

# Large-scale storage of grain surplus in the sixth millennium BC: the silos of Tel Tsaf

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*The authors report and describe the remarkable grain silos discovered at Tel Tsaf in the southern Levant. These tall, white, barrel-shaped towers seem to mark the first appearance of monuments of demonstrative surplus.*

*Keywords:* Levant, Chalcolithic, grain, agriculture, storage, silos

## Introduction

Silos for the storage of grain have been an essential aspect of all agricultural communities throughout the ages. Harvested crops need to be kept for at least a year until the next harvest. When the amount of stored grain is larger than that necessary for the consumption of the people harvesting it, a surplus is created. This surplus can become a commodity, which can be exchanged for other products. In human history, the first stage in the accumulation of wealth was the production of agricultural surpluses, in the form of grain and livestock. Surplus accumulation facilitated the development of full-time craft specialisation and socio-economic distinctions, the rise of urbanism and state formation. These aspects were already discussed by Gordon Childe in his groundbreaking essay *The Urban Revolution* (1950). The importance of silos has been noted in various case studies, usually associated with urban and state-level societies (Currid 1985: 98-100; Mazar 2001; Pfälzner 2002).

In the past, as well as today, several universal principles have guided the construction of silos worldwide (Currid 1985: 104-9; Beedle 2001). These principles can be seen on different scales, from the individual farm that stores a few tons of grain to large harbour installations that handle millions of tons each year:

1. A cylindrical shape, which better withstands the pressure of the grain, distributed evenly onto the sides of the silo and does not create stress on the base or corners of a rectilinear shape. A rounded wall requires less building material than rectilinear walls confining an equal space.
2. A number of silos are built in close proximity. It is easier to handle storage in a number of smaller silos than in one large installation, making it possible to store grain of different

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years, or different crops, separately. In the case of spoilage by fire, humidity, rodents or insects, not all the stored material will be affected.

3. Organisation in rows, adjacent to each other, optimising their arrangement within a confined space.

Tel Tsaf indicates that such silos were built in the ancient Near East as early as the late sixth millennium BC. In addition to their importance in the history of storage, they shed light on surplus accumulation and concentration of wealth on a scale never before reported from the Proto-historic Near East. Their location not in Greater Mesopotamia but in the southern Levant is surprising, as this area has not previously revealed evidence of economic and social complexity at such an early date.

## Tel Tsaf

Tel Tsaf is located in the central Jordan Valley near Beth Shean (Israel new grid map reference 2015.2024; Figure 1). In 2004-2007 four excavation seasons were conducted by Y. Garfinkel on behalf of the Institute of Archaeology of the Hebrew University of Jerusalem.

Nearly 800m<sup>2</sup> were opened and a densely built-up settlement has been unearthed (Garfinkel *et al.* 2007a & b). The site was occupied only during the Middle Chalcolithic period and a date of 5200-4600 cal BC has been established on the basis of eight recently obtained radiometric dates (Figure 2).

Large-scale excavations exposed a composite array of courtyard buildings combining rectilinear rooms, rounded rooms and 19 rounded silos (Figures 3-5). The silos, which vary in number and size, are located within large open courtyards. They are well-built mud-brick installations, 1-4m in diameter, with thick paved floors and rounded plastered walls (Figures 6-8). These silos conform with the three principles mentioned above: they are rounded, built in groups and arranged in straight lines.

Several aspects of the material culture of Tel Tsaf indicate the importance of this site. The basic dwelling unit was a large (over 250m<sup>2</sup>) courtyard structure. The site has an important assemblage, including an elaborate type of pottery, not found in any

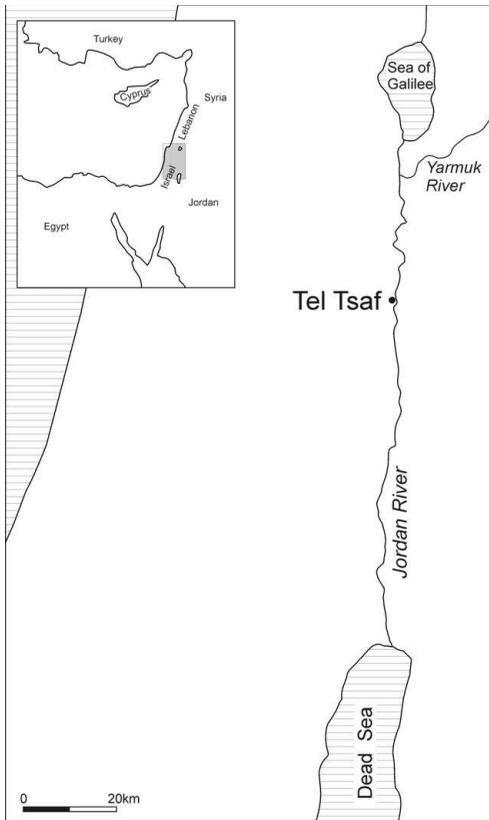


Figure 1. Map of the southern Levant and the location of Tel Tsaf.

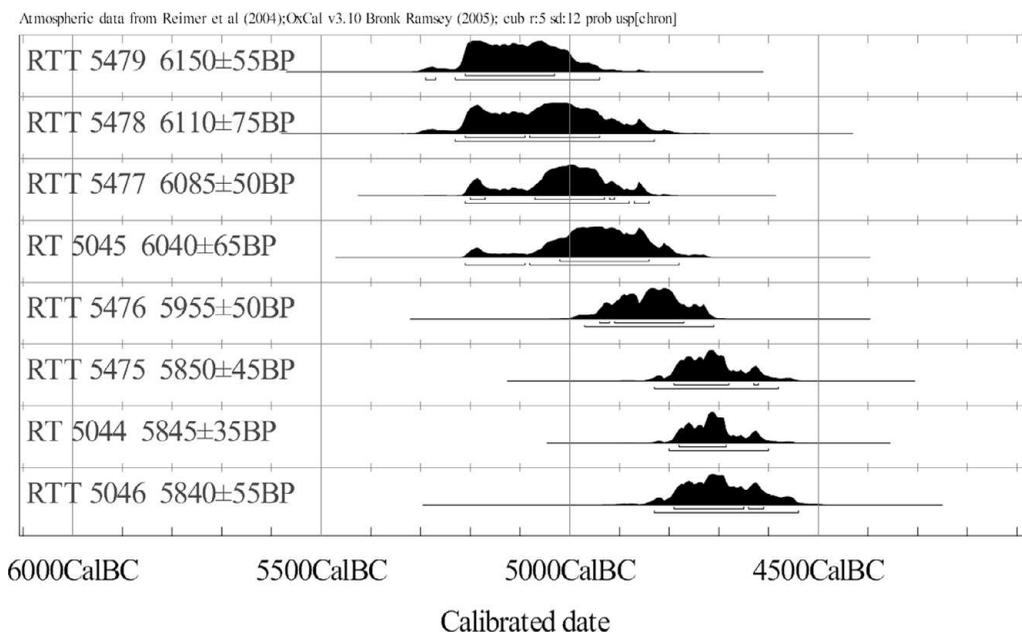


Figure 2. Radiometric dates from Tel Tsaf.

other site in Israel (Garfinkel 1999: 186-8), four sherds of Ubaid pottery (Garfinkel *et al.* 2007a: Figure 13) imported from either North Syria or Mesopotamia – such pottery has not previously been found in the southern Levant; a Nilotic shell together with a large number of Mediterranean shells (D. Bar-Yosef Mayer, *pers. comm.*); over 2500 beads made from ostrich egg shell, in two concentrations, one of *c.* 900 beads in a courtyard and the second of 1668 beads in a single grave; about 100 stone beads were made from various green, red and black minerals; a number of greenstone chunks, imported to the site as raw materials; 140 clay sealings and one stone seal. Obsidian, which was exported to the southern Levant from Turkey during the Neolithic and Early Chalcolithic periods, stopped circulating during the Middle Chalcolithic period. However, at Tel Tsaf nearly 15 obsidian items have been unearthed.

This evidence of an intensive exchange network and accumulation of wealth during the Middle Chalcolithic is known so far only from Tel Tsaf (Garfinkel *et al.* 2007a: 28-30).

## The silos

The basic information on the architecture of Tel Tsaf is presented in Tables 1 and 2 and Figures 4 and 5. The large horizontal exposure unearthed four major architectural units. Each of these units contained rounded silos:

**Building I** (Figure 5): a large open courtyard includes a large rectangular room (10 × 5m), rounded silos and many cooking installations (hearths, ovens and roasting pits). These

**Table 1. The different buildings in Area C at Tel Tsaf.**

Elements	Building I	Building II	Building III	Building IV
Exposure	Nearly complete	Nearly complete	Small part	Nearly complete
Excavated area	256m <sup>2</sup>	200m <sup>2</sup>	160m <sup>2</sup>	200m <sup>2</sup>
Courtyards	Large	Large	Large	Large
Roofed rooms and their number	Rectangular (1)	Upper phase rounded (2) Lower phase rounded (3)	Rectangular (3)	Rectangular (2)
Number of silos	Upper phase: 4 Lower phase: 5	Upper phase: 2 Lower phase: 3	1	Upper phase: 2 Lower phase: 4
Reconstructed storage capacity	Upper phase: 51.2m <sup>3</sup> Lower phase: 51.6m <sup>3</sup>	Upper phase: 21.7m <sup>3</sup> Lower phase: 25.3m <sup>3</sup>	7m <sup>3</sup>	Upper phase: 29.8m <sup>3</sup> Lower phase: 35.4m <sup>3</sup>
Reconstructed weight*	Upper phase: 35.8 tons Lower phase: 36.1 tons	Upper phase: 15.2 tons Lower phase: 17.7 tons	4.9 tons	Upper phase: 20.8 tons Lower phase: 24.8 tons
Reconstructed cultivated area in hectares**	Upper phase: 71.6 Lower phase: 72.2	Upper phase: 30.4 Lower phase: 35.4	9.8	Upper phase 41.6 Lower phase 49.6

\*700 kg per m<sup>3</sup>.

\*\*500 kg per hectare.

**Table 2. The silos of Tel Tsaf. The volume is estimated to a height of 2m.**

Silo no.	Building (stratum)	Outer (inner) diameter (m)	Inner area (m <sup>2</sup> )	Estimated capacity (m <sup>3</sup> )	Notes
<b>C53</b>	I (upper phase)	2.9	6.6	13.2	
<b>C64</b>	III	2.1	3.5	7	
<b>C66</b>	I (lower phase)	1.9	3.45	6.9	
<b>C74</b>	I (lower phase)	2.0	3.15	6.3	Adult burial C98
<b>C122</b>	II (C-3b)	1.5	1.8	3.6	
<b>C171</b>	I (lower phase)	2.2	3.8	7.6	
<b>C189</b>	? (C-4c)	1.6	2	4	
<b>C272</b>	II (C-3)	3.0	7.05	14.1	Jar burial C310
<b>C286</b>	I (upper phase)	3.3 (3.0)	7.05	14.1	
<b>C288</b>	II (C-3)	2.2	3.8	7.6	
<b>C339</b>	I (upper phase)	3.25 (3.0)	7.05	14.1	Adult burial C555
<b>C415</b>	I (upper phase)	2.8 (2.5)	4.9	9.8	
<b>C471</b>	II/IV (C-3b/4a)	2.6	5.3	10.6	
<b>C550</b>	IV (C-4b)	2.2 (1.85)	2.7	5.4	
<b>C565</b>	IV (C-4b)	1.8	2.55	5.1	
<b>C568</b>	IV (C-4b)	4.0	12.6	25.2	Plastered
<b>C582</b>	IV (C-4a)	3.5	9.6	19.2	Infant burial C518
<b>C603</b>	I (lower phase)	2.5	4.9	9.8	Charred cereals
<b>C633</b>	I (lower phase)	1.6	2	4	

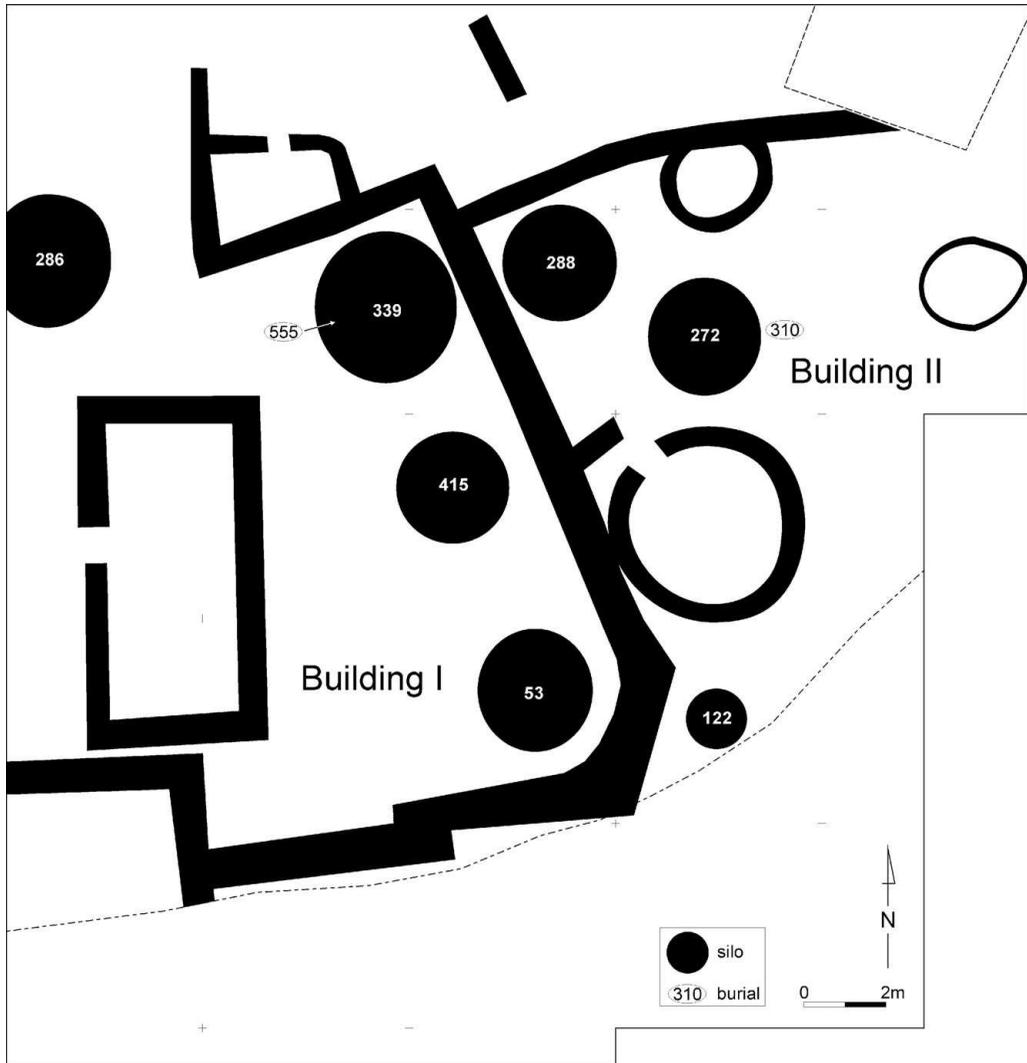
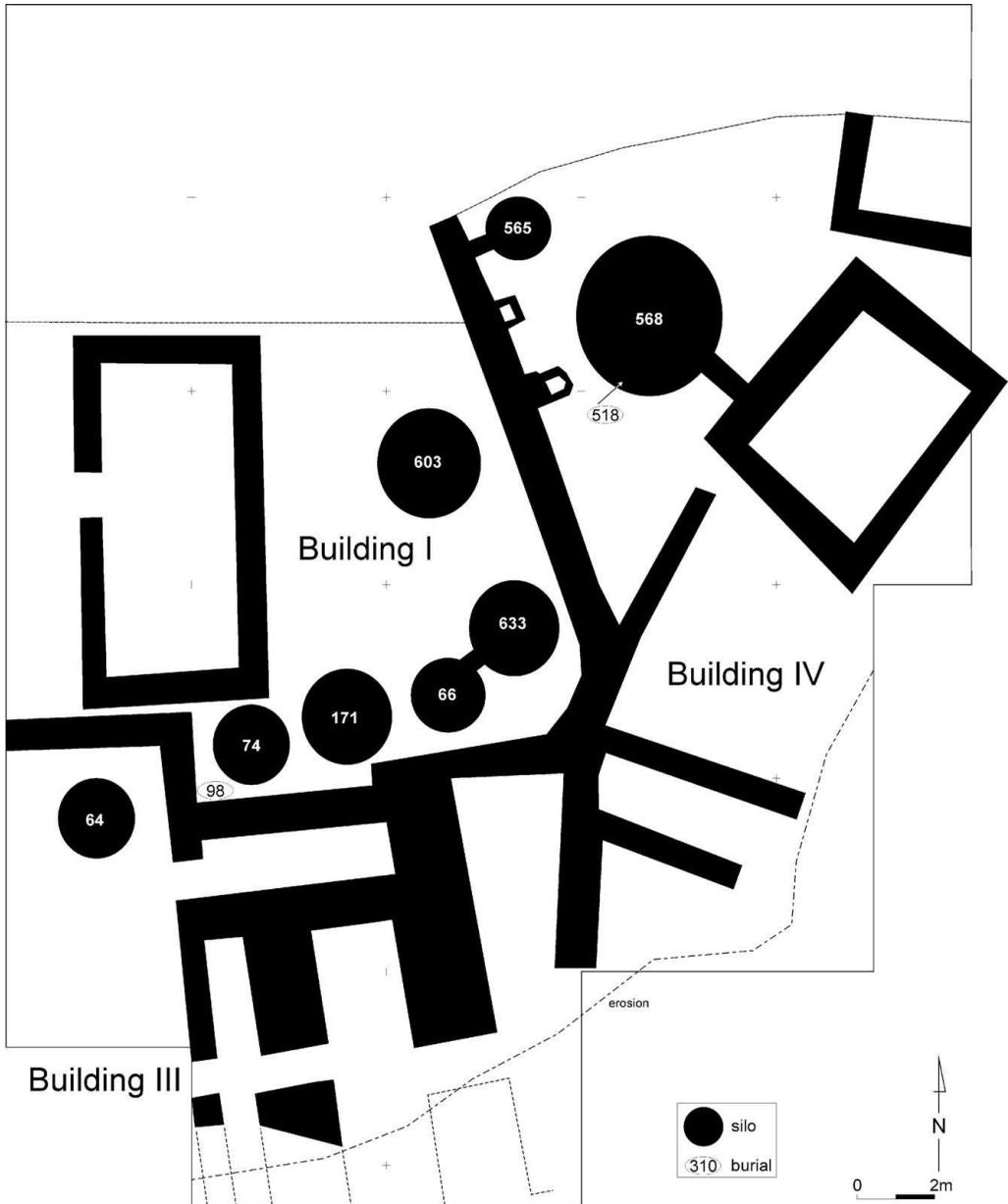


Figure 3. General map of Area C, upper phase.

installations measure roughly  $1.5 \times 0.8\text{m}$  and are filled with burnt stones and very large quantities of animal bones. It appears that feasts were held in the courtyard of the building from time to time.

Although two main stratigraphic phases were discerned here, the general plan did not change. In the lower phase (Figure 4) there are four equidistant silos of the same size and oriented on the same axis, with a cobbled floor of medium-sized angular pebbles between them (Table 1). This floor was covered by burnt debris containing large patches of charred wood and two anthropomorphic female figurines. An additional silo contained charred cereal seeds. In the south-west corner of the courtyard, adjacent to a silo, Burial C98 was found.



*Figure 4. General map of Area C, lower phase.*

In the upper phase (Figure 3) the courtyards contained four silos, which were larger than the earlier silos, reaching a diameter of 3.5m; however, they did not maintain the aligned orientation of the previous phase. In the centre of one of these silos a concentration of large stones covered Burial C555 (Figures 6 and 9).



Figure 5. Tel Tsaf Area C, general view at the end of the 2008 season, with Building Complex I in the foreground. A few stratigraphic phases are shown together.

**Building II:** a large open courtyard (the eastern part has been eroded away) with two rounded rooms in its upper phase and three rounded rooms in its lower phase. These rounded rooms were residential units, as indicated by living floors, cooking installations, pottery, flints and grinding stones (Figure 10). Unlike the silos, which were built on a podium, the lower parts of the rounded rooms were sunken below the courtyard floor level.

Three rounded silos were built here. One of them has three main phases. Its size was largest (4m in diameter) in the lowest phase and diminished as it was rebuilt (Figure 7; Silo C568, see Table 2). During the intermediate stage of this silo Burial C518 was inserted in the floor of the earlier silo (Figure 11). During the upper stage Jar Burial C310 was deposited next to the silo's eastern side (Figure 12).

**Building III:** only a small part of this structure has been excavated, and one silo was found in an open courtyard.

**Building IV:** this structure is located under Building II having a similar outline but different interior arrangement (Figure 4). Here large rectangular rooms were constructed, as well as three rounded silos and cooking installations.

The construction techniques of the silos are apparent from the field observations. The base comprised of one or two courses of bricks created a podium, probably to protect the



*Figure 6. Silo 339 in Building I, with stones covering burial in its centre.*

grain from rodents and humidity. While the bases were relatively well preserved, the walls of the silos had usually not survived, and consequently their height is not known. The outer wall of the silo was thin and built on top of the podium, with elongated bricks laid on their narrow end. When preserved to a height of about 0.3m (Figure 6) it indicates a cylindrical, barrel-shaped structure. According to ethnographic parallels (e.g. Aurenche 1981: Figure 207; Pfälzner 2002), as well as depictions on somewhat later cylinder seals (Figure 13), that show such structures accessed by ladders, (Amiet 1972: 652: Plate 16, 658-63), a total height of around 2m is estimated (Figure 14). This height seems a conservative approximation, as it is not likely that the height of such thick-floored structures would have been smaller than their diameter. This height is used for the reconstructed storage capacities given in Table 2 (the volume is calculated assuming a cylindrical shape).

The interpretation of these structures as silos is based on their cylindrical barrel shape and their spatial organisation, the thick base which protected the grains, and the large quantities of charred seeds found in one of them. On the outer walls of two of the silos, white plaster was still preserved. In their time the silos may have been white towers visible from a distance, manifestation of economic and probably political power. The roofing, which was not preserved, was probably made of a mixture of mud, reeds and wood, as testified by various chunks of such material found in the site's sediments.



Figure 7. Silo 568 in Building IV.

## The burials

Four burials were found in Tel Tsaf, all of them within or in association with the silos:

**Burial C98:** the burial is located adjacent to the south-west of Silo 74 and includes an individual laid in a flexed position, oriented with the head in the east and legs to the south. It was badly damaged by an oven pit cut into it at a later stage. Age at death was between 20 and 30 years. The thin margin of a fragment of an eye orbit may indicate that the deceased was a female. The bones are extremely fragmentary and were burned at varying high temperatures. No associated grave goods were found with the burial.

**Burial C310:** a jar burial containing a neonate, found adjacent to Silo 272 on its east (Figure 12). The skeleton was complete and lay on its side with knees flexed, the head in the east and the legs in the west. No associated grave goods were found with the burial.

**Burial C518:** a burial found in Silo 582, oriented east-west with the skull in the west (Figure 11). This complete and articulated skeleton was that of a one-year-old infant, lying on its right side with knees flexed. The head was turned to the right and the hands lay beside the body. No associated grave goods were found with the burial.



*Figure 8. Close-up of Silo 565 in Building IV.*

**Burial C555:** an articulated burial found in Silo 339, oriented north-south with the skull in the south. The head turns to the right, the knees were flexed and the arms were slightly flexed at the elbow. The remains are possibly those of a female aged approximately 40 years. The burial was found with 1668 beads placed on the frontal part of the pelvis, organised in six rows (Figure 9).

Each of these burials is of a single individual in articulation, usually in flexed position, and they are all associated with a silo, two inside a silo and the two others beside a silo. One of the burials was decorated with 1668 beads. Clearly, the vast majority of the population was not buried in relation to the silos, and these were probably buried in cemeteries outside the settlement, as at Late Chalcolithic Shiqmim (Levy 1987) and

other sites. The burials related to the silos reflect selected, possibly important, individuals.



*Figure 9. Close-up of the adult burial in Silo 339.*



Figure 10. A rounded room at Tel Tsaf.

## Discussion

### Storage facilities

During the Proto-historic period in the southern Levant, storage facilities were found in almost every chronological phase:

**Pottery Neolithic (c. 6400-5800 BC calibrated):** several large pottery vessels were found sunken below floor levels at Sha'ar Hagolan and Munhata (Garfinkel 1992: 1, Figure 60; 2004: 117-18). To avoid insect activities the jars were probably hermetically sealed, blocking the supply of oxygen and creating a modified atmosphere (Ben-Yehoshua 2005).

**Early Chalcolithic (c. 5800-5300 BC calibrated):** the large pottery vessels of the previous period were manufactured in this stage as well, which is known as the 'Wadi Rabah Culture' (Garfinkel 1999: 127).

**Middle Chalcolithic (c. 5300-4500 BC calibrated):** in this stage three different storage facilities types have been found: the silos of Tel Tsaf; large pottery jars were found sunken below the floor level at the sites of Herzliya and Tell Wadi Feinan (Garfinkel 1999: 191-3); and small, shallow and rounded subterranean installations, c. 1m or less in diameter, lined with stones. The floors of these silos were paved with flat slabs and their sides were lined with elongated slabs placed on their end. Their storage capacity was limited to a few hundred kilograms. These silos have been reported from many sites: Tel 'Ali, Kefar Gil'adi, Kabri, Kefar Galim, Tel Qiri and Tell Shuna (Garfinkel 1999: 155-8), Tel Teo, Asawir



Figure 11. Infant burial in Silo 582.

(Eisenberg *et al.* 2001: Figures 3.10, 3.17, 3.18; Yannai 2006: Figures 2.7, 2.8) and 'Néolithique récent' Byblos (Dunand 1973: Plates 33: 1-3, 39: 2).

**Late Chalcolithic (c. 4500-3600 BC calibrated):** different strategies were used in this period. Very large pottery vessels (up to 2m high) were found sunken below the floor level at Tell Dalhamiya, Tel Kitan and Abu Hamid (Garfinkel 1999: 249-53). At Gilat, rounded pit silos lined with stones or bricks were reported (Levy *et al.* 2006: 114-5, Plates 5.9-10); these were about 1-1.5m in diameter. At Abu Matar and Bir Safadi, bell-shaped pits interpreted as silos were found in rather large numbers (Perrot 1955).

The Tel Tsaf silos are in sharp contrast to all other Proto-historic silos unearthed in the southern Levant. They are above ground, carefully built and plastered, and their storage capacity is ten times that of the other examples, or even more. It is possible that they reflect a northern Mesopotamian tradition. Rounded free-standing storage installations, 2-4m in diameter, have been reported from a number of Proto-historic sites in Mesopotamia, like Hassuna, Yarim Tepe and Tell Sabi Abyad (Aurenche 1981: Plate 94; Merpert & Munchaev 1984; Verhoeven & Kranendonk 1996: 59-63, Figures 2.9, 2.12, 2.14-15). In contrast to the Tel Tsaf silos, they were never placed in an enclosed courtyard but were located in open areas between structures. Their number per site is quite limited, only two or three at a time.



Figure 12. Infant Burial 310 in jar, found adjacent to Silo 272.

Thus, the arrangement of the silos and the scale of storage at Tel Tsaf are outstanding for the period, even when compared to the Mesopotamian sites. As a matter of fact, they resemble storage installations of much later periods, when we can talk about state organisation in urban environments. Indeed, a similar installation was found at Tepe Farukhabad dated about a millennium later (Wright 1981: Plate 4b). Granaries with rows of rounded silos are known from various artistic representations (Figure 13): cylinder seals from Susa (Amiet 1972: 652, Plate 16, 658-63), Egyptian wall paintings (Currid 1985: 104, Figures 2-5 and references therein) and a clay model from the Greek island of Melos (Marinatos 1946).

## Social aspects

Various storage strategies can be inferred from ethnographic observations, each reflecting a different social and economic organisation. Community-level storage is when grain is stored for the common use of the community, with distribution according to need, social rank or other factors. The silos in this case are usually located in the centre of the settlement. Ethnographic examples of this have been obtained from Burkina Faso, West Africa, from the villages of the Lela and Nuna peoples (Bourdier & Minh-Ha 1985: 64-7). In these places a large group of silos is located in the centre of the village, around it or in non-confined open areas near the houses, and comprises common community-level storage (Bourdier & Minh-Ha 1985: 64-7, Plate D9; Pfälzner 2002: 264-6, Figures 6-9; for other examples

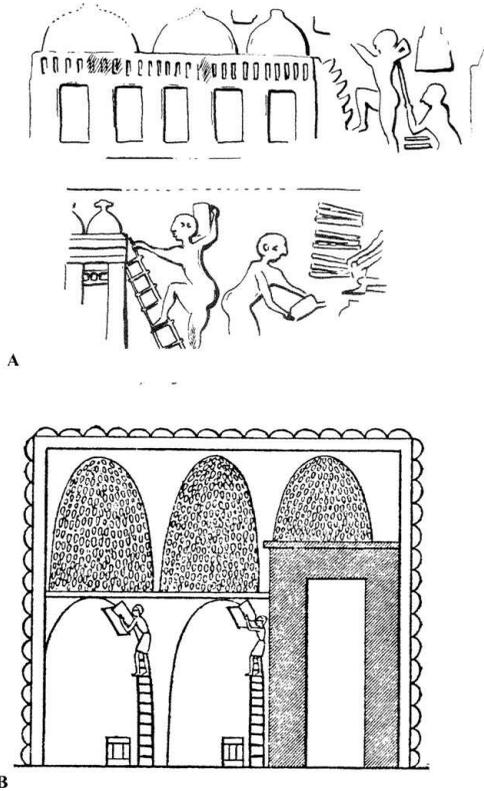


Figure 13. Depiction of rounded silos on cylinder seals from Susa (A: Amiet 1972: Plate 16, 660, 663) and on a wall-painting from Thebes (B: after Currid 1985: Figure 2).

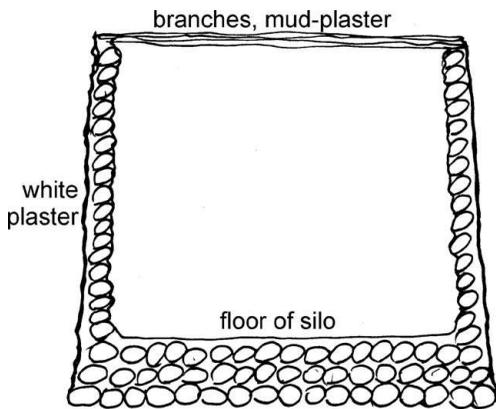


Figure 14. Reconstruction of a silo at Tel Tsaf.

at Tel Tsaf is 12 to 24 times larger, with figures like 15.2, 17.7, 20.8, 24.8, 35.8 and 36.1 tons (Table 1). Thus, we have a clear indication of surplus accumulation on a scale never unearthed before in the Proto-historic Near East. Possibly, the differences in storage capacities between the buildings at Tel Tsaf reflect differences in the socio-economic status of these families.

see p. 262 there). Private storage in jars also occurs in the various households as domestic-level storage (Pfälzner 2002: 266, Figure 10). This is probably an example of a relatively egalitarian society, as the whole community belongs to a single clan.

Storage on a family or household level is when grain is stored within private property. In an egalitarian society each family stores the products grown in the family's fields. In a stratified society, families of higher rank may receive a certain portion of the grain cultivated by other members of the community. An ethnographic example of this was observed at the village of Hasanabad in north-western Iran, where the chief of the village stores crops from the entire community in the especially large courtyard of his house, the *Qal'a* (Watson 1979: 34, 40, 294, Figure 5.29). In this case the goods 'taxed' from various parts of the community are stored in certain confined properties or in central 'institutional' structures (for early Near Eastern societies see e.g. Hole 1999; Pfälzner 2002 and references therein).

In the case of Tel Tsaf we are not dealing with community-level storage, as the silos are located within the privately owned courtyards. This is probably not domestic-level storage in an egalitarian society, due to the relatively large capacity of storage per household. Each building probably housed only a nuclear family, as the roofed area is quite limited. The common estimation of a person's consumption of cereals per year is around 200kg (Hole 1991; Mazar 2001: 458). Thus, a nuclear family does not need more than 1.5 tons of cereals per year. The storage capacity of the courtyard structures

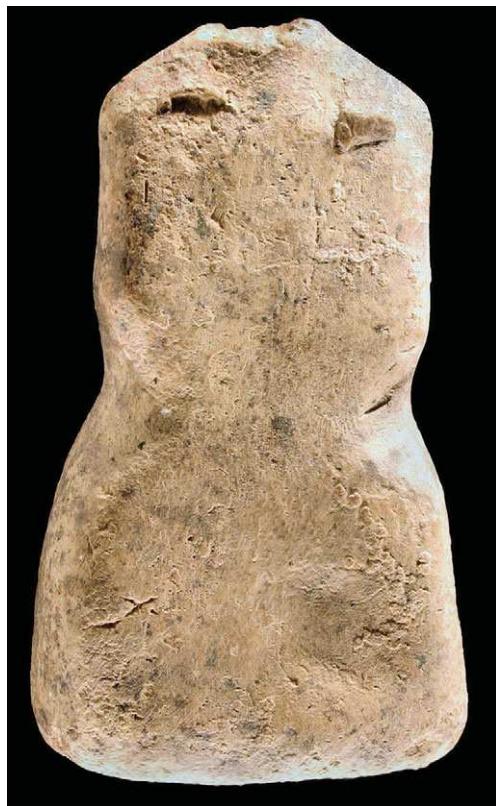


Figure 15. An anthropomorphic figurine found between two silos (photograph by V. Naikhin).

Moreover, traditional agriculture yields about 500kg of grain per hectare. Therefore, to accumulate 20 tons of grain, cultivation of 40ha is required. This is clearly beyond the working capacity of a single family, and raises several questions about the socio-economic structure of the settlement. Who cultivated the lands that produced such large amounts of grain to be stored within the silos at Tel Tsaf? Does this evidence indicate an economic system with 'landlords' owning large territories of land cultivated by 'serfs' or 'paying tenants'? Or, do we have evidence of a tax-collection system imposed by elite families on other families in the settlement? The storage strategies employed at Tel Tsaf must have involved some kind of long-range planning and can be considered evidence for some degree of administration, at least on the local settlement scale. A further link to administration and redistribution may be provided by a stone seal and 140 clay sealings found in the site.

## Symbolic aspects

The symbolic and religious importance of the silos at Tel Tsaf is implied by the figurines and burials associated with them. The only two large female figurines from the site were found between two silos in Building I (Figure 15). Connections between storage and cult have been noted in many cases (see, for example, Childe 1950; Mazar 2001). These connections may be explained by two rather universal mechanisms. The first is obtaining greater legitimacy for a taxation system by associating it with the needs or desires of a deity. The second is using supernatural forces to protect the silos from any possible threat.

As noted above, all four burials, adults and infants alike, were found within silos or adjacent to them. Human burials within or in relationship to silos probably occur in several other Chalcolithic sites in the southern Levant: Abu Matar (Perrot 1955: 26, 173, Figure 26a) and Gilat (Levy *et al.* 2006: 108, 337, Plate 5.19). Bar-Yosef & Ayalon (2001) suggested that the clay ossuaries used for secondary burials in the Late Chalcolithic period were made to imitate silos. They presented various ethnographic examples of similar silo structures from Israel, Iran, Georgia, Spain and Rajasthan, India. One may suggest that ossuary burials evolved from or were related to secondary burials in silos during the Late Chalcolithic, which in turn evolved from primary burials in silos in the Middle Chalcolithic.

Burials in relation to silos occur in other cultures and regions of the world in various periods: Iron Age France (Lambot 1998), seventh–first centuries BC Britain (Aldhouse-Green 2004: 331) and 1500-2000 BP Texas (Lovata 1997).

Burials in or near structures for the storage of grain may have reflected the belief in regeneration and the analogy made between the rebirth of a seed planted in the ground and the rebirth of a human buried in the silo. Such symbolic significance could have been associated with myths and beliefs related to death and rebirth. The oldest known case of such a myth is the Sumerian resurrection cycle of Inanna and Dumuzi (Jacobsen 1970; 1976), Osiris of the Egyptian mythology (Mettinger 2001: 217-18) and later Persephone in the Greek mythology. A connection between silos and resurrection myths was also suggested for reused silos in Iron Age Europe (Bradley 2003: 19). At Tel Tsaf the burials in silos are among the earliest examples of this concept. Furthermore, in the Sumerian mythology Inanna is associated with the storehouses (Jacobsen 1976: 36, 135), and at Tel Tsaf the two anthropomorphic female figurines were found near silos. Moreover, the two adult individuals buried in or near the silos seem to have been females.

## Conclusion

The silos of Tel Tsaf represent grain storage on a scale not previously unearthed in the Proto-historic Near East. Differences in the arrangement and sizes of the silos between the structures and the chronological phases probably represent different storage strategies. Their location within nuclear-family courtyard structures reflects a complex economic system with surpluses and accumulation of wealth, which is not distributed equally between members of the community. The amounts of grain that could have been stored in the silos by far exceed the needs of the inhabitants of the buildings accommodated in them, as well as exceeding the cultivation capacity of these people. Therefore, they indicate a high degree of social stratification in this period.

The symbolic and religious significance of the silos is indicated by the figurines and burials associated with them. The linkage between death and the storage of grain probably indicates early mythological belief in death and regeneration. This is possibly one of the earliest manifestations of this symbolism, which continues to be prominent in the ancient Near East and beyond for several millennia.

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