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A peek behind the curtain: spatial distribution of Neolithic plaster ware in indoor contexts at Tell Sabi Abyad, Northern Syria[☆]

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ABSTRACT

Plaster ware (PW) is a relatively overlooked category of Neolithic artefacts. Commonly known for its use in architectural features, plaster is less recognised for its use in the creation of portable containers.

This study examines the distribution, typology and use of PW at Tell Sabi Abyad, Syria, a well-stratified site where PW has been present from the Pre-Pottery Neolithic (PPN) period (7100 cal. BC) to the Halaf period (5900–5300 BCE), peaking during the Early Pottery Neolithic (EPN) (6700–6250 cal. BC) period. It focuses on the distribution of PW in indoor contexts.

The result revealed clear patterns in the distribution of PW vessel types over time. Initially, PW was used exclusively outdoors but gradually shifted towards indoor applications. Spatial analysis indicates PW's use for both long-term storage and daily use. PW was closely associated with items like grinding tools (e.g. slabs, grinders, mortars and pestles), strongly suggesting a connection to food processing. As a heavy and dense material, it was often semi-stationary and directly linked to specific areas.

PW as a domestic marker offers new insights into the lives of Neolithic people, highlighting the importance of connecting material with space and activity. These findings contribute to the research on the material culture and domestic practices of Neolithic societies.

1. Introduction

Extensive research has been conducted on Plaster technology in Late Neolithic Southwest Asia (7000–5000 cal. BC); however, little is known about the use of portable plaster containers known as plaster ware (PW), white ware, or *vaisselle blanche*. Although PW resembles early regional pottery, the *chaîne opératoire* for its production differs, and pottery and PW served distinct functions, making it a unique artefact category (Nilhamn, 2024).

This study examines the function of PW through its spatial distribution and typology. While residue analyses have not clarified the purpose of PW (Nilhamn, 2023), spatial distribution and typology can provide insights into its function. This study focuses on indoor contexts, as PW found in open areas was generally more scattered and difficult to connect stratigraphically to specific settlement phases. The quantity and type of vessels in different indoor contexts are examined, along with their relationships with other finds. Patterns in vessel concentration,

associations with other artefacts and room types clarify whether PW was used primarily for storage, food preparation or ritual activities.

Although relatively few PW artefacts have been uncovered in Southwestern Asia, recent excavations (Freikman, 2019; Molist et al., 2019; Nilhamn, 2003, 2023b; Rokitta-Krumnow and Wittmann-Gering, 2019) suggest that their prevalence may have been underestimated due to incomplete identification during past excavations. This study presents new results from the well-stratified site of Tell Sabi Abyad in northern Syria (Figs. 1–3), in the context of Neolithic Upper Mesopotamia. The material indicates that PW first emerged at the end of the Pre-Pottery Neolithic (PPN 9000–7000 cal. BC) period, continued through the Initial Pottery Neolithic (IPN; 7000–6700 cal. BC), and reached its peak during the Early Pottery Neolithic (EPN; 6700–6250 cal. BC) period. The production of PW ceased during the Halaf period (5900–5300 cal. BC), although existing vessels possibly remained in use (Nieuwenhuysen and Nilhamn, 2010; Nilhamn, 2024). During excavation campaigns between 2002 and 2009, all PW from Tell Sabi Abyad I Operation III, dated

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between 7100 and 5700 cal. BC (Van der Plicht et al., 2011), was meticulously counted to yield a total of 21,035 plaster sherds (raw count) weighing 1,175 kg (Fig. 4). These numbers differ slightly from those in previous publications (Nilhamn, 2023b, 2024) due to the inclusion of additional PW samples in the overall total.

Besides spatial distribution, material composition provides further clues to PW usage. Plaster is a composite material made from an inorganic binder, typically lime (calcium carbonate, CaCO_3) or gypsum (calcium sulphate dihydrate, $\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$), mixed with aggregates (often sand) and water to form a paste that hardens as it dries. Geochemical analyses indicate that the inhabitants of the Tell favoured gypsum plaster (92%), despite its local unavailability (Nilhamn, 2012; Nilhamn and Koek, 2013). Lime plaster, made of local limestone, was used mainly in the site's earliest layers (A16-A09, 7000–6620 cal. BC) but in smaller quantities.

Gypsum is traditionally linked to indoor applications like wall plastering and interior ornamentation, due to its properties. However, geochemical analyses of materials at Tell Sabi Abyad have indicated its use in outdoor settings too (Nilhamn, 2012; Nilhamn and Brüning, forthcoming).

By analysing the spatial relationships between PW, architectural features and associated artefacts, this study examines how these PW vessels functioned in Neolithic settlements. Identifying patterns of PW use over time also enables a broader discussion on technological choices, resource use and cultural practices during the Late Neolithic period.

2. Archaeological context and methodological approach

2.1. The Tell Sabi Abyad site

The PW for this study originated from Operation III at Tell Sabi Abyad (SAB I), situated in the Balikh Valley in northern Syria, near the

Turkish border. The site comprises four prehistoric mounds (SAB I–IV), varying in size from 0.5 to 5 ha and aligned north–south linearly. Excavations by Prof. P. Akkermans (Leiden University and the National Museum of Antiquity in Leiden, 1988–2011) uncovered extensive Neolithic settlements at SAB I–III, dating from the late eighth to the first half of the sixth millennium cal. BC (Akkermans et al., 2006, 2014; Akkermans and Brüning, 2019; Verhoeven and Akkermans, 2000; Akkermans, 1996). SAB IV is a modern cemetery and has not been investigated.

Initially, it appears that people lived on all four mounds, but after approximately 6800 BCE, habitation became concentrated on the main mound, SAB I, where excavations were carried out in five areas (Operations I–V) (Akkermans, 2014; Akkermans et al., 2006, 2014). The stratigraphy of the excavation areas has been thoroughly analysed. The chronology spans nearly two millennia and was established by integrating radiocarbon dates with Bayesian chronological modelling (Van der Plicht et al., 2011).

2.2. Methods

The PW was categorised using a codebook originally developed for Neolithic pottery from Tell Sabi Abyad (Nieuwenhuys, unpublished field manual), adapted with new terminology to suit the PW. Eight main vessel types were defined based on nearly complete profiles. The manufacturing technique—coiling, pinching, or coating other containers (e.g. basketry and pottery) or pits—was also noted. Comparisons with contemporary pottery typologies are detailed in Nilhamn (2024).

Vessel counts were estimated through the Minimum Number of Vessels (MNV) method, which calculates the minimum number of vessels based on rim and/or base sherds. A total of 1,521 individual items from SAB I Operation III were registered. Sherds were both counted and weighed, as weighing presented a picture different from counting.

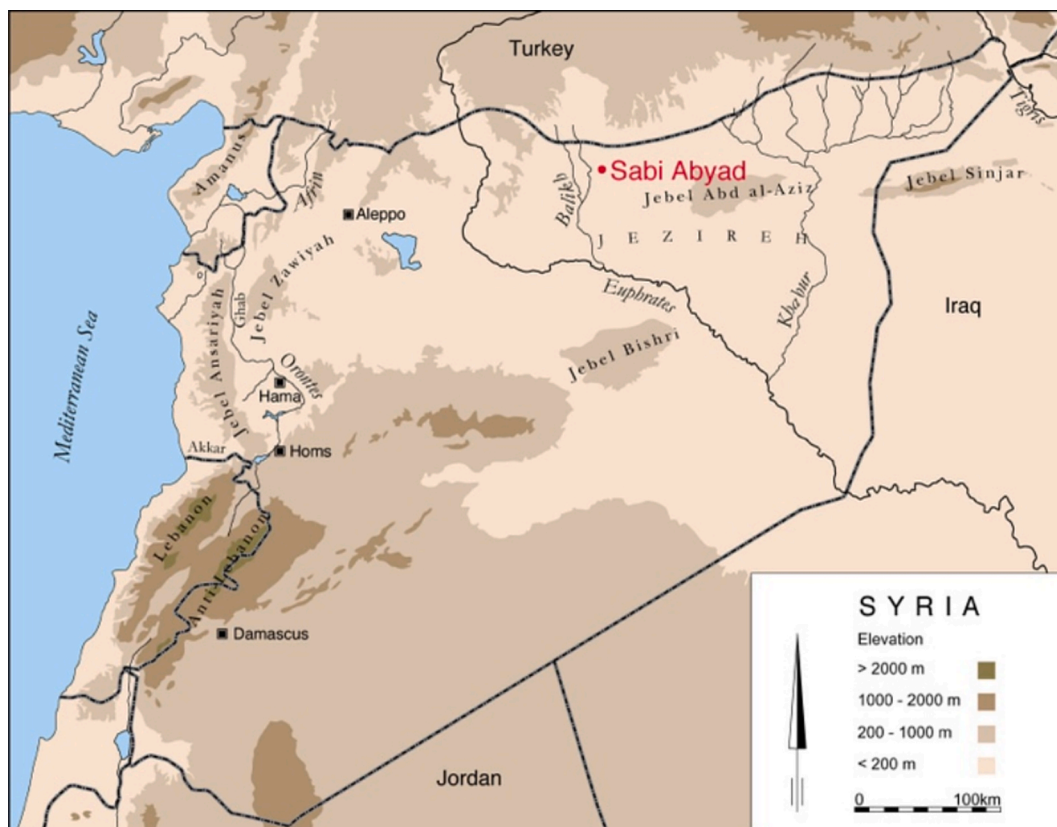


Fig. 1. Map of Syria with the site of Tell Sabi Abyad highlighted in red (Credit: Tell Sabi Abyad Archive). (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

Weight analysis provides a better understanding of quantification; plaster sherds found in indoor contexts were generally fewer but less fragmented.

Complete plaster vessels are extremely rare (three items). Complete sections are also uncommon (115 items). Experimental reconstructions (Nilhamn and Kume, 2024) estimate that a small open bowl (diameter 14 cm and height 5 cm) weighed 300–500 g, while a larger vessel (diameter 27 cm and height 9 cm) weighed 1200–2000 g. These values are provided for the reader’s understanding of weights and are not definitive archaeological data. Consequently, sherd concentrations below 100 g were classified as scattered fragments. By mapping the distribution of larger clusters (concentrations above 1000 g) of PW—spatial distribution vis-a-vis the architecture was examined. By distinguishing single-room tholoi (round buildings), single-room, two-to-three-room structures and multi-room facilities and considering where inside those structures clusters were found, both synchronic and diachronic patterns were sought.

The data may be skewed, as some areas and periods have been excavated more extensively than others. By 2010, levels A16–A06 (7000–6680 BCE) had been only partially excavated in squares D04, E03, and E04. Conversely, the younger levels A05–B09 (6485–6200 BCE), have been thoroughly investigated (Akkermans et al., 2006; Nieuwenhuys, 2018). Levels B07 to B01 (6125–5900 BCE) were

contemporaneous with Operation I, which had already undergone extensive investigation from 1988 to 1999 (Akkermans et al., 2014; Akkermans, 1996). Consequently, the exposure of these levels in Operation III was limited. Excavations revealed that most structures were no longer intact due to collapsed roofs and mud-brick walls, and with some roofs possibly dismantled for wood reuse. Objects left *in situ* were gradually buried under aeolian deposits, building material and other occupation debris. Buildings were often levelled to their foundations before rebuilding (Akkermans et al., 2011). If levelled soon after abandonment, objects were covered by mud-brick debris and toppled walls (Akkermans and Brüning, 2023, p. 35).

Data collected from previous petrographic and geochemical analyses were examined and correlated with the distribution. Polarising light microscope was used to identify microstructures, binders, mineral and organic inclusions. The classification and characterisation of the samples followed standard practices and established comparator charts (Quinn, 2022). The geochemical analyses were performed using portable energy-dispersive X-ray fluorescence (p-ED-XRF) Thermo Scientific™ Niton™ XL3t XRF Analyzer in 2010–2012 at VU University Amsterdam (Nilhamn, 2012) and ED-XRF Rigaku NEX-DE VS bench-top spectrometer in 2023–2024 at the Laboratory of Archaeology at the University of Helsinki. The data quality of the analyses conducted in 2023 was controlled by analyses of in-house standard reference

Date cal. BC	Period	Tell Sabi Abyad I Operations				
		I	II	III	IV	V
5700	Middle Halaf			D-seq		
5800	Early Halaf	level 1		C-Seq.		
5900		level 2	level 1			
6000	Transitional	level 3	level 2	level B01		phase III
6100	Pre-Halaf	level 4	level 3	level B02		
		level 5	level 4	level B03		
6200		level 6/BV		level B04		
6300	Early Pottery Neolithic (EPN)	level 7		level B05		
		level 8		level B06		
6400		P15-8		level B07		phase II
6500		P15-9		level B08		
6600		P15-10		level B09		
6700	Initial PN			level A01		phase I
6800				level A02	level 1	
6900				level A03	level 2	
7000	Late Pre Pottery Neolithic B (PPNB)			level A04		
7100				level A05		
				level A06		
				level A07		
				level A08		
				level A09		
				level A10		
				level A11		
				level A12		
				level A13		
				level A14		
				level A15		
				level A16		

Fig. 2. Settlement at the site began in the late Pre-Pottery Neolithic B (ca. 7100 cal. BC) period and ended in the middle Halaf period (5600 cal. BC). The material studied is from Operation III, with the darker blue indicating the A-levels – the focus of the plaster ware research. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

materials (e.g., NIST 634A Portland Cement), demonstrating good accuracy (relative errors lower than 10 %) and precision (relative variation coefficients below 2 %) for major and minor concentrations. For quantification, the spectrometer's software and fundamental parameters were used for quantifications. Some samples analysed in 2012 were reanalysed in 2023, allowing for comparison of the results and assessment of data consistency (Nilhamn and Brüning, forthcoming).

The sampling strategy of plaster during fieldwork targeted a diversity of periodic levels but was, unfortunately, not aimed at specific contexts or vessel typology. The material had to meet a set of predefined criteria: it displayed no visible decay and had to be from secure contexts, i.e. no disturbed or mixed contexts. Further, to investigate if a difference in composition over time existed, samples were taken from all levels (the youngest level B05 to the oldest A16). In total 164 plaster samples were collected and analysed (Nilhamn and Brüning, forthcoming) of which the focus in this article is on the 107 plaster *ware* samples (Supplementary Data).

3. Results

3.1. Plaster production

The site has not yielded any evidence of lime or gypsum rock burning or plaster mixing or curing. The raw plaster binder (as powder or burnt rock) had to be transported to the site, where the plaster was further crushed and mixed with water to create the paste for manufacturing PW or for use for architectural features such as floors, walls and bins. The benchtop ED-XRF analyses of plaster from floors, walls, bins and PW performed 2023 in combination with petrographic studies showed that the plaster paste was mixed differently depending on the intended purpose (Nilhamn and Brüning, forthcoming).

The analysed samples comprised calcium carbonate plaster (CaCO_3) or calcium sulphate plaster (CaSO_4) (Fig. 5). The original raw materials were limestone (CaCO_3) or gypsum ($\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$). Important to note is that the XRF only provides us with elemental concentrations. The most important elements are calcium (Ca) and sulphur (S) but also strontium (Sr) as it substitutes for Ca. Aluminium (Al), chlorine (Cl), iron (Fe), manganese (Mn) and silicon (Si) are also of interest as they can give information about the possible inclusions (mineral, clay, sand or pigments). To be able to calculate the ratios of different compounds such as

CaCO_3 and $\text{CaSO}_4 \cdot \frac{1}{2} \text{H}_2\text{O}$ one must consider that the XRF excludes lighter elements like oxygen (O), hydrogen (H), nitrogen (N) and carbon (C). Further, one must be cautious about dilution (causing lower counts for heavier elements) and closed sum effects. An increase in C, H, N, decreases the concentration and the measured counts of other individual elements (Löwemark et al., 2011). The closed sum effect, most likely caused by organic inclusions, exaggerates the ratio of S. This effect is less pronounced in lime plasters. This is especially noted in the 2012 analysis performed by using p-EDXRF (Fig. 5 and Supplementary Data). This further highlights the difficulties of comparing datasets.

Gypsum plaster consists of at least 50 % calcium sulphate (CaSO_4) (European Committee for Standardization, 2008; standard EN 13279-1:2009). However, here we classify all plasters with a main binder of calcium sulphate as a gypsum plaster. This plaster exists in two forms, hemihydrate (bassanite) or anhydrite, depending on the level of hydration. Bassanite, ($\text{CaSO}_4 \cdot \frac{1}{2} \text{H}_2\text{O}$), which in pure form corresponds to 55.2 % SO_3 , 38.6 % CaO and 6.2 % H_2O by mass) can, over time, undergo partial or complete transformation into the harder and denser anhydrite (CaSO_4 , with approximately 58.8 % SO_3 and 41.2 % CaO) due to environmental conditions. Anhydrite plaster can also be a result of over-calcined gypsum. Unfortunately, elemental data alone cannot distinguish between mineral phases such as gypsum, bassanite and anhydrite. Stoichiometric mass composition only applies to pure samples without inclusions. Petrographic analysis is therefore necessary to identify the material (see handbookofmineralogy.org; Quinn, 2022).

Plasters with a SO_3 content below 10 % are here classified as lime plasters. For clarity, we will use the terms lime and gypsum plaster, although calcium carbonate plaster and calcium sulphate plaster are more chemically accurate. Mixed plasters (gypsum/lime) are also common.

Floors and walls were constructed using gypsum plaster (79 % of 28 floor and wall samples) or lime plaster (21 %) (Nilhamn and Brüning, forthcoming). Both plasters were continually used side by side for architectural elements. Even the same building could have floors of different plaster types (see building A4.24). All sampled bins ($n = 18$) were made from gypsum plaster, some containing a larger quantity of lime, indicating a deliberate mixture possibly intended to enhance the material's hardness, durability and alkalinity (Nilhamn and Koek, 2013; Nilhamn and Brüning, forthcoming). Generally, gypsum plaster used for architectural features contained higher calcium levels than PW. The

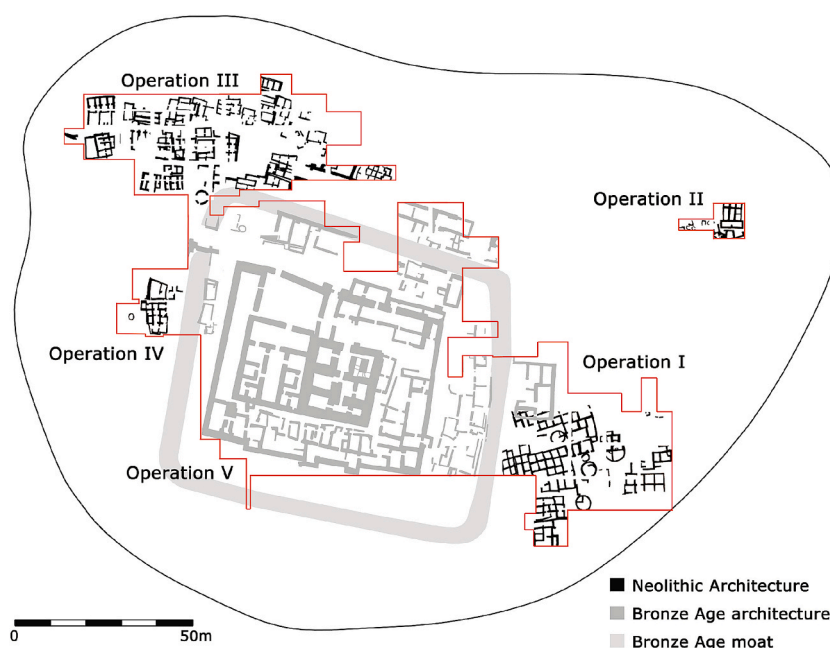


Fig. 3. Operation III is situated in the northwestern corner of the main mound, Tell Sabi Abyad I (Credit: M. Hense).

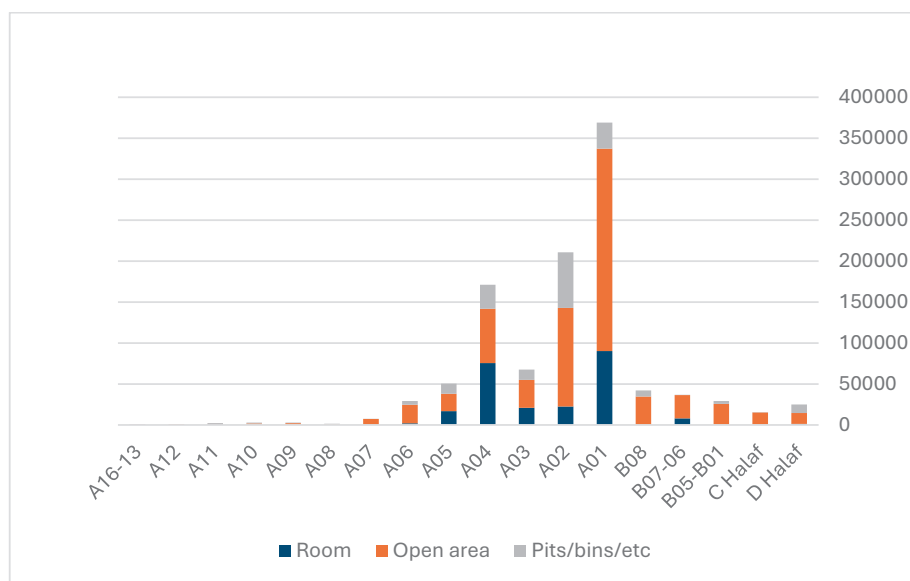


Fig. 4. Weight Distribution (g) per level and context. Operation III, Tell Sabi Abyad I.

majority of PW was made of gypsum plaster, with some individual variation in composition (Fig. 5). Lime plaster for PW is predominantly attested in the earliest periods A16–A09, with two exceptions; samples taken in main room 7 building A4.12 and in open area of level A04. The gypsum composition remained similar in the earliest levels, while in level A01, greater diversity developed, as seen in objects found in the same context (see building A1.13.1). Unfortunately, since the samples came from body sherds, most could not be correlated with specific vessel types. In some cases, the manufacturing method is recorded (Supplementary Data).

3.2. Typology

Vessels can be divided into three main categories: open bowls (average diameter 32.6 cm), closed vessels (diameter 22.1 cm), and straight-walled vessels (diameter 25.8 cm). In the early levels, A14–A08, all vessels had open shapes. In levels A07–A06, the ratio of open to closed vessels is relatively balanced (3 vs 4 vessels). From A05 onwards, open shapes continued to be more common (31–32 % per level) than closed shapes (17–21 % per level; Table 1 and Fig. 6). Jars are rare but appeared from level A04 onwards. This analysis excluded oval-shaped vessels and statistical outliers (diameter <5 cm or >100 cm). The height of these vessels rarely exceeds 20 cm, although some exceptions reach up to 45 cm. This indicates estimated average volumes ranging between 9 and 12 L, with outliers up to 180 L. Making vessels in or around basketry was the dominant manufacturing technique until level A03, when pinching or coiling became most common (Nilhamn, 2024). Bases of plaster ware were flat or rounded and occasionally thickened or equipped with stands and legs to enhance stability. The height of PW vessels was constrained by the plaster properties. Sulphate plaster is an especially dense material (bulk density 1.2–2.4 g/cm³) which limited the practical size, weight and usability of vessels. Experimental reconstructions (Nilhamn and Kume, 2024) demonstrate that constructing larger vessels through coiling required 3–5 cm thick coils, resulting in excessive weight. In contrast, thinner, harder and denser walls could be achieved through coating and moulding techniques using a more fluid paste, though this made the vessels more brittle.

3.3. Spatial distribution

3.3.1. Overview of distribution trends

Most PW was found outdoors in open areas, often in pits and debris

areas (Fig. 4). The material in the open areas is scattered, and the exact locations of the sherds were not always documented, as they were generally collected in bulk (per deposit). PW was found in 76 % of all buildings and 243 of 530 rooms. No PW was identified as part of deliberate grave goods. One plastered ceramic pot was discovered to have been used in a child burial (Plug and Nieuwenhuyse, 2018). SAB I yielded 296 PW sherd-clusters weighing over 1 kg, of which 75 originated from 42 buildings (Table 2). Open vessels were often found in front and main rooms, while closed vessels were confined to back rooms (Table 3). Beaded rim vessels were most likely to be found in back rooms and storage areas (Table 4). The beaded rim has been proposed to aid in sealing the vessel (Nilhamn, 2024). Objects connected to sealing off and closing containers were frequently found in these back rooms (Table 5).

The most common indoor finds associated with PW (across 31 buildings and 53 rooms) were basalt grinding tools like slabs, grinders, mortars and pestles. 64 % of the large clusters contained grinding tools. Stone vessels were found with PW in 25 buildings and 33 rooms, present in all but one of the 11 clusters in levels A04 and A05 but rare in A01 and A02. Bone tools (needles, awls, spatulas) were found in 24 buildings and 31 rooms. In levels A04 and A05, 50 % of large clusters contained bone tools, decreasing to 40 % in A01 and A02.

3.3.2. Early PW use: outdoor deposition and limited typology (7000–6760 BCE) (levels A16–A06)

The earliest levels (A16–A06) were excavated only to a limited extent in squares D04, E03 and E04. The IPN levels A16–A13 yielded only 0.81 kg of both gypsum (0.46 kg) and lime PW (0.3 kg, with 0.05 kg assumed to be lime but not analysed). The oldest fragment, a body sherd from level A16, has been identified as lime plaster by p-XRF in 2012. Most fragments were in too poor a condition to determine vessel types. PW mostly originated from open areas and pits surrounding the rectangular buildings. The oldest complete rim-to-base section is a gypsum plaster tray from level A14, with a diameter of 36.5 cm (Fig. 7). In level A13, 0.2 kg of lime plaster PW was found indoors. Level A12 contained 0.93 kg, all found outdoors. From A11 onwards, more PW (2.4 kg) began to emerge, with 0.81 kg found in building A11.1 and 0.07 kg in A11.2.

The first half of the EPN (A10–A06, 6760–6480 BCE) levels yielded 48.09 kg of PW. Level A10 contained 2.79 kg of PW, with only 0.19 kg found indoors, in the first attested tholos at SAB I. Only one open V-type lime plaster bowl found in an open area was identified. Level A09 contained 2.87 kg of PW, all outdoor finds; a single rim sherd was identified as part of an open V-type bowl (material not analysed).

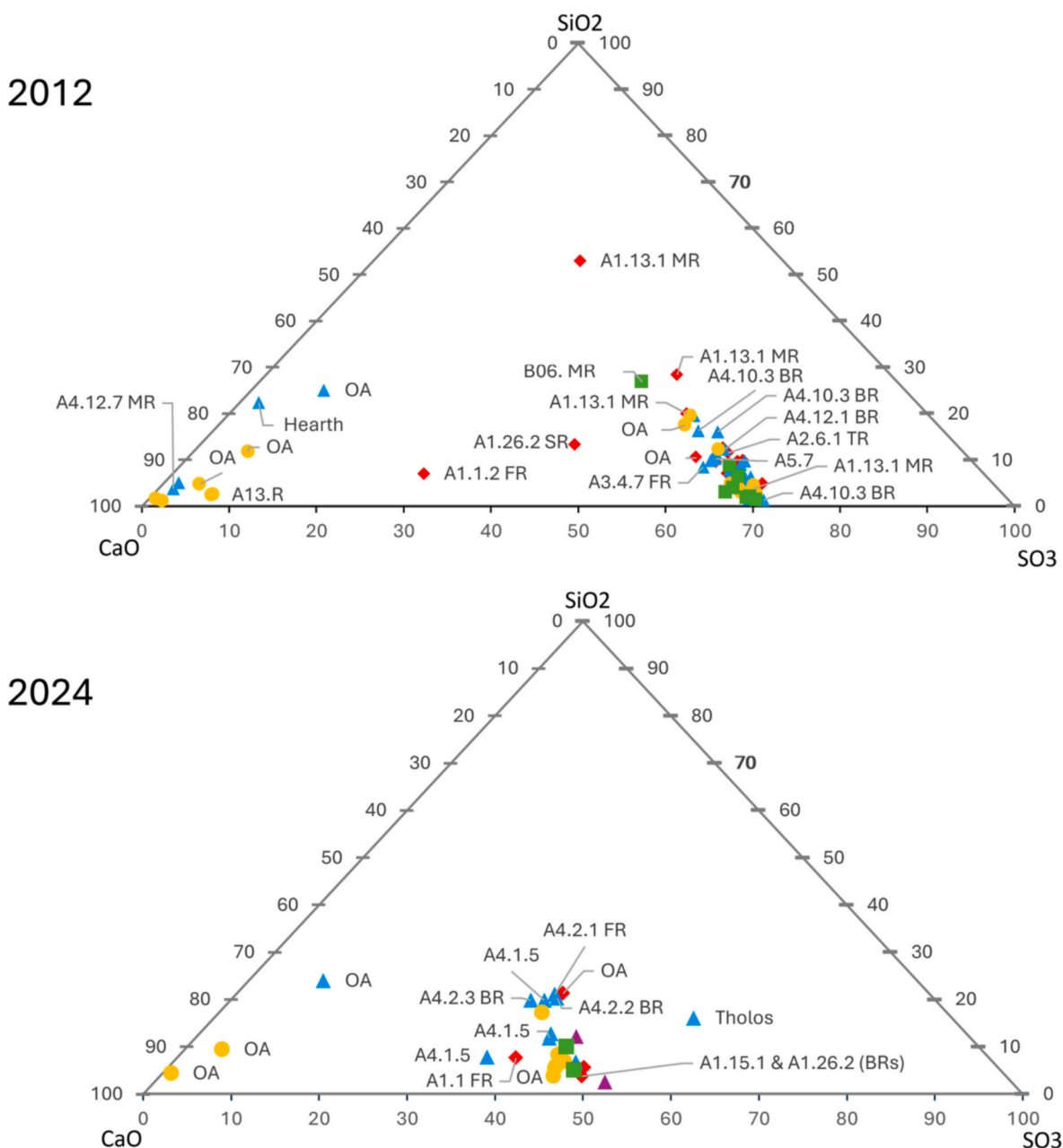


Fig. 5. Ternary diagrams based on ED-XRF results in 2012 and 2024 with the main elements SO₃, CaO and SiO₂. Orange Dot: Level A16-A07. Blue Triangle: A05-A03. Red Diamond: Level A01-A02. Green Square: Level B/C/D. The oxide ratio for pure gypsum (on an anhydrous basis as CaSO₄) is approximately: 58.8 % SO₃ and 41.2 % CaO. Pure lime plaster would be 100 % CaO. However, SiO₂ is a common third component. A high ratio of SiO₂ is possibly deliberately added aggregate (sand), while a lower ratio suggests contamination from surrounding soil or inclusions of the natural rock. Please note that XRF analyses from 2012 and 2024 differ as they were performed differently (2012 portable ED-XRF, 2024 benchtop ED-XRF). Differences in output format (elemental vs. oxide), normalization protocols, and instrument calibration lead to variations in Ca/S or CaO/SO₃ ratios. These differences reflect methodological handling rather than actual compositional variation. Therefore, 2012 and 2024 should not be compared with each other. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

Level A08's PW slightly decreased in weight (1.43 kg), due to the smaller volume of excavated ground. This level contained the oldest impression of coiled basketry on PW discovered at mound SAB I (Connan et al., 2023).

A07 contained 6.32 kg of PW, with one larger cluster from a mixed level open area (A07/A08). It included a C.4 pot, manufactured using the coiling technique (diameter 22 cm). Additionally, level A07 contained rim fragments from a straight-walled U-pot (diameter 61 cm) and a closed S.3-type vessel, marking the first appearance of closed vessel types. Analyses of three PW fragments confirmed gypsum plaster.

The quantity of PW between levels A07 and A06 (29.27 kg) increased

significantly, which can be partly attributed to the larger volume of excavated area. The material is well-preserved and less scattered. Seven larger clusters were identified, all in outdoor contexts; five were related to grinding stones. One cluster was associated with eight grinding stones and four stone vessels. Two plaster fragments showed coiled basketry impressions.

3.3.3. Middle EPN: increased indoor use & storage (6485–6385 BCE, levels A05–A04)

From level A05 onwards, houses featured individual yards with cooking facilities. Grinding stones were the most common co-finds with

Table 1

Typology of plaster ware per level in percentage, with the most common type per level highlighted in bold.

Type	Description	A14	A10	A09	A07	A06	A05	A04	A03	A02	A01	mix A	B08
C.1	Convex sided bowl unspecified				25 %		15 %	2 %	4 %	4 %	2 %		6 %
C.2	Open convex sided bowl					25 %	15 %	12 %	13 %	5 %	5 %		6 %
C.3	Vertical convex sided bowl									1 %	0 %		
C.4	Closed convex sided bowl				25 %	25 %	8 %	12 %	6 %	9 %	7 %		6 %
C.5	Very open convex sided bowl							6 %	4 %	4 %	6 %		11 %
U.1	Straight sided bowl/pot				25 %		23 %	20 %	15 %	16 %	13 %	50 %	11 %
U.2a	Straight sided round based lower bowl								2 %	1 %	<0.5 %		
U.2b	Open tray							5 %		1 %	2 %		
L.1	Straight sided flat based bowl							3 %			1 %		
L.2a	straight sided flat based lower bowl							2 %	2 %	2 %			
L.2b	Straight sided tray	100 %											
V.1	Straight to concave open bowl		100 %	100 %		25 %	8 %	11 %	15 %	18 %	16 %		28 %
V.2	Concave lower bowl						8 %	2 %	4 %	3 %	5 %		
Y/V.3	Concave, carinated bowl								2 %		1 %		
S.1.	Vertical S-shaped bowl										2 %		
S.2	Everted S-shaped bowl							5 %	2 %	4 %	4 %	50 %	
S.3	Closed S-shaped bowl				25 %		8 %	2 %	4 %	3 %	3 %		6 %
S.4	S-shaped miniature-sized(diam < 10 cm)												<0.5 %
S.6	Large, closed S-shaped pots/jars						8 %	3 %	9 %	8 %	6 %		
S.8	Very open S-shaped bowl									1 %	4 %		
ζ./CR 0	Neck unspecified							2 %	4 %	9 %	6 %		11 %
ζ./CR 1	Low-collared bowl and flattened base							2 %	2 %	0 %	<0.5 %		
ζ./CR 2	Low collar and gently rounded base										<0.5 %		
ζ./CR 3	Tall collar and gently rounded base									1 %	1 %		
O.1.a	Hole mouth pot, convex walled upper body					25 %		9 %	4 %	5 %	4 %		6 %
O.1.b	Hole mouth straight walled upper body						8 %		4 %	1 %	5 %		6 %
O.3.	Hole mouth pot with pottery/plaster							2 %	2 %		1 %		
O.4.	Hole mouth pot with interior ridge												
δ./J.1	Jars general, no further specification.							2 %	2 %	1 %	4 %		
δ. J.2	Hole mouth jar							2 %	4 %	5 %	3 %		6 %
Total objects (excl uncertain objects)		1	1	1	4	4	13	65	54	141	307	2	18

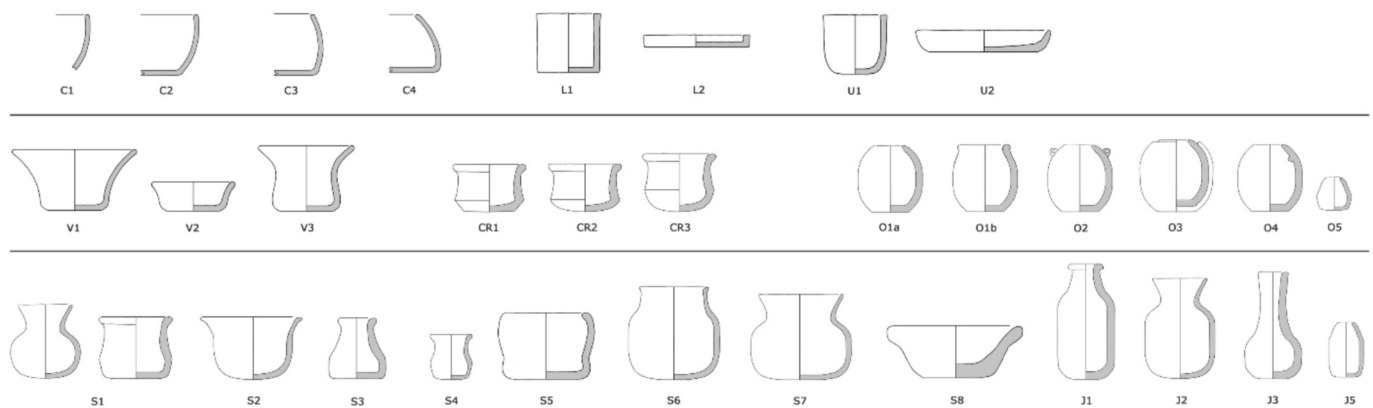


Fig. 6. Types present in the plaster ware assembly Operation III levels A14-B08, Tell Sabi Abyad (Credit: M. Hense).

the PW, along with stone bowls and bone tools. Storage structures like silos and bins were present (Fig. 8). Jar stoppers, seals and sealings were found only in the back rooms. Floors were plastered with lime or gypsum, while bins were always of gypsum plaster. A total of 50.43 kg of PW was identified, with 34 % found indoors (Table 2). Twelve large clusters were identified, of which five were indoors. The largest cluster (8.66 kg) was in Building A5.3, Room 1, containing one open V-bowl, one open C-bowl, one uncertain type and many co-finds.

Another noteworthy building is the multi-roomed A5.4. Room 1 contained 1 kg of PW, while Room 9 held the main cluster (3.4 kg) near a raised bench, along with a stone vessel (diameter 16 cm). Beneath the bench, a small C.2 open bowl (diameter 13 cm), an uncertain PW type, stone tools and bone awls were found. PW was present in Rooms 10, 11, and 12, all of which had plaster bins. Room 10 included basalt grinding stones, a pierced disc and a 34 cm oval pottery tray (in a bin). Room 11 had a large PW base fragment with a body-base diameter of 150 cm. As it

was a base, it was concluded that it did not belong to any of the stationary bins in the room. However, the size exceeds the practicalities of transporting the vessel; therefore, although the complete section shows that the vessel was not integrated into the gypsum plaster floor, it was most likely stationary as a bin and made *in situ*. Co-finds included grinding stones, stone vessel fragments and beads. In Room 12, a triangular plaster bin contained an almost complete animal clay figurine and an awl. Adjacent to it, another animal figurine was found alongside grinding stones and stone vessels. Floors in Rooms 4, 6, and 12 were of gypsum plaster, while the floor in Room 5 had mixed plaster with a higher lime content.

The following level A04 shows a remarkable increase in material (167.7 kg, of which 54.55 kg came from indoor contexts), due to the excavation methodology. Fifty-nine larger clusters were recorded, of which 19 were indoors (Fig. 9). The straight-sided U-pot or bowl and the open V-type bowl became the most common types. Pots and jars with

Table 2
Buildings per level with larger clusters (>1 kg) of plaster ware, Operation III Tell Sabi Abyad.

Level	Building	Total (g)	Room name (>1 kg PW)	Typology	MF (n =)	Rim ø (cm)	Stone vessels	Grinding stones	Bone tools	Other co-finds (with clusters)	Basketry impression	Remarks
A01A/B/C/D	A1.01	5635	2, 3, 4	C.4, δ.2, S/V	3	21.5–60.0	Yes	Yes	Yes	Room 1: stone bead, SW bowl (12 cm high 10 diam.), axe, palette Room 4: Polisher, plate, axe, bead of shell		XRF = Gypsum Plastered pottery/ PW in front room 2, Gypsum PW back room 4
A01C/D	A1.03	7330	1, 4, 5	C.1, C.5, V/S, ζ.0, O.1, S.2, S.8, U.1, V.1	19	11.5–30.0	Yes	Yes	Yes	Room 4: beads, disc, pottery tray, plastered pottery. Room 5: miniature vessel, figurine, beads, tokens, weight	Yes	Finger impressions, water damage
A01C/D	A1.05	4236	1, 2, 3	C.1, C.4, C.5, L, O.1, S.2	7	18.0–40.0	Yes	Yes	Yes	Room 1: pivot stone, sling missile, lump, jarstopper, husking tray. Room 2: plaster on pottery. Room 3: bead.		Rope marks
A01A/B/C/D	A1.07	11,796	1, 2, 3, 4, 5	C.5?, CR3, S.4, L, U/L, V.1	14	8.0–45.0	No	Yes	No	Room 1: beads of stone and clay. Room 2: jar stoppers, Room 3: beads, jarstoppers, hammer, loom weight. Room 4: beads. Room 5: No co-finds.		
A01C	A1.10	1185	3	S.6	2	26.5	No	Yes	Yes	Sling missiles, spindle whorl, jarstoppers, husking tray, hammer	Yes	Rope marks
A01C/D	A1.11	2490	1	S.1, S.3, U.1 V.1	6	11.5–31.0	No	Yes	Yes	Token, beads of stone, pottery bowl, husking tray		Some sec. burnt.
A01B/C/D	A1.12	8526	1, 2, 3	C.4, O.1, S.1, S.6, δ.1, δ.2, U.1, V.2	11	12.5–50.0	Yes	Yes	Yes	Room 1: pottery bowl SW (5.5 cm diameter). Room 2 beads of shell. Room 3: beads, doorsocket of stone		Rope marks
A01A/B	A1.13	1380	1	S.6	1	31.3	No	Yes	No	Two jarstoppers of gypsum (not fitting the rest)		XRF= PW main room 1
A01C	A1.14	1125	tholos	C.4	3	14.5–45.5	Yes	No	No	No		PW with rope marks. XRF = Gypsum floor/ wall.
A01A/B/C	A1.15	1190	2	n/a	n/a		No	No	No	Bead of pottery		XRF = Gypsum PW in backroom 1 and front room 2.
A01A/B/C	A1.16	13,720	4, 7	C.2, C.4, O.1, S.3	7	14.0–45.0	Yes	Yes	Yes	Room 4: plastered pottery, palette. Room 7: beads, figurine/labret, tokens, jar CSSW (46 cm high, 19 cm diam.), palette, hammers, axe, weight	Yes	17 grinding slabs!
A01A/B	A1.17	4445	tholos	C.2, C.40.1, S.1, U,	8	10.0–30.0	No	Yes	Yes	Sling missile, bead, pottery SMPT cup (7 cm high, 7 cm diam.), token	Yes	XRF = Wall plaster is lime plaster with ochre.
A01B	A1.18	5795	4	V.1, C.5	2	23.5–39.0	No	Yes	No	No		
A01B	A1.21	6205	1, 3	C.2, O.1, U.2, V.2, V.3	9	20.0–76.0	No	Yes	Yes	Room 1: bead of shell, hammer, ochre, sealing of burnt clay with rope impression. Room 3: jarstopper of plaster, pottery (9 and 10 cm	Yes	Sec. burnt, textile impression XRF = Gypsum

(continued on next page)

Table 2 (continued)

Level	Building	Total (g)	Room name (>1 kg PW)	Typology	MF (n =)	Rim ϕ (cm)	Stone vessels	Grinding stones	Bone tools	Other co-finds (with clusters)	Basketry impression	Remarks
A01B/C/D	A1.22	1694	2	C.2, ζ .3	2	45.0–48.0	No	Yes	No	in diam.), whetstone, sling missile, hammers No		
A01A	A1.25	2265	1	L, U	2	n/a	Yes	No	No	Tokens, loom weight		Sec. Burnt
A02A	A2.01	6357	2	O.1, S.3, V.1	8	13.0–30.0	Yes	Yes	Yes	sling missiles, hammer	Yes	One base showed signs of basketry, while two bases indicated that the objects were likely used as semi-portable bins, exhibiting marks of standing and scratches from movement.
A02A/B	A2.02	1100	2	C.5	1	47	No	No	No	Clay bead		Pigment/paint, traces of scraping.
A02A	A2.03	2515	1	n/a	1	n/a	No	No	No	CSSW pottery tray (oval 10 cm high, 36 cm long and 24 cm wide).		XRF = Gypsum PW in room 1. In phase A02B this was building A2.3 room 2. Burnt building and Sec. Burnt PW
A02A	A2.05	1700	4	C.4, S.6, V.1	4	26.5–60.0	Yes	Yes	Yes	Axe, hammers, labret, palette, polisher/sharpener, sling missiles, tokens, CW-pottery auroch horns, flint tools, palette, sling missiles, axe, pierced disc, pottery.		11 grinding slabs and 6 stone vessels!
A02B	A2.06	2070	3	U.2	3	25	Yes	Yes	Yes			13 grinding slabs found in room 3. An XRF sample came from scattered sherds in room 2 = Gypsum.
A02A	A2.09	1350	1	U/L.2	1	n/a	Yes	Yes	No	No		XRF = Gypsum in room 1. Phase not shown as figure. In phase A02B this was the location for building A2.3 room 3.
A03A	A3.01	3570	8, 9	V.2	2	Oval	No	No	Yes	Room 8: Drilled pierced bone tool, a lot of pottery, holemouth pot with loop handles, unbaked clay vessels, stone bead and complete section PW bowl.		Room 9 was completely plastered and contained burnt grain and 215 g PW but no other co-finds.
A03 A/B	A3.04	14,185	1, 2, 3, 4, 7	C.2, C.4, C.5, δ .1/S.3, S.6, U.1, U.2, V.1, V.2, O.1b	29	7.0–70.0	Yes	Yes	No	Room 1: palette. Room 2: stone bead. Room 3: pottery, aurochs horn, ovicaprid horn. Room 4 and 7: no co-finds.	Yes (room 3)	Room 3 contained most vessels (14 MF no) (former A.24 rebuilt). XRF = Gypsum PW and floor basin in back room 3 and PW front room 7.
A03 A/B	A3.08	1120	1	V.1	1	63	No	No	No	No		XRF = Gypsum PW in front room 1
A04C	A4.02	1608	2	C.1	3	24	Yes	Yes	Yes	Bitumen with basketry impression, jarstopper, axe, hammers and a possible clay figurine	Yes	At least 3C-type pots with coiled basketry impressions on the exterior sides while interior surfaces were smoothed. XRF = Gypsum PW in front room 1 and back rooms 2 and 3.

(continued on next page)

Table 2 (continued)

Level	Building	Total (g)	Room name (>1 kg PW)	Typology	MF (n =)	Rim ø (cm)	Stone vessels	Grinding stones	Bone tools	Other co-finds (with clusters)	Basketry impression	Remarks
A04C	A4.04	1035	2	n/a	n/a	n/a	Yes	No	Yes	Bead of shell		Room 3 also had a bin of gypsum. XRF= PW Gypsum in front room 6.
A04C	A4.05	5285	7, 8	C.2/C.5, U.2, V.2	4	7.0–72.0	Yes	Yes	Yes	Beads, figurines, axe and a pottery bowl (diam. 18 cm)	Yes (& rope marks)	Room 7 = 4,225 g, at least three plaster containers formed a set, incl. an open tray with a basketry impression (base diam. 35.5 cm), a small open C-type bowl (diam. 15 cm) and a large, slightly closed C-pot (diam. 72 cm). Suspended floor.
A04B	A4.06	1875	8	V.1	1	18.5	Yes	Yes	Yes	Pendant, mace head, whetstone, palette, and a larger concentration of flint beneath a suspended floor		
A04A/ B/C	A4.10	1760	3	U.2, δ.1/ S.6	2	31	No	No	No	No		Suspended floor. XRF = Gypsum PW in back room 3.
A04 A/C	A4.12	5670	1,7	V/S?, O.1a	3	31	Yes	Yes	Yes	Room 1: tokens, scraper. Room 7: stone tools, whetstone, hammers, sling missile, figurine, tokens, lumps of clay, stone bead		XRF = Gypsum PW in back room 1, transition room 3 and main room 7. Lime in main room 7.
A04B	A4.18	7280	1, 6	C.1, C.2, V.1	5	30.0–120.0	Yes	Yes	Yes	Room 1: pendant, figurine, pierced disc, labret, hammers, axes, polisher/sharpener, mace head		XRF = Gypsum bins (room1), floor (room 6).
A04A	A4.22	1695	5	V/S?, U?	2	30.0–45.0	Yes	Yes	Yes	Labret, jar stopper, token, palette, hammer, figurine, pierced disc		
A04A	A4.23	2490	3 (prev. 5)	O.3	1	22.5	Yes	Yes	Yes	pendant, stone bracelet?, palette		
A04B	A4.23	4145	2, 7	n/a	2	n/a	No	Yes	No	Palette, hammer, axe	Yes	
A04A	A4.24	5605	4, 6, 7	C.1, C.2, S.3, U/L	5	15.0–23.0	Yes	Yes	Yes	Room 6: bead, hammer, closed pottery bowls: CSSW 13 high diameter 13, SW (8 cm high, 7 diam.) Room 7: token, plain SW-pottery		XRF = room 3 floor was lime plaster. Room 9 floor was gypsum plaster.
A05A/ B	A5.01	2060	5/6, 9	n/a	2	40	Yes	Yes	Yes	Pottery with plaster, token	Yes	
A05A/ B	A5.03	8656	1	C.1?, V.1	3	n/a	Yes	Yes	Yes	Hammer and Coarse Mineral Plant tempered pottery ware (CMT) pottery bowls (diam. 8, 17, 19 and 27 cm).	Yes	
A05A/ B	A5.04	4410	1, 9	C.2	3	13	Yes	Yes	Yes	Room 1: a possible stamp, bead, clay weight, pottery bowl (oval)		
A05A/ B	A5.07	1195	?	n/a	n/a	n/a	No	Yes	No	Shell bead, token, whetstone, hammer, palette, axe		XRF = Gypsum PW

(continued on next page)

Table 2 (continued)

Level	Building	Total (g)	Room name (>1 kg PW)	Typology	MF (n =)	Rim ø (cm)	Stone vessels	Grinding stones	Bone tools	Other co-finds (with clusters)	Basketry impression	Remarks
A05A/B	A5.09	2210	1	C	2	n/a	Yes	Yes	No	Stone bead, shell, pottery, stone tools		
A04C	A6.01	1050	?	n/a	n/a	n/a	Yes	No	No		No	
		171013										

Table 3

Occurrence Yes/No of different types depending on the room context (front room, transition or back room).

	A05			A04			A03			A02			A01			
	Front	Trans	Back	Front	Trans	Back	Front	Trans	Back	Front	Trans	Back	Front	Trans/main	Back	Tholos
C.1 (Unsp.)	Yes			Yes		Yes										
C.2 (Open)	Yes				Yes	Yes			Yes				Yes	Yes		Yes
C.3 (Vertical)									Yes							
C.4 (Closed)								Yes	Yes		Yes		Yes	Yes	Yes	Yes
C.5 (Open)				Yes					Yes	Yes	Yes		Yes	Yes	Yes	
U.1 (Straight)					Yes			Yes	Yes				Yes	Yes	Yes	Yes
U.2a (Straight)				Yes		Yes			Yes		Yes				Yes	
U.2b (Tray)														Yes	Yes	
L.1 (Straight)					Yes								Yes	Yes	Yes	
L.2a (Straight)											Yes		Yes	Yes	Yes	
V.1 (Open)	Yes			Yes	Yes		Yes		Yes		Yes	Yes	Yes	Yes	Yes	
V.2 (Open)							Yes		Yes				Yes	Yes	Yes	
Y/V.3 (Open)														Yes	Yes	
S.1 (Vertical)														Yes	Yes	Yes
S.2 (Open)													Yes	Yes	Yes	
S.3. (Closed)				Yes				Yes				Yes	Yes	Yes	Yes	
S.6 (Closed)						yes			Yes		Yes		Yes	Yes	Yes	
S.8 (Open)															Yes	
ζ. 0/3 (Unspec.)													Yes	Yes	Yes	
O.1.a (Closed)						Yes						Yes	Yes	Yes	Yes	
O.1.b. (Closed)									Yes				Yes	Yes	Yes	Yes
δ.1.(Closed)								Yes					Yes	Yes	Yes	
δ.2. (Closed)													Yes	Yes	Yes	
Summary main:	Open	n/a	n/a	Open	Open	Closed	Open	Closed	Both	Open	Closed	Closed	Both	Both	Both	Both

Table 4

Distribution of vessels with beaded rims per indoor context and stratigraphic level.

BEADED rims	Front Room			Transition Room			Main Room or Tholos			Back/side/storage Room			Sum Indoor	Sum Beaded Rims all contexts
	Open	Straight	Closed	Open	Straight	Closed	Open	Straight	Closed	Open	Straight	Closed		
A05											1		1	4
A04	1				1		2						1	5
A03				2			1			1			1	5
A02	1	1							2				2	6
A01	1	2	2	1		1				3	5	1	7	23
Sum	3	3	2	3	1	3	3	0	3	6	2	11	40	255

Table 5

Distribution of jar stoppers, seals and sealings. The data from Operation I and II are not part of this study but presented here to show the development of storage practices and the increase in the use of seals to secure goods (see Akkermans, 2023 for further discussion).

Jar stopper/lid Op. III	Front room	Transition room	Main room	Back room	Sum Indoor	Sum all contexts	Other objects connected
A05				1	1	2	2 seals, 2 impressions in back rooms
A04		2	1	9	12	12	
A03					0	3	
A02					0	3	1 sealing in front room
A01	9		2	4	15	21	1 sealing in transition room
Sum	9	2	3	14	28	41	
Op I. 6070–5760 cal BC						79	322 sealings, 6 seals
Op. II 5990–5870 cal BC						39	17 sealings



Fig. 7. V08-59 level A14 Operation III Tell Sabi Abyad. Drawing and photo of actual sherd and reconstruction. (Credit: M. Hense).

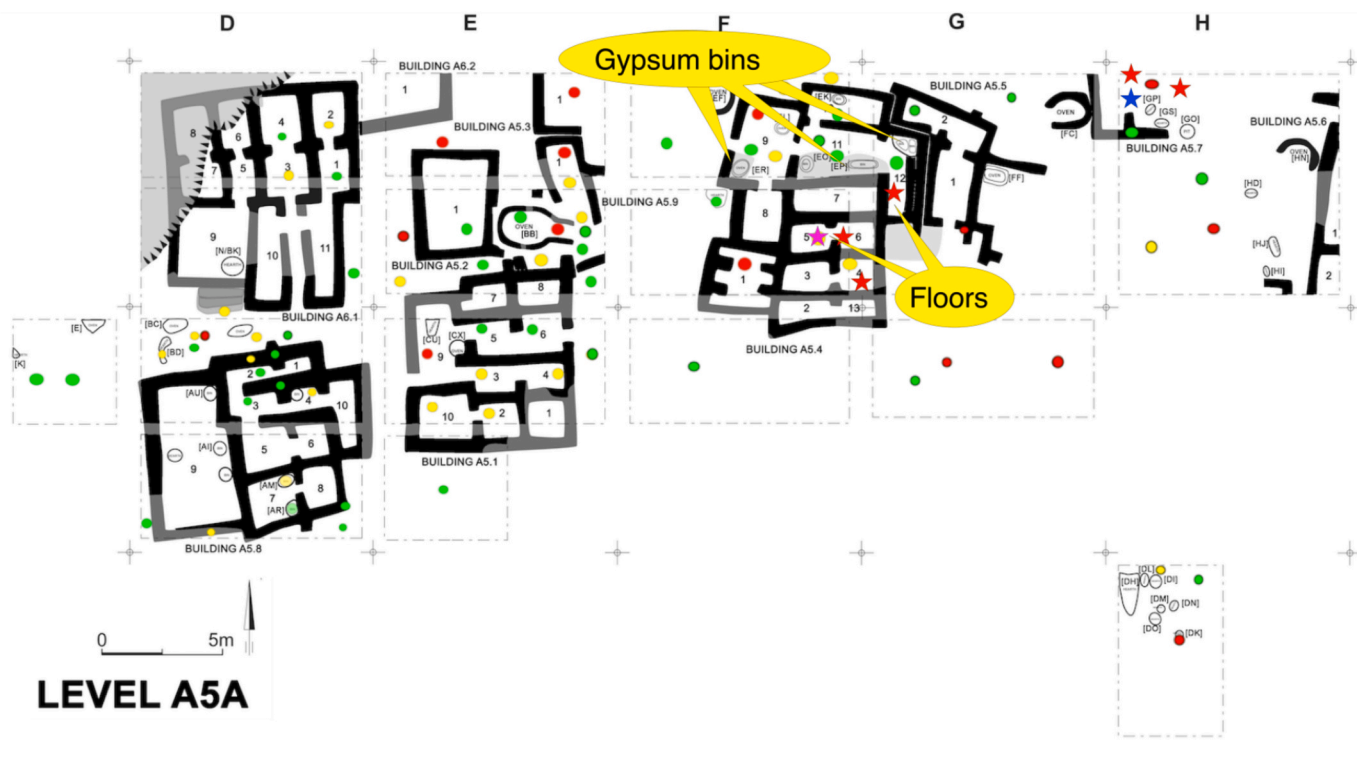


Fig. 8. Spatial distribution of plaster ware in Level A05A. Red dots indicate clusters exceeding 1 kg, green dots 0.1–1 kg, and yellow dots indicate less than 0.1 kg. Geochemical analyses of plaster from floors, walls and bins. Red stars indicate gypsum plaster; blue stars lime plaster and purple stars indicate gypsum/lime mix (Adapted map credit: Akemi Kaneda. Tell Sabi Abyad Archive). (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

necks and carination appeared for the first time. Basket-impressed PW was frequently discovered indoors. Jar stoppers continued to be connected to back rooms.

In level A04 (subphases D-A), the settlement expanded south-eastwards. Tholoi, circular formations of up to 5 m in diameter, were limited to one tholos per phase (Akkermans, 2010). On the eastern side of the settlement, a large plaza with several fire pits for cooking was present alongside a large 10 × 7 m, 90 cm-high platform. Three granaries or storehouses (A4.5, A4.6 and A4.10) were located nearby the plaza, which may have served as a focal point for communal activities. These buildings featured plastered, compartmentalised floors suspended over wooden lattices supported by the foundations of previous buildings. Such floors would have been suitable for storage, as they facilitated humidity and temperature control by providing air circulation (Brüning, 2024). Building A4.6 contained PW in all rooms, with its largest cluster

(1.88 kg) in Room 8, where a concentration of flint and co-finds was found beneath such a suspended floor (Brüning, 2024).

Building A4.18 had plaster mainly in Rooms 1 and 6. Room 1 contained 5.2 kg of PW, including four large vessels. Two had distinct bases with legs, and one slightly closed bowl had a rim diameter of 120 cm or was oval. A fourth vessel showed signs of secondary burning. Co-finds included grinding stones, hammers, bone tools, axes, a mace head, stone vessels, figurines, pendants and a pierced disc. Room 6 contained 2.08 kg of PW from an oval open vessel with a diameter of over 1 m. Like the larger vessel in Building A5.4, Room 11, it was not integrated into the floor, but its size made it stationary. Room 6 measured only 2.5 × 1.0 m, so even an oval vessel would have occupied a significant portion of the floor space. The building layout suggests that it was a secondary area used for domestic chores, like washing or laundry. The only co-find was a basalt fragment.



Fig. 9. Spatial distribution of plaster ware in Level A04A. Red dots indicate clusters exceeding 1 kg, green dots 0.1–1 kg, and yellow dots indicate less than 0.1 kg. Geochemical analyses of plaster from floors, walls and bins. Red stars indicate gypsum plaster and blue stars lime plaster (Adapted map credit: Akemi Kaneda. Tell Sabi Abyad Archive). (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

Building A4.24, Phase A04A, contained 5.61 kg of PW and diverse vessel shapes. Most rooms had smaller clusters (0.5–0.8 kg). Room 6 contained the largest cluster (1.67 kg) with a wide variety of co-finds. Several rooms had white-plastered, basin-shaped floors, indicating storage purposes. Analyses of the floors in Rooms 3 and 9 confirmed lime and gypsum plasters, respectively (Fig. 9).

3.3.4. Late EPN: stability and continuity of PW use (6395–6325 BCE, levels A03–A02)

At the end of the EPN (levels A03–A02), the village began to shrink (Fig. 10). Level A03 spans only two decades (6395–6375 BCE) but has shown significant architectural changes. The suspended plastered floors present in level A03B (Buildings A3.2, A3.3, A3.4, A3.6 and A3.7) disappeared in level A03A. Interestingly, only A3.4 exhibited larger clusters of PW. Tripartite multi-room buildings remained the most common, but the ‘three-room building’ (a central, larger living area with two smaller storage units) made its first appearance, possibly with designated room functions (Akkermans and Brüning, 2023). PW continued to be common during this period (67.63 kg, indoors 21.03 kg). It is less than in A04, but A03 has not been excavated to the same extent.

Building A3.4 was built on A4.24’s walls and likely served as a storage facility (Brüning, 2024). It contained over 14 kg of PW, with Room 3 holding 8.08 kg and at least 14 plaster vessels, including V.1-type bowls, C.5 and C.2-type pots, and S.6 jars. White crusts on some vessels indicate secondary deposits. Manufacturing methods varied, including coiling and moulding in baskets. Room 3 also had two grinding slabs, two stone vessels with peck marks and scratches from heavy use, and a gypsum-plastered floor/basin, possibly to facilitate cleaning and deter vermin. It was sunk into levelling debris from A04A. An aurochs horn core and an ovicaprid horn were discovered in the plaster basin, which may represent a foundation deposit. Room 1 contained 1.37 kg of PW, including a C.4 pot, a complete jar section (rim diameter 13 cm, body diameter 24 cm and height 17 cm), and a gypsum stone cup with plaster attached. Room 2 had 3.06 kg of PW from four vessels, including a complete section of an oval tray (72 cm long). Room 4 held 0.96 kg, including a U-bowl, a hole-mouth pot, and a plaster jar

stopper with a seal mark. Room 7 had 0.73 kg of PW, with one base fragment with red spots.

Level A02 featured a scattered settlement layout (Buildings A2.1–9). Three-room buildings formed small clusters (Akkermans and Brüning, 2023). Although level A02 spanned approximately 60 years (6385–6325 cal. BC), individual buildings typically had shorter life-spans, being used for about one generation (ca. 30 years). The importance of storage became increasingly pronounced during this period. The rising demand for everyday vessels is associated with the increase of plant-tempered pottery, which enabled larger (and lighter) storage vessels. This evolution was gradual, beginning in level A06 and culminating in level A02. The increase in larger containers, combined with the use of seals, indicates a growing emphasis on ownership and organisation (Duistermaat, 2013). Level A02 yielded 210.2 kg of PW, with 22.25 kg from indoor contexts. Among 44 larger clusters, only six were indoors (Table 2). However, the amount of material indoors remained stable from A03.

The most significant discovery was a complete section of an S-bowl showing red discoloration, black pigments and scraping marks (Fig. 11). It was found in building A2.2, Room 2, which was the only room to house PW. This sherd weighed 0.92 kg, indicating a vessel weight between 5 and 10 kg. Notably, the neighbouring Room 3 displayed the first indication of (deliberate) black paint on white plastered walls discovered at Tell Sabi Abyad (Fig. 12).

Building A2.6, Room 3 also displayed a notable concentration of finds, including 2 kg of PW. In one room corner, plaster had replaced and covered a broken ceramic storage pot (Fig. 12). Of the three identified PW vessels, one showed a complete section of an 8-cm-high U-bowl with a plain rim (diameter 25 cm). Its base exhibited a square impression, as if fixated or standing on something. Co-finds included three aurochs’ horns and 13 grinding slabs, many of them in excellent condition.

3.3.5. Initial Pre-Halaf period: peak use (6330–6200 BCE, level A01–B09)

The Pre-Halaf phase commenced with level A01 (6330–6225 cal. BC), divided into sub-phases A1D (earliest) to A1A (latest). The village and its buildings (A1.12–A1.24 and A1.25–26) gradually expanded. The

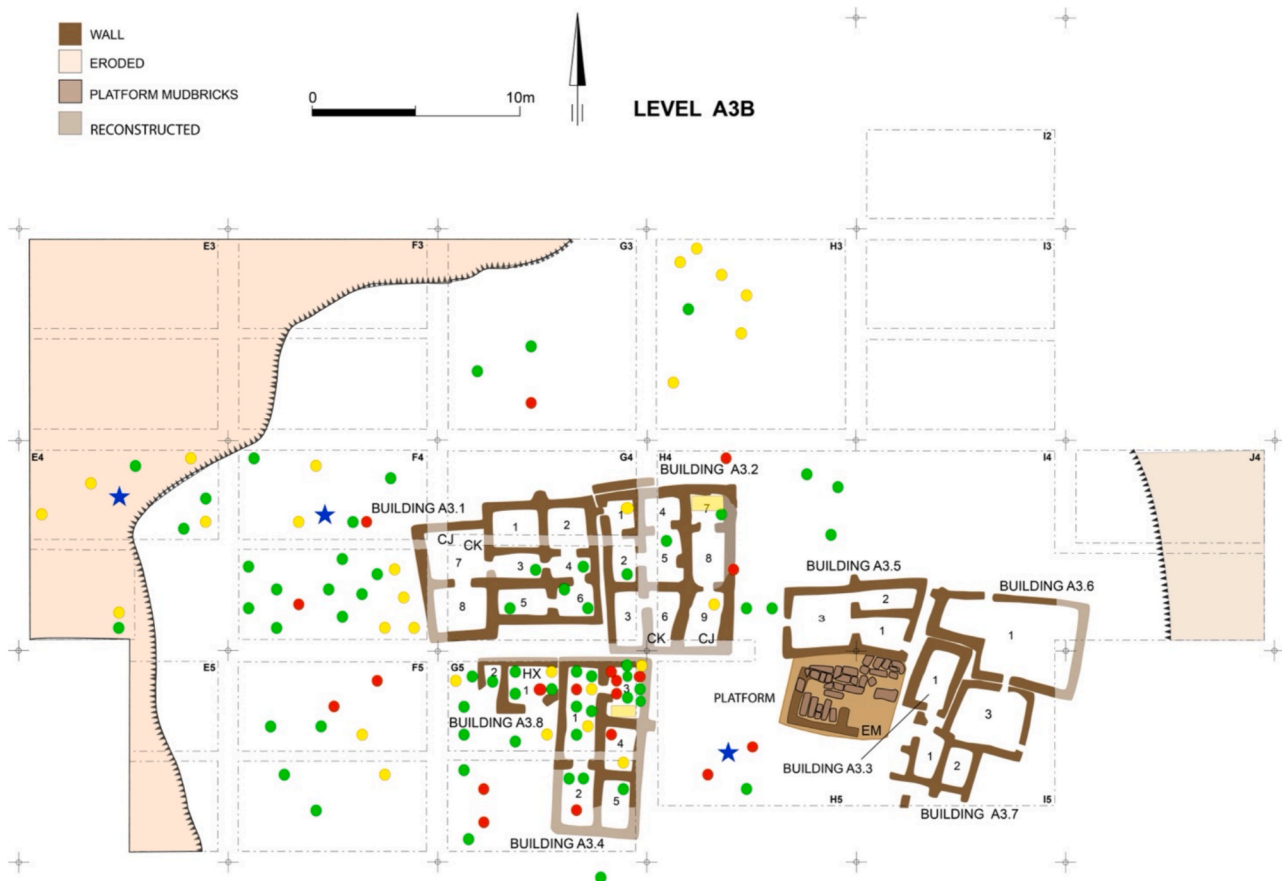


Fig. 10. Spatial distribution of plaster ware in Level A03B. Red dots indicate clusters exceeding 1 kg, green dots 0.1–1 kg, and yellow dots indicate less than 0.1 kg. Blue stars indicate lime plaster; all other analysed plaster was gypsum plaster. Plastered floors in A3.2.7 and A3.4.3 were analysed and found to be gypsum (Adapted map credit: Akemi Kaneda. Tell Sabi Abyad Archive). (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

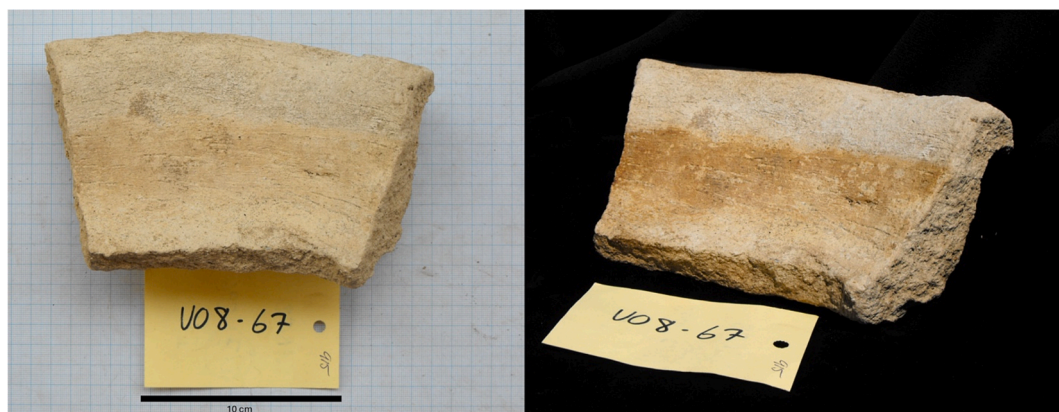


Fig. 11. V08-67 dry versus dipped in water to enhance shades (photo not digitally enhanced; background is black cloth; Diameter of 47 cm and a height of 8 cm. Photo: B. Nilhamn).

large multi-room buildings (A1.10, A1.13 and A1.16) used for communal storage (Nieuwenhuys and Akkermans, 2019), may point towards a new socio-economic lifestyle. Other building types, such as three-room buildings, possibly functioned as single-generation households (Akkermans, 2013; Akkermans and Brüning, 2019; Plug et al., 2021). A tholos (A1.14 and later A1.17) was also part of the village.

In total, 369.02 kg of PW, the largest assembly from a single level, was found mainly in open areas. A 15 kg cluster was found in an open area in trench G04, mirroring a 20 kg cluster found in level A02 south of

building A3.1/A1.3. Level A01 (Figs. 13 and 14) generated 109 larger clusters, with 33 from indoor contexts. Over 90 kg were found indoors. In all, 515 objects were registered: 142 open, 43 straight, 127 closed and the rest uncertain. Half of the closed vessels were made from one homogeneous plaster layer. Three (C/O-type) were coiled. The open vessels were predominantly V-type (n = 12), and only five straight vessels were U or S types. Jar stoppers were interestingly found more often in the front rooms, while beaded rim vessels were more common in the back rooms (Table 4 and 5).

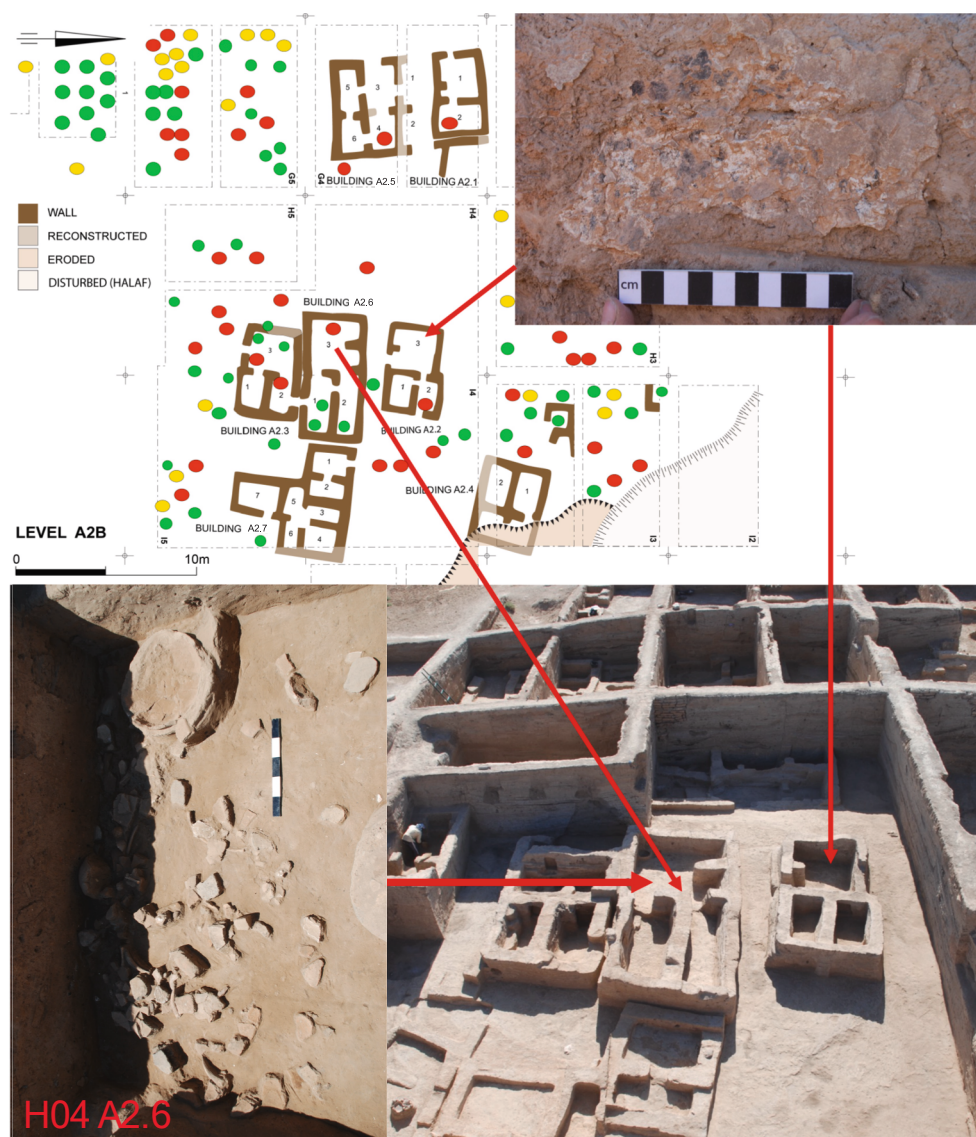


Fig. 12. Spatial distribution of plaster ware in Level A02B, showing Buildings A2.2 and A2.6. Red dots indicate clusters exceeding 1 kg, green dots 0.1–1 kg, and yellow dots indicate less than 0.1 kg. The inset in the upper right shows evidence of wall paintings in building A2.2, Room 3; the lower inset shows Room 3 of Building A2.6. Note: North is oriented to the right in this plan (Adapted map: A. Kaneda; Photo credit: Tell Sabi Abyad Archive). (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

Building A1.3 contained 7.33 kg of PW, mainly in Rooms 4 and 5 (over 3 kg each) (Fig. 14). Room 4 contained 13 vessels, including a C.5 bowl, an O.1b hole-mouth pot, an open C/V bowl, a V.1 bowl, an S.2 pot, and a U.1 pot. One sherd showed impressions of basketry on its interior. Another object was deformed by water. Some pottery appeared to be mended with plaster.

Building A1.7 contained 11.8 kg and 13 vessels. Seven open (V) bowls were found in sublevel A01C in back rooms 1, 2 and 5 with no other co-finds than a jar stopper. Room 3 mainly displayed material in sublevel A01A mixed with wall and roof debris. This front room yielded the best-preserved plaster vessel found at the site: an oval open beaded rim bowl (diameter 38–47 cm) weighing nearly 4 kg (Fig. 14:D).

Building A1.12 (A01D-B) contained 8.53 kg of PW and 11 vessels. Room 1 held only closed vessels (O.1, C.4, S.3, δ .2) with rim diameters of 12–25 cm. Room 2 contained two closed C-pots, two straight pots (U and S types), one S.6/ δ .1 jar and a 50 cm tray. Room 3 had a door socket, suggesting it was closable. One base fragment displayed rope impressions. Co-finds throughout the building included grinding slabs, bone tools and beads.

The largest cluster of plaster, weighing 12.3 kg, was found in Building A1.16 at Level A01B (Fig. 14). Room 7 held 10.33 kg of PW and at least six items, including two O.1-pots, one C.4-bowl, one S-bowl, one C/V-bowl and one unidentifiable item. A complete coarse ware pottery jar (diameter 19 cm, height 46 cm) and two oval bins—one plaster (45 × 20 cm, height 8 cm) and one clay—were also found, along with 17 grinding slabs and three stone vessels. In the Northern storage rooms (1–3) contained no significant PW. Room 4 had a doorstone. The room contained a body fragment with basketry impressions and a coarse ware pot partially covered in plaster.

Tholos A1.17 contained 4.45 kg of PW from at least eight vessels, including three open bowls (diam. 30 cm), three closed pots made by coiling (diam. 10–23 cm), and two bases with plaited twill basketry impressions on their interior (Fig. 14:C). One vessel featured surface deformation from water exposure, suggesting its use both indoors and outdoors.

Building A1.18 had a PW cluster in Room 4, including two open S.1-bowls with beaded or bevelled rims. One bowl was oval, with a length of at least 39 cm, height of 8 cm, and wall thickness of 2 cm (Fig. 14: A and



Fig. 13. Spatial distribution of plaster ware in Level A01C. Red dots indicate clusters exceeding 1 kg, green dots 0.1–1 kg, and yellow dots indicate less than 0.1 kg. (Adapted map credit: Akemi Kaneda. Tell Sabi Abyad Archive). (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

B). The material is exceptionally dense, with stone inclusions in the plaster. The total vessel weight remains uncertain, but 22 sherds weighing 4.82 kg form at least 25 % of the vessel. A grinder and mortar suggest the room was used for food preparation.

A1.21's main plaster cluster was in Room 1, but the finds suggest that this main room may have served a function other than food processing or storage. Some sherds displayed signs of secondary burning, with one featuring twill basketry impressions and another fragment with tightly woven textile impressions and a knob handle. Two lower open V-bowls were found. One complete section measured only 10 cm in height but had a diameter of 76 cm (albeit slightly oval). The most peculiar object, possibly used as a serving or display tray, was a plate with legs, a burnished interior and faint basketry impressions on part of the exterior. Back room 3 contained a large pit containing both open and closed PW, along with a jar stopper measuring approximately 10.5 cm in diameter (not fitting the plaster vessels). Front room 2 also yielded a complete ceramic pot, repaired with plaster (Nieuwenhuys and Koek, 2018).

3.3.6. The final decline: (6200–5700 BCE, levels B08–Halaf period (C/D))

There is a perceptible decline in PW starting in the Pre-Halaf period (6200–6015 BCE; levels B08–B04). The significant reduction in material between levels A01 and B09/B08 of Operation III is attributed to structural changes within the village. The northwest area (Operation III) came to be less utilised for domestic activities, while the village centre shifted to the southeast (Operations I and II). The northwest area continued to be used as a cemetery, with approximately 200 individuals identified, until the early Halaf period (Plug et al., 2014; Plug, 2023). Operations I and II yielded limited PW (249 and 750 fragments, respectively). Unfortunately, these findings have not been studied to the same extent as those from Operation III and were therefore excluded from the scope of this paper.

In total, 42 kg of PW was recovered from B09/B08, representing 42 objects, mainly open C- and V-bowls. Only one item had a possible basketry impression. No PW was discovered indoors. B07 yielded 25 kg, with just over 1 kg from indoor contexts. None of the 33 objects came from indoors. Vessels included open (C, S, V) and closed (jar) shapes with rim diameters between 7 and 36.5 cm. One sherd had twined basketry impressions. Over half of the PW in B06 came from indoors (6.94 of 13.13 kg), including four objects: a basketry-impressed sherd, a hole-mouth O.1-pot, a small U.1 pot and a lower bowl with a pedestal base confirmed as gypsum plaster by p-XRF (see [Supplementary Data S-nr 4485](#)).

Levels B05–B01 yielded less than 30 kg in total, with only 0.05 kg from indoors. Four items were found: two V-type bowls, a body fragment with plaited twill basketry impressions and a re-used plaster disc. These levels mostly featured homogeneous, single-layer plaster items made by moulding or pinching techniques.

During the Halaf period (5900–5700 BCE; Levels C and D), most PW was found in open areas and disturbed layers. In the Early Halaf period (C-sequence), new structures emerged in the northwest, coexisting with levels 1–3 of Operation I. In this period, only 0.295 kg of the total of 15.5 kg were located in indoor contexts. The middle Halaf (D-sequence) lacks absolute dates and is chronologically positioned based on its material culture, particularly painted Halaf pottery. Nearly 25 kg of PW was collected from this period, with 1.34 kg found indoors, of which 0.65 kg were in one tholos. Most of the 40 identified plaster vessels were open bowls featuring plain or beaded rims. Rope impressions were observed on some of the sherds.

4. Discussion

The spatial distribution of PW at Tell Sabi Abyad reveals an

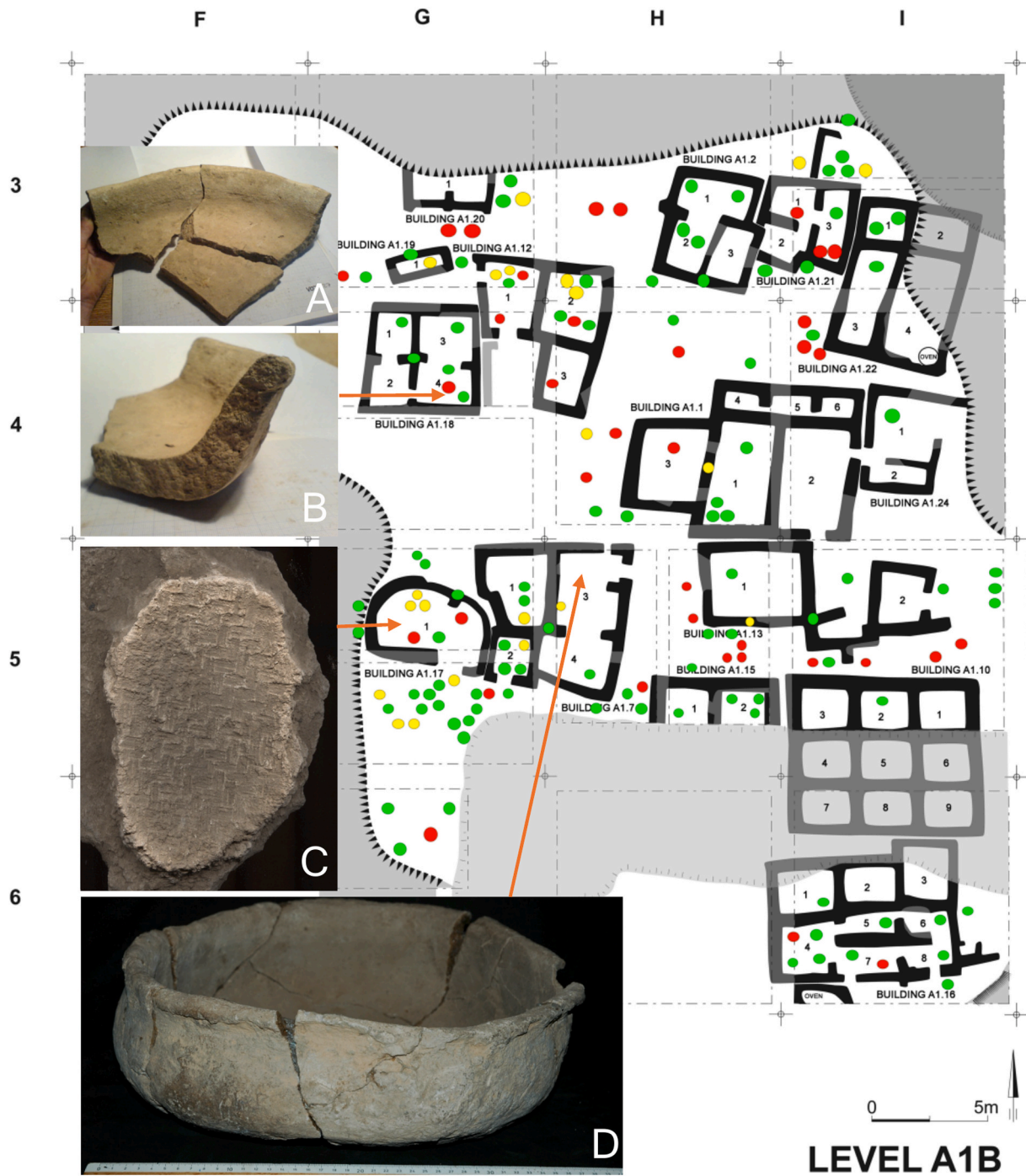


Fig. 14. Spatial distribution of plaster ware in Level A01B. Red dots indicate clusters exceeding 1 kg, green dots 0.1–1 kg, and yellow dots indicate less than 0.1 kg. The blue area indicates an open area with over 15 kg of PW. The orange area indicates building A1.16 containing nearly 14 kg of PW (Adapted map credit: Akemi Kaneda. Tell Sabi Abyad Archive); Photos A and B: V07-127 found in A1.18 room 4. C: V05-43 found in tholos A1.17 with plaited twill basketry impression on the interior side. D: V05-206, an almost complete vessel found in A1.7 room 2. (Photo credit: B. Nilhamn). (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

interesting pattern, excluding scattered sherds and focusing on clusters weighing over 1 kg. While PW was frequently found scattered in open areas, larger concentrations were often located in less disturbed indoor contexts. Typically, PW was concentrated in a single room, often near the entrance. Here, closer to daylight, it was easier to work and if the weather permitted, the work could be moved outdoors. The open bowls may have been used to mix culinary ingredients, prepare food, store grain and serve as sturdy kitchen sinks or even as water deposits for cleaning hands and commodities. Signs of scraping on some of the soft

plaster interiors suggest evidence of vigorous stirring or kneading. Some vessel surfaces were kept smooth and hard, akin to fine ware pottery used for serving. Co-finds such as domestic grinding slabs, grinders and mortars used for mashing food components also indicate food preparation activities.

Though Tell Sabi Abyad has no evidence of plastered skulls or other plastered cultic objects, we cannot dismiss the possibility of plaster containers having had ritual functions. The red-stained (gypsum) bowl found in building A2.2, possibly associated with a wall painting, may

suggest the use of PW for ritual practices. Early pure lime plaster possibly signified prestige and religious or sociopolitical importance, reflecting craftsmanship mastery. The purer the lime, the more its value may have been. Goren and Goldberg (1991) observed that plaster objects contained more burnt lime than architectural elements. At Tell Sabi Abyad, this is true for samples from early levels, also revealing high lime content (from level A04 onwards architecture has in general higher calcium content). Two lime plaster vessels have been found indoors (levels A13 and A04). Verhoeven (2002, 2011) suggests a shift from collective religious symbols in the aceramic Neolithic period to private, household rituals in the Pottery Neolithic (“domesticity”, Verhoeven, 2011, p. 799), though the timing is uncertain (Nieuwenhuys, 2022). Lime plaster may have held distinct significance before the emergence of gypsum as the main binder material around 6500 BCE. While shifts in worldview may have played a role, economic consideration is more plausible. Despite being heavier and less durable than lime, gypsum plaster was easier and faster to produce with lower fuel cost, which is evident in the increasing production scale (A07/06 ca 36 kg vs A05/04 ca 218 kg) (Nilhamn and Brüning, forthcoming).

In level A05, PW clusters were concentrated in the entrance rooms of the buildings. In level A04, a separation appears to exist between daily domestic activities and long-term storage. Specifically, in level A04, four larger clusters were identified in front rooms, five in transition rooms and eight in storage/back rooms. Level A01 revealed a different pattern, with 10 larger clusters in front rooms near the entrance, only three in transition rooms and 14 clusters deposited in storage rooms. Across levels A04 to A01, vessels in the back/storage rooms have survived better, showcasing a greater variety of individual items and types, many of which feature beaded rims. This suggests improved handling and the possibility of sealing them with rope and cloth (Nilhamn, 2024). Additionally, remains of basketry impressions are more likely to be found in

these areas. Storage room 3 in building A3.4 is extraordinary, given its small size. It must have been difficult to manoeuvre between all PW (Fig. 15). The room may have had wooden shelves; however, considering the weight of the plaster, PW is more likely to have been stored directly on the ground or stacked atop one another. PW was rarely a major find in multi-roomed storage facilities; when present, clusters were typically confined to a single room. Building A1.16 is an exception, indicating that the southern part of the building was most likely intended not for storage as initially thought (Nieuwenhuys and Akkermans, 2019) but for daily activities, possibly serving as a communal kitchen. The quantity of items suggests a storage function; however, storage rooms are often located in areas with a single entrance, typically at the back of the building. The concentration of items in Room 7 is particularly intriguing, as it is situated at the front and appears to serve as a passage between two other rooms; all rooms have two entrances, suggesting a dynamic workflow, implying that the entire building functioned as a vibrant food preparation and short-term storage area. Some rooms contained so-called husking trays, now believed to be associated with bread-baking (Taranto et al., 2023). Further, there are ovens and hearths located near the entrance. Future research may determine whether this could have been the village bakery.

XRF data indicated the presence of lime plaster predominantly outdoors (Fig. 5), while gypsum plaster exhibited no significant differences in composition, depending on the room context in levels A05 to A02. In building A4.2, PW composition was similar across rooms (1, 2 or 3) whereas in building A4.1, room 5 contained at least three different plaster compositions. However, this changed in level A01, which featured the largest variety in typology and plaster composition. PW in back rooms shared similar compositions, while a vessel in a front room contained a higher concentration of CaO. It is therefore plausible that the composition came to be linked to the typology and use.

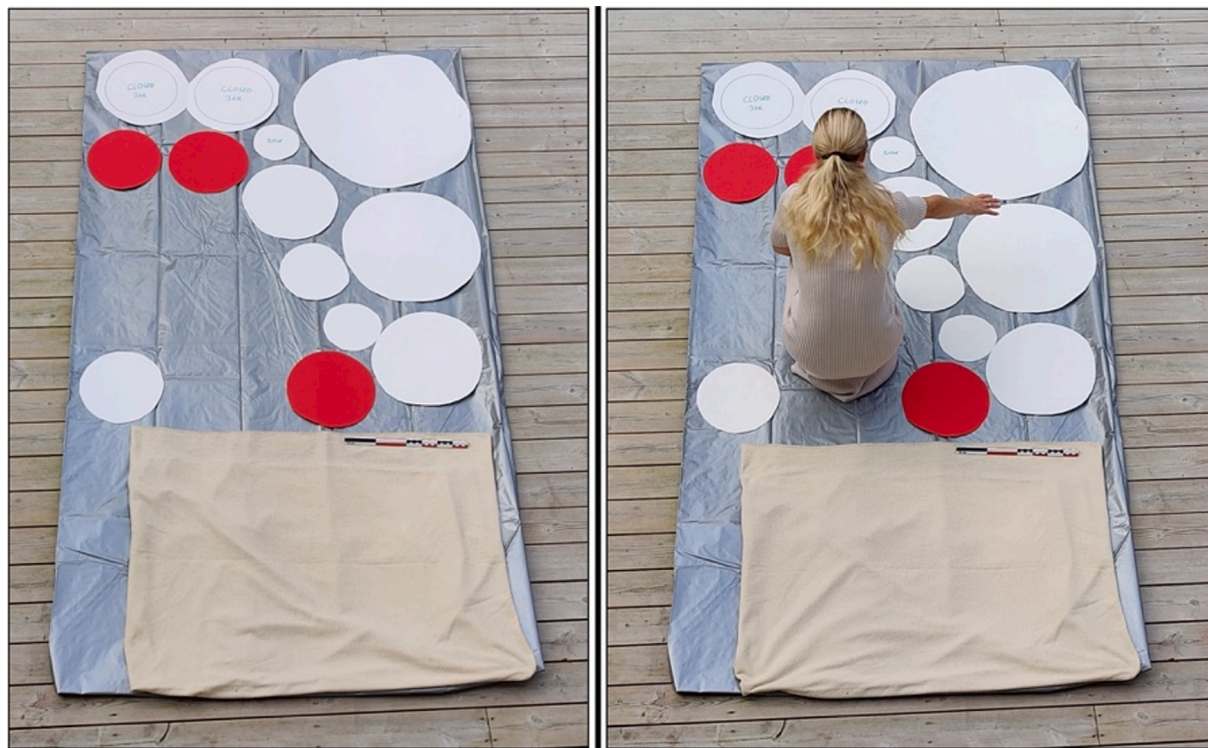


Fig. 15. Schematic reconstruction of Room A.3.4.2 (approx. 2.5×1.25 m), illustrating spatial dimensions and potential movement within the space. The room is oriented facing north, with the entrance located on the left (see also Fig. 9). Beige shading indicates a plastered floor or basin in the southern half of the room (1.15×0.85 m); white represents plaster ware; red indicates plaster ware with basketry impressions. Note: the positions of plaster ware vessels are schematic and do not correspond to the exact find locations. For scale, the figure includes the silhouette of a kneeling individual (height: 160 cm/5'3"). Additional co-finds—such as grinding stones, stone vessels, slabs, and plastered pottery—are not shown in this illustration. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

The rapid decrease in PW between levels A01 and B09/B08 can be attributed to changes in the village that had already begun in the Initial Pre-Halaf Period (6330–6200 BCE). Architectural developments suggest a new socio-economic lifestyle (Akkermans and Brüning, 2019; Plug et al., 2021), which is also evident in the increasing use of seals and sealings to control property, starting around 6,150 cal. BC, as seen in the material from Operations I and II (Table 5) (Akkermans, 2023). A gradual transition from agriculture and pig farming to cow herding and hunting introduced dairy products (Evershed et al., 2008; Nieuwenhuys et al., 2015) and wool, as supported by zooarchaeological (Russell, 2010) and isotopic data (Pearson et al., 2007; Van der Plicht et al., 2011). A rise in $\delta^{15}\text{N}$ levels observed in human burials around 6250 BCE may indicate a dietary change and drier environment. Burial practices also evolved, with fewer groups, reduced grave goods and new rituals (Plug, 2023). By the later Halaf period (5900–5300 BCE), PW had nearly disappeared, although plaster continued to be used in architectural contexts, such as floors and walls (Rehloff et al., 1990, samples 3, 5, and 6).

In sum, these factors may explain why containers needed to evolve to meet functional, demographic and ritual demands. Following Arnold's (Arnolds, 1989) argument that shifts in culinary and storage practices drive vessel innovation, it remains unclear how much Tell Sabi Abyad was affected by climatic change. However, climate influences both fuel availability and material choices. Seasonal weather conditions affect plaster production, making ceramic production more cost-effective and enabling scalable output with minimal community disruption (Brown, 1989). The decline of PW can perhaps be further explained by Jordan and Zvelebil's (2010) four-stage model of ceramic development: initially experimental and ritualistic, then refined with diverse forms, later integrated into daily life, and finally disseminated through exchange. When applied to plaster at Tell Sabi Abyad, this model suggests that while plaster progressed through the first three stages, it never reached the fourth, as it could not compete with the lighter and more colourful pottery.

5. Conclusion

Plaster Ware (PW) at Tell Sabi Abyad played an important role in domestic activities, primarily food preparation and storage. Spatial analysis shows that vessels were commonly found near entrances and storage rooms, often alongside stone vessels, grinding slabs and mortars. Some vessels exhibit evidence of active use, with deep scrape marks, while others may have served serving or even ritual purposes. Closed vessels with beaded rims were often used for storage.

PW evolved in both typology and raw material composition. Early open bowls were made of lime plaster, possibly valued for their prestige or symbolic significance, but over time, gypsum became dominant, possibly due to its lower fuel requirements and faster production. In the earliest levels of Tell Sabi Abyad (7000–6480 BCE), PW was predominantly found outdoors, often alongside domestic items like grinding tools, reinforcing its association with food processing. However, from level A05 (6485 BCE) onwards, there was a noticeable shift toward indoor usage, with its remaining strongly associated with grinding tools and stone vessels (Fig. 16). This trend continued through level A03 (6395–6375 BCE), with 31–44 % of PW located within dwellings. By level A02 (6385–6325 BCE), PW appears to have been discarded from houses, as only 10 % was found indoors.

This trend was briefly reversed in level A01 (6330–6200 BCE). Around the same time, society transformed, marked by a shift in materials and their distribution in the village. This phase, aligned with the broader regional 'Proto-Hassuna culture', saw the emergence of new pottery styles and wares, possibly reflecting evolving lifestyles, storage and food practices. These new food products, along with potentially new traditions and beliefs, necessitated practical, easy-to-make, portable, clean and aesthetically pleasing containers. Painted pottery, in particular, gained significant popularity. Initially, both pottery and PW increased in quantity and displayed greater compositional and functional diversity. However, pottery proved more adaptable to the needs of this dynamic new era. Consequently, PW declined rapidly. Despite this,



Fig. 16. A variety of co-finds surrounding the PW: basalt grinding stones, stone vessels, pestles, plastered pots, plaster jar stoppers and basketry now seen only as impressions in the plaster material (Credit: Tell Sabi Abyad Archive).

plaster technology did not disappear but continued to be used for architectural purposes, particularly in floors and walls.

Even though PW did not partake in the expressive dancing and feasting associated with the Halaf period (Nieuwenhuys, 2022), it played a significant role in domestic life in the periods leading up to the Halaf. Moreover, people invested in sturdy, reliable items. Alongside other heavy objects, such as grinding stones and stone vessels, PW was a domestic item, connecting the building to the material culture and connecting it, in turn, to the people. Once the building was abandoned, the heavier items were left *in situ*, becoming archaeological treasures, as they provide a unique glimpse into the lives of Tell Sabi Abyad's inhabitants during the EPN era.

CRedit authorship contribution statement

Bonnie Nilhamn: Writing – review & editing, Writing – original draft, Visualization, Validation, Resources, Project administration, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Merel L. Brüning:** Writing – review & editing, Visualization, Validation, Resources, Investigation, Data curation. **Akemi Kaneda:** Writing – review & editing, Visualization, Validation, Investigation, Data curation.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.jasrep.2025.105344>.

Data availability

Data will be made available on request.

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