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ORIGINAL ARTICLE

Kom W and X Basin: Erosion, Deposition, and the Potential for Village Occupation

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Abstract The twentieth-century excavations of stratified deposits at Kom W, adjacent to Lake Qarun in Fayum north shore, Egypt, led to a variety of interpretations, including the argument for the presence of a Neolithic village. This has influenced the evaluation of early to mid-Holocene occupation in Egypt. Here, we report our recent study of the erosion and deposition processes at the site and its environs in order to reassess these interpretations. Changes in the level of Lake Qarun, evidence for wind erosion, deflation, and deposition, and analyses of artifact density provide a geomorphic context for Kom W and its immediate environs. Radiocarbon determinations from surface hearths that surround the Kom are reported. From the time of its initial formation, Kom W was subject to post-depositional processes, particularly wind erosion, which have affected the site's current form, and the preservation of features and artifact within the deposits. These changes need to be considered when deriving behavioral interpretations from the archaeological record at Kom W and in the surrounding area. The composition of deflated deposits that surround Kom W suggests that the site is not as unique as once imagined. Remains that might have allowed interpretations of a village occupation have not survived. Instead, deposits are consistent with other early to mid-Holocene occupations interpreted as locations with the use of domesticates but without villages.

Résumé Les fouilles du XXe siècle des dépôts stratifiés de Kom W, adjacent au lac Qarun sur la rive nord du Fayoum, en Égypte, ont donné lieu à diverses interprétations. Notre récente étude des processus d'érosion et de dépôt sur le site et ses environs, dont il est question ici, permet de réévaluer ces interprétations. Les changements de niveau du lac Qarun, les preuves d'érosion éolienne, de déflation et de dépôt, et les analyses de la densité des artefacts fournissent un contexte géomorphique pour le Kom W et ses environs immédiats. On rapporte des déterminations de radiocarbone dans les foyers de surface qui entourent le Kom. Depuis sa formation initiale, le Kom W a été soumis à des processus post-dépôt, en particulier l'érosion éolienne, qui ont affecté la forme actuelle du site, et la préservation des caractéristiques et des artefacts dans les dépôts. Ces changements doivent être pris en compte lors de l'interprétation du comportement des

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vestiges archéologiques du Kom W et de ses environs. La composition des dépôts dégonflés qui entourent le Kom W suggère que le kom n'est. pas aussi unique qu'on l'avait imaginé. Les vestiges qui auraient pu permettre des interprétations de l'occupation d'un village n'ont pas survécu. Au contraire, les dépôts correspondent à d'autres occupations du début et du milieu de l'Holocène interprétées comme des lieu où l'on utilise des domestiques sans village.

Keywords Fayum · Egypt · Neolithic · Wind erosion · Site formation

Introduction

Caton-Thompson and Gardner (1934) excavated Kom W, on the north shore of the Fayum Depression, Egypt, during their 1925–1926 field season. The excavation revealed pits, hearth features, faunal remains, stone artifacts and pottery, among other forms of material culture. Based on these materials, they interpreted Kom W as the remains of a Neolithic village and this interpretation persisted in the early syntheses of the prehistory of the wider region (e.g,. Childe 1956; Braidwood 1958). Kom W represented the most extensive Neolithic site that Caton-Thompson and Gardner encountered in the Fayum, both in terms of the depth and extent of deposits, and in the concentration of portable material culture. Their interpretation of the site as a village settlement is therefore not surprising, particularly given knowledge of the Neolithic in the mid-twentieth century. However, recent reassessment of archaeological remains in Egypt, particularly those found in other parts of the Fayum north shore, suggests that previous interpretations need careful assessment in light of a contemporary knowledge of post-depositional formation processes in the region (Emmitt 2019; Holdaway et al. 2016; Holdaway and Wendrich 2017; Phillipps and Holdaway 2016; Phillipps et al. 2016a). Here, we further consider the archaeological record at Kom W with the study of the geomorphic processes that affected the deposits before and after Caton-Thompson and Gardner excavated the site in the 1920s, and have continued to impact the site into the twenty-first century. We also consider Kom W in relation to surface deposits of archaeological materials that surround the site. We comment on the significance of geomorphic processes for interpreting Kom W and the surrounding deposits in particular, and for current interpretations of the broader Egyptian Neolithic landscape in general.

Geomorphic Processes and the Archaeology of the Fayum Depression

Kom W is located within the Fayum Depression, a naturally occurring basin separated from the Nile Valley by a ridge known as the Nile-Fayum divide (Sandford and Arkell 1929; Fig. 1). Floodwaters from the Nile Valley once entered the Fayum Basin at Hawara and caused fluctuations in the level of Lake Qarun that formed within the basin (Hassan 1986). At present, the surface of the lake averages 44 m below sea level (bsl) but in the early Holocene, lake levels were considerably higher and therefore the lake covered a much greater surface area than it does today (Phillipps et al. 2016b). Kom W is located to the north of the lake, in an area referred to as the Fayum north shore.

Caton-Thompson and Gardner (1934) recorded evidence interpreted to represent fluctuations in the levels of Lake Qarun, and they incorporated these changes in their assessment of cultural shifts in the region including those that related to the origins of Egyptian Neolithic. Subsequent researchers also used these lake level changes to make chronostratigraphic correlations (e.g., Wendorf and Schild 1976). However, changes in the extent of Lake Qarun form only one of three sets of processes that have had a significant bearing on the archaeological deposits from the Fayum north shore, the other two being wind erosion and deposition of sediments. Ephemeral streams (*wadi*) on the north shore may have also had a minor influence on the archaeological deposits and there is some evidence for stream activity prior to and during the early to middle Holocene. In addition, more recent human activity in the form of modern development continues to impact the area significantly. Here, we consider the implications of all three processes for understanding archaeological site formation. We begin with the review of recent studies on the changes in the level of Lake Qarun.

Lake Qarun Level Changes

In their intial studies, Caton-Thompson and Gardner identified a series of depressions along the Fayum north shore that they termed basins, designating these with letters. Fig. 2 shows the locations of the basins as well as

Fig. 1 Sites mentioned in the text and the location of the Fayum in northeast Africa.

the 10 m, 18 m, 20 m and 24 m contours above sea level (asl) based on a modified digital surface model (DSM) derived from 1-m Worldview contours (Phillipps et al. 2016b). The figure also indicates the locations of the stratified sites identified by Caton-Thompson and Gardner (1934), Kom W and Kom K, and the surface sites identified in later work by Wendorf and Schild (1976), E29H1 and E29G1, together with high lake levels proposed in other studies (Hassan 1986). Any lake level between 18 m and 24 m would submerge all of these sites and the areas with surface archaeological deposits that surrounded them. Even a lake advance to the 18 m contour means that the majority of the areas identified with surface archaeological deposits would be beneath the lake waters. Therefore, the previous estimates of the lake level are inaccurate since archaeological deposits across the Fayum north shore do not indicate modification through water movement (Holdaway and Wendrich 2017; Phillipps et al. 2016b).

Caton-Thompson and Gardner (1934) suggested that one of their basins, Z basin, might have formed an inlet from the high stand Lake Qarun, thereby attracting occupation. A falling lake level then caused a series of additional basins, named X, K, L, N and U (a basin that they left unnamed hence the U designation), to become lagoons which also attracted settlements (Fig. 3). Calculations of the areal extent and steepness indicate that among these basins, K basin was the largest (6.06 km^2), followed by L basin (4.51 km^2), U basin (3.13 km^2), X basin (2.46 km^2), N basin (2.45 km^2) and Z basin (1.10 km^2) (Phillipps et al. 2016b). K basin has recently suffered from disturbance and so the size calculated from the DSM data may not be accurate. Leaving this basin aside, Z basin has the steepest gradient with a mean slope of 65.07° while X basin with a mean slope of 16.99° is the shallowest.

Caton-Thompson and Gardner (1934) noted wadis that directed water flow into the lake edge basins (Fig. 2). In a later study, Kozlowski and Ginter (1993, p. 333) also suggested that increased rainfall might have fed wadi activity during periods of lake recession. Phillipps et al. (2012) indicated that this wadi activity resulted from the southward movement of winter Mediterranean rainfall during the middle Holocene. Analysis of cores from the southern edge of the current extent of Lake Qarun supports this interpretation. The results show that since ca. 8.4-6.2 ka cal. BP, sediment flowed into the Fayum Basin from

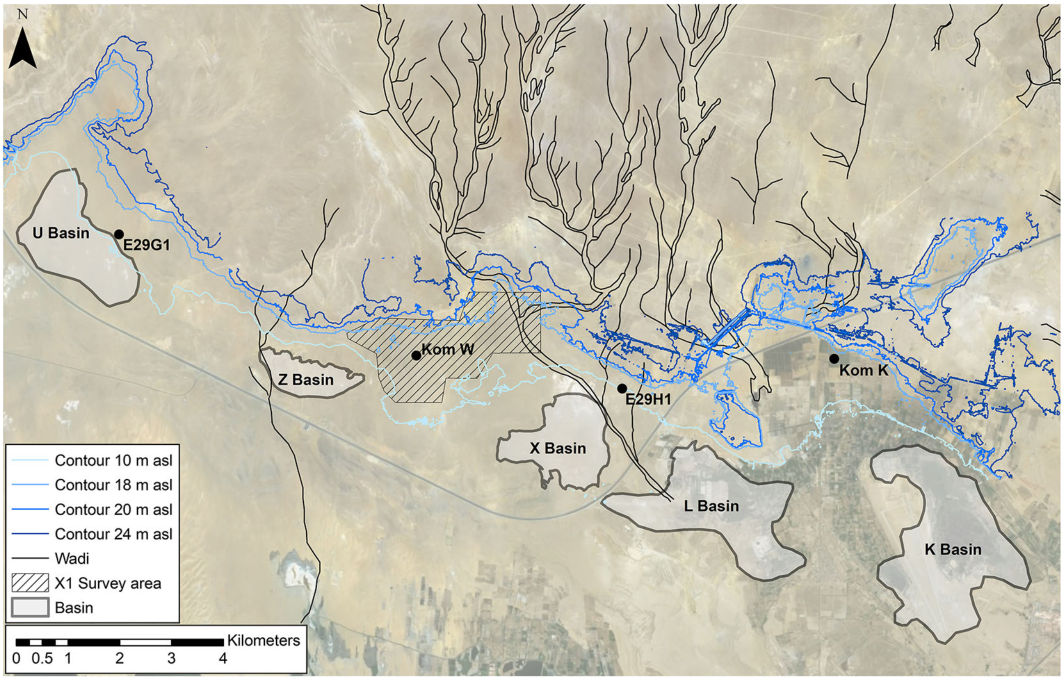

Fig. 2 The Fayum north shore with the locations of places mentioned in the text. Derived from Worldview 2 imagery dated 17 May 2012

terrigenous material during the winter, probably from wadi systems (Flower et al. 2012; Marks et al. 2016, 2018). The influence of the wadi systems on the ancient level of the larger Lake Qarun is unknown but is not likely to have influenced the lake level as much as inflow from the Nile. As long as a permanent connection existed between Lake Qarun and the Nile, the intensity of Nile discharge likely had some effect on the level of Lake Qarun. However, local topographic variability along the lake edge together with the quantity of discharge controlled the impact of any changes in lake level. Different areas of the land surface were subjected to inundation and exposure depending on the steepness of the local topography.

In 1939, Ball suggested that Lake Qarun rose and fell between 2.5 m and 4.0 m annually during the Nile flood. Using this estimate of lake level allows investigation of basin connectedness to the lake during low and high lake levels (Phillipps et al. 2016b). The reconstructed high (7 m) and low (4 m) lake stands show that Z and U were the only basins that would always have remained connected to the main lake, if the lake were to retreat 3 m during periods of lowered lake level (Fig. 1). In contrast, during high lake stands, all the basins remained connected to the lake. Based on such changes in lake level elevation across all the basins, approximately 235.7 km^2 of land surface would be alternatively inundated and exposed, if the lake level changed by as little as 3 m. Whether or not Ball's (1939) estimates are correct, changes in lake level had different impacts on the lake edge basins that Caton-Thompson and Gardner identified. Basins X, L, K, and N would likely have received sediment as part of the fall of the lake level, but U basin, and especially Z basin, would be more prone to erosion due to steepness of the slope along their edges. This has implications both for the archaeological deposits previously reported adjacent to the basins further to the east and for the deposits that surround Kom W near the X and Z basins. Koopman et al. (2016) describe the relationship between archaeological materials and sediment of the X basin, and compare this with the results of sediment analysis in the adjacent Z basin area. These studies suggest that processes of erosion and deposition occurred throughout the Holocene with implications for the types of vegetation and animal habitats that existed within the basins.

Wind Erosion, Deflation, and Deposition

Wind deflation and sediment deposition are today important processes that are continually transforming the land surfaces in the Fayum

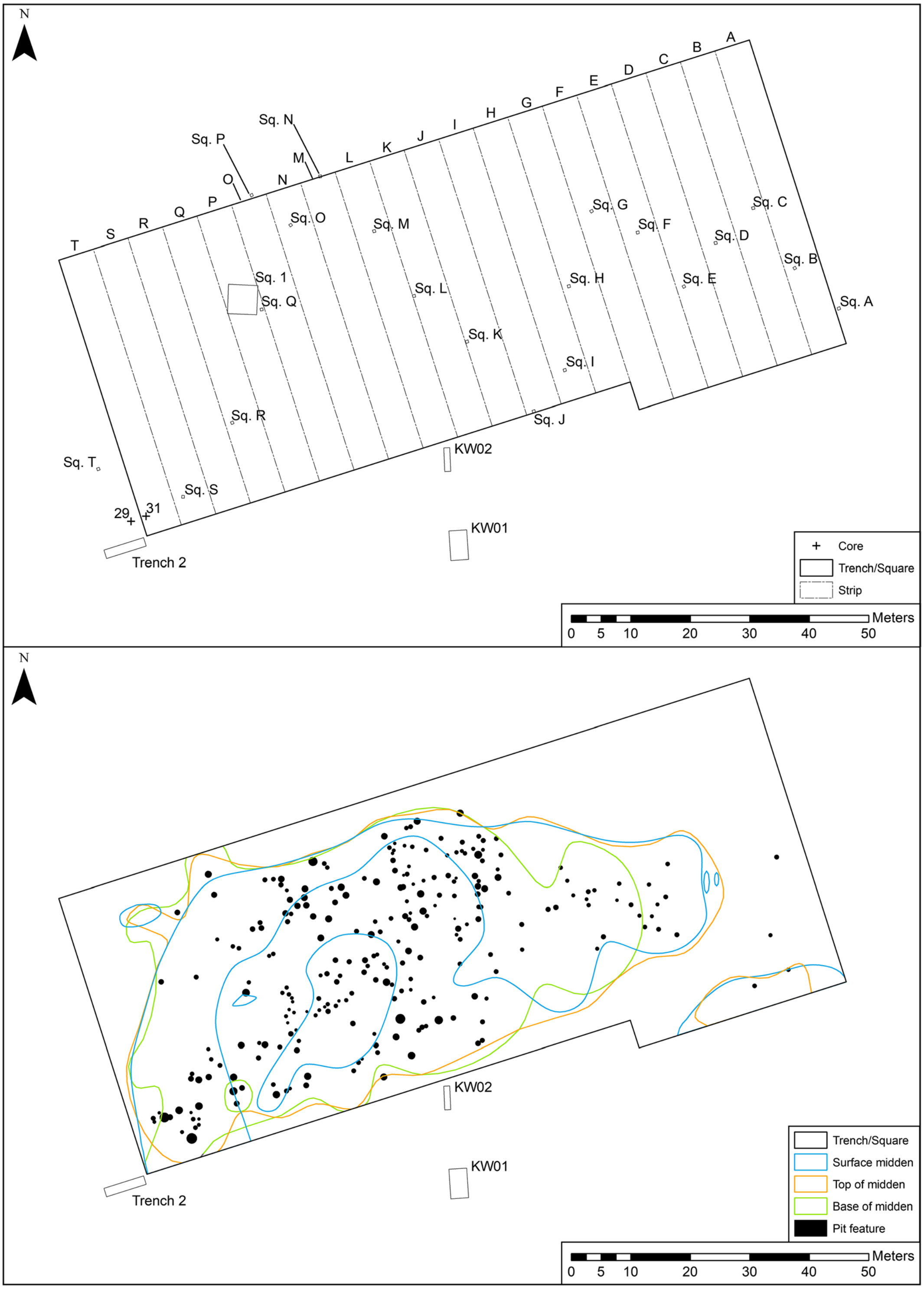

Fig. 3 Location of excavation and survey units and features mentioned in the text. Top: plan view of the Caton-Thompson and Gardner (1934, Pl. V) excavation strips, trench 2 excavated by Wendorf and Schild (1976); URU Fayum Project trenches KW01 and KW02, surface collection squares, sample squares, and cores. Bottom: reconstruction of the deposits and location of pit features excavated by Caton-Thompson and Gardner (1934, Pl. V). Surface midden: visible prior to excavation by Caton Thompson and Gardner; top of midden: full upper extent of the midden with surface drift sand removed; base of midden: extent of midden deposits encountered at the base of excavation

Depression. Hereher (2010) reports high winds in the northeastern parts of the Egyptian Western Desert with drift potential (DP) calculated for the Wadi El-Natroun weather station close to 440 DP, a value that Fryberger (1979) classified as a high-energy wind environment. Winds at this weather station are predominantly from the northwest. Brookes (2003) reports a shift in the predominant wind direction during the Holocene from westerlies that may have existed since the late Pleistocene, to the modern day northerlies/north-easterlies. He reports yardangs eroded by westerly winds with ages that are as recent as 6000 BP. Brookes suggests that these westerly winds did not shift to the north until after the establishment of the modern circulation over the eastern Sahara dated from 5000 BP to 3000 BP at the latest. El-Baz and Wolfe suggest that local topography influenced wind direction, at times more so than the broader desert trends (El-Baz and Wolfe 1982; Wolfe and El-Baz 1979). In the case of the Fayum wind data, wind direction derived from modern measurements shows that northerlies are the predominant wind direction in the area, with the alignment of modern dunes supporting the predominance of winds that carried sand towards the south (El-Baz 1986; El-Baz and Wolfe 1982). In the Fayum, the Gebel Qatrani escarpment also affects the movement of complex barchan dune chains across the area (El-Baz and Wolfe 1982).

Locally, the area that surrounds Kom W features buttes in various sizes, linear sand dunes that extend across the lake basins, areas with sand ripples and erosional features including exhumed muddy hills, and extensive gravel patches, all of which indicate wind erosion. These show the degree of land surface modification by wind erosion and deposition both in the past and continuing into the present. Our observations of these features provided the impetus to consider the impact of erosion and deposition on the archaeological deposits. We begin by considering the Kom W site itself, reconstructing its original form as first encountered by Caton-Thompson and Gardner (Emmitt et al. 2017), and then go on to consider the nature of the erosion process on archaeological deposits. Finally, we consider the broader sedimentary context of X basin (Koopman 2008). All of these studies indicate that deflation has been active throughout the sequence of deposition and post-deposition, with implications for interpreting Kom W and the surrounding archaeological deposits.

Kom W

Caton-Thompson and Gardner excavated Kom W in their 1925–1926 season. Six trenches (A–F) measuring 20 ft. (6.10 m) × 175 ft. (53.34 m) and 14 trenches (G–T) measuring 20 ft. (6.10 m) × 160 ft. (48.77 m) were excavated (Fig. 3). Each previously excavated trench contained the backfill from the next trench investigated. Caton-Thompson and Gardner drew stratigraphic profiles for each strip, as well as a profile diagram that ran along the east-west axis of the site at a local-longitude of 100. Objects with large dimensions or those considered to be of typological significance had their three dimensional positions recorded, a technique that illustrates just how advanced Caton-Thompson and Gardner's excavation methods were for their time. They identified three deposits: drift sand, midden, and lacustrine sand, which is considered a culturally sterile layer. They ceased excavations whenever they encountered this layer.

Caton-Thompson and Gardner identified 248 pit features during their excavations. They described these features as holes sunk into the basal sterile lacustrine sand. Variously described as "pot holes" (Gardner and Caton-Thompson 1926) and "fire holes" (Caton-Thompson and Gardner 1934, p. 24), some of these pit features likely served as pot holders, since they recorded 12 such examples that held complete ceramic vessels (Emmitt 2011). However, due to the indeterminate function of some of these features, we prefer the term "pit feature." These pit features were likely cut through the midden deposits into the underlying lacustrine deposits. However, the 1934 publication only recorded pit features that extended into the lacustrine sands (Fig. 3). Therefore, it is not possible to determine the location of cuts that originated and ended within the midden layer itself, a difficulty noted by Caton-Thompson and Gardner (1934, p. 25) during excavation. The distribution of pit features largely conforms to the maximum excavated extent of the midden deposit with all but a few of the westernmost pit features associated with this deposit type. No large pit features were present below drift sand deposits, possibly indicating that the smaller features below this deposit represent the remnants of larger pit cuts that were eroded before being covered by drift sand.

For trenches L through S, the published profile drawings indicate that layers of drift sand separate midden deposits, while drift sand deposits also cover the trenches further to the west. This suggests that areas of the site were exposed to wind-blown sand deposition (Fig. 3). Wendorf and Schild (1976, p. 212) who investigated Kom W (designated E29H2 in their work) made a similar observation. They noted that artifacts found on the surface of the site were more wind-worn than those retrieved from the excavated contexts. A recent analysis of levels of ceramic fragmentation supports the conclusion that Kom W was subject to erosional processes both during and between occupation periods (Emmitt 2017).

While it is known that Caton-Thompson and Gardner used the material from one trench to backfill the trench previously excavated, the details of how this method was employed are not well understood. We know that the artifact collection strategies used by Caton-Thompson and Gardner focused on objects that held typological significance. However, the fate of objects considered as undiagnostic remains undocumented. Many of these were likely included in the sediments used to backfill the excavated trenches, and some are now on or near the surface of the site, leading to densities that fall within the range of 160–730 artifacts per m^2 (Table 1) (Phillipps 2012). Such densities are much higher than observed on the deflated surfaces of the surrounding area. Excavations bordering the backfill of Caton-Thompson and Gardner's excavation indicate that artifacts are concentrated on or near the surface of the site. The objects encountered in KW02, offset to the leeward side of Caton-Thompson and Gardner's excavations, show that 83% of the recorded 913 objects recorded occurred within ca. 5 cm of the surface. By comparison, 27.6% of the ceramics from Wendorf and Schild's trench 2 (discussed further below) occur in layers defined as surface or subsurface. Such a high density of artifacts near the surface suggests not only that they were concentrated following deflation, but also that they were redeposited after the trenches were refilled. If Caton-Thompson and Gardner

Table 1 Density of stone artifacts and pottery from collection squares on the surface of Kom W

Square	Stone artifacts (*n*)	Pottery (*n*)	Total number of objects (*n*)	Density (m^2)
Sq. 1	4371	7	4378	175.12
Sq. A	32	0	32	160
Sq. B	30	7	37	185
Sq. C	82	1	83	415
Sq. D	67	0	67	335
Sq. E	59	0	59	295
Sq. F	54	9	63	315
Sq. G	86	14	100	500
Sq. H	81	2	83	415
Sq. I	121	4	125	625
Sq. J	69	77	146	730
Sq. K	69	19	88	440
Sq. L	68	11	79	395
Sq. M	54	0	54	270
Sq. N	100	11	111	555
Sq. O	70	17	87	435
Sq. P	72	2	74	370
Sq. Q	67	13	80	400
Sq. R	107	*	107	535
Sq. S	61	*	61	305
Sq. T	92	*	92	460

Square 1, 25 m^2 ; squares A-T, each 0.2 m^2

*Pottery was not recorded

followed the practices of artifact collection typical for the period, a collection would initially be made of all artifacts (Villing 2013). Identification of diagnostic artifacts would then occur with non-diagnostic items returned to the site, or placed nearby. Therefore, it is likely that the surface artifacts are both mixtures derived from multiple depths within the excavated trenches and concentrations formed on the surface as the result of post-excavation deposition. Also, since the time of excavation, wind erosion has resulted in further deflation and therefore the artifact-rich surface seen today.

A three-dimensional model reconstructed for Kom W visualizes the topography of the site prior to Caton-Thompson and Gardner's excavations in the 1920s (Emmitt et al. 2017). Based on the shape of the mound and the lack of surviving archaeological deposits and features on the northern side, the southern, leeward side of the site preserves the highest density of artifacts and cultural deposits because it was protected from northeastern wind erosion. This part of the site also survived because of the protective cap of artifacts that formed from deflated deposits before the 1920s excavations began. Caton-Thompson and Gardner (1934, p. 24) estimated these deflated objects derived from deposits that once extended ca. 20–30 cm above the pre-excavation surface they encountered. Recent fieldwork recorded dense scatters of artifacts east of Kom W, with these resting on deflated surfaces. The presence of these deposits may indicate that Kom W archaeological deposits once extended further to the east, has no firm boundaries, and is part of the broader archaeological landscape (see below).

Radiocarbon determinations from Kom W, obtained from excavations in KW01, indicate occupation activity within the range 6561–6405 cal. BP (Table 2) (Wendrich et al. 2010) after which no further deposition occurred, except for a small unit with Roman pottery dated between 1710 and 1617 cal. BP (UCIAMS-33837) (Wendrich et al. 2010). Brookes' (2003) conclusion, that the modern pattern of wind circulation over the eastern Sahara occurred more recently than 5000 BP, suggests that Kom W was subject to north/northeast wind erosion during much of the period after artifact deposition had ceased. This interpretation supports the inferences made from the reconstructions of Kom W's topography.

X1 Survey Area

In the region surrounding Kom W, extending from X basin in the east to Z basin in the west (referred to as the X1 survey area (Fig. 2)), Caton-Thompson and Gardner (1934) identified numerous surface scatters of artifacts. As part of our University of California Los Angeles, Groningen University, and University of Auckland Fayum Project (URU) and following the method described in Phillipps et al. (2017), this area was subject to a systematic survey recording the surface morphology and position of all artifacts over 2 cm in maximum dimension within a number of 1900-m^2 transects. Surveys also recorded the location and characteristics of hearths and grindstones (as described in Phillipps et al. 2017; Fig. 4). Small excavations and sediment cores provided observations needed to describe the near surface deposits.

Sedimentary Environment

A cross-section constructed from the analysis of samples from 13 sediment cores collected as part of the URU investigations allows inferences concerning the nature of depositional environments across the X basin survey area (Fig. 4). Following the methods described in Koopman et al. (2016), a series of core samples were taken beginning from the southwestern edge of Kom W, adjacent to and within trench two previously excavated by Wendorf and Schild in 1969 (Fig. 4) (Wendorf and Schild 1976, p. 211–215), and following in a southwest direction to the edge of Z basin. Analysis of the lithotypes and grain size frequencies obtained from the sediment cores indicated three main sedimentary environments: lacustrine, aeolian, and ephemeral riverine (Koopman 2008).

The lacustrine depositional environments contain contrasting facies reflecting possible cyclic changes in conditions with three variants. The first is a shallow lake margin, possibly with the presence of marshes, inferred from the presence of unsorted, whitish to (dark) greyish/brownish silty clay or muddy material (< 63 μm), which can be calcareous, with pale yellow sandy intercalations. These deposits contain abundant evaporitic minerals, pointing to numerous switches between wet and dry circumstances. The second is a littoral (lake shore) depositional environment inferred from the presence of well to moderately sorted, medium-sized sands (210–250 μm) with a white/greyish or pale color. The third

Table 2 Radiocarbon determinations from Kom W and the X1 survey area

Lab code	Sample	Material	$\delta^{13}C$ (‰) IRMS	^{14}C Age	Calibrated BP	Calibrated BC/AD
UCIAMS-33835[1]	KW01	Ch	–	5710 ± 20	6561–6435	4611–4485 BC
UCIAMS-33836[1]	KW01	Ch	–	5665 ± 20	6489–6406	4539–4456 BC
UCIAMS-33837[1]	KW01	Ch	–	1755 ± 15	1710–1617	240–333 AD
UCIAMS-33838[1]	KW01	Ch	–	5660 ± 20	6486–6405	4536–4455 BC
UCIAMS-33839[1]	KW01	Ch	–	5670 ± 15	6485–6409	4535–4459 BC
UCIAMS-93214	X1H671	CW	–	6870 ± 30	7788–7627	5838–5677 BC
UCIAMS-93215	X1H687–3	ChF	–	6695 ± 30	7615–7505	5665–5555 BC
UCIAMS-93216	X1H687–9	Ch	−13.9 ± 0.1	6595 ± 20	7561–7435	5611–5485 BC
UCIAMS-93217	X1H688	Ch	−25.5 ± 0.1	6190 ± 20	7167–7008	5217–5058 BC
UCIAMS-93218	X1H748	Ch	−25.4 ± 0.1	6550 ± 20	7490–7425	5540–5475 BC
UCIAMS-93219	X1H770	Ch	−17.4 ± 0.1	5960 ± 20	6879–6732	4929–4782 BC
UCIAMS-93220	X1H799	ChF	–	5835 ± 25	6731–6564	4781–4614 BC
UCIAMS-93221	X1H803	Ch	−15.3 ± 0.1	6205 ± 20	7232–7007	5282–5057 BC
UCIAMS-93222	X1H870	Ch	−27.0 ± 0.1	6055 ± 20	6973–6805	5023–4855 BC
UCIAMS-93223	X1H1002	ChF	–	6550 ± 60	7570–7328	5620–5378 BC
UCIAMS-93224	X1H1003	ChF	–	6120 ± 20	7157–6932	5207–4982 BC
UCIAMS-93225	X1H1010	Ch	–	6130 ± 20	7157–6946	5207–4996 BC
UCIAMS-93226	X1H1011	Ch	–	6160 ± 20	7160–6990	5210–5040 BC
UCIAMS-93227	X1H1033	ChF	–	5685 ± 25	6530–6406	4580–4456 BC
UCIAMS-93228	X1H1035	Ch	−15.5 ± 0.1	6010 ± 15	6895–6791	4945–4841 BC
UCIAMS-93229	X1H1036	Ch	–	5955 ± 20	6856–6726	4906–4776 BC
UCIAMS-93230	X1H2002	Ch	−25.1 ± 0.1	6115 ± 20	7155–6907	5205–4957 BC
UCIAMS-93231	X1H2003	Ch	−27.2 ± 0.1	6155 ± 20	7159–6982	5209–5032 BC
UCIAMS-93232	X1H2019	Ch	−10.9 ± 0.1	6415 ± 20	7420–7287	5470–5337 BC
UCIAMS-93233	X1H2020–2	Ch	–	6250 ± 20	7252–7160	5302–5210 BC

Calibrated determinations are given at 95.4% confidence using OxCal 4.3 with IntCal 13. Results calculated following the conventions in Stuiver and Polach (1977), corrected for fractionation using the reported value. Samples were prepared in an acid-base-acid (ABA) pretreatment

Ch charcoal, *ChF* charcoal flecks within soil/sediment matrix, *CW* charred wood

[1] Previously reported in Wendrich et al. (2010)

variant is a deeper lake sedimentary environment represented by the presence of white silty clay and clayey silt deposits, present in the lower parts of Z basin.

The aeolian depositional environment with (very) well to well sorted, fine- to medium-sized, poorly silty sands (75–250 μm) contain a predominantly subrounded grain morphology. The color of the sands, mainly (deep) yellowish, reflects oxidized depositional conditions. The facies occur mostly in the form of accumulative aeolian bedforms such as large wind ripples and dunes (for example between cores 48 and 2 in Fig. 5), as well as in a thin layer covering the upper surface. Aeolian sands are occasionally also traced within a lacustrine sedimentary environment. The greater part of Kom W is comprised of aeolian sands (Fig. 5). The ephemeral riverine sedimentary environment composed of facies with poorly sorted, very coarse and coarse to medium sands (300–850 μm), and clayey sand, sandy clay, gravel, and nummulites at different depths and locations.

The reconstructed sedimentary environments point to numerous shifts between arid and wet conditions, as well as changes in sediment transport mechanisms. Relatively high rates of concretion, crystallization, and mineral enrichment of the sediments indicate formation after primary deposition, and suggest fluctuating wet and dry conditions. Gypsum crystals, concreted gypsum, and salt crusts indicate evaporation as do exhumed

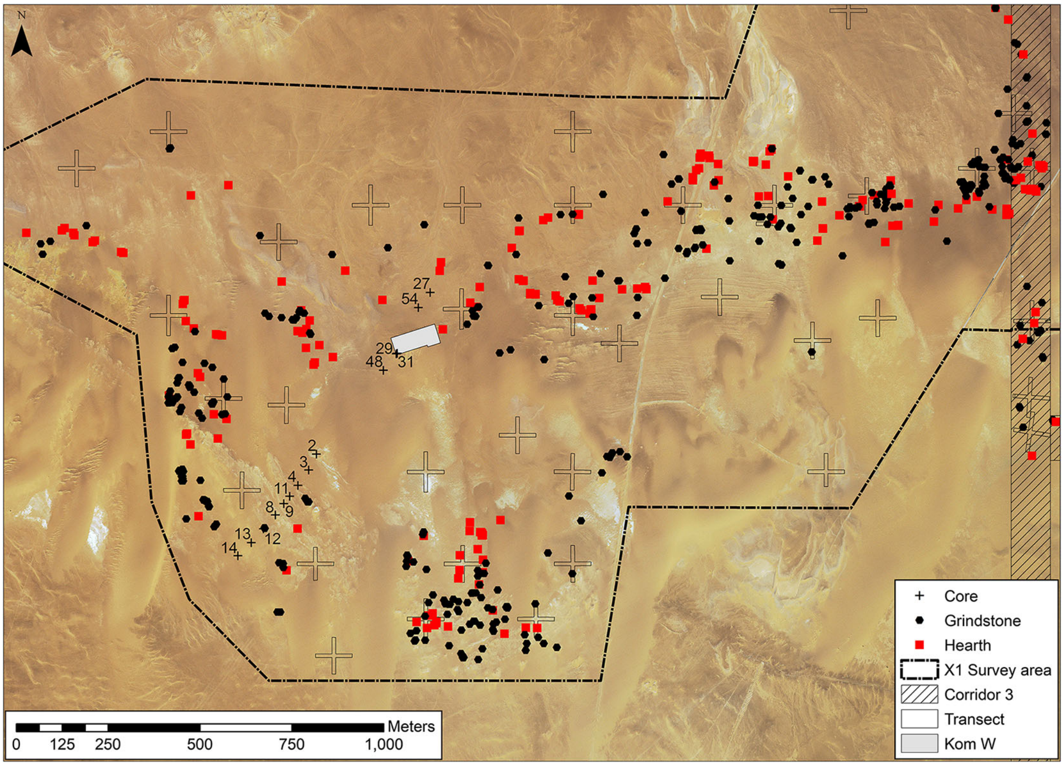

Fig. 4 Hearth, grinding stone, X1 survey area and location of the cores that compose cross section I

muddy hills resting on calcareous “tubes,” representing former plant root tubes, also known as rhizoliths (Glennie 2005, p. 181; Nichols 2006, p. 126) (Fig. 6a). Additional geomorphic features also reflect large-scale evaporation and desiccation, for example the polygonal patterns of cracks inside the mud-clay plain to the southeast of Kom W (Fig. 6b). These evaporation features are abundant in the subsurface deposits and on the surface, southwest and southeast of Kom W. The evaporation features point to periodic rises in the water table associated with lake level changes and periods of increased rainfall, as well as the influence of morning dew (Goldberg and Macphail 2006, p. 69).

Within Kom W, coarse- and medium-grained sand accumulations occur inside the lower part of the section of the mound, while medium- to fine-grained sands are present within the upper part of the site (Fig. 5: cores 31 and 29). These sand deposits indicate high oxidation rates suggesting a relatively dry environment during extensive periods. They contain less abundant evaporation features compared to the deposits southwest of the site

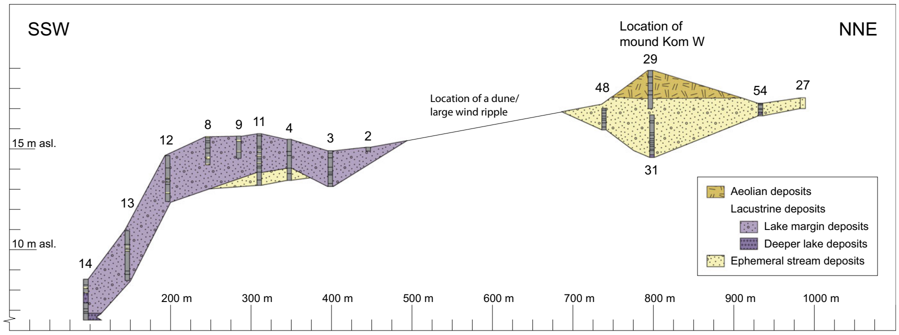

Fig. 5 Cross section I. See Fig. 4 for the location of the cores used in this cross section

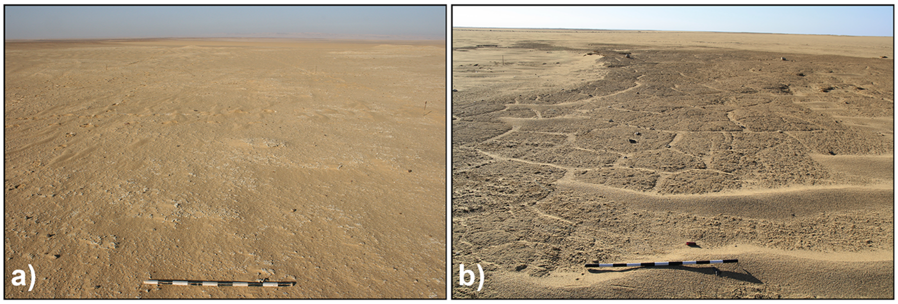

Fig. 6 Geomorphic features from the X1 survey area. **a** Rhizolith mounds. **b** Cracks on the mud-clay plain

(Koopman 2008), consistent with the inferences made above for erosion at Kom W. Lacustrine deposits (type 1) are found in cores to the southwest of Kom W and likely represent changes in lake levels associated with Z basin. Ephemeral stream deposits (type 3) occur in the center and lower parts of the site, to the north, as well below the lake margin deposits southwest of Kom W, reflecting more humid periods in the past (mostly before human occupation). Aeolian deposits (type 2) are present across the modern day surface and associated with the upper part of Kom W.

Artifact Density

Systematic archaeological survey allowed both the calculation of the densities of different artifact forms and the analysis of the distribution of these densities across the X1 survey area (Fig. 7). The calculated density values support the inference that Kom W was once greater in extent than it was at the time of its original excavation. However, densities of artifacts calculated from other survey transects located across the X1 survey area show that high densities of artifacts also occur in locations away from the Kom W

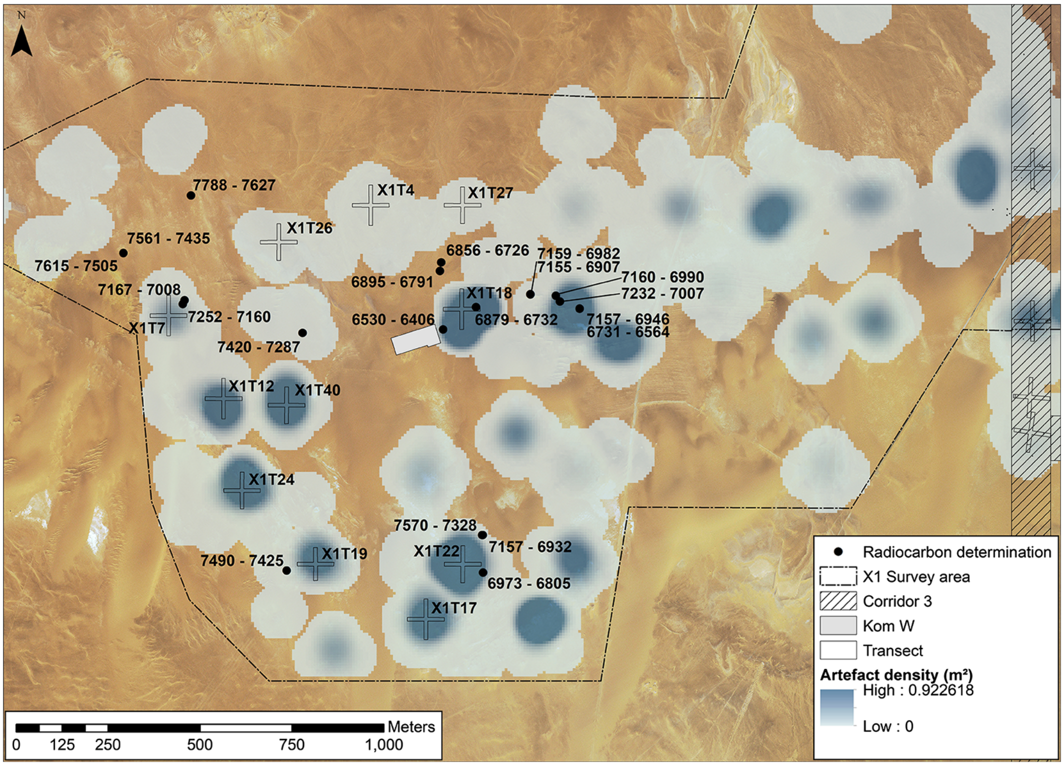

Fig. 7 Artifact point density from the X1 survey area, with reference to transects mentioned in text (radiocarbon determinations in cal. BP at 95.4% confidence)

mound. There are high artifact densities in the area immediately to the northeast of Kom W. In transect X1T18, 7134 artifacts were recorded in an area of 293 m^2 from the transect center, giving a density of 24.37 per m^2. In contrast, transects immediately to the north of Kom W (X1T4, X1T26, X1T27) have much lower densities (Table 3), either because artifact deposition did not occur in this region or erosion has removed artifacts to areas further south. The sediment cores from this area (27 and 54) show fluvial deposits that may relate to pre-Holocene wadi activity (Fig. 5). The transects in the south of Kom W (X1T17, X1T19, X1T22) and those in the west (X1T7, X1T12, X1T24, X1T40) have lower artifact densities than X1T18 and Kom W, but higher than those found in the transects to the north. Local erosion may have affected artifact densities in transects that border the steep-sided Z basin.

While the materials on the surface of Kom W are likely to have been deposited from the Caton-Thompson and Gardner excavations, the densities of materials found on the surface do align to some degree with the reconstructed location of the original subsurface midden deposits. These suggest that the survivorship of materials in and on Kom W was higher than on the surrounding areas because stratified deposits protected these materials prior to excavation. This interpretation also finds support from the analysis of pottery excavated by Caton-Thompson and Gardner. The rims of vessels found closer to the surface of the site were eroded while those from deeper in the deposits were degraded but had no evidence of erosion (Emmitt 2019). Wendorf and Schild (1976) excavated two trenches next to those of Caton-Thompson and Gardner. While they did not report artifact counts from each layer, the analysis of ceramics from their trench 2 gives an indication of the relative artifact distribution through the Kom W stratified deposits they investigated at the western end of the Caton-Thompson and Gardner 1920s excavation. Trench 2 was 7 m x 1.5 m in size (Fig. 3). The 76 ceramic sherds from the trench give a density of 7.32 sherds/m^2 if treated as a deflated deposit. By comparison, the density of ceramic material from X1T18 is 2.35 sherds/m^2.

Two trenches excavated on Kom W by the URU Fayum project, outside Caton-Thompson and Gardner's excavation area, measured 5 m by 3 m (KW01) and 4 m by 1 m (KW02). Counts and densities of artifacts for these trenches are presented in Table 4 and show a high density of materials with KW02 having a higher density than KW01. As with the Wendorf and Schild trenches, these artifact densities reflect the relative number on a single deflated surface. If only ceramic artifacts are considered, KW01 has a ceramic density of 25.47 sherds/m^2 and KW02 a ceramic density of 83.75 sherds/m^2. The density values from the Wendorf and Schild trenches and those from the URU Fayum project suggests higher survivorship of material in the Kom W deposits compared to that found in surrounding areas.

Table 3 Artifact counts and densities in transects discussed in text

Transect	Bone (*n*)	OES (*n*)	Pottery (*n*)	SA (*n*)	Artifact number (total)	Area surveyed (m^2)	Density (m^2)
X1T4	0	0	0	35	35	2000	0.018
X1T7	93	167	7	260	527	2030	0.26
X1T12	52	8	15	2265	2340	1978	1.18
X1T17	194	0	72	2116	2382	2015	1.18
X1T18	58	51	687	6338	7134	293	24.37
X1T19	181	0	126	1255	1562	1812	0.86
X1T22	120	16	78	7198	7412	1956	3.79
X1T24	98	4	0	3305	3407	1911	1.78
X1T26	0	0	0	19	19	1886	0.01
X1T27	0	0	0	2	2	1912	0.001
X1T40	204	2	1151	1946	3303	1910	1.73

OES Ostrich eggshell, *SA* stone artifact

Table 4 Artifact counts and densities for the KW01 and KW02 excavations

Trench	Bone	Pottery	Grindstone	OES	Shell	SA	Total	Density (m^2)
KW01	0	382	2	0	6	692	1082	72.13
KW02	2	335	0	4	0	591	932	233.00

OES Ostrich egg shell, *SA* stone artifact

Chronology

Table 2 provides the results from radiocarbon determinations obtained from 20 hearths excavated across the X1 area. Plotting these results against artifact densities indicates changes in activity areas through time (Fig. 7). To the east of the Z basin, and to the south of X1, high densities of artifacts are associated with dates that range from ca. 7400 cal. BP–6900 cal. BP. Age determinations obtained from the northeast and south of Kom W are slightly older than those from the Kom W itself. However, dates to the west of Kom W are the oldest, ca. 7700–7200 cal. BP. Kom W has the youngest occupation ages in the area. The oldest determination from samples within the Kom W deposit is 6561–6435 cal. BP (UCIAMS-33835) while after ca. 6300 cal. BP, there were no more artifacts deposited with the exception of a small unit of Roman pottery (although as discussed above, they were moved and deflated). This late date for Kom W may help to explain the state of preservation of artifact materials within the Kom deposits relative to those that surround it. The Kom W deposits show evidence of erosion before the Caton-Thompson and Gardner excavations particularly in the east where deflated deposits might indicate the former extent of the Kom. However, the extant stratified deposits indicate that erosion was locally variable. While the data available do not permit definitive conclusions, it is possible that as the last area occupied, Kom W was not subject to the same degree of land-use, trampling, water, and wind erosion that affected the surrounding areas prior to 6300 BP. Not all hearths encountered retained charcoal for radiocarbon samples. The hearth to the northeast of Kom W, for example, did not provide charcoal samples. It is tempting to think that many of these hearths may be older than those that did provide charcoal and that differential survival of dating materials is therefore influencing the chronology for the wider X basin region although at present we are unable to test this hypothesis. There are certainly older hearth deposits further to the east in L basin as documented in Holdaway and Wendrich (2017). The possibility that erosion removed artifacts and features is considered when assessing the village interpretations below.

Discussion

The results from both the visualization of Caton-Thompson's profiles, the sedimentological analysis of samples from X basin, inferences from studies of wind erosion, and the radiocarbon results from hearth excavations help to make sense of the geomorphic history of Kom W. In areas surrounding Kom W, results from sediment analyses indicate periods of increased moisture as well as periods of sustained evaporation. Lacustrine accumulations exist close to Z and X basins and in sedimentary units further to the north, but the repeated lake advances and retreats suggested in the older literature are not indicated (Holdaway and Wendrich 2017; Philipps et al. 2016b). Lake level changes certainly had a pronounced effect on the area of the lake and therefore the extent of the lake edge environment, but these did not directly affect the majority of the archaeological deposits on the north shore. Rainfall may be responsible for some of the changes in water table heights suggested by the lithological analyses since it is possible that rainfall levels were higher during the early to mid-Holocene than they are today (Phillipps et al. 2012).

While today Kom W forms a low mound covered by a carpet of artifacts, erosion played a significant role both in determining the form of the mound encountered by Caton-Thompson and Gardner, and changes in the 90 years since their excavations. Prior to Caton-Thompson and Gardner's work, wind-blown sand mostly covered the site. Their method of excavation redeposited the artifacts that they did not collect from the midden and sand layers, and probably made the site more susceptible to erosion. Since the original 1920's excavation, the stone artifacts and pottery discarded in the backfill have formed a protective cap across the deposit with fine sand and silt clasts winnowed away through wind action. These artifacts are responsible for the level of mound preservation and high surface artifact densities observed today. In addition, salt crusts formed in recent times may have helped to further protect Kom W, formed by an interplay of morning dew and evaporation (Koopman 2008). Wind-blown sand accumulations also occur in the eastern trenches excavated by Caton-Thompson and Gardner while lithological analysis of the trenches on the edge of Kom W indicate that deposits have at times lost finer sediments. Alternating burial and exposure likely occurred during the period of cultural material deposition, and subsequently after occupation had ceased, a process enhanced by the 1920s archaeological excavation.

Radiocarbon ages suggest that the Kom W deposits are unusual only because they are the most recent of a series of similar deposits that surround the site. While the surface artifact densities on Kom W are high, these are likely the result of the history of archaeological work at the site, combined with wind erosion. Considering this, and when compared with the densities of artifacts from other deposits in the X1 area, it is possible that Kom W was the most recent such deposit retaining stratified materials, whereas other deposits lack stratification due to a longer period of deflation. However, other than observing that there may be local differences in the degree of erosion across the Kom and in adjacent areas, a precise understanding of the erosion outcomes is not possible with the available data. Caton-Thompson and Gardner (1934, p. 23) acknowledged that the sites identified in the Fayum had been nearly "denuded to extinction" suggesting that those Neolithic sites were much bigger than the current archaeological deposits. The high densities of artifacts adjacent to Kom W might indicate the site was once more extensive than it is now. The reduced artifact densities were due to wind-erosion over at least the past 6000 years.

Where do these inferences leave the interpretation of Kom W as a Neolithic village? As we have noted elsewhere (Holdaway and Wendrich 2017, p. 5–6), the identification of the site as a village made sense at the time when Caton-Thompson and Gardner carried out their study and their suggestions were picked up in the syntheses of the day (e.g., Braidwood 1960; Childe 1956). Braidwood (1960), in particular, used the Fayum material as one of his five village assemblages and thereby incorporated the Fayum, and by default Egypt, into the notion of the "Neolithic package." The use of domestic species as a food source arrived as a package along with other technologies, with occupation in villages as one of the other key components. However, we now know that aspects of the so-called Neolithic Package took more than 10,000 years to develop in southwest Asia, with individual components having quite different temporal and/or spatial trajectories (Zeder 2009). There is therefore no necessity for the use of domesticates, for which there is evidence in the Fayum (Linseele et al. 2014), to be associated with a village-based settlement pattern. Based on the results presented here, Kom W is only a unique deposit in that it has undergone a somewhat less deflation than the deposits that surround it. However, the potential loss of features from the Kom and surrounding areas needs to be considered when assessing interpretations concerning the nature of occupation in the area.

Based on reconstructions from Caton-Thompson and Gardner's work, as well as our work and that of others at the site, there is no evidence for postholes or any other architectural features such as mudbrick that might indicate the outline of houses. While this absence does not rule out the existence of habitation structures made from perishable materials like mudbrick, material culture and the history of erosion suggest an intermittent rather than a permanent, continuous occupation. The features that do exist are pits. At least 12 of these held large ceramic vessels, and it is possible that others did so as well, although some of the features identified as pits were likely hearths. Investigations further to the east have indicated that storage features existed at Kom K and the K-pits (Holdaway and Wendrich 2017). However, neither of these locations was associated with evidence consistent with the existence of permanent house structures, or a village-like settlement pattern. What survived are pit features excavated into the substrate and therefore protected to some degree from erosion, although even some of these were likely eroded away. Some of these pits contained pottery vessels with evidence for the differential preservation of pottery (Emmitt 2019). In this sense, the Kom W site is similar to other locations on the Fayum north shore where evidence of the use of domesticates exists alongside evidence for food storage but without extant evidence for the existence of permanent habitation structures. Determining the nature of occupation at Kom W and environs must be based on further analysis of the artifacts from the site and the surrounding area (Emmitt 2019; Phillipps and Holdaway 2016).

Wengrow (2006, p. 83) describes the Neolithic and early Predynastic occupation in Egypt as an example of "complexity without villages." In contrast to the development of Near Eastern or southwest Asian tells, with their extensive vertical stratigraphic depth that resulted from the prolonged occupation of a single location, Wengrow suggests that the Predynastic and earlier occupations in the Egyptian Nile Valley "were for the most part light and ephemeral … human activity … defined by the lateral spreading of cultural material along a horizontal axis...." In other words, a form of horizontal rather than vertical tell (Phillipps et al. 2016a). Based on the results of the study presented here, at the scale represented by X basin, the Kom W and surrounding deposits seem to be closer to Wengrow's description than to the original designation of a village comparable to the others Braidwood (1960) identified in southwest Asia. However, this conclusion rests on interpretations derived from a geomorphic context affected by erosion. We cannot dismiss the notion of a Neolithic village nor can we accept it based on typological artifact comparisons and the site's contemporary appearance (e.g., Shirai 2016). Instead, building on the remarkable geoarchaeological foundations laid by Caton-Thompson and Gardner, and extended by Wendorf and Schild, the context of the site needs to be acknowledged and greater attention given to detailed analyses of the available portable material culture.

Conclusion

In keeping with the Fayum north shore in general, Kom W and the surface artifact deposits that surround it show the impact of erosion dating from the present to the time of the first artifact deposition. Changes in the levels of Lake Qarun due to shifts in Nile flood levels certainly had an impact on the environment of the area, particularly in the lake basins, but it is wind erosion and deposition that most affected Kom W and the surrounding archaeological deposits. Kom W survived as the most recent of the deposits in the X basin area and this may account for the presence of stratified deposits at the site that were lacking elsewhere. The high artifact densities across the surface of the site are partly reflective of erosion since deposition ceased 6300 BP but also of the methods that Caton-Thompson and Gardner employed while excavating the site. Today, modification continues through looting and erosional processes. The surrounding landscape has seen an increase in construction and agricultural activities, including the construction of a highway that promises to cause more disturbance to the archaeological resources of the area. The previous interpretation of Kom W as a Neolithic village reflects the understanding of the geomorphological evidence in the mid-twentieth century. While these interpretations cannot be overturned, results of the geomorphic studies of Kom W and the surrounding area reported here indicate that the types of evidence that might indicate the presence of permanent structures have not survived. Instead, Kom W is one of several archaeological deposits dating from the early to mid-Holocene, the interpretation of which must rest on detailed assessments of the remaining portable artifacts.

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Compliance with Ethical Standards

Conflict of Interest and Ethical Statement The authors declare that they have no conflict of interest.

Ethical Statement This article does not contain any studies with animals performed by any of the authors.

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