A 15-metre length of foundation trench for the north wall of the Great Aten Temple, exposing the remains of the original gypsum-concrete foundation layer. Archaeologist Juan Friedrichs draws a scale plan. View to the east. Photo by B. Kemp.
The Amarna Trust is registered with the Charity Commission as no. 1161292. Its registered address is

**The Amarna Trust**  
Newton Hall  
Town Street  
Newton  
Cambridge CB22 7ZE  
United Kingdom

The chairman of The Amarna Trust is  
**Prof. Paul Nicholson (Cardiff University)**

The contact for The Amarna Trust is  
**Prof. Barry Kemp, CBE, FBA**  
at the address to the left, or  
**The Amarna Project**  
1, Midan El-Tahrir  
Floor 5, flat 17  
Downtown  
Cairo  
Arab Republic of Egypt  
Cairo office: +20 22 795 5666  
mobile: +20 122 511 3357  
email: bjk2@cam.ac.uk

For donations and other financial matters the contact is the Honorary Treasurer  
**Susan Kelly**  
8 chemin Doctoresse-Champendal  
1206 Geneva  
Switzerland  
email: suekelly.canada@gmail.com

The Amarna Trust submits an annual set of accounts to the UK Charities Commission. None of its income is used in the furtherance of raising funds. Its overheads are modest.

The objectives of the Trust are:

To advance public education and to promote the conservation, protection and improvement of the ancient city of Tell el-Amarna, Egypt and the surrounding area for the benefit of the public in particular but not exclusively by:

i) creating a permanent facility for study (the research base – The Amarna Centre);  
iiv) providing, and assisting in the provision of, lectures and publications in furtherance of the stated objects;  

ii) undertaking and supporting field research (and publishing the useful results of such research);  
v) developing displays and exhibitions at a site museum for the benefit of the public and an educational outreach programme for the benefit of pupils at schools; and  

vi) working in partnership with the Supreme Council of Antiquities of Egypt to maintain the ancient city for the benefit of the public.

The Amarna Trust publishes *Horizon* on behalf of the Amarna Project and other interested parties. It is currently distributed free of charge. Should any recipient not wish to receive future issues please email bjk2@cam.ac.uk
The northern cemeteries: community ties at ancient Amarna

Since 2005, the Amarna Project has been studying the non-elite cemeteries of ancient Amarna. 2018 was a busy year, with fieldwork at two previously unexcavated burial grounds at the northern end of the site. Anna Stevens (University of Cambridge/Monash University) and Gretchen Dabbs (Southern Illinois University) report on the work, which was funded by a grant from the National Endowment for the Humanities.

The non-elite cemeteries of Amarna were first identified by surveyor Helen Fenwick in the early 2000s, spurring a multidisciplinary project to excavate and study the burials of Akhenaten’s people. From 2005 to 2017, fieldwork focussed on two very large burial grounds located in wadis (dried water channels) adjacent to the tombs of Akhenaten’s officials: the North Tombs and South Tombs Cemeteries. These each contain a few thousand individuals, most of whom were buried simply in pits cut into the sand. Study of the skeletal remains show that many of the people buried here had poor diets and difficult working lives. We think it likely that the South Tombs Cemetery is the main burial ground for people living in the Main City, although the North Tombs Cemetery is more difficult to interpret. It is a particularly unusual burial ground, containing individuals aged mostly between 11-18 years, who were often buried together. We suggest that they represent labourers’ community/ies, but it is not yet clear where they were living in the ancient city.

In 2018, we shifted our focus to two much smaller, but no less interesting, cemeteries located on the desert floor near the North Tombs. The North Cliffs Cemetery lies immediately below the Tomb of the Chief Priest Panehesy and the North Desert Cemetery is located a few hundred metres to its west. Like all the Amarna cemeteries, both sites have been heavily looted, but still hold remarkable research potential. We can ask: Who was buried here? Where did they live at Akhetaten? Why were they interred here? How do these graves and skeletons compare to others so far excavated at Amarna? And what were their individual lives like?

Preliminary results from 2018 show that these two cemeteries are similar to those previously excavated in terms of general approach to burial. Most people...
were wrapped in textile and then rolled in a mat made of plant material, or very occasionally placed in a wooden coffin. A few people had burial goods, including pottery vessels that may once have contained food and drink, pieces of jewellery and cosmetic items like combs and hairpins. Graves usually took the form of a simple pit cut into the desert surface, although the North Desert Cemetery also incorporated a small number of shaft-and-chamber tombs, located on a low rise of soft clay-like rock. These more elaborate tombs seem to have been thoroughly emptied of their contents by looters, but investigations of one tomb in 2018 showed that it had contained at least one individual, who had been buried in a painted wooden coffin. The only other places where tombs of this kind have been identified so far at Amarna are the two desert workers’ villages: the Workmen’s Village and Stone Village.

While analysis of the human remains from the North Cliffs and North Desert Cemeteries awaits, a preliminary impression is that they contain mixed populations of adults and children, males and females, more similar to the South Tombs Cemetery than the North Tombs Cemetery. An initial size estimate of c. 900–1400 individuals can be suggested for the North Cliffs Cemetery, and there are perhaps a few hundred people interred at the North Desert Cemetery.

The northern setting of these burial grounds suggests they likely served populations living in the northern areas of the ancient city – the North Suburb and/or North City – although it is less obvious why two separate cemeteries developed here. Perhaps the people buried in the North Cliffs Cemetery worked directly for the officials buried in the cliffs above, including Panehesy himself. Panehesy was responsible for overseeing the preparation of offerings for the Aten in the city’s vast open-air temples, a role that must have seen him in charge of large numbers of personnel. The North Desert Cemetery, which contains far fewer interments, has more of the feel of a small ‘community’ burial ground, like those at the workers’ villages. It seems to focus on the chamber tomb/s, as though these belonged to people who held elevated positions within this particular community, although their status was likely nowhere near that of the city and state officials who owned rock-cut tombs in the cliffs proper.

As the study of Amarna’s cemeteries continues, it is becoming increasingly clear that these are places that contain multi-faceted layers of information not just about life and death at Amarna, but about the community ties that helped shape experiences of living at this ancient city. We hope to continue work at the northern cemeteries in a future excavation season.
Matching statue fragments by means of 3D printing

The haphazard discovery and dispersal of Egyptian antiquities in the past has left pieces that once were parts of a single object in widely separated locations. There is already a long history of attempts at making joins and reconstructions using photographs and plaster casts. The rapid development in recent years of computer software able to create 3D images from multiple digital photographs and of 3D printers able to print from the results has added a further means of achieving the same end.

After the end of the Amarna Period the statues of the royal family, often laboriously fashioned in hard stones, were broken into thousands of pieces. Many now belong to museum collections across the world. Many more have been gathered by the Amarna Project and are kept in a secure store at the site itself. A long-term study of this material by Kristin Thompson is nearing completion. One outstanding matter is the matching of pieces in the Amarna store with fragments recovered by the excavations of Ludwig Borchardt between 1911 and 1914. The possibility of matches arises from the discovery some years ago of pieces left behind by the Borchardt expedition, some of them from the house of the sculptor Thutmose. Kristin suspected that six of the pieces might join fragments in the Ägyptisches Museum, Berlin. Rather than make and transport conventional casts of either the Amarna or Berlin pieces for direct matching, an experiment was set up to create 3D digital photographic replicas of the pieces in the Amarna store which could be printed on a 3D printer.

In spring 2018 photographer Andreas Mesli took multiple photographs of the six pieces in the expedition house using a simple turntable (Figure 1). A scale was supplied by Lego bricks (which follow standard sizes) (Figure 2). The files of images were sent to Christian Eckes of Cologne who used Recap Photo from Autodesk, 3DF Zephyr from 3DFLOW and open source tools such as MashLab in order to reconstruct a 3D model for each piece by applying structure-from-motion bundle adjustment algorithms (Figures 3, 4). Christian cut away the supporting structure and the turntable, filled some holes to make the models ‘watertight’ and scaled the models carefully.
Kristin is based at the University of Wisconsin-Madison in the USA. For the printing of the image files she turned to Peter Sengstock, also of the UW, who has constructed and runs a DIY 3D printer (Figure 5). Six printed replicas of the pieces, in a plain white plastic material, were the result (Figure 6). The final, matching stage took place in the Ägyptisches Museum in November, 2018, thanks to the co-operation of the Museum staff, under the supervision of Dr Friederike Seyfried.

Borchardt’s team excavated numerous houses in an area that has been identified as containing a concentration of sculptors’ workshops. Hence many of the pieces (including several from statues of princesses) that went to the museums in Cairo and Berlin were unfinished. The same was true for the more fragmentary pieces which Borchardt left at Amarna because they were not deemed display-worthy. The Ägyptisches Museum owns two quartzite ears from different statues. Three fragments of princess heads from Amarna were chosen as likely matches (S-5109, S-5118/5119, S-5120). One of them (S-5109), with an eye outlined in black paint, was highly likely to join to a Berlin fragment of a mouth and broken nose, given the shape of the break. A princess stomach-and-hip section of a statue from storage at Amarna (itself the result of joining two fragments, S-5214/5215) is made of a similar distinctive orange-brown quartzite, and in Berlin there are several small fragments in this same stone. One, already joined from two Berlin pieces, appeared to be part of a thigh. Finally, Borchardt left behind nearly a hundred pieces of a greywacke statue, including a slice of a shoulder. A greywacke shoulder in Berlin strongly resembled these pieces, so a replica of the Amarna shoulder was made.

These six replicas could at most result in five matches, since three of the partial princess heads were candidates to fit onto the two quartzite ears. In the event, four matches were made: each ear joined one of the princess-head fragments (Figures 7, 8, 9), the princess-eye piece matched the mouth-and-nose piece (Figure 10), and the thigh in Berlin fitted onto the Amarna stomach (Figures 11, 12). The remaining princess’s head fragment (S-5116/5117) did not match either of the ears in Berlin, whilst the greywacke shoulder also failed to match, though it still seems likely that the isolated piece in Berlin belongs to the same statue.

Since all of the quartzite princess fragments being tested were known to have been found at the Thutmose workshop, the matches show that many of the pieces left behind by Borchardt have the same provenance. (The pieces tested all belonged with groups of fragments probably from the same statues.) In addition, matching associated fragments in this way can aid in estimating how many statues were being made at the Thutmose workshop before its abandonment.
The project has been a success in itself, but also demonstrates a path that can be followed for recording and perhaps matching other sculpture fragments whose homes may be thousands of kilometres apart. It also illustrates the thoroughness with which statues of the Amarna royal family were finally broken up. Someone has crouched down over even unfinished statues and, with deliberation, hammered them into roughly fist-sized pieces.

**Details of the Amarna fragments**

S-5109: right eye and brow of a princess, painted in black. H 7.9 cm, W 9.9 cm, D 3.5 cm (joins AM 21207).

S-5118/5119: a princess’ shaved head, joined from two pieces, with a small flare into a missing ear. H 12.8 cm, W 10.4 cm, D 5.2 cm (joins AM 21206, one of two ear fragments with this number).

S-5120: fragment of a princess’ shaved head. H 9.5 cm, W 9.5 cm, D 2 cm (joins AM 21206, one of two ear fragments with this number).

S-5214/5215: a princess’ stomach, hip, and back pillar or panel. H 9.5 cm, W 15 cm, D 14 cm (joins AM 21372, one of seven fragments with this number).

**Further information**

[http://amarna.eckesvision.com](http://amarna.eckesvision.com)

timelapse videos of the printing process by Peter Sengstock:

[www.youtube.com/playlist?list=PLJsBmprdpv-cy3_4rcHKvWDFNpSs0jSsX3](www.youtube.com/playlist?list=PLJsBmprdpv-cy3_4rcHKvWDFNpSs0jSsX3)

Wine for the Aten
Mud jar-sealings from the Great Aten Temple
Miriam Bertram

Despite its novel appearance, the Great Aten Temple remained firmly within the Egyptian tradition of placing offerings of food and drink (and incense) at the centre of temple activities. Their variety and the care taken with their administration was recorded on at least one stela erected within the main temple precinct. One fragment (in the Metropolitan Museum of Art, New York) records wine categorised by type of container (Figure 1). The principal container was the pottery amphora (Figure 2). This has left its traces in the form of potsherds and fragments from thick mud sealings which can bear the remains of impressed designs.

Figure 1. Fragments from a quartzite stela which stood behind the Long Temple. Given a gridded format, the left-hand column of this part recorded at least four entries for wine in a particular kind of vessel (mni, presumably an amphora). A narrower column to the left would have recorded the number of vessels. The two larger joining fragments are in the Metropolitan Museum of Art, New York, Harris Brisbane Dick Fund 57.180.37d. Photo by William Barrette. The small bottom fragment (here labelled Pend 4) is from a hand copy of a group of fragments from the 1933 season of the Egypt Exploration Society. The right-hand column belongs to a different set of non-wine entries.

Figure 2. Part of a scene of offerings in the Great Aten Temple. Two-handed amphorae and bowls are supported on light wooden stands. Bowls of burning incense perch on top of foodstuffs and bouquets of flowers. After Davies, Rock Tombs I, Pl. XXXIII.
During the excavations at the Great Aten Temple, numerous mud jar-sealings have been recovered from the spoil heaps from earlier excavations at the front of the temple, from backfilled trenches of those excavations and from the levelling-rubble, one of the few in situ layers at the site, thrown in during the later building phases to even up the ground which has a slight slope down from north to south and from east to west.

The sealings were mostly made of Nile mud, stamped to indicate the contents of the vessel and to which institution it belonged (Figure 3). The great majority were for wine, and in these cases they were useful to prevent wine from being drunk or getting spilled during transport. They also made the jars airtight so as to prevent the contents from going bad.

Some sealings tell you where the wine was made. During Akhenaten’s reign, most of the vineyards recorded on the sealings were located at the “Western River” (in the north-west Delta, along the lower reaches of the Canopic branch of the Nile). ‘Wine of [the house of?] (queen) Tiy’ was amongst the sealings found in the temple enclosure in 1932. Another institutional source was ‘The House of the Aten in Heliopolis’, although in this case the stamp was applied to the handle of the amphora before it was fired (Figure 4). Place of origin is also revealed in other ways. The western cases (perhaps more specifically the Dakhla Oasis) can be identified from the composition of the clay of sherds from a distinctive type of amphora. Another source of information are the hieratic labels which were written on the shoulders of some amphorae. A fragment of one discovered in 2017 (object no. 43177) names Maketaten’s estate as origin of the vessel and its contents and gives the name of the chief of the vineyard, Pennay (Figure 5).

Concerning the location of the sealings, we have to differentiate between two general contexts. From 2012 to 2015 we concentrated on clearing the surface of the temple area. After the removal of modern village rubbish and spoil heaps left behind from previous excavations (those of Petrie and Pendlebury), we emptied the backfill of a number of trenches that had been dug through the levelling-rubble by Pendlebury, in this way revealing underlying features belonging to the first building phases. Subsequently we have concentrated on excavating areas of levelling-rubble which are free of features of interest on the surface that need to be preserved. These are primarily the sets of gypsum-lined basins which are now protected by a covering of sand.

Most of the sealings are or were originally cylindrical, the bottom (c. 0.12 m) slightly wider than the top (c. 0.11 m), and have either been vertically broken in half, or the

Figure 3. Mud jar sealing, object no. 42436, with stamp recording ‘Wine for the House of the Aten’. Drawing by A. Boyce; photos by M. Cavriani.

Figure 4. The hieroglyphic label ‘The House of the Aten in Heliopolis’ has here been stamped into the handle of an amphora. Object no. 42057, from square M27. Photo by A. Mesli.

Figure 5. Hieratic label written on the shoulder of an amphora, object no. 43177, from square 125 (17410). The copy, transcription and translation are by Marc Gabolde.
The upper part of the sealing had been chopped off horizontally. A few still show traces of criss-crossing, coarse grass that covered the mouths of the jars to prevent the still wet mud of the sealing from falling in (Figure 6). Fragments of the lower part of the sealings often show neck/shoulder/rim impressions of the jar. The latter help in estimating the size of the vessel.

The regularity and smoothness of the surface of the sealings suggest the use of a mould to model the mud either before it was put over the opening of the vessel or when it was just attached to it. Then it was stamped and went on its journey to the new capital to please the king, queen, priests and the Aten. Most of the sealings show several stamps: always one, sometimes two, on top, and at least one, sometimes up to three, on the sides. Tomb pictures in one of the Theban tombs (TT261) (Figure 7) show the stamping process and a stamp sitting in a small bowl (probably filled with water, to moisten the stamp) on top of an already sealed amphora.

The condition of the sealings varies a lot; some are eroded or faint, but the better preserved ones show stamp impressions dedicating the wine to the Aten or the House of the Aten, and some promise \textit{nfr nfr} wine of the best quality. When the sealings were broken off, the lower part would scatter into several pieces, and generally they easily fragment. The friability of the broken surfaces often means that it is impossible to be sure of joins between two originally adjacent fragments. We have so far made no attempt to join fragments but it is more than likely that there would be matches. Since one intact sealing might bear several impressions, a simple count of the number of each type found in the excavations runs the risk of overestimating the original number of sealings.

Further reading

A few of the stela fragments (but not the one listing wine) are illustrated in F. Seyfried, \textit{Im Licht von Amarna: 100 Jahre Fund der Nofretete}. Ägyptisches Museum und Papyrussammlung, Staatliche Museen zu Berlin 2012, 230–1.

The main treatments of Amarna jar sealings are: J.D.S. Pendlebury, \textit{City of Akhenaten} III. London, Egypt Exploration Society 1951, 143–215, Pls. LXXXI–LXXXIII, P. 182, Fig. 23 illustrates stamped jar handles.


Figure 6. Mud jar sealing, object no 42430. The top of the seal has broken off; the word ‘Aten’ preserved on the side is all that remains of the seal impression. The underside shows the impression of the rim of the amphora and the sagging surface of the mud which has been supported by pieces of coarse grass laid in a rough grid. The mud is a mixture of clay, coarse sand and tiny pebbles. Drawings by A. Boyce; photos by M. Cavriani.

Figure 7. Scene from the Theban tomb of Khaemwaset (TT 261) of the time of Tuthmosis IV. After J. Kuckertz, \textit{Gefässverschlüsse}, 21, Abb. 8; itself after M. Nasr, ‘The Theban Tomb 261 of Khemwese in Dra’ Abu El-Naga.’ Studien zur Ältdgyptischen Kultur 15 (1988), Tf. 15.
Further groups were found in the complex of buildings to the south of the temple enclosure. Part of this served as storage, although the area which Pendlebury labelled as ‘magazines’ was in fact a huge bakery. But with these buildings another factor has to be allowed for: they were equally close to the Great Palace. Temple and palace could have been served by the same source, where commodities were stored and food prepared (and jars opened or damaged).

The second distribution map (Figure 2 overleaf) shows a distinctive pattern of its own. The COA list for the temple ‘entrance’ gives a total of only 4 jar sealings, whereas the total number of fragments from the current excavations is 124. One might conclude that this is a measure of how much material was not noticed in 1932 and was thrown away in the spoil heaps. The current excavations, however, commenced with the excavation (which included sieving and examination of the dirt) of the old spoil heaps which had been left in front of the temple. Even allowing for breakage of pieces which had been thrown away, the number of fragments of jar sealings recovered is very small (with the exception of the group from square G25). The greatest number come from the current examination of the distinctive levelling-rubble.

Pendlebury excavated debris which lay above the levelling-rubble and also cut wide trenches through the same deposit. His dumps, therefore, must be a mixture of material from both sources. In only one place does he seem to have found jar sealings, however, in or near square G25. The concentration here comes from loose dusty sand in the triangular area in the north-west corner of the square. The explanation for this anomaly is present in the aerial photograph of the temple taken in 1935. It shows what seems to be a secondary spoil heap covering much of the floor of his trench in this area. The looser sand deposit in which we found the 25 fragments is thus most likely a dump from the trench that Pendlebury dug into the levelling-rubble. This highlights the near absence of...
sealings from the rest of the old spoil heaps, even of pieces which Pendlebury might not have thought worthy of registration.

The sealings from the levelling-rubble were not evenly spread. Many of the excavation units covered an entire 5 x 5 m square, so that, for example, the two groups in squares I25 and J25 could represent material from a single concentration which lay on the division between the squares. The absence of examples from squares H25 and I24 also suggests that the material had lain in clusters. Yet the pattern is far from being random. It concentrates in the south and west of the excavation area.

The origin of the levelling-rubble (which also contains lenses of sand) cannot be directly determined, although it is tempting to think that, at least in part, it derives from the temporary thick brick retaining wall that had been erected around the area of the large columns at the front of the temple and must have been demolished around the time that the rubble was laid down (Horizon 15, Autumn 2014, p. 6). If the jar sealings had been part of the rubble when it was introduced (whatever its source), then it is pointless to try to identify where the sealings had originally been thrown away. It is here that their non-random distribution becomes significant.
Figure 2. Distribution map of mud jar sealings from the excavations carried out between 2012 and 2018 at the front of the Long Temple. The distribution is according to each 5 x 5 m grid square. Data prepared by M. Bertram.

The concentration in the south-west covers two areas with different characteristics, separated by one of Pendlebury’s trenches. The northern area (G–I28, 29) had been covered with mud-brick offering-tables many of which had been removed to make way for a building supported on wooden posts, perhaps (to judge from pieces of painted pavement) a temporary palace. The southern area (G–I25, 26) had been the site of mud-brick offering-tables which had still been standing to their full height when the levelling-rubble was thrown down. The way that the jar sealing fragments have remained in concentrations could be the result of them lying in low heaps and then becoming incorporated in the rubble as it was being dumped. The northern sealings would then have belonged to the temporary palace, and the southern sealings to the offerings made on or around the brick offering-tables which stood on the edge of the field of over 900 of them. Did people squat on the mud floor which ran between the offering-tables, perhaps leaning their backs against them, and drink the wine from cups?

It is at this point, where the austere images of Aten worship meet the rough realities of material remains, that we fear to allow our imaginations to fill out the picture with possibilities. Over such a huge open space is it likely that people (exclusively ‘priests’?) maintained a formal, prescribed form of behaviour or could they act more informally as family groups, relaxed amongst themselves? We should try to imagine contour lines covering the huge temple enclosure, not measuring intervals in elevation, for example, but variations in formality of personal behaviour, thought and speech. High values (perhaps accompanied by reddish shading) would concentrate along the main temple axis, shading off to lower values and cooler colours as one moves further away and as people decided for themselves how to behave.

Notes
Regarding the totals for each location in Figure 1, in the lists in COA III, 212–15 the 23 blank entries in the first column (‘Number’, referring to sealing type) have been treated as ditto entries for the number in the line above. This yields slightly more examples than is marked on the map in B. Kemp and S. Garfi, A Survey of the Ancient City of El-‘Amarna. London, Egypt Exploration Society 1993, 51, Fig. 11. I have treated ‘pomegranate wine’ as ‘wine’.

That the ‘Temple dump south’ was ‘close to a gateway’ is stated in COA III, 11, also 6. The pottery found in the dump is summarised in Petrie, Tell El Amarna, 19; COA III, 20; and more particularly in P.J. Rose, Amarna Reports IV, 119–121, Area 12. Details of the pottery types are in P.J. Rose, The Eighteenth Dynasty Pottery Corpus from Amarna. London, Egypt Exploration Society 2007: incense bowls (pp. 203–7, types within class SD7); offering-stands (pp. 189–91, types SA3, SA4); and miniature vessels (pp. 211, 261, types SE1.1, SJ1–SJ4).

Building S39.1: in 1962 inspector Ali Hasan carried out an excavation for the Maliawi inspectorate and found 13 jar sealings for wine; specimens have been picked up by visitors since then.

The Stela site: one wine-jar sealing was found by our excavations in 2012, and an unstamped mud jar bung.
Working with fire: making glass beads at Amarna

Anna K. Hodgkinson and Miriam Bertram

A series of archaeological experiments were carried out in 2017 and 2018 to test how the production of glass beads might have taken place during the Amarna Period.

The investigation of the courtyard of houses M50.14–16 in the Main City South in 2014 and 2017 uncovered some small fireplaces, which appeared to have been used for the manufacture of glass beads. A large number of unfinished beads, sometimes displaying trails of glass that had not fused properly or had not been polished off, were found near the fireplaces and all across the courtyard (Figures 1a, b).

Modern beads are usually made by means of the so-called lamp-working method, by which a cane or rod of raw, coloured glass, is melted over a flame – usually a gas burner – and wound around a metal rod, referred to as a mandrel. The ancient Egyptian method of beadmaking is believed to have been very similar to this, and beads stuck to mandrels have been found at glass workshops at Amarna (Figure 1c).

However, not being in possession of high-temperature gas burners, the ancient Egyptians would have probably made their beads over a small fireplace, using a narrow, very hot flame. While modern, more thorough excavations have brought to light such fireplaces and pits, old excavations, such as those carried out at the beginning of the 20th century, have not revealed any evidence of such internal areas.
last century by the Deutsche Orient-Gesellschaft and the Egypt Exploration Society, often failed to locate such ephemeral features, excavation methods of that time being somewhat superficial. Hence, much information regarding ancient Egyptian bead-making technology has been lost.

Coloured glass as used by both ancient and modern beadmakers requires a temperature of between 850 and 950º C in order to become sufficiently viscous and workable. In order to find out whether it was possible to achieve such temperatures, and subsequently to make glass beads over a small fireplace which would not have left a significant trace in the archaeological record, Anna Hodgkinson and Miriam Bertram conducted a series of archaeological experiments in 2017 and 2018.

The experiments were set up behind the excavation house at Amarna next to the large experimental kiln built by Paul Nicholson and Caroline Jackson in the 1990s, which had been modelled on one of the kilns excavated at workshop O45.1 in the Main City North. While the latter structure achieved extremely high temperatures, producing glass from raw materials at c. 1150º C, the present experiments endeavored to establish whether a well-ventilated, but much less substantial fireplace might be capable of achieving a similar temperature.

The glass used in the experiments is modern glass, brought from Europe, as are the mandrels. Local acacia wood and charcoal were used as fuel, together with some lumps of dried animal dung, which were used for the initial firing. Several attempts were necessary to achieve conditions for bead-making. The first fire pit was both too deep and too wide, resulting in an uncontrollable flame (Figure 2). For the second attempt a clay-coated brick roof covered the fire pit. Through insufficient ventilation, however, the required temperature was not reached. For the third experiment, in the spring of 2018, a blacksmith from El-Till, Kamal Shawky, was present. He dug and constructed a clay-lined pit with a funnel-shaped superstructure. He attached and operated a set of goat-hide bellows and these provided the necessary ventilation. However, since the flame exiting the clay ring was not sufficiently hot, Kamal demolished half of the kiln, enabling us to work directly above the flame (Figures 3, 4). This was the first time that temperatures in excess of 850º C were reached and beads were made (Figures 5a, b, c).
The tomb of Rekhmire at Thebes (TT100) includes a scene depicting the use of bellows, albeit for metal-working, and ceramic bellows attachments, so-called tuyères, are also known from metal-working contexts including at Amarna (specifically at the Grid 12 group of houses not far from M50.14–16). Ceramic tuyères have not been found in association with glass-working at Amarna, however. Therefore, a different approach was tested. The use of blowpipes, presumably made from copper or bronze, to ventilate small bonfires is attested in tomb scenes from the Middle Kingdom and New Kingdom (e.g., the tombs of Amenemhat and Khety at Beni Hasan (Figure 6)). Although these scenes do not depict glass-working, this method was tested by the authors, since it creates a very narrow, well-ventilated spot in the fireplace, suitable for glass-bead production, albeit involving a larger team of participants.

For the most recent set of experiments, which took place in the autumn of 2018, a small, shallow pit (c. 15 cm deep and c. 40 cm in diameter) was dug into the sand. Its base was lined with a (modern) Nile clay potsherd, and no further clay lining was applied (Figure 7). The fire was fueled by a mixture of small pieces of acacia wood and charcoal. Some animal dung and dry plant remains were used to start the fire. After only one hour the fire was sufficiently hot to bend, although not to melt, and work a glass rod. In the first run, one, and during the second stage, two modern copper blowpipes, obtained locally in Mallawi, were operated by two participants, who blew in turns, providing constant ventilation for the fire (Figure 8). The blowpipes were covered with charcoal, but free from wood, and directed at a single spot, which soon reached 850°C.

This temperature caused the tip of the glass rod to glow and enter a molten, viscous state, thus making it possible to melt and work the glass into beads by winding these glowing and soft ends around the metal mandrels, which had
been coated in a parting layer (Figures 9a, b, c, d). Some colourful polychrome glass beads with spiral and eye decoration were also produced (Figure 10).

Although ventilation by means of blowpipes provided more or less constant heat (whenever the fire did not require refueling), it also caused the ashes from the burning charcoal to fly up and stick to the glass, making the surface of some beads dull. Future experiments are planned, possibly without the use of charcoal, in order to counter the flying ashes and, possibly, to test the manufacture of core-formed glass vessels over similar fire pits.

While these experiments do not teach us exactly the type of firing-structure or -pit the Egyptians used in the production of glass beads during the New Kingdom, it does give us a better idea and understanding of the logistics and difficulties involved in this type of production.

Further reading


http://www.amarnaproject.com/pages/recent_projects/excavation/beadwork


Frank Wiesenberg experimental study on Roman bead furnaces: http://www.glasofenexperiment.de/p_po_borg_1.htm


Photogrammetry at Amarna

Paul Docherty

During the autumn 2018 season it was decided to test out the possibilities of using photogrammetry to survey locations at Amarna. The first test was conducted around the site of the Great Aten Temple front. (A second test in spring 2019 at the site of the North Harim area of the Great Palace will be reported on in a future issue.)

Figure 1. Vertical point-cloud of the front of the Great Aten Temple generated by photogrammetry and based on photographs taken at ground level on November 10th, 2018.

Figure 2. Oblique point-cloud, looking as if to the north. The identified features are:

1. The reconstructed ramp leading up to the outer temple entrance between a pair of mud-brick pylons set within the mud-brick enclosure wall.
2. The outlines of a small stone building, probably a small palace. The new stonework rests on a layer of sand spread over thick foundations of gypsum concrete which preserve the plan of the building.
3. A temporary pit which allows access to the underlying mud floor on which are preserved many features that belong to the temple layout of an earlier phase. These are still under investigation. A layer of sand on the floor gives temporary protection.
4. The eight stone squares are to provide support for circular pads of white cement, 2.5 m across, which mark the positions of eight colossal columns which stood in front of the stone pylons.
5. On the north, the pads marking the positions of the columns have already been made.
The modern photogrammetric process begins by capturing the subject through a series of overlapping images taken from different viewpoints, ensuring that every surface is present in at least three images. This can lead to a considerable number of photographs taken in order to fully capture the subject. In the case of the Great Aten Temple entrance this amounted to 1200.

Once the images have been taken, they are processed using specialist photogrammetry software. Several commercial options are available, with Agisoft Metashape (formerly PhotoScan) and Reality Capture being the most widely used. There are also a few open-source options with Visual SFM (Structure from Motion) developed by Changchan Wu being one of the most popular. Irrespective of which software is used all processing follows the same general workflow in order to convert the images into 3D models and 2D orthophotographs.

The capture images are loaded into the software and all physical markers (points that are measurements of distance and height) are manually identified and tagged within each photograph to ensure the resulting 2D and 3D outputs are scaled and oriented correctly. Fortunately, in Agisoft Metashape this is a semi-automatic process reducing the time taken. Each image is then checked for identifying features which are indexed and compared with those in all the other images to find the corresponding overlaps and initial camera orientations. Once the camera locations have been determined in 3D space a sparse point cloud is generated from all the feature points used to tie the images together. This is our first indication as to the success or failure of the capture. Some adjustments may be needed at this stage but following on from this is the generation of a dense point cloud which effectively fills in the spaces between the sparse points and creates the 3D detail (Figures 1, 2). After this dense point cloud is produced, we can either generate a 2D orthophotograph from the height data (relative to a flat plane) or a 3D model by effectively joining the dots with geometric faces (an oversimplification of the process). Photogrammetry may seem a little longwinded, but apart from the capture time most of the processing is done automatically within the software, with periodic user input.

For the Great Aten Temple, a point-to-point panorama photography method was used. This involves standing at one point and taking a series of photos facing in multiple directions as if to create a 360-degree panorama, before moving on to another point and taking another series of photos. The photography was carried out on one morning after the work had finished, by Miriam Bertram using a small conventional digital camera. Horizontal measurements and heights came from the surveying already carried out on the newly laid stonework.

Photogrammetry is not meant to replace traditional surveying methods; however, it can enhance them by providing additional data in the form of in-between points and subtle undulations found in the surrounding surface which are not normally recorded. By taking slices through the point cloud we can generate a series of height contours which can be exported along with a digital elevation model (DEM) for use in other software such as Quantum GIS (open-source mapping software) to produce a contour map as can be seen in Figure 3. In this instance the map has been given a colour shift and hill shading to help identify height changes and features more easily. We also have the option to re-project contours back onto the original photographs as a 3D overlay giving yet another way to visualise a site (Figure 4).

Photographs of the temple at a later and more advanced stage are on page 24.
Roger Bailey, a Blue Badge Tourist Guide, describes how it is that the symbol of the Aten became incorporated into the memorials to the rebuilding of the city in 1948.

“The British city of Coventry, located in the Midlands, was rebuilt after the Second World War by Donald Gibson who, like many of his profession, was seemingly inspired by Amarna in the 1930s. In 1948 the foundation stone for Broadgate House was laid, and a single tall, slender column put in place (Figure 1), using scarce materials which a member of the architect’s department was obliged to acquire on the black market. A stone placed on the north face of the column was carved with an inscription recording the role of Princess Elizabeth in the ceremony. On the south side the young Coventry letter-carver and sculptor John Skelton carved emblems of the city’s weaving industries: scissors, a tea-se, a cap and a loom. At the base of the same column another emblem refers to a system of belief which had a simultaneously private and a public dimension. Gibson asked Skelton to carve there the symbol of the Egyptian pharaoh Akhnaton (Figure 2), who had become something of a cult figure after archaeological excavations resumed at Tell el-Amarna in the inter-war period. During the 1920s, Tell el-Amarna came to be viewed in terms of a lost utopia, an ideal city dedicated to the worship of the sun. It was described and depicted in terms of a prototype of the garden city, with extensive housing quarters and broad, well-planted avenues.”

**Further reading**

wrap.warwick.ac.uk/53223/1/WRAP_Campbell_paper_dream_city_current.pdf

The text associated with footnotes 62–65 treats the interest in Amarna and Akhenaten at that time.

One way by which the public would have learnt of the excavations at Amarna would have been through articles published in the widely read *Illustrated London News* (ILN), a large-format weekly journal noted for the quality of its illustrations. One of the 12 Amarna articles which appeared between 1921 and 1935 was the following:

J.D.S. Pendlebury, ‘A “monotheistic utopia” of ancient Egypt.’ *ILN* 182, no. 4907 (6 May 1933), 629–33.

Both John Pendlebury and his architect Ralph Lavers also gave lectures on Amarna at meetings of the Architectural Association in London; and the Egypt Exploration Society, the body responsible for the excavations, put on an annual exhibition of results in London which included the share of objects allotted to them by the Egyptian government.

The Coventry carving illustrates the impact which archaeology can have in the public domain.
Discussions have begun about the possibility of holding another Amarna open day in the summer of 2020 in Berlin.

On 7 September 2018, at a lecture on the work of the Amarna Project in the Legislatura de las Ciudad Autónoma de Buenos Aires, Barry Kemp was presented with a diploma as Guest of Honour of the City of Buenos Aires by Diputada María Patricia Vischi. The lecture was part of a series (with Juan Friedrichs and Miriam Bertram) given in Buenos Aires and La Plata.

Web site downloads

Northern Cemeteries

Great Aten Temple

Great Aten Temple – Autumn 2017, Spring and Autumn 2018 – Preliminary Report
Barry Kemp, Miriam Bertram, December 2018
The Solar Observation and Offering Platform at the Front of the Great Aten Temple
Barry Kemp, Paul Docherty, January 2019
Great Aten Temple – Spring 2019 – Preliminary Report
Barry Kemp, Miriam Bertram, October 2019
Great Aten Temple – Autumn 2019 – Preliminary Report
Barry Kemp, Miriam Bertram, November 2019

Publications


Anna K. Hodgkinson, Stefan Röhrs, Katharina Müller and Ina Reiche, ‘Portable X-Ray fluorescence analysis of Late Bronze Age glass from Amarna.’ http://repository.edition-topoi.org/collection/KBLT

The Annual Egyptological Colloquium of the British Museum, entitled Amarna: the Lived City (and in collaboration with the Amarna Project), took place on Thursday 19 and Friday 20 September 2019. It featured leading international speakers exploring life at ancient Amarna. Ticket prices included a donation towards the work of the Amarna Project.

The topics ranged widely and included differing views on whether we are right to assume that carved heads of Amarna royal women are accurate likenesses, the possibility of solar shrines on the roofs of people’s houses, the suggestion that the huge enclosure of the Great Aten Temple is an example of urban public space, the health and mortality of those buried in the Amarna cemeteries, the ‘angelic’ life of Coptic monks at Amarna, and many more.

Gemma Tully introduced a children’s book, Amarna, Life Under the Sun. It is the product of collaboration between the Egyptian Ministry of Antiquities, the University of Cambridge Department of Archaeology, the Amarna Project and both teachers and pupils from schools in Amarna and Cambridge. The book tells a parallel story about the daily lives of children from ancient and modern Amarna. The story is linked with cross-curricular learning activities to expand knowledge about Amarna, such as making mud bricks, designing clothing and measuring with cubits. The book is currently in preparation and will be published in a joint English-Arabic edition, targeted at Junior aged children (7–11 years old) in Amarna and across the globe, in late 2019.


Discussions have begun about the possibility of holding another Amarna open day in the summer of 2020 in Berlin.
Great Aten Temple limestone block scheme

Below are listed the names of those who have donated one or more of the limestone blocks being used to mark the shape of the temple front. Each block (obtained from the limestone quarries of El-Tura outside Cairo) bears the name of the donor. We greatly appreciate your support.

Many more blocks are needed. If you would like to dedicate one, visit our funding-page:
www.gofundme.com/be-part-of-the-great-aten-temple

It will be inscribed according to your wishes, and you will receive a certificate with a photo of your block and a note of its position in the temple, as the inscription will be not visible after it has been laid.

Adriana Gonzales
Adriana Tamayo
Agustina Puig
Agustina Scaro
Alan Brabant
Alejandro Dircks Cony
Alice Schulz
Alison Woillard
Allissa Bandy
Almudena Diaz
Amanda
Andre Veldmeijer
Andrea Anile
Andrea Romero
Andrea Zingarelli
Andreas Mesli
Andrés y Leonor
Andrew Prior
Ann Egnintine
Anna Hodgkinson
Anna Tribbier
Anne Godfrey
Annette Søderholm
Anonymous
Ano Münch
Barbara
Barbara Peterken
Barbara Shorf
Barry Kemp
Beth & Damian Asbury
Betty Baur
Bibiana Frege
Bijon Sinha & Richard Northridge
Bodo Sauer
Camila Zambrano
Carina Felske
Carlos Borrico
Carlos Paredes
Carolina Montal
Caroline Arbuckle
Carolyn Perry
Carolyn Prior
Catherine Rouse
Charlotte Dietrich
Christian Breuer
Christian Eckes
Christine Olivier
Claire Zerfahs
Clarisa Hernandez
Cordula Werschuhn
Cristina Bacquerisse
 Dagmar Altkeruse
Dan Brewer
Dana ivey
Danish Egyptological Society
Darren Gavin Simons
David Basano
David Hay
David Morley
Debra Tily & Suzanne Blackburn
Diana Aронoff
Diana Cortese
Diana Pisani
Diane Hagner & Rachel Goddell-Johnson
Dorothy Janson
Eduardo Cersosimo
Elaine Green
Elena Aon
Elisabeth Luecking
Elisabeth Schalleh
Enrique Luco Contestin
Familia Calomino
Francesca Jones
Francesco Tira’dritti
Frank Maroch
Gabriela Mohamed
Gabriela Pané
Gary Parks
Gill Ekić
Gimena Olmos Bazán
Giuliana Iribarren
GnT Tours
Gretchen Lima
Grisha Femme Martin
Guadalupe Alvarez
Hanadi Khalid
Heba el Nuby
Heidi Schneider
Helen Fenwick
Helle Thomsen
Hervé Lucas
Holger Schulz
Irene Rodriguez
Isabelle Sambrook
Isassmendi Maria Celeste
Jacquelyn Reeve
Jacquelyn Williamson
Jan Bailey
Jan Picton
Jane Fairies
Jane Stow
Janet Brewer
Janet Franklin
Janet Shepherd
Jasmin Beuren
Javier Musa
Javier Navarro
Javier Paysas
Jill Oliver
John James
John Wall
Jolina Bos
Jordan Galczynski
Jorge Carbia
Jorge Vento
Juan Ferguson
Juan Friedrichs
Judith Tulloch
Judy & Louis Galczynski
Julia Alonso
Julia Vilaro
Jutta Oldendorf
Kate Bowgett
Katja Lembke
Kaj Kossatz
Kees Tol
Kevin Stacey
Kimberly Sanders
Kirstin Armstrong
Kitty Guerberoff
Larry Stout
Lars Jacob
Laura Ranieri
Laurits Honore Ranne
Leonardo Paolo Lovari
Leticia Antonini
Liliana & Virginia
Linda Tobey
Lisa & Don Newman
Liz Jones
Lorna Oakes
Louis Galczynski
Louise East
Luciana Gignone
Lyne Jamieson
Mailen Correa
Manuela Gander
Marcos Alvarez
Maria & Armando Jinich
Maria Ines Garcia Hamilton
Maria Luisa Meiras
Mariangel Polich
Mariano Bello
Maribel Blanco
Mark Lehner
Martha Torres
Martin Carbia
Martin Labram
Martina Neuen
Mary Yeandon
Mariza Cavriani
Meredith Benson
Michael Berendt
Michael Tweddle
Michele MacDonald
Mike & Robyn Wright
Miles Nugent
Miriam Bertram
Mirta Intelisano
Monica B. Hernandez
Monica Nunez
Monika Szuhi
Myriam Har
Nancy Page Cooper
Natalia Ceres
Natalia Contreras
Nehuen Correa
Nélida Nuin
Nicola Gentili
Nir Szlagyi
Norma Alpazaray
Olha Zapletniuk
Omar Staltari
Osvaldo Ghisoni
Pat Remler
Patricia Gauna
Patricia Raffellini
Paula Benegas
Perla Rodriguez
Peter Black
Peter Lacovara
Polly Buxton
Renee Kastelein
Richard Glendon
Richard Grant
Robin Derricourt
Rodrigo Amigo Maria Nazarena
Roland Fernhout
Rolf Rosendahl
Rosemary Hawkins
Rosana Vitale
Ruth Fink-Winter
Ruth McCaffrey
Salwa Y. Amzourou
Samantha Stow
Samira Kirollos
Sandy Esene
Sarah Doherty
Sarah Rankin
Satsuki Watanabe
Sergio Badia
Sergio Baur
Sheila & Eric Beadel
Shelby Navone
Silvana Fantechi
Silvana Tomasa
Silvia Carbia
Silvia Buccafusca
Silvina Vera
Skye & Chris Newman
Sol Esposito
Søren Michael Sindbæk
Stefan Vleihauer
Stella y Carmen
Stephanie Lindeburg
Sue Kelly
Tamara Berlenghi
Tamina Logullo
Theo van der Vegt
Thomas Fiedler
Tilly Burton
Tim Hagedorn
Tina Bayrampour
Tomas Bican
Tony Carter
USAL CEEMO
Valeria Mayocchi
Vanessa Foot
Venny McKeown
Vernon Appleby
Veronica Gimenez
Vesna Đorlić
Victoria Thomson
Viviana Gomez
Vernon Appleby
Viviana Gomez
Vann Hamon
Yvonne Trawen
Ziff Jonker
The Trust invites donations from individuals or from corporations. Donations can be earmarked for particular purposes or they can be allocated by the Trust in pursuit of the stated objects of the Trust. The Trust is able to benefit from the present UK tax legislation by reclaiming tax on donations from UK tax-payers under the Gift Aid scheme, which increases the value of the gift by nearly a third. The JustGiving donations web site does this part of the transaction automatically. Otherwise it is necessary to accompany each donation with a Gift Aid declaration form or a similar letter. There are further tax advantages for donors who pay at higher rates.

For residents of the USA, donations can be made either to the Amarna Research Foundation or to the Cambridge in America Foundation (both 501(c)(3) tax-exempt organisations) with the request that the donation be made into a grant for The Amarna Trust.

To make a donation to the Amarna Trust, go to http://www.amarnatrust.com/supporting-amarna

All work done at Amarna relies upon the support and agreement of the Ministry of Antiquities of the Arab Republic of Egypt. We are indebted to its personnel, both local and in Cairo.

Thanks to those who have recently supported the Amarna Project:

**Meryra Circle**
- Vernon Appleby
- Lucilla Butler
- Mary Glesige
- James Harrell
- Fraser Matthews
- Jutta Oldendorf

**Akhetaten Circle**
- Amelia Alexander
- Frances Bailess *(in memory of Michael Coultons)*
- Miriam Bertram
- Kate Bowgett
- Barbara Burnett
- Barry Burnett
- Jeff Burzacott
- Krishna Datta
- Lucia Evans
- Jane Faiers
- Alison Gascoigne
- Anne Godfrey
- Eileen Goulding
- Annie Haward
- Anna Hodgkinson
- Barry Kemp
- Lachlan Moir
- Rita Murray
- Paul Nicholson
- Lorna Oakes
- Mark Ponman
- Edythe Scott
- Giovanni Sergio
- Bijon Sinha
- Anne Squires
- Anna Stevens
- Gary Thornton
- Julia Vilaró
- Stewart White
- Claire Zerfahs

**Anonymous**
- Jorge Alarcon
- Claudio Alvarez
- Marina Barone
- Margaret Beaumont
- William Beeston
- Eduardo Cersosimo
- Tim and Betty Dunn
- Tim Hagedorn
- Mónica Beatriz Hernández
- Samira Kirollos
- Sachie Osada
- Clinton W. Owen
- Mariangel Polich
- Shirley Priest
- Augustina Puig
- Pauline Rigby
- Perla Rodriguez
- Bodo Sauer
- Paula Terrey
- Martha Sandra Torres
- Christopher Turner
- Ms and Mr White
- Toby Wilkinson
- Olha Zapletniuk

Ancient World Tours run regular tours that include Amarna and we are proud to be sponsors of the excavations carried out by the Amarna Project. Contact AWT on +44 (0) 333 335 9494 or at www.ancient.co.uk or at amarna@ancient.co.uk
View to the east on June 6th, at the end of the spring 2019 season. The stonework of the central paved area is not yet completely laid.

How the scheme to mark the main features of the temple front in stone should look when finished. Visualisation by Paul Docherty.

Stonework in front of the temple pylons lies at ground level. Deliveries of sand enable the ground to be built up to a clean, level surface which is the same as the original ground level when the temple was in use.

Reconstruction of the main ancient features at the front of the temple. Visualisation by Paul Docherty.

Each of the eight large columns on either side of the temple axis is marked with a circular pad of white concrete, 2.5 m across, filling a circular iron mould. The white cement is mixed with pieces of limestone broken by hammering. A grid of iron rods adds strength to the mix.