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Production and Mortuary Consumption of Copper-Base Materials at Susa in the Early to Middle Bronze Age Transition

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Abstract

At the critical junction of the Early and Middle Bronze Ages, marked by the fall of the Ur III polity, the city of Susa in today's southwest Iran left Mesopotamian control and became the lowland seat of the Shimashki and then Sukkalmah dynasts of the Zagros mountains, who elevated Elam as a significant power on the dynamic early Middle Bronze Age Near Eastern geopolitical stage. This transition ushered in new political, economic, and social conditions, which this paper argues can be detected in Susa's mortuary record, particularly in the consumption of copper-base materials. A comparison of burial assemblages and evidence for the copper-base metallurgy industry before and after the transition demonstrates that while copper-base objects had already played a critical social role under Mesopotamian rule, their deployment in the structuring of Susian society expanded with the transition to eastern rule and more widespread changes in economic production and trade.

Keywords

Susa – Elam – Middle Bronze Age – Early Bronze Age – copper – bronze

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Introduction[1]

As a nexus of land and water routes in an immense trade network embracing the Iranian plateau, Central Asia, the Indus Valley, the Persian Gulf, Mesopotamia, Syria, and Anatolia, the city of Susa in today's southwest Iran was a desirable holding for competing political entities emanating from Mesopotamia in the west and the Zagros mountains in the east (map figure 1). For much of the later Early Bronze Age it was annexed to Mesopotamia. Under Sargon (ca. 2324-2285 BCE +/-30)[2] and his successors it hosted an Akkadian military garrison and palace, and served as an entrepot to support the Sargonic "international" commercial enterprise. Its documented contacts with distant regions indicate that it had linked northern trade coming overland from the Iranian highlands and maritime Persian Gulf trade with Lagash (Schrakamp 2015:258–59; Foster 2016:73; Steinkeller 2018:188–89).[3] Later it served as a strategic eastern communication hub and agropastoral resource for the Ur III (ca. 2110-2003 BCE) dynasts (Notizia 2009:17–18; Maekawa 2016:60, 62–63; Steinkeller 2018:194). Then, at the critical junction of the Early and Middle Bronze Ages (henceforth EBA and

FIGURE 1 Map showing main locations mentioned in text
GOOGLE EARTH 2022

1 All abbreviations follow https://cdli.ox.ac.uk/wiki/abbreviations_for_assyriology.

2 Absolute dates for third millennium BCE Mesopotamia follow the Middle Chronology of Sallaberger & Schrakamp 2015, tab. 39.

3 For the argument that the construction of the Sargonic empire was a largely commercial endeavor aimed at securing control over trade routes from the Indus Valley to the Levant in order to exploit them economically, see Laursen & Steinkeller 2017:31–32.

MBA), marked by the fall of the Ur III polity at the hands of the Shimashki in 2003 BCE, Susa left Mesopotamian control and became the lowland seat of the Shimashki and then Sukkalmah (ca. 1980–1550 BCE) dynasts of the Zagros mountains, who elevated Elam as a significant power on the dynamic early MBA Near Eastern geopolitical stage (e.g., Charpin & Durand 1991:66).[4] This transition from western to eastern rule ushered in new political, economic and social conditions, which this paper argues can be detected in Susa's mortuary record, particularly in the consumption of copper and its alloys.

French archaeological delegations at Susa unearthed hundreds of burials spanning the Akkadian to early Sukkalmah periods, most of them during expeditions between 1912 and 1939 directed by Roland de Mecquenem, who typically worked in haste with limited attention to stratigraphy and cursory documentation of burials. Notwithstanding these problems, there is adequate evidence to enable definition of certain patterns in mortuary behavior in the later EBA (Akkadian and Ur III) and early MBA (Shimashki and Sukkalmah). A comparison of burial assemblages between the two periods demonstrates that an already significant disposal of copper-base products in later EBA mortuary contexts increased to an unprecedented level in the early MBA alongside a diversification in copper-base object typologies and origins. This suggests a greater emphasis on copper-base products to give structure and definition to Susian society after its transition to eastern rule. Demand for copper-base products at Susa brought a surge in local production, technological experimentation, and an escalating use of tin bronze—a material that was growing in importance across the early MBA Near East. An increased access to and consumption of prestige products, particularly copper-base ones, is linked here to the rise of the Shimashki and Sukkalmah rulers of Elam on the Near Eastern geopolitical stage and reorganization of economic production and trade after the collapse of the Ur III polity.

Later EBA Mortuary Assemblages and the Production and Consumption of Copper-Base Metals

Burial Sample

Susa's EBA mortuary practices await a detailed study, but a preliminary review of the available documentation suggests that only the more southern trenches

4 The last Ur III ruler, Ibbi-Sin (ca. 2026-2003 BCE), had already lost Susa to the Shimashki in his third year, but seems to have periodically recaptured it before his—and the Ur III polity's—demise (Steinkeller 2007:223, fn. 3l; De Graef 2022:444–46). For the suggested date of ca. 1980 BCE for the transition from Shimashki to Sukkalmah reign, see De Graf 2022:451.

opened by the French delegations yielded later EBA burials; namely, the southwest angle (VR *sondage* 1) and flank (VR *sondage* 2) of the Ville Royale, and the far southern tip of the site referred to as "the Donjon" (plan figure 2). The relevant burials were often assigned by Mecquenem to a "25th century" phase,

FIGURE 2 Topographic plan of Susa showing main mounds
MODIFIED FROM GHIRSHMAN 1954, PLAN 1

which yielded material spanning mainly the Akkadian and Ur III periods,[5] but at times also clearly conflated slightly earlier and later material. He generally omitted details of the individual graves, offering only broad syntheses of burial methods, usually primary inhumation in a pit with or without matting, and grave good types.[6]

The only burials individually documented under Mecquenem's direction appear in his publication of over five hundred selected EBA and MBA burials in the Donjon mound excavated between 1934 and 1939 (Mecquenem 1943:70–126).[7] While the burials were not explicitly dated, crude top-down and cross-section drawings of the mound showing their approximate relative positions and simple renderings of selected pottery forms[8] and small finds in the assemblages allow a preliminary identification of 188 burials belonging to the last three to four centuries of the third millennium BCE.[9] Juvenile

5 Mecquenem's 25th century date refers the late Akkadian/post Akkadian period (compare chronology of Jacobsen 1939).

6 Burials in VR *sondage* 1: Mecquenem 1931a:3; 1931b:335–38 (1 x 2 m rectangular pits, mats); 1933:5; 1934a:3–4; 1934b:211 (pits of 1 m x 1 m, or more often 1 m x 2m, mats noted); 1935:2; 1939:5; 1943:56. Burials probably in VR *sondage* 2: Mecquenem 1930:4. Burials in the Donjon: Mecquenem 1933:8; 1934b:236; 1935:4; 1936:5; 1937a:5. Occasionally Mecquenem (e.g., 1934b:211; 1943:56) perceived ruined unbaked brick or earth chambers that had completely disintegrated over time.

7 Mecquenem (1943:74) included only the "most important" finds of 1934, 1938 and 1939, and discarded a quarter of the 1935, 1936 and 1937 data from the north side (A) of the mound.

8 Pottery forms taken as diagnostic of Akkadian to Ur III date are Mecquenem 1943, figs. 69.8 (continues into the MBA), 69.14, 69.17, 69.18, 69.19–22, 70.7, 70.9, and 70.33. However, some Akkadian period Mesopotamian pottery forms were also present in the ED IIIb period (perhaps at least partly due to a crossover of the reigns of Sargon and the last Early Dynastic king, Lugalzagesi; see McMahon 2006:1–4). And a similar ceramic continuity may apply to Susa, which was already closely connected by trade to Babylonia, particularly Lagash, prior to Akkadian rule. Thus, this dataset is offered with the caveat that some of the burials might slightly pre-date the Akkadian period.

9 Tombs: A112, A143a; pit burials: A65, A66, A67, A68, A69, A70, A73, A97, A98, A99, A103, A104, A111, A114, A117, A118, A119, A121, A125, A127, A128, A129, A131, A136, A137, A138, A139, A140, A142, A144, A145, A147, A154, A155b, A158, A159, A160, A162, A165, A168b, A169, A171, A174, A175, A176, A178, A184, A185, A186, A187, A190, A191, A192, A193, A196, A197, A198, A205, A207, A208, A211, A212, A213, A215, A216, A217, A218, A219, A225, A226a, A226b, A227, A230a, A230b, A231a, A231b, A232, A233, A234, A235, A236, A237, A242, A243, A245, A246, A247, A248, A249, A250, A251, A252, A253, A258, A259, A260, A261, A262, A263, A264, A265, A267, A268, A269, A271a, A271b, A272, A276, A277, A278, A279, A281, A282, A283, A288, A289, A290, A291, A292, A293, A294, A295, A296, A297, A298, A310, A327, A328, A329, A330, A331, A332, A335, A336, A338, A348, A350, B99, B102, B116, B117, B147, B150, B162, B167, B168, B169, B170, B171, B172, B173 (published with both late EBA and early MBA pottery forms), B174, B175b, B188, B189, B191, B195, B196, B197, B198, B199, B200, B201, B202,

burials—both those explicitly described as burials of "children" and vessel burials, which only seem to have been used for juveniles at this time—are removed from this dataset because they are difficult to compare to those of adults.[10] They tend to show different treatment in terms of burial method and assemblages (fewer and poorer goods, seldom vessels), suggesting that juveniles belonged to a different social category. Apart from two small tomb chambers, the sample seems to be composed entirely of pit burials.[11]

The reliability of the Donjon publication, which compiles notes of several of Mecquenem's colleagues, has been called into question because there are instances in which it contradicts the original field recordings (e.g., Carter 1985:43–45). Thus this paper avoids placing emphasis on potentially erroneous individual burial assemblages and instead focuses on establishing broad patterns that can be supported by more recently excavated and better documented burials. For the later EBA there are just four such burials. Three of them came from Elizabeth Carter's small Ville Royale I (VR I) trench at the edge of Mecquenem's VR *sondage* 1. Two were Akkadian period burials of matwrapped adults placed in pits with local and southern Mesopotamian pottery forms, presumably reflecting Akkadian control (Carter 1980:88–89, figs. 30–31, graves 539 [two interments] and 527, cut from levels 8 and 7 respectively). The third, a more elaborately equipped adult burial on a mat in a pit with a possible collapsed superstructure, probably dates to the late Ur III period (Carter 1980:104, fig. 40, grave 513, likely cut from level 4B or 5), perhaps even as late as the last two decades of Ibbi-Sin (ca. 2026-2003 BCE) when Susa seems to have passed between Ur III and Shimashki rule. The fourth burial, seemingly coeval with the previous, was an adult deposited under an overturned coffin in the small Ville Royale B (VR B) trench of Roman Ghirshman farther south at the edge of the mound bordering on Mecquenem's VR *sondage* 2 (Ghirshman 1968, fig. 11, T.4; Gasche 2000:212–213, pl. 107, S.177B, cut from level VII).

Mortuary Assemblages and Wealth Distribution

Lists of items in "25th century" burial assemblages point to the consistent inclusion of pottery vessels, frequent inclusion of copper-base (henceforth also cu/br) items including vessels, weapons (daggers, various blades, axes,

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B205, B206, B209, B210, B213, B214, B215, B216, B218, B221, B223, B226, B227, B229, B230, B233, B236a, B243, B253, B255, B259, B262, B269, B270a, B270b, B272.

10 Complete elimination is not guaranteed as the presence of a juvenile in a burial was probably not always recorded in the field.

11 "Burials on the ground" and "skeletons" without mention of containment are combined here with "burials in pits".

mace heads, javelin/lance/spear heads, arrowheads), tools, mirrors, toilet utensil sets, adornments (rings, bracelets, earrings, pins),[12] less frequent inclusion of stone vessels and cylinder seals, and occasional inclusion of shell items and beads. The sample of 188 later EBA Donjon burials likewise indicates a fairly consistent inclusion of pottery vessels (83% of all burials) and a less consistent inclusion of non-pottery items (53.7% of all burials),[13] amongst which copper-base items were most frequent (46.3% of all burials). By far the most common cu/br category, present in over one third of the graves (34.6%), was adornment—mainly simple cast finger rings and bracelets, pins, and occasional earrings. Far fewer graves yielded cu/br vessels (13.8%), weapons (9.0%), or other varia ("tools", needles, awls, knife, cleaver, spatula, key/linchpin, mirrors) (8.5%) (figure 3). Precious metals, almost always in the form of adornment, were exceedingly rare (6.4%), with silver (5.3%) represented in more burials than gold (1.1%).[14] Amongst the documented non-metal grave good types, the most common were non-metal adornments in the form of beads (11.7%) (exotic carnelian and lapis specified for 4.8%), then cylinder seals, often specified as shell (8.0%), and stone vessels, often specified as "alabaster", "marble", or "aragonite" (6.4%). Several burials contained miscellaneous

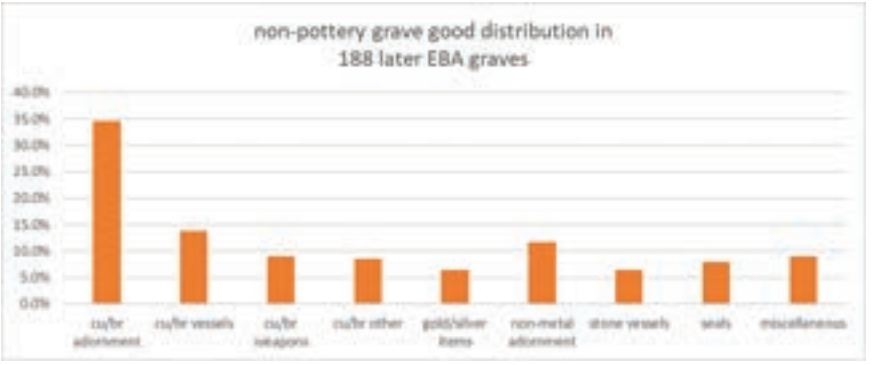

FIGURE 3 Distribution of non-pottery grave goods in preliminary dataset of 188 later EBA graves from the Donjon

12 Copper-base items of this period were once described as "quite rich" (Mecquenem 1939:5, with reference to "25th century" burials in VR *sondage* 1) and another time as "numerous" (Mecquenem 1943–44:136, a general comment on "period b").

13 Note: "pottery items" strictly refers to vessels; rare terracotta figurines and a spindle whorl are assigned to the miscellaneous non-pottery items category.

14 Some electrum items may also be subsumed under "gold".

varia (9%), none of which occurred more than twice apart from shell items in four burials ("a lamp", "a makeup shell", "a large shell", "a shell").

Even bearing in mind a probable overrepresentation of rich burials in the selection of data for publication, the frequency of copper-base items suggests that copper and its alloys were critical to identity definition on a fairly wide scale. Their presence alone cannot therefore be taken as diagnostic of high social status, but the volume of material invested, the alloy (see *copper-base metallurgy* section below), and any ideological value embedded in the various forms were probably distinguishing factors. An attempt to measure the overall wealth of assemblages containing copper-base objects (figure 4) using mean counts (light orange) and mean ranges (dark orange) of all non-pottery grave goods, which should be more indicative of wealth than pottery, does not show any copper-base category as compellingly linked to high status. Only rather modest differences separate those assemblages with, in ascending order of wealth, cu/br adornment,[15] cu/br "other", cu/br vessels, and cu/br weapons. Assemblages with non-metal adornment and other miscellaneous non-metal

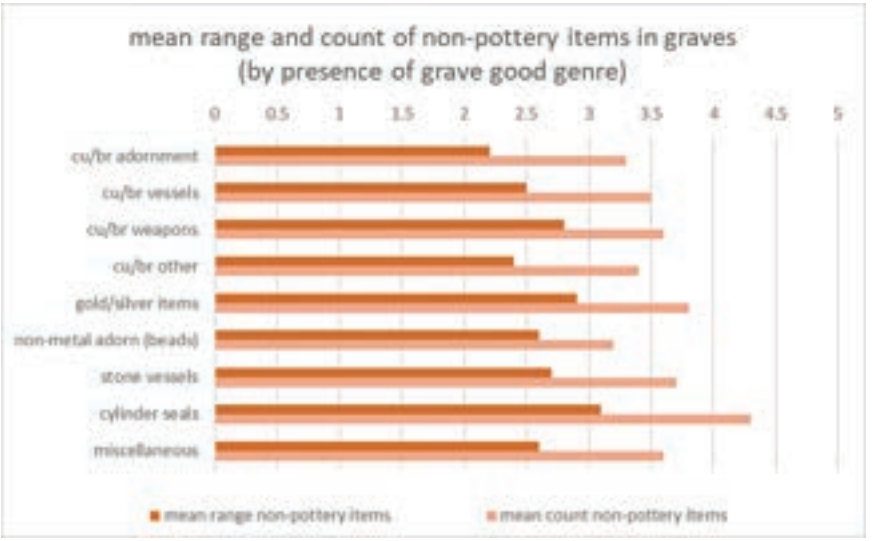

FIGURE 4 Mean range and count of non-pottery items in preliminary dataset of 188 later EBA graves from the Donjon

15 Groups of two or more finger rings in graves have been counted as only one item to facilitate comparison with other categories. But nevertheless, simple counts fail to capture differences in the volume of material and prestige encapsulated in the items.

items also differ little in their mean counts and ranges of non-pottery items.[16] The assemblages most differentiated by higher mean counts and ranges of non-pottery items, in ascending order, are stone vessels, gold/silver items, and cylinder seals. Nevertheless, the mean counts and ranges of non-pottery items across all categories vary by no more than one item and one category, respectively.

To further investigate the distribution of wealth, it is worth comparing the mean (dark orange) and median (light orange) counts of each category of non-pottery grave goods in the assemblages that contained them (figure 5). The means in every category are only slightly higher than the medians. This is because, in contrast to the MBA (below), there were no exceptionally rich burials skewing the distribution toward the higher end; indeed, the maximum count of non-pottery items in any one burial was just eight.

Most of the sample cannot be dated closely enough to facilitate subdivision into Akkadian and Ur III datasets to draw out changes in patterns of wealth

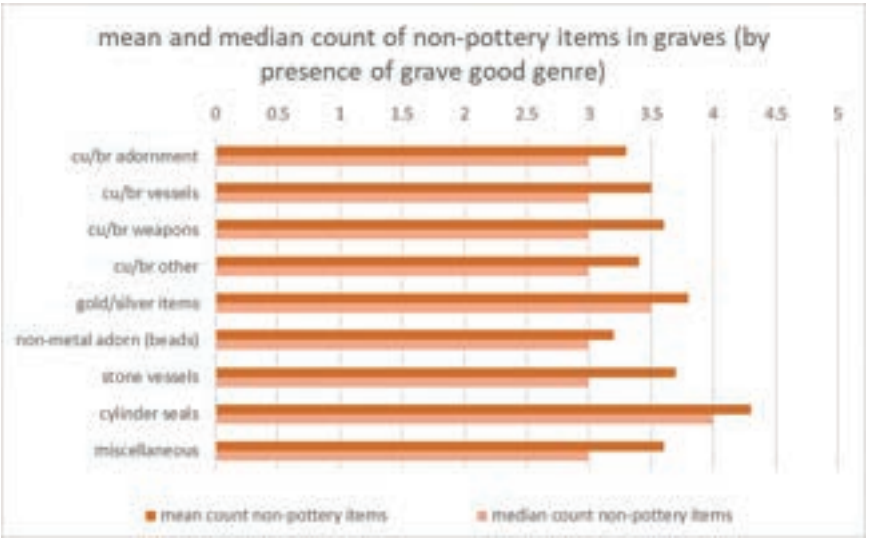

FIGURE 5 Mean and median count of non-pottery items in preliminary dataset of 188 later EBA graves from the Donjon

16 To avoid overstated object counts for burials with large numbers of beads, any metal beads (a pair in silver counted in the silver category) and non-metal beads have been reduced to a minimum count of one per burial, i.e., to a single piece of jewelry.

deposition and distribution between the two phases. However, Carter's VR I sample hints at an increase in the consumption of metal in mortuary contexts toward the end of the EBA: the Akkadian-era pit burials (graves 539 and 527) contained just two or three pottery vessels, whereas the assemblage of the probable late Ur III burial (grave 513) was much more elaborate with two cu/br bracelets, two cu/br finger rings, a diadem of linked lead or tin rings, eight pottery vessels, and sheep/goat bones. The late Ur III period coffin burial (T.4/S.177B) in Ghirshman's VR B trench provides a similar picture, preserving a silver bracelet, a pair of silver items (earrings?), a copper vessel, three river pebbles, a pottery bowl, and sheep/goat bones.

Copper-Base Metallurgy

An increased abundance of copper-base metallurgy, particularly in graves, is one of the most visible changes in material culture at Susa under Akkadian control. And this change is clearly reflected in the significant number of later EBA copper-base objects catalogued in François Tallon's 1987 influential two-volume study on Susa's metalwork from the late Neolithic to the MBA (all numbers, types, subtypes and variants cited herein reference Tallon 1987 unless otherwise specified).[17] Tallon (1987:339) attributed this increase to a relegation of copper to a raw material for manufacturing various objects after its replacement by silver as a means of payment and equivalent of value. Copper prices had certainly declined since the pre-Sargonic era, the silver to copper ratio going from 1:195 to as low as 1:240 (Foster 2016:113), as the vast supra-regional trade network fostered by the Akkadian rulers brought large volumes of copper into the region. Also important to bear in mind is that an increased disposal of copper-base items in the sealed context of burials, which can save them from recycling, may be amplifying the impression of an increased production.[18]

Ancient Magan, today's Oman peninsula, appears in texts at this time as the main supplier of copper to Mesopotamia, and hence probably also Susa. But as Lloyd Weeks (2016:16–17) has highlighted, potentially numerous sources were also feeding into the Persian Gulf network from as far afield as southeast Iran and South Asia; all of which would have been documented together with the Oman supply as coming from "Magan". An administrative text from Susa dating to the Classic Sargonic period (i.e., late in the reign of Naram-sin or Sharkalisharri; see Sallaberger & Schrakamp 2015:123) documents oil issued to men from/for (?) Magan and Meluhha (Legrain 1913, no. 42 obv. ii 3–4';

17 Tallon's 1987 typologies largely follow Deshayes 1960.

18 As noted by Moorey (1994:254) for Mesopotamia, base metals in the form of tools and weapons were systematically recycled.

Schrakamp 2015:259). This seems to confirm that Susa was plugged directly into the Persian Gulf network, which would also have supplied many of the later EBA shell items, semiprecious stones, and stone vessels. But copper would also have arrived indirectly from this network via Mesopotamia (see mention of copper traded between Mesopotamia and Susa in Foster 1993:62; 2016:75). While lead isotope analyses have been bringing clarity to sources for some sites and regions, copper-base artefacts excavated at Susa have yet to undergo such analyses.[19]

Metal composition analyses of a large sample of Tallon's corpus by Jean-Michel Malfoy and Michel Menu (1987:356), demonstrated that copper-arsenic alloys with over 1% arsenic (by weight) had dominated later EBA copper-base metallurgy at Susa. While Malfoy and Menu were by no means alone in adopting 1% arsenic content as a baseline for an alloy (see Weeks 2003:5; Peterson 2011:113, with references), they assumed that the arsenic had been added because it is naturally present at far lower levels than 1% in the ores of Oman, which they believed was Susa's main copper supplier based on textual evidence and the high nickel content of the artefacts they analyzed (Malfoy & Menu 1987:357). As noted above, however, copper from a range of sources may have coalesced into the "Magan" copper documented in texts, and P.R.S. Moorey (1994:247) highlighted that high nickel is not characteristic of all deposits in Oman and is found in deposits elsewhere including on the Iranian Plateau.[20] Therefore, while copper with 1%+ arsenic is referred to here as "arsenic bronze" (term for copper-arsenic alloy following e.g., Lechtman 1996), the issue of the copper sources is clearly plagued by problems. Furthermore, since arsenic was often present in older copper-base products at Susa (probably from the source ores; Malfoy & Menu 1987:357), its unintentional introduction via recycling must be considered. And more broadly, questions of how copper-arsenic "alloys" were produced and the degree to which they can be considered "intentional" remain open to debate (see Weeks 2003:113–120).

Malfoy and Menu (1987:360–61) similarly defined 1% or more tin in copper as a deliberate addition. However, they distinguished between alloys with 1–5% tin, where the addition was likely intended to aid fluidity or deoxidization and often co-occurred with 1% or more arsenic (again perhaps due

19 To the best of the present author's knowledge, none have been carried out.

20 Moorey (1994:247) points to high nickel levels in copper deposits in Iran's Anarak region, which Malfoy and Menu (1987:357) believed had supplied most of Susa's copper in the late Neolithic (Susa I). However, even if the Iranian plateau is presumed to be the source of Susa's early copper, the main deposits at Talmessi and Meskani, where native copper occurs with up to 20% arsenic and 10% nickel, have yet to yield evidence for ancient exploitation (see Pernicka 2004:234–35).

to recycling), and "true bronzes" with 5% tin or more to change the physical properties of the copper (e.g., hardness, color). The relative merits of tin and arsenic alloys warrant mention, since the notion that, resources permitting, tin bronze was invariably preferable, and that cheaper arsenic bronzes merely "sufficed" for utilitarian tools and weapons ignores scenarios in which arsenic bronze was, in fact, better adapted to the intended product and the technical knowhow available to make it. As Heather Lechtman (1996:502) has observed, the once-prevailing view of the copper-tin alloy as superior due to its higher potential strength as-cast, ignored other mechanical properties, of which ductility and toughness were the most relevant to the forming methods available to ancient metalworkers. As-cast arsenic bronze, though inferior in hardness to as-cast tin-bronze of 10% tin (by weight) or more, is remarkably ductile and can be cold or hot worked to a significant degree without cracking. These superior work hardening properties allow production of strong tools with blades less prone to damage (Lechtman 1996:481–82, 492, 502). And in sheet metal work even just 0.5–2% arsenic makes a significant difference, strengthening pure copper, which tends to yield under heavy work and form kinks when bent, while still maintaining excellent plastic behavior to fashion and maintain three-dimensional shapes such as vessels (Lechtman 1996:481, 507–510).[21]

As Brett Kaufmann (2011:87) has pointed out, the most appreciable difference between the two alloys is their fuel requirement. Tin bronze with 10% tin can be melted in an ordinary fire and is about 25% more fuel efficient than arsenic bronze with 3% arsenic, which, like copper, requires a closed furnace to produce. In southern Mesopotamia, which relied on animal dung for fuel, this was surely a desirable characteristic, and may be one of the factors contributing to its position as the first systematic producer of tin bronze (Kaufmann 2011:87–89); i.e., from the mid-third millennium BCE, as attested especially by the Royal Cemetery of Ur (Weeks 2003:174, with references; Helwing 2009:210–11). Nothing indicates specific interest in its mechanical properties. Rather, it was a luxury material for elite display (Stech 1999; Weeks 2003:188–91; Pigott 2021:830)—tin being a rare and exotic metal imported from somewhere to the east beyond Iran (see early MBA *copper-base metallurgy* section below). A limited use of tin bronze is attested at Susa by the ED IIIb (ca. 2475-2300±30)/late Susa IVA phase when metalworkers experimented with different alloy

21 None of the copper-base sheet metal vessels from the periods treated here have been analyzed, but most vessels from the late Susa IVA/ED IIIb *vase a la cachette* hoard analyzed by Malfoy and Menu 1987 were arsenic bronzes (nos. 694, 696, 697, 712, 713, 718, 751, 775, 781, 792, 1.1–6.29% As). Two others contained low levels of tin, arsenic, and lead (nos. 695, 717, 2.0–2.1% Sn, 1.4–1.8% As, 1.3–1.4% Pb), and two, plus a contemporary vessel from another context, were tin bronzes (nos. 789, 793, 795, 9.2–10.9% Sn).

compositions, mostly in the range of 6–11% tin, to make a variety of objects. And it remained relatively uncommon even in the Akkadian era, deployed as a prestige marker generally in the form of weapons (Tallon 1987:333, 339; Malfoy & Menu 1987:361). It was probably even rarer in copper-base production than might be inferred from the preserved corpus, since special items were far more likely than utilitarian ones to be deposited in burials and thereby spared from recycling.

Amongst Susa's later EBA corpus are two tin bronze items, both weapons, with an unusually high level of tin: a cracked tubular mace-head with 21.8% tin (no. 187),[22] and a flat axe with 14.2% tin (no. 465). Both amounts are notably above the eight parts of copper to one of tin (11% Sn) documented for bronze in a Classic Sargonic text from Susa (Legrain 1913, no. 35).[23] The reasons for using high levels of tin certainly cannot have been practical, since, although copper-tin alloys at concentrations above 13% tin rise rapidly in hardness, they become very brittle making it difficult to work harden blades and making weapons prone to shattering upon impact (Lechtman 1996:488, 502). It is likely that visual properties were at stake in the choice of alloy for these weapons, since tin bronze assumes a golden color that lightens as the proportion increases. Arsenic bronzes similarly change color, assuming a silvery hue from about 8% arsenic (Kaufmann 2011:87). However, there is no suggestion that this property was exploited. The arsenic levels of analyzed objects from Susa remain within the upper limit of 7.96% arsenic for functional arsenic bronze where the solid solubility limit is reached and the metal becomes brittle (Lechtman 1996:488).[24] Given their differing social value, the distribution of the two main alloys in the mortuary record would be a worthwhile avenue of investigation, but in the absence of proper recording and inventorying the copper-base objects from Susa can seldom be assigned to specific contexts—funerary or otherwise.

In terms of typologies, many of Susa's typical later EBA forms originated in Mesopotamia and had already appeared at the site in the ED IIIb/late Susa

22 Tallon (1987:131) considers a possible Akkadian date for this mace-head, but it may date one to two centuries earlier.

23 Legrain translates *annaku* (AN.NA), as "lead"; however, the translation should be "tin" (CAD A2, *annaku*). Later, in Ur III texts, alloys with between 9% and 17% tin are documented (Moorey 1994:251, with references). Susa's Classic Sargonic text corpus documents expenditures of copper-base weapons (Legrain 1913, nos. 85–86) but it is not clear if they were made at the site.

24 An arsenic-rich surface or "skin" can, however, be achieved in lower arsenic ranges by inverse segregation (Weeks 2003:112–13). The addition of arsenic to copper to produce silver-colored metal is well-attested in west Mexico (Hosler 1994).

IVA period when it was closely connected to the Lagash region by trade.[25] But when metallurgy gained momentum at Susa under Akkadian control—even if without major technical or formal innovations—the production of these forms burgeoned, and some continued until around the end of the millennium (Tallon 1987:336–37, 339). Amongst the best-attested of these is a rectangular-bladed axe with a cylindrical shaft-hole sometimes documented in mortuary contexts (figure 6d; Tallon 1987:337, nos. 1–20, subtype A 1; Gernez 2007:121, type H 2.A.a). Nineteen of these axes were analyzed by Malfoy and Menu, and ten of them, i.e., more than half, were arsenic bronze (1.12–3.19% As). However, various other metals were also used for the same distinctive form: six were unalloyed copper; one contained tin and arsenic (1.8% Sn, 1.95% As), one

FIGURE 6 Later EBA metalwork: a) spearhead with tang and socket, Donjon burial A98, l. 27.8 cm (Sb 10248, Tallon 1987, no. 204); b) epsilon axe, h. 24,8 cm, 2.9% As, 1.05% Sn (Sb 6811, Tallon 1987, no. 96); c) flat axe, l. 19.3 cm, 1.13% As (Sb 11261, Tallon 1987, no. 445); d) rectangular bladed axe, l. 10.3 cm, 2.45% As (Sb 8830, Tallon 1987, no. 7); e) sheet metal axe, l. 12.8 cm, 1.45% As, (Sb6803, Tallon 1987, no. 88); f) pin with stone (marble) head l. 18 cm, 1.2% As (Sb 13994, Tallon 1987, no. 1052); g) handled vessel, l. 17.2 cm (Sb 11212; Tallon 1987, no. 748)
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25 Trade discussed in Steinkeller 2018:181–83; for interaction between the regions visible in painted ceramic assemblages, see Renette 2015:59–61.

contained only lead (1.14% Pb), and a single inscribed axe bearing the name of an Akkadian-era governor of Elam, Ili-ishmani (Frayne 1993, no. E2.16.3)—clearly a special production—was tin bronze (no. 20, 5.9% Sn). Another axe form, noted in pit burials and in Donjon tomb A143, exhibits the same origin and production trajectory. Fashioned from a single sheet into a loose-fitting rolled collar and blade, it is light-weight and obviously intended only for display (figure 6e; Tallon 1987:337, nos. 76–94, tab. 4, var. A 1a-3a; Gernez 2007:212–15, type H 6).[26] All four analyzed specimens were arsenic bronze (1.2–4% As), which, as noted above, is well-adapted to sheet work, particularly for these axe collars requiring significant bending.[27] Also represented by at least three examples (nos. 95–97) is the epsilon axe, which was known in Mesopotamia from the ED III, became popular in the Akkadian period (Gernez 2007:180–81, 184–85, type H.3.C.a.), and apparently continued in circulation at Susa until at least the end of the EBA.[28] The only analyzed example contains arsenic and tin (figure 6b; 2.9% As, 1.05% Sn). Shaft-hole adzes, which can also be considered as weapons (Gernez 2018:43), likewise originated in ED III Mesopotamia and appear at Susa in the Akkadian period, including in pit burials in the Donjon (Tallon 1987:338, nos. 549–552, var. C 1a).

Pointed weapons include a long pike of a type found in Mesopotamia from the ED III to Ur III periods (nos. 205–207, var. A 4 a), tanged spearheads, which instead seem to be specific to Iran (nos. 202–203, var. A 3 a), and the first socketed spearheads, which were a significant invention of the later EBA even if still awkwardly fashioned (Tallon 1987:337–38, nos. 210–213 var. B 1 a-b). A probable precursor can be found in an exceptional tanged spearhead from Donjon pit burial A98 with an external metal socket wrapped around the shaft then folded back on itself and riveted (figure 6a; no. 204, var. A 3 b; Gernez 2007:322, var. L 3.C.d). Arrowheads specifically datable to this period are difficult to isolate, but one bifid arrow type has good ED IIIb/early Akkadian parallels (Tallon 1987:152, nos. 300–28, subtype A 1). All analyzed pointed weapons are arsenic bronze (nos. 203, 207, 210–213, 307, 1.01–2.7% As).

Later EBA tools include a well-represented flat axe type with a straight heel and divergent sides broadly dated like the other axes to the second half of the third millennium, but instead found in Upper Mesopotamia, Anatolia, Baluchistan, and the Indus Valley (Harappan civilization) (figure 6c; Tallon

26 One of these axes (no. 87) found in the Shimashki level VI of the VR B trench indicates use up to at least the end of the millennium.

27 Similarly, for Mesopotamian sheet axes with rolled collars a copper with arsenic of about 1.5% was often used (Gernez 2007:213).

28 Mecquenem (1924b:112, fig. 5) sketched an epsilon axe (no. 97) amongst objects from an "Ur III" level containing predominantly early MBA burials.

1987:163, nos. 439–461). Of the 22 analyzed specimens, 15 are arsenic bronze (1.13–4.23% As), two contain low levels of tin and arsenic (1.84–2.63% Sn, 1.34–2.71% As) and five are tin bronze (5.76–11% Sn). Copper-base sickles are new in this period, and the single analyzed specimen contains arsenic and tin (4% As, 1.1% Sn; Tallon 1987:338, nos. 602–609, subtype A 2).

Copper-base hammered sheet metal vessels included tall cylindrical beakers, simple shallow bowls, and deeper round-based bowls showing continuity with the previous period (Tallon 1987:338). A new type, a handled pan found from Mesopotamia to the Indus (figure 6g; Tallon 1987:338, nos. 745–749, subtype A 5), is also attested, one example having been found in the Akkadian-era burial Donjon A196 (Mecquenem 1943:95). No vessel datable to this period has been analyzed.

The simple, undecorated copper-base bracelets, finger rings, and, occasionally, pendant earrings that characterize the assemblages are reasonably new to the later EBA; indeed, in Carter's small VR I sample they were not present before the Ur III period. While the forms had already existed, they were only made until now in gold and silver for the highest elite, as in Mesopotamia and Luristan (Tallon 1987:253, 256). A strong representation of bracelets and finger rings could be linked partly to the difficulty of removing them from the corpse—some bracelets were so small that they could only have been placed on the wrist when the person was immature (Tallon 1987:253). The pin forms included a popular widespread type typical of the Akkadian period, an example of which made from arsenic bronze is the only analyzed adornment certainly dateable to this period (figure 6f; Tallon 1987:246–249, no. 1052, As 1.2%).[29]

Beyond the categories and forms placed in mortuary contexts in the interests of visual displays of status, the later EBA copper-base repertoire is fairly restricted, perhaps as a consequence of recycling.[30] Regarding the producers of these items, even if Tallon (1987:332) perceived certain influences from Luristan in Susa's later EBA metal corpus, most products were closely connected to those made by Mesopotamian metalworkers, as could be expected in the political context. Some may have been imported, but since smiths are amongst the skilled workers documented in what appears to be a self-sustaining Akkadian enclave under the direction of an Akkadian governor (Foster 2016:73), a transfer of Mesopotamian metalworkers by the state to manufacture metalwork at

29 A slightly earlier-dated bracelet from the "*vase a la cachette*" is also arsenic bronze (Tallon 1987, no. 1075, 1.3% As).

30 Tallon (1987:332) notes, for example, a lack of statuary at Susa in contrast to Mesopotamia where copper-base statuary production flourished.

Susa might be conceived, perhaps with a subsequent transmission of forms and techniques to local metalworkers.

Early MBA Mortuary Assemblages and the Production and Consumption of Copper-Base Metals

Burial Sample

The MBA brought visible changes in mortuary behavior at Susa, amongst which were an increase in residential burial (Gasche 2000). Disposal areas were also more widespread across the site, extending to the Apadana mound in the north where some of the richest graves were unearthed below and around the Achaemenid palace.[31] The expansion of burial zones probably reflects a visible population growth at Susa at around 2000 BCE (for which see Carter 1984:150) when a new "town"—probably a new quarter within Susa itself—is also mentioned in Shimashki texts (De Graef 2006:16). Mecquenem assigned numerous early MBA burials to an "Ur III" or "23rd century BCE" phase; a comprehensible error in view of the continuity in material culture under the Shimashki and early Sukkalmah rulers, who largely perpetuated the Ur III administrative scaffolding and the existing Mesopotamian aspects of Susa's culture. He assigned the remaining early MBA burials to a Hammurabi or "20th century" phase. Again, the only large sample of individually recorded burials derives from the Donjon where it is possible to isolate, after removal of juveniles, a dataset of 169 burials belonging to the earlier centuries of the MBA.[32] Almost

31 The records of Mecquenem's excavations in the Apadana suggest that prior to the early MBA there had been a significant gap in the occupation of the mound spanning much of the EBA. A similar gap was noted by Steve and Gasche (1990:18, 23) at the northern extremity of the mound (trench 24) where occupation recommenced in the early MBA with evidence for subfloor burials, which unfortunately the authors only cursorily describe.

32 Coffin burials: A1, A2, A3, A4, A5, A7, A8, A9, A10, A12, A14, A15, A16, A17, A18, A19, A22, A24, A26, A29, A33, A36, A38, A39, A45, A58, A63, A76, A77, A78, A79, A82, A83, A91, A93, A126, A152, B2, B3, B9, B12, B13, B15, B16, B19, B27, B29, B33, B34, B36, B39, B40, B42, B43, B44, B52, B55, B57, B58, B59, B60, B62, B64, B66, B69, B70, B72, B73, B75, B76, B77, B79, B80, B81, B82, B82a, B82b, B83a, B84, B85, B86, B92, B94, B96, B105, B111, B112, B113, B114, B119, B122, B124a, B124b, B125, B127, B128, B131, B132, B134, B146, B157; pit burials: A20, A21, A27, A27 (two burials assigned the same number), A30, A31, A35, A37a, A43, A44b, A46, A47, A48, A50, A52a, A52b, A54, A55, A57, A59, A60, A61a, A80, A84, A85, A86, A87, A88, A89b, A90, A94, A95, A96, A100, A108, A109, A115, A116, A157, A163, A164, A173, A238, B5, B10, B20, B21, B22, B25, B47, B49, B50, B65, B101, B103, B104, B108, B133, B136, B137a, B138, B139a, B139b, B141, B142, B143, B155, B179, B180, B182, B184, B185, B186. Dating of these burials as per Y. Wicks (in preparation) "*Elite Mortuary Culture in Early Middle Bronze Age Susa: An analysis of overturned clay coffin burials*".

half were pit burials, while the other half were overturned coffin burials. This latter method of using a clay coffin to cover the body became popular with Susa's elite after its introduction from Mesopotamia in the late Ur III period (e.g., VR B VII, tomb 4/S.177B).[33]

Early MBA changes in mortuary practice that emerge from Mecquenem's records can be confirmed by a small sample of nine recently excavated burials. The first is an early MBA sub-floor pit burial (grave 507) with two or possibly three consecutive adult inhumations in Carter's (1980:107, fig. 44) VR I trench. The remaining eight are from the residential area uncovered in Ghirshman's VR B trench: two sherd burials (S.166, S.175) and two coffin burials (S.168, S179) in the Shimashki period level VI; and one sherd burial (S.156) and three coffin burials (S.157 [3 individuals], S.161, S.178) in the early Sukkalmah period level V (Gasche 2000:203–213, 221–25).

Mortuary Assemblages and Wealth Distribution

Mecquenem's enumerations of early MBA assemblages reveal more numerous and varied non-pottery grave goods than the later EBA, particularly in association with overturned clay coffins.[34] The abundant copper-base items, even if mostly comparable in category, were now more typologically varied: adornment (finger rings, bracelets, anklets, pins, occasional earrings, bronze belt buckles), vessels, weapons (daggers, axes, adzes, mace-heads, "hammers", heads of spears, javelins, and arrows), tools (chisels, blades, tweezers, plates of precision hand-scales), grooming items (mirrors, small toilet utensil sets), and wagon paraphernalia (wheel rims, linchpins, harness elements). Also more numerous and varied were gold items (finger rings, bracelets, earrings, frontlets, beads, an imported pendant), silver items (frontlets, skullcaps,

33 Burials in the Apadana central court: Mecquenem 1922a:6–8; 1922b:2;1922c:134, 136–37, 139; 1923:2; 1924b:110–12; 1943–44:137–38. East court: Mecquenem 1922a:4; 1922c:131; 1923:4; 1924a:2–3; 1924b:113; 1925:2; 1926:3; 1929–30:84; 1943–44:137–38. Trench northeast of the palace: Mecquenem 1922a:11; 1922c:118; 1923:4; 1924a:3–4. Trench east of the palace: Mecquenem 1922a:9; 1922c:130; 1926:5. Burials in VR *sondage* 1: Mecquenem 1924a:5; 1924b:118; 1926:7; 1927:3; 1929:4; 1930:3; 1931a:3; 1932:4–5; 1933:5–6; 1934a:4; 1934b:211, 227; 1935:2–3; 1936:4; 1937a:4; 1937b:153; 1938:7; 1939:5; 1943:56. Burials in VR *sondage* 2: Mecquenem 1929:6–7; 1930:4–5; 1931a:5; 1932:6; 1933:6; 1934b:221, and the "west ravine" in 1928:3, 5. Burials in the Ville Royale-Donjon Isthmus: Mecquenem 1932:9; 1938:8. Burials in the Donjon: Mecquenem 1932:8; 1933:8–9; 1934a:5; 1935:3–4; 1936:5; 1937a:5–6; 1937b:153; 1938:8; various burials of 1943:77–116.

34 This can be observed in the numerous comments of Mecquenem cited above in fn. 33. See also, for example, passing comments in Amiet 1966:255; Álvarez-Mon 2020:202. Assemblages of overturned coffins are systematically examined and compared with those of other burial types in Y. Wicks (in preparation) "*Elite Mortuary Culture in Early Middle Bronze Age Susa: An analysis of overturned clay coffin burials*".

breastplates, earrings, beads, bracelets, rings, pins, a vessel), exotic non-metal items including semi-precious stone beads (carnelian, agate), shell items (makeup shells, decorative elements, beads), ivory and "black wood" (ebony?) decorative plaques, a painted ostrich egg, and alabaster and aragonite vessels, as well as locally carved bituminous stone vessels, often with zoomorphic elements, and numerous balance weights (usually hematite).

Immediately striking when comparing the sample of 169 early MBA burials with the later EBA sample from the Donjon is the decreased frequency of pottery vessels (56.8% of burials versus 83%), and, conversely, the increased frequency of non-pottery grave goods (59.2% of burials versus 53.7%). Amongst the latter, copper-base items were again most common, now represented in over half the burial sample (53.3% of burials versus 46.3%). Adornment remained the most common copper-base category (34.3%), occurring at much the same frequency as the later EBA, whereas a larger proportion of burials contained cu/br vessels (21.3%), weapons (13.0%), and other miscellaneous items (knives, spatulas, chisels, sockets, clamps, undefined "tools"/"utensils", a balance plate set, a gouge, shovel, sickle, sharpener, decorative nails, wagon wheel rims) (9.5%) (figure 7). Silver and gold items (adornments) almost tripled (14.2% [silver 13%, gold 3.6%]) from the later EBA, with silver especially lavishly expended in sheet form, usually in conjunction with remarkable concentrations and varieties of copper-base items. Amongst the documented non-metal grave good types, the most common were non-metal adornments, mainly beads (14.2%; exotic carnelian beads specified for 4.7% of burials, in one case accompanied by lapis and agate beads), followed by stone vessels (7.1%). Cylinder seals were rare (2.4%) and other miscellaneous items (8.3%)

FIGURE 7 Distribution of non-pottery grave goods in preliminary dataset of 169 early MBA graves from the Donjon

occurred no more than twice each except for balance weights, which were documented in four burials.

The mean counts (light blue) and ranges (dark blue) of non-pottery grave goods (figure 8) are higher than for the later EBA. Assemblages with cu/br adornments have the lowest mean count and range,[35] those with vessels and weapons are higher, suggesting a stronger association of these two categories with wealth, and those with cu/br "other" items have the highest mean count (but not range). Just behind, with fairly comparable mean counts and ranges, are assemblages with silver/gold items, adornments in non-metal materials, stone vessels, and cylinder seals, which were rare but kept separate from "miscellaneous" to enable comparison with the EBA when they were the most outstanding category. Well behind, but still ahead of assemblages with cu/br adornment, were those with miscellaneous varia.

The non-pottery item count ranges far more considerably than the later EBA, with up to 22 items in a single burial, and the median non-pottery grave good counts are higher for most categories (figure 9). Furthermore, the mean counts are now significantly higher than median counts. This reflects the presence of more extreme outliers at the higher end—a few lavishly equipped burials with non-pottery item counts far exceeding the median—skewing the distribution,

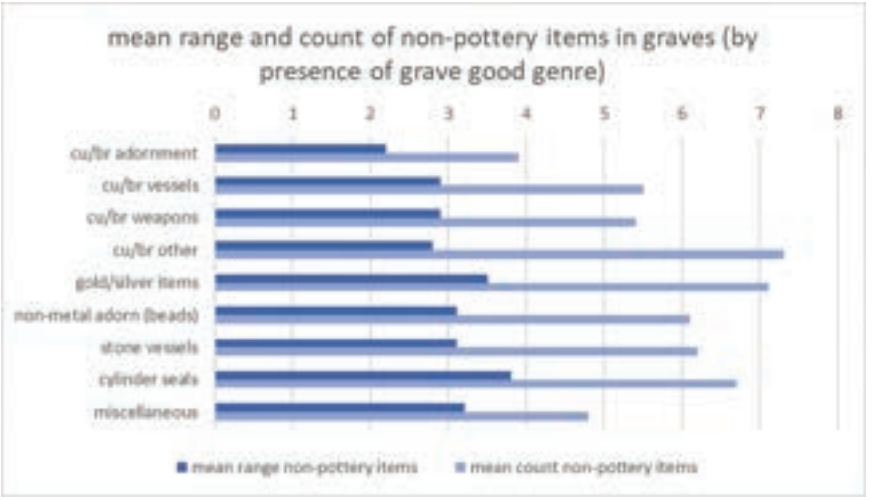

FIGURE 8 Mean range and count of non-pottery items in preliminary dataset of 169 early MBA graves from the Donjon

35 As for the later EBA, multiples of finger rings and beads are reduced to one item per burial.

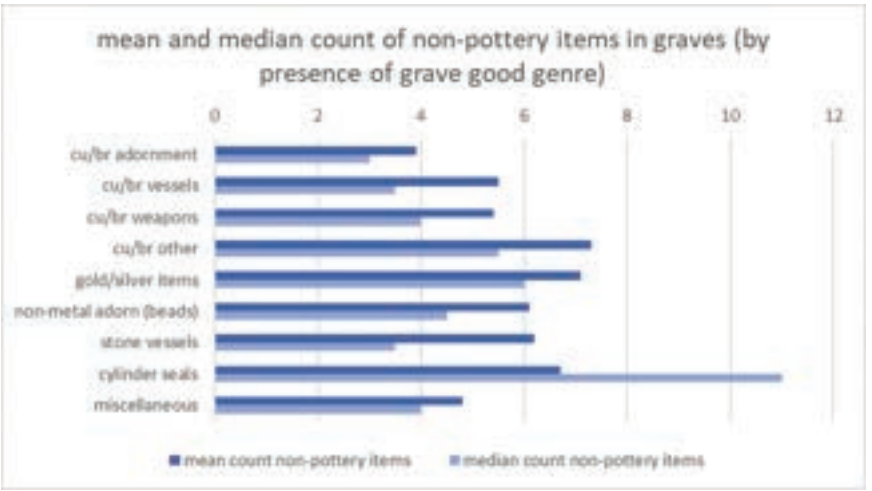

FIGURE 9 Mean and median count of non-pottery items in preliminary dataset of 169 early MBA graves from the Donjon

whether because of asymmetrical access to wealth (i.e., social inequality), or differences in social or theological motivations between groups to dispose of wealth in burials of selected individuals.[36]

Carter's and Girshman's burials reiterate an increase in deposition of wealth, particularly copper-base items, in the early MBA. Carter's VR I burial (grave 507) with two or three individuals contained two vessels, a spear point, a pike (function as per Gernez 2007:294, var. L 1.F.c), two anklets or bracelets and nine finger rings in copper/bronze. Girshman's VR B burials all contained copper-base items, a remarkably high 75% of them including cu/br vessels, while 25% contained silver (adornments). However, the wealth deposition differed noticeably between the two levels. Assemblages of the Shimashki-dated level VI had all of the silver items (in coffins), a mean count of 5.5 non-pottery items, of which 3.75 were cu/br, and a mean range of 3.5 non-pottery items; whereas the early Sukkalmah-dated level V assemblages had no silver items, a mean count of 1.75 non-pottery items, of which 1.5 were cu/br, and a mean range of 1.75 non-pottery items. A decline in wealth deposition sometime during the early MBA may not have been localized in this small trench, since Mecquenem consistently reported greater wealth in burials of his "23rd century BCE" level than his "20th century BCE" level.

36 Especially well-equipped with non-pottery items are Donjon burials A16, A35, A79, A89b, A152, B36, B39, B69, B75, B111, B112, and B125.

Copper-Base Metallurgy

The transition to the MBA at Susa brought new technical innovations and a flourishing copper-base metallurgy industry that generated a wide variety of novel forms, some local, others showing foreign influence. These appear in the archaeological record alongside enduring older forms and imports (Tallon 1987:340, 351). As in the later EBA, the copper sources supplying this industry would have been diverse. Some copper probably still originated in Oman where there is evidence for significant exploitation of copper ores in the late third millennium BCE (Weeks 2016:15).[37] After the Ur III collapse, merchants of Dilmun (i.e., Bahrain, the adjacent mainland of Saudi Arabia, and a new colony on Failaka) took over trade along the west side of the Persian Gulf, connecting southwest Iran and southern Mesopotamia to Oman and the Indus valley (Peyronel 2013:62). Dilmunite presence at Susa is well-attested by glyptic (Neumann 2013:85–86; Potts 2016:168; Laursen 2018, fig. 12.5, nos. 1–2) and by an early second millennium BCE contract sealed by a Dilmunite 1A type stamp seal (Laursen 2018:220, fig. 12.6a). It records a loan of 10 minas of copper by three sons of a Tem-Enzag, a theophoric name honoring the chief deity of Dilmun (Lambert 1976).[38]

The Near Eastern copper-base industry was now in the process of abandoning arsenic bronze production in favor of tin bronze, the reasons for which are debated (Pigott 2021:830–31). Consequently tin—still a rare and prized exotic material at the turn of the millennium—was in high demand. A capacity to exploit this demand may have been a cornerstone of the rise of the eastern dynasts, who were strategically placed to control routes supplying large volumes of tin from farther east to feed an increasingly hungry market.[39] By the early-mid eighteenth century, textual sources are clear that Elamite rulers

37 Malfoy and Menu (1987:357, 371) proposed a continued supply from the Persian Gulf.

38 It is tempting to imagine that these individuals had accessed their copper through Dilmunite contacts, but of course any source would be possible.

39 An increased frequency of tin-bronze in the archaeological record has been noted in the Kaftari phase (ca. 2200-1600 BCE) at the Elamite highland capital of Anshan (Tal-i Malyan). In the preceding Banesh phase arsenical bronze was exclusively used, whereas four of ten analyzed copper-base Kaftari artefact scraps ("bar-stocks" and a possible blade) were tin bronze: three ranging 8.8–11.8% tin and one a high-tin bronze with 16.8% tin (Pigott et al. 2003, tab. 14.1, appendix). The fact that tin bronze was not restricted to prestige weapons might indicate an early stable supply of tin to Anshan. However, the analyzed samples are not closely dated and may belong to the end of the Kaftari period—when Helwing (2021) observes that tin bronze was perhaps more common. Though unlikely to have been a major supplier by this time, a polymetallic deposit with copper and tin at Deh Hossein in Luristan was exploited by at least 1775-1522 BCE (Momenzadeh et al. 2005; Nezafati et al. 2006:3–4; Pigott 2011:284). Even before its discovery, Amiet (1988:81) had postulated the presence of an early MBA Elamite authority in Luristan to organize the metal trade.

controlled significant supplies of tin and had the capacity to choke the tin bronze production of their western competitors, potentially impacting production of military equipment (Durand 1998:392–93).[40] The Mari archives from Syria depict the king Zimri-Lim (ca. 1775–1762 BCE) at pains to maintain diplomacy with Elam to ensure access to this all-important metal (Potts 2016, tab. 6.2) and the impact of his relations with Elam on the price at which he could acquire it (Joannes 1991:68–71).

Shimashki rule over the Iranian Plateau induced a significant shift in trade routes. A major southern route traveling from Afghanistan to the Persian Gulf via eastern Iran seems to have declined, and a northern overland route comparable to the later Great Khorasan Road became dominant thanks to the recent introduction of the pack camel (Steinkeller 2014:701; 2016:128–29). Piotr Steinkeller (2013:423) argues that this route had already been increasing in importance under the Ur III rulers, who sought to control much of its course to access eastern resources including tin, copper, gold and lapis. The tin that entered the western markets was long presumed to have originated from sources in Afghanistan. But evidence is mounting for later EBA and MBA supplies from tin deposits in the Zarafshan mountain valley (Helwing 2009: 211; 2018:123) to the north of the lowland Murghab Delta and plain of Bactra, which hosted the major Bactria-Margiana Archaeological Complex (BMAC) centers. Two better-studied sites at Karnab in Uzbekistan and Mushiston in Tajikistan have together yielded evidence for extensive ore extraction, local processing and smelting of tin, and production of high-quality tin bronzes from at least 2000 BCE by Andronovo-Tazabag'jab groups. Both also provide evidence for the interaction of these groups with the BMAC cultures (Weeks 2003:170–72; Garner 2021:799–800, 805–809).

The rise and apparent prosperity of the BMAC sites in the MBA has been linked by Steinkeller (2016:134–37) to their potential to act as middlemen feeding tin mined by Andronovo populations along the northern overland route (notable amongst the finds at Karnab were camel bones; Garner 2021:807). He in turn posits that the success of the Shimashki (and later the Sukkalmahs)—who exhibit cultural links with the BMAC centers—derived from their capacity to exercise control over this trade. Susa has brought forth a small amount of material evidence for connections with BMAC at the elite level, particularly

40 The late 19th/early 18th century Assyrian ruler Shamshi-Adad is documented reducing an order of 10,000 bronze arrowheads to 5,000 due to a bronze shortage, demonstrating the precarity of the supply (Durand 1998:393–94, no. 663). When eastern supplies coming via the Zagros were disrupted, it seems that smaller, more local sources were exploited. Tin is documented in the Shemshara archives coming from the west, perhaps somewhere nearby (Eidem & Læssøe 2001:59–60).

the largest Margiana site, Gonur Depe, which has yielded radiocarbon dates spanning 2300/2250 BCE to the mid-second millennium BCE (Kraus 2021:775). Relevant MBA finds include precious metal adornment, ceremonial axes, and distinctive copper-base wheel rims in what may be wealthy merchant burials.[41] Margiana influence has also been observed in a locally made engraved bitumen stamp seal from Susa (Neumann 2013:86, fig. 36 [Amiet 1972, no. 1721]).

Malfoy and Menu (1987:371) considered the beginning of the second millennium BCE as the decisive starting point in tin bronze metallurgy at Susa, and they observed the selection now of metal compositions whose properties were most suited to the work. Tin bronze did not yet dominate copper-base production; rather, it was still reserved for prestige weapons and had little to no utilitarian use. But through the MBA its increasing use can be witnessed alongside a decline in arsenic bronze (Malfoy & Menu 1987:357, 360, 362).

Early MBA imports at Susa show a preference for acquisition of elite weapons in tin bronze. A small number of ceremonial winged axes and "hammers", all three analyzed examples of which are tin bronze ("hammers" nos. 189, 193, 195, 7.08–12.5% Sn), call to mind the insignia passed between the seated ruler and his high officials in investiture scenes on Shimashki glyptic (figure 10f and Amiet, 1972, nos. 1678–79, 2324). They probably came from farther east in Iran, or from Central Asia (Tallon 1987:341) where preferential use of tin-bronze for ceremonial axes versus arsenic bronze for other weapons and tools has been observed at Gonur Depe (Kraus 2021:786). Though clearly not a Mesopotamian product, one of the tin bronze "hammers" (no. 195), which came from an overturned coffin burial, carried the name of the Ur III ruler Shulgi. Potentially it was amongst the booty he collected after an attack on Anshan and had inscribed and distributed to major temples of his state (Steinkeller 2014:700). Other foreign prestige weapons include two harpés (sickle-swords) (nos. 100–101), and two tin bronze fenestrated axes (nos. 98–99, 7.05–9% Sn) that would have originated to Susa's west, the latter as far away as the Levant. Four globular mace-heads fabricated from a tin bronze with trace elements uncharacteristic of Susa's corpus must also be imports (Tallon 1987:347, nos. 180–183, 4.45–13.5% Sn).

Several early MBA burials yielded distinctive local shaft-hole axes with a signature projecting bulb at the upper rear of the collar—perhaps a vestigial wing—a molded ring just above the base, and an asymmetrical, upsweeping

41 For the wagon burials at Susa see Álvarez-Mon 2020:170–72; these and various other artefact connections addressed in Y. Wicks (in preparation) "*Elite Mortuary Culture in Early Middle Bronze Age Susa: An analysis of overturned clay coffin burials*". Lyonnet and Dubova (2021, fn. 31) raise the possibility that the rich Gonur Depe "royal" burials were in fact of merchants.

FIGURE 10 Early MBA metalwork: a) dagger with cast-on hilt from a coffin burial in Ville Royale sondage 1, h. 21.7 cm, hilt: 6.2% Sn, 4% As (Sb 12655, Tallon 1987, no. 172, var. C 2 c); b) dagger with cast-on hilt from a coffin burial in the Donjon, l. 24.7 cm, hilt: copper with 2.08% Fe, 2.11% Ni; blade: 4.43% Sn (Sb 6817, Tallon 1987, no. 160); c) arrowhead from coffin burial VR B VI, S. 179, l. 8.7 cm, 9.04% Sn, 1.11% As (Sb 10852, Tallon 1987, no. 265 var. A 2 b); d) ceremonial shaft-hole axe, h. 11.5 cm, 5.4% Sn (Sb 6815, Tallon 1987, no. 58); e) metal items from a coffin burial in the Apadana central court; f) sealing of the inscribed seal of Shimashki-era official Kuk-Simut IMAGES A-D FROM THE MUSEE DU LOUVRE COLLECTIONS, ANTIQUITES ORIENTALES UNDER CREATIVE COMMONS LICENSE, HTTPS://COLLECTIONS.LOUVRE.FR; IMAGE E: MECQUENEM 1922A, FIG. 21; SKETCH F: FROM ROACH 2008, NO. 2454 [AMIET 1972, NO. 1677]

blade with an often flat, non-functional cutting edge (figure 10d-e; Tallon 1987:82–88, nos. 46–66, subtypes B 3a-b). This axe type seems to have marked a specific identity at Susa. The single example excavated outside the city in a burial at Chigha Sabz in Luristan was taken by Pierre Amiet (1986:156) as an insignia bestowed upon a vassal ruler or a resident Susian official. Two have been analyzed and both, unsurprisingly, are tin bronze: one, now broken in half, has a high tin content (15% Sn) the other a more modest tin content

(5.4% Sn). One of two related axes with similar collars but longer symmetrical blades is also tin bronze (no. 44, 7.09%), while the other is arsenic bronze (no. 45, 1.93% As). These axes were adapted into an adze form attested by two examples (nos. 576–77), the analyzed one of which is tin bronze (8.05% Sn). A more common adze type, typified by a molded ring just above the collar base and a flat molding at the top (Tallon 1987:348, nos. 553–74, subtype C 2),[42] is attested in a variety of alloys: one high-tin bronze (16.0/17.2% Sn), two arsenic bronze (1.1–1.5% As), and four with low levels of both tin and arsenic (1.1–3.3% Sn, 0.98–2.3% As).

The MBA weapons corpus also included at least five variants of tanged daggers (no. 121, var. A 3 b; nos. 131–37, var. A 3 d/d'; nos. 150–51, 159, var. B 1 b/b'; nos. 167–68, var. C 1 a-b), and daggers with cast-on hilts (figure 10a-b; nos. 160–163, var. B 2a-c; nos. 169–173, var. C 2a-c).[43] Typically the hilts are made of copper and the blades are made of tin bronze. The lower melting point of the blade induced by addition of the tin (and sometimes arsenic) enabled the tang to melt superficially and partly fuse to the copper hilt during casting, providing a good example of the deliberate selection of metals to facilitate work. These seem to be amongst the earliest attempts at the casting-on technique, a significant innovation that would be in common use by the Iron Age (Tallon 1987:347, Malfoy & Menu 1987:362).

Pointed weapons included tanged spearheads (nos. 201, 209) and socketed spearheads (nos. 215–17). These were now well-made with sutures no longer visible to the naked eye. The two analyzed socketed examples are tin bronze (4.6–8.52% Sn), and the single analyzed tanged example has a low tin content (2.7% Sn). Arrowheads are well-represented by a triangular type documented particularly in richly equipped early MBA burials. Finds of bivalve stone molds for casting these arrowheads demonstrate a local production at Susa (e.g., figure 10c; Tallon 1987:151, 348, nos. 225–99, subtype A 2).[44] The metals of the 34 analyzed examples of these arrowheads are varied. Fifteen are tin bronze (7.43–15% Sn), including three high-tin specimens, making this the best-represented metal. Another five contain low levels of tin (1–3.2% Sn), four combine low levels of tin and arsenic (1–5.07% Sn, 1.08–3.6% As), five are arsenic bronzes (1.12–2.14% As), and five are copper.

As the lowland seat of the Shimashki and Sukkalmah rulers who appear to have employed weapons as symbols to aid visual definition to their political

42 No. 565 was found in VR B VII and probably therefore dates to the very late Ur III period.

43 Twelve of the fifteen dagger blades contained over 5% tin (nos. 135, 151, 160, 161, 163, 167, 169, 170, 171, 173, 174, 175). Only four of ten dagger hilts were tin bronzes (nos. 162, 163, 169, 172), but manufacture of hilts in copper was a technological requirement for casting them onto the bronze blades.

44 Tallon regards the arrowheads as "not very functional" without explanation.

structure, it is not surprising that weapons were the most elaborate copper-base forms at Susa. Nor is it surprising that experimentation with new copper-base metalworking technologies (e.g., daggers with cast-on hilts) and tin bronze were channeled into their production.[45] As in the EBA, the occasional use of high-tin bronze—an axe (no. 50, 15% Sn), an adze (no. 557, 16/17.2%), a dagger with cast-on hilt (no. 169, 13.8/21.8% Sn), and three arrowheads (nos. 257–58, 260, 13.5–15% Sn)—surely reflects a prioritization of visual or other culturally preferred properties over functionality.

The corpus of early MBA tools, some of which certainly come from mortuary contexts, is diverse. Some types continued from the EBA, such as straight-heeled flat axes (nos. 440–41), flat adzes (no. 464), certain chisels (e.g., no. 506), miniature blades (Tallon 1987:167, 348), and balance plates (no. 685). Others were new and either specific to Susa, such as expertly made chisels, gouges, and saws (nos. 505, 517–21, 626, 630–31), or shared with Mesopotamia, such as spades, sickles, chisels with transverse cutting edge, side scrapers, and tweezers (nos. 579–93, 610–20, 634–37, 639–40, 642, 653–54, 680) (Tallon 1987:348–49). One triangular blade (no. 651) shows links with eastern Iran and Bactria. The small sample of analyzed tools are all made of either arsenic bronze (nos. 440, 464, 506, 626, 1.17–3.2% As) or copper (nos. 441, 587, 590). The apparent lack of tin bronze tools, however, must be viewed against the relatively low proportion of tools overall in the preserved copper-base corpus and the very few analyzed examples when compared to weapons.

MBA copper/bronze vessels include both preexisting forms (e.g., handled basins) and new ones. Some seem to be specific to Susa, such as a concave-bodied bowl with convex base (nos. 763–65). Others show external links, such as a concave-bodied bowl with a discoidal base known in Bactria and the Indus Valley (nos. 766–71), a flat-bottomed goblet (nos. 772–73) found elsewhere in Iran, and bowls with a convex body and convex (nos. 719–23), discoidal (nos. 726–35) or flat base (nos. 737–44) attested also in Mesopotamia (Tallon 1987:349) (see various concave-bodied bowls in figure 10e). A repousse decorated bowl from Donjon burial B82b (Tallon 1987, fig. 60), a large repousse-decorated tray with handles (Tallon 1987, fig. 62), and closed forms, particularly bottles (e.g., figure 10e; no. 787), demonstrate a mastery of sheet metal working techniques to match the new mastery in casting technology (Tallon 1987:351). As for later EBA vessels, there is no data on the alloys utilized by smiths to create these new, more elaborate forms.

45 Apart from a silver "hammer" from Susa (Tallon 1987, no. 191) these kinds of ceremonial weapons were made in copper/bronze.

Adornment remained the most frequent copper/bronze category in early MBA graves and was again dominated by bracelets and rings (e.g., figure 10e). Other adornments included pins, the earliest-attested and still very rare anklets (Tallon 1987:254), and a pair of earrings. Only one early MBA adornment has been subject to analysis: an arsenic bronze bracelet from a juvenile burial in the early Sukkalmah-dated level V in Ghirshman's VR B trench (no. 1073, 6.9% As, burial S.165).

Because so few of the analyzed copper-base items can be assigned to specific assemblages, it is not possible to further investigate social complexity in later EBA and early MBA burials through the inclusion of different copper alloys. And without precise dates for most of the analyzed items, nor is it possible to assess the factors behind the use of a range of alloys to manufacture a certain object category, type, subtype, or even a single variant—like the later EBA rectangular-bladed shaft-hole axes and flat axes and the early MBA adzes and triangular arrowheads. For example, whether it might reflect chronological developments in alloy use, availability of raw materials, social factors such as adaptation of alloy to social context (e.g., ceremonial versus functional), or unequal access to different alloys across social groups.

Later EBA and Early MBA Production and Consumption of Copper-Base Materials at Susa in Historical Context

Even though copper-base metallurgy was far from new in the later EBA, the increased availability and reduced cost of copper seems to have facilitated an unprecedented production and consumption of copper-base metalwork at Susa under Mesopotamian rule. In contrast to the preceding centuries when a much more unequal access to copper-base materials can be posited from their documentation in only a handful of wealthy burials,[46] they were now put to the task of constructing social identities across a much broader spectrum of the society. Almost half of the population had access to—and chose to dispose of—copper-base products. And especially significant was the rise of copper-base adornment, which enabled display of the material directly, and sometimes permanently, on the body as a visual marker of identity. Further social nuances were introduced through the quantity and types of items, with some forms embodying more prestige than others, and probably also alloy

46 Notable rich burials of ca. mid-third millennium BCE with numerous copper/bronze items are VR I grave 555 (a presumed burial assemblage but skeleton not preserved) (Carter 1980:75), and Donjon A322 and B280 (Mecquenem 1943:103, 122–23).

types. In some cases, copper-base items were utilized in conjunction with precious metals, seals, and exotic imports to give further material definition to social hierarchies.

Production and consumption of copper-base metalwork at Susa further intensified in the early MBA under the eastern rulers, whose success and structural definition appears to have rested partly on the copper-base industry. And Susa's elite now enjoyed access to more abundant and diverse finished copper-base products exhibiting local developments and eastern influences, as well as direct imports. Albeit specific to the ruling class, two preserved letters addressed to Bilalama of Eshnunna—who bore an Elamite name and married his daughter to the Shimashki ruler Tan-ruhurater—illuminate an important social function of copper-base goods and the mechanisms by which they potentially entered the mortuary record. The letters attempt to elicit from him prestigious funeral gifts including a top-quality weapon and copper and bronze vessels in the context of an explicitly reciprocal exchange (Whiting 1987:50, nos. 11, 10–26', 15, 2–8').[47] Gifting of prestige goods, which effectively initiated a social contract demanding reciprocal obligation (Postgate 1992:191), was already practiced by Ur III rulers to help ensure the loyalty of local elites (Michalowski 2013:171). In the early MBA this deeply embedded social principal, served especially by the metallurgical industries, can be seen widely deployed by the ruling elite across the Near East to facilitate interregional diplomacy.[48] While the documented evidence may pertain only to the ruling class, the quantity and diversity of copper-base goods in Susa's mortuary record could suggest that the local elite also entered into such social contracts at a private level.

This leads naturally to the question of how private individuals were able to access so many and such diverse copper-base forms; the answer to which surely lies in the altered balance of privatized to state economy after the collapse of the Ur III polity when agricultural production entered the hands of private entrepreneurial households (Steinkeller 2004:109) and reduced direct

47 Bilalama's father, Kirikiri, also carried an Elamite name. De Graef (2022:415–416) considers a fire in the Shu-sin temple at the end of the reign of Eshnunna's previous ruler and the appearance of these Elamite-named rulers together as possible signs of dynastic interruption. The author of the first letter (no. 11), Ushashum, almost certainly a member of Bilalama's kin group, implores Bilalama to provide him with prestigious items for the public funeral of his father, the Amorite chieftain Abda-El. This would help him appear "important in the eyes of the Amorites" who were gathering with "the ambassadors of the whole land" for the funeral. Ushashum hoped they would select him to replace his father, who had probably acted as intermediary between Eshnunna and the Amorites.

48 The largest body of evidence for this derives from the archives at Mari; see Arkhipov 2012 for weapons produced as diplomatic gifts and Guichard 2005 for metal vessels, a number of which were sent to Elam.

state involvement in long-distance exchange networks promoted the agency of private individuals.[49] Connectivity and cosmopolitanism were already essential features of Susa in the later EBA, but were now enhanced by a more open and varied participation in production and exchange across the post-Ur III Near East. A documented private exchange of copper involving individuals linked to Dilmun has already demonstrated that this extended to copper-base materials.[50] This is not to say that the activities were unregulated: production of weapons signifying official status, for example, must have been strictly the prerogative of the state. More generally, an attempt to exercise control over the market is attested in the reign of the early twentieth century BCE Sukkal of Susa, Atta-hushu, who claims to have erected a stele in the marketplace to display the "just price", presumably an index of value much like the codex Eshnunna listing commodities that could be purchased for a shekel of silver (for which see, for example, Ialongo & Rahmstorf 2019:106).

With the emergence of a far more dynamic geopolitical and economic stage, instability and change characterized the EBA to MBA transition across the Near East. As exemplified by Susa's mortuary record, these conditions fostered an increasingly complex social stratification accommodating new political roles, new economic interaction groups and symbiotic relationships, and new propertied households keen to exploit their wealth to acquire luxury goods, particularly prestige copper-base items—in the process driving technological

49 "Private" signifies here independent of the "state". Ignace J. Gelb (1979:4–11) distinguished "private" familial and individual households from "public" crown/palace, temple, and official households, adding that the two could overlap. For example, rulers or officials could appropriate public land for private use or a family or individual could simultaneously own patrimonial land and household and possess or have right of usufruct in public land and household. The work of Piotr Steinkeller (2004) was especially critical in the identification of the presence of a substantial "private" or "independent" economy in Mesopotamia alongside state-owned and operated economic enterprise, and his use of the term "private" is frequently perpetuated even if he problematized its application to the Ur III economy because the two spheres blended quite seamlessly. At Susa, deeds of sale (Jalilvand Sadafi 2014) and leases (Oers 2013) of fields and gardens amply attest to "private" ownership of agricultural property even if state authorities reserved the right to temporarily assign privately owned property or fields to other groups (De Graef 2019:108). Private loans and partnership contracts for trade purposes are also well attested (Veenhof 1972:394; Badamchi & Pfeifer 2019). The rise of a wealthy propertied elite manifests at Susa in a restructure of settlement space in the Ville Royale A where small clustered houses with courtyards in level XV were replaced in levels XIV-XIII by spacious villas with courtyards paved with baked bricks, or "true small palaces" (Vallat 1998; see also recently Álvarez-Mon 2020:188).

50 Trade with Dilmun likewise became a private enterprise in Babylonia; see Steinkeller 2013:424–25.

developments in copper-base, especially tin bronze, metallurgy. Funerals were embraced as opportunities to create or reaffirm group identity and affiliations through symbolic display, ritual performance, and probably gift-giving in order to maneuver within realigning political, economic and social structures. Significantly, when Sukkalmah rule was stabilized at Susa towards the middle of the MBA, these overt mortuary displays of status declined.

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