragment with part of rim, fragment has two large twists causing folds and cracks, along the central and left hand sides the sheet has become folded back upon itself, edges fragile. Maximum length: 0.324m; maximum width: 0.276m; sheet thickness: 0.0015-0.0020m; rim width: 0.022m; surviving rim length: 0.567m; weight: 1.188kg. Part of body and rim with one finished edge
 10. Light grey surface, dark red, grey and white in breaks; a little soil still adhering; single sheet fragment, bottom has folded up underneath causing tears and cracks, left hand side has several cracks, top part of this area has doubled over, another large crack at right hand side, entire piece crumpled causing ridges and folds. Maximum length: 0.370m; maximum width: 0.216m; sheet thickness: 0.0015-0.0020m; weight: 1.166kg. Part of body, no finished edges
 11. Light grey surface, dark grey, dark red and white in breaks; single sheet fragment, part of top edge folded over, right hand side bent out of alignment, piece slightly crumpled. Maximum length: 0.108m; maximum width: 0.044m; sheet thickness: 0.0015-0.0020m; weight: 0.053kg. Part of body, no finished edges
 12. Light grey surface, mid grey, dark red and white to light grey in breaks; single sheet fragment, folded in half, small hairline cracks at folds, slightly crumpled. Maximum length: 0.081m; maximum width: 0.043m; sheet thickness: 0.0015-0.0020m; weight: 0.061kg. Part of body, no finished edges
 13. Light grey surface, dark grey, dark red-brown and light grey in breaks; two sheet fragments pressed against each other, upper sheet slightly crumpled, part of top of lower sheet folded outwards, otherwise it follows contours of upper sheet; probably originally a single piece folded over so severely that the fold snapped. Maximum length: 0.073m; maximum width: 0.048m; sheet thickness: 0.0015-0.0020m; weight: 0.070kg. Part of body, no finished edges
 14. Light grey surface, white, dark red and mid grey in breaks; single sheet fragment, folded in two, top part of sheet folded over, bottom part at right hand side also partially folded over, left hand side bent, piece slightly crumpled. Maximum length: 0.083m; maximum width: 0.047m; sheet thickness: 0.0015-0.0020m; weight: 0.049kg. Part of body, no finished edges
 15. Light to mid grey surface, white, dark red and mid grey in breaks; single sheet fragment, slightly crumpled causing hairline cracks. Maximum length: 0.092m; maximum width: 0.058m; sheet thickness: 0.0015-0.0020m; weight: 0.047kg. Part of body, no finished edges
 16. Light to mid grey surface, dark red, dark grey and white in breaks; single sheet fragment, upper part folded back on itself so that it has torn and almost broken away, three holes in fabric, edges very fragile, on left hand side part of edge almost broken away, entire piece crumpled. Maximum length: 0.090m; maximum width: 0.051m; sheet thickness: 0.0015-0.0020m; weight: 0.052kg. Part of body, no finished edges
 17. Light grey surface, dark red, white and mid grey in breaks; single sheet fragment, quite crumpled causing top edge to split into two and bottom edge into three, left hand side top edge slightly bent backwards. Maximum length: 0.078m; maximum width: 0.051m; sheet thickness: 0.0015-0.0020m; weight: 0.048kg. Part of body, no finished edges
 18. Light grey surface, light grey, mid grey and dark red in breaks; single sheet fragment, crack along left hand side, bottom of right hand side bent causing stress on underside of fabric, which has begun to split away and cause two small holes. Maximum length: 0.081m; maximum width: 0.053m; sheet thickness: 0.0015-0.0020m; weight: 0.046kg. Part of body, no finished edges
- The remaining fragments of the vessel (each below 0.07m in length) collectively weigh 0.774kg, giving the total weight of the surviving fragments of this vessel at 8.840kg.

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