British Mission to Tell el-Amarna

Study season on material excavated at M50.14-16

Autumn 2019

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November 11, 2019

Report on a study season on material excavated at site M50.14-16 at Amarna

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A study season was carried out between the 07 October and 10 November 2019 on material excavated at the domestic workshop site M50.14-16 at Amarna in the fall of 2014 and 2017 (Hodgkinson 2015 and 2019). The following team members were present: Dr. Anna K. Hodgkinson (project lead and main author of this report, Freie Universität Berlin), Dr. Sarah K. Doherty (ceramicist, University of Oxford), Dr. Frederik W. Rademakers (archaeometallurgist, KU Leuven), Dr. Rainer Gerisch (archaeobotanist, formerly Freie Universität Berlin) and Dr. Cecilie Lelek Tvetmarken (archaeologist, German Archaeological Institute Berlin). The work was carried out in collaboration with the Egyptian Ministry of Antiquities and the local inspectorate, to whom the team is most grateful.

1) Work on the fieldwork archive

The work comprised the completion of the digitisation of the fieldwork archive. In addition, the stratigraphy of the 2014 excavation was checked and revised. Further work on the archive will be carried out, in particular with regard to the effect of the early excavations conducted by Woolley in 1922 (Peet and Woolley 1923).

Figure 1: The digitised plan of site M50.14-16 (2014 and 2017 excavations). Digitised by A. Hodgkinson.

2) Object registration and documentation

The study season focussed on the study and documentation of the domestic and industrial pottery, the finds related to metallurgical activities and the charcoal excavated at M50.14-16, and these activities are reported on below, as described by the individual specialists.

During the season, a total of 34 objects were newly registered. 7 of these came from the 1922 spoil heap to the south of complex M50.14-16 in the Main City South, or had been collected on the surface, while the others were noted during the evaluation of those object categories previously registered in bulk, i.e. the pottery and bones. These objects were added to the existing database, which now comprises 2232 individually registered objects, and the new additions were photographed by Andreas Mesli.

Reg. #	Material	Type of Object	Grid square	Excavation unit / findspot
43206	Ceramic	Metal-working crucible	Surface	Old spoil heap to the South of site.
43207	Ceramic	Oven furniture	H-4	15620
43208	Clay	Jar sealing	G-3	15763
43209	Ceramic	Industrial vessel	K-4	15673
43210	Ceramic	Cylindrical vessel	Surface	Old spoil heap to the Southeast of site
43211	Ceramic	Cylindrical vessel	Surface	Area of N49.1, GPS: 27°37'56.2"N, 30°53'31.3"E
43212	Ceramic	Cylindrical vessel	Surface	Old spoil heap to the Southeast of site
43213	Ceramic	Cylindrical vessel	Surface	Old spoil heap to the Southeast of site
43214	Stone – sandstone	Rubber / polisher	Surface	Old spoil heap to the Southeast of site
43215	Glass	ingot fragment	Surface	Old spoil heap to the Southeast of site
43216	Ceramic	Cylindrical vessel	J-4	15704
43217	Ceramic	Cylindrical vessel	K-4	15686
43218	Ceramic	Cylindrical vessel	Surface	Old spoil heap to the Southeast of site
43219	Ceramic	Cylindrical vessel	I-4	15799
43220	Ceramic	Cylindrical vessel	K-4	15685
43221	Ceramic	Tool ?	K-4	15685
43222	Ceramic	Cylindrical vessel	J-5	17519
43223	Ceramic	Cylindrical vessel	H-2	17564
43224	Faience	Inlay	I-2	17550
43225	Ceramic	Cylindrical vessel	L-3	17512
43226	Ceramic	Cylindrical vessel (?)	I-2	17550
43242	Ceramic	Female figurine	L-2	17611
43243	Ceramic	Cylindrical vessel	Surface	M50.14-16 - surface
43244	Faience	Bead	I-3	15797

43250	Ceramic	Cylindrical vessel	J-2N	17659
43254	Ceramic	Pigment bowl	J-3	17542
43257	Ceramic	Cylindrical vessel	J-2	17508
43259	Faience	Bead	H-4	15646
43260	Faience	Bead	H-4	15646
43266	Bone	Worked bone object	K-4	15729
43291	Bone	Worked bone object	H-2	17585
43292	Bone	Worked bone object	i-2	17732
43313	Ceramic	Cylindrical vessel	I-4	15630
43314	Ceramic	Cylindrical vessel	I-3	15694

Table 1: Objects newly registered in 2019.

2.1 Pre-processing of animal bones

Cecilie Lelek Tvetmarken pre-sorted and described the animal bones excavated in 2014 and 2017 according to the diagnostic pieces found within each bag (by day and stratigraphic unit), producing a preliminary overview over species of animals encountered and used at the site. A number of animal bones with butchering marks were encountered, and these were photographed. In addition, three worked bone objects were found within the material. These objects can most probably be interpreted as piercing tools, possibly related to textile- or leather working.

2.2 Study of technological ceramics related to glass manufacture and -working

Figure 2: Cylindrical vessel base 40348 showing the vitrification layer below the parting layer. Photo: A. Hodgkinson.

Anna Hodgkinson continued her study of the glass-working remains, focussing on the cylindrical vessels used for the production of glass ingots (see figure on title page). Hereby, she studied the layers in the ceramic material as visible in the breaks of each vessel, showing the reaction between the glass, the calcareous parting layer, and the ceramic material. These layers, which can include a vitreous "bottle-green interface" and a pink/buff layer (Smirniou and Rehren 2016, see fig. 2) are indicative of the temperature to which the vessel was exposed in the kiln, and ultimately, whether or not it may have been used for the production of glass from raw materials. This layering has, to some extent, been identified in some of the vessels, although further study is necessary. As mentioned below, some of these vessels with remains of glass were analysed by handheld X-ray fluorescence by F. Rademakers.

2.3 Study of the metallurgical remains (F. W. Rademakers)

This study has focused on the metallurgical production waste encountered at M50.14-16. A total of 39 crucible fragments (fig. 3) have been studied, as well as 130 fragments of copper alloy. The aim has been to reconstruct the metallurgical activities encountered at M50.14-16.

Figure 3: Metal-working crucible fragment 41700 from M50.14-16. Photo: A. Hodgkinson.

Methods

Macroscopic study of the crucible fragments was performed to characterize the specific fabric developed for these technical ceramics. Furthermore, handheld X-ray fluorescence (HH-XRF) was performed for all of the crucibles in order to qualitatively assess the metal alloys that were processed in these crucibles (cf. Rademakers and Rehren 2016).

Similarly, macroscopic investigation as well as HH-XRF analysis were performed to study the various metal fragments, which highlight the processing of different alloys in the context of activities such as melting, casting, hammering, sheet working etc. (fig. 4). The combined study of crucibles and metal fragments thus provides an overview of the different metalworking activities taking place at M50, mainly revolving around copper alloys but equally including some precious metal processing.

Figure 4: The analytical setup for metallurgy in the autumn of 2019 at Amarna. Photo: F. Rademakers.

To further contextualize the results obtained at M50.14-16, a comparison is made to metallurgical waste encountered at other areas in Amarna. The (already published) crucibles from O45.1 (21 fragments: Nicholson 2007) and Grid 12 (167 fragments + 4 lead artefacts: Kemp and Stevens 2010b) were macroscopically compared to the M50.14-16 crucibles and all fragments were studied by HH-XRF using the same protocol (not performed in earlier studies). The comparison of technical ceramic fabrics and the metal compositions worked in these areas with regard to those encountered at M50.14-16 enables a more detailed assessment of how metallurgical activities in Amarna may have varied at a more refined scale than what has been possible so far. Furthermore, a detailed comparison will be made to the metallurgical waste from Pi-Ramesse which has been studied in detail using the same methods (Rademakers *et al*. 2018) to assess how metallurgical technology and raw material use may have varied between these different New Kingdom production contexts.

The HH-XRF analysis of 11 glass crucibles, studied in previous seasons by Anna Hodgkinson, has been replicated this season to verify results obtained using a different instrument (cf. Hodgkinson *et al.* 2019). Finally, an iron object from the Great Aten temple has been has studied (macroscopic + HH-XRF study). A total of 898 XRF analyses were performed across these different material assemblages.

2.4 Study of the ceramics (S. K. Doherty)

The M50 Study Season for the Pottery occurred between 9-30th October 2019. Prior to the ceramicist being on site, the excavators of M50.14-16 during the 2014 and 2017 seasons had already separated out the Marl clay sherds from the Nile Silt sherds. They then further separated the sherds between diagnostic and non-diagnostic types and weighed and counted them. This preliminary report outlines the initial analysis of the pottery from M50, and the notable sherds will be described. A more detailed report is to follow which will consider the ceramics in each grid square I-2 to L-4.The pottery analysed all date to the Amarna period, with some foreign imported wares from Canaan and the Levant.

Methods

(1) The sherds are separated into diagnostics and body sherds. The body sherds are further separated out into their different clay types based on the Vienna System of classification (Nordstrom and Bourriau 1993)[1] (Marl Clay, Silt, Roman, Aswan, Islamic, Modern). (2) These are then counted and weighed, and the diagnostic sherds are washed and sorted into their defining characteristics and sub-divided by shape, form and other features. If there is more than one type, all are counted, made a note of in the bulk recording form and pottery field notebook, and any new type or better example of existing type is set aside to be registered for the database. The typology used is based upon Rose (2007). (3) The selected sherds are given an identifying ceramic “C” number for the database, and all the details (measurements, and characteristics such as colour, clay type and manufacturing marks) are recorded into a spreadsheet. Each sherd is then labelled with the ceramic number e.g. C24178. (4) The labelled diagnostic sherd/vessel’s profile, estimated diameter and defining characteristics of the likely shape of the once complete vessel is then drawn. (5) The sherd is photographed, and then bagged to be stored.

Counts and Weights

Table 2: Marl

Quantity (sherds total) Marl	Quantity (diagnostics) Marl	% Diagnostic	Quantity (other sherds) Marl	Weight (sherds total) Marl (g)
3579	**576**	**16.09**	**2222**	**70.731**

[1] The Vienna System is used to identify the clays of dynastic sherds, and defines ceramics using various methods: hardness, sound, amount of sand particles and other inclusions, and colour. I follow Rose (2007) clay types for the Amarna New Kingdom examples, and Aston 1998 and (Wodzińska, 2010) for New Kingdom through to modern examples.

Table 3: Silts

Quantity (sherds total) Nile	Quantity (diagnostics) Nile	% Diagnostic	Quantity (other sherds) Nile	Weight (sherds total) Nile (g)
22429	**1871**	**8.34**	**14324**	**339.917**

In total 26,008 pottery sherds were collected over the two seasons at M50.14-16, of which 2447 were diagnostic and therefore useful for identifying the original type. However, many of the diagnostic pieces survived only as very small, abraded sherds, which proved to be challenging for their type identification. M50.14-16 is within one of the settlement areas of Amarna and most likely the ceramics were regularly trampled and churned about the area. M50.14-16 was also previously excavated by Woolley (in 1922) and therefore some sherds may not come from their ancient context.

The percentage of Marl diagnostics to the overall quantity collected is 16.09%, double the amount of Nile Silt diagnostics to the overall quantity collected (8.34%). This most likely attests to the better survival chances of the Marl clay, as they are generally harder wearing, and have usually been formed into large vessels such as Amphorae and Meat Jars. Nile Silts were used to form a wider variety of vessels at M50.14-16, ranging from bowls to large jars, and generally in greater quantities too (as can be seen in M50.14-16 with 22429 Nile Silt to 3579 Marls). This is a common situation for most New Kingdom settlement sites.

Notable vessels from M50

Complete Profiles

Interestingly, M50 contained only two vessels with complete profiles, and no totally complete vessels. All Types are from Rose (2007).

- C157213 a large bowl with simple rim, 20.5cm in diameter type SD 1.5 of Nile Silt (1.1) with a red slip. The interior was excessively worn down through use, possibly due to cleaning with an abrasive such as sand (see fig. 5).
- C157352 a large bowl with an upright rim, 23cm in diameter, type SD 3.2 of Nile Silt (1.1) with a red slip
- Near complete biconical jar CC-124 of Nile Silt 1.1, very abraded. The rim had been removed in antiquity.
- Near complete blue painted biconical jar CC-125, Nile Silt 1.1 with bands of blue paint and rounded base. The rim had been removed in antiquity. The pot had been buried into square L-3.

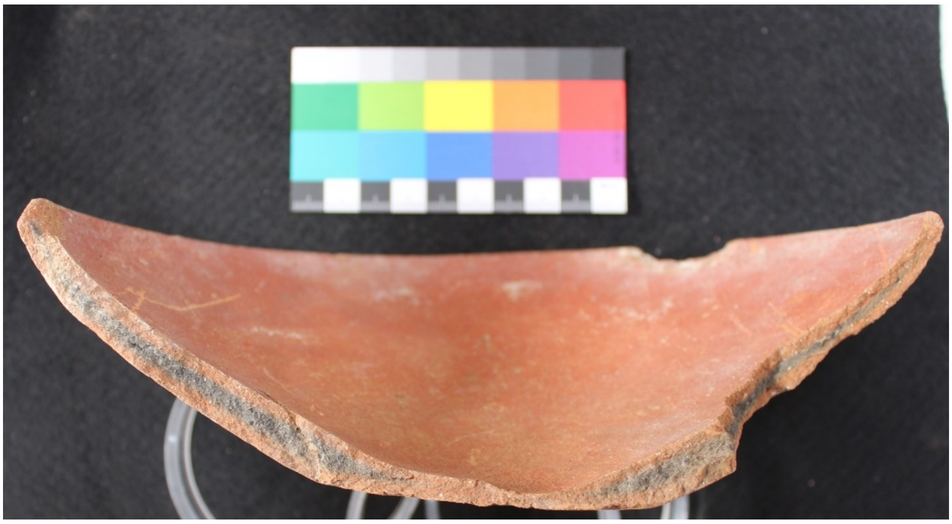

Figure 5: C157213, note the wearing down of the interior of the vessel through use (possibly cleaning with sand). Photo: S. K. Doherty.

Unusual Forms

- C157289, a Cobra Bowl (fig. 6) with a wavy rim (unfortunately no ceramic cobra survives), perhaps with a diameter of c20-22cm, SD 13.1 of Nile Silt (1.1) with a white wash
- C157310, an Imitation Pilgrim Flask (fig. 7), diameter of 6cm, type MH 1.2 of Nile Silt (1.3) with white wash
- C157292, an Imitation Pilgrim Flask, diameter of 4cm, type MF4.1 of Marl A2 (III.1) with a cream slip.

Figure 6: C157289 Cobra Bowl. Photo: S. K. Doherty.

Imports

- C157291, a Canaanite amphora handle, perhaps type NA 3.4.6
- C157296 a Canaanite amphora handle, type NB 1.2, of Canaanite fabric IV 1a
- C157288, a Canaanite pilgrim flask, just the body, of Canaanite fabric III.10 (Jezreel Valley, S. Levant). It was overfired, and had been painted with three concentric circles of red paint
- C157308, a Canaanite amphora handle, Canaanite IV.9 with cream slip
- C157299, perhaps black ring ware- to be further analysed
- C157304 perhaps black ring ware- to be further analysed.

Figure 7: C157310 Imitation Pilgrim Flask. Photo: S. K. Doherty.

2.5 Study of the wood charcoal (R. Gerisch)

During a stay of three weeks, anthracological studies were carried out on material recovered at M50.14-16 during the autumn season of 2014. Since 1996, wood charcoal had been analysed from different parts of Amarna, from the Main City and Central City up the slope to the Workmen’s Village and Stone Village, accompanied by the study of the present-day vegetation in the floodplain and wadis and use of fuel material. The regular procurement and provision of wood and fuel formed an integral part to sustain everyday life and craftsmen activities in this large-scale settlement region.

The charcoal pieces were broken manually or already existing breaks were used and the wood structure was analysed in the three anatomical planes transverse, tangential, and radial. The taxa were assigned to the genus, species, and family level. In the analysis of remnants of the ancient fuel, the main objective was to provide information on the taxonomic composition of the collected samples and the amounts by which the taxa are represented, especially for contexts associated with Egyptian faience, glass, and metal production where high temperatures are required. The results will be compared with those of the nearby house of Ranefer, the Grid 12 excavations (Kemp and Stevens 2010a and b), and the glass kiln area of house O45.1 (Nicholson 2007). In total, 88 samples of wood charcoal comprising about 3,600 pieces could be examined and documented which were obtained from squares G-3, G-4, H-3, H-5, I-4, I-5, J-3, J-4, K-4, and L-4 of Grid 12 (M50.14-16).

Figure 8: Sample content grouped after microscopic examination (#12, L-4, 15684), scale unit: 1 cm. Photo: R. Gerisch.

Microscopic analysis revealed 13 taxa, native and non-native, of which trees and shrubs grew in the floodplain of the Nile, the gardens on the desert plain, the wadis, and in the woodlands of the eastern Mediterranean region. Identified were: *Acacia nilotica*-type, *Acacia* sp., Chenopodiaceae, *Faidherbia albida*, *Ficus sycomorus*, *Mimusops* sp., *Prunus* sp. (*P. dulcis*), *Salix* sp., *Tamarix* sp., *Ziziphus spina-christi*, and Arecaceae (Palmae). Remnants from woodworking are represented by some pieces of charcoal from *Cedrus libani* and *Quercus* sp., evergreen. By the amount of pieces and volume, charcoal from the Nile acacia is dominating the assemblages, followed by a smaller portion of tamarisk and some pieces of the sycamore fig, mimusops and other taxa which represents the general tendency at Amarna [see fig. 8]. A few charred seeds of *Phoenix dactylifera* were also found, and pieces of the woody endocarp of *Hyphaene thebaica*.

2.6 Flotation (C. Lelek Tvetmarken)

One of the tasks scheduled to be completed during this season's work at Amarna was the processing of the flotation samples that had been collected during the excavation of site M.50 during the 2014 and 2017 seasons.

Materials and Methods

A total of seven soil samples had been collected during the excavation of site M.50 at Amarna; two samples in 2014 and five in 2017 (table 4). The soil samples had been collected, recorded and stored in plastic bags in the storage magazine following their on-site collection.

Sample No.	Grid square	Unit No.	Sample year
14-12	L-4	15785	2014
14-15	I-3	15797	2014
17-1	I-2/J-2	17732	2017
17-3	I-2	17669	2017
17-2	L-2	17744	2017
17-4	I-2	17669	2017
17-5	I-2/J-2	17757	2017

Table 4: Soil samples collected from site M50.14-16 at Amarna.

Based on the small number of soil samples collected and the low soil volume of each sample (see table 5), it was decided that a process using bucket flotation would be employed. Bucket flotation is a simple, portable method for retrieving charred plant remains. The sample—or part of it if the sample is large—is placed in a bucket (max. 3–5 litres of soil), water is added, and the sample is then stirred by hand and any lumps of sediment are gently broken up. After further stirring, the water is then poured over the lip of the bucket into a receiving fine sieve or graded wire mesh (0.50mm or 0.25mm), where the charred plant remains (or light fraction) are caught. More water is then added, the soil is stirred again as described, and the water poured into the receiving sieve. This process should be repeated at least three times for each sample (or portion of a sample). The heavy fraction that remains in the bucket is then poured into a coarser sieve (1mm or 2mm) and washed with water so that only bones, artefacts and stones remain. The latter is then places on a tray (or similar) and left to dry. If a sieve has been used to catch the light fraction, the latter needs to be transferred into a graded nylon mesh for drying. At Amarna, coffee filters were used for drying the light fraction, since no suitable mesh was available. The samples were then hung up on a string line to dry, in a location protected from direct, bright sunlight. This is because if the samples dry too quickly, it can cause the charcoal and charred seeds to crack.

Flotation No.	Sample No.	Site code	Grid	Unit No.	Volume (ml)	Sample date
1	14-12	TA-MC14	L-4	15785	300	09.11.2014
2	14-15	TA-MC14	I-3	15797	650	10.11.2014
3	17-1	TA-MC17	I-2/J-2	17732	600	28.10.2017
4	17-3	TA-MC17	I-2	17669	800	30.10.2017
5	17-2	TA-MC17	L-2	17744	300	30.10.2017
6	17-4	TA-MC17	I-2	17669	250	30.10.2017
7	17-5	TA-MC17	I-2/J-2	17757	100	31.10.2017

Table 5: The provenance information and volume of each flotation sample.

First, the provenance and visual characteristics of the soil were recorded for each sample. The former was noted in a spreadsheet and the latter on the relevant unit sheets, adding to the information documented during the excavation. The soil was then measured and the volume recorded in the same spreadsheet as the provenance information (Fig. 2). Initially, the first two samples (Flotation Nos. 1 and 2, both collected in 2014) were dry sieved using a 1mm sieve and the charred plant remains that were caught in the sieve were hand-picked using tweezers. This was done as a precaution in case the charred material would disintegrate in contact with water as this has been known to occur with flotation samples from other sites in regions with similar environmental and preservation conditions. However, during the flotation of these two samples it became clear that the charcoal and charred seeds did not break down in contact with water. It was therefore decided that the remaining five samples should not be dry sieved before flotation.

Flotation No.	Flotation light fraction	Dry sieving(*)	Heavy residue			
			Charcoal	Bones	Pottery	Metal
1	1	1	1			
2	1	1	1	1	1	
3	1		1	1	1	1
4	1			1	1	
5	1		1	1		1
6	1		1	1		
7	1			1		

Table 6: Types of material recovered from each flotation sample (charred plant remains (Flot, DS and HR), bones and artefacts (HR only)). (*) Only two samples were dry sieved prior to flotation.

When the flotation was completed and the samples had dried, the light fractions were transferred to plastic bags, labelled, recorded and stored in the storage magazine. The heavy residues were sorted, and any charred plant material, bone, pottery and other objects were collected, recorded and stored in the storage magazine (table 6).

3) Experimental manufacture of glass beads

The 2019 work comprised an archaeological experiment (03.11.2019), which belongs to a series of experiments concerned with the reconstruction of ancient domestic glass bead manufacture at Amarna (Hodgkinson and Bertram 2019). While previous work has succeeded in reaching 850° C and above while ventilating the fire with copper blow pipes, the latter were now coated in clay, which served to funnel the air, producing an even hotter working spot in the fire (>1,100° C) and which were baked during the process (fig. 9).

Figure 9: The copper blow pipes with the baked clay coatings. Photo: A. Hodgkinson.

A small number of glass beads (from modern glass) were made during the experiment (Fig. 10), although the organisation of the work and fuel consumption are still being considered and adjusted.

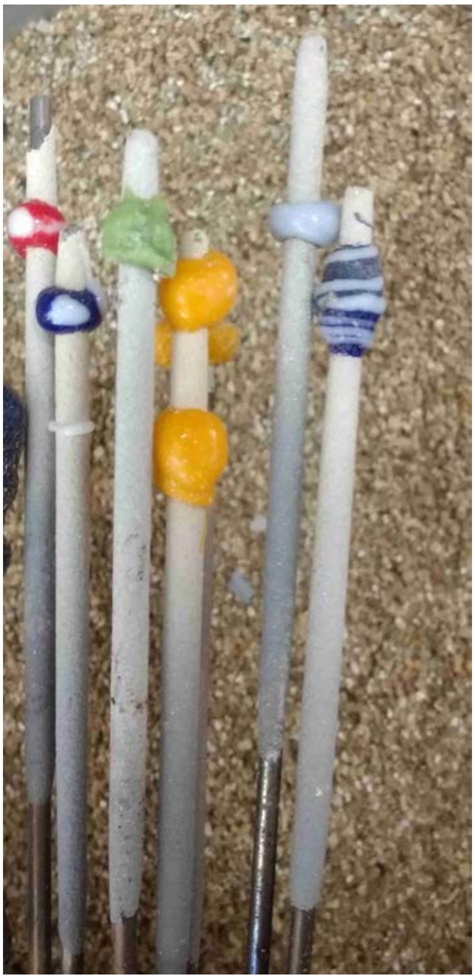

Figure 10: The experimental output: glass beads produced during the experiment, still on their mandrels. Photo: A. Hodgkinson.

4) Summary and conclusions

The ongoing study of the material excavated at site M50.14-16, of the archive of the archaeological fieldwork conducted in 2014 and 2017, and the experimental work continue to deliver data that enhance our understanding of the complex as an urban domestic workshop. Due to the fact that house M50.15 was erected on top of an earlier waste pit (that may initially have been used as a quarry pit), we can conclude that the site forms part of the later urban sprawl of Amarna, post-dating the earlier phases of settlement. Industries carried out at the site during this time include glass-working (and, possibly, production), faience manufacture, metal- and stone-working. The nearby excavations at the house of Ranefer and at Grid 12 in recent years yielded similar material (Kemp and Stevens 2010a and b). Thus, the work at M50.14-16 has enhanced our understanding of the socio-economic structures of the Main City South at Amarna, as well as the architecture and functionality of domestic structures and their involvement in industrial processes at Tell el-Amarna during the Eighteenth dynasty of ancient Egypt.

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Appendix 1: numbers of trays and object categories studied

Tray number given by MSA	Tray number project	Contents
103/2	1	TA-MC 14 #12 Water jar from H-4 (15788)
120/2	4	TA-MC 14 + 17 #12 Blue-painted pottery
113/2	5	TA-MC 14 #12 Pottery (diagnostics, non-industrial)
113/3	6	TA-MC 14 #12 Pottery (diagnostics, non-industrial)
113/1	7	TA-MC 14 #12 Pottery (diagnostics, non-industrial)
108/2	10	TA-MC 14 #12 Organic material: bone
107/1	11	TA-MC 14 #12 Organic material: charcoal
110/2	12	TA-MC 14 #12 Organic material: shells, charcoal
110/1	18	TA-MC 14 #12 Industrial ceramics
112/2	19	TA-MC 14 #12 Glass
112/3	20	TA-MC 14 #12 Small finds: faience, metal, worked agate, worked bone
112/1	22	TA-MC 17 #12 Small Finds (metal, faience, glass, industrial, textile, modern, worked bone)
108/1	23	TA-MC 17 #12 Organic material: bones, shells, fruits
111/111; 110/3	24	TA-MC17 #12 Industrial ceramics
33	25	TA-MC17 #12 Blue-painted vessel 42030 (taken to Ashmunein 07.11.2019)
98/3	26	TA-MC17 #12 Pottery (diagnostics, non-industrial)
98/2	27	TA-MC17 #12 Pottery (diagnostics, non-industrial)
98/4	28	TA-MC17 #12 Pottery (diagnostics, non-industrial)
98/1	29	TA-MC17 #12 Pottery (diagnostics, non-industrial)
98/5	30	TA-MC17 #12 Pottery (diagnostics, non-industrial)
109/3	38	TA-MC17 + 14 #12 Gypsum and soil samples (processed)